



U.S. AIR FORCE



ARCTIC RESOURCE COMPILATION

Economics & Resources and Technology & Materials in the Arctic Region



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Table of Contents

Preface	<u>ii</u>
Economics & Resources	<u>1</u>
1. Canada	<u>7</u>
2. Denmark (Greenland)	<u>24</u>
3. Finland	<u>39</u>
4. Iceland	<u>56</u>
5. Norway	<u>75</u>
6. Russia	<u>91</u>
7. Sweden	<u>116</u>
8. United States (Alaska)	<u>136</u>
9. China (Non-Arctic Country)	<u>157</u>
Technology & Materials	<u>187</u>
1. Canada	<u>195</u>
2. Denmark (Greenland)	<u>209</u>
3. Finland	<u>224</u>
4. Iceland	<u>240</u>
5. Norway	<u>252</u>
6. Russia	<u>265</u>
7. Sweden	<u>288</u>
8. United States (Alaska)	<u>307</u>
9. China (Non-Arctic Country)	<u>330</u>
Endnotes	<u>352</u>
Bibliography	<u>367</u>

Preface

This report creates a catalog of resources for use on the topic “Economics & Resources and Technology & Materials in the Arctic Region.” This catalog of resources is in response to a request by the U.S. Air Force (USAF) Air University (AU) Academic Centers, USAF Culture and Language Center (AFCLC) at Maxwell Air Force Base (AFB), Alabama and is in support of the AFCLC mission.

The mission of the AFCLC is to serve as the USAF focal point for creating and executing programs that sustain career-long development of Linguistically, Regionally, and Culturally competent Total Force Airmen to meet the Service’s global mission. In addition to providing subject matter expertise and support for Air Force Language, Regional Expertise, and Culture (LREC) governance, the AFCLC accomplishes this mission by designing, developing and delivering: 1) LREC familiarization education to AU officer, enlisted, and accessions programs; and 2) pre-deployment training and training products.

As a Research Analyst for Metro Professional Services, the researcher has identified open source material on Economics & Resources and Technology & Materials in the Arctic Region by using multiple sources during his research. This catalog includes academic journal articles, books and other legitimate peer-reviewed, academic resources. Sources are categorized by topic and broken down into relevant sub-topics based on the request of the AFCLC representative or on the discernment of the researcher. Catalog entries include Title, Author, Source, Date and Content Abstract, Summary or Overview that gives the end user a sense of what the author has to say about the selected topic and sub-topic. **The text used in this compilation is taken verbatim from the source, and none of this information is intended to be viewed as a product of AFCLC or Metro Professional Services. Incorporation in this compilation does not constitute endorsement of the source by AFCLC.**

Economics & Resources:

“Economic Resources,” Vaia, 2024 [1]

<https://www.hellovaia.com/explanations/microeconomics/economic-principles/economic-resources/>

Overview:

Economic resources definition

Economic resources are the inputs we use to produce goods and services. Economic resources can be divided into four categories: labor, land or natural resources, capital, and entrepreneurship (entrepreneurial ability). Labor refers to human effort and talent. Natural resources are resources, such as land, oil, and water. Capital refers to man-made equipment like machinery, buildings, or computers. Finally, entrepreneurship involves the effort and know-how to put all the other resources together.

Economic resources are also called factors of production.

Economic resources or factors of production are the inputs into the production process, such as land, labor, capital, and entrepreneurship.

Current & Relevant Information:

Types of economic resources

There are four types of economic resources: land, labor, capital, and entrepreneurship. We will analyze each of them below.

Land

Land constitutes natural resources such as water or metal. The natural environment as a whole is also classified under ‘land’.

Natural resources

Natural resources are sourced from nature and used for the production of goods and services. Natural resources are often limited in quantity due to the time it takes for them to form. Natural resources are classified further into non-renewable resources and renewable resources.

Example:

Oil and metal are examples of non-renewable resources.

Timber and solar power are examples of renewable resources.

Agricultural land

Depending on the industry, the importance of land as a natural resource may vary. Land is fundamental in the agricultural industry as it is used to grow food.

The environment

The 'environment' is a somewhat abstract term that includes all the resources in the surrounding environment that we can use. They primarily consist of:

- Abstract resources such as solar or wind energy.
- Gases such as oxygen and nitrogen.
- Physical resources such as coal, natural gas, and fresh water.

Labor

Under labor, we classify human resources. Human resources not only contribute to the production of goods but also play an essential role in offering services.

Human resources generally possess some form of education and skills. Businesses need to ensure their labor force is capable of conducting the production processes required by providing appropriate training and ensuring the safety of the work environment. However, human resources are also capable of adjusting themselves, because they are a dynamic factor of production. They can increase their productivity to contribute more to the efficiency of production.

In terms of education or training, businesses can source labor from a specific educational background to reduce the training time.

Example:

When hiring for the department of network security, an IT company will look for candidates with an educational background in Computer Science or other similar subjects. Thereby, they do not need to spend extra time on training the labor.

Capital

Capital resources are resources that contribute to the production process of other goods. Hence, economic capital is different from financial capital.

Financial capital refers to money in a broad sense, which does not contribute to the production process, though it is essential for businesses and entrepreneurs to carry on their economic activities.

There are various types of economic capital.

Example:

Machinery and tools are classified as fixed capital. Partly-produced goods (work-in-progress) and inventory are considered working capital.

Entrepreneurship

Entrepreneurship is a special human resource that not only refers to the entrepreneur who sets up a business. It also refers to the ability to come up with ideas that would be potentially turned into economic goods, risk-taking, decision-making, and running the business, which requires the incorporation of the other three factors of production.

Example:

An entrepreneur would need to take the risks of borrowing, renting land, and sourcing appropriate employees. The risk, in this case, involves the chances of not being able to pay the loan due to a failure in the production of goods or sourcing the factors of production.

Economic resources examples

In the table below, you can find examples of economic resources. Keep in mind that these are just a few examples of each category of economic resources, and there are many other resources that could be included in each category. Nonetheless, this table should give you a good sense of the types of resources that are used to produce goods and services in the economy.

Economic resource	Examples
Labour	The work of teachers, doctors, software engineers, chefs
Land	Crude oil, timber, freshwater, wind power, arable land
Capital	Manufacturing equipment, office buildings, delivery trucks, cash registers
Entrepreneurship	Business owners, inventors, startup founders, marketing consultants

“What is a Resource,” Business Standard, 2024 [2] <https://www.business-standard.com/about/what-is-resource>

Overview:

Resources are a kind of supply that can be drawn on by a person or organization in order to function and execute plans and projects. Resources can be in the form of money, material, staff, energy, expertise, time and management, among other things.

Resource is a broad term and its definition varies across fields — economics, biology and ecology, computer science, management, and human resources. In

economics, resource is defined as a service or other asset used to produce goods and services that meet human needs and wants. Also referred to as factors of production, economics classifies resources into four categories — land, labor, capital and enterprise. More recently, technology has also been recognized as a factor of production.

“Economics Defined with Types, Indicators, and Systems,” Adam Hayes, Investopedia, 28 June 2024 [3] <https://www.investopedia.com/terms/e/economics.asp>

Overview:

Economics: A social science concerned chiefly with description and analysis of the production, distribution, and consumption of goods and services.

Current & Relevant Information:

What Is Economics?

Economics is a social science that focuses on the production, distribution, and consumption of goods and services. The study of economics is primarily concerned with analyzing the choices that individuals, businesses, governments, and nations make to allocate limited resources. Economics has ramifications on a wide range of other fields, including politics, psychology, business, and law.

Understanding Economics

Assuming humans have unlimited wants within a world of limited means, economists analyze how resources are allocated for production, distribution, and consumption.

The study of microeconomics focuses on the choices of individuals and businesses, and macroeconomics concentrates on the behavior of the economy as a whole, on an aggregate level.

One of the earliest recorded economists was the 8th-century B.C. Greek farmer and poet Hesiod who wrote that labor, materials, and time needed to be allocated efficiently to overcome scarcity. The publication of Adam Smith's 1776 book, *An Inquiry Into the Nature and Causes of the Wealth of Nations* sparked the beginning of the current Western contemporary economic theories.

Microeconomics

Microeconomics studies how individual consumers and firms make decisions to allocate resources. Whether a single person, a household, or a business, economists may analyze how these entities respond to changes in price and why they demand what they do at particular price levels.

Microeconomics analyzes how and why goods are valued differently, how individuals make financial decisions, and how they trade, coordinate, and cooperate.

Within the dynamics of supply and demand, the costs of producing goods and services, and how labor is divided and allocated, microeconomics studies how businesses are organized and how individuals approach uncertainty and risk in their decision-making.

Macroeconomics

Macroeconomics is the branch of economics that studies the behavior and performance of an economy as a whole. Its primary focus is the recurrent economic cycles and broad economic growth and development.

It focuses on foreign trade, government fiscal and monetary policy, unemployment rates, the level of inflation, interest rates, the growth of total production output, and business cycles that result in expansions, booms, recessions, and depressions.

Using aggregate indicators, economists use macroeconomic models to help formulate economic policies and strategies.

“Land,” Editors of Encyclopaedia Britannica, Britannica Money, 18 August 2023

[4] <https://www.britannica.com/money/land-economics>

Overview:

Land, in economics, the natural resource used in production. In classical economics, the three factors of production are land, labor, and capital. Land was considered to be the “original and inexhaustible gift of nature.” In modern economics, it is broadly defined to include all that nature provides, including minerals, forest products, and water and land resources. While many of these are renewable resources, no one considers them “inexhaustible.” The payment to land is called rent. Like land, its definition has been broadened over time to include payment to any productive resource with a relatively fixed supply.

“Natural Resource Economics,” USDA: National Institute of Food and Agriculture, 2024 [5] <https://www.nifa.usda.gov/topics/natural-resource-economics>

Overview:

The long-term viability of the food supply depends upon the sustainable use of natural resources. Unlike most agricultural inputs, such as fertilizer or animal feed, most natural resources do not have prices determined in the market. The field of Natural Resource Economics seeks to value natural resources to aid in the optimization of the production of goods and services from agricultural lands while protecting the environment.

Current & Relevant Information:

Importance of Natural Resource Economics

Successful stewardship of the land entails understanding the complex interrelationships between environmental and market forces. Research is pursued to understand why producers adopt sustainable technologies and identify incentives as well as costs and benefits to producers and the environment.

Resource economists provide science-based information to help agriculture producers balance production demands with elements central to agricultural sustainability, including:

- Maintenance and improvement of air and soil quality
- Adaptation and management of climate change dynamics
- Efficient use of surface and groundwater supplies
- Maintenance of landscape vistas, wild plant and animal habitats, and recreational areas

Natural resource economics also demonstrates how policy incentives might motivate better choices by agriculture producers and makes predictions about the potential side effects of those choices.

“Arctic Ocean Economy,” National Ocean Economics Program, 17 March 2015 [\[6\] https://www.oceaneconomics.org/NOEP/Arctic/#:~:text=The%20NOEP%20analyzes%20the%20economic,taking%20place%20in%20the%20Arctic.](https://www.oceaneconomics.org/NOEP/Arctic/#:~:text=The%20NOEP%20analyzes%20the%20economic,taking%20place%20in%20the%20Arctic.)

Overview:

Eight nations border the Arctic- the US, Canada, Greenland, Iceland, Norway, Sweden, Finland and Russia- as well as 15,558,000 square kilometers of oceans. Many other nations use its waters. Climate change is causing massive alterations in the environment, including vast ice melt, leading to expanded, new and developing industries in previously undeveloped areas.

As the Arctic environment undergoes dramatic changes, NOEP is tracking the expansion of economic activity, and how this activity will impact the already shifting natural environment. We provide a full range of the most current economic, socioeconomic and natural resource information available on the changes and trends across the Arctic.

Our goal is to link nature, scope, and value of human activities to the Arctic by presenting useful information on the economics and the natural and social resources of the Arctic.

The NOEP analyzes the economic contribution of the Arctic by economic sector and geography over time, and serves the needs of decision-makers and the public by assisting with investment and management decisions that strive to balance conservation, preservation, and the growth taking place in the Arctic. Our data will,

over time, reveal “hot spots” of risk, where economic activity(ies) clashes with high value marine life and other natural assets to cause concern.

Current & Relevant Information:

Arctic Natural Resources

The natural resources of the Arctic are the mineral and animal resources within the Arctic Circle that can provide utility or economic benefit to humans. The mineral resources include major reserves of oil and natural gas, large quantities of minerals including iron ore, copper, nickel, zinc phosphates and diamonds. Living resources of the Arctic are primarily the abundant fisheries.

Living Resources

Arctic Fisheries Arctic Fisheries

Since 2011, over 8 million metric tons have been harvested from Arctic waters each year for commercial, artisanal, subsistence, and recreational uses, after declining from its peak of 17 million tons in 1968.

Arctic Mineral Resources

Arctic Oil & Gas

With declining prices, high risks, and disappointing exploratory results, only a few oil and gas companies remain interested in the Arctic, while production in the region remains steady at best, and except for Russia, may be in decline for the near future.

Arctic Minerals

Mineral Resources, while abundant in the Arctic regions need infrastructure to increase sites and production. Currently generating impressive revenues, mining practices often threaten the fragile Arctic environment. The most popular minerals include coal, iron ore, zinc, lead, nickel, precious metals, diamonds and gemstones.

Arctic Aggregates Production

Rock, stone, sand and gravel are mined throughout the Arctic region for a variety of construction projects onshore and off. As development increases, production of these resources will probably increase as well.

1. Canada:

“Canadian Arctic Capabilities by Sector – Canada,” Government of Canada, 16 January 2017 [7] <https://www.international.gc.ca/gac-amc/institution/tcs-sdc/publications/cacg-gcac/cacg-gcac.aspx?lang=eng>

Overview:

The intent of this new Canadian Arctic Capabilities Guide is to communicate information about the range of Arctic capabilities found in Canada—as well as exports of northern origin—in a comprehensive manner that encompasses most sectors. Our hope is that it will complement other publications, particularly directories of the many local and regional chambers of commerce and sector associations across Canada, and lead to greater exchanges of knowledge, expertise, products and services, and foster enhanced cross-fertilization between sectors.

The guide is organized by sector. Each sector comprises a broad overview of Canadian Arctic capabilities in that sector, and a listing containing brief profiles of companies and organizations with Arctic capabilities and who are interested in pursuing business opportunities internationally. Several companies and organizations are of northern origin. Users of the organizational listings should be mindful that each sector profiles only those companies that have identified the particular sector as its primary sector of focus. Notes have been inserted at the bottom of some sectors to cross-reference other companies listed in the guide with capabilities in that sector. In addition, a number of success stories are showcased throughout. The organizational listings and the success stories are not exhaustive, nor are they to be considered an endorsement. However, they do provide a representative exposé of the vast scope and quality of Canada's Arctic capabilities.

The development of this guide was led and coordinated by the Canadian International Arctic Centre (CIAC), in partnership with the Canadian Trade Commissioner Service (TCS) at Global Affairs Canada.

Current & Relevant Information:

Introduction

The Arctic makes up 40 percent of Canada's landmass, and is an essential part of our collective heritage and future. Economic and business development in Canada's Arctic, and in its sub-Arctic regions, has been shaped by a number of historical drivers that have resulted in a wide range of Arctic expertise across sectors.

Canada's Arctic capabilities are reaching new heights as a result of today's pursuit of enhanced scientific understanding, sustainable resource development and Arctic maritime readiness. Commercial opportunities are further advancing clean technology and renewable energy solutions, earth observation technologies and services, among many other areas of expertise.

Arctic know-how and competence are not only born out of or destined to the circumpolar Arctic. Each Canadian province has developed its own unique range of capabilities to address Arctic-like challenges locally. Although all provinces and territories have their particular strengths, a common thread spanning sectors across the country is a deep commitment to scientific research and education, technological innovation and sustainable economic development.

Canada's North is home to more than 100,000 people, many of whom are Indigenous and whose traditional livelihoods—including hunting, fishing, and arts and crafts—have long been the lifeline of the northern economy. Rooted in tradition, these economic activities will continue to be a mainstay. However, creativity, adaptability and resourcefulness are defining qualities of northern inhabitants, and have propelled not only cultural and creative industries—but all sectors—toward a more varied economy that embraces innovation and technological advancement.

“Arctic and Northern Policy Framework,” Government of Canada, 22 September 2022 [8] <https://www.rcaanc-cirnac.gc.ca/eng/1560523306861/1560523330587>

Overview:

The Arctic and Northern Policy Framework is a profound change of direction for the Government of Canada. For too long, Canada's Arctic and northern residents, especially Indigenous people, have not had access to the same services, opportunities, and standards of living as those enjoyed by other Canadians. There are longstanding inequalities in transportation, energy, communications, employment, community infrastructure, health and education. While almost all past governments have put forward northern strategies, none closed these gaps for the people of the North, or created a lasting legacy of sustainable economic development.

In her 2016 Interim Report on the Shared Arctic Leadership Model, Minister's Special Representative Mary Simon said, "the simple fact is that Arctic strategies throughout my lifetime have rarely matched or addressed the magnitude of the basic gaps between what exists in the Arctic and what other Canadians take for granted."

Co-developing the new framework became a bold opportunity to shape and direct change in the region by collaborating with governments, northerners and Indigenous governments and organizations. Consultation was not enough to meet the challenges and harness emerging opportunities in the Arctic and North. In a significant shift, the federal government, Indigenous peoples, Inuit, First Nations and Métis, 6 territorial and provincial governments (Yukon, Northwest Territories, Nunavut, Newfoundland and Labrador, Quebec, and Manitoba) contributed to this framework together.

A shared vision

Today, there is a shared vision of the future where northern and Arctic people are thriving, strong and safe. The Arctic and Northern Policy Framework gives us a roadmap to achieve this vision. There are clear priorities and actions set out by the federal government and its partners to:

- nurture healthy families and communities
- invest in the energy, transportation and communications infrastructure that northern and Arctic governments, economies and communities need

- create jobs, foster innovation and grow Arctic and northern economies
- support science, knowledge and research that is meaningful for communities and for decision-making
- face the effects of climate change and support healthy ecosystems in the Arctic and North
- ensure that Canada and our northern and Arctic residents are safe, secure and well-defended
- restore Canada's place as an international Arctic leader
- advance reconciliation and improve relationships between Indigenous and non-Indigenous peoples

Current & Relevant Information:

On the front lines of climate change...

The Canadian North is warming at about 3 times the global average rate, which is affecting the land, biological variability, cultures and traditions. At the same time, climate change and technology are making the Arctic more accessible.

The region has become an important crossroad where issues of climate change, international trade and global security meet. As melting sea ice opens shipping routes, it is also putting the rich wealth of northern natural resources within reach. Increased commercial and tourism interests also bring increased safety and security challenges that include search and rescue and human-created disasters.

By forging new partnerships, the framework will help address the massive implications of climate change for individuals, communities, businesses and governments alike, and ensure a more sustainable future for northerners.

...and a changing world

Unlike previous Arctic and northern policies, the framework better aligns Canada's current national and international policy objectives with the priorities of Indigenous peoples and of northerners. As the region undergoes rapid environmental change and international interest surges, Canada must demonstrate renewed Arctic leadership.

The Government of Canada will continue to support the co-operative, rules-based international order that has served national and global interests by fostering peace, security and stability for the circumpolar Arctic. Canada will also continue to ensure that the Canadian Arctic and North and its people are safe, secure and well defended. As part of achieving this goal, Canada has committed to increasing Search and Rescue reaction and responsiveness to emergencies for Arctic residents and visitors.

Our future

The Arctic and Northern Policy Framework is ambitious and has just over 10 years to translate its goals and objectives into reality. In that time, the Government of Canada and its partners will close the gaps that exist between this region, particularly in relation to its Indigenous peoples, and the rest of the country.

Canada sees a future in which the people of the Arctic and North are full participants in Canadian society, with access to the same services, opportunities and standards of living as those enjoyed by other Canadians. This ambition will require greater effort, focus, trust and collaboration amongst partners.

Other circumpolar nations are making significant investments to make their Arctic regions part of the global community. Supporting Canadian initiatives to keep pace with international efforts will bring increased opportunities, health and well-being to Indigenous peoples and northerners.

Indigenous and Northern leaders have offered their best innovative, adaptive policy solutions that call for trust and transparency. We can do no less than to respond with integrity, collaboration and openness. Building on these new partnerships, the Arctic and Northern Policy Framework provides a long-term foundation for transformative change, benefiting our Arctic, its Indigenous peoples, northern residents and all Canadians.

Our present

Longstanding inequalities in transportation, energy, communications, employment, community infrastructure, health and education continue to disadvantage people, especially Indigenous peoples, in Canada's Arctic and North. These gaps are evident in the socio-economic statistics and indicators for the region, and closing them is a priority for all partners.

A distinctive feature of the region is its high proportion of Indigenous people in the population. This includes Inuit, First Nations and Métis populations. The manner in which the Government of Canada interacts with Indigenous peoples continues to evolve.

The Principles Respecting the Government of Canada's Relationship with Indigenous Peoples affirm that "The Government of Canada's approach to reconciliation is guided by the United Nations Declaration on the Rights of Indigenous Peoples, the Truth and Reconciliation Commission's Calls to Action, constitutional values, and collaboration with Indigenous peoples as well as provincial and territorial governments." Inuit and the federal government have developed the Inuit Nunangat Declaration and formed an Inuit-Crown Partnership Committee to jointly advance shared priorities. These include the implementation of Inuit land claims agreements, and the implementation of reconciliation measures between Inuit and the Government of Canada.

The federal government agrees with the people of the Arctic and the North that they must play a greater part in governing the region — domestically and internationally. In addition to land claim and self-government agreements, devolution agreements have been signed with the Northwest Territories and Yukon, transferring some authorities to their respective territorial governments, and another such agreement is being negotiated with Nunavut. Relationships that better recognize the rights and aspirations of people in the region have also been negotiated with sectors other than government. Benefit and partnership agreements with local communities have been developed in the resource sector, and successful partnerships have been established with researchers, and with non-governmental organizations.

The Arctic and North has what is described as a mixed economy: some people depend on traditional economies of hunting, fishing, and gathering, others depend on a wage economy, and some depend on both. The cultures and lifestyles of the peoples of the region provide them not only with subsistence and cultural continuity and strength, but also a bridge to the wage economy.

Despite the poor communications infrastructure in many communities, connectivity is increasingly important to the region.

- Students in Nunavut can connect to students throughout Inuit Nunangat
- A telehealth network links 14 Yukon communities
- Yellowknife's booming tourism industry is transformed by visitors' social media posts
- Telehealth is providing an opportunity to close gaps within the care provided to patients in Labrador
- Remote presence technology is allowing people on the northern coast of Labrador to receive some health-care services in their home communities

However, though there have been significant advances, many northern communities still have slow internet connections and no cell phone service, and priority within networks must be kept for vital services such as telehealth.

Responsible, sustainable resource development and job creation are key to the economy of the region, and a source of prosperity for its communities and residents. Indigenous-owned businesses have for many years been providing resource industries with workers and services, and now Indigenous peoples are also moving into ownership positions in resource development businesses. Indigenous ownership, investment and participation in the resource industry are essential to the success of this sector and a means of economic reconciliation with Indigenous peoples.

Resource projects provide:

- education
- training and employment opportunities in communities

- direct Indigenous participation in supply and services business development

Looking to the future, there is no force likely to reshape the Arctic and the North greater than climate change. Globally, the region is amongst the most affected by climate change, which is redefining the environmental, social and economic landscape, both below the tree line and on the tundra. Arctic ecosystems are at a disproportionately high risk of experiencing the adverse effects of global warming.

The circumpolar Arctic is warming 2 to 3 times more rapidly than the global average, even though the region is not a leading source of greenhouse gas emissions. According to Canada's Changing Climate Report, 2019, northern warming will continue for both low and high global greenhouse gas emission trajectories. The high scenario projects that annual average temperatures could increase 4 times as much as under the low scenario, and that events such as extreme precipitation could be 4 times as common.

Both scenarios would see accelerating loss of seasonal sea ice across Canada's Arctic, with extensive sea ice-free periods projected by mid-century for the Canadian Arctic and Hudson Bay, thawing permafrost causing irreversible changes to the landscape, a changed distribution of species, changing patterns of precipitation and more frequent wildfires.

Indigenous communities are particularly affected: traditional food sources are disappearing; ice conditions are becoming unpredictable and therefore dangerous for travel by hunters using either dogsled or snowmobile; and melting ice and rising sea levels are exposing communities to destructive coastal erosion and costly damage to infrastructure.

The greenhouse gases driving climate change are also making the water more acidic, which has been shown to have negative effects on some marine life. Considering the depth and irreversible nature of changes brought about by climate change in the region, Indigenous peoples are finding their cultural and social well-being affected at unprecedented rates.

For peoples closely connected to the land, ways of knowing are challenged to keep pace with the change around them. This is affecting cultural and social norms, such as engaging youth on the land, accessing country foods, gathering medicinal plants and protecting water sources. Indigenous communities need tools and knowledge that are locally and culturally appropriate to adapt to these urgent issues.

If there is a single argument for a collaborative approach to a shared Arctic and northern future, it is the shared and complex challenges posed by climate change. The response of all partners to this challenge must be no less transformative in scale, scope or duration.

As the sea-ice pack recedes and cold-weather technologies improve, the Arctic and the North region are also becoming increasingly accessible for a broad range of activities, including:

- fishing
- tourism
- scientific research
- shipping, both small and large vessels
- other commercial activities

Increasing numbers of domestic and international resource developers are being drawn to the region, resulting in a mix of optimism about economic prospects and concerns about potential environmental, social and security impacts. Higher levels of activity also increase the acute security risks associated with irregular movements of people and goods, the pursuit of foreign interests and human-induced disasters. As a whole, these changes highlight the importance of enhancing situational awareness across the region, and of promoting research and observation, including charting and mapping, that will provide the information necessary for sound decision-making.

A collaborative approach to climate change research is underway in the region, bringing together Inuit organizations, northern communities, federal and provincial agencies and the private sector. This effort is directed at understanding how climate change will affect communities and biological variability. However, the current lack of baseline data poses major challenges to evidence-based decision-making. The responsible use of data can help cultivate a better understanding of the 'big picture' of environmental issues, contributing to the development of informed, data-driven policy and decisions that can help Arctic and northern communities build resiliency in the face of climate change.

“The Emerging Economy of the North American Arctic,” Jessica M. Shadian, Arctic 360, November 2018 [9]

<https://www.ourcommons.ca/Content/Committee/421/FAAE/Brief/BR10185960/br-external/ShadianJessica-e.pdf>

Summary:

This brief makes the argument that the most effective way for Canada to protect and strengthen its Arctic sovereignty is to turn attention to the critical need for infrastructure investment in the Canadian North. Rather than having a conversation about whether or not Russian battleships and submarines are making their way to Canada’s North, the geopolitical conversation about Canada’s Arctic sovereignty should be about building a strategy that lays out a long-term vision not only for the North in and of itself – but as part of a grander vision of the future role of Canada in global politics and economics and what the North has to offer in that respect.

This brief presents the argument as following: It begins by laying out the current state and consequences of the Infrastructure Gap in Northern Canada. It then turns to investments and developments being made by other Arctic countries with respect to their own Northern regions. The following section looks specifically at the state of private investment in the Canadian North, which is then compared to several non-Arctic countries' existing and planned investments in the region. Taking these factors together, this brief then makes the case that a comprehensive Infrastructure Investment Analysis for the North American Arctic is imperative. Such an Analysis would actively encourage Canadian investors to find ways to put their capital in the Canadian North. At the same time, it would set out the terms for foreign direct investment in the Canadian North and by doing so would reaffirm to the global community that Canada is a Northern nation and takes its North seriously. Lastly, this brief looks at the current focus of the Canadian Federal Government on the Northern Infrastructure gap in a global context to point to the existing foundations for the Federal Government to build this discussion upon.

Current & Relevant Information:

Introduction

It is difficult to argue the contrary; the Arctic has become a region of global interest. Climate change has led to an emerging new blue ocean at the top of the world. That factor coupled with the region's well-established mineral potential, prospective gas resources, the increasing capacity to transform global maritime trade, and its physical geography as the epicenter for climate science, is remaking the Arctic from a frozen periphery into a region of immense global geostrategic and economic significance.

Unlike the well-developed Nordic Arctic, the increasingly re-developed Russian Arctic, and despite being part of the OECD, historical legacies (from the perilous effects of colonization to the Cold War) and the lack of a persistent development strategy has left the North American Arctic (Alaska, Northern Canada and Greenland) far behind its Arctic neighbors as well as the region's own southern capitals. This collision of two forces – stagnant and undeveloped economies and increasing global interests in the region has, subsequently, turned the North American Arctic into an emerging economy more akin to emerging economies elsewhere in the world than to the economies of the countries of which they are a part.

In the North American Arctic, infrastructure including roads, housing, ports, SAR, fiber optic cable, and other necessary components of a basic economy (much less a prosperous economy) have been unevenly developed at best and in some instances are lacking altogether. When it comes to Canada in particular, the Canadian national discourse about its own North and the significant infrastructure deficit that persists is rarely, if ever, discussed in the context of the human and economic value that the

North has to offer. The economic potential of the North and how it can fit into Canada's role in the world is woefully disregarded. Instead, the Canadian Arctic is most often viewed solely as an aspect of the Federal Government's social obligations, rather than a significant economic opportunity.

The lack of infrastructure in the Canadian North, consequently, contributes directly to astronomical food prices for those items able to reach Northern supermarkets. Many Arctic Canadian families cannot even meet their basic food needs. Seven out of 10 Nunavut Inuit preschool children are food insecure and have limited access to fresh foods. Likewise, many Northerners are reliant on substandard K-12 education, have insufficient access health care, suffer from severe housing shortages, are denied access (due to the lack thereof) to the Internet, rely on rationed diesel for their energy needs, and lack potable water.

Likewise, the severe shortage of roads means that air travel is often the only mode of transportation in and out of many rural communities. Unfortunately, many of the airports that do exist only have gravel runways. Canada's North, much like the entire North American Arctic, is also critically deficient of major deep-water ports, and particularly year-round deep-sea ports.

The Canadian North is also home to a wealth of natural resources from expected gas reserves, its rich fisheries, and mineral resources such as cobalt, nickel, copper and others that are increasingly accessible and critical to the transition to a global renewable resource economy. However, the combination of lack of infrastructure, reliance on diesel, and limited internet connectivity increases the costs of the North's mineral production by 30 percent, rendering much of this potential uncompetitive in global markets and unavailable to help foster prosperous and self-sufficient Northern economies.

There is nothing fundamental that prohibits the development of Canada's North. Rather, the greatest obstacle to the economic development of the Canadian North and its prosperity is the limited vision that Canadians have about the value of its North. Those limits have played themselves out in numerous ways from affecting the health, well-being, human rights, and economic opportunities of those that live there to undervaluing the contributions that the North can make towards Canada's economic prosperity and global geopolitical significance.

Though visions of the prospects for the Canadian North - from former Prime Minister Lester B. Pearson's 1946 vision of the North as 'a land of the future' to former Minister of Northern Affairs and National Resources, Arthur Laing's 1966 'Road to Resources' concept - are sprinkled throughout the 20th century, those visions never equated into a long-term strategy or accompanying financing to see through the necessary infrastructure development required to realize those visions. In his 2016 report, David Emerson, Former Minister of International Trade, wrote that throughout

Canada's history 'northern infrastructure projects have been built on an ad hoc basis without a long-term cohesive plan or links to trade and travel corridors'.

“Canada: Economy,” The Arctic Institute, 1 January 2024 [10]
<https://www.thearcticinstitute.org/countries/canada/?cn-reloaded=1>

Overview:

Facts & Figures

AC member since 1996

Active Polar Icebreakers

6 (1 under construction)

Coordinates

Ottawa, ON: 45.4215° N, 75.6972° W

Iqaluit, NU: 63.7467° N, 68.5170° W

Population

Canada: 39.95 million (2024 estimate)

Northern Territories: 142,000

Land Area

Canada: 9.985 million km²

Northern Territories: 4.051 million km²

Coastline

162,000 km

Current & Relevant Information:

Alongside health and social issues, economic development dominates discussion in the north. Rich in resources ranging from oil and gas to fish and diamonds, the exploitation of these resources is seen by some as a solution to the high levels of unemployment in northern Canada and a path to a higher quality of life. Today mining (diamonds, gold, silver, lead, zinc), the public sector (government, social and health services), and the service industry (including tourism), are the three main sources of employment in Canada's Arctic. Despite flirting with the idea of oil and gas extraction in the region, commercial exploitation has been slow to materialize due to a lack of infrastructure, environmental concerns, conflicting stakeholder interests and, more recently, the low price of oil. The Norman Wells field in the Northwest Territories remains the only producing oil well in Canada's Arctic, although production has been suspended since 2017 due to a damaged pipeline.

Another important sector is that of traditional or subsistence economies. These activities are woven into the cultural fabric of many Indigenous communities and continue to play an important role in providing for their livelihoods. Although this aspect of the northern economy is often overlooked by traditional economic studies, Statistics Canada estimates that roughly \$40 million dollars of country (traditional) food is produced each year. The importance of these traditional economies resonates at the international level, as evidenced by the dispute between Canada and the European Union over the latter's ban on the trade of seal derived products. Concerns remain as to the impact of large scale extractive projects on these traditional activities.

Intimately linked to issues of sovereignty and identity, resource development in Canada's North has long been a priority. Beginning with the 1898 Klondike Gold Rush and continuing throughout the World Wars, Diefenbaker's drive for development during the 1950s, and the rise of opencast mining in the 1960s, resource development in Canada's north has been one-part economic development and one-part nation building. Given the low prices of raw materials, the high costs of operation in Canada's Arctic, a lack of infrastructure, and growing concerns over the environmental impact of these industries, most projects in the works have been put on indefinite hold. The implications of this are felt across many northern communities reliant on extractive industries for employment opportunities. Striking a balance between economic development and a multifaceted approach to sustainability, on the terms set by northern stakeholders, will be one of the key challenges going forward.

“The Arctic Policies of Canada and the United States: Domestic Motives and International Context,” SIPR, July 2012 [11]

<https://www.sipri.org/sites/default/files/files/insight/SIPRIInsight1201.pdf>

Summary:

The melting polar ice creates a fundamentally new geopolitical situation in the Arctic that warrants attention at both national and international levels. While the United States is just waking up to these changes, Canada has made the Arctic a top political priority.

Both countries need to pay attention to the challenges in the Arctic but should also be wary of how their domestic posturing in the region is affecting their international relations, including with each other. The abilities of Canada and the USA to pursue their interests in the region will rely on them cooperating closely, not least because from 2013 they will hold successive chairmanships of the Arctic Council.

Canadian–US relations will thus be an important factor in the future of a changing Arctic. Resolving key disagreements and identifying common priorities would strengthen both countries' positions in the region.

Current & Relevant Information:

Introduction

The Arctic ice is melting. If current trends continue, there will be dramatic changes in the region, with far-reaching implications. At the same time, the receding ice opens the region to economic development, including through the exploitation of previously inaccessible hydrocarbons and minerals. In September 2011, both the Northern Sea Route (along Russia's north coast, formerly known as the Northeast Passage) and the Northwest Passage (along the northern coasts of Alaska and Canada) were open for some time, potentially creating shorter shipping routes between Asia, Europe and North America. Increased human activity in the sparsely populated and inhospitable Arctic requires new initiatives to achieve safety and security for the region's environment and its inhabitants and visitors.

The nature of international governance in the Arctic has also changed, mainly through the development of the Arctic Council. The Council, which includes the eight states with Arctic territory and representatives of the region's indigenous populations, has evolved into a decision-making organization with a permanent secretariat and budget and it now attracts more attention from the rest of the world. Since 2006, three successive chairmanships of the Council have been held by Nordic states—Norway (2006–2009), Denmark (2009–11) and Sweden (2011–13)—which agreed on a common set of priorities to pursue. From 2013 it will be chaired by Canada (2013–15) and then the United States (2015–17) and there is now an opportunity for these two states to formulate a coordinated North American agenda for the Arctic Council. However, this approach will be hindered by the two countries' disagreements on several key Arctic issues.

Many features of Canadian and US societies are intimately intertwined. The two countries share the world's longest international border; each is the other's most important trading partners; and they work together militarily, both multilaterally through the North Atlantic Treaty Organization (NATO) and bilaterally through the North American Aerospace Defense Command (NORAD). Their bilateral relationship has often been the defining factor in their respective Arctic policies, yet despite their apparent similarities, they have adopted substantially different approaches to the Arctic region. While the two countries' different Arctic geographies account for many of the differences, other factors contribute to both differences and similarities. Among these, domestic factors should not be underestimated. The Arctic is a relatively low priority issue for the USA among the range of international challenges that it faces. The top levels of US leadership may pay attention to the region, but the Arctic is not in the minds of the US public and is thus not a politicized issue. Canada, in contrast, has made the Arctic a top national priority, closely linked to Canadian identity and sovereignty. This paper explores how the domestic motives for the Arctic policies of Canada and the USA have an impact on their foreign policies and how their bilateral interaction shapes the wider context of Arctic relations. Section II

describes the Arctic foreign policies of the two states with reference to three specific areas: security, governance and economic development. Section III outlines the complex relationship between domestic politics and Arctic foreign policy in each country. Section IV discusses the effect of Canadian–US relations on their Arctic policies. Section V presents conclusions.

**“Canada has created an Arctic conservation zone almost as big as Germany,”
Johnny Wood, World Economic Forum, 8 August 2019 [12]**

<https://www.weforum.org/agenda/2019/08/canada-has-created-an-arctic-conservation-zone-almost-as-big-as-germany/>

Overview:

Canada’s Inuit people, whose lands occupy the remote northeastern region of Nunavut, live in an Arctic wilderness of raw natural beauty that is now under threat from climate change.

Prime Minister Justin Trudeau has just turned the area into one of the world’s largest conservation areas, to counter the effects of rising temperatures on Arctic marine life and the indigenous people that call it home.

The initiative aims to build a conservation economy, which pairs environmental concerns with economic opportunities for local communities. New jobs will be created, accompanied by stewardship programs aimed at boosting monitoring and conservation of both the land and cultural sites.

In designating the new zone, Trudeau claims to have exceeded his government’s target of protecting 10% of Canada’s marine and coastal areas by 2020, reaching 14% a year ahead of schedule.

Current & Relevant Information:

Promoting environmental marine conservation by establishing conservation zones is in stark contrast to Canada’s decision to build the controversial Trans Mountain oil pipeline extension.

The Canadian government has committed billions of dollars to the project, which would carry crude oil from inland Edmonton across British Columbia to the port of Burnaby, on the west coast.

Transporting the oil to the markets of Asia, instead of the US, would significantly increase shipping in the Pacific Ocean, disrupting the area’s marine ecosystems.

While approving the project, the National Energy Board concluded that increased shipping was likely to adversely affect the Southern Resident killer whale population, while exacerbating global warming by fueling a significant rise in greenhouse gas emissions.

The last four years have been the warmest ever recorded, according to NASA. Without urgent action to reverse man-made climate change, summer Arctic Sea ice could soon retreat for the last time.

“Arctic economy within the Arctic nations,” Helen McDonald, Solveig Glomsrød and Ilmo Mäenpää, *The Economy of the North* [13]

https://www.ssb.no/a/english/publikasjoner/pdf/sa84_en/kap4.pdf

Overview:

In his book on the history of wealth and poverty of nations, Harvard professor David S. Landes devoted the introductory chapter to highlighting how natural conditions in the tropics represent serious barriers towards economic development. He did not consider the Arctic in the same context but the Arctic environment is generally seen as an even bigger challenge to livelihood than the tropics. Over the years people seem to have voted with their feet in this matter, while the tropics abound with people, the Arctic is sparsely populated. The 10 million people who currently live in the Arctic Region, what do they do for a living? To live in the Arctic, people must have their very special reasons, the remaining 99.8 per cent of the world population might easily think. One clear reason is the attraction of people and investments to natural resources. Another is the fascination of the qualities of nature, shifting from extreme and blending grandeur to darkness and stillness.

These special reasons should be reflected in the structure of the Arctic economy, indicating the extent to which nature in the Arctic has had its say in shaping the economy of the north. This chapter provides an overview of the predominant economic characteristics and the major industries of the Arctic regions within the Arctic nations. It also provides information about the contribution of the Arctic regions to the economy of the respective Arctic nations. Thus, for the most part, the information in this chapter is viewed from an intra-national rather than a comparative international perspective, although some comparisons among the regions are made in the concluding remarks to this chapter.

While there is significant economic variation across the Arctic regions of the Arctic countries, many of these regions host large resource-based industries. In many cases, resources produced in the Arctic are shipped outside the Arctic region to export markets or southern markets within the same country. At the same time, the Arctic regions tend to draw extensively on southern markets for specialized and professional labor, capital, and consumer products. While Arctic regions generate income and resource rent from natural wealth, they also receive transfer payments from national governments. In some Arctic regions resource exploitation generates economic activity within the region in the form of the construction and operation of pipelines, and the provision of services such as transportation, wholesaling and retailing and housing. With some exceptions, manufacturing activity tends to be limited in Arctic regions. The electronics industry in Oulu in Northern Finland and the

industrial sectors in Northern Russia and Northern Sweden are exceptions to this and the data presented in this chapter illustrate the variability in economic structure among Arctic regions that is frequently overlooked when the Arctic economy is discussed.

For each of the Arctic regions this chapter contains a core table showing regional gross domestic product (GDP) and the contribution to regional GDP by industry at a disaggregated level (for 17 industries). This level of detail is intended to capture all the main activities of the circumpolar Arctic region. The data for the Arctic excluding Russia are based on national statistics and World Development Indicators of the World Bank. Arctic Russian data by main industry are provided by Russia's Federal State Statistical Service and further harmonized with statistics for other Arctic regions using production and employment statistics. These core tables generally refer to the year 2002, which represents a compromise between coverage and timeliness. The tables present value added or contribution to GDP in local currency in order to focus on the Arctic element of their respective national or federal economies. Where available some more recent economic indicators are presented.

Current & Relevant Information:

For purposes of this report, the Canadian North is defined as the three Northern Territories, namely, Northwest Territories, Yukon Territory and Nunavut. The Northern Territories combined accounted for 0.5 per cent of Canadian GDP in 2004. The population of Arctic Canada was 101 900 in 2003, and was fairly evenly distributed among the three territories with about 40 thousand in the Northwest Territories and 30 thousand each in Yukon and Nunavut.

Public administration and defense was the largest single industry in 2002 accounting for 17 per cent of regional GDP. Mining and quarrying (excluding mineral fuels) came second at 13.2 per cent, followed closely by education, health and social work and the construction industry. Next was the oil and gas extraction with 10.3 per cent of total regional GDP. It should be noted that the real price of oil in 2002 was considerably lower than in 2005/2006. More recent data suggest that the dominance of the government in the Territorial economy has declined primarily because of the boost given to the mining sector by the diamond industry. All of the diamonds currently mined in Canada are produced in the Northwest Territories.

**“Resource development: Fostering resource development in the Territories,”
Government of Canada, 11 August 2021 [14]**

<https://www.cannor.gc.ca/eng/1368816364402/1368816377148>

Overview:

Much of Canada's mineral resource potential lies in the territories. There are existing mineral deposits with the potential to support resource extraction projects within the territories, including diamonds, gold, base metals and silver, tungsten, uranium, rare

earth element, iron ore, zinc, and copper. The Government of Canada supports sustainable mining including the mining of critical minerals that will help move Canada to a low carbon/green economy. Critical minerals are essential building blocks for renewable energy and clean technology applications (e.g., batteries, permanent magnets, solar panels and wind turbines), advanced manufacturing, consumer electronics and other applications.

Current & Relevant Information:

As of 2019, the value of mineral production in the North was projected as \$3.3 billion: \$1,817 million in Northwest Territories, \$1,315 million in Nunavut, and \$169 million in Yukon.

The mining sector is a cornerstone of the northern economy and is a significant customer of territorial and Indigenous businesses across sectors including communications, energy and transportation infrastructure, and commercial services.

The energy sector, including primary energy sources such as oil, natural gas, and renewables, also contributes to the northern economy, adding \$197 million to northern gross domestic product (GDP) in 2019 and creating over 546 jobs, primarily in oil and gas, electricity, and construction.

CanNor supports the sustainable development of the mining and energy sectors in a way that increases community capacity, maximizes jobs and creates prosperity in the territories, and has positive economic impacts in communities. Responsible and sustainable resource development balances economic, environmental, and social considerations and integrates the use of Indigenous knowledge into decision-making processes.

The natural resource exploration and development potential in Nunavut, Yukon and the Northwest Territories draws global interest and investment. Recognizing that future prosperity across the territories requires the development of its natural resources, the Government of Canada is working to create more efficient northern regulatory regimes that will continue to attract investment, create high-value jobs, safeguard the environment and ensure meaningful consultation with Indigenous peoples.

CanNor, through its regional economic development activities and its Northern Projects Management Office (NPMO), works with industry, territorial governments, communities, Indigenous groups and organizations and other partners to foster resource development across the territories.

Through its suite of funding programs, CanNor's support for the resource development sector has included funding for training, geosciences and other mining-related projects. CanNor's program funding helps attract investment to this sector, and increases the capacity of the territorial labor force to take greater advantage of employment opportunities.

2. Denmark (Greenland):

“Arctic economy within the Arctic nations,” Helen McDonald, Solveig Glomsrød and Ilmo Mäenpää, *The Economy of the North* [15]

https://www.ssb.no/a/english/publikasjoner/pdf/sa84_en/kap4.pdf

Overview:

In his book on the history of wealth and poverty of nations, Harvard professor David S. Landes devoted the introductory chapter to highlighting how natural conditions in the tropics represent serious barriers towards economic development. He did not consider the Arctic in the same context but the Arctic environment is generally seen as an even bigger challenge to livelihood than the tropics. Over the years people seem to have voted with their feet in this matter, while the tropics abound with people, the Arctic is sparsely populated. The 10 million people who currently live in the Arctic Region, what do they do for a living? To live in the Arctic, people must have their very special reasons, the remaining 99.8 per cent of the world population might easily think. One clear reason is the attraction of people and investments to natural resources. Another is the fascination of the qualities of nature, shifting from extreme and blending grandeur to darkness and stillness.

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Current & Relevant Information:

Greenland has a population of 57 000 people. A substantial share of the economy is owned and managed by the Greenland Home Rule Authorities.

Fishing is the largest industry in Greenland, followed by education, health and social work. Within the fishing industry, shrimp is the most important species. The Home Rule owned Royal Greenland is the world's largest supplier of cold-water shrimps. In fisheries there are individual quotas in combination with other Home Rule regulations. In shrimp fisheries the quotas are transferable. The cod fisheries are now of minor economic value due to decline of the resource base. Sheep husbandry has gained significance in recent years due in part to a warming climate and extended growth season. Increasingly, grass production has replaced imported fodder and created a profitable industry. The sheep industry mainly supplies the domestic market. There is no private ownership of land in Greenland, and the Home Rule Authorities allocates user rights to animal herders.

Currently there is no oil and gas extraction in Greenland, but according to US Geological Surveys 2000, Greenland has considerable expected reserves, which are not yet discovered mainly off East Greenland. Three licensing rounds were opened for ocean areas west of Greenland in 1992, 2002 and 2003. In recent years new seismic data off the west coast have been obtained, and the results are promising, according to the Ministry for Housing, Infrastructure and Minerals and Petroleum. In July 2006 another licensing round for offshore West Greenland (Disko West) was opened. The environmentally sensitive inner Disko Bay is not included in the licensing round. Environmental investigations have been carried out to assess the possible impact on the marine environment in the licensing area. However, environmental interest groups question the sustainability of future petroleum activity in the area.

Potential for hydro power production offers an opportunity for export-oriented processing industries.

There has recently been a marked increase in the exploration of minerals other than mineral fuels, primarily for gold, nickel and diamonds, and lately also molybdenum. A production license for gold was granted in 2003; in 2004 export of gold started up at Mill. DKK 130, already at about 10 per cent the level of total shrimp exports.

There has been an increase in Greenland's role in resource management in recent years and Greenland Home Rule Authorities and Denmark are currently negotiating their role in non-renewable resource extraction in Greenland.

“Denmark - Country Commercial Guide - Greenland,” International Trade Administration, 19 January 2024 [16] <https://www.trade.gov/country-commercial-guides/denmark-other-areas-kingdom-denmark>

Overview:

Denmark exercises control over the Kingdom's foreign affairs, security, and defense policy, in consultation with Greenland and the Faroe Islands.

Current & Relevant Information:

Greenland

Greenland is a self-governing region within the Kingdom of Denmark, and geographically a part of the North American continent. Along with Denmark, Greenland was an EU member from 1973; however, in 1985, Greenland left the EU. The Greenlandic government is actively working to attract investments to Greenland to diversify its economy and further integrate itself into the global economy.

Two-thirds of Greenland lies within the Arctic Circle, and its northern tip is less than 500 miles from the North Pole. Its land area is over 50 times that of Denmark, but has the lowest population density in the world, with approximately 56,000 inhabitants (or 1/100th the population of mainland Denmark), and the ice sheet covers nearly 80 percent of Greenland. Greenland can be reached by air from Denmark or Iceland. There are currently no direct commercial flights to or from the United States. Transportation infrastructure in Greenland is focused on air and sea due to the climate and geography. Greenland has no railroads or roads to connect towns and settlements, and passengers and goods are transported between regions by sea or air only.

Greenland's status within the Kingdom of Denmark is outlined in the Self Rule Act (SRA) of 2009, which details the Greenlandic government's right to assume a number of competencies from the Danish government, including the administration of justice, business and labor, aviation, immigration and border control, as well as financial regulation and supervision. Greenland has acquired control over taxation, fisheries, internal labor negotiations, natural resources, and oversight of offshore

labor, environment, and safety regulations. Denmark retains authority over foreign, security, and defense policy, as well as border control issues, including immigration into Greenland. Greenland's GDP was estimated at DKK 20.19 billion (USD 3.24 billion) in 2021. Denmark provides Greenland with an annual block grant of DKK 3.9 billion — roughly USD 511 million — which accounts for approximately 20 percent of Greenland's GDP and more than half of the public budget.

The Greenlandic government seeks to increase revenues by promoting economic diversification and greater development of the fisheries value chain, natural resources, tourism, and clean energy. Key initiatives include improving access to financing for new businesses and enhancing Greenland's corporate tax competitiveness. The Greenlandic government announced in 2022 an invitation to dialogue with prospective investors for tendering and licensing procedures for the exploitation of hydropower for the production of electricity for industry or a commercial project. The hydropower potentials are located on the southwest coast of Greenland, between Kangerlussuaq and Nuuk.

The capital city Nuuk, in the south, and Ilulissat in the north are Greenland's primary tourist destinations and have seen extensive construction activity in recent years. The ongoing expansion of their respective airports, which currently accommodate only smaller aircraft, is expected to lead to further growth and facilitate expansion of tourism. Upon completion expected in late 2024 in Nuuk and in 2025 in Ilulissat, the expanded runways will support large passenger aircraft, and the airports will be able to manage 800 and 600 passengers per hour, respectively. South Greenland is also a popular destination for tourists and cruise ships, and a new airport in the region's capital, Qaqortoq, should also open in 2025.

The Greenlandic subsoil contains a variety of valuable minerals, including rare earth metals, precious metals, precious stones, coal, graphite, and uranium. The rare earth element resources are considered globally significant and would rank in the top five worldwide if developed. Greenland has tremendous mineral resources, but Greenland's geography and climate have increased challenges to developing commercially viable mining operations. There are several mining companies with exploration and exploitation licenses. One company holds an exploitation license to re-launch a gold mine in South Greenland, while another company seeks to extract rare earth elements. A company involved in a separate rare earth element mining project in South Greenland has filed an arbitration claim against the Danish and Greenlandic governments.

“THE GREENLAND GOLD RUSH: Promise and Pitfalls of Greenland's Energy and Mineral Resources,” Tim Boersma and Kevin Foley, [brookings.edu](https://www.brookings.edu/wp-content/uploads/2016/06/24-greenland-energy-mineral-resources-boersma-foley-pdf-2.pdf), September 2014 [17] <https://www.brookings.edu/wp-content/uploads/2016/06/24-greenland-energy-mineral-resources-boersma-foley-pdf-2.pdf>

Summary:

This report targets three audiences. For foreign policy officials in Washington, D.C., there is growing interest in matters related to the Arctic region as the United States prepares to assume the chairmanship of the Arctic Council in 2015. For those in the United States who are not familiar with recent developments in Greenland, this report aims to provide a broad overview of the background to Greenland's self-rule government and some details on the history of Greenland's connection to Denmark. The report is also intended to be a resource for those in Greenland and Denmark who are engaged in ongoing debates about the strategic implications of Greenland's efforts to mine (amongst others) uranium and rare earth elements and about what many see as an emerging relationship with China. Finally, the report discusses Greenland in the context of its current and potential relationship to Europe, particularly as an alternative supplier of critical raw materials.

Current & Relevant Information:

SELF-RULE IN GREENLAND

Greenland's citizens voted for a new system of self-rule government that took effect in June 2009, and it must now find a way to pay for the costs of its government. Under the previous Home Rule system, a block grant was negotiated with Denmark each year that covered the cost of activities for which Greenland had authority and the grant increased as Greenland's social welfare obligations and other costs went up. The block grant is now frozen at real 2009 levels, and Greenland faces steadily increasing social welfare costs as the population ages over the next two decades. Both major parties in Greenland hope to address this anticipated shortfall with revenue from oil and minerals exploitation.

Mining projects have been an important part of Greenland's economy since the 19th century. Cryolite, a raw material once critical to the aluminum smelting process that was produced only in Greenland, was mined until the resource was depleted in 1987. The costs of exploration and extraction of other resources in Greenland are high due to the harsh environment and the lack of infrastructure, both of which are deterrents to investment. Like other areas on the frontiers of resource extraction, successful development of major projects in Greenland depends largely on international commodities prices.

The first years of Greenland's self-rule government (2009 to mid-2011) coincided with stratospheric prices for raw materials such as iron ore, copper, zinc, and rare earth elements. These prices were driven by global demand—in particular, by surging demand from China driven by heavy Chinese infrastructure spending from economic stimulus programs in the wake of the global financial crisis. Prices have now receded for most commodities, and although Greenland's economic development strategy still depends on the development of a mining industry, it now seems less certain that the country will be able to get projects off the ground on the ambitious schedule that it announced in 2014 in its oil and minerals strategy.

Nevertheless, Greenland is taking significant steps to promote itself as a destination for the mining industry, and it is our impression that large mining projects will eventually be developed.

The story is similar with offshore oil, although the chances of commercial oil production in the next few years appear to be nonexistent. Exploration costs for offshore oil in this part of the world are very significant, amounting to roughly \$100 million for a single exploration well under the most favorable conditions, and the harsh conditions pose a challenge with currently available technology. Although global warming is making Arctic waters more accessible, icebergs remain a potential hazard and exploration is still limited to a few months in the summer when daylight hours and temperatures are suitable. Based on our analysis and our conversations within the industry, we find that it could be decades before commercial oil production in Greenland takes place.

Investment in mineral and energy resources depends on a stable policy environment. There have been some complaints from the mining industry regarding the pace of Greenland's licensing process and about the transparency with which policies are set. But we did not find this to be a problem from a policy perspective. Rather, we found that Greenland's authorities have been appropriately cautious in their efforts to develop an effective regulatory and policy framework to manage extraction projects. At the same time, we acknowledge that the government—like any of its counterparts around the world—is walking a fine line between establishing the safeguards necessary to protect the environment and creating an attractive investment climate. The reality is that the government of Greenland is small and faces serious administrative bottlenecks when dealing with large, complex projects. A recent (and controversial) proposal by the government to relax transparency standards reflects the challenge the government faces in managing large and technically complex projects while reporting in three languages to the public and the industry. At the same time, NGOs have expressed concerns about the lack of transparency on a number of other occasions.

GREENLAND'S RESOURCE ENDOWMENT

For the parts of the country that have been properly explored, Greenland does indeed have a rich resource base consisting of a variety of minerals as well as promising potential for offshore oil, both to the east and the Impinger west of the country. Greenland has excellent potential for iron ore, copper, zinc, gold, uranium, and light and heavy rare earth elements. For areas that have not been explored, most estimates about resource potential are based on knowledge of shared geology with other areas, such as northern Canada and Norway, where resources have already been identified. As the larger part of the island has not been explored in any detail, it may well be that in the years ahead significant additional resource findings occur.

CHINA AND GREENLAND

Although some commentators and government officials have raised questions about China's strategic intentions in Greenland, a case-by-case review of Chinese interests in Greenland finds that the dominant narrative about China and Greenland is misleading. On the contrary, we find that Chinese companies have demonstrated little interest to date in projects in Greenland, despite substantial efforts to attract Chinese investment. This does not mean that these efforts have been misplaced—we conclude that seeking investment from Chinese firms is logical given the emergence over the last decade of Chinese mining and oil companies as major players in global resource investments. This is particularly true in the world of mining, where few major international mining companies are currently making investments in new projects. In this environment, Chinese firms stand out as at least slightly more likely than the rest of the industry to invest in new mines.

GREENLAND AND EUROPEAN CRITICAL RAW MATERIALS STRATEGY

Greenland features prominently in European plans to diversify its raw materials suppliers. Yet, it is too early to tell how successful these attempts have been or how much impact Greenland might have on European raw material supplies if or when mining projects become a reality. Historically, Europe has been closely associated with Greenland, as can be seen by the European Community's longstanding support for Greenland's fishing industry. In the spring of 2014, a new partnership agreement between Greenland and the EU aspires to build stronger ties in mineral and energy resources and climate change, and also includes funding commitments for education in Greenland. The details about Europe's role in Greenland's resource development are currently being debated, yet it is important to keep in mind that the EU mandate on this issue is limited, and private-sector and national-level policymakers play a more important role. Concerns about China locking in natural resources feature prominently in European discussions about raw materials security, and here we find that European concerns (which are shared in the United States and Japan) are exaggerated. Commentators in China have argued since at least 2008 that China should tighten its limits on rare earth exports, and when China made steps in early 2009 to restructure its rare earth industry, it did so with an eye to slowing exports. But contrary to what was widely reported at the time, we found no evidence that China halted exports of rare earths to Japan in response to a maritime dispute. China's ability to limit exports has been severely constrained by aggressive illegal mining of rare earths, which has kept supply of rare earth elements high in China. In fact, rare earth prices have steadily declined since 2011, and there are many new projects in the pipeline to mine rare earths outside of China. Chinese dominance in rare earth elements has little if anything to do with physical resources, but rather with processing capacity and knowledge. At this point, EU policies and actions do not give the impression that the supply chain for rare earth elements will be built up on the continent, and so even if Greenland were to extract these resources, processing

would largely (if not entirely) take place outside Europe. In the United States, efforts are underway to revitalize its processing industry, though opinions differ as to whether the U.S. will be able to make this sector profitable without significant government support, as the Chinese have developed an impressive knowledge base and can operate very competitively. Thus, it is our impression that the Chinese will continue to play a prominent role in rare earth elements, yet that many of the concerns about Chinese interests in rare earth elements are overblown. U.S. and European resource policies should be evaluated accordingly.

“Greenland: Mining, Minerals, and Fuel Resources,” G.P. Thomas, AZO Mining, 3 February 2020 [18] <https://www.azomining.com/Article.aspx?ArticleID=59>

Overview:

Greenland is an island country located in the northern part of the North American continent between the Arctic Ocean and the North Atlantic Ocean. It is the 12th largest country in the world with a total area of 2,166,086 km², and a small population of 57,691 as of July 2018, making it the 206th largest country by population. Roughly 80% of the land is ice-capped and the country experiences extreme arctic to subarctic climatic conditions.

Greenland was under colonial rule for a long time and the country gained greater control over its internal affairs when the Self-Government Act was made into law in June 2009. However, Denmark continues to have command over Greenland's security, foreign affairs, and financial policy and remains its largest trading partner.

Current & Relevant Information:

Economy and Resources Overview

Income from mineral exploration and extraction is responsible for a notable percentage of Greenland's economy. Greenland's economy contracted between 2012 and 2014 but grew by 1.7% in 2015 and in 2016 it had expanded by 7.7%. The country's GDP in 2015 was \$2.413 billion. Increased hydrocarbon and mineral exploration and extraction operations helped the country overcome the economic slump.

Greenland has many rich mineral and natural resources including hydrocarbons, lead, iron ore, zinc, rare earth metals, gold, precious gemstones including diamonds, platinum, and uranium. Geological surveys and studies indicate the possibility of oil and gas fields in the northern and north-eastern parts of the country.

“Economy of Greenland and Business Opportunities,” GlobalTenders.com, 2024 [19] <https://www.globaltenders.com/economy-of-greenland.php>

Overview:

The economy of Greenland is characterized as small, mixed, and vulnerable. Greenland's economy consists of a large public sector and comprehensive foreign trade.

Current & Relevant Information:

Top Sectors in Greenland

Fishing industry in Greenland

The second-largest sector by employment is Greenland's fishing industry. The commercial fishing fleet consists of approximately 5,000 dinghies, 300 cutters, and 25 trawlers. While cod was formerly the main catch, today the industry centers on cold-water shrimp and Greenland halibut. The fish processing industry is almost entirely centered on Royal Greenland, the world's largest retailer of cold-water shrimp.

Hunting and whaling in Greenland

Whaling and seal hunting were once traditional mainstays of Greenland's economy. Greenlanders still kill an estimated 170,000 seals a year and 175 whales a year, ranking them second and third in the world respectively. Both whaling and sealing have become controversial, limiting the potential market for their products. As such, the only seal tannery in the country - Great Greenland in Qaqortoq - is heavily subsidized by the government to maintain the livelihood of smaller communities which are economically dependent on the hunt.

Retail in Greenland

Approximately half of total sales are conducted by KNI, the state-owned successor to the Royal Greenland Trade Department; its rural sales division Pilersuisoq; or its daughter company - which has been purchased by the Danish Dagrofa - Pisiffik. The third major chain is the Brugsen association of cooperatives.

Mining in Greenland

Greenland's Bureau of Minerals and Petroleum is working to promote Greenland as an attractive destination for prospectors. Improvements in technology and increases in mineral prices have led to some mines being reopened, such as the lead and zinc mine at Maarmorilik and the gold mine at Nalunaq. Greenland is expected to be one of the world's next great mining frontiers as global warming starts to uncover precious metals from the frozen surroundings. Substantial volumes of minerals are now within reach of geological land mapping technologies, according to research conducted by GlobalData, a natural resources business intelligence provider.

Energy in Greenland

At 70%, Greenland has one of the highest shares of renewable energy in the world, mostly coming from hydropower. While the Greenland Home Rule Government has

primary sovereignty over mineral deposits on the mainland, oil resources are within the domain of the Danish exclusive economic zone. Electricity generation is controlled by the state-owned Nukissiorfiit. It is distributed at 220 V and 50 Hz and sockets of Danish type K are used. Electricity has historically been generated by oil or diesel power plants, even though there is a large surplus of potential hydropower. Because of rising oil prices, there is a program to build hydro power plants.

Tourism in Greenland

Tourism is limited by the short summers and high costs. Access is almost exclusively by air, mainly from Scandinavia and Iceland. Some tourists arrive by cruise ship (but they don't spend much locally, since the ship provides accommodation and meals). The state-owned tourism agency Visit Greenland has the web address Greenland.com. Tourism increased significantly between 2015 and 2019, with the number of visitors increasing from 77,000 per year to 105,000. One source estimated that in 2019 the revenue from this aspect of the economy was about 450 million kroner (US\$67 million).

Agriculture and forestry in Greenland

Agriculture is of little importance in the economy but due to climate change - in southern Greenland, the growing season averages about three weeks longer than a decade ago - which has enabled expanded production of existing crops. At present, local production accounts for 10% of potatoes consumption in Greenland, but that is projected to grow to 15% by 2020. Similarly, it has enabled new crops like apples, strawberries, broccoli, cauliflower, cabbage, and carrots to be grown and for the cultivated areas of the country to be extended although even now only about 1% of Greenland is considered arable. Expanded production is subsidized by the government through purchase guarantees by the state-owned Neqi A/S grocery store chain.

Animal husbandry in Greenland

Animal husbandry consists mainly of sheep farming, with free-grazing flocks. Modern sheep farming methods were introduced in the early 20th century, with the first farm built in 1906. The farms provide meat for local consumption and wool mainly for export.

Greenland - Key Economic Indicators

Exports & Imports

Greenland's exports are dominated by seafood products, particularly shrimp, prawns, and crab. Minerals like cryolite also contribute a small portion. Most imports are essential goods like machinery, food, and fuel, with a heavy reliance on Denmark.

Balance of Trade

Greenland has a chronic trade deficit, meaning the value of imports consistently exceeds exports. This gap is often financed by subsidies from Denmark.

Fiscal Policy

Greenland's fiscal policy is heavily influenced by Denmark. A significant portion of government revenue comes from block grants provided by the Danish government. Due to the limited tax base, Greenland focuses on prioritizing essential services and social programs.

Monetary Policy

Greenland does not have its own currency and relies on the Danish krone. Therefore, monetary policy is determined by the Danish National Bank, focusing on price stability and economic growth for Denmark as a whole.

Trade Agreements

Greenland participates in trade agreements through its association with Denmark. This provides access to the European Union's Single Market and preferential trade arrangements with other countries.

Environmental Regulations

Greenland has established environmental regulations to protect its unique Arctic ecosystem. These regulations focus on sustainable fishing practices, mining restrictions, and pollution control measures. Balancing economic development with environmental protection remains a key challenge.

Tax system

Capital Gains Tax: Information on a dedicated capital gains tax in Greenland is limited. Profits from sales of assets may be taxed as income under Greenland's income tax system. Consulting a tax professional in Greenland is recommended for specifics.

Corporate Tax Rate: The general corporate tax rate in Greenland is 30% (as of 2024). However, some exceptions exist: (i) Specific industries or newly established businesses may benefit from temporary tax breaks or lower rates. It's important to stay updated on these incentives as they can change. (ii) A special regime applies for oil, gas, and mineral activities, with a separate tax structure.

Sales Tax (Value Added Tax - VAT): Greenland is one of the very few countries in the world that does not charge a Value Added Tax (VAT). This can be beneficial for residents but also reduces a potential revenue stream for the government.

Property Tax: An annual property tax is levied on real estate in Greenland. Rates can vary depending on the property type, location, and value. There are also

additional property taxes levied on transactions like inheritance and property transfers.

Payroll Tax: Greenland has a social security system funded in part by payroll taxes. Employers and employees each contribute a percentage of wages and salaries towards social security. The combined contribution rate is around 38.3% (as of 2024).

Tax Deductions and Credits: Greenland offers various tax deductions and credits to incentivize specific activities or ease the burden on taxpayers. Specific details may change, so consulting a tax professional is recommended. Here are some potential examples: (i) Deductions for business expenses. (ii) Allowances for childcare or dependent care costs. (iii) Tax breaks for investments in certain sectors.

Tax Compliance: The efficiency of tax collection in Greenland has improved in recent years. However, challenges persist, particularly with regards to the informal sector.

Tax Burden: The overall tax burden in Greenland can vary depending on individual circumstances and business activities. The lack of a sales tax can be advantageous for consumers, but the corporate tax rate and social security contributions are significant.

“The fight over Greenland's natural resources,” Sara Moraca, Deutsche Welle, 9 April 2021 [20] <https://www.dw.com/en/the-battle-over-greenlands-untapped-natural-resources/a-57138809>

Overview:

A fight over Greenland's rich oil, gas and mineral deposits is raging, as global warming melts ice and exposes rich reserves. Now Greenlanders are struggling to balance economic growth and environmental protection.

Current & Relevant Information:

Environment vs. development

Kvanefjeld is home to one of the world's largest undeveloped deposits of rare-earth elements outside of China. Seventeen elements, including scandium and yttrium, are buried deep underground there. They are used in everything from cell phones and wind turbines to electric cars. Mining advocates say tapping into them would be a major financial boon for Greenland.

Greenland Minerals Limited (GML), the Australian company developing the mine, said that the country would receive \$240 million (€201 million) in taxes and royalties annually over the mine's planned 37-year lifespan. GML's biggest stakeholder is Shenghe Resources Holding, a Chinese rare-earths processing company.

For an economy largely dependent on fishing, tourism and a \$600 million annual subsidy from Denmark, resource exploitation is seen as a way to boost government coffers and provide a path to independence. Polls indicate support for secession from Denmark. One carried out in 2018 by researchers from the University of Copenhagen found around 67% of respondents supported an independent Greenland at some point in the future.

"It is not certain that the Kvanefjeld mine project will never be realized," said Mikaa Mered, a lecturer on Arctic affairs at HEC business school in Paris. "If the Siumut party returns to power in the future, the struggle for independence could still be played through the uranium mines."

But Kvanefjeld's opponents argue that economic arguments are overplayed, saying it won't bring jobs, because the expertise to develop, extract and process rare-earth minerals doesn't exist on the 56,000-strong island. Furthermore, they argue, the potential threat to the island's pristine ecosystem is underestimated.

"Normally, local people don't earn money from mines as promised in the beginning, but after mining they are left with polluted land," said Mariane Paviasen, an IA member of parliament from Narsaq who has been campaigning against the mine since 2013, speaking of similar projects around the world.

Narsaq's largely Inuit population were concerned that dust from uranium and other radioactive byproducts would be blown across the landscape. Locals and environmentalists, including Friends of the Earth Denmark, worried about contamination of soil, water and marine life from mining waste. Fishing is one of the town's main industries.

"Our life depends on the sea," said Ole Jorgen Davidsen, a fisherman and member the country's fishers' association KNAPK. "Our cultural heritage, our economy and even our free time are linked to where we live. Fishing is the livelihood method for the majority of families here."

GML refused to comment on the electoral outcome and what it would mean for the project but told DW before the election that it had done robust safety and environmental assessments.

"GML has used world experts in all possible environmental risk areas of the project to determine the impacts," said Jorn Skov Nielsen, the company's Executive General Manager.

“Greenland isn’t in a rush to fight climate change because it’s good for the country’s economy,” Marcello Rossi, Quartz, 22 October 2016 [21]

<https://qz.com/813742/climate-change-is-benefitting-greenland/>

Overview:

A few dozen kilometers northeast of Nuuk, Greenland's capital and largest city, a remote power plant is thriving because of the extra water coming from the melt of ancient glaciers.

The Buksefjord hydroelectric station is the biggest of five built since 1993 in order to disencumber the country from imported oil. Outside the plant, some employees now grow turnips and potatoes on land once too cold for anything but reindeer and lichen, while close to the station, cod, usually only seen much further south, flourish in the pristine water.

As with the rest of the Arctic region, Greenland is warming twice as fast as the global average: Since the early 1950s, the temperature in Greenland has risen by 1.5°C, compared with approximately 0.7°C worldwide.

In large part, this is because of the "albedo effect." Albedo is a coefficient measuring the ratio of reflected solar radiation to total incoming solar radiation. A high albedo means the surface reflects the majority of the radiation that hits it and absorbs the rest. A low albedo means the opposite. Snow-covered sea ice has a high albedo, reflecting up to 85% of sunlight.

In Greenland, as the area covered by ice and snow shrinks, the albedo is dropping and solar radiation that would have been reflected is now soaked up by open water instead, further warming it up. Heat from the warmer sea is released back into the air, raising atmospheric temperatures too. In turn, this melts more ice, in a loop that fuels itself. A recent study in the journal *Geophysical Research Letters* used satellite imagery to calculate that Greenland lost a bewildering one trillion tons of ice between 2011 and 2014. This year, melt season began so early that many scientists couldn't believe the data they were looking at.

According to the International Panel on Climate Change, besides causing irreparable environmental damage, climate change will also harm economies in almost all parts of the world and worsen already challenging situations by prompting more frequent and more disastrous floods, droughts, and heat waves. Low-lying tropical states such as Tuvalu and the Maldives view Greenland's 10,000-foot-thick ice sheet with dread: if it ever all melts, it would raise global sea level by about six meters.

Yet, paradoxically, no nation in the world will profit from climate change as much as the one at ground zero of it.

Current & Relevant Information:

The Winners and Losers

Nearly 75% of Greenland is covered by the only permanent ice sheet outside of Antarctica, so it's fairly obvious that warming temperatures would be a big deal there. "It's no secret that climate change poses a challenge to the Greenlandic

society,” says Mala Høy Kúko, the country’s minister for nature, energy, and environment.

Although it’s difficult to foresee the full impact of the great melt in the long run, some effects can already be seen. According to Kúko, the melting permafrost is endangering the construction and maintenance of some airports and other infrastructure. Greenland’s largest commercial airport, for example, is located in Kangerlussuaq, a zone of continuous permafrost melting in western Greenland.

The loss of ice is also hurting indigenous hunters whose livelihoods largely depend on the existence of permafrost, although, says Kúko, “no one has been forced—or is expected—to move away from his own settlement anytime soon.” Overall, the area of Arctic land covered by snow in early summer has shrunk by 25% since 1966. Several climate models predict that the Arctic Ocean could be ice-free in summers within a century. Others think it will happen sooner. Either way, in recent years, the sea freezes in February and starts to thaw in April, instead of icing over in December and melting in June. At the peak of winter, the ice might be only a foot thick—not nearly enough to support sleds or snowmobiles, cutting into seal and narwhal hunting seasons.

In 2015, after three years of contraction, there was economic growth in Greenland partly because a range of new opportunities brought by climate changes. Although agriculture isn’t a major part of Greenland’s economy, higher temperatures in the southern region have made growing seasons longer than a decade ago, enabling expanded production of existing crops, like potatoes. Meanwhile, new crops like carrots, cauliflower, cabbage, strawberries, apples, and broccoli can now be grown as the frozen tundra retreats northwards due to an increasingly early Arctic spring, making for more areas suitable for agriculture.

While Greenland’s main export remains cold-water shrimp—locally known as the “pink gold”—in recent years rising temperatures are attracting new types of harvestable fish like the Atlantic Bluefin tuna and mackerel, species pretty much never sighted in the waters off Greenland until 2011.

In 2015, almost 80,000 tons of mackerel were caught; paired with prices that have been steadily rising since 2012, it made for good earnings for companies like Royal Greenland, owned by the government, and Polar Seafood, Greenland’s biggest private company. “Of course, climate change is bad,” says Henrik Leth, chairman of Polar Seafood and leader of the Greenland Business Association. “But, alas, I can’t say it isn’t good overall for Greenland.”

Warmer temperatures are also helping the country bring back the Greenland cod, a pivotal species whose total disappearance in the early 1990s was caused by overfishing and a four-degree Celsius drop in the water temperature—and which deeply affected the country’s economy. Now that the seas around Greenland are at the highest temperatures since 1960s, cod are making their way back home, and

some Greenlanders are reaping the rewards. For example, Kim Hoegh-Dam, who runs the Qaqortoq-based firm Arctic Prime Production, spent \$1 million on a small fleet of cod trawlers and three processing plants 10 years ago. “It was clear warming temperatures would have brought cod and other species up from the south,” he says. Arctic Prime now exports its marine products worldwide.

“Greenland Economy 2024,” Theodora.com: Countries of the World, 4 May 2024
[22] https://theodora.com/wfbcurrent/greenland/greenland_economy.html

Overview:

Greenland is a large self-governing Danish territorial economy; preferential EU market access; high-income economy; dependent on Danish financial support, even for whaling and sealing industries; growing tourism; hydropower-fueled but environmentally fragile economy

Current & Relevant Information:

Industries

Fish processing (mainly shrimp and Greenland halibut), anorthosite and ruby mining, handicrafts, hides and skins, small shipyards

3. Finland:

“Arctic economy within the Arctic nations,” Helen McDonald, Solveig Glomsrød and Ilmo Mäenpää, The Economy of the North [23]
https://www.ssb.no/a/english/publikasjoner/pdf/sa84_en/kap4.pdf

Overview:

In his book on the history of wealth and poverty of nations, Harvard professor David S. Landes devoted the introductory chapter to highlighting how natural conditions in the tropics represent serious barriers towards economic development. He did not consider the Arctic in the same context but the Arctic environment is generally seen as an even bigger challenge to livelihood than the tropics. Over the years people seem to have voted with their feet in this matter, while the tropics abound with people, the Arctic is sparsely populated. The 10 million people who currently live in the Arctic Region, what do they do for a living? To live in the Arctic, people must have their very special reasons, the remaining 99.8 per cent of the world population might easily think. One clear reason is the attraction of people and investments to natural resources. Another is the fascination of the qualities of nature, shifting from extreme and blending grandeur to darkness and stillness.

These special reasons should be reflected in the structure of the Arctic economy, indicating the extent to which nature in the Arctic has had its say in shaping the economy of the north. This chapter provides an overview of the predominant economic characteristics and the major industries of the Arctic regions within the

Arctic nations. It also provides information about the contribution of the Arctic regions to the economy of the respective Arctic nations. Thus, for the most part, the information in this chapter is viewed from an intra-national rather than a comparative international perspective, although some comparisons among the regions are made in the concluding remarks to this chapter.

While there is significant economic variation across the Arctic regions of the Arctic countries, many of these regions host large resource-based industries. In many cases, resources produced in the Arctic are shipped outside the Arctic region to export markets or southern markets within the same country. At the same time, the Arctic regions tend to draw extensively on southern markets for specialized and professional labor, capital, and consumer products. While Arctic regions generate income and resource rent from natural wealth, they also receive transfer payments from national governments. In some Arctic regions resource exploitation generates economic activity within the region in the form of the construction and operation of pipelines, and the provision of services such as transportation, wholesaling and retailing and housing. With some exceptions, manufacturing activity tends to be limited in Arctic regions. The electronics industry in Oulu in Northern Finland and the industrial sectors in Northern Russia and Northern Sweden are exceptions to this and the data presented in this chapter illustrate the variability in economic structure among Arctic regions that is frequently overlooked when the Arctic economy is discussed.

For each of the Arctic regions this chapter contains a core table showing regional gross domestic product (GDP) and the contribution to regional GDP by industry at a disaggregated level (for 17 industries). This level of detail is intended to capture all the main activities of the circumpolar Arctic region. The data for the Arctic excluding Russia are based on national statistics and World Development Indicators of the World Bank. Arctic Russian data by main industry are provided by Russia's Federal State Statistical Service and further harmonized with statistics for other Arctic regions using production and employment statistics. These core tables generally refer to the year 2002, which represents a compromise between coverage and timeliness. The tables present value added or contribution to GDP in local currency in order to focus on the Arctic element of their respective national or federal economies. Where available some more recent economic indicators are presented.

Current & Relevant Information:

Arctic Finland consists of the two provinces Lapland and Oulu covering almost a half of the surface area of Finland. The province of Oulu is furthermore divided into Kainuu and North Ostrobothnia. The population of 645 000 amounts to about 10 per cent of the total population and the regional GDP about 11 per cent of national GDP.

Within Arctic Finland, North Ostrobothnia is the largest region in terms of population and economy. Lapland covers, however, almost two thirds of the land area of Arctic Finland.

The regional GDP per capita of Northern Finland is 14 per cent lower than that of the whole country. In Kainuu the per capita GDP was almost 32 per cent lower than the average for Finland. However, the disposable income of households is distributed markedly more equally, hence the per capita disposable income in the Arctic Finland is only 10 per cent lower than the average of the whole country and the differences between the sub-regions of Arctic Finland are negligible.

A characteristic of the industrial structure is that the share of both secondary industries and private services are rather high, about 36 per cent of the regional GDP. The share of primary production is 7 per cent, which is low in an Arctic context. Public services contribute about 22 per cent to regional GDP.

The largest manufacturing industry is electronic industry, which contributed about 39 per cent of the value added and 24 per cent of the employment of the manufacturing industry in Northern Finland. The electronics industry is a knowledge-based industry which in Arctic Finland is mostly situated at the vicinity of Oulu, the main city of North Ostrobothnia. Mobile telecommunication is the core technology area of the electronics industry even though the product variability is widening. The electronics industry in the region is an important spill-over of the University of Oulu and its large engineering faculty.

The most important natural resources in Finland are forests, metal minerals, energy resources and nature itself as a source of recreational services. Most of the natural resources extracted in Northern Finland are also processed there. Moreover, the processing industry of Northern Finland imports some natural resources from other Arctic regions such as raw wood and iron ore from North-West Russia and iron ore from Northern Sweden.

The forest sector – forestry and forest industries – comprises about 10 per cent of the regional GDP. The forest industry uses more raw wood than the yearly loggings provide and thus on the average 1.5 million m³ of logs and pulpwood are imported from Northwest Russia.

The value added of mining is small in Arctic Finland. However, the chromite mine in Lapland has been the base of the third largest stainless-steel plant in the world, Outokumpu Chrome near the city of Tornio. The carbon steel processing plant at the city of Raahe in North Ostrobothnia was first founded on the domestic iron ore resources of the Northern Finland but nowadays uses ore imported from Northern Sweden and Kostamus in Northwest Russia.

The energy resources consist of wood, peat and hydro power. Most of the larger cities in Arctic Finland have combined heat and power plants using peat as their

main fuel. Wood is used as energy resource mainly in combined heat and power plants in the forest industry, but the share of wood in communal heat and power plants is growing. Hydro power is the third most important energy source. Due to the large presence of processing industries, the electricity consumption amounts to about 80 per cent of the electricity generated in the region.

Tourism is based on the recreational services supplied by the nature. According to the regional tourism accounts of Finland, the value added of the tourism industry in Arctic Finland amounted to mill. EUR 1 200 in 2002, almost 10 per cent of the regional GDP or one quarter of the value added of private services. Especially the winter tourism in Lapland and Kainuu are important economic activities.

The natural resources extracted in Arctic Finland are thus processed in the region and some additional natural resources are supplied by the northern regions of neighboring countries. The resource-based industries including tourism contributed over 30 per cent to the regional GDP of Arctic Finland in 2002.

“Finland,” The Arctic Institute: Center for Circumpolar Security Studies, 1 August 2022 [24] <https://www.thearcticinstitute.org/countries/finland/>

Overview:

Facts & Figures

AC member since 1996

Active Polar Icebreakers

3

Coordinates

Helsinki: 60.1708° N, 24.9375° E

Rovaniemi: 66.5039° N, 25.7294° E

Population

Finland: 5.53 million

Lapland: 178,391

Land Area

Finland: 338,424 km²

Lapland: 98,984 km²

Current & Relevant Information:

From an economic and business point of view, Finland has a lot of potential within its own Arctic region as well as in the larger Arctic. The biggest industries in Northern

Finland are forestry, mining, tourism, renewable and bio-energy, technology, and metal industries. Finland also takes pride as a leading expert in shipping and shipbuilding. Facilitating these commercial activities, the infrastructure above the Arctic Circle in Finland is fairly advanced with roads between cities, towns and villages as well as airports in the major cities. Northern Finland is thus well connected to the rest of Finland, Europe and Russia. The Lapland Chamber of Commerce is the northernmost chamber of commerce in the European Union. It plays an important role advocating northern businesses and international cooperation.

In 2013, the forestry industry directly employed a total of 3,200 people in Lapland. Additionally, forestry provides a supplementary source of income to numerous forest owners. In Lapland, the forest sector accounts for a much larger percentage of the overall economic activity than in the rest of Finland. Mining is also attracting investment in Northern Finland because of the infrastructure capabilities and a close link to the European market.

One of the biggest employers in Lapland besides forestry and mining, is the tourism industry. Northern Finland is a very popular winter destination, especially its Arctic capital Rovaniemi and the Santa Claus village. The most popular winter downhill skiing resorts in Finland are located in the north and the annual number of overnight stays in Lapland is well over two million. The Finnish Lapland is easily accessible and there are four airports above the Arctic Circle in Rovaniemi, Kittilä, Ivalo and Enontekiö. Due to the importance of Chinese tourists to the region, which have become the largest group of foreign visitors, the outbreak of the coronavirus and subsequent travel restrictions have had considerable effects on the industry in Lapland. In January, the first case of a Chinese tourist from Wuhan suffering from the virus was confirmed.

Finland has a strong interest and well developed expertise in Arctic maritime technology, shipping and shipbuilding. Even though Finland does not border on the Arctic Ocean, it possesses five icebreakers and two multi-purpose vessels operated predominantly in the Baltic Sea by Arctia Shipping. The Finnish icebreakers are also lent to other countries and companies. An example of this, Finnish icebreakers were part of Royal Dutch Shell's Arctic oil and gas explorations in Alaska.

Finland is looking towards international partners for potential exports of Arctic offshore industries, especially with regards to technology and construction. Finland has approximately 150 companies working within offshore industries and 67% of those revenues come from technology. Finnish companies maintain their competitive advantage with their strong technological expertise, high quality products and innovation. The main partner in offshore industry for Finland is Norway whereas exports to Russia are mainly for Arctic offshore development.

Finland's energy politics is based on securing energy availability, competitive price of energy and keeping emissions within the international quota. Natural resource development and extraction in Finland is mostly concentrated on mining. Finland is, however, the least oil dependent of the industrialized OECD countries. With a growing renewable energy industry, Northern Finland is increasingly attracting foreign investment. In 2016, the Chinese company Sunshine Kaidi New Energy Group announced its plans to invest in a bio-energy refinery in Kemi creating more jobs for the community.

The area in Lapland is also well suited for wind power plants. Building wind farms has proven to be a challenge as those areas are important for communities as well as for tourism and reindeer herding. As a result, some of the planned wind power plants have been met with resistance from local communities. Oulu in Northern Finland is one of the fastest growing technological hubs in Finland with companies and start-ups attracting foreign investment.

The annual Arctic Business Forum is usually held in Rovaniemi to introduce the latest business developments and the future prospects of the Arctic economy. The forum attracts both Finnish and international participants from different industries, companies and governments. Helsinki hosts the annual Arctic Shipping Forum.

“Arctic Finland,” arcticfinland.fi [25] <https://www.arcticfinland.fi/EN/business>

Overview:

Because of the challenges facing the global economy and the great significance of exports and economic relations to Finland, it is extremely important for Finnish business and industry to seek growth in all areas where the prospects are favorable, and where Finnish companies have a chance of success. Such prospects are offered by the Arctic region.

Current & Relevant Information:

Finland's Arctic business and expertise

The strong expertise of Finland in Arctic questions is based on first-hand knowledge of the circumstances in the region. The best-known examples of Finland's Arctic expertise include Arctic marine technology and related business opportunities, solutions and services. Finland wants to promote growth and competitiveness in Arctic matters for example in cleantech and bioeconomy, always respecting the Arctic environment. Know-how and testing in the Arctic conditions are an important part of Finland's Arctic expertise. Sustainable and responsible tourism is also seen as an evolving opportunity for Finland. A more recent and growing field of Arctic expertise is Arctic design.

Bioeconomy

The special features of Finnish Arctic nature are large forest reserves and other varied and clean natural raw materials. The sustainable use of renewable natural resources includes various small-scale and large-scale methods from forest industry to collecting and exploiting natural resources, to entrepreneurship in the nature sector and to bioenergy production.

Technology

Finland has a long tradition in providing technological solutions that take into account the challenges of our Arctic operating environment. High-tech icebreakers and special vessels are built for Arctic conditions in Finland, and Finland wants to be one of the global leaders in research and development and education in marine technology and sea transport. In addition to marine technology Finland also has specialized expertise in other fields of cold climate engineering.

Tourism

Lapland is a leading tourism region in the Arctic. The keys of success are the unique nature and the experiences it can offer, and also high-quality services and infrastructure as well as tourism research and education.

Design

Arctic design refers to design that has the Arctic environment and understanding the Arctic conditions as starting points, and also takes into account human adaptation to Arctic circumstances.

Transport and logistics

The growth prospects of mining, the needs of tourism, the growing energy industry in the Barents region, the opening of the Northeast Passage have brought up development needs for transport and logistics, and the question of new connections in the north. Many potential investment and transport needs have also a cross-border dimension.

Expertise of Arctic circumstances

The Arctic is a challenging operational environment, but the location provides ample business opportunities. Lapland has become an important area for international vehicle industry for carrying out winter testing. The expertise and experience of Finnish shipping industries in challenging weather and ice conditions are valuable also internationally.

“Finland’s race for Arctic riches,” Reid Standish, Politico, 28 March 2018 [26]
<https://www.politico.eu/article/finlands-race-for-arctic-riches-resources-shipping-lanes-high-north/>

Overview:

A new frontier of geopolitics is opening up as countries move to control lucrative and strategically important natural resources and shipping lanes in the Arctic, and Finland doesn't want to be left behind.

The unprecedented rate at which the polar ice caps are melting is creating a flurry of activity. So far, Russia and China are leading the charge for the High North.

Moscow has been keen to stake its claim to an estimated \$35 trillion worth of untapped oil and natural gas under the Arctic seabed and to exert its sovereignty over the Northern Sea Route — a shipping lane through Russia's northern coast that represents a one-third quicker alternative from Asia to Europe than the Suez Canal. Beijing has also pushed its way into the region, announcing its vision in January for a "Polar Silk Road" as part of its trillion-dollar "Belt and Road" initiative.

For Finland, this presents a host of new opportunities.

Nestled in pine forests just 160 kilometers below the Arctic Circle, the snow swept city of Oulu along the northernmost reach of the Baltic Sea is perhaps best known as the home of Nokia's research and development facilities. But the city of 200,000 may soon be a vital hub for Helsinki as the government looks to leverage Finland's location as the European Union's northernmost point to become the bloc's gateway to the Arctic and to Asia over the next 30 years.

In the hope of gaining access to the potential flow of goods along the Northern Sea Route, the Finnish and Norwegian governments announced plans this month to move ahead with building a railway that would connect Finland, through Norway, to its deep-water ports in the Barents Sea.

A joint study by Oslo and Helsinki says the proposed railway would go from Oulu along to the Bay of Bothnia and connect to Rovaniemi in Finnish Lapland before ending in Kirkenes in northern Norway. Finalizing the rail link will require cutting through many layers of red tape, but the countries will begin looking at cost breakdowns and precise routing over the next two years.

Both the Finnish and Norwegian governments see the railway as an avenue for economic growth in their underdeveloped northern regions that could help a booming tourist industry, but also provide a more direct route for exporting Arctic resources from the area's lucrative mining, forestry and fisheries industries to Asian markets.

Current & Relevant Information:

The local Arctic goes global

Amid the talk of grand projects, there's still plenty of room for error and whether Finland's ambitions of gaining political and economic significance in the Arctic can be realized will depend on many factors.

For the disparate communities of the Arctic, the increased attention is both cause for celebration and concern. More development, tourism and industry mean more economic opportunity, but it could also disrupt the way of life for indigenous communities, such as the Sami that live across northern Norway, Sweden, Finland and Russia.

Lohi, the official from Lapland, agrees that any future plans will need to be carried out in careful consideration with the Sami and said developers should better protect reindeer populations, as herding provides a major source of livelihood for Sami communities. In 2017, more than 100 semi-domestic reindeer were killed by freight trains in northern Norway on a line that passes through traditional grazing areas.

In addition to the Arctic railway, there are also more immediate plans to build a high-speed rail tunnel under the Baltic Sea connecting Helsinki and Tallinn. Once completed (December 2024 is the tentative date), the tunnel will provide a straight north-south connection with the proposed Arctic railway for Asian markets to mainland Europe through Finland.

“Finland: Resources and Power,” Britannica [27]
<https://www.britannica.com/place/Finland/Resources-and-power>

Overview:

Trees are Finland's most important natural resource. Some three-fourths of the total land area is forested, with pine, spruce, and birch being the predominant species. Government cultivation programs, among other measures, have prevented forest depletion; and acid rain, which has devastated forests in central Europe, has not had any serious consequences in Finland. About one-fifth of all energy consumed in Finland is still derived from wood, though over half this total is waste sludge from pulp mills, and roughly another one-fourth consists of other forest-industry waste (bark, sawdust, etc.) rather than logs.

Peat deposits cover nearly one-third of the country, but only a small fraction of that land is suitable for large-scale peat production. Although expensive to ship and store, peat nevertheless provides a small percentage of Finnish energy and is also used in agriculture.

A variability of minerals occurs in the Precambrian bedrock, but mining output is modest, owing to the small size of the deposits and the low metal content of the ore. Most mines are located in the north. Iron is the most important of the industrial metals. The main nonferrous metals are nickel and zinc. Chromium, cobalt, and copper are also economically important. Gold, silver, cadmium, and titanium are obtained as by-products. There is no naturally occurring coal or oil in Finland. Some mica is quarried, mostly for export.

Because of the cold climate and the structure of the country's industry, Finland's per capita energy consumption ranks among the highest in the world. Industries account

for about half of total energy consumption, a much higher proportion than the European average. Domestic energy sources meet only about one-third of Finland's total energy requirement, and all fossil fuels must be imported.

Much of Finland's power comes from hydroelectric plants, but the low fall of water makes dam building necessary. The loss in 1944 of Karelian hydroelectric resources turned attention to the north of the country, where plants were built on the Oulu and Kemi rivers. Thermal-generated power is also important. Wind power is of lesser importance than it is in some other Scandinavian countries, but it is becoming more prevalent in the windier coastal areas. Finland's electricity grids are linked with those of Sweden and Russia, and electricity is imported. Fortum, the predominantly state-owned electric power company, operates a nuclear plant at Loviisa, east of Helsinki; nuclear power now constitutes about one-fourth of all power generated.

“The Arctic mineral resource rush and the ontological struggle for the Viiankiaapa peatland in Sodankylä, Finland,” Marija Lassila, *Globalizations*, 2021
[28] <https://www.tandfonline.com/doi/full/10.1080/14747731.2020.1831818>

Abstract:

The Nordic states and the Arctic have recently received increasing attention as a consequence of the rush to excavate newly discovered mineral resources in the Global North. Local land struggles related to the expansion of the extractive industry need to be assessed and constitute the focus of the present article. I examine the deeper levels of conflict between the mineral resource rush and local people. I highlight local people's plural ways of being in relation to the land through an ethnographic exploration of a pivotal mining project in Arctic Finland being resisted by Finns, who live in a pro-mining municipality. These people experience a threat to the continuation of their life worlds when large-scale extraction enters their territories. However, achieving legitimacy for their life worlds has been difficult. The article suggests that a key reason for this lack of legitimacy is the dominant 'one' world ontology and its 'nature' knowledge practices.

Current & Relevant Information:

Introduction

Recently, scholars have pointed out that capitalist modernity, which presupposes continuous economic progress, is responsible for the crisis now threatening the future survival of humans and other species (Gills, 2010; Gills & Morgan, 2019; Moore, 2015). The Cartesian and dualist nature vs. human world-making practices currently employed have faced considerable critique through political ontological, post-extractivist, post-development, and post-patriarchal work. In this work, alternative futures are emphasized through equality, community-based economies, non-capitalist practices and the nurturing of place-based relations (Acosta, 2015, 2017; Blaser, 2013; De la Cadena, 2015; De la Cadena & Blaser, 2018; Escobar,

2016, p. 15; Gibson-Graham, 2006; Gudynas, 2011, p. 1; Salleh, 2009, p. 11; Tsing, 2015, p. 63). Research on 'alternatives' has mainly focused on the Global South, while in the Global North and its Arctic regions, people are increasingly defending alternative ontologies and knowledge in relation to land. In these places, large-scale extractivism, particularly mining, has been gaining ground at an alarming pace since the mid-2000s, both on indigenous and non-indigenous lands (Kröger, 2019, 2016). Recent Arctic research on extractivism has largely focused on the Arctic's role in global resource competition (Avango et al., 2014; Borgerson, 2013; Sale & Potatov, 2010) and has increasingly focused on the conflict between indigenous self-determination and extractivism (Jaaskelainen, 2020; Kuokkanen, 2019; Lawrence & Larsen, 2017; Lawrence & Moritz, 2019; Persson et al., 2017; Willow, 2013). The research on Finland's mining boom has focused widely on the issue of obtaining a social license to operate, on the coexistence of extractivism and other livelihoods, and on sustainability and acceptability (e.g., Hast & Jokinen, 2016; Komu, 2020; Litmanen et al., 2016; Mononen & Suopajarvi, 2016; Tiainen et al., 2015). A more systematic 'alternatives' and land struggle discussion, however, needs to be held in relation to the Arctic and the Global North.

Finland, with its peaceful political atmosphere, is one of the most inviting regions in the world for mining companies (Stedman & Green, 2019). The acquisition of land by mining companies is fundamentally facilitated by the state through, for example, public access to geological data about the country's mineral resources (Lassila, 2018). The mining laws allow mining companies to reserve areas even in conservation areas for preliminary exploration via a simple announcement to the state, which could come from the other side of the world. The state also supports mining by setting low taxation rates, building infrastructure and offering financing for mining companies. This article focuses on an underground mining project, 'Sakatti', conducted by the British company Anglo American (AA) in the Sodankylä municipality. This mineral-rich region of Central Lapland, and the site of AA's project, is one of the most active sites for preliminary reservations and mineral exploration by foreign companies.

In this article, I focus on what I learned through my field research on the experiences of local Finns who are defending the continuity of their life worlds against the effects of large-scale extraction, which is producing novel socioecological vulnerabilities. The main orebody of the 'Sakatti' mining project that the company made public in 2009, was found in the 6595 ha Viiankiaapa peatland, a wet aapa mire. The deposit is speculated to be the richest copper and nickel discovery in Europe in the past several decades. At the same time, the peatland belongs to both the European Union Natura 2000 and to the national peatland conservation programs. This area, where Finns practice reindeer husbandry, is located outside of the indigenous Sámi homeland. However, the current extractivist reality faced by the Finns in this study takes place in the context of a Finnish settler colonialist past in northern Finland and

the denial of the indigenous Sámi's full self-determination and land rights by the state.

The questions I ask are as follows: What kinds of alternative ontological claims to their environment do Finns in the area have in the face of state and corporate land reservation for mining? What means are there to translate the singular bonds that the local people have for the Viiankiaapa peatland and the surrounding lands? Finally, how have those locals who would be most affected by the mining reacted to the prospect of such an undertaking? I argue that the problem of attending to non-dualist, alternative ontological claims over the territory extends also to people who are considered to belong to the majority population but whose environmental claims in their regions are marginal, due primarily to the extractive expansion that the state has enforced throughout in history. While the Finns' experiences, claims, and histories differ greatly from those of the Sámi in Finland, I demonstrate how the Finns discussed in this article have limited means to question the dominant assumptions of nature as exploitable in a majority pro-mining municipality. Living inside the 'one' reality, the knowledge framework of capitalist modernity, and in a 'state space' (see Sharma, 2020, p. 4; Law, 2015), people are faced with policies that fail to protect their heterogenic, existentially significant relations with the land in the studied area.

Conclusion

In this article, I have investigated the ontological conflict and environmental struggle inflicted by AA's planned multi-metal mine in the Viiankiaapa peatland in Arctic Finland. The expansion of global mining into Finland's peripheral areas has been made possible by measures that support the modern 'one' world system and its ontology of humans vs. nature. This includes the previous separation of people from the land through enclosure and colonization and the dismantling of self-sustaining rural economies, place-based relations, and ecological knowledge in a historical continuity of capitalist resource extraction. This article has contributed to locating differences and discussed the legitimation of alternative relations to the environment in a Nordic state. I have demonstrated how, against the background of the settler colonialist history vis-à-vis the indigenous Sámi in the north, Finns also find their places of integral ontological meaning to be incommensurable with the proposed extractive development. Within 'one' space of the state and corporate interests in a pro-mining municipality, the Finns in this article face a continuity of land enclosures, as conservation and recent multinational mining plans have ignored their place-based bonds. In relation to an externalized and extracted or conserved 'nature', in the nature/human dualism of today, the life worlds and territorial claims of nearby villagers, such as Riikka Karppinen, or those of the Viiankiaapa reindeer herders, are not legitimated or easily articulated. The place-based ontological bonds presented in this article and the people of the north, who engage in the struggle to preserve these bonds, present creative and generative alternatives to the global

extraction that is only intensifying. More research is needed on the variability of these unique lives and their forms of interlaced cohabitation. Such research should cast a spotlight on the existential situation of people in these situations, thereby helping them to persist. Finally, further research may clarify how they both envision and embody alternative futures for us all.

“What Are The Major Natural Resources Of Finland?” Benjamin Elisha Sawe, World Atlas, 8 January 2019 [29] <https://www.worldatlas.com/articles/what-are-the-major-natural-resources-of-finland.html>

Overview:

Finland is one of the most stable economies in the world with its \$300-billion nominal GDP ranking as the 41st largest in the world. While many of the country's export items come from its manufacturing industry, the country's natural resources also feature in its list of export items with some examples being pulp and paper, and sawn timber. Finland is among the European countries which are known for their dense forest covers. These forests are a major natural resource of the country and support one of Finland's largest industries, its forestry industry. The rivers and lakes are also important natural resources in Finland since they earn the country millions of dollars in fishing, hydroelectric power generation, and tourism.

Current & Relevant Information:

Forests

Finland is situated in a region which is known for thick forests running across most of northern Europe. About 72% of Finland is under forest cover, making it the second most forested country in Europe after Sweden. The thick forests are a major natural resource for the country and a major foreign exchange earner. The country is the leading producer of many forestry products not only in Europe but globally. Finland is among the largest producers of sawn timber in Europe and is one of the leading producers of paper and pulp globally. The prominence of forestry in Finland's economy can be seen in the dominance of forestry products in the country's exports where the industry is responsible for an estimated 20% of all exports from Finland. Some economists value the country's forestry industry at over \$20 billion. Some of the major players in the industry include Metsa Board and Stora Enso which are behemoths in the global forestry industry. The forestry industry is also a major employer in the country with more than 15% of all industrial workers in the country or more than 0.16 million people being employed by the industry. Majority of these workers are either indirectly or directly employed in the sawmill sector. The country is also home to the world's best carpenters who produce some of the finest woodwork in the world. Despite being largely-developed, more than 20% of the country's inhabitants use wood for energy which normally wastes from the pulp and paper mills found all over the country.

Minerals

Finland is a country which is laden with mineral wealth. Among the minerals found in the country include copper, iron ore, nickel, cobalt, and chromium, all of which are found in commercial quantities. However, the country seems to focus more on imports for its metal requirements despite having immense deposits of different types of metals. The reason behind the surprising preference is because the country concentrates more on adding value to processed metals. Nonetheless, metals are still a significant portion of the country's export items. Examples of such metals include welded steel pipes, coated sheets, and copper pipes.

Lakes

One of the most important natural resources of Finland is the country's thousands of lakes. Also known as "the land of a thousand lakes," Finland has one of the highest concentrations of lakes of any country in the world. The total number of lakes found in the country is estimated to be about 0.187 million. These lakes have innumerable economic benefits to Finland. The lakes support a wide range of aquatic life and are, therefore, crucial in the country's fishing industry. The nation's largest lake, Saimaa is important in water transport as it features a series of canals which are used in the transportation of a wide range of cargo. Another huge lake in the country is Paijanne which covers an area of over 413 square miles. The lake injects millions of dollars into the economy of tourist revenue as it attracts thousands of canoe enthusiasts each year.

Rivers

The northern European nation is home to thousands of miles in rivers which are also natural resources for the country. Some of the major rivers in the country include the Tenojoki, Kymijoki, Kitka, Simojoki, and Kemijoki rivers. Similar to the lakes, these rivers are home to many species of fish which are an important source of protein for residents of Finland. The Tenojoki River is notable for being among the best places for salmon fishing in the continent. Grayling and trout are other examples of fish found in the Finnish rivers. Apart from being important sources of fish, the rivers also play a crucial role in the country's energy industry through the production of hydroelectric power. Having the highest energy consumption per capita in the EU and with the world turning to renewable energy, Finland has invested heavily in renewable energy sources one of which being hydro-electricity projects in the major rivers. The country has over 300 hydroelectric power plants which in total produce more than 3.1 gigawatts.

Agricultural Land

Despite experiencing harsh climatic conditions, Finland's agricultural industry has grown to make the country self-sufficient. The abundance of agricultural products in the country which experiences harsh winters is made possible through the

employment of cutting-edge technology in the industry as well as the practice of large-scale farming. The country also has large tracts of land under irrigation to make them agricultural productive. These technologies enable Finland to be the sole country to practice agriculture at a significant scale in the extreme northern part of the globe. Finland agricultural industry is an important employer in the country, with an estimated 0.12 million people being employed in the industry. However, the importance of agriculture to Finland's economy has been on a decline with the number of people employed by the sector and the number of farms in the country gradually decreasing in recent years.

“Spaces of the forest-based bioeconomy in Finnish Lapland and Catalonia: practitioners, narratives and forgotten spatialities,” Diana Morales, Fennia, 2021
[30] <https://fennia.journal.fi/article/view/109523/71760>

Abstract:

Over the last decade, the bioeconomy has been increasingly promoted as a strategy able to shift our economies away from fossil fuels and boost local economic growth, especially of rural areas in Europe. The bioeconomy is an important part of the European Union agenda, it is promoted through European wide strategies that are translated into local and regional policies. However, the bioeconomy does not unfold equally across regions; it has different implications influenced by the spaces and the narratives with which the policies are created and implemented. Amongst all the actors participating in the bioeconomy strategies, local practitioners play a crucial role in interpreting the narratives and implementing the policies in a way that makes sense for their local contexts. Hence, there is a need to understand how local and regional practitioners apply bioeconomy strategies to grasp how those are expressed in different regional contexts. Through the case studies of the forest-based bioeconomy in Catalonia and Finnish Lapland, this paper explains why economic narratives prevail in the local bioeconomy and how regional spatialities are affected by it. The cases show that the bioeconomy remains close to economic growth and is applied through regional economic development policies, thus focusing on specific economic sectors and hindering the role of the bioeconomy in a wider regional transformation. Understanding the narratives and how these reflect the spatialities help us to advance a spatially sensitive approach to the bioeconomy, this is, a bioeconomy practiced according to the socio-spatial conditions, closer to ideas of comprehensiveness, plurality and justice, and with a greater role in a wider regional transformation, rather than the greening of specific economic sectors.

Current & Relevant Information:

Introduction

By promoting the bioeconomy, the European Union advocates for a technological and economic change to address climate change, and reaffirms its intention to maintain a leadership position in the transit towards a fossil fuel free society

(European Commission, 2012, 2019). The first European bioeconomy strategy was published in 2012 and, since, it has been modified and criticized for not addressing issues of ecological sustainability. In this paper, I refer to spatialities as the social, economic, cultural and natural processes that constitute the spaces inhabited and lived (Walker 2009; Merriman et al. 2012). By comparing how local practitioners understand and conceptualize the bioeconomy policies, and by examining the narratives with which it is reproduced in Lapland (Finland) and Catalonia (Spain), I argue that even if the conceptualizations tend to place the bioeconomy as a wider process of regional sustainable transformation beyond industries, some of the spatialities where it is applied are largely overlooked. This because the policy strategies used to implement the bioeconomy remain strongly linked to regional economic growth, imposing economic growth views over other ways of understanding the bioeconomy. The case studies show that those narratives favor the transition of specific economic sectors but hide varied socio-spatial configurations and, ultimately, downplay the role of the bioeconomy in a larger regional transformation (understood as a larger societal transformation that includes as much industrial modernization and economic growth as civil society participation, social innovation and environmental justice). Empirical studies explaining how local and regional actors interpret and adapt green policies are still scarce (Amundsen & Hermansen 2020), and with this paper I intend to contribute to this debate. I begin with an overview of the multiple definitions given to the bioeconomy, paying special attention to the branch of the bioeconomy based on forest resources, as it is the dominant type of bioeconomy in Lapland, and gaining relevance in Catalonia. Then I continue to the methodological and data collection strategies, followed by an explanation of the narratives and how these reflect and conflict with the spatialities. Conclusions can be found in the last section.

Conclusion

This paper provides material to unpack the spatialities with which the bioeconomy interacts and to reflect on the processes of implementing the bioeconomy as a policy concept. To answer whether the spatialities of the bioeconomy are reflected or overlooked in its narratives, and how this plays a role in a wider regional transformation, I analyzed the bioeconomy strategies in Catalonia and Finnish Lapland as portrayed by its practitioners. Table 2 summarizes the areas prioritized and overlooked within economic narratives of the bioeconomy.

Table 2. Summary of identified areas within the rural and industrial spatialities within the bioeconomy.

	Bioeconomy in	
	Rural spatialities	Industrial spatialities
Prioritised areas in economic growth narratives	<ul style="list-style-type: none"> Creation of jobs Modernisation Infrastructure Natural resources Income for rural inhabitants 	<ul style="list-style-type: none"> Creation of jobs Modernisation Infrastructure Natural resources Greening of forestry and other industries Agglomerations and collaborations Circular production
Overlooked areas in economic growth narratives	<ul style="list-style-type: none"> Non-economic relations with nature Local and traditional knowledges Conservation and biodiversity Spatial unevenness Environmental justice 	<ul style="list-style-type: none"> Sustainable use of resources Conservation and biodiversity

When the bioeconomy is understood as a policy concept able to create imagined futures, the narratives become powerful tools to shape the transformation process (Birch 2016; Bauer 2018). Successful narratives (or desirable imaginations), are supported while less successful ones are left with little support. The case studies show that dominant narratives of economic growth and industrial modernization, facilitate the transition of specific economic sectors but hide varied socio-spatial configurations and, ultimately, downplay the role of the bioeconomy in a larger regional transformation. That prevalence is partly explained by the set of policies and strategies the practitioners have at hand to implement the bioeconomy. Having no more tools than those traditionally used for regional economic growth, even if the bioeconomy is conceptualized as a wider regional transformation, the strategies with which it is grounded have an economic lens that do not see beyond creating economic value.

Questioning the dominant narratives and the strategies that apply and reproduce them is relevant when it comes to implementing the F-BB, as the impact on rural areas can be profound. The bioeconomy proposes a route for rural development: that forest biomass can replace fossil fuels and other materials to address climate change while stimulating economic growth, rural development and the modernization of the forestry industry. These narratives endorse imagined futures of rural spatialities that are not only too narrow in how non-urban spaces and nature are perceived. They also overlook local knowledge, the role of farmers, indigenous communities and other rural inhabitants in rural development (see Schmidt et al. 2012; Mustalahti 2018).

To finalize, this paper is limited by not accounting for local conflicts likely to occur when different economic actors compete for the same natural resources. A future research agenda includes questioning the relationship between the bioeconomy and local knowledges, lives and experiences. Several questions remain. What kind of conflicts can emerge from an increased demand for biomass, what is the impact of a forest-based bioeconomy in regional labor markets, or how to govern the bioeconomy and biomass production when its supply depends on a multitude of actors (farmers, landowners, states, corporations)? Addressing these kinds of questions is key to keep advancing our knowledge about sustainable transformations.

4. Iceland:

“Arctic economy within the Arctic nations,” Helen McDonald, Solveig Glomsrød and Ilmo Mäenpää, *The Economy of the North* [31]

https://www.ssb.no/a/english/publikasjoner/pdf/sa84_en/kap4.pdf

Overview:

In his book on the history of wealth and poverty of nations, Harvard professor David S. Landes devoted the introductory chapter to highlighting how natural conditions in the tropics represent serious barriers towards economic development. He did not consider the Arctic in the same context but the Arctic environment is generally seen as an even bigger challenge to livelihood than the tropics. Over the years people seem to have voted with their feet in this matter, while the tropics abound with people, the Arctic is sparsely populated. The 10 million people who currently live in the Arctic Region, what do they do for a living? To live in the Arctic, people must have their very special reasons, the remaining 99.8 per cent of the world population might easily think. One clear reason is the attraction of people and investments to natural resources. Another is the fascination of the qualities of nature, shifting from extreme and blending grandeur to darkness and stillness.

These special reasons should be reflected in the structure of the Arctic economy, indicating the extent to which nature in the Arctic has had its say in shaping the economy of the north. This chapter provides an overview of the predominant economic characteristics and the major industries of the Arctic regions within the Arctic nations. It also provides information about the contribution of the Arctic regions to the economy of the respective Arctic nations. Thus, for the most part, the information in this chapter is viewed from an intra-national rather than a comparative international perspective, although some comparisons among the regions are made in the concluding remarks to this chapter.

While there is significant economic variation across the Arctic regions of the Arctic countries, many of these regions host large resource-based industries. In many cases, resources produced in the Arctic are shipped outside the Arctic region to export markets or southern markets within the same country. At the same time, the

Arctic regions tend to draw extensively on southern markets for specialized and professional labor, capital, and consumer products. While Arctic regions generate income and resource rent from natural wealth, they also receive transfer payments from national governments. In some Arctic regions resource exploitation generates economic activity within the region in the form of the construction and operation of pipelines, and the provision of services such as transportation, wholesaling and retailing and housing. With some exceptions, manufacturing activity tends to be limited in Arctic regions. The electronics industry in Oulu in Northern Finland and the industrial sectors in Northern Russia and Northern Sweden are exceptions to this and the data presented in this chapter illustrate the variability in economic structure among Arctic regions that is frequently overlooked when the Arctic economy is discussed.

For each of the Arctic regions this chapter contains a core table showing regional gross domestic product (GDP) and the contribution to regional GDP by industry at a disaggregated level (for 17 industries). This level of detail is intended to capture all the main activities of the circumpolar Arctic region. The data for the Arctic excluding Russia are based on national statistics and World Development Indicators of the World Bank. Arctic Russian data by main industry are provided by Russia's Federal State Statistical Service and further harmonized with statistics for other Arctic regions using production and employment statistics. These core tables generally refer to the year 2002, which represents a compromise between coverage and timeliness. The tables present value added or contribution to GDP in local currency in order to focus on the Arctic element of their respective national or federal economies. Where available some more recent economic indicators are presented.

Current & Relevant Information:

Iceland is endowed with a mild and humid climate due to the influence of the North Atlantic Current. The country has a population of slightly above 300 000 people of which 115 000 lives in the capital of Reykjavik.

The Iceland economy is clearly focused on fishing, which accounted for 8.4 per cent of GDP in 2002. A system of individual fishing quotas was introduced as early as in 1984. Fishing together with fish processing (3 per cent) is still a pillar of the Iceland economy. However, income from manufacturing other than fish processing accounts for as much as 10.3 per cent of GDP. The mining industry is small, but the country is rich in hydropower and geothermal potential. Manufacture of primary metals is encouraged as a vehicle to export the energy surplus. The value of production in the metal industry increased by 63 per cent from 1998 to 2005. The tourism sector has expanded as a result of growth in eco-tourism and whale-watching. The completion of Iceland's circle road has made it easier to approach the Vatnajökull by car and has contributed to the growth in tourism.

The Iceland economy has grown rapidly in recent decades, and growth in GDP amounted to 8.2 per cent in 2004 and 5.6 per cent in 2005. Import volumes increased drastically after 2002, responding to high investment in the energy and the aluminum industries. The accompanying imbalances in the economy illustrate the difficulty of implementing large-scale projects in a small economy. The dynamics of the Iceland economy have established a secondary industry of 25 per cent of GDP in 2002, whereas primary production from extractive industries only accounted for 10 per cent of GDP. Besides fishing there is some agriculture amounting to 1.6 per cent of GDP. To determine the degree of nature-based production, we have to add the energy sector and processing of raw materials to the pure extractive industries. In total, 20 per cent of GDP can be said to be based on Iceland's own resources and nature. The wood and paper industry is included in this estimate. Iceland has carried out substantial tree planting programs, particularly over the last 50 years. There is also a government program for CO₂ sequestration in forests. Tourism is a growing industry that would have raised the indicator of natural resource dependency even higher if data were available. Its share in total employment increased from 3.3 per cent in 1992 to 4.4 per cent in 2004.

“Iceland,” The Arctic Institute: Center for Circumpolar Security Studies, 1 March 2023 [32] <https://www.thearcticinstitute.org/countries/iceland/>

Overview:

Facts & Figures

AC member since 1996

Active Polar Icebreakers

0

Coordinates

Reykjavík: 64.1265° N, 21.8174° W

Akureyri: 65.4100° N, 18.0516 W

Population

376,000

Land Area

103,000 km²

Arctic Coastline

4,970 km

Current & Relevant Information:

Iceland's economy is based on a social-market framework with a Nordic welfare system. The major sectors of Iceland's economy are fisheries, manufacturing, and tourism. Fisheries are the largest and most important sector of Iceland's economy, accounting for 40 percent of export earnings and roughly 27 percent of total GDP. By some estimates, ocean livelihoods account for 20 percent of the workforce, and include fishing, fish processing, and technological companies included in equipment manufacturing and biotechnical production. Cod makes up the majority of Iceland's harvest, with the 2015 quota set at 239,000 tons. With the introduction of the quota system, Icelanders have moved to supplementing cod in processing with blue whiting. As the Atlantic Ocean warms due to overall warmer seas from climate change, the Atlantic mackerel has moved into Iceland's national waters and fishermen have in turn harvested more mackerel, which has led to considerable political turmoil with the European Union.

Because of Iceland's geothermal and hydroelectric energy sources, power-intensive industries have become a strong component of Iceland's exports. Manufactured products constitute roughly 35 percent of all merchandise exports, the most important of these being Aluminum smelting. There are currently three plants in operation in Iceland, placing it 11th among all aluminum producing nations in the world. Rio Tinto Alcan has been operating the first aluminum smelter since 1969 at a capacity of 189,000 mtpy. Nordurál, a wholly owned subsidiary of U.S.-based Century Aluminum Company, owns the second smelter and US-based manufacturer Alcoa runs the third. Future smelting operations have been identified to expand the industry, including a jointly proposed smelter in the Northwest of the country by an Icelandic and Chinese company.

Tourism in Iceland has grown substantially over the past 15 years, accounting for over five percent of total GDP in 2015. A large part of the revenue from tourism comes from airfare, with other revenue generated from hotels, restaurants, and other service providers. Each year over one million people visit Iceland, with more projecting to continue in the future. Tourism was an important sector of economic growth during the 2007-2011 financial crisis, helping the country move past its recession.

Because of its small size, Iceland's economy is vulnerable to high volatility and has been the subject of much research and media coverage surrounding the financial crisis of 2007-2011. In late 2008, all three of Iceland's major privately owned commercial banks defaulted from difficulty refinancing short-term debt. Its systemic banking collapse was the largest experienced by any country in economic history and led to a severe depression and considerable political unrest, the legacy of which can still be seen today. The national currency, the Icelandic Króna, fell sharply in value and the stock exchange fell by more than 90 percent. Unemployment more than tripled in 2008, and in the years following the bank failures, GDP dropped by 10 percent in real terms. The effects of Iceland's financial crisis. The effects of the crisis

were not only felt inside the country, but also internationally, particularly from UK and Denmark investors who had millions of dollars in cash invested in Icelandic banks. In the heights of the crisis, one to two percent of the population was protesting against the banks and government reaction in Iceland's capital. In 2009, both the Prime Minister and Commerce Minister resigned, and there have been a number of special investigations and court cases leading up to today. Iceland began to recover in 2011, posting its first growth in mid-2011 since the bank failures. The recovery of Iceland from the financial crisis is seen as a success in the larger European financial crisis and continues to diversify its economy beyond international finance. It is to be seen what the wider implications of the Panama Papers will be for the Icelandic economy, though Prime Minister Sigmundur David Gunnlaugsson offered his resignation in April 2016 amid the controversy over his offshore holdings.

This created a climate of political instability and triggered a quick succession of elections. Sigmundur David Gunnlaugsson lost the premiership and the chairmanship of the Progressive Party to Sigurður Ingi Jóhannsson who later lost the election held in October 2016 against the leader of the Independence Party Bjarni Benediktsson. Benediktsson served as Prime Minister from January 2017 to November 2017 when the government collapsed after a scandal linked to the Prime Minister who had to call a snap election on October 27, 2017. In the aftermath of the elections, Katrín Jakobsdóttir, the leader of the Left-Green Movement was asked by President Guðni Th. Jóhannesson (2016 – present) to form a governing coalition. Jakobsdóttir became Iceland's 28th Prime Minister and only the second woman to serve as head of government after Jóhanna Sigurðardóttir (2009-2013). The new government brings together members of the Progressive Party, the Independence Party and the Left-Green Movement.

Beyond its financial crisis, Iceland has had some economic disappointments, particularly in the potential of its offshore hydrocarbon resources above the Arctic Circle. Iceland continues to search for oil, but it has yet to move forward beyond exploration. However, Iceland has the potential to grow in software production, biotechnology, and data storage through its geothermal energy in the years to come.

“Circular and renewable: lessons from the island of Iceland” Martina Chow, Economist Impact, 3 April 2023 [33]

<https://impact.economist.com/sustainability/ecosystems-resources/circular-and-renewable-lessons-from-the-island-of-iceland>

Overview:

As we reflect on the progress and pitfalls of 2022 here at Economist Impact, and [look ahead](#) to the challenges that will shape the coming months, it is clear that urgent and tangible action on the climate crisis is well-overdue. As governments and businesses implement their commitments, learning from the successes and challenges of others, particularly those with more experience, will be critical.

Iceland is one such example. The island nested between Greenland and Norway has successfully transitioned its economy from fossil-fuel-based to one grounded in renewable geothermal and hydropower energy. The [main drivers](#) of this transition were the difficulties associated with keeping up with fluctuating oil prices, which were only made worse by the 1973 [oil crisis that sent prices skyrocketing](#). Iceland therefore provides lessons for its neighbors in Europe currently dealing with an energy crisis accelerated by Russia's invasion of Ukraine.

Current & Relevant Information:

In October 2022 I was invited by [Green by Iceland](#) to learn more about exactly this: how Icelandic businesses and communities have been spearheading circular and renewable energy solutions. In this context of urgency, frustration and promise that is set to characterize the months and years ahead, the solutions I learnt about during my visit feel particularly relevant.

The International Energy Agency estimates that renewables are set to account for over [90%](#) of global electricity capacity expansion between 2022 and 2027, and will surpass coal to become the largest source of electricity generation by [2025](#).

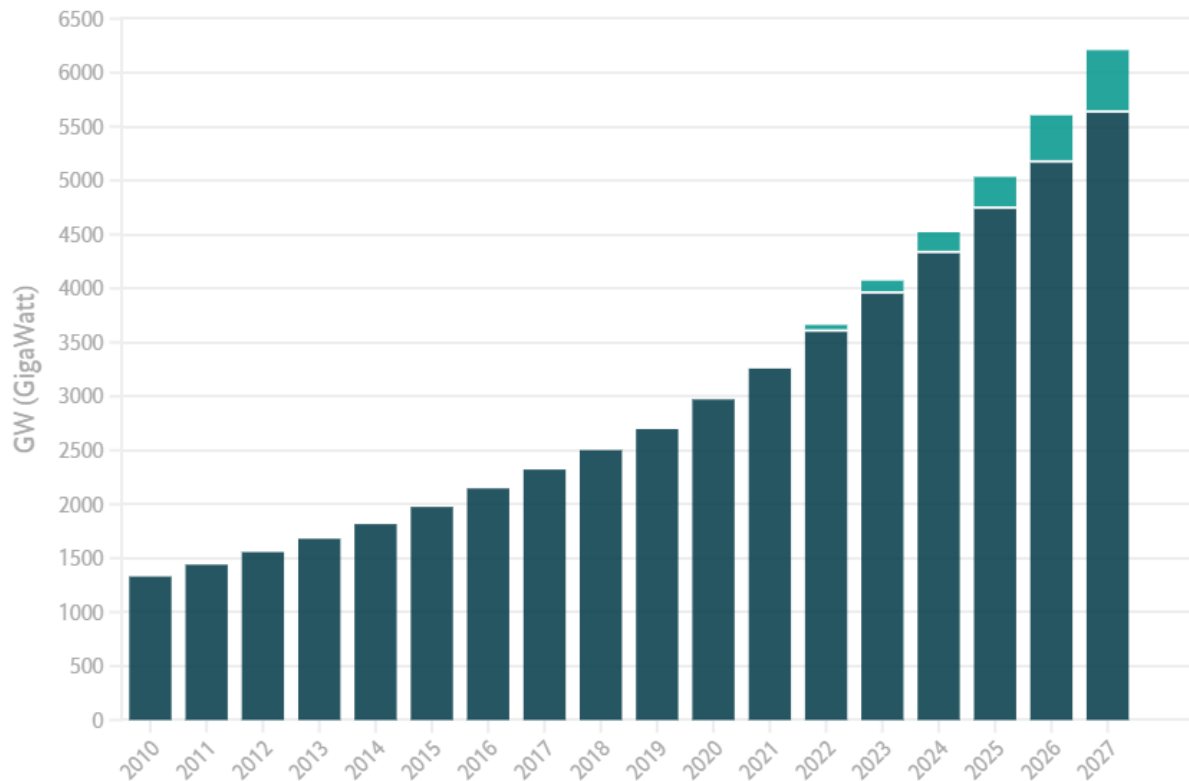
This will deliver benefits beyond a reduction in carbon emissions. Indeed, the 2022 Economist Impact study, [Sizing the Energy Transition](#), assessed the potential economic impacts of 1.5°C-consistent energy transition pathways for 2030. We found that investments in four key sectors—clean power, road transport electrification, green steel and clean hydrogen—could support more than 20 million jobs and add more than 4% to global GDP. The energy transition is currently dominated by wind and solar PV, which accounted for [32% and 51%](#) of renewable net capacity additions in 2021, respectively. Both are intermittent sources since they generate electricity from technologies whose [power output is weather-dependent](#). Storage and battery capacity is improving, which will mitigate this concern. Nonetheless, a comprehensive energy transition still requires the development of dispatchable energy sources. These are not weather-dependent, and can therefore be deployed in tandem to secure a [reliable supply of renewable energy](#). Geothermal energy—which uses heat from the earth's crust to generate electricity—is one of these energy sources. Iceland is known for its geothermal energy production. The country is just 103,000 km² (less than half the size of the UK), but is among the top ten global producers of geothermal energy—85% of its energy mix comes from domestic renewable sources, and geothermal sources account for 66% of its energy use. This saves Iceland US\$100m in fossil-fuel imports every year. During my trip I visited some of the country's largest geothermal energy plants, and learned more about the processes, challenges and opportunities for the sector going forward. Geothermal energy arguably attracts less coverage than other renewable energy sources since it is currently limited to areas with volcanic activity. However, geothermal resources can be [accessed in almost every country](#) through [enhanced geothermal systems](#) that tap into heat stored at depths of

as much as [3–4 km \(2–3 miles\)](#) into the earth’s mantle. But this comes with costs and risks.

Total global renewable energy capacity, main and accelerated case, 2010 - 2027

Source: International Energy Agency

■ Main case ■ Accelerated case



PROJECTED GROWTH RATES OF RENEWABLE ENERGY

Costs, risks and opportunities

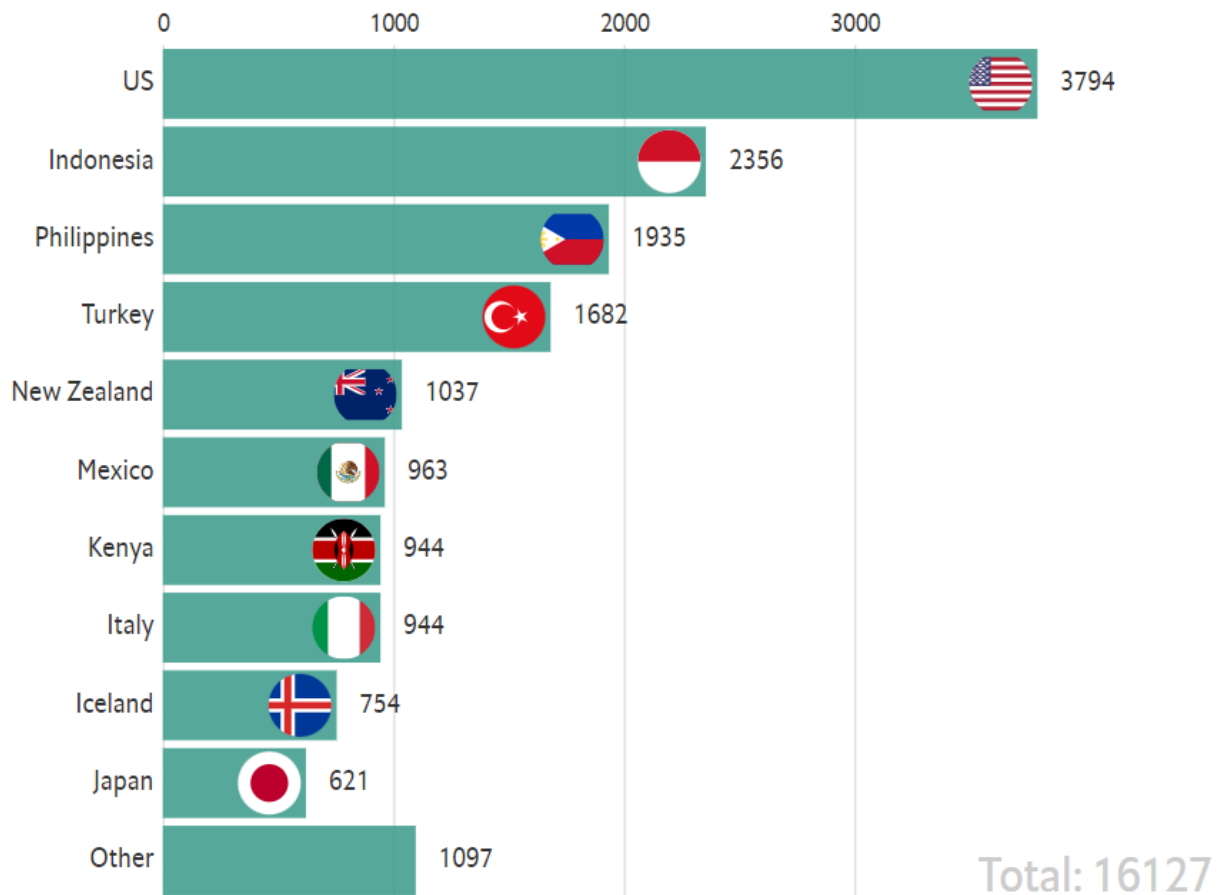
Deep-drilling technology has advanced rapidly in recent years, and expertise is growing. Indeed, Icelandic engineers have assisted engineers involved with geothermal projects in China, and are keen to export this knowledge further. The challenge is that, even if operating costs are relatively [low](#), geothermal energy has [high upfront costs](#), particularly in [challenging development sites](#). That said, the International Renewable Energy Agency estimates that the costs of the technology [will](#) fall, which will lower existing access barriers. And, as countries ramp up their decarbonization efforts, public investments in geothermal will increase.

Beyond Iceland, geothermal technology is already being developed further in countries like [Germany](#) and the [US](#) as part of their net-zero pledges. Looking ahead,

there is a lot more [potential](#) in parts of Asia, including Indonesia and the Philippines where resources are ample and the pressure to decarbonize is increasing. In this context, however, it is important that policies ensure that pre-development and resource extraction are conducted in an environmentally safe and socially just way, keeping in mind indigenous and local community land rights.

Top 10 Countries for Geothermal Installed Capacity (MWe), 2022

Source: ThinkGeoEnergy



TOP 10 COUNTRIES FOR GEOTHERMAL ENERGY

Circular (geothermal) energy systems

In addition to developing so much renewable capacity, Iceland integrates circular solutions in and around its geothermal plants. Principles of the circular economy will be crucial components of any system transformation, as they ensure that already-strained resources are used efficiently and kept within closed loops. This comes with challenges. In Economist Impact's podcast series, Inside the Circle, we explored the circular economy in action across four systems: plastics, food, fashion and cities. None of these systems has reached perfect circularity, but as more countries and businesses seek to incorporate these principles into their activities, our interviews revealed that pilot studies and learnings from best practices are crucial. My visit to

Iceland gave me a glimpse into a best practice of the circular economy in an additional system: energy. Each geothermal power plant we visited was located in a “resource park”. The power plant shares its land with various businesses that use its residual resources. At the ON Power geothermal park, a food tech company, VAXA, runs entirely on geothermal electricity from the plant and uses the plant’s residual CO2 as fuel for its vertical seaweed farm. The park also houses the Orca plant, a joint project between Carbfix and Climeworks, that directly captures CO2 from the atmosphere and injects it into the (basalt) rocks through a process called mineralization. At the HS Orka geothermal park, the Blue Lagoon uses geothermal water from the plant for its hot springs and extracts silica from the water for its health and cosmetic products. Discussions with Icelandic business leaders and industry experts reveal that circularity has become the norm for businesses, policymakers and the community alike. This theme was equally evident in an Economist Impact World Ocean Initiative interview about sustainable seafood with Dr Thor Sigfusson, founder and chairman of Iceland Ocean Cluster. There are lessons, then, not just in the realm of renewable energy solutions, but also in the intersections between systems transformations and principles of circularity.

Conclusion

When it comes to climate change and sustainability it can be easy to lose sight of progress amid the influx of bad news. But seeing these solutions in action gave me a new burst of energy, and was a reminder that the technologies, expertise and ideas are all at our disposal.

The energy transition is well upon us. Wind and solar PV are and will continue to be the main sources of renewable energy. But it is equally important that other—albeit less dominant—dispatchable energy sources, like geothermal energy, are properly and responsibly accounted for. As governments and businesses worldwide pursue their own decarbonization pathways, best practices are all the more important. In this context, Iceland serves as a source of inspiration for the rollout of renewables, the uptake of new technologies, and the incorporation of principles of circularity.

“Geography of Iceland,” John Misachi, World Atlas, 4 May 2021 [34]

<https://www.worldatlas.com/geography/geography-of-iceland.html>

Overview:

Iceland is an island country in the North Atlantic, located south of the Arctic Circle. It is approximately 290 kilometers off south of Greenland, 860 kilometers from Scotland, and about 4,200 kilometers from New York. Although the country comprises numerous islands, the main island covers 98.8% of the country’s total area (101,826 square kilometers of the 103,000 square kilometers). The main island is Europe’s second-largest and the world’s 18th largest island. Iceland has a coastline of about 4,970 kilometers.

Current & Relevant Information:

Natural Resources

Iceland has three major natural resources that have contributed significantly to its economic growth over the years. These major resources are fisheries, water, and renewable energy. Fishing has been one of the country's major economic activities since ancient times. Fisheries were so important to Iceland that they fought the UK over fishing limits. Today, Iceland's exclusive economic zone is approximately 751,345 square kilometers. Fish accounts for about 40% of the country's export value. In 2011, the sector contributed 27% of the GDP. According to the labor department, fisheries employ over 5% of the total workforce.

Iceland has vast amounts of geothermal and hydroelectric power due to its location. The country generates almost all its energy from clean sources, making it the world's largest renewable energy user. About 90% of homeowners use geothermal power to heat their homes. The government has constructed geothermal plants throughout the country, including Krafla and Nesjavellir.

Although Iceland is surrounded by the saline Atlantic Ocean, it has plenty of pure water. It is one of the major exporters of bottled water, with its water becoming more popular globally. Water remains an essential natural resource in Iceland because of its industrial and home use. Up to 70% of the country's electricity is hydropower, while other industries also rely on water for production.

“The Arctic Region,” Government of Iceland [35]

<https://www.government.is/topics/foreign-affairs/arctic-region/>

Overview:

Arctic issues have in recent years become ever more prominent internationally as well as domestically. The discussion on the changing Arctic and its relationship with climatic change, discussions on the utilization and protection of natural resources, continental shelf and sovereignty demands, societal changes and the opening of new seaways is and will be of interest today and in the future.

Current & Relevant Information:

It is clear that few states have a greater interest in the sustainable development of the area than Iceland, since all of the country and a large part of its territorial waters lie within the boundaries of the Arctic region. This is unique among the member states of the Arctic Council. Arctic issues touch nearly every aspect of Icelandic society and are a key foreign policy priority in Iceland.

Iceland's policy in Arctic issues is anchored in a parliamentary resolution adopted unanimously by Althingi in the spring of 2011 which outlines 12 priority areas. They cover e.g., Iceland's position in the region, the importance of the Arctic Council and the United Nations Convention on the Law of the Sea, climate change, sustainable

use of natural resources and security and commercial interests. Emphasis is furthermore placed on neighbor-state collaboration with the Faroe Islands and Greenland as well as the rights of indigenous peoples.

The Arctic Council, since its establishment in 1996, has become the most important multinational forum for Arctic issues. In addition to the eight founding members, six organizations of indigenous peoples have permanent seats on the Council and 39 parties have observer status: 13 states, 13 intergovernmental organizations and 13 non-governmental organizations. Decisions are made unanimously in the Council.

Three legally binding agreements have been negotiated under the auspices of the Council, on search and rescue, on prevention of oil pollution and the third one on enhancing scientific cooperation in the Arctic.

The large majority of the work of the Arctic Council takes place in six working groups whose contributions to the increased knowledge of the environment, biota and societies of the Arctic region have proven invaluable.

Two of those working groups, the Conservation of Arctic Flora and Fauna (CAFF) and the Protection of the Arctic Marine Environment (PAME) are located in Akureyri but in conformity with Iceland's Arctic policy an emphasis is placed on hosting a part of the operations of the Arctic Council in Iceland.

Iceland will assume chairmanship of the Arctic Council in 2019 and hold it until 2021. The chairmanship will clearly be among the biggest projects Iceland has undertaken internationally and will require careful and elaborate preparations. Iceland's position as one of eight member states of the Arctic Council is strong, and gives Icelanders the opportunity of having their voices heard and influence felt.

“Iceland: Small but Central,” Alyson Bailes, et al., kas.de [36]
https://www.kas.de/c/document_library/get_file?uuid=e861e1f4-bc1f-0c38-efdd-be81f6aeda16&groupId=252038

Overview:

If asked whether Iceland should be considered an Arctic or sub-Arctic state, the best answer would be both depending on the context. Geographically, Iceland lies outside the North polar zone proper, with its Northernmost Island of Grimsey just grazing the Arctic Circle. Settled around 1000 years ago, it has no indigenous peoples. Its vegetation is mostly sub-Arctic, although 11 percent of the land is covered by icesheets. However, in the work of the Arctic Council, such as the preparation of Arctic Human Development Reports (ADHR), Iceland and other territories even further South have been included as they are seen as part of a single environmental and economic complex. Iceland's economy is still heavily dependent on fishing and more generally on natural resources, which it exploits both for hydroelectric and geothermal power generation and to attract tourists; this gives it

more in common with North Norway, Greenland and the Faroes than, say, mainland Denmark.

In terms of conscious identity-framing and policy positioning, Iceland has stressed its Arctic credentials not only by becoming a founding member of the Barents Euro-Arctic Council (1993) and the Arctic Council (1996), but by asserting that it is just as much a High Northern 'littoral' (coastal) state as are the 'Big Five' who actually own land above the Arctic Circle. Overall, Iceland's attitude is well summed up by its claim to be the only sovereign state lying entirely within the Arctic zone.

This chapter starts by identifying some basics of Iceland's external orientation as a 'small state', then traces the development of its official Arctic policies, and the external relationships and institutional frameworks in which the nation pursues its interests. The full range of Icelandic stakeholders and shapers of Arctic strategy is then reviewed, from ministries and academia, to private corporations from major economic branches with additional details about the issues at stake. Finally, we stand back from day-to-day politics to consider the nature of Arctic discourse(s) in Iceland, and the (sub) Arctic as a factor in Icelandic identity. A short conclusion speculates on the way ahead.

Current & Relevant Information:

State owned enterprises and the private sector

Just as the Arctic has been growing in importance for the public sector, so it has for the private sector. Much has happened in the last few years. In 2013 the Icelandic Arctic Chamber of Commerce (IACC) was established with nine companies represented on its board: Arctic Services, Eykon Energy, Eimskip (shipping company), Icelandair, ÍAV (construction company), Íslandsbanki bank, Mannvit (engineering company), Norðurlugs (airline), and Samskip (shipping company). The IACC's main purpose is to create a business environment in the Arctic where Icelandic companies can compete for the emerging commercial opportunities. All the companies mentioned above have taken a leading position within Iceland's private sector as regards actual and potential Arctic business and have shown willingness to act upon actual and potential opportunities. That is not to say they are the only companies looking for Arctic openings: on the contrary, a rapidly growing number of private companies in different sectors are starting to show interest, ranging, for example, from Efla (an engineering consultancy firm) to the fast-growing tourism industry as outlined below.

Aware of their relatively small size, Icelandic enterprises have created specialized platforms to advertise their Arctic offerings such as, the Akureyri-based Arctic Services group who combine industrial and technical service providers, research facilities, engineering companies, aviation services and public utilities to offer high-quality services and infrastructure for those involved in exploration, oil search and mining in the Arctic. The Icelandic Arctic Cooperation Network was established in

2013 to facilitate cooperation amongst Icelandic public and private organizations, institutions, businesses and other actors involved in Arctic issues.

Shipping

Private sector roles can be more fully appreciated by looking at the Icelandic angle on some specific Arctic opportunities. In the shipping sector, Fáfni Offshore has invested more than 4.6 million Euro in a vessel specially equipped to service the offshore oil industry to the North and East of Iceland. Maritime service-related opportunities have been discussed in Iceland since early 2000, notably the idea of building a transshipment port, which private sector and local municipalities are exploring in cooperation with Icelandic and foreign investors. In 2012 the Parliament adopted a resolution tasking minister of foreign affairs and the interior, in cooperation with the rest of government, to explore the viability of the idea. However, there are also sceptics who question whether the new ice-free sea routes likely to open in the foreseeable future will actually include Iceland. Service harbors seem more feasible, especially in the context of plans for rapid extractive development in Greenland, where Iceland can offer the nearest ice-free locations. One such project became reality in 2013 when several private companies signed an agreement to invest some 51 million Euro in building a service harbor in the North-East of Iceland, at Dysnes in Eyjafjörður.

Oil exploration

The chances of Iceland becoming an oil producer are gaining increased attention. The Icelandic government have issued three licenses for explorations in the Dreki area of the seabed to the North-east of Iceland. Interestingly, one license was issued to a team of companies from Iceland (Eykon Energy), Norway (Petero), and China (China National Offshore Oil Corporation, CNOOC) - making Iceland the first state to open the door to a CNOOC stake in the Arctic. The Icelandic government has shown great interest in the development of this field, and the establishment of a state-owned oil company has been up for discussion, together with the idea of a Norwegian-style, oil-powered ethical investment fund.

Tourism

The geopolitical relevance of Arctic tourism rivals even resource extraction and may prove crucial for the self-sufficiency and economic security of smaller nations there. Tourism is a fast-growing industry in Iceland and a major pillar of its economy. The promotion of Iceland as an Arctic destination and gateway is expressed unambiguously in terms of celebrating its wilderness, cold climate and northern landscapes. The increased use of the adjective 'Arctic' in tourism companies' names (e.g., Arctic Sea Tours, Arctic Comfort Hotel, Arctic Experience etc.) attests to Icelanders' adaptation to the outer world's Arctic appetite. However, tourism also rivals oil extraction in its double-sided nature, given the dynamic interplay between producers and consumers, not to mention its environmental impact. The capacity to

receive growing numbers of tourists and yet preserve the very thing drawing them - Iceland's pristine nature – has become increasingly a point of contestation. Also contested are concessions to foreign-controlled tourism development. A case in point was the proposed purchase of a farmstead in a peripheral region in Iceland, Grímstaðir á Fjöllum, later reduced to a leasing request, by Chinese investment group Zhongkun. The company's tourism concept, a golf resort, was met with skepticism that some might see as linked simply with the ethnicity of its owners (the notion of 'polar orientalism'). Others saw reason for legitimate concern over China's growing worldwide power and its widely attested, dubious environmental/societal practices. The former government may have eventually rejected the Chinese proposal, but the current government has signaled a more positive inclination.

“Iceland,” Nations Encyclopedia [37]

<https://www.nationsencyclopedia.com/economies/Europe/Iceland.html>

Overview:

Location and Size

A small volcanic island located between the Greenland Sea and the North Atlantic Ocean in the Arctic; Iceland is the westernmost European country. Found between Greenland and Europe, just northwest of the United Kingdom, Iceland has an area of 103,000 square kilometers (39,768 square miles) of which 100,250 square kilometers (38,707 square miles) is land and 2,750 square kilometers (1,062 square miles) is water. Its coastline is 4,988 kilometers (3,099 miles) long. Iceland is about the size of the state of Kentucky. Its capital, Reykjavík, is located on the country's southwestern coast. The climate is moderated by the North Atlantic current. In Iceland winters are mild and windy and the summers are cool. Approximately four-fifths of the country is unpopulated and uninhabitable. Glaciers cover more of the land in Iceland than in all of Europe. In addition to glaciers, the island has lakes, mountains, a lava desert, lush green areas, and natural hot springs, making Iceland a spectacle of nature.

Population

The population of Iceland was estimated as 276,365 in July of 2000, with a slow growth rate of 0.57 percent. Iceland is the most sparsely populated country in Europe, with an average of 3 inhabitants per square kilometer. In 2000, the birth rate stood at 14.86 births per 1,000 population and the death rate at 6.87 deaths per 1,000 population.

The majority of Icelanders live in a narrow coastal belt in the valleys and in the southwest corner of the country. The Icelandic government reports that 99 percent of the population live in urban areas and 60 percent of the people reside in the republic's capital, Reykjavík, or in suburban areas directly outside of the city.

Iceland has a relatively young and middle-aged population—65 percent are between 15 and 64 years, 23 percent less than 14 years, and 12 percent aged 65 and older. It enjoys one of the highest life expectancy rates in the world. Life expectancy at birth was estimated in 2000 at 79.39 years (male: 77.19 years, female: 81.77 years). Iceland also possesses one of the world's highest literacy rates at 99.9 percent (1997 est.). Literature and poetry are a passion of the people and its per capita publication of books and magazines is the highest in the world.

Icelanders descended from the Norwegians and the Celts (Scottish and Irish). The national language is Icelandic, which of all the Nordic languages is the closest to the Old Norse language. The Icelandic spoken in 2001 has changed little since the 12th century. About 91 percent of the people belong to the state church, the Evangelical Lutheran Church. However, Iceland has complete religious freedom, and other Protestant and Catholic churches exist. Given Iceland's remote geographic location, its long-established culture and language, and its small population, it is a tightly-knit homogenous society.

Current & Relevant Information:

Agriculture

Agricultural production is a vital part of the Icelandic economy, accounting for 1 percent of its GDP (1998 est.) and employing over 16 percent of Iceland's workforce. Fish is the republic's main agricultural export but Iceland also produces potatoes, turnips, cattle, and sheep.

Fishing

The fishing industry has grown to symbolize Iceland's economic independence from its Scandinavian neighbors. The Icelandic Ministry of Fisheries reported that in 1999 the total catch of fish by the Icelandic fleet was 1.7 million tons. In 2000, marine products accounted for more than 70 percent of Iceland's total export earnings, making Iceland's economy vulnerable to changing world fish prices. Cod and capelin are the most abundant fish in the catch. Full free trade in fisheries products has been established not only within the European Free Trade Association (EFTA) but also in a series of free-trade agreements with countries in Central and Eastern Europe and in the Mediterranean.

Iceland recognized in the 1970s that it was in danger of depleting its fisheries, and initiated a plan involving Individual Transferable Quotas (ITQs) and Individual Vessel Quotas (IVQs). While complex, the aim of the plan is to fairly allocate fishing rights to those in the fishing industry. Some argue that the plan, because it encourages efficiency and speed, has rewarded larger vessel owners at the expense of smaller operators, thus it is still a matter of some disagreement in Iceland. But overall, most observers feel that the plan has succeeded in managing Iceland's fisheries.

Friction exists between Iceland and its European neighbors over fishing rights. Norway and Russia have complained about Iceland's herring fishing in the Barents Sea between Iceland and Norway. Canada has objected to Iceland's shrimp fishing off the coast of Newfoundland.

The European market is the most important outlet for Icelandic agricultural products. Iceland is a member of the European Economic Area (EEA), which gives it full access to the EU without requiring membership in the body. But progress in fish-processing technology and transport has opened up new trade possibilities with other countries. Exports to Japan are increasing and emerging markets, like China and Korea, hold promise for the future. Attempts to further open markets in the fisheries sector have given Iceland virtually tariff -free access for most of its exports to Europe. While EEA membership has reduced pressure for Iceland to join the EU, it risks being left on the sidelines as the European Union expands.

Industry

While a small country, Iceland has a strong industrial sector that accounts for 21 percent of its GDP. Like its 2 other main economic sectors, industry in Iceland is centered on its natural resources. Fish processing, aluminum smelting, ferrosilicon production, and geothermal power are its main industries.

Energy

Mineral resources are scarce in Iceland, though efforts are being made to develop deposits of diatomite (skeletal algae). Iceland has vast geothermal power sources (which develop power from the internal heat of the earth) and about 96 percent of the population enjoys geothermal heating in their homes. Geothermal energy plays an important role in Iceland's health-care system, which has shown interest in its medicinal possibilities. The Blue Lagoon, one of Iceland's most popular tourist attractions, is a good example of a combination of the traditional utilization of geothermal energy for economic reasons and its non-traditional utilization for healing. Geothermal energy is also used to generate electricity, and the effluents from power plants (extra thermal energy) can be used for many purposes in connection with spas and the tourist industry.

Iceland's abundant hydroelectric power sources are controlled by the government. The largest power station in Iceland has a capacity of 240 megawatts (mw). Other major hydroelectric stations are at Hrauneyjarsfoss (210 mw) and Sigala (10 mw). Efforts are underway by the government to export hydroelectric energy to Europe by transporting it via submarine cables. The government is also investigating ways to expand its aluminum and ferro-silicon melting plants. One such venture is the Nordural aluminum plant, which accounted for a 1 percent growth rate in Iceland's 1998 GDP. Nordural is a wholly-owned \$180 million investment by Columbia Ventures of the United States. As of 2001, plans were underway to build a new

aluminum plant in the east of Iceland or expand existing ones. A new or expanded plant would increase investment and GDP growth.

Services

Iceland's service sector accounts for approximately two-thirds of GDP, and has been rapidly increasing since the 1990s, particularly in the areas of financial services, tourism, software production, and biotechnology.

Tourism

Tourism is a growing and important industry in Iceland. In fact, the national airline, Icelandair, is one of the country's largest employers. According to Statistics Iceland, by 1999 tourism accounted for 4.4 percent of GDP on net receipts of 1kr282 million, up from 3 percent just 10 years earlier. The industry is expanding with the government's promotion of the country's magnificent natural attractions such as whale-watching, hot volcanic springs, glaciers, and horseback riding throughout the country. By 1999 the country boasted 24 hotels and guest-houses. It is a promising economic growth area and its numbers increased by 16 percent in 2000.

“Iceland - Country Commercial Guide,” International Trade Administration, 15 March 2024 [38] <https://www.trade.gov/country-commercial-guides/iceland-market-overview>

Overview:

Iceland is an island country located between North America and Europe in the Atlantic Ocean, near the Arctic Circle with an advanced economy that centers around three primary sectors: tourism, fishing, and aluminum smelting. With a population of 390,000, the domestic market is small. In 2022, tourism accounted for 26 percent of total value of exports of goods and services (35 percent in 2019 before the COVID-19 pandemic), manufacturing products accounted for 23 percent (mostly aluminum processing), and marine products were 26 percent of total exports. Industrial supplies were 28 percent of the total value of imported goods in Iceland in 2022, while capital goods (except transport) were 23 percent, followed by fuels and lubricants (15 percent), transportation equipment (14 percent), consumer goods (13 percent), and food and beverages (8 percent) according to Statistics Iceland, the center for official statistics in Iceland.

Tourism has been a growing force behind Iceland's economy over the last decade, with increased opportunities for investors in high-end tourism, including luxury resorts and hotels. The number of tourists in Iceland reached more than 2.3 million in 2018. Tourism in Iceland contracted in 2019 and 2020 due to COVID-19 with the total number of tourists going down to 2 million in 2019 and down to 486,000 in 2020. As of summer 2023, the tourism sector has fully recovered, with 1.8 million tourists in 2022, and a projected number of 2.3 million tourists expected for 2023.

The United States is Iceland's largest trading partner by country, primarily due to the number of American tourists in Iceland. In 2022, 27 percent of Iceland's tourists were American – by far the largest nationality visiting Iceland. Until recently, U.S. investment in Iceland has mostly been centered in the aluminum sector, with Alcoa and Century Aluminum operating smelters in Iceland. U.S. portfolio investments in Iceland have been steadily increasing in recent years. Iceland's convenient location between the United States and Europe, its high levels of education, connectivity, and English proficiency, along with general appreciation for U.S. products makes Iceland a promising market for U.S. companies.

The economic environment of Iceland has been characterized by a healthy economic growth rate over the last few years spurred by tourism (4.2 percent in 2017, 4.9 percent in 2018, 2.4 percent in 2019). However, the pandemic set back the tourism and service sectors, and the economy contracted by 7.1 percent in 2020. Economic recovery is well underway with GDP growth in 2021 reaching 4.3 percent, and 6.4 by 2022. Inflation rose due to the pandemic and measured 7.2 percent in May 2022, and currently stands at 7.7 percent as of August 2023. For the past few years, Iceland had a low unemployment rate (about 3.5 percent), and the Icelandic job market depended on foreign workers to fill unskilled and semi-skilled jobs in the tourism and service sectors. Unemployment stood at 2.9 percent as of August 2023. As Iceland is a member of European Economic Area (EEA), residents from other EEA countries, most notably Poland, immigrate to Iceland, alleviating some of the job market constraints. Iceland is not a member of the European Union (EU). The country is a member of NATO but has no armed forces of its own. The United States, on behalf of NATO, bears primary responsibility for the defense of Iceland under the terms of a 1951 bilateral defense agreement. The United States maintained a Naval Air Station in Iceland until September 2006 when the base was closed.

There is broad recognition within the Icelandic government that foreign direct investment (FDI) has been a key contributor to the country's economic revival after the 2008 financial collapse. As part of its investment promotion strategy, the Icelandic government operates a public-private agency called "Business Iceland" that facilitates foreign investment by providing information to potential investors and promoting investment incentives. Business Iceland and its sister agency Invest in Iceland have identified the following "key sectors" in Iceland: tourism, food and natural products, energy and green solutions, innovation, fisheries, creative industries, and life sciences. Iceland offers incentives to foreign investors in certain industries, such as the film industry.

Current & Relevant Information:

Market Challenges

Iceland's adoption of EU product standards and regulations, such as food product labeling and a requirement for products to bear the CE marking (the European Conformity or CE marking is an administrative marking that indicates conformity with health, safety, and environmental protection standards for products sold within the EEA) can be considered a barrier for U.S. companies wanting to export to Iceland. Even though Iceland is not in the EU, Iceland's membership in the EEA means that there are generally no exemptions to these rules.

There are high tariffs on most agricultural products originating from outside of the EU. There are also restrictions on importing raw or fresh agricultural products originating from outside of the EU. Meat, for example, needs to be frozen for thirty days prior to entering the country from non-EU countries.

The domestic market is small, with less than half a million inhabitants occupying the island. Tourism is a major industry in Iceland, however, increasing the number of consumers and opportunities in the market. Private consumption is high in Iceland, with most households having two incomes.

Logistics can be costly and time-consuming given the distance between Iceland and either the United States or continental Europe. Air freight is reliable and readily available, but expensive. Sea freight is available and cheaper, but it is less frequently available directly to and from the United States. Icelandic logistics company Eimskip sails a ship once per week to Portland, Maine. There are, however, two logistics companies that offer more frequent sea freight services between Iceland and Europe (connecting to Rotterdam, Hull, Aarhus, Bremerhaven, Aalborg, Torshavn, and Immingham), providing an alternate route for U.S. exports to Iceland.

Market Opportunities

Tourism has been a growing force behind Iceland's economy in the past decade, with opportunities for investors in high-end tourism, including luxury resorts and hotels. The number of tourists in Iceland reached more than 2.3 million in 2018. Tourism in Iceland contracted in 2019 and 2020 due to COVID-19, and the total number of tourists went down to 2 million in 2019 and then down to 486,000 in 2020. As of 2022, the tourism sector had recovered, with 698,000 tourists in 2021, 1.8 million tourists in 2022, and a projected 2.3 million tourists expected for 2023.

The startup and innovation communities in Iceland are flourishing, with IT and biotech startups seeking investors. The data center industry is relatively new in Iceland and there is room for growth. Iceland is a favorable location to host data centers due to its naturally cold climate (reducing energy costs), safe environment, and renewable energy.

The film industry has been growing in Iceland for the last decade. Iceland's dramatic landscapes are popular as backdrops in international films and television series.

Iceland offers special tax incentives to attract film production, with the maximum tax incentive at 35 percent.

Iceland is dependent on imported consumer goods. Potential growth areas for exports to Iceland include organic foods, fresh produce, wine and beer, computer equipment and software, children's products, recreational goods, and clothing.

Fish farming has been growing at a rapid rate, particularly salmon farming. Talks are ongoing about potential inland fish farming, which many locals see as the future of the industry.

5. Norway:

“Arctic economy within the Arctic nations,” Helen McDonald, Solveig Glomsrød and Ilmo Mäenpää, *The Economy of the North* [39]

https://www.ssb.no/a/english/publikasjoner/pdf/sa84_en/kap4.pdf

Overview:

In his book on the history of wealth and poverty of nations, Harvard professor David S. Landes devoted the introductory chapter to highlighting how natural conditions in the tropics represent serious barriers towards economic development. He did not consider the Arctic in the same context but the Arctic environment is generally seen as an even bigger challenge to livelihood than the tropics. Over the years people seem to have voted with their feet in this matter, while the tropics abound with people, the Arctic is sparsely populated. The 10 million people who currently live in the Arctic Region, what do they do for a living? To live in the Arctic, people must have their very special reasons, the remaining 99.8 per cent of the world population might easily think. One clear reason is the attraction of people and investments to natural resources. Another is the fascination of the qualities of nature, shifting from extreme and blending grandeur to darkness and stillness.

These special reasons should be reflected in the structure of the Arctic economy, indicating the extent to which nature in the Arctic has had its say in shaping the economy of the north. This chapter provides an overview of the predominant economic characteristics and the major industries of the Arctic regions within the Arctic nations. It also provides information about the contribution of the Arctic regions to the economy of the respective Arctic nations. Thus, for the most part, the information in this chapter is viewed from an intra-national rather than a comparative international perspective, although some comparisons among the regions are made in the concluding remarks to this chapter.

While there is significant economic variation across the Arctic regions of the Arctic countries, many of these regions host large resource-based industries. In many cases, resources produced in the Arctic are shipped outside the Arctic region to export markets or southern markets within the same country. At the same time, the Arctic regions tend to draw extensively on southern markets for specialized and

professional labor, capital, and consumer products. While Arctic regions generate income and resource rent from natural wealth, they also receive transfer payments from national governments. In some Arctic regions resource exploitation generates economic activity within the region in the form of the construction and operation of pipelines, and the provision of services such as transportation, wholesaling and retailing and housing. With some exceptions, manufacturing activity tends to be limited in Arctic regions. The electronics industry in Oulu in Northern Finland and the industrial sectors in Northern Russia and Northern Sweden are exceptions to this and the data presented in this chapter illustrate the variability in economic structure among Arctic regions that is frequently overlooked when the Arctic economy is discussed.

For each of the Arctic regions this chapter contains a core table showing regional gross domestic product (GDP) and the contribution to regional GDP by industry at a disaggregated level (for 17 industries). This level of detail is intended to capture all the main activities of the circumpolar Arctic region. The data for the Arctic excluding Russia are based on national statistics and World Development Indicators of the World Bank. Arctic Russian data by main industry are provided by Russia's Federal State Statistical Service and further harmonized with statistics for other Arctic regions using production and employment statistics. These core tables generally refer to the year 2002, which represents a compromise between coverage and timeliness. The tables present value added or contribution to GDP in local currency in order to focus on the Arctic element of their respective national or federal economies. Where available some more recent economic indicators are presented.

Current & Relevant Information:

For purposes of this report, Arctic Norway includes Finnmark, Troms, Nordland, the Svalbard Archipelago and Jan Mayen.

Education, health and social work is the largest industry in Arctic Norway, followed by public administration and defense. Electricity, gas and water supply and construction are also of clear significance. The fishing industry, which is considered a core element of the economy of Northern Norway, contributed only 3.7 per cent to regional GDP in 2002. Fishing activity in Northern Norway may have been underestimated in the statistics as fish is harvested and landed up north by fishing companies with headquarters in the southern part of Norway. As a consequence, part of the income from fishing in northern waters may be registered as income in the South of Norway.

The coal production registered in Arctic Norway is located on Svalbard. There was no oil and gas production in Arctic Norway in 2002. Currently the gas field Snøhvit is being developed north of Hammerfest, the northernmost city in the world. The natural gas will be liquefied (LNG) and exported by sea as the warm Norwegian Current keeps the southern part of the Barents Sea ice-free, even in winter.

The favorable climate has contributed to the economic importance of marine fisheries in Arctic Norway.

Almost half of all the fishermen in Norway are employed in the Arctic region of the country. In addition, the Arctic region accounts for 37 per cent of Norway's total value of production and 39 per cent of the gross value added in fishing. For mining, 22 per cent of national employment is in the Arctic, with similar shares for output and value added. For hydroelectric power, about 12 per cent of national employment (and output) is in the Arctic.

Tourism, hydropower production and fishing are the dominant activities among the nature-based industries of Arctic Norway. Hydroelectric power production is very capital intensive. Tourism, fishing and food processing are the largest employers after the government sector and non-government services. The government sector alone accounted for 46.2 per cent and the non-government services (excluding tourism) for 30.5 per cent of the region's total employment in 2002. In terms of income, the ranking is reversed with non-government services accounting for 43.7 per cent of gross value added, followed by general government services, which accounted for 32.8 per cent of total value added.

Roughly 20 per cent of the regional economy can be characterized as nature-based activities. The nature-based industries accounted for 18.7 per cent of employment. Hence the nature-based sector is the third largest sector in the economy of Arctic Norway and, when the petroleum industry is not included, has a higher share of employment and production in the Arctic than in the rest of Norway.

Tourism is the largest industry among the nature-based industries in Arctic Norway both in terms of employment and value added. Tourism had double the level of employment and generated 60 per cent higher income than the fishing industry in 2002. The cruise traffic to Svalbard has increased and the main tourist attractions in Svalbard are the Arctic wildlife, particularly the polar bears, as well as the vegetation and scenery. The development of the tourism industry may suffer if climate change and ice cover reductions drastically reduce the hunting ground of the polar bear. However, as discussed in chapter 6, there might also be positive effects of global warming that may facilitate tourism in the Arctic, in particular a prolonged tourist season.

“Managing the Arctic: A Norwegian Perspective,” Harvard International Review, 23 August 2019 [40] <https://hir.harvard.edu/managing-the-arctic-a-norwegian-perspective/>

Overview:

To most people the Arctic is a distant realm, almost another world, inhabited by polar bears. They may even think the frigid landmasses and icy seas of the Arctic are irrelevant to daily life farther south.

However, the Arctic is changing rapidly. The melting of the sea ice has thrust the region into the global spotlight as world leaders seek to assess both the environmental threats and economic opportunities of a smaller northern ice cap. Norwegians have long balanced a fierce commitment to environmental protection with our substantial Arctic economic interests, and we are eager to help devise responses to the worrying changes we have all observed.

The Arctic encompasses more than 15 million square miles or about 8 percent of the surface of the Earth, equivalent to four times the extent of U.S. territory. But the human residents of this vast area number only about 4 million, and are spread across eight countries—Norway, Russia, the United States, Canada, Finland, Sweden, Iceland and Denmark.

In the past 100 years, average temperature rise has increased twice as fast in the Arctic as in the world as a whole. One could say that The Arctic is the world's scientific advance warning. The changes are predominantly the result of climate forces and contaminants like CO₂ and heat-absorbent soot that originate far from the Arctic. And the repercussions are global. A warming Arctic may, for example, affect monsoon weather patterns, and may actually cause extremely cold winters in the United States and the northwestern parts of Europe. Scientists project that ice retraction in the polar areas will coincide with rising sea levels and accelerated global warming.

The Arctic ice melt may also bring opportunities, such as shorter trade routes and increased economic activity in northern waters that previously were covered by ice. Moreover, recent discoveries of oil, gas, minerals and diamonds in Arctic areas have made the region attractive to countries situated far away. In recent years, I have seen many misleading news headlines proclaiming a "race for Arctic resources," suggesting a Klondike-style rush that could spark tension and conflict. The resources are, however, mainly thought to be found in areas that are under national jurisdiction or in areas where jurisdiction will be clarified once the outer limits of the Arctic states' continental shelf have been determined. Fortunately, there are few unresolved jurisdiction issues in the Arctic, and most players appear committed to firmly established international rules.

Current & Relevant Information:

Marine Management & Sustainable Development

Norway takes an ecosystem- and science-based approach to sustainable resource management. Integrated management plans are among our most important tools, and our ultimate ambition is a comprehensive management approach that facilitates long-term value creation while safeguarding Arctic ecosystems.

There have been petroleum activities in the Norwegian High North for decades. Exploration and production on the Norwegian continental shelf in the Barents Sea

are expected to increase, generating social and economic benefits and contributing to the security of Europe's energy supply. Because of the warm North Atlantic Current, the Norwegian Barents offers better operating conditions than many other parts of the Arctic. Norway and Norwegian companies, with their state-of-the-art know-how and technologies, are global leaders in operating in harsh environments offshore. Petroleum activities on the Norwegian continental shelf are subject to the highest safety and environmental standards, and we are open to sharing our experiences with others to promote best-practice development.

Regional cooperation is essential to ensure that Arctic industrial progress does not come at the expense of living marine resources. Commercial fisheries in the central Arctic Ocean are not envisaged in the near future, but adjacent waters, and the Barents Sea in particular, are home to some of the world's most abundant fish resources, such as the Northeast Arctic cod.

Fisheries in the Barents Sea are managed by Norway and Russia in close cooperation, within the framework of a joint fisheries commission. The commission bases its decisions on recommendations by the International Council for the Exploration of the Sea (ICES). These recommendations are grounded largely in the findings of Norwegian and Russian scientists working under a joint research program that is reviewed annually. In fact, Norwegian and Russian scientists have been collaborating since the 1950s, and the establishment of the joint fisheries commission was agreed in 1975.

In recent years, this commission has devoted considerable attention to combating illegal, unregulated and unreported fishing. As a result, the estimated volume of illegally caught fish in the commission area has dropped from some 100,000 tons in 2005 to close to zero since 2010.

If we go back to 1988 the cod stock was at a low point, and strict measures to rebuild the stock were put in place by Russia and Norway together. Today the cod stock is estimated to be ten times bigger than it was 25 years ago. This development would not have been possible without the close and constructive fisheries cooperation between Russia and Norway. The results are literally being harvested by the fishermen. Just the catch value of the fish resources managed jointly by Russia and Norway corresponds to more than US\$2 billion. And it is a tremendous source of food. This year the Barents Sea alone will produce more than 5 billion meals of wild-caught seafood.

“Norway - Country Commercial Guide,” International Trade Administration, 20 January 2024 [41] <https://www.trade.gov/country-commercial-guides/norway-market-overview>

Overview:

The five main Nordic countries - Denmark, Finland, Norway, Sweden, and Iceland – are advanced, high income and highly connected countries. While each country has its own unique market and characteristics, there are certain synergies that tie these highly innovative marketplaces together. With an aggregate Gross Domestic Product (GDP) exceeding USD 1.8 trillion and a combined population of 27 million people, the Nordics are of genuine interest to many U.S. companies with leading and advanced products, technologies, and services.

Norway

- Norway is a modern, energy-rich country with a population of 5.5 million. It is considered one of the world's wealthiest countries with a GDP per capita of USD 106,148. Incomes are also more evenly distributed, making every person a consumer.
- Norway is located in Northern Europe and is part of the Scandinavian Peninsula. The Svalbard archipelago and Jan Mayen in the Arctic Ocean are also part of Norwegian territory.
- Most of the country shares a border to the east with Sweden while its northernmost region is bordered by Finland to the south and Russia to the east; and Denmark lies south of its southern tip across the Skagerrak Strait. Norway's extensive coastline is facing the North Atlantic Ocean and the Barents Sea.
- With its population covering 323,802 square kilometers, Norway is one of the most sparsely populated countries in Europe. It is a narrow and mountainous country nearly 1,600 miles long with a jagged coastline ten times its length.
- The country is richly endowed with natural resources - petroleum, hydropower, fish, forests, and minerals - and is highly dependent on the petroleum sector.
- The projected GDP growth for Norway in 2023 is 1.2%. In August 2023, the unemployment rate was 3.5% and the year-on-year inflation rate measured by the Consumer Price Index (Total Index) was 3.3%. Norway's Central Bank raised the key policy interest rate to 4.25% on September 22, 2023. The value of the Norwegian currency (NOK) has weakened by around 10% since January 2023 and trades at around NOK 11 to the USD in October 2023.
- The Norwegian economy features a combination of free market activity and government intervention. The government controls key areas, such as the vital petroleum sector, and maintains control over a number of large-scale state enterprises - some of them fully owned, and some publicly traded, but where the government has controlling interests.
- Norway's external financial position is very strong from a global perspective and the country has an important stake in promoting a liberal environment for foreign trade and investment.

- Russia's escalated war on Ukraine in 2022 has had a significant impact on the energy situation and energy security in Europe, which in turn has impacted the Norwegian economy.
- Norway is now the largest energy provider to Europe and ranks as the 4th largest exporter of natural gas globally.
- Norway's large merchant shipping fleet is one of the most modern among maritime nations and ranked the 4th largest by value. Other major industries, such as offshore shipping, shipbuilding, fishing and fish farming, green technologies, information and communication technologies, and light metals and other energy-intensive industries have prospered as well in recent years.
- Norway is a vibrant, stable democracy.
- Most Norwegians are fluent in English, and many have very close cultural and family ties to the United States.
- Norwegian business ethics are largely similar to those of the United States.
- Norway is not a member of the European Union (EU) but is linked to the EU through the European Economic Area (EEA) agreement. By virtue of the EEA, Norway is practically part of the EU's single market, except in fisheries and agriculture.
- Norway is part of the Schengen Agreement, which guarantees free movement of persons and the absence of internal border control between 22 of the 27 EU Member States, as well as

Norway, Iceland, Switzerland, and Liechtenstein. Passport controls between Schengen countries have been reintroduced in 2017.

Current & Relevant Information:

Market Challenges

The overall economic and trade relationship is strong, and Norway's import climate is generally open and receptive to U.S. products and investments, although the agriculture sector is well protected through trade barriers. For information on existing trade barriers (please see Leading Sectors for U.S. Exports below to learn more about the agriculture sector), use the link to the [National Trade Estimate Report on Foreign Trade Barriers](#), published by the United States Trade Representative (USTR).

The domestic market is small, but the country can serve as an attractive base for business operations in the Nordic and Baltic markets. Norway adheres to European Union sanctions against Russia, including those with an economic focus.

Market Opportunities

he Norwegian market offers many attractive opportunities for U.S. companies, who are well positioned to compete and collaborate to capture a significant share of new contracts in Norway's offshore energy (oil, gas, wind), green technologies, defense and aerospace, information technologies, shipping and maritime, healthcare, travel and tourism, and consumer goods sectors.

“Norway,” Arctic Council [42] <https://arctic-council.org/en/about/states/norway/>

Overview:

Nearly half of Norway's land mass is Arctic territory, consisting of the two counties Nordland and the combined county of Troms and Finnmark on the mainland, the Svalbard archipelago and the island of Jan Mayen. Norway's Arctic territory is home to around 490,000 people – one tenth of the Norwegian population. The country's Arctic maritime area is approximately 1,500,000 square kilometers, corresponding to the combined land area of France, Germany and Spain.

The Arctic Archipelago of Svalbard is located halfway between mainland Norway and the North Pole. About half the land is ice-covered. The largest island of the archipelago is called Spitsbergen, and until 1925 this name was used for the whole archipelago. The administrative center of Longyearbyen and the other inhabited areas of the archipelago are located on this island. Svalbard's main industries today are coal mining, tourism and research.

Norway houses the world's northernmost university, the Arctic University of Norway, in Tromsø. It is also home to NORD university in Bodø and the FRAM High North Research Centre for Climate and the Environment, where 500 scientists from 20 different institutions are engaged in research in the fields of natural science, technology and social sciences.

Current & Relevant Information:

Fishing and marine resources, in addition to livestock husbandry, has for centuries been the cornerstone of the economy in Northern Norway. Today's economy is much more diversified. Today's key industries include:

- Fisheries and aquaculture: This remains the largest export-sector in Norwegian Arctic region. Nordland county is Norway's third largest exporter of marine fisheries and aquaculture.
- Tourism: Norway's broad Arctic region attracts a growing number of tourists, who come to experience dramatic scenery and largely untouched wilderness.
- Sustainable energy: Norway is Europe's biggest producer of hydropower, and one of the country's largest hydroelectric power station in terms of annual production is located in Meløy. Raggovidda wind farm located on the Barents Sea coast in Berlevåg municipality is one of the world's most efficient producers of wind power.

- Power: In Hammerfest, Equinor operates a processing plant for liquefied natural gas from the Snøhvit field in the Barents Sea.
- Mining and transit: Narvik is an important port for the export of iron ore from Swedish mines. One of Svalbard's main industries today also includes coal mining.

“Norway,” The Arctic Institute: Center for Circumpolar Security Studies, 1 August 2022 [43] <https://www.thearcticinstitute.org/countries/norway/>

Overview:

Facts & Figures

AC member since 1996

Active Polar Icebreakers

1

Coordinates

Oslo: 59.9139° N, 10.7522° E

Tromsø: 69.6492° N, 18.9553° E

Population

Norway: 5.2 million

Northern Norway: 480,000

Land Area

Norway: 385,000 km²

Northern Norway: 185,000 km²

Coastline

25,148 km

Current & Relevant Information:

Although there is relatively little difference between Arctic and non-Arctic communities in Norway, some traits have historically been more prominent in the north. Given the region's sparse population, vast distances, natural geographic barriers and dependency on traditional subsistence economies (fisheries, reindeer herding, and agriculture), the northern counties have historically been poorer (in terms of GDP per capita) and less developed than the rest of Norway. As the Norwegian welfare state grew after WWII, the North was earmarked for regional development funds to help the region overcome the natural barriers that did not exist

to the same extent in the south. Albeit with a somewhat higher level of public employment and a slightly higher percentage of the population on welfare than the national average, the northern counties are no different than the other counties across Norway that also experienced a de-industrialization in the 1990s. In the north, this was coupled with the decline of the fisheries industry as quotas were reduced and the fleet modernized.

A system of differentiated employer's social security tax is meant to improve the conditions of operating businesses in the north. Similarly, parts of Troms og Finnmark county have since 1990 had a lower income tax, cancellation of student debt, and a higher rate of child support. In recent years, however, North Norway has been experiencing relatively high economic development. The region's emphasis on seafood and fisheries, industrial products and tourism has helped spur the growth. The region is experiencing steady population growth, while the increasing focus on the Arctic has helped the northern communities frame their regional development in a new context.

As with the rest of the Arctic, attention turned towards the potential of arctic industries in the north of Norway at the beginning of the new millennium. The emphasis was on the north as a new province for oil and gas development. Since 1979, seismic activity and exploratory drilling have taken place in the Barents Sea, with over a hundred wells drilled. Yet, in spite of substantial discoveries, there are only two producing fields as of January 2019—the Equinor Snøhvit field that has produced liquefied natural gas since 2006 and the ENI Goliat oil field in production since 2017. The main barriers for Barents Sea offshore development have been the lack of suitable markets and lack of infrastructure. Although there have been suggestions of extending the pipeline system transporting gas to Europe up to the Barents Sea (it currently stops more or less at the Arctic Circle), the low gas prices and the lack of political commitment in Europe have halted development, albeit not completely. Currently, the oil field Johan Castberg is being developed by Equinor. The more accessible offshore area around the Lofoten and Vesterålen archipelagos are thought to hold considerable hydrocarbon resources, but environmental concerns and popular resistance have hampered development there.

Norway also has the fifth most valuable shipping fleet in the world, and a substantial interest in a potential increase of traffic via the Northeast Passage. Kirkenes, on the border with Russia, has positioned itself, through business and potential harbor investments, as a receiving port. This development has yet to take off. Similarly, the prospects of mineral development in North Norway was heralded at the start of the millennium as the next big industry in Norway. In contrast to Sweden and Finland, Norway has, with some exceptions, not developed its relatively mineral rich mountains. As with the oil and gas sector, environmental concerns have halted development. Additionally, the mineral industry has met resistance from local and Sámi communities, as the land in question is already being used by reindeer herders

An industry which has had more success is fisheries and aquaculture. The Barents Sea cod is the largest cod stock in the world, and has in recent years seen record yields. Russia and Norway cooperate on managing this shared fish stock, often portrayed as a success story of bilateral resource management. Other types of fisheries and aquaculture—like salmon, herring, mackerel, shrimp, king and snow crab, and halibut—are also found in Norway’s Arctic waters. This blue industry is being heralded as the future for the north.

Similarly, the number of tourists visiting has increased steadily, spurring regional growth and employment. In addition, the region has a number of other sectors that are seeing rapid development, like research institutes and universities, IT companies, and the development of technological niche products.

“Why is exploitation of Arctic offshore oil and natural gas resources ongoing? A multi-level perspective on the cases of Norway and Russia,” Maria Morgunova, The Polar Journal, 13 May 2020 [44]

<https://www.tandfonline.com/doi/full/10.1080/2154896X.2020.1757823>

Abstract:

The study focuses on the challenging complexity of the energy industry transformation. Despite sustainability and climate concerns the exploitation of conventional oil and natural gas resources is ongoing. We investigate the case of Arctic offshore oil and natural gas resources exploitation through a set of interviews, providing two national examples of Norway and Russia. The study design and methodology are inspired by a multi-level perspective framework (MLP) to large socio-technical systems. We focus on the interaction between the landscape and regime levels of the energy industry. The MLP analysis shows that Norway and Russia act differently under the same landscape factors and adjust on the regime level according to their national goals. We conclude that the landscape level does not shape the regime level equally, which complicates the transformational processes in the energy industry. The paper contributes to the sustainability transitions literature through a rarely investigated case, and suggests theoretical implications regarding the interactions between the regime and landscape levels of MLP. The paper introduces a different analytical perspective for scholars of Arctic studies.

Current & Relevant Information:

Introduction

The Arctic has a long history of industrial activities related to oil and natural gas resources extraction. Commercial exploitation in the North began in the 1920s (Norman Wells in Canada’s Northwest Territories, northern Russia, and Alaska), and extensively developed during the World War II. In some countries, the Arctic became one of the major oil and natural gas provinces by the 1950s. In the 1980s, the

interest shifted towards the sea, supported by huge discoveries on the Norwegian shelf, in the Beaufort Sea, the North Slope, and in the Barents and Kara seas. The assessment by the United States Geological Survey promises significant amounts of the world's undiscovered conventional oil and natural gas resources in the offshore Arctic. The substantial part of these resources remains to be explored but attracting significant attention.

A substantial number of studies discussed oil and natural gas exploitation in the Arctic. Earlier publications of the 2000s supported the growing interest towards the Arctic region and resource extraction. They predominantly use extensive qualitative discourse and a simplified political perspective.

The topic received more attention during and in the aftermath of the economic crisis of 2008–2009, owing to the changing macroeconomic environment, low oil prices and transforming supply-demand geography of energy resources. In-depth studies on the future potential shares of offshore Arctic oil and natural gas resources in the global energy balance, and demand for these resources showed that the economics of these resources becomes more questionable. Growing energy resource competition (e.g., shale gas revolution, renewable energy) has placed many of the Arctic projects on long-term hold.

Current research has shown that economics is not always a decisive factor. Arctic socio-economic development and natural resources exploitation incorporates many other issues including geopolitics and security; territorial nationalism; rising concerns regarding climate change; indigenous peoples' rights; sustainability and environmental impacts of oil and natural gas exploitation activities. One of the dominating motives is that these resources can potentially contribute to satisfying growing energy demand and increase energy security of some countries.

There are eight Arctic countries, from which five – Canada, Denmark (via Greenland), Norway, Russia, and the United States – have an outlet to the Arctic Ocean. Three of these countries, namely, Canada, Russia, and the United States, have oil and natural gas onshore production in the Arctic region, and three of them – Norway, Russia, and the United States – produce offshore. Nowadays, mainly Russia and Norway show interest in developing these resources.

The exploitation of oil and natural gas resources is often positioned as the key driver of the socio-economic development of the Arctic. However, the question of whether these resources are necessary from both the global and regional perspective is open. Although global climate concerns are significant, and the energy industry is undergoing a transformation towards more sustainable energy production and consumption, exploitation in the offshore Arctic continues. Therefore, there is a need for an in-depth understanding of the reasoning supporting the ongoing oil and natural gas exploitation activities.

The sustainability transitions literature widely discusses the current changes in the energy industry. However, sustainability transitions studies predominantly focus on renewable energy deployment and renewable technology diffusion, while tending to disregard the oil and gas industry. The Arctic cases are rarely present in the energy transitions literature, even though they can provide a much deeper understanding of transformational processes in the energy industry.

Thus, by investigating the case of Arctic offshore oil and natural gas resources exploitation in the context of energy industry transformation, this study has a double agenda. This is to contribute to the understanding of offshore oil and natural gas resources exploitation in the Arctic by suggesting a different analytical perspective for the Arctic scholars, and to introduce the Arctic case to transition scholars.

This paper has the following structure. Section two introduces the research design and methodology of the study. Section three is devoted to results. Section four suggests the discussion, followed by limitations and future research in section five, and conclusion in section six.

Conclusion

Despite the ongoing transformation of the energy industry and significant challenges related to climate change, the extensive exploitation of conventional oil and natural gas resources is ongoing. One of the special cases is oil and natural gas resources exploitation offshore Arctic. Norway and Russia are the two circumpolar countries deeply engaged in developing these resources.

In this paper, we applied the MLP framework to the case of Arctic offshore oil and natural gas resources exploitation in Norway and Russia. It helped to gain a deeper understanding of countries' background and motives for these activities, and analyze the interactions between the landscape and regime levels. The four landscape pressures – growing energy demand, oil price, geopolitics, and climate change – both facilitate and constrain Arctic offshore oil and natural gas resources exploitation. Despite the similar character of the landscape pressures, they have no uniformity, and their effects on the regime level are divergent between Norway and Russia. The strongest influence is visible from the specific geopolitical shocks, whereby the climate change pressure is rather weak.

The conducted MLP analysis shows that landscape pressures cannot penetrate and shape equally the regime level. Moreover, the study shows that the regime level objectives dominate the landscape. The study results lead to the conclusion that the current view on the formatting function of the landscape level and the qualities and capacities of the regime is imperfect and needs to be revised. Overall, this complicates the transformational processes in the energy industry.

“Norway’s Arctic policy: still high North, low tension?,” Andreas Østhagen, The Polar Journal, 2021 [45]

<https://www.tandfonline.com/doi/full/10.1080/2154896X.2021.1911043>

Overview:

For Norway, the Arctic is an integral part of the country in terms of both economic development and security considerations. Since 2005, consecutive governments in Oslo have made use of this fact, in combination with international attention given to the north, to foster a High North policy framed around regional economic development, climate issues and international cooperation (especially vis-à-vis Russia). However, over the last few years, challenges have emerged. Focusing on the foreign and security policy aspects of Norway’s Arctic approach, this article defines Norway’s Northern engagement and how this engagement has evolved since 2005. Then, the challenges currently facing Norway in the domain of foreign and security policy are discussed in terms of the new Arctic policy document released in late-2020. These challenges are broadly surmised as relating to Russia’s military posture and the use of the Arctic as an arena for a China–US tug of war.

Current & Relevant Information:

Introduction

In 2005, the then Norwegian foreign minister Jonas Gahr Støre urged the people to ‘Look north.’ Speaking in Tromsø, the self-proclaimed Arctic capital of Norway, he launched what was to become Norway’s new foreign policy flagship: the High North policy (nordområdepolitikken). With one-third of the landmass and 80% of its maritime domain located north of the Arctic Circle, it is no wonder that Norwegian politicians have been quick to seize the opportunity to promote a hybrid mixture of foreign and regional policy tools as the world has turned its attention northwards. Other Arctic countries – like Denmark, Sweden and the USA – have been much slower to embrace the Arctic as a foreign policy priority, if at all.

In part, Norway’s orientation towards the Arctic occurred as the result of a domestic initiative because economic opportunities were increasingly becoming apparent in the North. In part, international conditions were ripe as climate awareness, resource potential and Russian re-emergence started to appear on the agenda. Lastly, the new majority government in office beginning in the autumn of 2005 acted as policy entrepreneurs, building on the discrete Northern policy steps taken by the previous government.

When the Norwegian High North policy saw the light of day 15 years ago, it was an optimistic promise of increased attention to the North, new economic opportunities and the strengthening of dialogue and cooperation with Russia. In the beginning, it looked hopeful: after the rather significant maritime boundary agreement with Russia regarding the Barents Sea was enacted in 2010, Russia’s then President Medvedev

declared a 'new era' of relations between Norway and Russia. A border regime was created in 2012 so that the inhabitants of north-eastern Norway could travel visa free across the border to northwest Russia. The Arctic Council, created in 1996 to ensure cooperation on a range of issues in the Arctic, rose in stature and Norway managed to get the secretariat to Tromsø in 2011.

However, in 2014, the mood soured. First and foremost, the Russian annexation of Crimea contributed to changing the political climate in the North. Falling oil prices also led to the disappearance of many of the economic interests associated with the High North and to projects being placed on hold. Those who had expected (or hoped for) a Klondike in the North were disappointed, and the enthusiasm for the entire High North policy began to cool. It went from being an 'priority' to a 'responsibility'.

In late-2020 the government in Oslo, which has held office for almost eight years, released the third Arctic policy of Norway (the first came in 2005 and the second in 2011). In terms of foreign policy, this signaled a third phase of the Norwegian High North policy: a phase that has been characterized by great power rivalry and harsh rhetoric outside Norway's borders. Of the various parts of the Arctic, challenges are the greatest in the European part – Norway's northern areas. Here, the military presence and provocative exercise activities have been increasing the most. *Aftenposten* – Norway's largest printed newspaper – describes this development as a 'power struggle on Norway's doorstep'. Although researchers have largely rejected the idea of a budding resource war in the North, the view of and discourse about the Arctic has changed. More countries are now looking North and seem eager to use the Arctic as an arena for foreign policy influence and symbolic politics.

In the last decade, the Norwegian government has made use of the phrase 'High North, low tension' to highlight that the Arctic, despite fantastical claims by some scholars and media outlets, is a region characterized by amicable affairs. However, the question remains as to whether this is still an accurate portrayal of the current state of affairs and – crucially – Norway's Arctic approach. This article examines and reviews Norway's Arctic endeavors, not only limited to the official policy documents but also taking into consideration wider security concerns and interests.

The focus is on foreign policy dimensions, with an explicit emphasis on security policies. The article examines what defines Norway's Northern engagement and how that engagement has evolved since 2005. Furthermore, how priorities have shifted in terms of security policy in the North is examined. The discussion then turns to the challenges that Norway is currently facing in the domains of foreign and security policy in 2021 and that it may face in the future. These challenges are broadly categorized as relating to Russia's military posture – as is typical in Norwegian foreign and security policy outlooks – and the use of the Arctic as an arena for a China–US tug of war, which has emerged as an entirely new dimension of Arctic politics.

Concluding remarks

Norway has been one of the most Arctic-focused of all the circumpolar countries in the past two decades. This is partly due to Norway's geographic position – located at the relatively temperate nexus between the North Atlantic, the Barents Sea and the Arctic Ocean – and partly a result of its political handwork starting in 2003-5 to elevate the importance of the High North on both foreign and domestic policy agendas. Norway's Arctic policy endeavor has undergone several phases since its creation over 15 years ago. Excitement and euphoria dominated the first phase, while security issues and economic disillusionment dominated the second. Now we are in the third phase, which has been dominated by geostrategic concerns and symbolic chest thumping by global actors.

Although the Norwegian High North (or Arctic if you will) policy is a unique hybrid mixture of regional and foreign policy tools, this article emphasizes the broader security dimensions of Norway's Northern policy approach over the last decades. As Arctic 'middle powers' that are often free of broad international entanglements, countries like Norway, Canada and Denmark are likely to make use of their advantageous geographic positions to influence the near abroad. They are also concerned with upholding regional and global governance mechanisms (hereunder international law) that ensure stability and cooperation in the North and are eager to avoid the Arctic getting dragged into global rivalries or conflicts originating elsewhere.

In any case, it appears that Norway will continue to pursue an active role in the North, regardless of changes in government or further deterioration of Arctic regional relations. That prediction comes from the simple fact that almost 10% of Norway's population and much more of its economic and resource potential lie north of the Arctic Circle: the region is not a periphery the same way that Alaska or Greenland are vis-à-vis Washington DC or Copenhagen. The Arctic is integral to Norwegian economic and security concerns, which Norway's Arctic policy in recent decades has both contributed to and been a consequence of. Norway's entry into the UN Security Council (from 2021 until 2023) and its increased engagement with global ocean politics are also linked to its Arctic policy priorities.

The idiom 'High North, low tension' still very much describe how Norway would prefer Arctic relations to be – especially vis-à-vis its Russian neighbor. Whether this description will continue to apply is up for debate. Military activity in the form of exercises and – at times– provocative maneuvers in the Barents Sea is nothing new to that part of the world. What has changed is how that activity is being interpreted and how certain political leaders make symbolic statements about Arctic geopolitics. The worry, however, is that such hype might spur further increases in military activity and thus fuel the very race that leaders are fearful of. Due to its role as both a NATO member and Russia's neighbor, Norway in particular has a special responsibility to

convey a cooler message while also continuing to encourage cooperative measures in the North, especially in the domain of security politics.

“Norway wants to lead on climate change. But first it must face its legacy of oil and gas,” Jariel Arvin, VOX, 15 January 2021 [46]

<https://www.vox.com/22227063/norway-oil-gas-climate-change>

Overview:

Norway’s ambition to be an international leader on climate change is at odds with its status as one of the world’s largest oil and gas exporters.

In 2019, the country was 15th on the list of the world’s top oil-producing countries, according to provisional data from the International Energy Agency, and ranked eighth in the world for natural gas production, behind Australia but ahead of Saudi Arabia.

The bulk of revenue from Norway’s oil and gas production is kept in a sovereign wealth fund, which was created to keep the money for the Norwegian people and future generations. The fund, which has amassed \$1 trillion since its inception in the 1990s, is a source of stability for the nation in times of economic instability, like the coronavirus pandemic.

In December, Norway’s Supreme Court ruled against environmental activists who sued the government because they felt oil-licensing permits granted in the Arctic threatened their right to a clean environment under the country’s constitution. The decision will now pave the way for more drilling in the Arctic.

Experts refer to this as Norway’s “paradox”: Norway wants to be at the forefront of international efforts to address climate change, yet it continues to rely on heavily polluting fossil fuel extraction for continued economic prosperity.

To get a better sense of this paradox and how Norway might be able to finally break out of it, I spoke with Bård Lahn, a researcher at Norway’s Center for International Climate Research (CICERO) in Oslo. Lahn is an expert on the country’s oil policy and how Norway is trying to align its ambitions on climate change with its role as a large oil and gas producer.

Conversation, edited for clarity and length, is found by going to the website via link above.

6. Russia:

“Arctic economy within the Arctic nations,” Helen McDonald, Solveig Glomsrød and Ilmo Mäenpää, The Economy of the North [47]

https://www.ssb.no/a/english/publikasjoner/pdf/sa84_en/kap4.pdf

Overview:

In his book on the history of wealth and poverty of nations, Harvard professor David S. Landes devoted the introductory chapter to highlighting how natural conditions in the tropics represent serious barriers towards economic development. He did not consider the Arctic in the same context but the Arctic environment is generally seen as an even bigger challenge to livelihood than the tropics. Over the years people seem to have voted with their feet in this matter, while the tropics abound with people, the Arctic is sparsely populated. The 10 million people who currently live in the Arctic Region, what do they do for a living? To live in the Arctic, people must have their very special reasons, the remaining 99.8 per cent of the world population might easily think. One clear reason is the attraction of people and investments to natural resources. Another is the fascination of the qualities of nature, shifting from extreme and blending grandeur to darkness and stillness.

These special reasons should be reflected in the structure of the Arctic economy, indicating the extent to which nature in the Arctic has had its say in shaping the economy of the north. This chapter provides an overview of the predominant economic characteristics and the major industries of the Arctic regions within the Arctic nations. It also provides information about the contribution of the Arctic regions to the economy of the respective Arctic nations. Thus, for the most part, the information in this chapter is viewed from an intra-national rather than a comparative international perspective, although some comparisons among the regions are made in the concluding remarks to this chapter.

While there is significant economic variation across the Arctic regions of the Arctic countries, many of these regions host large resource-based industries. In many cases, resources produced in the Arctic are shipped outside the Arctic region to export markets or southern markets within the same country. At the same time, the Arctic regions tend to draw extensively on southern markets for specialized and professional labor, capital, and consumer products. While Arctic regions generate income and resource rent from natural wealth, they also receive transfer payments from national governments. In some Arctic regions resource exploitation generates economic activity within the region in the form of the construction and operation of pipelines, and the provision of services such as transportation, wholesaling and retailing and housing. With some exceptions, manufacturing activity tends to be limited in Arctic regions. The electronics industry in Oulu in Northern Finland and the industrial sectors in Northern Russia and Northern Sweden are exceptions to this and the data presented in this chapter illustrate the variability in economic structure among Arctic regions that is frequently overlooked when the Arctic economy is discussed.

For each of the Arctic regions this chapter contains a core table showing regional gross domestic product (GDP) and the contribution to regional GDP by industry at a disaggregated level (for 17 industries). This level of detail is intended to capture all the main activities of the circumpolar Arctic region. The data for the Arctic excluding

Russia are based on national statistics and World Development Indicators of the World Bank. Arctic Russian data by main industry are provided by Russia's Federal State Statistical Service and further harmonized with statistics for other Arctic regions using production and employment statistics. These core tables generally refer to the year 2002, which represents a compromise between coverage and timeliness. The tables present value added or contribution to GDP in local currency in order to focus on the Arctic element of their respective national or federal economies. Where available some more recent economic indicators are presented.

Current & Relevant Information:

Arctic Russia is by far the largest among the Arctic regions, both in terms of land area and population. According to our definition it covers the regions of the Republics of Karelia, Komi, the oblasts of Arkhangelsk, Murmansk, the Autonomous Okrugs KhantyMansi and Yamalo-Nenets, Taymir, Evenks, Sakha, Chukotka, Magadan, Koryakia. In 2003, Northern Russia had a population of 7.1 million people down from 7.9 million in 1995.

The basic structure of the Russian economy was developed during the Soviet era with economic planning as a core instrument. As a consequence of planned public industry development, resource extraction and processing have to a large extent been organized in combines that are vertically integrated and produce multiple outputs. The extractive industries that are pre-dominant in Arctic Russia have this historic origin, and economic statistics have been compiled in formats associated with that institutional framework. Therefore, the data for Arctic Russia are not readily comparable with data for other Arctic regions. For instance, fishing is integrated with the food industry and the fuel industry may include refining and chemical products. The data on Russia in this report are provided by the Federal State Statistical Service of Russia. To present data on income and production by industry at about the same aggregation level as for other Arctic regions, some additional compilations have been made for this report using regional statistics on output and employment from the Russian Federal State Statistical Service. However, it is not possible to produce fully compatible tables.

The fuel industry was the largest single industry in the Russian Arctic in 2002. This industry, which includes oil and gas extraction, contributed 36 per cent to regional GDP. Transportation of petroleum via pipelines accounted for an additional 7.3 per cent of GDP. The level of activity reported in the chemical industry and ferrous metallurgy is minor, whereas non-ferrous metallurgy represents 4 per cent of regional GDP. Education, health and social security accounted for 8.7 per cent of regional GDP, while other services contributed 11.4 per cent. The share of private and public services is low compared to other Arctic regions. However, the low share may partly reflect the provision of social welfare services within other industries as was practiced extensively before the economic reforms.

Arctic Russia's share of the population of the whole Russian Federation declined to 4.1 per cent in 2003, down from 4.4 per cent in 1995. The GDP per capita is higher in Arctic Russia than in the Russian nation as a whole.

However, it is important to distinguish between Khanty-Mansi and Yamalo-Nenets and the other Arctic regions of Russia. In Khanty-Mansi and Yamalo-Nenets gross product per capita is considerably higher than in other parts of Russian Arctic. In these other parts of the Arctic regions gross product per capita is only slightly higher than the Russian average.

Approximately 55 per cent of Russian oil production takes place in Khanty-Mansi and more than 85 per cent of Russian natural gas production takes place in Yamalo-Nenets. Probably more than 50 per cent of total gas production in Europe and Northern parts of Asia is taking place in Yamalo-Nenets. The oil production in Khanty-Mansi is also substantial in a global perspective. The oil production in this area equals approximately 50 per cent of the oil production in Saudi Arabia. While the oil production in Russian Arctic has been increasing during the last decade, the gas production has been relatively stable.

In the years after 1990 the oil production in Khanty-Mansi dropped significantly. This drop was to a large extent caused by a parallel drop in domestic demand. The increased production in Khanty-Mansi during the recent years has, on the other hand, mainly been driven by increased export.

With respect to coal production, only a small share of the Russian production is taking place in the Arctic region.

Agriculture has a significantly smaller share of the workforce in the Arctic regions than in the rest of Russia. The employment share is especially small in Khanty-Mansi and Yamalo-Nenets. The remarkably large share of employment within the construction industry in these two regions is among other things probably related to petroleum production and transport.

“Russia,” The Arctic Institute: Center for Circumpolar Security Studies, 1 August 2022 [48]

<https://www.thearcticinstitute.org/countries/russia/#:~:text=The%20Russian%20economy%20is%20dominated,primarily%20oil%20and%20natural%20gas.&text=Russia's%20Arctic%20and%20sub%2DArctic%20regions%20account%20for%2090%20percent,high%20in%20natural%20gas%20production.>

Overview:

Facts & Figures

AC member since 1996

Active Polar Icebreakers

Coordinates

Moscow: 55.7558° N, 37.6173° E

Murmansk: 68.9585° N, 33.0827° E

Population

146 million, approximately 2.5 million in the Arctic

Land Area

17,098 million km²

Coastline

37,653 km

Current & Relevant Information:

The Russian economy is dominated by the extraction of natural resources, primarily oil and natural gas. The country is the world's third-largest producer of hydrocarbon resources and more than 50 percent of Russia's federal budget depends on revenue derived from oil and gas production. Russia's Arctic and sub-Arctic regions account for 90 percent of Russia's natural gas production and 10 percent of its oil production. However, in recent years, Russia has hit a record high in natural gas production. A total of 3.5 billion rubles were invested in the Russian energy sector in 2017, 10 percent more than previous years. Natural gas production in 2017 amounted to the highest volume in 17 years, while exports also peaked. The new Bovanenkovo field in the Yamal Peninsula will produce a record-high 115 billion cubic meters by 2020.

History of Oil and Gas in Russia's Arctic

The exploitation of oil and gas in the Russian Arctic dates back to the early 1930s. In 1930, the Arctic's first oil field, Chibyskoe, was discovered in the Republic of Komi followed by the Yarega oil fields in 1932. Some of Russia's largest oil and gas fields, which are still in production today, were discovered during geological prospecting in the 1960s and 1970s. Development focused on the West Siberian oil and gas province, and more specifically the Arctic part of the province known as Yamalo-Nenets Autonomous Okrug (YaNAO).

A number of giant natural gas fields surpassing any previously known has fields in scope and size were discovered in YaNOA starting with the Tazovskoe field, followed by the Novoportovskoe oil and gas condensate field in 1964, the Gubkinskoe oil and gas condensate field and the Zapolyarnoe gas field in 1965, the Urengoy oil and gas condensate field in 1966, the Medvezhyye gas field in 1967 and the Russkoe oil field in 1968.

Additional developments followed in the 1970s and 1980s in the northeastern part of the West Siberian oil and gas province along the lower reaches of the Yenisei River with the discovery of the Vankor, Tagul, Lodochnoe, and Suzun fields. During the 1970s and 1980s development followed on the Yamal peninsula with the discoveries of the Bovanenkovskoe gas field in 1971, the Kharasavey and South Tambey fields in 1974, and the Rostovtsev oil and gas field in 1986. To this day YaNAO part of the West Siberian oil and gas province remains the largest gas-producing region of the world and also provides substantial share of Russia's oil production.

In 2010, Norway and Russia resolved a 44-year dispute over the border delineation in the Barents Sea. The countries agreed to split the 175,000 square kilometer area under dispute which may contain up to 4 billion barrels of oil and 878 trillion cubic feet of natural gas. The implementation of Western sanctions by the United States and the European Union against Russia impacts the exploration and development of hydrocarbon resources in the Arctic. ExxonMobil signed a cooperation agreement with Rosneft for a total of 10 joint ventures, primarily exploration in the Kara and Black Seas as well as the joint development of the Bazhenov shale in West Siberia.

Following the sanctions, ExxonMobil was required to suspend its activities in the joint ventures. This follows the announcement from September 2014 of the successful discovery of petroleum resources at the Kay 1 well in the Kara Sea. Similarly, in June 2015 French energy company Total withdrew from a joint venture with Russia's Lukoil under which they had planned to develop the Bazhenov shale oil fields in West Siberia. The company also chose to return to Gazprom a 25 percent share it held in the postponed Shtokman gas field. Not affected by western sanctions is the development of the world's first ice-resistance oil platform Prirazlomnoye which Gazprom constructed in the Pechora Sea. Production of oil began in April 2014.

Russian Cooperation with China

In 2014, Russian energy giant Gazprom and the CNPC signed an agreement that shipped gas from the Russian Arctic to China. The deal was worth about \$400 billion. Although Europe remains Russia's largest energy export market, Russia is using such deals to diversify gas trading partners with Asian countries.

The Yamal LNG project is arguably the most remarkable example of China's cooperation with Russia in the Arctic. The Yamal LNG is a gas plant in the Russian Arctic which is estimated to hold 22 percent of the world's gas reserves. Chinese entities provide financing and hold large stakes in the project. In 2013, Novatek and the China National Petroleum Corporation (CNPC) signed a contract that gave a 20 percent stake of the Yamal LNG project to China's Silk Road Fund (SRF). The contract includes an agreement to ship more than 3 million tons of LNG every year to China.

In July 2018, Novatek delivered the first LNG cargo shipment via the Northern Sea Route (NSR) to China. Novatek head Leonid Mikhelson said that “utilizing the Northern Sea Route as a viable transportation route contributes to the development of the northern regions and is very important for [the] country’s economic development.” At the moment, the CNPC and SRF together own about 30 percent of the Yamal LNG project. Novatek owns 50.1 percent and French energy giant Total owns 20 percent. Chinese media celebrate the Yamal LNG as a “milestone in China-Russia cooperation” under the framework of the Belt Road Initiative (BRI). It is China’s first major Arctic energy project as part of its development strategy. The CNPC and SRF are now considering joining the multibillion-dollar Arctic LNG-2 project, set to be launched in 2023.

Northern Sea Route

Development of the Northern Sea Route (NSR) began in June 1936 when the Council of People’s Commissar of the former USSR established the Chief Directorate of the Northern Sea Route (Glavsevmorput). The Directorate was tasked with establishing and developing a route from the Barents Sea to the Bering Strait. Its task encompassed the establishment of sea, river and air transportation routes, the required telecommunications infrastructure and the leading of all Soviet research efforts in the Arctic. Furthermore, it also spearheaded the development of natural resources in the Arctic and the construction of required production facilities. In addition, it was also in charge of the promotion of the economic development of the indigenous peoples of the Arctic. The Northern Sea Route has since grown to be of the highest importance in national and regional development plans.

Following the end of the Cold War, many of the routes of communications deteriorated and associated infrastructure fell in disrepair with the decreasing use of the NSR. Cargo traffic decreased by nearly 90 percent during the 1990s compared to the early 1980s. With the onset of increasingly ice-free summer seasons, especially after the record melt season of 2007 and 2012, the NSR began a revival as a national and international transport corridor. While volumes remain very limited in comparison to global shipping hotspots like the Suez and Panama Canal, the route nonetheless is of key importance for the economic development of the Russian region situated along the route and the accessing, exploitation, and exporting of hydrocarbon resources in the Arctic.

In 2018, President Putin signed a decree which states that the NSR is to be developed continuously with annual goods volumes set to increase to 80 million tons by 2024. This is an 8-fold increase compared to 2017. This ties into Russia’s national strategy which emphasizes the development of the NSR into a global and comprehensive transport artery. Only 5 months after the Yamal liquefied natural gas (LNG) project in Northern Russia opened, volumes of shipment had exceeded two million tons of LNG. Another substantial goods increase on the NSR is coal. According to VostokCoal, 30 million tons of coal can be extracted annually by 2025

from the Taymyr Peninsula. Furthermore, a Maersk vessel loaded with Russian fish and South Korean electronics has become the first ship to fully navigate an Arctic Sea route. Russia hopes this will become its new shipping highway, cutting transport times from Asia to Europe significantly by avoiding the Suez Canal. The NSR is still not a viable and sustainable option for most shipping businesses, as the passage is only feasible for 3 months of the year.

In 2020, the world's first floating nuclear power plant Akademik Lomonosov has also been designed for the Arctic, and used by Rosatom. This is a new type of infrastructure used in Arctic waters, and supposed to supply electricity for remote Russian settlements.

“Russia in the Arctic—A Critical Examination,” Eugene Rumer, Richard Sokolsky, and Paul Stronski, Carnegie Endowment for International Peace, 29 March 2021
[49] <https://carnegieendowment.org/2021/03/29/russia-in-arctic-critical-examination-pub-84181>

Summary:

Russia's Arctic ambitions have attracted increasing attention in the West over the past decade as climate change opens up new opportunities in the region for navigation and exploration of its riches. For its part, Moscow casts a wary eye on what it sees as a challenge from the United States and the North Atlantic Treaty Organization (NATO) to its position and ambitions there. The Kremlin's rhetoric about Western encroachment has become more strident, in sync with its enhanced military posture and ambitious economic and infrastructure projects.

THE DRIVERS OF RUSSIA'S ARCTIC POLICY

Russian interest in the Arctic has deep historic roots that extend all the way to the sixteenth century and the conquest of Siberia driven by the never-ending quest for more resources and secure trading routes. Modern-day Russian posture in the Arctic is integral to its overall confrontation with the West, in which Europe is the principal theater. The saber-rattling in the Arctic and threatening rhetoric are driven by several factors: preparations for the unlikely, but potentially catastrophic contingency of war in Europe, the need to secure its second-strike nuclear capabilities (the bulk of which is based around the Kola Peninsula), and the quest for resources to pay for the proverbial guns and butter as the competition with the West shows no sign of abating. Great-power ambitions and the interests of powerful bureaucratic elites and business interests also play a role.

AMBITIONS VS. REALITY

It remains to be seen whether Russia will be successful in realizing these ambitions. Its nuclear and conventional naval forces in northwest Russia are increasingly vulnerable to NATO's long-range precision weapons. It is unclear whether the development of the Northern Sea Route (NSR) along Russia's northern coastline

into a major shipping route between Europe and Asia and the associated commercial projects are feasible and sustainable in the face of high costs and logistical complexity of operating in difficult climatic conditions with limited infrastructure, increased commercial competition from other countries, uncertain demand for hydrocarbons as the world shifts to green technologies, and the possibility of additional Western sanctions. The Kremlin's posture in the Arctic is likely to continue as it enjoys backing from President Vladimir Putin and top military, government, and business actors. Its ability to achieve these broad ambitions for the region, however, is questionable at best.

IMPLICATIONS FOR THE UNITED STATES AND NATO

Russia's conception of its security requirements and NATO's mutual-defense and deterrence commitments on the other hand have resulted in a tense standoff along the alliance's northern flank as their forces operate in close proximity. Tempting as it may be to view the Arctic through the prism of great-power competition—which undoubtedly would fit with Russia's quest for recognition as a great power—there is little to suggest that its military posture in the Arctic is a fundamentally new undertaking. Rather, it signals the return to a version of its Cold War-era posture centered around long-standing missions of protecting the sanctuaries of its ballistic missile submarine fleet and operations in the North Atlantic in the event of a war in Europe. Yet the Russian military is resuming these missions with fewer resources and facing a more formidable array of adversary capabilities than during the Cold War.

Russia has staked out ambitious territorial claims in the Arctic. Its rhetoric notwithstanding, it has thus far pursued them through legal means in compliance with the terms of the United Nations (UN) Convention on the Law of the Sea, which it has signed and ratified.

Russia's actions in the Arctic—its aggressive rhetoric and its far-reaching territorial claims—have done little to improve its diplomatic position there vis-à-vis other Arctic states and only antagonized them. Its only partner in its Arctic pursuits has been China, which claims that it is a “near-Arctic” state—a claim rejected by the United States and likely viewed with suspicion by other Arctic nations.

Considering the long-term nature of Russia's confrontation with the West, the return to the relatively benign geopolitical environment in the Arctic that existed there in the 1990s is unlikely. Moreover, the current situation is not due to a misunderstanding, but rather to a clash of the two parties' interests. That leaves two broad avenues for managing the standoff:

Diplomacy: Although Russia may not prove receptive, the United States and NATO should seek areas of cooperation where there is a convergence of interests, as well as to devise rules of the road similar to those that existed during

the Cold War to reduce tensions, avoid or manage crises, and mitigate the risks of conflict through an accident or miscalculation.

Deterrence: The United States and NATO should continue to improve their defenses to discourage Russia from harassing their military and commercial aircraft and ships in and around the Arctic, and to ensure that the alliance maintains the capability to execute its wartime reinforcement plans for its northern and eastern flanks.

The alliance should continue to manage competition with Russia through a combination of resolve and restraint, improving and demonstrating its capabilities for defense and deterrence, but without overreacting to Russian muscle-flexing. Striking the right balance will be difficult and will require communicating to Russia clearly where the allies' interests, objectives, and redlines are. The allies have been there before.

Current & Relevant Information:

INTRODUCTION

During the first post–Cold War decade, Russia approached the Arctic as an area of low tensions, where cooperation with other powers in addressing common challenges was desirable and feasible. Gradually, however, as relations with the West deteriorated, and especially since its 2014 invasion of Ukraine, Russia has adopted a much more competitive, even confrontational, perspective on the Arctic. Instead of emphasizing the benefits of cooperative engagement, its leaders have articulated their view of the Arctic as a sphere of military and economic expansion, and an arena for their great-power ambitions. As a result of this changing attitude, Moscow has prioritized military superiority to counter what it claims is a growing U.S./NATO challenge to its interests there.

By any objective standard, U.S./NATO military deployments in the Arctic do not currently represent a threat to Russia's Northern Fleet or to its other military assets there. The region possesses an abundance of natural resources, especially oil and gas, but these are available elsewhere in Russia. Exploring and extracting them in the Arctic requires huge capital investments and modern technology that would stretch its capacity. Global warming is opening up new commercial opportunities for shipping and fishing, but there is scant infrastructure in the region to capitalize on these opportunities, and rectifying this deficiency will be costly.

Russia's evolving Arctic ambitions have engendered growing concerns among other Arctic nations, yet surprisingly little is known about the basis for these ambitions. This paper therefore addresses the following questions: What are the drivers of Russia's Arctic policy? How does it define its interests in the region and what tools does it employ to advance them? Who are the Russian stakeholders that would benefit from the exploitation of the region? What are the prospects for Russia

realizing its ambitions? What are the implications of its actions and ambitions for U.S./NATO interests and policy?

CONCLUSION

In responding to Russia's ambitions in the Arctic, it is important for the United States and NATO to base their plans on a realistic assessment of its posture there, its drivers, and its capabilities. Tempting as it may be to view the Arctic through the prism of great-power competition—which undoubtedly would fit with Russia's quest for recognition as a great power—there is little to suggest that its military posture in the Arctic is a fundamentally new undertaking. Rather, it signals the return to a version of its Cold War–era posture centered around long-standing missions of protecting the sanctuaries of its ballistic missile submarine fleet and operations in the North Atlantic in the event of a war in Europe. The Russian military is resuming these missions with fewer resources and facing a more formidable array of adversary capabilities than during the Cold War.

Some hedging against a greater-than-anticipated Russian threat should be one element of the United States' and NATO's overall approach to the Arctic Region. But pursuing the goal of winning a great-power competition with Russia in this region is likely to be a distraction from other, more important U.S. pursuits. The alliance should act with prudence, realism, and restraint in protecting its core interests in the Arctic and carefully manage competition with Russia to avoid destabilizing consequences.

Even though their tense standoff is likely to continue, some cooperation between Russia and other Arctic nations, in practical areas that are largely depoliticized, is probably possible. These include climate change, search and rescue operations, and scientific research. Other opportunities for cooperation should be explored on issues of common concern, such as the safety of maritime shipping, environmental remediation, protection of fisheries, and incident management. In addition, it is essential for NATO allies to find potential diplomatic avenues for managing the standoff—that is, rules of the road to mitigate the risks of crises or incidents with the potential for escalation. No matter how unpromising they may seem, they should be explored. The allies have been here before.

“Russia’s Arctic Development: Problems and Priorities,” Rylin McGee, geohistory, 12 January 2018 [50] <https://geohistory.today/russia-arctic-development-power/>

Overview:

The Arctic region is a vast area whose economic potential, through climate change and advanced technology, is becoming accessible for the first time in history. This potential includes hydrocarbon resources as well as shipping lines, fishing rights, and metal deposits. Developing the Arctic will require massive investment –

particularly into transportation, extraction, and governance infrastructure. Yet beyond establishing infrastructure, Arctic states must also consider the various environmental and diplomatic risks associated with such development.

At present, Russia has already begun developing infrastructure for its substantial Arctic territories, integrating them into its long-term development plans. Congruent with Russia's development imperatives, these moves have given Russia an early lead in the Arctic territories. They have also been met with some alarm from other states.

This article will focus on the economic and military aspects of Russia's development of its coastal and oceanic Arctic regions and the issues of international concern that arise because of them. Overall, however, despite wider, growing geopolitical tensions, international cooperation is currently the norm in the Arctic, notably in resolving and expanding territorial disputes and in maintaining environmental stability there.

Current & Relevant Information:

Conclusion

International efforts to help resolve border placements and to protect the Arctic environment show that a precedent clearly exists for cooperation in the area, despite wider geopolitical tensions. While the United States has yet to ratify the UNCLS, it is currently viewed as working fairly for all parties, with littoral states being supportive and compliant. Because economic opportunity is foundational to interests in securing a regional presence, Arctic nations will likely continue their adherence to international law in order to preserve peaceful operations for as long as possible.

Thus, while climate change is resulting in increased economic, military, and environmental activity in the Arctic, political cooperation will likely continue into the future in order to support domestic economies and local environments.

“The Arctic as a resource base,” Bellona, 26 March 2024 [51]
<https://bellona.org/news/arctic/2024-03-the-arctic-as-a-resource-base>

Overview:

In recent years, Russia has been concerned with the development of its Arctic territories. However, it appears to be rather one-sided. The main focus is on the extraction and processing of natural resources, their export to the international market, and the development of the Northern Sea Route (NSR). Other directions of socio-economic development receive much less attention, and the environmental management of the region, particularly in the context of existing and planned economic activities, lags even further behind.

Legislation defining the concept of managing the Russian Arctic was mainly adopted before Russia's invasion of Ukraine. The international sanctions that followed have not yet affected this concept significantly, and has only adjusting certain indicators.

Current & Relevant Information:

What is the Russian Arctic and how is it managed?

The main documents establishing the legal regime and determining the strategy for managing Russia's Arctic territories include:

- [Fundamentals of the State Policy of the Russian Federation in the Arctic for the Period up to 2035](#),
- [Strategy for the Development of the Arctic Zone of the Russian Federation and Ensuring National Security for the Period up to 2035](#),
- Federal Law No. 193-FZ [“On State Support for Entrepreneurship in the Arctic Zone of the Russian Federation”](#),
- [Development Plan for the Northern Sea Route for the Period up to 2035](#),
- Federal Project [“Development of the Northern Sea Route”](#).

The boundaries of the Arctic Zone of the Russian Federation (AZRF) are established by Law No. 193-FZ. They differ significantly from the commonly accepted boundaries of the Arctic, which are conventionally determined either by the Arctic Circle or by the southern boundary of the tundra zone. Thus, the southernmost point of the AZRF (the south of the Turukhansky District of the Krasnoyarsk Territory) is approximately 800 km south of the Arctic Circle and 600 km south of the tundra zone boundary.

Since 2020, the AZRF has been regularly expanding with new territories. Soon, two more districts of the Khanty-Mansi Autonomous Okrug — Berezovsky and Beloyarsky — with areas of 88.1 and 41.6 thousand square kilometers, respectively, may be added to it. According to the text of the [corresponding bill](#), this will create favorable conditions for the development and utilization of these municipal districts and the Arctic zone overall.

These favorable conditions are related to the fact that the same Law No. 193-FZ established a special economic zone in the AZRF — a territory with a special legal status distinct the rest of the Russian Federation, which implies various preferential conditions for attracting business.

The same law introduces the concept of “AZRF resident”. Only legal entities registered in the Arctic can be residents. Currently, there are [723 of them](#). Major corporations such as Gazprom and Novatek are not on this list, but their subsidiaries, such as Rosatom's subsidiaries AO “Chukotatomenergo” and LLC “Arctic Atom-Service”, can be included.



Among the residents is one of the largest industrial companies operating in the Russian Arctic, LLC “Severnaya Zvezda”, the operator of the Syrdasayskoye coal deposit in the Taymyr (Krasnoyarsk Territory). It is planned that from 2029, the deposit will provide a cargo flow of 12 million tons along the Northern Sea Route (NSR).

Residents of the Arctic zone are [entitled](#) to tax preferences, such as a zero profit tax for 10 years from the moment of receiving the first profit (except for production related to the extraction of solid minerals), zero land tax, and others. Tax incentives may vary from region to region. Among the administrative bonuses is the possibility of obtaining land plots without auctions, which are state or municipal property, subsidizing the construction of infrastructure, and even assistance in personnel recruitment and management.

Moreover, the law provides for the possibility of applying the procedure of a free customs zone (FCZ) on developed and equipped areas of residents, which implies exemption from customs duties and VAT for the export and import of goods.

However, the FCZ procedure can be applied to specific areas of transportation facilities, such as seaports, international airports, as well as land plots adjacent to automobile or railway checkpoints, which may also be accessible to non-residents.

In addition to other benefits in the Arctic zone, established for non-residents, it is worth mentioning federal tax incentives for all organizations engaged in the search, evaluation, exploration, and extraction of hydrocarbon raw materials in certain territories of the Arctic zone and offshore deposits.

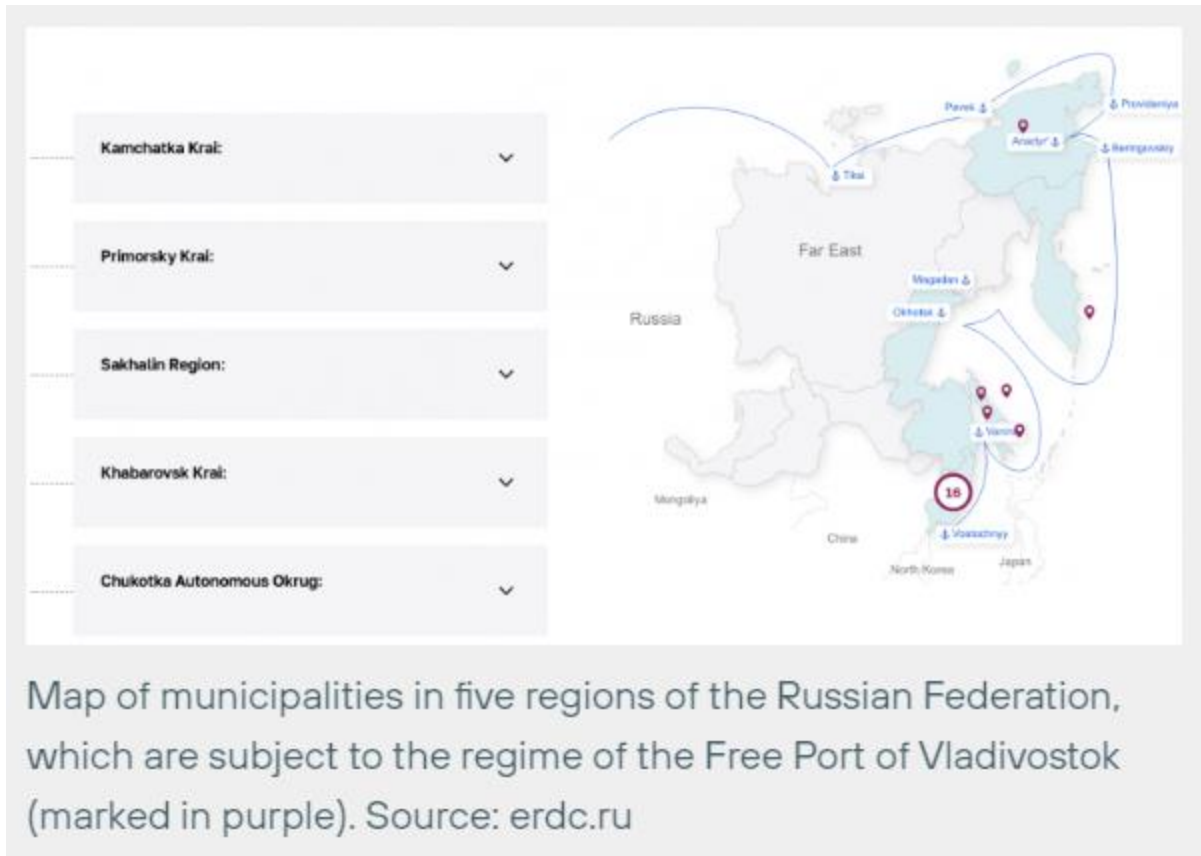
The law on the Arctic zone of the Russian Federation also includes two interesting points. The first is the possibility of conducting checks on residents, including compliance with environmental legislation, only with the consent of the Ministry for the Development of the Russian Far East and the Arctic (Minvostokrazvitiye) and within shortened deadlines. The second is that the managing company of the Arctic zone of the Russian Federation has the right to represent and defend the interests of applying residents in court, which increases their chances of success.

At the same time, the managing company for all residents is the Far East and Arctic Development Corporation (KRDV). It operates in both territories of advanced development (referred to as TOR in its Russian abbreviation), affiliated to the Far Eastern Federal District (FEFD), and in the Arctic zone of the Russian Federation. Both the Far Eastern TORs and the Arctic zone of the Russian Federation are under the control of Minvostokrazvitiye, and the chairman of the board of directors of KRDV is concurrently the head of Minvostokrazvitiye, Alexey Chekunkov. Thus, the activities of Arctic business are essentially protected by the state.

In the Arctic zone of the Russian Federation, there are also territories that have been separated from it into separate jurisdictions. For example, there are their own TORs here. These include the TOR “Arctic Capital” (Murmansk Region) specializing in port activities, logistics, industrial construction, and the TOR “Chukotka” (Chukotka Autonomous Okrug) specializing in “extraction of minerals and services to the population.” These TORs also have legislative incentives — in each individual case, they are different, and they also differ from the conditions in the rest of the Arctic zone of the Russian Federation.

But that’s not all. In the urban district of Pevek (Chukotka), the so-called Free Port of Vladivostok (FPV) regime is in effect, which also implies preferential tax, administrative, and customs regulation regimes, including the possibility of applying the FCZ procedure. In the urban district of Pevek, there is one of the most significant ports on the Northern Sea Route and large gold mining enterprises.

Thus, there are separate “autonomies” in the Russian Arctic living by their own rules.



The Arctic zone of the Russian Federation (AZRF) is the largest special economic zone in the world and, in turn, is also an “autonomy” with its own legal regime in relation to the rest of the country’s territory. The land area of the AZRF is approximately 5 million square kilometers. For comparison, the area of Russia is 17 million square kilometers (excluding Crimea and other occupied territories of Ukraine).

However, the development of the Arctic is not singled out as a separate direction but is controlled by the same structure that deals with the development of the Russian Far East (RFE) and manages all such “autonomies” both in the Arctic and in the RFE, despite their very serious environmental, climatic, socio-economic, and other differences.

Why all this is necessary?

Let’s turn to another important document that determines the fate of Russia’s Arctic territories. This is the presidential decree [“On the Basics of the State Policy of the Russian Federation in the Arctic until 2035.”](#)

The document begins with a list of six main national interests of Russia in the Arctic. Among them are sovereignty and territorial integrity; peace and partnership; the well-being of the population; environmental protection, including the interests of indigenous peoples.

Another point is dedicated to the economic aspect of the region's development. However, here the focus is solely on the extraction of minerals. Thus, one of the national interests is understood as the development of the AZRF "as a strategic resource base and its rational use to accelerate the economic growth of the Russian Federation."

The next point in the list is "the development of the Northern Sea Route (NSR) as a competitive national transport route on the world market."

The strategy for the development of the NSR, as well as the target indicators for its use, are detailed in other state documents. The first is the Federal Project "[Development of the Northern Sea Route.](#)" The main task is to increase cargo traffic along the NSR to 80 million tons by 2024 and to 150 million tons by 2030.

The second is the [Plan for the Development of the Northern Sea Route until 2035](#), approved by the government of the Russian Federation on August 22, 2022, and subsequently [supplemented](#) on April 28, 2023. It implies an even greater increase in cargo traffic compared to the federal project – up to 90 million tons by 2024 and up to 216.45 million tons by 2030.

The plan also includes a forecast for annual loading, according to which the bulk of the cargo flow along the NSR (approximately 70-75% depending on the year) should consist of oil, liquefied natural gas (LNG), non-ferrous metals, and coal produced in the AZRF by Gazprom, Rosneft, Novatek, Norilsk Nickel, LLC "Severnaya Zvezda," and LLC "Baims Mining Company."

The full implementation of these plans is in question, particularly due to sanctions. For example, the cargo traffic along the NSR in 2023, while breaking a historical record, reaching [36.25 million tons](#), still fell significantly short of the target indicator of the NSR Development Plan of 46.82 million tons.

Nevertheless, it is evident that a large portion of the cargo turnover along the NSR will eventually consist of minerals extracted in the AZRF. It is safe to say that two out of the six main interests of Russia in the Arctic, according to the Foundations of the State Policy in the region, are their extraction and transportation to markets.

Moreover, among the main threats to national security listed in the document is the "low pace of geological exploration of promising mineral resource centers in the Arctic zone of the Russian Federation."

The theme of resource development in the Arctic is widely reflected in the [Strategy for the Development of the Arctic Zone of the Russian Federation and Ensuring National Security until 2035](#), approved by the decree of the President of the Russian Federation.

Among other things, here, in seven points, the significance of the AZRF in the socio-economic development of the country and ensuring its national security is substantiated. Three points are devoted to the presence of useful minerals here, and a fourth — to the economic importance of the NSR.

Thus, the significance of the AZRF is justified by the fact that it contains 17% of all Russian oil (including gas condensate), and the continental shelf of the Russian Federation in the Arctic contains another 17.3 billion tons of oil (including gas condensate) and over 85.1 trillion cubic meters of natural gas, as well as the fact that the implementation of major economic projects in the AZRF (which again involves the extraction and export of raw materials) stimulates the production in Russia of high-tech and knowledge-intensive products and demand for them.

Target indicators and current situation at main initiatives in Arctic development projects		
Initiative	Target indicator	Current situation
Increase freight turnover on NSR	80 mln tons by 2024; 130 mln tons by 2030	36.25 tons in 2023
Build ships for Arctic navigation	8 new nuclear icebreakers, 4 non-nuclear icebreakers, 30 rescue vessels, 5 vessels of other types by 2035	885 vessels including 8 nuclear and 35 diesel and electric icebreakers working in arctic waters in 2022
Oil extraction	Development of more than 10 new oil fields, recovery in the Arctic of 26% of the national total oil recovery	21.4% of Russian oil was recovered in the Arctic in 2022
Gas extraction and LNG production	43 mln tons of LNG in 2024, 64 mln tons of LNG in 2030, 91 mln tons of LNG in 2035	20 mln tons of LNG in 2023
Metal and other useful resource extraction	Development of over 10 new deposits of coal, lithium, gold, copper and others	The Russian Arctic produced 40% of the world's palladium, 10% of its nickel, 30% of its diamonds, as well as gold, copper and platinum group metals
Environmental conservation	Creation of a permafrost monitoring system, development and adoption of regional adaptation plans, development of target indicators for reducing harmful emissions	Each year, Arctic enterprises emit 5.1 mln tons of pollutants 7.1 tons of greenhouse gases 363.5 tons of liquid waste
Population migration	Population growth rate of zero by 2030	-4.5 in 2022

Foreign Participation

Russia currently seems to lack sufficient resources of its own to fulfill existing plans for the development of the Arctic, so foreign capital is actively involved in their implementation.

According to Law No. 2395-1 [“On Subsoil,”](#) only legal entities registered in the Russian Federation can use subsoil resources. However, nothing prevents foreign companies from being owners of these legal entities either partially or fully.

Such examples exist among the largest Russian mega-projects in the Arctic.

For instance, LLC “GDK Baimskaya,” developing the Baimskoye gold-copper deposit in Chukotka, is 100% owned by the Kazakhstani company Trianon Limited. Novatek’s “Yamal LNG” project is owned 49.9% by companies from China and France, and 40% of the shares of another project, “Arctic LNG 2,” are held by companies from France, China, and Japan. Indian companies [have owned](#) 49% of OJSC “Vankorneft,” the operator of the Vankor field in the Krasnoyarsk Territory, since 2016.

Moreover, Vietnam’s participation in the development of the North-Purovsky gas condensate field in the Yamalo-Nenets Autonomous Okrug (YNAO) and the possibility of Thailand’s participation in projects for hydrocarbon extraction in the Arctic zone of the Russian Federation, including LNG, are being discussed.

An exception is made for the Russian Continental Shelf. Only Russian companies can operate there, with state participation exceeding 50%. Moreover, since 2016, there has been a moratorium on issuing new licenses for shelf development, and currently, only Gazprom and Rosneft operate there under previously issued licenses. Moreover, extraction is carried out only at one deposit — the Prirazlomnoye field.

Regarding transportation via the NSR of resources extracted in Russia, including in the Arctic zone of the Russian Federation, using vessels under a foreign flag, this is also possible according to the [Merchant Shipping Code](#). There are separate restrictions on the transportation of oil and gas; however, they do not apply to legal relations arising from international treaties concluded by Russia or any agreements concluded before February 1, 2018. An example of such cooperation are the 26 tankers chartered by Novatek, which are allowed to transport LNG and gas condensate via the Northern Sea Route under a foreign flag until 2044.

Environmental Policy in the Arctic

Thus, it is evident that in the Arctic zone of the Russian Federation (AZRF), there is active and planned new extraction and export of minerals. However, insufficient attention is currently paid to the environmental side of this process and to the overall fight against the environmental risks associated with economic activities in the region.

One of the main such risks is the thawing of permafrost. According to the Russian Ministry of Natural Resources, due to this process, 40% of the northern infrastructure in the country is already deformed. The potential economic damage to Russia could reach at least 5 trillion rubles (51.1 billion euros) by 2050, as stated by Deputy Minister of Ecology of the Russian Federation Sergey Anoprienko.

Therefore, in the updated edition of the “Foundations of State Policy of Russia in the Arctic until 2035,” issued on February 21, 2023, a point appeared on the creation of a state system for monitoring the condition of permafrost. And in the list of main threats to national security in the region provided in this document, there is mention of the unpreparedness of the environmental monitoring system located in the AZRF for environmental challenges.

The monitoring system began to be created in the first half of last year. On May 19, 2023, the first well for observing the condition of permafrost [was opened](#) in Salekhard. By the end of the year, there [were 20 of them](#) operating in five regions. By 2025, their number should increase to 140. Also, in December 2023, the first two stations for monitoring the concentration of greenhouse gases [were put into operation](#).

However, it is quite telling that the main Arctic documents usually focus not on combating climate change but on adapting to it. This can be explained by the fact that Russia still considers climate change not only as a threat but also as a stimulus for economic development. For example, in the Strategy for the Development of the AZRF, it is stated that climate change contributes not only to “risks for economic activities and the environment” but also to “new economic opportunities,” one of which is cited as increasing cargo traffic along the NSR.



The first bore hole of the permafrost monitoring system in the Russian Arctic. Photo: Ministry of Natural Resources of the Russian Federation

Also noteworthy is that, on the one hand, Russia considers climate change in the region as one of the threats to national security, while on the other hand, it enshrines in various regulatory legal acts a multiple increase in the extraction and export of hydrocarbons, the burning of which precisely contributes to global climate change and the rise in temperatures in the Arctic. However, unlike the ongoing development of oil and gas fields in the region, climate measures are only at the initial stage of implementation.

Furthermore, Russia is [not yet ready](#) to join the ban on the transportation and use of heavy fuel oil in the Arctic — a voluntary initiative developed by the International Maritime Organization of the UN. The ban [will begin to take effect](#) with some exceptions on July 1, 2024, and will come into full force in 2029. This measure will reduce black carbon emissions from shipping [by 44%](#), emphasize the “Clean Arctic” alliance, which includes “Bellona”.

Among other steps to reduce emissions in economic activities in the Arctic zone of the Russian Federation (AZRF), a set of 13 measures adopted on October 29, 2022, by [government directive No. 3219-r](#) is illustrative.

These measures include reducing the use of coal and heavy fuel oil as fuel, modernizing boiler houses and thermal power plants to switch them to natural gas, biofuels, or wood pellets and chips, measures to eliminate open storage of coal. It is also planned to work on improving the quality of treatment of domestic sewage in settlements and wastewater from ships calling at Arctic ports.

In addition, according to the document, plans are being developed to stimulate the transition of automotive, maritime, and inland water transport to natural gas fuel and to develop proposals to increase charges for emissions and discharges of pollutants into the atmosphere and into the seas and rivers. However, as seen, these points are currently only about developing plans and proposals, not about concrete steps.

At the same time, in some cases, individual effective measures are being taken to reduce the negative impact on the environment. For example, in 2021, the energy system of Vorkuta [was converted](#) from coal to gas, sharply reducing emissions into the atmosphere.

Despite this, in the following year, 2022, the Vorkuta urban district [took](#) the 8th place in the list of Russian cities with the most polluted air, with total emissions of 168 thousand tons, because many environmental problems related to coal mining, decommissioning of closed mines, and the liquidation of accumulated environmental damage [have not been addressed](#) for 20, 30, or more years.

Another example is the reduction of emissions by the Norilsk branch on the Kola Peninsula. Emissions here were also sharply reduced, but primarily because outdated production facilities were closed and transferred to the Zapolyarny branch of the company, also located in the AZRF — in Norilsk.

Norilsk itself, along with another 11 cities across the country, is part of the [federal project “Clean Air,”](#) launched in 2019. However, as of the end of 2022, emissions from the largest polluter — Norilsk Nickel — were only reduced from 1.8 billion tons to 1.78 billion tons (for comparison, all emissions into the atmosphere of the Norilsk urban district this year amounted to [1.79 billion tons](#)).

Summary

As a result of such environmental policy, emissions into the atmosphere from just the Arctic sites of Gazprom and Norilsk Nickel [exceed](#) those of the entire industry of Alaska and the Arctic zone of Canada combined. [According to Greenpeace](#), the Zapolyarny branch of Norilsk Nickel is the world’s largest anthropogenic source of sulfur dioxide pollution in the atmosphere, and areas of historically strong pollution and disruption of the natural environment (in many cases, dating back to the Soviet era) are scattered throughout the European part of the Russian Arctic zone (due to its greater development), but also occur in its Asian part.

However, in Russian state documents on Arctic management, environmental protection measures are relegated to the background compared to industrial development of the region, are fragmented, incomplete, and often do not extend beyond the development of plans, while concrete steps supported by target indicators are needed now.

The foundations of state policy, the development strategy of the region, and many other important documents defining the fate of the Russian Arctic are adopted until 2035, and major changes are unlikely to be expected. This means that, barring economic obstacles, such as a significant strengthening of international sanctions, serious anthropogenic pressure is planned for at least the next 10 years, which will increase environmental risks for the entire Arctic, not just its Russian part.

“How the Russian Invasion of Ukraine May Impact the Arctic,” Benjamin J. Sacks and Kristin Van Abel, The Rand Blog, 22 August 2022 [\[52\]](#)

<https://www.rand.org/blog/2022/08/how-the-russian-invasion-of-ukraine-may-impact-the.html>

Overview:

Seven countries that ring the North Pole recently declared that they would suspend cooperation with Russia at the Arctic Council, which Russia currently chairs, in response to Moscow's invasion of Ukraine. The council said it could not perpetuate an image of “business as usual.”

Current & Relevant Information:

The move by Canada, Denmark, Finland, Iceland, Norway, Sweden, and the United States was unprecedented in council history, and it threatens to unravel a set of governance mechanisms put in place by the Arctic Council and other international

forums that have maintained peace and collaboration in the Arctic for generations. Even Russia's illegal annexation of Crimea did not result in the same diplomatic response.

The seven Arctic states are cooperating in Arctic Council activities not involving Russia, including restarting scientific cooperation across countries. But the prospect of returning to the council's business as usual in the Arctic still seems very far away.

Although a conflict in the Arctic may be unlikely, it's hard to gauge whether it would happen, based on Russian President Vladimir Putin's unpredictable behavior and his invasion of Ukraine. The risk for miscalculation may be great—should a conflict spill over from the Ukraine invasion into the Arctic, the U.S. military is at somewhat of a disadvantage.

According to Mathieu Boulègue, a researcher at Chatham House, a London-based policy institute, “Moscow feels that it has a position of relative strength in the Arctic, which means that it is clearly seeking to obtain dividends from its perceived military superiority.” The United States and its Arctic partners might consider resuming diplomatic relations with Russia through the Arctic Council as soon as feasibly possible after the end of the war in Ukraine.

Russia is by far the largest Arctic state based on size, population, and military forces stationed in the region. It routinely conducts Arctic tactical exercises with thousands of troops, including specialized Arctic units. Russia also has reconnaissance stations, dual-use civilian-military facilities and bases equipped with missiles, and radar scattered across its vast northern Arctic border, including within 300 miles of Alaska. Russia's ongoing war in Ukraine, however, may have depleted some of its Arctic capabilities, or at least momentarily distracted it from the Arctic.

Suspension of cooperation with Russia leaves the Western Arctic powers without a major formal mechanism in which to discuss Arctic matters.

Suspending the Arctic Council's broader activities also potentially hurts the Arctic's 4 million inhabitants who have lived in peace since World War II—a remarkable peace that has survived the Cold War and its multiple proxy conflicts between the United States and the Soviet Union. And there is no forum to de-escalate military issues, since the Arctic Council does not deal with them.

If Arctic cooperation unravels, the lack of persistent U.S. presence and limited readiness for sustained joint tactical operations could present challenges for dealing with military conflict in the region. The most recent national defense strategy continues to view China as the top U.S. competitor, though it also acknowledges competition from Russia.

Although the United States has considerable assets in the Arctic region, many of them are more strategic than tactical in nature and are designed for homeland

defense, and global surveillance and power projection—not necessarily for sustained operations in the Arctic.

Many parts of the U.S. military are still learning (or relearning) how to operate in the Arctic. Efforts are hampered by extreme weather, poor communications stemming from a lack of polar satellites and atmospheric interference, equipment that is not optimized for the freezing temperatures, and limited ability to seamlessly rely on Arctic partners due to their continued inability to operate in conjunction with one another.

The limited infrastructure that does exist is neither interconnected nor equipped to support full-fledged military operations. Few airstrips north of the Arctic Circle are capable of accepting military aircraft, and even fewer hangars are available to protect them from the extreme elements. Land, sea, and air assets all require fuel—a rare resource in the U.S. Arctic.

The Arctic remains a relative weak spot in U.S. tactical defense. The United States has performed Arctic exercises, but not at the frequency or scale to train enough military forces to support extended operations in the region. In the European Arctic, a relatively small number of land forces train with their Norwegian counterparts to better survive and fight in harsh Arctic conditions.

Diplomacy with Russia may become an option at some point. But no matter how likely a conflict spillover may be, the United States could support its strategic interests by assuming a leadership stance in the Arctic Council in Russia's absence.

To do so, the United States could increase Arctic-ready tactical assets in Alaska, invest more in Arctic infrastructure, advance the Coast Guard's program to enhance U.S. situational awareness in the Arctic and reach local communities, and improve ground communication via Arctic satellites.

By taking these actions, the United States could demonstrate it is seriously committed to maintaining its defense and security position in the Arctic.

“Russia’s Arctic Strategy through 2035,” Janis Kluge and Michael Paul, Stiftung Wissenschaft und Politik, 26 November 2020 [53] <https://www.swp-berlin.org/10.18449/2020C57/>

Abstract:

Russia has adopted a development strategy for the Arctic for the period from October 2020 to 2035. Reflecting hopes and perceived threats associated with the successive warming of the Arctic, it aims to advance development of the region’s abundant resources, first and foremost oil and gas, and improve living conditions for the population. In the longer term, the Kremlin hopes to establish the Northern Sea Route as a new global shipping artery. Moscow also worries that an increasingly ice-free Arctic could create new territorial vulnerabilities in its Far North, and is

responding by re-building its military presence there. Finally, Moscow also wants to preserve the region's ecological balance. The indications are, however, that the interests of the energy sector and the military will be served, while funding to improve environmental protections and living conditions will remain inadequate.

Current & Relevant Information:

On 26 October Vladimir Putin formally adopted the new "Strategy for Developing the Russian Arctic Zone and Ensuring National Security through 2035". It is based on the "Basic Principles" for Arctic policy adopted in March and succeeds the Arctic strategy 2020 dating from 2013.

The political significance of the Arctic in Russia has grown steadily since the end of the 2000s, as reflected in various strategies, programs and presidential speeches, as well as the reactivation and modernization of military bases in the region. The Arctic region will also occupy the limelight in May 2021, when Russia is due to assume the chair of the Arctic Council for two years.

While the new strategy is largely built around continuity, shifts in Russian domestic and foreign policy since 2013 are also visible between the lines: The strategy does discuss the possibilities for international cooperation, but more space is devoted to threat scenarios. And where the 2013 Strategy named civil society organizations as implementation partners, they are now absent. Additionally, the assessment of climate change has also changed.

"Behind Putin's new Arctic Strategy lies a rude quest for natural resources," Atle Staalesen, The Barents Observer, 30 October 2020 [54]

<https://thebarentsobserver.com/en/climate-crisis/2020/10/behind-putins-new-arctic-strategy-lies-rude-quest-natural-resources>

Abstract:

The new guiding document for Russia's vast Arctic territories includes plenty of focus on oil, natural gas and shipping, and only few words about climate change and green energy.

Current & Relevant Information:

Putin announced his intention to endorse the strategy already in April, and on the 26th of October he finally put his signature under the document that outlines the country's main Arctic priorities for the period until 2035.

It comes less than half a year before Russia takes over the chair of the Arctic Council.

The 37-page document focuses primarily on social and economic development and national security. It includes also an appendix with 14 target indicators.

The strategy is adopted as Russia invests vast sums in new Arctic infrastructure, hydrocarbon development, shipping and military hardware. The Arctic has become a top priority region for the Kremlin, and Putin's demand for 80 million tons of shipments on the Northern Sea Route by 2024 is now a guideline for government.

No wonder, the prime focus in the document is on natural resource exploitation. The text includes the word "oil" (neft') 26 times and "gas" - 38 times. The Northern Sea Route is referred to 26 times, and "infrastructure" is mentioned 46 times.

7. Sweden:

"Arctic economy within the Arctic nations," Helen McDonald, Solveig Glomsrød and Ilmo Mäenpää, The Economy of the North [55]

https://www.ssb.no/a/english/publikasjoner/pdf/sa84_en/kap4.pdf

Overview:

In his book on the history of wealth and poverty of nations, Harvard professor David S. Landes devoted the introductory chapter to highlighting how natural conditions in the tropics represent serious barriers towards economic development. He did not consider the Arctic in the same context but the Arctic environment is generally seen as an even bigger challenge to livelihood than the tropics. Over the years people seem to have voted with their feet in this matter, while the tropics abound with people, the Arctic is sparsely populated. The 10 million people who currently live in the Arctic Region, what do they do for a living? To live in the Arctic, people must have their very special reasons, the remaining 99.8 per cent of the world population might easily think. One clear reason is the attraction of people and investments to natural resources. Another is the fascination of the qualities of nature, shifting from extreme and blending grandeur to darkness and stillness.

These special reasons should be reflected in the structure of the Arctic economy, indicating the extent to which nature in the Arctic has had its say in shaping the economy of the north. This chapter provides an overview of the predominant economic characteristics and the major industries of the Arctic regions within the Arctic nations. It also provides information about the contribution of the Arctic regions to the economy of the respective Arctic nations. Thus, for the most part, the information in this chapter is viewed from an intra-national rather than a comparative international perspective, although some comparisons among the regions are made in the concluding remarks to this chapter.

While there is significant economic variation across the Arctic regions of the Arctic countries, many of these regions host large resource-based industries. In many cases, resources produced in the Arctic are shipped outside the Arctic region to export markets or southern markets within the same country. At the same time, the Arctic regions tend to draw extensively on southern markets for specialized and professional labor, capital, and consumer products. While Arctic regions generate

income and resource rent from natural wealth, they also receive transfer payments from national governments. In some Arctic regions resource exploitation generates economic activity within the region in the form of the construction and operation of pipelines, and the provision of services such as transportation, wholesaling and retailing and housing. With some exceptions, manufacturing activity tends to be limited in Arctic regions. The electronics industry in Oulu in Northern Finland and the industrial sectors in Northern Russia and Northern Sweden are exceptions to this and the data presented in this chapter illustrate the variability in economic structure among Arctic regions that is frequently overlooked when the Arctic economy is discussed.

For each of the Arctic regions this chapter contains a core table showing regional gross domestic product (GDP) and the contribution to regional GDP by industry at a disaggregated level (for 17 industries). This level of detail is intended to capture all the main activities of the circumpolar Arctic region. The data for the Arctic excluding Russia are based on national statistics and World Development Indicators of the World Bank. Arctic Russian data by main industry are provided by Russia's Federal State Statistical Service and further harmonized with statistics for other Arctic regions using production and employment statistics. These core tables generally refer to the year 2002, which represents a compromise between coverage and timeliness. The tables present value added or contribution to GDP in local currency in order to focus on the Arctic element of their respective national or federal economies. Where available some more recent economic indicators are presented.

Current & Relevant Information:

Arctic Sweden covers the two northern counties, Västerbotten and Norrbotten. Together they account for slightly less than 5 per cent of total GDP in Sweden. Together they have a population of 523 000 people, or 5.8 per cent of the total Swedish population.

In 2002, the largest industries besides public and private services were other manufacturing (i.e., manufacturing excluding fish, food processing, manufacture of wood and paper, coal and oil, chemicals and basic metals).

The manufacturing sector accounted for 14.8 per cent of regional GDP in 2002. Within private services real estate, renting and business service companies is the largest single activity with about 14 per cent of regional GDP. Health and social work alone contributed slightly above 10 per cent. The largest resource sector is forestry followed by mining and quarrying.

“Sweden’s Arctic Strategy: An Overview,” Nima Khorrami, The Arctic Institute: Center for Circumpolar Security Studies, 16 April 2019 [56]

<https://www.thearcticinstitute.org/sweden-arctic-strategy-overview/>

Overview:

This article provides an overview of Sweden's Arctic strategy and is in parts based on the author's own discussions with Swedish officials.

To Sweden, the Arctic is both a matter of domestic politics and foreign policy. Any attempt at understanding Stockholm's approach towards its own Arctic region as well as the wider Arctic, therefore, must take into account not only its foreign policy priorities but also its domestic needs and sensitivity to various social, political, environmental, and economic developments that are taking place at an accelerating rate including, among other things, the possibility of an oil leak due to an accident on the sea or at an exploration site and its potential impact on the Arctic's fragile environment, biological variability, and its indigenous people. Nonetheless, Sweden's concerns with regard to the future trajectory of the region on both fronts share a large number of important similarities including effective and inclusive governance, environmental protection, peace and security, and sustainable economic growth.

This article is the first in a series of five exploring and explaining Sweden's Arctic policy. The objective is to provide a general overview of and/or guideline on the country's Arctic strategy as stipulated within the larger framework of its foreign and domestic policy making. Future papers will then shed light on and delve deeper into some of the more specific issues touched upon in this article. These include a survey of Swedish businesses in the Arctic and how they are contributing to the economic development of the region; Stockholm's approach towards a common Arctic policy at the European level; a critical analysis of Sweden's military neutrality in the High North and whether or not it can keep this position in the long run; and Stockholm's preferred role for the Nordic Cooperation and Nordic Defence Cooperation in the Scandinavian Arctic.

Current & Relevant Information:

Economics and Trade

It is a matter of national security and interest for Sweden to ensure the survival of the liberal international order and its accompanying free trade practices. The government is thus adamant to play a key role in securing free trade as part of its official policy via the EU. Expectedly, it has an interest in the EU remaining a free trade block. According to the government's own official document on Sweden's trade strategy, "Sweden must continue to push the EU to liberalize its trade policy, reduce its customs duties, phase out its trade barriers and make trade in services and the flow of data easier. Sweden, via the EU, must also influence rest (sic!) of the world to pursue an open trade and investment policy and avoid protectionist tendencies".

Given its large dependency on export, Sweden's economy is faced with the challenge of both maintaining and expanding its global market share. To this end, the government has set itself the objective of playing a more hands-on role in promoting small- and medium-size businesses abroad as evident in the case of

InnoVentum, a start-up company that offers innovative wooden towers for renewable energy, and its entry into the Filipino market. With regard to the Arctic region, there is consensus that local businesses are better placed to come up with relevant services and products, which can create jobs and prosperity and address socio-economic challenges faced by the region and its population. Some, while not all, Arctic communities have similar climatic and, albeit to a lesser extent, cultural and societal characteristics, and thus local businesses can establish a presence in other Arctic regions and states easier and more cost-effectively.

The Swedish government is directly and indirectly, by encouraging the private sector, investing heavily in the startup scene of its own Arctic region, setting up incubators like ABI, a startup incubator that only works with local startups. These efforts are further complimented by Finnish and Norwegian policies, which pursue the same priorities when it comes to the economic development of their Arctic regions. One promising area is the environment. Given its fragile ecosystem and the need for environmentally friendly practices, the hope is that Arctic-based startups might come up with unique products relevant to the region, which can then be scaled up and sold to other countries. In other words, in order to be able to survive and prosper, local companies have no option but to come up with unique ways in sync with the reality of the environment within which they operate. As such, an Arctic based company is much more likely to fabricate an innovative and environmentally friendly method of, for example, extraction than a Stockholm based company. Once they have mastered the technology, government hopes to be able to sell it to other environmentally conscious countries.

Moreover, the government is working on a strategy for new industrialization that aims to improve the conditions for Swedish industry to become a world leader in modern industrial production. Of particular importance is the mining sector.

Sitting on the mineral-rich Fennoscandian shield, the mining industry is an important economic player in Sweden, contributing to the country's economic growth as a main source of tax, employment, and indeed innovation in green technology. As a leading mining nation with clear technological advantages in terms of mining with state-of-the-art technology with minimal environmental impacts, opening of trade routes in the Arctic in conjecture with its rich mineral resources and fragile environment provides a unique opportunity for Swedish businesses to expand their market share by either winning projects in other Arctic states or selling their services and know-how to other mining operators. The likes of Atlas Copco, Sandvik, LKAB, Boliden, and Lundin Mining have been successful in creating a world class mining technology cluster and therefore have much to gain from – and contribute to the state coffers – an expansion of Arctic mining and trade.

Given the massive urbanization process that is underway today with two thirds of the world population expected to live in urban areas within the next four decades, there is no doubt that there will be a constant demand for metals mined and extracted in

an eco-friendly way. Since the vast majority of this urbanization process is going to take place in Asia, ensuring effective and uninterrupted transport and logistical systems in the Arctic is thus of key paramount to Sweden's economic growth, especially since the majority of its mines are located in its Arctic region.

"Establishment of the majority of new mines is planned in northern Sweden where there are environments of high natural and cultural value, an active outdoor life and where the Sami have a long tradition of reindeer husbandry. It is important that the mining expansion takes place in consensus with and with respect for other industries and values so as not to weaken the region's overall attractiveness".

"Sweden's Arctic Advantages: Critical Minerals, Space, and Data," Nima Khorrami, Wilson Center, 14 February 2023 [57]

<https://www.wilsoncenter.org/article/swedens-arctic-advantages-critical-minerals-space-and-data>

Overview:

The [Swedish Armed Forces' recently released study](#) on Sweden's evolving strategic role is yet another timely reminder of the growing prominence of geopolitical thinking amongst the country's elites and decision makers. It's why General Micael Bydén, Sweden's Supreme Commander, has made a remarkable request: to establish a new military unit in the Arctic city of Kiruna.

Current & Relevant Information:

On the one hand, the rationale behind General Bydén's proposal can be seen as a sober response to the Nordic nation's changed geo-strategic reality. Russia's invasion of Ukraine and Sweden's subsequent decision to join the North Atlantic Treaty Organization (NATO) justify such re-posturing for two reasons. First, given the current level of its Armed Forces' combat readiness, Sweden may not be able to implement its total defense strategy, let alone aid another NATO Ally should it become subject to Russian aggression.

Second, stunned by [Turkey's opposition](#) to its NATO membership Swedish decision makers are fully aware of the importance of showcasing their country's benefit to the Alliance. One way of to do that is to highlight Sweden's resources and status as an Arctic nation. Swedish membership would enable NATO to play a more direct role in the Arctic's fast intensifying strategic environment. This could become a bargaining chip in the hands of Swedish diplomats and officials during their membership deliberations with other members of the Alliance.

As valid as such reasonings are, they only paint a half, and therefore inaccurate, picture of the Swedish strategic thinking towards the Arctic and the country's subtle, yet indisputable, rising importance to transatlantic security. While it is true that the Swedish Supreme Commander is motivated by his country's pending NATO membership and Russia's irredentism in his call for the establishment of a

permanent military presence in the Arctic, his request has more to do with Northern Sweden's emerging importance as a key supplier of three resources: critical minerals, a space hub, and an ever-increasing number of data centres.

Sweden's Arctic region, and specifically the city of Kiruna, has played a key role in Europe's industrial development and resource security thanks to its sizable endowment of iron ore. The state-owned mining giant, LKAB, [produces](#) approximately 80% of the iron ore in Europe, while its recently launched ReeMAP project could soon turn the company into a major producer of rare earth elements and phosphorus in the EU. The strategic significance of this project lies in its potential to drastically reduce the EU's dependency on external producers of critical raw materials, thus boosting the European defence industrial base and its green transition while simultaneously expanding the continent's overall resiliency to external supply shocks.

Most importantly, however, [recent news](#) of the discovery of Europe's largest deposit of rare earth in Northern Sweden is set to elevate the country's geo-strategic standing, adding a critical layer of importance to its continued stability. At a time when China's dominant position as a supplier of rare earth materials is considered a [strategic vulnerability](#), this discovery is a major geopolitical plus for Europe and Sweden. It enables the continent to take a major step towards self-sufficiency in its green transition and the various industries associated with it, including the construction of wind turbines and batteries, while it allows Sweden to significantly punch above its weight in European and transatlantic affairs.

Besides its role as one of Europe's main suppliers of critical raw materials, Sweden's Arctic region is also home to Europe's first, and only, orbital satellite launch complex, Esrange. The strategic significance of Esrange, put broadly, can be discussed from three different angles. First, there is the near total absence of Europe in the [unfolding space race](#) between the United States, China, and Russia. Europe has been unable to match, let alone compete with, the American, Chinese, and Russian capabilities due to a dire lack of adequate EU-based resources and facilities. With Esrange fully operational, however, this state of affairs is set to change in that the Arctic based spaceport will "[offer an independent European gateway to space and contribute to creating a foundation for a resilient Europe in space](#)".

Secondly, the space complex is poised to significantly contribute to both Sweden and the EU's efforts at monitoring and addressing national, regional, and global effects of climate change. Data from space based satellites [tend](#) to help scientists and researchers to map the changing patterns of environmental degradation more accurately, an ability that has far reaching implications for city planning, agricultural planning, and, indeed, crisis responses.

Finally, space technologies are deemed essential if states are to secure their commercial and strategic interests in the Arctic. Given its harsh environment, lack of adequate infrastructure, and dispersed population centers, secure communication, surveillance, and safe passage are all largely [dependent](#) on space technologies. Not only can satellite services cater to such needs but they could also catalyze increased cooperation amongst partner nations by, among other things, encouraging burden sharing agreements and frameworks between both civilian and military authorities.

Also at play is the Swedish government's long term [plan](#) for turning the country's northern regions into a major data center hub. The social media giant Facebook has been operating a data center in Luleå since 2017 while both national and regional authorities are actively seeking to lure in more multinational tech companies and data center operators into Sweden; an initiative that has led to the emergence of a soft competition between Sweden and its two other Nordic neighbors, Finland and Norway.

From an industry [perspective](#), Northern Sweden, including the Arctic region of Norrbotten, is an ideal location for operating data centers, not least because Sweden has one of the lowest electricity prices in Europe while its electricity grids tend to have high redundancy and capacity rates. Added to these benefits are the country's highly developed digital infrastructure, its tech savvy workforce, and a long tradition of sustainable practices.

Yet, the presence of more data centers is a double edged sword. If data is the [new oil](#), then it is reasonable to characterize data centers as refineries of the future. Playing host to a large number of data centers, therefore, accrue both commercial and strategic benefits to the Swedish state. As countries vie for greater access to data, the mere presence of data centers turns Sweden into a prime target for both increased cyber-attacks and more traditional forms of offensive practices including missile attacks. Put together, Sweden needs to be able to assure investors and operators that it has the adequate means and resources in place in order to be able to ensure the safety and security of these 'refineries'. Such fulfilment, in turn, requires the articulation of a more nuanced cybersecurity strategy and a stronger military presence in the country's northern most regions.

Seen this way, it is crystal clear that Sweden's Arctic is on the fast track to become a critical node in the broader transatlantic geo-strategic network. Faced with Turkey's opposition to its NATO membership, Swedish officials and negotiators are better advised to alter the talking points from a purely technical deliberation into a more strategic one. As valuable as Swedish intelligence and military assets are, they are not, by any stretch of the imagination, mission critical to NATO's force structure. Sweden's Arctic based assets, however, are. As such, the focus of future membership talks must hinge more on the disadvantages of not having a resource, space and data hub in the Alliance and less on Sweden's tactical knowhow.

“Sweden's strategy for the Arctic region,” Government Offices of Sweden, 2020

[58]

<https://www.government.se/contentassets/85de9103bbbe4373b55eddd7f71608da/swedens-strategy-for-the-arctic-region-2020.pdf>

Overview:

Sweden is an Arctic country. Sweden therefore has a particular interest in and responsibility for promoting peaceful, stable and sustainable development and contributing to constructive international cooperation in the Arctic. As one of the eight Arctic countries, Sweden is a member of the Arctic Council.

The Arctic is facing both new opportunities and severe challenges. This applies especially to the dramatic climate and environmental changes. Global warming has hit the Arctic particularly hard, reducing the extent of ice and permafrost cover and affecting biological variability and the living conditions of the region's population. The indigenous peoples are particularly vulnerable. Climate change has also played a part in increasing the economic importance of the Arctic. The smaller ice cover creates new conditions for the use of natural resources and sea transport, for instance. The region's geostrategic importance has increased for both Arctic and non-Arctic states. Increased military presence and activity in the region have security policy consequences. COVID-19 has underlined the need for both resilience and preparedness in the local communities in the Arctic region to deal with pandemics.

Sweden has to take these changes in the Arctic into account. A Swedish core interest is to try to contribute to a peaceful, stable and sustainable development of the region through well-functioning international cooperation with Arctic and non-Arctic actors in the region. In both bilateral and multilateral settings, the Government will uphold an approach based on a broad concept of security. It is an overarching Swedish interest to uphold respect for international law and the rules-based world order, which form part of the foundations for international security and stability in the region. The Government will also contribute to achieving relevant global Sustainable Development Goals in the 2030 Agenda in the Arctic, too, and show leadership in the implementation of the international climate agreement (the Paris Agreement) to limit global warming, including in the Arctic.

The changes in the Arctic have also led to increased international interest in the region. Several countries in Europe and Asia have become observers to the Arctic Council. The European Union (EU) has strengthened its Arctic profile. The Government welcomes this development and takes a positive view of the possibility of mobilizing increased international support and engagement to address the global challenges, in the Arctic region, in particular the impacts of climate change.

At the same time, it is in Sweden's interest to safeguard the special role and position of the Arctic states in promoting peaceful, stable and sustainable development in the Arctic region, mainly by strengthening cooperation in the Arctic Council.

The Government's previous strategy for the Arctic region was adopted in 2011, the same year that Sweden assumed the rotating two-year Chairmanship of the Arctic Council for the first time. In the light of the rapid developments in the region, there is now reason for the Government to adopt a new integrated approach to Arctic policy.

This renewed strategy is intended to set out the Government's objectives and main priorities in relation to the Arctic region and to specify the political direction of further work on the Arctic in six thematic areas:

1. international collaboration;
2. security and stability;
3. climate and the environment;
4. polar research and environmental monitoring;
5. sustainable economic development and business interests;
6. securing good living conditions.

One important starting point for the strategy is to make use of the full range of knowledge and resources available in Sweden regarding the Arctic region so as to contribute to sustainable development in the Arctic and also to enhance Sweden's profile as an important actor in this respect. For a long time, Sweden's engagement in the Arctic has involved not only the Government, the Riksdag and government agencies, but also regional and local authorities, indigenous peoples' organizations, higher education institutions, businesses and other actors in Sweden's Arctic region.

Current & Relevant Information:

Sustainable economic development and business sector interests

Sweden wants to act for sustainable economic development in the Arctic, on the basis of the 2030 Agenda and taking special account of its vulnerable environment.

- The Government will contribute to sustainable trade and investments in the Arctic region, and work to ensure that the increase in economic activity in the Arctic benefits local economic growth.
- The Government will work to maintain and further develop a robust regulatory framework for free, fair and sustainable trade. Proactive work to address technical trade barriers and to promote greater border trade are also vital for economic development in the Arctic.
- On the basis of the 2030 Agenda and the EU's Green Deal, Sweden will force the pace of international cooperation to protect the unique environment in the Arctic and minimize the negative effects of and risks associated with the use of natural resources in the region.

- Sweden intends to be a forerunner regarding the green transition. Through innovation and sustainable environmental technology, Swedish companies can contribute to a reduced environmental footprint from economic activities in the Arctic and to the transition to a circular economy.
- The Government will work for joint initiatives in the EU, OECD and Arctic Council to also contribute to a sustainable mineral industry at global level. In the context of the Nordic Council of Ministers, Sweden intends, together with the other Nordic countries to, for instance, examine the potential for traceability and marking of metals for the introduction of a certification system, as well as the conditions for secondary extraction. Business models for products with sustainably produced metals will be examined.
- Through cooperation in the EU, Sweden will continue to follow the implementation of the Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean, and will also work in other ways for sustainable management of fisheries in the Arctic region.
- Sweden intends to promote long-term sustainable transport systems in the Arctic, in close cooperation with its Nordic neighbors and Russia.
- Sweden will actively support the ongoing work in the International Maritime Organization (IMO) to reduce emissions of greenhouse gases from shipping.
- Sweden intends to work for cooperation with other countries in the region and between various actors so as to develop sustainable and attractive tourist destinations that take into account the Arctic's sensitive environment and the needs and situation of its indigenous peoples.

Sweden will promote sustainable economic development in the Arctic on the basis of the 2030 Agenda. Several of the global Sustainable Development Goals are relevant, including Goal 8 Decent work and economic growth, Goal 9 Sustainable industry, innovation and infrastructure, Goal 12 Sustainable consumption and production, Goal 13 Combat climate change and its impacts and Goal 14 Conserve and sustainably use the oceans, seas and marine resources. Sustainable economic development is crucial in strengthening the region's sustainable growth, resilience to negative environmental changes and community well-being. The forms for further management and action in three central areas will be crucial in securing sustainable economic development in the Arctic: use of natural resources; transport and infrastructure; and tourism.

Sustainable use of natural resources

On the basis of the 2030 Agenda and the EU's Green Deal, Sweden intends to be a driver of international cooperation to protect the unique environment in the Arctic and to minimize the negative effects of and risks associated with the use of natural resources in the region.

Sustainable energy use

Around 30% of the world's undiscovered gas assets and 13% of its undiscovered oil assets are estimated to be north of the polar circle. As a result of the decreasing ice cover in the Arctic these natural resources may become more accessible, especially those located on the continental shelves of the coastal states. However, the sea-based extraction of deposits is, as yet, both complicated technically and associated with major costs.

Unlike the five Arctic coastal states, Sweden does not have its own oil and gas resources, so it does not participate in the energy policy cooperation in the region. Swedish industry does, however, play an important role in the industries that assist this energy sector. Examples include icebreaking, sea transport and consultancy services based on knowledge of business activities in an Arctic climate. The Government has commissioned the Swedish Export Credits Guarantee Board to review, along with AB Svensk Exportkredit, how the Swedish and international system for export financing should contribute to a clear transition and strong decrease in emissions of greenhouse gases.

Sweden has a prominent position in hydropower and wind power, solar and bioenergy and also technology for improving energy efficiency and reducing carbon dioxide emissions. The direction of Sweden's energy policy is to arrange energy supply using 100% renewable energy sources

Extraction of ore and minerals

The transition to circular and fossil-free energy technologies such as wind and solar power and electromobility generates greater demand for rare earth metals and other metals found in the Arctic as well as elsewhere. Interest in the extraction of metals at sea is expected to increase and regulatory frameworks and knowledge need to be developed to prevent negative effects.

The extraction of ore and minerals has led to considerable investments in the Swedish mining industry, a large part of which is in Sweden's Arctic region. Here Sweden and the Nordic region can play an important role both by contributing to sustainable production of metals and helping to create conditions for secondary extraction, and also by delivering sustainable environmental technology and solutions to other mining countries. When new mining activities are established in the Arctic, Sweden can contribute important knowledge and environmental technology.

Sustainable fisheries

Until recently the high seas portion the Central Arctic Ocean has been completely covered by ice all year, making fishing impossible, but the ice cover in the area has decreased in recent years. The Arctic region also includes parts of the North East Atlantic where fishing is regulated in part by the North East Atlantic Fisheries

Commission (NEAFC). In the North East Atlantic Swedish ships fish in international waters in the Norwegian Sea and Sweden also has fishing rights within the framework of the EU's Fisheries Partnership Agreement with Greenland.

Sustainable transport and infrastructure

Sustainable transport and densification are crucial for economic growth and development. The long distances in the Arctic region make high demands on a well-functioning transport system for both persons and goods. This also applies to Sweden's Arctic region. Rising transport demand may increase the demands on infrastructure and sustainable transport solutions in the Barents region, including in the form of expanded and effective railways. The Government takes a positive view of the European Commission's proposal to extend the core network corridor of the trans-European transport network, ScanMed, through Sweden to Narvik and Oulu. Sweden's Arctic region is also highly dependent on well-functioning air services.

Sea transport

Shipping lanes in the Arctic are becoming navigable for a longer part of the year, even though it will take time before conditions will permit commercial shipping on a large scale. At the same time, the large land and sea areas of the Arctic are a vulnerable part of the world's natural environment and climate system. For Sweden, care of the marine environment, both at sea and in coastal areas, is of crucial importance. Sweden will work for joint sea and air monitoring in the region, which contributes to safe and environment-friendly shipping.

Sustainable tourism

The tourism sector has grown globally for a long time. The Arctic region is very attractive and offers experiences of nature, cultural life and adventures relating to animal life, hunting and fishing. The midnight sun and the northern lights are natural phenomena that attract visitors. Tranquility and untouched expanses are also exotic for large parts of the global population.

“Economy of Sweden,” Staffan Helmfrid, Britannica, 31 October 2024 [59]

<https://www.britannica.com/place/Sweden/Economy>

Overview:

Sweden, country located on the Scandinavian Peninsula in northern Europe. The name Sweden was derived from the Svear, or Suiones, a people mentioned as early as 98 CE by the Roman author Tacitus. The country's ancient name was Svithiod. Stockholm has been the permanent capital since 1523.

Sweden occupies the greater part of the Scandinavian Peninsula, which it shares with Norway. The land slopes gently from the high mountains along the Norwegian frontier eastward to the Baltic Sea. Geologically, it is one of the oldest and most stable parts of the Earth's crust. Its surface formations and soils were altered by the

receding glaciers of the Pleistocene Epoch (about 2,600,000 to 11,700 years ago). Lakes dot the fairly flat landscape, and thousands of islands form archipelagoes along more than 1,300 miles (2,100 km) of jagged, rocky coastline. Like all of northwestern Europe, Sweden has a generally favorable climate relative to its northerly latitude owing to moderate southwesterly winds and the warm North Atlantic Current.

The country has a 1,000-year-long continuous history as a sovereign state, but its territorial expanse changed often until 1809. Today it is a constitutional monarchy with a well-established parliamentary democracy that dates from 1917. Swedish society is ethnically and religiously very homogeneous, although recent immigration has created some social variability. Historically, Sweden rose from backwardness and poverty into a highly developed postindustrial society and advanced welfare state with a standard of living and life expectancy that rank among the highest in the world.

Sweden long ago disavowed the military aggressiveness that once involved its armies deeply in Europe's centuries of dynastic warfare. It has chosen instead to play a balancing role among the world's conflicting ideological and political systems. It is for this reason that Swedish statesmen have often been sought out to fill major positions in the United Nations. At peace since 1814, Sweden has followed the doctrine, enunciated in every document on foreign policy since World War II, of "nonalignment in peace aiming at neutrality in war."

About 15 percent of the country lies within the Arctic Circle. From about late May until mid-July, sunlight lasts around the clock north of the Arctic Circle, but, even as far south as Stockholm, the nights during this period have only a few hours of semidarkness. In mid-December, on the other hand, Stockholm experiences only about 5.5 hours of daylight; in areas as far north as Lappland, there are nearly 20 hours of total darkness relieved by a mere 4 hours of twilight.

Current & Relevant Information:

Sweden's per capita gross national product (GNP) is among the highest in the world, but so are its taxes. Most enterprises are privately owned and market-oriented, but when transfer payments—such as pensions, sick pay, and child allowances—are included, roughly three-fifths of gross domestic product (GDP) passes through the public sector. Education, health care, and child care costs are primarily met by taxation. Government involvement in the distribution of national income, however, diminished over the last two decades of the 20th century.

With the value of exports amounting to about one-third of its GDP, Sweden is highly dependent on free international trade to maintain its living standard. In 1991 Sweden attached its currency, the krona, to the ecu (European currency unit, replaced in 1999 by the euro), but in 1992 Sweden abandoned its peg to the ecu and allowed the krona valuation to float. Sweden's currency remained independent even after the

country became a full member of the European Union (EU) in 1995. In 1999 an executive board of Sweden's Riksbank was established to set monetary policy and sustain price stability. Sweden also has to cope with problems of competitiveness that have caused industry to invest much more abroad than at home. Most of Sweden's large industrial companies are transnational, and some employ more people abroad than in Sweden, where production costs are high.

Agriculture, forestry, and fishing

The growing season in Sweden ranges from about 240 days in the south to 120 days in the north. Less than one-tenth of Sweden's land area is under cultivation. Most arable land is found in southern Sweden, but there are arable parcels up to the Arctic Circle. Wheat, barley, sugar beets, oilseeds, potatoes, and staple vegetables dominate in the south, while in the north hay and potatoes are the main crops. In Sweden as a whole, animal agriculture is more significant than cereal farming. Dairy cows are important in all parts of the country, while pig and poultry raising are concentrated in the extreme south. The yields of Swedish farms are among the highest in the world. Environmental problems, however, have made it necessary to reduce the use of fertilizers.

About half of Swedish forestland is privately owned, about one-fourth company-owned, and about one-fourth publicly owned. Forest work used to be complementary winter employment for small farmers using their horses; today forestry is carried on year-round by a small workforce and large, modern machinery. Nearly three-fourths of all Swedish farms have timberland. The average regrowth and harvest time for spruce and pine is about 50 years in the south and roughly 140 years in the north. Since the late 19th century, forestry in Sweden has been conducted on a sustained-yield basis, which establishes a ratio between cutting and new growth that is strictly enforced. Modern large-scale forestry methods have been subject to severe criticism, and major reforms were implemented in the 1990s. A thorough mapping and inventory of key woodland habitats was undertaken in the mid-1990s to identify areas with high biological variability values.

Fishing occupies a small sector of the Swedish economy. Through international agreements, Sweden has lost some of its traditional fishing areas in the North Sea. Herring, cod, plaice, mackerel, and salmon are fished, as well as shrimp and lobster. Gothenburg is the leading fishing harbor and fish market.

Resources and power

Wood, metallic ores, and waterpower constitute the historical basis for Sweden's industrial economy. The country is lacking in fossil fuels and must rely on imports for its needs. Hydroelectric power is used to a high degree but provides only about half of the electric energy needed; most of the rest is derived from nuclear power.

Sweden is well endowed with mineral resources. The huge state-owned iron ore deposits at Kiruna in Lappland were opened to export at the end of the 19th century. In the Boliden area of Norrland a wide range of metals, including gold, copper, lead, and zinc, are mined. The copper, silver, and iron ore deposits of central Sweden either have been largely exhausted or are unprofitable to extract.

“What Are The Major Natural Resources Of Sweden?” Sharon Omondi, WorldAtlas, 19 February 2019 [60] <https://www.worldatlas.com/articles/what-are-the-major-natural-resources-of-sweden.html>

Overview:

Sweden is a Scandinavian country located in Northern Europe. It borders Norway and Finland. Sweden is adorned with medieval towns as well as royal palaces, museums, and over 50 bridges. The country's population is 10.2 million people. Its capital city is Stockholm and the official language is Swedish. Sweden's economy is historically very strong as opposed to many developed world economies. During the 2007-2009 Global Financial Crisis, Sweden overcame the wave through its application of stringent fiscal discipline. Its current GDP per capita is \$54,474. The country's export-oriented mixed economy is pegged on the skilled labor force, telecommunication, and manufacturing. Some of the most important natural resources are water, minerals, arable land, forests, and fish.

Current & Relevant Information:

Major Natural Resources In Sweden

Minerals

Minerals form a major part of the natural resources in Sweden. They include arsenic, copper, gold, iron ore, lead, silver, uranium, zinc, tungsten, and feldspar. Norrbotten and Skellefte districts are the most significant mining areas in Sweden. Iron is among the major mineral resources in Sweden. The mining deposits are owned by the government and are located at Kiruna in Lappland. The Kiruna mining center has been operational since the 19th century. Other metals such as gold, copper, zinc, and lead are mined at Boliden in Norrland. Mining of metal ores contributes largely to the GDP of Sweden as the country is among the largest iron and steel producers in the world.

Water

The energy needs for the country are met by both hydroelectric power and nuclear power. Renewable energy is the primary source of energy due to the depletion of crude oil resources. The largest hydroelectric power plants are located on the Lule River in Northern Sweden. The largest plant, Harsprånget, produces nearly 1,000 megawatts. The center of the country also has a number of large and medium-sized plants.

Arable Land

Sweden's growing season is relatively short because the country is located within the Arctic Circle. However, Swedes still find time to engage in farming as approximately 45,000 square kilometers is cultivated. Fertile land is mostly located in southern Sweden, although arable portions of land also exist up to the Arctic Circle. Consequently, more farming takes place in the south compared to the north. Crops grown in Sweden include wheat, potatoes, barley, oilseeds, sugar beets, rapeseed, and staple vegetables. Farmers also cultivate hay in some portions of the land. Although farmers primarily engage in crop farming, they prefer animal agriculture. Dairy cows, poultry, and pig rearing are the predominant animal rearing activities. Dairy farming contributes 20% of the Swedish agricultural industry. Almost 5,000 dairy farmers produce 2.8 billion kilograms of milk every year. On average, Swedish farmers rear 70 cows. The farmers restrict the use of GMO products, provide 6 hours of grazing during summer, and engage the cows in "green walking." Sweden's farming sector employs over 177,500 people which amounts to 1.5% of its workforce.

Forests

Almost three-quarters of all Swedish farms possess timberland. The ownership of the forestland in the country is shared between private, corporate, and government owners in the ratio of 2:1:1 respectively. The trees that grow naturally in Swedish forests are spruce and pine whose average harvest period is 100 years in the north and 50 years in the south respectively. Sweden has a strict policy regulating the ratio between cutting and new growth of forestry to prevent deforestation and over logging. Wood from the forests in Sweden was once utilized in the mining industry as sources of coal for ore processing. Other forestry products included potash, wood, tar, and pitch that were exports in the Middle Ages. Some of the popular forests in Sweden today are Tiveden, Ed Forest, Kolmården, Kilsbergen, and Tylöskog.

Fish

Sweden has over 90,000 lakes. The largest lake is Lake Vänern which is 5,600 square kilometers by surface area. Besides lake fishing, residents also engage in river fishing and coastline fishing. Examples of fish caught in Sweden are garfish, sea trout, herring, pike, cod, plaice, perch, mackerel, salmon, shrimp, and lobster. The leading fishing market and harbor in Sweden is known as Gothenburg. The Fisheries Act regulates the fishing industry. One of the common rules of fishing is that fishing with nets and tip-up fishing without a license is not allowed. Fishing in Sweden is also done as a sport since it is cheap, easy, and simple. Some of the best winter fishing lakes include Ankarvattnet, Stora Bläsjön, Ockesjön, and Fillingen.

The Future Of Sweden's Natural Resources

Currently, one of the largest mining economies in the European Union, Sweden's future largely depends on minerals such as iron, lead, zinc, and copper. Consequently, its mining policy is designed to keep it in the lucrative mineral markets. The main economic resources in Sweden are part of the natural resources namely hydro-power, timber, and iron ore.

“Sweden and sustainability,” Sweden.se, 10 August 2024 [61]
<https://sweden.se/climate/sustainability/sweden-and-sustainability>

Overview:

Lowering emissions is key to saving the climate. Find out how Sweden does it.

Sweden is known for its undeveloped wilderness and archipelagoes, stretching from the European mainland to the Arctic. Meeting the environmental challenges of the future is not just about protecting landscapes, though. Sweden is making big strides towards safeguarding the future as well as conserving the past. Here's a brief overview of sustainability in Sweden.

Current & Relevant Information:

An environmental pioneer

The first country in the world to pass an environmental protection act in 1967, Sweden also hosted the first UN conference on the global environment in 1972. Since then, Sweden has not looked back, managing to grow its economy substantially while reducing carbon emissions and limiting pollution. Around 60 per cent of Sweden's national energy supply comes from renewables, and thorough legislation aims at further reducing emissions.

For more than a decade, Sweden has been in the top ten of the respected Environmental Performance Index produced by Columbia and Yale universities, with exceptionally clean air and clean water alongside its low emissions.

But there is still much to be done. Being one of the world's wealthiest countries increases Sweden's overall environmental footprint. It might seem impossible, but previous successes on everything from tackling acid rain to recycling show that environment and development can go hand in hand.

Ambitious goals for sustainability in Sweden

Climate change is one of the foremost global environment problems today. The Swedish government has set ambitious goals for sustainability, including going fossil-free by 2045 and 100 per cent renewable energy.

Statistics Sweden offers a breakdown of emissions of air pollutants in Sweden over time.

A hub for environmental research

The last few decades have seen Sweden become a focus for leading environmental research. Stockholm now boasts the Stockholm Environment Institute and the Stockholm Resilience Centre at the Stockholm University.

Professor Johan Rockström, co-founder of Stockholm Resilience Centre, thinks that Sweden could be a model for other countries to follow.

'Sweden has a disproportionate influence in this field and therefore also a large responsibility,' Rockström has said. 'Sweden, both in science and in action, should be able to show that combining sustainability with human well-being is a path for success and development.'

Sustainability and development hand in hand

The Swedish green model means integrating business and sustainability. Together with its Nordic neighbors, Sweden has emphasized that green growth can drive transition. This involves adapting society to cope with environmental changes already underway.

Man-made global warming means temperatures are predicted to rise by at least 2 degrees centigrade over the next century. Issues such as food security, extreme weather and economic upheaval could be felt by countries all over the world.

Innovations for a better world

In 2015, the world agreed on 17 sustainable development goals, aimed at creating a better and fairer world by 2030. Sweden still has some way to go, but current innovations show that safeguarding our environment and developing society are part of the same challenge.

Sweden has a long history of speaking up for the climate, and Greta Thunberg followed in those footsteps when she started striking for the climate in 2018. A year later, millions of schoolchildren around the world were protesting against climate change.

Climate-smart cities

By 2050 two-thirds of the world's population will live in cities, according to the UN, and Sweden has one of the fastest rates of urbanization in Europe.

The capital of Stockholm is growing so quickly that all kinds of challenges need to be met. Its 1950s motorways are overcrowded and millions of people need to be supplied with clean water, clean heat and clean energy.

In the developing world, the solution has often been to build more homes on forest and farmland, but in 1995 the city of Stockholm decided instead to found the world's first urban national park and protect its green spaces.

Several old industrial areas have been and are being redeveloped as efficient low-energy housing, and the city has extended its tram routes.

Sustainable housing

On the edge of Stockholm's urban park, the 'eco-quarter' of Norra Djurgårdsstaden, [Stockholm Royal Seaport](#), is using an old gasworks to build thousands of eco-friendly homes complete with biogas produced from food waste, as well as providing electric car chargers and planning a new tram line. But the real innovation is behind the walls and under the ground.

Stockholm Royal Seaport is a test bed for [a globally innovative smart energy grid](#) in partnership with energy companies, universities and homebuilders. Swedes use three times as much energy as the global average to combat the cold climate and power their high-tech society, but living in cities is potentially more energy-efficient too.

Future transport

Urban innovation is making waves in other parts of Sweden too. In Karlshamn in the south, the council now uses electric cargo bikes for some of its deliveries, rather than lorries. It's a solution with two-fold benefits: it's more environmentally friendly and safer for school children and people living in the area. A small pedal stroke for man, a big step for sustainability in Sweden?

In Stockholm around 850,000 people use public transport on a normal day. The entire underground system runs on green electricity, and since 2017 all buses have been running on renewable fuels, which was actually the target for 2025.

The city of the future could look a lot like a Swedish city. The real challenge is building these state-of-the-art solutions quickly enough to keep up with the rapid growth of the urban populations.

From resource economy to bioeconomy

An important part of Sweden's economic transition strategy – apart from reducing emissions – is about actively trying to use natural processes to produce energy, industrial products and much else. This so-called bioeconomy involves much more than making things more environmentally friendly. Sweden is pioneering ways to use natural materials that are 100 per cent recyclable and can be part of the 'cradle-to-grave' process.

Sweden has a wealth of sustainable natural resources to work with. Already, most of the energy consumed comes from renewables, and its managed forests already provide the main supply of wood products to the EU.

“Swedish Foreign Minister discusses the Arctic's future,” Mia Bennett, Anchorage Daily News, 1 June 2016 [62] <https://www.adn.com/arctic/article/swedish-foreign-minister-discusses-arctics-future/2012/06/28/>

Overview:

Swedish Foreign Minister Carl Bildt delivered a lecture to over 300 people at Carleton University in May entitled "Arctic Challenges and the Future Perspectives of Arctic Co-operation."

Current & Relevant Information:

The fact that Sweden does not have an Arctic coastline means that it is excluded from the informal Arctic-5 group, which includes Canada, Denmark, Norway, Russia, and the U.S. Norway enjoys sovereignty over all of the Scandinavian peninsula's northern coastline. The Sami people have, for centuries, inhabited Finnmark, the northeastern most county of Norway, which lies directly north of Sweden on the Barents Sea. Norway has had some form of control over the northern coastline since 1015. Yet, in 1611, Swedish King Charles IX claimed Finnmark. The land was under Danish-Norwegian control at the time, and Charles' claim eventually led to the two countries to war. The Norwegians were successful in wresting control of Finnmark, and the Kalmar War concluded with the Peace of Knäred in 1613. With it, dreams of Swedish control of the northern Scandinavian coastline (and its then thriving fur industry) died. You can see from these historical maps of Sweden that it never really came close to having an outlet on the Barents Sea. However, that did not stop Swedes from taking to the water as they do have a long coastline along the Baltic Sea. In fact, as Bildt describes, Swedish polar scientist Adolf Erik Nordenskiöld was the first to discover a commercially viable Northern Sea Route during his voyage on the Vega in 1878-1879. Nordenskiöld believed that the NSR, which connects to three major rivers in Russia, would allow trade with the country's interior and could possibly even foster commerce with China. More about Nordenskiöld's historic journey is available online in "Exploring Polar Frontiers."

Commercial potential for shipping was high as was the promise of resources in Sweden's northernmost region, Norrland. Bildt quotes 17th-century Swedish Lord High Chancellor Axel Oxenstierna, who remarked, "In Norrland we have an India within our borders, if only we realize we should be taking advantage of it." Today, Sweden is the largest exporter of iron ore in the EU. Like Quebec, which is currently pushing its Plan Nord, and like Canada more generally, much of the country's mineral resources lie in the North. The iron ore mines are in the northernmost part of the country, and there are also gold mines a bit farther south.

The resource boom and potential for northern shipping offer a lot of promise for the Nordic countries. Bildt stated, "New technology, new transport opportunities and new resources becoming accessible reverse the logic of previous years, at least in Europe. In the South, several EU member states are struggling with serious

economic problems. At the same time, in the extreme North, years of hardship has been replaced by solid growth."

In the 1990s, Sweden suffered a financial crisis of its own after the bust of a housing bubble and poor oversight of the banking industry. Between 1990 and 1993, GDP fell 4 percent. Yet, the country was able to come out of the recession successfully by having the government recapitalize the banks, a process which the New York Times explains in more detail. With Nordic countries' economies now doing well (and this despite their generous welfare policies), their governments now have the bandwidth to turn to problems that would otherwise be of secondary concern, such as sustainable development. Oftentimes during a recession, policies that might be seen as harmful to industry such as carbon caps or taxes are cast aside.

Despite all of this mining, Bildt proclaims that the foundation of Sweden's Arctic Strategy is sustainable development. He states, "The people who live in the North need jobs and economic growth just like everyone else. But this development must be balanced with protection of the sensitive Arctic nature and engagement with local societies."

8. United States (Alaska):

"Arctic economy within the Arctic nations," Helen McDonald, Solveig Glomsrød and Ilmo Mäenpää, *The Economy of the North* [63]

https://www.ssb.no/a/english/publikasjoner/pdf/sa84_en/kap4.pdf

Overview:

In his book on the history of wealth and poverty of nations, Harvard professor David S. Landes devoted the introductory chapter to highlighting how natural conditions in the tropics represent serious barriers towards economic development. He did not consider the Arctic in the same context but the Arctic environment is generally seen as an even bigger challenge to livelihood than the tropics. Over the years people seem to have voted with their feet in this matter, while the tropics abound with people, the Arctic is sparsely populated. The 10 million people who currently live in the Arctic Region, what do they do for a living? To live in the Arctic, people must have their very special reasons, the remaining 99.8 per cent of the world population might easily think. One clear reason is the attraction of people and investments to natural resources. Another is the fascination of the qualities of nature, shifting from extreme and blending grandeur to darkness and stillness.

These special reasons should be reflected in the structure of the Arctic economy, indicating the extent to which nature in the Arctic has had its say in shaping the economy of the north. This chapter provides an overview of the predominant economic characteristics and the major industries of the Arctic regions within the Arctic nations. It also provides information about the contribution of the Arctic regions to the economy of the respective Arctic nations. Thus, for the most part, the

information in this chapter is viewed from an intra-national rather than a comparative international perspective, although some comparisons among the regions are made in the concluding remarks to this chapter.

While there is significant economic variation across the Arctic regions of the Arctic countries, many of these regions host large resource-based industries. In many cases, resources produced in the Arctic are shipped outside the Arctic region to export markets or southern markets within the same country. At the same time, the Arctic regions tend to draw extensively on southern markets for specialized and professional labor, capital, and consumer products. While Arctic regions generate income and resource rent from natural wealth, they also receive transfer payments from national governments. In some Arctic regions resource exploitation generates economic activity within the region in the form of the construction and operation of pipelines, and the provision of services such as transportation, wholesaling and retailing and housing. With some exceptions, manufacturing activity tends to be limited in Arctic regions. The electronics industry in Oulu in Northern Finland and the industrial sectors in Northern Russia and Northern Sweden are exceptions to this and the data presented in this chapter illustrate the variability in economic structure among Arctic regions that is frequently overlooked when the Arctic economy is discussed.

For each of the Arctic regions this chapter contains a core table showing regional gross domestic product (GDP) and the contribution to regional GDP by industry at a disaggregated level (for 17 industries). This level of detail is intended to capture all the main activities of the circumpolar Arctic region. The data for the Arctic excluding Russia are based on national statistics and World Development Indicators of the World Bank. Arctic Russian data by main industry are provided by Russia's Federal State Statistical Service and further harmonized with statistics for other Arctic regions using production and employment statistics. These core tables generally refer to the year 2002, which represents a compromise between coverage and timeliness. The tables present value added or contribution to GDP in local currency in order to focus on the Arctic element of their respective national or federal economies. Where available some more recent economic indicators are presented.

Current & Relevant Information:

The economy of Alaska has a large contribution from resource-based industries such as petroleum, minerals, seafood, timber and tourism. However, national defense and other government services play an important role in the economy and international airfreight is a rapidly increasing service industry. In 2002 Alaska accounted for 2.9 per cent of the GDP of USA.

Alaska has a small and dispersed population of about 660 000 people. Many goods and services are imported by the region and contribute to a high cost of living and relatively high labor costs. Furthermore, the limited infrastructure in the state as well

as its distance from major American and foreign markets have restricted the development of processing and manufacturing industries. Natural resources, primarily oil, are extracted and generally shipped out of the state for processing. However, there is some manufacture of seafood, and to a modest extent, petroleum.

The Alaskan processing and manufacturing industries serve a limited number of international resource-based commodity markets that are cyclical in nature and price sensitive. As a high-cost producer Alaska tends to be the last into the market and first out when price fluctuates, exposing the economy to boom and bust cycles. Furthermore, the importance of US federal spending to Alaska makes the economy vulnerable to political decisions made at the national level. Fluctuations in military spending reflect the conflicting demands of security and federal budget constraints. The boom-and-bust nature of the Alaskan economy often results in an influx of workers during boom periods and an exodus when the boom ends.

Petroleum extraction and pipeline transportation taken together was the largest single industry in Alaska in 2002, followed by public administration and defense. Oil and gas extraction contributed about 25 per cent to Alaska's GDP. It can roughly be said that the economy of Alaska stands on two pillars – petroleum and the public and private services necessary to sustain the society. Agriculture and forestry play a negligible role, and fishing and fish processing each contribute only about one per cent to GDP. Forestry is even less important than agriculture as the harvest has drastically been reduced following the closure of two pulp mills in the 1990s due to high harvest costs and environmental regulation.

With 25 per cent of total income from petroleum extraction and pipeline transportation, the economy is naturally heavily exposed to fluctuations in the market price for oil and gas. The revenue in petroleum production is usually higher than in other economic activities, as the oil and gas prices contain a resource rent. On the other hand, the cost of petroleum production is higher in the Arctic than in other petroleum producing areas, hence the resource rent element of revenue is lower than in more accessible petroleum regions. As a consequence, price variability causes more uncertainty in Alaska than in most petroleum producing areas world-wide. This is also the case for mining.

Resource rent is a wealth component rather than income generated by labor and capital. To turn petroleum rent into a sustained source of income the Alaska Permanent Fund was created. The fund receives 25 per cent of royalties on oil production and has a value of about USD 34 billion. The fund has achieved a nominal rate of return of about 10 per cent per year over the last 20 years. A dividend program allocates a share of annual fund revenues to inhabitants of Alaska according to a scheme that smooths the return over the last 5 years. Each person received a dividend of USD 1 107 in the fiscal year 2006.

Petroleum royalties and taxes from oil production have historically generated large revenues for the state of Alaska to finance the public sector and build infrastructure. Although the growth in the economy has been significant during recent years it has not resulted in much economic diversification. The State government has encouraged diversification through the use of subsidies, but the Alaskan economy still relies heavily on petroleum.

Historically, the U.S. federal government has contributed to the Alaska economy, through direct expenditures and transfers to the state government. Direct expenditures to federal activities are related to management of public lands, services to Alaska natives and military operations. The level of federal government spending in Alaska is quite high both on a per capita basis and as a percentage of federal spending. The military is an important part of the economy; in 2004, about 23 000 military personnel were on active duty in Alaska. Growth in federal spending in Alaska has been strong in recent years facilitated by high oil prices. However, the shut-down in 2006 of the Prudhoe Bay field owing to pipeline repair over several months represents a significant loss of public revenue as 80-90 per cent of tax revenue in Alaska comes from that oil field.

Petroleum

The value of petroleum production at wellhead was USD 13 billion in 2004. Crude oil including natural gas liquids accounted for the lion's share of petroleum revenues with 96.5 per cent of total output in value terms. The value of oil and gas production increased 31 per cent from 2003 to 2004. This increase in value was largely a result of increased prices as annual crude oil production remained stable around 390 million barrels. With the exception of refining of crude oil for local consumption, the bulk of crude oil is exported outside the state.

Alaska ranks as the third largest U.S. producer of crude oil (after Texas and Federal Offshore production). The state accounted for 17 per cent of total crude oil production in the U.S. in 2004. The Prudhoe Bay field on Alaska's North Slope has dominated the oil production and is the largest oil field ever discovered in North America. Production from Prudhoe Bay peaked in the late 1980s and went into decline in spite of increasing production from discoveries of smaller fields. However, the Prudhoe Bay oil field alone still provides about 6 per cent of total US production.

The value of natural gas production accounted for 3.5 per cent of total petroleum production in 2004, up 38 per cent between 2000 and 2004. As in the case of crude oil the increase in production value came mainly from a considerable increase in price (31 per cent). Some natural gas is processed into LNG (liquefied natural gas) and ammonia-urea for export, and some is consumed within the state. At 15 per cent of the U.S. total, Alaska natural gas production (gross withdrawals) is ranked third after Texas and the Gulf of Mexico. However, 87 per cent of total gas production was re-injected to increase oil field pressure and enhance oil recovery.

Approximately 65 per cent of net withdrawal of gas is exported. Exports average about 124 billion cubic feet per year.

With petroleum production dominating the economy, the future reserve situation becomes of huge importance. Alaska has not been explored extensively compared to the rest of the U.S. In terms of proved reserves, Alaska's oil reserves accounted for 20.2 per cent of US reserves and Alaska's gas reserves for 4.4 per cent of US reserves in 2004.

Other minerals

The value of mineral production, at market prices, rose from USD 1 080 million in 2000 to USD 1 180 million in 2004, an increase of 9.2 per cent. The major mineral product in terms of value was zinc, which accounted for over 50 per cent of the value of mineral production in 2004. After zinc came gold (at 15.7 per cent) and lead (at 10.2 per cent). In volume terms, zinc production amounted to 680 015 tons, gold production was 454 680 ounces, and lead production was 150 796 tons. Virtually all the output of the mining sector is exported.

The mining industry is likely to benefit from growing world demand. However, further development is economically viable only for the largest deposits. This is because of a lack of access to, and power at, remote sites, as well as the high construction and operating costs at these sites.

Other industries

The landed value of fish and seafood landings amounted to USD 1 166 million in 2004, up from USD 942 million in 2000. However, the value of landings fluctuated during that period, as a result of significant variations in both prices and volume. Groundfish accounted for almost half of the total value of landings in 2004 followed by salmon (at 20.2 per cent), halibut (16.7 per cent) and shellfish (at 13.3 per cent).

The value of exports of fish products rose from USD 1 034 million in 2000 to USD 1 335 million in 2002. The Alaska fishing industry is close to full exploitation of its resource base. In recent years Alaskan salmon fisheries have faced significant international competition from farmed salmon in Norway, Chile, U.K., Canada and elsewhere.

Data on the value of the timber harvest and exports are not available, but with the closure of the two pulp mills in the state in the 1990s, the production of timber fell dramatically. In 1992 it was estimated at 1 017 million board feet, but by 2003 it was down to about 200 million board feet. This decline was due to a combination of high harvest and production costs and environmental concerns. This low level of production supports a work force of about 900.

Alaska attracts tourists both from elsewhere in the U.S. and abroad. Alaska is an attractive tourist destination and is expanding its capacity in terms of tourism

infrastructure. The number of tourists visiting Alaska increased steadily over the period from 1.15 million people in 2000 to 1.37 million people in 2004, an increase of 19.2 per cent. The 2004 level was already substantially above the level of 1990 when 716 000 tourists visited Alaska. This suggests that tourism in the Arctic is experiencing a long-term trend in growth. Reflecting the harshness of the climate, almost 90 per cent of tourists in 2004 visited Alaska during the summer.

International air cargo operations continue to expand at the Anchorage International Airport, and also at Fairbanks. The trans-Pacific air cargo market is growing rapidly and Alaska is well positioned to serve not only the trade associated primarily with economic growth in China, but also trade due to the shift in manufacturing growth to countries such as Malaysia and Vietnam.

“Economy of Alaska,” Maynard M. Miller and Donald Lynch, Britannica, 31 October 2024 [64] <https://www.britannica.com/place/Alaska/Economy>

Overview:

Alaska, constituent state of the United States of America. It was admitted to the union as the 49th state on January 3, 1959.

Alaska lies at the extreme northwest of the North American continent, and the Alaska Peninsula is the largest peninsula in the Western Hemisphere. Because the 180th meridian passes through the state’s Aleutian Islands, Alaska’s westernmost portion is in the Eastern Hemisphere. Thus, technically, Alaska is in both hemispheres.

Alaska is bounded by the Beaufort Sea and the Arctic Ocean to the north; Canada’s Yukon territory and British Columbia province to the east; the Gulf of Alaska and the Pacific Ocean to the south; the Bering Strait and the Bering Sea to the west; and the Chukchi Sea to the northwest. The capital is Juneau, which lies in the southeast, in the panhandle region.

Alaska is central to the great circle route connecting North America with Asia by sea and air and is equidistant from most of Asia and Europe. That central location has made Alaska militarily significant since the Japanese invasion of the Aleutians in 1942 during World War II. Alaska’s eastern border with Canada is about 1,538 miles (2,475 km) long, more than one-third the length of the entire U.S. boundary with Canada (3,987 miles [6,416 km]). Alaska’s western maritime boundary, separating the waters of the United States and Russia, was established in the Treaty of Cession of 1867 (which declared the transfer of Alaska from Russia to the United States). The roughly 1,000-mile (1,600-km) de facto boundary runs through the Chukchi Sea and the Bering Strait to a point between Alaska’s St. Lawrence Island and Russia’s Chukotskiy (Chukchi) Peninsula and to the southwest, between Attu Island, the westernmost island of the Alaskan Aleutian chain, and the Russian Komandor Islands. The boundary leaves a patch of international waters, known as the

“Doughnut Hole,” in the Bering Sea. Off the extreme western end of the state’s Seward Peninsula, Little Diomed Island, part of Alaska, lies in the Bering Strait only 2.5 miles (4 km) from Russian-owned Big Diomed Island. Both Russia and the United States have shown a tacit tolerance of unintentional airspace violations, which are common in bad weather.

Current & Relevant Information:

Economy of Alaska

The Alaskan economy is conditioned strongly by the state’s continuing status as a frontier. While the high costs of labor and transportation and complicated environmental and land-use constraints still tend to discourage outside investment, major improvements in infrastructure have lowered the costs of economic transformation significantly. The problem of the state’s inadequate tax base was remedied by the discovery in 1968 of the North Slope oil fields, which led to the creation of the Trans-Alaska Pipeline, thereby creating jobs and increasing revenue for the state. Alaska’s present-day economy is based on oil production, fishing, federal and state (both civilian and military) expenditures, research and development, and tourism.

Agriculture, forestry, and fishing

More than 3 million acres (1.2 million hectares) of potentially tillable land exist in Alaska, but only a small portion of the state’s economy is agricultural, and most foods must be imported. The state government promoted agricultural expansion in the 1970s, but the amount of cultivable land brought into production was small, and no major expansions have been made since then. Commercial farming (including the growing of barley and potatoes, as well as the raising of cows and pigs) is concentrated in the Matanuska-Susitna valley, which lies north of Anchorage, near the town of Delta Junction, which is southeast of Fairbanks, and to a lesser degree in the Kenai Peninsula. There is also considerable small-scale farming in the Fairbanks area itself, where vegetables, potatoes, and various grains grow rapidly due to the long hours of summer sunlight.

There is some livestock raising on Kodiak Island. Sheep are raised on Unimak Island, and caribou are raised for local consumption in the Kotzebue region. Alaska also produces feed for the increasing number of horses kept in the state for recreational use and for hunting and guided trips. American bison (buffalo), originally imported, are sometimes harvested in the Delta Junction region. Hunting, particularly of moose and caribou, as well as fishing and whaling in the Beaufort and Chukchi seas, plays a major role in the subsistence economy of native peoples.

Most of Alaska’s commercial timber resources are in the Tongass and Chugach national forests—respectively, in the panhandle and on the southern coast. Due to logging regulations, which restricted timber leases, the pulp mills in Sitka and

Ketchikan closed in the 1990s, and Alaskan timber and forestry-related activities and exports were significantly reduced. Efforts to establish an export forestry industry in the Tanana Valley have been unsuccessful.

Alaska's commercial fishing economy is one of the country's most significant, and the port of Kodiak is one of the largest fishing ports in the United States. Most of Alaska's fish production is exported. Salmon of various species are of special importance; the centers of the world's salmon-packing industry are at Ketchikan, on Kodiak Island, in the city of Unalaska, in Bristol Bay, and in Prince William Sound. Commercial fishing fleets also bring in significant quantities of herring, cod, pollack, and halibut, as well as Dungeness, king, and tanner crabs. International fishing of Alaska's waters is regulated by the 200-mile- (320-km-) wide exclusive economic zone and the U.S.-Canadian Pacific Salmon Treaty (1985), as well as by U.S.-Russian cooperation over control of the Bering Sea fisheries. Oysters and clams are harvested on aquatic farms.

Resources and power

Since 1880 hard-rock ore minerals have been mined in Alaska, more than nine-tenths of which yield gold, copper, zinc, and silver. Prospecting has continued with modern scientific technology and aerial exploration. Among the important mines are the Fort Knox and Pogo gold mines near Fairbanks and the Red Dog zinc mine near Kotzebue. A major molybdenum deposit exists near Ketchikan but has not been developed. The Greens Creek Mine near Juneau is one of the largest sources of silver in the United States and also produces lead, zinc, copper, and gold.

Newer initiatives include the Kensington gold mine, located about 45 miles (72 km) north-northwest of Juneau, and the Pebble Project, a mineral exploration plan in the Bristol Bay region, about 200 miles (320 km) southwest of Anchorage. Small-scale mining is prevalent in much of the interior and elsewhere, but it is constrained by environmental concerns. Copper mining as a major industry ended with the closing of the Kennecott Mine in 1938, although there are new prospects elsewhere.

Oil seeps were discovered as early as the 1880s in what is now the National Petroleum Reserve—Alaska, and petroleum was first extracted and refined between 1917 and 1933 in Katalla near Cordova. However, it was not until the development of the Kenai oil field in 1961 that the petroleum and natural gas industry surpassed the other types of Alaskan mineral production. In the late 1960s another major oil field was discovered at Prudhoe Bay, near the mouth of the Colville River, on the North Slope. A natural gas pipeline connects the Kenai gas fields to Anchorage, and the Trans-Alaska Pipeline delivers oil from Prudhoe Bay to ice-free tanker terminals at Valdez and to refineries near Fairbanks. Petroleum production peaked in the 1990s and has been steadily decreasing since then. (Alaska's potential oil reserves are still very large; however, attempts to drill for petroleum along the Beaufort Sea coast of the Arctic National Wildlife Refuge as well as in the National Petroleum

Reserve—Alaska have been met with continuing environmental opposition.) Similarly, the production of natural gas has declined significantly in Kenai and Cook Inlet. Prudhoe Bay also contains a major deposit of natural gas; plans for its development and export were discussed in the early 21st century.

Alaska has large coal reserves at the Beluga Coal Field in south-central Alaska, about 45 miles (72 km) west of Anchorage, and in the National Petroleum Reserve—Alaska. The only operating coal mine in Alaska, however, is the Usibelli mine near the town of Healy, located about 115 miles (185 km) south of Fairbanks. The low-sulfur coal produced there is transported to local power plants and is exported to South Korea through the port of Seward.

Alaska's immense hydropower potential is virtually untapped, but dams have been constructed that supply power to most of the major cities. The region from Homer, at the south of the Kenai Peninsula, up to Fairbanks, a route known as the Railbelt, is tied together so that electrical power is generated from three sources: coal at Healy, natural gas at Anchorage, and hydropower from the dams at Bradley and Eklutna lakes. Outside those areas that are served by coal, natural gas, or hydropower, electricity is generated by diesel fuel. The state of Alaska subsidizes electrical production in smaller communities through the Power Cost Equalization Fund.

“The Economic and Cultural Benefits of Northwest Alaska Wilderness,” Alex Whiting, National Park Service, 30 October 2021 [\[65\]](https://www.nps.gov/articles/aps-v13-i1-c5.htm)
<https://www.nps.gov/articles/aps-v13-i1-c5.htm>

Overview:

Northwest Alaska, from Kotzebue Sound to the headwaters of the Kobuk River, is approximately the size of Indiana. It is mostly roadless wildlands dotted by eleven villages that are located on the coast or along the major rivers.

The Red Dog Mine with its associated road and port site is the only large resource development project in the region, leaving most of the area in a natural state. Except for Red Dog, the relatively small rural communities, and the numerous but even smaller individual camps along the coasts and rivers, there is no obvious distinction between what is designated as formal wilderness and what is not. Federal lands in the form of parks, preserves, wilderness areas, a monument, and a national wildlife refuge comprise the majority of formal land designations in the region.

Wilderness areas include the Selawik Wilderness, Noatak Wilderness, Kobuk Valley Wilderness, and Gates of the Arctic Wilderness. Given the lack of habitat demarcation between wilderness areas and other areas, it is not surprising that you would be hard pressed to find any lifelong residents of northwest Alaska who could tell you where the formal wilderness areas are, or how they differ in management from other federal lands.

While most people in the region are aware that park units and other land designations exist, few are aware that formal wilderness areas occur here as well. This collective inability to identify the boundaries of wilderness areas demonstrates the intact nature of the land and local residents' strong cultural ties to it, with the only visible boundaries being on paper.

The formal designation of wilderness areas in northwest Alaska contributes to sustaining an ecosystem that is predicated on an expansive area of natural habitat that is not fragmented by human development.

The non-designated wilderness areas that adjoin formal wilderness add significantly to the benefits produced by the latter. The relatively small human disturbances in areas adjacent to designated wilderness are mitigated in part by the extensive intact ecosystem that stretches from the Chukchi Sea across the entire Brooks Range.

While all species present in northwest Alaska benefit from large areas of undisturbed habitat, it is critical to highly valued cultural and ecological keystone species like caribou, Dall sheep, grizzly bears, wolves, and wolverines, in particular.

Most people born in the region trace their ancestry back to people living essentially in the same countryside that remains today (including those areas that are now designated wilderness) and a few can trace their own birth, or that of their parents, back to a dwelling located in areas currently designated as wilderness. Being born and raised in wilderness was definitely not a consideration during the development of the Wilderness Act—which by definition is a place where people are visitors and do not remain.

Of course, for Arctic indigenous populations whose entire history and culture is defined by living in wilderness (whether formally designated or not), the wilderness concept is a western construct that is foreign to them. Much of the local traditions, folklore, notable landmarks, and family histories are associated with the country these wilderness areas encompass.

Current & Relevant Information:

Most Americans think about formal wilderness as areas that are representative of natural ecological spaces where nature is allowed to carry on substantially free from human interference and where people are only occasional visitors. Specifically, the main principle of most designated wilderness is for non-consumptive purposes where only photos are taken and footprints are left.

While designated wilderness areas found in northwest Alaska definitely have the ecological traits represented by traditional wilderness areas, there remain significant differences that set these areas apart from other wilderness areas in the Lower 48 and even those portions of Alaska where the 1980 Alaska National Interest Land Claims Act (ANILCA) legislation does not apply.

The most distinct difference is that these areas are treasured by local residents not for their wilderness character per se but for their economic contributions by providing food and income through hunting, fishing, fur production, and other traditional activities. This enables local people to continue their culture of living off the land and allows many to avoid having to move to distant urban centers to completely join the cash economy.

The beauty of land from a local perspective is anchored in its ability to sustain local culture through the production of high quality food and fur. The latter can be used to make warm, functional clothing that can be as much art as utilitarian garment, or sold to produce income. The former helps define a people who are first and foremost a hunting culture.

Continuing a way of life based on wild meat consumption is distinct from cultures based on domestic livestock in very qualitative ways. Most of the negatives surrounding western meat production and consumption are minimal or completely reversed to become positives. For example, while petroleum products are used in transportation to secure food and other resources from the country, they are not used to grow or produce them, an important distinction from most domestic food production that has a large carbon and aquifer-depleting footprint attached.

Other benefits from eating off the land include: plant and animal food species that are not genetically modified organisms; the production of meat is not industrialized with all the negative inputs and processes associated with this; the disposal of animal waste is not a negative issue and in fact provides natural fertilizer for the system. Most importantly the meat and other food items gathered in wilderness areas are very healthy based on their own nutritional merits and even more so in comparison to domesticated meat that studies show contribute to heart disease and other health issues. The health and cultural benefits of going out into the country with family and friends to obtain these resources also contributes greatly to the quality of life for residents in the region.

Of course while food and fur production is demonstrably the most valued contribution that wilderness provides to the regional way of life, other benefits of wilderness are also present. These landscapes provide local people with a sense of freedom, a tie to the ancestors, cultural expression, and spiritual renewal (Whiting 2004).

One of the most notable cultural contributions provided by utilizing the backcountry of northwest Alaska is the egalitarian effect it has on societal standing. The land affords greater privileges and rewards to those who earn it through experience, skill, and conditioning regardless of their net worth or formal resume. Technology and money can only compensate for a lack in any of these areas to a very limited degree. This situation allows for those that are experts at wilderness living and who may not necessarily participate in large part in western institutions to achieve a high

level of societal status and self-worth. The greatest respect in Iñupiaq society is still reserved for those that are successful hunters and providers and that are knowledgeable about living and surviving off the land.

The main social challenge for managing wilderness areas in northwest Alaska lies in balancing federal and nonlocal priorities with local priorities and norms. Management of them must be generally compatible with local traditions in order for local people to support their existence, and to reduce cross-cultural conflicts. Unfortunately, there is a fundamental difference between the core of wilderness management that defines “natural and healthy wildlife populations” as being not unduly influenced by humans, and the local perspective that indigenous people have been affecting wildlife populations through their hunting for millennia and thus are a natural part of the system. It is impossible for local people to subscribe to the theory that natural wildlife populations are only those not manipulated by humans, when set against the thousands of years of local wildlife populations coexisting with a subsistence culture. When can the presence of humans be natural? It’s when wild populations have evolved with their presence and influence over thousands of years, that’s when. For those that are skeptical of the ecological benefit of a hunting culture that has evolved with a landscape and its wildlife populations, it would serve well to remember the attitudes of people as it related to wolves in places like the Yellowstone National Park ecosystem. At one time, not that long ago, predators were seen as only detrimental to ecosystems and their removal was believed to be what was in the best interest of the nation’s treasured wild areas, like Yellowstone.

However, it is now well known that this understanding of ecosystems was incorrect and that predators are necessary to a healthy ecosystem. While conservation in the form of regulating human take for long-term sustainability is important, the Yellowstone example proves consumptive use of wildlife populations (within limits) promotes a healthier and more resilient ecosystem than would occur if these populations were not harvested at all, or minimally. While it is not always obvious to the casual observer, there are other ecological benefits besides the predator-prey relationship that humans have contributed to the Arctic systems.

One of the clearest examples being that some of the most productive habitats on the Arctic tundra are the numerous old house pits where more varied and productive plant species are found providing quality forage for herbivores and where raptors, foxes, rodents, and ermine find denning and hunting sites. In addition, even the smaller but more numerous butchering sites spread over the entire region provide essential nutrients for the plants and scavengers found in those locations. Human presence can be beneficial to wild systems, especially where coevolution over centuries has occurred.

Having a people with ties going back thousands of years continue consumptive use of wilderness areas should not be something that is merely “tolerated” or “allowed,”

but instead should be part and parcel with the celebration of these areas as national treasures. Supporting the continuation

of America's indigenous Arctic populations as a managing philosophy should be equal to all other management considerations of these wilderness areas and the other federal lands in northwest Alaska. Unfortunately, the attitude of many western managers, bureaucrats, and wilderness advocates continues to be one of not fully committing to the belief that the human presence in northwest Alaska is a natural part of the ecology. Due to this cultural dichotomy, federal and nongovernmental organizations are many times at odds with local standards, uses, and philosophies.

Policies that are meant to protect designated wilderness areas from small scale human use impacts (including consumptive use), while likely consistent with the Wilderness Act, are generally incompatible with local perspectives and needs.

Even though management of the northwest Alaska wilderness areas is not always agreeable with the local culture, the protected habitat found in these areas is critical to the resilience of the local ecosystem and the culture that depends on it. Their fates are inextricable. Many threats remain for both; some of the more notable include climate change, long-range contaminants, predator-prey balances, and insect and zoonotic outbreaks. Additionally, recent proposals to build road systems to the mineral resources in northwest Alaska and the mines that would be developed pose real challenges to the long-term ecological integrity of this region.

The wild matrix of intact wilderness that still exists inside and outside of designated wilderness areas, from the Chukchi Sea to the Canadian border, may partly ameliorate the negative effects of these impacts to the land and animals. Whether in the end it will be enough to enable both the indigenous cultures and the wilderness areas to survive and prosper remains to be seen.

“Alaska’s Oil & Gas Industry,” Resource Development Council [66]
<https://www.akrdc.org/oil-and-gas>

Overview:

Alaska's North Slope has responsibly produced more than 18 billion barrels of oil since the discovery of the Prudhoe Bay oil field. Oil production has been the engine of economic growth in Alaska. It has funded up to 90 percent of the state's unrestricted General Fund revenues in most years and has accounted for over \$180 billion in total revenue since statehood. The oil and gas industry paid over \$3.1 billion in state and local taxes and royalties in FY 2019, including \$2.7 billion to state government and \$449 million to local governments.

North Slope production averaged 496,106 barrels per day in FY2019. The April 2020 forecast assumes that production will decline to 486,400 bpd in FY2020 and 486,500 bpd in FY2021. New fields offer tremendous potential to increase production in the 2020s but these developments are still contingent on final investment decisions and

commitments of billions of dollars of new investments on the part of oil and gas producers.

The oil industry accounts for one-quarter of Alaska jobs and about one-half of the overall economy when the spending of state revenues from oil production is considered. In other words, without oil, Alaska's economy would be half its size. In 2018, the industry accounted for more than 77,600 direct and indirect jobs and \$4.8 billion in Alaska wages. Alaska residents represent 84 percent of primary company total employment in Alaska. For every primary company job, another eight are supported by primary company activity in Alaska and seven more jobs supported by oil-related taxes and royalty payments to the State of Alaska. Clearly, when the industry prospers, so does Alaska's economy.

While the economic impact of oil and gas activity and production in Alaska is profound, it is important to note that Alaska production has been in a long-term decline trend since peaking in 1988 when the state accounted for 25 percent of U.S. domestic production. In fact, the Trans-Alaska Pipeline System (TAPS) is now running at a quarter of its capacity. In recent years, Alaska has fallen from second to sixth in U.S. oil production.

With an estimated 40 to 50 billion barrels of conventional oil remaining to be developed on the North Slope and offshore areas of the Alaska Arctic, it's not for a lack of resource that production has declined. The majority of the remaining resource is located on federal lands and offshore areas where access has been hindered or blocked either by federal policy, environmental litigation, or a complex and ever-changing regulatory regime. On state lands, the government tax bite under the previous tax system (ACES) was so high that Alaska was unable to compete with other oil provinces for production-adding investment.

The good news is that a North Slope renaissance is now underway. The More Alaska Production Act, commonly referred to as SB 21, has drawn billions of dollars in new investment to Alaska over the past several years. The oil tax reform in 2013 made Alaska more competitive and a more attractive place to invest. As a result, Alaska saw no production decline in 2014, a slight dip in 2015, followed by the first production increase in 14 years in 2016. Moreover, new promising oil discoveries in the Nanushuk formation have led geologists to label the western North Slope as a new global energy "super basin" with the potential to add hundreds of thousands of barrels per day into TAPS.

Once a large oil province where daily production reached 230,000 barrels per day in 1970, Cook Inlet output slowed to a trickle over the decades but has risen in recent years to over 15,000 barrels per day, well above its FY 2008 level. The substantial increase in production occurred after oil tax policy reforms were enacted, resulting in a sharp increase in industry investment.

Current & Relevant Information:

Facts & Economic Impact

- Alaska's oil and gas industry has produced more than 18 billion barrels of oil and six billion cubic feet of natural gas, accounting for an average of 20 percent of the entire nation's domestic production (1980 - 2000).
- The oil industry continues to be the largest source of unrestricted revenue for the state. Oil production generated \$2.7 billion in revenue for the State in FY 2019, which accounts for approximately 90 percent of Alaska's tax revenue from business. (Alaska Oil and Gas Association)
- Based on the Spring oil price forecast, the state now expects the industry to generate total Unrestricted General Fund revenue of \$1.6 billion in FY 2020 and \$1.2 billion for FY 20221 based on an oil price forecast of \$51.65 per barrel in FY 2020 and \$37 per barrel in FY 2021, climbing to \$53 per barrel in FY 2029. The Spring 2020 forecast reflects a reduction of \$527 million in UGF revenue in FY 2020 from the Fall 2019 forecast and a \$461 million reduction in UGF revenue in FY 2021. However, the State warned there is a high degree in uncertainty in these forecasts. (Alaska Department of Revenue, 4/2020)
- In 2019, the annual average wage earnings for the industry were more than 2.5 times higher than the statewide average.
- For each job in Alaska's oil industry, there are 15 additional jobs in the Alaska economy connected to the industry. No other industry in Alaska comes close to the multiplier effect of the oil and gas industry. (McDowell Group: The Role of the Oil and Gas Industry in Alaska's Economy, 2020)
- The oil industry accounts for one-quarter of Alaska jobs and about one-half of the overall economy when the spending of state revenues from oil production is considered. In other words, without oil, Alaska's economy would be half its size. (McDowell Group, 2020, University of Alaska Institute of Social and Economic Research 2011)
- The Alaska OCS may be one of the largest untapped oil and gas basins in the world. An annual average of 54,700 new jobs would be created and sustained through the year 2057 by its development, with 68,600 during production and 91,500 at peak employment. (University of Alaska Institute of Social and Economic Research, 2011)
- Development of Alaska's OCS resources would result in a total of \$145 billion in new payroll through the year 2057, including \$63 billion to employees in Alaska and \$82 billion to employees in the Lower 48. (University of Alaska Institute of Social and Economic Research)
- Oil production in the Arctic OCS would generate \$193 billion in government revenue through 2057, with \$167 billion to the federal government, \$15 billion to

the State of Alaska, \$4 billion to local Alaska governments, and \$6.5 billion to other state governments. (University of Alaska Institute of Social and Economic Research)

- The Alaska Permanent Fund, worth approximately \$66 billion in February 2020, was created in 1976 to set aside a portion of oil revenues for future generations. The fund has paid out more than \$20 billion in dividends to Alaskans. (Alaska Permanent Fund Corporation)
- The oil and gas industry has invested over \$55 billion in North Slope and Cook Inlet infrastructure since the 1950s. (Alaska Oil and Gas Association)
- In 1974, the building of TAPS began, the largest construction project in the world. The original estimated cost was \$900 million, but when it was completed in 1977, final costs were over \$8 billion.
- The potential Alaska natural gas pipeline from the North Slope to tidewater in Southcentral Alaska is estimated to cost \$45 billion.

Production & Processing

- Prudhoe Bay remains the largest conventional oil field in North America. Four of the nation's top ten conventional producing oil fields are located on the North Slope. Alaska ranks sixth behind Texas, North Dakota, New Mexico, California, and Oklahoma in daily oil production.
- There are more than a dozen producing fields on the North Slope. Cumulative oil production from these fields is over 18 billion barrels. Ultimate production from Prudhoe Bay itself is expected to exceed 14 billion barrels. (Alaska Department of Revenue)
- Oil production in Alaska has dropped approximately 75 percent since hitting a peak of more than two million barrels per day (bpd) in 1988.
- North Slope production averaged 496,906 bpd in FY 2019.
- North Slope production is expected to decline to 486,400 bpd in FY 2020 and edge up to 486,500 bpd in FY 2021.
- New fields offer tremendous potential to increase production in the 2020s but these developments are still contingent on final investment decisions and commitments of at least \$11 billion dollars of new investments on the part of oil and gas producers.
- The State currently estimates Prudhoe Bay contains an additional 2.5 billion barrels of recoverable oil plus another 426 million in reserves from satellite development. New investments and improved technologies may increase future reserve estimates. (Alaska Department of Revenue)

- Improvements in drilling technology have not only reduced the surface footprint, but they have also greatly expanded the subsurface drillable area. Modern drill sites can now be limited to six acres, with a subsurface drillable area of 32,170 acres, or 8 miles out from the pad. (ConocoPhillips Alaska, Inc.)
- There are 28 producing oil and gas fields on the Kenai Peninsula and offshore Cook Inlet. This area has produced a cumulative total of over 1.3 billion barrels of oil and 7.75 trillion cubic feet of natural gas. The largest oil field, the McArthur River field, is expected to recover 639,000 barrels of oil. The largest gas field, the Kenai field, is ultimately projected to produce 2.427 trillion cubic feet of natural gas. Cook Inlet oil production peaked at 230,000 bpd in 1970 and fell to 8,900 bpd in FY 2010, before rebounding to over 15,000 bpd in 2016. (Alaska Department of Revenue)
- Cook Inlet production was forecast at 16,200 bpd in the Fall 2019 forecast and is down 12.4 percent in the Spring 2020 forecast to an estimated 14,200 bpd.
- Alaska has three refineries that produce gasoline, diesel, and jet fuel for Alaska markets. Refineries are located in Nikiski, Valdez, and North Pole.

“The U.S. still needs Arctic energy,” Charles K. Ebinger, Brookings, 14 September 2015 [67] <https://www.brookings.edu/blog/order-from-chaos/2015/09/14/the-u-s-still-needs-arctic-energy/>

Overview:

America has fallen behind its economic competitors—namely Russia and China—in Arctic resource and infrastructure investment. Charles Ebinger argues that the United States must better define its resource development policies and priorities in order to ensure U.S. leadership in the Arctic.

The recent decision by the United States to allow energy exploration drilling to recommence in the Alaskan Arctic’s Chukchi Sea this summer is a welcome development. Here’s why: Federal waters in offshore Alaska are estimated to hold roughly 27 billion barrels of oil and 132 trillion cubic feet of natural gas, the vast majority of which is located in the Arctic. Experts believe that the Chukchi in particular, which holds more resources than any other undeveloped U.S. energy basin, may represent one of the world’s largest sources of untapped oil and gas.

Until now America has regrettably been on the sidelines of Arctic resource and infrastructure investment while our economic competitors—Russia and China included—have moved forward. This policy vacuum was highlighted in a recent National Petroleum Council (NPC) report to the U.S. Secretary of Energy in which I participated and which warned that if we effect no policy changes on an urgent basis we will not stay ahead of or even keep pace with our foreign rivals, remain globally competitive, or provide global leadership and influence in this critical region.

Current & Relevant Information:

We have to Take Actions that Allow Exploration to Commence Now

Indeed, given the long lead time necessary to develop resources in this region, the NPC study stressed that it is vital for the U.S. to take actions now that allow exploration in Alaskan Arctic waters to commence. In that regard, the recent approval for Arctic offshore drilling to occur this summer was a win for both Alaska, which is dependent on the petroleum industry to fund approximately 90 percent of its coffers, and the country at large, which leans on Alaskan energy to meet our daily needs, especially on the West Coast.

To ensure the long-term feasibility of offshore development in the region, Interior Department regulations for the U.S. Arctic in part must facilitate the use of proven technologies and also encourage innovation by providing the flexibility to incorporate future technologies as advances occur and their capacities are demonstrated. In addition, and all the more significant given our accession to chairmanship of the Arctic Council in May, U.S. policies governing natural resource development in the Arctic must be defined and streamlined.

Questions Washington Has to Answer if the U.S. Wants to Ensure Its Leadership in the Arctic

For example, what is the country's official position on the development of oil, gas, mineral and fishery resources in the Arctic? Does it align with Alaska's policies? How will resource development affect standards of living for those residing in the region?

In addition to resource development policies, other important questions must be addressed to ensure U.S. leadership in the Arctic. With Prudhoe Bay production in serious decline and the Trans-Alaska Pipeline System running at historically low throughput levels, how will the U.S. ensure access to new sources like Alaska's Arctic offshore that can help all Americans? With just one heavy icebreaker in operation, and the cost of another tallying at least \$700 million, what actions are we prepared to take to build a fleet capable of meeting the demands in an increasingly active region?

These are just a few of the questions and concerns that Washington, D.C. will have to answer soon if the U.S. stands a chance of catching up to or surpassing other nations that have so far leapt ahead to the front of the Arctic line. Will President Obama rise to the occasion and make the right decisions?

“Why Alaska and the Arctic are Critical to the National Security of the United States,” Michael J. Forsyth, Military Review, February 2018 [68]

<https://www.armyupress.army.mil/Journals/Military-Review/English-Edition-Archives/January-February-2018/Why-Alaska-and-the-Arctic-are-Critical-to-the-National-Security-of-the-United-States/>

Overview:

Over the past five years, Russia has moved aggressively to build its Arctic military capabilities, apparently in an effort to secure its claims and interests in the region. Increasingly, human activity is occurring in the Arctic as the sea ice recedes and economic opportunity opens to nations via new shipping lanes. Characteristically, in any geographical area, with the rise in human activity there is also the corresponding possibility that friction will occur as people compete to exploit the natural resources and corresponding economic possibilities. Such friction—and potential conflict—in the Arctic is highly likely at some point unless preparations are made to mitigate it.

Alaska makes the United States an Arctic nation, and its location places the state and country at the center of this fast-evolving region. Thus, Alaska is critical to the national security of the United States; however, we are not, as a nation, keeping pace with the rapidly changing security situation in the Arctic. Lagging here could also have an enormous impact on our economy. To change this dynamic, there are several things that the U.S. military can do to ensure the future security of the region.

Current & Relevant Information:

Arctic Natural Resources

In addition to the great potential for shipping through the Arctic, there is considerable capacity for economic expansion based on the abundant natural resources in the region. There are across the entire Arctic oil, gas, coal, rare-earth metals, and fisheries. It is estimated that 13 percent of the undiscovered oil and 30 percent of the gas worldwide is in the region, along with a host of other resources. As a result, Arctic nations are very interested in tapping into these to facilitate economic growth and generate revenue. The retreat of sea ice and glacial melt is making these resources more accessible to Arctic and interested near-Arctic nations like China.

The desire to obtain this mineral and energy wealth is stimulating competition among these countries. All of the Arctic nations have made claims beyond their exclusive economic zones on the outer continental shelf so that they have exclusive right to exploit these resources (see figure 4). Claims are made under the auspices of the United Nations (UN), which then adjudicates them according to the UN Convention on the Law of the Sea. The problem is that many of these claims overlap, complicating the UN's ability to judge in a manner satisfactory to all the claimants. This in turn gives rise to friction among the nations as they increasingly confront each other. Herein lies the potential for conflict in the Arctic region, which has heretofore been known for regional cooperation and peace.

Conclusion

The U.S. position in the Arctic because of Alaska is of enormous strategic significance. The United States has vital interests in the Arctic region that are

unfortunately often overlooked because turbulence in other areas of the world often draw more attention. In time, these interests will come to be seen as both critical and vital to our own long-term economic interests as well as security. Consequently, there is a need to ensure our interests in the Arctic are sufficiently secured to ensure resolutions to territorial and resource claims remain peaceful.

To effect protection of our interests, the United States has to assert leadership using critical elements of national power, including the military. We must rebuild long-ignored Arctic military capabilities to provide a credible deterrent to any nation that may want to expand its territory outside of recognized international norms to exploit the tremendous resources of the Arctic. As human activity continues to increase in the Arctic, it will become more and more important for the United States to demonstrate its strength in the region. Failure to do so could allow the friction of human interaction to grow into needless regional confrontation with global implications. This is preventable with a commitment to leadership and peace in the region that stems from sufficient investment and preparation.

“U.S. Arctic Interests,” US Government Accountability Office [69]
<https://www.gao.gov/u.s.-arctic-interests>

Summary:

Climate change has led to record low levels of Arctic ice—expanding economic opportunities as well as environmental and safety risks. As Arctic waterways become more accessible, the region has attracted increased shipping activity in the U.S. Arctic (which includes the Bering Strait and regions surrounding Alaska), and greater global attention for its economic opportunities. At the same time, climate change has created challenges for the people living in the Arctic and the ecosystems upon which many of them rely.

Current & Relevant Information:

Federal agencies play a variety of roles in supporting and protecting Arctic activities.

For instance:

- Melting sea ice has drawn increased attention to three trans-Arctic routes—the Northern Sea Route, Northwest Passage, and Transpolar Route—which could save thousands of miles and several days of sailing between major trading blocs. However, the U.S. Arctic lacks maritime infrastructure (such as a deep-draft port and comprehensive nautical charting) to support increased traffic. The lack of infrastructure exacerbates the risks inherent to shipping in the Arctic, such as vast distances and dangerous weather.
- Over 70 out of 200 Alaska Native villages face significant threats from erosion, flooding, or thawing permafrost. Federal agencies provided \$391 million during FYs 2016-2020 to repair damaged infrastructure in Alaska Native villages and build their resilience to environmental threats. However,

more than one-third of highly threatened Native villages did not receive such federal assistance during these 5 years. An intergovernmental coordinating entity could help target federal investments in the region.

- As more navigable ocean water emerges in the Arctic and human activity increases, the Coast Guard expects to [face expanding responsibilities in the region](#). Icebreaking vessels can ensure year-round access to the Arctic—which is critical to protecting U.S. economic and national security interests. However, the Coast Guard’s only operating heavy polar icebreaker, the Polar Star, is near the end of its service life. To address this gap, the Coast Guard is partnering with the Navy to procure three heavy polar icebreakers, known as Polar Security Cutters. The Coast Guard plans to invest at least \$11.6 billion for acquisition, operations, and maintenance of these cutters. However, the design of the Polar Security Cutters is not yet mature, which has led to [an extended design phase and contributed to a 3-year schedule delay](#).

“Alaska Natural Resources Propel State Economy,” Susan Harrington, Alaska Business, 1 November 2015 [70] <https://www.akbizmag.com/industry/oil-gas/alaska-natural-resources-propel-state-economy/>

Overview:

Alaska is a natural resources state, which includes oil and gas, mining, forestry, fisheries, and tourism industries providing jobs and revenue to the overall economy as well as to state, local, and federal governments.

Current & Relevant Information:

In 2014, the Mining Industry provided:

- 4,400 direct mining jobs in Alaska
- 8,700 total direct and indirect jobs attributed to Alaska mining industry
- \$620 million in total direct and indirect payroll
- \$144 million in payments to Alaska Native corporations
- \$119 million in state government revenue through rents, royalties, fees, and taxes
- \$20 million in local government revenue through property taxes and payments in lieu of taxes

Forestry is beginning to make a comeback:

- 700 direct jobs supported (January-September)
- 105 federal jobs supported last year

- 153 million board feet harvested last year in Alaska

Fisheries are wild, sustainable, and globally important:

- 63,000 direct seasonal and full-time jobs
- 5.8 billion pounds of seafood was landed in Alaska in 2013
- \$1.9 billion in ex-vessel value; \$3.3 billion in sales to export markets
- \$200 million in revenue for state and local governments
- \$1.4 billion sportfishing industry provides 16,000 jobs, \$545 million in income, and \$125 million in state and local taxes

Tourism supports thousands of businesses:

- 39,000 direct and indirect jobs
- ~2 million visitors per year
- 86% travel in summer
- 50% arrive by cruise ship, 46% by air
- \$1.8 billion spent during year ending September 2014

9. China (Non-Arctic Country):

“China, Iceland and the Arctic,” Arthur Guschin, *The Diplomat*, 20 May 2015 [71] <https://thediplomat.com/2015/05/china-iceland-and-the-arctic/>

Overview:

China’s efforts in recent years to increase its presence in the Arctic can now be considered to have been a success. Until 2014, observers were surprised by the activities of Chinese diplomats, executives, and scientists in the region, and even debated “China’s threat” in the Arctic. These days, though, China is seen as an essential actor that provides strong links for the region and drives economic development. China’s achievement of observer status in the Arctic Council (AC) in 2013 symbolized an unspoken acceptance of Beijing’s Arctic expansion. At the same time, bilateral relationship building with each AC member has enabled China to begin its work solving economic issues in regional policy. Of strategic importance for China’s plan is Iceland.

Current & Relevant Information:

Economy and Ecology

Iceland’s economic prosperity is based on three main sectors: fish catching and processing, aluminum and ferrosilicon production, and the use of geothermal energy

for heating and electricity. Beijing evaluated the economic utility of these segments and proceeded to try and establish cooperation with an eye to the financial and technological benefits.

Beijing's interest in the industrial application of geothermal energy is part of its strategy for improving the environmental situation in the PRC. The use of coal as the main fuel for industry and residential heating has led to widespread air pollution and triggered ecological issues with a range of questions about priorities in the present five-year plan. At the end of 2015, clean energy should be meeting 11.4 percent of China's energy needs, and by 2020, 15 percent. In contrast to the market for wind and solar energy, where Beijing has been investing heavily since 2003 and 2011, respectively, the development of geothermal energy was never a possibility until Wen Jiabao visited Reykjavik. The pilot project using Icelandic know-how in China was launched in Xianyang City, in Shaanxi province in 2006. The original plan was for heat and electricity for 1 million square meters of living space. However, this year the overall residential area under geothermal power will exceed 30 million square meters, and it will reach 100 million in 2020. This will make Xianyang the most ecological city in the PRC. It has been decided to repeat the project's success in the provinces of Hebei (Baoding City), Shandong, Sichuan, and Yunnan, as well as in Tibet and Xinjiang. By the end of 2014, 85 percent of all residential space in Baoding (1.6 million square meters) was being heated by geothermal energy, saving 120,000 tons of coal. Moreover, local household heating expenses decreased to 15-18 yuan per square meter, down from 24 yuan when coal was the main source of heat.

To advance China's geothermal program, the leading Icelandic company Orka Energy worked with Sinopec to develop the joint venture Shaanxi Green Energy Geothermal Development (SGE), 51 percent of which is owned by the Chinese side. At the same time the Sinopec subsidiary Star Petroleum Co. signed an agreement with another Icelandic company, Geysir Green Energy.

According to data from the PRC's Ministry of Land and Resources, there are 12 geothermal sites in China with a cumulative energy potential equivalent to 853 billion tons of coal combustion. By comparison, China annually uses more than 3.5 billion tons of coal for industrial and residential use. However, the impact of geothermal energy production on the PRC's energy balance is relatively small and will not bring major changes anytime soon because, while the joint Iceland-China test projects have been successful, further study of local Chinese peculiarities are needed. Nevertheless, taking into account the high concentration of high-temperature geothermal sources at the junction of the tectonic plates in Tibet, Yunnan and Sichuan provinces, Beijing will foster efforts to develop geothermal energy clusters exactly in these regions to smooth over the lack of electricity output and to solve the critical problem of grid modernization.

China-Iceland cooperation for geothermal energy clusters is a mutually advantageous process. Reykjavik provides technology and highly experienced

specialists in well-drilling, research, and technical support. Moreover, each year Iceland hosts young researchers from the PRC for advanced training in the spheres of environmental sciences, geothermal utilization, and reservoir engineering as a part of a six-month UN University geothermal training program. In return, Reykjavik gains access to an enormous market estimated to be worth 70 billion yuan (\$11.3 billion), according to analyses by the Xinhua News Agency. Combining Iceland's technological experience and reputation with Chinese investment, we can assume that cooperation between two states has all the components to be repeated outside the PRC. For example, Beijing holds strong positions in Africa and Pacific Island states with abundant undeveloped geothermal potential.

Fisheries Potential

In 2013, Iceland exported about 786,000 tons of seafood for 1.9-billion-euro, accounting for 45 percent of its commodity exports that year. Of this, China accounted for just 1 percent, or 40 million euro. In the wake of the free trade agreement, this situation will very likely change. One of the big Iceland banks, Íslandsbanki, predicts that by 2022 changing Chinese diets will see fish consumption rising to 20.6 kg per person a year.

There are other factors for close Beijing-Reykjavik relations in fisheries. First, the Icelandic fishing industry has demonstrated stable annual growth rate of 10-15 percent since the 2008-2009 crisis. This means not only a growing catch and its direct export, but also an expansion of complementary manufacturing: fish processing. Iceland is a world leader in the full utilization of fish for food, feed (fishmeal is a strategic, high-priced asset), medicine, and technical uses. The current processing capacity in Iceland is limited and Reykjavik is considering a partial shift of production to China. Second, the issue of industry development is inextricably intertwined with modernization and a fishing fleet upgrade. The average age of Icelandic fishing vessels is 25 years. Issues of financing and new trawler purchases have at various times been on the agenda. Today, Icelandic authorities are contemplating the possibility of launching 11 new vessels at a cost 2 billion euro. However, the large debts of fishing companies, around 25 billion euros, could derail this plan without a Chinese interest in investing.

The third component of potential cooperation is aquaculture development, an area of focus for both Beijing and Reykjavik. Recently, China has faced significant challenges in artificial fish breeding: Last year, the number of fish farms plunged by 30 percent and another 20 percent were considered overexploited. The causes of these negative statistics were environmental pollution and uncontrolled catching. On the other hand, Iceland has demonstrated annual growth in local farm production. Within the last two years it has doubled the number of farmed fish to 14,000 tons. Chinese investment would enable Reykjavik to increase output and boost its competitive position. For reference, active fish farming in Norway enabled Oslo to produce 1.5 million tons of fish annually.

Finally, the academic potential of Iceland should not be overlooked. The United Nations University Fisheries Training Program has already offered 19 PRC citizens advanced training in sustainable aquaculture, fishery planning and management under the guidance of Icelandic specialists.

Solar Power and Arctic Ambitions

At present, the largest Chinese investment in Iceland is the Chinese National Bluestar Group's purchase of the Norwegian firm Elkem, which owns a ferrosilicon plant in Grundartangi. Ferrosilicon is an essential element in the mass production of solar cells and it made the purchase because it strengthens the PRC's dominance in this segment, providing additional benefits at a time of solar cell trade disputes with the U.S. and EU.

Moreover, Beijing's interest in Arctic development can be associated with two questions: Who will gain access to regional mineral resources and how will melting ice impact commercial shipping through Northern routes from Asia to Europe and back?

Iceland has two potential oil and gas shelf sites: Dreki and Gammur. Dreki is operated by a joint venture of CNOOC, Eykon Energy and Petoro Iceland, in which the Chinese side has a 60 percent share. A strategic environmental assessment of Gammur is still pending approval, so no licenses have been granted. However, it is evident that Chinese oil giants will participate in development bids.

Commercial shipping through Northern routes offers a broad perspective on the cooperation between Chinese COSCO and Icelandic Nesskip in the segment of container carriage, implementation of energy saving solutions, and reduction of CO2 emissions. In 2006, MOFA Iceland issued a preliminary plan for the development of a logistics hub that would be a transit port between Asia and Europe. Document authors suggested three possible locations: Eyjafjörður, Hvalfjörður and Reyðarfjörður. It is obvious that the completion of such a large logistics project would place a great burden on Iceland's budget and would require outside investment from China, not the EU, given the political tensions between Brussels and Reykjavik. Incidentally, Iceland's commitment to turning the country into the logistics hub of the Northern Sea Route is visible in Reykjavik's consultations with Germany's big engineering company Bremenports regarding the possible construction of port in Finnafjordur.

Should there be an increase in the transit traffic of Chinese companies through the Northern Sea Route in the near future, the ambitious plans of an Icelandic hub may become a reality, and nobody will be able to question the PRC's presence in the Arctic region.

“China's strategic interest in the Arctic goes beyond economics,” Swee Lean Collin Koh, DefenseNews, 12 May 2020 [\[72\]](#)

<https://www.defensenews.com/opinion/commentary/2020/05/11/chinas-strategic-interest-in-the-arctic-goes-beyond-economics/>

Overview:

In its Arctic policy published in 2018, China proclaimed itself as a “near-Arctic state,” a label that has since invited controversy.

Beijing has long regarded the Arctic as consequential to its strategic, economic and environmental interests. China also believes that, in line with international legal treaties — especially the United Nations Convention on the Law of the Sea and the Spitsbergen Treaty — it enjoys such rights as scientific research, freedom of navigation, and overflight, fishery, cable-laying and resource development in the Arctic high seas.

Even before the Arctic policy was unveiled, Beijing gradually expanded its footprint in the region. Notably, since 1999, the Chinese have conducted numerous Arctic expeditions and built their first research base, the Yellow River Station on Svalbard Island in 2004. Generally, China’s current policy involves the acquisition of knowledge about the region; protecting, exploiting and participating in the management of the Arctic Ocean; safeguarding the international community’s common interests; and promoting its sustainable development in the region.

China’s better-known Arctic activities are primarily economic, especially energy cooperation with Russia. As part of Beijing’s effort to wean off coal dependence for power generation and to bolster energy security, in December 2019, it inaugurated the 3,000-kilometer-long “Power of Siberia” natural gas pipeline linking Russia’s Siberian fields to northeast China. Chinese companies also play key roles in the Arctic LNG 2, the second major natural gas project currently under development in the Russian Arctic.

Energy aside, China’s collaboration with Russia on establishing a global transport corridor via the Northern Sea Route, or NSR, has in recent times seized no small amount of attention. Experts believe this route would be around 40 percent faster than the same journey via the Suez Canal, significantly slashing fuel costs. With global warming and the consequent opening up of more ice-free periods per year, the prospect of opening up international Arctic shipping via the NSR becomes brighter.

In order to make the NSR safe and commercially viable, Russia envisaged a network of port terminals and logistics centers along the route, which would therefore require massive investments beyond what Moscow’s limited coffers can offer. In this respect, China’s Belt and Road Initiative becomes an attractive proposition when it comes to the promise of major funding for infrastructure development, with Russian President Vladimir Putin seeking the incorporation of the

NSR as part of China's 21st Century Maritime Silk Road under the "Polar Silk Road" notion.

Still, questions about the slower speed of transit through ice, the need for ice-class vessels that also adds costs, and unpredictable transit times for just-in-time shipping as well as shallow waters dominating the Russian coast along the NSR led to hesitancy among shipping companies.

Current & Relevant Information:

Purely scientific research for mankind?

China's strategic interests in the Arctic, however, have largely been overshadowed by its economic interests, even though in recent times this aspect has become magnified through the broader geopolitical rivalry with the United States. In a speech at the Arctic Council ministerial meeting in May 2019, U.S. Secretary of State Mike Pompeo warned of the dangers of Chinese investment in the Arctic.

Beijing generally believes that Washington is seeking an anti-China containment scheme using the Arctic as another strategic front. Some Chinese scholars and military strategists, for example, viewed the recent U.S. withdrawal from the Intermediate-Range Nuclear Forces Treaty and President Donald Trump's interest in purchasing Greenland as part of the broader U.S. strategy to enhance nuclear deterrence, which could envisage the installation of a network of missile defense and post-INF Treaty offensive missile systems in the Arctic to counter both China and Russia.

It is with this strategic context in mind that China's lesser known, scientific interest in the Arctic becomes something to scrutinize closely. The numerous Arctic scientific research activities, especially made more prominent by the frequent deployment of an icebreaker, have been particularly interesting. Such expeditions incrementally add new, updated information into China's expanding knowledge database on the Arctic's climactic, meteorological, geomagnetic and marine environmental conditions.

To be sure, such expeditions might be easily passed off as purely civilian scientific research that contributes to future economic programs in the region. For example, the first China-Russia joint Arctic expedition in 2016 could be regarded as paving the way for future development of the NSR. And the same could even be said of the Arctic Science Observatory, which was jointly inaugurated by China and Iceland in 2018.

However, over the recent years Beijing has instituted a gradually expanding set of scientific research programs in the Arctic that clearly have both civilian and military applications. Since 2014, the Chinese Academy of Sciences kick-started an Arctic acoustic research program, which has been subsumed within the numerous expeditions to the region and involved placement of sensors for long-term ocean

observation. It needs to be noted that China has broad interests in creating ocean observation networks on a global scale. As part of this endeavor, Chinese scientists are enthusiastically exploring underwater acoustic sensor networks, with the Arctic also in mind.

The year 2018, when China unveiled its Arctic policy, was a bumper year for Beijing's ocean observation program in the Arctic. In August of that year, the ninth expedition installed China's first unmanned ice station in the region to observe multiple fluxes in the ocean, the sea ice and the atmosphere. The station was described to serve as "an effective supplement [to the research] in the absence of scientific expedition vessels." The same expedition also utilized for the first time China's indigenously developed Haiyi underwater glider.

In December 2018, the Chinese Academy of Sciences launched a project for a cloud-based online platform using remote sensing and numerical models. The platform provides open access to Arctic ice, ocean, land and atmospheric data. The following August-September, China's 10th Arctic research expedition was somewhat special; instead of deploying the workhorse icebreaker Xuelong (or Snow Dragon), the oceanographic research vessel Xiangyanghong 01 made its debut and deployed the indigenous Haiyan underwater glider for ocean observation.

These supposedly civilian, persistent ocean observation activities have inevitably provoked concerns among at least some of the Arctic littorals. For instance, Danish defense intelligence authorities warned in November 2019 that the Chinese People's Liberation Army is increasingly utilizing scientific research as a means of entering the Arctic, describing such activities as not just a matter of science but serving a "dual purpose."

The U.S. Defense Department's annual report to Congress, "Military and Security Developments Involving the People's Republic of China 2019," was more specific, stating that China's "civilian research could support a strengthened Chinese military presence in the Arctic Ocean, which could include deploying submarines to the region as a deterrent against nuclear attacks."

"Understanding China's Arctic activities," Marisa R. Lino, IISS, 25 February 2020
[73] <https://www.iiss.org/blogs/analysis/2020/02/china-arctic>

Overview:

China is stepping up its activities in the far north, seeking economic opportunities presented by the impacts of climate change. But what are the strategic implications of its activities and could they take on a military dimension? Marisa Lino explains.

A great deal of attention is being paid to Russia's increasing activities in the Arctic, and, rightly so, since Russia is an Arctic nation, with approximately one-fifth of its territory found north of the Arctic Circle. Russia is also home to the largest Arctic population. However, China has also been ramping up its efforts in the far north,

taking a long-term view of developments and opportunities presented by the impacts of climate change in the region.

China published its own Arctic strategy in January 2018. It famously declared itself a 'near-Arctic' state and outlined a 'Polar Silk Road' economic plan. At the time, a US official called the self-designation 'absurd' and pointed out to media that China is located 1,844 miles (3,000km) from the Arctic Circle. Nonetheless, China's Arctic activity will arouse concerns over the strategic implications of its economic activities and whether they might take on a military dimension in the longer term.

At a recent trade fair in Shanghai, China exhibited models of its new ice-capable LNG carriers, while previous reports have indicated that China has built or is building a number of hardened-hull cargo ships. Designing and building polar-capable ships has been a stated policy objective of the People's Republic since 2016, beginning with the thirteenth Five-Year Plan. For China, regular use of the Northern Route would be an economic boon. The distance from Shanghai to German ports is over 4,600km shorter via the Northern Route than via the Suez Canal.

Current & Relevant Information:

Investing in Arctic nations

The People's Republic of China became an observer nation on the Arctic Council in 2013. Its interest in the Arctic region is clear: access to Arctic natural resources and use of the Northern Route, which work together to enhance its image as a major power. The New York Times reported in May 2019 that China is investing heavily in projects in nearly every Arctic country.

For example, it has invested billions into extracting energy sources from beneath the permafrost on the Yamal Peninsula in northern Russia. During a visit to Russia in June 2019, Chinese President Xi Jinping presided over the launch of a joint venture to build the ice-capable LNG tanker ships that were recently exhibited. The joint venture is composed of the Chinese company Cosco and Russia's Sovcomflot. Funding is being provided by the Russian energy group Novatek and Beijing's Silk Road Fund.

The warming of the Arctic and the opening – at least for a few months a year – of the Northern Route has whetted China's appetite for delving into new areas, such as fisheries, mining, petroleum and shipping. The US Geological Survey estimates that the Arctic holds approximately 90 billion barrels of undiscovered oil – about 13% of global estimates – and 30% of the Earth's undiscovered natural gas.

**“China's Push-in Strategy in the Arctic and Its Impact on Regional Governance,”
Matilde Biagioni, Istituto Affari Internazionali, 5 September 2023 [74]**

<https://www.iai.it/en/pubblicazioni/chinas-push-strategy-arctic-and-its-impact-regional-governance>

Overview:

Since the early 2000s, Beijing's interest in the Arctic increased. In 2013, the People's Republic of China (PRC) was admitted as one of the Arctic Council's permanent observers, the main regional forum. The real turning point, however, was in 2018 when China published a [White Paper](#) regarding its policy and goals over the Arctic. In the document, Beijing defined itself as a "near-Arctic state" and set out the ambition to launch a Polar Silk Road. An examination of the reasons and strategies underlying the Chinese interest in the Arctic helps understand its possible impact on regional governance dynamics, and how this contributes to making the Arctic a more global environment.

Current & Relevant Information:

The Arctic's untapped potential

In the last two decades, international attention to the Arctic environment and ecology has intensified, increasingly turning its governance into a global issue. In parallel, the enormous potential of [Arctic resources](#) has fueled the growing interest of states in the region. The Arctic is home to 13 per cent and 30 per cent of undiscovered oil and natural gas respectively, as well as large amounts of raw materials and mineral resources.

Against this backdrop, the PRC defines itself as a near-Arctic state, first and foremost because climate crisis-related issues in the Arctic have a relevant impact on China. Indeed, research [highlights](#) that the melting of Arctic Sea ice has contributed to significant alterations in the Chinese climate (for example, heavy snowstorms in 2007 and 2008 or haze pollution in 2013).

However, China's interest in the Arctic moves from other types of considerations as well. Beijing must expand its energy supply to ensure its economic growth. China's dependence on [imported oil](#) is currently over 70 per cent and predicted to increase further in the coming years, while imports account for more than 40 per cent of the country's total [natural gas supply](#). Hence, the Arctic may significantly contribute to Chinese energy security.

Furthermore, the melting of Arctic Sea ice allows China to take advantage of new Arctic Sea lanes, such as the Northern Sea Route, which connects Asia to Europe. This is shorter and less expensive than the conventional Suez Canal route and would provide an effective alternative to China's over-reliance on congested trade through the Malacca Strait and the associated incidents of piracy.

Arctic governance: A strategic matter

The Arctic, however, is not just a high-potential territory, it is a region where states, especially great powers, can exercise influence on discussions concerning global issues (first and foremost, environmental and climate ones).

It is widely acknowledged that Xi Jinping's China strives to be recognized as a great power in the international system by being present in all regions and institutions considered strategic for global governance – including the Arctic Council. As the PRC seeks to become a more prominent player in global governance, [four distinct paths](#) for transformation have been identified as possible for Beijing: complier, reluctant member, bystander, and push-in strategy. The most relevant for Chinese-Arctic relations is the latter, which is applicable to the “cases where China is still excluded by the global governing institution in a specific issue area”. Indeed, Beijing must conduct push-in initiatives to have a say in Arctic matters. Although China is not a full member of the Arctic Council, its admittance as a permanent observer in 2013 enabled Beijing to pursue push-in measures. It obtained a voice in the decision-making process by gaining the opportunity to speak and propose projects during Council sessions. Since full admission is not possible in the short term, China must follow complementary push-in strategies to augment its status. Therefore, Beijing has developed its own rhetoric on Arctic issues and begun bilateral relations (mainly of an economic nature) with Arctic states.

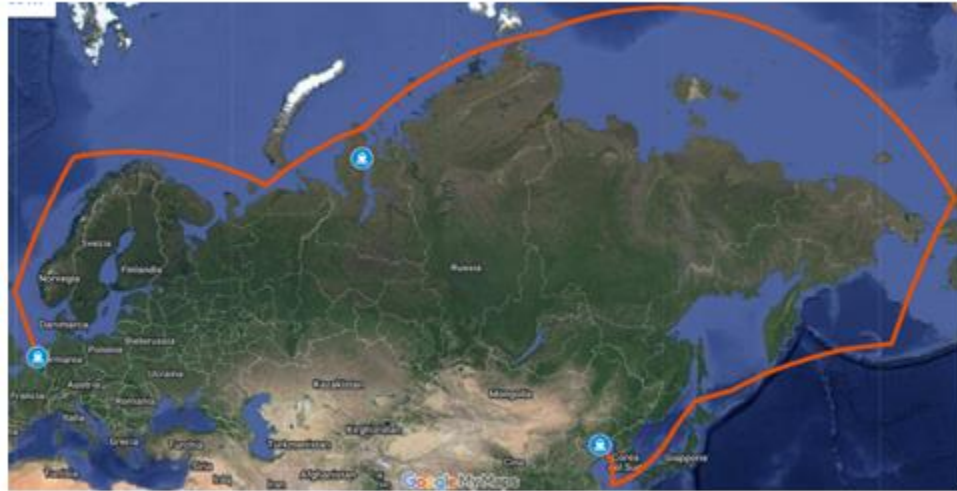
China's Arctic policy

According to the [2018 White Paper](#), Beijing's political objectives in the Arctic are protecting, developing and participating in regional governance. To achieve these goals, the PRC's Arctic policy commits to respecting and promoting international law as its main priority. Since Beijing is known to be an outsider state in the Arctic, it strategically set itself in a prominent position in [regional governance](#) through the international agreements to which it belongs. This strategy has become a rhetorical tool to validate Chinese presence in the Arctic. Already in 2015, at the opening ceremony of the third Arctic Circle Assembly, Foreign Minister Wang Yi held [a speech](#) stating that “the legitimate concerns of non-Arctic countries and the rights they enjoy under international law in the Arctic and the collective interests of the international community should be respected”. Such rhetoric could be supported by other non-Arctic countries in favour of their interests in the region. This seems to be India's case, which following Beijing's example, published its Arctic policy in 2022. In the document, New Delhi [expressed](#) its intention to increase its engagements in the Arctic region and echoed Chinese rhetoric on the need for all parties to respect international law.

As underlined in the 2018 White Paper, another key tool for implementing China's ambitions in the High North is the Polar Silk Road. This is the Arctic extension of the Belt and Road Initiative and outlines a plan to encourage the construction of

infrastructure in the Arctic, such as ports and transit lines. The proposed route goes via Japan, crosses the Bering Sea and the Northern Sea Route over Russia, passes through the Norwegian Sea, and arrives in the Netherlands (Figure 1).

Figure 1 | The Polar Silk Road



China's bilateral Arctic diplomacy – and the pushback against it

To develop the Polar Silk Road and its push-in into the Arctic affairs, China has developed relations with the Arctic states, above all, Russia, Iceland and Greenland.

Following Western sanctions imposed on Russia due to the Ukraine crisis in 2014, Moscow and Beijing have grown closer as strategic allies, and the Arctic has gradually turned into a long-term cooperation region. Russia is a relevant player in the Arctic Council due to its extent and proximity to the Arctic Circle. After 2014, the PRC started to invest in the Yamal project, a joint venture around a liquified natural gas plant located in the North-East of the Yamal Peninsula, in northwest Siberia. In 2016, Chinese banks [loaned](#) 12 billion US dollars to the plant, effectively stepping in as a potential lender and covering two-thirds of the project's external financing demands. China's National Petroleum Corporation and the Chinese company Silk Road Fund now have a 20 per cent and 9.9 per cent [share in the project](#), respectively. The Yamal plant is paramount because it is one of the Polar Silk Road's initial projects. It showcases Beijing's commitment to providing logistical support, such as port building and infrastructure in the Arctic; indeed, Chinese engineers have been involved in the development of infrastructure in the Yamal Peninsula, including a Chinese-made polar drilling rig. Moreover, in April 2023, the Russian and Chinese Coast Guard [signed](#) an Arctic cooperation agreement to strengthen maritime law and collaborate on joint exercises in the future. In parallel, pre-existing cooperation between Russia's and other Arctic states' coast guards through the Arctic Coast Guard Forum was suspended as a result of Moscow's

invasion of Ukraine, [boosting](#) the role of Beijing as a strategic partner for Moscow.

Meanwhile, in the wake of the 2008 global financial crisis, China emerged as an ideal commercial partner for Iceland, whose economy had been seriously harmed. The two countries' [free-trade agreement](#) signed in 2013 strengthened China's status and influence in the Arctic. This partnership is centered on energy and fisheries. Iceland delivers technology and highly qualified professionals in well-drilling, as well as technical support, while Beijing provides access to one of the largest markets in the world.

Greenland, the closest land to the North Pole, is also an important component of China's Arctic strategy. Its location makes it critical for any state seeking access to the Arctic. Chinese firms have expressed interest in investing in Greenland, especially its mineral reserves, which are becoming more accessible due to climate change. More specifically, a Chinese company established a [partnership](#) with an Australian firm to develop rare earth and uranium mining in Kvanefjeld, in Southern Greenland, in 2016.

Nonetheless, China's push-in strategies in the Arctic are also raising concerns in the US. Indeed, in 2019, during the Arctic Council's Ministerial Meeting in Finland, Washington warned the other Arctic states about China's economic and military ambitions over the region. The US Secretary of State Mike Pompeo [pointed out](#) the substantial investment of China in the Arctic states – estimated to be at 90 billion US dollars between 2012 and 2017 – and voiced the Pentagon's worries about Beijing possibly using its presence in the Arctic to reinforce its military activity. NATO Secretary-General Jens Stoltenberg shared such concerns, [saying](#) that China is expanding its reach over the High North through its "near-Arctic state" declaration, investments and partnership with Moscow. [According](#) to Stoltenberg, while the Arctic used to be characterized by low tensions, this is now changing due to its enormous opportunities and the resulting global competition over them. Also as a result of this push-back, some scholars highlight that the Polar Silk Road's future seems now uncertain since there is a significant gap between its stated objectives and concrete achievements. Indeed, the PRC's projects in the Arctic are suffering from Russia's invasion of Ukraine and Arctic states stepping back: for example, Greenland eventually [halted](#) the Kvanefjeld project in 2021.

China and the making of a global space?

Through the first two decades of the twenty-first century, Arctic governance entered a new phase, shifting from a separate territory with its policy agenda to a region with tighter linkages to the rest of the world. Today, notwithstanding the one-year [suspension](#) due to Western-Russia tensions related to the war against Ukraine, the Arctic Council is busier than ever because of the presence of China and other

observer states, including India, South Korea and Japan. In the future, China's involvement in the Arctic and its attempt to build the Polar Silk Road will present new opportunities as well as challenges to the Arctic governments. As a non-Arctic country, the success of China's Arctic policy will be determined by its push-in strategy, which includes the capacity to deepen regional cooperation, a focus on international agreements and associated rhetorical tools, as well as bilateral and economic diplomacy, and its capacity to deal with the pushback against it. However successful the PRC's strategy in the Arctic will eventually be, it is nonetheless already contributing to reshaping Arctic governance. The same fact that China–US tensions are emerging in the Arctic [is evidence](#) of how China's Arctic Policy is contributing to “reframe[ing] the Arctic as a global space”.

“China’s Economic Initiatives in the Arctic,” Yang Jian, GlobalAsia, December 2020 [75] https://www.globalasia.org/v15no4/cover/chinas-economic-initiatives-in-the-arctic_yang-jian

Abstract:

While China is not an Arctic country, it has taken numerous steps to stake out its interests and demonstrate its ability to play a constructive and environmentally sustainable role in the future development of the region. By further integrating its policies in line with the rapid economic changes in the Arctic, China is expected to be a major player in the years ahead.

Current & Relevant Information:

2013 was a remarkable year for China's participation in Arctic affairs. Beijing's Belt and Road Initiative (BRI) was first proposed by the government that year. Chinese shipping company Cosco's vessel Yong Sheng conducted the country's first commercial trial voyage to the Arctic Ocean in the same year. And it was in 2013 that China, along with several other Asian states, was granted formal observer status by the Arctic Council.

China is said to have taken a decade to transform from a non-Arctic state into an important Arctic partner and a stakeholder in Arctic affairs. In fact, China has gained great attention in Arctic economic development, Arctic climate and environmental governance because it is the world's second-largest economy and one of the largest emitters of carbon dioxide in the world. Its participation in the Arctic has also raised concerns about environmental protection and geopolitics.

Overall, China's BRI, including the so-called Polar Silk Road proposed by Beijing in a white paper in 2018, is a response to the global economic slump triggered by the financial crisis of 2008. After the crisis, Chinese policymakers felt that global economic flows had become stagnant. The US government's response was to pull manufacturing investment back to the US and regain trade advantages through strong bilateral trade negotiations. Based on its own development phase, China

found that joining and facilitating regional and world economic flows and consumption was the best way to deal with the economic downturn. Facilitating regional economic flows and consumption can transfer China's excess manufacturing capacity abroad, on the one hand, and prepare new markets for future prosperity, on the other hand.

China's approach to facilitating regional economic flows is inspired by the Asia-Pacific Economic Co-operation (APEC) forum, which was created by the US. Around 1990, when the boom in the ICT industry began to take off, the US facilitated and utilized economic flows around the Pacific Rim by forging APEC to achieve lasting prosperity. The experience of joining APEC's economic flows, especially China's co-operation with Japan, South Korea, the US and ASEAN, convinced the Chinese government that participating in the most intensive economic flows in the world was the best way to maintain China's economic development and to make up for China's relative economic weakness. For China, these economic flows entail goods (port construction, port equipment, shipbuilding and the shipping industry), capital (investment and financial markets), technology (technical standards, intellectual property transactions and data flows) and construction capacity (export of infrastructure equipment and construction workers).

China's BRI is designed to participate in and facilitate economic flows around and on the Eurasian continent, while maintaining the economic interrelations between China and countries in the Pacific region. Moreover, there are many important "engine countries" that promote regional economic flows around and on the Eurasian continent, including ASEAN, India, Russia, Turkey and Kazakhstan. China hopes to integrate this growing market by providing capital, technology, production capacity and infrastructure construction expertise. The joint efforts to build a blue economic passage linking East Asia and Europe via the Arctic Ocean are generally in line with the spirit of facilitating global economic flows.

Arctic Focus

China's economic co-operation projects in the Arctic are concentrated in two regions: Russia and Northern Europe. Building a global infrastructure network in the Arctic region, including coastal infrastructure and port facilities as well as economic development projects, contributes to economic flows. China did not propose the Polar Silk Road until 2018. The main reasons were: 1) Russia's determination to develop the Northern Sea Route (NSR) was not obvious before 2014; 2) Western countries and their companies were Russia's first choice for economic co-operation, while China was only Russia's secondary partner; and 3) Chinese enterprises lacked experience in developing projects in cold regions and lacked experience in making accurate assessments of the economic benefits and costs of environmental protection.

After the Crimean crisis in 2014, Western sanctions imposed on Russia turned China into a major source of inbound investment and a significant partner in Russia's Arctic development. Russia's determination to develop the Northern Sea Route and its Arctic energy strategy is becoming more and more obvious. Moreover, the LNG project in the Yamal Peninsula meets China's domestic demand for cleaner energy. China's participation in Arctic LNG projects is a part of its effort to replace coal and oil with natural gas, a less environmentally harmful fossil fuel. China's Silk Road Fund and the China Development Bank have also begun to invest in port construction projects in Russia. The launch of the Polar Silk Road means that China has the willingness to tap the economic flows frozen by the Cold War and cold weather. It signals that China will support Russia to build jointly the infrastructure in the Russian Arctic region needed for peaceful utilization of the sea routes in the future. The principle of co-operation is a win-win formulation in terms of the economy and sustainable development.

In September 2017, numerous Chinese companies announced that they were keen to invest in a new project near Arkhangel, which includes the Belkomur railway project and a deep-water port in the Northern Dvina River. A new port will be built near Mudyug Island in the Dvina River delta, close to the existing port facilities for larger vessels. In November 2017, Novatek, one of the largest independent natural gas producers in Russia, signed a strategic co-operation agreement with the Chinese National Petroleum Company (CNPC), which already owns 20 percent of Yamal LNG, a US\$27 billion production project. As part of the Saint Petersburg International Economic Forum in 2019, Novatek also signed a share purchase agreement with China National Offshore Oil Corporation (CNOOC). Under these agreements, Chinese companies will acquire a 20 percent share in Novatek's Yamal LNG 2 project under development, recently renamed Arctic LNG 2. With its construction, the demand for construction and transportation of LNG projects in the Arctic is expected to increase. It is foreseeable that Chinese shipping companies will continue to be important investors in Arctic LNG projects including provisions for ship leasing, logistic infrastructure, shipbuilding and so forth.

As for the Northeast Passage linking Asia and Europe, Russia has an important geographical advantage. It plays a key role in facilitating economic flows in the Arctic, but it also needs to improve the kinetic energy of the flows between the Far East region of Russia and the important economies in East Asia, and between Russia and Europe, especially the Nordic countries.

As a Nordic country, Iceland has the potential to be an Atlantic Arctic shipping hub, especially for traffic through the central Arctic shipping route that China has been led in exploring. Iceland hopes to enhance this hub role by facilitating co-operation with the important global economies, including the US and China. The successful co-operation between China and Iceland in polar science and education, geothermal energy and port cities has existed for many years. In 2012, China signed a

framework agreement with Iceland to support greater co-operation on geothermal energy, along with marine and polar science. The Chinese company Sinopec and Iceland's AGEC have developed joint geothermal projects in 23 cities in China making use of Icelandic technology.

As a country on the easternmost side of Fennoscandia, Finland has long experience in dealing with Russia. Now it intends to play a key role in economic relations among Nordic and Baltic countries, and Russia and East Asian countries. Helsinki provides the air hub between the Nordic countries and East Asia. It serves six destinations in Greater China with direct scheduled flights, more than any other Scandinavian airport. Passengers traveling on scheduled flights from Helsinki to China account for 5 percent of all international passengers, with China the eighth most popular destination country. China is one of the main markets for the export of Finnish Arctic shipping technology. In 2012, the Finnish shipbuilder Aker-Arctic provided the concept and basic design for Xuelong 2, considered the world's most advanced polar research vessel. This 122m-long Polar Class 3 icebreaker entered service in 2019.

International co-operation with Arctic nations on digital infrastructure including subsea cable projects is also on the Polar Silk Road agenda. China Telecom (one of the biggest telecommunication operators in China) is co-operating with Finnish counterparts on a planned 10,500-kilometer fiber-optic submarine cable across the Arctic Circle.

Norway, meanwhile, is a global maritime power and the Arctic is Norway's most important foreign policy priority. Economic growth is higher and unemployment lower in the Arctic part of Norway than in the rest of the country, ensuring a good balance between conservation and sustainable use. Norway has engaged in active co-operation with China in the protection and effective utilization of the ocean. Chinese equipment manufacturing companies help Norway build the world's largest intelligent deep-sea aquaculture cages to meet the increasing need for aquaculture in northern Norway and help Norwegian oil companies build large offshore oil drilling platforms. Kirkenes, Norway is the northernmost ice-free port located on the Barents Sea and the closest western port to Asia via the Northern Sea Route. Political representatives of Kirkenes, including the mayor of the Sor-Varanger municipality, Rune Gjertin Rafaelsen, visited China as a member of a delegation led by the Norwegian Minister of Research and Higher Education in 2018 to discuss the future demand of China's shipping industry for Arctic ports. He said that Kirkenes is well prepared to open the Northern Sea Route and co-operate with Chinese shipping companies.

While attracting China to participate in Arctic economic flows, some Arctic countries also have been expanding markets in China for their products, such as seafood from Greenland, Iceland, the Faroe Islands and Norway, and energy products from Russia and other countries.

China's infrastructure construction capacity and speed are world-class and it has engaged in co-operation on infrastructure construction, marine engineering and port construction in Iceland, Norway, Finland and Greenland. In 2019, the Trump administration in the US put forward a boycott on China's Polar Silk Road co-operation but Nordic countries, being independent from the US, recognize the opportunity and necessity of co-operation with China. They also hope that the Arctic issue can remain as an imperative agenda item under the framework of addressing climate change and that the Arctic should not become an arena of competition among the great powers.

Building Regional Co-operation

In addition to the two key co-operation regions in the Nordic countries and Russia, China attaches importance to strengthening Arctic economic co-operation with its neighbors, Japan and South Korea. This reflects the "North Pacific lens" in Arctic affairs. They are all important economies with similar views and interests concerning the economic elements of the Arctic. Japan, South Korea and China are all important LNG markets, manufacturers of LNG production equipment and investors. They are all partners in the construction of port infrastructure in northern Russia. Japan has become an investor in the Yamal LNG 2 project, and Japanese enterprises have realized economic benefits from the Arctic through joint ventures with Chinese shipping enterprises. Japan's Mitsui OSK and China's Cosco jointly own six vessels for charter to Sinopec and three of the 15 icebreaking LNG carriers that load Yamal LNG cargoes at the Port of Sabetta in the Russian Arctic. The shipbuilding industry of South Korea has built several icebreaking LNG carriers for Russia to transport LNG to East Asia via the NSR.

There are some differences in assessments about the pace of development and utilization of Arctic economic opportunities among the three countries. Chinese shipping companies are more optimistic about Arctic shipping in the future. They increasingly believe in the commercial value of the Northeast Passage. In Cosco's view, the value of the NSR is an important supplement to the traditional maritime routes, so the company is determined to carry on its commercial and regularized operations in the NSR each year. The biggest difference among the three countries is that China is not an ally of the US, while both Japan and South Korea are. In their co-operation with Russia on Arctic economic projects, Japan and South Korea have to take into account the strategic considerations and sanction decisions of the US.

China encourages its enterprises to engage in international co-operation on exploring and utilizing Arctic resources by making best use of their advantages in capital, technology and domestic markets. Sino-Russian Arctic co-operation in this context has a realistic basis. It is part of the co-operative construction of the Silk Road Economic Belt and the construction of the Eurasian Economic Union. China also hopes the Nordic countries, Japan and South Korea will be responsive to the BRI and jointly facilitate economic flows along the Northeast Passage in the Arctic.

In investing and joining economic projects in the Arctic, Chinese companies should pay attention to two issues: geopolitical concerns and environmental concerns. It is difficult for Chinese enterprises to cope with geopolitical interference caused by non-market factors. For example, a Chinese construction company was forced to quit the bidding for an airport expansion project in Greenland due to the direct intervention of the US. However, Chinese enterprises can meet Arctic countries' requirements in legal, technological and environmental protection by enhancing their technological solutions and learning capabilities in a short period of time. It is the responsibility of Chinese enterprises participating in Arctic economic activities to abide by local environmental protection laws and assessment procedures. In its 2018 white paper on Arctic Policy, Beijing made a commitment to utilize Arctic resources in a lawful and rational manner. The phrase "in a lawful and rational manner" means a careful balance between conservation and sustainable use.

As a non-Arctic state and the world's second largest economy, China and its enterprises should attach more attention to strengthening publicity and education on addressing climate change. The Chinese government has also made efforts to make the BRI initiative "greener" by issuing Guidance on Promoting a Green Belt and Road in 2017. The International Coalition for Green Development on Belt and Road was launched in 2019. Chinese companies can be expected to slow down their investment in the Arctic in the near future to increase the awareness of the requirements of responsible and reliable business activities.

"Northern expedition: China's Arctic activities and ambitions," Rush Doshi, Alexis Dale-Huang, and Gaoqi Zhang, Brookings, April 2021 [76]

<https://www.brookings.edu/research/northern-expedition-chinas-arctic-activities-and-ambitions/>

Summary:

This report explores China's internal discourse on the Arctic as well as its activities and ambitions across the region. It finds that China sometimes speaks with two voices on the Arctic: an external one aimed at foreign audiences and a more cynical internal one emphasizing competition and Beijing's Arctic ambitions. In examining China's political, military, scientific, and economic activity — as well as its coercion of Arctic states — the report also demonstrates the seriousness of China's aspirations to become a "polar great power." China has sent high-level figures to the region 33 times in the past two decades, engaged or joined most major Arctic institutions, sought a half dozen scientific facilities in Arctic states, pursued a range of plausibly dual-use economic projects, expanded its icebreaker fleet, and even sent its naval vessels into the region. The eight Arctic sovereign states — Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, and the United States — exercise great influence over the Arctic and its strategically valuable geography. China aspires to be among them.

Current & Relevant Information:

China seeks to become a “polar great power” but downplays this goal publicly. Speeches by President Xi Jinping and senior Chinese officials with responsibility for Arctic policy are clear that building China into a “polar great power” by 2030 is China’s top polar goal. Despite the prominence of this goal in these texts, China’s externally facing documents — including its white papers — rarely if ever mention it, suggesting a desire to calibrate external perceptions about its Arctic ambitions, particularly as its Arctic activities become the focus of greater international attention.

China describes the Arctic as one of the world’s “new strategic frontiers,” ripe for rivalry and extraction. China sees the Arctic — along with the Antarctic, the seabed, and space — as ungoverned or under governed spaces. While some of its external discourse emphasizes the need to constrain competition in these domains, several others take a more cynical view, emphasizing the need to prepare for competition within them and over their resources. A head of the Polar Research Institute for China, for example, called these kinds of public spaces the “most competitive resource treasures,” China’s National Security Law creates the legal capability to protect China’s rights across them, and top Chinese Communist Party (CCP) officials have suggested China’s share of these resources should be equal to its share of the global population.

Chinese military texts treat the Arctic as a zone of future military competition. Although several externally facing Chinese texts downplay the risk of military competition in the Arctic, which would likely be harmful to Chinese goals, military texts take the opposite perspective. They note that, “the game of great powers” will “increasingly focus on the struggle over and control of global public spaces” like the Arctic and Antarctic and argue that China “cannot rule out the possibility of using force” in this coming “scramble for new strategic spaces.” Chinese diplomats describe the region as the “new commanding heights” for global military competition too while scholars suggest controlling it allows one to obtain the “three continents and two oceans’ geographical advantage” over the Northern Hemisphere.

Chinese texts make clear that its investments in Arctic science are intended to buttress its Arctic influence and strategic position. Although externally facing messaging indicates China’s desire to pursue scientific research for its own benefit and for global welfare, China’s top scientific figures and high-level CCP members are clear that science is also motivated by a drive for “the right to speak,” for cultivating China’s “identity” as an Arctic state, and for securing resources and strategic access. China’s polar expeditions and various research stations assist Beijing with its resource extraction, with Arctic access, and with acquiring experience operating in the Arctic climate.

China supports existing Arctic governance mechanisms publicly but complains about them privately. Several Chinese texts indicate frustration with Arctic mechanisms and concern that the country will be excluded from the region's resources. Official texts suggest gently that the region's importance now transcends "its original inter-Arctic States," while scholars once feared Arctic states would launch an admittedly unlikely "eight-state polar region alliance" or institutionalize the Arctic Council in ways that "strengthen their dominant position" at China's expense. These texts stress China's pursuit of "identity diplomacy," namely, terming China a "near-Arctic State" because it is affected by climate change. They also indicate an interest in pushing alternative Chinese governance concepts — in some cases to supplement and other cases to run outside the Arctic Council — including a "Polar Silk Road" and China's "community with a shared future for mankind," though specifics are often lacking.

Accommodating China's Arctic ambitions rarely produces enduring goodwill. Norway was the first country to allow China to build an Arctic science station and Sweden was the first worldwide to allow China to build its own completely China-owned satellite facility. Both these efforts, which were richly praised by China at the time, did not protect either country from later economic coercion and harsh condemnation by China. In both cases, China punished these countries not only for the actions of their governments but also for the independent actions of their civil societies, which were to award Chinese dissident Liu Xiaobo the Nobel Peace Prize and to investigate China's kidnapping of Swedish citizen Gui Minhai. Efforts by both Norway and Sweden to reverse the slide — with Sweden keeping relatively quiet about the rendition of its citizen and Norway vigorously backing China's pursuit of Arctic Council observer status — were only met with restrictions on Norwegian fish exports and colorful threats of coercion against Sweden.

Arctic dependence on trade with China is often overstated, and trade flows are smaller than with other powers. Chinese economic statecraft is feared by some in the Arctic and around the world, but the region's dependence on China is remarkably small. For the five smallest Arctic economies — Sweden, Norway, Denmark, Finland, and Iceland — China accounts for an average of only 4.0% of their exports, less than the United States (6.2%) and far less than the NATO and EU economies excluding the United States (70.3%).

China has invested significantly in Arctic diplomacy to boost its regional influence. China has sent high-level figures — at the levels of president, premier, vice president, foreign minister, and defense minister — to visit Arctic countries other than the United States and Russia 33 times over the last 20 years. Beijing lobbied heavily to become an Arctic Council observer, became a strong presence at many other regional Track II fora, and launched its own diplomatic and Track II regional efforts, including a China-Russia Arctic Forum and the China-Nordic Arctic Research Center, to deepen relations with governments and sub-national actors.

China’s military profile in the Arctic has increased, and its scientific efforts provide strategic advantages too. China has dispatched naval vessels to the Arctic on two occasions, including to Alaska and later to Denmark, Sweden, and Finland for goodwill visits. It has built its first indigenously produced icebreaker, has plans for more conventional heavy icebreakers, and is considering investments in nuclear-powered icebreakers too.

China’s scientific activities in the Arctic give it greater operational experience and access. China has sent 10 scientific expeditions into the region on its Xuelong icebreaker, generally with more than 100 crew members, that officials acknowledge give it useful operational and navigational experience. China has also established science and satellite facilities in Norway, Iceland, and Sweden while pursuing additional facilities in Canada and Greenland — with its facility in Norway able to berth more than two dozen individuals and provide resupply. Finally, China has used the Arctic as a testing ground for new capabilities whether related to satellites coverage, fixed-wing aircraft, autonomous underwater gliders, buoys, and even an “unmanned ice station” configured for research.

China’s infrastructure investments in the Arctic sometimes appear dual-use. Several Chinese infrastructure projects that have little economic gain have raised concerns about strategic motivations and dual-use capabilities. These include efforts by a former Chinese propaganda official to purchase 250 square kilometers of Iceland to build a golf course and airfield in an area where golf cannot be played and later to buy 200 square kilometers of Norway’s Svalbard archipelago. Chinese companies have also sought to purchase an old naval base in Greenland; to build three airports in Greenland; to build Scandinavia’s largest port in Sweden; to acquire (successfully) a Swedish submarine base; to link Finland and the wider Arctic to China through rail; and to do the same with a major port and railway in Arkhangelsk in Russia.

China’s commodity investments in the Arctic have a mixed track record. Despite some important successes, a large number of Chinese investments have failed. For example, a major Chinese firm abandoned a Canadian zinc mine, refused to pay creditors, and left local governments to pay to clean up an environmental disaster. Another firm disappointed in its investment later sued, saying it had overpaid. In Greenland, a Chinese conglomerate abandoned its iron mine after running into legal trouble in China. In Iceland, a Chinese company withdrew from an Arctic exploration partnership due to poor initial resource estimates.

“China in the Arctic: Policies, Strategies, and Opportunities for Alaska,” Liz Bowman and Qingchao Xu, University of Alaska Fairbanks: Center for Arctic Policy Studies, February 2020 [77] https://uaf.edu/caps/our-work/Bowman%20and%20Xu_2020_China%20in%20the%20Arctic_Final18Feb2020.pdf

Overview:

The objective of this report is to describe China's policy and positionality in the Arctic and, more specifically, to discuss the bilateral relationship between Alaska and China. As a non-Arctic state, China has limited capacity to impact regional decision making directly. Consequently, China has engaged Arctic stakeholders in order to increase its participation and influence within northern regional affairs. For public and private sectors in Alaska and the U.S. more broadly, it is critical to understand the role that China plays in the Arctic region already, as well as its plans for the future. An accurate and unbiased analysis of the significant Arctic interests of China, as well as other nations with whom the U.S. may currently have strained relations, is vital to the security of the region. Understanding how other countries, in particular non-Arctic nations, perceive and operate in the High North allows Alaska and the U.S. to create stronger and more beneficial partnerships in business and other endeavors such as scientific discovery and search and rescue. Consequently, our report is jointly written by scholars from both Alaska and China with expertise in their home countries' northern interests and policies. To frame this paper, the following two areas of inquiry are considered. Firstly, how is China already working in the Arctic? More narrowly, what has shaped the nation's interest in the North from its internal political development and how does it view its presence in the Arctic currently and into the future? Secondly, how should the state of Alaska interpret this engagement and what role does the state play within the complex national relationship the U.S. has with China?

The Arctic has a long-standing operational history of joint initiatives, primarily based on the region's inherent remoteness, environmental conditions, and lack of infrastructure. In particular, bi- and multinational cooperation is strong in scientific endeavors. Areas of research that are already flourishing include those related to climate and weather, where China is engaged heavily because of known impacts of Arctic regional climate change on its domestic climate. For example, in 2018, China and Iceland inaugurated a joint Arctic science observatory outside of Akureyri, Iceland. In an effort to strengthen its Arctic science, China often draws comparisons between the Arctic and the "Third Pole" region, high mountain and frozen sections of the Himalayas, in order to provide expertise and support its justification for incorporation in Arctic research. This is because China has a long history of cryosphere research in the Himalayan region, and it can use this expertise to its advantage in the Arctic setting.

In order to better understand China's role and address the questions noted above, this paper discusses the following topics: China's interests and concerns in the Arctic, China's Arctic identity, policy and strategies, as well as China's engagement with climate change, economic and social development. It concludes with a section specific to the China-Alaska relationship and where there are opportunities for China and Alaska to expand collaboration.

Current & Relevant Information:

China plays a complex role in Arctic economic development and will continue to do so for the foreseeable future. As stated earlier, China has been involved in the Arctic since the region became more open and globalized, coinciding with the fall of the Soviet Union. In the following decades, economic development within the Arctic began to take shape. When discussing the potential for natural resource development, scholars often cite a 2008 United States Geological Survey (USGS) report, which estimated that the Arctic held approximately 30% of the world's undiscovered gas and 13% of the world's undiscovered oil reserves. China, likewise, views the Arctic as a potential energy supplier for its large population and growing economy. The geopolitical risks are much lower in the Arctic region compared to other regions in the world that are rich with natural resources, such as Africa or the Middle East. This is due in part to the Arctic's geopolitical landscape, which is based on a history of openness and an established regional norm of cooperation. The largest geopolitical risk is a 'race for resources,' which suggests that Arctic and Non-arctic States could take advantage of the melting sea ice in the Arctic to competitively exploit newly available natural resources. China is keen to do exactly this, develop available resources in partnership with Arctic states including oil, natural gas, minerals, marine resources, and tourism, and is already active in many areas of Arctic resource development. For example, China accounts for 50% of demand for Canadian minerals and has positioned itself as an investment partner within the Canadian mining industry. Similarly, China has a complex relationship with Greenland, operating in partnership with other states, such as Australia, on several large rare-earth mining operations. China continues to seek permits for mining operations in Greenland, as well as parts of the Canadian Arctic.

Beyond natural resources, in practice China has a keen interest in developing long-term transportation infrastructure through its vision of the 'Polar Silk Road.' The Polar Silk Road is an extension of the approach to economic development underlying China's Belt and Road Initiative (BRI). BRI is a critical foreign policy objective of China's President Xi Jinping. The principle of the BRI is to create a network of highways, railways, ports, and pipelines that will link Beijing via the Middle East to Europe, and later, Africa. To facilitate BRI projects and programs, China created unique financial mechanisms for international development, including the Silk Road Fund, the China Development Bank, and several state-owned companies. Thus far, approximately 900 projects have been identified as a part of the BRI at an estimated cost of \$900 billion.

The Polar Silk Road is a separate policy from the BRI, but it is aligned in its approach to development. This vision for the Arctic is to facilitate greater global trade and economic integration and, as such, to allow China to vary its maritime routes and minimize its expenditures for global trade. Since 2018, all aspects of the Polar Silk Road initiative are overseen by China's Ministry of Natural Resources. This has

elevated the profile of the policy. Prior to oversight by the Ministry of Natural Resources, all polar items were organized under the State Oceanic Administration subcommittee. This shifts polar issues from the oversight of oceans and environment to a larger body that oversees natural resources, including development.

The bulk of China's infrastructure interests tied to the Polar Silk Road are linked to shipping along the Northern Sea Route (NSR). Forecasts previously projected that approximately 5-15 % of China's foreign trade cargo (container ships) could be enroute over the NSR by 2020. We now know that these figures were overly ambitious, as polar shipping routes, particularly for cargo vessels, are far too environmentally unpredictable at present. However, seasonal NSR usage can be more economical than the traditional route (which traverses the Suez Canal) given Russia's lowering of NSR tariffs. Recently, China's Maritime Safety Agency hosted a conference titled "Practice and Prospects on the Polar Silk Road," which was set to inventory China's polar shipping capabilities and discuss priorities. This is a very serious issue for China, and it is critical for Arctic states to pay attention to the developments of the Polar Silk Road. Increased traffic and infrastructure can economically benefit Arctic communities along proposed shipping lanes, but it also comes with increased risks for accidents in maritime and extremely remote areas.

Other areas of interest which fit within the 'Polar Silk Road' vision include Finland's Arctic Corridor project, which the Arctic business community has suggested could benefit China's long-term strategic investment plans. The Arctic Corridor project will link Rovaniemi, Finland to Kirkenes, Norway by rail, creating a formal linkage to mainland Europe from the Arctic Ocean. A project statement for this initiative states that the "Arctic Corridor offers business and investors an opportunity to get involved in major projects in Arctic Europe." An additional component of this project includes fiber optic cable laying, which will increase the availability of digital infrastructure in the northern reaches of Scandinavia. The project states that the railway and accompanying infrastructure would benefit Asia and lower the cost of international freight, as well as cut 20 freight days on cargo trips from Asia to Europe. Although China is not yet directly involved in the project, there are targeted efforts by the Arctic Corridor project, mainly business leaders in Finland and Norway, to bring China onboard. The project site has listed a Chinese language investment brochure for the Arctic corridor project on its website. Chairman Yang Erlin of the Finnish Chinese Business Council states that "private and state investors from China are very interested in this project in terms of investment as well as providing equipment and labor... they can raise the money. Now the biggest issue will be concerns about the environmental impact." A report published by the Finnish government confirmed that the alignment of interests between Finland and China on this project could lead to an investment and partnership on its implementation. However, the latest news as of December 2019 is that continuous controversies within China over this proposed

corridor has led to a negative evaluation and final suspension support on the Chinese side.

Conclusion

China is extensively involved in the Arctic. It continues to maintain a strong position in various economic ventures despite a lack of physical territory in the Arctic. It has found success in pursuing projects and initiatives of mutual interest between itself and Arctic partners. As with any significant global power, China's interests are many and varied, so it shares some interests with Arctic states. As such, China has found success in partnering with Arctic states and institutions for activities of mutual interest, including natural resource extraction, climate research, and infrastructure development. At the same time, China also suffers from failures in investment on infrastructure in the name of the Polar Silk Road and negative impacts imposed by the ongoing trade war. These are emerging tendencies, deserving more attention from the industrial arena and academic realm in particular.

Scholars continue to debate whether the international community should view China's increased engagement with the Arctic as an opportunity for collaboration or a challenge to cooperation. This is because it is not clear if China is motivated by national interests, such as energy security and food security, or for the betterment of the global community, as in global climate research, or both. Undoubtedly, frequent and in-depth communications at a variety of levels between Alaska and China will give insight into answering this question. Therefore, in the case of Alaska, working with China on Arctic initiatives should be considered, but with great awareness of the potential geopolitical and economic risks.

“Chinese Perspective on the Arctic and its Implication for Nordic Countries,” Guo Peiqing and Chen Huiwen, The Arctic Institute, 20 June 2023 [78]
<https://www.thearcticinstitute.org/chinese-perspective-arctic-implication-nordic-countries/>

Overview:

Growing US concerns over Chinese involvement in Arctic. As the U.S. and China enter full-scale competition, the U.S. elite groups, despite serious domestic differences, have reached a rare consensus on committing to limiting China's ability to threaten the U.S. leadership position in the world and in the Arctic. The 59th Munich Security Conference saw both the U.S. and China depart from polite niceties as their competition entered a more dangerous phase.

The U.S.-China global competition is spilling over into the Arctic, which has been heating up in recent years, especially in the Arctic-Atlantic linkage zone where the five Nordic countries are located. This region connects the Arctic Ocean with the Atlantic Ocean north-south, overlooks the North American and European continents east-west, and is closely connected to the security of the U.S. homeland. The U.S.

can't afford to have China gain a foothold or grow strong there, and will therefore do its utmost to exclude China from this region. But at the same time, China regards the Nordic countries as the western end of the Chinese "Polar Silk Road," where China has important shipping, scientific and strategic interests. The "Polar Silk Road" is of great significance to China's "Belt and Road" initiative and connectivity between Asia and Europe. As expressed in China's official Arctic Policy, Beijing participates in Arctic affairs on the basis of the principles of mutual respect, cooperation, win-win and sustainability, abides by the universally recognized norms of international law, and has the right to participate in Arctic governance. China will not give up its interests in this region and will increase cooperation with Nordic states. However, the United States sees China's involvement in the Arctic as a quest for power expansion, so expresses its need to resist Chinese trade activities and infrastructure projects in the Arctic. The U.S. aims to prevent China from transforming economic benefits into political influence, and continues to incite the Nordic countries to side with it against China. The competition between the U.S. and China in the Nordic region will become increasingly intense in the foreseeable future. For the Nordic countries, what will this competition bring to them? How will they deal with the increasingly fierce competition, and avoid hurting their own interests, while gaining practical benefits from the major powers' competition? These issues have been put in the agenda of the Nordic countries.

Current & Relevant Information:

Core Values of the China's Arctic Policy

To achieve mutual development through win-win cooperation is the first aim of Chinese Arctic policy. China and the Nordic countries are highly complementary in terms of economic structure. China is an important manufacturing country with strong infrastructure capacity and is the world's largest consumer market. As for the Nordic countries, the pillar industries are animal husbandry, fisheries, shipping, resource extraction, high-tech manufacturing, and tourism. China and Nordic countries are complementary in the international industrial and supply chains and there is no competition. In China's Arctic Policy published in 2018, China systematically elaborates the objectives, principles and policy propositions of China's participation in Arctic affairs. Cooperation and mutual benefits are the basic position of China. Unlike the U.S. dichotomy of "friend or foe" and the confrontational mindset of "lose or win," China bases its policy on its long-history of Confucian culture and peace-harmony gene and does not force Nordic countries to take sides between China and the United States, but advocates the concept of "making friends with the world" and aims for win-win results. China advocates solidarity, mutual assistance and sharing the same boat, likes working together with other countries on Arctic climate, scientific research and trade issues, and hopes to extend China's concept of "community with a shared future for mankind" to the Arctic region.

Secondly, China will keep its promises when it deals with Nordic states. Keeping promises is one of China's important Arctic values. Keeping promises matters for China's international reputation and soft power, as the U.S. has more advantages over China in competition with the Nordic countries through its strong military, economic influence and shared values related to political and economic culture with the Nordic states. Therefore, keeping promises is highly important for China as a new entrant that wants to carry out practical cooperation with the Nordic countries. China can't afford the price of breaking its words in the China-Nordic relations. As a newcomer to the Arctic, China looks forward to constructing a positive international image and making progress to win the trust of the Nordic countries. Examining world history and contemporary international politics, it is clear that the U.S. is less committed to keeping its promises than China, and that the U.S. does not care about weaker nations. On the other hand, the Chinese Confucian culture advocates "words must be kept and deeds must be done", that is, to speak with credit and to do things with results. Keeping promises is deeply rooted in Chinese culture. Unlike the utilitarian and capitalist national values of the United States, the Chinese cultural tradition of not making promises lightly and striving to deliver on promises has helped China to bring more predictable benefits to the Nordic countries in cooperation.

In short, win-win cooperation and keeping promises are the principles that China will adhere to in its competition with the U.S. in the Nordic region.

The significance of China's Arctic policy for the Nordic countries

The strengthening of economic, trade and cultural exchanges between China and the Nordic countries not only greatly benefits the economic and social development of the Nordic countries, but more importantly provides the Nordic countries with more options, gives the Nordic countries more strategic leverage and greatly enhances the position of the small Nordic countries in the international arena.

Beneficial to the economic development of Nordic countries

Given the complementary economic structures between the Nordic countries and China, the Nordic countries keep increasing demand for infrastructure, a larger market for their resources and high-tech manufacturing. In recent years, bilateral economic and trade relations between China and the Nordic countries have grown steadily, with China being the largest trading partner of the five Nordic countries in Asia. Chinese investments to the Nordic countries increase year by year. China's participation in Arctic development and construction brings capital, technology and infrastructure to the Nordic countries, giving the Nordic people tangible and predictable benefits.

Throw out a minnow to catch a whale

The strengthening of China-Nordic countries' economic ties will certainly drive U.S. attention and investment in the Arctic. After the Cold War, the Arctic region was marginalized because the U.S. focused mainly on Eastern Europe, the Middle East and the Indo-Pacific region, and did not put much attention to the Arctic. China's increasing investment in the Arctic compels the U.S. to re-focus on the Arctic. U.S. Arctic investment is motivated mainly by the need for strategic competition with China and Russia. Since 2021, the contents related to the Arctic in the National Defense Authorization Act (NDAA) issued by the U.S. have increased year by year, and China's investment in the Arctic causes anxiety and the U.S. is evaluating China's Arctic investment.

The latest United States' National Strategy for the Arctic Region released in October 2022 expresses that the U.S. will strengthen investment in Arctic infrastructure, protect indigenous peoples, and develop emerging economies. It is predictable that the Nordic countries can not only gain economic benefits from China's Arctic involvement, but also gain increased attention from the U.S. due to competition with China in the Arctic. That is to say, the Nordic countries can maximize their economic benefits by profiting from power competition, thus realizing the big diplomacy of small countries.

This U.S. strategic realignment has already created opportunities to get more with less cost, and raise their profile on the international arena. The Marshall Islands, located between Hawaii and Australia, recently signed an agreement with the U.S. in which the U.S. committed \$700 million in new support for the country over four years. "It's because of China. We are not naive," admitted Marshall Islands Foreign Minister Kirtland Kabua. China is pouring a lot of money and attention into many Pacific islands nations with an effort to expand its influence and gain economic, diplomatic and military benefits in the Pacific, which forces the U.S. to follow and make adjustments.

A similar performance has shown in Nordic countries, where the United States directed Denmark to invest in Greenland's airport construction in 2018 in order to beat China in a bid to build Greenland's airport. China Communication Construction was pushed out of three airport construction projects due to U.S. pressure. Kalaallit Airports, the state-owned company of Denmark, received the rights to renovate, own and operate Greenland airports at a 33% stake. Copenhagen offers concessionary loans at a rate of 1%. Moreover, the Pentagon promised "potential" investment in Greenland infrastructure in the future. Thanks to the competition between U.S. and China, Greenland will have new and renovated airports at a lower price. However, this is almost impossible without Chinese involvement. To compete for the Nordic countries, future investments by the U.S. in the Arctic are expected to increase and bring practical benefits to the Nordic people.

The United States' Choice

The U.S. has no ability to oblige the Nordic countries to disengage with China

Expelling Chinese power from the Arctic and preventing China from gaining a foothold in the Nordic region is one of the goals of U.S. Arctic strategy. In recent years, the U.S. has strengthened its control over the Nordic countries through military and intelligence cooperation, constantly forced the Nordic countries to disengage from China and attempted to exclude China from the Nordic region while controlling the Nordic countries at the same time. But the complementary economic structures between the Nordic countries and China as well as the attractiveness of Chinese funding and infrastructure technology makes disengagement impractical. The Nordic countries will lose diplomatic autonomy if they blindly follow the US instruction. They will miss the opportunity to ride the Chinese development train.

Globally, it has been the goal of U.S. policymakers to push the U.S. and its allies to disengage with China in the areas of economic trade, technology, and education. This aim replicates the Cold War era when they ganged up and disintegrated the Soviet Union. Some experts call it the “New Cold War.” Such theorists argue that China will collapse if it is excluded from the current international system and prevented from benefiting from the world trading system and technological development – as what happened with the Soviet Union. However, policymakers holding this assumption do not realize the difference between today’s China and the Soviet Union of the Cold War era. China manufactures large amounts of industrial goods for the world every day, and has the largest and most comprehensive industrial system in the world. Even the United States is not yet able to decouple from China. Despite escalating national security tensions, trade between the United States and China hit a record high in 2022, with the bilateral goods trade between the countries rising to \$690.6 billion, according to official U.S. data, topping the previous record of \$658.8 billion in 2018. Exports to China increased by \$2.4 billion to \$153.8 billion, while imports of Chinese products rose by \$31.8 billion to \$536.8 billion, according to the U.S. Bureau of Economic Analysis.

The U.S. sanctions against China inevitably lead to damage to its allies’ economic systems. In President Joe Biden’s 2023 State of the Union address, the U.S. leader announced that it wants to begin a trade embargo against allies: “Tonight, I’m announcing new standards that all construction materials used in federal infrastructure projects must be made in the United States. America-made lumber, glass, gypsum board and fiber optic cable. American roads, American bridges and American highways will be made with American products.” U.S. alliance policy is filled with a plethora of inherent contradictions, such as targeting the embargo on products made by allies – harming the interests of allies. Will the U.S. policy succeed in defending “Made in America” and excluding Chinese and U.S. ally products? History and facts have proved its failure. As long as China insists on “equality and mutual benefit” and continues to strengthen the trade ties with the world, and if the U.S. allies can benefit from trade with China, the policy of

containing and isolating China is doomed to failure. Britain, France, West Germany, Japan and Canada traded with the Soviet Union despite the Iron Curtain during the Cold War. There is a similar situation with China today. At the request of Russia, the UN Security Council held a public meeting on February 21, 2023 for the Nord Stream gas pipeline explosion of last September. The convening nations discussed launching an international investigation of the Nord Stream II explosion. The results of the investigation may continue to tear apart the US-led Atlantic alliance system.

Because the U.S. shares more of the same political-economic values as the Nordic countries, China has never expected the Nordic countries to side with China, nor expected the Nordic countries to betray the United States. What China plans to do is to ignite Nordic countries' ideals for higher standards of living, to awaken their inspiration for national dignity and their dream for independent policy making. Nobody can stop people's aspiration for a better life once it is ignited. The elites and populations of the Nordic countries have the natural right to pursue higher levels of economic development, higher-level industrial structures and more autonomous national strategies. If the U.S. attempts to forcefully separate these countries from China, including commercial and academic exchanges between both sides, it may instead stimulate greater interest in their exchanges with China and raise the cost of U.S. control over its allies, since it is impossible to cut off the Nordic countries from China in the information age.

The United States is like a "mega corporation" consisting of many shareholders and groups, including the military-industrial complex and international energy groups. Every interest group can use the U.S. as a large corporation to pursue its own interests. Competition with China is bound to intensify domestic disputes and even conflicts within the U.S. The struggle between U.S. domestic interest groups also provides an opportunity for the Nordic countries to achieve their strategic autonomy.

The U.S. Nordic policy will eventually bite back at itself

The U.S. is a capitalist country, and the principle of confrontation with China in the Nordic region is subject to hegemonic and economic interests. The costs of competing with China in the Nordic region have to be calculated and balanced. Confrontation with China can only be profitable and sustainable if the benefits outweigh the costs. Once the costs are higher than the benefits, it will be difficult for the U.S. to sustain the competition. The profit-seeking properties of capital dictates a strong internal countervailing force which will make the U.S. tired of dealing with it. According to the analyses of Hillary Clinton, China has the advantage of a more powerful political system than the United States, which controls fewer national resources than China. "We'll never beat China unless 'we take back the means of production.'" China can utilize more resources and compete with the U.S. at any cost, but the U.S. political system cannot do so. Due to the political system advantages, China will be the last winner in the Nordic competing with the U.S.

According to Chinese Taoism, “Reversion is the action of Tao (反者道之动)”, which means that things may develop in the opposite direction of the will, and that strengths and weaknesses can be transformed into each other. U.S. Arctic policy is falling into the trap of “Reversion is the action of Tao” by aggravating friends, helping adversaries, and hurting itself. The result of oppressing allies and sacrificing their interests blindly is to push them toward China.

The U.S. is falling into a trap and vicious cycle. The greater the effort to boycott China, the greater the price it has to pay and the greater the loss it will suffer. Any miscalculation will push the U.S.’ allies toward China, which adhere to the principle of mutual benefit and win-win. The disastrous effects of U.S. policy are not visible now, but they will be in the future. The Nordic countries could maintain and increase cooperation with the U.S. rationally, while strengthening their ties with China which adhere to win-win cooperation and keeping its promises, and obtain practical benefits and national dignity in the face of power competition. For the United States, the only way out is to either give up the vicious competition with China or cooperate with China to maintain peace and prosperity in the North Atlantic and Arctic.

Conclusion

The competition between the major powers in the Arctic has brought pressure and crisis to the Nordic countries, but at the same time it has also brought opportunities. As long as the Nordic countries attach importance to their own national interests and catch the opportunities, they will benefit more from the power competition, gain more international influence and practical benefits that greatly exceed the size of their own territory and strength, and contribute to the promotion of peace in the Arctic.

Technology & Materials:

“What is materials technology at NTNU?” Norwegian University of Science and Technology [79] <https://www.ntnu.edu/ima/about-us/what-is-materials-technology>

Overview:

Materials technology is a relatively comprehensive discipline that begins with the production of goods from raw materials to processing of materials into the shapes and forms needed for specific applications.

Current & Relevant Information:

Materials - metals, plastics and ceramics - typically have completely different properties, which means that the technologies involved in their production are fundamentally different. Materials technology is a constantly evolving discipline, and new materials with interesting properties lead to new applications. For example, the combination of different materials into composites gives rise to entirely new material properties. Materials Science is closely related to materials technology. Materials

Science is a multidisciplinary field that connects material properties to the material's chemical composition, micro-structure and crystal structure.

The metallurgical industry and the production and processing of materials are very important aspects of Norwegian industry, and also offer significant added value to the economy through the export of products such as aluminum and ferrosilicon. Materials are also of very great importance in the oil and gas industry, such as in providing protection against the corrosion of steel in the marine environment.

“Critical Minerals in the Arctic: Forging the Path Forward,” Brett Watson, Steven Masterman, and Erin Whitney, Wilson Center, 10 July 2023 [80]

<https://www.wilsoncenter.org/sites/default/files/media/uploads/documents/Critical%20Minerals%20in%20the%20Arctic%20-%20Forging%20the%20Path%20Forward.pdf>

Overview:

Critical materials play a vital role in powering modern technologies, from renewable energy systems and electric vehicles to advanced electronics and national defense. However, the United States faces challenges in securing a reliable supply of these materials, which are essential for its economic competitiveness and national security. These materials include metals such as lithium, cobalt, rare earth elements, and graphite. They are essential for the manufacturing of high-tech products like batteries, semiconductors, magnets, and catalysts. With the increasing demand for electric vehicles, renewable energy systems, and advanced electronics, the United States heavily relies on critical materials to drive innovation and maintain its global economic competitiveness.

The United States faces several challenges in securing a stable supply of critical materials. One major challenge is the concentration of production in a few countries, primarily China. China dominates the global supply chain of critical materials, accounting for a significant share of mining, processing, and refining capacity. This dependency raises concerns about supply disruptions, geopolitical risks, and market manipulation.

This problem is complex requiring a multi-pronged approach to develop the best path forward. Attention from multiple agencies with private sector involvement is needed to address issues including resource definition, recovery technology development, recycling technologies, international relations, supply chain resilience and improvements and, domestic resource development policies. A successful outcome will necessitate a varied approach, strong collaborations, exchange of information and practices, and perhaps most importantly, persistence.

Ensuring a reliable and sustainable supply of these materials is essential for the country's economic growth, technological advancement, and national security. By investing in domestic production, promoting responsible sourcing, and fostering international collaborations, the United States aims to strengthen its critical materials

supply chains. These efforts will contribute to a more resilient and secure future, enabling the United States to maintain its position as a global leader in innovation and technology.

This overview explores the issue of critical materials supply chains in the United States, examining the importance of these materials, the challenges associated with their supply, efforts being made to address the issue, and research avenues.

Current & Relevant Information:

America's Arctic in the critical mineral arena

Arctic regions share many attributes that inspire and challenge resource development. Developing and sharing Arctic-friendly technologies and solutions across international borders, will strengthen Arctic relations, build Arctic economies, help disadvantaged communities and strengthen the nations critical mineral supply chain. Alaska is proud to participate alongside its Arctic colleagues in developing new technologies to meet this challenge.

Alaska's complex geological history has led to formation of a wide array of mineral deposit types containing commodities many list as critical. Alaska either has, is, or could produce almost all of the commodities on the US Geological Survey's 2022 list of critical minerals. Alaska is the largest producer of zinc in the nation, contains the nation's largest graphite deposit, is the state with the only domestic tin resources and, has been a producer of critical minerals in times of national need, e.g. During WWII Alaska contributed tin, PGE's, chrome, tungsten and antimony for the war effort. Most of the commodities produced to support the war effort have not been significantly produced since, and the resources remain in place, creating a ripe environment for meeting the nations need for these critical minerals.

Alaska is large in the domestic context, being about one fifth of the size of the contiguous states. Millions of acres of land selected by native corporations and the state were selected based on mineral potential. These, along with open federal lands provide almost half of Alaska's 400 million acres open to mineral development. Alaska has an active resource development industry known for rigorous environmental practices.

The University of Alaska is uniquely positioned to assist the national need for a stable critical minerals supply chain, with many of the necessary components to be a center of critical minerals research already in place, including the Mining Engineering and Mineral Processing, Geology, Economics and Chemistry departments, the Mineral Industry Research Laboratory, the unmanned aircraft program, the Geophysical Institute, the Institute of Northern Engineering, a strong relationship with the mineral industry, a strong state geological survey, and strong State of Alaska support for critical mineral research. Centered in the heart of Alaska's mineral industry, the University of Alaska's planned Alaska Critical Mineral

Research Center creates potential broad research areas to focus on to facilitate Alaskan, American, and Arctic critical mineral production.

What is important depends on your perspective

The perception of what constitutes a critical material is contingent upon one's perspective. Different industries and regions have distinct supply chains and material requirements. For instance, what is considered critical for a solar installation company in one country may not be for a vehicle manufacturer in another. Divergent perspectives arise from variations in supply chains and material needs. In the case of a thin-film solar panel manufacturer, concern might involve securing a stable supply of minerals like indium or tellurium. Conversely, a vehicle manufacturer might prioritize access to critical materials like lithium and cobalt, which are indispensable for the production of electric vehicle batteries. Engaging with industry to determine research needs is crucial to maximize research investment impacts.

Further, material criticality is dynamic. A material that is critical today may not be in the near future. Technological advancements play a crucial role in changing mineral criticality. For instance, the discovery of the Bayer process in 1888 revolutionized the extraction of aluminum from bauxite, significantly increasing its availability. Geopolitical forces also influence mineral criticality, as shifts in trade relationships, conflicts, and policy changes can impact the accessibility of certain minerals. As technologies advance and new applications emerge, the demand for certain minerals may increase or decrease, leading to shifts in their criticality over time. Potential for rapidly changing demand dynamics creates risk for mineral developers, disincentive to investment, and negatively impacts supply of these minerals.

Supply chains

The supply chains for critical materials in the United States face potential bottlenecks that extend beyond domestic mining. Even if the United States enhances its domestic mining operations, challenges are present in other stages of the supply chain. These include processing, refining, and manufacturing, which are equally critical for a secure and reliable supply of critical materials.

The case of copper is illustrative. The top four countries in terms of identified reserves of copper are Chile, Australia, Peru and Russia which collectively account for 49% of global reserves. The top four countries in terms of primary mine production are Chile, Congo (Kinshasa), Peru, and China which collectively account for 52% of primary mine production. However, at the refining stage, the top four countries of China, Chile, Congo (Kinshasa), and Japan collectively account for 63% of refined production, with China alone representing 42% of global refining.

In terms of processing and refining, the United States relies heavily on foreign countries for these crucial steps. Limited domestic processing facilities and expertise ensure foreign transformation of raw materials into usable forms. Investing in

domestic or allied processing capabilities will reduce dependence on foreign processing and mitigate potential disruptions. Engaging with processing facilities in allied countries to expand processing infrastructure and increase metal recovery in those facilities can strengthen the supply chain and reduce supply-chain vulnerability.

“Technology Roadmap: Materials and Manufacturing,” Shashank Modi and Abhay Vadhavkar, Center for Automotive Research, 2019 [81]

https://www.cargroup.org/wp-content/uploads/2019/10/Technology-Roadmap_Materials-and-Manufacturing.pdf

Overview:

The automotive, transportation, and mobility industries have experienced transformative changes due to advancements in connectivity and automation technologies, data analysis, and the rise of new mobility services. With such rapid changes in the industry’s landscape, an understanding of where technological development is at present and where it is likely headed is helpful to guide future decision-making.

With funding from the Michigan Economic Development Corporation (MEDC), the Center for Automotive Research (CAR) has prepared this technology roadmap based on internal research and a thorough analysis of available industry reports. CAR researchers vetted the study conclusions with critical input from a group of subject matter experts. This white paper updates CAR’s previous Technology Roadmap (Smith, Spulber, Modi, & Fiorelli, 2017) published in 2017.

Current & Relevant Information:

Materials

Materials are the core competence of any manufacturing industry. No matter how high-tech the final product is—production always starts with basic raw materials. In the last 100 years, the automotive industry has mastered the mass production of vehicle bodies (body-in-white and closures) made predominantly from steel with occasional use of aluminum, magnesium, plastics, polymer composites, and even wood. An average vehicle body in the U.S. fleet today is 65 percent steel, 13 percent aluminum, 4 percent magnesium, 6 percent plastic and polymer composites, and rest are comprised of other materials such as glass, adhesives, sealers, and foam. Powertrain components are around 58 percent iron and steel, 29 percent aluminum, 8 percent plastics and rubber, and rest is other materials. Engines are mostly aluminum. Other vehicle components such as interiors trims, seats, carpets, bumper, headlamps, engine cover, and hoses are made from plastics or polymer composites.

Manufacturing

Fast, cost-effective manufacturing processes is one of the top priorities in making profitable, good quality vehicles. Since steel and aluminum are currently the predominant materials, stamping, forging, extruding, CNC machining, and welding are the critical manufacturing processes. For plastics and polymer composites, injection molding, vacuum forming, and autoclave are the critical processes.

Conclusion

This report forecasts materials and manufacturing trends based on the CAR team's research findings as well as input from subject matter experts. The results show that several factors can affect the industry's progress on material technology in the coming decades, including fuel economy regulations, added weight due to batteries, ADAS, comfort features, increasing durability requirements for shared vehicles, and safety. CAR researchers found that vehicle light weighting will remain a top priority for the industry as automakers strive to use the right materials for the correct application promoting mixed-material body structures. The use of advanced HSS, high strength aluminum, plastics, and polymer composites will continue to increase.

To enable the production of lightweight parts, the use of advanced manufacturing technologies such as additive manufacturing, thin-wall casting, resin transfer molding, and structural adhesives are all expected to increase. To increase productivity, improve part quality, and reduce waste, automakers are investing in Industry 4.0 technologies such as smart sensors, cloud computing, and AI. Industry 4.0 investments are expected to double in the coming decade.

Finally, the future of materials and manufacturing technologies will depend on multiple factors, such as the availability of enabling technologies and the cost, consumer acceptance, recyclability, and supply chain and infrastructure required to support them. Design optimization is the key to balancing performance and cost requirements.

“Materials and technology for Arctic conditions,” Metalworking World Magazine, 9 April 2015 [82] <https://www.metalworkingworldmagazine.com/increasing-welding-production/>

Overview:

Finnish Lappeenranta University of Technology is developing a way to produce materials and technology suitable for Arctic conditions. Principles for safe and ecological design and manufacturing of structures and devices used for energy production in the Arctic have been defined in the Arctic Materials Technologies Development project.

The LUT research focuses on the properties of new high-strength steel grades suitable for Arctic construction and the welding methods they require. As a result, the productivity of welding has been significantly improved through reducing the groove angle essential to welding from 45 degrees to 30 degrees without compromising

quality. The new narrow groove welding means faster welding, fewer additives and fewer mistakes due to a reduced welding need. “Strength, endurance and lightness of structures are essential in steel construction in the Arctic. In sub-zero temperatures, steel becomes fragile. You have to master steel construction. This narrower groove angle, for example, is a big step towards more sustainable and ecological production in Arctic steel construction,” says Project Manager Markku Pirinen from LUT.

Current & Relevant Information:

New methods to protect the environment

A great deal is required from materials used in the Arctic. The structures must withstand temperatures as low as -60 °C. The materials must ensure production that is both safe and economical. The use of new high-strength steels examined at LUT in structures improves the environmental friendliness and energy and materials efficiency of Arctic steel construction. The structures developed are lighter, thinner and more durable than before, therefore reducing time, energy and raw materials consumed in manufacturing, transporting and welding materials. “The quality and safety of products and production improve through increasing automation, because welding is more rigorously controlled,” Pirinen says. As a result of the project, a comprehensive database of steel grades used in Arctic steel construction and their manufacturers was created, which will be very useful for companies. Knowledge of different countries’ approaches, cultural differences and business infrastructure also improves the competitiveness of companies operating in the region.

“Technology and Materials definition,” Law Insider [83]

<https://www.lawinsider.com/dictionary/technology-and-materials>

Overview:

Technology and Materials means and includes all materials, technology, technical information, intellectual property, know-how, expertise and trade secrets related to the Licensed Field of Use.

Current & Relevant Information:

Examples of Technology and Materials in a sentence:

Also in 2008, the Advanced Technology and Materials Company in Beijing and a PRC intermediary named Liaoning Industry and Trade Company reportedly sold to Iran large amounts of tungsten copper, and the United Arab Emirates intercepted a PRC shipment to Iran of specialized aluminum sheets, materials that could be applied to produce ballistic missiles.

Iran Gears Up to Export Peaceful Nuclear Technology and Materials.

“Getting Arctic raw materials requires a gentle hand,” Jeppe Wojcik, ScienceNordic, 2 October 2012 [84] <https://sciencenordic.com/animals-anthropology-biology/getting-arctic-raw-materials-requires-a-gentle-hand/1377258>

Overview:

We must be very careful if we want to preserve the Arctic region’s special natural environment and culture while ensuring that the coming raw materials boom doesn’t turn into a disaster.

The Arctic has been hot this summer – literally. Satellite images have shown that the inland ice cap has been melting at a disturbing speed, the temperatures were the highest for many years and the ice coverage was the lowest since 2007.

The Arctic and its climate were also at the top of the agenda recently when researchers from Denmark, Greenland and Canada met at Aarhus University’s annual Polar Research Day to discuss how extracting raw materials can be combined with sustainable development in the Arctic region – and especially in Greenland.

Having an extreme but very sensitive natural environment, Greenlanders feel the effects of climate change to a particularly great extent.

How can we avoid an even worse impact on Greenland, its environment and people when the hunt for the Arctic’s natural resources really begins?

Current & Relevant Information:

The Arctic has plenty of raw materials

With the world’s increasing need for a number of raw materials – energy, such as oil and gas; minerals, such as copper, zinc and iron; and, in particular, rare earths (which, for example, are used in mobile phones) – the Arctic and Greenland become increasingly interesting.

Currently there is just one small gold mine that extracts raw materials in Greenland – but it can soon get company.

“We know that traces of oil and gas have been found in Greenland,” said Ulrik Gregersen, a senior researcher at the Geological Survey of Denmark and Greenland (GEUS). “The oil companies are trying to find out how large the oil and gas reserves are.”

According to calculations by the U.S. Geological Survey (USGS), the Arctic has about:

- 13 percent of the Earth’s undiscovered oil reserves
- 30 percent of the Earth’s undiscovered gas reserves

Karen Hanghøj, who heads the Department of Petrology and Economic Geology at GEUS, said Greenland has many minerals, with numerous deposits along the ice-free coasts, but the size of these deposits remains unknown.

How to avoid destroying Greenland's nature

Greenland's natural environment and culture are under heavy pressure. If Greenland develops into an active producer of raw materials over the next 10-15 years, everyone must ensure that the pressure does not increase.

Plenty of large oil and gas companies have been given the green light to carry out exploratory surveys. Eight mining projects are already in the late planning stage.

But the many researchers at the Polar Research Day could each contribute towards answering the important and difficult question: "How do we extract Greenland's raw materials without spoiling Greenland's delicate natural environment?"

Among other aspects, the Polar Research Day revealed that:

1. Everyone must be very aware of the impact that carrying out surveys, drilling and mining operations, building infrastructure and sewage systems, and planning new sailing routes have on the wildlife habitats.
2. The requirements of the environmental impact assessment (EIA) of a raw materials project must apply to all firms involved in the project – and not just the business granted the license.
3. Having a very comprehensive emergency management system is the most essential element when dealing with e.g., an oil spill.

1. Canada:

"Draft Science and Technology Plan 2020-25," Government of Canada, 7 May 2019 [85] <https://www.canada.ca/en/polar-knowledge/science-and-technology-plan.html>

Summary:

Rapid change – social, economic, and environmental – is sweeping across the Canadian Arctic and northern communities are feeling the impact. Northerners, in particular, are looking to understand and adapt to the changes they see around them, and to anticipate and prepare for those which may come in future. Developing a better understanding of current and possible future changes, and preparing optimal responses, demands more knowledge than is currently available. This Science and Technology (S&T) Plan 2020-2025 outlines how Polar Knowledge

Canada (POLAR) will respond to this need to improve understanding for all Canadians.

Working Collaboratively to Understand Priority Issues

To better understand what new knowledge is needed in order to meet challenges associated with rapid change, POLAR engaged with Northerners and all Canadians. Priority issues, and opportunities to complement existing efforts that are underway were identified by:

- Reviewed current priority-setting documents and initiatives, including the outcomes of the comprehensive consultation exercise that led to the co-development of Canada's Arctic and Northern Policy Framework;
- Engaged directly with representatives from northern and Indigenous organizations; and
- Sought information and guidance from all Canadians via an online open Call for Input.

Based on information gathered, we developed an S&T Plan that supports knowledge creation that is essential to understanding and adapting to rapid change. The Plan is also consistent with what Canadians want and expect from POLAR, will respectfully include Indigenous knowledge holders, and will complement knowledge creation projects and initiatives already under way in Canada's North.

Setting Science and Technology Goals and Desired Outcomes

Through a statistical analysis of information collected through engagement, we identified three broad areas where more knowledge is needed. The primary Science and Technology goals and associated outcomes proposed for 2020-2025 are:

Goal 1: Improve understanding of dynamic northern ecosystems in the context of rapid change

Outcome: Advanced understanding of current changes taking place in Northern ecosystems by developing baseline information and monitoring systems to track key changes in order to project future changes and facilitate adaptation.

Goal 2: Advance sensible energy, technology and infrastructure solutions for the North

Outcome: Increased availability and use of clean energy, waste and waste water, and housing technologies and techniques that meet the unique environmental, social, and cultural conditions prevalent in remote northern communities.

Goal 3: Increase understanding of the connections between northern community wellness and environmental health

Outcome: Improved knowledge of wildlife health leading to a better understanding of country food quality and supply, and greater clarity on the connection between human activities and the environment.

To support these goals, we identified areas of focus and activities describing key ways of implementation.

Creating and Sharing New Knowledge

Based on the feedback received, we also developed five key approaches to guide the way knowledge will be created and shared:

1. Community involvement,
2. Collaboration,
3. Capacity building,
4. Knowledge mobilization,
5. Data management.

The overall objectives of the S&T Plan are to provide essential information to understand and adapt to a rapidly changing Arctic, and to return this information into the hands of communities and decision makers at a time of pressing need. This will reduce uncertainty regarding the future and provide information crucial to the development of sound adaptation strategies.

Current & Relevant Information:

Introduction

Climate warming is bringing rapid and unprecedented change to the circumpolar Arctic – air temperature in the Canadian Arctic is warming at a rate two times the global average (Melfoite, 2013; AMAP, 2017; IPCC, 2018; Bush and Lemmen, 2019). This has local, national and global consequences.

In Canada, residents of Northern and Arctic communities are affected the most by this dramatic warming. Each season now brings signs, some obvious and others more subtle, of a shift in long-familiar patterns of sea ice, winds, weather, and wildlife. This affects access to the local food that northern Indigenous communities depend on and has significant social and economic implications for the entire North.

Conclusion

This S&T Plan outlines the efforts that POLAR will be directly undertaking, and supporting, over the next five years, in response to knowledge needs that Northerners and all Canadians have identified.

Through our Goals for 2020-2025, POLAR will:

- Increase understanding of northern ecosystems and how they are changing to inform appropriate responses,

- Develop solutions to energy, technology, and infrastructure challenges, and
- Create new knowledge that contributes to community wellness.

We will achieve this through efforts by the in-house team, and through a wide variability of collaborators, including Indigenous organizations and knowledge holders, national and international research bodies, universities, and federal and territorial governments.

Over the next five years, we seek to become known for our innovative approaches, including building long-term, respectful relationships with Indigenous communities and supporting the development of Indigenous researchers. The state-of-the-art CHARS campus, which is integrated into the community of Cambridge Bay, Nunavut, will be used to full advantage.

We are confident that by the end of 2025, work undertaken or supported by our team will have brought significant, new understanding of climate change effects in the North. This new knowledge will also have equipped decision and policy makers, at all levels, with information they need to plan the way forward with clarity in a time of unfamiliar and rapid change.

“Researchers reveal changes in water of Canadian arctic,” Phys.org, 24 June 2020 [86] <https://phys.org/news/2020-06-reveal-canadian-arctic.html>

Overview:

Melting of Arctic ice due to climate change has exposed more sea surface to an atmosphere with higher concentrations of carbon dioxide. Scientists have long suspected this trend would raise CO₂ in Arctic Ocean water.

Current & Relevant Information:

Now University of Montana researcher Michael DeGrandpre and his patented sensors have helped an international team determine that, indeed, CO₂ levels are rising in water across wide swaths of the Arctic Ocean's Canada Basin. However, some areas have exhibited slower increases, suggesting other processes—such as biological uptake of CO₂—have counteracted expected increases.

DeGrandpre is a UM chemistry professor, and in 2015 he and the company he founded, Sunburst Sensors, won two coveted XPRIZE awards for developing inexpensive, durable sensors to better understand ocean acidification. Sunburst Sensor technology also was used in this recent study for a CO₂ measurement system placed on board a Canadian icebreaker, the CCGS Louis S. St. Laurent.

DeGrandpre said ocean measurements are taken while the icebreaker is underway, sometimes crashing through ice one to two meters thick. DeGrandpre and UM research associate Cory Beatty have participated in these research cruises since 2012 with support from the National Science Foundation Office of Polar Programs.

"Because of the inaccessibility of the Arctic and the typically harsh work conditions, we really need a world-class icebreaker to access these areas," DeGrandpre said. "It also has given us a high-quality, consistent dataset, which really helped with this latest study. Most Arctic CO2 datasets are from infrequent cruises that do not visit the same locations year to year."

He said the new study combines sporadic data dating back to 1994 with the more-frequent data they have collected since 2012. DeGrandpre said their consistent dataset will only improve, as NSF recently awarded them an \$890,000 grant to continue the icebreaker project through 2023.

“50 years of science and technology cooperation to build a better future,” Trade Commissioner Service, 14 March 2023 [87]

<https://www.tradecommissioner.gc.ca/innovators-innovateurs/50years-50ans.aspx?lang=eng>

Overview:

Canada and Germany are celebrating 50 successful years of science and technology cooperation which have helped, and continue to help, solve some of the world’s most pressing challenges. Since the 1971 signing of a Canada-Germany Science and Technology (S&T) Agreement it is estimated that more than 1000 joint research projects have materialized, including in priority areas such as space technologies and earth observation, fuel cells, sustainable energy, nanotechnology, photonics, metrology, ocean science, health and genomics, and Arctic science.

Current & Relevant Information:

Ocean and Arctic Science

Canada and Germany are strategic partners in Arctic research, with each country offering specific strengths that support our growing collaboration. While Canada has the geography and a network of renowned scientific institutions with a long history of conducting Arctic research, and an established, efficient infrastructure that allows scientists to access, explore and study the land and water. Germany, has something that makes it one of the world’s premier players in Arctic research: the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research. Since it was established in 1980, the institute has grown from just a handful of employees to more than a thousand, many of whom have dedicated their careers to Arctic research.

Having these respective strengths in place allows Canada and Germany to cooperate on a broad range of research. These include key areas such as marine and terrestrial geology, the geological record of climate change (which helps predict how climate will develop in the Arctic), and Earth observation. In the latter category, the German Aerospace Center is currently working with the Canadian Space Agency, the Canada Centre for Mapping and Earth Observation, and various

universities, with the aim of sharing radar data and using ground receiving stations in both countries.

Geological Cooperation north of the polar circle

The Arctic – with a frozen ocean twice as big as Australia, and surrounding the land masses of America, Asia and Europe – is still a huge “under-explored” part of our planet. In spite of the internet and the other advanced technologies that dominate the modern world, expeditions to the Arctic remain a significant challenge given the region’s remote location and its distance from essential infrastructure. Because of the high costs and logistical challenges, polar research is increasingly difficult for single nations to undertake, and thus necessitates bilateral or multinational cooperation. An example of such collaboration is evident in the work being carried out by Canadian and German geoscientists in the remote reaches of the Canadian Arctic Archipelago.

Since 1998 the Geological Survey of Canada (GSC) and the Federal Institute for Geosciences and Natural Resources (BGR) have been conducting joint research on the geological history of the arctic region. This collaborative effort involves mapping the Arctic islands, investigating the complex geological history of the region, and assessing the potential economic value of the natural resources contained in this area. This joint work has included seven land and ship-based expeditions to Nares Strait, Ellesmere Island and Ellef Ringnes Island, where Canadian and German Scientists established field camps in some of the most remote parts of Canada. From here researchers were able to study rock exposures and collect samples for more detailed laboratory analysis. Through subsequent research meetings, the exchange of scientists, and the joint publication of research and geological mapping, both Canada and Germany have made major advances in understanding of the geological history of the Arctic. This successful cooperation is expected to continue with future expeditions planned to both Svalbard and Ellesmere Island.

“CHARS unites science, technology with Inuit knowledge,” Patricia Williams, Daily Commercial News, 19 June 2018 [88]

<https://canada.constructconnect.com/dcn/news/projects/2018/06/chars-unites-science-technology-inuit-knowledge>

Overview:

The two-story, 4,800-square-meter main building at the Canadian High Arctic Research Station in Cambridge Bay, Nunavut (seen below in a September 2016 photo) is part of a campus that also includes a field and maintenance building and residences for researchers. A number of Inuit-owned or Nunavut Tunngavik Inc.-registered firms participated in construction.



Current & Relevant Information:

When the Montreal-based joint venture of EVOQ Architecture and NFOE was retained to design a research station in the Arctic, its mandate included integrating the facility into the local Inuit community.

“This represented both a challenge and a welcome opportunity,” says architect Alain Fournier, a founding partner in EVOQ, who leads his firm’s projects north of the 55th parallel.

Located in the hamlet of Cambridge Bay, Nunavut, the Canadian High Arctic Research Station (CHARS) brings science and technology and traditional Inuit knowledge under one roof.

Built as part of Canada’s northern strategy, the facility will provide a year-round presence and complement the network of research facilities across Canada’s North.

Construction of the station, which is now largely operational, was spearheaded by Indigenous and Northern Affairs Canada (INAC) — now Crown-Indigenous Relations and Northern Affairs Canada.

The two-story, 4,800-square-meter main building houses cutting-edge laboratories as well as public spaces. The campus also includes a field and maintenance building and residences for researchers.

The budget for architectural design, construction, equipment and fit-up of the campus is estimated at \$204 million. The official opening is pending.

The station has garnered attention not only for its state-of-the-art facilities but also for its integration of Inuit community-oriented spaces, values, art and heritage.

“While Canada has a number of research facilities in the North, what’s unique about this project is that it is actually integrated into an Indigenous, and in this case, Inuit community,” Fournier said.

The key to success was the fact the community was involved in the project from the very outset, said Fournier, whose firm has worked in the North for 35 years.

Meetings were held at various milestones during the design development process.

“This was really at the heart of our being able to develop a design that evoked the Inuit culture and more specifically the culture of the host Copper Inuit community,” Fournier said.

Both the process leading to the design and the design of the station itself were derived from a number of Inuit Qaujimajatuqangit principles, meaning “that which has always been known.”

Incorporation of these principles was done at the suggestion of the community, which has a population of about 1,700.

The planning principle of free, open, interconnected spaces is used in the layout of the public spaces. Design of these spaces was inspired by the qaggiq, a communal igloo, where locals and scientists can interact. Large artwork by Inuit artists are woven into the fabric of the station, including in the floors and glazing, giving “shape and meaning” to the building’s interior, the architect explained.

“The artworks reinforce the expression of Inuit culture and work hand in hand with the architectural narrative,” Fournier said.

Artists were commissioned to produce works following a competition held across the Inuit Nunangat territories, said to be a first of its kind in Canada.

Fournier said the main building’s exposed wood structure is intended to convey the ingenuity of the many Inuit-designed, stick-built assemblies. Copper-colored cladding is a nod to the host community.

LEED Gold, which is more commonly applied in southern environments, is being targeted. Fournier said the architects “translated and adapted” the system for application in Arctic conditions.

A construction management contract was awarded to EllisDon in joint venture with NCC Dowland Construction Ltd., a Northern firm.

A number of Inuit-owned or Nunavut Tunngavik Inc. registered firms participated in construction of the campus.

“Community integration involved more than just design,” Fournier said. “It also meant ensuring that jobs were created for local Inuit firms not just during construction but also when the station is up and running.”

Given its location, the project has posed certain challenges in terms of construction — among them coping with sometimes harsh weather conditions, and ferrying personnel and materials to the site.

Cambridge Bay is located on the southeast coast of Victoria Island.

“It’s all about logistics,” Fournier said.

In a number of cases, building materials were shipped to the site from the port of Valleyfield, about 70 kilometers southwest of Montreal, up the St. Lawrence River and the Labrador coast, and then across the Northwest Passage.

Materials were shipped from the West Coast as well.

“There is a short shipping season and it is often unpredictable,” Fournier said. “You’re never quite sure when the ice is going to break up and free up access to the community.”

INAC opted for the construction management project delivery approach in part to maximize participation by local contractors, he said.

“In this way, it was possible to carve out smaller construction packages.”

Construction of the campus began in summer 2014. The location was chosen following consultations with community members including elders and hamlet staff and an assessment of the station’s requirements.

The project manager was Public Services and Procurement Canada.

The facility is being operated by Polar Knowledge Canada, a federal agency responsible for advancing Canada’s knowledge of the Arctic and strengthening Canadian leadership in polar science and technology.

“Editor's choice: polar science,” Scientific Reports, 7 December 2020 [89]
https://www.nature.com/collections/szpxlrkbvq?gclid=EAlaIQobChMIudWn1OLd8gIVEY-GCh0EEwG0EAMYAyAAEgJj5fD_BwE

Overview:

Myriad facets of life on Earth are affected by changes in the Antarctic, the Arctic and high-altitude regions. Here, Scientific Reports presents work by international teams working in the polar regions. A wide-reaching Collection, it touches on pollution, climate change, atmospheric science, and ecology from micro- to macroscale.

“Canadian Arctic Soapstone Cooking Technology,” Liam Frank, Dashiell Glazer, and Karen Harry, North American Archaeologist, October 2012 [90]

https://www.researchgate.net/publication/270409796_Canadian_Arctic_Soapstone_Cooking_Technology

Abstract:

This article examines the thermal properties of soapstone in comparison to other materials, to help us explore why Arctic cooks might have elected to use this material for their cooking containers. Low energy water boiling experiments, designed to simulate the low energy, oil-based fuel technologies of the Arctic, were undertaken. The results indicate that compared to metal and ceramic containers, soapstone is better able to store heat. We propose that this property makes soapstone especially useful in Arctic environments, where fuel sources are limited and indigenous heating techniques commonly relied on low energy. By understanding how heat is absorbed into metal, ceramic, and stone containers and how it is subsequently released into water we gain important contextual insights into the technological choices made by Arctic people.

Current & Relevant Information:

Introduction

In this article we discuss the use of soapstone cooking vessels among Arctic hunter-gathers. Specifically, we present the results of experiments undertaken to investigate the thermal properties of vessels made from this material. In pre-historic and early historic times, Canadian Arctic people cooked in soapstone cookware, we first briefly outline the environmental and cultural context of its use. We then discuss the experiments we conducted with each of these three durable container technologies.

“The Canadian Arctic Weather Science Project: Introduction to the Iqaluit Site,” Paul Joe, et al., *Bulletin of the American Meteorological Society*, 1 March 2020 [91] <https://journals.ametsoc.org/view/journals/bams/101/2/bams-d-18-0291.1.xml>

Abstract:

The goal of the Canadian Arctic Weather Science (CAWS) project is to conduct research into the future operational monitoring and forecasting programs of Environment and Climate Change Canada in the Arctic where increased economic and recreational activities are expected with enhanced transportation and search and rescue requirements. Due to cost, remoteness and vast geographical coverage, the future monitoring concept includes a combination of space-based observations, sparse in situ surface measurements, and advanced reference sites. A prototype reference site has been established at Iqaluit, Nunavut (63°45'N, 68°33'W), that includes a Ka-band radar, water vapor lidars (both in-house and commercial versions), multiple Doppler lidars, ceilometers, radiation flux, and precipitation sensors. The scope of the project includes understanding of the polar processes, evaluating new technologies, validation of satellite products, validation of numerical

weather prediction systems, development of warning products, and communication of their risk to a variety of users. This contribution will provide an overview of the CAWS project to show some preliminary results and to encourage collaborations.

Current & Relevant Information:

Developmental pressures, combined with social–cultural, technological, and climate–environmental changes are driving and increasing human activity in the Canadian Arctic region. The Northwest Passage is expected to be a prime transportation corridor with enhanced ship traffic shifting close to Canadian coasts (Smith and Stephenson 2013). Air traffic statistics showed a substantial increase from nearly 400 transpolar flights in 2000 to 12,759 flights in 2014, with a subsequent annual projected growth of 3.5% (Arctic Council 2017).

Supporting infrastructure for navigation as well as for safety and security and for search and rescue (SAR) operations are yet to be fully defined but will no doubt be required. With increased human activity and changes in weather patterns, the Canadian Arctic (consisting of Nunavut, Northwest Territories, and Yukon Territory), experienced 240.5 ground-based SAR incidents per 100,000 population in 2012, which is about one to two orders of magnitude larger than that in British Columbia and Ontario (Statistics Canada 2020). Weather-related hazards, including blizzards, high winds, and low visibility are the primary contributing factors that affect navigation, safety, and mobility of those requiring emergency response and also those engaged in SAR operations. These hazardous conditions are expected to become more frequent, longer in duration, and less predictable under climate change scenarios (Ford et al. 2013).

The Canadian Arctic is sparsely observed. Recent efforts have been limited-time weather projects or have generally had a climate science focus. Projects include the Beaufort and Arctic Storms Experiment (Asuma et al. 1998), Mackenzie GEWEX (Global Energy and Water Experiment) Study (MAGS 2018), Storm Studies in the Arctic (Hanesiak et al. 2010), Canadian Network for the Detection of Atmospheric Change/Polar Environment Atmospheric Research Laboratory (CANDAC 2018), Atmospheric Radiation Measurement program of the U.S. Department of Energy (ARM 2018), the Indirect and Semi-Direct Aerosol Campaign (McFarquhar et al. 2011), and Canadian Sea Ice and Snow Evolution Network (CANSISE 2019). Results from these projects found that (i) precipitation is very light but ubiquitous (Stewart et al. 1998), (ii) the radiative effects of persistent light precipitation can lead to cold air outbreaks in the midlatitudes (Girard and Blanchet. 2001a, b), and (iii) changes in precipitation are early indicators of climate warming (IPCC 2014).

Environment and Climate Change Canada (ECCC) has begun the process of defining weather monitoring requirements for the Arctic. A network monitoring design consisting of a limited number of surface and radiosonde stations, satellite observations, and reference stations, due to logistics and operating costs, is

hypothesized. This project, called Canadian Arctic Weather Science (CAWS), has main priorities consistent with the recommendations of the Fourth Arctic Observing Summit (AOS 2018), namely,

- identify and test future operational monitoring technologies for the Arctic including remote sensing;
- validate weather-related satellite products, in particular, precipitation and wind estimates from the Global Precipitation Mission and Aeolus, respectively;
- understand Arctic weather phenomena and their impact on observation and prediction requirements;
- develop, validate, and verify atmospheric prediction products for high-impact local weather applications;
- co-design communication strategies for predictions and warnings with the indigenous community;
- quantify societal benefits and impacts; and
- collaborate and support other national and international projects such as, the Polar Prediction Project (Jung et al. 2016; YOPP 2019) and the Sustaining Arctic Observing Networks (SAON 2019).

Operationally, fog is frequent, particularly in the summer and fall and is a significant operational hazard for transportation, in particular at sea (with sea ice present), and presents a major concern for navigation and SAR operations. Blizzards can disrupt air traffic for days at a time. Winds can be very strong and affect transportation, sea ice movement, navigation, and hunting and are therefore critical to life among the indigenous people (Gearheard et al. 2010). Winds also affect catchment snow gauge measurements (WMO 2019) and reduce visibility in blizzard situations. Due to the high cost of operations, technologies for replacing radiosondes are also a significant focus of the CAWS project. Solid precipitation measurements of light precipitation in high-wind conditions is also significant challenge. Satellite measurements are able to provide broad coverage of various meteorological parameters with different accuracies and spatial and temporal resolutions compared to ground-based measurements and therefore are part of the overall monitoring network design. Therefore, validation of satellite missions producing precipitation products, temperature, wind and humidity profile products are of prime interest. Missions of interest include current operational geostationary (GOES) and polar (NPOESS, MetOp) satellites and science or preoperational near-polar orbiting satellites such as CloudSat (98° inclination; Stephens et al. 2008, 2018), the Global Precipitation Mission (65° inclination; Hou et al. 2014; Skofronick-Jackson et al. 2017), Aeolus (ESA 2018), and EarthCARE (both with 97° inclinations; Illingworth et al. 2015a).

The CAWS project coincides with a new responsibility for ECCC to provide meteorological services (METAREAs) in the Arctic. Higher-resolution coupled atmosphere–ocean–sea ice models in this region are being developed and require validation and verification. This provides the opportunity to develop products relevant to local weather applications such as terminal operations at airports and products specific to indigenous life the Arctic. These include fog, blizzard warnings, and high-resolution wind nowcasts. Communication of scientific products is a recognized issue to all end users. In particular, risk communication, as well as demonstrating societal impact and benefits, will require engagement of the indigenous community (AOS 2018).

The objective of this contribution is to inform the community about the site, the instruments, and the nature of the data through examples and to provide a base reference for scientific contributions. Examples will highlight the emerging observation requirements, some prediction products, verification/validation methodologies, and the approach for community engagement. This contribution is organized as follows: (i) the CAWS Iqaluit site and instruments are described, (ii) the Pan-Arctic prediction systems and postprocessed forecast products are presented, (iii) examples to illustrate the nature of the weather, (iv) discussion, and (v) a summary.

“Geoengineering in the Canadian Arctic: Governance Challenges,” Jill Barclay, North American and Arctic Defence and Security Network, 8 January 2021 [92]
<https://www.naadsn.ca/wp-content/uploads/2021/01/Barclay-geoengineering-policy-primer.pdf>.

Abstract:

Purpose: To explore the impacts of the potential deployment of Solar Radiation Management (SRM), a form of geoengineering, in the Canadian Arctic.

Although geoengineering technologies are potential remedial measures to mitigate and slow climate change, there remains no governance framework that can be applied to address the impacts and costs of such projects. This policy primer examines the potential use and governance of Solar Radiation Management (SRM) to increase albedo (reflectivity) in Canada’s Arctic region and divert incoming solar radiation to slow the warming of Arctic Sea ice and permafrost.

This primer considers governance models that may be applied to SRM governance in Canada. It is designed to help inform policymakers and other stakeholders of important considerations when contemplating frameworks. Given the serious threats that climate change poses to human security, Canada needs to be prepared for the proposed use of geoengineering to address these increasingly pressing issues.

Current & Relevant Information:

Geoengineering in the Arctic Context

Recently, the Arctic has been identified as needing locally-focused efforts to slow, stop, or mitigate the extreme effects of global temperature rise in the region. Strategies that have previously been proposed by academics and environmental scientists include using wind-powered pumps to pump Arctic sea water onto winter ice with the intention of thickening the ice over the winter seasons, brightening sea water around Arctic ice with hydrosols, and other Arctic ice restoration efforts using ocean surface albedo modification. Techniques aside, it is clear that the Arctic has already been identified as a location for geoengineering deployment to combat the effects of Arctic amplification.

At present, most forms of Carbon Dioxide Reduction (CDR) remain exceedingly expensive with average costs to sequester and store atmospheric carbon coming in at US\$100 per ton of carbon removed. To contextualize this, humans produce 20 billion tons of CO₂ per year. Sequestering even a quarter of the amount produced each year would cost \$500 billion annually. Effective CDR mechanisms are still being developed and the funding and logistics for extracting 20 billion tons of CO₂ per year are beyond the current realm of capabilities for most countries or institutions. Even the more cost-efficient CDR methods like afforestation and land management are nonviable options for the Arctic's extreme and harsh climate.

However, there currently exist a number of Solar Reduction Management (SRM) methods that are being deployed at a fraction of the cost of CDR. For example, the annual cost of delivering enough sulfuric particles into the stratosphere via stratospheric aerosol injection to combat greenhouse gas warming is estimated at US\$2-8 billion, depending on the method of deployment. While still costly, it is clearly a much cheaper option. To put these costs in perspective, the damage caused by our current rate of emissions is roughly US\$200 to \$2,000 billion per year. Cheaper still is the SRM technique of Surface Albedo Modification (SAM) that is estimated to cost US\$1 to \$5 billion yearly if deployed in areas of 100,000 square kilometers.

Conclusion

Arctic Sea ice is decreasing at a drastic and increasingly rapid pace and the current climate mitigation strategies are falling short. The use of SAM as a means to protect Arctic Sea ice and slow climate change, coupled with mitigation efforts, could protect the Arctic's crucial role in balancing the world's climate systems. Despite the contention that exists in the debate surrounding geoengineering, with each passing year the likelihood of climate-altering technologies being deployed to combat climate change increases.

The impacts of climate change are indisputable and the threat of climate change to Arctic Sea ice is even more immediate, with estimates of an ice-free Arctic as soon as the 2030s being a very alarming reality. Geoengineering technologies have increasingly been identified as potential remedial measures to mitigate and slow

climate change. It is important that a governance framework, like responsible innovation frameworks, be implemented in anticipation of geoengineering deployment in order to manage innovative technologies in a way that can be adaptive to information as it is learned. Since geoengineering has not yet been deployed on a global scale, there is a lack of existing policy avenues that would allow for the quick, uniform, and safe deployment of SAM. There is clearly a need for policy cohesion among different governing bodies. Geoengineering does not just have environmental impacts; it also has social impacts, economic impacts, and ethical and moral issues. None of the existing governance frameworks can address all of these concerns. Therefore, a new framework specifically designed to address all the intersecting issues affected by SAM and geoengineering as a whole is overdue.

Climate change is transforming the world and drastically transforming the Arctic in particular. Simultaneously, climate change is altering our interpretation and application of existing policies and laws. Even when coupled with international environmental treaties, national environmental impact assessments and responsible research codes are not enough to address all the complexities of governing geoengineering. What is available is not enough. It is clear that the creation and implementation of a governance framework intended to adaptively manage the use of climate-altering technologies in Canada and abroad is necessary. One hopeful aspect is that Canada has the opportunity to take steps towards creating an inclusive and responsible governance framework for SAM and SRM as a whole. While there may be risks to utilizing and deploying SAM, the risk of doing nothing may prove to be far worse as climate change continues to cause increasingly detrimental impacts around the world.

2. Denmark (Greenland):

“Mining magnets: Arctic island finds green power can be a curse,” Jacob Gronholt-Pedersen and Eric Onstad, Reuters, 2 March 2021 [\[93\]](https://www.reuters.com/article/us-rareearths-greenland-usa-china-insigh/mining-magnets-arctic-island-finds-green-power-can-be-a-curse-idUSKBN2AU0FM)
<https://www.reuters.com/article/us-rareearths-greenland-usa-china-insigh/mining-magnets-arctic-island-finds-green-power-can-be-a-curse-idUSKBN2AU0FM>

Overview:

In the tenth century, Erik the Red, a Viking from Iceland, was so impressed with the vegetation on another Arctic Island he had found he called it “the green land.” Today, it’s Greenland’s rocks that are attracting outsiders - superpowers riding a green revolution.

Current & Relevant Information:

The world’s biggest island has huge resources of metals known as ‘rare earths,’ used to create compact, super-strong magnets which help power equipment such as wind turbines, electric vehicles, combat aircraft and weapons systems.

The metals are abundant globally, but processing them is difficult and dirty - so much so that the United States, which used to dominate production, surrendered that position to China about 20 years ago.

As Greenland's ice sheet and glaciers recede, two Australia-based mining companies - one seeking funding in the United States, the other part-owned by a Chinese state-backed firm - are racing for approval to dig into what the U.S. Geological Survey (USGS) calls the world's biggest undeveloped deposits of rare earth metals.

The contest underscores the polluting side of clean energy, as well as how hard it is for the West to break free of China in production of a vital resource. Rare earth metals have many uses, and last year China produced about 90% of them, according to Toronto-based consultancy Adamas Intelligence. As U.S.-China tensions mount, President Joe Biden's administration said last month it will review key U.S. supplies, including rare earths, to ensure other countries cannot weaponize them against the United States.

Each Greenland mine would cost about \$500 million to develop, the companies say. Both plan to send mined material away for final processing, an activity that is heavily concentrated in China. The only rare earth mine now operating in the United States - Mountain Pass in California - is partly owned by a Chinese state-backed company that currently sends material mined in the U.S. to China for processing.

The Greenland sites are less than 16 km (10 miles) from each other at the southern tip of the island, near a UNESCO World Heritage Site. Debate on them has triggered a political crisis in the capital of Nuuk, forcing a general election on the island of 56,000, due in April. Many Greenlanders, while concerned about pollution, feel mining is key to develop their fragile economy. In a 2013 poll, just over half said they want raw materials to become the country's main source of income.

The country may ultimately back either project, both, or neither, but for those Greenlanders open to mining, the two proposals boil down to a choice between one mine that would not produce radioactive material, and another that would.

The first mine, a private initiative from an Australian geologist who has presented it to U.S. officials, would not involve nuclear material. It has won preliminary environmental approval, but it needs cash and a processing plan.

The second one has already spent more than \$100 million preparing to mine, has proven processing technology through its Chinese partner, and won initial political support from Greenland's coalition government. But its plans include exporting uranium, a nuclear fuel, and it recently ran into strong opposition, including from residents of the nearby town of Narsaq.

“As indigenous people we have lived in harmony with nature for many, many years,” said Mariane Paviasen, an opposition lawmaker who lives in the town. “We use these lands to hunt and fish.”

Greenland, a self-governing territory of the Kingdom of Denmark, has a gross domestic product of around \$3 billion - similar to Andorra and Burundi. With its people living mostly on fishing and grants from Copenhagen, its government is keen to attract foreign investments.

It does not have an estimate for royalties from the first project, but expects around 1.5 billion Danish crowns (\$245 million) each year from the Chinese-linked one - equivalent to roughly 15% of public spending.

Greenland’s government did not respond to requests for comment for this story. Acting Minister of Resources Vittus Qujaukitsoq said last month that if Greenlanders suddenly decide they don’t want the second project, “we’ll make a fool of investors. The credibility of the whole country is at stake.”

“The Rush for Greenlandic Metals,” Hanna Vikstrom, Technology Stories, 2 May 2017 [94] <https://www.technologystories.org/the-rush-for-greenlandic-metals/>

Overview:

Never before has the demand for metals been as high as it is now. Products and technologies we use every day, including smart phones, electric cars, wind turbines, cutlery and light bulbs are all constituted by metals, and demand is soaring. In spite of the ever-growing production, industrial and political actors are fearing resource scarcity.

Current & Relevant Information:

Historically, actors who perceive a shortage of a particular resource – be it mineral or agricultural – have often turned to the exploitation of regions perceived as “empty” and “unpopulated”. One of these places is the Arctic. The Arctic has been perceived as a future bonanza, one of the last frontiers left on the earth to explore. Oil and gas companies have since the 1970s oil crisis turned to the Arctic’s Sea floor in hopes of finding vast deposits. These recent booms are not the first time the Arctic has been the target for dreamers seeking treasure. The image of tough, manly individuals wresting treasure from a hostile environment spread to the Yukon and Alaska during the Klondike and Nome gold rushes of the late nineteenth century. But more organized efforts to find Arctic minerals also took place. In 1903 an expedition set out to find rare metals in the Canadian Arctic, in hopes of discovering deposits containing osmium, used as a filament in metal filament bulbs.

Around 2010, Greenland began to figure prominently in media reports about the most recent Arctic boom. Many of these reports credit melting ice as the reason behind the most recent plans for mining in the area. Because of global climate

change, the Island's minerals are, in their view, popping up, just waiting to be extracted. But is that really the reason that Greenlandic minerals have become so attractive? Geopolitical and commercial maneuvering to diversify and secure supplies and Greenland's own politics of autonomy and self-rule have more to do with the growing interest in mining than the notable recent changes in Greenland's ice cover.

Mining has long been important to Greenland, even before the rush of 2010. It has long been known that Greenland has a unique geology, and rests on deposits of rare metals and minerals, many of which are found and extracted in only a few sites around the world. The largest and economically most important mine was located in the town of Ivittuut, in the southern part of Greenland, where from 1854-1962 the Danish company Kriolitmine Selskabet (later Kryolitselskabet Øresund) extracted cryolite, a mineral crucial in the processing of aluminum, with exports continuing up until 1987. Cryolite was almost exclusively extracted in Greenland; other countries depended completely on Greenlandic supplies. During the Second World War, a time when access to aluminum for the manufacturing of airplanes was vital, Americans took over the defense of Greenland, in large part it seems, because of the cryolite mine. Other operations focused on copper, zinc and lead, coal, uranium, and marble. After 150 years however, many important mineral resources could no longer be profitably mined; in 1990, the Swedish Company Boliden closed down the only remaining mining operation, the lead-zinc mine Black Angel, situated in Maamorilik, due to depletion. Suddenly, Greenland was a country without mining.

Greenland's government responded to this by pushing harder to promote new mining activities, hoping to strengthen the island's economy and decrease their economic dependence on the annual Danish block grant which represented the primary basis of their national budget. Mining, they hoped, would pave the way for Greenlandic independence. To make this happen, they had to clarify who owned Greenland's minerals: Greenland itself, or Denmark? After a fierce debate, the Danish-Greenlandic Self-Rule Commission, determined that Greenlandic minerals belonged to Nuuk, not Copenhagen. In 2010, Greenland took control of sub-surface resources through the Mineral Resources Act, allowing them to negotiate directly with interested companies. There was no lack of interest as numerous companies had already undertaken prospecting activities.

It has long been known that Greenland has a unique geology, and rests on deposits of rare metals and minerals, many of which are found and extracted in only a few sites around the world. The EU, US, and numerous mining companies have first and foremost, perceived Greenland as a future Eldorado of rare earth elements (REEs). A group of seventeen metals found together with the radioactive elements uranium and thorium. REEs are crucial in electronics, in hybrid cars, in magnets for certain wind turbines, but also for the manufacturing of computers and smart phones. REEs allow electronic devices to be small: a magnet made of neodymium, for example,

can be made much smaller than magnets of other materials. Computer screens, televisions and smart phones also contain REEs. Growing demand for electronics, and the push for frequent product upgrades means that demand for REEs is soaring.

Apart from increasing demand though, fear of supply disruptions has driven many countries to diversify their sources. China has for the past twenty years dominated the global REE market, providing almost the entire world with these elements. Although the US was up until 2002 a large producer, the mining company, Molycorp was forced to close their only mine, Mountain Pass, due both to declining prices, and repeated environmental accidents. In 2001 for example millions of cubic meters of radioactive wastewater leaked out into the surrounding valleys. Now, there was no option but Chinese rare earths.

“Greenland Is Not For Sale. But It Has Rare Earth Minerals America Wants,” Jackie Northam, npr.org, 24 November 2019 [95]

<https://www.npr.org/2019/11/24/781598549/greenland-is-not-for-sale-but-it-has-the-rare-earth-minerals-america-wants>

Overview:

The southern Greenland town of Narsaq is just a speck of place. About 1,200 people live in colorful A-frame houses along a fjord, and it's a good hour's boat ride from the nearest community. While it may be remote, Narsaq has strategic importance.

Current & Relevant Information:

The craggy hills surrounding the town are estimated to hold about a quarter of the world's rare earth minerals. With names such as cerium and lanthanum, rare earths contain key ingredients used in many of today's technologies — from smartphones to MRI machines, as well as electric cars and military jets.

A bumpy ride up the hills delivers you to the Kvanefjeld project, one of two major rare earth mineral deposits in Greenland. The rocky plateau at the base offers majestic views of this corner of the vast Arctic Island. It is empty and silent out here; the mine is not yet up and running.

Across the plateau there are large piles of dull, gray rocks. When you shine an ultraviolet light on them, they explode with vivid pink and orange hues, revealing the rare earths inside the rocks.

When President Trump made the surprise suggestion in August that the U.S. should buy Greenland, which is a semi-autonomous territory of Denmark, it drew an immediate rejection from the leaders of both areas. The news caused widespread confusion and speculation about Trump's motivations. But mining experts have a hunch about one possible reason: Greenland holds rare earth minerals America wants — but which it largely relies on China to get.

Jorgen Waever Johansen, a former mining minister of Greenland, says the U.S. needs to find a way to be less reliant on China. "When you are so dependent on natural resources coming from one place then you are making yourself more vulnerable than you ought to be," he says.

The U.S. was once the world's top producer of rare earths. Now China is. China also has most of the world's capacity to process the elements. The Trump administration has labeled rare earth elements essential to national defense, and Washington is working to bolster the national industry.

In June, the U.S. signed a memorandum of understanding with Greenland to help develop its energy and mining sectors, including rare earth minerals.

Access to Greenland's resources could help break U.S. dependency on China for rare earths. But already a Chinese state-owned company has more than a 12% stake in the Kvanefjeld deposit.

Kvanefjeld is owned by Greenland Minerals, an Australian company, and China's Shenghe Resources is its largest shareholder and strategic partner.

The other major deposit in Greenland is owned by another Australian company, Tanbreez. Both firms are waiting for Greenland's government to give them the go-ahead to start mining.

Much of Greenland is buried under a sheet of ice, more than a mile thick in some places. But warming temperatures in the Arctic are making some of Greenland's riches, including gems, iron and zinc, more accessible, creating a geopolitical competition for new transportation routes and natural resources.

"The rare earth riches buried beneath Greenland's vast ice sheet," Fiona Harvey, The Guardian, 31 July 2012 [96]

<https://www.theguardian.com/environment/2012/jul/31/rare-earth-greenland>

Overview:

Small group of 17 elements is in extraordinary demand, but potential wealth must be balanced against environmental responsibilities.

Inside every wind turbine, inside computers, phones and other high-tech equipment from medical scanners to electric cars, are materials known as "rare earths". This small group of 17 elements are in extraordinary demand – but their supply is limited, and most of the existing sources have already been snapped up by China in its quest for ever more rapid economic growth.

Last month China – which controls more than 90% of the reserves of these essential elements – warned that its supplies were diminishing, despite quotas to limit exports. Beijing's top officials said in a memo: "After more than 50 years of excessive mining,

China's rare earth reserves have kept declining and the years of guaranteed rare earth supply have been reducing."

This could spell disaster for the future of green technologies such as renewable energy and low-carbon vehicles.

Current & Relevant Information:

Europe's rare earths diplomacy

That is why Europe has been engaging in a strenuous bout of diplomacy with the home rule government of Greenland to allow access to the island's natural resources. According to geological estimates, below Greenland's vast ice sheet could lie enough rare earths to satisfy at least a quarter of global demand in the future.

The vice-president of the European commission, Antonio Tajani, has led the push, forging an agreement with Greenland to look at joint development of some of the deposits. The agreement will extend beyond rare earths to metals such as gold and iron, and potentially to oil and gas, which are abundant in the waters around the island.

"We need innovative partnerships with other countries over raw materials. Companies are pushing the commission for this - they need this to survive. Europe is not so wealthy in raw materials and needs to do better [at forming partnerships with other countries]." Tajani said rising commodity prices had created "an intrinsic incentive [to governments] to be more responsive, because companies have to pay more for their raw materials".

Greenland, in return, is keen to press ahead with exploring for its mineral resources, which in many cases lie trapped under 150 meters of ice. Henrik Stendal, head of the geology department at Greenland's Bureau of Minerals and Petroleum, a Dane who has worked in Greenland since 1970, told the Guardian: "We have shown that we have huge potential – it has been an eye-opener for the mining industry. The EU has shown a lot of interest and that's been very good – we believe this could be very valuable for Greenland. There could be benefits for everyone – at present most of our income is from fishing and a little bit of tourism, so the government really wants another income."

“Greenland drills up gigantic resources,” Institute for rare earths and metals AG
[\[97\] https://en.institut-seltene-erden.de/gronland-bohrt-gigantischen-rohstoffschatz-an/](https://en.institut-seltene-erden.de/gronland-bohrt-gigantischen-rohstoffschatz-an/)

Overview:

The dream of prosperity has the Social Democrat Hammond registered the election victory: It wants to ensure that Greenland's resources benefit their own citizens. In fact, the people are sitting on a huge treasure.

Fish and prawns are still Greenland's most important exports. But this is about to change on the island striving for independence from Denmark between the Atlantic and the Arctic Ocean soon: mineral resources that are stored in Greenland's ice-free coastal strip, to be developed, increase the prosperity of the population and contribute to the financing of sovereignty.

Current & Relevant Information:

Social Democrat Aleqa Hammond has confidently won the parliamentary elections on the vast polar island with only 57 000 residents, with the promise of making this wealth available to residents. The future head of government wants to demand more from foreign investors, but also loosening the hitherto prevailing ban on mining uranium and rare earths. Hammond struck with their party Siumut the left-wing socialist leader Kuupik Kleist in the parliamentary election clear, was communicated on Wednesday in the capital Nuuk.

Hammond had accused the previous head of government in the election campaign, a premature sale of domestic resources to Chinese interested parties. Among other things, he had succeeded in overriding the Greenlandic minimum wage for several thousand Chinese miners in a planned ore mine north of Nuuk.

Hammond announced on election night that she would resubmit this regulation in the new parliament. She also wants to enforce higher taxation of foreign investors. Hammond also advocates a relaxation of the hitherto complete ban on uranium and "rare earth" mining, which are important for high-tech products.

The Greenlanders are connected with the ex-colonial power Denmark since 2009 only in a "Reichsgemeinschaft". You independently decide on all matters except foreign and security policy. But Greenland still has to cover half of it with subsidies from Copenhagen. There is an obvious way out: their own mineral resources, which have become much more accessible in the course of climate change.

Zinc from the lemon fjord

"Greenland needs to develop the resource sector," said Jorn Skov Nielsen, Vice Minister of Economy, Labor and Natural Resources, as he presented the island's resource wealth to an international audience at the PDAC Mining Fair in Toronto.

If Greenland, whose budget is now almost half financed by subsidies from Copenhagen, is leaving the country for Denmark, sources of revenue must be tapped. So far, the economy is based on a few pillars. Of the total export income of 2,5 billion Danish kroner (about 330 million euro), about 80 percent is accounted for by the sale of fish and shrimp. Tourism is another important revenue factor, while mining accounts for only one percent so far. "We have to mine minerals, oil and gas," explains Nielsen.

Greenland relies on people like Jonathan Downes. He is the director of the Australian company Ironbark, which plans to commission a zinc-lead mine in Greenland's northern Greenland at 2015. The fjord at the edge of the Greenland ice sheet has nothing in common with citrus fruit. The name was given in memory of a Danish resistance fighter against the German occupation in the Second World War, Jorgen Haagen Schmith, who led the code name "Citron".

Downes believes that the zinc price will rise if 2015 / 2016 comes to short supply shortages. "Then we're here." The zinc price crashed in the 2009 crisis to just over 1000 dollars per ton and is now at 2000 dollars. Zinc fjord is expected to produce zinc throughout the year and will be exported during the three months the river is navigable.

According to the government, Citron Fjord could be among the ten largest zinc mines in the world. The map of Greenland, on which raw material warehouses are displayed in different colors, shows a ribbon along much of the 44.000 kilometer long coast. Only the southwestern part of the coast with the capital Nuuk and most places is largely free of ice throughout the year.

Canadians and Australians lining up

The Federal Institute for Geosciences and Natural Resources and the German commodities agency DERA have in a study the "mineral raw material potential Greenland", put together - of metals such as gold, platinum, silver, copper, rare earths, molybdenum, tungsten and chromium on industrial minerals such as cryolite, graphite and Olivine up to precious, jewelry and natural stones. Greenland offers opportunities for the raw materials hungry industries of Europe and North America and for the Greenlandic population, as the increased use of domestic raw materials should finance autonomy, says the DERA. At the same time, however, the interest of Greenlanders and the rest of the world in protecting the "highly sensitive and unique ecosystem of the Greenlandic Arctic" must be considered.

The associated "extremely high approval requirements, the difficult climatic conditions and the largely non-existent infrastructure would have to be taken into account in investment decisions.

Around 40 companies are engaged in resource exploration and mine development, more than half of which come from Canada and Australia. 150 licenses for resource exploration, exploration and mining are in force, more than ever before. With nearly 95 million euros, 2011 exploration spending peaked.

Gold, titanium, rare earths

Greenland's politicians and the Geological Survey of Denmark and Greenland are now seeing the island on the threshold of exploration towards promising mining projects. Currently, there is only one producing mine, the Nalunaq Gold Mine, which

was mined by 2004 and 2008 Gold, then decommissioned for a year and has returned to precious metal since 2010.

Mines such as the Seqi olivine mine at Nuuk, the Maarmoril Black Angel zinc-lead mine and the molybdenum mine at Malmbjerg on the east coast have been temporarily decommissioned, which can re-produce at favorable market conditions. This is already planned for Black Angel. In addition to the Citron Fjord mine, plans for the mining of rare earth near Kringlirne at the southern tip of Greenland, for the development of the iron ore deposit at Nuuk and for ruby, iron, titanium and vanadium deposits in the Southwest.

Greenland expects opportunities to become one of the largest non-Chinese suppliers of rare earths important for the high-tech industry, with kringlirne and other depots. In coastal waters - such as between Greenland and Canada - oil and gas deposits are suspected.

Greenland has a very large raw material potential, even on a world scale, and is likely to become an important supplier of raw materials in the long term, according to DERA.

But the way there is far. The mining industry in Greenland has been experiencing an upsurge since 100 years. Mines were opened and closed, either because the deposits were exhausted or the world market prices made the promotion unprofitable.

But for the island, whose gross domestic product 2009 was just 1,9 billion dollars, even a few mines that could open in the coming years will mean a significant boost in gross domestic product and many jobs.

“Greenland’s Unique Kvanefjeld Multi-Element Rare Earth Project,” Damien Krebs, Johnson Matthey Technology Review, 2017 [98]
<https://technology.matthey.com/content/journals/10.1595/205651317X695181>

Overview:

At a time of consolidation and increased regulation of the rare earth sector in China, Greenland may become an important new source of rare earth elements, particularly the elements critical to the growing magnet sector.

Greenland is located in the North Atlantic Ocean between North America and Europe and is the world’s largest island, 2.2 million km², of which approximately 80% is permanently covered with ice. The Kvanefjeld project, one of the largest rare earths deposits in the world, can be found in the south of Greenland near the town of Narsaq.

The project comprises three linked deposits (Kvanefjeld itself, Zone 3 and Sørensen). These three deposits contain 1 billion tons of mineralized ore. The

predominant mineral is steenstrupine, which hosts both rare earths and uranium in significant quantities.

The Kvanefjeld project is owned by Greenland Minerals and Energy (GME) who acquired the Kvanefjeld project in 2007 and has spent approximately US\$60 million developing the project to its current advanced stage.

Current & Relevant Information:

Greenland Minerals and Energy and the Kvanefjeld Project

In total the three deposits contain approximately 270,000 tons of uranium and 11 million tons of rare earth oxide. The Kvanefjeld deposit is the largest and most rigorously defined of the three deposits and as a result it is this deposit that is the focal point of studies to evaluate the feasibility of mining and processing for the project.

GME has undertaken extensive metallurgical test work on material from the project area, including bench scale and pilot plant tests, and has developed a flow sheet for economically processing Kvanefjeld ore. The flow sheet, which utilizes well developed technologies, comprises a beneficiation circuit, an atmospheric leach circuit and solvent extraction circuit.

At the project site GME plans to construct a mine, a concentrator, a uranium and rare earth refinery and rare earth separation plant. These will be supported by sulfuric and hydrochloric acid plants and supporting infrastructure (power plant, port, accommodation, roads) some of which will be located near the town of Narsaq.

“Dorte Mandrup completes visitor centre in Greenland,” Amy Frearson, dezeen, 10 September 2021 [99] <https://www.dezeen.com/2021/09/10/ilulissat-icefjord-centre-dorte-mandrup-climate-research-centre-greenland/>

Overview:

Dorte Mandrup Arkitekter has revealed the first photographs of the Ilulissat Icefjord Centre, a climate visitor center on Greenland's rugged coastal landscape.

Located 250 kilometers north of the Arctic Circle, the center will function as a hub of research, education and exhibitions exploring the impact of climate change in this region.

Current & Relevant Information:

The architecture studio, led by Danish architect Dorte Mandrup, designed the building with a twisted, triangular structure and a rooftop viewing platform. The aim was to make it appear open and lightweight, so visitors feel connected to the landscape.

"The Icefjord Centre offers a refuge in the dramatic landscape and aims to become a natural gathering point from which you can experience the infinite, non-human scale of the Arctic wilderness, the transition between darkness and light, the midnight sun, and the northern lights dancing across the sky," said Mandrup.

In line with the building's function, the structure was designed to have a minimal impact on the environment.

To reduce the need for concrete, a material understood to have a significant carbon footprint, Mandrup's team specified a steel frame.

Lightweight steel beams effectively pin the building to the bedrock terrain, allowing it to be slightly raised. This means the space underneath the building can continue to be a habitat for plants and wildlife.

The main form of the building is generated by a series of steel trusses that gradually curve and rotate as they extend across the landscape. This creates the unusual twisted shape, which helps to prevent snow build-up on the roof.

Mandrup likens the form to "a snowy owl's flight through the landscape".

The twist also has the benefit of providing pedestrian access onto the sloping roof. This elevated viewpoint naturally forms a new end point for local hiking routes, offering a view out to the icebergs of the Kangia Icefjord.

Interior spaces are fully glazed on all sides, plus there are also some open-air terraces sheltered beneath the roof. The aim was to allow visitors to experience Greenland's dramatic lighting conditions throughout.

"In Greenland, you only have daylight during the summertime. In the winter it's very dark, but you have reflection from the snow and the ground," said Mandrup, speaking about the project while it was still under construction.

"In the summer, the color of the light is very different; you have blue light on one side and a very reddish light on the other side," she explained. "Hopefully you will experience that when you move through the building."

Ilulissat Icefjord Centre is now open to the public, with facilities including an exhibition gallery, a movie theatre, research and educational facilities, a cafe and a shop.

The exhibition, designed by JAC Studios, features archeological objects and films contained in glass prisms that were designed to replicate real-life ice blocks. It also includes ice core drillings, dating from 124,000 BC to the present.

Dorte Mandrup Arkitekter first unveiled its design for the Ilulissat Icefjord Centre back in 2016 and also presented the design at the Venice Architecture Biennale in 2018.

The project was funded by local and national government, with support from Danish philanthropical foundation Realdania.

The studio previously completed the thatched Wadden Sea Centre and the angular Ama'r Children's Culture House, both in Denmark, and has also designed a whale watching center for the northern coast of Norway. However, this is its first project in Greenland.

“Comparative life cycle assessment of four buildings in Greenland,” Morten Walbech Ryberg, et al., Building and Environment, 2021 [100]

<https://www.sciencedirect.com/science/article/pii/S036013232100531X>

Abstract:

Assessment of environmental impacts across the life-cycle of buildings are lacking for Arctic areas, such as Greenland. Indeed, life-cycle assessments of buildings mainly focus on European or North American conditions which are very different from Arctic conditions. Hence, there is a need for assessing the life-cycle impacts pertaining to different building types to support environmentally sound decisions on the type of buildings to be constructed and used in Arctic areas such as Greenland. We conducted a life-cycle assessment on four buildings in Greenland, i.e., concrete building, CLT building, a timber frame building and a renovation of an existing concrete building. We evaluated the environmental impacts at midpoint indicator and overall damages to human health, ecosystem quality, and resources, to identify the building type with the lowest environmental impacts. Results show that renovation of existing buildings has the lowest environmental impact across all impact categories. The difference in environmental impacts among the new building types is generally small. Across all impact categories, the average difference between largest and smallest impact score for the new buildings was a factor 3.6. Still, the CLT and timber frame building appears to have the best environmental performance. The findings of this study go against current building practice in Greenland, which is dominated by construction of new concrete buildings while renovation is uncommon. Thus, a larger use of assessment methods, such as life-cycle assessment, and a reconsideration of the current building practice is recommended to support a more environmentally sustainable building practice in Greenland.

Current & Relevant Information:

Introduction

It is becoming clear that the increasing pressure on the environment, as a result of human activities, are starting to cause unacceptable impacts on the environment. For instance, the increase in climate change and loss of biological variability. Creating the societal changes needed for making humanity environmentally sustainable is a global challenge and require contribution from all regions, including the Arctic, which is among the regions most impacted by global warming. In this

regard, construction and use of buildings are traditionally a large contributor to environmental impacts because of the energy used during building operation and because of the materials and energy that is needed for construction of the building and the disposal of these after the building is demolished. Indeed, buildings account for about 39% of global energy related CO₂ emissions.

Today's choice of building materials in Greenland is largely influenced by the Danish traditions and lack of timber, meaning that most multi story buildings are constructed using concrete as the primary material. This is a concern because previous assessments have shown that concrete has a considerable environmental footprint, mainly due to the production of cement. Moreover, due to the colder climate in Greenland, the need for insulation and/or energy for heating is large. This means that the environmental impacts associated with buildings in Greenland are expected to be larger than e.g., European buildings. Furthermore, Greenland have very few natural resources that can be used for building materials and very little production of building materials. Consequently, most building materials must be transported to Greenland with water, sand and gravel for concrete production as exceptions. Hence, there is a need for investigating the environmental impact related to buildings in Greenland and where these occur in the buildings' life-cycle. Previous LCAs have compared different building types and identified the materials, processes, and life-cycle stages that contribute most to environmental impact. Here it was generally found that the energy consumption associated with the operation and maintenance stage of a building's lifetime is the main contributing factor to the environmental impact of a building. Andersen et al. found that the use stage contributes to 60–70% of a residential building's GHG emissions and Sharma et al. found that the use stage is responsible for 80–85% of a building's energy consumption. Maslesa et al. found that older buildings have higher environmental impacts during the use stage, while newer buildings have higher embodied impacts in the materials stage. However, all of these studies were generally representative of European or North American conditions. Indeed, most LCA studies on buildings are focused on countries in temperate and sub-tropic regions while building LCAs in Arctic regions are generally not well represented in the literature. An LCA was conducted on a school building in Iceland, but the study only evaluated embodied impacts and did not cover the use stage and end-of-life stage.

Indeed, Greenland and the Arctic in general, represents a context that is very different from the conditions in Europe and North America. The weather conditions are more extreme and buildings are worn down faster and the cold climate means that either insulation or heating is needed to maintain an adequate indoor temperature. This means that the existing knowledge about environmental impacts of different buildings and the most contributing materials, processes, and life-cycle stages might be completely different for Arctic and Greenlandic conditions. Thus, there is a need for conducting LCA on buildings situated in Arctic areas in order to support environmentally sound decisions on the type of buildings to be constructed

and used in Arctic areas such as Greenland. In addition, the Arctic is very heterogeneous in the availability of natural resources. For instance, part of the Arctic has an abundance of forest that can be used for wood-based constructions (e.g., Canada). Greenland does not have forests and generally has fewer materials and technologies available on-site, thus necessitating additional transport of materials. LCA of Greenlandic conditions may therefore not apply for other Arctic regions.

To close this knowledge gap, the purpose of this study was to conduct a comparative LCA to evaluate the environmental performance of four building types in Greenland to identify the environmentally best performing building type. Moreover, an objective was to identify the materials, processes, and life-cycle stages that contribute most to environmental impact across each building type's life-cycle. There is an ongoing discussion on what is most sustainable in Greenland: 1) wood-based constructions, as wood in a European context often is seen as the most sustainable building material due to renewability, or 2) concrete constructions as only the cement has to be imported, while all other building materials must be transported to Greenland. Thus, this study is very important for supporting informed decisions on the construction of buildings in Greenland and the Arctic in terms of which building types to prioritize and where to focus to further reduce the environmental impacts of the different building types.

Conclusion

This study conducted an LCA on four buildings in Greenland, a concrete building, a CLT building, a light timber frame building, and a renovation of an existing concrete building to compare the environmental performance of the four buildings. We evaluated the environmental impacts at midpoint indicator level and in terms of damages to human health, ecosystem quality, and resources, to identify the building type with the lowest environmental impacts. We found that renovation was the environmentally speaking best solution as it had the lowest environmental impact across all impact categories. Thereby, the findings of this study go against current building practice in Greenland, which is dominated by construction of new concrete buildings while renovation is uncommon. Thus, we recommend reconsidering this practice to lower environmental impacts by increased renovation. For new buildings, we were not able to unanimously identify the best performing building. Overall, the CLT building and the timber frame building performed best in 10 and 7 out of 18 midpoint impact categories, respectively. This was also reflected in the damage level assessments, where the timber frame and CLT building, in general, performed better than the concrete building. Overall, our result show that current Greenlandic building practice, which is predominantly based on construction of new multi-story concrete buildings, could be revised to include more renovation and also test the use of new buildings based on timber to improve the environmental performance of the building sector in Greenland. In general, it is recommended to apply holistic assessments

such as LCA, as part of the decision process, to support more environmentally sound decisions regarding the construction of buildings in Greenland.

3. Finland:

“Finland, A Cool Arctic Country,” Finland Toolbox, 23 July 2020 [101]

<https://toolbox.finland.fi/business-innovation/finland-a-cool-arctic-country-with-snow-how/>

Overview:

The arctic climate gave Finland guts – or ‘sisu’ as we call it. Neither frost nor snow can stop the Finns. Roads, airports and vital sea routes are kept open all winter, and machines and equipment keep working. Finland is a country with undisputable arctic expertise. Of course, the nation’s long traditions in this area are based on close familiarity with arctic conditions and the efficient, problem-solving application of such knowledge.

Current & Relevant Information:

Finland is one of the world’s leading experts in arctic shipbuilding, shipping, winter navigation and maritime and offshore technology. Finland manufactures advanced state-of-the-art arctic ice-breakers and specialized offshore vessels. A number of engineering firms in Finland design and develop solutions for maritime logistics, offshore applications and a range of arctic vessels. Special expertise is also available on winter navigation and logistics, ice-breaking, monitoring and controlling sea transport, as well as weather and ice information services.

Finnish shipyards have built more polar class icebreakers than those of any other country. The latest vessel in the Finnish icebreaker fleet, Polaris, is unique in many ways. It is the first icebreaker in the world capable of running on both liquefied natural gas (LNG) and ultra-low-sulphur diesel. Its total output of about 22 MW also makes it Finland’s most powerful icebreaker. Polaris is the most environmentally friendly diesel-electric icebreaker in the world.

Another important and growing area is Arctic testing. Over the past few decades, Lapland has become an increasingly important development and testing ground for the international vehicle industry; this has boosted European low-temperature technology around the world.

“Digitalisation in a local food system: Emphasis on Finnish Lapland,” Dele Raheem, Open Agriculture, January 2020 [102]

<https://www.degruyter.com/document/doi/10.1515/opag-2020-0049/html>

Abstract:

The positive adoption of digital technology within the food sector can boost sustainable development in Finnish Lapland. There is a need for a food system in

the region to respond to current trends from consumers and ensure a better supply of local foods that are processed efficiently with minimal waste. In this article, a review of the literature on the benefits of digitalization as a tool amongst food processors was carried out. The opportunities offered by digital technology are expected to make local food business operators more transparent, efficient and sustainable. Digitalization can help to minimize the environmental impacts of food processing and ultimately improve sustainability. In meeting the demand of local consumers, distributed and localized manufacturing will help to add value to local food crops, lower transportation and storage costs. The adoption of food digitalization will open up market accessibility for the locally produced food products in local communities. In the future, digitalization is likely to have major impacts in the local food system of the Lapland region.

Current & Relevant Information:

Introduction

Northern people in the circumpolar Arctic region have relied for millennia upon the landscape for their food through hunting, reindeer herding, gathering, fishing and small-scale gardening (Gjertsen and Halseth 2015). Agriculture, rural livelihoods, sustainable management of natural resources and food security are inextricably linked to climate change and other development challenges of the 21st century.

The Finnish Lapland as a European Arctic region presents a unique social, economic and environmental setting in Europe. With a sparse population spread across a vast land area, the natural conditions of Lapland with wealth of natural resources, and a distinct challenge, in long geographical distances between sparsely-populated communities offer both opportunities and challenges (Teräs et al. 2018). In the high-latitude North, rural livelihoods are tightly connected to climate, weather and ecosystems. It includes food and agriculture that contribute significantly to and are heavily impacted by the climate change, while also offering a range of opportunities for mitigating greenhouse gases through their role in emission reductions and carbon sequestration (Vermeulen et al. 2012). The climate change has a decisive and stronger consequence on the natural conditions in the Arctic region than elsewhere, which presents the region of almost four million people with an additional challenge and a need to adapt (ACIA 2004). It is estimated that 25% of the total global greenhouse gas emissions are directly caused by crop and animal production and forestry, especially deforestation, including 2% of emissions accounted in other sectors, from the production of fertilizers, herbicides, pesticides, and from the energy consumption for tillage, irrigation, fertilization and harvest (IPCC 2014).

The conversion of natural ecosystems to agriculture causes losses of soil organic carbon up to 80 tons per hectare, most of which are emitted into the atmosphere (Lal 2004). Agriculture also suffers from the consequences of climate change such as

rising temperatures, pests and diseases, water shortages, extreme weather events, loss of biological variability and other impacts. It is important that sensors to monitor the related activities within a local system will improve efficiency and help to create a more sustainable food system.

Food system digitalization refers to the application of innovative technology to enhance harvesting, processing, distribution and storage operations along the agri-food value chain (Raheem et al. 2019). As the European Arctic is particularly vulnerable to climate change, there is a need to promote business innovation that will respond to climate change and associated weather risks that build resilience to them.

It was suggested that the food systems have cumulative impacts on climate change and vice versa with consequences on the viability of individual and community health (Gerlach et al. 2011). In considering the future of food and agriculture in Finnish Lapland, which may bring new opportunities for new crops to grow in the region, it will be necessary to seek a sustainable food system. However, there are challenges for the introduction of new pests that will make their way into the region and will need to be planned adequately.

This article reviews the literature on the need to transform the food system holistically by encouraging local participation along the value chains. The need for a sustainable local food system through smart specialization is highlighted in Section 2, while Section 3 discusses the future possibilities in Finnish Lapland concerning value addition to local foods and the relevance of distributed, localized manufacturing. Section 4 discusses personalized nutrition as a growing trend. Finally, Section 5 includes conclusions.

Concluding Remarks

There is a need to encourage a sustainable food system with considerations to our natural resources. In this paper, the need for a local food system to adopt digital solutions to ensure food security and safety is highlighted. With accurate data to inform, the value chain of local products will lead to opportunities to improve on processes at different stages. It will also be easier to share best practices and monitor food safety. The collation of processing data parameters on what goes on at each stage can provide useful information to help artisan food producers at local levels. With the latest technology that incorporates big data, there will be a drive to map and integrate data from across the whole food supply chain, from weather and remote sensing in agriculture, to tracing where raw ingredients were sourced from, the nutritional content of foods, tracking how food has been produced and handled. These innovative breakthroughs are making their ways to the future food system with smart labels on food that can be scanned to reveal a whole host of information about a product, which allow consumers to differentiate between products on health and sustainability grounds.

“Bacterial communities in Arctic fields of Finnish Lapland are stable but highly pH-dependent,” Minna K. Männistö, Marja Tirola, and Max M. Häggblom, *FEMS Microbiology Ecology*, 2 February 2007 [103]

<https://academic.oup.com/femsec/article/59/2/452/553520>

Abstract:

The seasonal and spatial variations of microbial communities in Arctic fields of Finnish Lapland were studied. Phospholipid fatty acid analysis (PLFA) and terminal restriction fragment analysis (T-RFLP) of amplified 16S rRNA genes were used to assess the effect of soil conditions and vegetation on microbial community structures along different altitudes of two fields, Saana and Jehkas. Terminal restriction fragments were additionally analyzed from c. 160 cloned sequences and isolated bacterial strains and matched with those of soil DNA samples. T-RFLP and PLFA analyses indicated relatively similar microbial communities at various altitudes and under different vegetation of the two fields. However, soil pH had a major influence on microbial community composition. Members of the phylum Acidobacteria dominated especially in the low pH soils (pH 4.6–5.2), but above pH 5.5, the relative amount of terminal restriction fragments corresponding to acidobacterial clones was substantially lower. Both T-RFLP and PLFA analysis indicated stable microbial communities as the DNA and fatty acid profiles were similar in spring and late summer samples sampled over 3 years. These results indicate that differences in microbial community composition could be explained primarily by variation in the bedrock materials that cause variation in the soil pH.

Current & Relevant Information:

Introduction

Finnish Lapland is mainly situated in the taiga (boreal forest) zone although Arctic-alpine tundra (treeless heaths) dominate the environment in the far northwestern part of Lapland. Arctic tundra soils are characterized by extreme conditions such as long periods of low temperatures, multiple episodes of freezing and thawing during spring and fall and relatively wide annual temperature variation. It is often assumed that below 0°C microbial activity ceases, and in boreal and Arctic environments the soil microbial activity is minimal outside the growing season. However, microbial activity has been reported in soil at subzero temperatures (Clein & Schimel, 1995; Mikan et al., 2002) and even at temperatures down to -20°C (Rivkina et al., 2000). Larsen et al. (2002) reported substantial carbon mineralization in soils of northern Sweden during the winter months as compared to the annual carbon flux. In tundra and taiga soils it was estimated that microbial respiration during winter accounted for 10–30% of the annual carbon loss (Clein & Schimel, 1995).

Global warming is expected to affect the Arctic ecosystems severely as both increased air temperature and increased snow accumulation will lead to significant warming of the soil and subsequently increased microbial activity and CO₂ release

from the Arctic tundra (Welker et al., 2000). Microbial activity of Arctic tundra soils has consequently received keen interest during the past decade. Studies of cold soils have, however, concentrated mainly on analyzing microbial respiration, carbon and nitrogen mineralization, while the structures of microbial communities are poorly characterized. Potential applications for cold-active microorganisms and microbial by-products have also been a strong motivation for the exploration of extremely cold environments and numerous novel bacterial species have been isolated and described from the polar environments (for a review, see e.g., Cavicchioli et al., 2002). Microbial community structures of alpine tundra soils have been studied in the Niwot Ridge, Colorado (Lipson et al., 2002; Schadt et al., 2003; Lipson & Schmidt, 2004; Monson et al., 2006) and a few reports exist on the microbial variability of high Arctic tundra in Siberia (Zhou et al., 1997) and Canada (Neufeld et al., 2004). Amplified 16S rRNA genes of alpine soils of the Niwot Ridge were dominated by Acidobacteria, Alpha- and Betaproteobacteria, members of the Verrucomicrobia division and Bacteroidetes (Lipson & Schmidt, 2004). Siberian permafrost tundra was dominated by Alpha- and Gammaproteobacteria (Zhou et al., 1997) while Deltaproteobacteria were reported to dominate in the high Arctic of Canada (Neufeld et al., 2004). Very little is known, however, on the microbial community structures of sub-Arctic and Arctic-alpine environments of the Fennoscandia, where the microorganisms are challenged by not only low temperatures but also repeated freeze–thaw cycles and a relatively wide annual temperature fluctuation. Fennoscandian tundra environments extend from the mountainous (field) areas of southern Norway to the far northernmost parts of Finland. In Finland, the Scandinavian Caledonides extend to the Kilpisjärvi region, which is considered one of the coldest places in Continental Europe with an annual temperature of -2.2°C and a growing season of c. 100 days. The Fennoscandian tundra differs from the arctic tundra of Canada and Siberia by the absence of permafrost. Consequently, these soils experience a larger annual temperature variation as well as variation in the soil water content when there is no permafrost to trap the moisture (Richardson et al., 2003). Moreover, the Fennoscandian tundra differs from the more temperate alpine soils by e.g., a shorter plant growth season and differences in the photoperiods.

The aim of this study was to investigate the major bacterial groups dominating in the Arctic-alpine tundra soils of Lapland. Particular interest was paid to the spatial and seasonal stability of these microbial communities. Therefore, the variability of the microbial community of tundra soils was studied in two fields with two culture-independent community profiling methods, phospholipid fatty acid analysis (PLFA) and terminal restriction fragment analysis (T-RFLP), with the aim of assessing the effect of altitude, vegetation and soil conditions, as well as the seasonal variation in the microbial community composition. By comparing the data obtained from T-RFLP analyses from soil DNA, cultivated isolates and a 16S rRNA gene clone library, it was possible to link the community profiles to a more detailed phylogenetic analysis of the bacterial community.

Summary

In summary, similarities in the soil microbial communities at the two fells (Saana and Jehkas), as indicated by T-RFLP, the clonal library and PLFA analyses, as well as cultivation, suggested that certain bacterial taxa may be ubiquitously distributed in the Arctic tundra. Moreover, many clones of this study were closely related to GenBank sequences from Alaska (Toolik Lake) tundra soils indicating circumpolar distribution of these species in the tundra environments. Furthermore, these microbial communities appear to be stable with little variation observed during the summer season or from year to year. Variation in structure of the soil microbial communities appears to be controlled by pH more than temperature fluctuations. The results of this study indicate that soil temperature may have a limited impact on bacterial community composition. Climate change and subsequent increase of temperature fluctuations and freeze–thaw events may therefore not modify the soil bacterial communities as much as generally thought. More detailed research is, however, needed to assess the microbial community structures in frozen soil and after various freeze–thaw cycles.

“In the name of security: Governmentality apparatus in a multilingual mine in Arctic Finland,” Maiju Strömmer, *Journal of Sociolinguistics*, 17 January 2021

[104] <https://onlinelibrary.wiley.com/doi/full/10.1111/josl.12458>

Abstract:

This critical sociolinguistic study explores how mining work is governed in the name of security in a mine in Arctic Finland. Although the mining industry is dominated by multinational corporations, mines themselves tend to be concentrated in peripheries where a mobile and multilingual workforce is recruited. Mining is a high-risk business: industrial accidents and environmental damage can be severe. Discursive practices play a crucial role in risk management. In this study, the nexus of language, security, and production in mining work is analyzed by applying the Foucauldian concept of ‘governmentality’. The data comprise ethnographic observations, work-related documents, and interviews collected onsite in 2018-2019. The analysis illustrates how security and production are interwoven in the mine’s safety program that applies the neoliberal logic of responsabilization and disciplinary strategies of surveillance, supervision and regulations. On a broader level, this governmentality apparatus serves the state in securitizing its economy and population.

Current & Relevant Information:

Introduction

Mining is a high-risk business: the risks for environmental damage and industrial accidents are substantial (see Kröger, 2016; Rolston, 2010). Communication is considered essential for safety in mining, in which long working hours, high-risk

tasks, and shift work pose major challenges (Chirkov et al., 2017: 62). Hence, unsuccessful communication is regarded as a major reason for occupational accidents in high-risk industries (Albert et al., 2014; Keffane, 2015). However, critical sociolinguistic research has questioned the notion of straightforward causality between language problems and safety (see Daveluy, 2012; Kraft, 2019, 2020; Theodoropoulou, 2019). The higher accident rates among migrant employees can also be explained by aspects other than language, such as the employee leasing system and constantly changing personnel (Kraft, 2019, 2020). Capitalist logic entails that corporations seek to transfer risks to other organizations and individuals, such as temporary staff and subcontractors (Daudigeos et al., 2016; Gray, 2009). A strong focus on production can weaken risk perception and increase the risk for organizational accidents (Goh et al., 2012). However, it is in the interests of mining organizations to keep the accident rate low, not least to keep production uninterruptedly on stream (see Rolston, 2010).

This critical sociolinguistic study explores how mining work is governed in the name of security in a mine in Arctic Finland owned by a multinational corporation. Whereas mining is a global industry involving transnational corporations and global financial and international markets (Ellem, 2015), mineral deposits are place specific (Kröger, 2016: 543; Suopajärvi et al., 2017). In Arctic Finland, the “golden era” of mining began in the 1960s when the industry brought large-scale factory work and a new infrastructure to the northern peripheries (Pietikäinen & Allan, 2020). Since the mid-2000s, mining and prospecting for minerals in Finland has again grown rapidly (Kröger, 2016). In 2017, Finland was ranked the best country in the world for investing in mining (Stedman & Green, 2018) due to low land costs and mining taxes, detailed geodata, reliable legislative procedures, and a good infrastructure (see also Kröger, 2016; Noras, 2016; Tolvanen et al., 2019).

Because mines are mostly located in peripheral areas, mining regions have for centuries been characterized by labor mobility and multilingual mining communities (see Cornips & Muysken, 2019; Pietikäinen, 2019; Hiss, 2017). Most of the research on language issues in mining has addressed historical cases (e.g., Cornips & Rooij, 2019; Hiss, 2017; Marzo, 2019; Muysken, 2019). Ethnographic studies are rare, probably because gaining access to mining projects is challenging due to strict security procedures (see, however, Aikman, 2017; Bell, 2017; Kraft, 2020). Workplace safety and communication has to some extent been studied ethnographically in language disciplines (e.g., Daveluy, 2012; Handford & Matous, 2015; Kraft, 2019; Theodoropoulou, 2019)¹. This study contributes to this research strand in the mining context.

To explore the nexus of security, multilingualism, and mining work from a critical sociolinguistic approach, I apply the concepts of ‘governmentality’ and ‘apparatus’ (Foucault, 2009). Governmentality refers to the technologies by which state and institutions govern individuals’ conduct and thoughts (Dean, 1999; Foucault, 2002,

2009; Rose, 1999). Closely related to governmentality, apparatus refers to the complex assemblage of discourses, practices, and regulations that answer an urgent need to govern individuals' behavior in certain ways (Agamben, 2009; Foucault, 2009). This article investigates how mining work is governed in the name of security, utilizing ethnographic and discourse analytic data gathered in a mine in northern Finland (2018–2019). To analyze the interconnections and contradictions of governing safety and economy, I also apply insights from the ethnographic and discourse analytical approach of nexus analysis (Lane, 2014; Pietikäinen, 2015; Scollon & Scollon, 2007; Strömmer, 2016). This study illustrates how security and production are interwoven in the governmentality apparatus that utilizes different discursive strategies and forms of power, especially the neoliberal logics of responsabilization of risks and disciplinary power, including preventive surveillance and supervision.

Conclusion

This article analyzed how mining work is governed in the name of security in a multilingual mining company in Finland. The critical sociolinguistic analysis revealed that a discourse of safety permeates work-related documents and practices. In the governmentality apparatus, safety is interwoven with production: both the economic and safety risks of the enterprise are partially transferred to its subcontractors and employees. These governmentalizing strategies are linked to the state's aims of securitizing its economy and citizens: the mine produces metal ore for export and provides secure jobs for the Finnish population, while managing fluctuation in labor needs by hiring subcontractors.

The mining company uses a safety program as a concrete apparatus of governmentality, utilizing global bodies of knowledge. In modern societies, most power is normalizing: certain actions, such as safety procedures, are regarded as norms that everybody has to follow (see Foucault, 2009: 85). Accordingly, the main tool of the mine's safety program is the work card, which functions as a disciplinary apparatus by setting the norms to be followed. The program also includes a "Supervision Formula", in which disciplinary power draws on supervision and surveillance. The work card acts as a responsabilization mechanism (see Lemke, 2001) by making supervisors and subordinates responsible for the safe continuation of work. The work card frames shared understanding, safety, and production as the key elements to be controlled. However, language problems are not considered in this system: the work card does not give guidance on how to act if a shared understanding of tasks and risks is hard to achieve. Hence, supervisors working with multilingual surplus labor are subjected to the tensions of being responsible for workplace safety in a situation where their subordinates are not equipped to fully follow the company's preferred language practices. This means that employees have to affirm shared understanding in circumstances where investment in good practices for communication problems is lacking.

The previous research on language and mining has illustrated the long history of language contact and multilingual practices in mining communities (Aikman, 2017; Cornips & de Rooij, 2019; Hiss, 2017; Marzo, 2019; Muysken, 2019). The present study contributes to this research strand in the context of the current globalized mining industry. The analysis shows how the multilingual employees of subcontractors are framed as difficult subjects to govern. In addition to language barriers, other factors may explain the higher accident rate among subcontractors' personnel (see also Kraft, 2019, 2020). For instance, surplus labor might not be as familiar as permanent labor with the organization's work and safety culture or working methods. Here, the work card may be useful as it offers a model of safe work routines. It is important to acknowledge that the organization's safety program works well in general: accident rates among both permanent and surplus labor have fallen since its introduction (see also Rolston, 2010). Safety at work and the terms and conditions of employment are relatively good in the mining industry in Finland compared to other countries (Noras, 2016). However, the impact of language and culture variability on workplace safety could more systematically be considered in the safety program: alternative strategies such as audio-visual materials, color-coded signs, and hands-on training opportunities could be offered to employees who encounter language barriers (see De Jesus-Rivas et al., 2016).

A critical sociolinguistics of governmentality has addressed how neoliberal governmentality operates through the processes of subjectification and self-governance in particular (e.g., Allan, 2013; Barakos, 2016; Del Percio, 2018; Dlaske, 2016; Martín Rojo, 2019). This article illustrated how a nexus of different governmentality technologies and bodies of knowledge are employed in the mine's governmentality apparatus that combines the neoliberal technology of responsabilization with the disciplinary strategies of surveillance, supervision, and regulations. However, I was not able to analyze the perspectives of the governed subjects in depth because of the limitations of the data. Hence, this study could inspire further sociolinguistic research on how governmentality apparatuses are adapted, resisted, or modified by individuals in industrial work contexts.

“Lapland among regions not in favour of wind power compensation for eastern Finland,” Eye on the Arctic, 27 April 2022 [105] <https://www.rcinet.ca/eye-on-the-arctic/2022/04/27/lapland-among-regions-not-in-favour-of-wind-power-compensation-for-eastern-finland/>.

Overview:

Regional leaders are calling for a new compensation system in wind power tax revenue due to a clear disparity between western and eastern Finland in terms of wind power distribution, with most of the turbines concentrated in western areas.

Current & Relevant Information:

The primary reason for this is a matter of defense policy as wind turbines can interfere with regional surveillance and radar operations.

Any plans to build new wind turbines more than 50 meters tall or within the vicinity of a strategic area, must be submitted to the General Staff of the Armed Forces, which has the right to block any such project. Between 2011 and 2021, roughly 15 percent of projects were prohibited by the Defence Forces, according to its own figures.

Most wind farms are situated around the Gulf of Bothnia on Finland's western coast. More are on the way as the Finnish Climate Change Panel stated in a report that the Nordic Countries have set a goal of boosting their wind power capacity five-fold by 2050.

While this development is welcomed warmly by western regions, areas in the east say they are not reaping the benefits of this "wind boom".

"Territorial control of the Defence Forces has been a very important reason for [our lack of wind power], and we understand those reasons," Markus Hirvonen from the Regional Council of North Karelia, a region along the Russian border that has no wind turbines.

The government of Prime Minister Sanna Marin (SDP) has sought to identify ways to work around these national defense concerns in order to evenly distribute wind power across the country.

With Russia's invasion of Ukraine limiting Russian energy imports and Finland winding down peat burning for fuel, the need for alternative energy sources is growing. In Finland's east, this presents new challenges.

Eastern regions want wind power compensation

According to a report by the Association of Finnish Local and Regional Authorities, municipalities received 17 million euros in real estate tax from wind farms last year. That number is expected to grow to at least 19 million euros this year.

The Finnish Wind Power Association believes that this number can rise to 30 million euros within the next few years.

Eastern Finland would like to see some of this money as well, which is why regional councils are calling for a new compensation system to bolster municipality tax revenue for those without access to wind power.

"A municipal compensation model should be part of the next government program and implemented with extensive production by the ministries," Hirvonen told Yle.

He further emphasized that the eastern regions are happy to control the eastern border — because the defense of the whole of Finland requires it.

“But the basic principle of the rule of law is that the disadvantages caused by it, such as the loss of wind power, must be compensated for,” he clarified.

Hirvonen’s model would see wind power revenues go to the state treasury, and then distributed amongst Finland’s regions, especially those in the border region.

“If even a small part of the income were distributed to the border regions, the system would be fair,” Hirvonen argued.

Other regional leaders agree with Hirvonen’s point of view on a fairer distribution of funds.

“If the construction of wind power is restricted or completely banned in part of Finland, renewable energy and other financing measures should be directed in particular to these areas,” said Jaakko Mikkola from the Regional Council of Kymenlaakso.

West not in favor of compensation

The call from eastern regions for equitable compensation is not a popular position in other regions.

“If we want to promote wind power, the compensation proposal is not effective,” said Pauli Harju from the Council of Oulu Region.

With 349 wind turbines, Northern Ostrobothnia — in the west — has Finland’s largest share of the energy generating devices, and accounts for more than one-third of the country’s turbines.

According to Harju, the best solution would be dividing Finland into price areas in terms of the market price of electricity, a similar model to one that has been implemented in Sweden and Norway.

“This would have an impact on the price of electricity and create competitiveness in these areas, much more effectively than with any compensation model,” Harju explained.

Other regions in Finland’s “wind belt” express sympathy towards the eastern regions, but are not in favor of compensation.

“In Lapland this would mean a virtual halt to wind power projects,” said Mika Riipi, from the Regional Council of Lapland.

Riipi argued that wind power still comes with negative consequences — such as loss of landscape value and noise pollution.

With these disadvantages, Riipi argued that it is only fair that areas with wind turbines reap their benefits.

“Full tax revenues for municipalities that deal with the disadvantages of wind power,” Riipi said.

“Finland’s Strategy for Arctic Policy,” Finnish Government, 2021 [106]

[https://www.europeanpolarboard.org/fileadmin/user_upload/Finland Arctic Strategy 2021.pdf](https://www.europeanpolarboard.org/fileadmin/user_upload/Finland_Arctic_Strategy_2021.pdf)

Abstract:

Finland’s new Arctic policy strategy sets out Finland’s key objectives in the Arctic region. All activities in the Arctic region must be based on ecological carrying capacity, climate protection, principles of sustainable development, and respect for the rights of indigenous peoples. The objectives arising from Finland’s economic interests can also be examined from this perspective. The strategy extends to the year 2030.

The need to strengthen Arctic cooperation has been identified in the strategic section titled ‘Globally influential Finland’ of the Programme of Prime Minister Marin’s Government. The previous Arctic strategy was adopted in 2013.

The international framework for Arctic policy and issues of Arctic security are presented in the introduction to the strategy. The priorities of the new strategy are as follows:

1. Climate change mitigation and adaptation
2. Inhabitants (promotion of wellbeing and the rights of the Saami as an indigenous people)
3. Arctic expertise (livelihoods and leading edge research)
4. Infrastructure and logistics

The priorities of the strategy present the situational picture of each priority area, the objectives for the Arctic region, and the concrete actions to achieve the objectives.

Finland’s Arctic policy strategy has been prepared under the auspices of the Prime Minister’s Office. All ministries have participated in the preparation of the document.

Current & Relevant Information:

Outlines and objectives of Finland’s Arctic policy until 2030

Finland is an Arctic country and one of the eight permanent members of the Arctic Council. Through close cooperation, sustainable development goals relevant to this region can be attained and, in combination with global measures, the accelerating climate change and its harmful impacts can be mitigated.

Finland's goal is a peaceful Arctic region marked by constructive cooperation. Increasing tensions and conflict potential must be avoided.

The Arctic region is warming up faster than other areas. The direction of climate change in the Arctic region can be turned through global emission reductions. While the actors contributing to the climate change are primarily located outside the Arctic region, there are also countries among the Arctic States with substantial emissions.

Good living conditions and possibilities for participation in cooperation and decision-making on the Arctic must be safeguarded for the people living in this region. In particular, cross-border cooperation and dialogue between people and NGOs should be facilitated and promoted. The indigenous peoples living in the Arctic should be able to preserve and develop the vitality of their cultures, languages and traditions and obtain the necessary capabilities for adapting to the challenges created by the changes affecting the region.

Finland's Arctic expertise is a key part of our country's Arctic profile. Biological variability and the carrying capacity of nature, protecting the climate and the environment, the principles of sustainable development, the welfare and participation of the local population as well as indigenous peoples' rights will be addressed in all economic activity in the Arctic region. While all business is not harmful for the environment, unsustainable business is. Circular economy and other new principles of economic activity as well as technological solutions may also create entirely new business opportunities.

Finland's position and attraction as an international top expert in the Arctic will be strengthened by investments in education and research. The knowledge and expertise produced by Arctic research will be utilized widely. Research evidence will underpin high-quality and timely decisions in different sectors and fields and promote the ability of the Arctic population to live a good life.

Infrastructure and logistics in the Arctic region will be developed to serve businesses and the needs of the region's population through sustainable and low-emission methods and modes of transport. Digitalization will be promoted in the services of the region and in transport system development. The accessibility of telecommunications will be improved to meet the needs of the authorities, companies and citizens.

The overall image of Finland as an Arctic country is created as the sum of many actors. In addition to various levels of public administration and policy-making, universities, research institutes and business life, such stakeholders as NGOs and informal networks also play a role. At all levels, both institutional knowledge and individual-level expertise and activity have significance.

Ensuring the general visibility of Finland's Arctic activities and making sure that the multiple voices are heard will also be important in terms of the objectives of the Strategy for Arctic Policy. Additionally, it is essential that the stakeholders involved in Finland's Arctic activities have a good ability to network with each other and form

partnerships with a low threshold. Arctic cooperation is also part of Nordic cooperation.

The objectives of Finland's Arctic policy and Arctic activities have cross-cutting significance for different sectors across Finland. A silo effect can be prevented by engaging in cooperation across sectoral boundaries and encouraging activities that collectively promote Finland as an Arctic country.

“Solar Power Just Miles from the Arctic Circle? In Icy Nordic Climes, It’s Become the Norm, Paul Hockenos, Inside Climate News, 24 February 2020 [107]

<https://insideclimatenews.org/news/24022020/solar-finland-nordic-renewables-sanna-marin-climate-targets-turku/>

Overview:

As solar prices fall and efficiency increases, countries like Finland are discovering the benefits of summertime solar.

Current & Relevant Information:

For years after northern Finland’s largest printing plant blanketed its facility’s eight roofs with solar panels, the curious beat a path to the extraordinary spectacle.

There were skeptics who doubted that solar power would pay off in this northern city, just 100 miles shy of the Arctic Circle, a geography known not for its sunny climes but rather its dark, snow-bound, sub-zero winters.

“They wanted to see what we’d done, how it worked, whether it worked,” said Juha Rönning, chief technician at the Kaleva Media printing plant. In 2015, the 1,604 solar photovoltaic (PV) units made Kaleva Media’s rooftop the most powerful photovoltaic solar plant in Finland, and indeed in all of Scandinavia’s north country.

Today, Kaleva Media’s rooftop PV park is no longer a curiosity—it’s not even the largest solar producer in the city of Oulu, much less all of Finland. Across Europe’s far north, municipalities, businesses and households are increasingly taking advantage of solar power as solar cells’ efficiency increases and costs fall.

While Germany was experiencing its mega solar boom in the 2000s, in Nordic countries like Sweden, Iceland, Norway, Denmark and Finland the sight of a suburban home with a PV panel was an oddity. Today, although still dwarfed by Germany’s solar force, tens of thousands of buildings, from Copenhagen to the Arctic Circle, brandish the cutting edge in solar tech.

“The technological developments in PV [cells] have driven the price way down,” said Henrik Borreby, the Nordic representative of BayWa r.e., a global renewable energy developer. “The general perception had been that the further north you go, the harder it was to make a business case, even impossible. That’s not so anymore,” he said, though he acknowledged that the further north one pushes—and the lower the

domestic power price—the longer it takes to make the upfront investment in solar pay itself back.

Europe's Nordic countries, roughly at the latitude of Alaska, are pushing the boundaries of solar power deployment.

They boast some of the world's most progressive climate protection agendas, and much of the momentum behind the growth of renewables there stems from their national action plans, which are designed to meet the Paris Agreement's goal of keeping global warming well below 2 degrees Celsius. Norway is still a major oil producer, but Finland's new progressive government—led by the world's youngest prime minister, 34-year-old Sanna Marin—has set ambitious decarbonization targets that would render the country of 5.5 million carbon neutral by 2035.

The solar pioneers of the north country have discovered that their environs actually proffer certain advantages for the technology beyond round-the-clock summer days. The output of PV panels is significantly greater when they're not overheated, which can happen in sun-blessed southerly regions. This cool-temperature perk gives northerners more bang for the euro: up to 25 percent more electricity per hour.

The Finns also swear by vertical PV installations. These are walls—usually southward-facing facades—composed of hundreds of collectors that turn buildings into vertical power generators. The solar walls' angle and location maximizes the rays of the Finnish winter's low-slung sun, as well as light's reflection off the snow. Kaleva Media's downtown office building sports a solar wall, as does the city's power plant.

“Finland's first Pohjanmaa-class corvette begins steel-cutting,” John Hill, Naval Technology, 1 November 2023 [108] <https://www.naval-technology.com/news/finlands-first-pohjanmaa-class-corvette-begins-steel-cutting/>

Overview:

After several years of design phase delays, Rauma Marine Constructions (RMC) have reached the steel-cutting milestone for Finland's Pohjanmaa-class corvettes.

Current & Relevant Information:

Finland's naval manufacturer [Rauma Marine Constructions](#) (RMC) celebrated the steel-cutting of the country's first *Pohjanmaa*-class corvette on 30 October.

This marks the start of the construction phase of the €1.23bn (\$1.36bn) '[Squadron 2020](#)' program to replace the Finnish Navy's legacy seven-ship fleet.

Finland's Defence Forces Logistics Command signed the [shipbuilding contract](#) with RMC for four *Pohjanmaa*-class corvettes in September 2019.

According to Finland's MoD, construction will continue until 2029. In [April](#), the Government issued a call for technical experts to join the build, citing “delays in the

initial build phase” of the project. The first-in-class vessel is planned to be operational by 2027.

As the Finnish Border Guard and Navy are upgrading their primary surface fleet, naval vessels and surface combatants form the second-largest sector in the Finnish defence market. The total value for this sector is \$1.2bn in 2023-28, GlobalData intelligence indicates. Value allocation across the forecast period is predicted to peak in 2025 at \$285m.

Features of the *Pohjanmaa*-class

With a length of 117 metres (m), width of 16m and a draught of 5m, the first *Pohjanmaa* corvette will be able to carry 70 servicepeople. The vessel can also reach a speed of 25 knots (48km/h).

“The design of the corvettes pays particular attention to shock resistance, noise levels and stealth technology,” says Timo Ståhlhammar, Commodore (ret.) and Project Director at RMC.

“The multi-role corvettes are the first vessel class in the Finnish Navy that are designed and constructed under the surveillance of the ship classification society, including the ship’s performance in ice.”

RMC designed Finland’s four corvettes to operate in the Baltic Sea year-round in various circumstances ranging from autumn storms to icy and freezing conditions.

The [Pohjanmaa-class](#) is equipped with monitoring capacities for air, surface and underwater surveillance. They are also capable of laying navy mines, performing defence actions against surface vessels, submarines and various airborne targets and conducting maritime operations. In addition to domestic operations, the vessels can be used in crisis management measures and as part of Nato’s Standing Naval Forces.

The open architecture of the [Saab](#) 9LV combat management system will enable the integration of third-party sensors, armament and systems, allowing Finland’s Navy to interoperate more closely with its Nato partners since the country joined the alliance earlier this year.

Special investment in the lead up to construction

The corvettes will be constructed in a new multi-purpose hall that has been built specifically for this project. The hall will provide excellent conditions for production and will guarantee security and quality.

RMC has also made significant investments in steel production, which will allow for the welding of even thinner plates.

Furthermore, RMC has constructed a prototype of the vessel to determine the technical production capacity of the project. This has been done to ensure that the

investments are suitable to produce military vessels, to confirm dimensional and form accuracy, to verify the planned practices and to test technical solutions for various appliances and materials.

4. Iceland:

“Green Building in the Arctic Region: State-of-the-Art and Future Research Opportunities,” Lucrezia Ravasio, Svein-Erik Sveen, and Raymond Riise, MDPI, 10 November 2020 [109] <https://www.mdpi.com/2071-1050/12/22/9325/pdf>

Abstract:

The concept of Green Building refers to environmentally friendly constructions with the target of minimizing the impact on the natural environment through sustainable and efficient use of resources over their life cycle. Since modern buildings are large contributors to global energy consumption and greenhouse gas emissions, policies and international strategies intended to reduce the carbon footprint of conventional buildings are highlighting the role of this recently introduced building concept. This study provides a systematic literature review of existing research related to Green Buildings in the Arctic. Despite numerous studies and projects developed during the last decades, a study describing the current research status for this region is still missing. The review first examines the role that national and international policies developed by the arctic countries have on the development process of Green Buildings. Second, it provides an overview of the most commonly used and promoted Green Building rating systems used by the same countries in the region. The analysis highlights benefits and critical issues of Green Buildings located in the Arctic in comparison with conventional buildings, focusing on environmental, economic, and social dimensions. Finally, future research opportunities are presented and discussed.

Current & Relevant Information:

Introduction

In recent decades, the consciousness of the impact of human activity on the natural environment has grown. This awareness has affected the construction industry, highlighting the link between sustainability and environment and thereby giving it strength and momentum. The green movement, having spread in all fields of society, has led to the emergence of worldwide, national, and local programs advancing green principles in both construction and home-building sectors. Indeed, studies show that buildings play a significant role in climate change.

The term climate change generally refers to the long-term shift in global or local climate patterns, usually identified with the rise of average temperature over the years, owing to human activities. Among all the regions of the planet, because of its special physical and geographical properties, the Arctic is experiencing the most severe effect of climate change through greater and more rapid rise of average

temperature. The Arctic Region is commonly defined as the area north of the Arctic Circle (66°32'0" N), or as the area north of the 10 °C July isotherm as shown in Figure 1a. Alternatively, it can also be defined by vegetation or oceanographic characteristics. In this review, the definition used by the Arctic Monitoring and Assessment Program (AMAP) is adopted. It considers the area delimited by the tree line as shown in Figure 1b. The arctic climate is typically characterized by extreme seasonality and variation in temperature and precipitation, strong gradient in latitude solar, and UV radiation. In addition, low temperatures lead to an extensive and permanently ice-covered or frozen ground, i.e., permafrost, which makes the region vulnerable to climate change. Warming of the Arctic and consequent melting has global implications, such as alteration of global ocean circulation, sea level rise, and release of methane and carbon dioxide trapped in the permafrost, i.e., gases that are feeding and accelerating the process of temperature-rise.

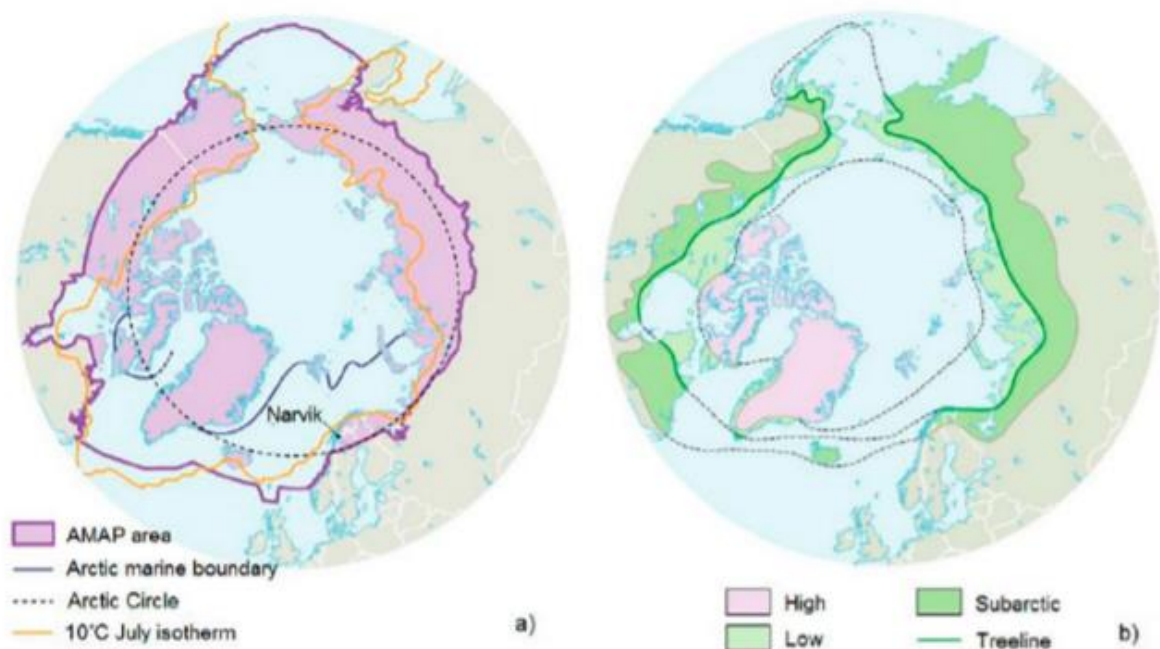


Figure 1. (a) The Arctic defined by the 10 °C July isotherm. (b) Arctic floristic boundaries [7].

According to the Global Status Report of 2019, buildings and constructions together account for 36% of global energy use and 39% of energy-related carbon dioxide emissions in 2018. This makes buildings the largest contributing sector to global warming. The same report declares that, due to the strong floor area and population expansions, total global energy consumption in buildings in 2018 increased 1% from 2017. In perspective, Green Buildings become a potential strategy and investment to limit demand and reduce energy intensity. In fact, through the introduction of new building codes and adoption of advanced certifications for high-energy performance, all participants in the building and construction value chain are globally contributing

to decarbonization of building stocks and to the improvement of building's energy performances.

By definition, a Green Building is a high-performance building with a reduced negative impact on the natural environment and human health. This is achieved by applying measures that take into account the building location, as well as water, energy and material use efficiency, resource conservation, indoor air quality, building operation, and maintenance over the entire building life-cycle. Green Buildings also provide benefits from an economic and social perspective, through lower building life-cycle costs and improved comfort and well-being of their occupants. This promising solution is also expressed in different building concepts related to sustainable and environmental design such as net and nearly zero-energy buildings, zero-emission, zero-carbon, and carbon-neutral buildings.

With this backdrop, policies aimed at safeguarding and protecting the arctic environment represent a challenge of paramount importance for the region at the present and for the future. Governments with territories in the Arctic—Norway, Sweden, Finland, Denmark, Iceland, Russia, Canada, and United States—are closely involved in the development of new initiatives both locally, with national legislation, and globally, through the Arctic Council. Established in 1996 with the Ottawa Declaration, the Arctic Council is an intergovernmental forum promoting cooperation, coordination and interaction among the Arctic States. The Arctic Cooperation also includes the European Union, the Nordic Cooperation, the Barents Cooperation, and the United Nations.

The purpose of this research is to present local and global initiatives stated by the institutions and the bodies on reduction of building's carbon footprint in the Arctic. The aim is to examine the players in the Green Buildings transition process in the Arctic and evaluate the applicability of currently used assessment tools in these special climate conditions. By identifying benefits and criticalities, and design practices of Green Buildings Arctic climate, the study highlights the current state of the art and future research opportunities. Therefore, this results in practical interest for companies and institutions that want to invest resources for development solutions for reducing the buildings' carbon footprint in the region.

Iceland

Iceland's Climate Policy is introduced in the report "Iceland's Climate Action Plan for 2018–2030", released in September 2018. Once again, efforts are directed at cutting net emissions to meet the Paris Agreement targets for 2030 and reach the government's ambitious aim of carbon neutrality before 2040. The plan consists of 34 actions, divided in four categories—clean energy transfer in transport; clean energy transformation in other sectors; climate mitigation in land use and forestry; other measures—in which buildings and use of energy do not find a direct collocation. In fact, as largely covered by the document "Iceland's Seventh National

Communication and Third Biennial Report”, the construction sector, with a high energy-demanding space heating, accounts for the 6% of the total GHG emissions in the energy sector in 2015.

However, according to the same report, 99% of energy used for space heating is already produced by renewable energy sources such as hydropower and geothermal power. Specific legislation and regulation on construction are mostly intended to ensure safety human life and the environment. Sustainable development is also a guiding concern in design and construction of energy efficiency in building operations. In addition, the Arctic Council Chairmanship program 2019–2021 “Together Towards a Sustainable Arctic”—which highlight the national commitment for the sustainable development and protection of the Arctic environment, does not refer directly to a plan for the building sector. Measures primarily involve the arctic marine environment, the Arctic Council, the people and the community, the climate, and green energy solutions. In this last section, the government encourages the development and application of practical green energy solutions in the Arctic to reduce emissions and improve air quality.

Conclusions and Future Research Opportunities

In this paper, a critical review of existing studies related to development of Green Buildings has been presented for seven of the Arctic countries. Even though there is an abundance of literature covering Green Buildings, the field is still lacking of studies specifically related to the Arctic. Below, the conclusions of each section are summarized:

- The review identifies the main actors in the Green Buildings development in the Arctic region. Indeed, global commitments aimed at mitigating climate change effects are leading governments to advance polices and national building codes responding to stricter standards, therefore pushing the construction industry and the market to adapt sustainable solutions. The transition to Green Buildings in the Arctic can be achieved if policies and building standards are implemented considering local climate and urbanistic patterns as well as the future local climate trend.
- Green Building rating tools are also playing a key role in promoting of sustainable, green constructions. Setting standards and requirements, they are pushing boundaries of sustainability in the building sector. The evaluation process takes into consideration different parameters according to different climate conditions and geographical characteristics, making the tools reliable and versatile. Despite the small number of buildings certificated in the Arctic, the criteria considered by the different tools showed the applicability of these systems in the Arctic. However, since Green Building rating tools are not designed on Arctic climate and local characteristics, the review identified that some of the evaluated criteria—such as transport and energy—are penalizing the achievement of certifications and high

scores. In addition, more research is needed to identify the factors that are slowing the adoption of this type of sustainable solutions in the region.

- The review highlights general benefits and exposes criticalities of Green Buildings, focusing on the technologies needed for their development in the Arctic. In fact, the Arctic offers several solutions for green electricity generation. The challenge is creating a network that can reach rural areas, or alternatively, installing on-site production facilities. For this reason, it is necessary to develop technologies for on-site generation that can meet arctic requirements. To understand if Green Buildings located in the Arctic benefit from economic advantages, future research should also focus on arctic Green Building energy performance and cost analysis. In this way, it will be possible to calculate and estimate the average energy demand, energy savings, and the related accomplishments in economic terms.
- Green Buildings should be designed to meet current green standards and keep them over the time. Indeed, durability is an important feature of green design, and, since the Arctic is experiencing higher average temperature and permafrost melting, buildings should be designed taking into account these challenging changes in local climate patterns.

“Arctic-Tecture,” John Lassen, Design Build Network, 20 July 2008 [110]
<https://www.designbuild-network.com/features/feature2164/>

Overview:

Eve Kushner explores how buildings are being equipped to endure the challenging climate of Scandinavia.

You might assume there would be straightforward rules for building in an extreme climate: keep the heat in and the cold out. And you might assume that one cold, northern country is pretty much like the next. But it's not nearly that simple.

There is enormous climatic variation across Scandinavia. Seasonal changes create two very different worlds: a landscape with endless summer light and a wintry environment in which the sun appears briefly, if at all.

From Iceland's reliance on hot springs and Norway's use of ground heat to Denmark's harnessing of the wind, as well as Norway's wood, Denmark's clay and Iceland's stone – the countries draw on very different raw materials.

The choice of raw materials has shaped not only the vernacular architecture but also each culture's attitudes towards conservation and energy efficiency.

Current & Relevant Information:

EXTERIOR MATERIALS

Norway and Sweden have abundant supplies of wood. “Relatively cheap and plentiful, wood seems an obvious building material that one uses reflexively and

even mindlessly,” says architect Einar Jarmund of Oslo-based Jarmund / Vignsnaes Architects.

Wood creates a warm feeling, so Icelanders particularly appreciate it. Because trees can't grow tall in their climate, Icelanders import any wood they use. They also tried importing the idea of wooden houses from Norway and Sweden. But under siege from Icelandic winds, such houses became untenable and eventually acquired corrugated steel cladding.

For a more durable, exotic and expensive cladding choice, copper is one possibility. Traditionally used for high-quality roofs, copper has been key to the success of the Svalbard Science Centre in northernmost Norway. In 2005, Jarmund's firm finished an expansion of the existing science center, cladding all exteriors in copper.

“China Iceland Arctic Research Observatory,” EU-Interact, 2017 [111] <https://eu-interact.org/field-sites/karholl-research-station/>

Overview:

China Iceland Arctic Research Observatory – CIAO. Land and buildings owned by Aurora Observatory, AO, an Icelandic non-profit foundation. Operated under a long-term lease agreement with AO by the Polar Research Institute of China – PRIC.

The CIAO Observatory is located at Kárhóll, about 1,5 km south of the small community of Laugar, approx. 60 km east of Akureyri in Northern Iceland at 65° 42.431'N, 17° 22.017'W. The land of the Observatory is 156 hectares. It was previously a privately owned farm, designated partially as agricultural land and partially as forestry area under a contract with the Forest Service. The location is in the valley of Reykjadalur, with glacier carved soft hillsides on the west and east side, open view to the ocean 32 km to the north and the Icelandic interior highlands to the south. The nature reserve of Lake Mývatn with its renowned natural features and the Vatnajökull national park are within close driving distance.

Current & Relevant Information:

Biological variability and natural environment

The Observatory land extends 2 km from the small salmon river Reykjadalur at about 50 m altitude to the top of the soft hill of Mýraöxl at 301 m. The land is all vegetated. The lower and flatter part is grass fields that are not harvested any more. The middle part is forested (larix, pines, spruces, willows) and managed under a contract with the Forestry Service, gradually changing to moor and then tundra on top. The climate is relatively mild, given the northerly latitude, and dry as it is inland and a fair distance from the ocean, with mean temperature + 6.3°C and annual precipitation 450 mm.

History and facilities

The Observatory was formally opened in October 2018. It consists of a new research building, farmhouse with accommodation facilities for min 10 persons and older farmhouses for service, wet-labs, workshops and storage. The Observatory research building is 763 m² on three floors. It includes a guest center and an auditorium seating 56 people intended for public outreach (education and tourism), to be opened fall 2019. The second floor has meeting rooms, work spaces, cafeteria and research facilities. The third floor is designed for research facilities, work spaces, six camera towers and laser/lidar rooms. In the outside area there is already a radio-meter field with 37 antennas installed, two magnetic meters, weather stations and more.

General research and databases

CIAO is a state-of-the-art facility with latest research equipment related to aurora and upper atmosphere research already in place in carefully specially designed facilities currently including six all-sky camera towers and a laser/lidar. More equipment and for further research fields is to be installed. The Observatory is also intended as a work hub for research conducted in its greater area. CIAO offers excellent working conditions for its users with spacious work spaces, laboratory facilities from high-tech dry labs to wet labs, latest servers and computer systems, communication equipment, fiber internet connection, special current stabilized electrical installation, high voltage wiring, and more, in a design-award environment. Station manager, technical and science support staff and administrative support staff is available for users benefit.

Human dimension

The Observatory is located in the rural municipality of Þingeyjarsveit, with an area of 6.005 km² and a population of 962 people in 2018. Main livelihood is from farming, community service and increasingly tourism. The nearest community is Laugar, 1.5 km to the north, with a population of about 150 people, mostly employed in service. Laugar hosts a secondary school and a high school, shop, restaurant, bank and of course an outdoor swimming pool. 60 km to the west is the community of Akureyri, the largest community outside of the Reykjavík area, with a population of 20.000+ and the community of Húsavík with a population of 2.300 42 km to the north.

Access

The CIAO Observatory is on the main nr. 1 ring road so driving connection to and from is very good, all year. The distance from Reykjavík is 440 km. Akureyri airport is 60 km to the west. The airport has multiple daily connections to Reykjavík as well as direct flights to Keflavík International Airport. Akureyri has also some direct international connections, including to Greenland. Húsavík airport, 35 km away, has daily flights to Reykjavík domestic airport. Public buses run daily by the Observatory. Car rentals are widely available in the area.

“This Is What Iceland Looks Like After A Decade Of Green Technology Investment,” Kate Bubacz, BuzzFeed News, 26 January 2021 [112]

<https://www.buzzfeednews.com/article/katebubacz/photos-iceland-green-tech>

Overview:

As the US rejoins the Paris climate agreement and global powerhouses such as China make big pledges for carbon reductions, there is more interest in finding innovative, climate-friendly solutions.

What does a carbon neutral future even look like? The world faces catastrophic global warming, and the only way to prevent that fate is for humans to stop releasing so much climate pollution, such as carbon dioxide, into the atmosphere. But how would that work? Simone Tramonte has a possible answer. The Italian photographer's most recent project focuses on the progress already made by societies where green energy and sustainability policies are favored, starting with Iceland. The country intends to be carbon neutral by 2040 and may reach that goal even sooner, thanks to aggressive and innovative carbon policies.

Tramonte partnered with researcher Francesca Dini, who relied on connections as a grant writer within the tech industry to find promising companies, eventually looking at carbon capture programs, geothermal energy plants, greenhouses, and fisheries that provided sustainable local food sources, among others. "We're hoping to show Iceland as a model, at least compared to other countries, so we thought it was a good start. In general, we want to show what's going on and what is next," Dini said.

Current & Relevant Information:

Iceland has the most comprehensive programs to show, in part because the country invested heavily in green technology after the 2008 financial crisis. The island nation also has pushed for public campaigns to show the effects of climate change on the country, hosting a funeral for its first glacier lost to climate change and working to reforest its land after it was extensively logged by the Vikings centuries ago. "They understood that the green economy and green tech could be a way, so they invested a lot," Dini said. "The other reason that we saw was the fact that their glaciers are melting, so climate change was something that was happening in front of their eyes."

After months of research, Tramonte and Dini were able to visit Iceland for a few weeks during a summer lull in the coronavirus pandemic. The final project highlights a growing interdependence between technology, humans, and the natural world. "We wanted to cover several aspects of green policy. For example, the plastic recycling — it's not directly related to climate change, but it helps the environment," Dini said.

“Iceland and Arctic politics,” University of Iceland [113]

https://english.hi.is/iceland_and_arctic_politics

Overview:

The Arctic has received ever growing attention in the international discourse because of climate change; resource utilization; ideas on new shipping routes brought about by the melting Arctic ice, and environmental threats. Valur Ingimundarson, Professor of History, is very interested in this new state of affairs. He is currently researching the development of politics, international management and security in the Arctic, with a special emphasis on Icelandic policy. Ingimundarson says that the changed geopolitical position of Iceland after the Cold War and the departure of the US Military sparked the study.

Current & Relevant Information:

Ingimundarson speculates that political discussion on the international scene is often characterized by misinterpretations – not least in the media. He gives as examples exaggerated ideas on “anarchy” and the looming race for resources in the North and the abundant economic opportunities following the opening of new shipping routes. “It is often left out of this equation that the Arctic Ocean will still be covered with ice for a large part of the year despite climate change.”

Ingimundarson is a specialist in international and modern history and has mostly focused on international communication and security. A few years back he led a group of specialists who evaluated risks that might be faced by Iceland in the immediate future for the Icelandic government.

In connection with the study Ingimundarson has researched communication between the countries of the Arctic and other countries considering the interests of the region with special emphasis on the tension between considerations of autonomy and international management. “Finally, I studied the attempts of Iceland to be recognized as a coastal county in the Arctic. This is a new aspect to Icelandic policy based on the fact that our territorial waters reach into the Greenland Sea by the Arctic Ocean. The Icelandic government therefore claims that Iceland should be defined as a fully valid coastal state in the Arctic just like the five states who claim territorial rights in the Arctic Ocean, i.e., the USA, Canada, Russia, Norway and Denmark on behalf of Greenland.” Ingimundarson furthermore says that Iceland has a stronger position than Finland and Sweden who have no coast on the Arctic seas. On the other hand, the five “coastal countries” have not wanted to accept Iceland as one of them. Ingimundarson says that this subject offers many possibilities concerning Iceland. “Recently the basis for a policy on the Arctic has been laid down here. All political parties agree that this is a priority in Icelandic foreign policy. I put this policy into the context of different international factors such as communication within the Arctic region and Iceland’s ties to various states and external parties, such as China and the European Union, and regional and international bodies such as the Arctic Council and the United Nations.”

Ingimundarson says that influential Asian states such as China, Japan, South Korea and Singapore have requested permanent audience membership of the Arctic Council, which is gaining in political importance. He says that the main question Iceland and the other countries of the region face is how accessible should the area be to other states. This may lead to increased tension between these parties and external countries who claim to have valid interests in the area. This is not only a question of identity politics where states and organizations are divided up according to their current power positions and agency where division is decided by who is in and who is out. It also revolves around the issue of who has most influence on decision-making in the Arctic area in the future,” says Ingimundarson.

“Orca: The first large-scale plant,” climeworks [114] <https://climeworks.com/plant-orca>

Overview:

Located in Iceland, Orca is the world's first large-scale carbon dioxide removal plant.

Current & Relevant Information:

From vision to reality: Orca is launched

On September 8, 2021, we launched Orca, the world's first and largest direct air capture and storage plant, making carbon dioxide removal on large-scale a reality.

We improved the capture capacity of Orca by applying a new technology design. The facility consists of eight collector containers, with an annual capture capacity of 500 tons each. The containers are arranged around a central process hall that accommodates all electrics, such as the processing unit, allowing us to operate and control the facility from afar.

The heat and electricity required to run the direct air capture process is supplied by the Hellisheidi Geothermal Power Plant. An important aspect was that Orca is smoothly integrated into the beautiful Icelandic landscape. We therefore chose earthy colors and natural materials that give it a natural touch.

“Published report Mapping Arctic Research in Iceland,” rannis, 27 November 2020 [115] <https://en.rannis.is/news/published-report-mapping-arctic-research-in-iceland>

Overview:

The report *Mapping Arctic Research in Iceland* has been published in cooperation between The Icelandic Centre for Research, Stefansson Arctic Institute and the Icelandic Arctic Cooperation Network.

Current & Relevant Information:

FULL REPORT (3.520 KB)

In these uncertain times of warming climate, the Arctic Region is becoming even more important for the global community. The ice cover of the Arctic, the temperatures and currents in the Arctic Ocean have a huge impact on the climate and weather in the lower latitudes. Iceland is an integrated part of the Arctic region where approximately 4 million inhabitants live. For those living in the Arctic, research on the region is a priority in order to understand the changes which are occurring and what they might expect in the future.

The report seeks to provide an overview of the main actors having a role in Icelandic policy and coordination on Arctic research and international cooperation. Next it presents a profile of the main performers of Arctic research in Iceland, namely universities, research institutes, agencies, companies and infrastructures. This is followed by an analysis of those domestic and international competitive funds which are supporting Arctic research. Finally, the report describes selected international Arctic research projects with Icelandic participation and platforms that serve Arctic issues which are often relevant to Arctic research.

“Iceland’s Energy Bounty,” Devon Geography, 19 February 2023 [116]
<https://devongeography.wordpress.com/2023/02/19/icelands-energy-bounty/>

Overview:

While the UK agonizes over its energy policy, and holds lengthy debates about gas from Europe, fracking for oil, and building new nuclear power stations, there is one country in the world that does not need to spend time on such issues. That country is Iceland, in the unique position of being able to generate all its electricity requirements from renewable sources.

Current & Relevant Information:

Total electricity consumption

Iceland total electricity consumption: 17.7 billion kwh

UK total electricity consumption: 309.2 billion kwh

Electricity production = 100% renewable

Iceland generates 73% of its electricity from HYDRO-ELECTRIC POWER

Iceland generates 27% of its electricity from GEOTHERMAL POWER

Electricity Production – Comparing Iceland and the UK

ENERGY SOURCE	ICELAND (%) 2022	UK (%) 2022
COAL	0	1
OIL	0	0
GAS	0	42
NUCLEAR	0	17
WIND	0	29
HYDRO ELECTRIC	73	1
GEO THERMAL	27	0
SOLAR	0	4
BIO MASS	0	6
	Data: government.is	Data: National Grid Live

While it is obviously much easier to provide energy for a smaller nation – Iceland has a total population of just 370,000 – it also allows Iceland to be the largest electricity producer per capita, with approximately 55,000 kWh per person per year. By comparison, the EU average is less than 6,000 kWh, and the UK figure 4,593 kWh. Iceland's availability of HEP and geothermal sources also makes it the world's largest green energy producer per capita.

However, Iceland is one of the largest per capita consumers of electricity in the world.

Iceland – 52,374 kWh/person/year (Norway = 23,174; USA 5th – 13,246; Japan 7,848)

Why is this?

- Energy supplies are abundant
- Energy production is cheap
- Iceland has a number of energy-intensive industries, namely aluminum smelting, fishing-related industries and greenhouse agriculture
- The country experiences long, cold, dark winters

Iceland's consumption rate is closely followed by other Scandinavian countries, Norway, Finland and Sweden

5. Norway:

“Green Building in the Arctic Region: State-of-the-Art and Future Research Opportunities,” Lucrezia Ravasio, Svein-Erik Sveen, and Raymond Riise, MDPI, 10 November 2020 [117] <https://www.mdpi.com/2071-1050/12/22/9325/pdf>

Abstract:

The concept of Green Building refers to environmentally friendly constructions with the target of minimizing the impact on the natural environment through sustainable and efficient use of resources over their life cycle. Since modern buildings are large contributors to global energy consumption and greenhouse gas emissions, policies and international strategies intended to reduce the carbon footprint of conventional buildings are highlighting the role of this recently introduced building concept. This study provides a systematic literature review of existing research related to Green Buildings in the Arctic. Despite numerous studies and projects developed during the last decades, a study describing the current research status for this region is still missing. The review first examines the role that national and international policies developed by the arctic countries have on the development process of Green Buildings. Second, it provides an overview of the most commonly used and promoted Green Building rating systems used by the same countries in the region. The analysis highlights benefits and critical issues of Green Buildings located in the Arctic in comparison with conventional buildings, focusing on environmental, economic, and social dimensions. Finally, future research opportunities are presented and discussed.

Current & Relevant Information:

Introduction

In recent decades, the consciousness of the impact of human activity on the natural environment has grown. This awareness has affected the construction industry, highlighting the link between sustainability and environment and thereby giving it strength and momentum. The green movement, having spread in all fields of society, has led to the emergence of worldwide, national, and local programs advancing green principles in both construction and home-building sectors. Indeed, studies show that buildings play a significant role in climate change.

The term climate change generally refers to the long-term shift in global or local climate patterns, usually identified with the rise of average temperature over the years, owing to human activities. Among all the regions of the planet, because of its special physical and geographical properties, the Arctic is experiencing the most severe effect of climate change through greater and more rapid rise of average temperature. The Arctic Region is commonly defined as the area north of the Arctic

Circle (66°32'0" N), or as the area north of the 10 °C July isotherm as shown in Figure 1a. Alternatively, it can also be defined by vegetation or oceanographic characteristics. In this review, the definition used by the Arctic Monitoring and Assessment Program (AMAP) is adopted. It considers the area delimited by the tree line as shown in Figure 1b. The arctic climate is typically characterized by extreme seasonality and variation in temperature and precipitation, strong gradient in latitude solar, and UV radiation. In addition, low temperatures lead to an extensive and permanently ice-covered or frozen ground, i.e., permafrost, which makes the region vulnerable to climate change. Warming of the Arctic and consequent melting has global implications, such as alteration of global ocean circulation, sea level rise, and release of methane and carbon dioxide trapped in the permafrost, i.e., gases that are feeding and accelerating the process of temperature-rise.

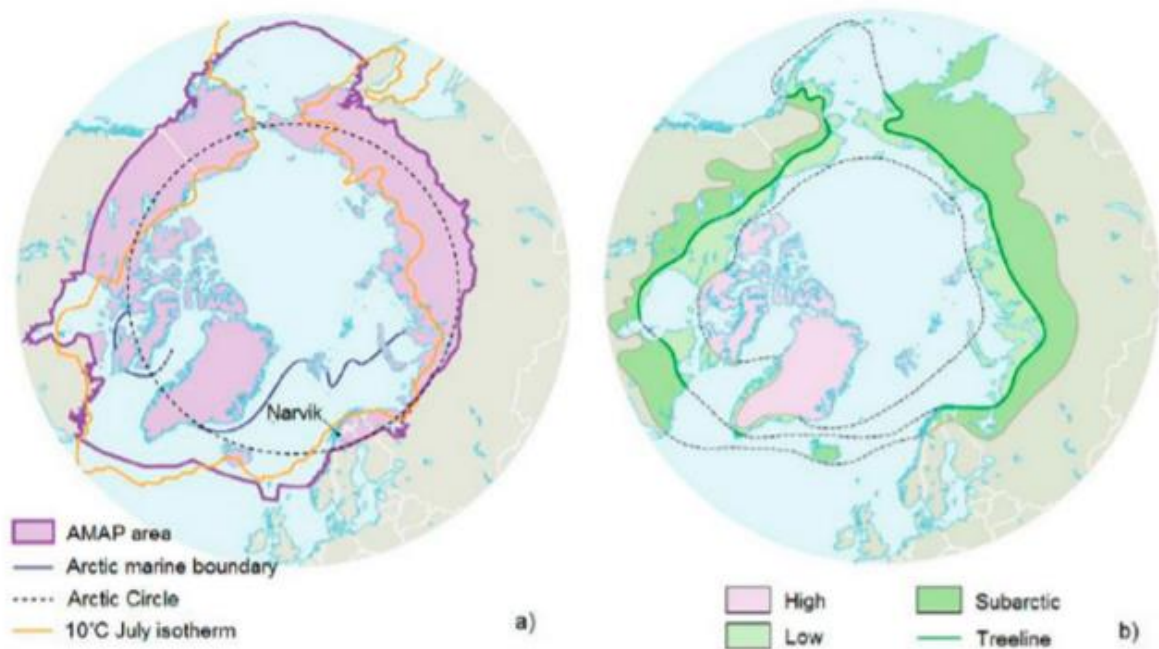


Figure 1. (a) The Arctic defined by the 10 °C July isotherm. (b) Arctic floristic boundaries [7].

According to the Global Status Report of 2019, buildings and constructions together account for 36% of global energy use and 39% of energy-related carbon dioxide emissions in 2018. This makes buildings the largest contributing sector to global warming. The same report declares that, due to the strong floor area and population expansions, total global energy consumption in buildings in 2018 increased 1% from 2017. In perspective, Green Buildings become a potential strategy and investment to limit demand and reduce energy intensity. In fact, through the introduction of new building codes and adoption of advanced certifications for high-energy performance, all participants in the building and construction value chain are globally contributing to decarbonization of building stocks and to the improvement of building's energy performances.

By definition, a Green Building is a high-performance building with a reduced negative impact on the natural environment and human health. This is achieved by applying measures that take into account the building location, as well as water, energy and material use efficiency, resource conservation, indoor air quality, building operation, and maintenance over the entire building life-cycle. Green Buildings also provide benefits from an economic and social perspective, through lower building life-cycle costs and improved comfort and well-being of their occupants. This promising solution is also expressed in different building concepts related to sustainable and environmental design such as net and nearly zero-energy buildings, zero-emission, zero-carbon, and carbon-neutral buildings.

With this backdrop, policies aimed at safeguarding and protecting the arctic environment represent a challenge of paramount importance for the region at the present and for the future. Governments with territories in the Arctic—Norway, Sweden, Finland, Denmark, Iceland, Russia, Canada, and United States—are closely involved in the development of new initiatives both locally, with national legislation, and globally, through the Arctic Council. Established in 1996 with the Ottawa Declaration, the Arctic Council is an intergovernmental forum promoting cooperation, coordination and interaction among the Arctic States. The Arctic Cooperation also includes the European Union, the Nordic Cooperation, the Barents Cooperation, and the United Nations.

The purpose of this research is to present local and global initiatives stated by the institutions and the bodies on reduction of building's carbon footprint in the Arctic. The aim is to examine the players in the Green Buildings transition process in the Arctic and evaluate the applicability of currently used assessment tools in these special climate conditions. By identifying benefits and criticalities, and design practices of Green Buildings Arctic climate, the study highlights the current state of the art and future research opportunities. Therefore, this results in practical interest for companies and institutions that want to invest resources for development solutions for reducing the buildings' carbon footprint in the region.

Norway

The strategy for fulfilling targets of the Paris Agreement is presented in the “Climate Change Act” released in 2018. The national goals to achieve together with the European Union (EU) include reduction of greenhouse gases by at least 40% by 2030 and reducing of greenhouse gas emissions in the order of 80–95% by 2050, resulting in Norway becoming a low-emission society. In both cases, the reference year is 1990 and climate targets should be reviewed every five years. The Climate Change Act identifies five priorities areas: Transportation sector; supply of renewable energies; low emissions and clean production technologies; environmentally sound shipping; and carbon capture and storage.

Development in the Arctic has also been a priority in the Norwegian Government's agenda since 2005, demonstrated by several proposals released over the years. The most significant official publications include "New Building Blocks for the High North" and "Norway's Arctic Strategies between geopolitics and social development". The first program, established in 2006 and released in 2009, contains 22 specific action points enclosed in seven prioritized areas ranging from technical to humanity. The purpose of the project is to enhance knowledge in and about the north, increasing government activity and presence in the area, and lay foundations for sustainable economic and social development in the Arctic regions. The second program, presented in 2017, reveals the government's vision for economic, environmental, and social sustainability in the Arctic, highlighting the need to reduce greenhouse gas emissions and pollution through promotion and transition to green transport, energy, and construction. However, both plans, released in a unified manner on a national level, lack strategies strictly related to the building sector.

As described in the document "The Property Sector's Roadmap toward 2050"—released in June 2016 by the Norwegian Green Building Council, Grønn Byggallianse, and Norsk Eiendom—the vision for 2050 is to achieve a climate-neutral construction industry with zero emissions of environmental toxins, in accordance with the Paris Agreement. The requirements to meet national and international goals for greenhouse gases emissions reduction for the building sector are provided in the national building code "Regulations on technical requirements for construction works—TEK 17", whose latest version was released in July 2017. However, attention is not only on new buildings, in which energy requirements have been tightened to nearly-zero Energy Building standards in 2020, but also on existing building stocks, whose performance must be upgraded in case of a planned renovation. In reference to refurbishing of existing buildings, Grønn Byggalliance released a booklet in November 2019, "Think twice before demolishing", encouraging renovation of dwellings instead of their demolishing, promoting their conversion into Green Buildings to achieve the 2050 climate goals. Long-term initiatives for reducing the carbon footprint of buildings can also be found in the program "Building for the future—environmental action plan for the housing and building sector 2009–2012". It states long-term initiatives for reducing the carbon footprint of buildings, acting on their energy needs and waste production.

Conclusions and Future Research Opportunities

In this paper, a critical review of existing studies related to development of Green Buildings has been presented for seven of the Arctic countries. Even though there is an abundance of literature covering Green Buildings, the field is still lacking of studies specifically related to the Arctic. Below, the conclusions of each section are summarized:

- The review identifies the main actors in the Green Buildings development in the Arctic region. Indeed, global commitments aimed at mitigating climate change

effects are leading governments to advance policies and national building codes responding to stricter standards, therefore pushing the construction industry and the market to adapt sustainable solutions. The transition to Green Buildings in the Arctic can be achieved if policies and building standards are implemented considering local climate and urbanistic patterns as well as the future local climate trend.

- Green Building rating tools are also playing a key role in promoting of sustainable, green constructions. Setting standards and requirements, they are pushing boundaries of sustainability in the building sector. The evaluation process takes into consideration different parameters according to different climate conditions and geographical characteristics, making the tools reliable and versatile. Despite the small number of buildings certificated in the Arctic, the criteria considered by the different tools showed the applicability of these systems in the Arctic. However, since Green Building rating tools are not designed on Arctic climate and local characteristics, the review identified that some of the evaluated criteria—such as transport and energy—are penalizing the achievement of certifications and high scores. In addition, more research is needed to identify the factors that are slowing the adoption of this type of sustainable solutions in the region.

- The review highlights general benefits and exposes criticalities of Green Buildings, focusing on the technologies needed for their development in the Arctic. In fact, the Arctic offers several solutions for green electricity generation. The challenge is creating a network that can reach rural areas, or alternatively, installing on-site production facilities. For this reason, it is necessary to develop technologies for on-site generation that can meet arctic requirements. To understand if Green Buildings located in the Arctic benefit from economic advantages, future research should also focus on arctic Green Building energy performance and cost analysis. In this way, it will be possible to calculate and estimate the average energy demand, energy savings, and the related accomplishments in economic terms.

- Green Buildings should be designed to meet current green standards and keep them over the time. Indeed, durability is an important feature of green design, and, since the Arctic is experiencing higher average temperature and permafrost melting, buildings should be designed taking into account these challenging changes in local climate patterns.

“Norway,” equinor [118] <https://www.equinor.com/where-we-are/norway>

Overview:

Transforming the Norwegian continental shelf (NCS) for sustainable value creation in the decades ahead.

Equinor is on track to maintain profitable production from the NCS at current level towards 2030. After 2030 the NCS will enter a more mature phase. It is therefore necessary to introduce new measures to tackle the future challenges of declining

production from the big fields, ageing installations and the need for reduced CO2 emissions.

Current & Relevant Information:

Our new ambition for the NCS is this: transforming the NCS for sustainable value creation for many decades. There are still substantial remaining oil and gas resources on the NCS. Some of these resources are near existing infrastructure, while other resources are difficult to find or located in smaller deposits requiring further technology development to become profitable.

Active exploration on the NCS is vital to succeed in revitalizing the continental shelf. We are making two important moves: We have developed a strategy for more gas exploration. We will also test new ideas in some prospects every year. The likelihood of discovery in these wells will be lower than in other targets, but we see it as necessary to regularly test a few of what we call “game changing wells” in order to explore the NCS to its full potential.

Over the coming decades Equinor plans to drill up to 3000 production and exploration wells. This is almost as many wells as the company has drilled since it was established 50 years ago. This is an important measure to extract more profitable barrels from the fields we operate. We aim to achieve an average recovery rate of 60 and 85 percent respectively on our oil and gas fields.

The NCS still holds a lot of potential, but securing value creation and thousands of jobs for the decades to come is not an easy task. The changes needed will be bigger than ever before and are necessary as we continue to develop as a broad energy company.

“Can Smart Societies support Innovation in the Arctic?” Rob McMahon and Andreas Raspotnik, The Arctic Institute: Center for Circumpolar Security Studies, 19 February 2019 [119] <https://www.thearcticinstitute.org/smart-societies-innovation-arctic/>

Overview:

The Norwegian city of Tromsø annually hosts the Arctic Frontiers conference, with the 2019 edition having focused on a Smart Arctic. This focus is timely, given present interest in Smart Innovation. But what does ‘smart’ mean in Arctic contexts? And how can Northern peoples and organizations benefit from it?

Discussions of ‘Smart Societies’ in the Arctic must engage local and regional actors to shape policy and regulation to enable appropriate community and economic development initiatives. Northern governments, companies and civil society organizations are all paying increased attention to the potential of digital connectivity. Decisions regarding these systems should refer to the unique circumstances and assets of northern societies and their potential for smart

specialization. Many northern regions belong to a system of economic and political relations that puts residents in uneasy tension with state and multinational influences.

In this context, perhaps the most important issue moving forward is ensuring that Arctic residents are engaged in decisions regarding circumpolar connectivity. Conditions must be put in place to identify development goals through structured planning and dialogue: leaders and administrators from urban, rural, remote and Indigenous regions must substantively engage in strategic planning regarding how digital connectivity is built, setup, owned, paid for, distributed, managed and used in and across their communities and regions. This engages a variety of users to make decisions on how infrastructure and bandwidth delivers essential services and supports digital economies. This involves working with Arctic residents to develop northern-specific indicators that identify and capitalize on their unique assets, while working to mitigate digital inequalities and divides.

Current & Relevant Information:

Have you heard about Smart Cities in the Arctic?

The urban cities of the far North are expanding economic and political globalization in ways that reflect the potential of digital connectivity. For example, the northern Finnish city of Oulu has been characterized as an ideal Smart City. Located just 170 km south of the Arctic Circle, Oulu was ranked as the third 'Silicon Valley' in the 1990s. The origins of the city's digital economy can be traced to the 1980s with the development of Nokia's Research Center and the Oulu Technology Park, which housed small-to-midsize ICT enterprises. Despite Nokia's demise in the 2000s, Oulu still ranks as one of the best global cities for startup companies – a well-earned reputation, given that it houses more than 600 ICT companies, some of which utilize open platforms, including a 5G test network, OuluHealth (an 'innovation ecosystem' to test health product developments), and a city-wide open and free wireless network (panOULU). Oulu's success is often explained by its 'public-private-people-partnership approach', part of a long tradition of co-operation between education and research institutes, companies, the public sector, and individuals. The test user forum PATIO, for example, is described as the world's first combined citizens' forum and 'living lab'. It is not by accident that Oulu co-coordinates the European Union's (EU) Partnership on Digital Transition to provide better public services to citizens around Europe. These and other activities reflect Oulu's evolution from 'innovation hub' to 'innovation node' in a regional urban network extending both inside and beyond Finland's borders. Today, Oulu serves as a prime example of urban-oriented Arctic innovation that holds important lessons not only for European Arctic states, but for cities across the North. Similar discussions have also reached North Norway and the city of Bodø. The Norwegian Air Force's decision to move and shut down the military airport in Bodø has led the city to reconsider their urban development plans and develop a modern, smart city in the Norwegian North. The blue economy

is key to the city's future orientation and focus of many recent and future events and discussions in Bodø; currently also highlighted in the AlaskaNor-project, coordinated by the High North Center at Nord University, with The Arctic Institute being one of the project's key partners.

“Japan-Norway Arctic Science and Innovation Week,” Nancy Bazilchuk, Norwegian SciTech News, 4 January 2016 [120]

<https://norwegianscitechnews.com/2016/04/japan-norway-arctic-science-and-innovation-week/>

Overview:

Representatives from Japanese and Norwegian universities, research institutions, government agencies and industries interested in polar issues will gather in Tokyo in early June to present research results and build partnerships.

Japan may seem far from the Arctic, but it has long been an active member of the global research community in studying everything from marine ecosystems to pollution in Arctic, with research stations in Ny-Ålesund in Svalbard, and in Antarctica in Drønning Maud Land.

In early June, academics, research funding agencies, industries and government officials from both Norway and Japan who work with polar issues will gather in Tokyo for the Japan-Norway Arctic Science and Innovation Week, where much of this research will be discussed.

“The Arctic is important for Norway, and it is important for Japan,” said Svein Grandum, Counsellor, science, technology and higher education at Innovation Norway's Japan office, who helped organize the event.

The goal of the gathering is “to strengthen cooperation between leading Norwegian and Japanese institutions actively involved in research, higher education and industry/business activities in the Arctic and the Antarctic,” according to the organizers.

Sveinung Løset, director of NTNU's Sustainable Arctic Marine and Coastal Technology (SAMCoT) program, will be among the speakers at the event. As the Arctic's summer sea ice cover shrinks, more and more countries, including Japan, are considering the use of the northern sea route across the top of the globe. SAMCoT's research is focused on ensuring that marine and coastal operations in the Arctic are both safe and with minimal environmental impact.

Current & Relevant Information:

Here's a sampling of results from SAMCoT's research:

[Keeping Arctic villages, infrastructure from falling into the sea](#)

The Arctic is set to be a 21st century boomtown, as summer sea ice melts away, opening the area to increased trans-Arctic shipping and oil and gas development. A new understanding of Arctic coastal erosion offers clues to how to best protect the docks and other infrastructure this development will bring.

[Drilling down to understand sea ice](#)

Global warming is upending virtually everything that scientists know about the Arctic ice cap. During the first half of 2015, a multinational team of researchers froze the RV Lance into the Arctic ice to learn more about how this ice has changed. NTNU researchers were among the scientists seeking to learn more about this changing environment.

[Working safely to protect a cold, remote place](#)

Researchers with NTNU's Sustainable Arctic Marine and Coastal Technology center don't just study health, safety and environment (HSE) issues in their research in the High Arctic – they live HSE first hand. That first-hand experience makes industry safer, and protects the Arctic's fragile environments.

[Celebrity ice](#)

Not since the Titanic has a block of ice been quite so famous. In early June, Discovery Channel Canada came to NTNU's Structural Impact Laboratory (SIMLab) to watch ice researchers from NTNU's Sustainable Arctic Marine and Coastal Technology program use a giant machine to simulate what happens when a ship slams into an iceberg.

[Crash course](#)

As the Arctic Ocean's summer ice cap melts away, new trans-Arctic shipping routes will open and see a growing amount of shipping traffic. But what's the best way to protect ships and other ocean structures if they crash into icebergs?

[Secrets of the High North](#)

The Norwegian arctic island archipelago of Svalbard offers scientists the chance to investigate some of the most intriguing – and perplexing – puzzles facing the high north.

**“Ductile materials for Arctic conditions,” Åse Dragland,
partner.sciencenorway.no, 15 January 2015 [\[121\]](#)**

<https://partner.sciencenorway.no/arctic-forskningno-material-technology/ductile-materials-for-arctic-conditions/1412834>

Overview:

The production of oil and gas at temperatures between 40 and 60 degrees below zero means that researchers must advance the development of materials that can withstand these harsh conditions.

The oil industry is heading north. It is said that 30 percent of remaining gas, and 13 per cent of remaining oil, reserves are to be found in the Arctic. We're talking about billions.

The Snøhvit and Goliat projects are being developed for operation in temperatures of minus 20 degrees. In the even harsher conditions further north, steel constructions must be able to withstand temperatures as low as minus 60 degrees.

But our current materials are not tough enough, because when temperatures fall below minus 20 degrees, the steel becomes brittle and more likely to fracture.

Current & Relevant Information:

Tests, tests and more tests

Senior researcher Odd Magne Akselsen is heading a group at Sintef in Trondheim whose aim is to enhance the fracture resistance of construction materials.

The idea is to develop precise mathematical models, predict materials properties and make the necessary modifications. To achieve this, they need a lot of information at both micro- and nanoscales.

"There are two factors", says Akselsen. "The ductility (fracture resistance) of a material is dramatically reduced when temperatures fall below zero", he says.

"Moreover, steel plates used in platform construction have to be welded together. After welding, involving high rates of heating and cooling, it becomes easier for cracks to develop", he says.

– And just one crack is dangerous?

"A single crack can result in brittle fracture by which the material breaks in two in just a couple of seconds", says Akselsen.

"Such fractures are unstable, impossible to predict and very dangerous – potentially resulting in catastrophic accidents.

In order to avert such hazards, the researchers are carrying out numerous tests involving the flexing and stretching of cracks inserted into welds, followed by the examination of small samples using an electron microscope.

"Space Technology for a Smart and Resilient Arctic," Wilson Center, 11 June 2018 [122] <https://www.wilsoncenter.org/event/space-technology-for-smart-and-resilient-arctic>

Overview:

The Arctic continues to change at a rapid pace with northern communities experiencing social, political, environmental, and economic impacts of such change. With over four million residents above the Arctic Circle, and many millions more living in the Arctic region, including indigenous peoples, the communities of the North are looking to a broad range of balanced economic development, the application of new and applicable technologies, and opportunities to shape their future.

The availability and application of new and innovative technologies will be critical components of building and maintaining a future Arctic where incorporation, balanced economic development, and informed decision-making should be the norm. Dependable and affordable telecommunications are still a challenge throughout the Arctic - yet such connectivity is essential to equitable educational opportunities, health care, workforce development, resource development, subsistence activities, marine transportation, search and rescue, oil spill preparedness and prevention, research, and environmental monitoring, to name just a few. Arctic communities require both terrestrial and space-based infrastructure that enables them to connect with the world outside the Arctic - as well as with other regions within the Arctic.

The importance of satellite technology in the Arctic cannot be overstated. Norway is a world leader in this respect, with major facilities for reading signals from satellites on Svalbard and a number of vehicles in space. The “smart Arctic,” where communities are connected and can cooperate in areas such as education or medicine is vision shared by all Arctic nations.

Experts from private industry, academia, government, and Arctic communities explored these important issues by considering the following questions:

How can we better connect the Arctic – through space technology, terrestrial communication systems, and the resulting development and exchange of expertise and knowledge? How can space-based technologies contribute to more sustainable Arctic communities and a greening of Arctic economies? What role can space technology play in monitoring and surveillance, and contributing to the currently level cooperation in the Arctic?

The objective of this program was to a) showcase the role of satellite technologies in current Arctic connectivity infrastructures and b) discuss how infrastructures and connectivity can be further enhanced by new technologies and their deployment.

“Norway Gets the Go Ahead to Drill Into the Arctic,” Kyree Leary, *Futurism*, 4 January 2018 [123] <https://futurism.com/norway-go-ahead-drill-into-arctic>

Overview:

The government has said any new drilling projects wouldn't start for another 10-15 years.

Current & Relevant Information:

ARCTIC DRILLING

Norway recently unveiled plans to ban the use of oil for heating purposes by 2020, but until then, the country will still drill for oil in places where it feels doing so is justified. In support of the plan is a recent ruling by Norway's government, in which an Oslo court approved the country's plans to drill for oil in the Arctic.

As reported by Reuters, the case was brought forward by environmental groups Greenpeace and Nature and Youth Group, who argued the act of drilling went against citizens' rights to a healthy environment. Specifically, the groups called out a 2015 oil licensing round in the Arctic that awarded gas and oil companies like Chevron, calling it unconstitutional. Their assertion ultimately failed to sway the court, which stated it was "inappropriate" to attempt to use the country's constitution in their argument (even going so far as to characterize it as a publicity stunt) instead of putting forth better regulations on greenhouse gases.

"The environmental organizations' argument that the plan violates the Constitution's Article 112 has not succeeded," the Oslo district court ruled, according to Reuters. "The state, represented by the Ministry of Petroleum and Energy, is exonerated."

ACKNOWLEDGING GLOBAL WARMING

Norway hasn't completely lost sight of its green agenda, however, which includes being carbon neutral by 2030, converting all cars to electric, and the construction of an electric highway. The country's government said it's taking note of global warming's effects on ice in the Arctic, and any new drilling projects wouldn't start for another 10-15 years. The Arctic's output is also relatively small compared to other areas, with Reuters noting it may provide ways to replace oil production in areas in the North Sea and Norwegian Sea.

Still, Norway remains one of Europe's largest producers of oil and gas. It's continued oil drilling goes against the environmentally friendly decisions it's made in the past, as well as its support of the Paris Agreement. It may be that in the 10-15 years the country has said will elapse before it starts any new drilling operations in the Arctic, new rules and regulations will be put in place to prevent further drilling. As climate scientists have already warned, the impact of losing more Arctic ice would have devastating consequences for millions around the world.

"Information about the Observatory," Kartverket, 16 September 2021 [\[124\]](https://www.kartverket.no/en/about-kartverket/geodetic-earth-observatory/information-about-the-observatory)
<https://www.kartverket.no/en/about-kartverket/geodetic-earth-observatory/information-about-the-observatory>

Overview:

The Norwegian Mapping Authority's Geodetic Earth Observatory ranks as the northernmost facility of its kind.

Current & Relevant Information:

The Norwegian Mapping Authority's Geodetic Earth Observatory, featuring a 20-meter radio telescope, was first established at Hamnerabben in Ny-Ålesund, Svalbard in 1993. Construction of a new facility at Brandal a couple kilometers further north began in 2013, and the new observatory was officially opened in 2018. The new observatory will gradually be phased in, replacing the facility at Hamnerabben.

The new observatory - once fully operational - will be among a handful of the world's first core sites within the Global Geodetic Observing System (GGOS), co-locating the four space geodetic techniques: Very Long Baseline Interferometry (VLBI), Satellite Laser Ranging (SLR), Global Navigation Satellite System (GNSS) and Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS).

As such, the observatory will be a fundamental part of a network of stations which define the global geodetic reference frame, and will be crucial to realise GGOS's ambitious goals of 1 mm accuracy and 0.1 mm/yr stability.

Next-generation technology

The new observatory, which has an estimated cost of about NOK 300 million, features cutting-edge technology, including next-generation VGOS (VLBI Global Observing System), twin telescopes with fast-slewing antennas and a broadband (2-14 GHz) signal acquisition chain.

The telescopes, surrounded by the Brandal lagoon, Cape Mitra and Kings Fjord, are an impressive 13.2 meters in diameter and loom 18 meters above the ground.

The southernmost telescope has been operational since 2020. Work is currently ongoing to complete the installation of the signal acquisition chain in the other telescope.

NASA cooperation

Through an agreement between NASA and the Norwegian Mapping Authority, a state-of-the-art Satellite Laser Ranging (SLR) facility will be constructed, and installed in Ny-Ålesund. This facility, with its location at a latitude of 79° N, will be important because it will allow us to observe polar-orbiting satellites, such as ICESat-2, with extremely good coverage. The installation in Ny-Ålesund is scheduled to start in 2022, and the SLR will be ready for operating by 2025.

6. Russia:

“Green Building in the Arctic Region: State-of-the-Art and Future Research Opportunities,” Lucrezia Ravasio, Svein-Erik Sveen, and Raymond Riise, MDPI, 10 November 2020 [125] <https://www.mdpi.com/2071-1050/12/22/9325/pdf>

Abstract:

The concept of Green Building refers to environmentally friendly constructions with the target of minimizing the impact on the natural environment through sustainable and efficient use of resources over their life cycle. Since modern buildings are large contributors to global energy consumption and greenhouse gas emissions, policies and international strategies intended to reduce the carbon footprint of conventional buildings are highlighting the role of this recently introduced building concept. This study provides a systematic literature review of existing research related to Green Buildings in the Arctic. Despite numerous studies and projects developed during the last decades, a study describing the current research status for this region is still missing. The review first examines the role that national and international policies developed by the arctic countries have on the development process of Green Buildings. Second, it provides an overview of the most commonly used and promoted Green Building rating systems used by the same countries in the region. The analysis highlights benefits and critical issues of Green Buildings located in the Arctic in comparison with conventional buildings, focusing on environmental, economic, and social dimensions. Finally, future research opportunities are presented and discussed.

Current & Relevant Information:

Introduction

In recent decades, the consciousness of the impact of human activity on the natural environment has grown. This awareness has affected the construction industry, highlighting the link between sustainability and environment and thereby giving it strength and momentum. The green movement, having spread in all fields of society, has led to the emergence of worldwide, national, and local programs advancing green principles in both construction and home-building sectors. Indeed, studies show that buildings play a significant role in climate change.

The term climate change generally refers to the long-term shift in global or local climate patterns, usually identified with the rise of average temperature over the years, owing to human activities. Among all the regions of the planet, because of its special physical and geographical properties, the Arctic is experiencing the most severe effect of climate change through greater and more rapid rise of average temperature. The Arctic Region is commonly defined as the area north of the Arctic Circle (66°32' N), or as the area north of the 10 °C July isotherm as shown in Figure 1a. Alternatively, it can also be defined by vegetation or oceanographic

characteristics. In this review, the definition used by the Arctic Monitoring and Assessment Program (AMAP) is adopted. It considers the area delimited by the tree line as shown in Figure 1b. The arctic climate is typically characterized by extreme seasonality and variation in temperature and precipitation, strong gradient in latitude solar, and UV radiation. In addition, low temperatures lead to an extensive and permanently ice-covered or frozen ground, i.e., permafrost, which makes the region vulnerable to climate change. Warming of the Arctic and consequent melting has global implications, such as alteration of global ocean circulation, sea level rise, and release of methane and carbon dioxide trapped in the permafrost, i.e., gases that are feeding and accelerating the process of temperature-rise.

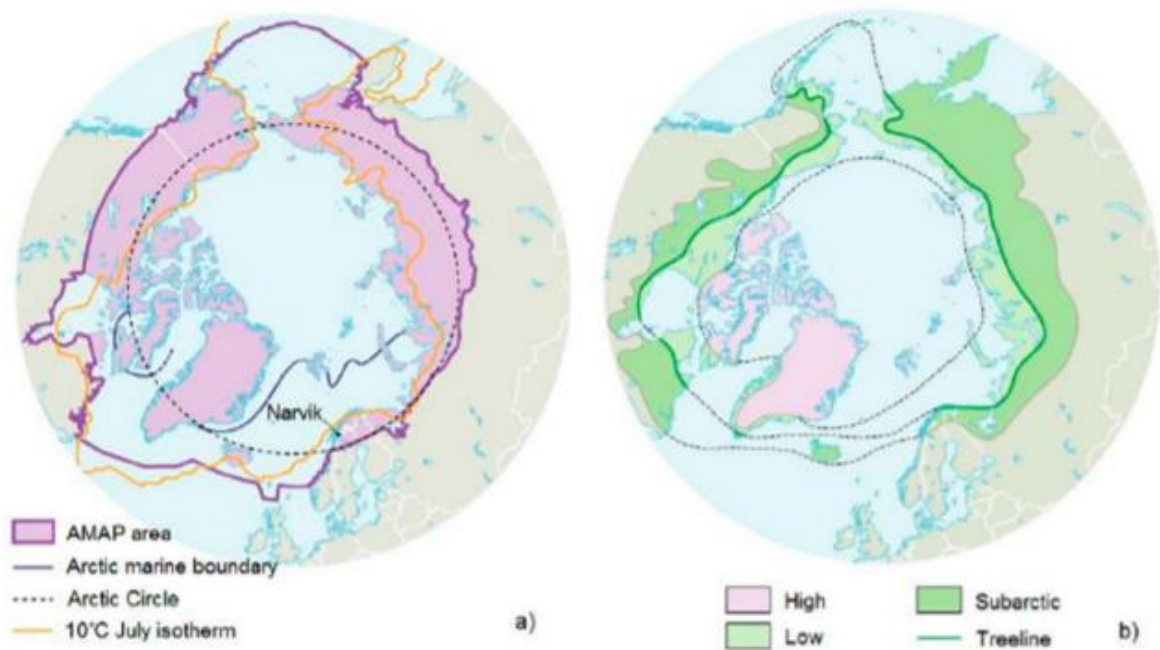


Figure 1. (a) The Arctic defined by the 10 °C July isotherm. (b) Arctic floristic boundaries [7].

According to the Global Status Report of 2019, buildings and constructions together account for 36% of global energy use and 39% of energy-related carbon dioxide emissions in 2018. This makes buildings the largest contributing sector to global warming. The same report declares that, due to the strong floor area and population expansions, total global energy consumption in buildings in 2018 increased 1% from 2017. In perspective, Green Buildings become a potential strategy and investment to limit demand and reduce energy intensity. In fact, through the introduction of new building codes and adoption of advanced certifications for high-energy performance, all participants in the building and construction value chain are globally contributing to decarbonization of building stocks and to the improvement of building's energy performances.

By definition, a Green Building is a high-performance building with a reduced negative impact on the natural environment and human health. This is achieved by applying measures that take into account the building location, as well as water, energy and material use efficiency, resource conservation, indoor air quality, building operation, and maintenance over the entire building life-cycle. Green Buildings also provide benefits from an economic and social perspective, through lower building life-cycle costs and improved comfort and well-being of their occupants. This promising solution is also expressed in different building concepts related to sustainable and environmental design such as net and nearly zero-energy buildings, zero-emission, zero-carbon, and carbon-neutral buildings.

With this backdrop, policies aimed at safeguarding and protecting the arctic environment represent a challenge of paramount importance for the region at the present and for the future. Governments with territories in the Arctic—Norway, Sweden, Finland, Denmark, Iceland, Russia, Canada, and United States—are closely involved in the development of new initiatives both locally, with national legislation, and globally, through the Arctic Council. Established in 1996 with the Ottawa Declaration, the Arctic Council is an intergovernmental forum promoting cooperation, coordination and interaction among the Arctic States. The Arctic Cooperation also includes the European Union, the Nordic Cooperation, the Barents Cooperation, and the United Nations.

The purpose of this research is to present local and global initiatives stated by the institutions and the bodies on reduction of building's carbon footprint in the Arctic. The aim is to examine the players in the Green Buildings transition process in the Arctic and evaluate the applicability of currently used assessment tools in these special climate conditions. By identifying benefits and criticalities, and design practices of Green Buildings Arctic climate, the study highlights the current state of the art and future research opportunities. Therefore, this results in practical interest for companies and institutions that want to invest resources for development solutions for reducing the buildings' carbon footprint in the region.

Russia

In 2008, the Russian Federation defined a state policy comprehended the national interest for the Arctic to be achieved by the end of 2020 — “Basic Principle of Russian Federation State Policy in the Arctic to 2020”. Primary goals include promotion of social and economic development, peace and cooperation, protection of the ecosystem, and a shipping route through the Northeast Passage. In March 2020, the government released a new version — “Basic Principles of Russian Federation State Policy in the Arctic to 2035” — updating the goals to achieve by the end of 2035. Even though the strategy lacks direct or indirect measures for reducing the carbon footprint of buildings in the Arctic, national building legislation is continuously evolving. Indeed, to meet EE (Energy Efficiency) standards, the Government implemented rules for determining energy efficiency class of apartment

buildings (Order of the Ministry of Russia n.339/pr of 6 June 2016), and the requirements for energy efficiency of building, structures, and facilities (Order of the Ministry of Russia n.1550/pr of 17 November 2017). In 2016, it also released a “Road Map for EE buildings and structures” (Russian Federation Government Order N.1853-R of 1 September 2016), in which primary objectives for the housing sector are emphasized, such as the rational use of energy resources; increase of high-energy efficiency in design and construction of buildings; and development of technical regulation and standardization in EE. In addition to new energy efficiency standards, in 2017 the government set several mandatory technical requirements regarding measuring energy consumption in new dwellings and the implementation of requirements for building envelopes. Russia’s most recent plan for the building sector aims at modernizing building and production, and increasing the contribution from the technological sector in reducing the energy consumption for the Gross National Product (GDP) by at least 1.5% per year. It also aims to provide a large-scale increase of energy efficiency of Russian economy by intensifying the renewable-sources-based energy generation, as well as large-scale electrification. The goals to be achieved in order to meet the Paris Agreement’s target are reduction of Russian GDP by 9% by 2030 and carbon neutrality by 2050.

Conclusions and Future Research Opportunities

In this paper, a critical review of existing studies related to development of Green Buildings has been presented for seven of the Arctic countries. Even though there is an abundance of literature covering Green Buildings, the field is still lacking of studies specifically related to the Arctic. Below, the conclusions of each section are summarized:

- The review identifies the main actors in the Green Buildings development in the Arctic region. Indeed, global commitments aimed at mitigating climate change effects are leading governments to advance policies and national building codes responding to stricter standards, therefore pushing the construction industry and the market to adapt sustainable solutions. The transition to Green Buildings in the Arctic can be achieved if policies and building standards are implemented considering local climate and urbanistic patterns as well as the future local climate trend.
- Green Building rating tools are also playing a key role in promoting of sustainable, green constructions. Setting standards and requirements, they are pushing boundaries of sustainability in the building sector. The evaluation process takes into consideration different parameters according to different climate conditions and geographical characteristics, making the tools reliable and versatile. Despite the small number of buildings certificated in the Arctic, the criteria considered by the different tools showed the applicability of these systems in the Arctic. However, since Green Building rating tools are not designed on Arctic climate and local characteristics, the review identified that some of the evaluated criteria—such as transport and energy—are penalizing the achievement of certifications and high

scores. In addition, more research is needed to identify the factors that are slowing the adoption of this type of sustainable solutions in the region.

- The review highlights general benefits and exposes criticalities of Green Buildings, focusing on the technologies needed for their development in the Arctic. In fact, the Arctic offers several solutions for green electricity generation. The challenge is creating a network that can reach rural areas, or alternatively, installing on-site production facilities. For this reason, it is necessary to develop technologies for on-site generation that can meet arctic requirements. To understand if Green Buildings located in the Arctic benefit from economic advantages, future research should also focus on arctic Green Building energy performance and cost analysis. In this way, it will be possible to calculate and estimate the average energy demand, energy savings, and the related accomplishments in economic terms.
- Green Buildings should be designed to meet current green standards and keep them over the time. Indeed, durability is an important feature of green design, and, since the Arctic is experiencing higher average temperature and permafrost melting, buildings should be designed taking into account these challenging changes in local climate patterns.

“Satellite images show huge Russian military buildup in the Arctic,” Nick Paton Walsh, CNN, 5 April 2021 [126] <https://www.cnn.com/2021/04/05/europe/russia-arctic-nato-military-intl-cmd/index.html>

Overview:

Russia is amassing unprecedented military might in the Arctic and testing its newest weapons in a region freshly ice-free due to the climate emergency, in a bid to secure its northern coast and open up a key shipping route from Asia to Europe.

Current & Relevant Information:

Weapons experts and Western officials have expressed particular concern about one Russian 'super-weapon,' the Poseidon 2M39 torpedo. Development of the torpedo is moving fast with Russian President Vladimir Putin requesting an update on a "key stage" of the tests in February from his defense minister Sergei Shoigu, with further tests planned this year, according to multiple reports in state media.

This unmanned stealth torpedo is powered by a nuclear reactor and intended by Russian designers to sneak past coastal defenses -- like those of the US -- on the sea floor.

The device is intended to deliver a warhead of multiple megatons, according to Russian officials, causing radioactive waves that would render swathes of the target coastline uninhabitable for decades.

In November, Christopher A Ford, then assistant secretary of state for International Security and Non-Proliferation, said the Poseidon is designed to "inundate U.S. coastal cities with radioactive tsunamis."

Experts agree that the weapon is "very real" and already coming to fruition. The head of Norwegian intelligence, Vice Admiral Nils Andreas Stensønes, told CNN that his agency has assessed the Poseidon as "part of the new type of nuclear deterrent weapons. And it is in a testing phase. But it's a strategic system and it's aimed at targets ... and has an influence far beyond the region in which they test it currently." Stensønes declined to give details on the torpedo's testing progress so far.

Satellite images provided to CNN by space technology company Maxar detail a stark and continuous build-up of Russian military bases and hardware on the country's Arctic coastline, together with underground storage facilities likely for the Poseidon and other new high-tech weapons. The Russian hardware in the High North area includes bombers and MiG31BM jets, and new radar systems close to the coast of Alaska.

The Russian build-up has been matched by NATO and US troop and equipment movements. American B-1 Lancer bombers stationed in Norway's Ørland air base have recently completed missions in the eastern Barents Sea, for example. The US military's stealth Seawolf submarine was acknowledged by US officials in August as being in the area.

A senior State Department official told CNN: "There's clearly a military challenge from the Russians in the Arctic," including their refitting of old Cold War bases and build-up of new facilities on the Kola Peninsula near the city of Murmansk. "That has implications for the United States and its allies, not least because it creates the capacity to project power up to the North Atlantic," the official said.

The satellite images show the slow and methodical strengthening of airfields and "trefoil" bases -- with a shamrock-like design, daubed in the red, white and blue of the Russian flag -- at several locations along Russia's Arctic coast over the past five years. The bases are inside Russian territory and part of a legitimate defense of its borders and coastline. US officials have voiced concern, however, that the forces might be used to establish de facto control over areas of the Arctic that are further afield, and soon to be ice-free.

"Russia is refurbishing Soviet-era airfields and radar installations, constructing new ports and search-and-rescue centers, and building up its fleet of nuclear- and conventionally-powered icebreakers," Lt. Col. Thomas Campbell, a Pentagon spokesman, told CNN.

"It is also expanding its network of air and coastal defense missile systems, thus strengthening its anti-access and area-denial capabilities over key portions of the Arctic," he added.

Campbell also noted the recent creation of a Quick Reaction Alert force at two Arctic airfields -- Rogachevo and Anadyr -- and the trial of one at Nagurskoye airfield last year. Satellite imagery from March 16 shows probable MiG31BMs at Nagurskoye for what is thought to be the first time, bringing a new capability of Russian stealth air power to the far north.

High-tech weapons are also being regularly tested in the Arctic area, according to Russian officials quoted in state media and Western officials.

Campbell added that in November, Russia claimed the successful test of the 'Tsirkon' anti-ship hypersonic cruise missile.

The Tsirkon and the Poseidon are part of a new generation of weapons pledged by Putin in 2018 as strategic game changers in a fast-changing world.

At the time US officials scorned the new weapons as technically far-fetched and improbable, yet they appear to be nearing fruition. The Norwegian intelligence chief Stensønnes told CNN the Tsirkon as a "new technology, with hypersonic speeds, which makes it hard to defend against."

On Thursday, Russian state news agency TASS cited a source in the military industrial complex as saying there had been another successful test of the Tsirkon from the Admiral Gorshkov warship, saying all four test rockets had hit their target, and that another more advanced level of tests would begin in May or June.

The climate emergency has removed many of Russia's natural defenses to its north, such as walls of sheet ice, at an unanticipated rate. "The melt is moving faster than scientists predicted or thought possible several years ago," said the senior State Department official. "It's going to be a dramatic transformation in the decades ahead in terms of physical access."

US officials also expressed concern at Moscow's apparent bid to influence the "Northern Sea Route" -- a shipping lane that runs from between Norway and Alaska, along Russia's northern coast, across to the North Atlantic. The 'NSR' potentially halves the time it currently takes shipping containers to reach Europe from Asia via the Suez Canal.

Russia's Rosatom state nuclear company released elaborately produced drone video this February of the 'Christophe de Margerie' tanker completing an eastern route across the Arctic in winter for the first time, accompanied by the '50 Let Pobedy' nuclear icebreaker for its journey in three of the six Arctic seas.

Campbell said Russia sought to exploit the NSR as a "major international shipping lane," yet voiced concern at the rules Moscow was seeking to impose on vessels using the route. "Russian laws governing NSR transits exceed Russia's authority under international law," the Pentagon spokesman said.

"They require any vessel transiting the NSR through international waters to have a Russian pilot onboard to guide the vessel. Russia is also attempting to require foreign vessels to obtain permission before entering the NSR."

The senior State Department official added: "The Russian assertions about the Northern Sea Route is most certainly an effort to lay down some rules of the road, get some de facto acquiescence on the part of the international community, and then claim this is the way things are supposed to work."

Elizabeth Buchanan, lecturer of Strategic Studies at Deakin University, Australia, said that "basic geography affords Russia the NSR which is increasingly seeing thinner ice for more of the year making it commercially viable to use as a transport artery. This might yet transform global shipping, and with it the movements of 90+% of all goods globally."

The State Department official believes the Russians are mostly interested in exporting hydrocarbons -- essential to the country's economy -- along the route, but also in the resources being uncovered by the fast melt. The flexing of their military muscles in the north -- key to Moscow's nuclear defense strategy, and also mostly on Russian coastal territory -- could be a bid to impose their writ on the wider area, the official said.

"When the Russians are testing weapons, jamming GPS signals, closing off airspace or sea space for exercises, or flying bombers over the Arctic along the airspace of allies and partners, they are always trying to send a message," the official added.

“Technological Windows of Opportunity for Russian Arctic Regions: Modeling and Exploitation Prospects,” Vera P. Samarina, et al., MDPI, 25 August 2021 [\[127\]](https://www.mdpi.com/1911-8074/14/9/400/pdf)
<https://www.mdpi.com/1911-8074/14/9/400/pdf>

Abstract:

The problems of exploitation of technological windows of opportunity are of particular scientific and practical interest in terms of the development of Russia's national economy, and the Arctic region, which has a strong mineral and raw materials potential, is important in terms of its use for achieving the technological and national security of the Russian state. Considering this, the study of the theoretical and methodical aspects of the development of emerging technological windows of opportunity is important and relevant for the regions of the Russian Arctic zone. The purpose of this study is to assess the potential and reserves for exploitation of the emerging technological windows of opportunity during the deployment of a new technological order by mobilizing material and human capital in the Arctic regions. Methodological tools for the study of this problem included dynamic series analysis, structural analysis, comparison, description, descriptive statistics, cross-correlation analysis, production function model and its visualization. An analytical review of scientific publications, a set of tools and methods of research, allowed to obtain the

following scientific results: A significant variability in the contribution of science-intensive and high-tech industry to the formation of gross value added in the Arctic region has been revealed; meanwhile, we can note stable dynamics of the contribution of the Arctic economy to the gross domestic product (GRP) of Russia as a whole. There is a steady excess of the productivity index over the Russian average, which can be regarded as a potential for growth of high-tech components of labor in the development of the economy of the Arctic region. There is a negative statistically significant relationship between the share of the gross regional product of the Arctic in the Russian GRP and the share of gross value added (GVA) of science-intensive products in the Arctic GRP, which can be regarded as a factor preventing the exploitation of the emerging technological windows of opportunity. The construction of a model of production function of technological windows of opportunities for the Arctic zone of Russia pointed to the presence of potential in the exploitation of emerging technological windows in the Arctic zone of Russia in the development of human capital through the activation and use of high labor productivity, creating high-performance jobs. The results of the study, its findings and its proposals can be used in the development, monitoring and implementation of state federal and regional programs and projects aimed at improving the level of technology and science intensity of production in the Arctic zone, improving its competitiveness, which is highly important for the national economy.

Current & Relevant Information:

Introduction

The problem of development of the Arctic zone has been becoming particularly important and relevant over the past few years. These aspects are associated, firstly, with development and implementation of the Sustainable Development Goals (Sustainable Development Goals 2021), secondly, with the need to reduce differentiation in the level of socio-economic development of Russian regions, and thirdly, in the search for new opportunities for innovative, scientific and technological development of border areas in order to achieve national and technological security. Since 2015, Russia has been implementing the state program “Social and Economic Development of the Arctic zone of the Russian Federation” (Government Programs Portal 2021). One of the key goals of this program is the development of science and technology and the increase in the efficiency of using the resource base of the Russian Arctic zone and the continental shelf of the Russian Federation in the Arctic. We believe that these prospects for scientific and technical, technological and science-intensive production, with the support of the state and business, can be considered as emerging technological windows of opportunity when estimating technological orders and management paradigms in the modern innovative economy. The key aspect of using the emerging technological windows of opportunity is the formation of an advanced scientific and technical basis and technologies in promising directions for the Arctic zone—oil and gas and industrial

engineering—which will facilitate the production of competitive high-tech products and will provide a significant reduction in the technological lag of the Russian economy behind the world level.

The research problem is that at present, there is no comprehensive analysis of assessing the impact of indicators of economic and technological development on changes in the macroeconomic parameters of the Arctic regions. In this regard, it is relevant to study the development trends of the Arctic region within the framework of a unified systematic assessment, taking into account the relationship of the main macroeconomic parameters. The study involves the use of modeling tools, in particular, correlation-regression analysis, trend analysis and a production function model. The hypothesis of the research is that for the Arctic regions, despite the high capital intensity and energy intensity of economic development, the priority in the opening technological windows of opportunities belongs to human capital, as the driver of the program.

The Arctic zone is one of the hard-to-reach regions, which makes it difficult to study and introduce innovations in order to achieve sustainable development. On the other hand, the Arctic region has a significant natural resource potential, the study, disclosure and use of which can become a key factor in ensuring technological and environmental safety not only for the Russian Federation, but also for the global ecosystem as a whole. In this regard, the problem of studying the prospects for the use of opening technological windows of opportunities when changing technological structures for the development of the Arctic regions is considered as significant and relevant.

At the end of 2020, the volume of investments in fixed capital for the development of the Arctic territory amounted to 1528.4 million rubles, which is 10% of the total volume of Russia-wide investment. Of these, the share of own funds was 53.5% and the share of obtained funds was 46.5%. In the types of investments in fixed assets, the largest share of investment was in buildings, 55.3%, machines and equipment, 23.8%, and the objects of intellectual property, 4.7% (Rosstat 2021). At the same time, the total volume of the state program for the development of the Arctic zone during the period of its implementation will be about 7 billion rubles from budgetary sources until 2025.

Considering this, we believe that the need to explore the emerging technological windows of opportunities for the development of the Arctic regions of Russia in the modern innovation economy is becoming particularly important and relevant.

The problem of development of the Arctic, including the economic, social and environmental aspects of the topic, is reflected in such areas of scientific research as the Arctic air flows (You et al. 2021), Arctic water management (Alkire et al. 2021), management of the Arctic carbon footprint (Amon 2021), mountain seismicity of the Arctic regions (Shebalin et al. 2020), Arctic ecosystem (Csapó et al. 2021) and

Arctic climate change (Tseng 2021; Durner et al. 2009). However, these issues are mainly focused on the study of the environmental problems of the Arctic zone, while the economic and technological developments of the Arctic zone regions within them are addressed indirectly.

The study of the possibilities of emerging technological windows is noteworthy, in particular: “green windows of opportunity” (Dai et al. 2020), “green technologies” (Bas and Oliu 2018; Zhou et al. 2020), etc., however, similar to the study of the development of the Arctic, environmental focus prevails in scientific research on this problem. In this study, we will understand, via technological windows of opportunity, the prospects for using the latest scientific achievements for the development of high-tech activities that open up for production when changing technological structures.

The issues of achieving sustainable development are also important for the Arctic region, as reflected in research areas such as the regional and international problem of achieving the Sustainable Development Goals (Tambovceva et al. 2019; Fahed and Daou 2021), spatial development (Popović et al. 2021), modernization of management concepts (Skufina et al. 2019; Spinosa and Doshi 2021; Novoselova et al. 2020), development of Arctic frontier territories (Samarina et al. 2018), interrelation between macroeconomic indicators and Sustainable Development Goals (Cook and Davidsdottir 2021) and others. The environmental component also dominates these studies.

The problems of economic development of the territories in the face of changing technological systems are represented by such areas of research as the management of intellectual capital in the innovation economy (Kudryavtseva and Shinkevich 2015), cluster management technologies for changing technological orders (Dyrdonova 2016), socioeconomic differentiation of regions in the era of the fourth industrial revolution (Vertakova et al. 2017), factors of innovation in prospective sectors of the economy (Klimenko et al. 2018), business systems in the context of transformational economy (Klochko and Brizhak 2019), digital ecosystem modernization (Shkarupeta et al. 2020), etc. Despite the wide range of considered problems during the change of technological orders, the authors do not view them in the context of individual territories, in particular, the Russian Arctic zone.

The theory on the issue of searching and expanding opportunities for Russian arctic regions is presented in the works of the following authors: a multi-criteria approach to land-use planning in northern Quebec (Grandmont et al. 2012), thaw settlement in soils of the Arctic Coastal Plain (Pullman et al. 2007), comparative estimates of Kamchatka territory development in the context of northern territories of foreign countries (Shelomentsev et al. 2014), comparative analysis of regional development of Northern Territories (Shelomentsev et al. 2015), development of the Arctic regions of the Russian Federation (Voronina 2020), development problems of the

Arctic Circle (Koch et al. 2020), climate change (Czerniawska and Chlachula 2020), effects of experimental warming in the Arctic (Davenport et al. 2020), etc.

Thus, despite the extensive coverage of Arctic development issues, as the “windows of opportunity” in achieving the goals of sustainable development of the Arctic zone, we believe it is necessary to supplement the existing areas of research by studying technological and human resources using the emerging technological windows of opportunities in the change of technological orders for the Arctic regions. This provision predetermined the choice of the topic of the study, the tools used and the structure of the article.

Conclusions

The study of the prospects for the development of the emerging technological windows of opportunities in the Russian Arctic zone allowed us to draw the following conclusions:

1. There is considerable variability in the contribution of science-intensive and high-tech industries to the formation of gross value added in the Arctic region. At the same time, there is a stable dynamic of the contribution of the Arctic economy to the formation of the GRP of Russia as a whole.
2. There is a steady growth of the productivity index over the average Russian indicators, which can be considered as the potential for growth of high-tech components of labor in the development of the economy of the Arctic zone.
3. A negative statistically significant relationship has been identified between the share of the gross regional product of the Arctic in the Russian GRP and the share of GVAintensive products in the Arctic GRP, which may be regarded as a factor preventing the use of opportunities of the emerging technological windows.
4. Building a model of production function of technological windows of opportunities for the Russian Arctic zone pointed to the presence of potential in the exploitation of emerging technological windows of opportunity in the Russian Arctic zone in the development of human capital by activating and using high labor productivity, and creating high-performance jobs.

Based on the results of the study, it is possible to propose a set of measures exploiting the emerging technological windows of opportunity for the Arctic regions:

- Incorporation of cross-indicators into the program of socio-economic development of the Arctic zone of the Russian Federation, allowing to assess and analyze the dynamics of the relation between indicators of material and human capital development.
- Development of regional and industry sub-programs and projects of development of the region’s human capital as a key driver of technological development.

- Development of basic projects to expand the range of high-tech production facilities of the existing technological order for the Arctic regions, implemented based on the principles of public–private partnership.
- Implementation of industrial and social infrastructure projects aimed at achieving balance of interests in the development of material and human capital in the region.

The theoretical significance of the study lies in the generalization and systematization of institutional theory, project management theory and the theory of systems for managing the development of the Arctic region based on the use of opening technological windows of opportunities when changing technological structures. In addition, the methodology and tools presented in the article can be used as an initial methodological base for further research in this area in order to improve the efficiency of management of the Arctic territory.

We believe that the results of the study, its conclusions and its proposals can be used in the development, monitoring and implementation of state federal and regional programs and projects aimed at improving the level of technology and science of production in the Arctic zone, increasing its competitiveness, which is highly important for the national economy.

“Russia announces new renewables-powered arctic research station,” Philip Gordon, Smart Energy International, 20 February 2020 [128] <https://www.smart-energy.com/renewable-energy/russia-announces-new-renewables-powered-arctic-research-station/>

Overview:

Russia’s Moscow Institute of Physics and Technology (MIPT) has announced the start of construction on a year-round fully autonomous, renewables and hydrogen-powered International Arctic Station (IAS) in the Land of Hope, in the foothills of the Polar Urals.

Current & Relevant Information:

The station will have a modular structure and rely on renewable energy sources and hydrogen fuel, without burning diesel. The autonomy of the station will be provided by the energy of the sun and wind, and hydrogen obtained in the cleanest way possible. The station, dubbed Snowflake, is scheduled to begin operation in 2022.

The objective of the IAS is to test, improve, and promote solutions in the field of environmentally friendly technologies of the future for life support and the maintenance of remote settlements and facilities in the Arctic region.

Solutions to be tested will include for telecommunication, medicine, biotech, clean agriculture, robotics, the internet of things, smart home and smart settlement, 3D printing, advanced materials and construction technologies, and artificial intelligence systems.

“With the government’s support, MIPT is initiating an ambitious international project in the Arctic Council, which Russia will preside over in 2021-23,” said MIPT Rector Nikolay Kudryavtsev.

“That project envisages a carbon-free Arctic station, which would host visitors from all over the world: researchers, engineers, talented science students, and even high schoolers. They could all make working visits to the station year-round to test and demonstrate technologies that would be a part of our life tomorrow.”

“We are making the International Arctic Station an open platform that is convenient for all foreign partners willing to participate,” the rector went on. “We will also not limit ourselves to power engineering, creating opportunities for R&D in telecom, medicine, biotech, robotics, the internet of things, artificial intelligence, and more.”

According to Yury Vasiliev, the executive director of the MIPT Institute of Arctic Technologies, the construction of the station will be a challenging endeavor for Russian and foreign scientists. The total cost of the project is about €10-12 million.

“Mapping Russia’s Arctic Hydrocarbon Development Scheme,” Rylin McGee, The Arctic Institute Center for Circumpolar Security Studies, 18 February 2020 [129]
<https://www.thearcticinstitute.org/mapping-russia-arctic-hydrocarbon-development-scheme/?cn-reloaded=1>

Overview:

Globally, climate change presents major implications for hydrocarbon development and is especially relevant in the Arctic, where surface air temperatures warm at approximately twice the global rate. In the past five decades, Arctic regions saw downward trends in sea ice levels and snow cover extent, increased permafrost thaw, and an intensified hydrological cycle resulting from warming air temperatures. The Arctic is also one of the world’s most significant and extensive regions of untapped oil and gas. The Russian Arctic alone comprises over 35,700 billion cubic meters of natural gas and over 2,300 million metric tons of oil and condensate with the majority concentrated in the Yamal and Gydan peninsulas. However, successful hydrocarbon industries depend not only on resource reserves, but also on physical infrastructure, political structures and environmental context. Thus, fossil fuel development must be considered in relation to the complex entanglement of local firms, extraction sites and distribution systems which connect local resources to global markets, as well as the unique Arctic environments and global climate in which such networks are spatially embedded.

Concurrent with changing global temperatures, Russian President Vladimir Putin used the Fifth International Arctic Forum as a platform to announce Russia’s intentions to continue expanding its network of fossil fuel activity. Over the next decade and a half, Russia’s Arctic development strategy will focus on expanding fossil fuel extraction in Russia’s Arctic regions and developing the Northern Sea

Route as a primary means of distributing extracted hydrocarbons to market. In particular, Russia's resource distribution network and centralized state control play key roles linking local production to global consumption. Specifically, Russia relies on over 10,000 kilometers of pipeline and its re-emerging Northern Sea Route (NSR) to bring Arctic hydrocarbons to consumers in the East and West. As warming temperatures create ice-free or weakened ice corridors, the NSR has increasingly allowed Russia to realize its Arctic economic potential. In 2019, the volume of traffic shipped by nuclear icebreakers on the NSR reached 30.28 million tons. With increased infrastructural and technological investment, Russia seeks to reach 80 million tons by 2024. To complement such growth, Russia also plans to operate thirteen heavy-duty linear icebreakers by 2035, nine of which will be nuclear powered.

While investment in Arctic ports, infrastructure and technology allow Russia to expand its fossil fuel distribution network, dynamic geographic factors and environmental conditions such as climate, sea ice, sea levels, permafrost and remoteness also influence Russia's Arctic hydrocarbon landscape and emerge as key constraints to fossil fuel development at local, national and global scales. Thus, such factors must also be considered when attempting to understand the spatial network of Russia's developing Arctic hydrocarbon landscape. With large implications for the global environment and international markets, it is important to understand the current state of the Russian Arctic oil and gas industry. However, doing so requires us to consider the multidimensional and spatially-embedded series of networks which define Russia's Arctic hydrocarbon development activities. Building upon Stephenson and Agnew's (2015) work discussing Russia's Arctic oil and gas sector in relation to network theory, the maps below provide visual representations of Russia's Arctic fossil fuel network and reveal the spatial configuration of the region's development activity, as well as how the interaction between local, regional, and global fossil fuel networks are both territorial and trans-boundary in nature.

Current & Relevant Information:

Spatial Embeddedness and Changing Environmental Conditions

Visualizing Russia's Arctic fossil fuel development scheme reveals its spatially-embedded character, as changing Arctic environmental conditions such as permafrost thaw, melting sea ice extent, and rising sea levels closely influence the direction and development of regional activities. According to the Arctic Climate Impact Assessment (ACIA) program, the area of permafrost in the northern hemisphere will decrease 10 to 18% by 2030; 15 to 25% by 2050; and 25 to 50% by 2080 due to climate change. This means normally frozen regions will begin to thaw and recede, increasing the risk of accidents involving hydrocarbon infrastructure built in permafrost regions. Many pipelines in Russia's Arctic are built on full or partial permafrost zones, making them susceptible to soil expansion and recession and

thus damage with high repair costs and extensive environmental impacts. Here, the stability of Arctic pipelines and Russia's ability to connect local resources to global and primarily Western markets will be heavily influenced by future permafrost conditions. Sea ice conditions, which vary on seasonal bases, also pose a challenge. While state-owned corporation Rosatom will develop icebreakers to support Russia's targets for NSR export volumes, current conditions and sea ice variability render investment by many shipping firms unprofitable, due to limited navigability windows, icebreaker fees, insurance costs and other economic factors associated with Arctic maritime operations. Further, sea level rise in coastal regions presents the risk of erosion and flood damage, threatening infrastructure and key ports. Thus, the functioning of Russia's primary means of distributing LNG to eastern markets depends upon the ability of infrastructure and technology including tanker terminals, nuclear icebreakers and Arctic ports to withstand and overcome environmental factors. Russia's NSR is embedded in and contends with this changing environment.

Russia's hydrocarbon and NSR development scheme also exacerbates the very environmental changes which influence the realization of such ventures. Locally, emissions from shipping including black carbon intensify warming effects in already climate-sensitive Arctic regions, and the global consumption of Russian fossil fuels will intensify climate change impacts in regions extending beyond the Arctic. Therefore, Russia's Arctic fossil fuel development scheme must also be considered in relation to the geographic redistribution of emissions which will occur within the global fossil fuel network, as well as in relation to the resulting climate-induced economic costs and opportunities which will arise across the globe as a result.

Conclusion

Viewing each map in relation to one another, Russia's Arctic fossil fuel resources, infrastructure, transportation schemes, and environmental conditions interact with one another to form a complex series of networks which will continue to establish themselves in Russia's Arctic and beyond, especially as the state continues to invest in the fossil fuel industry. In particular, Russia's Arctic development strategy will stimulate investment in physical, midstream fossil-fuel distribution infrastructure and strengthen the connection between both local and global economies, as well as upstream and downstream fossil fuel activity. This in turn reinforces the connection between political and spatial networks. Thus, as Stephenson and Agnew underscore, the dynamism of political, social and physical geographies surrounding the Arctic extractive industry will continue to change the future functioning of networks embedded within them, especially as Russia continues to expand its fossil fuel economy in a warming world.

“The Arctic in Russia’s crosshairs,” Stefan Hedlund, Geopolitical Intelligence Services, 17 April 2023 [130] <https://www.gisreportsonline.com/r/the-arctic/>

Overview:

Intense military buildups and drills have replaced international cooperation in the Arctic. War is unlikely but expect growing East-West tensions.

In a nutshell

- Russia holds the Arctic Council's rotating presidency for 2021-2023
- Its seven non-Russian members halted participation in all meetings
- Russia's and NATO's military presence in the Arctic is increasing

Global warming and the melting Arctic ice cap were once associated with visions of a new era of international cooperation on initiatives like hydrocarbon exploitation and speeding up east-west transport via the Northern Sea Route. Now, those phenomena have triggered another type of heating – in the militarization race between Russia and the NATO alliance.

As Western governments resolved to stand by Ukraine after Russia's full-scale invasion, cooperation was replaced by open conflict, and there likely can be no going back any time soon. The danger of a military confrontation in the Arctic is the highest since the peak of the Cold War.

A harbinger of coming trouble was the 2014 launch of the first stage of the Russian invasion, the Crimea takeover.

In 2010, Norway and Russia decided to resolve a long-standing dispute over the common border in the Arctic. That was seen to pave the way for joint exploitation of the massive offshore deposits of oil and gas. Norway was not alone in getting ready. Global energy giant Exxon struck a multibillion-dollar deal with its Russian counterpart Rosneft.

Following the Russian annexation of Crimea in 2014, all of this had to be put on hold. While Exxon and others began pulling back from all Russian ventures, the Russian military embarked on a program for Arctic militarization. Aimed at projecting power into the north and at protecting the basing areas for the Northern Fleet at the Kola Peninsula, the program was comprehensive.

Current & Relevant Information:

Russia's ambitious militarization program

The land component entailed upgrading long-neglected military bases and forming special-purpose arctic brigades. The maritime counterpart saw the addition of modern ballistic submarines, testing highly capable naval weapon systems, and an expansion of the nuclear-powered icebreaker fleet.

Despite this Russian activity, the Western powers remained hopeful that mutually profitable energy cooperation would prevail and that the Arctic would not be

transformed into another arena for military confrontation. The full-scale invasion of Ukraine in February 2022 caused all such hopes to collapse.

Hardening attitudes

Ironically, Russia holds the rotating presidency of the Arctic Council for 2021-2023. Moscow was still looking at cooperative relations when it took over the helm. A policy document published in March 2020 called for the “strengthening of good neighborly relations with the Arctic states” in economic, scientific, cultural and cross-border cooperation. The other members voiced no open objections to the Russian leadership.

Norway was a case in point. It continued meeting Russian representatives at the border town of Kirkenes, where good personal relations had long allowed practical issues to be resolved locally. Together with neutral Finland and Sweden, it also maintained cooperation within the intergovernmental Barents Euro-Arctic Council and the Barents Regional Council. The latter body has 13 member counties and a representative of the indigenous peoples in the northernmost parts of Finland, Norway and Sweden and North-West Russia. Both councils had served to facilitate cooperation in the Barents Region in areas ranging from health and environment to maritime search and rescue.

The initial reaction to the full-scale attack on Ukraine was soft. On March 3, 2022, the seven non-Russian members of the Arctic Council announced a temporary halt to participation in all meetings of the Council. A year later, a senior United States official could note that “Moscow’s decision to invade its neighbor, an independent and sovereign state, makes cooperation virtually impossible for [the] foreseeable future.” The conclusion was that work within the Arctic Council must proceed without Russia.

Russia, in return, presented a new version of its Arctic strategy that deleted all prior references to multilateral regional cooperation formats like the Arctic Council and the Barents Council. Reflecting concern about the viability of the Northern Sea Route, it also emphasized Russian self-reliance, calling for “import independence of the shipbuilding complex.” Sanctions have constrained Russia’s ability to build icebreakers and to purchase ice-capable tankers from Western shipbuilders.

Facts & figures: The Arctic Council

The Arctic Council was created in Ottawa in 1996. Member states of the council include Denmark, Canada, Norway, the U.S., Russia, Sweden, Finland and Iceland. The council also has permanent participants drawn from groups that represent communities and peoples indigenous to the Arctic. The body’s secretariat is located in Tromsø, Norway.

Norway at the center of the rivalry

Norway, an Arctic frontline state with a long coastline that reaches the Russian border, is at the epicenter of the mounting tensions. Oslo is seriously concerned about increased activity by Russian submarines and aviation. Norwegian intelligence claims that the Russian Northern Fleet vessels are being deployed with tactical nuclear weapons on board for the first time since the end of the Cold War.

The U.S. has responded by increasing its involvement. Since the height of the Cold War, the U.S. Marine Corps has operated a prepositioning program in Norway. It uses cave complexes to store equipment and supplies sufficient to sustain a Marine Expeditionary Brigade in combat for 30 days. In recent years, U.S. Marines have deployed to Norway and Finland to enhance their skills in winter warfare.

During 10 days in March this year, 12,000 Norwegian and allied troops took part in the biannual Joint Viking ground forces exercise, while 8,000 participated in the parallel British marine exercise Joint Warrior, conducted off the coast of Norway. In tandem with these drills, the Norwegian Home Guard mobilized 4,200 troops for a three-week training exercise.

The strategic importance of the Arctic revolves around the Russian Kola Peninsula, which is home to the Northern Fleet and its ballistic missile submarines. In 2018, in response to mounting Russian assertiveness in the North Atlantic and the Arctic, the U.S. reestablished its Second Fleet, which had been deactivated in 2011. Its importance is now on the rise.

NATO countermeasures

In late February 2023, the U.S. Strategic Command sent one of its E-6B Mercury planes to Iceland. Colloquially known as a “doomsday plane,” it is designed to serve as a command-and-control center for the U.S. Navy, enabling secure communications with its strategic nuclear submarines. In an emergency, the plane can be used as a command post for the president, who may authorize the launch of nuclear weapons. Given that the plane is hard to detect on radar and has considerable endurance, its forward posting was a clear signal to the Kremlin.

A similar signal was sent in early March when the U.S. Air Force sent a B-52H Stratofortress strategic bomber to patrol the Gulf of Finland. Being capable of carrying nuclear weapons, it approached within 200 kilometers of St. Petersburg, where it turned south across the three Baltic republics. Just shy of the border between Lithuania and the Russian Kaliningrad exclave, it turned west, hugging the Russian border until it was over open water. Polish Defense Minister Mariusz Blaszczak posted a proud Twitter message saying that the American B-52 had been escorted by Polish fighter jets.

Although the adversarial posturing and rhetoric are reasons for concern, the likelihood of an open military confrontation between Russia and NATO remains low. The downside for Russia is that so much of its land forces have been destroyed in

Ukraine. The losses notably include among the Arctic brigades. Both troops and special-purpose Arctic equipment from these units have been observed on the battlefields in Ukraine. The exact magnitude of their degradation is unclear but believed to be substantial. Although Arctic bases remain staffed by skeleton units, there can be little doubt that Russian military strength in the region has been degraded.

New strategic reality

This is occurring when Finland just has joined NATO, and Sweden is about to follow suit. The addition of the armed forces of these two countries – highly capable in winter warfare in mountainous terrain – makes short shrift of previous scenarios of a Russian push toward the west to reach the coast of Norway.

Russian military planners will now instead have to consider the danger of a NATO ground operation to take out the Russian bases on Kola at a time when its ground forces are fully committed in Ukraine. The long common Russian-Finnish border, and the fact that Finland has the most potent artillery force in Europe, constitute a particular threat to Russia's northwestern flank. Yet, given that a NATO ground offensive would be sure to provoke a nuclear response, this is not a likely scenario.

What does remain as a threat against NATO in the north is the fact that Russian naval forces remain largely intact. The nuclear ballistic missile submarines present a severe strategic challenge, and modern Kilo-class conventional submarines are not to be trifled with. Russia also has smaller surface ships like the Gorshkov-class frigates that offer capable platforms for launching cruise and anti-ship missiles. The Russian Air Force is also believed to be largely intact. Mostly absent from Ukrainian airspace, it has sustained minor losses only – at least in comparison to the ground forces.

Russian brinkmanship expected

Discounting the danger of a ground war in the Arctic, the question that remains concerns just how combat-capable the Russian naval and air assets are. Military analysts have already been proven fundamentally wrong in their assessments of the capability of the Russian ground forces. The fact that the Russian air force failed to achieve air superiority in Ukraine, and has since been mainly withheld from combat, does say something meaningful about its capability.

The prior media hype about advanced Russian missile technology has taken an even bigger hit. It is not enough that the stocks of some of the more advanced missiles have been seriously depleted. Their accuracy has already proven to be poor, and as planners dig deeper into old stockpiles, reliability will deteriorate even further.

If the Russian military command were to contemplate getting into a shooting war with NATO, it would have to consider that indiscriminate bombing of civilian targets

in Ukraine offers a very different challenge from engaging technologically advanced NATO forces that possess effective countermeasures, including long-range precision strike capabilities that have been denied the Ukrainian defenders.

While the danger of Russia deliberately initiating a large-scale armed conflict in the Arctic may, in consequence, be viewed as slim to nonexistent, there remains a danger of close encounters that may result in serious escalation. The incident with a Russian fighter jet downing a U.S. reconnaissance drone over the Black Sea in March brings that message home.

The leading cause for concern is that as Russia realizes it is losing the war in Ukraine, it will likely seek to save face by engaging in brinkmanship elsewhere. Given its location and its increasingly important role as a supplier of gas to the European Union, Norway offers a tempting target for deniable Russian intelligence and sabotage actions.

The waters off its long coastline offer soft targets that range from drilling platforms to pipelines and assorted underwater cables. The sabotage against the Nord Stream pipelines illustrates vulnerability, and there have been mounting indications of Russian ambitions to scout and chart such assets. Following numerous incidents of drones flying close to critical installations on land, members of the Norwegian Home Guard have also been called up to patrol and protect such potential targets.

“Sun, wind, and hydrogen: New Arctic station will do without diesel fuel,”
EurekaAlert, 30 January 2020 [131] <https://www.eurekaalert.org/news-releases/594604>

Overview:

The Moscow Institute of Physics and Technology (MIPT) has initiated a project of the Russian Federation called "Arctic Hydrogen Energy Applications and Demonstrations" (AHEAD) in the Arctic Council's Sustainable Development Working Group (SDWG). The project is supported by the Russian Ministry of Science and Higher Education, the Ministry of Foreign Affairs, the Ministry for the Development of the Russian Far East and Arctic, the governor of Yamalo-Nenets Autonomous Okrug, and the EnergyNet infrastructure center of the National Technology Initiative.

Current & Relevant Information:

Together with its Russian and foreign partners, MIPT undertakes to build a year-round fully autonomous International Arctic Station (IAS) in the Land of Hope, in the foothills of the Polar Urals. The station will have a modular structure and rely on renewable energy sources and hydrogen fuel, without burning diesel. The autonomy of the station will be provided by the energy of the sun and wind, and hydrogen obtained in the cleanest way. The station, dubbed Snowflake, is scheduled to begin operation in 2022.

The objective of the IAS is to test, improve, and promote solutions in the field of environmentally friendly technologies of the future for life support and the maintenance of remote settlements and facilities in the Arctic region. This includes solutions for telecommunication, medicine, biotech, clean agriculture, robotics, the internet of things, smart home and smart settlement, 3D printing, advanced materials and construction technologies, and artificial intelligence systems that improve the living and working conditions in the Arctic.

"With the government's support, MIPT is initiating an ambitious international project in the Arctic Council, which Russia will preside over in 2021-23," said MIPT Rector Nikolay Kudryavtsev. "That project envisages a carbon-free Arctic station, which would host visitors from all over the world: researchers, engineers, talented science students, and even high schoolers. They could all make working visits to the station year-round to test and demonstrate technologies that would be a part of our life tomorrow."

"We are making the International Arctic Station an open platform that is convenient for all foreign partners willing to participate," the rector went on. "We will also not limit ourselves to power engineering, creating opportunities for R&D in telecom, medicine, biotech, robotics, the internet of things, artificial intelligence, and more."

According to Yury Vasiliev, the executive director of the MIPT Institute of Arctic Technologies, the construction of the station will be a challenging endeavor for Russian and foreign scientists. The total cost of the project is about 10-12 million euros.

"The main building of Snowflake will be a panoramic view dome, connected with a range of other modules. Two of them will host laboratories, and two more provide accommodation, with about 30 single rooms for researchers and guests to feel comfortable. Other modules will house a kitchen, a dining room, a library, and leisure areas, including a gym and a sauna. Three more separately standing domes will form a hydrogen complex for the production and storage of compressed gas," said Vasiliev.

"An all-terrain vehicle will run year-round between the station, Salekhard, and its airport, with a gas station for electric vehicles and a helipad for emergency assistance on the way," he added.

The authors of the project paid serious attention to preserving the lifestyle of indigenous peoples and bringing new clean technologies to the Arctic.

“How Russia’s Future With NATO Will Impact the Arctic,” Christian Perez, Foreign Policy Insider, 25 February 2022 [132] <https://foreignpolicy.com/2022/02/25/arctic-ukraine-russia-china-eu-invasion-nato/#:~:text=Armed%20conflict%20threatens%20longstanding%20Arctic%20cooperati>

[on&text=Since%202014%2C%20Russia%20has%20built,most%20recently%20in%20January%202022.](#)

Overview:

The geopolitical importance of the Arctic region is coming back into focus as Russian troops further encroach into Ukraine. The Russian invasion is further deteriorating relations and highlighting critical fault lines between Russia and NATO-allied states. In determining their response to Russian aggression, NATO allies are weighing key considerations, including the various impacts from the potential use of force, balancing the use of sanctions with Europe's reliance on Russian energy supplies, and addressing Russia's strengthening ties with China.

The Arctic region is set to play a key role in each of these considerations. Abundant natural gas and energy reserves are concentrated in Russian Arctic territory, which European countries are highly dependent on for their energy supply. Meanwhile, Russia has made the Arctic a focal point of its military modernization efforts, leading to a steady buildup of Russian and NATO forces throughout the region. The widespread military buildup since 2007 amplifies the potential for a conflict between Russia and NATO-allied states to spill over into the region. Armed conflict in the Arctic could permanently damage regional cooperation, compromising coordinated efforts, dating back to 1996, among the Arctic states (Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, and the U.S.) in search-and-rescue operations, environmental protection, and prevention of illegal fishing, among other issues. President Putin is also leveraging Arctic resources to strengthen his hand elsewhere, including deepening connections with China by announcing renewed cooperation in the Arctic and signing a new 30-year agreement on energy exports in early February.

As the Ukraine crisis evolves, the Arctic's role and the impact the crisis could have on the region are broken down below.

Current & Relevant Information:

Arctic Competition

Rapidly receding sea ice is enabling access to a range of highly valuable resources across the Arctic. In addition to energy reserves, critical minerals, and fisheries, newly opened shipping lanes across the Arctic could potentially help to re-route global trade and enable high-speed internet connectivity between Europe and Asia. The ability to exploit newly available Arctic resources is drawing increasing interest from both commercial and national actors and is enticing nations, such as China and Japan, to pour both political and financial capital into the region.

As new commercial relationships emerge in the Arctic, Russia and China are increasingly collaborating on Arctic development—with China providing capital for Russian energy and infrastructure projects. At the same time, Russia has been

militarizing its Arctic territory, re-opening Soviet-era military bases, investing in new Arctic-specific technologies, and conducting extensive war games across the region. This has prompted NATO countries, led by Norway and the U.S., to conduct their own war games in the region and has raised concerns over the potential emergence of a Russia-China alliance in the region.

Russia and China's relationship is nuanced. The two countries have their own competing interests in the Arctic, with interactions between the two actors to proceed at a cautious pace for now. However, increasing military activity in the region continues to elevate the risk of a misunderstanding, or an outside conflict spilling over into the Arctic, particularly in the absence of an official security body for national actors through which to address regional defense issues.

With new players, commercial relationships, and extensive military buildup emerging in the Arctic, there has been an attendant increase in international tensions. Commercially, strengthening ties between Asian and European nations, deepening levels of Chinese investment across the region, and Russia's emerging primacy are generating U.S. pushback. Militarily, Russia's extensive defense buildup, and alternating military exercises by Russia and NATO actors have created a potentially more volatile region. Against a global backdrop of heightening U.S.-Russia tensions and the wider uncoupling of the U.S. and Chinese economies, the Arctic is emerging as an arena of great power competition.

7. Sweden:

“Green Building in the Arctic Region: State-of-the-Art and Future Research Opportunities,” Lucrezia Ravasio, Svein-Erik Sveen, and Raymond Riise, MDPI, 10 November 2020 [133] <https://www.mdpi.com/2071-1050/12/22/9325/pdf>

Abstract:

The concept of Green Building refers to environmentally friendly constructions with the target of minimizing the impact on the natural environment through sustainable and efficient use of resources over their life cycle. Since modern buildings are large contributors to global energy consumption and greenhouse gas emissions, policies and international strategies intended to reduce the carbon footprint of conventional buildings are highlighting the role of this recently introduced building concept. This study provides a systematic literature review of existing research related to Green Buildings in the Arctic. Despite numerous studies and projects developed during the last decades, a study describing the current research status for this region is still missing. The review first examines the role that national and international policies developed by the arctic countries have on the development process of Green Buildings. Second, it provides an overview of the most commonly used and promoted Green Building rating systems used by the same countries in the region. The analysis highlights benefits and critical issues of Green Buildings located in the Arctic in comparison with conventional buildings, focusing on environmental,

economic, and social dimensions. Finally, future research opportunities are presented and discussed.

Current & Relevant Information:

Introduction

In recent decades, the consciousness of the impact of human activity on the natural environment has grown. This awareness has affected the construction industry, highlighting the link between sustainability and environment and thereby giving it strength and momentum. The green movement, having spread in all fields of society, has led to the emergence of worldwide, national, and local programs advancing green principles in both construction and home-building sectors. Indeed, studies show that buildings play a significant role in climate change.

The term climate change generally refers to the long-term shift in global or local climate patterns, usually identified with the rise of average temperature over the years, owing to human activities. Among all the regions of the planet, because of its special physical and geographical properties, the Arctic is experiencing the most severe effect of climate change through greater and more rapid rise of average temperature. The Arctic Region is commonly defined as the area north of the Arctic Circle (66°32' N), or as the area north of the 10 °C July isotherm as shown in Figure 1a. Alternatively, it can also be defined by vegetation or oceanographic characteristics. In this review, the definition used by the Arctic Monitoring and Assessment Program (AMAP) is adopted. It considers the area delimited by the tree line as shown in Figure 1b. The arctic climate is typically characterized by extreme seasonality and variation in temperature and precipitation, strong gradient in latitude solar, and UV radiation. In addition, low temperatures lead to an extensive and permanently ice-covered or frozen ground, i.e., permafrost, which makes the region vulnerable to climate change. Warming of the Arctic and consequent melting has global implications, such as alteration of global ocean circulation, sea level rise, and release of methane and carbon dioxide trapped in the permafrost, i.e., gases that are feeding and accelerating the process of temperature-rise.

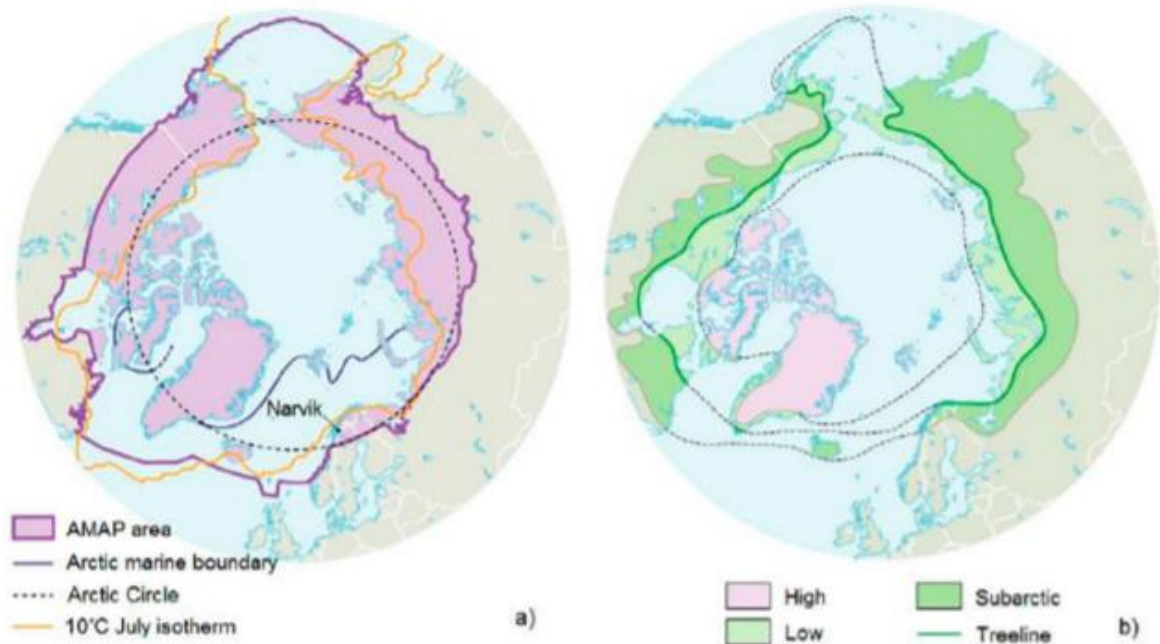


Figure 1. (a) The Arctic defined by the 10 °C July isotherm. (b) Arctic floristic boundaries [7].

According to the Global Status Report of 2019, buildings and constructions together account for 36% of global energy use and 39% of energy-related carbon dioxide emissions in 2018. This makes buildings the largest contributing sector to global warming. The same report declares that, due to the strong floor area and population expansions, total global energy consumption in buildings in 2018 increased 1% from 2017. In perspective, Green Buildings become a potential strategy and investment to limit demand and reduce energy intensity. In fact, through the introduction of new building codes and adoption of advanced certifications for high-energy performance, all participants in the building and construction value chain are globally contributing to decarbonization of building stocks and to the improvement of building's energy performances.

By definition, a Green Building is a high-performance building with a reduced negative impact on the natural environment and human health. This is achieved by applying measures that take into account the building location, as well as water, energy and material use efficiency, resource conservation, indoor air quality, building operation, and maintenance over the entire building life-cycle. Green Buildings also provide benefits from an economic and social perspective, through lower building life-cycle costs and improved comfort and well-being of their occupants. This promising solution is also expressed in different building concepts related to sustainable and environmental design such as net and nearly zero-energy buildings, zero-emission, zero-carbon, and carbon-neutral buildings.

With this backdrop, policies aimed at safeguarding and protecting the arctic environment represent a challenge of paramount importance for the region at the present and for the future. Governments with territories in the Arctic—Norway, Sweden, Finland, Denmark, Iceland, Russia, Canada, and United States—are closely involved in the development of new initiatives both locally, with national legislation, and globally, through the Arctic Council. Established in 1996 with the Ottawa Declaration, the Arctic Council is an intergovernmental forum promoting cooperation, coordination and interaction among the Arctic States. The Arctic Cooperation also includes the European Union, the Nordic Cooperation, the Barents Cooperation, and the United Nations.

The purpose of this research is to present local and global initiatives stated by the institutions and the bodies on reduction of building's carbon footprint in the Arctic. The aim is to examine the players in the Green Buildings transition process in the Arctic and evaluate the applicability of currently used assessment tools in these special climate conditions. By identifying benefits and criticalities, and design practices of Green Buildings Arctic climate, the study highlights the current state of the art and future research opportunities. Therefore, this results in practical interest for companies and institutions that want to invest resources for development solutions for reducing the buildings' carbon footprint in the region.

Sweden

The Swedish climate change and energy policies framework was published by the Swedish parliament in June 2018. According to EU regulations and the Paris Agreement, main objectives are set at 10-year intervals and mainly include reduction of emissions, taking 1990 as a reference year. These policies are presented in the report "Sweden's draft integrated national energy and climate plan", which introduces the following measures for achieve the climate target set for 2030 for dwelling houses:

1. Limits in the specific energy use (kWh/m² and year), average thermal transmittance [W/(m²K)], and building's average air leakage [1/(sm²)] for new and existing buildings.
2. A support scheme for renovation and energy efficiency of rental apartments, introduced to incentivize renovation and energy efficiency of rental apartments in areas with socioeconomic challenges.
3. Establishment of an Information Centre for Sustainable Building for promoting energy-efficient renovation and energy-efficient construction using sustainable materials and low climate impact from a life-cycle perspective.
4. Implementation of an Energy Performance Certificate Act, a law on energy performance certificates for buildings, to promote efficient use of energy and healthy indoor environment.

These strategies, which are similar to those implemented in Norway, with TEK 17 and Energi-forskriften (Energy Regulation), were also presented in the document “Sweden’s Seventh National Communication on Climate Change”, along with the report of the downward trend in emissions between 1990 and 2015, due to the transition from oil-fueled heating of homes and commercial to electricity.

However, actions are being taken by the government at a regional and local level, and include a new energy labelling directive (Ecodesign Act SFS 2008:112) as well as requirements for setting minimum energy performance standards (Energy Performance of Building Directive 2010/31/EC), and the implementation of a law on energy performance certificates for buildings (Energy Performance Certificate Act SFS 2006:985). Specific policies regarding the construction sector have been developed by the Swedish National Board of Housing, Building, and Planning and include the Planning and Building Act (2010:900), and the Planning and Building Ordinance (2011:338). In particular, the second chapter of the legislation 2010:900 aims to promote a planning with regards to natural and cultural values, environmental and climate aspects through also a long-lasting and effective management of land and water areas, energy resources and raw materials.

The strategy developed by the Swedish Government for the Arctic was presented in 2014 through the “Sweden’s strategy for the Arctic region” program, where priorities and the outlook for Sweden’s arctic policy have been outlined. The government’s goal is to promote sustainable development in an economic, social and environmental dimension, and to reduce global emissions of greenhouse gases and short-lived climate forces, along with the implementation of the Arctic cooperation program.

Conclusions and Future Research Opportunities

In this paper, a critical review of existing studies related to development of Green Buildings has been presented for seven of the Arctic countries. Even though there is an abundance of literature covering Green Buildings, the field is still lacking of studies specifically related to the Arctic. Below, the conclusions of each section are summarized:

- The review identifies the main actors in the Green Buildings development in the Arctic region. Indeed, global commitments aimed at mitigating climate change effects are leading governments to advance polices and national building codes responding to stricter standards, therefore pushing the construction industry and the market to adapt sustainable solutions. The transition to Green Buildings in the Arctic can be achieved if policies and building standards are implemented considering local climate and urbanistic patterns as well as the future local climate trend.
- Green Building rating tools are also playing a key role in promoting of sustainable, green constructions. Setting standards and requirements, they are pushing boundaries of sustainability in the building sector. The evaluation process takes into

consideration different parameters according to different climate conditions and geographical characteristics, making the tools reliable and versatile. Despite the small number of buildings certificated in the Arctic, the criteria considered by the different tools showed the applicability of these systems in the Arctic. However, since Green Building rating tools are not designed on Arctic climate and local characteristics, the review identified that some of the evaluated criteria—such as transport and energy—are penalizing the achievement of certifications and high scores. In addition, more research is needed to identify the factors that are slowing the adoption of this type of sustainable solutions in the region.

- The review highlights general benefits and exposes criticalities of Green Buildings, focusing on the technologies needed for their development in the Arctic. In fact, the Arctic offers several solutions for green electricity generation. The challenge is creating a network that can reach rural areas, or alternatively, installing on-site production facilities. For this reason, it is necessary to develop technologies for on-site generation that can meet arctic requirements. To understand if Green Buildings located in the Arctic benefit from economic advantages, future research should also focus on arctic Green Building energy performance and cost analysis. In this way, it will be possible to calculate and estimate the average energy demand, energy savings, and the related accomplishments in economic terms.
- Green Buildings should be designed to meet current green standards and keep them over the time. Indeed, durability is an important feature of green design, and, since the Arctic is experiencing higher average temperature and permafrost melting, buildings should be designed taking into account these challenging changes in local climate patterns.

“Sweden Becomes Electric Car Battery and Green Tech Hub, a New Silicon Valley Emerges at The Arctic Circle,” Hydrogen Central, 11 October 2022 [134]

https://hydrogen-central.com/sweden-becomes-electric-car-battery-green-tech-hub-new-silicon-valley-emerges-arctic-circle/#google_vignette

Overview:

Sweden becomes electric car battery and green tech hub, A New Silicon Valley Emerges at the Arctic Circle.

Dozens of Swedish startups are working on clean-energy mobility, creating what some call “Sustainability Valley.”

Current & Relevant Information:

Just below the Arctic Circle, a vast factory owned by Northvolt AB churns out electric-vehicle batteries for Europe’s biggest automakers. On Sweden’s west coast, four-year-old Heart Aerospace AB is building an electric plane ordered by United Airlines and Air Canada.

And in Stockholm, startup X Shore AB has developed a \$99,000 battery-powered vessel it says heralds a “Tesla moment” for leisure boating.

These companies and dozens more make Sweden a thriving hub for innovations in greener transportation, with the most tech investment per capita in Europe. A skilled workforce, abundant investment capital for climate projects, and ample supplies of renewable energy have helped the country of 10 million become a leader in clean-technology startups.

“Technological Innovations for a Sustainable Arctic,” Jong Deog Kim, et al., Global Asia, December 2020 [135]

https://www.globalasia.org/v15no4/cover/technological-innovations-for-a-sustainable-arctic_jong-deog-kimsungwoo-leeminsu-kimjeehye-kim

Overview:

The Arctic region is often seen as the barometer of climate change, a place where threat and opportunity coexist. There are limitations imposed by extreme weather conditions, the risk of shipping accidents, pollution of the marine environment and isolated living conditions that make building communication networks and infrastructure difficult. But as global warming accelerates the melting of sea ice in the Arctic Ocean, the once-frozen space has become more accessible and conducive to the development of resources and the use of sea routes. This is changing the region’s industry, economy, society and culture.

Particularly in the last decade, changes have been drastic. The minimum extent of sea ice was recorded in 2012, and glaciers in Greenland are melting at an unprecedented rate. Rising temperatures, melting permafrost and acidification of the Arctic Ocean are all impacting flora and fauna and the livelihoods of the region’s peoples. Simultaneously, Arctic states and their global business partners have invested in mega oil and gas developments, infrastructure projects and other logistic efforts. Growing human activities, including tourism, have raised environmental risks and increased economic impacts on local communities.

The 2010s were marked by international co-operation as the Arctic Council, the highest intergovernmental forum in the Arctic, produced rules-based agreements on search and rescue, marine oil pollution and scientific co-operation. These agreements together with the Central Arctic Ocean Fisheries Agreement all emphasize science as the common language of Arctic governance.

Non-Arctic states, including China, Japan and the Republic of Korea (referred to below as South Korea), were approved as observers in the Arctic Council in 2013. They have all increased their Arctic activities through bilateral and multilateral co-operative mechanisms. Needless to say, the Covid-19 pandemic in 2020 has produced socio-economic impacts in the Arctic. These have accelerated complexity and increased risks and challenges.

To reduce and manage these risks, we should consider the use of technology based on sustainable principles. In this regard, the innovative technologies associated with what is known as the fourth industrial revolution have the potential to help meet these challenges in a harmonious and practical way.

Current & Relevant Information:

Innovative Approaches to the Arctic

The global economic value of innovative technologies is increasing, gaining attention as a means of reducing risks, and expanding opportunities in the Arctic and elsewhere.

Factors such as the extreme climate and the unique nature of Arctic biological variability increase vulnerability and make the need for advanced ICT technologies greater than in other regions. To protect the environment and ecosystems, the demand will be high for a combination of technologies including monitoring technologies that use Big Data to predict and forecast climate change and data collected by drones to manage Arctic biological variability and ecosystems. Potential areas for the application of fourth industrial revolution technologies include the development of ports and related infrastructure to make sea routes safe and efficient. As climate change leads to resource and infrastructure development, demand seems certain to grow for high-tech innovative technologies attuned to the Arctic's unique features.

Against this backdrop, this essay seeks to highlight the perceived level of current innovative technology in the Arctic and future needs from a Korean perspective. Innovative technologies could help address significant issues related to the supply of labor, which is an important matter for the development of the Arctic. While development in the Arctic is expected, led by natural resources and infrastructure, the working population needed to support such development is insufficient.

According to Guggenheim Partners, investments in Arctic infrastructure are expected to reach US\$1 trillion over the next 15 years. In comparison, the Arctic population is expected to increase only from 4,050,000 in 2010 to 4,200,000 in 2030, a mere 4 percent increase over 20 years compared to the projected 29 percent increase in global population during the same period. Therefore, the future demand for innovative technologies that use automation and unmanned systems is expected to be high. Arctic industries driven by such innovative technologies will play an important role in achieving sustainable development in the Arctic.

Gaps and Challenges

The survey results indicate that the perception of the need for innovative technologies for various Arctic issues is high, whereas the perception of the actual use of these technologies is low. Also, there is a gap between current and future levels of their use as seen through the eyes of experts.

To reduce the gap, policy initiatives and international co-operation must go hand in hand. There is a need to increase investments in R&D relating to innovative technologies. This could produce a socio-economic ripple effect through the industrial network, including the environment-resource-infrastructure-shipping-logistics network. Also, consideration should be paid to expanding technological exchange and co-operation, including joint research with other technologically advanced countries. According to the World Economic Forum, for example, South Korea ranked as the most innovative country among some 200 countries surveyed.⁴ All Arctic states ranked within the world's top 25, with Sweden, Finland and Denmark ranked second, seventh, and eighth, respectively. South Korea and the Arctic countries are all leaders in innovation, and this shows that there is potential for South Korea among the non-Arctic States to make contributions in applying innovative technologies to industries in the Arctic, thereby contributing to sustainable and responsible development.

Still, it is difficult to say that a satisfactory analysis has been conducted by just considering perceived levels of current innovative technologies as applied in the Arctic based on one simple survey of Korean experts. The role and importance of technologies will differ across applicable areas and types of technology. In future studies, additional analysis will be needed according to different technology types, applicable areas and the level of technology currently in use in order to arrive at a more comprehensive and accurate picture. Nevertheless, this study is valuable as a point of departure for future research.

Innovative technologies are making significant impacts around the world, across a wide range of industries and spaces. The Arctic is seen as one of the regions that will have the greatest need for innovative technologies to overcome environmental and human resource limitations and to eliminate social costs. It is predicted that Arctic states will actively seek to promote policies encouraging the adoption of innovative technologies and enhancing co-operation with states that possess such technologies.

In the meantime, the Covid-19 pandemic is further isolating the Arctic region due to its extreme climate, geographical isolation, low population density and infrastructure deficits. In response, solutions designed to address the impacts of Covid-19 in the Arctic are developing rapidly. The emergence of “un-tact” technologies is accelerating, as the time needed for commercialization of these technologies is becoming shorter.⁵ Whereas before the outbreak of Covid-19, the usefulness of innovative technologies sometimes seemed low due to the high price of development compared with likely benefits, the pandemic has caused a rapid rise in demand for innovative technologies, making them realistic solutions to specific problems.

Finally, in adapting innovative technologies for use in the Arctic, it is essential to consider extreme climatic conditions. There is some question whether innovative

technologies can function as well under extreme weather conditions as they do in more temperate climate zones. “Winterization” of innovative technologies will be needed in the Arctic, further strengthening the focus on the importance of research and development.

While the potential and the demand for innovative technologies in the Arctic to help ensure sustainable development is clear, there are differences in approach among the Arctic states with regard to their policies, investments and existing uses of innovative technologies. It is time to search for ways to safeguard the Arctic region from the adverse impacts of global warming by encouraging the development of cooperative initiatives to make use of innovative technologies. South Korea is ready to play an active role in this effort.

“In Sweden’s Far North, a Space Complex Takes Shape,” Thomas Erdbrink and Christina Anderson, *The New York Times*, 10 June 2021 [136]

<https://www.nytimes.com/2021/05/23/world/europe/sweden-space-arctic-satellites.html>

Overview:

The Esrange Space Center, which shares a landing zone that is more than 2,000 square miles, will be a testing ground for Europe’s first reusable vertical rocket in 2022.

Local reindeer herder Aslak Allas and his family. Mr. Allas fears that the noise of more rocket launches will drive away his reindeer.

The path to the reindeer herder’s spring home took him across four frozen lakes and countless snowy hilltops. Arriving to a light dusting of snow, the herder, Aslak Allas, switched off his snowmobile, and the overwhelming silence of Sweden’s Arctic settled in.

His reindeer, thousands of them, were nowhere to be seen. “They are very scared of noise,” Mr. Allas explained, pointing to his vehicle.

He then motioned toward the distant hills dotted with birch trees, their buds swelling with the warming spring sun. “Now, the noise coming from there, that will be something else,” Mr. Allas sighed.

That noise is expected to arrive with a roar next year, when Sweden is scheduled to complete construction of a rocket-launching complex in the frozen lands north of the Arctic Circle and jump into the commercial space race, the first country in Europe to do so.

Current & Relevant Information:

With the crystal-clear air of the Arctic night and a decent telescope, it’s easy to pick out some of the thousands of shoebox-size commercial satellites orbiting the earth. Their numbers are set to explode in the coming decade, powered by the use of light,

reusable rockets developed by innovative U.S. companies like Elon Musk's SpaceX. He and several competitors are planning to send up to 50,000 such satellites into space in coming years, compared with fewer than 3,000 out there now.

While the United States, China, Russia and several other countries already have spaceports, Sweden's would be the first orbital launch site for satellites in Europe — capable of launching spacecraft into orbit around Earth or on interplanetary trajectories. Currently, the intergovernmental European Space Agency launches its traditional single-use Ariane rockets from French Guiana.

Several private European companies are designing spaceports in Europe to host a new generation of smaller rockets. Portugal is looking into building one on the Azores Islands, two remote sites have been allocated in Britain and Norway is upgrading its Andoya Space Center.

But none are as far along as Sweden, which is transforming an old Arctic space research center into a complex featuring several new pads for orbital launches and landings. The Esrange Space Center will be a testing ground for Europe's first reusable vertical rocket in 2022, and it can conduct engine tests as well.

In 1972, the Swedish government took over the base from the European Space Agency, which no longer needed it. For decades, the Swedes hired out the site for smaller, slower research rockets, satellite ground-control services and the launching of stratospheric balloons. But with the commercial space race promising new revenue, the government-owned Swedish Space Corporation, which manages the site, is offering launch services to private ventures wishing to send satellites into space.

“Swedish Polar Research Secretariat,” polar.se, 2024 [137]
<https://www.polar.se/en/about-the-secretariat/>

Overview:

As a government agency, the Swedish Polar Research Secretariat is mandated to co-ordinate and promote Swedish polar research. The agency's primary mission is to organize and support research expeditions to the polar regions and manage research infrastructure. The Secretariat also helps to create favorable conditions for polar research that does not involve fieldwork.

Current & Relevant Information:

The Director of the authority is Katarina Gårdfeldt. The Swedish Polar Research Secretariat is a single-council-authority, which means that the head of authority (i.e. the Director-General) is completely responsible for all activities. The Government has appointed an Advisory Council that will provide public insight in the organisation and give the Director-General advice.

The Swedish Polar Research Secretariat has about 30 employees engaged in research planning, research infrastructure, communication and administration. The Secretariat provides expertise and raises awareness of polar regions and polar research in order to advance high quality polar research and the dissemination and use of research findings in society. The Secretariat is also involved in international negotiations and partner-ships, among else led by the Swedish Ministry for Foreign Affairs.

Environmental protection and permits

The Secretariat also works actively to improve environmental protection in the polar regions and dispenses permits according to the Swedish Antarctic Act.

Polar research

Polar research plays a key role in the development of knowledge related to issues including climate change and the environment. Research is carried out and pertains mainly to the Arctic and Antarctic regions, although scientists are also keenly interested in the subpolar regions and Swedish mountain areas.

The Swedish Polar Research Secretariat follows and supports scientists from concept to publication, through research expeditions and other data collection, as well as making data available and communicating research findings.

For research planning, the Secretariat co-operates with the Swedish Research Council.

“Sweden’s long-term strategy for reducing greenhouse gas emissions,”
Government Offices of Sweden: Ministry of the Environment, December 2020
[138] https://unfccc.int/sites/default/files/resource/LTS1_Sweden.pdf

Summary:

Purpose

Long term strategies shall contribute to fulfilling Parties commitments under the UNFCCC and the Paris Agreement to reduce anthropogenic greenhouse gas emissions and enhance removals by sinks, and to promote increased carbon sequestration. Reporting concerns national long-term objectives for territorial emissions. This document constitutes Sweden’s reporting and derives from Sweden’s existing targets, and policy instruments and actions decided on in the field of energy and climate. The strategy is largely based on the national climate policy framework and Government “Bill En samlad politik för klimatet – klimatpolitisk handlingsplan” (A coherent policy for the climate – climate policy action plan).

The Swedish Climate Policy Framework

Under the Paris Agreement, all countries are to contribute towards holding the increase in the global average temperature to well below 2 °C and pursuing efforts to

limit the temperature increase to 1.5 °C. This demands wide-ranging action to reduce greenhouse gas emissions and also demands that every sector of society plays a part in the climate transition. In 2017, the Swedish Parliament (Riksdag) adopted a climate policy framework with (1) national climate goals, (2) a Climate Act and (3) a Climate Policy Council.

The climate policy framework's long-term climate goal establishes that, by 2045 at the latest, Sweden is to have zero net emissions of greenhouse gases into the atmosphere and should thereafter achieve negative emissions. By 2045, greenhouse gas emissions from Swedish territory are to be at least 85 per cent lower than emissions in 1990. To achieve net zero emissions, supplementary measures may be counted in line with rules decided at international level. Supplementary measures may be (1) increased net removal of carbon dioxide in forests and land, (2) verified emission reductions from investments in other countries, and (3) negative emission technologies such as capture and storage of biogenic carbon dioxide (BECCS).

Milestone targets for Swedish territorial emissions in the sectors covered by the EU's Effort Sharing Regulation have been adopted for 2020, 2030 and 2040. Emissions from domestic transport, excluding domestic aviation which is included in the EU ETS, are to be reduced by at least 70 per cent by 2030 compared with 2010.

Sweden's Climate Act imposes an obligation on current and future governments to pursue a policy based on the national climate goals. The Act contains elements that ensure that the policy is planned and followed up.

Sweden's Climate Policy Council is an independent expert body tasked with evaluating whether the overall policy decided by the Government is compatible with the climate goals.

The EU's climate policy has a major impact on how Swedish policy can be conducted. The EU's current climate target is to cut greenhouse gas emissions by at least 40 per cent in the EU by 2030 compared to 1990. In September 2020 the European Commission presented its 2030 Climate Target Plan which proposed to increase the target to at least 55 per cent. The EU's heads of state and government are expected to endorse such an enhanced target at the end of 2020.

The emissions covered are territorial and do not include the emissions that the EU causes outside the EU's borders. A number of policy instruments at EU level, including emission standards for vehicles and emissions trading are very important to Sweden's possibility to meet its own national targets.

Sweden uses a number of national and EU-wide policy instruments to meet the national climate goals. Emissions pricing forms the basis of governance and is supplemented by targeted initiatives. The policy instruments in Sweden and the EU span all sectors of society. It is estimated that they will help to achieve the targets

but that further measures will be needed to fully attain them. Areas of possible actions to attain the long-term climate target have been identified in the respective sectors. Government spending on climate related initiatives has increased substantially in recent years.

The costs related to climate change and the cost of failing to act will be very high. Several reports have shown that the costs of not taking action widely exceed the costs of doing so.

The economic consequences of national policy to attain Sweden's national climate goals are hard to calculate. Many of the consequences will depend on how Sweden reaches the goals and under which conditions. In recent decades, Sweden has succeeded in combining reduced emissions with strong economic development.

A long-term and stable climate policy is needed if Sweden is to lead the way on a global transition. A broad parliamentary majority backs the decision made in 2017 on the climate policy framework. It is also vital that Sweden involves a broad range of groups in producing and implementing the policy and that different actors in society are given every opportunity to play their part in the climate transition. Several large actors in Sweden have already shown that they have the desire, ambition, conditions and opportunity to make their operations climate-friendly while retaining competitiveness. In the initiative for a Fossil Free Sweden instigated by the Swedish Government, a considerable number of sectors and industries have themselves drawn up roadmaps towards very low or zero emissions. The initiative is an important platform for dialogue and cooperation between key actors for a competitive climate transition.

Current & Relevant Information:

Introduction

Sweden is pleased to submit its long-term strategy in accordance with article 4.19 of the Paris Agreement, complementing the submission by Croatia and the European Commission dated 6 March 2020. The Swedish long-term strategy builds on our submission to the European Commission in response to Regulation (EU) 2018/1999.

Climate developments are deeply concerning. The IPCC's special report from October 2018 on the impacts of a global warming of 1.5 °C shows very far-reaching consequences of a temperature rise of two degrees. Global warming is proceeding at such a pace that ecosystems are unable to adapt in time. Humans depend on well-functioning ecosystems, making climate change one of the greatest threats of our age. The decisions we make today are vital for the planet and for future generations.

Through the Paris Agreement, the countries of the world have committed to limiting global warming to less than 2 °C above pre-industrial levels and pursuing efforts to limit the increase to 1.5 °C. The average global temperature has already increased

by approximately 1,1 °C compared with pre-industrial levels and is continuing to rise by around 0,2 degrees per decade.

Though the issue of climate change is now prioritized on the global agenda and investments in fossil-free technology are hitting record heights in Sweden and across the globe, we have not yet seen a clear and persistent turnaround in the upward trend in emissions. In Sweden, territorial emissions have been reduced over time, but progress is too slow. Additional measures are needed if Sweden is to be able to live up to the commitments made in the Paris Agreement, to reach its national emission targets and to attain the Government's ambition of becoming the world's first fossil-free welfare nation.

The climate goals must be met. Several major climate measures, such as the Klimatklivet initiative (the Climate Leap), the reduction obligation, a bonus– malus-system for new light vehicles, the urban environment agreements, and the industrial green investment aid program Industriklivet (the Industrial Leap) are now in place. These reforms pave the way for the transition that Sweden has begun and entail us to take important steps towards a society that is not dependent on fossil fuels.

More ambitious policy instruments are needed, and the climate transition needs to be made in such a way that everyone has an opportunity to be part of the solution. All sectors of society at all levels (local, regional, national and international) need to play their part in the transition towards sustainable, fossil-free development. For this to happen, climate policy needs to be integrated into all relevant policy areas and at all levels in society. Sweden has taken some important steps on this route already. The Government decides the rate of emission mitigation and whether they need to increase for the climate targets to be met through existing instruments and new measures.

More than 400 actors from the business community, municipalities, regions, research institutions and civil society organizations are working together in the Fossil Free Sweden initiative to achieve this aim. 22 sectors have so far produced and submitted roadmaps for fossil-free competitiveness to the Government. This includes large emitting sectors such as steel, cement, mining and minerals and the automotive sector.

The roadmaps contain proposals for how the sectors intend to bring about the transition to fossil-free operation and what the Government can do to facilitate this.

Sweden is one of the countries in the world that has the capacity to lead the way and show that a fossil-free society is possible. Besides the Swedish Climate Act and ambitious emission targets, there is a broad consensus behind the climate transition among the Swedish people and in the Swedish business community. Swedish companies lie at the forefront in offering innovative solutions. The Government is determined to meet the national climate goals and to fulfil Sweden's commitments under the Paris Agreement.

“Eco-Innovation Country Profile 2022: Sweden,” Mathilde Rosenberg Johansen, CIRCABC, 15 September 2022 [139] <https://circabc.europa.eu/ui/group/96ccdecd-11b4-4a35-a046-30e01459ea9e/library/a28d6b32-bc8e-4dc9-9280-d26b368ad824/details>

Summary:

Sweden has scored 161 in the overall Eco-Innovation Index, making it one of the eco-innovation frontrunners. The country scores above average in sustainable resource management and business operations, but below in societal behaviors.

Circular economic developments in Sweden are primarily driven by the National Strategy for Circular Economy and the National Action Plan. The strategy and action plan set targets and measurements for most of the focal sectors in the EU’s Circular Economy Action Plan (CEAP), including, textiles, plastics, biobased raw material, food, construction, and critical minerals. Circular economy is also important in the consumption of goods, both public and private. 68% of all Swedes find sustainability important when buying goods, and green public procurement (GPP) has become important in the 2022 budget. Furthermore, circular business models are a part of public strategies, to accelerate the transition.

The large attention for circular economy is one of Sweden’s most important drivers for eco-innovation and circular economy. However, the lack of information for business funding opportunities is a challenge for the creation of innovative and circular business models. Furthermore, the large forestry and mining industries makes circular waste management difficult.

The policy landscape for circular economy and eco-innovation is influenced by the overall strategy and action plan, and a national waste management plan, sector specific plans, and producer responsibility have all been developed. Different measurements have been made, including new plastic products that shall consist of 30% recycled plastic by 2030, a ban on single-use plastic products (from January 2022) the new ‘Act on Climate Declarations’ for new buildings will apply in 2022, and the reduction of food waste by 20% from 2020-2025.

As a response to the COVID-19 pandemic, the Recovery and Resilience Facility was developed to mitigate the economic and social impact of the pandemic in Europe. Sweden has gained EURO 3.3 billion in grants and has developed a plan where 44% will support climate objectives. The plan consists of five focus areas with the first area deals with green transition. However, the focus on circular economy in the Swedish Recovery and Resilience Plan is limited. The Plan mainly focus on reducing CO2 emissions, creating jobs, housing, and digitalization.

Current & Relevant Information:

Sweden has long been a leader in both innovation and circularity. In the 2021 innovation scoreboard, Sweden ranked first and was defined as an Innovation

Leader. Sweden is also an eco-innovation leader and ranked fourth in the latest eco-innovation index.

Sweden is known for setting ambitious goals for sustainability, and the overall generation goal is to be net zero in 2045, which require ambitious targets and real action. In 2017, the Government published targets and measurements in the Agenda 2030 plan, and in the later years, plans towards circularity have been developed. Eco-innovation and circular economy have long been a key element in Swedish policies and in 2020 and 2021, the first Circular Economy Strategy and Action Plan were developed respectively. Other strategies addressing textiles, plastic, and construction have also been developed, addressing sectors important for a circular transition.

But Sweden also faced challenges for the transition and innovation, especially regarding businesses' lack of financial knowledge needed for eco-innovation and the mining and forestry industries. Furthermore, as a western economy, Sweden consumes more than twice the global average, mainly from virgin materials.

This report will examine the current Swedish policies, drivers, and challenges for circular economy and eco-innovation. Firstly, circular economy developments will be examined through circularity across the board, consumers, and business models. Secondly, drivers and challenges for Sweden in the transition to a circular economy will be discussed. Thirdly, the political landscape towards circular economy will be presented, and lastly, the Swedish Recovery and Resilience Plan in relation to circular economy will be explored.

“Could the Swedish Arctic hold the key to Europe’s green energy transition?”

Investment Monitor, 28 April 2023 [140]

<https://www.investmentmonitor.ai/sponsored/could-the-swedish-arctic-hold-the-key-to-europes-green-energy-transition/>

Overview:

The world is on the hunt for the raw materials that will power electric vehicle production. The discovery of more than one million tons of rare earth oxides near Kiruna in northern Sweden could be a game changer.

Current & Relevant Information:

The global auto market has embraced electric vehicles (EVs), and battery demand is soaring.

Gigafactories – large-scale electric battery factories, with production capacities typically expressed in gigawatt hours (GWh) – are cropping up in places such as Australia, China, Germany, Sweden, the UK and the US.

However, despite this global concerted effort to meet the rising demand, a shortage of electric batteries is expected by 2025, owing to a shortage of the raw materials

needed to produce them. Could a new mine in Sweden's northernmost town help to secure supply for Europe's fast-growing market?

Investment into gigafactories is heating up, with global capacity predicted to be ten times its 2020 level by 2030, according to research by GlobalData. Currently, China is home to the largest share of gigafactories, but, by 2030, Europe is set to be home to a much larger share, going from 9% in 2020 to a projected 32% in 2030.

For EVs, analysis by global management consultancy McKinsey shows worldwide demand growing by around 30% to reach almost 4,500GWh a year by 2030. The McKinsey report also projects the global battery value chain will increase by as much as ten times between 2020 and 2030 to reach annual revenues of \$410bn.

"EVs are already supply constrained," says Daniel Clarke, an analyst at GlobalData. "Demand will continue to rise and supply will not accelerate at the same rate. This is likely to get worse by mid-decade because mines take between seven and ten years to come online."

Key to ultimately alleviating this future shortage is a greater supply of raw materials. Currently, China is also the source of most mined rare earth minerals, but a new mine in the north of Sweden – Europe's largest known deposit of rare earth minerals – will be essential in continuing the global green transition.

In 2022, European Commission President Ursula von der Leyen said rare earth elements, needed to manufacture battery components central to a transition away from fossil fuels, would "soon be more important than oil and gas".

Europe currently imports 99% of its rare earth elements from China, and a new mine closer to home has benefits beyond securing a supply of raw materials.

With supply chain lines tossed into disarray by Covid-19 and geopolitical events in Europe, manufacturers are looking to have all components of their products close to home. More than ever, parts-makers want to be able to source raw materials, manufacture batteries and install them in vehicles within a small radius. Ideally, those production points are also close to market.

While China has the biggest EV market, Europe leads the way for share of total car sales, share of existing car inventories and sales per million people, according to the International Energy Agency. In terms of EV demand growth, Europe is the dominant market, especially in the Nordic countries, where EVs accounted for more than half of all cars sold in 2021.

The new mine in Sweden has the potential to relieve supply demand from China while also boosting Europe's capabilities to manufacture cars with European-sourced materials.

"This place ... is at the very forefront of the green transition in Europe," said Sweden's minister for energy, business and industry while speaking at the mine.

“This is the site of the most modern underground iron ore mine in the world. LKAB has taken the lead in a global transformation of the iron and steel industry by setting a new world standard for mining, producing carbon-free sponge iron and extracting critical minerals.”

It will be a while before the mine comes online, but it remains a bright spot for Europe’s energy transition.

An unparalleled tech ecosystem

As a country, Sweden is home to many battery companies that could benefit from the Kiruna mine. Perhaps the most high-profile of these is battery manufacturer Northvolt, but there are a many smaller companies as well, including Stockholm-based X Shore, which makes electric boats.

“A great number of industries need decarbonizing and disrupting – we are doing it for boating,” explains X Shore CEO Jenny Keisu.

For boats, batteries must be especially strong.

“Broadly speaking, the components in a boat battery are similar to those used in EVs,” Keisu says. “The differences come when you look at the requirements to withstand long-term exposure to saltwater, mists and such. Boats also require more continuous power and torque than cars – water is 800-times denser than air – so the battery, inverter and motor must be accordingly powerful.”

Founded in 2016, the start-up needed the right environment in which to tackle the unique challenge presented by electric boats. Stockholm was just the place.

“Stockholm is an incredibly supportive environment and the best place to live and work,” says Keisu. “The access to talent, capital and wider support is remarkable.”

Sweden is the leading destination for tech start-ups in Europe and broke previous inward investment levels in 2021, more than doubling investment from 2020. The capital, Stockholm, has ensured a holistic evolution in its support infrastructure with public funds and investments focused on start-ups across sectors. In 2021, Stockholm was found to be the most innovative region in Europe, according to the Global Innovation Index.

According to the Stockholm Home of Impact report, the Stockholm region offers a high survival rate for start-ups; an unparalleled tech ecosystem and world-class digital infrastructure; a community that encourages knowledge sharing; a high density of angel investors and venture capitalists; an economy exceeding expectations in a post-pandemic landscape; and public support from state-run agencies including the Swedish Innovation Agency and the Swedish Agency for Economic and Regional Growth.

“For two years in a row, Stockholm has been ranked the tenth most popular start-up hub among European start-up founders, based on the start-up Heatmap Trust Score Index,” the report reads. “And European founders rate Stockholm’s start-up ecosystem positively with high ratings on industry connections, regulations, talent and funding availability.”

X Shore’s Keisu would surely agree. “We are very aware that X Shore’s success is closely linked with Stockholm’s status as a bastion of technology and innovation,” she says.

8. United States (Alaska):

“Green Building in the Arctic Region: State-of-the-Art and Future Research Opportunities,” Lucrezia Ravasio, Svein-Erik Sveen, and Raymond Riise, MDPI, 10 November 2020 [141] <https://www.mdpi.com/2071-1050/12/22/9325/pdf>

Abstract:

The concept of Green Building refers to environmentally friendly constructions with the target of minimizing the impact on the natural environment through sustainable and efficient use of resources over their life cycle. Since modern buildings are large contributors to global energy consumption and greenhouse gas emissions, policies and international strategies intended to reduce the carbon footprint of conventional buildings are highlighting the role of this recently introduced building concept. This study provides a systematic literature review of existing research related to Green Buildings in the Arctic. Despite numerous studies and projects developed during the last decades, a study describing the current research status for this region is still missing. The review first examines the role that national and international policies developed by the arctic countries have on the development process of Green Buildings. Second, it provides an overview of the most commonly used and promoted Green Building rating systems used by the same countries in the region. The analysis highlights benefits and critical issues of Green Buildings located in the Arctic in comparison with conventional buildings, focusing on environmental, economic, and social dimensions. Finally, future research opportunities are presented and discussed.

Current & Relevant Information:

Introduction

In recent decades, the consciousness of the impact of human activity on the natural environment has grown. This awareness has affected the construction industry, highlighting the link between sustainability and environment and thereby giving it strength and momentum. The green movement, having spread in all fields of society, has led to the emergence of worldwide, national, and local programs advancing green principles in both construction and home-building sectors. Indeed, studies show that buildings play a significant role in climate change.

The term climate change generally refers to the long-term shift in global or local climate patterns, usually identified with the rise of average temperature over the years, owing to human activities. Among all the regions of the planet, because of its special physical and geographical properties, the Arctic is experiencing the most severe effect of climate change through greater and more rapid rise of average temperature. The Arctic Region is commonly defined as the area north of the Arctic Circle (66°32'0" N), or as the area north of the 10 °C July isotherm as shown in Figure 1a. Alternatively, it can also be defined by vegetation or oceanographic characteristics. In this review, the definition used by the Arctic Monitoring and Assessment Program (AMAP) is adopted. It considers the area delimited by the tree line as shown in Figure 1b. The arctic climate is typically characterized by extreme seasonality and variation in temperature and precipitation, strong gradient in latitude solar, and UV radiation. In addition, low temperatures lead to an extensive and permanently ice-covered or frozen ground, i.e., permafrost, which makes the region vulnerable to climate change. Warming of the Arctic and consequent melting has global implications, such as alteration of global ocean circulation, sea level rise, and release of methane and carbon dioxide trapped in the permafrost, i.e., gases that are feeding and accelerating the process of temperature-rise.

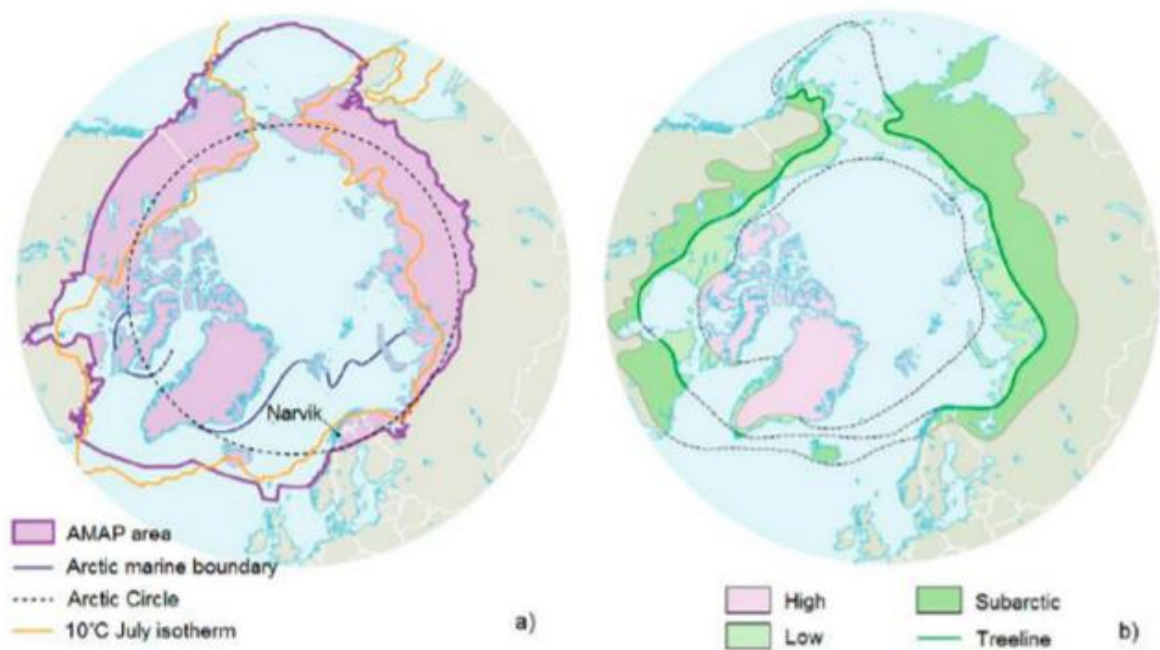


Figure 1. (a) The Arctic defined by the 10 °C July isotherm. (b) Arctic floristic boundaries [7].

According to the Global Status Report of 2019, buildings and constructions together account for 36% of global energy use and 39% of energy-related carbon dioxide emissions in 2018. This makes buildings the largest contributing sector to global warming. The same report declares that, due to the strong floor area and population expansions, total global energy consumption in buildings in 2018 increased 1% from

2017. In perspective, Green Buildings become a potential strategy and investment to limit demand and reduce energy intensity. In fact, through the introduction of new building codes and adoption of advanced certifications for high-energy performance, all participants in the building and construction value chain are globally contributing to decarbonization of building stocks and to the improvement of building's energy performances.

By definition, a Green Building is a high-performance building with a reduced negative impact on the natural environment and human health. This is achieved by applying measures that take into account the building location, as well as water, energy and material use efficiency, resource conservation, indoor air quality, building operation, and maintenance over the entire building life-cycle. Green Buildings also provide benefits from an economic and social perspective, through lower building life-cycle costs and improved comfort and well-being of their occupants. This promising solution is also expressed in different building concepts related to sustainable and environmental design such as net and nearly zero-energy buildings, zero-emission, zero-carbon, and carbon-neutral buildings.

With this backdrop, policies aimed at safeguarding and protecting the arctic environment represent a challenge of paramount importance for the region at the present and for the future. Governments with territories in the Arctic—Norway, Sweden, Finland, Denmark, Iceland, Russia, Canada, and United States—are closely involved in the development of new initiatives both locally, with national legislation, and globally, through the Arctic Council. Established in 1996 with the Ottawa Declaration, the Arctic Council is an intergovernmental forum promoting cooperation, coordination and interaction among the Arctic States. The Arctic Cooperation also includes the European Union, the Nordic Cooperation, the Barents Cooperation, and the United Nations.

The purpose of this research is to present local and global initiatives stated by the institutions and the bodies on reduction of building's carbon footprint in the Arctic. The aim is to examine the players in the Green Buildings transition process in the Arctic and evaluate the applicability of currently used assessment tools in these special climate conditions. By identifying benefits and criticalities, and design practices of Green Buildings Arctic climate, the study highlights the current state of the art and future research opportunities. Therefore, this results in practical interest for companies and institutions that want to invest resources for development solutions for reducing the buildings' carbon footprint in the region.

Alaska

United States' policy for the Arctic — “National Strategy for the Arctic Region” — was first released in May 2013, implemented in January 2014, and later updated in March 2016. The main points covered by the strategy concern the advancing of United States security interests; pursuing responsible Arctic Region stewardship;

and strengthening international cooperation. In addition, development of renewable energy resources and the adoption of sustainable strategies are on the Government's Arctic agenda. Despite the USA government withdraw from Paris Agreement in November 2019, the main targets of Alaska for Climate Change, presented in the report "Climate Change Action Plan Recommendations to the Governor", are still to support and incentivize energy efficiency, renewable energy, decarbonization and beneficial electrification across all sectors. In line with this program, the State of Alaska is currently following the Building Energy Efficiency Standards (BEES), regulations established and updated since 1991, comprised of the 2018 International Energy Conservation Code (IECC); ASHRAE 62.2 2016 and Alaska Specific Amendments. These standards aim to promote construction of energy efficient building and nowadays a minimum energy rating of five stars is required.

Conclusions and Future Research Opportunities

In this paper, a critical review of existing studies related to development of Green Buildings has been presented for seven of the Arctic countries. Even though there is an abundance of literature covering Green Buildings, the field is still lacking of studies specifically related to the Arctic. Below, the conclusions of each section are summarized:

- The review identifies the main actors in the Green Buildings development in the Arctic region. Indeed, global commitments aimed at mitigating climate change effects are leading governments to advance polices and national building codes responding to stricter standards, therefore pushing the construction industry and the market to adapt sustainable solutions. The transition to Green Buildings in the Arctic can be achieved if policies and building standards are implemented considering local climate and urbanistic patterns as well as the future local climate trend.
- Green Building rating tools are also playing a key role in promoting of sustainable, green constructions. Setting standards and requirements, they are pushing boundaries of sustainability in the building sector. The evaluation process takes into consideration different parameters according to different climate conditions and geographical characteristics, making the tools reliable and versatile. Despite the small number of buildings certificated in the Arctic, the criteria considered by the different tools showed the applicability of these systems in the Arctic. However, since Green Building rating tools are not designed on Arctic climate and local characteristics, the review identified that some of the evaluated criteria—such as transport and energy—are penalizing the achievement of certifications and high scores. In addition, more research is needed to identify the factors that are slowing the adoption of this type of sustainable solutions in the region.
- The review highlights general benefits and exposes criticalities of Green Buildings, focusing on the technologies needed for their development in the Arctic. In fact, the

Arctic offers several solutions for green electricity generation. The challenge is creating a network that can reach rural areas, or alternatively, installing on-site production facilities. For this reason, it is necessary to develop technologies for on-site generation that can meet arctic requirements. To understand if Green Buildings located in the Arctic benefit from economic advantages, future research should also focus on arctic Green Building energy performance and cost analysis. In this way, it will be possible to calculate and estimate the average energy demand, energy savings, and the related accomplishments in economic terms.

- Green Buildings should be designed to meet current green standards and keep them over the time. Indeed, durability is an important feature of green design, and, since the Arctic is experiencing higher average temperature and permafrost melting, buildings should be designed taking into account these challenging changes in local climate patterns.

“Arctic Infrastructure Resilience and Arctic Research at Sandia National Laboratories,” Lori Parrott, et al., Sandia National Laboratories, 6 September 2018
[142] <https://www.osti.gov/servlets/purl/1583071>

Overview:

Sandia Labs has maintained a consistent operational research presence and capability in the Alaska High Arctic for over 20 years; where the Sandia Atmospheric Sciences group has supported measurement systems and field campaigns for the DOE Atmospheric Radiation Measurement program since 1997. As such, Sandia has seen first-hand the extent of change for the Arctic landscape and the impacts of those changes on the environment, communities, industry, and security conditions - with national - and global consequences. Efforts to fill research and technology gaps are greatly needed to protect national interests.

Current & Relevant Information:

4 | Sandia Arctic-Related Work

Energy projects for Alaska villages and research



- Venetie microgrid optimization study
- Kodiak energy storage analysis project
- Cordova flywheel energy storage resilience project
- St. Mary's/Pitka's Point DOE/DOD grid-bridging for energy storage and renewables
- Bifacial PV panels at high latitudes study
- Sandia advanced sensors DOE grid modernization project

Controlled Airspaces in High Arctic

- FAA approved, DOE Sandia managed
- 2nm radius around Oliktok Point
- 40x700nm from Oliktok Point toward North Pole
- Search & Rescue drill with Coast Guard using UAVs in Oliktok Point controlled airspace
- Regular use of UAVs (drones) and tethered balloons

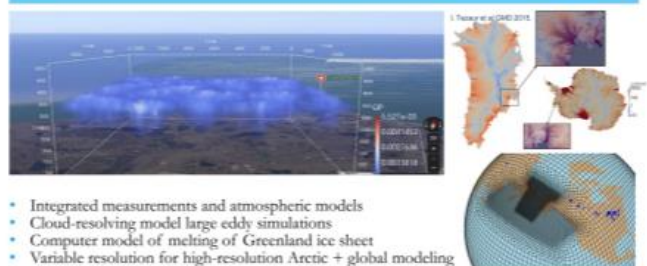


Polar operations and data collection

- 20 years of climate measurement at DOE ARM sites
- Utqiagvik/Barrow, Oliktok Point, and Atkasuk
- Use of unmanned aerial vehicles (UAVs/drones and tethered balloons)
- Seismic sensing of permafrost active layer
- Nuclear materials management for Air Force
- Airborne radar for crevasse detection in ice sheet

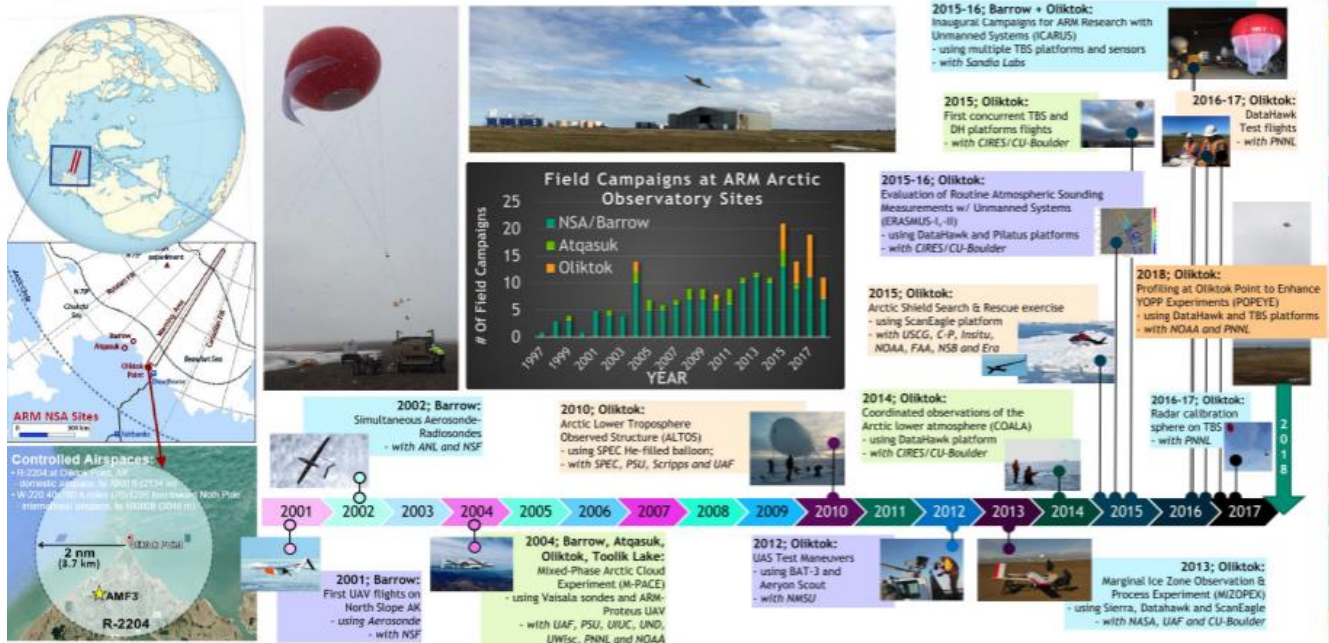


Climate Modeling



- Integrated measurements and atmospheric models
- Cloud-resolving model large eddy simulations
- Computer model of melting of Greenland ice sheet
- Variable resolution for high-resolution Arctic + global modeling

5 | Sandia Arctic: Unmanned Aerial System Campaigns

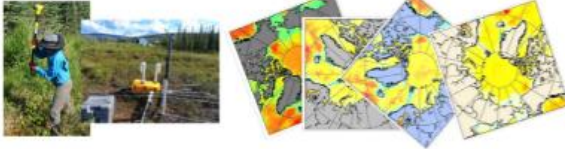


6 | Sandia Arctic: Sandia-funded Projects



Permafrost Thaw

- Forecasting Marine Sediment Properties On and Near the Arctic Shelf (to generate probabilistic maps for the best estimates of Arctic seafloor properties to date)
- Permafrost in Active Layer Seismic Interferometry (PAISIE) (to monitor active layer thickness change with seismic measurements at Poker Flat)



Coastal Erosion

- A Predictive Model for Arctic Coastal Erosion (field research and analysis at Drew Point)



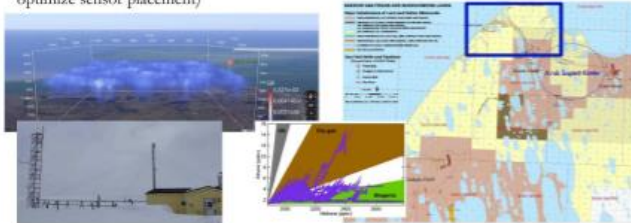
Ice Migration

- Deciphering Atmospheric Ice Nucleation Using Molecular-Scale Microscopy



Climate Modeling

- High Resolution Atmospheric Measurements + Ultra-High Resolution Modeling in the Arctic
- Arctic Methane, Carbon Aerosols and Tracers in the Arctic (longest continuous measurements of these on North Slope Alaska)
- Attribution of Methane Emissions (comparisons between Utqiagvik and Prudhoe Bay)
- Fugitive Emissions Sensor Networks Optimization (develop methods and software to optimize sensor placement)



Observation Capabilities

- Tethered Balloon Systems (TBS) Maritime Operations (with sensors and fiber optic system)
- Evaluating High Altitude Infrasonic Heliotropic Platforms in the Arctic (use 24-hr solar to provide simple, inexpensive long-term high-altitude flight with sensors)
- Joint UAV and Balloon Arctic Operations (JUBA) (sensors integration and calibration, preparations for icing tests for UAV flight safety)



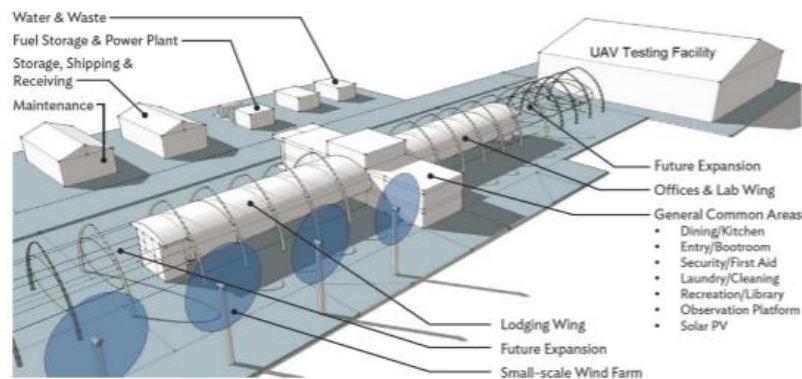
12 | Sandia Arctic Science & Security Initiative



U.S. High Arctic Research Center (USHARC)

Vision: USHARC shall be a shared national asset to support a comprehensive Arctic science and security program that addresses the needs of Arctic stakeholders to include Federal and State government, industry, Arctic communities, and researchers. Stakeholder collaborations and establishment of an Arctic station network (with Utqiagvik/Barrow and Toolik Lake) will advance U.S. understanding of the Arctic to improve environmental stewardship, security and economic opportunity.

Purpose: To pursue research of Arctic infrastructure, emergency response, search and rescue, domain awareness, environmental change, and technologies that support these; leading to positive economic development, environmental protection, and national security improvements.



13 | Sandia Arctic Science & Security Initiative

U.S. High Arctic Research Center (USHARC)

USHARC will support cooperative research, identify appropriate Arctic technologies, and conduct field tests and exercises to enable advances in the development, resilience, preservation and stewardship of Arctic resources, communities and environment.

- World-class Arctic research requires year-round access and facilities. The Station will include labs for research, testing and technology development, a center for UAS and autonomous platform operations, staff and researcher lodging, operational support infrastructure, and spaces for teaching and training.
- Research, testing and exercise personnel will be able to focus on successful high-quality work by utilizing the combined experience of UAF, Sandia and partners, along with the assets and infrastructure of the Station.
- USHARC at Oliktok Point: The opportunity exists to take advantage of existing assets and infrastructure, controlled airspace, an active unmanned aircraft systems (UAS) program and local partnerships to develop the existing facilities currently operated by Sandia into a multi-disciplinary, year-round facility; where Arctic conditions and human activity intersect.



“Arctic Petroleum Technology Developments,” EveryCRSReport.com, 23 January 2006 [143] <https://www.everycrsreport.com/reports/RL31022.html>

Summary:

Congressional debate over opening the coastal plain of the Arctic National Wildlife Refuge (ANWR) on a portion of the North Slope of Alaska to petroleum exploration and development is under way in the 109th Congress. Current law prohibits such development in ANWR.

The North Slope is home to the two largest oil fields in North America and to the largest U.S. oil field discovered in the last decade. The North Slope also is home to a varied, unique, and fragile ecosystem – resulting in extensive federal, state, and local regulatory protection. Partly due to increased restrictions since the discovery of Prudhoe Bay, operators have developed less environmentally intrusive ways to recover arctic oil, primarily through innovations in several types of technology.

Seismic technology offers the exploration sector advanced analytical methods that generate high resolution images of geologic structures and that help identify oil and gas accumulations by looking for anomalies or hydrocarbon indicators in the seismic data. Ice-based technology has been improved so as to better serve remote areas

during exploratory drilling and production. Computers now allow the manipulation and interpretation of vast amounts of data, offering more precise well locations, thereby reducing the number of wells needed to find hydrocarbon accumulations.

Recent advances in drilling can reduce the footprint of petroleum operations in arctic environments. New drilling bit designs, fluid formulas, and advanced forms of drilling, such as extended reach, horizontal, and designer wells, permit drilling to reach as far as five miles from a wellhead location and to drill around geological barriers to find and develop hydrocarbon accumulations. Advances in drilling allow less space for a drilling rig, and reduce volumes and weights of both equipment and drilling waste.

Production facilities are now more compact, with modules performing many functions. A project goal of operators on the North Slope is zero discharge of solid and fluid wastes. Production drilling techniques using slim hole technology, such as coiled tubing and multilateral drilling, can contribute to smaller footprints, less waste, and better recovery of hydrocarbons from each well.

Proponents of opening ANWR to energy development maintain that these technologies substantially mitigate the effects on the environment of oil and gas operations, and assert that the increase in domestically-produced energy would be worth any minimal environmental impacts. Opponents counter that a facility of any size would still be an industrial site and an intrusion on the ecosystem, and argue that the need for gravel and scarce water, the permanent roads, ports, and airstrips that would follow, and the unknown number of spills would destroy vegetation, contaminate water resources, and interfere with wildlife.

Current & Relevant Information:

Introduction and Overview

Background and Scope

Congressional concern over high oil prices, growing U.S. dependence on oil imports, budgetary pressures, and maintenance of the Alaskan oil infrastructure has revived discussion over possibly opening part of the Arctic National Wildlife Refuge (ANWR) to oil and gas exploration and development. That part is a 1.5-million-acre area called the "coastal plain"—the so-called 1002 area. Among the arguments put forward by proponents of opening ANWR is that there would be a much smaller surface impact, or footprint, from the petroleum industry's presence compared with procedures, operations, and equipment discussed in the 1987 Final Legislative Environmental Impact Statement (FLEIS) on the Refuge prepared by the Department of the Interior. Current law prohibits petroleum and gas development in ANWR.

Some environmental impact is unavoidable with industry activity. Searching for oil and gas involves drilling into the earth with heavy equipment; and various facilities

and other activities are necessary to support such drilling. The downscaling of petroleum equipment and operations and the advanced technological solutions to exploration, drilling, and production difficulties have reduced these impacts, however. Improved exploration and development technologies that have become more widely available include advanced seismic data analysis, ice-based technology, slim hole and high-performance drilling techniques, and methods to reduce waste.

Such innovation also is a factor in addressing the economic obstacles to finding and developing hydrocarbons. Technological advance has more than doubled exploration success rates and markedly improved drilling and production performance and efficiency. Petroleum industry worker productivity has increased and the industry indicates that the potential impact of oil and gas operations on the arctic environment has decreased.

Of course, use of the new technologies in ANWR or elsewhere significantly depends upon the nature of the requirements for exploration, development, and production, and on oil prices.

The policy issue of whether ANWR should or should not be opened to oil and gas development is not addressed in this report. For more information on ANWR controversies and legislation, see CRS Issue Brief IB10136, Arctic National Wildlife Refuge (ANWR): Controversies for the 109th Congress. Similarly, the report does not discuss in detail possible effects on the biological environment of industry operations, or the use of the new technologies in light of regulatory requirements for pipeline construction, spill containment, and reclamation of exploration and production sites. Discussion and analysis of some of these matters can be found in CRS Report RL31278, Arctic National Wildlife Refuge: Background and Issues, by [author name scrubbed] et al. However, to put the technology developments—the focus of this report—in perspective, the report's initial section summarizes some of the concerns expressed by opponents of development in the Arctic National Wildlife Refuge, as well as some of the benefits of ANWR development offered by proponents.

Exploration and drilling technologies are discussed next, as exploration is the first step toward commercial production of hydrocarbons. After successful drilling of an exploration well or wells, there are a variety of technological options available to the industry for starting the development of the discovery. Production technologies that make it possible to effectively recover the hydrocarbons will complete the technology discussion. The report also compares the procedures and potential environmental effects described in the 1987 FLEIS report with today's available procedures and their possible impacts.

Potential Issues

While it can be reasonably argued that advanced arctic petroleum technologies substantially mitigate the environmental impact of oil and gas operations compared with how North Slope Alaska oil was developed originally, it also is contended that the use of natural resources such as gravel and water, the probability of spills, and the loss of wilderness as a result of human intrusion are issues that technology advances cannot address.

Gravel would be used in development of the 1002 area—at least for things such as main pads, airstrips, and connecting roads. Mining the gravel might result in local changes in topography; roads may have to be built to transport the gravel to exploration and production sites; and there would be a direct loss of coastal plain habitat due to secondary effects of gravel spray, dust deposition, and altered snow melt and erosion patterns stemming from facility construction and gravel mining. Very large quantities of water will have to be used for various activities, such as drilling, ice road and ice pad construction, and support of camp facilities, including human consumption. Water probably would have to be transported into the area.

The long-term effects of winter exploration, drilling, and production operations are unknown. Summer erosion and melting of permafrost may due to the heat generated near productions sites. Tundra may be destroyed around the perimeter of insulated ice pads. Compaction, destruction, and delayed growth of vegetation may occur around ice pad production sites. And even minor spills may cause some destruction of vegetation, contamination of waters, and mortality of small food organisms. Surface disturbances probably would be numerous, with production facilities connected by a gathering network or a system of pipelines to an existing or a future pipeline; and production and related equipment may have to be staged at another location over the summer months, then transported to the field during the winter. The use of ice roads may be limited by hilly topography.

On the other hand, oil and gas development of the Refuge, it is argued, could yield possibly significant gains in energy security and economic benefits. Development supporters contend that ANWR oil would reduce U.S. dependency upon foreign petroleum, create jobs in Alaska and elsewhere in the United States, generate tax revenues, extend the economic life of the Trans Alaska Pipeline System, and possibly lower oil prices. These potential benefits are discussed and analyzed at length in CRS Report RL31278, Arctic National Wildlife Refuge: Background and Issues and in CRS Report RS21030, ANWR Development: Economic Impacts.

Conclusions

There are supportable grounds for proponents of opening ANWR to energy development to assert that the advanced technologies for oil and gas development in the Arctic might significantly mitigate the effects on the environment of oil and gas operations. But opponents assert that, notwithstanding technological improvements, facilities of any size would be an industrial site and an intrusion on the ecosystem

that would use the area's natural resources, interfere with wildlife, risk spills of hazardous materials, and result in a permanent loss of wilderness. In the final analysis, the issue of whether to open ANWR to energy development remains a policy decision.

Exploration Within ANWR

Section 1002 (a) of, the Alaska National Interest Lands Conservation Act of 1980 (ANILCA) directed the Department of the Interior (DOI) to assess the plant and animal resources and the hydrocarbon potential in 1.5 million acres of the coastal plain portion of ANWR, referred to as the 1002 area. This assessment included surface geological and geophysical work, but no exploration drilling.

1983-1985 Oil and Gas Exploration Programs

Exploration crews from 15 companies visited the 1002 area during the summers of 1983-1985. Access by helicopter was allowed, but no ground vehicles were permitted. The work was monitored by the U.S. Fish and Wildlife Service (FWS), which observed no adverse effects on fish and wildlife from geological field operations such as collection of rock samples and mapping. The goal of the field work was to collect rock or outcrop data to better understand the rocks that could be potential reservoir and source rocks. However, the data to determine rock type and distribution in the area were from outcrops covering only 4.0% of the 1002 area.

Seismic operations were permitted during the winters of 1983-1984 and 1984-1985, when most wildlife species were absent or present in smaller numbers. As seismic surveys are the only exploration technique involving mechanized surface transportation, it posed the greatest possibility of adverse environmental effects. To avoid significant adverse impacts, access was limited to one seismic contractor and activities in acutely environmentally sensitive areas were restricted. The total distance in straight and parallel tracks called line-miles in the 2-D seismic survey was restricted to approximately 1,300 line-miles, which the FWS believed was sufficient to identify potential areas for the purpose of the FLEIS report. Full-time FWS monitors accompanied each seismic crew. The FWS effectively limited short-term adverse environmental effects, but follow-up studies were planned to determine the long-term impacts. It is unclear if such studies were carried out or published.

Petroleum Geology

ANWR's 1002 area is between two known petroleum provinces, the U.S. North Slope to the west and the Canadian Beaufort Sea and Mackenzie Delta province to the east. Interpretation of the regional geological data collected during the summers of 1983-1985 and more recent nearby well data by the Bureau of Land Management (BLM) in 1991 and the U.S. Geological Survey in 1998 indicate that the rocks of both provinces may extend into the 1002 area.

The approximate 1,300 line-miles of seismic data were reprocessed and reinterpreted between 1987 and 1998. These data, in addition to the geological data, were used in the 1991 petroleum assessments of ANWR by BLM and by the USGS in 1998. In its 1998 study, the USGS divided the 1002 area into two areas based on the type of geological structures or potential hydrocarbon traps. The first is a structurally simple area called the undeformed area, and the second a more structurally complex, more stressed area called the deformed area. The geological sequence in the northwestern portion of the 1002 area, the undeformed area, is similar to the sequence encountered within the North Slope, which includes the Prudhoe Bay, Kuparuk River, and Alpine fields.

The southeastern deformed region of the 1002 area is more like the Canadian Beaufort and Mackenzie Delta, which include more than 36 hydrocarbon fields totaling 740 million barrels of oil and 10 trillion cubic feet of gas. Because of the geologic complexity, selection, acquisition, and interpretation of data in the deformed area is difficult compared with acquiring and interpreting data from the undeformed area. If ANWR were opened, drilling and production techniques in the deformed area would be different than in the undeformed area because of this complexity.

The determination of the existence of a source rock that can generate petroleum is important before active exploration begins in a new area. The potential for rocks to generate hydrocarbons is determined by the organic geochemistry of the rocks on the surface or in the subsurface. The geochemistry of the outcrops, analyzed from the outcrop samples taken in 1983-1985, indicate that five rock sequences sampled in the 1002 area have the potential to generate oil and gas. Gas can be generated from the same rocks that produce oil, but the rocks need to have been buried to greater depths and higher temperatures. Gas can also be generated from rocks with a different organic content than the oil-generating rocks. Only one of the five rock sequences in the 1002 area is more prone to producing oil than gas. The other four identified rock sequences are more likely to produce gas.

“New UAF research center to focus on Arctic infrastructure,” Jeff Richardson, University of Alaska Fairbanks, 11 March 2021 [144] <https://news.uaf.edu/new-uaf-research-center-to-focus-on-arctic-infrastructure/>

Overview:

The University of Alaska Fairbanks has expanded the scope of its transportation-focused research center to include a broader emphasis on Arctic infrastructure as climate change reshapes the far north.

Current & Relevant Information:

The Arctic Infrastructure Development Center will continue to include a focus on building northern roads, bridges and airports. It will also expand to study other elements of cold-region engineering. Those include the effect of thawing permafrost

on communities and city services, techniques to address climate change impacts, and building design.

“We’re starting to see that many of the technologies we have been employing may not be applicable to the future with climate change,” said Billy Connor, the AIDC director. “We realize we need to look at how we make course adjustments in engineering under these conditions.”

The AIDC replaces the Alaska University Transportation Center, which had been based at UAF’s College of Engineering and Mines since it was established in 2005.

The AIDC’s broader mission reflects a recent evolution at the transportation center, Connor said. It had become clear that many of the challenges in designing cold-region roads and airports are present in other types of infrastructure.

Several existing UAF laboratories will work on AIDC research. These include labs at UAF’s Institute of Northern Engineering that test frozen soils, study traffic and safety, advance the design of asphalt and other materials, and test building technology. Research will also be conducted at the high-bay large-scale testing facility and cold rooms at UAF’s Engineering Learning and Innovation Facility.

“A lot of the things we were doing under transportation are synergistic with the change in our missions,” he said. “We were studying these things already, and this adds a little more depth and breadth to that research.”

“Building on Permafrost,” Isaac Stone Simonelli, Alaska Business, 24 September 2018 [145] <https://www.akbizmag.com/industry/architecture/building-on-permafrost/>

Overview:

When constructing in the Arctic or near-Arctic regions of the world where permafrost dominates, the adage “If it’s frozen, keep it frozen; if it’s thawed keep it thawed” provides a strong foundation. Doing this, however, is one of the greatest challenges for engineers and construction companies that specialize in building in some of the coldest places on Earth.

Current & Relevant Information:

Frozen Foundations

Changing climate is just another challenge for builders keeping it cool in the Arctic

“The design of the foundation, which is the interface between permafrost and the building, can be directly related to the success of or failure of a building on frozen ground,” explains Bruno C. Grunau, chief programs officer at the Cold Climate Housing Research Center (CCHRC). CCHRC is an industry-based, private, nonprofit corporation with the mission to promote and advance the development of healthy, durable, and sustainable shelter for Alaskans and other circumpolar people. “Once the permafrost thaws, the foundation can sink, damaging the building it supports.

The key to successfully building on frozen ground in the North is to maintain a near-constant subsurface thermal regime where the foundation bears on the soil.”

A poorly designed or poorly maintained heated structure can be the catalyst for repeated thawing and freezing cycles of the ground, causing it to heave, slough, and even creep—usually to the detriment of the building.

“There is a myriad of things to consider when looking at a project on permafrost. I always first consider the importance of the project and the consequences of a failure,” Arctic Foundations President Ed Yarmak says. “And then, of course, there’s the budget, which turns into the usual constraint for many public projects. Budget and service life are the main drivers. Sometimes there’s trade-offs... and service life is compromised.”

An early step in the design process of a project is to get good site data. Ideally, a team would be able to obtain the vertical temperature distribution down into the permafrost over the course of a year.

“We hardly ever get that data because of schedules or budgets,” Yarmak says. “Engineers can make estimates, but then, that’s just another uncertainty in the design that needs to be taken into account.”

What data they are able to collect allows a team to—among other things—determine if the site is thaw stable, which is generally a factor of how much ice is in the permafrost material.

“If it is thaw stable, then standard construction techniques utilized for non-permafrost sites in cold regions can generally be used,” Yarmak says. “If it is not thaw stable, then engineers either design the structure using specialized materials and construction techniques to keep the heat balance negative or build the structure in a way that it can be maintained as the permafrost thaws and settles.”

Permafrost Permutations

Though many think of permafrost as permanently frozen soil, it can be more broadly defined as any earth materials (granite bedrock in the mountains to silty soil on the Tundra) that remain below 32 degrees Fahrenheit for at least two consecutive years.

These back-to-back years of freezing temperatures are caused by a negative heat balance, meaning that more heat leaves the ground during the winter than is absorbed via geothermal heating and the summer sun. Two years, of course, is just a minimum requirement. Some of the permafrost in Alaska has been around since the Pleistocene Epoch (during which the Ice Age occurred), which is why there are areas on the North Slope where it’s 2,000 feet thick.

“The ground surface will freeze and thaw every year over permafrost. That zone of surface freeze-thaw is the active layer,” Yarmak explains. “When the winter cooling is not sufficient to freeze the active layer to the top of the permafrost, a talik [a layer

of unfrozen ground in a permafrost area] will be formed between the base of the active layer and the top of permafrost. Existence of a talik like this is generally an indicator that the heat balance has moved from negative to positive and that the permafrost is degrading.”

The degradation of permafrost can happen both through climate warming and the construction of man-made structures on top of it. However, Arctic engineers have a number of methods to prevent permafrost from thawing below buildings.

“As Arctic Melts, a Race to Test Oil Spill Cleanup Technology,” Joel K. Bourne, Jr., National Geographic, 14 September 2013 [146]

<https://www.nationalgeographic.com/science/article/130913-arctic-oil-spill-cleanup-technology>

Overview:

As ice melt opens the Arctic to exploration and shipping, researchers are testing drones, sensors, skimmers, and dispersants for tackling oil spills in icy waters.

Current & Relevant Information:

The U.S. Coast Guard Cutter Healy—one of two working icebreakers in the nation's fleet—concluded a sobering mission Tuesday in the ice-strewn waters north of Barrow, Alaska. The crew's task was to practice deploying equipment they hoped they would never use: new, high-tech gear for responding to a massive oil spill in the Arctic Ocean.

Some of the new technology, which included military-style drone aircraft and an unmanned underwater vehicle dubbed the Jaguar by its developers at Woods Hole Oceanographic Institution, was designed to hunt and track oil trapped in or under ice. Other devices, such as oil skimmers and ROVs (remotely operated vehicles), were more robust Arctic versions of tools that took center stage during the 2010 Deepwater Horizon disaster in the Gulf of Mexico, the largest maritime oil spill in U.S. history.

The infamous BP blowout has cast a long shadow over the industry, leaving many wondering if the Coast Guard (USCG) and the oil industry really are ready to deal with a big spill in the Arctic, where the weather is far worse and any help is much farther away. Add to the mix one more complication: The Arctic Ocean annually freezes into a jumbled, floating mass of ice larger than Canada and Alaska combined.

Ship spills are another concern. Ship transit through the Bering Strait, the gateway from the North Pacific Ocean to the Arctic, more than doubled between 2008 and 2012. And as of this week 495 ships had received permission to travel Russia's Northern Sea Route this year up from zero just five years ago. Some experts predict that by 2030, the route will carry a quarter of all trade between Asia and Europe.

Others are skeptical that harsh and costly crossings of the Arctic will ever compete with southerly routes for shipping cargo, but they see ship traffic increasing nevertheless as nations seek to reap newly accessible resources—oil, natural gas, minerals, and fish—at the top of the world.

Seeking the Right Tools

The rush of interest lent urgency to the Healy's practice mission off Alaska's north coast.

In addition to U.S. Coast Guard crew and the Woods Hole researchers, scientists from the U.S. National Oceanic and Atmospheric Administration (NOAA) and the University of Alaska Fairbanks joined in the simulated detection and recovery of oil from the icy waters. The test flights of small unmanned aircraft systems were the first ever in the Arctic Ocean. "We accomplished all our goals and gathered data to move forward in our mission as stewards of the pristine Arctic environment," said Rich Hansen, the chief scientist and director of the USCG Research and Development Center in New London, Connecticut, who led the exercise, in a prepared statement.

In an interview before the team set out to the test site, Hansen explained further: "We're really looking at how to deploy these devices in Arctic conditions. All the things we are bringing with us have a pretty good chance of working."

But is the Coast Guard really ready to handle an oil spill in the Arctic?

"I just evaluate the equipment for the Coast Guard," Hansen said. "The answer to that question is above my pay grade."

In 2011, Coast Guard Commandant Admiral Robert Papp, was more definitive. Papp testified before Congress that his agency was totally unprepared for a BP-type spill in the Arctic. "If this were to happen off the North Slope of Alaska, we'd have nothing," Papp said. "We're starting from ground zero today."

And yet, it is the question that is on everyone's mind these days—at least everyone interested in either the Arctic's abundant hydrocarbon resources or its increasingly stressed wildlife, including endangered beluga and bowhead whales, and threatened polar bears, walrus, and ringed and bearded seals. The rapid melting of sea ice, with some experts predicting ice-free summers at the pole before mid-century, coincides with another reality: the U.S. Geological Survey's estimate that the Arctic could contain 30 percent of the world's undiscovered natural gas and 13 percent of its undiscovered oil.

Shell holds leases for offshore exploration in the Chukchi and Beaufort Seas, but its effort is on hold while it assesses numerous issues that arose during its 2012 foray in the Arctic. ConocoPhillips also has deferred drilling plans, but in Russia and Europe several Arctic oil and natural gas projects are moving forward.

Meanwhile, numerous studies are under way on just how to deal with the inevitable oil spill in Arctic waters as the oil and shipping industries begin steaming north.

This summer, two U.S. and Canadian Coast Guard vessels tested a "vessel of opportunity" skimming system in open water near Teller, Alaska—a system to deploy local fishing and other commercial vessels to aid in cleanup.

Meanwhile, the world's largest test tank at Ohmsett, the National Oil Spill Response Research & Renewable Energy Test Facility in New Jersey, spent the entire month of February putting Arctic skimmers and other spill response equipment to the test picking up oil amid blocks of frozen sea ice.

Even the U.S. National Academy of Sciences has convened a new panel to investigate the issue, while the oil and gas industry has launched its second large Joint Industry Program (JIP) since 2006 to determine the best tools for dealing with oil in, on, or under ice.

Drilling in the Arctic—as well as cleaning up oil spills there—is nothing new. Hundreds of wells have been drilled in Alaska's Prudhoe Bay alone since the 1970s, and since 1996 the sprawling industrial complex has averaged more than one hydrocarbon or chemical spill a day. Most of the spills are small and on land. The industry has long maintained that it can clean up spills in hard ice or in open water using traditional booms, skimmers, and burns.

“Department of the Air Force Arctic Strategy,” Department of the Air Force, 21 July 2020 [147]

<https://www.af.mil/Portals/1/documents/2020SAF/July/ArcticStrategy.pdf>

Summary:

The Department of the Air Force Arctic Strategy fully supports the 2018 National Defense Strategy (NDS) and implements the 2019 Department of Defense (DoD) Arctic Strategy embracing the DoD's desired Arctic end-state: A secure and stable region where U.S. national interests are safeguarded, the homeland is protected, and nations address shared challenges cooperatively.

The strategy outlines the Department of the Air Force's unique role and optimizes Air Force and Space Force capabilities for the region. The Arctic's increasing strategic importance, coupled with the Services' significant regional investment, requires the Department to have a unified, deliberate, and forward-looking approach, ensuring the Air and Space Forces can compete and defend the nation's interests in the Arctic region.

Residing at the intersection between the U.S. homeland and two critical theaters, Indo-Pacific and Europe, the Arctic is an increasingly vital region for U.S. national security interests. The Arctic's capacity as a strategic buffer is eroding, making it an avenue of threat to the homeland, due to advancements by great power competitors.

Additionally, it hosts critical launch points for global power projection and increasingly accessible natural resources. While the DoD analyzes the immediate prospect of conflict in the Arctic as low, the confluence of activities in the region by great power competitors with increased physical access due to receding land ice and sea ice, yields the potential for intensified regional competition as well as opportunities for cooperative endeavors with allies and partners.

The Department of the Air Force contributions to U.S. national security in the Arctic are large, but relatively unknown. Given the Arctic's vast distances and challenges to surface operations, air and space capabilities have long been essential to gain rapid access and provide all-domain awareness, early warning, satellite command and control, and effective deterrence. Offering a solid foundation on which to build and project power across the region, the Department of the Air Force is the most active and invested U.S. military department in the Arctic.

The strategy identifies the Arctic as a region of strategic opportunity for the Air and Space Forces, Joint Force, allies, and partners. It provides recommendations in light of the Arctic's most significant strategic threats and opportunities, based on Combatant Commander requirements and the Air and Space Forces' missions.

The Department approaches the Arctic with four main lines of effort: Vigilance, Power Projection, Cooperation, and Preparation. The strategy outlines how the Air and Space Forces will organize, train, and equip to provide Combatant Commanders with combat-credible assets capable of conducting operations throughout the Arctic into the future.

First, through investments in missile warning and defense, as well as command, control, communications, intelligence, surveillance, and reconnaissance (C3ISR), the Air and Space Forces will defend the homeland by maintaining vigilance.

Second, the Air and Space Forces will utilize unique positioning afforded by bases in locations like Alaska and Greenland to project combat-credible, all-domain air and space power. Infrastructure, focused on thermal efficiency and durability, will be combined with fifth generation aircraft and lethal capabilities to ensure the Air and Space Forces remain agile and capable in the future.

Third, strong alliances and partnerships in the Arctic are a strategic advantage for the United States. The strategy outlines ways to enhance cooperation as well as interoperability, operations, and exercises between the United States and its Arctic partners. To uphold the international rules-based order in the Arctic, the Air and Space Forces must leverage the strong defense relationships among Arctic nations and work closely with regional and joint partners.

Finally, the strategy outlines essential training and preparation for operations within this unique environment. To meet this challenge, the Department will renew focus on

training, research, and development for Arctic operations, while leveraging the Arctic expertise of the Total Force.

Current & Relevant Information:

The Air & Space Forces in the Arctic

The Arctic represents a cornerstone of the nation's defense. The Department of the Air Force provides close to 80% of DoD resourcing to the Arctic region. Installations across Alaska, Canada, and Greenland include large bases, training complexes, satellite command and control stations, and a constellation of more than 50 early warning and missile defense radars.

Several factors make the Arctic particularly reliant on air, space, and cyberspace power to provide rapid access, reach, and domain awareness. The area above the Arctic Circle (above 66 degrees North latitude) is vast, almost 2.5 times the size of the continental United States. Lacking the climate-moderating effect of the warm Gulf Stream, the North American Arctic hosts a much harsher environment than the European Arctic and significantly less road and maritime infrastructure. Alaska epitomizes this geographical disparity in infrastructure. It is the largest state (twice the size of Texas) covering 586,000 square miles, but offering only 5,600 miles of highway.

The Arctic is a region of immense geostrategic significance and a key location for global power projection. With two large Alaska air bases, Joint Base Elmendorf-Richardson and Eielson Air Force Base (AFB), and other strategic facilities, the Air and Space Forces project power into two critical theaters: Indo-Pacific and Europe. Often unrecognized, Alaska offers the quickest flight access to strategic locations across the Pacific region and western Russia. As evidence of Alaska's strategic location, once the planned F-35 bed-down is complete, Alaska will be home to more advanced fighters than any other location in the world.

As strategic as the Arctic is to power projection, it is equally critical to deterrence and U.S. defense. From an air and space power perspective, it is the shortest distance for adversaries to threaten the homeland with strategic air and missile attacks. The Alaska Radar System and the 50-plus radars that comprise the North Warning System across Canada provide vital early warning for homeland defense and North American Aerospace Defense Command (NORAD). Locations like Clear, Alaska and Thule, Greenland uniquely enable missile warning and defense in addition to space domain awareness, helping USSPACECOM track tens of thousands of objects daily.

From aerial refueling tankers to the Air National Guard's ski-equipped aircraft, the Air Force brings mobility capabilities that provide access to some of the harshest and most remote locations in the Arctic. Meanwhile the Alaska Rescue Coordination

Center and affiliated rescue squadrons work closely with partners, including the U.S. Coast Guard, on hundreds of search and rescue missions annually.

Department of the Air Force Equities in the Arctic

Alaska

JOINT BASE ELMENDORF-RICHARDSON (JBER): F-22, E-3, C-17, C-130, C-12F, Alaska Rescue Coordination Center: HC-130, HH-60

EIELSON AFB: F-35, F-16, ANG KC-135, Polar Survival School

JOINT PACIFIC ALASKA RANGE COMPLEX (JPARC): Airspace & Training Grounds

CLEAR AFS: Ballistic Missile Early Warning, Space Domain Awareness

POINT BARROW/NORTH SLOPE: Alaska Radar System (15 radars, 3 part of North Warning System)

EARECKSON AS: Missile Defense Radar

Canada

NORAD: North Warning System (~50 radars)

Greenland

THULE AB: Ballistic Missile Early Warning, Space Domain Awareness RAVEN

CAMP: ANG Training for LC-130

Conclusion

Since its earliest days, the Department of the Air Force has recognized the strategic importance of the Arctic. The Department will continue to lead as the DoD's most active and invested department in the region – critical as a juncture between the homeland, Indo-Pacific, and Europe. Building on a globally capable force and its current posture in the Arctic, the Department will continue innovating along four lines of effort:

1. Vigilance in All Domains
2. Projecting Power through a Combat-Credible Force
3. Cooperation with Allies & Partners
4. Preparation for Arctic Operations

The Air and Space Forces value the Arctic. As the Arctic's importance increases, so too will the Department of the Air Force's focus on the region.

The Department of the Air Force's Arctic Strategy supports both the NDS and DoD's effort to secure a stable region where U.S. national interests are safeguarded, the homeland is protected, and nations address shared challenges cooperatively.

“Energy security in the Arctic: Policies and technologies for integration of renewable energy,” Magnus de Witt, Hlynur Stefánsson, and Ágúst Valfells, Arctic Yearbook, 2019 [148] <https://arcticyearbook.com/arctic-yearbook/2019/2019-briefing-notes/329-energy-security-in-the-arctic-policies-and-technologies-for-integration-of-renewable-energy>

Abstract:

Remote Arctic communities depend 80% on diesel as the primary energy source. Besides the negative climate impact, the use of diesel has a negative impact on mid-term energy security. The mid-term energy security impact is due to the transportation of fuel to the communities. Harsh Arctic weather conditions restrict the transportation period and within a relatively short time window the annual consumed fuel needs to be shipped to the communities. Local energy sources can help to get independence from imported fuels. The use of local energy sources will increase the upstream energy security, which is affected by fuel price changes, oil exploration and oil production/delivery insecurity. Renewable energy technologies adopted to Arctic conditions exist but come with a significantly higher price than the same technologies in tempered areas. Policy can help to lower the barrier to entry and support a secure and sustainable energy supply in the Arctic.

This paper discusses the special implication of energy security for Arctic communities and how policy can help to strengthen energy security and concurrently reduce CO2 emissions. Energy policy incorporates three different dimensions: energy security, affordability of energy and environmental soundness. The analysis described in this paper reviews the strengths and weaknesses of different available energy technologies and policies with a focus on energy security in remote Arctic areas.

Current & Relevant Information:

Energy policy of Alaska

The Alaska State Legislator setup a Renewable Energy Fund (REF) in 2008 with annual contributions of 50 million USD (Alaska Energy Authority, 2018). The year 2008 was the peak year of oil prices (NASDAQ, 2018). First the fund was planned for five years, but in 2012 the fund was extended for ten more years (Alaska Energy Authority, 2018). The fund is managed by the Alaska Energy Authority, which is an independent, public corporation responsible for assisting energy projects development, operation and financing in the state of Alaska. The mission is to reduce the cost of energy and increase energy security. Other programs such as the ‘Rural Power System Upgrades’ program helps rural communities with less than 2000 inhabitants to increase the efficiency of their generators (Alaska Energy Authority, 2019). Nearly 100 million USD has been leveraged since the introduction of that program in the year 2000 (Alaska Energy Authority, 2019).

Since the introduction of the Renewable Energy Fund (REF) in Alaska over 280 grants for projects have been assessed and over 250 million USD have been allocated to projects. The fund helped 73 projects which are now in operation. With the executed projects it is possible to save a lot of diesel. The total financial savings from displaced diesel are annually over 70 million USD. In 2018 a number of the 56 projects supported by the REF have been under progress (Alaska Energy Authority, 2019).

Another program very specific to remote communities is the Rural power System Upgrade (RPSU) program, which has successfully completed 86 projects among small remote communities. The average increase of efficiency is around 15% but peaks sometimes even above 30% (Alaska Energy Authority, 2019). The increase in efficiency is due to a more efficient use of the diesel. For example, less diesel is used to provide the needed amount of energy – that would result in lower energy generation costs. Another example would be to recover heat from a generator and use it for heating purposes. This would not directly decrease the cost of generation, but the new product heat can be sold, which reduces the cost indirectly.

An observation shows that modern technology can be a problem in small remote communities. For example, clean and technically more complicated diesel engines according to the tier 4 standard are not very common. For such a technically complicated engine it is hard to find a skilled workforce in many remote places.

Alaska has a long experience with islanded microgrids. A lot of research and development has been done, on a scientific level e.g., at the Alaska Centre for Power and Energy or by private companies and utility companies. For this achievement, dedicated funds have been very important, from the state, region etc. Alaska is, with 25 – 30% renewables in the electricity mix, more than halfway towards its target of 50% renewables in 2025. It will be ambitious to achieve the remaining half in the next six years.

Comparison of energy policies among the Arctic countries

A comparison of the hydropower electricity generation in the different countries shows on a first look that Greenland produces more than 70% of its electricity by using renewables (WWF, 2017). In Canada it is around 66% renewables (Natural Resources Canada, 2018). USA is far behind with 25 – 30% renewables, but these numbers are on a country level (EIA, 2019). A breakdown on just remote areas draws a different picture. In Greenland all communities are remote, so nothing changes. But a look on Canadian remote communities shows that just 25% of all remote communities can supplement the diesel electricity generation with renewables. In Alaska 15% of all remote communities harvest a portion of the electricity from renewables. The lower use of renewables in remote places can be associated with the high investment cost for renewable power projects.

It can be seen that renewables are a viable option to support electricity generation and lower the carbon footprint of society. The introduction of renewables has a positive effect on electricity prices. It is among the Arctic communities that the highest electricity prices around the world can be found. For example, in Alaska prices can be 2 – 5 times higher compared to the lower 48.

Conclusion

At the current stage there is mature technology available to power entire Arctic communities by renewables like hydropower, or at least to supplement the electricity mix with renewable energy such as wind and solar. It is important to assess the local circumstances, which natural resources are available and which amount can be harnessed. Moreover, it has to be analyzed if renewable energy can be harnessed in an economically viable way and cost-effective policies introduced to facilitate the transition. Alaska and Greenland have already implemented policies to support directly the use of renewable energy resources. Canada is however focusing directly on the reduction of greenhouse gas emissions, which will lead to an increase of low carbon technologies such as renewables. To reach these goal's several initiatives have been started by the governments, reaching from a country wide approach up to specific programs just for rural Arctic communities. Overall, it can however be seen that the share of renewable energy in the Arctic is still very low.

Sustainable energy technologies are at a point of development where the integration in to Arctic electricity systems is feasible. The use of local energy sources can increase the energy security in communities and lower the cost of energy. For the small communities such projects are often very complicated to execute because of the high upfront investment cost. Since many sustainable systems are modular it is however possible for the communities to adjust the output in accordance to the demand, if the population growth or businesses require more energy. The policies that have already been introduced are helpful and the launched funding programs are very important for supporting the implementation of renewable energy in the Arctic. However, more funding is needed to stimulate the transition, and smaller communities also need expert assistance for evaluating resource and technological potentials and with applying for funding.

9. China (Non-Arctic Country):

“China Enters the Arctic Digitization Race,” Maria Shagina and Elizabeth Buchanan, The National Interest, 17 January 2021 [149]

<https://nationalinterest.org/feature/china-enters-arctic-digitization-race-176541>

Overview:

Moscow is not alone in eyeing the potential of the Arctic's digital silk roads. In 2018, China flagged its global interest in the Arctic region as a key facet of its Belt and Road Initiative—with the High North featuring as the Polar Silk Road.

Current & Relevant Information:

In our global information age, connectivity plays a central role. The geopolitics of connectivity is increasingly garnering attention, presenting various challenges and opportunities. Unfolding in real-time is a new great game of sorts: the digitalization of the Arctic. Stakeholders range from public to private enterprises and include autocratic and democratic governments. The “prize” is control over the flow of information within the Arctic, which affords both political and economic windfalls. Of course, restricting access to information is a well-known playbook of states like China, North Korea and Iran. After all, information is power.

Economically, digitalization directly improves living standards, an important precursor to socio-economic development. Indeed, the key economic drawcard for digitalization in the Arctic is the geographic reality that the region is the shortest distance connecting Europe to Asia. In tech-speak, this means data fiber-cables are shorter which translates to optimal latency. Latency, the holy grail of digital communication, is essentially the “delay” in which information moves between origin and destination. The global financial system is merely one key sector that has its eye on the prime latency which Arctic digital avenues provide.

Traditional security challenges like great-power politics, resource politics, and the contemporary climate change threat, are the usual headlines of Arctic security coverage. We outline Russia’s digitization strategy and argue, in the Arctic context, the geopolitics of connectivity is somewhat overlooked. The Arctic’s digital transformation matters, as global connectivity becomes increasingly weaponized.

China Enters the Arctic Digitization Race

Moscow is not alone in eying the potential of the Arctic’s digital silk roads. In 2018, China flagged its global interest in the Arctic region as a key facet of its Belt and Road Initiative (BRI)—with the High North featuring as the Polar Silk Road. While high-level assessment of Beijing’s Arctic strategy tends to focus on the growing Chinese footprint in the region (rationalized by Beijing in terms of environmental stewardship of the Arctic “commons”), China’s Arctic reach is also evident in the connectivity sphere. Indeed, within the digitalization context, China has taken a partnership approach to developing its data interests. Given the geographical position of Russia and its frontier Arctic Ocean proximity—ideal for running data cables linking in the shortest distance possible Asia and Europe—China is looking to partner with Moscow on more than just energy projects.

Beijing’s own strategic interest in the development of its Digital Silk Road (DSR) component of the BRI dovetails nicely with the emerging Arctic theatre. A key aim of the DSR is of course to market Chinese-state technology and Chinese tech solutions for digital projects internationally. While this agenda may be primarily commercial given its role within the BRI context—it is the case that military-security concerns

arise from the strategic edge afforded to China in the context of DSR state technology.

Beijing's interest in expanding the DSR to the Russian Arctic is cautiously welcomed by Moscow. Russia has a cash-flow problem, in dire need of capital investment and China is working hard to capitalize on Moscow's limited access to Western funds. Recently, China has targeted Russian Arctic energy ventures to participate in by way of capital injections. However, Arctic digital infrastructure projects are emerging as an increasingly attractive sector for China—further representing another sphere of win-win cooperation within the broader mutually beneficial Sino-Russian partnership. That said, Chinese capital does not make Russia and China natural allies in the digital sphere. Lingering bilateral mistrust perseveres and Moscow would ideally promote Russian-made technology for its digital economy. Problem is, home-grown Russian solutions are slow off the mark. From the Russian perspective, companies like Huawei undermine Moscow's sovereignty in terms of information security. This would appear to be a concern Russia shares with the West. But in light of weaponized technology being somewhat unavoidable, it is perhaps the case that the Kremlin would rather expose itself to the risk of being wiretapped by the Chinese than being vulnerable to Western technology.

“China's Arctic ambitions have revived US interest in the region,” Mary Kay Magistad, The World, 12 October 2020 [150] <https://www.pri.org/stories/2020-10-12/chinas-arctic-ambitions-have-revived-us-interest-region>

Abstract:

This essay is part of "On China's New Silk Road," a podcast by the Global Reporting Centre that tracks China's global ambitions. Over nine episodes, Mary Kay Magistad, a former China correspondent for The World, partners with local journalists on five continents to uncover the effects of the most sweeping global infrastructure initiative in history.

Current & Relevant Information:

Melting ice in the Arctic Ocean and on Greenland's ice sheet are signs of accelerating climate change — but China's leaders see an upside.

“The melting ice also provides economic opportunities for the development of the Arctic, including for the Asian countries,” said Gao Feng, China's special representative for Arctic Affairs, at the October 2019 Arctic Circle conference in Reykjavík.

China has even added a "Polar Silk Road" to its Belt and Road Initiative, one of the most ambitious global infrastructure projects ever. Through it, loans from Chinese state banks are funding the building of roads, railways, ports, pipelines, 5G telecommunications systems and more, all around the world — and now, in the Arctic as well.

The Polar Silk Road applies the same approach to Arctic countries, with China investing in mining and energy, and setting up research stations and satellite data receiver stations. It is also working with Russia to link the Northern Sea Route through the Arctic Ocean with China's Maritime Silk Road that starts in Asia and extends to Europe. That route can shave 10 days or more off a journey between China and Europe, compared to going through the Suez Canal.

China's initiative has revived US interest in the Arctic and stoked concerns over an ambitious rising power.

Over the past decade, China has made its Arctic ambitions known and its presence felt throughout the region. It successfully lobbied to become, in 2013, a permanent observer to the Arctic Council, a high-level, intergovernmental forum formed by the eight countries that have territory in the Arctic: Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden and the United States.

Greenland is of particular interest to China for myriad reasons: its uranium and rare earth elements; oil and gas reserves believed to lie off its shores; fish in its territorial waters, and its strategic position relatively near the United States.

The US has had a military presence in Greenland since World War II; the US set up air bases there when Germany occupied Denmark — then the colonial power controlling Greenland. The US Consulate in Greenland closed in 1953. Its only military base now is Thule Air Base in northern Greenland.

Greenland has had home rule since 1979, with Denmark still controlling foreign and military policy. A strong pro-independence movement is pushing for Greenland to eventually become its own sovereign state. A Beijing-based, Arctic think tank has noted that an independent Greenland, with 57,000 people on a resource-rich territory larger than Alaska, could be a real opportunity for China.

"This will be the key node for the successful implementation of the Polar Silk Road," said Xiao Yang, director of the Arctic Research Center at Beijing International Studies University, in a recent paper.

That may be one reason President Donald Trump offered to buy Greenland from Denmark — an offer Denmark's Prime Minister Mette Frederiksen called "absurd." It's also led to the reopening this past June of a US Consulate in Greenland's capital city, Nuuk, and to increased US engagement in Greenland and the Arctic.

"We are hosting military exercises, strengthening our force presence, rebuilding our icebreaker fleet, expanding coast guard funding, and creating a new senior military post for Arctic affairs, inside of our own military," US Secretary of State Mike Pompeo said in a May 2019 speech to the Arctic Council.

That came less than a year after Russia held its largest military exercises since the Cold War, with 300,000 troops and a small Chinese military contingent joining in for

maneuvers held, in part, in the Arctic. They were followed by NATO's largest military exercises since the Cold War, with 50,000 troops going through maneuvers in the same region.

"Certainly, the Chinese military has been more involved in the Arctic, especially through cooperation with Russia," said Marc Lanteigne, chief editor of *Over the Circle*, a website on Arctic security.

He is also an associate professor of politics, security and international relations at the Arctic University of Norway in Tromsø. But Lanteigne says China's primary interests in the Arctic are more about access to resources and to the Northern Sea Route through the Arctic Ocean. For now, the route is only open from late July until the waters freeze, and Russia uses a fleet of icebreakers to clear ice even then. China has two icebreakers of its own. Both Russia and China expect that climate change will make increased use of the Northern Sea Route possible — and profitable.

Meanwhile, China has taken a 30% stake in a liquified natural gas project in northern Russia's Yamal Peninsula, with about half of China's liquified natural gas now coming from Russia.

China has been investing elsewhere in the Arctic, too. Greenland's government has courted such investment.

"The Greenland government has conducted annual trips to China to promote investment opportunities in Greenland for the past nine years," said Vittus Qujaukitsoq, Greenland's finance minister. "And I've been to China on three occasions in various portfolios I've had, but most recently, to promote industrial investment opportunities in Greenland."

Chinese companies are interested in mining in Greenland, including a proposed project to mine rare earth minerals and uranium, working with an Australian partner. The proposal is now undergoing safety and environmental reviews.

A leading Chinese state-owned enterprise, the China Communications Construction Company, was also under consideration to expand three of Greenland's airports, in Nuuk, Ilulissat and Qaqortoq, to increase tourism. But US pressure on Denmark related to security concerns led the Danish government to contribute funding for the airport expansion projects, and choose a different contractor.

Still, Greenland Finance Minister Qujaukitsoq hasn't given up on Chinese investment.

"At the end of the day, it's not interesting for me whether the money comes from China or from the US, or from Canada, or from any country," he said. "For me, the most interesting part is making progress and growth in Greenland."

He says before Greenland can become independent, a goal he supports, it needs more and better education and job opportunities for Greenlanders. More than 80% are Inuit, close cousins of Inuit in Alaska and Canada, and climate change has affected the ability of some to live and hunt in smaller, more remote communities. He sees a future for Greenland in which tourism and investment bring new opportunities, both economic and political. And he hopes much of that investment comes from Greenland's nearest neighbors and NATO partners, the United States and Canada.

"We have other considerations in terms of security matters, which foreign bodies that we attract to Greenland, not only short term, but in the long term," he said.

Qujaukitsoq sees a future for an independent Greenland that is also still firmly part of NATO and not, like Djibouti in eastern Africa, a host to both a US military base and a Chinese one.

"I don't think it's desirable for us to have Chinese military in Greenland," he said. "It's out of the question, as I see it."

"Trade, tech ... and now the Arctic? The next frontier in the China-US struggle for global control," Simone McCarthy, South China Morning Post, 14 January 2020
[151] <https://www.scmp.com/news/china/diplomacy/article/3046072/trade-tech-and-now-arctic-next-frontier-china-us-struggle>

Overview:

- Beijing has defined itself as a 'near-Arctic state' and is taking a growing interest in shipping and economic development of other countries in the area
- But Washington is wary of its rival's ambitions and the potential for Chinese science and commerce to morph into a security threat

China and the United States have been diplomatically banging heads over trade disputes for the best part of the last 18 months, while elsewhere their rivalry is playing out as a global grappling match for power and influence from the South China Sea to Africa. The Arctic may be next on the list.

This month is the second anniversary of China's announcement of a policy to include the polar region in its Belt and Road Initiative, an ambitious effort to build land and maritime trading routes across the globe.

Beijing's release of the Arctic white paper in 2018, in which it referred to itself as a "near-Arctic state", caused something of a skeptical stir in Washington, not for what it contained, but what it lacked: military ambition.

China will "play a major role in expanding the network of shipping routes in the Arctic and facilitating the economic and social progress of the coastal states along the routes", the paper read.

Six months later, the trade war began, and Washington launched an economic and technology offensive against China, raising alarm bells and focusing attention on debt traps concealed in belt and road loans, and cybersecurity risks in deals with Chinese companies like Huawei Technologies.

Current & Relevant Information:

While the Arctic may not yet be at the top of China's belt and road spending list, it's clear the region has a special allure in Beijing.

"The Arctic is the last frontier for China's dramatically expanding world vision," said Zhang Xin, an associate professor at the school of advanced international and area studies at Shanghai's East China Normal University.

"There is a great attraction not only to the sea [shipping] route and the abundant natural resources and the increasingly evident commercial value ... but also to this idea that we need to be there and be part of this evolving global vision – that is very strong."

Washington's opposition to all that will face the same hurdles as in other places where China is pursuing its belt and road ambitions: Beijing's cash has proven to open doors in economically struggling regions, and Nordic capitals can have just as much interest in Chinese investment and scientific collaboration.

Beijing and Moscow declared a "new era" of bilateral relations last year, listing energy, trade, technology, diplomacy and defense as areas for deeper and broader cooperation.

That was on show in December when Russia turned on a US\$55 billion gas pipeline to supply China. Russia also has 24,140km (15,000 miles) of resource-rich Arctic coastline to attract further Chinese investment.

Since Beijing put its Arctic interests into writing, Chinese scientists have pinged radio signals from the Arctic sea route into Chinese cities to test short-wave communications and embarked on missions to measure sea ice and Arctic weather patterns, building on its expanding, decades-old research interest in the region.

A joint research facility with Iceland has opened, with agreements for similar centers signed with Finnish and Russian scientific institutions.

Scientific progress is the "most meaningful" of China's Arctic objectives, according to Liu Xu, assistant professor in the school of international studies at Renmin University in Beijing. The others were sea routes, energy resources, environmental protection and forging closer ties with Arctic countries, he said.

"The Chinese government thinks that the Arctic Ocean is the commonwealth of human beings, it's not only the wealth of Arctic countries, because it has a great

meaning for people all over the world,” he said, adding that this was in part because of the shared effects of global climate change.

“China well understands the territorial sensitivities in the Arctic region, and its policy takes this seriously.”

But the US and some European states are unconvinced by the claims for science, pointing to controversies involving China-funded institutes at universities in the West. A Belgian university shut the Confucius Institute on its campus in December after accusations that the former head conducted espionage for China.

The Pentagon has said the Chinese scientific presence paves the way for China’s military, including submarines.

Denmark and Sweden have raised similar concerns about China’s scientific research in the Arctic being used to open up the region for other purposes.

Yun Sun, director of the China Program at the Stimson Centre think tank in Washington, explained the US concern: “For example, the Chinese are trying to develop a GPS system that covers that Arctic. If they do develop that system, they could say it’s for scientific research, but it could also be used for military purpose.”

Some of this concern was overblown, said Camilla Sørensen, associate professor at the Institute for Strategy at the Royal Danish Defence College.

“The Nordic Arctic countries ... know that of course the Chinese are increasingly interested in the Arctic for shipping routes and resources, but it’s not like they are there in strong numbers or it’s a huge priority for the Chinese,” she said.

What this did mean was that for some Arctic nations with ties to the US but interested in Chinese investment the “room to maneuver is simply getting smaller”, she said.

And having the cooperation of Arctic nations was key, said Gao Tianming, director at the Arctic Blue Economy Research Centre of Harbin Engineering University in northeastern China.

Development of an economic corridor in the Arctic “requires extensive construction and reconstruction of the infrastructure along the entire route from Russian Chukotka in the east to Iceland and Greenland in the west”, he said. That included deep-water ports with modern logistics and services, and refueling points for vessels on the entire route from China to Europe and back.

“In such a situation, future development of the [corridor] and China’s position in the initiative depend on the willingness of Nordic countries and Russia to welcome China’s contribution,” Gao said.

When considering the scale and difficulty of building infrastructure projects like ports, bridges, tunnels and railways, the Arctic provides new challenges entirely.

“A lot of this is still in the paper napkin stage, and we are waiting to see what comes next. Will we see railways? Will we see a growth of Chinese shipping?” said Marc Lanteigne, an associate professor of political science at Norway’s University of Tromsø. He said two China-funded mining projects in Greenland had yet to begin, and talk of investment in railways in Finland and Norway was still just that – talk.

“The belt and road are now very much a part of the Arctic, but what’s interesting though is that we are not exactly sure how far it stretches into the region ... You go beyond Russia and things get a bit fuzzy,” he said.

But it’s a different story in the Russian Arctic, where the investment is definitely far beyond a napkin.

On parallel peninsulas jutting out in the frigid Kara Sea, China has a 30 per cent stake in a massive natural gas project known as Yamal LNG and owns 20 per cent of the nearby Arctic LNG 2.

When fully operational, the US\$48 billion projects are expected to help their operator Novatek to reach its goal of cornering 10 per cent of the global LNG market by 2030, according to Bloomberg. Yamal LNG is the biggest LNG project in Russia with an aggregate share of about 5 per cent of the global LNG market, the company said in its 2018 annual report.

These LNG ventures led to the creation of a Chinese-Russian Arctic shipping company in July.

Russia has thrown its arms open to Chinese investment as “severe Western sanctions” have cut access to capital and technology, while a strengthened diplomatic relationship “necessitates a more accommodating attitude by Moscow toward Beijing’s Arctic aspirations”, according to Artyom Lukin, a researcher with the school of regional and international studies at the Far Eastern Federal University in Vladivostok.

“Without Chinese participation, it will be difficult to carry out major projects in the Russian Arctic that Russia cannot afford to implement on its own due to their huge costs and technological complexity,” Lukin said.

As for Western concerns about China’s military presence following its economic and scientific growth in the region, “the Arctic is not the South China Sea”, he said.

“In the Arctic, it’s Russia which has all the military assets, all the capabilities, so we are really at home there. China is just a guest, so we are pretty much in control of the Arctic and we can afford to be relaxed about the Chinese presence.

“At least as long as China is willing to invest.”

“Why China’s Interests in the Arctic are Constrained,” Yun Sun, The Wire China Archives, 26 June 2020 [152] <https://www.stimson.org/wp->

Overview:

China has broad ambitions for influence in the Arctic region, the northern polar region that is rich in natural resources, central to halting the effects of global warming and encircled by the eight, so-called arctic nations: Canada, Denmark, Finland, Iceland, Norway, Sweden, Russia, and the United States.

In recent years, China has invested heavily in the region, declared itself a “near Arctic state,” built ice-breakers and ships capable of exploring and traversing a region that could cut short its route to Germany, and included it in its plans for a “Polar Silk Road.” Taken together, these actions have alarmed some in the United States government, who have pressed Denmark to prevent China from buying an old military base in Greenland or helping build airports on the territory.

Some observers have even drawn links between China’s aggressive behavior in the South China Sea and its future potential behaviors in the Arctic. The popular conclusion is that actions such as land reclamation, as Beijing has done in the South China Sea, could represent a Chinese pattern in all maritime domains, especially a remote and faraway region such as the Arctic.

But hyped-up American concerns about what China might do, or could do, are largely exaggerated. There are, for instance, considerable constraints on China’s ambitions in the Arctic — namely it is not one of the eight Arctic nations — and there are critical distinctions between how Beijing approaches the South China Sea and the Arctic. In the South China Sea, China’s goal is to keep it closed, especially militarily and politically, to foreign powers. It intends to be the regional power and authority of its own backyard, with the fence gate closed to outsiders.

Current & Relevant Information:

In the Arctic, on the other hand, China has no territorial claim. In 2018, the country tried to test how far it could get with a self-claimed status as a “near-Arctic state” (turns out, most countries don’t deem 900 miles as very “near”), but China seems to recognize that its most important weakness in its Arctic ambitions lies in its non-Arctic state identity. Its goal, then, is to keep the Arctic open, demanding the region remain as free and accessible as possible. If any comparison can be made, China’s policy towards the Arctic is more comparable to its goals in the Indian Ocean — it wants access, both for its blue water navy and in order to exercise its global economic presence.

But China faces an uphill battle here. The fact that China does not have any territorial or maritime claim in the Arctic has critical implications for China’s available venues for accessing and working in the region. Although China is trying to pry its

way into the Arctic through economic engagement and science diplomacy, its ability to maneuver or play a dominant role is extremely limited.

Compounding its challenges, China is a late comer to the Arctic. The country's Arctic engagement did not really begin until the 1990s when China "rediscovered" its signatory status to the Svalbard Treaty, which recognizes Norwegian sovereignty over the archipelago while affording foreign signatories certain rights. Since then, China's Arctic activities have been mostly exploratory — e.g., science research expedition and exploration of commercial development — although it certainly has much more exploitative ambitions, especially in the economic arena. The United Nations Convention on the Law of the Sea (UNCLOS) affords China certain rights, especially in the Arctic high seas. But China's direct security and military involvement in the Arctic still suffers from fundamental legal, political, technical and other practical constraints. In other words, without bilateral collaboration with Arctic states or a multilateral approach with more nations, China's mobility and operability in the Arctic is significantly limited.

In other regions, the most effective tool in China's foreign policy toolbox has been its financial capital. For example, major investments have paved a much smoother path in Africa for Beijing to establish, strengthen and expand its influence. But, with the exception of Russia, Iceland, and some local and commercial actors in Alaska and Greenland, the Arctic states are generally not poor and are unlikely to be vulnerable to or dependent on Chinese financing. The more comprehensive and stringent foreign investment regulations, especially in terms of environmental and social impacts, by the Scandinavian and North American countries make them rather immune to the Chinese "predatory" lending.

Russia is perhaps China's most consequential partner in the Arctic, thanks to the strategic alignment between the two since the 2014 Ukraine crisis and, consequently, the crippling sanctions on the Russian economy. But people should bear in mind that this is a relatively new phenomenon. In 2012, Russia rejected a Chinese vessel seeking to conduct research in its Northern Sea Route and previously had long opposed its observer status at the Arctic Council.

Even with the Russian desire for Chinese financing, however, Chinese money has not proven entirely successful in terms of granting access. Russia has turned to China to stimulate the energy resources exploration in its High North and to reinvigorate the infrastructure of its Northern Sea Route in order to create more revenue, but Russia is not willing to subject itself to exploitative and predatory Chinese financing that could jeopardize Russian sovereignty and security down the road. For example, the Yamal LNG project — a joint venture to develop the natural gas reserve of Russia's Yamal peninsula — has been a successful Chinese project in the Arctic region, but — crucially — the port development in Sabetta, which serves the Yamal project, has been solely funded by the Russian government.

Moscow simply does not let China in on strategically important projects in its High North. The Russian desire for cash has led to many enthusiastic discussions between the two countries on the surface, but they have rendered few concrete projects. In the end, Russian reluctance to surrender ownership gives China less incentive to spend on any major infrastructure projects in the Russian High North.

Which brings us back to the comparisons to the South China Sea. The Arctic does still have security implications for China, especially through missile deployment and missile defense systems since the Arctic represents the shorter attack distance between North America and Asia.

The potential of a naval blockade in the Arctic — which would affect China’s LNG from Yamal peninsula as well as the safety and security of China’s LNG tankers and other commercial shipping in the region — is also a concern. But any Chinese military or security presence in the Arctic would have to be endorsed (or not objected) by at least one Arctic state. And it is difficult to see Russia extending that invitation letter. This is critical, because without a polar maritime environment to develop, practice and exercise operational capability in the High North, China, especially the Chinese Navy, has little operational background and ability.

In the Chinese playbook, then, the Arctic will simply not be the primary theater for a conflict so it is unlikely to push aggressively in the region the way it has in the South China Sea. It doesn’t mean that China does not have ambitions there. But it does mean that such ambitions are less likely to be vital or dominant.

“Polar Expertise in China's 14th Five-Year Plan,” Trym Eiterjord, The Arctic Institute: Center for Circumpolar Security Studies, 7 December 2023 [153]
<https://www.thearcticinstitute.org/polar-expertise-chinas-14th-five-year-plan/>

Overview:

Science makes up the bulk of China’s activities in the Arctic. In past five-year plans, sections on science and technology have been the places to look for mentions of the Arctic. This is true for the fourteenth Five-Year Plan, too. In Chapter 4 (“Strengthening national strategic science capabilities”) of the new national plan, the development of heavy icebreakers and the establishment of a “three-dimensional polar observation platform” are listed as priority areas. The plan also states that the second phase of China’s polar expedition program will launch during the current five-year plan period. This program was initiated by the State Oceanic Administration, an agency which, prior to being incorporated into the new Ministry of Natural Resource in 2018, was tasked with developing China’s ocean policy. The program was launched in order to improve China’s “operational capabilities and governance capacity in the polar regions,” with the goal of turning China into a “polar great power.” In other words, to grow the country’s polar expertise.

Sprinkled throughout the national five-year plan are also other, more general items with implications for the Arctic. The plan calls for upgrading the country's shipbuilding and marine engineering base and developing advanced marine technology, achieving global coverage with China's homegrown satellite navigation and remote sensing infrastructure, boosting the development of small modular and marine nuclear reactors, and for the country's scientific communities to take a more active part in international research projects.

The National Natural Science Foundation, China's main funder of basic research, includes in its own five-year plan a section on "marine processes and polar environments," stressing polar climate change research, tri-polar cryospheric research between the Arctic, Antarctic, and the Tibetan Plateau, as well as ecological and infrastructural safety related issues arising from polar warming. A second section of the plan is concerned with the design and maintenance of polar and deep-sea research infrastructure, such as for polar underwater acoustics research. A five-year plan issued jointly by the National Development and Reform Commission and the China Meteorological Administration calls for improving the country's remote sensing and meteorological monitoring capacity along the Belt and Road as well as in the Arctic and Antarctic regions; achieving full satellite remote sensing coverage of important marine areas and shipping routes; establishing a global blue-water navigation service using domestic technology; and, to explore the development of a weather service for Arctic sea routes.

Current & Relevant Information:

Subnational plans

Polar technologies and research have also found their way into provincial five-year plans. The coastal province of Zhejiang, for example, plans to accelerate the development of ice-strengthened vessels, according to the five-year plan for the province's manufacturing industry. Neighboring Jiangsu province plans to strengthen development of polar cruise vessels. Liaoning similarly lists polar research icebreakers and improving the country's "polar observation system" among the maritime technologies it will focus on, with plans to establish a provincial "polar maritime technology innovation center." A subsection of Shandong province's shipping and maritime engineering five-year plan is dedicated to polar shipping, with heavy icebreakers and "polar deep-sea exploration vessels" listed as key technologies. Shanghai has included polar research and the development of polar technologies in its five-year plan to become a global center for innovation, noting that it will build polar-going vessels and boost China's capacity to develop polar technologies. The megacity's five-year plan for its "strategic industries" likewise includes icebreakers in its list of marine technologies to pursue. But more noteworthy is the province of Heilongjiang, which lists equipment for underwater operations in the polar regions, a "polar maritime emergency platform," and nuclear icebreakers as priorities for the province's research institutions.

Nuclear icebreakers were first introduced during the 13th Five-Year Plan period, when the technology was included in a plan for the country's "strategic emerging industries" alongside several other polar-related technologies. Several state-owned companies and research institutes have since embarked on a project to develop such vessels. The Heilongjiang provincial plan looks to be the only plan that makes a mention of the technology this time around. But leading up to the adoption of the current five-year plan, a deputy chairman of China's National Nuclear Strategic Planning Research Institute included nuclear-powered icebreakers in his recommendations for the upcoming plan. Experts have also emphasized polar vessels as a commercial shipbuilding niche. At the 2020 INMEX maritime industry convention in Guangzhou, a representative from the National Marine Data and Information Service argued that for the 14th Five-Year Plan period, China's shipbuilding industry should make efforts to boost the country's market share when it comes to higher value-added ship types, such as polar icebreakers.

National key research and development programs

More clues about China's evolving Arctic interests and capabilities can be found in the many research projects being commissioned for the current five-year period. The Ministry of Science and Technology has published funding guidelines for several so-called "National Key Research and Development Programs." These programs have been set up to support research and direct funding toward areas considered to be strategically important. Among the topics included in the current funding round, both the "Earth Observation and Navigation Program" and the "Key Technologies and Equipment for the Deep Sea and Polar Regions Program" heavily feature the Arctic, with the latter offering funding for the development of "technologies, equipment, and systems for utilizing polar resources and protecting polar environments," and to improve China's "polar monitoring and forecasting capabilities." The guidelines go on to list a handful of polar projects and technologies, among them shipboard cranes designed for heavy lift operations involving manned submersibles and polar-capable unmanned amphibious vessels.

Also included in these plans are projects with more direct connections to Beijing's Polar Silk Road vision. Specifically, the ministry is looking to fund research on communication and navigation technologies for maritime activities in the Arctic that uses the country's homegrown BeiDou Navigation Satellite System. Moreover, the guidelines call for the complete "indigenization" of sea ice remote sensing technology, with the reasoning that, "considering the importance of sea ice detection for Arctic shipping, polar research, and climate change, and China's weak polar observation capabilities," there is now a need to "make domestic breakthroughs in satellite-based remote sensing technology for sea ice in the Arctic, and to develop fully independent sea ice remote sensing systems and products." These documents also set out deliverables such as developing shipboard integrated radio communication systems and navigation systems that can reliably receive ice chart

information using the BeiDou satellite network; developing an information platform for navigation in the Arctic; a database of nautical charts “covering more than 80 percent of the Northeast Passage;” and, oddly specific, “30 nautical charts for the Northwest Passage.” The documents also list the development of high-resolution microwave sounding technology and the use of aerial remote sensing in the Arctic, both framed as steps toward developing regional shipping. Previous funding programs have stressed the need to deepen science cooperation with Arctic states. Guidelines from 2018, for example, include the following objectives: “Constructing one Arctic ground station able to receive data from no less than five China-European satellites,” and establishing “two to three joint observation stations in the Arctic in order to provide China-European satellite-based remote sensing monitoring and forecasting products and for supporting research vessels and commercial traffic in the Arctic.”

But hard technology is not the only focus. Attention is also being paid to the softer aspects of navigating the Arctic. The ministry urges researchers to “comprehensively study the international conventions and national regulations governing Arctic shipping routes.” Similar guidelines published in 2019 emphasized legal research about the Arctic and called for forging closer collaborative ties with research communities in the region, setting the target to “establish international polar cooperation mechanisms with no fewer than two countries/regions” during that five-year period. This links back to the goals of improving China’s governance capacity in the polar regions and building up its domestic Arctic expertise.

Arctic expertise

By looking at its five-year plans and other related, more technical planning documents, we can better trace the contours of China’s evolving interests in the Arctic. The relative dearth of Chinese activities in the region should impel researchers to examine developments taking place domestically instead. The key role played by science and technology in Arctic geopolitics also means that documents detailing such developments can act as a useful proxies for understanding countries’ Arctic ambitions.

The outsize focus on remote sensing, communication, and monitoring technologies in China’s five-year plans demonstrates this. In the absence of any Arctic territory, research programs and remotely operated sensors allow non-Arctic states like China to develop a degree of situational awareness in the region. Climate research, shipping, and resource development all demand information by Arctic environments. Moreover, by boosting its knowledge about the Arctic, China can also grow its position as a regional knowledge producer and, in turn, improve the way it participates in regional governance.

Speaking at the Arctic Circle Forum in Tokyo in March, Gao Feng, the country’s special envoy on Arctic Affairs, reiterated the four pillars of China’s Arctic policy: To

understand, protect, develop, and participate in governing the region. But, he stressed, that first pillar, to understand, is becoming more and more important. Studying how China is gearing up to better understand the Arctic, politically as well as environmentally, should be a focus for research that wants to understand the country's trajectory in the region.

“China is cementing its position as an Arctic superpower through Russia,”
Faustine Ngila, Quartz, 20 April 2023 [154] <https://qz.com/china-russia-arctic-antarctica-superpower-1850351933>

Overview:

China is courting Russia to consolidate its power in the Arctic, even as it builds a fifth research station in Antarctica

China is advancing its superpower status in the world's coldest regions. And to get there faster, the country has built stronger ties to Russia to supply equipment in the Arctic, a new report by the Center for Strategic and International Studies (CSIS) reveals.

Moscow initially opposed Beijing's plans to explore its Arctic region through the northern sea route, which runs along the Arctic coast of Russia. This is because Russia operates its most sensitive security apparatus there, the CSIS report says, “including ballistic missile submarines, strategic test sites, missile defense systems, and advanced radar arrays.”

But the war in Ukraine has seemingly changed Russia's view of China. Isolated by the rest of the world, Russia's only friend is now arguably China, offering not just money for Russian oil but also investments in Russian tech and infrastructure.

China is now a key defender of Russia, and has said it will not recognize the Arctic Council if it keeps shunning Russia for its invasion of Ukraine.

Current & Relevant Information:

Why is China so vested in the Arctic region?

As the world's second-biggest economy, China is looking for footholds in the polar region so that it can access the Arctic's rich mineral deposits, shipping lanes, and energy stores. All of these resources are becoming increasingly available as Arctic ice melts. “[China has] a clear intent to not be excluded from Arctic developments as the region becomes more accessible,” Stephanie Pezard, a senior political scientist at the US policy think tank RAND, wrote last December.

The Arctic region has been warming four times faster than anywhere else on the planet over the past four decades. China is taking advantage of the sea trade and fishing routes that have been opened by the changing climate.

In its 2018 Arctic policy paper, China declared itself a “near-Arctic state,” claiming protection under the United Nations Convention on the Law of the Sea and the Spitsbergen Treaty. Like NATO members, China says it enjoys rights to freedom of navigation and overflight, scientific research, fishing, cable-laying, and resource development in the Arctic high seas.

Now Chinese scholars have identified 13 Russian ports that can be used to access the Arctic, based on their natural conditions, infrastructure, operations, interior environment, and geographic location. Chinese companies have presences in most of the ports identified. An example is China Poly Group, which has injected some \$300 million into a coal terminal in Murmansk and now plans to develop a deepwater port at Arkhangelsk, according to the CSIS report.

China describes the Arctic as one of the world’s “new strategic frontiers,” as it targets to become a “polar great power” by 2030. It has sent high-level officials to the region 33 times in the past two decades, and has been expanding its icebreaker fleet and naval vessels in the region.

China is expanding its presence in Antarctica

After five years of relative inertia, China is also speeding up construction of its fifth research station in the Antarctic region.

Imaging data shows that significant progress is being made for the first time since 2018. The CSIS report describes the base as a “5,000 square meter station” with a construction plan that includes “a scientific research and observation area, an energy facility, a main building, a logistics facility, and a wharf built for China’s Xuelong icebreakers.”

The report calls the station, located on Inexpressible Island near the Ross Sea, as China’s “most significant expansion of its footprint there in a decade.” Though the US State Department found no ongoing military work there in 2020, the new station will have a dual-purpose ground satellite, CSIS said.

The satellite will give the station the ability to monitor and collect intelligence signals from Australia and New Zealand, both US allies. It also allows China to collect telemetry and spatial data on rockets launching from newly established space facilities in both nations.

“Does China control Arctic mineral raw materials,” Patrik Andersson and Per Kalvig, Danish Institute for International Studies, 30 June 2022 [155]

<https://www.diis.dk/en/research/does-china-control-arctic-mineral-raw-materials-0>

Overview:

In this DIIS Working Paper, we explore Chinese companies’ control over Arctic mining and mineral exploration projects, the strategies they employ, and the degree to which their investments align with Chinese official strategies and policies. We do

so through an approach that moves beyond ownership of mines as a measurement of control. Mine ownership in itself has little significance for where the raw materials go to be processed. Industry demand and supply security hinge more on highly processed materials and advanced products than bulk raw materials. Our approach is instead to assess Chinese control over mineral flows from the Arctic using a set of 'control parameters'. Compared to an ownership-based approach, we begin one step further upstream in the supply chain – at mineral exploration – and look one step further downstream, by taking into account control via, for example, offtake agreements or monopoly over processing technology.

We find that Chinese companies are involved in a very small share of Arctic projects overall, that their activities cover a very wide range of commodities, most of which are focused on exploration, and that they are heavily concentrated in Canada. The scale of Chinese involvement might, however, be more extensive than our data shows because many Western miners view Chinese companies as their natural – and first choice – offtake partners. It is thus likely that many companies expect to sell to China but have not entered into a formal offtake agreement, or that we have just not been able to find evidence of such agreements.

Our findings also suggest that while Chinese engagement in the Arctic mineral sector has been limited, the investments that have been made appear to support China's mineral strategy relatively well. This is evident from both the range of commodities that are targeted and from variations in degree of control across commodities that are differently prioritized in China's mineral strategy.

Current & Relevant Information:

China's domestic mineral resources are inadequate to support the demand of the country's industry and infrastructure development. This demand has been generated not only by China's domestic needs. As China has taken on the role as the 'factory of the world', a proportion of resources has in effect been used to manufacture goods for the rest of the world (Woetzel et al., 2019). To ensure long-term supply of the resources China needs, Chinese companies are increasingly engaging in mining and mineral exploration projects overseas (Ericsson et al., 2020), and their interest in the Arctic as a source of mineral raw materials has grown (Andersson et al., 2018).

This pursuit of minerals in the Arctic and elsewhere has given rise to concerns in the West. Fears have ranged from China's enormous demand driving up commodity prices globally to state-backed Chinese companies taking control over mines overseas. This is a bid to strengthen their grip on global supply chains of minerals – in particular the processed, high-quality materials and products that are used for producing renewable energy and communication technologies. Because of their perceived economic importance and associated supply risks – in many cases caused by China's quasi-monopolistic position in their supply chains – these

materials are considered ‘critical’ in countries with advanced manufacturing sectors, such as the United States (US), Europe and Japan (USGS, 2022; EC, 2020). There have also been concerns that Chinese state and private firms behave not only as profit-seeking businesses but also to accomplish the long-term geopolitical projects of the Chinese Communist Party (CCP). This is the case also in the Arctic, where Chinese companies’ engagement in Arctic mining and mineral exploration is often viewed through the prism of Arctic geopolitics and China’s growing Arctic ambitions (Brady, 2017).

Scholars have disagreed on the impact of China’s global quest for primary mineral raw materials. Some have argued that China is seeking to lay claim to resources overseas ‘by all means necessary’, and, in so doing, is ‘changing the world’ (Economy and Levi, 2014). Others have argued that Chinese control over mining globally has been exaggerated and is in fact very limited (Ericsson et al., 2020). This paper feeds into this debate by focusing on Chinese interests in Arctic mining and mineral exploration activities. Despite Arctic resource extraction supposedly being an important component of China’s goal of becoming a ‘Polar Great Power’ (Brady, 2017), little is known about the scale and scope of Chinese engagement in the Arctic mineral sector, and how much control Chinese companies actually have over Arctic mineral flows. And while some claim that Chinese firms have ‘locked up supplies of strategic minerals and metals overseas through a ‘combination of state-directed investment and state-backed capital (FP, 2019), little is known about the degree to which their activities are actually aligned with Chinese official strategies and policies.

In this working paper, we explore these questions based on analysis of a dataset of mining and mineral exploration projects covering all the major commodities or commodity groups in six Arctic countries or territories – Canada, Greenland, Finland, Sweden, Norway and Alaska. We do so through an approach that moves beyond ownership of mines as a measurement of control. Mine ownership in itself has little significance for where the raw materials go to be processed. Industry demand and supply security hinge more on highly processed materials and advanced products than bulk raw materials. Our approach is instead to assess Chinese control over mineral flows from the Arctic using a comprehensive set of ‘control parameters’. Compared to an ownership-based approach, we begin one step further upstream in the supply chain – at mineral exploration – and look one step further downstream, by taking into account control via, for example, offtake agreements or monopoly over processing technology.

We find that Chinese companies are involved in a very small share of Arctic projects overall, that their activities cover a very wide range of commodities, most of which are focused on exploration, and that they are heavily concentrated in Canada. The scale of Chinese involvement might, however, be more extensive than our data shows because many Western miners view Chinese companies as their natural – and first choice – offtake partners. It is thus likely that many companies expect to sell

to China but have not entered into a formal offtake agreement, or that we have just not been able to find evidence of such agreements. Our findings also suggest that while Chinese engagement in the Arctic mineral sector has been limited, the investments that have been made appear to support China's mineral strategy relatively well. This is evident from both the range of commodities that are targeted and from variations in degree of control across commodities that are differently prioritized in China's mineral strategy.

We begin by introducing the concept of raw material 'criticality'. We then briefly review debates about the drivers behind China's resource quest in the Arctic and beyond, and the role of supportive state policies in encouraging Chinese companies to invest overseas. We proceed by discussing Chinese plans for the mineral and foreign policy sectors, which is where we find the main policies and incentives that Chinese mining companies respond to. This is followed by a detailed description of our methodology. Finally, we present the results of the analysis, before arriving at our conclusions.

“The Ice Silk Road: Is China a “Near-Arctic State”?” Maud Descamps, Focus Asia, February 2019 [156] <https://www.isdp.eu/publication/the-ice-silk-road-is-china-a-near-artic-state/>

Abstract:

Ms. Maud Descamps explores the economic and political impact surrounding potential new trade routes that could open-up in the Arctic region given the rapid pace of melting polar ice-caps. Her paper provides an analysis on the measures taken by China to ascertain greater access to the region and reap the financial benefits of this new frontier.

Current & Relevant Information:

Since embracing a market-oriented system, China has become increasingly dependent on foreign trade, with imports and exports having become deeply embedded in Chinese society and economic practice. Reliance on overseas consumer markets and producers means that shipping lanes and port infrastructure are of the utmost importance to Beijing and the Chinese leadership has made sustained economic growth as a national security priority.

For this reason, China is seeking new commercial avenues and this thinking plays a key role in the ambitious Belt and Road Initiative (BRI). Global climate change is providing Chinese planners with interesting options to develop new trade routes. While it has very serious and destructive consequences for the global eco-system, the effects of climate change afford opportunities in maritime trade.

The Impending Thaw

The rapid pace of the melting ice-caps is set to open up a 6,000 km sea route through the Arctic; connecting Northern Europe and East Asia. If this new northern passage is accessible enough for sea-borne trade, it would have the potential to upend, or at least significantly alter, the current shipping lanes that dominate the Euro-Asian trade flows. A new northern route, or “Arctic Silk Road” as it is sometimes styled by proponents, would represent a noticeable reduction in the time and cost of circum-continental transportation. In addition, while connecting Europe, Asia and North America, an open Arctic passage would present an alternative artery for Chinese trade, enabling it to bypass several important strategic chokepoints.

Aside from the perspective of cost-saving benefits afforded by new shipping lanes, a further potential economic “advantage” of climate change in Arctic is energy accessibility. The Arctic represents a massive reservoir of untapped and undiscovered energy resources. Rising temperatures however, will in the medium and long term be a game changer. It is estimated that about 30 percent of the world’s undiscovered gas reserves lie at the bottom of the Arctic Sea, while a potential 13 percent of global oil reserves are situated in the Arctic.

China and the Arctic

All of this considered, it is not surprising that the People’s Republic of China (PRC) is investing heavily in Arctic affairs. Beijing has sought to obtain membership in many international Arctic-related organizations (such as the Polar Navigation and Equipment Committee), engaging in free trade agreements, investment schemes in mining and infrastructural projects, as well as improving diplomatic relations with all the Arctic states.

Factually speaking, China is not an Arctic country: its coasts do not border with the Arctic Sea nor does it claim to have sovereignty on under-continental shelves or water in the Arctic. The PRC defines itself as a “Near-Arctic State” with larger interests drawing its attention toward the region. Back in 2014, President Xi Jinping made public the will of his government to make China a “Polar Power”.

As the PRC lacks sovereignty over the Arctic, China is not in a position to conduct resource extraction operations or commercial fishing within foreign territorial waters or international waters as defined by the United Nations Convention on the Law of the Sea (UNCLOS). Beijing’s commitment to this treaty dates back to 1925 when the then Republic of China joined the “Spitsbergen Treaty” (or Svalbard Treaty - established in 1920). However, today priorities have shifted as the region within the polar circle is continually growing in significance.

Nevertheless, as explained in the PRC’s White Paper released this January, the new context of fast changing climate and environment, the opportunities in the Arctic are multiple. Indeed, in terms of the economic potential, scientific insights (establishing weather patterns in light of the change in world’s climate), biological variability, sea routes, untapped natural resources, as well as the strategic footholds it could grant,

the region is of clear interest not only to the Chinese government but to many stake holders.

The possible benefit of linking its shipping lanes to the North Atlantic through the region places China at the forefront of Arctic development. As such, China has developed its own term of classification to link its relations with the Arctic: "a Near-Arctic State." This use of terminology is indication of the role that Beijing wishes to play and the legitimacy in the region it wants to assert. However, this self-proclaimed status is not granted official recognition in the international rule-based system, nor do the claims propagated by domestic Chinese legislation.

More significant is the expression of interest which draws upon Chinese foreign policy in terms of the diplomatic, trade and environmental approach which is embedded in the larger scheme of the BRI. The maritime route in the Arctic, often called the Northern Sea Routes, has become part of the new maritime Silk Road and has entered Chinese planning and strategic thinking.

The key role of the Arctic is becoming clear; the question of its governance management, protections and stability is shaped by a number of treaties, among which the UNCLOS is to be found.

The Chinese strategy, as shown in its Arctic White Paper, is designed to deflect fears of Beijing's ambitions. This approach shows China as a Zhilao hu ("Paper tiger" is a literal English translation of the Chinese phrase zhilao hu. The term refers to something or someone that claims or appears to be powerful or threatening, but is actually ineffectual and unable to withstand challenge.).

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