Arctic Infrastructure: Considerations in the Green Transition

Position paper written by scholars from Fulbright Arctic Initiative III

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The global green transition has put a new focus on the Arctic region and its resources (eg.energy, minerals, and access to land) at the same time as Arctic communities are looking for development, self-determination, and growth. Arctic infrastructural "fingerprints" will exemplify key considerations within the green transition in a changing arctic climate, with competing visions and framings of what the green transition is about, and the rationale for its need. Global green transition involves resources that may be found in the Arctic. The argument of this paper is built around the position that it is of particular importance to hear, value, integrate, and prioritizes the voices of Arctic Indigenous Peoples and others living in the North. Findings from fieldwork and observations conclude that: 1. The Arctic has a new strategic role because of the green transition, 2. Arctic communities lack physical as well as policy infrastructure for a successful transition, 3. Green transition is not "a one size fits all" in the Arctic. Different communities have different opportunities as well as requirements when it comes to green transition, 4. There is a knowledge gap both in terms of what arctic communities need from a transition and how these needs best could be met, and 5. Green transition can become an important driver of change in the Arctic.

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Figure. 1. Nuuk, Greenland. Photograph by Lill Rastad Bjørst, Greenland August 2022

Background

Climate change impact is a living global reality. Over the last 49 years, the Arctic has warmed three times faster than the world as a whole (AMAP, 2021: 4). The thawing permafrost, wildfires, extreme and rising temperatures, and sea-level rise are changing the landscape and living reality for the people of this ecologically vulnerable region. To reduce the climate impact, a green transition agenda is pushed forward by heads of states and industry. An agenda which has been even more accelerated with world events such as the war in the Ukraine, global economic recession, and extreme climatic events. This position paper demonstrates that the green transition presented in international politics, and how it plays out locally in the Arctic, differ. At the same time, there are goal conflicts between international and national decisions. The ramifications and when it is to be

implemented in a regional and local context can be illustrated by the discussion at the Conference of the Parties of the UNFCCC (COP-meetings) and the implementation of Sustainable Development Goals (SDGs) (Degai & Petrov, 2021).

The Arctic has a new strategic role because of the green transition

The green transition agenda is at the center of attention for governments, organizations, businesses, and academia (Stokes, 2022). The goal with the European Green Deal is, for instance, to reach climate neutrality by 2050, and to support the transformation of the EU into a fair and prosperous society with a modern and competitive economy (European Council, 2023). Currently, the environment, security, and economy go hand-in-hand for many countries. The war in Ukraine and dependencies on Russian gas have made the European countries speed up the transition to renewables. In "The EU in the Arctic" policy paper from 2021, the overall focus is on "a stronger EU engagement for a peaceful, sustainable, and prosperous Arctic." In the text it is specified that "The EU's full engagement in Arctic matters is a geopolitical necessity" (EU, 2021: 2). In the same vein, the US National Strategy for the Arctic Region (2022) (launched after the war in Ukraine) has "Security" as its first pillar and "environment" (Climate Change and Environmental Protection) as its second, with pillar three being "Sustainable Economic Development," and pillar four as, "International Cooperation and Governance". Recently, the relationship between environment, security, and economy has been translated into green transition, such as in the US Inflation Reduction Act (2023). In our Fulbright Arctic Initiative (FAI) III endeavor, we have observed that the Arctic policies currently being formulated have begun to echo these green transition agendas (from Europe and the US) as well, which are closely connected to local dilemmas.

In discussing Arctic infrastructure in our FAI III cohort, we became attentive to the new infrastructure facilitated by the global green transition. A large expansion of wind power, PV, batteries, and electric vehicles are seen by the International Energy Agency (IEA, 2021) as being critical to reach climate neutrality, while still meeting the future needs for the benefits that energy services provide. If greenhouse gases are not reduced fast enough, there will be a need for carbon offsetting, including carbon storage (IPCC SP1.5, 2018). The Arctic could be an important provider of both material and energy resources, as well as the carbon storage needed for the global transition, thus taking up a new strategic role due to the green transition. Our focus is on Arctic communities, while being attentive to these communities' (and countries') relationship to the rest of the world.

Without seeking to theorize too much as an interdisciplinary group of scholars, we have a dynamic approach to studying infrastructures that goes beyond the built environment (Larkin, 2013). This paper is based on many field trips to various Arctic locations that the authors took alone or together during the FAI III where we consulted with professionals and locals. As of today, the Arctic lacks physical as well as institutional policy infrastructure (Bennett & Bouffard, 2022) for a successful engagement in the green transition. Melting permafrost, extreme weather events, and lack of connectivity in many of the Arctic regions makes it expensive and challenging to build physical infrastructure such as roads, power lines, wind power plants, and airstrips. In parallel, the lack of inclusive processes, knowledge and resources supporting, and speaking to local needs slows down the green transition locally (see Fulbright Arctic Initiative III Policy Brief 2023 in DeSimone et al, 2023). A small disclaimer for not overestimating comparisons within the Arctic is that remote and rural characteristics, and seasonal and year round access are highly impactful on the ease and cost of building infrastructure in the Arctic. The argument of this paper is built around the position that it is of particular importance to hear, value, integrate, and prioritize the voices of Arctic Indigenous peoples and others living in the North. This paper addresses the research question: What are the key considerations and significant fingerprints of Arctic infrastructure in the green transition?

Many Arctic regions have a delicate history of land grabbing, land claims, nation building, and self-determination. Several Arctic nations have unresolved land and resource issues with Indigenous peoples. These issues become prevalent in green transition projects as well. For example, the Southern Sámi living within Norwegian borders experience what they call "Green colonialism" because of the wind energy development in their region (Normann, 2021). The examples from NWT illustrate how new Arctic infrastructure and green transition is also about understanding the needs of Indigenous peoples in regard to the Arctic and to create the right relationships, as in any decolonising project. The example from Greenland highlights how the Government of Greenland has the right to land and resources, and looks for ways to become an exporter of energy and minerals so as to "live up to the name, Greenland"". Meanwhile, policy infrastructure and commitments are lacking (i.e. a national climate strategy and Nationally Determined Contributions speaking to the goals of the Paris Agreement) and the dilemmas about local impact and benefits from the development are still unresolved. Many Arctic nations search for ways to be more self-sustaining when it comes to resources, minerals, and energy; a process where Iceland comes out as a forerunner.

With the global resource pressure from Russia tailored to oil and natural gas exports, enhanced with the war in Ukraine, a tendency to resource nationalism has reappeared in international politics where governments position themselves around their access to potential resource wealth, according to the U.S. Agency for International Development (2021: 5-6). The US Inflation Reduction Act (2022) intends to support a green transition but could also cause friction between the EU and the US. It should not be underestimated that some areas of the Arctic are dependent on the use of fossil fuels and have national interest in local security of the supply for development not to be remotely controlled by others.

Relevance: Arctic fingerprints in green transition

In political debates, "green transition" is often mentioned as self-evident, but without pointing toward any specific object. This makes the concept politically powerful. Being so unclearly defined enables green transition to appear in surprising sectors and contexts (Bjørst, 2022; Karlsson & Hovelsrud, 2021). The ambiguity of 'greening' is not a new tendency in environmental discourses. This form of "green speak" is closely connected to globalization, speaking to the idea of a "global green consciousness" (Harré et al., 1999). An idea that was articulated in the work of the Brundtland Commission (Brundtland 1987), which promised a "common future" that at the time gave some comfort to its belief in the possibility of "Managing the Commons" (ibid, 1987: 261). Recently the philosopher, Bruno Latour, evaluated this idea. He concluded that: "The absence of a common world we can share is driving us crazy" (2018: 2). The relationship between global problems and local affairs are altered with the green transition, whereas Arctic resources and energy production are increasingly developed to accommodate globalization. Scholars like McCauley & Heffron (2018) have advocated for more fairness and equity as part of the transition away from fossil fuels – with a green transition in the Arctic it could be difficult to live up to those ideals.

Today, branding your country as "green" or as part of a "green transition" can be a powerful new way of presenting a country as modern and progressive (i.e. at UN COP meetings, or in the European Parliament). Bjørst (2022) writes about the differences between sustainability and the green transition, presented as part of a political discourse: "Whereas 'sustainability' is about sustaining something (i.e. environment, Indigenous communities, the economy) - green transition is about transforming something and not having the ambition to sustain (not to change) to the same extent. In other words, green transition can be rather transformational for Arctic communities in the years to come. Something must go as part of this transformation (e.g., oil, gas,

imported food)" (Bjørst, 2022: 4). The community will be expected to change and build new infrastructure and energy systems as part of this process.

As part of the FAI III (2021-2023), we have been discussing green transition processes with a focus on Arctic infrastructure. Utilizing our regional expert knowledge from Iceland, the Canadian Northwest Territories (NWT), Greenland, Norway, Sweden, and the US. Arctic infrastructural "fingerprints" will exemplify key considerations within the green transition in a changing arctic climate, with competing visions and framings of what the green transition is about, and the rationale for its need in an era where many Arctic communities are looking for development, self-determination, and growth. This is a multidisciplinary position paper dealing with a pressing matter of concern. With the help of the FAI III, we were inspired to use a collaborative, multidisciplinary approach to enquire about the green transition in the Arctic. To work across academic disciplines (Architecture, Energy Engineering, Planning and Design, Computational Engineering, Art, Anthropology, and Arctic Studies) takes dedication and time as "science cannot race ahead in isolation but must learn instead to slow down" (Stengers, 2018). This position paper and a policy brief as presented at the Wilson Center in Washington DC in April 2023 (DeSimone et al, 2023) is the fruit of our endeavors.

In this paper, light will be shed on the different status in the Arctic by highlighting fingerprints from various places (Iceland, Greenland, NWT and Norway). Certainly, the diversity of the region that is considered the Arctic is great. Therefore, it can be difficult to compare different regions, but nevertheless, they can learn from each other. The four cases are selected based on both relevance for a discussion about green transition, and where we as a group had expertise. Unfortunately, the authors did not have the time nor funding to visit all the Arctic countries - however these fingerprints show the variety of statuses across the Arctic.

The fingerprint (regional examples) from Iceland proves that large-scale transformation can occur within countries in a short period of time based on cooperation. Greenland's fingerprint illustrates a recent political paradigm shift towards a green transition agenda with the ambition to utilize its hydropower potential, in addition to extracting mineral resources relevant for green technologies. The fingerprint from Indigenous communities in the Northwest Territories (NWT) illustrates how some communities are attempting to break free of their petrol dependency, planning alternative local renewable energy solutions, and the way this relates to the need for decolonization. Finally, the fingerprint from Norway reminds us about how green transition can be governed - but also how it can be experienced as harmful to specific Indigenous groups' livelihoods.

Fingerprint: Iceland

Iceland lies over a volcanic hotspot on the Mid-Atlantic Ridge. Ever since the Viking Age, Icelanders have used natural hot springs for washing and bathing. Uniquely, the island also possesses underground water reservoirs continually replenished by rain (Mims, 2022). Magma underneath the island heats these reservoirs to hundreds of degrees, making natural conditions in Iceland favorable for geothermal power production. Almost all heating and electricity generation is provided for by renewables – both hydro and geothermal energy.

Figure 2. The Carbfix provides a natural and permanent storage solution by turning CO_2 into stone underground in less than two years. Iceland proves that big transformation can happen within countries in a short period of time based on cooperation. That is a lesson that can be useful to everyone to fight the climate crises today. Photograph Lill Rastad Bjørst, Hellisheiðarvirkjun, Iceland June 2022

Icelanders have gone through an energy transition twice

The first was when they started to produce electricity with hydropower and the second when oil was replaced by geothermal heat to heat houses. It is estimated that in Iceland, the first electric light bulb was switched on in 1899, and in 1904, electricity production began in Hafnarfjörður. When the oil crisis struck in the early 1970s, the world market price for crude oil rose by 70%. At the same time, heat from oil served over 50% of the population in Iceland. The oil crises caused Iceland to change its energy policy, reducing oil use and increasing domestic energy resources, such as hydropower and geothermal. This policy meant exploring new geothermal resources and building new heating utilities across the country. Due to the urgency and constructive cooperation, it took only 12 years to decrease oil for heating from 50% 1973, to 5% 1985. This involved converting household heating systems from oil to geothermal heat, based on constructive cooperation between the state, cities, municipalities, and private citizens. Now more than 90% of houses in Iceland are heated by a system based on the direct use of geothermal heat. There are also several gas-fired heating plants in operation, where electricity is most often used as a source of energy. As such, almost all domestic heating in Iceland is based on renewable energy sources, primarily geothermal energy.

In the following years, each municipality established an electricity utility, and the electricity was either produced with oil or hydropower. After the Second World War, the use of electricity became common in the country's urban areas. Electricity was then used to power various machines in industry and business. After the 1960's, larger hydropower plants were built throughout the

country. The development had been quite fast and now the electricity production in the country is one of the most environmentally friendly in the world. The initiative for electrification came from enterprising individuals, then moved mostly to the municipalities, and finally to the state level.

Iceland faces a green transition in the form of a third energy exchange: replacing fossil fuels in transport with green, domestic energy sources. According to a study by UI and UR for Samorka (Government of Iceland, 2023a), energy exchange in transport is economically viable and a great benefit for the environment. Energy transition in transport is one of the biggest opportunities for the Government of Iceland to meet international climate agreements. The Government of Iceland aims to achieve carbon neutrality before 2040 and to cut greenhouse gas emissions by 40% by 2030 under the Paris Agreement (2015) (Government of Iceland, 2023b). Iceland has great potential for carbon uptake from the atmosphere by afforestation, revegetation, and to curb emissions from soils by reclaiming drained wetlands. The biggest sources of emissions (outside land use) are industrial processes, road transport, agriculture, fisheries, and waste management.

More wind energy in Iceland can be the way forward

With the implementation of the EU framework, the energy landscape has changed rapidly. The clearest manifestation is the 34 wind energy projects that have been put on the table of the fourth phase of the framework plan. There is a serious lack of framework for this issue, but a bill is expected soon. Wind quality is high in Iceland, and wind energy can, in many ways, fit well with the country's energy system. The wind blows, for example, more in the winter when there is less water in the reservoirs, but slows down in the summer when the reservoir situation improves. Iceland has a wide range of renewable energy resources and therefore has greater utilization potential compared with most other countries. At the same time, it faces a greater challenge regarding the management of unique natural qualities. The value of nature grows in times of climate change and the effect of utilizing geothermal, hydropower, and wind is different when looking at the structure of structures as well as the different nature of the resources as energy sources (Logadóttir 2002a). The National Energy Authorities, Orkustofnun, confirmed that a lot of lessons can be learned from building wind power in steps and that it is necessary to look at wind power at sea, as well as on land, when choosing locations for the future (Logadóttir, 2022b). It is also necessary to work out how dividends from energy sources are returned to the nation and local communities, since most energy projects are now carried out by private actors and not by state owned companies like in the past.

Furthermore, there has never been so much fermentation in the field of energy and climate issues. One of the biggest achievements of the year 2021 was probably the milestone of scientists in the United States in the field of nuclear fusion, a technology that could transform energy issues in the coming decades. In Iceland, many climate-related companies have developed These include Alor (which works on a new type of battery), Carbfix (which has technology to turn CO_2 into stone (figure 2)) (Kristjánsdóttir & Kristjánsdóttir 2021), Laka (which works to improve the safety of systems), Sidewind (which uses wind energy on cargo ships and Transition Labs, which has invested in the growth of green solutions.) Innovation and technological development could work for Iceland when it comes to creating the greatest benefit in all utilization for society, so progress is closely monitored.

Summary - fingerprint from Iceland

Today, the entire transportation system in Iceland depends on the nations that produce oil. By replacing oil with domestically produced green energy, society can become self-sufficient in the

energy it needs. Icelandic society will not be affected by external factors that may affect the supply or price of oil, for example, due to war.

Iceland could become the first Arctic country to use only green, renewable energy. The Icelandic population uses about a million tons of oil a year and pays 100 billion ISK for it. If Iceland manages to stop this, the benefit could be cleaner air and a sustainable standard of living in Iceland along the way.

Fingerprint: Greenland

Figure 3. Kangia, Ilulissat Icefjord. Photograph by Lill Rastad Bjørst. Greenland August 2021.

Kalaallit Nunaat (Greenland), is self-governing sub-national territory within the Kingdom of Denmark (Ackrén & Jakobsen 2015) and the world's biggest island. A unique feature of Greenland is that 81% of the land is covered by ice and the total population is just about 57,000 (Statistics Greenland 2022). The Self-government Act of 2009 gives, among other things, Greenland full responsibility regarding its own natural resources. The citizens of Greenland share common property rights. In 2021, the Government of Greenland changed the political discourse from being focusing on the extractive future of Greenland with no commitment to global binding climate deals - to focus and plan for a "green transition," become an exporter of renewable energy, and potentially ratifying the Paris Agreement (Bjørst 2022). Therefore, the new focus for the Government of Greenland is on developing more hydropower, establishing PtX installations, and planning extraction of minerals which would be important for new green technology. Despite this new ambition, Greenland lacks physical as well as policy infrastructure. Physical infrastructure, meaning a lack of roads between towns, international airports, along with runways[1] long enough for bigger cargo, modern seaports, connectivity and high-speed internet (Abildgaard et al., 2022; Sejersen, 2015), and a larger STEM educated workforce is just some of it. The lack of policy

infrastructure speaks to the fact that Greenland, has for a decade, not been part of international climate agreements such as Copenhagen Accord (2009), the Rio Convention, (2012) or the Paris Agreement (2015). At the time of writing, the Government of Greenland just signed the Paris Agreement by the UNFCCC. This signifies a turning point for the climate action and Greenland's commitment to bring down greenhouse gas emissions. "We join in acknowledgment that we are an Indigenous people with the right to self-determination. We are responsible for our climate policy, and we join the Paris Agreement on these terms," Greenlandic Minister, Kalistat Lund, stated in a press release (UN, 2023). Now follows the work, with a formal climate strategy for the country, setting the nationally determined contributions (NDC) for Greenland, and explaining the potential implications and possibilities to civil society (Berthelsen, 2023).

Despite being mentioned often in the climate change debate, the discussions about climate politics in Greenland is a relatively new thing (Bjørst, 2019). Nevertheless, Greenland has a unique potential in green transition if managed accordingly, the authors would argue. It is the Greenlanders who have the right to the subsurface, resources, and the hydropower installation that are managed by the Government of Greenland. In other words, when it comes to mining rights and title to land, ownership to the land cannot be obtained in Greenland. However, local people, institutions, or companies may apply to obtain a right to use a piece of land for a defined purpose. In effect, Greenland has no major unresolved problems with land rights - but lately controversies about land-use and extractive projects have appeared and a civil society resistance has evolved, especially around the mining of Greenland's uranium (Bjørst, Sejersen & Thisted, 2023; Hansen & Johnstone 2019). So far, development of hydropower plants has not sparked the same resistance in the public. The same goes for wind and solar energy.

Greenland ice cap = an energy island?

The Greenland ice cap is called the "world's biggest battery" by the national energy company, Nukissiorfiit (figure 3). The CEO Kasper Mondrup, in an interview with the Danish newspaper, Berlingske, said about the capacity of the meltwater from the Greenland ice cap: "It can produce energy for the next eight hundred years if it continues to melt at the current rate." He sees a big potential for Greenland as "The world's hydropower potential is about to be fully exploited. Greenland is one of the places in the world where there is a lot of unused hydropower" (Østergaard 2022: 7). The unused energy from Greenland are currently inspiring politicians to think about possibilities for energy exports and use the presumably cheap renewable energy as a pull factor to attract more private business to Greenland from the rest of the world (data centers, PtX converters, factories ect.). Today, hydroelectric generators produce far less carbon dioxide than power plants that burn fossil fuels and it is considered an alternative to coal, natural gas, and oil. As good as it sounds, hydroelectric development can also produce a broad range of environmental impacts and changes to the land and biodiversity (Winemiller et al., 2016). To boost the energy production in Greenland and attract new industries, might not in the first instance lead to less emissions of CO_2 in total as Greenland (except the fishing industry) does not have bigger industrial complexes at the moment (like aluminum smelters or large-scale extractive industries like mining, oil, and gas extraction). This is also part of the reason why the political party Siumut has been reluctant towards committing to the Paris Agreement (2015). They fear it will impact Greenland's competitiveness when planning for new industrial development (Larsen & Kristensen, 2023). Future fishing, shipping, aviation, and energy consumption in cities and towns without access to hydropower might be unable to transition fast enough in the years to come.

With access to cheap renewable energy, a green industrial revolution might be set in motion. Despite the possibilities for renewable energy in Greenland, diesel will for a long time be part of

the energy mix for industries in remote sites in Greenland such as the remote mining activities in northeast Greenland. However, domestic energy use is dominated by renewable energy - especially from hydropower. At a side event at COP26 (01.11.2021), the Greenlandic Prime Minister, Múte B. Egede, described the ambition for a green transition like this:

> Naalakkersuisut (the Government of Greenland) believes that we who call the Arctic home must do what we can to lead by example by aiming to reduce CO_2 emissions and to promote a sustainable, green transition in Greenland and beyond. Sustainable green energy solutions are the future, and we have a lot to gain by this transition. Greenland has an abundance of hydropower resources, which surmounts our domestic energy needs. We are right now in the process of opening up to investors, who can help develop these areas, so that Greenland can fuel cheap and sustainable energy for data centers or as an input into storing of energy in hydrogen via PtX processes for example (Múte B. Egede at COP26 2021, as quoted in Bjørst 2022).

At COP26, Greenland was inspired by examples from the energy transition projects in Iceland and Norway and used the politics of comparison to argue for Greenland's role in the global green transition (Bjørst, 2022). What Greenland's Prime Minister described was a landscape of intensification (Jones, 2014) to give the green transition momentum (a lot to gain) and placed it within the discourse of national leadership ("lead by example"). Greenland's minerals were not mentioned by the MPs at COP26, but visiting Greenland's plans for industrial development reveal that mining is still part of the portfolio. Greenland's mineral deposits and mineralization profile show great diversity and quantities (GEUS, 2013; Kalvig, 2021). Greenland commands resources that could be important for green technology, which has raised the interest in Greenland from a geopolitical point of view (Rahbek-Clemmensen & Nielsen, 2020).

Over the past 10 years, the total consumption of Rare Earth Elements (REE) has grown by about 50% and with the current use of REE for new technologies the world may face a supply challenge by 2030 (Kalvig, 2021:23). REE in the South Greenland (Kuannersuit/ Kvanefjeld and Killavaat Alannguat /Kringlerne) has raised public attention (Bjørst, 2016; Thisted, 2020, Vestergaard, 2015). However, the Kvanefjeld project is quite close (6-8 km) to the local community, sparking concerns over health, local environment, and the many long-term impacts (Bjørst, Sejersen & Thisted, 2023; Hansen & Johnstone, 2019; Thisted, 2020). REEs in the Kvanefjeld project also include the mining of uranium and thorium – meaning that waste and tailings can potentially contaminate the local environment. In general, there is a significant climate impact in the production of REE and the recycling rate of REE is very limited (Kalvig, 2021). Still, the mining companies promote themselves as green. In a video produced by Greenland Minerals A/S to inform the public about the Kvanefjeld mining project, they describe how Kvanefjeld would "make the world greener," (Greenland Minerals A/S, 2021) indirectly imagining the end product of the production and how this would impact "the world". The mining company TANBREEZ (planning for mining in Killavaat Alannguat /Kringlerne in South Greenland) echo a similar storyline with the slogan "Mining for Green Technologies" (http://tanbreez.com). The Australian company operating in Greenland, formerly known as "Greenland Minerals Ltd," recently changed their name to "Energy Transition Minerals Ltd", rebranding themselves from being a mining company now being an energy transition company. Another example is the Hudson Resources, with an open Pit Mine located 80 km SW from Kangerlussuaq known for their mining of Greenland's anorthosite (calcium feldspar). On their webpage they copy a recent humoristic Carlsberg beer commercial[2] and writing "Possibly the Greenest Mine in the World" (https://hudsonresourcesinc.com/),

describe how it is "an operating mine producing green product"[3]. These two cases illustrate the general tendency in mining projects where the "green" is mostly related to the product itself and less to the local impacts or what the locals will get out of this transition.

Will Greenland be more green?

In the dominant political discourse in Greenland, a green transition and the future and identity of the nation are linked. As Naaja Nathanielsen, Greenlandic Naalakkersuisoq (Minister) for Housing, Infrastructure, Justice, Minerals, and Gender Equality said in her keynote at the 2021 Arctic Circle Assembly: "We want to be known for our commitment to renewable resources and live up to our name, Greenland." At the time of writing, Greenland has some way to go in international climate change policy-making (Bjørst, 2018: 22). Thus, the Government of Greenland is still discussing its climate policy and potentially, Nationally Determined Contributions (NDCs) to implement the Paris Agreement (Veirum, 2023). Following the political climate change debate in Greenland the last 20 years underpins a shift in the discourse with the introduction of the concept "green transition" in the conversation about climate change and Greenland's development (Bjørst, 2022). The concept "green transition" is not fixed and pops up in the conversation. It offers a "promise," about being green and transformative. One that is not articulated and therefore seldom binding, by offering the mining companies a stage to perform as green if they mine for REE or contribute to the global production of green technology. It is an empty signifier and under constant revision, but at the same time unifying with a lot of political effects (Bjørst, 2022). The versions of the green transition that Greenland is planning for contain the paradox that it comes with a new form of industrialization, which invites industrial projects and businesses to come to Greenland and make use of the abundance of hydropower. An industrialization that may increase the CO_2 locally when adding activity, while decreasing the CO_2 globally (from products being produced with fossil free electricity). More activity also requires better infrastructure such as harbors, runways, roads, buildings, energy systems, cables, and more. At the same time Greenland could be more dominant as a business partner and as a country offering green solutions.

Summary - fingerprint from Greenland

To return to the key considerations and significant fingerprints of Greenlandic infrastructure in the green transition it is important to remember that the Greenland ice cap might be melting - but Greenland has never been more solid when it comes to governance and right to land and resources (eg. Self-Government Act of 2009). Greenland is a self-declared welfare society (Arnfjord, 2022) like Denmark, which means that green transition in Greenlandic politics is expected to support and sustain the welfare model. However, as this paper shows, the political green transition agenda might call for considerations when it comes to physical, institutional as well as policy infrastructures to support the Greenlandic society. This fingerprint from Greenland mostly focused on the paradigm shift in the political agenda around green transition in Greenland. At the time of writing, these discussions have, so far, not surfaced in civil society discussions. Some of the missing links are: First, what does the local community need from this transition and how can local towns benefit? Second, what will be Greenland's national climate strategy and NDC to fully commit to the Paris Agreement? Third, the local impact of exploring the hydropower resources to accommodate new industrial complexes and potentially become an energy exporter is not articulated. Fourth, the fact that green transition as a concept is not fixed paves the way for green open claims. One of the effects is that the local dilemmas and social-environmental impacts can be easily overlooked when an initiative speaks to green transition on a global scale.

Fingerprint: Northwest Territories (NWT), Canada

Figure 4. Photography by Lill Rastad Bjørst, NWT, close to Yellowknife, September 2022.

Indigenous peoples, especially in North America, populate a large portion of the Arctic region. Currently in the case of Canada, 170 of 292 remote communities are Indigenous, with the majority relying heavily on a microgrid of energy generation using fossil fuels (Hussein & Musilek, 2021). Due to their inextricable interconnectivity to the land and environment, the green transition is of particular importance to the continuation and proliferation of Indigenous cultures. This is even more true in our rapidly changing environment, in which Arctic temperatures are increasing at a much higher rate than those to the south (Rantanen, Karpechko, Lipponen et al., 2022). With the continuation of temperature increases and climate change, the ability for Indigenous peoples to continue, let alone reclaim, their respective ways of life will become increasingly tenuous. Thus, the need to advance and move beyond the green transition becomes a human rights issue, especially as Indigenous communities attempt to recover from the long lasting as well as devastating effects of colonialism (Cameron, 2015). Nevertheless, Indigenous people have the human right to continue cultural practices, and at the core of those practices is the connection with the environment (Anaya, 2000). As Kraj indicates, "Regeneration of the land is critical to the sustainability of the place. Development that occurs on the given land must not exceed what the land can hold and replenish by itself", and so the pathway to development must be reciprocal as well as sustainable (Kraj, 2023).

Although the ideals of Indigeneity and environmentalism are generally well aligned, so too can they be at odds with one another. Conservation of species, the sustainable use of resources and energy, and the elimination of climate change are issues generally agreed upon. Nevertheless, Indigenous peoples can oppose movements of environmentalists as well, especially when it comes to

Indigenous rights to harvest fish and animals for food and fur for clothing (Wenzel, 1991). Despite this, the majority of the threat to both the environment and the continuation of an Indigenous way of life in the Arctic come from the massive amounts of carbon produced in the world south of the region. Regardless of the relatively minute contribution of climate changing actions occurring in Arctic regions, the global consequences of melting glacial and periglacial (permafrost) bodies releasing eons of trapped greenhouse gasses such as methane and carbon dioxide, may prove immense (Ravasio, Riise & Sveen, 2020). Thus, regional influences of pollution require Arctic infrastructure to lead by example and quickly transition to those exemplifying the green transition.

To break free of petroleum dependency

Of those 292 remote Canadian communities, 257 rely on individual, independent, and highly carbon producing diesel energy generation microgrids (Hussein & Musilek, 2021). Energy production, too, may be even more essential in Arctic regions due to the need for heating in the severe cold and for light in long dark winters. Some communities do not have sunlight at all for weeks or months on end. Nevertheless, many communities are trying to break free of this petroleum dependency, and to a larger extent colonialism through the installation of alternative energy solutions, such as photovoltaics (PV). Although this source is essential to a microgrid of sustainable energy generation, other sources must also be included since solar is most abundant during long and bright Arctic summers, but lowest in the cold dark winters when it is most needed. Ground sink heat sources would also be a very complicated or impossible option, especially in permafrost rich areas, which would cause a thaw and create other ecological devastations. In Inuvik, a community in Canada's Northwest Territories near the coast of the Arctic Ocean, the Gwich'in Tribal Council is currently constructing a windmill to further reduce their reliance on diesel. The latter of which is extremely costly due to the shipping of the fuel and energy production monopolies. If effective, this will demonstrate the potential of wind energy for that region, as well as in frigid temperatures throughout the circumpolar North.

This energy transition is essential in remote Indigenous communities, but must be done with the engagement and incorporation of Indigenous peoples' participation (Hussein & Musilek, 2021). Furthermore, although there has been a long history of exclusion of Indigenous peoples from participating in the determination of infrastructure affecting them, many are reclaiming the right for self-determination, and pushing forward the agenda of the green transition. One such Arctic Indigenous community is the Łutsel K'e Dene First Nation[4], whose members initiated, planned, and implemented a National Park upon their ancestral lands; the Thaidene Nene National Park Reserve. For decades, their traditional homeland, the Akaitcho Territory, has been the location of various diamond mines and other developments (figure 4). Additionally, this community has experienced a devastating loss in historic numbers of caribou; a herd of animals they have been following, living with, and depended upon for thousands of years until present. After years of negotiation with federal and territorial governments, for the survival of the land, animals, and culture of these people, the First Nation created the wildlife reserve in 2019. On the East Arm of the Great Slave Lake in the Northwest Territories (NWT), the massive refuge consisting of 26,376 km^2 (6.5 million acres) of land and protects the sensitive ecological zone transitioning from the boreal forest to the Arctic tundra (Thaidene Nene: Land of the Ancestors Website 2023). Without the determined efforts of this First Nation, a people still intimately connected with their land, this Arctic Canadian National Park Reserve would not exist, nor have moved the green transition agenda forward.

Summary: fingerprint from NWT

Canada does not have a cohesive Arctic infrastructure strategy or accompanying road map (Chiang, 2023). In a recent report from Arctic360, Canada's premier Arctic think tank, it is stated that "Canada's strategy up to now for the North is engaging in spontaneous reactions, as it moves from one crisis to the next" (Shadian, 2022: 5). Currently, these requests are challenged with competing in the political negotiations with Canadians who are struggling with high prices, money to advance Canada's green energy transition, and keep the country competitive (Taylor, 2023). In summary, the northern infrastructure gap and participation in the green transition needs to be addressed, and creating the right relationships with Indigenous nations is of utmost importance. Understanding the needs of Indigenous peoples, in regard to Arctic infrastructure, comes through a process of the creation of right relationships, as it is in any decolonising project (Howell et al., 2016). Thus, determining the infrastructural requirements in the region requires the consultation of the Indigenous communities that the infrastructure project is meant to serve. Additionally, it is critical to form meaningful relationships with Indigenous peoples, not only because it is right, but also for the advancement of reconciliation and Indigenous self-determination (Howell et al., 2016). Meaningful community engagement with Indigenous Nations affected by any infrastructure project through proper protocols and with the appropriate facilitator is a part of the decolonisation objective (ibid).

Fingerprint: Norway

Figure 5. Wind power outside Narvik, Norway. Photography by Anna Krook-Riekkola.

Norway represents an interesting paradox regarding the green transition. On the one hand, Norway is a world leader in renewable energy. With 61% of the total final energy consumption in the year 2020 (IEA 2022), 99% of the electricity generation in 2022 (Our World in Data, 2023) come from renewable energy sources. Electricity generation has historically been generated from almost 100% hydro power (normal year generating 137 TWh), while wind power has increased rapidly from 2 TWh in 2016 to 16 TWh in 2022 (Our World in Data, 2023). Nearly 80% of all new vehicle sales

are electric-only vehicles, a rate which continues to grow (Statista, 2023). On the other hand, Norway remains an important global producer of oil and gas, with the European Union and the United Kingdom being its most important markets as well as Norway being an important provider of oil and gas to these countries (Lewis, 2021; Lundberg, 2021). In 2021, the export of these commodities accounted for almost 50% of Norway's total export revenues (IEA, 2022). A large amount of these revenues are invested in the Government Pension Fund Global that was established when Norway discovered oil in the North Sea. This to make sure "that both current and future generations of Norway get to benefit from our oil wealth" (Norges Bank Investment Management, 2023). Given the war in Ukraine and the necessity for Europe to secure oil and gas from non-Russian sources, Norway's oil and gas industry is likely to remain important for years to come. The Government Pension Fund Global is not a unique case. Norway has "a long history of schemes that provide society with a share of the revenues from industries that earn very well, thanks to access to Norwegian natural resources. This has meant that revenues from hydropower, oil and gas have benefited us all. The proposals announced by the Government are based on foundations that we already have in our tax system" (Government of Norway, 2022, as stated in a press release from the Ministry of Finance in Norway).

Some other important dimensions to understanding Norway's transition include: a carbon pricing system that has been in place since 1991 and part of EU emission trading scheme, a joint Norwegian-Swedish electricity certificate market aiming to increase electricity generated from renewables since 2012 (currently being phased out), policies to increase electric vehicles and ships, and efforts to decarbonize the petroleum industry through electrification of production, carbon capture, and sequestration. In June 2021, the Government of Norway released the White Paper "Putting Green Energy to Work" that outlined four long-term goals for how to create values from Norwegian energy resources: 1) more jobs in Norway, 2) further electrification to make Norway greener and better, 3) establishment of new, profitable industries/technologies, and 4) refine the oil and gas sector within the framework of the climate change goals. The White Paper was published together with a proposal for the further development of offshore wind in Norway and a road map for hydrogen (White paper Meld. St. 36 (2020–2021)).

In May 2021, the International Energy Agency (IEA) released the Net Zero by 2050 Report, the "world's first comprehensive study of how to transition to a net zero energy system by 2050 while ensuring stable and affordable energy supplies, providing universal energy access, and enabling robust economic growth," as was stated in the Press release (IEA, 18 May 2021). The special report was designed to inform the high-level negotiations that took place at the twenty sixth Conference of the Parties (COP26) of the United Nations Climate Change Framework Convention in Glasgow in November 2021. One of the messages in the report was that no new gas or oil field should be permitted if the world should net zero by 2050. In September 2021, there was a general election in Norway, offering a potential shift of the governing bodies and political agendas related to climate, fossil fuels, and the country's interests moving forward. Norway's Green Party, for example, wanted this general election to shut down the country's multi-billion dollar oil industry (Adomaitis, 2021).[5]

Norway's late venture into wind power

Norway started the deployment of wind power later than many other European countries. In 2016, when Norway generated 1 TWh, Denmark (a much smaller country in size) generated 13 TWh

(Our World in Data, 2023). One explanation is that Norway already had fossil free electricity production, while Denmark was phasing out its coal. The resistance against wind power has been strong in Norway. Vasstrøm and Lysgård (2021) put forward an explanation to be "the Norwegian national identity embedded in Norwegian cultural citizenship" that includes "the perception of individual rights and imagined landscape values". Another explanation could be that – unlike with the case of revenues from hydropower, oil and gas giving back to the society – the local communities have not received any revenues even though their visible landscape has been changed.

Another conflict is the one between wind power plants and reindeer herding, the very debated wind power project on Fosen that was built between 2016 and 2022. In 2018, the Saami Council first began advocating for land rights by submitting a request to the UN Committee on the Elimination of Racial Discrimination (CERD) to suspend the construction of the power plants within the traditional territory of the Fovsen Njaarke reindeer herding communities. The UN Committee ignored this request. A year later in 2019, the power plants were completed. According to President of the Saami Council, Christina Henriksen, "irreparable damage was done to the historical winter pastures of the Sámi community and its members' possibility to continuously pursue its ancient livelihood, traditional Sámi reindeer herding, the backbone of their cultural identity'" (Hætta, 2021). This case has created debate in national and international forum. After ongoing persistence by the Saami Council and people, the Government of Norway ruled in favor of Sámi rights, though it remains unclear how this will be imposed on the green energy transition of the country (Henley, 2021). Norway's Supreme Court ruled, according to Article 27 of the United Nations Declaration of Human Rights (1949), that two wind farms in western Norway are harming reindeer herders from the Sámi people by encroaching on their pastures. Article 27 states that minority ethnic people "shall not be denied the right in community with the other members of their group, to enjoy their own culture, to profess and practice their own religion, or to use their own language" (UN 1949: 6). Thus, traditional Sámi reindeer herding is a form of protected cultural practice. More than 150 turbines may be torn down after licenses to operate and build them are declared null and void.

As of 27 February 2023, Sámi youth activists have been occupying the Norwegian Ministry's Energy Office to protest illegal wind farms, also known as the Fosen Vind Project (Ahtone, 2023). With respect to the complexities of this case, the authors have not unfolded this case further. We just would like to mention that in April 2022, the Norwegian government announced it would resume licenses for new wind farm applications in municipalities as long as specific measures were implemented such as including the involvement of Sámi interests in all stages of the process (IEA, 2022: 77). Vasstrøm and Lysgård (2021) has concluded that, "Norwegian wind power is at a crossroad. Arguments on energy security, climate mitigation, market conditions and efficiency are challenged by broad public contestations concerning environmental and nature values, local participation and transparency, and the distribution of burdens and goods" (Vasstrøm & Lysgård, 2021: 9).

Summary - fingerprint from Norway

The fingerprint from Norway exemplifies how it is of particular importance to understand and respect the rights and voices of Indigenous peoples in green transition projects in the Arctic. The IEA (2021) emphasizes that wind and solar energy need to increase substantially over the next decade to not make it too difficult to reach the 1.5 degree target. Offshore wind power is one way forward for Norway. Nevertheless, onshore wind power is much cheaper. In the years to come, there is a need to better understand the societal conflicts that stick to renewable projects.

Position: Green transition as a driver of change

The Arctic has the potential to play an important role in the green transition, as illustrated in the four fingerprints. Both as an important provider of resources (material and energy), and as assistance to meet the climate goals agreed upon in the 2015 Paris Agreement by making it easier to replace fossil fuels with renewables as well as providing carbon storage. Meanwhile, changes also bring opportunities and green transition can be a driver of change in the Arctic – to improve quality of life, well-being, and support the local livelihoods in Arctic communities. For the peoples of the Arctic, there is a need for both sustaining the good life while being part of a global green transition moving away from fossil fuels dependency. Green transitions, if managed well, can be of particular importance to the continuation and proliferation of Indigenous cultures, as we learned from NWT. However, other settings we have identified include how the concept can offer a "promise" about being green and transformative without being binding or committing to local needs or agendas. As FAI scholars, we would like to encourage a green transition informed by the knowledge and expertise that already exists within the local communities, also make sure to connect local communities across the Arctic regions as to be inspired by each other (instead of flying consultants up from the south). There are many good examples across the Arctics - like our fingerprints - that can be beneficial for building multipurpose and multiuser infrastructure fit for Arctic citizens.

Takeaways from our field trips, observations, and document analysis conducted in various places in the Arctic on the current position is: 1. The Arctic has a new strategic role because of the green transition, 2. Arctic communities lack physical as well as policy infrastructure for a successful transition, 3. Green transition is not "a one size fits all" in the Arctic; different communities have different opportunities as well as requirements when it comes to green transition, 4. There is a knowledge gap both in terms of what Arctic communities need from a transition, and how these needs best could be met, and 5. Green transition can become an important driver of change in the Arctic.

Notes

1. But two new airports are in construction and plan to open in 2024.
2. "Carlsberg 0.0 - Probably the best beer in the world"
3. (https://hudsonresourcesinc.com/projects/white-mountain-anorthosite-project/)
4. Author Chris Clarke-McQueen is a Yellowknife Chipewyan Dene, Akaitcho Territory, Treaty 8 member of the Łutsel K'e Dene First Nation.
5. Despite high support in the poll ahead of the election, the party did not get many voters.

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