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OTHER FUTURES FOR ARCTIC ECONOMIES? SEARCHING FOR ALTERNATIVES TO RESOURCE EXTRACTION



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The debate on Arctic economies has been dominated by large-scale resource extraction and trans-Arctic shipping. This was the case in particular after 2007, when high resource prices and climate change impacts were expected to trigger Arctic economic boom, which was associated with hopes for regional development and concerns over environmental impacts. By the mid-2010s, these notions are replaced by more modest outlook, as the pace of developments – largely due to low resource prices – is much slower than projected and various technical, economic and social constraints for extraction and shipping are better understood. However, Arctic regions continue to face major developmental, social and demographic challenges. In order to address pertaining problems, many regional policymakers and economic actors are increasingly turning to a broader range of economic activities, and searching for other pathways to economic security and growth. They aim to facilitate job creation within the northern regions and emphasize the role of the local small and medium enterprises. Many of these new pathways are thought to be more environmentally and socially sustainable than resource-focused economies. Information and communication technologies, circular economy transitions, bioeconomy, and utilizing Arctic natural conditions have become a part of the

current discourse on Arctic development, especially in Nordic northernmost regions such as Lapland, Norrbotten and Troms. The new way of thinking about the development of the Arctic is also visible in Finland's 2013 Arctic strategy. This paper discusses chosen activities representative for these development ideas, including data centres, cold climate testing, high value agricultural production, bioenergy, small-scale local circular solutions and Arctic creative industries. The particular challenge is to facilitate economic developments normally associated with large urban centres to gain foothold in remote and sparsely populated areas, as well as to find innovative solutions and ideas tailored to realities of peripheral Arctic locations. A clear shortcoming of this paper is limited coverage of developments currently taking place in Russia.

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Fading hopes for Arctic large-scale extractives and shipping

The discussion on the socio-economic development of remote, peripheral and sparsely populated Arctic regions had been focused on extraction of resources – both non-renewable (hydrocarbons and minerals) and renewable (primarily fisheries and forestry) – as well as trans-Arctic shipping. Climate change and rising resource demand in the mid-2000s raised expectations for economic boom associated with these activities. Across the Arctic, the interest of private sector as well as policy-makers led to optimistic investment plans, regulatory changes or – especially in Greenland and northern Canada – hopes for increased economic independence.

However, drop in gas, mineral and finally oil prices resulted in discontinuation of a number of exploration and extraction projects, closure of mines, and falling profits of extractive companies. In addition to low resource prices – which may rebound in longer perspective – there is also greater awareness of technical, environmental and social challenges connected with large-scale developments in the Arctic (EY 2013; Käpylä and Mikkola 2015; Stepień *et al.* 2014).

As a result, the discourse in terms of regional strategies has changed, and currently a much broader spectrum of economic activities is being discussed. That includes tourism, bioeconomy, cold-climate technologies and information and communication technologies (ICT). While Arctic regions are likely to remain highly dependent on primary (extractive) sectors (e.g., Exner-Pirot 2015; Olsen *et al.* 2016; Rasmussen

2011; Stepień *et al.* 2016), some locations – especially Nordic regions – are well positioned to diversify their development strategies and economic profiles.

Compared to the development based on extractive industries and the public sector, there are hopes that a broader set of activities would lead to greater resilience to fluctuations in resource prices and allow for a more environmentally and socially sustainable growth. The aim is also to create more and better quality jobs in the North itself and allow local small and medium enterprises (SMEs) to find niche activities and markets. Eventually, activities discussed in this paper can benefit economic actors both within and outside the Arctic (e.g., those developing solutions and services to be applied in Arctic conditions).

Characteristics of Arctic regions relevant for a broader scope of economic activities

Arctic regions vary significantly, but there are certain common characteristics relevant for a broad range of activities discussed in this paper. These include:

- peripherality and remoteness, sparse population, challenges for accessibility and connectivity, including high transport costs;
- challenging weather conditions (with climate change increasing uncertainty);
- limited socio-economic and intellectual critical mass with constraints on human capital;
- proportionally high dependence on public sector and budget transfers, as well as high dependence on primary (extractive) sector

(Niskanen and Miettinen 2014; Rasmussen 2011; Stepien *et al.* 2014).¹

Importantly, discussed here ICT opportunities, ideas related to circular economy, and creative industries have been primarily developing within the context of urbanization, without much consideration being given to peripheral and sparsely populated regions.

Four trends

Four cross-cutting, interrelated features stand out when economic trends and opportunities alternative to large-scale resource extraction and shipping are discussed:

- positioning Arctic regions within global technology-driven and knowledge-based economic changes, especially:
 - o an ongoing **digitization and ICT** transformation, and
 - o the expected **circular economy transition**, which entails limiting new resource extraction and waste, and which relies on renewable energy, bioeconomy and biotechnology;
- developing more locally beneficial and profitable, long-term and more environmentally sustainable ways of **utilizing Arctic environment** (natural resources and natural conditions), including by means of carrying out refining in the North;
- **commercializing Arctic creativity**, building on northern skills, knowledge,

culture and innovations, as well as generating value from the “Arctic brand”.

After examining these four features, we turn to various concrete economic activities that reflect them.

Digitization and the ICT

Internet is changing economies around the world and North American and Nordic Arctic states are at the forefront of the transformation. E-commerce, cloud computing, e-government, e-services, or Internet of Things are but few of developments. For instance, in 2014, the Internet's share of Finnish and Swedish GDP was 8,2% (among highest in Europe) with ICT exports 3% and 6% of GDP respectively. Some reports predict e-GDP to grow over four times the average GDP growth (despite declining digital infrastructure investments in the Nordic states) (Alm *et al.* 2016; Warrenstein *et al.* 2016). Moreover, Finland and Sweden rank high in venture capital funding and the number of successful IT start-ups (Kristoffersen *et al.* 2016). However, the current growth and emerging opportunities are not necessarily reflected in the Arctic regions and more remote communities. How can Arctic locations benefit from the ICT transition?

E-services promise more cost-effective access to basic services and higher quality and safety of life, transport and economic activities in the Arctic locations, especially in peripheral countryside. This includes remote sensing, environmental and transport/logistics monitoring (Niskanen and Miettinen 2014). While not without risks – for instance related to user challenges for older generation or network failures – development of e-services can be important for enhancing attractiveness of living in remote regions, facilitating emergence of

¹ According to the Arctic Human Development Report (2004 and 2014), Northern economies are composed of three main types of economic activities: large-scale extraction strongly linked to global demand (primarily mineral extraction, fisheries and forestry), small-scale

extraction of renewable resources for local market, as well as public transfers. In many Arctic regions mixed economy – where subsistence and cash economy contribute to people's livelihoods – remains an important feature (Arctic Council 2004; Larsen and Fondahl 2015).

more internationally connected and diversified economies; and consequently, contributing to strengthening human capital in the North.

It is less clear how ICT sectors could contribute to growth and job creation within the northern regions. Emergence of successful IT companies as well as investments of big players in the region are constrained by insufficient critical mass or lack of IT clusters (with the exception of urban centres such as Oulu and Luleå). Furthermore, needed education and skills are often lacking and broadband access continues to be deficient in more remote locations, especially outside Fennoscandia. Existing IT developments are largely confined to Arctic cities.

Nonetheless, there are IT-related sectors where Arctic regions may be comparatively better positioned, including data centres, creating and testing e-services, remote sensing and monitoring, cold climate testing or Arctic creative industries.

Circular economy transition

Circular economy (CE) is an industrial economy that is restorative by design, replacing current dominant linear take-make-dispose model. It strives to maintain the utility and value of products and materials, to limit the extraction of new raw materials, while at the same time creating growth and jobs within increased circular activities such as recycling and refurbishing (Eea 2016; Ellen MacArthur Foundation 2013; Ellen MacArthur Foundation and McKinsey & Company 2014).

What is the place of Arctic regions – peripheral, sparsely-populated, dependent on extractive sectors – in the hoped-for transition of global economy towards circularity?

In the long term, CE transition in principle would lead to decreased demand for and prices of raw materials, positioning Arctic regions on the losing side of the CE transition. That is owing to high costs of extraction in the North and, at the same time, regions' high dependence on extractive industries. Notwithstanding realization of such a lower demand scenario, some new extraction will still occur. High environmental standards and green solutions applied in extractive activities may – ideally – become an added value for environmentally-conscious buyers of raw materials and for consumers of their products. Especially Nordic regions aim at positioning themselves as sources of comparatively cleaner raw materials.²

CE requires continued environmentally sustainable extraction of bio-resources. Economic activities related to bioeconomy (both extraction and bio-based production) may become strengths of Arctic regions, as places of origin for pure, organic, high-quality bio-products for global circular economy. Purity of bio-products is critical if toxicity of bio-waste returned to the biosphere is to be limited.

CE transition depends also on the availability of renewable energy. Arctic regions have significant hydropower, wind and bioenergy potential. While hydropower investments slowed down after the 1970s in northern Fennoscandia, major projects have been proposed and implemented in Iceland, Greenland and North America. Currently, wind power is expanding throughout circumpolar North, especially in the European Arctic. Availability of renewables can offer opportunities for energy exports: directly to energy markets or indirectly through the products of industries looking for clean and cheap energy sources (e.g., earlier aluminium smelters in Iceland and Greenland, currently data centres in Sweden). However, renewable energy, especially bioenergy and hydropower,

² Regional and national development strategies, in particular in Northern Fennoscandia (e.g. Länsstyrelsen i Norrbottens län 2013; Regional Council of Lapland 2013), already attempt to promote and build-up the expertise in

more responsible or environmentally and socially sustainable resource extraction (e.g. Green Mining programme in Finland or CSR strategies of companies such as Swedish LKAB or Lundin Mining).

yields environmental impacts and often meets with resistance of social actors.

There are also attempts to induce small-scale circular solutions at the local level in the Arctic. These include, for instance, wood-based bioenergy for the forestry, ash utilization, and locally produced and used biogas (e.g., Niskanen and Miettinen 2014). In the future innovative developments such as 3D waste-based printing may be possible. Large distances and comparatively small volumes of both industrial and domestic waste limit the environmental and economic sustainability of reuse, collection, refurbishing, and recycling schemes developed

for southerly, highly-urbanized regions. There is a need for research and development efforts towards economically-sound solutions suitable for remote, small communities. Smart (cost-effective application of ICT) and integrated (bringing together many sectors within local economic systems) solutions could be potentially commercially reproduced across the Arctic region. It might be also beneficial to consider material and waste flows at the cross-regional, transnational level, e.g. through the Barents Region or across northern Europe.³

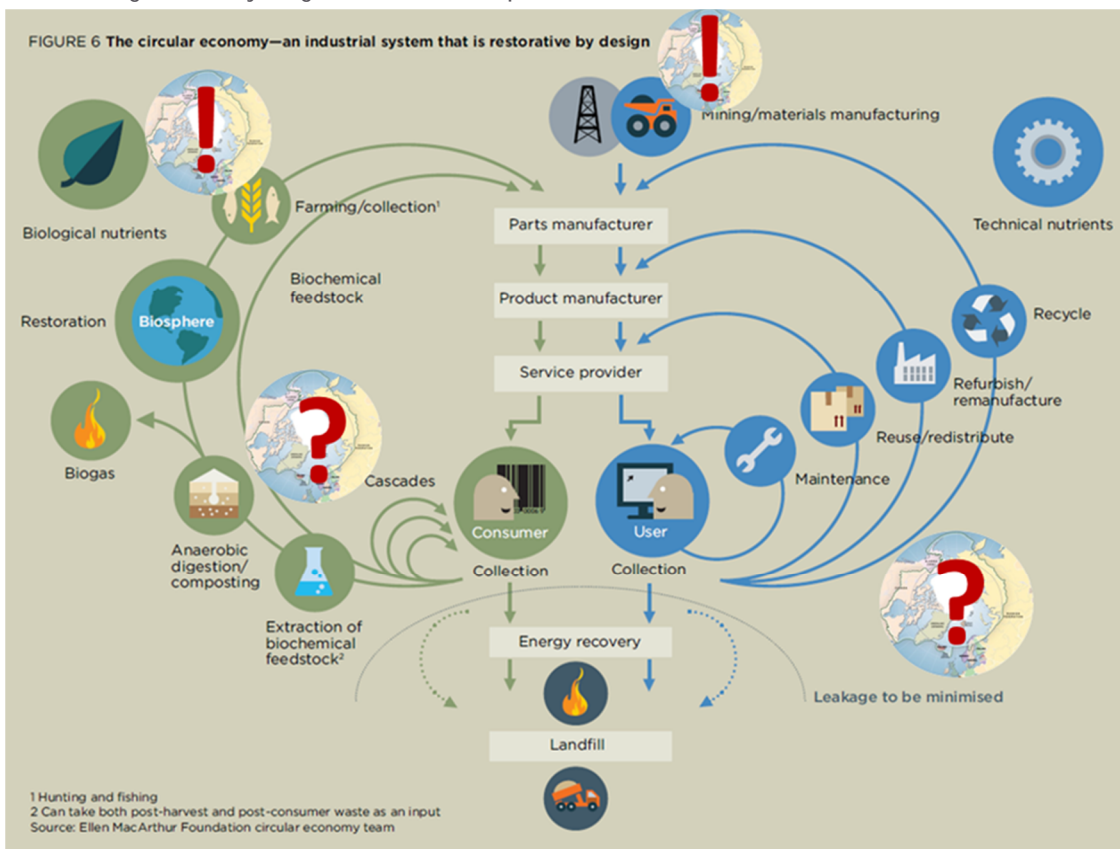


Figure 1: Conceptual structure of circular economy showing circulation of technical nutrients (artificial components and materials) and biological nutrients (extracted – and partly returned – to biosphere). The positioning of Arctic regions is indicated: exclamation marks: primarily sources of biological and mineral raw materials (and possibly initial refining); question marks: unclear role within the key envisioned circular added value chains.

Source: Ellen MacArthur Foundation (2013), *Towards the Circular Economy: Economic and business rationale for an accelerated transition*, Part 1

³ E.g., in 2009-2010, an Interreg IV North project examined possibilities for internal waste market in North Calotte <http://2007->

2013.interregnord.com/en/projects/north/3-regional-functionality-and-identity/development-of-an-internal-waste-market-in-the-north-calotte.aspx

Utilizing Arctic environment

Sparse population and lack of major urban centres make the use of natural resources and natural conditions central to regional development strategies. However, utilization of Arctic nature goes beyond extraction of mineral and renewable resources. The goals are:

- to enhance the use of renewable resources (forests, fisheries, agri- and aqua- culture) by developing more environmentally sustainable modes of production, increasing the added value of extracted products and increasing the high-quality employment associated with Arctic resource extraction (e.g. by producing high-quality exportable products);
- to refine extracted non-renewable and renewable resources within Arctic regions;
- to utilize natural conditions (landscape, nature and colder climate) via non-extractive activities, including tourism, cold-climate testing facilities or data centres;
- to renew emphasis on renewable energy production, including wind power, as well as – with environmental challenges – bioenergy, hydropower and peat.

A central part of circular economy is bioeconomy, where the basic building blocks for materials, chemicals and energy are derived from renewable biological resources, with the application of biotechnology (Olsen *et al.* 2016 quo. Lindbert *et al.* 2016). Much expertise on fisheries and forestry (especially northern Finland and Sweden) is located in the North,

where these industries have had long history. Bioeconomy has recently become one of the key themes within Nordic cooperation, with distinct attention to Arctic bioeconomy.⁴ However, technological and structural changes within these industries led to significant decrease in employment. Current regional development strategies aim at promoting new uses for more efficiently harvested timber (bioenergy including wood pellets), and high value bio-products (high quality foodstuffs, dietary supplements, cosmetics, chemicals, etc.) refined within the region.

Commercializing Arctic creativity

Increasing attention is given to innovation and creative industries⁵ in the Arctic. As creativity and innovation are thought to underpin many of the 21st century industries, creative human capital⁶ is seen by analysts as one of the pillars for transformation and reinvention of Arctic societies and economies (Olsen *et al.* 2016; Petrov 2014). Creative capital should not be seen only from the perspective of cultural industries but also in the context of tourism (making region's more attractive and better known), technical innovation (with emergence of local or regional critical mass across sectors) or cultural and identity viability (especially for indigenous peoples and minorities). Indigenous creative cultural industry is particularly visible and vibrant in the Arctic context. Creative capital is associated primarily with urbanization; and therefore, existing Arctic creativity and innovation is naturally concentrated in Arctic towns, with notable exception of indigenous cultural industries.

and ingenuity. Creative industries include sectors such as advertising, arts, crafts, design, designer fashion, film, computer games, music, performing arts, publishing, software and television, cultural industries in general (Olsen *et al.* 2016).

⁶ So-called "creative class" includes highly educated persons, leaders, entrepreneurs and people engaged in cultural activities.

⁴ Nordic Council of Ministers website at <http://www.norden.org/en/theme/nordic-bioeconomy> and <http://www.norden.org/en/theme/nordic-bioeconomy/bioeconomy-in-the-arctic-region>

⁵ Creative capital may be defined as a stock of creative abilities and knowledges embodied in a group of individuals (Petrov 2014). Human creativity is considered an ultimate economic resource, associated with originality

One constraint is the disconnection between fairly high education levels and vibrant cultural industries on one hand and low position on entrepreneurship scales on the other (Exner-Pirot 2015; Olsen *et al.* 2016; Petrov 2014). There also appears to be a gap between the very high level of innovation taking place within Arctic large-scale industries, stimulated by international companies, and small-scale local innovations, where various microinnovations – while intrinsically valuable – do not necessarily translate to commercialized and job-creating activities (Exner-Pirot 2015).

Overview of chosen prospective activities

The aforementioned four features of economic prospects alternative to large-scale resource extraction translate to various concrete activities, of which only chosen are presented below. Arctic is composed of very diverse regions, each being a place for different developments.

Data centres

Northern regions are attractive for data centres and cloud services not only due to colder climate, which decreases the costs for server cooling, but also due to availability of cheaper renewable energy, as IT companies aim at using exclusively renewables due to business image considerations. Up to 80% of energy consumption when using online applications occurs in data centres and it is 5-10 times cheaper to transport data than electricity. Apart from direct employment and investment, data centres generate contracts for local companies, e.g. in terms of electric installations. Presence of data centres could make Arctic towns more

attractive for technically-skilled creative young people (Nilsen 2016; Warrenstein *et al.* 2016).

Swedish Norrbotten has been particularly successful in attracting data centres. Facebook,⁷ KnC miner (Bitcoin) and several colocation facilities (serving couple hundreds of companies) have been located in Luleå and Boden. In 2015, almost 7000 direct and indirect jobs were associated with all Swedish data centres (over 135-155 locations nationally), although that includes 3300 jobs in construction phase. Economic impact is estimated at EUR 1,35 bln (half in construction activities) (Warrenstein *et al.* 2016). Relative attractiveness of Sweden stems from favourable tax regime, stable political and regulatory situation, availability of highly skilled Nordic work force, and sufficient broadband connections. Further investments are planned in North Sweden, but data centre construction is also considered in Oulu, Finland. Notable investments have been made also in Iceland. It is unclear whether other Arctic towns can benefit from the demand for data centres or whether North Sweden is a singular case of success.

Cold-climate testing facilities and cold-climate technologies

Cold-climate technologies constitute a very broad category of materials, products and solutions developed in order to be deployed in cold-climate conditions. They range from marine technology for maritime navigation in ice-cover waters and industrial operations in cold and extreme weather conditions to materials designed specifically for cold temperatures and Arctic weather conditions. Clothing and Arctic-ready construction have been long acknowledged as prospective areas for development, with Arctic states being at the

⁷ Direct economic impact of Facebook data centre totals so far EUR 160 mln in investment (with second centre being built and third planned), 100 direct jobs, and

indirectly it is estimated at 800 jobs and EUR 357 mln for the economy (Nilsen 2016).

technological forefront (Niskanen and Miettinen 2014). Cold-climate technologies are tested in the Arctic, but can be also advanced by northern companies and institutions. Finnish Lapland's strategy for smart specialization (Regional Council of Lapland 2013) as well as Finland's Arctic strategy (Prime Minister's Office 2013) highlight prospects for such developments.

Products and materials – both specifically designed for cold climate and other products – need to be tested for cold-climate and winter use in real-life conditions. That creates opportunities for regions across circumpolar Arctic: investments have been made or planned in Greenland (Volkswagen), Canada (plane engines, cars, industrial equipment⁸), and Alaska (cold climate housing, Audi testing grounds⁹). Testing activities proliferated in North Sweden and Finnish Lapland, where car and tire testing generated high turnovers and employment (Lapland Chamber of Commerce 2016).¹⁰

Similarly to data centres, testing facilities create demand for services of local companies. Testing requires investment in high quality facilities, good network connections and technically-skilled personnel. Moreover, “testers” need accommodation, hospitality and transport capabilities, which can be more easily provided in regions with strong tourism sector.

E-services, remote monitoring of infrastructure and habitats

E-services and remote monitoring have potential to enhance safety and comfort of living in remote locations, in particular in regions where population decline is coupled with rising percentage of elderly population. E-health and assisted living solutions provide, for instance,

medical expertise based on real-time physiological data measured on-site or allow for constant monitoring (Niskanen and Miettinen 2014). Progress requires development of reliable and easy to use medical sensor devices, wearable technology, in-body sensors, and technologies for managing private information. Utilizing personal mobile devices and promoting private-public partnerships are among likely trends in this area.

Remote monitoring of environment (crisis situations and habitats monitoring) and infrastructure (management and analysis of structural and functional integrity) holds great potential in remote and sparsely populated areas. Sensors developed for environmental and infrastructure monitoring need to operate in cold conditions with appropriate battery lifetime. It is also a challenge to monitor large areas, as that entails large number of sensors (Niskanen and Miettinen 2014). Using drones for monitoring, surveying and research becomes increasingly common.

Ideally, the developed solutions could be commercialized and sold to service providers across the circumpolar North and to other regions characterized by sparsity and remoteness, with Arctic developers ripping benefits from development and management of e-services. However, so far northern business success stories related to e-service developments are few. Dominant public sector cannot be expected to drive commercialization of e-services while private actors may find Arctic market too limited for developing solutions independently from public sector's demand.

⁸ In Manitoba, see <http://mbaerospace.ca/maa/aerospace-in-manitoba/cold-weather-testing/>

⁹ Come to Fairbanks website, <http://www.cometofairbanks.com/bcold.php>; Alaska Dispatch News, [http://www.adn.com/business/article/audi-build-arctic-](http://www.adn.com/business/article/audi-build-arctic-ice-road-test-vehicles-near-alaskas-prudhoe-bay-0/2015/12/10/)

[ice-road-test-vehicles-near-alaskas-prudhoe-bay-0/2015/12/10/](http://www.adn.com/business/article/audi-build-arctic-ice-road-test-vehicles-near-alaskas-prudhoe-bay-0/2015/12/10/)

¹⁰ Including companies like Lapland Proving Grounds (www.laplandpg.fi/), Test World (<http://www.testworld.fi/>), Arctic Testing Services (<http://www.arctictesting.fi/>). Testing facilities development were promoted by regional authorities (<http://www.northernmosttesting.com/>).

Arctic broadband and data cables

In the coming years, the Arctic could become a location for regional and trans-continental data cables. As much as 99% of global communications is carried by nearly 300 submarine optical fiber cables, with Arctic Ocean being one of the last basins – next to the Southern Ocean – not traversed by these connections. The advantage of Arctic connections is slightly shorter latency (delay) for Europe-Asia communication, a critical feature for example for stock markets. Climate change and diminishing sea ice in the summer months may allow for more cost-effective laying works. Advantage of Arctic waters is lower risk of damage to the cables from shipping and fishing (anchors and nets) as these activities are limited compared to other locations, even in the long-term (Delaunay 2014).

Two major Arctic maritime trans-continental projects have been considered. Quintillion Holdings, an Alaska-based company,¹¹ is currently laying a cable to the Alaskan North Slope and along the state's north coast, to be completed by 2017. While the first stage is focused on providing cheaper and more reliable connection for northern Alaska, the second stage is to extend the cable from Seattle eastwards via Alaska to Tokyo and third stage westwards via Northwest Passage to London. The latter cable could also provide broadband to Canadian Nunavut communities, but that would depend on public support for the project.¹² The cost of the project is estimated at USD 650 mln

with Nunavut and Nunavik connections entailing additional USD 237 mln (Delaunay 2014). The second major project links Europe with Asia via Northern Sea Route and Finland, estimated at USD 1,9 bln total.¹³ Notably, connecting Arctic communities to the trans-continental cables is very costly and depends on public support for these otherwise commercial projects. Arctic regions would – apart from advantages derived from broadband connectivity – gain little direct benefits from laying subsea cables.

Connectivity is one of the great challenges of Arctic regions, especially beyond northern Fennoscandia. Satellite communications are key to safe Arctic navigation, search and rescue, as well as potential industrial developments, especially considering that above 72°N the coverage is poor and above 78°N hardly existent.¹⁴ However, satellite communication is not sufficient for discussed earlier e-services and remote monitoring (Niskanen and Miettinen 2014). Broadband connections can make a tangible difference for households, local businesses, extractive industries, shipping and research.¹⁵ Greenland, Svalbard and Iceland are already connected to the global network via optical fiber cables, with benefits for local economies (e.g. mentioned data centre development in Iceland).

¹¹ The company took over Arctic Fibre, which developed the cable project.

¹² <http://www.cbc.ca/news/canada/north/arctic-fibre-optic-internet-sale-quintillion-1.3591825> ; http://quintillionnetworks.com/?page_id=172

¹³ The project was proposed by Russian company Polarnet with Finnish government indicating its support although not funding. <http://barentsobserver.com/en/business/2013/12/finland-supports-data-cable-along-northern-sea-route-16-12>

¹⁴ Among others, Telenor Satellite Broadcasting AS and the Norwegian Space Centre currently carry out a project

assessing data needs and possible solutions, with utilizing old satellites for broadband connectivity as one possibility.

<https://www.sintef.no/en/projects/satellite-communication-and-broadband-in-the-arctic/> ; <http://www.wsj.com/articles/SB10001424052702303947904579338123242192890> ;

<http://thebarentsobserver.com/arctic-security/2016/05/old-satellites-will-give-broadband-arctic>

¹⁵ Tara Sweeney at Alaska Dispatch News, 7 September 2015

<http://www.adn.com/opinions/2016/07/09/making-the-connection-why-the-arctic-needs-broadband-access/>

Small-scale, high-value bio-production

For small rural communities, a prospective opening is finding niche in the production of high value foodstuffs from regionally available resources such as berries or reindeer. Such products have export potential, for instance to Asian markets.¹⁶ Small companies play here a central role. Arctic branding of food products as clean, pure, and exotic may translate to higher prices and higher sales. Marketing of Arctic foods can benefit from lesser amount of pesticides used in colder climate. Specialized food production can be also combined with food tourism. Challenges include climate, demographics with many villages being currently partly abandoned, and distance from large markets (Olsen *et al.* 2016). Moreover, Arctic production of high value foods – as well as bio-based chemicals or dietary supplements – requires combination of traditional skills and occupations with high-tech bio-refining skills (see also, Regional Council of Lapland 2015; Troms Fylke 2013).



Figure 2: Arctic foods. A picture from NAM NAM exhibition on Arctic food culture at the Arctic Centre, University of Lapland.
Photo: Arktikum Science Centre / Arto Vitikka

Blue economy: more value from Arctic waters

Fisheries has been the backbone of many Arctic communities and economies for centuries. Current challenge for businesses and policymakers is to gain more value from extracted resources. Similarly to land-based bio-based production, that can be achieved by processing the produce within the region.

Furthermore, great potential is expected to lie in biotechnology, including production of marine-based enzymes, bioactive compounds, biochemicals, cosmetics, oils, vitamins, and dietary supplements. SMEs may play a key role in finding regional bioeconomy and blue economy niche. Bioprospecting will in the future constitute crucial facilitator for new developments, but it remains to be seen whether it directly benefits economic actors within the circumpolar North.

North Norway and Iceland are already at the forefront of these developments, with viable biotechnological clusters established. Northern businesses practice innovations from fish skin transplants for skin and tissue repair to using disposed guts and entrails as raw materials for chemical industry (Olsen *et al.* 2016).

Alongside biotechnology applications, new blue economy sectors emerge. For instance, seaweed collection and farming for food, feed, fertilisers, biofuel production and power generation has been for several decades practiced in southern Canada and Europe but now gradually finds its way into the Arctic. Freshwater aquaculture is growing, partly as a result of technological advancements (Olsen *et al.* 2016).

¹⁶ Finpro website at http://www.finpro.fi/web/finpro-eng/news/-/asset_publisher/R46o/content/id/1505910

Bioenergy and biofuels

As Fennoscandian regions consider new uses for growing volumes of timber (Olsen *et al.* 2016; Prime Minister's Office 2013), bioenergy and biofuels emerge as clear opportunities. Energy sector already uses local wood, peat, as well as forestry and pulp mill waste products, especially for district heating. Production of biofuels is facilitated by increased demand for renewable fuels in transport sector. Biogas is a local option, while biodiesel could be exported internationally, with some projects currently under consideration.¹⁷ Most Fennoscandian pulp and paper companies are already engaged in bio-refining projects, primarily in liquid biofuels sector (Olsen *et al.* 2016). However, there is still a gap between the development of technologies and their large-scale commercialization.

The challenge is sustainability of bioenergy and biofuels, as not only the quantities potentially harvested (in terms of renewal of forests) but also impacts on biodiversity from ongoing harvesting need to be taken into consideration.

Expansion of bioenergy, renewables and upgrading community power sources in the North will require further investment in power grids (Caló and Pongrácz 2013). Smart grids¹⁸ would allow for better management of power flows and monitoring of the condition of the power networks infrastructure, both features of importance for Arctic regions characterized by long distances, remoteness of infrastructure in case of problems caused by harsh weather, as well as presence of small energy produces and communities disconnected from the grid (Niskanen and Miettinen 2014).

¹⁷ In particular, Kaidi biofuel refinery in Kemi, Finnish Lapland, which is to utilize remaining capacities in North Finland's forest sector.

¹⁸ Smart grid is an "electricity network that uses digital and other advanced technologies to monitor and manage the transport of electricity from all generation source to meet

Ash utilization

One of the ways to increase value added from timber is utilizing ashes from bioenergy production, with Finland being currently in the pole position. Bio-based ash and sludge can be used in construction materials, especially replacing sand, gravel and granulates for low-level and forest roads and landscaping (e.g., Vanhanen *et al.* 2014). Furthermore, utilizing ash from bioenergy production as fertilizer is considered by the SMARCTIC project as a highly prospective development (Korpijarvi *et al.* 2012; Niskanen and Miettinen 2014). The key technological challenge for ash-based fertilizers and construction materials is the risk of contamination of soil with heavy metals (Vanhanen *et al.* 2014).

Creative industries

Arctic creative industries often build on interconnecting knowledge of Arctic nature, Arctic-specific cultural features and synergy between cultural economy, entrepreneurship and leadership, rather than on formal education (Olsen *et al.* 2016; Petrov 2014). Arctic brand and the notion of authenticity is central to promotional strategies and competing with cheap, massively manufactured products.

Currently, much attention is dedicated to design, highlighting the environmental sustainability, interconnection with traditional handicrafts and materials, utilization of digital technologies, focus on cold-climate conditions, and creating products or services with sparsely-populated peripheral areas in mind (Olsen *et al.* 2016).¹⁹

the varying electricity demands from all diverse end-users" (Niskanen and Miettinen 2014: 38).

¹⁹ The emerging focus on Arctic design in Rovaniemi (in particular, the annual Arctic Design Week initiative <http://arcticdesignweek.fi/en/> as well as university programme) is mirrored by similar initiatives across the circumpolar Arctic.

Tourism: new openings

Tourism is a fairly well-established and persistently expanding – in some areas at stunning over 10% annually in recent years – industry in Arctic regions (Maher *et al.* 2014). Many locations attempt to catch-up with leaders such as Lapland (e.g., Fylkeskommune 2013; Regional Council of Lapland 2013). Major advantage of tourism in contrast to mega-investments such as extractives or data centres is that fairly small investments generate larger number of jobs.²⁰ The stated aim across the region is to achieve sustainable tourism development, which would avoid overcrowding (a major challenge for instance in Iceland), limit impact on environment, respect local cultures, and increase revenue that remains within the region (Maher *et al.* 2014; Olsen *et al.* 2016). Moreover, climate change poses challenge to operations of Arctic winter-oriented destinations.

Increasing quality, specialization and personalisation (and as a result also higher pricing) of the tourism offer appears to be a trend across the region, creating business opportunities especially for local SMEs. Tourist destinations are nowadays expected to propose visitors content (activities, unique experiences), not only sights.²¹ New tailored offer includes food culture tourism, wellness tourism and the promotion of consumptive wildlife tourism (hunting and fishing). Also indigenous tourism – entailing small-scale cultural experiences – is promoted and good practice and ethical standards have emerged over the last decades (Olsen *et al.* 2016).²² Collaboration across broader regions in order to propose comprehensive set of northern destinations and avoid repetition of destinations' offer is seen as

a challenge to be tackled (e.g., cruise tourism in West Nordic region and "Visit Arctic Europe" project in northern Fennoscandia).²³

Cruise tourism is growing slowly and unevenly, but also here operators attempt to make their offer more unique (MERMAID Consortium 2016; Olsen *et al.* 2016; Sander *et al.* 2016). Cruise operators pledge to bring more added value for visited communities, combine destinations, and propose tailored services, especially for expedition cruises (Maher *et al.* 2014).²⁴

²⁰ Based on discussion with Johan Edelheim from the Lapland University Consortium's Multidimensional Tourism Institute (Rovaniemi, 15 August 2016).

²¹ *Ibid.*

²² Similar development strategies are implemented across the circumpolar Arctic, e.g. in Murmansk region, see

http://www.arcticyearbook.com/images/Arcticles_2014/Suutarinen_AY2014_FINAL.pdf

²³ Visit Arctic Europe at

<http://www.lme.fi/hankkeet/visit-arctic-europe.html>

²⁴ See, e.g., various guidelines issued by the Association of Arctic Expedition Cruise Operators (AECO) at <http://www.aeco.no/guidelines/>.

Uncertainties and constraints

Many of the discussed economic activities require boost in innovation, entrepreneurship as well as adjustments in northerners' skills and education. There are a number of constraints for these to materialize:

- lack of regional critical mass for generating commercializable activities, accessing needed capital, providing basis for the development of local human capital, or acquiring access to large-enough markets (lack of economics of scale);
- distance to the main markets, including within the respective nation states;
- high entry costs for SMEs in key northern economic sectors, including access to capital, sometimes higher costs of implementing environmental standards (necessary in the context of vulnerable Arctic environment);
- limited access to affordable telecommunication infrastructure (especially in northeast Russia, Greenland and North Canada);
- outflow of young professionals (especially with science, technology, engineering and mathematics education) acquiring education to southern population centres;
- large size of public sector, yielding greater risk aversion (Exner-Pirot 2015; Larsen and Fondahl 2015; Rasmussen 2011).

These challenges translate to key uncertainties regarding novel economic developments in the Arctic: Will some Arctic regions join the mainstream of global developments or remain a periphery? Will Arctic communities become not just consumers of IT and high-tech solutions, but places where these solutions are being

developed? Will the Arctic be positioned within the global CE as a region specialized in delivering raw materials and cheap renewable energy or perhaps some Arctic locations will find ways to benefit from biotechnology, bioeconomy and CE developments?

A particular challenge is facilitating economic developments normally associated with large urban centres (ICT and circular solutions) to gain foothold in remote and sparsely populated areas. That calls for finding innovative solutions tailored to realities of peripheral Arctic locations. Also, positioning Arctic locations as testbeds, living labs or interim markets could be one option for achieving local gains from discussed developments in the short term.

It is unlikely that discussed here activities can become themselves a basis for northern economies, replacing current reliance on resource extraction and the support from national budgets. More likely, various activities would – in addition to already dominant service sector – further complement rather than replace primary industries.

Stakeholders across most sectors consistently point out that accessibility and connectivity are key challenges for business developments. This has many dimensions: access to markets, cost-effective travel for tourists into and within Arctic regions, connections between communities, reasonable environmentally acceptable logistics, broadband, communities' access to services, etc. Due to these additional operational costs, Arctic economic actors are likely to remain in a relatively disadvantaged position as compared to their southern counterparts. Addressing these constraints is challenging owing to large distances, environmental impacts of new infrastructure, and limited availability of public resources. Creating additional incentives for small businesses operating in peripheral areas is among proposed responses.

Sustained development of remote Arctic communities may to great extent rely on However, underdeveloped culture of entrepreneurship and lack of specific high-tech skills could hinder progress (Olsen *et al.* 2016). There is a risk that Arctic regions would be primarily consumers of technological developments developed (and commercially benefitting) southern innovation and manufacturing centres. Responses to these challenges include greater collaboration, sharing and selling solutions across the circumpolar North, as well as boosting human capital in the Arctic regions.

However, building human capital in the North is challenging. Researchers (e.g., Dubois and Roto 2012) highlight insufficient critical mass for many developments – especially those associated with urban environments. Remoteness and sparsity are exacerbated by poor intra-regional connections between communities, hindering establishing larger functional clusters. Acquiring education and skills often requires young people to move to southern urban centres, and – although incentives exist in many countries – not everybody is willing to come back to work and settle in the North. Many locations lack diversified labour market offering opportunities for whole families.

Actors across the Arctic appear to be aware of the aforementioned constraints, risks and uncertainties. For instance, Lapland's Smart Specialization strategy (Regional Council of Lapland 2013; Regional Council of Lapland 2015) emphasizes the need to promote and develop local expertise, build up critical mass through clusters and facilitate local refining of renewable and non-renewable resources extracted in the North (Smart Specialization strategy, Arctic Smartness Portfolio). In Yukon Territory of Canada, a local collage has

established Cold Climate Innovation research centre.²⁵ In Alaska, the "Made in Alaska" logo is to promote local products nationally and internationally.

While all Arctic regions are affected by the hurdles listed above, one should keep in mind that regions differ significantly as regards the degree these challenges are manifested. While Northern Fennoscandia is peripheral in terms of accessibility and population density when compared to other European regions, within the context of circumpolar Arctic it enjoys good telecommunications connectivity, more than fair accessibility, developed human capital and ranks relatively high on innovation scales.

²⁵ Yukon Collage website at https://www.yukoncollege.yk.ca/research/programs/cold_climate_innovation

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