

The Challenges & Opportunities for Arctic Microstates in Developing an Energy Sector: The Role of Human Capital and Knowledge Institutes

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Like many Arctic states, Iceland and the Faroe Islands used to be the resource-based economies which Greenland is today. Remotely located in relation to the World economy, Iceland and the Faroe Islands have succeeded in developing a knowledge-based economy, also related to their energy sector. To create a knowledge-based economy a sufficient mass of human capital is of crucial importance. In forming this critical mass, higher education and knowledge institutes play a central role. The cases of the Faroe Islands and Iceland show that it is possible to create a critical mass of human capital by developing strong knowledge institutes and stimulating the exchange of knowledge. Iceland has successfully developed a knowledge-based energy sector based on hydropower over the last century. Icelanders bringing home knowledge gained via graduate education at top institutes abroad, appeared of major importance. More recently the Faroe Islands have developed human capital based on oil and gas exploration activities, while no economically viable resources have been found yet. Greenland on the other side has made some important steps in creating and strengthening strong knowledge institutes, but is still far from a full-fledged knowledge-based economy such as the one in Iceland. Are there lessons to be learned from Iceland and the Faroe Islands, and how much do historic path-dependencies matter in this context? These are questions that this article will explore.

Introduction

Just like in many other Arctic states, natural resources form the basis of the Icelandic, Faroese and Greenlandic economies (Glomsrød & Aslaksen 2009). Within this context energy plays and has played an important role in the development of these states. To benefit from the exploitation of natural resources, including energy resources, the authors believe that a knowledge-based economy and a strong educational sector are essential. However, the small size of these societies brings about specific challenges and opportunities. All three countries can be regarded as very small or microstates, due to the small size of their societies: populations of 315,281, 49,709 and 57,714 for Iceland, the Faroe Islands and Greenland respectively (www.cia.gov).

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This article will analyse the challenges and opportunities in the creation of a knowledge-based economy around natural resources, with the development of an energy sector as an example. The focus of this analysis will be on the creation of human capital and the role of knowledge institutes, since education increases social capital which helps building human capital (World Bank 2009; World Bank 2003). The question is whether historical path dependencies matter in developing a strong educational sector that is critical in the creation of human capital and a knowledge-based economy? To answer this question, the history and circumstances under which especially Iceland and the Faroe Islands have already developed their knowledge-based economy will be explored. Greenland finds itself much more at the beginning of developing a knowledge-based economy, and could benefit from the lessons learned of the other two countries.

The case of Iceland will be explored first, since it has successfully developed a knowledge-based energy sector based on hydropower (and geothermal power outside the scope of this article). Long established knowledge institutes like the University of Iceland (1911) have played a central role in the development of human capital and a knowledge-based economy in Iceland. Furthermore, “brain circulation” (see, for instance, Solimano 2008), defined as Icelanders going abroad to leading international universities and returning home with the gained knowledge, has been an important factor as well. Second, the much more recent case of the Faroe Islands will be discussed. Over the past 15 years the Faroe Islands have built up a knowledge-based economy on the back of oil and gas exploration activities, even though no economically viable reserves have yet been found. The Maritime College (1893) and the University of the Faroe Islands (1963), have played an important role in the transition from a resource-based economy to a knowledge-based economy.

Compared to Iceland and the Faroe Islands, Greenland stands at the early stages of developing a knowledge-based economy. As part of its strategy to diversify its economy, Greenland is currently looking to develop an energy sector. In order to maximise local benefits of these offshore activities, Greenland has implemented a number of tools in its regulation. Education is seen as a central element and much effort is made to prepare and qualify society for participation in these industrial activities.

Iceland

One of the teachers of Rasmus Gjedssø Bertelsen (co-author of this article) at the Austurbæjarskóli primary school in Reykjavik was the prominent Icelandic poet and translator Vilborg Dagbjartsdóttir. Vilborg was born in 1930 in the east coast settlement of Vestdalsheiði, near Seyðisfjörður, which is now abandoned. Vilborg told stories from her childhood of massive losses of life to tuberculosis and other infectious diseases and to the sea, and the self-sufficiency of households living off the land and the sea. When Vilborg was born in 1930, Iceland had just become a sovereign and independent state as the Kingdom of Iceland, having a common king with the Kingdom of Denmark since 1918. It would last another 14 years before Iceland would declare the republic it is today.

At the moment, we all know Iceland as an exceptionally highly developed independent very small state, with one of the highest levels of human development in the world (number 13; notwithstanding the 2008 financial crisis) (UNDP 2013). This development raises the question: what explains Iceland’s remarkable political and socio-economic achievements over the 1900s?

In this article it is argued that an important explanation of those achievements is the combination of a strong educational sector, strong human capital and abundant natural resources (Bertelsen & Hansen 2014; Bertelsen, Justinussen & Smits 2014).

Iceland is a natural resources-based economy as are all Arctic economies. In particular marine resources (which are outside the scope of this article) and renewable energy resources (the topic of this article) have played and continue to play a key role in the Icelandic economy and society. Icelandic exports have overwhelmingly been based on marine resources since the mechanization of Icelandic fisheries (the industrialization of Iceland) in the early 1900s. Iceland, as a micro or very small island economy and peripheral to the world economy, has throughout its independent history struggled to develop and diversify its economy. This struggle to diversify and develop the Icelandic economy was closely connected with Iceland's other great natural resource: renewable hydro- and geothermal energy (Ármansson 2005; Ísleifsson 2007; Jónsson 2005; Karlsdóttir 2010; Kristinsson 2005; Kristjánsson 1997; Pálsdóttir 2005; Ragnarsson 1975, 1976, 1977; Sigurðsson 2002; Þórðarson 2004).

The authors argue that Iceland has managed to create a domestically controlled, globally connected, knowledge-based energy sector (Bertelsen & Hansen 2014; Bertelsen, Justinussen & Smits 2014). This development has created work and intellectual opportunities for Icelanders at home and increasingly abroad. This development was driven by a fortuitous combination of a strong domestic tradition of primary, secondary, increasingly tertiary, and vocational education combined with a strong and successful tradition of "brain circulation": by going abroad for study or work experience and returning to Iceland with new knowledge and networks. This section of the article will discuss how this combination has laid the foundation of this domestically controlled, globally connected, knowledge-based energy sector. The article acknowledges the environmental tradeoffs in hydro- and geothermal energy projects, which has been the topic of intense debate in Icelandic society since the early 1900s. This topic is treated extensively in literature (see e.g. Hálfðanarson & Karlsdóttir 2005; Karlsdóttir 2010 for historical overview), but is outside the scope of this article.

The History of Icelandic Development

Iceland suggests a strong path dependency for the development of human capital, where building knowledge-based societies and economies has very deep historical roots in excellent domestic education in the native language combined with "brain circulation" with the outside world. This path dependency raises difficult questions for Greenland, while the Faroe Islands offer answers. Icelanders have travelled to Europe for knowledge since the settlement of Iceland in the Viking Age (~800 to ~1100), which is recorded in the Sagas. As a logical consequence of this close intellectual connection with Europe since its earliest settlement, the two late Viking age bishoprics of Iceland, first Skálholt in Southwest Iceland in the second half of the 1000s and subsequently Hólar in North Iceland in 1106, founded Latin Schools or grammar schools. The Skálholt school still exists today as the Reykjavik Grammar School (Menntaskólinn í Reykjavík, MR), which produced the first Kingdom of Denmark Nobel laureate, Niels Rybberg Finsen (Medicine, 1903), and the literature Nobel laureate Halldór Laxness in 1955 (although he had left the school early). Since the Protestant reformation the school and church language of Iceland has been Icelandic.

The Skálholt and Hólar schools supplied lower ranking clergy and equipped Icelanders to travel (especially) to Denmark for higher education throughout the centuries. This shows that Iceland has had a long history of strong domestic primary and secondary educational tradition in the national language, equipping Icelanders for going abroad to enjoy higher education. This “brain circulation” supplied a steady stream of Icelandic pastors for church leadership and education, jurists for administration and physicians for the nascent health service. It also maintained a vibrant Icelandic intellectual life in Copenhagen among Icelandic students and scholars, which would have profound impact on Icelandic political, social and intellectual development. In 1828 and 1832 these Icelandic intellectual circles would voice the first calls for building tertiary educational capacity in Iceland, in order to supply for the necessary highly skilled and locally relevant human capital in theology, philosophy, medicine, natural history, economics and commerce for local socio-economic development. These early voices called for adding higher education offerings to the secondary school offerings of the old Skálholt school (Jónsson 1961; Háskóli Íslands 2014). It was a debate predicting much later debates throughout the Arctic about building higher education capacity in northern communities.

The development of Icelandic higher education capacity is closely intertwined with state-building and independence politics. The Icelandic Althingi [Parliament] was reconstituted as a consultative assembly of the Danish King in 1845, and the School of Theology was created in Reykjavik in 1847 as a public administration capacity building initiative. In 1874, the Althingi gained legislative power over Icelandic affairs, and in 1876 the School of Medicine was created in Reykjavik to address recruitment problems and create locally relevant knowledge. In 1904, Iceland gained executive home rule, and in 1908 the School of Law was established in Reykjavik in light of the key role of building domestic law on the road to statehood. In 1911, the University of Iceland was founded, combining these schools and adding humanities with a clear purpose of supporting Icelandic state-building and independence aspirations. In 1918, Iceland gained sovereignty in a personal union with Denmark. In 1940, the University of Iceland inaugurated the main building of its future campus, which together with the neighboring National Museum from 1950 (the National Museum was founded in 1863 as a nation-building institution) are key architectural manifestations of statehood and the republic declared in 1944. The University of Iceland has since grown by leaps and bounds to an about 14,000 students-strong research university, which is supplemented by the University of Akureyri (1987) with the satellite campus University Centre of the West Fjords in Ísafjörður (2005), the private Reykjavik University (1998), Bifröst University (1988), Hólar University College (2003) and the Agricultural University of Iceland (1889/1947). These institutions have deep roots in older schools. What should be noted about these universities, is that they are all founded and overwhelmingly staffed by Icelanders with graduate credentials from leading universities of North America, Europe and various other parts of the World (Jónsson 1961; Háskóli Íslands 2014).

The Role of Brain Circulation in the Development of Icelandic Hydro- and Geothermal Power

The renewable energy sector is the clearest example of how strong human capital has allowed Iceland to benefit from natural resources. Strong local human capital and the interaction with knowledge abroad, are leading throughout the history of Icelandic hydro and geothermal power. In the late 1800s, the world was gripped by the prospects of hydropower as an important

resource fueling the energy-intensive high-tech industry of the day, namely nitrogen-based fertilizer. Iceland was keenly aware of these developments and a heated debate raged on the possibility of modernizing and diversifying the Icelandic economy, based on combining Icelandic hydropower resources, foreign capital and technology. Three key Icelanders serve to illustrate the importance of human capital and “brain circulation”: Frímánn B. Arngrímsson (1855-1936) was an Icelandic emigrant to North America, who had studied science at the University of Manitoba. He saw the potential of combining Icelandic energy resources and the technology of the day, and was its first advocate in Iceland, although in vain. Einar Benediktsson (1864-1940) was a prominent politician, poet and lawyer, trained at the University of Copenhagen. It should be noticed that he was a very active entrepreneur who founded hydropower investment companies with foreign capital. However, in 1904 it was master carpenter Jóhannes Reykdal (1874-1946) from Hafnarfjörður, who made the first small hydro electrical power plant in Iceland, after having spent time with his sister in Norway, a pioneering country in hydro electrical technology at that time (Ísleifsson 2007; Jónsson 2005; Karlsdóttir 2010; Kristjánsson 1997; Sigurðsson 2002; Þórðarson 2004).

The early dreams of industrializing Iceland through hydropower, foreign capital and technology did not materialize for domestic, international political and financial reasons. Instead Iceland was electrified from the bottom-up with local installations. However, throughout this time, Icelandic engineering authorities did surveying work of the hydropower resources and from the late 1940s the National Director of Electricity guided large-scale geological and glaciological studies for hydropower development. Here it must be emphasized that this work was done by Icelanders, often as graduate students at or postgraduates from foreign universities working with foreign supervisors and colleagues, in collaboration with Harza Engineering International of the USA (Ísleifsson 2007; Jónsson 2005; Karlsdóttir 2010; Kristjánsson 1997; Sigurðsson 2002; Þórðarson 2004).

The Conservative-Social Democratic “Restoration” government of 1959-1971 (Viðreisnarstjórn) sought to internationalize and modernize the Icelandic economy. A key element was attracting the international energy-intensive industry, which was now the aluminum industry. In the 1960s, the Icelandic government secured funding from the World Bank and a power sales agreement with Alusuisse to build the Búrfell power station (the first large-scale hydro power station), powering the aluminum smelter at Straumsvík, which opened in 1969. What should be noticed here is that Harza Engineering International designed this first large-scale power plan, while Icelandic workers built it. Icelanders carried out much of the science, planning, law and financial negotiations. In the successive decades (1970s, 1980s and 1990s) a number of large-scale hydro power plants were built in Iceland. These power plants were to an ever increasing and eventually full extent designed by Icelandic engineering companies, and built by Icelandic contractors. Finally, in the 2000s the enormous Fljótsdal/Kárahnjúkar power plant was designed again by Icelandic-international engineering companies, while the workers were now Portuguese and Chinese. So Iceland had come full circle from Icelandic workers building for American engineers to Chinese workers building for Icelandic engineers (Jónsson 2005; Karlsdóttir 2010; Pálsdóttir 2005; Sigurðsson 2002). This development could only be realized based on the strong Icelandic human capital basis, which seems to be built on a thousand-year-long tradition of a strong domestic primary, secondary and vocational (and recent tertiary) educational tradition coupled with successful “brain circulation”.

Knowledge-based energy work has also become an important part of Iceland's international and transnational relations with the outside world. Exploring and surveying these resources has linked Icelandic and foreign universities and scientists since far back in the 1900s. Later, the Icelandic (engineering) companies, which have developed around hydro- and geothermal energy, have turned to market their knowledge and know-how internationally. This international work is often linked to Iceland's use of its hydro- and especially geothermal energy knowledge in its development work with developing countries that hold geothermal potential. Here the United Nations University Geothermal Training Programme must be emphasized. The UNU GTP is hosted by the National Energy Authority of Iceland. Since 1979 it has run a geothermal training program, which had trained 525 professionals from 53 countries in geothermal energy by 2012 (Friðleifsson, Svanbjörnsson & Thorsteinsson 1984; personal communication).

Challenges in Present-Day Iceland

Today, Iceland is in a way threatened by its own human capital success. Especially graduate study opportunities have expanded exponentially at the University of Iceland during the past 15 years. Earlier, young Icelanders could receive an excellent undergraduate degree in a wide range of topics from the University of Iceland, but were usually forced to go abroad for graduate studies. Faced with this choice, young Icelanders often chose international top-universities for their graduate study. This fed the highly fortuitous "brain circulation": supplying Icelandic academia, government and business with human capital with an excellent international background. However, going abroad for years of graduate studies comes with a steep economic and personal price. Today, young Icelanders often have the opportunity to stay at home for their graduate studies. If this leads to a slowdown of the "brain circulation" and internal recruiting practices related to especially academia, it will have very negative effects on Icelandic human capital. Iceland must ensure that domestic graduate studies are for those without the option of going abroad and foreign students, while the flow of Icelandic talent to and from the world's top-universities does not slow down.

Evolution of Human Capital and Knowledge Institutions in the Faroe Islands

The modernisation of the Faroese society has largely depended on the expansion of commercial fishing in the North Atlantic region, helping it to transform from an agricultural peasant society to a market based economy successfully integrated into the world economy, creating an extreme dependency on domestic resources. The exploitation of marine resources has therefore played a dominant role in the social, political and economic life on the islands for over a century and still does (Joensen, 1992b; Justinussen, 1999; Mørkøre, 1991; OECD, 2011). However, for almost 15 years, oil and gas exploration has taken place in the Faroese waters. So far, no economically viable reserves have been found, yet the Faroe Islands have still benefitted from these activities by creating a thriving knowledge-based economy related to the offshore energy sector. This offshore sector is now operating not just in the Faroes, but also worldwide. The important point is that this new energy sector is not competitive because of domestic natural resources, because none have been found yet. It is competitive because of the knowledge and expertise that has been developed since exploration began, thus breaking with the previous development path. In this section we shall look at the role of knowledge institutions in this development.

The Faroe Islands has a centuries-old tradition of regionally important knowledge-building institutions that contributed to the level of human capital apparent today. Faroese formal academic education dates back at least as far as to the priest college in Kirkjubø that educated King Sverri of Norway in the 1200s (Debes, 2000; Young, 1982). After the Reformation, this centre of learning was closed down, and a Latin school was established in Tórshavn. It was a tiny school, steeped in poverty, and almost eradicated by small pox in 1709, but a school with far reaching consequences for the development of the entire Faroese society, and beyond (Debes, 2000). It is possible to divide the evolution of modern Faroese academic institutions into four distinct phases, beginning with the Latin school.

The Historical Evolution of Faroese Academic Institutions

The *first phase* emerges with the creation of the Latin school in the 1500s. The main purpose of this school was to recruit and train candidates for the clergy. Young boys were educated and prepared for later university studies in Copenhagen (Denmark) or Bergen (Norway), where they could become educated as priests. However, the school produced an excess of ‘graduates’, and only a small fraction of them left the country for further studies. The majority went back home to their villages, where they taught others to read and write. Many of these candidates became Sheriffs (*Síðslumaður*), Law Men (*Løgmaður*), Law-officers (*Løgrættarmenn*), administrators, and others engaged in trade. Thus the unintended consequence of the Latin school was a society-wide education of the people and the creation of a Faroese elite (Debes, 2000; Hentze, 2000) with direct ties, through classmates, abroad, creating a domestic and international “brain circulation”.

The *second phase* occurred during the social transformation from an agricultural to a fishery society in the second half of the 1800s (Joensen, 1992a). The Latin school had closed down and new educational demands had emerged as commercial fishery continued to develop. By the end of the 19th century, compulsory public education was introduced, and a teacher college was established (Holm, 1970). Even the remotest villages were guaranteed education through a travelling teacher system (Petersen, 1994). This was a huge step forward and created the basis for further education in the professional schools that followed.

The *third phase* begins with the establishment of a Faroese scientific society (*Societas Scientiarum Faroensis*) in 1952. The society started a scientific journal in Faroese and organised a regular public lecture series (Gaini, 2002). In 1965, the University of the Faroe Islands was established. A modern Faroese University was now a reality. A driving motivation behind this initiative was the idea that the university should contribute to cultural nation-building (Marnersdóttir, 2003), especially in light of concerns that national identity was being eroded. A key element in this process was language. The main emphasis was therefore to develop a Faroese dictionary, and to collect and document Faroese language usage and traditions (Joensen, 1988). The first academic employed was a professor in linguistics (Joensen, 1990). In this period the university offered BA programmes in Faroese and history.

The *fourth phase* begins around the turn of the 21st century. The language battle was over and Faroese was established as a national language taught in all schools from primary to university level education. Today, the Faroese scientific journal, *Fróðskaparrit*, is over 50 years old, and Wikipedia has over 10,000 articles in Faroese (Jacobsen, 2014). In this phase, the purpose of the

University is not primarily cultural nation-building anymore, but also to be a major driver in the economic development of the society (Fróðskaparsetur Føroya, 2014). Having good quality higher education available at a national level has been a major advantage for building up human capital and supports the development of a knowledge-based economy, which the Faroe Islands experiences today.

The University in the Knowledge Economy

Today it is recognized that research and development play a major role in the emerging Faroese knowledge economy (MTI, 2005; Vinnumálaráðið, 2013). Two major institutional and technological changes took place in this phase, which have made this transition possible.

First, the rapid innovation and spread of information technology and the Internet, which has revolutionised the world and given rise to completely new kinds of industries, and new ways to organise and conduct business. This technology has been particularly important for the Faroe Islands, since it has minimized the impact of distance and remoteness and not least, has provided access to information and research databases anywhere in the world. This technological innovation has made a new kind of “brain circulation” possible that is less tied to geography, and opens up completely new development paths for a remote microstate such as the Faroe Islands.

Second, since oil and gas exploration commenced in Faroese waters, licence holders have been obliged to pay a ‘tax’ to the Competence Development Fund. The purpose of the Fund is to promote education and research programmes that can increase the human capital in the country. The Fund has financed several large-scale research programmes conducted at the University of the Faroe Islands as well as several PhD projects.

Together these developments have fundamentally changed the playing field for knowledge institutions, giving rise to many new and exciting educational and research projects within the energy and other sectors. Over the last 15 years substantial expertise has built up in several fields, making it possible for the University to offer Bachelor degrees in the sciences, humanities, and social sciences, as well as Masters in Faroese Language and Law. Doctoral programmes are also offered on an individual basis. The most recent addition to the professorships at the University occurred in 2014, when Statoil, one of the major players in oil exploration in Faroese waters, funded a full professorship in energy engineering.

The University and the Public Sector

An important feature of the University lies in its close network and informal ties to researchers in other public institutions that conduct research related to their respective fields. For example, the Faroese Petroleum Administration (*Jarðfeingi*) has geologists, physicists, and PhD students engaged in research. These researchers frequently appear as guest lecturers at the University, helping to supplement the faculty’s knowledge base. Similarly, the following public sector institutions all conduct research as a part of their duties and supply the University with guest lecturers on an informal basis:

- *Føroya Landsbókasavn* (Faroese National Library)
- *Føroya Fornminnisavn* (Faroese Archaeological Museum)
- *Nátúrugripasavnið* (Natural History Museum)

- Biofar (Kaldbak Marine Bio Lab)
- *Heilsufrøðiliga Starvstovan* (Environmental Agency)
- *Havstovan* (Faroese Marine Research Institute)
- *Landskjalasavnið* (National Archives)
- *Jarðfeingi* (Faroese Oil Administration)
- *Fiskaaling* (Aquaculture)
- *Landsjúkrahúsið* (National Hospital of the Faroe Islands)
- iNova (Research Park)

Since the inception of the University it has been recognized that, should the University have a chance to survive and flourish, it would need to draw on all available resources. On its own, the University does not have enough manpower and resources to cover all areas necessary for offering relevant research-based educational programmes. However, these partnerships have never been formalised in form of a contract between the University and the public sector, except for a recent agreement of understanding between the University and the *Landskjúkrahúsið* (National Hospital of the Faroe Islands), and the recently created iNova (Research Park). Nevertheless, it has been a *de facto* practice over the years that employees in public institutions who are engaged in research are allowed to give lectures at the University during their usual working hours (Joensen, 1988).

Though these kinds of networks are by no means exceptional, they are nevertheless exceptionally important for the University, since they provide vital input into the teaching and make it possible to offer a research-based education that extends far beyond the research conducted by the 73 academics currently employed at the University. The effect of this informal organisation is twofold. On the one hand these informal networks thus compensate for the limited scope for specialisation in a microstate, and make it possible to offer research-based teaching in a much wider range of areas than otherwise would have been possible. On the other hand they also integrate a much wider network of people in the process of research and teaching at university level and thus populate the critical mass necessary for an emerging knowledge economy.

Current Challenges

One of the challenges in the development of human capital, which is so essential for knowledge based economy, is the integration of education and knowledge institutions in local society. Without a general society-wide integration of knowledge institutions, it is difficult to build up a critical mass for a knowledge-based economy. Education for a select few will not build a knowledge economy for the masses. In the Faroese case there has been a gradual long-term evolution of academic institutions and learning, which have embedded knowledge institutions into the wider society. However, the growth of education has outstripped the physical infrastructure and now knowledge institutes are widely dispersed. The University itself is scattered around the city in several different buildings. This sprawling decentralised development path is currently being counterbalanced by an attempt to centralise and integrate the many differentiated parts into larger units. The trend to formalise the 50-year-old tradition of informal cooperation between the University and other public institutions (Weihe et al., 2005), can be seen as a part of this process.

For years there have been talks about a new modern university campus in Tórshavn. However, these plans are still on the drawing board. The major challenge in the process will be to integrate the many different institutions into a cohesive unit, while at the same time living up to the nation's proud, historical educational roots, and ensuring society-wide backing for a national centre of learning.

A more pressing challenge is the exodus of young people travelling abroad for education and not coming back. Here the new campus might curb this emigration, however, the small population sets an inescapable limit on the range of educational opportunities – even in the best circumstances.

Greenland

Like many other Arctic economies, Greenland's economy is mainly dependent on fisheries and the public sector. At the same time that Greenland is the largest island in the world, it has only ~56,000 inhabitants, which live scattered along the coast. As part of the strategy to diversify its economy, Greenland is looking to develop an energy sector based on oil and gas exploitation (Naalakkersuisut 2014). Until now, 14 exploration wells have been drilled (BMP n.d.), of which five have been drilled in the 1970s, one in 2000 and another eight in 2010 and 2011. In order to maximise the local benefits of these offshore activities, Greenland has implemented a number of tools in its regulatory framework. Education is seen as a central element and much effort is made to prepare and qualify society for participation in these industrial activities. Unlike the cases of Iceland and the Faroe Islands, Greenland has a much shorter history of higher education, building up human capital and a knowledge-based economy. Important steps towards a knowledge-based economy have been made over the past century, however education and building up human capital remains a focal point for the future.

The vast distances, the limited infrastructure and the small size of the population create challenges as well. Transforming the economy from one that is primarily focused on fisheries and the public sector, into a globally competitive knowledge-based economy with relevance for the private sector is not easy. In a country where costs are high and education levels are currently low (Naalakkersuisut 2014), a lot needs to happen before a competitive knowledge-based economy will become reality. The School of Minerals and Petroleum (Råstofskolen) plays a central role in this context and is expanding its network (Christensen 2012; Troelsen 2012). The challenge for Greenland will be to establish a critical mass of skilled labour and to deal with the challenge of foreign labour influx if oil and gas activities really take off.

The Development of Greenlandic Knowledge Institutes and Education

Greenland is part of the Kingdom of Denmark, but has gained Home Rule since 1979 (Goldback & Winther-Jensen 1988) and it was granted Self-Rule in 2009 (Hansen 2014). Up until 1979 Denmark was initiating the policies and reformations of the educational system, but since 1979 this became a major responsibility of the Greenlandic government. Changing the primary language from Danish into Greenlandic was one of the most important decisions taken just after gaining Home Rule in 1979. Since then the teaching system has been more and more tailored towards the Greenlandic situation (Goldback & Winther-Jensen 1988).

In 1983 the Inuit Institute was founded in Nuuk as a study centre for Greenlandic literature, history and grammar (Olsen 2013). Later, in 1987, the Inuit Institute became the University of Greenland, Ilisimatusarfik (www.ilisimatursarfik.gl). The University was established to provide higher education in Greenland itself, instead of in Denmark. Like its predecessor, the University of Greenland has remained focused on social sciences, culture and history until to date. It has contributed to nation-building and Greenland's cultural identity (European Commission 2013). Over time, the university has maintained and established cooperation with various foreign universities and is also part of the University of the Arctic (www.uni.gl).

Since 2004 the Greenlandic government has determined that education is a top priority (Naalakkersuisut 2012). This is reflected in the increased government budget and attention to education and training as of that year (European Commission 2007). In 2006 it became an aim of the Greenlandic government to increase the share of higher educated people in its workforce (European Commission 2007), supported by an overall education strategy up until 2020 in the "Greenland Education Program". The first phase (until 2013) of the Greenland Education Program aims at vocational training and making sure people acquire the right skills and qualifications for jobs above an unskilled level. The second phase (until 2020) focuses on the provision and increase of higher education to build up a critical mass of human capital locally. The European Union has identified education as a main domain for cooperation with Greenland.

Creating Human Capital and a Knowledge-Based Economy

In a world economy that becomes increasingly globalised it is important to create sufficiently large human capital that is qualified, flexible and competitive in order for Greenland to make economic progress and establish a knowledge-based economy. Only by making economic progress can Greenland pursue its long term goal of becoming financially independent from Denmark. In order to become financially independent it does not only need to diversify its economy, but also localise the benefits of the (new) economic activities by participation of Greenlanders (Naalakkersuisut 2014). Participation can only take place if people have the right skills and qualifications.

Creating a critical mass of human capital for a knowledge-based economy is challenging. In 2006 only one third of the potential workforce (15-62) had acquired an educational level that would qualify them for jobs above unskilled level (European Commission 2007). However, the total number of graduates from post-primary education in Greenland has increased by 64% during the first phase of the "Greenland Education Program" (www.nanoq.gl) and is promising. As drop-out rates have remained roughly the same, it can be concluded that more people have obtained post-primary education. This forms a positive basis for phase two, to increase the amount of people that have received higher education and thereby can contribute to the development of a knowledge-based economy.

Most of the higher education institutes are located in Nuuk, of which the University of Greenland is currently the largest institute of higher education in Greenland. The enrolment of students to this university has risen steadily over time (European Commission 2013), however the curriculum of the university remains limited. It includes, amongst other, cultural & social sciences, theology and language, but is missing (natural) science as a subject. The lack of (natural)

science in the University's curriculum should not necessarily have to do with the country's small population size, since also the University of the Faroese Islands has a small population and has got science in its curriculum (European Commission 2013). Science is crucial in relation to economic progress and industrial activities, since it will educate highly-skilled (natural) scientist, that could well be needed by the currently developing natural resource activities. Developing this type of knowledge locally remains a challenge for Greenland, but partnerships like the ones existing in the Faroe Islands could be a solution.

Next to the University there are also a number of other institutes for higher education in Greenland, such as the Building School, Sanaartornermik Ilinniarfik, in Sisimiut. This institute includes a School of Minerals and Petroleum (Råstofskolen) and a Centre for Arctic Technology (ARTEK), which all have strong links with the Technical University of Denmark (DTU). It is the ambition of these institutes to become the technical powerhouse of Greenland. The School of Minerals and Petroleum in Sisimiut has been established in 2010 (www.sanilin.gl) and illustrates the need to build practical capacity and knowledge in the field of mineral resources by the Greenland society. The School provides training on a practical level and aims at providing Greenlanders with the right set of skills and qualifications to be able to apply for jobs in these industries. The School of Minerals and Petroleum cooperates closely with the Colorado School of Mines (United States), Ole Vig Upper Secondary School (Norway) and the Northern Centre for Advanced Technology in Sudbury (Canada) (Bell 2011). In this way "brain circulation" is being initiated and developed, supporting human capital building in Greenland.

Future Challenges and Opportunities

It is likely that the level of industrial activities related to natural resource and energy development is going to increase in the future (Naalakkersuisut 2014). In recent years these activities have increased steadily, which are likely to continue now that a construction permit has been granted to the London Mining project on iron ore and the ban on uranium mining has been lifted, freeing the way for other large mining projects (RT 2013). In the meantime, the oil and gas industry is continuing its exploration activities and is likely to continue doing so in the future (Naalakkersuisut 2014). However, when these activities will take place exactly is not certain, and currently the industry tends to take longer before large investments in the Arctic region are decided upon. Therefore one of the challenges for Greenland will be to educate its workforce at the right time with the right skills.

In general one can state that the expected increased industrial activities form an opportunity for Greenland to diversify its economy and maximise the local benefits. However, both the mining and the oil and gas industries require skilled labour with the right qualifications to work on their projects. In order for Greenland to maximise its local benefits of these industries, the main challenge will be to increase the level of (highly) skilled workforce that has acquired the right set of skills for these industries. A recent study however has indicated that the shortage of a highly educated workforce will continue to grow in the near future and last until at least 2025 (European Commission 2013). Various initiatives, mainly revolving around the Building School, School of Minerals and Petroleum and Centre for Arctic Technology in Sisimiut, have been taken to increase the level of skilled workers for these industries so that the Greenlandic society will be ready to take the employment opportunities when they arrive. Without having a critical mass of human capital in place, Greenland will not be able to maximise the local benefits and

successfully create a knowledge-based economy. It will run the risk of foreign labour coming into the country to perform the jobs. The University of Greenland, which is currently focussed on social, historical and cultural sciences, can facilitate the creation of a highly skilled work force by including Science in its curriculum. It is expected that graduates from this subject will face no difficulties in finding a job (European Commission 2013). Lagging behind in capacity-building compared to the pace of industrial development could also prevent expertise and knowledge from becoming an export product in the future. This can become a serious strain on the process of becoming a self-sustaining economy.

Conclusion

The three cases that were studied more closely in this article illustrate the importance of local knowledge institutions and human capital building. The development of an internationally renowned knowledge-based energy sector based on hydro- and geothermal power in Iceland shows how local knowledge institutes, developed over centuries, were of crucial importance in creating human capital, which in turn enabled Iceland to maximise the local benefits. Century long “brain circulation”, powered by Icelanders studying at top institutes abroad and returning home with the knowledge they gained, appears to be crucial. The development of this knowledge-based energy sector has been a lengthy process in which foreign (engineering) companies took the lead. Gradually Icelandic companies started to take over the design works, until in the 2000s the point was reached where the design was made by Icelandic companies and the actual building was performed by Chinese labour. This case suggests a strong historic path-dependency, by centuries of human capital creation leading to a full-fledged knowledge-based economy based on natural resources in the 21st century. One of the main future challenges for Iceland will be to maintain a diversified portfolio of domestic educational and research programs, while at the same time maintaining a strong tradition of “brain circulation” with international top-universities.

The Faroe Islands illustrate that a knowledge-based energy sector can be created even though no economically viable oil and gas resources are found and with a less extensive history of human capital building and “brain circulation”. Over the past 100 years the main steps have been taken to create the human capital base it has today. In recent years revenues from exploration activities have been used to support knowledge institutes and increase their capacity. In turn, these institutes supply the economic sectors with human capital that remains closely linked to these institutes via guest lectures and research opportunities. Technological innovations and the Internet have reduced the impact of remoteness and distance, particularly important for the Faroe Islands, and have thereby increased the opportunities for “brain circulation” with the rest of the world. The main challenge for the Faroe Islands in the future will therefore be to develop a new University campus in Tórshavn with the necessary facilities to attract more students and researchers to the country.

Greenland stands at the beginning of creating a knowledge-based economy. Human capital is an important factor, and the Icelandic and Faroese examples show that even a small state can create sufficient human capital to support a knowledge-based economy. This is particularly important if it wants to localise the benefits from a future energy sector as much as possible. The example of the Faroe Islands is most promising to Greenland, since it illustrates that it is not mandatory to

have a century-long history in large scale human capital building and “brain circulation”. Breaking with an economy based on primarily natural resources can be achieved, provided that emphasis is placed on building strong knowledge institutes and creating a critical mass of human capital locally. Education and the creation of human capital are defined as one of the top priorities and receive a lot of attention in Greenland. Institutes such as the School of Minerals and Petroleum have been created to support knowledge development related to the oil and gas sector. “Brain circulation” and exchange of experience takes mainly place with Denmark, Norway and North America (USA and Canada). The main challenge for Greenland will be to establish a critical mass of skilled labour and to deal with the risk of foreign labour influx if oil and gas activities really take off.

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