Northeast Iceland Infrastructure Analysis

Compiled in preparation for energy intensive industry in the region in accordance with a memorandum of understanding between the Icelandic government and regional municipalities signed on May 25, 2011

February 2012

Reinhard Reynisson
Jóna Matthíasdóttir
Tryggvi Finnsson
Ari Páll Pálsson

Atvinnuþróunarfélag Þingeyinga hf.

Northeast Iceland Infrastructure Analysis
February 2012

Compiled by Northeast Iceland Development Agency (*Atvinnuþróunarfélag Þingeyinga hf.*) in preparation for energy intensive industry in the region by agreement with the ministry of industry, energy and tourism, Landsvirkjun and a project management team assigned on the basis of an MOU between the government and the municipalities of Norðurþing, Skútustaðahreppur, Þingeyjarsveit and Tjörneshreppur, signed on May 25, 2011.

Authors:
Reinhard Reynisson
Tryggvi Finnsson
Jóna Matthíasdóttir
Ari Páll Pálsson

English translation (May 2012):
Ari Páll Pálsson

Table of Contents

Introduction

The compilation of this analysis is based on a provision in a memorandum between the government of Iceland and the municipalities Norðurþing, Skútustaðahreppur, Þingeyjarsveit and Tjörneshreppur, signed on May 25, 2011. The MOU stipulates that among responsibilities of the assigned project management team is "analysing the current infrastructure and assessing the costs of necessary improvements".

According to the MOU, the project management team will also work on the following projects in order to prepare the region in terms of the anticipated changes in the regional employment market;

1) Assess the need for improvement and reinforcement of regional infrastructure.
2) Assess the need for reinforcement of public services.
3) Pay attention to internal growth and diversity within the regional job market.

In order to achieve these objectives, which are further defined in the MOU, this report is divided into 10 subjects covered in chapters 2 through 11; Planning and land use, Energy, Conditions for construction, Environmental factors, transportation, Employment market, Service, Competitive status and finally Taxation and concessions. Each chapter starts with describing the present state of affairs for that particular subject. A discussion then follows, where applicable, with recommendations as to which factors require special consideration in order to meet the demands and challenges of large scale industrial development based on the harnessing the regions energy resources. At the end of each chapter is a list of further reading material related to its subject.

The following analysis was initiated by the project management team assembled on the basis the aforementioned MOU and carried out through a project contract with Landsvirkjun and the Ministry of Industry, Energy and Tourism. Thanks are also due to several others have made valuable contributions to this work, including the municipalities involved, Landsvirkjun, Landsnet and Invest in Iceland.

1 Definition of the subject area

In defining the subject area, we have applied some commonly accepted paradigms in this type of work and also drawn on extensive socioeconomic research conducted by RHA, The University of Akureyri Research Centre[1] in connection with large scale industrial development in East Iceland. The definition applies to communities which are likely to be directly affected by the proposed development of energy intensive industry through utilization of regional energy resources, particularly geothermal energy, in Northeast Iceland. The plans assume that the bulk of the industrial development will be concentrated at the designated industrial area in Bakki north of Húsavík and the energy will be harnessed at designated high temperature geothermal sites in Northeast Iceland.[2]

The subject area covers ten municipalities from Eyjafjörður fjord to Langanes peninsula; Akureyri, Eyjafjarðarsveit, Svalbarðsstrandarhreppur, Grýtubakkahreppur, Þingeyjarsveit, Skútustaðahreppur, Norðurþing, Tjörneshreppur, Svalbarðshreppur and Langanesbyggð. Their combined population is roughly 23 thousand. It is evident that the proposed development will impact communities within the subject area in different degrees and will also have impact outside the defined subject area. The impact will be greatest in the local region of development where it will affect the job market directly while the impact on regions further away will mainly be through providing miscellaneous services. Judging from experience, large scale industrial development in the region will have considerable impact outside the subject area, particularly in the Capital region of Reykjavík, due to its role in service and administration as well as being the hub of transportation in Iceland. [3]

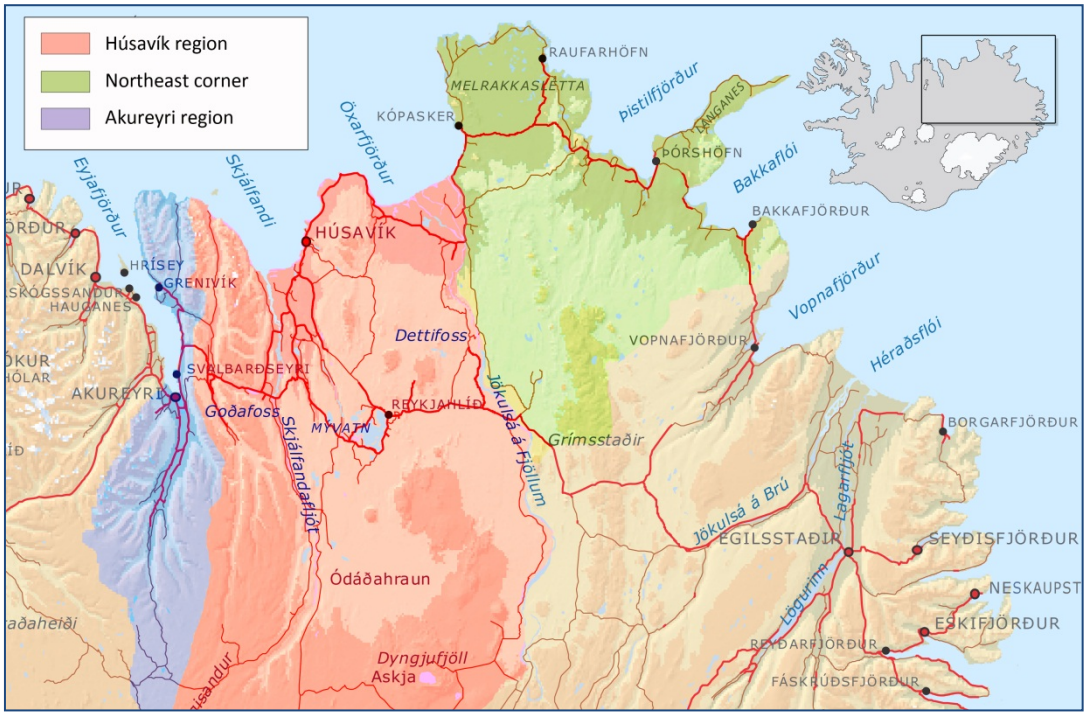

Figure 1: Definition of the subject area for infrastructure analysis in Northeast Iceland

[1] Research published by RHA is accessible on their website at http://www.rha.is/en/page/published_work . While most of their reports are in Icelandic, some material is available in English.

[2] These sites are defined in the municipal plan for Norðurþing 2010-2030, (Norðurþing, 2010 24 - 27) as well as a regional plan for high temperature geothermal areas in Þingeyjarsýsla County 2007-2025, (Samvinnunefnd um svæðisskipulag háhitasvæða í Þingeyjarsýslum, 2008)

[3] (Jóhannesson H. , 2010, p. 14)

To a large extent, the boundaries used to define regions in this analysis follow municipal boundaries, the reason being that various statistical data is not available for smaller geographical units. An important deviation from this, however, is that in this analysis the villages of Kópasker and Raufarhöfn in the eastern part of Norðurþing Municipality are defined as part of the Northeast corner far region, as both of these villages lie outside the defining parameters of the ”near region”. This provides a more realistic assessment of existing conditions and the measures necessary to reinforce infrastructure and stimulate growth in the regional labour market.

Looking at the subject region as a whole, population development has been positive over the past decade, although not on par with population increase in the total population of Iceland. Over a ten year period from 2001 to 2011, population in the subject area increased by 6.4% (1,397) while the total population of Iceland increased by 12.4%. Taking a closer look at individual regions within the subject area, we see great disparity in population development. In the Húsavík near region, there was a 9.6% population decline (-422) and in the far region of the Northeast corner, the population decline was 21.9% (-260). At the same time, the far region of Akureyri and vicinity enjoyed a population increase of 12.9% (2,079).

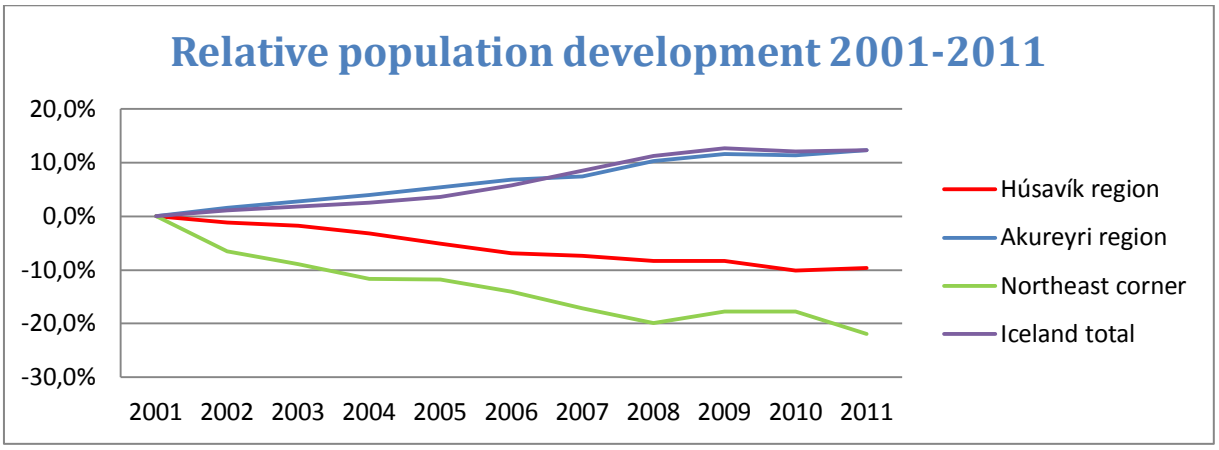

Figure 2: Population development within the subject region over the past decade

1.1 Near region

The “near region” – here also referred to as the Húsavík region – is defined based on a daily work commute of 45 minutes (each way), which is commonly used as a benchmark[4]. In addition to Húsavík, the near region then includes the rural part of Norðurþing Municipality as far as the river Jökulsá á Fjöllum, as well as the municipalities of Skútustaðahreppur, Tjörneshreppur and Þingeyjarsveit.

In January of 2011, the population of the near region was 3,977 residents, thereof 2,237 in Húsavík. The population has declined by 422 or 9.6% since 2001, thereof 186 in Húsavík or 7.7%. The population decline consists mostly of young people with children as is evident in the age pyramid in Figure 3. There you can see a considerable deficit in children under the age of ten as well as people in the age group from 25 to 40 when compared with the total population of Iceland.

[4] (Jóhannesson H. , 2010, p. 13)

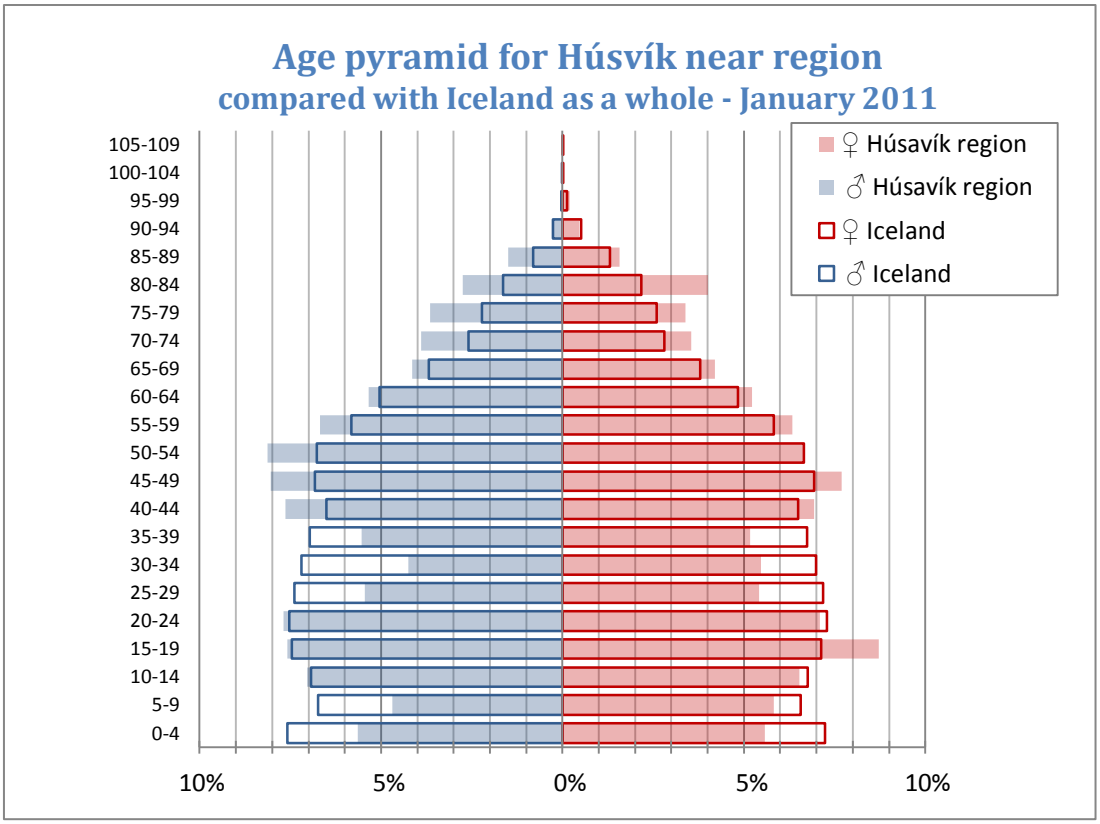

Figure 3: Age pyramid for Húsavík region compared with the total population of Iceland

Taking a closer look at this development, we find that the population decline is much greater in these age groups than the rest of the population for the period examined. From 2001-2010, the number of children under 10 decreased by 32.6% and the reduction in people between 25 and forty was 30.3% for the same period. This development is shown graphically in Figure 4 which shows greatest decline in these two age groups while the ratio of people older than 45 has grown. This should be kept in mind when considering developmental options and their impact.

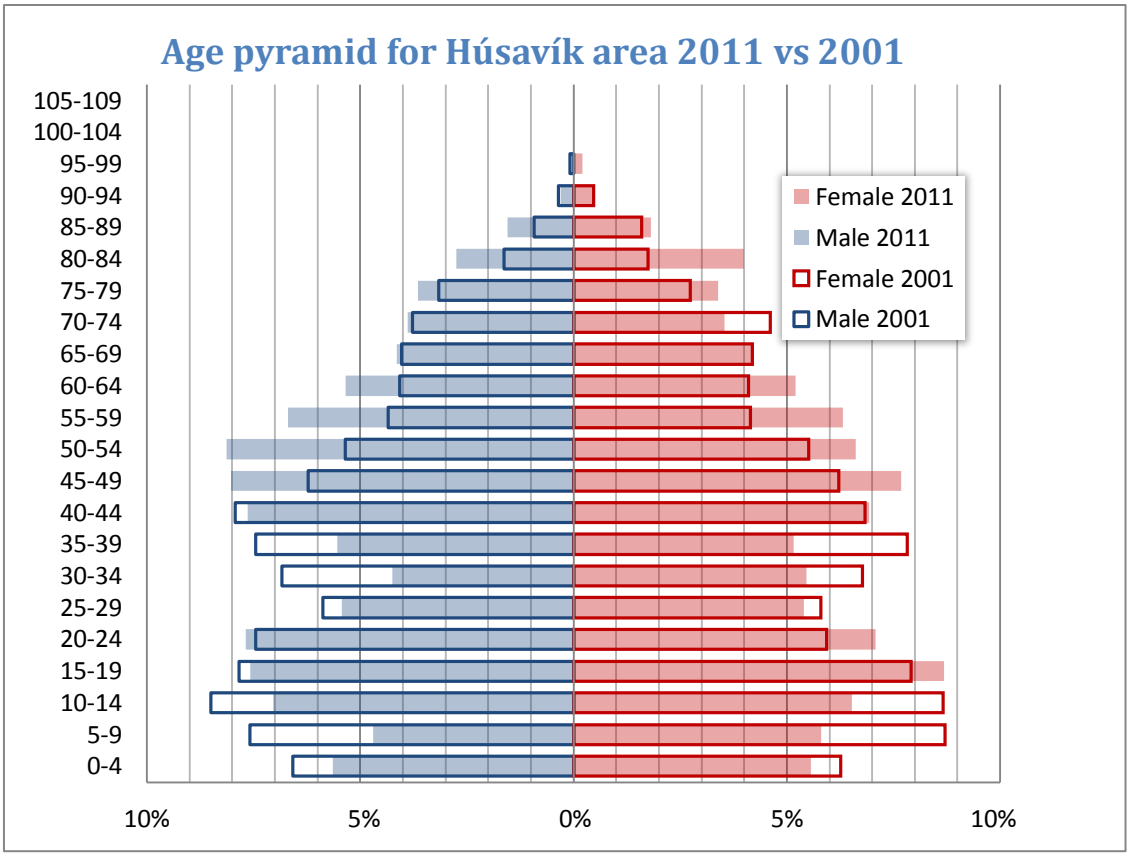

Figure 4: Age pyramid for Húsavík area in 2011 compared with 2001

1.2 Far regions

The two neighbouring regions defined as "far regions" are on one hand the Northeast corner to the east, which includes Kópasker and Raufarhöfn in the eastern part of Norðurþing Municipality as well as the municipalities of Svalbarðshreppur and Langanesbyggð. To the west, on the other hand, is the Akureyri region which includes the municipalities of Grýtubakkahreppur, Svalbarðsstrandarhreppur, and Eyjafjarðarsveit in addition to the town of Akureyri[5].

Population in these regions has developed in entirely different ways. In January of 2011 population in the Northeast corner stood at 926 or 260 people fewer than in 2001, a decline of 21.9%. In the Akureyri region, on the other hand, the population stood at 18,488 and had increased by 12.55% since 2001, which is slightly above the average increase for the total population of Iceland.

Examining the composition of these populations in age pyramids reveals that the Northeast corner has the common traits of areas with declining population; large gaps in the age group 25-40. It is interesting, however, that in the area the ratio of children under 10 is not that far below the national average. When examining statistics for this area, one should of course bear in mind that each individual carries considerable weight percent-wise in such a small population.

Age distribution in the Akureyri region is largely on par with the national average which correlates with the population development having closely followed the national average. It does come to attention, however, that there are relatively fewer young people (25-40) than in Iceland as a whole.

[5] Population figures for Akureyri refer only to the town itself, not the municipality (which includes the islands of Hrísey and Grímsey which are considered outside the subject area).

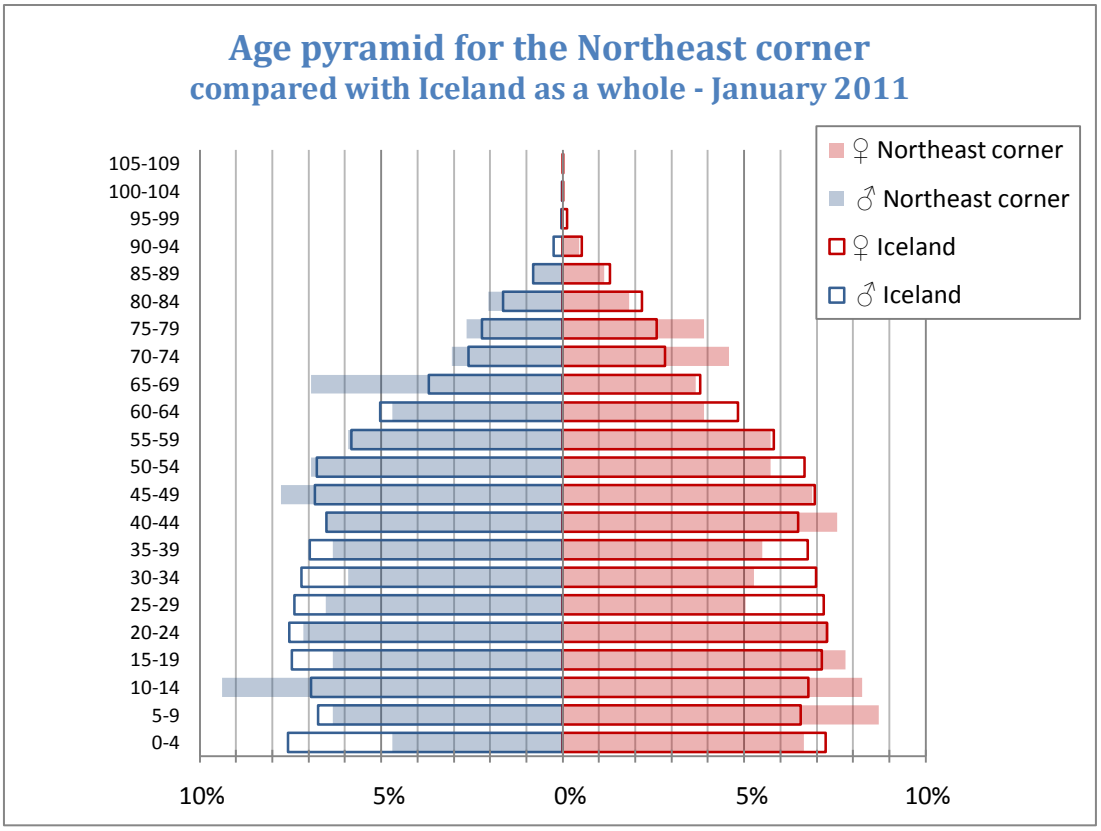

Figure 5: Age distribution in the Northeast corner compared with the national average

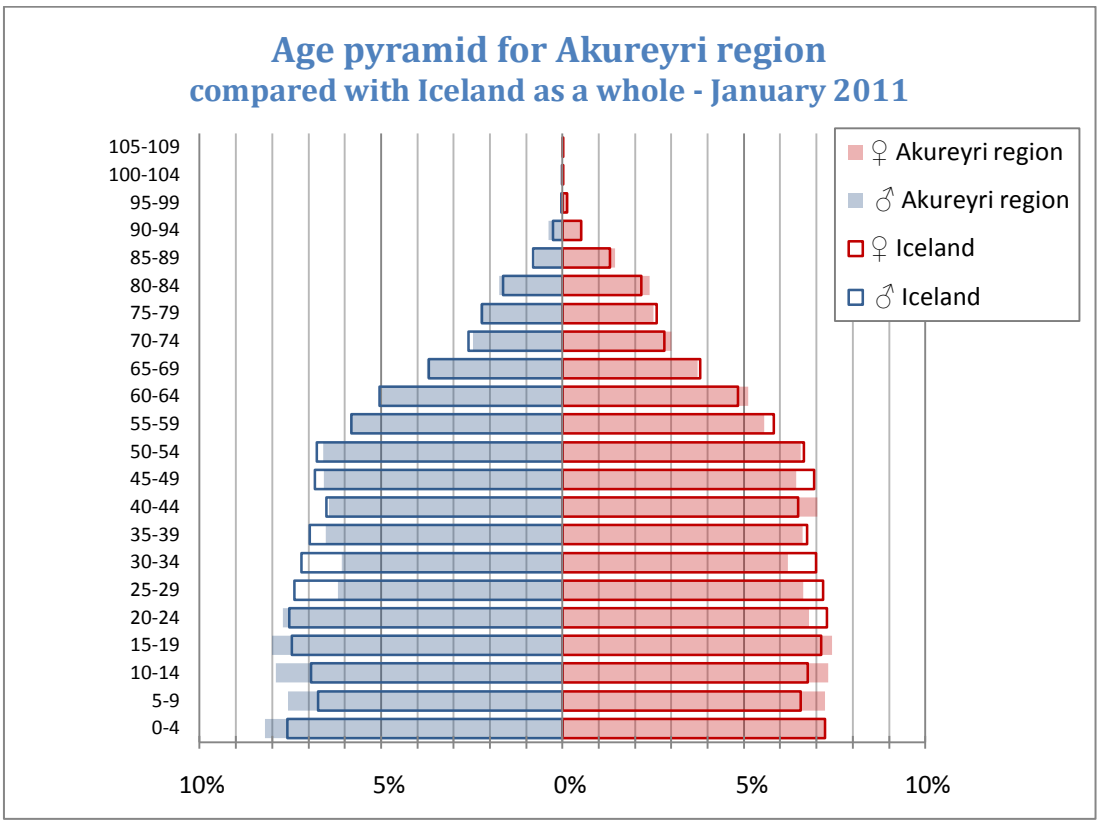

Figure 6: Age distribution in Akureyri region compared with the national average

2 Planning and land use

2.1 Municipal and regional plan

A municipal plan for Norðurþing, valid 2010-2030 was approved by the municipal council on November 16, 2010 and confirmed by the Minister for the Environment on December 22, 2010. The plan calls for large scale industrial development at Bakki near Húsavík which will generate an increase in industrial and service related jobs and consequently population increase, particularly in the Húsavík region. [6]

A municipal plan currently in effect for Skútustaðahreppur is for 1996-2015. A new municipal plan for 2011-2022 is still in preparation and due to be approved by the municipal council in the first half of 2012. The municipality's aim is strong, diverse and progressive economy based on local resources and unique strengths. This includes continued prospecting and harnessing of geothermal energy in designated industrial areas at Krafla and Bjarnarflag for public use and industrial development. [7]

Municipal plan for Tjörneshreppur 2008-2020 was approved by the municipal council February 3, 2011 and confirmed by the Minister for the Environment on May 2, 2011. Among goals set forth in the plan is increased diversity in employment opportunities based on developing agriculture and tourism. The plan anticipates population growth during its time frame. [8]

In Þingeyjarsveit, a municipal plan for 2010-2022 was approved by the municipal council on February 24, 2011 and confirmed by the Minister for the Environment on June 20, 2011. Among its main goals, as described in an exposition accompanying the plan, are strengthening and reinforcing the municipality and reversing the negative population development by increasing employment opportunities at farms and elsewhere as well as providing leeway for economic development such as geothermal energy production – without reducing the existing qualities of the municipality. [9]

A regional plan for high temperature geothermal areas in Þingeyjarsýsla County 2007-2025, drafted collectively by the municipalities of Norðurþing, Skútustaðahreppur and Þingeyjarsveit was confirmed by the Minister for the Environment on January 16, 2008. Energy production sites and energy transmission routes are defined in the plan which is in accordance with the respective municipal plans. [10]

2.2 Energy production areas

According to the municipal plans in effect for Skútustaðahreppur and Þingeyjarsveit as well as the aforementioned regional plan, three main energy production areas are defined. Their respective size and estimated production capacity based on resistivity surveys is as follows: [11]

a) Krafla – Bjarnarflag: estimated area 62 km^2 and estimated production capacity 310 MW_e
b) Þeistareykir: estimated area 48 km^2 and estimated production capacity 240 MW_e
c) Gjástykki: estimated area 11 km^2 and estimated production capacity 55 MW_e

[6] (Norðurþing, 2010 1-22, p. 17)
[7] (Skútustaðahreppur, 2011 b, pp. 19 - 20)
[8] (Tjörneshreppur, 2010, p. 5)
[9] (Þingeyjarsveit, 2010, p. 3)
[10] (Samvinnunefnd um svæðisskipulag háhitasvæða í Þingeyjarsýslum, 2008)
[11] (Orkustofnun, 2009)

Current energy production in the region consists of Krafla geothermal station (60 MW_e), Bjarnarflag geothermal station (3 MW_e) and Laxá Hydropower station (27.5 MW_e)

2.3 Industrial areas

The municipal plans allocate industrial and moving areas, providing leeway for new development:

a) At Bakki, north of Húsavík, about 200 hectares are allocated for industry in the municipal plan for Norðurþing 2010-2030. According to the plan this industrial area will be connected with the Landsnet power grid with two 220 kV lines which will be connected with the proposed power stations at Þeistareykir and Krafla-Bjarnarflag and enter the area north of Húsavík mountain. The industrial area at Bakki will also be connected with Húsavík harbour by a designated road connection as shown in Figure 7. [12]
b) In and around Húsavík a few smaller areas, totalling 50-60 hectares, are also designated for industry or light industry. [13]
c) In a proposal for the pending municipal plan for Skútustaðahreppur 2011-2022, a few industrial areas are designated which are also in accordance with the prevailing plan. They are mainly an area of 140 hectares in Bjarnarflag divided into three parts and 1513 hectares in the Krafla area. [14]
d) The municipal plan of Tjörneshreppur aims at developing agriculture and tourism and thus has no designated industrial area other than what has already been designated for Kaldakvísl hydropower station (2 MW_e) in a prevailing local plan. [15]
e) The municipal plan for Þingeyjarsveit 2010-2022 designates several small areas for industry or light industry which allows for some industrial development on a smaller scale. The plan does have a provision stating that there will be designated industrial areas at the sites of larger hydropower plants and in high temperature geothermal areas, but those will be specifically for, and limited to energy production and related services, and may not be used for unrelated industry. [16]

[12] (Norðurþing, 2010 24 - 27, pp. , 18.)
[13] (Norðurþing, 2010 24 - 27, pp. , 16-19)
[14] (Skútustaðahreppur, 2011 a, p. 34)
[15] (Tjörneshreppur, 2010, p. 37)
[16] (Þingeyjarsveit, 2010, p. 47.)

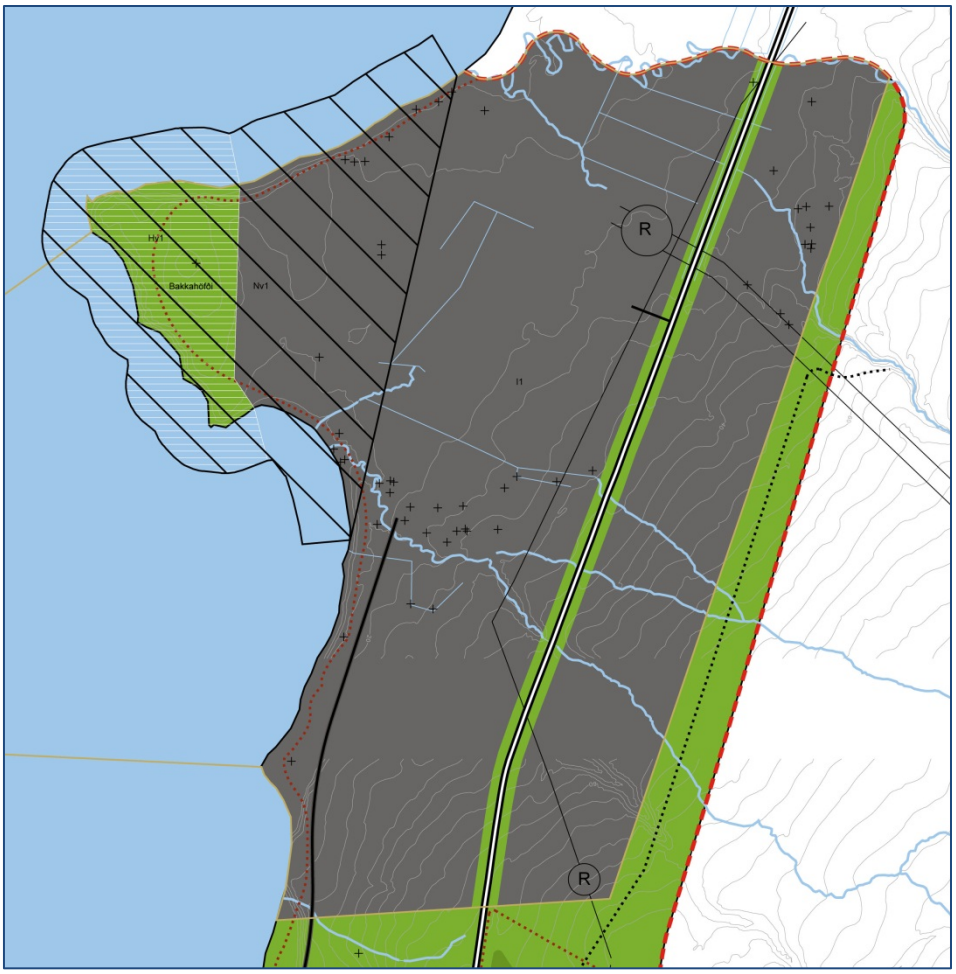

Figure 7: Bakki industrial area in municipal plan for Norðurþing 2010-2030[17]

2.4 Húsavík harbour area

The harbour area in Húsavík designated in the municipal plan for Norðurþing 2010-2030 covers a total of approximately 26 hectares, divided into a few parts. Two of these parts are designated for shipping operations and service facilities for proposed industry in the area. One is the North harbour (9.4 ha) which includes the piers Norðurgarður and Bökugarður and the other is Snásugarður (10.7 ha) – see Figure 8). The North harbour is near completion but does allow for expansion in order to accommodate larger ships and for increased operational area. Snásugarður has been designed and its construction will be scheduled should the need arise. Its construction is subject to an Environmental Impact Assessment according to Annex 1 of the EIA Act no.106/2000.

The harbour conditions are discussed in more detail in chapter 7.1.

[17] http://www.nordurthing.is/static/files/adalskipulag-2010-2030/uppdraettir/husavik-uppdrattur.pdf

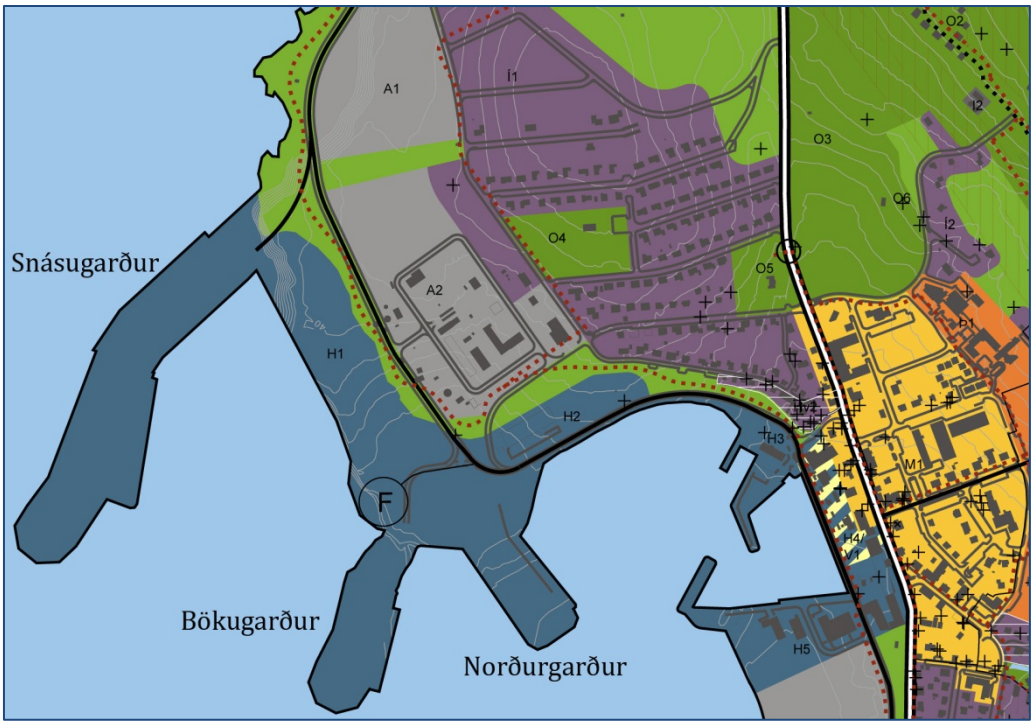

Figure 8: Húsavík harbour area in municipal plan for Norðurþing 2010-2030

2.5 Residential areas

The combined residential areas designated in Norðurþing municipal plan 2010-2030 in the town of Húsavík can accommodate 366-460 residential units depending on the combination of single, double and multiple family units.[18] The plan also allows for up to eight single family homes at Hrísateigur in Reykjahverfi (12 km from Húsavík) as well as up to 10 single family homes by Skúlagarður in Kelduhverfi (45 km from Húsavík).[19] Additionally, the plan also has provisions for up to three residential houses on each farm site unrelated to agriculture.[20]

The Skútustaðahreppur municipal plan 2011-2022 has provisions for residential areas in the village of Reykjahlíð as well as Skútustaðir. Although it is not clear at the time of this writing how many residential units they could accommodate, a rough estimate is in the range of 50-70. In addition to the abovementioned, some smaller residential areas are designated in the proposed plan which also provides for up to three residential houses on each farm site unrelated to agriculture.[21]

The Tjörneshreppur municipal plan 2008-2020 does not have provisions for designated residential areas but allows for up to two residential houses on each farm site unrelated to agriculture provided they are built on designated lots.[22]

The municipal plan for Þingeyjarsveit 2010-2022 provides for 60-80 new residential units in three urban clusters within the municipality; 30-45 at Laugar in Reykjadalur, 18 at Hafralækur in Aðaldalur and 13-18 at Stórutjarnir in Ljósavatnsskarð pass. Designated residential areas in urban areas provide

[18] (Norðurþing, 2010 24 - 27, pp. 9-12)
[19] (Norðurþing, 2010 23, p. 4)
[20] (Norðurþing, 2010 23, p. 13)
[21] (Skútustaðahreppur, 2011 a, pp. 24-25 og 38)
[22] (Tjörneshreppur, 2010, p. 49)

for an additional 25 residential units and the plan has provisions for up to three residential houses on each farm site unrelated to agriculture.[23]

For the Húsavík near region as a whole, residential areas designated in the municipal plans can accommodate 520-660 residential units as well as the residential houses allowed on farm sites unrelated to agriculture. Assuming an average of 2.5 residents in each unit this can accommodate 1,300-1,650 residents. Municipalities in the region should be careful not to promote overinvestment in residential construction through their competition for residents. Such competition played a large role in the overinvestment in residential construction in East Iceland which has been considered one of the biggest mistakes in the large scale industrial development there.[24]

2.6 Further reading (in Icelandic)

Norðurþing municipal plan 2010-2030:
http://www.nordurthing.is/is/thjonusta/skipulags-og-byggingarmal/skipulagsmal/adalskipulag

Skútustaðahreppur municipal plan 2011-2022 – introductory proposal: http://myv.is/frettir/nr/766/

Tjörneshreppur municipal plan 2008-2020: http://www.murinn.is/skipulag/skipulag.html

Þingeyjarsveit municipal plan 2010-2022: http://thingeyjarsveit.is/skipulagsmal/

Social impacts of an aluminium plant and hydroelectric power plant in East Iceland 2002-2008 – final report): http://www.rha.is/static/files/Rannsoknir/2010/Samfelagsahrif_alvers_og_virkjunar_A-landi_lokaskyrsla_2010.pdf

Icelandic planning act no. 123/2010: http://www.althingi.is/lagas/nuna/2010123.html

Planning ordinance no. 400/2010 - amendments no. 47/2001 and 420/2002 (bottom of page):
http://www.reglugerd.is/interpro/dkm/WebGuard.nsf/aa0d47377abc977400256a090053ff91/4055124e8b989d2300256a62004cf38f?OpenDocument

[23] (Þingeyjarsveit, 2010, p. 52)
[24] (Jóhannesson H. , 2010, p. 4)

3 Environmental Impact Assessment

3.1 Projects subject to assessment

According to the Environmental Impact Assessment Act, the developer is responsible for the preparation of the EIA and shall bear the cost of it. [25] Neither the act nor its provisions contain any stipulations of certification for preparation of the required documentation. A number of consulting firms in Iceland are available for such work, including all larger engineering firms.

EIA requirements for individual projects are listed in annexes 1 and 2 of the EIA Act. Annex 1 contains projects which are always subject to EIA while Annex 2 contains projects which may be subject to EIA based on case-to-case assessment.

Figure 9 shows a flow chart outlining the main phases of the EIA process.

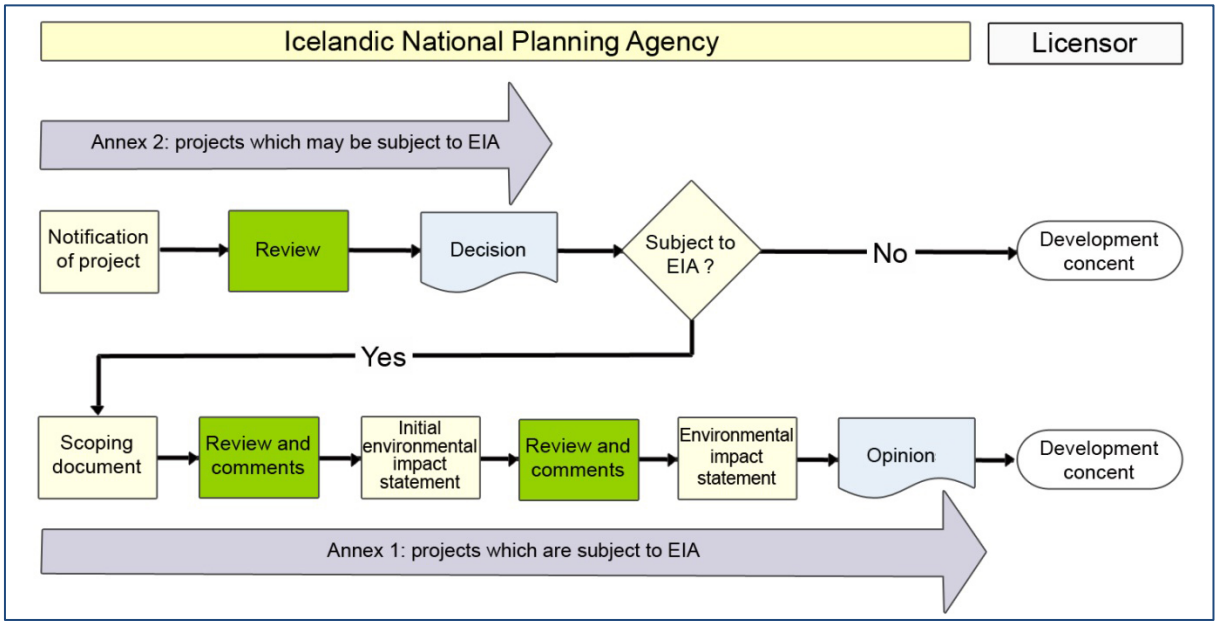

Figure 9: Process of environmental impact assessment (modified from www.skipulagsstofnun.is)

3.2 Status of EIA in connection with proposed industrial development

In recent years, several projects in connection with large scale industrial development in the region have entered the EIA process, particularly projects in connection with plans for an Alcoa aluminium smelter. These include projects which were subject to notification only as well as projects which were ruled as subject to EIA.

The projects along with their status in the EIA process are listed in Table 1. Available data on these projects, including scoping documents, EIA statements and decisions (if applicable) are accessible on the website of the Icelandic National Planning Agency. [26]

[25] (Environmental Impact Assessment Act No. 106/2000)

[26] This applies to all projects listed except Bjarnarflagsvirkjun. The scoping document for Bjarnarflagsvirkjun (Hönnun, 2003) can be found at the website of Landsvirkjun (www.landsvirkjun.is).

Project	Not subject to EIA	Decision date	Subject to EIA	EIA statement approved	INPA opinion -end of process
Vaðlaheiði Tunnel	X	20.9.2006			
High voltage power lines between Krafla, Þeistareykir and Bakki			X	29.5.2008	24.11.2010
Bjarnarflag power plant – up to 90 MW_e			X	18.7.2003	26.2.2004
Þeistareykir power plant – up to 200 MW_e			X	6.11.2009	24.11.2010
Krafla II power plant – up to 150 MW_e			X	6.11.2009	24.11.2010
Alcoa aluminium smelter at Bakki – up to 346 thousand tons			X	27.11.2008	24.11.2010
Alcoa aluminium smelter at Bakki, high voltage power lines and power plants at Krafla and Þeistareykir – joint EIA			X	6.11.2009	24.11.2010
Kemira Sodium Chlorate factory at Bakki	X	19.9.2011			
PCC silicon factory at Bakki			X	2.2.2012	

Table 1: Regional projects which have entered the EIA process

As seen in Table 1, most key projects involved in the industrial development at Bakki have already been subjected to the EIA process. Status of other relevant projects regarding EIA is as follows:

- Expansion of Húsavík harbour within the current harbour area may be subject to notification pursuant to Annex 2 (13a) of the EIA act no. 106/2000.
- The construction of Snásugarður pier is subject to EIA pursuant to Annex 1 (11) of the EIA act no. 106/2000.
- The construction of an industrial road connection between the industrial site at Bakki and Húsavík harbour may be subject to notification pursuant to Annex 2, cf. criteria 3 in Annex 3 of the EIA act no. 106/2000.

3.3 Further reading

Environmental Impact Assessment Act No. 106, 25 May 2000:
http://www.althingi.is/lagas/139b/2000106.html (in Icelandic)
http://www.skipulagsstofnun.is/media/umhverfismat/MAUlogm2005br.pdf (English translation)

Regulation on Environmental Impact Assessment (1123/2005):
http://www.stjornartidindi.is/Advert.aspx?ID=bf366397-93bb-4014-951e-8553e02d6a61 (Icelandic)
http://eng.umhverfisraduneyti.is/media/PDF_skrar/Thyding-a-reglugerd-um-mau.pdf (Engl. transl.)

Schedule of fees for Environmental Impact Assessment:
http://www.skipulagsstofnun.is/focal/webguard.nsf/key2/gekr5vnere.html (Icelandic)

Guidelines for Environmental Impact Assessment (Published in 2005 and revised in March 2012):
http://www.skipulagsstofnun.is/media/pdf-skjol/MAU_LEIDBEININGAR_desember2005_UPPFAERT_MARS_2012.pdf

The Icelandic National Planning Agency ruling on Vaðlaheiði tunnel:
http://www.skipulagsstofnun.is/media/attachments/Umhverfismat/274/2006010074.PDF (Icelandic)

The Icelandic National Planning Agency ruling on Kemira Sodium Chlorate factory at Bakki:
http://www.skipulagsstofnun.is/media/attachments/Umhverfismat/867/201105053.pdf (Icelandic)

4 Energy

Northeast Iceland is rich with energy resources, particularly geothermal but also in hydropower.

Geothermal areas are commonly divided into two categories, high and low temperature areas. High temperature areas, where the temperature is above 200°C at a depth of 1000 m, are found within the active volcanic zone which follows the rift zone from Reykjanes peninsula northeast to Öxarfjörður bay. Seven high temperature geothermal areas have been identified north of Vatnajökull glacier. From north to south, they are Þeistareykir, Gjástykki, Krafla, Námafjall, Fremrinámar, Hrúthálsar and Askja. [27]

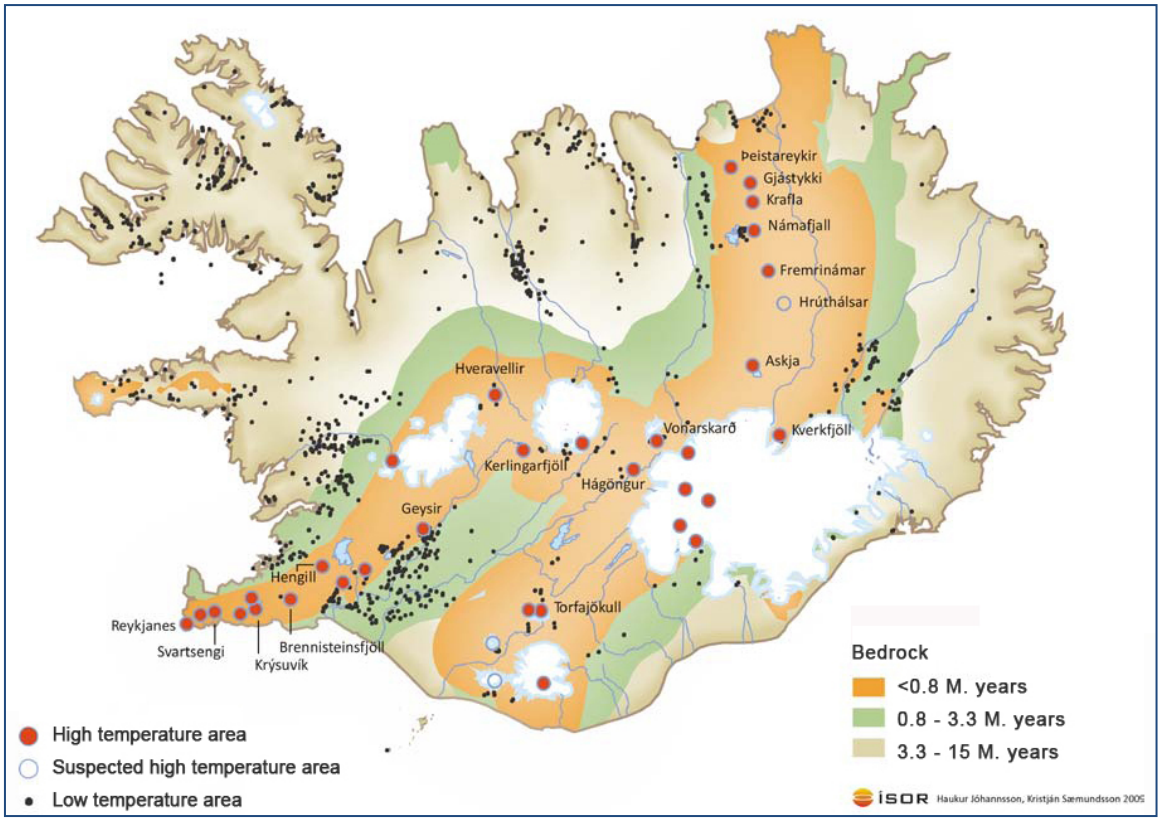

Figure 10: Known geothermal areas in Iceland (Orkustofnun, 2009)

Vatnajökull glacier feeds two rivers in Northeast Iceland, Jökulsá á Fjöllum and Skjálfandafljót. A number of fresh water rivers are also found in the region. Among the larger ones are (from west to east): Fnjóská, Laxá in Aðaldalur, Kaldakvísl in Tjörnes and in Þistilfjörður region the rivers Sandá and Hafralónsá.

A *Master Plan for Hydro and Geothermal Energy Resources* initiated by the Government of Iceland has been on going for some years. In this process, potential energy harnessing projects are evaluated and graded on the basis of their overall feasibility in terms of protections and/or utilisation. The plan has not been finalized, but a preliminary parliamentary resolution has been made available for public debate. After the review of the comments and information received in the process, a parliamentary resolution will be issued jointly by the Minister of Industry and the Minister for the Environment. [28]

[27] (Stefán Arnórsson, 2011)
[28] http://www.rammaaaetlun.is/umsagnir/um-ferlid/ferlid/

Table 2 lists the potential energy projects which have been evaluated in Northeast and how they are categorized in the current preliminary resolution. [29]

Name and number of potential energy projects			Utilization	On hold	Protection
Hydropower					
Skjálfandafljót	9	Fljótshnjúksvirkjun		X	
Skjálfandafljót	10	Hrafnabjargavirkjun A		X	
Skjálfandafljót	11	Eyjadalsárvirkjun		X	
Jökulsá á Fjöllum	12	Arnardalsvirkjun			X
Jökulsá á Fjöllum	13	Helmingsvirkjun			X
Geothermal power					
Námafjall area	97	Bjarnarflag	X		
Krafla area	98	Krafla I, expansion	X		
Krafla area	99	Krafla II, phase 1	X		
Krafla area	103	Krafla II, phase 2	X		
Þeistareykir area	102	Þeistareykir, eastern area	X		
Þeistareykir area	101	Þeistareykir, western area	X		
Hrútháls area	95	Hrúthálsar		X	
Fremrinámar area	96	Fremrinámar		X	
Gjástykki area	100	Gjástykki			X
Askja	94	Askja			

Table 2: Categorization of energy option in Northeast Iceland in the preliminary parliamentary resolution

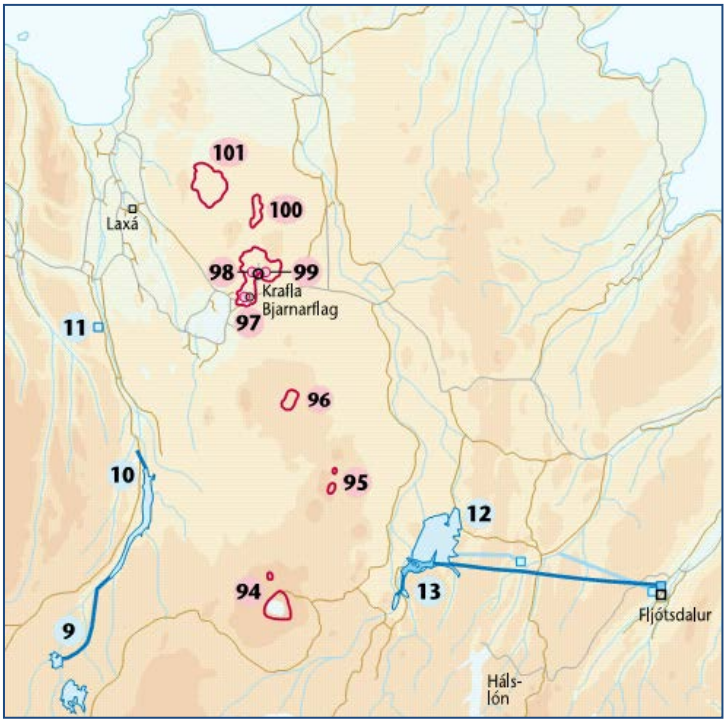

Figure 11: Potential energy harnessing options in Northeast Iceland evaluated in Master Plan

[29] (Iðnaðarráðherra og umhverfisráðherra, 2011)

In addition to the proposed options evaluated in the Master Plan process, other potential energy harvesting options have also been studied. There are ideas for harnessing river Fnjóská in connection with the construction of Vaðlaheiði tunnel. A 2 MW power plant at Kaldakvísl on Tjörnes is already under construction and harnessing possibilities have been defined for rivers Sandá and Hafralónsá in Þistilfjörður region. Finally, micro hydro power stations have been built and operated in the region for decades. These so called farmer power stations are more common here than elsewhere in Iceland.

4.1 Energy production

The National Energy Authority of Iceland has estimated the production capacity of geothermal areas in Iceland based on resistivity surveys and comparison with production capacity of known geothermal sites. The estimated capacity for each area based on a production period of 50 years is presented as a range with a maximum value, median value and a minimum value. According to this, the production capacity of geothermal areas in Northeast Iceland is 400-1200 MW. The median value of estimated production capacity is 675 MW. The size and estimated capacity values for individual areas are outlined in Table 3. [30]

Area	Size	Max	Med	Min
	KM2		MW	
Þeistareykir	48	432	240	144
Gjástykki	11	99	55	33
Krafla- Bjarnarflag	62	558	310	186
Fremrinámar	10	90	50	30
Hrúthálsar	4	36	20	12
Total:	**851**	**1.215**	**675**	**405**

Table 3: Estimated production capacity of geothermal areas in Northeast Iceland

In the joint EIA statement for Alcoa aluminium smelter at Bakki, high voltage power lines and power plants at Krafla and Þeistareykir, the power companies Landsvirkjun and Þeistareykir ehf. plan for new power plants in the Krafla area, at Bjarnarflag and at Þeistareykir. According to the statement, the combined capacity with new power plants at these three sites is estimated at 440 MW as shown in Table 4. [31]

Production site	Power
Bjarnarflag	90 MW
Þeistareykir	200 MW
Krafla 2	150 MW
Total:	**440 MW**

Table 4: Estimated new power production for Alcoa smelter at Bakki according to EIA statement

Based on results of exploration drilling among other things, managing director of Landsvirkjun announced in the fall of 2011 that the company was prepared to negotiate a binding contract for up to 200 MW. Furthermore the company was prepared to negotiate provisional contracts for additional

[30] (Orkustofnun, 2009)
[31] (Mannvit hf., 2010 a, p. 21)

200 MW on the condition that the energy is found. [32] Landsvirkjun has signed agreements for design of the planned geothermal power stations and consultancy services for the first phases of the energy production which is in three phases as shown in Table 5. [33]

Bjarnarflag	45 MW	Activation in late 2014
Þeistareykir	45 MW	Activation in early 2015
Þeistareykir	45 MW	Activation in late 2015
Total	**135 MW**	

Table 5: Work plan for Landsvirkjun power production in Northeast Iceland until 2015

Installed capacity of the three power stations which Landsvirkjun operates already in the region is 90.5 MW as shown in Table 6.

Laxárvirkjun – hydropower	27.5 MW	MW
Bjarnarflag – geothermal	3.0 MW	MW
Krafla I – geothermal	60.0 MW	MW
Total	**90.5 MW**	**MW**

Table 6: Installed capacity of Landsvirkjun in Northeast Iceland

Energy production in the region could therefore reach 225.5 MW within four years. The national grid also has about 170-180 MW of excess capacity (60 MW belonging to Landsvirkjun) but transmitting it to this region might be problematic.

4.2 Power transmission

4.2.1 Transmission system

Landsnet was founded in 2003 to operate Iceland's electricity transmission grid. The company operates under a concession arrangement and is subject to regulation by the National Energy Authority.[34] The current electricity transmission system of Landsnet in Northeast Iceland consists of a 132 kV line which runs from Rangárvellir in Akureyri via Krafla to East Iceland and is part of the Icelandic circular pass-through system. Another 66 kV line runs from Rangárvellir via Laxá hydropower station to Kópasker village in Northeast Iceland. Húsavík is connected to Laxá power station with a 33 kV line which is over 60 years old. In addition to Landsnet's grid in Northeast Iceland, is a distribution network serving the region of Raufarhöfn, Þórshöfn and Bakkafjörður, operated by the Iceland State Electricity.[35]

[32] This was revealed in a presentation by Hörður Arnarson, managing director of Landsvirkjun at a public meeting in Húsavík on November 2nd 2011. http://www.landsvirkjun.is/frettir/frettasafn/nr/1495
[33] http://www.landsvirkjun.is/frettir/frettasafn/nr/1495
[34] http://www.landsnet.is
[35] http://rarik.is/english/rarik

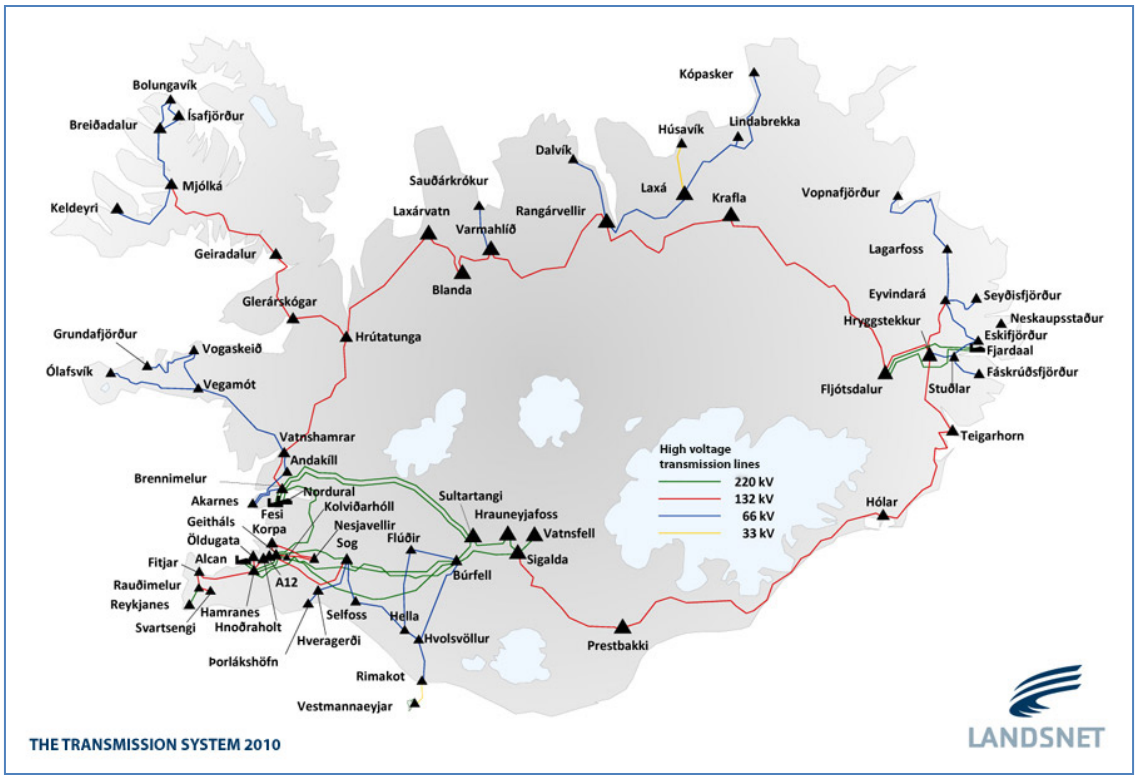

Figure 12: The Transmission system 2010 (www.landsnet.is)

In the joint EIA statement for Alcoa aluminium smelter at Bakki, high voltage power lines and power plants at Krafla and Þeistareykir, Landsnet lays out plans for two 220 kV power lines from the power stations to the industrial site at Bakki in order to meet power and security demands for an aluminium smelter up to 346,000 tonnes. The total distance from Krafla via Þeistareykir to Bakki is 60 km. The plans also include a 10 km underground line from Bjarnarflagsvirkjun to Krafla. [36]

Premises for the construction of new transmission infrastructure in Northeast Iceland changed considerably in the fall of 2011 after Alcoa announced that the company had decided to discontinue the development of a proposed aluminium smelter at Bakki after concluding that long-term, competitively priced power supply would not be available.[37]

Currently, the focus is on smaller industrial options and Landsnet is revaluating its plans for new transmission lines. The current working plans propose the construction of one line from Krafla via Þeistareykir to Bakki which would initially run at 132 kV with the option of enhancement to 220 kV as the demand for power increases. It is expected that at the time of this expansion, a second 220 kV line would also be constructed from Krafla via Hólasandur to Bakki in order to further secure the delivery there. [38]

In addition to the above mentioned line construction, a 66 kV line connecting Þeistareykir power station to the Kópasker 1 line is also under consideration. An enhanced connection to the town of Húsavík is also under review. One option is using the same connection point at the Kópasker line and another might be an output from the industrial site at Bakki which would be dependent on the

[36] (Mannvit hf., 2010 b, p. i)
[37] http://www.alcoa.com/iceland/ic/news/whats_new/2011/2011_10_bakki.asp
[38] Árni Jón Elíasson specialist at Landsnet – e-mail correspondence February 6, 2012

development of power consumption there. A third possibility would be a new line directly from Laxá power station.

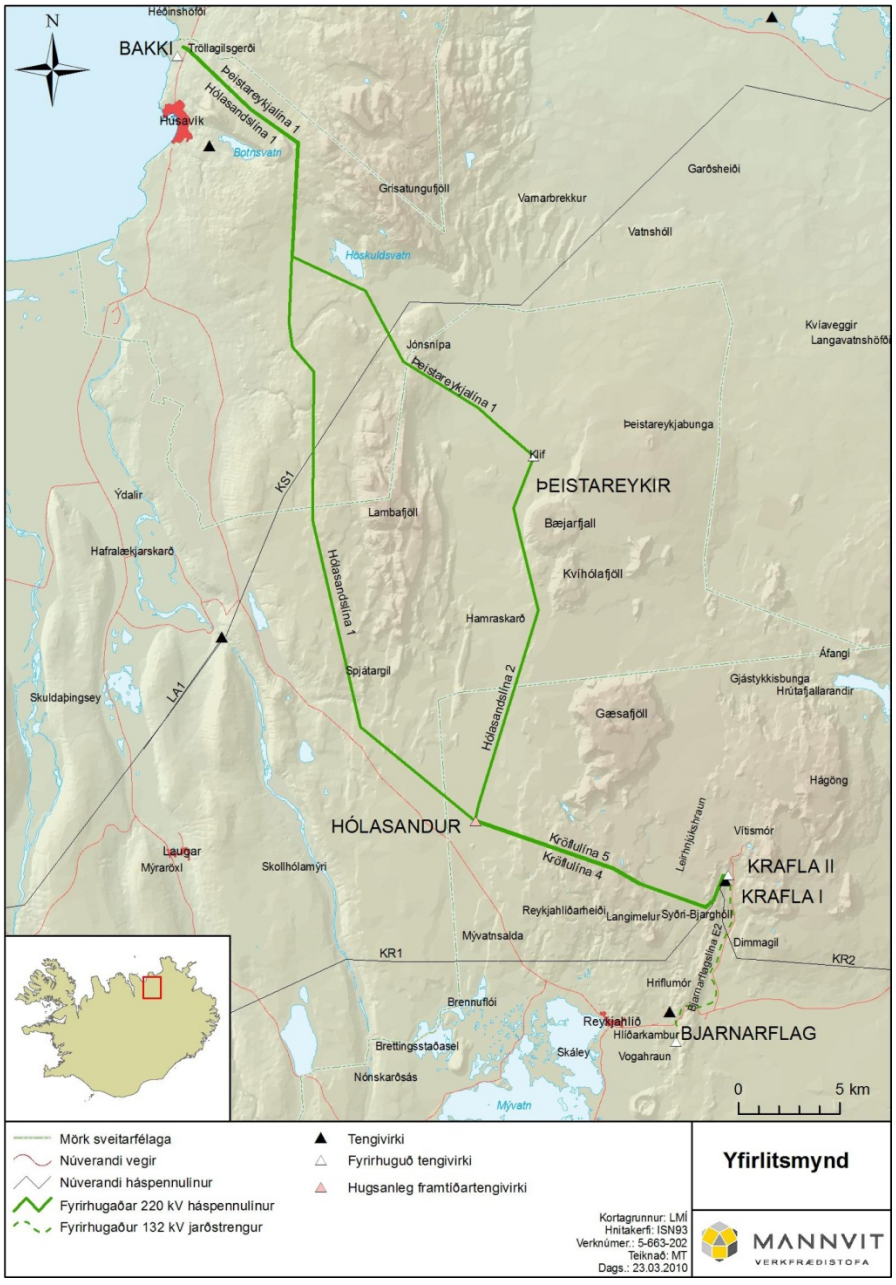

Figure 13: Layout of power transmission lines from geothermal areas in Northeast Iceland to the proposed industrial site at Bakki (Mannvit hf., 2010 b)

Providing that Landsnet´s plans for the construction of transmission lines to Bakki from Krafla and Þeistareykir are implemented and a new connection to Húsavík is established, one could say that the area will be fairly well connected. There is still, however, the issue of restricted transmission capacity from Kópasker east to Þórshöfn which needs to be addressed. It clearly puts local industry like the fishmeal factory in Þórshöfn at a competitive disadvantage. Being unable to get enough electricity to power their cookers, they are forced to use oil which increases both costs and pollution. [39]

[39] Information from directors of Ísfélag Vestmannaeyja hf. in Þórshöfn.

4.2.2 Steam pipeline

A preliminary investigation conducted by Tækniþing ehf. in 2002 assessed the cost of laying a steam pipe from Þeistareykir to Húsavík. The study was instigated by a feasibility study for an alumina refinery proposed near Húsavík at that time. The calculations were based on a pipe with internal diameter of 1.52 m which would give the required steam flow of 5 million tons pr. year or 159 kg/s. The pipeline would be about 30 km long and pressure drop approximately 2 bars. Calculated heat loss results in approximately 2% enthalpy loss in the 30 km pipeline and estimated total cost in 2002 was around 4 billion ISK. [40]

A steam pipelined from Þeistareykir to Húsavík was also investigated in by parties interested in constructing a Glycol plant near Húsavík. Data from this investigation is, however, not available as far as is known.

4.2.3 Further reading

A Master Plan for Hydro and Geothermal Energy Resources
http://www.rammaaaetlun.is/english

Moderate utilisation of Jökulsá á Fjöllum for piping to Hálslón reservoir (in Icelandic)
http://www.rha.is/static/files/JF%20skyrsla%20pdf.pdf

High voltage power lines (220 kV) from Krafla and Þeistareykir to Bakki near Húsavík & under ground power line (132 kV) from Bjarnarflag to Krafla – EIA statement (Icelandic)
http://www.skipulagsstofnun.is/media/attachments/Umhverfismat/819/Matssk%C3%BDrsla%20h%C3%A1spennul%C3%ADnur_150.pdf

Alcoa aluminium smelter at Bakki, high voltage power lines and power plants at Krafla and Þeistareykir – joint EIA (in Icelandic)
http://mannvit.is/media/PDF/Frummatsskyrsla_Lokaeintak_200410_a.pdf

[40] (Tækniþing, 2002)

5 Environmental factors

5.1 Climate

In general, climate in Iceland is considerably more moderate than is to be expected from its northerly latitude. This is due to the warm North Atlantic Drift and Irminger currents which are fed by the Gulf Stream. Because of Iceland's location between Arctic and temperate seas the weather can be quite variable. Classification of climate in Iceland ranges from tundra in the highland interior to cool temperate maritime in the coastal regions and on average it is warmest along the southwest coast.[41]

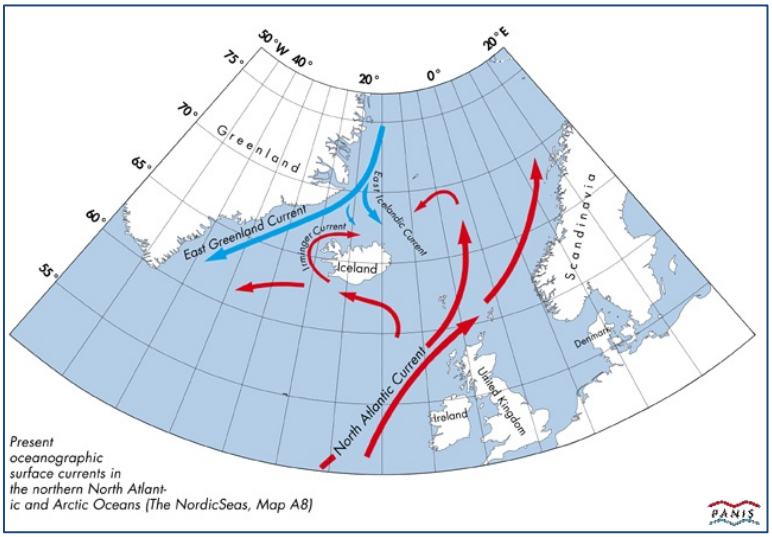

Figure 14: Surface currents around Iceland ((PANIS, 2006)

5.1.1 Weather stations and meteorological data

A manned weather station (no.477) was operated in Húsavík from 1924 until 1995. An automatic weather station (no.3696) was installed in town in 2002 and three temporary stations were also set up in the town's vicinity in 2002. The stations at Gvendarbás (no.3693) and by Húsavík mountain (no.3694) operated from 2002-2005 and a station located on Bakkahöfði (no.3692) collected data until 2009. The station by Húsavík mountain measured temperature only, but the other two temporary stations measured wind direction and velocity as well. In addition to the above stations, operated by the Icelandic Meteorological Office, an automatic station owned by Húsavík Harbour (no.3691) has been in operation since 1997.

At Mánárbakki on Tjörnes peninsula, 20km north of Húsavík, a manned weather station (no.479) has been operated since 1956 and an automatic station (no.3797) since 2005. An automatic station was installed at Héðinshöfði (no.3695) in 2007. Data on wind direction and wind velocity at Héðinshöfði are also available from September 1981 to October 1983.[42] A manned weather station (no.452) was also operated at Sandur in Aðaldalur valley (13 km SW of Húsavík) 1933-2005.

The Icelandic Meteorological Office has compiled a database of meteorological information from weather stations operated by IMO reaching as far back as 1931 and made it available to the public on-line in cooperation with the companies RIV (Institute for Meteorological Research) and

[41] (Ingólfsson, 2008)
[42] (Sigurðsson, Hjartarson, Antonsson, & Arason, 2003)

DataMarket.[43] Several reports and analyses based on these and other data are also available at IMO's web site www.vedur.is.

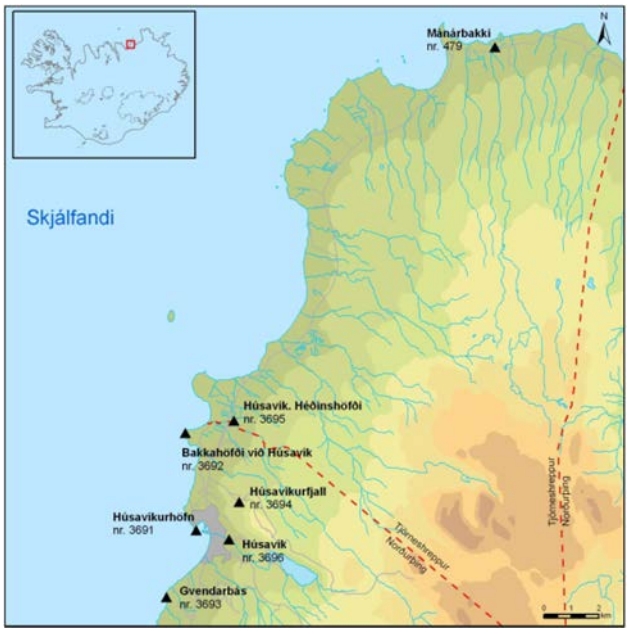

Figure 15: Meteorological stations in the vicinity of Bakki near Húsavík[44]

5.1.2 Temperature

The map from the Icelandic Meteorological Office in Figure 10 shows annual mean temperature in Iceland based on data from 1961-1990. [45]

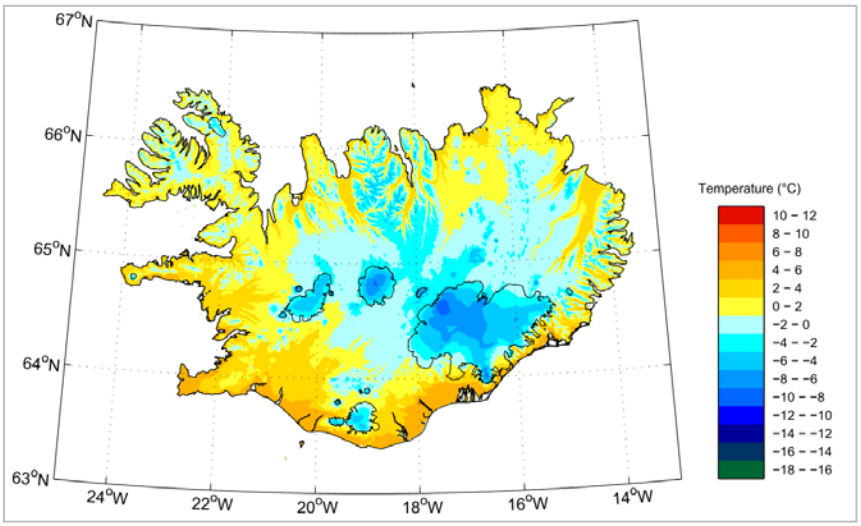

Figure 16: Annual mean temperature 1961-1990[46]

Annual mean temperature in the area around Húsavík was 4.1°C in 2010, and this is also the average annual mean temperature for the past decade (2001-2010). January and February are generally the

[43] See http://riv.is/languages/en_EN - and www.datamarket.net
[44] (HRV Engineering, 2010, p. 92)
[45] The annual mean temperature has since increased. For Mánárbakki station, the mean temperature for this period was 2.8°C but for 1991-2000 it was 3.3°C and for 2001-2010, which was the warmest decade in 60 years (Crochet & Jóhannesson, 2011), the mean temperature for Mánárbakki was 4.1°C .
[46] (Björnsson, Jónsson, Gylfadóttir, & Ólason, 2007) obtained from (Veðurstofa Íslands, 2011)

coldest months with mean temperatures around 0°C whilst July and August are the warmest with mean temperatures around 10°C. Temperature figures for Húsavík and Mánárbakki are very similar although the summers are slightly cooler and the winters slightly warmer on average at Mánárbakki where the ocean probably has a more tempering effect.

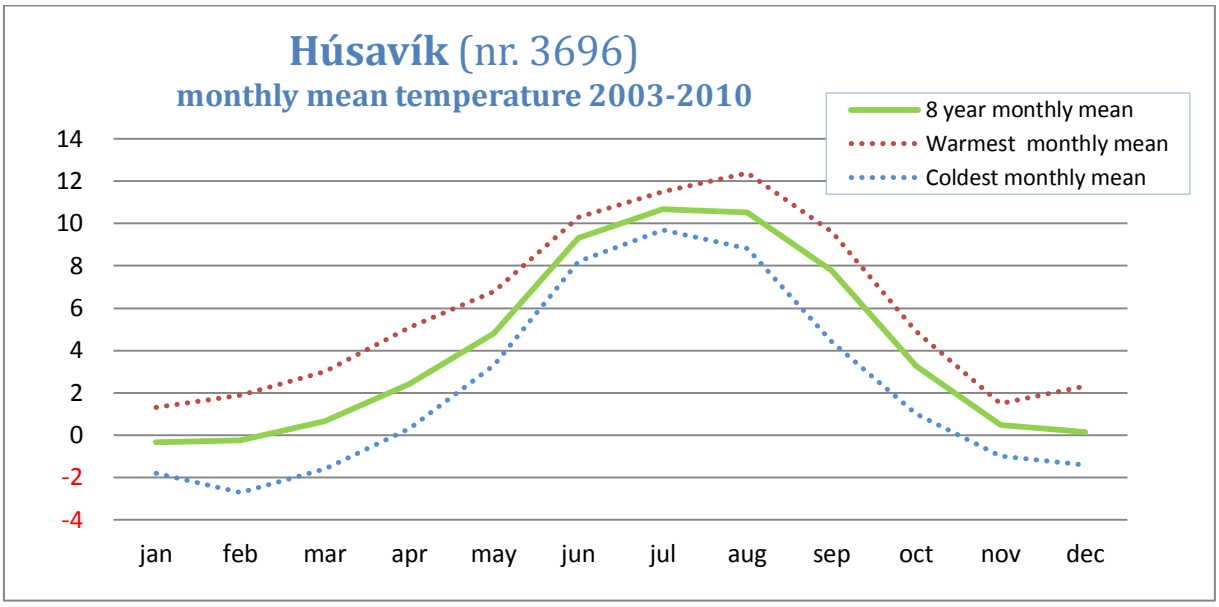

Figure 17: Monthly mean temperature in Húsavík 2003-2010

The lowest recorded temperature in Húsavík (since September 2002) was -14.3°C in January of 2003, and the highest was 24.9°C in July of 2008.

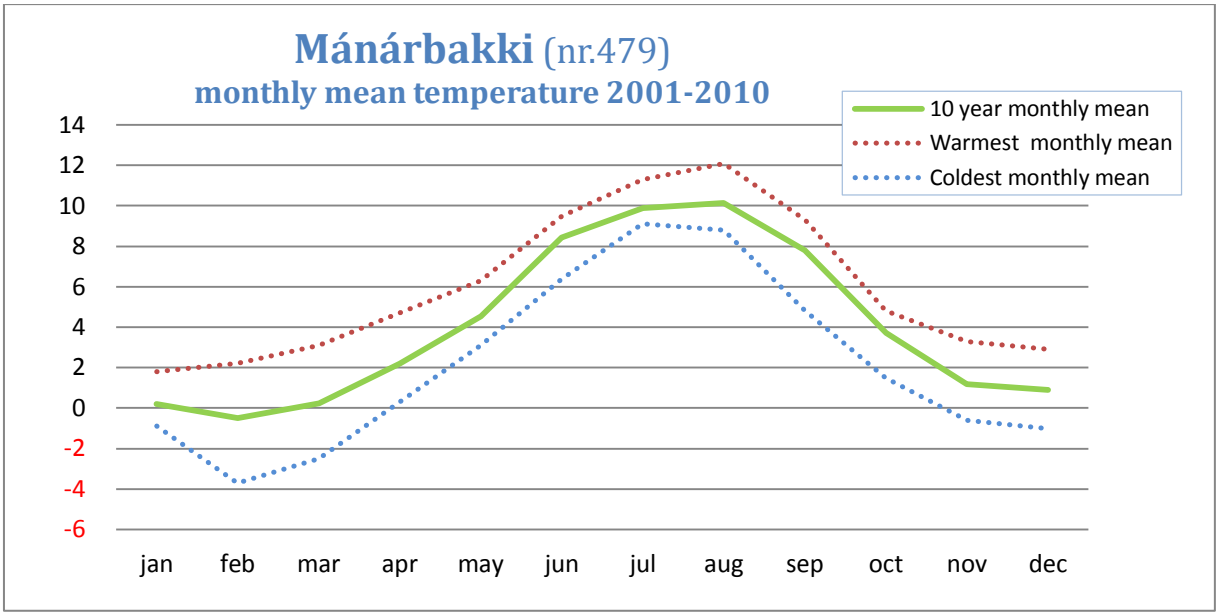

Figure 18: Monthly mean temperature in Mánárbakki 2001-2010

The lowest recorded temperature in Mánárbakki since August 1956 was -22.9°C in March of 1969 and the highest recorded temperature was 25.0°C in July of 1999.[47]

[47] Charts base on data from (DataMarket, 2011)

5.1.3 Precipitation

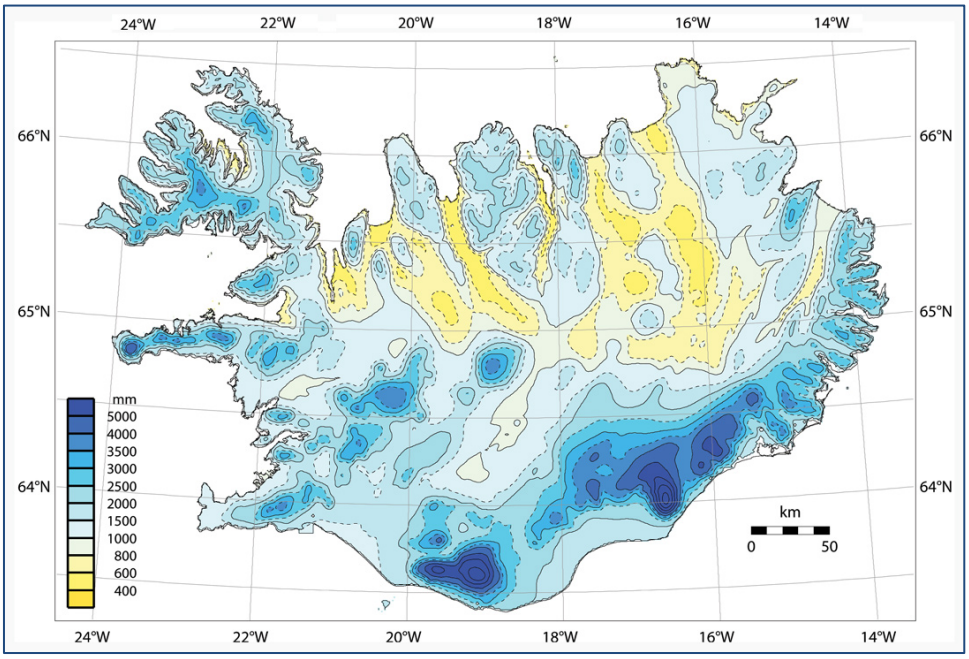

Figure 19: Annual mean precipitation in Iceland 1971-2000[48]

Based on data recorded 1961-1994, average annual total precipitation in Húsavík was 833.9 mm. Precipitation is highest from September through January (80-100 mm/month). During the six month period from November through April, snow or sleet is a prominent part of the total precipitation. [49]

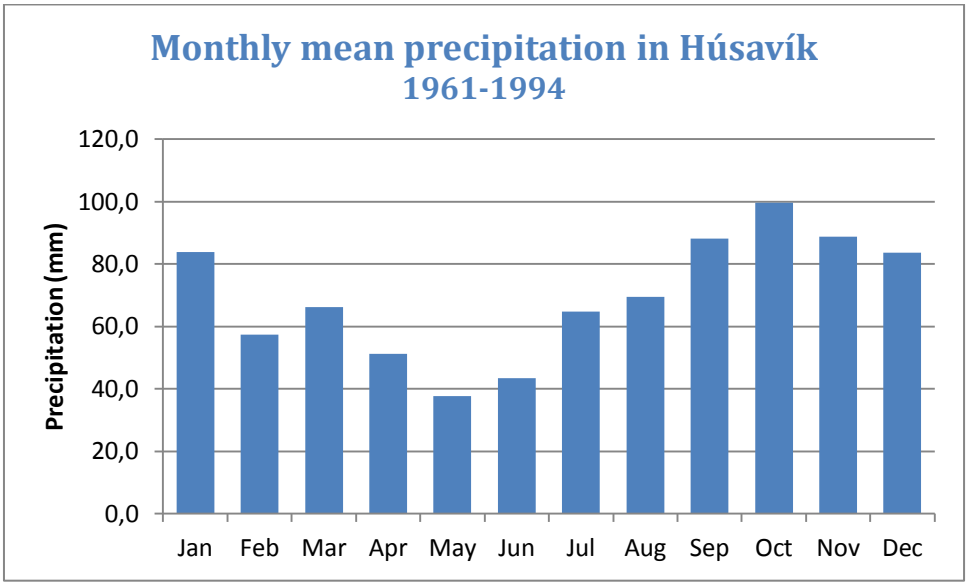

Figure 20: Monthly mean precipitation in Húsavík 1961-1994[50]

[48] (Crochet, o.fl., 2007) obtained from (Veðurstofa Íslands, 2008)
[49] (Hönnun, 2005, p. 24) (HRV Engineering, 2010, p. 93)
[50] Based on data from a manned station (no.477) in Húsavík, obtained from Icelandic Meteorological Office.

5.1.4 Wind

For the year as a whole, southerly winds are most common at Bakkahöfði, north of Húsavík and south-easterly winds at Húsavík station. The difference is largely explained by the contours of the land. During the winter half of the year as well as during summer nights, winds blowing from the colder land towards the warmer sea are dominating. Southerly winds have then the highest frequency at Bakkahöfði and south-easterly winds at Húsavík. During daytime in summer, the land is usually warmer than the sea and a northerly sea breeze is then dominating at Bakkahöfði while winds between north and northwest are most common at the Húsavík station. [51]

The average annual wind velocity at Bakkahöfði, according to observations in 2002-2004, is 6.4 m/s but considerably lower or 4.5-5.0 m/s at the relatively sheltered station in Húsavík. The highest 10-minute wind velocity observed at Bakkahöfði during 2003-2004 was 25.4 m/s and highest gust observed was 31.7 m/s. At Húsavík the highest observed 10-minute wind was 18.7 m/s and the highest gust 31.9 m/s. [52]

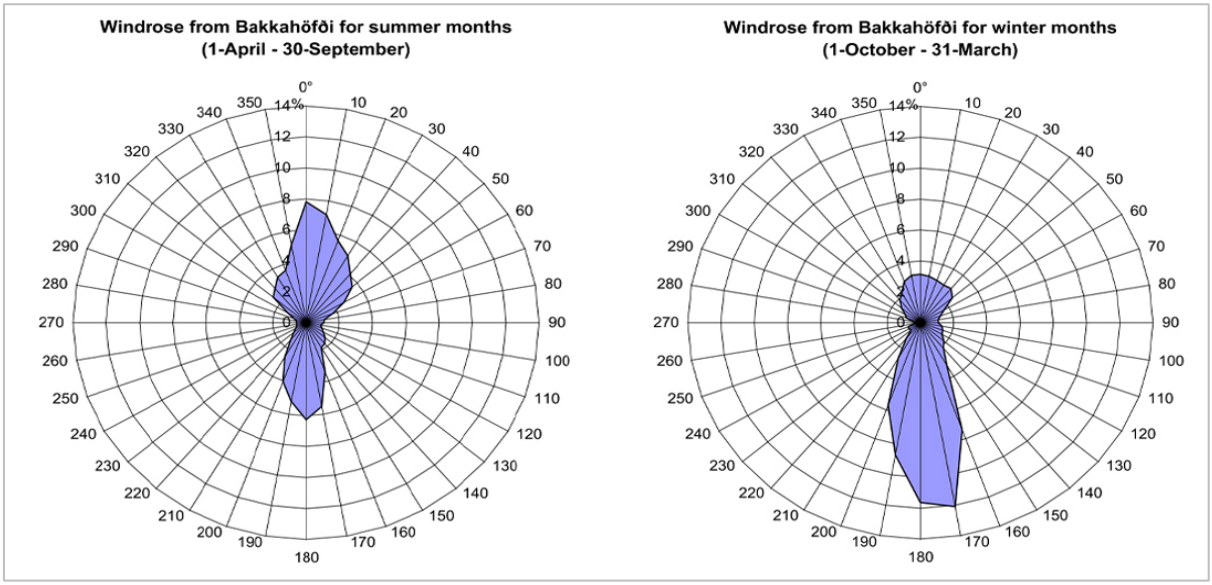

Figure 21: Wind roses for winter and summer months at Bakkahöfði 2002-2005[53]

[51] (Sigurðsson, Hjartarson, Antonsson, & Arason, 2003, p. 11)
[52] (Hönnun, 2005, p. 27)
[53] The measurements used cover a period from September 13, 2002 to January 12, 2005 and are on a 10-minute basis (Kjaran & Myer, 2005)

5.2 Geological factors

5.2.1 Earthquake hazard

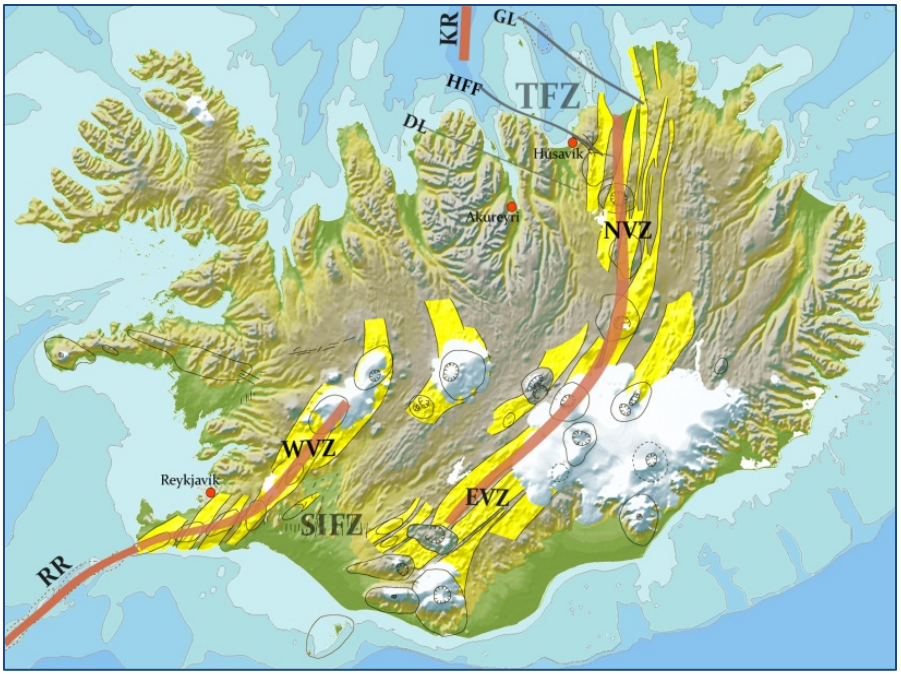

Figure 22: Volcanic systems, rift- and fracture zones

Iceland is located on the Mid-Atlantic ridge (MAR), a divergent plate boundary separating the Eurasian and North American tectonic plates. Iceland also sits on top of a „hot spot“, or a mantle plume. The movement of the Iceland mantle plume relative to the plate boundaries has caused the rift zone to migrate eastwards, forming a kink in plate boundaries where they pass through Iceland. The Icelandic rift system is connected to the submarine Mid-Atlantic ridge via two fracture zones where seismic activity in Iceland is most frequent. The South Iceland Fracture Zone (SIFZ) links the Eastern Volcanic Zone (EVZ) to Reykjanes peninsula and the Reykjanes Ridge south of Iceland. The Northern Volcanic Zone (NVZ) is linked to the oceanic Kolbeinsey Ridge (KR) north of Iceland via the Tjörnes Fracture Zone (TFZ).[54]

The Tjörnes Fracture Zone in Northeast Iceland represents the lateral shift of the spreading zone between the Northern Volcanic Zone and the offshore Kolbeinsey Ridge, approximately 150 km long. Seismicity occurs on three lineaments. Furthest south is the Dalvík Lineament (DL) with low current seismic activity. Furthest north is the Grímsey Lineament (GL)[55] which is currently the most active of the three lineaments. Between them lies the Húsavík Flatey-Fault (HFF) where the main transform motion has taken place, a 7–9 Myr old right-lateral fault which is mostly offshore but with its easternmost part on land.[56]

Considerable amount of research has been conducted on the TFZ and in particular the HFF, not least due to its proximity (2.5 km) to the potential industrial site at Bakki. [57] Historic records exist of some

[54] See for example (Trønnes, 2003)
[55] Also referred to as the Grímsey Oblique Rift (GOR)
[56] (Sigmundsson, 2006), (Rögnvaldsson, Guðmundsson, & Slunga, 1998)
[57] See for example (Þóroddsson, Hallgrímsson, Haraldsson, & Nielsen, 1984), (Halldórsson, 2005), (Sæmundsson & Karson, 2006) and (Sigbjörnsson & Snæbjörnsson, 2007).

large earthquakes in the area, the first from Flatey in 1260. In 1755 there was an earthquake with an epicentre in Skjálfandi bay between Húsavík and Flatey which from descriptions has been estimated at M7.0. The latest big seismic event on the HFF was in 1872 when two quakes struck an hour apart, both estimated at M6.5, the first one with its epicentre just off shore from Húsavík and the second further west.[58]

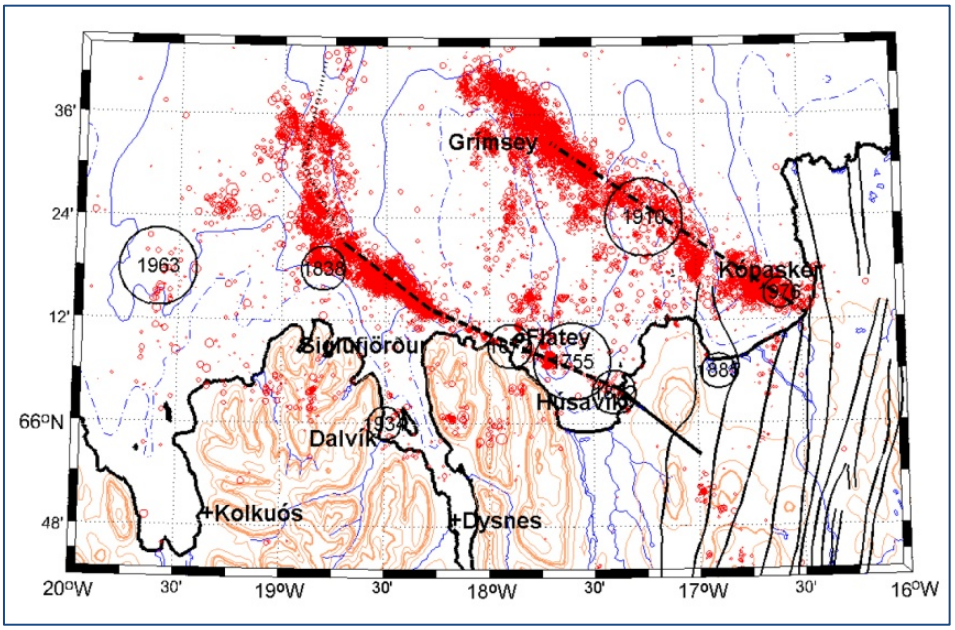

Figure 23: Earthquakes over M1.5 1994-2005 and large historic quakes[59]

Though transform motion in the TFZ has mostly been along the Húsavík-Flatey Fault, seismic activity and other evidence may suggest that the transform motion is shifting more over to the Grímsey Lineament. Transient deformation due to plate movement in the Tjörnes Fracture Zone has been monitored with GPS equipment since 1997 and in 2006 the number of GPS stations was expanded from 4 to 14. Results from continuous data collection with the GPS network 2006-2010 indicate that a third (34±3%) of the total transfer motion of TFZ is accommodated by the HFF and two thirds (66±3%) by the GL.[60] After the Krafla Fires 1975-1984, seismicity at the eastern end of the HFF was greatly reduced, indicating that this rifting episode relieved some stress from the fault.[61]

Acceleration is the key component in assessing potential damage and determining structural design and key factors in acceleration are distance and intensity of the earthquake. In order to assess earthquake hazard for large scale industry near Húsavík two analyses have been conducted by two independent institutions.

In a report the Icelandic Meteorology Office about Earthquake activity in North Iceland, significance of nearby earthquake activity, effects of large historical earthquakes, and probable peak ground acceleration over a period of 500 years were analysed for Bakki among other sites. The report

[58] (Halldórsson, 2005), (Stefánsson, Guðmundsson, & Halldórsson, 2008)
[59] (Halldórsson, 2005, p. 4)
[60] (Sigmundsson, 2006), (Metzger, Jónsson, & Geirsson, 2011), (Björnsson, Jónsson, Gylfadóttir, & Ólason, 2007)
[61] (Metzger, Jónsson, & Geirsson, 2011)

concludes that the largest probable earthquake in the nearby region (2.5 km) could be 6.5 to 7.0 in magnitude and could cause ground acceleration to peak between 64 and 66% g at Bakki. [62]

Scientists at the Earthquake Engineering Research Centre of University of Iceland conducted a preliminary assessment of the seismic hazard and earthquake action for the proposed industrial site at Bakki applying probabilistic methods which entail evaluating the probability of exceeding a particular level of ground motion at a site during a specific time interval. The analysis must incorporate the inherent uncertainty of the size, location, and time of occurrence of future earthquakes, and the attenuation of seismic waves as they propagate from all possible sources in the region to all possible sites. The analysis was applied to obtain peak ground acceleration values and spectral acceleration response ordinates corresponding to 10% probability of exceedance in 50 years. Based on the analysis this corresponds to a return period of 475 years. The values given this return period are in reasonable agreement with published maps for earthquake hazard in Iceland. Given these criteria the peak ground acceleration value derived for Bakki 45% g. [63]

A study by scientist at Iceland Geosurvey presents an assessment of the geology and structure of the proposed industrial site and its surroundings. The area has been included in many previous reports and many maps have been published with different fault interpretations. Special effort was made to critically examine evidence for faults in the area as the scientists carried out detailed, ground-based investigations to evaluate previous reports of the geology of the area with special attention to proposed faults in critical areas. In addition to studying existing bedrock exposures (e.g. riverbanks, irrigation ditches, quarries etc.) several trenches were dug. Among them were trenches dug down to hardened conglomerate or moraine across two of the most prominent lineaments proposed on the maps. No disturbance attributable to faulting was seen in the several ash layers revealed, including the S-layer from Askja which is 11,200 years old. The investigation shows that many of the faults shown there are without basis and these findings indicate that most previous maps showing faults at or near the site seem to be based on rather meagre field work and. [64]

5.2.2 Volcanic risk

Volcanic activity in Iceland occurs in distinct volcanic systems associated with the spreading zone (see Figure 17). The Northern Volcanic Zone is characterized by large swarms of N-S fissures and faults which pass through a central volcano, forming together a volcanic system. These systems are 3-10 km wide and extend to over 100km arranged en-echelon parallel to the NVZ. Volcanic activity and rifting occurs en episodes which may last a few years. In the last 400 years, such episodes have occurred about once per century in the northern part of the NVZ and always involved rifting. The latest activity was the Krafla fires 1975-1984, a series of fissure eruptions in the Krafla volcanic system which has been the most active system north of Askja for the past 3000 years. A similar episode occurred in the Krafla system 250 years earlier (The Mývatn fires 1724-1729) and before that about 1000 years ago. Another event is not considered likely in the next 100-200 years.

The last volcanic activity in the Þeistareykir system occurred about 2500 years ago and renewed activity there is considered very unlikely in the near future. The possibility of a recurrent dyke injection is more likely in the distant future which in the long term is beneficial as these are the heat

[62] (Halldórsson, 2005)
[63] (Sigbjörnsson & Snæbjörnsson, 2007)
[64] (Sæmundsson & Karson, 2006), (Mannvit hf., 2010 a, p. 180)

source for geothermal energy. Bakki and Húsavík are located outside of the volcanic zone and risk from volcanic eruptions there is minimal. [65]

5.3 Sea ice

Shipping routes along the coast of Iceland are generally safe and without difficulties. Sea ice at the coasts of Iceland is a very irregular incident in certain conditions it enters Icelandic waters and at times enough cause difficulties. There have been instances when sea Ice has approached Icelandic shores directly from the north in prolonged northern winds, but this is rare as the ice is usually quite far north of Iceland. When ice approaches it is usually carried into the Icelandic Sea from Denmark Strait when prevailing westerly winds have been long standing.

Three main factors determine whether this happens and to what extent; the amount of sea ice carried into Denmark Strait from the north with the East Greenland Current, prevailing wind due to atmospheric circulation in the northern hemisphere and oceanographic conditions in the Iceland sea. [66] As the amount of sea ice in Denmark Strait is most during the spring, sea ice conditions in Icelandic waters are most common in May. [67] Off the coast north of Iceland, warm and saline sea from the Atlantic Ocean meets with cold polar sea low in salinity. Fluctuations in the mean temperature of the ocean are greater where these currents meet that elsewhere around the Icelandic coast and the longevity of sea ice is affected by both temperature and the salinity of the seawater. [68]

The Icelandic Meteorological Office oversees monitoring of ice in Icelandic waters and issues warnings when necessary. Sea ice is monitored by regular flights and information is also gathered from observations by the Icelandic Coast Guard and other vessels. Ice data is also gathered from nearby regions monitored by other countries. As of December 2011, IMO gets automatic sea ice reports from the Maritime Alert Centre[69] which handles emergency telecommunication, automatic ship reporting duty and general radio communications with ships and boats. The information is immediately posted on line by IMO staff on 24hr watch. When necessary, IMO meteorologists will generate charts and predictions of how the ice will drift. [70]

In order to make year to year comparisons on Icelandic sea ice data from various sources, an index was developed in the 1940's by the Danish scientist Lauge Koch and used to present graphically sea ice conditions around Iceland from the first ages of settlement until 1939. Though not clearly defined in his work, a version of the Koch index has since been applied later years. The index value represents the number of weeks in which sea ice is observed near Iceland. The coastline is divided into ten parts, the number of "ice days" in each recorded and the index value then calculated. [71]

The graph in Figure 19 represents sea ice weeks around Iceland from 1880 to 1984. It should be noted that the values refer to the entire country. Most ice days are in the area around Hornstrandir

[65] (Björnsson, Sæmundsson, Sigmundsson, Halldórsson, Sigurbjörnsson, & Snæbjörnsson, 2007), (Mannvit hf., 2010 a, p. 178) (HRV Engineering, 2010, p. 108), (HRV Engineering, 2006)
[66] (Jakobsson, 2006)
[67] (Jakobsson, Sigurðsson, Ármannsdóttir, & Gylfadóttir, 2002, p. 4)
[68] (Guðmundsson, et al., 2000, p. 16), (Björnsson, et al., 2008)
[69] http://www.112.is/english/maritime-/
[70] From IMP website: (http://www.vedur.is/um-vi/frettir/nr/2430)
[71] (Wallevik & Sigurjónsson, 1998)

in the West fjords. There are fewer ice days along the north coast and ice is much less common east of Eyjafjörður than to the west of the fjord. It should also be noted that these are ice sightings which do not necessarily represent disturbance of sea travel. [72]

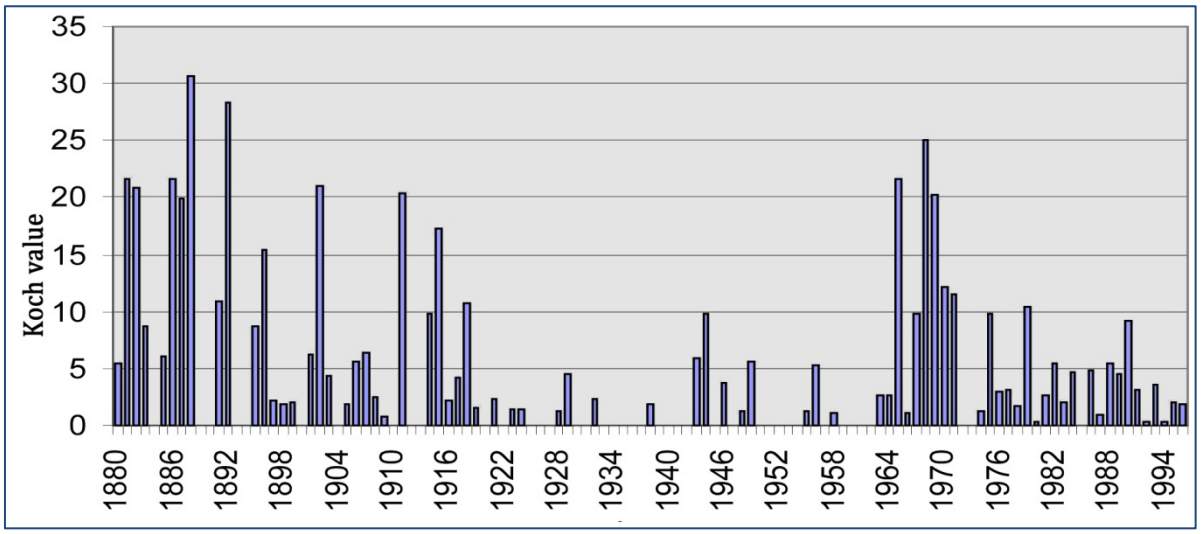

Figure 24: Koch index for sea ice around Iceland 1880-1996

Satellite records of sea ice extent are relatively constant from 1978. Since then, the annual mean extent of arctic sea ice has declined at the rate of 2.7 ±0.6% per decade. The change is even more drastic for summer ice which has declined at the rate of 7.4 ± 2.4% per decade since 1979. This is consistent with data from other sources on sea ice extent.[73]

The intergovernmental Panel on Climate Change (IPCC) has developed scenarios for climate change in the 21st century based on varying premises. Even when given that greenhouse gas emissions will remain unchanged from their level in the year 2000, mean temperatures are expected to rise during this century. Scientists therefore conclude that extent of arctic sea ice will continue to decrease and that by the end of the century sea ice coverage will be seasonal in large parts of the Arctic Ocean. [74]

Despite indications for rising mean temperatures throughout this century, surface temperature is known to fluctuate in relation to the so called North Atlantic Oscillation. This phenomenon describes the negative correlation between atmospheric pressure around Iceland on one hand and the Azores on the other. When atmospheric pressure is unusually high in Iceland it tends to be relatively low in around the Azores and vice versa. The pressure difference determines the strength of prevailing westerly winds between the two places and thus has a considerable impact on climate. An index based on the average pressure difference determines whether the NAO is positive (above average) or negative (below average). [75]

[72] (Jakobsson, Sigurðsson, Ármannsdóttir, & Gylfadóttir, 2002, pp. 10-13)
[73] (Lemke, et al., 2007, pp. 351-376)
[74] (Björnsson, et al., 2008, p. 21)
[75] (Jónsson, 2010)

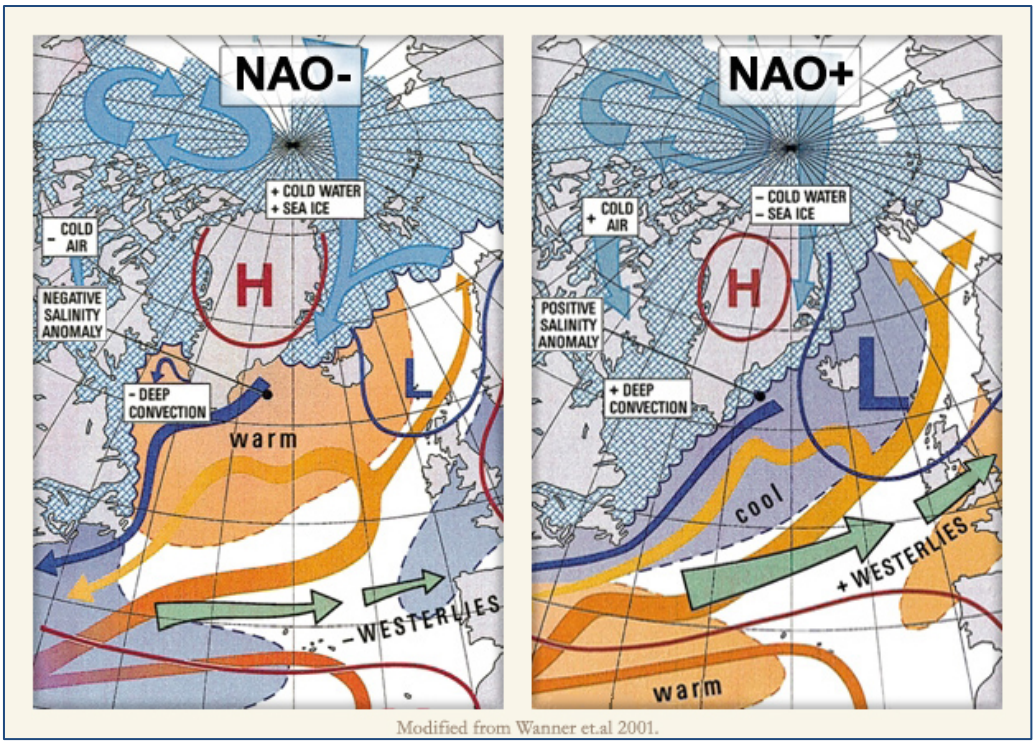

Figure 25: NAO effects on climate in the North Atlantic region

On a decadal scale, there is a correlation between the NAO index and sea ice conditions. When the index is low (NAO-) conditions are better for sea ice near Iceland. When the index is high (NAO+), more ice is produced in the Arctic but it passes more freely south along the eastern shore of Greenland and is less likely to drift eastwards. [76]

In 2007, a risk assessment for sea ice along Northern Iceland was conducted in connection with a potential aluminium smelter at Bakki. In a 50 year worst case scenario prediction, conditions are not expected to become worse than in 1968 which is the worst sea ice year on record since 1888. That year, shipping to Húsavík was blocked or difficult 45 days out of the year. Based on climate development, sea ice years are expected to be fewer than they were in the 20th century and in the long term it is considered unlikely that sea ice conditions like to those experienced in the 19th century will reoccur in the next 200 years. The probability of worst case conditions, in which both the eastern and western shipping routes to Húsavík are blocked simultaneously, is considered once in a century and that year the harbour could be closed for up to 50 days. [77]

5.4 Further reading

Aluminum Plant in North Iceland - Site comparison study (HRV Engineering, 2006)

Meteorological Data Centre (*Gagnatorg veðurupplýsinga*) (RIV, 2011) – Icelandic

Publication by the Icelandic Meteorological Office: http://en.vedur.is/about-imo/publications/ and http://www.vedur.is/um-vi/utgafa/ (in Icelandic)

Aluminum Plant in North Iceland - Site comparison study - Air dispersion calculations (Kjaran & Myer, 2005)

[76] (Wanner, et al., 2001)
[77] (Gorman, Zagon, & Jónsson, 2007)

Bjarnarflagsvirkjun og Bjarnarflagslína – Mat á umhverfisáhrifum (Hönnun, 2003) – (in Icelandic)

Assessment of geo-hazards affecting energy production and transmission systems emphasizing structural design criteria and mitigation of risk (Björnsson, Sæmundsson, Sigmundsson, Halldórsson, Sigurbjörnsson, & Snæbjörnsson, 2007)

Húsavík – Jarðgrunnskönnun (Hönnun, 2002) – (in Icelandic)

Jarðfræðin á Þeistareykjum (Sæmundsson, 2007) – (in Icelandic)

First results from the North Iceland Experiment (Riedel, et al., 2006)

Interactions between magmatizm and tectonics in Iceland: a review (Dauteuil & Bergerat, 2005)

Dynamics of Volcanic Systems in Iceland (Guðmundsson Á. , Dynamics of Volcanic Systems in Iceland: Example of Tectonism and Volcanism at Juxtaposed Hot Spot and Mid-Ocean Ridge Systems, 2000)

Plate boundaries, rifts and transforms in Iceland (Einarsson, Plate boundaries, rifts and transforms in Iceland, 2008)

Present day geodynamics in Iceland monitored by a permanent network (Völksen, Árnadóttir, Geirsson, & Valsson, 2009)

Immature and mature transform zones near a hot spot: The South Iceland Seismic Zone and the Tjörnes Fracture Zone (Iceland) (Bergerat & Angelier, 2008)

Recent and present-day tectonics near a hot spot: the transform zones of Iceland (Bergerat, Angelier, Homberg, Garcia, Verrier, & Bellou, 2010)

Tectonic analysis of an oceanic transform fault zone based on fault-slip data and earthquake focal mechanisms: the Húsavík–Flatey Fault zone, Iceland (Garcia, Angelier, Bergerat, & Homberg, 2002)

Infrastructure and evolution of ocean-ridge discontinuities in Iceland (Guðmundsson Á. , 2007)

Seismotectonic analysis of the Tjörnes Fracture Zone, an active transform fault in north Iceland (Rögnvaldsson, Guðmundsson, & Slunga, 1998)

Rift-transform junction in North Iceland: rigid blocks and narrow accommodation zones revealed by GPS 1997–1999–2002 (Jouanne, Villemin, Berger, & Henriot, 2006)

Future abrupt reductions in the summer Arctic sea ice (Holland, Bitz, & Tremblay, 2006)

Maritime Alert Centre – website: http://www.112.is/english/maritime-/

Icelandic Coast Guard – website: http://www.lhg.is/english

6 Construction logistics

6.1 Building materials

Most general building material will need to be imported and, unless shipped directly to Húsavík, transported domestically by trucks.

Concrete aggregate for foundation base may be processed at Bakki site as crushed bedrock and obtained from mining sites in the vicinity. The closest mining sites identified in the municipal plan for Norðurþing are Krókalág (4.9 km) Katlar (6.6 km) and Skógargerðismelur (4.1 km). These three sites are expected to yield over 500,000 m^2 of concrete aggregate.

The feasible mining site for cement aggregate is probably at mining sites by Skjálfandafljót river (about 29 km) which should have sufficient volume for all cement work at the construction site. The aggregate for cement could potentially be obtained at other nearby sites. Yet another option is shipping it from more distant locations as was done when Alcoa built the Fjarðaál smelter in Reyðarfjörður and imported the aggregate. That decision will be made on basis of feasibility studies when the time comes.

6.2 Building and development permits

Building and development permits for the industrial site at Bakki will be issued by Norðurþing on the basis of its municipal plan. The industrial site at Bakki has been sufficiently defined in the current municipal plan for 2010-2030. A local development plan will subsequently have to be made with regards to the particular development proposed at the site.

Permits for buildings and other structures are issued by the municipal building officer on basis of the Icelandic Construction Act no. 160/2010, the Building Regulation no. 112/201 and adopted local plans. Also taken into consideration are other laws and regulations which may apply.

According to the Icelandic planning act no. 123/2010, a development permit is required for substantial development projects (which are not subject to a building permit) which have an effect on the environment and alter its appearance. Before issuing development permits, the municipal council determines whether the project is in accordance with adopted development plans. The municipal council must also obtain references from appropriate parties, as determined by the case at hand, before issuing development permits. More detailed stipulations regarding development permits are due in a special regulation which has not yet been published.

6.3 Further reading

The Icelandic Construction Act (*Lög um mannvirki*) no. 160/2010 – (in Icelandic)
http://www.stjornartidindi.is/Advert.aspx?ID=8a6e018b-acbe-4294-8ea0-784aa30ab5c9

Icelandic Planning Act (*Skipulagslög*) no. 13/2010 – (in Icelandic)
http://www.althingi.is/lagas/nuna/2010123.html

Translation of the now abolished Planning and Building Act No. 73/1997 w. amendments No. 135/1997 and 58/1999
http://www.skipulagsstofnun.is/media/skipulagsmal/Planning-and-Building-Act.PDF

Building Regulation no. 112 /2012 – (in Icelandic)
http://stjornartidindi.is/Advert.aspx?ID=6456f377-e3d0-4e10-b504-1c48449e0f83

7 Transportation

7.1 Shipping

Húsavík harbour area can be divided into three main areas on basis of its use. The north harbour is defined as a transportation harbour. The central harbour area is designated for mixed use of tourism and fishing related activity. The south harbour is designated for fisheries and related industry.

The north harbour has two piers, Norðurgarður which has a 120 m quay with 8 m depth and Bökugarður which has a 135 m quay with 10 m depth. Transportation through the harbour in 2010 amounted to 7 freight ships with a total of 5,600 tonnes of freight and 4 cruise ship arrivals.

Activity in the central harbour area has increased considerably in recent years with rapidly increasing whale watching and other maritime tourism. An estimated 50 thousand people went whale watching from Húsavík in 2011. The whale watching season starts in late April and lasts into October. The central harbour area also serves as docking for fishing boats.

The south harbour is where most of the fisheries industry is located and where the bulk of the fishing catch is brought to dock. About 30 fishing vessels are registered in Húsavík and the total catch brought to harbour in 2011 was nearly 6,500 tonnes. Two fish processing companies located in the south harbour process approximately 6-7 thousand tonnes annually.

Possibilities for expanding harbour structures and a road connection between the harbour and the industrial area at Bakki are now being explored by the municipality in collaboration with the Icelandic Maritime Administration and the Icelandic Road Administration. The objective of that work is to develop the harbour and other relevant areas in accordance with the needs of companies interested in industrial development in the area.

Expansion possibilities for the harbour have been proposed where Bökugarður quay is extended up to 200 m, depth increased to 12 m and manoeuvring area added. Norðurgarður quay could also be extended to 125 m and depth increased to 10 m. With this expansion, Bökugarður could accommodate bulk ships up to 200 m long and 40,000 DWT. Norðurgarður could then accommodate container ships up to 10,000 DWT. These expansion possibilities are illustrated in Figure 26.

It is proposed that the road connection between the harbour and Bakki industrial site will be defined as part of the designated industrial area and closed to general traffic. Different options are being explored for the road connection, including an underground tunnel for part of the road. This would minimise environmental impact and considerably reduce the road's gradient, thereby reducing transportation costs. The proposed layout of the tunnel is shown in Figure 27. The figure also displays the proposed new pier Snásugarður which has been designed and model tested by the Icelandic Maritime Administration and is included in the municipal plan for Norðurþing as mentioned in chapter 2.4.

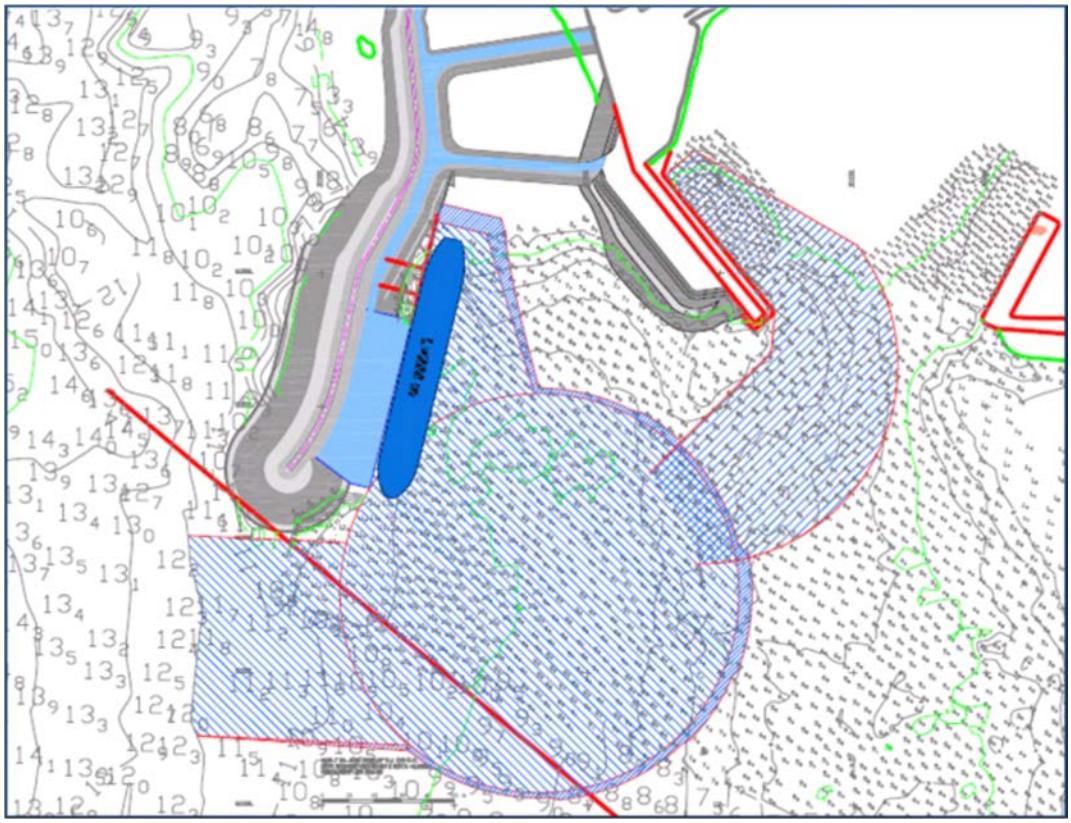

Figure 26: Expansion possibilities for the current harbour in Húsavík

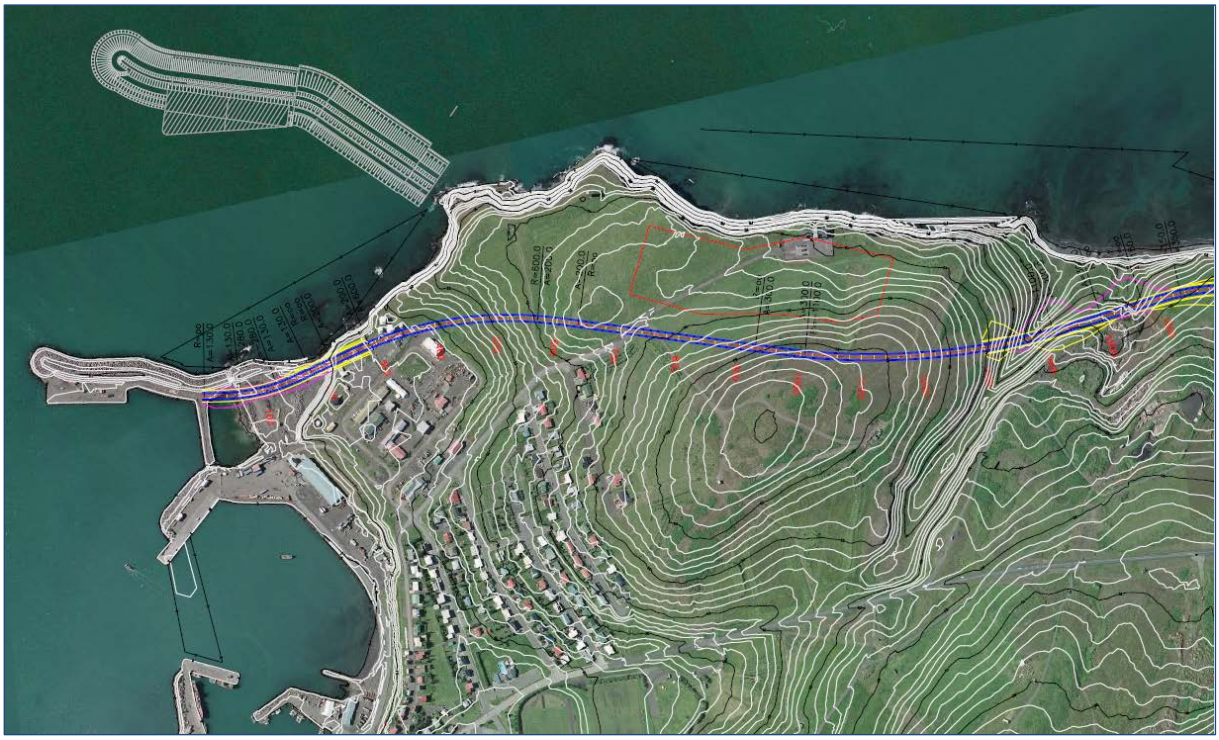

Figure 27: Proposed layout of a road tunnel between Húsavík harbour and Bakki site

7.2 Road transportation

Húsavík is located on road no. 85 which connects with ring road no. 1 in Ljósavatnsskarð pass, 45 km east of Akureyri. The road connection between Húsavík and Akureyri is paved with asphalt stabilized

gravel and is part of the primary road system (see Figure 28). It is of types C10 and C8 (as defined by the Icelandic Road Administration) which refers to a two way single lane road with shoulders, 10 m and 8 m wide respectively. [78]

Húsavík- Reykjavík	479 km
Húsavík- Akureyri	91 km
Húsavík- Egilsstaðir	219 km
Húsavík- Reyðarfjörður	252 km

Table 7: Some key distances from Húsavík

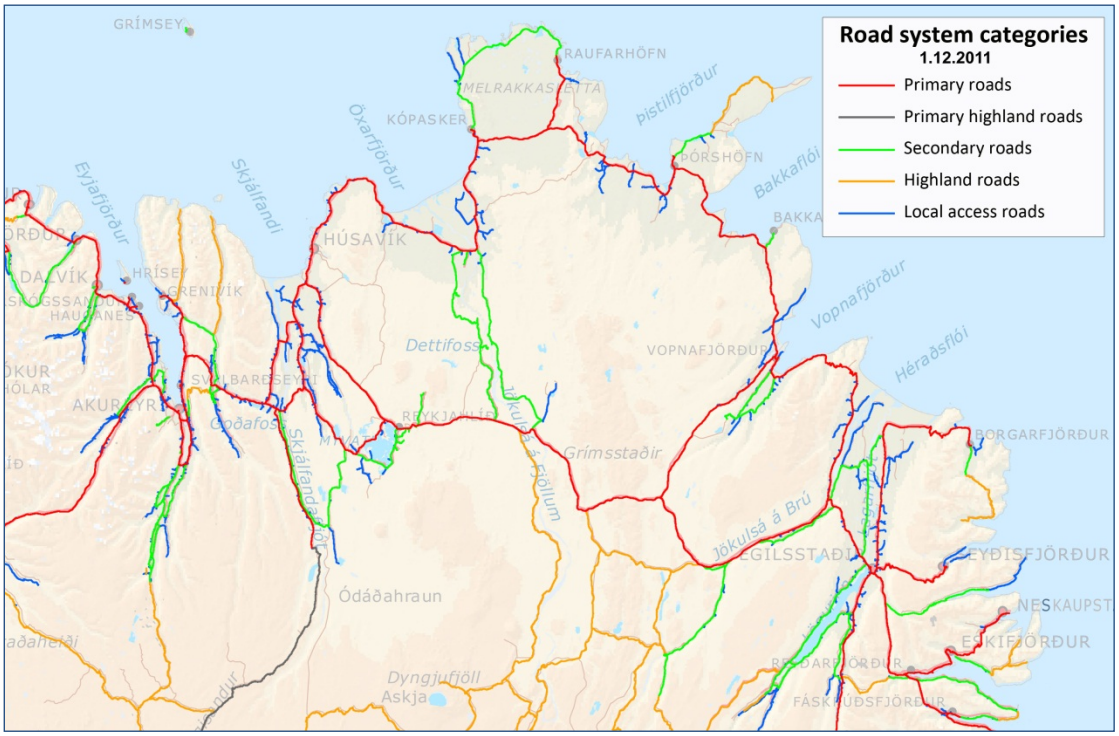

Figure 28: The road system in Northeast Iceland (www.vegagerdin.is)

According to the Icelandic Road Administration's winter service schedule, the road to Akureyri and onwards to Reykjavík is ploughed every day of the week. The same applies to the road from Húsavík to Mývatn by way of Aðaldalur (no. 85, 869 and 1). The road east from Húsavík to Kópasker, Raufarhöfn and Þórshöfn (no.85, 870 and 874) are ploughed every day except Saturday. Other roads in the region have less service as illustrated in Figure 29. [79] More information, including a detailed handbook published by the Road Administration, is available (in Icelandic) on their website. [80]

[78] See http://www.vegagerdin.is/vegakerfid/vegtegundir/ and http://www.vegagerdin.is/vegakerfid/vegaskra/
[79] www.vegagerdin.is
[80] (Vegagerðin, 2011)

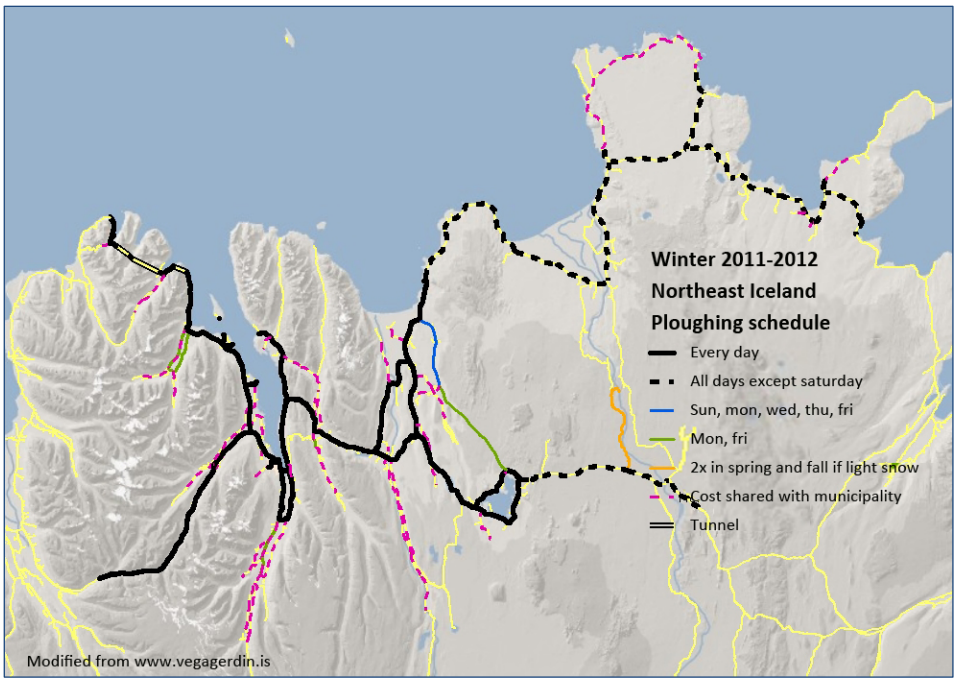

Figure 29: Winter road service in Northeast Iceland

The weakest link in the regional road system, with regards to production industry, is a single lane bridge with insufficient carrying capacity across Skjálfandafljót river on road no. 85. All heavy goods transportation must currently cross over Fljótsheiði heath which increases both distance and elevation and consequently transportation cost. Ring road no.1 also has single lane bridges crossing the rivers Skjálfandafljót and Jökulsá á Fjöllum. Among unfinished but urgent road construction in the region are primary road no.87, where 11 km need to be rebuilt and paved, and also the completion of road no. 862 from Dettifoss to road no. 85 near Ásbyrgi in Kelduhverfi.

Among goals set out in the proposed National Transport Plan 2011-2022, which has been submitted to the Icelandic parliament (*Alþingi*), are building a primary road network with full carrying capacity and paved surface and to abolish single lane bridges on roads where traffic exceeds 200 AADT.[81]

In light of this goal, it is disappointing that construction on road no.85 by river Skjálfandafljót (where AADT was 468 cars in 2010)[82] is not scheduled in the National Transport Plan until in the third phase (2019-2020), and will not even be completed in the plan's duration. The planned construction will shorten the distance between Húsavík and Akureyri by 3 km. [83] Preparations by the company *Greið Leið ehf* are also underway for drilling a road tunnel through Vaðlaheiði heath. The proposed tunnel will shorten ring road no.1 by 16 km, and is expected to be ready for traffic in 2015 according the company's plans.[84] The two projects combined will shorten the distance between Húsavík and Akureyri by 19 km, down to a total of 72 km which also will be entirely on lowland.

The National Transport Plan does not include any construction on primary road no.87 (AADT 238), which must be regarded as unacceptable in light of the aforementioned goal. It would seem that this road should have a higher priority as it connects the main development areas involved in the

[81] (Alþingi, 2011, p. 167) AADT or Annual Average Daily Traffic is the average daily traffic in a given year.
[82] (Vegagerðin, umferðardeild, 2010)
[83] (Alþingi, 2011, p. 20 og 182)
[84] http://www.visir.is/laegsta-tilbod-eykur-likur-a-vadlaheidargongum/article/2011111019755

industrial development in Northeast Iceland. Being the connection between Mývatn and the harbour in Húsavík, improvements on road no. 87 is a prerequisite to locating any industrial production near the power plants in that area.

Scheduled for the second phase of the plan are the completion of road no.862 from Dettifoss to road no.85 and reconstruction of the single lane bridges crossing rivers Skjálfandafljót and Jökulsá á Fjöllum on ring road no.1. [85]

SBA Norðurleið has a daily bus schedule between Húsavík and Akureyri with 2-4 trips on weekdays and 1 trip on weekends. Buses also run three times per week between Akureyri and Þórshöfn with stops in Húsavík, Kópasker and Raufarhöfn. [86]

Two leading transport companies in Iceland, Eimskip-Flytjandi and Landflutningar-Samskip have daily weekday schedule between Húsavík and Reykjavík and east to Þórshöfn and Vopnafjörður. [87]

7.3 Air transport

Húsavík airport is located in Aðaldalur 10 km south of the town. The 1,605 m long runway and ramp are paved with asphalt stabilized gravel. The airport has a spacious and fairly recent terminal building as well as a storage building. Runway approach is excellent and unimpeded by geographical features unlike many Icelandic airports.

Scheduled flights between Húsavík and Reykjavík were discontinued in 2000. While the airport was in operation it offered all basic flight services and a recent study by Northeast Iceland Development Agency concludes that it re-establishing these services should not be difficult. [88] Flights between Húsavík and Reykjavík will be re-established by the Icelandic company Eagle Air as of April 15th, 2012 with 7 scheduled flights per week. [89]

Akureyri airport has a 2,400 m long runway and a 150 m safety area at each end. The airport serves for both domestic and international air traffic. Numerous daily flights are scheduled between Akureyri and Reykjavík year round. [90]

7.4 Further reading

Húsavíkurflugvöllur í Aðaldal – A report on Húsavík airport (in Icelandic)
http://www.atthing.is/wp-content/uploads/2011/12/Husavikurflugvollur-EdgeOfTheArctic-final_.pdf

Millilandaflug til Norðurlands – A study on international flights to North Iceland submitted as a final paper at Keilir Aviation Academy by Friðrik Sigurðsson:
http://www.atthing.is/wp-content/uploads/2011/12/Lokaritger%C3%B0-Flugrekstrarfr%C3%A6%C3%B0i_763420269.pdf

National Transport Plan 2011-2022 (Icelandic): http://www.althingi.is/altext/140/s/pdf/0534.pdf

[85] (Alþingi, 2011, p. 181 og 185)
[86] See http://www.english.sba.is/Scheduledbusservice/
[87] See (in Icelandic): http://www.landflutningar.is/aaetlanir/ and http://eimskip.is/IS/Eimskipnnanlands/flytjandi/flutningathjonusta/%C3%81%C3%A6tlanaflutningar/default.html
[88] Based on (Atvinnuþróunarfélag Þingeyinga, 2011)
[89] See http://www.eagleair.is/schedule/husavik/
[90] See (in Icelandic): http://www.akureyri.is/is/ibuagatt/frettir/lenging-akureyrarflugvallar

8 Labour market

8.1 Commuting regions

Commuting regions have no single conclusive definition. In the UK, for example, Travel to Work Areas (TTWA) are defined as a regions where "of the resident economically active population, at least 75% actually work in the area, and also, that of everyone working in the area, at least 75% actually live in the area". [91]

Regional Development Agencies in Iceland in collaboration with The Icelandic Regional Development Institute have analysed and defined urban commuting regions as areas where people travel between home and workplace at least once on a daily basis. According to this definition, the commuting region of Húsavík reaches to Ljósavatnsskarð pass in the west, Mývatn region in the south and as far as Kelduhverfi in the east. This area conforms fairly well to what was defined as the near region for this report in chapter 1.1.

Other commuting regions in the study area (as seen in Figure 30) are the Akureyri region (12), which covers Eyjarfjörður and reaches to Ólafsfjörður in the north and southwest into Hörgárdalur, the Kópasker region (14) which reaches from Ásbyrgi to Leirhöfn, Raufarhöfn region (15) which covers the village's immediate vicinity and Þórshöfn region (16) which reaches from Langanes to Rauðanes point in Þistilfjörður bay.

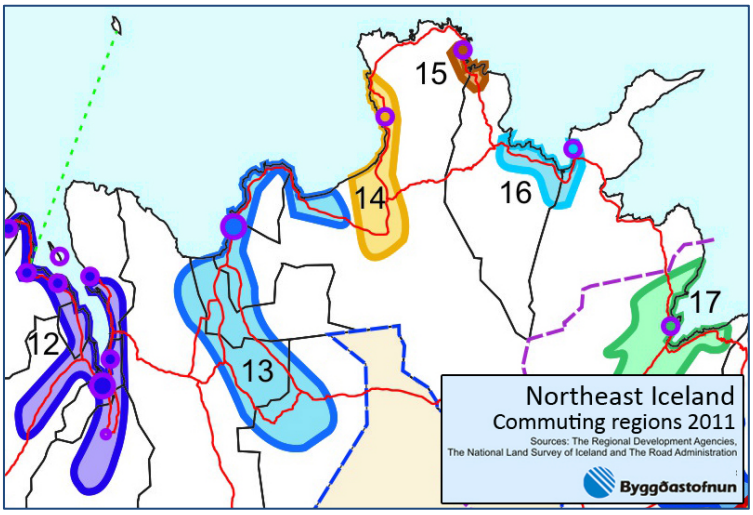

Figure 30: Commuting regions in Northeast Iceland (modified from www.byggdastofnun.is)

8.2 Labour force

The labour force is considered to consist of employed and unemployed persons[92]. Activity rate is the ratio of the labour force to the total population of working age (16-74 yrs.). [93] Activity rate is not available on regional basis from Iceland Statistics but can be distinguished between the capital area on one hand and the rest of the country on the other hand. This distinction does not show much difference in activity rate but more difference is revealed when activity rate is distinguished by age and gender. According to the data, activity rate outside the capital area was around 81% in 2008-

[91] http://en.wikipedia.org/wiki/Travel_to_Work_Area
[92] For further metadata on the labour force survey see:
http://www.statice.is/pages/1786/?src=../../vorulysingar_en/v_transporter.asp?filename=V00611.htm
[93] (Hagstofa Íslands, 2011 c)

2011. For the purpose of this study, the size of the regional labour force is estimated by applying the above activity rate to the regional populations of working age (16-74 yrs.). Using this method, the labour force amounts to about 56% of the total national population. [94]

Population of the study area on January 1, 2011 was 24,152, which constitutes a fairly large labour market on an Icelandic scale, in fact the largest outside the capital area. Of the total population, 16,922 people were of working age (16-74 yrs.). Given the above activity rate, the labour force can be estimated at 13,700 in the study area.

In the near region, which largely corresponds to the Húsavík commuting region, the population was 3,977 on January 1, 2011. The working age population (16-74 yrs.) was 2,852, which indicates a labour force of around 2,300.

On January 1, 2011, the total population of the Akureyri region was 19,249 of which 13,419 were of working age, which indicates a labour force of about 10,900. In the Northeast corner, the total population was 926 of which 651 were of working age giving an estimated labour force of about 530.

8.3 Economic activity

Data on employment rate is not available by regions and smaller areas from Statistics Iceland. Data is, however, distinguished between the capital area and the rest of the country. [95] According to Statistics Iceland, the number of persons employed outside the capital area in 2010 was 59,800. Of them 14.2% worked in agriculture and fishing, 24.7% in industrial jobs and 61.1% in services. [96]

In an annual employment survey conducted by Northeast Iceland Development Agency, data is gathered on the number of employees and full time positions with regional businesses for both winter and summer seasons. Weighing out seasonal differences, the survey shows a monthly mean of 1,764 employed in the Húsavík near region in 2010, which amounts to 77% of the estimated labour force. Their distribution between business sectors was that 17% worked in agriculture and fishing,[97] 21% in industry and 62% in services. [98]

The low ratio of people employed in the industrial sector and high ratio in agriculture provide certain opportunities for industrial development. On one hand, there exists a relatively large service sector which has surplus capacity and on the other hand there are indications of hidden unemployment within the agricultural sector which might comply with demands for shift work in industry.

8.4 Age and gender ratios

As seen in chapter 1.1, mean age of the population in the Húsavík near region is somewhat higher than for the national population. This is largely explained by lack of young people in the age group 25-40 and consequently the age group most active on the labour market (25-54 yrs.) is relatively

[94] This method gives a slightly lower ratio than that used by (Jóhannesson, Ólafsson, Heiðarsson, & Sigurbjarnarson, 2009) which results in the labour force being 58% of the total population.
[95] The capital area is defined as including the municipalities of Reykjavík, Seltjarnarnes, Kópavogur, Hafnarfjörður, Garðarbær, Mosfellsbær, Álftanes and Kjósahreppur.
[96] www.hagstofa.is
[97] This ratio is higher than the average outside the capital area due to high ratio in agriculture in the region, 15% compared with 7.3% for the total area outside the capital.
[98] The data from Northeast Iceland Development Agency is obtained by different methods than those used by Iceland Statistics and comparisons should be viewed with that in mind.

smaller in the Húsavík near region than the national average. The youngest age group (16-24 yrs.) is quite similar to the national average and the oldest group (55-74 yrs.) is somewhat bigger. Figure 31 shows age and gender ratios for people of working age in the near region compared with the national population. [99]

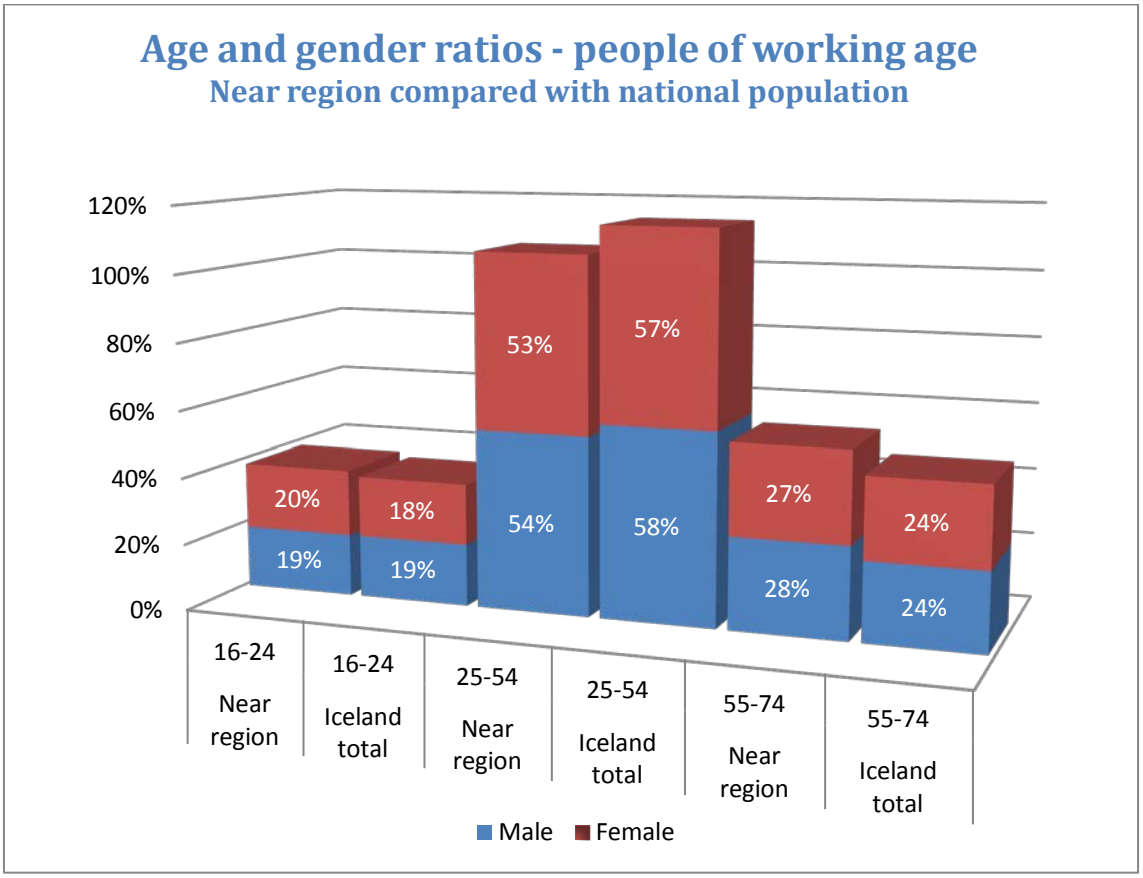

Figure 31: Age and gender ratio for working age in near region compared with national population

On January 1, 2011 the total population of working age (16-74 yrs.) in the study area consisted of 8,644 men and 8,456 women. The working age population in the near region was 1,456 men and 1,396 women. In the Akureyri region the working age population consisted of 6,653 men and 6,766 women and in the Northeast corner 357 men and 294 women.

Gender distribution in the study area is very even and quite close to the national average where men constitute 50.6% of the working age population. The Húsavík region has slightly more men than women but deviates less than 1% from the national ratio. The Akureyri region has a slightly higher ratio of women than the national average while the male population in the Northeast corner is quite a bit higher than average or 54.84%. Figure 32 shows the gender ratio for working age population in the study area and its individual regions as well as the national population. [100]

[99] Based on data from Statistics Iceland, www.statice.is
[100] Based on data from Statistics Iceland, www.statice.is/

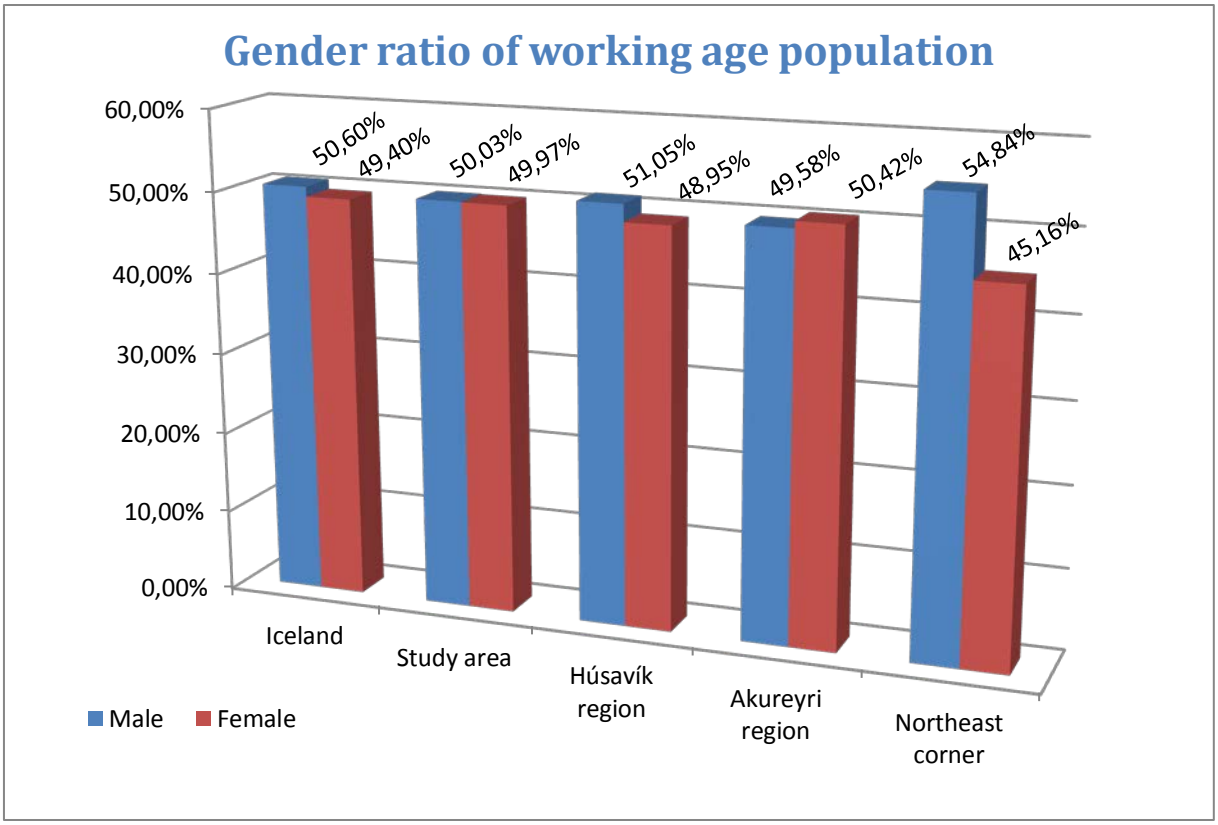

Figure 32: Gender ratio of working age population for individual regions

Data on gender ratios within business sectors is not available for individual regions but according to Iceland Statistics 82.5% of women employed outside the capital area worked in the services sector compared with 43.9% of men. The gender difference is relatively highest in public administration, education and health and social services. Of employed people outside the capital area 51.4% of women worked in these sectors compared with 17.1% of the men. [101]

It is evident that gender ratio of the working age population in the Húsavík region is in good balance and no apparent need for specific gender based actions. It is, however, important to maintain gender balance in new industrial development since the present service sector has surplus capacity and can therefore meet considerable population increase without equivalent increase in its labour force. This is particularly true for public administration.

8.5 Education

According to Statistics Iceland, the total labour force in Iceland in 2010 was 180.800, of which 35% had compulsory education (ISCED 1,2), 37% had upper secondary education (ISCED 3,4) and 28% had tertiary level education (ISCED 5,6). [102] Data on educational level is not available from public institutions but can sometimes be gleaned from miscellaneous studies. In a study conducted by The University of Akureyri Research Centre (RHA) on the social impacts of an aluminium plant in East Iceland 2002-2008, Northeast Iceland was within the study area. Though the findings should be interpreted with some reservation due to the small sample size, they do indicate some variation from the national ratio of educational level within the labour force. According to the study, 44% had

[101] Data from Statistics Iceland, www.statice.is/
[102] Based on data from (Statistics Iceland, 2012) – classification of Icelandic education is based on ISCED97.

completed the compulsory level, 30% upper secondary level and 26% tertiary level education. While no conclusive explanation is given, one contributing factor could be the age distribution. Educational level is generally higher among younger adults, which is the age group notably below national mean in this region. [103]

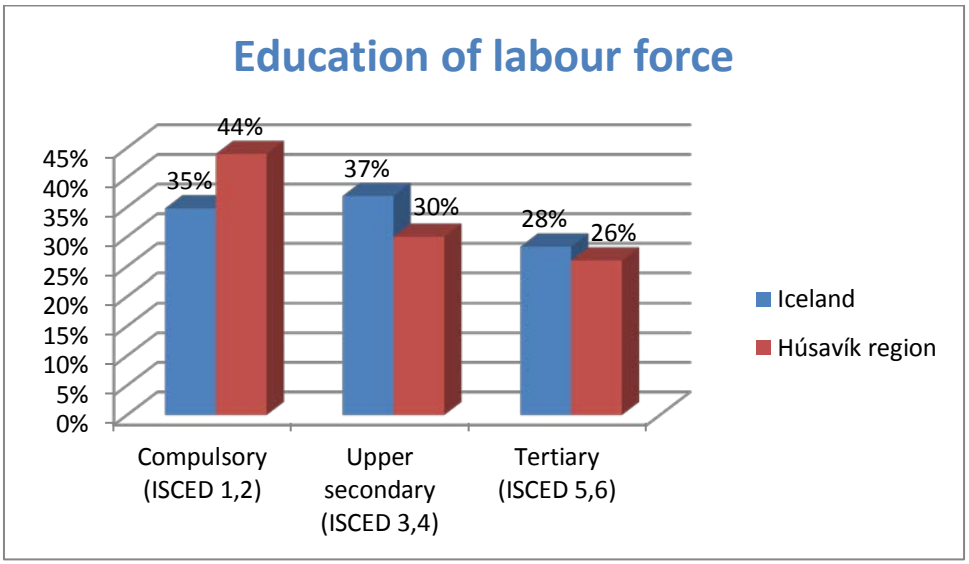

Figure 33: Educational level of national and regional labour force

One could reasonably surmise that the low ratio of persons with upper secondary education in the region reflects the current composition of the regional economy as there are not many industrial jobs which require specialized education. This can be seen as an opportunity for secondary schools in the region but it is also important to create job opportunities for people at this educational level. If this group of the regional population does not grow in numbers, it is hard to see how to reverse the negative population development and balance the skewed age distribution.

8.6 Labour market - status and outlook

Information on unemployment gathered by The Directorate of Labour is only available for larger areas of Iceland. It is evident from these data that since the collapse of the banking system in 2008, unemployment is generally higher in the southwest and capital area than in other parts of the country. Since beginning of 2010, unemployment rate has been lower in north eastern Iceland [104] than the average outside the capital area as is evident in Figure 34 which also shows that the rate of unemployment since 2009 has dropped most in north eastern Iceland. [105]

[103] See for example (Jóhannesson H. , 2010, p. 28)
[104] Note that north eastern Iceland here refers to a larger area than the subject area as defined in chapter 1.
[105] Information based on data from the Directorate of Labour website www.vmst.is. Figures for 2011 represent the first 11 months only.

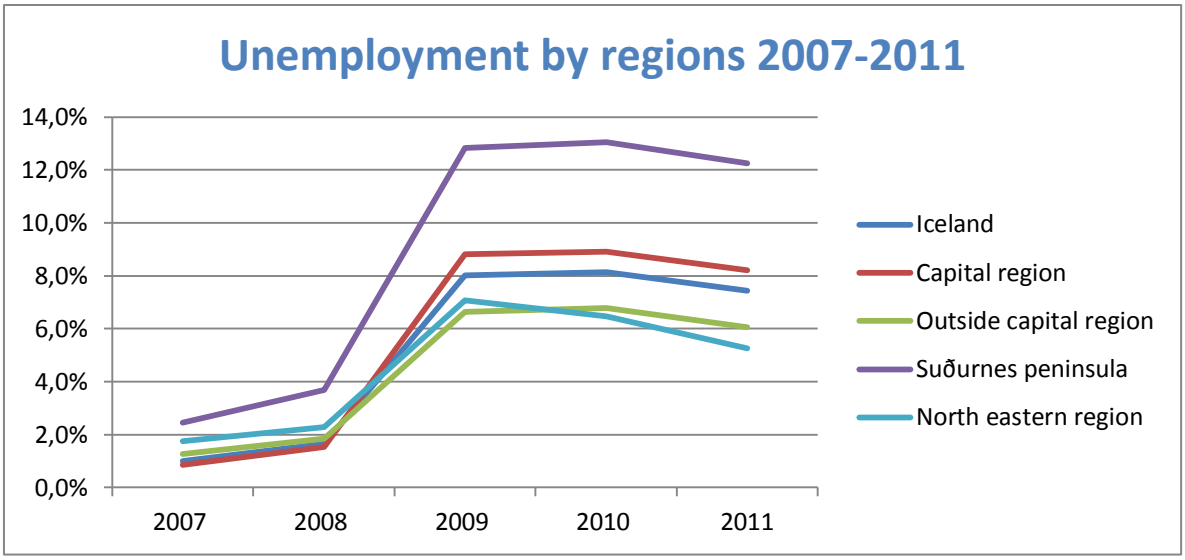

Figure 34: Unemployment by regions, 2007-2011

In order to acquire more detailed information for the subject area, and the near region in particular, an official at the Directorate of Labour was asked to calculate unemployment rate from available information of the number of unemployed at the end of each month for the period December 2010 to November 2011. As is evident in Figure 35, the unemployment rate for the region as a whole has gone down considerably in this twelve month period. The rate has remained lowest in the Húsavík region where the 12 month mean rate was 5.0% while it was 6.0% in the Akureyri region and 6.8% in the Northeast corner. Unemployment rate was higher among women than men in all three regions. In the Húsavík region it was 4.7% for men and 5.4% for women. In the Akureyri region it was 5.5% for men and 6.1% for women. The gender difference is greatest in the Northeast corner where it was 5.1% for men compared with 9.1% for women. [106]

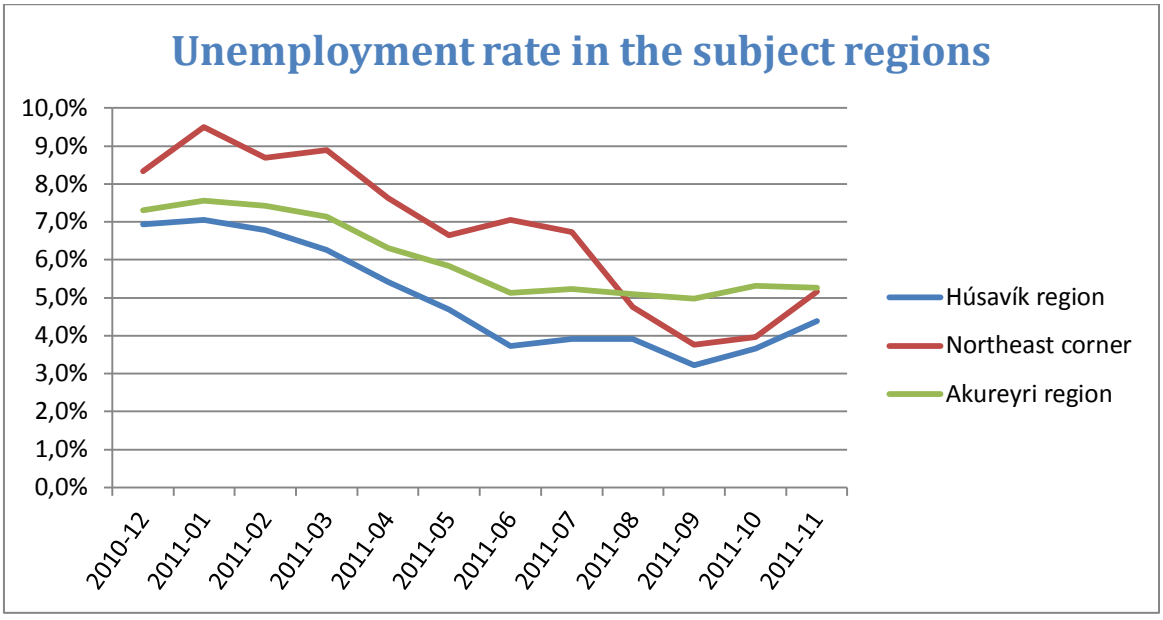

Figure 35: Unemployment rate in the subject regions

[106] Information based on unpublished data from the Directorate of Labour. To simplify calculations, end of month figures for unemployment were used rather than monthly mean values.

All things being equal, major changes in the regional economy are not foreseeable in the near future though some indicators point to increased number of jobs rather than a declining labour market. This will for the most part be determined by the national economy in general but on a regional basis there are also expectations for increase tourism in the near region and outlook is also good for fish farming and fish processing in the region.

Based on the status of the regional economy as described above, particularly for the near region, it is clear that job opportunities connected with new industrial development will to some degree draw labour from other sectors in the region (crowding out effect). The degree of this effect will be determined by the competitiveness of the new industry with regards to employee facilities, wages and benefits. Most of the new jobs will, however, be filled by migration of people who come to work in the new industry or fill crowded out jobs in existing sectors.

8.7 Further reading

Labour market statistics, 3rd quarter 2011: https://hagstofa.is/lisalib/getfile.aspx?ItemID=13068

Statistical yearbook of Iceland 2011 – Wages, income and labour market: www.statice.is/pages/2532

9 Services

9.1 Public administration

A variety of services run by the government are on par with the best in our part of the world. Iceland has two administrative levels, state and municipalities, which divide responsibilities for public projects and services. Generally, the miscellaneous local services are under municipal administration, e.g. pre-primary schools, primary and lower secondary schools [107], music schools, social services, services to the elderly, sanitary inspection, waste disposal, waterworks, sewerage, planning and building inspection. [108] Among services administered at the State level are upper secondary schools, universities, healthcare, law enforcement and pollution and environmental protection. All public services offered in Iceland are available within the subject region and at a higher level and variety than anywhere else outside the capital region.

9.1.1 Municipal administration

As previously mentioned in chapter 1, the subject area covers ten municipalities; Akureyri, Eyjafjarðarsveit, Svalbarðsstrandarhreppur, Grýtubakkahreppur, Þingeyjarsveit, Skútustaðahreppur, Norðurþing, Tjörneshreppur, Svalbarðshreppur and Langanesbyggð. Population and development level varies greatly among them. Tjörneshreppur has the smallest population with 57 residents while Akureyri is the most developed with a population of 17,500. Consequently, the level of service and administration is quite different from one municipality to another but through cooperation the municipalities strive to ensure access for all residents in the region in the most cost effective way.

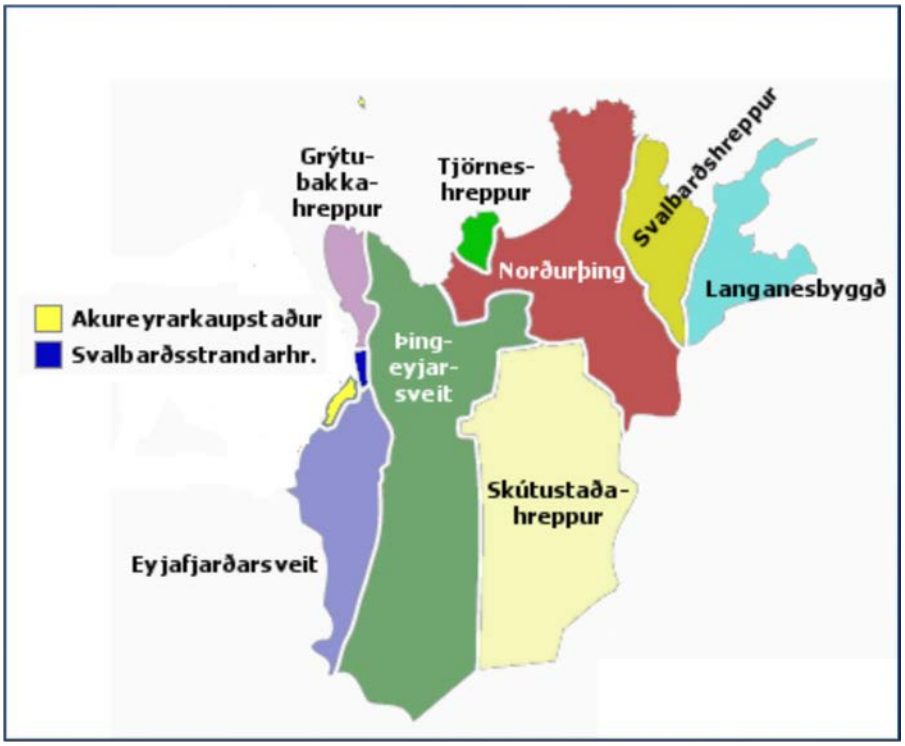

Figure 36: Municipalities in the subject region (www.innanrikisraduneyti.is)

[107] The Icelandic *grunnskóli* is a comprehensive single structure with 10 grades, compulsory for children age 6-15

[108] Responsibilities and authority of municipalities are defined in the Local Government Act, no. 138/2011 as well as in various special laws.

The near region includes four municipalities, Norðurþing (population 2,905), Skútustaðahreppur (386), Tjörneshreppur (57) and Þingeyjarsveit (944). Government of the municipalities is in the hands of municipal councils. They determine their own affairs within the framework of the Local Government Act and all have the same status and legal duties, regardless of population. The administration of the four municipalities in the near region varies greatly because of their disparate sizes. All except Tjörneshreppur employ a full time manager (or mayor) in addition to an organized, professionally staffed administration which handles fiscal management and other administrative duties. There is much cooperation between these four municipalities in the areas of education, social and elderly services, planning and building affairs, fire prevention and civil defence. [109]

9.1.2 Preschools and compulsory schools

For the purpose of this study and due to the local nature of this service, this chapter focuses mainly on schools in the near region and their ability to meet (at least temporarily) a sudden increase in students at these levels. Long term increase in students is also expected to have a greater affect in the near region.

The near region has five pre-primary schools or programs connected with the compulsory schools which combined can accommodate over 200 children. Norðurþing municipality also runs a pre-school program in Lundur (currently with 10 children) and in Kópasker (currently with 7 children). Both of these could triple their number of children without expanding their facilities. Lundur and Kópasker are just outside the defined near region, respectively 70 km and 100 km from Húsavík. [110] According to law, pre-primary schools are for children below the age of compulsory education (6-15). The law does not give a lower limit to the starting age which is usually determined by supply and demand. [111]

One preschool with seven departments is operated in Húsavík. The school, *Grænuvellir* had 138 children enrolled in autumn of 2011, the youngest in their second year. It is the policy of Norðurþing municipality to have preschool enrolment available to all children in the year they turn two years old. There is a short waiting list but it is apparent that an increase in enrolment beyond current development can not be accommodated without expanding facilities and increasing staff. Maximum capacity is 145 children at present but can vary somewhat as factors such as age composition, length of stay and special needs enter into how the number of children is calculated.

The preschool *Ylur*, operated in Skútustaðahreppur had 17 children enrolled in autumn of 2011. The youngest were one year old and current maximum capacity is 20 children.

Three preschool programs are operated in Þingeyjarsveit in connection with the compulsory schools. In the autumn of 2011 11 children were enrolled in *Tjarnarskjól* at Stórutjarnir school, 22 in *Barnaborg* at Hafralækur school and 16 children in *Krílabær* at Litlulaugar school. The youngest children accepted are around one year old.

[109] The level of cooperation varies on subjects matters and is part of formal cooperation between the six municipalities which form the Regional Committee of Þingeyjarsýsla (*Héraðsnefnd Þingeyinga*). They are: Þingeyjarsveit, Skútustaðahreppur, Norðurþing, Tjörneshreppur, Svalbarðshreppur and Langanesbyggð.
[110] Information on the pre-schools is based on conversations with their staff and directors as well as their websites unless cited otherwise.
[111] (Pre-primary School Act, 2008)

Table 8 gives an overview of preschools in the near region, their distance from Húsavík, current enrolment and potential capacity in present facility. The table displays a fairly good balance between current enrolment and capacity. Due to the nature of the service, demand is expected to increase mainly in Húsavík which is closest to Bakki industrial site. To accommodate the needs of an increased population following industrial development it is apparent that Norðurþing would soon have to build a new preschool.

Preschool	Distance from Húsavík (km.)	Number of children in autumn 2011	Maximum capacity without expansion	Unused capacity without expansion
Grænuvellir	-	138	145	7
Ylur	50	17	20	3
Tjarnarskjól	52	11	30	19
Barnaborg	22	22	22	0
Krílabær	39	16	16	0
Total		**204**	**233**	**29**

Table 8: Preschools in the near region (source: preschool directors)

Studies show that young people are more likely to migrate than older people. Assuming that the net increase in the population consist only of people under 54 years of age, around 11.5% of them would likely be at preschool age (0-5 yrs.) given the national age distribution. [112] The preschool capacity could therefore potentially need to increase by 11-12 children for every 100 immigrants to meet demand.

Five comprehensive compulsory schools with grades 1-10 for children aged 6-15 are operated in the near region; *Borgarhólsskóli* in Húsavík, *Hafralækjarskóli*, *Litlulaugaskóli* and *Stórutjarnarskóli* all in Þingeyjarsveit and *Reykjahlíðarskóli* in Skútustaðahreppur. A sixth school, *Öxarfjarðarskóli* operates in Lundur, just east of the defined near region. Students of compulsory school age residing in Tjörneshreppur have attended Hafralækjarskóli which is jointly operated by Þingeyjarsveit, Norðurþing and Tjörneshreppur. Thriving music schools are operated in connection with each of the schools. Sports facilities and swimming pools are also available to students for education and leisure.

Table 9 gives an overview of compulsory schools in the near region, their distance from Húsavík, current enrolment and potential capacity in present facility. As a result of greatly reduced number of students of compulsory school age in the near region, the schools have the capacity to meet an increase of almost 60% before having to expand facilities. In the two schools closest to Bakki alone, unused capacity in present facility is close to 160 students.

[112] Based on age distribution data from www.statice.is/Statistics/Population

Compulsory school (*Grunnskóli*)	Distance from Húsavík (km.)	Number of children in autumn 2011	Maximum capacity without expansion	Unused capacity without expansion
Borgarhólsskóli	-	304	400	96
Hafralækjarskóli	22	39	100	61
Litlulaugaskóli	39	26	70	44
Stórutjarnaskóli	52	48	80-100	32-52
Reykjahlíðarskóli	50	43	80	37
Öxarfjarðarskóli	70	40	60	20
Total		**500**	**790-810**	**290-310**

Table 9: Compulsory schools in the near region (Source: school directors)

Using the same premises about potential population increase as in the preschool discussion above, about 18% are likely to be of compulsory school age (6-15). Given the unused capacity, the school districts of Borgarhólsskóli and Hafralækjarskóli can accommodate a population growth of almost 900 before having to expand school facilities. [113]

9.1.3 Upper secondary schools

Two state run upper secondary schools operate within the near region. [114] Nearly 150 students are enrolled in the Húsavík Upper Secondary School (FSH), thereof 110 attend day school. FSH graduates 15-30 students annually with matriculation examination granting access to university or completing a vocational programme. Current school facility could accommodate double the current number of day school students. The school has open access and puts emphasis on serving the population of Þingeyjarsýsla County.

Of the national population aged 0-54 approximately 8% are of upper secondary school age (16-19) and using the same premises as before, the area could accommodate population increase of nearly 1,200 before having to expand school facilities.

Laugar Upper Secondary School (FL) is a boarding school with around 120 students from all across the country. The school offers a general study programme to prepare for tertiary education, a programme in tourism and a sports and fitness vocational programme. The school has the capacity to accommodate 15 additional boarding students and 30 additional day school students without expanding its facilities.

Akureyri has two large and established upper secondary schools. The Akureyri Junior College (MA) offers traditional academic education, has about 800 students and graduates approximately 150 students annually. Akureyri Comprehensive College (VMA) offers academic programmes as well as good facilities for various vocational programmes. Around 1,200 students attend the day school and an additional 800 are enrolled in evening and distance learning programmes. [115]

[113] Information on the compulsory schools is based on conversations with their staff and directors as well as their websites unless cited otherwise.
[114] Information on the upper secondary schools is based on conversations with their staff and directors as well as their websites unless cited otherwise.
[115] (Jóhannesson H. , 2010, p. 42)

An upper secondary programme is offered in Þórshöfn by Laugar Upper Secondary School in collaboration with Húsavík Academic Centre and Langanesbyggð municipality. The programme makes use of distance learning and local supervision.

9.1.4 Higher education

The University of Akureyri was established in 1987 and has grown rapidly since then. The university currently has about 1,500 students and a staff of nearly 200. The education is divided into the faculty of health sciences, faculty of business and science and the faculty of humanities and social sciences. Both basic studies and postgraduate studies are available and 12 study programmes within the three faculties are offered in the 2011-2012 academic year. The University of Akureyri has been very progressive in offering distance learning which is utilized by a large number of students. Research has also been advancing within the University, often in collaboration with other institutes located in the campus area. [116]

9.1.5 Other educational activity

The Húsavík Academic Centre (icel. *Þekkingarnet Þingeyinga*) is a centre for lifelong learning, university studies and interdisciplinary research. The centre has its main base in Húsavík but serves the entire county of Þingeyjarsýsla. It offers academic, vocational and recreational courses and study programmes to people in the community in collaboration with universities and regional parties of interest, such as municipalities, labour organizations and the business community. The centre also provides study facilities with teleconferencing and other services for higher education students who live in the region. The centre also serves as base for visiting researchers conducting studies in the regions whether for long or short periods. [117]

9.1.6 Health services

Two health institutions are located in the subject area. Serving the near region is HÞ, the Health Centre of Þingeyjarsýsla (icel. *Heilbrigðisstofnun Þingeyinga*), which consists of the Húsavík Hospital and Health Centre as well as health centres in Þórshöfn, Raufarhöfn, Kópasker, Mývatn and Laugar. General health care service is provided at all locations and general hospital service is provided at the hospital in Húsavík. The Húsavík Hospital has a 16 bed hospital ward, 18 bed nursing ward as well as support wards including rehabilitation, research lab, radiology and reception. The Húsavík hospital and Health Centre are located in the same building which also houses a year round dental practice with 1-2 dentists. The Health Centre of Þingeyjarsýsla has a total of 150-200 employees, including six doctors, four located in Húsavík, one in Kópasker and one in Þórshöfn.

A physiotherapist employed by the Health Centre is based in *Hvammur* nursing home, which is located in a building connected with the Húsavík Health Centre. Hvammur Nursing Home has 22 nursing beds, 18 residential beds and 13 day care beds available to elderly individuals who live in private homes.

The Health Centre of Þingeyjarsýsla operates ambulance services in four locations with EMT drives on call 24/7. Two ambulances are based in Húsavík and the villages of Kópasker, Raufarhöfn and Þórshöfn each have an ambulance.

[116] (Jóhannesson H. , 2010, pp. 42-43). See also http://english.unak.is/
[117] Húsavík Academic Centre´s website: www.hac.is/english/

The Health Centre of Þingeyjarsýsla is well equipped in terms of facilities and equipment and could accommodate additional work load such as in emergency reception. This would, however, require increased staff and employment ratio for various specialists. The maternity ward, for example, has been discontinued and doctor duty is kept at a minimum. No surgeon or anaesthetist is on duty and only selected procedures are conducted in the surgery. All emergency service is in the responsibility of the Akureyri Hospital (FSA), which is located 90 km from Húsavík and on the other side of a mountain pass (*Víkurskarð*) which can be hazardous in the winter time.

Akureyri Hospital is the second largest hospital in Iceland. Defined as a high tech hospital it has state of the art surgeries, intensive care and emergency service to respond to accidents and emergencies. A helipad is located by the hospital and Akureyri is defined as the centre for ambulance flights in North and East Iceland. The main building of Akureyri Hospital covers 25,000 m^2 and has about 180 registered nursing beds. Approximately 650 employees fill the nearly 500 full time positions at the hospital, thereof about 50 practising doctors. [118]

Proposed industrial development in the region will likely add considerable strain on The Health Centre of Þingeyjarsýsla, particularly during the construction phase. Experience from industrial development in East Iceland showed that it is important to strengthen particularly services related to accidents and emergencies. In order to achieve acceptable response time in such incidents it is therefore necessary to boost the capacity of HÞ to deal with them even though Akureyri Hospital will still be used for the most serious incidents. [119]

9.1.7 District Commissioner

District commissioners represent the government in various administrative duties within their district. Among the duties of district commissioners outside Reykjavík are family law, legal age issues, estate administration, registration and recording, procedures of enforcement, various licencing, tax collection as well as administration of medical and social insurance. The district commissioner in Þingeyjarsýsla County also administers law enforcement within his district. The district administrative office located in Húsavík has a staff of nine in addition to seven police officers.

The administrative district covers an area of 18,500 km^2 from Vaðlaheiði pass in the west to Bakkafjörður village in the east and south to Vatnajökull glacier. The district includes the following six municipalities: Þingeyjarsveit, Skútustaðahreppur, Norðurþing, Tjörneshreppur, Svalbarðshreppur and Langanesbyggð. In addition to the administrative office and police station in Húsavík, there is a police station in Þórshöfn. A police station was also located in Raufarhöfn but has been closed due to cutbacks in funds.

The district commissioner's office has undergone some financial cutbacks in recent years which have led to a reduction in the police force and consequently less traffic policing. In the event of industrial development in the region, it is apparent that the police force must be increased. [120]

9.2 Private sector services

All general services to the economy are available in the subject region. Most basic services can be found in the near region although the companies may be small and service capacity limited in some

[118] (Jóhannesson H. , 2010, p. 45)
[119] Based on conversations with executives at HÞ. See also discussion in (Capacent, 2011) – (in Icelandic)
[120] Based on conversations with executives at the Commissioner's office and their website.

cases. Northeast Iceland Development Agency has in recent years collected information on the number of employees and full time positions in the region for both winter and summer seasons. The database is broken down by various factors such as region and economic activity.

9.2.1 Architecture and engineering

Iceland's largest engineering firm, Mannvit operates an office in Húsavík with five employees. All major engineering firms in Iceland (e.g. Mannvit, Verkís and Efla) also have offices in Akureyri. Raftákn is an electrical engineering firm with offices in Akureyri and Reykjavík.

An architect with private practice is located in Húsavík and an interior architect is located in Skútustaðahreppur. Several architecture offices are located in Akureyri, some independent and also branches from larger architecture firms in the capital area.

9.2.2 Construction and contracting services

Diverse construction services are offered in Húsavík and vicinity. Table 10 lists the type of services and number of companies and employees in this sector operating in Húsavík and vicinity in 2010. [121]

Services	Businesses	Employees
Building contractors	11	48
Electrical contractors	3	11
Plumbing	2	4
Masonry	3	4
Construction equipment	11	23
Painters	2	4
Landscaping	1	3
Auto repair	4	18
Machine shops	2	21
Other	5	15
Total	**44**	**151**

Table 10: Construction and contracting services in Húsavík and vicinity

As is evident from Table 10, most of the companies are small and in many cases one man operations. The companies are quite disparate concerning certification and adoption of quality control systems. While some of the larger ones have already started that process it is important that more follow suit in order to meet the growing demands for quality management and certification. [122] The Federation of Icelandic Industries (SI) has encouraged member businesses to explore the practices of quality management and assist members in taking the first steps in that process. [123]

[121] Figures are based on Northeast Iceland Development Agency database for economic activity in 2010.
[122] This is the experience of companies doing business with Alcoa in East Iceland. See also (in Icelandic): http://www.si.is/malaflokkar/gaedastjornun-og-rekstur/gaedafrettir/nr/9193
[123] See the Federation of Icelandic Industries website: http://www.si.is/english/nr/1362

9.2.3 Professional services

Accounting and auditing services are offered in the region. PriceWaterhouseCoopers has an office in Húsavík as well as in Akureyri where Deloitte & Touche and KPMG can also be found. A few smaller companies are also operating in this field.

One lawyer has a private practice in Húsavík and several law practices can be found in Akureyri, both independent and branches from larger nation based law firms.

The Nordic IT company Advania operates an office with two employees in Húsavík and also services the region from their offices in Akureyri. Another IT service provider Þekking hf also has an operation in Akureyri. [124]

A few management consultancy firms offer their services in the region, including recruitment, surveying, research and education. Largest among them is Capacent ehf which has an office in Akureyri.

Regional lifelong learning centres offer diverse adult education and training programmes. Húsavík Academic Centre also oversees various research projects. North East Iceland Nature Centre (NNA) is one of seven regional nature centres in Iceland. The nature centre conducts scientific research and data collection with focus on Northeast Iceland in accordance with Act no. 60/1992 on the Icelandic Institute of Natural History and Natural History Museum Centres. [125]

9.2.4 Other services

Miscellaneous stores and services can be found in the Húsavík area. Table 11 lists the number of other service companies by type of service. Nearly every kind of service offered in Iceland can also be found in Akureyri.

[124] For more information see their websites at: www.advania.com and www.thekking.is/page/english
[125] For the Act in Icelandic see (Lög um Náttúrufræðistofnun Íslands og náttúrustofur, 1992).
For information in English see: http://en.ni.is/aboutus/role/legislation/act-on-the-iinh/

Type of service	Companies	Additional information
Grocery stores	2	Samkaup - Úrval / Kaskó
Bakery	1	
Meat processing	2	Norðlenska / Viðbót
Restaurants and coffee shops	3 / 6	Year round / summers only
Hotels and guest houses	6	Fosshótel and smaller guesthouses
Clothing and shoe stores	4	
Flower and gift stores	3	
Pharmacy/Hairdressing/Massage	8	
Printing/Photography	3	
Car rental/Car repair/Machine rental	3	
Dry cleaning	1	
Hardware and electrical stores	4	Húsasmiðjan/Múrbúðin/Ormsson/Heimilistæki
Liquor shop (ÁTVR)	1	*(State Alcohol and Tobacco Company of Iceland)*
Banks	3	Íslandsbanki/Landsbanki/Sparisj. S. Þing
Petrol and service stations	3	N1/Olís/Orkuskálinn
Insurance companies	3	VÍS/Sjóvá/TM
Transport companies	2	Eimskip-Flytjandi / Landflutningar

Table 11: Various other services offered in the Húsavík area

9.3 Further reading

Local Government Act no. 138/2011: http://www.althingi.is/lagas/140a/2011138.html (in Icelandic)

The Association of Local Authorities in Iceland, website: http://www.samband.is/um-okkur/english/

The educational system in Iceland – ministry of education website:
http://eng.menntamalaraduneyti.is/education-in-iceland/Educational_system/

Pre-primary school Act no.90/2008:
http://eng.menntamalaraduneyti.is/media/MRN-pdf_Annad/Preschool_Act.pdf

Information on education in Norðurþing (in Icelandic):
http://www.nordurthing.is/is/thjonusta/menntun

Website of Reykjahlíðarskóli compulsory school in Skútustaðahreppur:
http://www.myv.is/reykjahlidarskoli

Information on education in Þingeyjarsveit (in Icelandic):
http://thingeyjarsveit.is/starfsemi/fraedslumalskolar/

Húsavík Upper Secondary School website: http://www.fsh.is/forsida/ (in Icelandic)

Laugar Upper Secondary School website: http://www.laugar.is/ (in Icelandic)

Húsavík Academic Centre website: http://www.hac.is/english/

North East Iceland Nature Centre website: http://www.nna.is/english/

Health Centre of Þingeyjarsýsla Action plan for major accidents, published in June 2011 (in Icelandic): http://www.heilhus.is/Files/Skra_0053248.pdf

District commissioner website (in Icelandic): http://www.syslumenn.is/syslumadurinn/Husavik/

Hönnunarverksmiðjan, Húsavík based architecture and design firm (Icel.): http://www.honnunarverksmidjan.is/

Mannvit engineering firm website: http://www.mannvit.com/

Efla engineering firm website: http://www.efla-engineers.com/

Verkís engineering firm website: http://www.verkis.com/

Raftákn electrical Consulting company website: http://raftakn.is/en/page/the_company

Álver á Bakka við Húsavík, mat á samfélagsáhrifum. Socioeconomic impact assessment of an Aluminium Plant at Bakki. Report by the Research Centre of the University of Akureyri (RHA) published in January 2009: (in Icelandic) http://www.rha.is/static/files/Rannsoknir/2009/Alver-Husavik_samfelagsmat_Jan-09.pdf

Samfélagsáhrif á Heilbrigðisstofnun Þingeyinga og Norðurþing, ef álver á Bakka rís? A B.Sc. paper on socioeconomic impact of an aluminium plant at Bakki on the Health Centre of Þingeyjarsýsla and Norðurþing municipality. Submitted at Bifröst University by Erla Bjarnadóttir in August 2009: http://skemman.is/stream/get/1946/4061/11744/1/erla_bjarnadottir_fixed.pdf (in Icelandic)

Mat á eftirspurn eftir heilbrigðisþjónustu vegna mannaflsfrekra framkvæmda. Impact assessment of labour intensive projects on demand for health services. Report compiled by Capacent, and published in October 2011, commissioned by Norðurþing, Tjörneshreppur, Skútustaðahreppur and Þingeyjarsveit.

Health Centre of Þingeyjarsýsla organizational chart (7.ed.) published February 2011 (in Icelandic): http://heilhus.is/files/Skra_0048463.pdf

10 Competitive status

The competitive status of regions, including the subject region, is determined by both internal and external factors. The external factors relate to international and national conditions while internal factors relate to region specific conditions.

10.1 Competitive status of Iceland

For several years The World Economic Forum has published The Global Competitiveness Report in which countries and individual economies are rated based on a broad array of indicators for competitiveness termed the Global Competitiveness Index. In The Global Competitiveness Report 2011-2012 Iceland ranks number 30 of the 142 economies rated. [126]

The countries are categorized into three stages of development. Iceland, along with 34 other countries, is placed at the highest development stage as an innovation-driven economy where innovation and business sophistication is advanced. The overall rating is based on twelve pillars which are weighed differently depending on the economy's stage of development. Figure 37 shows Iceland's rating compared to the average of innovation driven economies.

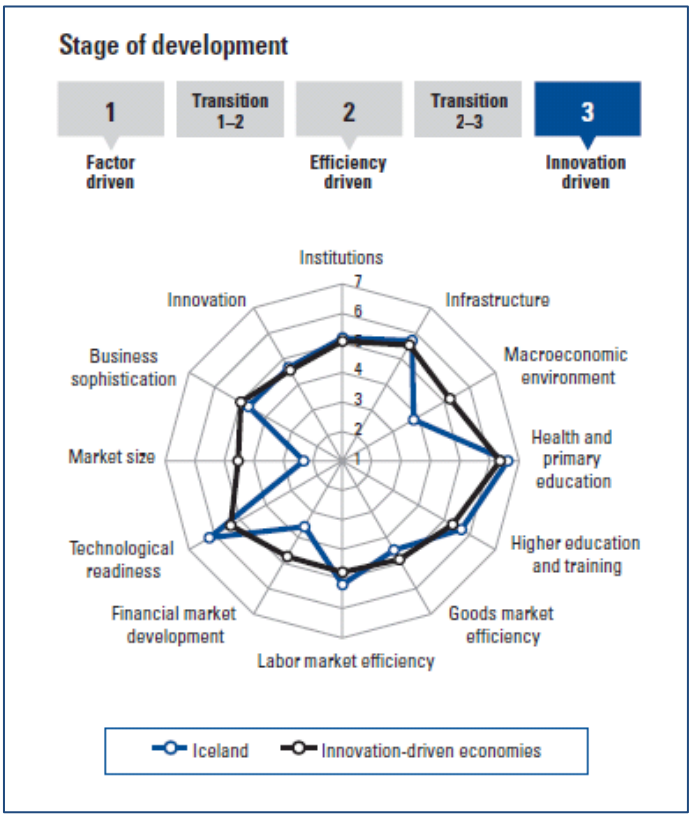

Figure 37: Competitive rating of Iceland (World Economic Forum, 2011, p. 202)

As the figure clearly shows, there are mainly three areas where Iceland lags behind its competitors in the highest development stage. Domestic market size is an obvious weakness as it is often the springboard for international marketing. The small domestic market size can also hinder companies in reaching the size efficiency necessary to compete in the global market. Another weakness compared with its competitors is the macroeconomic environment, due mainly to the government

[126] (World Economic Forum, 2011) http://www.weforum.org/

budget deficit, low national savings rate and high government debt. The third weakness, compared with competitors in this group, is the financial market development which scores low mainly due to the vulnerable status of the banks, weak local equity market and restriction on capital flows.

The chief competitive strengths of the Icelandic economy are high technological readiness in both the business and public domains, and a good health care system and a strong educational system at all levels. [127]

A summary of indicators on the ease of doing business in Iceland is accessible in the Doing Business Report compiled by The World Bank. Out of the 183 countries covered in the 2012 report, Iceland is ranked number 9 for countries where it is easiest to establish and run businesses, climbing 13 seats from the previous year. [128]

10.2 Competitive status of the region

The project management team assigned on the basis of an MOU between the government and the municipalities of Norðurþing, Skútustaðahreppur and Þingeyjarsveit on October 22, 2009, initiated a SWOT analysis of the region. The analysis, conducted by Northeast Iceland Development Agency, was carried out by a group of twelve individuals selected from the three municipalities. The result was a list of strengths and opportunities on one hand and weaknesses and threats on the other. [129]

10.3 Strengths and opportunities

- ✓ Energy resources
  - o Abundant energy
  - o Diverse energy options
  - o Good access to energy resources
  - o Proximity to population and defined industrial areas
  - o Minimal transmission cost and load loss
  - o Rising energy prices
  - o Growing demand for clean and renewable energy
  - o Phased development maximises local knowledge base and economic gain
- ✓ Infrastructure and administration
  - o Underutilized service systems (e.g. schools and health services)
  - o Easily expandable harbour facilities
  - o Airport ready for scheduled flights
  - o Waste Incineration capable of hazardous waste disposal
  - o Strong cooperation among municipalities in terms of basic services
  - o Special cooperation among municipalities regarding utilization of energy resources, including a confirmed regional plan for high temperature geothermal areas
  - o Proximity to a large labour force and diverse services in Akureyri
  - o Improved road connections to and within the area, including Dettifoss road and Vaðlaheiði tunnel

[127] See (World Economic Forum, 2011, pp. 3-9;89-90;202-203) for the underlying factors, reading the indicators and the rating of Iceland.
[128] See http://doingbusiness.org/data/exploreeconomies/iceland#starting-a-business and (World Bank, 2011)
[129] (Atvinnuþróunarfélag Þingeyinga, 2010)

- ✓ Social resources and knowledge level
  - o Strong local support for utilizing regional energy resources
  - o Building a knowledge base in the field of geothermal energy and its utilization
  - o Extensive knowledge of the region's nature and culture within local institutes
  - o Relatively diverse economy

10.4 Weaknesses and threats

- ✓ Energy resources
  - o Capacity of energy resources needs further confirmation
  - o Distance between energy production sites increases cost of investment
  - o Tecto-volcanic activity such as eruptions and earthquakes can alter the characteristics of the geothermal areas
  - o Phased development of energy production can limit industrial options
- ✓ Infrastructure, administration and politics
  - o Many municipalities and weak sense of regional identity
  - o Negative net migration, small population and low economic diversity
  - o Weak existing regional power grid
  - o Distance to international airports and impeded sea and ground transport
  - o Region not well known and at a competitive disadvantage to Southwest Iceland
  - o Potential pollution from power plants and industry
  - o Political resistance to utilisation of energy resources at the national level
  - o Stiff competition for energy with other regions
- ✓ Economics and financing
  - o Low investment capacity within the region
  - o Temporary overheating of the economy during construction
  - o Global economic problems
  - o High domestic interest rates and weak national economy
  - o Distance to key global markets

10.5 Further reading

Orkufrekur iðnaður í Þingeyjarsýslu – SVÓT greining 2010 – A SWOT analysis report on energy intensive industry in Þingeyjarsýsla County in 2010 (in Icelandic):
http://www.atthing.is/files/SV%C3%93T%20greining-greinarger%C3%B0-loka_1872249845.pdf

11 Taxes and concessions

11.1 Taxes

Taxation of business investments and operations is divided between state and local governments according to regulations. The municipalities collect licencing fees for the construction and then land lease fees and real property tax in addition to operational fees for service such as water use and sewage and the collection and disposal of waste. Among fees due to the state are customs and import fees, corporate income tax and value-added tax. A good overview of Icelandic taxation can be found in the report *Doing Business in Iceland* published by *Invest in Iceland* and *Promote Iceland*. [130]

11.2 Concessions

The Act on Concessions for New Investment in Iceland, no. 99/2010 is based on European Commission Regulation No 800/2008 (General block exemption Regulation) which declares certain categories of aid compatible with the common market in application of Articles 61 and 62 of the EEA agreement as adopted into the EEA agreement by decision of the joint EEA committee no.120/2008 published in EEA Supplement no.79 to the Official Journal of the European Union on December 18, 2008.

The concessions are twofold; on one hand those which can be granted on the basis of location as regional development aid, and on the other hand what can be defined as general incentives. The regional incentives are restricted to financial investment and operation in specific regions defined and agreed upon by the Icelandic government and the EFTA Surveillance Authority on basis of the EEA agreement. According to the current regional aid map for Iceland 2008-2013 (see Figure 38), regional incentives apply anywhere in Iceland outside the Reykjavík and Southwest constituencies.

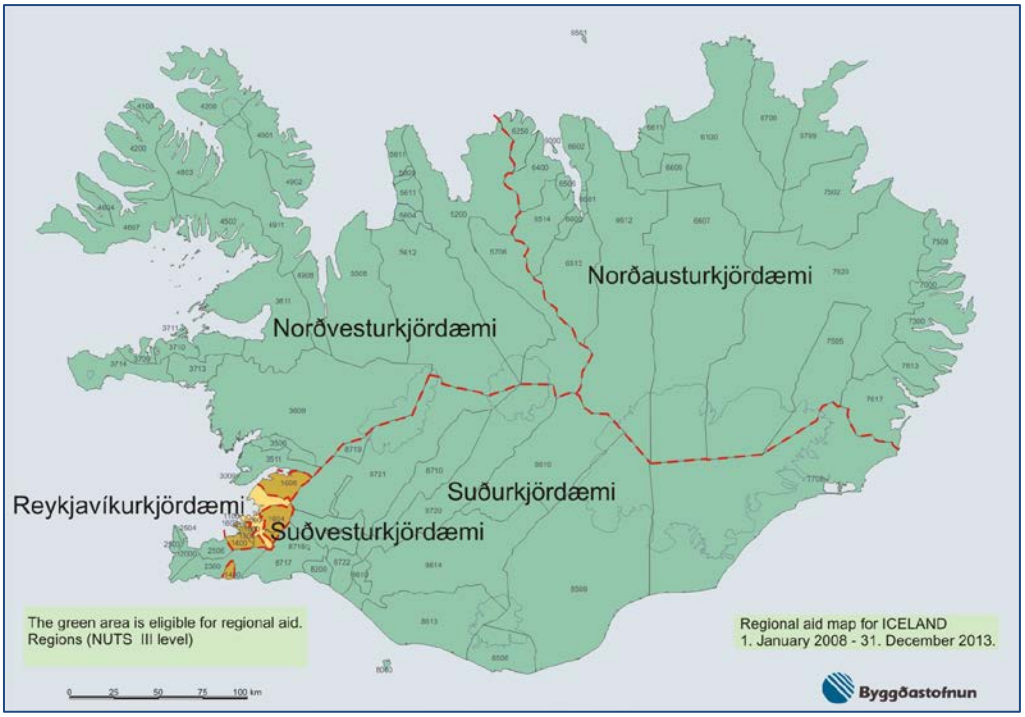

Figure 38: Regional aid map for Iceland 2008-2013 (www.byggdastofnun.is)

[130] (Íslandsstofa, 2011)

The concessions available can be in the form of direct cash grants, fixed ceiling on the rate of income tax for 10 years, favourable depreciation rules, certain derogations from certain taxes and charges, security clauses in terms of new taxation and authorization to lease sites from the state or municipalities below market price.

The general incentives which are not location dependent may include training aid, aid to SMEs, aid to R&D investment and aid to environmental investment projects. [131]

11.3 Further reading

Act on Municipalities' Revenue Bases no.4/1995 with later amendments:
http://www.samband.is/media/enska/Act-no-4-1995-on-Municipalities'-Revenue-Bases.pdf

Act on fees for municipal street construction no.153/2006 (in Icelandic):
http://www.althingi.is/lagas/139b/2006153.html

Information on the general business environment and investment opportunities in Iceland:
http://www.invest.is/resources/Files/DoingBusinessInIceland_April_2011.pdf

European Commission Regulation No 800/2008 (General block exemption Regulation):
http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:214:0003:0047:EN:PDF

Act on Concessions for New Investment in Iceland, no. 99/2010 (in Icelandic):
http://www.althingi.is/altext/stjt/2010.099.html

Regulation on Concessions for New Investment in Iceland, no. 985/2010:
http://www.reglugerd.is/interpro/dkm/WebGuard.nsf/b7fd33650490f8cf00256a07003476bb/dcc712d0b8186b13002578200006997 8?OpenDocument

Regulation on amendments to regulation no. 985/2010 on Concessions for New Investment in Iceland, no. 1150/2010 (in Icelandic):
http://www.stjornartidindi.is/Advert.aspx?ID=27675e9f-3dc2-4e1a-894e-03665617b22e

Requirements for granting concessions (in Icelandic):
http://www.idnadarraduneyti.is/media/Acrobat/Skilyrdi-fyrir-veitingu-ivilnana.pdf

[131] Based on unpublished slideshow presentation from Ingvi Már Pétursson lawyer at the Ministry of industry, energy and tourism. See also: (Íslandsstofa, 2011)

12 Index of figures

13 Index of tables

14 Bibliography

Alþingi. (2011). *Tillaga til þingsályktunar um samgönguáætlun fyrir árin 2011-2022.* Retrieved 01 05, 2012, from http://www.althingi.is/altext/140/s/0534.html

Atvinnuþróunarfélag Þingeyinga. (2010). *Orkufrekur iðnaður í Þingeyjarsýslu - SVÓT greining.* Retrieved 12 8, 2011, from http://www.atthing.is/files/SV%C3%93T%20greining-greinarger%C3%B0-loka_1872249845.pdf

Atvinnuþróunarfélag Þingeyinga. (2011). *Húsavíkurflugvöllur í Aðaldal.*

Bergerat, F., & Angelier, J. (2008, February 1). Immature and mature transform zones near a hot spot: The South Iceland Seismic Zone and the Tjörnes Fracture Zone (Iceland). *Tectonophysics, 447*(1-4), 142-154.

Bergerat, F., Angelier, J., Homberg, C., Garcia, S., Verrier, S., & Bellou, M. (2010). Recent and present-day tectonics near a hot spot : the transform zones of iceland. *Iceland in the Central Northern Atlantic : hotspot, sea currents and climate change.* Brest, France.

Björnsson, A., Sæmundsson, K., Sigmundsson, F., Halldórsson, P., Sigurbjörnsson, R., & Snæbjörnsson, J. Þ. (2007). *Geothermal Projects in NE Iceland at Krafla, Bjarnarflag, Gjástykki and Theistareykir. Assessment of geo-hazards affecting ernergy production and transmission systems emphasizing structural design criteria and mitigation of risk.* Unnið fyrir Þeistareyki ehf, Landsnet hf og Landsvirkjun.

Björnsson, H., Jónsson, T., Gylfadóttir, S. S., & Ólason, E. Ö. (2007). Mapping the Annual Cycle of Temperature in Iceland. *Meteorolog. Zeitschrift*, Vol. 16 (1), 045-056.

Björnsson, H., Sveinbjörnsdóttir, Á. E., Daníelsdóttir, A. K., Snorrason, Á., Sigðursson, B. D., Sveinbjörnsson, E., et al. (2008). *Hnattrænar loftslagsbreytingar og áhrif þeirra á Ísland - Skýrsla vísindanefndar um loftslagsbreytingar.* Reykjavík: Umhverfisráðuneytið.

Capacent. (2011). *MAT Á EFTIRSPURN EFTIR HEILBRIGÐISÞJÓNUSTU VEGNA MANNAFLSFREKRA FRAMKVÆMDA.* Óbirt skýrsla unnin fyrir Norðurþing, Skútustaðahrepp, Tjörneshrepp og Þingeyjarsveit.

Crochet, P., & Jóhannesson, T. (2011). A data set of gridded daily temperature in Iceland, 1949-2010. *Jökull*(61), 1-18.

Crochet, P., Jóhannesson, T., Jónsson, T., Sigurðsson, O., Björnsson, H., Pálsson, F., et al. (2007). Estimating the spatial distribution of precipitation in Iceland using a linear model of orographic precipitation. *Journal of Hydrometeorology*, Vol.8 (6), 1285-1306.

DataMarket. (2011, 12 9). *Veðurmælingar á Íslandi*. Retrieved 12 9, 2011, from DataMarket: http://datamarket.com/data/set/1h23/vedurmaelingar-a-islandi#sub_1h23

Dauteuil, O., & Bergerat, F. (2005). Interactions between magmatism and tectonics in Iceland: a review. *Geodinamica Acta, 18*(1), 1-9.

Einarsson, P. (2008). Plate boundaries, rifts and transforms in Iceland. *Jökull, 58*, 35-58.

Einarsson, P., & Sæmundsson, K. (1987). Upptök jarðskjálfta 1982-1985 og eldstöðvakerfi á Íslandi. *Í hlutarins eðli*. Reykjavík: Menningarsjóður.

Environmental Impact Assessment Act No. 106/2000. (n.d.). *http://www.skipulagsstofnun.is/english.* Retrieved April 9, 2012, from http://www.skipulagsstofnun.is/: http://www.skipulagsstofnun.is/media/umhverfismat/MAUlogm2005br.pdf

Garcia, S., Angelier, J., Bergerat, F., & Homberg, C. (2002, 2 28). Tectonic analysis of an oceanic transform fault zone based on fault-slip data and earthquake focal mechanisms: the Húsavík–Flatey Fault zone, Iceland. *Tectonophysics, 344*(3-4), 157-174.

Gorman, R., Zagon, T., & Jónsson, T. (2007). *Final Report Sea Ice Risk Assessment for the Bakki Aluminium Smelter Iceland.* Montrréal: Enfotec Technical Services.

Guðmundsson, Á. (2000). Dynamics of Volcanic Systems in Iceland: Example of Tectonism and Volcanism at Juxtaposed Hot Spot and Mid-Ocean Ridge Systems. *Annu. Rev. Earth Planet. Sci., 28*, 107-40.

Guðmundsson, Á. (2007, January). Infrastructure and evolution of ocean-ridge discontinuities in Iceland. *Journal of Geodynamics, 43*(1), 6-29.

Guðmundsson, S., Sveinbjörnsdóttir, Á., Viggósson, G., Sigurjónsson, J., Ólafsson, J., Ólafsson, S., et al. (2000). *Veðurfarsbreytingar og afleiðingar þeirra - skýrsla vísindanefndar um loftslagsbreytingar.* Reykjavík: Umhverfisráðuneytið.

Hagstofa Íslands. (2011 a). *Vinnumarkaður 1. ársfjórðungi 2011.* Retrieved 01 04, 2012, from https://hagstofa.is/lisalib/getfile.aspx?ItemID=12373

Hagstofa Íslands. (2011 b). *Vinnumarkaður á 2. ársfjórðungi 2011.* Retrieved 01 04, 2012, from https://hagstofa.is/lisalib/getfile.aspx?ItemID=12570

Hagstofa Íslands. (2011 c). *Vinnumarkaður á 3. ársfjórðungi 2011.* Retrieved 12 23, 2011, from https://hagstofa.is/lisalib/getfile.aspx?ItemID=13068

Hagstofa Íslands. (2011 d). *Vinnumarkaður á 4. ársfjórðungi 2010.* Retrieved 01 04, 2012, from https://hagstofa.is/lisalib/getfile.aspx?ItemID=12089

Halldórsson, P. (2005). *Jarðskjálftavirkni á Norðurlandi.* Reykjavík: Veðurstofa Íslands.

Hjálmsdóttir og fl. (2011). *Greinargerð faghóps Háskólans á Akureyri vegna samgönguaætlunar 2011-2022.* Retrieved 02 06, 2012, from http://www.rha.is/static/files/Rannsoknir/2011/HA_um_samgonguaaetlun.pdf

Holland, M. M., Bitz, C. M., & Tremblay, B. (2006). Future abrubt reductions in the summer Arctic sea ice. *Geophysical Research Letters, 33*(L23503).

HRV Engineering. (2006). *Aluminum Plant in North Iceland - Comparison Study.* Reykjavík: Ministry of Industry and Commerce.

HRV Engineering. (2010). *Álver Alcoa á Bakka við Húsavík - Matsskýrsla.* ALCOA.

HRV Engineering. (2010). *Álver á Bakka við Húsavík í Norðurþingi - Matsskýrsla.* Alcoa.

Hönnun. (2002). *Húsavík – Jarðgrunnskönnun.* Unnið fyrir Fjárfestingarastofu - Orkusvið.

Hönnun. (2003). *Bjarnarflagsvirkjun 90 MW e og 132 kV Bjarnarflagslína 1 í Skútustaðahreppi - Mat á umhverfisáhrifum.* Landsvirkjun.

Hönnun. (2005). *PRIMARY ALUMINUM PLANT LOCATED NEAR HUSAVIK - Site study.* Ministry of Industry and Commerce.

Iðnaðarráðherra og umhverfisráðherra. (2011). *Drög að tillögu til þingsályktunar um áætlun um vernd og orkunýtingu landssvæða.* Retrieved 01 05, 2012, from http://www.rammaaaetlun.is/media/samradsferli/Tillaga-til-thingsalyktunar-18agust-LOKAEINTAK.pdf

Ingólfsson, Ó. (2008, 3 28). *Climate in iceland*. Retrieved 12 7, 2011, from Ólafur Ingólfsson: https://notendur.hi.is/oi/climate_in_iceland.htm

Íslandsstofa. (2011). *Doing Business in Iceland.* Retrieved 02 09, 2012, from http://www.invest.is/resources/Files/DoingBusinessInIceland_April_2011.pdf

Jakobsson, Þ. (2006, 12 20). *Hafís við Ísland*. Retrieved 02 02, 2012, from Veðurstofa Íslands: http://www.vedur.is/hafis/frodleikur/nr/453

Jakobsson, Þ., Sigurðsson, E., Ármannsdóttir, S., & Gylfadóttir, S. S. (2002). *Hafíshætta með tilliti til siglinga úti fyrir Norðurlandi.* Unnið fyrir Fjárfestingastofuna - orkusvið. Reykjavík: Veðurstofa Íslands.

Jouanne, F., Villemin, T., Berger, A., & Henriot, O. (2006). Rift-transform junction in North Iceland: rigid blocks and narrow accommodation zones revealed by GPS 1997–1999–2002. *Geophysical Journal International*, 1439-1446.

Jóhannesson, H. (2010). *Rannsókn á samfélagsáhrifum álvers og virkjunarframkvæmda á Austurlandi - lokaskýrsla.* (H. Jóhannesson, Ed.) Retrieved 11 9, 2011, from http://www.rha.is/static/files/Rannsoknir/2010/Samfelagsahrif_alvers_og_virkjunar_A-landi_lokaskyrsla_2010.pdf

Jóhannesson, H., Ólafsson, K., Heiðarsson, J. Þ., & Sigurbjarnarson, V. (2009). *Álver á Bakka við Húsavík - Mat á samfélagsáhrifum.* Akureyri: RHA.

Jónsson, T. (2010, 1 25). *Ísland og nao-fyrirbrigðið*. Retrieved 2 9, 2012, from Veðurstofa Íslands: http://www.vedur.is/vedur/frodleikur/greinar/nr/1803

Kjaran, S. P., & Myer, E. M. (2005). *Aluminum Plant in North Iceland - Site comparison study Air dispersion calculations.* Reykjavík: Vatnaskil, Engineering.

Krafla. (n.d.). Retrieved 1 21, 2012, from Institute of Earth Sciences: http://earthice.hi.is/page/ies_krafla

Lemke, P., Ren, J., Alley, R. B., Allison, I., Carrasco, J., Flato, G., et al. (2007). Observations: Changes in Snow, Ice and Frozen Ground. In S. Solomon, Q. D., M. Manning, Z. Chen, M. Marquis, K. B. Averyt, et al. (Eds.), *Climate Change 2007: The Physical Science Basis - Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 337-384). Cambridge, UK: Cambridge University press.

Lög um leikskóla. (2008). *Lög um leikskóla nr. 90/2008.* Retrieved 12 15, 2011, from http://www.althingi.is/lagas/139b/2008090.html

Lög um mat á umhverfisáhrifum. (2000). *Lög um mat á umhverfisáhrifum nr. 106/2000.* Retrieved 12 6, 2011, from http://www.althingi.is/lagas/139b/2000106.html

Lög um Náttúrufræðistofnun Íslands og náttúrustofur. (1992). *Lög um Náttúrufræðistofnun Íslands og náttúrustofur nr. 60/1992.* Retrieved 01 20, 2012, from http://www.althingi.is/lagas/139b/1992060.html

Mannvit hf. (2010 a). *Sameiginlegt mat á umhverfisáhrifum álvers á Bakka við Húsavík, Þeistareykjavirkjunar, Kröfluvirkjunar II og háspennilína frá Köflu og Þeistareykjum að Bakka við Húsavíik - matsskýrsla.* Retrieved 12 15, 2011, from http://www.skipulagsstofnun.is/media/attachments/Umhverfismat/822/Matsskyrsla_sameiginlegt%20mat_150.pdf

Mannvit hf. (2010 b). *Háspennulínur (220 kV) frá Kröflu og Þeistareykjum að Bakka við Húsavík Jarðstrengur (132 kV) frá Bjarnarflagi að Kröflu - MAT Á UMHVERFISÁHRIFUM - Matsskýrsla.* Retrieved 12 07, 2011, from http://www.skipulagsstofnun.is/media/attachments/Umhverfismat/819/Matssk%C3%BDrsla%20h%C3%A1spennul%C3%ADnur_150.pdf

Metzger, S., Jónsson, S., & Geirsson, H. (2011, November). Locking depth and slip-rate of the Húsavík Flatey fault, North Iceland, derived from continuous GPS data 2006–2010. *Geophysical Journal International, 187*(2), 564-576.

Norðurþing. (2010 1-22). *Aðalskipulag Norðurþings 2010-2030 1.-22. kafli.* Retrieved 10 11, 2011, from http://www.nordurthing.is/static/files/adalskipulag-2010-2030/syn-og-meginstefna.pdf

Norðurþing. (2010 23). *Aðalskipulag Norðurþings 2010-2030 23. kafli.* Retrieved 12 06, 2011, from http://www.nordurthing.is/static/files/adalskipulag-2010-2030/skipulag-dreifbylis.pdf

Norðurþing. (2010 24 - 27). *Aðalskipulag Norðurþings 2010-2030 24.-27. kafli.* Retrieved 12 06, 2011, from http://www.nordurthing.is/static/files/adalskipulag-2010-2030/skipulag-thettbylis.pdf

Orkustofnun. (2009). *Mat á vinnslugetu háhitasvæða.* Retrieved 10 12, 2011, from http://www.os.is/gogn/Skyrslur/OS-2009/OS-2009-009.pdf

Orkustofnun. (2009). *Mat á vinnslugetu háhitasvæða.* Retrieved 10 12, 2011, from http://www.os.is/gogn/Skyrslur/OS-2009/OS-2009-009.pdf

PANIS. (2006, 3 8). *Surface circulation around Iceland*. Retrieved 12 29, 2011, from PANIS - Palaeoenvironments on the North Icelandic Shelf: https://notendur.hi.is/jeir/panis_currents.html

Pre-primary School Act. (2008, 06 12). *Pre-primary School Act no.90/2008.* Retrieved 5 4, 2012, from Ministry of education, science and culture: http://eng.menntamalaraduneyti.is/media/MRN-pdf_Annad/Preschool_Act.pdf

Riedel, C., Tryggvason, A., Brandsdóttir, B., Dahm, T., Stefánsson, R., Hensch, M., et al. (2006). First results from the North Iceland experiment. *Marine Geophysical Research, 27*(4), 267-281.

RIV. (2011, 12 9). *Gagnatorg veðurupplýsinga*. Retrieved 12 9, 2011, from Reiknistofa í Veðurfræði: http://portal.belgingur.is/

Rögnvaldsson, S. T., Guðmundsson, Á., & Slunga, R. (1998). Seismotectonic analysis of the Tjörnes Fracture Zone, an active transform fault in north Iceland. *Journal of Geophysical Research, 103*(B12), 30,117-30,129.

Samvinnunefnd um svæðisskipulag háhitasvæða í Þingeyjarsýslum. (2008). *Svæðisskipuag háhitasvæða í Þingeyjarsýslum.* Retrieved 10 22, 2011, from http://teikna.is/

Sigbjörnsson, R., & Snæbjörnsson, J. Þ. (2007). *Earthquake hazard - Preliminary assessment for an industria lot at Bakki near Húsavík.* Earthquake Engineering Research Centre, University of Iceland.

Sigmundsson, F. (2006). *Iceland Geodynamics - Crustal Deformation and Divergent Plate Tectonics.* Chichester, UK: Springer Verlag.

Sigurðsson, F. H., & Magnúsdóttir, G. (1984). *Vindmælingar á Héðinshöfða og veðurfar á Húsavíkursvæðinu (Wind Observations at Héðinshöfði and Climate of the Húsavík Area).* Reykjavík: Veðurstofa Íslands.

Sigurðsson, F. H., Hjartarson, H., Antonsson, T. K., & Arason, Þ. (2003). *Wind and Stability Observations in the Húsavík Area. September 2002-September 2003.* Reykjavík: Veðurstofa Íslands.

Skútustaðahreppur. (2011 a). *Aðalskipulag Skútustaðahrepps 2011-2022 - landnotkun og skipulagsákvæði - greinargerð okt. 2011.* Retrieved 12 9, 2011, from http://myv.is/files/Landnotkun_1203294799.pdf

Skútustaðahreppur. (2011 b). *Aðalskipulag Skútustaðahrepps 2011-2022 - stefna sveitarstjórnar - greinargerð okt. 2011.* Retrieved 12 9, 2011, from http://www.myv.is/files/Stefna%20sveitarstj%C3%B3rnar_607180065.pdf

Statistics Iceland. (2012, 02 21). *Labour market by sex, age, region and education 1991-2011* . Retrieved 05 03, 2012, from Statistics Iceland: http://www.statice.is/Statistics/Wages,-income-and-labour-market/Labour-market

Stefán Arnórsson. (2011). *Jarðhiti á Íslandi - viðauki við skýrslu verkefnisstjórnar um 2. áfnag rammaáætlunar.* Retrieved 11 17, 2011, from http://www.idnadarraduneyti.is/media/Acrobat/Vidaukaskyrsla.pdf

Stefánsson, R., Guðmundsson, G. B., & Halldórsson, P. (2008, 2 1). Tjörnes fracture zone. New and old seismic evidences for the link between the North Iceland rift zone and the Mid-Atlantic ridge. *Tectonopysics, 447*(1-4), 117-126.

Sturkell, E., Einarsson, P., Sigmundsson, F., Geirsson, H., Ólafsson, H., Pedersen, R., et al. (2006). Volcano geodesy and magma dynamics in Iceland. *Journal of Volcanology and Geothermal Research, 150*, 14-34.

Sæmundsson, K. (2007). *Jarðfræðin á Þeistareykjum.* Ísor - Unnið fyrir Þeistareyki ehf.

Sæmundsson, K., & Karson, J. A. (2006). *Stratigraphy and Tectonics of the Húsavík – Western Tjörnes Area.* ÍSOR, Iceland Geosurvey.

Tjörneshreppur. (2010). *Aðalskipulag Tjörneshrepps 2008-2020.* Retrieved 10 11, 2011, from http://www.murinn.is/skipulag/skipulag.pdf

Trønnes, R. G. (2003). *Geology and geodynamics of Iceland.* Retrieved 1 12, 2012, from Institute of Earth Sciences - University of Iceland: http://earthice.hi.is/page/ies_geology

Tækniþing. (2002). *Steam Pipe from Theistareykir to the Coast, U-bend or Bellow compensated.* Húsavík.

Veðurstofa Íslands. (2008, 1 25). *Veðurfarsmyndir - úrkoma*. Retrieved 1 5, 2012, from Veðurstofa Íslands: http://brunnur.vedur.is/eldrivefir/vedurfar/vedurfarsmyndir/Download/Urkoma/EPSfigs/

Veðurstofa Íslands. (2011, 9 1). *Veðurfarsmyndir - hiti*. Retrieved 1 5, 2012, from Gagnabrunnur Veðurstofu Íslands: http://brunnur.vedur.is/eldrivefir/vedurfar/vedurfarsmyndir/Download/Hiti/EPSfigs/

Vegagerðin. (2011). *Handbók um vetrarþjónustu.* Retrieved 01 30, 2012, from http://www.vegagerdin.is/vefur2.nsf/Files/HandbVetrarthj2011-12/$file/Handb%C3%B3k%20Vetrar%C3%BEj%C3%B3nusta%202011-12.pdf

Vegagerðin, umferðardeild. (2010). *Umferð á þjóðvegum.* Retrieved 12 2011, from Vegagerðin: http://www.vegagerdin.is/vefur2.nsf/Files/Umferdartolur_2010/$file/Umfer%C3%B0art%C3%B6lur%202010.pdf

Völksen, C., Árnadóttir, T., Geirsson, H., & Valsson, G. (2009, December). Present day geodynamics in Iceland monitored by a permanent network. *Journal of Geodynamics, 48*(3-5), 279-283.

Wallevik, J. E., & Sigurjónsson, H. (1998). *The Koch Index. Formulation, corrections and extension.* Reykjavík: Veðurstofa Íslands.

Wanner, H., Brönnimann, S., Casty, C., Gyalistras, D., Luterbacher, J., Schmutz, C., et al. (2001). North Atlantic Oscillation - Concepts and studies. *Surveys in Geophysics, 22*(4), 321-382.

World Bank. (2011). *Doing Business 2012.* Retrieved 01 12, 2012, from http://doingbusiness.org/~/media/fpdkm/doing%20business/documents/profiles/country/ISL.pdf

World Economic Forum. (2011). *The Global Competitiveness Report 2011-2012.* Geneva: World Economic Forum.

World Economic Forum. (2011). *The Global Competitiveness Report 2011-2012.* Retrieved 02 03, 2012, from http://www3.weforum.org/docs/WEF_GCR_Report_2011-12.pdf

Þingeyjarsveit. (2010). *Aðalskipulag Þingeyjarsveitar 2010-2022.* Retrieved 10 11, 2011, from http://thingeyjarsveit.is/skipulagsmal/

Þóroddsson, Þ. F., Hallgrímsson, H., Haraldsson, Þ., & Nielsen, Ó. K. (1984). *Húsavík. Náttúrufar og minjar.* Akureyri: Náttúrugripasafnið á Akureyri.