Environmental Report
Reykjavik Energy

2014

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Summary

Environmental affairs are an important aspect of discussion in the society, and Reykjavik Energy's performance in this field is important. Following is a recap of important projects in 2014.

Noteworthy results in 2014

- Attention was directed to and understanding strengthened of the importance of water conservation, especially in Heidmörk.
- A milestone was reached in June when operation of a hydrogen sulphide abatement unit was initiated at Hellisheidi Geothermal Power Plant that removes up to 25% of hydrogen sulphide emitted from the power plant.
- Construction was commenced for the Hverahlíd Pipeline to support the sustainability of Hellisheidi Geothermal Power Plant.
- In Hellisheidi new effective procedures were employed to reclaim vegetation in the area and put finishing touches on the restoration of disturbed areas there.
- It was proven possible to quickly and permanently mineralise the greenhouse gas carbon dioxide in basaltic rock at Hellisheidi Geothermal Power Plant.
- A work procedure was developed to reduce the likelihood of seismic activity induced by the re-injection of disposal water at Hellisheidi Geothermal Power Plant.
- The first fast-charging stations for electric cars were opened in Iceland—six within the capital area and three in neighbouring municipalities.

Challenges

- Ensure responsible resource management of geothermal production fields in the Hengill area.
- Improve management of re-injection of disposal water at Hellisheidi Geothermal Power Plant.
- Continuing operation of the hydrogen sulphide abatement unit and research on the mineralisation of hydrogen sulphide.
- Build an experimental steam hood, at Hellisheidi Geothermal Power Plant to increase the dispersal of hydrogen sulphide and further reduce its concentration in urban areas.
- Discontinue the surface discharge of disposal water from Nesjavellir Geothermal Power Plant to reduce impact on Lake Thingvallavatn.
- Encourage multiple utilisations of thermal energy, electricity and geothermal gases from Hellisheidi Geothermal Power Plant.
- Ensure responsible control of production from water resources and richly emphasise water conservation and the quality of potable water.
- Increase production capacity of the geothermal district heating utilities in West Iceland and start further research to provide hot water in South Iceland.
- Continue the reconstruction of sewerage systems in Akranes, Borgarnes and Kjalarnes.

Figure 1. Maintenance. Photo: Bjarni Líndal.

Introduction

Reykjavik Energy's operations are certified in accordance with the ISO 14001environmental management system. This entails monitoring the impact operations have on the environment, and efforts to achieve continual improvements in environmental affairs. Reykjavik Energy also keeps accounts on its operations in accordance with the Regulation on Green Accounting.

Environmental Report 2014 discusses the progress on the significant environmental aspects defined under the five main rules set out in Reykjavik Energy's Environmental and Resource Policy. The rules regard:

- Responsible resource management.
- Value of Reykjavik Energy's utility operations.
- Emissions and discharge from the operations into the environment.
- The effect Reykjavik Energy has outside of its operations.
- Reykjavik Energy's operations.

In addition to this, an account is given of Reykjavik Energy's production, its own use of hot and cold water, along with electricity and its carbon footprint. Reykjavik Energy's values: foresight, efficiency and integrity are the guidelines when following up on the policy.

The unbundling of Reykjavik Energy in accordance with the Electricity Act that entered into force on 1 January 2014. Reykjavik Energy´s Group, in addition to the parent company, includes:

- Orka náttúrunnar (Our Nature).
- Reykjavik Energy Utilities.
- Reykjavik Fibre Network.

Services and projects extending across the operations of Reykjavik Energy belong to the parent company.

The Environmental Report uses the name Reykjavik Energy when referring generally to the group, the parent company or utilities' operations. The name Orka náttúrunnar (Our Nature) is used when specifically discussing the tasks and projects of that subsidiary.

There have been notable achievements in Reykjavik Energy's environmental affairs, but there is always room for improvement. Consultative meetings are held with permit issuers and stakeholders where environmental affairs are delved into and discussed. Informed discussion is important because it directs attention and focus on what matters most. Environmental affairs are urgent, and it is the duty of Reykjavik Energy to look far into the future in this regard.

Figure 2. Sampling in Hellisheidi. Photo: Magnea Magnúsdóttir.

The environment and resource policy and significant environmental aspects

The environment and resources policy is Reykjavik Energy's commitment to continually improve in environmental affairs. The policy provides constraint in setting goals and is the basis of good collaboration with stakeholders. The environmental resources policy builds on Reykjavik Energy's values and overall policy.

Reykjavik Energy adheres to all statutory and regulatory provisions applying to its operations. The environmental and resources policy is set out below with the main rules and further detailed with purposeful management and improvements of significant environmental factors.

Responsible resources management

Reykjavik Energy is entrusted with responsibility for the resources that it utilises. The responsibility entails working according to a framework of sustainable development and ensuring sustainable utilisation. It is that future generations shall have the same opportunities as current generations to utilise the resources, and that it shall be possible to confirm adherence to the task. Reykjavik Energy undertakes to seek successful solutions, where the utilisation of resources for the public benefit is weighed and assessed in the context of other interests. Reykjavik Energy will protect the resources from threat and encroachment because of their importance and the responsibility with which Reykjavik Energy is entrusted.

Value of utility operations

Reykjavik Energy's production and utility operations promotes healthy quality of life and opportunities for environmentally sound operations that access to Reykjavik Energy's utilities is a prerequisite for. This positive environmental impact of operations is determinative when decisions are made on the development of power plants and utilities. Decisions are based on Reykjavik Energy setting the bar high for quality, delivery security and efficiency, and it publishes detailed information on its performance and future plans in this regard.

Impact of emissions and discharge

Reykjavik Energy's operations inevitably lead to substances and energy being released into the environment. Reykjavik Energy takes the utmost precautions in its operations. Emissions, therefore, occur only in a manner having negligible impact on health and acceptable impact on the environment. Reykjavik Energy reduces the emission or discharge of pollutants as is possible and emphasizes research and development in order to employ the best possible solutions for that purpose.

Impact on society

Nationally Reykjavik Energy is a big company, the employees possess valuable experience, knowledge and skills on the utilisation of geothermal energy and other aspects of the company's utility operations. Employees share knowledge and have influence on the value chain. This encourages others to act towards the environment in a responsible way and has positive impact on society.

Operations

Reykjavik Energy's operations build on the organised and disciplined actions of many employees in distributed work sites. This includes responsible utilisation of supplies, treating structures, lots and received land with care, handling waste in a responsible way and urging environmentally friendly transport. Reykjavik Energy wants to be exemplary and build up employees' qualifications in this regard.

Significant environmental aspects

Reykjavik Energy has defined the following environmental aspects as significant in connection with the main rules stated in the environmental and resources policy. Reykjavik Energy sets goals for itself on these environmental factors and defines responsibility:

Responsible resources management:

- Managing high-temperature geothermal resources
- Managing low-temperature geothermal resources
- Greenfields
- Conservation of potable water resources

Value of utility operations:

- Access to multiple utilisation possibilities of high-temperature geothermal resources
- Access to electricity utility
- Access to hot water utility
- Access to cold water utility
- Access to sewerage system

Impact of emissions and discharge:

- Discharge of disposal water and monitoring of groundwate
- Emissions of hydrogen sulphide
- Emissions of other geothermal gases (carbon dioxide, hydrogen and methane)
- Seismic activity associated with re-injection of disposal water
- Discharge of wastewater from sewage treat-ment plants
- Discharge of drainage through overflows

Impact on society:

- Dissemination of knowledge on geothermal energy utilisation and other aspects of the operations
- Procurement

Operations:

- Waste
- Transport
- Structures and maintenance
- Use of substances

Responsible resources management

Reykjavik Energy is entrusted with responsibility for the resources that it utilises. The responsibility entails working according to the framework of sustainable development, requiring that future generations shall have the same opportunities as current generations to utilise the resources. It is important to be able to confirm adherence to the task. Reykjavik Energy undertakes to seek successful solutions, where the utilisation of resources for the public benefit is weighed and assessed in the context of other interests. Reykjavik Energy will protect the resources from treat and encroachment because of their importance and the responsibility with which Reykjavik Energy is entrusted.

Managing high-temperature geothermal resources

Power production in Nesjavellir and Hellisheidi is in accordance with the power station permits. In order to assure the full production of Hellisheidi Geothermal Power Plant over the next several years, the high-temperature geothermal field in Hverahlíd will be connected by a steam pipe with the power plant. Construction of the Hverahlíd pipeline was commenced in the autumn 2014.

Did you know?

Hengill is an active volcanic system that last erupted 2000 years ago. There was induced seismic activity in the Hengill area in the period 1994-1998. The source is thought to be a magma intrusion. Such intrusions are the sources of heat in the geothermal field.

GOALS:

Our Nature's geothermal power plants shall get the geothermal energy required because of obligations to sell power, although within the framework of utilisation in the power station licence for Hellisheidi Geothermal Power Plant. Comparable criteria are assumed to apply to Nesjavellir Geothermal Power Plant. Goals on the utilisation of geothermal energy are expressed in terms of criteria for how fast pressure and temperature may drop in the geothermal system.

The response of the production field in Hengill to utilisation is monitored. The pressure and temperature in wells is regularly measured, and changes are closely monitored. It is thus possible to predict how the production fields will respond in the future, see Environmental Report 2013. Production reports for the power stations are published each year. In 2014 Reykjavik Energy and the power companies Landsvirkjun and HS Orka collaborated on coordinating the collection and presentation of information regarding requirements in operation and power station permits. The goal is to facilitate the collection, processing and sharing of information and to thus promote responsible resources management.

Nesjavellir Geothermal Power Plant

After 25 years of operations in Nesjavellir, it is much easier and more reliable to predict how the production field responds to utilisation. Drawdown (i.e., the pressure drop in the geothermal reservoir) has increased in line with increased production, especially after a fourth turbine in the power plant was taken into use in 2005 (Annex 2a). The time has come to drill a new production well, referred to as a make-up well, in order to maintain electricity production in the power plant because of drawdown. The drilling is planned in 2015. Drawdown in the field is in accordance with simulated pressure, but since drilling of a make-up well has been delayed, energy production has decreased slightly. Energy production in Nesjavellir is in accordance with the power station permit and goals of Our Nature.

Hellisheidi Geothermal Power Plant

The history of power production in Hellisheidi is short, and considerable uncertainty is expected in predictions regarding how the production field will respond to utilisation as time goes by. Measurements in 2014 show that pressure drawdown in the production field are in accordance with simulated drawdown, as in previous years. Furthermore drawdown is within the limits set in the power station permit and is in accordance with the goals of Our Nature (Annex 2b). Research shows that the current production field will not be sufficient for full production in the future in Hellisheidi Geothermal Power Plant. The production field planned is less than expected according to initial research. The successful course was therefore deemed to be to expand the production field and acquire additional steam for the production of electricity and hot water in Hellisheidi Geothermal Power Plant. This will be done by further utilising wells that have already been drilled at Hverahlíd, rather than drilling make-up wells in the current production field. The construction of a steam pipe connecting the geothermal field in Hverahlíd with Hellisheidi Geothermal Power Plant began in the autumn of 2014. By utilising the wells at Hverahlíd, knowledge is obtained on the size and production capacity of this field before deciding on future utilisation. In 2014 work was done on revising the utilisation permit for geothermal energy in Hellisheidi. Plans call for completing that work in mid-2015 since the permit must be obtained before utilisation starts from wells in Hverahlíd at year-end 2015.

Flow paths for re-injected disposal water

In the summer of 2013 tracer testing was initiated to discover flow paths in the injection fields of Hellisheidi Geothermal Power Plant at Húsmúli and Gráuhnúkar. The goals of the testing include shedding light on the flow paths for re-injected disposal water in the geothermal system. By returning disposal water to the geothermal reservoir, it may be possible to work against the pressure drawdown. The concentration of tracers in the production and monitoring wells is followed from the time they are injected along with the disposal water. Preliminary results indicate that a considerable portion of disposal water reaches the production fields on the western side of Mt. Skardsmýrarfjall and at Mt. Reykjafell. In these parts of the geothermal reservoir the pressure is supported by reinjection but may also cause cooling, particularly on the western side of Mt. Skardsmýrarfjall.

Managing low-temperature geothermal resources

Production from the low-temperature fields in the capital area and in West and South Iceland is in accordance with Reykjavik Energy's operating permits and goals. Reykjavik Energy is working on increasing the production capacity in some of the geothermal district heating utilities in West Iceland, and further research will begin in 2015 to provide hot water in South Iceland.

GOALS:
Water extraction in low-temperature fields shall not curtail the possibility of corresponding water extraction in the future.

For decades Reykjavik Energy has gained experience from utilising low-temperature fields in the metropolitan area. Simulation models have been set up for the low-temperature fields in the capital area and in Stykkishólmur. They are used to predict the future condition of the production fields. Measurements of the water level and temperature in wells are used to monitor how the production fields will respond to utilisation, see Environmental Report 2013. It is possible to respond to changes by reducing production, by re-injecting into fields and re-casing wells. The chemical content of water in the low-temperature fields is monitored in order to gather information early enough to avoid closing down the whole field due to overexploitation. Some chemicals show changes if cold water is mixed with geothermal water. This can occur if pressure drops in the geothermal field, and cold water flows into it. Chemical changes can indicate cold water inflow before changes in temperature are observed. The chemical compounds particularly showing these changes are silica (SiO_2), fluorine (F), dissolved oxygen (O_2) and hydrogen sulphide (H_2S). The findings from chemical analyses of hot water shown in Annexes 3 and 4. Production reports are published every year for the utilities.

Reykjavik Energy operates district heating utilities in the capital area, West and South Iceland (Table 2 in the section on Access to Geothermal District Heating Utility and the picture of Reykjavik Energy's utilities in Annex 1).

Capital Area

Equilibrium between production and pressure decline has been reached in the low-temperature fields in the capital area and everything points to being able to maintain this situation in the foreseeable future, if nothing unexpected comes up. The groundwater level is stable in general and in accordance with operating permits (Annex 5). Figure 3 shows how hot water is distributed in the capital area. The main difference in the content of water between neighbourhoods is the quantity of silica (SiO_2). The concentration of silica is highest in water coming from the wells in the Lauganes low-temperature field, where the water is hottest. The water from Nesjavellir and Hellisheidi is heated groundwater with a low concentration of silica.

South and West Iceland

Low-temperature fields can be found in South and West Iceland where the production is below their production capacity and is therefore in equilibrium. These areas are utilised by small district heating services in sparsely populated areas, like Skorradalur, Munadarnes, Nordurárdalur and Bifröst in West Iceland and Öndverdarnes, Gljúfurárholt, Efri-Reykir, Thorlákshöfn, Hveragerdi and Bakki in Ölfus in South Iceland.

The same kind of measurement is done in the low-temperature fields in South and West Iceland as in the capital area. Production monitoring in previous years shows that the condition of most of the low-temperature fields that Reykjavik Energy operates in South and West Iceland is generally good and in accordance with operating permits. On the other hand, the production capacity in some of the low-temperature fields must be increased, and this is currently being worked on in West Iceland. In 2015 further research to provide hot water in South Iceland for Rangá Utility will be conducted, and a future policy on increasing productivity will be formulated.

Did you know?

About fifty percent of the hot water utilised for district heating in the capital area is geothermal water from the low-temperature fields in Reykjavik and Mosfellsbaer. The rest is groundwater that is heated with geothermal energy in the power stations in Nesjavellir and Hellisheidi.

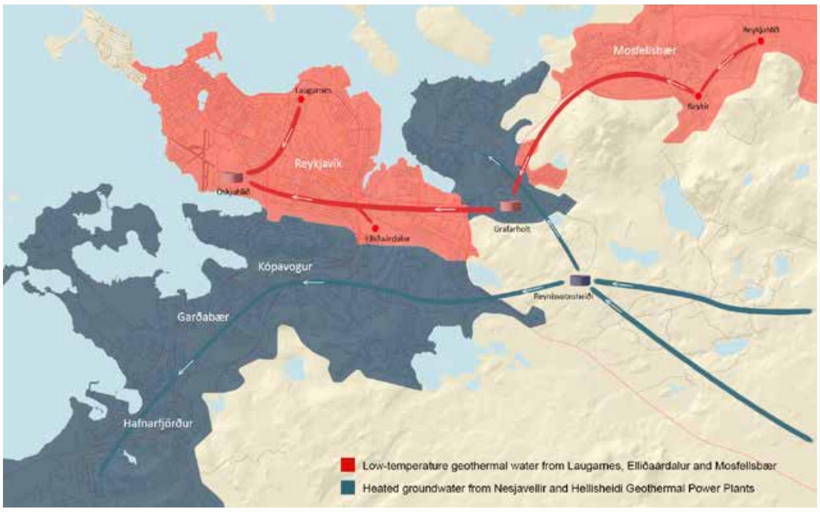


Figure 3. The figure shows how hot water is distributed for space heating in the capital area. Reykjavik residents west of Grafarvogur, residents in Úlfarsárdalur, people in Mosfellsbaer and Kjalarnes usually get low-temperature geothermal water from wells in the capital area. Grafarholt, Grafarvogur, Kópavogur, Gardabaer and Hafnarfjörður, on the other hand, get heated groundwater from Nesjavellir and Hellisheidi.

Greenfields

Emphasis will continue on restoration and reclamation of disturbed areas in Hellisheidi in cooperation with the permit issuers. Maintenance was carried out, for example, on the walking paths in the Hengill area.

GOALS:

Land disturbance because of constructions shall be minimal, and restoration of disturbed areas shall aim at being in harmony with nearby areas, cf. instructions on visual impacts and restoration. Roads, tracks and paths required by constructions shall also be utilised, as relevant, to improve access to nearby nature areas. Travellers shall be given an opportunity to learn on-site about the utilisation of natural resources and the nature in nearby areas.

In the previous decade a lots of land was allocated to the construction of Hellisheidi Geothermal Power Plant. Restoration and reclamation of disturbed areas are emphasised. Ways are also sought to direct traffic while also allowing people opportunities to experience magnificent landscape and diverse forms of geothermal features along with the utilisation of geothermal energy, see Environmental Report 2013.

Hverahlíd Pipe, visual impacts and restoration

Construction of a steam pipe connecting the geothermal field in Hverahlíd in Hellisheidi with Hellisheidi Geothermal Power Plant began in the autumn of 2014. A three-dimensional model of the pipe and its environment were used during design to reduce negative visual impacts. The tender specification for the pipe included criteria to utilise the vegetation in the area, which is expected to be immediately disturbed, for restoration or preserve it for later use for that purpose. In the starting phase, earthworks contractors were given instructions on environmental concerns in a course held on environmental affairs. During the session, possible disturbance of nature because of earthworks was reviewed, along with the goals for the removal and restoration of vegetation and soil, and good working procedures were presented. In the autumn 2014, search and rescue brigades and other groups were obtained to collect moss in the planned construction area. The moss was placed in a freezing container and will be used restore the area in the spring of 2015 (Figure 4 and 5). Strips of turf were also removed along the pipeline path and utilised for restoration.

A public information meeting was held at the start of winter, where the project was described and ways presented to reduce the visual impact, and how the restoration would be achieved with native vegetation. Utilising native vegetation maintains biological diversity of the area, plays a vital role in the health and prosperity of the ecosystem and minimises visual impacts. The pipe ought to be taken into use at year-end 2015, and restoration is to be complete in 2016.

Work procedures on restoration and various projects

In 2014 work procedures for visual impacts and restoration were developed, along with a procedure for building and evaluation of structures and lot. In 2015 a description will be added in the tender specification of projects on training in environmental affairs for contractors and subcontractors. Instructions will also be issued on restoration regarding projects on vegetated land, and how it is possible to reclaim native vegetation in urban areas.

Since the autumn of 2012 reforms have been initiated on the release of drainage water from Sleggja cooling tower; shallow wells have been drilled and pipes buried underground. The shallow wells did not drain the water as well as expected. The result was that, in the autumn of 2014, the pond that had formed south of Draugatjörn Pond swelled temporarily. After the shallow wells were cleaned, they drained all of the water, and the pond subsequently shrank.

In 2014 the steam pipe on the side of Mt. Skardmýrarfjall was painted with colour and a mat finish that blends into the environment. This way of reducing the visual impact of the pipe was decided in consultation with the permit issuers.

It has become common in Iceland to release drainage from drilling pads into brooks, run-off channels, and fissures on the surface or shallow wells. This has been applied to both drainage from drilling and blow yield tests. Active environmental management requires that such release shall be controlled to prevent negative environmental impacts. In 2014 Iceland Drilling Company Ltd., Landsvirkjun, Our Nature, Reykjavik Energy and HS Orka prepared a report to shed light on the status of matters and possible reforms. A meeting was held

Did you know?

It is possible to mix moss with cultured milk (súrmjólk) and spread the mixture on the ground to stimulate the growth of moss and speed up land reclamation. The cultured milk helps stabilise the surface. The moss sticks to the soil better, and the cultured milk is good nourishment for it.

with the environmental authorities, where the situation was discussed, and possible reforms were presented.

At the start of April 2014, a failure occurred in the hot water pipe from Nesjavellir to the capital area. Hot water filled the overflow at Háhryggur and flowed across soil and vegetated land. The impacted area is small and was reclaimed that summer.

Travellers and outdoor recreation

In connection with construction of the Hverahlíd Pipe, efforts have been made to find solutions so that the nearby area will continue to be utilised for outdoor recreation. It will be possible to cross the new pipe in five locations. Signs with information on this, along with marked walking paths in the area, will be placed at selected sites, for example, in the parking lot at Hellisheidi Geothermal Power Plant and a parking lot at the intersection of South Iceland Highway and Grígahnúkur Road.

The number of travellers in the Hengill area is increasing, and the walking paths there clearly show signs of this. In the summer of 2014 emphasis was placed on maintenance of the educational path at Nesjavellir. Also, the Scout Rescue Unit in Reykjavik saw to the maintenance of other walking paths in the Hengill area. Maintenance and signing will continue over the next several years, but steps must be taken to ensure that increase in the number of travellers does not have negative impact on the area.

Figure 4 and 5. Moss was collected in the pipeline path of the Hverahlíd Pipe before construction began in the autumn of 2014. The moss was placed in a freezing container and will be utilised for restoring the area in the spring of 2015. Photo: Magnea Magnúsdóttir.

Conservation of potable water resources

Reykjavik Energy heavily emphasises water conservation and responsible management of water resources, so that it will be possible to ensure users healthy potable water in the distant future. Water samples taken in Reykjavik Energy's utility systems met quality standards 98% of the time.

GOALS:

The water supplies that the users in Reykjavik Energy's water protection areas rely on may not be contaminated. Water extraction shall not curtail the possibility of corresponding future water extraction.

Reykjavik Energy has a duty to meet the water demands of people and companies in the utility area. Potable water shall fulfil the provisions of the Regulation on Food Inspection and Hygiene, cf. Regulation no. 536/2001 on potable water, see Environmental Report 2013.

Water utilities

Reykjavik Energy has 15 water supplies, and the water is piped to areas in West Iceland, South Iceland and the capital area (Table 2 in the section on Access to Cold Water Utility and a picture of Reykjavik Energy's utilities in Annex 1).

Preventive measures are systematically worked on along with monitoring to ensure the quality of the water since Reykjavik Energy cannot recall polluted potable water. Risk factors in water protection areas and distribution systems are analysed. Samples are regularly taken to monitor the water quality, and notifications of needed repairs and improvements are responded to. Tasks vary by region, see Environmental Report 2013. In 2014 efforts were made to update a contingency plan for water utilities, with special emphasis on the effects of natural catastrophes.

Water conservation in the capital area

Heidmörk is Reykjavik Energy's main water extraction field for the capital area, and that water production is based solely on pure and untreated groundwater. The traffic of motorised vehicles on roads in the water protection area is heavy; urban areas have moved closer to it along with various types of activities. Ideas at various stages of projects in and around the area cause Reykjavik Energy concern. This encroaches on the water supply and water protection areas of the capital area, see Environmental Report 2013.

Reykjavik Energy's keeps the water protection area under surveillance, including transport of oil and gasoline, along with other substances of concern (Table 1). Thirteen trips were made in 2014, accompanying vehicles transporting substances of concern.

In 2014 various projects were initiated promoting the conservation of potable water, such as replacing oil transformers in water protection areas with dry type transformers and setting up transformers with more environmentally friendly oil in accordance with advice from licensors. Risk assessment was made regarding a back-up generator in Jadar in Heidmörk, powered by diesel oil. A decision was made to place the back-up generator in this area until 2017. After that period, the back-up generator, along with oil tanks, will be moved out of the water protection area.

Plans call for taking three existing wells in use and thus increasing the water production in Vatnsendakrikar. This will have a positive impact on the operational security of the water utility, along with responding to foreseeable growth in the number of residents the next 15 years. Application was made for an utilisation permit for the production.

In 2014 preparation of a comprehensive overview of potable water affairs of the capital area began, taking into account geology, environmental affairs, water use, operations, risk, reputation and future vision.

Water conservation in West and South Iceland

The most productive water supply in Iceland is currently in Grámelur at Nesjavellir, and the cold water from there is heated up in the Nesjavellir Geothermal Power Plant for space heating in the capital area and used as drinking water in the power station area (Figure 6). A summer cottage in Ridvík owned by Reykjavik Energy is located close to the water supply, and in the autumn of 2014 the decision was made to demolish it in the summer of 2015 to ensure better water conservation in the area.

The aim is to revise the groundwater model for the water extraction field in Engidalur near Hellisheidi Geothermal Power Plant and prepare a long-term prediction for the production, taking into account the expansion of the power station's district heating utility.

Figure 6. Pumping station in Grámelur at Nesjavellir, which is the most productive water supply in Iceland. Photo: Magnea Magnúsdóttir.

AMOUNT OF FUEL AND SLUDGE TRANSPORTED UNDIR SUPERVISION

PLACE	CATEGORY	UNIT	2010	2011	2012	2013	2014
Bláfjöll ski area	Oil	Liters	15,085	42,136	48,100	45,744	43,189
Elliðavatn	Oil	Liters	1,684	3,342	918	1,486	1,649
Þríhnjúkar	Oil	Liters				3,000	
Jaðar	Oil	Liters	2,533		2.488		
Total oil		**Liters**	**19,302**	**45,478**	**48,100**	**50,230**	**44,838**
Bláfjöll ski area	Gasoline	Liters	1,323	3,006	2,063	3,663	2,950
Total gasoline		**Liters**	**1,323**	**3,006**	**2,064**	**3,664**	**2,950**
Gvendarbrunnar	Sludge	Liters	2,000		2,000		
Jaðar	Sludge	Liters	2,000	6,500			
Vatnsendakrikar	Sludge	Liters				2,500	
Vatnstankur T-4	Sludge	Liters			2,500		
Total sludge		**Liters**	**4,000**	**6,500**	**4,500**	**2,500**	**0**

Table 1. Quantity of fuel and sludge (solid constituents from sewage) transported under supervision across the water protection area of the capital area in the period 2010-2014. The use of oil and gasoline in Bláfjöll ski area is determined by how much it snows in the area and also by projects. It explains annual variability.

Monitoring water quality

Each year the public health board takes samples from all Reykjavik Energy's water utilities for microbial analysis, and the number of samples is determined by the Potable Water Regulation no. 536/2001. Samples are also taken for overall chemical analysis (Annexes 6-7).

In 2014, 100 water samples were taken in Reykjavik. Microbes exceeding the criteria were found in two samples, but upon repeating the sampling, the samples met the quality requirements, and this therefore involves a negligible deviation. Results for the last 29 years are shown in Figure 5. Since 1997 97-100% of samples have met the quality requirements.

In 2014 25 samples were taken in Akranes, Álftanes, Borgarfjördur, Grundarfjördur, Hellisheidi, Hlídarveita, Hvanneyri, Nesjavellir, Reykholt and Stykkishólmur. All of the samples met the quality requirements.

In recent years users have complained of silt in the water from the water supply at Grábrók. Filtering equipment is being selected to set up in the water extraction field.

Symposia, development plans and opinions on water conservation

In 2014 Reykjavik Energy continued calling attention to the importance of water conservation in opinions given on development plans in the capital area, in symposia and the mass media.

A proposal on re-examining water conservation in the capital area was notified in the autumn of 2014, and a proposed new regional plan in the capital area was notified near the end of 2014. Water conservation is one of the main goals of the new regional plan. Demarcation of water protection areas in the proposal takes into account much more detailed research than before, which is encouraging. In parallel with changed demarcation of water protection areas, decisions must be taken on which rules shall apply to the scope of operations in the areas. Many have stakes in the water protection area, and many perspectives have to be reconciled. Reykjavik Energy hopes that a new water conservation plan will be a powerful tool for safeguarding the natural qualities of healthy and untreated water. It is important to richly emphasise water conservation for the benefit of coming generations. Conservation of potable water and responsible management of the production are prerequisites for Reykjavik Energy being able to perform its duties and meet the water needs of people and companies in the utility area far into the future.

Did you know?

The City of Reykjavik was awarded the Nordic Council Nature and Environment Prize 2014, and good performance in monitoring and conservation of water supplies was cited as one of the reasons for the Adjudication Committee's conclusion.

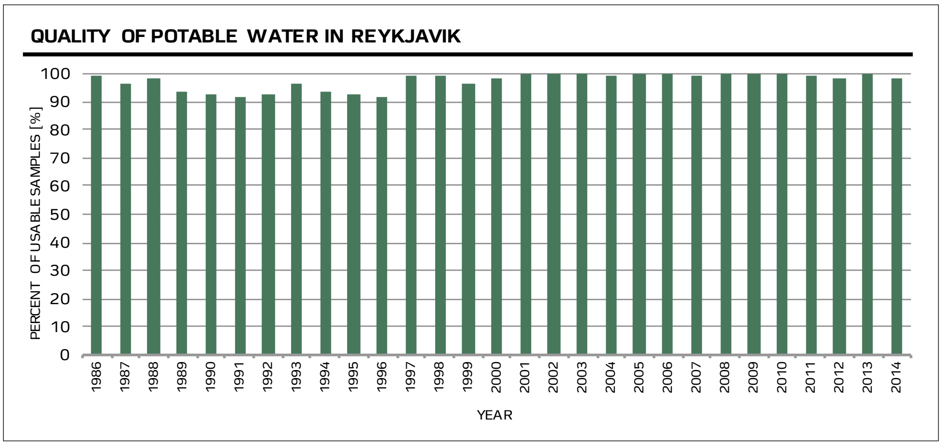


Figure 7. Percentage of samples in Reykjavik meeting the quality requirements in 1986-2014. In 1997 the HACCP monitoring system was introduced to ensure water quality.

Value of utility operations

Reykjavik Energy's production and utility operations are prerequisites for people and companies having access to geothermal energy, pure potable water and hot water on hand for space heating, electricity and sewage connections. This access promotes healthy quality of life for people and provides opportunities for environmentally sound operations. This positive environmental impact is a determining factor when decisions are taken on the development of power plants and utilities. The decisions are based on Reykjavik Energy setting the bar high for quality requirements for production, utility services and efficient operations. In addition, Reykjavik Energy publishes clear information on its performance and future plans in that regard.

Access to multiple utilisation possibilities of high-temperature geothermal resources

Ways are being sought to encourage diverse use of the thermal energy, electricity and geothermal gas from Hellisheidi Geothermal Power Plant in a resources and science park west of the power station. Increased emphasis will be placed on this project in 2015.

Did you know?

Carbon dioxide is one of the main greenhouse gases. By removing carbon dioxide from geothermal steam emitted from Hellisheidi Geothermal Power Plant, it can become a high-demand product for cultivation and fuel production.

GOALS:

To make multiple uses of the products of high-temperature geothermal power plants, particularly thermal energy and electricity, in addition to streams of substances that would otherwise have to be emitted or disposed of, depending on environmental requirements and efficiency. The product offering is based on the efficient operation of systems in Our Nature's core operations.

Multiple use of geothermal energy can increase efficiency and strengthen environmentally sound operations and innovation in the business community. For this purpose the Municipality of Ölfus has made its contribution to such multiple utilisations in the Hengill area by issuing a local plan for a resources and science park at Hellisheidi Geothermal Power Plant.

Our Nature's customers have been offered electricity, steam, hot and cold water along with geothermal gases. Investors have expressed interest in the resources and science park at Hellisheidi Geothermal Power Plant in the field of aquaculture and algae cultivation and the utilisation of carbon dioxide. In 2014 GeoSilica continued working on an experimental project, where separated water from the power plant is used in the production of dietary supplements. In 2013 Prokatín began experimental production of protein flour to mix into fish fodder and organic sulphur for use as fertiliser, but less has come out of the project in 2014 than planned. In collaboration with the scientific community, grants for further multiple uses of geothermal gases have been applied for. This endeavour has not yet borne fruit. In 2014 more emphasis was placed on publicising possibilities of multiple uses of high-temperature resources. Efforts will continue on the project to acquire new customers that can better utilise the products of high-temperature geothermal power stations.

In 2015 an experimental station will be built at Hellisheidi Geothermal Power Plant to develop a method for removing carbon dioxide from the water re-injected in the SulFix project, see section on Emissions of Hydrogen Sulphide. The station will strengthen the premises underlying the design and feasibility study for an industrial scale station that, in addition, can entail possibilities for utilising carbon dioxide. Another option being examined is whether the water re-injected in the SulFix project, which is saturated with carbon dioxide and hydrogen sulphide, can be utilised in the production cycle of Hellisheidi Geothermal Power Plant in order to reduce the likelihood of scale formations in the district heating utility and the injection utility of the power station.

When decisions on innovation projects are made in connection with the development of high-temperature geothermal power stations, the requirement for positive environmental impact is determinative. In addition, such decisions are always based on requirements for quality, security and efficiency.

Figure 8. From the opening of the hydrogen sulphide abatement unit at Hellisheidi Geothermal Power Plant. Photo: Thorvaldur Árnason.

Access to electricity utility

Reykjavik Energy assures the residents and business community in the distribution area electricity in harmony with the quality standards and provisions in laws and regulations. The laying of the underground Kjalarnes Power Line continues, and in the autumn 2014 the laying of the underground Ellidavatn Power Line was finished.

GOALS:

The residents and business operations in Reykjavik Energy's distribution areas shall have the option of connecting with an electricity utility. Power outages in an electricity utility shall be negligible, among other things, because of reliability in the construction of the distribution system. The quality of electricity shall be in accordance with quality standards and regulations.

Reykjavik Energy distributes electricity in Akranes, Mosfellsbaer, Reykjavik, Seltjarnarnes, Kópavogur, Gardabaer north of Hraunholtslaekur and to Hellisheidi in the Municipality of Ölfus (picture of Reykjavik Energy's utilities in Annex 1). Nearly 99,000 households and companies were connected with Reykjavik Energy's electricity grid in 2014. Of these there were more than 750 new users. The grid's production capacity must be reinforced in the capital area in order to meet the increase in the number of residents, the densification of urban areas and industrial development expected in the next several years.

The load on the electricity grid is continually monitored. In 2014 electricity in the capital area fulfilled quality standards and provisions in laws and regulations. As in previous years only the most necessary, nonpostponable projects were launched to reinforce and maintain the distribution grid. In addition, the Ellidavatn Power Line is worth mentioning. It was laid underground in the latter part of 2014, and the laying of the first and second phases of the underground Kjalarnes Power Line were worked on. The Kjalarnes Power Line project is scheduled to be finished in 2015 or 2016.

In 2014 fewer operational disturbances occurred in the electricity grid than in 2013. Factors like the weather and construction have considerable effect on the number of disturbances. There were 21.13 minutes of power outage due to sudden operational disturbances in 2014.

Did you know?

A new supply station is being built in Akranes. Its purpose is to increase delivery security and meet increased demand for electricity.

Figure 9. The Ellidavatn Power Line laid underground in the autumn 2014. Technology and work procedures were carefully utilised to minimise the disturbance on vegetated land. Photo: Ingvar Jón Ingvarsson**.**

Access to geothermal district heating utility

The productive capacity of the geothermal district heating utility in the capital area is sufficient to meet the needs of a growing population and industrial development in the next several years. A new storage tank for hot water was taken into use in Akranes. In the latter part of 2014 a pumping station was installed to increase the transport capacity of the district heating utility from Kaldárholt to those living in Rangá District.

GOALS:

Residents in Reykjavik Energy's distribution areas shall have the option to connect to the distribution system in accordance with the company's connection terms. Upon fulfilment of residents' needs, companies shall have the option of utilising hot water for industrial operations. The expansion of the distribution system and customers' particular connections shall be determined, for example, by technical prerequisites and efficiency.

Reykjavik Energy operates 14 hot water utilities, seven in South Iceland, six in West Iceland and one in the capital area, which is the largest—annually producing about 70 million m^3 of water. Hot water utilised in the capital area comes from Nesjavellir, Hellisheidi, two of the low-temperature geothermal fields within Reykjavik's city limits, and two of the low-temperature geothermal fields in Mosfellsbaer (Table 2 and the picture of Reykjavik Energy's utilities in Annex 1). The section on Managing High-Temperature Geothermal Resources shows from where different parts of the capital area get hot water for district heating.

The distribution system offers, on one hand, a mixture of geothermal hot water from the four low-temperature fields and, on the other, ground water heated in Hellisheidi and Nesjavellir Geothermal Power plants. The water from Nesjavellir and Hellisheidi may not be mixed with the water from the low-temperature geothermal fields. The productive capacity of the system, with the planned build-up in the capital area, is sufficient to meet the needs of a growing population and industrial development the next several years.

At the beginning of April 2014, there was a failure in the hot water pipe from Nesjavellir to the capital area when automatic vacuum equipment malfunctioned. The flow through the pipe dropped substantially for a day. During this time the production of hot water was increased in Hellisheidi Geothermal Power Plant and the low-temperature geothermal fields in Mosfellsbaer, Laugarnes and Ellidaárdalur.

As previously stated in the Environmental Report 2013, the delivery security of hot water for district heating in Akranes has been affected by the Deildartunga Pipe. It is the longest hot water pipeline in Iceland, but is showing its age and is stretched to the limit of its transport capacity. Also, serious break-

Figure 10. Work at the hot water duct in Rofabaer, Reykjavik. Photo: Hildur Ingvarsdóttir.

REYKJAVIK ENERGY´S DISTRICT HEATING UTILITIES

UTILITY	PRODUCTION FIELD	NO. OF WELLS	ANNUAL PRODUCTION		QUANTITY	COMMENTS	IMPORVEMENTS
			thous. tons	l/s			
Capital area	Laugarnes	10	4,126	131	Sufficient		
	Ellidaár	7	1,739	55	Sufficient		
	Reykir	22	11,698	371	Sufficient	Wholesale to Mosfellsbaer	
	Reykjahlíd	12	13,946	442	Sufficient	Wholesale to Mosfellsbaer	
	Nesjavellir	18	24,541	778	More than ample		
	Hellisheidi	31	10,462	332	More than ample		
WEST ICELAND:							
HAB	Deildartunguhver	1	4,175	132	Limited		Work on production capacity
	Wells in Baeir	2	366	12	Limited		
Skorradalur	Well in Stóra Drageyri	1	290	9	Sufficient		
Munadarnes	Well in Munadarnes	1	195	6	Sufficient		
Nordurárdalur	Well in Svartagil	3	371	12	Sufficient		
Bifröst	Well at Bifröst	1	139	4	Sufficient		
Stykkishólmur	Wells at Stykkishólmur	2	863	27	Sufficient	One injection well and back-up power	
SOUTH ICELAND:							
Hveragerdi	Wells in Hveragerdi	3	Data not available		Sufficient	Steam utility and closed circuit systems	
Ölfus	Bakki II	1	47	1	Sufficient		
Thorlákshöfn	Bakki I	2	1,169	37	Sufficient		
Austurveita Utility	Wells at Gljúfurárholt	3	449	14	Sufficient	Part of the water used in Hveragerdi	
Grímsnesveita Utility	Wells in Öndverðarnes	3	1,666	53	More than ample	Two wells in use	
Hlídarveita Utility	Well in Efri-Reykir	1	760	24	Sufficient	Renewal of well head in preparation	
Rangárveita Utility	Wells at Kaldárholt	2	1,196	38	Sufficient		Further research to provide hot water in
	Wells at Laugaland	2	596	19	Limited		

Table 2. Reykjavik Energy's district heating utilities along with information on the annual production, comments and improvements.

downs of the pipe have recently increased in the area near Akranes. Construction of a new storage tank for hot water in the town was expedited, and it was taken into use in December 2014. The close finish will be completed early 2015.

In the latter part of 2014 a pumping station was set up on the land of Sörlatunga just north of Lake Gíslholtsvatn. This measure increases the transport capacity of Rangá District's Heating Utility from Kaldárholt.

The Thorlákshöfn District Heating Utility utilises two wells, and the water level of one of them has dropped. The situation is closely monitored.

A thermal power station is operated in Hveragerdi, and two wells provide the steam. Scale formations in wells require drilling to clean them out every two years to keep them working. In May 2014 one of the two wells was cleaned by drilling. As has been done for decades, rinse water from the drilling was run through a drainage conduit running from the hot spring field down toward Varmá River. Water from the hot spring field and the thermal power station generally runs through the conduit. The project was bigger in scope than anticipated which meant that more aggregates went into Varmá River than usual. It is clear that the preparations were insufficient. Following this incident the matter was reviewed with the permit issuers, and proposed improvements were set out that have proved effective. An operating permit for Hveragerdi's District Heating Utility was renewed in 2014.

Nearly 56,000 users (intake) were connected to the distribution system of Reykjavik Energy's District Heating Service in 2014, of these there were more than 250 new users (intake).

Did you know?

The district heating utility in the capital area has about 900 MW of thermal power in use, which is comparable to the total power of all Landsvirkjun's hydropower plants in the Thjorsa River area.

Access to cold water utility

Reykjavik Energy water utilities ensure residents and companies in the distribution area potable water in accordance with the quality standards and provisions of laws and regulations. There was a water shortage in Grundarfjördur early year 2014, but this was resolved successfully in collaboration with users in the area.

GOALS:

Residents in Reykjavik Energy's distribution areas have secure access to cold water in accordance with quality standards and regulations. After fulfilment of the needs of residents, companies have the option to utilise potable water for production or export. The expansion of the distribution system outside urban areas and customers' particular connections shall be determined, for example, by technical prerequisites and efficiency.

The production of potable water for the capital area is in Heidmörk, but Reykjavik Energy operates, in addition, water utilities in Stykkishólmur, Grundarfjördur, Akranes, Borgarnes and the remote rural areas of Borgarbyggd, Úthlíd, Álftanes and at Nesjavellir and Hellisheidi Geothermal Power Plants (Table 3 and a picture of Reykjavik Energy's utilities in Annex 1). Potable water is also sold at wholesale to Seltjarnarnes and Mosfellsbaer, see Environmental Report 2013.

In the distribution area Reykjavik Energy has attained the quality of cold water that meets the quality standards and provisions of laws and regulations; however, see the discussion of silt in water from the water supply at Grábrók in the section on Conservation of Potable Water Resources.

In February 2014 there was a shortage of cold water in Grundarfjördur. Residents were urged to save water. Management of the utility was improved, and its operations were balanced.

In 2014 the operating permit of the water utility in Borgarnes was merged with the operating permit for the water utility in Grábrók.

REYKJAVIK ENERGY´S COLD WATER UTILITIES

AREA	UTILITY	WATER SUPPLY	MONITORING METHOD	ANNUAL PRODUCTION		COMMENTS	IMPORVEMENTS
				thous. tons	l/s		
Capital area	Reykjavík, Seltjarnanes, Mosfellsbaer	Gvendarbrunnar, Myllulaekur and Vatnsendakrikar	Well sampling	22,465	712		
	Álftanes	Vatnsendakrikar	Well sampling	375	12	Water purchased from Gardabaer	
	Hellisheidi	Engidalur	Well sampling	24,504	776		
	Nesjavellir	Grámelur	Tank sampling	56,348	1,786	Thermal pollution	Substantially reduce chemical and thermal release before year end 2016
Vest Iceland	Akranes	Berjadalur, Slöguveita Utility and Ósveita Utility	Overflow	1,502	48	UV water purification	
	Borgarnes, Bifröst and Munadarnes	Grábrók, Seleyri as back-up for Borgarnes	Well sampling	1,174	37	Wells at Seleyri used as a backup water supply for Borgarnes in water shortages and when silt is detected from Grábrók	Pipe rinsed regularly, pumping speed kept constant, filtering equipment will be purchased in 2015
	Grundarfjördur	Grund	Well sampling	666	21		
	Hvanneyri	Fossamelar	Overflow	75	2		
	Reykholt, Kleppjárnsreykir	Steindórsstadir	Well sampling	103	3		
	Stykkishólmur	Svelgsárhraun	Overflow	524	17		
South Iceland	Hlídarveita Utility	Bjarnarfell	Overflow	93	3	Water obtained from Bláskógabyggd if there is water shortage	

Table 3. Reykjavik Energy's cold water utilities along with information on monitoring measures on the water level, annual production, comments and improvements.

More than 24,000 users (intake) were connected with Reykjavik Energy's distribution system in 2014. Of these there were less than 150 new users (intake). It must be mentioned that information about users (intake) is lacking in some instances since a large portion of intake was installed by house owners at one point.

Figure 11. Employees practising fall precautions and co-worker rescue in a closed well of a cold water utility at Hólmsá River at Raudhólar. Photo: Hildur Ingvarsdóttir.

Did you know?

Potable water in the capital area falls as precipitation in Bláfjöll Mountains and Heiðmörk.

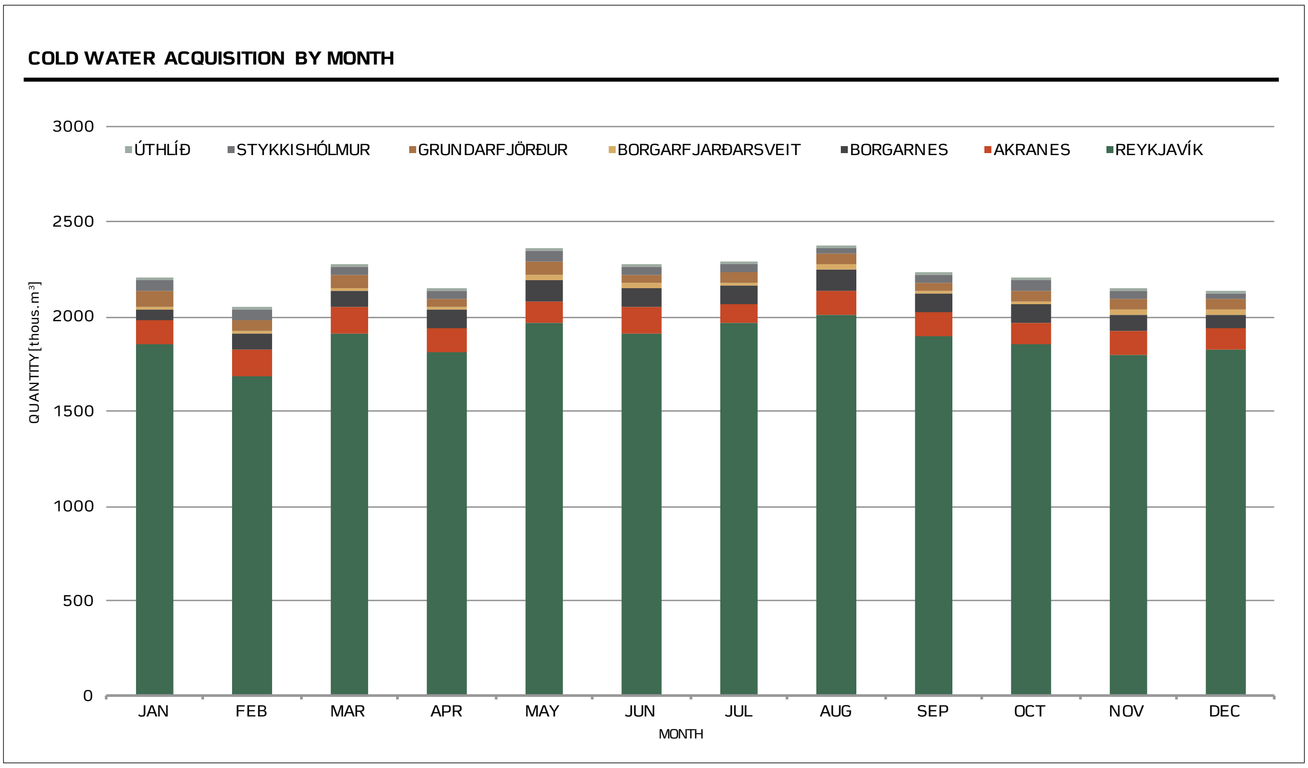


Figure 12. Cold water acquisition in 2014 by month in Reykjavik Energy's distribution area.

Access to sewerage system

Plans call for taking sewage treatment plants into use in West Iceland in 2016.

GOALS:
Residents and the business community in Reykjavik Energy's collection areas shall have the option of connecting to sewerage systems or treatment works fulfilling the requirements of laws and regulations.

Reykjavik Energy sees to the development and operation of sewerage systems in Reykjavik, Akranes, Borgarnes, Bifröst, Hvanneyri, Varmaland and Reykholt. Sewage from Kópavogur and Mosfellsbaer, in addition to parts of Seltjarnarnes and Gardabaer, is also handled in sewage treatment plants at Ánanaust and Klettagardar (picture of Reykjavik Energy's utilities in Annex 1).
In Reykjavik over 99% of residents and companies are connected to sewerage systems or treatment plants. Development of sewerage systems in Akranes and Borgarnes is not finished, but the goal is that sewage treatment plants there will be taken into use in 2016.

A continuation of "The Plan", which was to strengthen Reykjavik Energy's operations, will prioritise projects with lot not having access to sewerage system.

Did you know?

The toilet is not a wastebasket, and examples of what should not go into it include kitchen roll sheets, wet wipes, cotton, cotton swabs and sanitary napkins. Sewage is pumped into sewage treatment plants, and these foreign objects plug the pumps. They can also plug the pipe system, particularly if they are mixed with fat, which speeds up wear and tear on the sewerage system. About 800 tons of this waste are trapped each year by grates and needs to be disposed of.

Figure 13. Pumping station at Laugalaekur. Photo: Thorsteinn Ari Thorgeirsson.

Impact of emissions and discharge

Reykjavik Energy's operations inevitably lead to substances and energy being released into the environment. Reykjavik Energy takes the utmost precautions in its operations. Emissions, therefore, occur only if it is assured that the effect on people's health is negligible, and the impact on the environment acceptable. Reykjavik Energy reduces the emission of pollutants as much as possible and emphasizes research and development to be able to utilize the best possible solutions for that purpose.

Discharge of disposal water and monitoring of groundwater

The reception of disposal water into the reinjection fields at Hellisheidi Geothermal Power Plant has dropped and projects were prioritized to increase their capacity. At Nesjavellir efforts are being made to reduce the surface discharge of thermal water before year-end 2016 and finding a good solution for better utilizing or releasing heated ground water from the power plant.

GOALS:

Construct and operating permits shall be fulfilled regarding chemical and heat pollution in groundwater outside the defined dilution areas nearby the geothermal power plants. No disposal water shall be discharged onto the surface of the ground except if breakdowns occur. Counteract pressure drop in the geothermal system.

Hellisheidi Geothermal Power Plant

At Hellisheidi Geothermal Power Plant the fluid harnessed is returned to the geothermal reservoir by re-injection into wells. The fluid is called disposal water, which is a term for both separated water (geothermal water from wells along with geothermal steam, both containing dissolved solids from the rock) and condensate water (geothermal steam that has condensed, which can contain dissolved geothermal gases). In accordance with the construct and operating permit, all separated water and part of condensate water ought to be re-injected into the geothermal reservoir. This is done to protect surface water and groundwater in addition to better utilizing the geothermal reservoir. The construct and operating permit authorises surface release in emergency instances. Hellisheidi Geothermal Power Plant is the only geothermal plant in Iceland operating in accordance with such stringent requirements on the release of disposal water.

Many research and development projects are underway to fulfil the aforementioned requirements on reinjection, and various problems need resolution. It is worth mentioning in this regard that the reception of the reinjection fields at Hellisheidi Geothermal Power Plant has decreased. It has therefore not been possible to re-inject all of the disposal water from the power plant into the geothermal reservoir except by operating the thermal heating utility at full power in order to cool the water. This has proved effective in year 2014 but has also entailed an increased load on the thermal heating utility and cooling towers.

The following projects are in progress to ensure secure operations of the injection utility of Hellisheidi Geothermal Power Plant:

- Disposal water is cooled to facilitate its release.
- Disposal water is re-injected into wells that are not utilised for the production of steam.
- Reinjection wells are stimulated. This, among other things, cleans out scale formations that may clog the wells.
- Work is in progress to prevent scale formations in injection wells.
- Drilling additional injection wells is being considered, as well as channelling disposal water to the ocean.

The projects launched in 2014 proved to be successful, and reception in the reinjection fields increased. However, more will be required.

To assure the production of Hellisheidi Geothermal Power Plant without drilling additional wells in the production field, all available production wells will be utilised for the production of steam, despite the fact that some of them are not very productive. These wells are relatively low in enthalphy which means that the water flow is high compared to the steam flow, and disposal water from the power plant has therefore increased. With this, the load increases on the injection system of the power plant beyond the benefit gained with the projects described above. Therefore, the operations of Hellisheidi Geothermal Power Plant had to be arranged so that disposal water would be discharged via overflow despite there being no major breakdowns involved. The permit issuers have been kept informed of the situation and the measures possible to employ each time, as well as the projects being worked on to increase reception of the power station's injection fields.

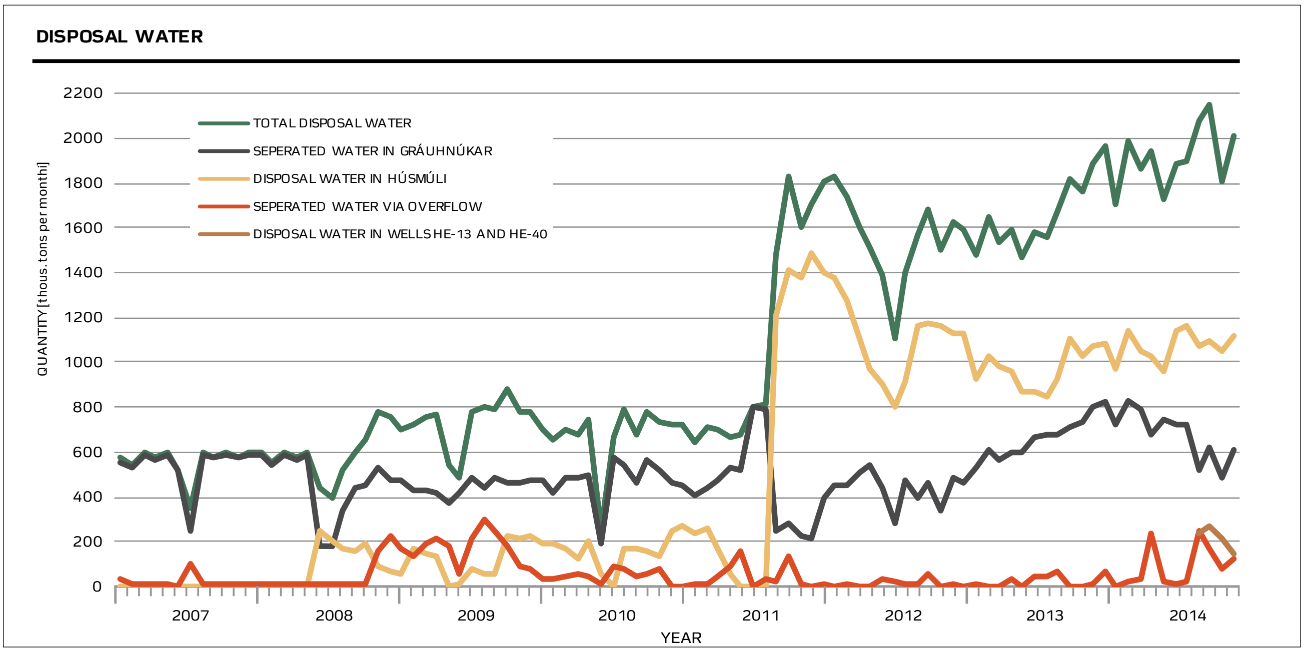


Figure 14. The quantity of disposal water (tons/month) from Hellisheidi Geothermal Power Plant 2007–2014, by release route. Until September 2011 the main portion of disposal water was re-injected into wells at Gráuhnúkar. Disposal water from the power plant increased when the Sleggjan Plant was commissioned in the autumn 2011. The reinjection field at Húsmúli was then taken into full operation. The release of disposal water on the surface via overflow decreased significantly in the latter part of 2011 with improvements in the power station's operations but increased again around mid-2014 with the dwindling reception of reinjection fields.

Figure 14 shows the quantity of disposal water from Hellisheidi Geothermal Power Plant and its release routes. In 2014 more than 23 million tons of disposal water were re-injected into the geothermal system at Gráuhnúkar, Húsmúli and wells that were not utilised for steam production. Part of the disposal water, more than 1 million tons, was released via overflow at the surface (Table 4).

In light of the greater amount of disposal water being released via overflow in 2014, the frequency of sampling has been increased in order to follow the chemical composition of groundwater in observation wells in the area (Annexes 8 and 9). Less than 4.5% of the power plant's disposal water was released via overflow because of breakdowns and operational difficulties with the station's injection system in 2014 (Table 4). Up to now more than 5 million tons of disposal water have been released via overflow. Annex 10 shows a summary of events since 2014 causing disposal water to be released via overflow at Hellisheidi Geothermal Power Plant.

The geothermal reservoir is under close surveillance, e.g., with help of chemical tracers, so that the impact of reinjection on it can be analysed. The first results indicate that the reinjection supports pressure in part of the geothermal system. However, there is also a risk of reinjection cooling the production fields, see section on Managing High-Temperature Geothermal Resources. It is therefore necessary to find balance between reinjection and production in the field and control the quantity of water

DISPOSAL WATER AT HELLISHEIDI

	SEPERATED WATER VIA OVERFLOW	SEPARATED WATER IN GRÁUHNÚKAR	DISPOSAL WATER IN HÚSMÚLI	DISPOSAL WATER IN WELLS HE-13 AND HE-40	TOTAL DISPOSAL WATER
YEAR	**[tons/yr]**	**[tons/yr]**	**[tons/yr]**	**[tons/yr]**	**[tons/yr]**
2007	215,290	6,502,485	0		6,717,776
2008	482,961	5,439,180	1,123,300		7,045,441
2009	2,050,421	5,334,842	1,381,544		8,766,807
2010	571,887	5,684,478	1,825,974		8,082,339
2011	505,895	5,373,601	6,461,122		12,340,619
2012	163,496	5,223,595	13,358,110		18,745,201
2013	232,714	7,620,175	11,732,828		19,585,717
2014	1,024,406	8,281,272	12,841,626	859,838	23,007,142
TOTAL	**5,247,072**	**49,459,629**	**48,724,504**	**859,838**	**104,291,042**

Table 4. Disposal water (tons/year) from Hellisheidi Geothermal Power Plant 2007–2014, by release route.

re-injected in order to reduce cooling of the field. Considerable work on tracer testing was performed in 2014 in order to better map the impact of reinjection on the geothermal production.

In connection with the measures mentioned above to increase the reception of reinjection fields, a procedure has been followed to reduce the likelihood of increased seismic activity induced by reinjection, see section on Seismic Activity Associated with Reinjection of Disposal Water.

Hopefully within a few years, experience and increased knowledge of the complex process of reinjection in Hellisheidi will become sufficient to ensure efficient and secure operation of the power station's injection system. The experience with re-injecting disposal water from Hellisheidi Geothermal Power Plant will be utilised by other geothermal plants in Iceland and abroad.

Monitoring groundwater at Hellisheidi Geothermal Power Plant

The impact of Hellisheidi Geothermal Power Plant on groundwater in surveillance wells at and around the plant is monitored. Samples are taken for analysis of overall chemical and heavy-metal content; in addition, the temperature, conductivity and acidity are measured (Annexes 8 and 9). The concentration of dissolved solids in wells is far below the limits set for potable water and has not increased. Annex 11 shows the typical concentration of several trace elements in separated water from Hellisheidi Geothermal Power Plant and their maximum recommended concentration in potable water.

Nesjavellir Geothermal Power Plant

Disposal water at Nesjavellir Geothermal Power Plant consists of separated water and water from condensation as well as heated groundwater from Grámelur at Lake Thingvallavatn. About half of the separated water and most of the condensate water is injected to the lower groundwater layers via injection wells, while the rest is released at the surface, i.e., into shallow wells or into Nesjavellir Brook (Table 5). During summer when there is less demand for hot water for space heating than during winter, the largest portion of the disposal water released at the surface is heated groundwater (hot water for space heating)(Table 5).

Our Nature has a duty to minimise the power station's impact on the quality of groundwater, and the impact on Lake Thingvallavatn shall be monitored in particular(Figure 14). As stated in Environmental Report 2013, the impact of thermal pollution from the power station is now perceptible in Lake Thingvallavatn in an area of approximately 2 km along the lake's shore, and the impact penetrates to a depth of approximately 40 cm and some distance from the shore, depending on weather conditions. Improvements have been prioritised in order to reduce the undesirable impact. In the spring of 2014 the plan through year-end 2016 was reviewed at a meeting with the permit issuers for the purpose of reducing thermal and chemical release on the surface in Nesjavellir. Examples of promising projects already producing results and planned projects are:

- Cooling of heated groundwater through spraying it into a brook channel to reduce heat release on the surface.

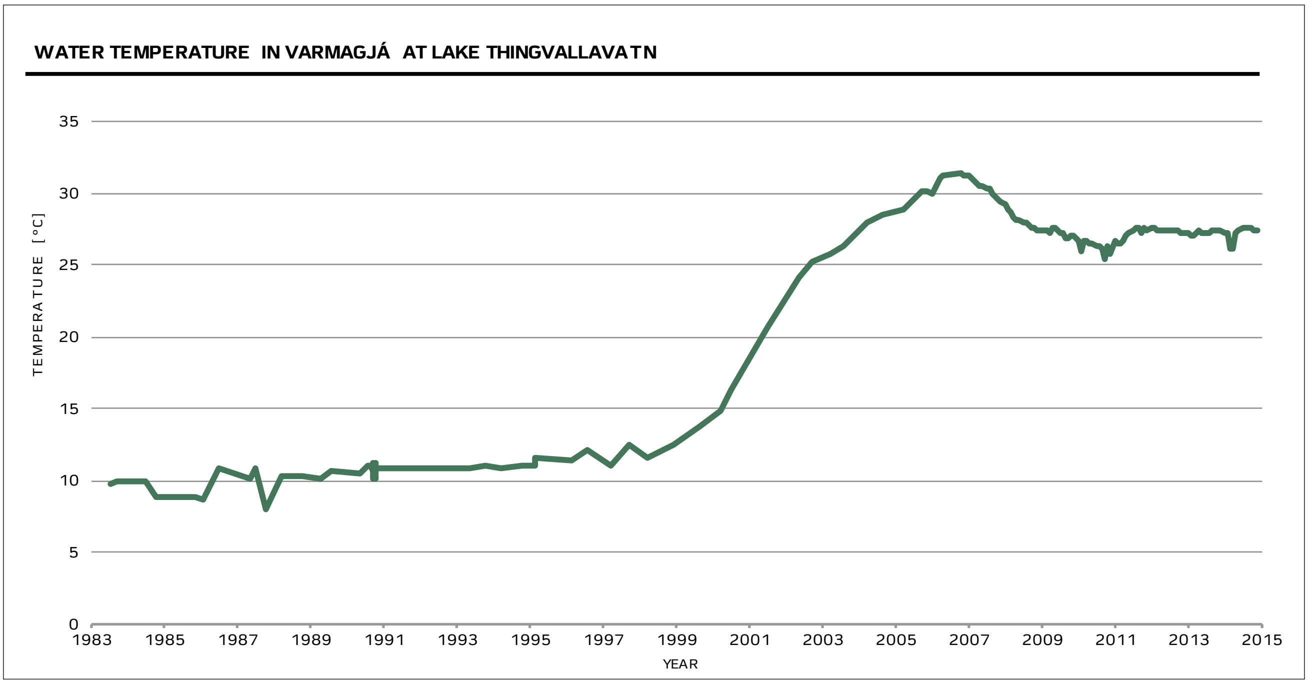


Figure 15. Water temperature (°C) in Varmagjá 1983-2014. When electricity production began in Nesjavellir Geothermal Plant in 1998, thermal pollution increased considerably but decreased slightly when injection wells were taken into use in the period 2004-2008 as well as a cooling tower in 2005.

DISPOSAL WATER AT NESJAVELLIR

YEAR	SEPARATED WATER		CONDENSATE WATER		HEATED GROUNDWATER	DISPOSAL WATER
	INJECTION WELLS	STREAM	INJECTION WELLS	SURFACE	SURFACE	TOTAL
	[thous. m^3/yr]	[thous. m^3/yr]	[thous. m^3/yr]	[thous. m^3/yr]	[thous. m^3/yr]	[thous. m^3/yr]
2013	3,461	4,567	4,269	3,257	26,687	42,241
2014	2,788	5,288	4,529	3,078	29,333	45,016

Table 5. Disposal water (in thousands of cubic metres/year) from Nesjavellir Geothermal Plant in 2014 by release route.

- Drilling of two injection wells to dispose of separated and condensate water that currently is released onto the surface. The planned completion date of the project is spring 2015.
- Better utilisation of the excess production of heated groundwater instead of releasing it on the surface or re-injecting it.

The goal of these projects is to stop the discharge of separated water and condensate water on the surface at year-end 2016. Another goal is to find a solution for utilisation or release of heated groundwater from Nesjavellir in the capital area. Reykjavik Energy has therefore established a special-effort group to look for ways in this respect as quickly as possible.

Monitoring groundwater at Nesjavellir Geothermal Power Plant

The effect of Nesjavellir Geothermal Power Plant on groundwater in surveillance wells in Nesjahraun at the power station. In addition to temperature measurements in the wells, there is also monitoring of the chemical composition and temperature in brooks near the power station and Lake Thingvallavatn shoreline springs. Annex 11 shows the typical concentration of several trace elements in separated water from Nesjavellir Geothermal Power Plant and their permissible concentration in potable water.

Numerical groundwater model of the Hengill area and casing of injection wells

A numerical groundwater model of the Hengill area is revised every year. It is part of the groundwater model that also covers the water supply of the capital area. This information is important for the power stations' heating utility water acquisition, and the impact of disposal water on groundwater. Injection wells are cased down past the upper groundwater layers in the production fields to prevent disposal water from mixing with the upper groundwater layers.

Monitoring the biology in Thorsteinsvík at Lake Thingvallavatn

The biology in Thorsteinsvík at Lake Thingvallavatn has been monitored since before Nesjavellir Geothermal Power Plant was built. The goal of the surveillance is to follow the possible effect of non-organic trace elements in disposal water from the power station on the biology of Lake Thingvallavatn, in order to be able to respond if something adverse happens. Arsenic, lead, cadmium and mercury in disposal water from Nesjavellir Geothermal Power Plant have been deemed to have negative impact on biology of Lake Thingvallavatn. Measurements by the Natural History Museum of Kópavogur indicate that these trace elements do not have statistically significant effects on the biology, see Environmental Report 2013.

Did you know?

A substantial groundwater system is in the Hengill area. The groundwater flows in three main directions: northeast to Lake Thingvallavatn, south to the sea at Selvogur and west to the Ellidaá catchment area. The total flow of groundwater is more than 50 m^3/s.

Mynd 16. Nesjavellir Geothermal Power Plant and Lake Thingvallavatn. Photo: Gretar Ívarsson.

Emissions of hydrogen sulphide

The concentration of ambient hydrogen sulphide in urban areas was below regulation limits in 2014. A hydrogen sulphide abatement unit was commenced at Hellisheidi Geothermal Power Plant in June. It removes up to 25% of the power station's hydrogen sulphide emission. In 2015 an experimental steam hood will be built at the power plant, to ensure increased dispersal of hydrogen sulphide and further reduce its concentration in urban areas.

GOALS:

Provisions of regulations on the concentration of hydrogen sulphide in the atmosphere shall be fulfilled.

Emission of geothermal gases is an inevitable part of high-temperature geothermal utilisation. The concentration of most of them is low and does not cause problems. Quite some quantity of hydrogen sulphide (H_2S) is emitted, inevitably affecting air quality in the vicinity of the power plants in the Hengill area. Emission of hydrogen sulphide is the main environmental issue with which Our Nature contends in its operations, see Environmental Report 2013.

Total emissions of hydrogen sulphide from Nesjavellir and Hellisheidi Geothermal Power Plants were about 17,760 tons in 2014. This is considerably less than was reported in the two previous environmental reports. The data on the hydrogen sulphide emitted the past two years have been corrected in light of an error in the calculations of hydrogen sulphide concentration in the steam. Monitors and permit issuers were immediately informed of the matter, and outside specialists were hired to review the measurements and calculation process. The error has no impact on measurement in the air quality monitoring stations. Summaries of hydrogen sulphide emissions from the power stations are shown in Annexes 12 and 13 show. Figure 17 shows hydrogen sulphide emissions per energy unit from Hellisheidi and Nesjavellir.

Environmental limits and exemption from regulation

Under Regulation no. 514/2010, on the Concentration of Hydrogen Sulphide in the Atmosphere, environmental limits are set, 50 µg/m³, based on the maximum daily running 24-hour average. The concentrations may exceed those limits three times every year, see discussion of exemption from the regulations below. Other environmental limits are that the maximum annual average shall be 5 µg/m³, and the environmental authorities shall be notified when the

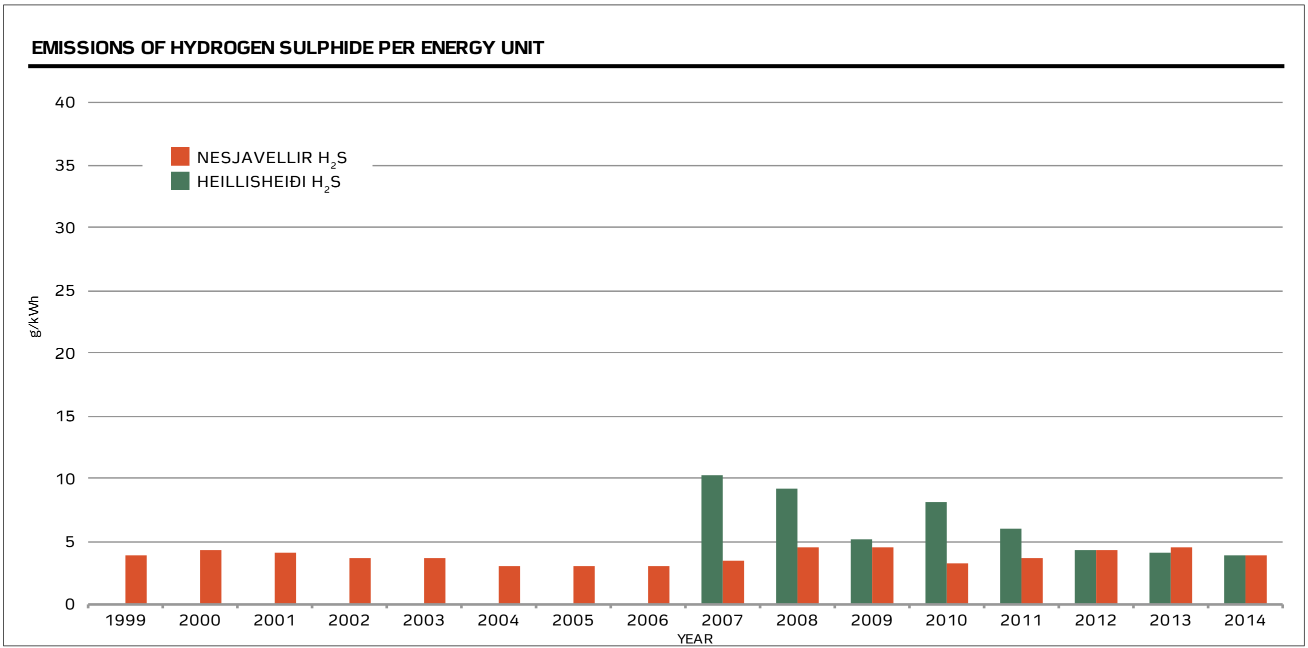


Figure 17. Emissions of hydrogen sulphide (H_2S) per energy unit from Hellisheidi Geothermal Power Plant 2007-2014 and from Nesjavellir Geothermal Power Plant 1999-2014. Some variability in emissions between years is explained, among other things, by the quantity of water and steam harnessed from the production fields and the variable concentration of the gas between fields.

concentration measured exceeds 150 µg/m³ for three continuous hours. Regulation no. 514/2010 does not apply in the industrial areas at Hellisheidi and Nesjavellir Geothermal Power Plants. There, Regulation no. 390/2009 on Pollution Limits and Methods to Reduce Pollution in Workplaces applies. The pollution limit in a work environment is 7000 µg/m³ and depends on the average of an eight-hour workday, and 14,000 µg/m³ when based on the average over a 15-minute period. Annex 14 shows a comparison between environmental limits of regulations in µg/m³, on one hand, and ppm, on the other.

Early 2014, Reykjavik Energy applied to the Ministry for the Environment and Natural Resources for a six-year exemption from tightened provisions of Regulation no. 514/2010 on the Concentration of Hydrogen Sulphide in the Atmosphere. Six years is the estimated time required to develop and establish the purification procedure (the SulFix procedure) described in the project plan. Early June 2014, the ministry granted a two-year exemption from deregulation, with conditions. It is stated that no later than 15 January 2015, Reykjavik Energy shall inform the South Iceland Public Health Board and the Environment Agency of Iceland of the status of the SulFix Project, and before 1 July 2015 the company shall make a decision on whether the project will continue, and whether other purification procedures will be launched.

Monitoring the concentration of hydrogen sulphide in the air

According to the provisions in the operating licence of Nesjavellir and Hellisheidi Geothermal Power Plants, the concentration of hydrogen sulphide in the atmosphere is monitored in the vicinity of the power stations and in urban areas, in collaboration with the South Iceland Public Health Board, i.e., in Hveragerdi, Nordlingaholt, and in the industrial areas at Hellisheidi and Nesjavellir. The real-time data can be accessed on the webpage of South Iceland Public Health Board, www.heilbrigdiseftirlitid.is, and the website of the Environment Agency of Iceland, www.ust.is. In the autumn 2014, it was decided to purchase a mobile air quality monitoring station. The plan is to operate the station for one year in Laekjarbotnar and utilise it in more places if required. The goal is to start up the station in February 2015. In 2014 a rule of standardised procedure was worked on regarding the response if hydrogen sulphide in the atmosphere exceeds the notification limit, and how announcements to permit issuers shall be done.

Following the volcanic activity north of Vatnajökull Glacier, at the request of Environment Agency of Iceland and the South Iceland Public Health Board, it was decided to change measurements in the air quality monitoring stations so that they measure the concentration of hydrogen sulphide along with the concentration of sulphur dioxide because of the volcanic activity. The change entails increased lack of sensitivity in measurements of hydrogen sulphide, particularly while the concentration of sulphur dioxide is high.

In 2014 the concentration of hydrogen sulphide was below the annual average in Hveragerdi (3.7 µg/m³) and in Nordlingaholt (4.0 µg/m³). In Nordlingaholt the concentration twice exceeded the environmental limits for the maximum daily running 24-hour average (50 µg/m³), Figures 18 and 19 .

The concentration was below the notification limits (150 µg/m³). Annex 15 shows the 24-hour averages and monthly averages for the concentration of hydrogen sulphide in Hveragerdi and Nordlingaholt for 2014. Annex 16 specifies the thirty highest hourly averages for the concentration in Hveragerdi and Nordlingaholt. This information can be found on Reykjavik Energy's webpage: www.or.is. In Hellisheidi the minimum average

Figure 18. At Nesjavellir. Photo: Magnea Magnúsdóttir

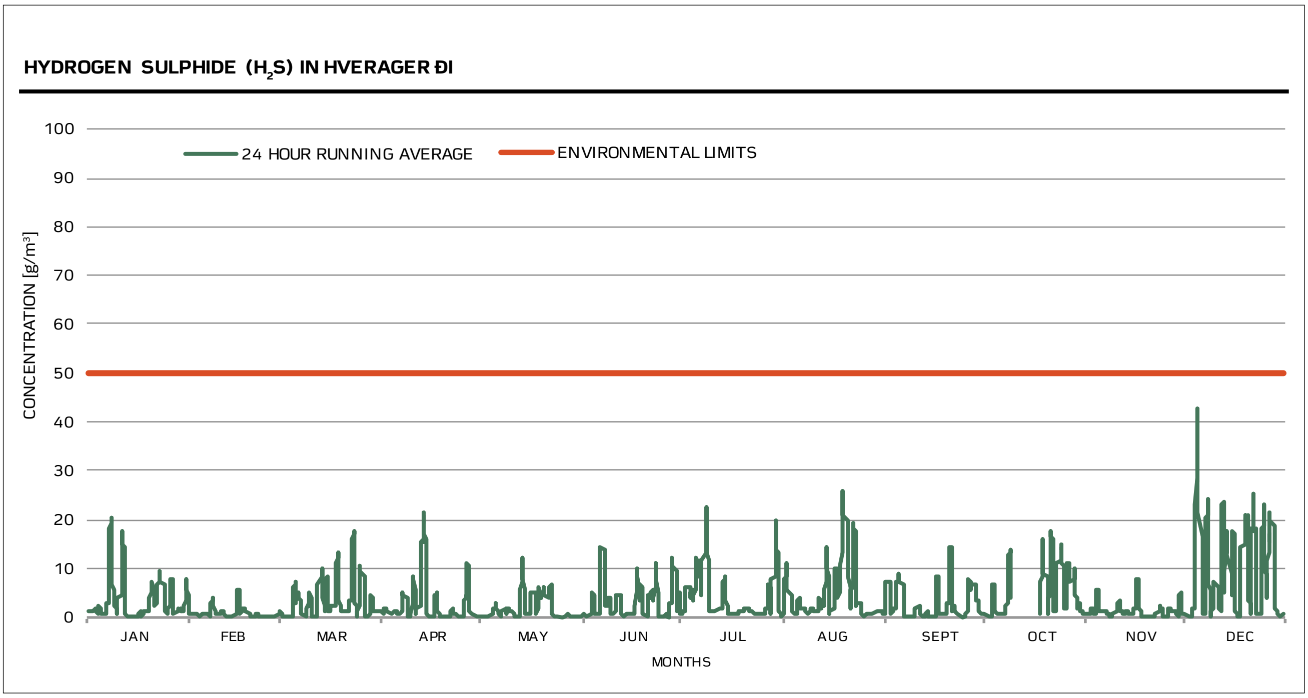


Figure 19. The daily concentration (running 24-hour average) of hydrogen sulphide (H_2S) in Hveragerdi in 2014. For comparison the environmental limits under Regulation no. 514/2010 are shown. The concentration did not exceed the limits.

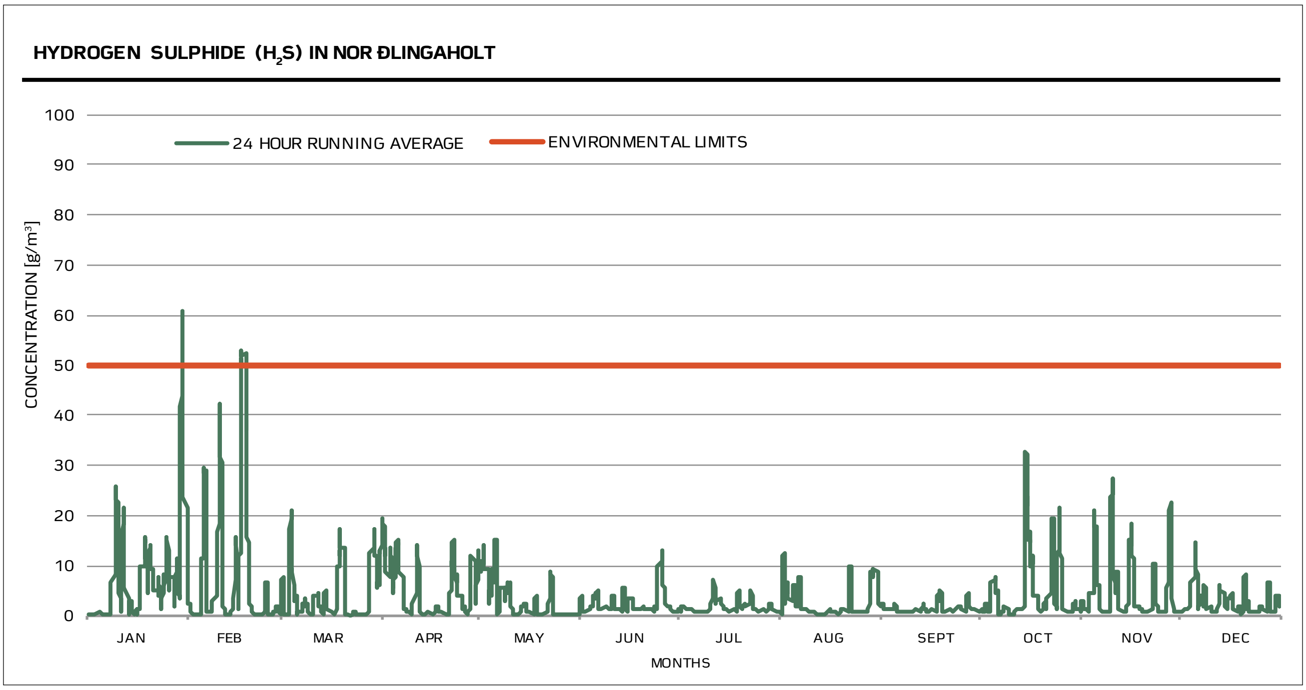


Figure 20. The daily concentration (running 24-hour average) of hydrogen sulphide (H_2S) in Nordlingaholt in 2014. For comparison the environmental limits under Regulation no. 514/2010 are shown. The concentration exceeded the limits twice.

hourly concentration was 0 μg/m³, and the maximum valued was 992 μg/m³, which is below the limits for a work environment. In Nesjavellir the minimum concentration was 0 μg/m³, and the maximum value was 789 μg/m³, which is below the limits for a work environment.

Hydrogen sulphide in the atmosphere is also routinely monitored at over 130 measuring plots in the Hengill area. The findings show that the concentration in previous years has exceeded the odour limits in the industrial area at Hellisheidi and Nesjavellir and in their immediate vicinities.

Hydrogen sulphide abatement unit and steam hood at Hellisheidi Geothermal Power Plant

The last several years, systematic and organised work has been ongoing to reduce the concentration of hydrogen sulphide in the air with environmentally sound and efficient solutions. The goal is to find a way to dispose of hydrogen sulphide by re-injecting it via wells into the geothermal reservoir in the vicinity of Hellisheidi Geothermal Power Plant. It is expected that there the hydrogen sulphide will form minerals rich in hydrogen sulphide and remain sequestered in the bedrock. This project, which has been developed in collaboration with the power companies Landsvirkjun and HS Orka, seeks to imitate a natural process occurring in geothermal fields to sequester hydrogen sulphide in the bedrock. The companies' joint project plan was agreed and made public in February 2013. Operation of a hydrogen sulphide abatement unit was initiated early June 2014. There hydrogen sulphide and carbon dioxide are separated from other geothermal gases in the steam, dissolved in water from the power station and re-injected into basaltic rock at 1000 m depth. The hydrogen sulphide abatement unit removes up to 25% of the power station's hydrogen sulphide emissions. According to calculations, about 1300 tons of hydrogen sulphide have been channelled down into the bedrock since early June 2014 to the end of December 2014. The flow into the re-injection well is very closely monitored in order to find signs of clogging. So far there are no signs of this. During preparations for the SulFix project, numerous studies were undertaken on the sequestration of hydrogen sulphide in geothermal systems. Their findings indicate that hydrogen sulphide re-injected into the geothermal system is sequestered in the form of minerals, as long as the hydrogen sulphide concentration in the re-injected water is higher than its concentration in the geothermal system. Tracers are injected in order to assess how much hydrogen sulphide is sequestered in the geothermal system. The results will become available in 2015.

A construction of an experimental steam hood at the power station is being prepared. Meteorological research there indicates that the steam hood will ensure increased dispersal of hydrogen sulphide and thereby reduce its concentration in the air of urban areas. Plans call for the steam hood to be built in the first quarter of 2015.

Further experiments with geothermal gases

In 2015 an experimental station will be built at Hellisheidi Geothermal Power Plant to develop a method to remove carbon dioxide from the water re-injected in the SulFix project. The purpose is to re-inject pure hydrogen sulphide instead of a mixture of carbon dioxide and hydrogen sulphide, as is now done, and thus create more space for re-injecting hydrogen sulphide into the bedrock. This opens possibilities for utilising carbon dioxide, which could promote the multiple utilisation of geothermal energy, see section on Access to Multiple Utilisation Possibilities of High-Temperature Geothermal Resources and Emissions of Other Geothermal Gases. Known procedures for isolating carbon dioxide from hydrogen sulphide entail the use of non-local chemicals. On the other hand, Our Nature, in cooperation with the power companies Landsvirkjun and HS Orka, wants to find other environmentally sounder ways to separate hydrogen sulphide without using hazardous chemicals.

Research on dispersion of hydrogen sulphide

Our Nature has supported research under the auspices of the University of Iceland. It monitors the dispersion of hydrogen sulphide for a radius of up to 30 km from the geothermal power plants in the Hengill area and in three cross sections of the capital area. The findings show that the weather, landscape and type of soil affect the dispersal of hydrogen sulphide from the power stations. Steam plumes can follow the landscape and lie alongside mountain ranges. The findings also show that high values in urban areas have been measured when the weather is cold (< 3 °C, low wind speed (1.5 - 4 m/s)), and there is little mixing of the air. In 2014 there were few opportunities to measure the concentration of hydrogen sulphide in cross sections of the capital area since weather conditions for measurements were unfavourable. The findings from this research are expected to be utilised, for example, in improving models of the dispersal of hydrogen sulphide.

Research on the effect of hydrogen sulphide on vegetation

In 2012 surveillance of vegetation began in the vicinities of the geothermal power plants in Nesjavellir and Hellisheidi, see Environmental Report 2013. The first findings indicate that hydrogen sulphide affects moss closest to the power station.

Did you know?

In the autumn 2014, the volcanic eruption north of Vatnajökull Glacier released more sulphur into the air each day than the geothermal plants in the Hengill area usually do in one year.

Emissions of other geothermal gases (carbon dioxide, hydrogen and methane)

Opportunities are followed for utilising geothermal gases and making them marketable. The findings of the CarbFix Project at Hellisheidi Geothermal Power Plant show it is possible to sequester carbon dioxide quickly and permanently in basaltic bedrock and thus reduce its release.

GOALS:
To increase the multiple utilisations of Our Nature's power plants by making geothermal gases marketable, depending on viability.

The emissions of geothermal gases like carbon dioxide (CO_2), hydrogen (H_2) and methane (CH_4) have increased with geothermal energy production in the Hengill area. Recently, the interest of Our Nature and prospective customers has increased in utilising these gases, i.e. carbon dioxide for greenhouse farming and hydrogen and methane for transport or chemical processes in industry. Information has been gathered on the cost of processing geothermal gases in a marketable form. In 2015 an experimental station will be built at Hellisheidi Geothermal Power Plant to develop a method to remove carbon dioxide from the water re-injected in the SulFix project, see section on Emissions of Hydrogen Sulphide. The station strengthens the premises for the design of and feasibility study for an industrial scale station that, in addition, can entail possibilities for utilising carbon dioxide.

In 2014 the combined emissions of carbon dioxide from Nesjavellir Geothermal Power Plant and Hellisheidi Geothermal Power Plant were about 55,440 tons in 2014. The emission of hydrogen was 950 tons and of methane about 140 tons in 2014. Annex 12 contains a summary of the emissions of carbon dioxide, hydrogen and methane from Hellisheidi and Nesjavellir for the period 2003-2014.

In Nesjavellir the emissions of carbon dioxide per unit of energy decreased for the period 2000-2006 as well as in Hellisheidi for the period 2007-2013 (Figure 21). The most likely explanation is that the concentration of carbon dioxide diminished over time, as is common with long-term production.

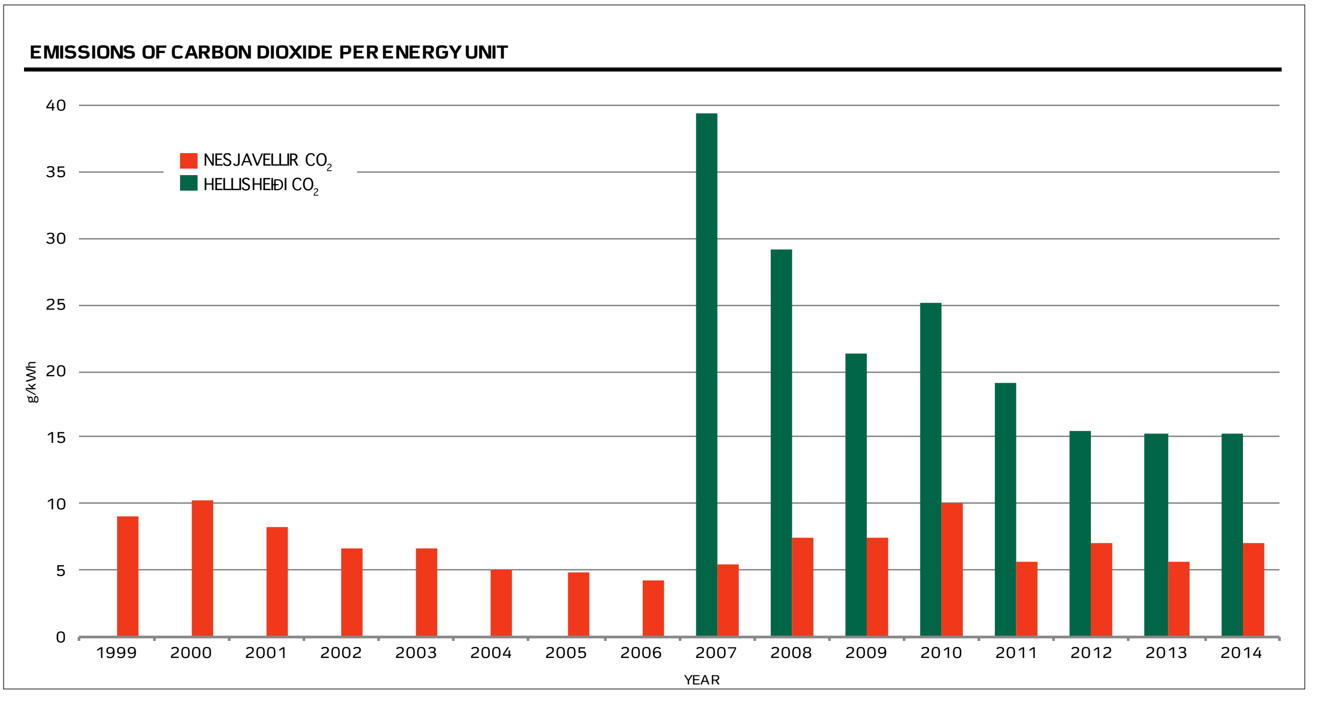


Figure 21. Emissions of carbon dioxide (CO_2) per energy unit from Hellisheidi Geothermal Power Plant 2007-2014 and from Nesjavellir Geothermal Power Plant 1999-2014. Emissions from the power stations differ considerably. The most likely explanation is the variable concentration of carbon dioxide between fields.

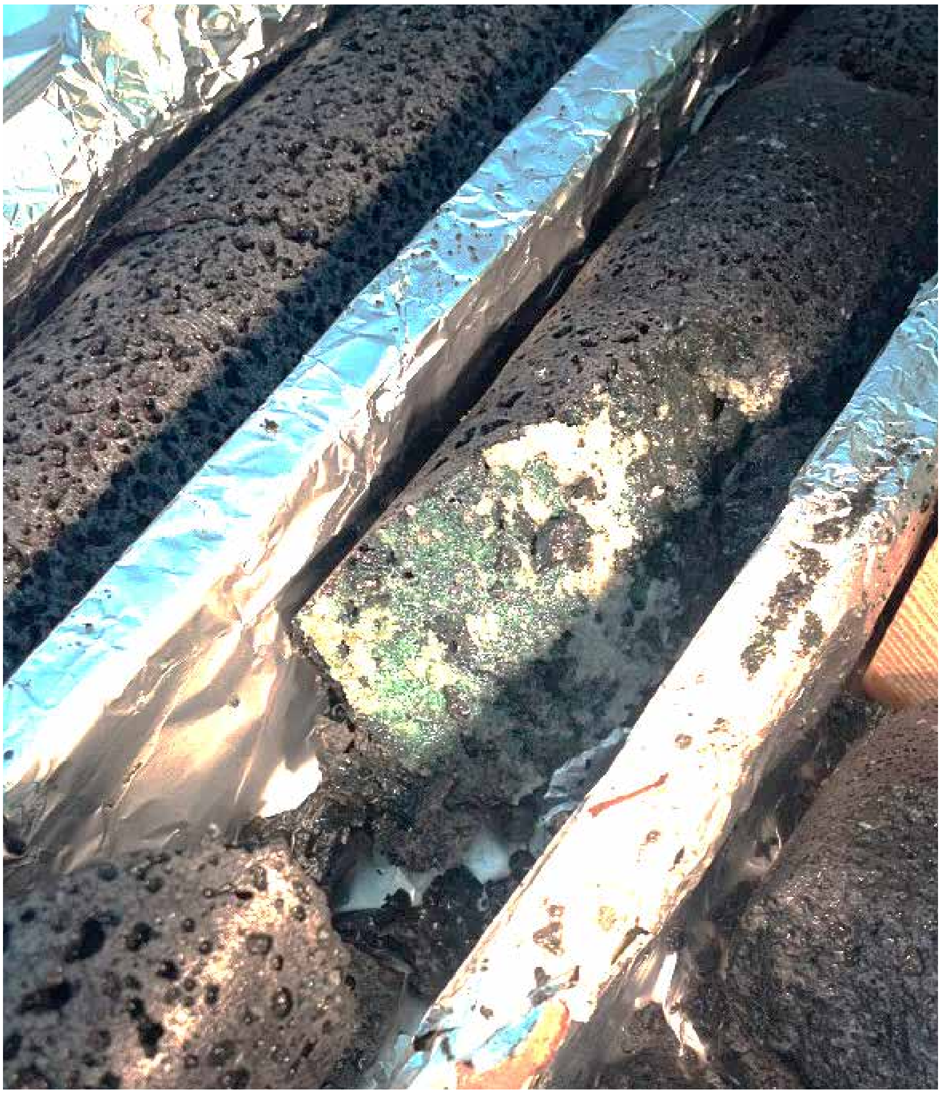


Figure 22. Calcite in basaltic bedrock in the CarbFix Project field at Hellisheidi Geothermal Plant following re-injections of dissolved carbon dioxide from the power station. Tracers (green tinge) distinguish between newer and older calcite precipitates. Photo: Sandra Ósk Snaebjörnsdóttir.

Innovation and development project: CarbFix

The CarbFix project initiated at Hellisheidi Geothermal Power Plant in 2007. Its goal is to reduce emissions of carbon dioxide from the power plant by re-injecting it, dissolved in water, into the basaltic bedrock in the power station's vicinity and sequestering it there in mineral form. About 250 tons of carbon dioxide have been channelled down into the bedrock at a depth of 400-800 m in the experimental. Samples taken from a monitoring well in the vicinity prove a sequestration rate of 80-90% in mineral form within a year from re-injection. In the autumn 2014 a core sample of rock was taken by drilling in the CarbFix project field. The core clearly showed that carbon-rich precipitates had formed following re-injection of carbon dioxide in the area (Figure 21). The core samples further support the findings of the project that carbon dioxide can be sequestered quickly and permanently in basalt bedrock and thus reduce emissions from this greenhouse gas.

The findings of the CarbFix Project, methodology and technical equipment have been utilised directly in the SulFix project where the goal is to remove hydrogen sulphide from emissions from Hellisheidi Geothermal Power Plant, see section on Emissions of Hydrogen Sulphide. The CarbFix project is an example of collaboration between an Icelandic company and universities located on both sides of the Atlantic Ocean. This was a prerequisite for the development of this idea into a realistic project useful to the business community. It is clear that Our Nature is much better prepared to handle the number of demanding tasks accompanying the SulFix project because of experience and networks from the CarbFix Project.

Did you know?

Carbon dioxide from Hellisheidi Geothermal Power Plant originates from the magma of the Hengill volcanic system and can be utilised for the production of eco-friendly fuel.

Seismic activity associated with re-injection of disposal water

Did you know?

Re-injecting disposal water into the geothermal reservoir at Hellisheidi Geothermal Power Plant is done to make it possible to better utilise the geothermal reservoir.

Seismic activity increased at Hellisheidi Geothermal Power Plant in the spring of 2014 in connection with the testing and starting up of the SulFix project. However, the activity was within acceptable limits and was, for the most part, finished in the summer. A work procedure was developed to reduce the likelihood of seismic activity induced by re-injection of disposal water at Hellisheidi Geothermal Power Plant.

GOALS:

Seismic activity possibly associated with re-injection of disposal water shall cause the least possible inconvenience and never cause damage.

The re-injection field at Húsmúli at Hellisheidi Geothermal Power Plant was taken into use in the autumn 2011, and since then disposal water has been continuously re-injected into the geothermal reservoir. The commencing of the re-injection field caused considerable induced seismicity at the start, but it fell off considerably as the winter passed, and in the summer of 2012, it was, for the most part, finished. Some seismic activity occurred in March and April of 2014 in connection with the testing and starting up of the SulFix project, see section on Emissions of Hydrogen Sulphide. The activity was within acceptable limits and was, for the most part, finished in the summer. In the latter part of 2014, seismic activity at Hellisheidi Geothermal Power Plant was negligible, see Annex 17.

In 2014 a work procedure was introduced for re-injection of disposal water that reduces the likelihood of seismic activity induced by the flow (Figure 22). The work procedure builds on international instructions regarding re-injection. It involves a colour-coded flowchart that is used in many places for geothermal projects. Permit issuers and other stakeholders in the vicinity of re-injection fields are informed of measures if they are deemed to possibly affect seismic activity. As matters now stand, acceleration measurements are not available in real-time, and it was therefore decided to use the magnitude of earthquakes as a criterion each time in order to determine whether and which measures shall be employed.

WORK PROCEDURE FOR CHANGES IN REINJECTION OF DISPOSAL WATER

Event		Field Operation	Communications
Start	Seismic monitors in place and active	Injection started slowly. Pumping increased in stages with lag time in between.	Notify the Department of Civil Protection and Emergency Management and Icelandic Meteorological Office (IMO).
No flow increase	M 2.0 to 2.5	No flow or pressure increase for two hours.	Status report sent to IMO.
Decrease flow	M 2.5 to 3.5	Injection is decreased by one step and a 12 hour stop on further injection changes.	Status report to regulators, Department of Civil Protection and Emergency Management and IMO.
Stop injection	M > 3.5t	Stop injection operation.	Status report to regulators, Department of Civil Protection and IMO. Assess possible damages.
End	Reinjection stable	No action.	Notify Department of Civil Protection and Emergency Management and IMO.

Figure 23. New work procedure for major change in the re-injection of disposal water into the geothermal reservoir near Hellisheidi Geothermal Power Plant.

Discharge of wastewater from sewage treatment plants

The discharge of sewage from Reykjavik Energy's treatment plants in the capital area and Borgarfjördur is in accordance with Reykjavik Energy's operating permit and goals. The load within the sewage dilution areas in the capital area is within acceptable limits.

GOALS:

Reykjavik Energy shall ensure that the load within the sewage dilution areas is within acceptable limits, and that pollution at their perimeter and at the coast does not exceed the limits set in laws and regulations. Reykjavik Energy monitors the reception of sewage in accordance with provisions of operating permits.

Sewage discharge reporting for Reykjavik

The sewage discharge reporting for the treatment plants in Ánanaust and Klettagardar in Reykjavik states information on the outflow of pollutants exceeding criteria in Annex II of Regulation (EC) no. 166/2006. Calculations are based on samples collected from treated sewage four times a year regarding measurements of nitrogen and phosphorus and twice a year for trace elements. The data for 2014 are presented in Annex 18, and sewage discharge reporting for the plants in Ánanaust and Klettagardar is presented in Annexes 19 and 20.

Research on marine load within dilution areas and at the coast of the capital area

The operating permits of sewage treatment plants in Reykjavik define dilution areas, where microbes may exceed environmental limits, but outside their boundaries microbes shall be below limits (Figure 24). Operating permits stipulate that exhaustive research on the impact of discharge into the sea shall be carried out every four years. Research in accordance with operating permits was

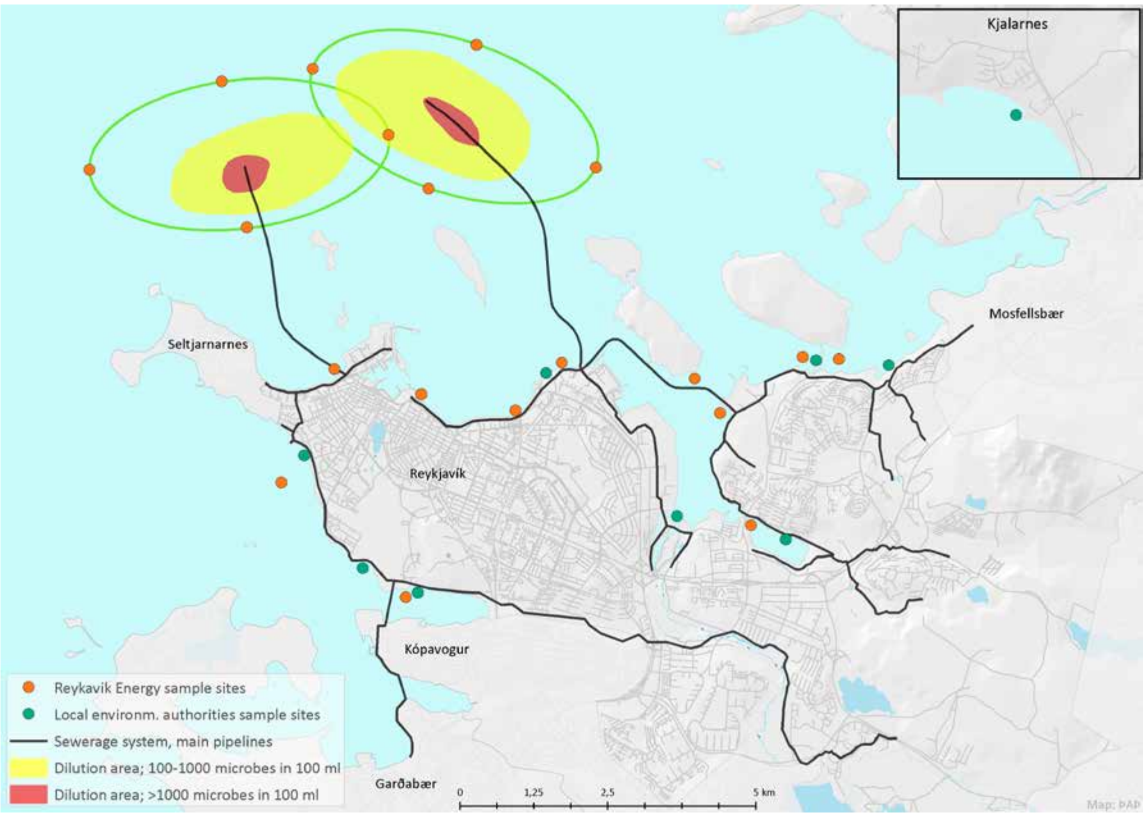


Figure 24. Dilution areas for outlets from sewage treatment plants in Ánanaust and at Klettagardar in Reykjavik and locations of sampling sites.

SEA WATER QUALITY

SEA WATER QUALITY AT THE COAST							
Samples	**Heat-tolerant microbes**		**2010**	**2011**	**2012**	**2013**	**2014**
RDEP AND RE	Faecal coliforms	%	94	96	97	90	86*
	Enterococci	%	91	97	99	99	95*
SEA WATER QUALITY AT THE PERIPHERY OF DILUTION AREAS							
Samples	**Heat-tolerant microbes**		**2010**	**2011**	**2012**	**2013**	**2014**
RE	Faecal coliforms	%					97
	Enterococci	%					100

* In 2014 Reykjavik Energy (RE) collected samples in addition to those collected by Reykjavik's Department of Environment and Planning (RDEP), and the findings are shown in the table. RDEP's sampling sites in Brautarholt and Kollafjördur are not in RE's area of influence and are not included in the results for 2014.

Table 6. Sea water quality. The percentage (%) of samples below limits, i.e., less than 100 in a 100 ml sample at the coast in Reykjavik and less than 1000 in a 100 ml sample at the periphery of dilution areas for the period 2010-2014.

Did you know?

The annual drainage from Reykjavik Energy's sewage treatment plants in Klettagardar and Ánanaust is more than 80 million tons.

carried out during the period 2008-2011. In accordance with the findings, it may be concluded that silt in the discharge areas is not under pollutant load that is traceable to sewage. Consequently, further treatment of the sewage would not improve the environmental impact on the marine sediment.

Under Regulation no. 798/1999 on Sewerage Systems and Sewage and Reykjavik Energy's goals, the number of heat-tolerant microbes outside dilution areas in the sea shall be less than 1000 in a 100 ml sample in at least 90% of instances. At the coast where there are outdoor recreational areas, or there is food manufacturing in the vicinity, the number shall be less than 100 in a 100 ml sample in 90% of instances.

In 2014 samples were collected under the auspices of Reykjavik Energy to measure the number of heat-tolerant microbes at 11 sites at the coast near overflows, and eight samples were collected at the periphery of the dilution area (Figure 24). The samples were collected four times, in March, June, September and December. The measurements came in addition to sampling by Reykjavik's Department of Environment and Planning, which collects samples from nine sites within the area of influence of Reykjavik Energy's sewerage system, where there is relatively easy access to the coast. The department's sampling is performed once a month during the period from April into October, a total of 63 samples. Results show that samples are under the criteria limits in 90% of instances, except samples for faecal coliforms (86%) at the coast (Table 6).

Washing equipment for waste and sand

In 2014 the installation of equipment for washing waste and sand off grates in sewage treatment plants was worked on in Klettagardar and at Ánanaust. It will be taken into use at the start of 2015. Improvements were also carried out on a grease cistern in the treatment plant in Klettagardar, which will facilitate emptying it.

Biological sewage treatment plants in West Iceland

In Borgarfjördur Reykjavik Energy operates four biological sewage treatment plants, in Bifröst, Hvanneyri, Varmaland and Reykholt. At the plants testing of sewage takes place four times a year in accordance with the operating permits. Samples are collected from the drainage, and suspended particles, fat/grease, COD, phosphorus, nitrates, enterococci and faecal coliform are analysed. The values of samples taken in 2014 were within limits except regarding enterococci and faecal coliform. Last year an attempt was made to find explanations for this, in cooperation with the West Iceland Public Health Board. Acceptable explanations for the microbes have not yet been found, but work will continue on finding ways to remedy the situation.

Mynd 25. In a sewage treatment plant. Photo: Hildur Ingvarsdóttir.

Discharge of drainage through overflows

Discharge of drainage via overflows was within limits in the capital area.

GOALS:

The use of overflows to deal with load from rainwater shall be less than 5% of the year, and emergency overflows shall never be active.

Under Regulation no. 798/1999 on Sewerage systems and Sewage overflow in the sewerage system may be active for up to 5% of the year, or when the ratio of sewage mixed with hot water from district heating utilities or rainwater is at least 1:5.

In 2014 the discharge of drainage via overflows was within limits in the capital area (Figure 26). The emergency overflow in Skeljanes was active less than 2% of the year, mostly at the start of December because of maintenance.

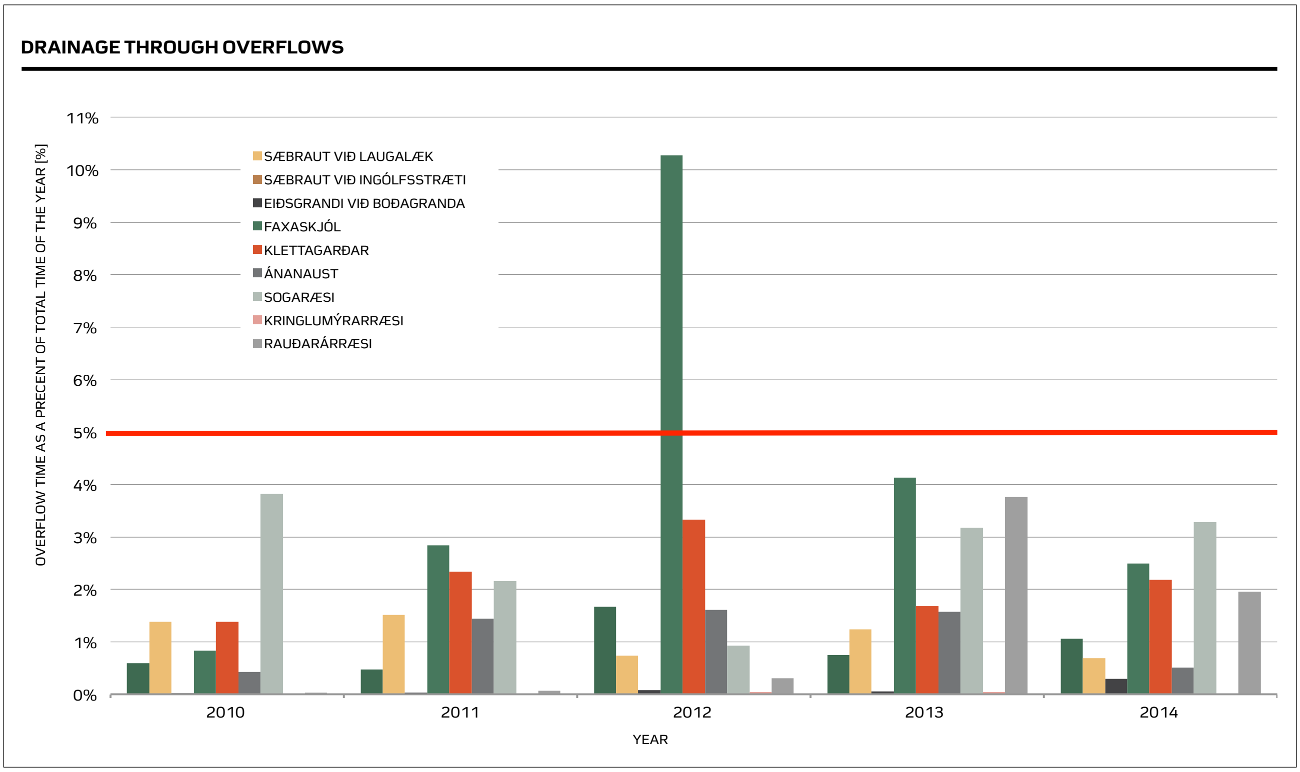


Figure 26. Overflow time in pumping stations and overflows in Reykjavik Energy's sewerage system in the capital area 2010-2014. The 5% criterion is shown with a red line.

Figure 27. Maintenance. Photo: Bjarni Líndal.

Did you know?

The results of testing of the chemical content of sewage have been used to assess the use of narcotics in the utility area.
Impact on society

Impact on society

Nationally, Reykjavik Energy is a big company, and the employees have valuable experience, knowledge and skills on the utilisation of geothermal energy and other aspects of the company's utility operations. Employees share knowledge and have influence on the value chain. This encourages others to act towards the environment in a responsible way and has positive impact on society.

Dissemination of knowledge on geothermal energy utilisation and other aspects of the operations

Reykjavik Energy and Our Nature's Science Day was held for the first time in 2014, and the attendance was good. Domestic and foreign media provided considerable coverage of the CarbFix project in 2014. Employees gave diverse talks on the operations of Reykjavik Energy at the spring meeting of Samorka (Association of Energy and Utility Companies in Iceland).

Did you know?
In the spring of 2014, an article on the CarbFix project was published in Science. The article's authors are co-workers of Reykjavik Energy in the project: Dr. Sigurdur R. Gíslason, research professor at the University of Iceland's Institute of Earth Sciences, and Dr. Eric Oelkers, professor at University College in London and CNRS in Toulouse.

GOALS:

Information that is useful to others and does not harm Reykjavik Energy's utility systems or its business interests shall be accessible. This pertains, for example, to reports, articles and presentations, insofar as possible, and published publicity materials.

Reykjavik Energy's employees possess valuable experience, knowledge and skills on the production and distribution of power and water to residents and companies. It is important to share this practical know-how, which could encourage others to act towards the environment in a responsible way and has positive social impact.

Reykjavik Energy and Our Nature's Science Day was held for the first time in March 2014. Its purpose is to present research done for and in collaboration with the companies. The findings of the research done by scientists were presented, and utilisation of geothermal energy in Iceland and its impact were prominent on the programme. About 100 guests attended Science Day. Plans call for Science Day to become an annual event.

Six public presentation meetings were held in 2014 at Reykjavik Energy's headquarters about various aspects of its operations.

Domestic and foreign media provided considerable coverage of the CarbFix project in 2014. In April, for example, an article was published on the project in *Science*, and in September its results were presented on a webpage for the EU's Energy Plan, which has generously supported the project. In September a core sample of rock was drilles in the experimental area of the CarbFix Project in the vicinity of Hellisheidi Geothermal Power Plant. The core clearly showed that carbon-rich precipitates had formed following re-injection of carbon dioxide in the area (Figure 22). Journalists came to the country, for example, from the NY Times, The Nordic Council of Ministers, in addition to a team from French television working on a documentary regarding matters related to CarbFix. Reykjavik Energy's scientists were interviewed along with their co-workers on the project, and photos were taken at the drilling site. More media coverage of the project can be expected in coming months.

At the end of August 2014, Reykjavik Energy played a part in the International Carbon Conference (ICC2014), which was held in Iceland. Scientists met there in five European and Nordic networks, working on projects related to geothermal energy and geochemistry: CarbFix, CO_2-React, MetTrans, MINSC and NORDICS. About 160 people attended the conference, including 35 students. Most of those attending the conference came from the Nordic countries and the United States.

Samorka's spring meeting was held in Akureyri in May 2014. The meeting is a mixture of seminars and exhibition on the affairs of utility companies. Nearly 50 talks were given at the meeting. Ten of Reykjavik Energy's employees either gave presentations or directed discussions (Figure 28). Following that, they gave presentations at a meeting for their co-workers in Reykjavik Energy.

Figure 28. Magnea Magnúsdóttir, Our Nature's manager of Land Reclamation, gives a talk on restoration and land reclamation at Hellisheidi Geothermal Power Plant at Samorka's spring meeting that was held in Akureyri. Photo: Sigurdur Ágústsson.

Procurement

In 2014 Reykjavik Energy became a founding member of the Procurement Network overseen by the Environment Agency of Iceland, and environmental requirements will continue to be fine-tuned for procurement in 2015.

GOALS:

The environmental impact of procurement shall be taken into consideration, wherever possible, for example, by analysing lifecycle costs and using recognised environmental criteria and checklists. Procurement shall be organised and coordinated, with side effects in mind, for example, transport and the quantity of packaging.

Reykjavik Energy's purchases of goods and services are extensive. Since 2008 the company has striven to utilise materials that Reykjavik Energy has in inventories or sell them off. In this way, the waste of raw materials, energy, time and money has been avoided, see Environmental Report 2013.

In tenders for automobiles for work categories in 2014, criteria were set for emissions of carbon dioxide, and in a tender for delivery vans, one condition was that they would be powered by methane. Electric cable spools are returned to the manufacturers instead of disposing of them. All print paper and all substances utilised for cleaning are environmentally labelled. In the latter part of 2012 print control was established, which entails that employees use access cards for printing and photocopying. The number of printers with print control has slowly but surely increased, and printing and photocopying, combined, have decreased by nearly 20% since 2012.

In the latter part of 2014 Reykjavik Energy became a founding member of the Procurement Network, which is a group of companies that wants to reduce environmental impact with ecological purchases. Environmental labelling is used in the purchase of operating supplies, for example, paper, cleaning products, office products, et cetera.

In 2015 environmental requirements for purchasing will be fine-tuned further. This entails informing suppliers of increased ecological emphases in purchasing, for example, in tender advertisements, wherever possible. It will also be possible to distinguish ecological products from other products on suppliers' invoices in the product categories defined in the Purchase Network. The build-up of knowledge of ecological purchasing will continue in 2015.

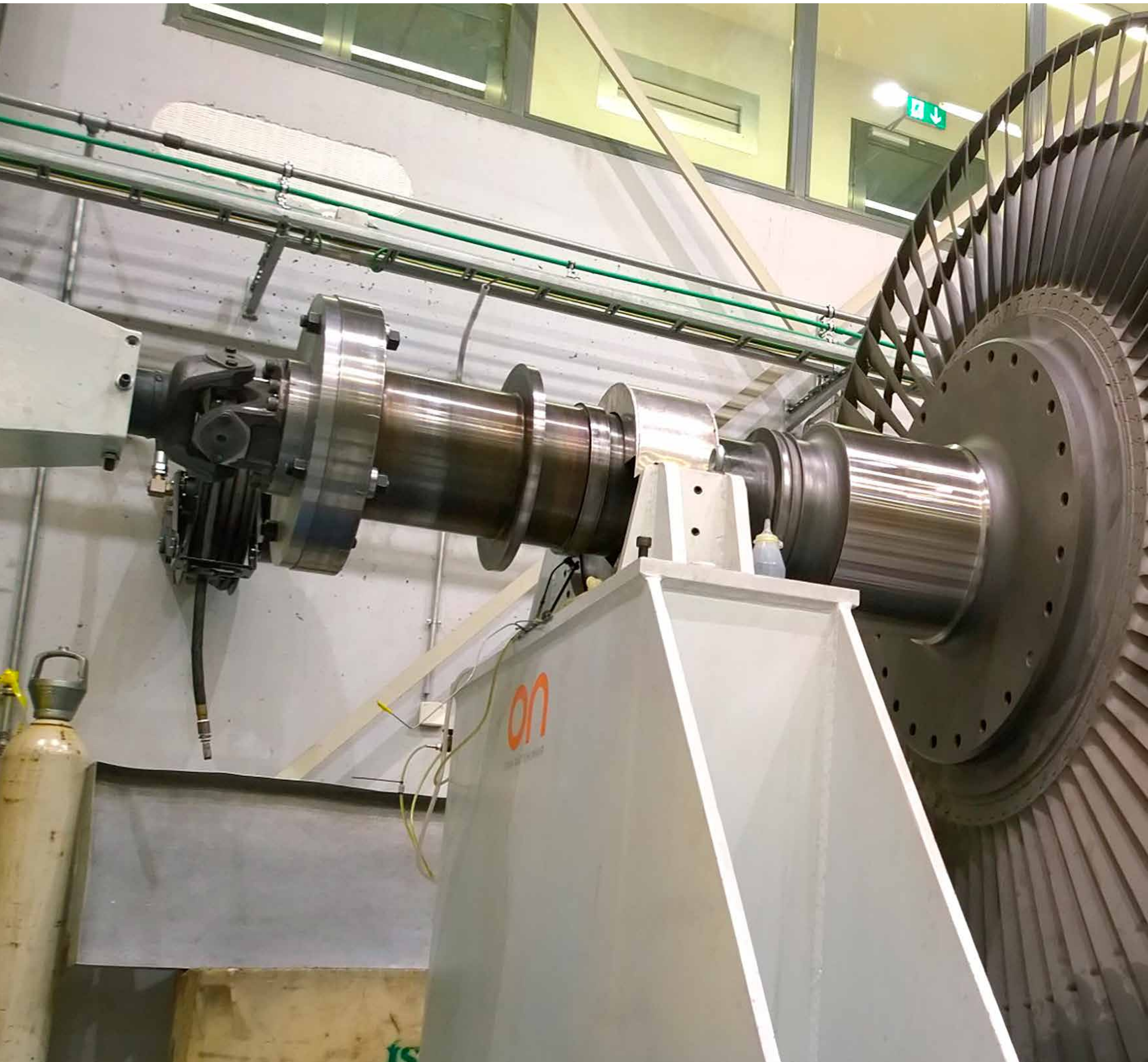
Did you know?

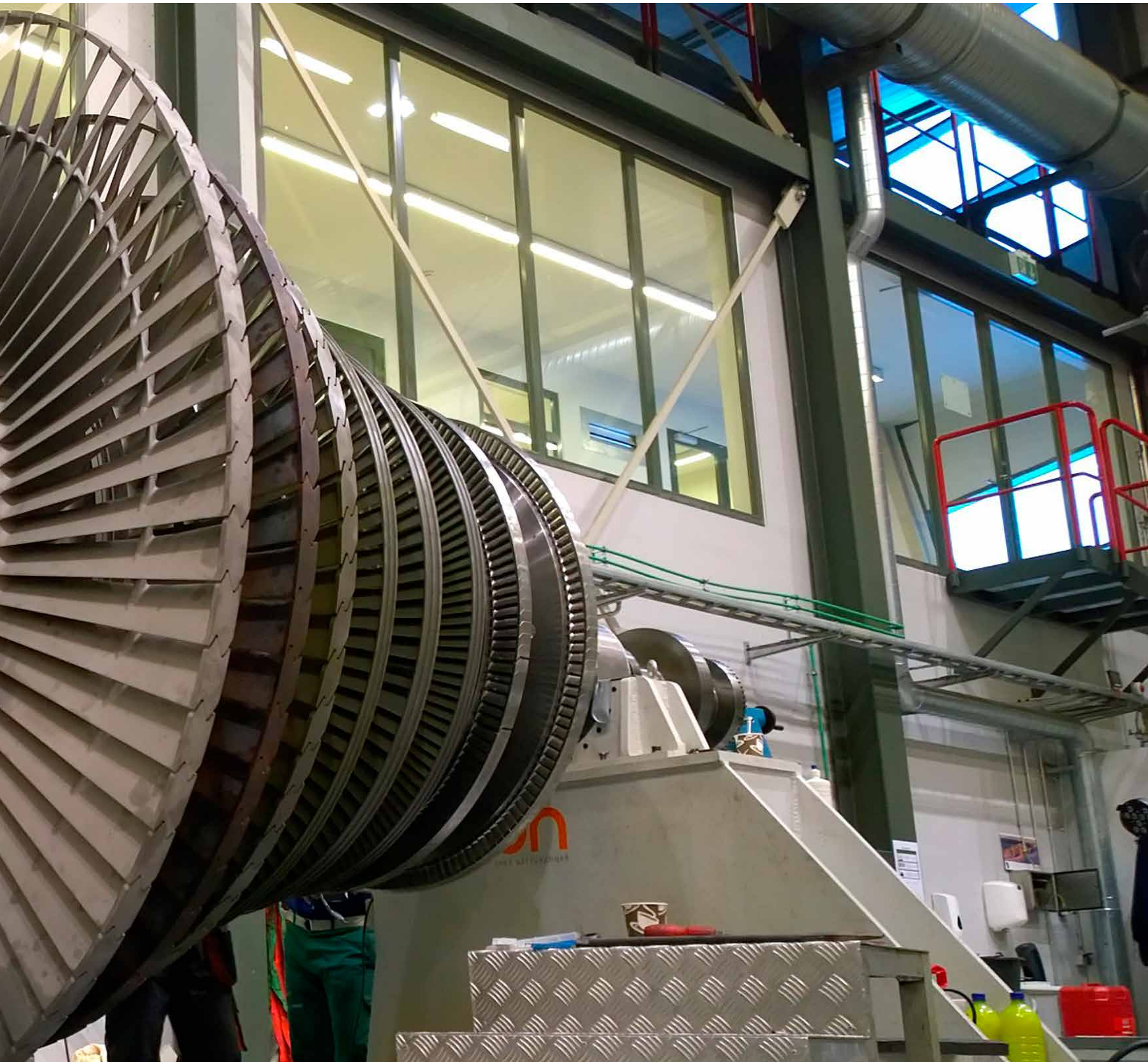
Reykjavik Energy purposefully defines purchases and strives to utilise purchased materials well. As an example the utilisation of older inventories in 2014 was good, and the balances of older inventories decreased by 19%. Purchase of about 800 product types was discontinued.

Figure 29. Pipe inventory in Hellisheidi. Photo: Magnea Magnúsdóttir.

Operations

Reykjavik Energy's operations build on the organised and disciplined actions of many employees in distributed work sites. This includes responsible utilisation of supplies, treating structures with care and taking good care of lots and received land, handling waste responsibly and urging environmentally friendly transport. Reykjavik Energy wants its practices to be exemplary and to train and reinforce employees' qualifications in this regard.





Waste

Did you know?

It is possible to convert 1 kg of organic waste into 0.6 kg of compost.

Training was reinforced on recycling and sorting waste from Reykjavik Energy in 2014, and work procedures were improved.

GOALS:

There will be the least possible waste, and it will be recycled insofar as possible. The least possible amount of active waste shall be buried.

A great deal of waste accumulates in Reykjavik Energy's operations, and after treatment it is divided into three categories:

- Waste for landfilling (divided into solid constituents from sewage and general waste).
- Waste for recycling.
- Hazardous waste.

There were more than 1500 tons of waste in 2014, the main part of it coming from sewage treatment plants —more than 1300 tons (about 87%) (Figure 29). The rest was about 200 tons. Of this about 75 tons were general and coarse waste. There were about 135 tons of waste for recycling and nearly 6 tons of hazardous waste. Annexes 21 and 22 show how waste is divided between categories and work sites.

In 2014 instruction for Reykjavik Energy's employees was reinforced regarding the recycling and sorting of waste. Sorting of plastic and renewable instructions began in coffee and printing facilities and open space, which better describes our reality than the old instructions. Instructions were also improved on the sorting of coarse waste and hazardous waste. Companies renting facilities in Reykjavik Energy's headquarters also participated in the project. Following the campaign, no notably significant change occurred in the quantity of waste for landfilling or recycling. On the other hand, employees are more conscious about sorting waste, which is positive. In 2015 information will be collected on gravel, soil and asphalt that accumulate and are disposed of because of projects.

By sorting and recycling waste, each and every one of us can make a contribution and have positive impact on the environment.

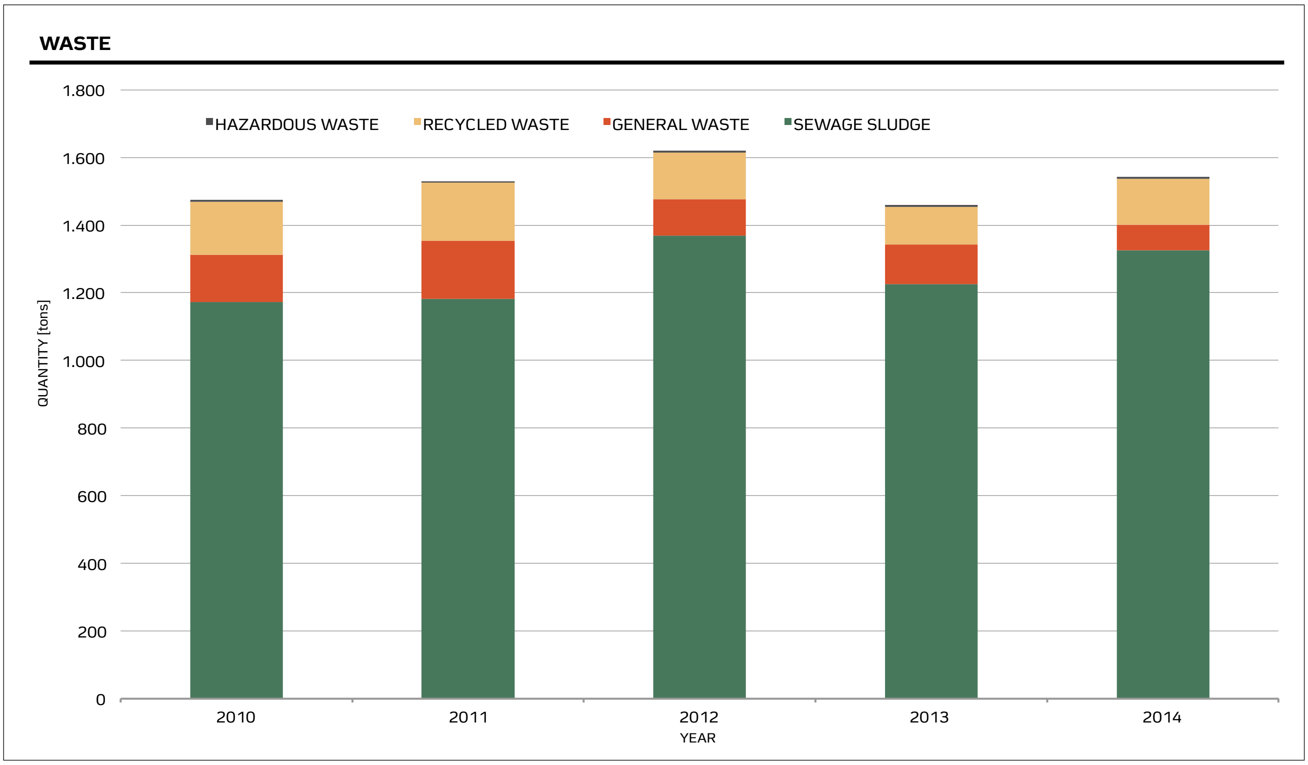


Figure 30. Waste from Reykjavik Energy's operations in 2010-2014. In 2012 sewage from geothermal power plants in the Hengill area and biological sewage treatment plants in Borgarfjördur was counted for the first time.

Figure 31. In June employees from Reykjavik Energy visited Íslenska gámathjónustan to learn about sorting, recycling and waste for landfilling. Photo: Hildur Ingvarsdóttir.

Transport

A workgroup was appointed in 2014 with the goal of reducing greenhouse gas emissions from transport and increasing utilisation of Reykjavik Energy's utilities and products for environmentally friendly transport. Nine fast-charging stations for electric cars have been opened, three of them in rural areas. The adoption of electric cars will continue to be monitored and its development supported.

Did you know?

In 2014 the number of electric cars in Iceland increased from 80 to 203. At year-end 2012 there were 19 electric cars.

GOALS:

Transport because of Reykjavik Energy's operations shall emit the least possible greenhouse gases through the company's selection of the transport vehicles with the lowest emissions that are deemed efficient and suitable for the operations. Employees shall be encouraged to choose environmentally friendly means of transport to and from work. Reykjavik Energy shall take an active part in collecting experience and disseminating knowledge about foreseeable change in the energy sources for transport.

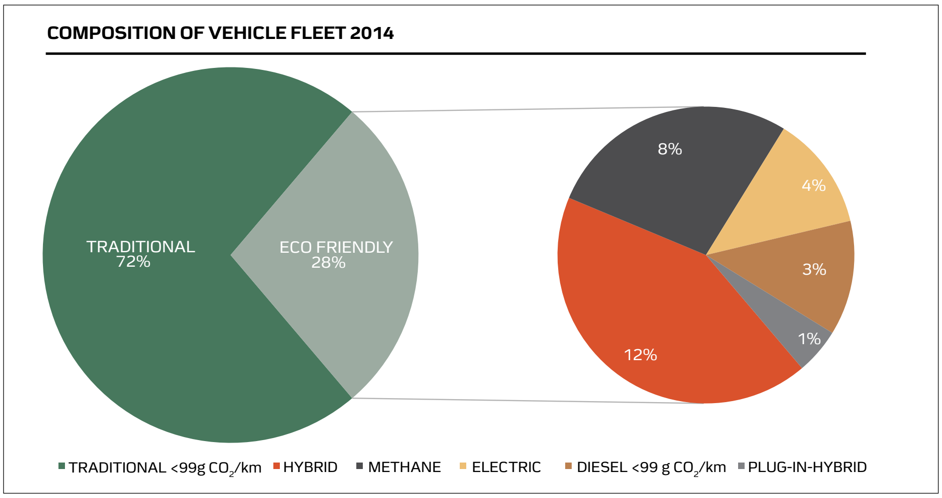
At the start of 2014, a workgroup was appointed within Reykjavik Energy on environmentally friendly transport in the broadest sense. Consideration will be given to environmentally friendly transport equipment, fuel and infrastructure to assure access to renewable fuel in addition to utilisation of different means of transport. The goal is to reduce greenhouse gas emissions from transport and increase utilisation of Reykjavik Energy's utilities and products for environmentally sound transport.

In the period 2010-2013 the percentage of vehicles and heavy equipment powered by renewable energy sources, like methane, hydrogen and electricity, was about 15%. In 2014 the percentage rose to 28% (Figure 31). In the first half of 2014, 17 environmentally friendly vehicles were purchased for Reykjavik Energy's Services Division and two for Our Nature. Annex 23 contains a list of the company's vehicle fleet from 2010 to 2014. Fuel consumption for the company's own vehicles and vehicles that were leased is shown for the same period in Annex 24. As can be seen there, fuel consumption decreased somewhat from the year before, especially regarding renewal of the vehicle fleet since vehicles with better mileage than the existing ones were purchased.

In recent years, Reykjavik Energy has followed and supported the trend of adopting electric cars and will continue doing so. Through an agreement with BL (dealership) and Nissan Europe, signed in 2013, Reykjavik Energy undertook the installation and operation of at least 10 fast-charging stations for electric cars. At the start electricity from the stations will be at no cost for everyone. Our Nature took over the agreement at the start of 2014. The project is intended to promote increase in the number of electric cars and increase people's belief in them as an option. Sites for the stations were selected, taking into consideration that most electric car owners are in the capital area (Figure 33).

In the autumn of 2014, a survey was conducted on the travel customs of Reykjavik Energy's employees to and from work. About 80% of employees travelled to and from

Figure 32. The composition of Reykjavik Energy's vehicle fleet in 2014. Traditional cars powered by gasoline and diesel fuel accounted for 72% and environmentally friendly cars for 28%. In the latter category hybrids accounted for 12%, cars powered by methane for 8%, electricity for 4%, diesel for 3% and plug-in hybrids for 1%.



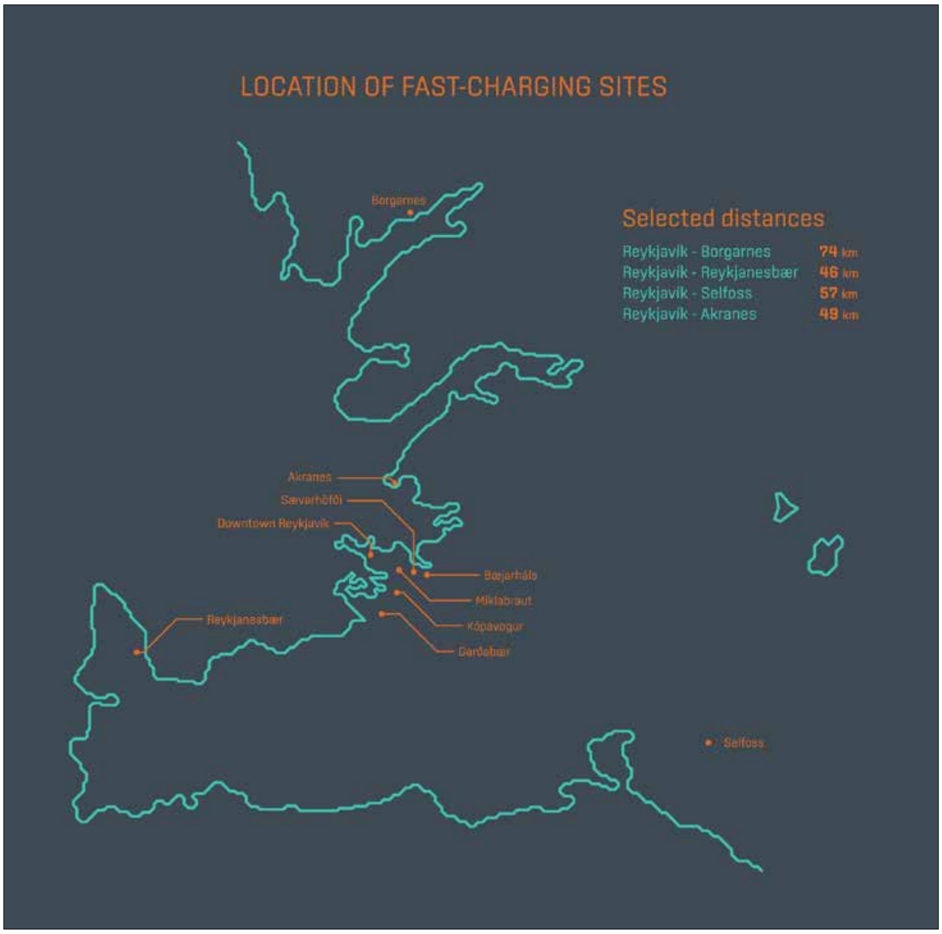


Figure 33. Location of fast-charging stations for electric cars that were set up in 2014. They are located at Baejarháls, Saevarhöfda, the Shell station at Miklabraut and on Fríkirkjuvegur in Reykjavik, Smáralind in Kópavogur, IKEA in Gardabaer, at Fitjar in Reykjanes Town, at N1 in Borgarnes and Olís in Selfoss.

Figure 34. A customer at one of Our Nature's new fast-charging stations for electric cars at Fríkirkjuvegur. Photo: Thorvaldur Árnason.

work in a private car or got a lift. About 20% of employees bicycled, walked or took the bus (Figure 35). These findings are similar to a corresponding survey carried out in 2013. About 56% of those replying could imagine using another means of transportation than they did when the survey was done. More than 50% of them wanted to bicycle to and from work. Less than 16% wanted to use buses, and 10% wanted to walk or run. Surveys of employees' means of travel are done every year, and a plan for improvements is formulated.

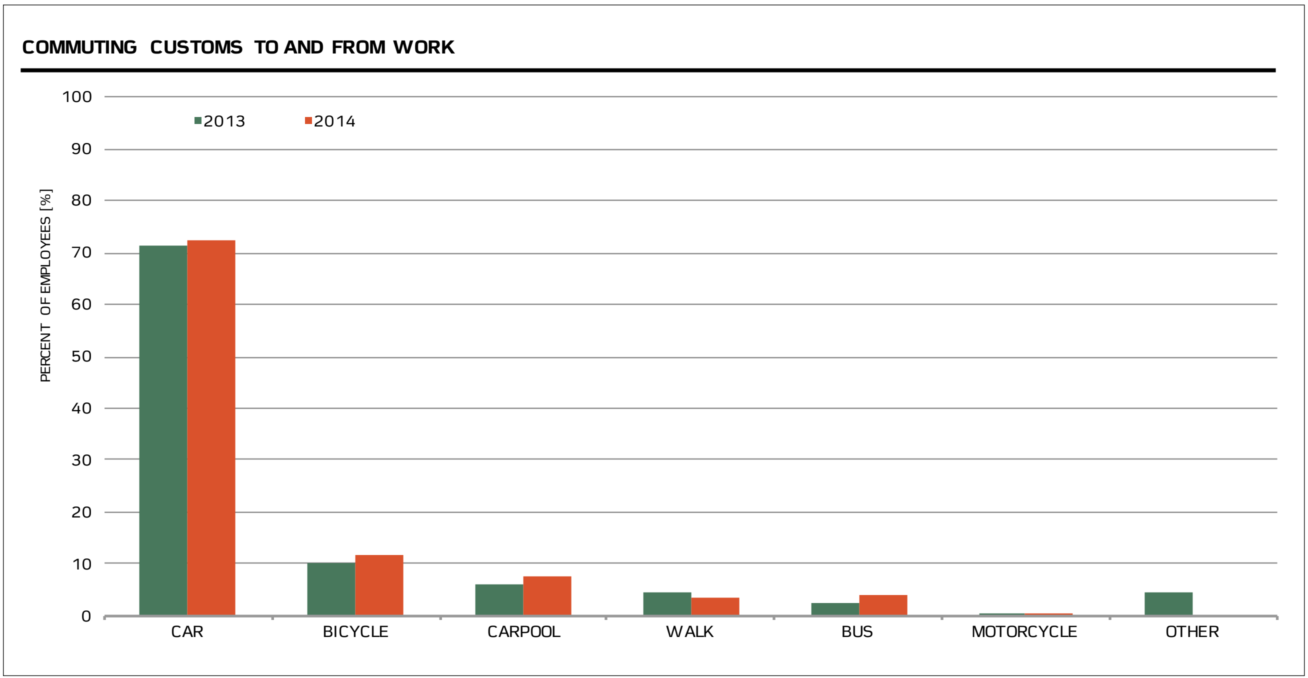


Figure 35. The findings of the survey of employees' commuting customs to and from work in 2013 and the autumn of 2014. The response rate was 58% in 2013 and 67% in 2014. Unfortunately, in the survey in 2014, the option for employees to reply "Other" was not included in the answers to the question about which means of travel the respondent would most enjoy using in coming to and from work. This could distort the picture somewhat, but the main gist is clear.

Structures and maintainance

Summer employees kept lots and structures tidy in 2014 despite Reykjavik Energy's limited financial means. Work procedures for visual impacts and restoration were developed, and will be published in 2015.

GOALS:

All Reykjavik Energy's structures and lots shall be tidy and blend in well with their environment. The design of structures and restoration of lots shall be in accord with instructions on visual impacts and restoration, as relevant.

Vegetation thrived and maintaining and caring for lots the summer of 2014 was easier than previously, thanks to the good collaboration with summer employees on the organisation of tasks and improved work procedures. The company's structures were successfully kept tidy. On the other hand, it is clear that more funds needs to be spent on maintenance and care in order for the company's goal to be reached. Usually the condition of structures and lots is assessed every year. In 2014 a checklist was developed for assessing their condition. The comments received by the company are mainly directed at graffiti, weeds and lawn mowing, and there were fewer of them in 2014 than in 2013. Work was done on the finishing of lots at Hellisheidi Geothermal Power Plant in order to utilise native vegetation and minimise maintenance.

In 2014 further development began of a work procedure for visual impact and restoration, where instruction for contractors was revised, along with a procedure for building and evaluating structures and lots, as well as procedures for land reclamation. Next year instruction on environmental affairs will be improved in a tender specification for projects. Instructions will also be issued on restoration following projects on vegetated land, and how it is possible to reclaim heat land in urban areas.

Figure 36

Did you know?

Each year Reykjavik Energy supervises about 12,000 structures and lots requiring maintenance and care, along with about 18,000 ha of land and 10 rivers and lakes that require monitoring. Since the economic collapse, the land owned by Reykjavik Energy has decreased by about 15%, and the number of structures and lots has decreased by 1% as the sale of assets not falling under Reykjavik Energy's core operations.

Figure 37.Moss and scoria from Hellisheidi utilised for the finishing of the entrance to Hellisheidi Geothermal Power Plant. Photos: Magnea Magnúsdóttir.

Use of substances

In 2014 it was decided to prepare workshops for Reykjavik Energy's employees on hazardous substances. The workshops will be held in 2015. At the same time a work procedure will be revised regarding selection of substances used in the operations.

GOALS:

To use as few hazardous substances as possible and they shall be disposed of responsibly. It shall be easy to get information on harmless substances that can replace hazardous ones.

In 2014 it was decided to prepare workshops for Reykjavik Energy's employees who use hazardous substances in their work instead of reviewing the inventory substances in each work unit, as has been done in previous years. The workshops will be held in the spring months of 2015. There the use of substances at the relevant worksite will be discussed, risks of substances, safety instructions and warning labels. Examples will be given of using suitable substances that can replace the hazardous ones, and employees will analyse the use of substances in individual work units. Finally, a work procedure on the selection, purchase and use of the substances will be revised.

Figure 38. New risk labels. 1 Dangerous to health, 2 Corrosive, 3 Combustible, 4 Hazardous to the environment, 5 Protracted health risk, 6 Flammable, 7 Acutely poisonous, 8 Gas under pressure and 9 Explosive.
Figure: www.ust.is.

Did you know?

New risk labels have been taken in use, based on an international system. Older labels will be cancelled on 1 June 2015.

Other environmental factors

In 2014 noise was successfully reduced in the thermal power station in Hveragerdi, and sound measurements at Hellisheidi Geothermal Power Plant show that the power plant fulfils the provisions of the operating permit. Goals were achieved on minimal flow below Andakílsá Hydropower Station and water level fluctuations in Lake Skorradalsvatn.

Did you know?

Operations at Ellidaá Hydropower Station were terminated. The power station along with all its equipment is protected for its historical significance.

Acoustics

There were considerable complaints in 2014 about noise from Reykjavik Energy's thermal power station in Hveragerdi, and it was clear that it was necessary to launch improvements. In the autumn of 2014, the construction and installation of a muffler at the station was finished, and a steam hood was fixed. After this measure, noise is negligible (Figure 39).

Hellisheidi Geothermal Power Plant is operated all around the clock, every day of the year. Operations in the station are rather stable, but the functionality of wells can vary. Findings from sound measurements and recording of noise in the work area of Hellisheidi Geothermal Power Plant in the latter part of 2013 indicate that the power station fulfils the provisions on noise limitations in the operating permit (Annex 25).

Hydroelectric power

In 2014 the goal was achieved of keeping flow below Andakílsá Hydropower Station within limits, so that is no less than 2.23 m^3/s because of salmon and the river's ecosystem. The goal was also achieved of keeping the water level fluctuations in Lake Skorradalsvatn within limits, which are 1.08 m during normal operations in winter, but 0.4 m in the summer (Annex 26).

Figure 39. Muffler and steam hood in Hveragerdi. Photo: Bjarni Líndal.

Production, own use and carbon footprint

Reykjavik Energy provides pure potable water and hot water for space heating and channels drainage and rainwater out to sea. Reykjavik Energy also produces electricity for households and industry from high-temperature geothermal areas in the vicinity of the capital area and distributes it to customers. Electricity is also produced in Andakílsá Hydropower Station. Reykjavik Energy uses hot and cold water at its worksites. Its own use of electricity is mainly due to the production of hot water, pumping of sewage, hot and cold water and the operation of real estate. The net greenhouse gas emissions from Reykjavik Energy's operations in 2014 were about 1.4% of total emissions in Iceland.

Production and own use

In 2014 Reykjavik Energy's production of electricity, potable water and hot water for space heating was similar to what it was in 2013. Reykjavik Energy's own use of cold and hot water increased, but its own use of electricity decreased.

Did you know?

Our Nature now sells people and companies electricity produced with two windmills owned by Biokraft, which were constructed in Thykkvabaer in 2014. The production is the equivalent of the electricity needs of about 1000 households.

Total production

In 2014 Reykjavik Energy's production of hot water was nearly 79 million m³ and nearly 27 million m³ of cold water (Table 7). Of the nearly 79 million m³ of hot water produced, nearly 35 million m³ were cold water that was heated in Our Nature's power plants in the Hengill area, but the rest was geothermal water from the low-temperature areas.

Our Nature's electricity production with geothermal steam was more than 3.4 million MWh. More than 1 million MWh were produced in Nesjavellir and less than 2.4 MWh in Hellisheidi. Less than 27,000 MWh of electricity were produced with hydroelectric power in Ellidaá and Andakílsá Hydropower Stations.

Own use

Reykjavik Energy's own use of cold and hot water increased, but its own use of electricity decreased (Table 8). Its own use of electricity is mainly due to the production of hot water, pumping of sewage, hot and cold water and operation of real estate.

All of the thermal energy used to heat buildings in Hellisheidi is in a closed system. The same water is recirculated, and the use of thermal energy is not measured. In recent years this use of hot water has been estimated and published in an environmental report. This was not done in 2012, 2013 and 2014. Rather, only recorded information was published. For this reason figures on use of hot water are considerably lower in the period 2012-2014 than prior to that.

Own use of cold water is almost solely because of Our Nature's geothermal power plants in the Hengill area. There nearly 81 million m³ of cold water were pumped up in 2014. Of these less than 46 million m³ were utilised for heat production, among other things for space heating in the capital area, and less than 35 million m³ were utilised for the power plants' operations and cooling of equipment.

TOTAL PRODUCTION

						ON	RE
	UNIT	2010	2011	2012	2013	2014	
Hot water *	m³	84,828,000	88,800,000	80,949,330	81,300,498	34,920,000	43,791,000
Cold water	m³	26,873,000	25,900,000	26,930,000	27,106,000		26,976,788
Electricity from Hellisheidi Geothermal Power Plant	MWst	1,627,996	1,824,100	2,438,841	2,390,439	2,388,344	
Electricity from Nesjavellir Geothermal Power Plant	MWst	974,393	1,011,852	1,011,932	1,004,570	1,028,335	
Electricity from hydropower plants	MWst	20,548	33,622	28,271	26,753	26,752	

*In 2012, 2013 and 2014 figures are given on production quantity of hot water pumped out of wells

Table 7. Reykjavik Energy's (RE) total production in the period 2010-2014. ON refers to Our Nature.

OWN USE

						ON	RE
	UNIT	2010	2011	2012	2013	2014	
Electricity	MWst	233,703	269,504	287,539	295,451	231,824	52,456
Hot water	m³	969,589	1,007,282	609.729 *	552.023 *	339.646*	306,238
Cold water	m³	55,806,843	72,427,148	66,844,128	75,399,668	80,852,000	78,873

* See explanation of less use of hot water in text.

Table 8. Reykjavik Energy's (RE) own use in the period 2010-2014. ON refers to Our Nature.

Reykjavik energy's carbon footprint

The net greenhouse gas emissions from Reykjavik Energy's operations in 2014 were about 58,000 tons of CO_2-equivalents or 1.4% of total emissions in Iceland.

Did you know?
Operations at Ellidaá Hydropower Station were terminated. The power station along with all its equipment is protected for its historical significance.

Greenhouse gas emissions

The greenhouse gases carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and sulphur hexafluoride (SF_6) are emitted in some measure from Reykjavik Energy's operations. For further details see the sections on the Emission of Other Geothermal Gases and Transport. The emissions of greenhouse gases from operations are categorized by their origin:

- Nesjavellir Geothermal Power Plant.
- Hellisheidi Geothermal Power Plant.
- Back-up power generators.
- Car fleet.

Information on greenhouse gas emissions from Reykjavik Energy's operations for the period 2010-2014 is stated in Table 9. Release of carbon dioxide increased in Nesjavellir but decreased in Hellisheidi in 2014, compared to 2013, but emissions of methane increased in both locations. In Hellisheidi less steam was harnessed in 2014 than before. Also, the concentration of gases varies between wells. Greenhouse gas emissions from the car fleet were lower in 2014 than in previous years.

Sulphur hexafluoride (SF_6) is used as an insulating gas in the power stations' high-voltage equipment in Reykjavik Energy's supply and distribution stations. In June there was a leak of sulphur hexafluoride in one of the high-voltage switches of Hellisheidi Geothermal Power Plant, and more than 0.5 kg were released into the atmosphere. Measures have been taken to prevent a repetition of this.

Carbon footprint

The carbon footprint is a measure showing the effect of greenhouse gas emissions caused by human activity in warming the atmosphere. The effect of greenhouse gases on the Earth's temperature varies. The unit of measure for the carbon footprint is kg or tons of CO_2-equivalents, i.e., the global warming effect of different greenhouse gases is converted into equivalents of CO_2.

GREENHOUSE GAS EMISSION

GREENHOUS GAS	ORIGIN	UNIT	2010	2011	2012	2013	2014
Carbon dioxide (CO_2)	Nesjavellir	tons	28,396	14,800	18,612	14,794	16,579
	Hellisheidi	tons	41,722	39,479	43,158	44,934	41,242
	Hverahlíd	tons					
	Backup power	tons	74	29	75	5	25
	Car fleet	tons	991	775	550	511	482
	Heating central	tons	0.7	1	0	0	0
	Total CO_2	**tons**	**71,184**	**55,084**	**62,395**	**60,244**	**58,328**
Methane (CH_4)	Nesjavellir	kg	111,000	46,620	28,000	46,200	53,453
	Hellisheidi	kg	46,000	57,000	51,000	72,000	80,829
	Hverahlíd	kg	0	0	0	0	0
	Backup power	kg	7	2	5	0	2
	Car fleet	kg	102	50	56	48	47
	Heating central	kg	0	0	0	0	0
	Total CH_4	**kg**	**157,109**	**103,672**	**79,061**	**118,249**	**134,330**
Nitrous oxide (N_2O)	Backup power	kg	0	0	1	0	0
	Car fleet	kg	10	7	5	5	5
	Heating central	kg	0	0	0	0	0
	Total N_2O	**kg**	**10**	**7**	**6**	**5**	**5**
Sulfur hexafluoride (SF_6)	**Total SF_6**	**kg**	**0**	**0**	**0.527**	**0.527**	**0.527**

Table 9. Greenhouse gas emissions from Reykjavik Energy's operations 2010-2014.

Did you know?

In the period 2010–2013 the percentage of Reykjavik Energy's vehicles and heavy equipment using renewable energy sources, like methane, hydrogen and electricity, was about 15%. In 2014 the proportion was 28%. Fuel consumption decreased somewhat from the year before, especially regarding renewal of the vehicle fleet, since vehicles with better mileage than the existing ones were purchased.

CARBON SEQUESTRATION

CARBON SEQUESTRATION	UNIT	2010	2011	2012	2013	2014
Land reclamation	tons	1,229	1,238	1,086	1,110	1,149
Forestation	tons	3,700	3,700	3,626	3,626	3,626
Total carbon sequestration per year	**tons**	**4,929**	**4,938**	**4,712**	**4,736**	**4,774**

Table 10, Reykjavik Energy's carbon sequestration 2010-2014,

Land reclamation and forestry sequester carbon and offset emissions. Net emissions are therefore total emissions less sequestration. Calculation of carbon sequestration builds on the findings of studies indicating that the average sequestration in an Icelandic forest is about 4.4 tons of carbon dioxide per hectare of land. A density of 2000 plants per hectare is assumed. It has also been discovered that the average sequestration per hectare per year because of reclamation is about 2.8 tons of carbon dioxide. There were forested areas under the auspices of Reykjavik Energy covering 824 ha and land reclamation areas of 418 ha in 2014. Table 10 shows Reykjavik Energy's total carbon sequestration—about 5000 tons per year.

Reykjavik Energy's carbon footprint shows annual greenhouse gas emissions, converted to CO_2-equivalents, from the company's operations, less carbon sequestration from land reclamation and forestry. Table 11 shows Reykjavik Energy's carbon footprint for 2014 and, for comparison, 2010-2013.

CARBON FOOTPRINT

	2010	2011	2012	2013	2014
	CO_2-equivalence [tons]	CO_2-equivalence [tons]	CO_2-equivalence [tons]	CO_2-equivalence [tons]	CO_2-equivalence [tons]
Emission from power production					
Nesjavellir Geothermal Power Plant1)	30,727	15,779	19,200	15,764	17,702
Hellisheidi Geothermal Power Plant1)	42,688	40,676	44,229	46,446	42,939
Steam from Hverahlíð	196	0	0	0	0
Sulfur hexafluoride (SF_6) from Hellisheidi			13	13	13
Emissions from fuel consumption					
Backup power (fixed and mobile stations)2), 3)	74	29	75	5	25
Vehicles (own and leased)2), 4)	991	778	553	513	484
Heating central (because of testing)5)	1	1	0	0	0
Flights, international and domestic	46	33	39	72	88
Emissions from waste for landfilling					
Waste	1,680	1,744	1,846	1,664	1,759
Emissions from supply and distribution system					
Sulfur hexafluoride (SF_6)	0	0	0	0	0
Total greenhouse gas emission	**76,403**	**59,040**	**65,954**	**64,477**	**63,009**
Carbon sequestration					
Land reclamation and forestation	-4,929	-4,938	-4,712	-4,736	-4,774
Reykjavik Energy's carbon footprint	**71,474**	**54,102**	**61,243**	**59,741**	**58,235**

1) All emissions from Nesjavellir and Hellisheidi are based on the power stations' operations and drilling of exploration and make-up wells in the geothermal field.

2) Oil consumption from back-up power generators and automobiles is converted into emissions of greenhouse gases by using emissions constants, which are published and approved by the United Nations Intergovernmental Panel on Climate Change (IPCC).

3) Back-up power generators, for example, are small electricity generators powered by coloured diesel fuel to run pumps during drilling, or if there is a breakdown in electricity connections where pumps are operated. Coloured diesel fuel is purchased every other year.

4) Emissions from cars are calculated, based on the recorded quantity of fuel.

5) A heating central in Baejarháls was closed and its operating permit returned at year-end 2011.

Table 10. Reykjavik Energy's carbon footprint

Statement by Reykjavik Energy's Board of Directors

According to the best knowledge of the Board of Directors of Reykjavik Energy, the Environmental Report 2014 complies with the provisions of Regulation no. 851/2002 on Green Accounting. The Environmental Report discusses the aspects of Reykjavik Energy's operations impacting the environment, and how environmental affairs are arranged in the operations.

It is the opinion of the Board of Directors' that the figures and information specified in Reykjavik Energy's Environmental Report, which come from its accounting, give a good view of the trend and results in environmental affairs.

The Board of Directors of Reykjavik Energy hereby confirms the Environmental Report 2014.

Reykjavik, 23 February 2015

Board of Directors:

Haraldur Flosi Tryggvason
Chairman

Brynhildur Davíðsdóttir
Vice-chairman

Áslaug Friðriksdóttir

Gylfi Magnússon

Kjartan Magnússon

Valdís Eyjólfsdóttir

Endorsement of the Auditor

I have reviewed the calculations and information presented in Reykjavik Energy Environmental Report 2014. The Environmental Report is presented by the management of Reykjavik Energy and on their responsibility. My responsibility is to express an opinion on the information presented in the Environmental Report based on the audit.

The audit is in accordance with duties in Regulation no. 851/2002 on Green Accounting. It entails analytical procedures, spot checks and checking of data to verify information in the Environmental Report. The audit also entails checking calculations employed in assessing the scale and importance of particular factors listed in the Environmental Report. I believe that the audit is a sufficiently reliable basis on which to base my opinion.

In my opinion the Environmental Report gives a true and fair view of the environmental impact of the operations in 2014, in accordance with good and recognized practices in the profession.

Reykjavik, 4 February 2015
VSO Consulting

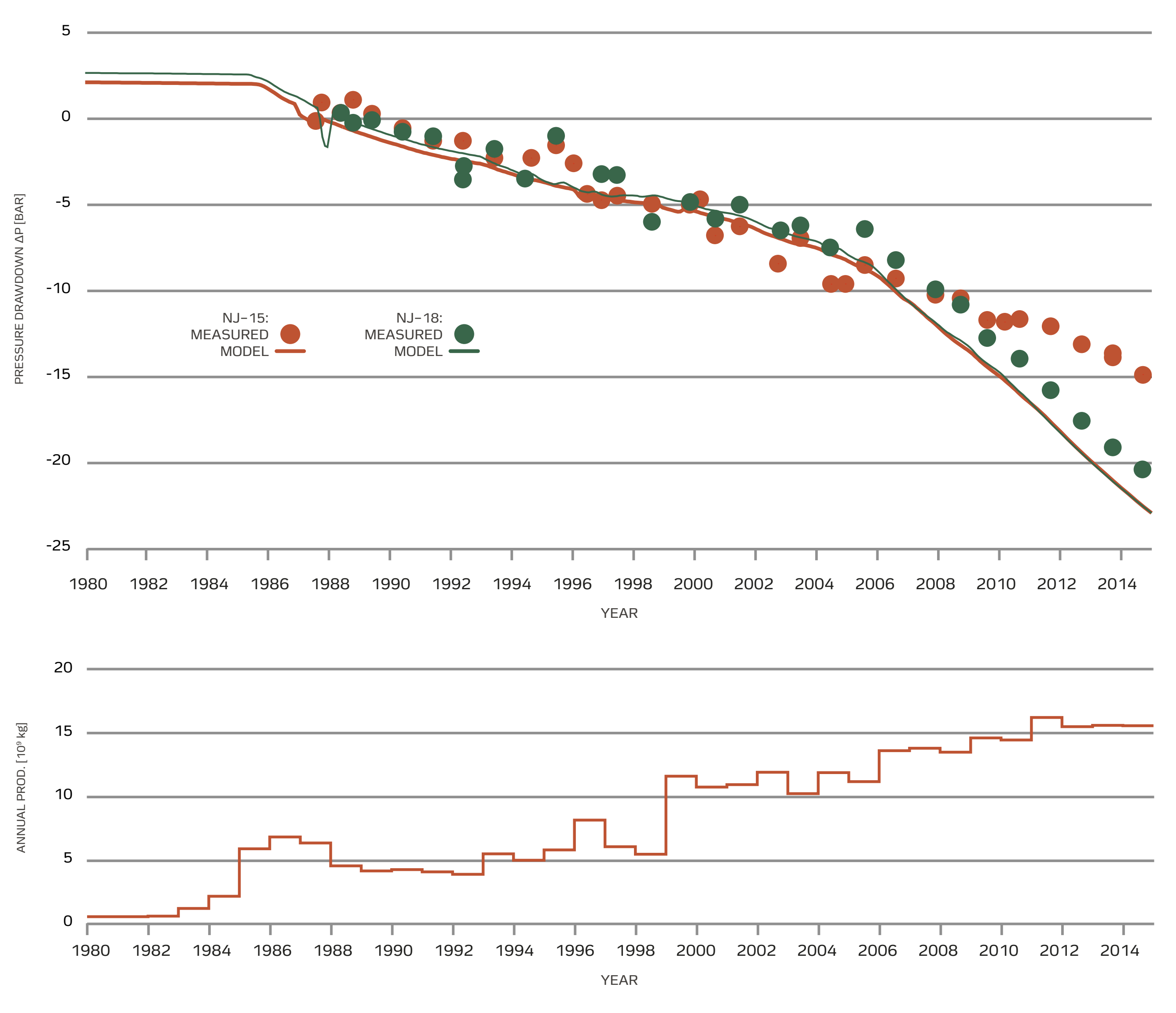
Gudjón Jónsson
Chemical Engineer

ANNEXES

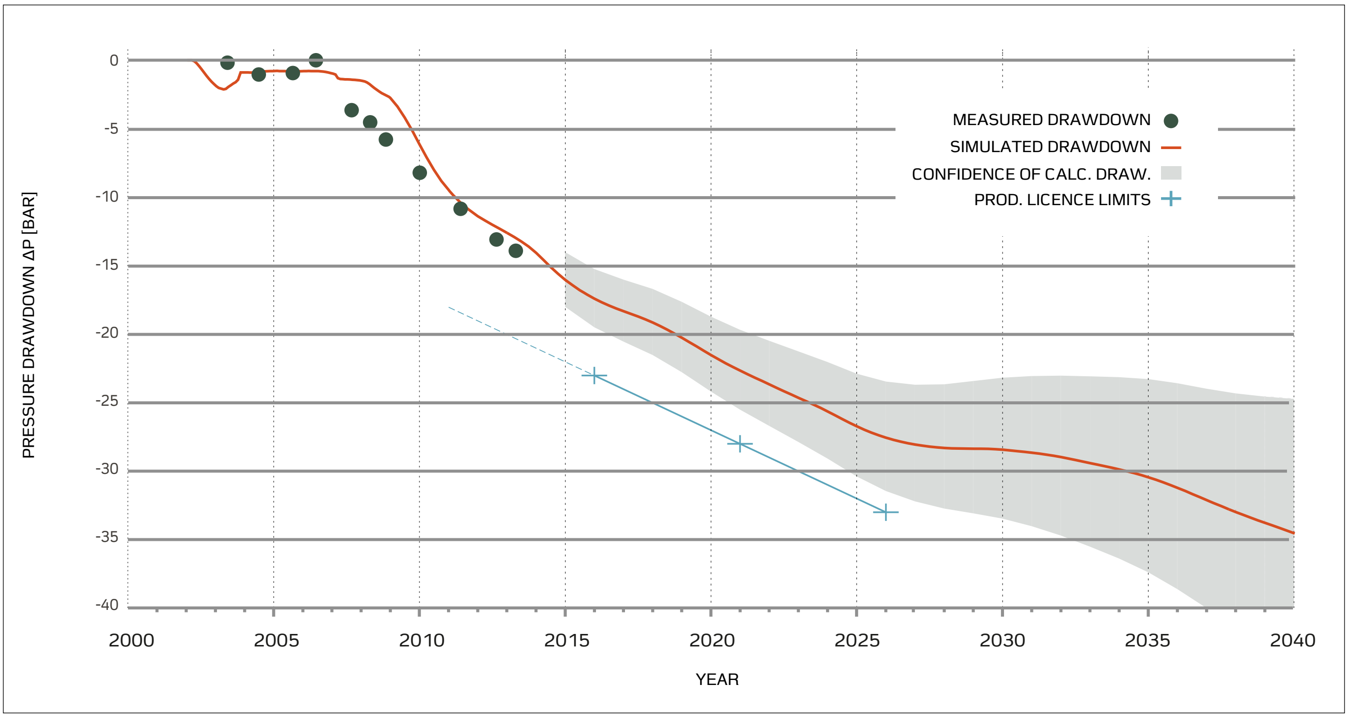
Annex 1. **Reykjavik Energy's utilities**

Annex 2. **Drawdown 1980-2014**

2a. Pressure drawdown DP (bar) and annual average production (kg/s) in Nesjavellir 1980-2014. A comparison between measured and simulated results appears in the upper part of the figure and the annual average production in the lower part of it. Solid curves are simulated results, while dots show measured values in wells at a depth of 800-1000 m. The red curve shows the pressure drawdown in well NJ-18 and the green curve in well NJ-15.



2b. Pressure drawdown DP (bar) in Hellisheidi 2000-2040. Comparison between measured and simulated pressure drawdown DP (bar), in hole HE-4. The grey colour shows the confidence of simulated pressure drawdown. The crosses are limits in accordance with the power station licence. A curve is drawn between the crosses, but the points are drawn according to 2011 when the licence entered into force.



Annex 3. **Chemical analyses of hot water in the capital area 2014**

	UNIT	LAUGARNES	ELLIDAÁR	REYKIR	REYKJAHLÍD	NESJAVELLIR	HELLISHEIDI
		RV-5	RV-39	MG-25	MG-39	Heated water	Heated water
DATE		**1/20/2014**	**1/20/2014**	**3/5/2014**	**2/26/2014**	**4/7/2014**	**6/26/2013**
SAMPLE NO.		**14-5002**	**14-5001**	**14-5065**	**14-5053**	**14-5089**	**13-5138**
Water temp.	°C	128.8	79.8	92.7	92.2	80	80
pH		9.40	9.37	9.70	-	8.54	8.81
pH-temp.	°C	22.7	22.9	22.8	-	17.7	8.4
Conductivity	µS/cm	360	205	-	240	-	-
Conduct. temp.	°C	23.0	23.0	-	23.0	-	-
CO_2	mg/kg	16.9	29.1	23.9	24.0	45.6	22.7
H_2S	mg/kg	0.53	0.00	0.81	1.23	-	0.24
SiO_2	mg/kg	143.9	70.1	95.8	97.3	41.7	23.4
Na	mg/kg	74.7	43.9	46.0	48.6	19.2	6.7
K	mg/kg	3.09	0.96	0.99	1.28	2.65	0.95
Ca	mg/kg	4.22	3.05	2.37	1.93	9.58	5.50
Mg	mg/kg	<0.004	0.006	<0.0025	0.008	5.189	3.2
Fe	mg/kg	0.052	0.036	0.007	0.051	0.051	<0.025
Al	mg/kg	0.191	0.131	0.159	0.203	0.157	<0.015
Li	mg/kg	-	<0. 01	-	-	0.009	<0.015
Cl	mg/kg	53.1	22.0	15.9	12.4	12.7	7.0
SO_4	mg/kg	27.5	11.7	16.6	16.9	23.1	-
F	mg/kg	0.910	0.170	0.571	0.669	0.000	-
B	mg/kg	0.075	0.017	0.043	0.044	0.110	<0.025
Dissolved O_2	µg/kg	0	100	0	0	0	0

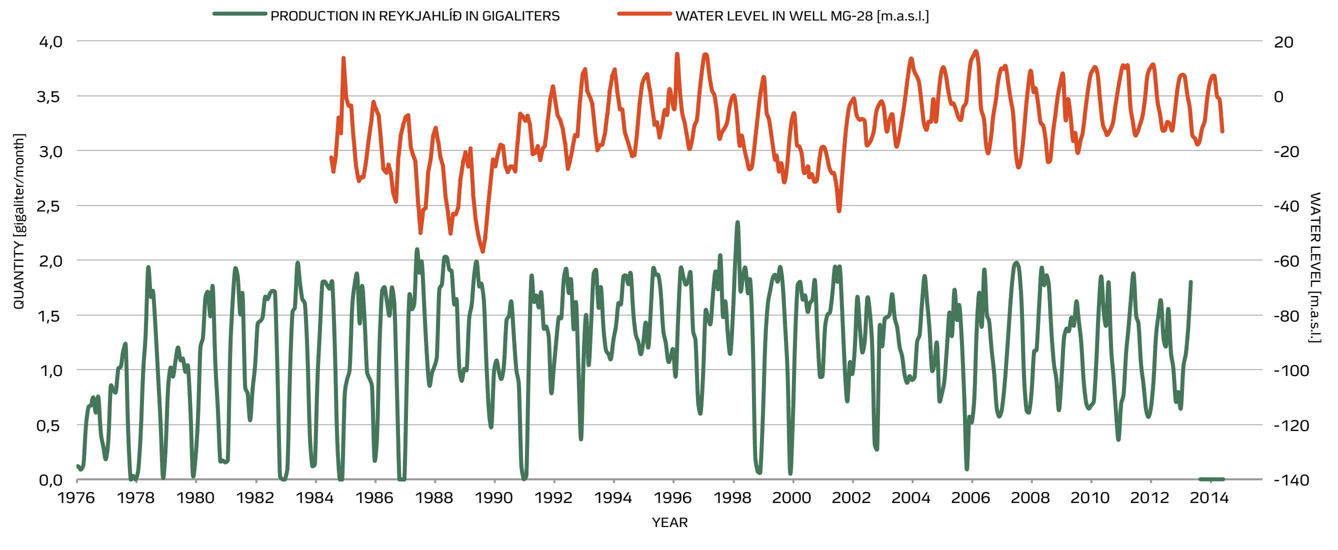
Annex 4. **Chemical analyses of hot water in south and west Iceland 2014**

CHEMICAL ANALYSIS OF HOT WATER IN SOUTH AND WEST ICELAND

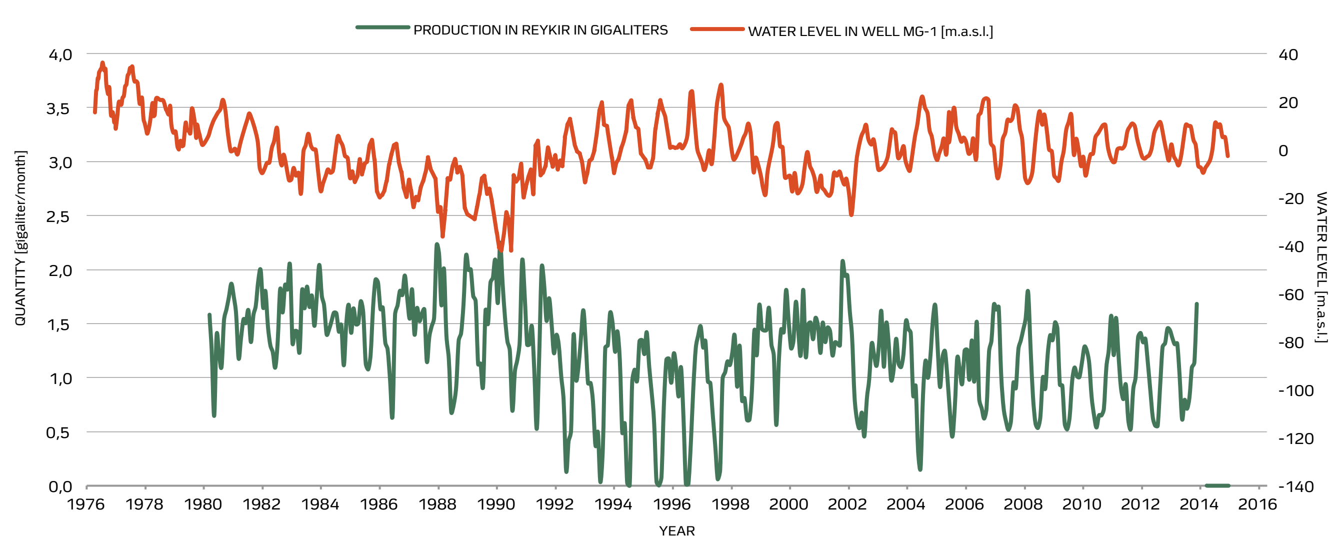
		AKRANES OG BORGARFJÖRDUR UTILITIES		RANGÁ UTILITY		THORLÁKS-HÖFN UTILITY	ÖLFUS UTILITY	AUSTUR UTILITY	GRÍMSNES UTILITY	HLÍÐ UTILITY	MUNADAR-NES	NORDURÁRDALUR UTILITY		STYKKIS-HÓLMUR UTILITY
	UNIT	Deildartunguhver	LH-1	KH-37	LW-4	BA-01	EB-01	GH-4	HÖ-29	ER-23	MN-8	SG-3	BI-3	HO-1
DATE		**1/24/2014**	**1/24/2014**	**2/12/2014**	**2/12/2014**	**1/31/2014**	**1/31/2014**	**1/31/2014**	**2/13/2014**	**2/13/2014**	**1/24/2014**	**1/24/2014**	**1/24/2014**	**1/23/2014**
SAMPLE NO.		**14-5029**	**14-5030**	**14-5046**	**14-5044**	**14-5037**	**14-5039**	**14-5041**	**14-5048**	**14-5047**	**14-5026**	**14-5028**	**14-5027**	**14-5024**
Water temp.	°C	96.1	88.6	66.0	97.4	-	119.7	-	80.0	96.2	87.7	67.3	66.4	85.6
pH		9.44	9.20	10.39	9.85	8.84	8.79	8.96	9.42	9.54	9.36	8.83	9.07	-
pH-temp.	°C	23.3	23.1	23.3	23.2	23.3	23.3	23.0	23.2	23.1	23.1	23.5	23.2	-
Conductivity	µS/cm	365	580	290	425	2050	1510	540	550	460	440	330	320	6400
Conduct. temp.	°C	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0	23.0
CO_2	mg/kg	25.8	11.5	10.7	19.3	4.1	8.9	43.5	14.6	23.3	14.9	76.7	59.2	5.2
H_2S	mg/kg	0.37	0.28	0.12	0.08	0.26	0.63	0.19	0.10	3.42	0.14	0.01	0.04	0.05
SiO_2	mg/kg	135.8	117.5	77.8	96.4	131.7	119.5	140.4	82.9	233.2	115.2	102.2	91.8	69.6
Na	mg/kg	81.1	114.3	57.9	95.0	382.9	294.7	121.8	120.2	109.5	89.5	76.8	72.7	705.5
K	mg/kg	2.22	2.53	0.64	1.93	16.90	12.20	3.61	3.02	5.58	2.28	1.13	1.33	14.20
Ca	mg/kg	3.39	14.02	2.34	3.08	54.03	45.15	4.36	8.33	2.01	6.79	3.38	3.03	170.31
Mg	mg/kg	0.017	0.013	<0.004	<0.004	0.017	0.035	0.007	0.011	<0.004	0.008	0.011	0.010	0.509
Fe	mg/kg	0.018	0.028	0.012	0.017	0.045	0.053	0.032	0.018	0.010	0.027	0.011	0.020	0.122
Al	mg/kg	0.140	0.026	0.110	0.211	0.073	0.084	0.147	0.052	0.492	0.062	0.020	0.029	<0.076
Li	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-
Cl	mg/kg	31.5	106.7	22.4	46.0	585.2	391.9	102.8	129.6	55.4	70.3	23.2	25.7	2547.0
SO_4	mg/kg	50.1	69.6	20.4	67.3	112.6	122.4	48.5	48.7	57.2	53.5	27.2	29.9	230.0
F	mg/kg	2.46	1.92	2.37	0.766	0.36	0.38	0.81	0.556	2.952	1.65	0.46	0.54	0.77
B	mg/kg	0.267	0.231	0.112	0.257	0.255	0.256	0.311	0.118	0.186	0.226	0.206	0.241	0.09
Dissolved O_2	µg/kg	0	0	0	0	100	20	20	0	0	0	20	0	0

Annex 5. **Water production and water level in wells in the low-temperature fields in Reykjahlíd and Reykir in Mosfellsbaer and Ellidaárdalur and Laugarnes in Reykjavik**

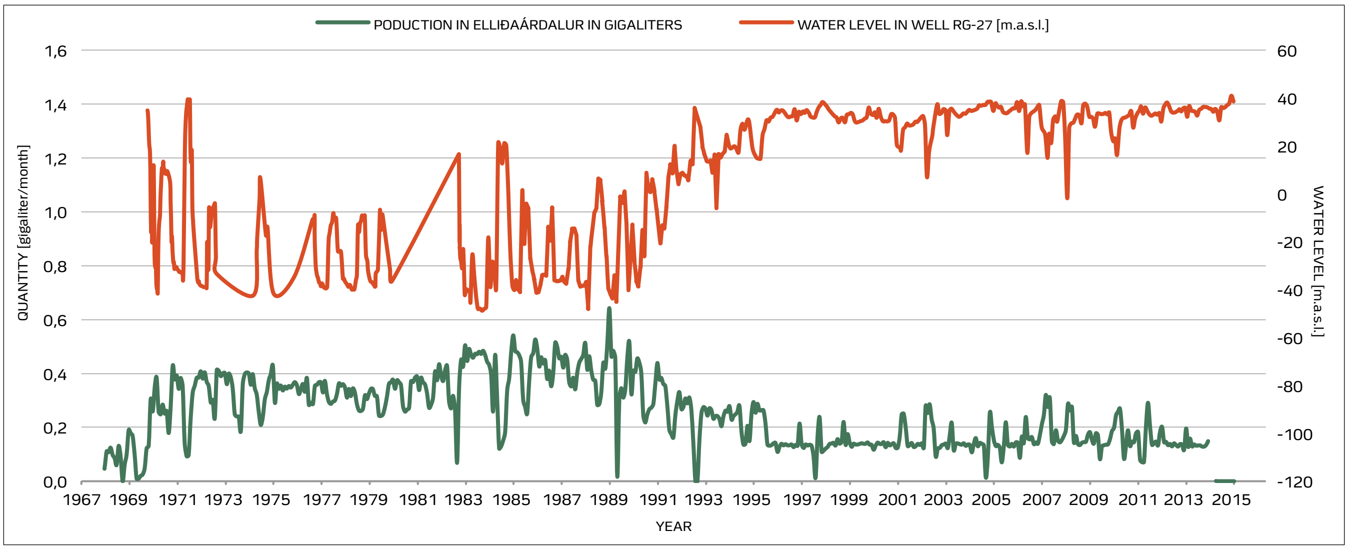
5a) The low-temperature field in Reykjahlíd in Mosfellsbaer. Water production and water level in well MG-28 1976-2014.



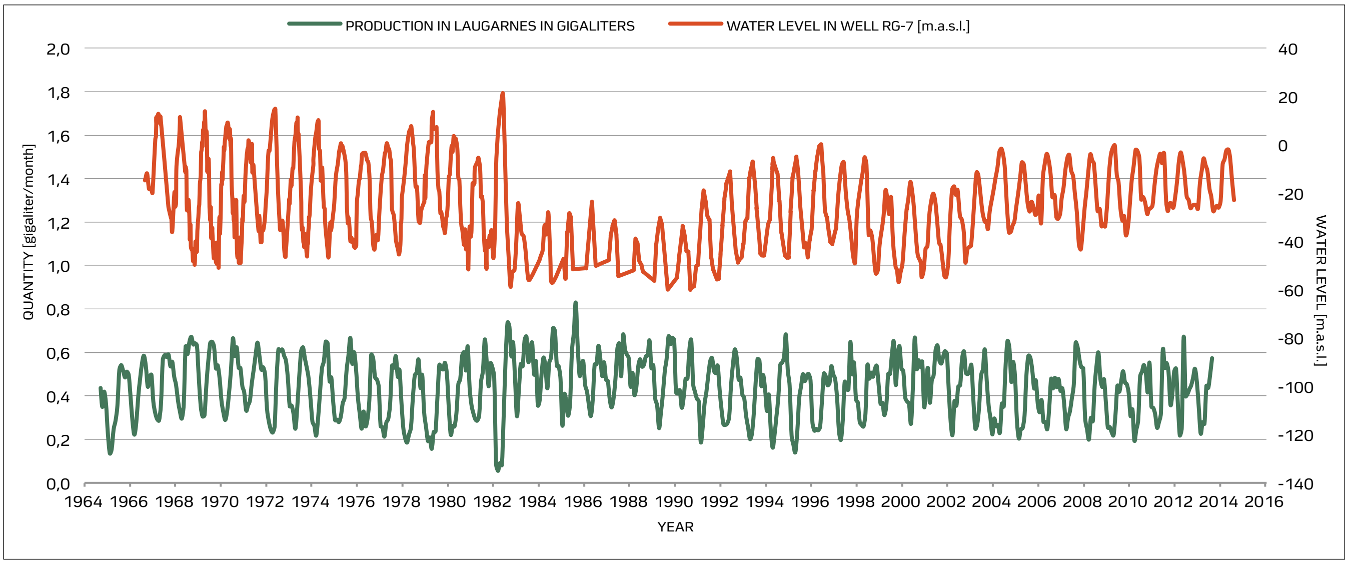
5b) The low-temperature field in Reykir in Mosfellsbaer. Water production and water level in well MG-1 1976-2014.



5c) The low-temperature field in Elliðaádalur í Reykjavik. Water production and water level in well RG-27 1976-2014.



5d) The low-temperature field in Laugarnes in Reykjavik. Water production and water level in well RG-7 1976-2014.



Annex 6. **Microbes and chemical composition of potable water in Reykjavik 2014**

MICROBES IN POTABLE WATER 2014

	MAX RECOMMENDED	JAÐARSVÆÐI			LAXALÓN LOKAHÚS			VATNSENDAKRIKI VK1			LOKAHÚS KRINGLUMÝRARBRAUT		
	VALUE	AVERAGE	MAX	MIN	AVERAGE	MAX	MIN	AVERAGE	MAX	MIN	AVERAGE	MAX	MIN
Total microbes at 22°C	100/ ml	0	2	0	1.08	3	0	0	0	0	0.44	2	0
Escherichia coli (E. Coli)	0/100 ml	0	0	0	0	0	0	0	0	0	0	0	0
Enterococci	0/100 ml	0	0	0	0	0	0	0	0	0	0	0	0

CHEMICAL COMPOSITION OF POTABLE WATER

PHYSIOLOGICAL AND CHEMICAL PROPERTIES	UNIT	MAX RECOMM-ENDED VALUE	CO.	LABORATORY	JAÐAR-SVÆÐI	LAXALÓN LOKAHÚS	VATNSENDA-KRIKI VK1	LOKAHÚS KRINGLU-MÝRAR-BRAUT
Sample no.					R14-370-2/4339	R-14-2013-2/4701	R14-2013-1	R14-370-1/4338
					February 2014	August 2014	August 2014	February 2014
Sample colour	mgPt/l			ALS	5	5	5	<5
Turbidity	NTU	adequate	(1)	MATÍS	0.12	0.39	<0.10	0.11
Temperature	°C	25		MATÍS	4.2	4.4	3.8	4.1
pH	pH unit			MATÍS	9.05	8.90	8.95	9.10
Conductivity	µS/cm	2500		MATÍS	87	79	79	84
Klóríð (Cl)	mg/l	250		ALS	8.61	8.72	8.76	9.69
Súlfat (SO_4)	mg/l	250		ALS	1.98	1.79	1.82	2.06
Flúoríð (F)	mg/l	1.5		ALS	<0.200	<0.200	<0.200	<0.200
Nitrat (NO_3)	mg/l	50		ALS	0.173	0.151	0.186	0.168
Nitrít (NO_2)	mg/l	0.5		ALS	<0.01	<0.01	<0.01	<0.01
Ammóníum (NH_4-N)	mg/l	0.5		ALS	<0.026	<0.026	<0.026	<0.026
TOC	mg/l	no abnormal changes		ALS	<0.50	<0.50	<0.50	<0.50
Kalsíum (Ca)	mg/l	100	(3)	ALS	4.37	5.19	5.27	4.59
Járn (Fe)	mg/l	0.2		ALS	<0.0004	<0.0004	0.001	<0.0004
Kalíum (K)	mg/l	12	(3)	ALS	0.441	0.471	0.441	<0.4
Magnesíum (Mg)	mg/l	50	(3)	ALS	0.867	0.939	0.923	0.788
Natríum (Na)	mg/l	200		ALS	11.7	9.65	9.69	12.2
Brennisteinn (S)	mg/l		(4)	ALS	0.758	0.708	0.721	0.749
Kísill (Si)	mg/l		(4)	ALS	6.61	6.75	6.77	6.53
Ál (Al)	µg/l	200		ALS	19.0	19.0	20.7	17.6
Arsen (As)	µg/l	10		ALS	<0.05	<0.05	<0.05	<0.05
Bór (B)	µg/l	1000		ALS	<10	<10	<10	<10
Baríum (Ba)	µg/l	700	(3)	ALS	0.036	0.111	0.060	0.045

Kadmíum (Cd)	µg/l	5.0		ALS	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	µg/l		(4)	ALS	<0.005	0.005	0.009	<0.005
Króm (Cr)	µg/l	50		ALS	0.948	0.875	0.942	1.02
Kopar (Cu)	µg/l	2000		ALS	<0.1	<0.1	<0.1	0.188
Kvikasilfur (Hg)	µg/l	1.0		ALS	<0.002	<0.002	<0.002	<0.002
Mangan (Mn)	µg/l	50		ALS	<0.03	0.111	0.082	<0.03
Molybdenum (Mo)	µg/l		(4)	ALS	0.075	0.072	0.089	0.112
Nikkel (Ni)	µg/l	20		ALS	<0.05	<0.05	<0.05	<0.05
Fosfór (P)	µg/l	5000	(3)	ALS	14.7	19.2	21.8	15.4
Blý (Pb)	µg/l	10		ALS	<0.01	<0.01	<0.01	0.013
Antimon (Sb)	µg/l	5.0		ALS	<0.01	<0.01	0.013	<0.01
Selen (Se)	µg/l	10		ALS	<0.5	<0.5	<0.5	<0.5
Strontium (Sr)	µg/l		(4)	ALS	2.78	3.17	2.83	2.18
Sink (Zn)	µg/l	3000	(3)	ALS	0.29	0.41	0.863	0.406
Vanadium (V)	µg/l			ALS	13.8	14.9	15.8	14
Syaníð (CN total)	µg/l	50		ALS	<0.005	<0.005	<0.005	<0.005
diklormetan	µg/l			ALS	<2.0	<2.0	<2.0	<2.0
1,1 - diklóretan	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
1,2 - diklóretan	µg/l	3.0		ALS	<0.50	<0.10	<0.10	<0.50
trans 1,2 - diklóreten	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
cis 1,2 - diklóreten	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
1,2 - diklórpropan	µg/l			ALS	<1.0	<1.0	<1.0	<1.0
tetraklórmetan	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
1,1,1 - triklóretan	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
1,1,2 - triklóretan	µg/l			ALS	<0.20	<0.20	<0.20	<0.20
triklóreten	µg/l	10	(2)	ALS	<0.10	<0.10	<0.10	<0.10
tetraklóreten	µg/l		(2)	ALS	<0.20	<0.20	<0.20	<0.20
Vinyl klóríð	µg/l			ALS	<1.0	<1.0	<1.0	<1.0
bensen	µg/l	1.0		ALS	<0.20	<0.20	<0.20	<0.20
toluen	µg/l			ALS	<1.0	<0.20	<0.20	<1.0
etylbensen	µg/l			ALS	<0.10	<0.20	<0.20	<0.10
summa xylener	µg/l			ALS	<0.15	<0.20	<0.20	<0.15
triklórmetan	µg/l			ALS	<0.30	<0.30	<0.30	<0.30
tribrómmetan	µg/l			ALS	<0.20	<0.20	<0.20	<0.20
dibrómklórmetan	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
brómdiklórmetan	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
summa trihalometan	µg/l			ALS	<0.35	<0.35	<0.35	<0.35
o-xylen	µg/l			ALS	<0.10	<0.20	<0.20	<0.10
summa xylen	µg/l			ALS	<0.15	<0.15	<0.15	<0.15
naftalen	µg/l			ALS	<0.20	<0.20	<0.20	<0.20
acenaftylen	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
acenaften	µg/l			ALS	<0.0070	<0.0070	<0.0070	<0.0070
flúoren	µg/l			ALS	<0.010	<0.010	<0.010	<0.010
fenantren	µg/l			ALS	<0.040	<0.040	<0.040	<0.040
antracen	µg/l			ALS	<0.0050	<0.0050	<0.0050	<0.0050
flúoranten	µg/l			ALS	<0.0050	<0.0050	<0.0050	<0.0050
pyren	µg/l			ALS	<0.0050	<0.0050	<0.0050	<0.0050
*bens(a)antracen	µg/l			ALS	<0.0030	<0.0030	<0.0030	<0.0030
*krysen	µg/l			ALS	<0.0070	<0.0070	<0.0070	<0.0070
*benz(b)flúoranten	µg/l	0.1	(5)	ALS	<0.0040	<0.0040	<0.0040	<0.0040
*bens(k)flúoranten	µg/l		(5)	ALS	<0.0020	<0.0020	<0.0020	<0.0020
*bens(a)pyren	µg/l	0.01		ALS	<0.0020	<0.0020	<0.0020	<0.0020
*dibens(ah)antracen	µg/l			ALS	<0.0020	<0.0020	<0.0020	<0.0020
benzo(ghi)perylen	µg/l		(5)	ALS	<0.0030	<0.0030	<0.0030	<0.0030
*indeno(123cd)pyren	µg/l		(5)	ALS	<0.0030	<0.0030	<0.0030	<0.0030
summa 16 EPA-PAH	µg/l			ALS	<0.20	<0.20	<0.20	<0.20
*summa PAH cancerogena	µg/l			ALS	<0.012	<0.012	<0.012	<0.012
summa PAH annað	µg/l			ALS	<0.19	<0.20	<0.19	<0.19

Commentary:

(1) Adequate for consuption and no uncharacteristically changes
(2) Maximum value for sum of thrichlorethene and tetrachlorethene
(3) Maximum value in older Icelandic regulations 319/1995 (void)
(4) Maximum value not in Icelandic regulations
(5) Maximum value for the sum of the following substances:benzo(b)fluoranten. benzo(k) fluoranten. benzo(ghi)perylen.indeno(123cd)pyren"

Laboratories:

MATÍS: Matís ohf, Laboratory
ALS: ALS Scandinavia AB (Sweden)
* : Iceland GeoSurvey

Annex 7. **Microbes and chemical composition of potable water in west Iceland 2014**

	MAX RECOMM-ENDED	AKRANES GEISLAHÚS			GRÁBRÓKARVEITA			GRUNDARFJÖRÐUR DÆLUHÚS			STYKKISHÓLMUR DÆLUHÚS		
	VALUE	AVERAGE	MAX	MIN	AVER-AGE	MAX	MIN	AVERAGE	MAX	MIN	AVER-AGE	MAX	MIN
Total microbes at 22°C	100/ ml	6.29	30	0	1.00	3	0	0.40	1	0	8.50	13	0
Escherichia coli (E. Coli)	0/100 ml	0	0	0	0	0	0	0	0	0	0	0	0
Enterococci	0/100 ml	0	0	0	0	0	0	0	0	0	0	0	0

CHEMICAL COMPOSITION OF POTABLE WATER

PHYSIOLOGICAL AND CHEMICAL PROPERTIES	UNIT	MAX RECOMM-ENDED VALUE	CO.		AKRA-NES	GRÁBRÓK-ARVEITA	GRUNDAR-FJÖRÐUR DÆLUHÚS	STYKKIS-HÓLMUR DÆLUHÚS
Sample no.					R14-1224-7	R14-1224-4	R14-1224-3	R14-1224-1
					June 2014	June 2014	June 2014	June 2014
Sample colour	mgPt/l			ALS	<5	<5	<5	<5
Turbidity	NTU	Adequate	(1)	MATÍS	<0.10	0.11	0.15	<0.10
Temperature	°C	25		MATÍS	5.2	3.7	3.3	3.7
pH	pH unit			MATÍS	7.20	7.10	6.80	7.15
Conductivity	µS/cm	2500		MATÍS	97	62	56	50
Klóríð (Cl)	mg/l	250		ALS	12.5	7.69	8.52	6.91
Súlfat (SO_4)	mg/l	250		ALS	2.84	1.46	1.64	1.91
Flúoríð (F)	mg/l	1.5		ALS	<0.200	<0.200	<0.200	<0.200
Nitrat (NO_3)	mg/l	50		ALS	0.336	0.137	0.102	0.089
Nitrít (NO_2)	mg/l	0.5		ALS	<0.01	<0.01	<0.01	<0.01
Ammóníum (NH_4-N)	mg/l	0.5		ALS	<0.026	<0.026	<0.026	<0.026
TOC	mg/l	no abnormal changes		ALS	<0.50	<0.50	<0.50	<0.50
Kalsíum (Ca)	mg/l	100	(3)	ALS	5.56	3.38	2.79	1.93
Járn (Fe)	mg/l	0.2		ALS	0.007	0.007	0.004	0.001
Kalíum (K)	mg/l	12	(3)	ALS	<0.4	<0.4	0.577	0.575
Magnesíum (Mg)	mg/l	50	(3)	ALS	2.12	1.51	1.6	1.37
Natríum (Na)	mg/l	200		ALS	10.1	6.51	5.67	5.42
Brennisteinn (S)	mg/l		(4)	ALS	1	0.593	0.554	0.566
Kísill (Si)	mg/l		(4)	ALS	6.92	4.06	4.19	5.02
Ál (Al)	µg/l	200		ALS	2.25	3.09	0.675	2.73
Arsen (As)	µg/l	10		ALS	<0.05	<0.05	<0.05	<0.05
Bór (B)	µg/l	1000		ALS	<10	<10	<10	<10
Baríum (Ba)	µg/l	700	(3)	ALS	0.045	0.355	0.749	0.373
Kadmíum (Cd)	µg/l	5.0		ALS	<0.002	<0.002	<0.002	<0.002
Cobalt (Co)	µg/l		(4)	ALS	0.011	<0.005	<0.005	<0.005
Króm (Cr)	µg/l	50		ALS	0.456	0.019	<0.01	0.125
Kopar (Cu)	µg/l	2000		ALS	0.281	0.962	0.227	1.12
Kvikasilfur (Hg)	µg/l	1.0		ALS	<0.002	<0.002	<0.002	<0.002
Mangan (Mn)	µg/l	50		ALS	0.258	0.565	0.222	<0.03
Molybdenum (Mo)	µg/l		(4)	ALS	<0.05	<0.05	0.196	0.251
Nikkel (Ni)	µg/l	20		ALS	0.998	0.067	0.108	0.058
Fosfór (P)	µg/l	5000	(3)	ALS	17.4	1.96	8.55	35.7
Blý (Pb)	µg/l	10		ALS	0.020	0.272	0.061	0.213
Antimon (Sb)	µg/l	5.0		ALS	<0.01	<0.01	<0.01	0.011
Selen (Se)	µg/l	10		ALS	<0.5	<0.5	<0.5	<0.5
Strontium (Sr)	µg/l		(4)	ALS	2.5	8.25	11.1	7.73
Sink (Zn)	µg/l	3000	(3)	ALS	2.14	1.41	2.34	8.75
Vanadium (V)	µg/l			ALS	3.46	0.531	0.515	12.7
Syaníð (CN total)	µg/l	50		ALS	<0.005	<0.005	<0.005	<0.005
diklormetan	µg/l			ALS	<2.0	<2.0	<2.0	<2.0
1,1 - diklóretan	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
1,2 - diklóretan	µg/l	3.0		ALS	<0.10	<0.10	<0.10	<0.10
trans 1,2 - diklóreten	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
cis 1,2 - diklóreten	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
1,2 - diklórpropan	µg/l			ALS	<1.0	<1.0	<1.0	<1.0

tetraklórmetan	µg/l			ALS		<0.10		<0.10		<0.10		<0.10	
1,1,1 - triklóretan	µg/l			ALS		<0.10		<0.10		<0.10		<0.10	
1,1,2 - triklóretan	µg/l			ALS		<0.20		<0.20		<0.20		<0.20	
triklóreten	µg/l	10	(2)	ALS		<0.10		<0.10		<0.10		<0.10	
tetraklóreten	µg/l		(2)	ALS		<0.20		<0.20		<0.20		<0.20	
Vinyl klóríð	µg/l			ALS		<1.0		<1.0		<1.0		<1.0	
bensen	µg/l	1.0		ALS		<0.20		<0.20		<0.20		<0.20	
toluen	µg/l			ALS		<0.20		<0.20		<0.20		<0.20	
etylbensen	µg/l			ALS		<0.20		<0.20		<0.20		<0.20	
summa xylener	µg/l			ALS		<0.20		<0.20		<0.20		<0.20	
triklórmetan	µg/l			ALS		<0.30		<0.30		<0.30		<0.30	
tribrómmetan	µg/l			ALS		<0.20		<0.20		<0.20		<0.20	
dibrómklórmetan	µg/l			ALS		<0.10		<0.10		<0.10		<0.10	
brómdiklórmetan	µg/l			ALS		<0.10		<0.10		<0.10		<0.10	
summa trihalometan	µg/l			ALS		<0.35		<0.35		<0.35		<0.35	
o-xylen	µg/l			ALS		<0.20		<0.20		<0.20		<0.20	
summa xylen	µg/l			ALS		<0.15		<0.15		<0.15		<0.15	
naftalen	µg/l			ALS		<0.20		<0.20		<0.20		<0.20	
acenaftylen	µg/l			ALS		<0.10		<0.10		<0.10		<0.10	
acenaften	µg/l			ALS		<0.0070		<0.0070		<0.0070		<0.0070	
flúoren	µg/l			ALS		<0.010		<0.010		<0.010		<0.010	
fenantren	µg/l			ALS		<0.040		<0.040		<0.040		<0.040	
antracen	µg/l			ALS		<0.0050		<0.0050		<0.0050		<0.0050	
flúoranten	µg/l			ALS		<0.0050		<0.0050		<0.0050		<0.0050	
pyren	µg/l			ALS		<0.0050		<0.0050		<0.0050		<0.0050	
*bens(a)antracen	µg/l			ALS		<0.0030		<0.0030		<0.0030		<0.0030	
*krysen	µg/l			ALS		<0.0070		<0.0070		<0.0070		<0.0070	
*benz(b)flúoranten	µg/l	0.1	(5)	ALS		<0.0040		<0.0040		<0.0040		<0.0040	
*bens(k)flúoranten	µg/l		(5)	ALS		<0.0020		<0.0020		<0.0020		<0.0020	
*bens(a)pyren	µg/l	0.01		ALS		<0.0020		<0.0020		<0.0020		<0.0020	
*dibens(ah)antracen	µg/l			ALS		<0.0020		<0.0020		<0.0020		<0.0020	
benzo(ghi)perylen	µg/l		(5)	ALS		<0.0030		<0.0030		<0.0030		<0.0030	
*indeno(123cd)pyren	µg/l		(5)	ALS		<0.0030		<0.0030		<0.0030		<0.0030	
summa 16 EPA-PAH	µg/l			ALS		<0.20		<0.20		<0.20		<0.20	
*summa PAH cancerogena	µg/l			ALS		<0.012		<0.012		<0.012		<0.012	
summa PAH annað	µg/l			ALS		<0.20		<0.20		<0.20		<0.20	

Commentary:

(1) Adequate for consuption and no uncharacteristically changes

(2) Maximum value for sum of thrichlorethene and tetrachlorethene

(3) Maximum value in older Icelandic regulations 319/1995 (void)

(4) Maximum value not in Icelandic regulations

"(5) Maximum value for the sum of the following substances:
benzo(b)fluoranten. benzo(k)fluoranten. benzo(ghi)perylen. indeno(123cd)pyren"

Laboratories:

MATÍS: Matís ohf, Laboratory

ALS: ALS Scandinavia AB (Sweden)

* : Iceland GeoSurvey

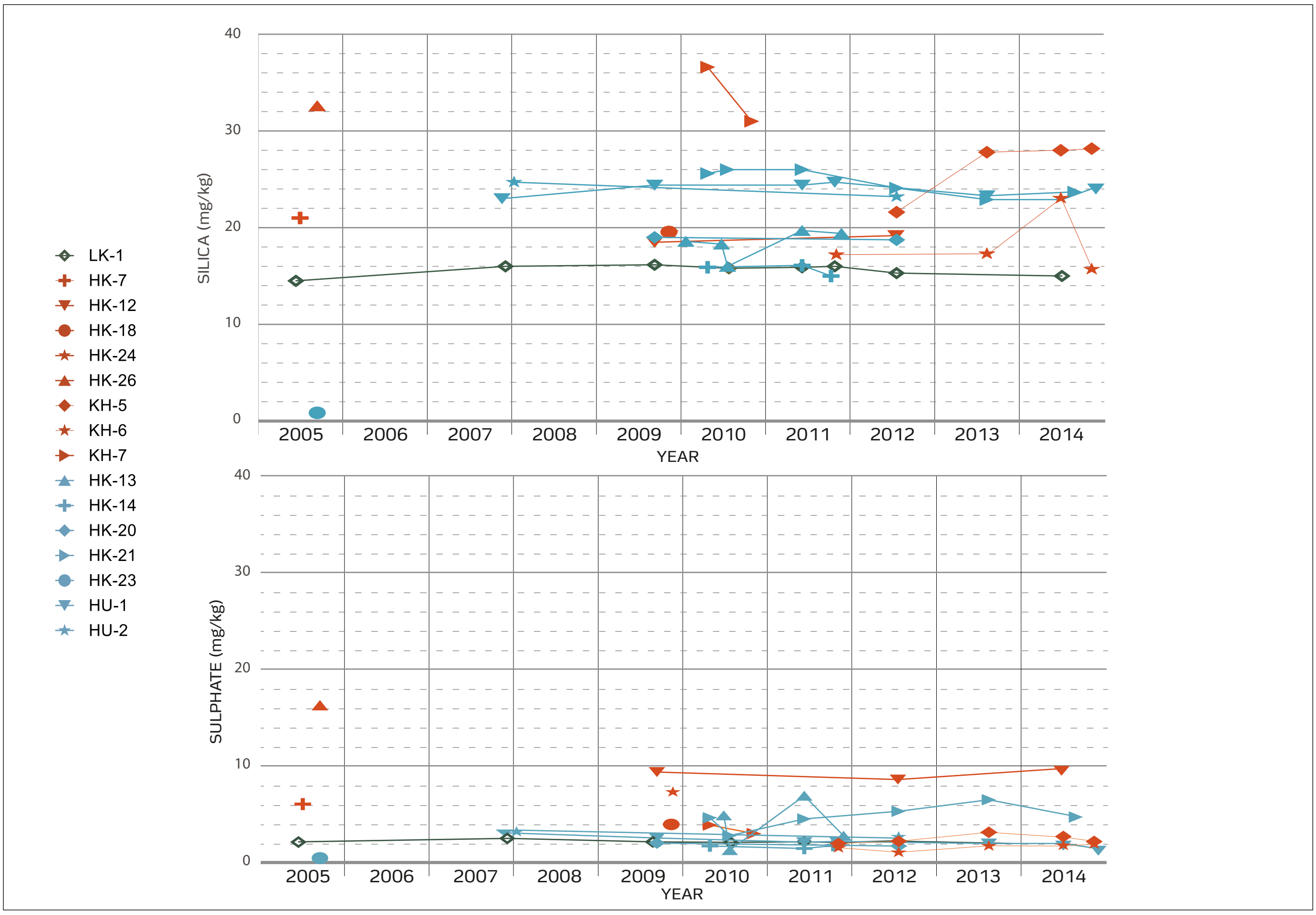
Annex 8. **Chemical composition of groundwater from observation wells in the vicinity of Hellisheidi Geothermal Power Plant 2014**

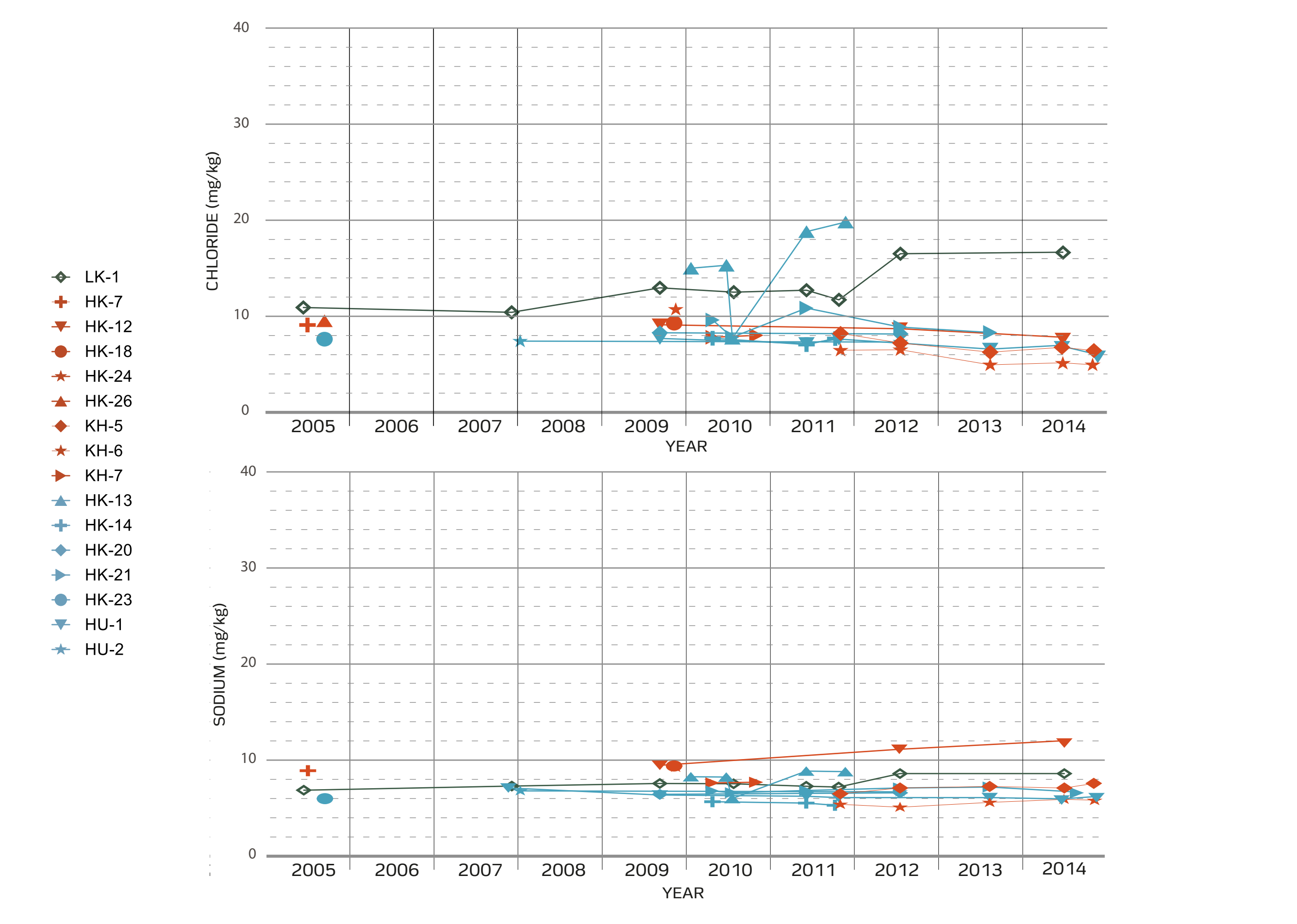
CHEMICAL COMPOSITION OF GROUNDWATER IN WELLS NEAR HELLISHEIÐI POWER PLANT 2014

WELL			HK-12	KH-5	KH-5	KH-6	KH-6	HK-21	HU-1	HU-1	LK-1	Surface water from Húsmúli at Draugatjörn
GROUNDWATER FLOW	UNIT	MAX RECOMMENDED VALUE	SELVOGSSTRAUMUR					ÞINGVALLASTRAUMUR				SELVOGS-STRAUMUR
Sample no.			2014-5190	2014-5189	2014-5385	2014-5185	2014-5386	2014-5192	2014-5185	2014-5405	2014-5194	2014-5193
Date			6/27/2014	6/27/2014	11/5/2014	6/24/2014	11/5/2014	6/27/2014	6/25/2014	11/21/2014	6/28/2014	6/28/2014
PHYSICAL AND CHEMICAL PROPERTIES												
pH			8.08	7.54	6.77	6.98	6.48	7.33	7.57	7.32	7.19	7.01
T (pH)	°C		23.3	23.3	23.3	23.3	23.3	23.2	23.3	23.4	23.4	23.5
Conductivity	µS/cm	2,500	187	118.9	123.3	82.5	86.1	98.5	79.1	79	97	57.4
T (conductivity)	°C		21.8	21.5	21.5	21.5	21.8	21.6	21.6	21.9	21.7	21.8
CO_2	mg/kg	*	61.7	41.3	42.3	34.55	37.2	31.3	23.5	25.7	16.3	37.9
F	mg/kg	1.5	0.000	0.034	0.04	0.54	0.02	0.047	0.034	0.04	0.000	0.00
SiO_2	mg/kg	*	20.30	27.79	28.00	23.02	16.00	23.64	23.02	24.00	15.07	14.54
Na	mg/kg	200	12.08	7.17	7.60	5.98	5.80	6.74	5.98	6.30	8.73	4.69
K	mg/kg	12	1.26	0.78	0.81	0.83	0.58	0.92	0.83	0.87	0.92	0.44
Ca	mg/kg	100	14.14	8.17	8.36	4.54	4.56	6.87	4.54	4.56	4.29	2.79
Mg	mg/kg	50	7.03	5.21	5.16	2.78	4.17	3.47	2.78	2.67	2.78	2.14
Fe	mg/kg	0.2	0.012	0.011	0.014	<0.0075	0.022	0.047	<0.0075	0.020	0.012	0.47
Al	mg/kg	0.2	<0.007	<0.007	0.006	<0.007	0.005	<0.007	<0.007	0.004	0.011	0.045
Sr	mg/kg	*	0.027	0.013		0.009		0.017	0.009		0.008	0.009
Mn	mg/kg	0.05	<0.002	<0.002		<0.002		0.065	<0.002		<0.002	0.034
SO_4	mg/kg	250	9.34	2.61	2.23	1.65	1.80	4.65	1.90	1.36	1.81	1.1
P	mg/kg	5	<0.03	0.059		0.047		<0.03	0.047		<0.03	<0.03
Li	mg/kg	*	<0.01	<0.01		<0.01		<0.01	<0.01		<0.01	<0.01
Cl	mg/kg	250	7.6	6.6	6.2	5.0	4.85	7.1	6.8	5.8	16.7	5.3
B	mg/kg	1	0.010	<0.0075	<0.005	<0.0075	<0.005	<0.0075	<0.0075	<0.005	<0.0075	<0.0075

* Maximum value not in Icelandic regulations

Annex 9. **Chemical composition of groundwater from observation wells around Hellisheidi Geothermal Power Plant 2005-2014**





Annex 10. **Release of separated water via overflow at Hellisheidi Geothermal Power Plant 2014**

RELEASE OF SEPARATED WATER VIA OVERFLOW AT HELLISHEIDI

DATE	MALFUNCTION	24-HOUR AVERAGE FLOW
8 January	Malfunction	66 l/s
19-29 January	Malfunction	47 l/s
6-12 March	Malfunction	26 l/s
24-29 March	Disturbances in injection system	13-35 l/s
22-25 April	Malfunction	5-20 l/s
28 April - 19 May	Malfunction	150-200 l/s
28-29 May	Disturbances in injection system	44 l/s
5-16 June	Malfunction	32 l/s
15-16 July	Disturbances in injection system	50 l/s
18-20 July	Malfunction	50 l/s
30 August - 7 September	Malfunction	92 l/s
7 September - 9 October	Malfunction	50-135 l/s
9-23 October	Malfunction	60-135 l/s
27 October	Malfunction	60 l/s
16 November - 31 December	Malfunction	25-76 l/s

ANNEX 11. **Trace elements in separated water from Hellisheidi and Nesjavellir Geothermal Power Plants**

Typical concentrations (mg/kg) of several trace elements in separated water from Hellisheidi and Nesjavellir Geothermal Power Plants and their maximum recommended concentrations (mg/kg) for potable water. When the chemical content of separated water is compared to potable water standards, it is seen that, in separated water from Hellisheidi Geothermal Power Plant, the concentration of potassium is approximately three times higher and the concentration of aluminium and of arsenic is about 10 times higher than recommended for potable water. In separated water from Nesjavellir Geothermal Power Plant, the concentration of potassium is about three times higher, the concentration of aluminium about 10 times higher, and the concentration of arsenic is about 12 times higher than recommended for potable water. The concentration of other substances in separated water is lower than the given limits for potable water.

TRACE ELEMENTS IN SEPERATED WATER FROM POWER PLANTS IN HENGILL

ELEMENT	UNIT	MAX RECOMM. VALUE FOR POTABLE WATER	SEPERATED WATER HELLISHEIÐI	SEPERATED WATER NESJAVELLIR
Aluminium (Al)	mg/kg	0.2	1.7	2
Arsenic (As)	mg/kg	0.01	0.09	0.12
Barium (Ba)	mg/kg	-	0.078	*
Cadmium (Cd)	mg/kg	0.005	0.000	0.000
Chrome (Cr)	mg/kg	0.05	0.000	*
Copper(Cu)	mg/kg	2	0.002	0.001
Mercury (Hg)	mg/kg	0.001	0.000	0.000
Potassium (K)	mg/kg	12	38.4	31.5
Nickel (Ni)	mg/kg	0.02	0.000	0.001
Lead (Pb)	mg/kg	0.01	0.004	0.000
Zinc (Zn)	mg/kg	3	0.010	0.001

*Values for Br and Cr have not been measured

Annex 12. **Emissions of carbon dioxide (CO_2), hydrogen sulphide (H_2S), hydrogen (H_2) and methane (CH_4) from Hellisheidi and Nesjavellir 2003-2014**

HELLISHEIÐI

YEAR	CO_2 [tons/yr]	H_2S [tons/yr]	H_2 [tons/yr]	CH_4 [tons/yr]
2003	3,602	1,283	76	0
2004	1,943	748	38	0
2005	4,581	819	*	*
2006	0	0	*	*
2007	24,210	6,902	276	20
2008	32,937	10,323	407	30
2009	35,325	8,581	269	36
2010	41,722	13,340	389	46
2011	39,479	12,212	401	57
2012	43,158	12,044	417	51
2013	44,934	12,374	529	72
2014	38,861	8,484	459	81

* Data not available for 2005 and 2006

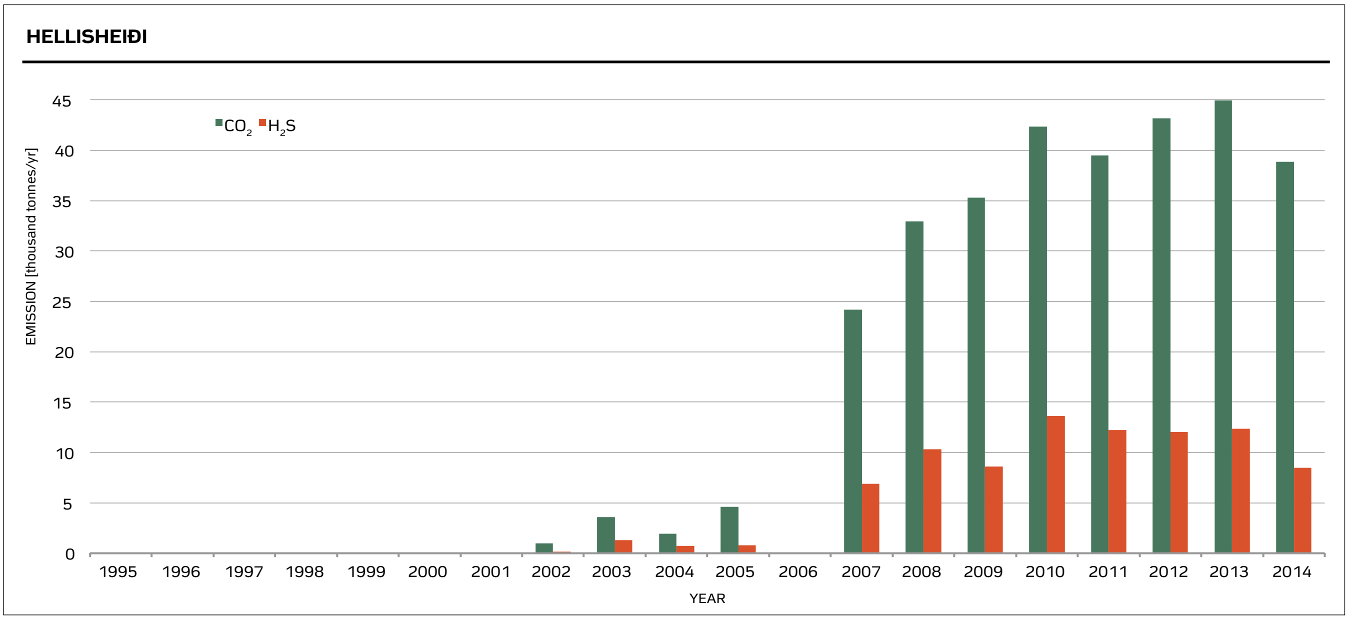
Commentary 2014:
1) Approx. million tons less steam than 2013
2) CO_2 og H_2S in condensate subtracted. Was not done in previous years.
3) Approx. 2400 tons of CO_2 and approx. 1300 tons of H_2S were injected in the SulFix project.

NESJAVELLIR

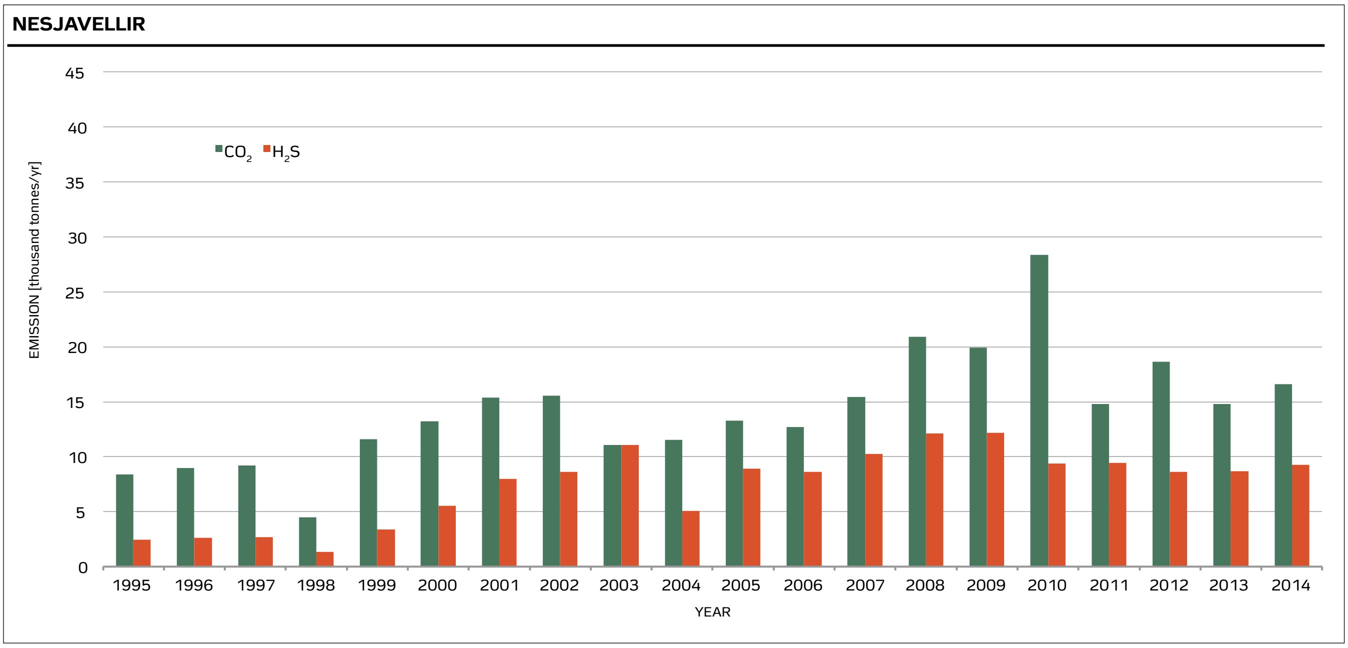
YEAR	CO_2 [tons/yr]	H_2S [tons/yr]	H_2 [tons/yr]	CH_4 [tons/yr]
2003	11,058	5,941	313	14
2004	11,551	5,084	317	21
2005	13,259	8,918	410	29
2006	12,673	8,650	*	*
2007	15,412	10,275	410	26
2008	20,904	12,114	658	24
2009	19,918	12,175	640	24
2010	28,396	9,384	481	111
2011	14,800	9,414	470	47
2012	18,612	8,640	456	28
2013	14,794	8,709	481	46
2014	16,579	9,275	491	55

* Data not available for 2006

Annex 13. **Emissions of carbon dioxide (CO_2) and hydrogen sulphide (H_2S), from Hellisheidi 2002-2013 and Nesjavellir 1995-2014**



1) Approx. million tons less steam than 2013
2) CO_2 og H_2S in condensate subtracted. Was not done in previous years.
3) Approx. 2400 tons of CO_2 and approx. 1300 tons of H_2S were injected in the SulFix project.

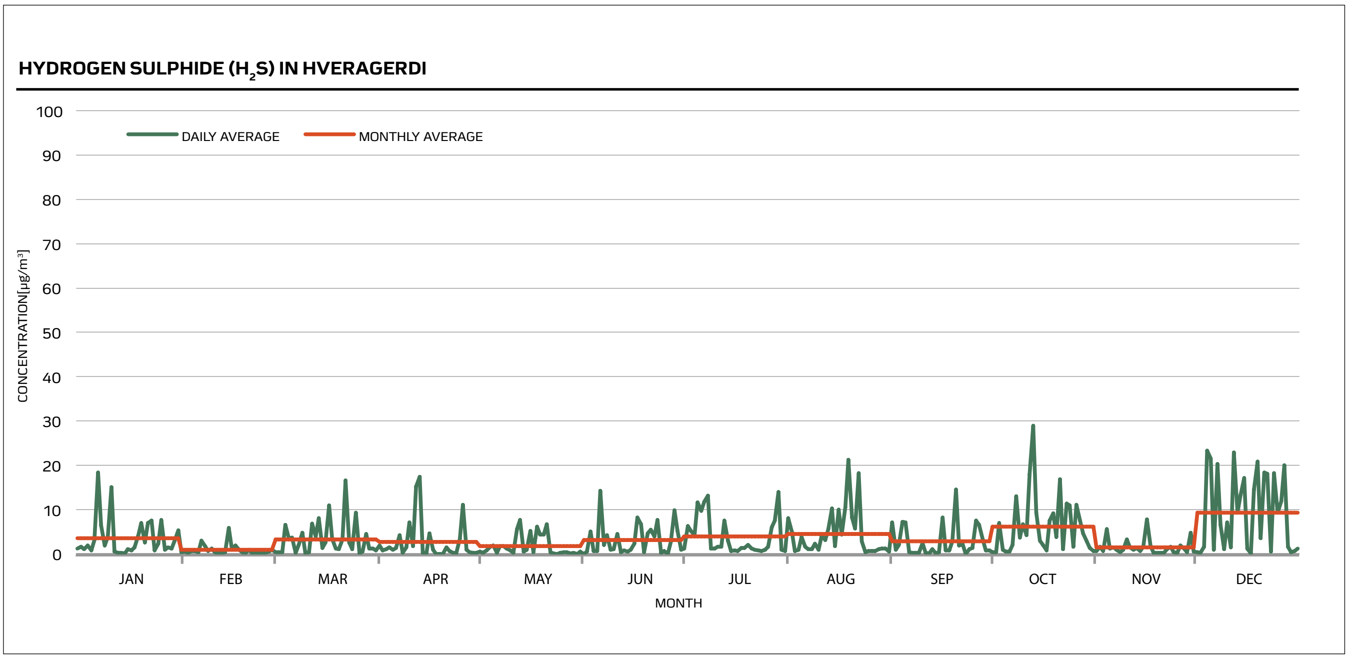


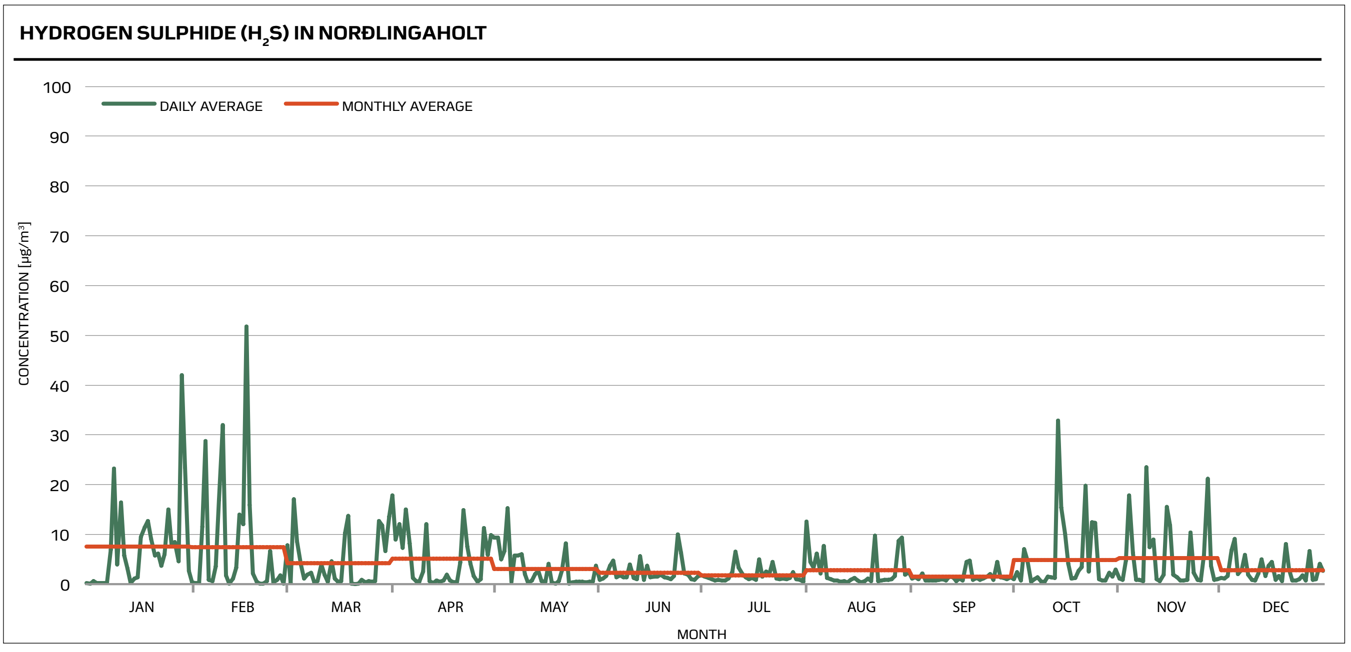
Annex 14. **Comparison between environmental limits of regulations for hydrogen sulphide in µg/m³ and ppm**

COMPARISON OF H_2S CONCENTRATION IN µg/m³ AND ppm

µg/m³	ppm	COMMENTS
5	0.004	Maximum annual average
7 - 15	0,0054 - 0,012	Odour threshold
50	0.039	Maximum daily average
150	0.12	Notification limits (three continuour hours)
7,000	5.41	Limit in a work environment of an eight-hour workday
14,000	10.8	Limit in a work environment of fifteen-min period

Annex 15. **Daily averages and monthly averages for the concentration of hydrogen sulphide in Hveragerdi and Nordlingaholt in 2014**





Annex 16. **Thirty highest hourly averages of the concentration of hydrogen sulphide in Hveragerdi and Nordlingaholt, date and time in 2014**

HVERAGERDI

HYDROGEN SULPHIDE CONCENTRATION 2014 - 30 HIGHEST HOURLY AVERAGES

CONCENTRATION [µg/m³]	TIME	CONCENTRATION [µg/m³]	TIME	CONCENTRATION [µg/m3]	TIME
222	4/12/2014 22:59	76	24/12/2014 10:59	59	25/3/2014 7:59
124	21/12/2014 18:59	75	27/12/2014 12:59	58	22/12/2014 12:59
123	4/12/2014 23:59	67	19/12/2014 19:59	57	12/12/2014 14:59
120	5/12/2014 0:59	67	27/12/2014 15:59	56	11/1/2014 12:59
117	13/12/2014 23:59	66	18/10/2014 20:59	55	22/12/2014 14:59
104	14/12/2014 0:59	66	13/12/2014 21:59	54	31/1/2014 1:59
95	21/12/2014 17:59	64	7/12/2014 20:59	54	8/10/2014 8:59
92	4/12/2014 21:59	62	27/12/2014 12:59	53	19/12/2014 20:59
87	7/12/2014 22:59	61	15/12/2014 8:59	52	26/1/2014 17:59
80	12/12/2014 11:59	59	7/1/2014 7:59	52	27/12/2014 14:59

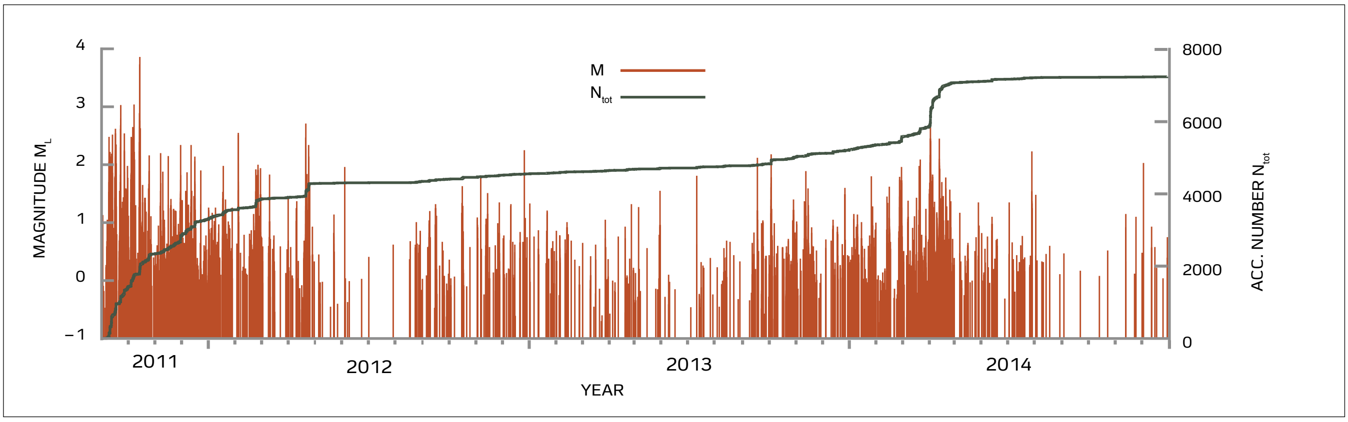
NORDLINGAHOLT

HYDROGEN SULPHIDE CONCENTRATION 2014 - 30 HIGHEST HOURLY AVERAGES

CONCENTRATION [µg/m³]	TIME	CONCENTRATION [µg/m³]	TIME	CONCENTRATION [µg/m³]	TIME
117	10/2/2014 2:59	94	11/1/2014 21:59	84	29/1/2014 16:59
115	17/2/2014 15:59	94	29/1/2014 20:59	82	5/2/2014 8:59
114	29/1/2014 11:59	90	18/2/2014 8:59	81	15/2/2014 2:59
113	10/2/2014 3:59	90	17/2/2014 5:59	80	14/10/2014 8:59
112	30/1/2014 2:59	89	17/2/2014 16:59	80	4/11/2014 6:59
104	29/1/2014 15:59	89	14/2/2014 23:59	79	5/2/2014 18:59
103	1/29/2014 10:59	88	1/29/2014 19:59	79	1/11/2014 19:59
101	2/17/2014 0:59	88	2/10/2014 4:59	78	8/21/2014 7:59
97	2/10/2014 1:59	87	1/30/2014 3:59	77	11/9/2014 13:59
96	2/17/2014 6:59	84	2/10/2014 0:59	77	1/29/2014 18:59

Annex 17. **Seismic activity at Hellisheidi Geothermal Power Plant in the autumn of 2011 through year-end 2014**

The figure shows, on one hand, the magnitude of seismic activity and, on the other, the accumulated number of seismic activity during the period. The seismic data are obtained from the national seismometer network of the Icelandic Meteorological Office. Intense induced seismicity followed the commission of the Húsmúli reinjection field in September 2011, and it reached maximum in mid-October when two events of magnitude of 4 occurred. At the end of 2011/beginning of 2012, the seismicity slowly decreased and in the summer of 2012, it had almost faded out. In the autumn of 2012, the activity increased again but was nothing like what it was when it started. The reason was that the heat exchangers of the district heating utility were put online in Hellisheidi. This somewhat cooled the disposal water, and its flow subsequently increased. The seismicity was far from being as intense as the year before when the reinjection field was taken into use.



Since then the seismic activity has been minor and has made itself felt during changes in the operations of the district heating utility in Hellisheidi until early in 2014 in connection with the testing and starting up of the SulFix project. The activity was within acceptable limits and, for the most part, had petered out in the summer. Since then seismicity at Hellisheidi Geothermal Power Plant has been negligible.

Annex 18. **Trace elements from sewage treatment plants in Reykjavik in 2014**

Discharge of pollutants (mg/l) from sewage treatment plants in Reykjavik in 2014. The average flow in Klettagardar was 1280 l/sec, and in Ánanaust it was 1120 l/sec.

KLETTAGARDAR	MARCH	JUNE	SEPTEMBER	DECEMBER	MEAN VALUE
	mg/l	mg/l	mg/l	mg/l	mg/l
Total nitrogen (N)	6.2	16.5	10.9	9.0	10.7
Total phosphorus (P)	0.3	2.2	1.3	1.6	1.4
Arsenic (As)	<0.050*		<0.020*		Below the detection limit
Cadmium (Cd)	<0.0010*		<0.0010*		Below the detection limit
Cromium (Cr)	0.011		<0.0050*		Below or near the detection limit
Copper (Cu)	0.011		0.042		0.027
Mercury (Hg)	<0.00050*		<0.00050*		Below the detection limit
Nickel (Ni)	0.035		<0.0050*		Below or near the detection limit
Lead (Pb)	<0.0050*		0.010		Below or near the detection limit
Zinc (Zn)	0.033		0.048		0.041
ÁNANAUST	**MARCH**	**JUNE**	**SEPTEMBER**	**DECEMBER**	**MEAN VALUE**
	mg/l	mg/l	mg/l	mg/l	mg/l
Total nitrogen (N)	11.5	15.6	9.2	9.2	11.4
Total phosphorus (P)	1.5	2.3	1.9	1.7	1.9
Arsenic (As)	<0.050*		<0.020*		Below the detection limit
Cadmium (Cd)	0.001		<0.0010*		Below or near the detection limit
Cromium (Cr)	<0.0050*		<0.0050*		Below the detection limit
Copper (Cu)	0.009		0.041		0.025
Mercury (Hg)	<0.00050*		<0.00050*		Below the detection limit
Nickel (Ni)	0.010		<0.0050*		Below or near the detection limit
Lead (Pb)	<0.0050*		<0.0050*		Below the detection limit
Zinc (Zn)	0.039		0.074		0.057

* Below the detection limit
- When both samples collected 2014 are below the detection limits, the column "mean value" states " below the detection limit"
- When one of two samples collected 2014 is below the detection limits the column and the other sample is just over the detection limit, mean value is not calculated. In the column "mean value" states "below on near the detection limit"

Annex 19. **Sewage discharge reporting—Ánanaust 2014**

The sewage discharge reporting is based on the average values of each polluting factor according to the results from samples collected twice a year for trace elements and four times for nitrogen and phosphorus (see Annex 18) and the average flow of the plant, which was 1120 l/sec.

REFERENCE YEAR	2014
INFORMATION ON THE OPERATIONAL UNIT	
Name of the parent corpany	Reykjavik Energy
Name of the operational unit	RE Utilities - Sewage Plant Ánanaust
National ID of the operational unit	501213-1870
Address	Ánanaust 10
Town/location	Reykjavik
Postal code	101
Country	Iceland
Location coordinates	354,566.305/412,477.62
Catchment area district	
Code for occupational category under EC/EU law	90.01
Most Important Occupational Activitie	Collection And Treatment Of Sewage
OPTIONAL INFORMATION	
Production quantity	
Number of centers	1
Number of operational hours per year	
Number of employees	

Field for textual information or web address referring to environmental information that the operational unit or parent corporation wants to present
All operation of the operational unit according to Annex I (according to the coding system in Annex I and the IPPC code, if available)

OPERATION NO.	OPERATION	IPPC CODE	
5.(f)	Sewage treatment plants for urban areas	-	

Disposal of each pollutant exceeding the quantity of the criterion value (in accordance with Annex II)

POLLUTANTS ACCORDING TO ANNEX II		PROCEDURE		DISPOSAL IN WATER	
No.	Name	M/C/E	Prodedure	Total [kg/yr]	Incident [kg/yr]
12	Total nitrogen	M	ALT - EN ISO 11905-1	401,769	
13	Total phosphorus	M	ALT - EN 1189	65,343	
17	As and compounds	M	EPA 200.8 K(ICP-MS)	Below the detection limit	
18	Cd and compounds	M	EPA 200.8 K(ICP-MS)	Below or near the detection limit	
19	Cr and compounds	M	EPA 200.8 K(ICP-MS)	Below the detection limit	
20	Cu and compounds	M	EPA 200.8 K(ICP-MS)	878	
21	Hg and compounds	M	ALT - EN ISO 17852:2006	Below the detection limit	
22	Ni and compounds	M	EPA 200.8 K(ICP-MS)	Below or near the detection limit	
23	Pb and compounds	M	EPA 200.8 K(ICP-MS)	Below the detection limit	
24	Zn and compounds	M	EPA 200.8 K(ICP-MS)	1,996	

COMPETENT AUTHORITY TO WHICH THE PUBLIC CAN TURN:	
Name	The Environment Agency of Iceland
Address	Sudurlandsbraut 24
Town/location	Reykjavík
Telephone	5912000
Fax	5912020
E-mail address	ust@ust.is

Annex 20. **Sewage discharge reporting—Klettagardar 2014**

The sewage discharge reporting is based on the average values of each polluting factor according to the results from samples collected twice a year for trace elements and four times for nitrogen and phosphorus (see Annex 18) and the average flow of the plant, which was 1280 l/sec.

REFERENCE YEAR	**2014**
INFORMATION ON THE OPERATIONAL UNIT	
Name of the parent corpany	Reykjavik Energy
Name of the operational unit	RE Utilities - Sewage Plant Klettagardar
National ID of the operational unit	501213-1870
Address	Klettagardar 14
Town/location	Reykjavík
Postal code	104
Country	Iceland
Location coordinates	357,634.866/413,556.416
Catchment area district	
Code for occupational category under EC/EU law	90.01
Most important occupational activitie	Collection and treatment of sewage
OPTIONAL INFORMATION	
Production quantity	
Number of centers	1
Number of operational hours per year	
Number of employees	

Field for textual information or web address referring to environmental information that the operational unit or parent corporation wants to present
All operation of the operational unit according to Annex I (according to the coding system in Annex I and the IPPC code, if available)

OPERATION NO.	**OPERATION**	**IPPC CODE**	
5.(f)	Sewage treatment plants for urban areas	-	

Disposal of each pollutant exceeding the quantity of the criterion value (in accordance with Annex II)

POLLUTANTS ACCORDING TO ANNEX II		**PROCEDURE**		**DISPOSAL IN WATER**	
No.	Name	M/C/E	Prodedure	Total [kg/yr]	Incident [kg/yr]
12	Total nitrogen	M	ALT - EN ISO 11905-1	429,899	
13	Total phosphorus	M	ALT - EN 1189	54,494	
17	As and compounds	M	EPA 200.8 K(ICP-MS)	Below the detection limit	
18	Cd and compounds	M	EPA 200.8 K(ICP-MS)	Below the detection limit	
19	Cr and compounds	M	EPA 200.8 K(ICP-MS)	Below or near the detection limit	
20	Cu and compounds	M	EPA 200.8 K(ICP-MS)	1,070	
21	Hg and compounds	M	ALT - EN ISO 17852:2006	Below the detection limit	
22	Ni and compounds	M	EPA 200.8 K(ICP-MS)	Below or near the detection limit	
23	Pb and compounds	M	EPA 200.8 K(ICP-MS)	Below or near the detection limit	
24	Zn and compounds	M	EPA 200.8 K(ICP-MS)	1,635	

COMPETENT AUTHORITY TO WHICH THE PUBLIC CAN TURN:	
Name	The Environment Agency of Iceland
Address	Sudurlandsbraut 24
Town/location	Reykjavík
Telephone	5912000
Fax	5912020
E-mail address	ust@ust.is

Annex 21. **Waste 2010-2014**

WASTE CATEGORIES 2010-2014

CATEGORY	UNIT	2010	2011	2012	2013	2014
General waste	kg	63,500	86,590	57,640	52,770	53,210
Coarse waste	kg	45,580	84,950	40,430	27,550	10,129
Asbestos	kg	29,480	1,264	8,620	35,700	11,700
Sludge (solid constituents from sewage)	kg	1,172,900	1,181,610	1,369,210	1,131,500	1,325,860
TOTAL FOR LANDFILLING	**kg**	**1,311,460**	**1,354,414**	**1,475,900**	**1,247,520**	**1,400,899**
Green bin	kg	6,900	8,900	6,420	5,870	6,860
Metals	kg	51,010	58,680	72,230	46,430	59,390
Timber - uncoloured	kg	44,990	33,650	17,050	5,760	18,160
Timber - coloured	kg	3,930	21,260	13,790	11,540	8,800
Garden waste	kg					3,320
Plastic	kg	7,080	5,100	2,610	4,810	3,140
Corrugated cardboard	kg	8,570	12,600	6,480	9,850	7,520
Office paper	kg	2,730	3,120	2,280	3,510	3,010
Newspapers and magazines	kg	3,040	760	670	1,530	110
Orgainc waste	kg	28,650	27,030	17,550	22,560	25,740
TOTAL FOR RECYCLING	**kg**	**156,900**	**171,100**	**139,080**	**111,860**	**136,050**
Unknown waste	kg	5,414	4,253	1,180	93	170
Light bulbs	kg			1,310	1,309	649
Batteries	kg				29	10
Car batteries	kg			1,546	500	1,394
Electronic waste	kg				77	771
Paint, toner etc.	kg			118	98	420
Oil and waste contaminated with oil	kg					1,901
Solvents	kg					154
Organic pollutants, cooking oil	kg				408	273
Plaster	kg				150	
TOTAL HAZARDOUS WASTE	**kg**	**5,414**	**4,253**	**4,154**	**2,664**	**5,742**
TOTAL WASTE	**kg**	**1,473,774**	**1,529,767**	**1,619,134**	**1,362,044**	**1,542,691**

Annex 22. **Waste by worksites in 2014**

WASTE CATEGORIES 2014 DIVIDED BETWEEN WORKSITES

CATEGORY	UNIT	NESJA-VELLIR	HELLISHEIDI	BÆJAR-HÁLS	ELLIÐAÁ-STATION	AKRA-NES	BORGAR-NES	ÁNA-NAUST SEWAGE PLANT	KLETTA-GARÐAR SEWAGE PLANT	PUMPING STATIONS IN THE METROPOLITAN AREA	SEWAGE TREATMENT PLANTS IN BORGAR-FJÖRÐUR	TOTAL
General waste	kg	6,580	8,660	32,920	1,050	2,420	510		1,070			53,210
Coarse waste	kg		3,069	7,020		40						10,129
Asbestos	kg	27,000	35,000					360,180	740,000	106,680	57,000	1,325,860
Sludge (solid constituents from sewage)	kg						11,700					11,700
TOTAL FOR LANDFILLING	**kg**	**33,580**	**46,729**	**39,940**	**1,050**	**2,460**	**12,210**	**360,180**	**741,070**	**106,680**	**57,000**	**1,400,899**
Green barrel	kg		840	5,830					190			6,860
Metals	kg	4,360	15,040	39,990								59,390
Timber - uncoloured	kg	2,220	11,420	4,520								18,160
Timber - coloured	kg		2,100	6,700								8,800
Garden waste	kg		3,320									3,320
Plastic	kg			2,580		460	100					3,140
Corrugated cardboard	kg			6,950		490	80					7,520
Office paper	kg			3,010								3,010
Newspapers and magazines	kg					110						110
Orgainc waste	kg		660	25,080								25,740
TOTAL FOR RECYCLING	**kg**	**6,580**	**33,380**	**94,660**	**0**	**1,060**	**180**	**0**	**190**	**0**	**0**	**136,050**
Unknown waste	kg			170								170
Bulbs	kg		25	554		70						649
Batteries	kg		10									10
Car batteries	kg		554	710		130						1,394
Electronic waste	kg		41	730								771
Paint, toner etc.	kg		2	418								420
Oil and waste contaminated with oil	kg		1,493	391		17						1,901
Solvents	kg		61	93								154
Organic pollutants, cooking oil	kg		273									273
Plaster	kg											
TOTAL HAZARDOUS WASTE	**kg**	**0**	**2,459**	**3,066**	**0**	**217**	**0**	**0**	**0**			**5,742**

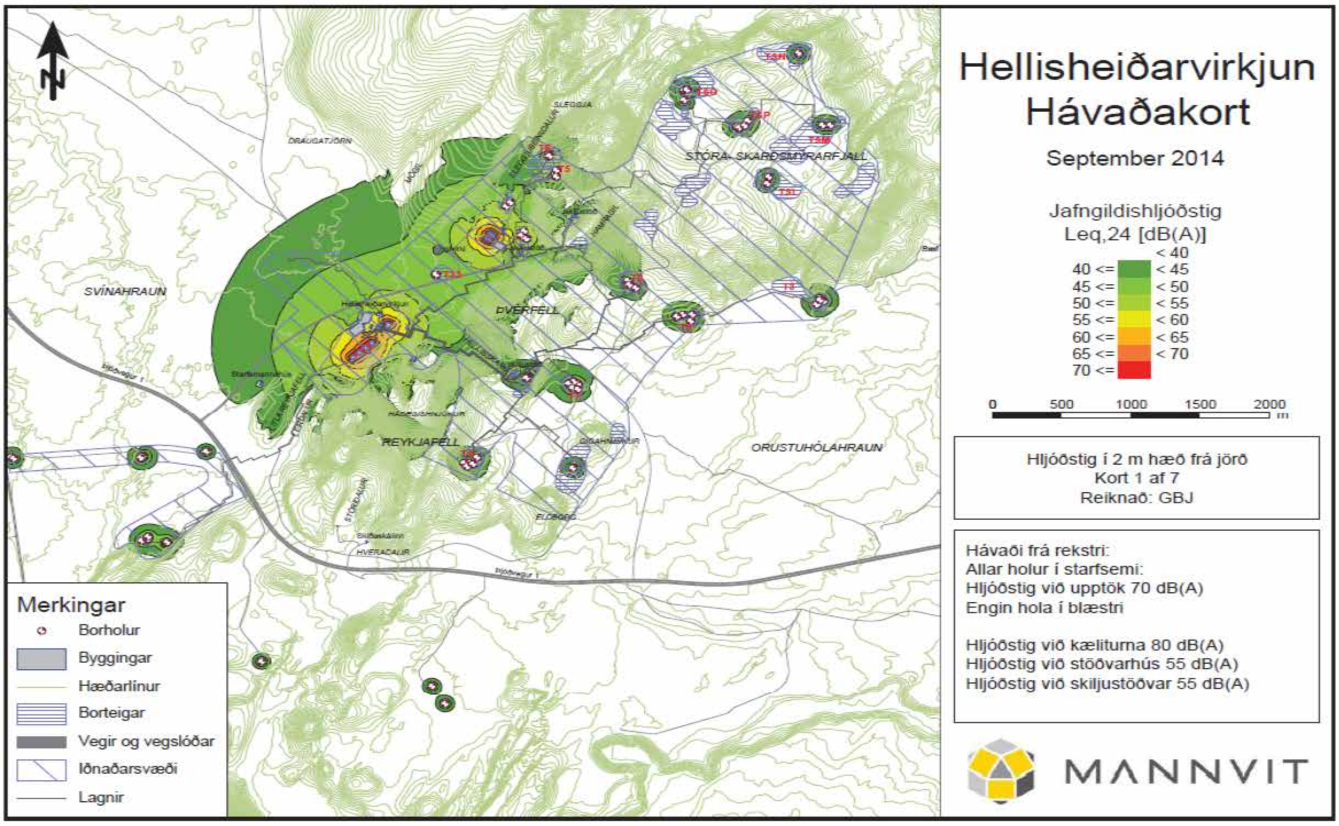
Annex 23. **Number of Reykjavik Energy's cars, based on energy sources and emission values at the end of each year for the period 2010-2014**

CARS	ENERGY SOURCE	2010	2011	2012	2013	2014
Traditional	Gasoline >99 g CO_2/km	35	29	24	21	14
	Diesel >99 g CO_2/km	92	85	76	83	91
Environmentally friendly	Diesel <99 g CO_2/km					5
	Hybrid					17
	Plug-in hybrid					2
	Electricity	1	1	2	5	5
	Methane	21	21	16	14	11
	Hydrogen	1	0	0	0	0
TOTAL		**150**	**136**	**118**	**123**	**145**

Annex 24. **Fuel consumption of vehicles that Reykjavik Energy utilised 2010-2014**

ENERGY SOURCE	UNIT	2010	2011	2012	2013	2014
Gasoline	Litres	85,361	60,181	44,499	33,347	34,088
Diesel	Litres	308,835	297,644	174,164	168,326	156,529
Methane	m^3	27,838	28,010	20,522	19,542	10,110
Hydrogen	m^3	476	181	0	0	0

Annex 25. **Noise from Hellisheidi Geothermal Power Plant at year-end 2013, based on no well being vented**



The Regulation on Noise no. 724/2008 states that noise at the wall of an industrial building or in work areas shall not be greater than 70 dB (A). This can generally be interpreted to mean that operations shall not cause noise exceeding 70 dB(A) outside a defined work area.

Annex 26. **Water level in Lake Skorradalur 2014**