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OR Reykjavík Energy

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Summary

Environmental issues are a key element in the social debate and the performance of Reykjavik Energy (OR) and its subsidiaries is therefore important. This is a brief summary of the main progress made in the environmental projects developed in 2016.

Noteworthy results in 2016

VEITUR UTILITIES AND ON POWER

- Veitur Utilities and ON Power ensured the supply of potable water to residents and business community in the utility area.

ON POWER

- The Hverahlíd pipeline came into use during the year to support the operation of the Hellisheidi Geothermal Power Plant to make it possible to rest parts of the production field of the plant. But improvements still need to be made.
- About 95% of the geothermal water from the Hellisheidi Geothermal Power Plant has been reinjected, but there is clearly a need to further increase the capacity of the reinjection fields.
- Research shows that distributed and moderate reinjection reduces the pressure drop in the geothermal reservoir and can increase the utilisation of the reservoir.
- New and effective procedures continued to be applied to reclaim vegetation and restore disturbed areas in Hellisheidi.
- The enlargement of the hydrogen sulphide abatement unit at the Hellisheidi Power Plant was completed in July. About 50% of the hydrogen sulphide was removed from the power plant's emissions in 2016.
- Over 20% of the annual carbon dioxide emissions from the Hellisheidi Geothermal Power Plant were mineralised in the bedrock by the plant.
- ON Power obtained the biggest grant issued by the Ministry of Industries and Innovation in 2016 for the development of infrastructure for the electrification of transport.

VEITUR UTILITIES

- Endeavours were made to increase water and steam production in Hveragerdi. The geothermal system in Laugaland in Holt was further researched with a view to increasing the hot water supply at the Rangá Utility in South Iceland.
- Construction was mostly completed on the new sewage treatment plants at Akranes, Borgarnes and Kjalarnes. In all the collection areas of Veitur Utilities, the residents and business community will soon have the option of connecting to sewerage systems or treatment works.

OR AND ON POWER

- The "Gas into rock" project attracted worldwide attention when an article about its results appeared in the internationally renowned Science Magazine. The article discussed the CarbFix climate change project which has been conducted at the Hellisheidi Geothermal Power Plant since 2007.

Challenges

VEITUR UTILITIES AND ON POWER

- Ensure responsible management of production from water resources and strongly emphasise water conservation and the quality of potable water.

ON POWER

- To better manage production from the high-temperature geothermal fields at the Hellisheidi and Nesjavellir Geothermal Power Plants.
- Prioritise achieving the full management of the discharge of geothermal water at the Hellisheidi and Nesjavellir geothermal power plants.
- Emphasis will continue on the restoration and reclamation of disturbed areas in Hellisheidi in cooperation with licensing authorities.
- Promote a diversified use of thermal energy, electricity and geothermal gases from the Hellisheidi Geothermal Power Plant.

VEITUR UTILITIES

- Increase water and steam production in Hveragerði, increase the production capacity of the Rangá Utility in South Iceland and continue research into providing hot water in Akranes and Borgarnes.
- Explore which methods would be suitable for extracting microplastics from sewage and rainwater.
- Ensure that the flow of the sewerage system in Skerjafjördur functions at peak times.

OR

- Continue research on the sequestration of hydrogen and carbon dioxide in basaltic rock.
- Maintainance of walking paths at Ölkelduhnúkur and Reykjadalur north of Hveragerdi, which have deteriorated as a result of the traffic of hikers.

OR AND ITS SUBSIDIARIES

- Use the infrastructure, products, know-how and capacity of OR and its subsidiaries to increase the proportion of climate-friendly transport and reduce greenhouse gas emissions.

Definitions

Geothermal reservoir	A delimited volume of hot rock containing usable geothermal fluids.
Geothermal gases	Gases contained in geothermal fluids. These are mostly carbon dioxide (CO_2), hydrogen sulphide (H_2S) and hydrogen (H_2) in the Hengill area.
Geothermal water	Geothermal water is the aqueous phase of the geothermal fluid. The aqueous phase of geothermal fluids undergoes changes, both in terms of its volume and chemical composition, depending on which geothermal fluid process it has been subjected to. Geothermal fluids are often solely made up of geothermal water and geothermal gases, e.g. in low-temperature fields where the fluids do not boil into geothermal steam due to lower temperatures than those found in high-temperature geothermal fields. In high-temperature geothermal fields the geothermal fluids can only be in geothermal steam form, e.g. in the Geyser area in North America. In its processing at geothermal power plants, geothermal water can be divided into separated water and condensate water at various stages of the processing. Geothermal water is a resource flow that can be recycled by, for example, reinjecting it back into the geothermal reservoir, thus offsetting its pressuredrop. This can increase the production capacity of the geothermal field. Geothermal water is also used for other purposes such as bathing, cosmetics production and algae culture. Part of the geothermal water is sometimes discharged onto the surface of the earth.
Geothermal fluid	Geothermal fluid is a mixture of geothermal water, geothermal steam and various kinds of geothermal gases, from geothermal wells, for example.
Drawdown	Drawdown is a pressure drop in a geothermal system. It normally occurs as a result of the utilisation of geothermal energy which causes the pressure to drop.
Separated water	In its processing at geothermal power plants, geothermal water can be divided into separated water and condensate water at various stages of the processing. Separated water is the part of the geothermal fluid that is separated from the geothermal steam under a certain pressure and continues through the process in this state. Separated water is rich in minerals from the rock as a result of the temperature of the geothermal reservoir. The separated water and condensate water are often mixed back together after the energy production process and its volume and chemical composition will be similar to what they were when they originally were pumped from the geothermal reservoir.
Enthalpy	Enthalpy is a yardstick of energy content, in our case the energy content of geothermal fluid. Enthalpy is expressed in weight units kJ/kg [kilo-Joule per kg] and this is primarily used to describe the characteristics of the geothermal fluid from the boreholes in a high-temperature geothermal fields. In high-temperature geothermal fields, geothermal fluid from the geothermal wells is in the form of steam and water – often actually in a blend of the two and its energy content depends on, among other things, the percentage of steam. Temperature alone is therefore not sufficient to describe the energy content of fluids such as those in low-temperature fields where they are only processed in aqueous form. There is a direct correlation between enthalpy and the percentage of steam and water in a fluid and is therefore a very useful yardstick for gauging the energy content of a fluid.
Condensate water	In its processing at geothermal power plants, geothermal water can be divided into separated water and condensate water at various stages of the processing. Condensate water is formed when the geothermal steam phase is condensed in a condenser after the geothermal steam has been used to power the steam turbines. The separated water and condensate water are often mixed back together after the energy production process and its volume and chemical composition will be similar to what they were when they originally were pumped from the geothermal reservoir.
Watered-down geothermal water	Watered-down geothermal water occurs when heated groundwater (which is not utilised for space heating when demand is low in the summer) is mixed with separated water and condensate water and then re-injected into the bedrock. This is done in Nesjavellir, for example.

Introduction

The operations of Reykjavik Energy (OR) and its subsidiariesare certified in accordance with the ISO 14001 environmental management system. The values of OR and its subsidiaries: foresight, efficiency and integrity serve as the guiding principles for the implementation of the environment and resources policy of the group.

Climate change objectives of OR and its subsidiaries

In 2016, OR and its subsidiaries set themselves the goal of reducing carbon dioxide emissions in the companies' energy production and activities. The climate change objective is to halve OR and its subsidarie's carbon footprint by 2030. The reduction in geothermal gas emissions in the energy production of ON Power in high-temperature geothermal fields weighs the heaviest in the companies' operations. With the increase in climate-friendly vehicles and by encouraging employees to choose more climate-friendly ways of travelling to and from work, the emissions they produce can be reduced by 70-90% by 2030. Measures will include increasing the percentage of recycled waste, the reclamation of wetlands in OR's land property, and the reduction of food waste, see section on carbon footprint. The measures of OR and its subsidiaries are in accordance with the climate change declaration issued by the City of Reykjavík and Festa, Centre for Corporate Social Responsibility, which was signed by the companies and submitted to the United Nations Climate Change Conference in Paris in December 2015. Iceland has enjoyed a positive image thanks to its high percentage of renewable energy, but discharges per capita are still high. In Iceland the discharge per inhabitant is 14 tons, compared to 7 tons per inhabitant in the EU and 5 tons per inhabitant worldwide.

Collaboration with stakeholders

Collaboration with licensing authorities, stakeholders and customers is important to the personnel of OR and its subsidaries because they focus our attention and priorities on what matters most to people. An informed discussion on challenges such as the state of natural resources in high and low-temperature fields, water conservation and the quality of potable water, hydrogen sulphide emissions and geothermal water, the construction of sewerage systems, restoration of disturbed areas and the sorting of waste and how these issues are being tackled is of vital importance. In 2016 we strove to better disseminate information from OR and its subsidaries to social networks and thus provide interested parties with a stable and informed service.

Complaints

In 2016, 80 notifications were received from customers concerning environmental issues and 75 of them concerned conduct, one a possible oil leak near a water conservation area, one concerning hydrogen sulphide and one the discharge of drainage through overflows. All cases were investigated and their processing has been completed. There is a discussion on how these complaints were addressed in the sections regarding the Protection of potable water, Hydrogen sulphide missions, and Structures and maintenance.

In 2016, 50 notifications regarding environmental issues were received from the staff of Reykjavik Energy and most of them concerned conduct, i.e. over 30. Seven notifications concerned oil leaks or the risk of leakages and four hazardous substances. There is a discussion on how they were addressed in the sections on the Protection of potable water, structures and maintenance and the Use of hazardous substances. Two environmental incidents occurred near water conservation areas where cleaning actions were required, see section on the Protection of potable water.

One notification was sent to the licensing authorities to inform them that the concentration of hydrogen sulphide exceeded the daily limit in a populated area and another notification was sent to inform them of a maintenance stop in the hydrogen sulphide abatement unit at the Hellisheidi Geothermal Power Plant, see section on Hydrogen Sulphide Emissions. Two notifications were sent to monitoring and emergency response units regarding the likelihood of seismic activity due to reinjection. However, no earthquakes were then observed in the populated areas, see section on Seismic activity induced by reinjection of geothermal water. Twenty notifications were sent out to licensing authorities regarding discharged geothermal water through overflows at the Hellisheidi Geothermal Power Plant and ten notifications of discharges through overflows in sewerage systems, see sections on the Discharge of geothermal water and the Discharge of drainage through overflows.

Environmental report

The operations of Reykjavik Energy are certified in accordance with the ISO 14001 environmental management system, which entails the continuous monitoring of all stations and the evaluation and analysis of the effects operations have on the environment and community and the remedies required to reduce negative impacts.

As has been the case over the past two years, the 2016 Environmental Report focuses on the progress of the most significant environmental elements that have been defined under the five principles laid down in the environmental and resources policy of ORand its subsidiaries and revolve around responsible resource management, the value of utility operations, emissions into the environment caused by activities, the impact of the OR Group's operations and management. The values of OR and its subsidaries: foresight, efficiency and integrity serve as the guiding principles for the implementation of the policy.

The preparation of the 2016 Environmental Report, was founded on the sustainability reporting guidelines of the Global Reporting Initiative (GRI), which is a leading institution in the field of CSR reporting, see section 11 of the 2016 Annual Report of OR.

Environmental and resource policy and significant environmental aspects

The Environmental and Resources policy reflects OR and its subsidiaries' commitment to continually improve in the field of environmental affairs. It serves as a guide to the company and forms the basis for good collaboration with stakeholders. The Environmental and Resources policy is founded on the values of the comprehensive policy of OR and its subsidaries.

OR complies with all the statutory and regulatory provisions that apply to its activities. The Environmental and Resources policy is established on the basis of the following principles and implemented in detail through targeted management and improvements in significant environmental elements.

Responsible resource management
OR is entrusted with responsibility for the resources that it utilises. The responsibility entails working according to the ideology of sustainable development and therefore ensuring sustainable utilisation. This is so that future generations can enjoy the same opportunities as current generations to utilise the resources, and that it is possible to confirm OR's commitment to that goal. OR undertakes to seek effective solutions in which the utilisation of resources for the public benefit is weighed and assessed in the context of other interests. OR shall protect the resources from threats and intrusions in line with the responsibility the company has been entrusted with.

Value of utility operations
Access to OR's utilities promotes healthy living and opportunities for climate-friendly operations in the community. This positive environmental impact is a determining factor in decision-making regarding the development of power plants and utilities. Decisions are based on setting the bar high for quality, delivery security and efficiency, and it publishes detailed information on its activities and future plans.

Impact of emissions
OR's operations inevitably result in substances and energy being released into the environment. OR takes the utmost precautions in its operations. Emissions are therefore only allowed to occur in a manner that has a negligible impact on health and an acceptable effect on the environment. OR strives to reduce the emission of pollutants as much as possible and prioritise research and development to seek the best possible solutions for that purpose.

Impact on society
The OR Group is a big company in Iceland and its workforce possesses extensive knowledge and experience in the use of geothermal energy and other aspects of the company's operations. The company passes on its know-how and influences the value chain, which encourages a responsible treatment of the environment and has a positive impact on the community.

Operations
OR's operations are founded on the organised and disciplined working procedures of many employees in widespread work sites. Day-to-day tasks include, among other things, the responsible utilisation of supplies, maintenance on constructions, tending to plots of land, handling waste responsibly and promoting climate-friendly transport. OR aims to run exemplary operations and to develop its personnel's qualifications in this regard.

Significant environmental factors
OR and its subsidiaries have defined the following environmental factors as significant with regard to the principles stated in the Environmental and Resource policy. The factors are defined in order to be able to approach the organisation of environmental issues with objectives and defined responsibilities. There are 22 significant environmental factors and responsibility is divided so that Veitur Utilities assumes responsibility for six factors, ON Power for six factors, the Reykjavik Fibre Network for one factor and Veitur Utilities and ON Power jointly bear responsibility for one factor. OR and its subsidiaries jointly bear responsibility for eight significant environmental factors.

An emphasis is placed on the protection of water and the responsible management of water resources to ensure the long-term supply of potable water to the residents and business community in the distribution area. Hydrogen sulphide emissions from the power plant in the Hengill area have been the biggest environmental issue, which ON Power grapples with in its operations. The hydrogen sulphide abatement unit at the Hellisheidi Geothermal Power Plant has been operating effectively and removes over 60% of the hydrogen sulphide and 30% of the carbon dioxide emissions from the power plant. Some 95% of the geothermal water from the Hellisheidi Geothermal Power Plant have been reinjected into the geothermal field at the power plant. Their ability to handle all the geothermal water that accumulate in energy production is limited and priority has been given to achieving the full management of the discharge of geothermal water at the Hellisheidi and Nesjavellir geothermal power plants. Most of the construction work has been completed on the new treatment plants at Akranes, Borgarnes and Kjalarnes and they will become operational in 2017. In all the collection areas of Veitur Utilities, the residents and business community will soon have the option of connecting to sewerage systems or treatment works. OR and its subsidiaries intend to be at the forefront of climate-friendly transport. They will use their infrastructure, products, know-how and capacity to increase the proportion of climate-friendly transport in society and reduce greenhouse gas emissions.

Responsible resource management:

ON Orka náttúrunnar

- Managing production in high-temperature geothermal fields

Veitur

- Managing production in low-temperature geothermal fields

OR Orkuveita Reykjavíkur, Veitur, ON Orka náttúrunnar, Gagnaveita Reykjavíkur

- Developing areas by power plants and other premises
- Conservation of potable water resources

Value of utility operations:

ON Orka náttúrunnar

- Access to a more diversified utilisation of high-temperature geothermal resources
- Access to cold water utility

Veitur

- Access to electricity utility
- Access to geothermal district heating utility
- Access to cold water utility
- Access to sewerage system utility

Gagnaveita Reykjavíkur

- Access to fiber network utility

Impact of emissions:

ON Orka náttúrunnar

- Discharge of geothermal water and monitoring of groundwater
- Hydrogen sulphide emissions
- Carbon dioxide, hydrogen and methane emissions
- Seismic activity induced by reinjection of geothermal water

Veitur

- Discharge of waste water from sewage treatment plants
- Discharge of drainage through overflows

Impact on community:

OR Orkuveita Reykjavíkur, Veitur, ON Orka náttúrunnar, Gagnaveita Reykjavíkur

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

Operations:

OR Orkuveita Reykjavíkur, Veitur, ON Orka náttúrunnar, Gagnaveita Reykjavíkur

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

Responsible resource management

Reykjavik Energy (OR) and its subsidaries are entrusted with responsibility for the resources that it utilises. The responsibility entails working according to the ideology of sustainable development and therefore ensuring sustainable utilisation so that future generations can enjoy the same opportunities as current generations to utilise the resources, and that it is possible to confirm The OR Group's commitment to that goal. OR and its subsidiaries undertake to seek effective solutions in which the utilisation of resources for the public benefit is weighed and assessed in the context of other interests. The Group shall protect the resources from threats and intrusions, in line with the responsibility the company has been entrusted with.

Managing production in high-temperature geothermal fields

Power production in Nesjavellir and Hellisheidi is in accordance with the geothermal utilisation licence for the power plants. The pipeline connecting the geothermal field in Hverahlíd with the Hellisheidi Geothermal Power Plant came into operation in January 2016 and the plant now uses steam from it. At the same time endeavours were made to rest the wells with ample water in the western part of Hellisheidi, which has turned out to be useful to improve energy reserve levels and reduce the load on reinjection. Measurements made in 2016 show a continuing decrease in steam due to drawdown in the production field at the Hellisheidi Geothermal Power Plant.

OBJECTIVE::
To ensure On Power's geothermal power plants receive the geothermal energy required to meet its energy sale obligations within the utilisation framework stipulated in the geothermal utilisation licence of the Hellisheidi Geothermal Power Plant. Comparable criteria are assumed to apply to Nesjavellir. Goals on the utilisation of geothermal energy are expressed in terms of criteria regarding how fast pressure and temperatures may drop in the geothermal system.

Did you know?

A distributed and moderate reinjection reduces the pressure drop in the geothermal reservoir at the Hellisheidi Geothermal Power Plant and can increase its utilisation capacity. Production wells in the vicinity of the reinjection are carefully monitored to ensure it is not excessive.

The production fields of the Hellisheidi Geothermal Power Plant, which are currently being utilised are in western Hellisheidi and by Hverahlíd and the production field used by the Nesjavellir Geothermal Power Plant is at Nesjavellir (Figure 1).

Monitoring increased in the Hengill area
Over the past decades, the responses of Hengill's production fields to utilisation have been monitored. At the beginning of 2016, the capacity of production wells was monitored more closely.

2016 saw the completion of the revision of the conceptual model for Hellisheidi to better understand the nature of the geothermal production fields.

The conceptual model for Hengill was revised in 2015-2016. The model is used to predict the fields' response to production in order to gauge the impact of their behaviour. The production history of the geothermal production field also helps to clarify the position.

Production reports are compiled annually and submitted to the National Energy Authority.

Production capacity of the Nesjavellir Geothermal Power Plant
Production at Nesjavellir has been going well until now, but new measurements indicate that the enthalpy of the geothermal fluid has dropped (in this case, enthalpy is a yardstick for the energy content of the geothermal fluids). Up until now, measurements over the past 25 years have shown that the utilisation drawdown has risen in line with increased production, particularly after a fourth turbine in the plant came into use in 2005 (Annex 2a). Since the drilling of new wells (so called make-up wells) has been delayed, and the capacity of the new well, which was drilled in 2015, was below expectations, energy production has decreased slightly. According to the new well capacity measurements, a make-up well needs to be drilled next year to maintain energy production.

At the end of 2016, an application for a utilisation licence for geothermal energy in Nesjavellir was sent to the National Energy Authority.

Energy production at Nesjavellir is in accordance with the operating licence and the objectives of On Power.

Critical production capacity situation at Hellisheidi Geothermal Power Plant
As has been stated in the 2012-2015 environmental reports, the production field in western Hellisheidi will not be sufficient for full production in the future at the Hellisheidi Geothermal Power Plant. It was therefore deemed best in 2013 to expand the production field and acquire additional steam from wells that had already been drilled at Hverahlíd. A pipeline connecting the geo-thermal field in Hverahlíd with the Hellisheidi Geothermal Power Plant came into operation in January 2016, and the plant utilises the steam from there. In parallel with the utilisation of wells in Hverahlíd, endeavours were finally made to rest the wells with ample water in western Hellisheidi in the summer of 2016. This has turned out to be useful to improve energy reserve levels and reduce the load on reinjection. Moreover, endeavours have been made to distribute reinjection in the production field of the Hellisheidi Geothermal Power Plant to support the pressure in the geothermal reservoir and slow down its drop. See section on Discharge of geothermal water and monitoring of groundwater.

Measurements made in 2016 show a continuing decrease in steam due to drawdown, i.e. a drop in pressure in the geothermal reservoir in the production field of the Hellisheidi Geothermal Power Plant. In 2016, total production at Hellisheidi amounted to approximately 28 million tons and in Hverahlíd to around five million tons. The enthalpy of the geothermal fluid increased with the influx of steam from Hverahlíd (Figure 2). On the basis of these well capacity measurements, between two to four make-up wells have to be drilled annually over the coming years to maintain energy production. Production has taken place in a small area in relation to the size of the plant, but with the arrival of the Hverahlíd pipeline, the situation has improved thanks to the bigger extractions areas.

In 2016, a new make-up well was drilled at the plant and it came into use at the end of the year. Due to drilling difficulties, it was impossible to fully drill the well, so its capacity is below expectations.

The drawdown in this field is within the thresholds of the energy utilisation licence (Annex 2b).

In the autumn of 2016, the revision of the utilisation licence for the Hellisheidi Geothermal Power Plant was completed.

Hverahlíð
In the autumn of 2016, measurements revealed some drawdown in the boreholes of Hverahlíd and monitoring has been increased. It is not completely clear what impact these findings will have on the future utilisation of this area.

ON Power is exploring possibilities on how the natural resources can be better utilised and ensuring operational security.

Flow paths for reinjected geothermal water at Hellisheidi and Nesjavellir
Tracer testing conducted at the Hellisheidi Geothermal Power Plant since 2013 reveal that a substantial portion of the geothermal water that is reinjected into the geothermal system reaches the production field on the western side of Mt.Skardsmýrarfjall and at Mt. Reykjafell. A distributed and moderate reinjection reduces the pressure drop in the geothermal reservoir and can increase its utilisation capacity. Production wells in the vicinity of the reinjection are carefully monitored to evaluate their cooling effect and ensure there is no excessive reinjection. The cooling effect that was expected in the production wells has not manifested itself.

In 2016, experimental injection of heated groundwater commenced in one well in Kýrdalur by Nesjavellir. It has transpired that it had an effect on the enthalpy of the surrounding production wells. See section on Discharge of geothermal water and monitoring of groundwater.

Figure 1. The production fields at the Hellisheidi Geothermal Power Plant are in western Hellisheidi and in Hverahlíd. The production field for the Nesjavellir Geothermal Power Plant is in Nesjavellir.

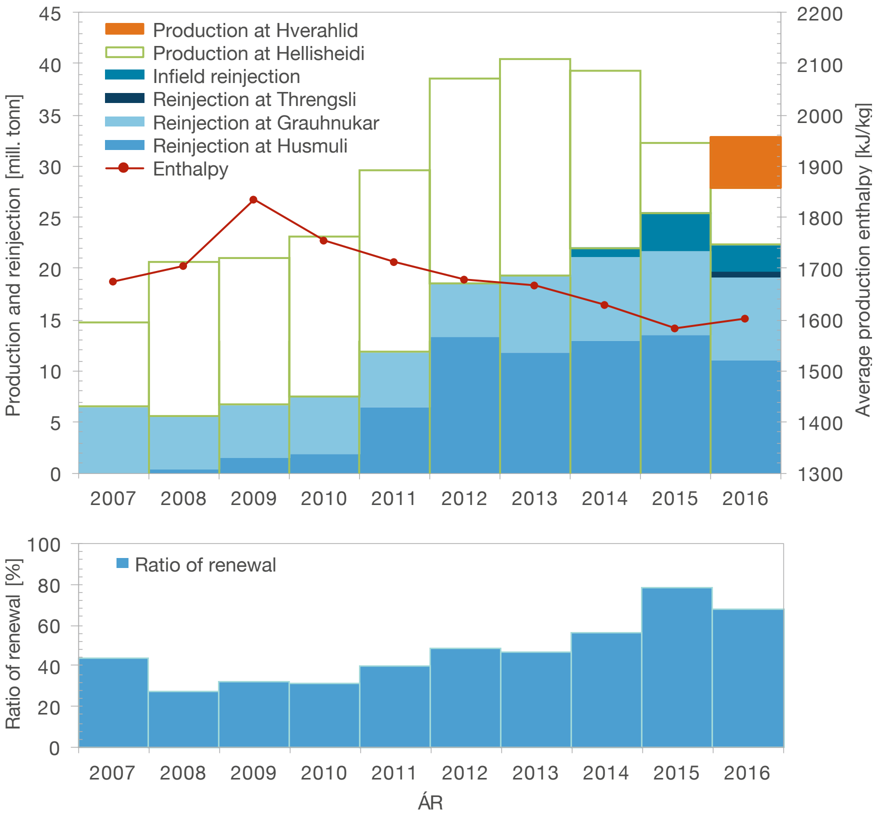


Figure 2. Production at Hverahlíd (million tons per annum) in 2016, production at Hellisheidi (million tons per annum) from 2007 to 2016 and reinjection (million tons per annum) by release route. The blue colours show the volume of geothermal water (million tons per annum) re-injected into the field in the production wells that are not used for steam production, in re-injection wells in Gráuhnúkar and Húsmúli and in boreholes at Threngsli. The red curve shows the enthalpy of the geothermal fluids (kJ/kg) from 2007 to 2016, since the heat is a yardstick for the energy content of the geothermal fluid. The heat increased in 2009, after the high-enthalpy wells were connected to the steam utility of the plant in mid 2008 and again in 2016 with the influx of steam from Hverahlíd. The lower figure shows the ratio of the renewal, i. e. mass balance of the system. In 2015 approximately 80% of the produced fluid was reinjected but that year many wells with ample water were in operation.

Managing production in low-temperature geothermal fields

Production from the low-temperature fields in the capital area and in South and West Iceland is in line with the objectives of Veitur Utilities. In 2016, endeavours were made to increase water and steam production in Hveragerdi. The geothermal system in Laugaland in Holt was further researched in order to locate a production well there to produce hotter water at the Rangá Utility. Research into increasing hot water supplies in the utilities of Akranes and Borgarnes will be conducted in 2017.

Did you know?

Thermal power makes up 80% of the total power generated by the Nesjavellir Geothermal Power Plant and over 40% of the total power at the Hellisheidi Geothermal Power Plant.

OBJECTIVE:
To ensure water extraction in low-temperature fields does not diminish the possibility of corresponding water extraction in the future.

Heating utilities
Veitur Utilities operates thirteen heating utilities: in the capital area, in West Iceland and South Iceland (Table 2 in the section on Access to heating utilities and the map of the utility areas of OR and its subsidaries (Annex 1).

There have been decades of experience in geothermal production utilising numerous low-temperature fields. The measurements of water levels and temperatures in wells are used to monitor how the production fields respond to utilisation. It is possible to respond to changes by: reducing production, reinjecting in fields and re-casing wells. The results of the chemical analyses of hot water can be seen in Annexes 3 and 4. Production reports for the heating utilities are published annually.

Capital area
Low-temperature fields are utilised in a stable and balanced manner in the capital area and everything indicates that this usage can be maintained for the foreseeable future, barring the unexpected. The water level is generally good (Annex 5).

South and West Iceland
Production monitoring over the past years shows that the condition of most of the low-temperature fields, which Veitur Utilities runs in South and West Iceland, is good and in accordance with the objectives of Veitur Utilities. There are, however, some exceptions.

Veitur Utilities is concerned that the production field in Laugaland in Holt does not meet the demand for sufficiently hot water because the water level has dropped in recent years. In 2016, temperature gradient wells were drilled to ascertain how the heat changed according to depth in the vicinity of Laugaland, but this yielded no decisive results to make it possible to locate a production well. Following this, production wells were measured in Laugaland with a televiewer in order to better map the fracture zone in the area. Moreover, the conceptual model of the geothermal production field was revised. A new deep production well has been located by Laugaland and drilling is scheduled to begin in the spring of 2017.

In Hveragerdi the pressure has dropped in the production field in recent years. The wells there are flowing artesian wells. The pressure is now below the level deemed satisfactory for secure operation. In 2016, projects were launched to increase the production of water and steam and this included utilising the state-owned production wells in Ölfus. Licences are awaited for the utilisation of these production wells, since it is clear that with their usage the Hveragerdi population will be guaranteed sufficient energy to heat their houses and for business activities well into the future. Registering of data has been lacking on production and water levels in Hveragerdi, however the registering of data is expected to be satisfactory by the spring of 2017.

In 2016, improvements were completed on the registering of data at the Skorradalur utility, which now provides a good view of the position of natural resources. Research into increasing hot water supplies in the utilities of Akranes and Borgarnes (HAB) continued in 2016. Geothermal energy rights acquired for district heating in Stykkishólmur in the territory of Arnarstadur in Helgafellssveit in 2016.

Geothermal well in Hveragerdi. Photograph: Ægir Lúdvíksson.

Developing areas by power plants and other premises

Emphasis will continue on the restoration and reclamation of disturbed areas in Hellisheidi in cooperation with licensing authorities and according to the objectives of OR and its subsidiaries. Projects will be launched in 2017 to maintain walking paths at Ölkelduhnúkur and Reykjadalur north of Hveragerdi, which have deteriorated as a result of the increased traffic of hikers.

Did you know?

Moss was collected from the pipeline path along the Hverahlíd pipeline and stored in a freezing container in 2014 to keep it alive while construction was still in progress. The moss, which came out of the container all green and fresh, was then used in the restoration of the construction area in the summer of 2016.

OBJECTIVE:
To minimise disturbance to the land caused by constructions and to restore the disturbed areas in harmony with the surrounding landscape, cf. guidelines on visual impacts and restoration. The roads, tracks and paths that are required for the constructions shall also be utilised, where appropriate, 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.

The operations of OR and its subsidiaries are broad ranging and vast areas of land have been allocated to their activities. The companies administer about 19,000 ha of land, some 16,000 ha of which are within protected areas, see Annex 6. Annex 7 contains a list of the species of birds and plants on the Red List who have habitats within the areas which are administered by OR and its subsidiaries

Hellisheidi restoration procedure
In 2016, emphasis continued to be placed on good restoration and reclamation of disturbed areas at the Hellisheidi Geothermal Power Plant, as well as the construction of a steam pipeline connecting the geothermal field in Hverahlíd to the Hellisheidi plant. Strips of turf, moss and other materials that were removed along the pipeline path were successfully used in the restoration of the construction area and also the restoration of older constructions at the Hellisheidi Geothermal Power Plant (Figure 3). Lava and moss from the pipeline path were, for example, used to restore the lava field landscape on old drilling pads. In 2016, 6 ha of land were reclaimed with local vegetation in parallel with new constructions and 20 ha of land in older disturbed areas.

Experience in Hellisheidi shows that it is important for construction designs to take into account the procedures that are used in restoration. It is also very important to instruct earthworks and servicing contractors at the beginning of a project and when new workers start working. Potential disturbances to the nature that may be caused by earthworks need to be carefully reviewed, along with the goals for the removal and restoration of vegetation and soil, and good working procedures need to be presented. In recent years, OR and its subsidiaries have made a great deal of progress in restoration.

Restoration work procedures and guidelines
Many constructors have shown an interest in using the so-called Hellisheidi restoration procedure for areas disturbed by construction. When HS Orka, the National Power Company of Iceland (Landsvirkjun) and Landsnet started, for example, to organise the restoration of project sites around their power plants and construction areas, they approached ON Power for guidelines on the reclamation of vegetation. This reflects the good collaboration there is between companies in the use of simple and effective methods for the restoration and maintenance of biodiversity. Videos and other informative material on the use of local vegetation for the restoration of construction sites were posted in 2016 on websites of ON Power and the Environment Agency of Iceland, as well as social networks, such as Facebook and YouTube.

Travellers, energy utilisation and outdoor recreation
The Hengill area is a diversified recreation area with almost all the best things Icelandic nature has to offer. Over the past 26 years, OR has overseen 110 km of walking paths in the Hengill and neighbouring areas, which need to be maintained on an annual basis and the REY-SAR scouts in Reykjavik have taken on this task over the past thirteen years. In the winter between 2015 and 2016, there was less snow than in previous years and there was a sunny summer with little rain so the maintenance went well. The walking path in Dyradalur was mended and information signposts were changed at eight start-off points along the path. The plan is to complete all signs by the summer of 2017. Fences were taken down at Stangarháls, as well as old water pipes at Sleggjubeinsdalur. Many use these walking paths and further repairs to the most popular paths will be funded in the summer of 2017. The integration of outdoor activities and energy production has gone well in the Hengill area and the plan for 2017 or 2018 is to mark the walking paths by the Hellisheidi Geothermal Power Plant in connection with the Geothermal exhibition in a similar way to what was done in the Nesjavellir Geothermal Power Plant.

Figure 3. During construction, strips of turf were removed from a road path by Hellisheidi and placed on the edge of the road after construction. Photograph: Magnea Magnúsdóttir.

Conservation of potable water resources

In 2016, Veitur Utilities and ON Power ensured the supply of potable water to the residents and business community in the distribution area. Veitur Utilities started to review its analysis of risk factors in the water protection areas of the Capital area. Flow measurements from source areas in Akranes were improved in order to assess the likelihood of water depletion.

OBJECTIVE:
To ensure that water supplies, which users of Veitur Utilities rely on, are not contaminated. To ensure that water extraction does not diminish the possibility of corresponding water extraction in the future.

Veitur Utilities has a duty to meet the water demands of people and companies in the utility area. Potable water shall fulfil the provisions of the Regulations on Food Inspection and Hygiene, cf. Regulation no. 536/2001 on potable water.

Veitur Utilities has thirteen water sources, and the water is used in the capital area as well as in West and South Iceland, while ON Power has two water sources (Table 3 in the section on Access to water utilities and the map of OR and its subsidaries utilities in Annex 1). Preventive measures are systematically worked on and the quality of the water is monitored. Risk factors in water protection areas and distribution systems are analysed. The health authorities in each utility area regularly take samples to monitor the quality of the water and respond to notifications of required repairs and improvements. The results of the sampling are published on Veitur Utilities' website www.veitur.is.

In 2016, two notifications were received from customers concerning bad maintenance of water protection areas and a possible oil leak in thearea. The health authorities in charge of monitoring the relevant areas were contacted. In 2016, seven notifications of oil leaks or potential oil leaks were received from employees of OR and its subsidiaries. In two cases oil leaked down close to water protection areas and clean-ups had to be made. All the oil was cleared away.

Water conservation and risk assessment of water sources in the Capital area
Heidmörk is Veitur Utilities' main water extraction field for the capital area and this water production is based solely on pure and untreated groundwater. The water conservation zone is delimited around the water sources and is about 230 km^2 in size.

In 2016, Veitur Utilities started to review its risk factor analysis of water protected areas in the capital area. The transport of oil and traffic of motorised vehicles on the South Iceland road in addition to traffic on roads in Heidmörk pose the greatest risk to water sources. Populated areas by the lake of Ellidavatn, motorised traffic in the Bláfjöll area, the extraction of material and landfills in Bolaöldur, the storage of fossil fuels along the South Iceland road and the envisaged construction of the Sandskeið Line 1 are examples of activities that are a source of concern to Veitur Utilities.

Veitur Utilities keeps the water protection area under surveillance, including the transport of oil and gasoline, along with other hazardous substances (Table 1). Some 15 trips were made in 2016, accompanying vehicles transporting hazardous substances.

In 2016 various projects were continued to promote the conservation of potable water, such as replacing oil-filled overhead power line distribution transformers in water protection areas with dry transformers, see section on Access to electricity utilities. As was mentioned in the 2015 Environmental Report, the back-up generator in Jadar in Heidmörk, which is powered by diesel oil, and oil tanks will be moved out of the water protection area in 2018. The work plan and risk assessment of the project will be worked on in 2017.

In the autumn of 2016, production started with the operation of three wells at the Vatnsendakrikar plant. This is being done to improve the operational security of the water utility, and in response to the projected demographic growth over the coming years. A risk assessment was conducted for the

The upper Reykjavik settlements lie close to water protection areas. Photograph: Gretar Ívarsson.

QUANTITY OF FUEL AND SLUDGE TRANSPORTED UNDER SUPERVISION

AREA	CATEGORY	UNIT	2012	2013	2014	2015	2016
Bláfjöll, ski area	Oil	Liters	48,100	45,744	43,189	54,219	51,938
Elliðavatn	Oil	Liters	918	1,486	1,649	2,688	856
Þríhnjúkar	Oil	Liters		3,000			
Jaðar	Oil	Liters	2,488				
Total oil		**Liters**	**48,100**	**50,230**	**44,838**	**56,907**	**52,794**
Bláfjöll, ski area	Gasoline	Liters	2,063	3,663	2,950	2,951	1,976
Total gasoline		**Liters**	**2,064**	**3,664**	**2,950**	**2,951**	**1,976**
Elliðavatn	Sludge	Liters					17,500
Gvendarbrunnar	Sludge	Liters	2,000			2,000	
Jaðar	Sludge	Liters					
Vatnsendakrikar	Sludge	Liters		2,500			
Vatnstankur T-4	Sludge	Liters	2,500			2,000	
Total sludge	**Total sludge**	**Liters**	**4,500**	**2,500**	**0**	**4,000**	**17,500**

Table 1. Volume of fuel and sludge transported under supervision in the water protection area of the capital area between 2012-2016.

project and a lot of demands were made on contractors regarding their tender documents. Courses on construction in water protection areas were held for contractors, with an emphasis on risk management and good orderliness. The course was held in collaboration with the Reykjavik Health Authority. The municipality of Hafnarfjördur appealed against the decision made by the National Planning Agency in December 2014 that the increased water production in Vatnsendakrikar should not be subject to an environmental impact assessment. At the end of 2016, the Appeals Committee for Environmental and Resource Matters overruled the National Planning Agency's decision. The future remains unclear until the National Energy Authority and National Planning Agency have explained to Veitur Utilities what the next step should be.

At the beginning of 2016, a summer house, which OR acquired in 2014 and stood in the water protection area by the lake of Ellidavatn, was torn down to ensure better water conservation in the area.

The water utilities of the capital area share many common interests, and ideas have been proposed to boost their cooperation on water resources. Veitur Utilities will follow up on these ideas and encourage increased cooperation between water utilities in the area.

Many have stakes in the capital's water protection area, and many perspectives have to be reconciled. It is important to strongly emphasise water conservation to ensure future generations can enjoy the natural quality of wholesome and untreated water.

Water conservation in South and West Iceland

In Akranes in 2016, a project was conducted to improve flow measurements from sources so that the likelihood of water depletion can be assessed. The project was completed in 2016 and the flow will be connected to automatic measuring equipment in 2017.

It is likely that the production capacity of the water source in Raudsgil at Steindórsstadur will have to be increased in 2017, see section on Access to water supply.

Monitoring of water quality

Every year the health authorities take samples from all of the water utilities of the Veitur Utilities and ON Power for microbial analysis, and the number of samples is determined by Potable Water Regulation no. 536/2001 Samples are also taken for overall chemical analysis (Annexes 8-9).

In 2016, 104 samples were taken in Reykjavik and they all met the quality requirements. Results for the last seventeen years are shown in Figure 4. Since 2001, 97-100% of the samples have met the quality requirements. In 2016, some 28 samples were taken in Akranes, Álftanes, Borgarfjördur, Bláskógabyggd, Grundarfjördur, Hellisheidi, Hvanneyri, Nesjavellir, Reykholt and Stykkishólmur. All samples met the quality requirements.

QUALITY OF POTABLE WATER IN REYKJAVIK

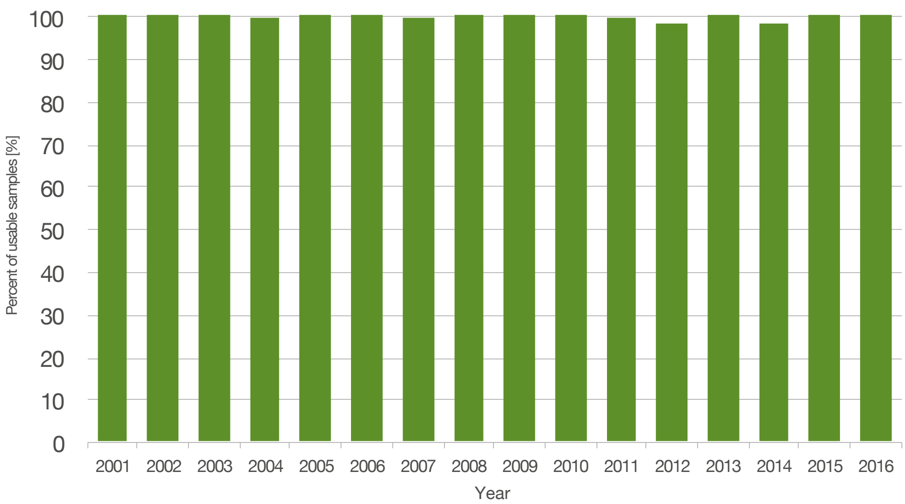


Figure 4. Percentage of water samples which fulfilled quality requirements between 2001-2016.

Did you know?

The concentration of minerals in potable water in Iceland is low in comparison with neighbouring countries.


VEITUR

Value of utility operations

Access to the OR Group's utilities promotes healthy living and opportunities for climate-friendly operations in the community. This positive environmental impact is a determining factor in decision-making regarding the development of power plants and utilities. These decisions are based on OR and its subsidiaries setting the bar high for quality, delivery security and efficiency, and they publish detailed information on the activities and future plans.

Access to a more diversified utilisation of high-temperature geothermal resources

Ways are being sought to encourage a diversified usage of the thermal energy, electricity and geothermal gas from the Hellisheidi Geothermal Power Plant in the geothermal park by the plant. Increased emphasis will be placed on this project in 2017.

OBJECTIVE:
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 discharged or disposed of, depending on environmental and efficiency requirements. The product offering shall be based on the efficient operation of systems in the core operations of ON Power.

In 2016, preparations began for the creation of a geothermal park by the Hellisheidi Geothermal Power Plant, since a diversified use of geothermal energy can increase cost effectiveness and boost climate-friendly management and innovation in the economy. Better quantitative analysis was, for example, conducted on the geothermal gas streams at the plant in order to see how much of them could be used.

Over the past years there has been a growing interest among ON Power, OR, scientists and potential clients to utilise geothermal gases. 2016 saw the completion of the Ecogas Project, which identified the most suitable processes for the removal of carbon dioxide, and explored whether it is sensible to use carbon dioxide from the plant for the production of fuel. The project was supported by RANNÍS (Icelandic Centre for Research). At the end of 2016, ON Power and the National Power Company of Iceland (Landsvirkjun) started a collaboration with the German company Electrochaea in the experimental production of methane by mixing hydrogen and carbon dioxide with the aid of thermophilic microorganisms. The findings and results of a feasibility study are expected to be ready in the spring of 2017.

In 2016, the GeoSilica company enlarged its production unit where separated water from the plant is used to produce dietary supplements.

Work will continue on mapping and promoting multiple uses of high-temperature geothermal resources to find new customers who can better utilise the production from high-temperature geothermal plants.

When decisions on innovative projects are made in connection with the development of high-temperature geothermal power plants, the requirement for positive environmental impact is a determining factor. Moreover, these decisions are always founded on quality, security and efficiency requirements.

Did you know?

The aim at the geothermal park at the Hellisheidi Geothermal Power Plant is to diversify the use of geothermal energy to increase cost effectiveness and boost the climate-friendly management of the plant.

Moss on the walls of the powerstation at the Hellisheidi Geothermal Power Plant and the hydrogen sulphide abatement unit in the background. Photograph: Magnea Magnúsdóttir.

Access to electricity utility

In 2016, Veitur Utilities ensured the supply of electricity to the residents and business community in the distribution area, in accordance with established quality standards and statutory and regulatory provisions. Endeavours have been made in the water conservation areas of the capital area to replace overhead oil-filled overhead powerline distribution transformers with dry transformers to facilitate the protection of potable water.

Did you know?

Veitur Utilities' electricity grid is 3,415 km. Some 128 km of the grid is in overhead lines, but systematic efforts are being made to place them underground by 2025.

OBJECTIVE:
To ensure residents and business operations in Veitur Utilitie's distribution areas have the option of connecting with an electricity utility. Ensure power outages in electricity utilities are negligible, thanks to, among other things, the reliability of the construction of the distribution grid. Ensure the quality of the electricity complies with quality standards and regulations.

Veitur Utilities distributes electricity in Akranes, Mosfellsbaer, Reykjavik, Seltjarnarnes, Kópavogur, Gardabaer north of Hraunholtslaekur and Hellisheidi in the Municipality of Ölfus (Map of the utilities of OR and its subsidaries in Annex 1). Over 100 thousand households (about 55% of the nation) and companies were connected to Veitur Utilities' electricity grid in 2016, and about 850 of them were new users. Veitur Utilities' distribution system in the utility area needs to be strengthened to meet the demographic growth, densification of urban areas, industrial development and the electrification of transport and ports in the coming years.

Granting everyone access to electricity with negligible outages is one of the prerequisites for a flourishing modern society, see the sustainable development goals of the United Nations. The load on the electricity grid is continually monitored and the quality of the voltage is evaluated on an annual basis. In 2016, the electricity supply in the capital area fulfilled quality standards and statutory and regulatory provisions. The most necessary tasks were prioritised to strengthen and fix the grid.

In Lækjarbotnar two oil-filled overhead power line distribution transformers were replaced by one dry transformer on ground, since Lækjarbotnar is in a water protection area. In Kjalarnes five oil-filled overhead pover line transformers were replaced by dry transformers on ground. Overhead oi-filledl transformers were replaced with dry transformers in water protection areas south of the lake of Ellidavatn. Overhead oil-filled transformer was temporarily set up for a dry transformer at Hella in the water protectection area by Sudurlandsvegur.

In 2016, the third phase of the laying of the Kjalarnes underground power line was launched. The Kjalarnes Power Line project is scheduled to be completed in 2018. The building of a new supply station in Akranes was completed, which increases delivery security and meets the growing demand for electricity. The first phase of the laying of the Úlfarsfell underground line was launched.

There were less operational disturbances in both in the low and high-voltage parts of the grid in relation to 2015. Factors such as weather and construction have a considerable impact on the number of disturbances. There were 23.0 minutes of power outages due to unforeseeable operational disturbances in 2016.

Working on the renovation of the electricity grid in the centre of Reykjavik. Photograph: Hildur Ingvarsdóttir.

Access to geothermal district heating utility

Veitur's district heating guarantees residents in the distribution area hot water to spaceheating in accordance with the company's established quality standards and statutory and regulatory provisions. In 2016, work was done on renovating both Reykir pipelines over Ártúnsholt in Reykjavík. Various projects were undertaken in West and South Iceland to guarantee the operating safety of the district heating utilities.

OBJECTIVE:
To ensure that residents within Veitur Utilities' distribution areas 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 by, for example, technical prerequisites and cost-effectiveness.

Did you know?

Hydrogen sulphide in the hot water utility gives off a hot spring smell, but it also prevents the corrosion of pipes and radiators.

Veitur Utilities operates thirteen district heating utilities, seven in South Iceland, five in West Iceland and one in the capital area, which is the largest and produced about 69 million m^3 of water in 2016. The hot water used in the capital area comes from Nesjavellir, Hellisheidi, Ellidaárdalur and Laugarnes within Reykjavik's city limits, as well as Reykir and Reykjahlíd in Mosfellsbær (Figure 5, Table 2 and the map of the utility areas of OR and its subsidaries in Annex 1). Annex 10 shows where the various sections of the capital area get their hot water from. The productive capacity of the system, with the envisaged build-up in the capital area, is sufficient to meet the needs of a growing population and industrial development over the coming years.

Granting everyone access to a hot water utility with negligible outages is one of the prerequisites for the health of residents and flourishing economic activity in a modern society, see the sustainable development goals of the United Nations. In 2016, work was done on renovating both Reykir pipelines over Ártúnsholt in Reykjavík. They are both 20 km long and stretch between the geothermal production fields in Reykir and Reykjahlíd in Mosfellsbær to the water reservoirs in Öskjuhlíd. Various projects were undertaken in South and West Iceland to guarantee the operating safety of the district heating utilities, see section on Managing production in low-temperature geothermal fields.

Over 56 thousand users were connected to Veitur Utilities' District Heating distribution system in 2016, some 250 of whom were new users. The district heating distribution system caters for 70% of the nation.

HOT WATER ACQUISITION BY MONTH

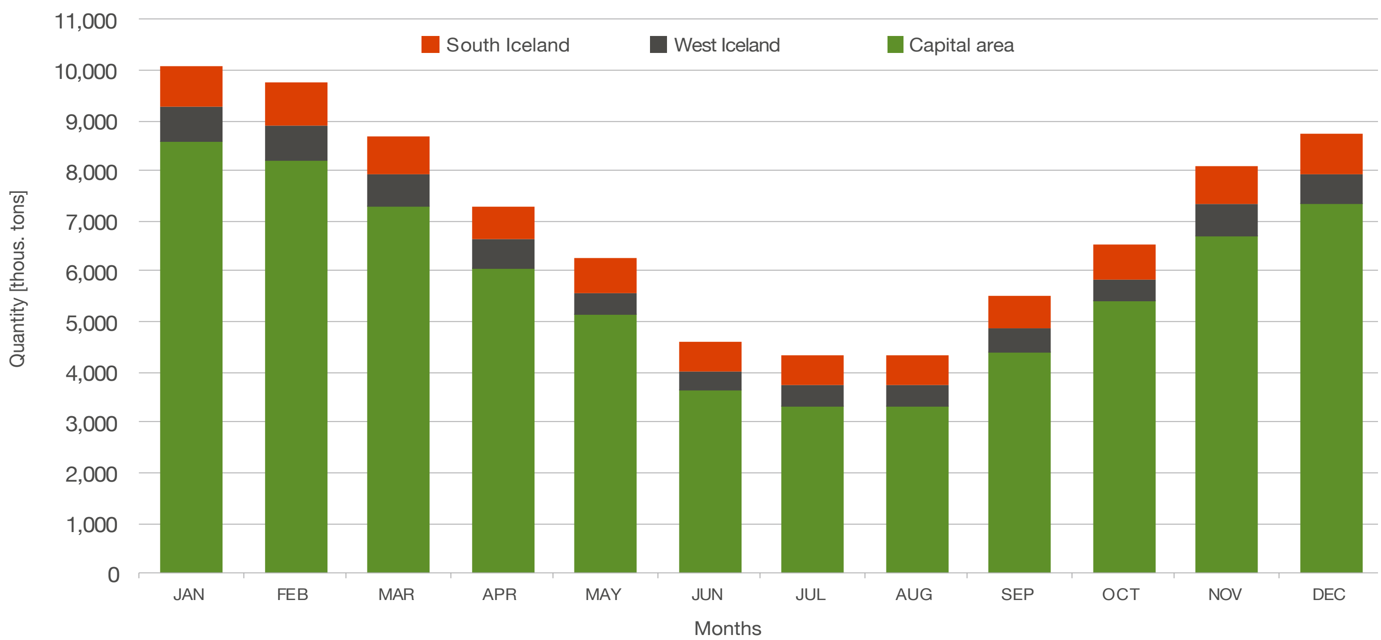


Figure 5. Hot water supplied by Veitur Utilities per month in its distribution area in 2016.

Working on a hot water utility in Reykjavík. Photograph: Bjarni Líndal Snorrason.

REYKJAVIK ENERGY'S DISTRICT HEATING UTILITIES

			ANNUAL PRODUCTION				
UTILITY	**PRODUCTION FIELD**	**NUMBER OF WELLS**	**thous. tons**	**l/s**	**QUANTITY**	**COMMENTS**	**IMPORVEMENTS**
Capital area	Laugarnes	10	4,972	158	Sufficient		
	Elliðaár	7	1,766	56	Sufficient		
	Reykir	22	12,582	399	Sufficient	Wholesale to Mosfellsbaer	
	Reykjahlíð	12	14,236	451	Sufficient	Wholesale to Mosfellsbaer	
	Nesjavellir	18	27,472	871	Sufficient		
	Hellisheiði	31	8,421	267	Sufficient		
WEST ICELAND:							
HAB	Deildartunguhver	1	4,131	131	Limited		Further research to provide hot water to continue in 2017
	Wells in Baeir	2	492	16	Limited		
Skorradalur	Well in Stóra Drageyri	1	296	9	Sufficient		
Munadarnes	Well in Munadarnes	1	207	7	Sufficient		
Nordurárdalur	Well in Svartagil	3	534	17	Sufficient		
Bifröst	Well at Bifröst	1	157	5	Sufficient		
Stykkishólmur	Wells at Stykkishólmur	2	811	26	Sufficient	One injection well and back-up power	
SOUTH ICELAND:							
Hveragerdi	Borholur í Hveragerði	3	1,054		Limited	Steam utility and closed circuit systems	Work on improvements regarding the reservoir
Ölfus	Bakki II	1	71	2	Sufficient		
Thorlákshöfn	Bakki I	2	1,134	36	Sufficient		
Austurveita Utility	Borholur við Gljúfurárholt	3	438	14	Sufficient	Part of the water used in Hveragerdi	
Grímsnesveita Utility	Borholur í Öndverdarnesi	3	1,884	60	More than ample	Two wells in use	
Hlídarveita Utility	Borhola að Efri-Reykjum	1	793	25	Sufficient	The well provides water for two utilities	
Rangárveita Utility	Borholur við Kaldárholt	2	2,000	63	Sufficient		Work on production capacity and prepare research to provide hot water
	Borholur við Laugaland	2	293	9	Limited		

Table 2. District heating utilities of OR and its subsidaries, with data on water volume, remarks and improvements.

Access to cold water utility

In 2016, Veitur Utilities and ON Power ensured the supply of potable water to the residents and business community in the distribution area, in accordance with established quality standards and statutory and regulatory provisions. It is likely that the production capacity of the water sources in Raudsgil at Steindórsstadur in West Iceland will have to be increased in 2017.

Did you know?

The design of a water utility is geared to the future because it has to last 60-100 years.

OBJECTIVE:
To ensure residents in the distribution area of Veitur Utilities and ON Power have guaranteed access to 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 by, among other things, technical prerequisites and cost-effectiveness.

The production of potable water for the capital area is in Heidmörk, but Veitur Utilities also operates water utilities in Stykkishólmur, Grundarfjördur, Akranes, Borgarnes and the upcountry of Borgarbyggd, Úthlíd and Álftanes. Cold water is also sold wholesale to Seltjarnarnes and Mosfellsbaer (Figure 6). ON Power operates water utilities at the Hellisheidi Geothermal Power Plants (Table 3 and map of utility areas of OR and its subsidaries in Annex 1).

The cold water distributed by Veitur Utilities and ON Power meets quality standards in accordance with statutory and regulatory provisions. At the end of the year there was a serious malfunction in the filtering equipment and the situation is being evaluated. Due to the planned bathing facilities in Deildartunguhver, it is likely that in 2017 the production capacity of water sources will have to be increased in Raudsgil at Steindórsstadur, which handles potable water for Reykholt and Kleppjárnsreykir .

Granting everyone access to healthy potable water with negligible outages is one of the prerequisites for a healthy population and flourishing economic activity in a modern society, see the sustainable development goals of the United Nations. Preventive measures and monitoring are systematically conducted to guarantee the quality of the water because Veitur Utilities and ON Power cannot recall contaminated potable water.

Approximately 25 thousand users were connected to Veitur Utilities' District distribution system in 2016, over 150 of whom were new users. It should be noted that user data are missing in some cases, since a large portion of intake was initially installed by house owners at the time. The water utilities' distribution system caters for up to 45% of the nation.

COLD WATER ACQUISITION BY MONTH

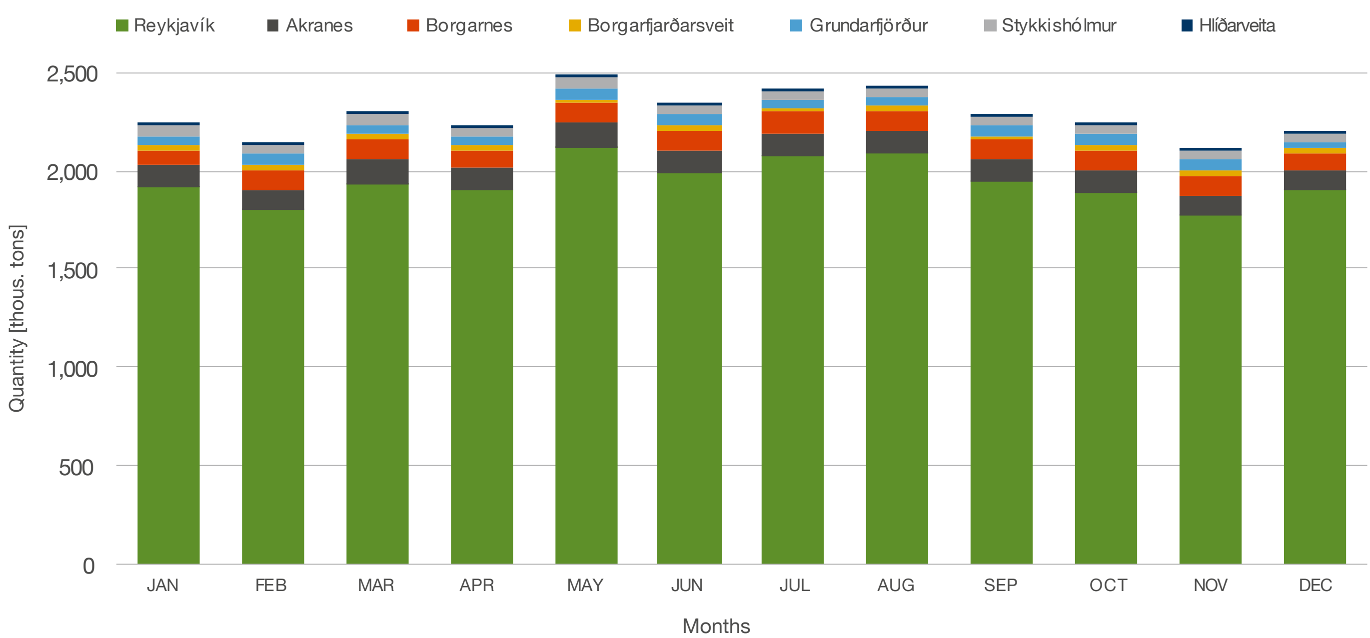


Figure 6. Water extraction per month in the distribution area of Veitur Utilities in 2016.

Working on the water supply pipeline in Reykjavík. Photograph: Hildur Ingvarsdóttir.

VEITUR'S WATER UTILITIES

AREA	UTILITY	WATER SUPPLY	MONITORING METHOD	ANNUAL PRODUCTION		COMMENTS	IMPROVEMENTS
				thous. tons	l/s		
Capital area	Reykjavík	Gvendarbrunnar, Jadar, Myllulaekur and Vatnsendakrikar	Well sampling	23,305	739		
	Seltjarnanes						
	Mosfellsbaer						
	Álftanes	Vatnsendakrikar	Well sampling	420	13	Water purchased from Gardabaer	
West Iceland	Akranes	Berjadalur, Slöguveita Utility and Ósveita Utility	Overflow	1,379	44	UV water purification	
	Borgarnes, Bifröst and Munadarnes	Grábrók, Seleyri as back-up for Borgarnes	Well sampling	1,327	42	Wells at Seleyri used as a backup water supply for Borgarnes in water shortages and when silt is detected from Grábrók	Filter unit installed in autumn 2015 has failed, situation under reassessment
	Grundarfjördur	Grund	Well sampling	604	19		
	Hvanneyri	Fossamelar	Overflow	59	2		
	Reykholt, Kleppjárnsreykir	Steindórsstadir	Well sampling	134	4	Inflow of water has reduced	Improvements will be implemented in 2017
	Stykkishólmur	Svelgsárhraun	Overflow	554	18		
South Iceland	Hlídarveita Utility	Bjarnarfell	Overflow	80	3	Water obtained from Bláskógabyggd if there is water shortage	

ON POWER'S WATER UTILITIES

AREA	UTILITY	WATER SUPPLY	MONITORING METHOD	ANNUAL PRODUCTION		COMMENTS	IMPORVEMENTS
				thous, tons	l/s		
Hengill	Hellisheidi	Engidalur	Well sampling	23,936	759		
	Nesjavellir	Grámelur	Tank sampling	56,713	1,798	Thermal pollution	Substantially thermal release before mid year 2017

Table 3. The water utilities of Veitur Utilities and ON Power and information on the supervisory procedures applied to the water situation in each area, water volume, remarks and improvements.

Access to sewerage system utility

In 2016, construction was mostly completed on the new treatment plants in Akranes, Borgarnes and Kjalarnes was completed and they will become operational in 2017. In all the collection areas of Veitur Utilities, the residents and business community will soon have the option of connecting to sewerage systems or treatment works.

OBJECTIVE:
To ensure residents and the business community in the collection areas of Veitur Utilities have the option of connecting to sewerage systems or treatment works fulfilling statutory and regulatory requirements.

Veitur Utilities manages 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 (Map of OR and its subsidaries in Annex 1). In Reykjavík, Akranes and Borgarnes, almost all residents and businesses are connected to a pipeline system or treatment plant.

Granting residents and businesses access to a sewage system is one of the prerequisites for a healthy and flourishing society, see the sustainable development goals of the United Nations. In 2016, Veitur Utilities' construction work on sewerage systems in West Iceland continued and the most extensive were the laying of the sea pipeline in Borgarnes and the pipeline along Krókalón in Akranes. In addition to this, work was done on the pumping and treatment equipment, steel works and the electricity and management systems. The treatment plants will start operating in the spring of 2017 and, following this, work will start on connecting areas that do not have access to sewerage systems. In all the collection areas of Veitur Utilities, the residents and business community will soon have the option of connecting to sewerage systems or treatment works.

Did you know?

More than a billion of the world's population live without access to water utilities and sewage systems, and yet these are prerequisites for a modern urban community.

Near the treatment plant in Kalmansvík in Akranes. Photograph: Fjóla Jóhannesdóttir

Access to fibre network utility

Reykjavik Fibre Network operates a telecommunications network, fibre optics and quality connections that cater for 80 thousand households and thousands of companies. Access to an open high-speed telecommunications distribution network is a prerequisite for improving the efficient processing of issues and promoting the Internet of Things (IOT) in the community and reducing greenhouse gas emissions.

Did you know?

The Reykjavik Fibre Network uses an app to register information on its activities and in doing so reduces the use of paper.

OBJECTIVE:
To ensure residents and businesses in the servicing area of the Reykjavik Fibre Network have the option of connecting to the high-speed telecommunications distribution net-work of the Reykjavik Fiber Network. The distribution system is based on principles of reliability and foresight regarding further developments in the future. The Reykjavik Fibre Network is an ISO 9001 certified company, operates in accordance with these standards and establishes measurable objectives to guarantee its high level of service to customers.

The Reykjavik Fibre Network is a telecommunications company owned by OR. Its operations consist in developing and managing a high-speed telecommunications distribution network and business with the system, i.e. the sale of data transmission services to households, companies and institutions in South-West Iceland. The current action plan of the Reykjavik Fibre Network is to connect all households in the greater Reykjavik area over the coming years.

The distribution system of the Reykjavik Fibre Network is founded on its fibre optics system and IP networks. The company operates under the guiding principle of working well and minimising disruptions in its tasks both outside and inside the homes of its customers. The "One Visit" project supports the OR group's environmental policy, since it eliminates the need to make two or more journeys to customers to install fibre optics and telecommunication equipment. A part of Reykjavik Fibre Network's vehicles are electric and their selection is guided by their environmental ratings.

Granting everyone access to an open high-speed telecommunications distribution network is a prerequisite for increasing efficiency, speed and cost effectiveness in, for example, resolving issues and it helps to promote home automation in the community, see the sustainable development goals of the United Nations. The Reykjavik Fibre Network therefore offers a technical solution that reduces the use of paper, and also greenhouse gas emissions by reducing journeys between places.

Some 80 thousand households and thousands of businesses were connected to the Reykjavik Fibre Network in 2016.

A technician from the Reykjavik Fibre Network performing maintenance work on a cable pit in Seljahverfi in Reykjavík.
Photograph: Valur Heidar Sævarsson.

Impact of emissions

The activities of Reykjavik Energy (OR) and its subsidiaries inevitably result in substances and energy being released into the environment. The principal emissions worth mentioning are discharge of geothermal water and geothermal gases such as hydrogen sulphide and carbon dioxide from the power plants of ON Power in the Hengill area and the discharge of sewage from Veitur Utilities. The OR Group takes the utmost precautions in its operations. Emissions are therefore only allowed to occur in a manner that has a negligible impact on health and an acceptable effect on the environment. OR and its subsidaries reduces the emission of pollutants in accordance with legal and regulatory provisions and endeavours to go even further, where possible. An emphasis is placed on research and development in order to utilise the best possible solutions for that purpose.

Discharge of geothermal water and monitoring of groundwater

Some 95% of the geothermal water from the Hellisheidi Geothermal Power Plant have been reinjected into the geothermal field at the power plant. It is clear that their ability to receive all the geothermal water from the power plant is limited. The set priority is to achieve the full management of the discharge of geothermal water at the Hellisheidi and Nesjavellir Geothermal Power Plants.

OBJECTIVE:
To ensure that the power plants and operating licences meet requirements regarding chemical and heat pollution in groundwater outside the defined dilution areas in the vicinity of the power plants. To ensure no separated water is discharged on the surface of the ground, except if breakdowns occur. To offset the pressure drop in the geothermal system. Hellisheidi and Nesjavellir Geothermal Power Plants.

At the Hellisheidi Geothermal Power Plant, most of the geothermal fluid (a mix of geothermal water, geothermal steam and geothermal gases) that is harnessed is returned to the geothermal reservoir by reinjection into wells. Geothermal water are made up of separated water (the part of the geothermal fluid that is separated from the geothermal steam under a certain pressure and continues in this form in the plant's processing) and condensate water (geothermal steam that has condensed with cooling so as to form water, which may contain dissolved geothermal gases). In accordance with the power plant licence, all separated water and part of the condensate water needs to be reinjected into the geothermal reservoir.

The purpose of the reinjection of the geothermal water is to protect surface water and groundwater because it has a different chemical composition, is hotter than groundwater, and could contaminate it. The target behind reinjecting geothermal water into the geothermal reservoir is also to better utilise the geothermal reservoir.

Reception of reinjection fields at the Hellisheidi Geothermal Power Plant
The volume of geothermal water at the Hellisheidi Geothermal Power Plant was over 20 million tons at the end of 2016 (Figure 7 and Table 4). As was mentioned in the 2014 and 2015 Environmental Reports, many research and development projects have been undertaken to fulfil reinjection requirements at Hellisheidi and considerable results have been achieved:

DISPOSAL WATER

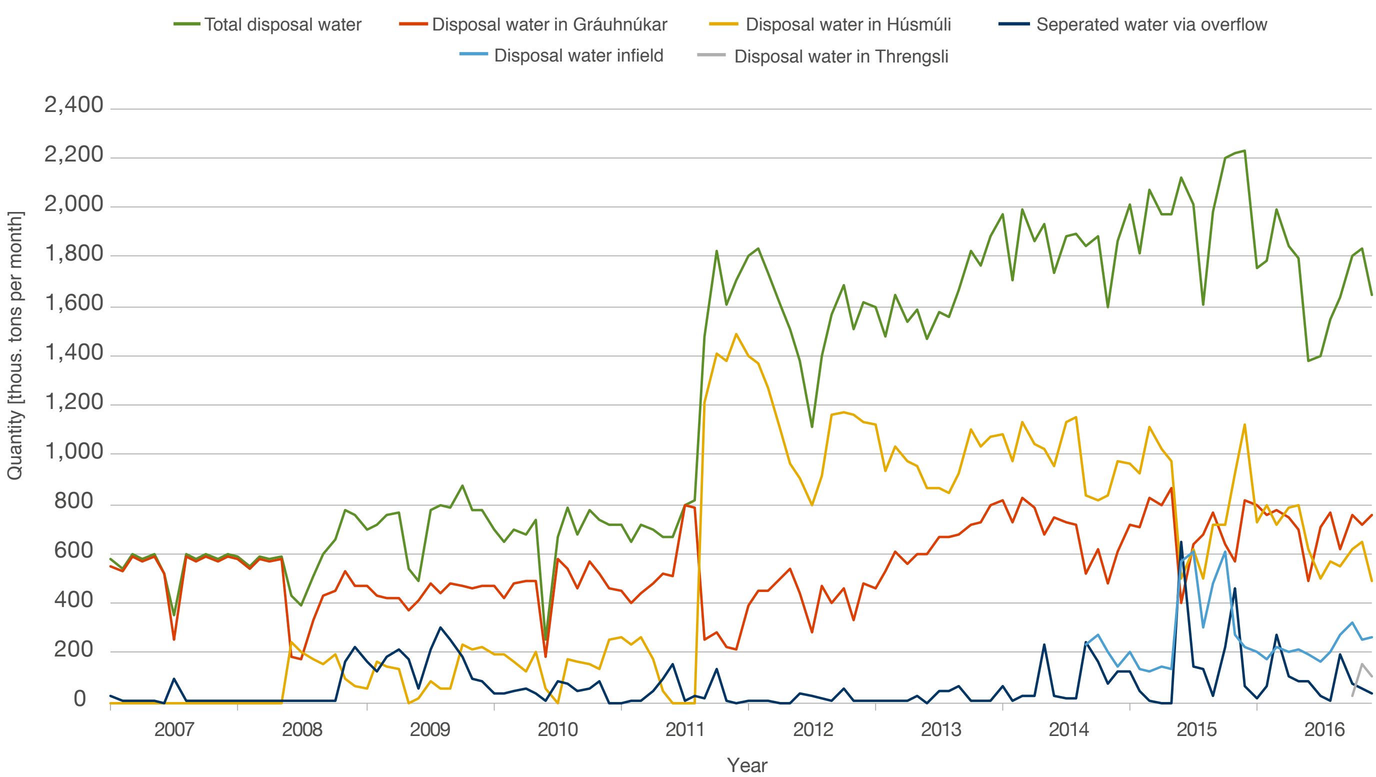


Figure 7. Volume of geothermal water (tons/month) from the Hellisheidi Geothermal Power Plant between 2007–2016 by release route. Until September 2011, the largest part of geothermal water was reinjected through wells in Gráuhnúkar. Geothermal water from the plant increased when the Sleggjan plant was launched in autumn 2011, but the reinjection field at Húsmúli was then taken into full operation. Since then the geothermal water from the plant has increased. Reinjection in discontinued production wells within the production field started in 2014 and in boreholes in Threngsli in 2016. There was a significant decrease in the release of geothermal water on the surface via overflow in the latter part of 2011 with improvements in the power station's operations, but they increased again around mid-2014 with the diminishing reception of reinjection fields.

GEOTHERMAL WATER AT HELLISHEIDI POWER PLANT

YEAR	SEPERATED WATER VIA OVERFLOW	GEOTHERMAL WATER IN GRÁUHNÚKAR	GEOTHERMAL WATER IN HÚSMÚLI	GEOTHERMAL WATER IN ÞRENGSLIN	GEOTHERMAL WATER WITHIN PRODUCTION AREA	TOTAL GEOTHERMAL WATER
	[tons/yr]	[tons/yr]	[tons/yr]	[tons/yr]	[tons/yr]	[tons/yr]
2007	215,290	6,502,485				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	22,147,304
2015	1,869,993	8,422,037	13,909,532		3,802,757	24,201,563
2016	1,025,403	8,585,414	7,831,161	288,054	2,686,880	20,416,911
TOTAL	**8,142,468**	**66,467,080**	**70,465,196**	**288,054**	**7,349,475**	**148,049,678**

Table 4. Geothermal water (tons/year) from the Hellisheidi Geothermal Power Plant between 2007-2016 by release route.

- The behaviour of reinjection fields has been analysed.
- The geothermal water has been cooled to facilitate its discharge and this has been successful.
- Geothermal water has been reinjected into production wells that are not used for steam production in Sleggjubeinsdalur. In the latter part of 2016, three wells of this kind in Skardsmýrarfjall were used for reinjection and the plan is to add another two in the summer of 2017. In this manner reinjection is distributed across the production fields of the Hellisheidi Geothermal Power Plant.
- In the second half of 2016, reinjection started into wells in the CarbFix area, which is outside the plant's production field.
- Condensate water is mixed into endeavour to reduce scale formations in the reinjection wells.
- Drilling additional reinjection wells is being considered, as well as channelling geothermal water to the ocean.

In addition to these projects, attempts were made to stimulate reinjection wells with alkali but this did not work as planned.

The result of the above projects in 2015 and 2016 is that it is possible to reinject most of the growing volume of geothermal water. The projects continue in 2017, since there is still room for improvements. The reception of reinjection fields is not sufficient at the moment to reinject all the geothermal water that come from the power plant into the geothermal reservoir. It is clear that for the foreseeable future, a variety of measures will be required for the operations of the Hellisheidi Geothermal Power Plant and new ways are being explored. In the summer of 2016 endeavours were finally made to rest the wells with ample water in western Hellisheidi and this reduced the load on reinjection unit of the plant.

A procedure has been adopted to reduce the likelihood of increased seismic activity induced by reinjection, see section on Seismic ctivity inducedby reinjection of geothermal water.

Volume of geothermal water from the Hellisheidi Geothermal Power Plant by release route

The reinjection utility is sensitive to any changes in operations and about 5% of the geothermal water went into overflows at the Hellisheidi Geothermal Power Plant was lost, over one tenth of which was due to major malfunctions. The licensing authorities have been kept informed of the situation and the possible measures that can be taken each time, as well as the projects that are being worked on to increase the reception of the plant's reinjection utility.

Figure 7 shows the volume of geothermal water from the Hellisheidi Geothermal Power Plant and their release routes, see also Figure 2 of the section on Managing production in high-temperature geothermal fields. In 2016, 19 million tons of geothermal water was reinjected into the geothermal system at Gráuhnúkar, Húsmúli and production wells that are not used for steam production (infield reinjection) and 0.3 million tons in boreholes at Threngsli. Part of the geothermal water, about 1 million tons, was released on the surface via overflow (Table 4). About 130 million tons of geothermal water have been reinjected into the geothermal system and over 8 million tons were released via overflow since the power plant started operating.

Annex 11 shows a summary of events since 2016, which caused geothermal water to be released via overflow at the Hellisheidi Geothermal Power Plant and in Hverahlíd and which were notified to the licensing authorities. In the autumn of 2016 work started on opening routes for the overflow down the fissures to avoid the formation of ponds on the surface. The work is proceeding well and so far the fissures seem to be absorbing the water. In the summer of 2017, the cleaning up of the site will be completed, with the reclamation of local vegetation.

Pressure support from geothermal water at the Hellisheidi Geothermal Power Plant

The geothermal reservoir is monitored with, for example, chemical tracers and borehole measurements, in order to be able to analyse the impact reinjection has on it. Results indicate that the reinjection supports pressure in part of the geothermal system. The cooling effect that had been expected in the production wells has not manifested itself, see section on Managing production in high-temperature geothermal areas. There is a need to strike a balance between reinjection and production in the field and controlling the volume of water in the injection wells to hinder the cooling of the fields, but at the same time provide the appropriate pressure support in the production field.

Monitoring groundwater at the Hellisheidi Geothermal Power Plant

The impact of the Hellisheidi Geothermal Power Plant on groundwater in surveillance wells at and around the plant has been monitored over the past decade. In 2016, monitoring was increased and a surveillance well (KH-50) was added to the existing 17 wells. Samples are taken to analyse overall chemical content and trace elements, in addition to measuring their temperature, conductivity and acidity (Annexes 12 and 13). The concentration of dissolved solids in wells is far below the limits set for potable water.

Overflows at the Hellisheidi Geothermal Power Plant only release separated water, which contains a considerably higher concen-

Lake Thingvallavatn. Photograph: Gretar Ívarsson.

Did you know?

The Hengill volcano has erupted several times since the Ice Age. Two thousand years ago, for example, the Nesjahraun lava flowed out of the Kýrdalssprunga crevice by the Nesjavellir Geothermal Power Plant.

tration of most of the substances and trace elements that are to be found in the groundwater in the area. It is therefore relatively easy to see pollution from the overflows with the passage of time. No measurements have indicated geothermal water from overflows at the Hellisheidi Geothermal Power Plant in any surveillance wells. On the other hand, the concentration of sulphates has risen considerably above background limits in well KH-7 (north of the power Hellisheidi Geothermal Power Plant) and in wells HK-7 and KH-50 without any substantial increase in silica, sodium and chlorine. Sulphate is created from the oxidation of hydrogen sulphide which follows the steam from the power plant. Up until 2016, when the hydrogen sulphide abatement unit was launched at the Hellisheidi Geothermal Power Plant, the bulk of the hydrogen sulphide filtered through the cooling tower along with the condensate water where the oxidation took place. Approximately 10 kg/s of water goes into the overflow of each cooling tower, but this water is released into shallow wells at the plant. Moreover, trace elements, which are mostly in gas form, have been measured in well KH-50 (selenium and mercury, although both well below the limits set for potable water), while other substances which mostly follow separated water, e.g. arsenic, have not been measured in the same well. The chemical composition will continue to be monitored in the surveillance well to gain a better picture of groundwater flows and the release of geothermal water from the Hellisheidi Geothermal Power Plant.

Annex 14 shows the typical concentration of several trace elements in geothermal water from the Hellisheidi Geothermal Power Plant and their maximum recommended concentration in potable water.

Reinjection projects at the Nesjavellir Geothermal Power Plant
Geothermal water at the Nesjavellir Geothermal Power Plant consist of separated water and condensate water, but also heated groundwater from Grámelur at Lake Thingvallavatn, which is used to cool machinery but is not utilised in the hot water utility when there is less demand. Projects were launched in Nesjavellir in 2015 to reinject geothermal water from the plant below the upper groundwater layer and many of them were completed in 2016 with good results. About 65% of the geothermal water are now reinjected belowthe cold groundwater layer, while the rest is released on the surface, i.e. into shallow wells or the Nesjavellir Brook. This shows an improvement from previous years. In the summertime, when there is less demand for hot water to space heating than in the winter, the largest portion of this water, which is released on the surface at the Nesjavellir Geothermal Power Plant, was heated up groundwater (Table 5).
The following projects were conducted in Nesjavellir in 2015-2016:

- The discharge of geothermal water in three reinjection wells, which were previously released onto the surface.
- Experimental injection of heated groundwater in two 170 m deep boreholes in Mosfellsheidi and one well in Kýrdalur at Nesjavellir, which reaches the geothermal reservoir. Measurements indicate that the reinjection in Kýrdalur has had negative impact on production wells.
- Redesign of a cooling tower so that water from two turbines in the power plant can now be cooled instead of one. This reduces the need for cooling water from water sources at Grámelur by a third, which in turn substantially reduces the discharge of heated groundwater in the summer.

The objective of these projects was to stop the steady discharge of geothermal water on the surface by the end of 2016, as well as to find a good solution for the utilisation or release of the excess production of heated groundwater from the plant. It is clear that this objective will not be achieved until mid-summer 2017. That volume will be a fraction of what has been released on the surface over the past decades.The licensing authorities have been kept informed of the situation. In addition to these projects, the preparation and design of a connection of the Árbær residential area in Reykjavík to the hot water utility at the Nesjavellir Geothermal Power Plant to increase the exploitation of the plant's excess production in the summer. Construction is scheduled for 2017 and 2018.

It is to be expected that some geothermal water needs to be released on the surface when the control equipment of the power plant needs to respond to disturbances or fluctuations and the equipment has to be protected against shocks.

Monitoring groundwater at the Nesjavellir Geothermal Power Plant
It is the responsibility of ON Power to minimise the impact of the power plant on the quality of the ground water and this needs to be particularly monitored in Lake Thingvallavatn (Figure 8). The impact of the Nesjavellir Geothermal Power Plant on groundwater in surveillance wells in Nesjahraun is monitored at the power plant. In addition to temperature measurements in the wells, the chemical composition and temperature in boreholes at Grámelur and brooks near the power station, as well as springs by Lake Thingvallavatn are also monitored. As has been mentioned in the environmental reports of recent years, there is thermal pollution caused by the impact of the power plant on the springs and bays by Lake Thingvallavatn. The effects have been perceptible 2 km along the shore of the lake between Markagjá and Grámelur and they reach a depth of over 40 cm, depending on weather conditions. The aforementioned projects are all aimed at reducing this impact.

GEOTHERMAL WATER AT NESJAVELLIR POWER PLANT

YEAR	INJECTION WELLS [thous. m³/yr]	SURFACE [thous. m³/yr]	TOTAL GEOTHERMAL WATER [thous. m³/yr]	HEATED GROUNDWATER [thous. m³/yr]
2013	7,730	7,824	15,554	26,687
2014	7,317	8,367	15,684	29,333
2015	7,388	9,545	16,933	26,371
2016	9,917	5,504	15,421	24,009

Table 5. Geothermal water (thousand cubic metres/year) from the Nesjavellir Geothermal Power Plant in 2013-2016 by release route.

In August 2015, tracer testing was conducted at the Nesjavellir Geothermal Power Plant to determine whether the geothermal water that is reinjected through wells to a depth of 300 to 600 m enter springs by Lake Thingvallavatn. Results from samples taken from streams by Lake Thingvallavatn and wells by Grámelur show that chemical tracers have reached there and confirm that, contrary to what was previously thought, the geothermal water that is reinjected is mixed with the groundwater in Nesjahraun. Increased focus will be laid on the available data on chemical and thermal pollution to increase the knowledge of flow of reinjected water in the field. That analysis will be used to plan the disposal of geothermal water at Nesjavellir with the aim to minimise chemical and thermal pollution in Nesjahraun

Annex 14 shows the typical concentration of several trace elements in geothermal water from the Nesjavellir Geothermal Power Plant and their maximum recommended concentration in potable water.

Groundwater model of the power plant area

The numerical groundwater model of the Hengill area is revised annually, but a part of the groundwater model also covers the water supply of the capital area. This information is important for the water supply of the power stations' heating utility and for gauging the impact of geothermal water on groundwater

WATER TEMPERATURE IN VARMAGJÁ AT LAKE THINGVALLAVATN

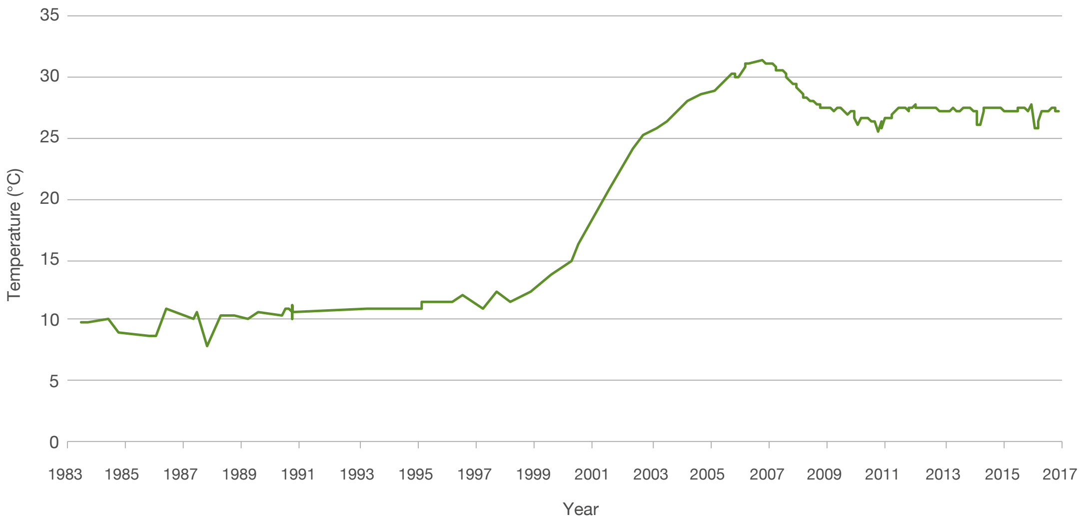


Figure 8. Water temperature (°C) in Varmagjá 1983-2016. The Nesjavellir Geothermal Power Plant became operational in 1990. When electricity production started at the plant in 1998, thermal pollution increased significantly, but decreased somewhat after injection wells came into use between2004-2008 and the cooling tower came into operation in 2005.

Hydrogen sulphide emissions

The concentration of ambient hydrogen sulphide in urban areas was below regulatory limits in 2016. The enlargement of the hydrogen sulphide abatement unit at the Hellisheidi Geothermal Power Plant was completed in July 2016. About 50% of the hydrogen sulphide was removed from the power plant in 2016.

OBJECTIVE:
To ensure compliance with regulations regarding the concentration of hydrogen sulphide.

Hydrogen sulphide (H_2S) emissions from the power plant in the Hengill area have been the biggest environmental issue, which ON Power grapples with in its operations. Hydrogen sulphide causes odour pollution, corrosion, and in high concentrations is a hazard to people. Hydrogen sulphide emissions from the Nesjavellir and Hellisheidi geothermal power plants amounted to approximately 12 thousand tons in 2016. Figure 9 shows hydrogen sulphide emissions per energy unit from Hellisheidi and Nesjavellir.

Monitoring concentration of hydrogen sulphide in the atmosphere.
The reviewed operating licence for the Hellisheidi Geothermal Power Plant came into effect in October 2016 and remains valid until 2028. According to the provisions of the operating licence, ON Power shall manage at least three fixed air quality monitoring stations and some mobile stations. The concentration of hydrogen sulphide in the atmosphere is monitored in the vicinity of the power stations and in populated areas, in collaboration with the South Iceland Health authorities, i.e., in Hveragerdi, Nordlingaholt, as well as the industrial areas at the Hellisheidi and Nesjavellir Geothermal Power Plants. In February 2015, a mobile air quality monitoring station was installed in Lækjarbotnar and will be operated there until at least the winter when the concentration in the atmosphere can be expected to be highest. The real-time data can be accessed on the websites of the South Iceland Public Health Board, www.heilbrigdiseftirlitid.is, and the website of the Environment Agency of Iceland, www.loftgaedi.is.

In 2016, the concentration of hydrogen sulphide was below the annual average in Hveragerdi (3.5 µg/m³) and in Nordlingaholt (3.5 µg/m³). The concentration was below the environmental limits for the maximum daily running 24-hour average (50 µg/m³) in Hveragerdi, but on one occasion exceeded the limit in Nordlingaholt, although it may exceed the limit three times a year (Figure 10 and 11). The concentration of hydrogen sulphide was constantly below the notification limits (150 µg/m³). Annex 18 shows the 24-hour averages and monthly averages for the concentration of hydrogen sulphide in Hveragerdi and Nordlingaholt for 2016. Annex 19 specifies the 30 highest hourly averages for the concentration of hydrogen sulphide in Hveragerdi and Nordlingaholt. This data can be found on the ON Power website www.on.is. In Hellisheidi the minimum average hourly concentration was 0 µg/m³, and the maximum concentration was 747 µg/m³, which is below the pollution limits for a work environment. In Nesjavellir the minimum concentration was 0 µg/m³ and the maximum value was 481 µg/m³, which is

EMISSIONS OF HYDROGEN SULPHIDE PER ENERGY UNIT

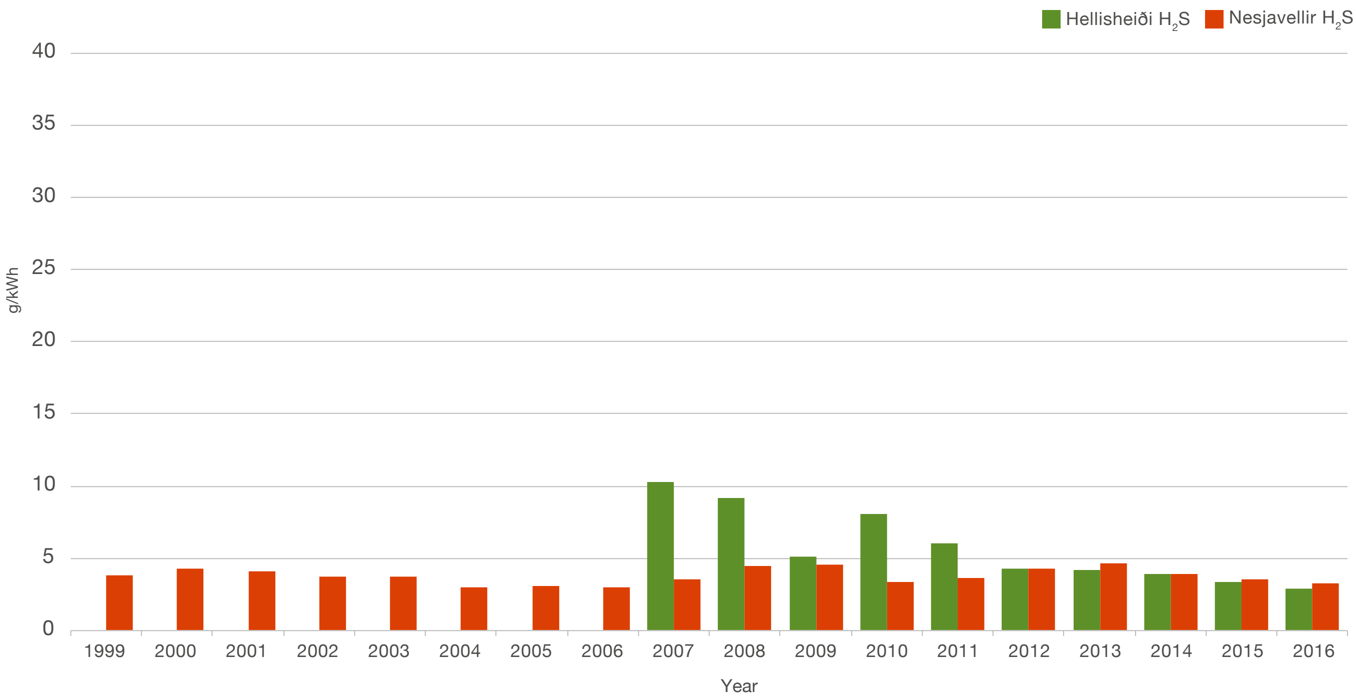


Figure 9. Hydrogen sulphide emissions (H2S) per energy unit from the Hellisheidi Geothermal Power Plant 2007 – 2016 and from the Nesjavellir Geothermal Power Plant 1999 – 2016. There are some differences in emissions between years, which can be attributed to, among other things, the volume of water and steam that is extracted from the fields and variable concentrations of the gas between fields.

At Ölkelduháls. Photograph: Gretar Ívarsson.

below the pollution limits for a work environment. At ON Power's mobile air quality monitoring station in Lækjarbotnar, the concentration exceeded the limit for the maximum daily running 24-hour average (50 µg/m^3) five times the first part of 2016 and was below the notification limits (150 µg/m^3).

One notification was sent to the licensing authorities to inform them that the concentration of hydrogen sulphide exceeded the daily limit in Nordlingaholt and another notification was sent to inform them of a maintenance stop in the hydrogen sulphide abatement unit at the Hellisheidi Geothermal Power Plant. One notification regarding hydrogen sulphide was received from a customer and ON Power investigated whether anything unusual was going on at the plant. This turned out not to be the case and the customer was informed accordingly.

Handheld measurements of hydrogen sulphide in the atmosphere have been taken since the year 2000. Measurements have been taken at over 130 measuring plots in the Hengill area. The results show significant localised decreases in the concentration of hydrogen sulphide in all areas, except in the west of the Hellisheidi Geothermal Power Plant and in Ölkelduháls, after the hydrogen sulphide abatement unit started operating in June 2014. The rising concentration in Ölkelduháls can be attributed to geothermal activity in the area but it is not clear why the concentration has increased west of the Hellisheidi Geothermal Power Plant. Further measurements will probably explain the causes.

Annex 17 shows a comparison between regulatory environmental limits for hydrogen sulphide in µg/m^3, on one hand, and ppm, on the other.

Increased capacity of hydrogen sulphide abatement unit at the Hellisheidi Geothermal Power Plant

In July 2016, the enlargement of the hydrogen sulphide abatement unit was completed at Hellisheidi. There hydrogen sulphide and carbon dioxide are separated from other geothermal gases in the steam, dissolved in water from the power plant and reinjected into basaltic rock at a depth of 1000 m. The hydrogen sulphide abatement unit can now remove over 60% of the hydrogen sulphide emissions from the power plant's steam. According to calculations, 3,900 tons of hydrogen sulphide were reinjected into the bedrock in 2016, i.e. about 50% of the carbon dioxide emissions from the plant that year. The results of chemical tracer tests show that about 75% of the hydrogen sulphide that is reinjected into the geothermal system is sequestered in the form of minerals within a year.

In parallel with the reinjection of hydrogen sulphide, in 2015 a steam hood was installed at the plant on an experimental basis. The experimental use of the hood has been successful. In September 2016, a mast was raised to monitor the weather on Mt. Skardsmýrarfjall. This was to be used, among other things, to improve forecasts on the dispersal of hydrogen sulphide from the Hellisheidi Geothermal Power Plant. In mid-November 2016 the mast collapsed in very icy weather. It is not known yet whether the mast will be raised again.

Research of impact of hydrogen sulphide on vegetation

In 2012, the monitoring of vegetation began in the vicinity of the geothermal power plants in Nesjavellir and Hellisheidi. Moreover, a doctoral thesis, which explored the impact of emissions on the ecosystem around the plant, was completed in 2016. The results of the project indicate that hydrogen sulphide has accumulated in the moss and soil closest to the power station. No significant differences were observed in the accumulation of trace elements between neighbouring power plants, on one hand, and reference areas, on the other. Increased measurements of trace elements from power plants and a tighter measuring network of vegetation and soil in the environment around the plants were proposed with the aim of explaining how various environmental factors (e.g. weather, the type of soil and landscape) have an impact on the distribution of trace elements.

Did you know?

The hydrogen sulphide abatement unit at the Hellisheidi Geothermal Power Plant can now remove about 60% of the hydrogen sulphide that comes from the plant.

HYDROGEN SULPHIDE (H_2S) IN HVERAGERDI

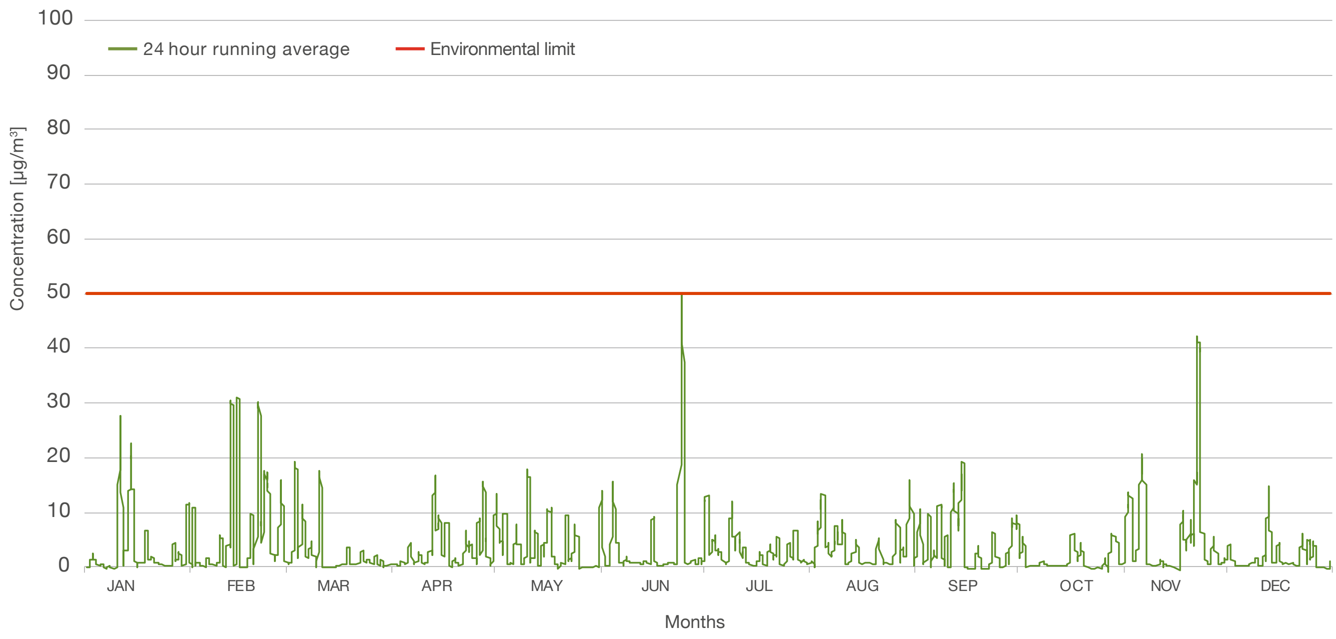


Figure 10. 24 hour concentration (daily running 24-hour average) of hydrogen sulphide (H2S) in Hveragerdi in 2016. As a frame of reference these are the environmental limits in regulations no. 514/2010. The concentration did not exceed the established environmental limits.

HYDROGEN SULPHIDE (H_2S) IN NORDLINGAHOLT

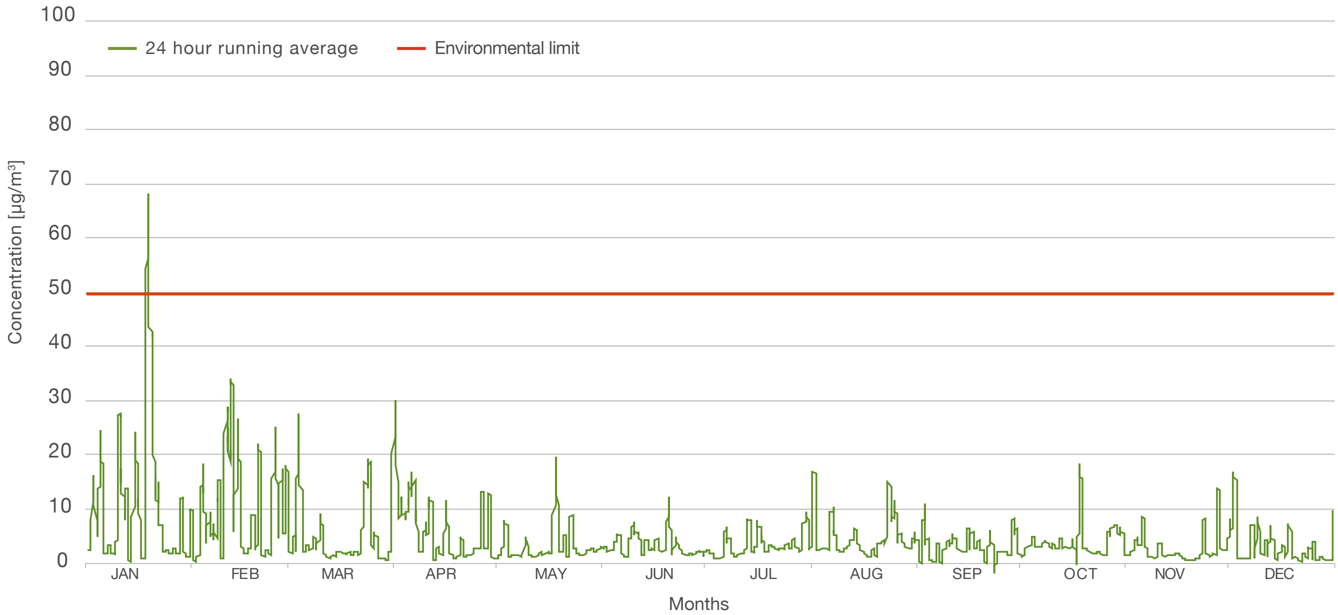


Figure 11. 24 hour concentration (daily running 24-hour average) of hydrogen sulphide (H2S) in Nordlingaholt in 2016. As a frame of reference these are the environmental limits in regulations no. 514/2010. The concentration exceeded environmental limits once.

Carbon dioxide, hydrogen sulphide and methane emissions

There is a growing interest in utilising geothermal gases and making them marketable. Some 6,400 tons of carbon dioxide have been reinjected into the bedrock at the Hellisheidi Geothermal Power Plant in 2016 where it is permanently sequestered, i.e. over 20% of the annual carbon dioxide emissions from the power plant in 2016.

OBJECTIVE:
To increase the multiple utilisations of ON Power's power plants by making geothermal gases marketable, depending on cost-effectiveness.

Did you know?

In June 2016, an article appeared in Science magazine, a famous and widely distributed scientific publication. The article discussed the CarbFix climate change project which has been conducted at the Hellisheidi Geothermal Power Plant since 2007.

Carbon dioxide emissions from the Nesjavellir and Hellisheidi geothermal power plants amounted to approximately 41 thousand tons in 2016. Hydrogen sulphide emissions totalled over 800 tons and methane approximately 100 tons in 2016. Annexes 15 and 16 provide an overview of the emissions of carbon dioxide, hydrogen sulphide and methane from Hellisheidi and Nesjavellir.

In Nesjavellir carbon dioxide emissions per energy unit diminished between 2000 and 2006 and in 2016, while in Hellisheidi between 2007 and 2013 and 2015 until 2016 (Figure 12). This is partly due to the fact that in the earlier part of the operational period of the power plants new wells were allowed to blow in order to measure their capacity.

Over the past years there has been a growing interest among ON Power, OR, scientists and potential clients to utilise geothermal gases, see section on Access to multiple utilisations of high-temperature resources.

Gas into rock
In June 2016, an article appeared in Science magazine, one of the most famous and widely distributed scientific publications in the world. The article discussed the CarbFix climate change project which has been conducted at the Hellisheidi Geothermal Power Plant since 2007. The Icelandic title of the project was Gas í grjót (gas into rock). Its goal is to reduce carbon dioxide emissions from the power plant by reinjecting it, dissolved in water, into the basaltic bedrock in the vicinity and sequestering it there in mineral form. Some 6,400 tons of carbon dioxide were channelled down into the bedrock in 2016, i.e. over 20% of the carbon dioxide annually emitted by the plant. The results indicate a 95% mineralisation within two years of reinjection and not centuries or millennia, as had been previously thought. The carbon dioxide is therefore being swiftly and permanently sequestered in the basaltic bedrock.

The results of the project, as well as its methodology and technical equipment have been used directly in the project to remove the hydrogen sulphide emissions from the Hellisheidi Geothermal Power Plant, see section on Emissions of hydrogen sulphide. The project is an example of collaboration between an Icelandic company and universities on both sides of the Atlantic. This was a prerequisite for the development of ideas into a realistic project useful to the business community.

Bergur Sigfússon, an expert on the CarbFix project, being interviewed by PBC News Hour. Photograph: Screen shot from video on PBC News Hour website.

EMISSION OF CARBON DIOXIDE PER ENERGY UNIT

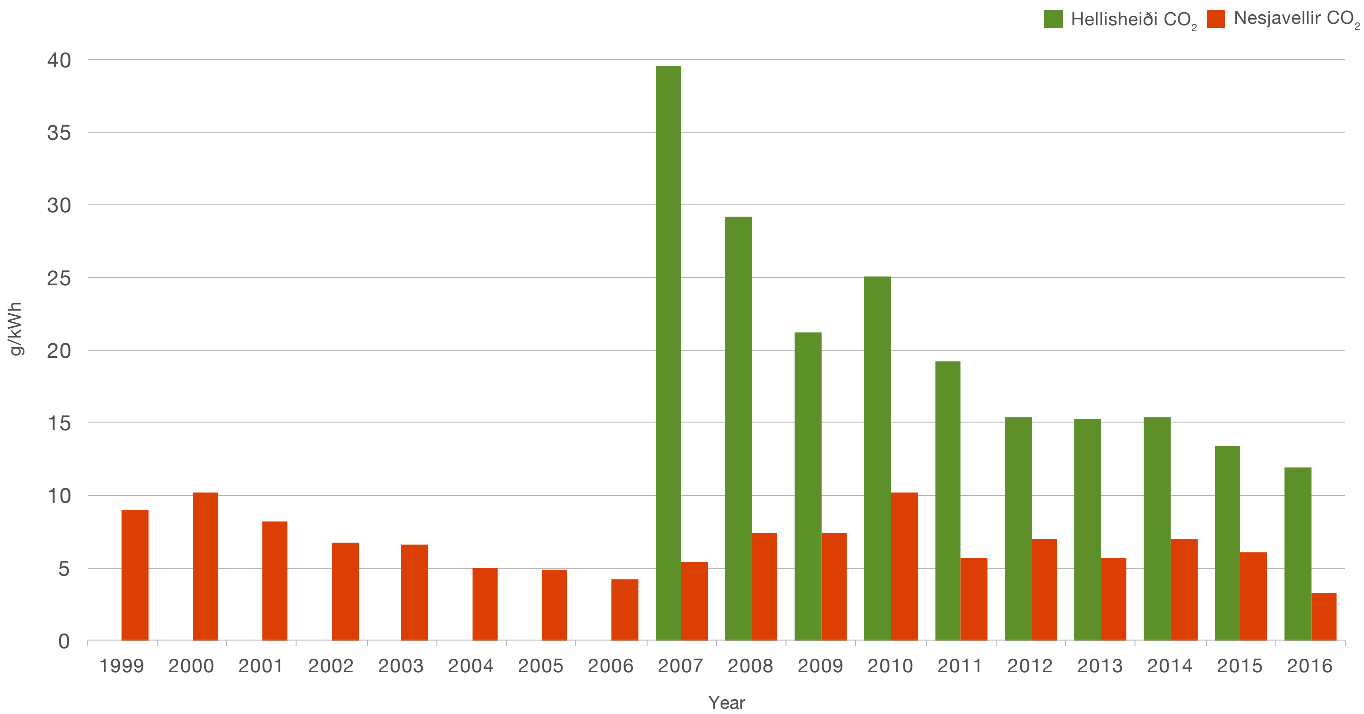


Figure 12. Carbon dioxide emissions per energy unit from the Hellisheidi Geothermal Power Plant from 2007-2016 and the Nesjavellir Geothermal Power Plant from 1999-2016. There are substantial differences in emissions from the power plants, which can be attributed to, among other things, variable gas quantities between fields.

Seismic activity induced by reinjection of geothermal water

Seismic activity started in the Húsmúli area by the Hellisheidi Geothermal Power Plant in mid-September 2016 and the tremors were felt in populated areas. No changes were made in the plant's reinjection utility in the lead up to this seismic activity. Seismic measurements have been increased in order to be able to better locate earth tremors caused by reinjection.

OBJECTIVE:
To ensure that seismic activity that may be associated with the reinjection of geothermal water causes the least possible inconvenience and never any damage.

Reinjection can cause seismic activity, so-called induced seismic activity. This is well known in the reinjection fields of the Hellisheidi Geothermal Power Plant, particularly in the Húsmúli area. The earthquakes are so-called triggered earthquakes and occur when the reinjection releases tension that has built up in the bedrock, due to movements in the earth's crust. ON Power follows work procedures which are designed to minimise the risk of induced earthquakes in the area.

In the first half of 2016, two notifications were sent to the Icelandic Meteorological Office and the Department of Civil Protection of the Icelandic Police due to changes in reinjection. Minor tremors were measured in connection with these changes, as was to be expected, but none of them were powerful enough to be felt in populated areas.

On the eve of 17 September, seismic activity started in the Húsmúli area by the Hellisheidi Geothermal Power Plant (Annex 20). Four earthquakes over a magnitude of ML 3 occurred. Experience from operating the reinjection utility at the Hellisheidi Geothermal Power Plant has shown that seismic activity can be caused by sudden changes in operations. An examination of the operations of the reinjection utility in relation to the seismic activity in September revealed that no changes had been made in the lead-up to the series of tremors. There was some discussion in the media following the seismic activity.

Six new seismic indicators were installed to the south of Hengill in the autumn of 2016. The sensitivity of this measuring network is considerably greater than the national seismic system (SIL) in this area. Precision in locating these earthquakes and evaluating their depth will be greater with this network and it is also important for increasing our understanding of geothermal energy and its links to seismic activity.

Hellisheidi Geothermal Power Plant The reinjection well at Húsmúli can be seen in the middle of the picture. Photograph: Gretar Ívarsson.

Did you know?

About 1,660 earthquakes were measured in the Hengill area in 2016. Most of them were recorded around Húsmúli, i.e. 1,280. About half of the quakes by Húsmúli were in a set of quakes that occurred in mid-September. The biggest earthquake of the year in the Hengill area occurred in this set on 18 September and measured at ML 3.56.

Discharge of wastewater from sewage treatment plants

Results of measurements on the periphery of the dilution area in Faxaflói in 2016 show that the number of microbes was under environmental limits, but above the threshold in several places on the coast. In 2016, Veitur Utilities started to explore which methods would be suitable for extracting microplastics from sewage and rainwater.

Did you know?

In the early days, Reykjavik's sewerage system comprised open sewers along the streats. The sewer in Austurstræti was called "Golden sewer" because it was considered an expensive construction. At the end of the sewer there was a valve that could be opened and drained when the sea level was high.

OBJECTIVE:
Veitur Utilities shall ensure that the load within the sewage dilution areas is within acceptable limits, and that pollution at their perimeter and the coast does not exceed the legal and regulatory limits. Veitur Utilities shall monitor the reception of sewage in accordance with the provisions of operating licences.

Sewage discharge reporting for Reykjavik
The sewage discharge reports for the treatment plants in Ánanaust and Klettagardar in Reykjavik provide information on the outflow of pollutants exceeding the reference values in Annex II of Regulation (EC) no. 166/2006. Calculations are based on the results of analyses on samples collected from treated sewage four times a year regarding measurements of nitrogen and phosphorus and twice a year for trace elements. The measurement results for 2016 are to be found in Annex 21 and sewage discharge reporting results for the plants in Ánanaust and Klettagardar areas are presented in Annexes 22 and 23.

Research on marine load within dilution areas and on the coast of the capital area
The operating licences of sewage treatment plants in Reykjavik define dilution areas, where microbial contamination may exceed environmental limits, but outside their boundaries microbial contamination shall be below limits (Figure 13). Operating licences stipulate that exhaustive research into the impact of discharges into the sea must be carried out every four years. Results have shown that the discharge of sewage has little if any effect on the quality of sea water. Veitur Utilities will have meetings with the Reykjavik Health Authorities to determine whether it is possible to lengthen the periods between broad-ranging research.

Under Regulations no. 798/1999 on Sewerage Systems and Sewage and the objectives of Veitur Utilities, 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 cases. 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 100ml sample in 90% of cases. In 2016, samples were collected by Veitur Utilities to measure the number of heat-tolerant microbes at 11 sites at the coast near overflows, and eight samples were collected on the periphery of the dilution area (Figure 13). Samples were collected three times, in March, June and September, but no samples were taken in December. The measurements came in addition to sampling by Reykjavik's Health Authority, which collects samples from ten sites within the area of influence of Veitur Utilities' sewerage system, where there is relatively easy access to the shore. The health authorities' sampling is conducted once a month during the period from April to October, with a total of 70 samples. Results show that samples are under the criteria limits in 90% of instances, except for enterococci (85%) in several places along the coast (Table 6).

Microplastics in waistwater
There has been some debate about microplastics in waistwater, in the wake of research conducted by Matís, which evaluated the discharge of microplastics from treatment plants at Klettagardar and in Hafnarfjördur. The conclusion of the research was, among other things that the treatment plants managed to remove little of the microplastics when compared to treatment plants in Sweden and Finland. Research into microplastics in the sea are limited in the world. However, Swedish research shows that the largest capture of microplastics comes from surface water on roads, e.g. asphalt particles, rubber particles and plastic from road paint. Microplastics also get into the sewerage systems from rubber that is used in artificial grass fields and from the washing of synthetics from fishing gear, industry and cosmetics. This is not an exhaustive list.

In 2016, Veitur Utilities started to explore which filtering methods would be suitable to remove microplastics from the waistwater of its treatment plants in Reykjavik and how much it would cost. Moreover, Innovation Centre Iceland is examining the research that has already been conducted on microplastics in waistwater in order to gain a better understanding of the problem. Further research is needed to determine which methods can be used to reduce the discharge of microplastics, including by educating the public.

In November, the Water and Wastewater Association of Iceland (VAFRÍ) and Samorka (Icelandic Energy and Utilities) held a conference on microplastics in waistwater. At the conference, there was a discussion of existing knowledge on this subject in Iceland, as well as the source and distribution of microplastics in waistwater and possible cleanising methods to protect flora and fauna from the reception of sewage. The conclusions of the conference were i.a. 1) more research is needed into how to hinder microplastics from getting into sewerage systems, 2) that most microplastics probably get into the sewerage systems with surface water, which does not all go through the treatment plants and 3) that the first full stage of sewage treatment would probably remove about 90% of the microplastics that reach the treatment plants

Biological sewage treatment plants in West Iceland
In Borgarfjördur Veitur Utilities runs four biological sewage treatment plants in Bifröst, Hvanneyri, Varmaland and Reykholt. Sewage is tested at the plants four times a year, in accordance with their operating licences. Samples are collected from the drainage of the stations and/or at reception and suspended particles, fat/grease, COD, phosphorus, nitrates, enterococci and faecal coliform are analysed. The values of samples taken in 2016 were within the set limits, except in the cases of enterococci and faecal coliform that exeted limits in Bifröst, Hvanneyri and Reykholt. Furthermore suspended particles exeted limits in one

sample at Varmaland.Over the past years, endeavours have been made to find an explanation for this in collaboration with the health authorities of West Iceland. An acceptable explanation for the presence of the microbes has yet to be found, but work will continue on trying to find a remedy.

Blue-green surface water solutions
Rainwater in populated areas is generally channelled into the sea through the sewerage system. With heavy downpours or great thaws the system may become overfilled, particularly in old recidential areas and densely populated areas under increased strain. This can cause flooding with a consequent impact on constructions and ecosystems. Experience in neighbouring countries has shown that blue-green surface water solutions alleviate the load on the sewerage system, and reduce pollution in rivers and lakes, where it is possible to collect pollutants and remove them where the surface water sinks. Residents can appreciate the enhanced environments where these solutions have been applied. Veitur Utilities is exploring the possible use of blue-green surface water solutions in collaboration with municipalities, where the burden of rainwater on sewage pipes needs to be reduced

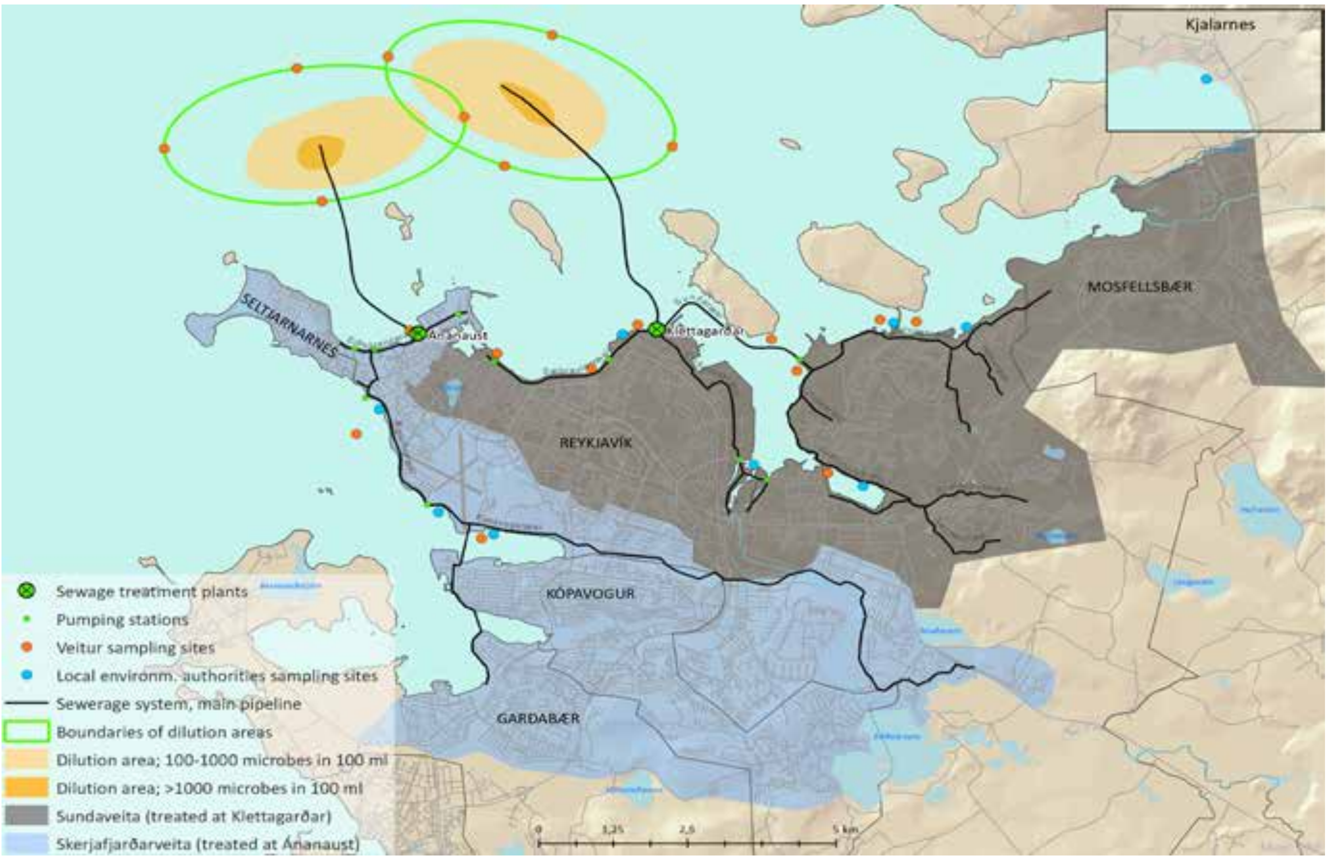


Figure 13. Veitur Utilities is responsible for the development and management of sewerage systems in Reykjavik. Waistwater from Kópavogur, Mosfellsbaer and large parts of Gardabær and Seltjarnarnes is treated in sewage treatment plants in Klettagardar and Ánanaust. The map also shows the dilution areas for the outlets of the sewage treatment plants and locations used for sampling.

SEA WATER QUALITY

SEA WATER QUALITY AT THE COAST							
Samples	**Heat-tolerant microbes**		**2012**	**2013**	**2014**	**2015**	**2016**
RDEP and Veitur	Faecal coliforms	%	97	90	86*	92*	85*
	Enterococci	%	99	99	95*	96*	95*

SEA WATER QUALITY AT THE PERIPHERY OF DILUTION AREAS							
Samples	**Heat-tolerant microbes**		**2012**	**2013**	**2014**	**2015**	**2016**
Veitur	Faecal coliforms	%			97	97	100
	Enterococci	%			100	100	100

* Since 2014, Veitur have collected samples in addition to those collected by Reykjavik's Department of Environment and Planning (RDEP), and the findings are shown in the table.

Table 6. Sea water quality The percentage (%) of samples below limits, i.e., less than 100 in a 100 ml sample at the coast by Reykjavik and less than 1000 in a 100 ml sample at the periphery of dilution areas for the period 2012-2016.

Discharge of waistwater through overflows

Discharge of waistwater via overflows was within limits in the capital area, except in Faxaskjól.

OBJECTIVE:
To ensure the use of overflows to deal with loads from rainwater is less than 5% of the year, and that emergency overflows are not 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 sewage mixed with hot water from district heating utilities or rainwater is at least on a ratio of 1:5. In 2016, the discharge of waistwater via overflows was within Veitur Utilities' established limits, with the exception of Faxaskjól where the overflow was active for 7.1% of the year. (Figure 14). There are generally signs of pollution when emergency overflows open. The emergency overflow in Skeljanes was active for 1.6% of the year and opened repeatedly because of heavy precipitation in the first months of the year and in October 2016. Ten notifications were sent to licensing authorities regarding the discharge of waistwater through overflows.

Part of the pipeline between Skeljanes and Faxaskjól and the system between Faxaskjól and Bodagrandi do not perform drainage at peak times. Work is being done on examining the system as a whole to ascertain where rainwater penetrates into it and where the transport capacity needs to be increased. Preliminary results show that there is not one big inward leakage, but several smaller inward leakages in the upland. Further research is needed to map the problem.

The situation in Skeljanes is cause for concern because of its closeness to the geothermal beach in Nauthólsvík.

Did you know?

Sewerage systems are designed so that the waistwater flowes through the overflows at pumping stations during heavy precipitation. In these cases the waistwater is heavily diluted by rainwater. These measures prevent the waistwater and rainwater from flowing into constructions during heavy precipitation and thaw.

DRAINAGE THROUGH OVERFLOWS

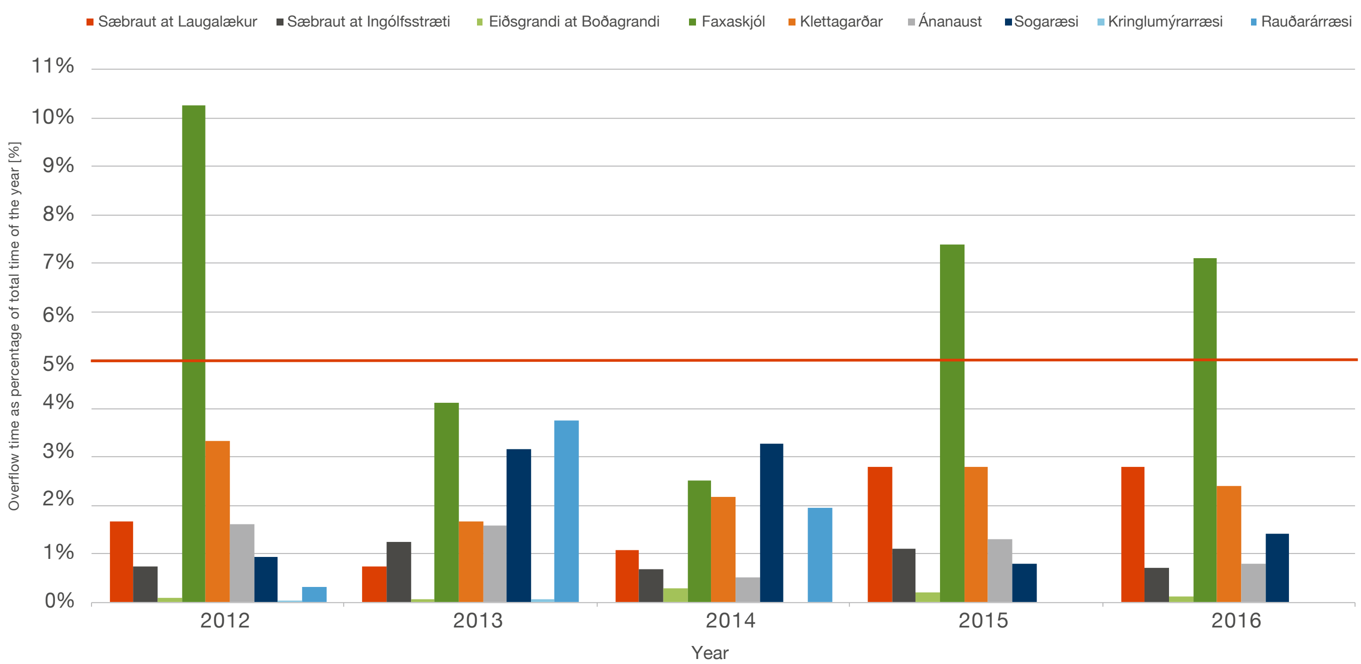


Figure 14. Overflow times in pumping stations and overflows of Veitur Utilities in the capital area 2012-2016. The 5% limit is indicated with the red line. Information from the sewers at Kringlumýri and Raudará are not available due to malfunctions in the measurements.

Impact on the community

The OR Group is a big company in Iceland and its workforce possesses vast knowledge and experience in the use of geothermal energy and other aspects of the company's operations. The Group disseminates its know-how and influences the value chain, which encourages a responsible treatment of the environment and has a positive impact on the community.

Dissemination of know-how on geothermal energy utilisation and other aspects of operations

OR and its subsidarie's Science Day was held for the third time in 2016. The "Gas into rock" project attracted worldwide attention when an article about its results was published in Science magazine. Employees gave diverse talks on the operations of the Group at conferences and international congresses.

Did you know?

In 2016, seven international networks sent news teams to Iceland to interview scientists and experts from OR and its subsidiaries on the CarbFix climate change project.

OBJECTIVE:
To ensure information, which may be useful to others and does not undermine the utility systems of OR and its subsidaries or its business interests, is accessible. This applies to, for example, reports, articles and presentations, insofar as possible, as well as published promotion material.

The personnel of OR and its subsidiaries possesses a vast knowledge regarding the production and distribution of power and water to residents and businesses. It is important to pass on this useful know-how which can encourage a responsible treatment of the environment and have a positive social impact.

Dissemination of know-how domestically
The CEO of the Reykjavik Fibre Network gave a presentation at the UTMESSAN IT conference in February on how fibre optics can play a key role in the Internet of Things (IOT) in Icelandic homes and the country's infrastructure.

OR and its subsidarie's Science Day was held for the third time on Pi Day itself on 14 Mar 2016. On this occasion, the results of 25 research and scientific projects were presented and the utilisation of geothermal energy in Iceland and its impact featured prominently. About 120 guests attended the Science Day and the live stream of the event was watched more than 500 times.

The Icelandic Water Studies Committee and the Icelandic UNESCO committee held a meeting on the occasion of International Water Day in March. The theme of the day was water and work and OR's director of environmental affairs gave a presentation.

The OR Group was one of the principal sponsors behind the Iceland Geothermal Conference, which was held in Harpa in April. Many global scientists and experts in the field of geothermal energy addressed the conference. Staff from OR and its subsidaries chaired two seminars, two delivered lectures and one manned the group's promotional stall.

The primary school of Árbær has been involved in a collaboration with OR and its subsidiaries since the autumn of 2015 on a vocational project called "Industry and Technology" and the first group graduated in the spring of 2016. The objective of the project is to arouse students' interest in industrial and technical professions by introducing them to the great variety of jobs and professional opportunities which industrial and technical studies have to offer.

Samorka hosted a professional conference on electrical power issues in May. About 20 presentations were made, eight of which were by employees of OR and its subsidaries or they chaired discussions.

In September, the Festa Centre for Corporate Social Responsibility held a conference on companies' climate change objectives and two members of OR Group's staff participated in a panel discussion.

The 2016 Nordic Drinking Water Conference was held in Reykjavik in September. About 40 presentations were made at the conference, five of which by employees of OR and its subsidaries or they chaired discussions.

Veitur Utilities held theme days for each medium: hot and cold water, electricity and sewerage systems, in which the subject matter was introduced in videos. Informative material was posted on Veitur Utilities' website and social networks. To mark International Toilet Day in November, a video called "Wet wipes are a nightmare" was made and attracted media attention.

In November, Samorka and Íslandsbanki hosted a conference on the adoption of electric cars. An employee from ON Power gave a presentation. Moreover, the GEORG international Geothermal Workshop was held. Three OR employees delivered presentations there and participated in panel discussions.

There has been a campaign to promote the use of social networks among OR and its subsidaries. The objective behind increasing visibility on social networks is to promote a better and broader dissemination of information and know-how about our activities, offer customers a better service, strengthen brand awareness and image, educate and entertain.

The CarbFix and SulFix innovation and development projects continued to attract global attention. In response to this increased coverage, these projects were better highlighted in the OR Group's promotional material. In Icelandic these projects now go under the name of "Gas í grjót" ("Gas into Rock).

Experts from OR and its subsidiaries have taught, delivered lectures and guided students in their studies and final dissertations at the University of Iceland, Iceland School of Energy and the University of Reykjavík, as well as the Geothermal Training Programme of the United Nations University (UNU-GTP).

International dissemination of know-how
Experts from OR participated in the Stanford Geothermal Workshop in California in February 2016. There they gave presentations on the management of geothermal power plants and the challenges that have been tackled in connection with energy production and reservoir management of geothermal systems in the Hengill area.

In June 2016, an article was published in Science magazine, one of the most famous and widely distributed scientific publications in the world. The article discussed the CarbFix climate change project which has been conducted at the Hellisheidi Geothermal Power Plant since 2007. OR and later ON Power were the main sponsors of the project from the very outset. This has involved many scientists, in addition to craftsmen and technicians from OR and later ON Power. Dozens of articles relating to these projects have been published and discussed at countless conferences and seminars. The US PBS television network broadcast a detailed programme about the project and sent a news team to Iceland to interview scientists from OR and ON Power. PBS is one of the biggest public broadcasters in the United States and its material is distributed to 350 smaller television stations around the country.

OR sent representatives to the World Energy Congress in Istanbul in Turkey in October 2016, where the director of OR's Development division delivered a presentation on the CarbFix project at the "Decarbonising the future" session and the role of carbon capture and storage (CCS) technology, which is precisely the core of the project.

Two employees from Veitur Utilities delivered presentations on the importance of water protection and the company's experience in the production of quality water and untreated potable water at the National Water and Wastewater Conference, which was held in November 2016 in Toronto, Canada.

The United Nation's Conference on Climate Change (COP21) was held in November 2016. At an informative meeting at the Conference on Climate Change, the director of OR's Development division delivered a presentation on the methods being used for the sequestration of geothermal gases in bedrock at the Hellisheidi Geothermal Power Plant, which are a lot swifter than traditional methods and cost considerably less. Moreover, OR's director of environmental affairs gave a presentation on the background leading to the sequestration of gas in rock at the Hellisheidi Geothermal Power Plant in 2007, and placed it in the context of the development of the utilisation of geothermal energy by OR and ON Power. The Ministry for the Environment and Natural Resources organised the informative meeting in collaboration with OR and the Ministry of Foreign Affairs.

Procurement

OR is a founding member of the Procurement Network and eco-friendly labels are favoured in the procurement of operational goods, such as paper and detergents.

OBJECTIVE:
To take the environmental impact of procurement into consideration wherever possible by, for example, analysing life cycle costs and applying recognised environmental criteria and checklists. Procurement shall be organised and coordinated bearing side effects in mind, such as transport and the quantity of packaging.

OR and its subsidiaries procure a great deal of goods and services, particularly when it comes to heating utility pipes and electrical equipments. Procurement requirements are systematically analysed in the companies and efforts are made to utilise materials that have been purchased or are in stock or to sell them off. As an indication of this, there was a good usage of older inventories in 2016, and leftovers from older stocks decreased by 2%.

OR is a founding member of the Procurement Network, which is a group of companies that wants to reduce environmental impact with eco-friendly purchases. Eco-friendly labels are favoured in the procurement of operational goods, such as paper and detergents, and the companies are obliged to deliver information on their eco-friendly procurement in April of every year. About 70% of the procurement in 2015 of photo-copying paper, envelopes, printed material, detergents, stationery and printing cartridges carried eco-friendly labels. The use of print control has steadily increased and printing and photocopying have dropped by about 33% since 2012 and remained stable for the past two years. In 2016, the aim was to distinguish eco-friendly products from other products on suppliers' invoices in the product categories defined in the Procurement Network. This was reviewed and a decision was made to shelve the project due to its complexity.

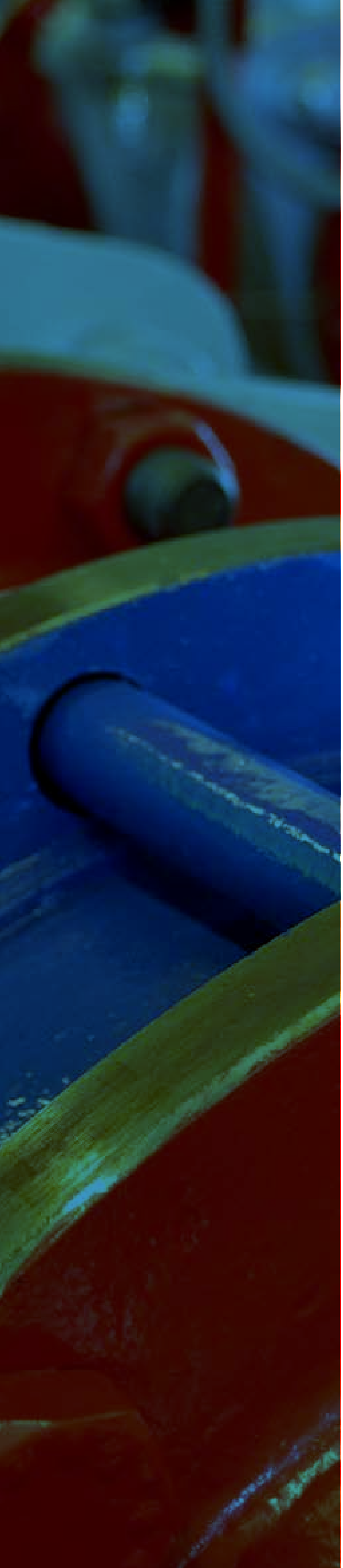
At OR and its subsidiaries, the group's suppliers have not been screened for environmental indicators. The companies do not have any assessments of the potential or real risks posed by the negative environmental impact of their supply chain or responses to those impacts.

In 2016, efforts continued to improve OR's knowledge of eco-friendly procurement.

Did you know?

In 2016, we stopped sending out printed notifications, except to customers who are 67 years old or older. Moreover, a project was launched to reduce the number of people who receive printed versions of energy bills. The use of paper and envelopes for energy, water and sewerage bills has therefore decreased by 29% since the beginning of 2016.

Figure 15. "The charger" at OR's headquarters. Photograph: Einar Örn Jónsson.



Operations

The operations of Reykjavik Energy (OR) and subsidiaries are founded on the organised and disciplined working procedures of many employees in widespread work sites. Day-to-day tasks include, among other things, the responsible utilisation of supplies, maintenance on constructions, tending to plots of land, handling waste responsibly and promoting climate-friendly transport. OR and its subsidaries aims to run exemplary operations and to develop its personnel's competence in this field.

Waste

The staff's awareness of recycling and sorting issues has generally been good.

OBJECTIVE:
To minimise waste and recycle as much as possible and ensure negligible amounts of active waste are buried.

Did you know?

According to the climate change objectives of OR and its subsidiaries until 2030, 90% of the waste from their offices is expected to be recycled, compared to its current level of 80%.

A great deal of waste accumulates in the operations of OR and its subsidiaries and it is divided into three categories:

- Waste for landfilling (e.g. general waste, asbestos and sewage)
- Waste for recycling
- Hazardous waste

Up until now the environmental reports have published joint figures on the volume of waste from OR and its subsidiaries and tenants. This coverage has been improved to be able to see how much waste is produced by the operations of each company within the OR Group minus the companies that rent premises at the OR Group's headquarters in Bæjarhálsi. The staff's awareness of recycling and sorting issues has generally been good.

The total volume of waste amounted to 1,400 tons in 2016, most of which came from sewage treatment plants, which produced over 700 tons, i.e. 50% of the total waste (Figure 16). Asbestos to landfilling increased substantially, i.e. from 19 tons to 300 tons and was 20% of the total waste. Waste other than waste from sewage treatment plants amounted to 400 tons, some 100 tons of which was general and coarse waste. There were 250 tons of waste for recycling and 12 tons of hazardous waste. Annexes 24 and 25 show how waste is divided between categories and work sites. Asbestos to landfilling increased due to increased maintanence of the Deildartunga pipe. Furthermore general and hazardous waste increased as well as waste for recycling.

As has been mentioned in the section on Hydrogen sulphide emissions, hydrogen sulphide and carbon dioxide have been reinjected into basaltic rock at a depth of 1000 m. with remarkable results over the past years. These geothermal gases are, of course, waste that comes from energy production in geothermal production fields and it should be mentioned that the reinjection protects the earth's atmosphere from the negative effects which their emission can entail. Since 2014, some 13,000 tons of carbon dioxide and 7,000 tons of hydrogen sulphide have been mineralised in the basaltic rock in this manner.

The staff's awareness of recycling and sorting issues has generally been good. In 2016 information was gathered for the Environmental Report regarding the gravel, soil and asphalt that is accumulated and disposed of in projects. (Annex 24).

By sorting and recycling waste, we can all make a contribution and have a positive impact on the environment.

WASTE

Figure 16. Waste from the operations of OR and its subsidiaries between 2011-2016. Waste from sewerage systems contracted by 50% following the installation of equipment to clean waste and sand at sewage treatment plants at the beginning of 2015.

Transport

In 2016, OR and its subsidaries initiated a project to increase the proportion of climate-friendly transport in society and reduce greenhouse gas emissions from transport. About 95% of employees are very or quite keen on climate-friendly modes of transport. ON Power obtained the biggest grant issued by the Ministry of Industries and Innovation in 2016 for the development of infrastructure for the electrification of mobility and transport in Iceland.

OBJECTIVE:
To ensure that transport due to the operations of OR and its subsidiaries emits the least possible greenhouse gases by selecting vehicles with the lowest emissions and which are deemed cost-effective and suitable for operations. To encourage employees to choose climate-friendly means of transport to and from the workplace. OR and its subsidiaries shall play an active role in acquiring experience and disseminating knowledge about foreseeable changes in energy sources for transport.

Did you know?

A car that is in motion possesses a kinetic energy. In order to stop the car, the kinetic energy needs to be converted into another energy form. In a normal petrol-fuelled car this is done by converting the energy into heat in the braking system of the car. In an electric car the energy is converted into potential energy in the battery. It is only when the car has to suddenly brake that the kinetic energy is converted to heat. Thus the electric car can re-use the same energy many times.

Climate-friendly transport strategy
In the spring of 2016, OR and its subsidiaries approved an climate-friendly transport strategy. The group intends to be at the forefront of climate-friendly transport by setting a good example, developing and building up infrastructure, and by using its products to produce climate-friendly energy sources. OR and its subsidiaries believe it is their social duty to use their know-how and capacity to conduct projects of this kind.

Project to increase the proportion of climate-friendly transport
The OR Group launched a project to increase the proportion of climate-friendly transport in society, since it is clear that the companies have an opportunity to make a positive contribution in this field. The overall objective is to reduce greenhouse gas emissions from transport in Iceland.

The objectives of the projects include, among other things:

- OR and its subsidiaries shall be exemplary and demonstrate that climate-friendly transport is well suited to Iceland.
- Minimise greenhouse gas emissions from the company's car fleet within a set time-frame for its renewal.
- Reappraise the premises underlying the design of the electricity grid to ensure it has a sufficient transport capacity to meet the needs of electrified mobility and transport.
- The renewal and development of the electricity grid will be guided by the needs of climate-friendly transport.
- OR and its subsidaries shall take the initiative to promote the discussion of climate-friendly transport within the scientific community by making all of the group's material on the subject available to students and scientists, and encouraging more research and processing.
- Boost the marketing and installation of charging facilities for people who use electric cars around the country.
- Analyse and promote the possibilities of using geothermal power plants for the production of fuel.
- Collect, develop and promote information on electric cars and how they can be charged in homes, companies and public entities.
- Facilitate the staff of OR and its subsidiaries in the use of climate-friendly transport to and from work and in their personal lives through education and the creation of facilities.
- Increase the supply of climate-friendly fuel for the car fleet.

Climate-friendly vehicles at OR and its subsidiaries
A plan for the renewal of the car fleet of OR and its subsidiaries has been established until 2030. The objective is to, among other things, reduce greenhouse gas emissions by over 75%.

Since 2013, the percentage of vehicles and heavy machinery at OR and its subsidiaries, which were powered by renewable energy sources, such as methane, hydrogen and electricity, has increased from 15% to 37% in 2016 (Figure 17). In 2016, there were 65 climate-friendly cars at the OR Group, of which 21 were electric cars, 2 were plug-in hybrids and 19 were methane cars. Annex 27 contains a list of the company's vehicle fleet from 2012 to 2016. Fuel consumption for the company's own vehicles and leased vehicles is shown for the same period in Annex 28.

Information was gathered on the number of kilometres driven by the company's own cars from 2014 to 2016. As can be seen, the company's own cars are consuming more fuel for every 100 kilometres driven in 2016 than in previous years (Figure 18). At the end of 2016, tachographs were installed in OR's vehicles and this will, for example, provide more precise information on this aspect. In 2016, there were 0.4 vehicles per average equivalent position at the ORGroup and this did not change from 2015 (Annex 26).

The number of electric cars in Iceland has increased nine-fold since the beginning of 2014. At the same time, ON Power has opened 11 rapid-charging stations for electric cars in South-West Iceland and two in Akureyri and thus been at the forefront of the development of infrastructure for electric cars (Figure 19). ON Power obtained the biggest grant issued by the Ministry of Industries and Innovation in 2016 for the development of infrastructure for the electrification of transport.

THE VEHICLE FLEET 2016

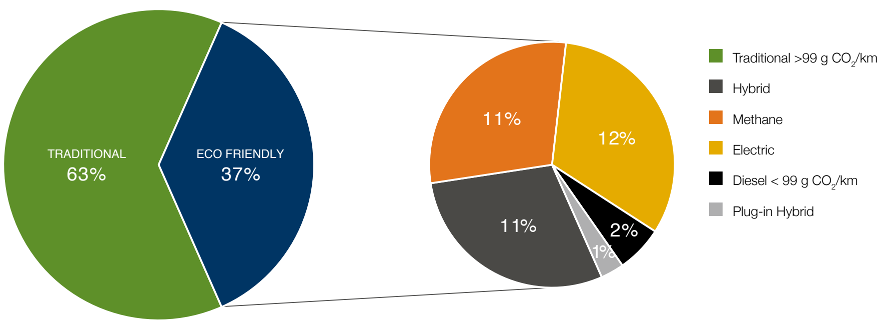


Figure 17. Composition of OR's car fleet in 2016. Conventional cars powered by gasoline or diesel oil accounted for 63% and climate-friendly vehicles 37%, some 11% of which were hybrid vehicles,11% were methane-powered, 12% electric, 2% diesel and 1% plug-in hybrid.

Facilities for electric cars and electric bicycles

Of the 430 parking spaces for cars at the headquarters of OR and its subsidiaries in 2016, some 33 spaces were reserved for electric cars and plug-in hybrids. Six of these spaces are called "chargers" and are solely intended for electric cars while they are being charged (Figure 15) and the same applies to two spaces connected to rapid-charging stations. Electric bikes can be charged in the staff's bicycle parking area.

Travel habits of personnel to and from work

According to a survey on the travel habits of the staff of OR and its subsidiaries, which was conducted in June 2016, 95% of employees are very or quite keen on climate-friendly modes of transport. Employees were asked directly about the obstacles preventing them from travelling by more climate-friendly means. On the basis of their answers and more, an action plan was launched in 2016 to make it easier for the personnel to travel to and from work in a climate-friendly manner.

The survey, conducted in June 2016, revealed that 66% of the staff mostly travelled to work in their own car, 15% on bicycles and 7% in electric cars or on electric bikes (Figure 20). At the end of December 2016, 28% of the staff were receiving transport grants, i.e. 130 employees. This was an increase of over 8% from the previous year.

Provisions of transport agreement extended

Since the spring of 2015 the staff of OR and its subsidiaries have been offered transport agreements. The purpose of the agreements is to promote climate-friendly transport, reduce traffic on the roads, save parking space at the workplace, encourage exercise and improve the staff's health. In the autumn of 2016, the provisions of the agreement were extended. Now employees who get lifts to work or have organised car-pools to and from work, and personnel that travels in electric or methane cars are eligible for transport grants.

Wheels of nature

The "Wheels of nature" project started in June 2016 and consisted in allowing employees to rent electric bikes for a period of one week at a time without payment. The purpose of the project was to raise awareness of this climate-friendly mode of transport and offer employees a chance to improve their health while involving them in these changes in the utilisation of energy in transport. Some 165 employees tried out electric bikes in 2016.

Education and training in climate-friendly transport

On the intranet of OR and its subsidiaries there is a section dedicated to climate-friendly transport, information and advice. Occasionally, consultants and lecturers have been invited to talk about aspects of climate-friendly transport such as cycling skills the choice of cycles and their handling. The plan is to mix practical courses, lectures and incentive videos.

Electric cars offered to employees during work hours

OR and its subsidiaries recently started to use a car rental system that makes it easier for personnel to choose electric cars for work-related journeys. There are a total of 65 climate-friendly cars in the OR Group, and 21 of those are electric cars. Electric cars have their own parking spaces.

FUEL EFFICIENCY

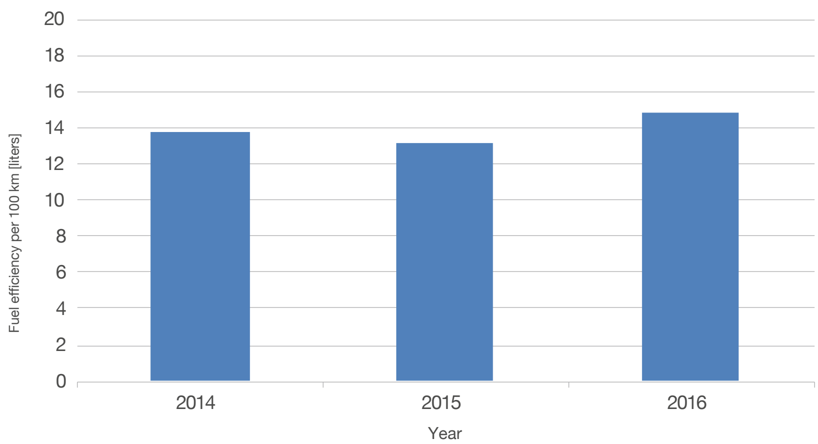


Figure 18. Fuel consumption per 100km driven between 2014-2016. The data do not include exclusively electric cars and methane cars.

NUMBER OF ELECTRIC CARS ON POWER'S FAST-CHARGING STATIONS 2014-2016

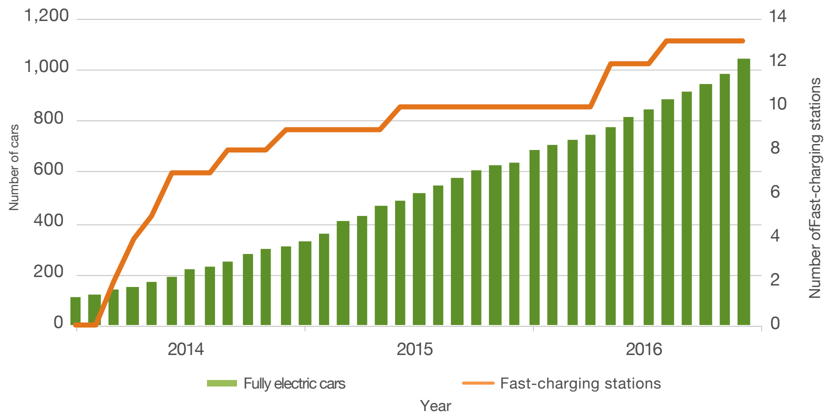


Figure 19. The number of electric cars in Iceland has increased almost nine-fold since the beginning of 2014. At the same time ON Power (ON) has installed recharging stations to encourage this trend. Data from Icelandic Transport Authority.

TRAVELLING CUSTOMS TO AND FROM WORK

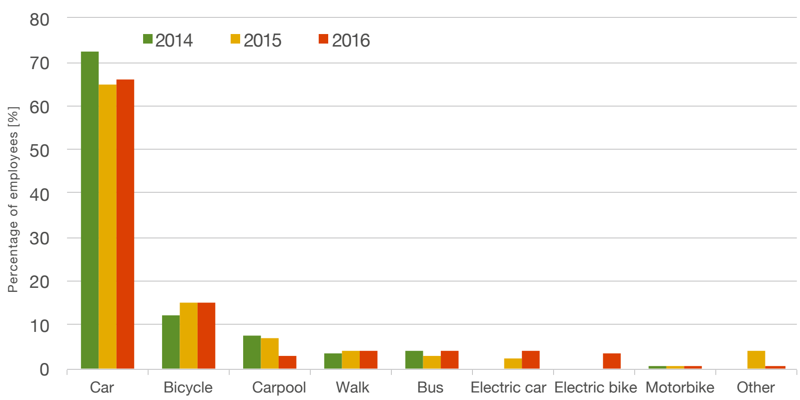


Figure 20. Results of survey on the travel habits of employees to and from work from 2013-2016. The response rate was 58% in 2013, 67% in 2014, 65% in 2015 and 61% in 2016.

Structures and maintenance

In 2016, the lots and structures of OR and its subsidiaries were successfully kept tidy. All notifications regarding their care were responded to. In 2016 visual impact and restoration guidelines were issued on how it is possible to reclaim localvegetation in urban areas.

OBJECTIVE:
To ensure all of the structures and lots of OR and its subsidaries are tidy and blend in harmoniously with their environment. To ensure that the design of structures and restoration of lots are in accordance with visual impact and restoration guidelines.

In 2016, the lots and structures of OR and its subsidiaries were successfully kept tidy. Generally the condition of structures and lots is assessed annually. Some 75 notifications regarding their care were received and they were all dealt with, but most of them concerned graffiti.

Work continued on clearing up lots at ON Power's plants in order to utilise local vegetation and minimise maintenance. In Hellisheidi, rangeland plants were collected in parallel with constructions and they were planted in beds by the power plant (Figure 21). Asphalt was also laid and container areas were tidied up. The mowing of grass was reduced by the Nesjavellir Geothermal Power Plant to reclaim local vegetation. Fences were taken down at Nesjavellir and in the Veitur Utilities area by Deildartunguhver in Borgarfjördur. New fences will be installed at the hot springs to improve people's view and safety in the area in the spring of 2017. In the summer of 2016, rangeland vegetation was used for restoring an area around a summer house owned by the Employees Association of OR in the highlands above Akureyri. The same kind of restoration is being envisaged for Veitur Utilities' new pumping station in Reykjanesbraut in Gardabær in 2017, in addition to other places where applicable. OR and its subsidiaries operate under the guiding principle of working well and minimising disruptions in their tasks both outside and inside the homes of their customers.

In 2016, visual impact and restoration guidelines were issued on how it is possible to reclaim local vegetation in urban areas to reduce the need for their care. They define which vegetation is best suited to these plots of land but also rooftops. Many constructors have shown an interest in the procedure of using local vegetation in the restoration of project sites and guidelines were published on the websites of ON Power in 2016.

Did you know?

In many towns across the Nordic region, it is obligatory to have vegetation on the rooftops of new buildings. The advantage is primarily that it improves the quality of the air, but it also supports the water cycle and enhancement of the environment.

Figure 21. Armeria maritima in lava bed. Photograph: Magnea Magnúsdóttir.

Use of substances

In 2016, awareness creation and improvements continued at most of the work places of the ORGroup regarding the storage, use and disposal of hazardous substances.

Did you know?

Every year guarantors examine the workplaces of the Reykjavik Energy GroupOR and its subsidaries to go over the hazardous substances that are used and ascertain whether they can be replaced with harmless substances.

OBJECTIVE:
To minimise the use of hazardous substances as much as possible and dispose of them responsibly. To facilitate access to information regarding harmless substances that can substitute hazardous ones.

Helstu varasömu efnin í notkun hjá OR og The main hazardous substances used by OR and its subsidiaries are asbestos, the base material used in insulation foam, chlorine, acids and bases, welding gases, geothermal gases such as hydrogen sulphide, oil and solvents. In 2016, awareness creation and improvements were promoted in most of the work places of the OR Group, e.g. in the storage of hazardous substances and how they are sorted and disposed of. The guidelines on procurement and the supervision of hazardous substances specify that that the selection of hazardous substances shall always aim to minimise any damage to human health and the environment. An emphasis is placed on establishing a dialogue and courses about hazardous substances.

In the autumn of 2016, meetings were held with the management and staff of Reykjavik EnergyOR and its subsidiaries to introduce preventive measures and first responses to pollution accidents. Procedures regarding the first responses of staff and service desks at Bæjarháls to chemical accidents were updated. Towards the end of 2016, workshops on hazardous substances were held for the staff of the Reykjavik Energy Group who work with these substances. More courses are planned to be held in 2017.

Reykjavik Energy and its subsidiaries do not emit any ozone-depleting substances in their activities.

The transport of various hazardous substances is covered in Table 7 and also Table 1 of the section on the conservation of potable water.

Four notifications were received from employees regarding hazardous substances in 2016, two of which concerned oil leaks or the risk of oil leakages. The substances did not spread in the environment. The relevant health authorities were contacted and remedies were made.

A new and labelled cabinet for acids was installed at the Veitur Utilities workplace in Bæjarháls in 2016. Photograph: Unnur Jónsdóttir.

QUANTITY OF HAZARDOUS SUBSTANCES TRANSPORTED

SITE	CATEGORY	UNIT	2015	2016
Nesjavellir Power Plant	Oil	Liters	2,028	0
Total oil		**Liters**	**2,028**	**0**
Hellisheidi Power Plant	Sludge	kg	16,000	41,000
Nesjavellir Power Plant	Sludge	kg	51,940	40,900
West Iceland	Sludge	kg	28,760	59,700
Total sludge		**kg**	**96,700**	**141,600**
Hellisheidi Power Plant	Chlorine	Liters	13,420	16,800
Nesjavellir Power Plant	Chlorine	Liters	9,680	2,000
Total chlorine		**Liters**	**23,100**	**18,800**
West Iceland	Asbestos	kg	18,260	297,780
Total asbestos		**kg**	**18,260**	**297,780**

Table 7. The quantity of asbestos that was moved for landfilling in Fíflholt in West Iceland and sludge by Veitur Utilities and the quantity of fuel, chlorine and sludge that was moved by ON Power in the Hengill area.

Other environmental factors

In 2016 goals were achieved on minimal flow below the Andakílsá Hydropower Station and water level fluctuations in Lake Skorradalsvatn. Increased natural radioactivity was measured on scale formations at the Hellisheidi Geothermal Power Plant. These are small in quantity and ON Power has applied for the appropriate permit for the temporary storage of the scale formations for up to three years, after which it will be possible to dispose of them in the traditional manner.

Noise
In 2016, Veitur Utilities worked on improving the noise issue at the supply station at Hnodraholt in Kópavogur. The task is financed by the municipality of Kópavogur, since Veitur Utilities had warned at the planning stage that residential areas would be closer to the station than the initial plan had envisaged. Work was conducted on mapping and improving a noise issue at a supply station in Meistaravellir in Reykjavik and the task is expected to be completed in 2017. In 2016, some modifications were made to the cooling equipment of the Reykjavik Fibre Network in the transformer plants of Veitur Utilities, which had in many cases caused disturbances.

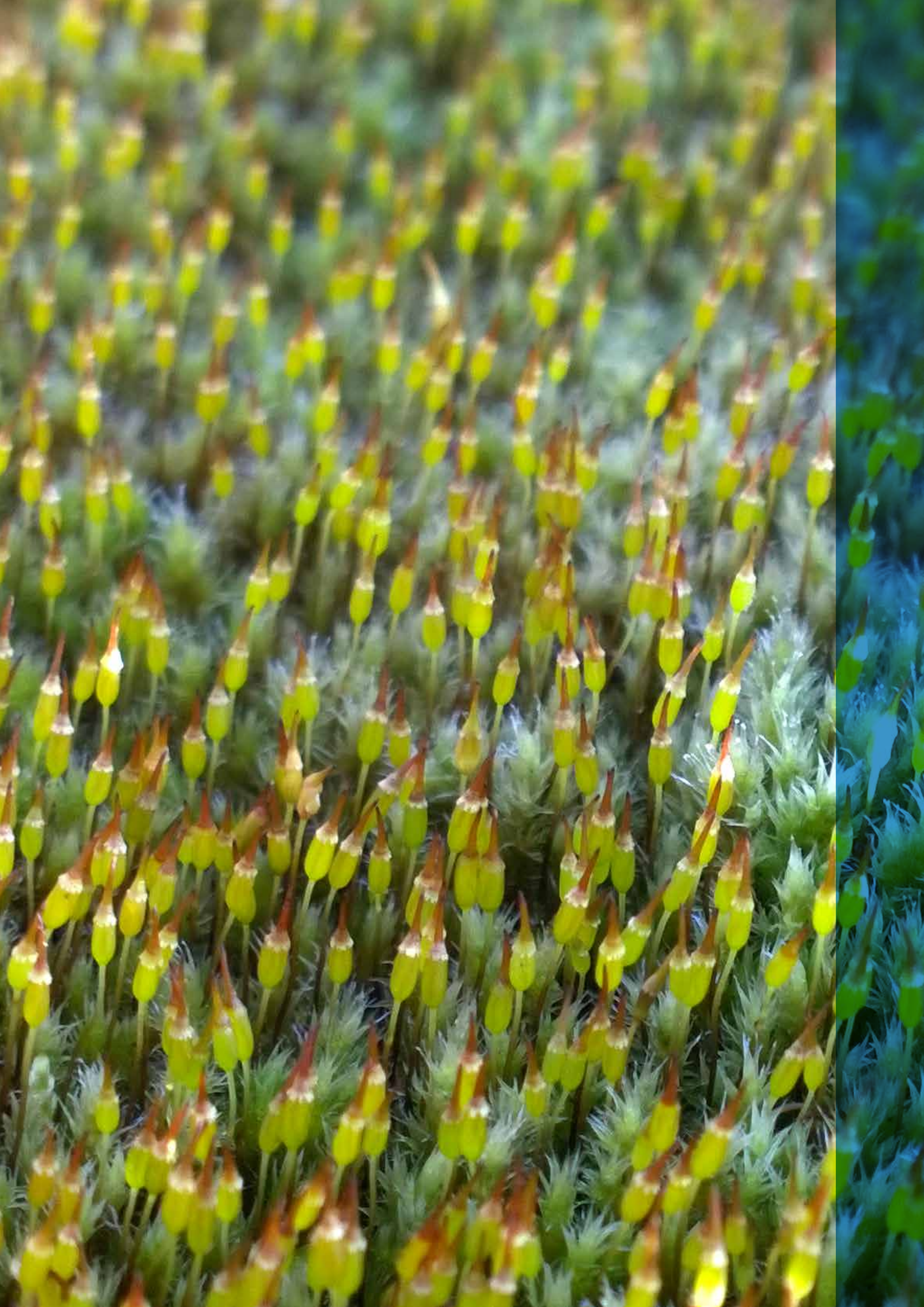
Hydroelectric power
In 2016 the goal of keeping the flow below the Andakílsá Hydropower Station within limits to ensure it is no less than 2 m3/s was achieved to safeguard the river's ecosystem and salmon. Apart from a few days between October and December, water level fluctuation targets in Lake Skorradalsvatn were met and within the limits, which are 1.08 m in normal operations in the winter and 0.4 m in the summer, despite heavy precipitation in the autumn of 2016 (Annex 29).

Radiation measurements
The Icelandic Radiation Safety Authority worked on evaluating the concentration of natural radioactivity from scale formations in geothermal power plants in Iceland in, among other places, Nesjavellir and Hellisheidi. The concentration is low and the maximum potential radiation due to the management of a so-called mist eliminator with these scale formations is far below the limit which workers can be exposed to, according the regulations (1 mSv per year). Since there is an increase in natural radioactivity in the scale formations, ON Power has applied for a permit to store mist eliminators with radioactive scale formations for three years or until their radioactivity has been broken down. After that time, they will be cleaned and the scale formations will be disposed of in the traditional manner.

Did you know?

Natural radioactivity occurs everywhere in the environment. It is formed by cosmic rays at high altitudes or can be attributable to radioactive materials in rocks and soil. Icelandic rock is alkaline and low in radioactive materials.

Working on a hot water utility in Hveragerdi. Photograph: Gretar Ívarsson.



Production, own use and carbon footprint

Veitur Utilities supplies pure potable water and hot water for space heating and channels drainage and rainwater out to sea. Moreover, ON Power 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 at the Andakílsá Hydropower Station. OR and its subsidaries uses hot and cold water at its worksites. Its own use of electricity is solely for the treatment of hot water, the pumping of sewage, hot and cold water and the operation of premises. Greenhouse gas emissions from the activities of OR and its subsidaries account for 0.9% of total emissions in Iceland.

Production and own use

In 2016, Veitur Utilities and ON Power's production of electricity, potable water and hot water for space heating and electricity to households and businesses was similar to what it was in 2015. ON Power, Reykjavik Fibre Network and the ORGroup's own use of electricity increased in 2016, but their use of hot and cold water contracted. Veitur Utilities' own use of electricity and cold water contracted in electricity and cold water, but its use of hot water increased.

Total production
In 2016, OR Group's output of hot water was over 84 million m^3 and approximately 28 million m^3 of cold water (Table 8). Of the over 84 million m^3 of hot water produced, nearly 36 million m^3 was cold water, which was heated in ON Power's plants in the Hengill area, but the rest was geothermal water from the low-temperature areas. ON Power's electricity production with geothermal steam was approximately 3.4 million MWh. On the other hand, more than 1 million MWh were produced in Nesjavellir and about 2.4 million MWh in Hellisheidi. About 31 thousand MWh of the electricity was produced in the Andakílsá Hydropower Station.

Own use
Th OR Group's own use of hot and cold water and electricity contracted (Table 9). Own use of electricity is solely for treatment of hot water, the pumping of sewage, hot and cold water, and the operation of premises.

The percentage of ON Power's own use of electricity in relation to the volume it produced in 2016 was 7% and has been similar over the past two years. 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. Own use of cold water is almost exclusively for ON Power's geothermal power plants in the Hengill area. Over 72 million m^3 of cold water were pumped up there in 2016. Of these almost 36 million m^3 were utilised for heat production in, among other things, space heating in the greater Reykjavik area, and about 36 million m^3 were utilised for the power plants' operations and cooling of equipment, i.e. about 50%.

The percentage of Veitur Utilities' own use of hot water is very low in relation to the volume produced. Veitur Utilities' own use of electricity and cold water has contracted since 2015, but its use of hot water has increased. Reykjavik Fibre Network's own use of electricity has increased and OR's own use of cold water has decreased. OR and its subsidaries took no specific measures to reduce energy consumption in 2016.

Did you know?

Of the approximately 23 million tons of potable water that were produced in Heidmörk in 2016, 60% went to households and 40% to business activities.

TOTAL PRODUCTION

		ON POWER	VEITUR UTILITIES	ON POWER	VEITUR UTILITIES	ON POWER	VEITUR UTILITIES
	UNIT	2014		2015		2016	
Hot water	m^3	34,920,000	43,791,000	38,042,194	48,956,870	35,893	48,455
Cold water	m^3		26,976,788		26,914,174		27,803
Electricity from Hellisheidi Geothermal Power Plant	MWst	2,388,344		2,227,374		2,366,830	
Electricity from Nesjavellir Geothermal Power Plant	MWst	1,028,335		983,997		1,013,430	
Electricity from Andakílsá Hydro Power Plant	MWst	26,752		37,883		30,850	

Table 8. Total production of OR and its subsidaries 2014-2016. ON refers to ON Power.

OWN USE

			ON POWER	OR	ON POWER	VEITUR UTILITIES	GR	OR	ON POWER	VEITUR UTILITIES	GR	OR
	UNIT	2013	2014		2015				2016			
Electricity	MWh	295,451	231,824	52,456	232,760 *	74,228	815	2,940	244,814	70,436	1,159	3,274
Hot water	m^3	552,023	339,646	306,238	395,219	52,600		289,245	267,271	56,101		267,812
Cold water	m^3	75,399,668	80,852,000	78,873	78,849,438	27,526	4,909	83,922	72,228,010	15,060	4,495	39,969

* Data were not received from Andakílsá hydroelectric power plant in May and June. The missing power is estimated at 30-40 MWh.

Table 9. Own use of the OR Group 2014-2016. ON refers to ON Power, GR to Reykjavik Fibre Network (Gagnaveita Reykjavíkur) and OR to the mother company.

Carbon footprint of OR and its subsidiaries

The net greenhouse gas emissions from the operations of OR and its subsidiaries in 2016 amounted to approximately 40 thousand tons of CO_2 equivalents, i.e. about 0.9% of total emissions in Iceland.

Did you know?

Land use such as land reclamation and forestration sequester carbon and the reclamation of wetlands significantly reduces its emissions.

2016 yet another record year of heat
Measurements reveal that in 2016 the earth's temperature was 1.2°C higher than when the Industrial Revolution began and higher than the temperature in 2015, which broke all records. The Arctic is warming at a rate of almost twice the global average. Reactions to these changes in temperature mostly manifest themselves in the oceans.

The Paris Framework Convention on Climate Change came into force globally in November 2016, and Iceland was among the first 55 countries to sign it. Iceland aims to reduce greenhouse gas emissions by 40% by 2030, in relation to 1990, in collaboration with the member states of the EU and Norway. Iceland has enjoyed a positive image thanks to its high percentage of renewable energy, but discharges per capita are still high. In Iceland the discharge per inhabitant is 14 tons, compared to 7 tons per inhabitant in the EU and 5 tons per inhabitant worldwide.

Climate change objectives of OR and its subsidaries until 2030
The consequences of climate change will probably be greater than we can imagine. It is clear that changes in precipitation and temperatures will have an impact on all utility systems and rising sea levels will have an effect on sewerage systems.

In 2016, OR and its subsidiaries set themselves the goal of reducing carbon dioxide emissions in the group's energy production and activities. The climate change objective is to halve OR Group's carbon footprint by 2030 and the baseline year is 2015. The contraction in geothermal gas emissions in the energy production of ON Power in high-temperature geothermal areas weighs the heaviest in the companies' operations. With the increase in climate-friendly vehicles, and by encouraging employees to choose more climate-friendly ways of travelling to and from work, the emissions they produce will be reduced by 70-90% by 2030. Measures will include increasing the percentage of recycled waste, the reclamation of wetlands by filling ditches in OR's land property, and the reduction of food waste (Figure 22). The measures of OR and its subsidiaries are in accordance with the climate change declaration made by the City of Reykjavík and Festa Centre for Corporate Social Responsibility, which was signed by the companies and submitted to the United Nations Climate Change Conference in Paris in December 2015.

The projects that have been launched to reduce greenhouse gas emissions are:

- Increasing drilling powered by electricity rather than diesel oil.
- A climate-friendly car fleet and development of a network of rapid charging stations.
- Reducing waste from the construction and maintenance of utility systems.
- Increase staff's use of climate-friendly transport.
- Less food waste.
- Reduce emissions by converting geothermal gases into rock.
- Reclamation of wetlands.

The 2017 Environmental Report will analyse the results of the projects conducted to reduce greenhouse gas emissions.

Figure 22. The climate change objectives of OR and its subsidiaries until 2030.

Discharge, sequestration and utilisation of greenhouse gases
The method OR and its subsidiaries use to assess greenhouse gas emissions is based on the "GHG Protocol", see www.ghgprotocol.org

Direct greenhouse gas emissions from the activities of OR and its subsidiaries (scope 1) are classified under:

- Geothermal power production in high-temperature fields.
- Power production in low-temperature fields.
- Supply and distribution system.
- Transport

The indirect greenhouse gas emissions of OR and its subsidiaries (scope 3) are classified under:

- Transport to and from work and airtravel by staff.
- Waste for landfilling.
- Organic waste for compost.

Sequestration and utilisation which offset greenhouse gas emissions from the activities of OR and its subsidiaries is classified under:

- Land reclamation.
- Forestation.
- Reclamation of wetlands.
- Sequestration of carbon dioxide in rock.
- Carbon dioxide utilization in geothermal power plants.

In 2016, wetlands were reclaimed on OR's land and the results are still awaited. Preparations have begun for the utilization of carbon dioxide at geothermal power plants and the results are expected in two years' time.

Data on greenhouse gas emissions due to the OR Group's operations between 2012-2016 is to be found in Annex 30 and CO_2 sequestration in Annex 31.

CARBON FOOTPRINT

	2012	2013	2014	2015	2016
	CO_2-equivalents (tonnes)	CO_2-equivalents (tonnes)	CO_2-equivalents (tonnes)	CO_2-equivalents (tonnes)	CO_2-equivalents (tonnes)
Emissions from ON Power's Geothermal Power Plants					
Nesjavellir Geothermal Power Plant	19,396	16,088	18,076	16,770	15,873
Hellisheidi Geothermal Power Plant	44,586	46,950	43,505	39,216	34,088
Steam from Hverahlíð	0	0	0	0	0
Sulfur hexafluoride (SF_6) for tracer flow testing (TFT) in the Hengill area	-	-	0,4	1	2
Sulfur hexafluoride (SF_6) at Nesjavellir	0	12	0	0	0
Sulfur hexafluoride (SF_6) at Hellisheidi	12	0	12	0	6
Veitur's low-temperature heating utilities					
Low-temperature geothermal areas*	0	0	0	0	0
Emissions from Veitur's supply and distribution system					
Backup power (fixed and mobile stations)	75	5	25	5	2
Construction and maintenance of utility systems**					
Sulfur hexafluoride (SF_6)	0	0	0	0	0
Tetrafluorethane (HFC-134a)	7	7	7	20	20
OR and subsidiaries' transportation					
Vehicles (own and leased)	570	528	498	601	551
Employees commuting to and from work***	-	84	86	82	91
Flights, international and domestic	27	50	62	70	64
OR and subsidiaries' landfill waste emissions					
Office/Stationary waste	33	31	31	32	33
Úrgangur frá starfsstöðvum	823	693	782	441	629
OR and subsidiaries' emissions from organic waste for compost					
Organic waste for compost	3	4	5	5	4
OR and subsidiaries' total greenhouse gas emissions	**65,532**	**64,452**	**63,088**	**57,243**	**51,362**
Carbon sequestration					
Land reclamation	-1,086	-1,110	-1,149	-1,202	-1,249
Forestation	-3,626	-3,626	-3,626	-3,626	-3,626
Reclamation of wetlands**					
Carbon mineralization in basaltic bedrock (Carbfix project)	-110	-3	-2,381	-3,911	-6,644
Utilization of carbon dioxide at geothermal power plants**					
Carbon footprint of OR and its subsidiaries	**61,796**	**60,823**	**57,081**	**49,706**	**39,843**

OR Group's net greenhouse gas emissions rate as a precentage of total emissions from Iceland, information retrieved at: https://www.ust.is/einstaklingar/loftslagsbreytingar/losun-islands/
Estimated net greenhouse gas emissions from Iceland 2014: 4,597 Gg in CO_2-equivalence
Information for global warming potential (GWP) of greenhouse gasses, see: https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf
* Emissons for low-temperature geothermal fields are close to zero.
** Projects for reducing greenhouse gas emissions. Preliminary results will be presented in Environmental reports for either 2017 or 2018.
*** Assuming 250 working days a year and that employees' own cars emit about the same as a Toyota Yaris, approx. 91 g CO_2/km. Information not available for 2012.

Table 10. Carbon footprint of the OR Group 2012-2016.

Carbon footprint

The carbon footprint is a measure showing the effect of greenhouse gas emissions caused by human activity in warming the atmosphere. The unit of measure for the carbon footprint is kg or tons of CO_2 equivalents. The global warming effect of different greenhouse gases is converted into equivalents of CO_2 by using greenhouse gas coefficients issued by the Intergovernmental Panel on Climate Change, IPPC (Annex 32) and calculations are furthermore based on coefficents for emission and sequestration (Annex 33).

Greenhouse gas emissions from the activities of OR and its subsidiaries were 51,362 tons of CO_2 equivalents. Of these emissions, some 97% were from ON Power, 2% from Veitur Utilities, 0.3% from the Reykjavik Fibre Network and 0.7% from OR. ON Power's share is mainly the emissions from its geothermal power plants in the Hengill area (Figure 23).

The carbon footprint of OR and its subsidaries shows annual greenhouse gas emissions, calculated in CO_2 equivalents, from the operations of the company minus the carbon sequestration due to land reclamation, forestation and reinjection into the basaltic bedrock (Annex 31). Table 10 shows the carbon footprint of the OR Group for 2016 in comparison with 2012 to 2015.

On the basis of all the operations of OR and its subsidaries in 2016 the total emission of greenhouse gases amounted to 51,362 tons CO_2 equivalents. Taking into consideration the carbon sequestration achieved by the company through land reclamation, forestration and reinjection into the basaltic bedrock, amounting to 11,519 tons CO_2 equivalents, net greenhouse gas emissions from operations in 2016 amounted to 39,843 tons CO_2 equivalents, representing an approximate 20% contraction between years. Greenhouse gas emissions from the operations of he OR Group make up 0.9% of total emissions in Iceland on the basis of the total emissions recorded in 2014 (Environment Agency of Iceland, 2016).

CARBON EMISSIONS AND CARBON SEQUESTRATION

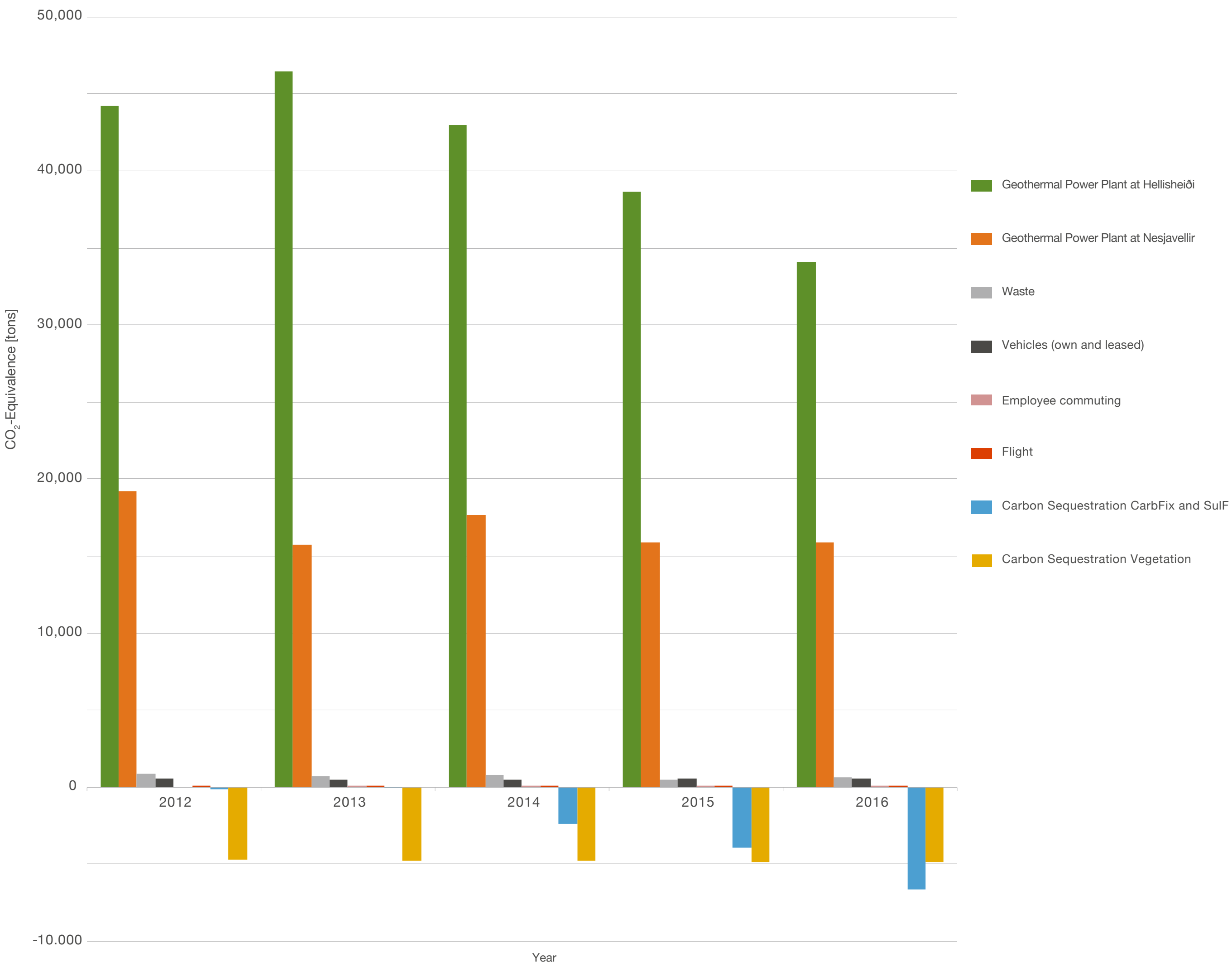


Figure 23. Carbon emission and sequestration of OR and its subsidiaries 2012-2016.

Statement by OR's Board of Directors

To the best knowledge of the Board of Directors of Orkuveita Reykjavíkur (OR), the 2016 Environmental Report complies with the provisions of Regulation no. 851/2002 on Green Accounting. The Environmental Report discusses the aspects of OR and subsidiaries' operations that have an impact on the environment, and how environmental issues are addressed in operations.

It is the opinion of the Board of Directors that the figures and information specified in the Environmental Report compiled by OR and its subsidiaries, and which come from their accounts, give a good picture of the trends and results achieved in its environmental affairs.

The Board of Directors of Orkuveita Reykjavíkur hereby endorses the Environmental Report 2016.

Reykjavík, 20 February 2017

Board of Directors:

Brynhildur Davíðsdóttir
chairman

Gylfi Magnússon
vice-chairman

Áslaug Friðriksdóttir

Kjartan Magnússon

Sigríður Rut Júlíusdóttir

Valdís Eyjólfsdóttir

Indipendent Auditors' Report

I have reviewed the calculations and information presented in the 2016 Environmental Report of Reykjavik Energy (OR) and its subsidiaries. The Environmental Report is presented by the management of OR and subsidiaries and under 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 the stipulations of Regulations no. 851/2002 on Green Accounting. It entails analytical procedures, spot checks and the examination of data to verify information in the Environmental Report. The audit also entails checking calculations applied in assessing the scale and importance of particular factors listed in the Environmental Report.

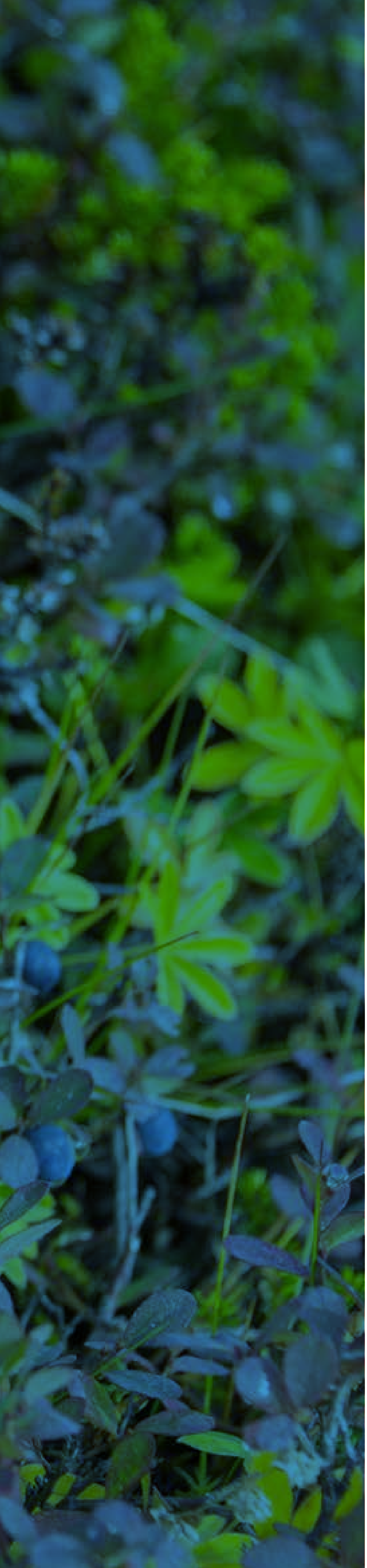
I believe that the audit is a sufficiently reliable basis on which to base my opinion.

In my opinion, the Environmental Report gives a true and fair view of the environmental impact of operations in 2016, in accordance with sound and recognized practices in this sector.

Reykjavik, 14 February 2017

VSO Consulting

Guðjón Jónsson
Chemical Engineer

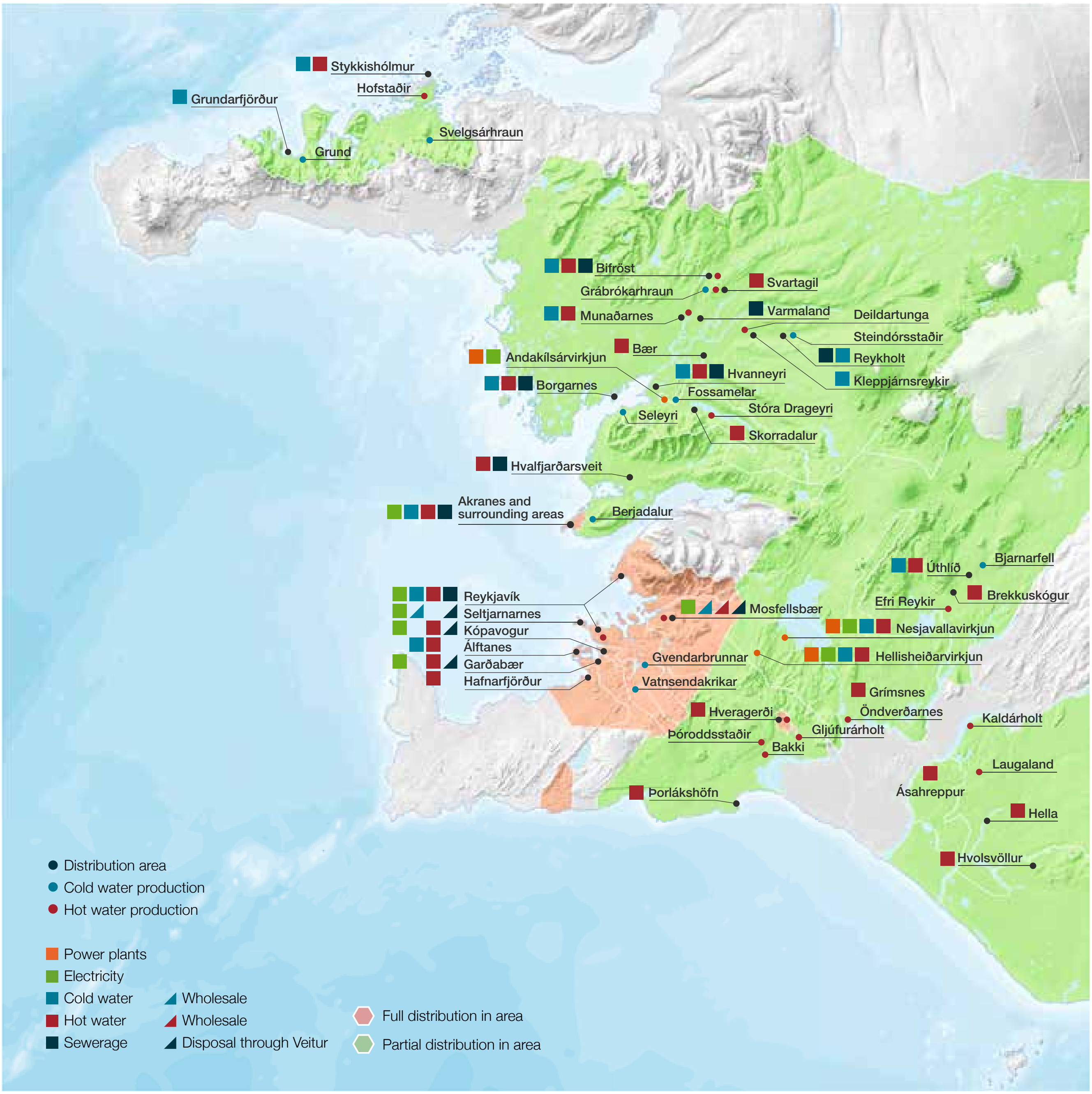


Annexes

Annexes

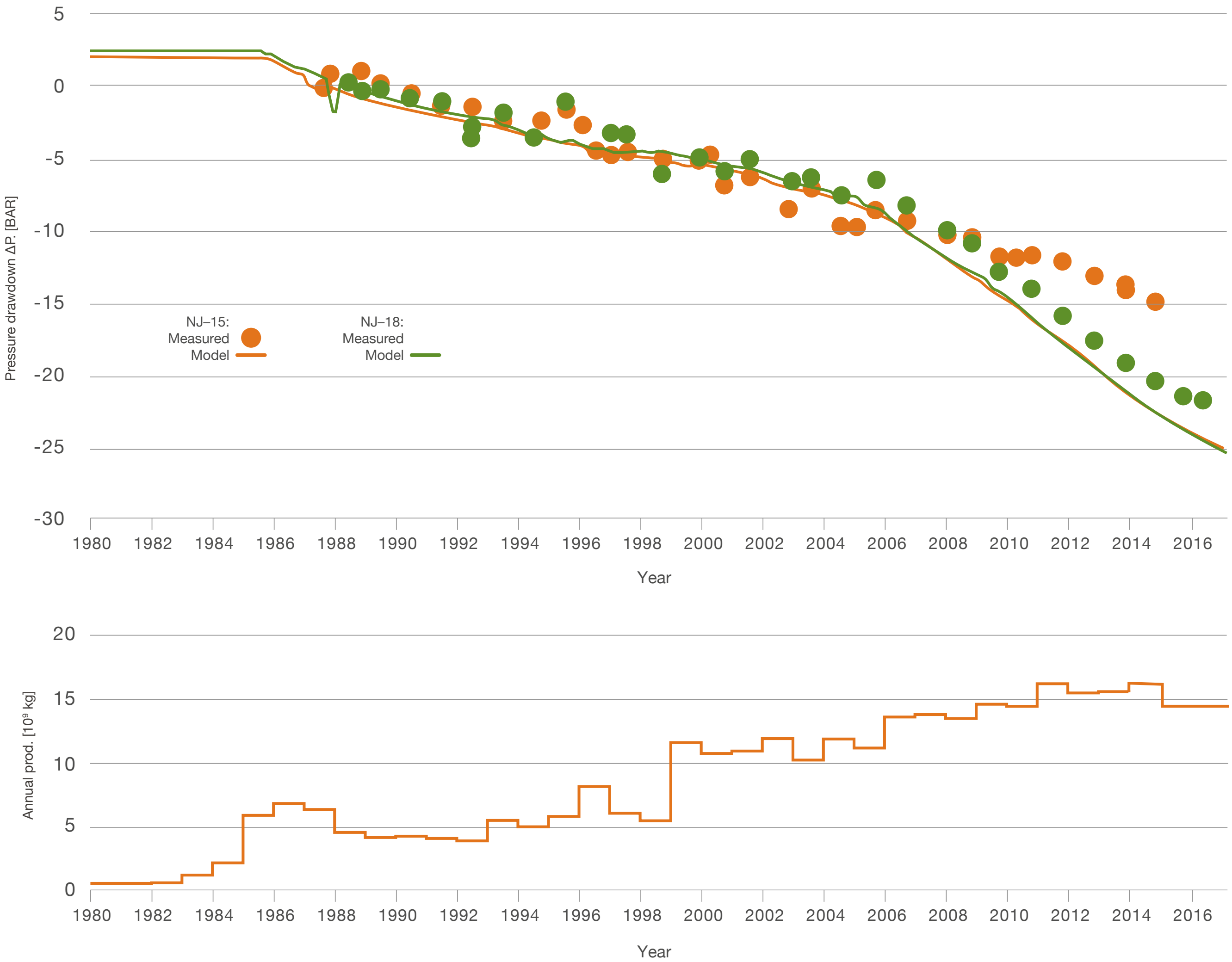
Annex 1. **OR and subsidiaries' main area of operation**

Our service area is primarily in the capital but also in many parts of the South and West Iceland. Our system is extensive; pipes and cables are a total of 9,000 km in length, corresponding to the distance from Reykjavik to Shanghai. In the capital area there are distribution stations, wells, well shelters, tanks, pumping stations, sewage treatment plants etc. in our care.

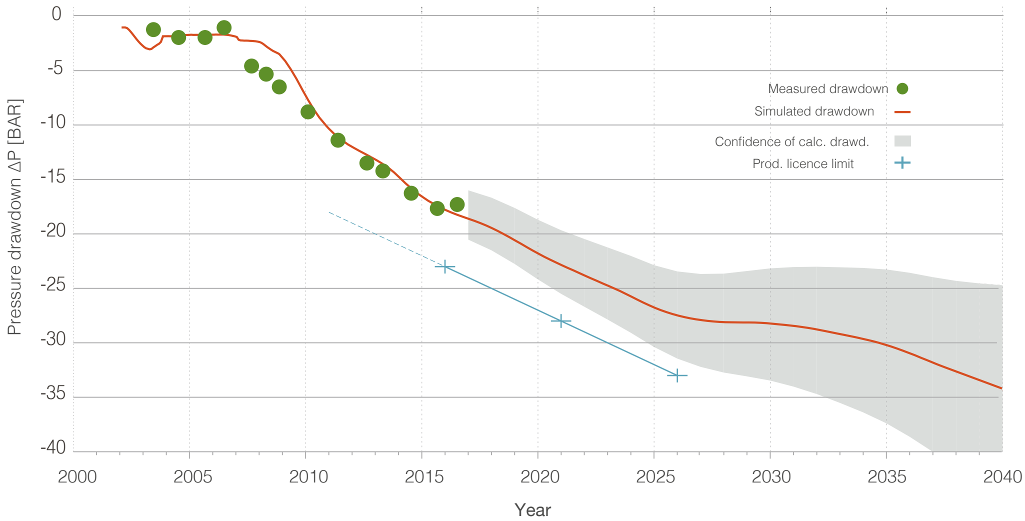


Annex 2. **Drawdown 1980-2016**

2a). Drawdown (bar) and average annual production (kg/s) in Nesjavellir 1980-2015. A comparison between the measured and calculated drawdown appears in the upper part of the figure and the annual average production in the lower part. Solid curves show simulated results, while dots show measured values in wells at a depth of 800-1000 m. The green curve shows the drawdown in well NJ-18 and the orange curve in well NJ-15. The NJ-15 well came into operation in 2015 and was therefore not measured.



2b). Drawdown in Hellisheidi. Comparison of the measured and estimated pressure drop, the so-called drawdown (bar), in well HE-4 in Hellisheidi 2000-2040. The crosses are limits according to the power plant licence. A line is drawn between the crosses, but the points are drawn according to 2011 when the licence entered into force. The confidence of the simulated pressure drawdown are shown in grey.



Annex 3. **Chemical analyses of hot water in the capital area 2016**

CHEMICAL ANALYSES OF HOT WATER IN THE CAPITAL AREA 2016

	UNIT	LAUGARNES RV-5	ELLIÐAÁR RV-23	REYKIR MG-25	REYKJAHLÍÐ MG-39	NESJAVELLIR Heated water	HELLISHEIÐI Heated water
DATE		**06/01/2016**	**06/01/2016**	**08/01/2016**	**15/01/2016**	**03/08/2016**	**03/08/2016**
SAMPLE NO.		**16-5005**	**16-5001**	**16-5018**	**16-5024**	**16-5223**	**16-5224**
Water temp.	°C	128.5	88.1	90.6	92.2	80	80
pH		9.42	9.43	9.62	9.7	8.38	7.77
pH-temp.	°C	22.9	25	22.7	22.1	15.8	-
Conductivity	μS/cm	362	240	218	275	192	90.1
Conduct. temp.	°C	22.4	22.5	22.7	22.1	22.5	22.5
CO_2	mg/kg	17.4	27.6	24.5	25.8	42.6	23.9
H_2S	mg/kg	0.57	0.01	0.68	1.19	0.44	0.22
SiO_2	mg/kg	142.3	80.7	94.4	97.0	45.4	24.0
Na	mg/kg	71.8	46.8	45.9	48.4	18.6	6.9
K	mg/kg	2.95	1.23	0.91	1.10	-	-
Ca	mg/kg	3.85	3.11	2.44	2.10	8.89	5.55
Mg	mg/kg	<0.005	0.0120	<0.005	<0.005	4.37	2.95
Fe	mg/kg	0.086	0.0564	<0.005	0.0216	<0.05	<0.05
Al	mg/kg	0.1888	0.1255	0.1563	0.1828	0.24	0.1
Li	mg/kg	-	-	-	-	-	-
Cl	mg/kg	54.1	25.3	15.9	14.4	16.0	7.4
SO_4	mg/kg	26.3	13.7	14.7	14.9	13.0	3.2
F	mg/kg	0.817	0.340	0.603	0.570	0.020	0.020
B	mg/kg	0.070	0.024	0.043	0.044	0.130	<0.1
Dissolved O_2	μg/kg	0	300	0	0	0	0

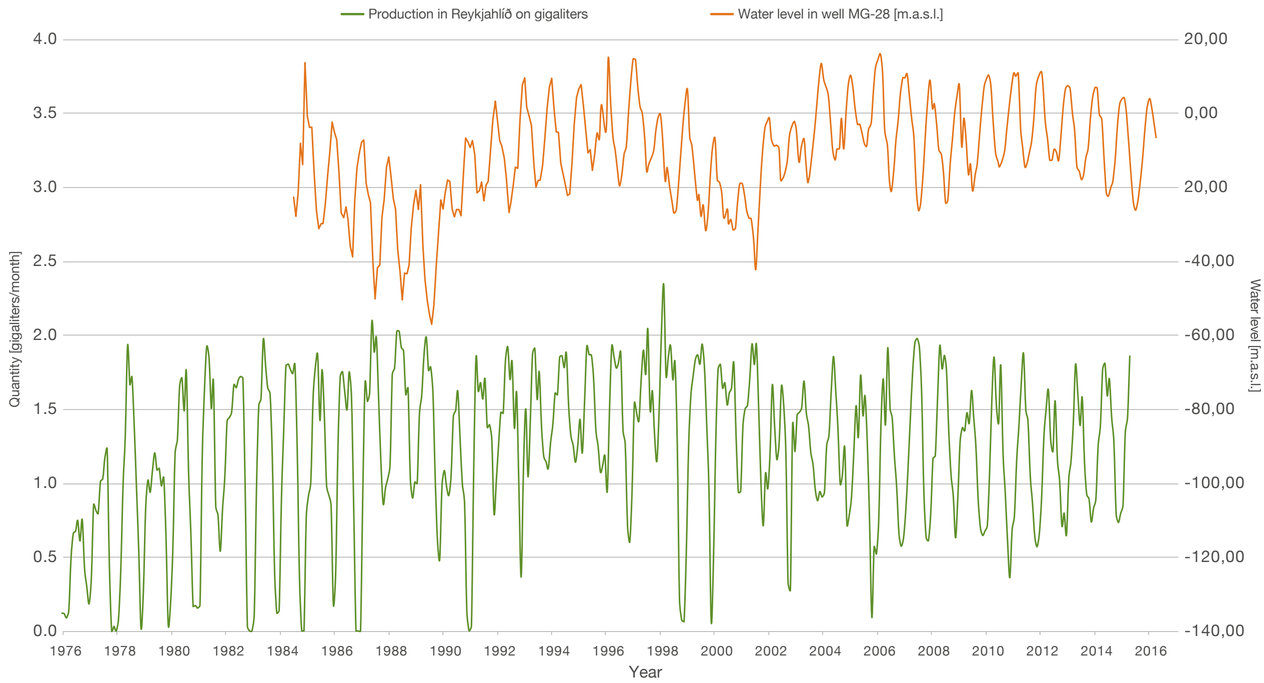
Annex 4. Chemical analyses of hot water in South and West Iceland 2016

CHEMICAL ANALYSES OF HOT WATER IN SOUTH AND WEST ICELAND

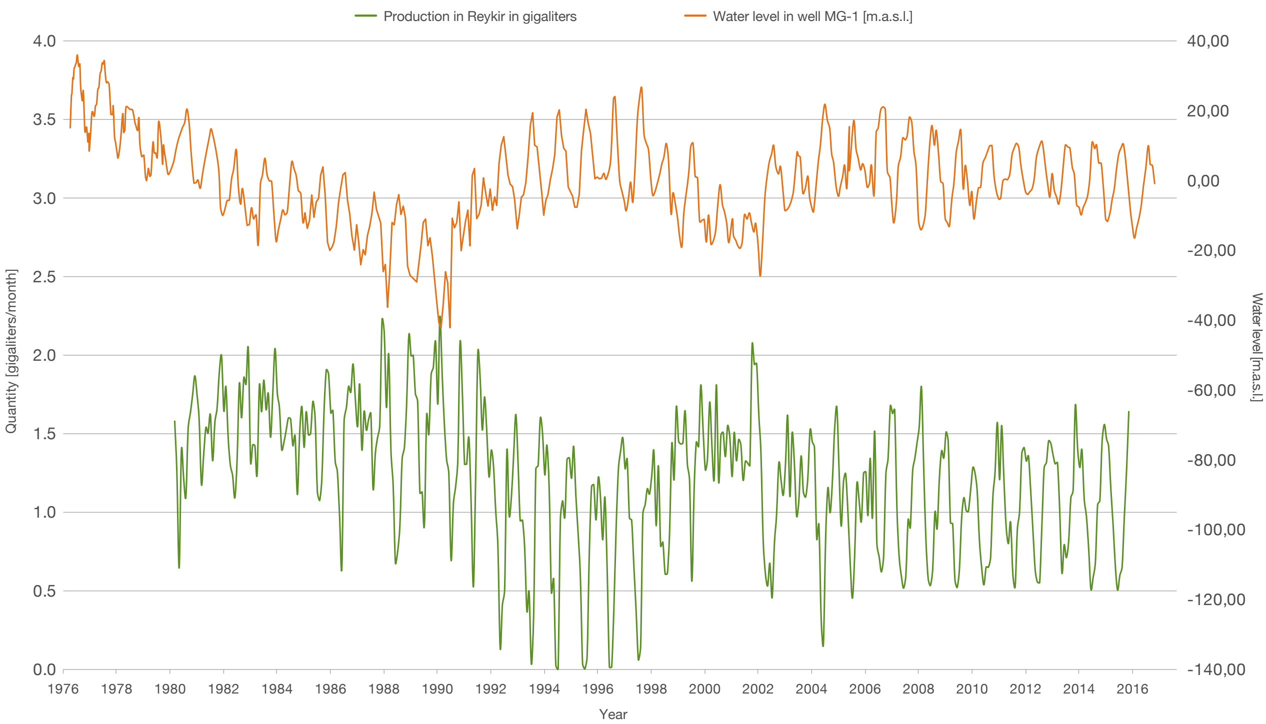
	UNIT	HITAVEITA AKRANESS OG BORGARFJARÐAR		RANGÁ UTILITY		ÞORLÁKS-HÖFN UTILITY	ÖLFUS UTILITY	AUSTUR-VEITA	GRÍMSNES UTILITY	HLÍÐ UTILITY	MUNAÐAR-NES	NORÐURÁRDALUR UTILITY		STYKKIS-HÓLMUR UTILITY
SAMPLE SITE		**Deildar-tunguhver**	**LH-1**	**KH-37**	**LW-4**	**BA-01**	**EB-01**	**GH-4**	**HÖ-29**	**ER-23**	**MN-8**	**SG-3**	**BI-3**	**HO-1**
DATE		**09/02/2016**	**09/02/2016**	**25/01/2016**	**25/01/2016**	**08/02/2016**	**08/02/2016**	**25/01/2016**	**08/02/2016**	**08/02/2016**	**09/02/2016**	**09/02/2016**	**09/02/2016**	**14/01/2016**
SAMPLE NO.		**16-5072**	**16-5073**	**16-5033**	**16-5031**	**16-5067**	**16-5066**	**16-5036**	**16-5065**	**16-5063**	**16-5069**	**16-5070**	**16-5071**	**16-5023**
Water temp.	°C	92.6	88.4	65.8	97.2	131.3	119.0	115.1	78.5	96.3	88.1	68.3	66.7	85.5
pH		9.45	9.19	10.33	9.80	8.89	8.82	8.86	9.45	9.51	9.36	8.88	9.05	8.32
pH-temp.	°C	22.1	22.2	22.4	22.3	21.8	22.0	22.3	21.8	21.4	22.1	22.1	22.3	20.5
Conductivity	µS/cm	393	652	341	478	2,390	1,685	647	704	521	504	383	354	9,350
Conduct. temp.	°C	21.8	21.8	21.8	21.8	21.3	21.1	21.8	21.2	21.5	21.9	21.8	21.8	22.3
CO_2	mg/kg	26.6	14.2	13.3	21.0	6.4	9.9	43.5	16.3	23.9	15.7	81.6	61.1	6.8
H_2S	mg/kg	1.19	0.79	0.16	0.13	0.51	0.66	0.21	0.10	3.34	0.40	0.04	0.07	0.04
SiO_2	mg/kg	133.5	116.5	88.7	97.7	131.3	119.0	138.0	83.0	231.4	113.6	102.9	91.4	67.7
Na	mg/kg	77.8	110.5	65.5	92.0	371.8	280.7	120.4	134.1	106.3	88.1	76.0	70.2	677.1
K	mg/kg	2.23	2.56	0.69	1.79	16.71	11.76	3.70	3.45	5.69	2.22	1.27	1.11	13.87
Ca	mg/kg	3.02	13.46	2.80	3.04	42.29	40.91	4.44	7.95	1.91	6.90	3.42	2.86	46.78
Mg	mg/kg	<0.005	<0.005	<0.005	<0.005	0.0100	0.0060	<0.005	0.0068	<0.005	<0.005	0.0120	0.0060	0.4720
Fe	mg/kg	0.0066	0.007	0.0614	0.0239	0.0066	0.0096	0.0472	0.0162	0.0117	0.0231	0.0073	<0.005	0.0236
Al	mg/kg	0.129	0.021	0.127	0.216	0.061	0.071	0.145	0.059	0.449	0.053	0.018	0.020	<0.0075
Li	mg/kg	-	-	-	-	-	-	-	-	-	-	-	-	-
Cl	mg/kg	33.58	110.5	23.7	44.3	610.5	412.4	107.8	132.3	55.3	70.9	25.3	27.0	2751.1
SO_4	mg/kg	52.2	71.1	20.8	64.6	114.9	122.7	51.2	50.2	54.5	55.2	29.3	31.6	328.1
F	mg/kg	2.4453	1.8883	2.202	1.5726	0.23	0.3847	0.8435	0.5501	2.4739	1.6914	0.3267	0.3942	1.0722
B	mg/kg	0.2566	0.2242	0.1293	0.2529	0.2476	0.2451	0.3048	0.1197	0.1855	0.2223	0.1997	0.2298	0.0911
Dissolved O_2	µg/kg	0	0	0	0	12	0	0	0	0	0	0	0	0

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

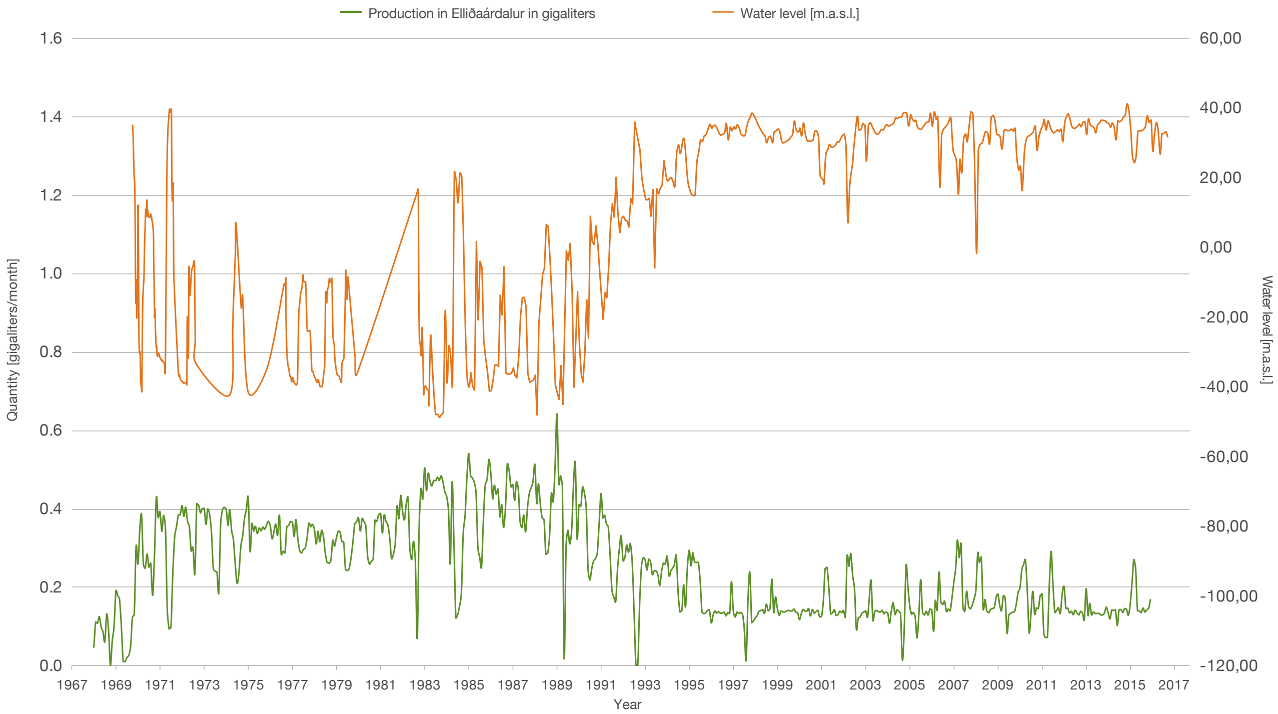
5a) Low-temperature geothermal fields in Reykjahlíd in Mosfellsbaer. Water production and water level in well MG-28 between 1976- 2016.



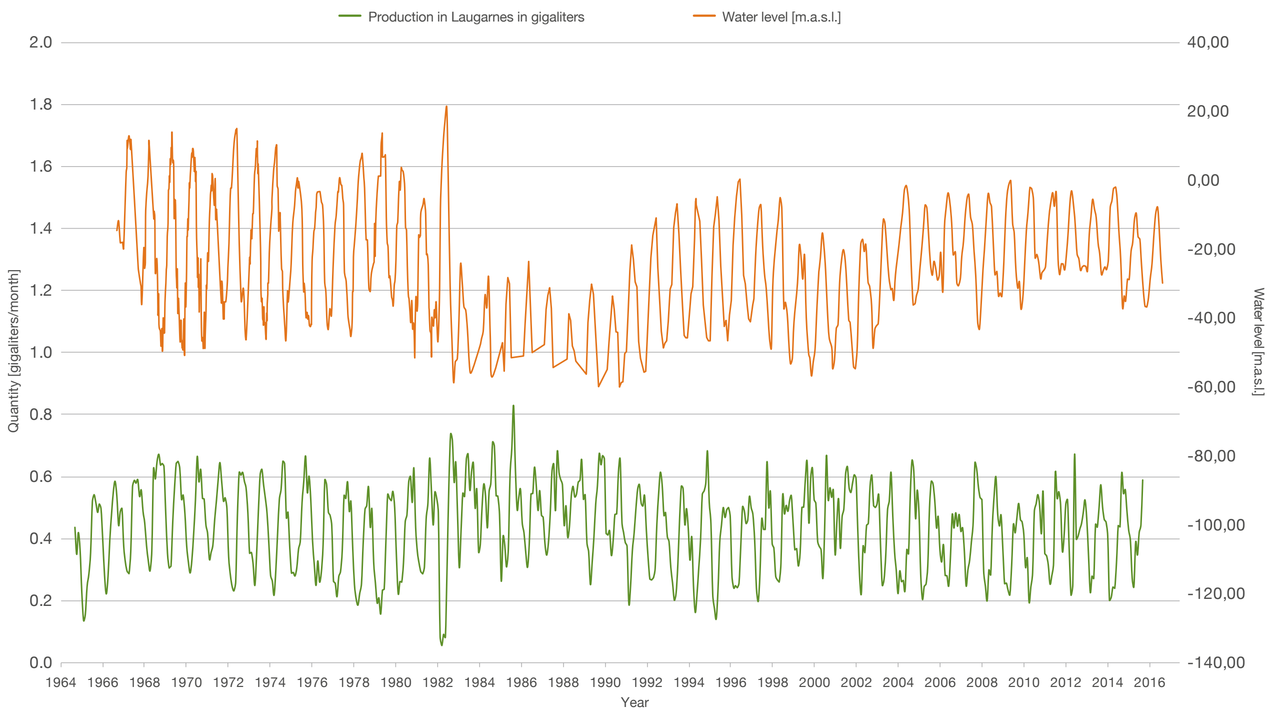
5b) Low-temperature geothermal fields in Reykir in Mosfellsbaer. Water production and water level in well MG-1 between 1976-2016.



5c) Low-temperature geothermal fields in the Ellidaárdalur valley in Reykjavik. Water production and water level in well RG-27 between 1968- 2016.



5d) Low-temperature geothermal fields in Laugarnes in Reykjavik. Water production and water level in well RG-7 between 1965-2016.



Annex 6. **Location and name of land owned, rented or administered by OR and its subsidiaries in protected areas**

OR and its subsidiaries administer about 19,000 ha of land, some 16,000 ha of which are within protected areas. These include water conservation areas, protected characteristics in regional, municipal and local plans, protected areas around Lake Thingvallavatn, areas covered by the natural features' data base etc.

AREA	NAME OF PLACE	WATER CONSERVATION	PROTECTED ARCHAEOLOGICAL SITES	NATURAL FEATURES DATA BASE	PROTECTED CHARACTERISTICS IN REGIONAL, MUNICIPAL AND LOCAL PLANS
Capital area	Bláfjöll - Heidmörk etc.	Water conservation areas.			Sudurá: Wetland, abundant birdlife. Hólmshraun: Lavafields covered with moss.
	Heidmörk	Water conservation areas in Gvenndarbrunnar, Myllulaekur and Vatnsendakrikar.	Thingnes: Archaeological remains at an ancient gathering site. Raudhólar: Protected as naturepark 1974. Size 45 ha.	Myllulaekjartjörn in Heidmörk	Bugda and Raudhólar: Wetland, abundant birdlife. Raudhólar: Protected naturepark. Rootless cones in lava approx. 4500 years old. Bugda wetland, abundant vegetation and birdlife during nesting time.
	Ellidavatn				Ellidavatn: Local environment, vegetation and birdlife.
West Iceland	Berjadalur, Slöguveita and Ósveita, Grábrók, Seleyri, Grund, Fossamelar, Steindórsstadir, Svelgsárhraun	Water conservation area etc.			
South Iceland	Úthlíd	Water conservation area Bjarnarfell			
Hengill	Nesjavellir	Law on the protection of lake Thingvallavatn and its water catchment area no. 85/2005.		The Hengill area: Magnificent landscapes and geologically diverse including geothermal areas.	
Nesjavellir	Dyrdalur Sporhelludalur Skeggjadalur	Water spring in Grámelur in Nesjahraun lava field for Nesjavellir geothermal power plant. Two water springs and water conservation areas in Nesjalaugagil.			Small valley and ridges consisting of hyaloclastite. The ancient Dyravegur path in Dyradalur valley. In Sporhelludalur valley are visible ancient paths in the ground. Dyrnar and Sporhellan classified as historic relics.
	Fálkaklettar-Selklettar (crater row)	Water conservation area.			Multiformed row of craters, the whole magnificent, and the greatest of the northern Hengill area. Historical artefacts related to the oldest farm site at Nesjavellir and Selklettar.
	Botnadalur, Illagil, Krummar				A magnificent landscape in Botnadalur valley and well-preserved remains of human settlement. Continuous brushy lands in Illagil canyon and east of Krummi.
	Skógarhóll, Eldborg and Grámelur	Water conservation area.			Remarkable eruptive remnants in Nesjahraun, a moss and brush covered lava field with beautifully shaped craters. Eldborg is an elegantly shaped rootless cone.
	Raudstrýta and surroundings	Water conservation area.			Brushy and fractured lava formation with a crater and a fault.
	Gíghólar east of Hveralaekur				Impressive crater formations that have been preserved within Nesjavellir power plant's production field.
	Nesjalaugargil Köldulaugargil	Nesjalaugagil: Water conservation area.			Colourful geothermal area with scales and deposit and a variety of hot springs and pools. Spectacular river gullies with waterfalls.
	Hagavíkurlaugar				Due to its increasing popularity as a general outdoors recreation area, general guideline rules regarding orderliness and conduct are to be made. The building of huts will be forbidden, the traffic of automotive vehicles limited, grazing of horses prohibited along with all use of firearms.
Kolvidarhóll	Engidalur Hellisskard	Hellisheidi power plant's water supply in Engidalskvísl west of Húsmúli. Groundwater recharge area.			Faults in the B/C lava below Hellisskard. It circumvents the slope downhill of Búasteinn and in the same manner on the side of mt. Reykjafell.
	Stóra-Reykjafell				All of mt. Stóra-Reykjafell. However the mountain contains two large explosive craters; Daudadalur valley in the north face of mt. Stóra-Reykjafell and Hveradalir valley on its southern flanks. Both craters are relatively unspoiled. Daudadalur valley is as good as untouched.
	Kolvidarhóll				Archeological remains by Kolvidarhóll are protected according to the local plan in the area - sources like dwellings, burial sites, field wall, peat extraction sites, cairns etc.

AREA	NAME OF PLACE	WATER CONSERVATION	PROTECTED ARCHAEOLOGICAL SITES	NATURAL FEATURES DATA BASE	PROTECTED CHARACTERISTICS IN REGIONAL, MUNICIPAL AND LOCAL PLANS
Hjallatorfan (Hellisheiði og Ölfus)	Eldborg by Meitlar etc.	Water conservation area.	Old national routes	Eldborg by Meitlar. A big cinder cone.	Preservation of the Hengill area as a nature and recreation reserve.
	Hellukofi, Varmá and Ölfusforir		A rock hut stacked between 1830-1840. Archeologically preserved.	Varmá and Ölfusforir - Ölfusforir include expansive, wet pastures and inhabited by a great a diverse birdlife. Varmá holds a high scientific value.	The southern craters in the B/C lava, which is about 5.800 years old. These are low-rising unspoiled cinder- and scoria cones.
	Cairns by Hellukofinn, Thurá, D-lava	Thurá: Water conservation area.	Cairns by the path to the east of Hellukofinn.	A old shoreline west of Thurárhnúkur. Shore ridges above Thurá by the main road. The most prominent evidence in the region of sea-level changes at the end of the last ice age.	The northern craters in the D-lava, which is aged at around 2.000 years. These are low-rising unspoiled cinder- and scoria cones.
	Thorlákshafnarsel Eldborgir by mt. Lambafell Eystri-Thurá	Eldborgir by mt. Lambafell: Water conservation area.	The ruins of Thorlákshafnarsel in Hellisheidi. Document signed by ÞM 20.01.1976. Officially registered 16.06.1977	Eldborgir by mt. Lambafell. Beutifully shaped volcanic craters formed in historical times. The volcanic craters, their lava channels and the surrounding lava field.	Archeological remains by East-Thurá. Sources of dwellings, staples, barns and peat excavation sites (528;1-9)
	Meitlar Eldborgarhraun Skálafell	Water conservation area.			Outdoors recreation area located between Sudurlandsvegur (main road), Threngsli and Hjallatorfan.
	Breidabólsstadur				Archeolandical remains that are protected according to the local plan in the area - Breidabólsstadur 544:1-44. Sources of dwellings, a church, staples, field walls, irrigation, cairns etc.
Ölfusvatn	Kýrgil Ölkelduháls Tjarnahnjúkur Ölfusvatnsbaerinn	Law on the protection of lake Thingvallavatn and its water catchment area no. 85/2005.	Artefacts near the old Ölfusvatn farm.		Pristine geothermal field, wetlands and river gullies. Power utilization needs to be developed with great care. Ölfusvatn's old farm along with its surroundings. Diverse archeolandical remnants.
	Laki, Álftatjörn and Efri-Kattartjörn	Water supply by Ölfusvatnsá river - water not safe for consumption.	Ancient wall fence, named Grímkelsgerdi and a large hummock within called the grave of Grímkell, preserved in 1898.		Pristine and diverse landscape and geolandical features; river gullies, a scoria cone, explosive crates and hot springs. Ponds and wetlands.
	Ölfusvatnsárglúfur west of Stapafell	Water supply by the river in wetlands by the camping site - water not safe for consumption.	A basaltic rock (olivín þóleit) fixed to the ground, carrying the inscription "VES+1736". Believed to be someone's initials and year. Protected in 1927.		Pristine and diverse river gully and erosive formations. Archeological remnants in Seltún.
	Ölfusvatnsá, Villingavatnsá etc.				Ölfusvatnsá and Villingavatnsá rivers along with adjacent wetlands and shore of lake Thingvallavatn. Meandering riverbeds, small deltas and brushy vegetated wetlands.
	Lambhagi				A promontory that juts out into lake Thingvallavatn and connects to land via a low sand bar. High recreational value and a unique view over lake Thingvallavatn. An ancient wall lies across the sand bar.
					Due to its increasing popularity as a general outdoors recreation area, general guideline rules regarding orderliness and conduct are to be made. The building of huts will be forbidden, the traffic of automotive vehicles limited, grazing of horses prohibited along with all use of firearms.
Bakki				Varmá and Ölfusforir - Ölfusforir are expansive, wet pastures and inhabited by a great a diverse birdlife. Varmá holds a high scientific value.	

Annex 7. **Species of birds (a) and plants (b) on the Red List of the Icelandic Institute of Natural History (NÍ) and the IUCN Red List of threatened species on land owned, rented or administered by OR and its subsidiaries**

7a) Bird species

STATUS ON NÍ RED LIST	SPECIES	AREA, LAST SIGHTING	PREMISE FOR THE NÍ RED LIST	STATUS ON IUCN RED LIST
Extinct in the wild (EW)	Little Auk (Alle alle)	Heidmörk, Helluvatn, 2005	Ceased nesting in Iceland around 1995	LC (Least concern)
	Water Rail (Rallus aquaticus)	Heidmörk, 2013	Ceased nesting in Iceland around 1970	LC (Least concern)
Endangered (EN)	White-tailed Sea-eagle (Haliaeetus albicilla)	Heidmörk, 2015	Small population, <250 individuals	LC (Least concern)
	Barnacle Goose (Branta leucopsis)	Heidmörk, by Bugda north of Raudhólar, 2011 / Ölfusforir 2011	Small population, <250 individuals	LC (Least concern)
	Barrow's Goldeneye (Bucephala islandica)	Heidmörk, Helluvatn, 2013	Small population, <250 individuals	LC (Least concern)
	Northern Shoveler (Anas clypeata)	Heidmörk, 2015	Small population, <250 individuals	LC (Least concern)
Vulnerable (VU)	Short-eared Owl (Asio flammeus)	Heidmörk, 2016	Small population, <1000 individuals	LC (Least concern)
	Gyrfalcon (Falco rusticolus)	Heidmörk, 2016 Nesjavellir, (2009)	Small population, <1000 individuals	LC (Least concern)
	Horned Grebe (Podiceps auritus)	Heidmörk, Ellidavatn, 2014	Small population, <1000 individuals	VU (Vulnerable)
	Gadwall (Anas strepera)	Heidmörk, Ellidavatn, 2013, Ölfusforir 2011	Small population, <1000 individuals	LC (Least concern)
	Greylag Goose (Anser anser)	Heidmörk, 2016 Ölfusforir, 2011, Hellisskard/Kolvidarhóll	Population reduction, >20% reduction in 10 years	LC (Least concern)
	Goosander (Mergus merganser)	Heidmörk, 2016	Small population, <1000 individuals	LC (Least concern)
	Common Loon (Gavia immer)	Heidmörk, Myllulækjartjörn, Hrauntúnstjörn, 2016	Small population, <1000 individuals	LC (Least concern)
	Common Raven (Corvus corax)	Heidmörk, 2016, Ölfusforir 2011, Hellisskard/Nesjavellir 2005	Population reduction, >20% reduction in 10 years	LC (Least concern)
	Great Black-backed Gull (Larus marinus)	Heidmörk, 1999; hardly any sighting since 2000, Ölfusforir 2011	Greatly reduced	LC (Least concern)
Lower risk (LR)	Harlequin Duck (Histrionicus histrionicus)	Heidmörk, 2016; Middalur/ Fremstidalur/ Ölkelduháls, 2005; Bitra (2006)	Conservation dependent, Iceland is the only nesting site in Europe	LC (Least concern)
	Northern Pintail (Anas acuta)	Heidmörk, Helluvatn, 2005, Ölfusforir 2011	Conservation dependent	LC (Least concern)

Hafsteinn Björgvinsson's annual reports: Birds and other animals in water conservation areas of Reykjavik, available at: www.or.is
Categories and criteria of the International Union for Conservation of Nature (and Natural Resources') (IUCN) Red List:
http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria#categories
Válisti 2 Fuglar (See p. 12-13 in http://utgafa.ni.is/valistar/valisti-2.pdf). Náttúrufrædistofnun Íslands, 2000.

7b) Plant species

STATUS ON NÍ RED LIST	SPECIES	AREA, AGE OF DATA	STATUS ON IUCN RED LIST
Vulnerable (VU)	Blue Water-speedwell (Veronica anagallis-aquatica)	Hengill area, 2005 / Ölkelduháls, 2006 / Hellisheidi, 2006	LC (Least concern)
	Lesser smoothcap (Atrichum angustatum)	Fremstadal, 2002, 2004 / near Ölkelduháls 2001, 2006 / Hellisheidi, 2006	NE (Not evaluated)
	Heath star moss (Campylopus introflexus)	Fremstadal, 2002 / Hellisheidi 2006 / Ölkelduháls 2006	NE (Not evaluated)
Lower risk (LR)	Small adder’s-tongue fern (Ophioglossum azoricum)	Middalur, 2005 / Near Ölkelduháls, 2001, 2005, 2006 /Hellisheidi 2006	NE (Not evaluated)
	Campylopus moss (Campylopus flexuosus)	Fremstadal 2002 / Hellisheidi 2006	NE (Not evaluated)
Near threatened (NT) Conservated species not Red Listed	Marsh cudweed (Filaginella uliginosa)	Near Ölkelduháls, 2005, 2006 / Fremstadal, 2005 / Hellisheidi, 2006	NE (Not evaluated)
	Eggleaf twayblade (Listera ovata)	Heidmörk, 2006	NE (Not evaluated)
Not applicable (NA)	Dickie’s Bladder-fern (Cystopteris fragilis f. dickieana)	Heidmörk, 2006	NE (Not evaluated)

Categories and criteria of the International Union for Conservation of Nature (and Natural Resources’) (IUCN) Red List:
http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria#categories

Annex 8. **Measurement of microbes and chemical composition of potable water in Reykjavik 2016**

MICROBES IN POTABLE WATER 2016

	MAX RECOMM-ENDED VALUE	JAÐAR V-5			LAXALÓN LOKAHÚS			VATNSENDAKRIKAR VK-1			GAGNVEGUR DÆLUSTÖÐ		
		AVERAGE	MAX	MIN	AVERAGE	MAX	MIN	AVERAGE	MAX	MIN	AVERAGE	MAX	MIN
Total microbes 22°C	100/ml	4.5	6	3	1.8	23	0	0	0	0	0.96	4	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. RECOMMENDED VALUE	CO.	LABORATORY	JAÐAR V-5 HEIÐMÖRK	LAXALÓN LOKAHÚS	VATNSENDA-KRIKAR VK-1 HEIÐMÖRK	GAGNVEGUR DÆLUSTÖÐ
SAMPLE NO.					R-15-1093-1/4991	R-16-2996-2/6335	R-15-2801-1/6701	R-15-2801-2/6702
SAMPLING DATE					03/05/2016	24/10/2016	24/10/2016	03/05/2016
Colour of sample	mgPt/l			<5	<5	<5	<5	<5
Turbidity	NTU	adequate	(1)	<0.10	0.14	0.17	<0.10	<0.10
Temperature	°C	25		4.2			4.7	4.7
pH	pH eining			9,05	8.95	9.00	8.90	8.90
Conductivity	µS/cm	2500		86	77	80	79	79
Chloride (Cl)	mg/l	250		10.5	9.19	9.4	9.12	9.12
Sulphate (SO_4)	mg/l	250		2.23	2.02	1.98	2.12	2.12
Fluoride (F)	mg/l	1.5		<0.200	<0.200	<0.200	<0.200	<0.200
Nitrate (NO_3)	mg/l	50		0.168	0.221	0.243	0.226	0.226
Nitrite (NO_2)	mg/l	0.5		<0.01	<0.01	<0.01	<0.01	<0.01
Ammonium (NH_4-N)	mg/l	0.5		<0.026	<0.026	<0.026	<0.026	<0.026
TOC	mg/l	no abnormal changes		<0.50	<0.50	<0.50	<0.50	<0.50
Calcium (Ca)	mg/l	100	(3)	ALS	4,74	5,33	5,34	5,33
Iron (Fe)	mg/l	0,2		ALS	0.00062	<0.0004	0.00171	0.00074
Potassium (K)	mg/l	12	(3)	ALS	<0.4	0.418	<0.4	0.427
Magnesium (Mg)	mg/l	50	(3)	ALS	0.866	0.897	0.89	0.898
Sodium (Na)	mg/l	200		ALS	12.5	9.64	9.62	9.82
Sulphur (S)	mg/l		(4)	ALS	0.755	0.673	0.724	0.735
Silica (Si)	mg/l		(4)	ALS	6.23	6.44	6.38	6.4
Aluminium (Al)	µg/l	200		ALS	21.0	18.6	20.1	21
Arsen (As)	µg/l	10		ALS	<0.05	0.0543	0	0.0651
Boron (B)	µg/l	1000		ALS	<10	<10	<10	<10
Barium (Ba)	µg/l	700	(3)	ALS	0.0462	0.1210	0.0769	0.251
Cadmium (Cd)	µg/l	5.0		ALS	<0.002	<0.002	<0.002	0.00245
Cobalt (Co)	µg/l		(4)	ALS	<0.005	<0.005	0,0072	<0.005
Chromium (Cr)	µg/l	50		ALS	1.05	0.913	0.889	0.907
Copper (Cu)	µg/l	2000		ALS	0.168	<0.1	0.105	0.116
Mercury (Hg)	µg/l	1.0		ALS	<0.002	<0.002	<0.002	<0.002
Manganese (Mn)	µg/l	50		ALS	<0.03	<0.03	<0.03	0.041
Molybdenum (Mo)	µg/l		(4)	ALS	0.0730	0.0817	0.0839	0.0763
Nickel (Ni)	µg/l	20		ALS	<0.05	<0.05	<0.05	<0.05
Phosphorus (P)	µg/l	5000	(3)	ALS	15.6	20.1	18.3	21.2
Lead (Pb)	µg/l	10		ALS	<0.01	<0.01	<0.01	0.0198
Antimon (Sb)	µg/l	5.0		ALS	<0.01	<0.01	<0.01	<0.01
Selen (Se)	µg/l	10		ALS	<0.5	<0.5	<0.5	<0.5
Strontium (Sr)	µg/l		(4)	ALS	2.79	3.07	2.83	3.32
Zinc (Zn)	µg/l	3000	(3)	ALS	0.343	0.51	1.13	1.99
Vanadium (V)	µg/l			ALS	13.9	15.8	15.9	17.6

PHYSIOLOGICAL AND CHEMICAL PROPERTIES	UNIT	MAX. RECOMMENDED VALUE	CO.	LABORATORY	JAÐAR V-5 HEIÐMÖRK	LAXALÓN LOKAHÚS	VATNSENDA-KRIKAR VK-1 HEIÐMÖRK	GAGNVEGUR DÆLUSTÖÐ
benzene	µg/l	1.0		ALS	<0.20	<0.20	<0.20	<0.20
toluene	µg/l			ALS	<0.20	<0.20	<0.20	<0.20
ethylbenzene	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
m,p-xylene	µg/l			ALS	<0.20	<0.20	<0.20	<0.20
o-xylene	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
sum xylene	µg/l			ALS	<0.20	<0.20	<0.20	<0.20
dichloromethane	µg/l			ALS	<2.0	<2.0	<2.0	<2.0
1,1 - dichloroethane	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
1,2 - dichloroethane	µg/l	3.0		ALS	<0.50	<0.50	<0.50	<0.50
trans 1,2 - dichloroethane	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
cis 1,2 - dichloroethane	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
1,2 - dichloropropane	µg/l			ALS	<1.0	<1.0	<1.0	<1.0
trichloromethane	µg/l	100		ALS	<0.30	<0.30	<0.30	<0.30
tetrachloromethane	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
1,1,1 - trichloroethane	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
1,1,2 - trichloroethane	µg/l			ALS	<0.20	<0.20	<0.20	<0.20
trichloroethene	µg/l	10	(2)	ALS	<0.10	<0.10	<0.10	<0.10
tetrachloroethene	µg/l	10	(2)	ALS	<0.20	<0.20	<0.20	<0.20
vinyl chloride	µg/l	0.5		ALS	<1.0	<1.0	<1.0	<1.0
naphtalen	µg/l			ALS	<0.20	<0.20	<0.20	<0.20
acenaphthylene	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
acenaphthene	µg/l			ALS	<0.0070	<0.0070	<0.0070	<0.0070
fluorene	µg/l			ALS	<0.010	<0.010	<0.010	<0.010
phenanthrene	µg/l			ALS	<0.040	<0.040	<0.040	<0.040
anthracene	µg/l			ALS	<0.0050	<0.0050	<0.0050	<0.0050
fluoroanthene	µg/l			ALS	<0.0050	<0.0050	<0.0050	<0.0050
pyrene	µg/l			ALS	<0.0050	<0.0050	<0.0050	<0.0050
benz(a)anthracene	µg/l			ALS	<0.0030	<0.0030	<0.0030	<0.0030
chrysene	µg/l			ALS	<0.0070	<0.0070	<0.0070	<0.0070
benzo(b)fluoranthene	µg/l	0.1	(5)	ALS	<0.0040	<0.0040	<0.0040	<0.0040
benzo(k)fluoranthene	µg/l	0.1	(5)	ALS	<0.0020	<0.0020	<0.0020	<0.0020
benzo(a)pyrene	µg/l	0.01		ALS	<0.0020	<0.0020	<0.0020	<0.0020
dibenzo(ah)anthracene	µg/l			ALS	<0.0020	<0.0020	<0.0020	<0.0020
benzo(ghi)perylene	µg/l	0.1	(5)	ALS	<0.0030	<0.0030	<0.0030	<0.0030
indeno(123-cd)pyrene	µg/l		(5)	ALS	<0.0030	<0.0030	<0.0030	<0.0030
sum 16 EPA-PAH	µg/l			ALS	<0.20	<0.20	<0.20	<0.20
sum PAH cancerogene	µg/l			ALS	<0.012	<0.012	<0.012	<0.012
sum PAH other	µg/l			ALS	<0.20	<0.20	<0.20	<0.20
sum PAH 4	µg/l			ALS	<0.0060	<0.0060	<0.0060	<0.0060
sum PAH L	µg/l			ALS	<0.20	<0.20	<0.20	<0.20
sum PAH M	µg/l			ALS	<0.040	<0.040	<0.040	<0.040
sum PAH H	µg/l			ALS	<0.013	<0.013	<0.013	<0.013
tribromomethane	µg/l			ALS	<0.20	<0.20	<0.20	<0.20
dibromochloromethane	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
bromodichloromethane	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
sum trihalomethane	µg/l			ALS	<0.35	<0.35	<0.35	<0.35
cyanide (CN total)	µg/l	50		ALS	<0.005	<0.005	<0.005	<0.005
Syaníð (CN total)	µg/l	50		ALS	<0.005	<0.005	<0.005	<0.005

Commentary:

(1) Adequate for consuption and no uncharacteristical 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)

Annex 9. **Measurement of microbes and chemical composition of potable water in West Iceland 2016**

CHEMICAL COMPOSITION OF POTABLE WATER IN WEST ICELAND

	MAX RECOMM-ENDED VALUE	AKRANES GEISLAHÚS			GRÁBRÓK LAGNAHÚS HAMRI			GRUNDARFJÖRÐUR DÆLUHÚS GRUNDAÁ			STYKKISHÓLMUR DÆLUHÚS		
		AVERAGE	MAX	MIN	AVERAGE	MAX	MIN	AVERAGE	MAX	MIN	AVERAGE	MAX	MIN
Total microbes at 22°C	100/ml	5	25	0	3	9	0	0	0	0	1	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 IN WEST ICELAND

PHYSIOLOGICAL AND CHEMICAL PROPERTIES	UNIT	MAX. RECOMMENDED VALUE	CO.	LABORATORY	AKRANES GEISLAHÚS	GRÁBRÓK LAGNAHÚS HAMRI	GRUNDAR-FJÖRÐUR DÆLUHÚS GRUNDAÁ	STYKKIS-HÓLMUR DÆLUHÚS
SAMPLE NO.					R16-1869-5/712	R16-1869-4	R16-1598-2/289	R16-1598-1/289
SAMPLING DATE					12/07/2016	12/07/2016	21/06/2016	21/06/2016
Colour of sample	mgPt/l			ALS	<5	<5	<5	<5
Turbidity	NTU	adequate	(1)	MATÍS	0.65	0.35	0.11	0.16
Temperature	°C	25		MATÍS	5.5	6.5	6.3	6.2
pH	pH eining			MATÍS	7.35	7.50	6.90	7.20
Conductivity	µS/cm	2500		MATÍS	100	68	51	50
Chloride (Cl)	mg/l	250		ALS	8.73	14.5	5.35	6.73
Sulphate (SO_4)	mg/l	250		ALS	1.51	2.47	1.93	1.75
Fluoride (F)	mg/l	1,5		ALS	<0.200	<0.200	<0.200	<0.200
Nitrate (NO_3)	mg/l	50		ALS	0.319	0.31	0.142	0.159
Nitrite (NO_2)	mg/l	0.5		ALS	<0.01	<0.01	<0.01	<0.01
Ammonium (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
Calcium (Ca)	mg/l	100	(3)	ALS	3.62	5.27	2.51	1.97
Iron (Fe)	mg/l	0.2		ALS	0.0168	0.00358	0.0221	0.00076
Potassium (K)	mg/l	12	(3)	ALS	0.594	0.697	0.561	0.597
Magnesium (Mg)	mg/l	50	(3)	ALS	1.5	1.98	1.33	1.27
Sodium (Na)	mg/l	200		ALS	7.1	11.1	5.42	5,77
Sulphur (S)	mg/l		(4)	ALS	0.613	1.03	0.625	0.521
Silica (Si)	mg/l		(4)	ALS	3.97	6.27	3.77	4.59
Aluminium (Al)	µg/l	200		ALS	5.4	2.4	1.4	2.9
Arsen (As)	µg/l	10		ALS	0	0.0832	<0.05	0.0748
Boron (B)	µg/l	1000		ALS	<10	<10	<10	<10
Barium (Ba)	µg/l	700	(3)	ALS	0.367	0.0443	0.661	0.437
Cadmium (Cd)	µg/l	5.0		ALS	0.00394	<0.002	<0.002	<0.002
Cobalt (Co)	µg/l		(4)	ALS	<0.005	0.00578	<0.005	<0.005
Chromium (Cr)	µg/l	50		ALS	0.0394	0.292	0.0251	0.129
Copper (Cu)	µg/l	2000		ALS	1.06	0.344	0.579	0.436
Mercury (Hg)	µg/l	1,0		ALS	<0.002	<0.002	<0.002	<0.002
Manganese (Mn)	µg/l	50		ALS	1.58	0.232	0.275	0.0806
Molybdenum (Mo)	µg/l		(4)	ALS	0.0644	0.0738	0.1640	0.282
Nickel (Ni)	µg/l	20		ALS	<0.05	1.96	<0.05	<0.05
Phosphorus (P)	µg/l	5000	(3)	ALS	2.64	11.7	10.7	39.8
Lead (Pb)	µg/l	10		ALS	0.227	0.03	0.536	0,041
Antimon (Sb)	µg/l	5,0		ALS	<0.01	<0.01	<0.01	0.0105
Selen (Se)	µg/l	10		ALS	<0.5	<0.5	<0.5	<0.5
Strontium (Sr)	µg/l		(4)	ALS	8.41	2.92	9.44	7.54
Zinc (Zn)	µg/l	3000	(3)	ALS	0.781	2.46	3.14	4.46
Vanadium (V)	µg/l			ALS	0.647	3.2	0.556	14

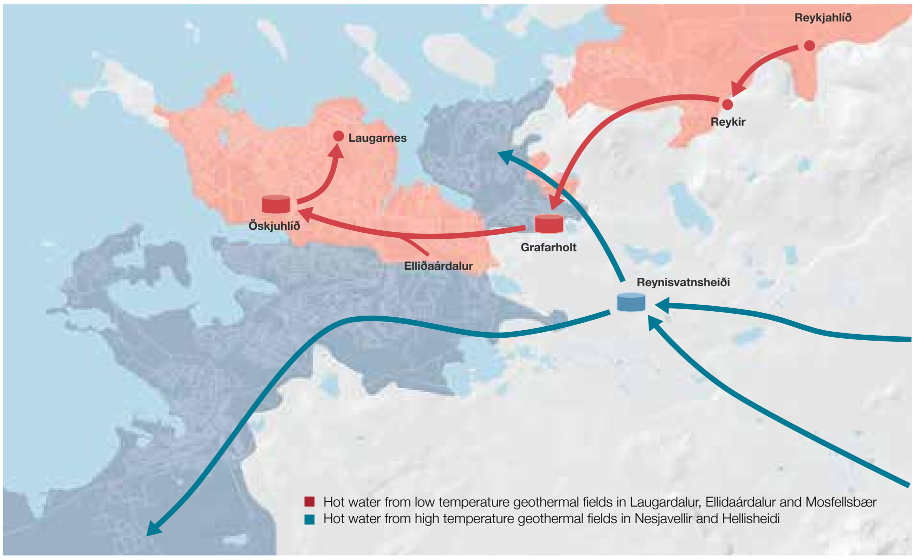
PHYSIOLOGICAL AND CHEMICAL PROPERTIES	UNIT	MAX RECOMM-ENDED VALUE	CO.	LABORATORY	AKRANES GEISLAHÚS	GRÁBRÓK LAGNAHÚS HAMRI	GRUNDAR-FJÖRÐUR DÆLUHÚS GRUNDAÁ	STYKKIS-HÓLMUR DÆLUHÚS
benzene	µg/l	1.0		ALS	<0.20	<0.20	<0.20	<0.20
toluene	µg/l			ALS	<0.20	<0.20	<0.20	<0.20
ethylbenzene	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
m,p-xylene	µg/l			ALS	<0.20	<0.20	<0.20	<0.20
o-xylene	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
sum xylene	µg/l			ALS	<0.20	<0.20	<0.20	<0.20
dichloromethane	µg/l			ALS	<2.0	<2.0	<2.0	<2.0
1,1 - dichloroethane	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
1,2 - dichloroethane	µg/l	3.0		ALS	<0.50	<0.50	<0.50	<0.50
trans 1,2 - dichloroethane	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
cis 1,2 - dichloroethane	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
1,2 - dichloropropane	µg/l			ALS	<1.0	<1.0	<1.0	<1.0
trichloromethane	µg/l	100		ALS	<0.30	<0.30	<0.30	<0.30
tetrachloromethane	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
1,1,1 - trichloroethane	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
1,1,2 - trichloroethane	µg/l			ALS	<0.20	<0.20	<0.20	<0.20
trichloroethene	µg/l	10	(2)	ALS	0,35	0,38	<0.10	<0.10
tetrachloroethene	µg/l	10	(2)	ALS	<0.20	<0.20	<0.20	<0.20
vinyl chloride	µg/l	0.5		ALS	<1.0	<1.0	<1.0	<1.0
naphtalen	µg/l			ALS				
acenaphthylene	µg/l			ALS	<0.20	<0.20	<0.20	<0.20
acenaphthene	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
fluorene	µg/l			ALS	<0.0070	<0.0070	<0.0070	<0.0070
phenanthrene	µg/l			ALS	<0.010	<0.010	<0.010	<0.010
anthracene	µg/l			ALS	<0.040	<0.040	<0.040	<0.040
fluoroanthene	µg/l			ALS	<0.0050	<0.0050	<0.0050	<0.0050
pyrene	µg/l			ALS	<0.0050	<0.0050	<0.0050	<0.0050
benz(a)anthracene	µg/l			ALS	<0.0050	<0.0050	<0.0050	<0.0050
chrysene	µg/l			ALS	<0.0030	<0.0030	<0.0030	<0.0030
benzo(b)fluoranthene	µg/l			ALS	<0.0070	<0.0070	<0.0070	<0.0070
benzo(k)fluoranthene	µg/l	0.1	(5)	ALS	<0.0040	<0.0040	<0.0040	<0.0040
benzo(a)pyrene	µg/l	0.1	(5)	ALS	<0.0020	<0.0020	<0.0020	<0.0020
dibenzo(ah)anthracene	µg/l	0.01		ALS	<0.0020	<0.0020	<0.0020	<0.0020
benzo(ghi)perylene	µg/l			ALS	<0.0020	<0.0020	<0.0020	<0.0020
indeno(123-cd)pyrene	µg/l	0.1	(5)	ALS	<0.0030	<0.0030	<0.0030	<0.0030
sum 16 EPA-PAH	µg/l		(5)	ALS	<0.0030	<0.0030	<0.0030	<0.0030
sum PAH cancerogene	µg/l			ALS	<0.20	<0.20	<0.20	<0.20
sum PAH other	µg/l			ALS	<0.012	<0.012	<0.012	<0.012
sum PAH 4	µg/l			ALS	<0.20	<0.20	<0.20	<0.20
sum PAH L	µg/l			ALS	<0.0060	<0.0060	<0.0060	<0.0060
sum PAH M	µg/l			ALS	<0.20	<0.20	<0.20	<0.20
sum PAH H	µg/l			ALS	<0.040	<0.040	<0.040	<0.040
tribromomethane	µg/l			ALS	<0.013	<0.013	<0.013	<0.013
dibromochloromethane	µg/l			ALS	<0.20	<0.20	<0.20	<0.20
bromodichloromethane	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
sum trihalomethane	µg/l			ALS	<0.10	<0.10	<0.10	<0.10
cyanide (CN total)	µg/l			ALS	<0.35	<0.35	<0.35	<0.35
Syaníð (CN total)	µg/l	50		ALS	<0.005	<0.005	<0.005	<0.005

Commentary:
(1) Adequate for consuption and no uncharacteristical 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)

Annex 10. **Distribution of hot water in the capital area**

The figure shows how hot water is distributed in the capital area. Reykjavik residents west of Grafarvogur and in Úlfarsárdalur, Mosfellsbaer and Kjalarnes usually get low-temperature geothermal water from wells. On the other hand, Grafarholt, Grafarvogur, Kópavogur, Gardabaer and Hafnarfjördur get their heated groundwater from Nesjavellir and Hellisheidi. In some areas water from other sources can be used in certain periods.



Annex 11. **Separated water discharged via overflows at the Hellisheidi Geothermal Power Plant and at Hverahlid in 2016**

RELEASE OF SEPARATED WATER VIA OVERFLOW AT HELLISHEIDI POWER PLANT

DATE	TYPE OF DISTURBANCE	24-HOUR AVERAGE FLOW	TOTAL m³
5. - 16. January	Maintenance	14 l/s	17,400
1. February	Maintenance	45 l/s	550
2. February	Malfunction	150 l/s	1,160
10. February	Maintenance	30 l/s	860
19. - 20. February	Maintenance	50 l/s	5,320
22. February - 28. April	Maintenance	80 l/s	431,500
7. - 17. May	Maintenance	90 l/s	37,700
24. - 25. May	Maintenance	15 l/s	4,400
27. May - 3. June	Malfunction	50 l/s	44,800
7. - 12. June	Malfunction	100 l/s	20,600
19. - 20. June	Malfunction	20 l/s	3,130
22. - 29. June	Maintenance	105 l/s	49,300
8. - 12. July	Malfunction	30 l/s	12,500
22. - 27. July	Malfunction	15 l/s	2,200
27. July - 5. August	Operational	20 l/s	12,200
5. - 7. September	Maintenance/Malfunction	25 l/s	16,000
13. - 18. September	Malfunction	50 l/s	10,050
18. September - 4. October	Maintenance/Malfunction	75 l/s	174,800
22. October - 3. November	Maintenance/Malfunction	20 l/s	58,070
3. - 14. November	Maintenance/Malfunction	43 l/s	42,000
28. - 29. November	Maintenance/Malfunction	25 l/s	5,600
9. - 10. December	Maintenance/Malfunction	25 l/s	3,475
12. - 18. December	Maintenance/Malfunction	25 l/s	15,400
19. - 21. December	Malfunction	35 l/s	6,750
26. - 27. December	Malfunction	15 l/s	1,700

RELEASE OF SEPARATED WATER VIA OVERFLOW AT HVERAHLID

DATE	TYPE OF DISTURBANCE	24-HOUR AVERAGE FLOW	TOTAL m³
10. - 11. May	Malfunction	100 l/s	17,300
15. - 19. June	Maintenance/Malfunction	80 l/s	27,700

Annex 12. **Chemical composition of groundwater from wells in the vicinity of the Hellisheidi Geothermal Power Plant 2016**

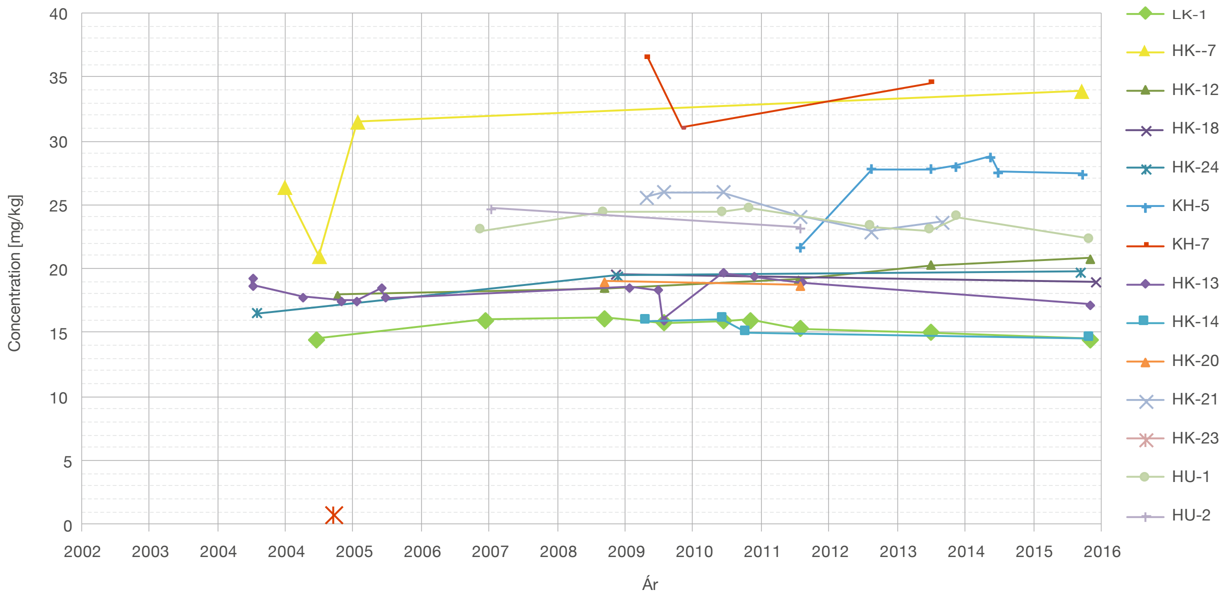
CHEMICAL COMPOSITION OF GROUNDWATER FROM WELLS NEAR HELLISHEIDI GEOTHERMAL POWER PLANT 2016

WELL			HK-24	HK-07	HK-25	HK-12	HK-31	HK-18	KH-50	HK-13	LK-1	KH-05	KH-06	HU-1	HK-14
GROUNDWATER FLOW			SELVOGSSTRAUMUR							SELVOGSSTRAUMUR/ ELLIÐAÁRSTRAUMUR	ELLIÐAÁR-STRAUMUR	ÞINGVALLASTRAUMUR			
Sample no.			16-5260	16-5269	16-5270	16-5335	16-5337	16-5364	16-5365	16-5336	16-5345	16-5282	16-5283	16-5344	16-5343
Date			02/09/ 2016	15/09/ 2016	15/09/ 2016	25/10/ 2016	26/10/ 2016	23/11/ 2016	23/11/ 2016	25/10/ 2016	02/11/ 2016	21/09/ 2016	21/09/ 2016	02/11/ 2016	02/11/ 2016
EFNI	EINING	LEYFILEGUR HÁMARKSST.													
pH			7.72	7.64	8.00	8.08	9.67	8.21	7.1	7.51	7.92			7.86	8.04
T (pH-mæl)	°C		22.8	22.9	22.6	22.5	21.6	22.4	22.3	21.9	22.4	22.4	22.5	22.2	22.6
Leiðni	µS/cm	2,500	162	210	183.6	199	273	155.7	172.8	124	84.3	144	86	82.4	80
T (leiðni)	°C		22.3	22.2		22.4	22.4			22.4	22.3	22.3	22.3	22.3	22.3
CO_2	mg/kg	*	35.9	48.8	58.9	50.4	68.1	39.6	29.4	23.8	14.0	47.3	33.5	22.8	17.1
F	mg/kg	1.5	0.01	0.25	0.08	0.02	0.71	0.04	0.07	0.01	0.02	0.02	0.02	0.03	0.01
Cl	mg/kg	*	10.74	18.42	12.00	9.24	7.82	9.28	9.89	16.90	11.18	6.49	5.36	6.76	6.16
SO_4	mg/kg	200	12.28	31.33	10.90	16.52	8.29	4.20	32.89	5.72	1.83	2.61	1.62	1.63	1.38
Ca	mg/kg	100	9.55	10.70	11.50	13.70	1.84	8.47	7.84	6.11	3.19	8.70	4.17	4.50	2.62
Fe	mg/kg	0.2	0.01	0.01	0.00	0.02	0.01	0.00	0.00	0.01	0.01	0.01	0.01	0.00	0.00
K	mg/kg	12	1.12	1.08	1.43	1.25	1.31	0.96	1.44	1.03	0.75	0.89	0.64	0.81	0.67
Mg	mg/kg	50	5.05	9.40	7.43	6.43	0.14	4.74	8.01	3.51	1.92	5.22	3.69	2.54	1.74
Na	mg/kg	200	9.68	9.39	11.80	11.00	59.60	11.10	11.30	10.30	7.48	7.40	5.31	6.02	5.63
SiO_2	mg/kg	*	19.74	33.86	23.14	20.79	52.50	19.03	36.43	17.21	14.53	27.43	14.70	22.29	14.57
Al	µg/kg	200	2.99	1.84	3.05	5.49	83.90	4.46	1.24	1.74	6.02	0.64	0.80	0.65	3.70
As	µg/kg	10	<0.05	<0.05	0.05	0.06	1.12	0.08	<0.05	<0.05	<0.05	0.05	<0.05	<0.05	<0.05
Ba	µg/kg	700	0.91	0.30	1.13	1.60	0.38	0.86	0.85	0.66	0.32	0.09	0.89	0.41	0.17
Cd	µg/kg	5	0.004	<0.002	0.004	0.004	0.004	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Co	µg/kg	*	0.0	0.0	<0.005	0.0	<0.005	0.006	0.013	0.025	0.010	0.0	0.0	0.009	0.010
Cr	µg/kg	50	0.46	0.49	0.83	2.75	0.08	0.89	0.32	0.31	0.18	0.43	0.06	0.59	0.26
Cu	µg/kg	2,000	0.16	0.24	0.11	0.29	0.16	0.11	0.56	0.32	0.28	<0.1	0.53	0.12	0.25
Hg	µg/kg	1	<0.002	<0.002	<0.002	<0.002	<0.002	0.003	0.004	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
Mn	µg/kg	50	3.21	0.70	0.20	1.84	0.99	1.02	0.60	1.79	0.86	1.27	1.03	<0.03	0.80
Mo	µg/kg	*	0.35	0.41	0.37	0.28	2.37	0.36	0.23	0.18	0.07	0.15	0.06	0.17	0.08
Ni	µg/kg	20	<0.05	0.09	<0.05	1.32	0.09	0.12	0.22	0.16	0.13	<0.05	0.16	<0.05	0.12
P	µg/kg	5,000	19.5	52.9	36.3	25.4	11.1	42.4	34.5	9.1	14.6	56.4	5.5	43.9	18.0
Pb	µg/kg	10	0.013	0.012	0.011	0.020	0.013	0.012	<0.01	0.016	0.022	0.010	<0.01	<0.01	0.017
Se	µg/kg	10	0.56	0.65	<0.5	<0.5	<0.5	<0.5	1.01	1.06	<0.5	<0.5	<0.5	<0.5	<0.5
Sr	µg/kg	*	20.6	22.6	19.5	25.7	5.6	14.5	19.3	17.0	6.6	13.5	8.0	8.6	6.0
Ti	µg/kg	*	0.026	0.014	0.065	<0.001	0.092	0.034	0.025	0.029	0.030	<0.001	0.015	0.007	0.039
V	µg/kg	*	12.5	24	14.2	17.9	27.3	25	7.63	5.98	7.14	9.8	2.55	5.87	5.75
Zn	µg/kg	3,000	0.90	2.11	0.73	1.16	0.60	1.04	4.84	3.42	209.00	0.55	2.30	2.95	1.67

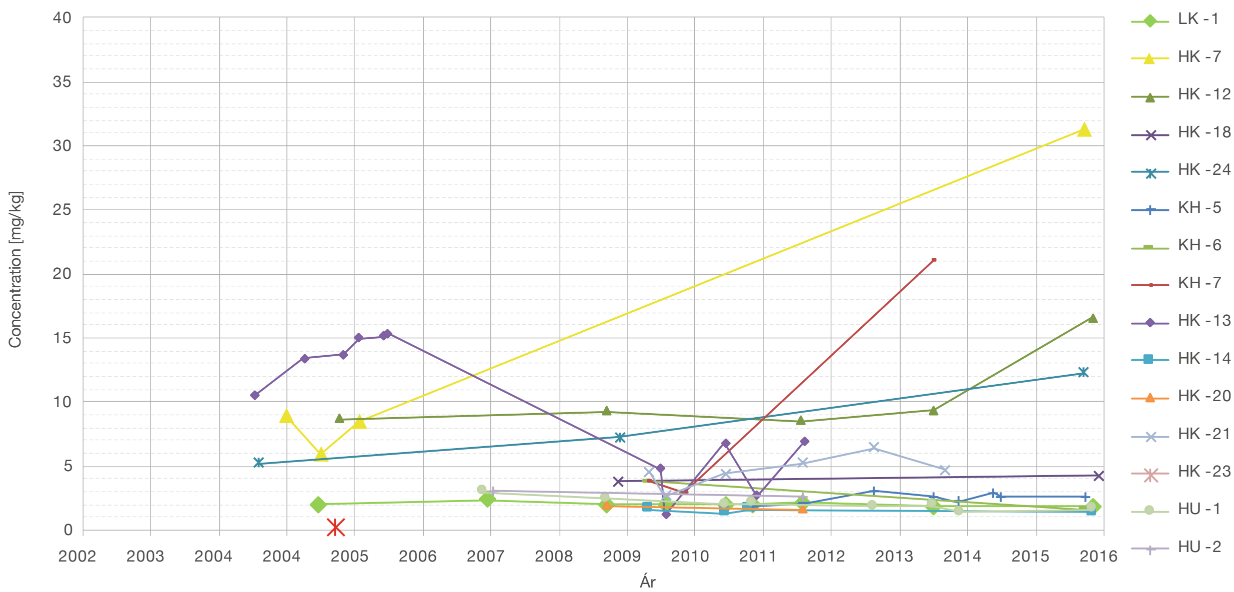
* Maximum value not found in Icelandic regulations

Annex 13. **Chemical composition of groundwater from wells in the vicinity of the Hellisheidi Geothermal Power Plant 2005-2016**

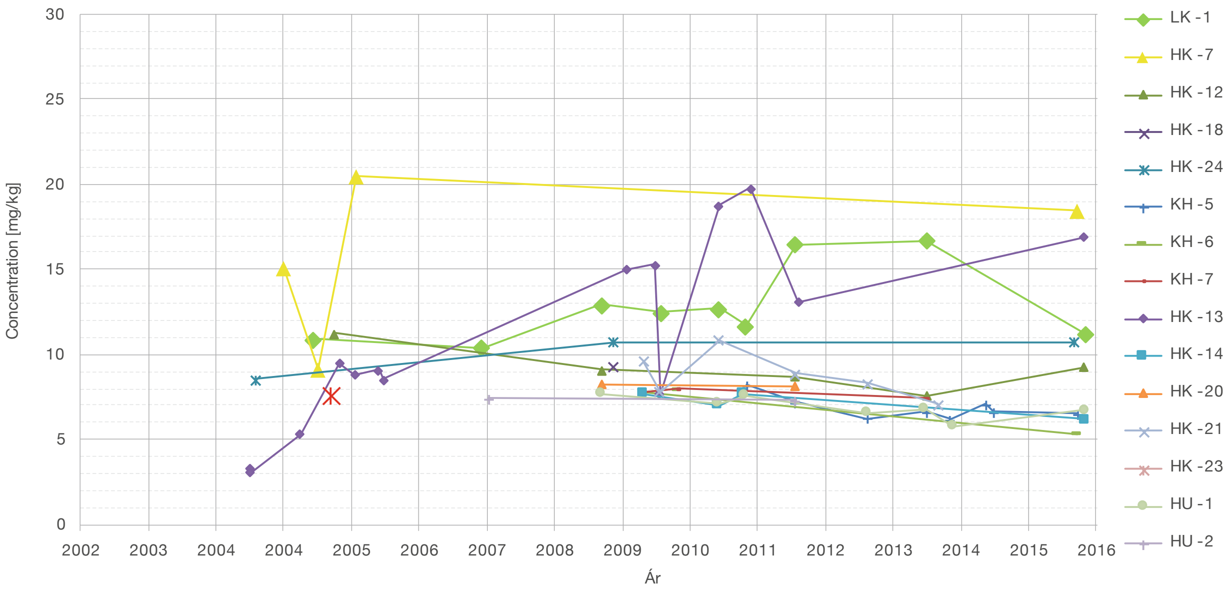
SILICA (SiO_2)



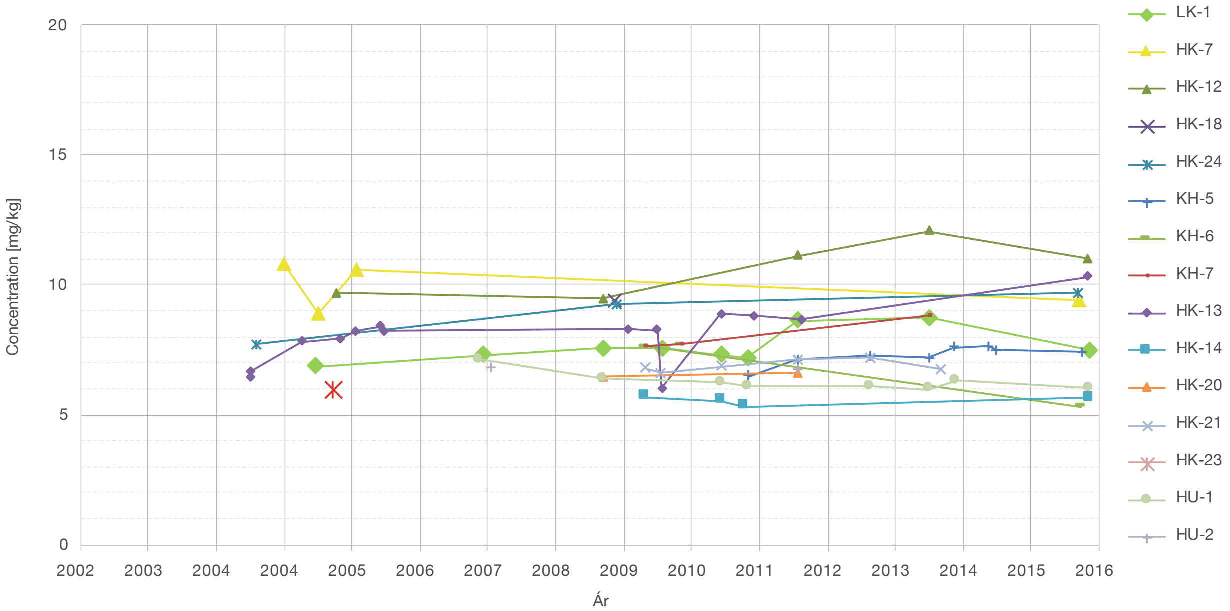
SULPHATE (SO_4)



CLORIDE (Cl)



SODIUM (Na)



Annex 14. **Trace elements in geothermal water from the Hellisheidi and Nesjavellir Geothermal Power Plants**

Typical concentrations (µg/kg) of several trace elements in geothermal water (separated and condensed water) from the Hellisheidi and Nesjavellir Geothermal Power Plants and their maximum permissible concentrations (µg/kg) for potable water. When the chemical content of separated water is compared to potable water standards, one can see that in separated water from the Hellisheidi Geothermal Power Plant, the concentration of aluminium is about ten times higher, concentration of arsenic is about four times higher and the concentration of selenium is 50% higher than permissible levels for potable water. In separated water from the Nesjavellir Geothermal Power Plant, the concentration of aluminium is about ten times higher, the concentration of arsenic is about six times higher and the concentration of selenium around 10% higher than permissible levels for potable water. The concentration of other substances in separated water is lower than the given limits for potable water.

TRACE ELEMENTS IN GEOTHERMAL WATER FROM POWER PLANTS IN HENGILL

ELEMENT	UNIT	MAX RECOMMENDED VALUE FOR POTABLE WATER	SEPERATED WATER		CONDENSED WATER	
			HELLISHEIÐI	NESJAVELLIR	HELLISHEIÐI	NESJAVELLIR
Aluminium (Al)	µg/kg	200	1,800	1,930	0.427	0.629
Arsenic (As)	µg/kg	10	37	60	<0.05	0.0879
Barium (Ba)	µg/kg	700	0.33	1.53	0.0269	0.0661
Cadmium (Cd)	µg/kg	5	<0.002	<0.002	<0.002	<0.002
Cobolt (Co)	µg/kg	-	0.027	0.026	0.007	0.054
Chrome (Cr)	µg/kg	50	0.071	0.36	0.087	3.87
Copper (Cu)	µg/kg	2,000	0.4	2.7	<0.1	<0.1
Mercury (Hg)	µg/kg	1	<0.002	<0.002	<0.002	0.0134
Mangan (Mn)	µg/kg	50	0.61	17	0.257	1.73
Molybdenum (Mo)	µg/kg	-	4.7	2.4	<0.05	<0.05
Nickel (Ni)	µg/kg	20	0.17	1.57	0.828	4.47
Phosphorus (P)	µg/kg	5,000	<1	11.3	<1	<1
Lead (Pb)	µg/kg	10	<0.01	0.062	0.027	0.0261
Selenium (Se)	µg/kg	10	15.3	10.9	<0.5	<0.5
Strontium(Sr)	µg/kg	-	4.3	<2	0.064	0.0966
Titanium (Ti)	µg/kg	-	0.079	0.06	0.0223	0.0254
Vanadium (V)	µg/kg	-	4.2	2.5	0.0185	0.0475
Zinc (Zn)	µg/kg	3,000	0.3	19.1	1.28	2.39

Annex 15. **Emissions of carbon dioxide (CO_2), hydrogen sulphide (H_2S), hydrogen (H_2) and methane (CH_4) from Hellisheidi and Nesjavellir 2003-2016**

It is expected the current limits of error is 5%.

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
2015	33,077	6,384	386	80
2016	26,102	3,893	337	48

* Data not available for 2005 and 2006

Commentary 2016:

1) CO_2 and H_2S dissolved and reinjected in condensate water subtracted.

2) Approx. 6.600 tons of CO_2 and 3.900 tons of H_2S were reinjected in the SulFix and CarbFix projects.

NESJAVELLIR

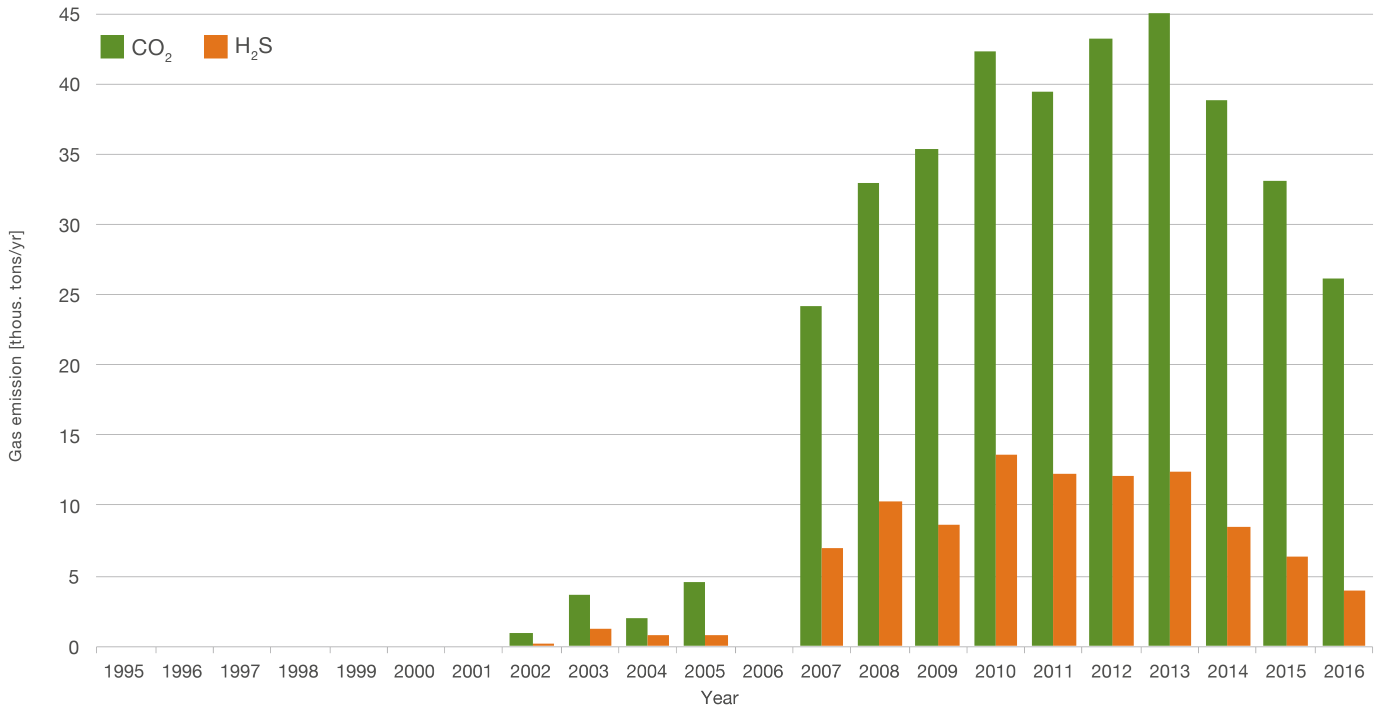
YEAR	CO_2 tons/yr	H_2S tons/yr	H_2 tons/yr	CH_4 tons/yr
2003	11,058	5,941	313	14
2004	11,551	5,084	317	21
2005	13,259	8,918	410	29
2006	12,673	8,650	*	*
2007	15,412	10,275	410	26
2008	20,904	12,114	658	24
2009	19,918	12,175	640	24
2010	28,396	9,384	481	111
2011	14,800	9,414	470	47
2012	18,612	8,640	456	28
2013	14,794	8,709	481	46
2014	16,579	9,275	491	55
2015	14,726	8,359	497	54
2016	14,655	8,076	474	44

* Data not available for 2005 and 2006

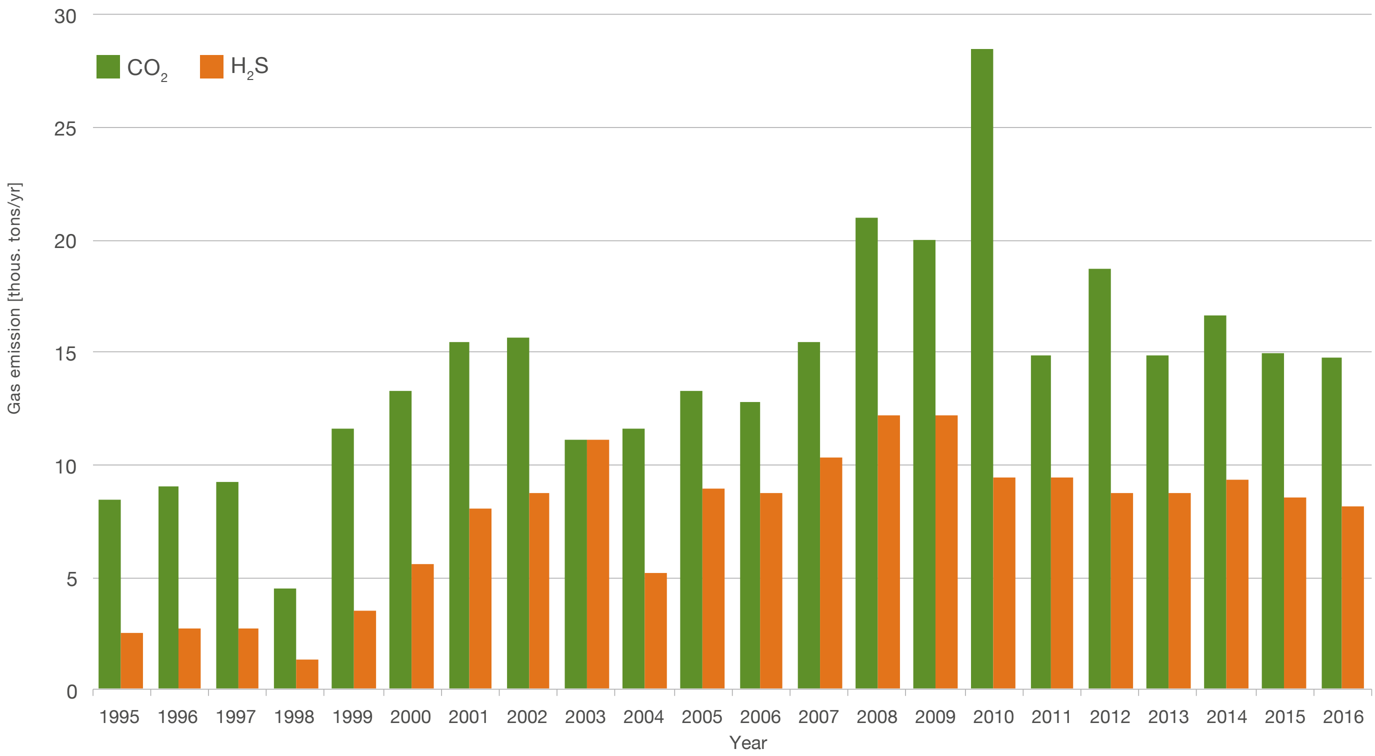
Annex 16. **Emissions of carbon dioxide (CO_2) and hydrogen sulphide (H_2S), from Hellisheidi 2002-2016 and Nesjavellir 1995-2016**

It is expected the current limits of error is 5%.

HELLISHEIÐI



NESJAVELLIR



Viðauki 17. **Comparison between regulatory limits of hydrogen sulphide in µg/m³ and ppm**

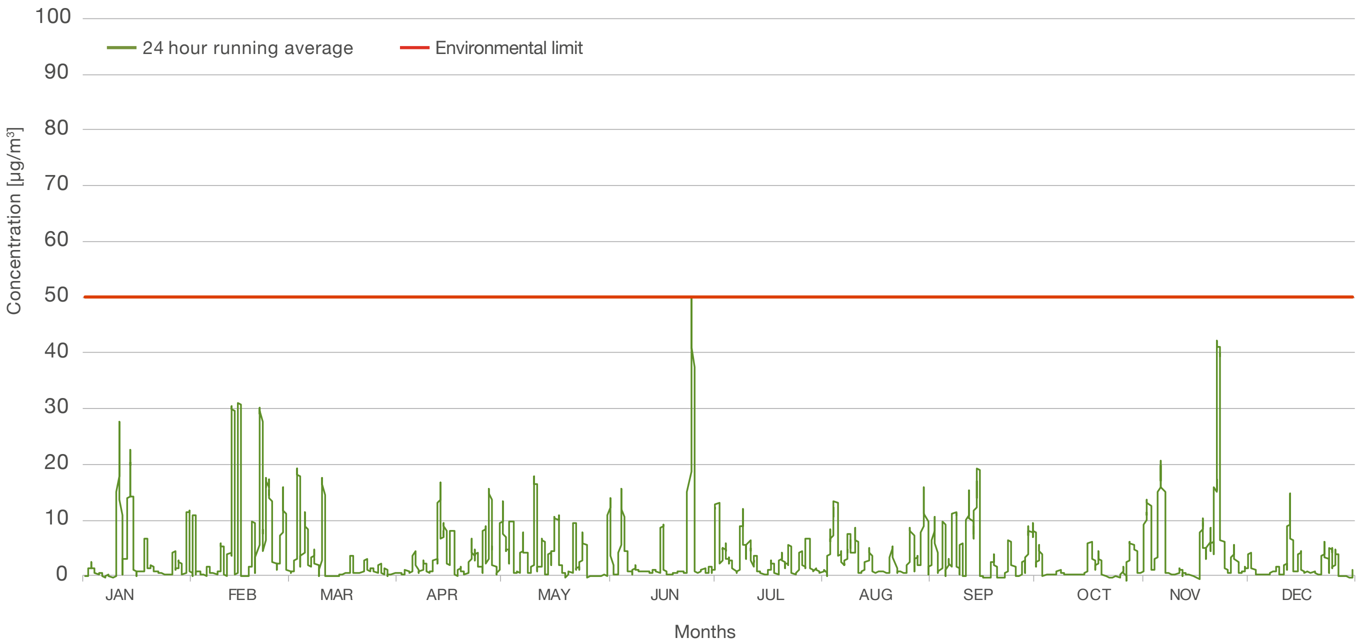
Under Regulation no. 514/2010 regarding the Concentration of Hydrogen Sulphide in the Atmosphere, environmental limits are set at 50 µg/m³, based on the maximum daily running 24-hour average. The concentrations may exceed those limits three times per annum. Other environmental limits are that the maximum annual average shall be 5 µg/m³ and the environmental authorities shall be notified when the concentration measured exceeds 150 µg/m³ for three consecutive hours. Regulation no. 514/2010 does not apply to the industrial areas of the 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 7,000 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.

COMPARISON OF H2S CONCENTRATION µg/m3 AND ppm

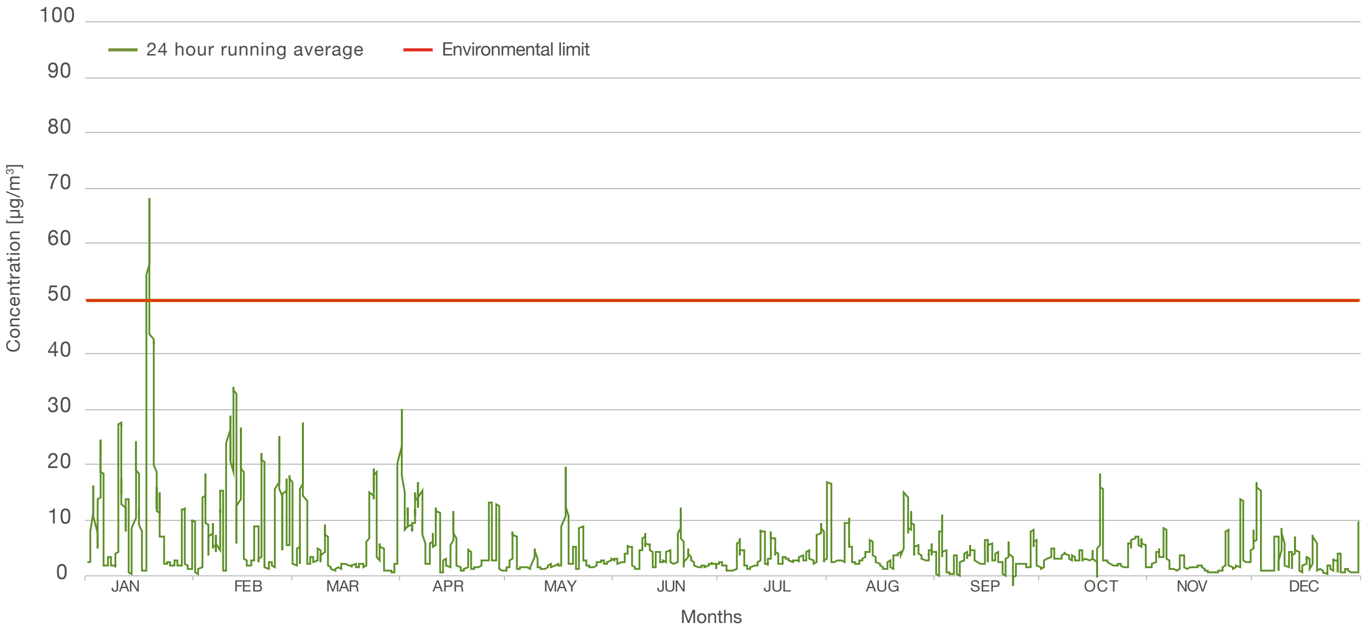
µg/m³	ppm	COMMENTS
5	0,0039	Maximum annual average
7-15	0,0054 - 0,012	Odour threshold
50	0,039	Maximum daily average
150	0,12	Notification limitis (three continuous hours)
7.000	5,41	Limit in a work environment for an eight-hour workday
14.000	10,8	Limit in a work environment for a fifteen-minute period
>14.000	>10,8	Irritation in airway, sense of smell fades and other symptoms. GET OUT OF THE SITUATION.

Annex 18. **Daily and monthly averages for the concentration of hydrogen sulphide in Hveragerdi and Nordlingaholt in 2016**

HYDROGEN SULPHIDE (H_2S) Í HVERAGERDI



HYDROGEN SULPHIDE (H_2S) Í NORDLINGAHOLT



Annex 19. **30 highest hourly averages for the concentration of hydrogen sulphide in Hveragerdi and Nordlingaholt and timing in 2016**

H_2S MONITORING Í HVERAGERDI

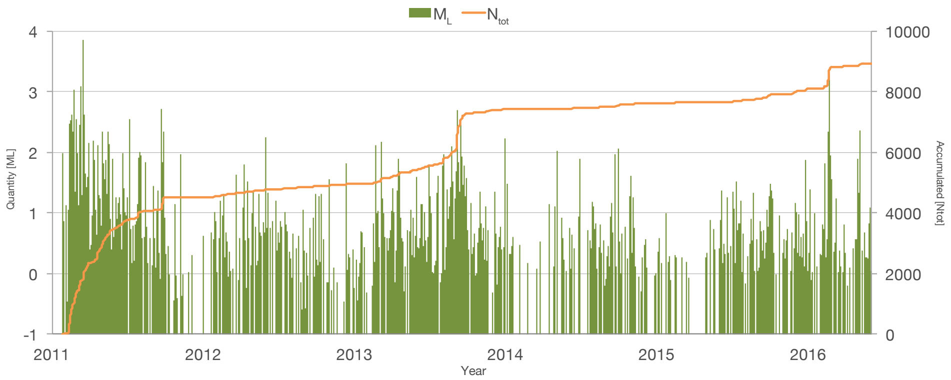
HYDROGEN SULPHIDE 2016 - 30 HIGHEST HOURLY AVERAGES					
CONCENTRATION [µg/m³]	DATE & TIME	CONCENTRATION [µg/m³]	DATE & TIME	CONCENTRATION [µg/m³]	DATE & TIME
179	12/02/2016 07:00	100	14/02/2016 15:00	85	20/02/2016 05:00
156	12/02/2016 08:00	97	14/02/2016 11:00	77	22/02/2016 10:00
154	12/02/2016 06:00	97	23/06/2016 07:00	75	23/06/2016 09:00
143	21/11/2016 21:00	93	20/02/2016 04:00	74	23/06/2016 02:00
121	22/06/2016 23:00	93	23/06/2016 05:00	73	21/11/2016 19:00
115	21/11/2016 20:00	91	22/06/2016 22:00	72	23/06/2016 04:00
106	14/02/2016 14:00	90	21/07/2016 05:00	71	23/06/2016 01:00
105	23/06/2016 08:00	88	23/06/2016 00:00	69	14/01/2016 07:00
101	23/06/2016 03:00	87	02/03/2016 13:00	67	01/02/2016 12:00
101	14/02/2016 13:00	85	21/11/2016 15:00	66	22/02/2016 09:00

H_2S MONITORING Í NORDLINGAHOLT

HYDROGEN SULPHIDE 2016 - 30 HIGHEST HOURLY AVERAGES					
CONCENTRATION [µg/m³]	DATE & TIME	CONCENTRATION [µg/m³]	DATE & TIME	CONCENTRATION [µg/m³]	DATE & TIME
145	18/01/2016 20:00	91	12/02/2016 16:00	77	16/05/2016 23:00
142	18/01/2016 19:00	88	12/02/2016 13:00	75	31/03/2016 00:00
128	20/02/2016 06:00	86	02/03/2016 22:00	73	18/01/2016 23:00
114	18/01/2016 21:00	85	02/01/2016 23:00	73	08/02/2016 03:00
99	20/02/2016 05:00	83	18/01/2016 09:00	72	31/07/2016 08:00
98	30/03/2016 22:00	81	25/04/2016 08:00	71	08/02/2016 04:00
96	10/02/2016 09:00	81	19/01/2016 07:00	71	19/01/2016 22:00
96	12/02/2016 14:00	80	12/02/2016 12:00	71	18/01/2016 15:00
96	18/01/2016 18:00	80	10/02/2016 23:00	70	13/02/2016 21:00
93	10/02/2016 10:00	77	03/01/2016 00:00	70	11/01/2016 17:00

Annex 20. **Development of seismic activity at the Hellisheidi Geothermal Power Plant from the autumn of 2011 to the end of 2016**

On one hand, the figure shows the magnitude of seismic activity and, on the other hand, the accumulated number of seismic tremors 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 peaked in mid-October when two magnitude ML 4 events occurred. At the end of 2011/beginning of 2012, seismic activity gradually decreased and, by the summer of 2012, had almost faded out. Activity increased again in the autumn of 2012, but was nothing like what it was when it started. The reason for this was that production at the district heating utility started again after a summer break. This cooled the disposal water somewhat and its flow subsequently increased, which in turn resulted in a rise in the capacity of the reinjection wells and in seismic activity. In early 2014 there was some seismic activity related to the testing and launching of the SulFix project. This activity was within acceptable limits and had mostly faded by the summer. Since then seismic activity by the Hellisheidi Geothermal Power Plant has been low. In mid-September, seismic activity started in the Húsmúli area by the Hellisheidi Geothermal Power Plant. Experience from operating the reinjection utility at the Hellisheidi Geothermal Power Plant has shown that seismic activity can be caused by sudden changes in operations. An examination of the operations of the reinjection utility in relation to the seismic activity in September revealed that no changes had been made in the lead-up to the series of tremors.



Annex 21. **Trace elements from sewage treatment plants in Reykjavik in 2016**

Discharge of pollutants (mg/l) from sewage treatment plants in Reykjavik in 2016. The average flow in Klettagardar was 1,311 l/sec, and in Ánanaust it was 1,139 l/sec.

SAMPLING RESULTS

KLETTAGARÐAR	MARCH mg/l	JUNE mg/l	SEPTEMBER mg/l	DECEMBER mg/l	AVERAGE VALUE mg/l
Total nitrogen (N)	5.8	16.6	14.2	6.3	10.7
Total phosphorus (P)	0.9	3.0	3.1	1.4	2.1
Silver (Ag)	< 0.001*		<0.01*		Below the detection limit
Arsen (As)	<0.001*		<0.05*		Below the detection limit
Cadmium (Cd)	<0.0002*		<0.001*		Below the detection limit
Cromium (Cr)	0.002		0.013		0.01
Copper (Cu)	0.008		0.026		0.02
Mercury (Hg)	<0.0001*		<0.0005*		Below the detection limit
Nickel (Ni)	0.003		0.012		0.01
Lead (Pb)	0.001		<0.005*		Below the detection limit
Zinc (Zn)	0.0680		0.200		0.13
ÁNANAUST	**MARCH mg/l**	**JUNE mg/l**	**SEPTEMBER mg/l**	**DECEMBER mg/l**	**AVERAGE VALUE mg/l**
Total nitrogen (N)	8.4	18.8	12.4	7.4	11.8
Total phosphorus (P)	1.5	3.1	2.8	1.5	2.2
Silver (Ag)	<0.001*		<0.01*		Below the detection limit
Arsen (As)	0.0020		<0.05*		Below or near the detection limit
Cadmium (Cd)	<0.0002*		<0.001*		Below the detection limit
Cromium (Cr)	0.003		<0.005*		Below or near the detection limit
Copper (Cu)	0.0080		<0.005*		Below or near the detection limit
Mercury (Hg)	<0.0001*		<0.0005*		Below the detection limit
Nickel (Ni)	0.004		0.022		0.01
Lead (Pb)	0.002		<0.005*		Below or near the detection limit
Zinc (Zn)	0.052		0.02		0.04

* Below detection limits
- When both samples collected are below the detection limits, the column "mean value" states " below the detection limit"
" - When one of two samples 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 or near the detection limit"

Annex 22. **Sewage discharge reporting - Ánanaust 2016**

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 21) and the average flow of the plant, which was 1,139 l/sec.

REFERENCE YEAR 2016	
INFORMATION ON THE OPERATIONAL UNIT	
Name of parent corpany	Reykjavik Energy
Name of the operational unit	Utilities - Sewerage treatment plant Ananaust
National ID of the operational unit	501213-1870
Address	Ananaust 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
VALKVÆÐAR UPPLÝSINGAR	
Production quantity	
Number of plants	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	Procedure	Total [kg/yr]	Incident [kg/yr]
12	Total nitrogen	M	ALT - EN ISO 11905-1	423,876	
13	Total phosphorus	M	ALT - EN 1189	79,028	
17	As and compounds	M	EPA 200.8 K(ICP-MS)	Undir greiningarmörkum	
18	Cd and compounds	M	EPA 200.8 K(ICP-MS)	Undir greiningarmörkum	
19	Cr and compounds	M	EPA 200.8 K(ICP-MS)	Undir eða við greiningarmörk	
20	Cu and compounds	M	EPA 200.8 K(ICP-MS)	Undir eða við greiningarmörk	
21	Hg and compounds	M	ALT - EN ISO 17852:2006	Undir greiningarmörkum	
22	Ni and compounds	M	EPA 200.8 K(ICP-MS)	538	
23	Pb and compounds	M	EPA 200.8 K(ICP-MS)	Undir greiningarmörkum	
24	Zn and compounds	M	EPA 200.8 K(ICP-MS)	1,489	

COMPETENT AUTHORITY TO WHICH THE PUBLIC CAN TURN

Name	The Environment Agency of Iceland
Address	Sudurlandsbraut 24
Town/location	Reykjavik
Telephone	591 2000
Fax	591 2020
E-mail address	ust@ust.is

Annex 23. **Sewage discharge reporting - Klettagardar 2016**

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 21) and the average flow of the plant, which was 1,311 l/sec.

REFERENCE YEAR 2016	
INFORMATION ON THE OPERATIONAL UNIT	
Name of parent corpany	Reykjavik Energy
Name of the operational unit	Utilities - Sewerage treatment plant Klettagardar
National ID of the operational unit	501213-1870
Address	Klettagardar 14
Town/location	Reykjavik
Postal code	104
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 plants	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	Procedure	Total [kg/yr]	Incident [kg/yr]
12	Total nitrogen	M	ALT - EN ISO 11905-1	443,540	
13	Total phosphorus	M	ALT - EN 1189	86,847	
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)	310	
20	Cu and compounds	M	EPA 200.8 K(ICP-MS)	703	
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)	310	
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)	5,542	

COMPETENT AUTHORITY TO WHICH THE PUBLIC CAN TURN

Name	The Environment Agency of Iceland
Address	Sudurlandsbraut 24
Town/location	Reykjavik
Telephone	591 2000
Fax	591 2020
E-mail address	ust@ust.is

Annex 24. **Waste sorting 2012-2016**

WASTE CATEGORIES 2012-2016

CATEGORY	UNIT	2012	2013	2014	2015	2016
General waste	kg	57,640	52,770	53,210	55,300	57,070
Bulk waste	kg	40,430	27,550	10,129	19,400	54,440
Asbestos	kg	8,620	35,700	11,700	18,260	297,780
Sludge (solid constituents from sewage)	kg	1,369,210	1,131,500	1,325,860	722,280	732,160
Til urðunar samtals	**kg**	**1,475,900**	**1,247,520**	**1,400,899**	**815,240**	**1,141,450**
Green bin	kg	6,420	5,870	6,860	8,220	8,133
Metals	kg	72,230	46,430	59,390	81,280	124,010
Timber - unpainted	kg	17,050	5,760	18,160	23,340	11,580
Timber - painted	kg	13,790	11,540	8,800	19,490	40,500
Garden waste	kg			3,320	13,580	20,230
Glass and minerals	kg				12,680	1,760
Plastic	kg	2,610	4,810	3,140	3,340	8,204
Corrugated cardboard	kg	6,480	9,850	7,520	13,230	24,847
Office paper	kg	2,280	3,510	3,010	2,950	1,830
Newspapers and magazines	kg	670	1,530	110	140	670
Organic waste	kg	17,550	22,560	25,740	26,120	20,226
Total for recycling	**kg**	**139,080**	**111,860**	**136,050**	**204,370**	**261,990**
Unknown materials	kg	1,180	93	170	3,237	25
Light bulbs	kg	1,310	1,309	649	1,158	995
Batteries	kg		29	10	18	101
Car batteries	kg	1,546	500	1,394	683	2,569
Electronic equipment	kg		77	771	1,413	2,173
Paint and print waste	kg	118	98	420	93	52
Oil and oil contaminated waste	kg			1,901	2,103	5,529
Solvents	kg			154	51	47
Organic pollutants, cooking oil	kg		408	273	327	415
Inorganic pollutants	kg				68	40
Plaster	kg		150			
Total hazardous waste	**kg**	**4,154**	**2,664**	**5,742**	**9,151**	**11,946**
Total waste	**kg**	**1,619,134**	**1,362,044**	**1,542,691**	**1,028,761**	**1,415,386**
Earthmowing *	tons			5,027	4,733	5,840
Asphalt	tons			440	800	1,270

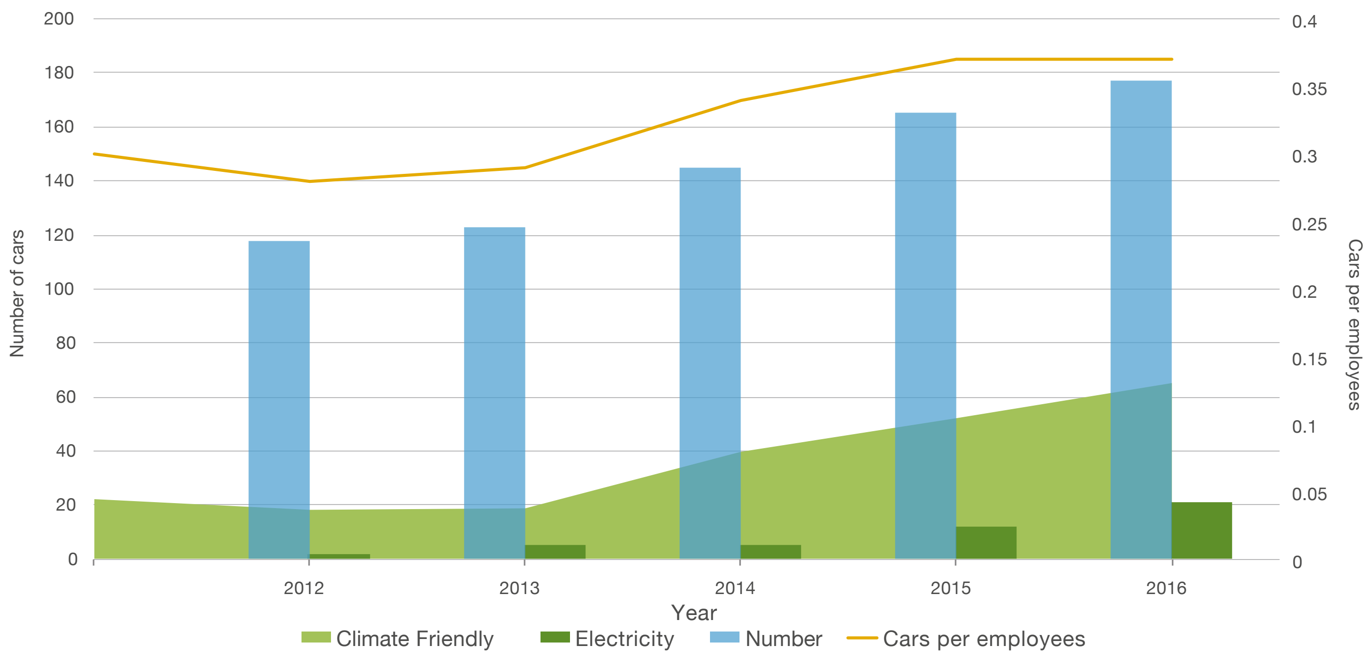
* When calculating the weight of earthmowing due to constructions it is assumed that every m^3 contains 2.000 kg.

WASTE CATEGORIES 2016 BY WORKSITES

		OR	ON POWER				REYKJAVIK FIBRE NETWORK	VEITUR UTILITIES								
CATEGORY	UNIT	REYKJAVIK (BÆJARHÁLS)*	REYKJAVIK (BÆJARHÁLS)*	NESJA-VELLIR	HELLIS-HEIDI	ANDAKÍLSÁR-VIRKJUN	REYKJAVIK (BÆJARHÁLS, NORÐURHÚS)*	REYKJAVIK (NORÐURHÚS BÆJARHÁLSI)*	ÁNANAUST SEWAGE TREATMENT	KLETTAGARDAR SEWAGE TREATMENT	PUMPING STATIONS IN THE METROPOLITAN AREA	SEWERAGE TREATMENT PLANTS IN BORGARFJÖRDUR	ELLIDAÁR STATION	AKRANES	BORGARNES	OR AND SUBSIDIARIES TOTAL
General waste*	kg	11,564	1,423	3,690	19,560	1,780	4,625	9,429		1,390			780	2,530	300	57,071
Bulk waste	kg	20,903	2,573	960	1,940	100	8,361	17,044						2,560		54,440
Asbestos	kg														297,780	297,780
Sludge (solid constituents from sewage)	kg			40,900	41,000				232,920	319,120	38,520	59,700				732,160
Total for landfilling	**kg**	**32,466**	**3,996**	**45,550**	**62,500**	**1,880**	**12,987**	**26,473**	**232,920**	**320,510**	**38,520**	**59,700**	**780**	**5,090**	**298,080**	**1,141,451**
Green bin*	kg	3,435	423				1,374	2,801		100						8,133
Metals	kg			44,000	16,560			63,270						180		124,010
Timber - unpainted	kg				4,460			6,960						160		11,580
Timber - painted	kg			7,620	18,810	140		13,390						540		40,500
Garden waste	kg	10,230						10,000								20,230
Glass and minerals	kg				900	360								500		1,760
Plastic*	kg	1,885	232		2,030		2,020	1,537						360	140	8,204
Corrugated cardboard*	kg	8,838	1,088	540	2,910	340	3,535	7,206						340	50	24,847
Office paper*	kg	1,830														1,830
Newspapers and magazines*	kg	390				140								140		670
Organic waste*	kg	8,649	1,065				3,460	7,052								20,226
Total for recycling	**kg**	**35,257**	**2,807**	**52,160**	**45,670**	**980**	**10,389**	**112,217**	**0**	**100**	**0**	**0**	**0**	**2,220**	**190**	**261,990**
Unknown materials	kg							15						10		25
Light bulbs	kg			7	283			705								995
Batteries	kg				67			34								101
Car batteries	kg			4	993			1,572								2,569
Electronic equipment*	kg				753		765	655								2,173
Paint and print waste	kg							52								52
Oil and oil contaminated waste	kg			1,291	3,051			1,187								5,529
Solvents	kg			4	41			2								47
Organic pollutants, cooking oil	kg			33	272		60	50								415
Inorganic pollutants	kg				40											40
Plaster	kg															0
Total hazardous waste	**kg**	**0**	**0**	**1,339**	**5,500**		**825**	**4,272**	**0**	**0**	**0**	**0**	**0**	**10**	**0**	**11,946**

Office waste from subsidiaries is split by by number of employees. Estimated waste from software companies that rent at Bæjarháls, Reykjavik is not included in the waste accounting of OR and its subsidiaries.
*Estimated quantity of waste from rental companies are subtracted from numbers for Reykjavik (Bæjarháls). The remaining amount is the divided between OR and its subsidiaries by number of employees working at Bæjarháls.

Annex 26. **Total number of vehicles of OR, number of cars per average equivalent position, number of climate friendly cars and pure electric powered cars at the end of each year 2012-2016.**



Annex 27. **Number of cars of OR, based on energy sources and emission values at the end of each year for the period 2012-2016**

NUMBER OF CARS 2016

VEHICLES	ENERGY SOURCE	2012	2013	2014	2015	2016
Traditional	Gasoline >99 g CO_2/km	24	21	14	5	3
	Diesel >99 g CO_2/km	76	83	91	110	109
Climate friendly	Diesel <99 g CO_2/km			5	4	4
	Hybrid			17	19	19
	Plug-in hybrid			2	2	2
	Electricity	2	5	5	12	21
	Methane	16	14	11	17	19
Total		**118**	**123**	**145**	**169**	**177**

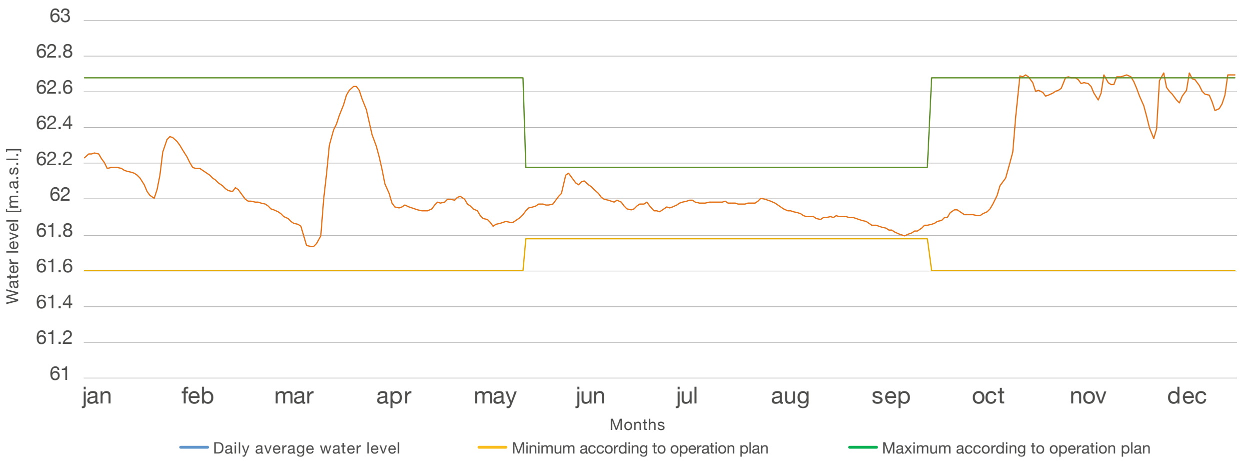
Annex 28. **Fuel consumption of vehicles used by OR 2012-2016**

VEHICLE FLEET'S FUEL CONSUMPTION

ENERGY SOURCE	UNIT	2012	2013	2014	2015	2016
Gasoline	Liters	44,499	33,347	34,088	27,509	17,349
Diesel	Liters	174,164	168,326	156,529	200,523	190,565
Methane	m^3	20,522	19,542	10,110	8,968	9,305

Annex 29. **Water level in Lake Skorradalsvatn 2016**

WATER LEVEL SKORRADALSVATN 2016



Viðauki 30. **Greenhouse gas emissions from the activities of OR and its subsidiaries 2012-2016**

Greenhouse gas emissions from ON power's geothermal power plants at Nesjavellir and Hellisheidi is based on the operations of the power plants as well as makeup drilling and drilling due to research in new geothermal fields. Emissions of carbon dioxide decreased at Hellisheiði and Nesjavellir in 2016 compared to 2015. Methane emissions decreased at Hellisheiði and Nesjavellir. Greenhouse gas emissions from the car fleet was lower in 2016 than in previous years. Sulfur hexafluoride (SF_6) is used as an insulating gas for high voltage equipment in power plants and in the supply and distribution system of the OR Group. In December there was leakage of SF_6 in one of the high-voltage switches of the Hellisheidi Geothermal Power Plant. SF_6 is used for tracer flow tests (TFT).

EMISSIONS OF GREENHOUSE GASSES

GREENHOUSE GAS	ORIGIN	UNIT	2012	2013	2014	2015	2016
Carbon dioxide (CO_2)	Nesjavellir	tons	18,612	14,794	16,579	15,271	14,655
	Hellisheidi and Hverahlid	tons	43,158	44,934	41,242	36,988	32,746
	Low-temperature geothermal fields	tons	0	0	0	0	0
	Supply and distribution system	tons	75	5	25	5	2
	Construction and utility systems maintenance**	tons					
	Vehicle fleet (CO_2 equivalence)	tons	550	511	482	582	551
	Flights, international and domestic (CO_2 equivalence)	tons	27	50	62	70	64
	Office waste for landfilling (CO_2 equivalence)	tons	33	31	31	32	33
	Worksite waste for landfilling (CO_2 equivalence)	tons	823	693	782	441	629
	Organic waste for compost (CO_2 equivalence)	tons	3	4	5	5	4
	Total CO_2	**tons**	**63,282**	**61,022**	**59,207**	**53,393**	**48,684**
Methane (CH_4)	Nesjavellir	kg	28,000	46,200	53,453	53,538	43,500
	Hellisheidi and Hverahlid	kg	51,000	72,000	80,829	79,601	47,930
	Supply and distribution system	kg	5	0	2	0	2
	Samtals CH_4	**kg**	**103,672**	**79,061**	**118,249**	**133,139**	**91,432**
Nitrous oxide (N_2O)	Supply and distribution system	kg	1	0	0	0	0
	Samtals N_2O	**kg**	**1**	**0**	**0**	**0**	**0**
Tetrafluorethane (HFC-134a)	Supply and distribution system	kg	10	10	10	10	10
	Samtals HFC-134a	**kg**	**10**	**10**	**10**	**10**	**10**
Sulphur hexafluoride (SF_6)*	Nesjavellir	kg		0.53			
	Hellisheidi	kg	0.53		0.53		0.26
	Tracer flow tests in Hengill area (TFT)	kg			0.02	0.04	0.08
	Supply and distribution system	kg					
	Samtals SF_6	**kg**	**0.53**	**0.53**	**0.55**	**0.04**	**0.34**

* Heildarmagn SF_6 í rafbúnaði er um 5,7 tonn og í birgðum um 1 tonn. Magn birgða hefur hækkað milli ára en árið 2015 láðist að greina frá magni í einni aðveitustöð og magn í dreifistöðvum hafði verið vanmetið.
** Verkefni til að draga úr losun gróðurhúsalofttegunda. Fyrstu niðurstöður verða settar fram í Umhverfisskýrslu 2017 eða 2018.
Upplýsingar um upphitunarstuðla gróðurhúsa lofttegunda, sjá: : http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WG1AR5_Chapter08_FINAL.pdf og í viðauka X
Þróun hefur sem samsvarar um 1200 grömmum af SF_6 í birgðum

Annex 31. **Carbon sequestration of OR and its subsidiaries 2012-2016**

Carbon sequestration due to land reclamation and forestration and reinjection of carbon dioxide is calculated from the size of the land and the coefficients shown in Annex 33

CARBON SEQUESTRATION

CARBON SEQUESTRATION	UNIT	2012	2013	2014	2015	2016
Land reclamation CO_2 sequestration	tons	1,086	1,110	1,149	1,202	1,249
Forestry CO_2 sequestration	tons	3,626	3,626	3,626	3,626	3,626
Sequestration in CarbFix and SulFix projects	tons	110	3	2,381	3,911	6,644
Total carbon sequestration per year	**tons**	**4,822**	**4,739**	**7,155**	**8,739**	**11,519**

Annex 32. **100-year global warming potential (GWP) for calculating CO_2-equivalencies of greenhouse gasses**

100-YEAR GLOBAL WARMING POTENTIAL (GWP) FOR CALCULATING CO_2-EQUIVALENCIES OF GREENHOUSE GASSES

GREENHOUSE GAS	COEFFICIENT	SOURCE
CARBON DIOXIDE (CO_2)	1	IPCC, 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change
METHANE (CH_4)	28	
NITROUS OXIDE (N_2O)	265	
TETRAFLUORETHANE (HFC-134a)	1,300	
SULPHUR HEXAFLUORIDE (SF_6)	23,500	

Annex 33. **Coefficients used for calculating emissions from transportation and waste and carbon sequestration of forestry and land reclamation**

COEFFICIENTS FOR CALCULATING CARBON EMISSIONS AND SEQUESTRATION

TYPE OF EMSSION / SEQUESTRATION	ENERGY SOURCE / SEQUESTRATION	UNITS	COEFFICIENT	SOURCES
Transportation / Backup power	Gasoline	kg CO_2 /L fuel	2.31	orkusetur.is; kolvidur.is
	Diesel	kg CO_2 /L fuel	2.68	orkusetur.is; kolvidur.is
	Flights	See calculator**	Variable*	International Civil Aviation Organization (ICAO)**
Waste	Emission from landfills	kg CO_2 /kg of waste	0.58	Efla's Life Cycle Analyses (LCA) application
	Emission from compost	kg CO_2 /kg of waste	0.1894	National Inventory Report 2016
Carbon sequestration	Forestry	tonnes CO_2/hectare***	4.40	Snorrason A, et al 2002. Carbon sequestration in forest plantations in Iceland. Icelandic Agricultural Sciences, 15, 81–93.
	Land reclamation	tonn CO_2/hectare	2.75	National Inventory Report 2008

* Coefficient varible for fuel type, duration of trip, type of aircraft, payload weight etc.
** Calculator for flight emissions: http://www.icao.int/environmental-protection/CarbonOffset/Pages/default.aspx
On premises of calculator: http://www.icao.int/environmental-protection/CarbonOffset/Documents/Methodology_ICAO_Carbon_Calculator_v9_2016.pdf
*** Based on 2,000 trees per hectare