Landsvirkjun has been conducting preparation work and research at Theistareykir for many years. Construction work began in May 2015 and a 90 MW geothermal station will be built in two phases. The first phase of operations is expected to begin at the end of 2017 and the second phase in early 2018.
Preparation work for the power station

Preparation work and research on the sustainable utilisation of geothermal energy at Theistareykir began with the establishment of Theistareykir ehf. in 1999. The association was founded by Húsavík Energy, Akureyri Electricity Utility and Akureyri Heating and Water Utilities, Adaldælahreppur County and Reykdælahreppur County. Landsvirkjun has been involved in the project since 2005. Theistareykir ehf. and Landsvirkjun merged in the beginning of 2014.

The land utilisation and protection plan for the Theistareykir area was developed in cooperation with the municipalities and energy companies in 2006. Full consultation was sought from various stakeholders during the development of the plan. A regional plan was subsequently developed for the high temperature areas in Thingeyjasýsla Municipality covering the period from 2007 to 2025. A particular emphasis was placed on integrating power harnessing plans and environmental protection so that the natural environment and nature conservation would be given full consideration.

An environmental impact assessment has been carried out for anything up to a 200 MW power station at Theistareykir. The energy capacity of the area has been assessed since 2002, with exploratory drilling and resistivity measurements. The construction of a 90 MW power station in two phases is expected to be the first step in geothermal energy production in the area. The first phase of operations is expected to begin at the end of 2017 and the second phase in early 2018.
Computer rendering of Theistareykir Power Station, steam supply systems and the surrounding area.
Schematic progress flow diagram of Theistareykir Geothermal Power Station.
Geothermal electricity production at Theistareykir

The Theistareykir Geothermal Power Station harnesses geothermal energy for electrical power production. The illustration shows a simplified schematic of the process flow through the power station.

Harnessing geothermal energy
Production wells are drilled into the geothermal reservoir to harness geothermal energy. The wells can be up to 2500 m in length and 2000 m in depth. They are either drilled straight or directionally. Directional drilling reduces environmental impact as many wells can be located at the same drill pad.

A well muffler is located on each drill pad for use in well tests, as well as in cases when electricity production needs to be stopped for a longer period.

Steam supply system
The two phase geothermal fluid flows from the production wells through steam gathering pipelines to a steam separator. This separates the steam from the water phase, now called separated water. If electricity production needs to be stopped for a shorter period, the steam can be exhausted through the well mufflers. The steam flows through main steam pipelines into a mist eliminator where any moisture is removed. The nearly dry steam then enters the geothermal turbine. If electricity production needs to be stopped for a shorter period, the steam can be exhausted through the well muffler.

The separated water is mixed with condensed water from the condenser and is re-injected into the geothermal reservoir through re-injection wells.

Turbine, generator and cold end
Geothermal steam flows through the turbine, turning a rotor and generates electricity through the generator. The remaining steam enters a condenser and is condensed with cooling water in a heat exchanger. The condensate is pumped from the condenser, mixed with the separated water and then re-injected into the geothermal reservoir.

The cooling water used in the condenser is cooled in a cooling tower before being circulated back again to the condenser.

The steam contains traces of non-condensable gases up to 0.2%. Geothermal gases are extracted from the condenser with steam ejectors and vacuum pumps to prevent the accumulation of geothermal gases. The geothermal gases are then vented to the atmosphere, above the fans, in the cooling tower.
From research to utilisation

Preparation work has been carried out in the area over the past few years. This includes construction of an access road, groundwork on the powerhouse foundation, the construction of water facilities and other infrastructure.

In 2015, work began on the construction of a powerhouse and steam supply. The powerhouse consists of two turbine halls, a service building and a workshop. A steam separator station, re-injection system and pumping station for the cold-water supply are also being constructed. The electrical equipment, control systems and machinery for the station will be installed once construction of the powerhouse is completed.

The first phase of operations is scheduled to begin at the end of 2017 and the second phase in early 2018. The installed capacity of Theistareykir Power Station will then be 90 MW.

The partnership between Mannvit and Verkís is responsible for design and consultation work on the Theistareykir project, assisted by Tark Architects, Landslag and Johann Indridason Engineers.

Various contractors were involved in the project:

LNS Saga (from 2017 Munck Íslandi) — A contractor working on steam supply and the powerhouse
Jarðboranir ehf. — Drilling of production wells
Fuji Electric / Balcke–Dürr — Production and installation of machinery and cooling towers
ABB — Production and installation of control systems
Tamini — Production of generators
Rafeyri — Station services and auxiliary systems
Vélsmiðjan Héðinn — Production of separators
G. Hjálmarsson — Groundwork on the powerhouse foundation
þ.S. verktakar — Water supply system
Area of construction for 1st and 2nd phase.
Safety at the forefront

Landsvirkjun is a leading company when it comes to health and safety. Landsvirkjun follows a zero-accident policy with a focus on employee wellbeing in the workplace. The policy is a priority and is a key factor in creating a positive work environment.

One of Landsvirkjun’s goals is to create an accident-free workplace at Theistareykir via an active safety system, supervision and training. All employees at the Theistareykir site attend an HSE induction course. All on-site contractors take an active part in implementing these safety measures by operating in accordance with Landsvirkjun’s safety policy, registering all accidents, near-misses and dangerous circumstances. Learning from these occurrences is believed to be a key factor in preventing future incidents. Landsvirkjun is continually evolving its safety practices via active on-site surveillance and the analysis of any accidents and incidents. Landsvirkjun hopes to continue its progress in HSE practices at Theistareykir by supporting a cooperative effort between employees and management.
The unique nature of the area was given special consideration during the execution of all preparation and construction work and a particular emphasis was placed on environmental aspects.

The area was previously almost untouched, with the exception of archaeological artefacts and traces of sulphur mining from previous centuries. Plans for development have therefore included the demarcation of areas protected for archaeological and environmental reasons to prevent any disturbance to these areas.

Visual aspects have also been taken into consideration during the design process for the power station. Landscaping and finishing work is therefore completed alongside construction work. Examples of this include sowing on road verges and the utilisation of vegetation cover extracted from construction areas to vegetate the roadside and to cover earthen berms. Land reclamation projects have already begun as a result of any land lost due to the construction of the power station. Effective communication with the local community is important and a number of meetings have been held to consult and share information with local residents.

Extensive research and monitoring
Regular monitoring is already being conducted on environmental aspects in the geothermal area at Theistareykir and its vicinity. The objective is to recognise and record the environmental baseline before operations commence at the power station. Monitoring will continue once operations have begun and will reveal if and how geothermal utilisation affects its surroundings. The environmental factors monitored include surface temperature, the geothermal system, groundwater, air quality, noise, birdlife and vegetation.

The Sustainability Project
In 2015, the sustainability project for North Iceland was restarted in cooperation with local municipalities and the University of Akureyri Research Center. The Húsavík Academic Center was hired to manage the project. Landsnet, PCC Bakki Silicon and various tourism associations are now also participating. The objective of the program is to monitor any changes to society, the economy and the environment within the area connected to the construction of the Theistareykir Geothermal Power Station.
The Theistareykir area

1 Theistareykir is approximately 350 meters above sea level north of the Bæjarfjall Mountain. The area is considered to be of historical relevance with over 50 registered heritage sites. It is uninhabited, but has a ramblers’ hut and is used as a grazing common for 5,000 sheep.

2 Mælifell was the name of a farm located beneath a “fell” (small mountain) with the same name. The first records of the farm date from 1318 but by the end of the 15th century it was abandoned and later used as outbuildings for the Reykir Farm in Reykjahverfi. Traces of the farm can be seen close to Mælifell.

3 Theistareykjakraun lava field is the most recent lava field in the area, estimated to be 2,400 years old. The lava field is mainly characterised by „Bungurnar“, a long, curved chain of lava formations stretching northward from the crater Stórihver. Some protected stalactite caves are also located in the area.

4 The Stórihver crater formed the lava field at Theistareykir. It is an oblong crater with several lava channels running from it. The eastbound channel is particularly beautiful and a peculiar row of landslides lie to the north.

5 The Togarahellir cave is located in the Theistareykjakraun lava field. Discovered in 1960, it was filled with enough water to sail a rubber dinghy tens of meters underground but the find was greatly exaggerated by its first explorers, who claimed that the cave was so large that a full-size trawler could sail many kilometres inside it. As a result, the cave was named Togarahellir (Trawler Cave).

6 Skildingahóll is a pyramid–shaped hill to the northeast of Mælifell. Legend has it that thieves were caught on the hill in 1800, having stolen silver shillings from Thorsteinn the Rich in Reykjahlíd. The hill has been called Skildingahóll (Shillings Hill) ever since.

7 Theistareykjabunga is an expansive shield volcano, one of the largest in Iceland.

8 Stóravíti is the main crater of the Theistareykir shield volcano. The Stóravítishraun lava flowed from this area more than 12,000 years ago, over the heathland area up to Kelduhverfi area, the Theistareykir area and the entire Gjástykki area.

9 Litlavíti is a pit crater to the south of Stóravíti. Litlavíti is a stunning natural formation, regular and circular with vertical cliffs.

10 Langavíti is an oblong volcanic crater to the north of Stóravíti. The lava from this area is younger than the shield volcano itself.

11 Lambafjöll is the name of the mountain range to the west of Theistareykir area. The northernmost area is called Höfudreidar-múli. Jónsnípa and Jónsnípuskard pass are located a short distance south of Höfudreidar-múli. Steep cliffs can be found in the eastern part of the mountains and the cliff terrace Skeidin is located to the south.
Theistareykir is in the Thingeyjarsveit Municipality, 25 km southeast of Húsavík. Theistareykir spans the area from Höfudreidarmúli in the north to Hólasandur in the south. The area is demarcated by the cliffs of Lambafjöll Mountains to the west and Bæjarfjall and Ketilfjall Mountains to the east. To the north is Sæluhúsmúli, and the heathlands of Kelduhverfi and Theistareykjabunga mark the eastern boundary.
Inhabitants, resources and geological formations

The geothermal area at Theistareykir is registered in the Icelandic Nature Conservation Register as the fumaroles located there are very active. The Theistareykjahraun lava field is approximately 525 m². The main characteristic of the lava field is the so-called “Bungur”, a long and winding chain of lava formations stretching to the north from the crater. Theistareykjahraun lava field is the most recent lava field in the area, approximately 2,400 years old. Several caves are found in Theistareykjahraun lava field, including stalactite caves that are under protection and may not be disrupted in any way.

Theistareykir is considered to be among the most important heritage sites in Iceland. The first references made to Theistareykir and Mælifell farm as being inhabited areas stem from the 14th and 15th century. In total, there are 58 registered heritage sites in Theistareykir and it is believed that an outlying church stood there, although the exact location remains unknown.

Mælifell was abandoned at the end of the 15th century but it appears that Theistareykir was continuously inhabited throughout the 16th and 17th centuries. The area was inhabited intermittently throughout the 18th century and was finally abandoned in 1873. Today, the land is used as a summer grazing area for the counties of Adaldælahreppur and Reykðælahreppur.

Sources reveal that sulphur was exported from Iceland in the 13th century and was mainly harvested in Thingeyjarsýsla Municipality. The mines in Theistareykir were closest to the export harbour in Húsavík but richer sulphur mines were found in the Mývatn area. Harvesting of sulphur was mostly discontinued in Theistareykir at the end of the 19th century but attempts were made to export unprocessed sulphur in the 20th century. When those attempts were dropped shortly after it marked the end of sulphur trade in the Theistareykir area.
# The history of Theistareykir Power Station

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>The company Theistareykir ehf. was established</td>
</tr>
<tr>
<td>2002</td>
<td>First deep research well was drilled</td>
</tr>
<tr>
<td>2005</td>
<td>Landsvirkjun buys a 32% stake in Theistareykir ehf</td>
</tr>
<tr>
<td>2007</td>
<td>Regional Plan approved for the high temperature area</td>
</tr>
<tr>
<td>2010</td>
<td>Environmental Impact Assessment complete</td>
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<tr>
<td>2011</td>
<td>Energy capacity surpasses 45 MW</td>
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<tr>
<td>2012</td>
<td>Roadwork begins</td>
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<tr>
<td>2014</td>
<td>Theistareykir ehf. merged with Landsvirkjun</td>
</tr>
<tr>
<td>2015</td>
<td>Development of supporting infrastructure and powerhouse foundation</td>
</tr>
<tr>
<td>2017</td>
<td>Construction of powerhouse and installation of steam supply system begins</td>
</tr>
<tr>
<td>2018</td>
<td>Operation of the first phase expected to begin</td>
</tr>
<tr>
<td>2018</td>
<td>Operation of the second phase expected to begin</td>
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</tbody>
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- Energy capacity surpasses 50 MW
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