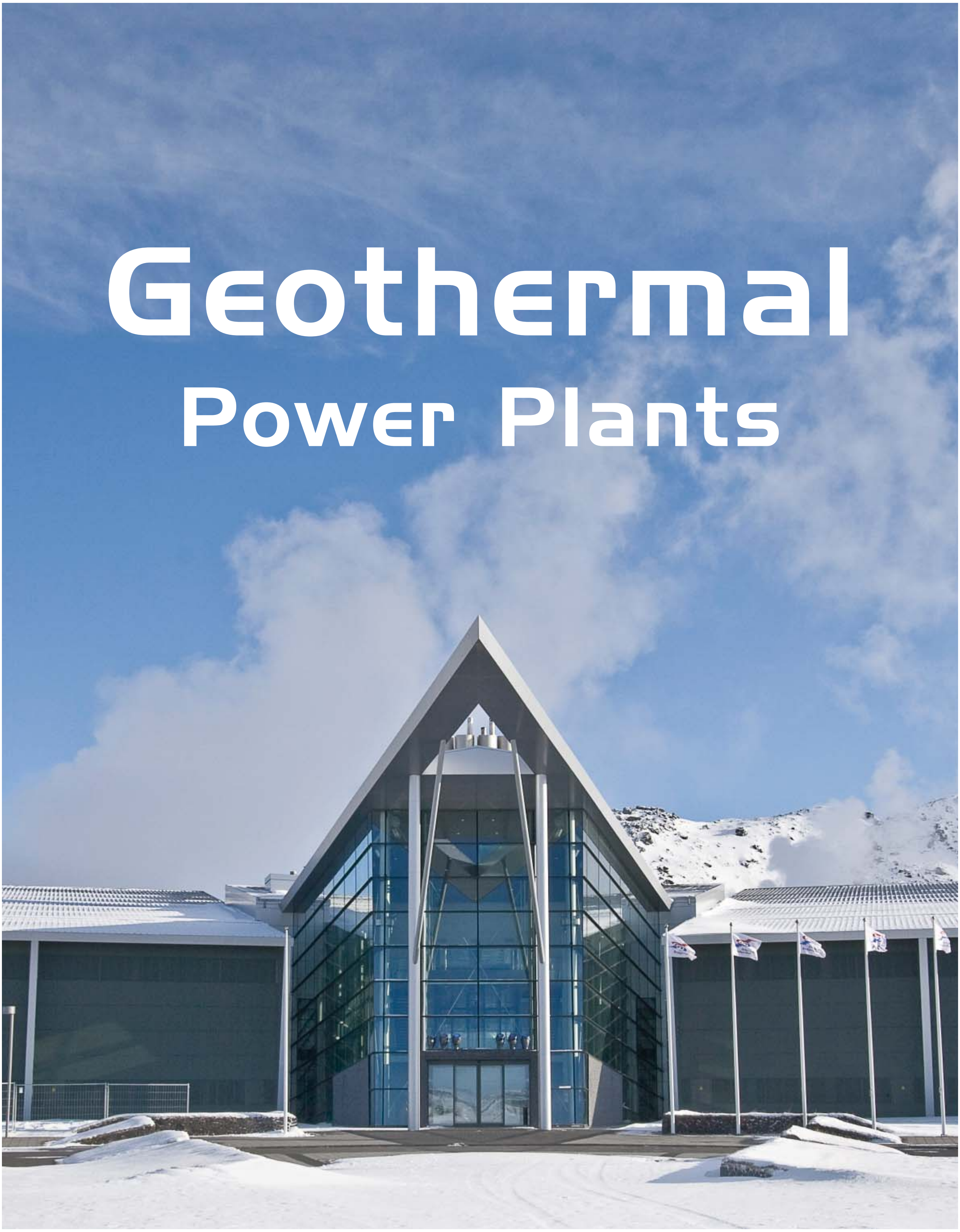
Geothermal Power Plants



MANNVIT ENGINEERING


Leaders in
Geothermal Energy

Geothermal Power Plants

Geothermal power plants utilize heat energy from the Earth to produce electricity and sometimes for combined heat and power (CHP). They are cost effective, reliable and environmentally friendly. And, though previously restricted to certain geographic locations, technological advances in drilling and plant design allow for the development of what were once thought to be non-viable resources. As a result, more and more public and private entities are looking into geothermal power as part of their strategy to mitigate global warming while still meeting growing energy demands.

Mannvit Engineering of Iceland is a world leader in geothermal power plants with decades of experience in Iceland and abroad. The company designs and builds geothermal power plants tailored to match specific resource conditions which, in the most general sense, can be categorized by their thermodynamic potential, or enthalpy.

The specific geothermal power plant configurations must match the heat resource to maximize its potential but also must take into account a variety of other criteria including local conditions and requirements as well as the needs of a community. The geothermal engineers, geoscientists and other company specialists at Mannvit have successfully tackled numerous complex challenges involving geothermal heat utilization all over the world.

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Mannvit services:

- Process Design
- Cogeneration of Electricity & Hot Water
- Feasibility Studies & Cost Estimations
- Conceptual Design
- Site Layout & Planning
- Overall Plant Design
- Equipment Specifications
- Bid Preparation & Tender Evaluation
- Site Supervision
- Commissioning
- Acceptance Test
- Training of Operators
- Monitoring at Well Head
- Environmental Monitoring

Within Iceland, Mannvit has been involved in all the geothermal power plants built since the early 1970s. The electricity from these plants provides approximately 27% of the country's electrical needs, whereas hot water from these plants heats over 90% of the homes and buildings.

Additional information:
Claus Ballzus: claus@mannvit.is
Kristinn Ingason: kristinn@mannvit.is

Iceland Geothermal Power Plants:

- Svartsengi Combined Heat and Power (CHP) Geothermal Power Plant
- Bjarnaflag Geothermal Power Plant
- Nesjavellir (CHP) Geothermal Power Plant
- Krafla Geothermal Power Plant
- Reykjanes Geothermal Power Plant
- Hellisheidi (CHP) Geothermal Power Plant
- Husavik Kalina Cycle Geothermal Power Plant

Outside of Iceland the company is applying their experience and expertise to projects in Europe and South America based largely on their innovations in Kalina technology, which allows the production of electricity from low temperature geothermal resources.

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Project example:

Hellisheiði Power Plant

Hellisheidi geothermal power plant is a combined heat and power plant (CHP) located in SW-Iceland, on one of the largest wet geothermal systems (high-enthalpy) in Iceland. The plant's purpose is to meet increasing demand for electricity and hot water for space heating. Development plans call for incremental or phased expansion from 2006 to 2010 to an estimated maximum output of 300 MWe and 400 MWth, making it the largest geothermal combined heat and power plant in Iceland. The plant owner is Reykjavik Energy.

The first phase included two high-pressure 45 MWe turbines that went online in October, 2006 and then one low pressure 33 MWe turbine went online in Fall, 2007. The most recent expansion phase consisted of two additional 45 MWe turbines that went online in Fall, 2008. The next expansion phase will be the first stage of the thermal power plant scheduled for 2010 and 2 x 45 MWe turbines in 2010.

Additional information:
Claus Ballzus: claus@mannvit.is
Kristinn Ingason: kristinn@mannvit.is

Hellisheidi Geothermal Power Plant details:

- Combined heat and power (CHP)
- Planned total output: 300MWe & 400MWth
- Phase 1: 2 x 45 MWe (90 MW total) went online October, 2006
- Phase 2: 33 MWe went online Fall, 2007
- Phase 3: 2 x 45 MWe, went online Fall, 2008
- Phase 4: First stage thermal power plant scheduled for 2010
- Phase 5: 2 x 45 MWe, scheduled for 2010
- 50 boreholes were drilled, from 1,000-2,200 meters

Mannvit services:

- Project management
- Overall plant design
- Environmental impact assessment
- Detailed mechanical design of the plant
- Detailed design of HVAC systems
- Bid preparation and tender evaluation
- Site supervision
- Commissioning
- Acceptance test
- Training of operators

Project example:

Nesjavellir Power Plant

The Nesjavellir geothermal field is a high-enthalpy geothermal system within the Hengill area of SW-Iceland. Construction of the geothermal power plant began in 1987 and the first stage of the thermal plant was commissioned in 1990, following an intensive drilling and testing phase in the 1980s. The last 30 MWe turbine generator unit was commissioned in 2005.

Nesjavellir Geothermal Power Plant details:

- Combined cycle geothermal plant
- 120 MWe, developed in three phases
- 300 MWth, or 1,800 liters/second of hot water at approximately 83° C
- 25 boreholes were drilled, from 1,000-2,200 meters

Mannvit Services:

- Project management
- Overall plant design
- Environmental impact assessment
- Detailed mechanical design of the plant
- Detailed design of HVAC systems
- Bid preparation and tender evaluation
- Site supervision
- Commissioning
- Acceptance test
- Training of operators

The Nesjavellir power plant is a combined heat and power plant (CHP) wherein it produces electricity and hot water for district heating. The plant itself is a combined cycle plant, wherein a mixture of steam and geothermal brine is transported from the wells to a central separation station at 200° C and 14 bars.

From there the fluid (steam and liquid) goes into a steam separator and the two phases are separated. Moisture is removed from the steam, which is then sent through the turbine after which it is condensed in a condenser. Within the condenser fresh water is preheated. The preheated fresh water is then run through a system of heat exchangers, which utilize the heat from the liquid part of the brine after the steam separator. The fresh water is heated to the required temperature and sent through deareators, which remove the bulk of the oxygen. Then finally a small amount of geothermal steam containing acidic gases (hydrogen sulfide) is injected into the water to remove any remaining oxygen, thereby preventing corrosion and scaling.

This hot water is then pumped to a large storage tank at an elevation of 406 meters. From there, the hot water flows by gravity to two smaller storage tanks on the outskirts of Reykjavik to be used for heating and hot tap water.

Additional information:

Claus Ballzus: claus@mannvit.is
Kristinn Ingason: kristinn@mannvit.is

Project example:

Kalina Power Plant

Iceland's first Kalina cycle geothermal power plant was designed and constructed by Mannvit. This project was done in collaboration with Exorka International Limited, a global sub-licensee for the Kalina power cycle technology.

The plant was installed in 1999 near the small town of Husavik, in Northern Iceland. This binary geothermal plant produces 2 MW from a geothermal brine flow of 90 kg/s at 120 °C. The plant was commissioned in mid-2000. The outgoing brine leaves the plant at 80 °C and is then used for district heating and other industrial uses.

This 2 MW plant will provide up to 80 percent of the town's electric power demand. The heat source for the plant will come from geothermal wells located 20 km south of Husavík.

The distinguishing trait of the Kalina Cycle is its working fluid of ammonia-water. The efficiency gain is achieved by the ability of this working fluid to closely parallel the temperature of the heat source (in this case – hot geothermal brine) and the heat sink (cooling water). Cost effective energy recuperation within the cycle is also possible due to the unique characteristics of the ammonia-water mixture.

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Claus Ballzus: claus@mannvit.is
Kristinn Ingason: kristinn@mannvit.is

MANNVIT
LEADERS IN GEOTHERMAL ENERGY

Mannvit hf.

Grensásvegi 1
108 Reykjavík
Iceland

@: mannvit@mannvit.is
w: www.mannvit.is

t: +354 422 3000
f: +354 422 3001