Geothermal Experience in Iceland

A Leader in the use of Renewable Resources

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National Energy Authority, Iceland, Poland, September 2017
Our Team

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Utilisation of Geothermal Energy in Iceland

Geothermal Experience In Iceland Lessons Learned

Baldur Pétursson, Manager International Projects and PR
Overview of Presentation

• Orkustofnun (National Energy Authority)

• Development of Hydropower and Geothermal District Heating (GeoDH) in Iceland

• Economic and Environmental Opportunities

• Geothermal Policy – Financial Support - Lessons Learned

• International Cooperation
  • UNU-GTP
  • World Bank Cooperation
  • EEA Grants
  • ERA NET
  • International Projects Cooperation
Role of Orkustofnun

- Research licence
- Utilisation licence
- Power Plant licence
- Transmission regulation
- Distribution regulation
- Ruling committee
  - Resource Act
- Ruling committee
  - Electricity Act
Share of Renewables in Total Primary Energy use 2014

Countries: Iceland, Norway, Sweden, Finland, Denmark, India, Germany, China, OECD-average, France, USA, UK, Japan, Russia

Sources: OECD, IEA, Samorka
Primary Energy Use in Iceland 1940-2015

Source: Orkustofnun Data Repository OS-2016-T002-01
Geothermal Electricity Generation

Electricity generation GWh/year


(1) Bjarnarflag 3,2 MW
(2) Svartsengi 76,4 MW
(3) Krafla 60 MW
(4) Nesjavellir 120 MW
(5) Húsavík 2 MW
(6) Reykjanes 100 MW
(7) Hellisheiði 303 MW

Source: Orkustofnun Data Repository OS-2016-T003-01
Geothermal Fields in Iceland

\[ T_{avg} = 0^\circ C \text{ (January)} \text{ to } 10^\circ C \text{ (July)} \text{ in Reykjavik} \]
The Oil Crises

History of crude oil prices

1862-1865
US Civil War drives up commodity prices; tax on competing illuminant raises demand for oil

1865-1890
Prices boom and bust with fluctuations in US drilling

1891-1894
Pennsylvania oilfields begin to decline, setting the stage for higher prices in 1895

1894
Cholera epidemic cuts production in Baku, Azerbaijan, contributing to 1895 spike

1920
Rapid adoption of the automobile drastically raises oil consumption, leading to the “West Coast Gasoline Famine”

1931
Prices hit record low as onset of Great Depression reduces demand

1947
Post-war automotive boom creates fuel shortages in some US states

1948
Demand response to supply shortage pushes prices down

1950-1956
Removal of US military from Iran and Nixon Doctrine

1958-1960
US production peaks

1961
Suez crisis takes 10% of world’s oil off the market — but production outside of the Middle East stymies a price spike in the interim

1965
India attacks Pakistan

1970-1974
Arab states institute embargo against countries supporting Israel in the Yom Kippur War

1973-1974
US oil production peaks

1975-1976
Saudi Arabia increases production to regain market share

1978
Iran, Iraq increase output with end of embargo

1978
Iraq, Iran increase output with end of embargo

1979
1979
Iranian Revolution

1980
Iran-Iraq War begins; exports from the region slow further

1982
1988
Demand and response to supply shortage pushes prices down

1986
1988
Iraq, Iran increase output with end of embargo

1980
1988
Iraq, Iran increase output with end of embargo

1980
1988
Iraq, Iran increase output with end of embargo

1990
1991
New Persian Gulf War

1990
1991
New Persian Gulf War

2001-2003
9/11 and invasion of Iraq raise concerns about Middle East stability; Venezuelan oil workers’ strike

2007-2008
Global Financial Crisis

2011
Arab Spring: civil war disrupts Libyan output

2014 YTD avg.
Strong non-OPEC production; weak demand growth; OPEC shifts toward maintaining market share

2015
Prices expected to fall further as the market searches for a new equilibrium
Expansion of GeoDH
Space Heating by Source 1970–2013

• Biggest steps in GeoDH were taken during the oil & war crises 1970 – 1982
• External conditions – raised the need of evaluation and GeoDH Planning
• Policy goals to increase geothermal – both national and within main cities
• It took only 12 years to increase GeoDH from 40% to 80% of total space heating
District Heating – Map of Iceland
Renewable Energy mitigates Global Warming

Activities and Opportunities by using Geothermal Resources

- Geothermal power station
- Binary fluid power station
- Drying of fruits and vegetables
- Carbonated drinks
- Mushroom drying
- Drying of cement
- Drying of onions
- Food processing
- Snow melting and de-icing
- Pulp and papermill
- Fish farming
- Concrete block curing
- Batheology
- Freezing and refrigeration
- Cloth drying
- Heating of greenhouses and soil-baking
- Domestic hot water
- Heating & cooling of buildings
- Soil warming
- Ethanol and biofuel production
- Evaporation in sugar refining
- Food processing & pasteurizing
- Biogas production
Comparison of Energy Prices for Residential Heating Mid year 2013

Sources: Orkustofnun 2014
Economic Benefits of Geothermal District Heating
National Savings by Geothermal District Heating,
as a % of GDP 1914–2013

- Savings are up to 7% of GDP or equivalent to
  - 3000 $ per capita per year, or
  - 12,000 $ per home with 4 persons, per year
- On average about 2% of GDP

Savings are defined as the difference in value between price of heating by oil and price of heating by GeoDH

Source: Orkustofnun, 2014
Reduction in CO$_2$ emissions in Reykjavík due to space heating

Source: Reykjavik Energy

Reykjavík – biggest District Heating network in the World

Renewable Energy mitigates Global Warming
Environmental Benefits of Geothermal Utilisation

Reykjavík 1933

Reykjavík today

Source: Reykjavik Energy
Renewable Energy mitigates Global Warming

Accumulative CO2 Savings using Renewables instead of oil in Iceland 1944-2014

**Annual CO2 Saving by Renewables in Iceland**
- equal to 18 million tons of CO2
- equal to 9 billion trees in bindings of CO2
- equal to 43 thousand square km of woods –
- equal to 41% of the size of Iceland
- equal to 6 million tons of oil annually

**Items for consideration**
- Important to show important results of renewables in fighting with CO2 - in visible terms – that can be understood - trees
- growth of renewables are going too slow
- global temp. are increasing faster than expected
- the climate risk is growing
- renewables / geothermal have a great potential – in fighting against rising climate risk

Orkustofnun Data Repository: OS-2015-T008-01
Renewable Energy mitigates Global Warming

Renewable savings of CO$_2$ 2014, was equal to additional wood covering 41% of Iceland

Source: Orkustofnun
Global Warming
The Paris Agreement 2015 – Relevant Action Needed
Global Warming

Temperature in February 1.35 °C on average warmer than 1951 – 1980, NASA
Global Warming

Five-year Global Temperature Anomalies from 1880 – 2015

1883 - 2100 (NASA)

1967 - 1971

> 44 years >

2011 - 2015

The future will depend on actions today

2050 - 2055

The future will depend on actions today

2094 - 2101
Global Warming

This time series shows global changes in the concentration and distribution of carbon dioxide from 2002-2016 at an altitude range of 1.9 to 8 miles. The yellow-to-red regions indicate higher concentrations of CO2, while blue-to-green areas indicate lower concentrations, measured in parts per million (ppm) (NASA).

The lifetime in the air of CO2, the most significant man-made greenhouse gas, is probably the most difficult to determine, because there are several processes that remove carbon dioxide from the atmosphere. Between 65% and 80% of CO2 released into the air dissolves into the ocean over a period of 20–200 years. The rest is removed by slower processes that take up to several hundreds of thousands of years, including chemical weathering and rock formation. This means that once in the atmosphere, carbon dioxide can continue to affect climate for thousands of years.

If CO2 is once in the air ➞ CO2 remains for very long time in the air - tens and hundred of years

CO2 that constantly increase the global temperature for very long time

CO2 is a long term global risk

https://climate.nasa.gov/interactives/climate-time-machine
Global Warming

This visualization shows the annual Arctic sea ice minimum from 1979 to 2014. At the end of each summer, the sea ice cover reaches its minimum extent, leaving what is called the perennial ice cover. The area of the perennial ice has been steadily decreasing since the satellite record began in 1979 (NASA).

35 or 70 more years - will the ice disappear – and if so – what about the sea level??

https://climate.nasa.gov/interactives/climate-time-machine
Global Warming

Recent satellite observations have detected a thinning of parts of the Greenland ice sheet at lower elevations. A partial melting of this ice sheet would cause a 1-meter (3-foot) rise. If melted completely, the Greenland ice sheet contains enough water to raise sea level by 5-7 meters (16-23 feet).

This visualization shows the effect on coastal regions for each meter of sea level rise, up to 6 meters (19.7 feet). Land that would be covered in water is shaded red.

https://climate.nasa.gov/interactives/climate-time-machine
Global Warming
More and more weather extremes

Flooding in Germany June 2013, damage 3 billion € - insurance claims

Flooding in Paris 2016

Philippines 2013

Long Island, New York “Frankenstorm”
Hurricane Sandy 2012
Global Warming
More and more weather extremes

Hurricane Irma, streets in central Miami 2017

Hurricane Harvey, Houston 2017
Global Warming
More and more weather extremes

Storm in Poland August 2017, 30,000 square km – destroyed
Global Warming

More and more weather extremes

Vatnajökull Iceland – Glacier Museum

1890

2000

2100

2200

ORKUSTOFNUN
National Energy Authority
Global Warming
More and more weather extremes
Vatnajökull Iceland – Glacier Museum
Global Warming

Ban Ki-moon: There is no plan B, because we have no planet B
Risk Mitigation

Lessons learned from Iceland

• Important to recognize the importance of GeoDH for
  • economy (savings),
  • energy security and
  • mitigate climate change

• Important to lower the risk of projects in the beginning e.g. by supporting exploration and test drilling

• Importance for Financial Institutions to recognise opportunities within GeoDH

• Validation geothermal resources through test drilling is capital intensive and risky
• Commercial financing for test drilling is hard to find
• Private equity and governmental support are the only capital to undertake test drilling

Sources: ESMAP, Report 2012
Lessons learned from Icelandic GeoDH Policy

1. **World wars and oil crises (1970 – 1980) highlighted the need for GeoDH Policy**
   - These global crises highlighted the necessity for GeoDH Policy in Iceland

2. **Political, Public, Sectoral and Financial - recognition for the GeoDH Policy**
   - For *energy security, economic and environmental* reasons (oil crises), the GeoDH policy was recognised at **national level and within main cities**
   - This political and sectoral recognition – was base for the policy and implementations

3. **Risk loans - for exploration drilling to lower the risk barriers for GeoDH operation**

4. **Financial support to homeowners for transformation to GeoDH**

5. **Finance / loans for drilling and building Geothermal District Heating (GeoDH)**

6. **Importance for Financial Institutions to recognise opportunities within GeoDH**

7. **Renewables for heating in Iceland is already saving up to 7% of GDP or equivalent 3000 US $ per capita per year**

8. **Favourable / neutral – Legal Framework**
Competitiveness of the Geothermal Sector
Success of Geothermal District Heating is based on 8 Key Factors

8 Key Elements of Success in the Geothermal Sector and District Heating

1. Authorities and regulation,
2. Geothermal resources,
3. Scientific & technical factors,
4. Education & human factors,
5. Access to capital,
6. Infrastructure and access to markets, sectors and other clusters,
7. Access to international markets and services,
8. The company, management, expertise & industry, clusters assessment

In cooperation with international and domestic experts, on geothermal resources, finance, legal, management and other expertise.

Source: Sölvell & Lindquist 2012, Amended, B. Petursson, National Energy Authority, 2014
The Geothermal Training Programme of the United Nations University (UNU-GTP) is a postgraduate training programme, aiming at assisting developing countries in capacity building within geothermal exploration and development. The programme consists of six months annual training for practicing professionals from developing and transitional countries with significant geothermal potential. Priority is given to countries where geothermal development is under way, in order to maximize technology transfer.
International Cooperation - Geothermal
Orkustofnun (Iceland) is the lead partner for
the European Geothermal ERA NET Cooperation

<table>
<thead>
<tr>
<th>Country</th>
<th>Partner</th>
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<tbody>
<tr>
<td>IS</td>
<td>Orkustofnun (National Energy Authority),</td>
</tr>
<tr>
<td>NL</td>
<td>Rijksdienst voor Ondernemend Nederland</td>
</tr>
<tr>
<td>CH</td>
<td>Swiss Federal Office of Energy (SFOE)</td>
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<tr>
<td>I</td>
<td>National Research Council of Italy (CNR)</td>
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<td>D</td>
<td>Jülich (PTJ)</td>
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<td>F</td>
<td>ADEME (BRGM as third party)</td>
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<tr>
<td>IS</td>
<td>Icelandic Centre for Research (RANNÍS)</td>
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<tr>
<td>TR</td>
<td>TÜBITAK (Scientific and Technological Research Council of Turkey)</td>
</tr>
<tr>
<td>SVK</td>
<td>Slovak Ministry of Education, Science, Research and Sport</td>
</tr>
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**New partners**

- MFIG Hungarian Geological and Geophysical Institute
- SED Slovenian Energy Directorate
- EAD Electricidade dos Acores

**Lead partner is Orkustofnun operating the Geothermal ERA NET Coordination Office**

**Good geographical balance** (North-West to South-East Europe) Partner countries chosen a.o. on basis of their 2020/2050 geothermal ambitions
ERA NET
three important Geothermal EU Pillars

More cooperation and communication necessary at European level, National level and Company level

Industry, RD&D, Banks, etc - Cooperation
• Practical information
• Using existing information
• Highlight barriers
• Financial - opportunities
• Awareness – building
• Policy - recommendation
Geothermal ERA NET – Objective
http://www.geothermaleranet.is/

Exchange information on the status of geothermal energy

Lay groundwork to create a European Geothermal Information Platform

Highlight barriers and recommend practical solutions

Recommend measures to Strengthen European Geothermal Development, for Economic Opportunities, Energy Security and Mitigate Climate Change
The Geothermal ERA - Opportunities

3 Factors Affecting Geothermal District Heating

- Awareness of Potential of GeoDH
- Financing
- Responsive Policy Environment

Conclusion:
International Cooperation – EEA Grants
Orkustofnun is Donor Program Partner (DPP) for Renewables in some Countries
Geothermal DH Potential in Europe
Actual Geothermal DH production towards the 2020 target (ktoe)

Source: EGEC
Hungary

- Renewable Energy Programme in Hungary (7,7 M€)
  - Focus on geothermal areas where a market for heat is in place (GeoDH)
  - Higher education in geothermal and specialized courses
  - Increase awareness and public acceptance
  - Icelandic expertise
  - UNU Program - education, training capacity building
  - Drilling in Kiskunhalas
Romania

• RONDINE Programme in Romania (12,3 M€)
  – Small hydro power plants across Romania.
  – Focus on geothermal areas
  – Icelandic expertise
  – UNU Program – education, training capacity building
  – Drilling and pump station in Oradea
  – Drilling and District Heating in Ilfov
Romania

Old coal power plant in Oradea is (500 MW) – closing and replaced by gas and geothermal resources – reducing emission, mitigating climate change and improve quality of life.
Romania

Various meetings and conferences in Romania and Iceland
Portugal

- GAia Programme in Portugal (4 M€)
  - Build 3 MW geothermal power plant in Terceira, Azores
  - Use existing high temperature production wells
  - Icelandic expertise
  - Six months training at UNU-GTP and short courses organized by the school
Pre-Feasibility Study of Geothermal District Heating in Beius, Romania

Final draft
April 2017

Pre-Feasibility Study Geothermal District Heating in Oradea, Romania

Final draft
April 2017

Romania
Bilateral Projects in Poland
Poddebice

Geothermal Energy Utilisation Potential in Poland – town Poddębice
Study Visits' Report
June 2017
Energy Supply Composition of District Heating Generated in 2013

Iceland

- Geothermal: 2.6%
- Other renewables: 97.4%

Poland

- Coal and coal products: 72.7%
- Natural gas: 12.0%
- Industrial surplus heat: 7.7%
- Renewable waste: 3.9%
- Oil and petroleum products: 3.5%
- Combustible renewables: 0.2%
- Non-renewable waste: 0.1%

District Heating Prices in Europe in 2013

Average District Heating Prices in Europe, the United States, Japan and S-Korea

Average price 5.5 c€/kWh excluding Japan

Source: Orkustofnun Data Repository: OS-2016-01. All prices are without VAT

* Subsidised Price, without VAT 2015.
Geothermal Policy Options and Instruments for Ukraine

Based on Icelandic and International Geothermal Experience

Report Prepared for the Ministry for Foreign Affairs in Iceland

April 2016
Geothermal Policy Options and Instruments for Ukraine

Ministry for Foreign Affairs, Iceland

Orkustofnun, National Energy Authority

European Bank for Reconstruction and Development

Financing green growth for a quarter of a century

The World Bank

State Agency on Energy Efficiency and Energy Saving of Ukraine

Institute for Renewable Energy, Kiev, Ukraine
Geothermal District Heating
Options and Possibilities in Europe

Geothermal cities in Europe with district heating systems

Geothermal heat at 2000 meters

proportion of NUTS-3 regions, where in 2000 m deep
4%: T > 200 °C
8%: 200 °C > T > 100 °C
19%: 100 °C > T > 60 °C
Benefits of Geothermal District Heating

GEOTHERMAL ENERGY – Offers Major Opportunities

1. Harnessing Natural Resources  
2. Economic opportunities and savings  
3. Improve energy security  
4. Reducing greenhouse gas emissions  
5. Reducing dependence on fossil fuels for energy use  
6. Improving industrial and economic activity  
7. Growing the low-Carbon and Geothermal technology industry, and create employment opportunities  
8. Improving quality of life
International Geothermal Projects with Icelandic Participation
Utilisation of Geothermal Energy in Iceland

Utilization of Low Temperature Geothermal Systems at Egilsstaðir-Fell, Iceland

Helga Tulinius, Senior Geophysicist
Contents

• Utilization of Low Temperature Geothermal Systems
• Egilsstaðir-Fell

• Evolution of
  – Flow rates
    • Dependence on weather
  – Water level
  – Water temperature

• How is increased utilization met?
Egilsstaðir-Fell, E-Iceland

• Domestic utilization of LT Systems

A geological map of Iceland showing the volcanic zones and geothermal areas
Egilsstaðir-Fell and surroundings

- A low temperature geothermal system lies under Urriðavatn
- Utilized from 1979 by Hitaveita Egilsstaða og Fella (HEF) – for 2900 inhabitants (2014)
- Common knowledge: Holes in the ice during long periods of freezing.
- Confirmed 1962 with 25°C and later up to 59.5°C in the lake.
Egilsstaðir-Fell and surroundings

- Geological studies from 1963, results:
  - tertiary basalts
  - potential for providing geothermal water for heating and domestic use
- Exploration wells drilled, the 4th one utilized at the end of 1979
- The following year well number 5 was drilled
- Nr. 4 and 5 were the main utilization wells until 1984
Egilsstaðir-Fell and surroundings

- Their main feed zones were at shallow depths and the water cooled within a year or two from 64°C to 53°C
- The next well did not meet expectations
- Review of available information at Orkustofunun/ÍSOR
  - Why did the wells cool so quickly?
  - How to avoid it?
  - How deep and where could warm and accessible feed zones and a more stable system for utilization be found?
Egilsstaðir-Fell and surroundings

- Electromagnetic soundings and geological investigations before drilling more wells
- Studies to find the geothermal gradient highest values in the lake
- The yellow line represents the direction of the low resistivity, often linked to temperature alteration minerals
- Dykes (black)
- All of these are consistent in a NNE-SSW direction, which is the main tectonic direction in the area
Egilsstaðir-Fell and surroundings

- Ten boreholes have been drilled so far
- Two mainly in operation, UV-10B and UV-8
- UV-8 was the main well until late in the year 2006
- UV-9 had not been up to expectations and had only been used for extra power when needed
- From 2006 UV-10B has been the main utilization well and UV-8 is used during maintenance or to rest the main well
UV-10B: Daily averages of flow rates and water level

- Water level:
  - Missing data during periods of maintenance or problems with the monitoring devices
  - Shows to be relatively stable, higher during parts of 2009 than 2008
  - Probably the well has recovered after being rested for a while

- Flow rate:
  - Periods of missing data, partly when UV-8 was producing, partly due to problems with the monitoring devices, e.g. 170 days in 2010
Urriðavatn – deducing flow rates from $T_{corr}$

- **A**: Daily averages of flow rate against daily temperatures including the wind effect ($T_{corr}$) from 2009 to 8 May 2010
  - Flow rate data was missing for 170 days in 2010, hence using data from 2009 and part of 2010 to account for all of the seasons
- **B**: Flow rates including deduced data (Using relation from Figure above)
  - The relation found from the figure above was used to deduce the flow rate during days of missing data
**Urriðavatn** - Monthly averages of flow rate and temperature

- **UV-8**: The water temperature
  - had gradually decreased down to 75.5°C while it was still the main well
  - In 2008 it was 75.2°C while producing for a while
  - Mixing with colder water? Confirmed with chemical analysis of water samples during the resting periods - less minerals

- **UV-10B main well from late 2006**:
  - Stable temperature from the beginning of monitoring, 77.7°C, indicating a stable system with respect to temperature
Urriðavatn, yearly utilization

• Flow rate has increased steadily from the beginning of utilization
  • During 1994 to 2004 more warm water was needed than the geothermal wells provided
    – A diesel station was used to warm up cold water for satisfying the domestic needs
  • After UV-10B became the main well
    – the flow rate from the geothermal system has been sufficient for the needs of the communities
    – The temperature of the water has not changed from 2008
    – Reminding that the system was almost considered “bankrupt”
Urriðavatn the future

- Make a heated beach at the lake (similar as in Reykjavík)
- Need more water
- Further modeling to forecast the respond of the reservoir to increased flow rate
- Drill new well(s)
Conclusions and recommendations

• Recommendations: Monitoring each well and each system is necessary to be able to
  – model and forecast the evolution of each system
  – take precautions and avoid overexploitation of the systems, possibly reinjection
Thank you

Dalvík

Takk fyrir

Egilsstaðir
Utilisation of Geothermal Energy in Iceland

District Heating in Iceland

Óskar P. Einarsson, Mechanical Engineer
District Heating in Iceland - History

- 13th century - Geothermal bath
- 1930: 70 buildings and a swimming pool in Reykjavik connected to geothermal district heating system
- 1943: Reykjavik Energy starts operation of a geothermal district heating system. Over 80% of buildings in Reykjavik connected.
- 1965: Pumping from geothermal wells begins
- 1976: Svartsengi geothermal power plant starts operation – Effluent water from a power plant used for district heating and other use.
- 1990: Nesjavellir power plant starts operation using geothermal steam to produce hot water for district heating in Reykjavík
District Heating – Map of Iceland
Geothermal Energy – Utilization

- Space heating: 54%
- Electricity generation: 28%
- Swimming pools: 4%
- Snow melting: 4%
- Industry: 2%
- Fish farming: 5%
- Greenhouses: 3%
District Heating – Installed Capacity

- Installed heating capacity in some geothermal district heating systems in Iceland:
  - Reykjavík Area: 1050 MW
  - Reykjanes Peninsula: 150 MW
  - Akureyri: 80 MW
  - Hveragerði: 65 MW
  - Húsavík: 11 MW
  - Stykkishólmur: 6 MW
Geothermal district heating system
  • Heat source
  • Temperature
  • Chemical content
  • Depth, Capacity, Flow rate from each well
Transmission pipeline from geothermal field to distribution system
Eventual peak load boiler
  • LOW ANNUAL ENERGY USE OF PEAK LOAD FUELS IN ICELAND
Distribution system
House connection and heating system in buildings
District Heating – Iceland vs. Other Countries

- Icelandic geothermal district heating
  - High temperature, 80-120°C
  - Water often used directly without heat exchangers
  - Peak load uncommon
  - Reinjection uncommon – open geothermal resource

- Other countries
  - Resource temperature lower, 40-80°C common
  - Closed distribution loop, heat exchangers
  - Peak load almost always needed
    - Heat pumps
    - Peak load boiler for coldest days
  - More complex systems than in Iceland
  - We have worked extensively in such systems in the past 20 years and adapted our knowledge accordingly
District Heating – Example from Stykkisholmur

- District heating in Stykkisholmur, West Iceland
  - 6 MWth, Operated for 20 years
  - Multi use: Swimming pool uses geothermal return water
  - Reservoir drawdown for the first 8 years in operation
- Reinjection implemented in 2007
  - Water level rose rapidly
  - Successful reinjection, no cooling of reservoir
- Heat exchangers and equipment added in 2015
  - Larger heat exchanger area, higher capacity
- Trouble-free operation in the last 2 years
- Similar system as in other countries
  - Closed-loop heating
  - Heat exchanger between geothermal fluid and DH loop
  - Reinjection
- Overall, a very successful project
Stykkisholmur – Recovery of Reservoir

Water-level depth (m)

00 01 02 03 04 05 06 07 08 09

HO-1
Stykkisholmur – HO-01 Production Well
Stykkisholmur – Heat Central, Exterior
Stykkisholmur – Heat Central, Interior
Utilisation of Geothermal Energy in Iceland

The utilization of geothermal energy and heat pumps. The Icelandic & Swedish experience

Friðfinnur K. Daníelsson, Mechanical Engineer
The volcanic activity has different faces!
Husafell, W-Iceland

- An example of a successful drilling!
- 25 l/s at 62°C. 6 bar artesian flow!
- The distribution network now covers 190 houses plus a hotel!
A heat pump in a geothermal country!

- Heat pump installed 1\textsuperscript{st} of April 2015.
- Has saved 1,97 GWh as of 15.09.2017 and already returned investment cost.
- Link to HP: [www.netbiter.net](http://www.netbiter.net)
  User name: alvarr
  Password: Skoli.vik
The heat pump plant in Lund, Sweden

- This heat pump plant was built > 30 years ago.
- It’s still running and doing fine.
It takes more than one person.

- The harnessing of geothermal energy requires a cluster of different expertise.
Thank you!

- Yet another successful drilling. 40 l/sec. 74°C 4 bar artesian pressure.
Geothermal Energy is a Powerful Tool to Fight Against Global Warming

Thank You