Role of the National Energy Authority

• Grants and monitors licenses for research and utilization of energy resources and power plant licenses
• Contracts and conducts research in the field of energy
• Maintains databases on the energy resources
• Informs the public on energy sources and utilisation
• Administers energy affairs and advises the minister
• Hosts the UNU Geothermal Training Programme
Legal framework in Iceland

• The ownership of geothermal resources is associated to land ownership.

• On public land resources in the ground are the property of the State of Iceland, unless others can prove their right of ownership.

• Research and utilisation is subject to licensing:
  – Act on Survey and Utilisation of Ground Resources, No. 57/1998
  – Electricity Act, No. 65/2003

• Survey, utilisation and other development pursuant to these Acts are also subject to the:
  – Nature Conservation Act
  – Planning and Building Act
  – Environmental Impact Assessment Act
  – Other acts relating to the survey and utilisation of land and land benefits.
Geothermal Fields in Iceland

$T_{avg} = 0^\circ\text{C (January) to } 10^\circ\text{C (July) in Reykjavik}$

- High temperature field
- Low temperature field

Bedrock
- < 0.8 m. years
- 0.8 - 3.3 m. years
- 3.3 - 15 m. years

In low temperature geothermal systems, temperatures in the uppermost 1,000 m may reach up to 150°C. In the high temperature fields, on the other hand, temperatures reach over 200°C at 1,000 m depth. High temperature geothermal areas are found within the active volcanic zone of Iceland.
Initial use of geothermal heat and electricity

- During Reykjavik’s first 1000 years geothermal heat was primarily used for washing, bathing and cooking.
- The first uses of geothermal energy to heat houses can be traced back to a farmer in 1908 who led a pipe to his farm.
- Extensive distribution of hot water for heating homes began in 1930 in the capital area.
- The first hydropower turbine began operation in 1904.

A borehole at Sudurreykir. The houses in the background are the ones first heated with geothermal water in Iceland in 1908.
1939-1943
18 km pipeline installed to Reykjavik

1943  200 l/s of 86° C water, 1300 houses connected
1945  2850 houses connected (population 44,000)
1960-1990

Deeper wells and downhole pumps installed

- Initially only artesian flow from springs and relatively shallow drill holes was used for district heating in Reykjavik.
- In the sixties and early seventies deep production wells were drilled in all the fields and downhole pumps installed, multiplying the flowrate from the fields.
Oil Crisis Changes National Policy

- When the oil crisis struck in the early 1970s, the world market price for crude oil rose by 70%.
- Heat from oil served over 50% of the population.
- In order to reduce the effect of rising oil prices, Iceland began subsidizing those who used oil for space heating.
- The oil crises in caused Iceland to change its policy, deemphasizing oil, turning to domestic energy resources, hydropower and geothermal heat.

Why so successful?

• No private developers willing to fund
• The National Energy Fund (NEF) provided risk insurance:
  – NEF would reimburse up to 80% of cost of unsuccessful drillings.
  – Later on it included grant support for geothermal development, mainly for exploratory activities.
  – NEF played a critical role in enhancing the development
Laugarnes

- Area: 0.28 km$^2$
- Heat: 125-130 °C
- Max capacity: 330 l/s
- Wells: 10
Four wells can be seen from the Grand Hotel
Comparison of energy prices for residential heating

- Geothermal power and heat is cost competitive with large hydro in Iceland and is not subsidised

- Direct oil and electrical heating is subsidized in Iceland for regional purposes
Avoided cost by harnessing a domestic source of energy

Savings in 2008 equivalent to 91% of the total imports of refined oil products.
Primary Energy Use 1940-2010
Highlights for 2011

- All stationary energy is renewable
- 86% of primary energy is renewable
- Oil still needed for 14% of the primary energy demand
  - About half to operate the fishing fleet
  - The other half mainly for motor vehicles
- Electricity generation amounted to 17.2 TWh
  - Hydro power plants 73%
  - Geothermal power plants 27%
  - 77% to the power intensive industry
- 99% of houses heated with renewables
Geothermal Energy Utilisation
Sectoral Share

- Swimming pools: 4%
- Snow melting: 4%
- Industry: 2%
- Fish farming: 4%
- Greenhouses: 2%
- Electricity generation: 39%
- Space heating: 45%

Total 41.7 PJ
Geothermal Electricity Generation

Electricity Generation (GWh/year)

- Bjarnarflag 3.2 MW
- Hellisheiði 213 MW
- Reykjanes 100 MW
- Húsavík 2 MW
- Nesjavellir 120 MW
- Krafla 60 MW
- Svartsengi 76.4 MW

Years:
- 1969
- 1974
- 1979
- 1984
- 1994
- 1999
- 2004
- 2009
Looking ahead…
Master Plan for hydro and geothermal energy resources in Iceland

• Parliament started the work in 1997
• Proposed power projects are evaluated on the basis of:
  – Environmental impact
  – Social impact
  – Economical impact
• Projects are then categorized
  – To be developed
  – To be protected
  – To be considered
• Has been presented to the Parliament for legislation

<table>
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<th>Potential Power</th>
<th>Hydro TWh/a</th>
<th>Geoth. TWh/a</th>
<th>% of Total</th>
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<td>To be protected</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>31</strong></td>
<td><strong>35</strong></td>
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</table>
The Research Project IDDP
The hottest well in the World

• By joining forces of key players Iceland has been able to pull off one of the most promising research projects.

• The IDDP-1 well drilled in Krafla is at the moment the hottest well in the word with a temperature of 450°C at 40 bar pressure and 12 kg/s steam flow on surface with an estimated 25-35 MWe electric production capacity

• Second well in preparation in Reykjanes

• Previously mentioned reserve estimates exclude supercritical resources
GEORG was founded early 2009 with the support of the Science and Technology Policy Council in Iceland through their Centers of Excellence and Research Clusters – program. The support amount to 70MISK per year for seven years.

GEORG is a partnership of 22 partners, combining all major players on geothermal research and utilization in Iceland and their key international collaborators.

GEORG creates a platform for joint effort to strengthen research and development of innovations in the field of geothermal energy.

GEORG has supported numerous interesting projects on various aspects of geothermal research and utilization.
Merci / Takk fyrir