How policy, technology and innovation can foster geothermal district heating development

An Icelandic case study

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Overview

• Reykjavík district heating – forerunner of geothermal utilization in Iceland

• The Westman Islands Enhanced Geothermal District Heating System – The lava district heating system

*The first EGS system in the world?*
Laundry springs in Reykjavík
Reykjavík district heating - Milestones

• 1930 – Laugaveita → 14 l/s, 87°C hot water

• 1943 – Reykjaveita → 200 l/s, 86°C hot water

• 1958 – Deep wells drilled - Deep well pumps developed

• 1970 – All houses in Reykjavík connected

• 1990 – Nesjavellir CHP → 1680 l/s, 83°C hot water, 300 MW_{th}

• 2013 – Hellisheiði CHP → 800 l/s, 85°C hot water, 150 MW_{th}

• 2016 – 190,000 people connected
Austurbæjarskóli, connected 1930
Vote for the district heating today!

Announcement regarding house heating systems

Due to plans of installing district heating in Reykjavik, those who are constructing new houses or renovating old ones shall install heating systems that can fully utilize the new district heating!
The first Reykir piping main installed in 1943

14 km, 2 x 14 in seamless steel pipes from the USA
Insulation with Icelandic turf
In the 1960’s
Reykjavík district heating development

Construction phases

1908 - 1938
Reykjavík district heating development
Reykjavík district heating development
Reykjavík district heating development
Reykjavík district heating development

Construction phases:
- 1908 - 1938
- 1939 - 1944
- 1945 - 1961
- 1962 - 1972
- 1973 - 1977
Reykjavík district heating development
Reykjavík district heating development
Reykjavík geothermal fields – $1GW_{th}$

• Laugarnes → 10 wells, 340 l/s, 125 – 130°C, 125 MW$_{th}$
• Ellidaar → 8 wells, 260 l/s, 85 – 95°C, 50 MW$_{th}$
• Reykir – Reykjahlid → 34 wells, 1980 l/s, 85 – 100°C, 375 MW$_{th}$
• Nesjavellir – CHP → Heated & de-aerated cold water, 1680l/s, 83°C, 300 MW$_{th}$
• Hellisheiði – CHP → Heated & de-aerated cold water, 800l/s, 85°C, 150 MW$_{th}$
Reykjavík today – 100% heated with geothermal
January 23\textsuperscript{rd} 1973 - Eruption at Heimaey
1.5 km long volcanic fissure opened in the east part of the island
Heimay - Westman islands

- 1973: 5,300 inhabitants
- Lava field:
  - 250 million cubic meters
  - Thickness 100-130 m
  - Estimated energy contained: 250 million megawatt hours
- Increased island area from 11.2 km$^2$ to 13.44 km$^2$
The “wise guys”
Lava district heating system

Main system components:
- House heating systems
- District heating system
- Pumping station
- Supply/return piping
- Heat exchanger
- Steam Collector
District heating system
Supply and return water pipes from the pumping station
A steam collector installation
Steam collector site

Steam pipe connected to the cave part of the heat exchanger

Plastic cover

Steam collector covered with permeable lava rocks
“Cave and tube” heat exchangers
The tube bundle
Prefabrcicated concrete “cave” covers for the heat exchangers
The town, seen from one of the production areas
Milestones and latest development

- 1973 Eruption in Heimaey, one of the Westman islands
- 1975 Installation of the district heating system started
- 1977 Heating with lava energy starts; + 3 MW peak load oil boiler
- 1988 Electrical boiler installed, 20 MW + 2 x 7 MW oil boilers as backup
- 1998 Waste heat harnessed from a waste heat boiler
- 2000 Waste heat from fishing industry added to the system
- 2016: 4,300 inhabitants on the island,
  - Installed power: 20 MW
  - Energy consumption: 67 GWh p.a.,
  - 81% electricity, 9% from waste heat boilers, 6% fish processing factories and 4% oil.
- 2017-2018: 3-9 MW seawater heat pump

The key: Correctly designed district heating system and house heating systems that can harness low grade heating energy
The town of Heimay today

Do what you can with what you have where you are.
(Theodore Roosevelt)
Thank you for your attention
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