# Geothermal Experience in Iceland

Iceland Liechtenstein Norway grants


**Baldur Pétursson, Manager International Projects and PR**
**Helga Tulinius, Reservoir / Senior Geophysicist**
**Óskar P. Einarsson, Mechanical Engineer**
**Friðfinnur K. Daníelsson, Mechanical Engineer**

**National Energy Authority, Iceland,**
**Poland, September 2017**

# Our Team

- **Baldur Pétursson, Manager International Projects and PR**
- **Helga Tulinius, Reservoir / Senior Geophysicist**
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- **Friðfinnur K. Daníelsson, Mechanical Engineer**

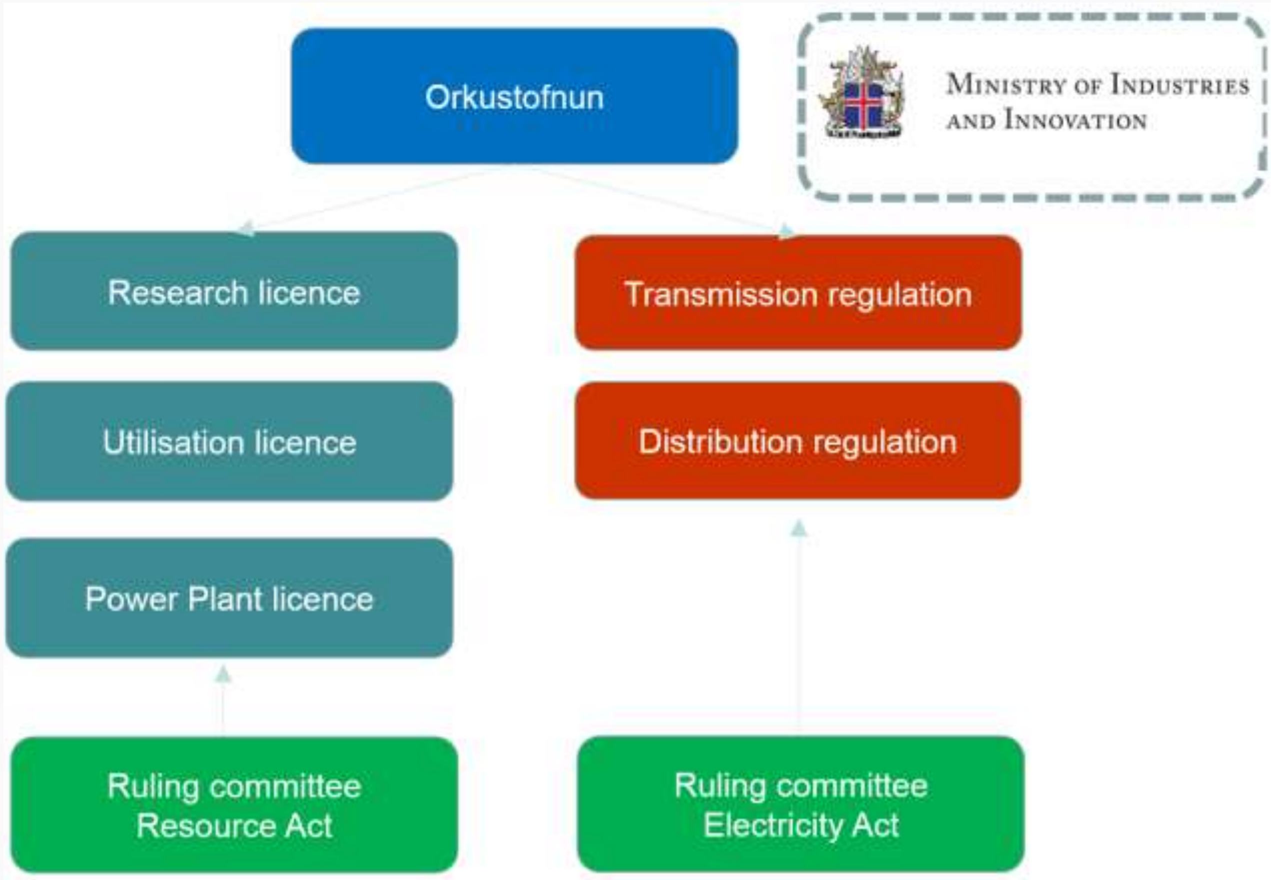
# Geothermal Experience In Iceland Lessons Learned

**Baldur Pétursson,**
**Manager International Projects and PR**

# Overview of Presentation

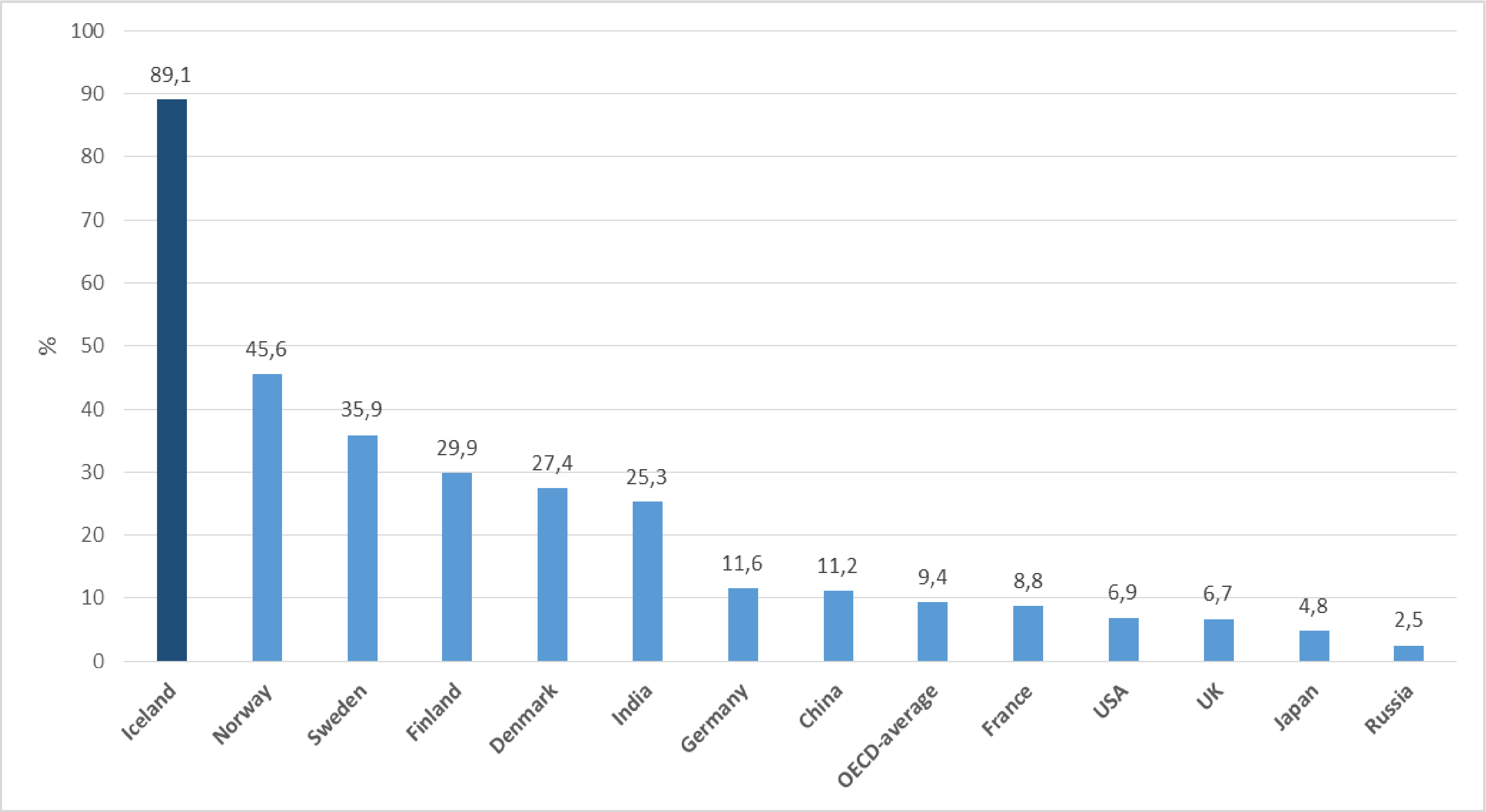
- Orkustofnun (National Energy Authority)
- Development of Hydropower and Geothermal District Heating (GeoDH) in Iceland
- Economic and Environmental Opportunities
- Geothermal Policy – Financial Support - Lessons Learned
- International Cooperation
    - UNU-GTP
    - World Bank Cooperation
    - EEA Grants
    - ERA NET
    - International Projects Cooperation

# Role of Orkustofnun




# Share of Renewables in Total Primary Energy use 2014

%




Sources: OECD, IEA, Samorka

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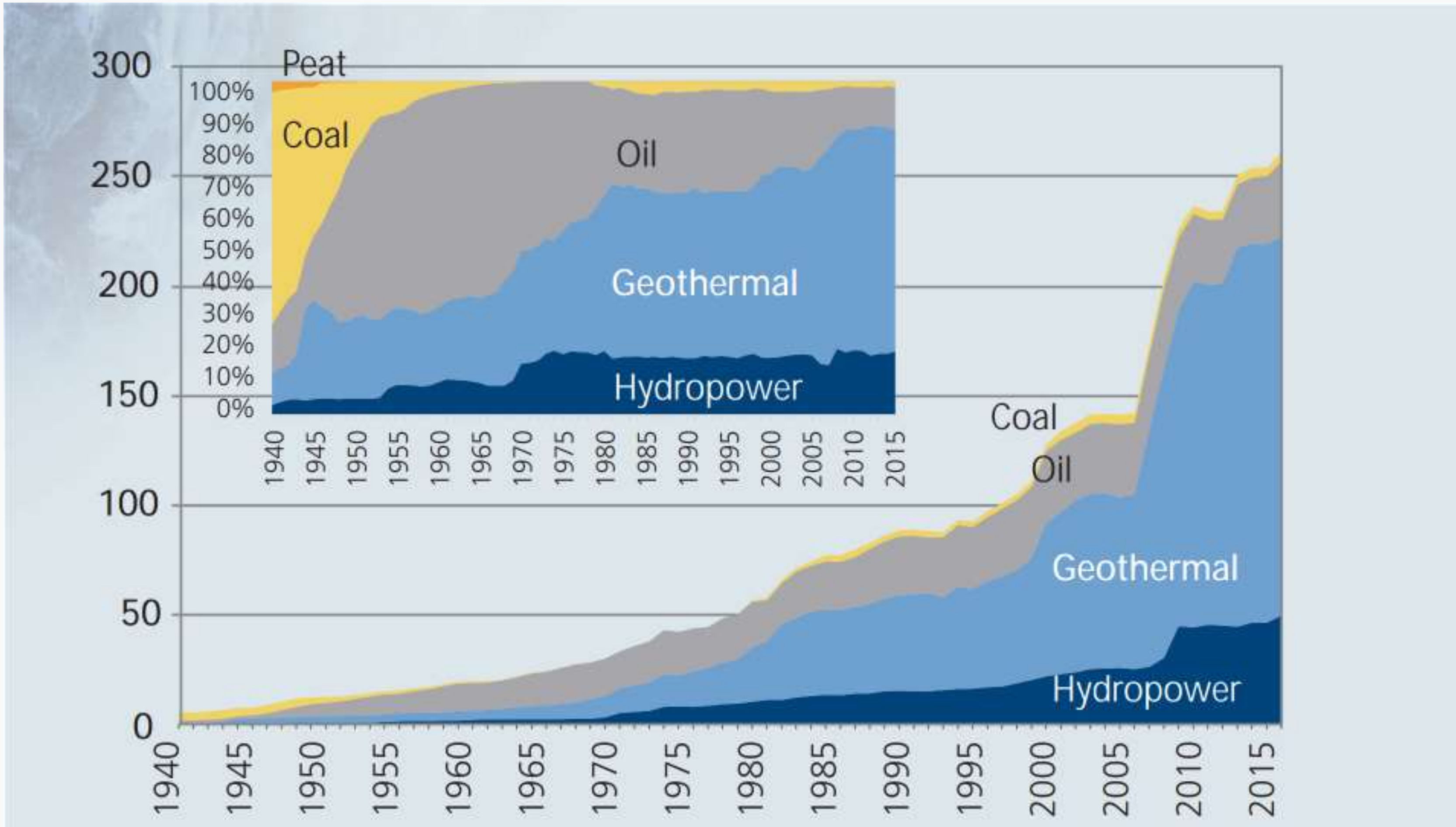
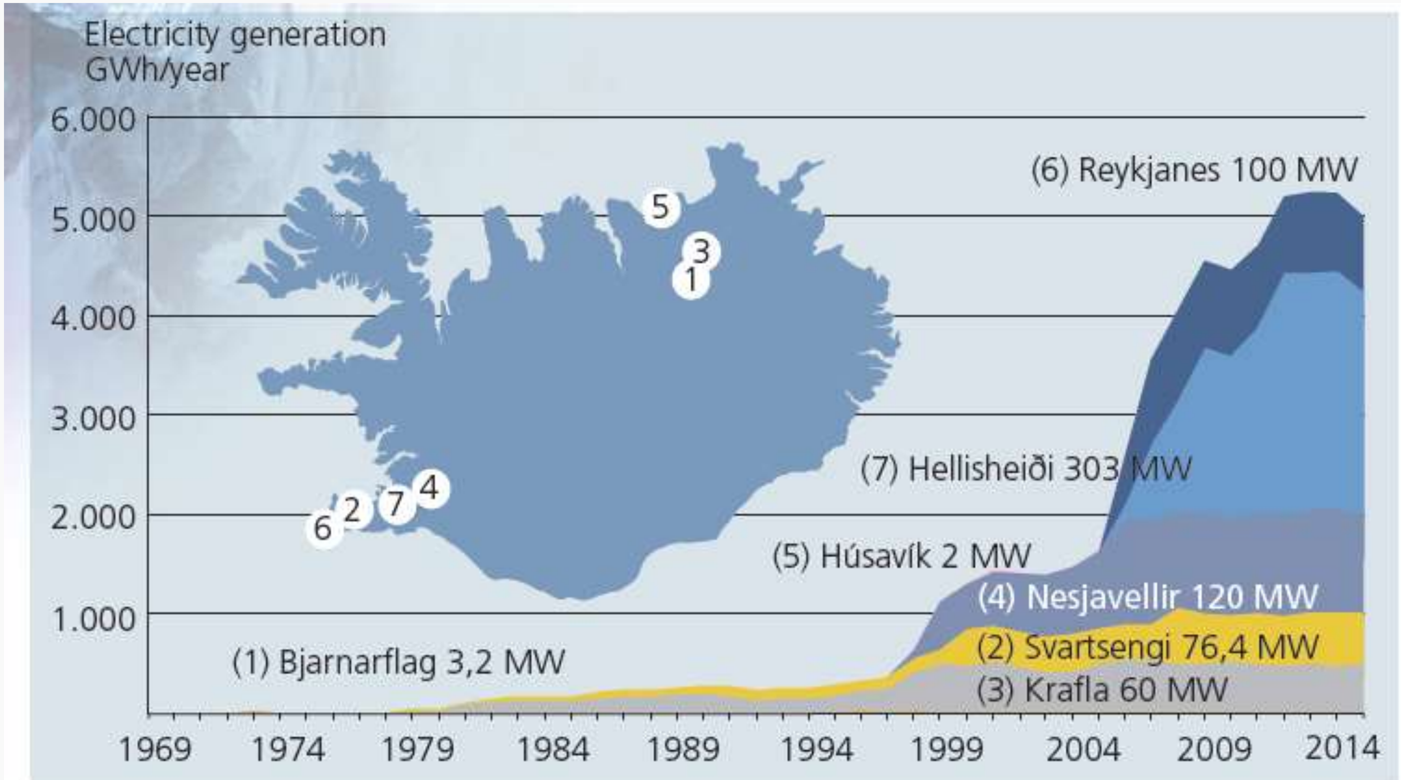
# Primary Energy Use in Iceland 1940-2015




Source: Orkustofnun Data Repository OS-2016-T002-01

# Geothermal Electricity Generation




Source: Orkustofnun Data Repository OS-2016-T003-01





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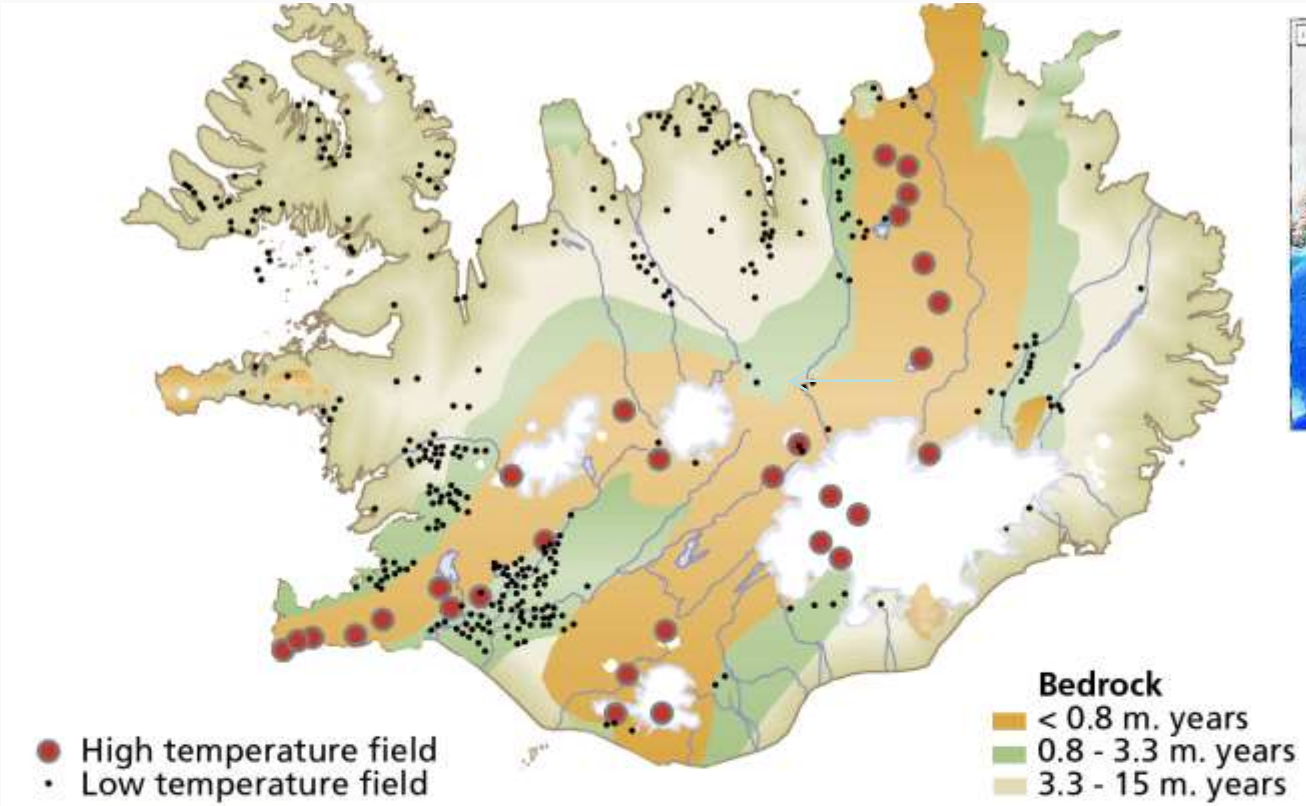
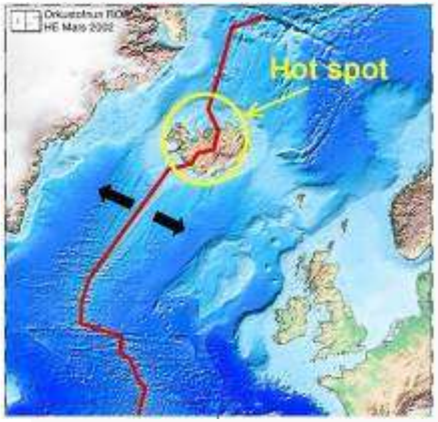
# Geothermal Fields in Iceland




$T_{avg}$ = 0°C (january) to 10°C (july) in Reykjavík

**High and low temperature**

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.

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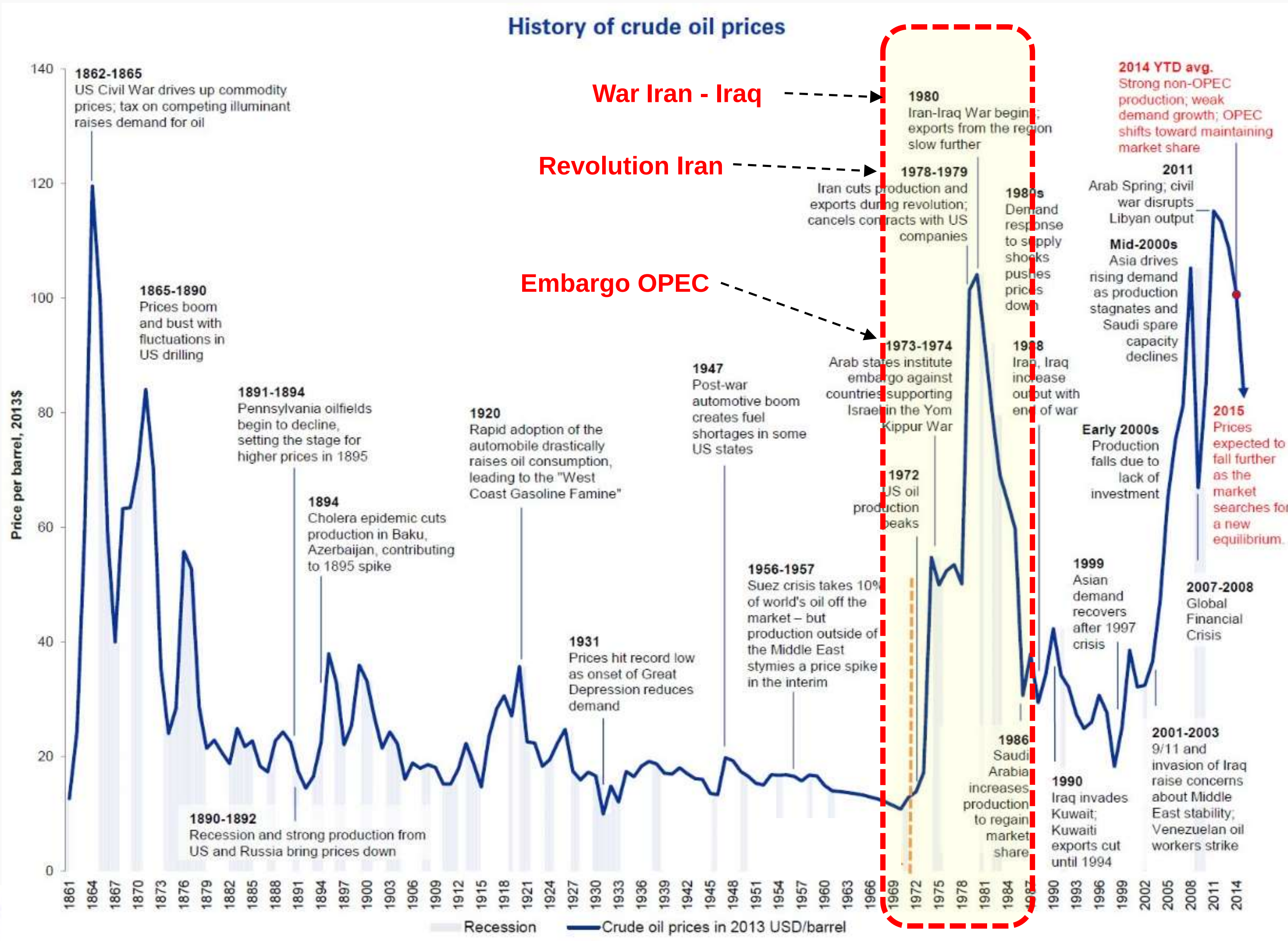
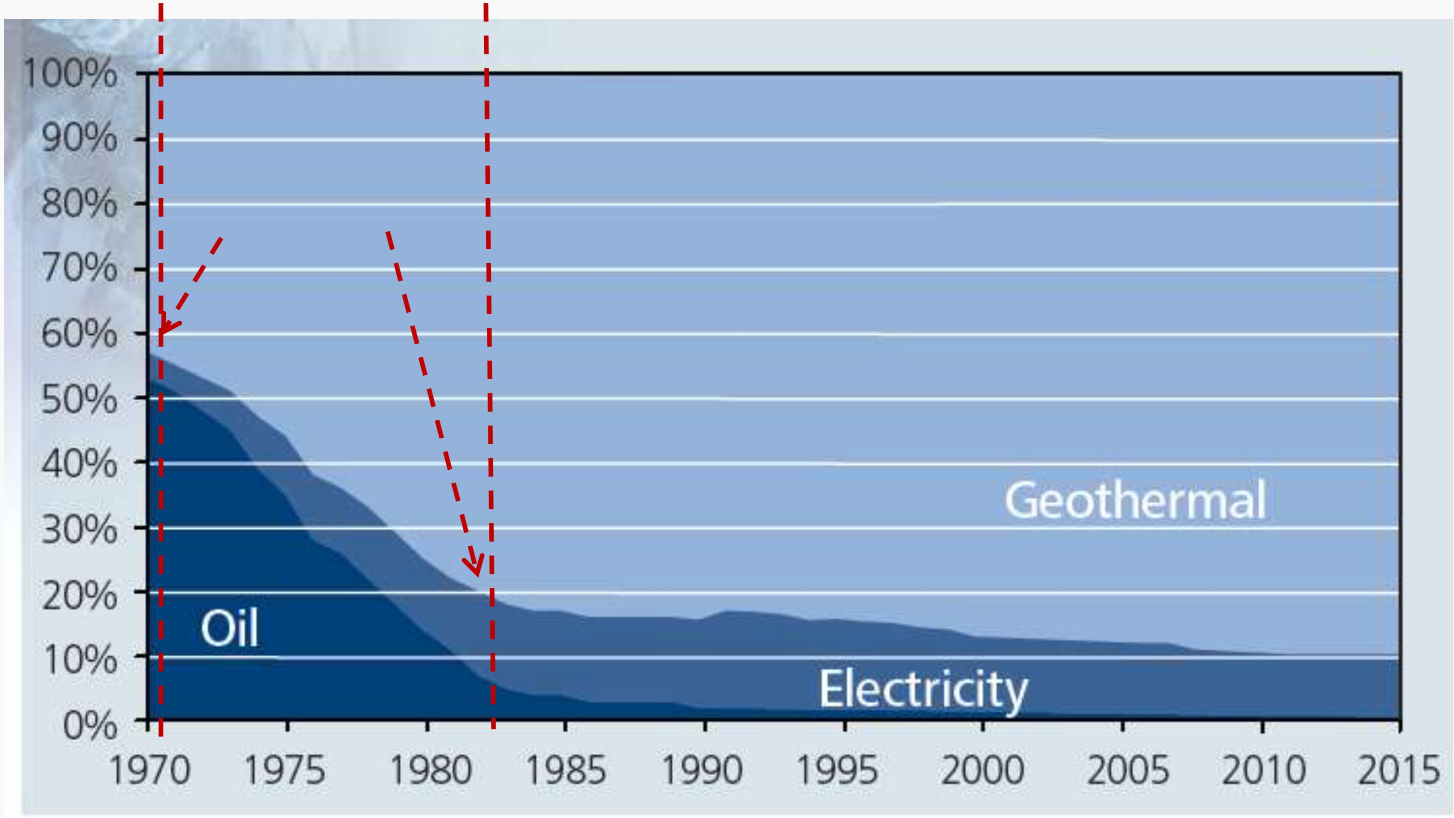
# The Oil Crises



# Expansion of GeoDH

## Space Heating by Source 1970–2013

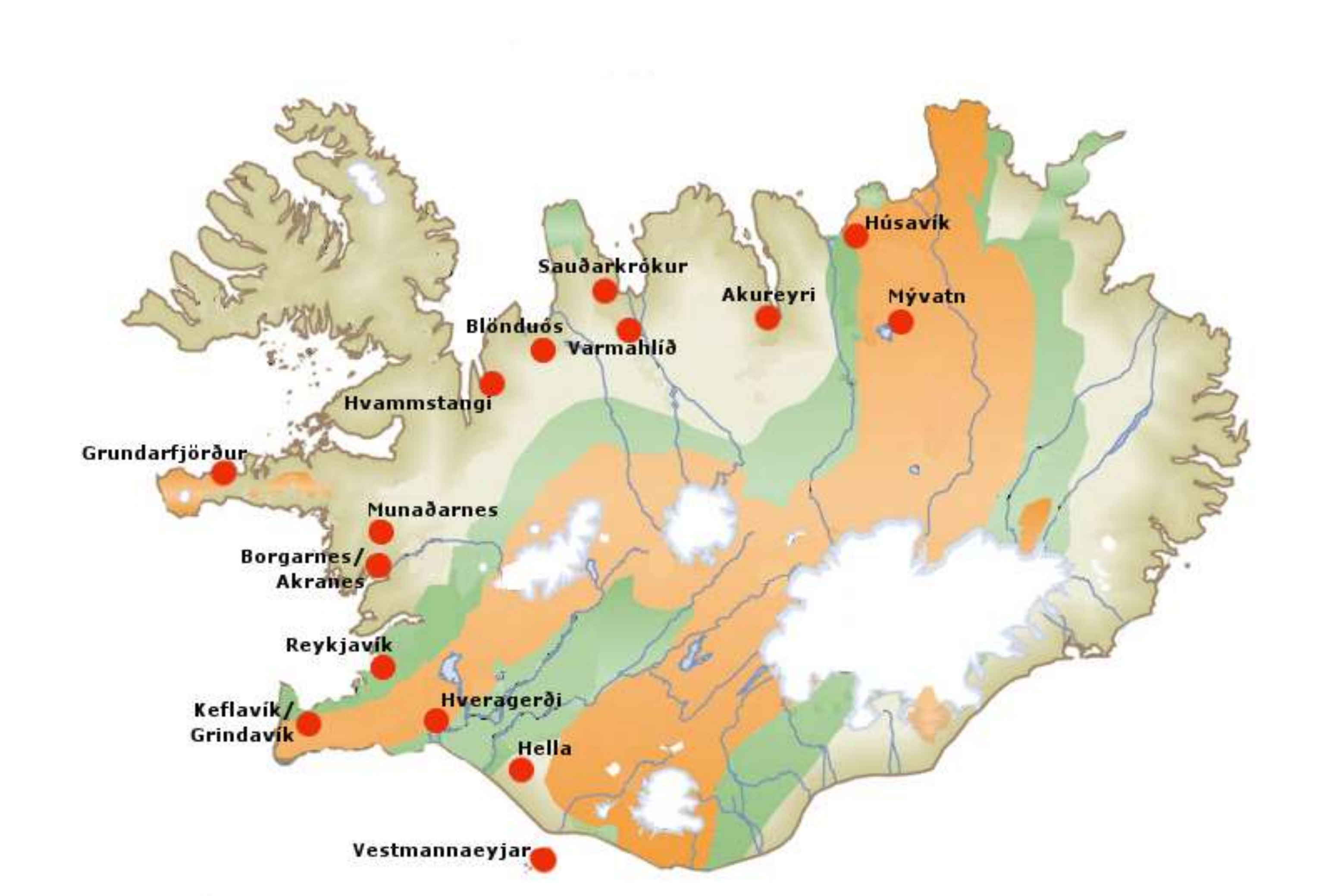
- Biggest steps in GeoDH were taken during the oil & war crises 1970 – 1982
- External conditions – raised the need of evaluation and GeoDH Planning
- Policy goals to increase geothermal – both national and within main cities
- It took only **12** years to increase GeoDH from **40% to 80%** of total space heating




Source: Orkustofnun

OR...
National Energy Authority

# District Heating – Map of Iceland

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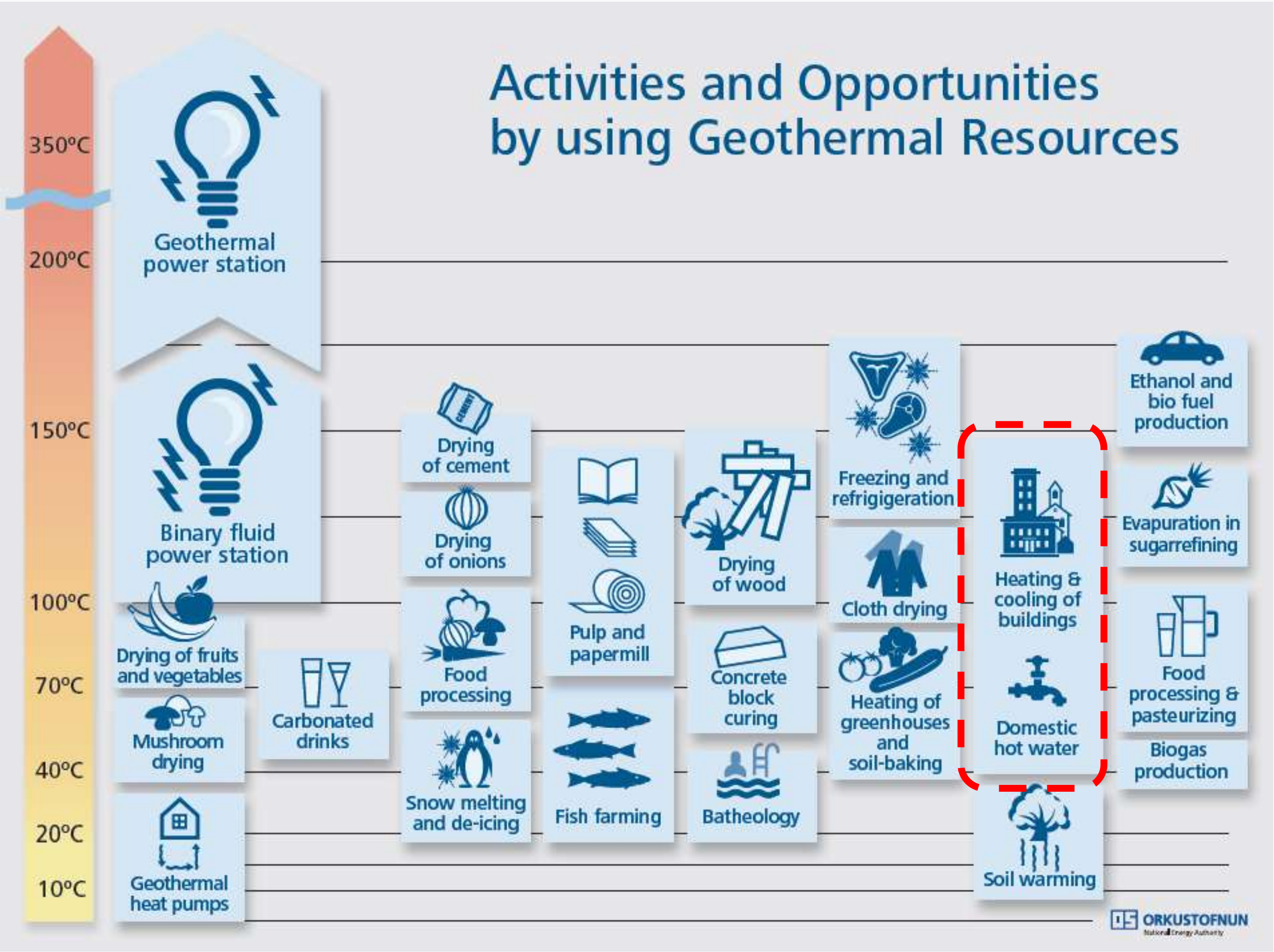
# Renewable Energy mitigates Global Warming

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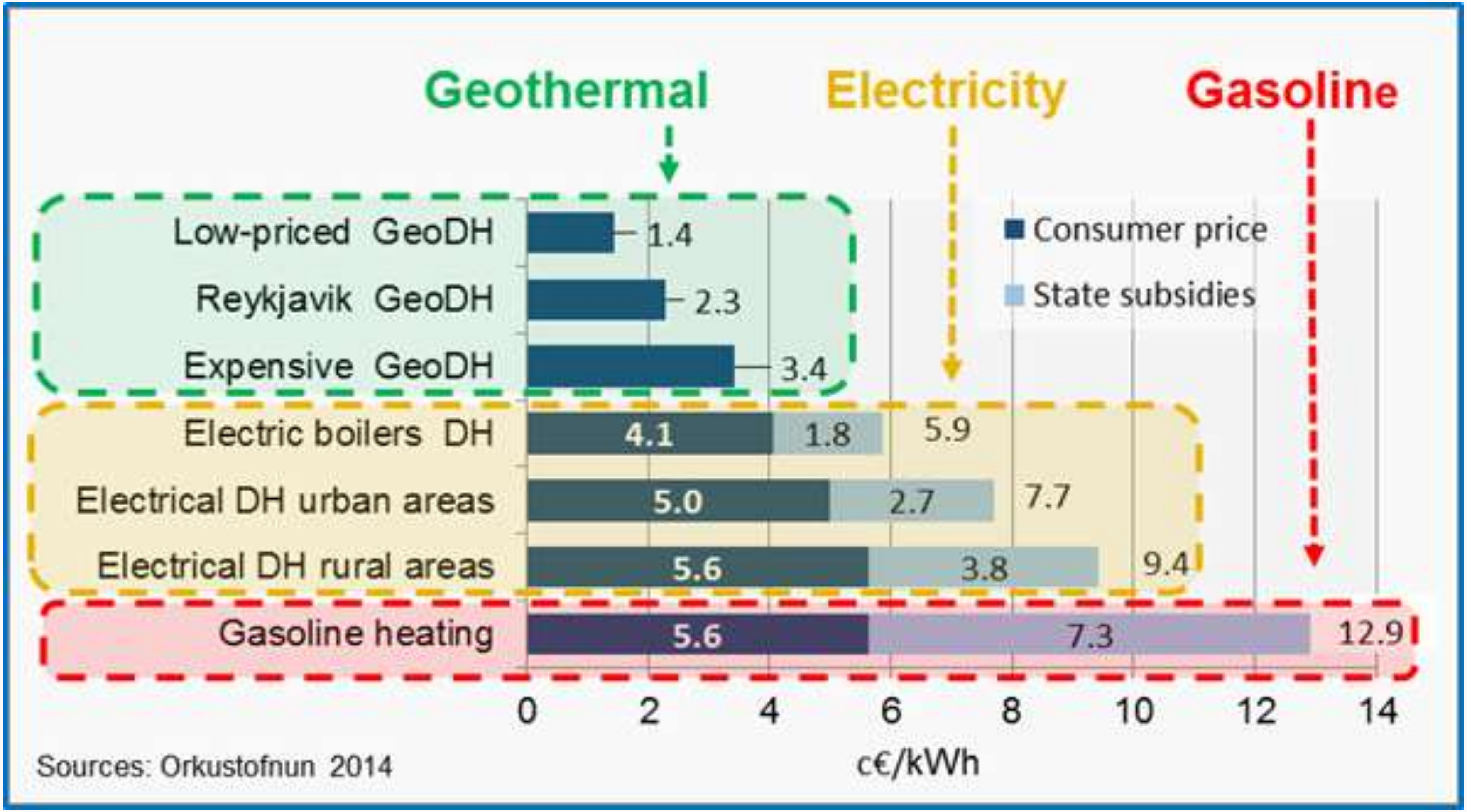
# Comparison of Energy Prices for Residential Heating Mid year 2013

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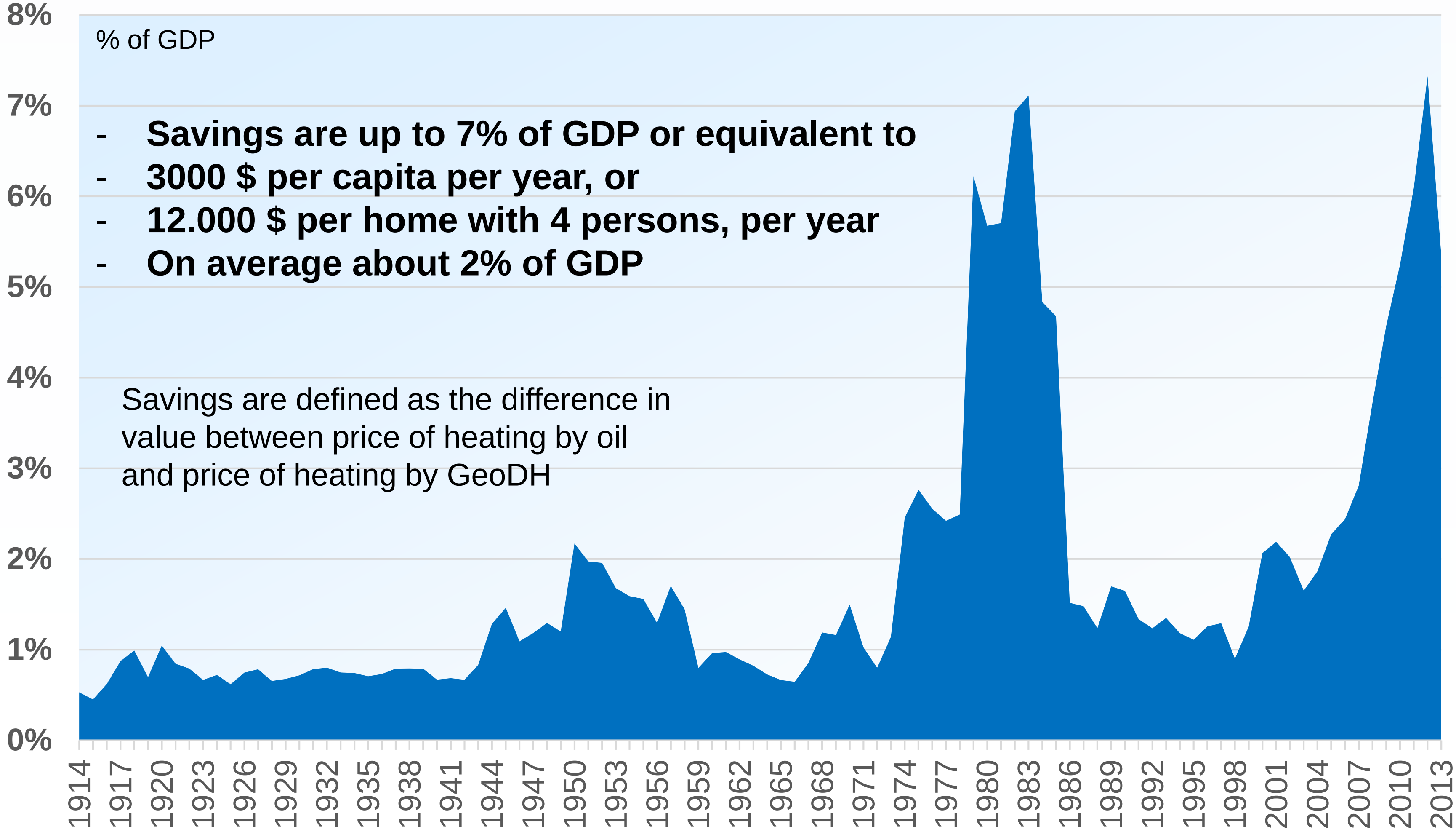
# Economic Benefits of Geothermal District Heating
# National Savings by Geothermal District Heating,
## as a % of GDP 1914–2013




Source: Orkustofnun, 2014

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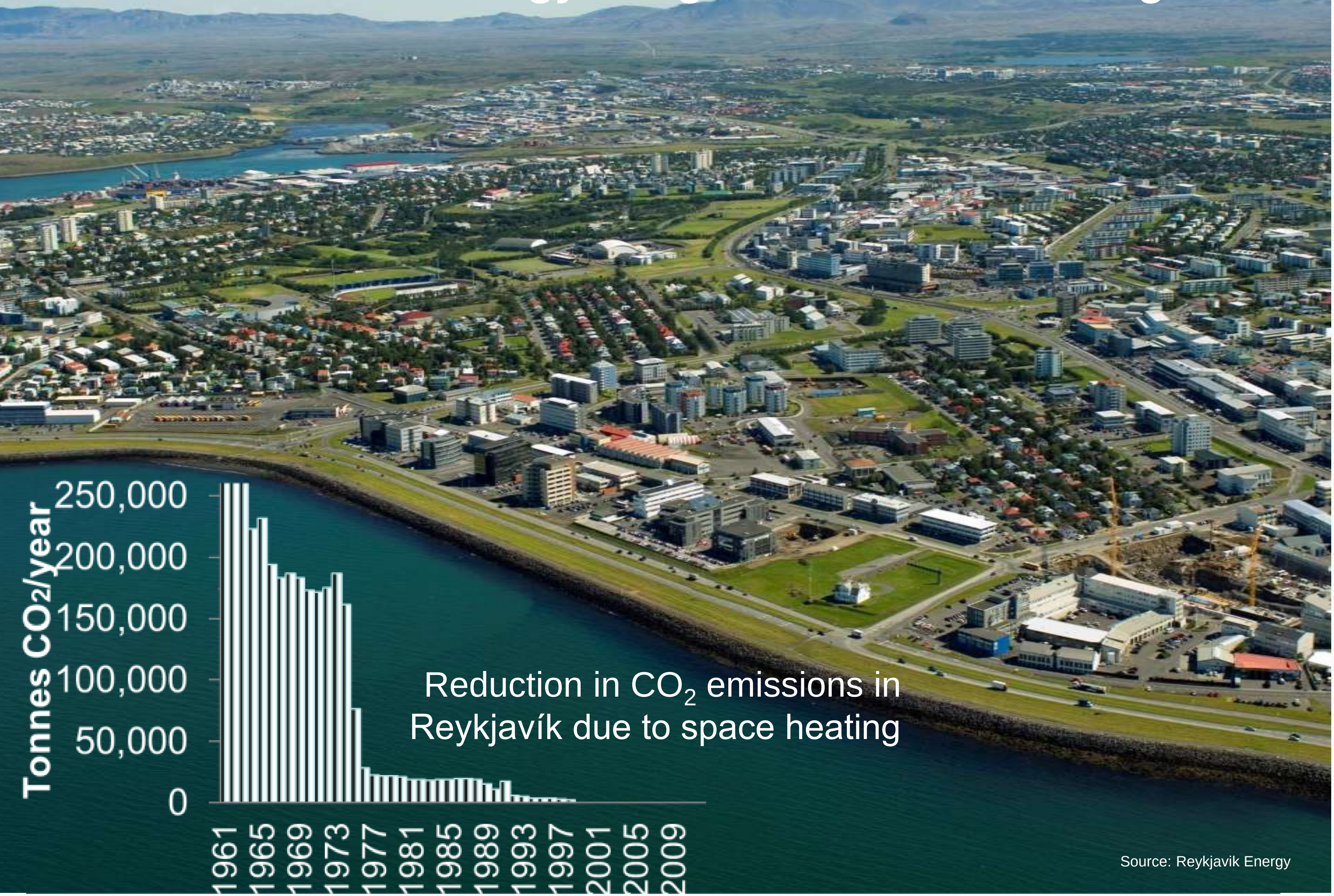
# Reykjavik – biggest District Heating network in the World
# Renewable Energy mitigates Global Warming




Source: Reykjavik Energy

# Environmental Benefits of Geothermal Utilisation

Reykjavík 1933

Reykjavík today

Source: Reykjavik Energy

# Renewable Energy mitigates Global Warming

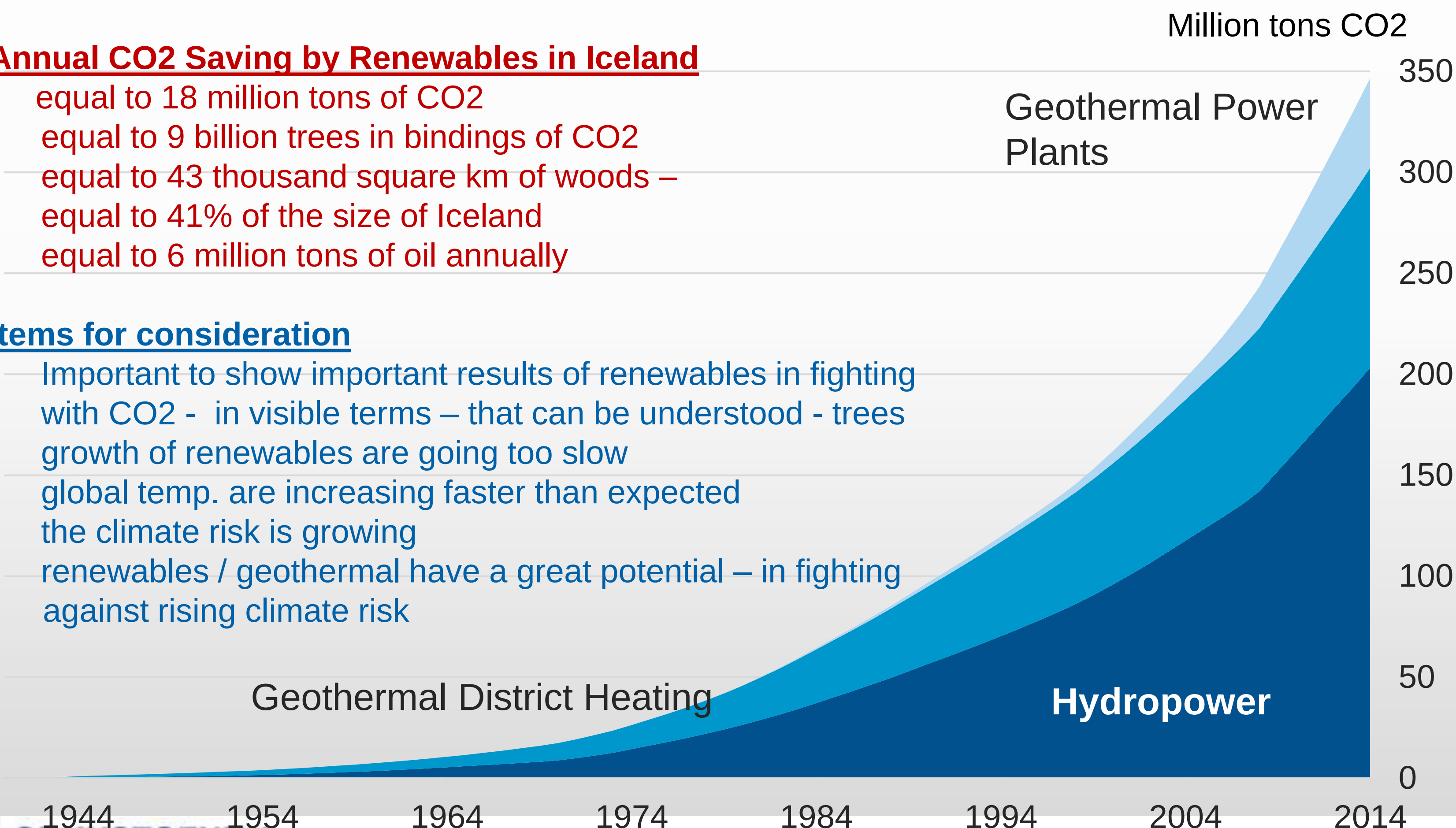
## Accumulative CO2 Savings using Renewables instead of oil in Iceland 1944-2014

**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

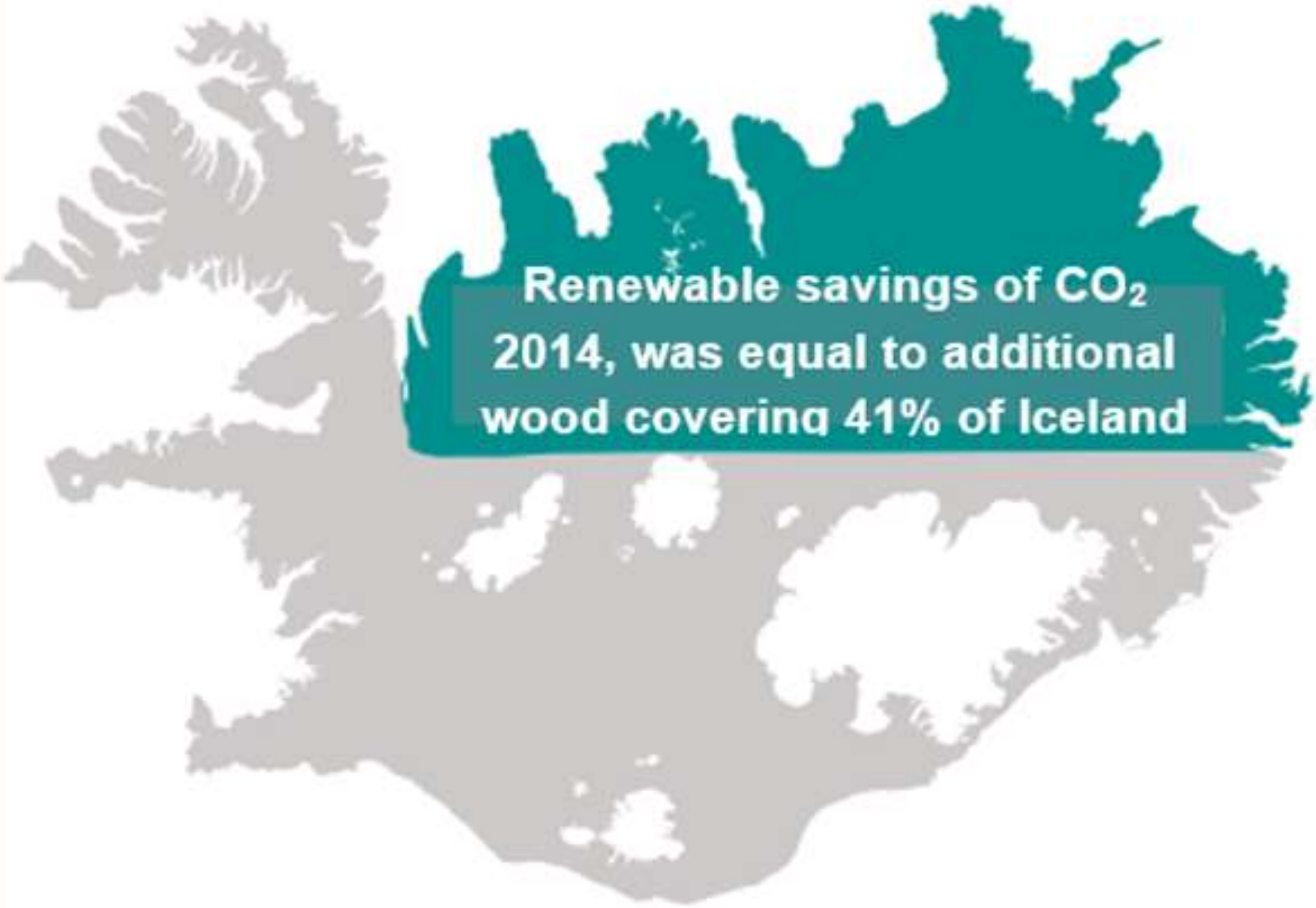
**Items for consideration**

- 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



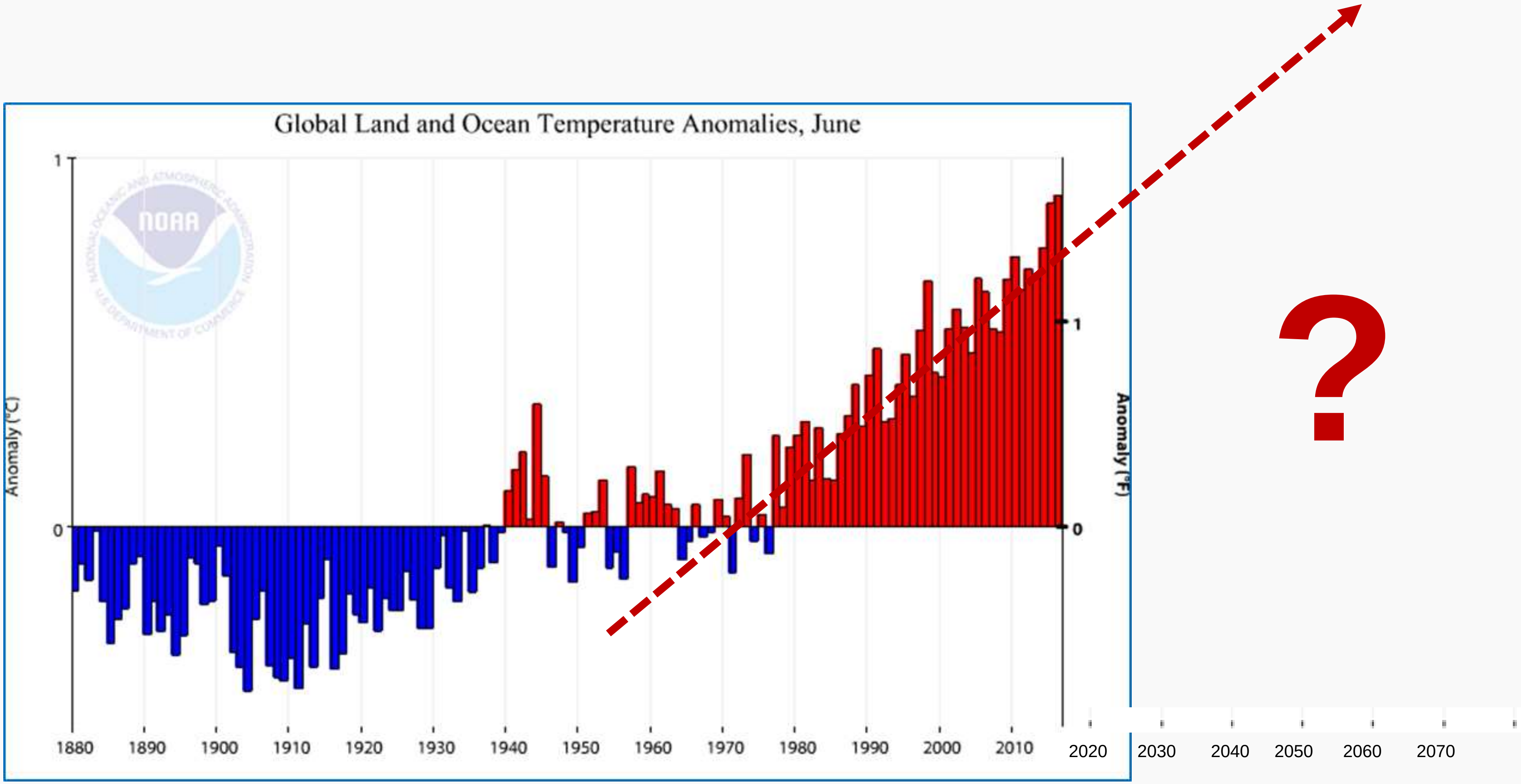

Source: Orkustofnun

# Global Warming

## The Paris Agreement 2015 – Relevant Action Needed

# Global Warming

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

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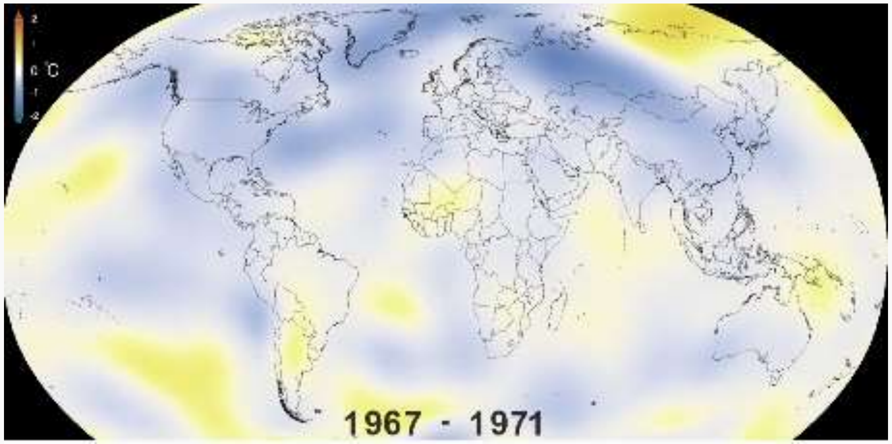
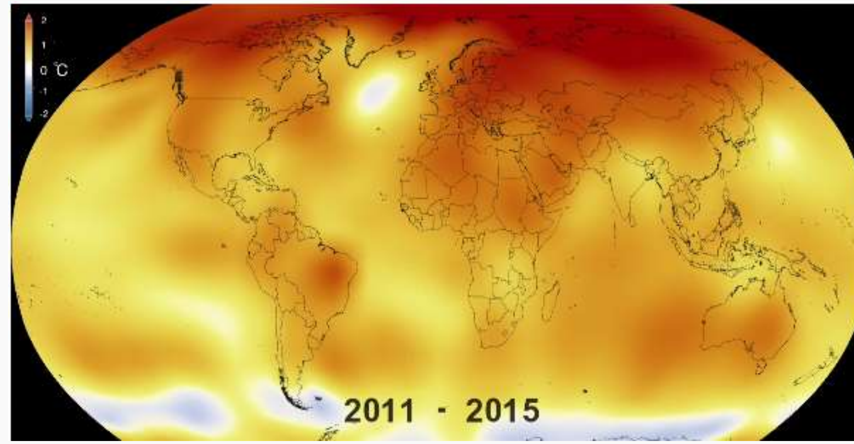
# Global Warming

## Five-year Global Temperature Anomalies from 1880 – 2015
## 1883 - 2100 (NASA)

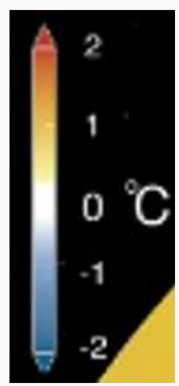



**1967 - 1971** **> 44 years >** **2011 - 2015**

**The future**
will depends on
**actions today**
**?**

**2050 - 2055**

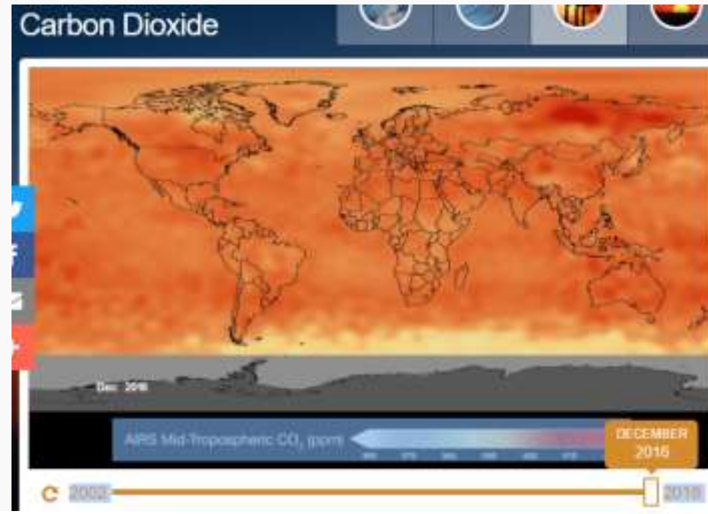



**The future**
will depends on
**actions today**
**?**

**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 $CO_2$, while blue-to-green areas indicate lower concentrations, measured in parts per million (ppm) (NASA)

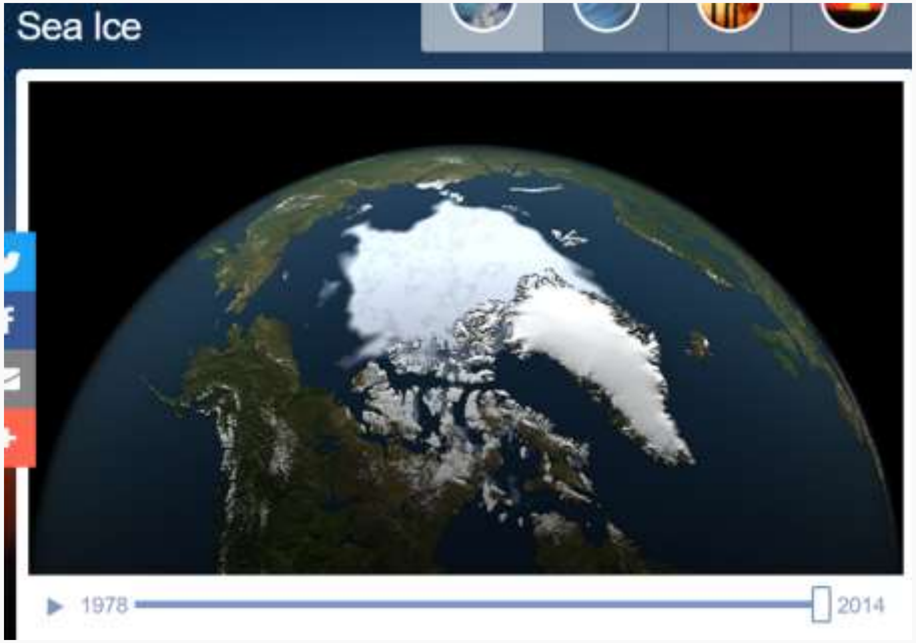

**2002** **(ppm 370)** **> 14 years  14% increase >** **2016** **(ppm 420)**

The lifetime in the air of $CO_2$, 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 $CO_2$ 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 $CO_2$ is once in the air  = >  $CO_2$ remains for very long time in the air  - tens and hundred of years**
**$CO_2$ that constantly increase the global temperature for very long time**
**$CO_2$ is a long term global risk**

# 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)


**1978** **- > 35 years - >** **2014**

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

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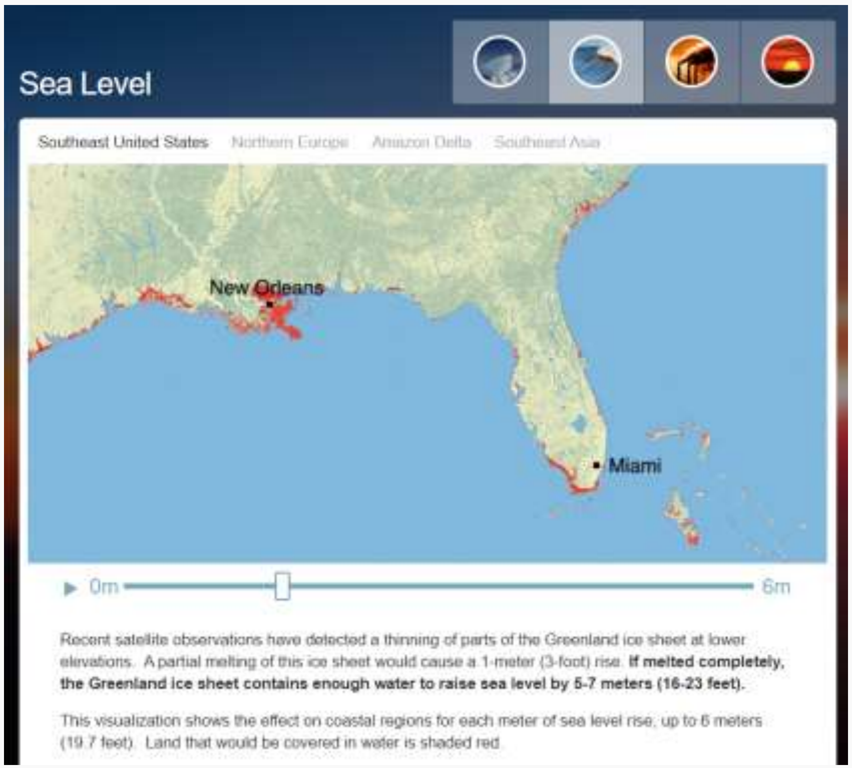
https://climate.nasa.gov/interactives/climate-time-machine

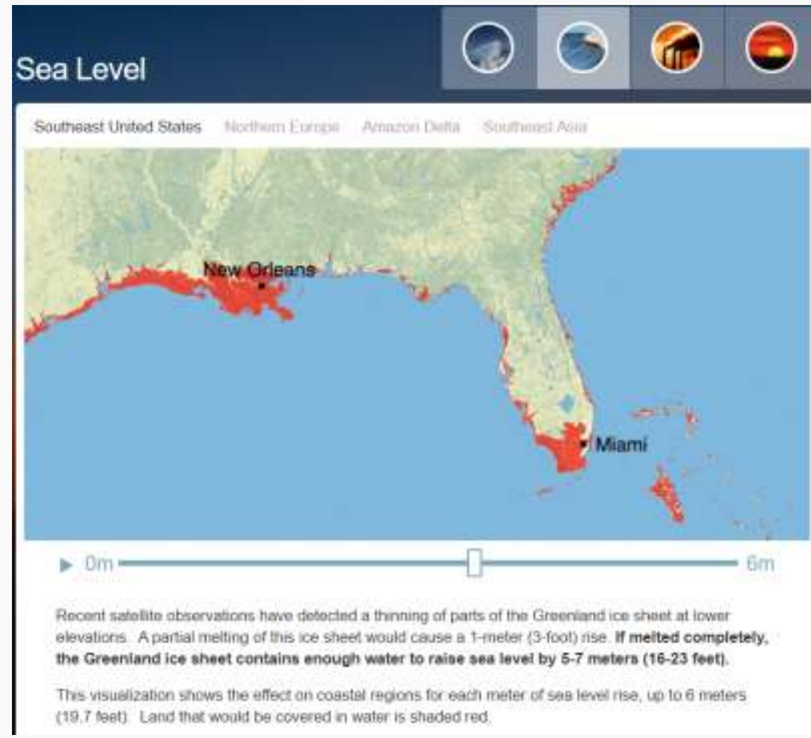
# Global Warming

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.




1 meter rise




3 meter rise

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

# Global Warming

## More and more weather extremes

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

Floods in Paris 2016

Long Islands, New York “Frankenstorm”
Hurricane Sandy 2012

Philippines 2013

# Global Warming

## More and more weather extremes


**Wow — Watch Hurricane Irma Turn The Streets Of Miami Into An Overflowing River**

9/10/2017 3:57 PM ET | Filed under: Twitter • Health • Scary! • Instagram • Viral: News • Gotta Have Faith

Like 2.2K

Hurricane Irma, streets in central Miami 2017


Interstate 45 in Houston after Hurricane Harvey. REUTERS/Richard Carson

Hurricane Harvey, Houston 2017

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# 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




# 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**

● INNLENT | 20:08 | 08. OKTÓBER 2016

Líkar þetta 2


NADINE GUÐRÚN YAGHI SKRIFAR

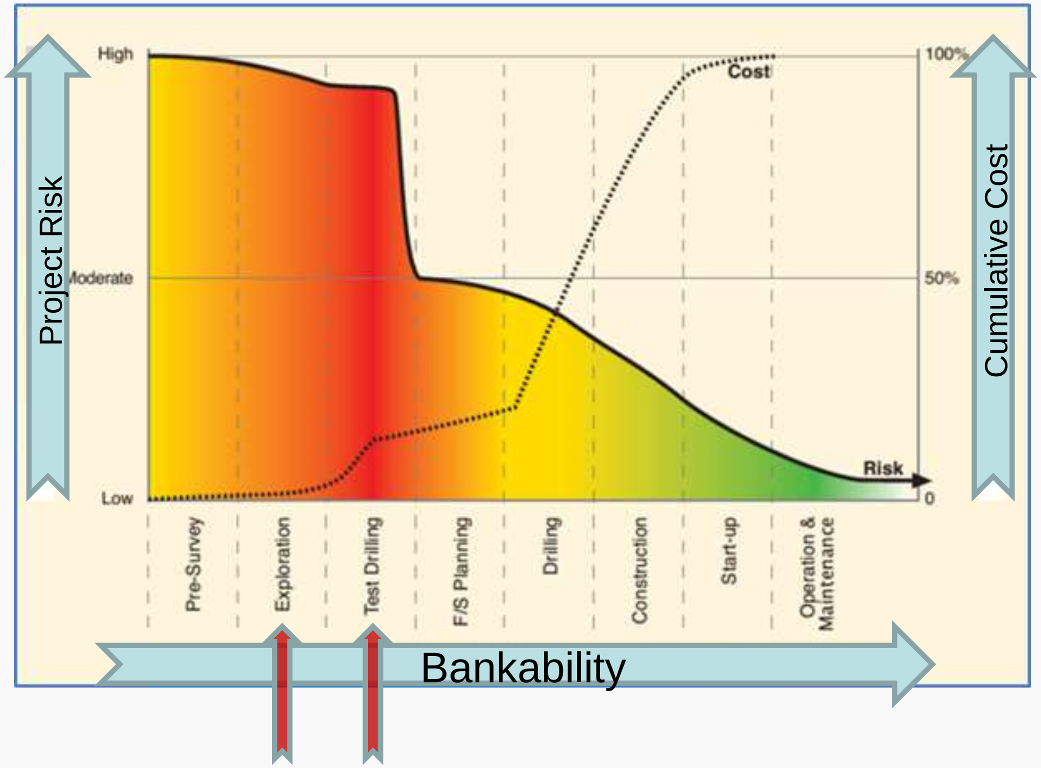
# Risk Mitigation

**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

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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 crisis 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**

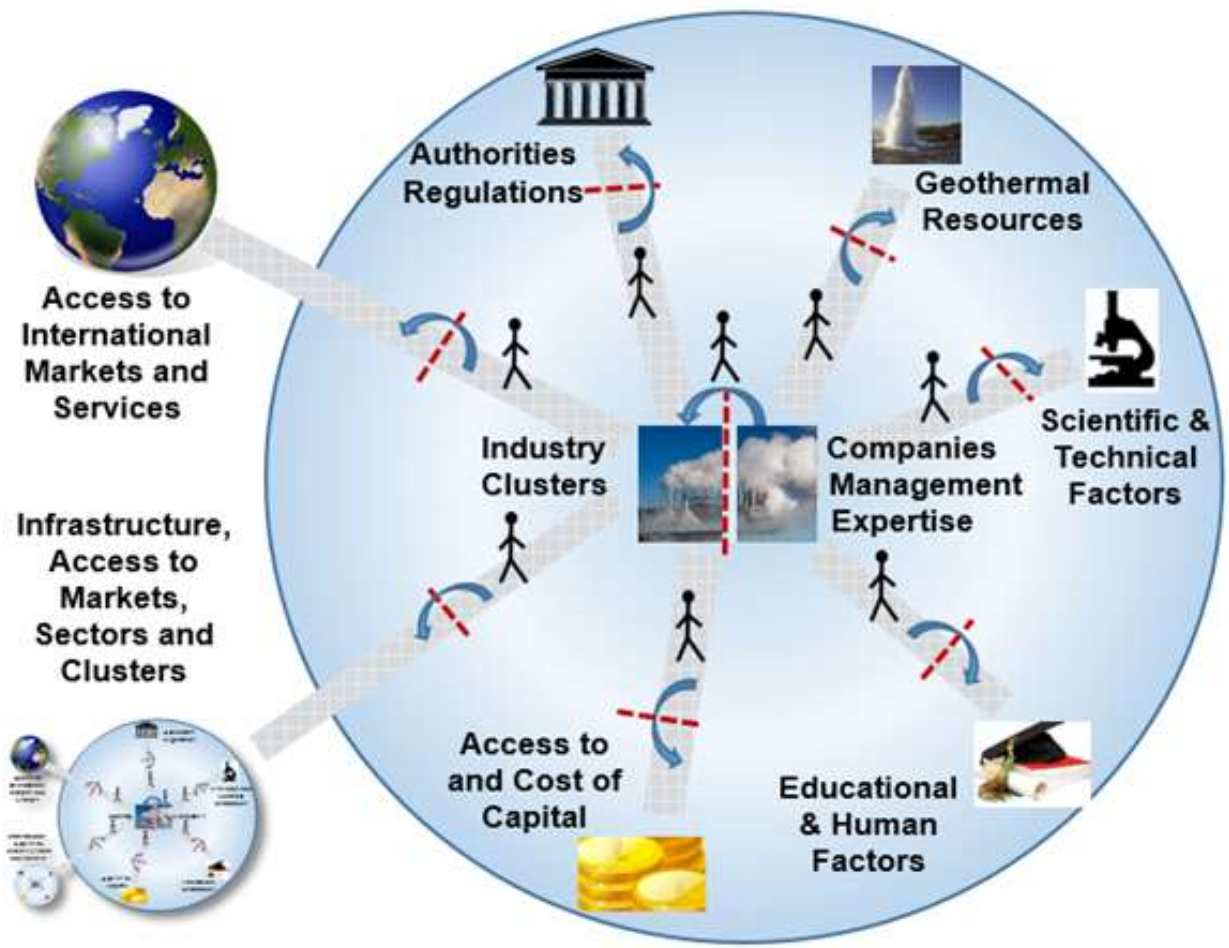
# Competitiveness of the Geothermal Sector

## 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

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# International Cooperation - Geothermal

## The United Nations University Geothermal Training Programme in Iceland


*UNU-GTP Fellows in Iceland 1979-2014 – 583 from 58 countries.*

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

| | |
|---|---|
| IS | Orkustofnun (National Energy Authority), |
| NL | Rijksdienst voor Ondernemend Nederland |
| CH | Swiss Federal Office of Energy (SFOE) |
| I | National Research Council of Italy (CNR) |
| D | Jülich (PTJ) |
| F | ADEME ( BRGM as third party) |
| IS | Icelandic Centre for Research (RANNÍS) |
| TR | TÜBITAK (Scientific and Technological Research Council of Turkey) |
| SVK | Slovak Ministry of Education, Science, Research and Sport |

*New partners*

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

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

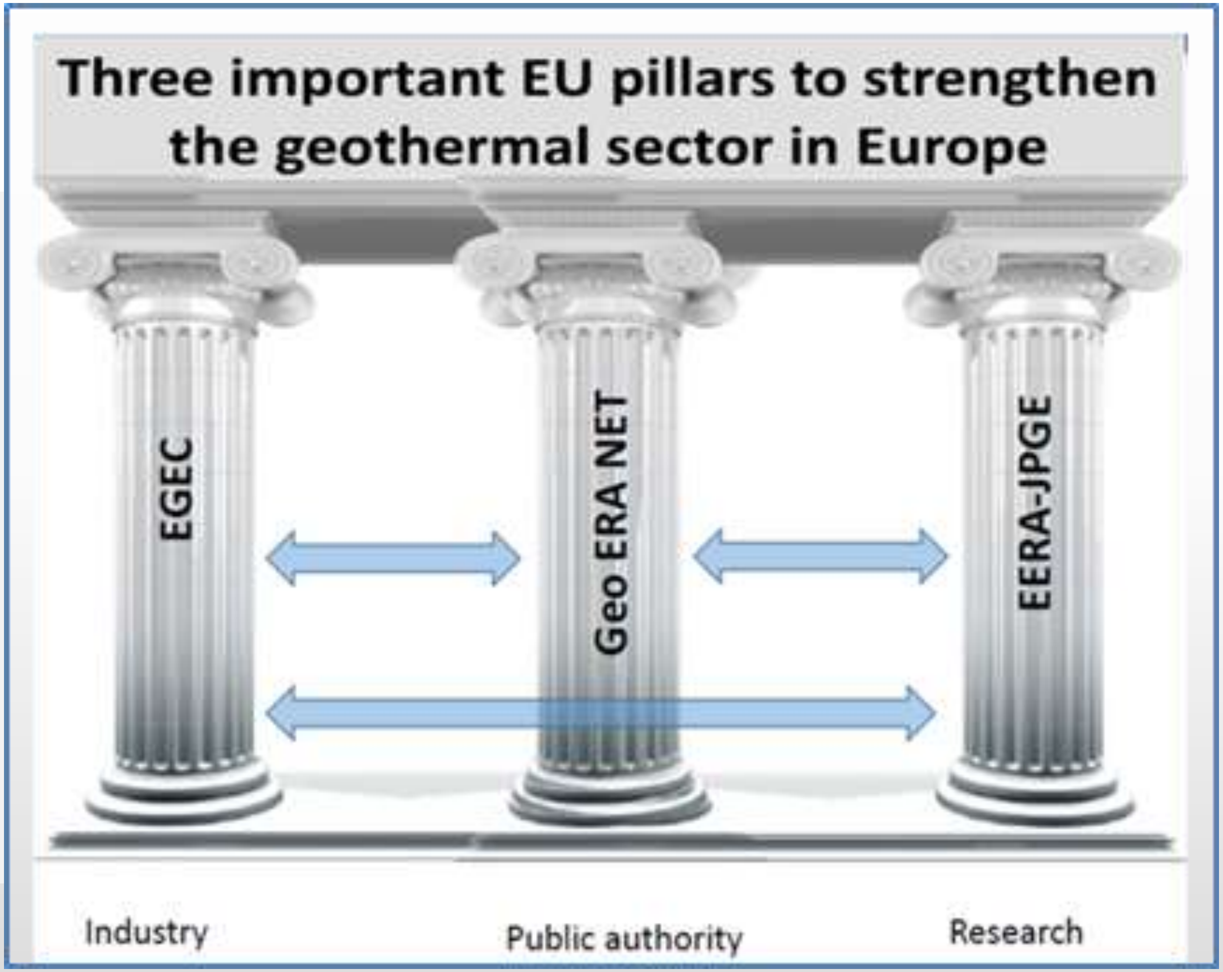
**Good geographical balance** (North-West to South-East Europe) Partner countries chosen a.o. on basis of their 2020/2050 geothermal ambitions

# 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/

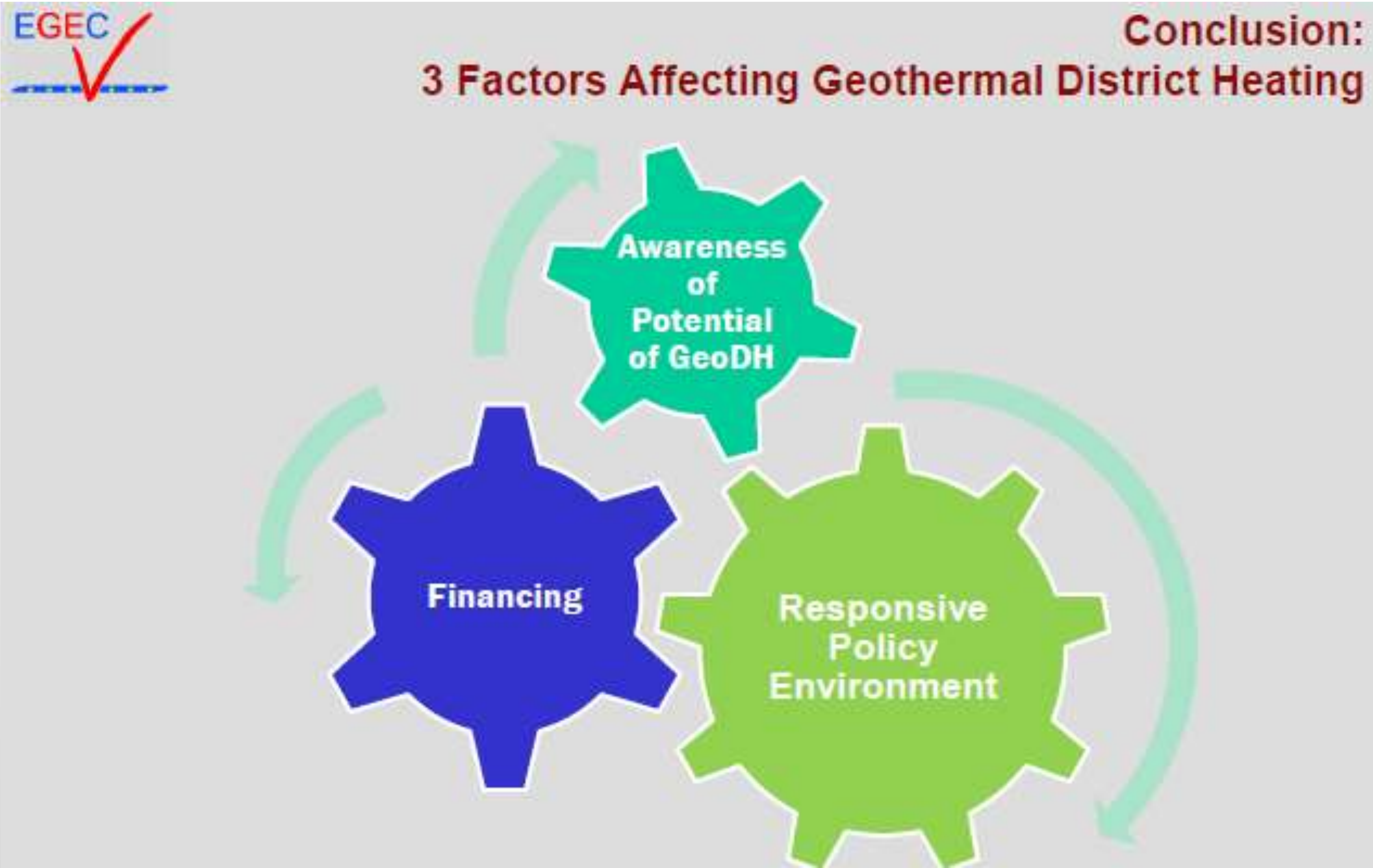
**Exchange information** on the status of geothermal energy

Lay groundwork to create a **European Geothermal Information Platform**

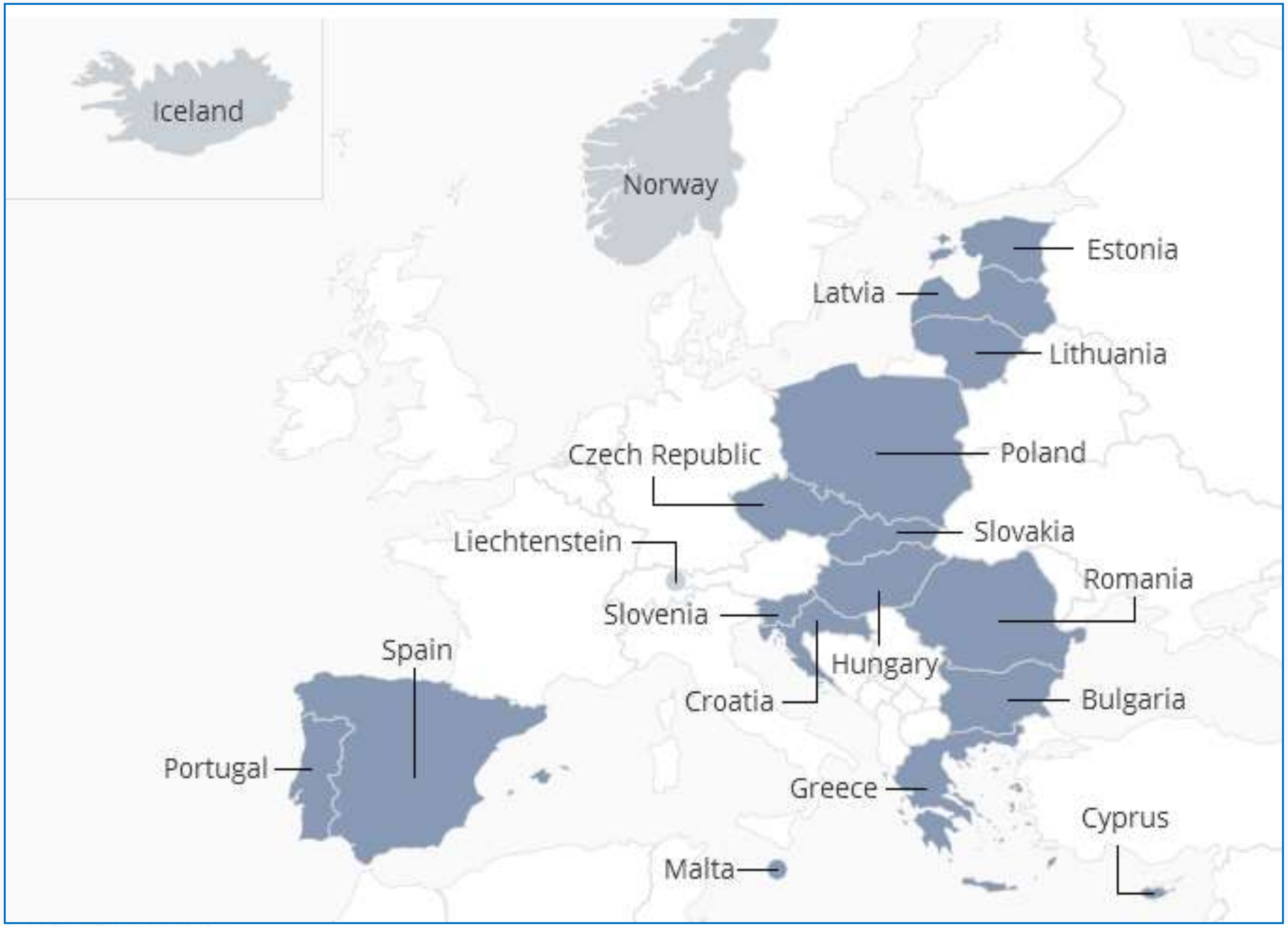
Highlight **barriers** and **recommend practical solutions**

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

# The Geothermal ERA- Opportunities

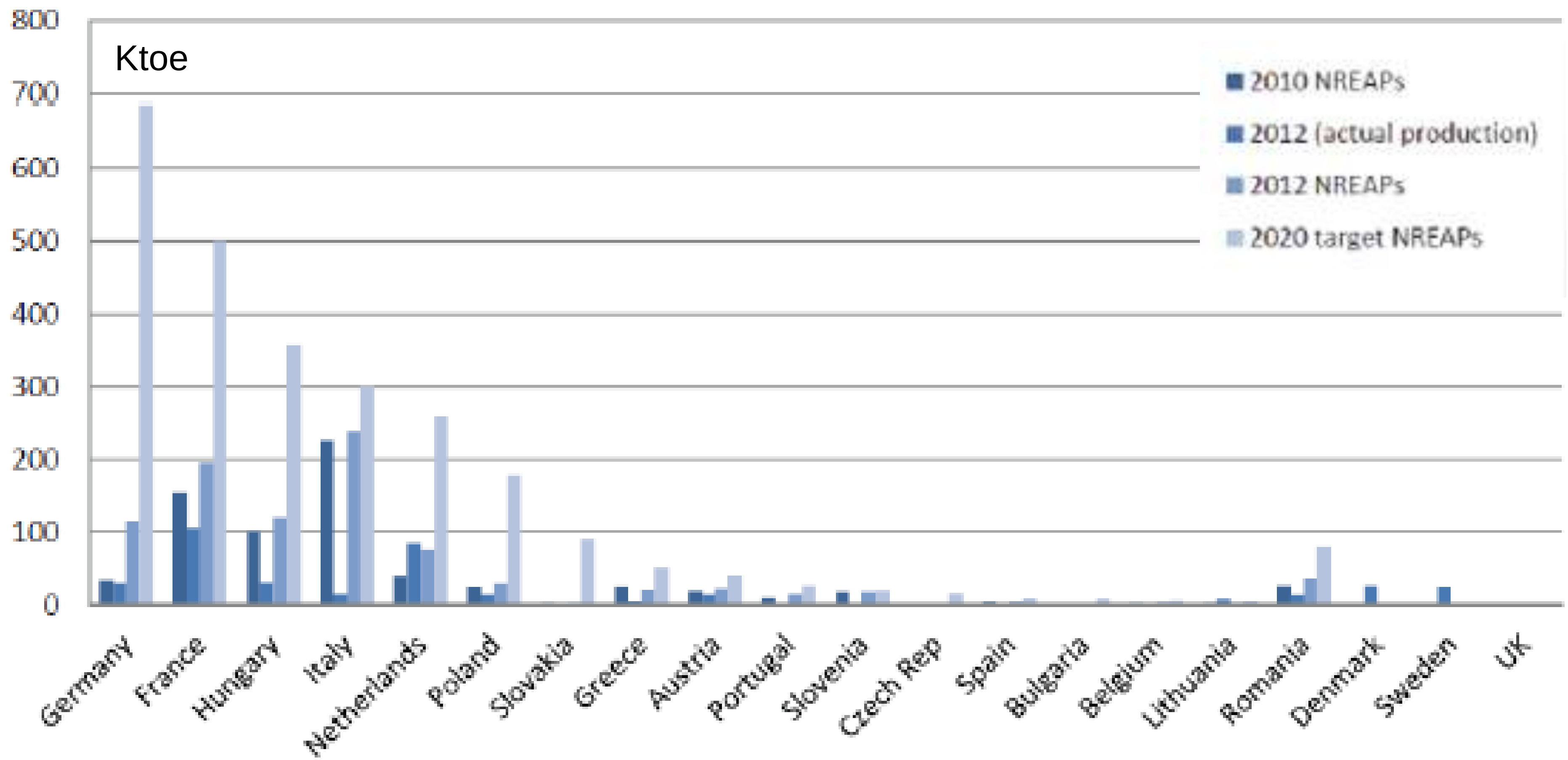


# International Cooperation – EEA Grants
## Orkustofnun is Donor Program Partner (DPP) for Renewables in some Countries



# Geothermal DH Potential in Europe

## Actual Geothermal DH production towards the 2020 target (ktoe)




Source: EGEC

ICELAND LIECHTENSTEIN NORWAY eea grants

# Hungary

Rondine GOOD THINGS SPRING HERE

- 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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# 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.

ICELAND
LIECHTENSTEIN
NORWAY
eea grants

# Romania

Rondine
GOOD THINGS SPRING HERE

**Various meetings and conferences in Romania and Iceland**

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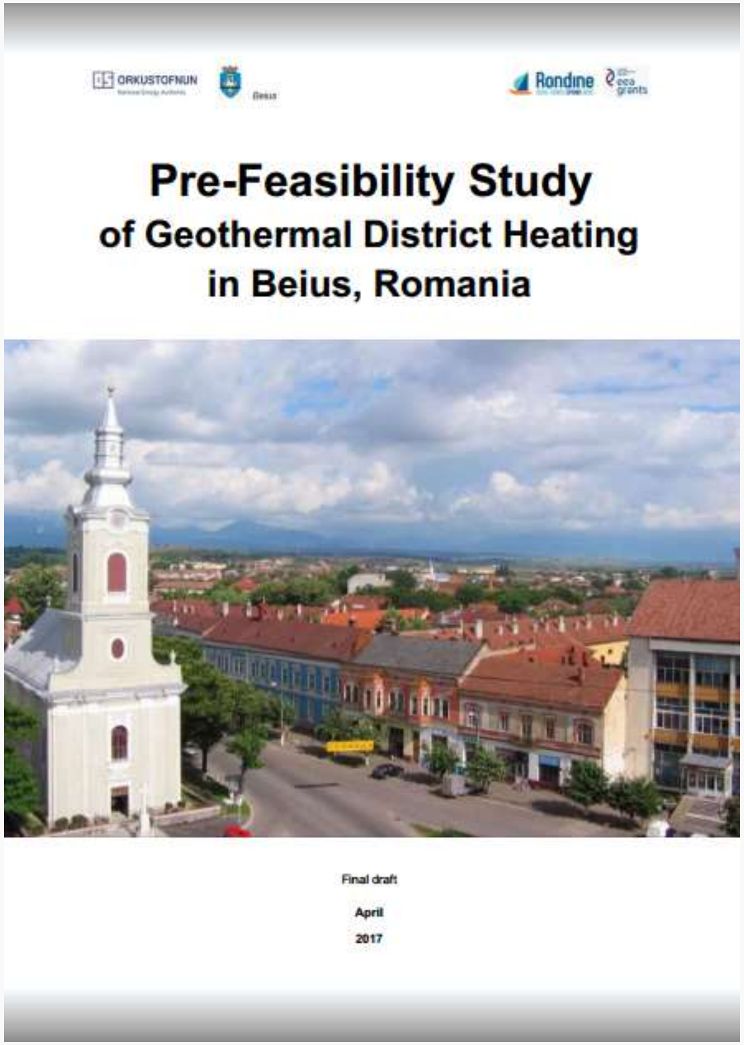
# Portugal

GAia Programme
Geothermal Azores - Iceland


- 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

# Romania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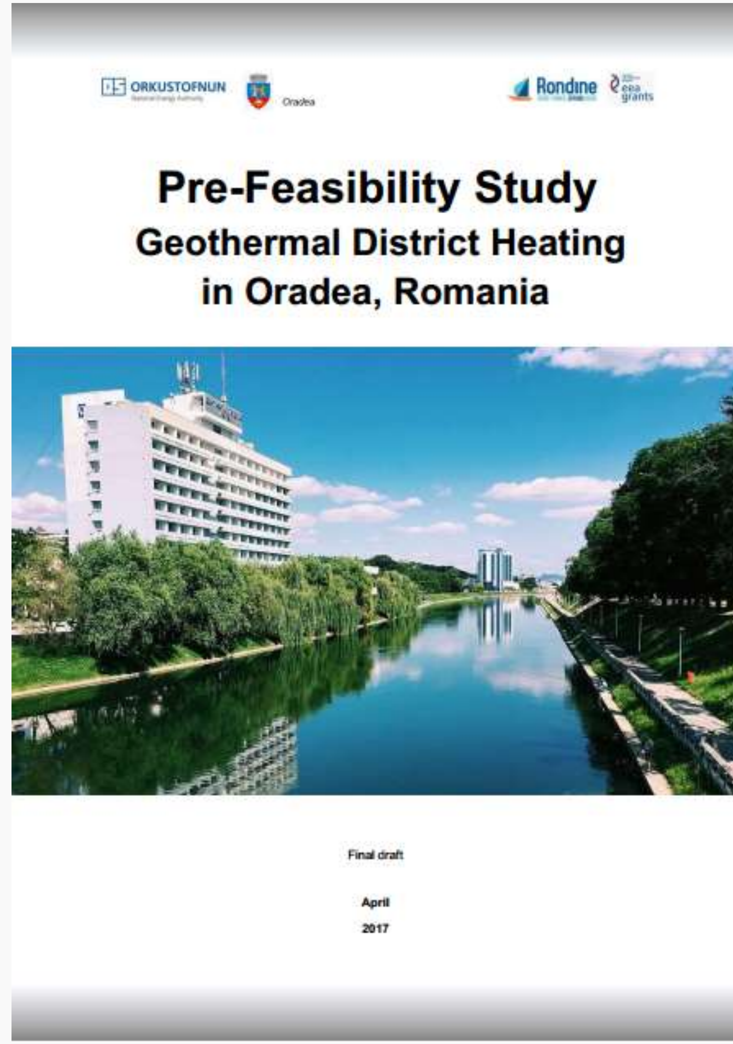
Beius
Rondine
eea grants

**Pre-Feasibility Study**
**of Geothermal District Heating**
**in Beius, Romania**

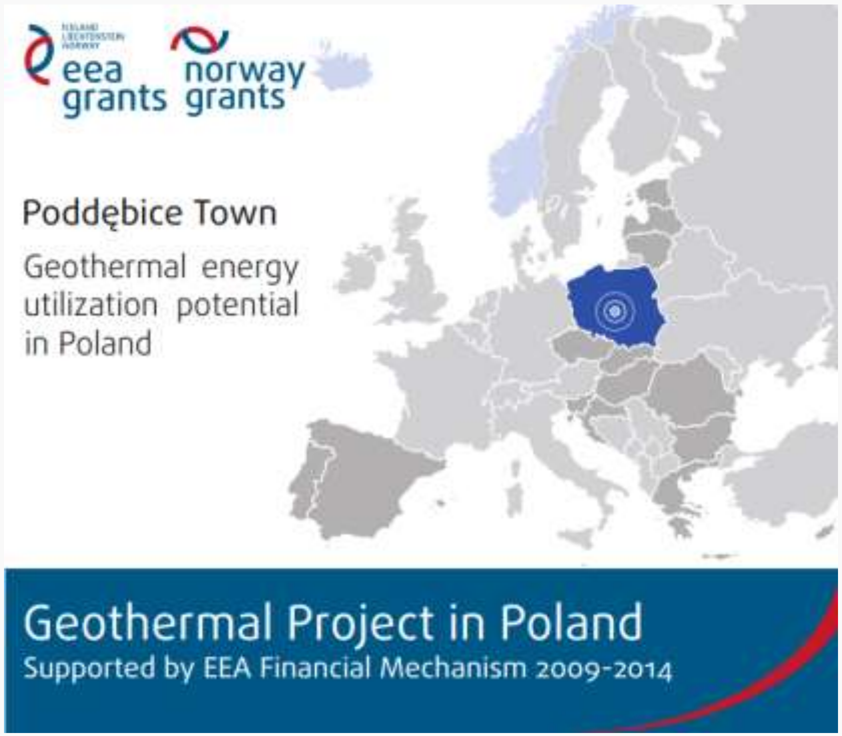
Final draft
April
2017

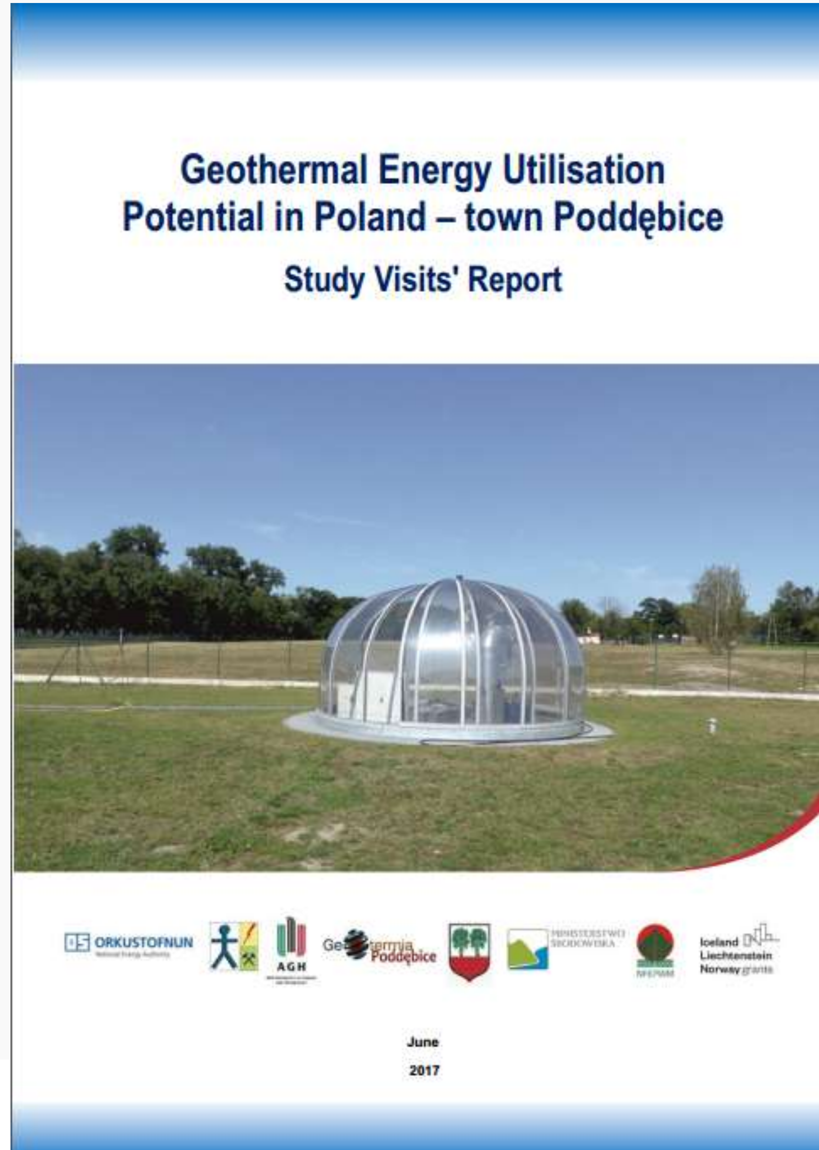

ORKUSTOFNUN
Oradea
Rondine
eea grants

**Pre-Feasibility Study**
**Geothermal District Heating**
**in Oradea, Romania**

Final draft
April
2017

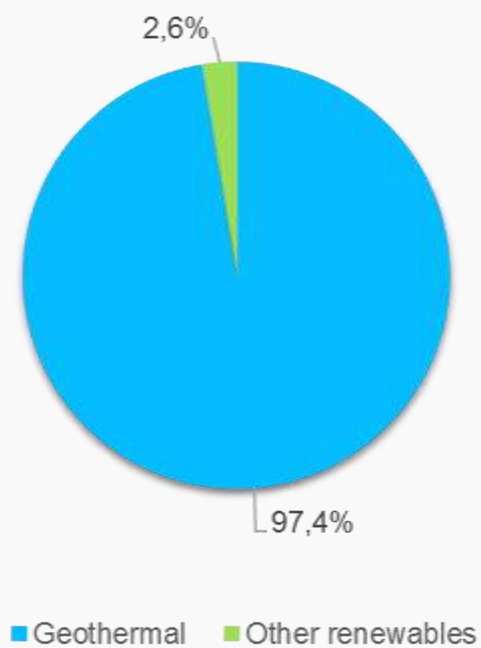
# Bilateral Projects in Poland
# Poddebice



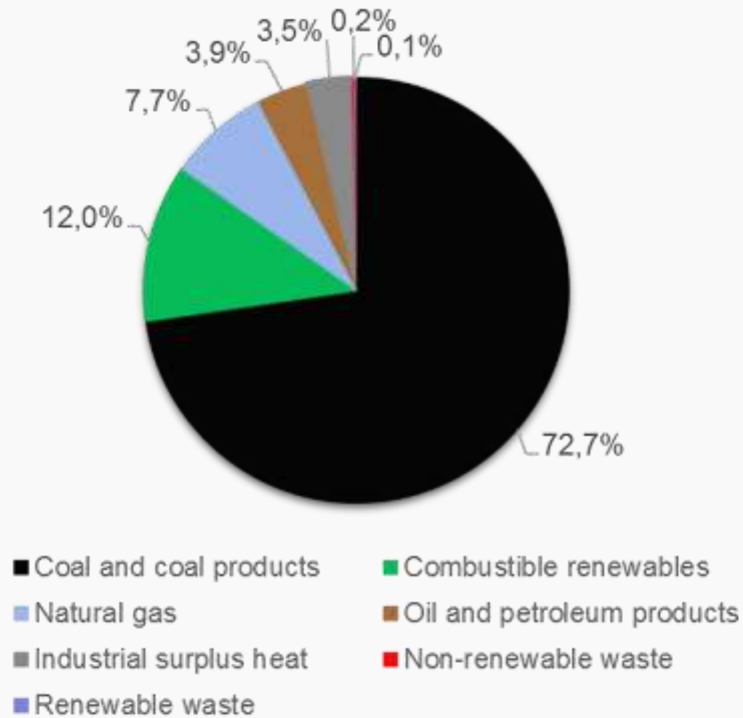
# Energy Supply Composition of District Heating Generated in 2013

## Iceland



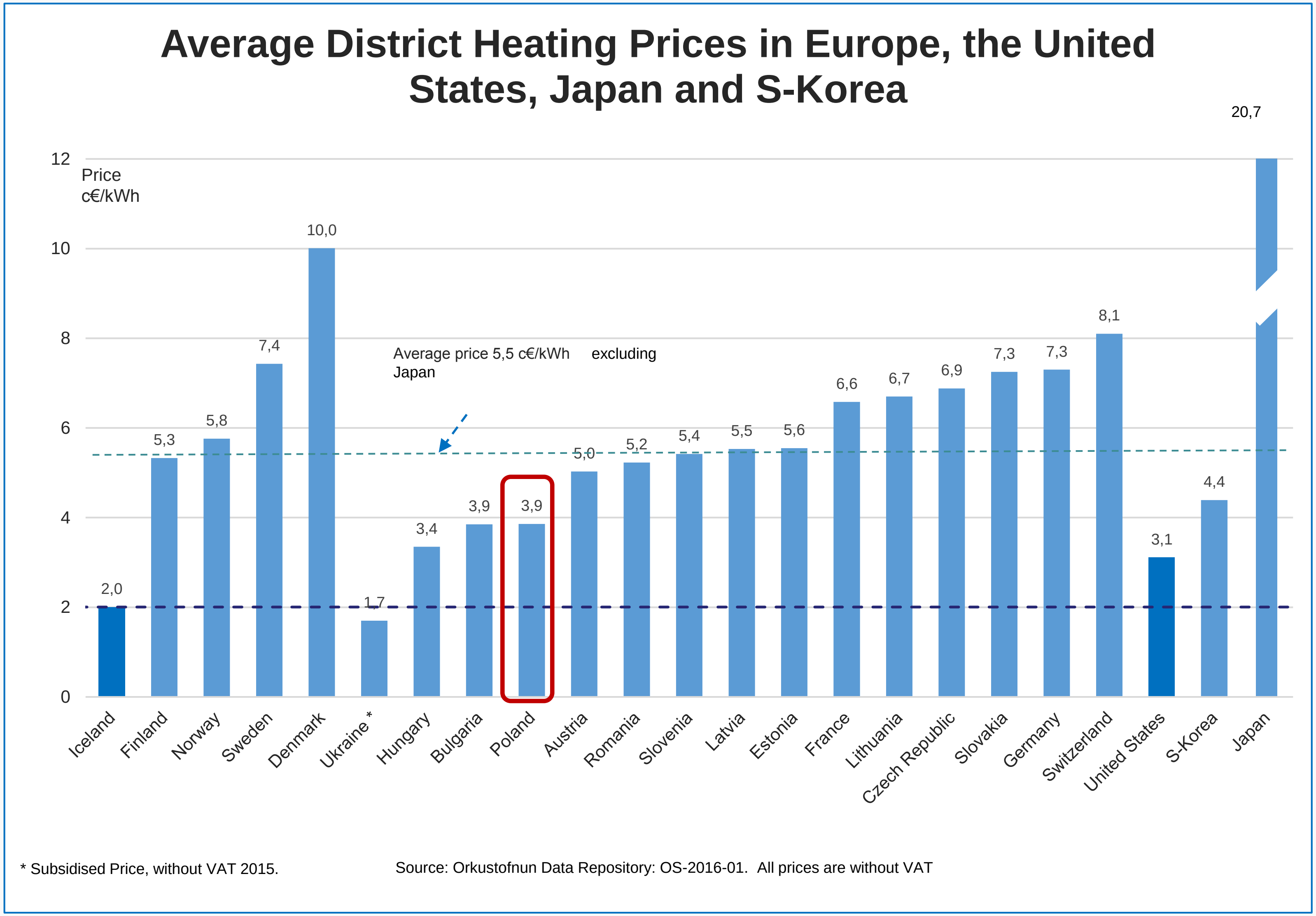

Source: Euroheat&Power, 2015.

## Poland




Source: Euroheat&Power, 2015.

# District Heating Prices in Europe in 2013

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# 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

**Orkustofnun, National Energy Authority**

**Ministry for Foreign Affairs, Iceland**

European Bank
for Reconstruction and Development


THE WORLD BANK
IBRD · IDA | WORLD BANK GROUP

**Ministry for Foreign Affairs, Ukraine**


ДЕРЖЕНЕРГОЕФЕКТИВНОСТІ УКРАЇНИ
State Agency on Energy Efficiency and Energy Saving of Ukraine


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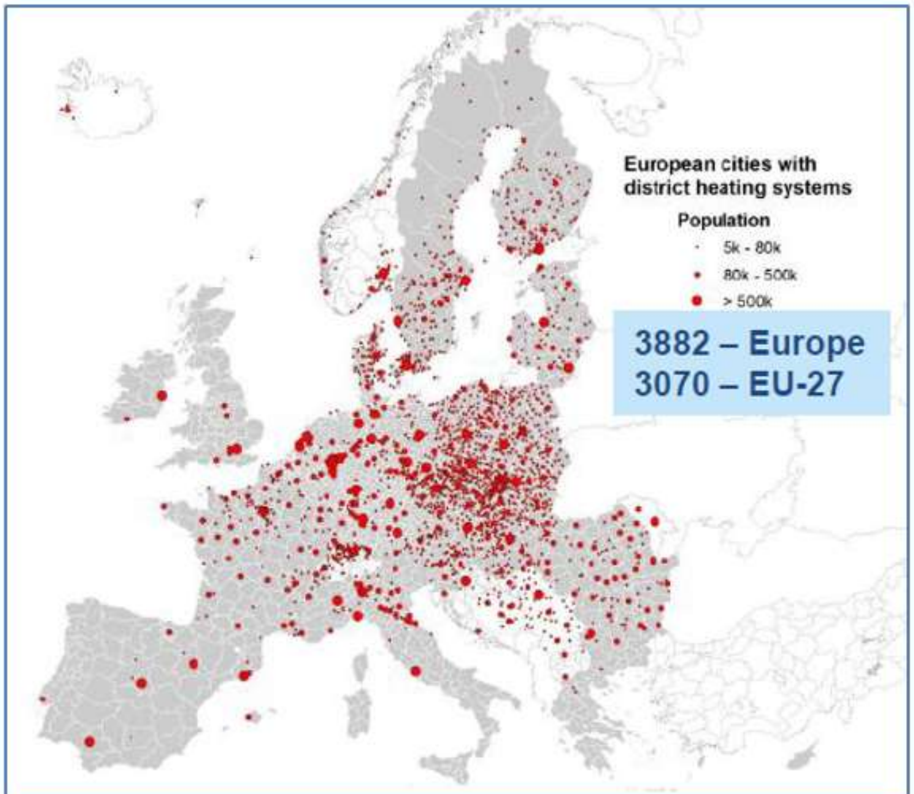
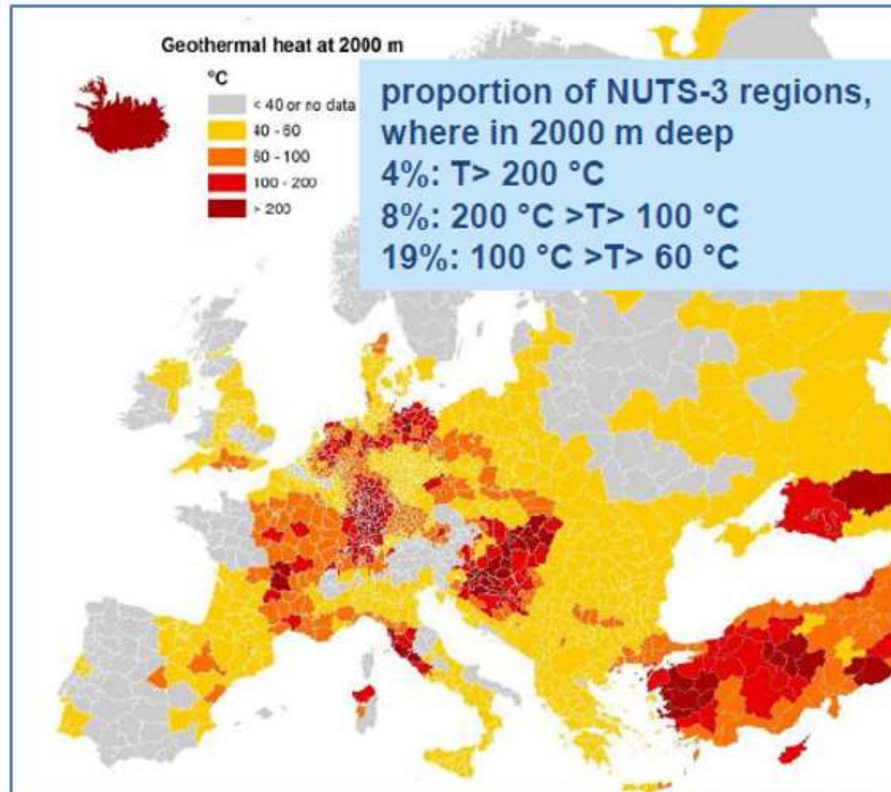
National Energy Authority

# Geothermal District Heating Options and Possibilities in Europe

***Geothermal cities in Europe with district heating systems***




***Geothermal heat at 2000 meters***

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# 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


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

**Helga Tulinius,**
**Senior Geophysicist**

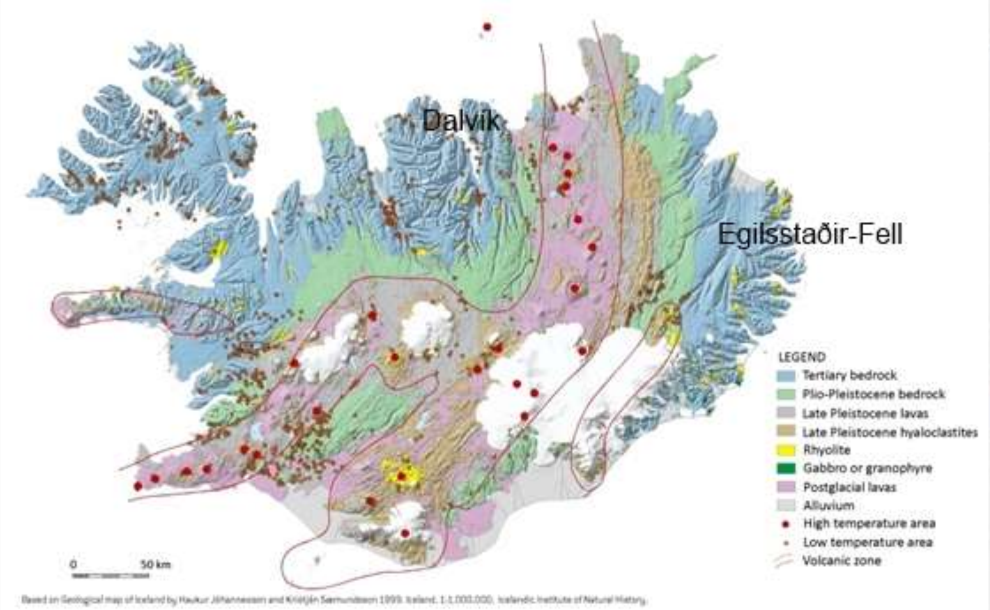
# Contents

- Utilization of Low Temperature Geothermal Systems
- Egilsstaðir-Fell

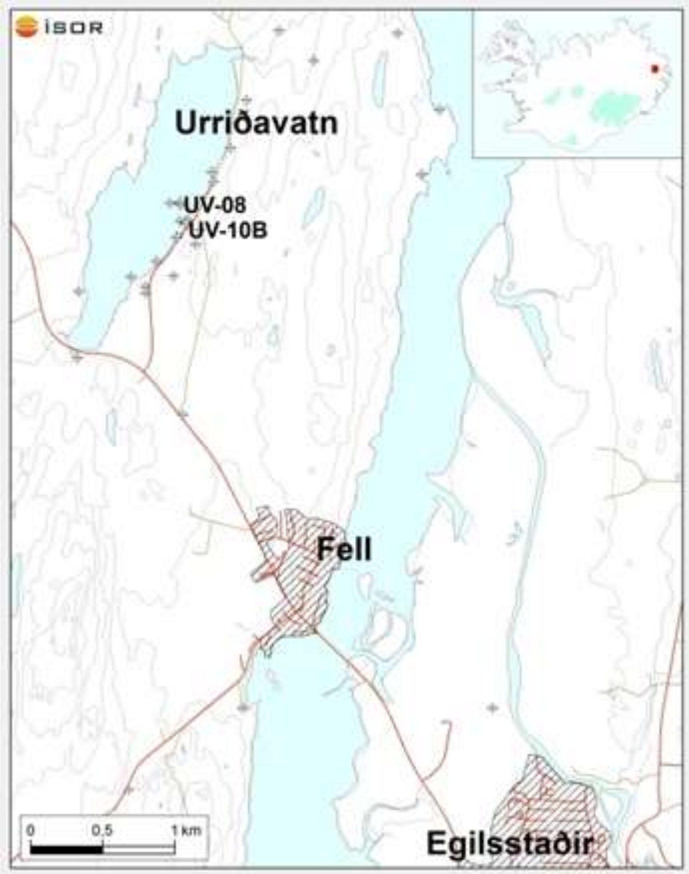
- Evolution of
  - Flow rates
    - Dependence on weather
  - Water level
  - Water temperature
- How is increased utilization met?

# Egilsstaðir-Fell, E-Iceland

- Domestic utilization of LT Systems




*A geological map of Iceland showing the volcanic zones and geothermal areas*

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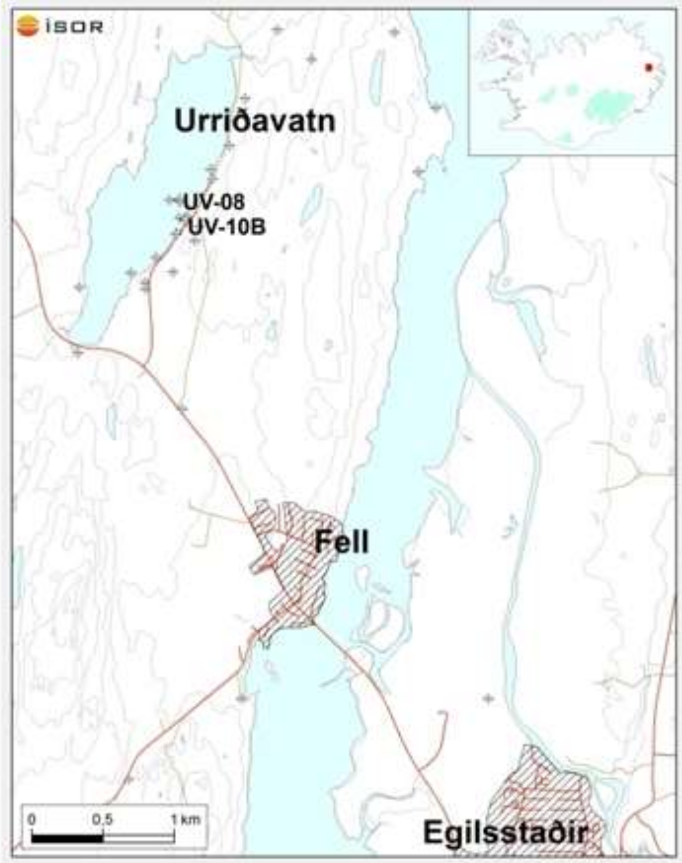
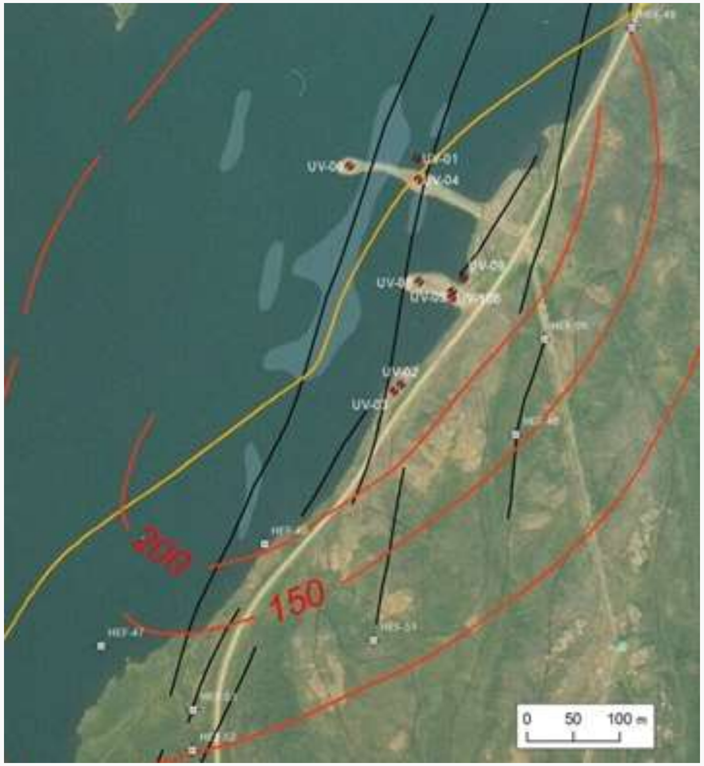
# Egilsstaðir-Fell and surroundings

- 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.



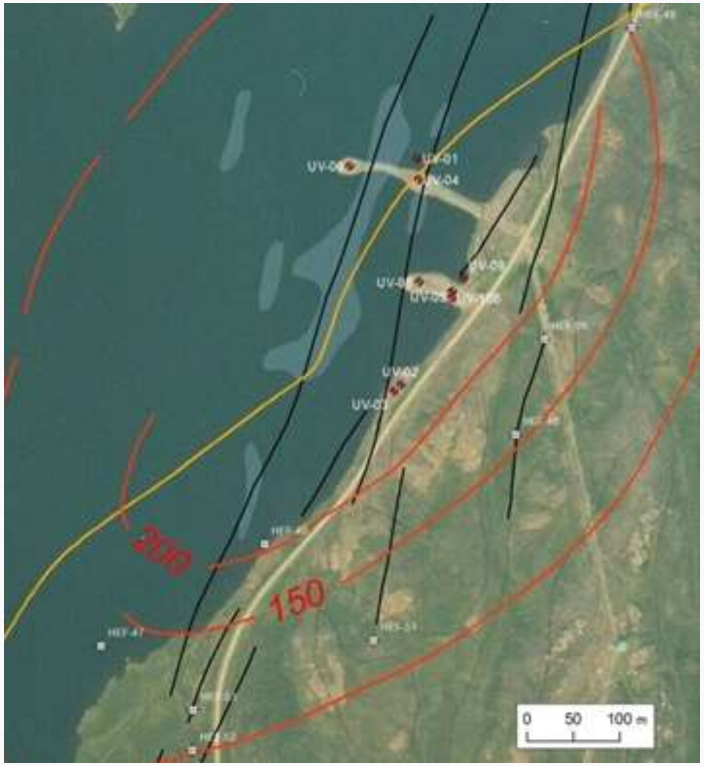
# Egilsstaðir-Fell and surroundings

- 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



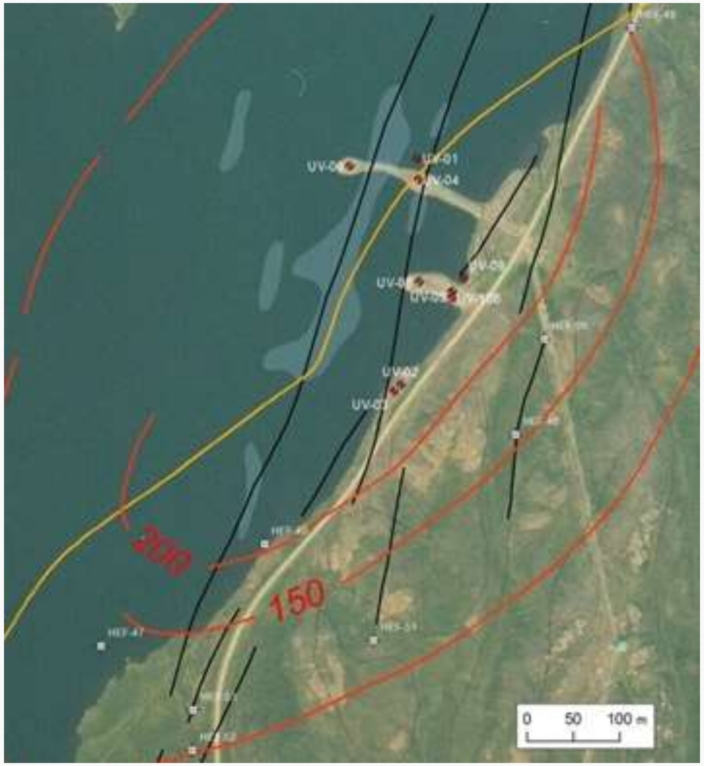
# Egilsstaðir-Fell and surroundings

- 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?



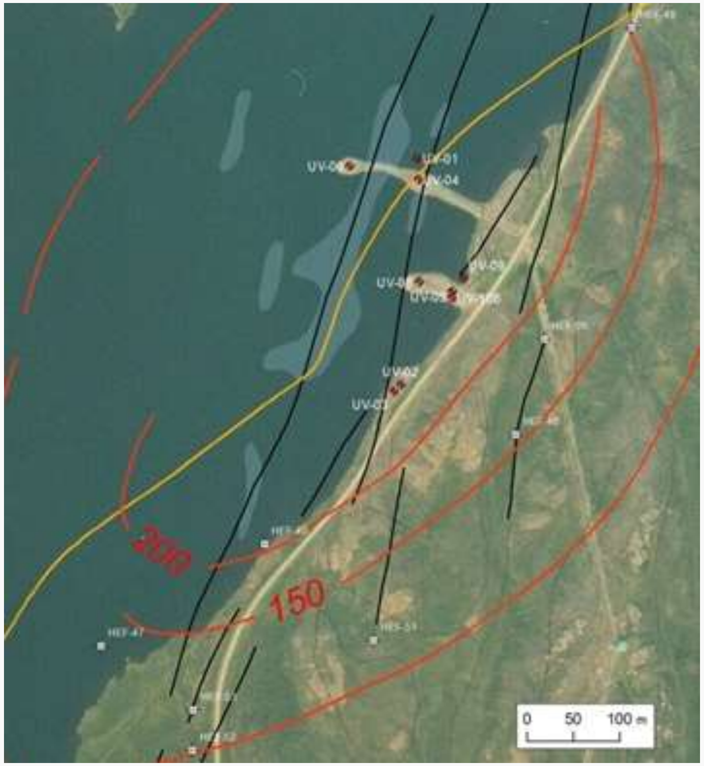
# Egilsstaðir-Fell and surroundings

- 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

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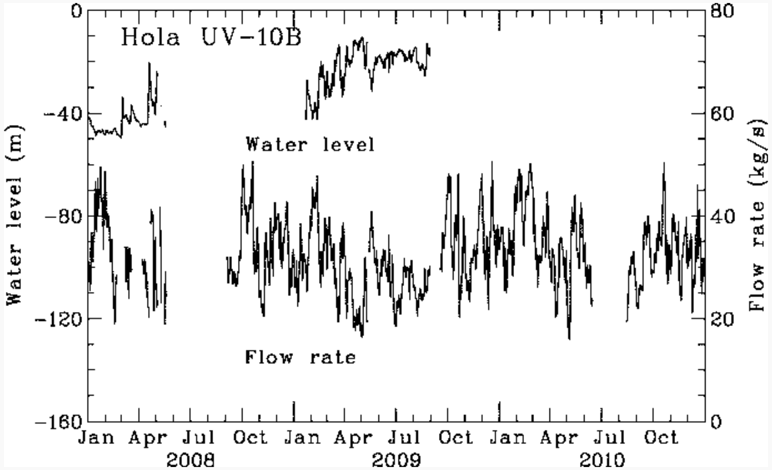
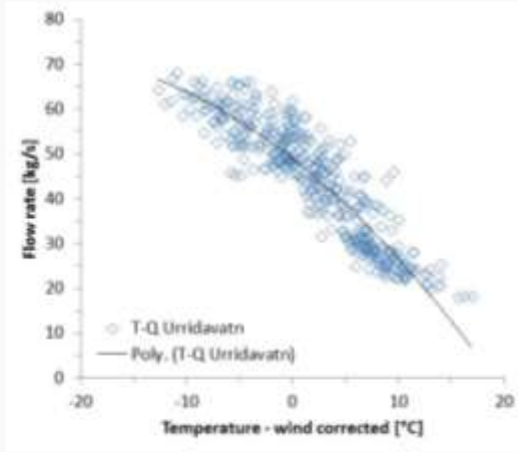
# UV-10B: Daily averages of flow rates and water level

- 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

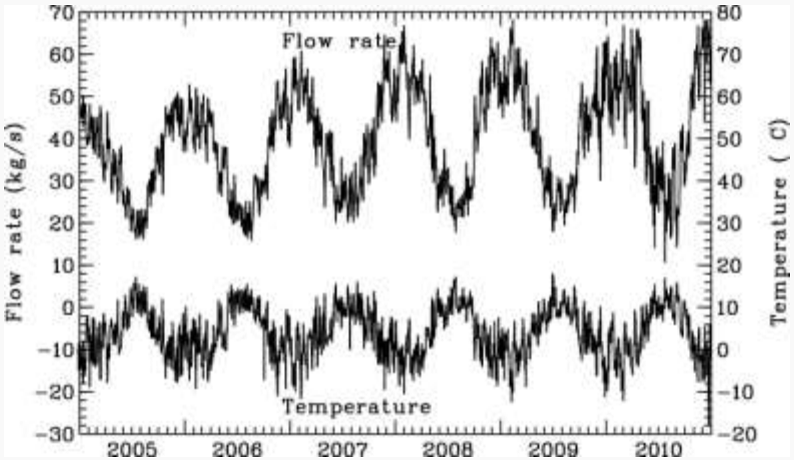


# Urriðavatn – deducing flow rates from $T_{corr}$

- 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



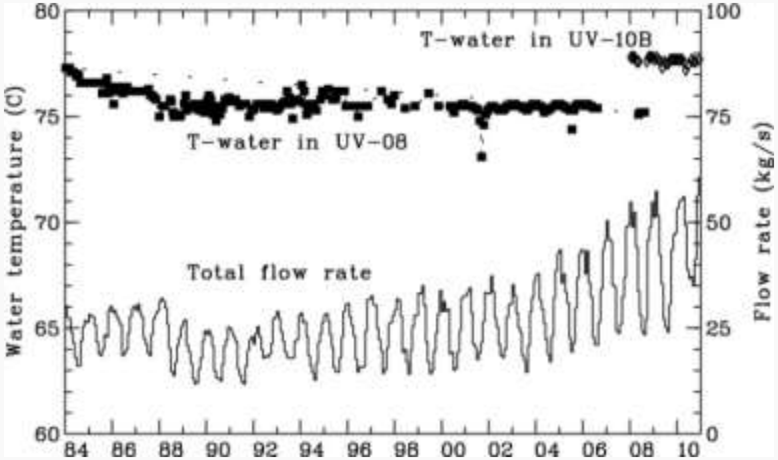

A




B

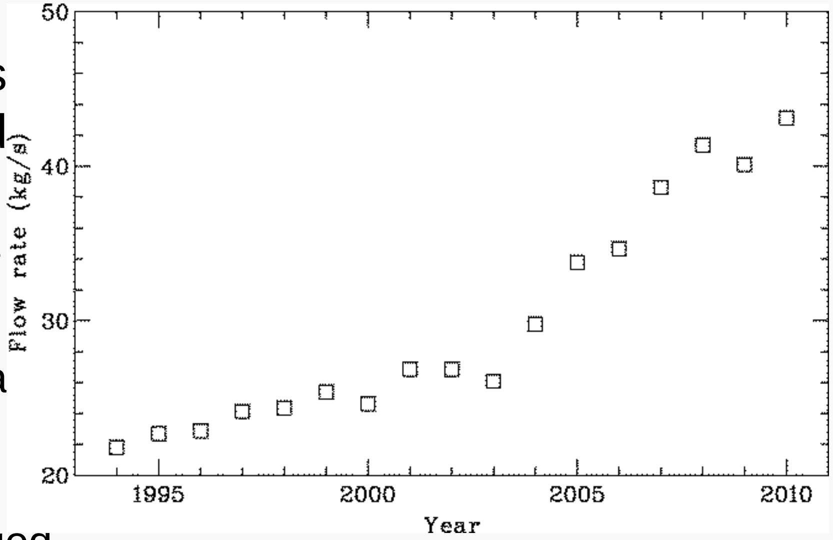
# Urriðavatn - Monthly averages of flow rate and temperature

- 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

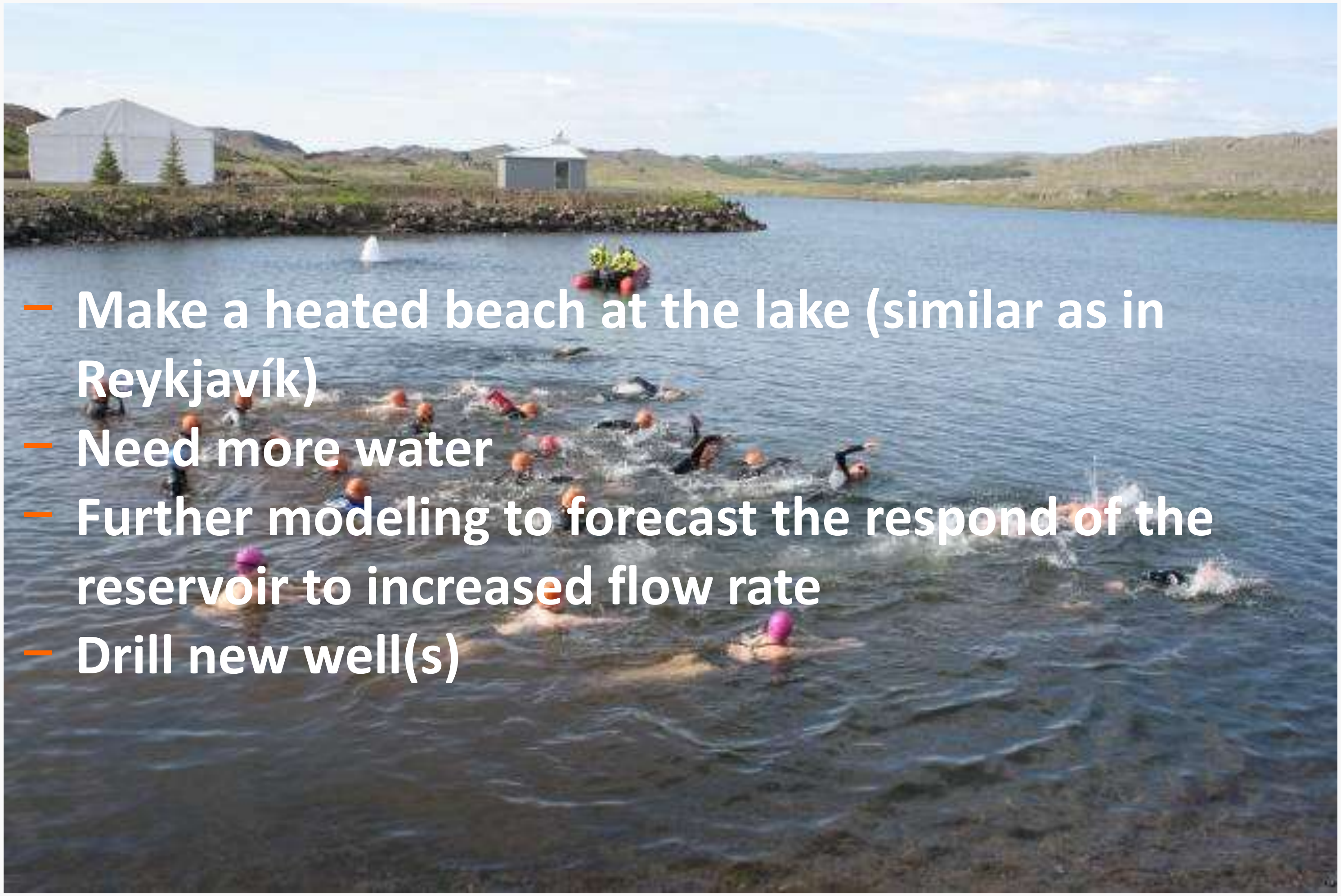


# Urriðavatn, yearly utilization

- 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 ha 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"



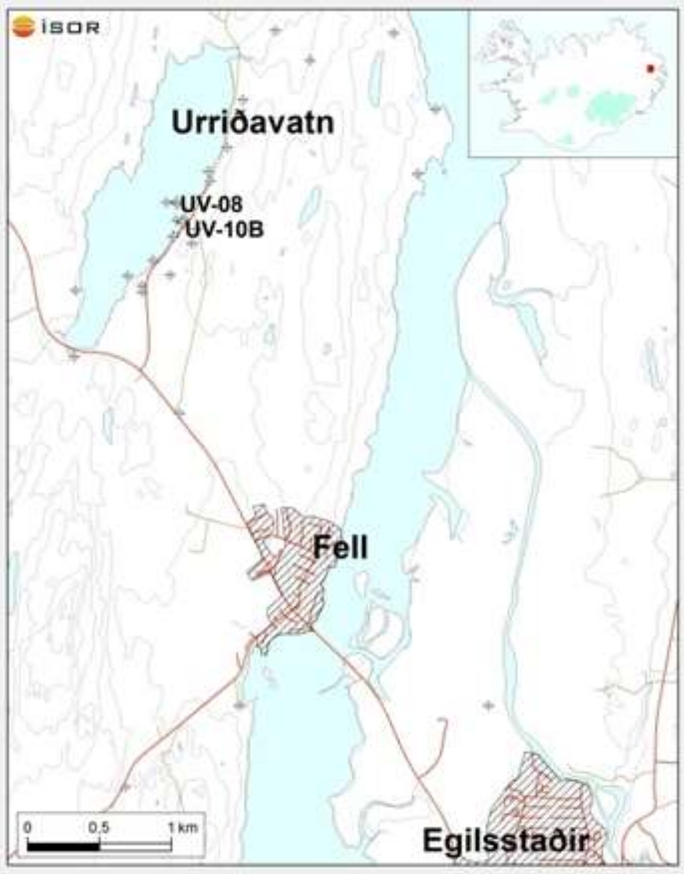
# Urriðavatn the future



- 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

Iceland Liechtenstein Norway grants

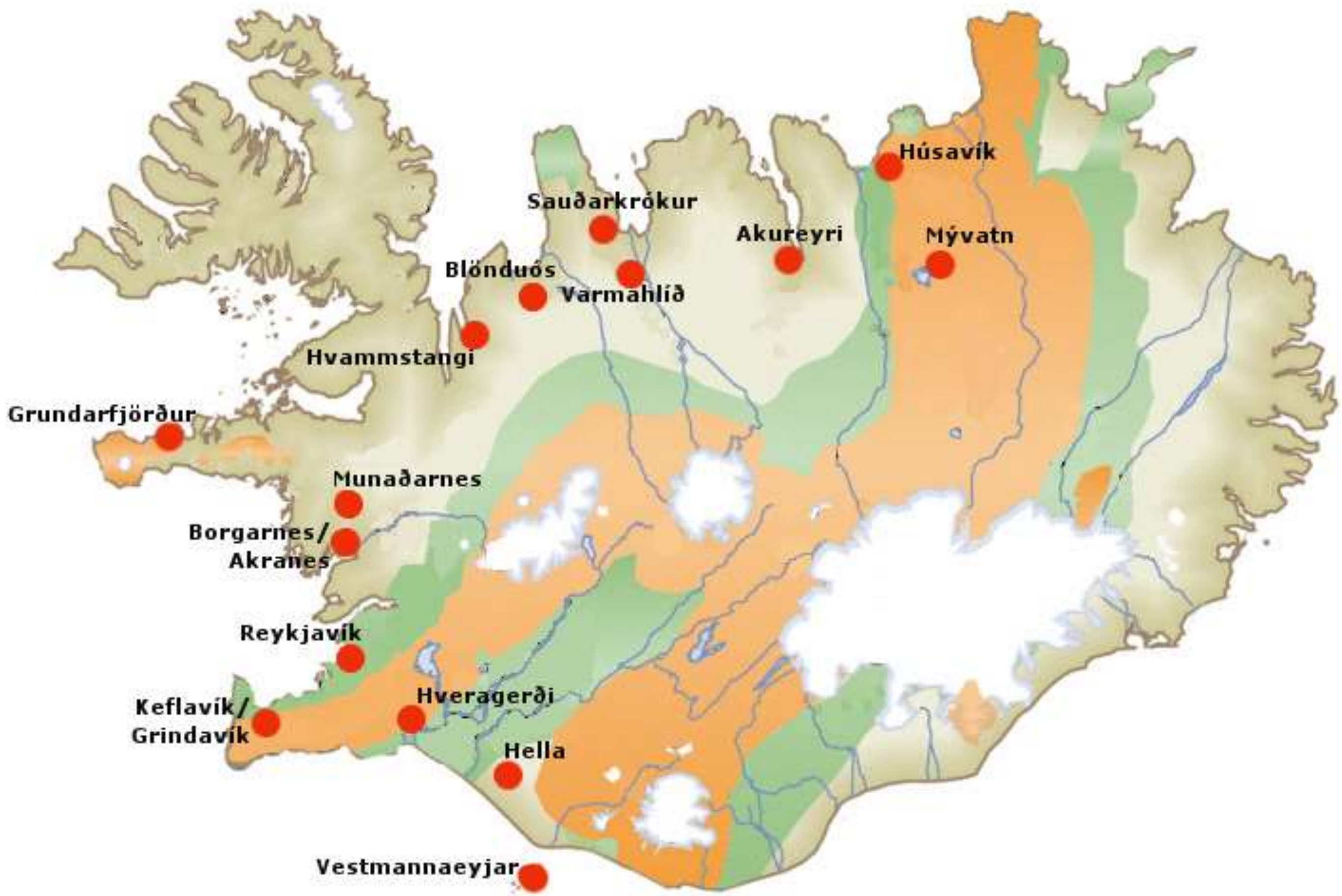
# District Heating in Iceland

**Óskar P. Einarsson,**
**Mechanical Engineer**

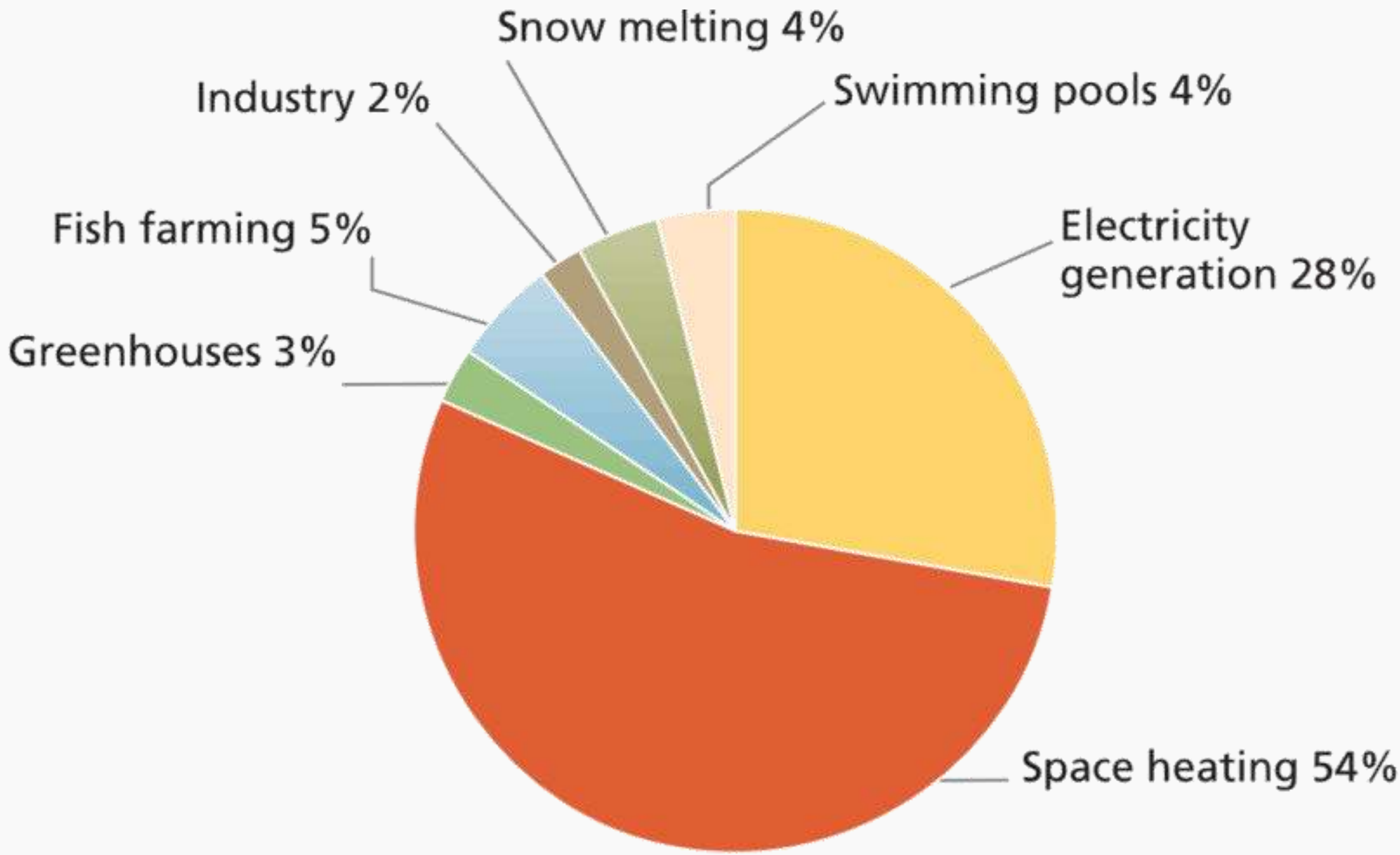
# District Heating in Iceland- History

- 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 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



# 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

# District Heating – Key Components

- 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

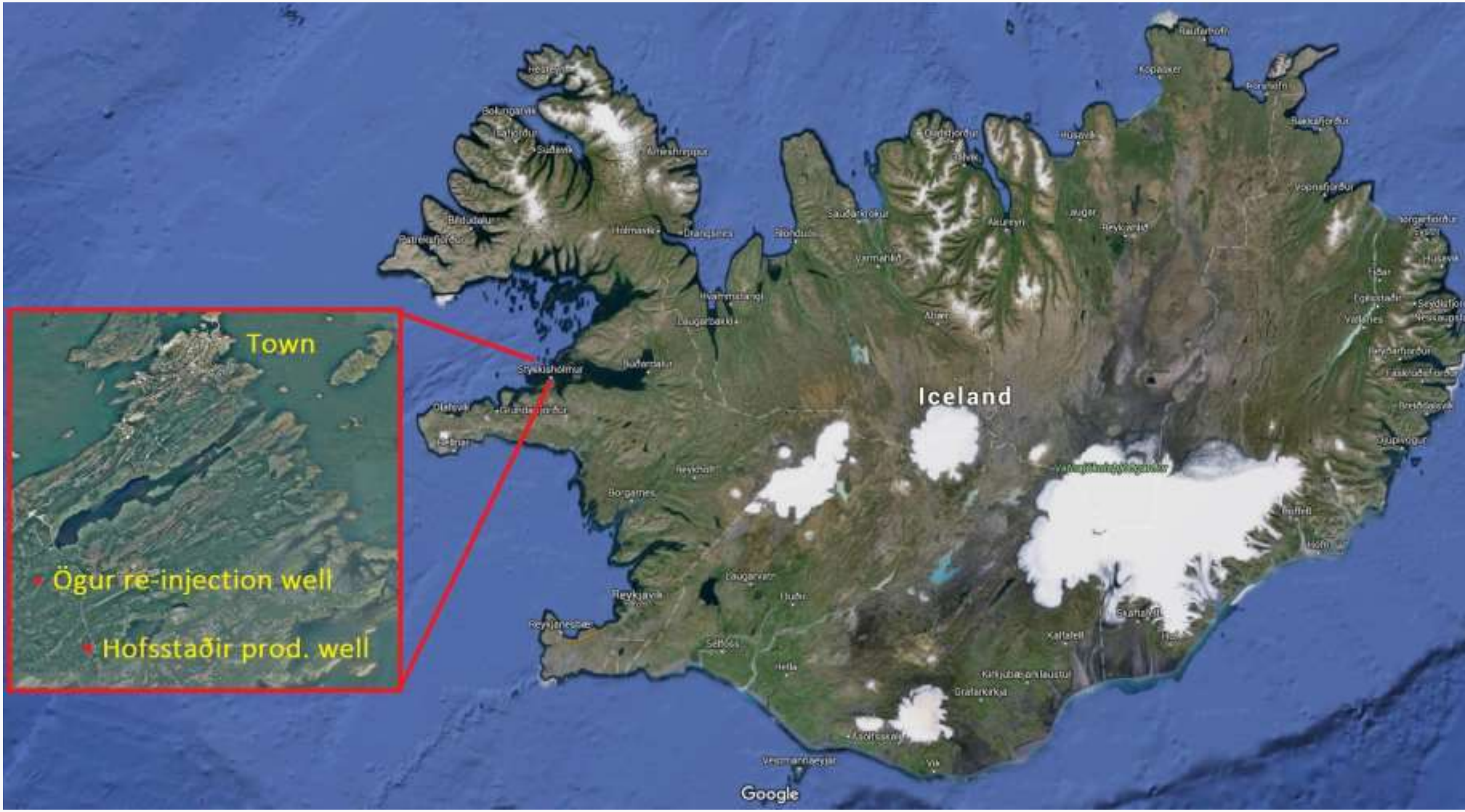
# District Heating – Iceland vs. Other Countries

- 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

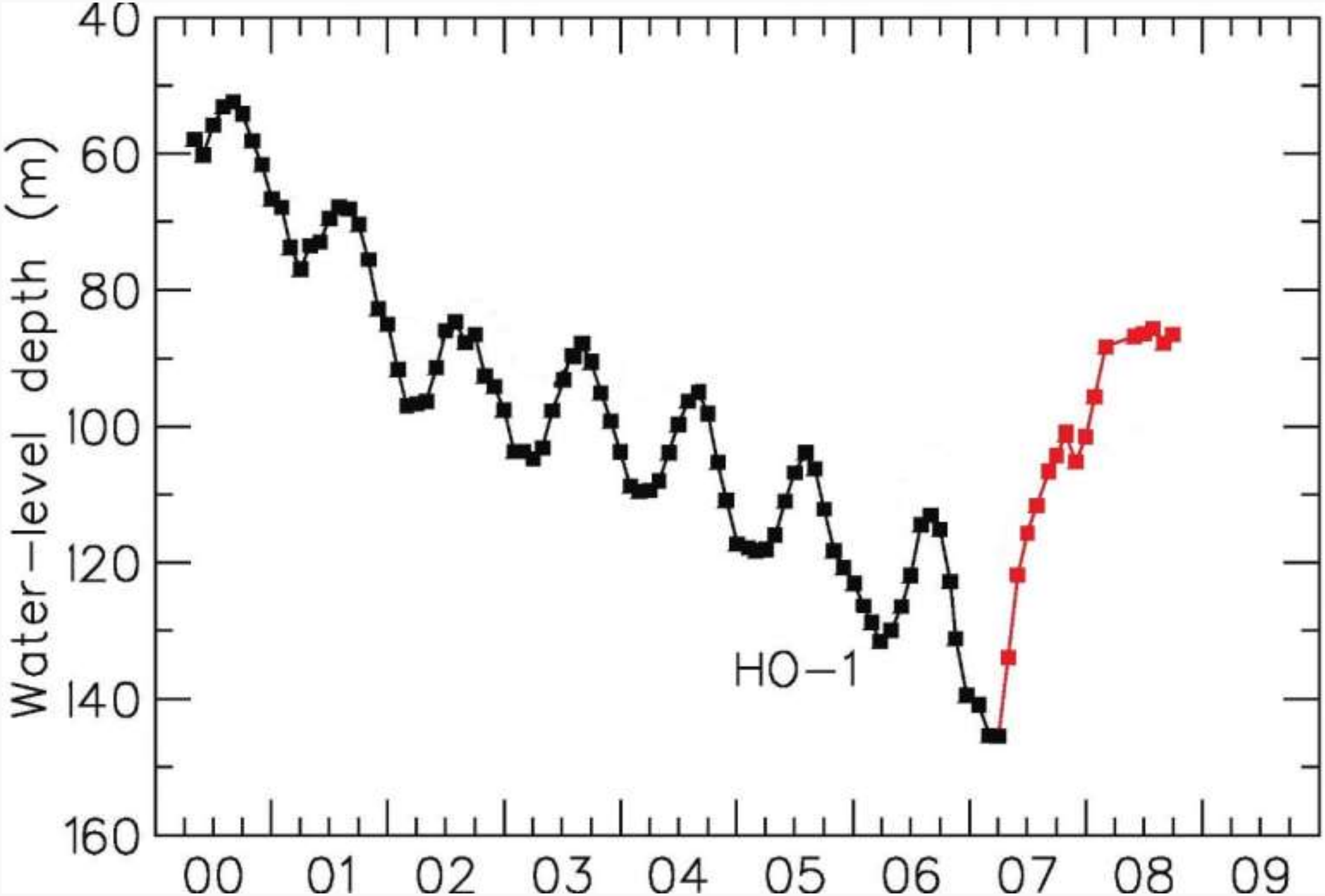
# District Heating – Example from Stykkisholmur

- 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 - Map



# Stykkisholmur – Recovery of Reservoir

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# Stykkisholmur – HO-01 Production Well

# Stykkisholmur – Heat Central, Exterior

# Stykkisholmur – Heat Central, Interior

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# Stykkisholmur – Swimming Pool

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

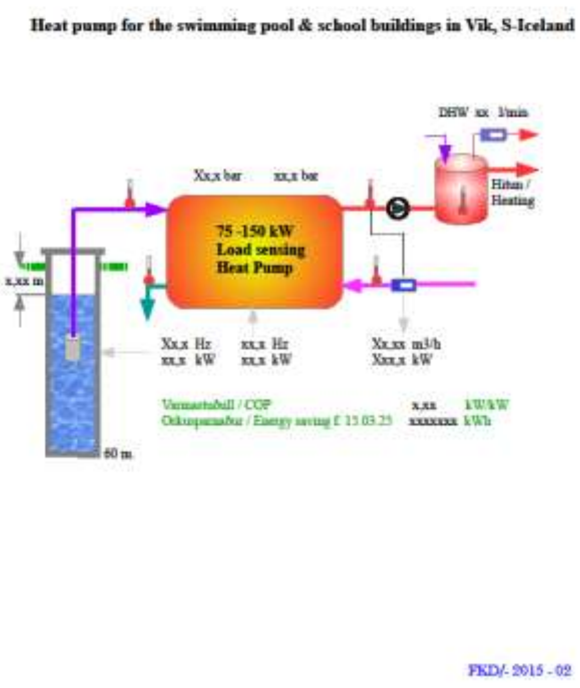
**Friðfinnur K. Daníelsson,**
**Mechanical Engineer**

# The volcanic activity has different faces !

# Husafell, W-Iceland

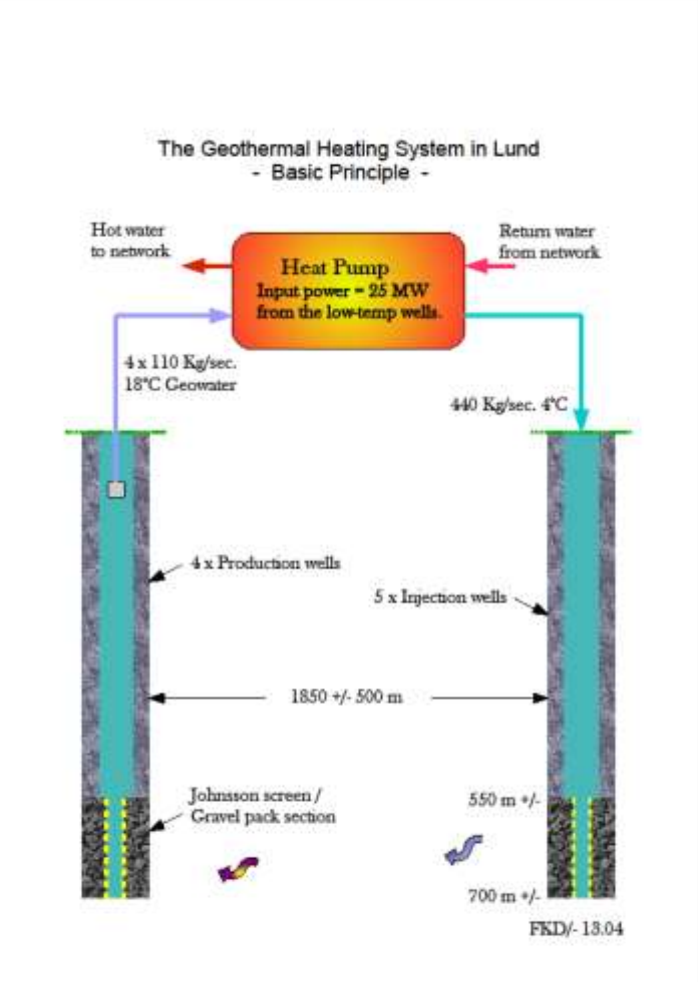
- An example of a successful drilling !
- 25 l/s at 62°C.
  6 bar artesian flow !
- The distribution network now covers 190 houses plus a hotel !

# A heat pump in a geothermal country !




- Heat pump installed 1st of April 2015.
- Has saved 1,97 GWh as of 15.09.2017 and already returned investment cost.
- Link to HP: 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.

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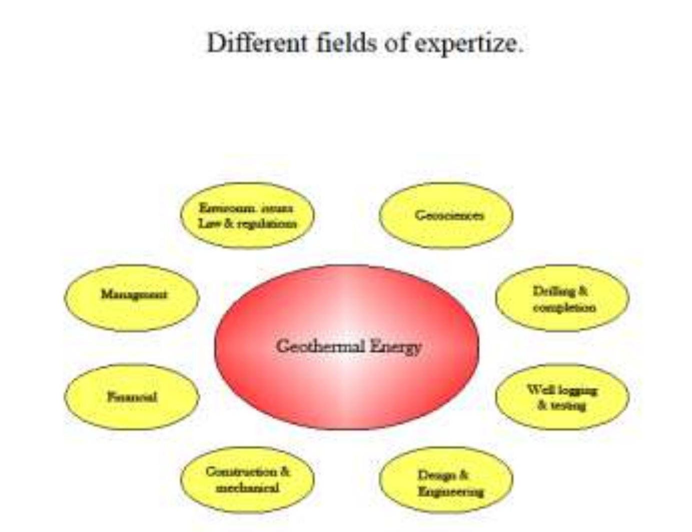
# It takes more than one person..




- The harnessing of geothermal energy requires a cluster of different expertize.

# 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