

# Geothermal experience, training, education and lessons learned in Iceland

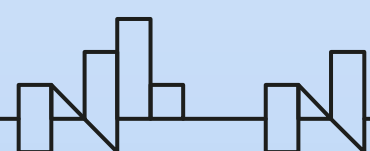
**Baldur Pétursson – Project Manager**  
**Orkustofnun / NEA side**

In cooperation with  
Jón Ragnar Guðmundsson  
Specialist - Engineering Management of DH



**Orkustofnun**  
**National Energy Authority (NEA)**

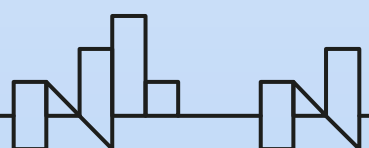
09.02.2021





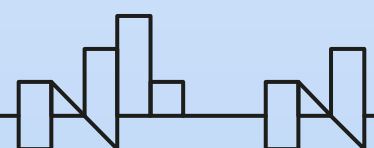
# Role and tasks of Orkustofnun

1. Energy Policy Recommendation
2. Licensing resources
3. Monitoring resources
4. National Regulatory Authority
5. International cooperation, EEA Grants, WEC, IGA, IEA, etc.
6. Energy Fund
7. The Energy Agency, (Orkusetur Akureyri)
8. Initiatives for geothermal exploration
9. Dissemination of information
10. Data, energy efficiency, research



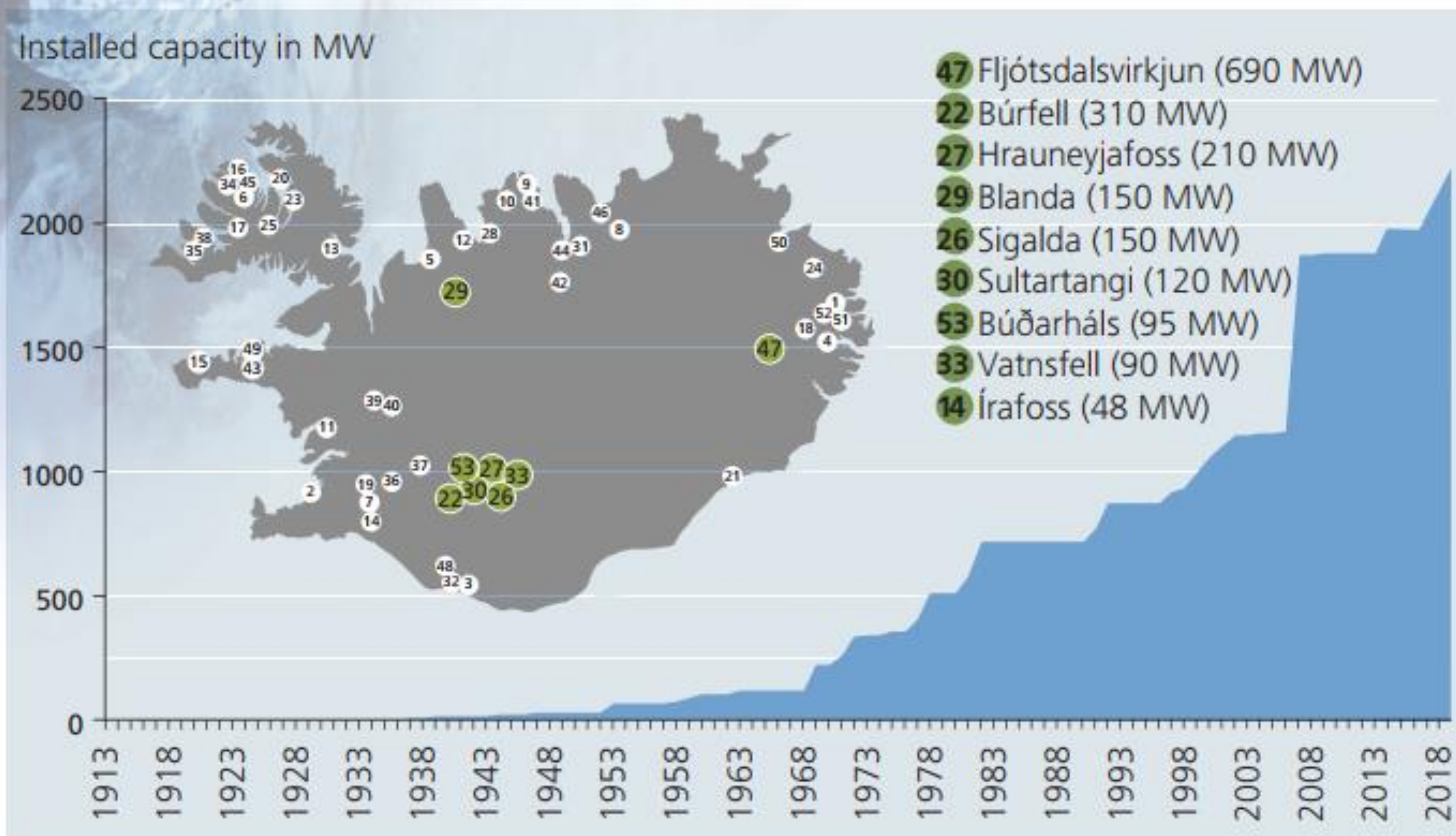
# Our EEA Grant Team

- Baldur Pétursson, Manager - International Projects/Public Relations
- Jónas Ketilsson, Senior Manager - Deputy Director General
- Harpa Þ. Pétursdóttir, Legal Advisor,
- María Guðmundsdóttir, Specialist - Geothermal Energy Economics
- Jón Ragnar Guðmundsson, Specialist - Engineering Management of DH
- + additional experts



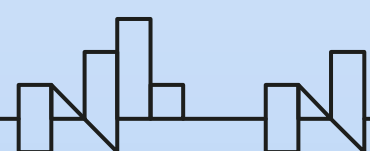


# Installed capacity in hydro power plants 1913-2019



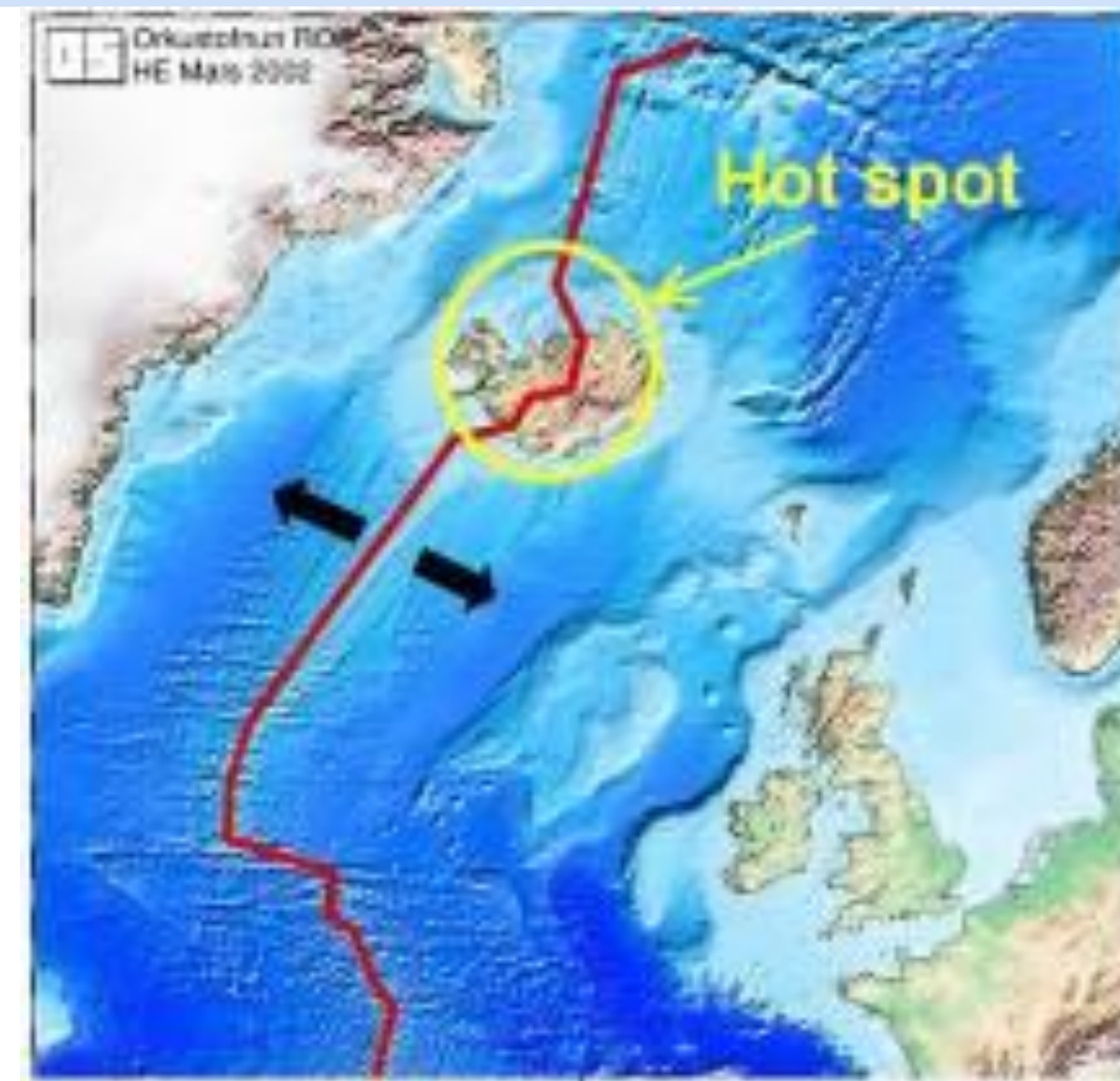
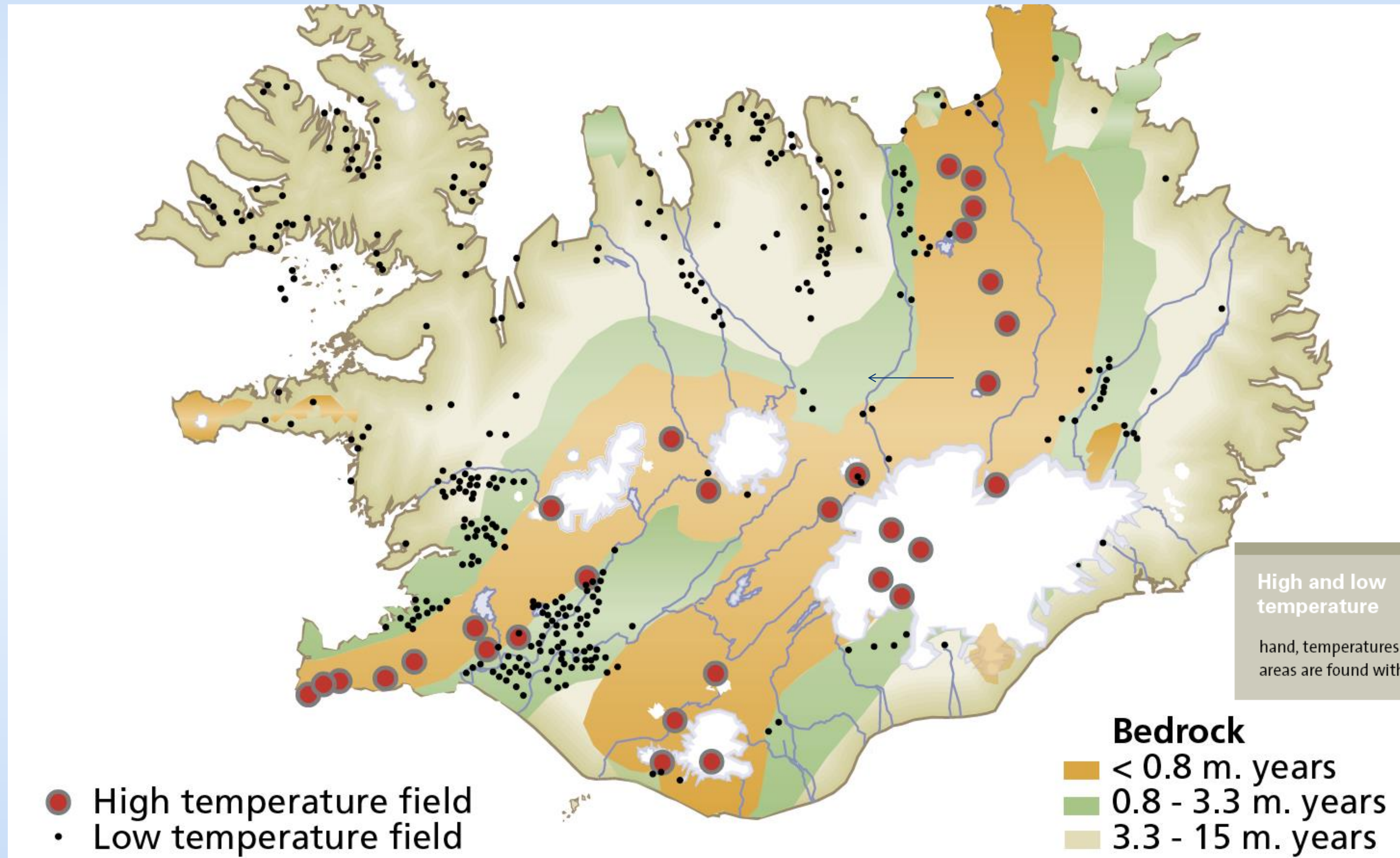
The numbered dots in the picture show the main hydro power plants in Iceland.  
The largest are specified (green dots).

Source: Orkustofnun





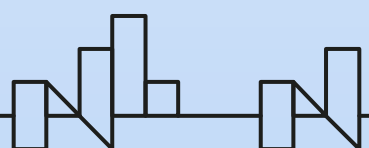
# Geothermal Fields in Iceland



## High and low temperature

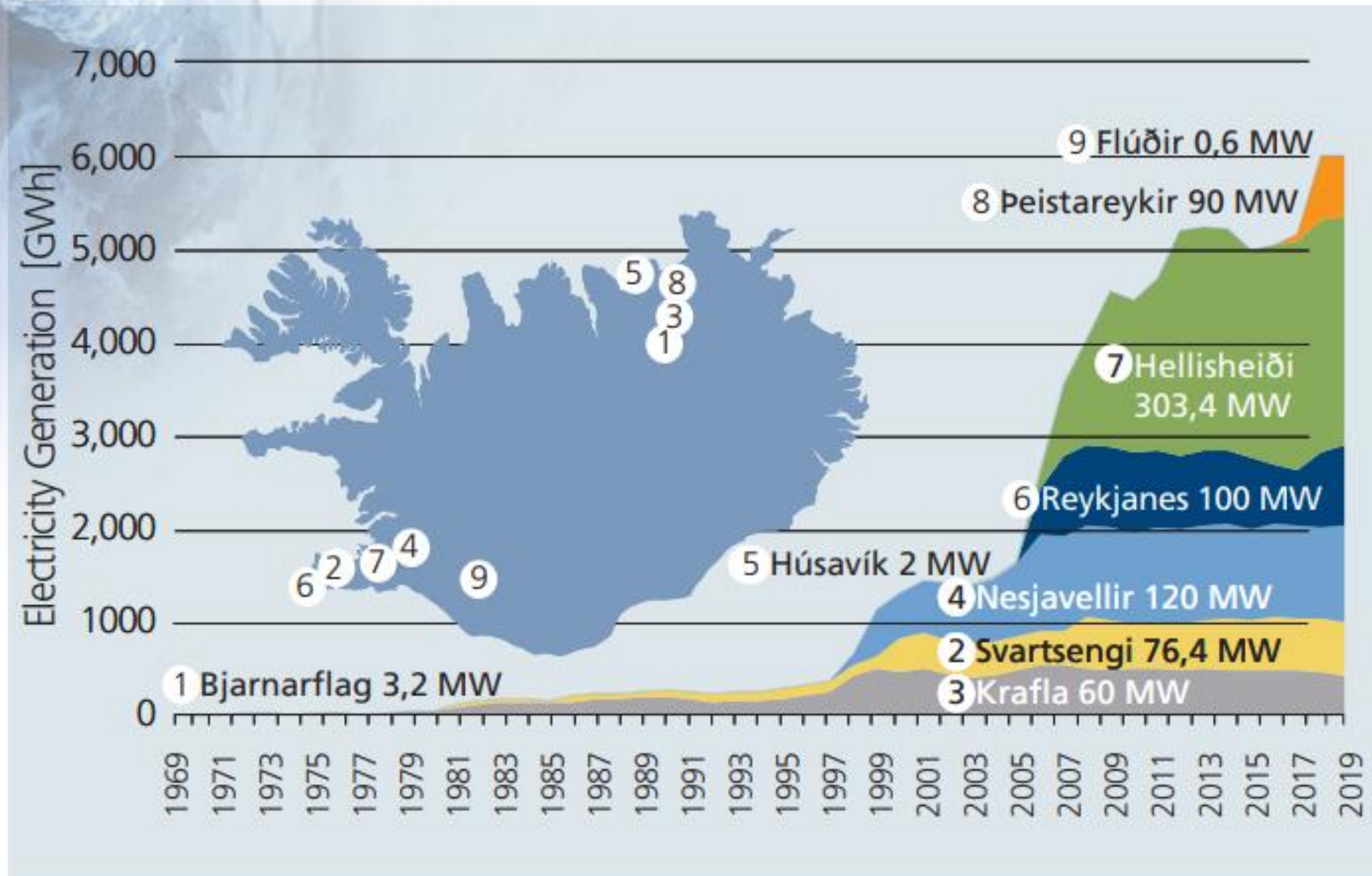
In low temperature geothermal systems, temperatures in the uppermost 1,000 m may reach up to 150°C. In the high temperature fields, on the other hand, temperatures reach over 200°C at 1,000 m depth. High temperature geothermal areas are found within the active volcanic zone of Iceland.

$T_{avg} = 0^{\circ}\text{C}$  (january) to  $10^{\circ}\text{C}$  (july) in Reykjavík

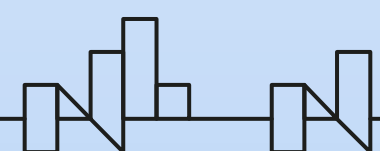
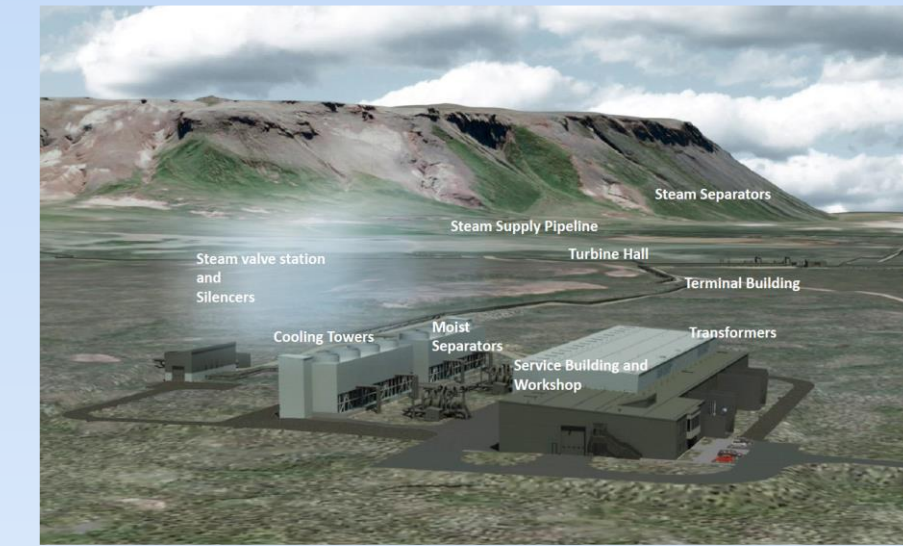




# Electricity generation of geothermal power plants 1969-2019

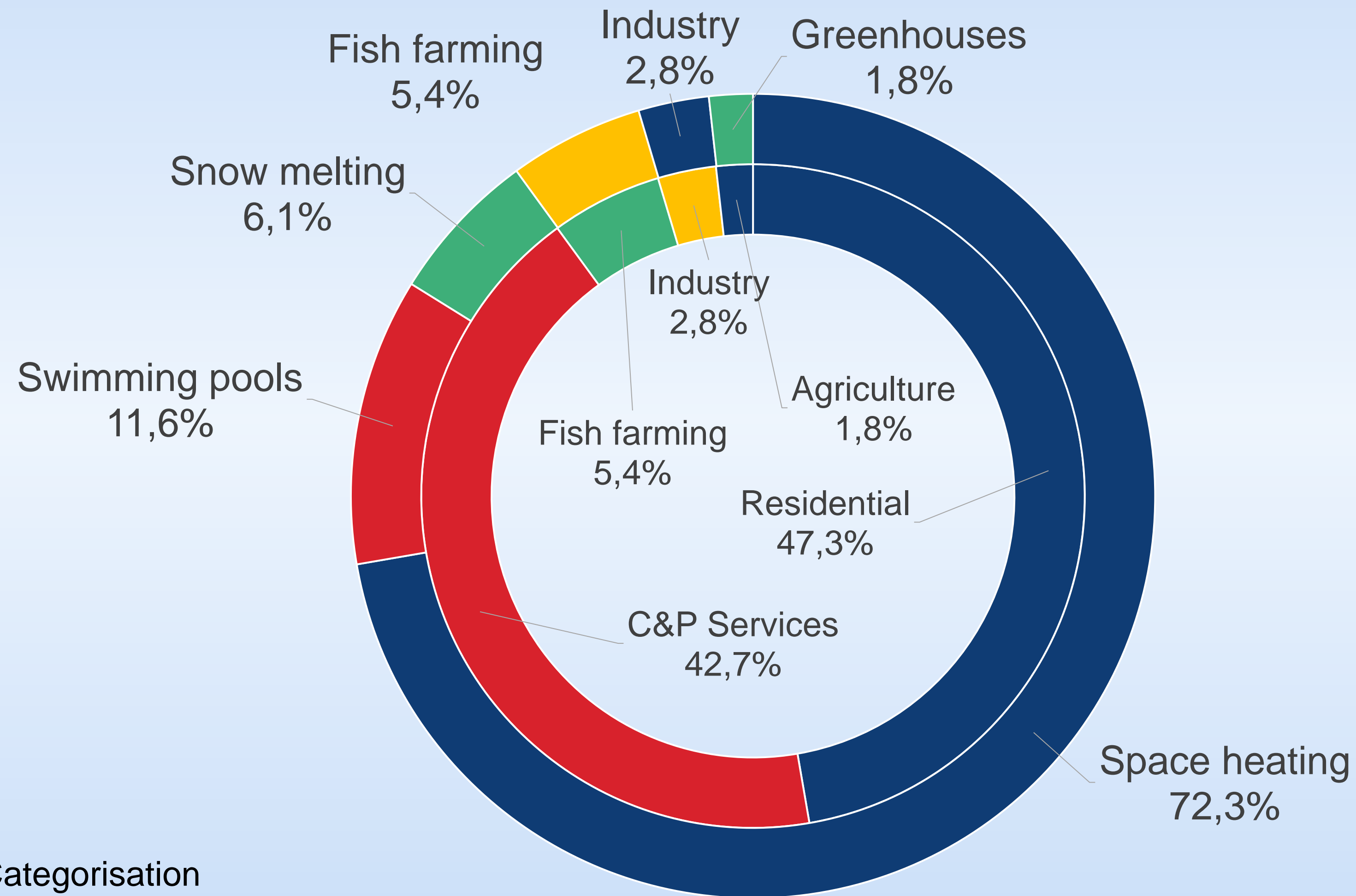


Orkustofnun Data Repository: OS-2020-T006-01





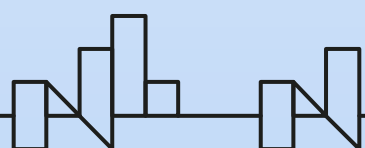
# Total Heat Use 2019



Total Heat Use: 33,7 PJ  
Geothermal: 97,4%

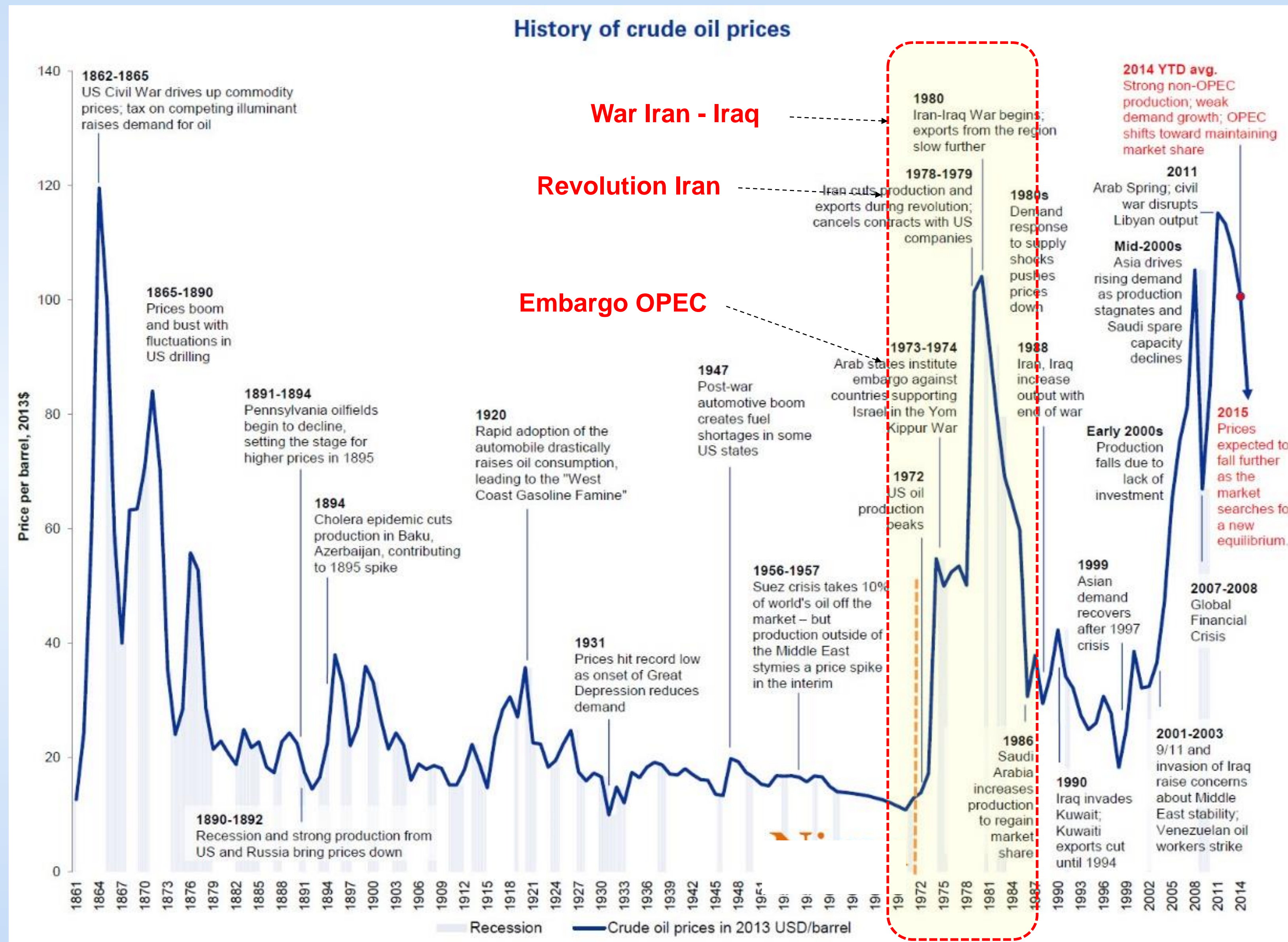
Inner ring - Eurostat Categorisation  
Outer ring - IGA Categorisation

Orkustofnun Data Repository: OS-2020-T010-01





# The Oil Crises 1970 -1980

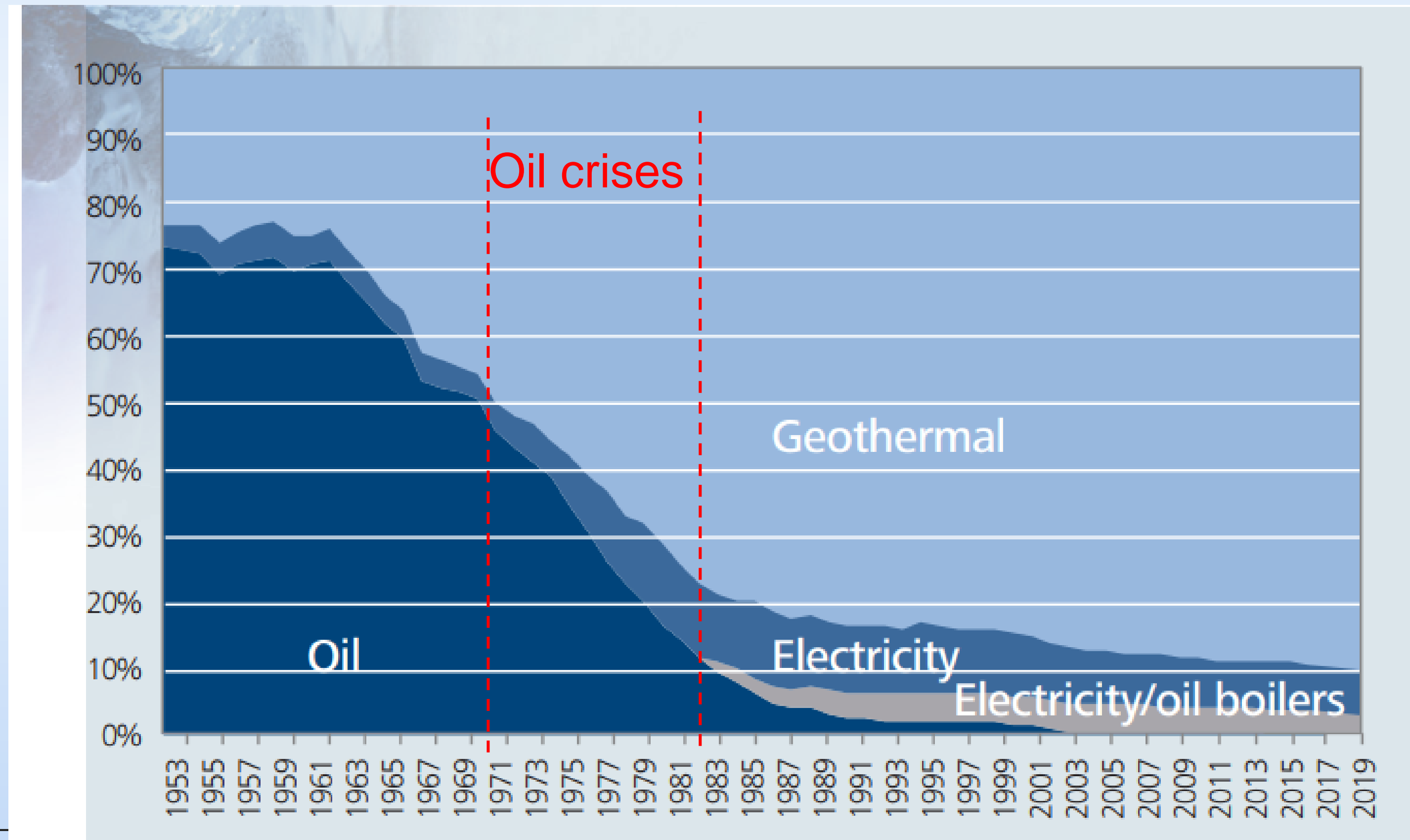




# Expansion of GeoDH

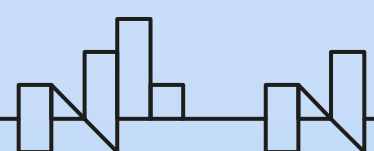
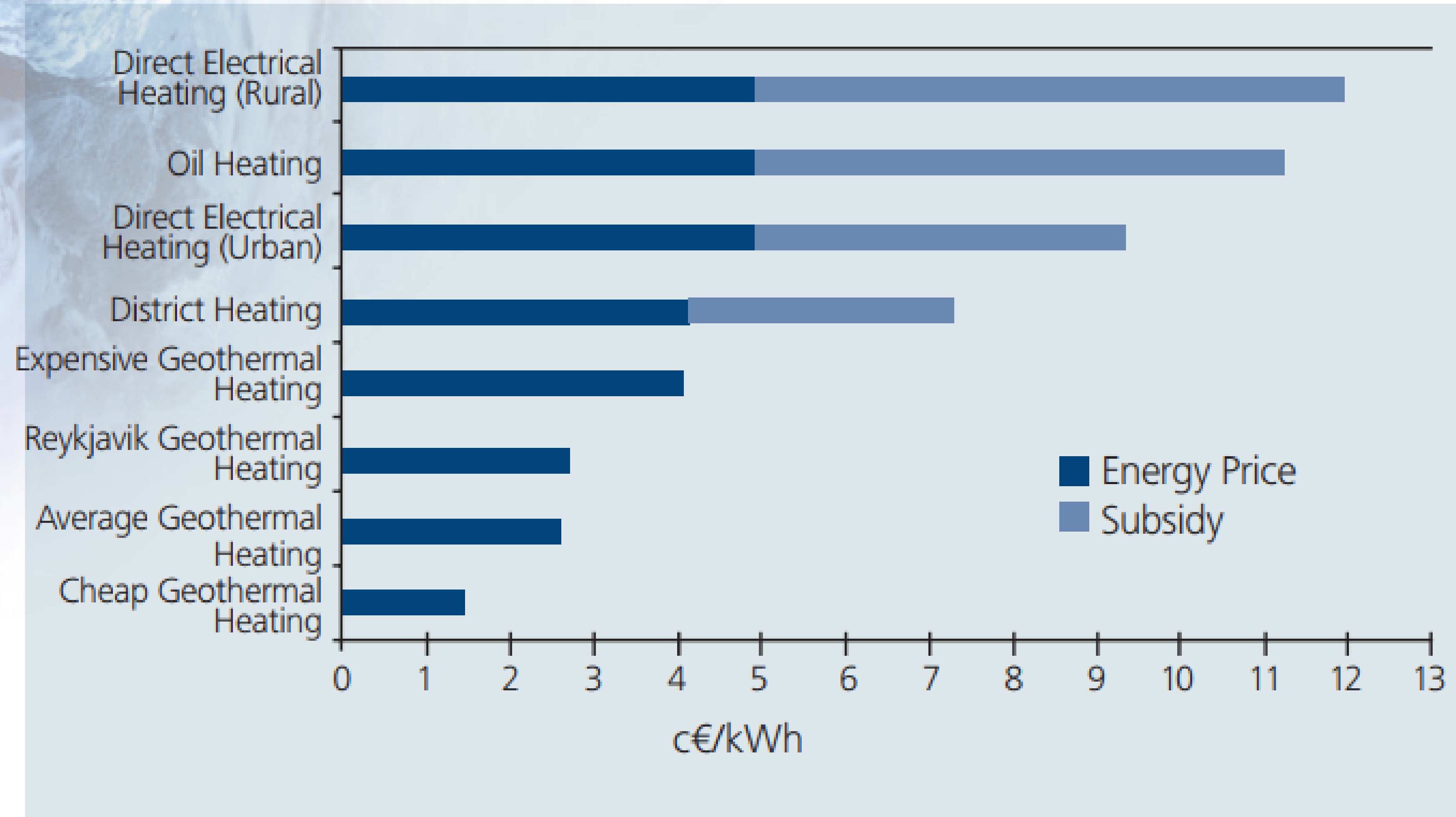
## Space Heating by Source 1953–2019

- 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 **50% to 80%** of total space heating
- **It took only 12 years to decrease oil for heating from 50% to 10% in 12 years**



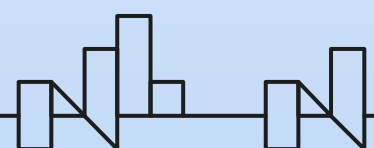
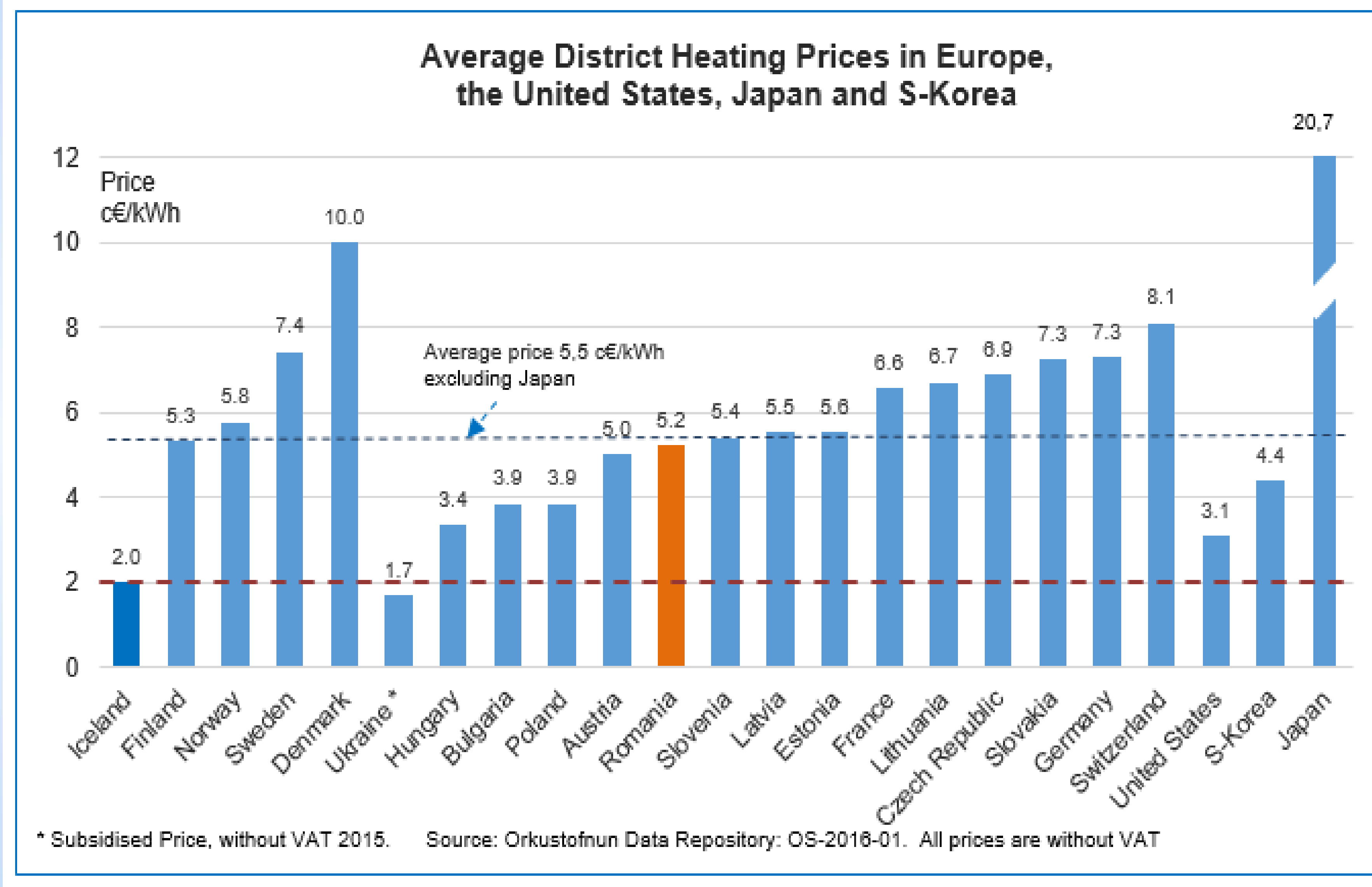


# Energy price for space heating in September 2019



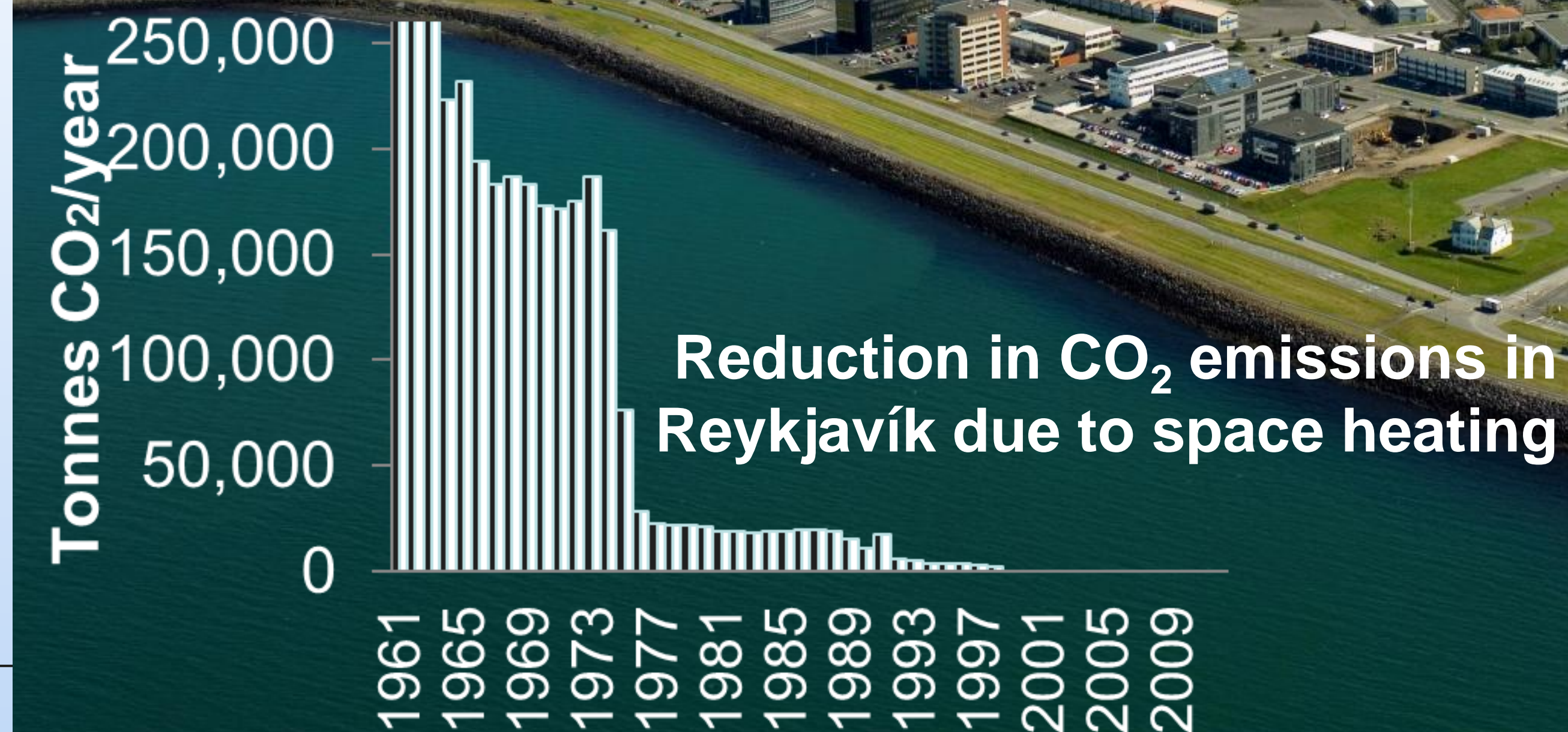


# District Heating Prices in Europe in 2015





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



Source: Reykjavik Energy



# Environmental Benefits of Geothermal Utilisation

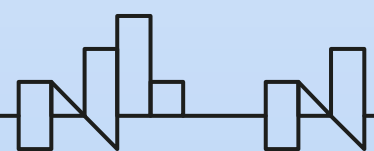
Reykjavík 1933



Reykjavík today



Source: Reykjavik Energy





# Utilisation of Geothermal Energy

## Companies within the Resources Park at Reykjanes

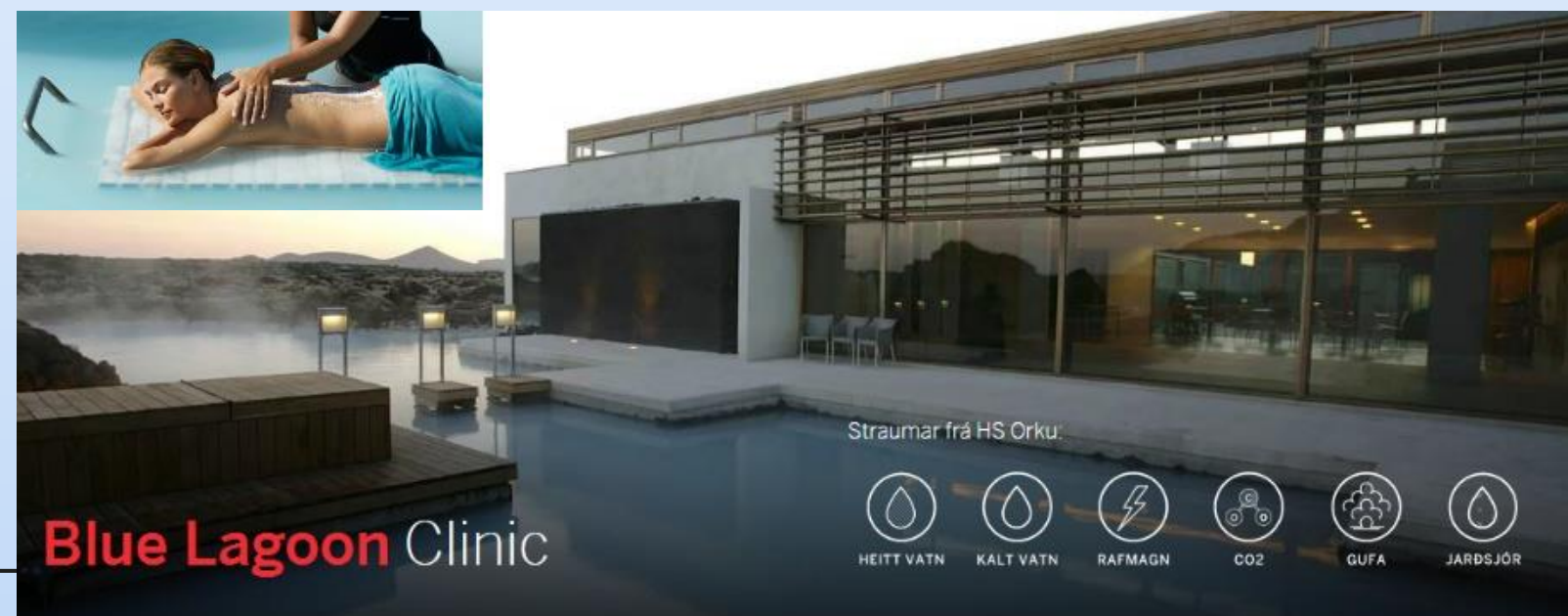
### Geothermal Power and Heat Generation



### Blue Lagoon Health Spa



### Blue Lagoon Clinic



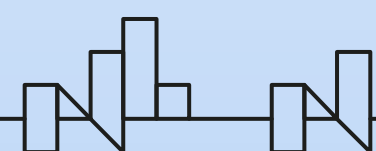
### Geothermal Power and Heat Distribution



### Blue Lagoon R&D Centre



### Fish Drying

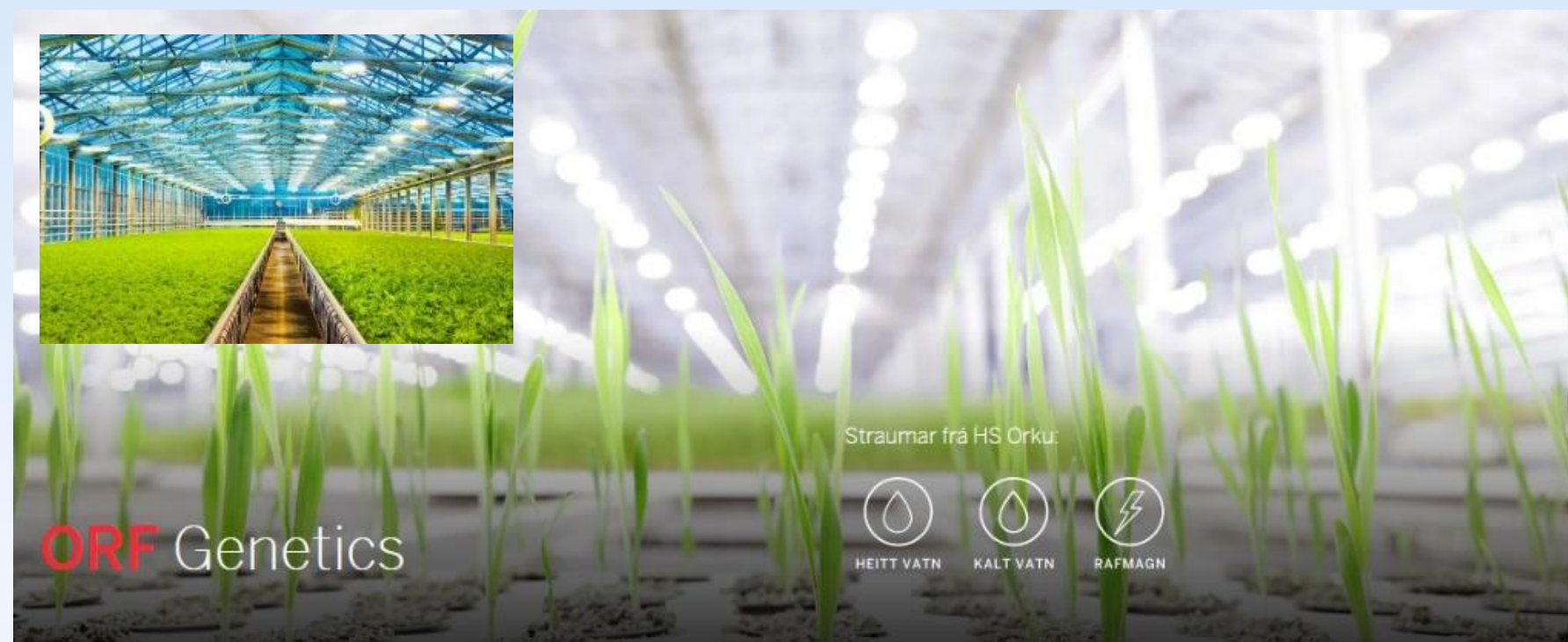




# Utilisation of Geothermal Energy

## Companies within the Resources Park at Reykjanes

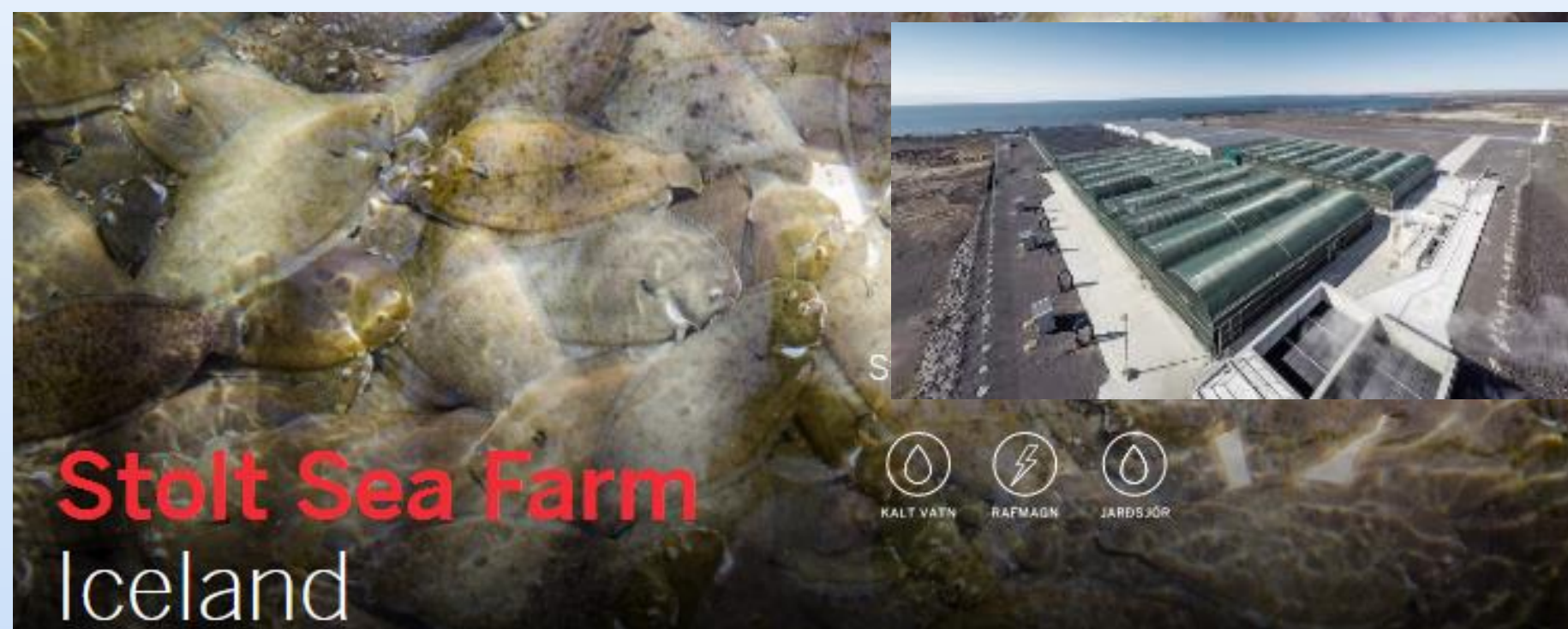
ORF Genetics



Hotel



Stolt Sea Farm



Carbon Recycling





# Utilisation of Geothermal Energy

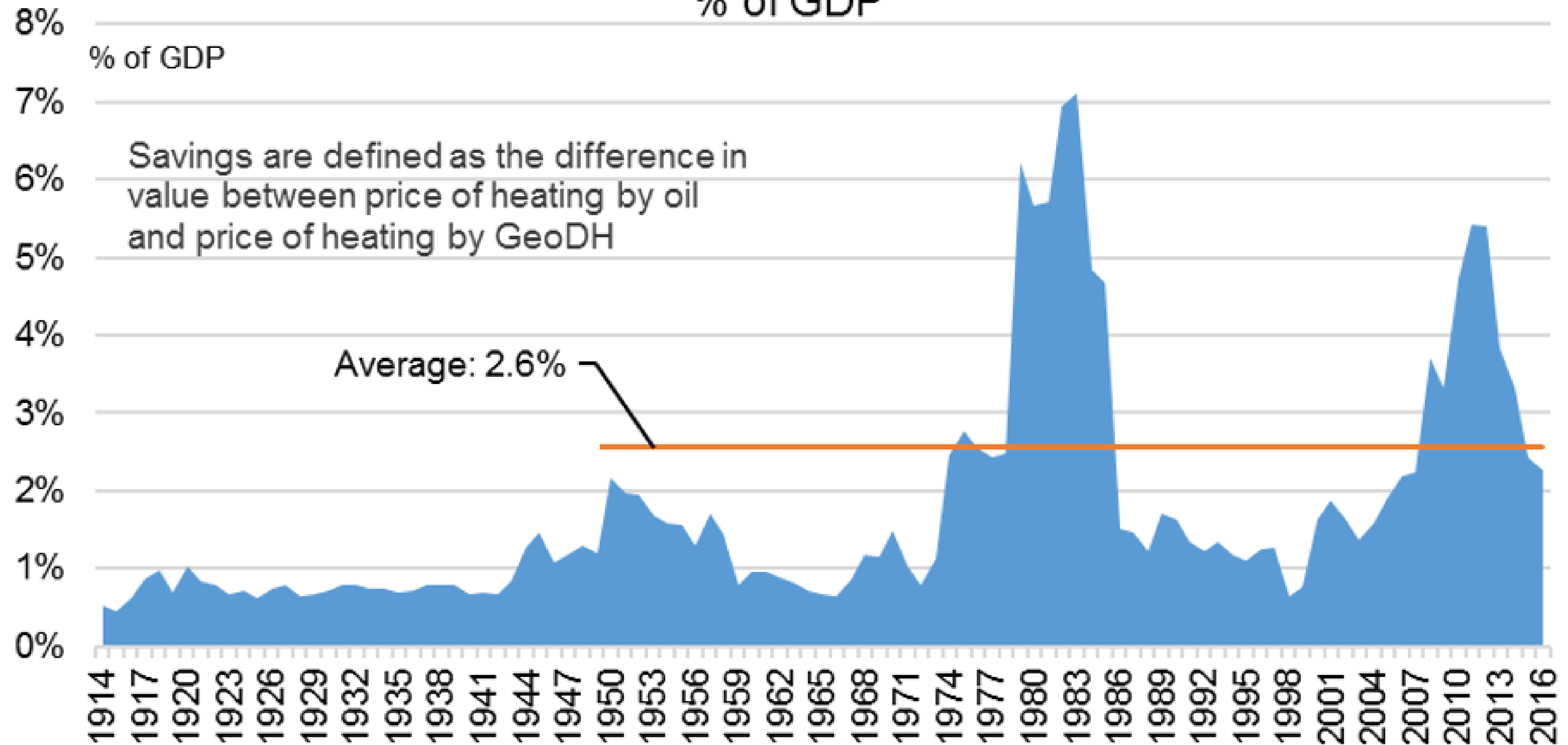
District heating, swimming pools, spas, greenhouses, various industrial applications.



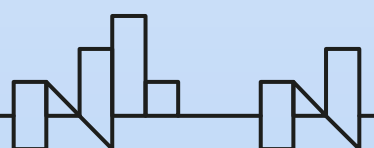


# National Savings by Geothermal District Heating

% of GDP



Source: Orkustofnun





# Renewable Energy - mitigate Global Warming

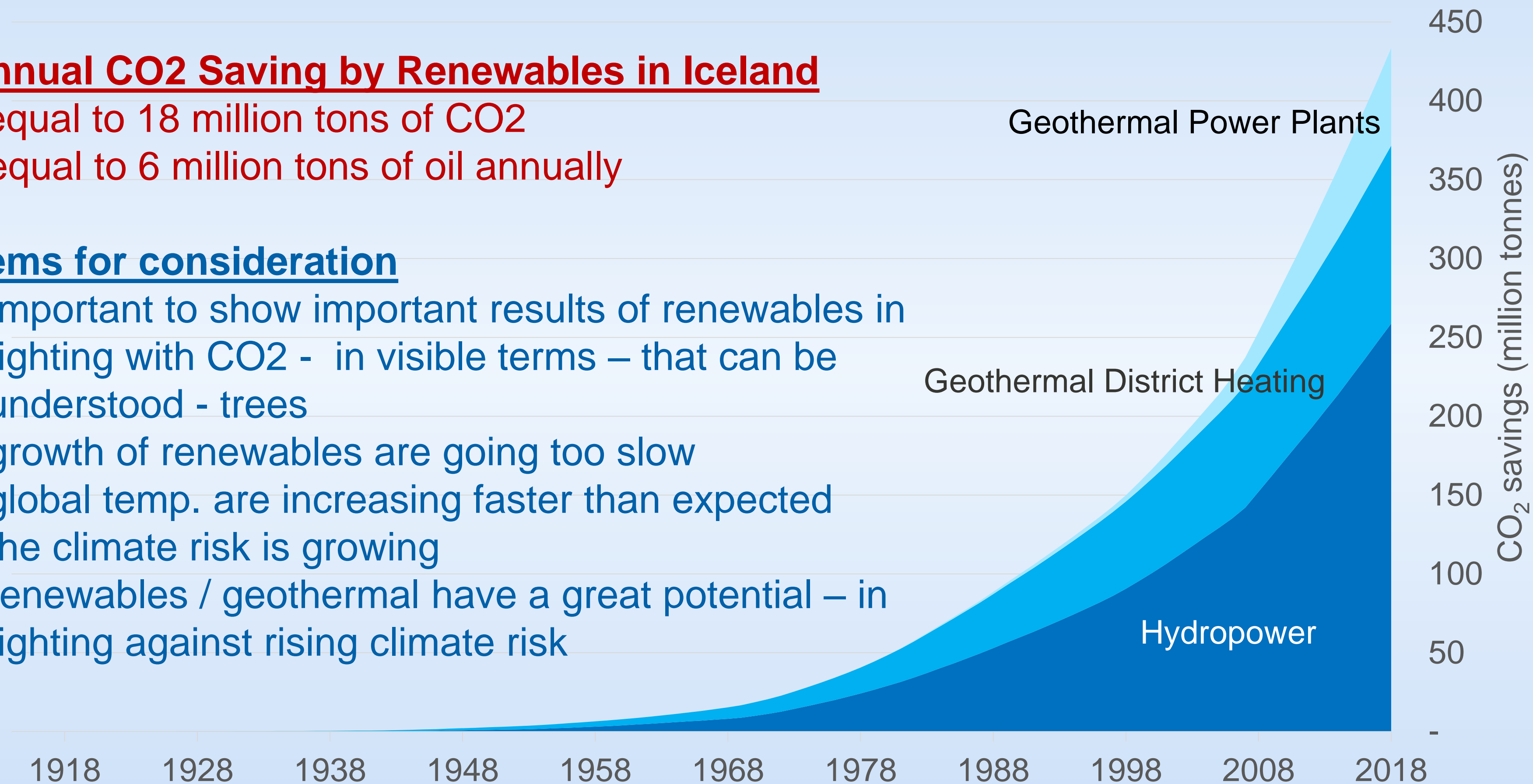
Accumulative CO2 savings using renewables instead of oil

## Annual CO2 Saving by Renewables in Iceland

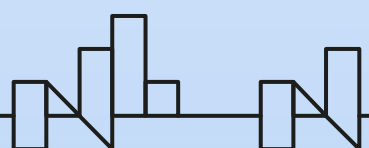
- equal to 18 million tons of CO2
- equal to 6 million tons of oil annually

## 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

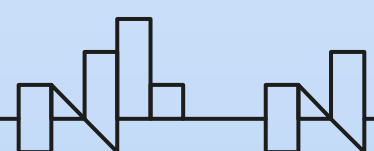
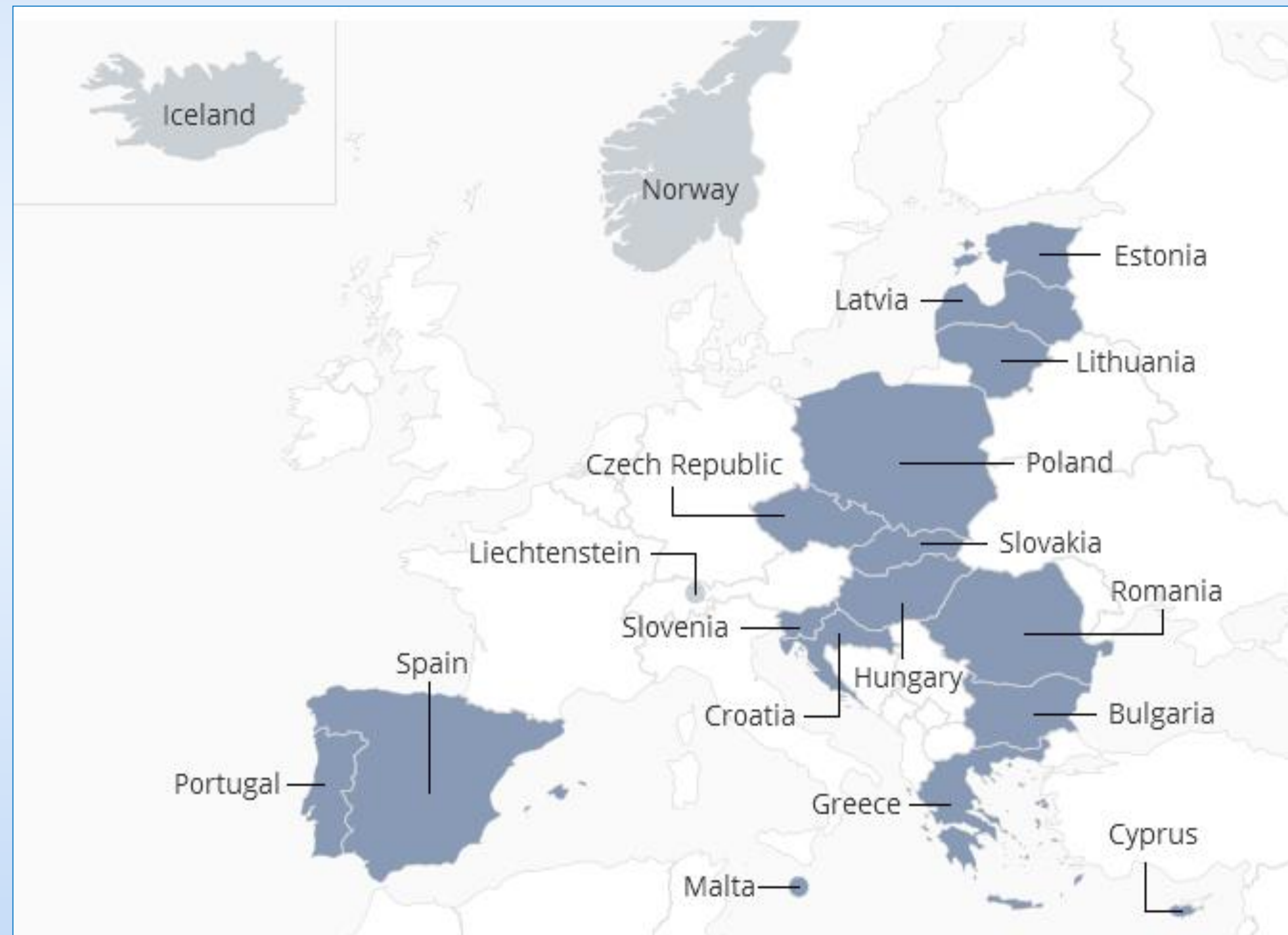


Orkustofnun Data Repository: OS-2019-T011-01





# International Cooperation – EEA Grants Orkustofnun is Donor Program Partner (DPP) for Renewables in some Countries, Poland, Romania and Bulgaria 2014-2021





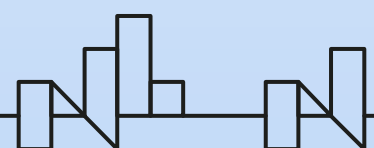
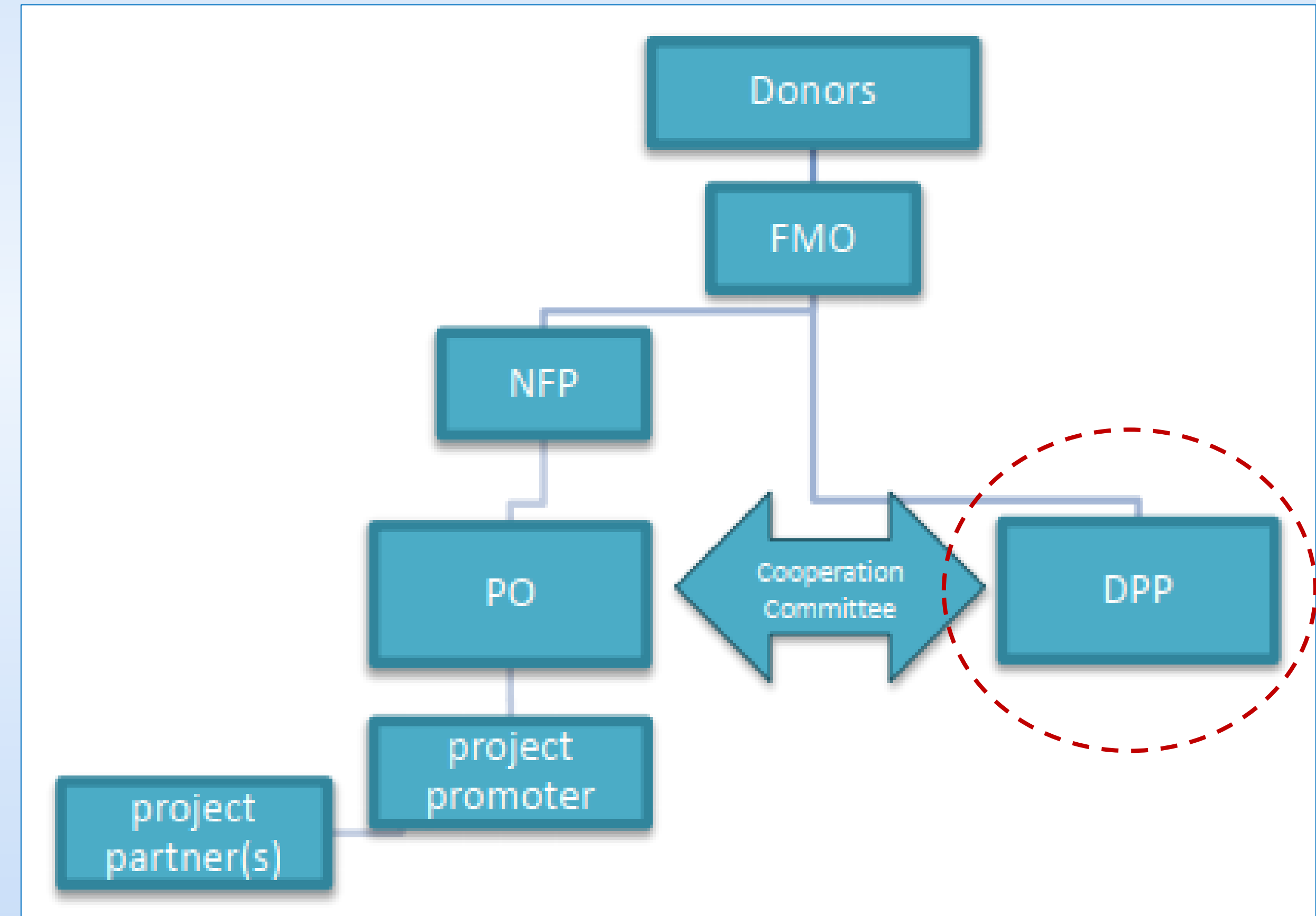
# International Cooperation – EEA Grants

## Orkustofnun is Donor Program Partner (DPP)

### for Renewables in some Countries on behalf Iceland

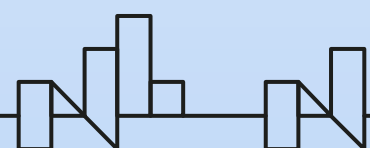
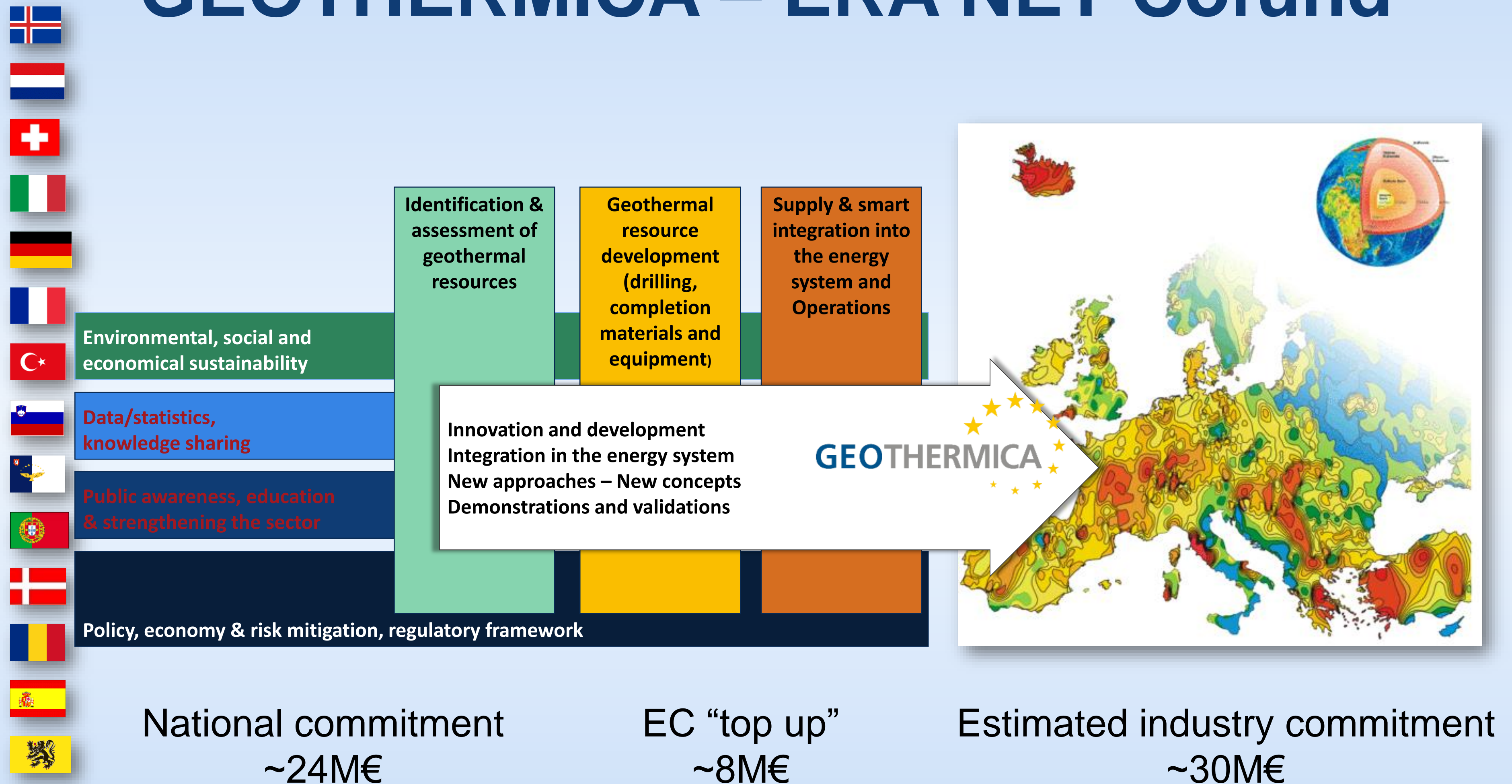
#### The role of Orkustofnun (National Energy Authority) as a Donor Program Partner (DPP)

- advise and support bilateral activities
- advise on selection criteria and the texts for call(s) for proposals;
- review progress made towards strengthening bilateral relations;
- advise the PO of any revision of the programme likely to facilitate the achievement of the program's expected outcome(s) and objective; and
- advise on the use of funds for bilateral relations





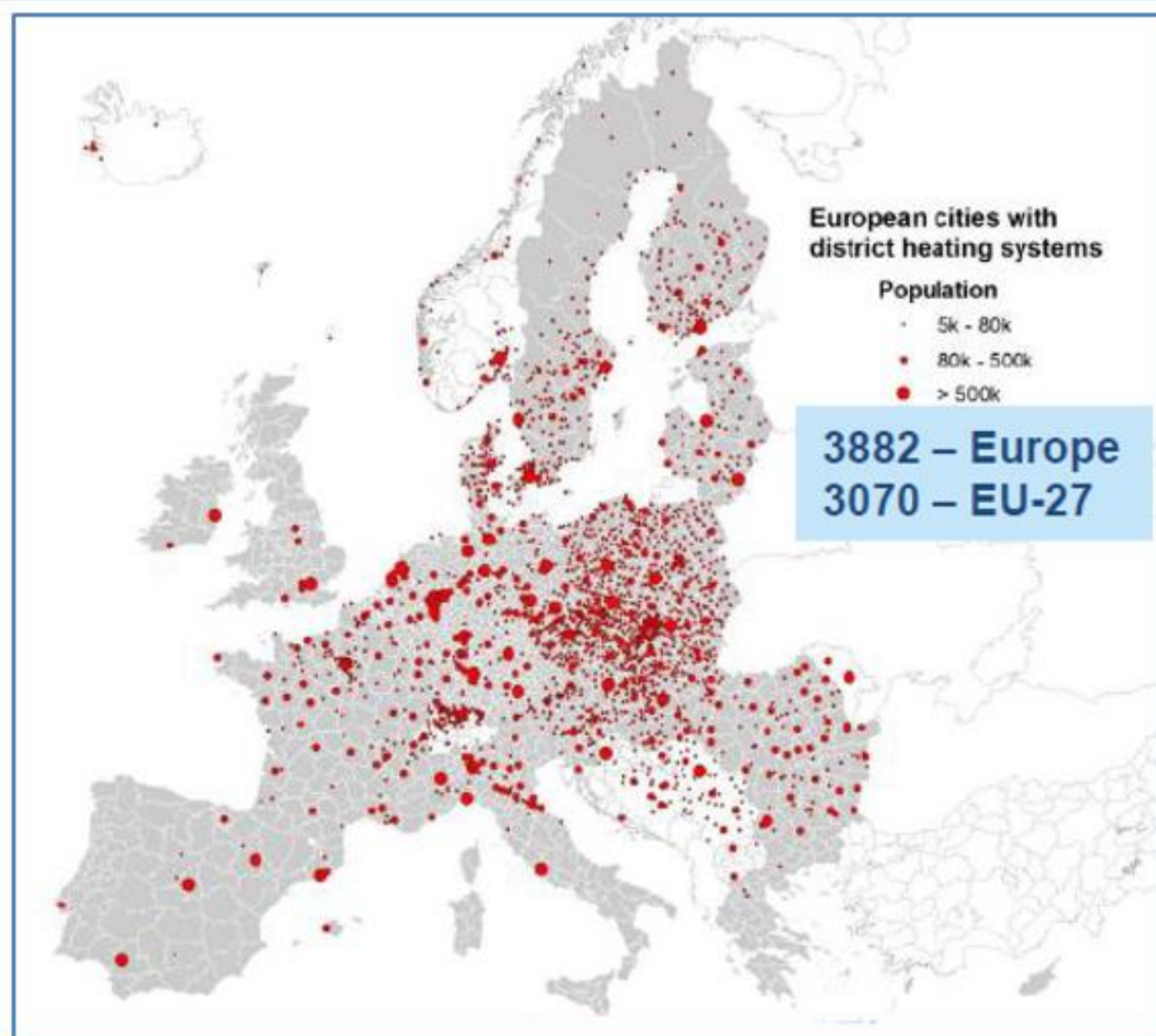
# The follow up GEOTHERMICA – ERA NET Cofund



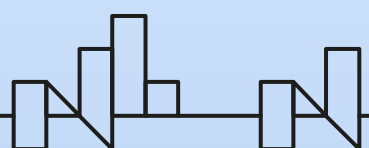
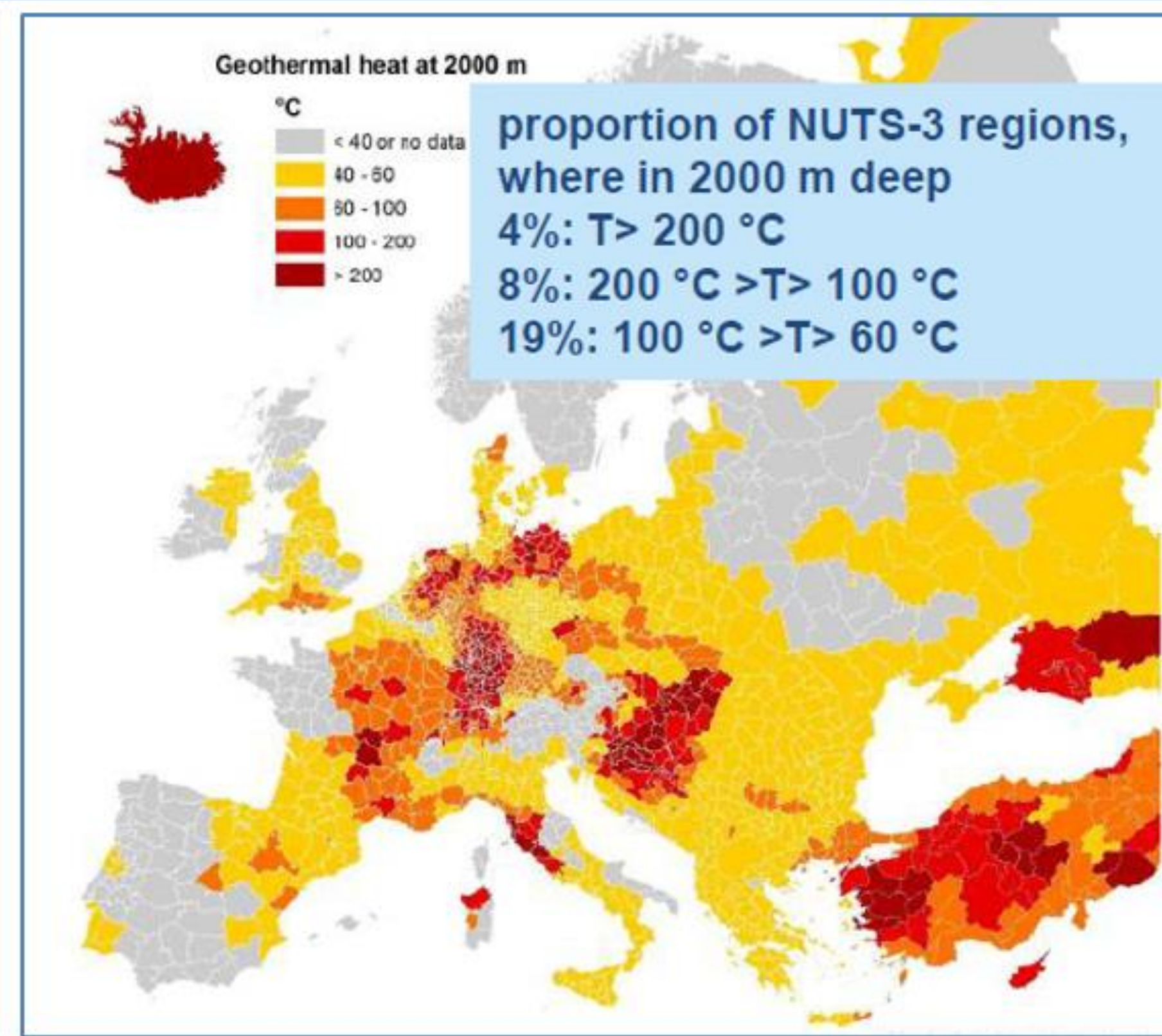


# Geothermal District Heating Options and Possibilities in Europe

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



## ***Geothermal heat at 2000 meters***





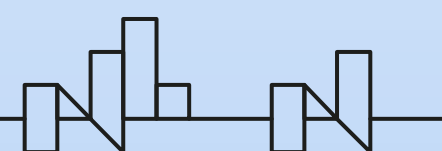
# One more Geothermal project between Iceland and Poland 2020

Iceland   
Liechtenstein  
Norway grants

**Capacity building of key stakeholders  
in the area of geothermal energy**



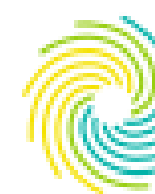
**Project co-financed by the EEA Financial Mechanism for 2014–2021**  
**"Environment, Energy and Climate Change" Program**  
**"Energy" Program Area**  
**Poland**





# One more Geothermal project between Iceland and Poland as a preparation step for further cooperation

## Program Operators



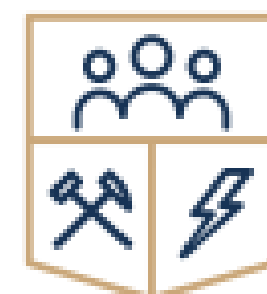
Ministry of Climate  
and Environment



National Fund  
for Environmental Protection  
and Water Management

[www.keygeothermal.pl](http://www.keygeothermal.pl)

## Project Partners



Mineral and Energy  
Economy Research  
Institute  
Polish Academy of Sciences



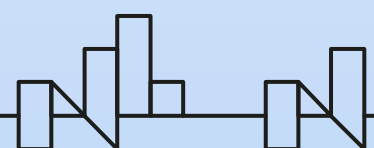
**ORKUSTOFNUN**  
National Energy Authority

Together we work for a **green**, **competitive** and **inclusive** Europe



# The Project Objective

- To build the knowledge of key stakeholders in Poland regarding an optimal use of geothermal energy and management of its resources, especially for the needs of low emission heating
- To enhance capacity building and knowledgebase methods rooted in long experience of geothermal energy in Iceland. This will be done through sharing good methods, practice, and technologies supported by appropriate government initiatives, financial mechanisms, and management strategies
- To increase energy security, development of low-emission heating, an opportunity to increase social and economic equality by providing clean energy and, inter alia, lowering heating costs
- The Project aims also to decrease pollution, CO emissions and contribute towards mitigating climate changes

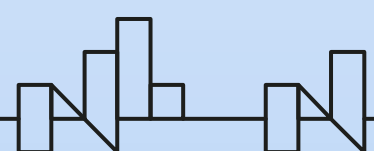




# Project target groups

Representatives of key stakeholders in Poland from the public and private sector:

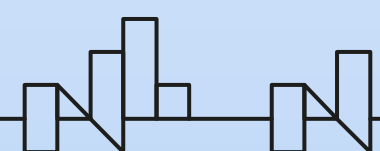
- Administration of various levels
- Local governments
- Operators, investors of existing implemented and planned heating plants and other geothermal installations
- Beneficiaries of government programs supporting the identification of resources and geothermal energy use in Poland
- Scientific-research entities
- Geological administration
- Service providers, consultants
- NGOs
- Other entities from the geothermal sector





# Main Project Activities

- Training activities in Poland (2021–2023)
- Study visits in Iceland (2021–2023)
- Expert study visits in selected localities prospective for geothermal development in Poland (2022–2023)
- Report from Expert study visits on possibilities of geothermal energy use in selected localities in Poland (2022–2023)
- Final report (2024)
- Information and communication (2020– 2024)
- Final report (2024)
- Project management (2020–2024)



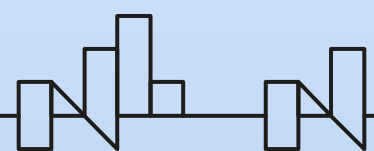


# Study visits in Iceland (2021–2023). Leader: Orkustofnun / NEA

- **17 participants each year**
- **3 days of study visits** (+ 2 days travel): selected geothermal heating installations , etc., meetings with experts, operators, etc.
- **When** – October / November each year. **2021** – proposed days: beginning November 2021 (decision on organising the visit in 2021 will be taken in later date).
- **Conducting the visits** – experts from Iceland (Orkustofnun / NEA, other)
- **Free participation in the visits.** Costs covered by the Project budget, i.e.: flights, local transport, information materials, interpretation, catering, 3 overnights
- **Applications for study visits** (incl. preferred year of participation) via online form at Project website (since March 2021)\*, \*\*
- **Applications for study visits in 2021: until 7 May 2021\***

\* *Participation in Study visits in Iceland – for prs who have previously participated in training in Poland (A.1)*

\*\* *Participation in a visit in a given year will also depend on the order of applications and belonging to one of the Project target group*





# One more Geothermal project between Iceland and Poland – as a preparation step for further cooperation

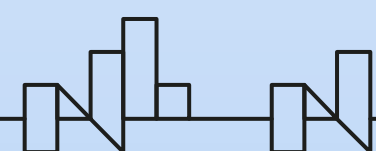
Together we work for a **green, competitive** and **inclusive Europe**



Geothermal wells, Podhale (Poland) source: PEC Geotermia Podhalańska SA



Geothermal installation, Hitaveita Hornafjarðar, source: RARIK



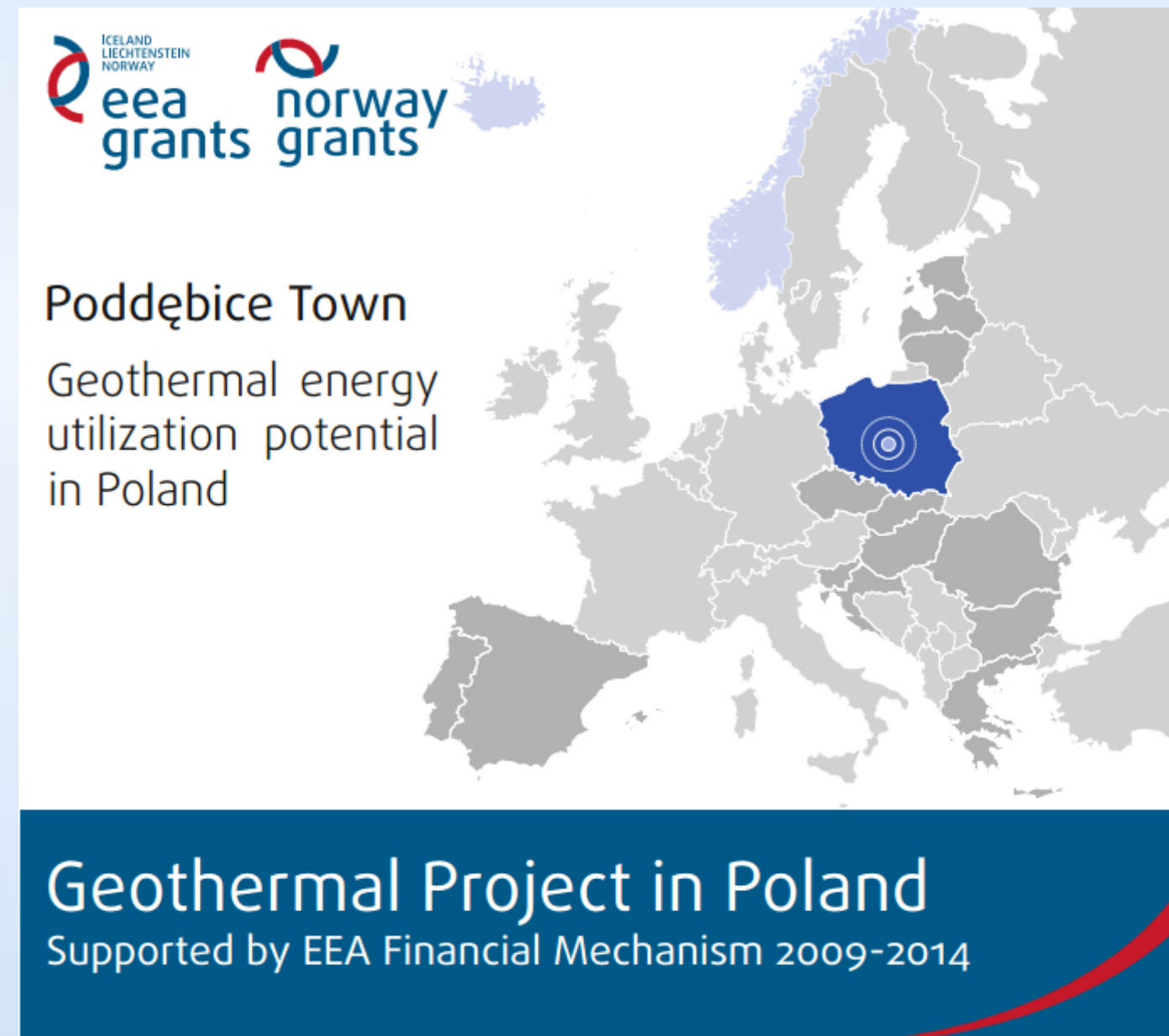


# Bilateral Projects in Poland

## Poddebice, EEA Grant 2009-14

[Link to the report](#)

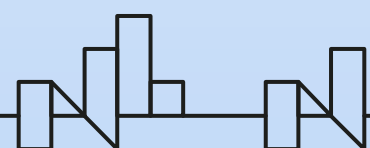
The report can be used for preparation of various cooperation projects, including regarding EEA Grant Geothermal calls 2014-2021



### Geothermal Energy Utilisation Potential in Poland – town Poddebice Study Visits' Report



June  
2017





# Bilateral Projects in Poland in 4 cities, EEA Grant 2009-14

[Link to the report](#)

[Link to EEA Grant Poland Information at Orkustofnun](#)

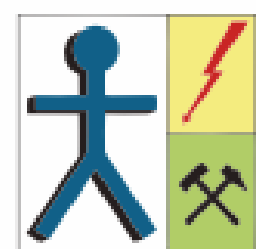
EEA Grant 2009-2014

The report can be used for preparation of various cooperation projects, including regarding EEA Grant Geothermal calls 2014-2021

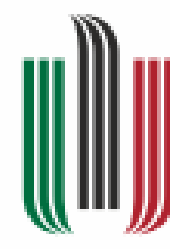


## Project Partners and Performers

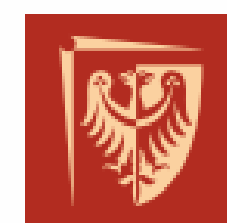
### Consortium



MEERI PAS



AGH  
AGH UNIVERSITY OF SCIENCE  
AND TECHNOLOGY



Wrocław  
University of Science  
and Technology

### Donors



Christian Michelsen Research



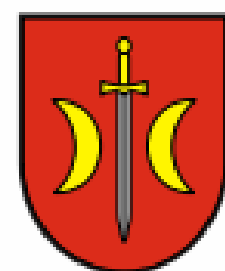
ORKUSTOFNUN  
National Energy Authority



## Programme Operators



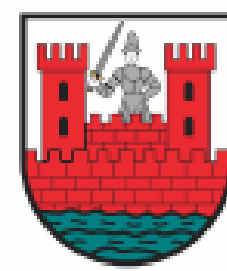
MINISTRY  
OF THE ENVIRONMENT



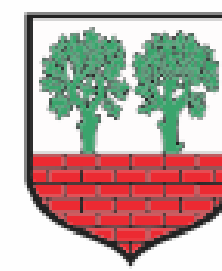
Konstantynów Łódzki



Łądek Zdrój



Sochaczew



Poddębice



Uzdrowisko  
Łądek-Długopole SA



# Constructive cooperation in 2009-2014 on projects and several meetings in Poland and Iceland





# Presidents and ministers participated in the presentation of a new EEA Grants programme on Climate, Environment and Energy 2014-2021 in Poland in March 2020





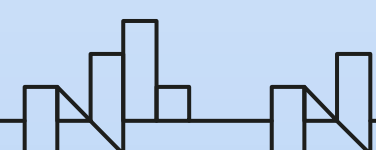
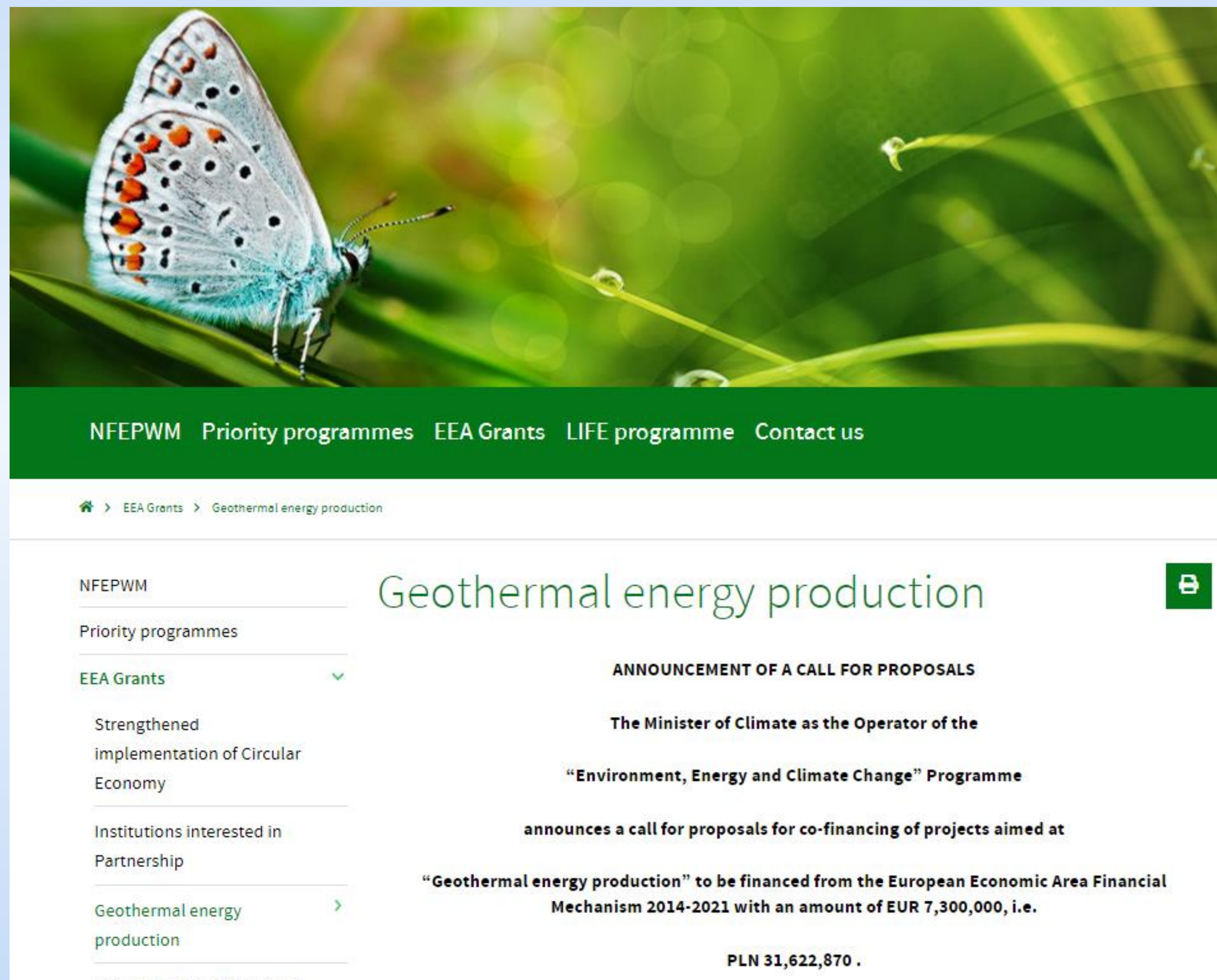
# The Geothermal Call is still ongoing until end of March 2021

## It is great opportunity for further cooperation

### 2.Type of projects

The purpose of the project shall be to create energy production systems based on the “deep” geothermal energy sources. The applications may include one or more of the below activities such as:

- Production and injection wells in areas with documented geothermal potential;
- Construction and/or extension of a geothermal heating plant;
- Construction of infrastructure connection(s) to integrate geothermal heat into an existing district heating system;
- Technological and infrastructure changes to existing district heating systems in order to integrate geothermal energy source(s);





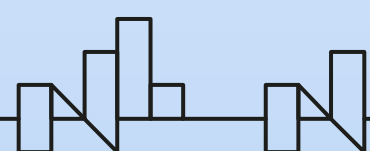
# Portugal EEA Grant 2009-2014



- 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



Successful outcome

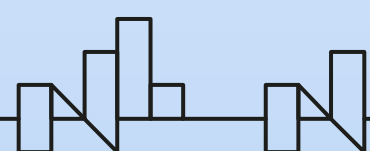




# EEA Grant 2009-2014

- RONDINE Programme in Romania (12,3 M€)
  - Small hydro power plants across Romania and geothermal projects.
  - Icelandic experts participated in both portions, with good results.
  - Feasibility studies in Oradea and Beius.
  - Four fellows attended the 6 month UNU-Geothermal Training Programme in Iceland in 2016.
  - UNU-GTP short courses and workshops in Romania.
  - Several trips organized for experts from both countries to visit each other.

Successful outcome

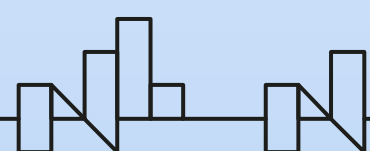




# Romania, EEA Grant 2009-2014

- Ilfov County project – geothermal district heating (1,45 M€)
  - Geothermal heating using an existing well for a hospital in Balotesti in Ilfov county, north of Bucharest, was successfully implemented in 2016 with the support of the EEA grants, and has replaced the gas heating system, producing great savings for the hospital.
  - Geothermal heating potential in the Bucharest area has now been proven.
  - Ilfov county is planning to move ahead with the development of at least two more geothermal heating systems, following the success of the EEA grants project in Balotesti.
  - Plans to further utilise the geothermal fluid for pools for the patients in the hospital.

Successful outcome

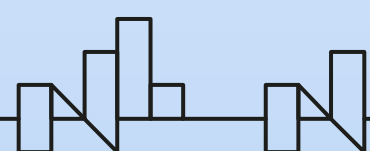
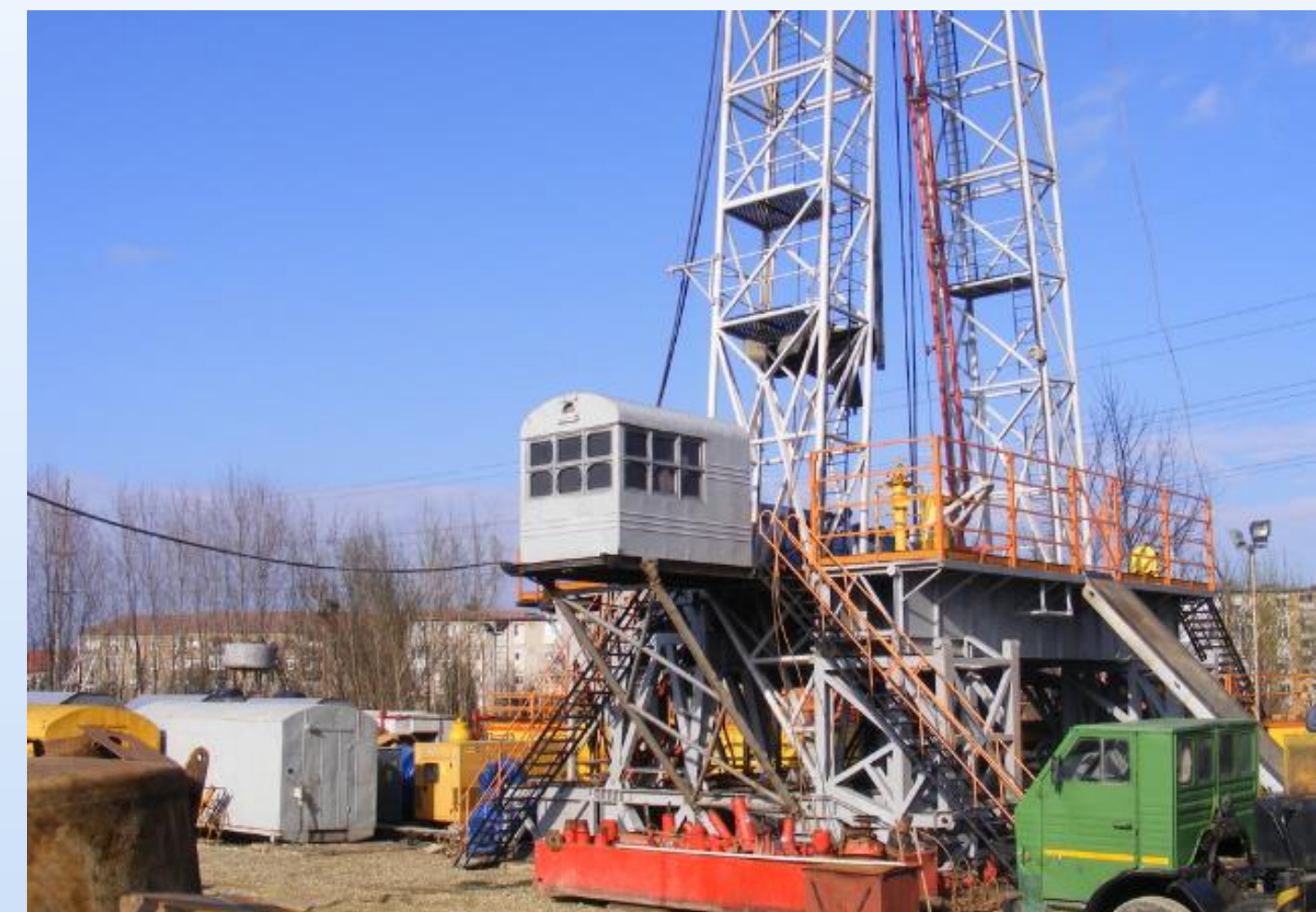




# Romania, EEA Grant 2009-2014

- Oradea project – geothermal district heating(3 M€)
- When geothermal energy replaces fossil fuels it reduces emissions, increases energy security by shifting to local resources and prices remain stable, giving a long term benefit to consumers
- In n Oradea in Romania, coal is replaced by geothermal energy from water in district heating.

Successful outcome



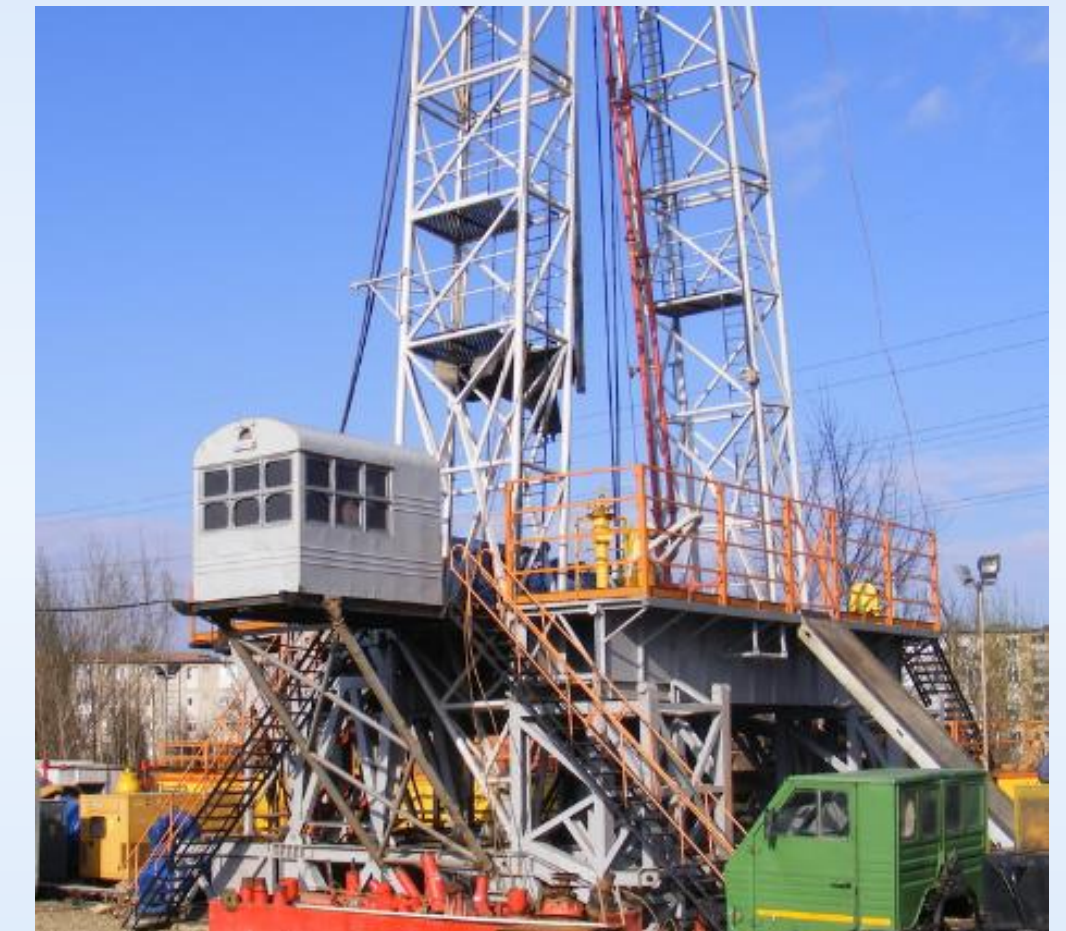


# Romania

## EEA Grant 2009-2014



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.



Successful outcome

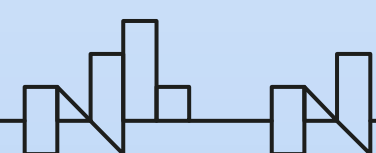
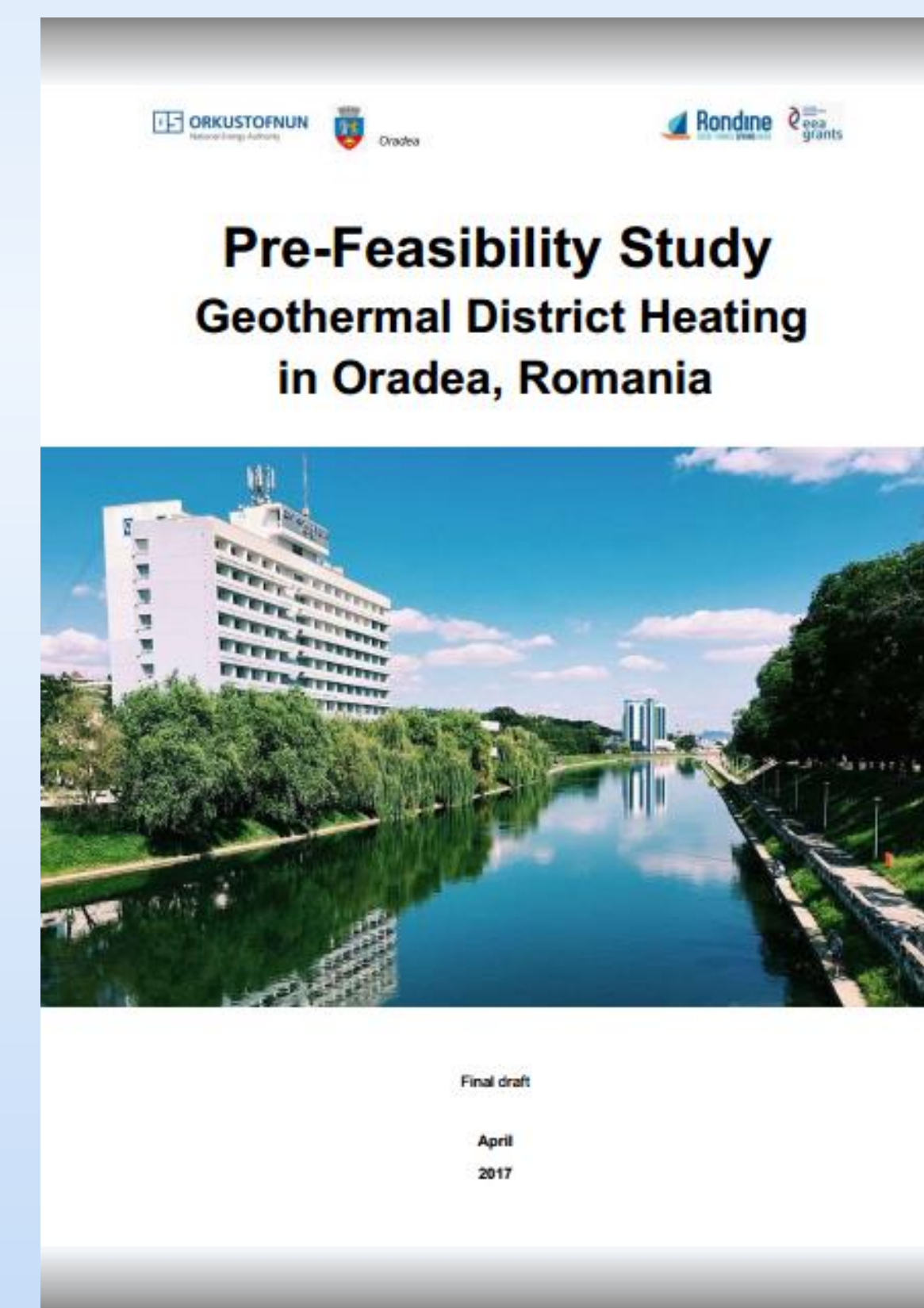
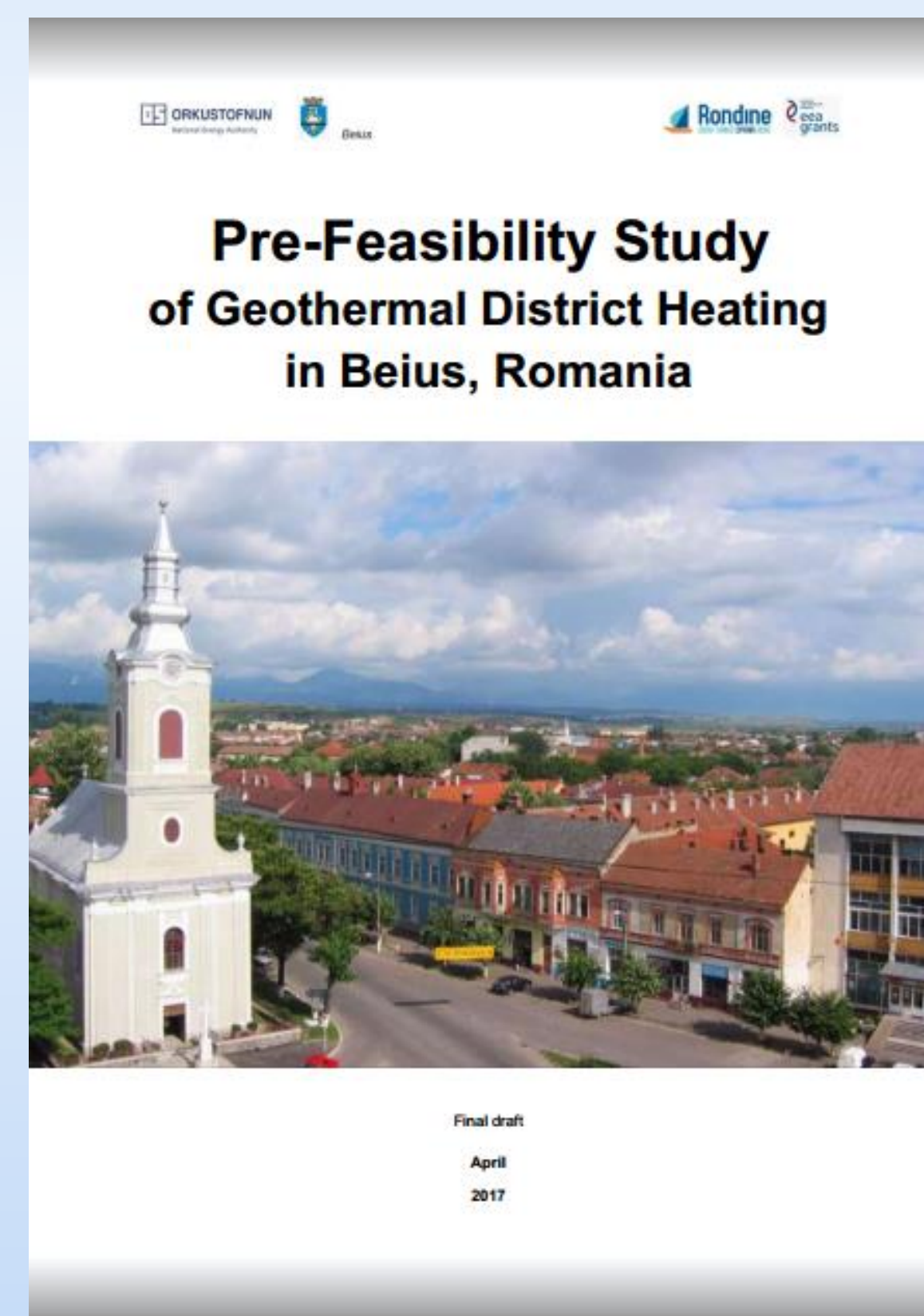


# Romania

## EEA Grant 2009-2014

### Pre-Feasibility Studies on geothermal possibilities in cities in Romania

The report can be used for preparation of various cooperation projects, including regarding EEA Grant Geothermal calls 2014-2021





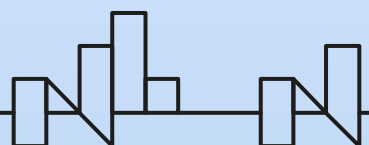
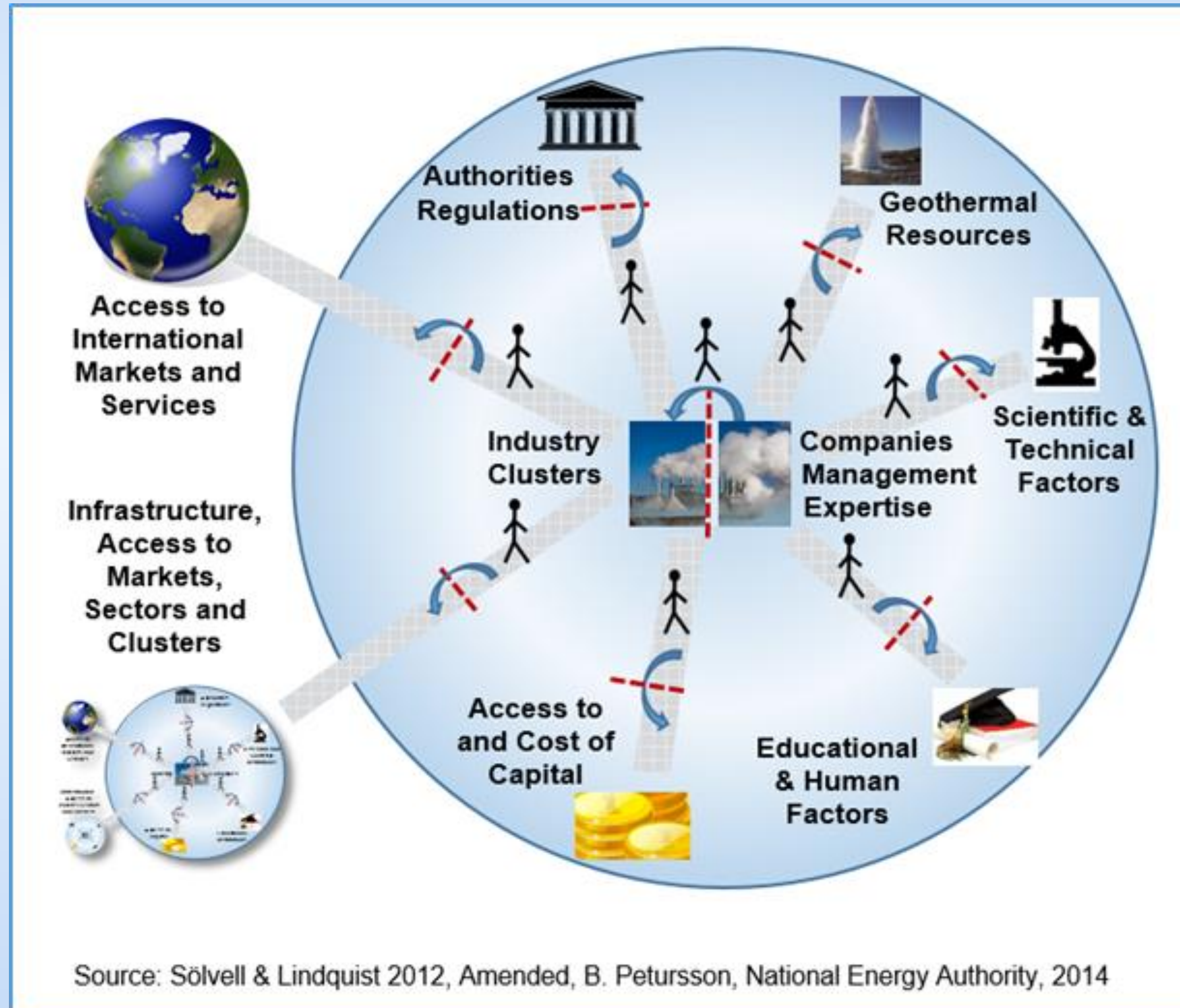
# Competitiveness of the Geothermal Sector

## 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.



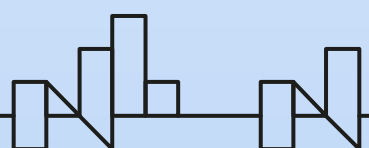


# Some lessons from Iceland

## **Geothermal Options, Opportunities and Benefits**

**The geothermal heat generation has several advantages, such as:**

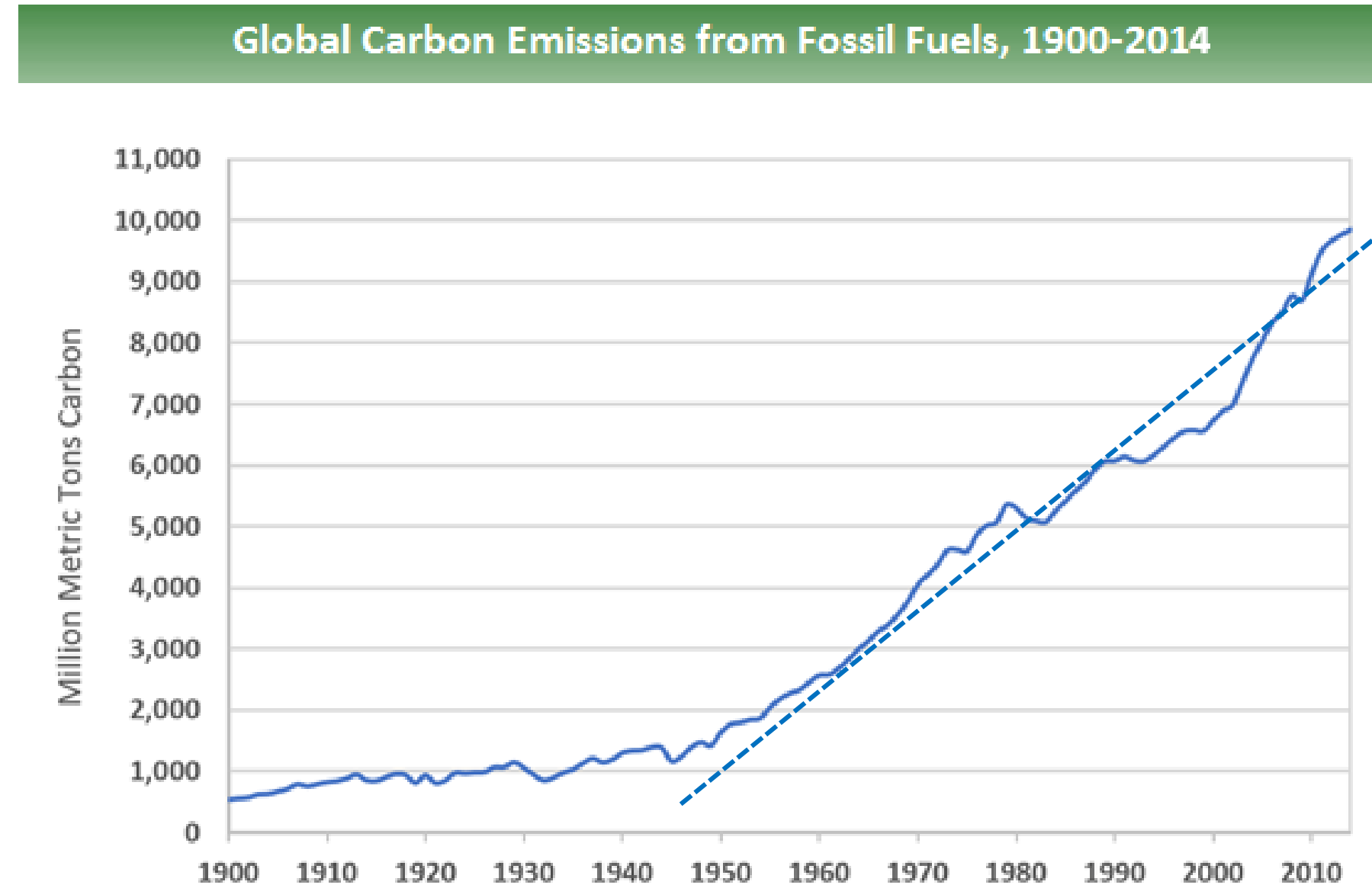
1. Economic opportunity and savings.
2. Improvement of energy security.
3. Reducing greenhouse gas emissions.
4. Harnessing local resources.
5. Improve and simplify financial support.
6. Reducing dependency on fossil fuels for energy use.
7. Improving industrial and economic activity.
8. Develop low carbon and geothermal technology industry, and create employment opportunities.
9. Local payback in exchange for local support for geothermal drilling.
10. Improving quality of life based on economic and environmental / climate benefits.



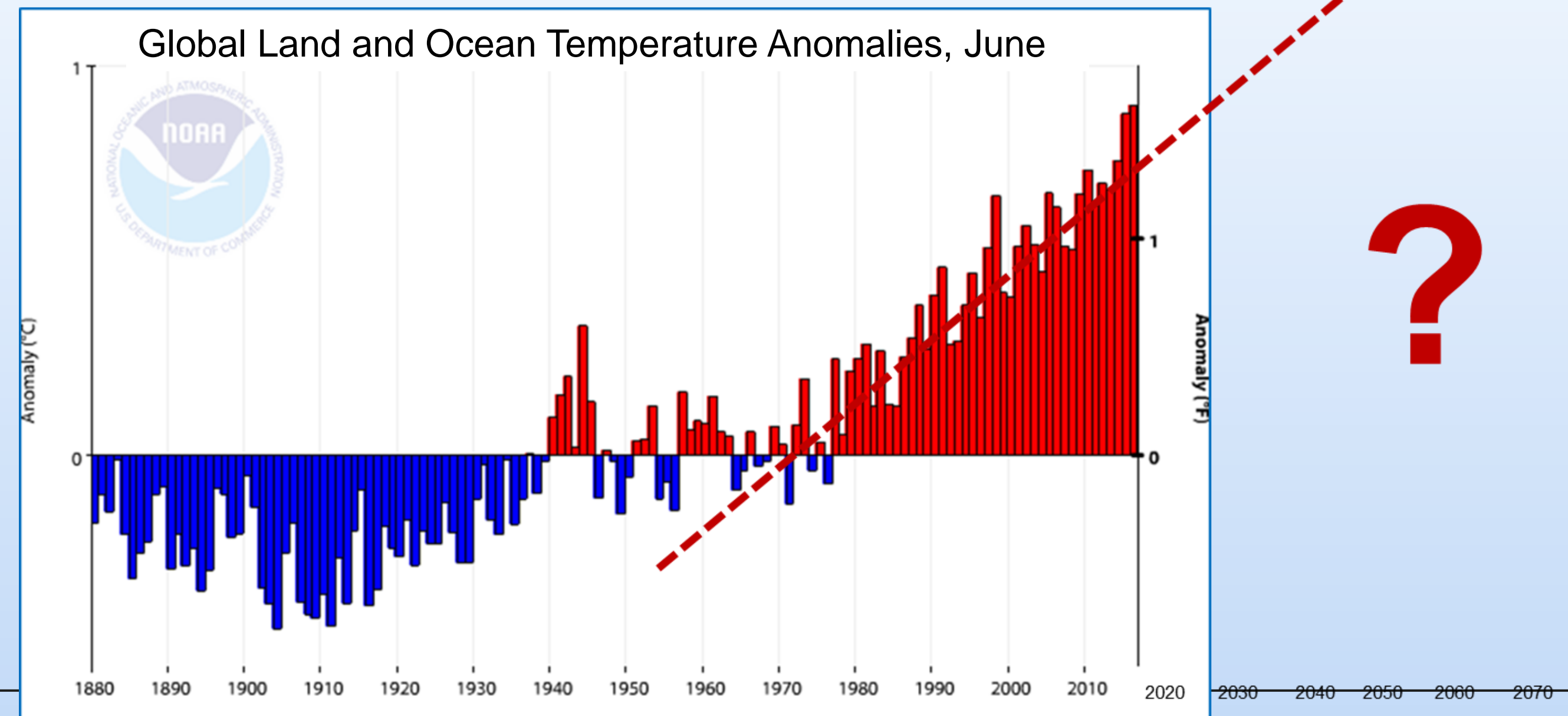


Global  
Warming  
More and more  
weather extremes

## Trends in Global Emissions



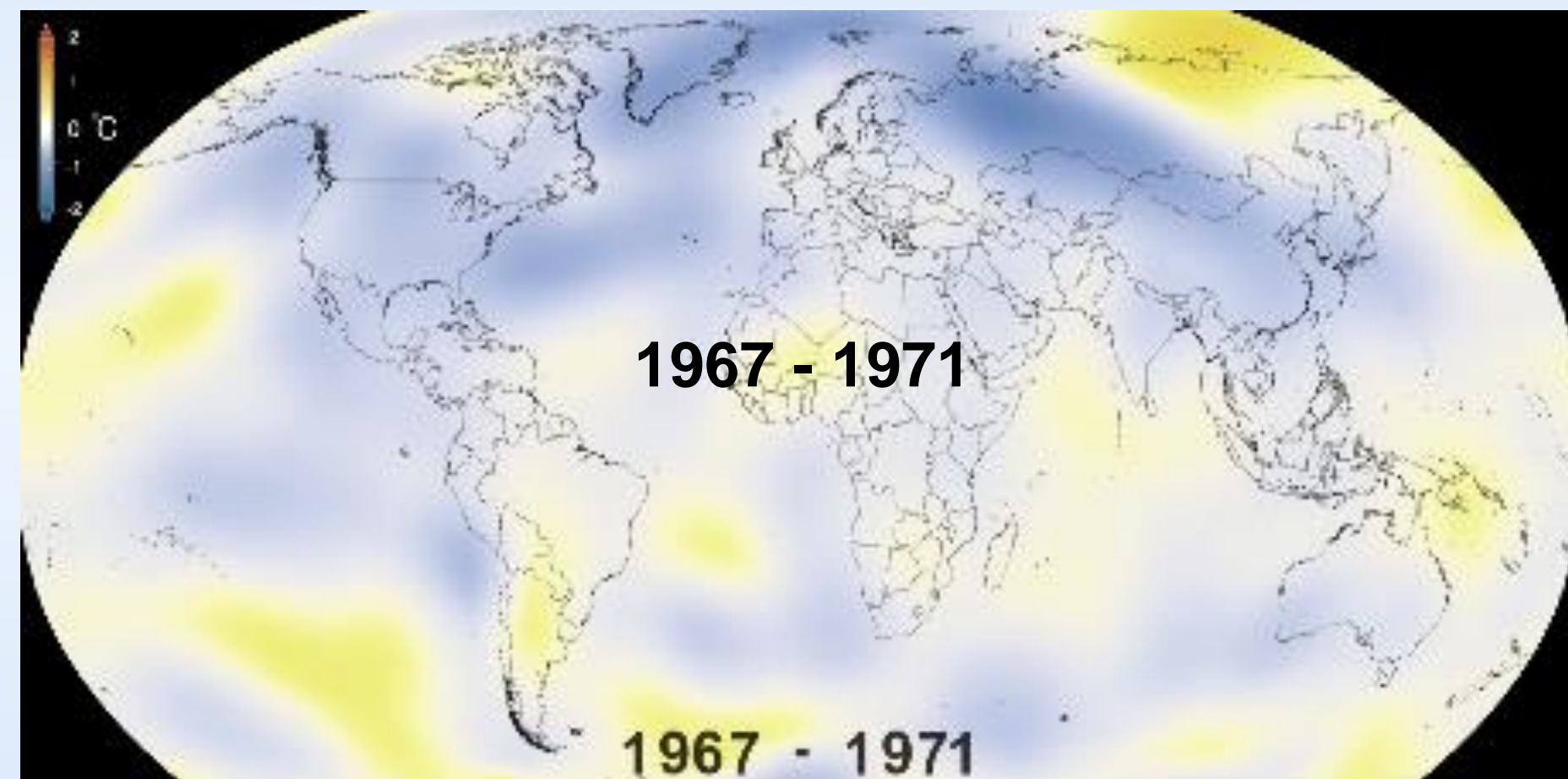
Source: Boden, T.A., Marland, G., and Andres, R.J. (2017). [Global, Regional, and National Fossil-Fuel](#)



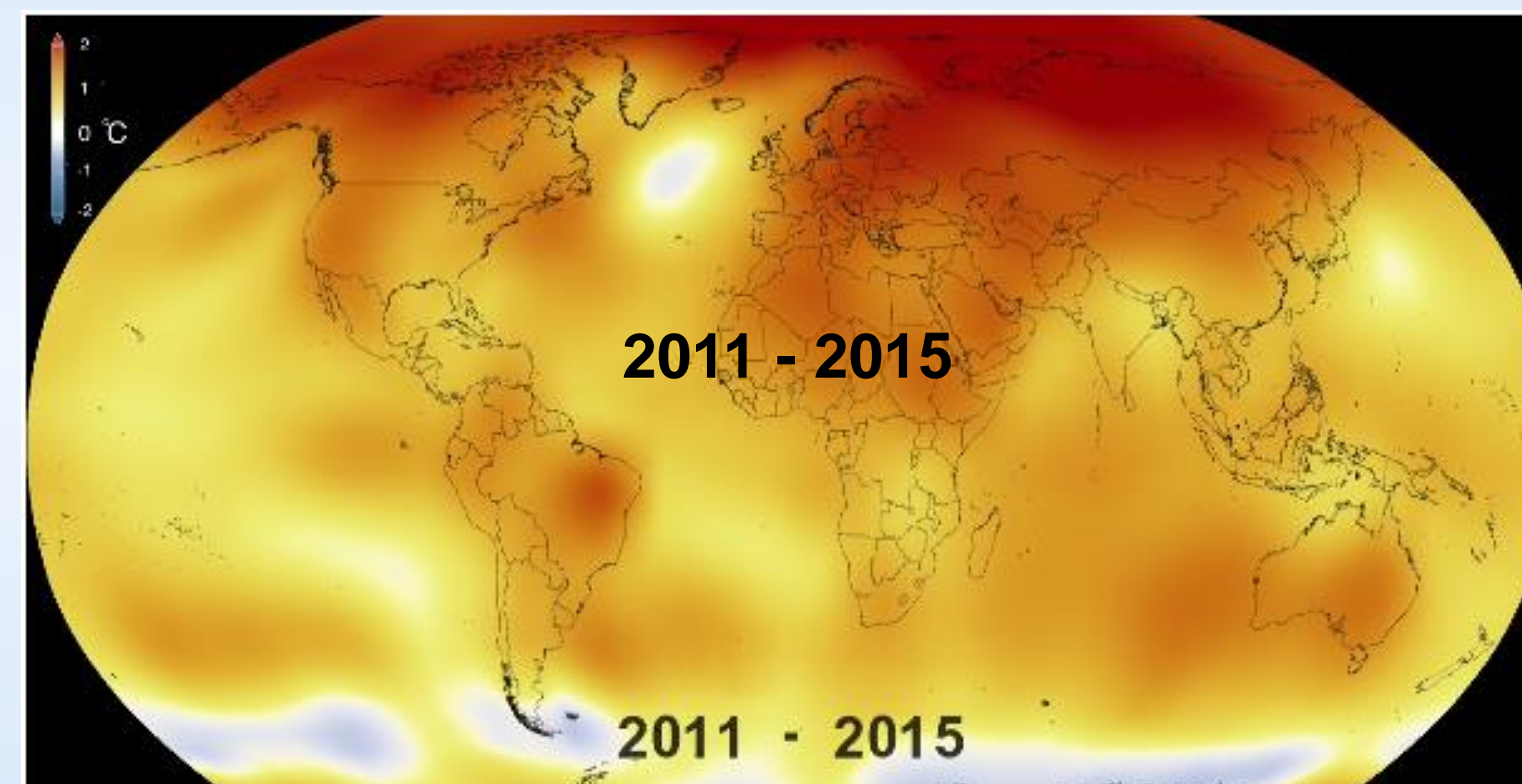


# Global Warming

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

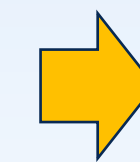


> 44 years >



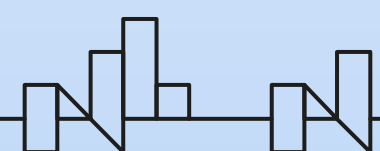
> 44 years >

How will the  
future look like



??

2050 - 2055





# Global Warming

## More and more weather extremes



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



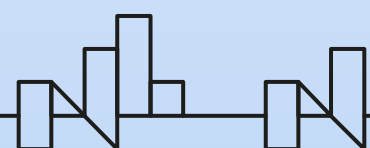
Floods in Paris 2016



Long Islands, New York “Frankenstorm”  
Hurricane Sandy 2012



Philippines 2013



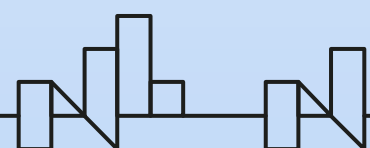


# Global Warming

## More and more weather extremes



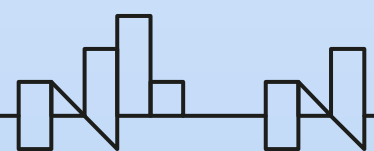
Storm in Poland August 2017, 30.000 square km – broken trees and destroyed forest





# Global Warming

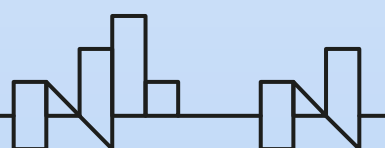
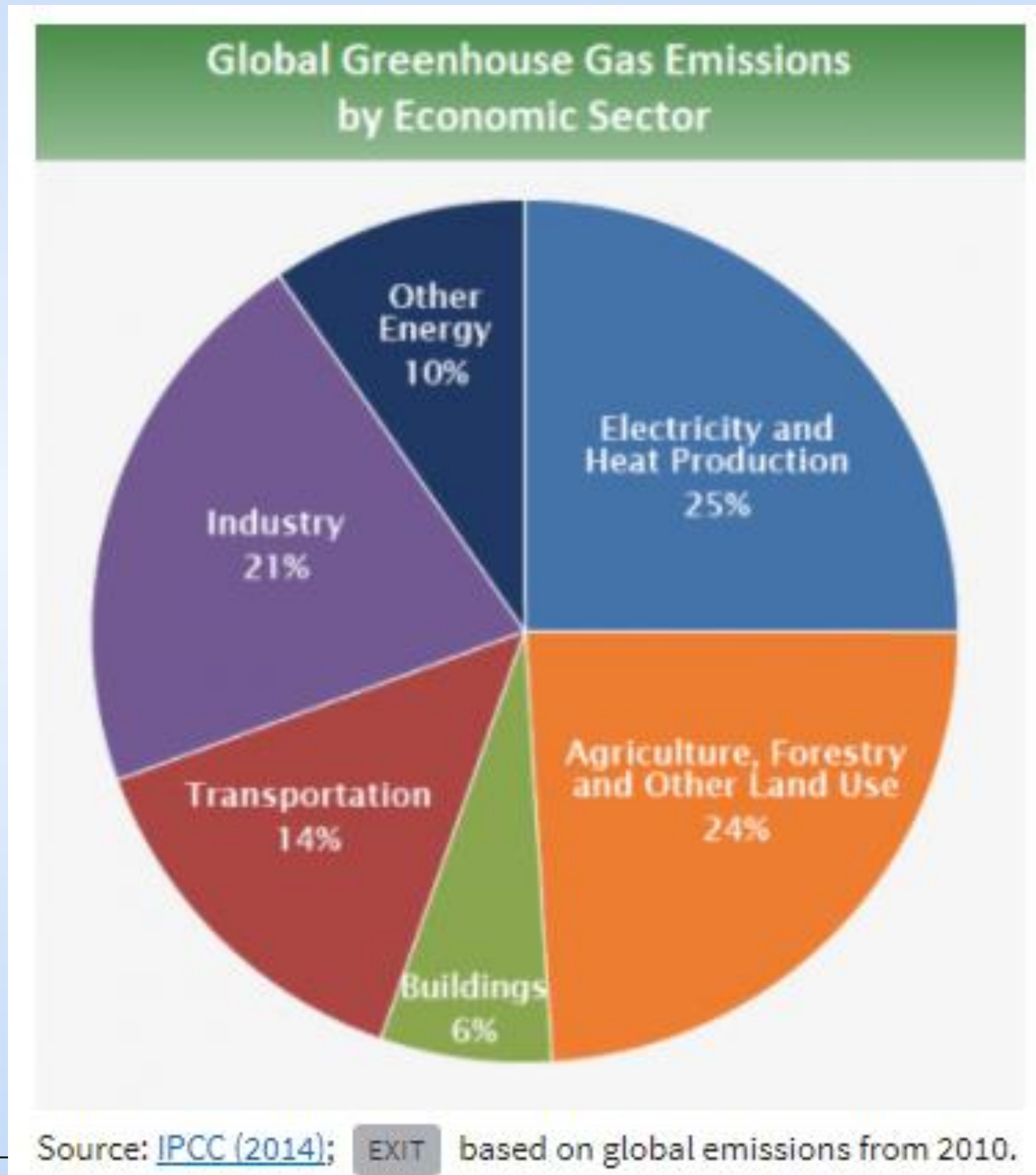
## More and more weather extremes Iceland 2020





# Global Warming

## More and more weather extremes





# Contact information

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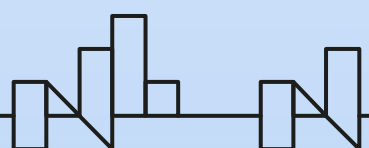
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**Geothermal district heating  
is a powerful tool  
to fight against global warming**

