Final Conference User4GeoEnergy
Improving the energy efficiency of geothermal energy utilisation by adjusting the user characteristics

Possibilities of practical results implementations, bottle necks in the Projects Partners country

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Overview of presentation

1. Geothermal in energy policy in Iceland
2. Economic and climate value of geothermal resources.
3. Heating in Iceland as Good Practices for Poland
4. Geothermal clusters & resources parks
5. Geothermal competitiveness - international and Icelandic recommendation

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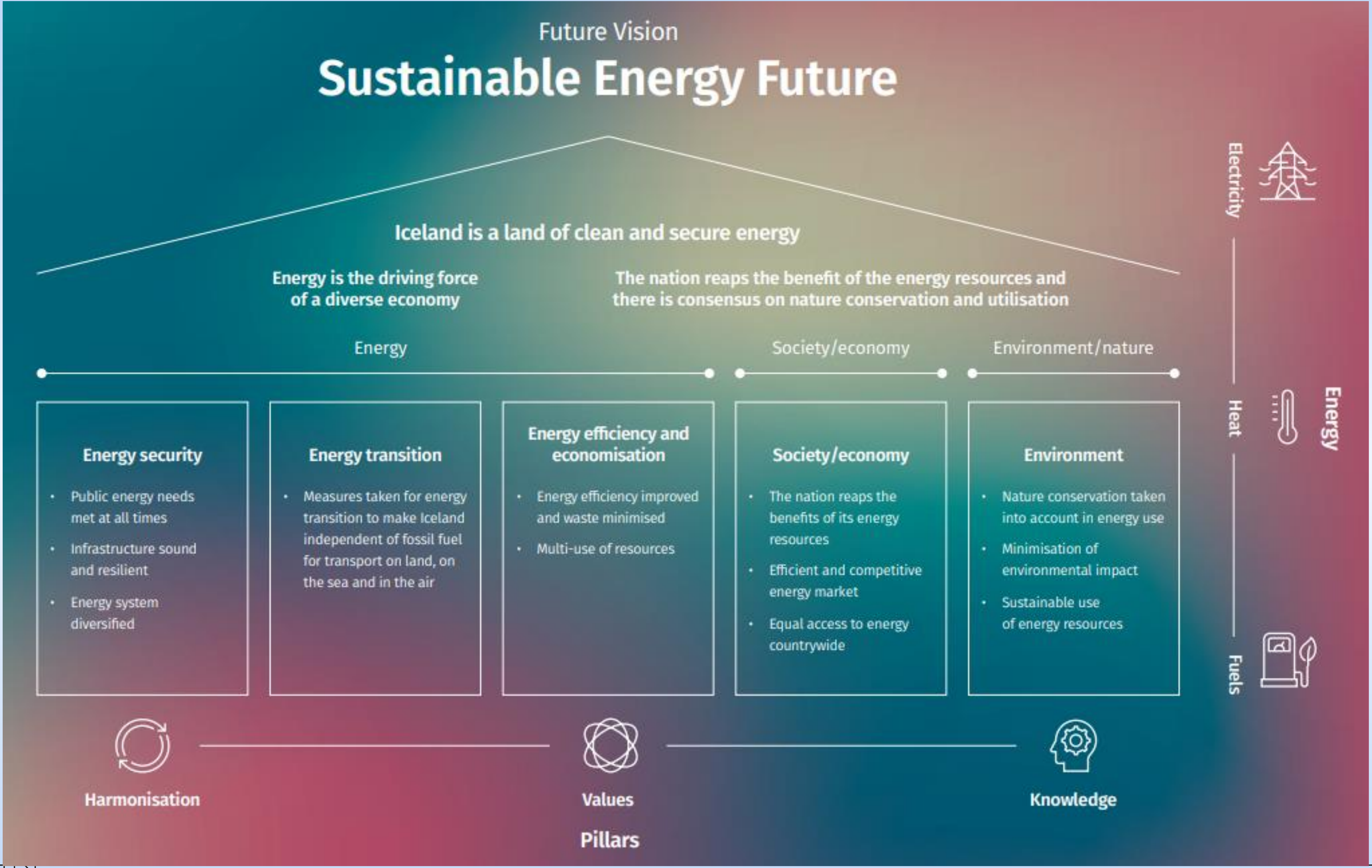

Source: Ministry of Industries and Innovation, Iceland

The fundamental values of the Energy Policy are reflected in all its principal objectives. Iceland’s Energy Policy is based on sustainable development, where efforts will be made to meet contemporary needs without curtailing the opportunities of coming generations to meet their needs.

Sustainable development is based on three dimensions:

- environmental
- economy,
- community

where none can exist without the other.

The fundamental values are reflected in these three dimensions and the balance among them.

Fundamental values of the Energy Policy

Environment

- Sustainability
- Carbon neutrality
- Precautionary principle
- Polluter-pays principle
- Best available techniques

Community

- Macroeconomic efficiency
- Quality of life
- Public interests
- Non-discrimination
- Knowledge
- Technological neutrality
- Transparency
- Consultation

Economy

- Competitiveness
- Efficiency
- Stability
- Market law
- Value creation

Source: Ministry of Industries and Innovation, Iceland

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2. **Economic and climate value of geothermal resources.**
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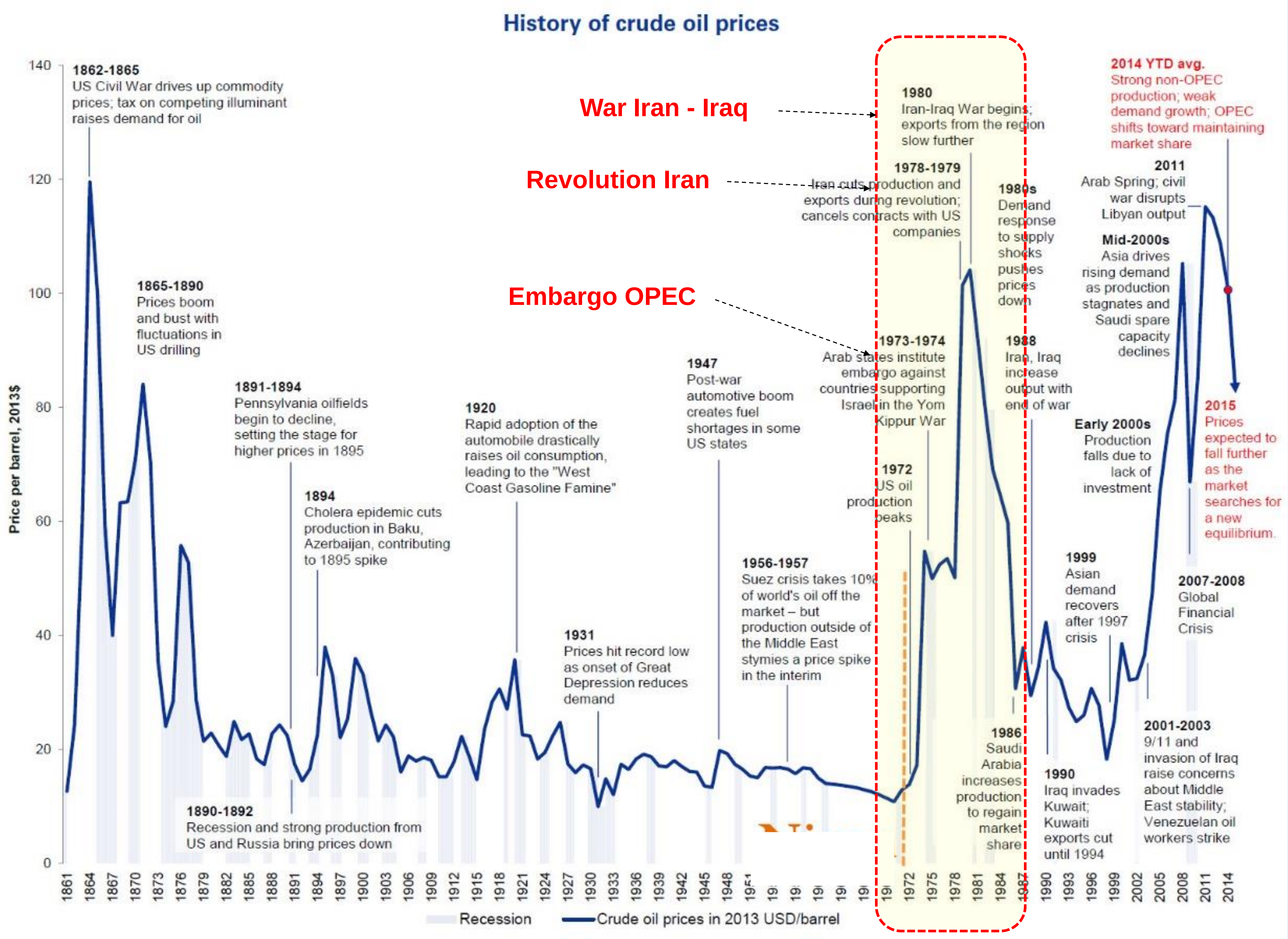
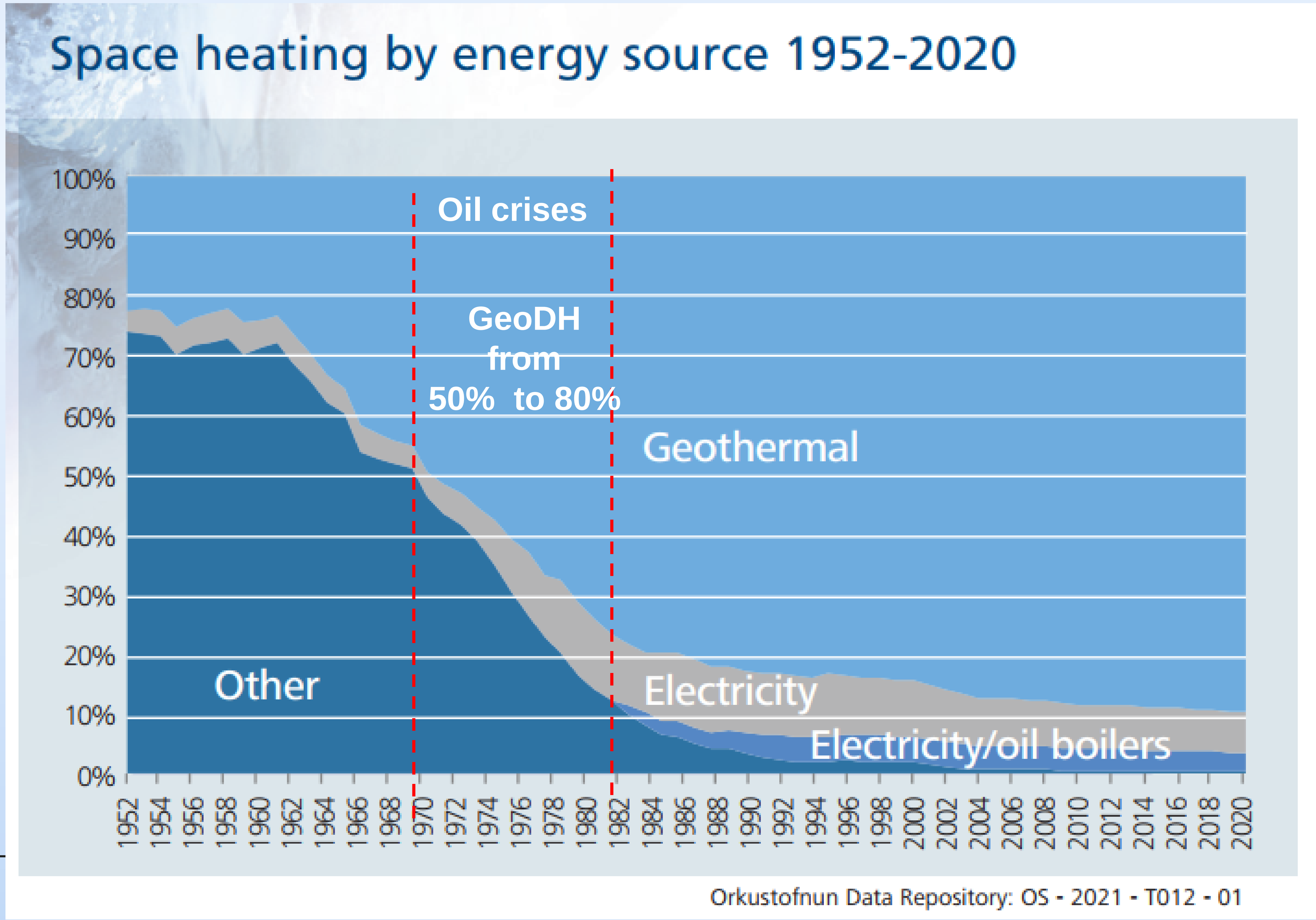
The Oil Crises 1970 -1980

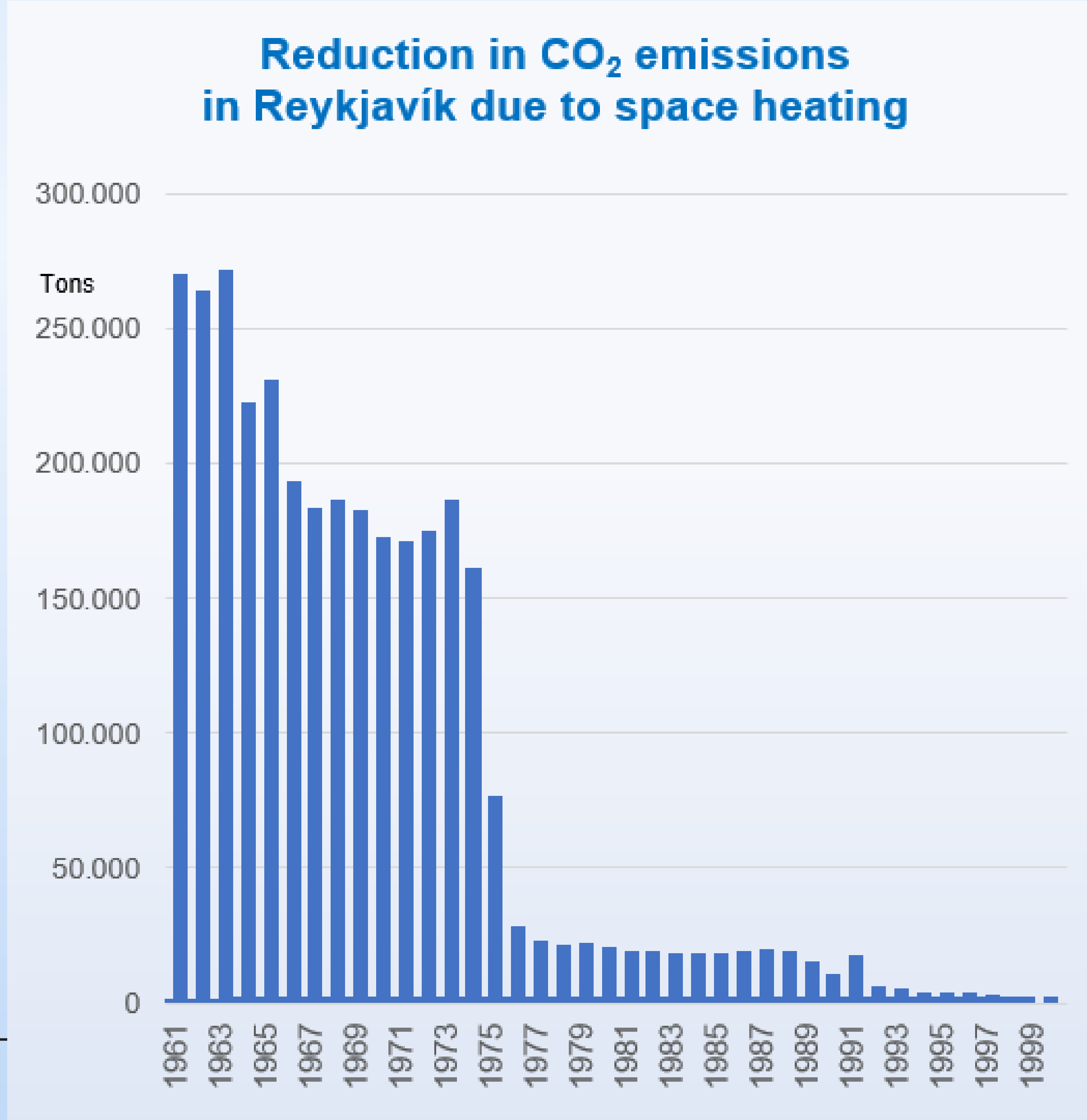


Expansion of GeoDH

Space Heating by Source 1953–2019 and reduction of CO2

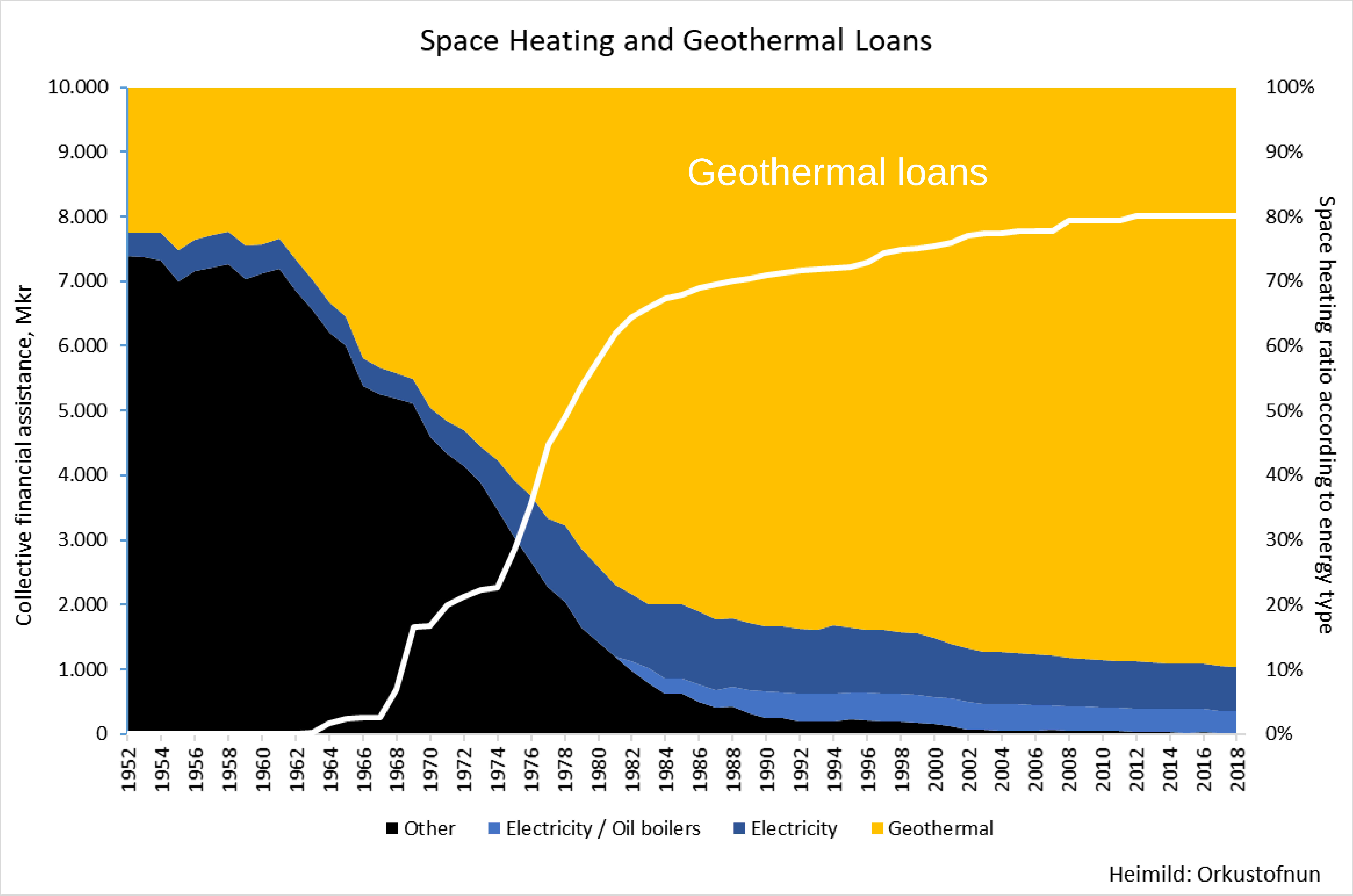
- External conditions – raised the need to increase geothermal heat and GeoDH Planning 1970 - 1982
- It took only 12 years to increase GeoDH from 50% to 90% of total space heating
- and it took only 12 years to decrease oil for heating from 50% to 10%
- the reduction of CO_2 emissions in Reykjavík decreased from 170.000 tons to 18.000 or 90%



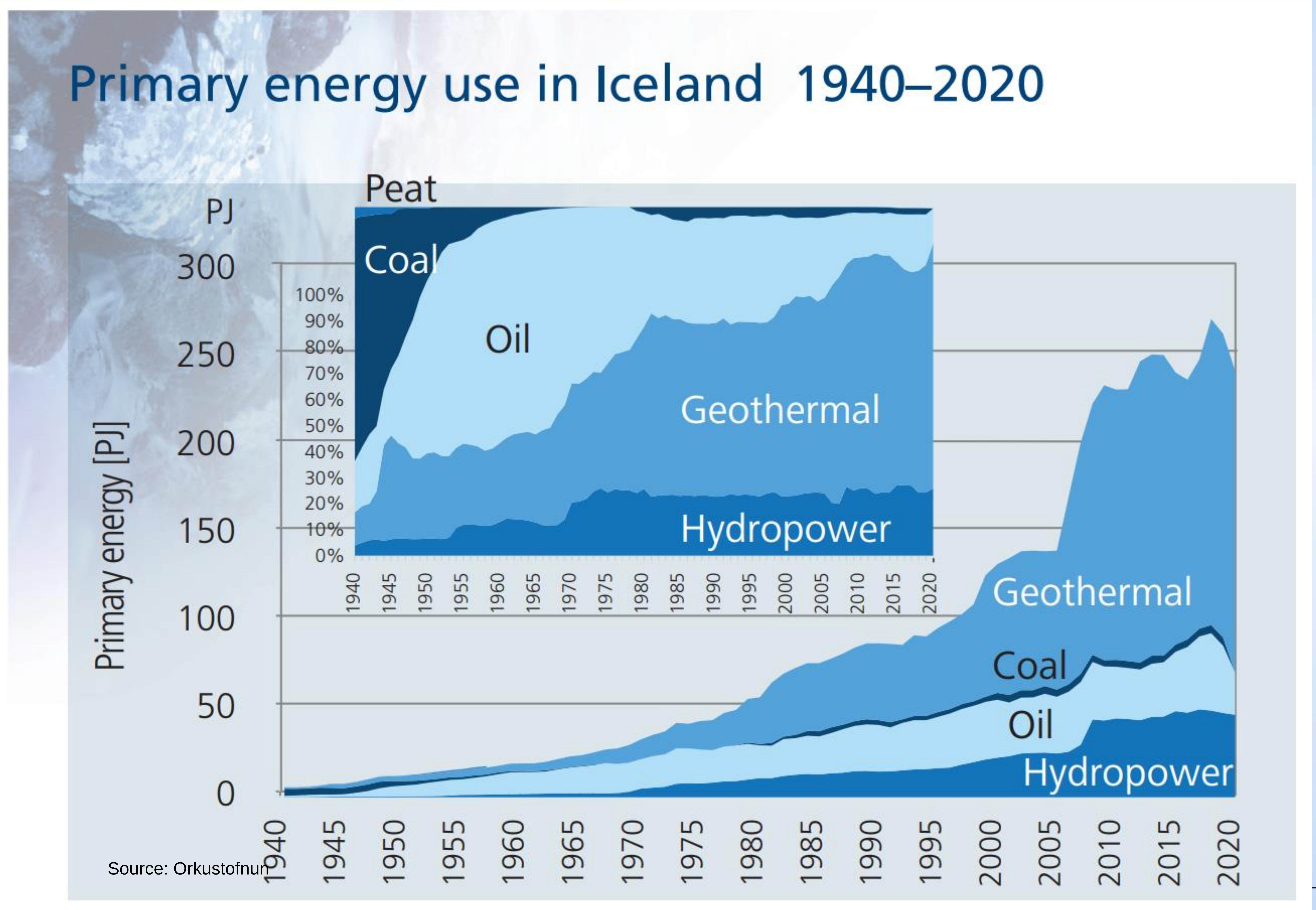


Earlier transition based on loans

now more direct support



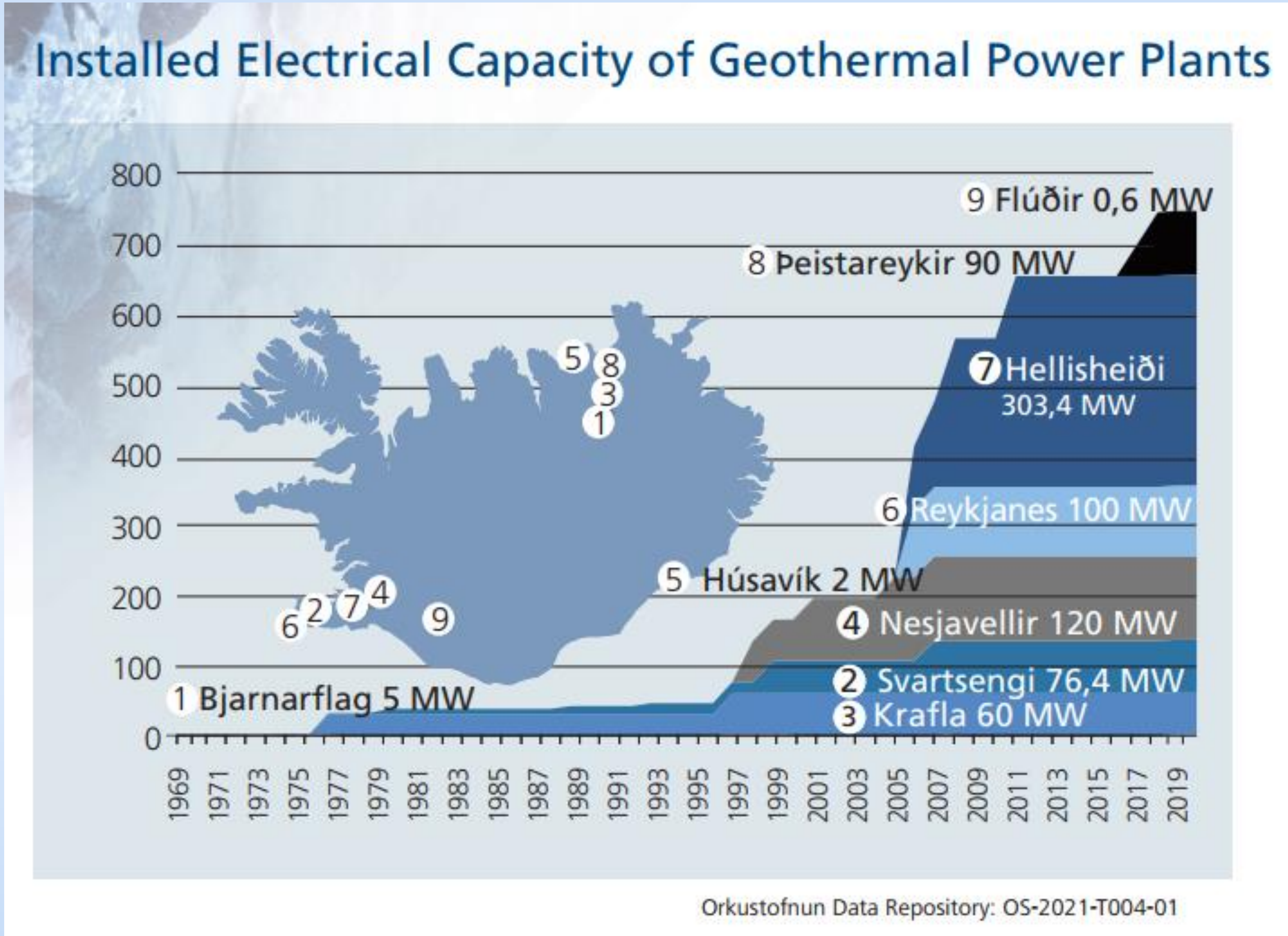
Primary energy used in Iceland



Source: Orkustofnun

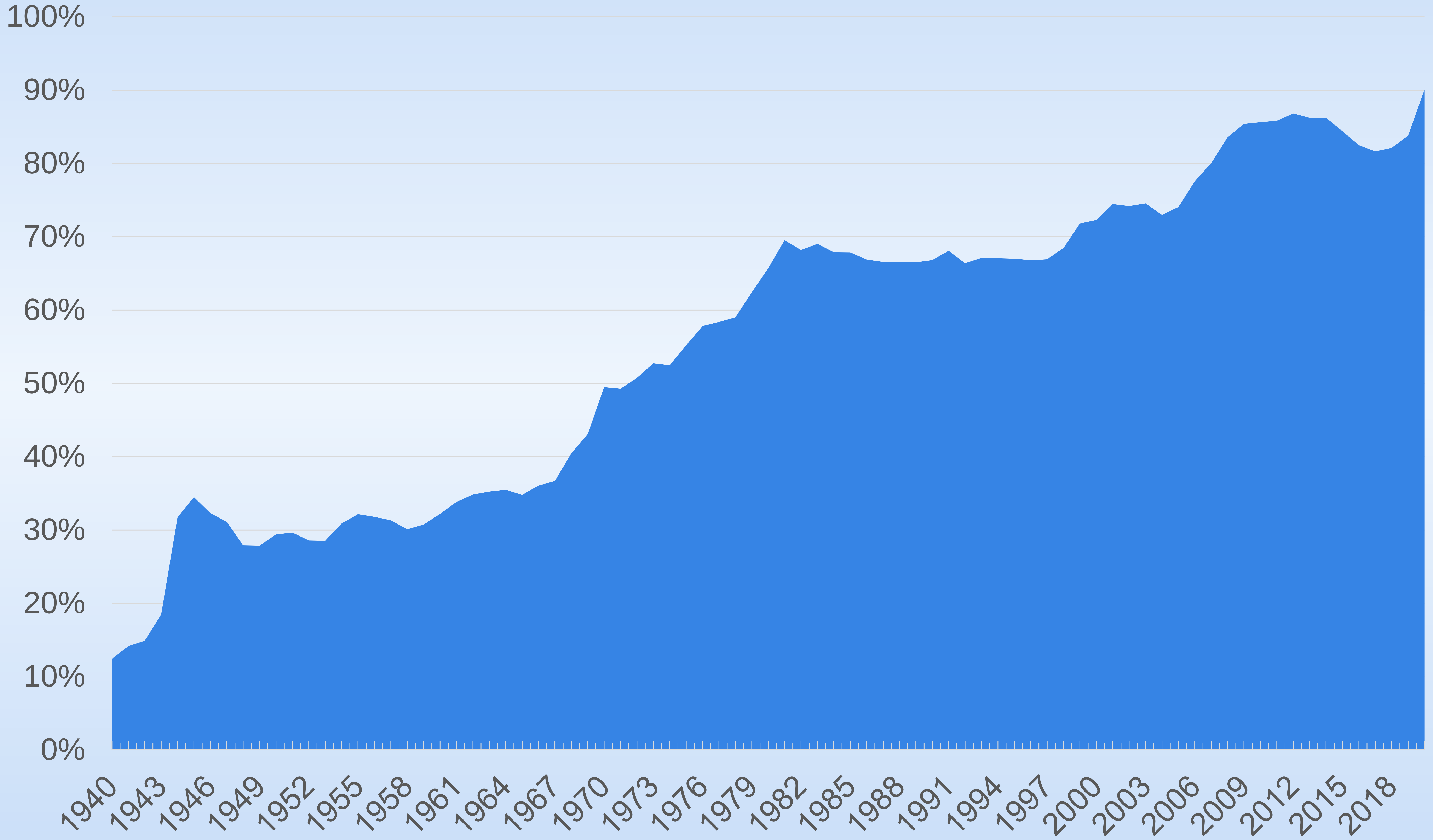
Installed Geothermal Capacity





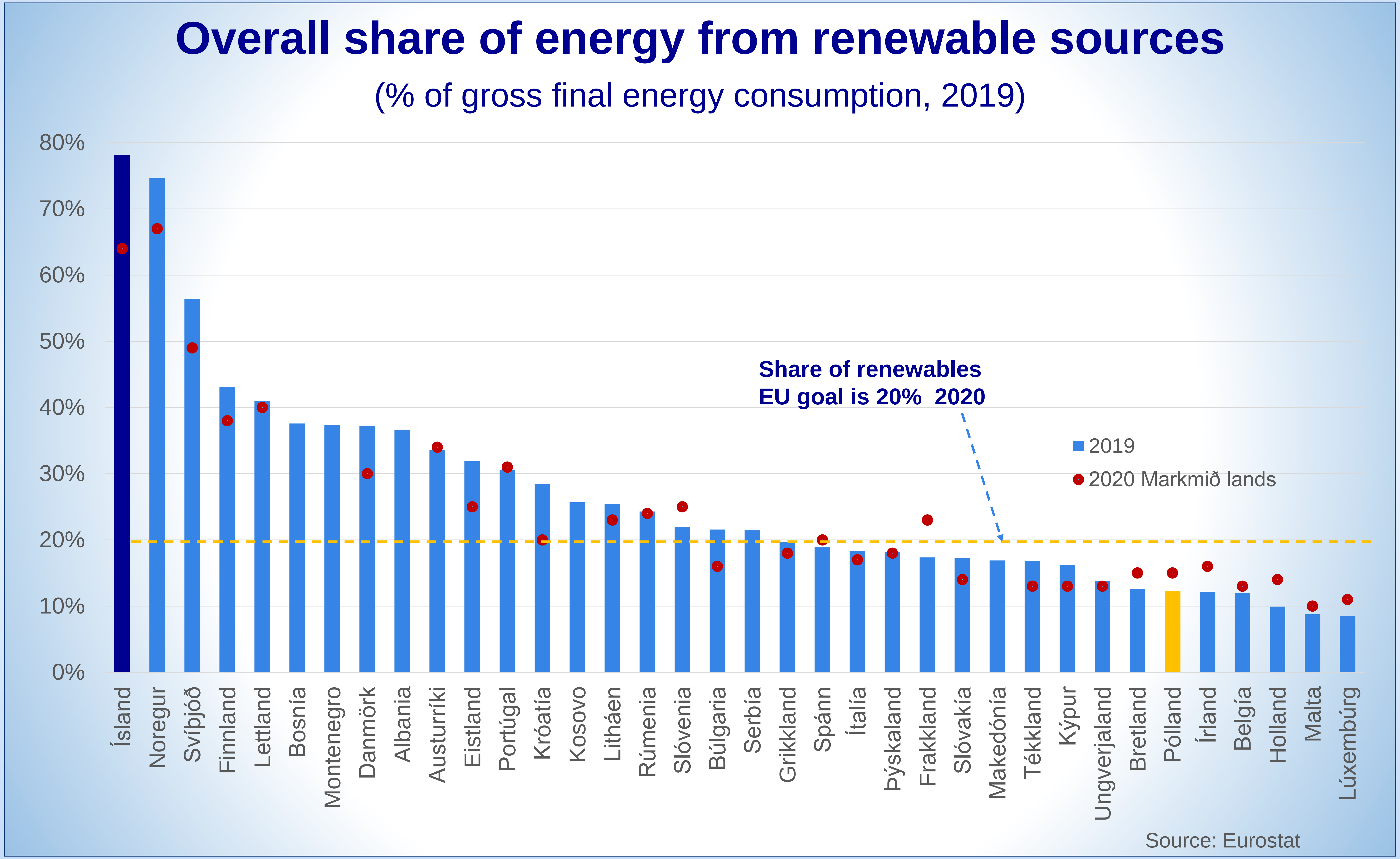

Renewable energy – mitigate global warming

Share of Renewables in Primary Energy Use 1940-2020

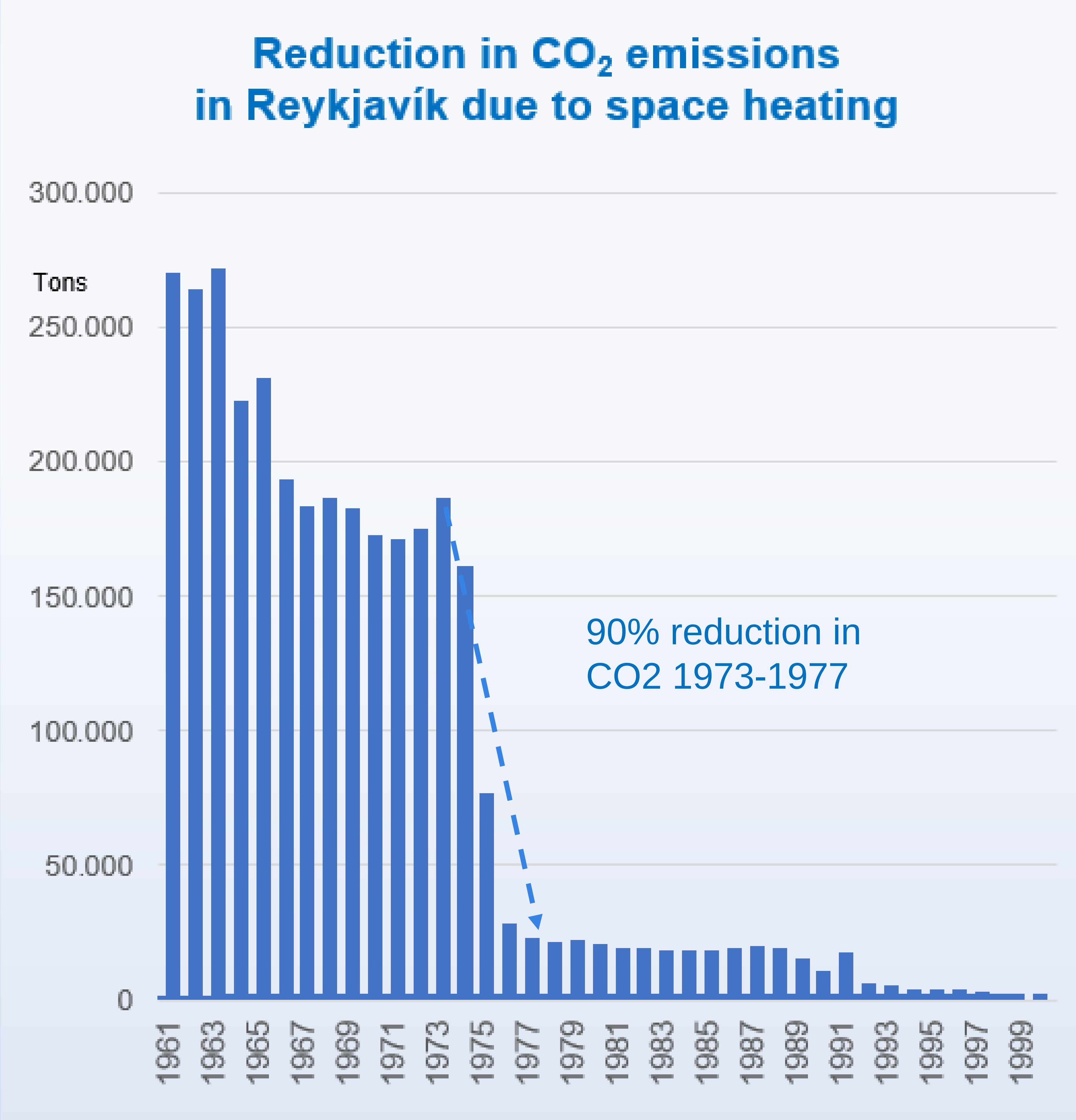


Talnaefni Orkustofnunar: OS-2021-T008-01

Renewable energy – mitigate global warming



Environmental and climate benefits of geothermal utilisation is mitigating climate changes

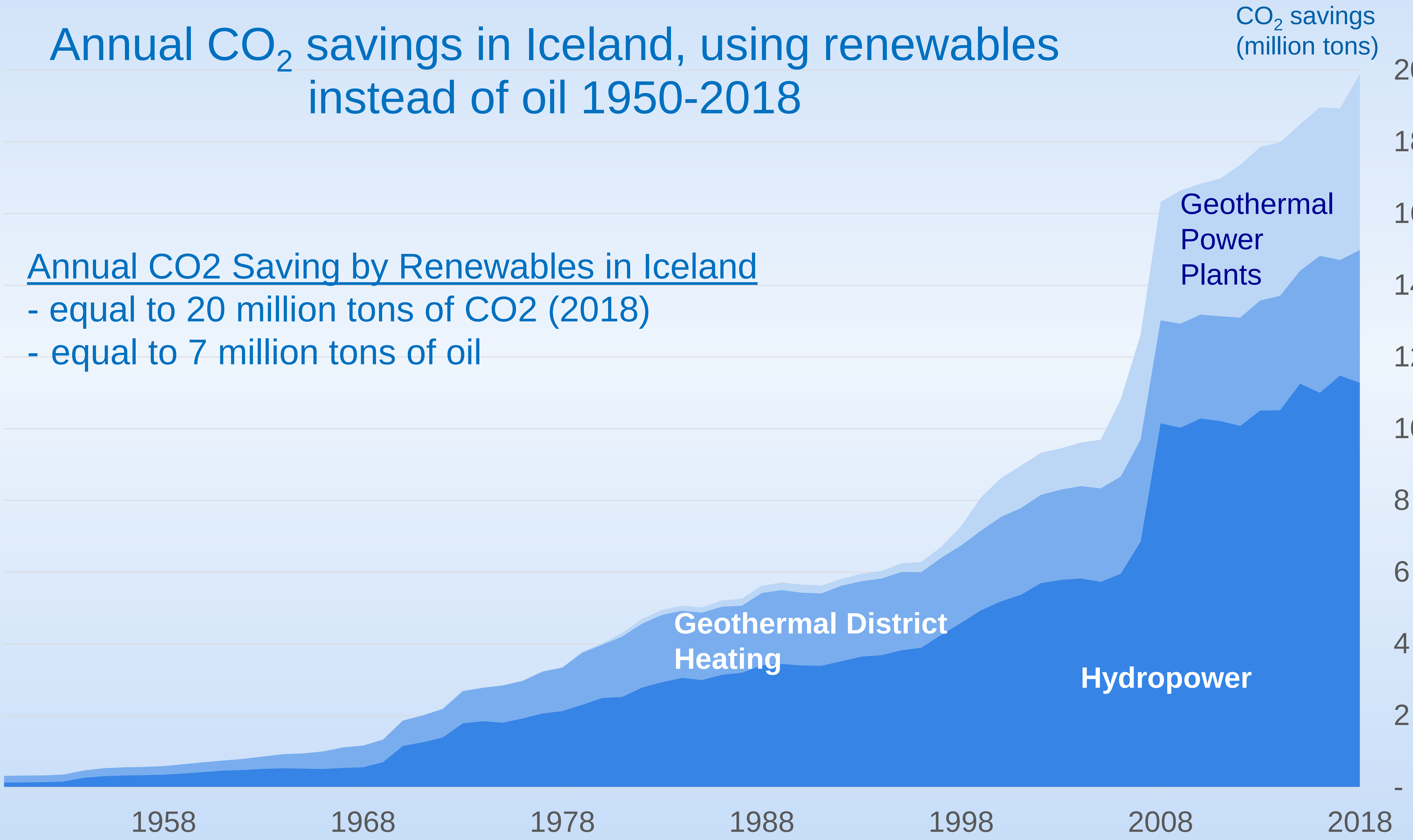


Reykjavík 1933 and today

Source: Reykjavik Energy

Renewable energy – mitigate global warming

Annual CO_2 savings in Iceland, using renewables instead of oil 1950-2018

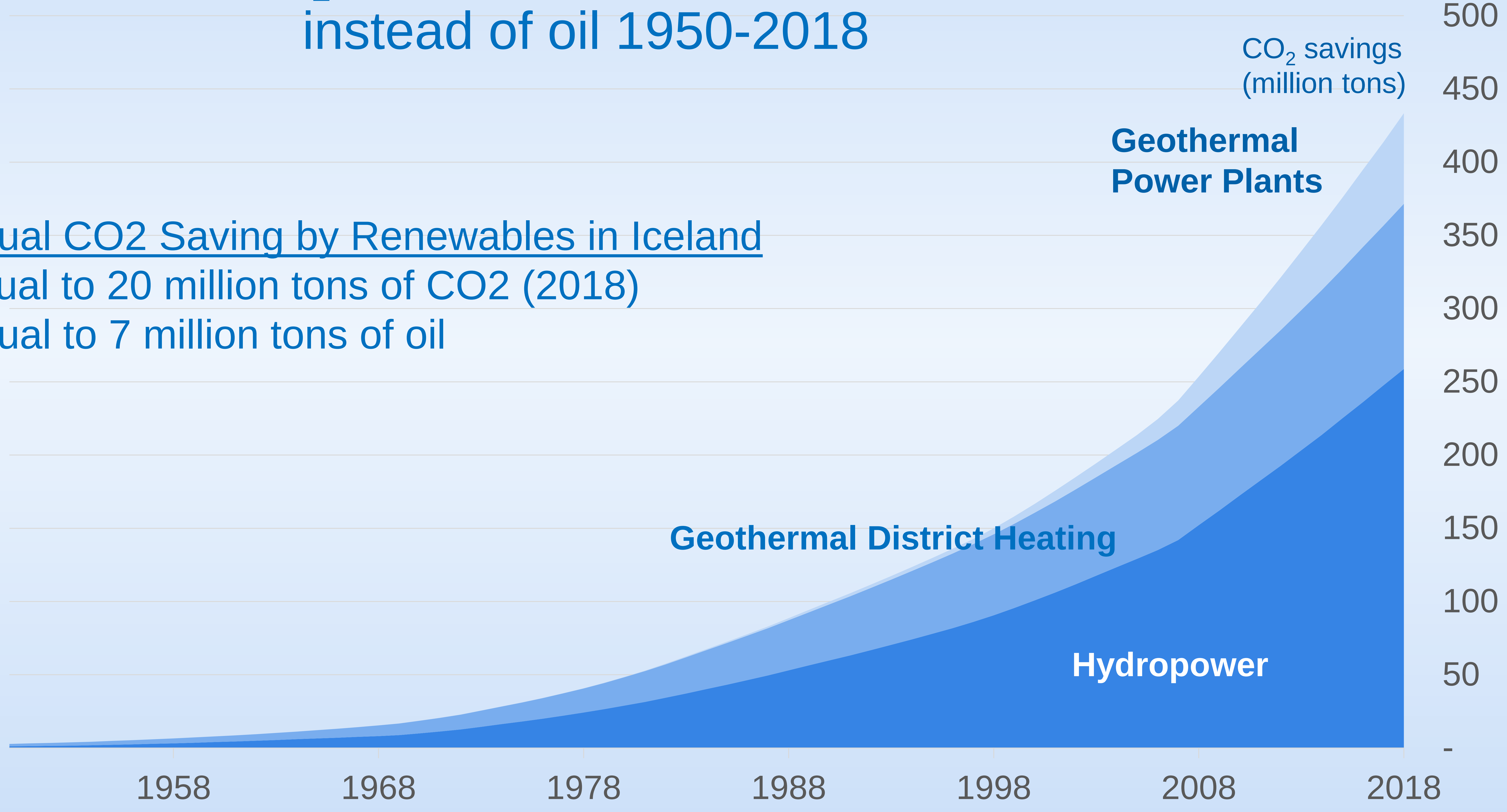


Annual CO2 Saving by Renewables in Iceland
- equal to 20 million tons of CO2 (2018)
- equal to 7 million tons of oil

Orkustofnun Data Repository: OS-2019-T011-01

Renewable energy – mitigate global warming

Cumulated CO_2 savings in Iceland, using renewables instead of oil 1950-2018



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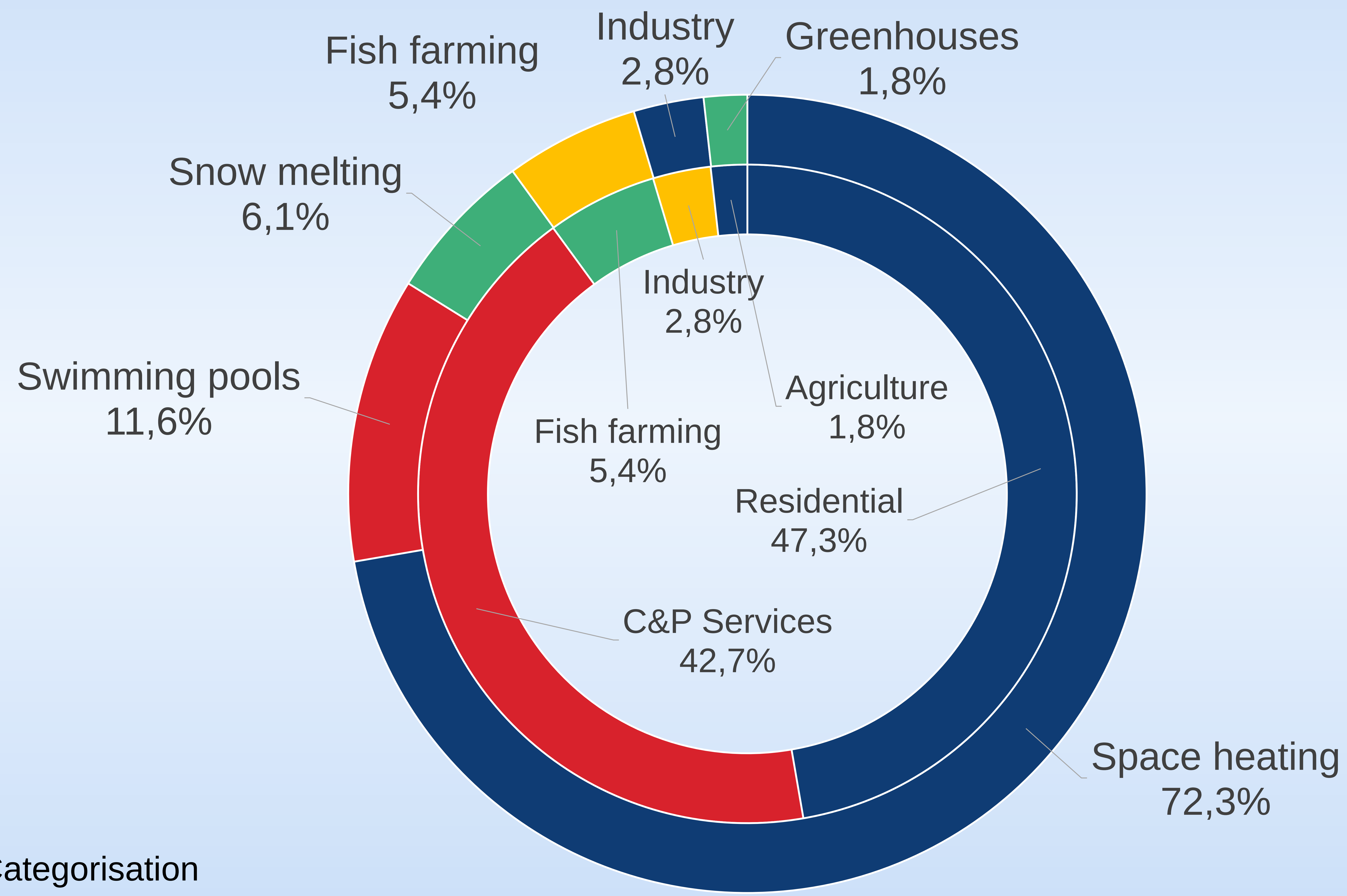
Orkustofnun Data Repository: OS-2019-T011-01

Total Heat Use 2019

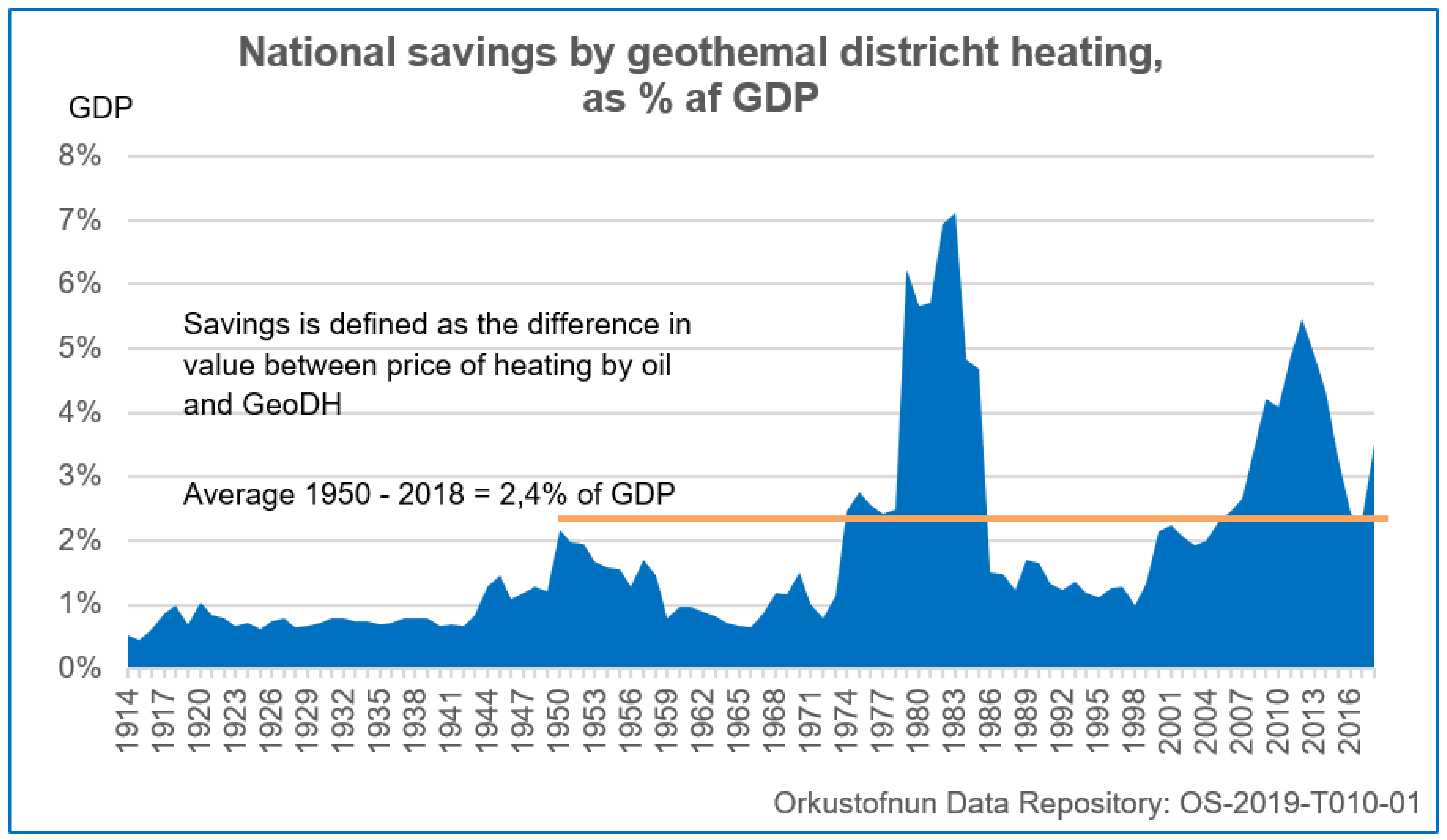


Total Heat Use: 33,7 PJ
Geothermal: 97,4%

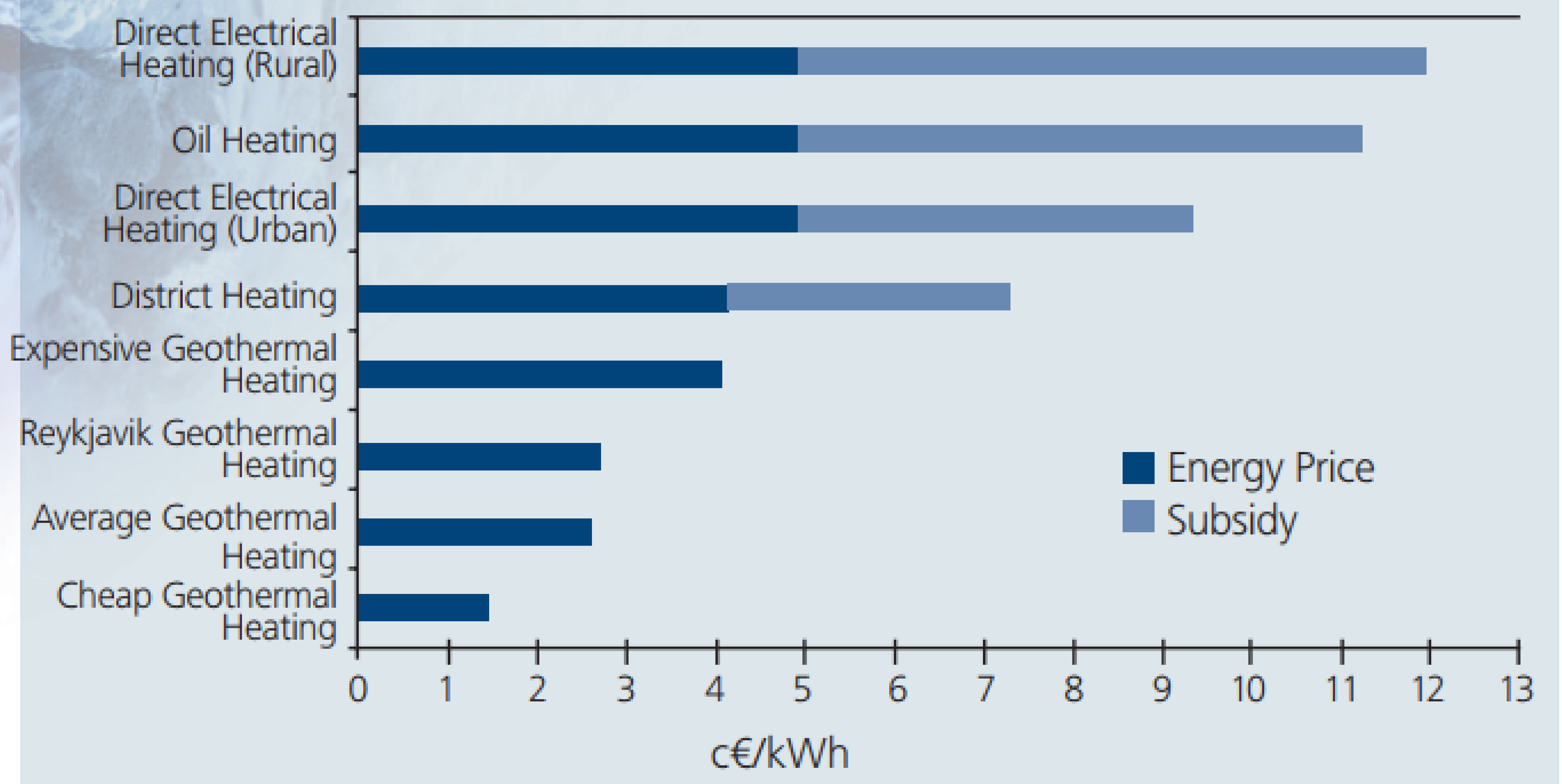
Inner ring - Eurostat Categorisation
Outer ring - IGA Categorisation

Orkustofnun Data Repository: OS-2020-T010-01

Economic benefits of geothermal utilisation is valuable and increase energy security

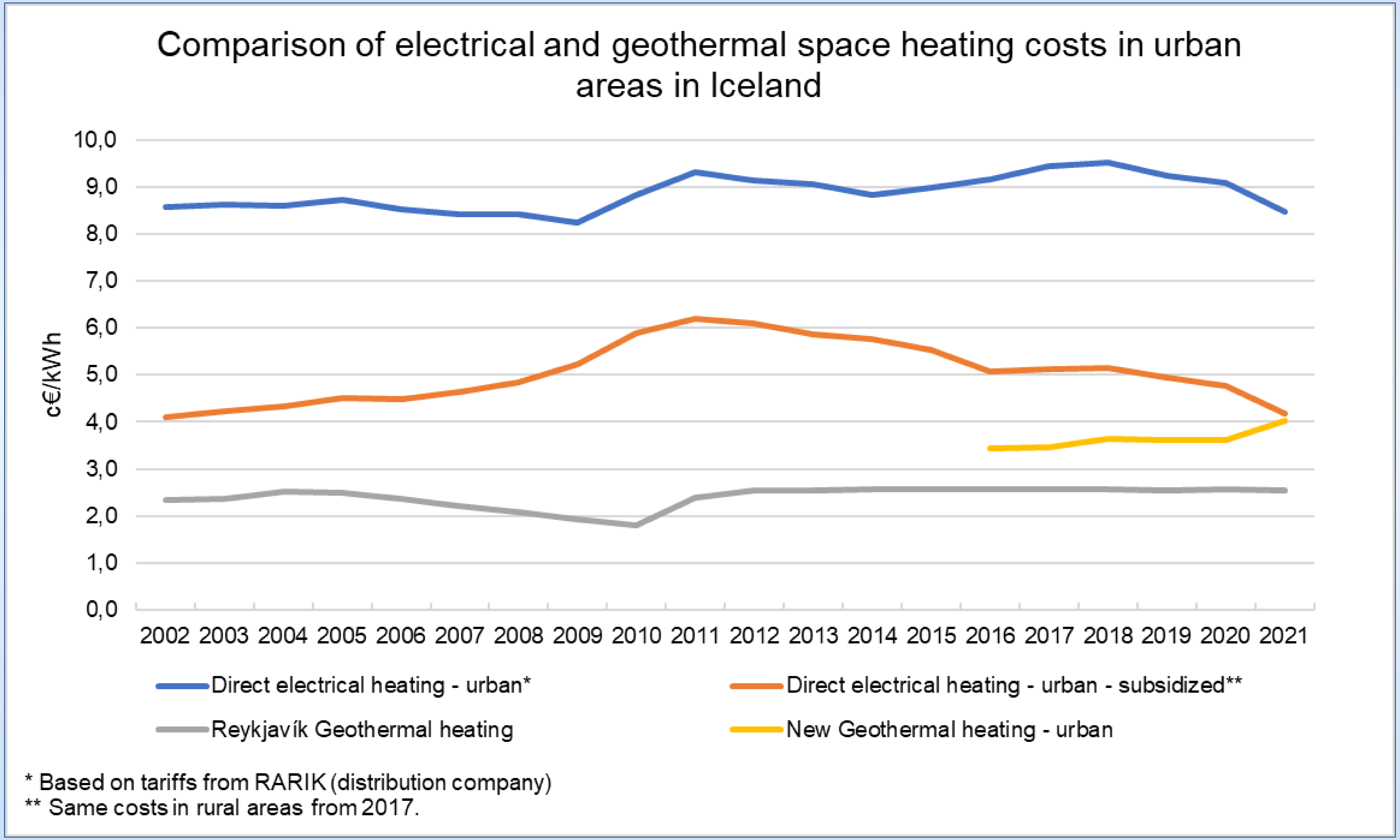


Energy price for space heating in September 2019

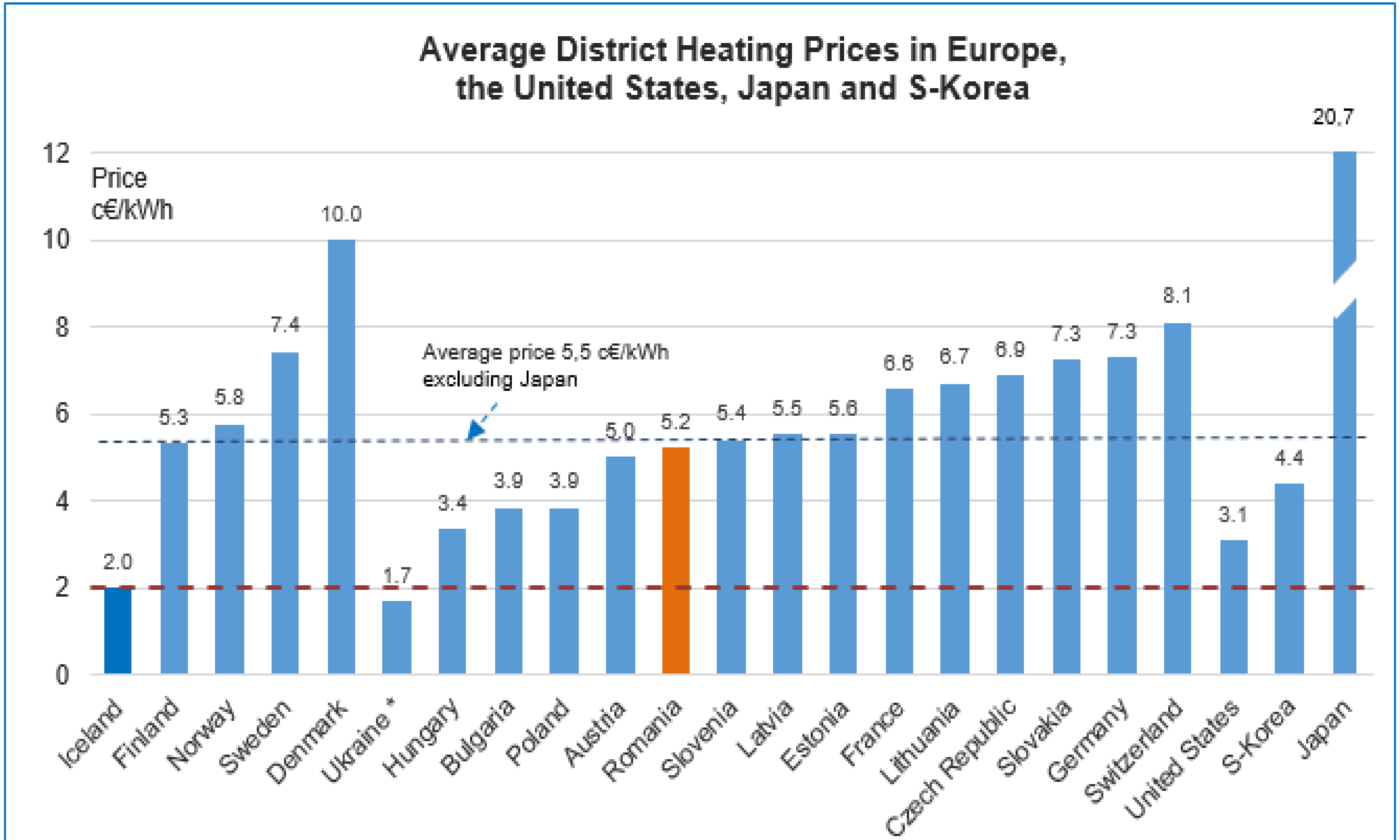


Orkustofnun Data Repository: OS-2020-T005-01

Geothermal District Heating System in Iceland



District Heating Prices in Europe in 2015



* Subsidised Price, without VAT 2015. Source: Orkustofnun Data Repository: OS-2016-01. All prices are without VAT

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)**

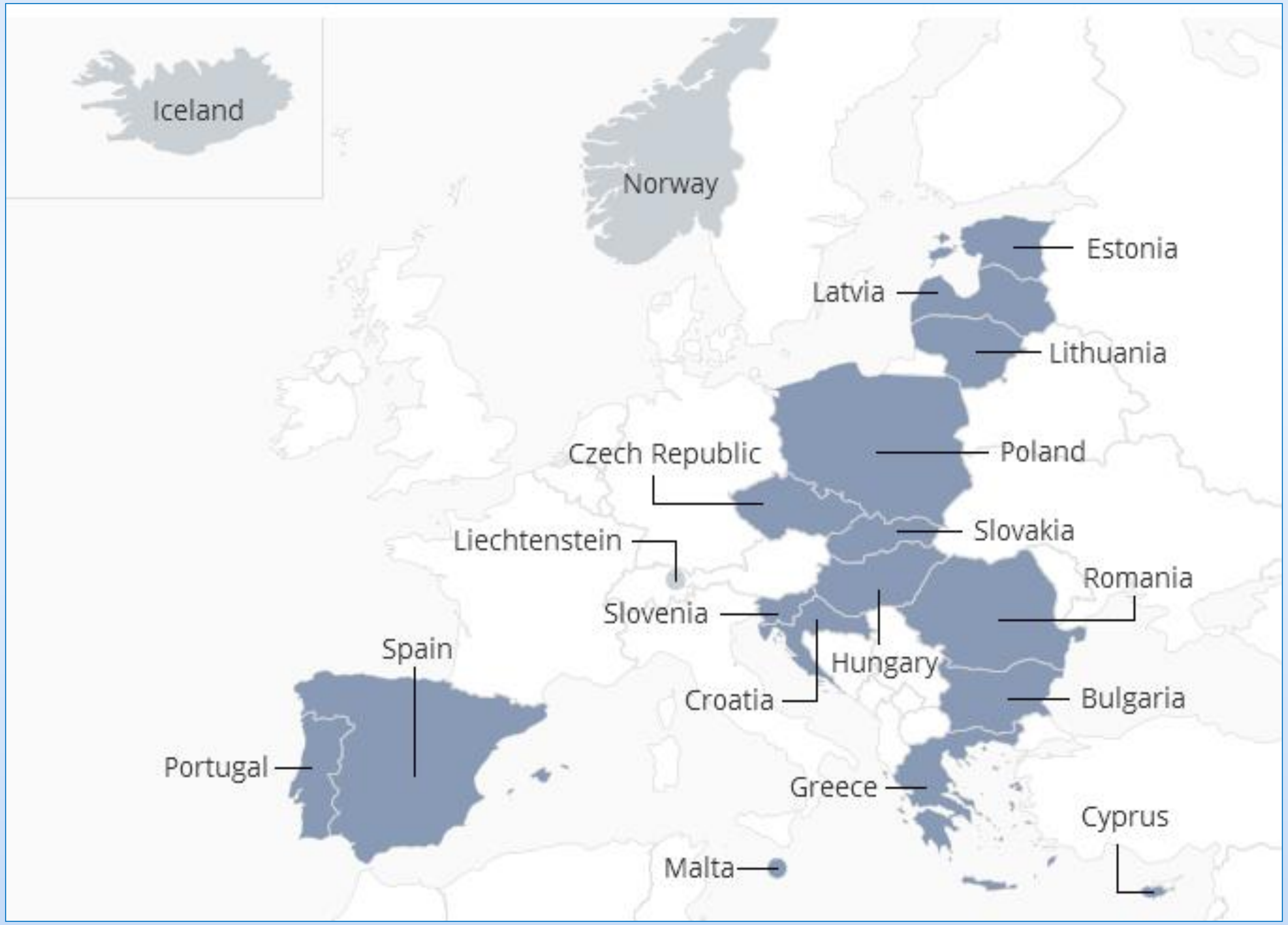
6. **Importance for Financial Institutions to recognise opportunities within GeoDH**

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**

Icelandic geothermal experience can help other countries through the EEA Grants

Orkustofnun is Donor Program Partner (DPP)



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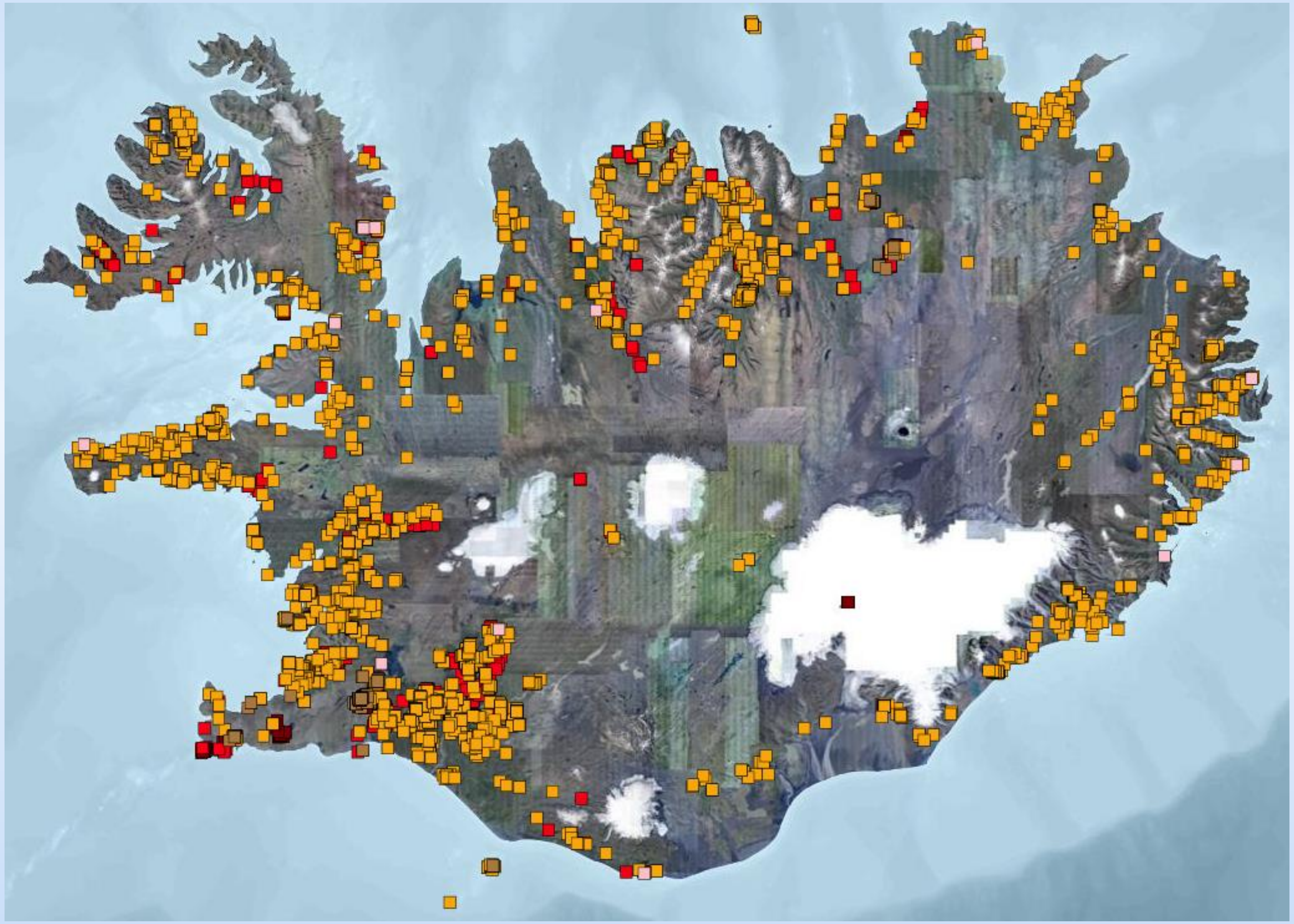
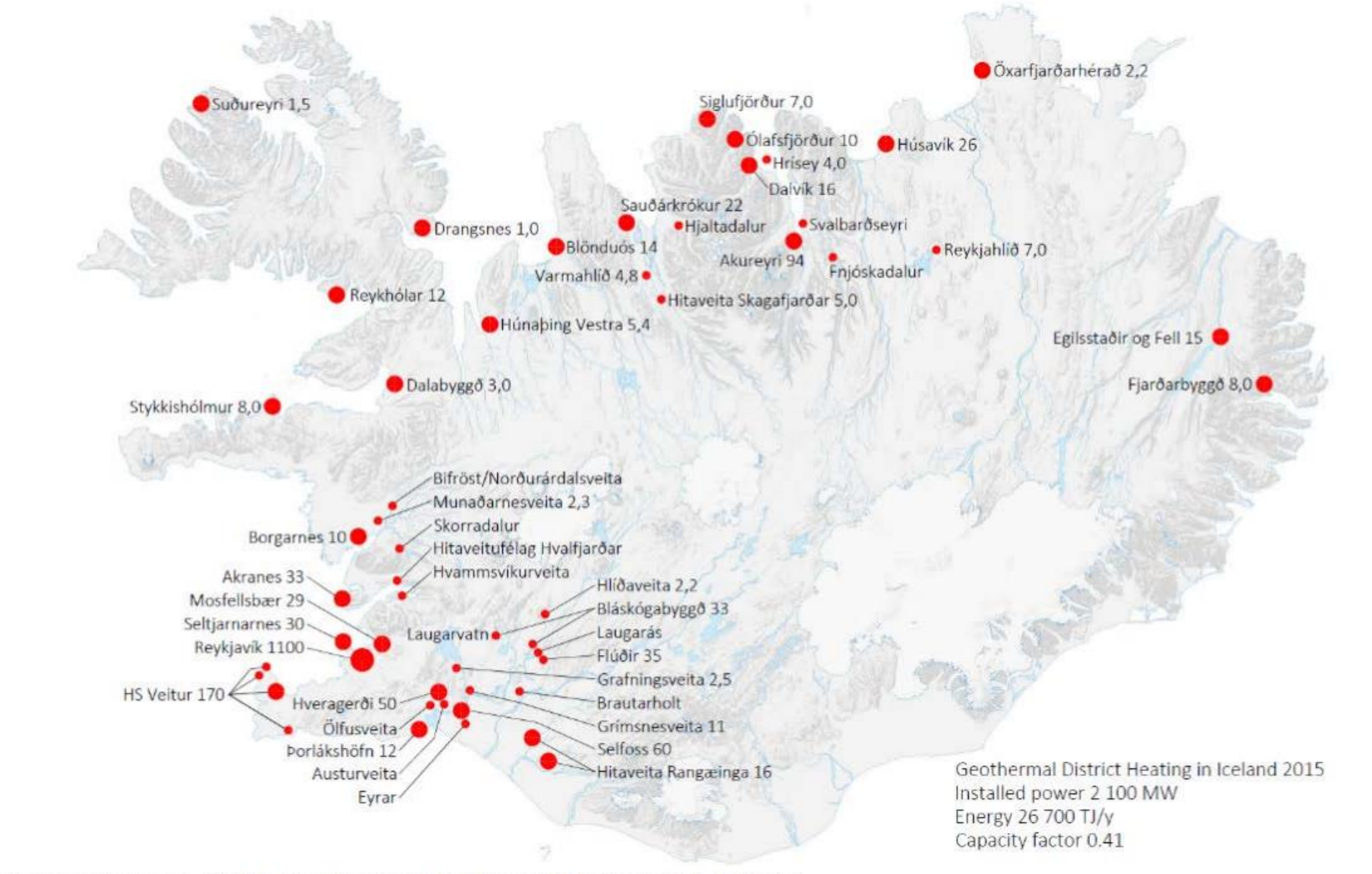
Overview of geothermal wells in Iceland



Geothermal District Heating System in Iceland 2015



Þorleikur Johannesson – ESMAP – Global Geothermal Development Plan, Roundtable 3– April 2016

Inside the pump station in Vestmannaeyjar

A few years ago a centralized seawater heat pump was installed in a town of 4,500 people on an island, named Vestmannaeyjar, south of Iceland. It was connected to a previously installed electric boiler heating system that served most of the island's households.

Its purpose was and is to save energy, increase the island's energy independence and make it more cost-efficient for both the company and users. It has proven to be successful, saving around 2/3 of annual energy use.

Geothermal District Heating System in Höfn

Overview

- A district heating system that used an electric boiler to heat water.
  - Established in 1980, in a town named Höfn.
- Around 1.800 people live in the town.
  - Close to 2.400 people in the municipality itself.
- Was connected to 75% of the town.
  - The rest using direct electrical heating.
- To be able to operate and offer affordable prices the company had a specific agreement regarding electricity buying.
  - Paid a lower price for the electricity in return for the risk of not receiving it if there would be a temporary shortage in the country's power grid.
  - Would need to generate necessary electricity using oil boilers.

Geothermal District Heating System in Höfn

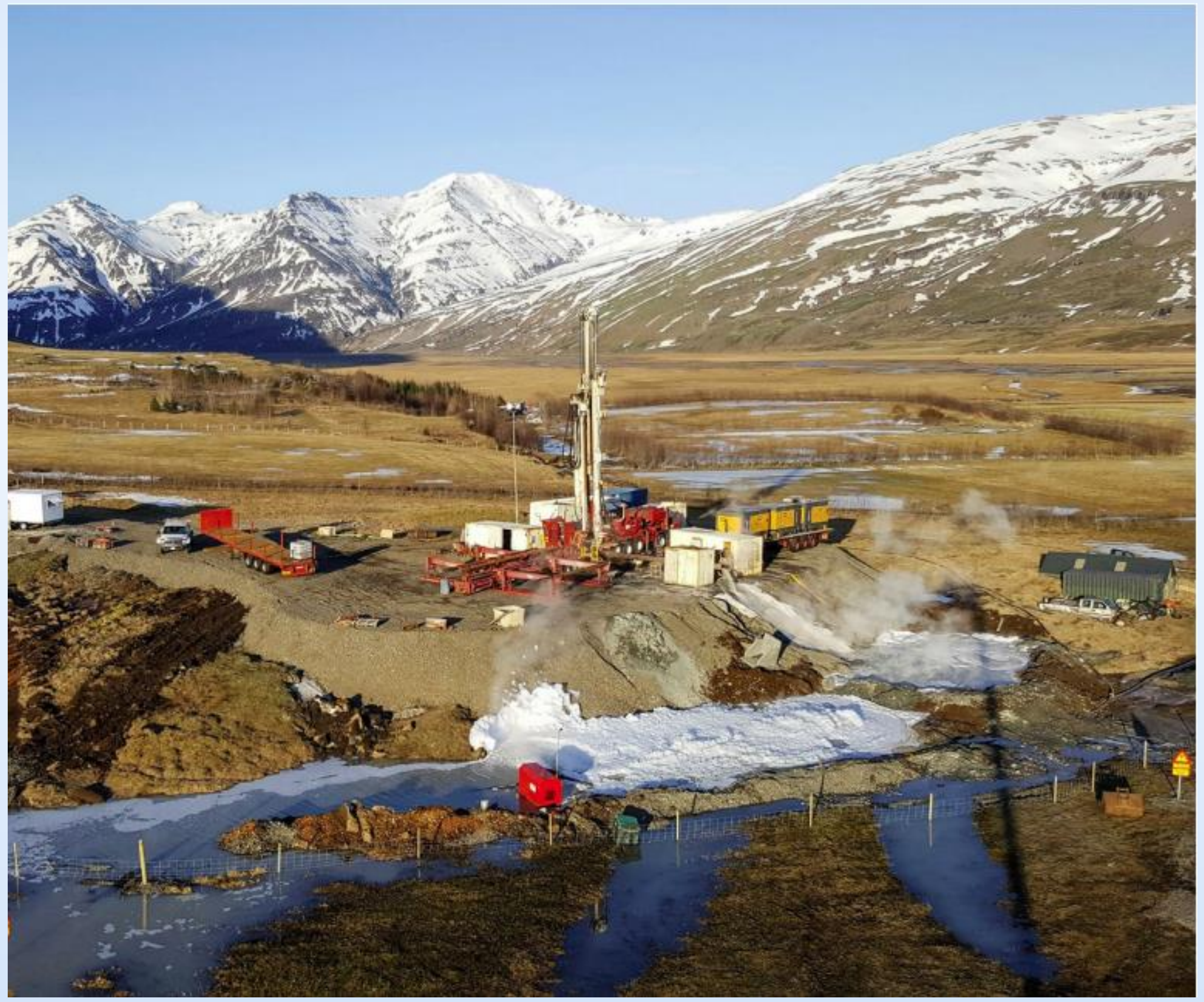
Overview

- Operational conditions for this type of district heating system in Iceland have become more difficult in past years.
- This pushed the owners into searching for a usable geothermal source for a new geothermal district heating system.
- In a short story, the search was a success, and the new geothermal district heating system was put into operation in December 2020.
- The first and only case in Iceland where geothermal district heating directly took over a district heating system using electric boiler.

Source: RARIK.

The Geothermal Resource

- The municipality started the search for geothermal in 1992.
- The company RARIK took over operations as new owners in 2002.
  - Until 2006, roughly 30 research wells were drilled (60-300m).
- 21 wells drilled since 2012, after a short break in the search.
  - 12 shallow research wells.
  - one 150 m well.
  - three 500 m wells.
  - five research wells, varying from 1.084 m to 1.750 m.
- Four of the five deepest wells are suitable for production but only three of them have been connected; HF-03, HF-04 and HF-05.
- The wells are in a land within the municipality named Hoffell, located 20 km north of Höfn.



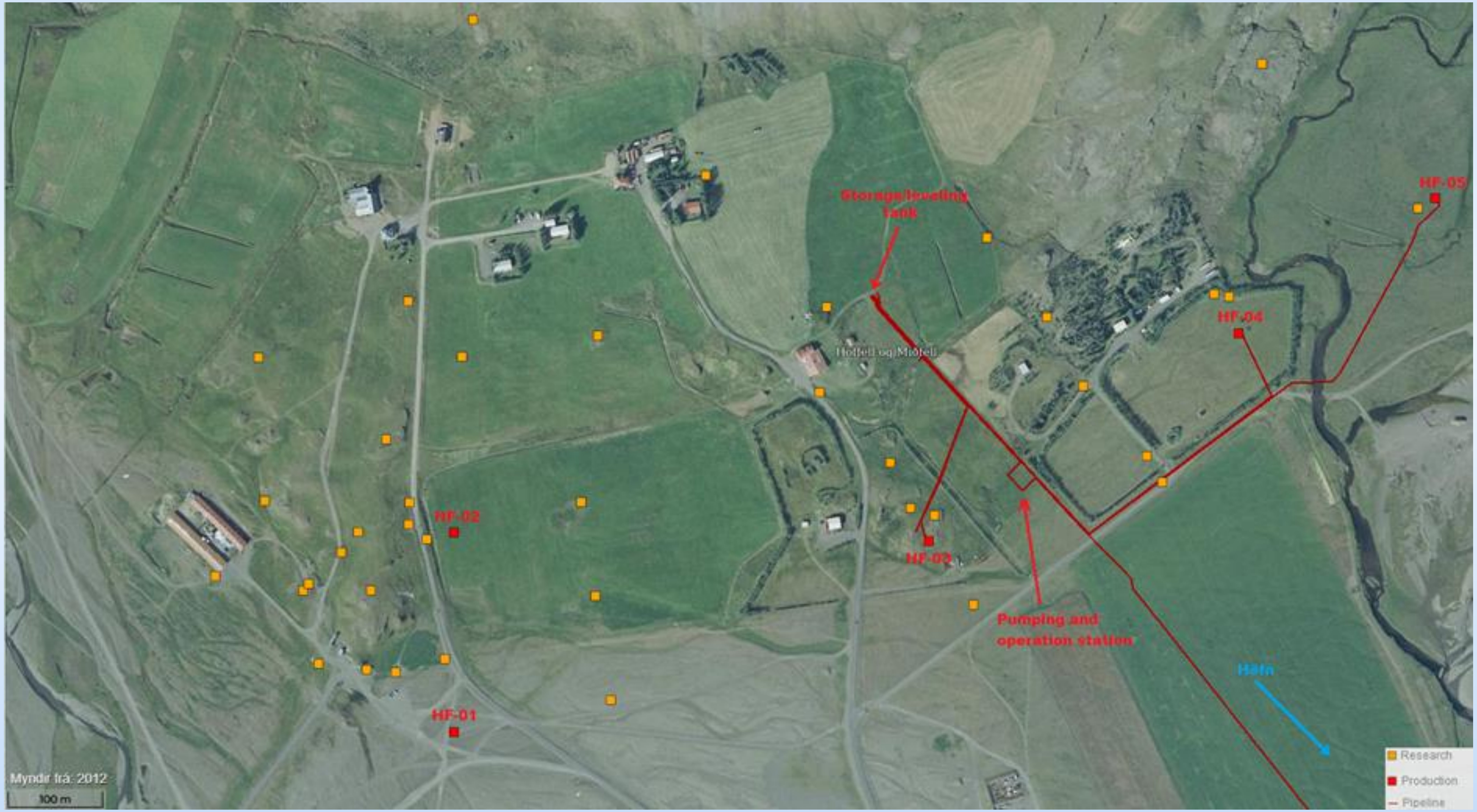
Source: RARIK.

The Geothermal Resource

- The estimated temperature of the water in the distribution system is
  - 70°C during minimum load.
  - up to 78°C during maximum load.
- The geothermal reservoir is estimated to be able to deliver up to 95 l/s during maximum load but for short time.
- In the long term, it is estimated to be on average 30-40 l/s.
- One well should be sufficient to meet the demand or two during maximum load.
  - 1-2 backup production wells and one available for connection.

Well name	Amount [l/s]	Temperature [°C]	Depth [m]
HF-01	15-20	74	1.606,5
HF-02	-	-	1.686
HF-03	25-35	74	1.084
HF-04	35-40	83	1.750
HF-05	25-30	78	1.727

Wells and System Around Hoffell



The Geothermal District Heating System

- In Hoffell are
  - pumping and operation station.
  - storage tank.
  - three well houses around the connected production wells.
- The station hosts electrical and operational equipment for the production and pumping of the water towards Höfn.
  - Another pumping station 9 km from Hoffell.
  - Third and final pumping station located in the old heating station in Höfn.

Source: RARIK.

Source: RARIK.

The Geothermal District Heating System

- The three well houses are 41 m^2 each and specially designed to reduce visual and sound pollution.
- The storage tank is 314 m^3 (593,4 m^3 the building in total) and is also meant to be a gas separator.
  - Cleans the geothermal of natural gases, such as nitrogen, methane and more.
  - Aluminium covered steel tank with a concrete base and concrete connecting basement

Source: RARIK.

Source: RARIK.

Wells and System Around Hoffell

Source: RARIK.

The Geothermal District Heating System

- The main pipeline is about 20 km.
- It consists of around 1.200 pre-isolated DN250/400 steel pipes (16 m and 544 kg each) at a depth of 0,8-1,2 m
  - Around 2.000 weldings were needed, including turns and connections.
- In addition, just over two kilometres of DN200/315 collection pipes are in Hoffell.

Source: RARIK, OS modified.

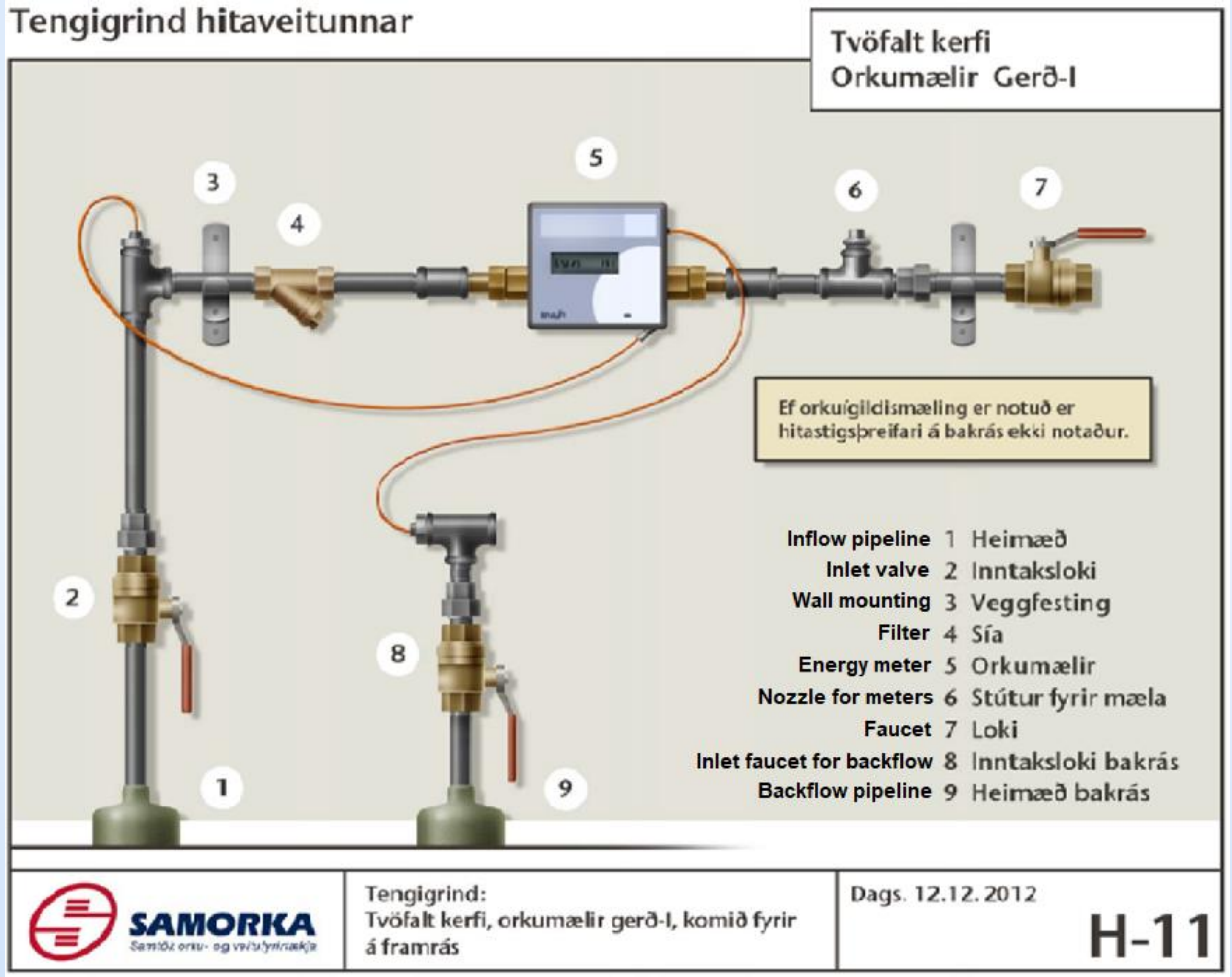
The Geothermal District Heating System

- The distribution pipelines are estimated to be
  - 16 km of plastic pipes (PEX) in the urban area.
  - 4 km in the rural area.
- There was (and is) only need to lay pipelines to houses that use(d) direct electrical heating.
  - Others had been using pipelines in their heating systems.
- The distribution system in Höfn is based on the previous distribution system.
  - Dual system.
- In the rural area, the distribution system will be single.
  - The users are responsible for the deviation of the return water.
- The heating station is meant to be in operation in the next years.
  - The plan is to replace it with a heat pump to use the heat from the return water.

Source: RARIK.

The Geothermal District Heating System

- The new system uses energy meters in accordance with the latest technology.
  - Ensure as much equality as possible among the users.
- In Iceland is a regulation that stipulates that the energy meters must have the backflow temperature fixed as 30°C.
- This means that users have incentives to try to increase their heating system efficiency.
  - If users have their backflow temperature lower than 30°C they are not paying for the energy they use below that temperature, i.e., their price for the kilowatt-hour is theoretically lower.
  - If users have a backflow temperature higher than 30°C they are paying for energy they are not using, i.e., they are not using the full potential of the energy source and are paying extra for it.
- This leads to increased awareness.



Dual system with energy meter installed on inflow.

Costs and Public Support

- The total costs of activating the geothermal, connecting all main and distribution pipelines, housing and others is around 24,8 million € (115 million PLN).
- Part of the cost related to the pipelines is eligible for a public grant.
- Total grant amount is not yet confirmed.
  - If all accessible users will connect – 10,6 million € (49,3 million PLN)
  - If reasonable and efficient use of the resource is considered - 7,8 million € (36,2 million PLN)
    - Minimum of 50°C hot water to be delivered.
- At the end of the year 2021, 3,6 million € (16,5 million PLN) had been paid.
  - The rest is planned to be paid out in this and next year.
- Subsidies will decrease.
  - Annual subsidy savings are estimated to be around 0,9 million € (3,9 million PLN).

Costs and Public Support

- The user’s connection cost and work differ between the type of heating system already installed in their houses.
- Houses connected to the electrical boiler-based district heating system or have already installed water-based heating systems.
  - 3.500 € (16.400 PLN) for:
    - removing hot water cylinders (heaters) and drinking water heaters.
    - possible need to enlarge ovens due to lower temperature of the hot water.
    - installing equipment and heat exchangers.
- Houses using direct electrical heating (no water-based indoor heating system).
  - 10.500 € (49.200 PLN) for:
    - New indoor heating system – switching out electric ovens and removing water heaters.
    - Install new pipes.
    - Installing equipment and heat exchangers.
      - Heat exchangers are mandatory in the urban area but a recommendation in rural areas.

Map of Höfn, subsidized electrical heating in early 2021 and heating station.

Costs and Public Support

- Base connection cost in 2021 – 2.800 € (13.100 PLN).
- Users are eligible for public grants for this.
    - Urban area: 7.100 € (32.900 PLN) – max.
    - Rural area: 14.200 € (65.800 PLN) – max.
- Installing this new geothermal heating system is not cost-effective for all users.
- Residential users have the right to deny the connection.
    - If a comparison for the next ten years shows that current heating is more cost-effective than the new geothermal heating.
- Houses other than residential are not eligible for subsidization and public support.
    - Have full control whether they want to connect or not.

The Pricing

- The new geothermal heating was put into operation in December 2020.
- Users were paying between 4,51-11,83 c€/kWh for heating.
    - Differs between locations and types of heating.
- The initial price for the new geothermal heating system was 4,82 c€/kWh.
- Up to 60% cheaper for housing without subsidized heating.
- More expensive for housing with subsidized heating.
    - Mandatory for users connected to the previously installed electric boiler district heating system.

c€/kWh (VAT incl.)	Geothermal district heating	Electric boiler district heating	Direct electrical heating - Urban	Direct electrical heating - Rural
Full price	4,82	8,09	9,10	11,83
Subsidy	-	3,58	4,33	7,06
Subsidized	4,82	4,51	4,77	4,77

Comparison of energy prices for space heating in Höfn in December 2020.

The Pricing

- Geothermal district heating systems are considered a social project.
- Benefits for users vary – overall, the results are positive for the community.
- Geothermal district heating offers a more stabilized price.
- Positive effect on the economy and increases the competitiveness of the local companies nationwide.
- Geothermal is a much safer and more environmentally friendly energy source than previously available.
    - Offers a better quality of life.
- Some users will change to geothermal heating regardless of whether the result is cost-effective or not.

Source: Sundlaugar.is

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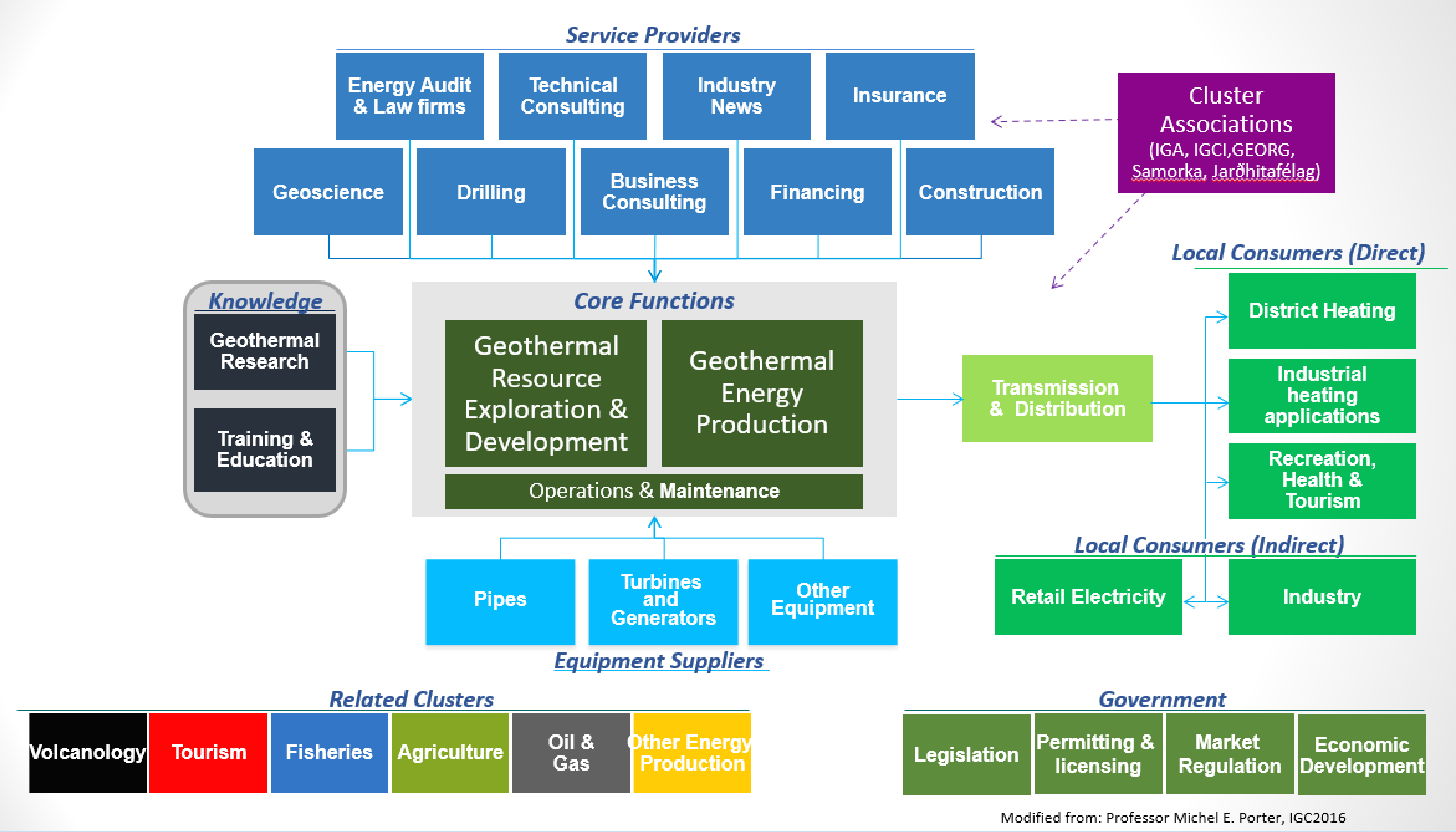
Icelandic Geothermal Cluster



Icelandic Energy Cluster

Source: Icelandic Geothermal Cluster Initiative

Icelandic Energy Cluster

Iceland Renewable Energy Cluster

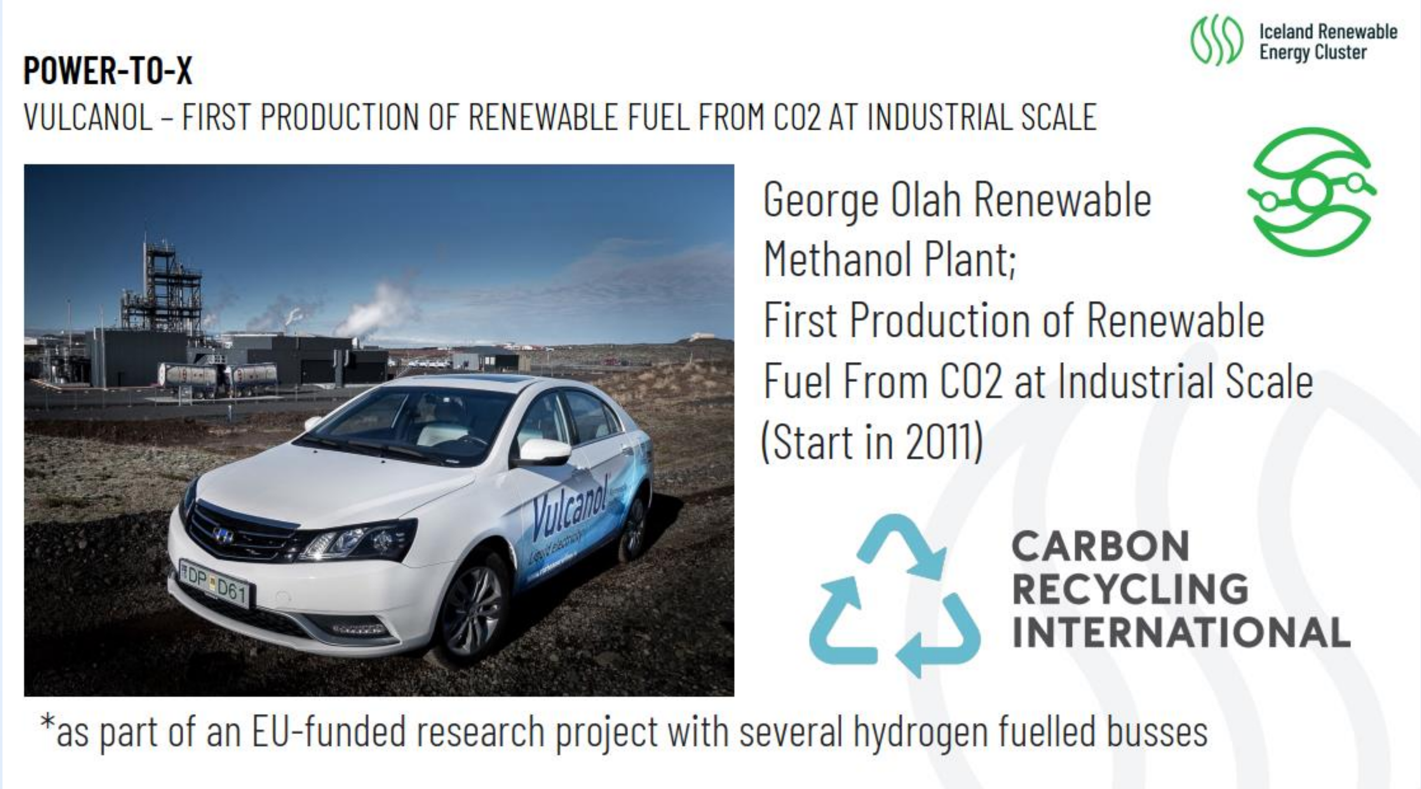
ICELAND RENEWABLE ENERGY CLUSTER
ELEMENTS OF OUR WORK

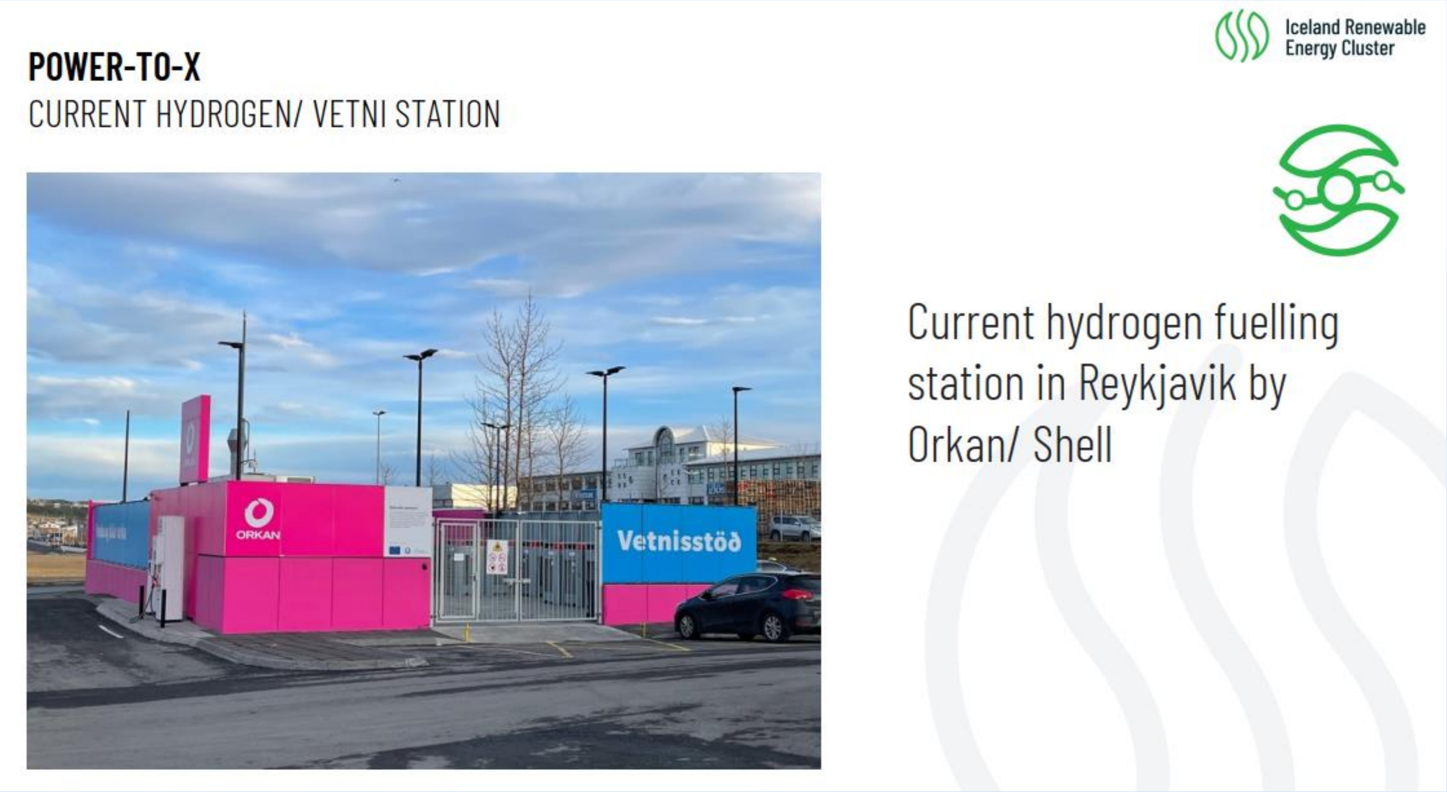
With a focus on the different sources of energy, including storage, we aim to provide forums for the various aspects related to the activities in these different fields as part of working groups and projects.

	Geothermal	Hydropower	Wind	E-fuels	Energy Storage
Production, O&M					
Infrastructure					
Storage/ CCS					
Effiency					
Sector Coupling, system integration & digitalization					
Innovation (IP, technology etc.)					
International & marketing (AOK)					

Source: Icelandic Renewable Energy Cluster

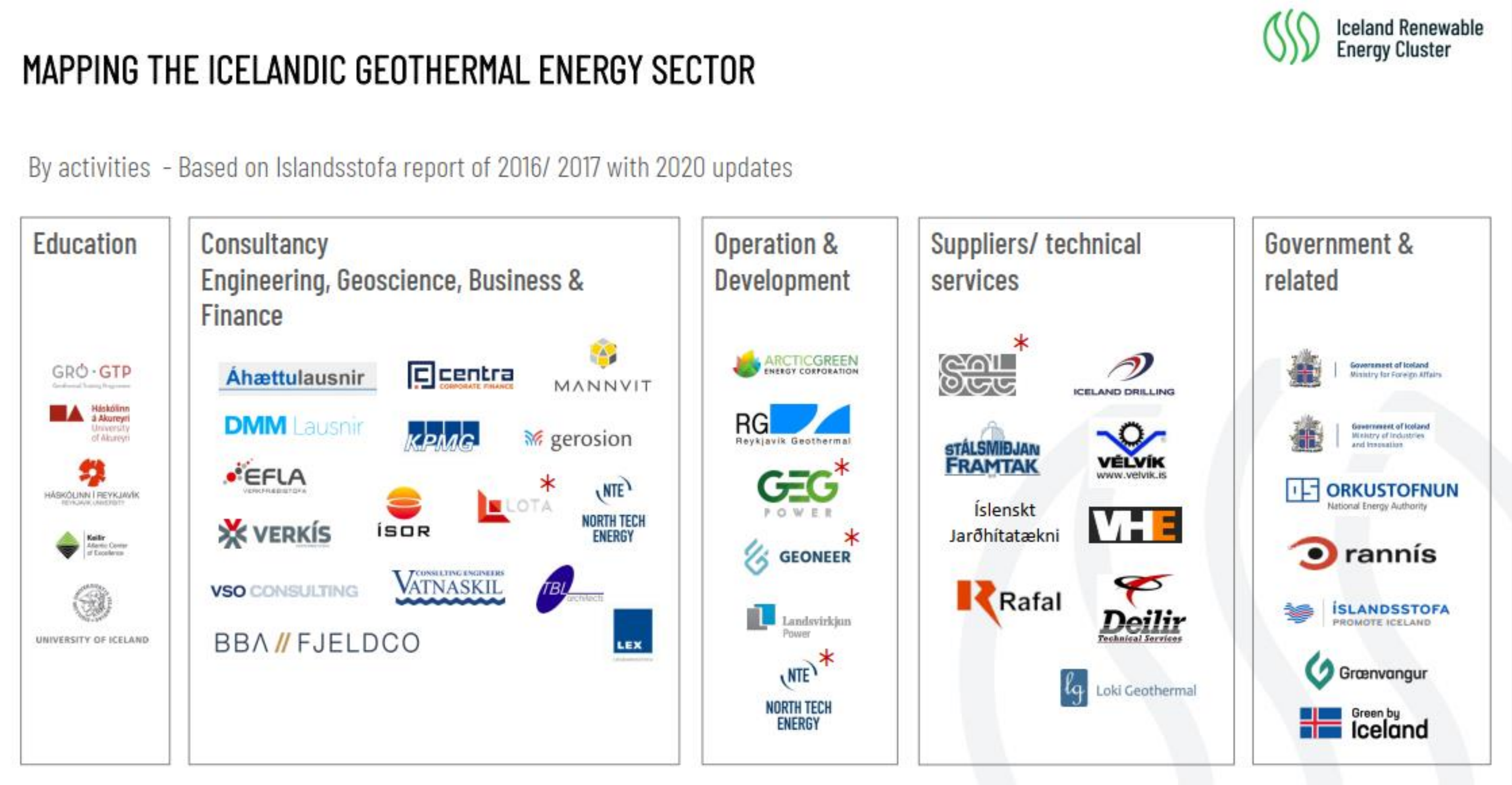
Icelandic Energy Cluster – ongoing and future





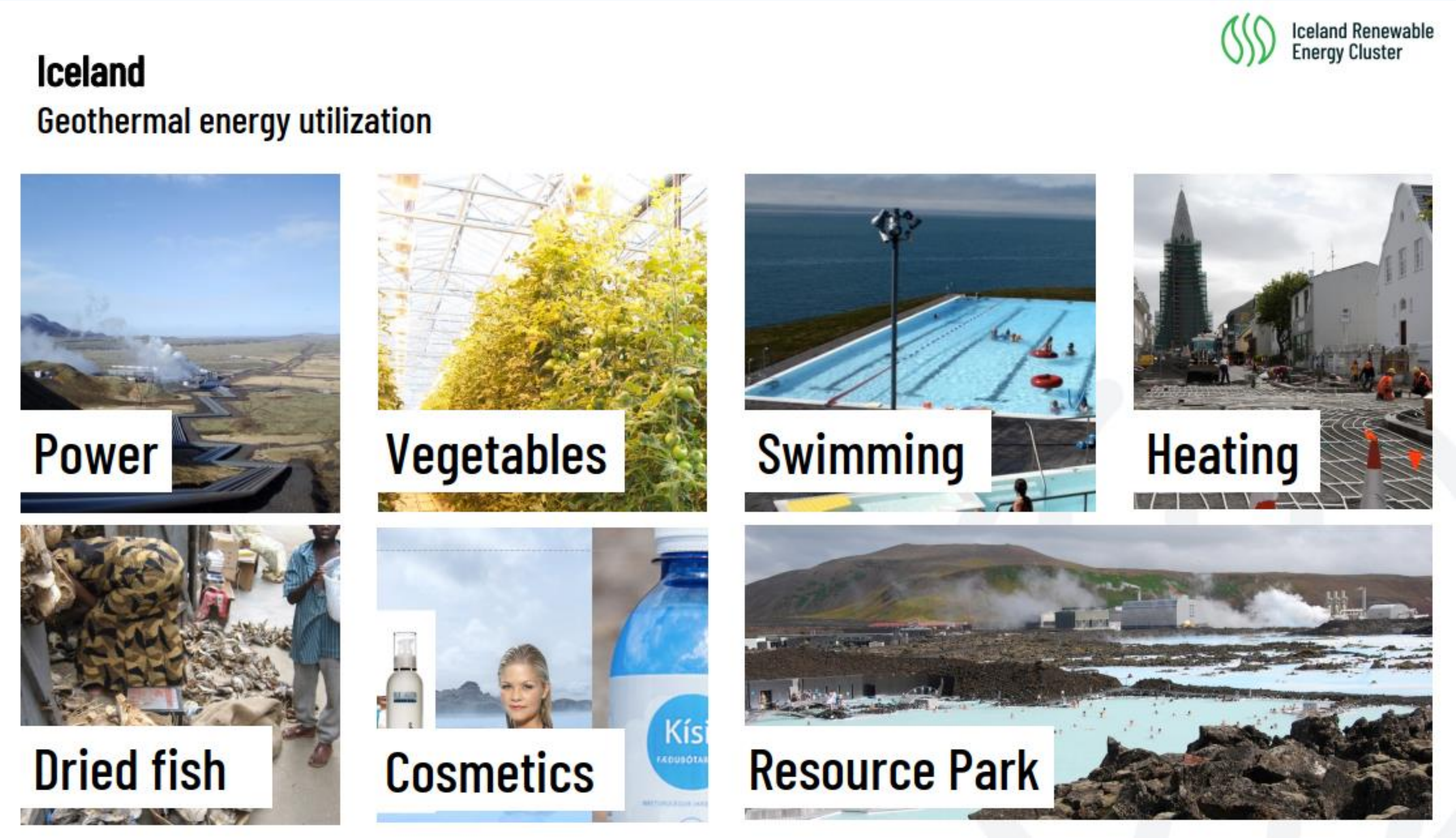
Source: Icelandic Renewable Energy Cluster

Icelandic Renewable Energy Cluster



Source: Icelandic Renewable Energy Cluster

Icelandic Renewable Energy Cluster

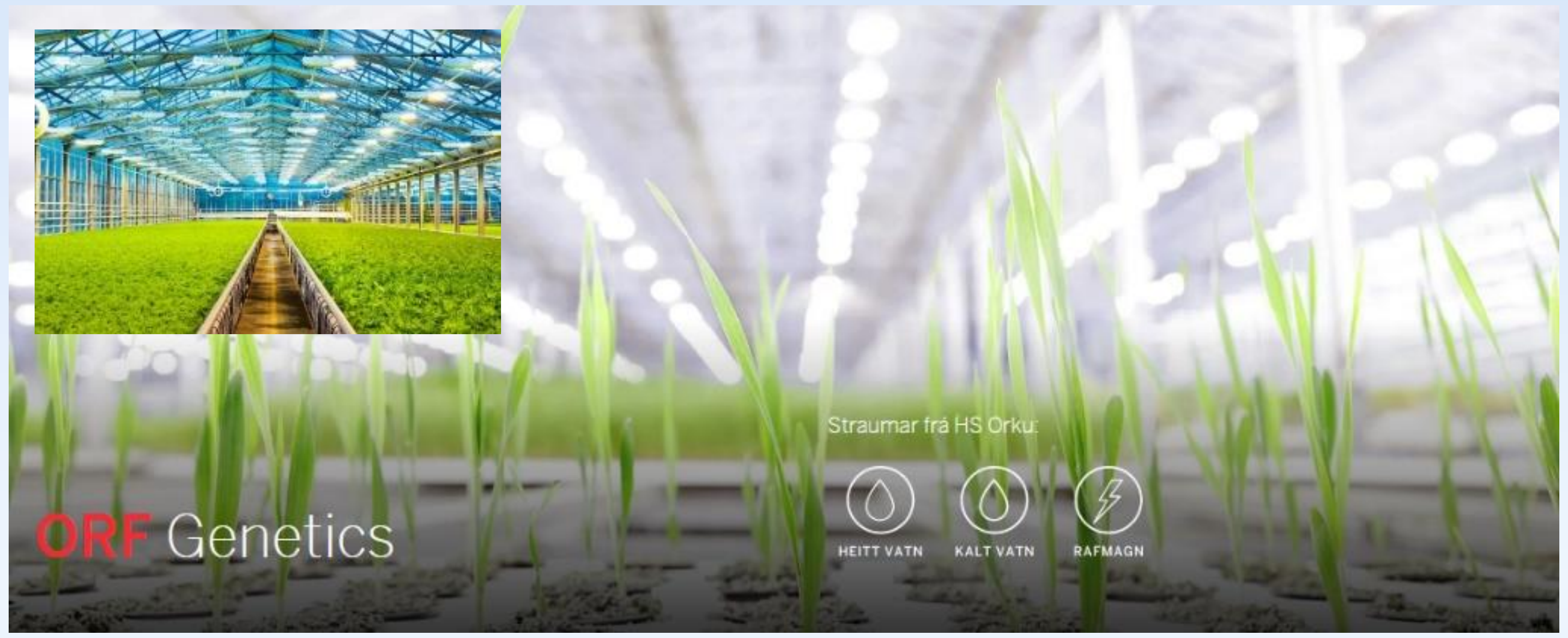


Source: Icelandic Renewable Energy Cluster

Utilisation of Geothermal Energy - Renewable innovation

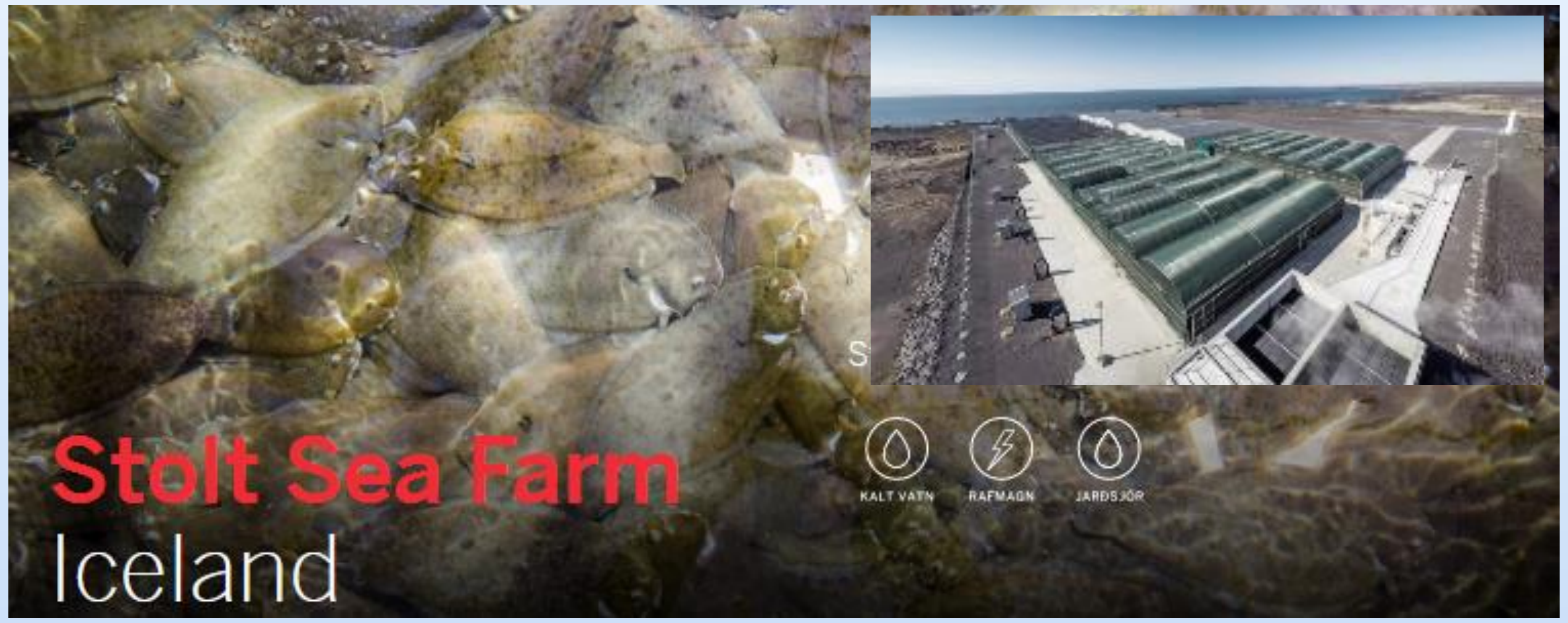
Companies within the Resources Park at Reykjanes

ORF Genetics



Hotel

Stolt Sea Farm



Carbon Recycling

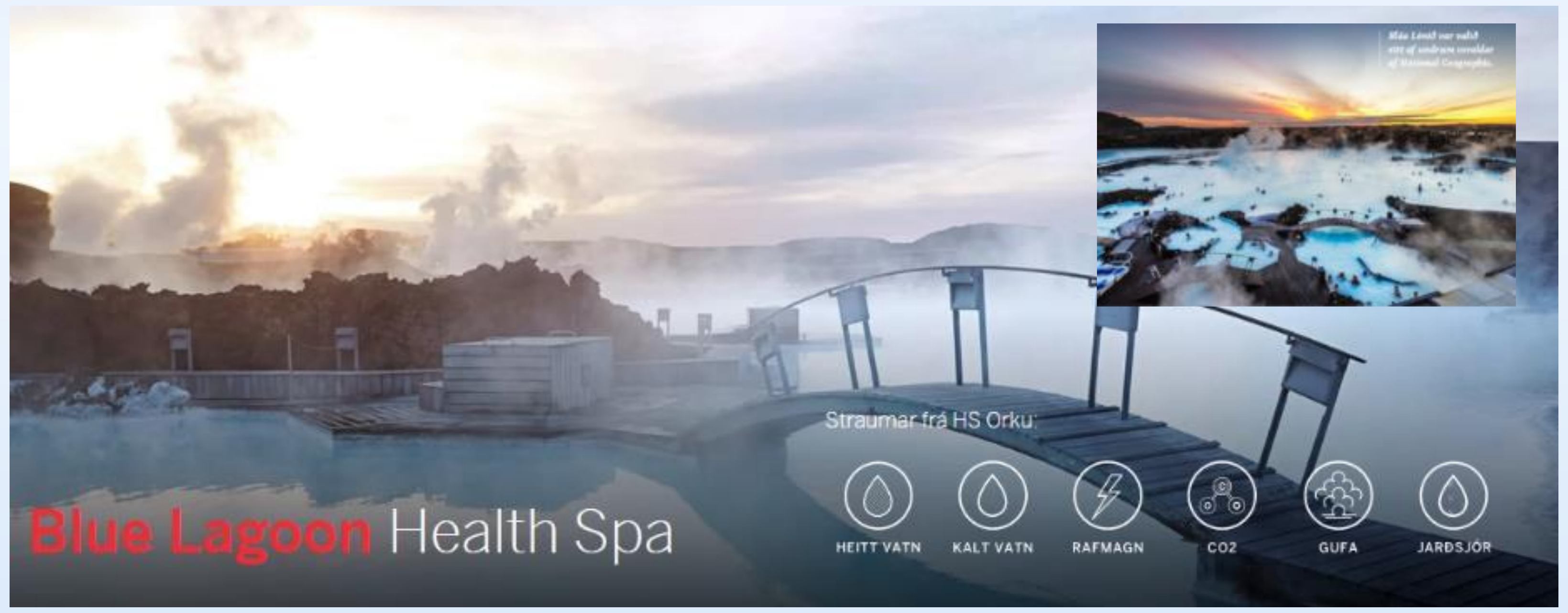
Utilisation of Geothermal Energy

Companies within the Resources Park at Reykjanes

Geothermal Power and Heat Generation

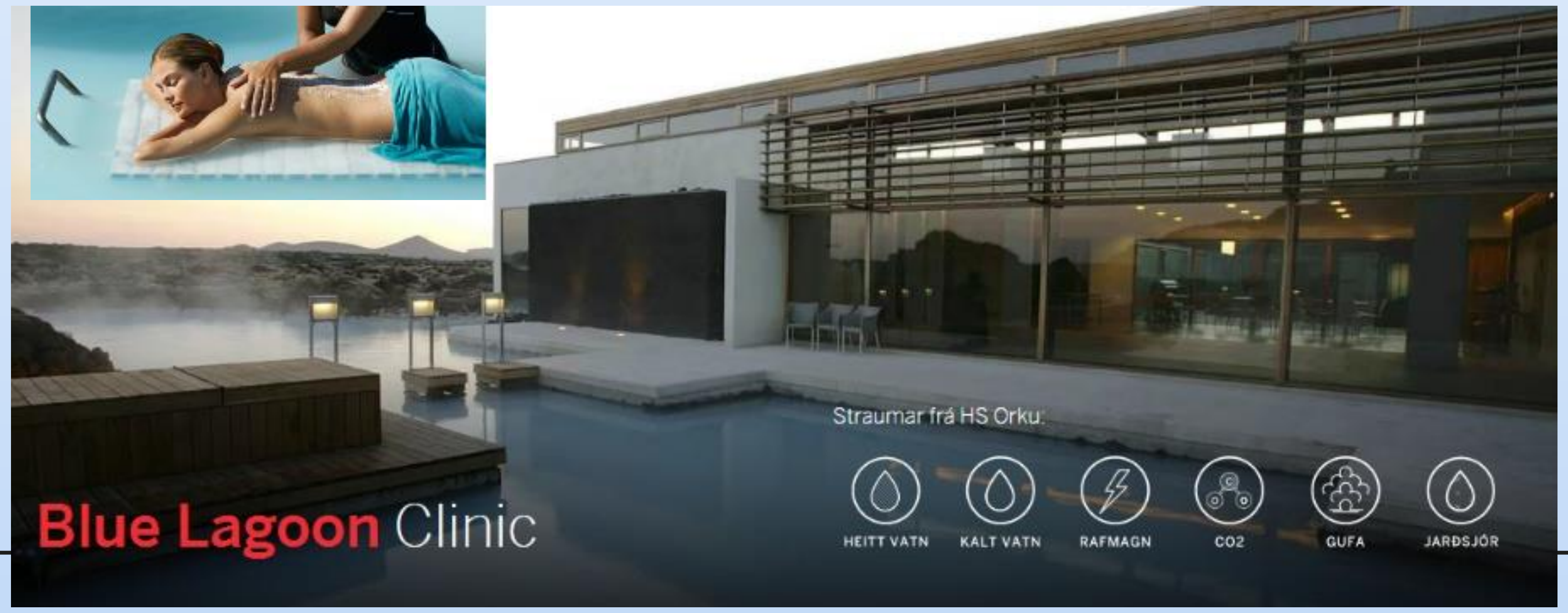
Geothermal Power and Heat Distribution

Blue Lagoon Health Spa

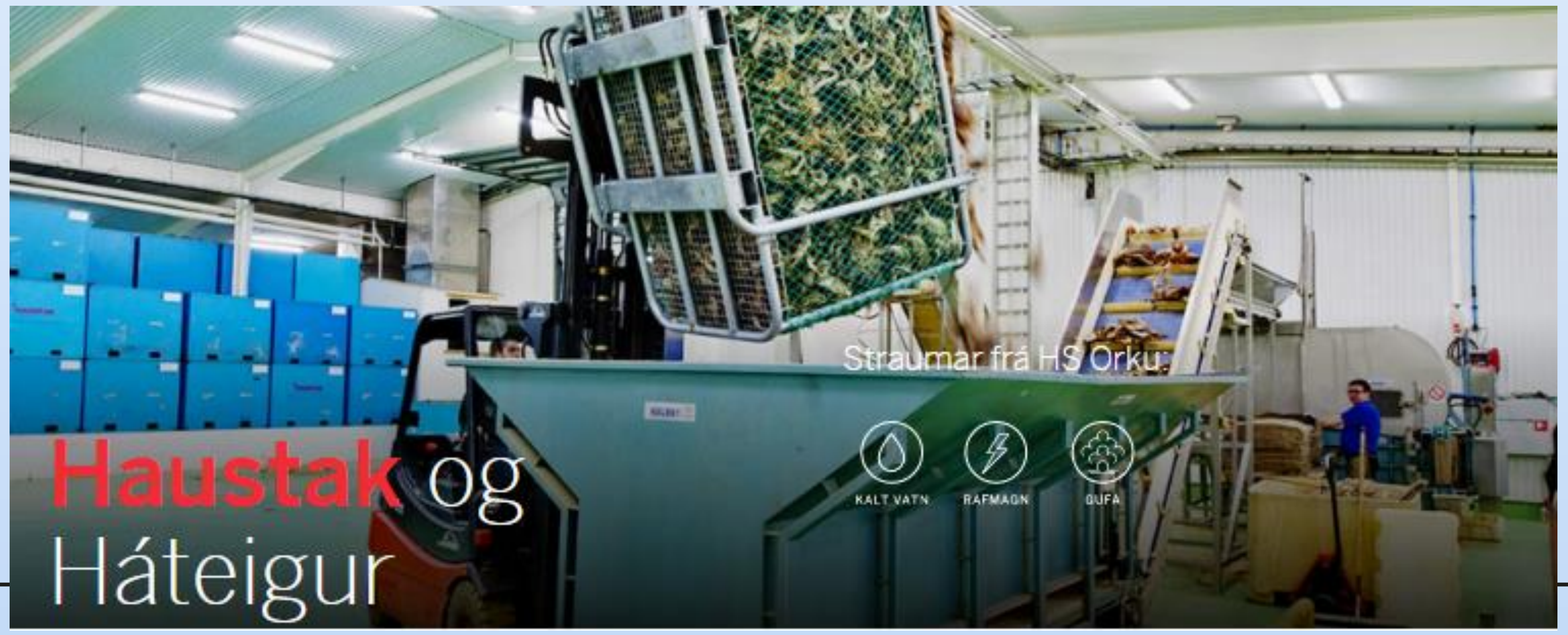


Blue Lagoon R&D Centre

Blue Lagoon Clinic



Fish Drying



Utilisation of Geothermal Energy

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

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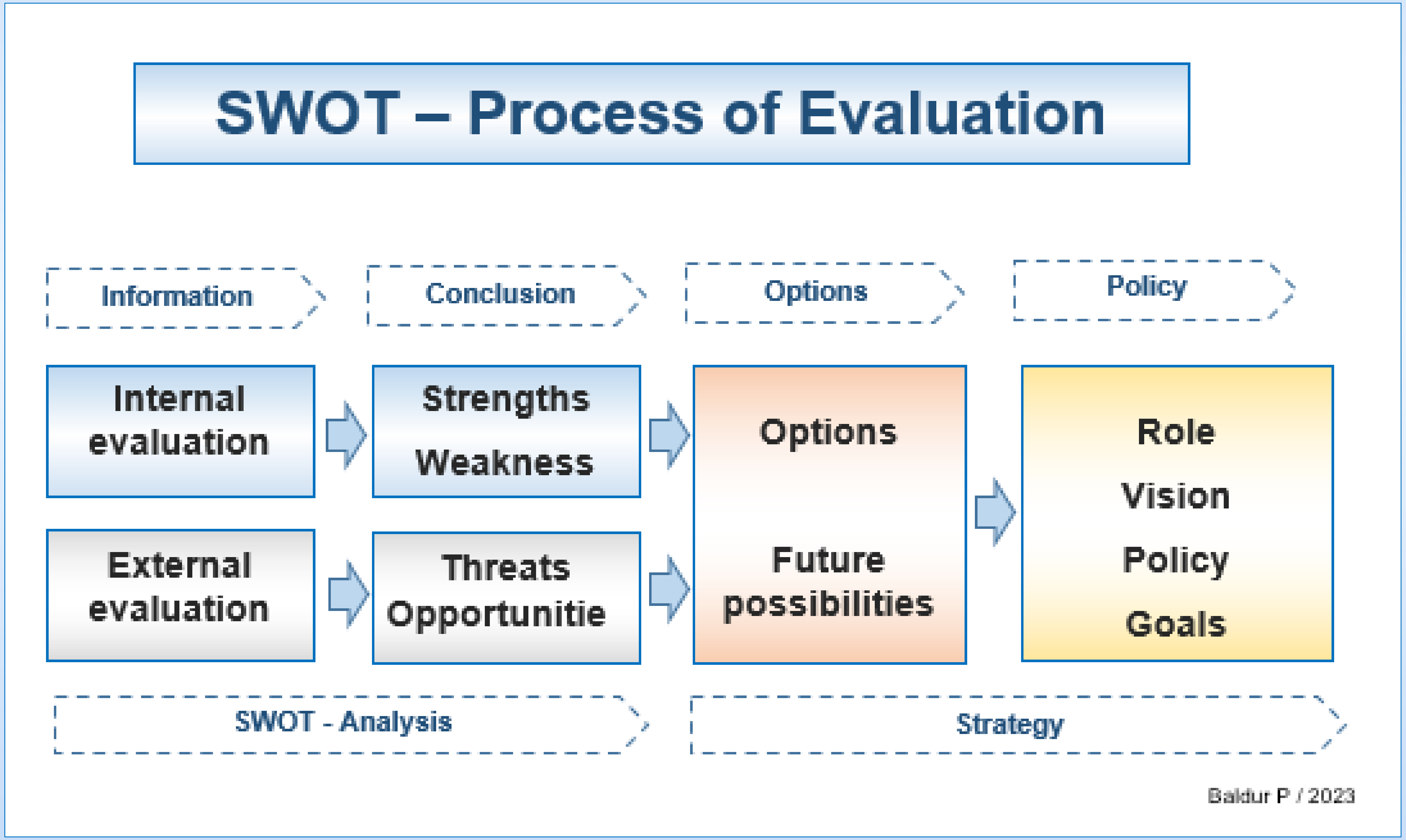
Competitiveness of the Geothermal Sector

Success of Geothermal District Heating
is based on Internal and External Factors



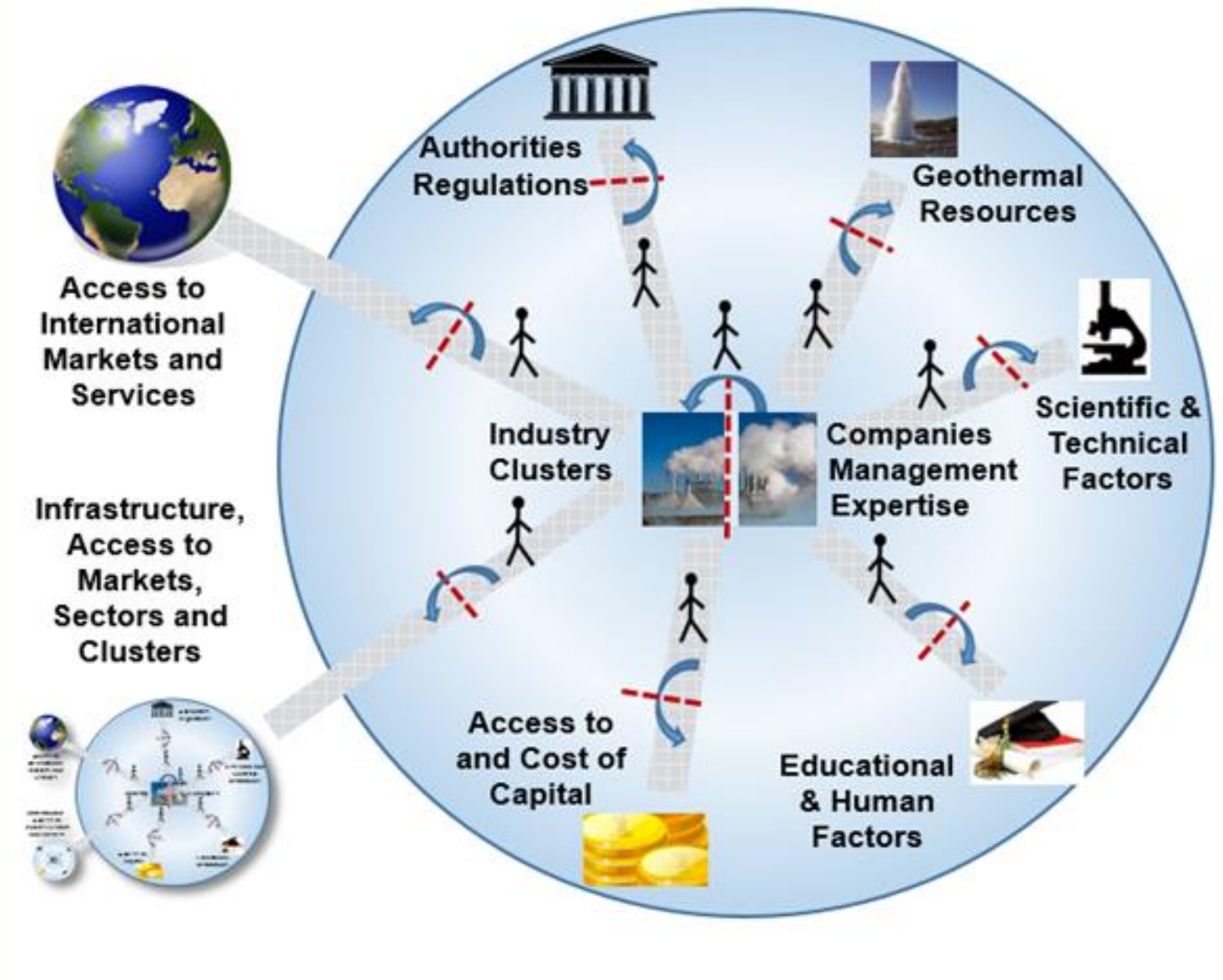
Competitiveness of the Geothermal Sector

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

Some International lessons

Geothermal utilisation - international framework recommendation

In many countries in Europe, geothermal district heating has potential possibilities to replace a significant part of imported oil and gas for heating in households and industry. The following general recommendations are highlighted:

1. Simplify the administrative procedures to create market conditions that facilitate development.
   a. Separate law regarding geothermal resources and other fossil fuels resources.
   b. Improve access to geothermal data - to improve development of geothermal utilization.
2. Establish a level playing field, by liberalizing the gas price and taxing greenhouse gas emissions in the heat sector appropriately.
3. Increase the awareness of regional and local decision-makers on geothermal potential and its advantages.
4. Modernize the district heating system:
   a. Better quality of service.
   b. Lower cost.
   c. Improved transparency.
   d. Following improvements of financial viability of district heating companies.
   e. Reduce cost of supply.
   f. Increase revenue.
   g. Quality service should be affordable.
5. Improve the role of independent regulators.
6. Improve the role of district heating companies.
7. Additional elements of public authorities.
   a. Finance energy efficiency programs.
   b. Support public awareness campaigns for benefits of metering.
   c. Providing incentives for demand-side management.
   d. Providing target support to poor customers.

Some International lessons

Geothermal utilisation - international framework recommendation

8. Harmonization with EU Law.
9. Train technicians and decision makers from regional and local authorities in order to provide the technical background necessary to approve and support projects.
10. Develop innovative financial models for geothermal district heating, including a risk insurance scheme, and the intensive use of structural funds;
    a. Grants / risk loans to geothermal district heating for exploration and test drilling to lower the risk.
    b. Grants to individuals (apartments) for changing to geothermal district heating.
    c. Grants to district heating companies for transformation to geothermal district heating.
    d. Loans to district heating companies' tor transformation to geothermal district heating.
11. What can international financing institutions (EEA Grant / EU funds) do to help?
    a. Financing / Support district heating transformation towards clean CO_2 geothermal district heating
    b. Financing and implementing heat metering and consumption-based billing.
    c. Financing energy efficiency measures along the supply line.
    d. Technical assistance to newly established regulators.
    e. Technical assistance for the design of targeted social safety nets.
12. Access to International Geothermal Expertise, Markets and Services.

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.

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Thank you!

ORKUSTOFNUN National Energy Authority

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