RENEWABLE ENERGY CLUSTER
Iceland the Land of Renewable Resources

Iceland

Overview - Energy Market & Geothermal Energy

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Iceland - An Overview

Iceland
A short overview

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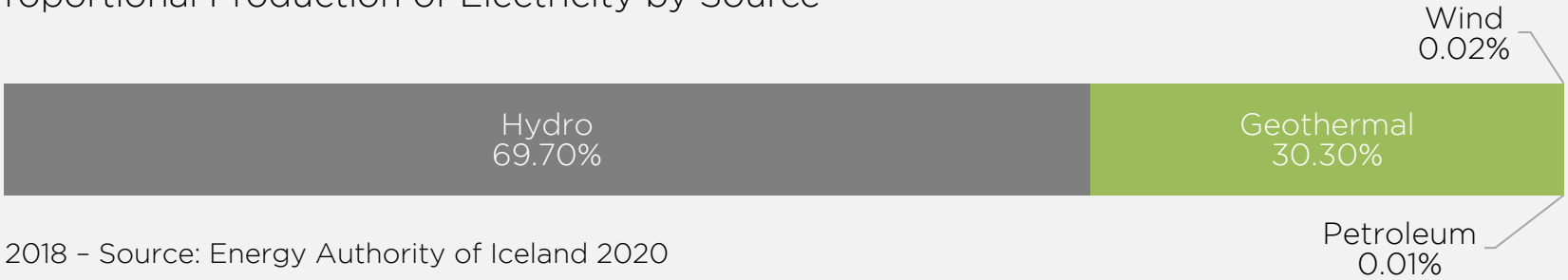
Size of country	103,000 km2
Population	364,143
Years of geothermal power production	47 years (1969)
Installed capacity (geothermal)*	755 MWe
Installed capacity of other sources*	2,173 MWe
Electricity production from geothermal*	6,010 GWh
Electricity production from other sources*	13,820 GWh

Proportional Production of Electricity by Source*



* 2018 – Source: Energy Authority of Iceland 2020

Iceland
Use of geothermal

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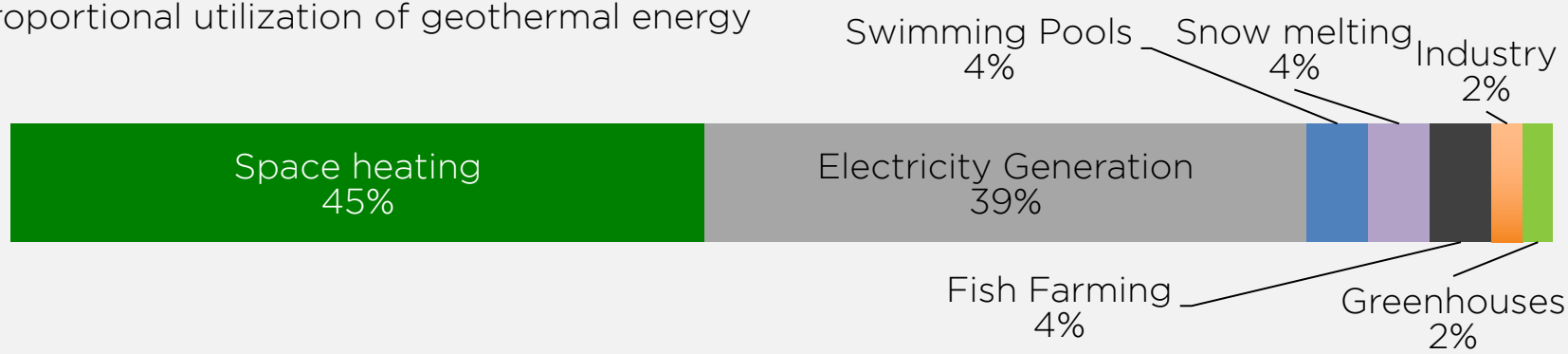
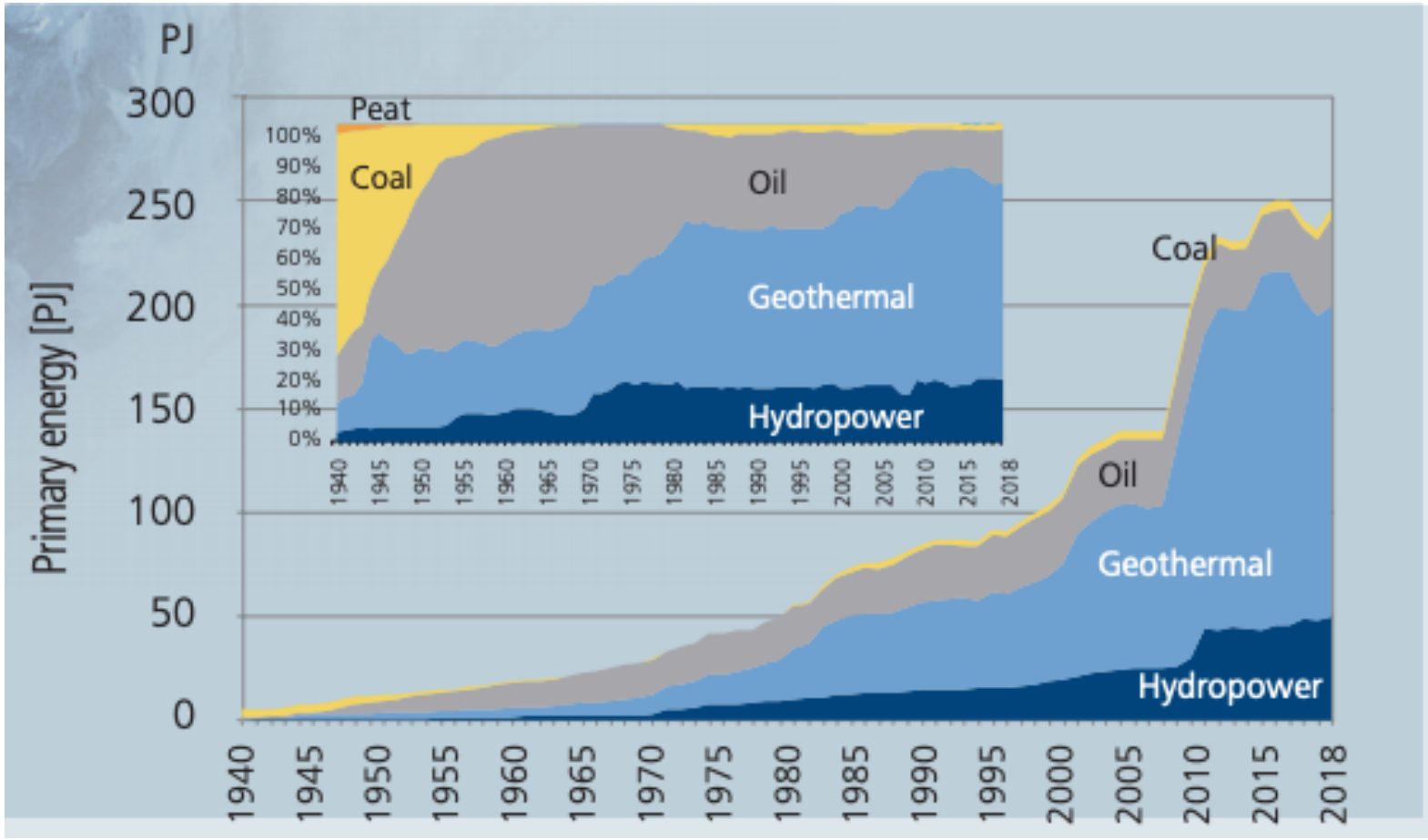
Years of geothermal power production	47 years (1969)
Installed power generation capacity (geothermal)	755 MW e
Years of geothermal heat use	~1,100 years (since first settlement)
Installed heat generation capacity (geothermal)	~2,100 MW th

Proportional utilization of geothermal energy



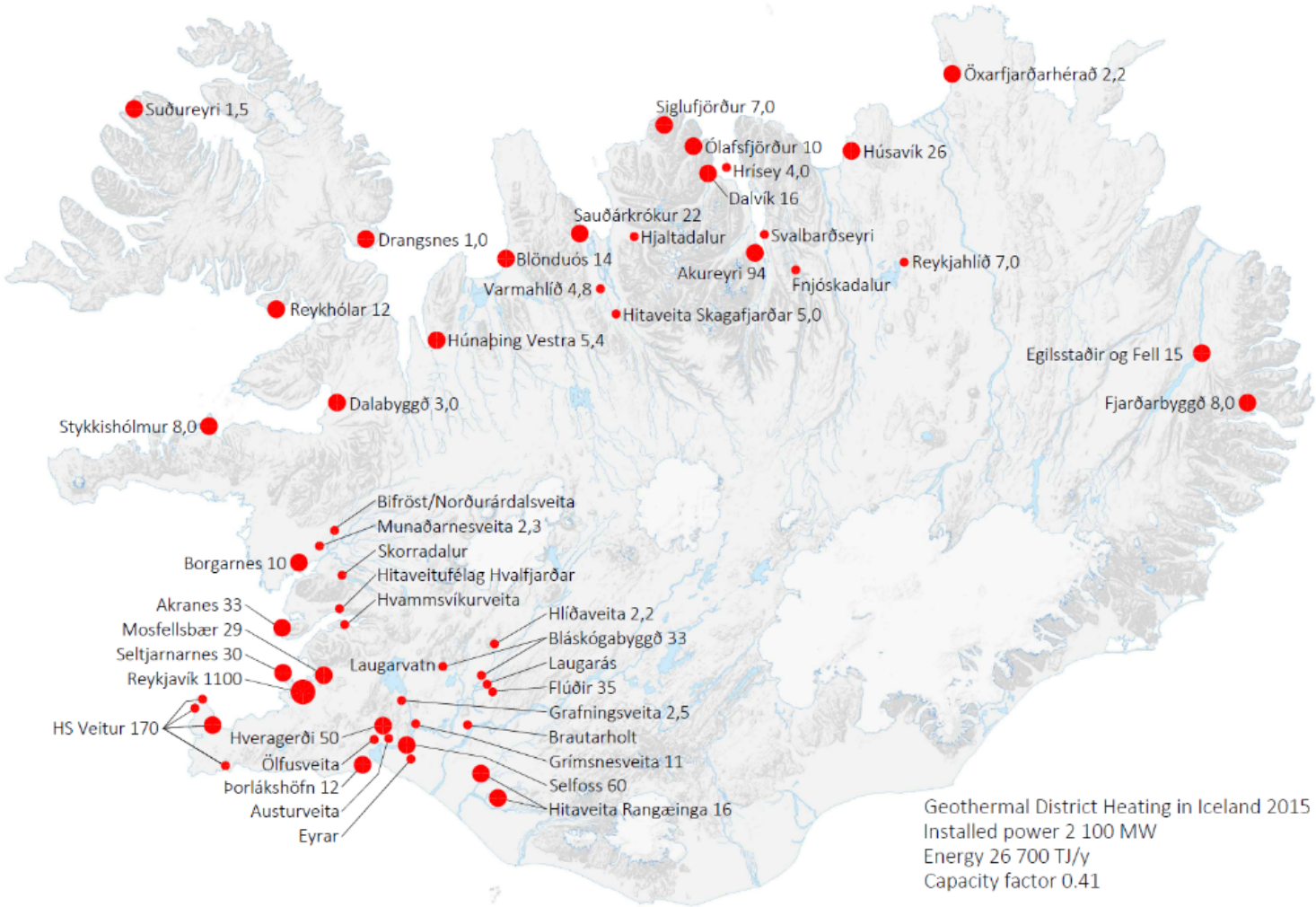
Source: Energy Authority of Iceland 2016

Iceland
Primary Energy Supply



Source: Energy Authority of Iceland 2020

Iceland
Geothermal
District
Heating
Systems
(MW th)



Reykjavik: 1,100 MW_{th} - Clean & renewable energy

1900 - Laundry springs in Reykjavík

Reykjavík
Geothermal district heating

- **1908 - Farmer piped geothermal water from a hot spring into his house**
- **1930 – Laugaveita**
  - 14 shallow wells, 14 l/s of 87°C hot water in the vicinity of the laundry springs
  - 3 km long transmission pipeline from the hot springs towards the town center
  - Primary school, Austurbaejarskóli, Swimming pool and 60-70 houses heated
- **1943 – Reykjaveita**
  - Shallow wells, self flowing, 200 l/s of 86°C hot geothermal water
  - 17 km long transmission pipeline, first Reykir piping main
  - 2 850 houses connected

1930: Connection of Austurbæjarskóli

1940 – Coal smog above Reykjavík

Reykjavík
Geothermal district heating

- **1958** - More wells drilled and deep well pumps installed
- **1970** – All houses in Reykjavík heated. Increased capacity from Reykjaveita and second Reykir piping main. Expansion starts to the neighboring suburbs
- **1990 –** Nesjavellir CHP power plant taken into service (Nesjavellir piping main)
- **2005 –** Hellisheidi CHP power plant taken into service (Hellisheidi piping main)

- **Today** - Reykjavik district heating among the largest in the world, 75 million cubic meters per year of hot water to some 200,000 inhabitants, deriving heat from CHP plants and low-temperature fields in Reykjavík and its vicinity. Locally, 52 wells deliver a total of 2,400 liters per second of 62–132°C hot water.

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VOTE FOR THE DISTRICT HEATING TODAY!

Announcement regarding house heating systems due to plans of the new district heating in reykjavik, those who are constructing new houses or renovating old ones shall install heating systems that can fully utilize the water from the new district heating system!

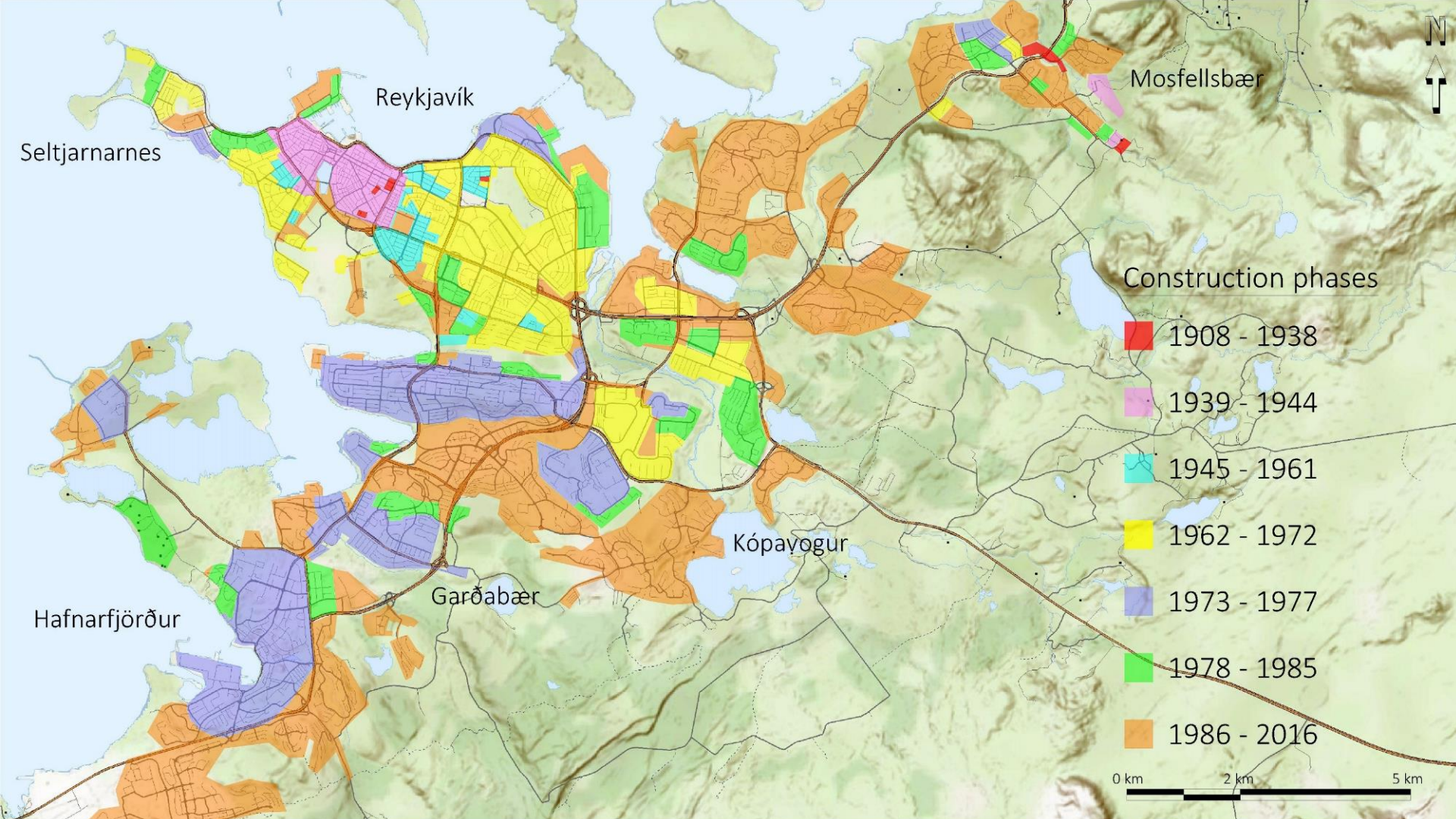
Hitaveita Reykjavíkur.

Auglýsing viðvíkjandi hitalögnum

Vegna væntanlegrar hitaveitu er þeim, er byggja ný hús eða breyta gömlum húsum, ráðlagt að haga hitalögnunum í húsunum þannig, að fult tillit sje tekið til hinnar nýju hitaveitu, er hitalagnir eru ákveðnar.

Skrifstofa Hitaveitu Reykjavíkur, Austurstræti 16, mun gefa upplýsingar um þetta kl. 11—12 f. h. daglega.

Bæjarverkfræðingur.


Reykjavík
Seltjarnarnes
Mosfellsbær
Kópavogur
Garðabær
Hafnarfjörður
N
Construction phases
1908 - 1938
1939 - 1944
1945 - 1961
1962 - 1972
1973 - 1977
1978 - 1985
1986 - 2016
0 km
2 km
5 km

Reykjavik

Source of geothermal heat used

Field	Temp. (°C)	Capacity (l/s)	MWth	No. of exploitation wells
Laugarnes	125-130	340	125	10
Ellidaar	85-95	260	50	8
Reykir-Reykjahlid	85-100	1,980	370	34
Nesjavellir (high heat, CHP)*	83	1,680	300	14*
Hellisheidi (high heat, CHP)	85	800	150	~50*

* Wells used for the power plant and its excess water for heating being supplied to Reykjavik by pipes. Nesjavellir-Reykjavik pipes of 27 km, Hellisheidi-Reyjavik around 30km, number is not including re-injection wells.

Source: Einar Gunnlaugsson, Reykjavik Energy (2009

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Hot water tanks above the city

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Reykjavik geothermal wells for district heating in the city

Laugarnes well & pump

Hellisheidi geothermal heat & power plant

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Geothermal drilling support and risk mitigation

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- Early 1960s – geothermal fund was established, now **National Energy Fund**

- **Goal of fund:**
  1. To provide low-interest loans to municipalities, firms or individuals for geothermal drilling both for public supply, use in horticulture and similar economic activities and heating of individual homes, especially in rural areas
  2. Sharing by the state of risk of geothermal development undertaken by developers.

- Provision that if an attempt to develop field is unsuccessful **loan may be converted into a grant and does not have to be repaid**

- **Loans for drilling provided by the energy fund normally cover 60% of total drilling costs,** later including **grant support of up to 50%** (mainly for exploratory activities)

- Arrangement has been instrumental over years in furthering geothermal development in Iceland

Iceland

Geothermal drilling support and risk mitigation

- Research on resources by **National Energy Authority**
- 1940s **a state drilling company** was established to drill, which was privatised in 1986.
- Now Iceland Drilling is a private company focusing on high heat drilling in Iceland and internationally, while there are several small drillers focused on lower heat and shallower drilling for heating project across Iceland.
- Geoscience department of authority was spin out in 2003 with the foundation of Iceland GeoSurvey (ÍSOR) as agency owned by the Icelandic state.

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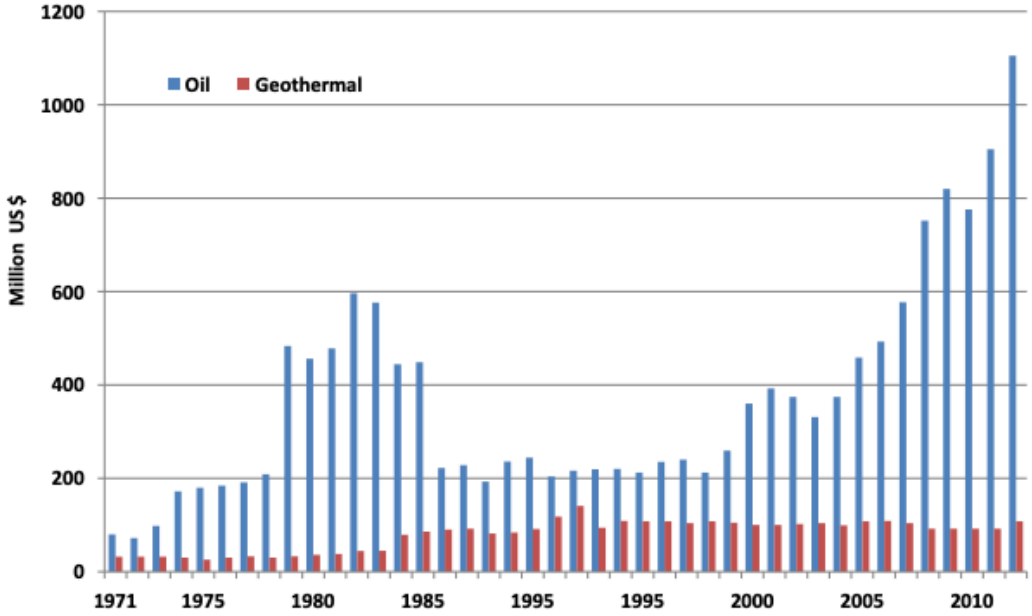
Economic savings by geothermal district heating

- **Accumulated savings** over 40 years (1979 to 2008) are around **USD 9.5 billion** or around three times Iceland's national budget
- Estimated oil savings around USD 22 billion
- Total **economic benefits** from geothermal in 2010 around **USD 480-830** million or around **4-6% of GDP** of the country (incl. benefits for space heating, related industry benefits and social impacts)

Revenues heating utilities of geothermal heating compared to cost of heating with oil

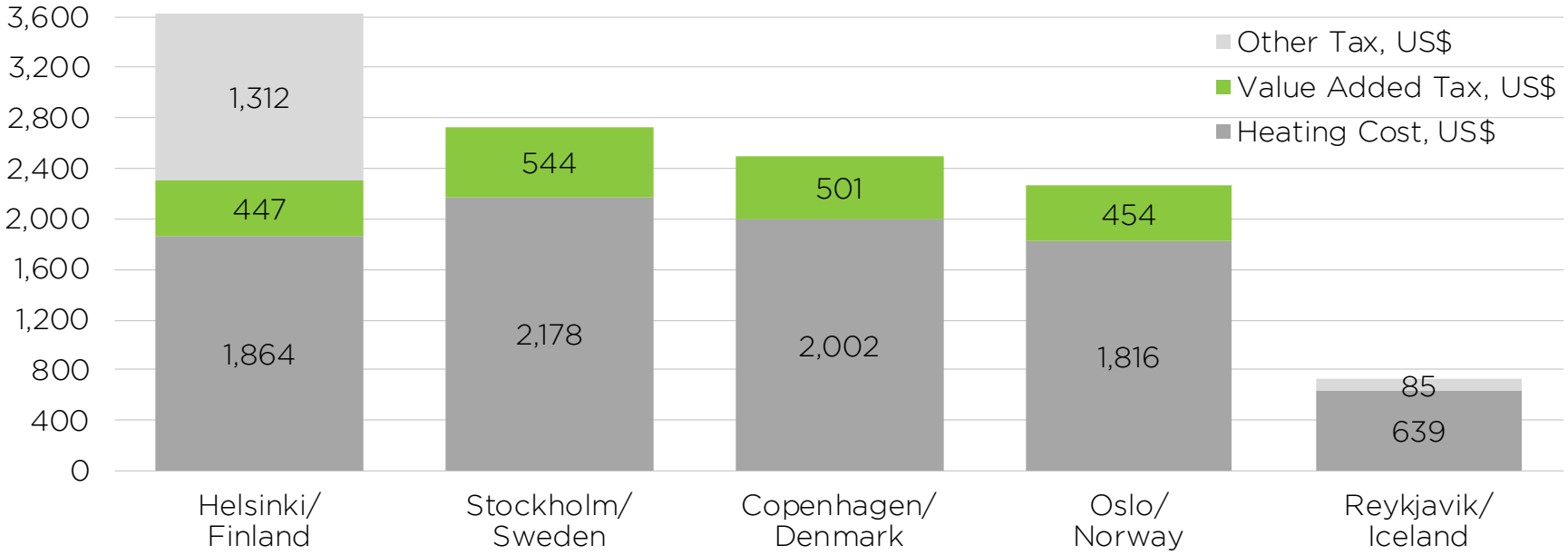


Source: Iceland National Energy Authority 2014, Gunnlaugsson, E., Ivarsson G., Fridriksson J.S., Ivarsson WGC 2015 Proceedings

Residential heating in the Nordics

Cost per Household for District Heating, US$

Based on: 100 sq.m (1,080 sq. feet), 495 tons of hot water use/ annually
Sources: largest heating utility in each capital city



Source: Samorka, Iceland (August 2016)

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Snow melting

International Case Study

Export success story - China

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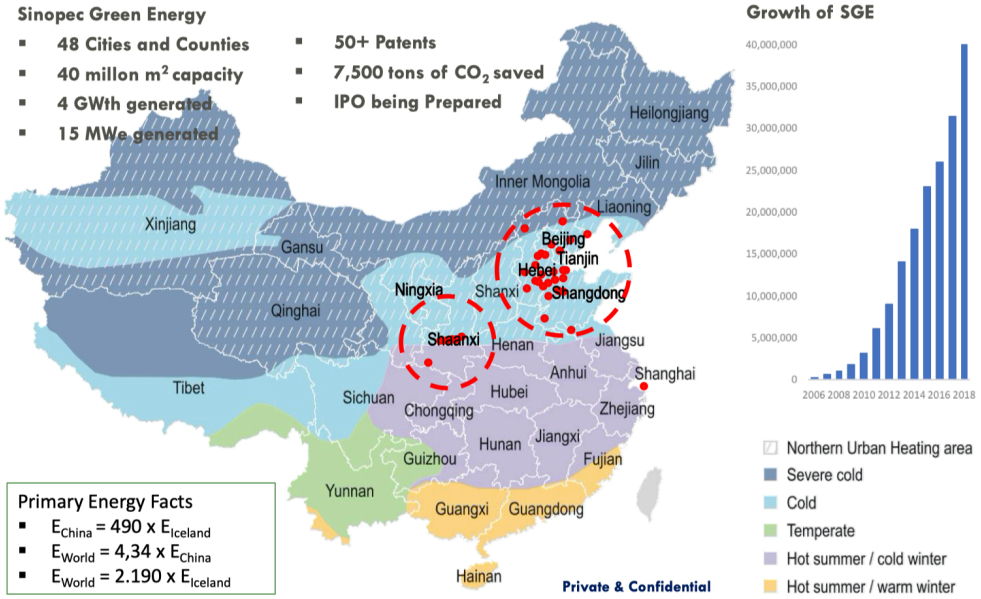
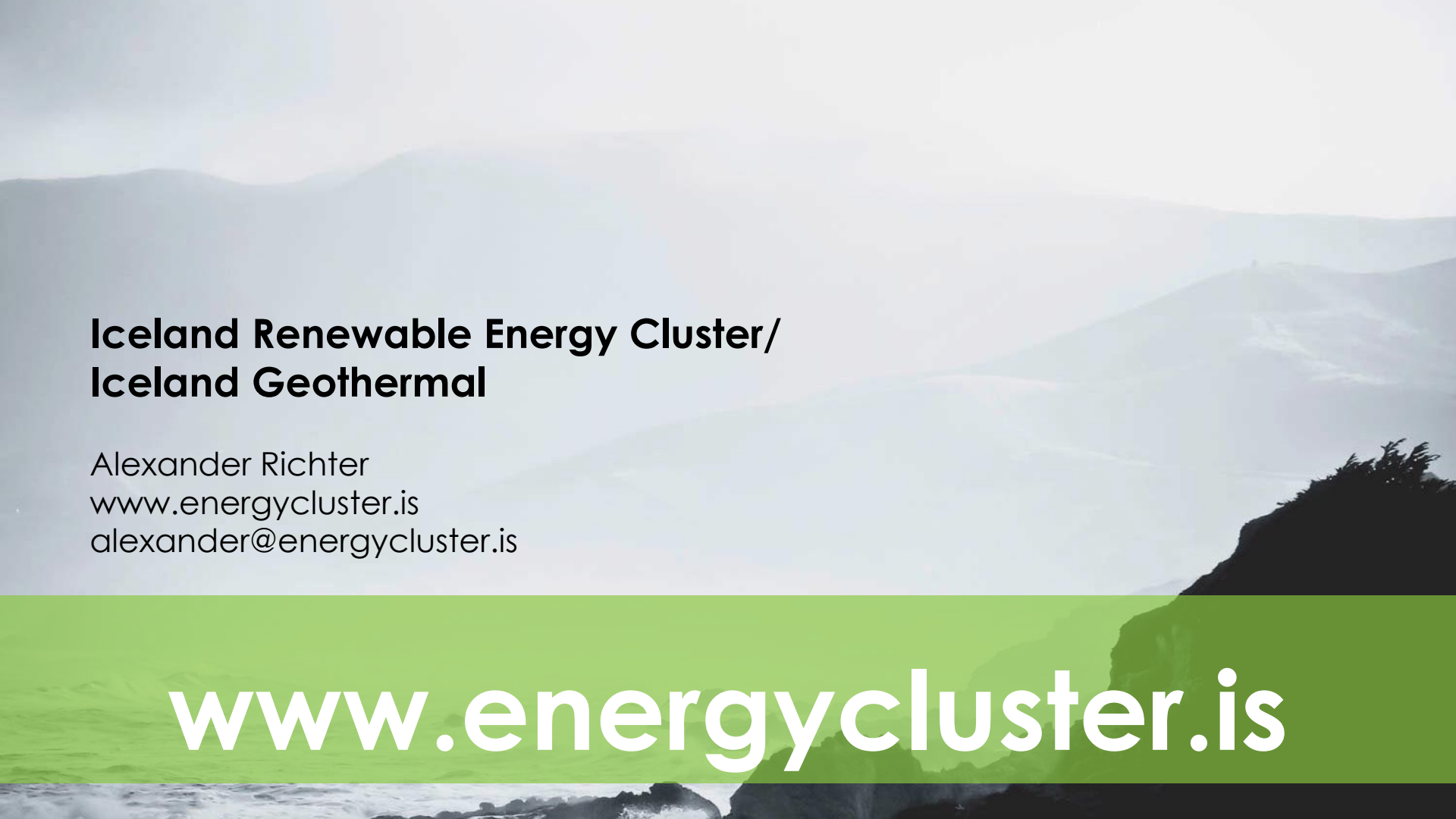
Sinopec Green Energy

- Icelandic-Chinese joint venture with Sinopec
- Established 2006, profitable since 2009
- World's largest and fastest growing geothermal heating company
- To grow at least 5x over next 5 years
- Market leader in China both in terms of size and technological advancement
- Already in over 50 cities and counties in China including Xiong'an New Area
- The JV is being prepared for an IPO

Sinopec ARCTICGREEN ENERGY CORPORATION





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