VERKÍS

Geothermal district heating & cooling (Drying)

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Verkís – Iceland

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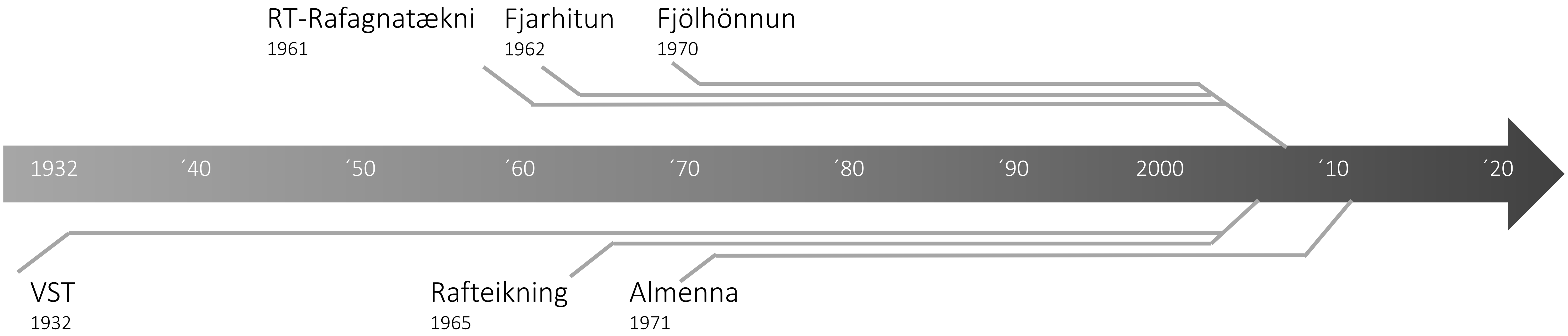
Verkís Consulting Engineers

- Verkís was founded in 2008 by merger of five leading Icelandic consulting engineering firms
- The origin of the firm dates back to 1932
- Partnership owned by 93 professionals with a staff of 320 employees



Geothermal power

District heating

Geothermal utilization

Hydropower

Power transmission

Other renewables

District heating systems

Supply mains

Storage tanks

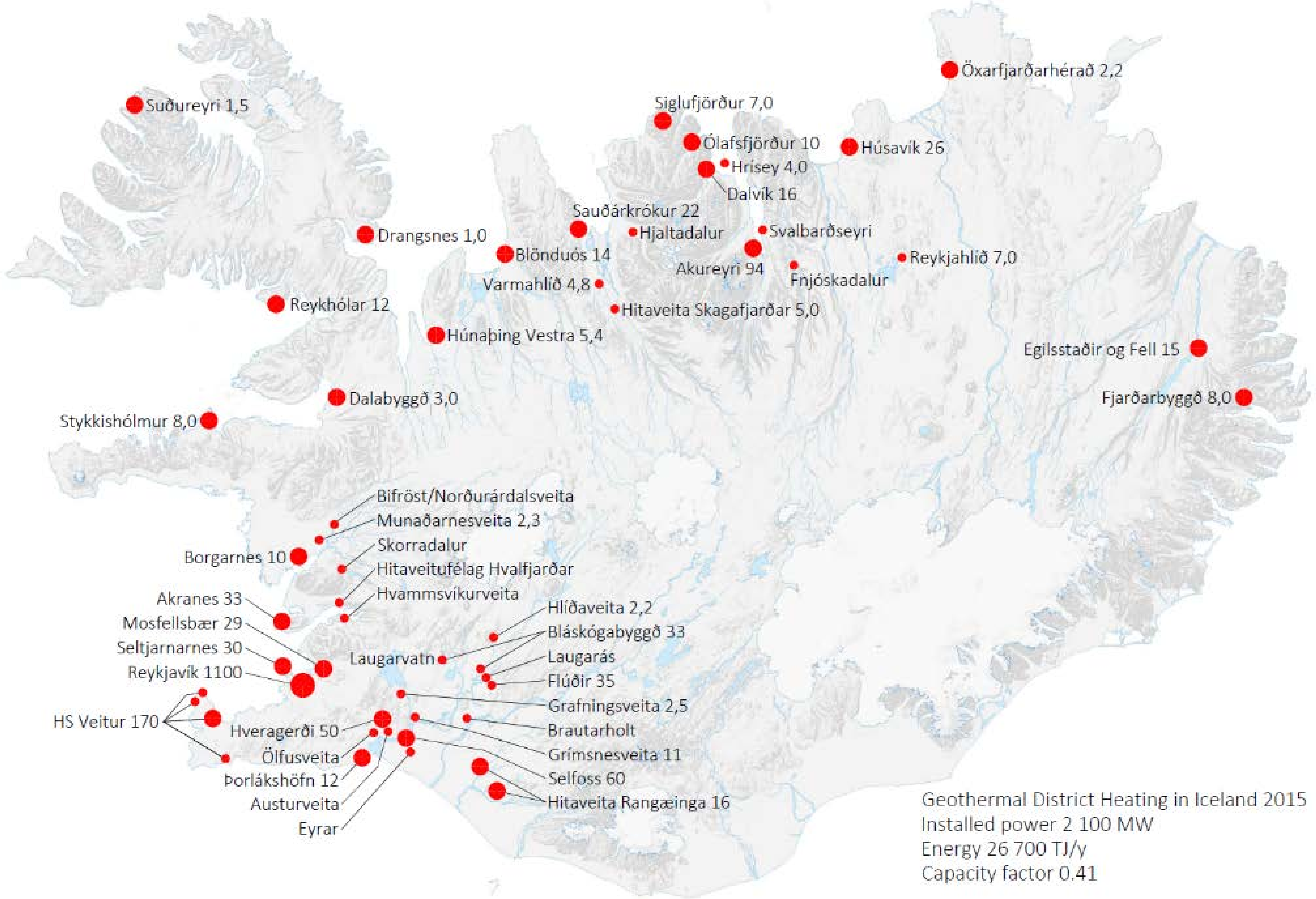
Pumping stations

Distribution systems

House connections

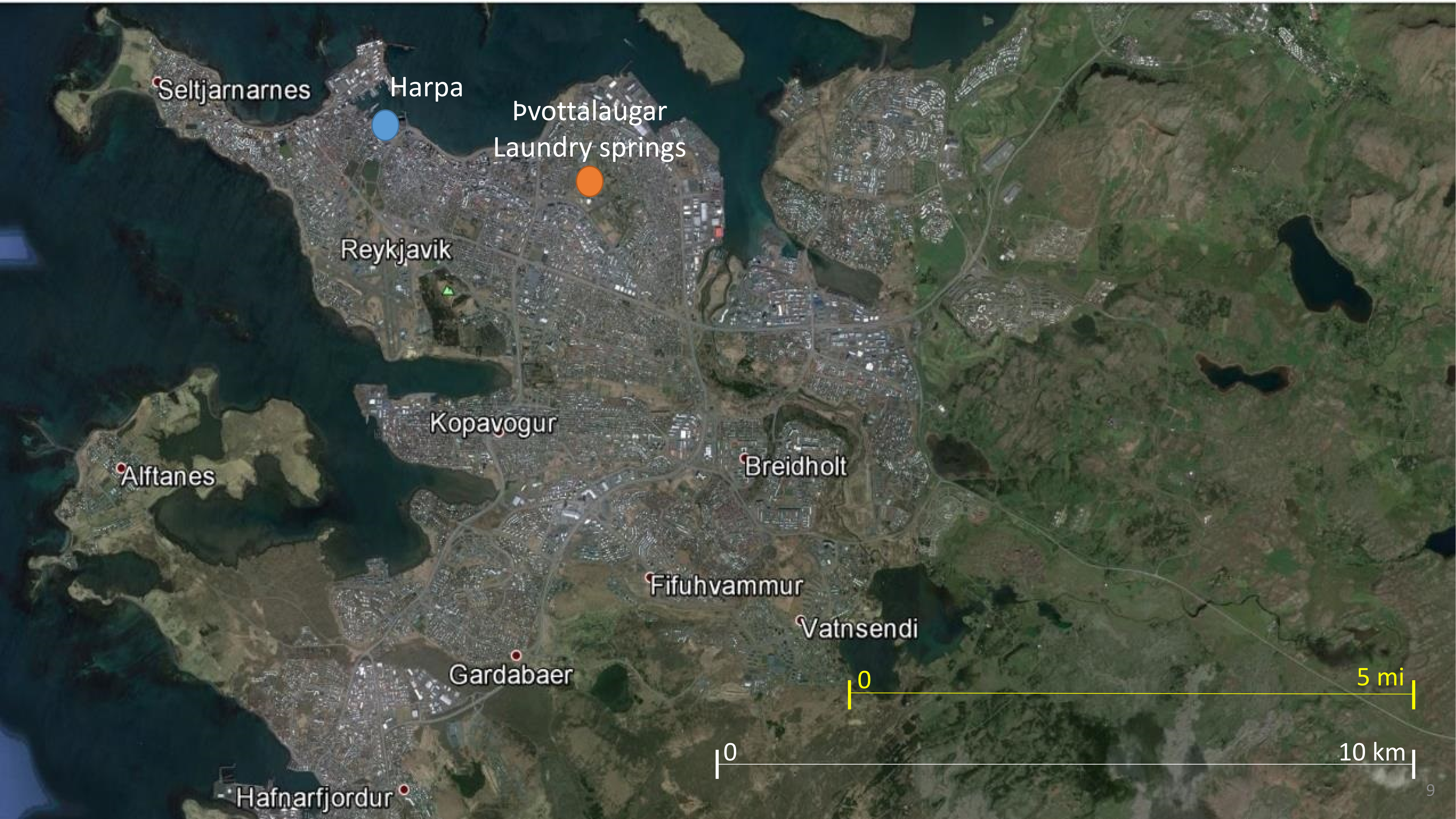
Geothermal District Heating in Iceland

Over 90% of all homes heated with geothermal



Geothermal District Heating in Iceland 2015
Installed power 2 100 MW
Energy 26 700 TJ/y
Capacity factor 0.41

Þvottalaugar - Laundry springs in Reykjavík

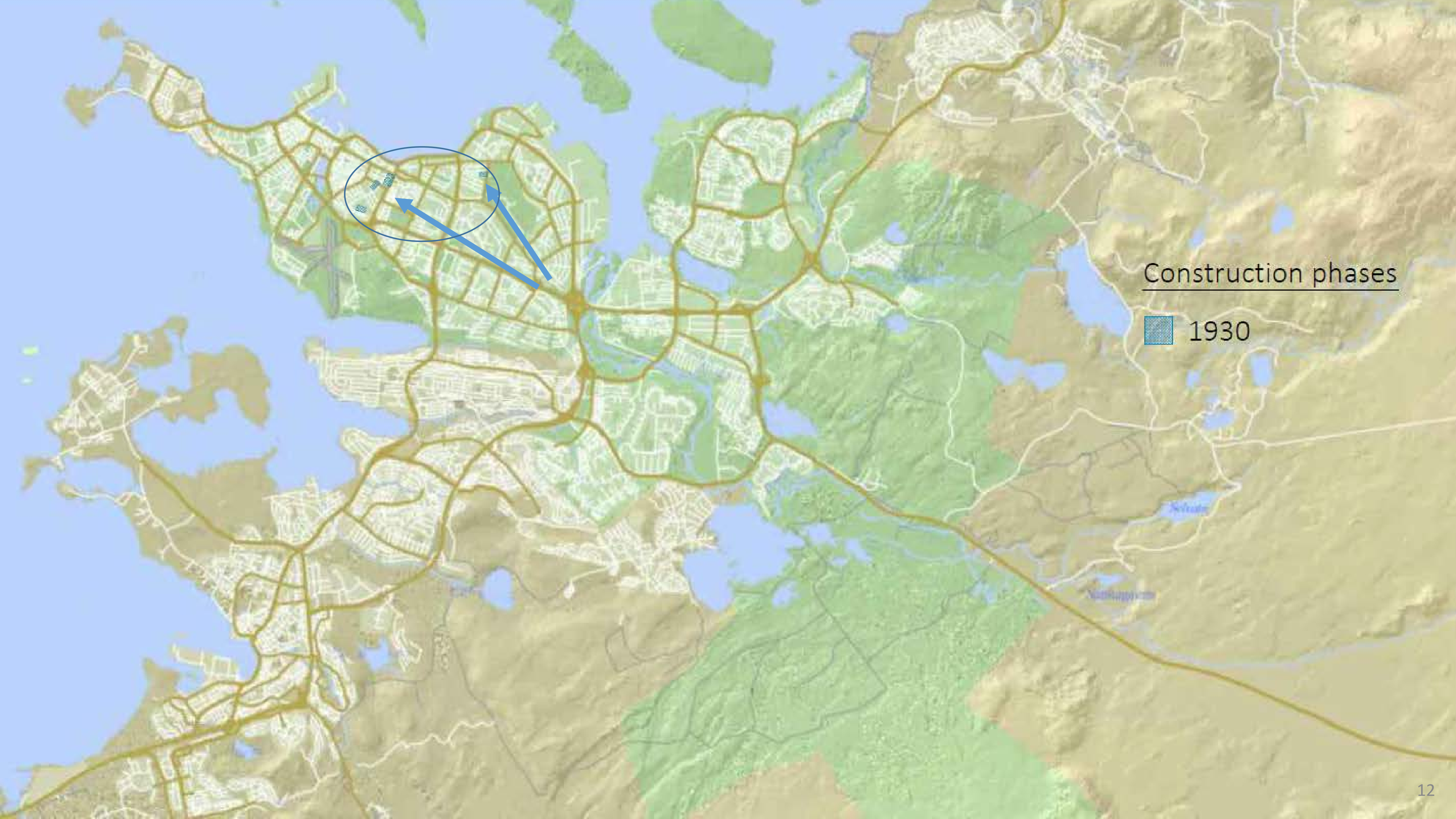

Seltjarnarnes
Harpa
Þvottalaugar
Laundry springs
Reykjavik
Kopavogur
Alftanes
Breidholt
Fifuhvammur
Vatnsendi
Gardabaer
Hafnarfjordur
0
5 mi
0
10 km

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, Austurbæjarskóli, 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

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 – Hellisheiði CHP power plant taken into service (Hellisheiði piping main)
- 2016 - Reykjavík and all suburbs heated, serving 200.000 people


Construction phases
1930

Austurbæjarskóli, connected 1930

Morgunblaðið

Kjósið hitaveituna í dag — C-listann

Reykurinn yfir bænum, sem hitaveitan útrýmir!

Hreint loft yfir Reykjavík, þegar hitaveitan er komin! Sólar nýtur til fulls!

Reykvíkingar! Tryggið yður hitaveituna með því að kjósa C-listann

Vote for the district heating today!

Announcement regarding house heating systems

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

Hitaveita Reykjavíkur.

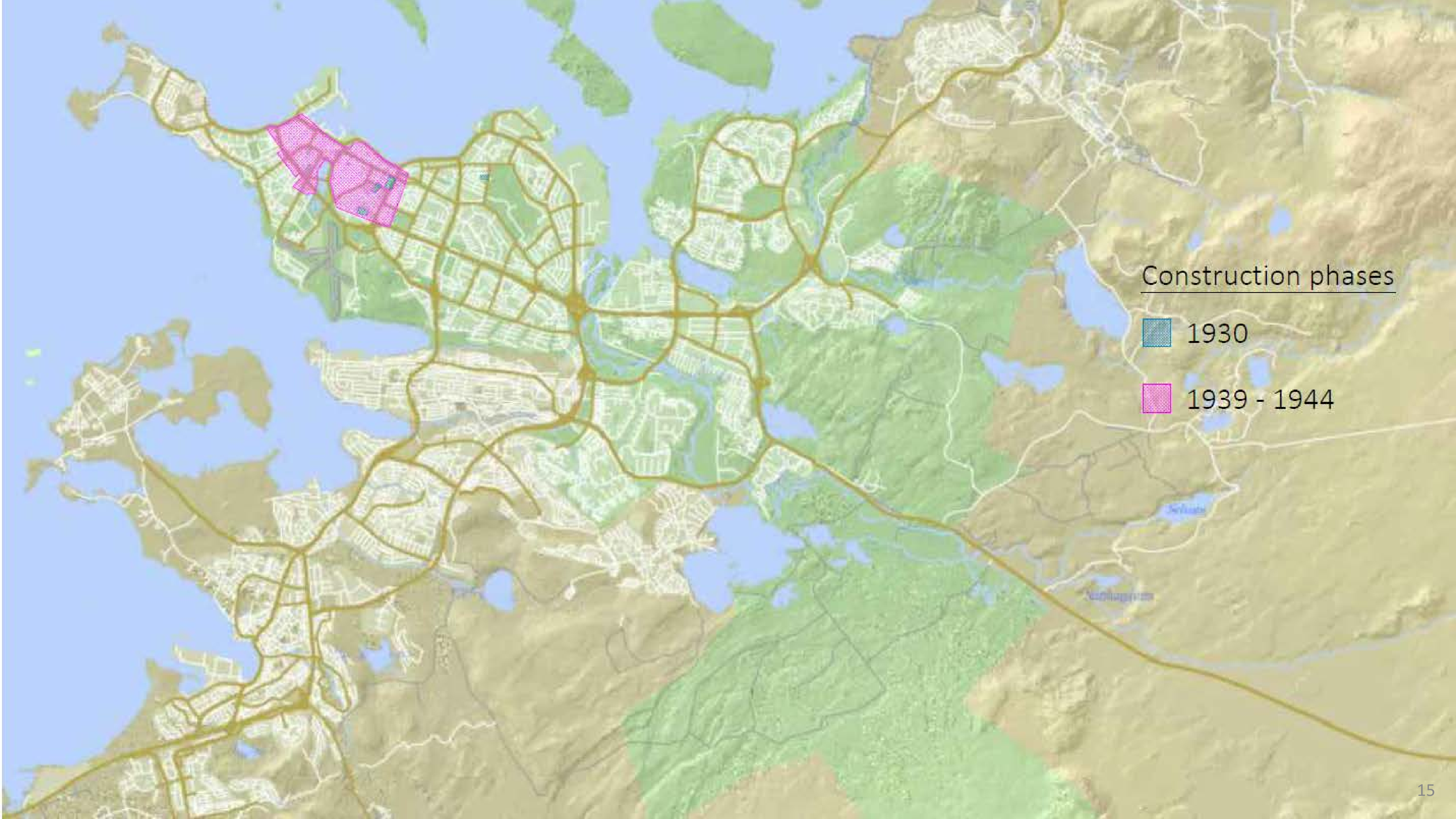
Auglýsing viðvíkjandi hitalögnum

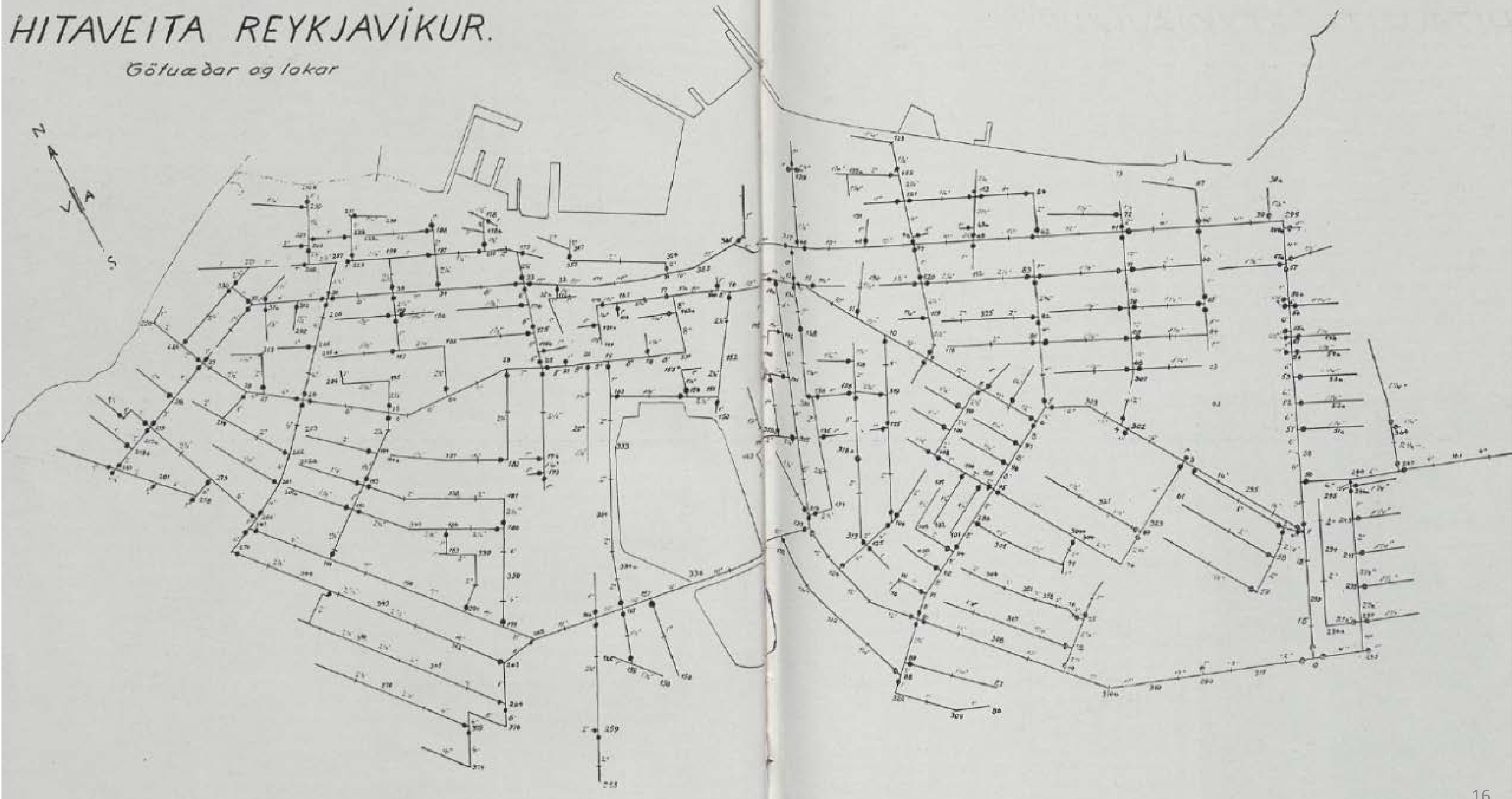
Vegna væntanlegrar hitaveitu er þeim, er byggja ný hús eða breyta gömlum húsum, ráðlagt að haga hitalögnunum í húsunum þannig, að fult tillit sje tekið til hinnar nýju hitaveitu, er hitalagnir eru ákveðnar.

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

Bæjarverkfræðingur.

VERKÍS


Construction phases
1930
1939 - 1944

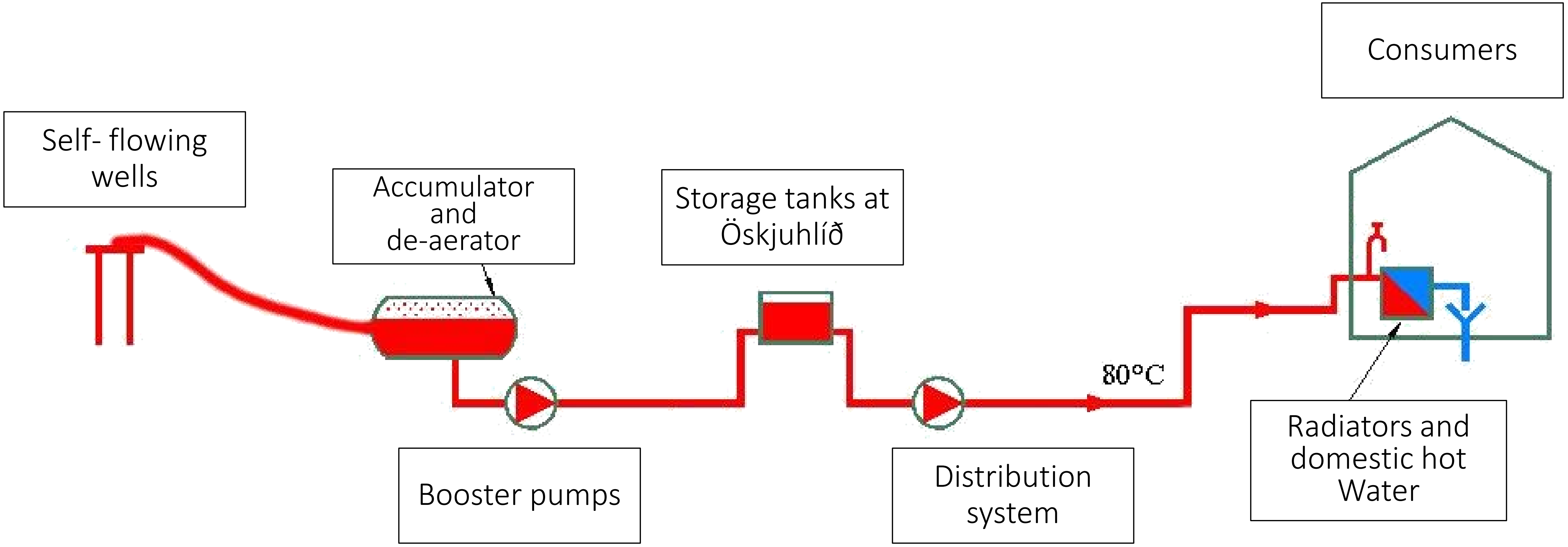

HITAVEITA REYKJAVÍKUR.
Götuæðar og lokar
N
S


The first Reykir piping main
1943. 14 km, 2 x 14 in seamless
steel pipes from USA

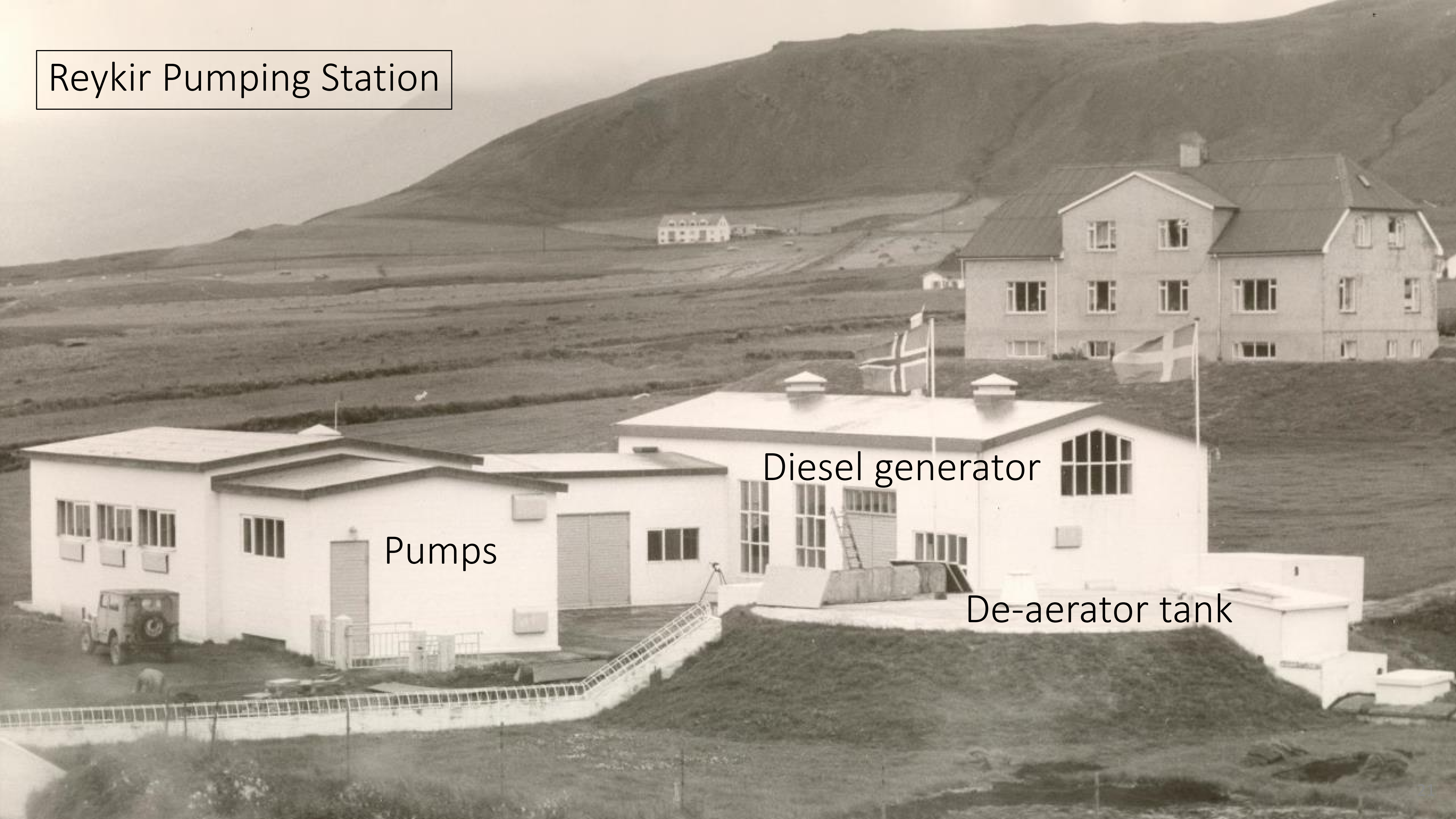
Insulation with Icelandic turf

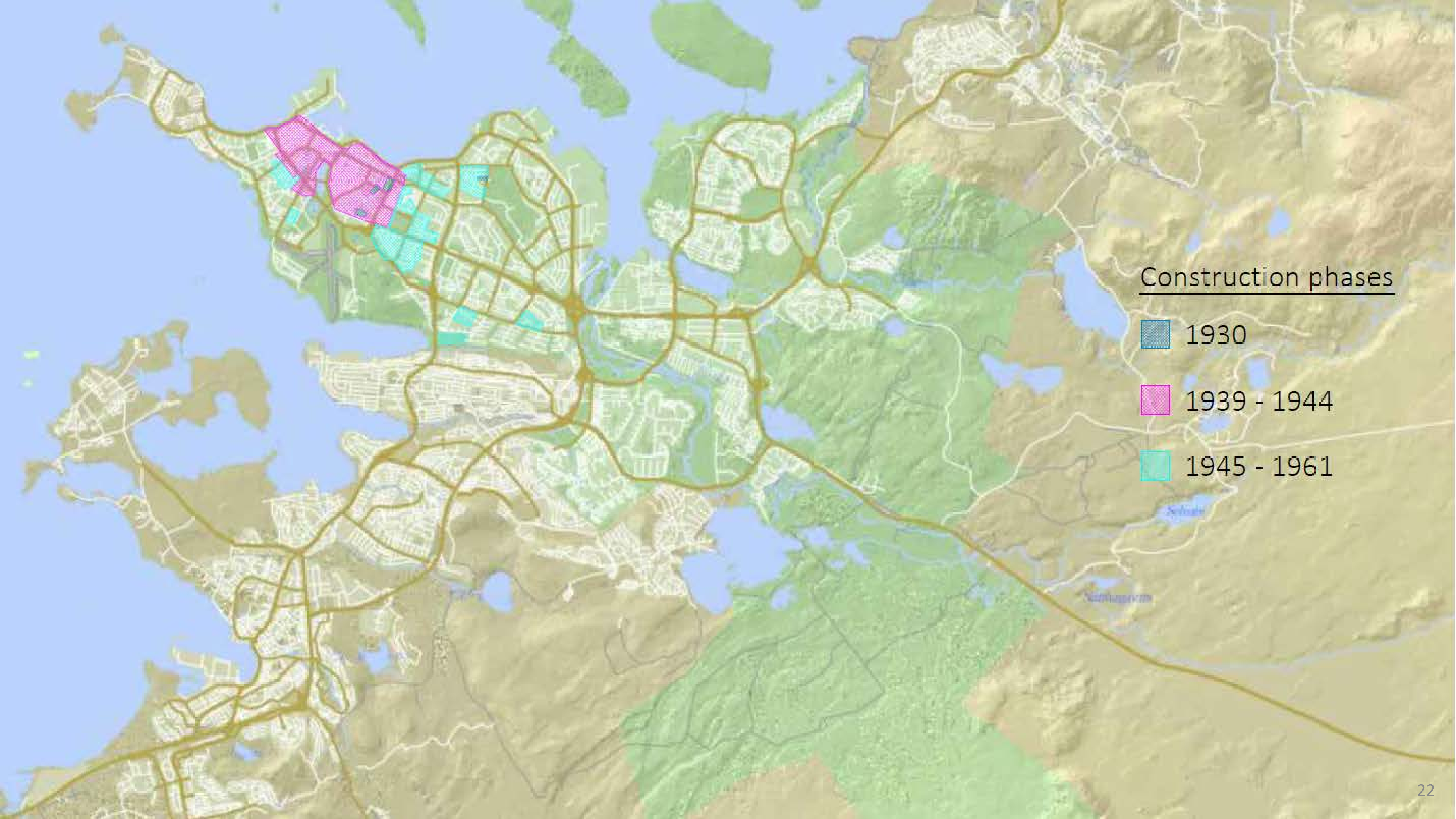
Concrete duct and cover

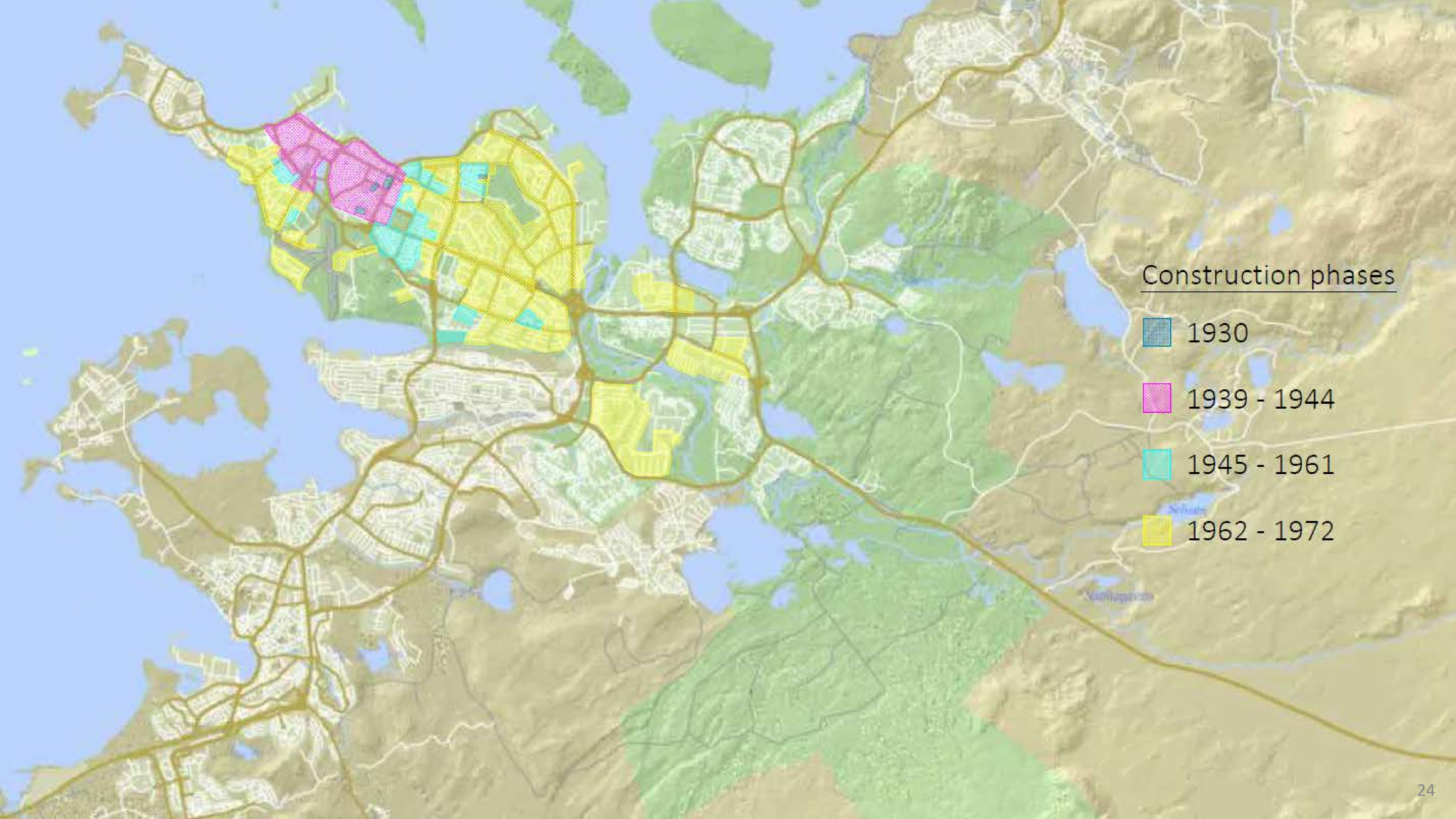
Very simple system



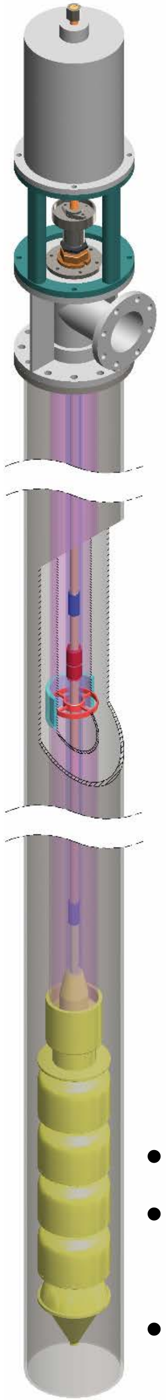
Reykir Pumping Station

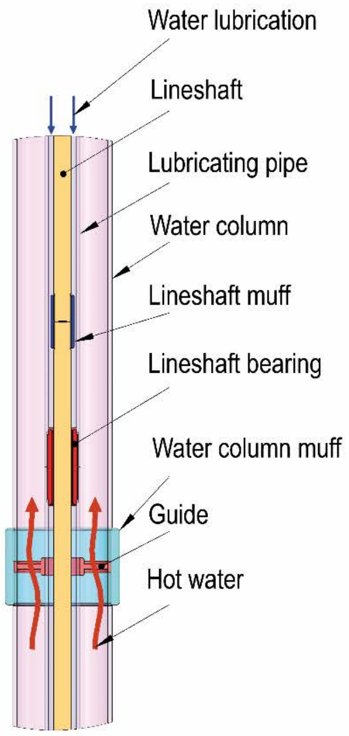



Construction phases
1930
1939 - 1944
1945 - 1961

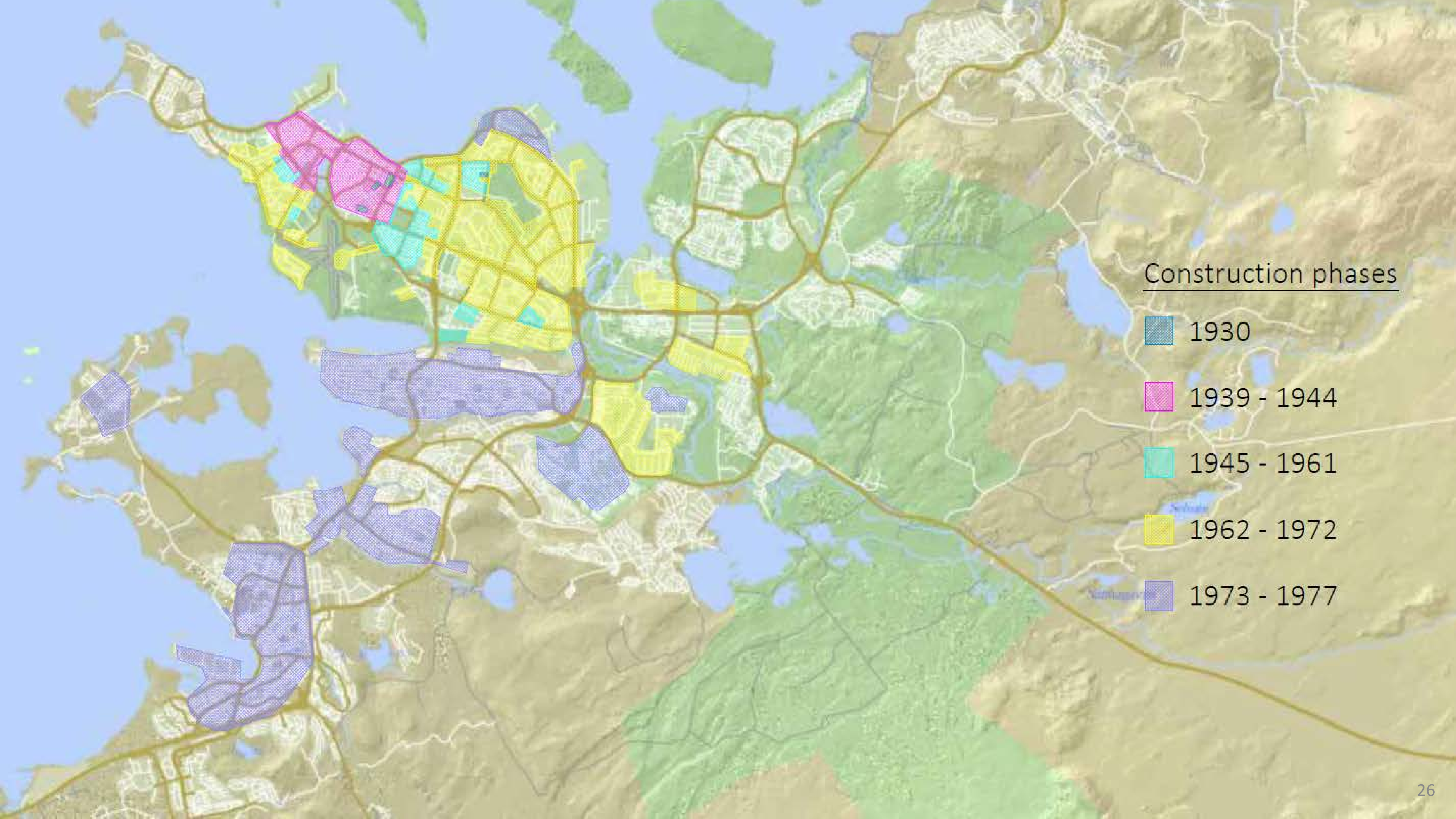

Construction phases
1930
1939 - 1944
1945 - 1961
1962 - 1972

Icelandic geothermal well pump



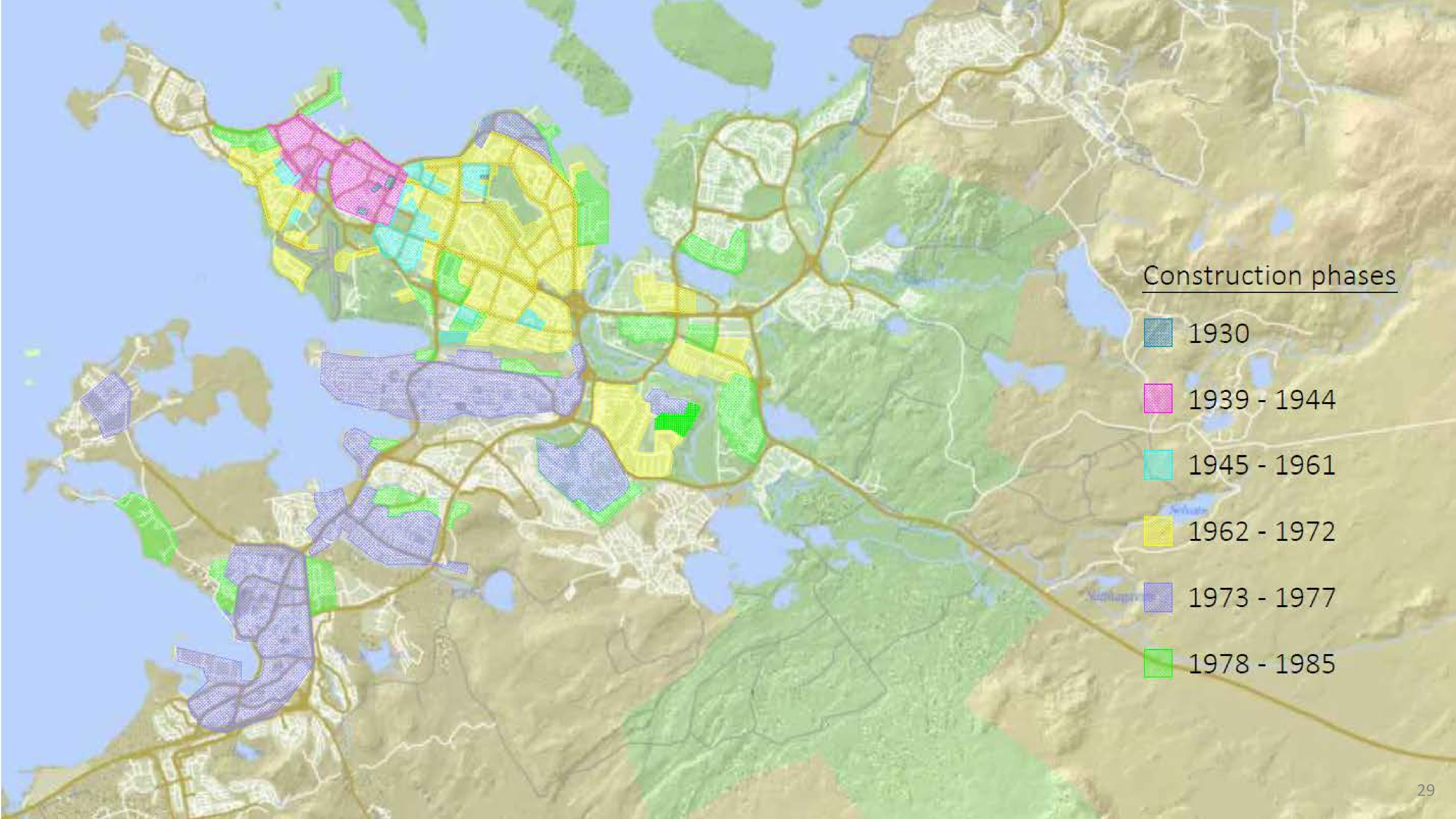


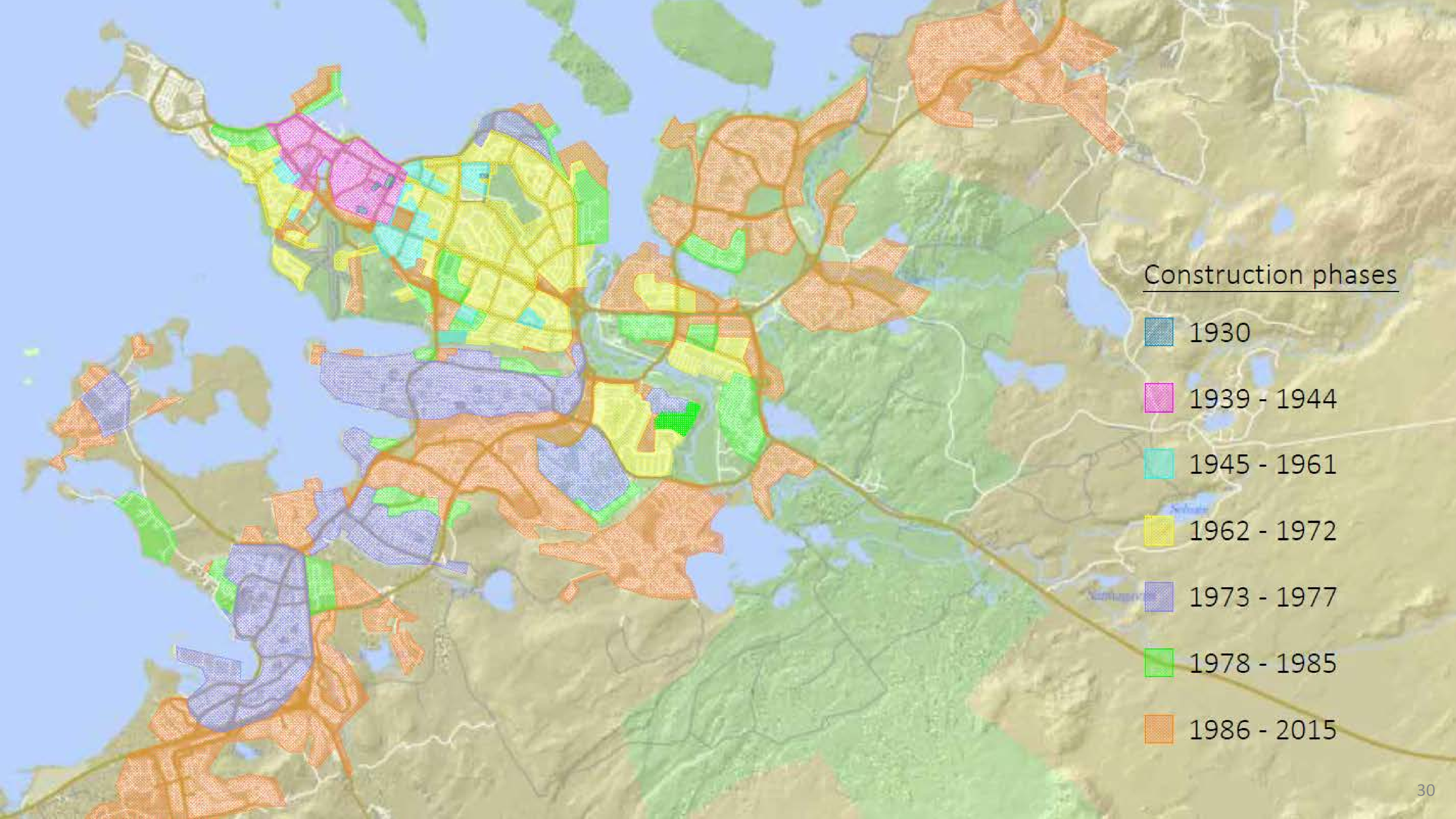
- Enclosed line shaft
- Water lubricated with filtered water
- Teflon bearings!!


Construction phases
1930
1939 - 1944
1945 - 1961
1962 - 1972
1973 - 1977

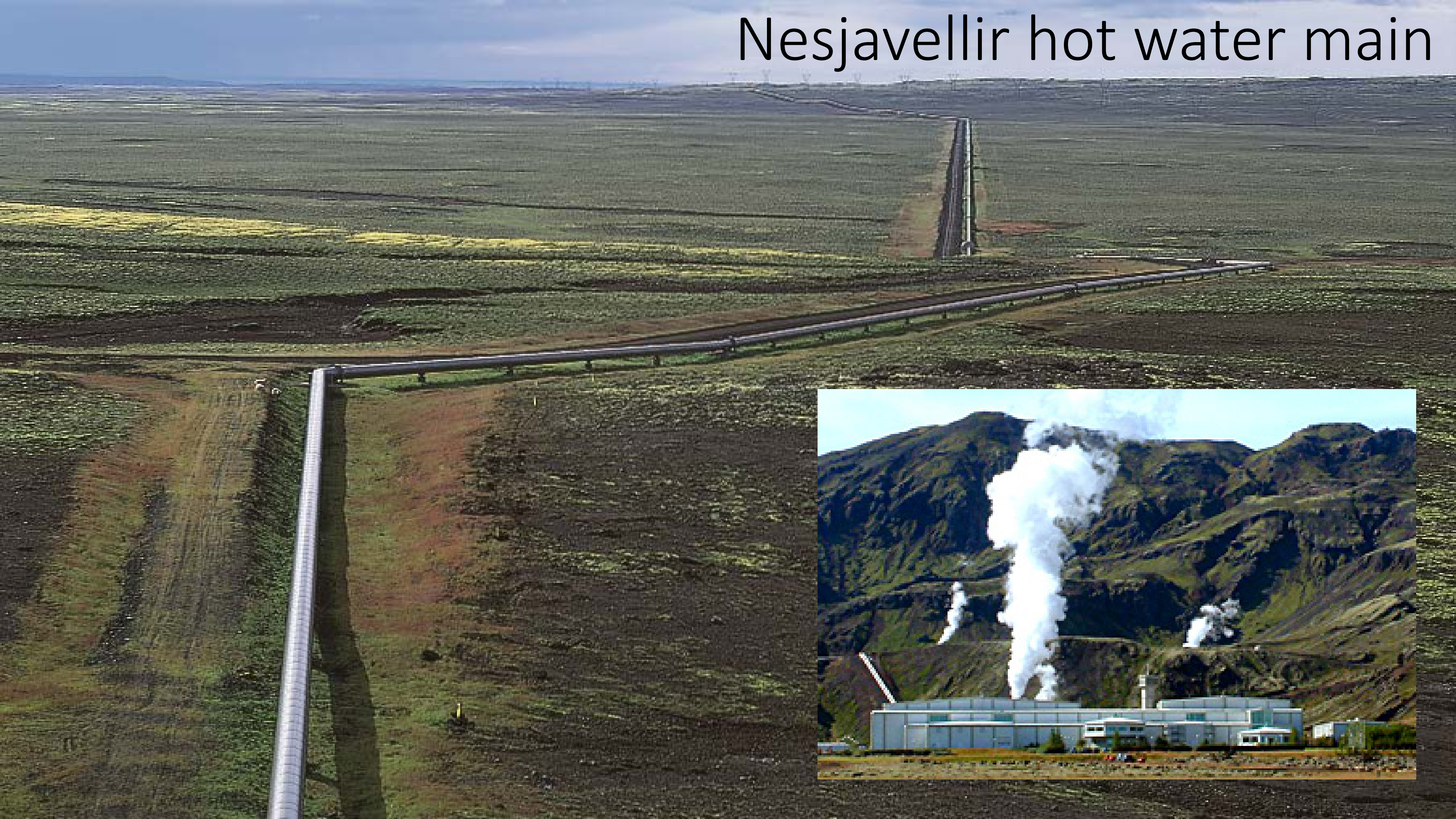
Garðabær suburb, 1973

Garðabær suburb, 2015


Construction phases
1930
1939 - 1944
1945 - 1961
1962 - 1972
1973 - 1977
1978 - 1985


Construction phases
1930
1939 - 1944
1945 - 1961
1962 - 1972
1973 - 1977
1978 - 1985
1986 - 2015

Nesjavellir hot water main



Reykjavík geothermal fields, 1000 MW

- Laugarnes
  - 10 wells, 340 l/s, 125 – 130°C, 125 MWt
- Ellidaar
  - 8 wells, 260 l/s, 85 – 95°C, 50 MWt
- Reykir – Reykjahlid
  - 34 wells, 1980 l/s, 85 – 100°C, 375 MWt
- Nesjavellir – CHP
  - Heated and de-aerated cold water, 1680 l/s, 83°C, 300 MWt
- Hellisheiði – CHP
  - Heated and de-aerated cold water, 800 l/s, 85°C, 150 MWt

Seltjarnarnes
Laugarnes
Reykir & Reykjahlíð
Reykjavik
Ellidaar
Nesjavellir
25 km
Kopavogur
Alftanes
Breidholt
Hellisheidi
20 km
Fifuhvammur
Vatnsendi
Gardabaer
Reykajvík Energy
Geothermal Fields
Hafnarfjordur

Reykjavík geothermal systems

- High grade, high porosity „open“ hydrothermal reservoirs
- Relatively easy to harness
- „High quality“ low temperature (80-130°C) geothermal water, used directly on district heating systems
- No re-injection needed as long as inflow/outflow is in balance
- Key factors of why geothermal heating in Reykjavik is inexpensive!

Benefits of District Heating

- District heating is comfortable and effortless
- No need for individuals to purchase and handle fuels
- Limited servicing of equipment's for individuals
- Steady temperature at all times
- Pricing stable
- Reduces consumption, despite some heat losses in the network
- With access to geothermal heat as a base load, a win – win solution

Geothermal District Heating in China

Iceland – China cooperation

3 Provinces – Geothermal utilization

Development 2004 - 2015

Project management	Feasibility study	Conceptual Design	Construction supervision

Key numbers, Heated floor space – Installed power – Heat from geothermal

- Heated indoor area 2008: ~ 1 M m^2 50 MW – 11 GWh/y -
- Heated indoor area 2016: ~ 15 M m^2 600 MW – 1200 GWh/y
- Future plans 2020: ~ **80 M m^2 3200 MW – 5800 GWh/y – 21000 TJ/y**
- Environmental impact 2020
  - Annual coal savings ~ 1,0 Million Tons
  - CO_2 ~ 2,6 Million tons (500.000 cars)

Heat centrals and wells 2015:

- Total heat centrals : ~ 150
- Production wells: ~ 170
- Reinjection wells: ~ 80

New houses with floor heating systems







ol

District cooling

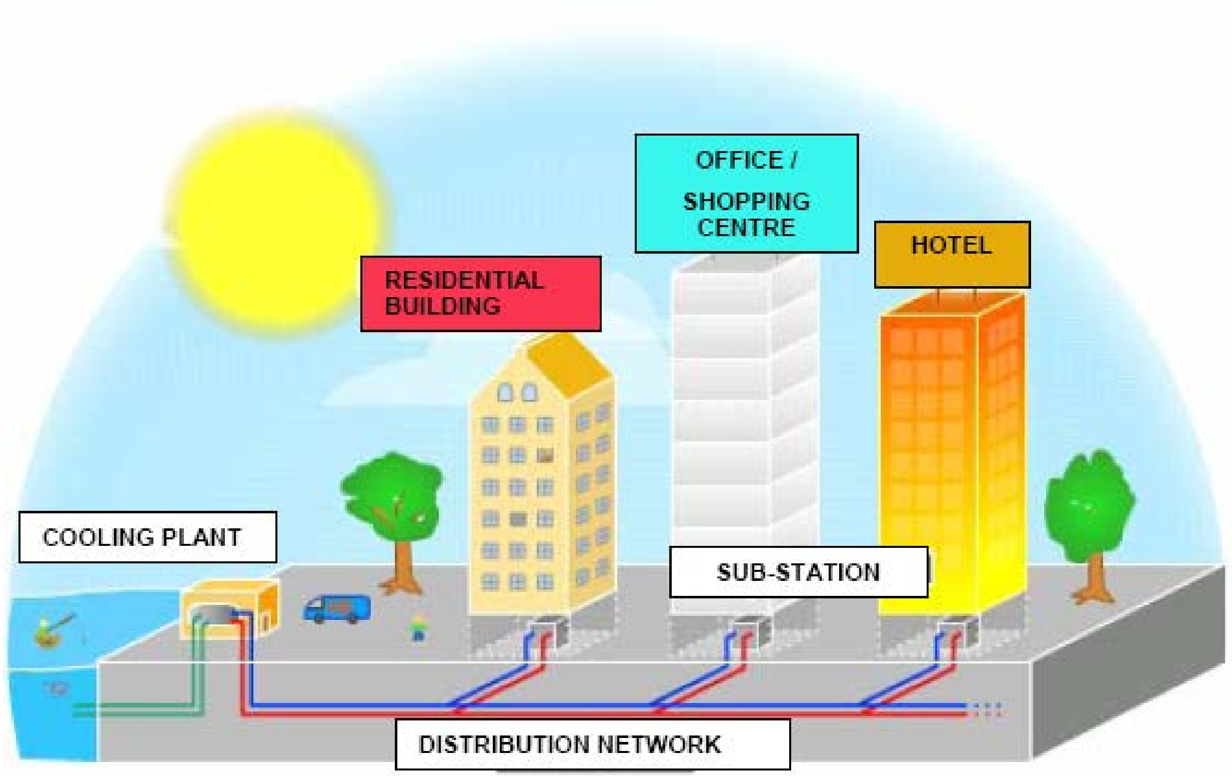
... with geothermal energy

District cooling

Distribution of **chilled water**, often around **6°C** from a **central cooling plant, equipped with heat pumps** to multiple buildings through a **network of pipes** for use in **space cooling** equipment.

The heated water is **piped back** to the cooling plant at **16°C**.

Heat discharge to a cold sink, sea/lake – or to the ambient



Compressor cooling Cycle

Medium capital cost

High operating cost

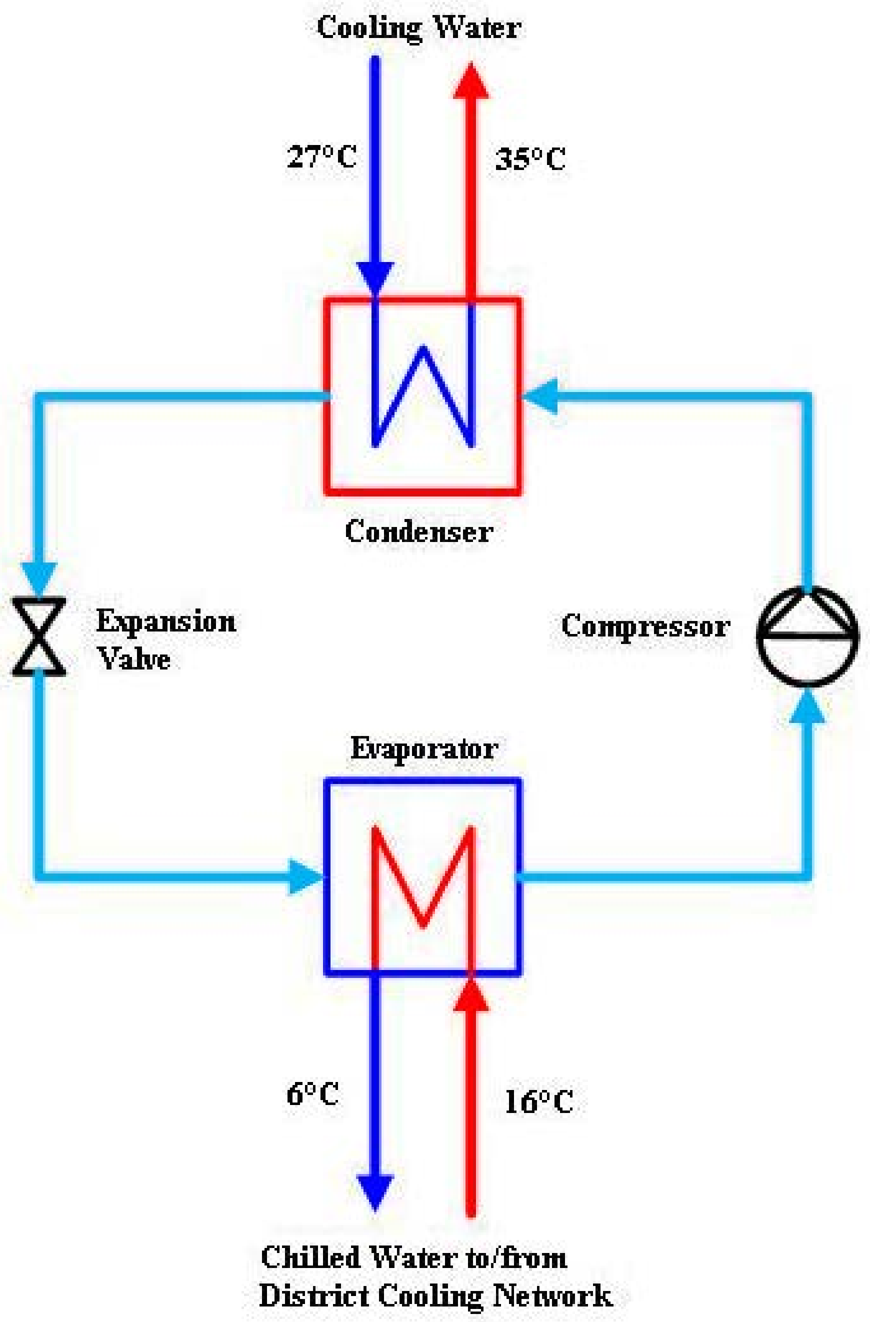
High maintenance cost

Lifetime ~10 years

Uses electricity and cooling water

Expected/Typical values

- Electricity
- Cooling Water: 27/35 °C
- Chilled Water: 16/6 °C
- Coefficient of Performance: 3 - 5



Absorption cooling cycle

High capital cost

- ~1,5 – 2 x compressor driven chiller

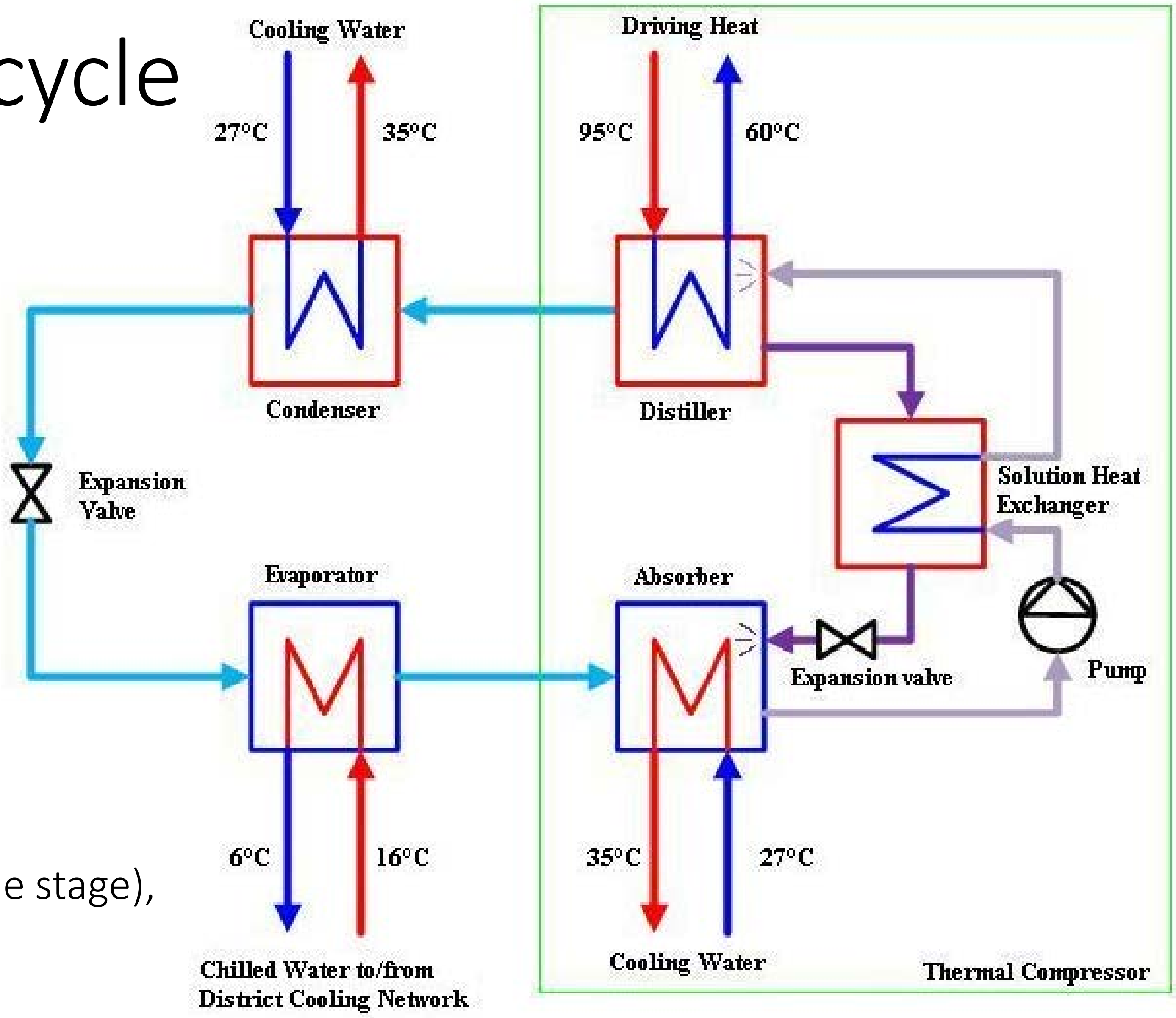
Low operating cost (geothermal)

Low maintenance cost

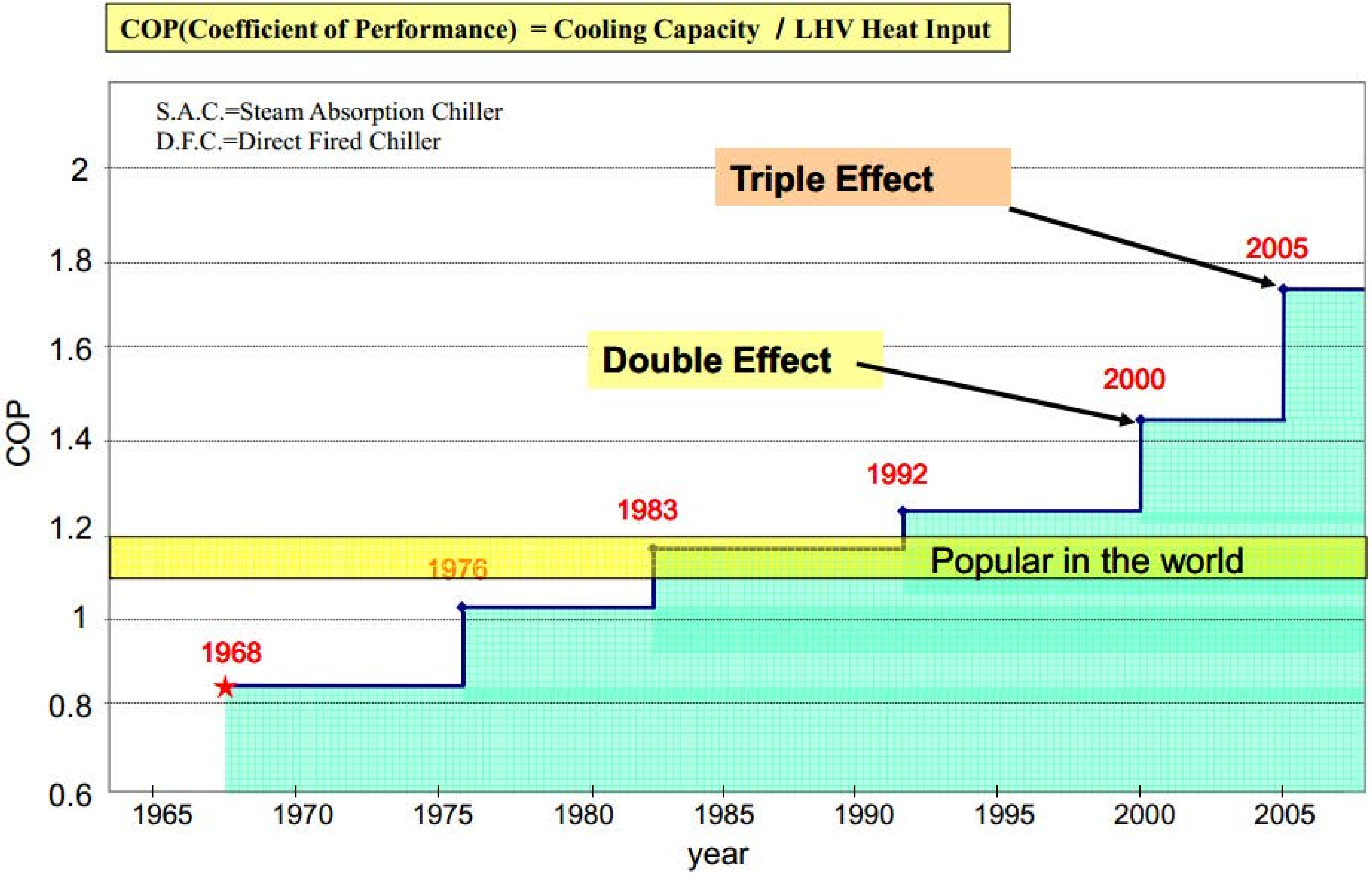
Lifetime 20+ years

Expected/Typical values

- Driving Heat: 95/60 °C
- Cooling Water: 27/35 °C
- Chilled Water: 16/6 °C
- Coefficient of Performance: 0,7 (single stage), (1,0 double stage)

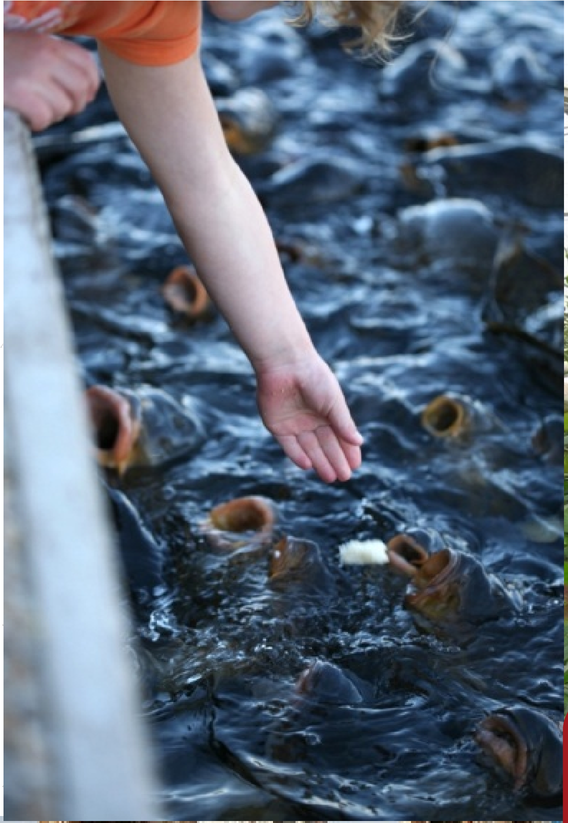


Continuous effort for Higher COP Hajime Ybase 2013

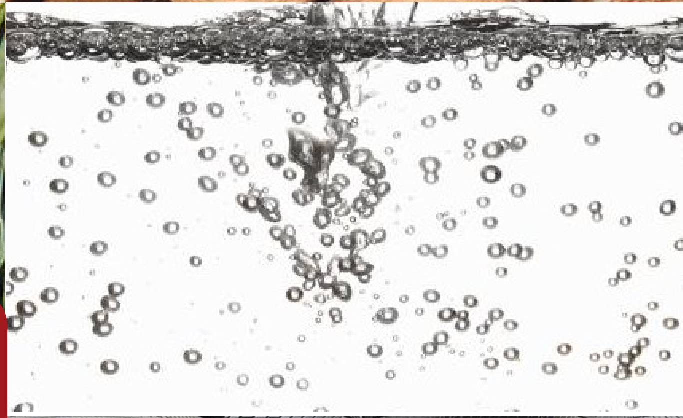


Other geothermal uses

Drying



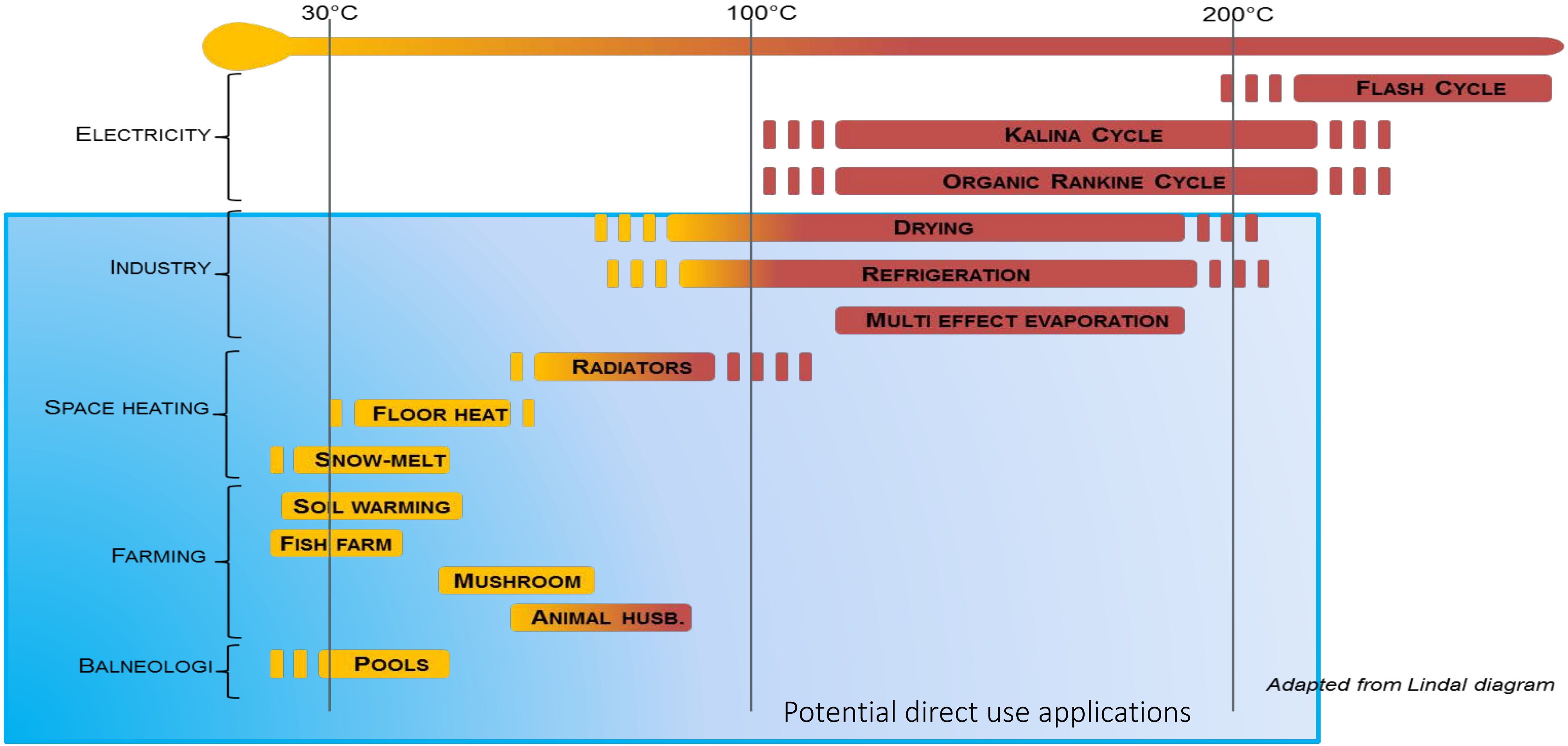


Diversity of uses



Geothermal utilization



Food conservation – fish drying

Source: http://www.flickr.com/photos/riggott/

Source: http://www.haustak.is/

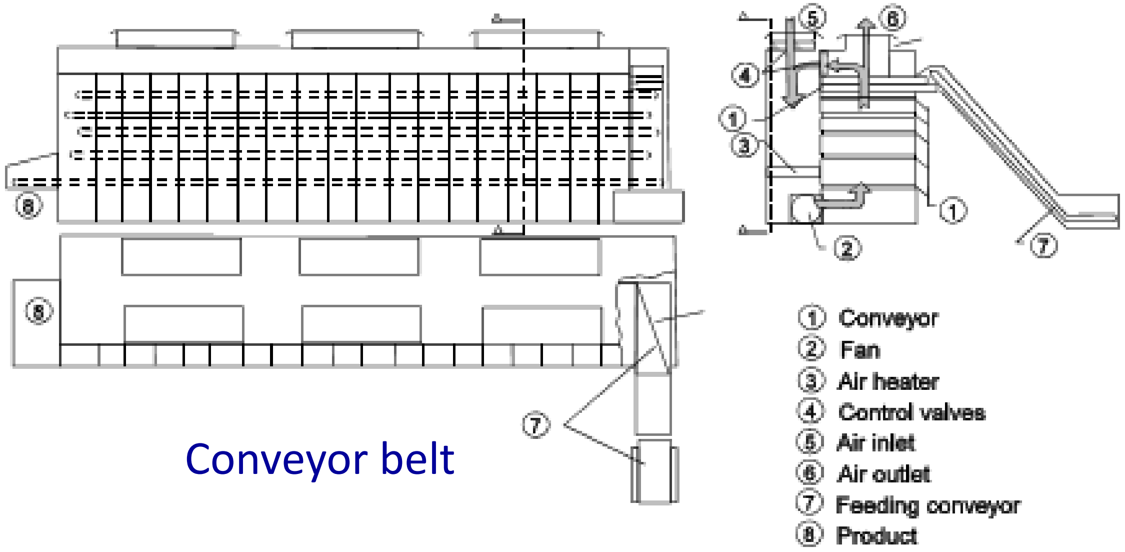
Haustak – fish drying in Reykjanes

- Geothermal fluid: 80-40°C / Drying process in 2 steps:

1. Rack cabinet of the conveyor belt :24–40 h
    - Air temperature: ~18-25°C
    - Relative humidity 20-50%
    - Air velocity 3 m/s.
    - Water content from 82% down to 55% in the process

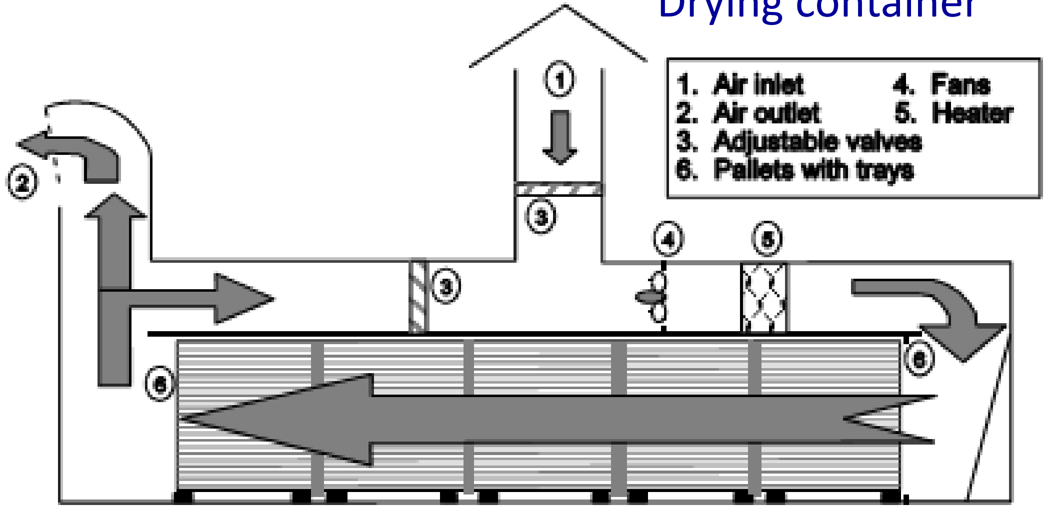
2. Drying container: 72 h
    - Air temperature: ~ 22-26°C
    - Relative humidity 20-50%
    - Air velocity 0.5–1 m/s
    - Water content after drying is lower than 15%

Drying process - equipment



Conveyor belt

Drying container



Source: Sigurjón Árason *The drying of fish and utilization of geothermal energy – The Icelandic expreience* GHS bulletin December 2003.


Do what you can with what you have where you are.
(Theodore Roosevelt)

Thank you