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Government of Ireland

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann

Ireland's Geothermal Potential

Dr Sarah Blake

Groundwater & Geothermal Unit

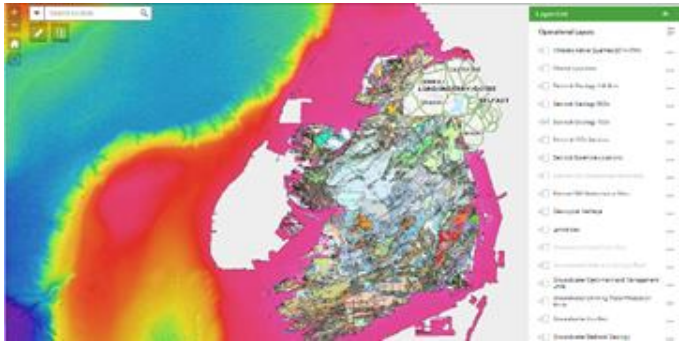
Heat Pumps in Agriculture, Feb 22nd 2022

About us

- Geological Survey Ireland is Ireland's public earth science knowledge centre and is a division of the Department of the Environment, Climate and Communications.

Geological Survey
Suirbhéireacht Gheolaíochta
Ireland | Éireann
175 years | bliain 1845-2020

- We provide free, open and accurate data and maps on Ireland's subsurface.

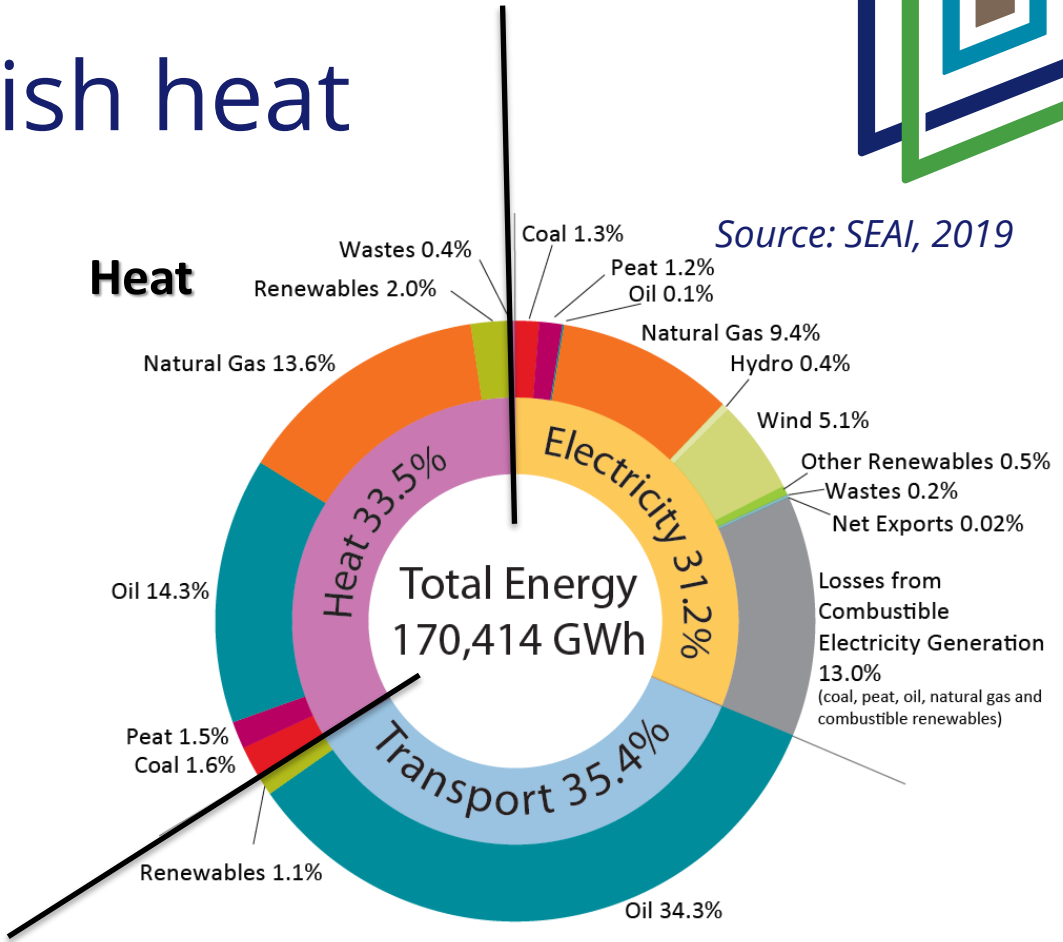


- We deal with a diverse array of topics including bedrock, groundwater, seabed mapping, natural disasters, and public health risks.

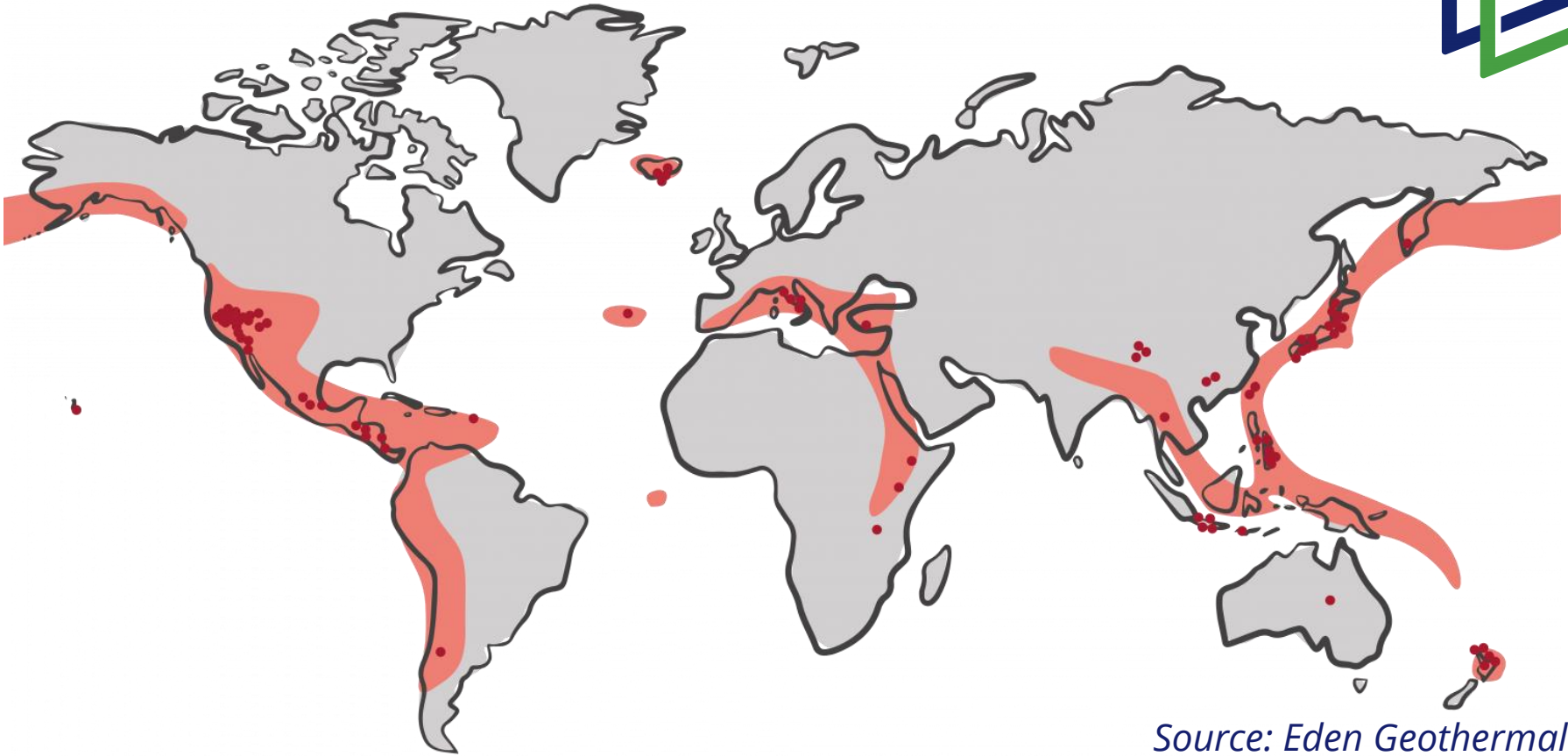
www.gsi.ie

Decarbonising Irish heat

- The heat sector accounts for approximately one-third of our total energy expenditure
- Solution: **district heating** where the heat demand/population density is high enough, and by individual **heat pumps** in other (rural) settings (Connolly et al., 2016)



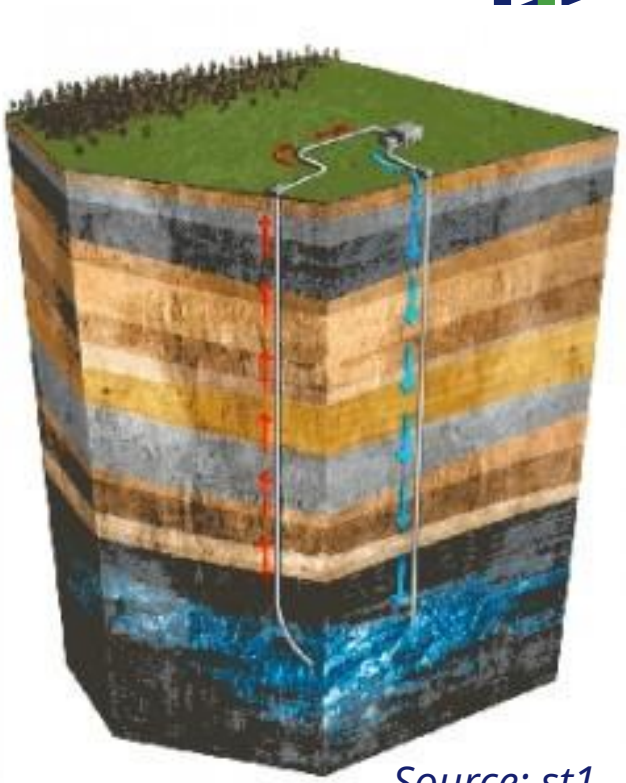
The heat beneath our feet



Source: Eden Geothermal

The heat beneath our feet

Source: Getty images



Source: st1

OVERVIEW OF SHALLOW GEOTHERMAL ENERGY SYSTEMS IN AREAS

SGE is ubiquitous, available any time, weather independent, efficient and renewable

From 0 to 200 m under the surface (exceptionally up to 400 m) **SHALLOW**

Stored/exchanged in/with the subsurface **GEOTHERMAL**

Heat extracted/injected from/to the subsurface with (or without) HEAT PUMPS **ENERGY**

The Sun is the true main source of SGE

1. IAE, "Energy Technology Perspectives" (2016)
2. PBL Netherlands Environmental Assessment Agency, "Facts and Figures on Cities and Urban Areas" (2016)
3. Nature Geoscience 5, 671-696 (2012)
4. BP, "Statistical Review of World Energy" (2019)
5. Turcotte D.L. & Schubert G., "Geodynamics" (2nd ed. 2002)

64 % of **World primary energy** is consumed in urban areas (1)

72% of **EU population** lives in urban areas (2)

70 % of **World CO_2 emissions** are concentrated in cities (1)

17% of **EU land** is considered as "**urban**" (2)

CTES, BTES, ATES
Excess heat from solar collectors (>30 °C) to ground storage

GSHP
Ground Source Heat Pump

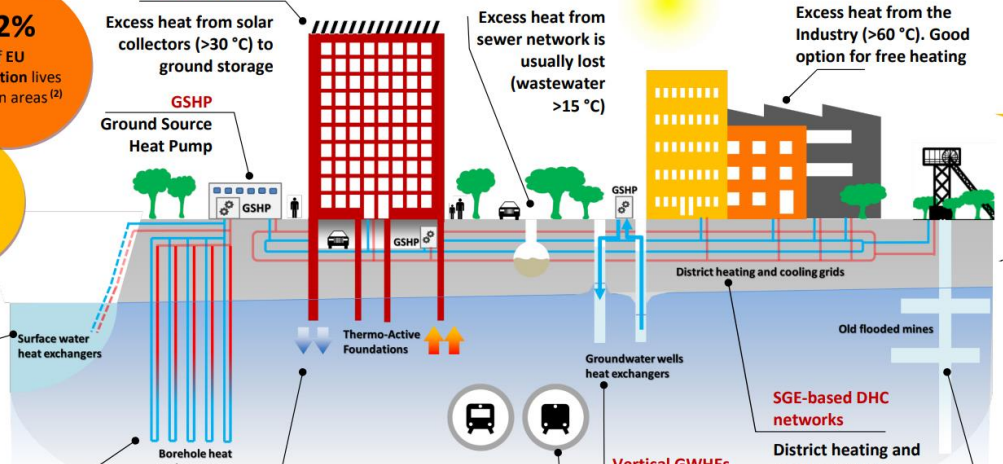
Excess heat from sewer network is usually lost (wastewater >15 °C)

Excess heat from the Industry (>60 °C). Good option for free heating

Average solar radiation absorbed at the Earth's surface (3)
165 W/m²

World human average power consumption (4)
→ 34 mW/m²

Average power reaching the Earth crust from its internal heat budget (5)
40 - 90 mW/m²
Average value in continental areas ~ 65 mW/m²

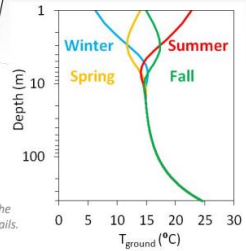


OL-SWHEs, CL-SWHEs
Large water bodies like rivers, lakes and the sea show a reduced yearly temperature variation compared to air. Good option for free cooling

Vertical BHEs, BTES
The geo-exchange within the ground using close loop systems (CL).

Almost constant temperature along the year (10 - 18 °C) below 10m depth to 100 - 200 m

TAFs
Heat exchanger can be embedded in deep foundations (>10 m)



T_{ground} is dominated by solar irradiation close to the surface. Afterwards, the geothermal gradient prevails.

Vertical GWHEs
The groundwater exchange abstracting and injecting groundwater from the aquifers

Excess heat from underground infrastructures causes cumulative ground warming and warm air at tunnels (>25 °C)

SGE-based DHC networks
District heating and cooling systems powered with SGE technologies or combined with other RES or waste heat sources

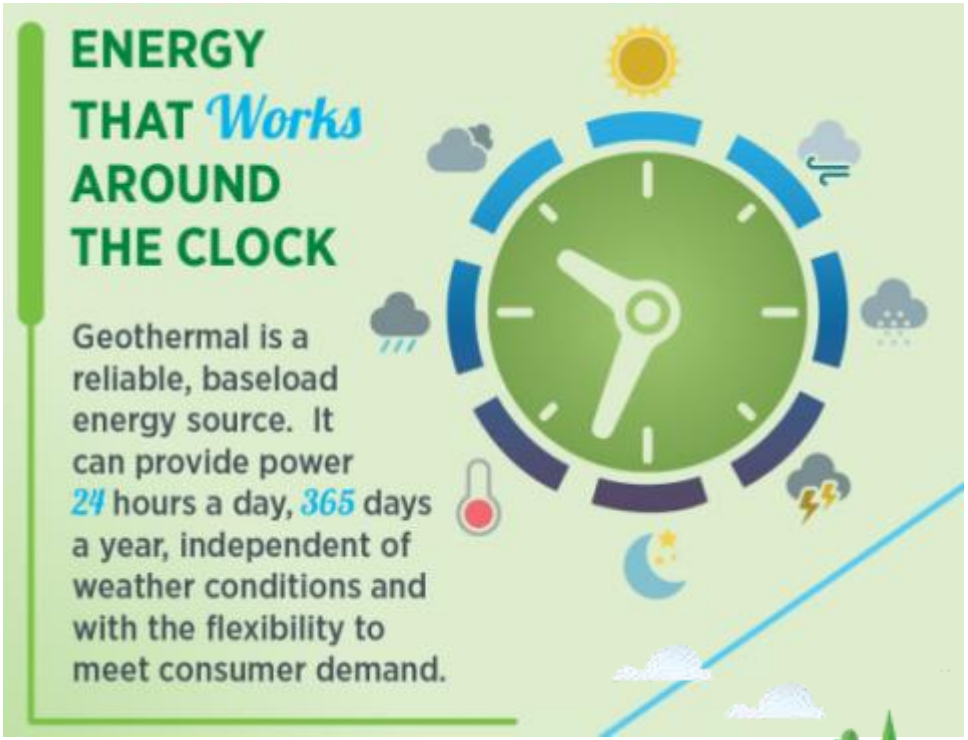
CTES, GWHEs
Abandoned and naturally flooded mines with groundwater

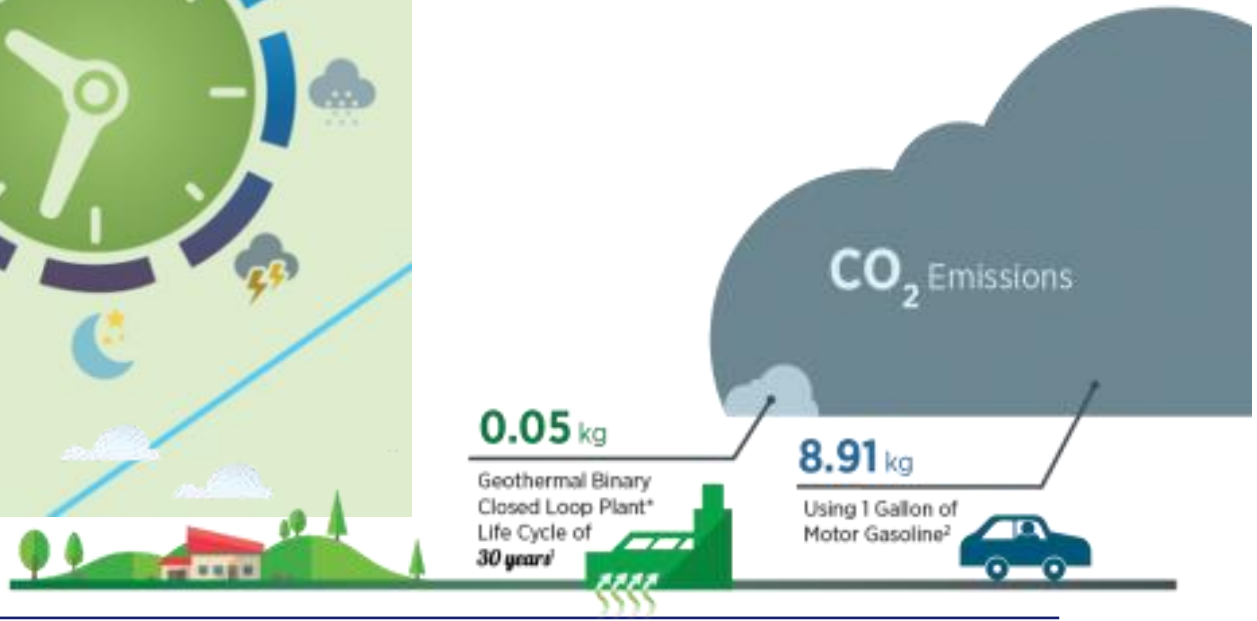
MUSE GeoERA
Managing Urban Shallow Geothermal Energy

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731166

OL and CL: open and closed-loop / SW and GW: surface- and groundwater / B: Borehole; C: Cavern; A: Aquifer / HE: heat exchanger; TES: thermal energy storage / TAF: Thermo-active foundation / DHC: District heating and cooling

The heat beneath our feet

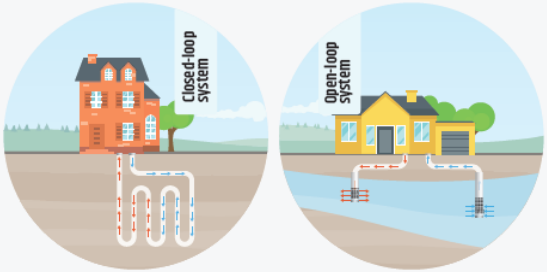




Source: USDoE

The heat beneath our feet

This renewable technology uses either open-loop (OL) or closed-loop (CL) systems to provide heating, cooling, domestic hot water or thermal energy storage.



Benefits....

Reliable
Shallow geothermal energy is stable and capable of providing heating and cooling 24/7 throughout the year. It does not depend on weather conditions like wind or daylight.

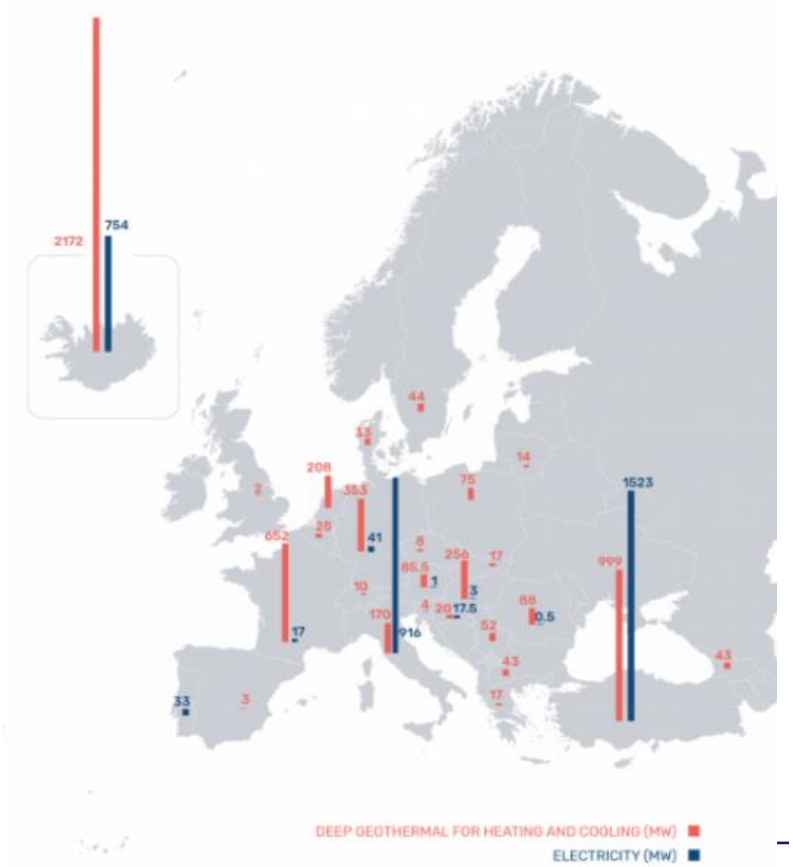
All-rounder
A given system is able to provide domestic hot water, space heating and cooling without additional investments. The ground serves as seasonal storage in a new generation of local heating and cooling grids. All systems are adaptable to different types of resources and demands.

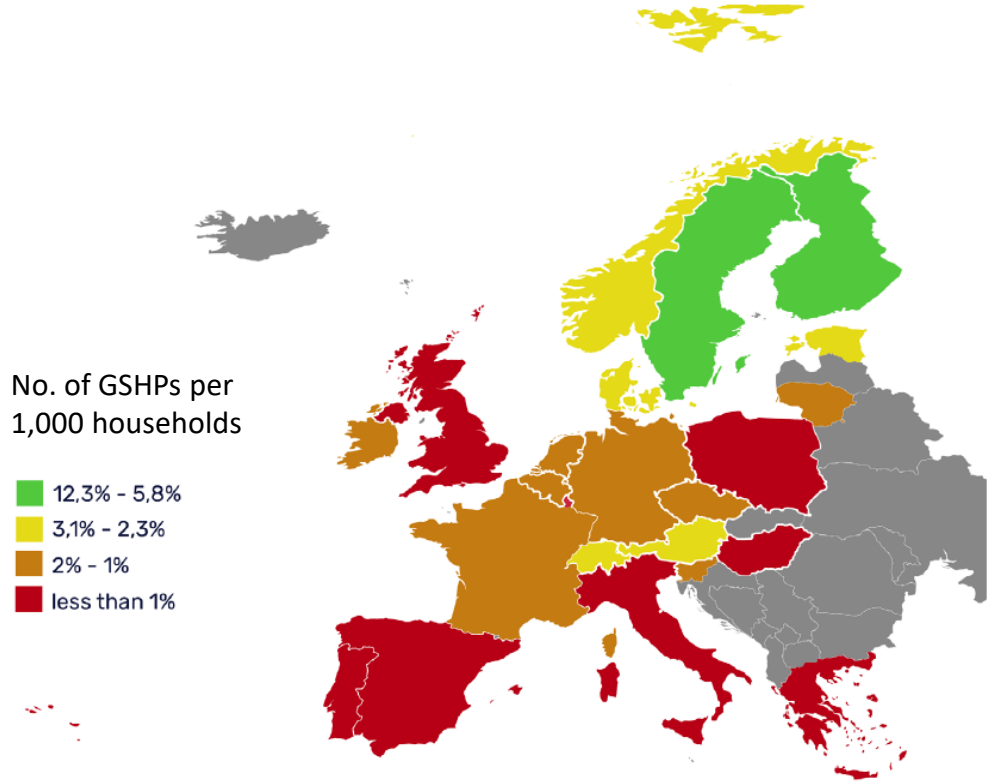
Green and clean
It reduces harmful emissions, such as smog and greenhouse gases. Combined with renewable electricity, the technology produces zero emissions. This supports climate and environmental policies.

Efficient
Shallow geothermal energy systems are a high performing and efficient technology with little land use. In combination with a heat pump, each kW of electricity consumed can produce at least 4 kW of space heating .

Source: GeoERA MUSE project

Irish geothermal sector





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EGEC, 2020

Irish geothermal resources

Irish geothermal resources

Svartsengi geothermal power station, Iceland

Irish geothermal resources

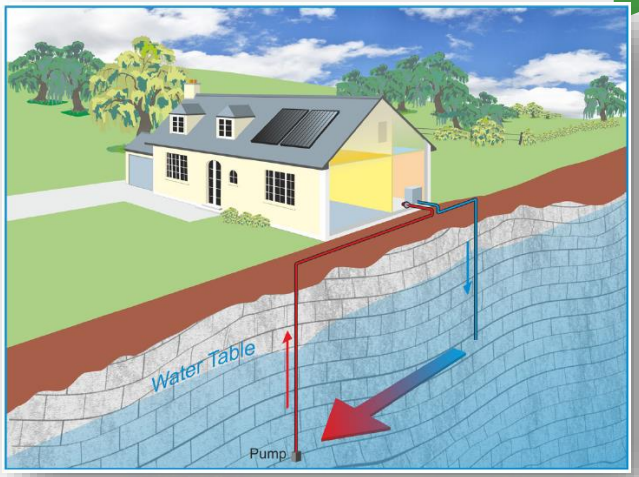
Svartsengi geothermal power station, Iceland

Villejuif geothermal heat plant in Paris, France

Irish geothermal resources

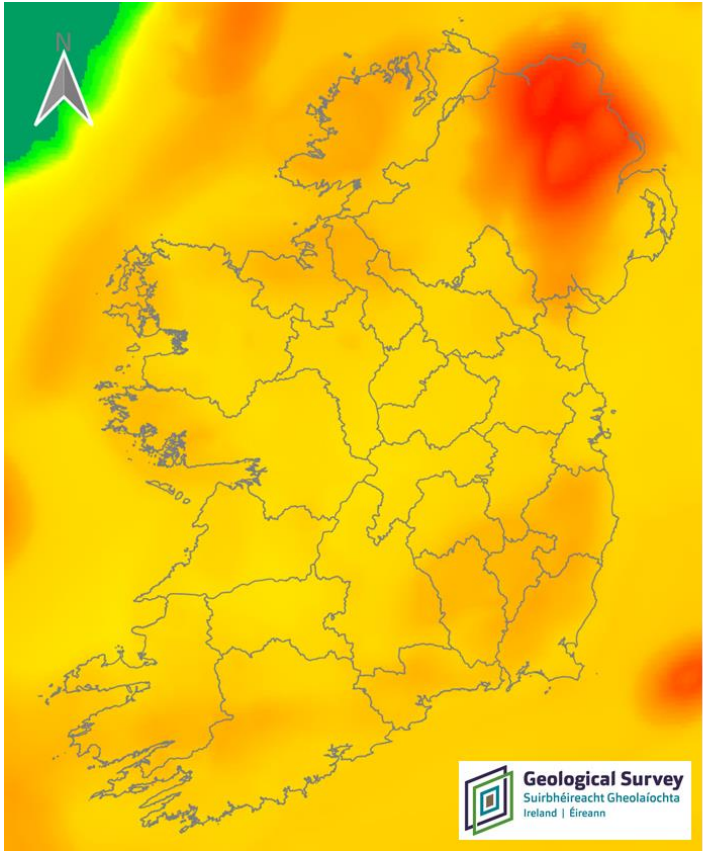
- **‘Shallow’** resources are relatively well characterized and accessible across the whole country (domestic and commercial heating)
- Used with a heat pump, some financial support available
- GSI existing products:
  - Geothermal Suitability maps
  - Homeowner’s Guide (2015)

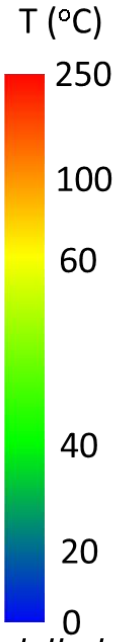
[Access GSI shallow geothermal products here]



Irish geothermal resources

- **Deeper** resources are not as well characterised
- Estimated crustal geothermal gradient 25 – 30 °C/km
- Low-enthalpy (low-temperature) geothermal setting

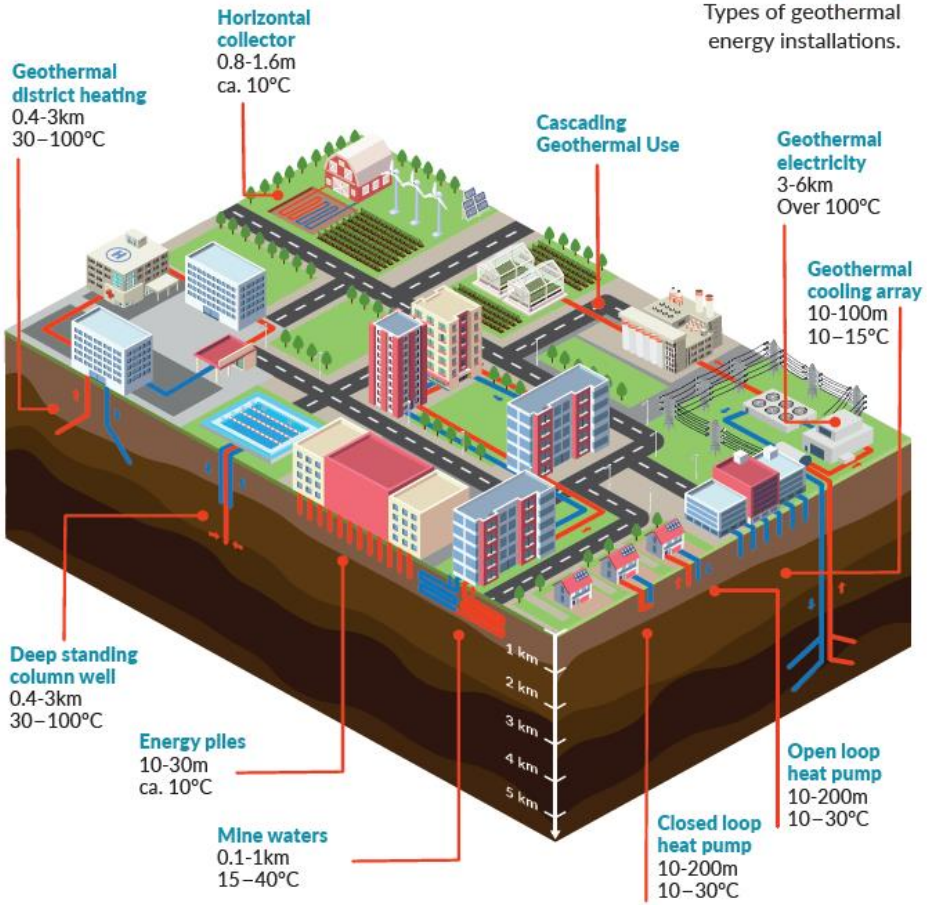


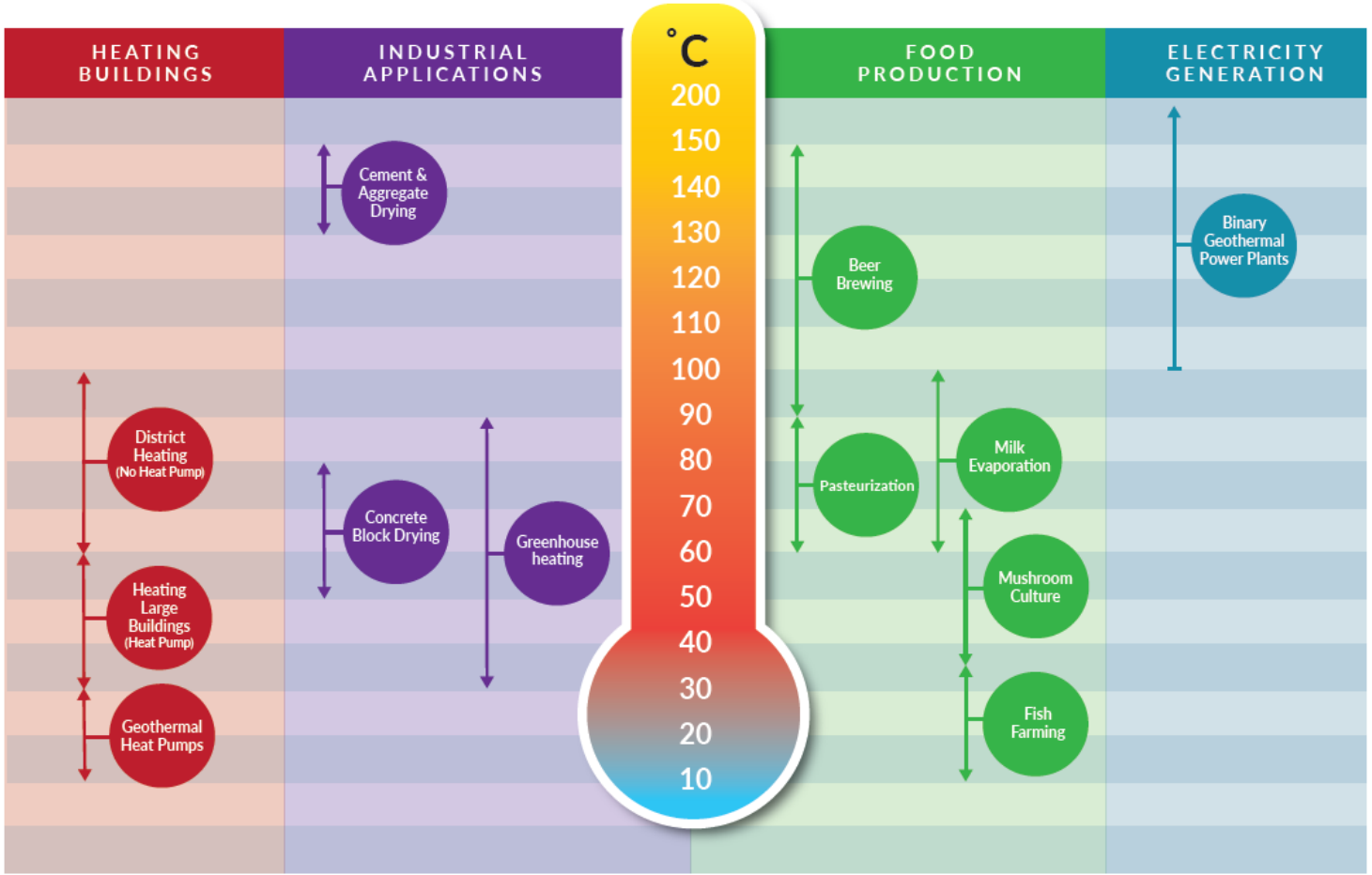


Modelled temperatures at 2.5 km depth. Data from Mather et al. (2019)

Using geothermal energy in Ireland

- Heating individual homes
- Heating large buildings
  - e.g., IKEA (1.5 MW_{th})
- Cooling buildings & industry
  - e.g., Vistakon (0.9 MW_{th})
- Industrial processes
  - Drying/Brewing
- Horticulture
  - Greenhouses
- District heating
- Electricity production
  - Enhanced geothermal systems
  - Low-temperature turbines




HEATING BUILDINGS
INDUSTRIAL APPLICATIONS
°C
FOOD PRODUCTION
ELECTRICITY GENERATION
200
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Cement & Aggregate Drying
Beer Brewing
Binary Geothermal Power Plants
District Heating (No Heat Pump)
Concrete Block Drying
Greenhouse heating
Pasteurization
Milk Evaporation
Heating Large Buildings (Heat Pump)
Mushroom Culture
Geothermal Heat Pumps
Fish Farming

Geothermal veg: case study from NL

Geothermal propels Dutch horticulture industry to new heights

Westland Greenhouse, Wateringen, The Netherlands (Source: Flickr/ Jeroen van Luin, Creative Commons)

Backed by government subsidies, the geothermal heating project in Koekoekspolder has allowed its horticulture industry to shift away from burning natural gas.

- "Aardwarmetcluster" 23.5 hectares of greenhouses in Koekoekspolder
- 5 growers in a 2 km radius
- Doublet drilled to 1.95 km depth
- 72 ˚C waters at surface
- 7.4 MW_{th}
- Cost €12.5 M, funded by growers with assistance from loans and grants from national and local govt.

Sources: Thinkgeoenergy (2019)
greenhousegeopower.nl

80,500,000kg

Less CO2 emissions since 2012

45.0 million m³ of natural gas saved

AARDWARMTE KOEKOEKSPOLDER

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Building a geothermal industry

Aims
Increase installed capacity
Decarbonise heat sector
Jobs and skills

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Barriers
Lack of public interest/support for GT
No “proof of concept” in Ireland (deep)
Lack of funding for demonstrator projects
Lack of regulatory framework
Lack of subsurface knowledge

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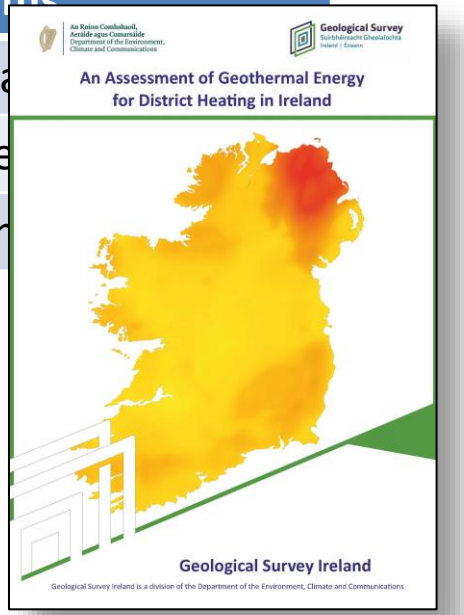

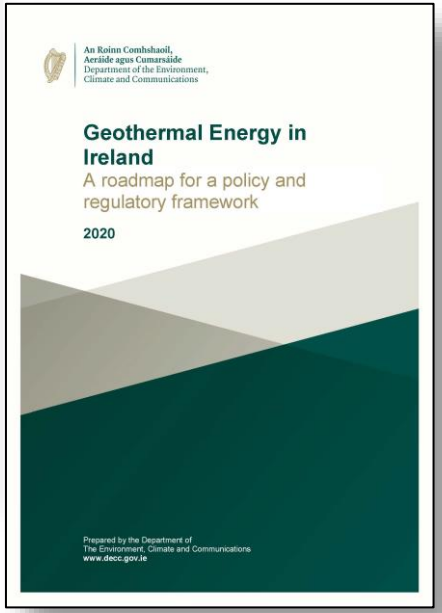

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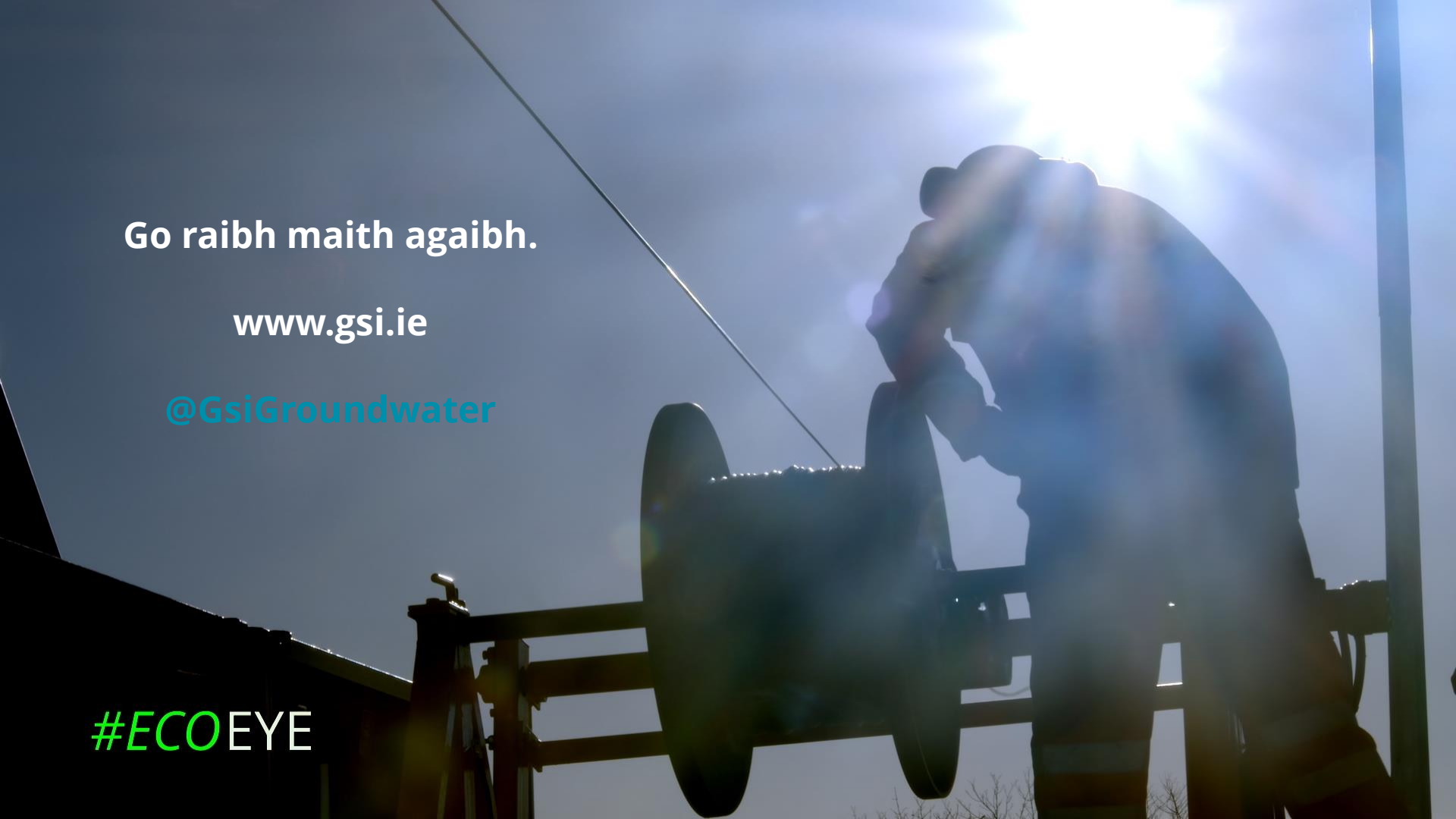
Takeaway messages

- Geothermal energy can be found everywhere at depth ***even in Ireland***
- **It is extremely clean, secure and stable (baseload)**
- Shallow geothermal heat (for heat pumps) is available everywhere
- Deeper resources can be accessed using boreholes (expensive)
- Projects pay for themselves after several years
- Improving our geological knowledge is vital to reduce risk for deeper projects
- Financial support is necessary to develop shallow and deep industries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