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Geothermal for all: non-conventional geothermal options

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WHY GEOTHERMAL?

- Geothermal energy/heat is one of the truly unlimited sources that we have at our disposal
- NL has geothermal potential, but current use is limited
- But.. with some unconventional thinking we might be able to give this a push

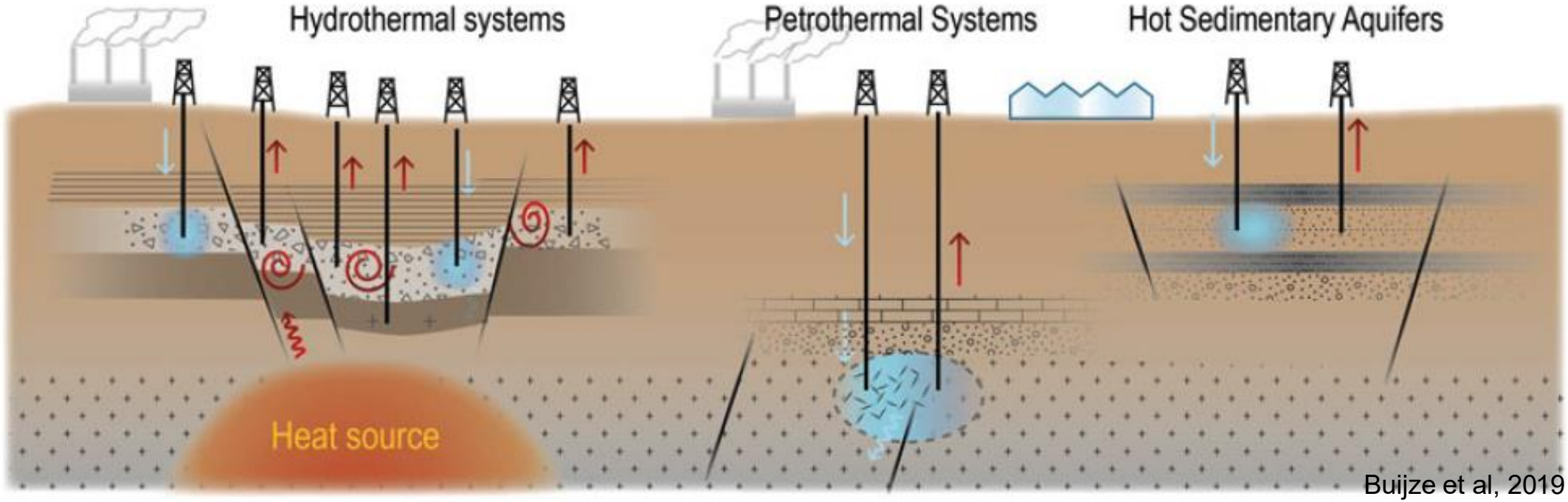
- So lets go on a journey through geothermal country and explore what we do today and particularly what we can/should do tomorrow

WHAT IS GEOTHERMAL?

- Heat-cold exchange: shallow solutions (often max 300m) makes use of heatpump or heat-cold-exchange. Heat and/or cold (max 15 – 20 C) is extracted from the soil or groundwater or actually stored there.
- Geothermal energy: 500 meter and deeper. Makes use of hot water in porous sandstone layers. In The Netherlands the focus for this kind of heat is in the depth domain of around 2-3 km depth.

GEOTHERMAL OPTIONS

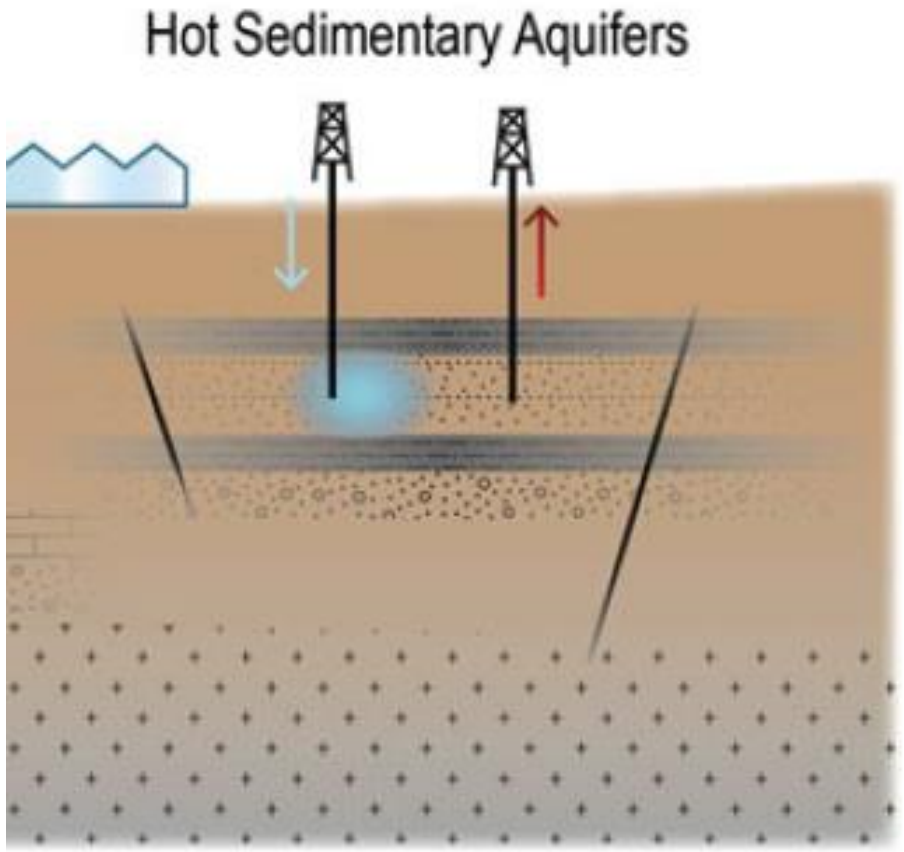
- There is actually only 1 option possible in NL. Deeper options are potentially possible but not yet fully explored.



Buijze et al, 2019

GEOTHERMAL OPTIONS

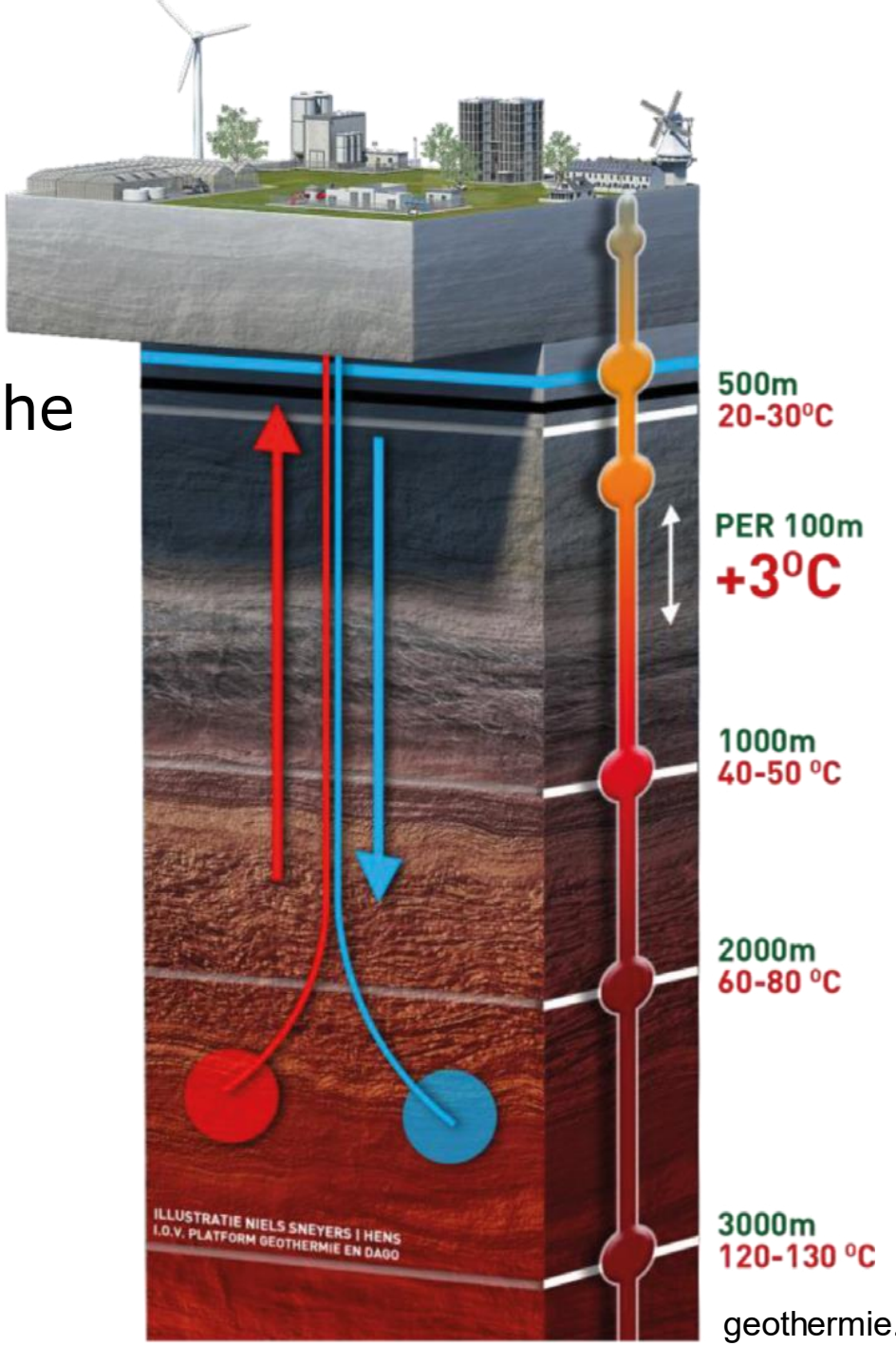
- Mostly low-to-average temperatures (30–150 ° C) in porous layers at 1–4 km depth.
- Water circulates between two wells (doublet) under (low) pressure.
- Temperatures are mostly suitable for direct heating through hot water supply.



Buijze et al, 2019

GEOTHERMAL ENERGY

- Makes use of natural heat in the Earth
- Hot water stored at depth is pumped to the surface
- Hot water is used for heating
- Cooled water is pumped back into the reservoir
- Water flows slowly back to pump location and heats up during that process



geothermie.nl

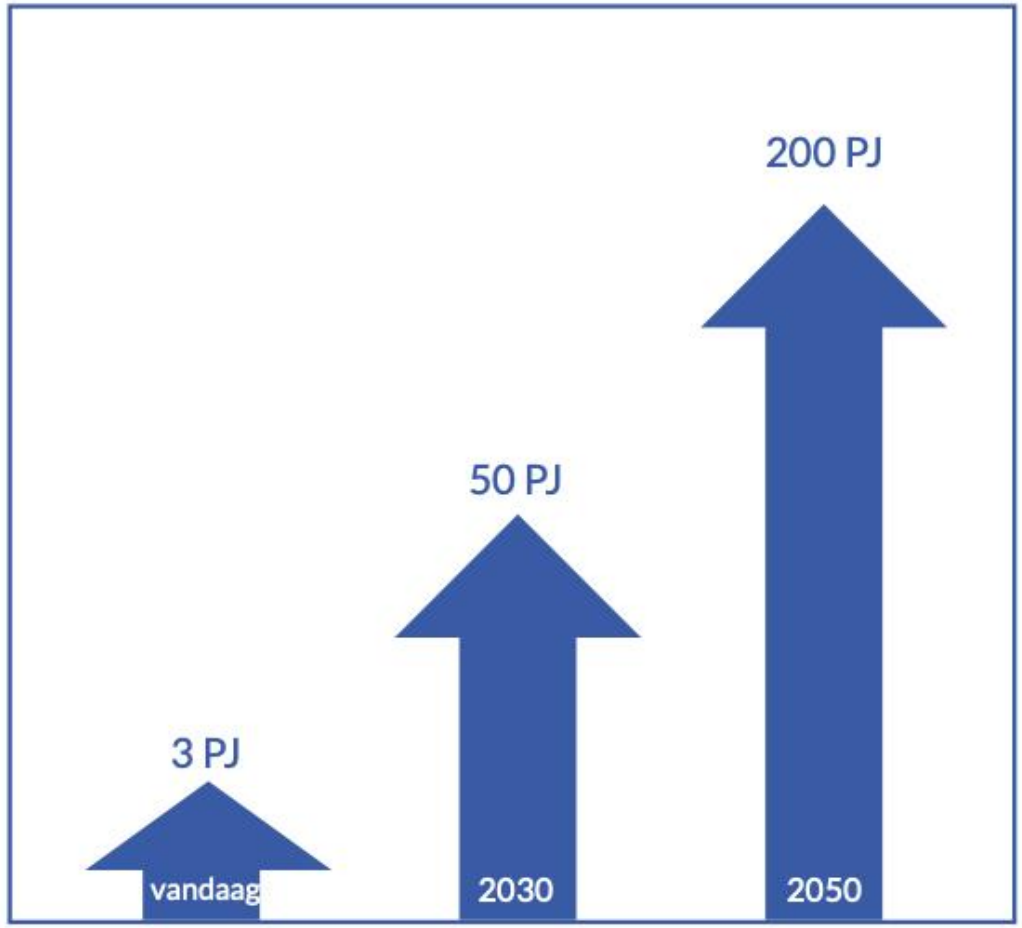
WHY NO ELECTRICITY?

- It is most efficient to use heat directly as heat, instead of transfer it into electricity (and then maybe use it then again to convert to heat).

- For generation of electricity the water needs to be really hot to be efficient in the conversion process (higher temperature → less loss in the conversion). For a reasonable conversion efficiency the water should be preferably not less than 180 degrees. For such temperatures you would need to drill to at least 4500 meters (Ultradeep geothermal, UDG).

- UDG is not yet applied in NL (there is not enough knowledge of the deeper subsurface)

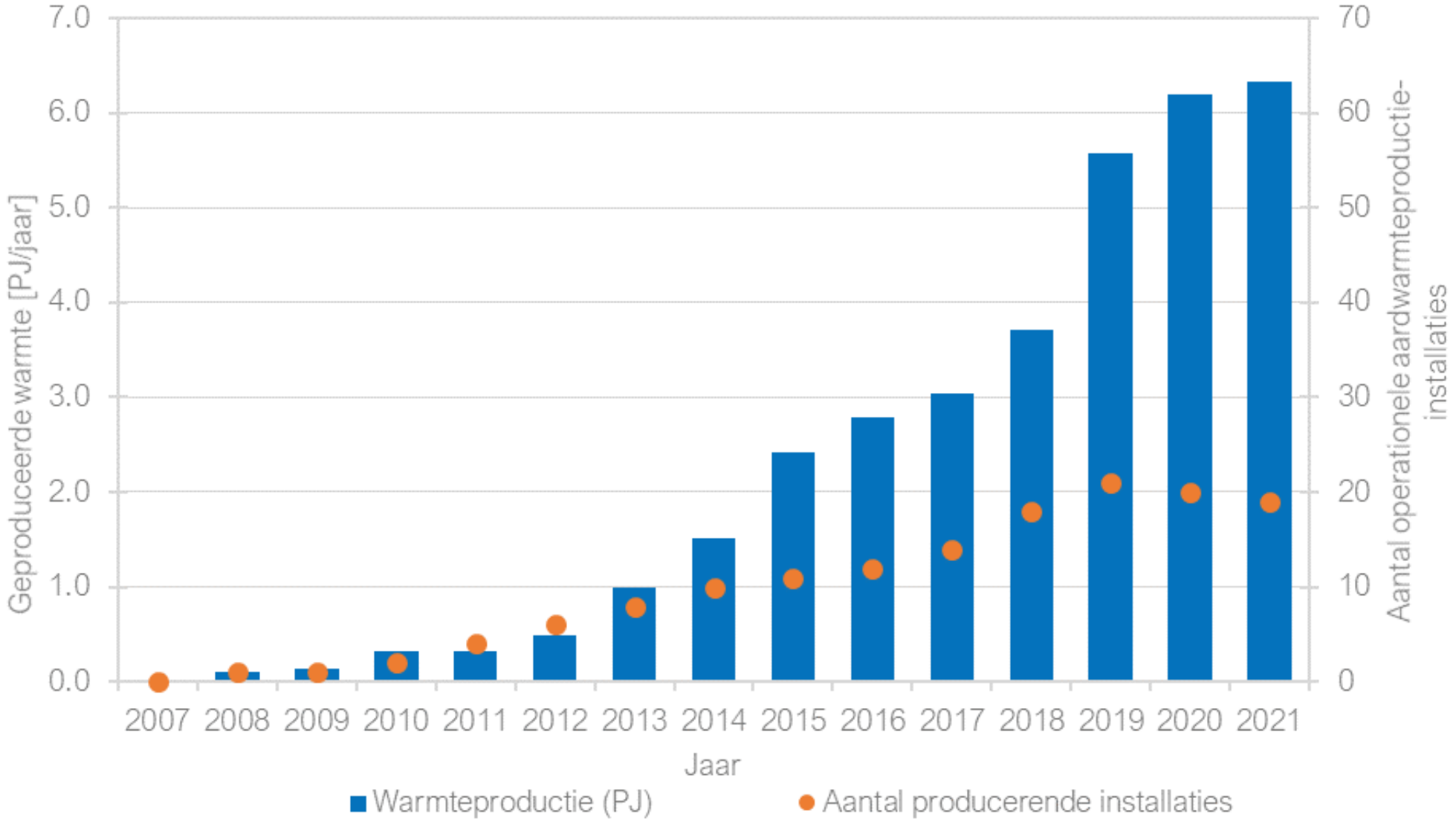
GEOTHERMAL AMBITIONS



	2018	2030	2050
Aantal doubletten (#)	17 1-2 nieuwe per jaar	175 20 nieuwe per jaar	700 25 nieuwe per jaar
Aantal gebouwen aangesloten op een warmtenet	<1k	570k 20 PJ	3,8m 135 PJ
Bovengronds ruimtebeslag (ha)	10 17 voetbalvelden	110 Volendam	450 Centrum Rotterdam
Werkgelegenheid (FTE)	240	2400	3400
direct[1]	70	700	1000
indirect[2]	170	1700	2400

PRESENT STATUS

yearreport 2021 - Delfstoffen en aardwarmte in Nederland



EXPLORATION AND EXPLOITATION

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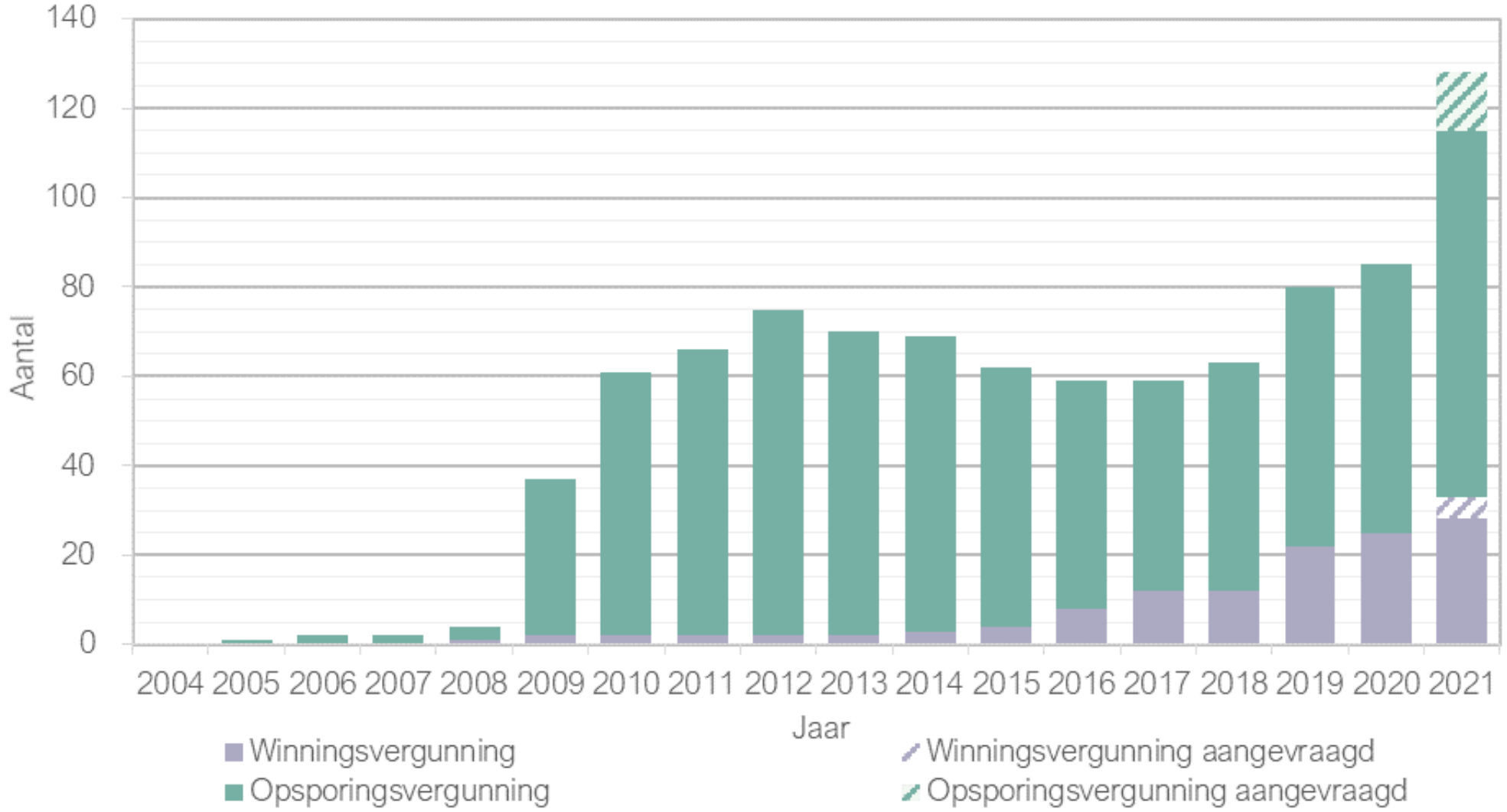
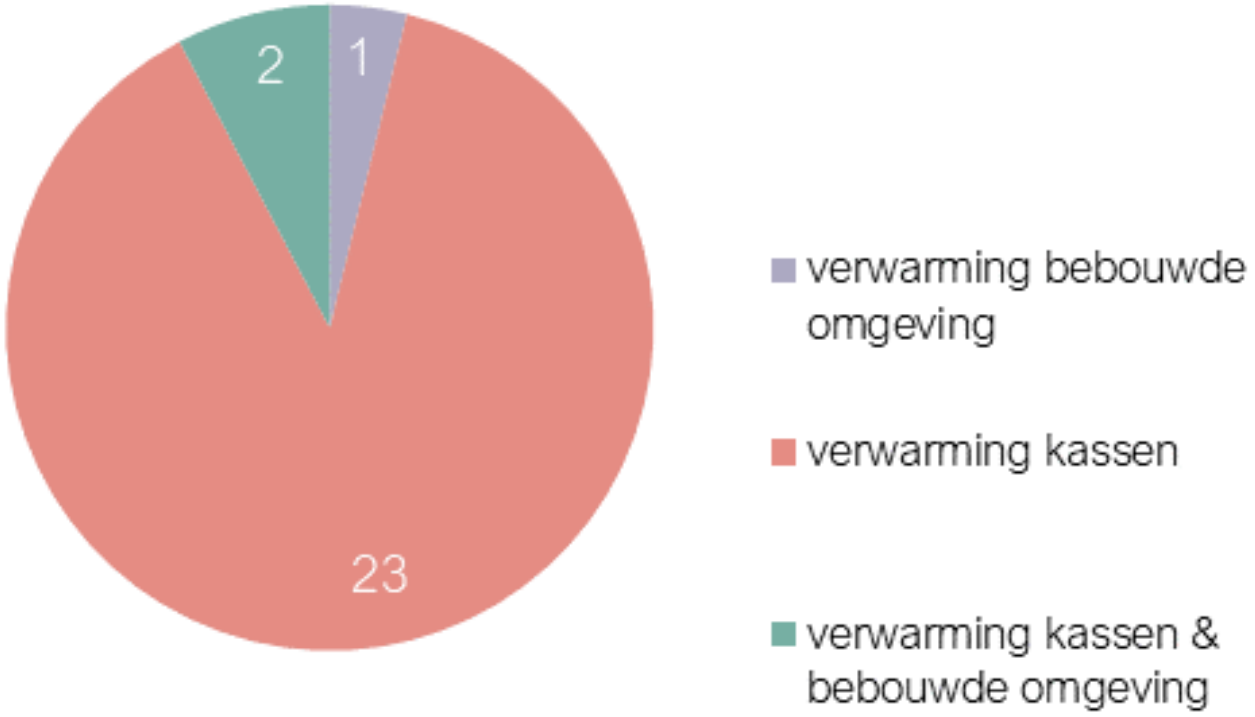


USE OF GEOTHERMAL

Use of geothermal

- Mostly for greenhouses
- Little bit for households

Role of geothermal in the energy transition is still very limited….



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GEOTHERMAL IN NL

- Limited activity
- Mostly in west of NL
- Almost 100% related to heat only
- No electricity production
- No increase anymore
- Most of it is shallow

- Where to go to reach ambitions?

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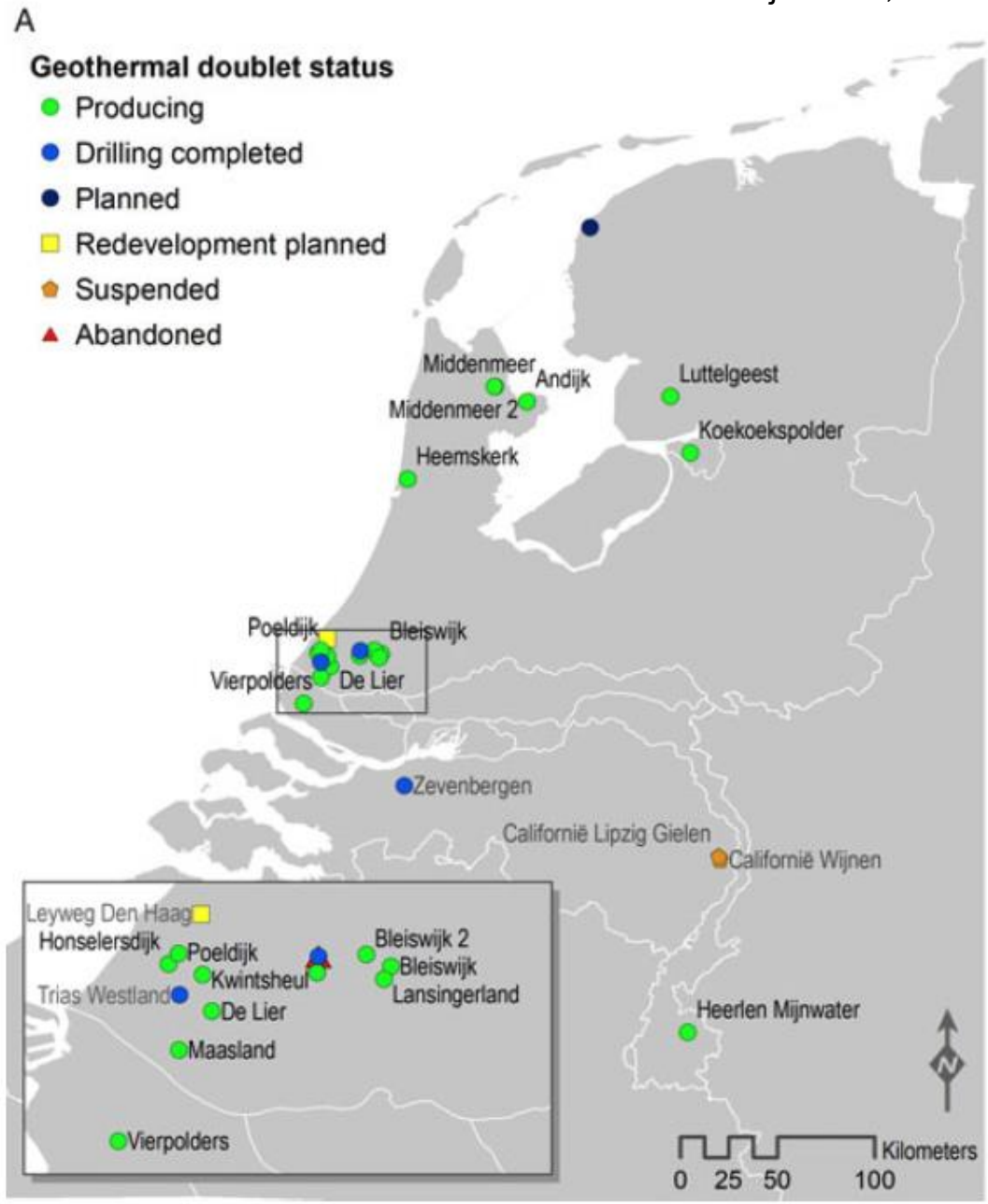

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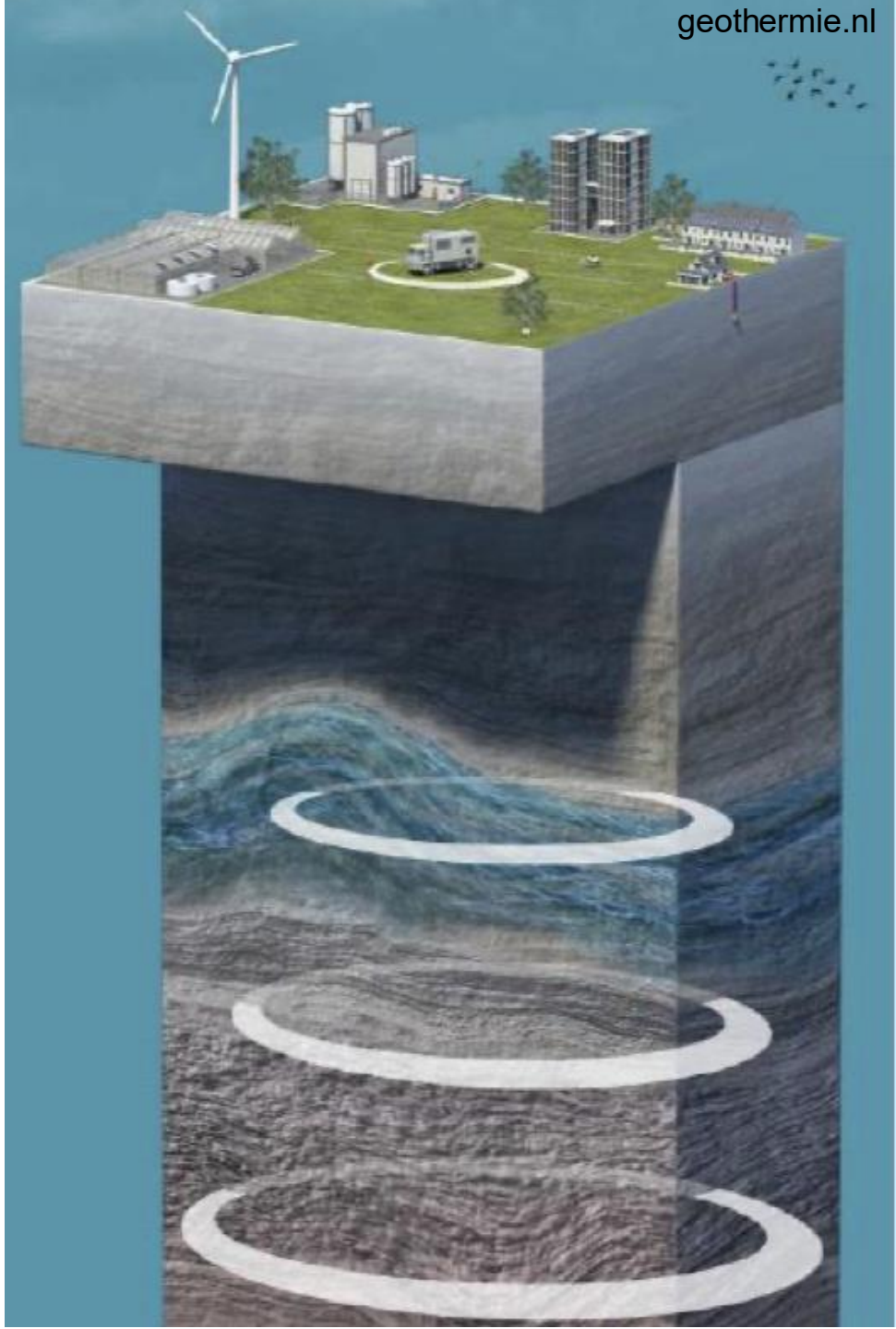
SUBSURFACE INFO

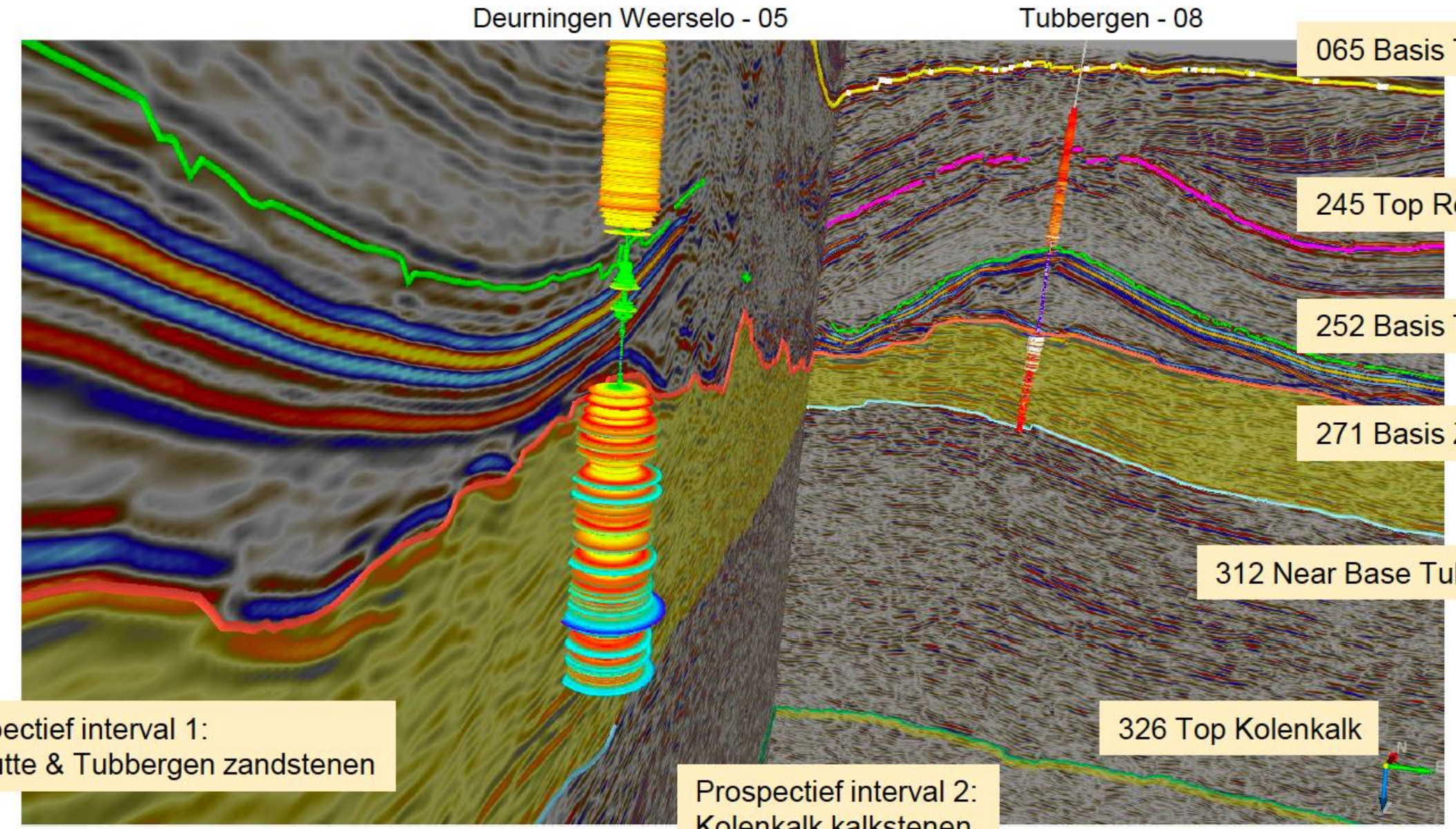
- Where is now the geothermal energy?
- We need to find layers that contain lots of hot water and where water can flow freely
- With seismic investigations we try to image the subsurface



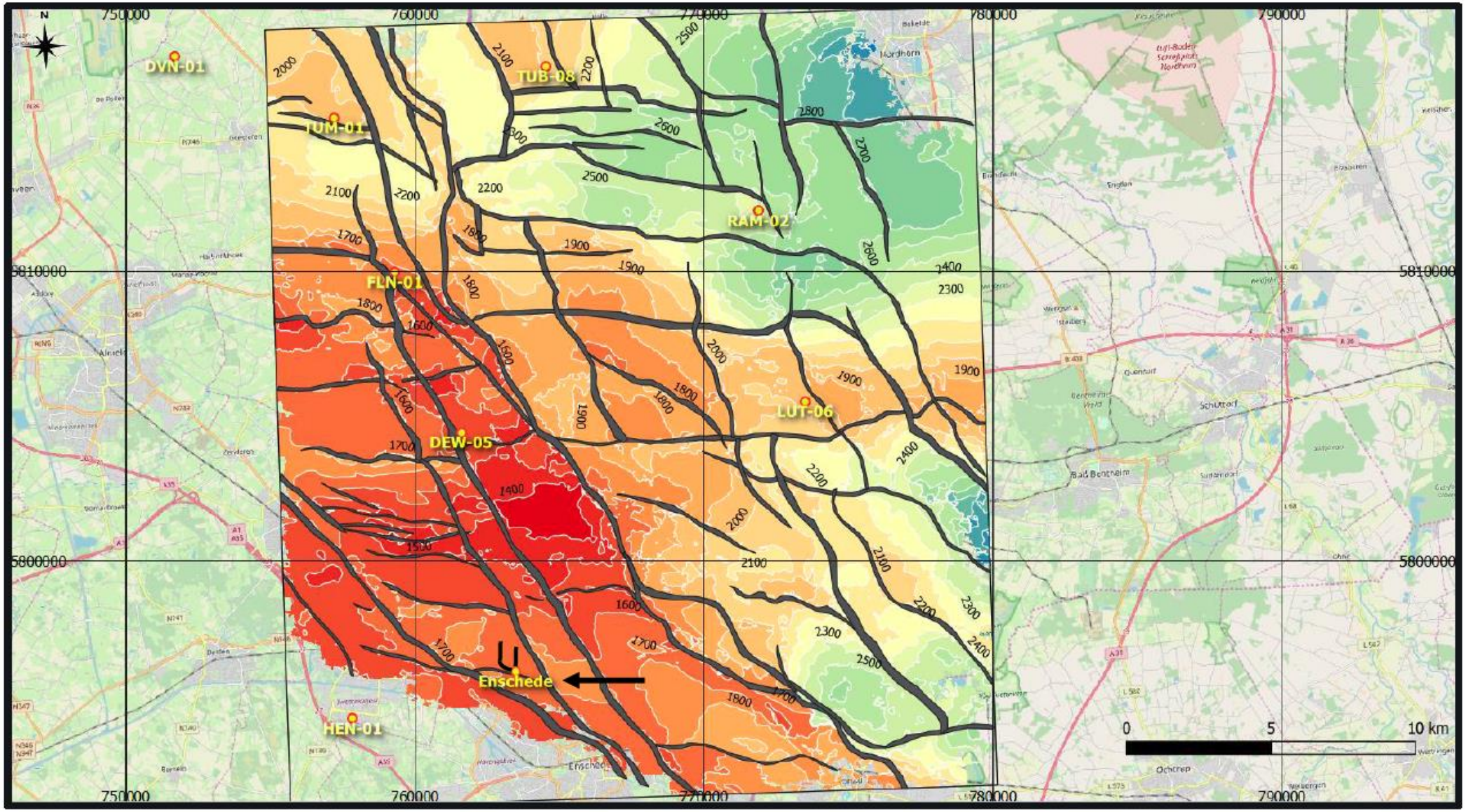
SUBSURFACE KNOWLEDGE IN NL

- NL is (partly) well investigated in terms of subsurface (but till max 3 km depth)
- Mostly in purple areas (3D info)
- Large areas poorly explored
- Makes application of geothermal a risk

Seismische Interpretatie



Basis Zechstein diepte kaart

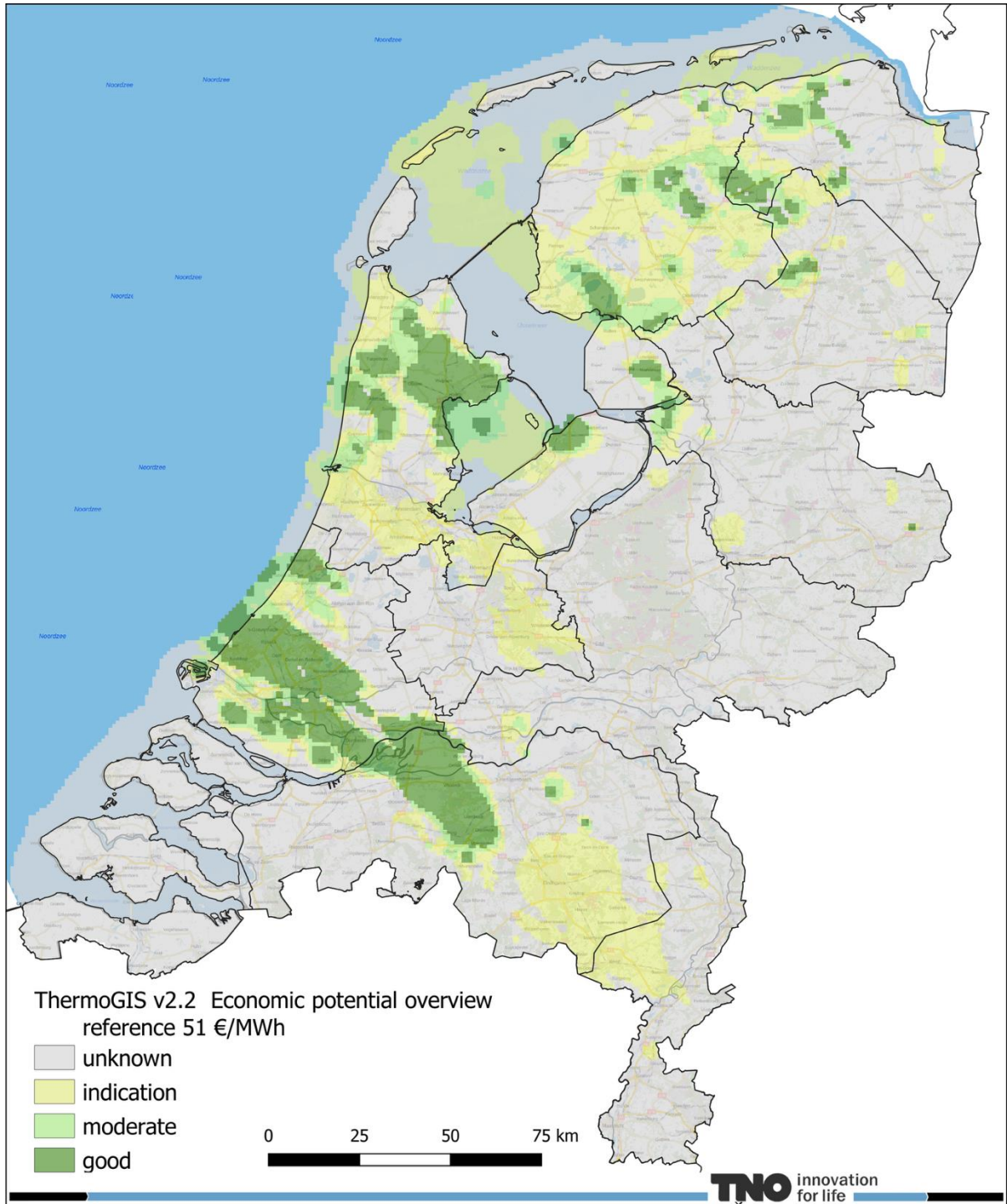


POTENTIAL

- Oost NL very limited
- Assessment of economic potential is very low

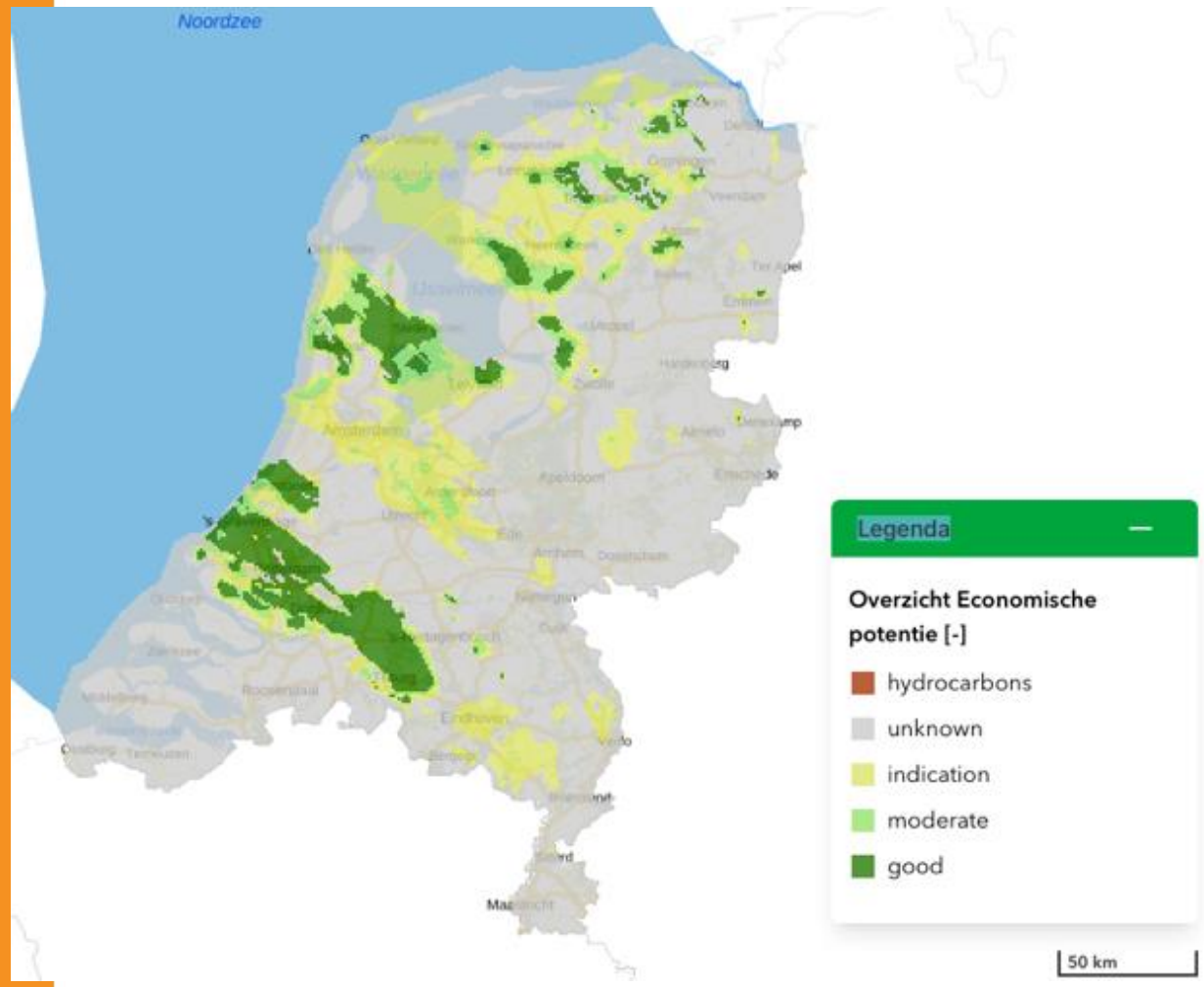
- Based on standard ‘doublet’

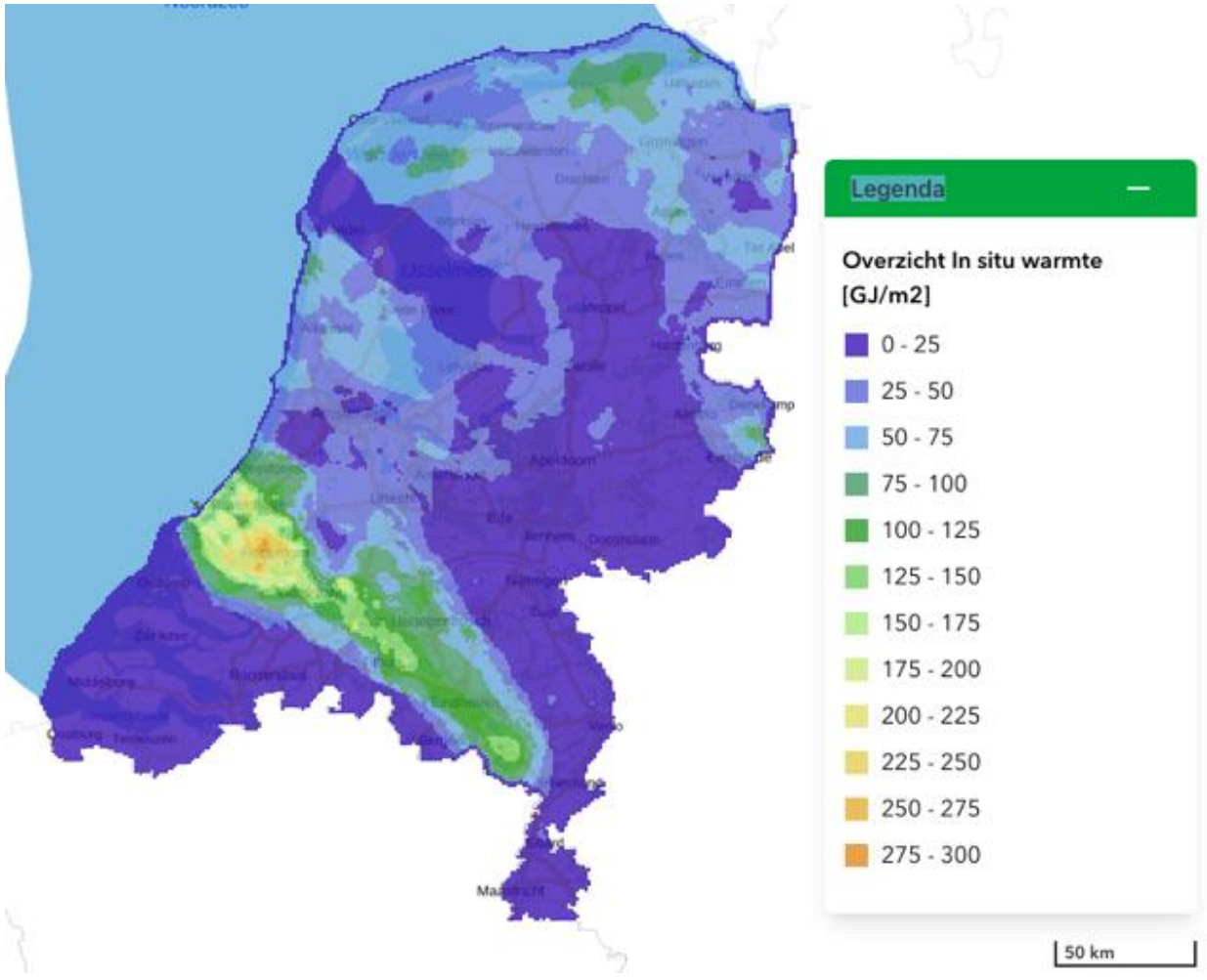
- But what is possible?



Thermogis.nl

HEAT AND POTENTIAL

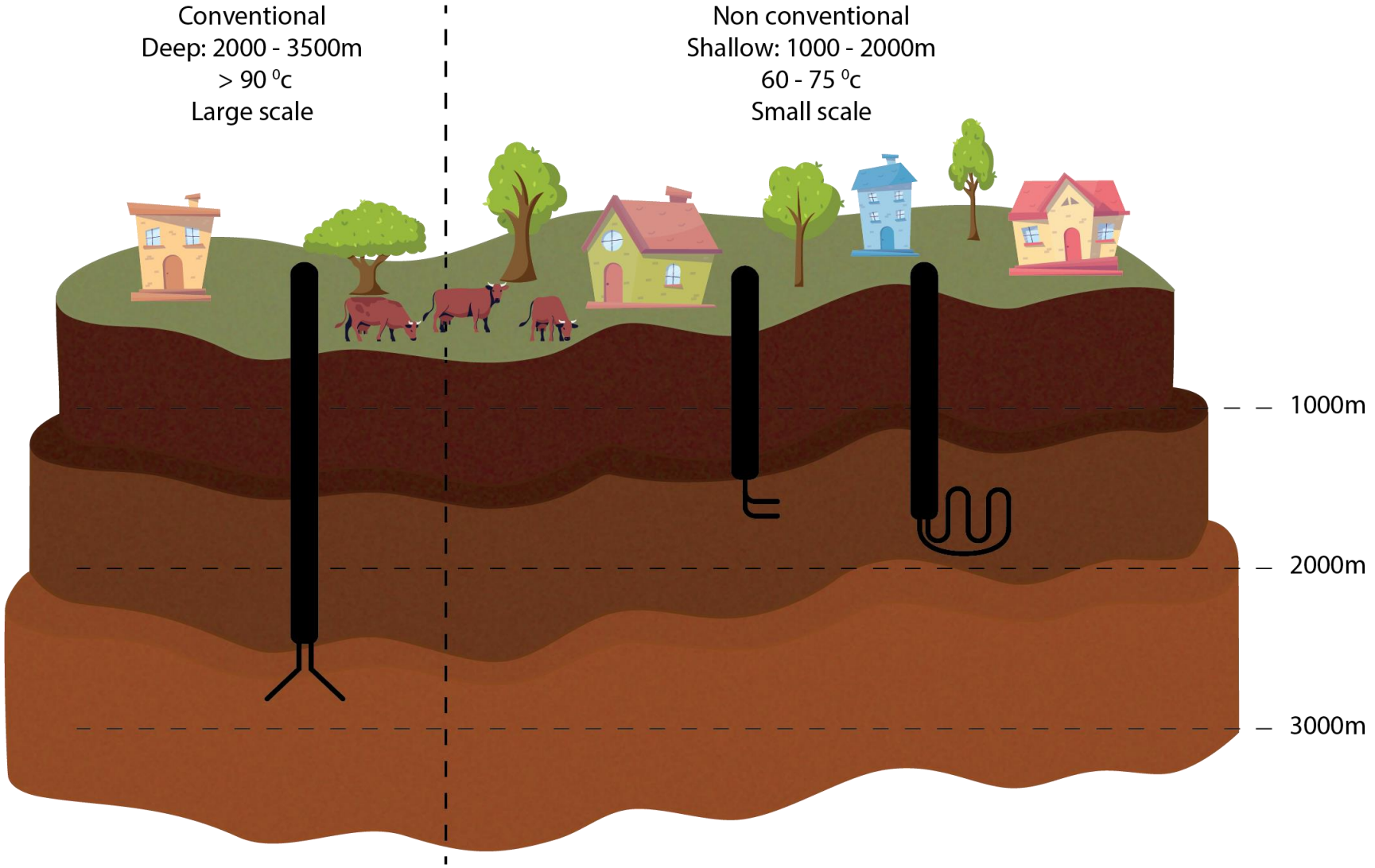




WHAT DO WE WANT TO DO

- Develop geothermal for many more places in NL
- More small-scale solution
- Lower temperatures
- Different layers in the subsurface
- Different geothermal properties (flow, temperature, pressure)

DIFFERENCES (NON) CONVENTIONAL



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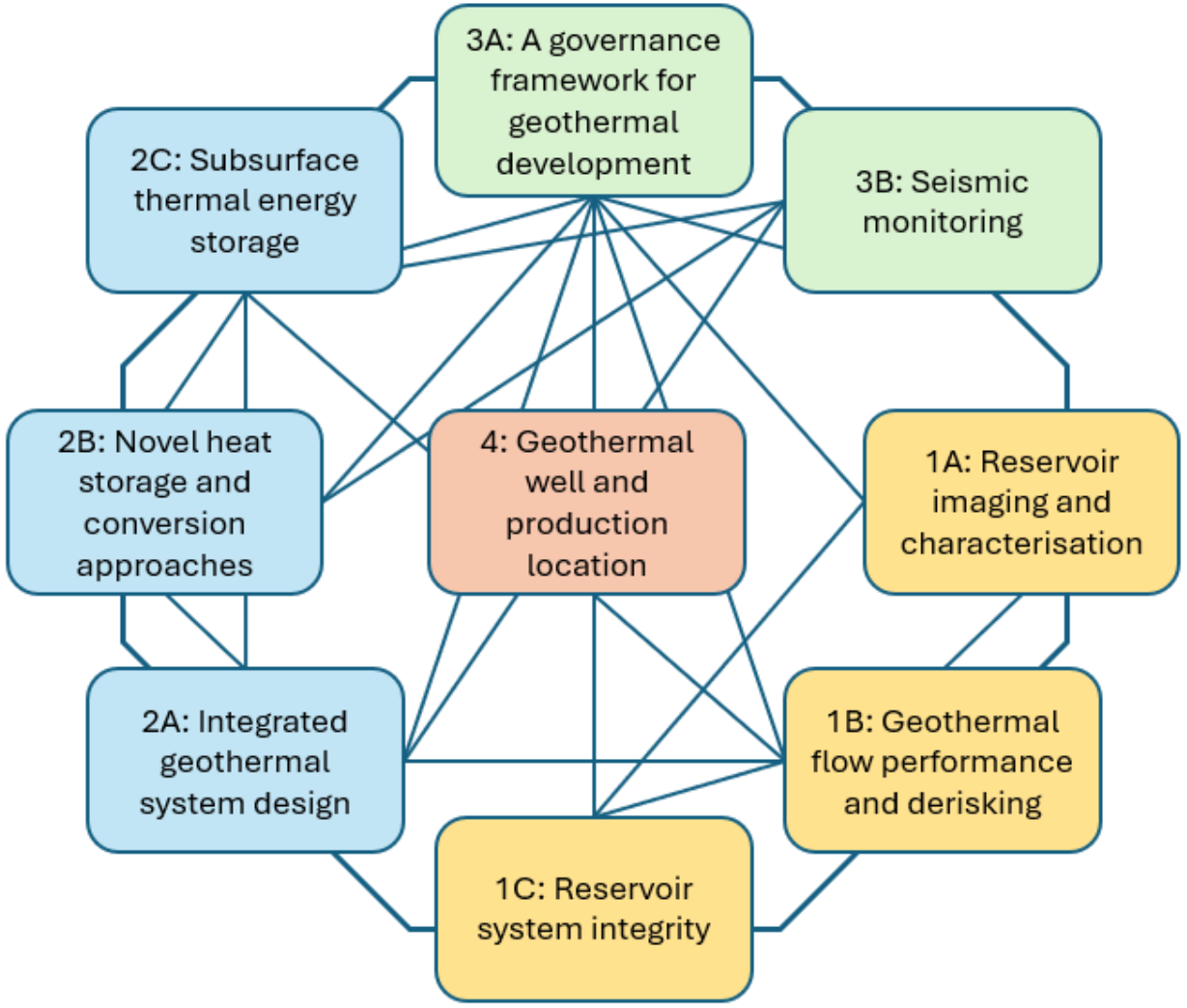
WHAT DO WE WANT TO DO

- Develop local small-scale geothermal solution
- Explore feasibility and capacity for non-conventional reservoirs
- Follow full flow from source to household
- Next generation heat systems with warming, cooling and storage integrated in one approach
- Redundancy in heat supply – not depending on single source
- Include governance issues

4 DIFFERENT DOMAINS OF A SYSTEM

What do we need to know?

- Subsurface characterisation
- Integrated system design
- Governance and safety
- A non-conventional well



EARTHQUAKE RISK?

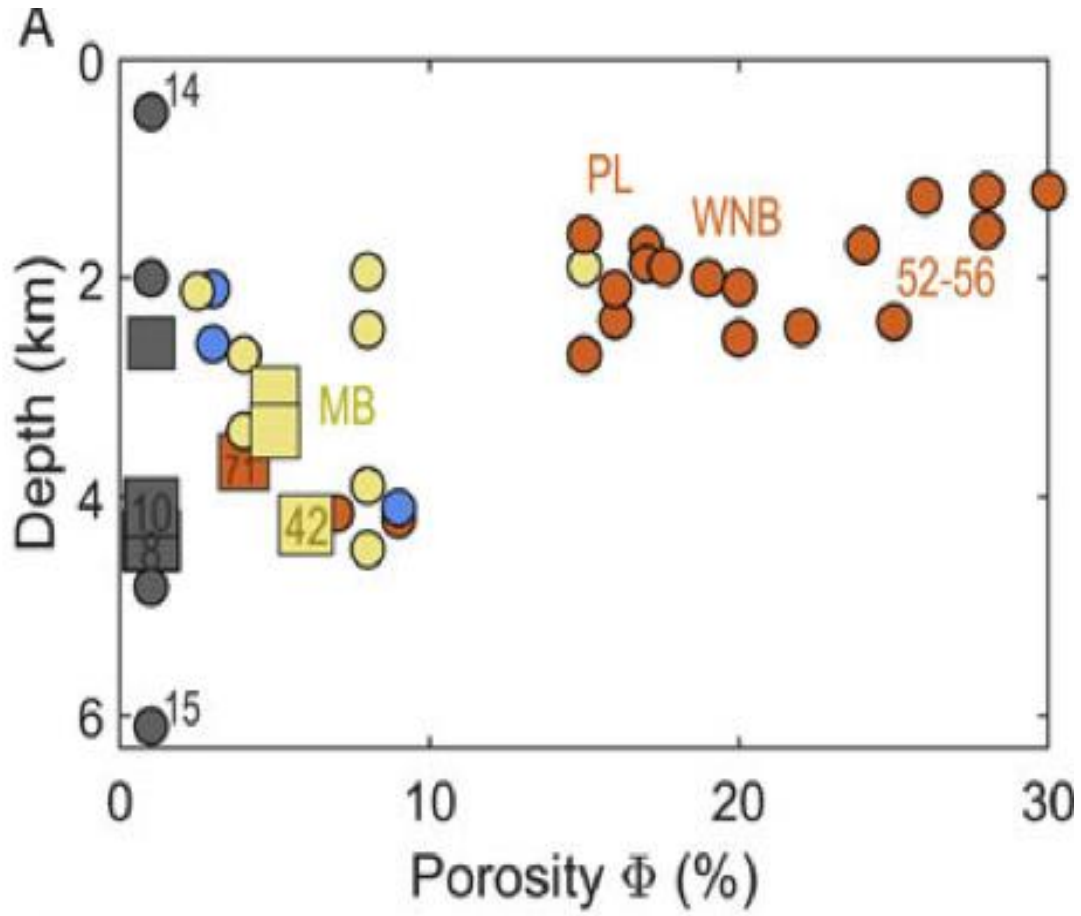
- Production in NL is relatively shallow
- High porosity

→ Low pressure, low temperature systems

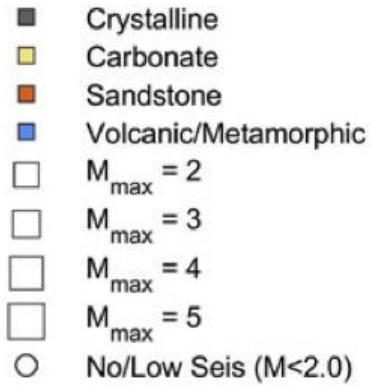
Mostly in sandstones, not in carbonate formations

And that has positive consequences (based on worldwide study, see next slide)

EARTHQUAKES AND GEOTHERMAL



- Global study of earthquakes in geothermal sedimentary reservoirs, in relation to geology
- → no earthquakes in shallow sandstone formations



Buijze et al, 2019

IN SUMMARY

- Geothermal in NL is still under development
- New opportunities are possible but require other thinking
  - Setup of the future
  - Smaller systems
  - Lower temperatures
  - Include cooling and temporal storage options
  - Make society upfront part of this development

→ **Future proof geothermal concept!**