

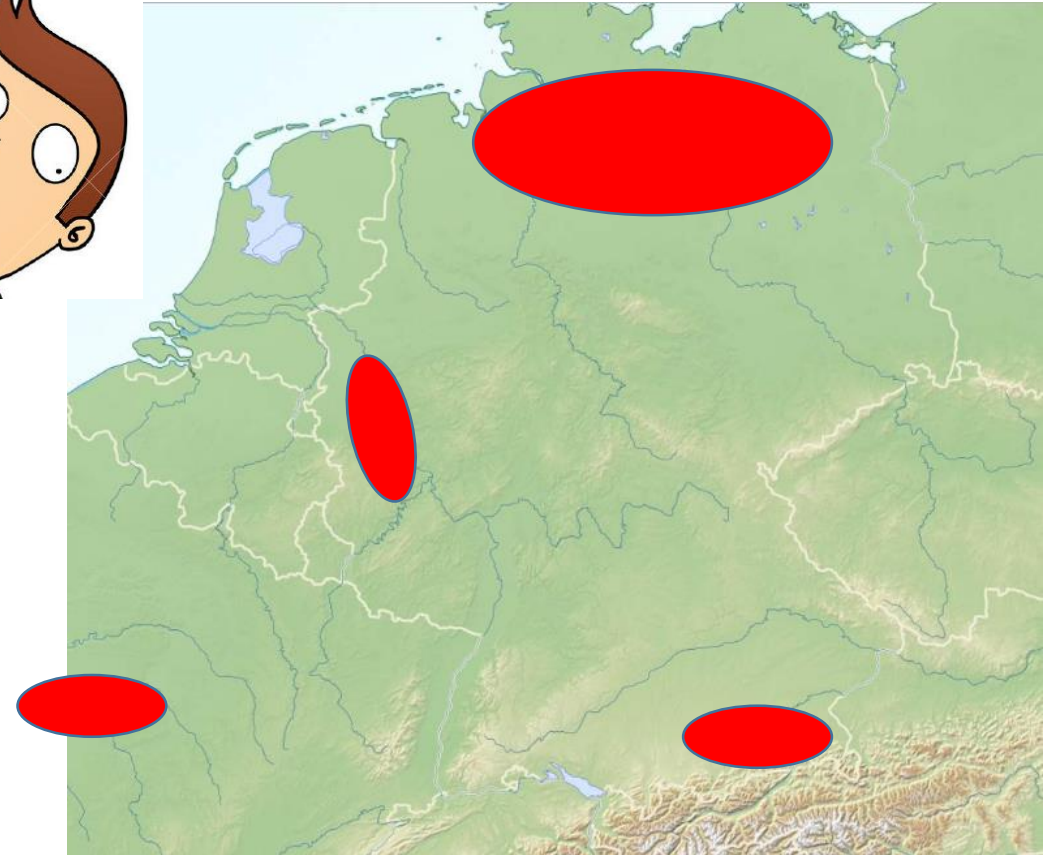
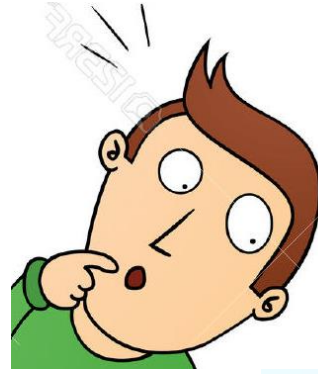
Technical developments in geothermal systems in the Netherlands

From water to oil and gas to geothermal

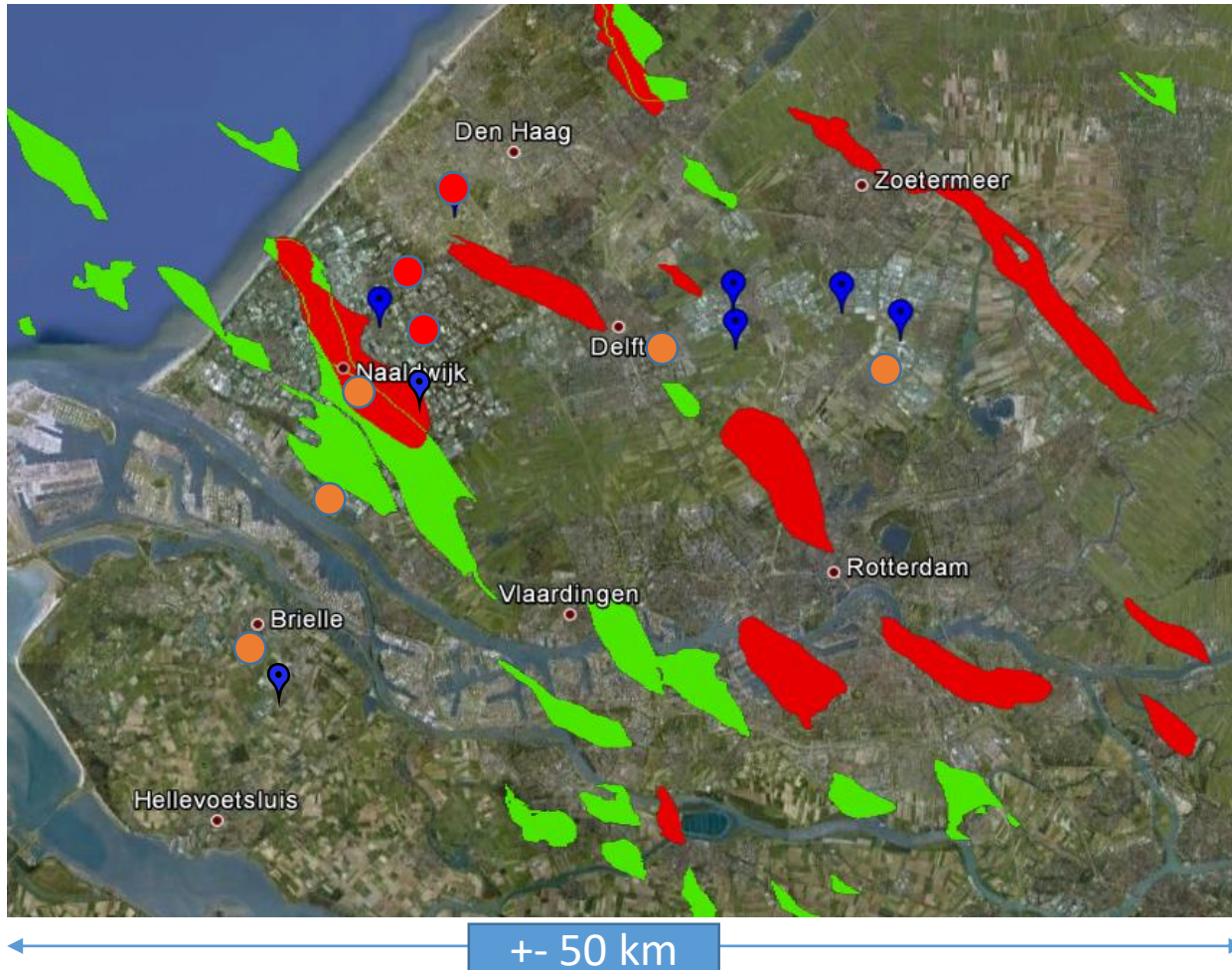


Content

- Dutch situation
- Injection problems
- Dissolved Gas
- Corrosion and scaling (LSA)
- Well tests
- Well design
- Coring
- Geothermal and oil/gas synergies

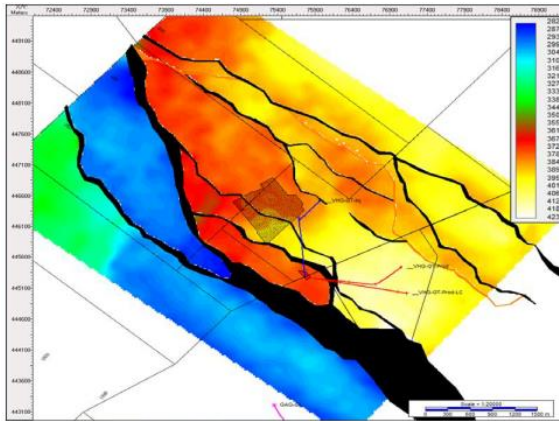


West Netherlands



Governmental support

RNES – Geological Insurance



- Temperature
 - Permeability,
 - Effective reservoir thickness
- No engineering failures

SDE - Subsidy per PJ energy

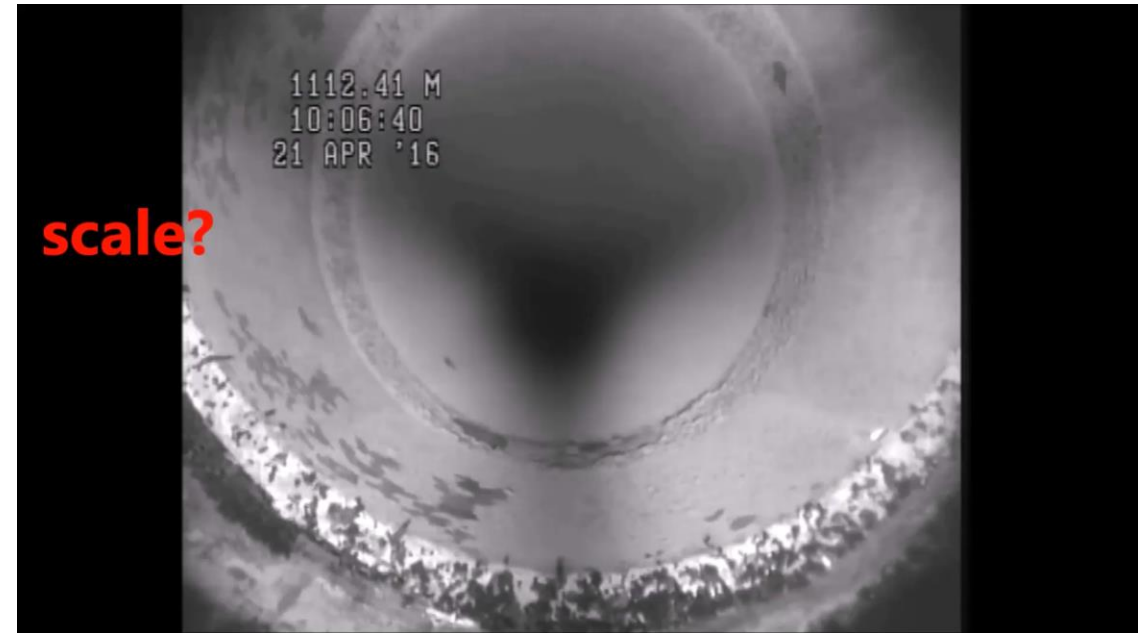


- In competition with other renewables
- Incentive for cooling
- Additional support for electricity

Injection Problems

How to tackle?

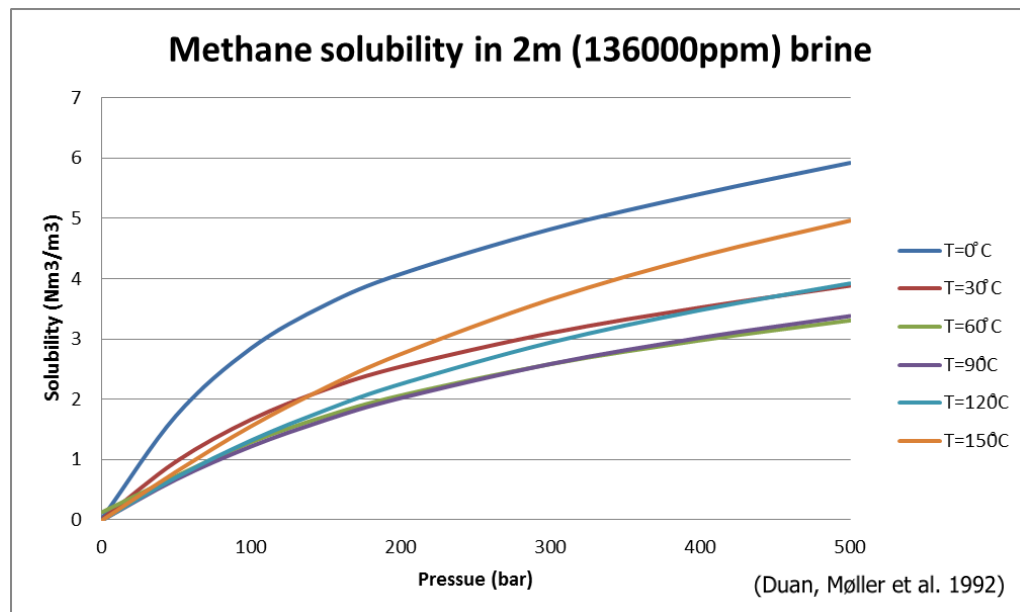
- O₂ entry
- Connectivity problems
- Well filled up with sand
- Screen/well damage
- Fines
- (carbonate) Scales
- Corrosion products
- Biological



Injection Problems – Workover Vierpolders

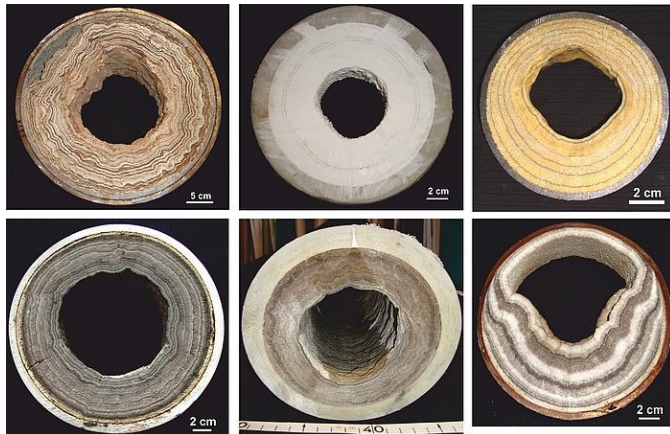


Gas in geothermal projects



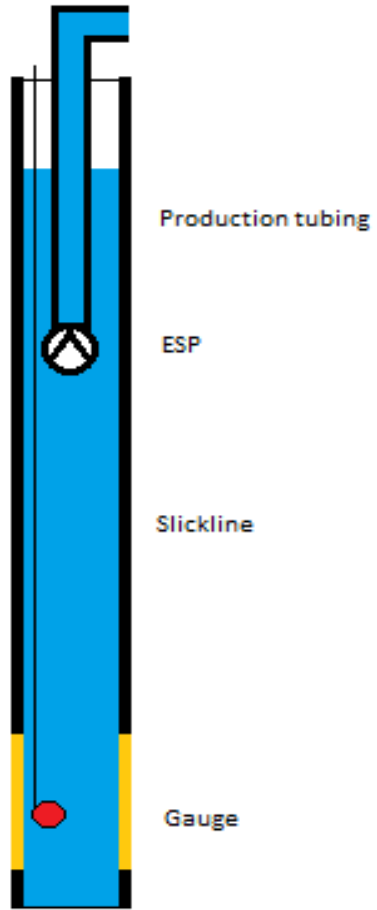
- Upto 1,5 Nm³ gas per m³ brine
- >85% CH₄ + N₂ + CO₂ + ..
- Pressurizing not possible for high GWR
- Separators + Boilers/CHP

Corrosion and Scaling



- Scaling and corrosion products: PbS , CaCO_3 , Fe_2O_3 , Fe_3O_4 , FeS , Cu (s) , BaSO_4 , ..
- Inhibitor strings
- Composites in surface installations and wells
- CO_2 injection, Corrosion prevention polymers, Scaling polymers, biocides.
- Casing inspections

Well testing



Test with ESP +
downhole P/T sensor

Temperatures:
65-95 °C

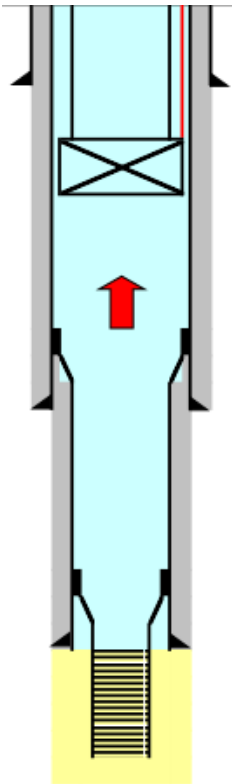
Interference tests

Gas >1Nm³/m³ brine
Methane >90%

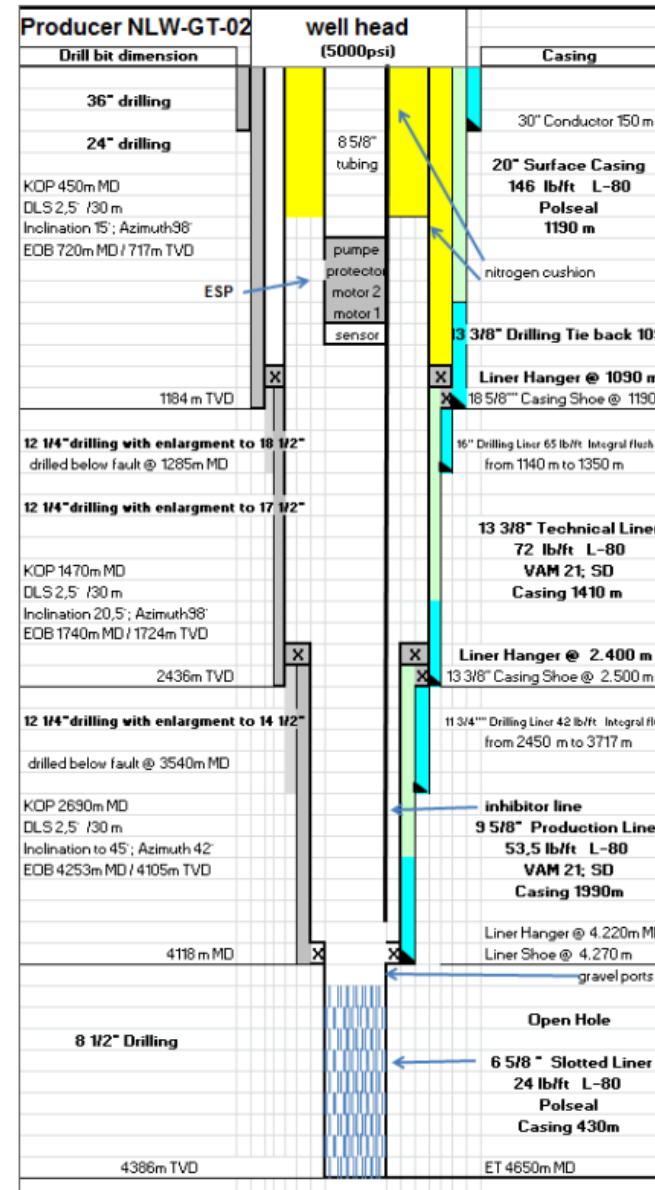


Well Designs

2007



- 150 m³/h (42 l/s)
- Well head < 1500 PSI
- K55 steel
- 4 ½" screens



2016 4 km deep project

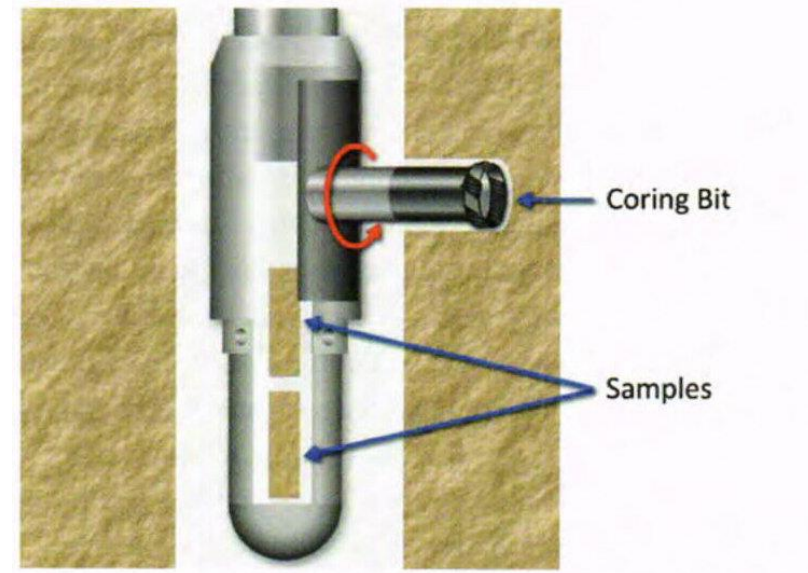
- 380 m³/h
- Well head 5000 psi
- L80Cr13 steel
- 6 5/8" perforated liners
- Inhibitor string
- Double casing
- Insulation gas in annulus
- Smart drilling muds

Coring sandstones

Micro core bit (Tercel)



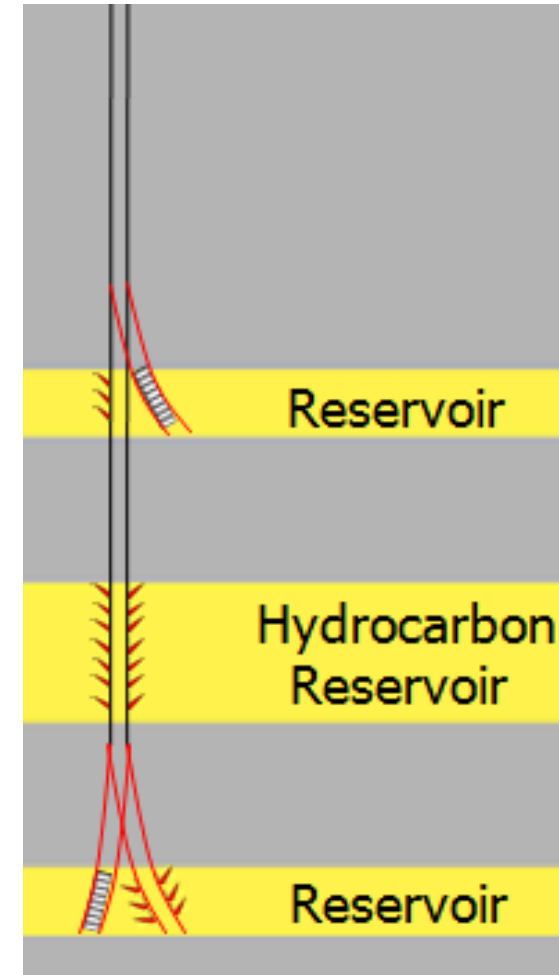
Sidewall Coring



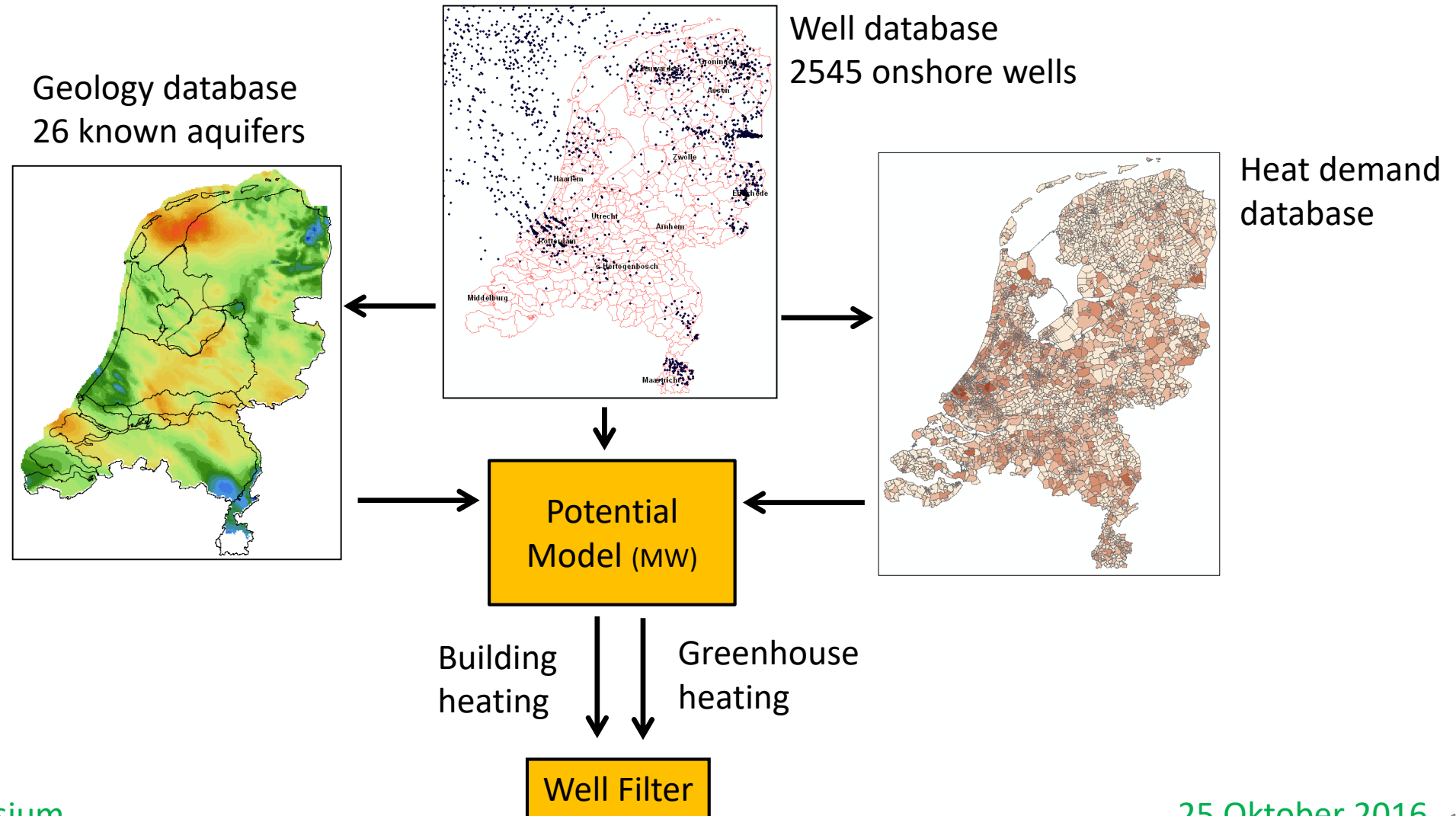
Use conventional coring...

Synergies with the oil and gas industry

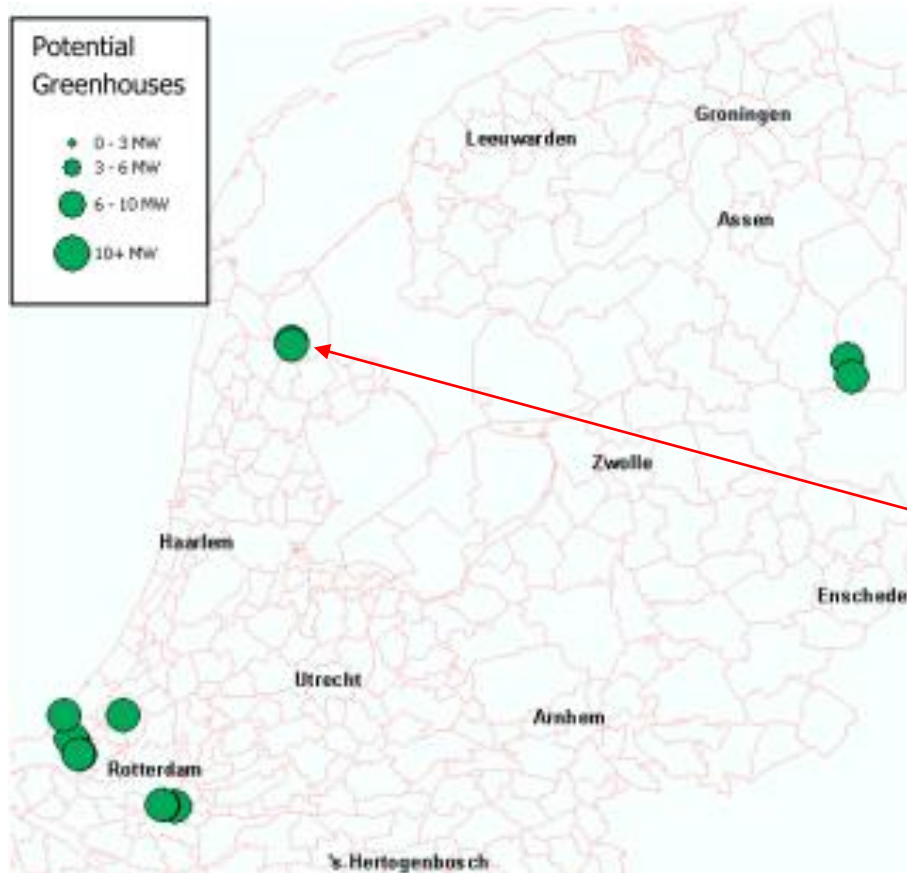
- Dual exploration
 - Experiences by accident
 - $P_{(40\%)} * \text{€€€} + P_{(90\%)} * \text{€}$
Oil/gas Geothermal
- Dual production
 - Oil with high OWR examples worldwide
 - Residual heat Gas production
 - Gas utilisation in geothermal (NL, Serbia, ..)
 - Variety of case studies
- Re-use of wells
 - Gross Schönebeck (Germany)
 - Zakopane (Poland)



Re-use of wells for geothermal or dual production



Result 1: focus on Greenhouses heating

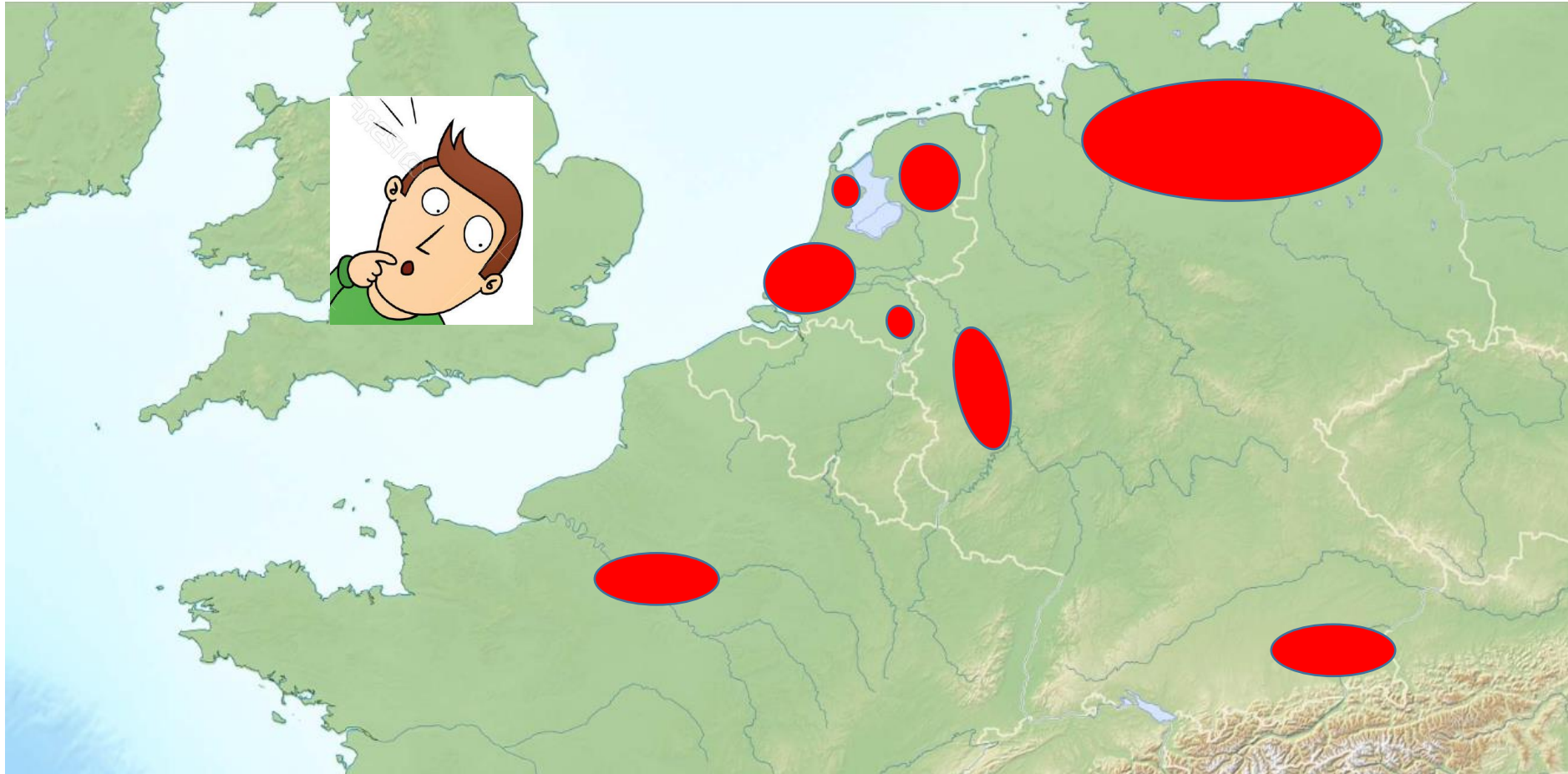


- Total potential with existing wells:
 - 11 GW building heating (>300.000 households)
 - 2,5 GW Greenhouse heating

Best result in 2012

- Modells being runned for direct heat and dual production
- End of production 2017

Thanks and I hope you are inspired to geothermise europe further 😊



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