

Geothermal Activity in Denmark

Agenda

E.N. Veenhof

28 November 2018

Der Geothermie Kongress 2018

Introduction

2018 Geothermal License Award

Geothermal Energy in Denmark

Comparison with Oil & Gas industry

Comparison Geothermal: NL & DK

Recommendations

NAIL RESOURCES

DENMARK

Your Speaker: Experienced Oil&Gas, Geothermal Novice



- Utrecht 1979
- Shell - 1985-1998
 - UK, Turkey, the Netherlands and Malaysia



- Clyde Petroleum – 1998
 - the Netherlands
 - Exploration & New Ventures Manager



- Wintershall Noordzee – 2002
 - Exploration Manager
 - the Netherlands, Denmark and the UK
 - set-up and ran a large (40+) department



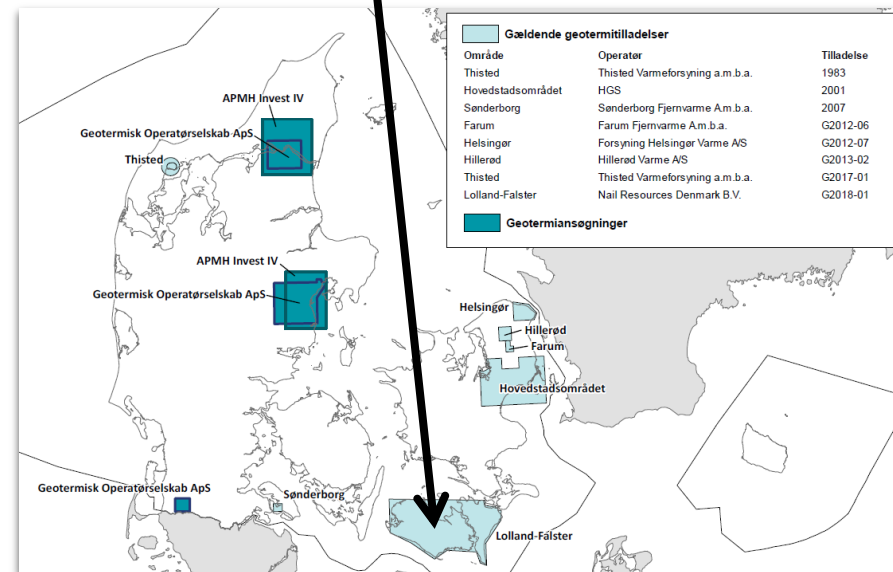
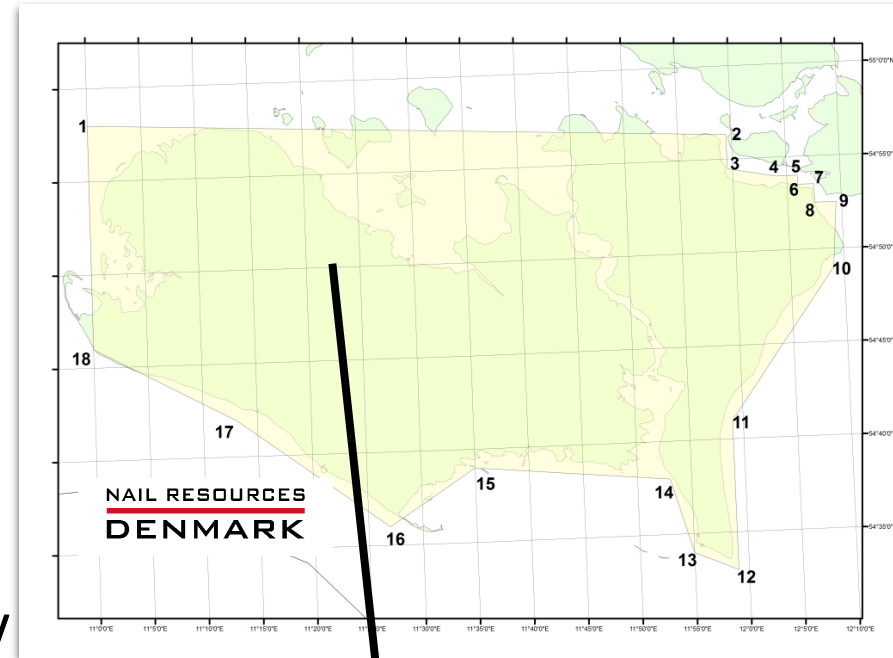
- Dyas – 2007 (Non-Operated)
 - New Ventures and Commercial Manager
 - Managing Director
 - many transactions
 - built the present organisation



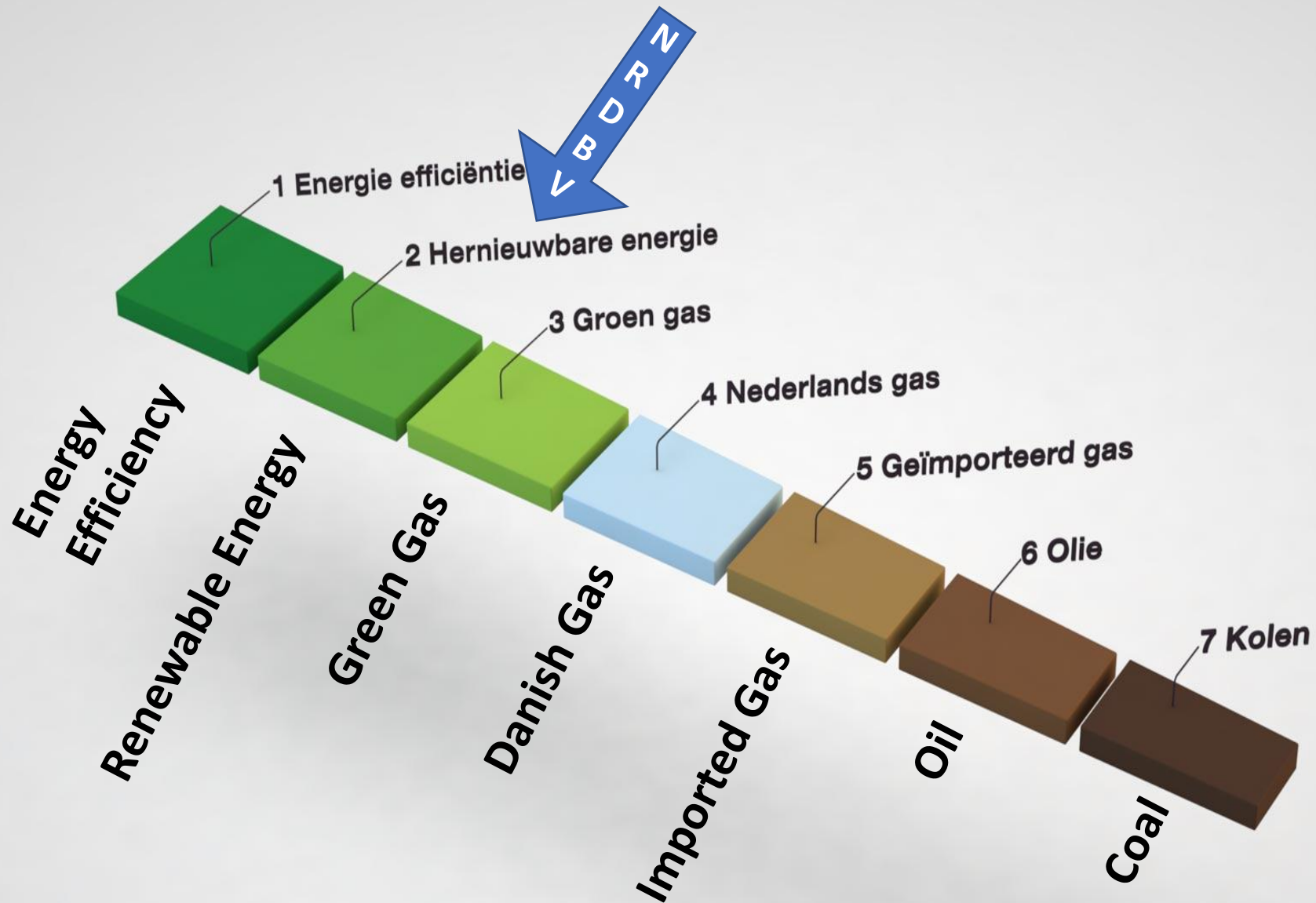
- Nail Petroleum – 2014 – consult & invest

2018 Danish Geothermal Award

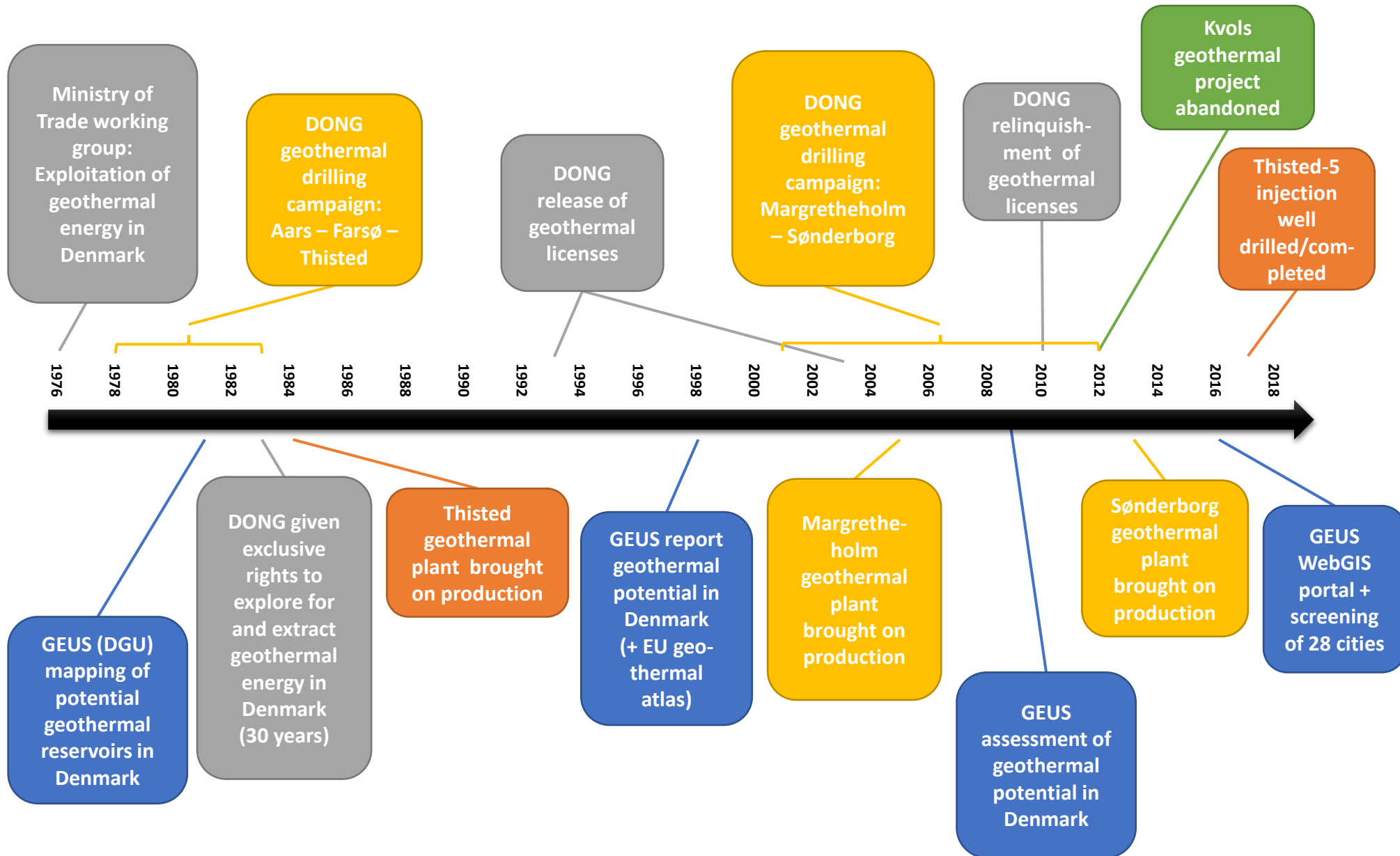
- License Award
 - Lolland-Falster islands
 - From 29.03.2018, 6-year term
 - District Heating
 - Award to Nail Resources Denmark BV
 - Founders
 - 50% Nail Petroleum BV
 - 50% Danica Resources ApS
 - Farminee NewCo ApS
 - \$, feasibility study, enlarged team



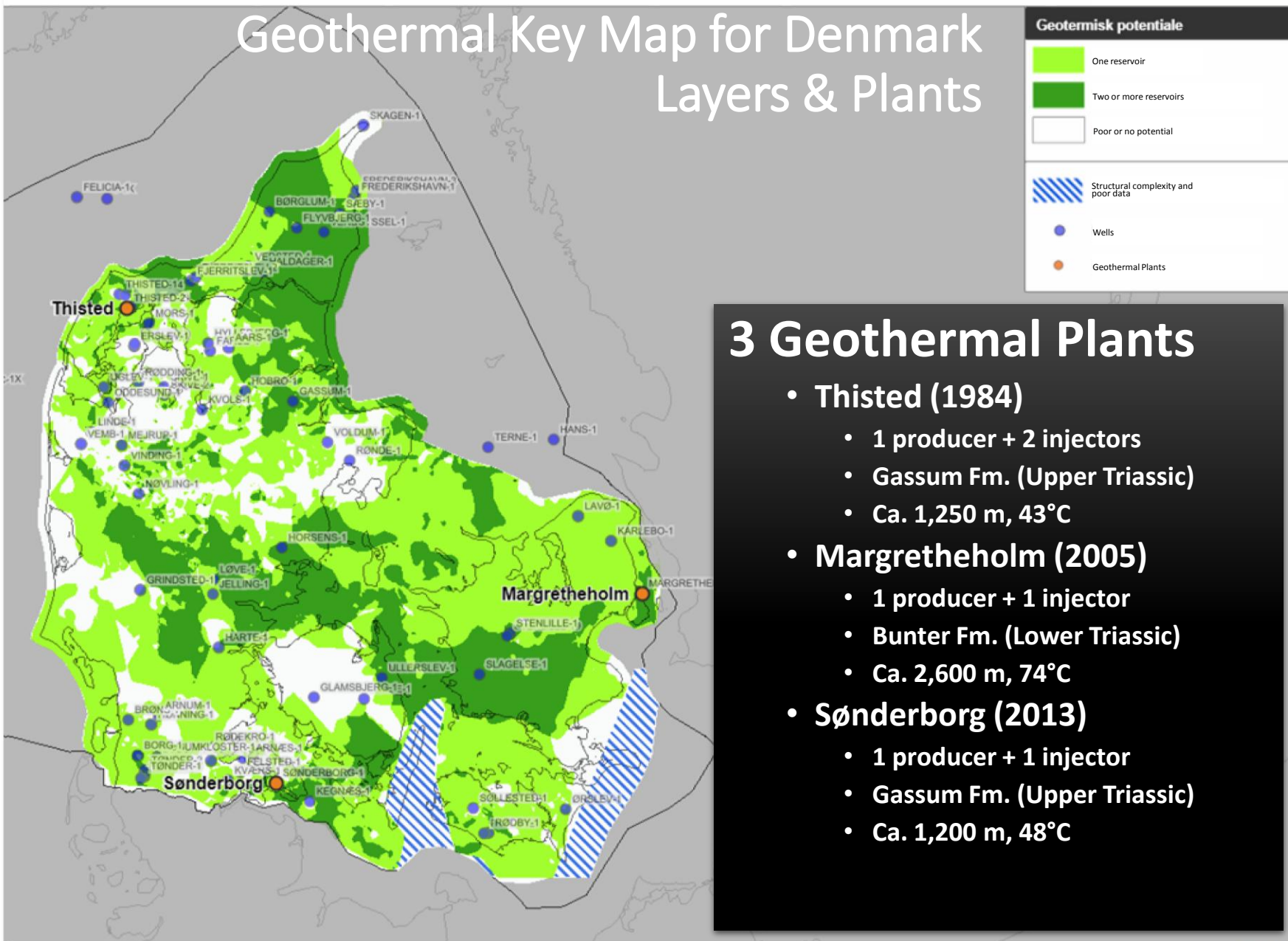
The “Ladder Of 7” (decreasing CO₂ footprint)



Geothermal in Denmark - timeline



Geothermal Key Map for Denmark Layers & Plants



Geothermal in Denmark - Potential

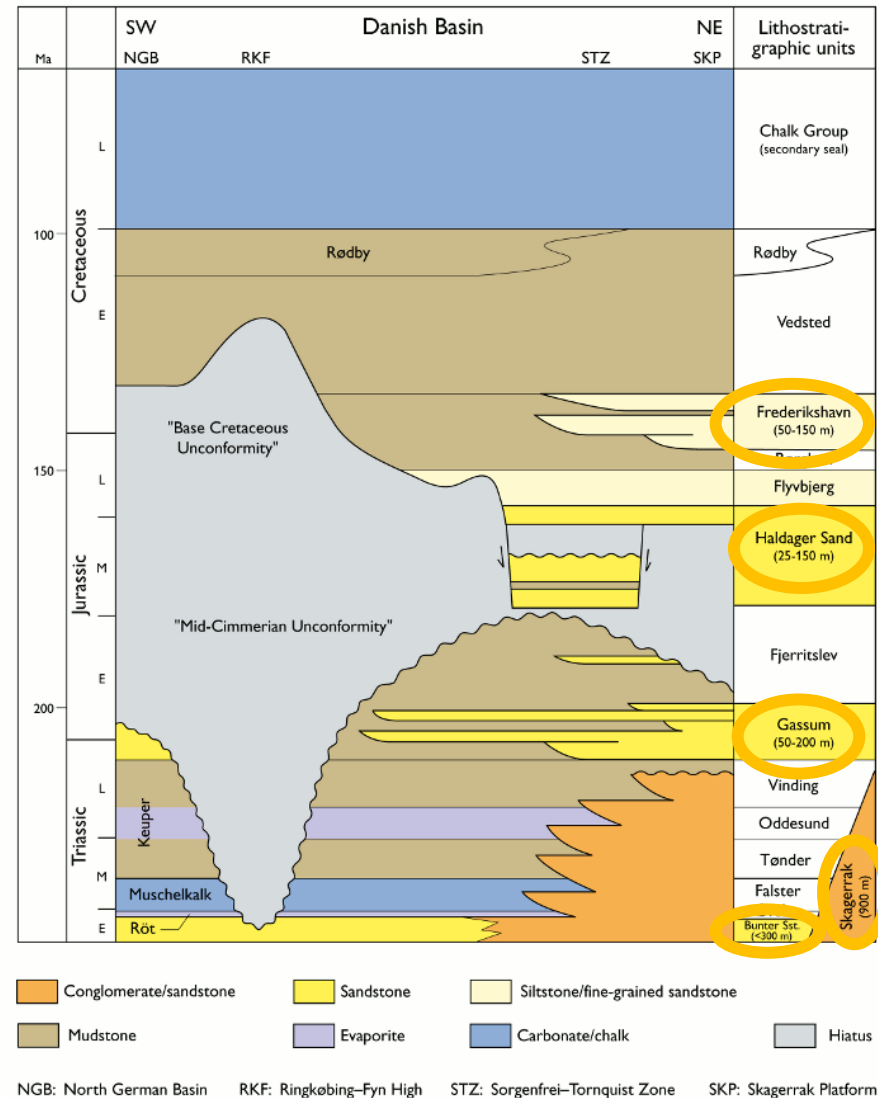
- GEUS

- 800m>GeothPotential<3000m
 - Deep = higher temp & lower poro/perm
 - Shallow = lower temp & higher poro/perm

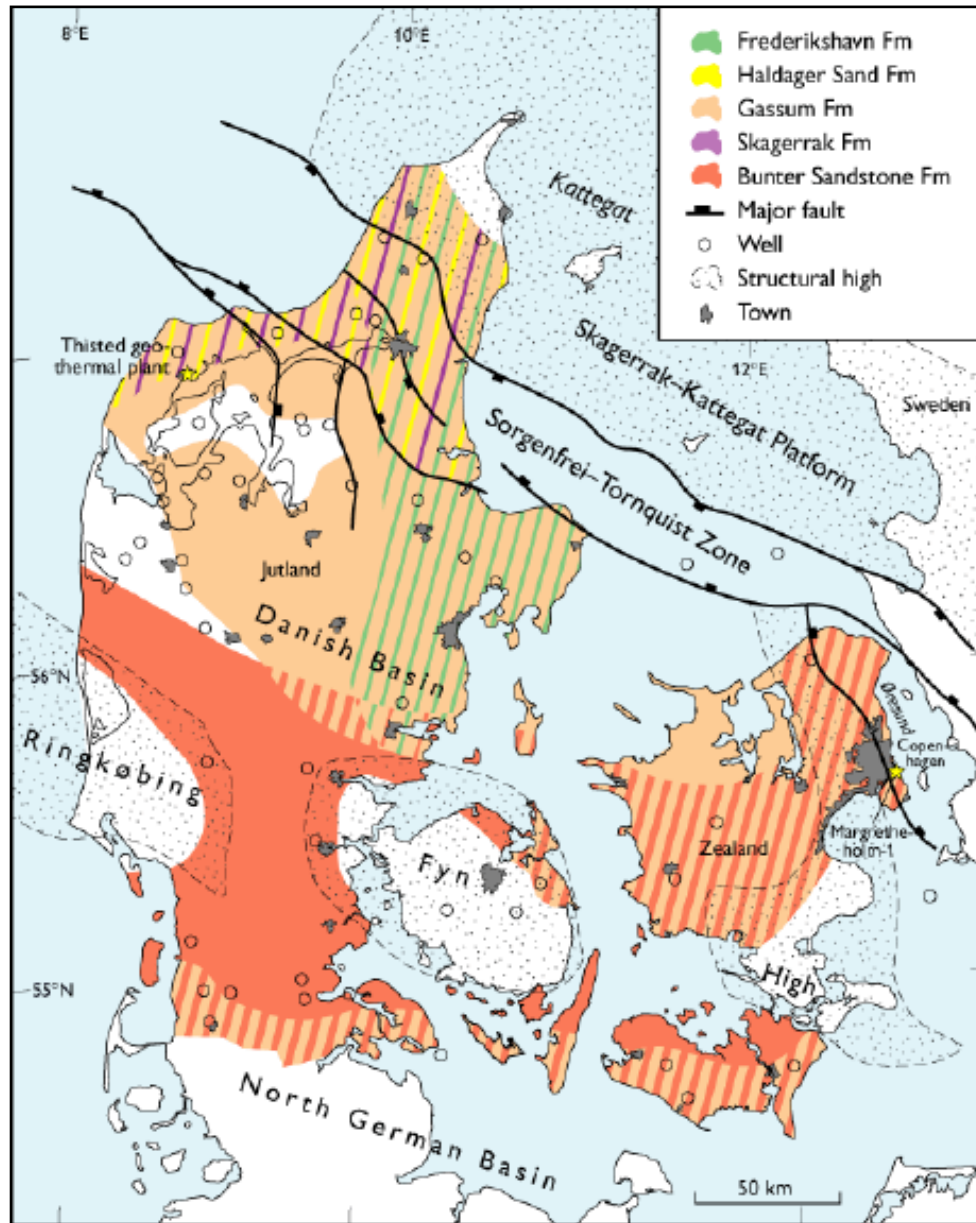
- Potential sandstone reservoirs

- Cretaceous: Frederikshavn Formation
- Jurassic: Haldager Sand Formation
- Triassic: Gassum Formation
- Triassic : Skagerrak Formation
- Triassic: Bunter Sandstone Formation

- Geothermal potential mapped by GEUS available online: "Geotermi WebGIS-portalen"



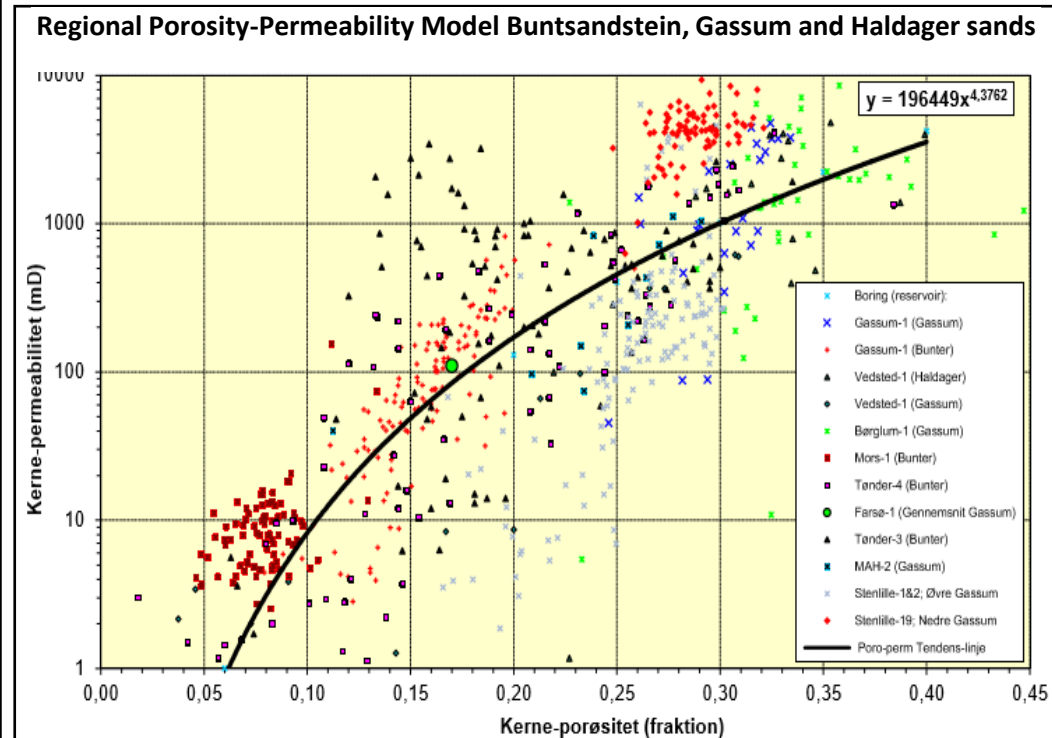
Lolland – Falster: mainly Triassic Geothermal Potential



• Geus Map

- Regional geothermal potential of possible aquifer formations, based on
 - burial depth of 1000–2500 m
 - sand thickness of more than 25 m.

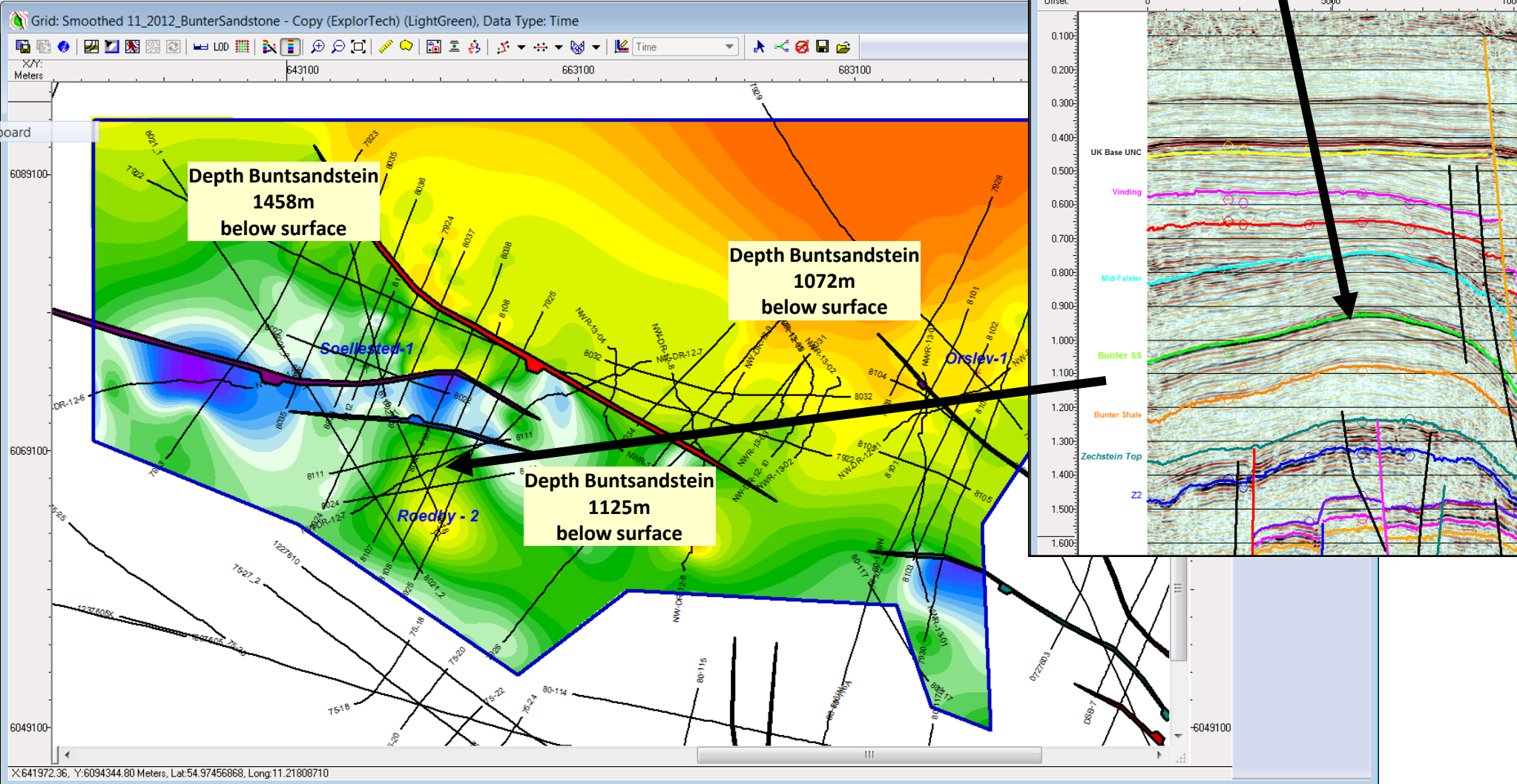
• Bunter & Gassum Formations



Lolland – Falster: NRDBV Database

Buntsandstein Time Structure across Lolland – Falster. Note that the contours represent seismic Two-Way-Traveltimes. Depth of Main Triassic Reservoir indicated for the three drilled wells. Existing 2D seismic coverage and faults are also shown.

**Buntsandstein
geothermal
reservoir**



Geothermal Plans for Lolland - Falster

- Shallow Geothermal Projects

- In conjunction with Farminee
- Our project attempts to revolutionise the cost and applications for Geothermal energy
 - This will focus on the currently untapped “near-shallow” geothermal resource (between 800 – 1400 m); between the deeper, existing district heating projects and the shallower, hot water storage projects
 - This will be achieved by identifying these near-shallow geothermal resources, simplifying drilling & completion techniques and developing fit-for-purpose, low cost surface equipment to exploit the low-grade heat
 - Our project will not only develop the methodologies to deliver low cost geothermal energy solutions, but will demonstrate this with a proof-of-concept drilling and implementation project

- Deep Geothermal Application in preparation

- West-Lolland has deep seated faults
 - Deep Geothermal Source?
- Jutland Hot Spots?

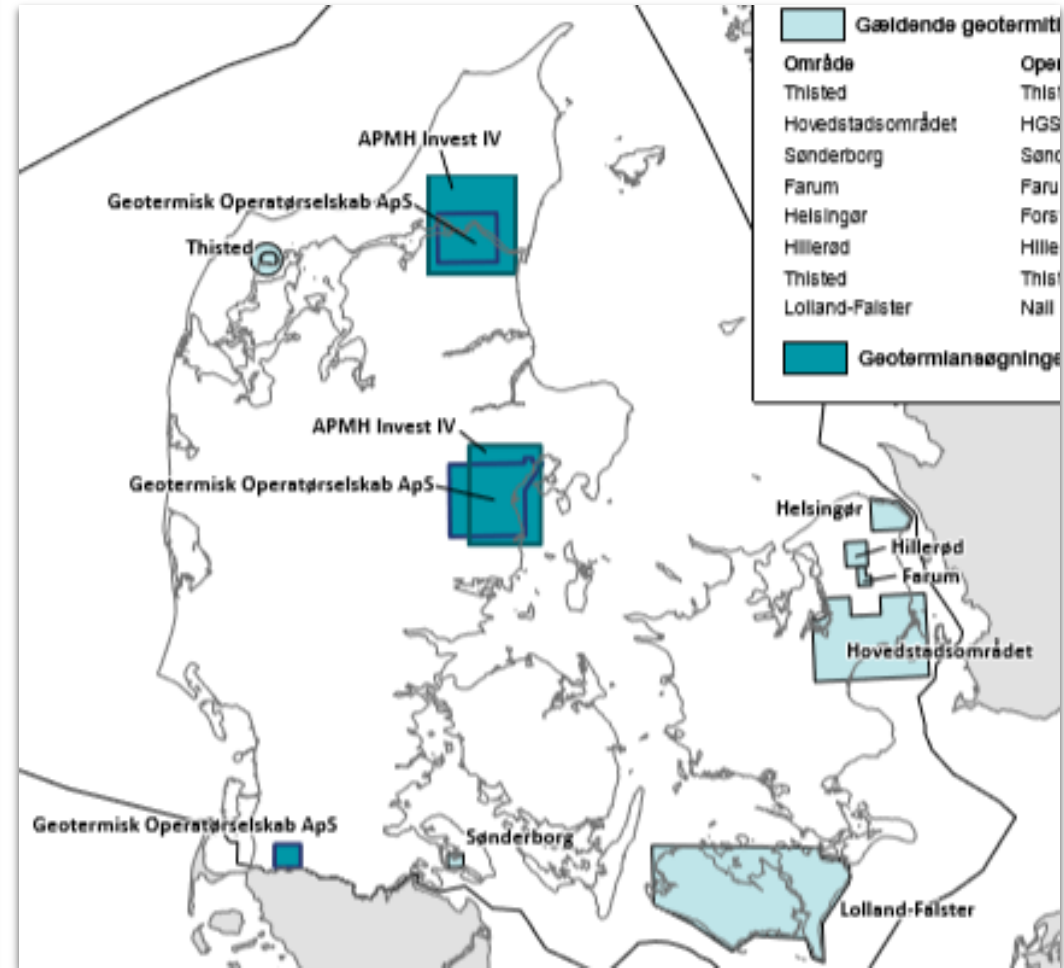
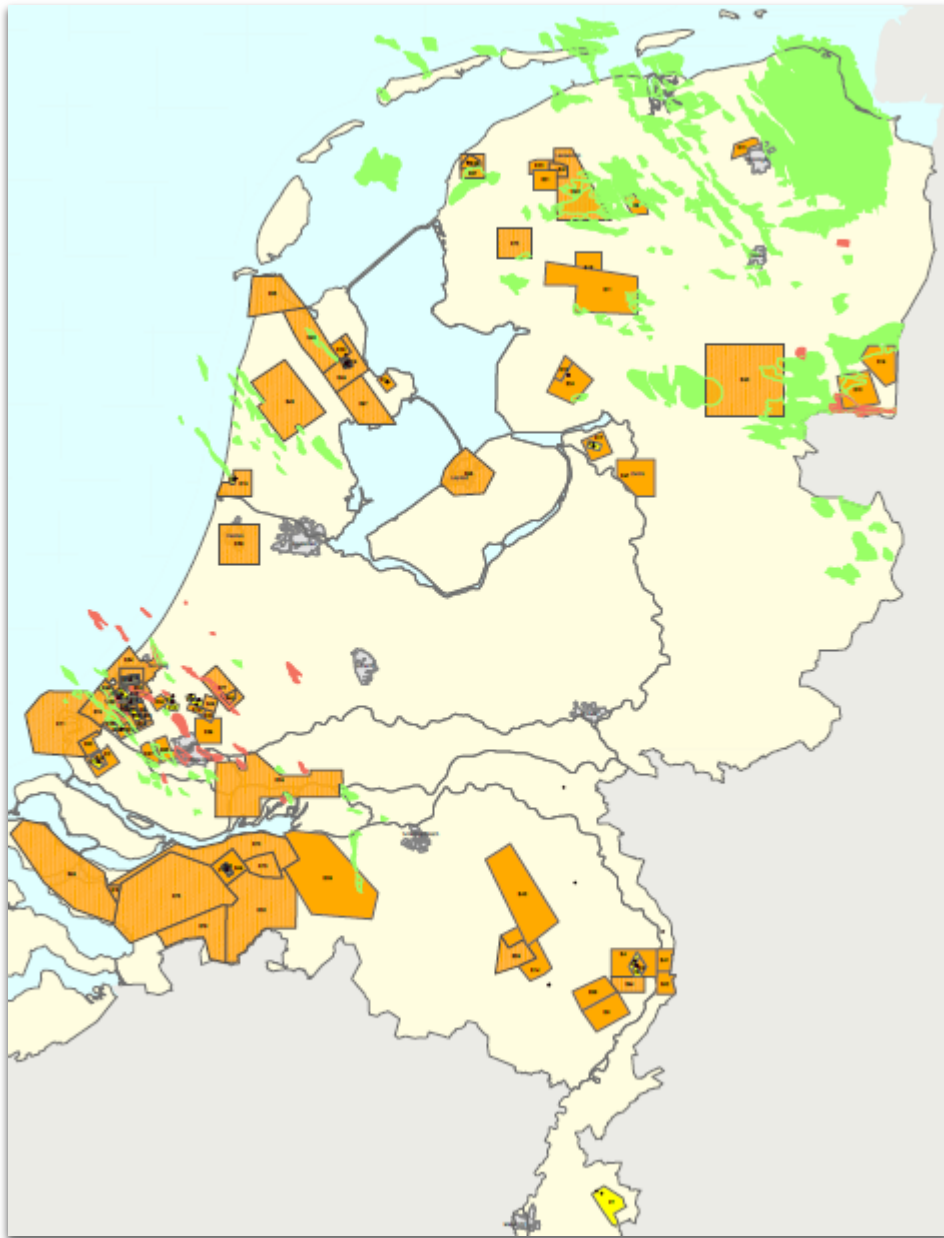
Comparison Geothermal vs. Oil&Gas

| | Oil & Gas | Geothermal |
|--|--------------------------------|---|
| Subsurface Exploration Modelling Reservoir Engineering | ✓ | ✓ |
| Well Planning | ✓ | ✓ + Authorities |
| Well Operations | ✓ (above geological target) | ✓ (next to client) Authorities, Neighbours, Logistics |
| Cost | Small in Lifecycle | Large in Lifecycle (watch risk/reward Fo District Heating Operator) |
| Personnel | ✓ | ✓ |

Comparison Geothermal: NL vs. DK

| | Netherlands | Denmark |
|--------------------------------------|-----------------|---------------------|
| Operational Geothermal Plants | 16 (~50 MWth) | 3 (~33 MWth) |
| Issued Licences | See Next Slide | 6 |
| No. Of Players | 20-40 | 5-10 |
| Subsidy | ✓ (on Revenues) | ✓ (Capex Guarantee) |

Geothermal Licenses – NL & DK – Existing Licenses & License Applications



Recommendations

- Denmark has great geothermal potential in large parts of the country
 - Good Geology
 - 3 operational plants
 - Legal framework in place & willing government/regulator
 - Increasing amount of licenses & players
- Recommendations
 - Simplify Danish licensing procedures
 - Procedure is demanding
 - 3 stages of approval by the DEA
 - License per client? (District Heating vs. Industrial Customers)
 - Phase out unnecessary environmental screening
 - All three projects were thoroughly screened and it was found that there are no environmental issues in any of the plants.
 - Increase subsidy by introducing, next to the CAPEX-overrun guarantee scheme, a subsidy on revenues (like SDE+ in the Netherlands)
- Netherlands – new advisory for the geothermal sector
 - Team of seasoned Geothermal & Oil/Gas experts, www.geothermiepartners.nl

