# GEAN 2024 Stavanger

# Transfer in Focus:

# Is O&G drilling and well competence needed for geothermal resource extraction?

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# Yup.

( just a hunch )

(and reservoir engineers,
mudloggers,
geochemists,
geophysicists,
exploration teams,
etc.

# Geothermal potential

## Mainland Norway

- Average gradient 18 °C/km. Locally ca. 26°C/km

## NCS Offshore gradients

- 35 °C/km North Sea average geothermal gradient
- 45°C/km Central Graben & Utsira High
- 59 °C/km Gro discovery, Mime etc.

## Reservoirs 80 to 160°C

## 10% are above 100°C (OGS-21 report)

Maystrenko

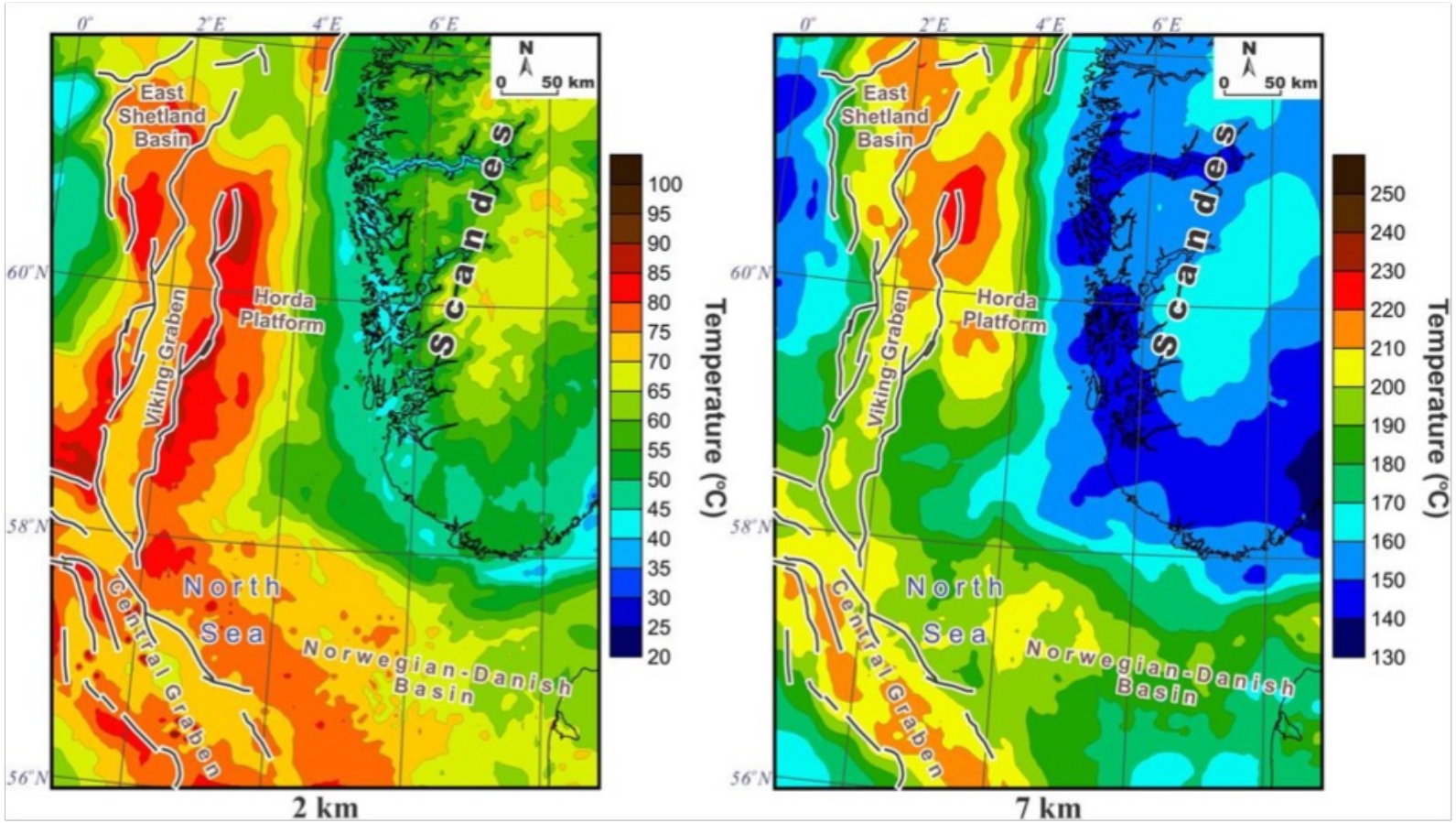


**Figure 5: Modelled temperatures within the upper part of the study area. Temperature maps for depths of 2 km and 7 km which are extracted from the 3D thermal model.**

*Source: NPD fact pages*

# Geothermal potential I

## Mainland Norway

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- 45°C/km Central Graben & Utsira High
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## Reservoirs 80 to 160°C

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| Field | Well | Water depth | Geothermal gradient avg.,°C/km | Reservoir | |
|---|---|---|---|---|---|
| | | | | approx. T °C | depth (m rsf) |
| Balder | 25/11-4 S | 127 | 52.9 | 94 | 1773 |
| Grane | 25/11-21A | 129 | 46.8 | 83 | 1775 |
| Fram H-Nord | 35/11-15 | 360 | 46.5 | 121 | 2601 |
| Johan Sverdrup | 16/2-10 | 115 | 46.1 | 84 | 1820 |
| Tambar | 1/3-4 | 72 | 45.1 | 186 | 4128 |
| Edvard Grieg | 16/1-15 | 111 | 44.7 | 95 | 2125 |
| Rev | 15/12-17 | 87 | 44.3 | 123 | 2770 |
| Dvalin | 6507/7-15 | 399 | 39.9 | 164 | 4100 |
| Gyda | 2/1-8 | 66 | 38.6 | 154 | 4000 |
| Morvin | 6506/11-8 | 380 | 38.6 | 167 | 4320 |
| Kristin | 6406/2-3 | 372 | 38.5 | 163 | 4230 |
| Embla | 2/7-27 | 71 | 37.7 | 151 | 4000 |
| Valemon | 34/11-5 | 190 | 37.8 | 152 | 4010 |
| Kvitebjorn | 34/11-3 | 208 | 37.5 | 142 | 3790 |
| Martin Linge | 29/6-1 | 125 | 34.9 | 149 | 4275 |

*Source: NPD fact pages*

# Geothermal potential II

- Fluid temp < 110: platform heating (or pipeline?)
- Fluid temp >110: electricity (ORC)

| Field | Well | Water depth | Geothermal gradient avg.,°C/km | Reservoir | | 200°C Isotherm | | Notes |
|---|---|---|---|---|---|---|---|---|
| | | | | approx. T °C | depth (m rsf) | depth (m rsf) | Dist. below reservoir (m) | production; structure |
| **Balder** | 25/11-4 S | 127 | **52.9** | 94 | 1773 | 3782 | 2009 | Oil/Gas; fpso |
| **Grane** | 25/11-21A | 129 | **46.8** | 83 | 1775 | 4275 | 2500 | Oil; platform |
| **Fram H-Nord** | 35/11-15 | 360 | **46.5** | 121 | 2601 | 4298 | 1697 | Oil/Gas; subsea |
| **Johan Sverdrup** | 16/2-10 | 115 | **46.1** | 84 | 1820 | 4337 | 2517 | Oil; platform, electrif. |
| **Tambar** | 1/3-4 | 72 | **45.1** | 186 | 4128 | 4430 | 302 | Oil; wellhead platf. |
| **Edvard Grieg** | 16/1-15 | 111 | **44.7** | 95 | 2125 | 4476 | 2351 | Oil; platform |
| **Rev** | 15/12-17 | 87 | **44.3** | 123 | 2770 | 4512 | 1742 | Gas/cond; subsea |
| **Dvalin** | 6507/7-15 | 399 | **39.9** | 164 | 4100 | 5012 | 912 | Gas; subsea |
| **Gyda** | 2/1-8 | 66 | **38.6** | 154 | 4000 | 5183 | 1183 | Oil; decommissioned. |
| **Morvin** | 6506/11-8 | 380 | **38.6** | 167 | 4320 | 5186 | 866 | Gas/Oil; subsea |
| **Kristin** | 6406/2-3 | 372 | **38.5** | 163 | 4230 | 5198 | 968 | Gas/Cond; semi-sub |
| **Embla** | 2/7-27 | 71 | **37.7** | 151 | 4000 | 5307 | 1307 | Oil/Gas; wellhead platf. |
| **Valemon** | 34/11-5 | 190 | **37.8** | 152 | 4010 | 5292 | 1282 | Gas/Cond; platf. |
| **Kvitebjorn** | 34/11-3 | 208 | **37.5** | 142 | 3790 | 5337 | 1547 | Gas/Cond; p latf. |
| **Martin Linge** | 29/6-1 | 125 | **34.9** | 149 | 4275 | 5723 | 1448 | Gas/Cond; Platf+FSO |

*Source: NPD fact pages*

# Geothermal potential III

## How deep, below the reservoir, is 200°C ?

- efficient electricity production

| Field | Well | Water depth | Geothermal gradient avg.,°C/km | Reservoir | | 200°C Isotherm | | Notes |
|---|---|---|---|---|---|---|---|---|
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| **Tambar** | 1/3-4 | 72 | **45.1** | 186 | 4128 | 4430 | 302 | Oil; wellhead platf. |
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*Source: NPD fact pages*

# Electricity from water cut

## Preliminary calculations from Turboden

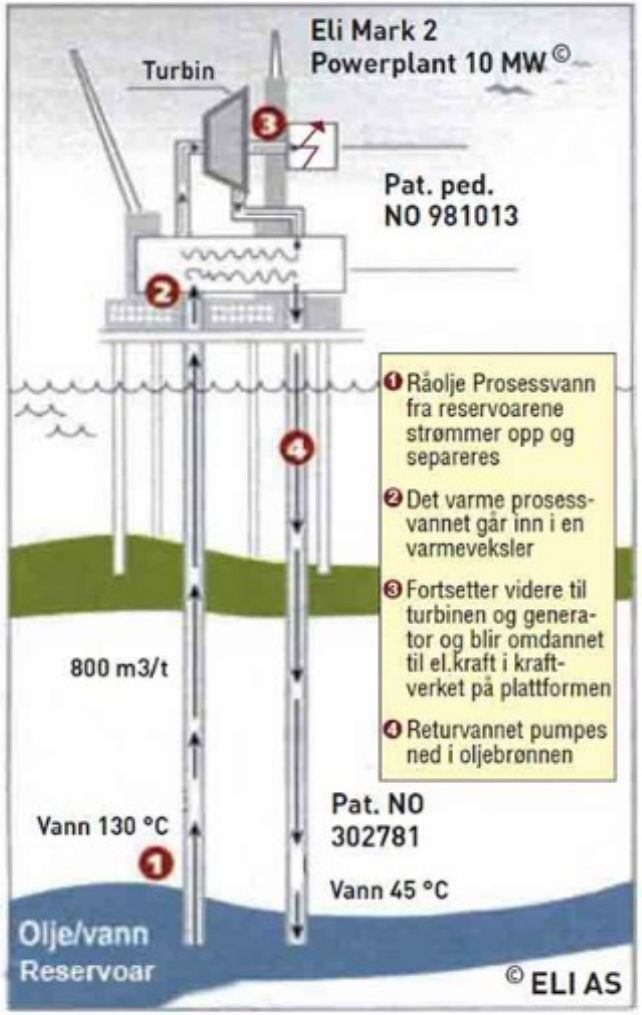
- Kristin: < 1 MWe gross from water cut ( 11 l/s at 160°C)
- Ekofisk: 7 MWe gross from water cut (444 l/s at 110°C)
  - Geothermal brine outlet temperature = 58°C
  - **Plant footprint (if on land)  35 x 25 m**

*Pretty small output.*

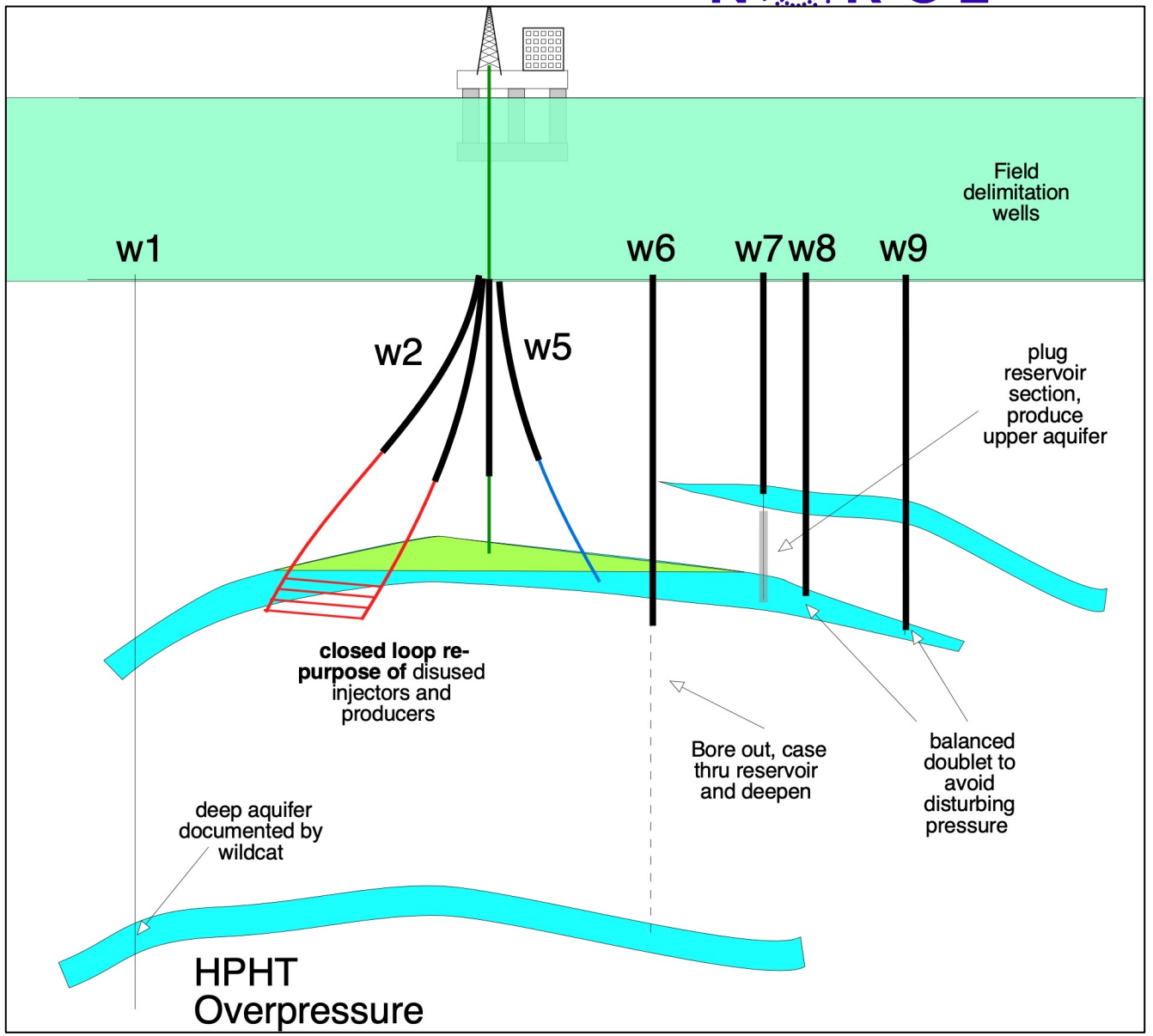
Why not use the water legs (130°)?
- flooded producers
- out-of-service injectors
- residual oil / gas lift...

# Producing thermal fluids

1997 concept for 10 MWe




*Source:https://www.energiaktuelt.no/cppage.6524952-575505.html*



# Producing thermal fluids

## Producing geothermal fluids

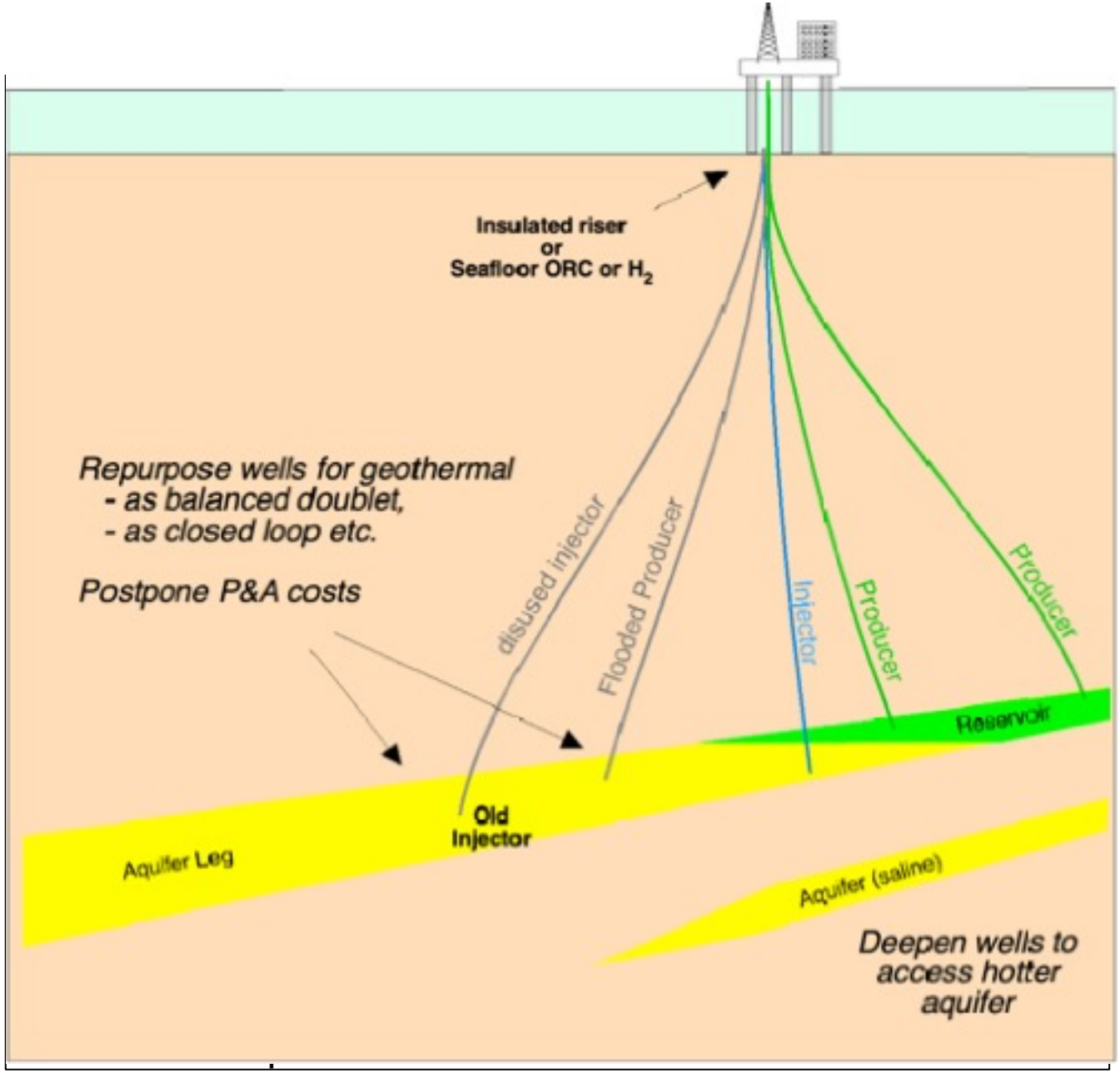
- re-purpose out-of use wells (postpone P&A)
- re-completing in non-reservoir aquifers
- injector-producer or closed-loop

## Direct-use of thermal fluids

- platform heat (reduce electric 15-20%)
- process heat for H2 & $NH_4$
- Fresh water from flash

## Electricity generation

- ORC binary above 110°C
- 10 MWe requires 1000 m3/h (Ekofisk)
- Platform or seafloor?
- Reservoir hydraulic storage (Fervo)

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# Thinking about WPs

| | | | | | | |
|---|---|---|---|---|---|---|
| COSTS | New investment | Modification vs new build | Which aquifer | completion type | | |
| SYNERGIES | Wind integration | Hydrogen integration | Energy system security | Energy Hub | Post-oil energy hub | |
| BUSINESS CASE | ROI | postponing P&A and Decom | CO2 tax avoidance | New Green Ventures | | |
| SOCIO-ECONOMIC CASE | Social Economics | Regulations | Jobs & re-training | Maritime industry | Export technology | Electric demand |

# Moving Offshore Geothermal FORWARD

INCREASE TRL from 4 to 6 +

**Government programs (Research Council)**
100% for a “knowledge for society”
80% - 20% funding “knowledge building for industry”
50% - 50% funding “industry projects”
100% - Green Platform

JIP
(organized through ETN or GCE Node or ...)

Limited field examples
Approximate costs & solutions
- direct use of heat
- electric generation

Business cases
- Present O&G
- Post oil
- postponed P&A

Value to society
- social value
- economic value

JIP members as partners in R&D proposals

Exploration
Detailed plans
Representative costs
Other RE (Wind, H2)
Pilots & Demos of Equipment & Concepts)
Full scale platform & reservoir demo
Other sectors of North Sea
Innovation funding

# Drilling expertise?

# Yup.

Thanks for listening

Maystrenko

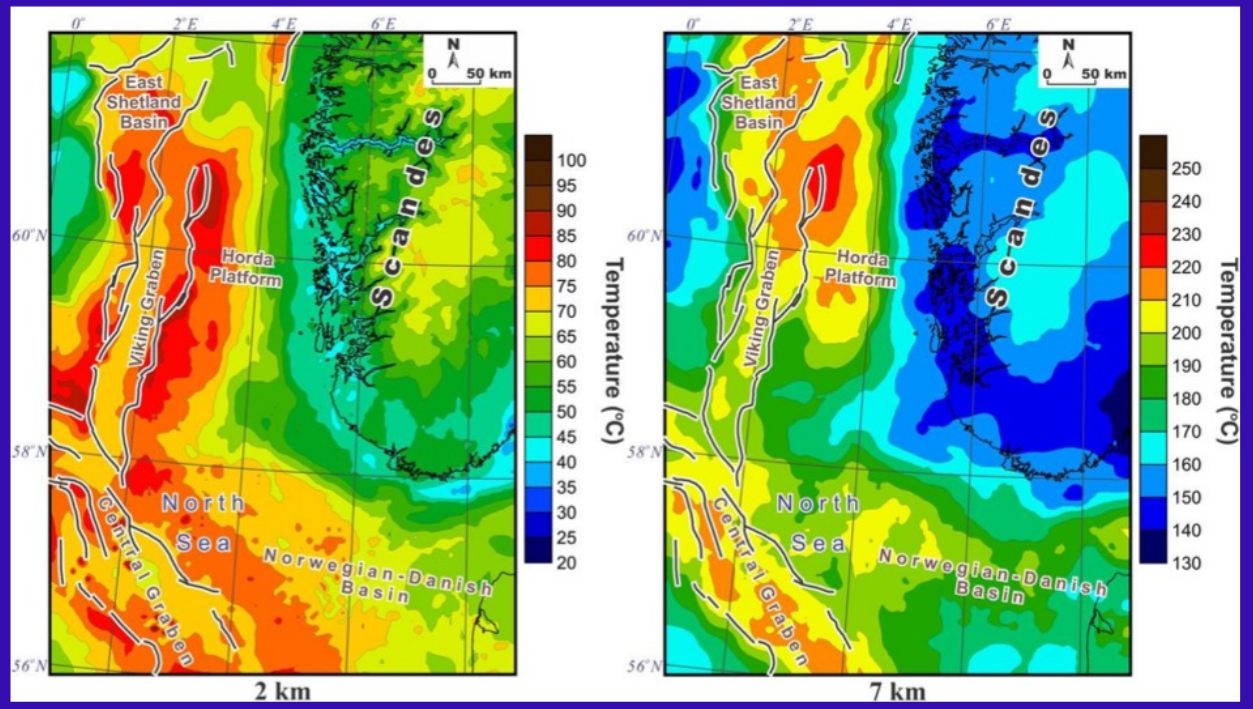


Figure 5: Modelled temperatures within the upper part of the study area. Temperature maps for depths of 2 km and 7 km which are extracted from the 3D thermal model.