NORTH SEA ENERGY DAYS

NORTH SEA – RENEWABLE ENERGY AND FLEXIBILITY TO EUROPE

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RAMBOLL Bright ideas. Sustainable change.

TRENDS AND CONSEQUENCES

- New windfarms are moving further offshore
- New windfarms and turbines are increasing in size

Implications:

- HVDC conversion must take place offshore
- Interconnectors to shore increase in price with distance and capacity
- … and are not likely to match max windfarm capacity

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PROBLEM

Increasing interconnector capacity:

- **HIGH** marginal **cost**
- **LOW** marginal **benefit** of increasing interconnector capacity
  - only in use when operating at high capacity
  - … which is the same time that power prices are low
- Not commercially or economically efficient to build
- Are there better ways of adding flexibility than building increased interconnector capacity to cover full load?

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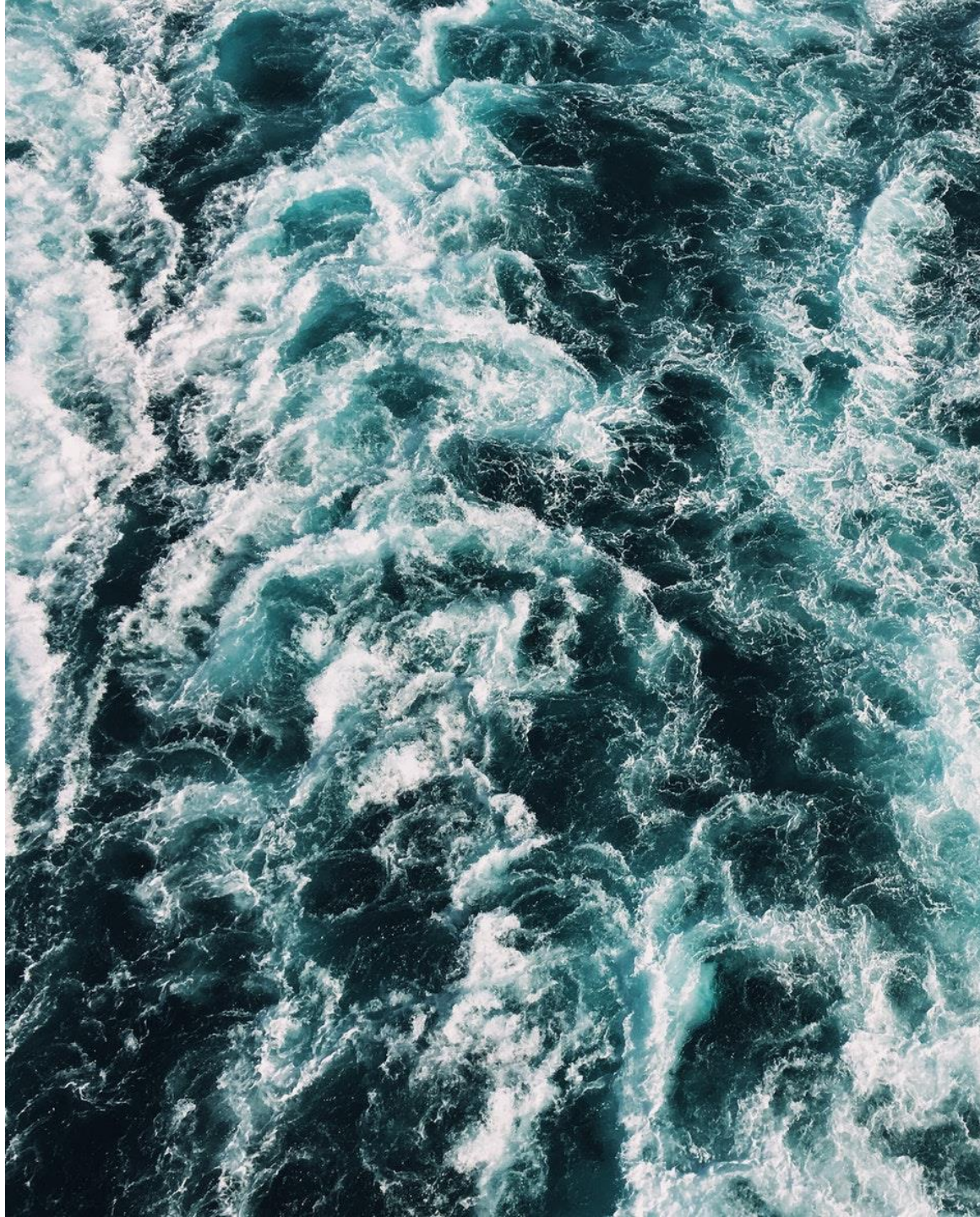
OPPORTUNITIES IN NORTH SEA

- The North Sea offers many opportunities
  - Oil and gas infrastructure is available – with unused capacities
  - Facilities (ports, service providers etc.) already existing
  - Many neighboring countries and markets
  - Resilient energy systems to complement at shore
- Natural gas pipelines from North Sea to all of Europe offers an efficient and cheap corridor to transport energy



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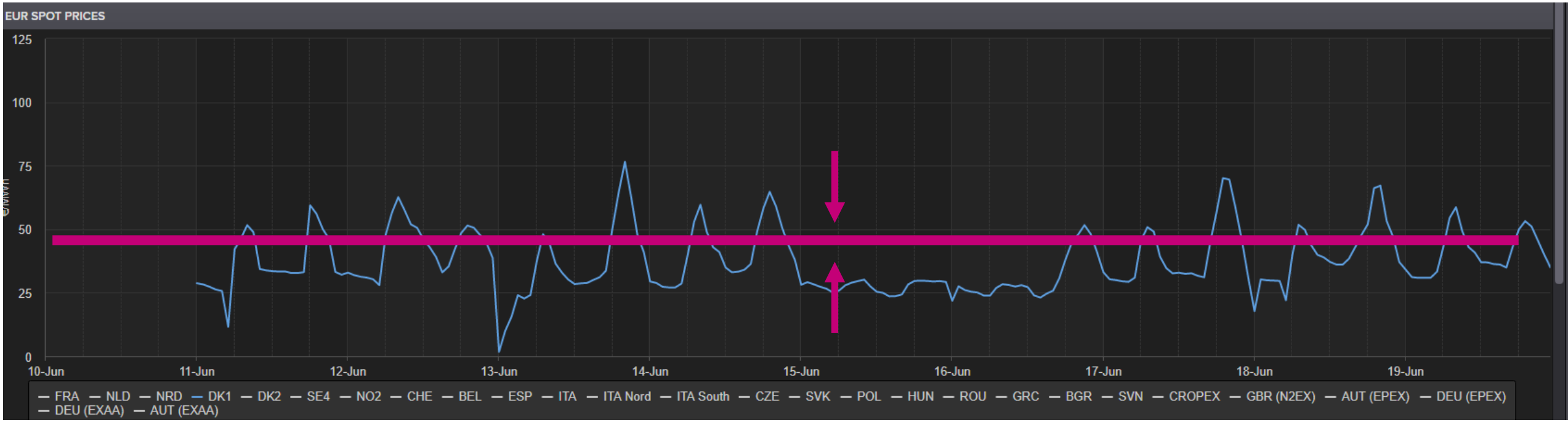
CAN P2X BE THE SOLUTION?

- Wind power can be used in two main path-ways: Power-to-gas (P2G) and Power-to-liquid (P2L)
- Can such production offshore be commercially viable? – and at what power prices?
- What specific P2X solution should be chosen?



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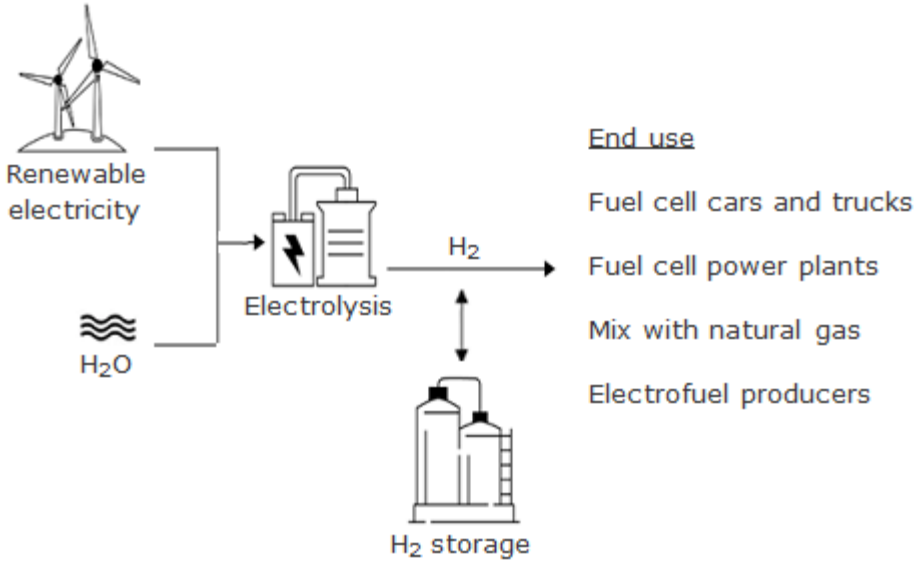
DK1 (West Denmark) Power Prices

Source: Thompson Reuters Eikon

P2X RELIES ON KNOWN PROCESSES WHICH ARE BECOMING INCREASINGLY FEASIBLE

- **Hydrogen.** For heat and power production, transport (fuel cells), and refineries. Smaller amounts possible in the natural gas networks. Does not require CO2.
- **Synthetic methane (P2G).** Can be added directly to the natural gas transmission network. Requires CO2.
- **Synthetic liquid fuels (P2L).** Methanol, petrol, kerosene (jet fuel), diesel and gas oil. Requires CO2.
- **Ammonia**. For fertilizer production and industry. Does not require CO2, but merely nitrogen from the air.



The figure shows production of hydrogen

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POWER TO X (METHANOL)

1 GW wind farm

4500 hours full load

4.500 GWh

Electrolysis

66.316 t H_2

663.158 t CO_2

Methanol

473.684 t

2.592 GWh

279.474 t water

710.526 t O_2

- Efficiency loss: Yes
  - But only with low power prices
- Efficiency changes depending on fuel
- More CO_2 than H_2 is needed for production of methanol
- CO_2 as a traded commodity will enable both carbon capture and P2X

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Simple calculation excluding all technical constraints.

POWER TO X

- H_2 can potentially be stored in salt horsts in the North Sea close to existing fields.
  - Close to for instance to the Gorm, Dagmar and Skjold fields in the Danish North Sea.
  - Can be exported via ship or by pipelines from the platforms. Using e.g. the Tyra platform for connections
- Long term potential: Upgrade existing natural gas pipelines to pure H_2
- Electrofuels can be used in the transportation sector to replace the use of fossil fuels

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CAVEATS

- No standard solutions operational yet
- Large scale and offshore production processes not yet developed
- How will a P2X plant fit on a platform?
- Will there be CO_2 available?
- Investment costs
- Maturing windfarms and P2X at a matching pace
- How to build a viable business case based on marginal wind operation

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NORTH SEA AS THE SOURCE OF FLEXIBILITY AND RENEWABLE ENERGY FOR EUROPE

- Continue the strong tradition of working offshore providing energy for Europe
- Harvest knowhow from the current North Sea operations to benefit the future ones
- Build on a great international collaboration around the North Sea

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