Increasing revenues of offshore wind farms with co-located energy storage systems

Rasmus Juhlin

Elvin Eren

EERA Deepwind 2024 – Trondheim Norway

Objectives

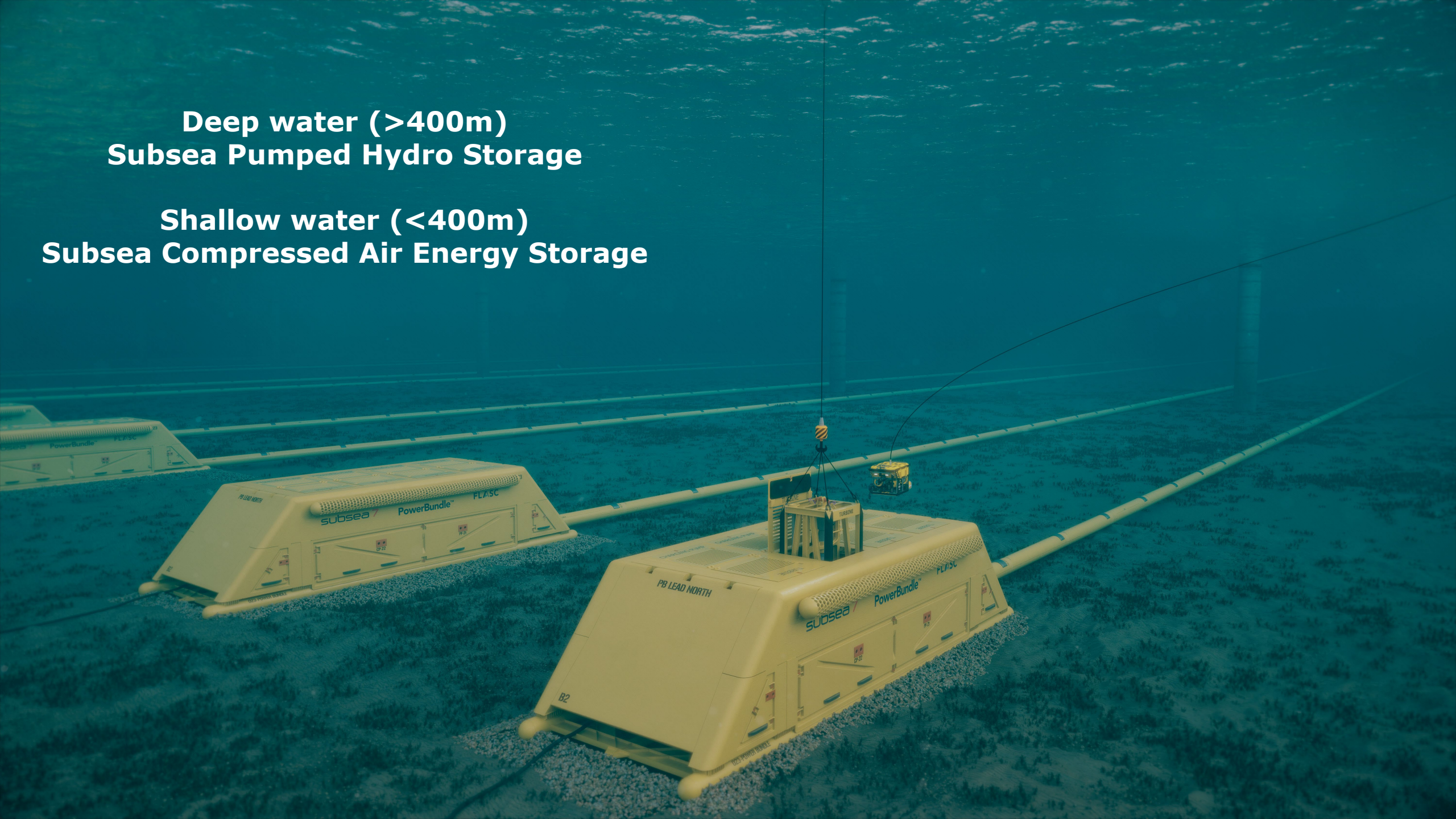
To improve stability of green power supply to the grid

To increase revenue generation of offshore wind farms with minimum additional investment

With a correctly sized, fast-response offshore storage system, offshore wind farms can participate in short-term markets more confidently.

Deep water (>400m)
Subsea Pumped Hydro Storage

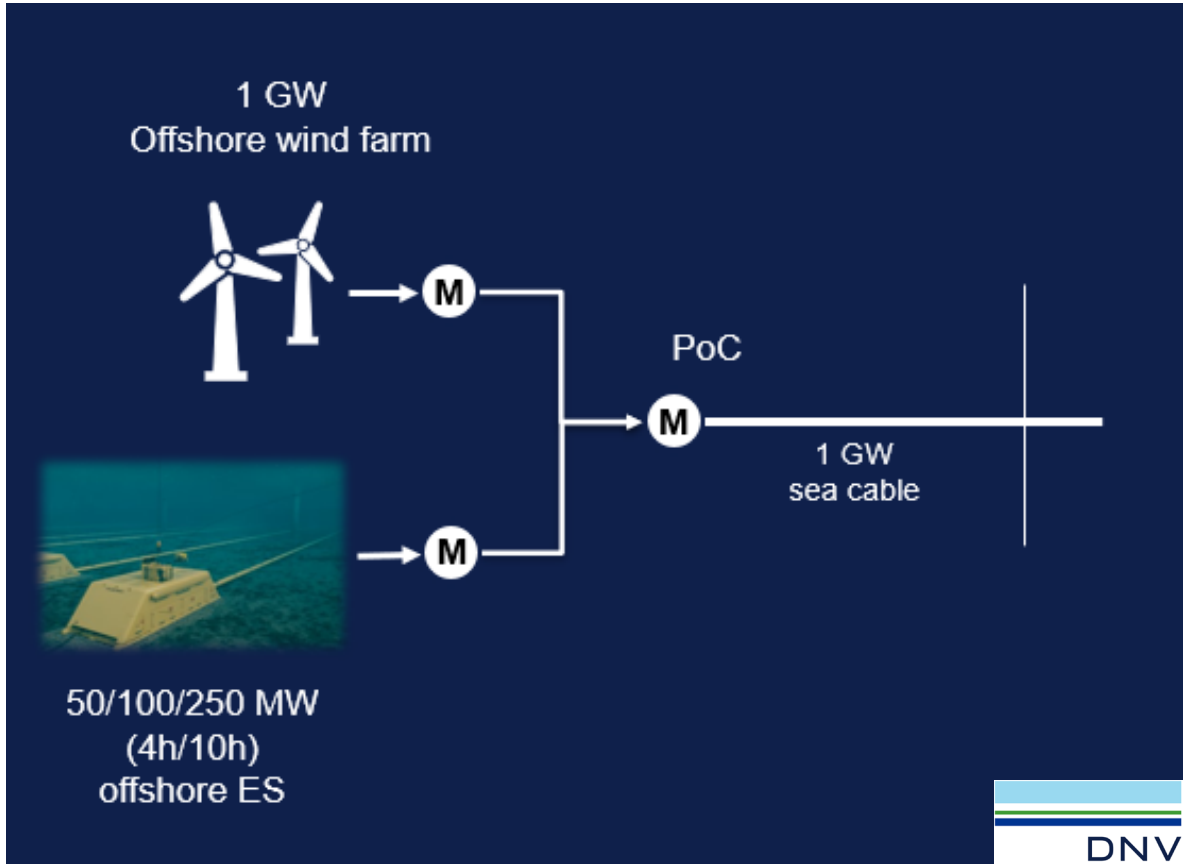
Shallow water (<400m)
Subsea Compressed Air Energy Storage



Co-location example in the German market

Assumptions:

- Various storage system options (4h vs 10h OR 50/100/250 MW storage capacity) were considered.
- Both the 1GW offshore wind farm and the offshore storage system are owned by the same operator.
- No dispatch priority was considered for renewables.
- The offshore wind farm was assumed to be participating in the:
  - wholesale market, i.e. day-ahead markets
  - ancillary services market including Frequency Containment Reserves (FCR and automatic Frequency Restoration Reserve (aFRR).

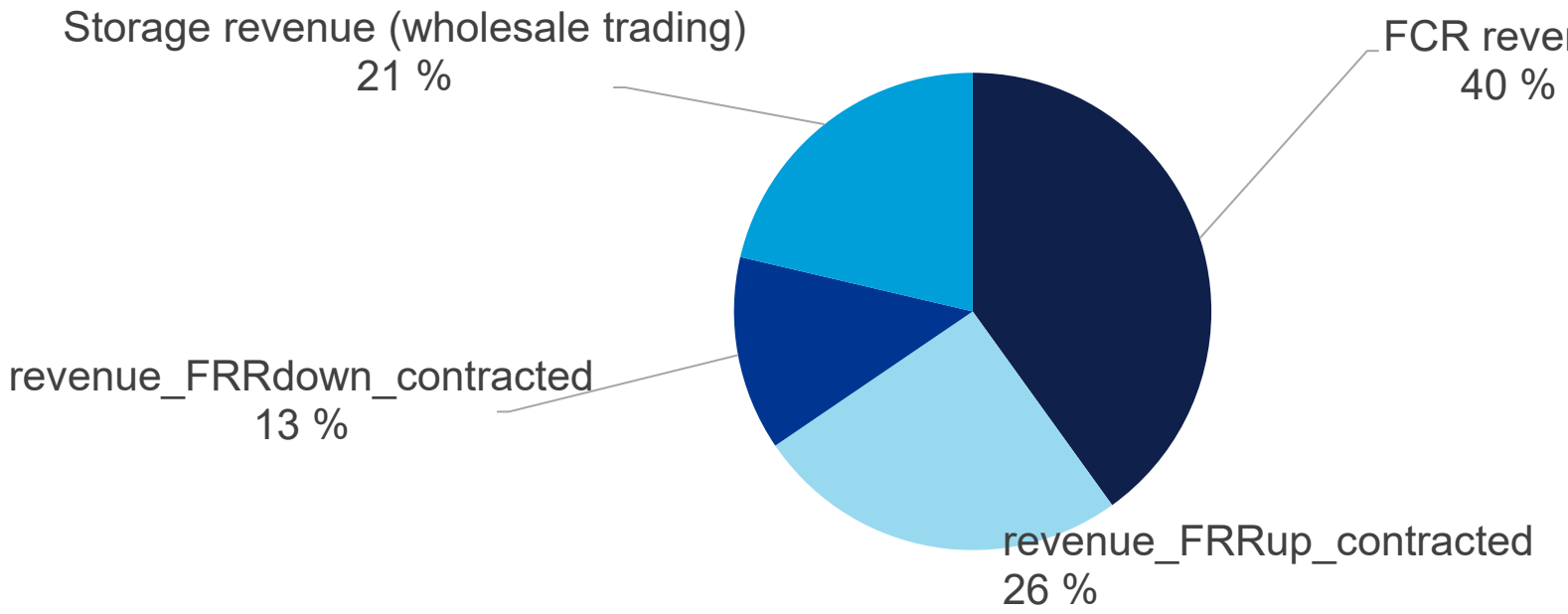


Following analysis, it was found that a 4h system with 50 – 100MW capacity is the optimum solution for the given market and the project concept.

Results of the Business Case (Germany)

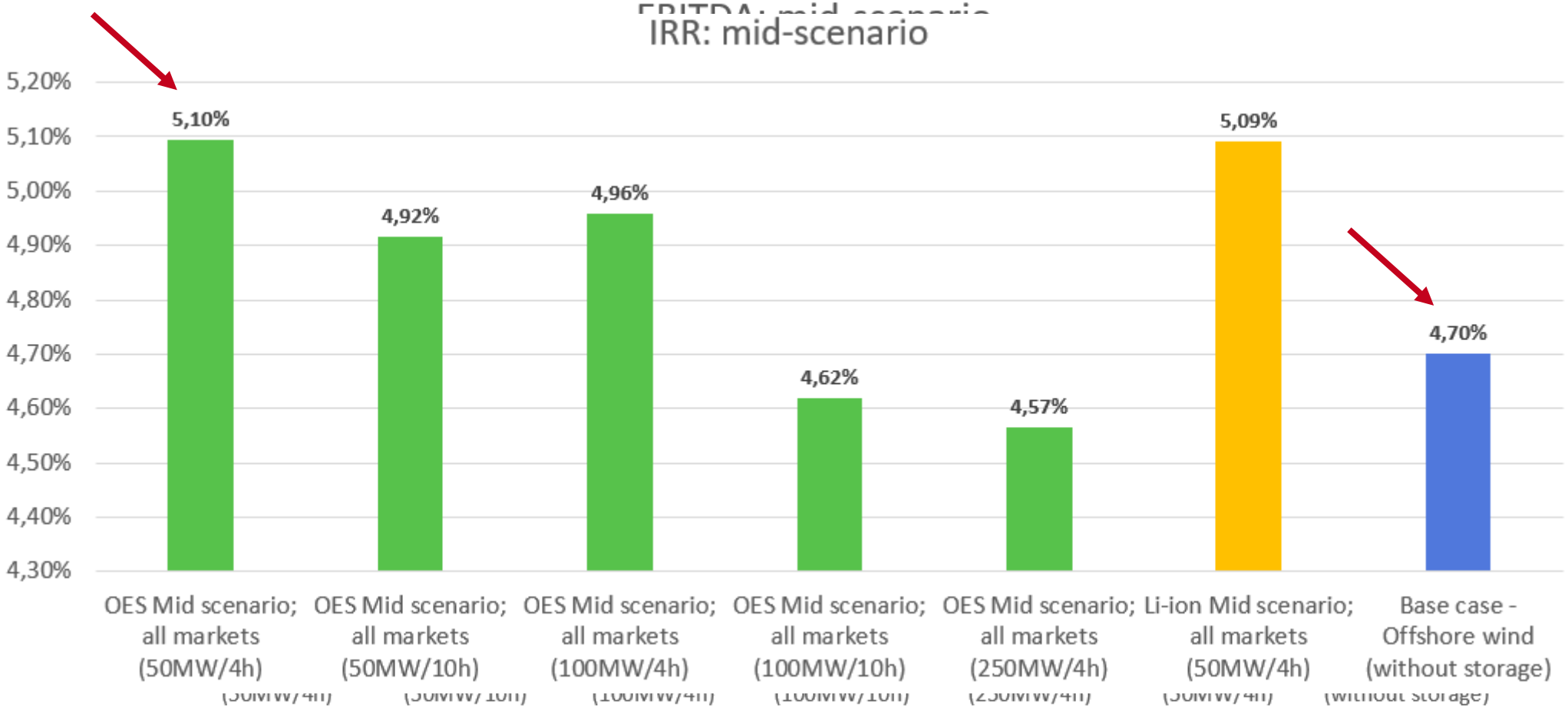
- Future evolution of market prices in different segments includes inherently an uncertainty. To assess the power market dynamics, DNV's PLEXOS software was used.

- According to the mid scenario, it is seen that trading in wholesale markets (i.e. energy arbitrage) contributes to 21% of additional revenues and the rest of revenues, i.e. appr 80%, are generated by participating in capacity markets with a 50MW/4h offshore storage system.



Results of the Business Case (Germany)

- What is the cost of this system at the moment?
  - CAPEX of the 4h system: 690 EUR/kWh
  - OPEX of the 4h system: 2% of CAPEX increasing 2% per annum with inflation



Co-location in UK Offshore Wind Market

- Ownership of Transmission Assets
  - Transmission System Operator (TSO) EU vs OFTO in the UK
  - An offshore storage solution can be a more appropriate solution due to policy related reasons and operational complexities of an onshore storage system.

- Dynamics of power markets
  - In Future Energy Scenarios (FES) of National Grid (UK's TSO), it is expected that the UK power demand increases significantly on the path to Net Zero Emissions.
  - The UK has been perhaps relying more on offshore wind as part of transition plans compared to other European counterparts. And wind is inconsistent.
  - Additionally, how quickly National Grid will be able to upgrade the transmission system as part of Holistic Network Design (HND) is yet to be seen.
  - Therefore, it would be fair to expect higher volatility in UK power market segments.

Under these circumstances, co-location of an offshore storage system gains even more importance. There is a stronger business case in the UK market which we are analysing in a separate study in progress.

Conclusions

- Offshore storage systems are being increasingly considered as part of project concepts. As deployments increase, costs can be expected to be reduced and operational limitations will be better understood.
- Relatively longer-term systems (such as 4h-12h) with a capacity to be optimised based on the size of the offshore wind farm and its route to market strategy can improve:
  - financial metrices such as (EBITDA and IRR) and
  - profitability of the project.
- The level of profitability will be market specific as dynamics of each power market is different.
- The higher the volatility in markets, the higher the chance of increasing revenues from energy arbitrage.
- The more curtailment occurs in a market or the more a grid is technically constraint, the higher the revenues will be from the balancing markets.

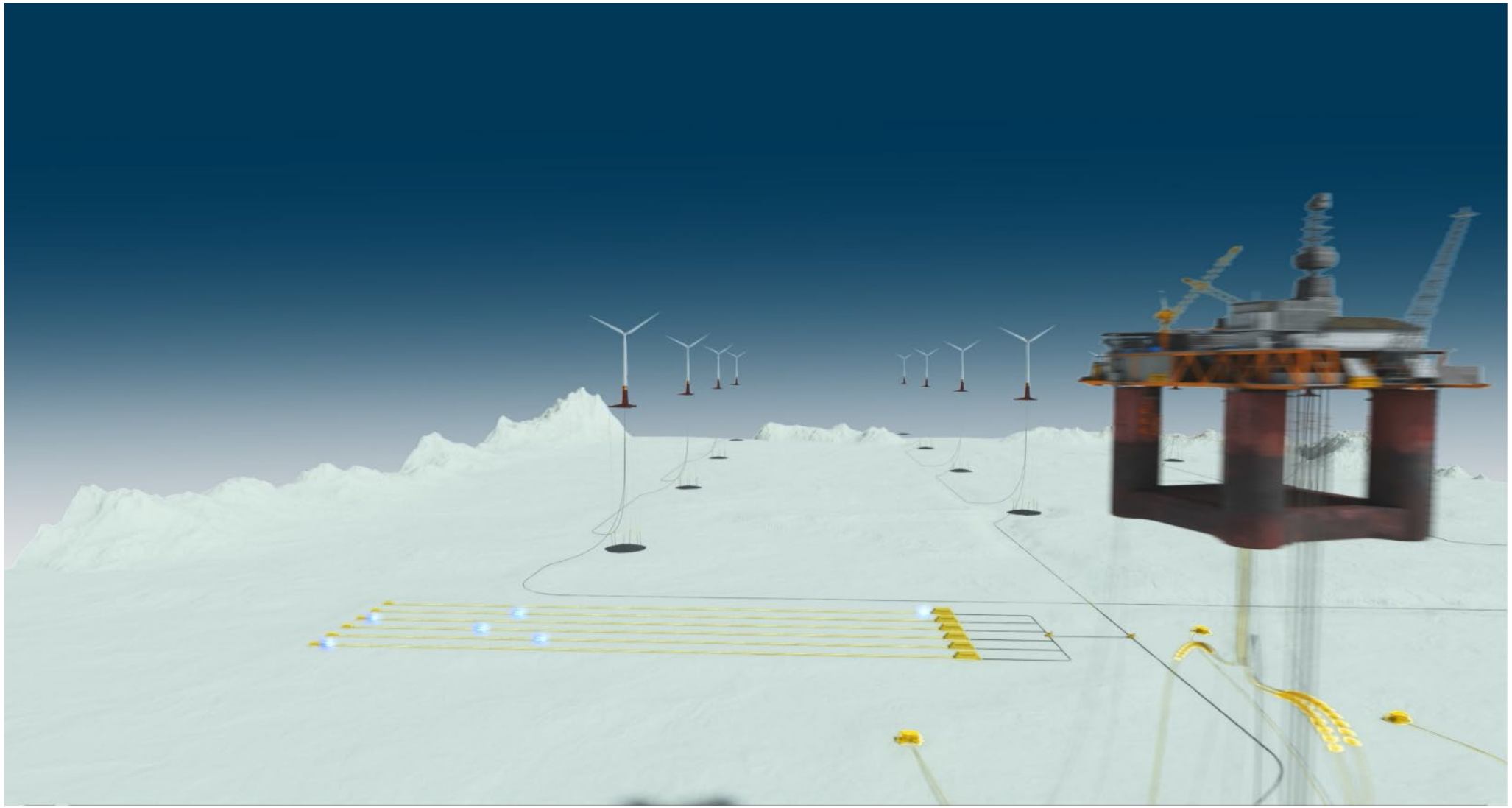
THANK YOU

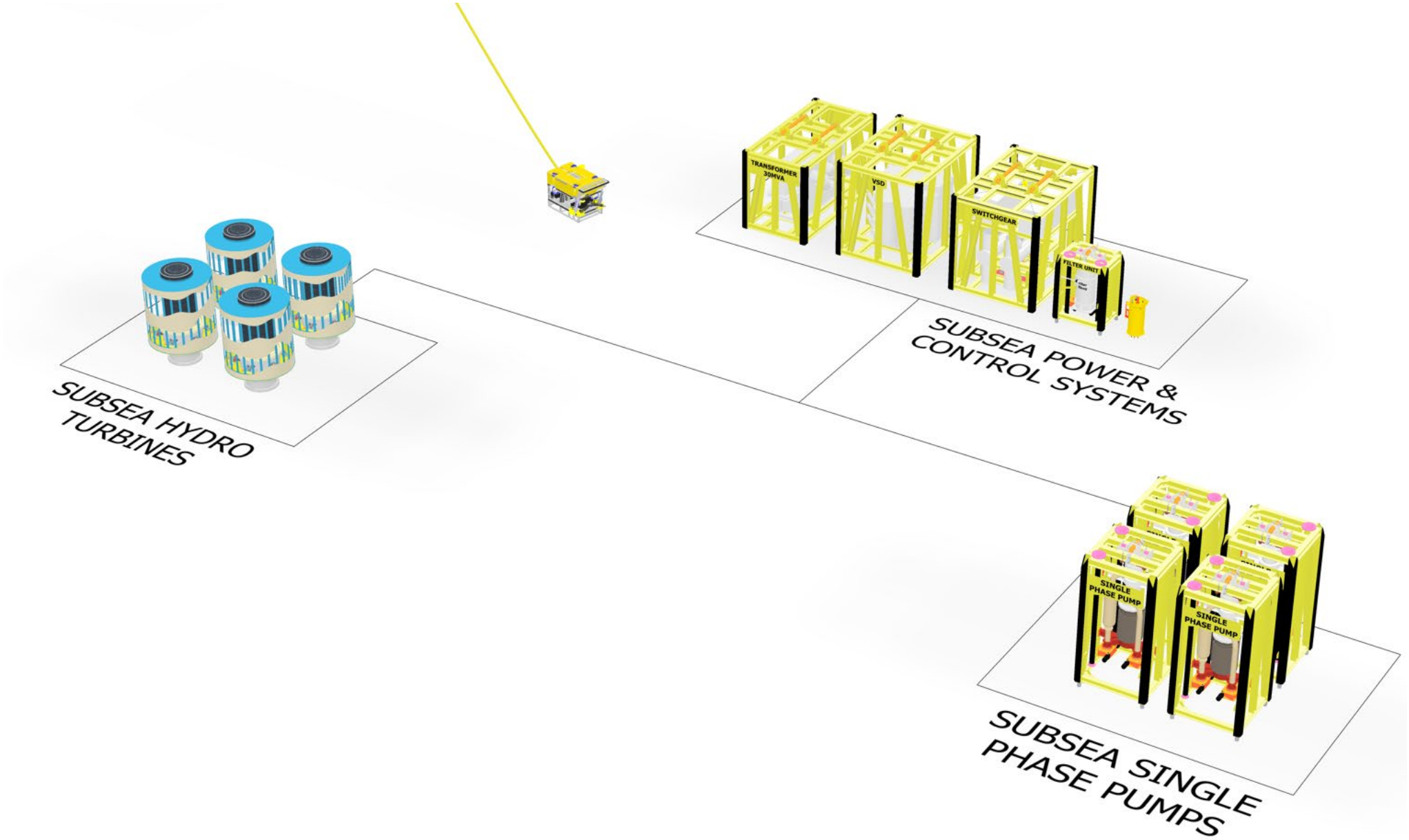
Seaway7 is a leader with 10+ years' experience in delivering offshore wind projects.

We are proud to have executed several floating wind cable-lay projects. We have invested in floating wind technology and are dedicated to the continuous development of cost-effective, innovative floating wind solutions.

As a leader in the delivery of offshore wind projects, we have contributed towards over 11 gigawatts through the installation of fixed offshore wind foundations and submarine cables in Europe, Asia and the USA.

BACKUP SLIDES





Potential Energy Density