

ENERGY

Cost of offshore transmission

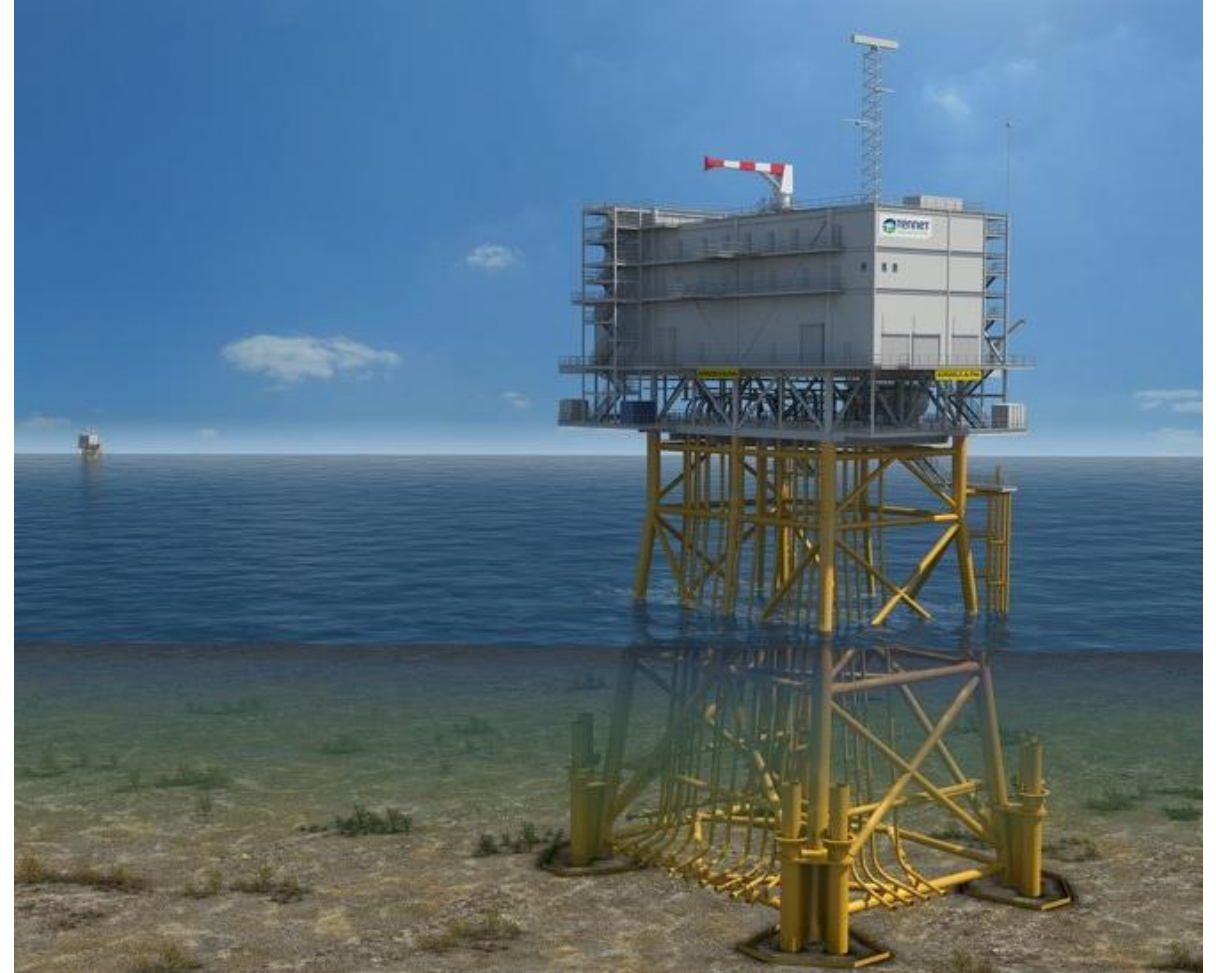
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27 June 2019

Introduction

- Cost of offshore wind energy have significantly decreased recently
- Grid connection cost become a larger fraction of total LCOE
- TenneT wishes to benchmark the cost of their standard HVAC platform and grid connection system to comparable offshore transmission systems
- In the UK, offshore transmission systems are being transferred to OFTO's. The Transfer Prices (initial, indicative and final) are published by Ofgem, and can be used for comparison.
- Denmark has also published final costs that can be used for comparison.
- France investment costs have been provided by RTE

Disclaimer: Note that the tender systems in NL, UK, FR and DK are different in terms of scope and nature. The comparison presented is meant as a qualitative indication of the LCOE and CAPEX in these countries.



Transfer Values available



Tenders Round Legend

- Round 1
- Round 2
- Round 3
- Round 4
- Round 5

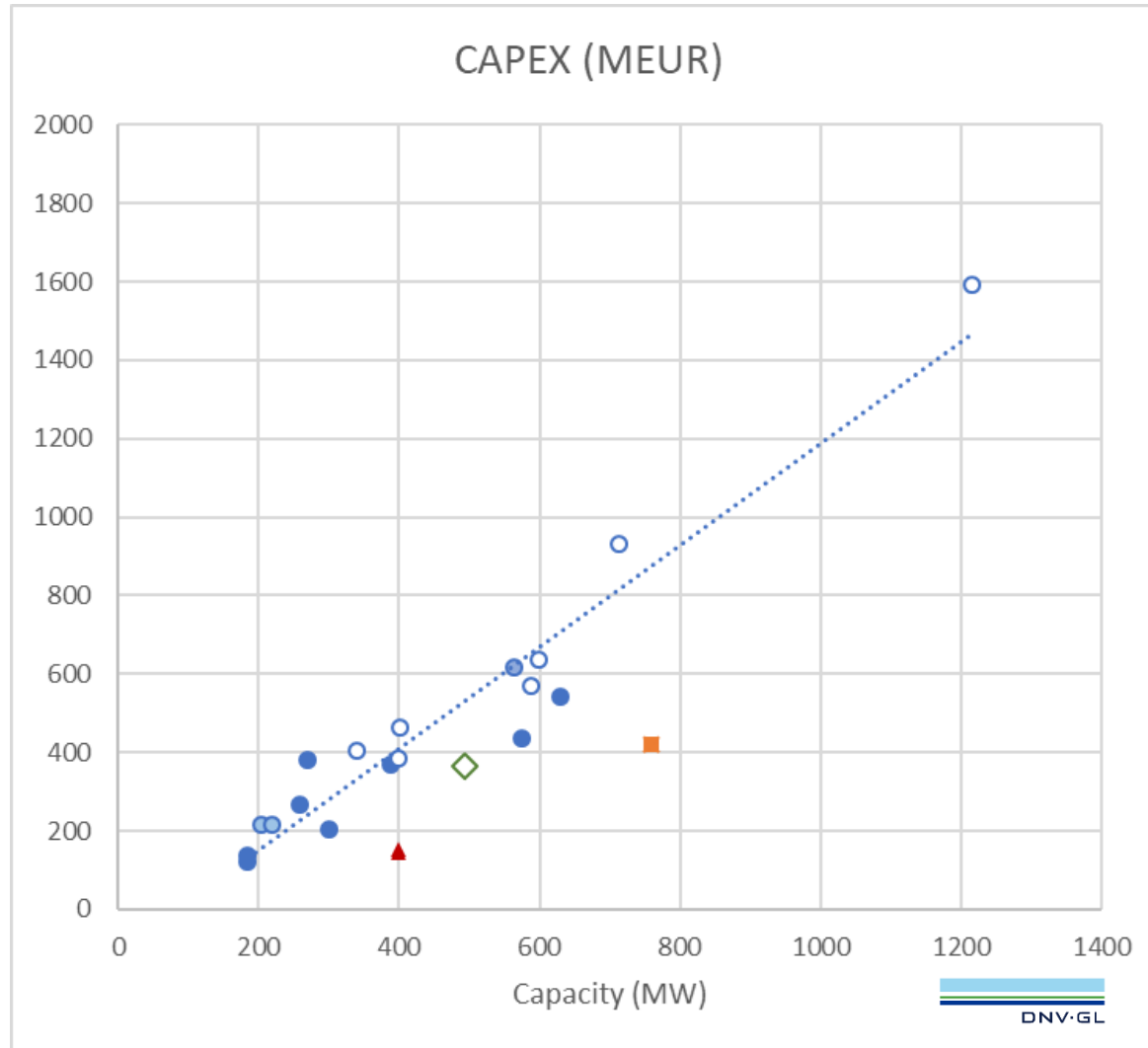
Transfer Value Legend

- * Developer's initial transfer value
- ** Indicative transfer value (ITV)
- *** Final transfer value (FTV)

- In the UK, 6 rounds of offshore transmission systems are tendered and transferred to Offshore Transmissions Operators (OFTO)
 - Final transfer value (14)
 - Indicative transfer value (3)
 - Developer's initial value (7)
- Total capital expenditures in Denmark are available for
 - Anholt
 - Horns Rev 3
- Capital expenditures in NL are based on public domain cost published by TenneT (Borssele, HKZ, HKN)
- Capital expenditures in FR have been provided by RTE and are based on 3 offshore wind farms

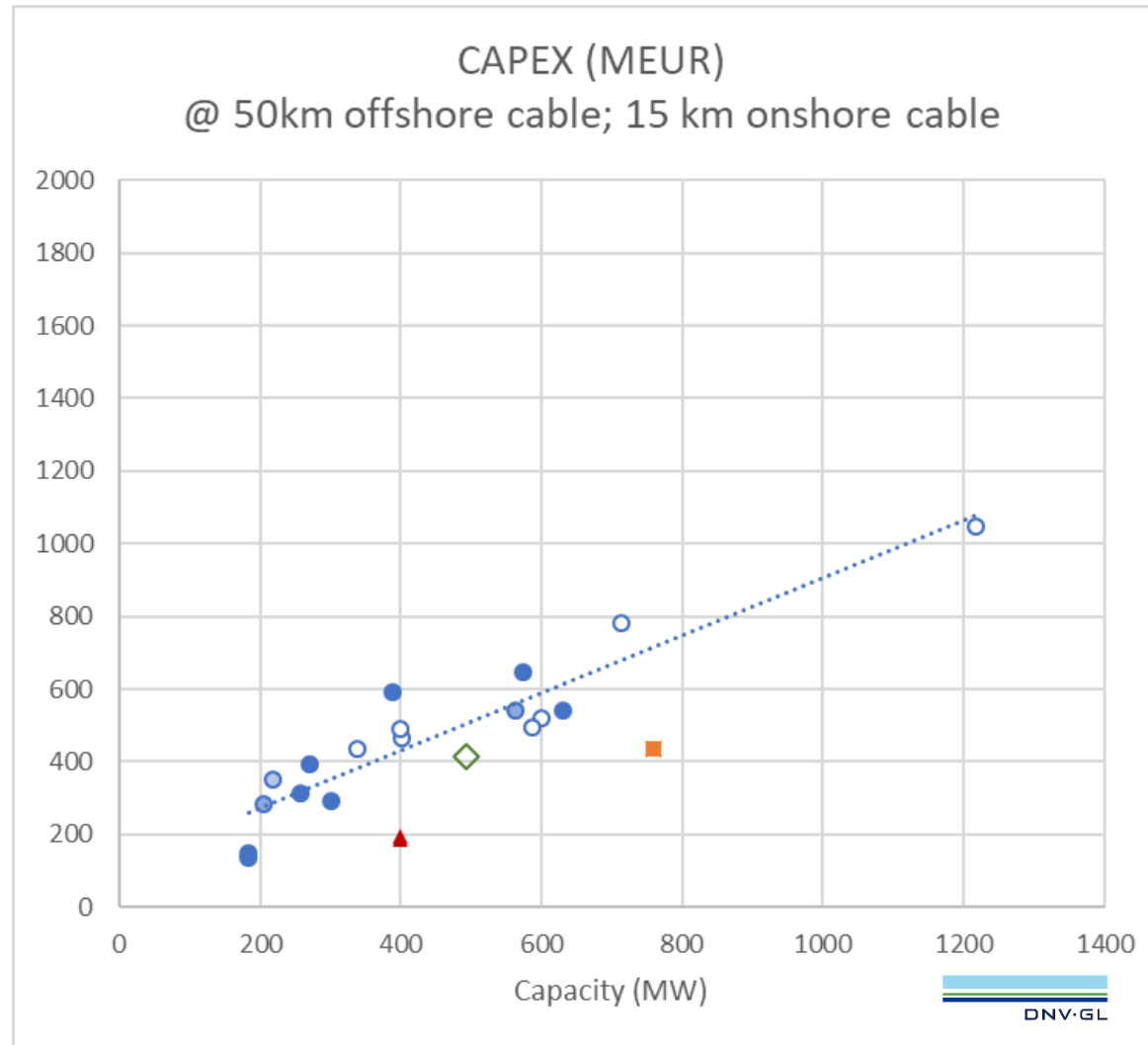
CAPEX Offshore transmission system

- UK, final transfer value
- UK, indicative value
- UK, initial transfer value
- NL, budget value
- ▲ DK, final value
- ◇ FR, budget value



CAPEX Offshore transmission system normalized for 50 km offshore cable and 15 km onshore cable

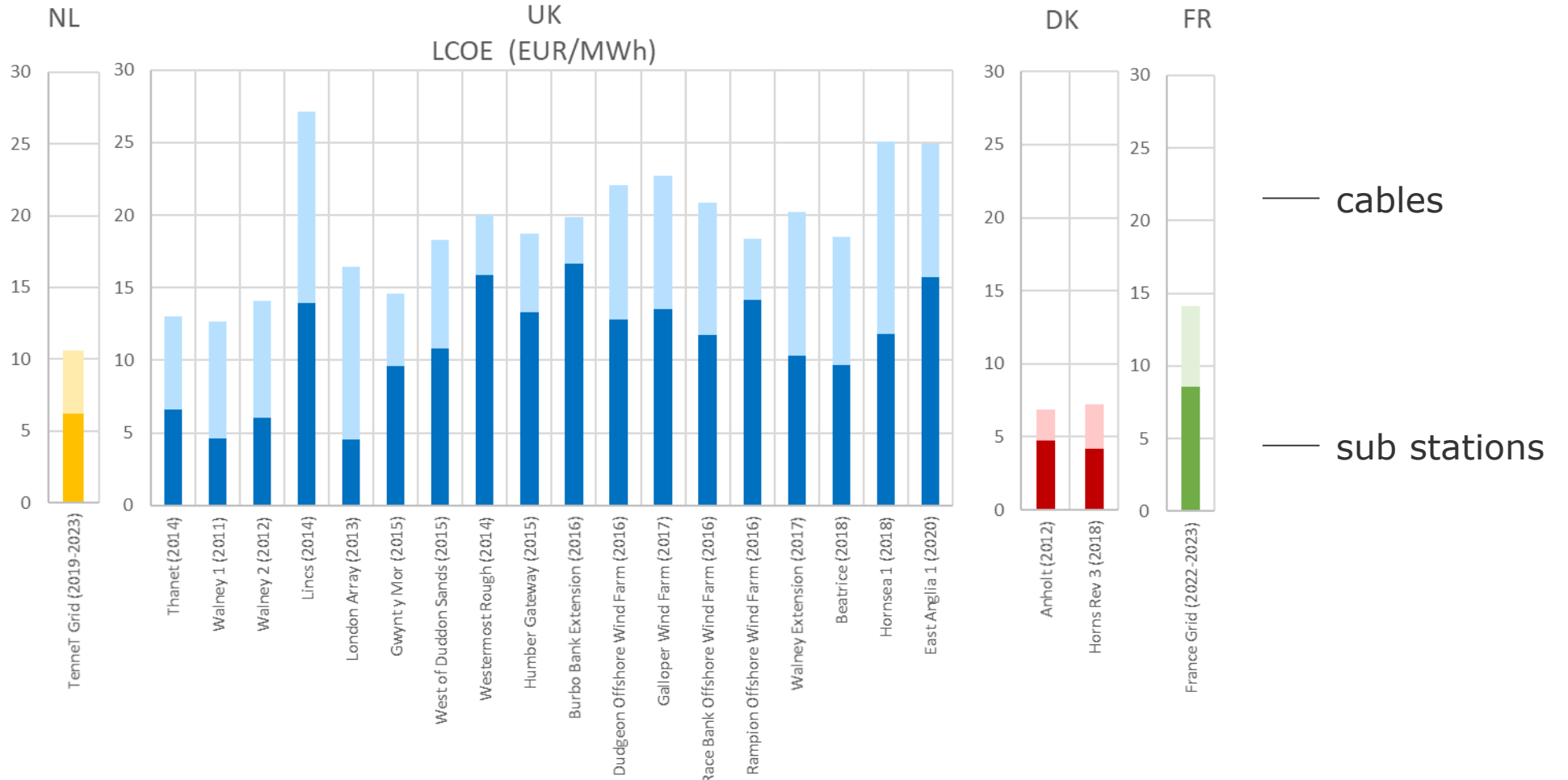
- UK, final transfer value
- UK, indicative value
- UK, initial transfer value
- NL, budget value
- ▲ DK, final value
- ◇ FR, budget value



Conclusions CAPEX offshore transmission systems

- Comparison shows that UK has higher CAPEX per installed MW than NL, DK and FR, also when adjusted for cable length
- Scope of offshore transmission is comparable (offshore substation, offshore cable, onshore cable, landstation)
- Denmark has shorter offshore cable length; UK and NL are comparable (~50 km cable length).
- Considerable variation in onshore cable length in the various countries

Comparison LCOE of Transmission Systems(EUR/MWh) NL – UK – DK – FR



Assumptions

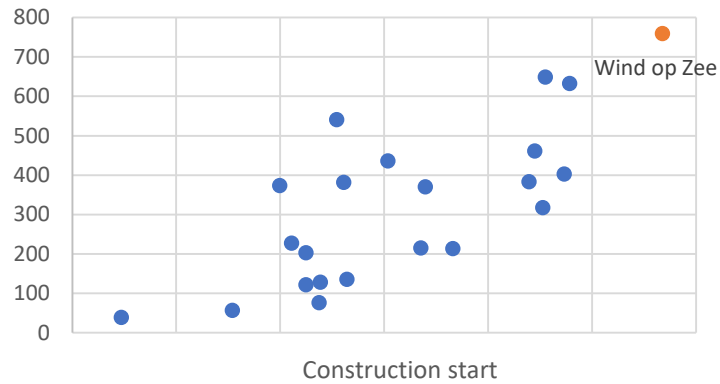
- $LCOE = \frac{CAPEX + NPV(\sum OPEX)}{NPV(\sum Energy)}$

- Assumptions
 - AC Offshore transmission system: Offshore substation, offshore cable, onshore cable, land station (extension)
 - Nominal CAPEX
 - Annual OPEX: 1% of CAPEX
 - Wind farm capacity factor: 46% or 4000 Full Load Hours
 - Nominal WACC: 4.4%

- Note that the presented LCOE are intended for comparison purposes only. Not for comparison with grid tariffs

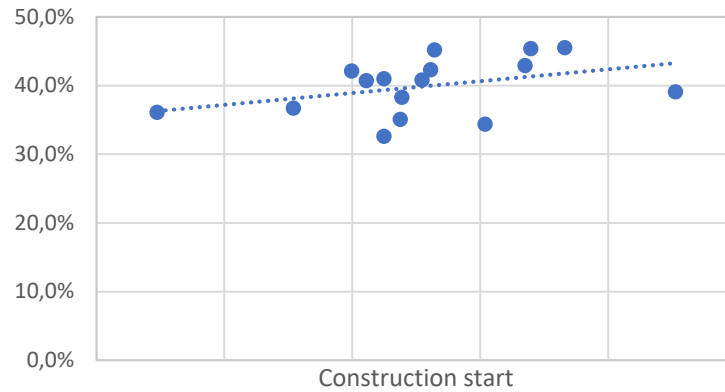
Possible cause for cost differences

Wind Farm Power (MW)



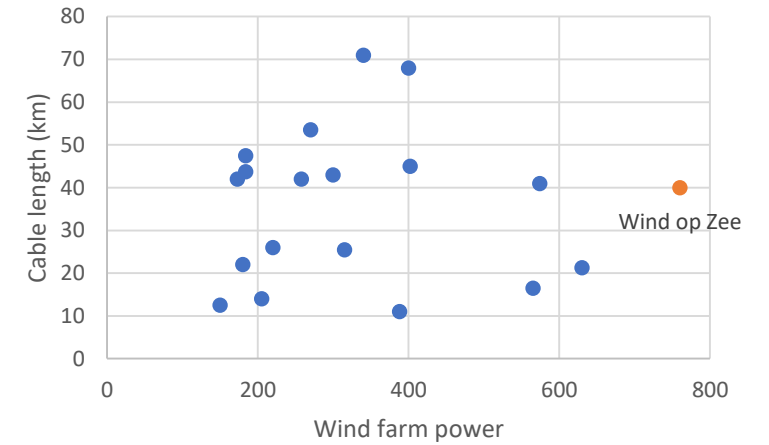
Wind farm size has increased over time, offering potential cost savings due to upscaling

Wind farm capacity factor



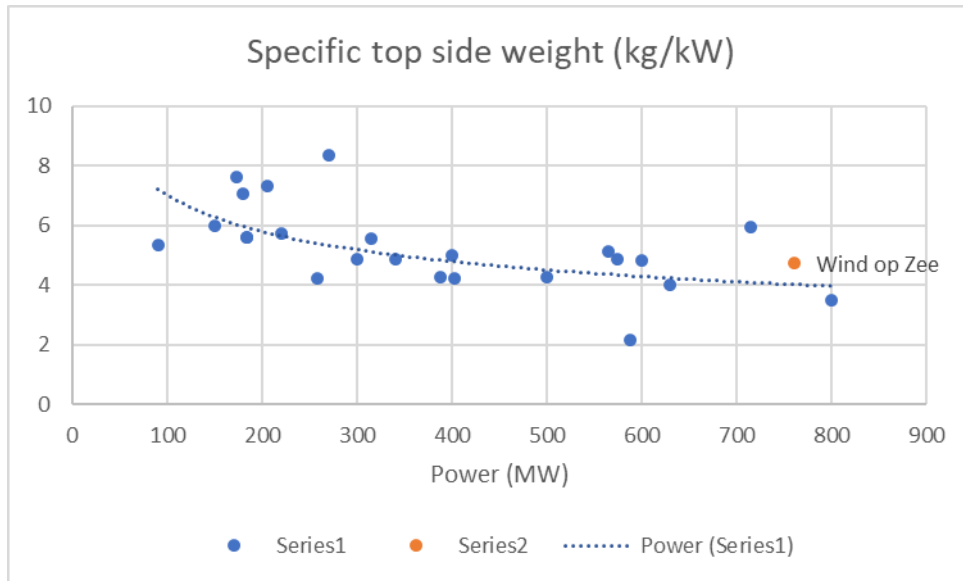
Capacity factor has increased, leading to better increased grid utilisation

Distance vs Wind Farm Size

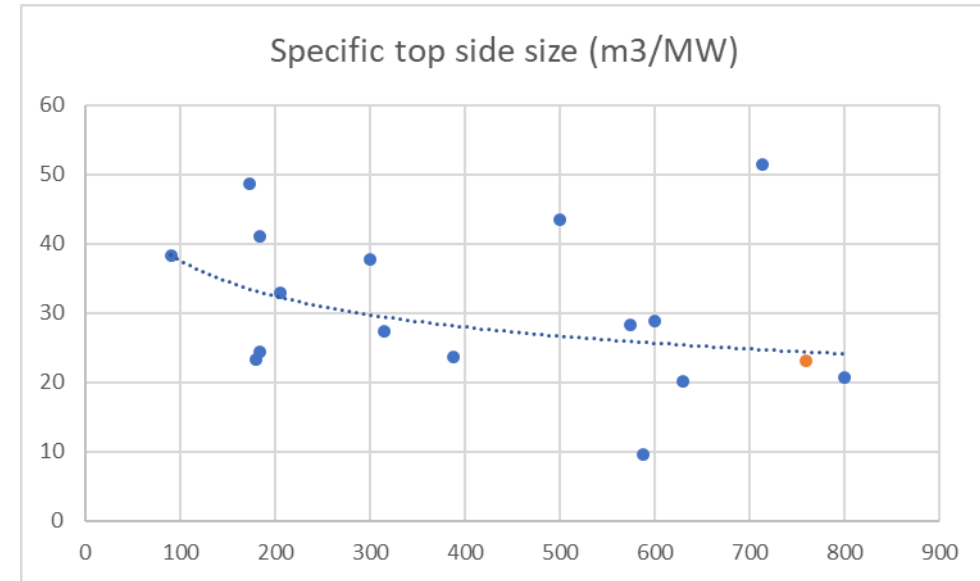


There is no relation between power and cable length

Comparison topside design key numbers



Specific weight of NL substation in line with larger substations in UK



Topside size is low compared to substations in the UK

Source: 4COffshore, TenneT. Note that these values are estimates with inherent uncertainty about size definitions

References

- References:

- <https://www.ft.dk/samling/20171/almdel/efk/spm/253/svar/1495662/1906403/index.htm>
- <https://www.ofgem.gov.uk/electricity/transmission-networks/offshore-transmission/offshore-transmission-tenders>
- Marktdesign für eine effiziente Netzanbindung von Offshore-Windenergie, DIW ECON, Berlin, Februar 2019
- Communication with RTE, June 2019



www.dnvgl.com

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