New Foundations for Deeper & Larger OW

PO.ID 130

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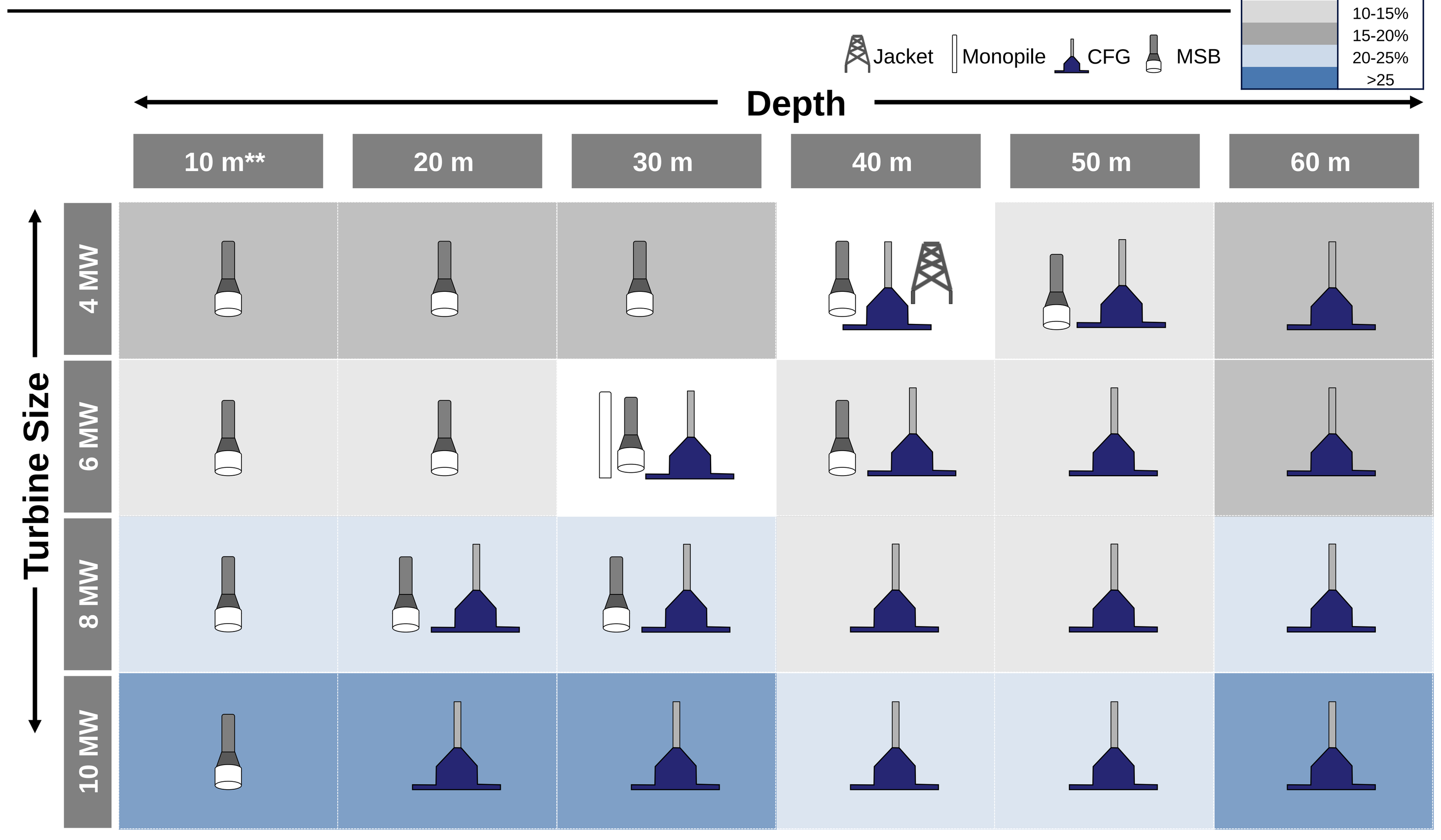
Abstract

Monopiles and jackets are not likely to be the right foundation solution for the 27 GW OW capacity to start constructing by 2020, as they wouldn't be cost effective compared to the new innovative designs and simultaneously have a vessel availability supply chain risk.

Analysis of the upcoming OW projects which are expected to start construction by 2020 shows that around 6000 turbines are to be installed in Europe. of which dominant size is expected to increase from 4 MW & 6 MW in 2015 to 6 MW & 8 MW in 2020. Also future foundations will be installed farther from shore at much larger depths, increasing the weight of the foundation to range of 800 - 2000 tonnes. Vessels with this lifting capacity available currently in the market were analysed against the demand for conventional foundations designs. The results have cleary shown the advantages of commercially adopting the new designs in terms on cost reduction and lesser supply chain risks.

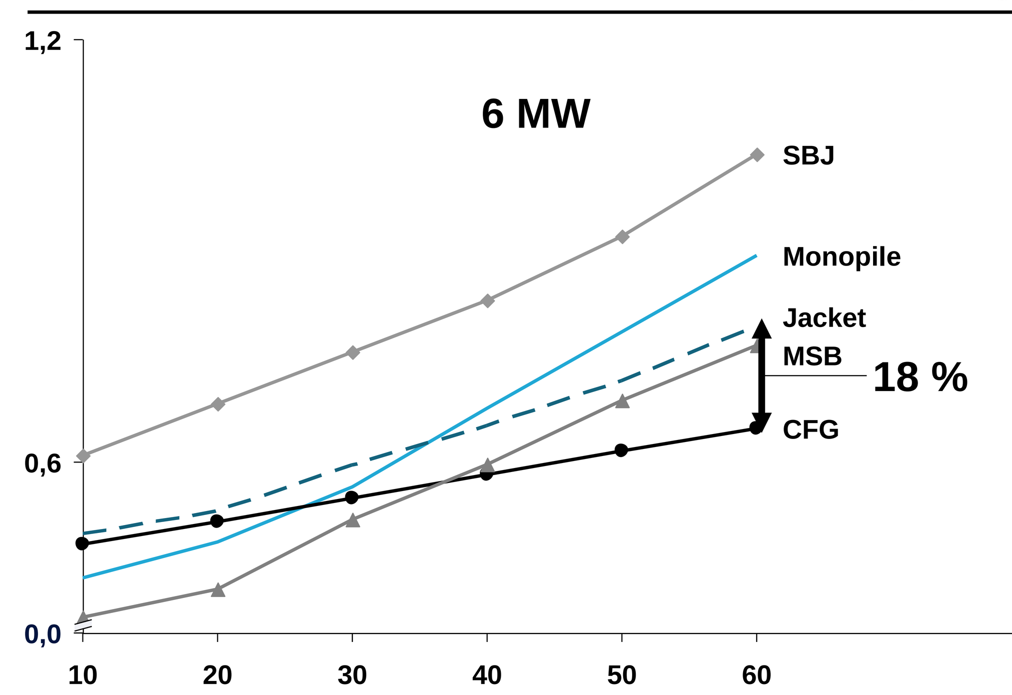
New foundations can reduce the foundation cost by 10-30% over conventional designs

New foundations could replace conventional designs at almost all OW specifications

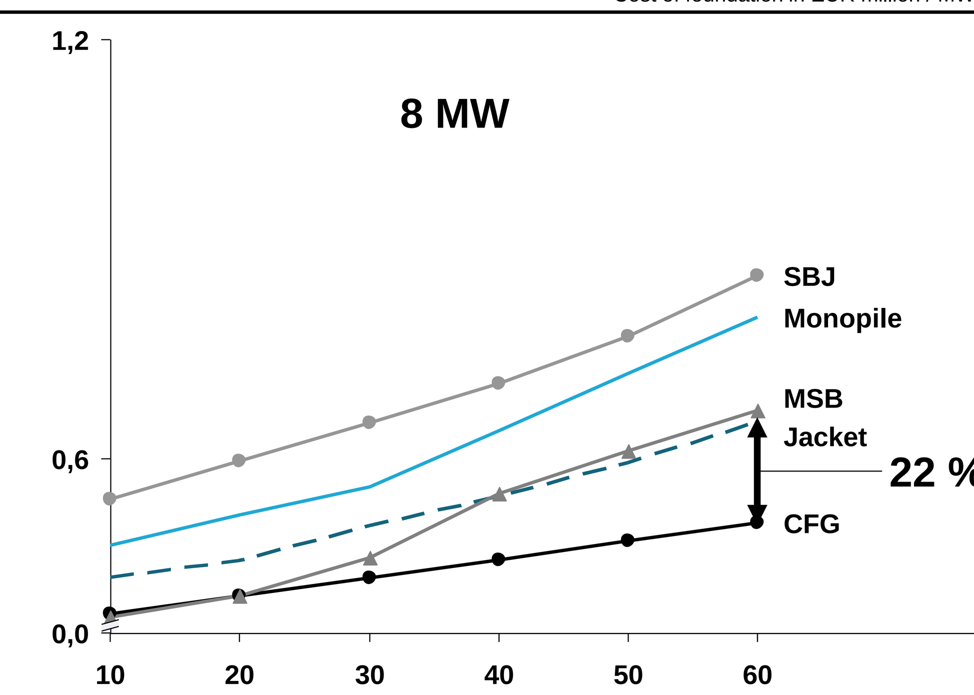


While Mono Suction Bucket is cost effective for projects with turbine sizes 4 MW and 6 MW and/or lower to medium depths, Cranefree Gravity is suitable for 6 and 8 MW and depths greater than 30m,

Cost of foundation in EUR million / MW



Approx. 18% foundation cost reduction is possible with new foundations at larger depths



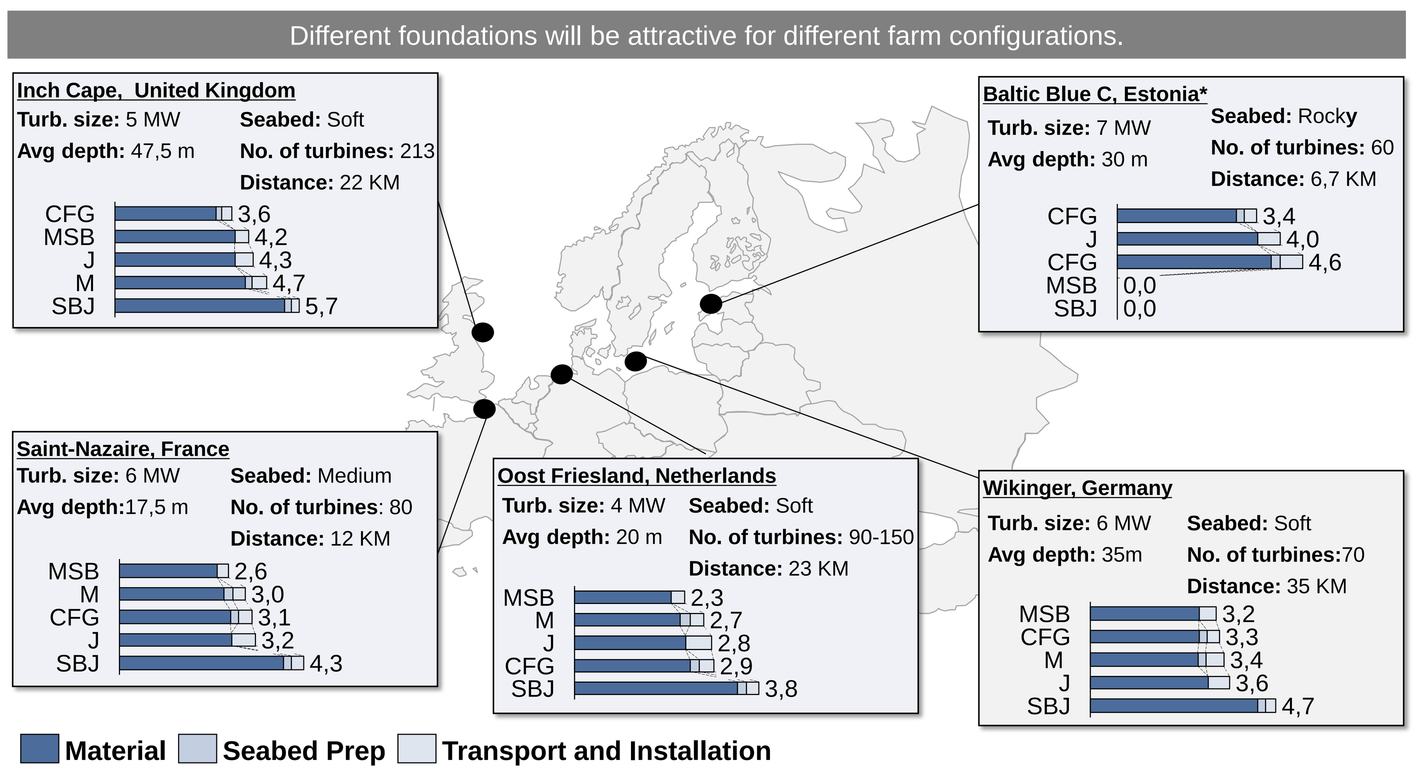
Cost reduction increases to 22% with even larger turbine and depth, indicating attractiveness of new foundations

More than 50 percent of OW projects would significantly benefit if the construction risks are managed by contracting model

Analysing on select OW farms, shows the main driver of cost is the reduction in material cost

Cost of foundation in EUR million

Different foundations will be attractive for different farm configurations.



Note: This mapping is based on the results of the cost simulation model built by MEC+. Transportation cost is computed from the nearest manufacturer
* Since practical application of the suction bucket concepts in rocky seabed are highly unlikely, the cost comparisons are therefore not shown
Source MEC+ analysis, The Wind Power database

Projects in UK, France, and Netherlands could have the most benefit on foundation cost

Cost Reduction Potential: 05-10%, 10-15%, 15-20%, 20-25%, >25

Year	UK	Germany	Denmark	Netherlands / Belgium / France	Sweden / Estonia / Finland
2015	NOWDC Kentish Flats II	Gode Wind 2 Gode Wind 1 Sandbank		Westermeerdijk Gemini	
2016	D.B.Creyke Beck A Hornsea1Njord, Heron Race Bank Dudgeon Neart na Gaoithe Beatrice Galloper Hywind Pilot Burbo Bank	Wikinger Nordsee One Nordergründe	Horns Rev 3	THV Mermaid Norther Belwind II	Suurhiekka Blekinge
2017	Rampion D.B. Creyke Beck B Walney Extension Moray Firth Telford Inch Cape Hornsea 2 - Optimus Hornsea 2 - Breesea EOWDC	Arcadis Ost 1 Veja Mate		Courseulles-Sur-Mer Fécamp Offshore	
2018	East Anglia One Moray Firth Stevenson	Arkonabecken Südost Albatros Deutsche Bucht Borkum Riffgrund II	Mejlflak	Saint-Brieuc Calvados Seastar Rentel	Taggen Vindpark
2019	Moray Firth MacColl Triton Knoll	Trianel Borkum Ph. 2 Delta Nordsee 1 & 2	Kriegers Flak	Saint-Nazaire	
2020	Firth of Forth 2 C Firth of Forth 2 D Firth of Forth 2 E	Gode Wind IV			Hiiumaa

Risk and premium costs can be managed by choosing construction contract

○ Low ● High

Contracting Structure	Brief Description	Value proposition to developer	Developer's Benefit: Risk*	Developer's Benefit: Cost	Suitable foundation**
Multi-contract	Project owner signs many contracts within each segment, manages the project in-house	No risk premium to pay and full project control	●	◑	Monopile, Jacket
EPCM	Construction management is out sourced	Limited EPC capabilities needed, which takes time and are costly to develop	◑	◔	MSB, Monopile, CFG, SBJ
Package EPC	Construction contracts given out in packages of turbines, foundations, etc	Sub package risks are at the supplier and limited risk premium to pay combined with project control	◑	◑	MSB, CFG, SBJ
Project EPC	One contract for the entire project	Limited EPC capabilities needed, which takes time and are costly to develop	◔	●	Monopile, Jacket

* The definition of risks is limited to systematic project risks inherent in the business and excludes unexpected weather, geotechnical & political risks
** Suitability is based on the key need to manage risk at project level for the developer or contractor

Offshore construction vessels could potentially see a much lower demand as the new installation concepts reduce the need for vessels

Future OW farms plans will be installed using specialised fleet, posing risk of unavailibilty of appropriate lifting capacity. This risk is significantly reduced through new foundation designs

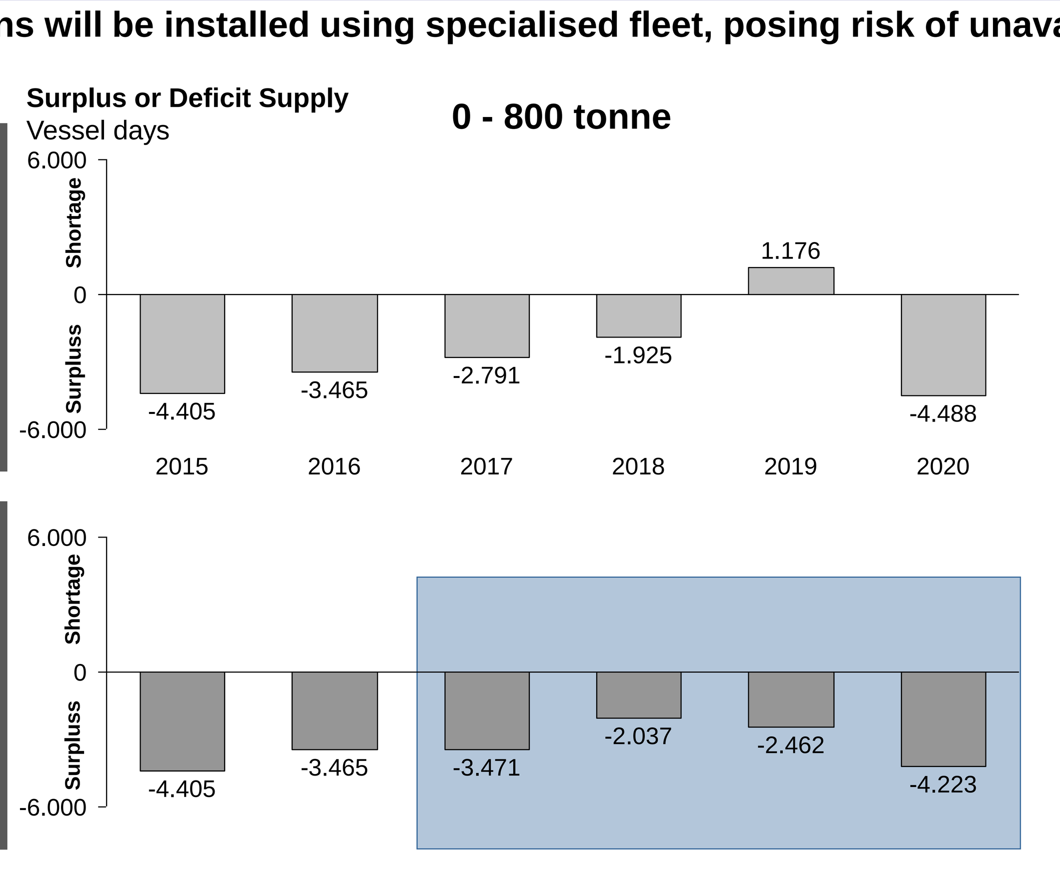
Scenario 1:

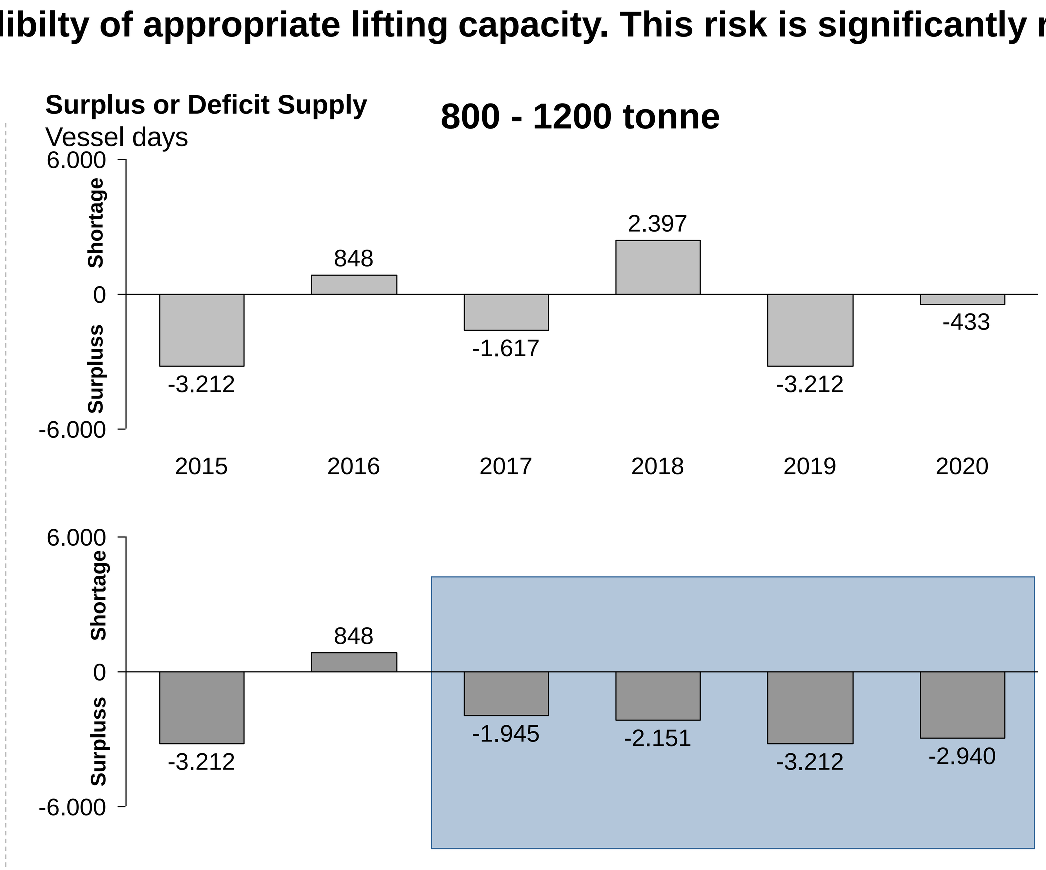
Monopiles & Jackets are installed at all planned OW farms till 2020 in Europe

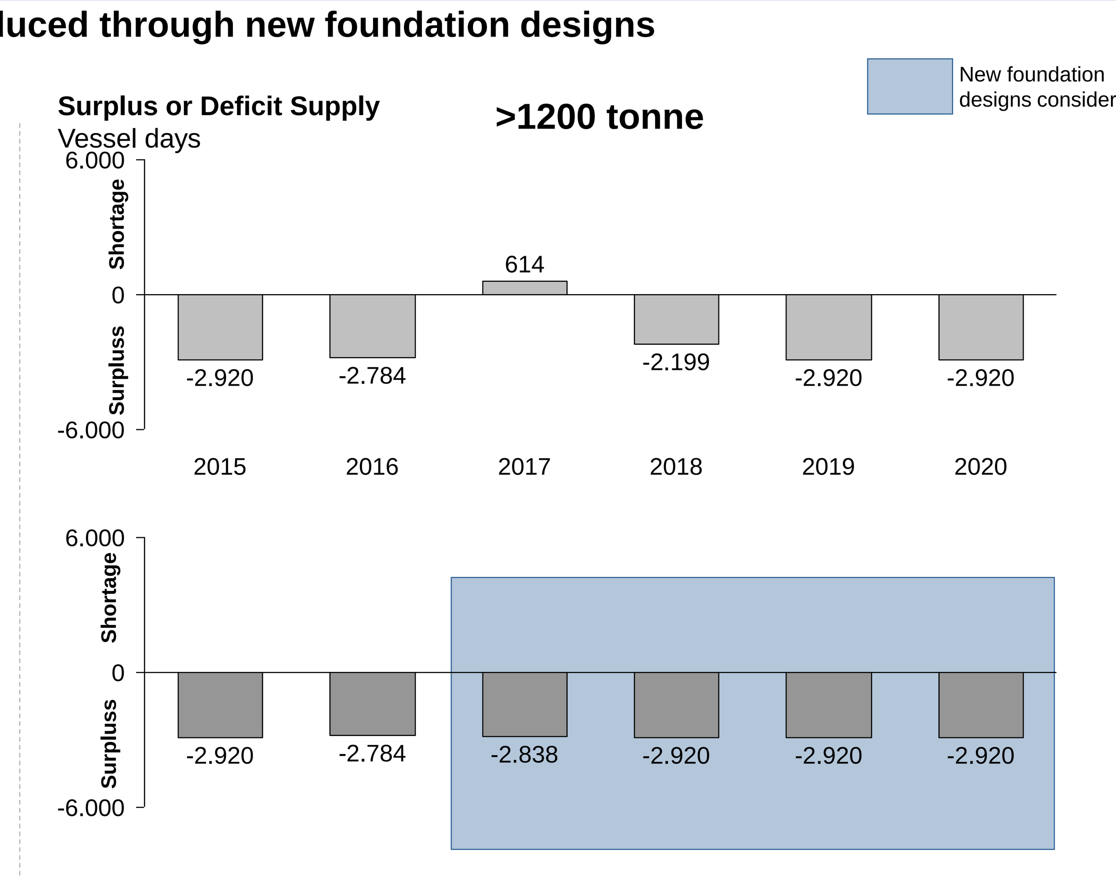
Scenario 2:

Selecting cost effective design, assuming that new designs are commercial from 2017

New foundation designs considered

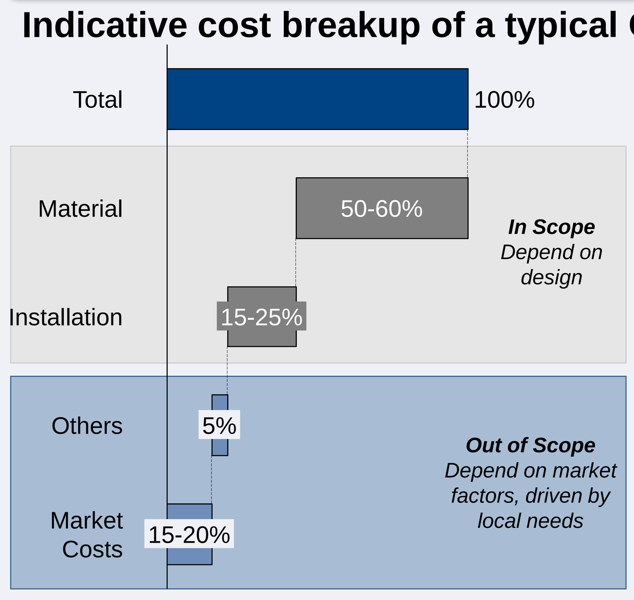






Methodology & References

Indicative cost breakup of a typical OW foundation & analysis methodology



MATERIAL COSTS
Material used to manufacture the foundation, e.g.
- Different types of steel
- Concrete
- Others

INSTALLATION COSTS
Installation at site using
- Installation vessels
- Drilling/pilling/ suction pumps,
- Sand ballasting, Grouting, Scour protection, etc.

OTHERS
Includes costs that are due to design advantages but are not significant in light of comparisons
- Noise mitigation
- Decommissioning

MARKET COSTS
- Onshore logistics
- Sea-fastening
- Risk premiums
- Insurances
- Profit margins

Vessel supply demand is based on following

1. **Demand assumption**
   - Demand for vessels is estimated on the construction/installation start year of the OW farms. Planned capacity till 2020 is 27 GW
   - Installation of foundation & turbine will be done by a single vessel. The complete process will take about 7.5 days on average.
   - Demand from OW construction, O&M and oil & gas has not been considered, which will lead to even higher demand for vessels
   - Post 2017, the commercial adaptation of the new designs has been undertaken as the prototype are already under testing phases. Therefore the demand has been calculated for the installation of monopiles, jacket, Mono Suction Bucket, CraneFree Gravity & Suction Bucket Jacket, wherever applicable cost effectively.
   - Average days to install MSB foundations is assumed as 2 days, (excluding turbine installation)
2. **Supply Assumptions**
   - Around 43 vessels are available for OW construction
   - Lifting cranes vessels are expected to operate for 10-11 months a year

Abbreviations

1. **M:** Monopile
2. **J:** Jacket
3. **MSB:** Mono suction Bucket
4. **CFG:** CraneFree Gravity
5. **SBJ:** Suction Bucket Jacket
6. **OW:** Offshore Wind

References

1. Company websites, press releases and articles from various OW companies
2. Publications from various wind associations including EWEA

OFFSHORE 2015 COPENHAGEN ORGANISED BY EWEA

EWEA Offshore 2015 – Copenhagen – 10-12 March 2015