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The importance of the supply chain from an offshore wind energy developer‘s perspective

Offshore Wind Supply Chain Information Session

February 22nd, 2019
COVE – Dartmouth, Nova Scotia

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Presentation overview

I. PNE AG company overview
II. PNE AG offshore project development activities
III. The supply chain in the development process
IV. Lessons learned in Germany
V. Conclusions

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A leading developer of wind energy projects…

- Established 1995, stock listed since 1998
- Headquarter office in Cuxhaven, Germany
- Staff of 360, across 13 countries
- PNE Group, consisting of the companies PNE AG and WKN GmbH

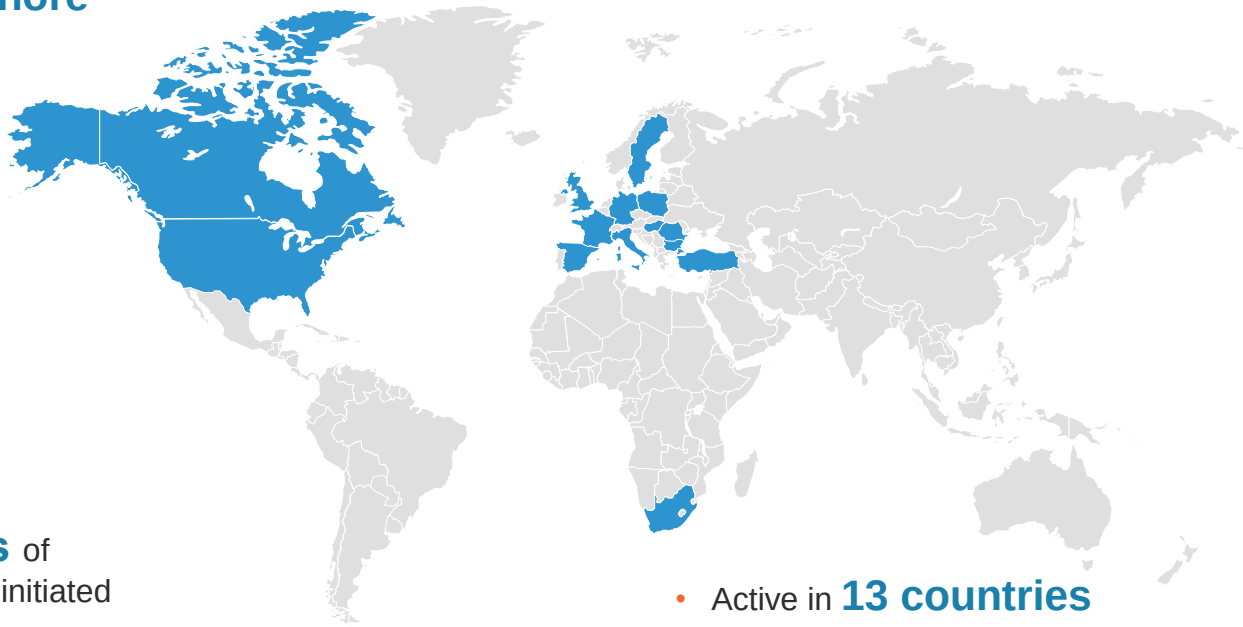
>2,600 MW realized onshore

- Germany's most successful project developer with

8 offshore projects sold totaling 2,852 MW

- Nr. 2 player in operations & management in Germany with

>1,500 MW under management



- **> € 9bn Euros** of investment done or initiated

- Active in **13 countries on 3 continents**

…with a strong market position – nationally and internationally

Our business model has proven successful

Development | **Financing** | **Construction** | **Sale** IPP | **Service**

- Acquisition of the site
- Resource analysis
- Selection of equipment
- Permits

- Financial analysis
- Legal concept
- Sales/ marketing
- Project financing

- Grid connection
- Infrastructure
- Assembly
- Start-up of operations

- IPP
- Utility
- Infrastructure fund

- Technical and commercial management

Development, planning, construction and operation of wind farms onshore and offshore

Premium, bankable projects with high certainty of realization

Covering the entire value chain – from a single source

Major deals in recent years

2012	2012-15	2015	2016-17	2017
OFFSHORE	ONSHORE	ONSHORE	ONSHORE	OFFSHORE
GODE WIND Pipeline Deal	Various Project sales	UK Pipeline deal	Wind farm portfolio	ATLANTIS I
DONG	INVESTORS	BROOKFIELD	ALLIANZ	VATTENFALL
Gode Wind ~ 924 MW • Payments of €134m received • Up to €24m due as milestone payments B. Riffgrund ~ 760 MW	• KGAL • CEE • CHORUS • ALLIANZ • ENBW • ENEL • JOHN LAING	PNE WIND UK ~ 1,200 MW of projects • GBP 40m upfront payment • Up to GBP 63m in milestones possible till 2021	142.5 MW of projects • Enterprise value (EV) > €330m • Sales price in 2016 €103m for 80% • Subsequent sales price of €21m in 2017 and increase of EV to > €360m through optimization of financing	Atlantis I ~584 MW • Low double digit € m payment • Further milestone payments expected

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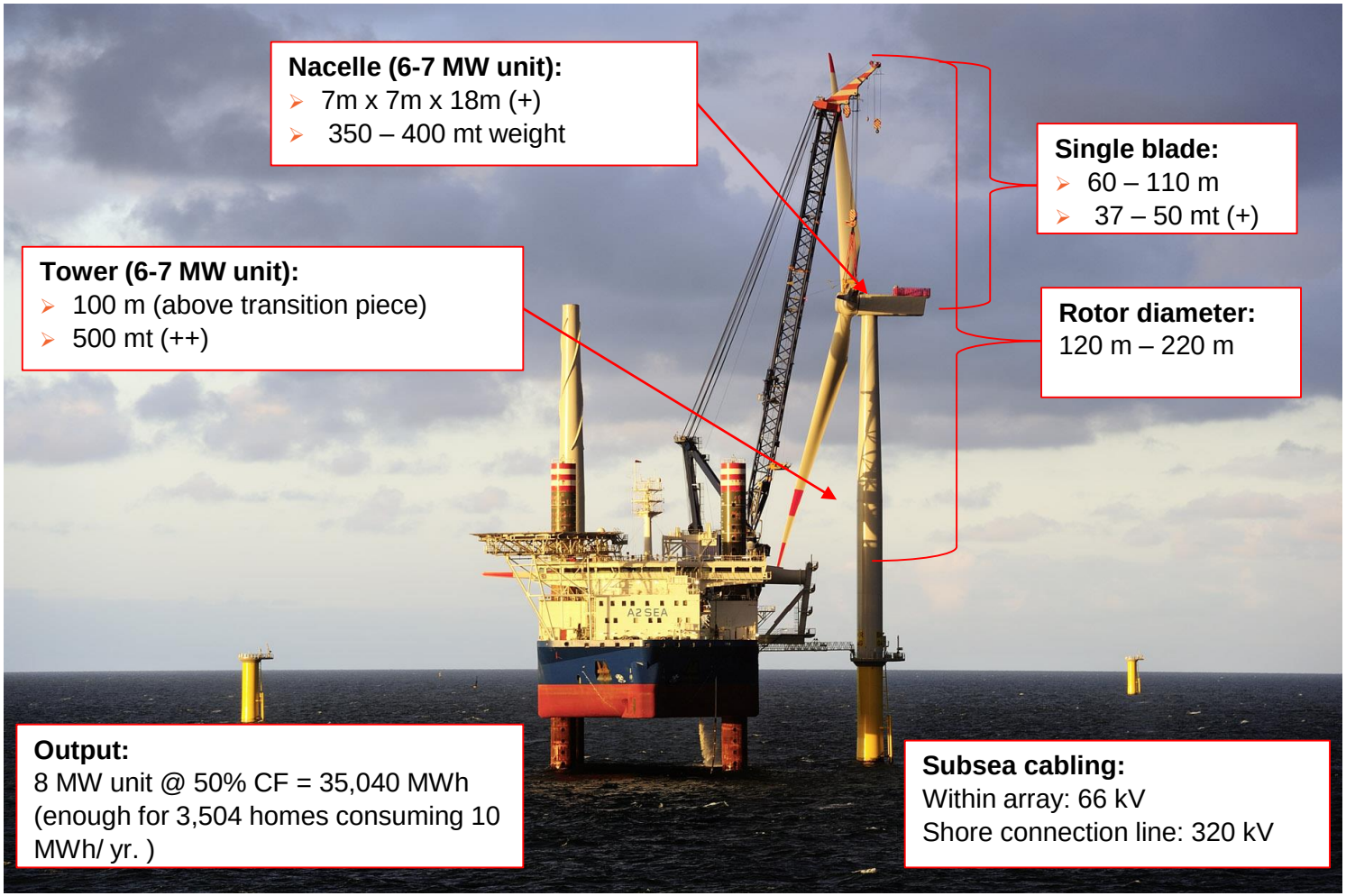
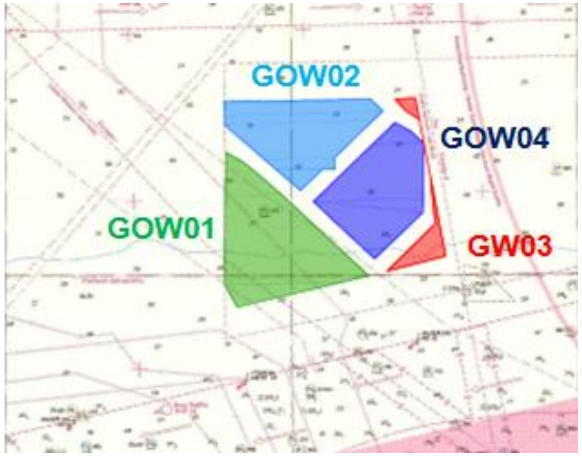
Offshore wind energy dimensions …



PNE Offshore Projects Germany

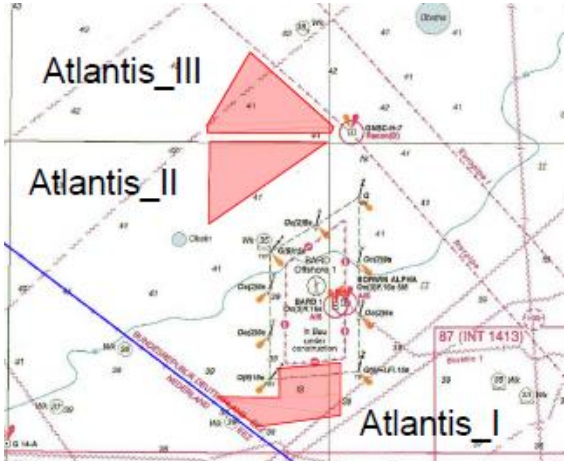
Borkum Riffgrund

- Location: 38 km from Borkum in the German North Sea
- Water depth: apprx. 23-29 m
- BKR 01: 78 turbines - 312 MW
  BKR 02: 56 turbines - 450 MW
- Projects sold in 2009
- Start of construction Borkum Riffgrund I in 2013, in operation since 2015
- FID Borkum Riffgrund II in 2016, construction and implementation in 2018



Gode Wind

- Location: 33 km north of Norderney in the German North Sea
- Water depth: apprx. 29 - 34 m
- GOW 01+02: 97 turbines – 582 MW
  GOW 04: 42 turbines – 336 MW
  GOW 03: 14 turbines – 110 MW
- Projects sold in 2012
- Start of construction of GW 01 + 02 in 2015, in operation since 2016
- Gode Wind 3 has won in the first offshore tender in Germany in 2017
- Gode Wind 4 has won in the second offshore tender in Germany in 2018



Atlantis

- Location: 83 km north of Borkum in the German North Sea
- Water depth: apprx. 37,5 – 39,5 m
- A1: 73 turbines – 613 MW
  A2: 82 turbines – 688 MW
  A3: 75 turbines – 630 MW
- September 2013: acquisition by PNE
- Technical re-development and submission of application documents
- Atlantis I sold in February 2017
- Atlantis I has participated in the first offshore tender in Germany in 2017

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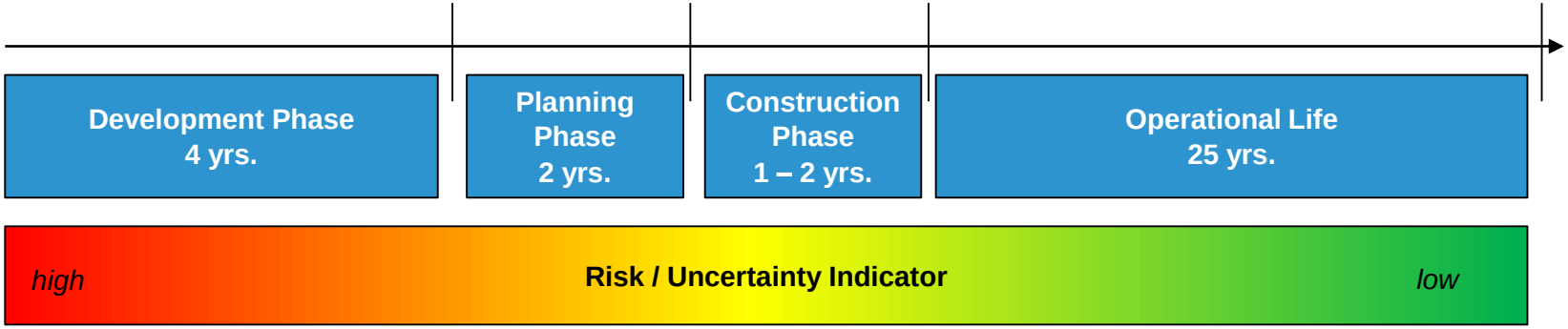
Offshore wind energy project development



Objective:

Design technically and economically feasible projects

Guiding principle:

Identify, manage and mitigate risks and uncertainties along the project development process … using local qualified resources and expertise if available

The supply chain in the project development process

Development Phase 4 yrs.	Planning Phase 2 yrs.	Construction Phase 1 – 2 yrs.	Operational Life 25 yrs.

Development Phase 4 yrs.

Comprehensive analysis of the working environment

- Baseline study on business environment and policy, including energy market developments
- Verification of legal implications applicable to offshore wind energy
- Resource assessment from meteorological data from lidar buoys, weather stations, etc.
- Marine biosphere analysis
- Geological assessment on marine geology
- Administrative work with authorities in regard to securing subsea concessions

Requirement for experts and specialized engineering services

The supply chain in the project development process

Development Phase 4 yrs.	Planning Phase 2 yrs.	Construction Phase 1 – 2 yrs.	Operational Life 25 yrs.

Planning Phase 2 yrs.

Preparing the project's final engineering, procurement and economics

- Geotechnical services: Maritime appraisal and zoning of marine location (geotechnical identification and marking of sea bed concessions)
- Environmental engineering services: Performing studies related to permitting (environmental, marine safety, operational procedures, …) to obtain required permits
- Construction engineering services: Preparing the detailed engineering prior to construction phase by offshore specialists
- Commercial project management: Arranging the commercial elements – procurement, energy offtake contracts, structuring the finance

Requirement for legal / commercial experts and specialized engineering services

The supply chain in the project development process

Development Phase 4 yrs.	Planning Phase 2 yrs.	Construction Phase 1 – 2 yrs.	Operational Life 25 yrs.

Construction Phase 1 – 2 yrs.

Putting it together:

- **Manufacturing supply chain – turbine**: sourcing wind turbine components (towers, hubs, nacelles, blades, transition pieces and foundations) locally vs. internationally, availability of competitive suppliers?
- **Manufacturing supply chain – bill of plant**: sourcing subsea cables, substations
- **Onshore logistic supply chain -** for large components such as tower elements, blades, hubs and nacelles
- **Offshore logistics supply chain** – port infrastructure and specialized fleet availability for large and heavy components
- **Construction supply chain** – availability of a specialized fleet for transport and installation

The procurement comes to life and supply chain elements deliver at previously agreed conditions, discrepancies threaten project economics

The supply chain in the project development process

Development Phase 4 yrs.	Planning Phase 2 yrs.	Construction Phase 1 – 2 yrs.	Operational Life 25 yrs.

Operational Life 25 yrs.

Operations Service Supply Chain:

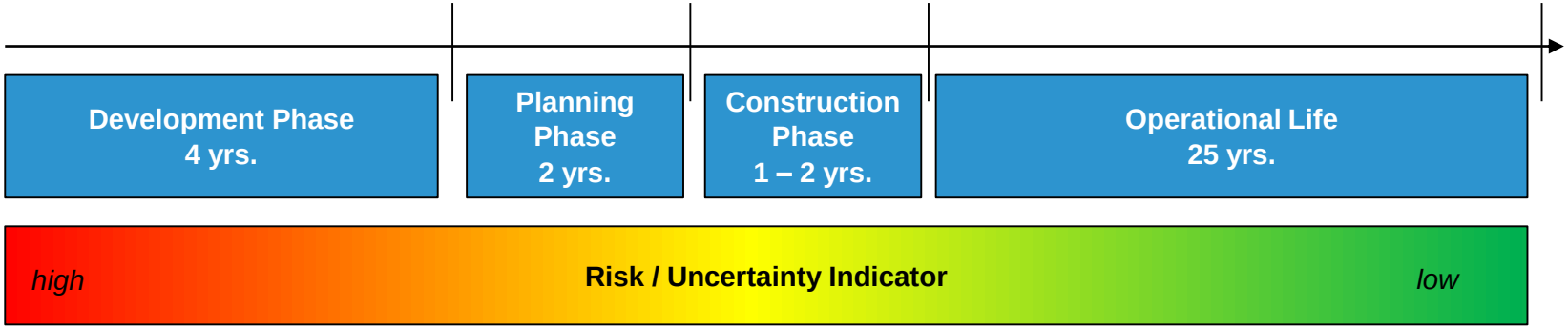
- Turbine maintenance and repair supply chain
- Foundation maintenance and repair supply chain
- Subsea cabling and substation maintenance

- Nearby availability of offshore professionals (staff)
- Nearby availability of maintenance spare parts and materials
- Specialized fleets for housing staff
- Specialized fleets for transporting staff to turbines and back
- Marine health and safety providers for safe and reliable operation of the wind farm

The O&M procurement comes to life, supply chain elements must deliver at previously agreed conditions

Sensitivity: Economic impact of technical down time is higher in offshore wind farms than onshore due to generator size

Offshore wind energy project development



The supply chain environment plays an important role in designing offshore wind energy projects, assessing the business economics and associated risks as precisely as possible.

The availability of an elaborate supply chain reduces uncertainty, thus decreasing business risk and allowing for a cost efficient use of offshore wind energy.

The offshore wind energy supply chain provides an abundance of business opportunities, but …

- Industrial investments require sustainable market potential
- What are the long term market perspectives for offshore wind energy?
- What is backing the long term perspectives? Policy? Market demand?

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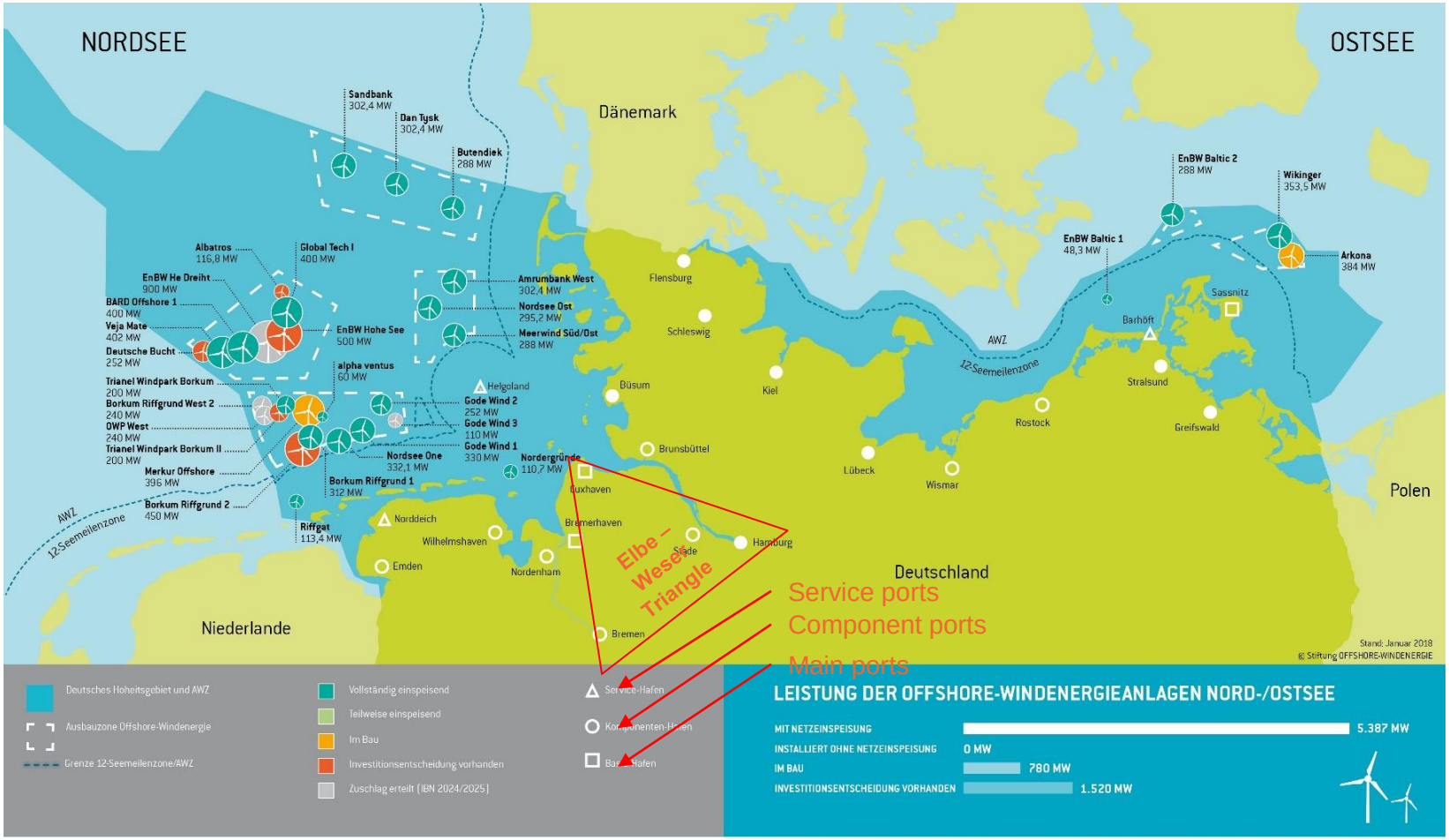
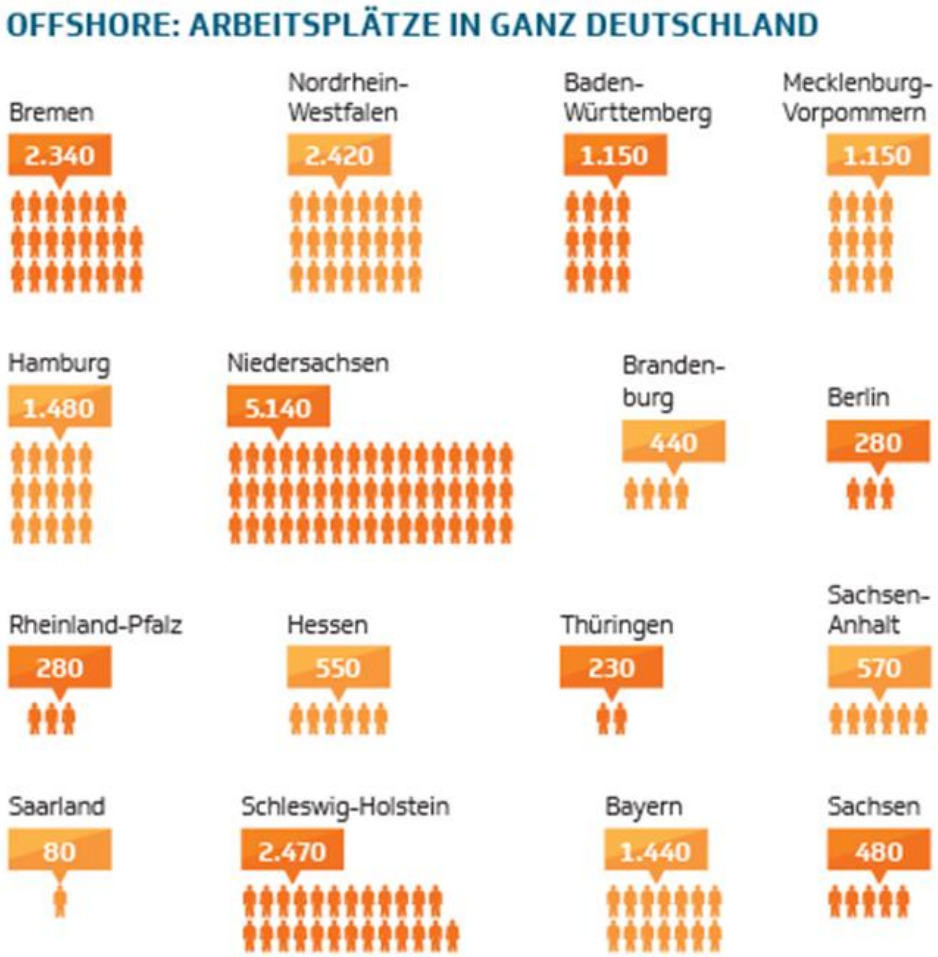
Positives: Strong growth of industry related employment and port infrastructure from > 6 GW of realized offshore projects in Germany



Positives: education and employment

- Educational centers for developing the business and working in the industry (e.g. Hochschule Bremerhaven, Master of Wind Energy at the university of Oldenburg)
- Direct job creation in the Elbe – Weser triangle (18.000 people are working in the offshore industry in Germany; estimated increase of up to 30.0000 over coming years)
- Indirect business increase through offshore developments in the Elbe – Weser triangle (high tech composites, specialized tools, materials etc.)

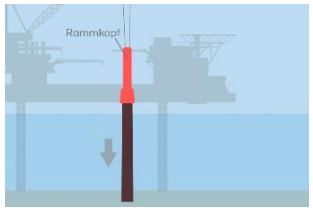


Offshore-Arbeitsplätze nach Bundesländern 2015
Quelle: GWS 2017

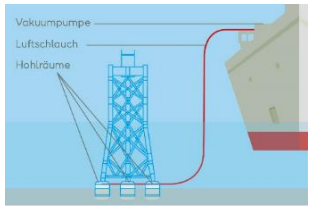
Positives: technology advances

- Innovation in technology through sustainable and expanding offshore market
- Design of larger and more efficient offshore wind turbines
- Improvement of installation processes to reduce environmental impact
- Need for complex and high endurance material, due to high wind speed and storms → innovation driver to avoid higher costs

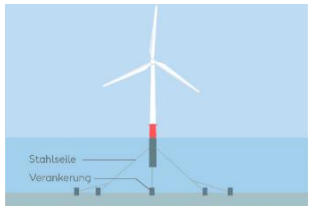
Example of technology advance within 10 yrs.



Ramming of foundations



Installation using vacuum



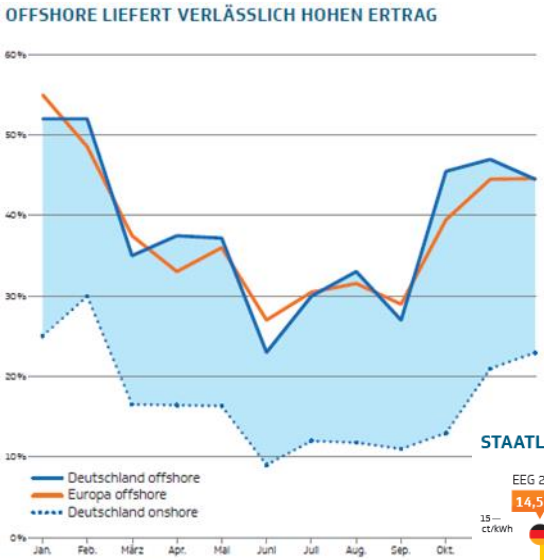
Floating offshore turbines using moorings

Positives: Improved project economics

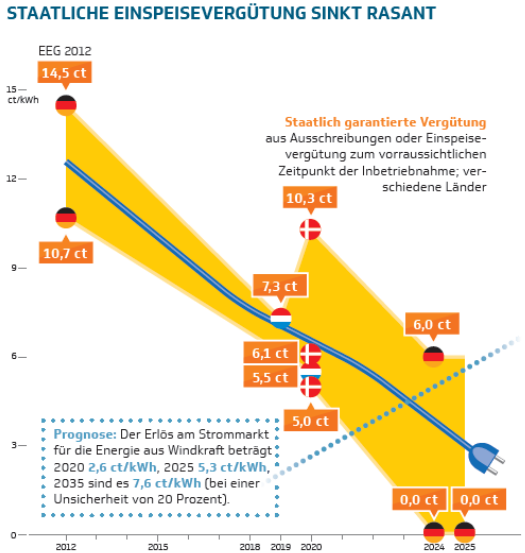
- Since alpha ventus (first German Offshore park; 2010), offshore technology is proven to operate economical (over 6GW installed, only in Germany)
- Construction phases of below one year (alpha ventus)
- High amount of hours operating at full load (up to 3500h to 4500h per year – capacity factors of 40 – 50% possible, positive outlook)
- Learning curve remains steep - innovation and new technology are expected to provide savings potentials and falling generation costs in coming years

Indicators:

- 2017: first offshore parks without state subsidy in planning
- State auction results are dropping in price
- Potential to replace nuclear and coal electricity production by volume



Hoher Ertrag pro installierter Leistung: Kapazitätsfaktor (Anteil tatsächlicher Produktion am theoretischen Höchstwert) an Land und auf See
Quelle: Windguard, WindEurope 2017



Quelle: Offshore: Deutschlands Windstärke 2017, Energy Brainpool

Negatives / challenges:

- Steep learning curve and technology advance requires innovative and agile supply chain elements to ensure successful implementation
- Working in a new environment (marine environment) requires extra awareness for environmental impact
- Need for complex and high endurance material, due to high wind speed and storms → higher costs
- Upgrade of marine safety schemes of growing importance (ship collision prevention important as installations grow)
- Need for a high capacity grid connection at the land site – offshore capacity growing faster than onshore grid capacity
- Lack of coordination between offshore service harbors Wilhelmshaven / Bremerhaven / Cuxhaven has resulted in redundant high invest industrial installations going out of business or working at low utilization rates and job uncertainty for specialized work force
- Government policy – the double edged knife: + create a market by defining and sponsoring the development of offshore wind energy capacity / - change in distribution of subsea concessions from “first come – first serve” to “bid to secure”

Current situation of Regulatory Changes:

- According to WindSeeG (German policy for offshore wind) several projects will be brought into the “Central Model” to be tendered off by the government
- Developers had previously invested substantially
- Legal opinions conclude that parts of WindSeeG are unconstitutional

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Conclusions:

- Project developers look at a supply chain very early in the process and for each phase of the project well in advance of project realization
- The supply chain has direct impact on uncertainty and risk of project development and the offshore wind project at realization and operation phase
- The offshore wind energy experience has been predominantly positive in Germany to the benefit of education, employment and innovation
- Offshore energy is destined to drop in generation cost, thus playing an important role in the global energy transition
- The young industry's steep learning curve and dynamic evolution provides challenges though for elements of the supply chain. The industry must remain innovative and agile
- Changes in regulatory frameworks can add further challenges to a nascent industry

Thank you!

Questions?

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