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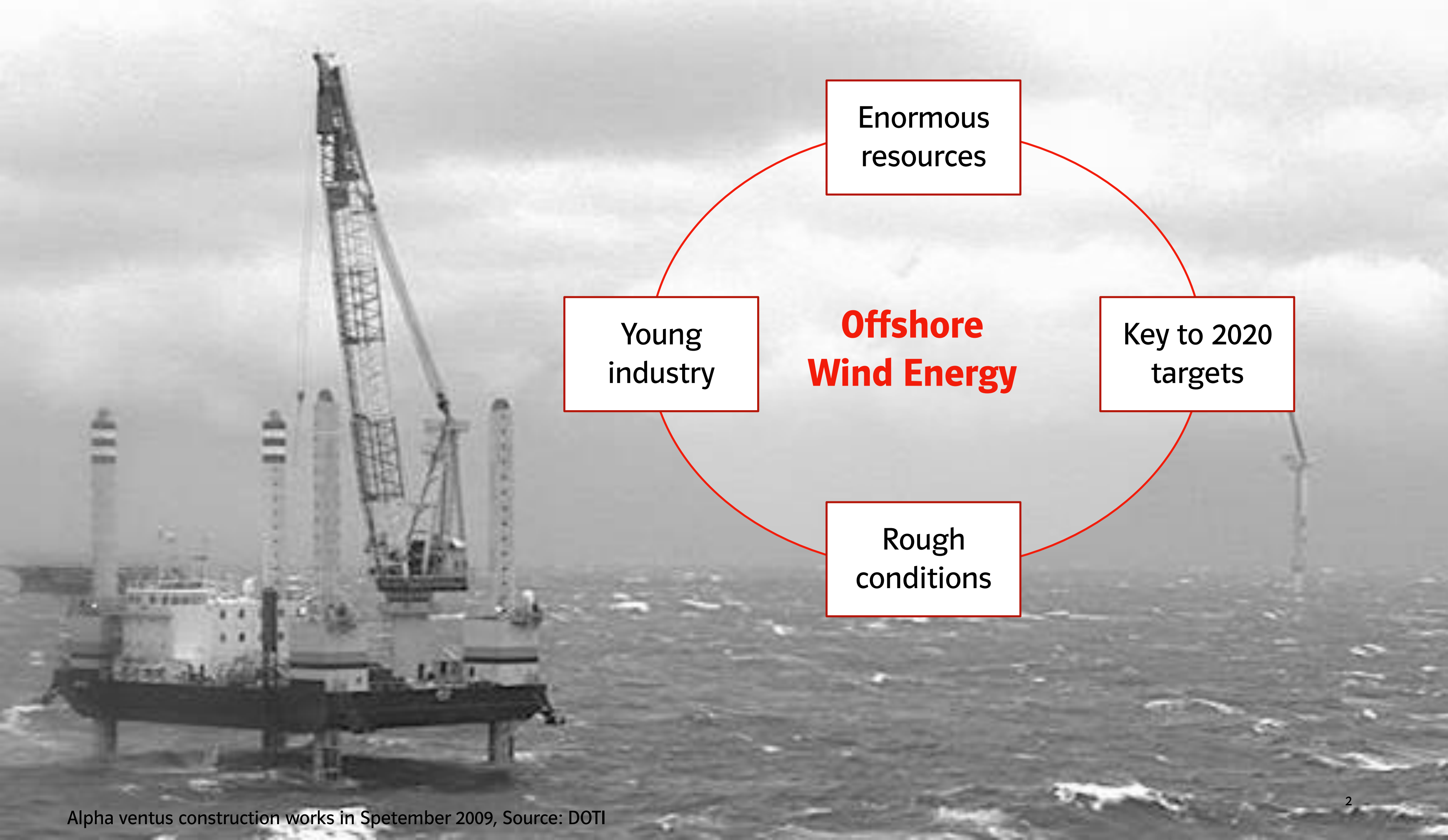
From close to the coast to farshore – E.ON´s Experience with Offshore Wind Energy Projects

Dr. Frank Mastiaux, CEO

Eufores-Conference, 16th of September 2010

Offshore wind energy: more than wind onshore with "wet feet"



Enormous resources

Young industry

Offshore Wind Energy

Key to 2020 targets

Rough conditions

Alpha ventus construction works in Spetember 2009, Source: DOTI

Enormous resource and new levels of scale

	Potential	Dimensions
 Onshore	• 2,000 full load hours per year • Limited space available • Projects facing local opposition	• Wind turbines 1 -3 MW • Wind farms of 20 – 50 MW each • Capex of €30 – 70m per wind farm
 Offshore	• 4,000 full load hours per year • Large space available	• Wind turbines 2.3 - 5 MW • Wind farms of up to 1,000 MW each • Capex of €1 – 3 bn per wind farm

- High expectations to exploit the offshore wind in European waters
  - EEA* sees an offshore potential of 900 GW till 2030, EWEA a project pipeline of 150 GW by 2030
  - Feasibility strongly depends on development of technologies, infrastructure and financing
- Offshore wind projects are significantly larger than onshore in terms of capacity and investment
- So far every offshore project is unique, but future projects must achieve economies of scale through industrial style construction methods and serial build
- Unlike onshore, project feasibility, technology, logistics and economics depend strongly on:
  - Water depth and seabed conditions
  - Distance to shore
  - Tides, currents and waves

*European Environment Agency, **European Wind Energy Association

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Offshore wind is key to EU´s 2020 renewables targets

- Offshore wind energy plays a significant role in the National Renewables Action Plans (NREAPs):

Country	2020 Target	Today
UK	13,000 MW	1,400 MW
DE	10,000 MW	60 MW
NL	5,000 MW	200 MW
F	5,000 MW	0 MW
Es	3,000 MW	0 MW
DK	1,300 MW	700 MW
EU total*	**39,700 MW**	**2,400 MW**

- Targeted growth from 2,400 MW installed today to about 40,000 MW* in 2020
  - Required growth rate of average 3,600 MW per year
- About 120 bn € of investment required
  - Tremendous budget exceeding financial capabilities of single energy companies
  - External financing is an issue due to high risk profile

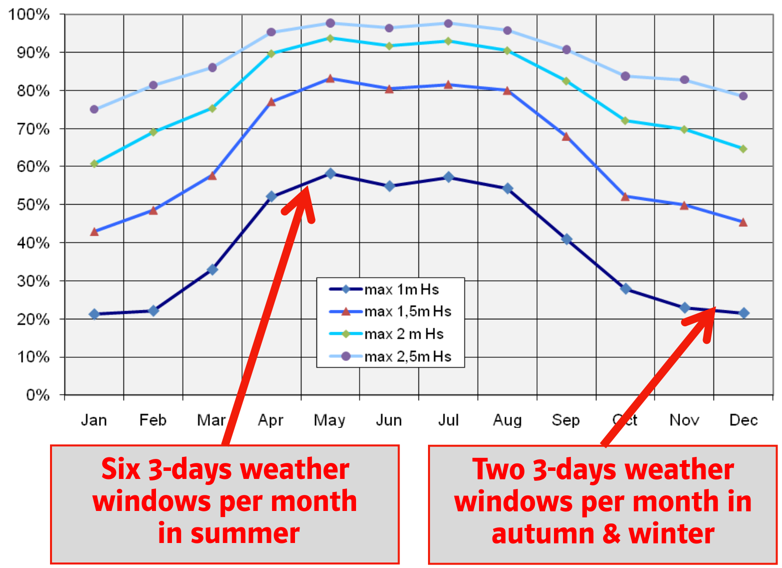
*does not include Belgium

Rough conditions: Waves, Wind & Weather limit accessibility

Access factors

- Site access at times limited due to wind, waves and weather (fog, ice etc.)
- Scheduling of offshore works requires excellent planning and large flexibility
- Lack of access during break downs results in lost generation mostly in wind-rich winters
- Large standby cost for logistics and staff due to postponed works (from days to weeks)

Offshore accessibility depending on wave height



- Currently, majority of vessels can only operate with wave heights of 1.0 m, which are rare over a time period of 3 days for major works
- Going forward, installation times have to be reduced and robustness against waves (> 2 m) needs to be increased to increase accessibility

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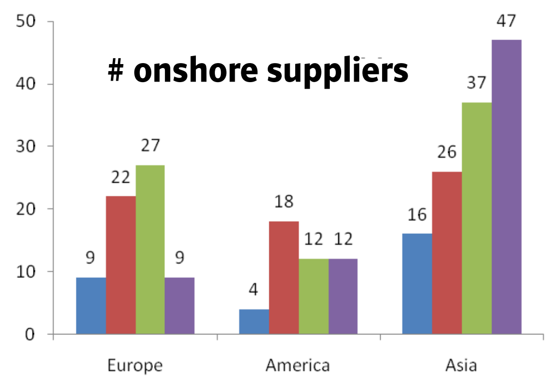
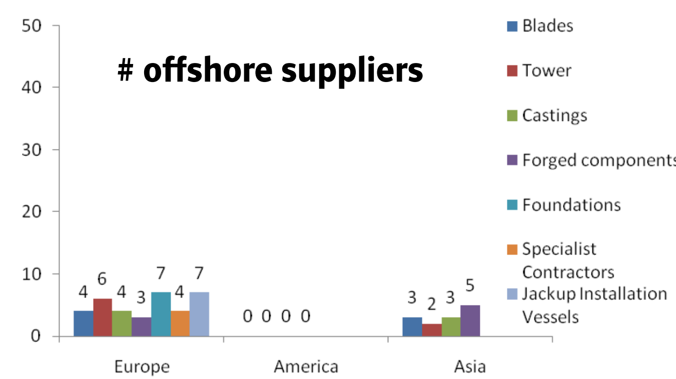
Young market facing big challenges

Technology

- Offshore wind requires different technologies and processes than onshore
- Equipment from oil & gas industry has proven limited suitability

Material And People





- So far, very few specialized suppliers throughout the entire value chain
- Only 4 turbine suppliers with 5 new players on the way
- Only 2 purpose-built vessels with a few new ones under construction
- Lack of specially trained offshore specialists, worksmen and engineers

Infrastructure

- Port infrastructure limited and not fitting needs
- Lack of storage & installation facilities onshore close to building site
- Great opportunity for EU-based high-tech industry and for coastal locations, but industry and infrastructure must emerge

Source: BTM 2010

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Offshore plays a key role in E.ON´s Renewables strategy

E.ON Offshore Wind Farm Blyth, UK, 4 MW

- Offshore wind fits perfectly with E.ON´s "Boutique to Industrial" approach for Renewables
  - Shaping the renewable industry from small projects to industrial scale to bring down costs and enhance reliability
  - Competence in development, construction and operations of large energy projects
- From the first offshore project Blyth in 2001, to the current construction of London Array, E.ON has
  - Gone from 4 MW projects to 1 GW projects
  - Committed more than €1 billion to offshore wind
  - Gained strong diverse experience from all a wide variety of projects, along a long and sometimes painful and costly learning curve

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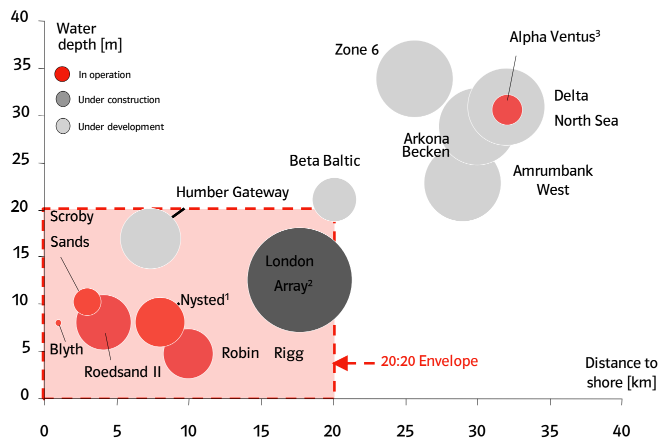
E.ON is building up a strong offshore wind portfolio

Diversification of E.ON Portfolio

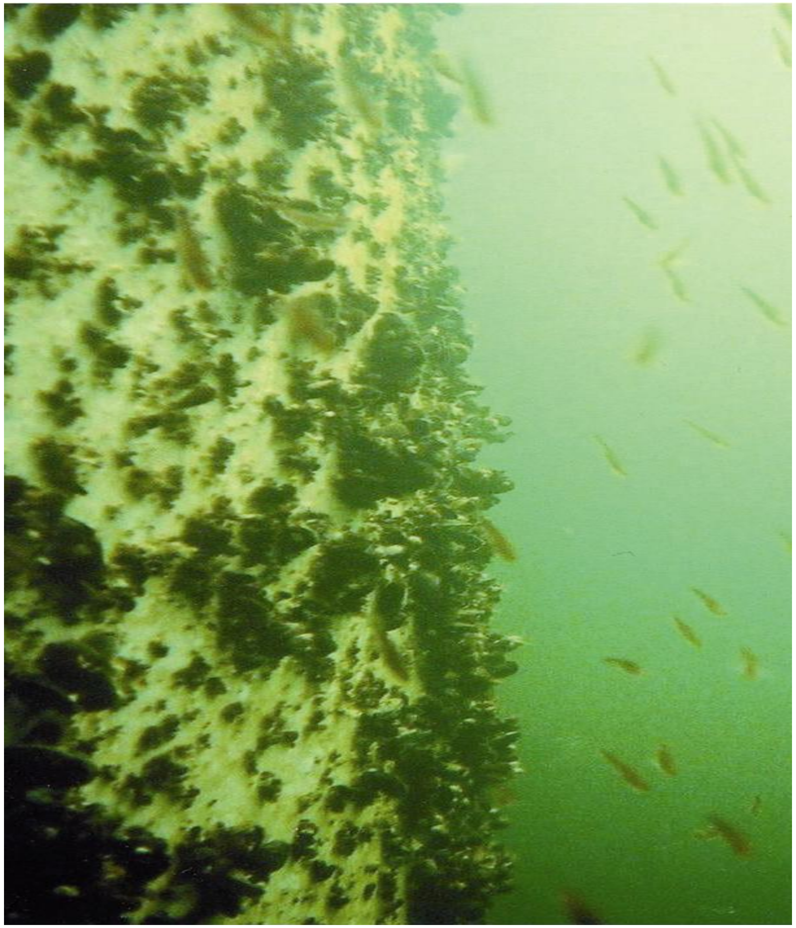


- Completion of Alpha Ventus marks first step beyond 20:20 Envelope
- E.ON continues to move "step-by-step" into deeper waters

- 6 offshore wind farms with around 500 MW in operation in UK, Denmark and Germany
- E.ON installed 64% of new offshore capacity in Europe in H1/2010
  - Robin Rigg (UK, 180 MW) in operation 04/2010
  - Rødsand 2 (DK, 207 MW) in operation 07/2010
  - First deep water, far-shore wind farm Alpha Ventus[1] (Germany, 60 MW) in operation 09/2009
- Phase 1 of world's largest offshore wind farm London Array[2] (630 MW) under construction
- Unique, diversified project pipeline > 4 GW in the North Sea and the Baltic Sea

[1] JV of E.ON Climate & Renewables (26.25%), EWE (47.5%) and Vattenfall Europe (26.25%), [2] JV of E.ON Climate & Renewables (30%), DONG (50%) and Masdar (20%)

Promoting the sustainable development of offshore wind



Mossels and fishes settling at offshore foundation

- Offshore safety and protection of the marine environment are a priority for E.ON
- Together with IUCN*, E.ON has conducted an extensive study about the impact of offshore wind farms on the marine environment
  - Reducing the construction noise is the most important issue
  - Offshore wind farms are protected from trawling and fishing
  - Offshore installations create new habitats and artificial reefs which increase biodiversity and provide breeding grounds
  - Many species return after the construction phase – only some water birds avoid the wind farms
  - Migrating birds regard the wind farms as barriers that they avoid, very few bird strikes occur

Source: IUCN *(International Union for Conservation of Nature)

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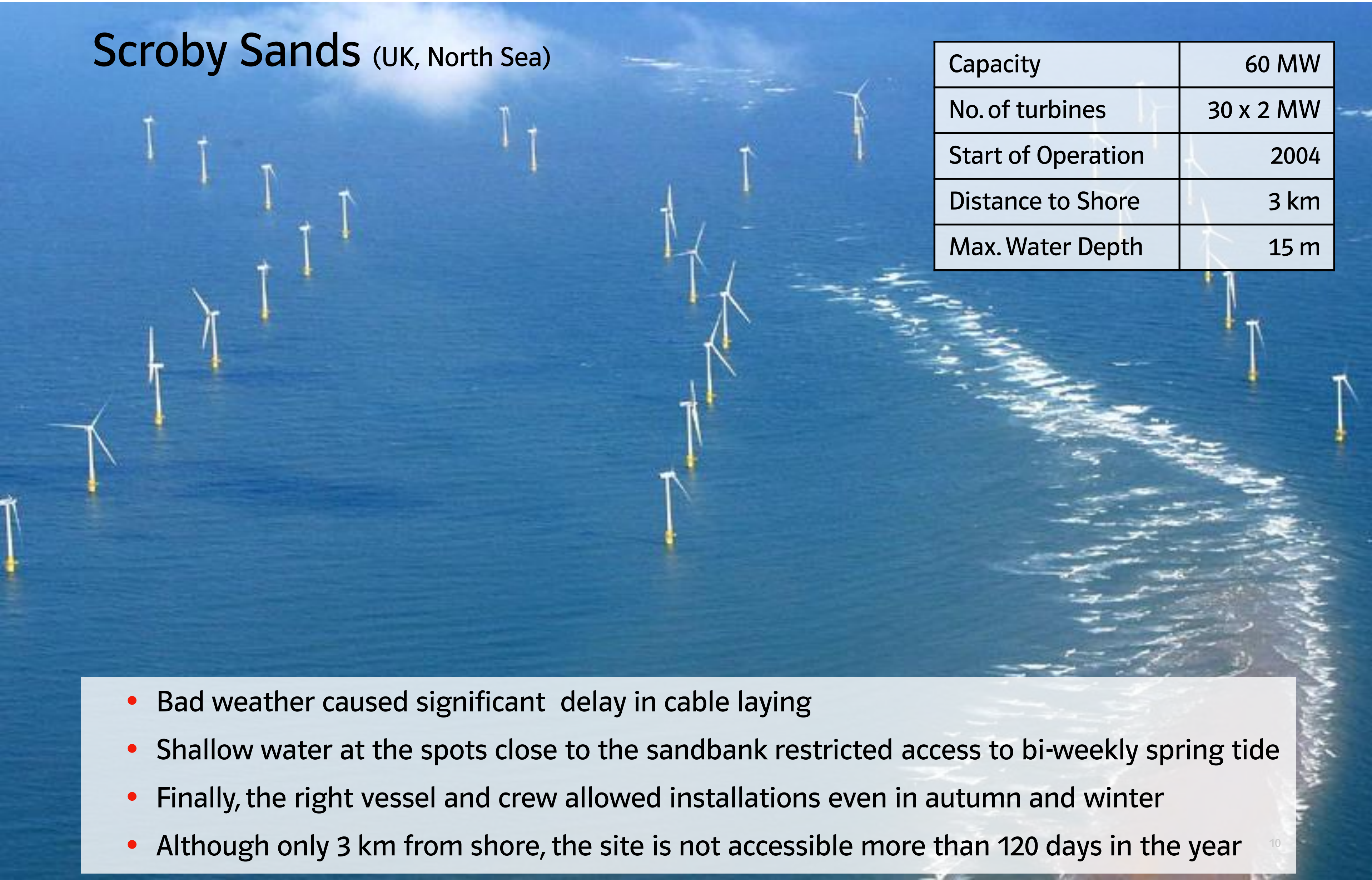
Scroby Sands (UK, North Sea)



Capacity	60 MW
No. of turbines	30 x 2 MW
Start of Operation	2004
Distance to Shore	3 km
Max. Water Depth	15 m

- Bad weather caused significant delay in cable laying
- Shallow water at the spots close to the sandbank restricted access to bi-weekly spring tide
- Finally, the right vessel and crew allowed installations even in autumn and winter
- Although only 3 km from shore, the site is not accessible more than 120 days in the year

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Robin Rigg (UK, Irish Sea)

Capacity	180 MW
No. of turbines	60 x 3 MW
Start of Operation	2010
Distance to Shore	10 km
Max. Water Depth	9 m

- Using a "nearly suitable" vessel lead to significant delays and caused serious trouble
- Using a well-equipped purpose-built vessel instead lead to rapid learning and quicker installation – from the installation of 1 foundation in a month to 1 per day

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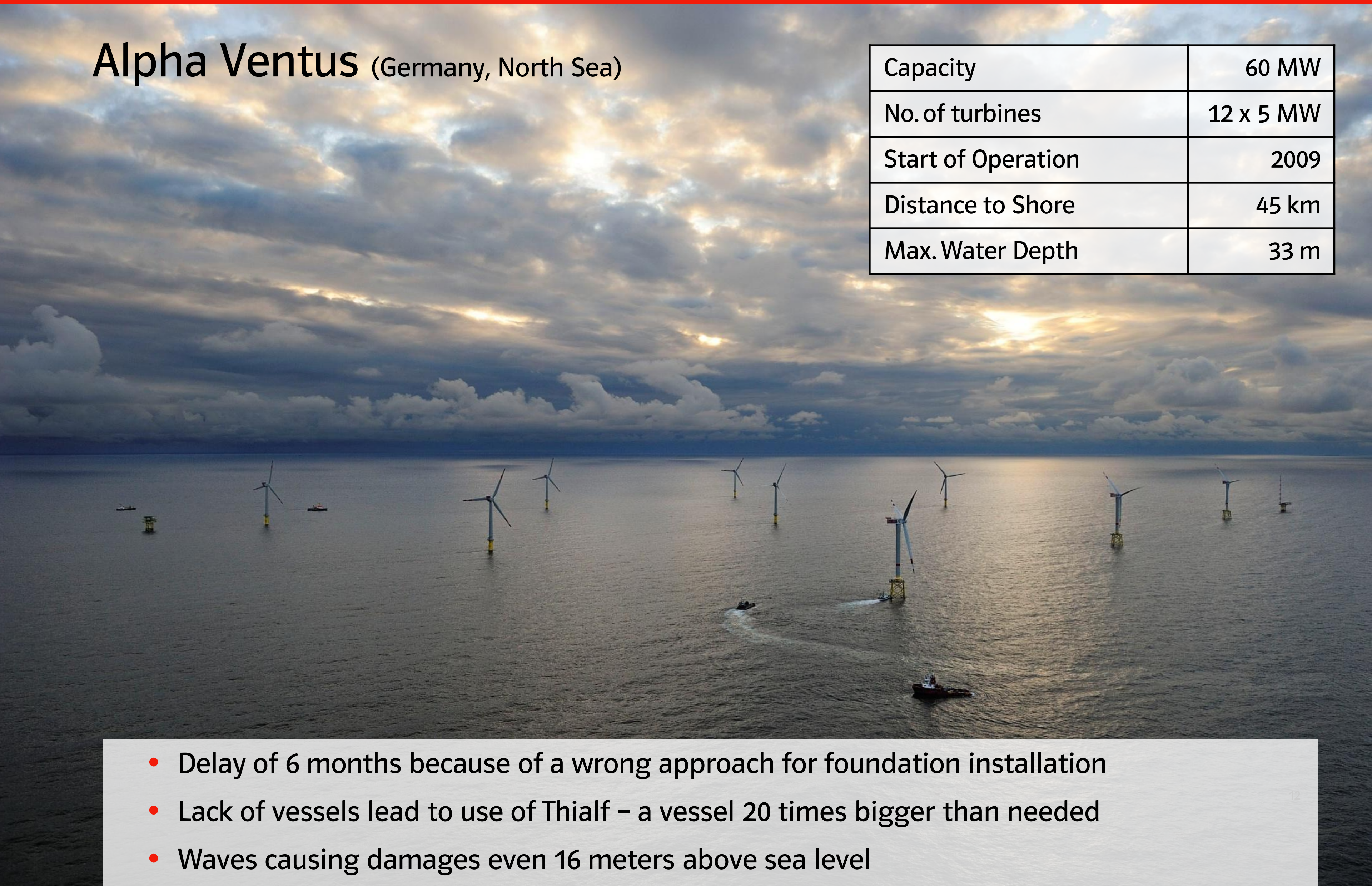
Alpha Ventus (Germany, North Sea)

Capacity	60 MW
No. of turbines	12 x 5 MW
Start of Operation	2009
Distance to Shore	45 km
Max. Water Depth	33 m



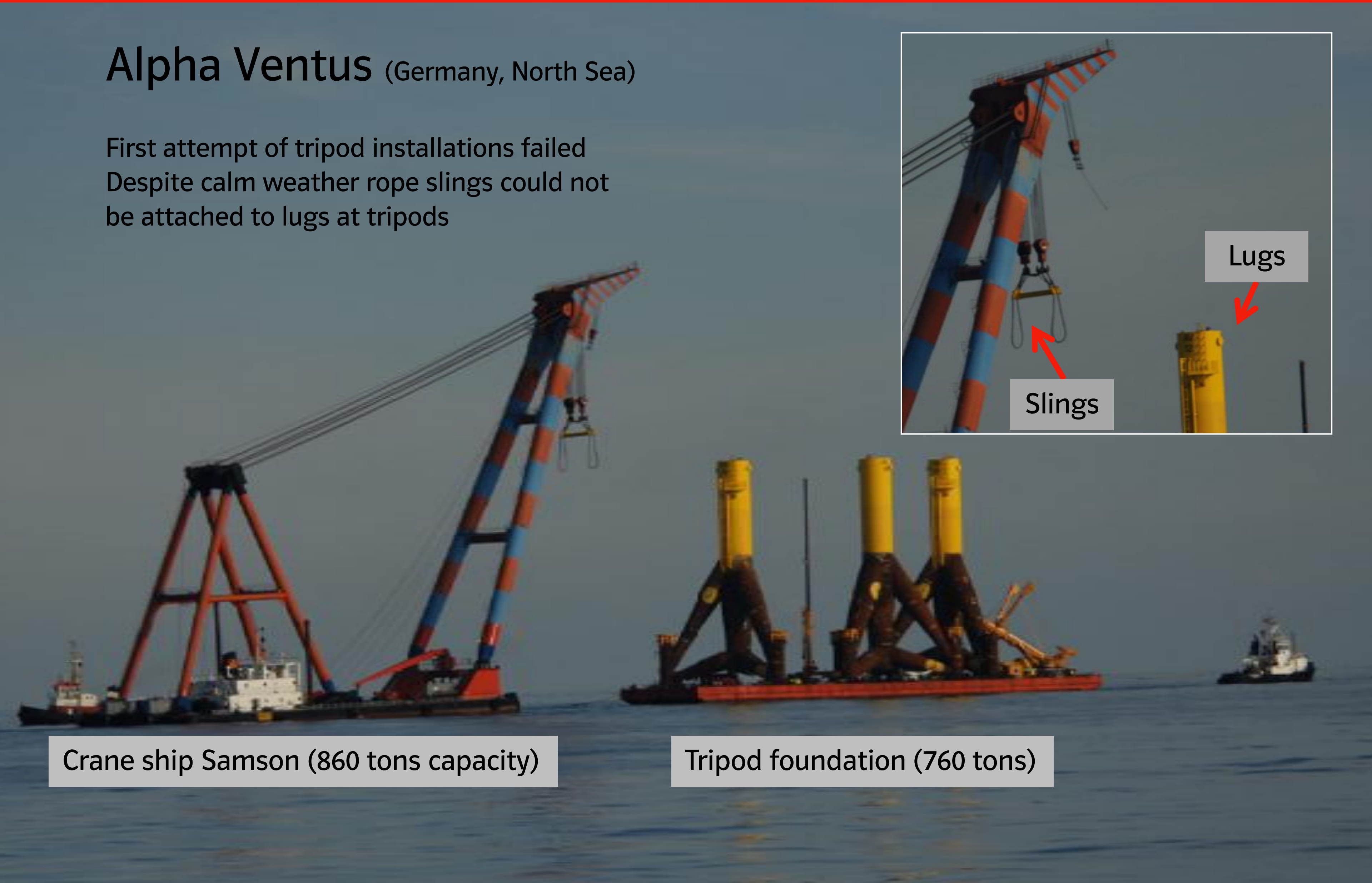
- Delay of 6 months because of a wrong approach for foundation installation
- Lack of vessels lead to use of Thialf – a vessel 20 times bigger than needed
- Waves causing damages even 16 meters above sea level

Alpha Ventus (Germany, North Sea)

Tripod foundations of 760 tons weight and 45 meters height
To be fixed to the seabed with
3 piles of 40 meters and 100 tons

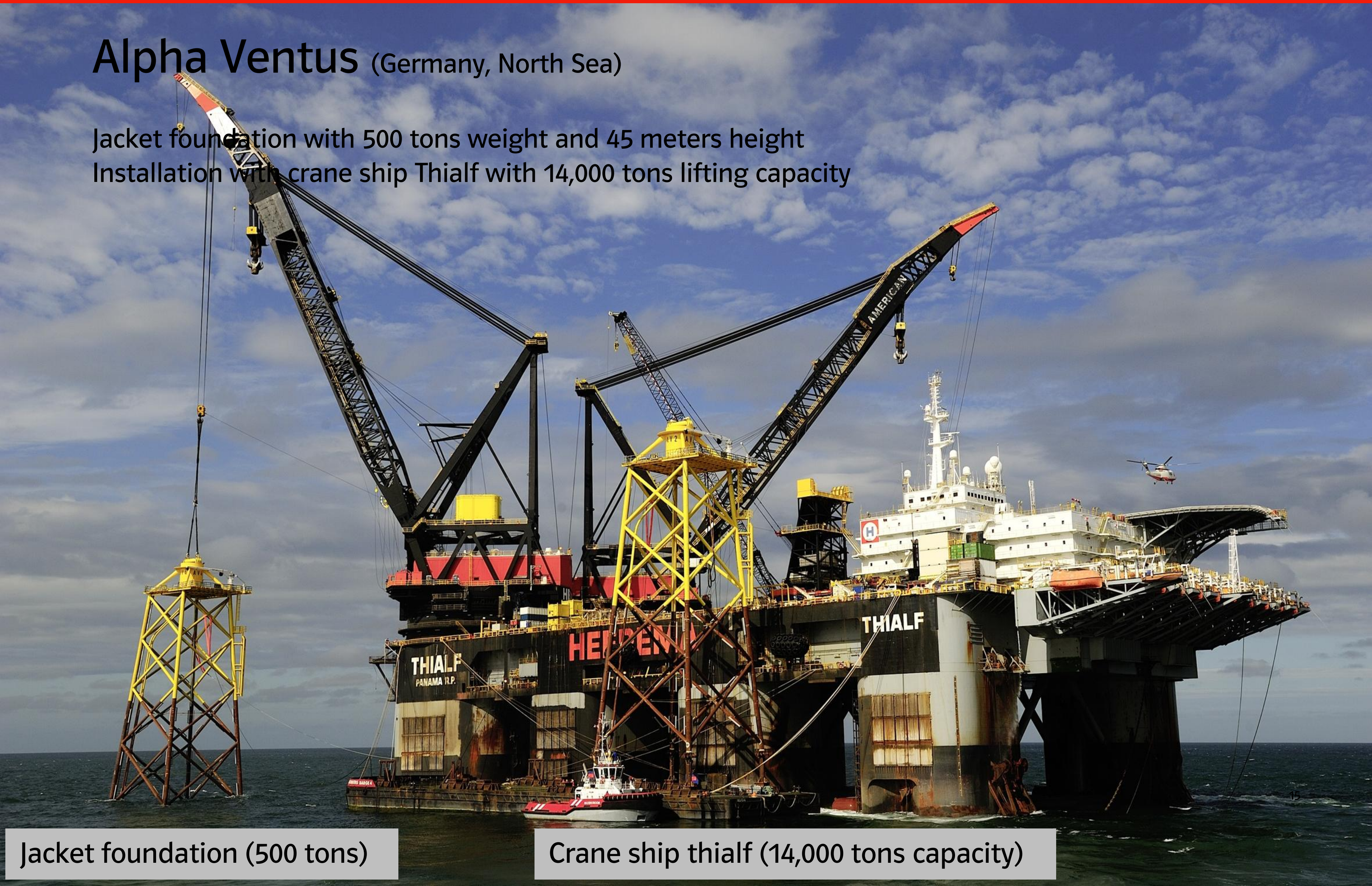
Alpha Ventus (Germany, North Sea)

First attempt of tripod installations failed
Despite calm weather rope slings could not be attached to lugs at tripods



Alpha Ventus (Germany, North Sea)

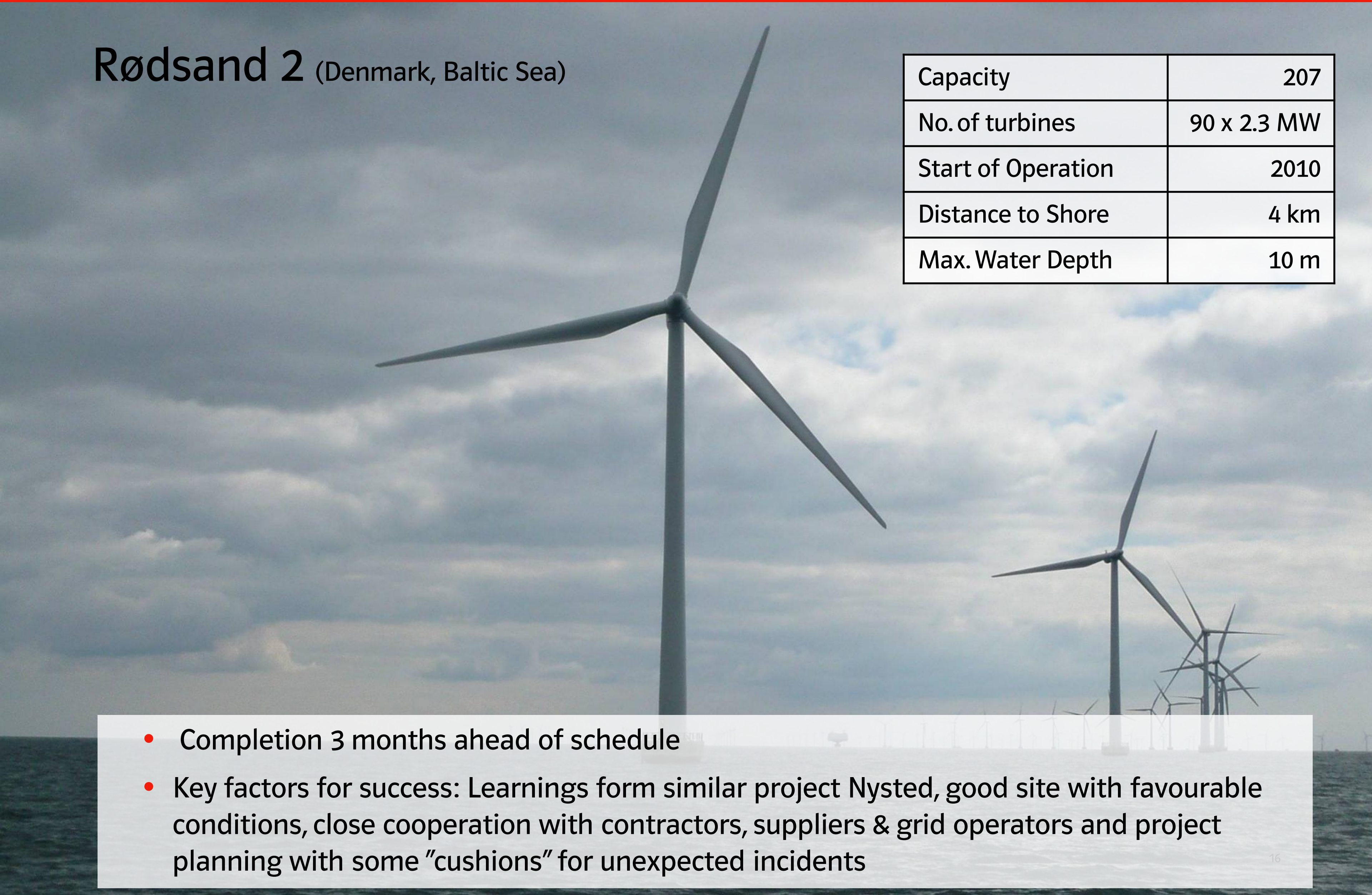
Jacket foundation with 500 tons weight and 45 meters height
Installation with crane ship Thialf with 14,000 tons lifting capacity



Jacket foundation (500 tons)

Crane ship thialf (14,000 tons capacity)

Rødsand 2 (Denmark, Baltic Sea)



Capacity	207
No. of turbines	90 x 2.3 MW
Start of Operation	2010
Distance to Shore	4 km
Max. Water Depth	10 m

- Completion 3 months ahead of schedule
- Key factors for success: Learnings form similar project Nysted, good site with favourable conditions, close cooperation with contractors, suppliers & grid operators and project planning with some ”cushions” for unexpected incidents

Regulatory issues of offshore wind energy

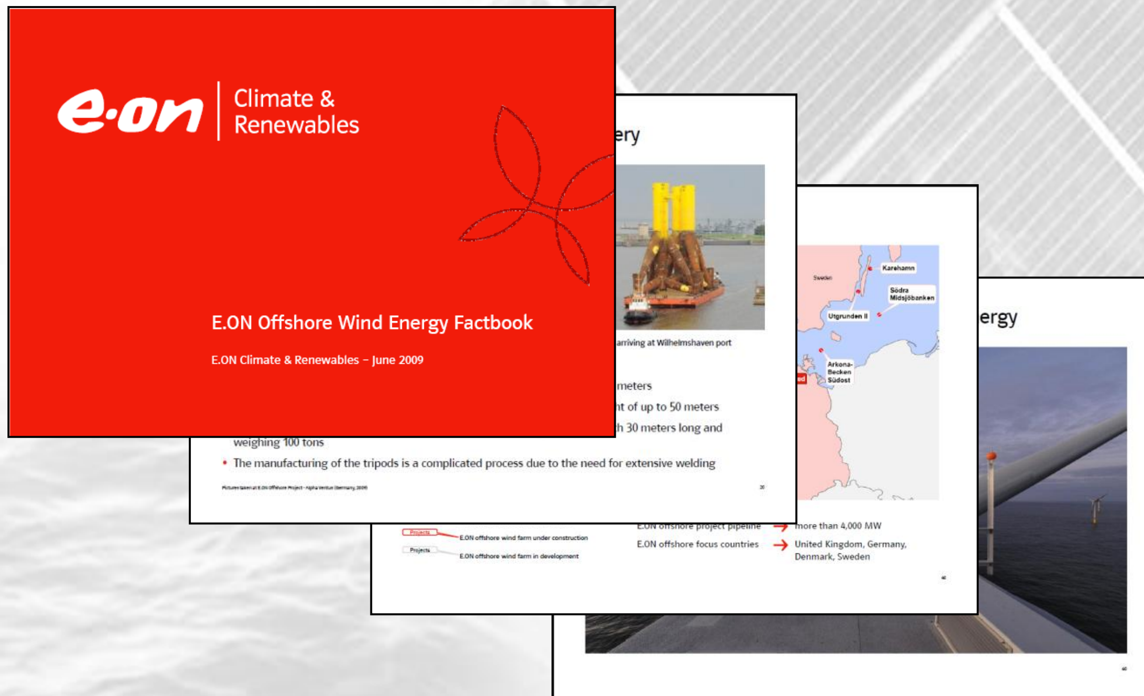
- **Grid capacities lagging behind required schedule**
  - Grid extension onshore is already delayed and grid connection offshore becomes a pressing issue
  - Clustering of grid connections and international coordination of offshore grid expansion needed
- **Provision of adequate port infrastructure for construction and operation**
  - Lack of suitable infrastructure makes near-shore projects "far-distance projects"
  - Great opportunity for coastal areas to establish new industry
- **Establishing international standards for offshore**
  - Experience in one country is not yet sufficiently transferred to others (e.g. for foundations)
  - Best practice for EU-wide standards for permitting or health, safety and environmental issues
- **Establishing "Flexible Mechanisms" to support offshore wind across borders**
  - Tremendous offshore potential will not be used domestically by all EU member states
  - Trigger to establish "Flexible Mechanisms" of the EU-RES directive to support offshore projects

Conclusions

- **Offshore wind energy provides great resource potential for Europe**
  - Significant contribution to EU 2020 Renewables targets and beyond
  - Build-up of new European high-tech industry and economic stimulus for coastal regions
- **Success of offshore wind energy depends on several factors**
  - Technical challenge and tremendous financing needs
  - Young industry and technologies need to make rapid progress
- **Offshore wind energy requires a Pan-European approach**
  - Cross-border support, cooperation and coordination of grid infrastructure
  - Best practice as basis for common understanding, standards and future planning
- **E.ON is determined to become the market leader in offshore wind energy**
  - Pushing forward the growth and development of offshore wind energy in Europe
  - Learning to tackle the offshore challenges from daily work out in the sea

Thank you for your attention!

Dr. Frank Mastiaux, CEO



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For further information

please refer to our

"E.ON Offshore Wind Energy Factbook" at www.eon.com