

Global Wind Day

Seoul 2018



Fred. Olsen Ocean

Installation and O&M Solutions for the Offshore Wind Korea

Ludmila Mondino
Business Development Manager



‘South Korea is called the
Land of Morning Calm’

Despite that **windy seas** are clutching
at its coasts, bringing an **Inexhaustible
Natural Resource – the Offshore
Wind**

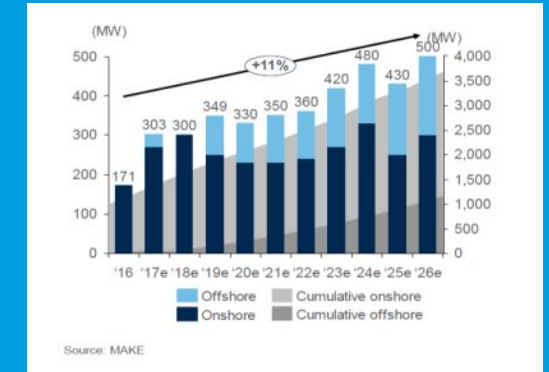


Offshore Wind Drivers and Business Context

- **Policy Support** through the **8th Basic Plan for Electricity Supply and Demand**, increasing the share of renewable from **6.2% to 20% by 2030** and the **Renewable Energy 3020 Implementation Plan** proposing the deployment of **13GW offshore wind**
- **30 MW Tamra**, a utility-scale offshore wind project, grid connected 1H/2017 accelerating further development

Market Progress:

- **60MW Southwest Offshore Demonstration** under construction (1st phase of 2.5GW)
- **99.2 MW Saemangeum** in pre-construction
- **22 projects under development** totalling ~ 7GW
- +5 GW across zones of potential and 1GW Floating Offshore wind



Fred. Olsen Related Companies



Renewable energy



100%

Fred. Olsen
Renewables AS

Shipping/ Offshore wind



100%

Fred. Olsen Ocean
Ltd.

Offshore drilling



51.9%

Fred. Olsen Energy
ASA

Cruise



100%

Fred. Olsen
Cruise Lines Ltd.

Other investments



54%

NHST Media Group
AS

Bonheur ASA companies in Renewables

Listed Oslo Stock Exchange

 **Fred. Olsen Windcarrier**

 **Fred. Olsen Renewables**



Wind farm owner operator

- 11 wind farms
- 679 MW capacity (~1,9TWh/yr)
- Development pipeline of 2,2 GW secured and under development

100%
owned

 **Fred. Olsen Windcarrier**



Jack-up installation

- 2 custom built jack-up installation vessels
- Turbine and foundation installation
- Op. and maintenance

100%
owned

 **Universal Foundation**



Wind turbine foundation

- The Carbon Trust's championed design
- 10+ MW WTGs
- Quick and silent installation
- No grouting

100%
owned



Technical manpower

- ~850 personnel
- On and offshore
- Installation, Service & maintenance
- Main component exchange
- HV

75.5%
owned

 **harland and wolff**
heavy industries ltd



Renewables hub

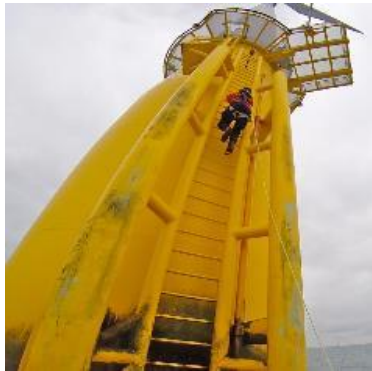
- Assembly
- Logistics
- Foundations
- Vessel repair and maintenance

Subsidiary of
Fred. Olsen Energy

51.9%
owned

Fred. Olsen related companies in renewables

Privately owned



Renewable Energy Consultancy and Service Provider

- Renewable energy consultants
- 360 degree lifecycle approach
- 350+ renewable experts



Communications and Service Provider

- Leading marine mgmt. and monitoring system SeaPlanner
- Supports near and farshore offshore projects
- Communication container solution 'SeaHub'



Wind Lidar System

- The original wind lidar est. 2007
- 1000+ deployments globally, 10m+ operational hours
- Cost effective alternative to traditional Met. Masts

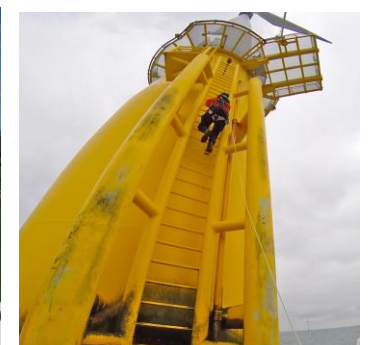
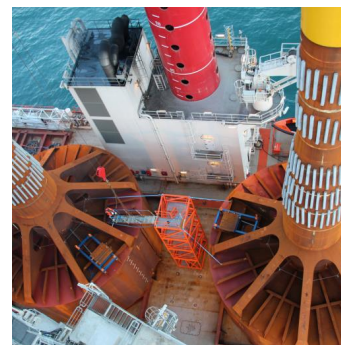
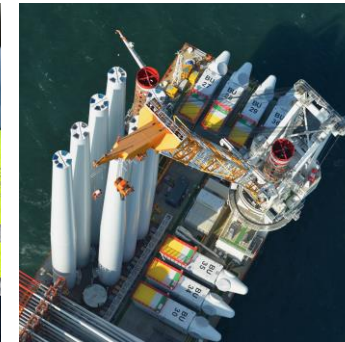
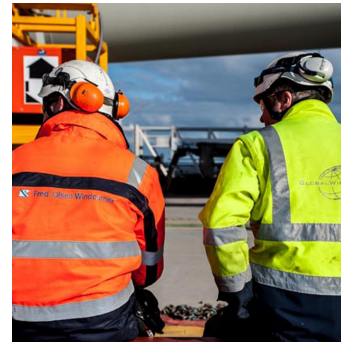


Pioneering Wave Energy Generator

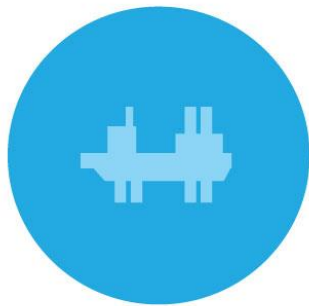
- Ground breaking reliability
- Continuous power output
- Currently deployed by US Navy off Hawaii

Fred. Olsen related companies have built a solid position in renewable energy

- 25 years in renewables
- 170 years in offshore, shipping and marine
- 10 established companies
- Employing ca. 1,500
- Working in over 40 countries
- Onshore wind; delivered **11 industrial scale onshore windfarms** with **679 MW** installed capacity (generation ~1.9 TWh/yr)
- Offshore wind; **installed 311 WTGs** with **1453 MW** installed capacity (5.2TWh/year)



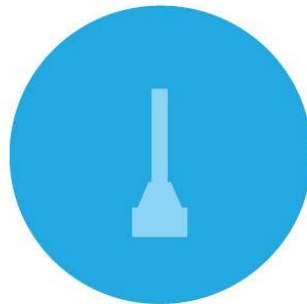
Fred. Olsen Ocean



Fred. Olsen Windcarrier

100%

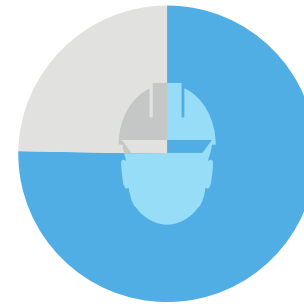
Jack-up installation
vessels



Universal Foundation

100%

Mono Bucket foundations



Global Wind Service

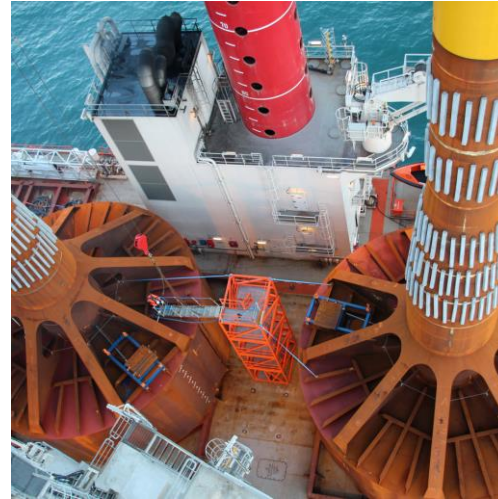
75.5%

Technical manpower



Fred. Olsen Windcarrier

- Two custom built jack up vessels
- Wind turbine & foundation installation
- Operations & maintenance



Universal Foundation

- Design championed by the Carbon Trust
- 10+ MW wind turbines
- Fast & silent installation
- No grouting



- >850 personnel on & offshore
- Installation, service & maintenance
- Main component exchange
- High Voltage (HV)

Health, Safety, Environment, Quality (HSEQ)

We are committed to being recognized as a leading organisation for HSEQ management

HSE:

- Zero incidents mindset
- Risk management is an integrated part of all activities
- Detailed HSE requirements defined to ensure safety at all levels
- Open reporting culture, focusing on learning

Quality:

- Our 'Improve Quality (iQ)' programme aspiration:
"Always right the first time and on time – with enthusiastically satisfied customers"
- **ISO 9001, ISO 14001, OHSAS 18001 and Achilles certified**

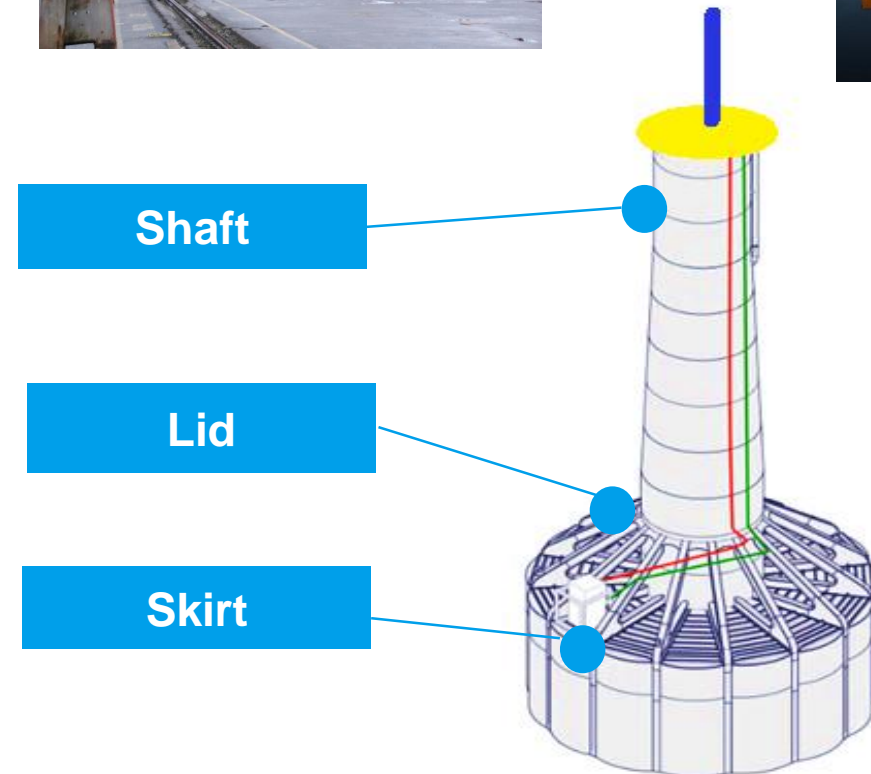
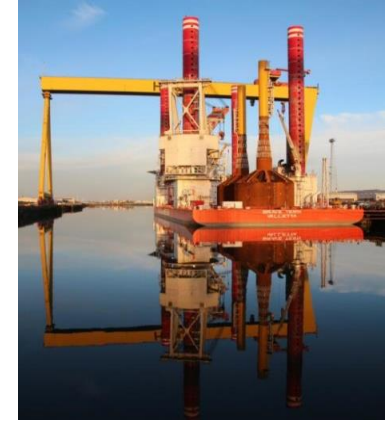


Foundation Design Solutions

Universal Foundation: The Mono Bucket Foundation Solution

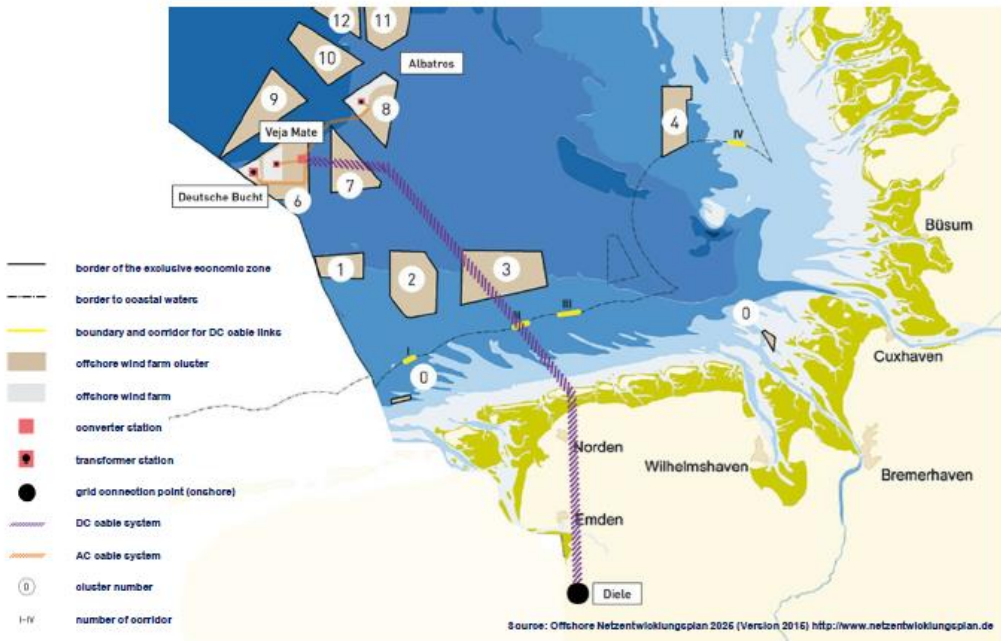
A **hybrid design** combining the **benefits of a gravity base foundation, a monopile and a suction bucket**.

- Noise-Free Installation
- Suitable for +10MW WTGs
- 20-25% lighter than monopiles
- Optimal range coverage: 20-55 metres
- No grouted connections - integrated transition piece
- No seabed preparations, integral scour prevention
- Single-lift or self-floating installation
- Completely removable – reducing the need for “Bank-Aval”
- Proven to reduce the LCOE



Universal Foundation in the Deutsche Bucht Pilot Project

DEUTSCHE BUCHT – 252MW



RECHARGE WIND



Mono Buckets used as foundations for recently decommissioned met-masts at the UK's Dogger Bank project site. Photo: Universal Foundation

New-breed Mono Buckets head for Deutsche Bucht debut



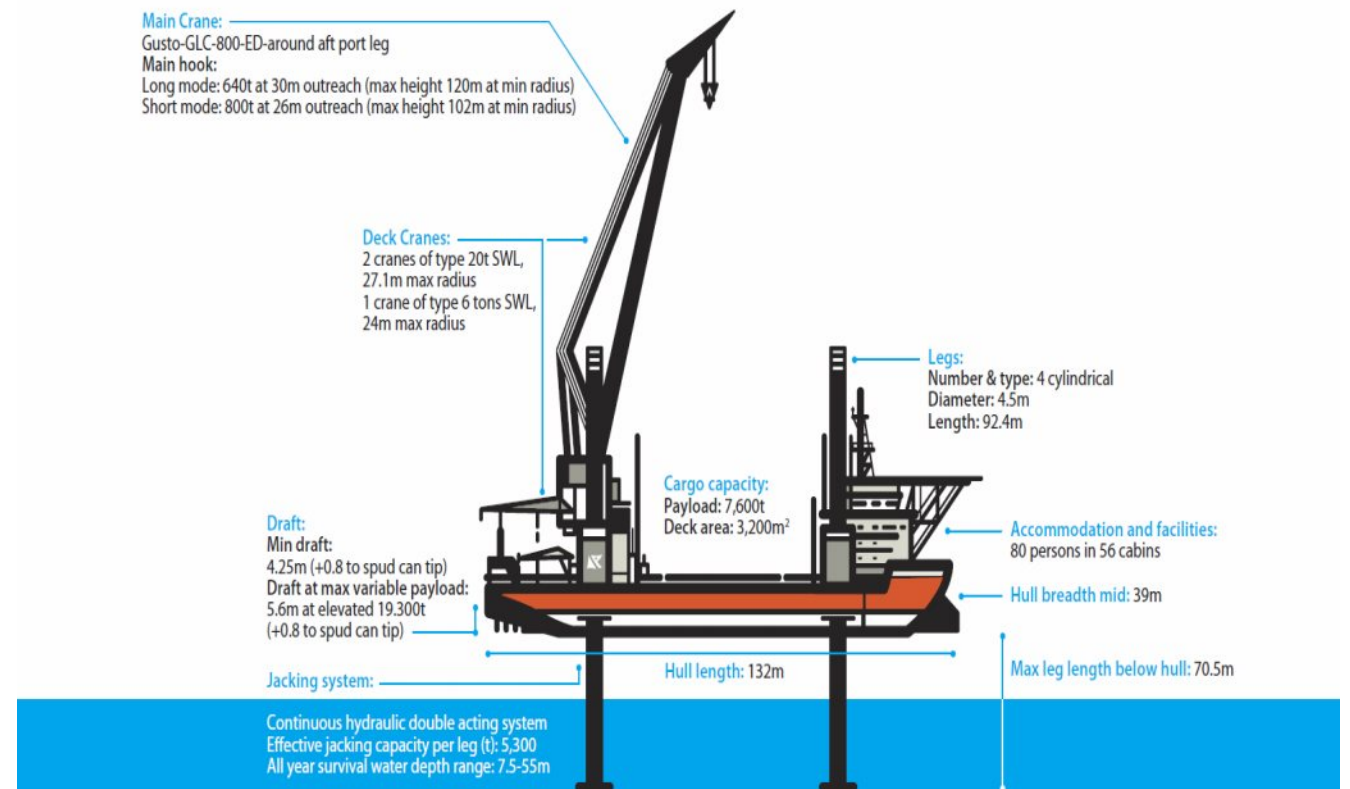
Construction Services

Transport & Installation Solutions in Offshore Wind Projects

Bold Tern & Brave Tern – our Specialist Jack-up Vessels

We offer clients all the key elements in the **Transport & Installation Scope:**

- ✓ Complete Design & Engineering
- ✓ Experienced Project Managers
- ✓ Supply chain management & logistics

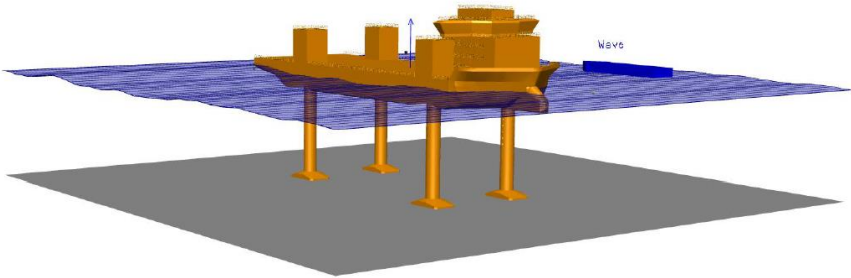


Lessons learned from projects with challenging soil conditions

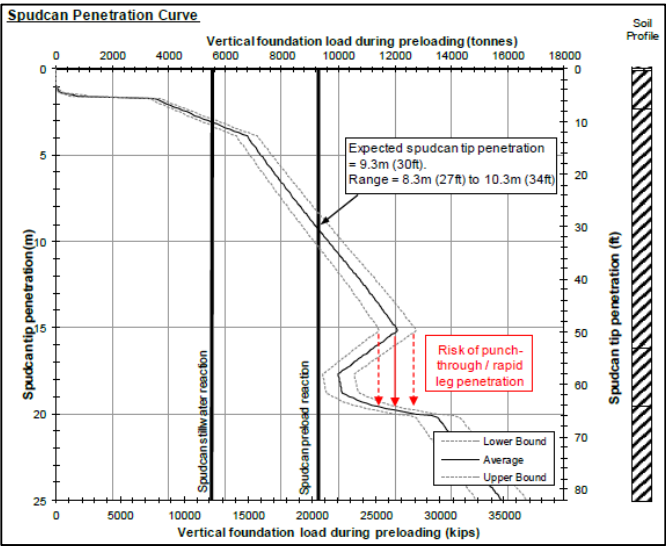
Jack-Up Operations & Geotechnical Aspects

| Operational Experience at Challenging Sites of Operation | | |
|--|-----------------------|---|
| OWF | Leg Penetration Range | Jacking Related Issues |
| Wikinger | 1.1m – 14.7m | <ul style="list-style-type: none">Punch-through riskLateral variability (in-depth channels)Boulders |
| Galloper | 5.8m – 12.4m | <ul style="list-style-type: none">Deep penetrationsLeg extraction“Relaxing” soils |
| Forewind | 1.4m – 33.0m | <ul style="list-style-type: none">Deep penetrationsLeg extractionInsufficient leg length |

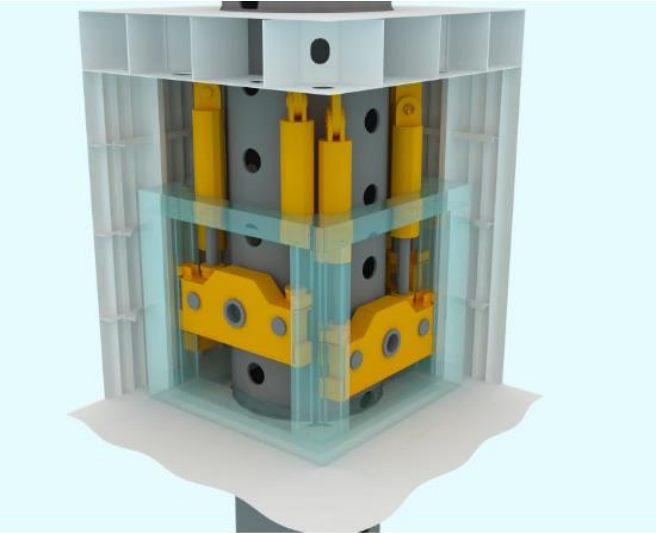
Preload Operation Prior Jack-Up



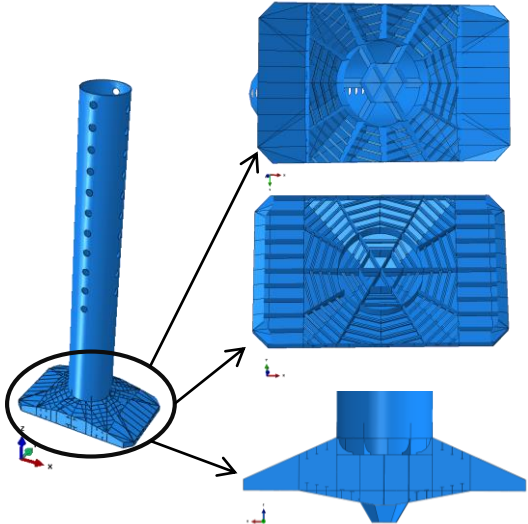
Leg Penetration Analysis (LPA)



Continuous Hydraulic Jacking System



Spudcans with Jetting System



Installation Track Record



1
GERMANY
Riffgat
Siemens
2013
30 x SWT 3.6 MW

2
GERMANY
BARD Offshore 1
BARD
2013
14 x BARD 5.0 MW

3
BELGIUM
Belwind
Alstom
2013
1 x Haliade 6.0 MW

4
UK
Dogger Bank
Forewind
2014
2 x UF Foundations

5
GERMANY
Global Tech I
Areva
2014
75 x Areva 5.0 MW

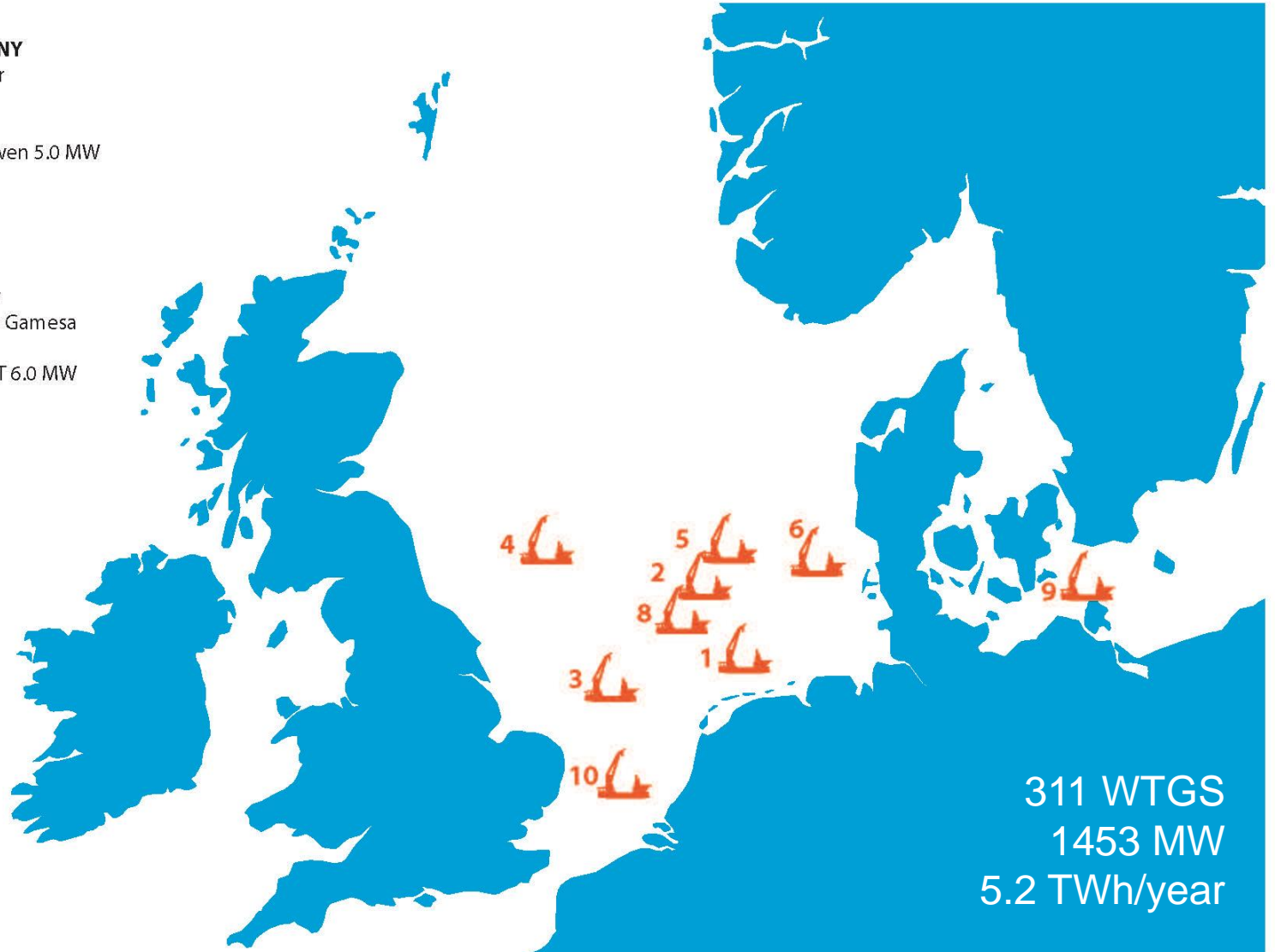
6
GERMANY
Butendiek
Siemens
2015
80 x SWT 3.6 MW

7
USA
Block Island
Deepwater Wind
2016
5 x GE 6.0 MW

8
GERMANY
Veja Mate
Siemens Gamesa
2017
19 x SWT 6.0 MW

9
GERMANY
Wikinger
Adwen
2017
70 x Adwen 5.0 MW

10
UK
Galloper
Siemens Gamesa
2017
17 x SWT 6.0 MW



Operations & Maintenance

Fred. Olsen related companies provide Clients with **Complete O&M solutions**:

- ✓ Marine spread
- ✓ Resources
- ✓ Expertise for efficient scheduled and unscheduled operations and maintenance services.

We set up an alliance of family companies capable of delivering an integrated O&M offering in-house.

‘Best in Class’ scope of **integrated services** in the offshore wind:

- Covering a wide scope of O&M services through a single contracting body at competitive prices.
- Reduce operational risks, management interfaces and contractual complexity through seamless coordination.
- Tailor made to meet particular Client’s requirements.



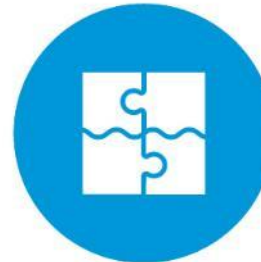
Our O&M Service Offerings



Inspections



Major component
exchange



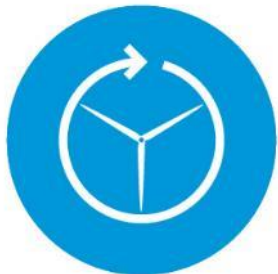
Integrated
service
campaigns



Blade repair



Advanced
performance
engineering



Decommissioning
repowering and life
extension



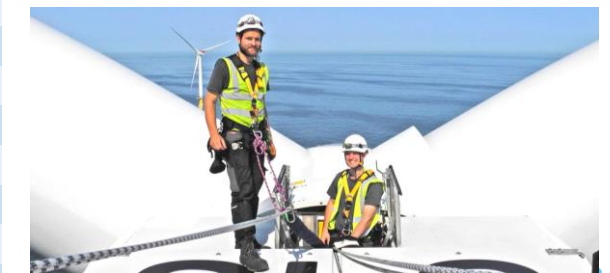
High voltage
management
and repair



Marine
co-ordination
and logistics

Combined O&M Offshore Experience

| Country | Turbine type | Scope of work | Jack-up | CTV | Manpower |
|---------|--------------|--|---------|-----|----------|
| DK | 2.0 MW | Service & maintenance, exchange of main components, 500h service | | ✓ | ✓ |
| GER | 2.3 MW | Service | | ✓ | |
| IR | 3.6 MW | Exchange Offshore of main components | | | ✓ |
| NL | 3.0 MW | Service & maintenance | | | ✓ |
| NL | 3.0 MW | Service & maintenance | | | ✓ |
| UK | 2.0 MW | Service & maintenance | | | ✓ |
| UK | 3.0 MW | Service & maintenance | | | ✓ |
| UK | 3.6 MW | Service & maintenance | | ✓ | ✓ |
| UK | 3.6 MW | Service & Maintenance, exchange of main components, 500h service | | | ✓ |
| UK | 3.6 MW | Service & Maintenance, exchange of main components, retrofit | | | ✓ |
| UK | 3.6 MW | Service & maintenance | | | ✓ |
| UK | 2.3 MW | Service & maintenance | | | ✓ |
| UK | 3.0 MW | Service & Maintenance, exchange of main components | | | ✓ |
| UK | 3.6 MW | Exchange of main components | ✓ | ✓ | |
| UK | 3.6 MW | Exchange of main components | ✓ | ✓ | |
| NL | 2.0 MW | Rolling blade exchange | ✓ | | |
| GER | 5.0 MW | Service & maintenance | | | ✓ |
| GER | 6.2 MW | Service & Maintenance, exchange of main components | ✓ | | ✓ |
| UK | 3.6 MW | Exchange of main components | ✓ | | |
| GER | 3.6 MW | Exchange of main components | ✓ | | |
| GER | >5 MW | Exchange of main components, blade repair | ✓ | | |
| GER | >5 MW | Exchange of main components | ✓ | | |
| UK | >5 MW | Exchange of main components | ✓ | ✓ | |
| GER | >5 MW | Exchange of main components | ✓ | | |
| GER | <5 MW | Exchange of main components | ✓ | | |
| UK | >5 MW | Exchange of main components | ✓ | | |
| DK | 3.6 MW | Retrofit | | | ✓ |
| NL | 4 MW | Service Campaign | | | ✓ |
| DE | 5 MW | 500h service | | | ✓ |



Expanding Renewable Energy Capacity in South Korea

- The utility-scale 30 MW Tamra project proves offshore wind's viability in South Korea
- Favorable policy landscape and an established local wind power supply chain
- KEPCO's role as leader in large-scale renewable projects (to comprise 11% of its total energy generation capacity by 2029)



Thank you!

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