



Opportunities in Global Wind O & M Market

Lucintel Brief

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Market Intelligence + Growth Consulting + Opportunity Screening + M&A Due Diligence + Benchmarking = **Your Company's Growth.**

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Table of Contents

- ***Executive Summary***
- ***O & M Overview***
- ***Opportunity Analysis***
- ***Strategic Growth Opportunities***
- ***About Lucintel***

Executive Summary

- **Global wind turbine cumulative installation is expected to reach 616 GW by 2019**
 - Onshore wind accounts for ~98% of the global wind cumulative installations in 2013 whereas offshore accounts for ~2%, mainly driven by Europe
 - Europe accounted for ~38% of the cumulative installations in 2013, followed by APAC with ~37%, NA with ~23% and RoW with ~2% share
- **Global wind O&M market is estimated at \$7.5 B in 2013 and expected to grow at a CAGR of 15% from 2013 to 2019**
 - Europe was the largest market contributing ~46% of the global O & M market, followed by APAC at ~30%, NA at ~21% and ROW at ~2% in 2013
 - Onshore O & M market accounts for ~94% of the total O&M market and offshore accounts ~6% in 2013
 - Low accessibility, low availability level and logistic issues etc. make offshore O & M services difficult to render, resulting in higher offshore O&M cost than onshore O&M
- **Increasing use of predictive maintenance, innovations in key components, increasing distance from shore & depth of offshore wind farms, & long term service contracts are key emerging trends in wind O&M market**
- **By analyzing the contributing factors of O&M for onshore and offshore, European onshore O&M looks the most attractive market**

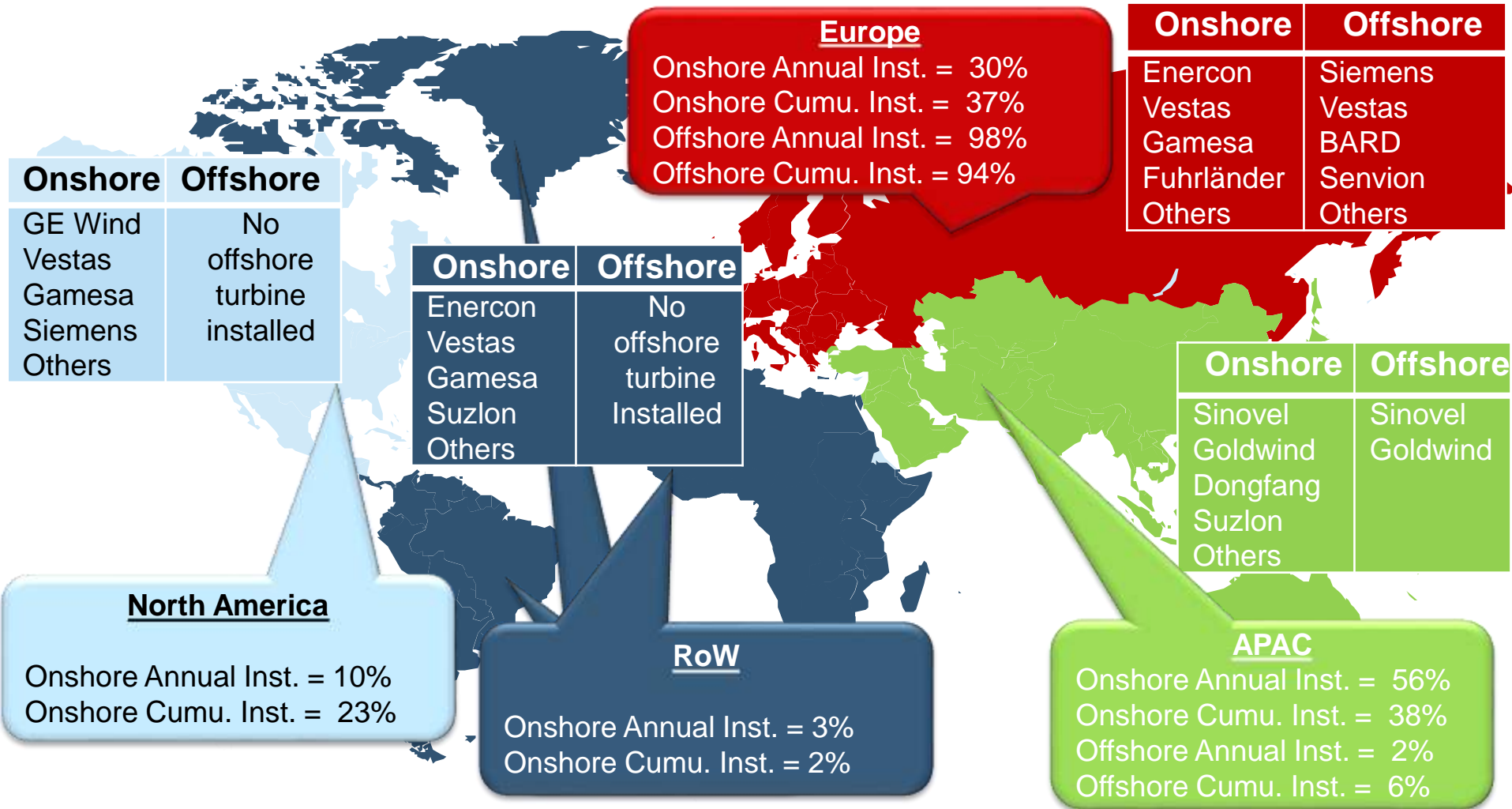
Table of Contents

- ***Executive Summary***
- ***O & M Overview***
- ***Opportunity Analysis***
- ***Strategic Growth Opportunities***
- ***About Lucintel***

Wind Energy Operation & Maintenance: Overview

- Onshore are land based wind turbines whereas offshore are installed in the ocean. Onshore wind energy has advantage of cheaper capital cost, O&M cost and availability of grid connection etc. where as offshore has advantage of high capacity factor over onshore due to swift and continuous wind. There are mainly two costs associated with wind energy during its life - Capital cost and O&M cost. Capital cost is done once at its lifetime in the initial phase whereas O&M costs are recurring costs that are necessary for the proper operation of a wind turbines.
- Operation costs are control oriented costs which help to run wind turbines such as site management, additional staff, tools & equipment cost and SCADA cost etc. These costs are not directly involved in repairing and overhauling of components but plays an important role for overall O&M cost.
- Maintenance costs are directly associated with the wind turbines. Every component has estimated life time in the overall 20 year lifetime of the wind turbines. Maintenance costs are based on size and configuration, and generally escalate over time as the machines' age and parts wear out.

Geographical Footprint of Wind Energy with Presence of Major OEMs



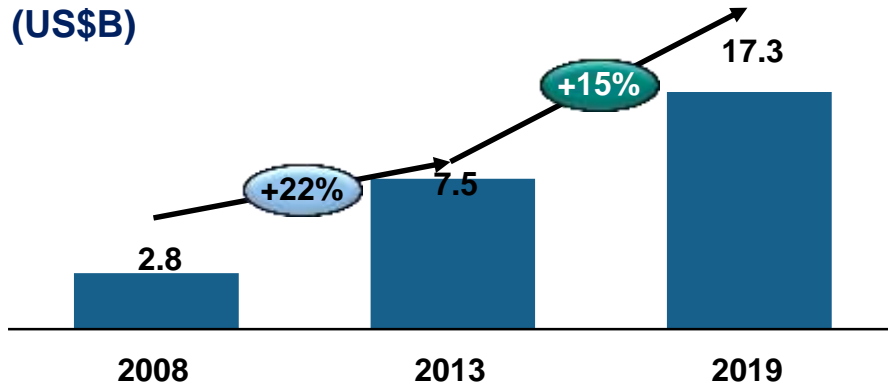
NOTE: % denotes regional market share of global annual and cumulative wind MW installations

Table of Contents

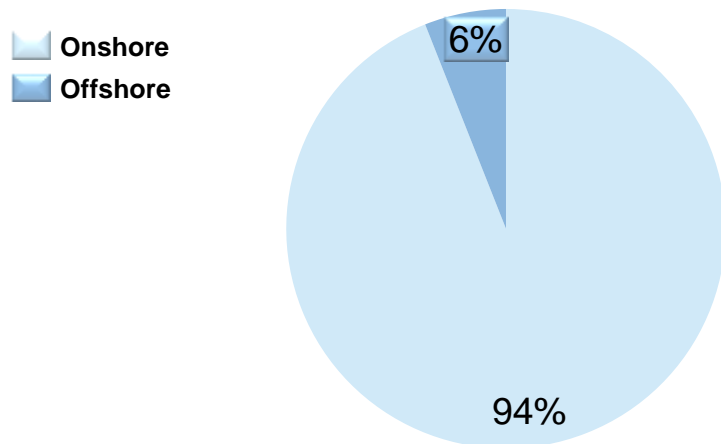
- ***Executive Summary***
- ***O & M Overview***
- ***Opportunity Analysis***
- ***Strategic Growth Opportunities***
- ***About Lucintel***

Trend & Forecast in Wind O&M Market

Global Wind O&M Market Trend and Forecast (US\$B)



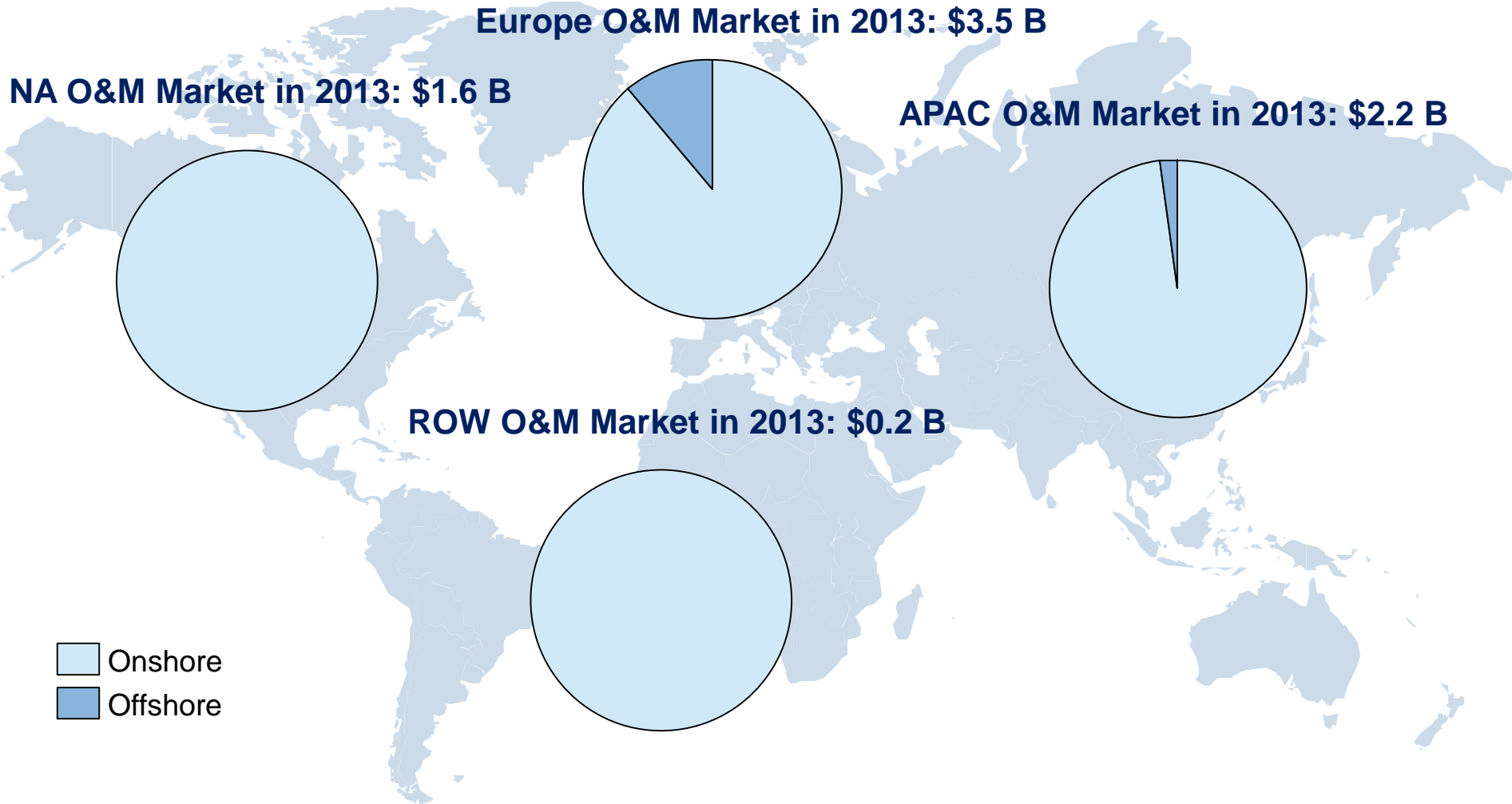
Global Wind O&M Market by Shore (US\$B) (2010)



Key Insights

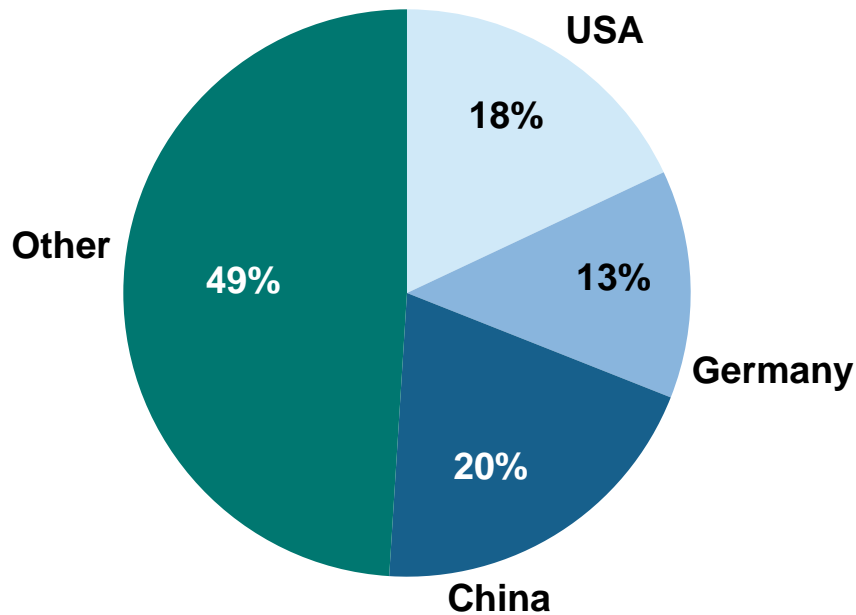
- Global wind O&M market is estimated at \$7.5 B in 2013 and expected to grow at a CAGR of 15% from 2013 to 2019
- Higher offshore O&M market in comparison to total offshore MW cumulative installations
 - Offshore accounts for ~2.2% of global cumulative wind installations where as 6% in global wind O&M market
 - Offshore O&M cost is close to 2.5-3 times expensive than onshore
- Global wind O&M market by region
 - European market is the largest wind O&M market, followed by APAC & NA
 - China & India are the major contributors in Asia-Pacific offshore O & M market

Global Wind O&M Market by Region

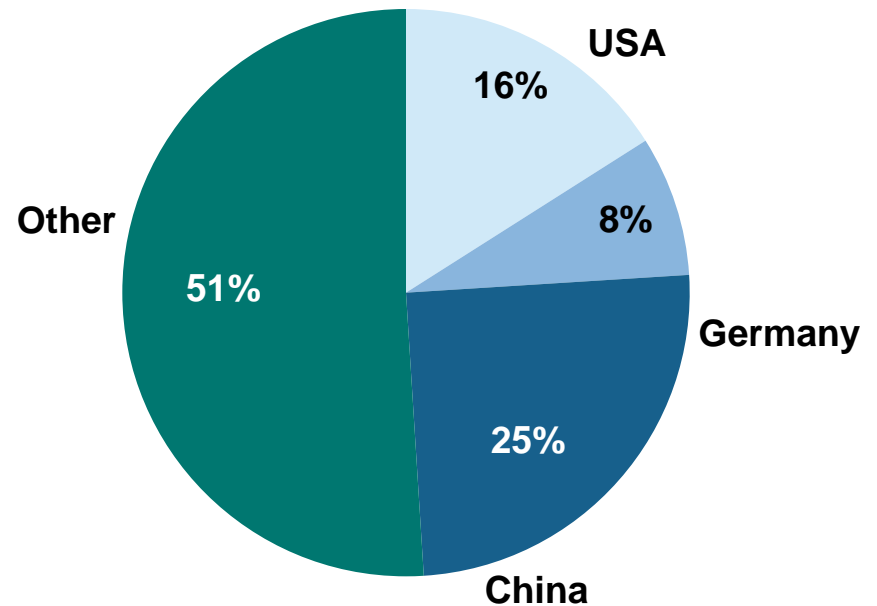


Market Share of Top 3 Countries in Global Wind O&M Market

Market Share Analysis of Top 3 Countries in Global Wind O&M Market 2013 (\$ 7.5 B)



Market Share Analysis of Top 3 Countries in Global Wind O&M Market 2019 (\$ 17.3 B)



Key Insights

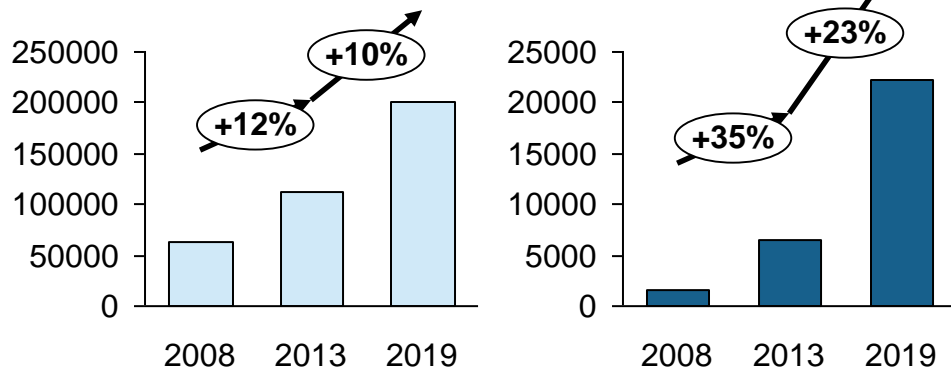
- China is the largest O&M market in 2013 followed by US and Germany
- China installed ~11 GW of wind turbines in 2013 and is expected to lead the wind installations in future

Global Wind Energy Trend and Forecast: Cumulative MW basis

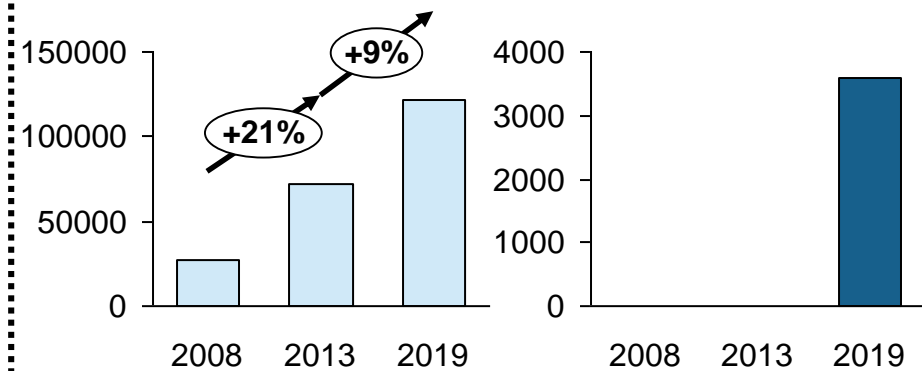
Regional and Onshore v/s Offshore Analysis

Onshore Offshore

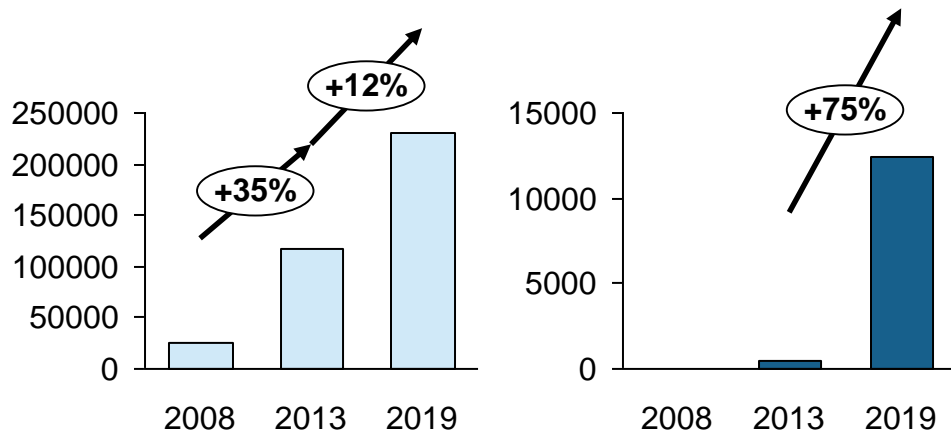
Europe cumulative wind MW CAGR by shore



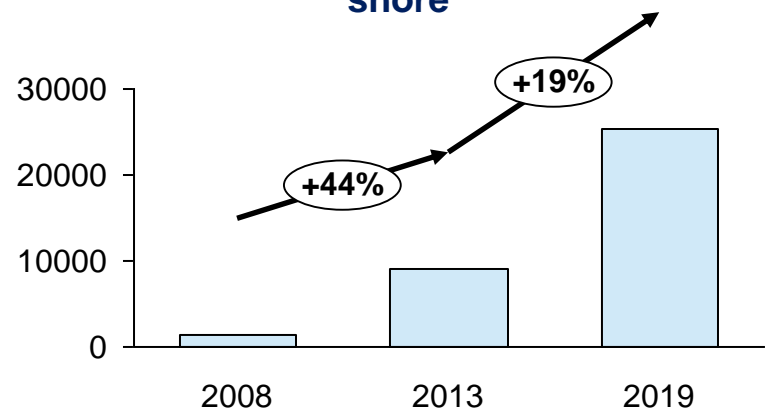
North America cumulative wind MW CAGR by shore



Asia-Pacific cumulative wind MW CAGR by shore

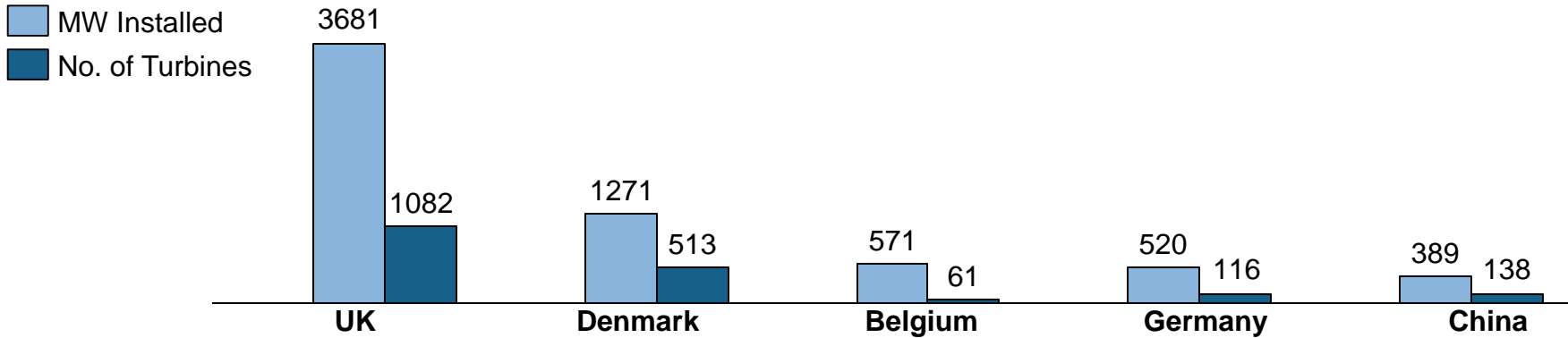


Rest of the World cumulative wind MW CAGR by shore



Current and Future Major Offshore Wind Energy Countries

Cumulative Offshore Wind MW Installed for Top 5 Major Countries (up to 2013)



Future major offshore wind energy countries

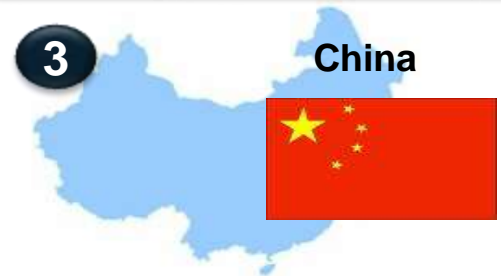
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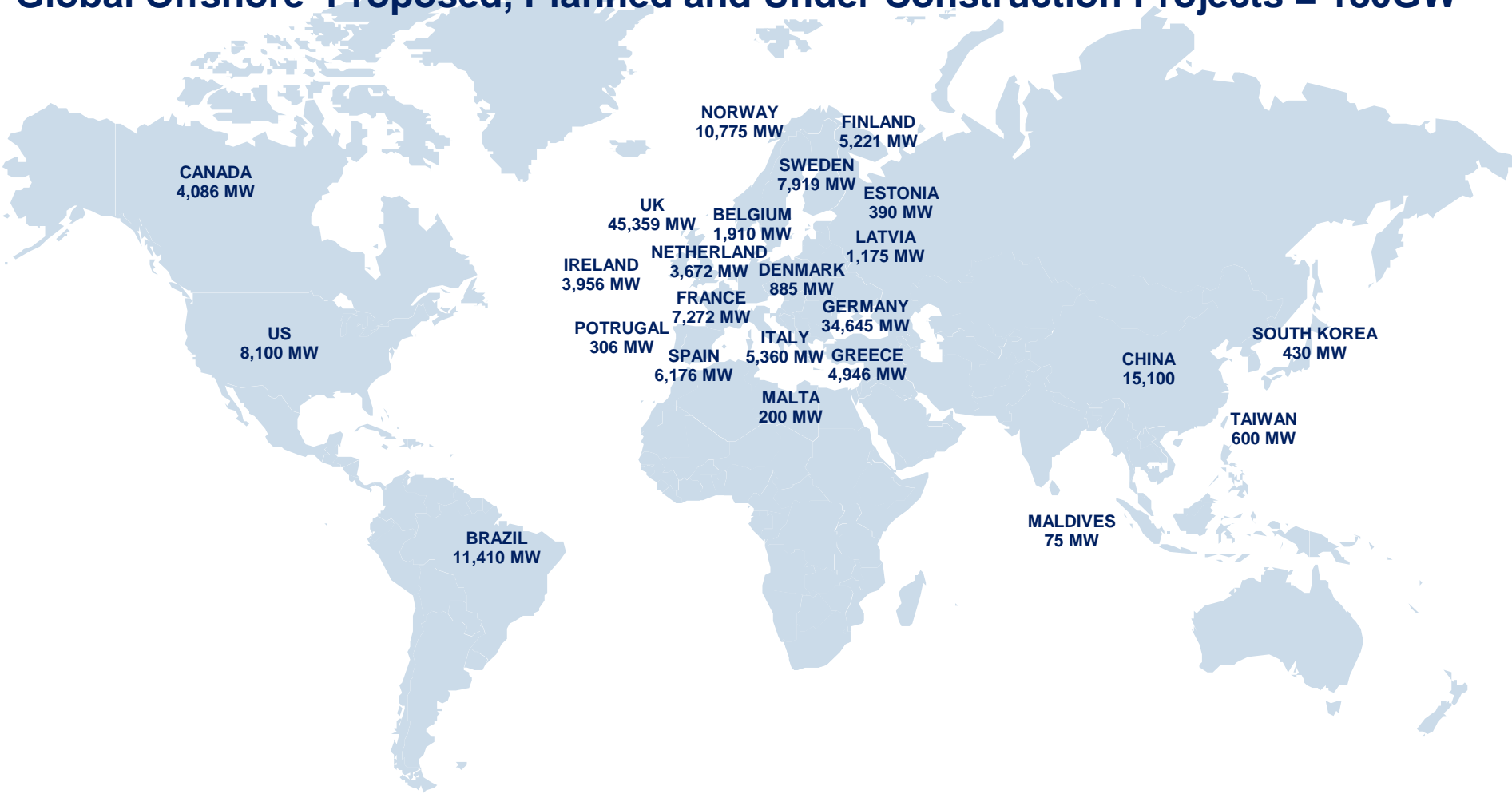
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Under construction, approved, planned wind parks, supportive policies and other factors will support UK to remain as leader in offshore wind energy market whereas Germany & China overtake Denmark & Netherland in future in offshore wind energy market

Offshore Wind Energy Potential: Consideration of Proposed , Planned and Under Construction Projects

Global Offshore Proposed, Planned and Under Construction Projects = 180GW



Comparison of O&M Cost Incurred by Onshore v/s Offshore

Type of service	Activities	Onshore O&M	Offshore O&M	
Operational cost	Site maintenance cost	Low	High	→
	Equipments and tools cost	Low	High	→
	Management fees	Low	High	→
Maintenance cost	Routine Maintenance cost	High	Nil	→
	Repair and replacement cost	Low	High	→
	Service fees	Low	High	→

Reasons for high offshore operation cost compare to onshore

- Wave heights
- Low accessibility
- Stormy whether
- Poor visibility
- Transportation Vehicles Boats, helicopters etc.
- Lifting machines Oil and gas industry lifting vessels
- Personnel safety equipments
- Difficulty in maintaining and monitoring
- Higher number of staff

Reasons for high offshore maintenance cost compare to onshore

- Do not perform generally routine maintenance in offshore as low accessibility issues
- Component failure
- Corrosion due to salty water
- Longer down time
- Low Proximitie s of OEMs
- Low availability of technicians
- Work in difficult whether conditions

Typical Failure Causes and Corrective Repair Activities for Wind Turbines

Component	Typical Cause for failure	Repair activity
Gear box	<ul style="list-style-type: none"> • Severe wear in a bearing • Worn out planet bearing • Wear particles on magnet • Grinding temper on gear wheel • Broken tooth on gear wheel 	<ul style="list-style-type: none"> • All tooth surfaces inspected, gearing is replaced if deterioration detected. • Seals and oil filters are replaced and gearbox is filled with new oil in accordance with environment conditions. • All tolerances are measured to return the gearbox to optimal performance.
Generator	<ul style="list-style-type: none"> • Wear effects due to heat and wind • Bearing failure • Coupling failure due to misalignment 	<ul style="list-style-type: none"> • Complete rewind of generator with replacement bearings and thermal protection.
Blades	<ul style="list-style-type: none"> • Scaling of topcoat due to air trapped in the manufacturing process • Repair of crack in trailing edge • Large repairs near root • Failure in manufacturing • Longitudinal crack in trailing edge due to vibrations • Damage from lightening stroke 	<ul style="list-style-type: none"> • Inspection of blade surfaces • Cleaning of blades • Tensioning of blade bolts

Major Reasons for Wind Blade Failure

Manufacturing Failure

- Failures occur as a results of materials and manufacturing process such as air trapped during manufacturing of wind blades



Manufacturing Failure



Topcoat due to Air Trapped in the Manufacturing Process

Blade Distortion/ Bending Failure

- Increase in length increases stress and deflection resulting blade distortion/bending



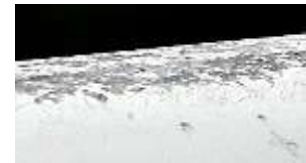
Bent Blade



Bent Blade

Fatigue Failure

- Continuous compression and tension increases fatigue effects
- Pressure load cycle due to wind gradient



Leading Edge Deterioration



Cracks in Trailing Edge

Failure due to Natural Calamities

- Natural calamities such as lightning, storm and icing etc. cause wind blade failures



Blade Tip Damaged by Lightning Strike



Wind Blade Damage by Fierce Strom

Table of Contents

- ***Executive Summary***
- ***O & M Overview***
- ***Opportunity Analysis***
- ***Strategic Growth Opportunities***
- ***About Lucintel***

Emerging Trends in Global Wind O & M Market

Emerging Trends in Wind O&M Market

Trend A

Increasing Use of Predictive maintenance

Trend B

Long Term Contracts & Extending Wind O&M Service Packages

Trend C

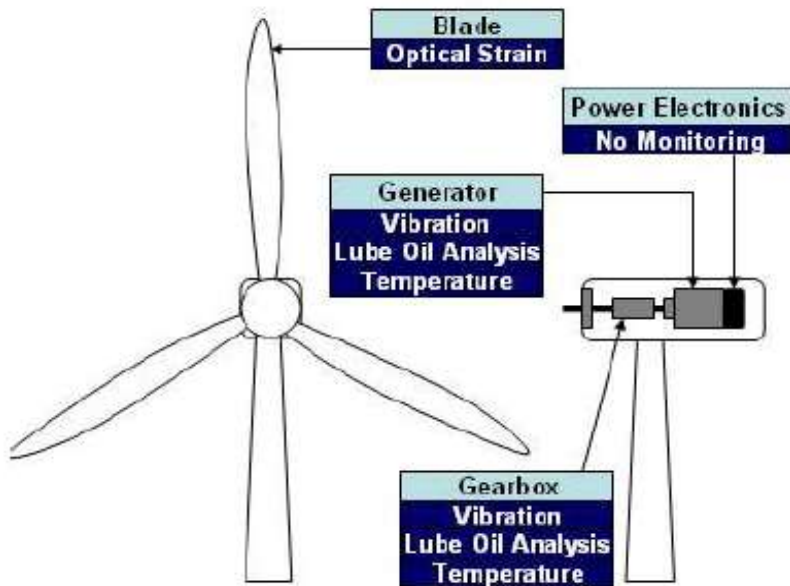
Increasing Distance from Shore & Water Depth in Offshore

Trend D

Innovations in Components

Emerging Trends in Wind O & M Market

Trend A: Increasing Use of Predictive Maintenance



Condition Monitoring Systems (CMS)

- System monitors the status of all components subject to wear, such as the gearbox, bearings and generator
- Compares ideal and actual situation and in the event of a discrepancy signals a preventive service operation
- Possible to significantly reduce unforeseen downtimes resulting from wear or damage to components.

Benefits from CMS

- Predict failures before they occur resulting saved money by reducing the down-time
- Money saved on repairs due to the fact that the errors are detected in an early stage
- Typical cost savings :
 - Costs of CMS system ~ \$12,000-\$20,000
 - Pay back period ~ 5-6 months
- Predict how much service life is left in the turbine.

Trend B: Long Term Contracts & Extending Wind O&M Service Packages

- OEMs and ISPs are extending and expanding the service packages offered by them to the wind fleet owners. Extending warranty can guarantee enhanced monitoring capabilities, and increase availability of parts
- OEMs & wind farm owners are entering into long term O & M service contracts



Gamesa, has secured a 10-year, full service operation and maintenance (O&M) agreement with NedPower, to service their 264-megawatt Mount Storm Wind Farm in West Virginia, USA



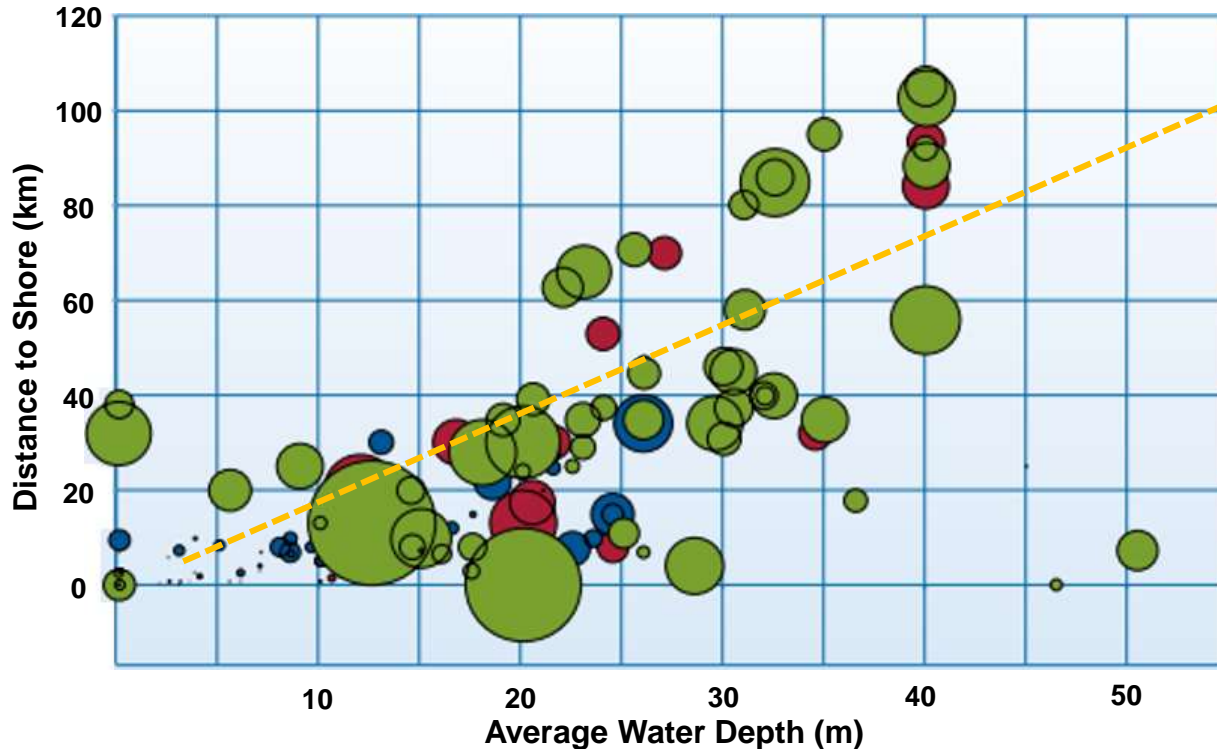
GE signs wind O&M deal with Taiwan Power Co. to provide maintenance activities such as remote monitoring, planned and unplanned maintenance, and on-site services



EDF Renewable Energy Service Corporation (eSC), an EDF Energies Nouvelles Company has signed a long-term Operations and Maintenance Agreement with TPW Petersburg Wind, LLC to provide on-site O&M for the balance of plant during the turbine warranty period, and subsequently for the entire project

Trend C: Increasing Distance from Shore & Water Depth

Average Water Depth & Distance to Shore for Online, Under Construction & Consented Offshore Wind Farms



- Majority of wind farms in operation are less than 20 km distance from the shore & 20 m deeper
- Next Generation offshore wind farms will be constructed farther away from the shore in deeper water
- It is likely to create challenges in O & M

Bubble size represents the total capacity of the wind farm

Source: EWEA

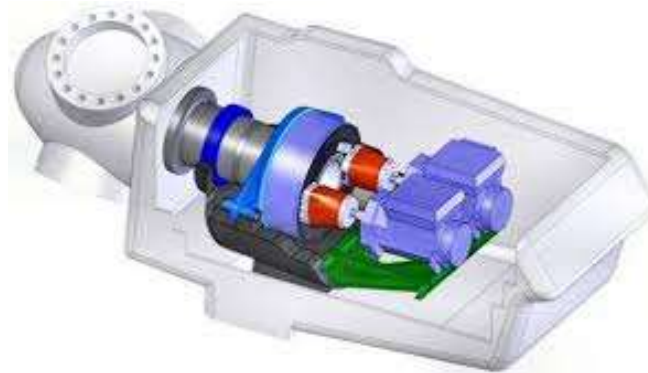
● Online

● Under Construction

● Consented

Trend D: Innovation in Components

Digital Displacement Transmission



- MPSE introduced SeaAngel, an offshore specific wind turbine
- The 7MW SeaAngel has Digital Displacement® Transmission (DDT) drive system and a rotor diameter of 167m
- The Digital Displacement® Transmission (DDT) inside SeaAngel, which consists of Digital Displacement® 2Pump (DDP) and Motor (DDM), replaces a conventional gearbox. This enables a very high operating efficiency even in part load conditions, unprecedented controllability, and the use of highly reliable synchronous generators

Trend D: Innovation in Components

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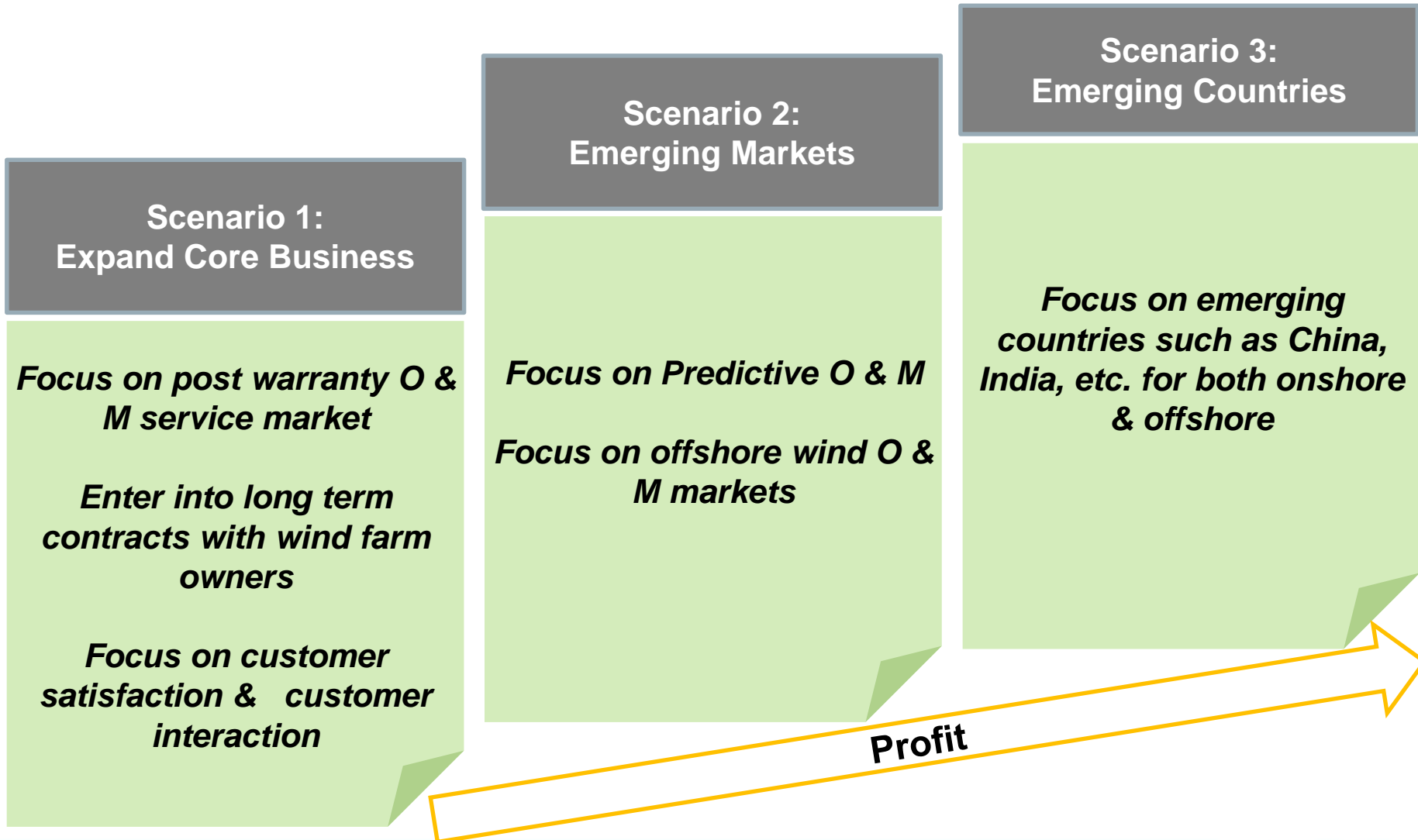
Seamless Modular Technology



- In December 2012, the Department of Energy and Climate Change (DECC) put forward a challenge that offshore wind should reach a levelised cost of energy (LCOE) of £100/MWh by 2020
- Blade Dynamics' is using patented seamless modular technology for ETI's project of developing world's largest blades
- Key target by 2015: Blade Length of >100m & LCOE Reduction by 3%-5%

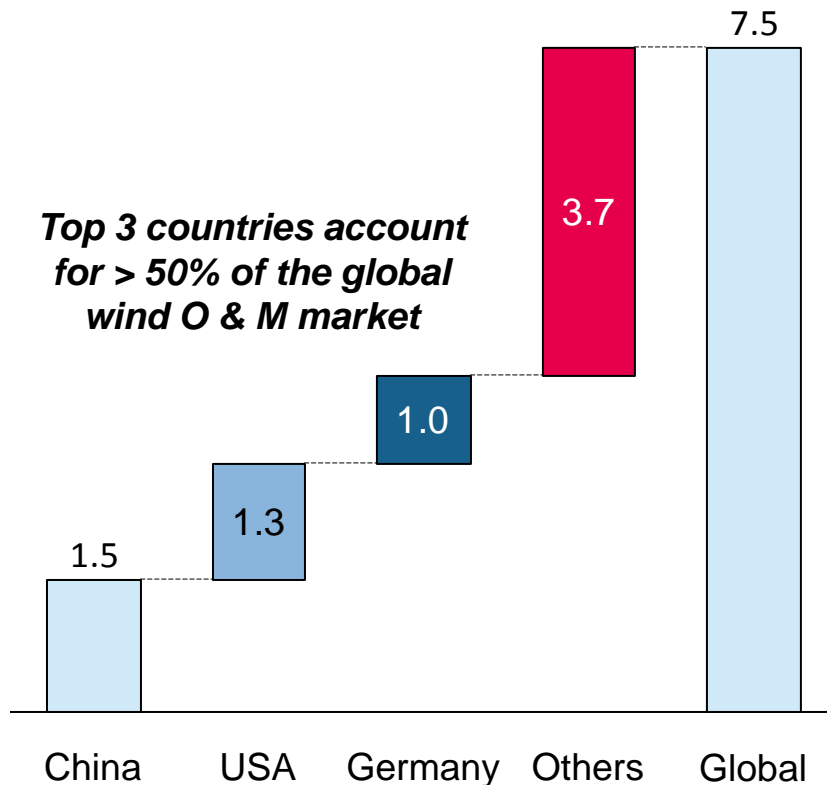
Strategic Growth Opportunities in Global Wind O & M Market

Three Growth and Profit Scenarios for in Wind O & M Industry until 2019



Viable Opportunities Exist for Players in O & M Industry to Grow Globally Organically or Inorganically

**Global Wind O & M Market in by Countries
(In \$ Billion in 2013)**



Industry Insights

- Significant opportunities exist in Asia-Pacific, especially China
- Increasing offshore wind installations present high opportunities in offshore O & M market
 - Currently, major share of offshore installations are concentrated in Europe
 - APAC, NA & Europe, all have big plans to increase offshore wind capacity in future
- Trend toward larger, modular wind blades, higher wind capacity turbines, typically with more complex design consideration present opportunities for O & M players

Growth Strategies for Companies in Wind O & M Industry

1. **Identify Growth Applications based on Synergy**



- *Identify new opportunities with good synergy and profitability*
- *Identify growing regions*

2. **Trained Manpower**



- *Trained manpower with better skill sets for on-site wind O&M who should be highly responsible, able to manage and understand the technology, organized to face challenges such as heights, harsh weather, and work in tight quarters*

3. **Focus on Customer Satisfaction**



- *Higher dissatisfaction of developers for OEM O&M services in Europe, need of complete understanding of O&M requirements on achievable maintenance schedules, responsive services for repair needs*

4. **Improve Supply Chain**



- *Building a strong network of component suppliers*
- *Partnership with Oil and Gas industry service providers*

Table of Contents

- ***Executive Summary***
- ***O & M Overview***
- ***Opportunity Analysis***
- ***Strategic Growth Opportunities***
- ***About Lucintel***

About Lucintel

Vision:

- Passion for data and insights. Empower companies develop better products and growth platform

History

- Founded in 1998
- Over 120 full time analysts / consultants. Global presence

Industry Leadership

- Over 1000 clients – Fortune 500 companies
- Fifteen years of proven management consulting & market research experience
- Panelists and key note speakers at leading conferences
- Subject matter expertise in composites, adhesives, chemicals, automotive, aerospace, energy and construction markets.

Lucintel Ensures Strategic Insights for the Right Market Entry

“Lucintel has its finger on the pulse of the market and drives deep Strategic Insight”

- Andy Schmidt, MacQuarie Partners, Managing Partner

- Lucintel has performed hundreds of consulting projects in the area of M & A, market entry strategy, opportunity screening, competitive benchmarking, value chain analysis, unmet needs analysis and others in a variety of markets for last 14 years.
- Lucintel with its profound business success knowledge, has driven strategic success across the value chain from material suppliers to component makers to OEM's to Investors seeking sustainable winning strategies.
- Access to vital, hard to find insights through detailed primary and secondary research and analysis. Incomparable data accuracy and integrity
- Lucintel has over 30,000 contacts in its database for conducting primary research
- Lucintel has +500 market reports on various market segments:
 - No Learning Curve - Deep industry knowledge and insight. Quality, Accuracy & Depth

Over thousand clients around 70 countries value our service



... with Project Teams with an Appropriate Mix between Technical and Business Expertise for Results that Drive the Bottom Line.

- Senior level consultants and analysts
- PhDs and MBAs
- Masters level engineers
- Scientists and Industry experts
- Past projects ranging from start up to multi-national Fortune 500 companies.
- Over 120 full time analysts / consultants

Lucintel has published +500 multi-client market reports & conducted hundreds of consulting projects across multiple markets

Market Reports



Aerospace



Transportation



Marine



Construction



Renewable Energy



Recreational



Composite Materials

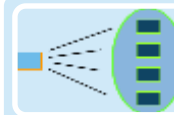
Consulting



Strategic Growth Consulting



Benchmarking



Opportunity Screening



Partner Search and Evaluation



Due Diligence and M&A



Market Entry Strategy

Lucintel's Experience in Due Diligence and Strategic Analysis

- Lucintel has over thousand customers in 70 countries. It has worked with a variety of global companies, including (but not limited to) 3M, Audi, Carlyle, Credit Swiss, Cytec, DSM, Eastman, GE, Gurit, Sverica International, Sumitomo, etc. and has good experience in dealing with due diligence, M & A, market entry strategy, target screening and strategic growth consulting.
- Lucintel has deep knowledge in composites industry
- Lucintel provides accurate data since we triangulate data using various means. During this project, Lucintel will talk to suppliers, buyers and users to drive insights about this project. We have more than 30,000 contacts from more than 70 countries across the different industry.
- Lucintel team consists of engineers, PhDs, and MBAs with good technical and market knowledge. Lucintel has over 120 full time analysts / consultants.
- Lucintel has performed a significant number of projects in market assessment, M & A, due diligence, and winning strategy formulation. Below are comments from our satisfied clients in the area of M & A, and Due Diligence, demonstrating our capabilities in management consulting and timely delivery.
 - “I was very happy with Lucintel’s work. It helped us in making a confident investment decision. They delivered the project in a timely manner. – Dave Finley, Managing Director, Sverica International.
 - “Lucintel has its finger on the pulse of the market and drives deep strategic insights.”
Andy Schmidt, Managing Partner, MacQuarie Partners

Why Lucintel?

- Lucintel is a management consulting firm, providing strategic consulting to fortune 500 companies. It has vast experience in executing many projects related to growth consulting, market entry, winning strategy formulation, investment thesis, due diligence, etc. in Composites, Transportation, Construction, and Aerospace market.
- Lucintel is a subject matter expert and has over 15 years of market research and consulting experience.
- Lucintel has conducted hundreds of market entry and due diligence projects for various Fortune 500 companies as well as PE Firms
- Top management consulting firms such as BCG, McKinsey, etc. rely on Lucintel's strategic insights to meet their clients' needs.
- Lucintel brings forward the best opportunities and combines them with strategic and actionable insights that enables our clients to making confident business decisions and avoid costly mistakes.
- Project will be completed in a timely manner due to Lucintel's extensive project execution knowledge in target screening and management consulting projects.
- Extensive experience in surveying, collecting both primary and secondary information and validation means greater accuracy of data.

Thank You