



Opportunities in the 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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Executive Summary

- **The global wind turbine cumulative installation was ~ 724 GW in 2020, which is expected to reach 1,079 GW by 2025 at ~8.3% CAGR**
 - Onshore wind accounted for ~95% of the global wind cumulative installations in 2020, whereas offshore accounts for ~5%, mainly driven by APAC
 - APAC accounted for ~46% of the cumulative installations in 2020, followed by Europe with ~30%, NA with ~19% and ROW with ~5% share
- **The global wind O&M market was estimated at \$17.7 B in 2020 and is expected to grow at a CAGR of 10% from 2020 to 2025**
 - Europe was the largest market contributing to ~46% of the global O & M market, followed by APAC at ~34%, NA at ~16% and ROW at ~4% in 2020
 - Onshore O & M market accounted for ~78% of the total O&M market and offshore accounted for ~22% in 2020. Low accessibility, low level of availability, and logistical issues make offshore O & M services difficult to render, resulting in higher offshore O&M cost than onshore O&M
 - A surge in the number of wind turbines out of warranty period will greatly promote development of the wind farm O&M market
- **Increasing use of predictive maintenance, use of artificial intelligence, increasing usage of drones with HD camera and thermal cameras for wind blade inspection, innovations in key components, increasing distance from shore & depth of offshore wind farms, are key emerging trends in the wind O&M market**
- **To strengthen position in this market, companies can target post warranty turbines, long-term contracts and partnerships with wind farm owners in different regions to access new locations and new customers, and increase the use of AI and automated drones for O&M services**

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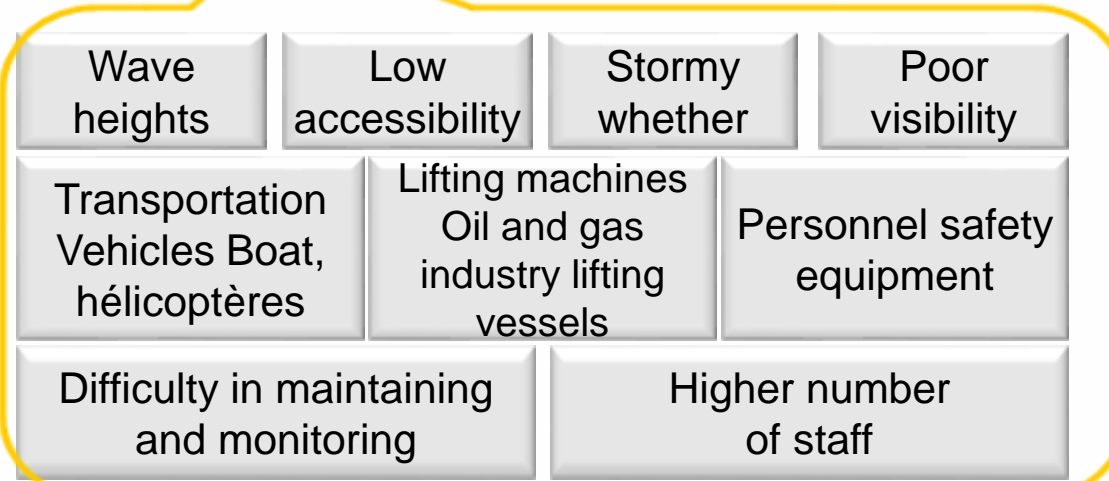
Offshore Wind O&M Market is Expected to Grow at a CAGR of 19% During the Forecast Period

Wind Blade O&M Market	Market Size (\$B)-2020	CAGR % (2020-2025)	Global Cumulative Installation GW in 2020	Future Outlook	Major O&M Companies
Onshore	~\$13.9	7.2%	689	<ul style="list-style-type: none"> The onshore market is expected to remain the largest market for O&M services as it dominates the wind installation market, and turbines which were installed years back need O&M services for proper functioning 	
Offshore	~\$3.8	18.7%	35	<ul style="list-style-type: none"> Offshore wind installation provides significant opportunities for O&M services as the installation is expected to gain momentum in many countries across the globe, especially in the US and China . 	

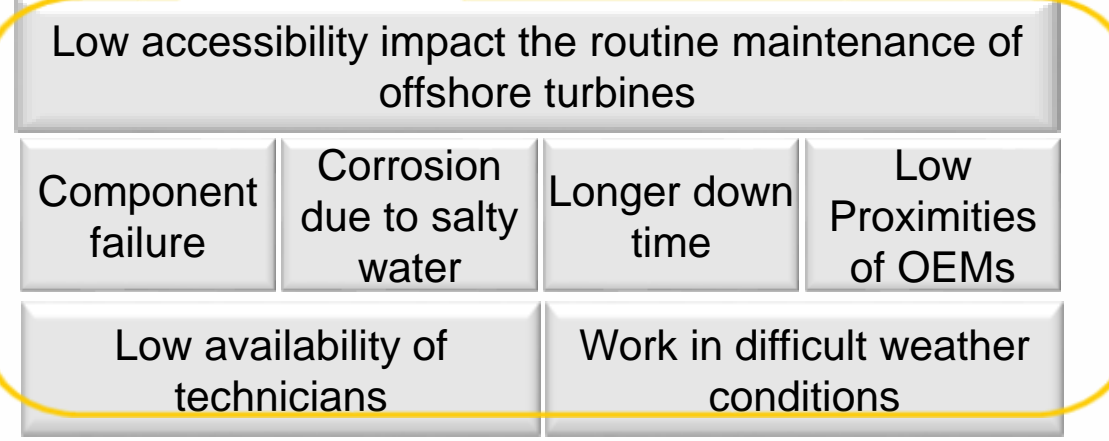
Offshore Wind Energy O&M Cost is Higher than Onshore O&M Due to Low Accessibility, Poor Visibility, and Higher Number of Staff Required

Type of service	Activities	Onshore O&M	Offshore O&M
Operational cost	Site maintenance cost	Low	High
	Equipment and tool 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 compared to onshore



Reasons for high offshore maintenance cost compared to onshore



Lighting Strikes, Bearing Failures, Gear Fatigue, Material or Manufacturing Failure, etc. are the Most Common Failure in Wind Turbines

Component	Typical Causes 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 environmental 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

Manufacturing Inaccuracy, Blade Disorder, etc. are the Major Reasons for Wind Blade Failure

Manufacturing Failure

- Failures occur as a result of materials and manufacturing process mistakes such as air being 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 in blade distortion/bending



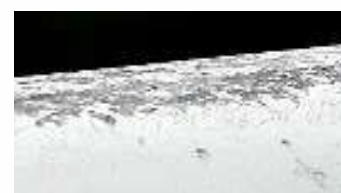
Bent Blade



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 cause wind blade failures



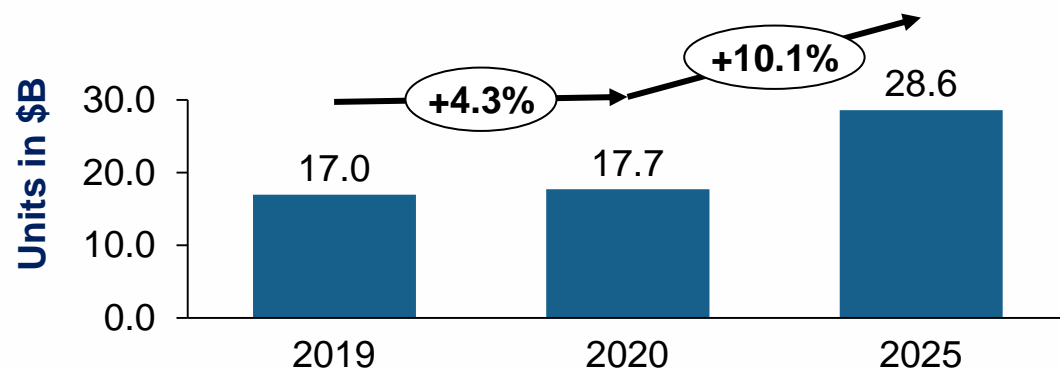
Blade Tip Damaged by Lightning Strike



Wind Blade Damage by Fierce Storm

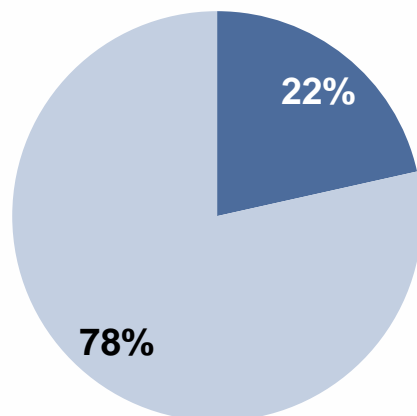
Future of Wind O&M Market Looks Promising with Opportunities in Onshore and Offshore Segments

Global Wind O&M Market Trend and Forecast: 2019-2025



Global Wind O&M Market by Shore in 2020: ~\$17.7 Billion

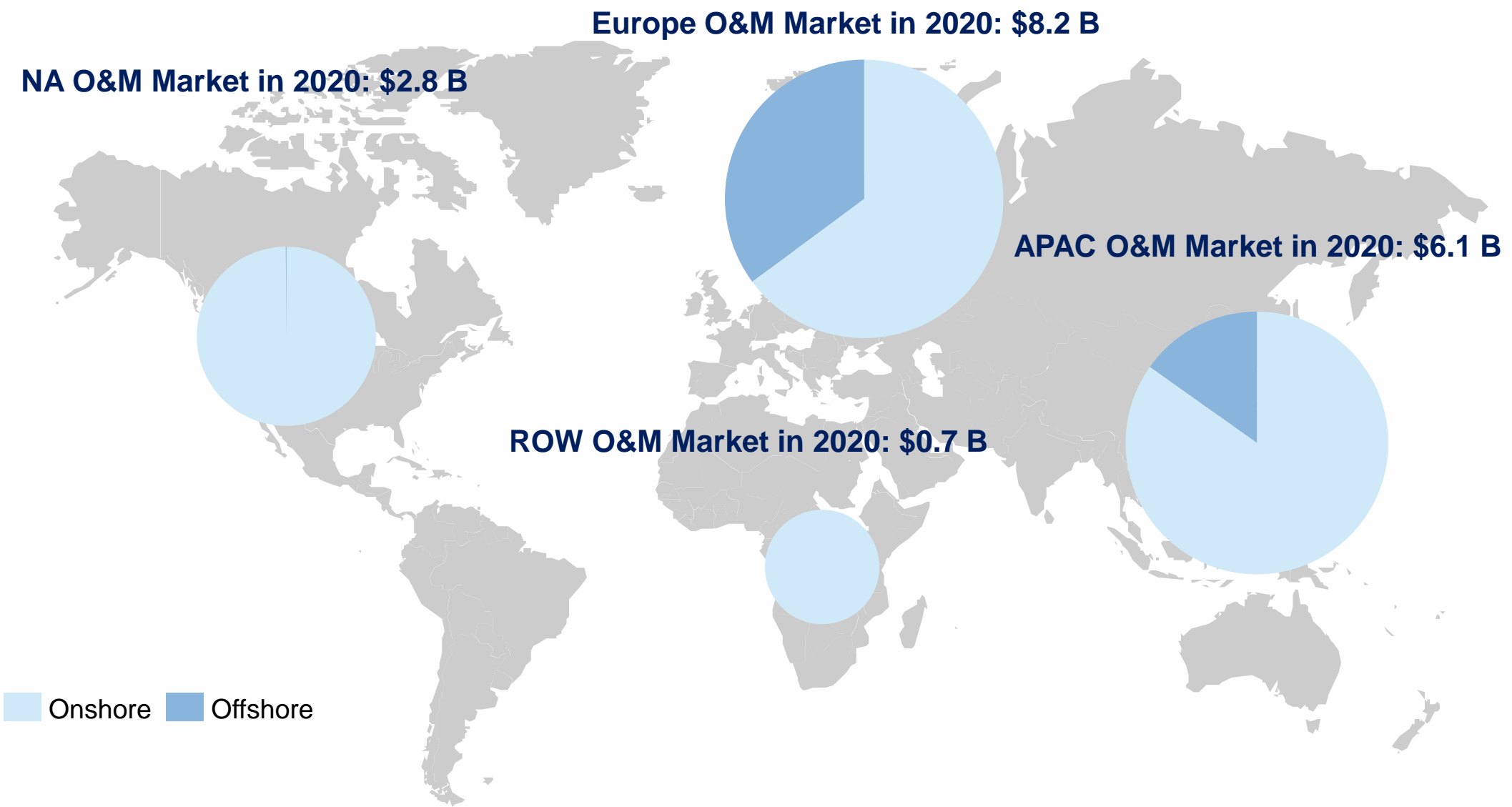
■ Offshore
■ Onshore



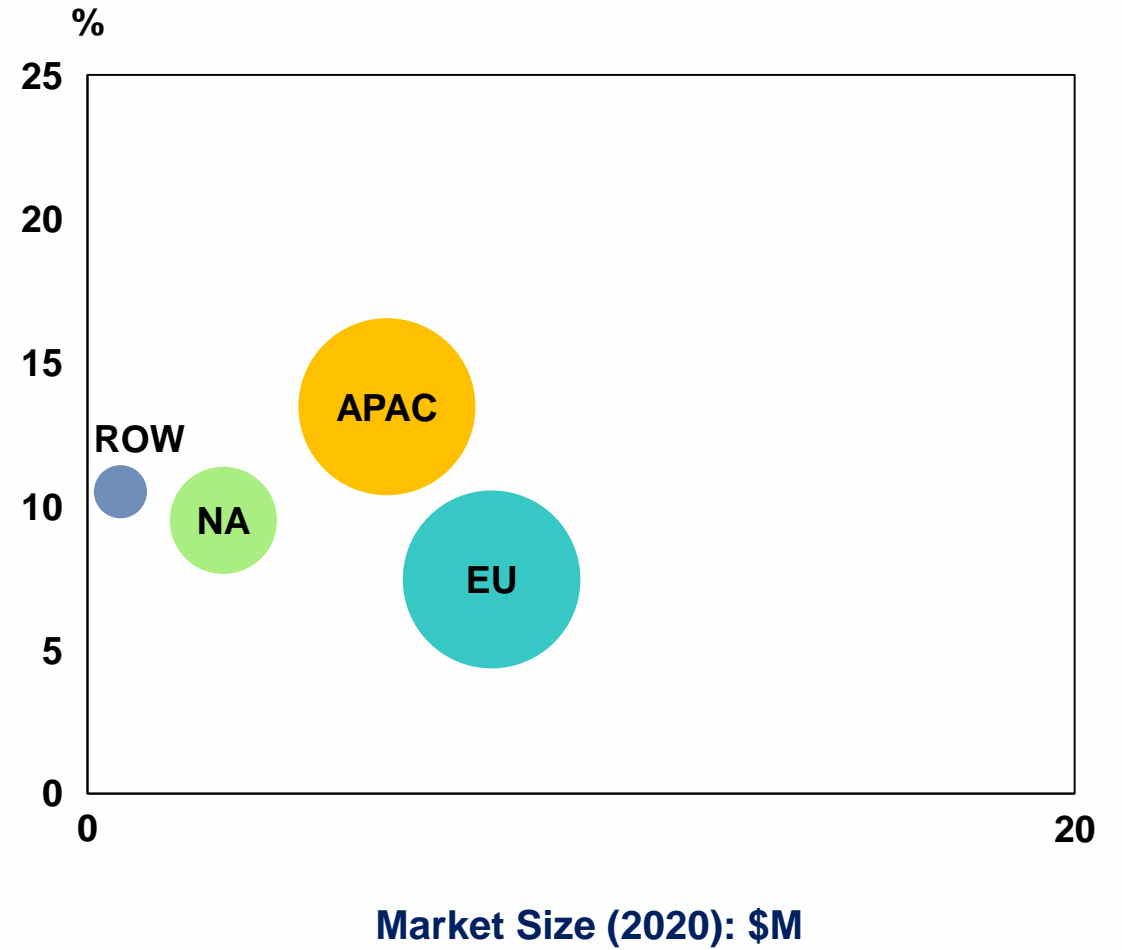
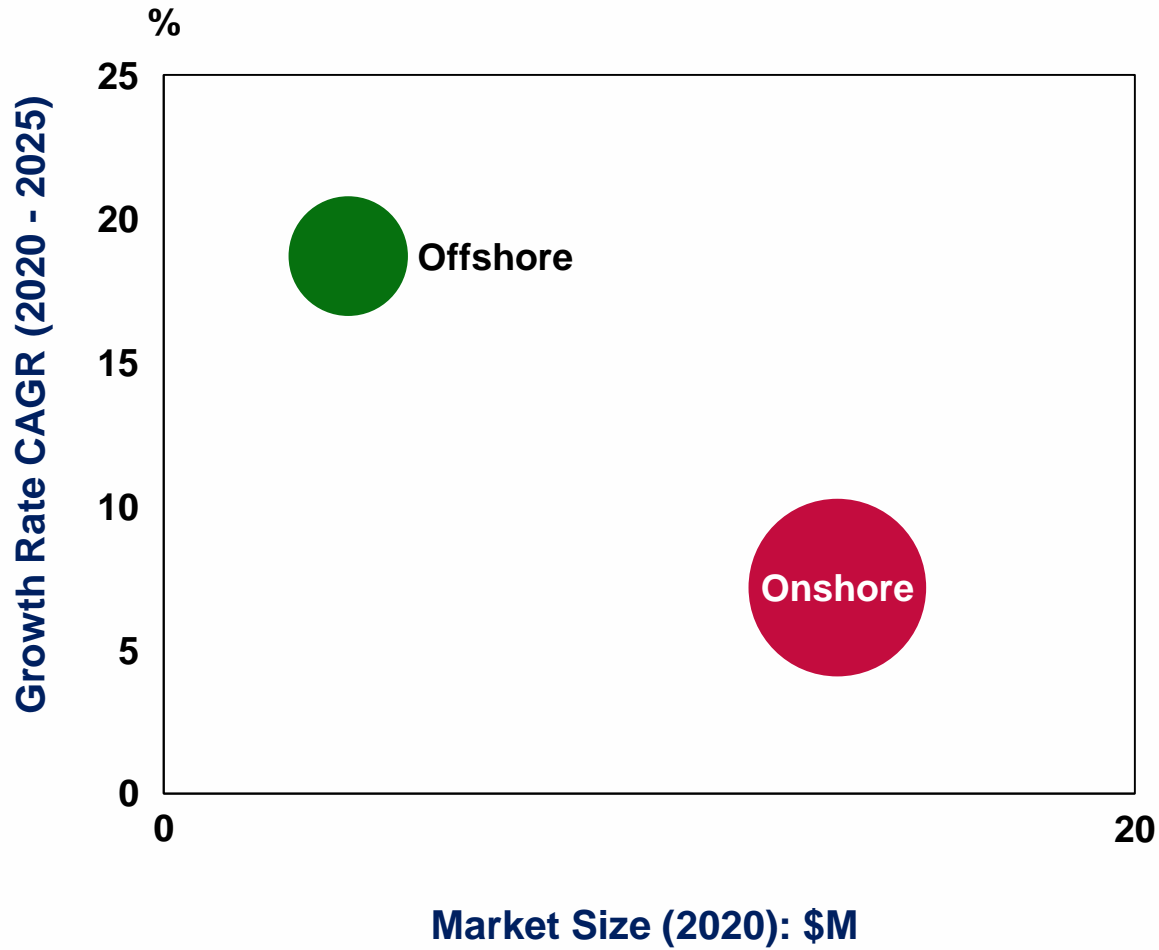
Key Insights

- The global wind O&M market was ~\$17.7 B in 2020 and is expected to grow at a CAGR of 10.1% from 2020 to 2025 to reach \$28.6 B
- High O&M cost increases offshore segment share in the global wind O&M value market
 - Offshore accounted for 22% of global wind O&M market in 2020, but in terms of total wind installation it contributed only 5%
 - Offshore O&M cost is close to 4-5 times more expensive than onshore
- The global wind O&M market by region:
 - The European market is the largest wind O&M market, followed by APAC & NA
 - China & Taiwan are the major contributors in the Asia-Pacific offshore O & M market

Global Wind O&M Market by Region: Europe was the Largest Wind O&M Market with 46% Share, Followed by APAC with 34% Share in 2020



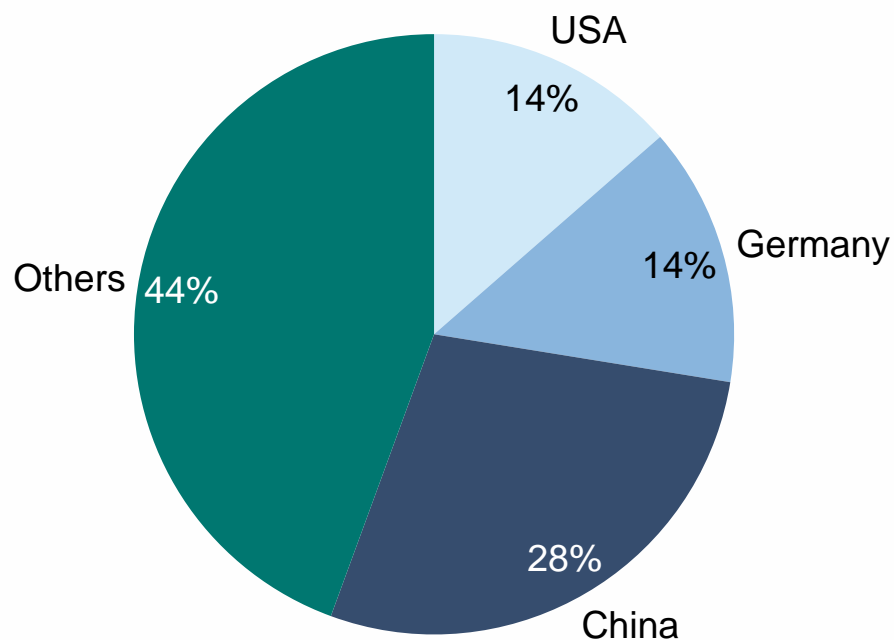
Onshore will Offer the Largest Opportunity for Wind O&M. APAC will Likely Remain the Largest Regional Market for Wind O&M



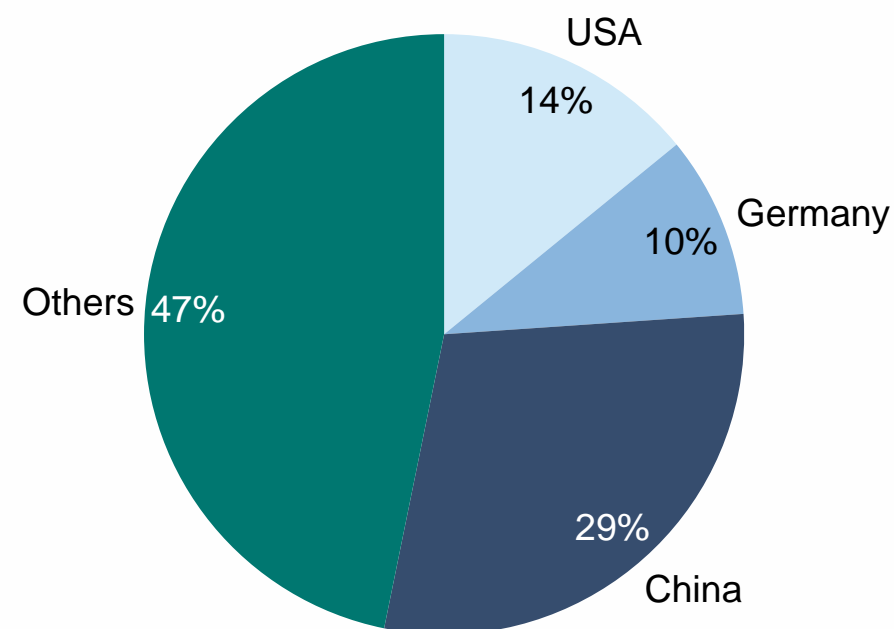
Note: Bubble size represents market size in 2025

Global Wind O&M Market: With Highest Number of Wind Farms China, USA, and Germany Leads the Wind O&M Market

Market Share Analysis of Top 3 Countries in the Global Wind O&M Market 2020 (\$17.7 B)



Market Share Analysis of Top 3 Countries in the Global Wind O&M Market 2025 (\$28.6 B)

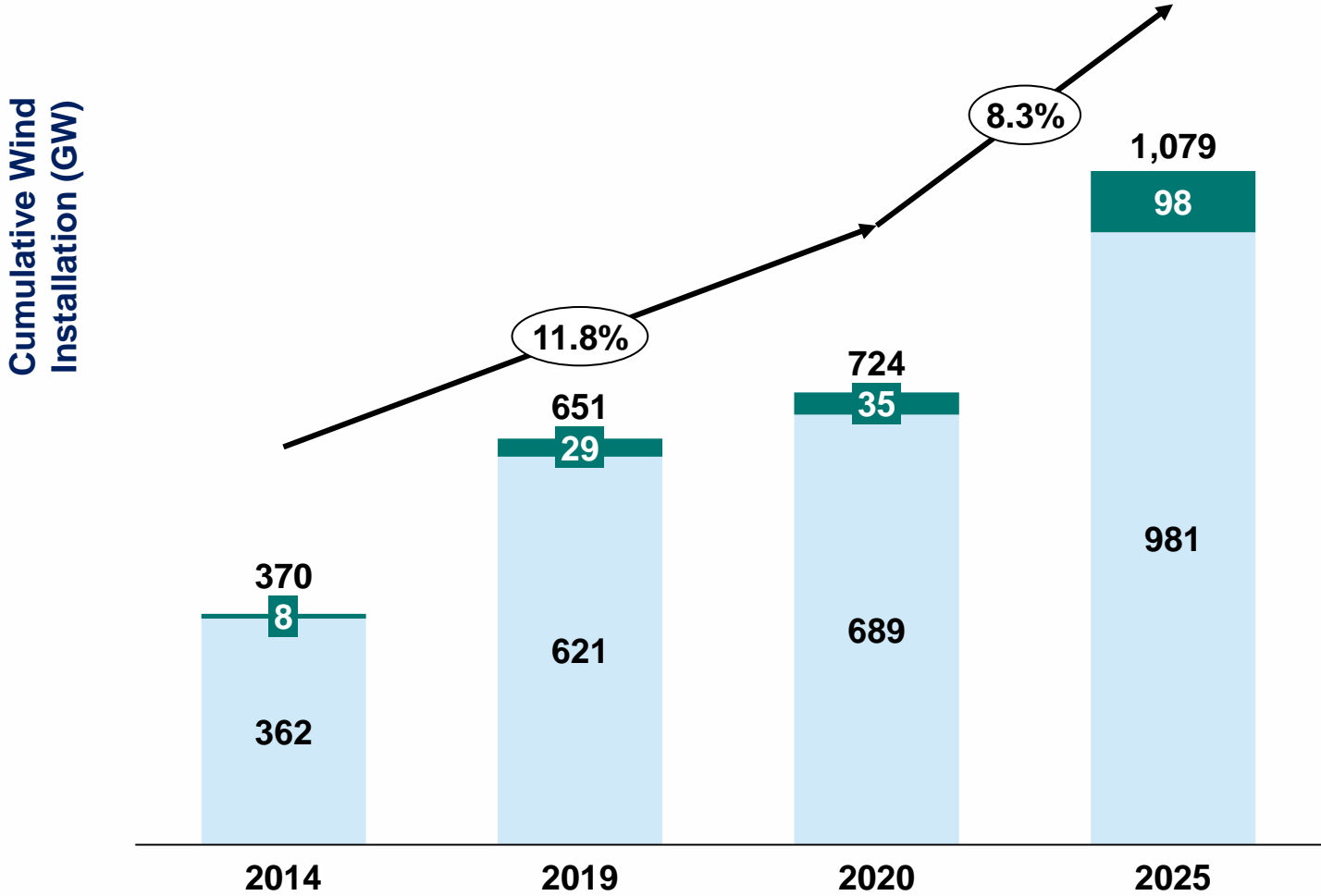


Key Insights

- China is the largest O&M market in 2020 followed by the US and Germany
- China is the world's largest wind power market in both new and cumulative installations

Global Wind Energy Installation is Expected to Grow at ~8% CAGR to Reach 1,079 GW by 2025, Offshore Wind is Expected to Grow at a Higher Pace than Onshore

Global Cumulative Wind Installation by Installation Type: Trend and Forecast



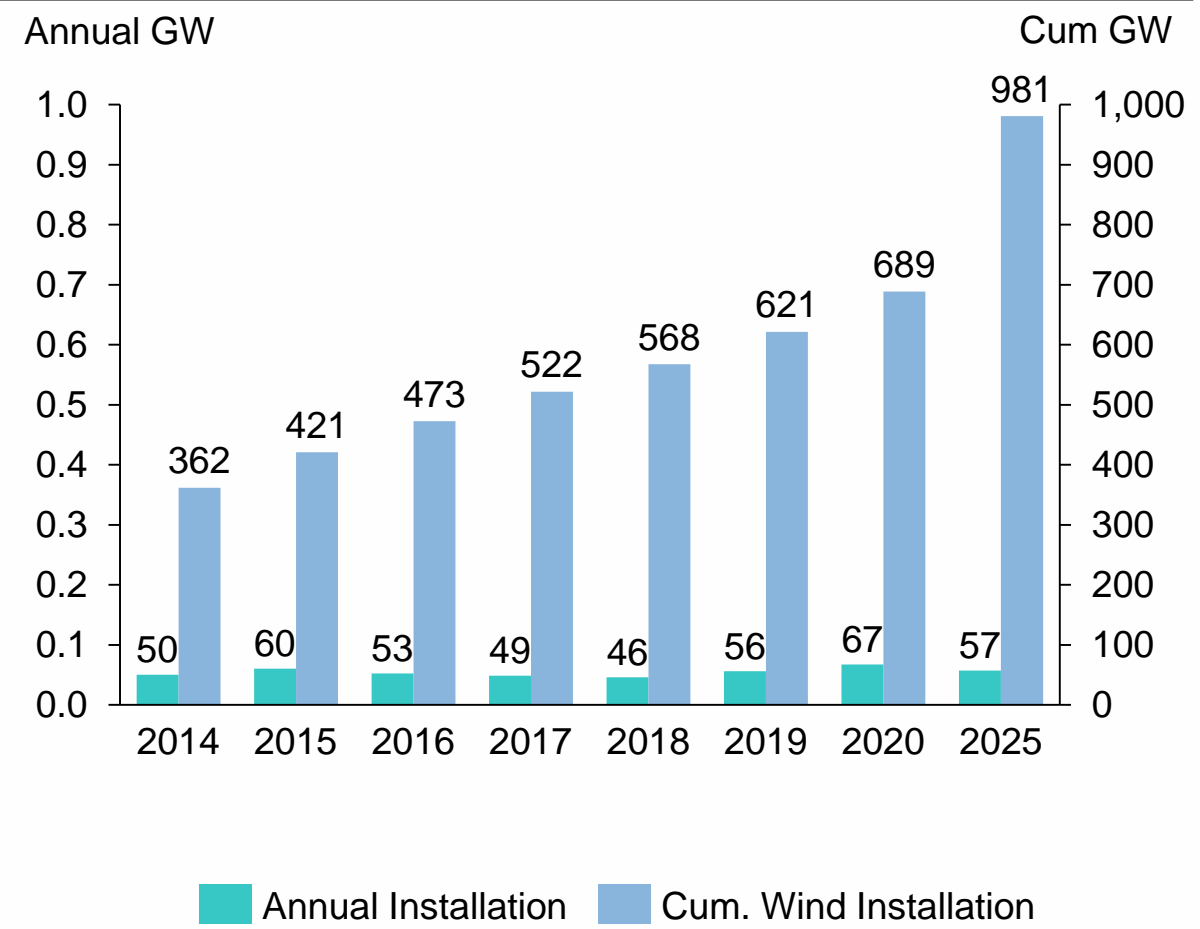
	CAGR %	2014-20	2020-25
Offshore		28.1%	22.6%
Onshore		11.3%	7.3%

About 75% of cumulative wind installation is out of warranty and creating good opportunity for O&M services to maintain the global fleet for productivity

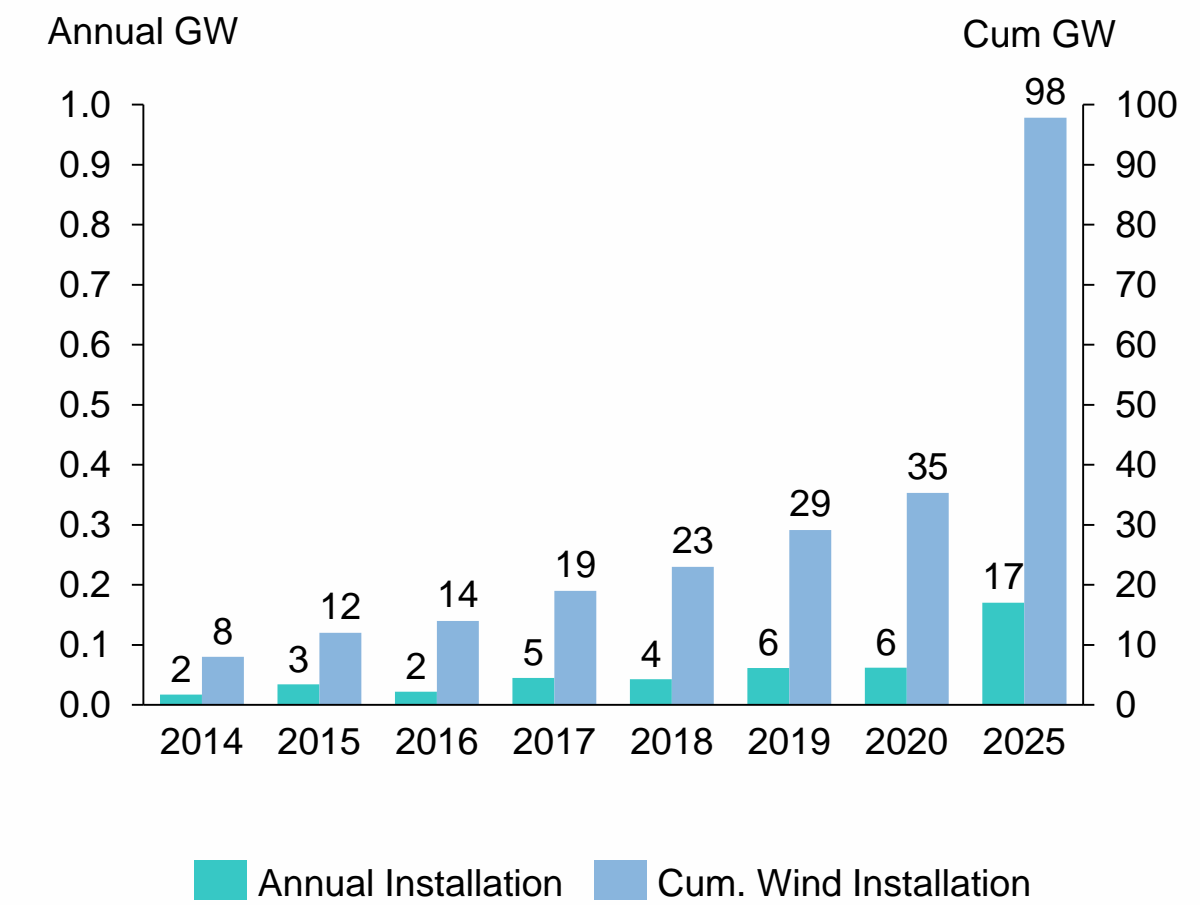
Source: Lucintel, GWEC, and Wood Mackenzie

Onshore Wind Installation is Expected to Remain Largest Market but Offshore Wind Installation is Gearing Up and will Grow at 23% to Reach 98 GW by 2025

Cumulative and Annual Onshore Wind Energy Installation



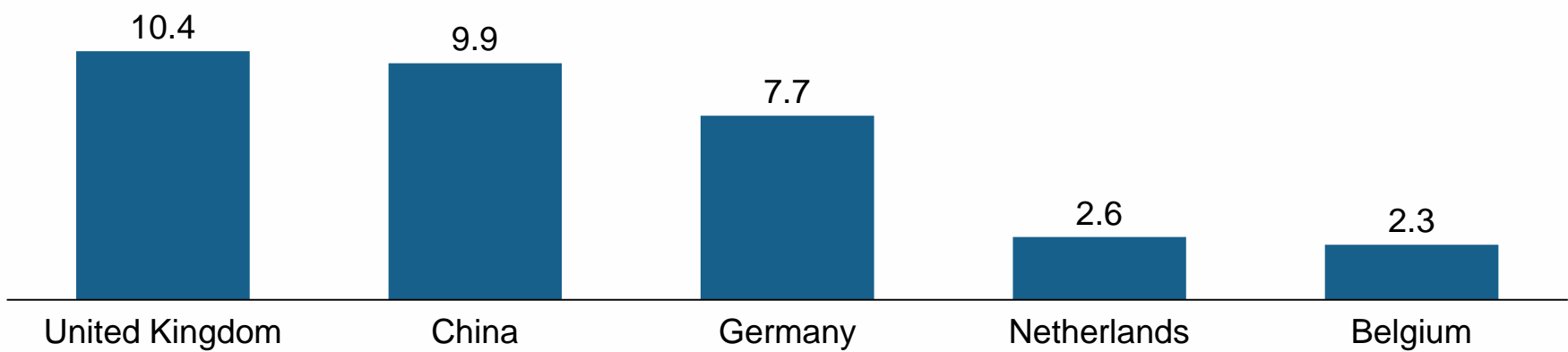
Cumulative and Annual Offshore Wind Energy Installation



Source: Lucintel, GWEC, and Wood Mackenzie

Major Offshore Wind Energy Countries: China is Expected to Overtake the UK and Secure First Position in Offshore Wind in Coming years

Cum. GW Installed-2020



Future Major Offshore Wind Energy Countries



China had overtaken Germany in 2020 by adding 3 GW of new offshore wind capacity and it is now the world's second-largest offshore wind market by cumulative installed capacity after United Kingdom. China has already demonstrated rapid reduction in LCOE for onshore wind via large magnitudes of volume and investment. It is expected that China will overtake the UK in near future

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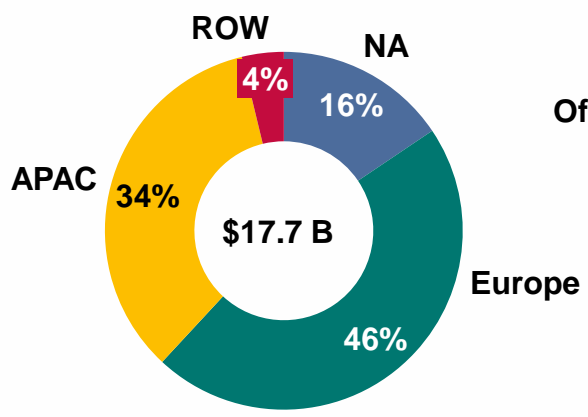
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Growth Summary: Offshore Wind O&M is Likely to Grow at ~19% CAGR by 2020-2025. APAC is Expected to See the Highest Growth

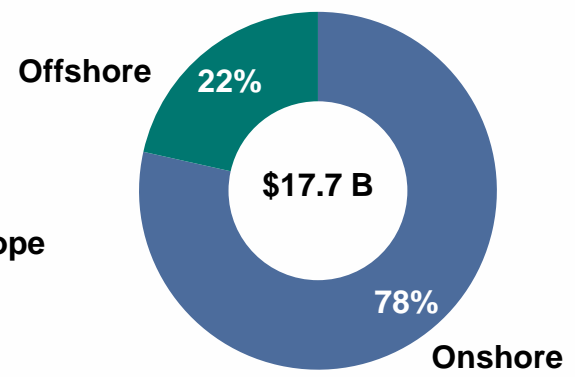
Wind Energy O&M



Wind O&M Market by Region in 2020

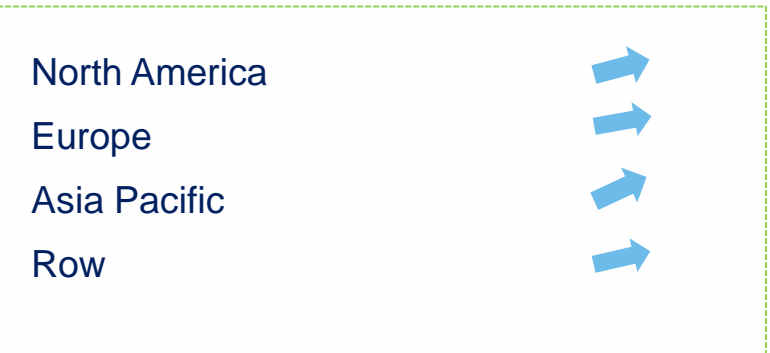


Wind O&M Market by Installation Type in 2020



- The Global wind O&M market is highly attractive, offering significant growth opportunities
- Ageing wind turbines and increase in installation will drive the O&M market in the next five years
- In terms of new installation, offshore wind is expected to see double-digit growth and offer good opportunity for O&M

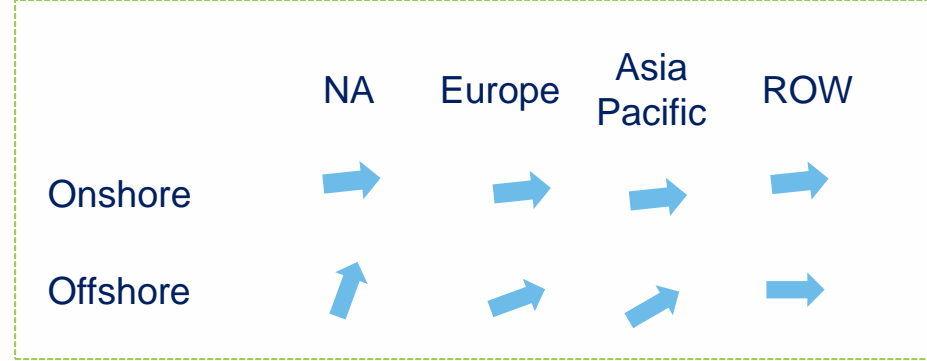
Future Outlook: Wind O&M by Region



Future Outlook: Wind O&M by Installation

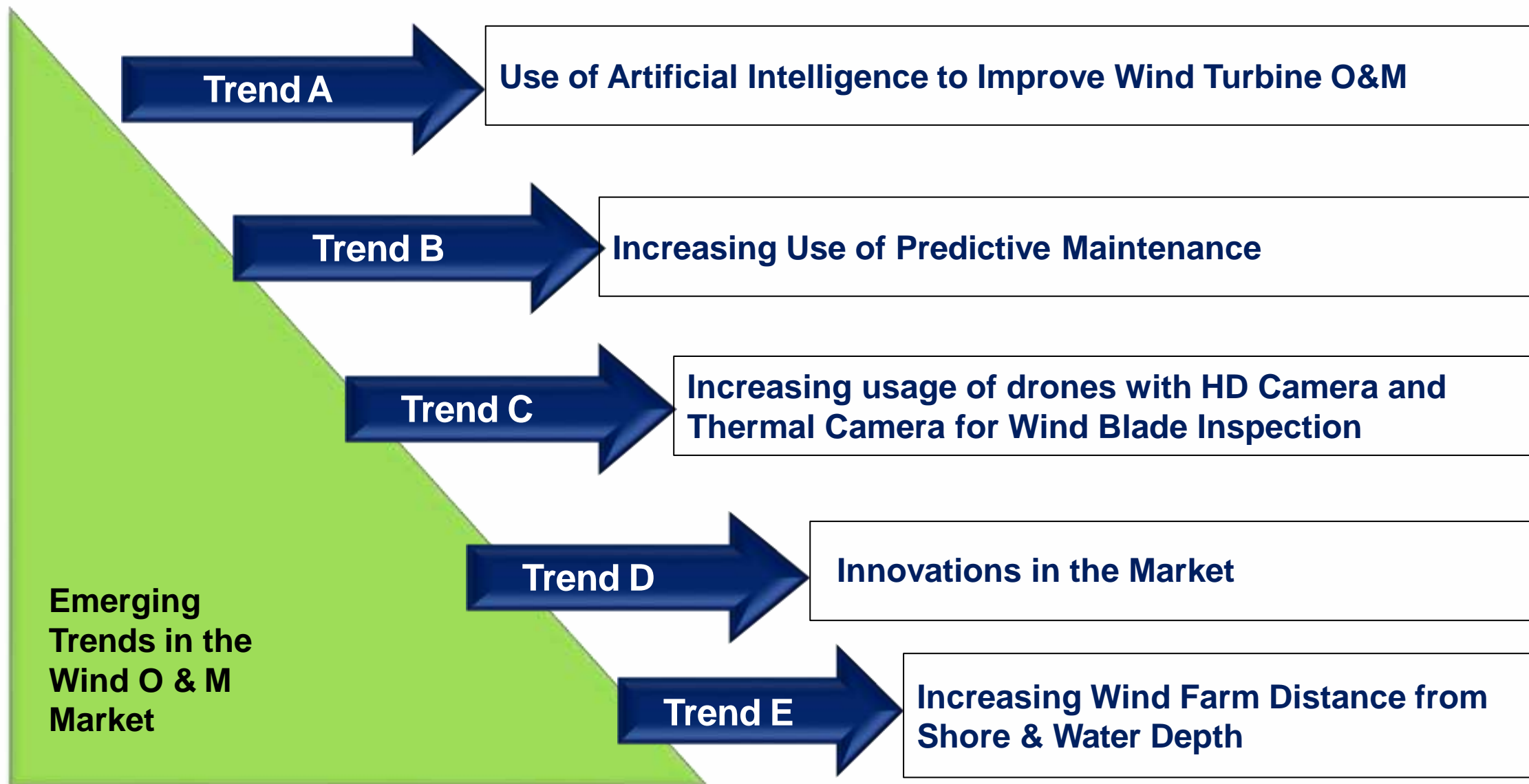


Future Outlook: Wind O&M Regional Market by Installation

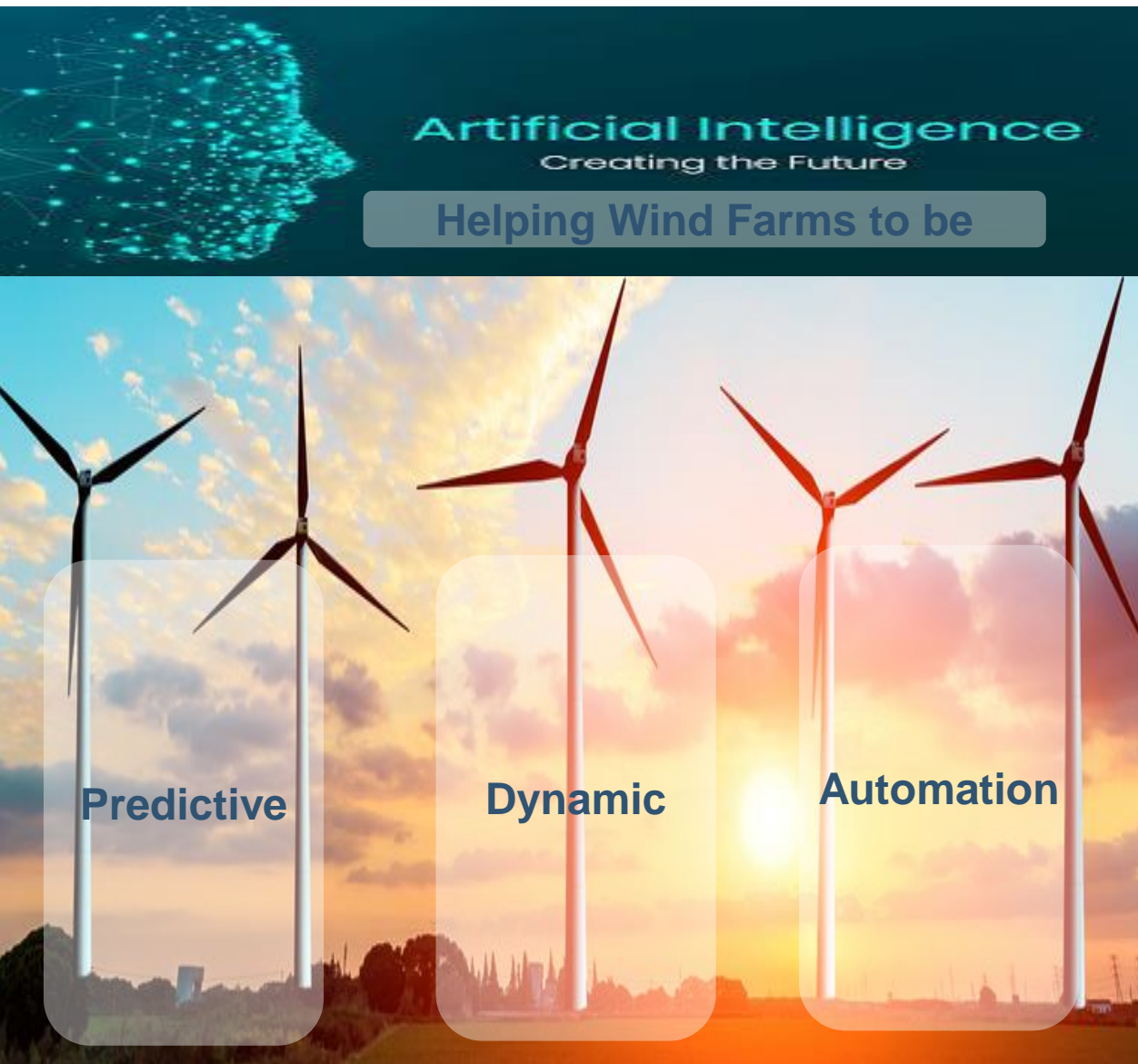


➔ Note: Position of arrow denotes the future growth potential

Emerging Trends in the Wind O&M Market: Increasing use of Artificial Intelligence, Predictive Maintenance, Drones with HD Camera, etc. are the Key Trends



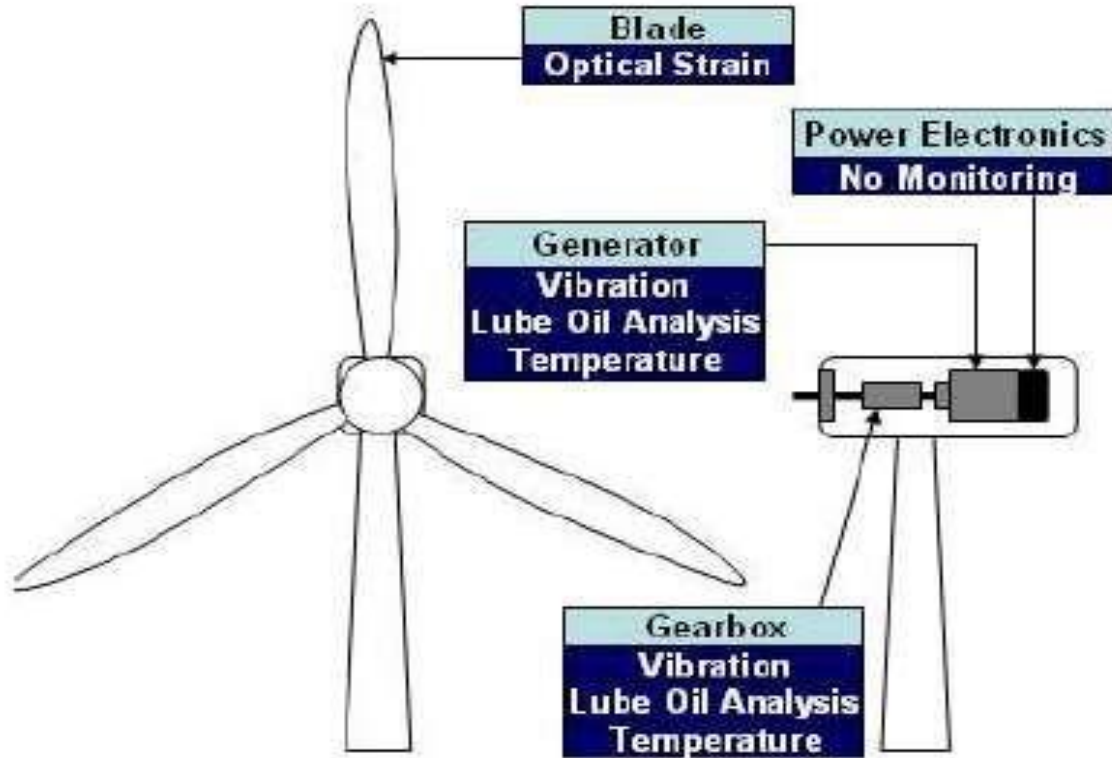
Trend A: Use of Artificial Intelligence is Growing in Wind O&M to Increase Efficiency, Reduce Downtime



Artificial Intelligence

- Artificial intelligence is set of methods or algorithms that use a large amount of data to learn rules or patterns, and continuously improves with additional data
- Usage of AI is increasing in wind O&M to increase efficiency, reduce downtime, and lower unplanned maintenance costs
- AI helps wind farm O&M to be predictive, dynamic, and automated
- AI is helping companies to accelerate due diligence, and reduce man hours in investment of planning and analysis

Trend B: Increasing Use of Predictive Maintenance



Condition Monitoring Systems (CMS)

- Condition monitoring Systems monitor the status of all components subject to wear, such as the gearbox, bearings, and generator. It 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
- Predict failures before they occur resulting in saving money by reducing the downtime
- Money saved on repairs as errors are detected at an early stage
- Typical cost savings:
 - ❑ Costs of CMS system ~ \$12,000-\$20,000
 - ❑ Pay back period ~ 5-6 months
- Predicts how much service life is left in the turbine

Trend C: Increased Usage of Drones with HD and Thermal Cameras for Wind Blade Inspection



Wind Blade Inspection through HD and Thermal Drones

- Wind blade inspection is the key O&M procedure in the wind energy industry to avoid major damage and related costs. 85% of blade failures result from poor maintenance. Drone inspection technology provide lower-cost inspections and it doubles wind turbine inspection rates and also provides better data analysis, and enables high precision & predictive maintenance
- Drones are playing an increasingly important role in the maintenance of wind turbine. Drones provide a practical solution for the inspection of wind turbines, as well as associated infrastructure such as feeder poles, collector lines, and electrical substations
- Wind turbines, which typically stand hundreds of feet high, are in constant contact with the elements, and the blades require regular inspection to ensure the maintenance of efficient energy production
- Drones equipped with high-resolution digital and infrared cameras can save time and costs, inspecting multiple wind turbines
- Cost savings, fewer workplace accidents, and continuous improvement in service are the advantages of drone inspections

Trend D: Companies are Developing New Materials, Methods, and Technologies to fulfill Unmet Needs in the Market

Nano Coating



- WINDGO launched nanotech thermal coatings to prevent blades from ice build up
- Timken developed ES302 coating to provide maximum durability where metal-on-metal contact occurs like rollers for main shaft and bearings

Ground-Based Habitat for Blade Repair



- For a faster turnaround on blade repair GEV Wind Power has suggested bringing blades down to the ground and putting them in enclosure or habitat under controlled environmental conditions.
- The method eliminates the stand-by periods that often accompany bad weather and up-tower repairs.

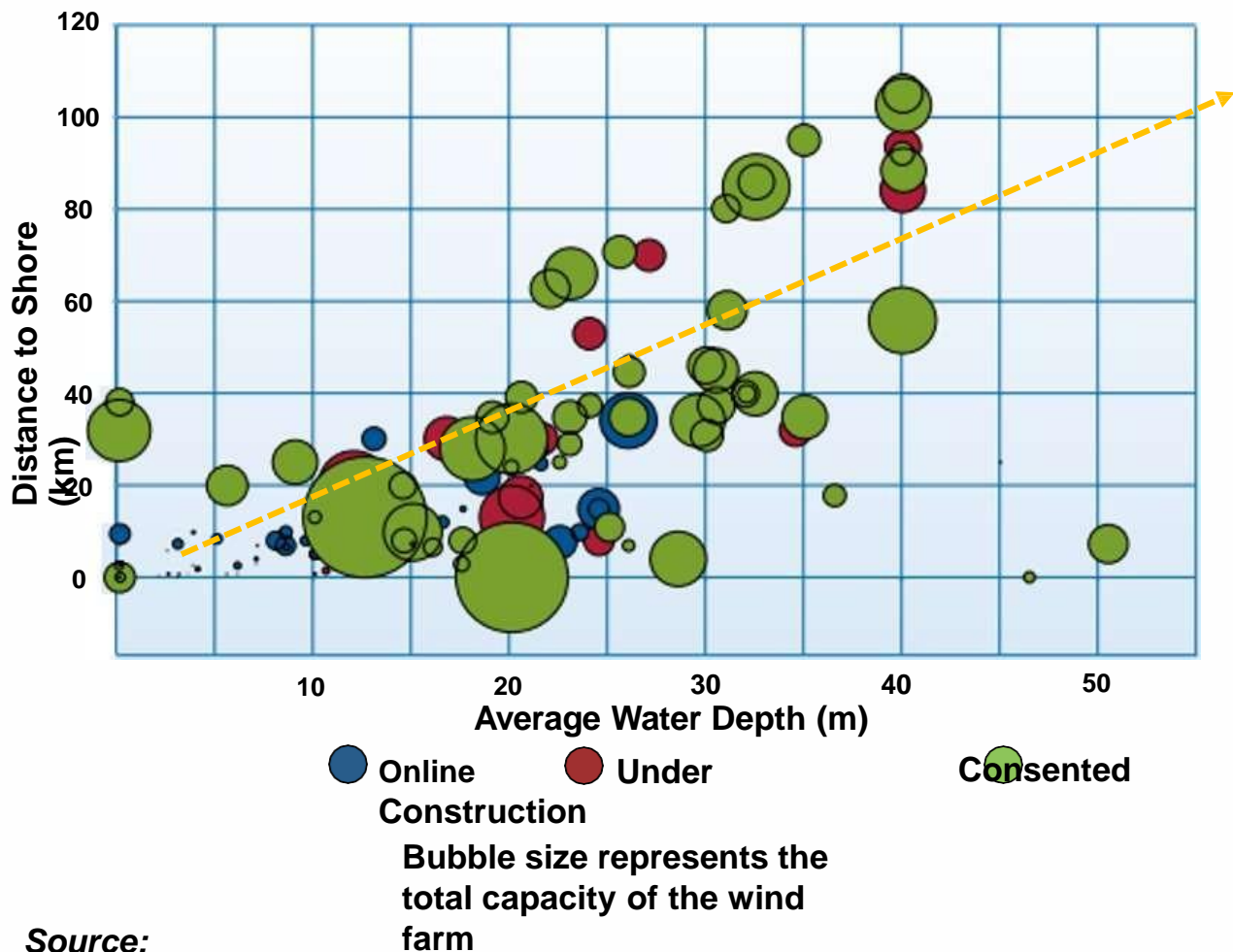
Software for Ice Detection



- Icing increases loads on wind blade and reduces aerodynamics, which increase the risk of equipment damage and turbine downtime.
- Clir Renewable developed a software system that automatically detects icing and quantifies the related losses

Trend E: Increasing Distance of Offshore Wind Farms from Shore & Water Depth is Expected to Create More Opportunities for Offshore O&M

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



Source:
EWEA

Key Insights

- 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

Three Growth and Profit Scenarios: Companies Need to Focus on Long-Term Contracts, More Advanced Technologies, and Emerging Countries

Scenario 1: Expand Core Business

Focus on the post warranty O & M service market

Enter into long-term contracts with wind farm owners

Focus on customer satisfaction & customer interaction

Scenario 2: Emerging Markets

Focus on Predictive O & M

Focus on the offshore wind O & M markets

Use AI and Drone Services for Low Downtime and Complexity

Scenario 3: Emerging Countries

Focus on emerging countries such as China, India for both onshore & offshore

Profit

Growth Strategies for Companies: Identification of Growing Regions, Trained Manpower, Strong Network, and Customer Satisfaction are the Major Keys for Growth

1. Identify Growth Applications based on Synergy



- Identify new opportunities with good synergy and profitability
- Identify growing regions
- Focus on AI and Drone Services for Low Downtime and Complexity

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 for 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

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Lucintel - At a Glance

- Premier management consulting and market research firm. Founded in 1998.
- Deep global insights into major industries. Team of over 120 analysts / consultants across globe
- Management comprised of PhDs, MBAs, and subject matter experts. Head quarter in Dallas, USA.

Conducted 500+ consulting projects across industries for 3M, Audi, Dupont, Carlyle, GE, etc.

Consulting Services



Why Lucintel

Trusted insights: Reliable insights. Widely cited in Wall Street Journal, Financial Times, Forbes, etc.

Clients we serve: Over 1000 clients from 70 countries – Fortune 500 companies

Strategic advice: Over 20 years of proven global strategic management consulting experience

Industries Served



1000+ Clients in 70 Countries Value Our Service



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Thank You