Offshore Wind -
High Cost is the Key Barrier to Break

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VP Offshore Projects Development, Suzlon Energy Ltd.
On 25th April 2013
Group companies

**Suzlon Energy Ltd.**

**Infrastructure**
Access roads, power evacuation, grid interconnection and power lines

**Equipment Supply**
Onshore and Offshore WTG & Component design, development and manufacturing

**Services**
EPC, project execution, installation, commissioning and O&M

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**Suzlon Wind**

Wind turbine manufacturer and turnkey solution provider

**Repower**

Wind turbine manufacturer (Subsidiary of Suzlon)

**Geographical Presence**

- **Suzlon Wind**: India, USA, China, Australia, Europe, Latin America, South Africa
- **Repower**: China, Europe (mainly Germany), Canada, USA

**Market Share**

7.6% (5th largest globally)

**Current Mfg. Capacity (MW)**

- **Suzlon Wind**: ~3,600
- **Repower**: ~1,700

**Product Portfolio**

- **Suzlon Wind**: Low to Medium capacity WTGs (600kW – 2.25 MW) - onshore
- **Repower**: Medium to High capacity WTGs (2.0 MW – 6.15 MW incl. offshore)

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**Integrated Business Model**
Offshore Wind Farms work in the same way as their onshore counterparts, but higher/stronger winds mean they generate more energy. However, it is more expensive to build and run offshore wind farm due to harsh and unpredictable marine environment. Each offshore wind farm presents unique challenge due to its location and sea bed conditions being completely different.
## Current Offshore Market Outlook

### Table: Offshore Wind Farms

<table>
<thead>
<tr>
<th>Continent</th>
<th>Country</th>
<th>No. of Farms</th>
<th>No. of Turbines</th>
<th>Capacity Operational *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Europe</td>
<td>United Kingdom</td>
<td>26</td>
<td>750</td>
<td>2515.7</td>
</tr>
<tr>
<td></td>
<td>Denmark</td>
<td>15</td>
<td>403</td>
<td>864.5</td>
</tr>
<tr>
<td></td>
<td>Netherlands</td>
<td>4</td>
<td>128</td>
<td>246.8</td>
</tr>
<tr>
<td></td>
<td>Germany</td>
<td>8</td>
<td>56</td>
<td>220.3</td>
</tr>
<tr>
<td></td>
<td>Belgium</td>
<td>3</td>
<td>73</td>
<td>268.8</td>
</tr>
<tr>
<td></td>
<td>Sweden</td>
<td>5</td>
<td>75</td>
<td>163.7</td>
</tr>
<tr>
<td></td>
<td>Finland</td>
<td>2</td>
<td>9</td>
<td>26.3</td>
</tr>
<tr>
<td></td>
<td>Ireland</td>
<td>1</td>
<td>7</td>
<td>25.2</td>
</tr>
<tr>
<td></td>
<td>Norway</td>
<td>1</td>
<td>1</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>Portugal</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Asia</td>
<td>China</td>
<td>3</td>
<td>92</td>
<td>251.3</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>69</td>
<td>1595</td>
<td>4586.9</td>
</tr>
</tbody>
</table>

* Data as on 30 June 2012 for Europe and Nov 2012 for China

Sources: EWEA & Wikipedia

14 offshore projects currently under construction of capacity totaling 3.3 GW
Prep. Work in progress on 7 other projects with a cumulative capacity of 1,174 MW.
2013 installations expected 1,400 MW
2014 installations around 1,900 MW.
Offshore Wind Farm Cost

Capital cost w. r. to Distance/Depth/OWT Capacity

Typical Life Cycle Cost Breakup

Cost of Capital Breakup - 2015

Source: UK Renewable Advisory Board Report by BVG Associates

Ref: http://www.nrel.gov/docs/fy10osti/45889.pdf
Offshore Cost Component Breakup

OWT Excluding Tower

- 51% Labour
- 32% Materials
- 17% Other

Installation & Commissioning

- 25% Labour
- 6% Materials
- 69% Other

Balance Of Power

- 26% Labour
- 57% Materials
- 17% Other

OPEX

- 35% Labour
- 14% Materials
- 52% Other

Source: UK Renewable Advisory Board Report by BVG Associates
Further to higher capital costs, offshore wind energy currently has a higher cost of energy than comparable technologies.

This cost of energy can be broadly calculated as the sum of all up-front annualized capital equipment costs and operations and maintenance costs over the life of the project, divided by the total energy output of the project.
DOE of USA

DOE of USA has planned for reducing the cost of offshore wind energy from $0.27 per kWh in 2010 to $0.07 per kWh in 2030 by increasing system efficiency and decreasing capital costs through the development of larger systems, innovative components and fully integrated system designs.

They claim, it would result in installed capital cost will decline by 39% from $4,259/kW to $2,600/kW, average turbine rating will increase from 3.6 MW to 10.0 MW, and turbine capacity factor will improve from 39% to 45%.

They intend to focus to expand access to the most promising wind resource areas. More than half of the estimated life-cycle cost of an offshore wind turbine farm is determined by following which shall be addressed:

- Foundation
- Electrical infrastructure,
- Installation and logistics,
- Operations and maintenance costs.
### Potential Path to Reduce Cost of Offshore Wind Energy in Class 6 Wind

<table>
<thead>
<tr>
<th>Component</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
<th>2010 - Land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed Capital Cost ($/kW)</td>
<td>$4,259</td>
<td>$2,900</td>
<td>$2,600</td>
<td>$2,120</td>
</tr>
<tr>
<td>Discount Rate Factor (DRF) (^6)</td>
<td>20%</td>
<td>14%</td>
<td>8%</td>
<td>12%</td>
</tr>
<tr>
<td>Turbine Rating (MW)</td>
<td>3.6</td>
<td>8.0</td>
<td>10.0</td>
<td>1.5</td>
</tr>
<tr>
<td>Rotor Diameter (m)</td>
<td>107</td>
<td>156</td>
<td>175</td>
<td>77</td>
</tr>
<tr>
<td>Annual Energy Production / Turbine (MWh)</td>
<td>12,276</td>
<td>31,040</td>
<td>39,381</td>
<td>4684</td>
</tr>
<tr>
<td>Capacity Factor</td>
<td>39%</td>
<td>44%</td>
<td>45%</td>
<td>36%</td>
</tr>
<tr>
<td>Array Losses</td>
<td>10%</td>
<td>7%</td>
<td>7%</td>
<td>15%</td>
</tr>
<tr>
<td>Availability</td>
<td>95%</td>
<td>97%</td>
<td>97%</td>
<td>98%</td>
</tr>
<tr>
<td>Rotor Coefficient of Power</td>
<td>0.45</td>
<td>0.49</td>
<td>0.49</td>
<td>.47</td>
</tr>
<tr>
<td>Drivetrain Efficiency</td>
<td>0.9</td>
<td>0.95</td>
<td>0.95</td>
<td>0.9</td>
</tr>
<tr>
<td>Rated Windspeed (m/s)</td>
<td>12.03</td>
<td>12.03</td>
<td>12.03</td>
<td>10.97</td>
</tr>
<tr>
<td>Average Wind Speed at Hub Heights (m/s)</td>
<td>8.8</td>
<td>9.09</td>
<td>9.17</td>
<td>7.75</td>
</tr>
<tr>
<td>Wind Shear</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>.143</td>
</tr>
<tr>
<td>Hub Height (m)</td>
<td>80</td>
<td>110</td>
<td>120</td>
<td>80</td>
</tr>
<tr>
<td>Cost of Energy ($/kWh)</td>
<td>0.27</td>
<td>0.10</td>
<td>0.07</td>
<td>0.09</td>
</tr>
<tr>
<td>Cost of Energy ($/kWh) at constant 7% DR</td>
<td>0.12</td>
<td>0.08</td>
<td>0.07</td>
<td>0.08</td>
</tr>
</tbody>
</table>

*Courtesy NREL-USA*
Reduction in Cost of Energy – European Drive

Offshore Wind Accelerator - Research, Development and Demonstration Project to reduce cost of offshore CAPEX by 10% by 2014 @ Budget GBP40Million with 9 developers & Carbon Trust

<table>
<thead>
<tr>
<th>DONG Energy</th>
<th>E.ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAINSTREAM RENEWABLE POWER</td>
<td>RWE</td>
</tr>
<tr>
<td>SSE Renewables</td>
<td>SCOTTISHPOWER RENEWABLES</td>
</tr>
<tr>
<td>Statoil</td>
<td>Statkraft</td>
</tr>
<tr>
<td>VATTENFALL</td>
<td>Carbon Trust</td>
</tr>
</tbody>
</table>

60% (30GW of licensed capacity in UK waters)
DECC UK Grant for Cost Reduction

Offshore wind innovation has been given a boost by the Department of Energy and Climate Change (DECC) UK. **Innovation** is key to improving efficiency and has the potential to drive down costs of offshore wind by **25 % by 2020** and **60 % by 2050**

The DECC grant will give the companies the boost they need to take their innovative designs to the next level, helping cut costs in offshore wind generation.

The DECC grant has been awarded for project ideas @ GBP 4 Million each viz.

- Create an integrated offshore high voltage network management system (OHVMS) for wind farms
- Develop and build innovative HVAC cables
- Develop the design and serial manufacturing process for innovative WindFloat floating foundations for wind turbines

10MW for depths beyond 50m, Principle Power is deploying the WindFloat technology worldwide - pursuing projects in Portugal, Oregon and Maine.
The cost of offshore in UK have increased since early 2000. This has been attributed to supply chain bottle necks, also to move to deeper water sites. Recent wind farm projects have indicated that cost has stabilized around GBP 140/MWh for projects FID in 2011. UK Government and industry have worked together to shape up the offshore wind industry and investment in new technologies and facilities. The future cost is considered critical in deciding the future size in UK. Participation with 120 related companies has resulted that reducing the cost of offshore wind to 100GBP/MWh by 2020 is achievable (Pathway Study)

**Cost Driver Analysis Approach**

- **Site Characteristics**
  - Water depth
  - Distance to shore
  - Wind speed

- **Industry Evolution (Story)**
  - Size of the market (GW)
  - Technology progress
  - Supply Chain response
  - Finance

- **Technical assumptions**
  - Operational life
  - Decommissioning costs
  - O&M costs

- **Exogenous Factors**
  - Interest rates (risk free rate)
  - Commodity prices (steel, copper)
  - Exchange rates

*Source: Offshore wind cost reduction pathways study*
Offshore Wind Cost Reduction Pathway Study

Cost Reduction Opportunity by Technology & Supply Chain as % Reduction in LCOE. 

Source: The Crown Estate
Sensitivity Modeling Results

Impact on LCOE

-10%  -5%   0%   5%   10%

Currency fluctuations (€)
Commodity prices
Increase operating lifetime
Risk free rate
O&M costs
Residual value at end of life

Source: Offshore wind cost reduction pathways study
**Offshore Requirement**

**Installation Specific**
- Multi Task Capability
- High Speed (~14knots)
- Higher Installation rate
- Pay load - 10 to 12 Installation in single voyage
  - Jackable weight & system capability
  - ~7000 to 8000t
- Crane - Optimum Position
  - Crane Capacity (~ 800 to 1200t)
  - Crane Curve /out reach/hook height (~ 115m)
- Accommodation (80 to 100 men)
- Propulsion; Transit speed & DP 2 capabilities (4xAzimuth thrusters +Tunnel thruster)
- Power: In accordance with above, critical DP with jacking (~ 12,000 to 14,000KW)
- Vessel to be in accordance with Class Regulations

**Site Specific (TIV)**
- Range of Water Depth – 50 to 70m
- Deck Strength (min. 10t/m²)
- Length of leg (~130m)
- Distance to coast – max 100 km
- Relevant Harbor in proximity - ~250nm
- Environment Conditions– Wave Ht. Transit; Stand on Bottom Off; Operational & Survival
  - Current Velocity (Typical range 0.9 to 1.2 m/sec, Max. 1.8m/sec)
- Soil Condition – Pre loading capacity / Leg penetration / Spud cans
- Operational Availability – ( 250 to 290 days a year /aimed 75%)

Large number of new generation installation vessels are needed featuring innovative technologies, capable of operating in deeper waters (up to 75 m) and in harsher sea conditions.
Advance TIVs
(Clockwise)
Swire Blue Ocean
MML Vessel
SWATH –WTS Husiman
RWE Innogy Vessel
MPI MV Adventure
Beluga Hochtief
Cost Of Operation & Maintenance

The costs of O&M figures show a spread of values, with the majority in the range £10/MWh to £20/MWh.


Courtesy TU Delft
Typical Port Infrastructure

- Area for storage: 6 to 25 ha (60,000 m² to 25,000 m²)
- Dedicated road between storage and quay side
- Quay length: approximate 150 m - 250 m
- Quay bearing capacity: 3 to 6 Ton/m²
- Seabed with sufficient bearing capacity near the pier
- Draft: minimum 6 m
- Ware house facilities 1000-1500 m²
- Access for smaller vessels (pontoon bridge, Barge etc.)
- Access 365-24/7
- Access for heavy /oversize trucks
- Helicopter transfer
- Longer estimated period of use for construction + O&M
Offshore Foundations

73% of substructures are monopiles, 13% jackets, 6% tripods, 5% tripiles & 3% gravity based foundations. There are also two full scale grid connected floating turbines, and two down-scaled prototypes.
Foundation Technologies Comparison

Cost & Functionally Effective Foundations


<table>
<thead>
<tr>
<th>Siting</th>
<th>Monopile</th>
<th>Jacket</th>
<th>Tripod</th>
<th>Tripile</th>
<th>Gravity base</th>
<th>Suction bucket</th>
<th>Floating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varying soil conditions</td>
<td>0.08</td>
<td>0.1</td>
<td>0.09</td>
<td>0.09</td>
<td>0.03</td>
<td>0.02</td>
<td>0.09</td>
</tr>
<tr>
<td>Poor soil conditions</td>
<td>0.06</td>
<td>0.08</td>
<td>0.07</td>
<td>0.07</td>
<td>0.03</td>
<td>0.03</td>
<td>0.08</td>
</tr>
<tr>
<td>Sloping sea</td>
<td>0.05</td>
<td>0.08</td>
<td>0.08</td>
<td>0.08</td>
<td>0.02</td>
<td>0.03</td>
<td>0.1</td>
</tr>
<tr>
<td>Ice</td>
<td>0.06</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
<td>0.08</td>
<td>0.06</td>
<td>0.06</td>
</tr>
<tr>
<td>Total</td>
<td>0.063</td>
<td>0.075</td>
<td>0.07</td>
<td>0.07</td>
<td>0.04</td>
<td>0.035</td>
<td>0.083</td>
</tr>
</tbody>
</table>

Courtesy: Wind Energy Update
Hywind floating wind:
Wind turbine
- Capacity: SWT-2.3 MW, built by Siemens
- Weight of turbine: 138 tonnes
- Turbine height: 65 metres
- Rotor diameter: 82.4 metres

Floatation element and offshore installation
- Built by Technip
- Consists of a steel floater filled with ballast
- Floatation element’s draught below sea surface: 100 metres
- Diameter of floatation element: 8.3 metres
- Total weight: 5300 tonnes.
- Diameter at sea surface: 6 metres.
- No. of anchor moorings: 3

StatoilHydro and Siemens have jointly developed a special control system to control the movement of the floating structure.
Future Developments - Offshore

Partners including Clipper of UK & Sway AS of Norway

Private partnership comprising of BP, Caterpillar, EDF, E.ON, Rolls-Royce, Shell, BP, EDF, EON, Caterpillar, the UK Government and Wind Power Limited

Project Partners: Risø DTU, DTU Mekanik, TUDelft, DHI, Statoil (NO), National Renewable Energy Laboratory (NREL) (US), and a major Danish wind turbine manufacturer - DeepWind
Hybrid Solution

CONVERTING WIND, WAVES TO ELECTRICITY
Grays Harbor Ocean Energy Co. is proposing to build up to 100 wind-and-wave-energy platforms over an 80-square-mile area off Moloka‘i. The proposed site is within a marine sanctuary for humpback whales.

HOW IT WORKS
Motion

About the Project
SITE: Penguin Bank (eroded summit of sunken volcano)
PROJECT: 100 wind-and-wave-energy platforms over an 80-square-mile area
ESTIMATED COST: $4 billion
PLANNED POWER CAPACITY: 1,100 megawatts
PLANNED POWER CAPACITY PER PLATFORM: 10 megawatts from wind, 1 megawatt from waves
PROJECTED PROJECT COMPLETION: 2016
Source: Grays Harbor Ocean Energy Co.
## Increase in Offshore Installation Cost

### As a Function of Distance to the Coast

<table>
<thead>
<tr>
<th>Cost (EUR/kW)</th>
<th>0-10</th>
<th>10-20</th>
<th>20-30</th>
<th>30-40</th>
<th>40-50</th>
<th>50-100</th>
<th>100-200</th>
<th>&gt; 200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbine</td>
<td>772</td>
<td>772</td>
<td>772</td>
<td>772</td>
<td>772</td>
<td>772</td>
<td>772</td>
<td>772</td>
</tr>
<tr>
<td>Foundation</td>
<td>352</td>
<td>352</td>
<td>352</td>
<td>352</td>
<td>352</td>
<td>352</td>
<td>352</td>
<td>352</td>
</tr>
<tr>
<td>Installation</td>
<td>465</td>
<td>476</td>
<td>488</td>
<td>500</td>
<td>511</td>
<td>607</td>
<td>816</td>
<td>964</td>
</tr>
<tr>
<td>Grid connection</td>
<td>133</td>
<td>159</td>
<td>185</td>
<td>211</td>
<td>236</td>
<td>314</td>
<td>507</td>
<td>702</td>
</tr>
<tr>
<td>Others</td>
<td>79</td>
<td>81</td>
<td>82</td>
<td>85</td>
<td>87</td>
<td>88</td>
<td>89</td>
<td></td>
</tr>
<tr>
<td><strong>Total cost (EUR/kW)</strong></td>
<td>1,800</td>
<td>1,839</td>
<td>1,878</td>
<td>1,918</td>
<td>1,956</td>
<td>2,131</td>
<td>2,534</td>
<td>2,878</td>
</tr>
<tr>
<td><strong>Scale factor</strong></td>
<td>1.022</td>
<td>1.043</td>
<td>1.065</td>
<td>1.086</td>
<td>1.183</td>
<td>1.408</td>
<td>1.598</td>
<td></td>
</tr>
</tbody>
</table>

### As a Function of Water Depth

<table>
<thead>
<tr>
<th>Cost (EUR/kW)</th>
<th>10-20</th>
<th>20-30</th>
<th>30-40</th>
<th>40-50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turbine</td>
<td>772</td>
<td>772</td>
<td>772</td>
<td>772</td>
</tr>
<tr>
<td>Foundation</td>
<td>352</td>
<td>466</td>
<td>625</td>
<td>900</td>
</tr>
<tr>
<td>Installation</td>
<td>465</td>
<td>465</td>
<td>605</td>
<td>605</td>
</tr>
<tr>
<td>Grid connection</td>
<td>133</td>
<td>133</td>
<td>133</td>
<td>133</td>
</tr>
<tr>
<td>Others</td>
<td>79</td>
<td>85</td>
<td>92</td>
<td>105</td>
</tr>
<tr>
<td><strong>Total cost (EUR/kW)</strong></td>
<td>1,800</td>
<td>1,920</td>
<td>2,227</td>
<td>2,514</td>
</tr>
<tr>
<td><strong>Scale factor</strong></td>
<td>1.000</td>
<td>1.067</td>
<td>1.237</td>
<td>1.396</td>
</tr>
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</table>

### As a Function of Water Depth Distance to Coast

<table>
<thead>
<tr>
<th>Depth (m)</th>
<th>0-10</th>
<th>10-20</th>
<th>20-30</th>
<th>30-40</th>
<th>40-50</th>
<th>50-100</th>
<th>100-200</th>
<th>&gt; 200</th>
</tr>
</thead>
<tbody>
<tr>
<td>10-20</td>
<td>1</td>
<td>1.022</td>
<td>1.043</td>
<td>1.065</td>
<td>1.086</td>
<td>1.183</td>
<td>1.408</td>
<td>1.598</td>
</tr>
<tr>
<td>20-30</td>
<td>1.067</td>
<td>1.090</td>
<td>1.113</td>
<td>1.136</td>
<td>1.159</td>
<td>1.262</td>
<td>1.501</td>
<td>1.705</td>
</tr>
<tr>
<td>30-40</td>
<td>1.237</td>
<td>1.264</td>
<td>1.290</td>
<td>1.317</td>
<td>1.344</td>
<td>1.464</td>
<td>1.741</td>
<td>1.977</td>
</tr>
<tr>
<td>40-50</td>
<td>1.396</td>
<td>1.427</td>
<td>1.457</td>
<td>1.487</td>
<td>1.517</td>
<td>1.653</td>
<td>1.966</td>
<td>2.232</td>
</tr>
</tbody>
</table>

**Source:** EEA,
Installation Cost Reduction By Large Number Installations

Reduced Cost - Longer Life Cycle

Courtesy - www.windpower.org
Safety Performance of Offshore Operations

Safety performance of offshore operations compared with construction and all industries, 1996/7 to 2010/11

Fatal injury rates (per 100 000)

Year:
- 1996/97
- 1997/98
- 1998/99
- 1999/00
- 2000/01
- 2001/02
- 2002/03
- 2003/04
- 2004/05
- 2005/06
- 2006/07
- 2007/08
- 2008/09
- 2009/10
- 2010/11

Note: Offshore operations include both oil and gas and offshore wind, but exclude air transport activities and cover all workers. Construction and all industries cover employees only.

Source: Health and Safety Executive
Low Cost Offshore Wind Measurement
Identified Offshore Challenges 1

- Large turbines
- Large project sizes
- Lower O&M cost
- Holistic design of the tower with the foundation
- Improvements in blade aerodynamics
- Continuously variable transmission drive trains
- Multi-variable optimization of array layouts
- Buoyant concrete gravity base foundations
- Introduction of DC power take-off (incl impact of DC array cables)
- Improvements in jacket manufacturing
- Introduction of direct-drive superconducting drive trains
- Introduction of float out and sink installation of turbine and support
- Increase in turbine power rating
Identified Offshore Challenges 2

- Integrated offshore grid system
  - Higher standardization – e.g. platform design
  - Technology improvements
  - Improved risk management process
- Advance materials and coatings against protection from sea environment
- LIDAR, SODAR and remote wind sensing for wind measurements
- Condition based monitoring and predictive maintenance
- Optimization of design for offshore
- Weather window forecasting
- Improved access vessel
- Advance Installation vessels of foundations, turbines & substations
- Ease to remove sub structure while decommissioning
India’s Coast Line 7500 KM +
EEZ = 2305143 Sq KM (including A&N Islands)
Offshore Area (Assumption) :
As 20% of 7500 ie. 1500 KM
Up to 50 km distance = 75000 Sq KM
This should accommodate = 100,000 MW

Offshore Wind Farms Area - Europe Vis a Vis India
Offshore Way Ahead in India

Enhance green/wind energy potential of the country by formulating plans & policy to introduce offshore component.

Ensure timely regulatory and permitting approvals that too will help reduce financing costs.

Focused effort to integrate the resources and expertise of the country to propel the India to the leading edge of offshore wind technology.

Initially the focus area be on risk reduction to facilitate the initial deployment of offshore wind projects in the Indian waters.

Over the long term, adopt developing new technologies that lower the cost of energy, promote/sustain growth of domestic industry leveraging cheaper labor, cheaper steel fabrication and extending existing Oil & Gas offshore EPC to wind industry there by make offshore wind cost-competitive without compromising high standards of HSE.
Thank You

Suzlon wind farm in Paracuru, Brazil
## Industry Stories

<table>
<thead>
<tr>
<th>1. ‘Slow Progression’</th>
<th>2. ‘Technology Acceleration’</th>
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<tbody>
<tr>
<td>31GW in Europe by 2020 (12GW in UK)</td>
<td>36GW in Europe by 2020 (17GW in UK)</td>
</tr>
<tr>
<td>Incremental technology evolution, progress limited by market size</td>
<td>High levels of technology evolution across all wind farm elements (e.g. turbines progress rapidly to 5-7MW+)</td>
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<tr>
<td>Limited competition/economies of scale</td>
<td>Fragmented supply chain with some improvement in collaboration</td>
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<tr>
<td>Modest developments in financing solutions, reduced in risk/cost of capital</td>
<td>Limited improvement in cost of capital due to ongoing changes in technology</td>
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<th>3. ‘Supply Chain Efficiency’</th>
<th>4. ‘Rapid Growth’</th>
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<tr>
<td>36GW in Europe by 2020 (17GW in UK)</td>
<td>43GW in Europe by 2020 (23GW in UK)</td>
</tr>
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<td>Incremental technology evolution (e.g. steady progress to 5-7MW turbines)</td>
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</tr>
<tr>
<td>Greater compensation, investment, project collaboration and better risk management</td>
<td>Greater competition, investment, project collaboration and better risk management</td>
</tr>
<tr>
<td>Deeper financial markets, lower risk/lower cost of capital</td>
<td>Challenging volume of finance required</td>
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