Wind Power in our future energy system

May 2023

Per Hessellund Lauritsen

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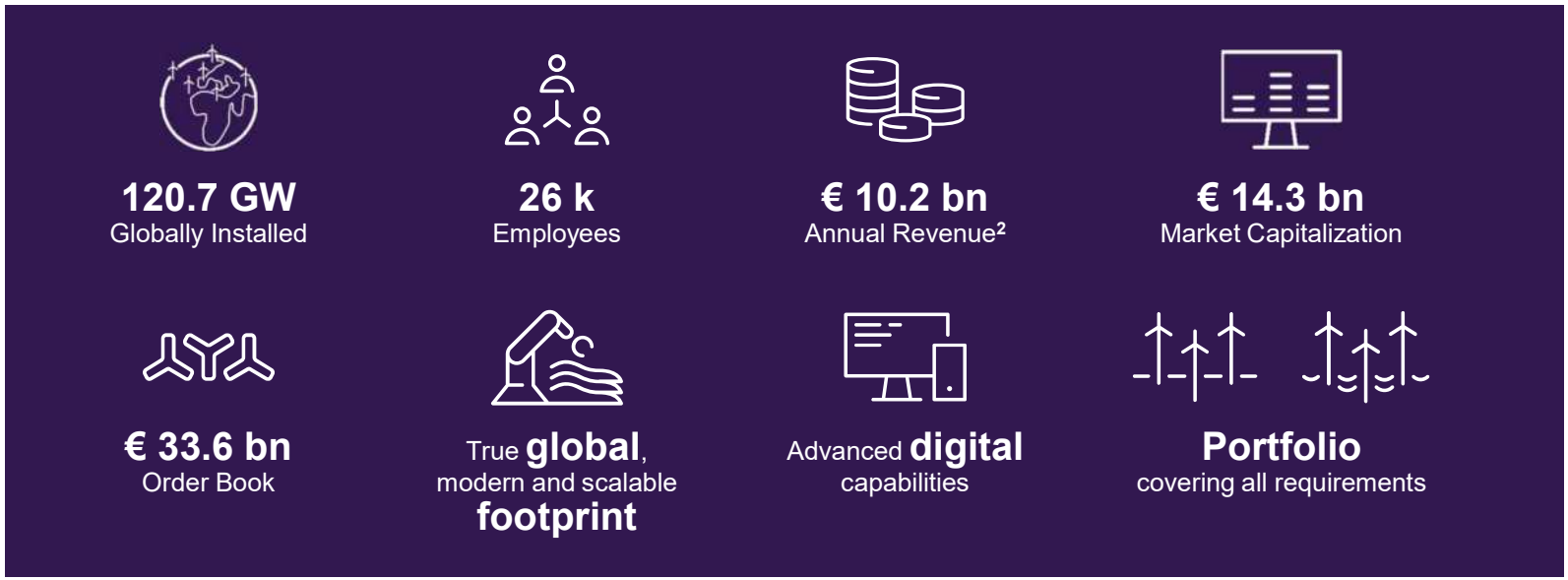
Key Facts[1]



[1] End of December 2021
[2] End of September 2021

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Three business units strongly positioned in the market

Onshore

101.5 GW
installed since 1979

The **technological partner of choice** for onshore wind power project.

Offshore

19.2 GW
installed since 1991

Most experienced offshore wind company with the most reliable product portfolio in the market.

Service

82 GW
maintained

Commitment beyond the supply of the wind turbine **to reach the profitability goals.**

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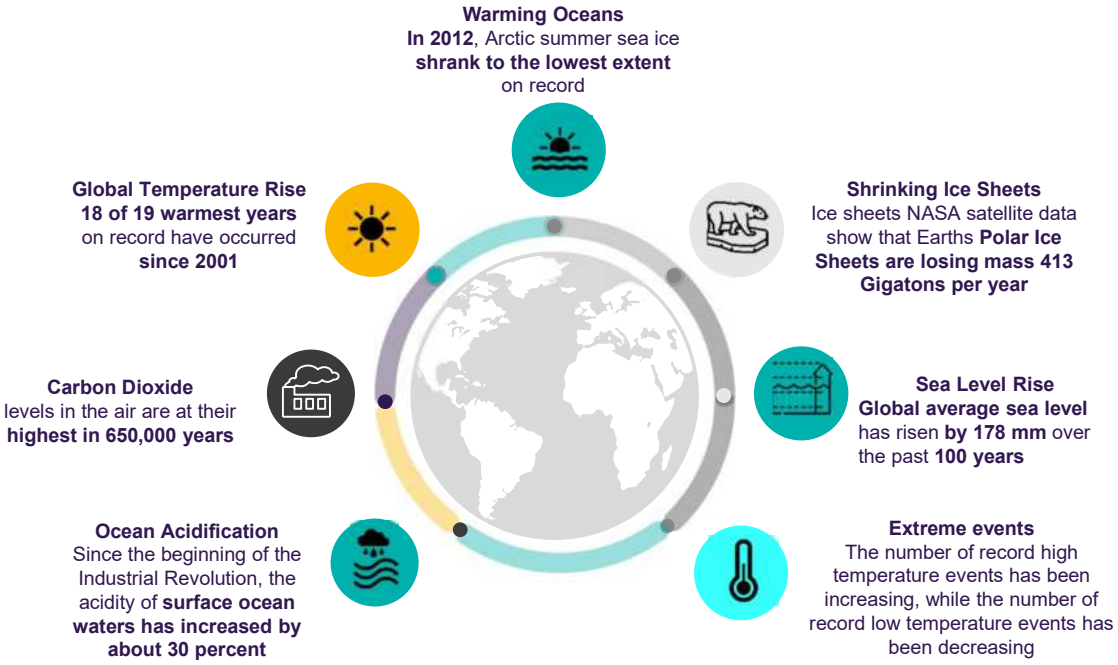
SGRE Offshore and Globalization

The Purpose that Drives us

Global Climate Change - Vital Signs & Facts



Global Climate change vital signs of the planet Source: https://climate.nasa.gov/evidence/

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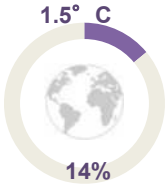
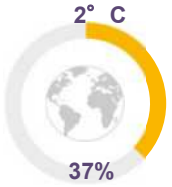
Would the world be the same? The difference between 1.5 °C & 2 °C increase

Extreme Heat

Global Population exposed to severe heat at least once every 5 years





Impacts of 2° C

2.6x Worse

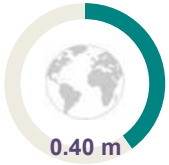
Sea Ice Free Arctic

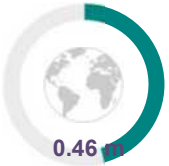
Number of ice free summers

10x Worse

Sea Level Rise

Amount of sea level rise by 2100





0.06 meter More

Source: World Resource Institute https://www.wri.org/blog/2018/10/half-degree-and-world-apart-difference-climate-impacts-between-15-c-and-2-c-warming

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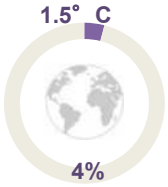
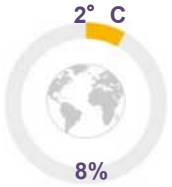
Would the world be the same? The difference between 1.5 °C & 2 °C increase

Species Loss Vertebrates

Vertebrates lose at least half of their range



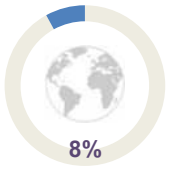


Impacts of 2° C

2x Worse

Species Loss Plants

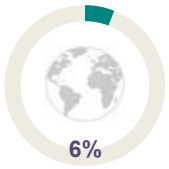
Plants lose at least half of their range



2x Worse

Species Loss Insects

Insects lose at least half of their range



3x Worse

Source: World Resource Institute https://www.wri.org/blog/2018/10/half-degree-and-world-apart-difference-climate-impacts-between-15-c-and-2-c-warming

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Would the world, as we know it, be the same for generations to come ?

Source:
School_strike_for_climate

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SGRE Offshore and Globalization

Industrializing Offshore Wind

Global manufacturing footprint

Aalborg, Denmark

- Siemens Gamesa IntegralBlade manufacturing
- Part of world's largest wind turbine test facility
- Advanced blade testing
- Production began: CY2002

Cuxhaven, Germany

- Nacelle backends, generators and hub assembly
- Allows loading via Ro-Ro ramp directly onto a transport vessel
- Production began: CY2017

Hull, England

- Siemens Gamesa Integral-Blade manufacturing
- Pre-assembly of offshore wind power plant components
- Production began: end of CY2016

Taichung, Taiwan

- Nacelle component marriage
- First SGRE Offshore nacelle assembly outside of Europe
- Production planned to begin: CY2021

Le Havre, France

- Blade manufacturing, nacelle assembly, and pre-assembly
- Will allow manufacturing and installing from the same place
- Production planned to begin: CY2021

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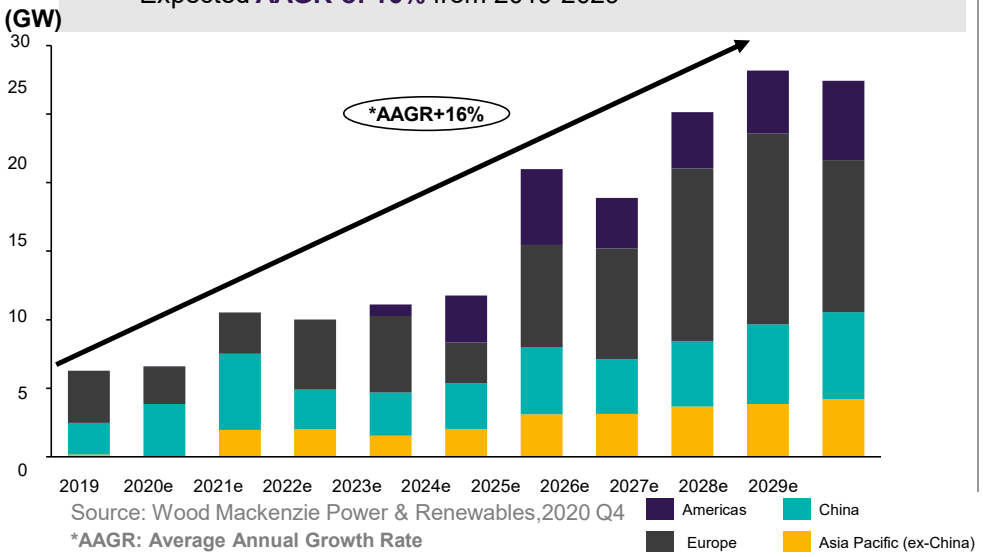
Industry growth will facilitate further cost reductions

Market Growth

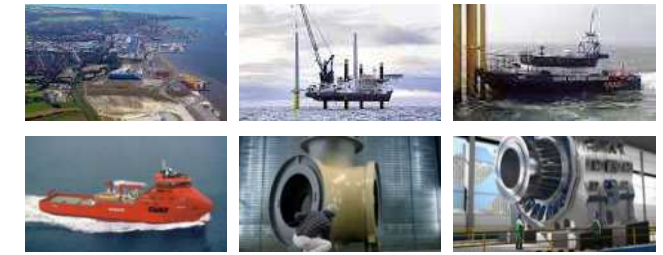
- Offshore wind will surge to over 234 GW by 2030. More than 205 GW of new offshore wind capacity will be added globally*
- Expected **AAGR of 16%** from 2019-2029



Source: Wood Mackenzie Power & Renewables,2020 Q4

*AAGR: Average Annual Growth Rate

Industry Growth



These volumes will drive a more diverse OEM and supplier market – which in turn will drive further cost reduction and innovation*

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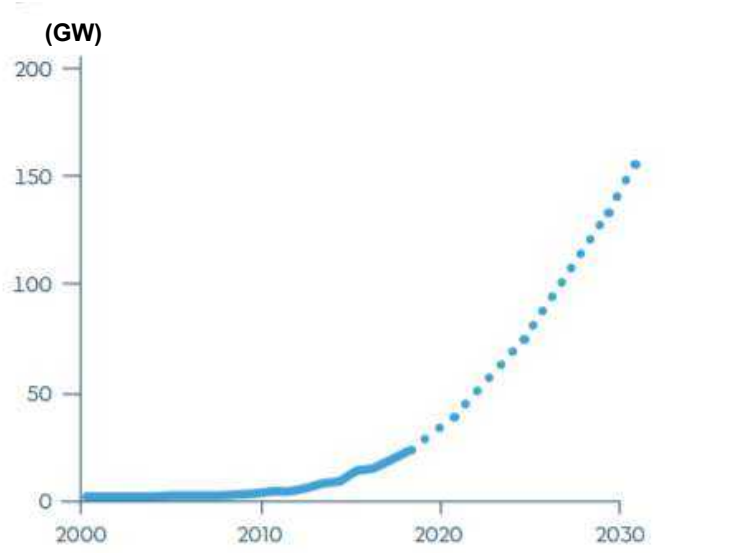
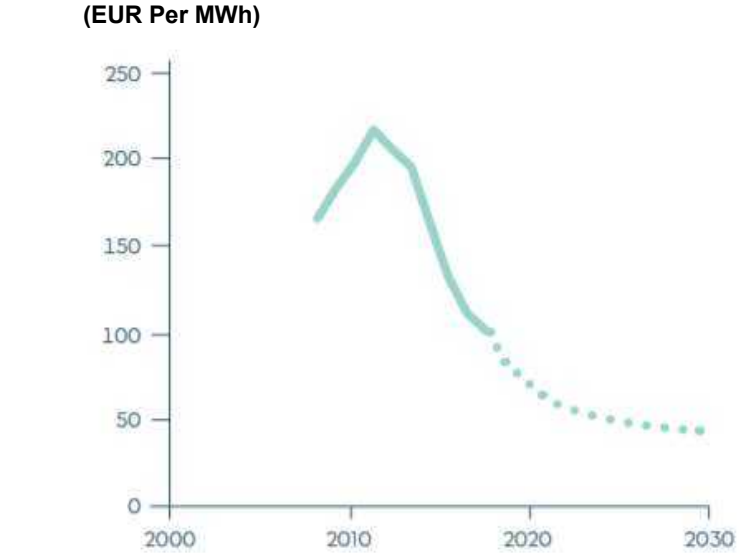
Costs are decreasing as more Offshore Wind Capacity is installed

Global Installed Offshore Wind Capacity



Global Levelized Cost of Electricity (LCOE) Benchmark



Offshore Wind is developing at very high pace on installed Capacity and LCOE

Source: Bloomberg New Energy Finance, June 2019

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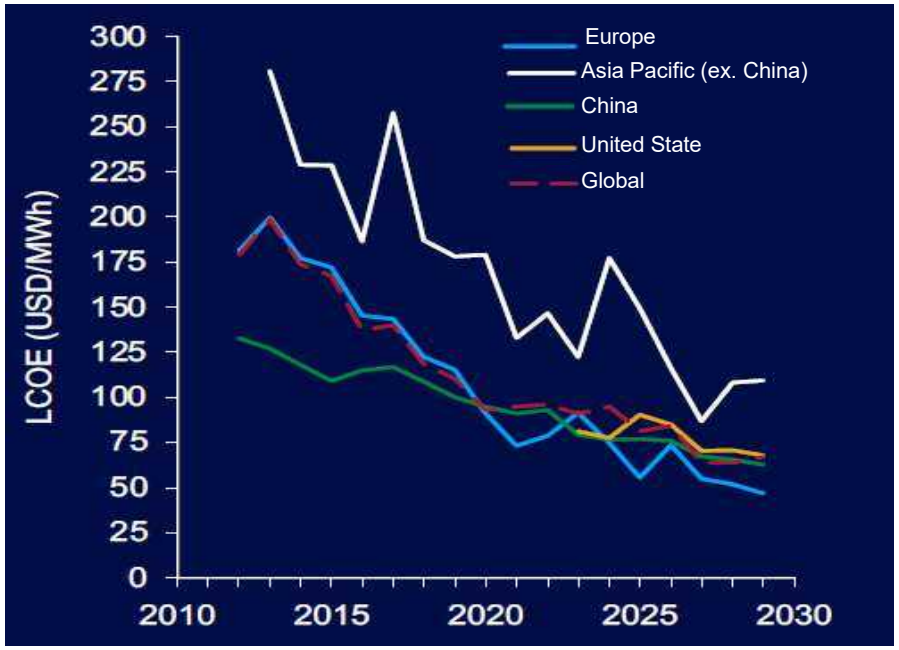
Levelized Cost of Electricity – Offshore Wind Forecast

Global bottom-fixed offshore wind LCOE



Source: Wood Mackenzie Power & Renewables, December 2020

- Between 2012-2018:
  - LCOE dropped by 60%, making offshore wind energy
  - cheaper than new coal, gas and nuclear-based power generation
- By 2029:
  - Average global LCOE will drop by 28%
  - Global CAPEX and OPEX will on average drop by 23% and 20% respectively
  - This picture may be altered due to raw material price increase
- Next generation platforms will increase the net capacity factors of the offshore turbines
- The focus will be on scaling up and cost reductions by leveraging innovations, power-to-X and new forms of hybrid projects and energy islands.

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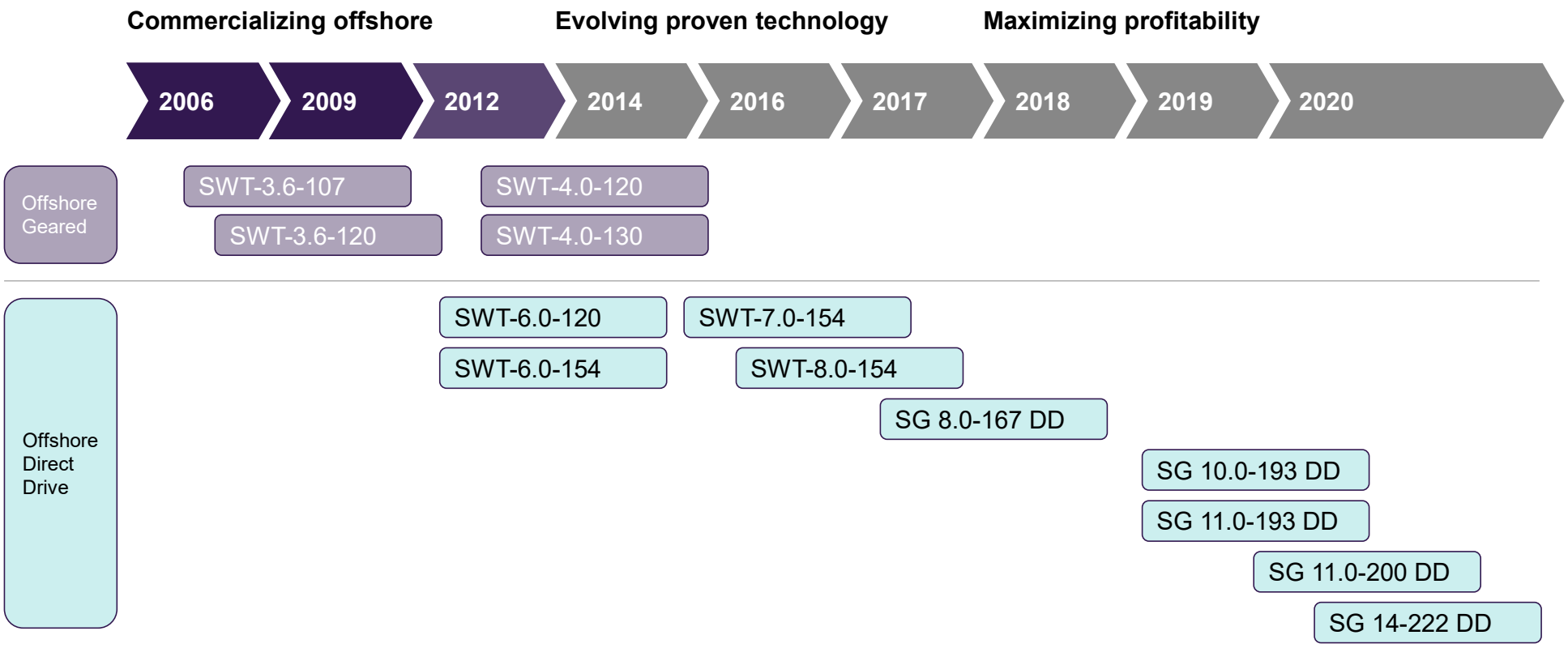
Offshore product portfolio

Historical development of Product Portfolio to match market and customer needs



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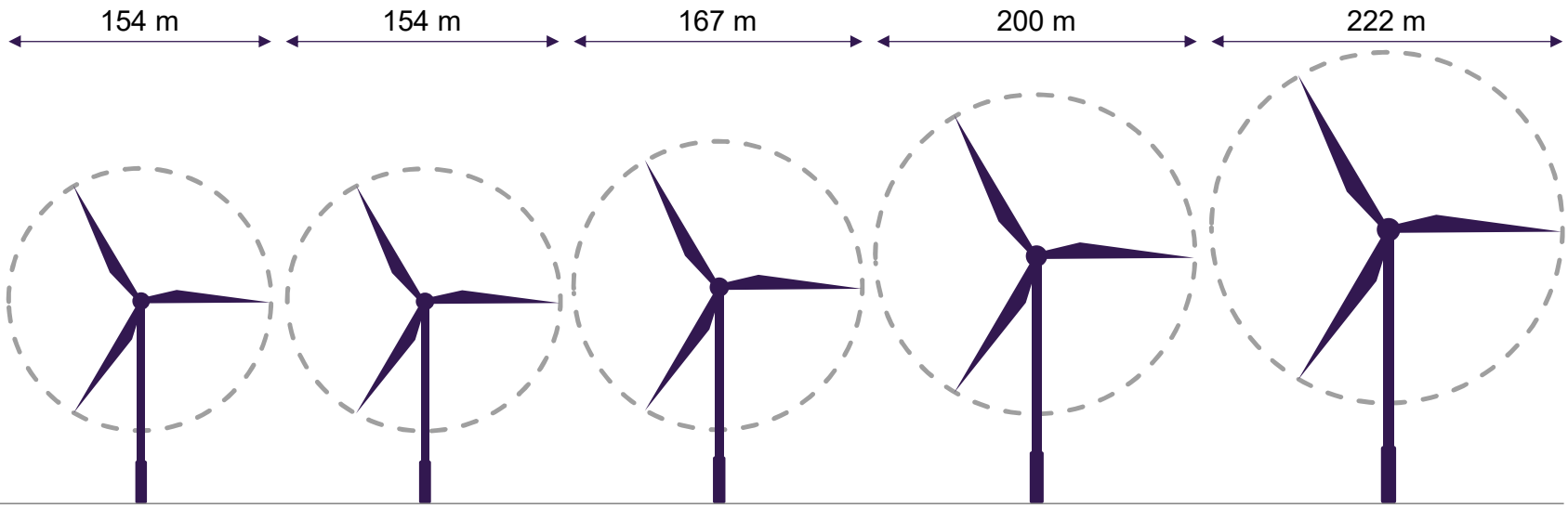
Generations of Offshore Direct Drive



	SWT-6.0-154	SWT-7.0-154	SG 8.0-167 DD	SG 11.0-200 DD	SG 14-222 DD
IEC Class	I, S	I, S	I, S	I, S	I, S
Nominal Power	6 MW	7 MW	8 MW	11 MW	14 MW
Blade length	75 m	75 m	81.4 m	97 m	108 m

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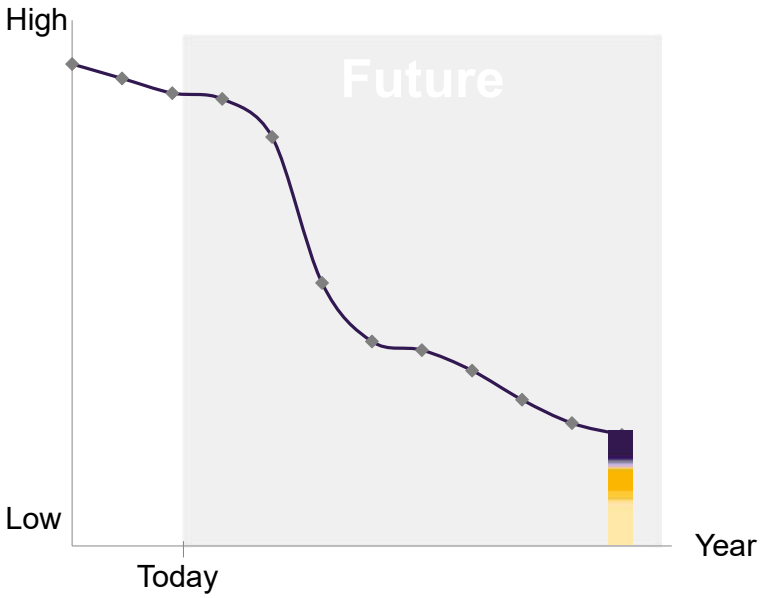
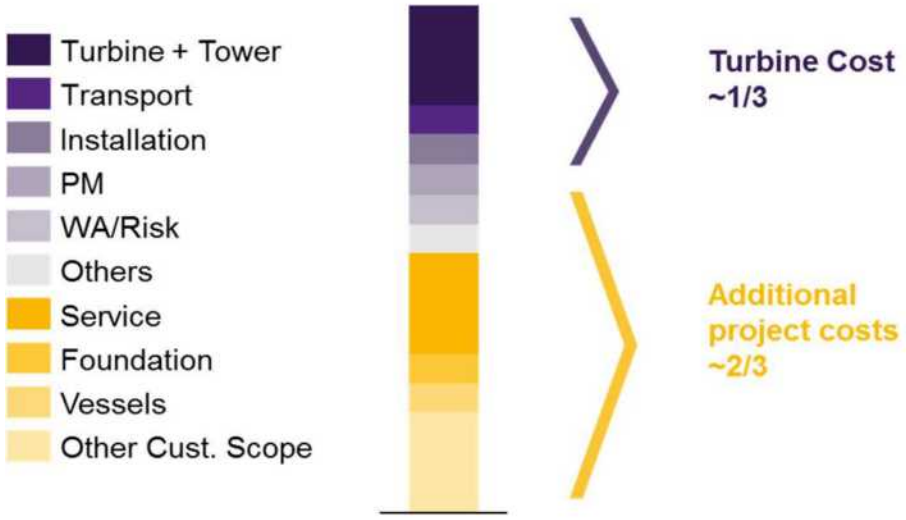
Total project cost need to be optimized in order to reach a lower LCoE target

LCoE Offshore Wind (EUR/MWh)



Offshore Wind Project Cost Distribution*



*The charts are illustrative

Source: Goldman Sachs_ Re-Imagining Big Oils-08/10/2018

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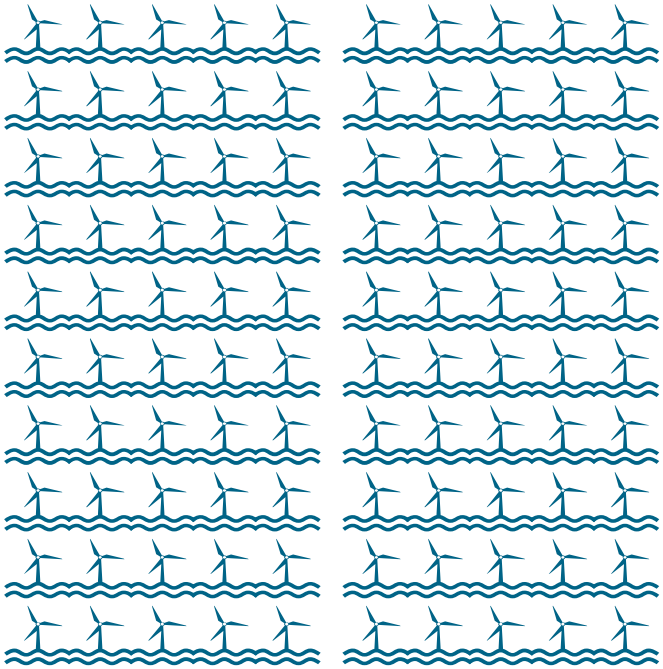
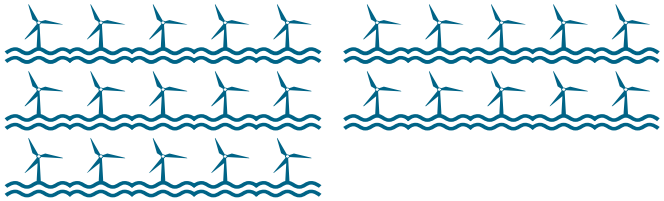
Higher ratings require less # of machines per park and enable further cost reductions

Assuming a 5 MW machine vs. a 20 MW machine for a park size of 500 MW

5 MW turbines



20 MW turbines



Less quantity of machines

Means less…

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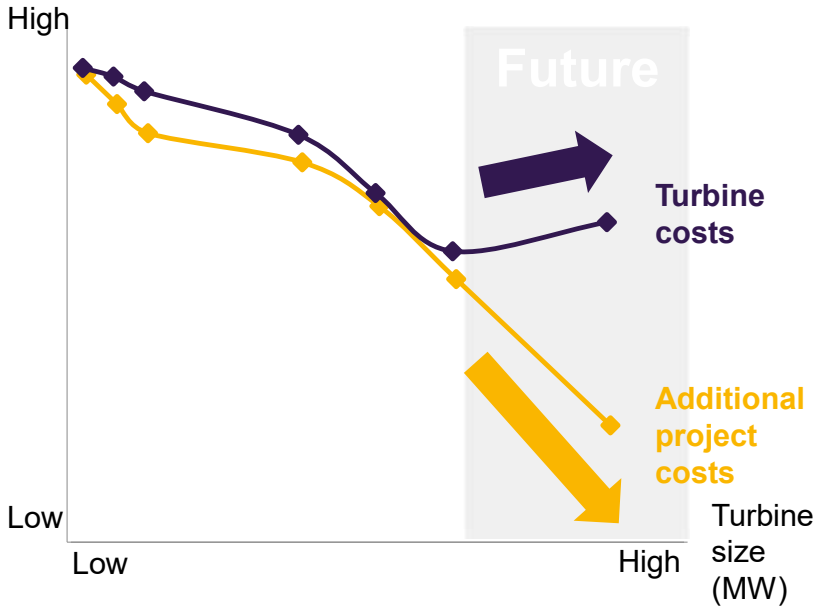
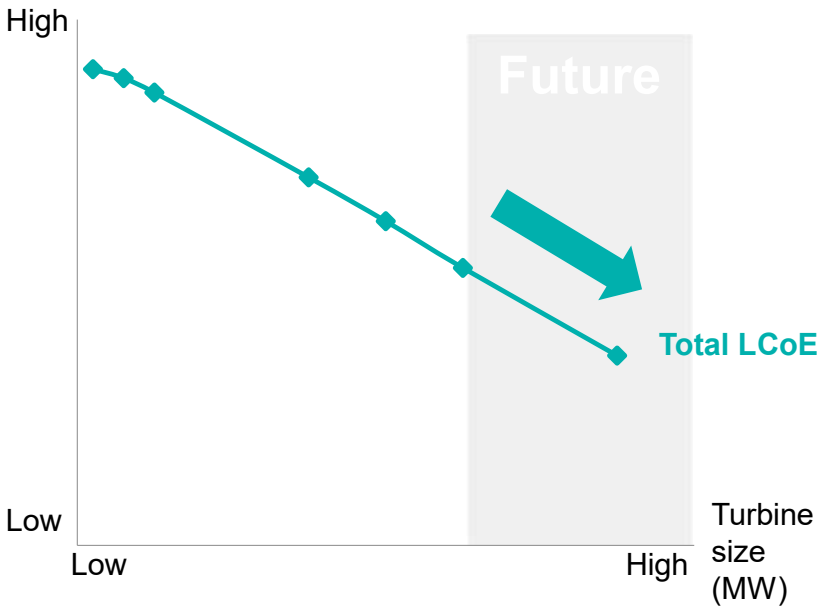
Even if turbine costs are higher than for the predecessors, project costs are lower than ever

WTG cost and additional project costs (EUR/MWh)*



Total Project Cost: Turbine cost and additional project costs combined (EUR/MWh)*



Turbine design will be driving down the additional project cost. Additional levers for cost reduction: 1. #WTG per Park, 2. Digitalization; 3. Volume

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The Brande Hydrogen test site went from investment decision to first test-run in 10 months.
The WTG is directly connected to the electrolyzer to be able to test island-mode operations

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Brande Hydrogen Test site – Regulatory Test-Zone awarded 05.05.2021

On 5 May 2021, the Danish Energy Agency has granted GreenLab and Siemens Gamesa's Brande Hydrogen project status as official regulatory test zones.

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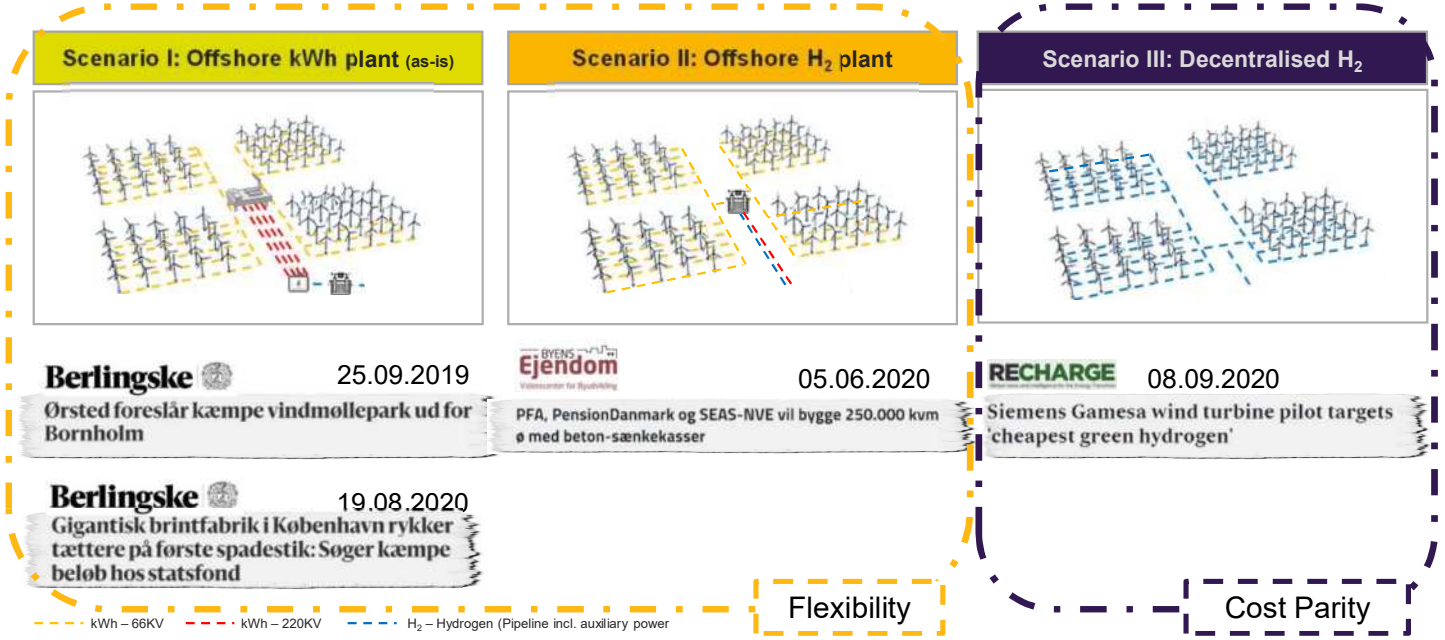
Offshore wind is key to get the scale needed - The three ways to go from electron to molecule



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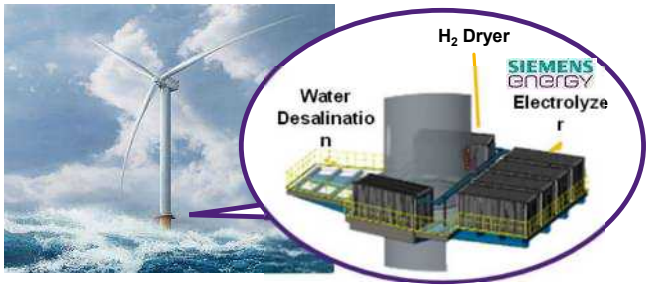
SGRE already taking significant steps in shaping the industry: Decentralized offshore solution

Offshore decentralized solution description



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Wind turbine

Modified WTG to produce H_2 at turbine level

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Electrolyzer

Plug & play containerized solution on a platform located at sea level

Advantages taking us to Cost-Parity

- **High utilization of off-grid electrolyzer**
- **Electrical CAPEX savings**
- **Cost-out through modularity in scale**

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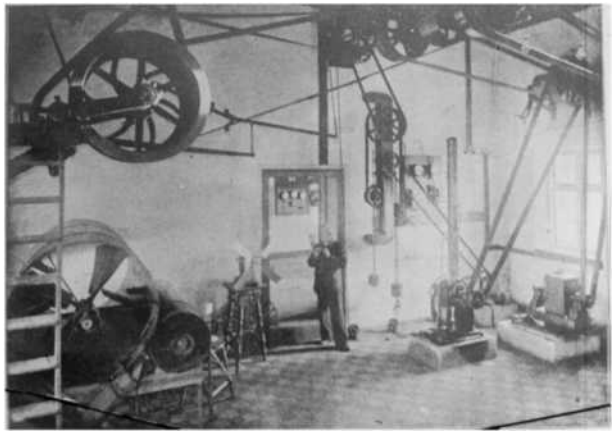
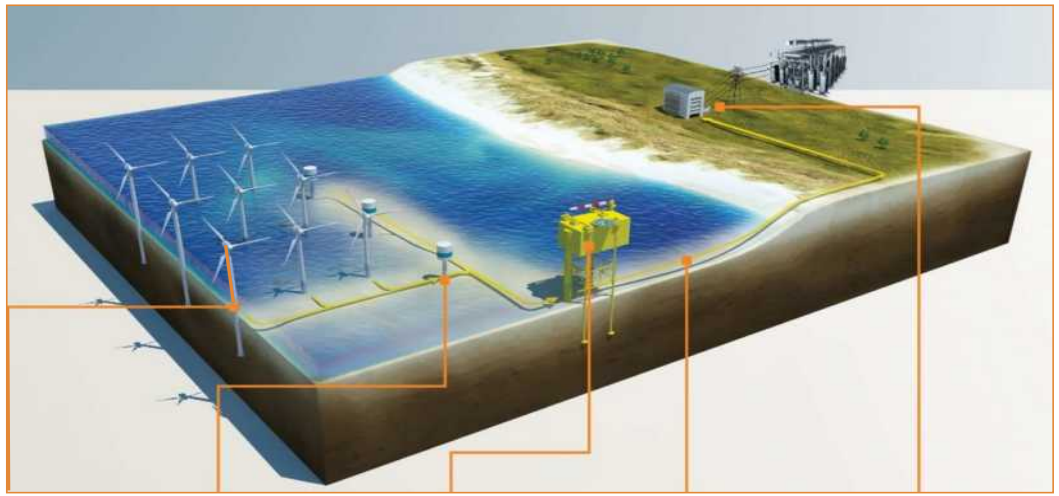
Poul La Cour's first test turbine in 1891 became a hydrogen production unit already in 1894.

Poul La Cour's 1891 test turbine was in 1894 connected to an Electrolyzer array from the Italian inventor Pompeo Garuti. The turbine would pull a dynamo which powered water separation in 10 electrolysis chambers in the basement.

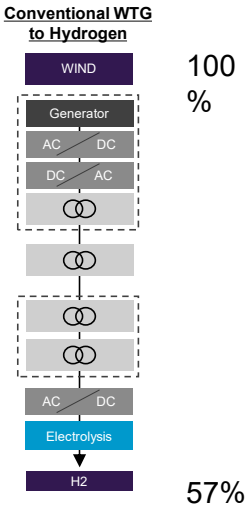


Picture: Steffen M. Søndergaard, 2002: Poul la Cours forsøgsmolle og mølleforsøgene i Askov, p. 35 & Poul La Cour Museet Introduktion, 2012, p. 6 & 18.

120 years later we have achieved scale of our wind resources by going offshore…



WTG Transformer steps | Array Cables | OF Substation | Export Cable | ON Substation & Grid



100 %

57%

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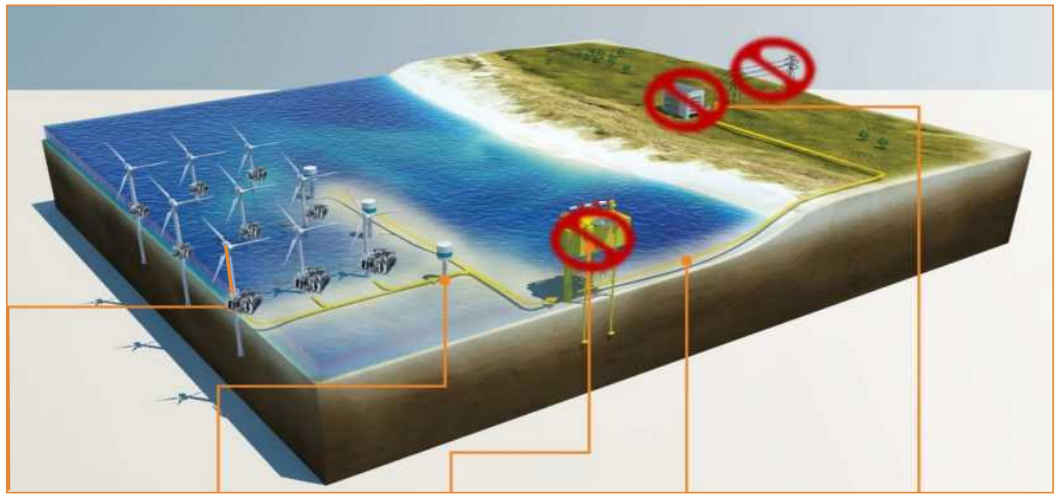
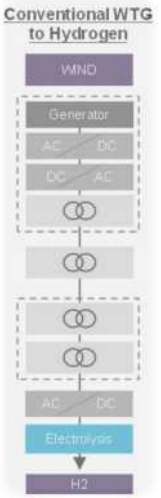
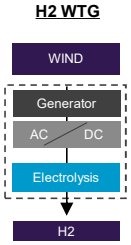
Our concept follows the original logic – Move conversion as close to the source as possible. This lowers conversion losses, minimizes the disturbance to wildlife and people.



WTG Transformer steps | Array Cables Pipes | ~~OF Substation~~ | Export Cable Pipe | ~~ON Substation & Grid~~





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SG DD-222 / 236 Product Development

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Blade factory in Aalborg, Denmark (April 2021)
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NORTH SEA YARD
ROTRA MARE
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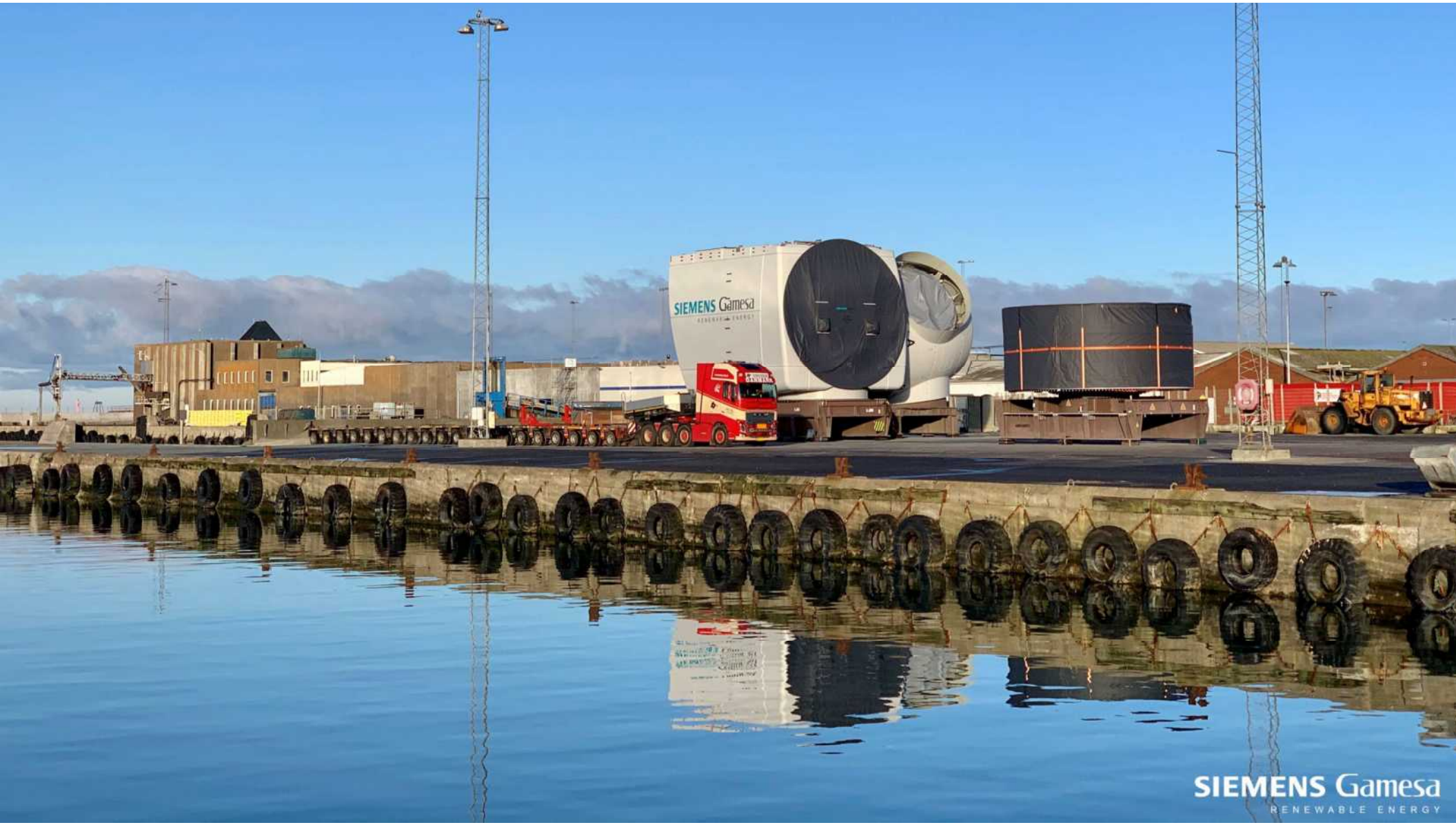
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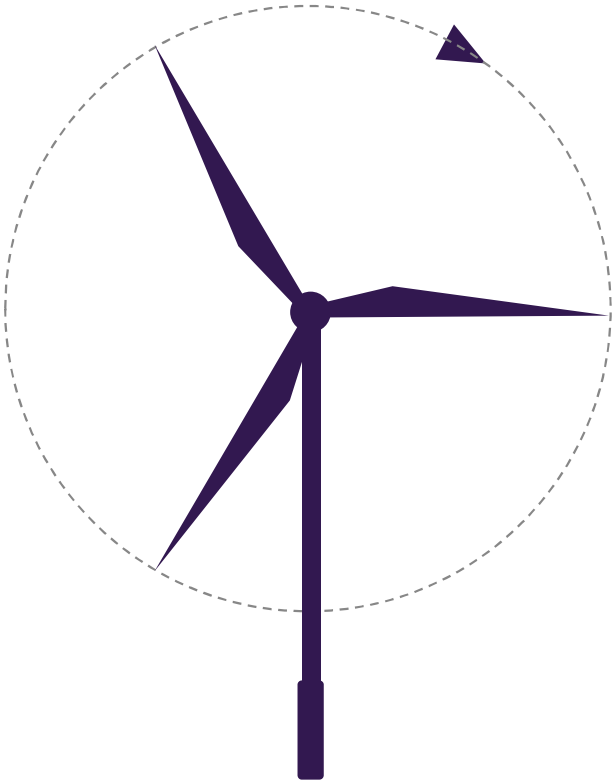
30 years of development…

How much energy is produced by one revolution?



"One single rotation of a modern offshore wind turbine produces sufficient energy to supply an average household by electricity for a one day".

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Swept area 38.700 m²

5 x

~470 tons/s of air through rotor at 10 m/s

12 x

Energy Production

15.000 x

Wind load in blade root

~4 km Stick

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Thank you!

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