Offshore Wind Energy: A vision for the future

Feargal Brennan, 08 July 2020

University of Strathclyde Engineering

Presentation Overview

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- The energy and climate change context
- Offshore Wind in the UK and Europe today
- Challenges and learning
- Future projections and trends for Offshore Wind
- Offshore Wind Structures and Opportunities
- Summary and Conclusions

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Energy: The Fundamentals

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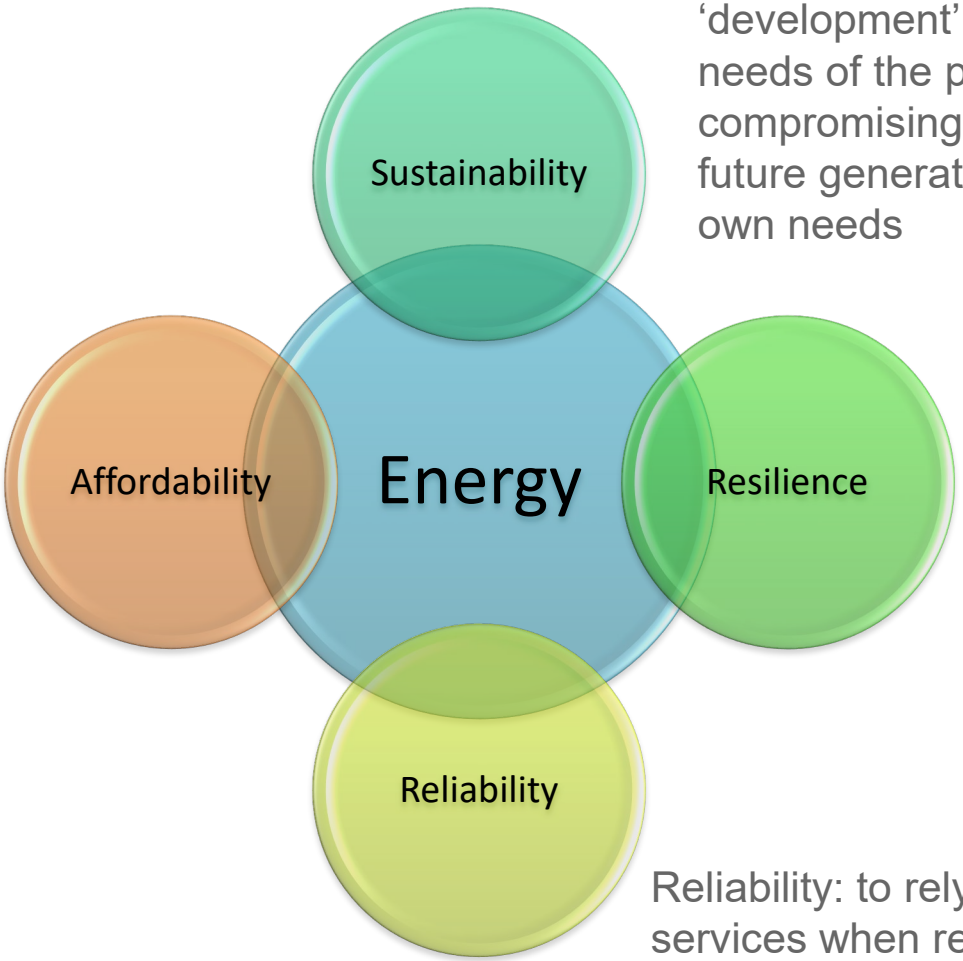


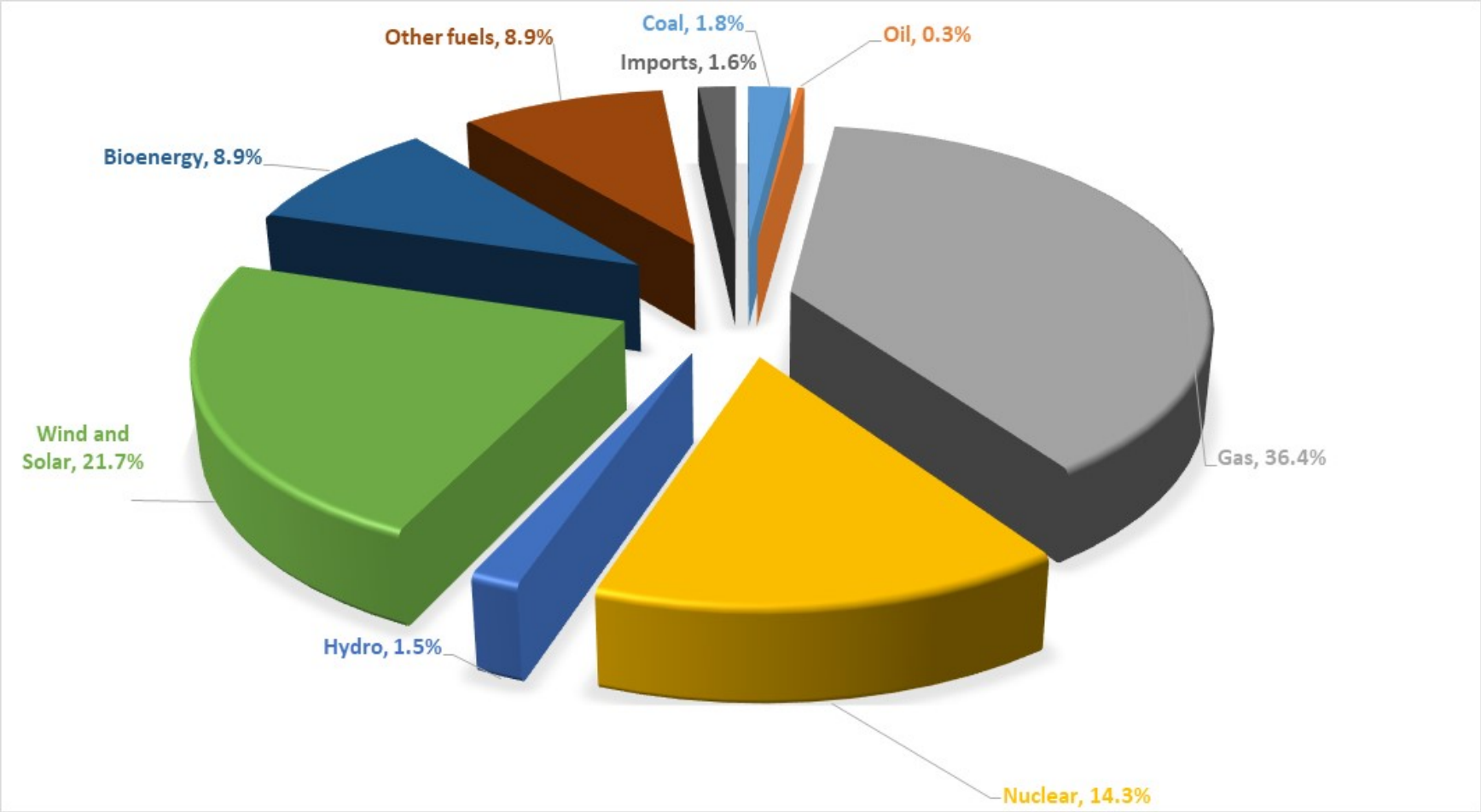
'development' that meets the needs of the present without compromising the ability of future generations to meet their own needs

Affordable energy at a level that allows economic growth and maintains standards of living.

Resilience is the ability of the system to cope with shocks and change.

Reliability: to rely upon energy services when required.

UK Electricity Generation 2019



Source: BEIS, Energy Trends, 2020

Wind Power in the UK: The Numbers

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19.7%	17.4m	£17.5bn
of UK's total Electricity (2019)	Homes powered per year	Planned investment (2018-22)
10,790	23.3GW	28.3m
Wind turbines in operation	Operational capacity	Tonnes of CO2 saved per year

Onshore: 13.6GW
Offshore: 9.7GW

renewableUK
The voice of wind & marine energy

Offshore wind energy in the UK

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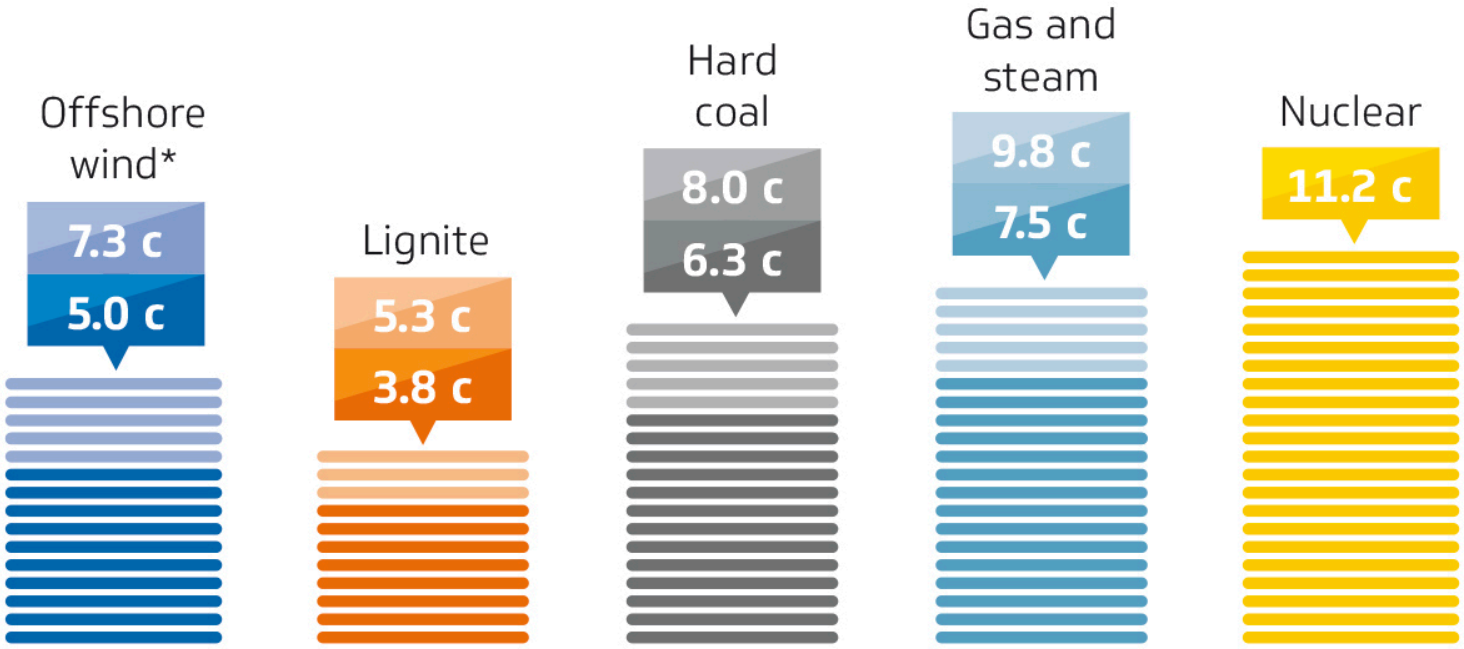
	TODAY	2030	2050
	7.9GW of generation capacity, providing c. 8.5% of the country's electricity	30GW of generation capacity, providing c. 35% of the country's electricity	50GW of generation capacity, providing c. 50% of the country's electricity
	c. 11,000 skilled jobs	c. 27,000 skilled jobs	c. 39,000 skilled jobs
£	£0.5 billion / year in exports	£2.6 billion / year in exports	£5.1 billion / year in exports

OffshoreWind IndustryCouncil

OFFSHORE PRICES MEASURE UP WELL



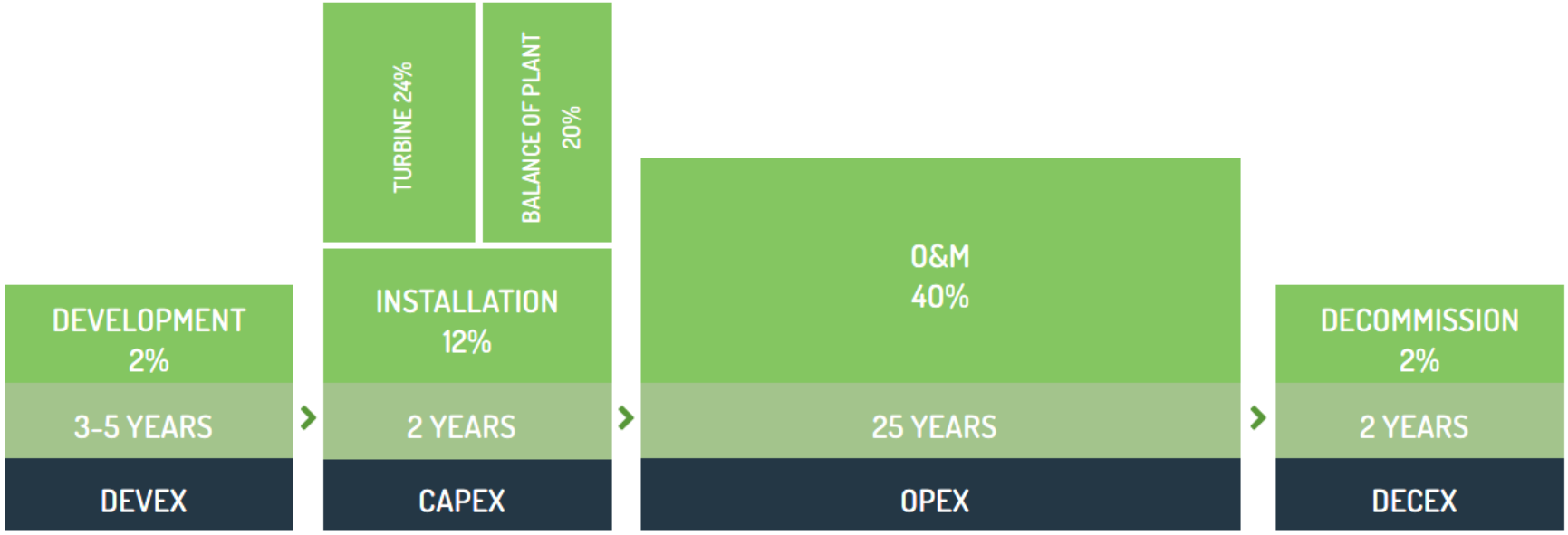
Cost of electricity for new plants in Germany (in c/kWh), for renewable and conventional sources
*Source: KfW, *offshore wind: auction results for start-up from 2020*

Infographics: Ahnen&Enkel

Changing names for a changing world…

equinor

Lifetime costs for a typical offshore wind farm



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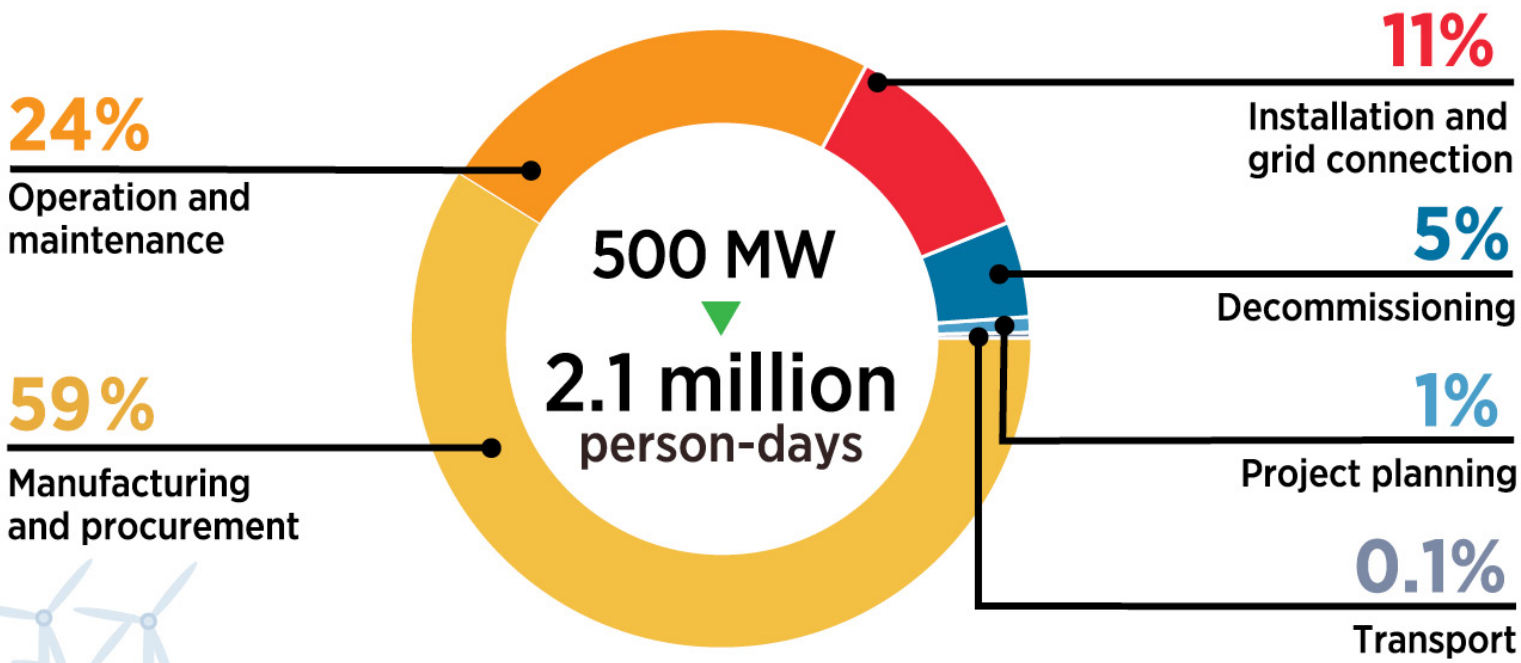
500 MW of offshore wind generates 2.1 million person-days of employment



CLYDE&CO

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AUGUST
07
2017

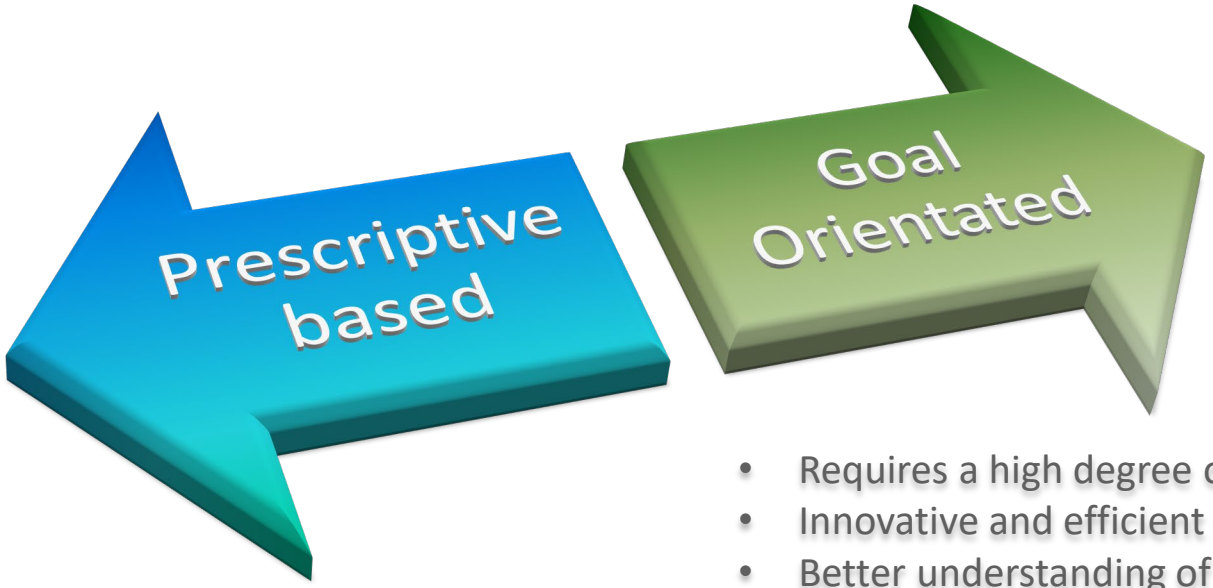
Robin Rigg Supreme Court decision

First published in Offshore Wind Journal - written by Mark Walsh, Mark de la Haye and John Dowlman

Why complying with an agreed international standard can still land you in stormy waters

In a decision that may come as a shock to many, and that will have potentially wide-reaching ramifications for English law contracts, the UK Supreme Court has overturned the Court of Appeal's decision in the long-running Robin Rigg offshore wind farm dispute, by finding in favour of E.ON Climate & Renewables (E.ON).

Approaches to standardisation



- Simple to implement
- Low development costs
- Easy to regulate and legislate for
- Good protection against known risks

- Limits innovation
- Multiple project failures might occur

- Requires a high degree of competency
- Innovative and efficient solutions
- Better understanding of responsibilities
- Flexible and can significantly broaden supply base

- Heavily dependent on technical competence
- More difficult to verify conformity

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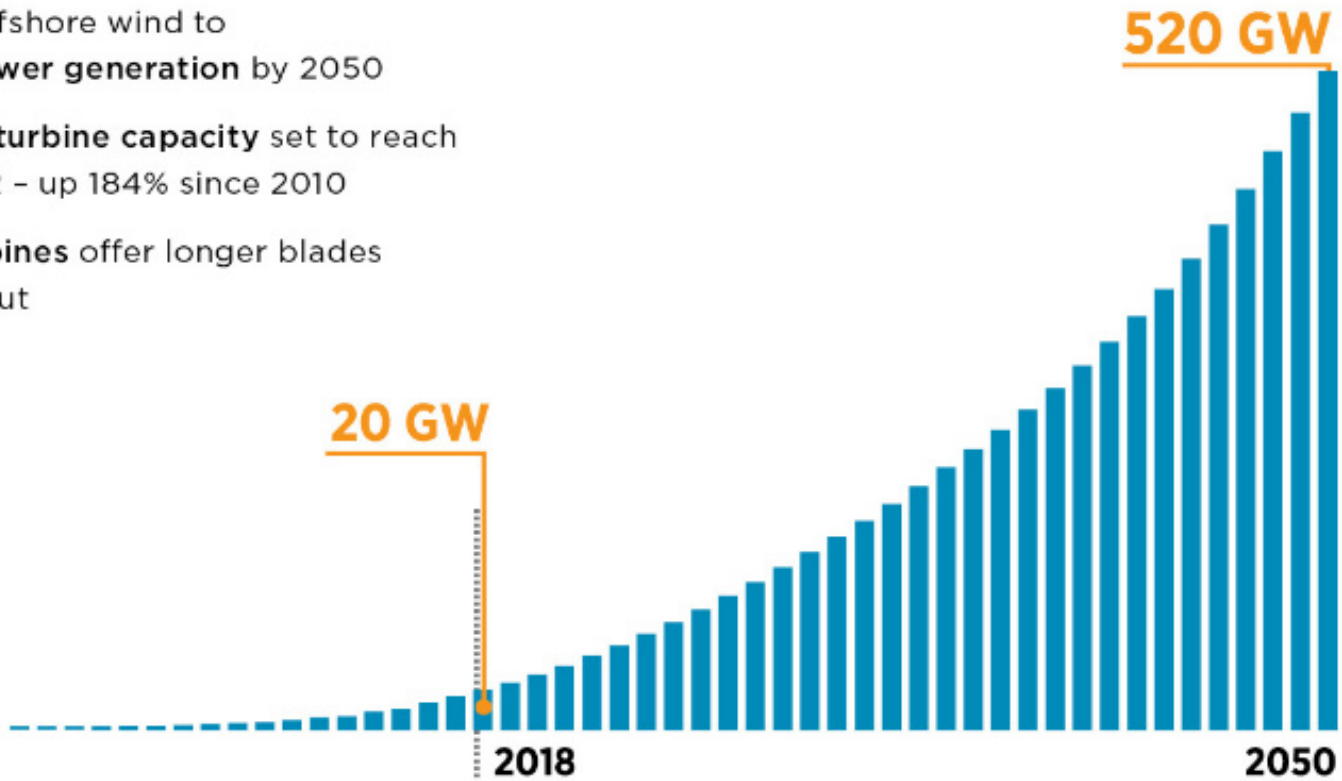
Offshore wind capacity set to reach 520 GW by 2050

- Could raise offshore wind to **4% of global power generation** by 2050
- Average **new turbine capacity** set to reach **8.3 MW** by 2022 – up 184% since 2010
- **Next-gen turbines** offer longer blades and higher output



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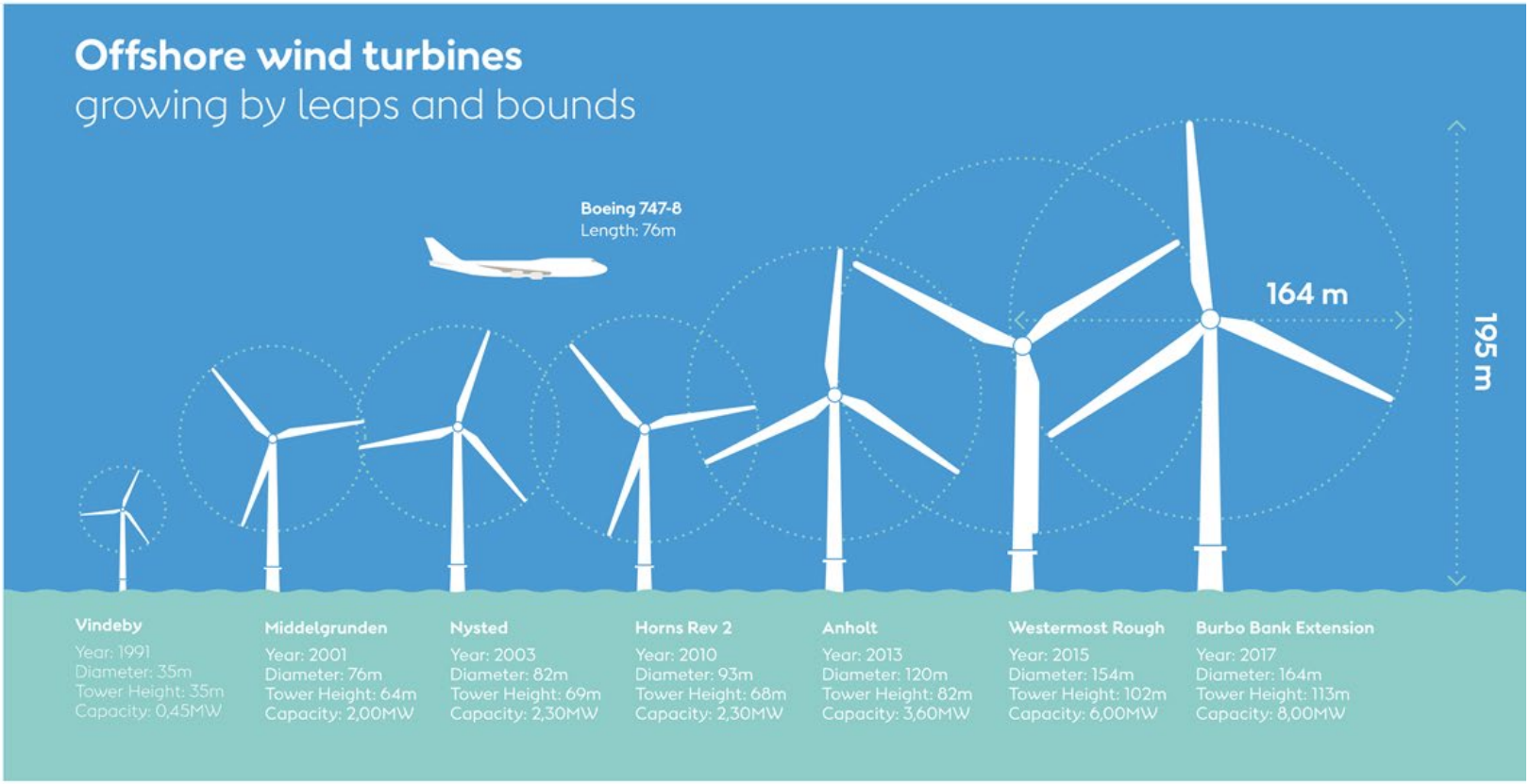
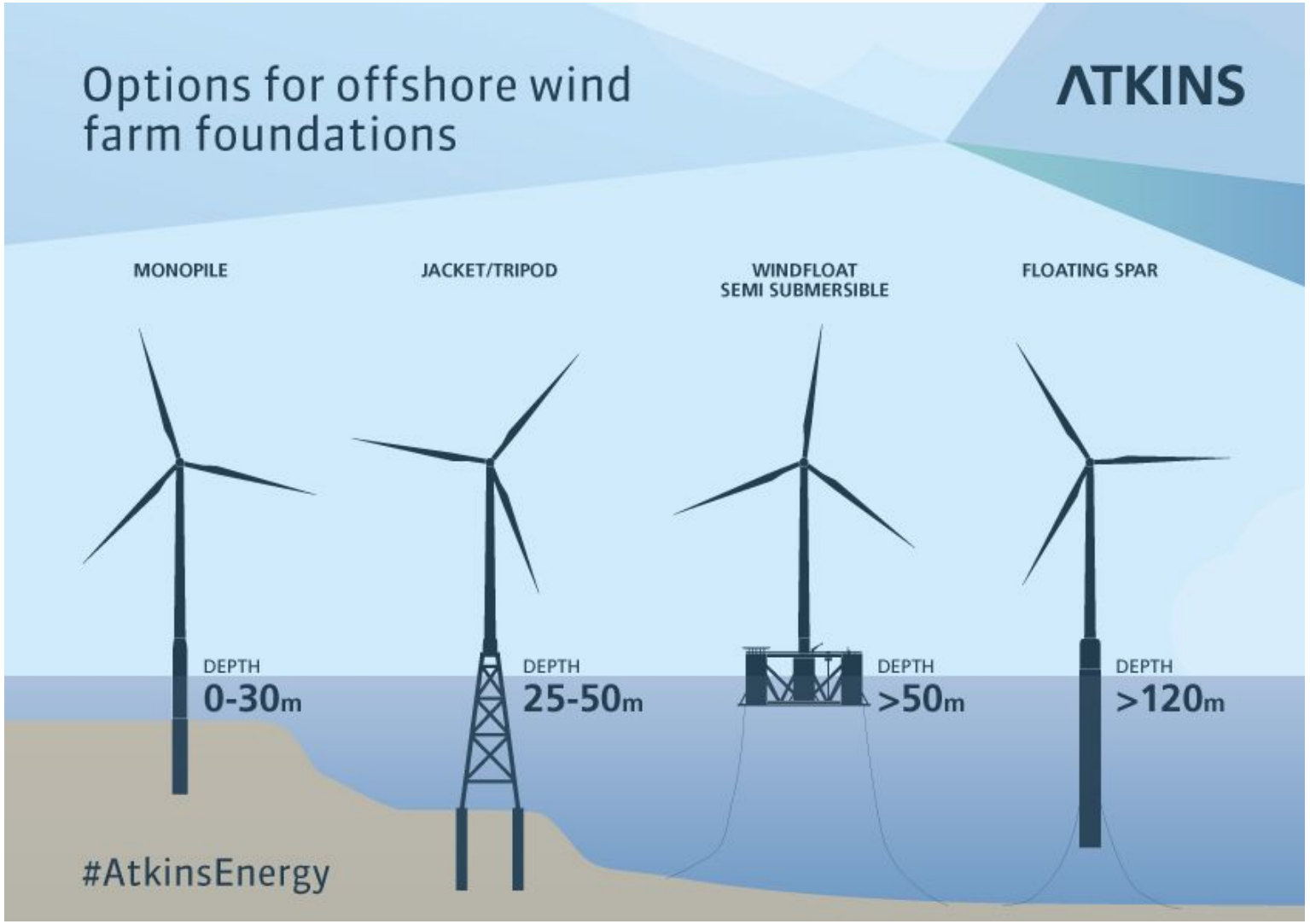
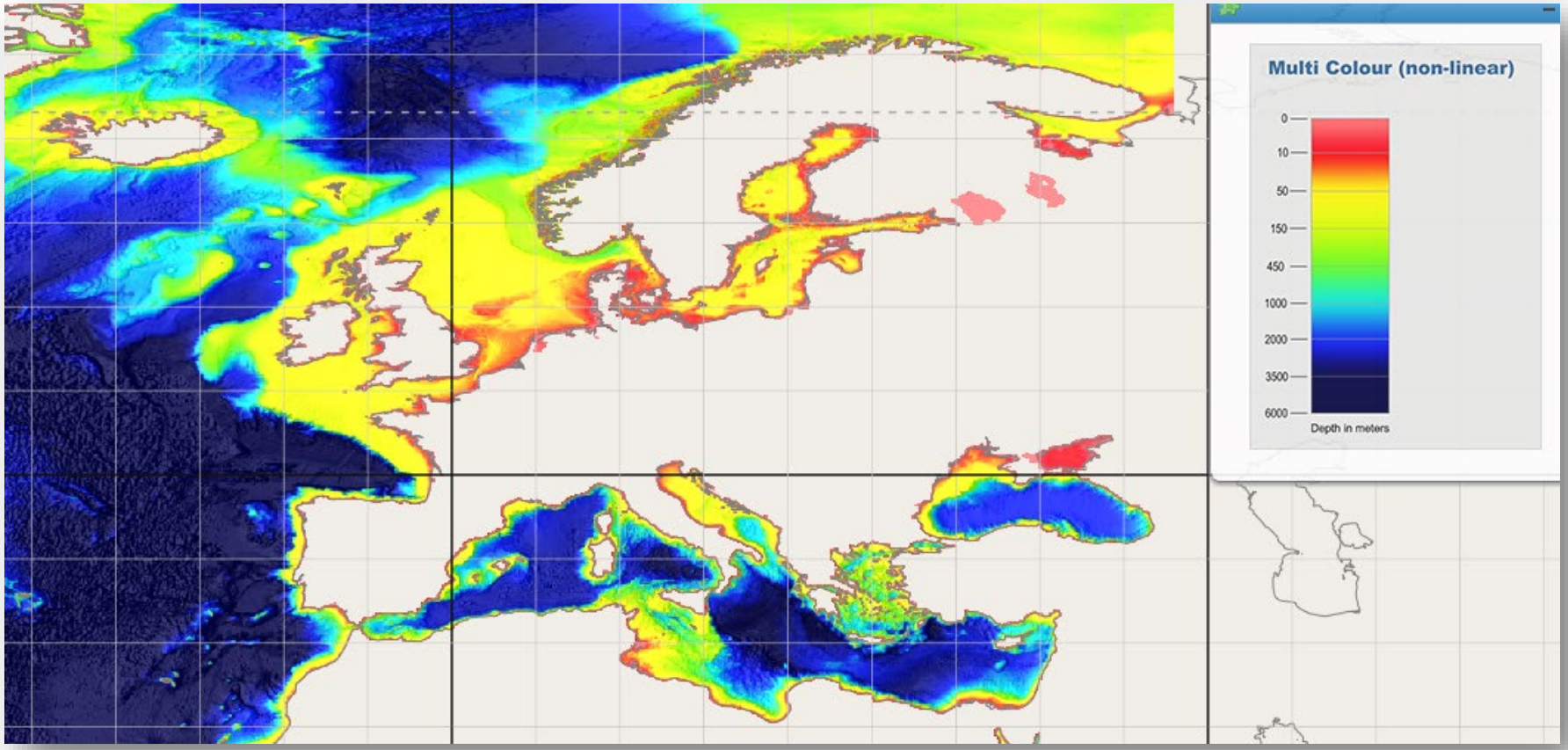


Haliade-X 12 MW


Options for offshore wind farm foundations
ATKINS
MONOPILE
JACKET/TRIPOD
WINDFLOAT SEMI SUBMERSIBLE
FLOATING SPAR
DEPTH 0-30m
DEPTH 25-50m
DEPTH >50m
DEPTH >120m
#AtkinsEnergy

European Water Depths



EMODnet
European Marine Observation and Data Network

USA Water Depths

Image Courtesy of Google Earth

A step change: Floating Wind

The World's first floating wind array

5 x 6MW Floating Spars installed in 2017 off Peterhead (Courtesy Equinor)

Floating Wind (Semi submersible)

(Courtesy WindFloat)

Floating opportunities

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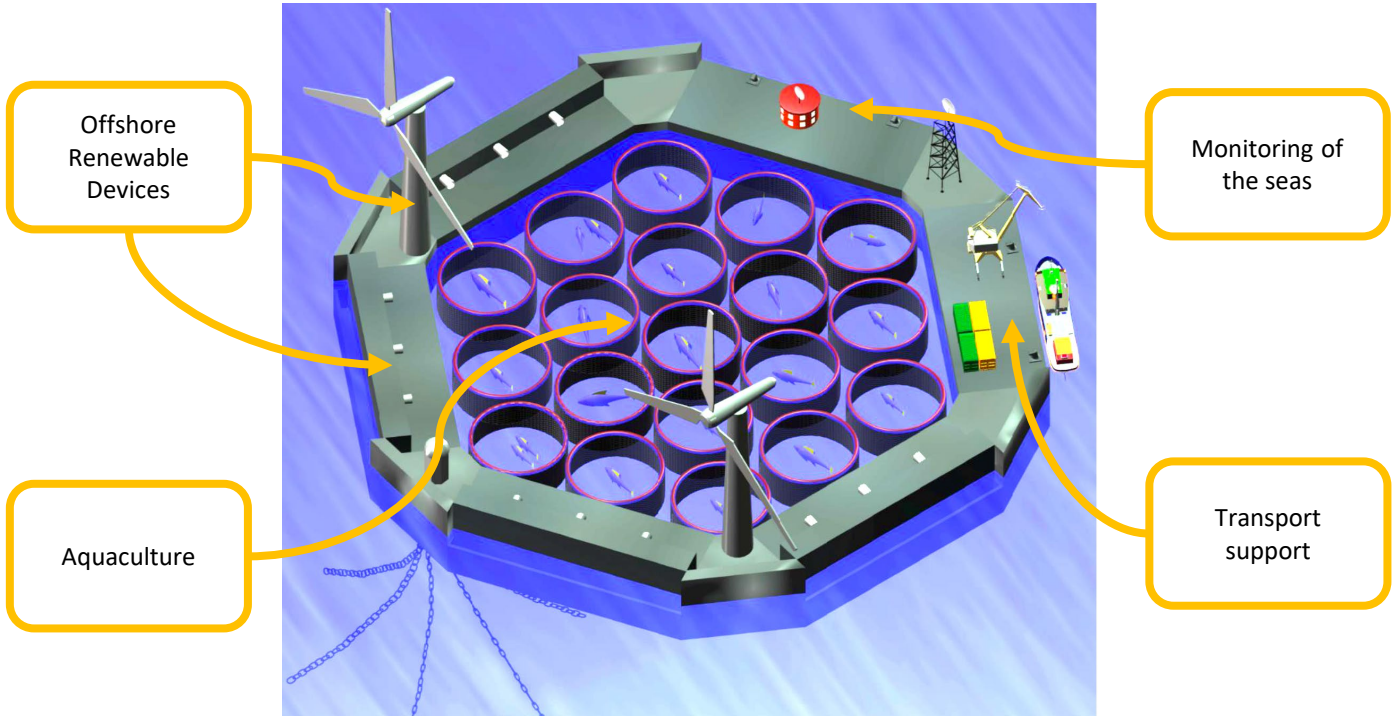
- Removing humans entirely from offshore installation, operations & maintenance?
- Integral unit deployment can significantly avoid offshore site assembly, high lifts etc. making all-year-round installation possible;
- Reversible moorings can mean major interventions and retrofits can be conducted in coastal/near-shore;
- Floaters and mooring systems can be designed to have significant damage tolerance;
- Floaters have no deep water depth limit.

Multi-Purpose Platform (MPP)



Multi-Purpose Platform (MPP) - Artist impression

Offshore Wind – Novel Concepts

The Aerogenerator X concept (Courtesy Wind Power Ltd and Grimshaw)

Multiple Rotors

(Courtesy Vestas)

HEXICON

The Power of Offshore Wind™
Managed Efficiently

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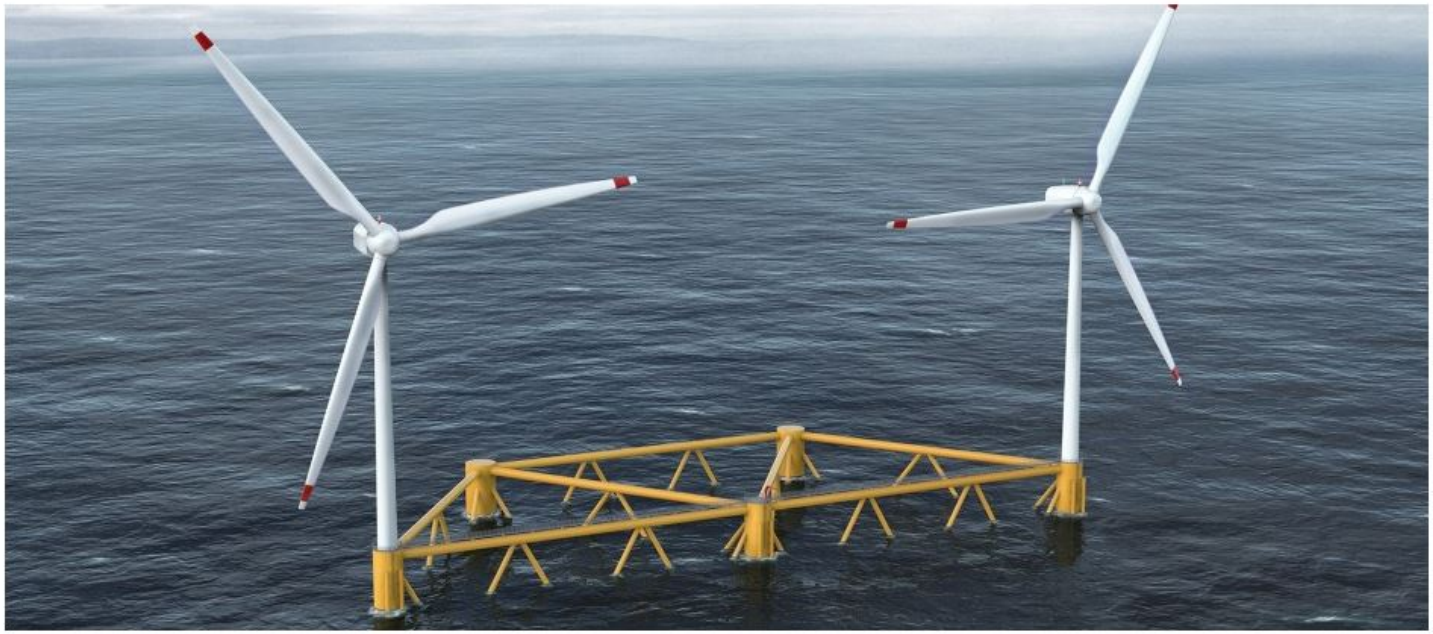

THE POWER OF OFFSHORE WIND - *For a clean and sustainable future*

Hexicon is a Swedish Design and Engineering house developing floating multi-turbine platforms. Our patented technology enables the platform to align with the wind direction, maximising energy yield from free wind for its turbines. This enables efficient harvesting of the best offshore energy resources further offshore in deeper waters.

EXECUTIVE SUMMARY

Curtailment

gtm: Solar Grid Edge Storage Wind Trending Podcasts White Papers Webinars

GRID EDGE

UK Struggles With Sagging Power Demand and Surging Renewables

Curtailment of U.K. wind farms surged as COVID-19 lockdowns depressed power demand. More batteries on the grid would help, but how?

JOHN PARNELL | JUNE 10, 2020

The Pen y Cymoedd wind farm in Wales.

Smart electric vehicle charging and other flexibility services could have saved British ratepayers £133 million ($104 million) this summer, power companies claim, as the U.K. grapples with surging renewables output.

Low electricity demand during the COVID-19 lockdown and ever-increasing wind and solar capacities have seen U.K. power prices collapse this year — and curtailment costs soar. A pair of public holidays in May exacerbated the problem, sending power demand even lower.

National Grid ESO, the U.K. system operator, expects to spend an additional £500 million to balance the grid over the course of this summer, much of it in the form of payments to wind farms to stop generating. In total, National Grid expects to spend £826 million to balance the grid in the period May to August.

A host of power companies, including major suppliers Centrica and E.ON, sent an open letter this week calling on National Grid to accelerate the deployment of smart EV charging infrastructure, energy storage and other flexibility services, allowing homeowners to make their own contribution to the energy transition and perhaps share in the profits along the way.

"National Grid ESO, the U.K. system operator, expects to spend an <u>additional £500 million to balance the grid over the course of this summer, much of it in the form of payments to wind farms to stop generating</u>. In total, National Grid expects to spend £826 million to balance the grid in the period May to August."

Green & Blue Hydrogen

Table 2.1 Summary of net-zero implications for energy system infrastructure

System-wide aggregation	Implications	Assessment of feasibility
Electricity use in 2050: 594 TWh (300 TWh in 2017)	• Generation required: 645 TWh • Peak demand: up to 150 GW • Generation capacity build rate: 9-12 GW p.a.	Requires increase in deployment of baseload and variable low-carbon power, and development of CCS and hydrogen infrastructure.
Hydrogen use in 2050: 270 TWh (27 TWh in 2017)	• Production capacity in 2050: 29 GW of advanced methane reformation plant and 6-17 GW of electrolyser capacity (depending on load factor). • Production capacity build rate: 2-3 GW p.a.	Requires low-carbon hydrogen production at scale from advanced methane reformation, as well as some electrolysis. Will also require hydrogen gas grids, or alternative transportation infrastructure, and development of CCS infrastructure.
Carbon captured and stored in 2050: 176 $MtCO_2$ (0 in 2017)	CCS infrastructure required for decarbonisation across the economy: • Hydrogen production: 46 Mt • Power generation: 57 Mt • BECCS: 35 Mt • Industry: 24 Mt • Biofuel production: 9 Mt	Requires CCS transportation and storage infrastructure at scale by the 2030s.

Source: CCC analysis.
Notes: Methane reformation is assumed produce 0.8 units of hydrogen per unit of natural gas input (80% efficiency) and capture 95% of process CO_2. Electrolysers are assumed to produce 0.74 units of hydrogen per unit of electricity input (74% efficiency), and run at load factors of 30-90%. Estimates for CCS in power and hydrogen should be considered upper bounds.

Innovative solutions with multi-purpose offshore platforms

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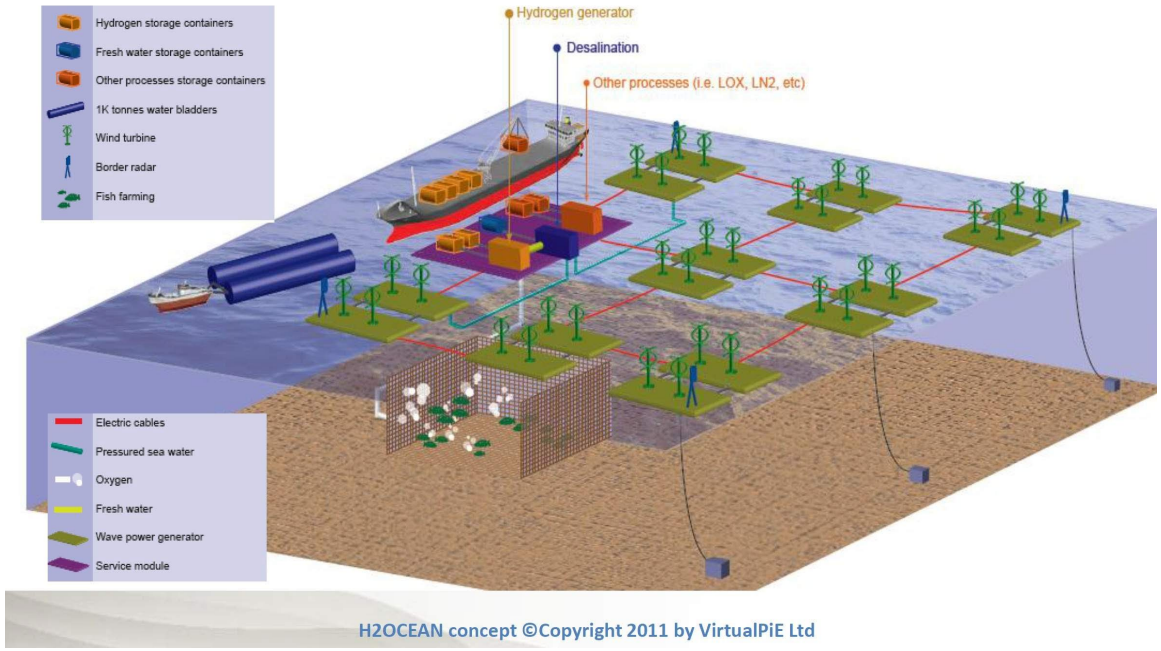
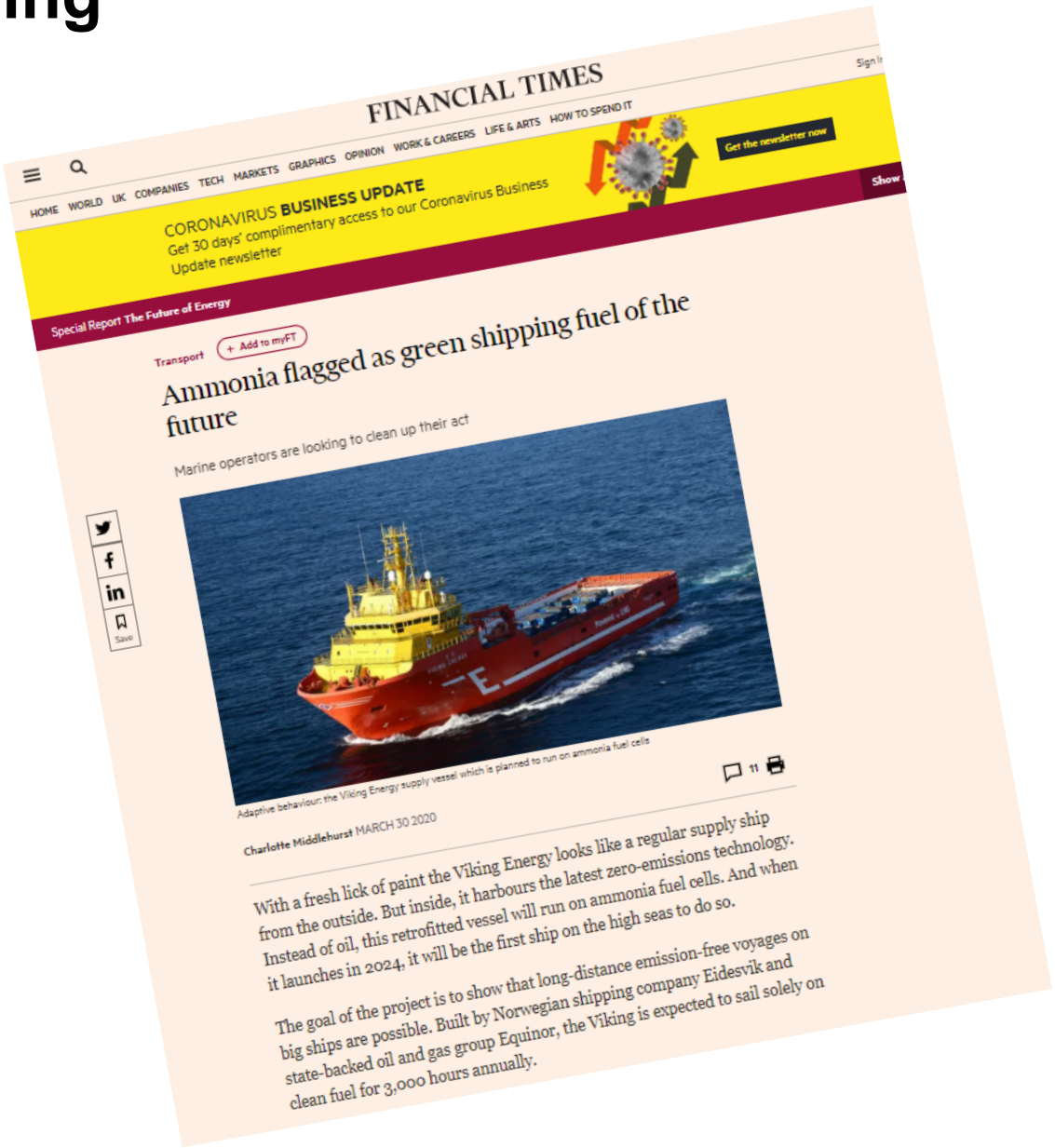
- Designs at a conceptual level
  - Production of hydrogen through water electrolysis,
  - Production of ammonia
  - Production of aquaculture (fish, shellfish, sea weeds, etc.).



Whole energy system: Low carbon shipping



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Ammonia flagged as green shipping fuel of the future

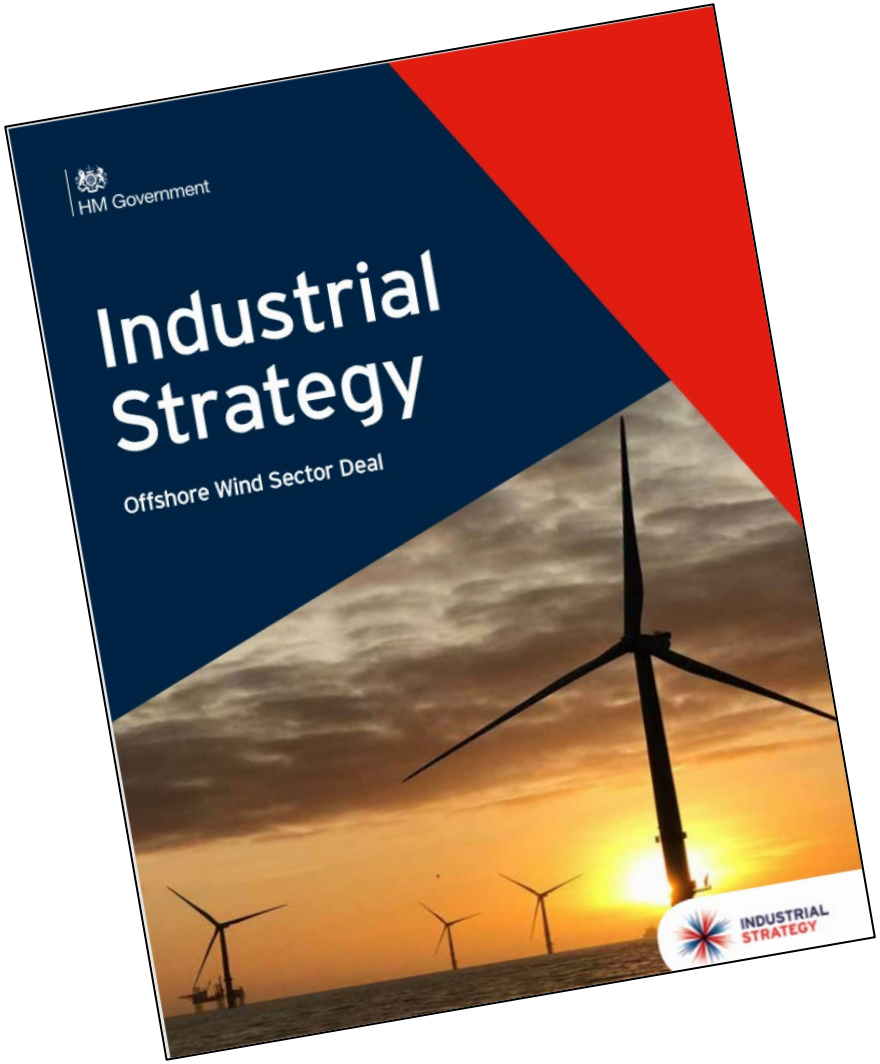
Marine operators are looking to clean up their act

Adaptive behaviour: the Viking Energy supply vessel which is planned to run on ammonia fuel cells

Charlotte Middlehurst MARCH 30 2020

With a fresh lick of paint the Viking Energy looks like a regular supply ship from the outside. But inside, it harbours the latest zero-emissions technology. Instead of oil, this retrofitted vessel will run on ammonia fuel cells. And when it launches in 2024, it will be the first ship on the high seas to do so.

The goal of the project is to show that long-distance emission-free voyages on big ships are possible. Built by Norwegian shipping company Eidesvik and state-backed oil and gas group Equinor, the Viking is expected to sail solely on clean fuel for 3,000 hours annually.



30GW by 2030

60% Local Content

33.3% Female

Blue Growth EU Strategy

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- http://ec.europa.eu/maritimeaffairs/policy/blue_growth/
- *"Blue Growth is the long term strategy to support* **sustainable growth** *in the marine and maritime sectors as a whole.*
- **Seas and oceans** *are drivers for the European economy and have great* **potential for innovation and growth***.*
- *It is the maritime contribution to achieving the goals of the Europe 2020 strategy for smart,* **sustainable** *and inclusive growth."*

So, where's the Future?

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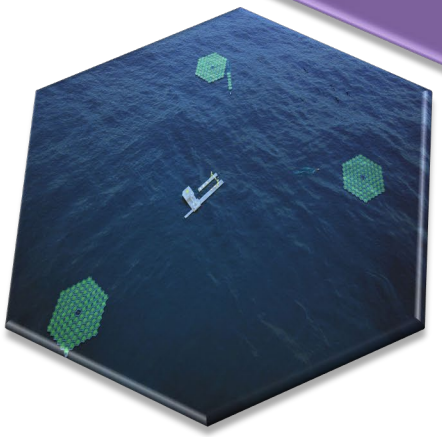
- Larger floating deeper water wind platforms;
- Shallow water deployment and maintenance;
- New turbine technologies including multiple rotors and optimal farm configurations;
- Safety i.e. ultimately human-free, autonomous installation, operation and maintenance;
- Non grid-connected - far offshore liquid fuel generating plants;
- Resilient energy system: Energy storage and a diverse balanced portfolio of resources and technologies.

Future Direction and Initiatives

Safety of Offshore Systems – fully autonomous offshore operations.

Standards and Guidance based on cotemporary and emerging technologies – supporting local capabilities.



Future offshore structures and systems for energy (electricity & fuels) and aquaculture.

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