energy technologies institute

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Offshore Wind – Floating Turbines

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What is the ETI?

- The ETI is a public-private partnership between global energy and engineering companies and the UK Government.
- Targeted development, demonstration and de-risking of new technologies for affordable and secure energy
- Shared risk

ETI members

bp

CATERPILLAR®

EDF ENERGY

Rolls-Royce

Department for Business, Energy & Industrial Strategy

EPSRC Pioneering research and skills

Innovate UK Technology Strategy Board

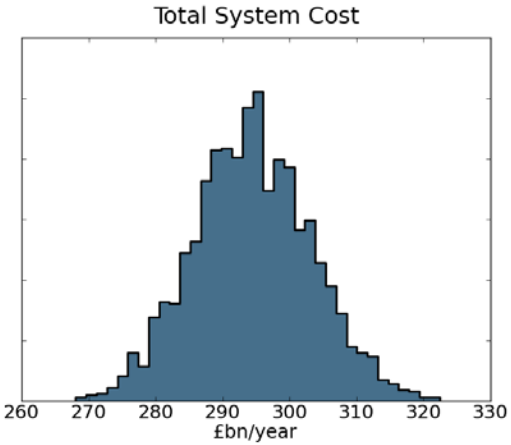
ETI programme associate

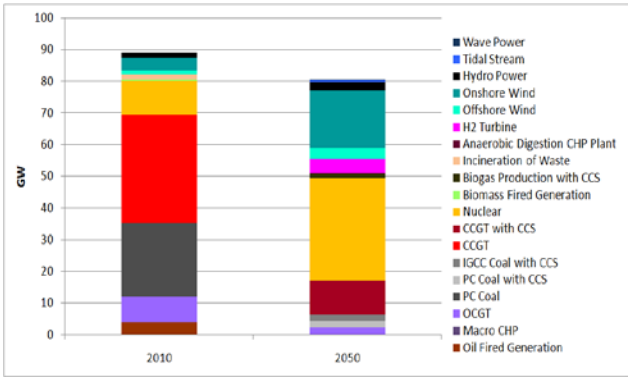
HITACHI Inspire the Next

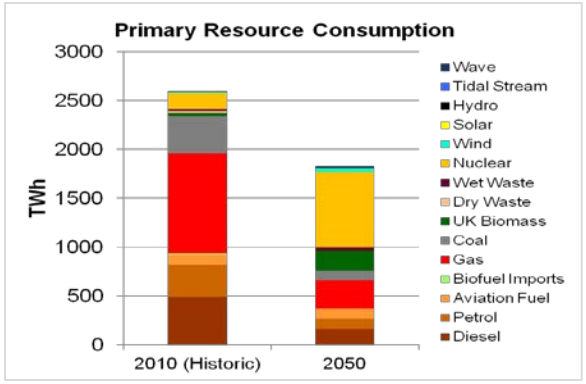
ESME – ETI's system design tool

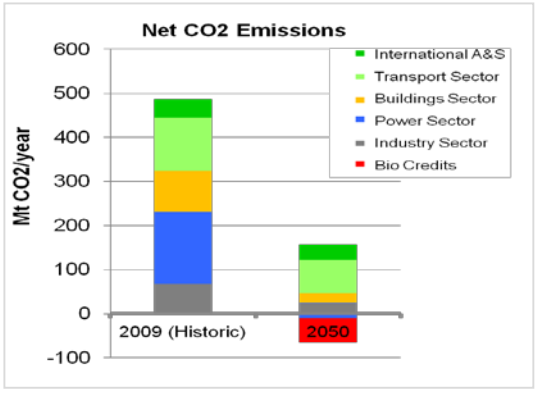
integrating power, heat, transport and infrastructure
providing national / regional system designs

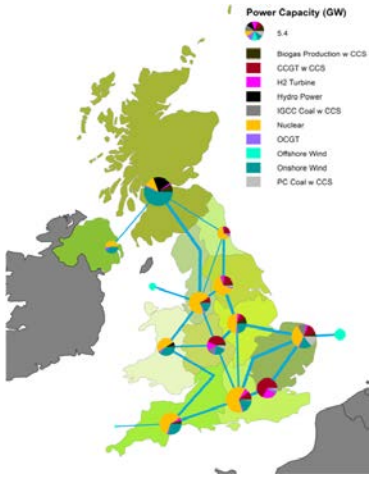
ESME
Energy System Modelling Environment

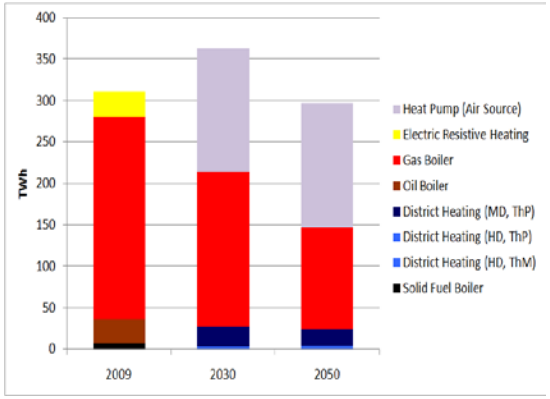










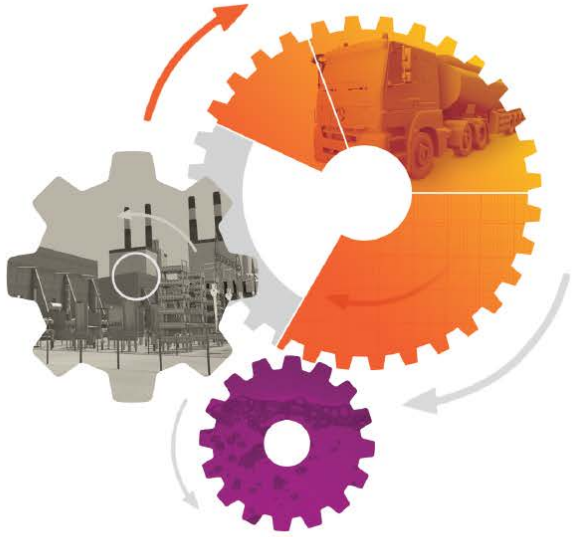


ESME example outputs

Energy System Scenarios

- **Clockwork**

- 2050 electricity capacity ~ 130GW
  - 20GW Offshore Wind
  - 15GW Onshore Wind
  - 10GW Other renewables



- **Patchwork**

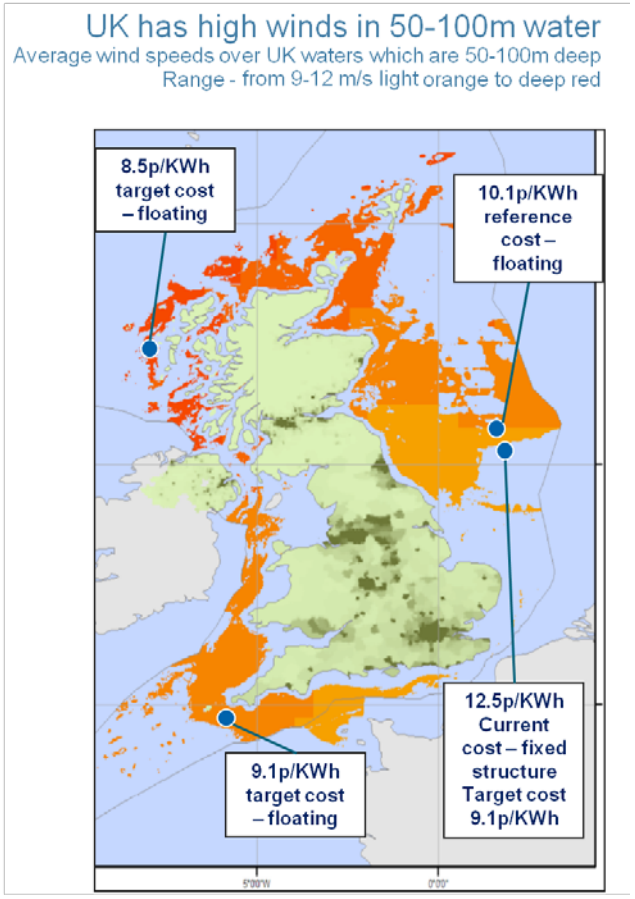
- 2050 electricity capacity ~190GW
  - 55GW Offshore wind
  - 20GW Onshore wind
  - 45GW Other renewables

Offshore Wind

The marginal power technology and an important hedging option – cost reduction is critical

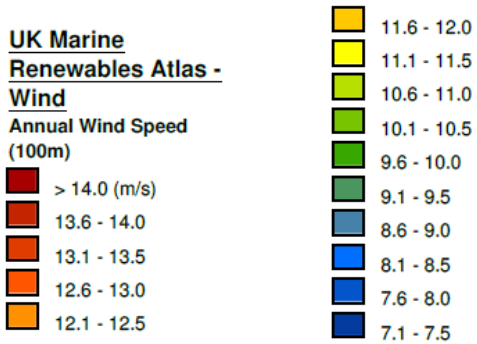
- DECC cost reduction task force has identified routes to achieving £100/MWh by 2020 –
  - Contract and project structures
  - Financing and risk management
  - Technology innovation
- ETI has already invested £40m in technology development projects to target further cost reductions
- ETI has launched £30m of new projects to develop next generation, low cost, deepwater floating platform and very long blade turbine technology
- ETI Targeting ~£90/MWh post 2020 through applying these technologies in high wind speed areas off UK west coast

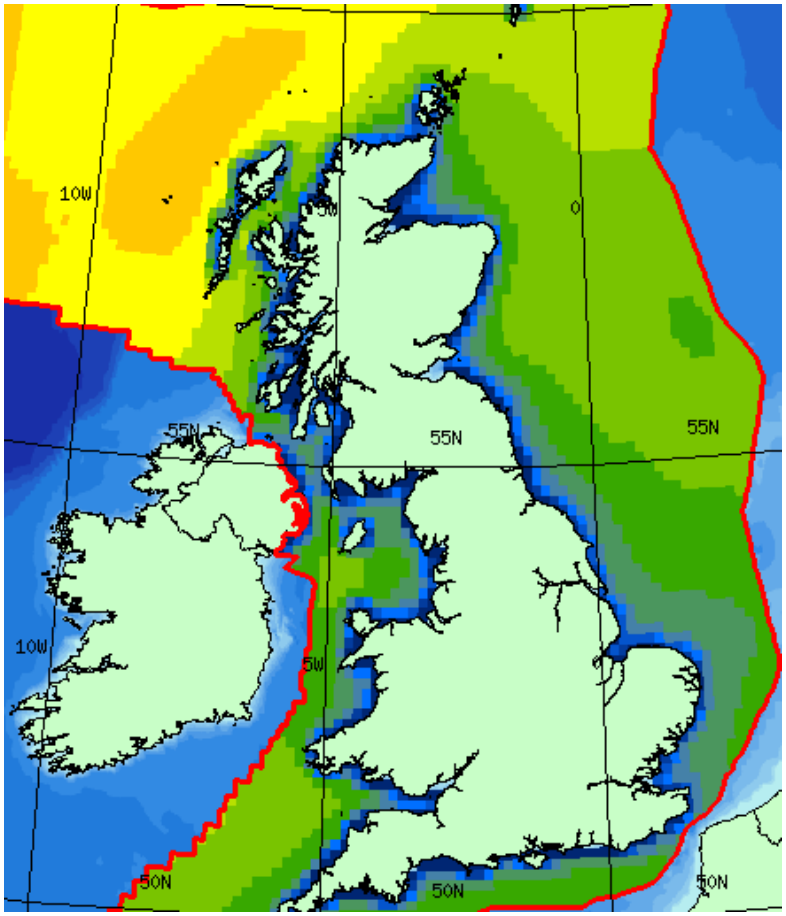
(£100/MWh = 10p/KWh, £90/MWh = 9p/KWh)



Offshore Wind

- For the lowest cost of energy
  - Windy sites
  - Close to shore
  - Effective energy conversion

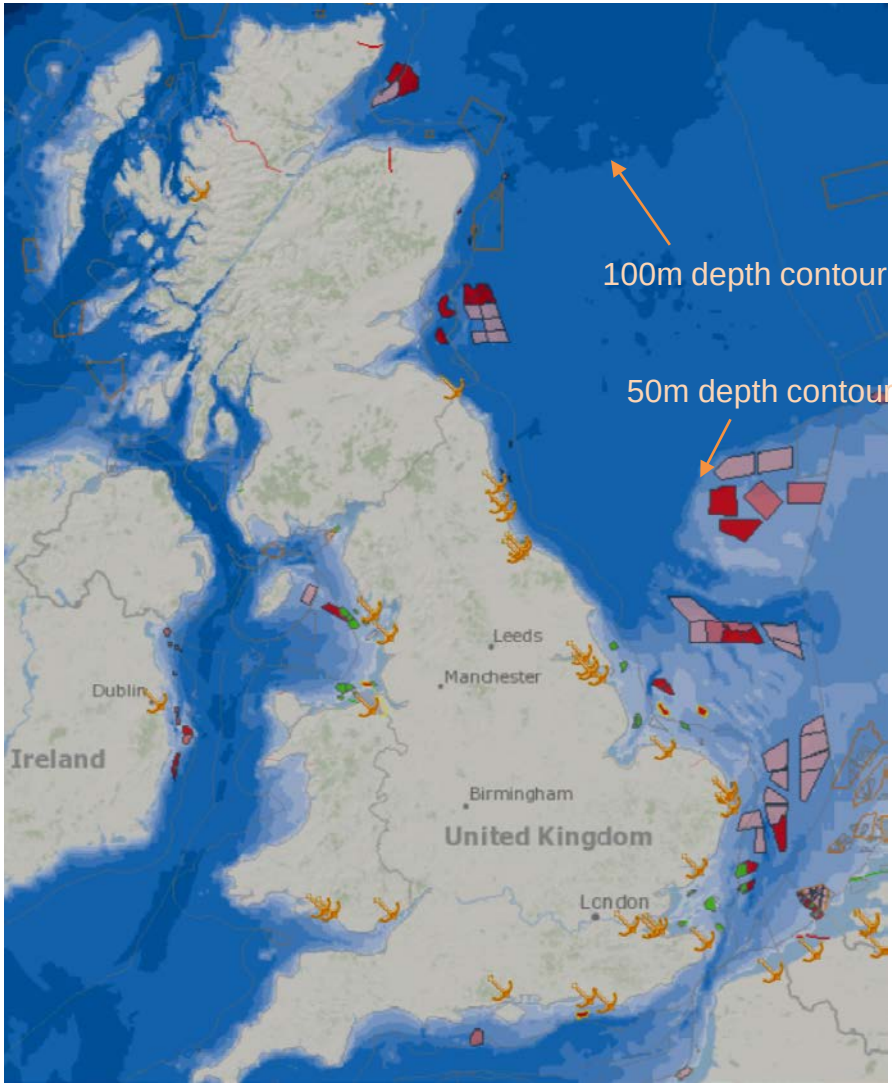




Source – Atlas of UK Marine Renewable Energy

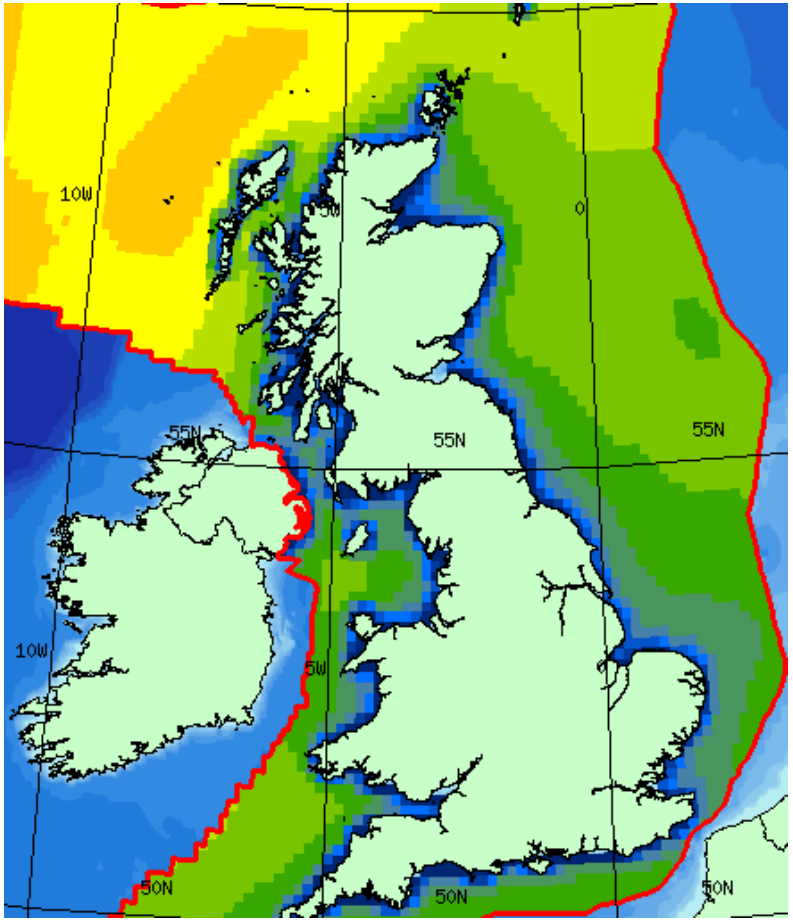
Water Depth

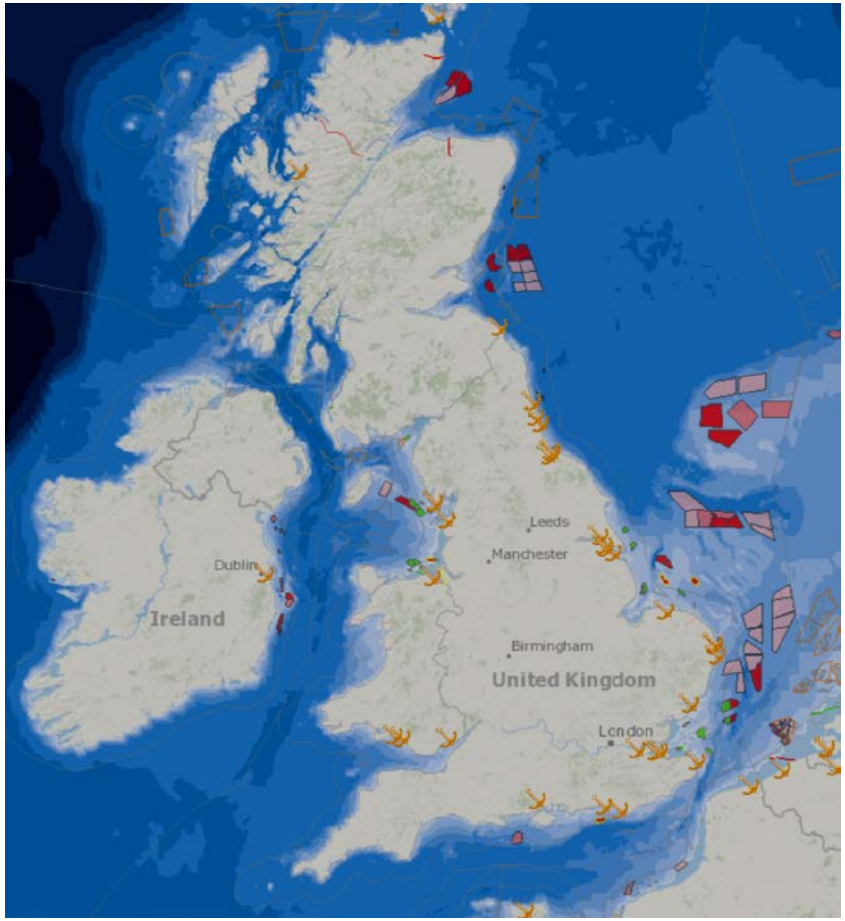
- Existing Arrays built in water less than 40m
  - On sandbanks
  - In low-wave areas



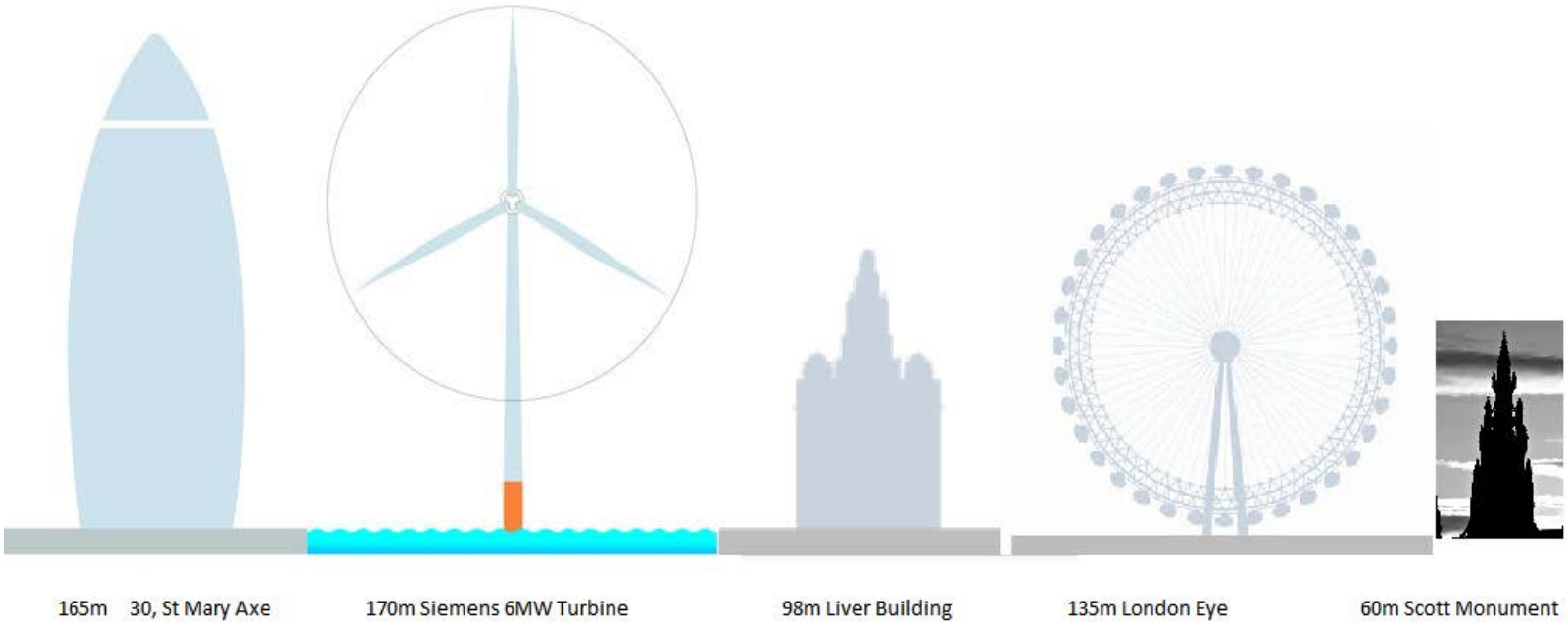
Source – Atlas of UK Marine Renewable Energy

Wind Resource and Water Depth Compared





Offshore Wind Turbines

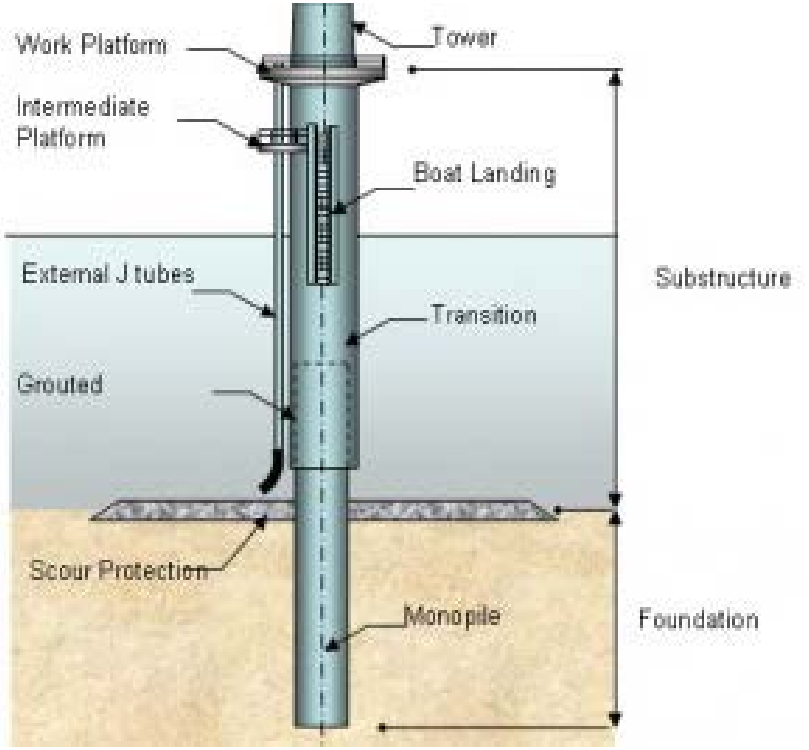


Courtesy of Dong Energy and Siemens Wind Power

Offshore Wind Turbines

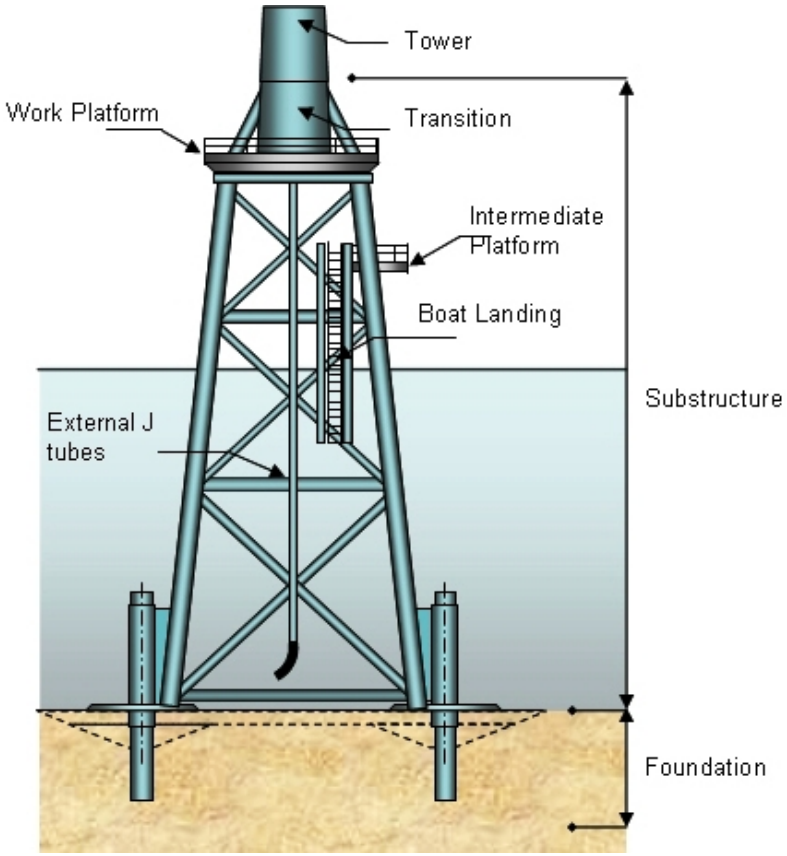
What do we use for Offshore Wind today?

- In shallow water, less than 35m
  - Monopile foundations



What do we use for Offshore Wind today?

- Jacket Structures
- Water more than 25m deep

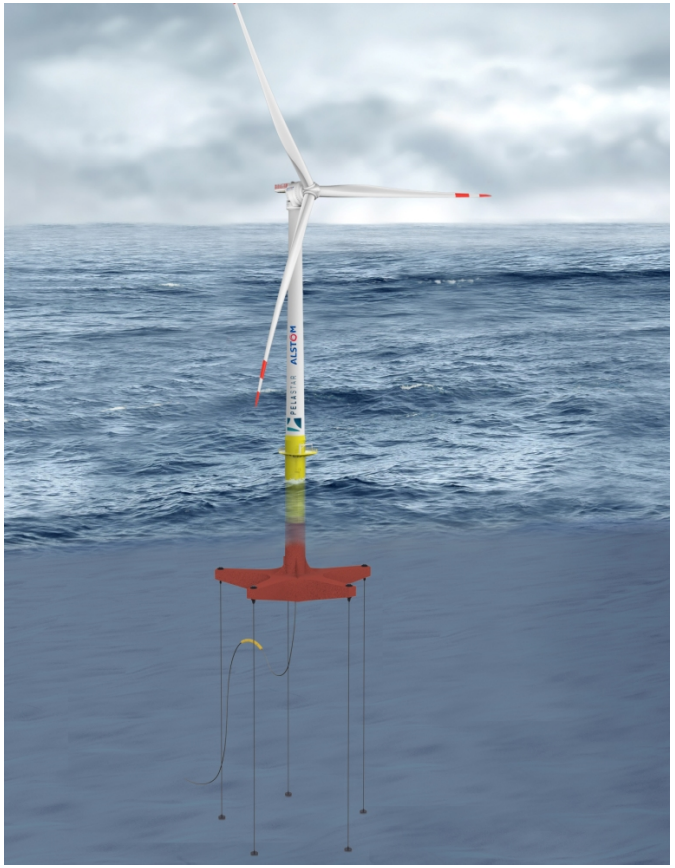


Foundation Types

Cost Drivers	Jacket	HyWind	WindFloat	*PelaStar*
Onshore Assembly	✗	✗	✓	✓
Lightweight Structure	-	✗	✗	✓
Turbine Performance	✓	✓	✗	✓
Siting Flexibility	✗	✗	✓	✓
Serial Production	✗	✓	✓	✓

Source: Glosten Associates

Floating Wind - Tension Leg Platform



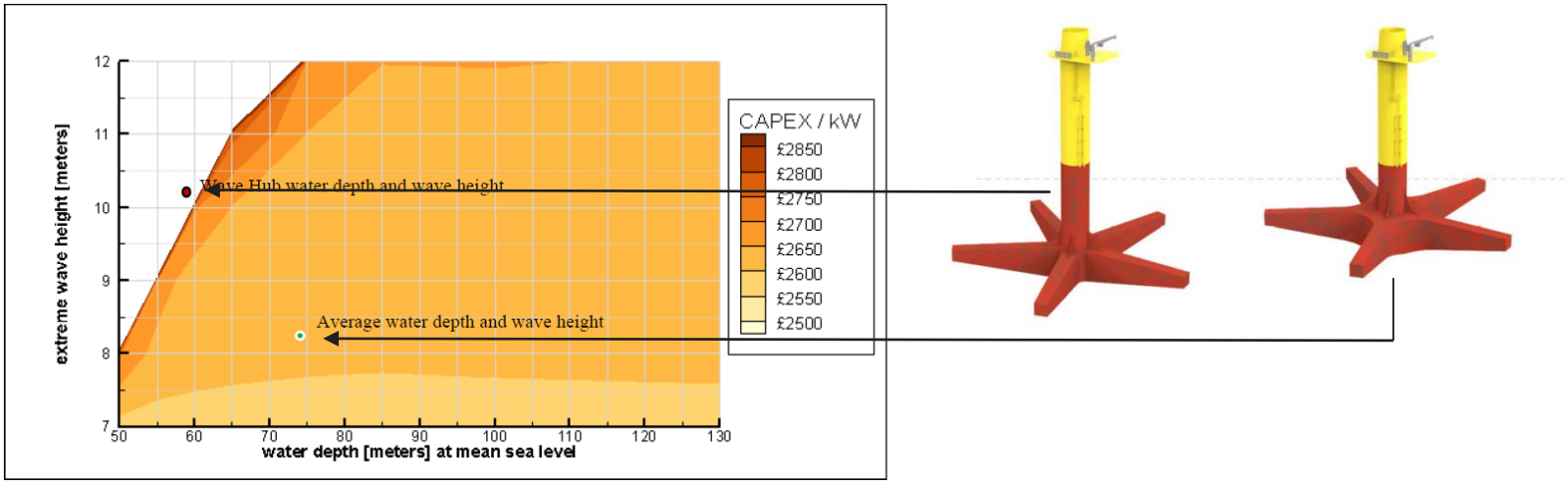
- Objectives
  - Understand LCOE potential of Glosten TLP technology
  - Develop a design for a full scale demonstrator
    - To inform the LCOE study
    - Provide a highly detailed design for a specific site that with validated costs

Engineering Design

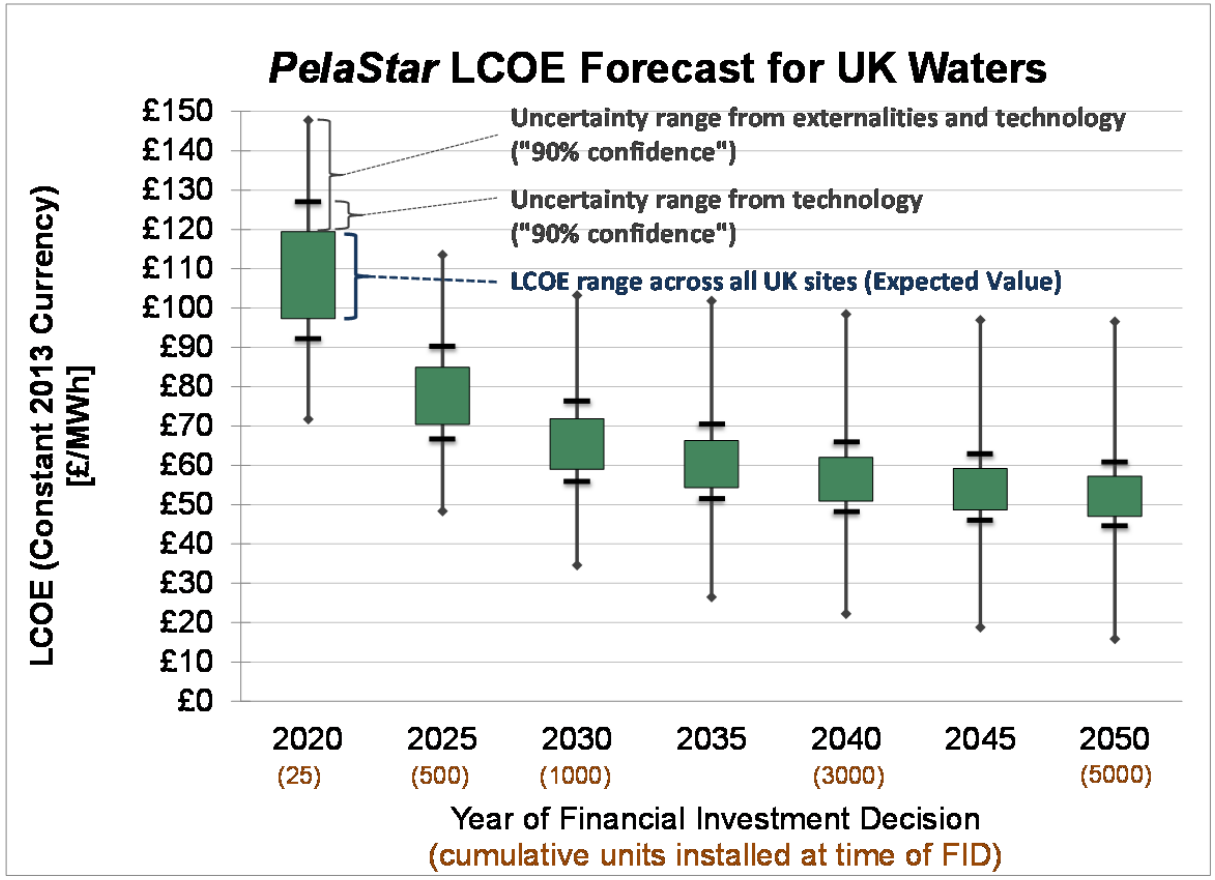
- Led by Glosten Associates
  - Alstom 6MW turbine
    - 150m Diameter Rotor
    - Direct Drive Generator
    - 900V Full Converter
    - 100m Hub Height
  - Buoyant Hull
    - 5 “arms”
    - 1100 – 1400 tonnes steel
    - Synthetic tethers
  - Piled Anchors
    - 19m deep

Cost Study - CAPEX

- Based on 500MW array (83 turbines), 60 to 100m water depth with FID in 2020
- CAPEX range £2529 to £2798/kW
  - Average is £2536/kW



LCoE Forecast



Conclusions

- **Offshore Wind has a significant role to play in the UK 2050 energy mix**
  - **With a range of Fixed and Floating foundations, UK can optimise the offshore fleet LCoE**
- **Floating Wind has potential to deliver costs at less than £85/MWh from mid-2020s, and further significant cost reduction afterwards**

- Further Work
  - Demonstration at full-scale
  - Geographical distribution and cost optimisation
  - Establish cost of energy potential for other floating technologies

10 YEARS TO PREPARE

for a low carbon transition

With technology and supply chain development there is a

clear and credible trajectory to delivering commercial offshore wind farms

Floating wind has the potential to be

a cost-effective, secure and safe low carbon energy source

which could deliver a levelised cost of energy of less than £85/MWh from the mid 2020s

£85 per MWh

To deliver improved costs, offshore wind needs

access to good quality wind resource

close enough to shore and power users

so that transmission costs are minimised and operations/maintenance costs reduced

Floating wind technology can provide access to high quality wind resources

relatively close to the UK shoreline and in the proximity of population centres

In water depths of less than 30m

fixed foundations will be the prime solution

30m

In water depths of over 50m

floating foundations provide the lowest cost solution

50m

The UK has the world's highest offshore wind capacity

over **4** GW installed

over **1100** turbines

with an average power rating of 3.4MW

1.4 GW in construction

4.8 GW has planning permission

and world's largest in-service offshore wind farm is in the outer Thames Estuary

UK wind resources are abundant and exploitable

supplied **9.4%**

of the UK's electricity needs in 2014

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