

# Offshore Wind Accelerator

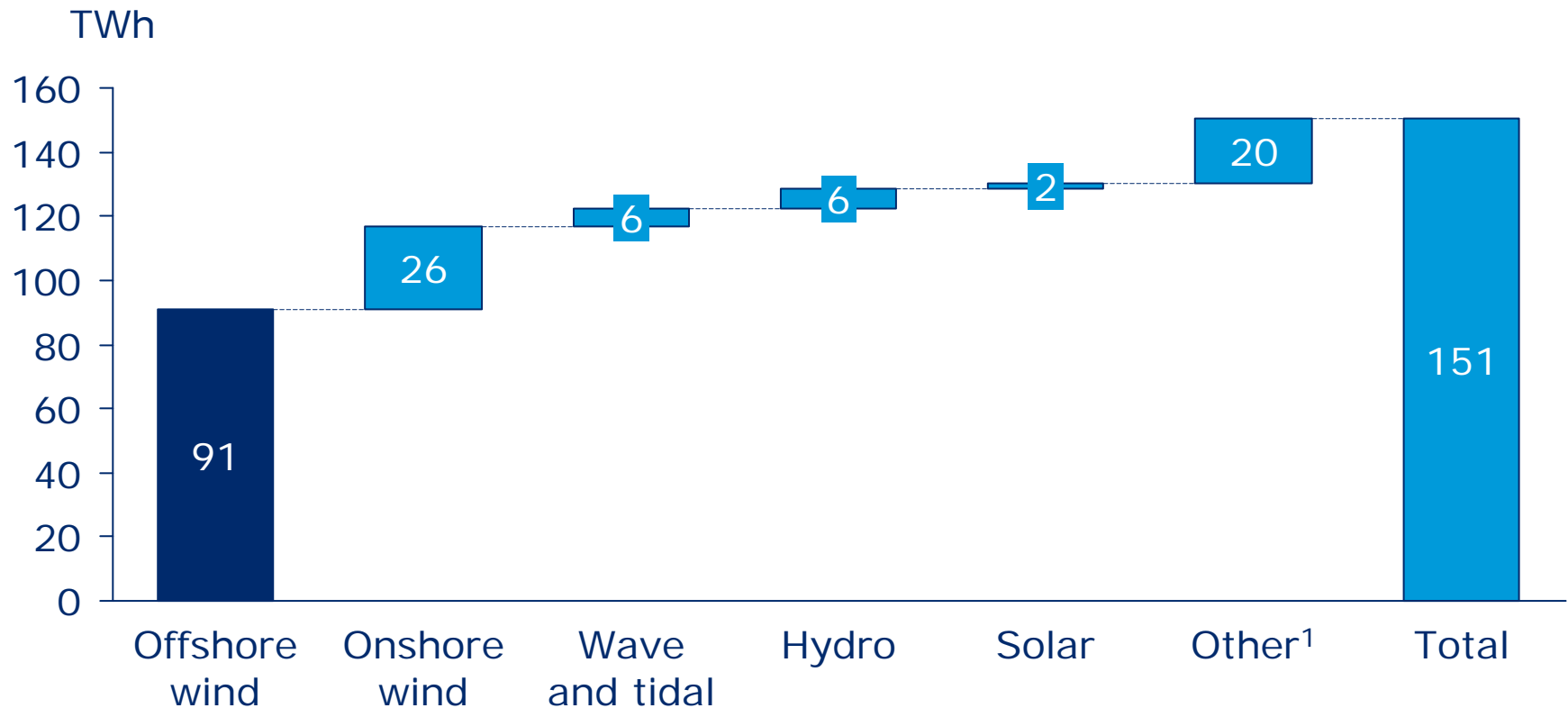
RenewableUK, Offshore Wind 2010  
Liverpool, Wednesday 30 June 2010

Phil de Villiers



# Mass deployment of offshore wind required to meet targets

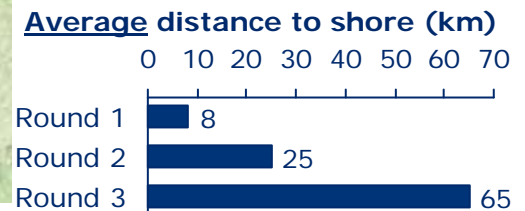
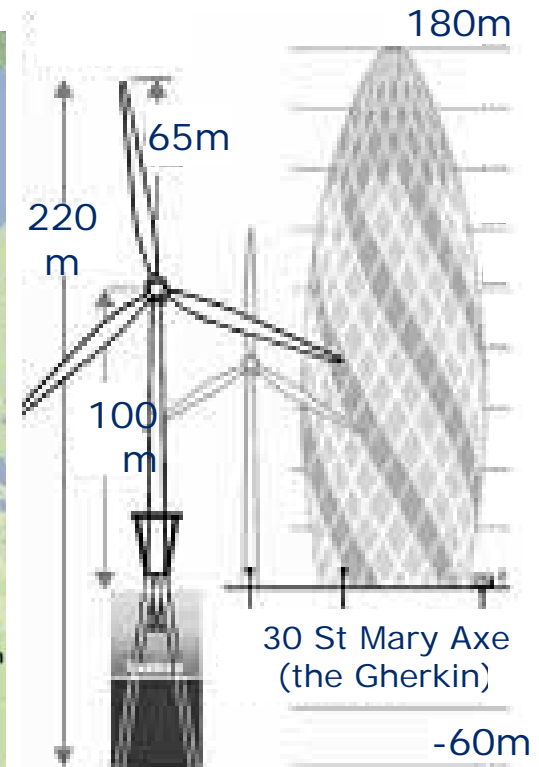
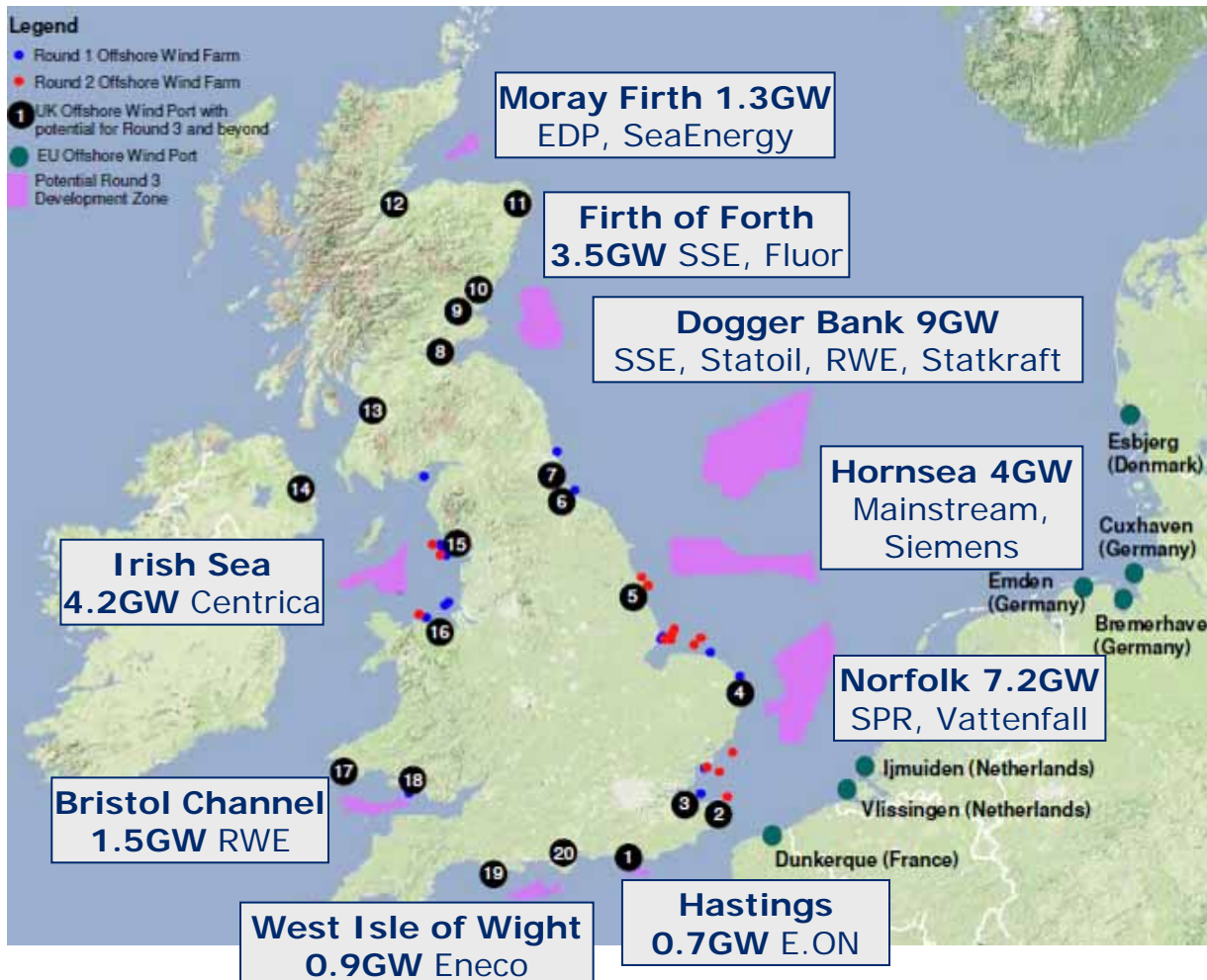
Forecast UK 2020 electricity supply in 40% scenario



1. Landfill, co-firing, biomass

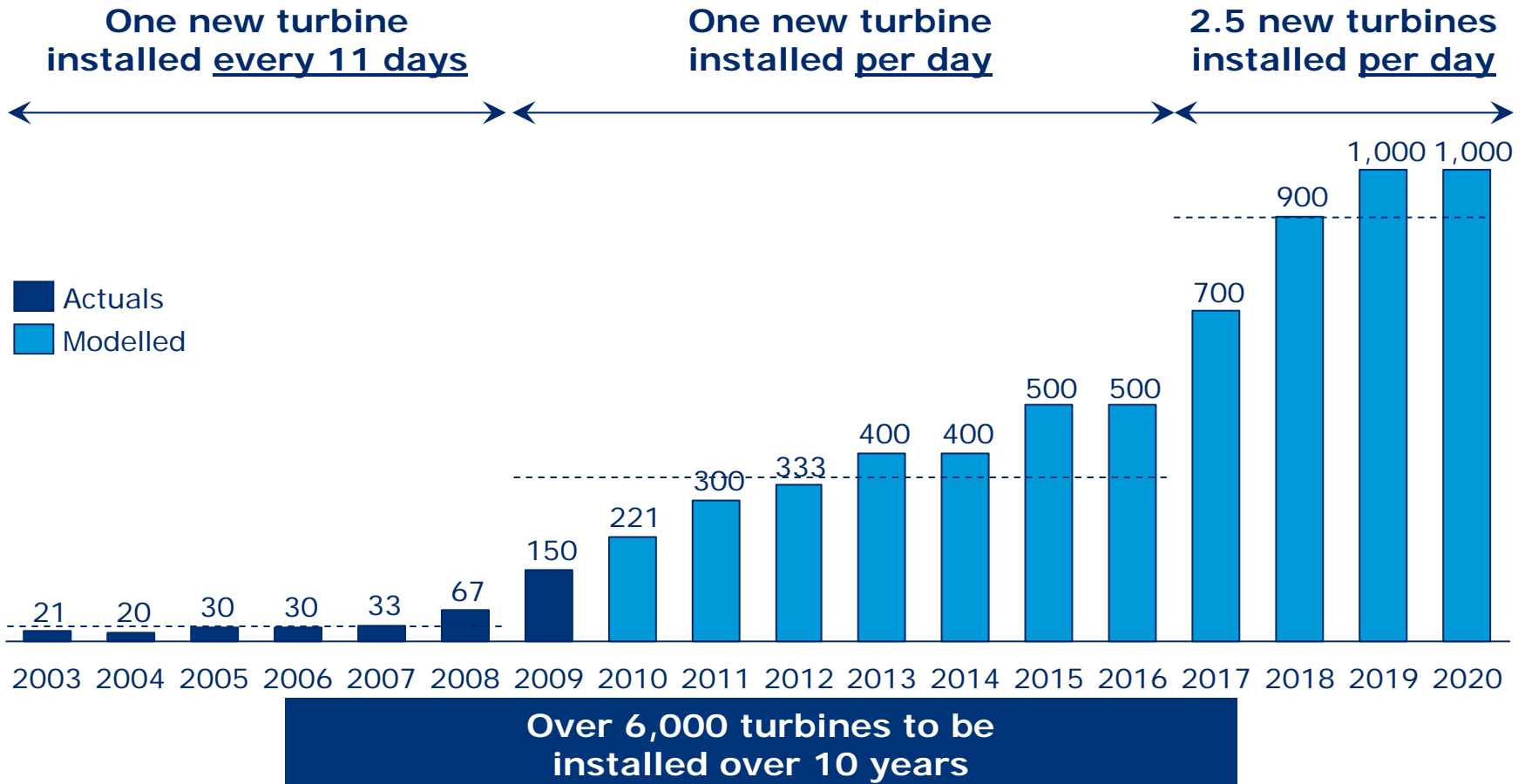
Source: Carbon Trust "Offshore wind power: big challenge, big opportunity", 2008; BCG analysis 2008

# 6,000 turbines required, 65km from shore in 60m depths



# Turbine installation rates will need to increase dramatically

Number of turbines installed per year 2003 - 2020<sup>1</sup>



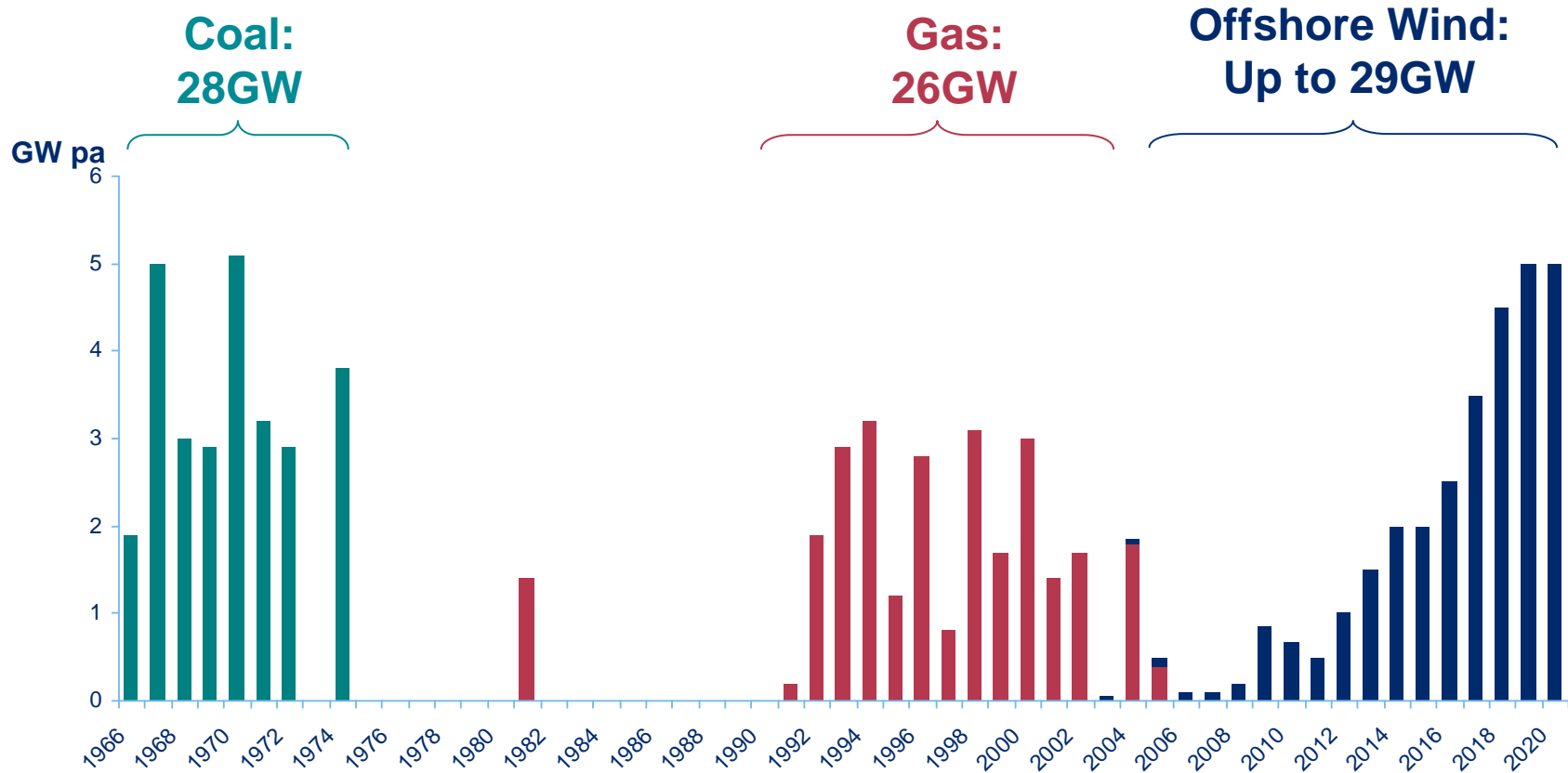
1. Number of turbines calculated from actual and forecast installed capacity figures, assuming 3MW turbines 2003 – 2013, and 5MW turbines from 2014

Source: Carbon Trust "Offshore wind power: big challenge, big opportunity", 2008; Carbon Trust analysis 2010

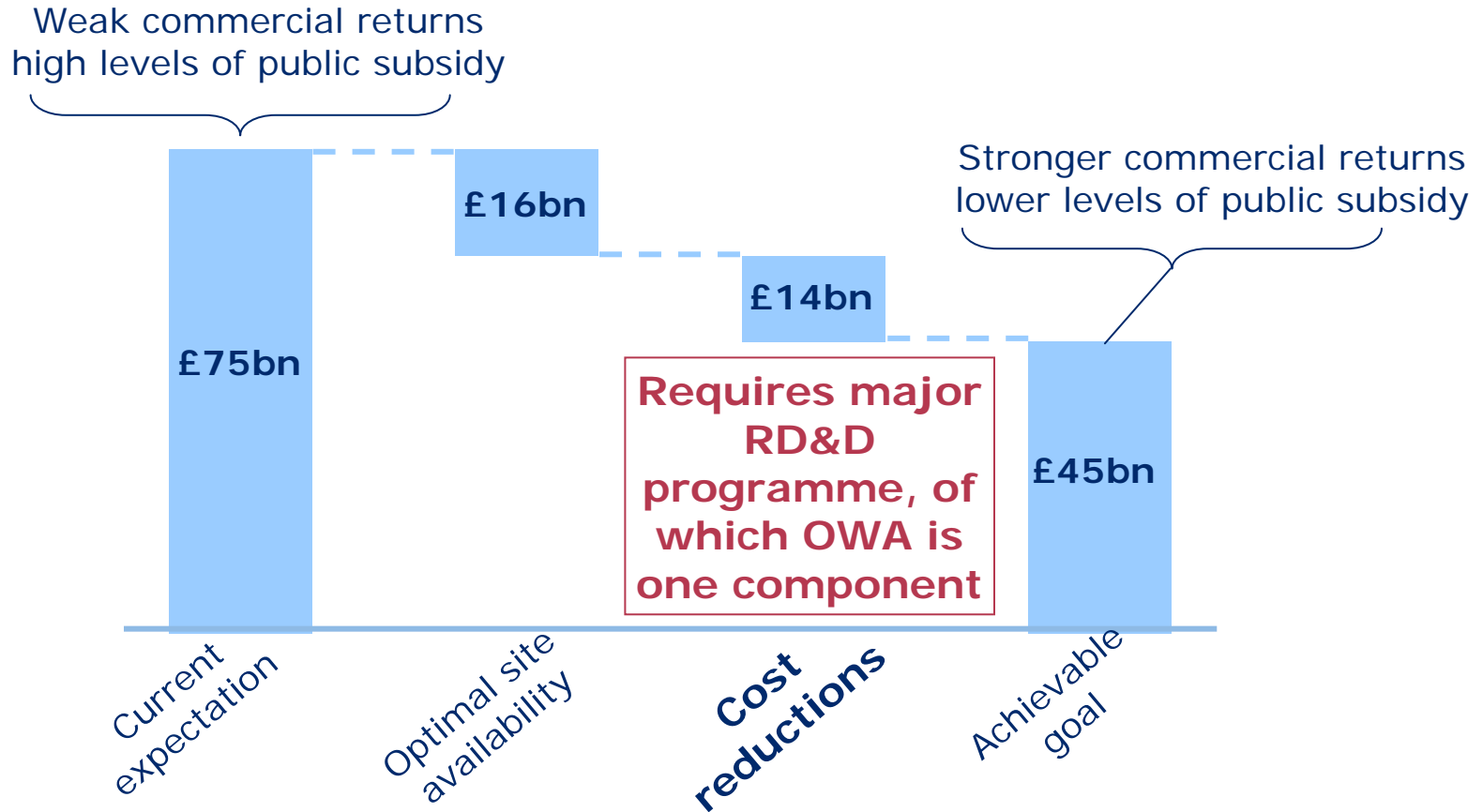
# Build rate similar to coal in the 1970s and gas in the 1990s



Power generation capacity additions 1966 - 2020



# RD&D critical for reducing cost



# Offshore Wind Accelerator is a consortium to reduce costs

Objective: Reduce cost of energy by 10% through RD&D



## Original partnership



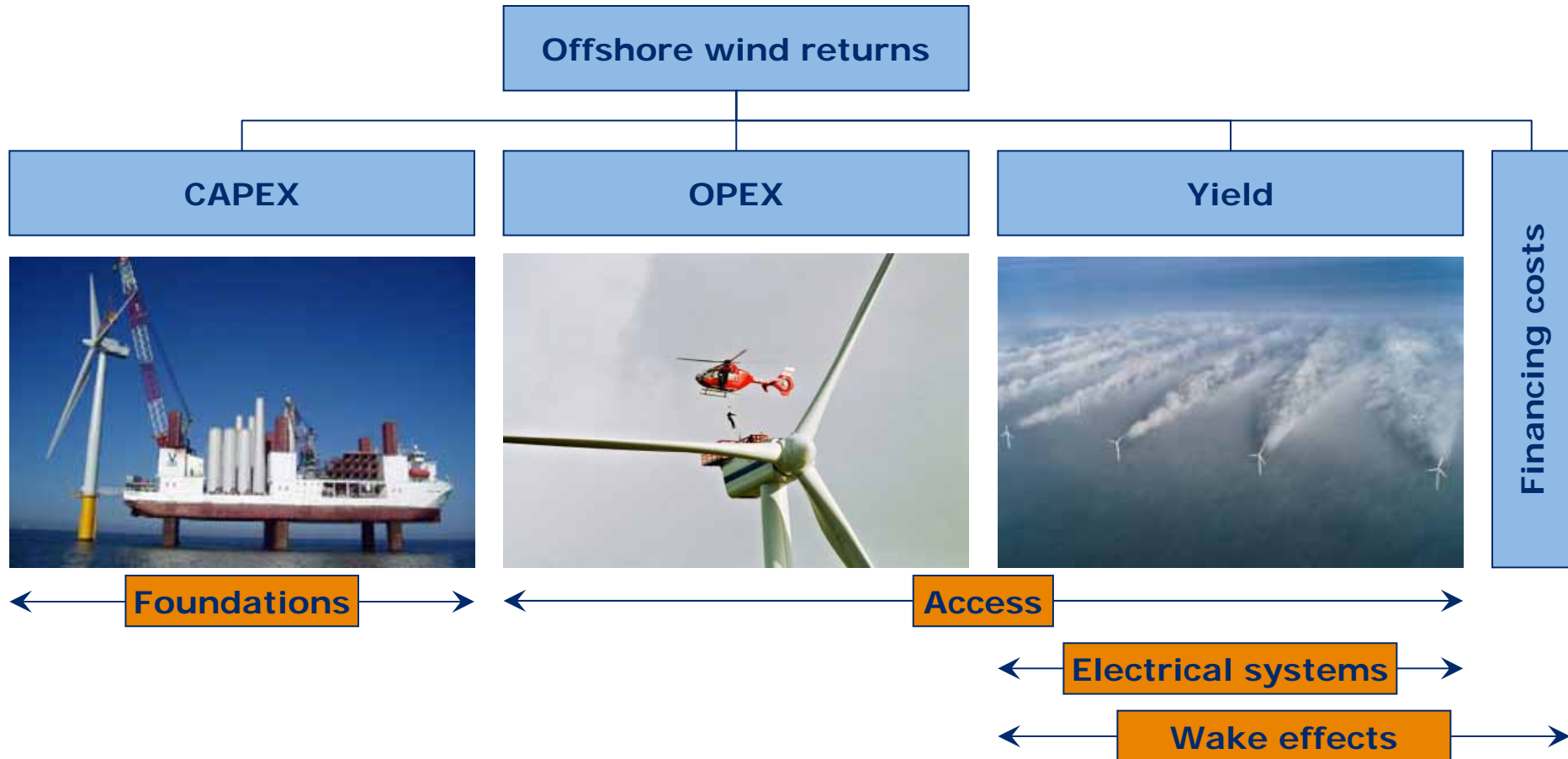
## New partners



- **7 developers + Carbon Trust**
  - 56% of UK licensed capacity (~27GW)
  
- **4-year commitment**
  
- **Focusing on technologies for**
  - Round 2 extensions
  - Round 3
  - Scottish Territorial Waters
  
- **Total budget**
  - £10m for collaborative R&D
  - Up to £30m for demonstrations

# OWA focuses on strengthening economics of offshore wind

Stage I (Oct '08 to Apr '10) examined four technical areas



Four technology areas, selected on basis of detailed analysis of over 70 technical barriers

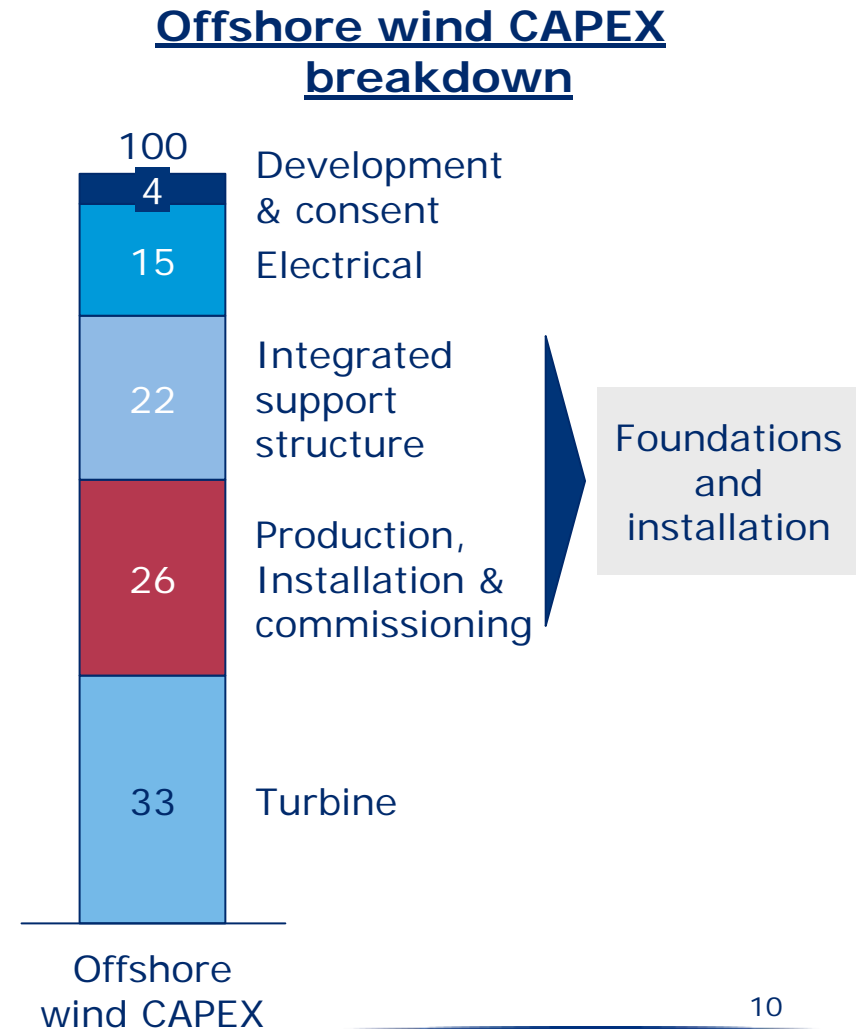
# Agenda

## Findings from first stage of OWA

- Foundations
- Access, transportation and logistics
- Wake effects
- Electrical systems

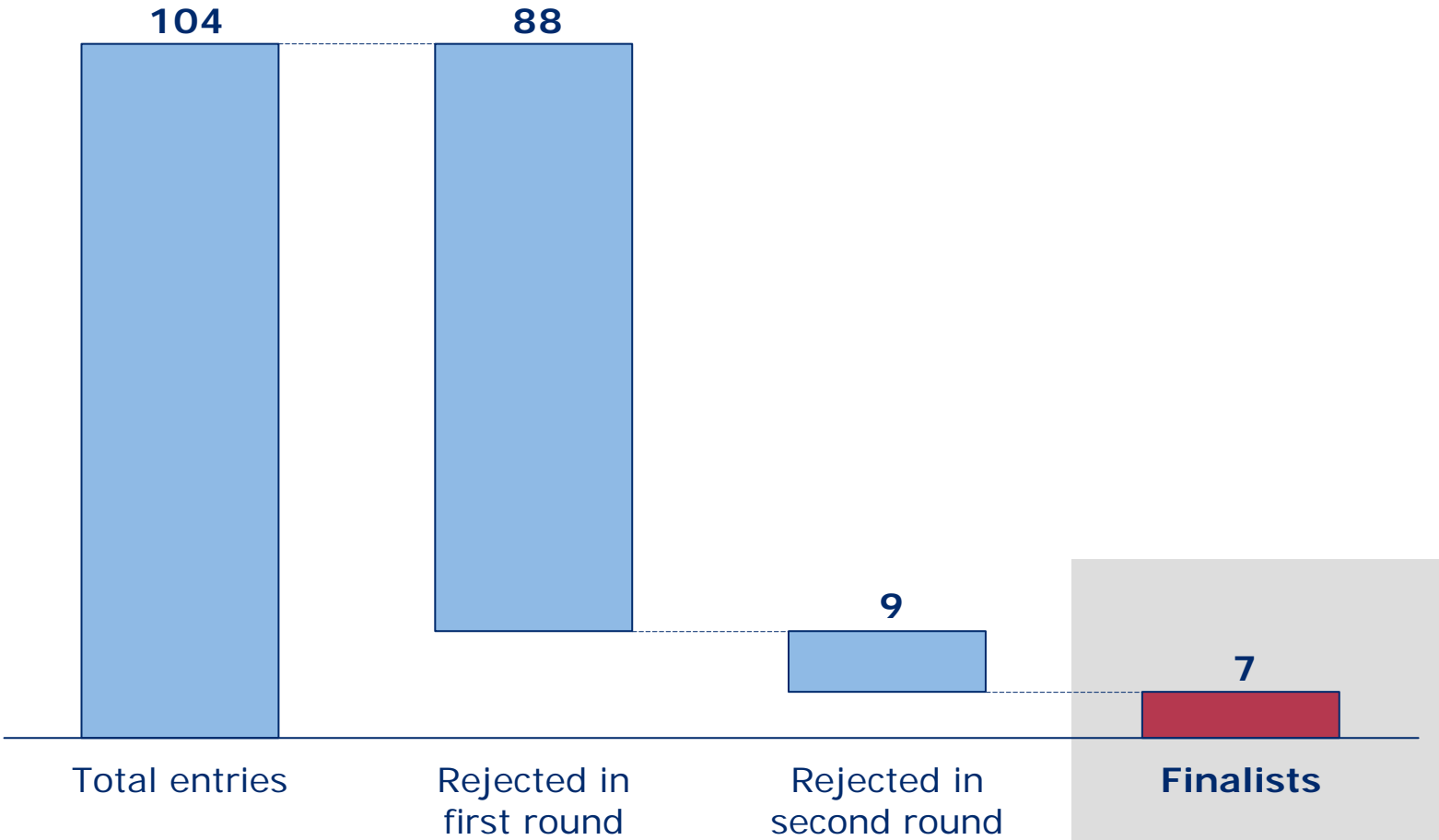
# Foundations vision: Reduce cost of deeper water foundations

- To demonstrate new, lower-cost foundation designs
  - For 30-60m depths expected in late Round 2 & Round 3
- To reduce lifecycle cost of foundations by 30%
  - TDC target £0.4-0.6m/MW
- To stimulate the supply chain
  - Particularly in volume manufacturing and installation
  - To provide more competition and flexibility in the market



# Competition attracted 104 entries from around the World

Seven concepts were selected as finalists



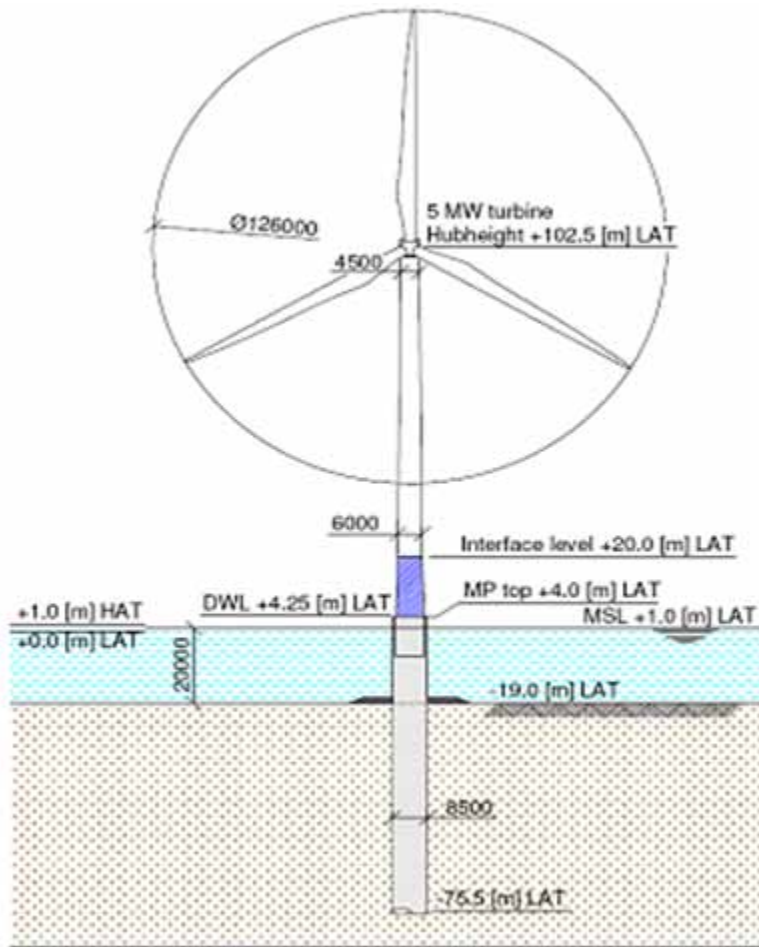
# Seven finalists show innovation in structures and installation



	Fixed structure		Floating
	Offshore turbine assembly	Quay-side turbine assembly	
Gravity-based		Gifford-BMT-Freyssinet Gravity Base Structure	
Monopile	Ballast Nedam drilled concrete monopile		
	MBD Offshore suction bucket monopile		
Jacket	Keystone twisted jacket		
Tri-bucket or jack-in		SPT Offshore & Wood Group tri-bucket	
		OWPST Titan 3-leg jack-up	
Tension-leg			Glosten tension leg platform

Concrete  
 Steel

# Ballast Nedam drilled monopile works best in shallower water



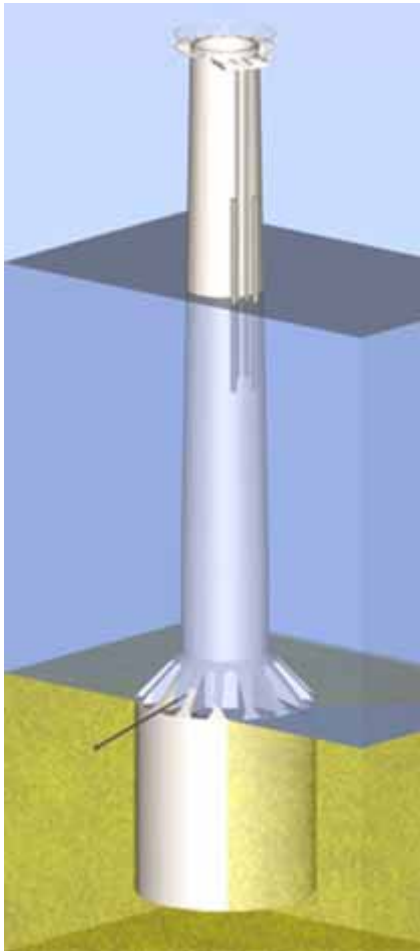
## Structure

- Concrete monopile, built in sections – easy to manufacture
- Suitable for up to 30m for smaller turbines

## Installation

- Drilled monopile
- Assembled in sections, which allows smaller lifting vessel
- Requires bespoke drilling barge

# MBD suction bucket monopile is simpler to mfr and install



## Structure

- Less steel, simple welds
- Suitable for 30-60m

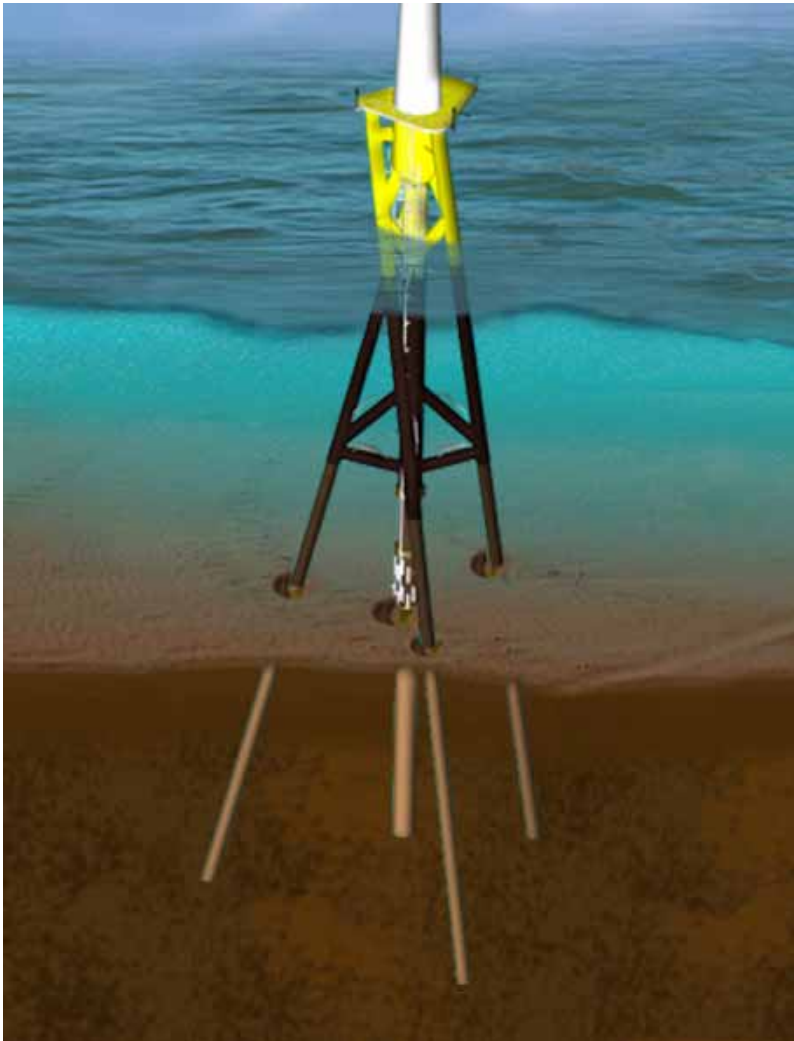
## Installation

- Fewer offshore operations and smaller vessels and equipment
  - Simpler installation as foundation towed out
- No piling
- Less scour protection required

## Decommissioning

- Easier to retrieve for decommissioning

# Keystone is an innovative jacket



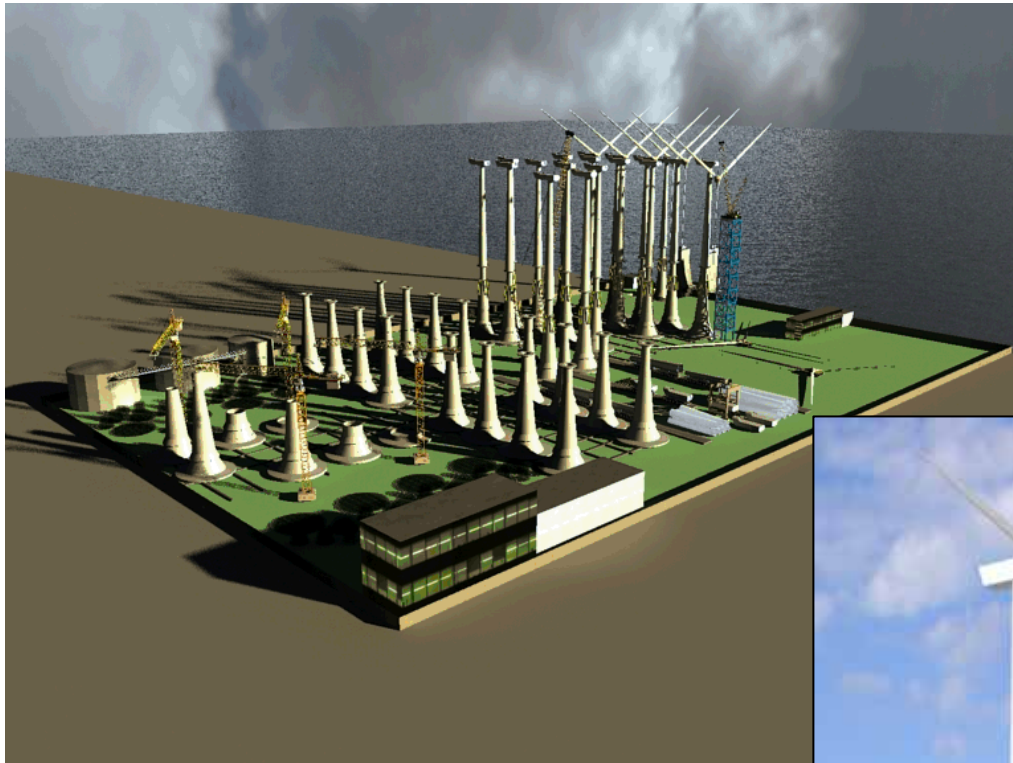
## Structure

- Twisted jacket uses less steel vs conventional jackets
- Elegant transition piece
  - Uses innovative composite materials
- Proven in Hurricane Katrina
- Suitable for 30-60m

## Installation

- Faster installation time
  - Fewer installation manoeuvres
  - No driving template required
- Improved utilisation of deck space increases transportation efficiency

# Gifford/BMT/Freyssinet gravity structure faster to build, install



## Structure

- Slipforming stem – reduces production time
- Mass fabrication process developed
- Concrete prices less variable than steel
- Suitable for 30-45m

## Installation

- Cheaper, bespoke unmanned vessel transports structure to wind farm
- Entire foundation / turbine structure could be transported

## Decommissioning

- Structure easy to de-ballast and remove

# SPT Offshore & Wood Group tribucket simple to install

Self Installing Wind Turbine (SIWT)



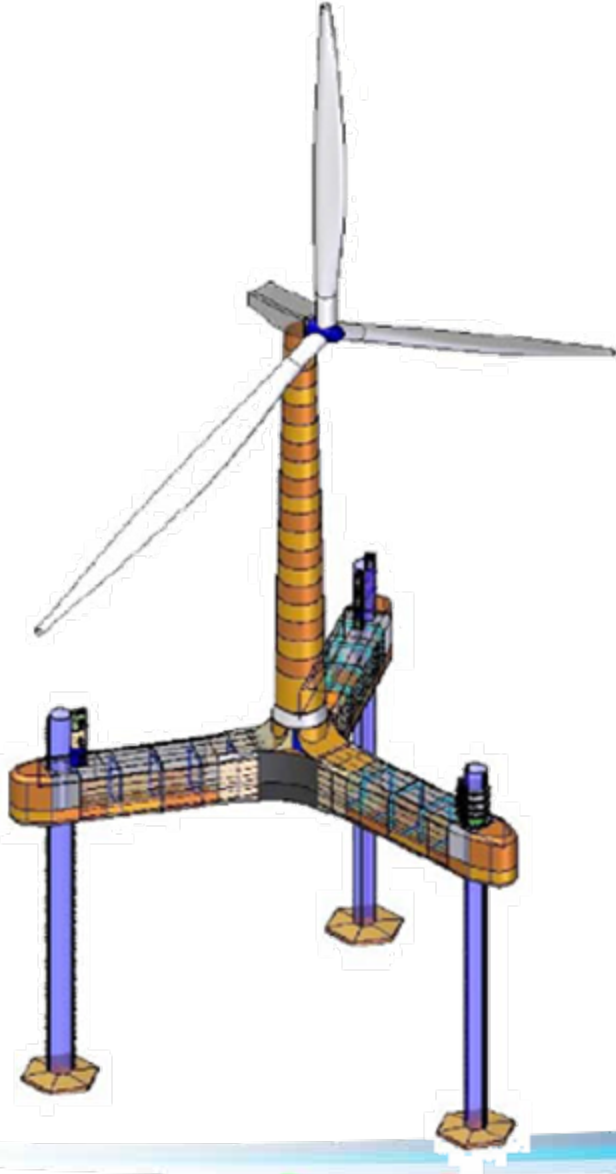
## Structure

- Self-installing tribucket
- Entire foundation / turbine structure assembled in port
- Suitable for 30-60m

## Installation

- Entire foundation / turbine structure transported to wind farm
- Standard marine equipment, eg, flat barge & tugs, strand jacks & suction
- No piling or drilling

# No heavy lift vessel required to install OWPSE Titan



## Structure

- Entire foundation / turbine structure assembled in port
- Suitable for 35-45m

## Installation

- Whole structure transported to wind farm
- No heavy lift vessels required
- Three-legged jack-up structure means no piling or drilling; low impact to sea floor

## Maintenance

- Potentially at shore

## Decommissioning

- Easier to retrieve for decommissioning

# Glosten design takes floating turbines into shallower waters



## Structure

- Tension leg, steel hull – cost far less sensitive to depth than fixed structure
- Suitable for >55m in North Sea sea states – shallower depths possible in regimes with lower sea states

## Installation

- Whole foundation / turbine floated to wind farm without heavy lift vessels

## Maintenance

- Potentially at shore

## Decommissioning

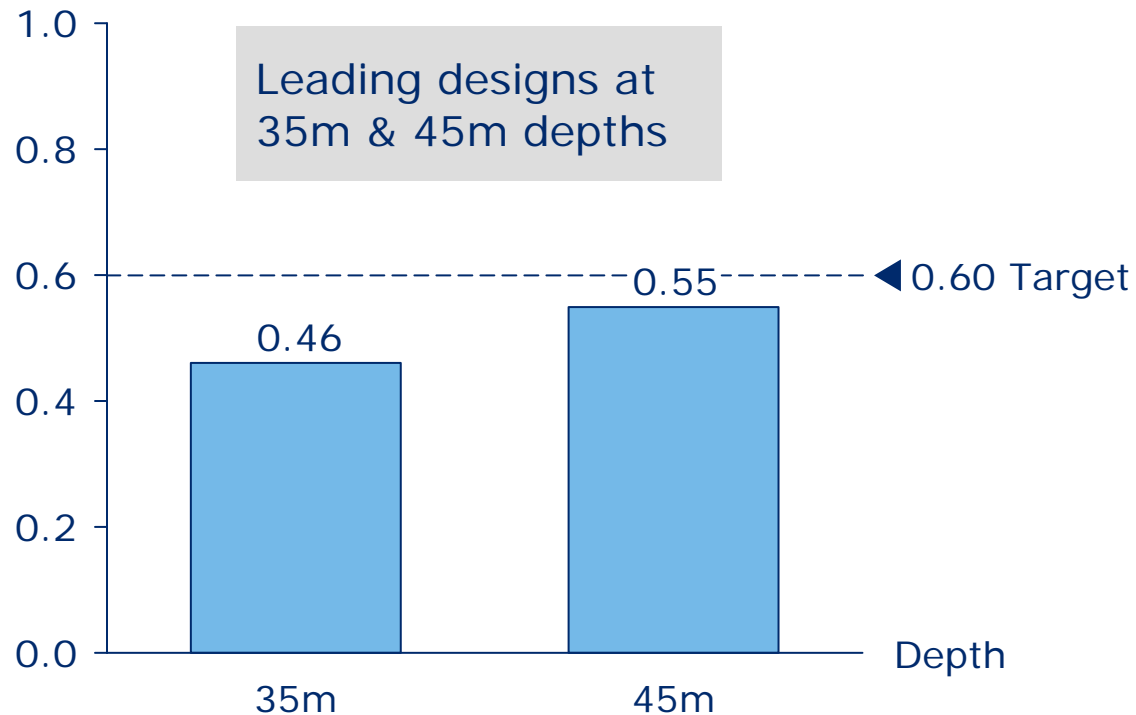
- Easier to retrieve for decommissioning

# Estimated installed costs show promise

5MW turbine, normal climate



Estimated installed cost per MW (£m)



**Equivalent to 15-30% cost reduction**

Note: Estimated costs include manufacturing and installation

# OWA has chosen four designs for further development

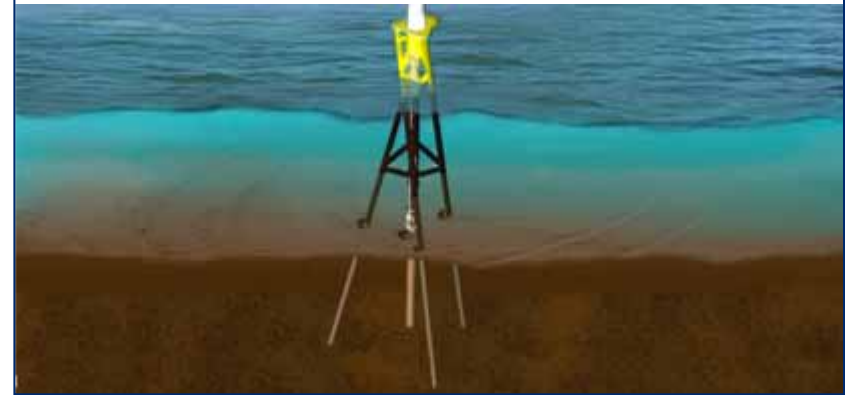
Selected based on expected installed cost on R3 sites



**Gifford-BMT-Freyssinet**



**Keystone**



**MBD**



**SPT Offshore & Wood Group**



# Wake effects vision: increase yields, reduce financing costs



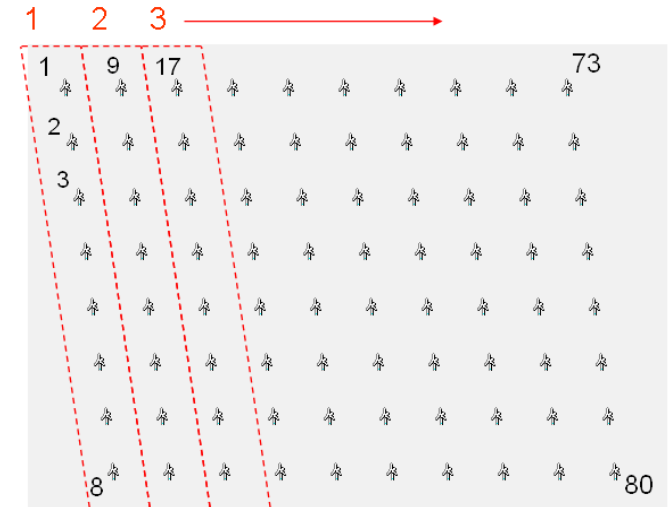
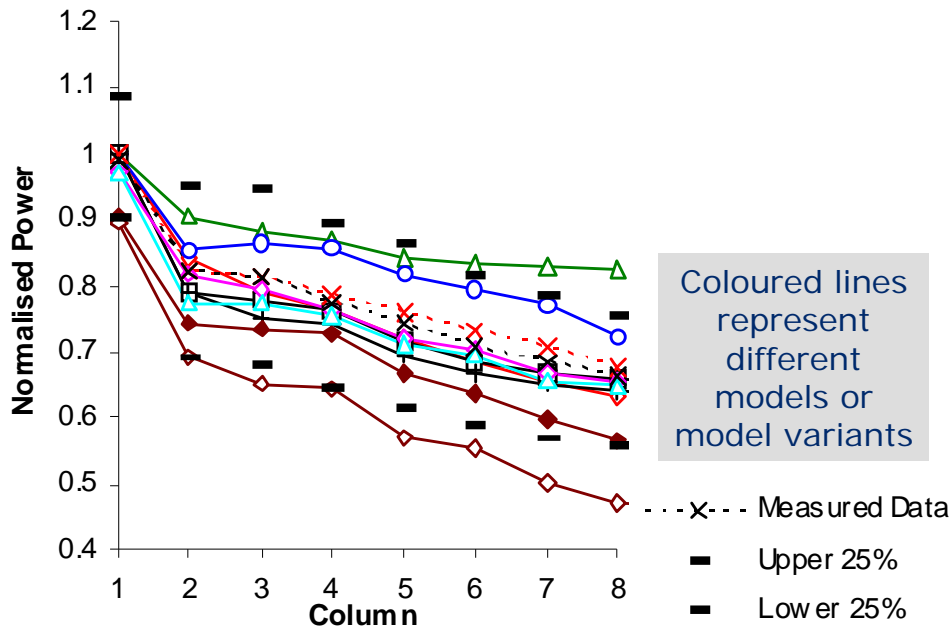
## Objectives

- To reduce cost of energy by
  - Reducing financing costs (P90:P50) by improving yield forecasting accuracy
  - Increasing yields from large arrays
- To make software available in time for designing late Round 2 and Round 3 projects

## Approach

- Software tools currently used by partners were reviewed
- Literature review to inform direction of developments
- Benchmarking of seven wake effects models vs real data
  - Accuracy measured vs partner and public data
  - High fidelity testing, using small sector sizes
- Specific model improvements commissioned from vendors

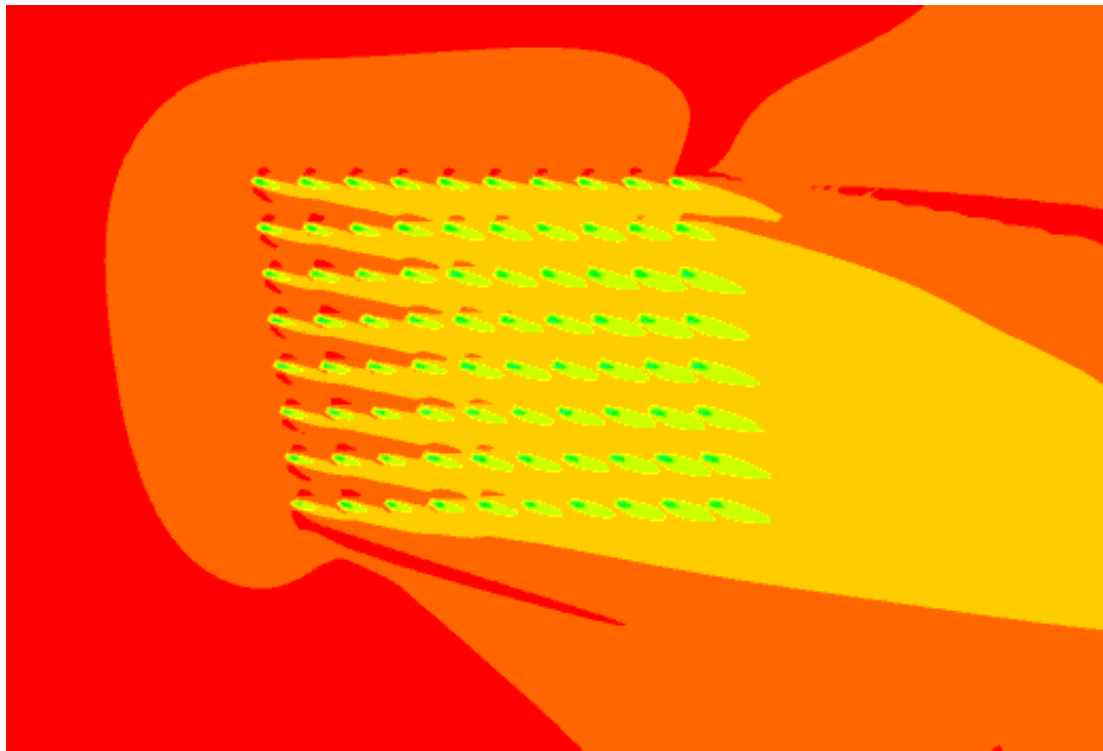
# Accuracy of models benchmarked vs actual data



- “Case studies” formed basis of benchmarking
- Under-prediction of wake effects identified in many scenarios
- The results enabled OWA to commission specific improvements to three packages and to develop one entirely new model
  - Sophistication of engineering and CFD models has been increased to add greater realism and increase accuracy of predictions

# OWA is starting to understand large wind farm wake effects

For example, upstream blockages and lateral speed-ups



- Higher fidelity models are providing unique insight into 3D effects
  - Upstream blockages ahead of arrays
  - Flow acceleration between rows and at edge of farms
- This has implications for
  - Build-out of wind farms within zones
  - Layout of farms



# Access vision: increase availability of large wind farms



- To increase availability of large offshore wind farms to reduce cost of energy
  - Increasing window for safe and efficient access to large-scale wind farms, far from shore
  - Building on these improved access methods for re-thinking and improving other aspects of offshore wind operation
  
- To demonstrate access systems that will make a step-change in accessibility for late Round 2 and Round 3 offshore wind farms
  - For both O&M and construction phases

# Optimising O&M strategies will improve availability

Potential availability improvements vs current strategies



	Number of turbines		
	100	200	300
<b>Near shore</b> (0-50km)	Low	Low	Low
<b>Intermediate</b> (50-100km)	Low	Medium	Medium
<b>Far shore</b> (>100km)	Medium	Medium	High

➤ **O&M model built to calculate wind farm availability**

- Based on frequency of different sea states, transfer system limitations

➤ **% points improvements identified vs benchmark strategies**

- For example, using combinations of vessels and transfer systems to replace offshore bases with helicopter support

# Screening market has revealed a technology gap



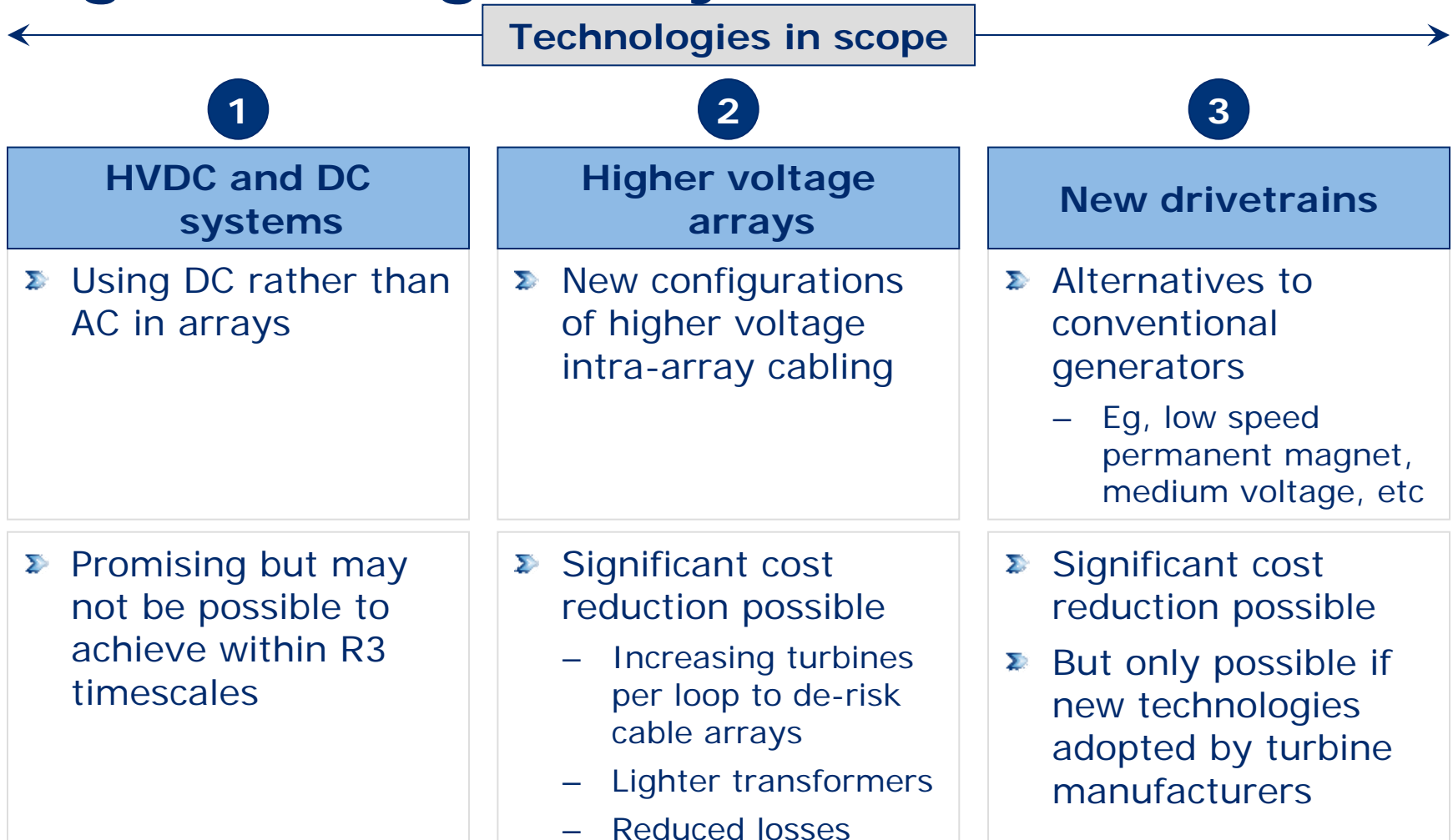
- **Current solutions focused on near-shore monopiles**
  
- **New systems required for Round 3 conditions**
  - Further from shore
  - Heavier seas
  - New foundations
  
- **Technology gaps identified in**
  - Transfer systems
  - Vessels
  - Launch & recovery systems

# Electrical Systems vision: improve efficiency of collection & transmission



- To reduce the cost of energy from offshore wind through the development of new electrical systems
  - To increase the efficiency and reliability of collecting and transmitting electricity from large-scale wind projects far from shore
  - To increase the cost effectiveness of deploying such systems

# Our assessment suggests greatest benefits likely from higher voltage arrays



# Agenda



- Next steps

# New Foundations objective: Faster, cheaper installation

## Stage I: Identify better foundation structures

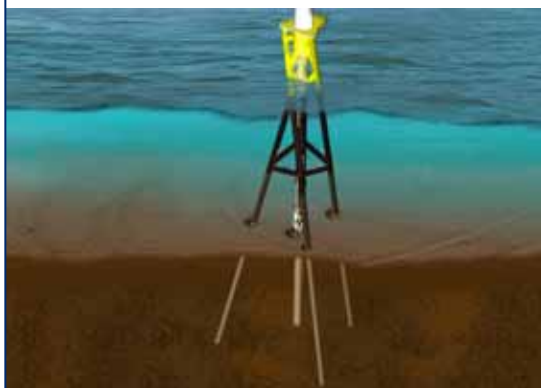
Gifford-BMT-Freyssinet



MBD



Keystone



SPT & Wood Group



## Stage II: Faster, cheaper installation

- **Up to 6,000 turbines to install by 2020**
  - Up to 2.5 per day
  
- **OWA is issuing ITT for installers to optimise processes**
  - Faster installation
  - Cheaper cost
  
- **Foundation designers to optimise for**
  - Mass production
  - Installation

# Wake Effects: develop two wake effects models; assess measurement state of the art



- Two wake effects models identified in Stage I to be further developed
  - A model with excellent predictive accuracy to be enhanced to include atmospheric effects
  - A linearised CFD model with low computing requirements to be developed – will offer capability of running more simulations
  
- Data measurement campaign to be scoped
  - Confirm requirements for new lower-cost wind measurement equipment
  - Develop a project for delivering lower cost data measurement



# In late summer 2010, we will launch an Access competition

Competition for novel access systems – three elements



1

## Transfer systems



2

## Vessels



3

## Launch & recovery systems



**Objective:** safer transfer systems in heavy seas, far from shore

**Prize:** OWA will fund development of short-listed designs

**Launch date:** Expected to be late-Summer 2010

# Electrical systems to focus on higher voltage arrays



- Engineering design study underway to validate costs and benefits of moving to higher voltage intra-array cabling
  - Determining incremental impact of higher voltage on the wind farm design
    - eg, transition piece, location of switchgear
  - Engaging with suppliers to determine costs, performance and availability of equipment
  - Determining the optimal voltage level



# Questions?

