CATAPULT
Offshore Renewable Energy

Project economics for near-shore systems
PRO-TIDE Conference
Port of Dover

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Innovate UK

Catapults:
A long-term vision for innovation & growth

CATAPULT Offshore Renewable Energy

Catapults

- Established by Innovate UK, part of a network of 7 Catapults
- Designed to transform the UK's capability for innovation
- Generate income from the 1:1:1 leveraged funding model.

The Offshore Renewable Energy Catapult

Abundant, affordable energy from offshore wind, wave and tide

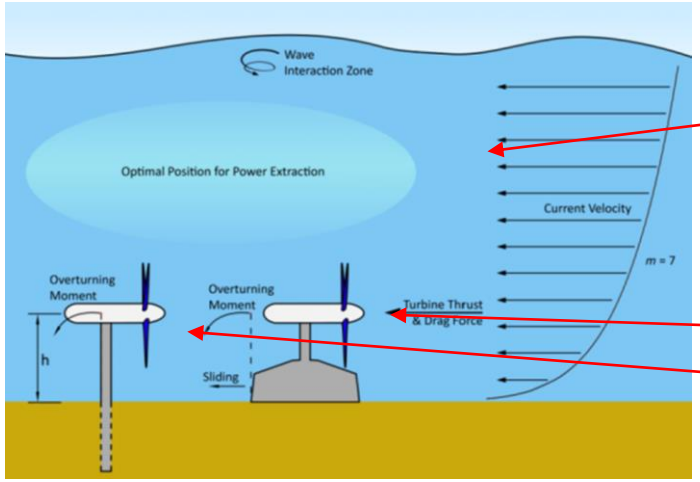
ORE Catapult

- The Offshore Renewable Energy Catapult
  - is the UK's flagship technology innovation and research centre for offshore wind, wave and tidal energy
  - collaborates with industry, academia and Government to **reduce the cost** of offshore renewable energy and create **UK economic benefit**
  - delivers prioritised research underpinned by world-class test and demonstration facilities

Locations	Size
Glasgow Blyth (National Renewable Energy Centre)	c120 employees

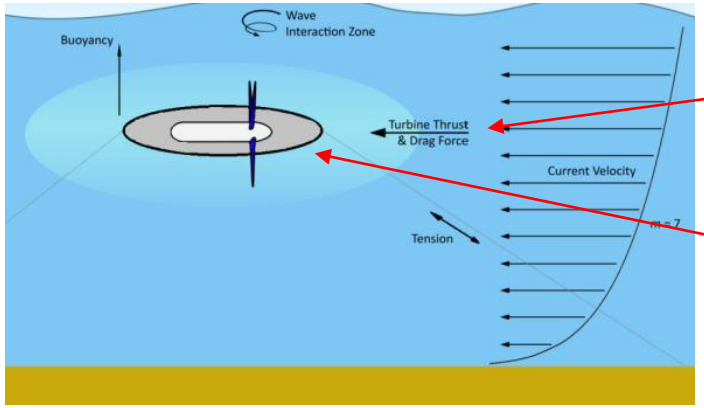
Why are we doing this?

Tidal energy is capable of supplying 20-100TWh of the 350TWh of the UK's annual electricity demand



1/7th power law – where is optimised tidal flow across ebb and flow tides

Deep water 40m to 60m bottom mounted, Trend is for turbine sizes between 1MW and 1.5MW



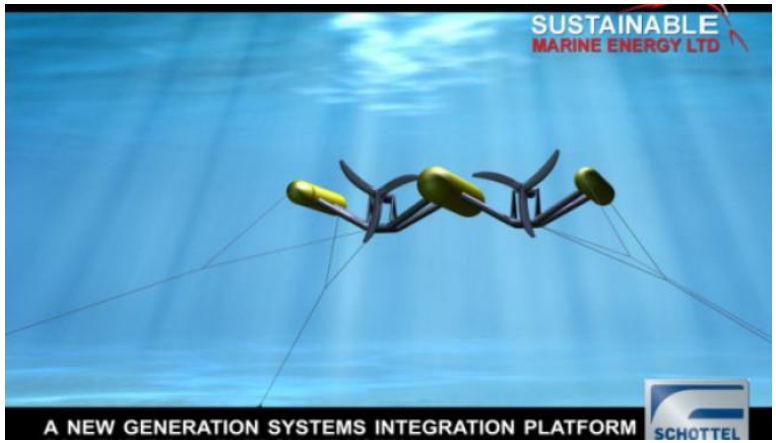
Surface and mid water floating – seek to exploit better resource

Can be shallower 10m – 40m Trend is for turbine sizes between 0.5MW and 1.5MW

We've been doing this for years !

Micro hydro designs 0.5-5 kW are cheap, ecologically friendly and are suitable for developing countries.

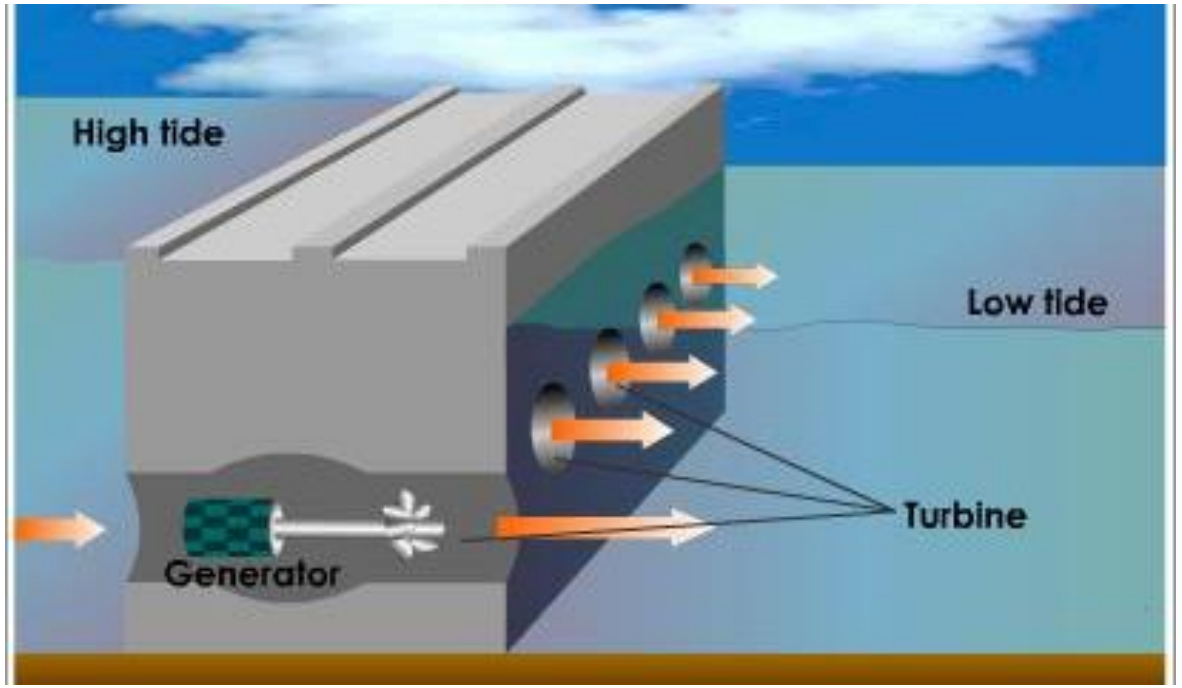
Floating Systems



Example - PLATO-O Sustainable marine Energy
Isle of Wight, UK

Barrage and Lagoons

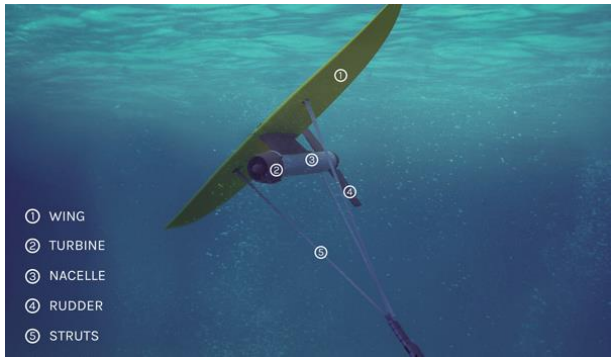
Barrage or lagoon



Principle is well understood. Technology is available.

Civil costs and large area environmental concerns make projects difficult to fund and launch.

Minesto



Minesto - Deep Green could produce electricity at sites with velocities between 1.2-2.5 m/s.

2nd generation technology. Control systems and maintenance access

Near Shore/Off shore - Pros and Cons

	Near Shore		Off Shore	
Features	**Pros**	**Cons**	**Pros**	**Cons**
Locations	Easy access. Wider choice, less competition for sites	Local objections to lease and license consents. Seasonal river flow impacts output	Competition for high resource sites	Vagaries of slack tide, weather windows
Site Characterisation	May mean easier/cheaper to deploy monitoring equipment	Wave action may hinder data collection. River flows will require selective device positioning in channel cross section	A growing number of environmental engineers claim to be able to undertake this work	Expensive upfront cost made difficult in areas of high tidal flow
Environmental	Enable access across estuaries (Barrage)	System features potentially visible form shore	Not generally visible from shore	Can offer stepping stone for invasive species
Capex	Potentially lower design and materials costs if in a sheltered environment	Design standards do not enable lean design techniques	Meygen model has raised funding (but may not be easily repeatable	High costs driven by over engineering, need for survivability, installation costs
Opex	Greater accessibility for maintenance	Small installations may not offer rich economies of scale	Experience is growing from Alstom, AHH, Atlantis, Scott Renewables	Poor reliability resulting in unplanned maintenance interventions
Decommissioning	Proximity to shore and sheltered location will aid logistics	Extraction may be highly visible requiring greater post landscaping	Design consolidation will enable streamlined extraction operations	Distance frim shore and reliance on slack water weather window combinations
Project financing	Community orientated sites may attract local investment	Traditional financiers may be sceptical of achievable IRR particularly on small projects	ETI TEC study indicated TEC at 200MW could be cost competitive	Poor IRR until at multi device and high MW capacity

Tidal Stream First Arrays Estimates

Capex (£/kW)	Low	High
Device	3,500	3,000
Foundations	800	900
Electrical	900	2,100
Installation	1,100	1,000
Other	700	2,200
Total Capex	7,000	9,200

Opex (£/kW)	Low	High
O&M	140	300
Insurance	10	10
Total Opex	150	310

Capex and Opex ranges driven by various factors, including:

- Site conditions
- Device type
- Foundation type
- Installation method
- Electrical architecture
- Risk/contracting approach
- Grid connection options
- On/Offshore O&M strategy

Source: ORE Catapult internal analysis

Notes:
- Published project costs for initial Raz Blanchard arrays in France have a range of £6,000 - £13,000 per kW
- Anecdotal evidence from Canada suggests similar range for first arrays

Conclusions

- Tidal energy is capable of supplying 20-100TWh of the 350TWh of the UK's annual electricity demand
- Near-shore locations, estuaries, tidal rivers and coastal defense infrastructure systems may offer an achievable route to market
- Changes in design standards enabling leaner designs reducing Capex costs and definitive data informing cost modelling will influence investors
- ORE Catapult is prepared to work with technology and project developers to understand how we can best serve their interests

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