

Fundy Ocean Research Center for Energy

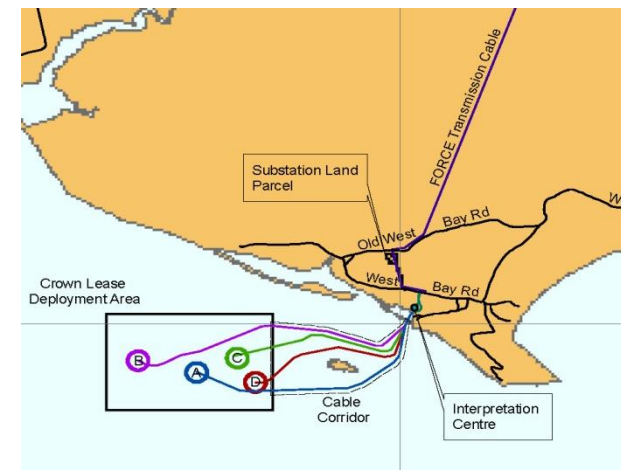
Canada's leading test center for in-stream tidal energy

Assets:

- 10km transmission line, substation + equipment
- Visitor/Observation facility
- EA approval for 4 berth sites, 5 MW
- 4 x 34.5kV subsea power cables; 64 MW capacity to be installed
- Comprehensive site and current data

Activities & upcoming events:

- Development of platform for high flow sensors (FAST)
- Ongoing environmental monitoring & research
- Oct: cable lay rehearsals; Power cables 2014
- Nov: 4th berth RFP closes; FIT to be set fall 2013
- Next turbine 2015

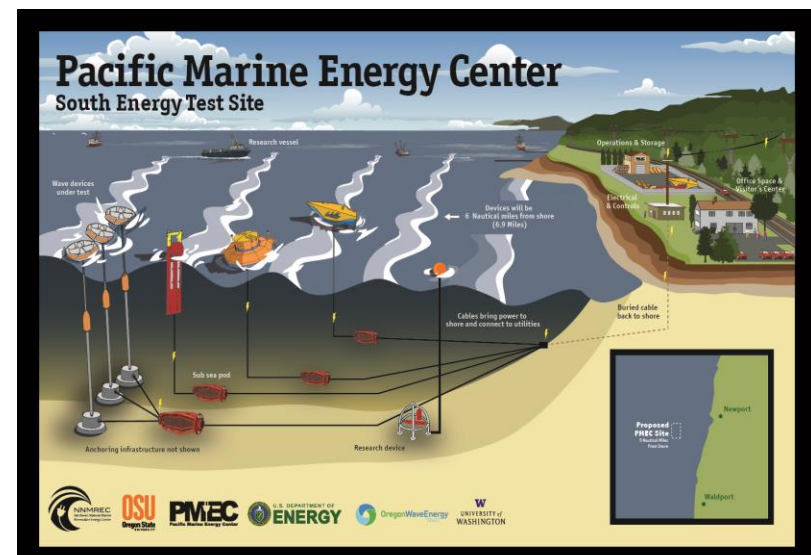
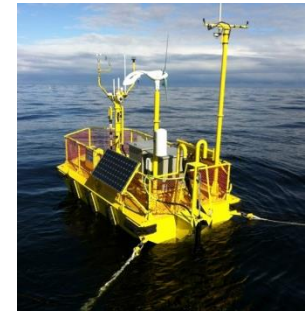
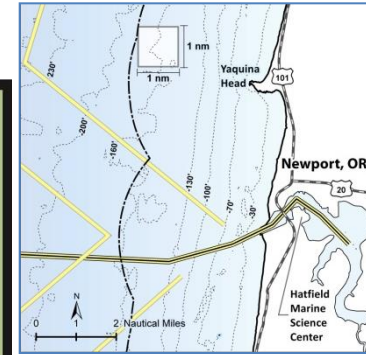
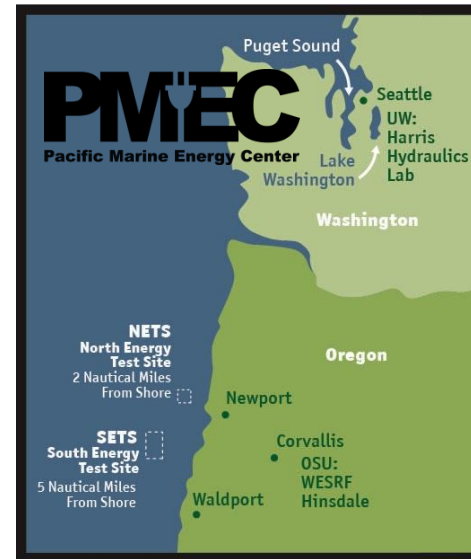




NNMREC: Research and Testing

NNMREC is a collaboration between Oregon State University and University of Washington, providing *research and testing* that advances wave and tidal energy technology. NNMREC's expertise includes technical, environmental, and social aspects, and our work informs the industry and policy makers.

The Pacific Marine Energy Center is NNMREC's suite of testing facilities. PMEC includes scaled laboratory testing, as well as intermediate and full-scale open water testing.





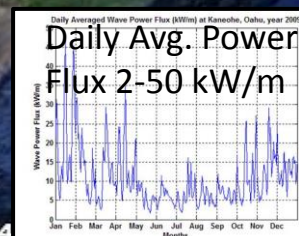
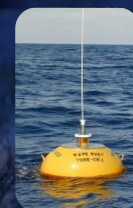
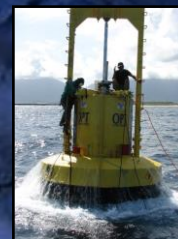
Wave Energy Test Site in Hawaii

Funded by:
US Navy
US Dept. of Energy

- 30m berth in place (~1km offshore)
 - Hosted OPT device
- 60, 80m berths by Dec 2014 (~2km offshore)
- Cabled to shore/grid connected
- Wave input, power matrix, acoustics, EMF measured

Hawaii National Marine Renewable Energy
Center (HINMREC)

Hawaii Natural Energy Institute (HNEI)
School of Ocean and Earth Science and Technology
University of Hawaii at Manoa

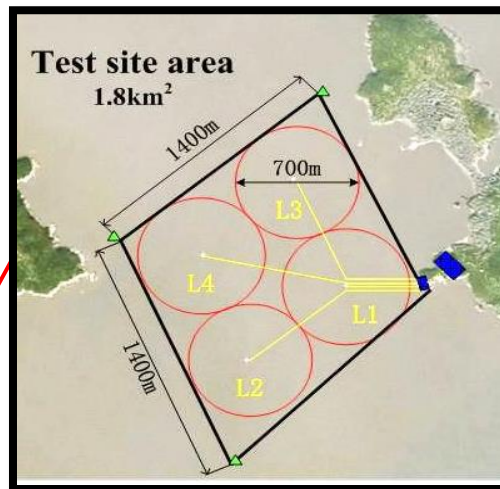


13.914' W elev -64

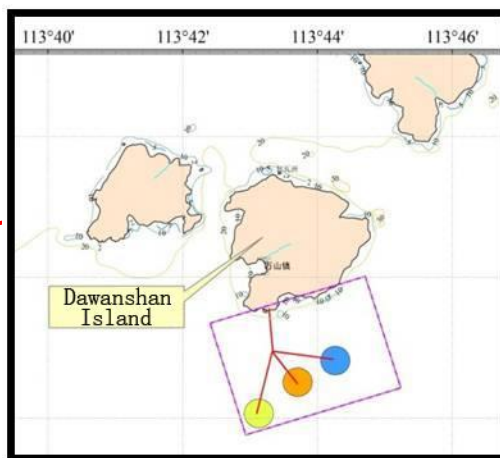


Plan for Marine Energy Device Testing Sites in China

National Ocean Technology Center: Tianjin, China



- Testing site of tidal current energy conversion devices in Zhoushan, Zhejiang;
- 4 tidal test berths;
- 1 MW capacity for single berth.



- Testing site of wave energy conversion devices in Dawanshan, Guangdong ;
- 3 wave test berths;
- 100 kW capacity for single berth.

The funding of supporting test sites construction from Chinese government is more than £ 8m up to 2013 .

Our Test Facilities

Sluice Gates

5 m/s

Open channel flow
Max rotor diameter: 3m
@100kWp devices
No waves, Little turbulence



Towing

2m/s

Pushing by boat
Max rotor diameter: 8m
@ 250kWp



Offshore

2m/s

1MW Grid connection
Floating
Anchors & umbilical
provided







- **Test site infrastructure** within the overall FEM R&D offer :
Environmental impact, resource assessment, marine operations & safety, materials, grid connection, numerical modeling tools etc.
- **A simplified consenting regime** with consistent approach across the sites
- **Le Croisic** : floating wave and wind converters - *hard infrastructure in place, dedicated team, environmental monitoring since 2009*
- **Bordeaux (SEENEOH)** : estuarine tidal or scale ocean tidal - *consents granted, detailed engineering in progress*
- **Paimpol** : tidal - *cable laid, ongoing R&D projects on environment monitoring*
- **Groix & Fos/Mer** : floating offshore wind - *multi MW technologies, Atlantic and Mediterranean, consenting & engineering in progress*



Bimep: Basque Country, Spain

A new up-and-running test centre

- 4 Berths 20 MW connected to the grid
- Fully pre-permitted
- Environmental monitoring
- Favorable wave conditions

Hs<1m	20%
1m<Hs<5m	78%
5m<Hs	2%

Good climate windows for O&M

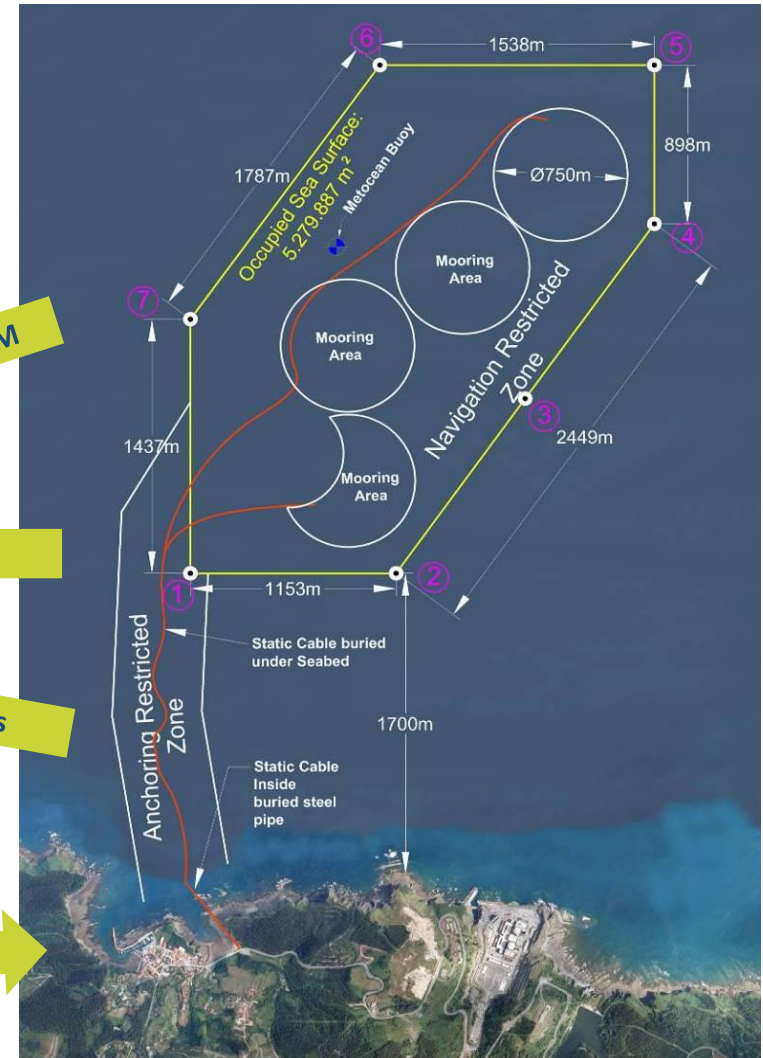
The waves you need

Low exposure extreme waves

- Water depth 50-90 m
- Close enough for fast access
- 24/7 Surveillance and emergency response

1 nmi to port

Next step: floating off-shore wind trials



Danish Wave Energy Test and Demonstration sites

Two sites: Nissum Bredning Test Site - Est. by Nordic Folkecenter on VE in 1998-2000 – 1:40 scale gridconnected infjord site – 6 m depth - 140 m pier – 1st gridconnected WEC – approx. 30 WECs tested .
Hansthholm –Infrastructure Under est. from 2013 – Foundation est. 2009-10 on public funds – Gridconnected ‘Wavestar Energy’ since sept. 2009 (Docked sept. 2013) - 1:2 – 1:1 scales – 6m -30m depths - average 6-15 kW m - 4-5 berths to be est. in ocean marked area 2-3 km from coast – gridconnected in few years –



Services:



Danish Converters



Hanstholm
DanWEC
Danish Wave Energy Center



Ocean Energy Ireland

Atlantic Marine Energy Test Site

- Full-scale open ocean site suitable for trials of arrays
- Foreshore lease application and shore station planning permission submitted

AMETS

Tidal
Test
facility

Galway Bay ¼ scale test site

- National test and demonstration facility for marine energy and technology
- Current user – Acoustic Monitoring IBM/MI/SEAI/Biospheric Engineering
- Infrastructure upgrade underway: Power and data cable and subsea test and monitoring platforms

Galway Bay

Marine Energy
Test Facilities

Irish Maritime and Energy Resource Cluster

- Integration of research and industry expertise
- 2,500 m² Ocean Energy Test Facility
- Lab Scale Wave & Tidal Test facilities
- MaREI

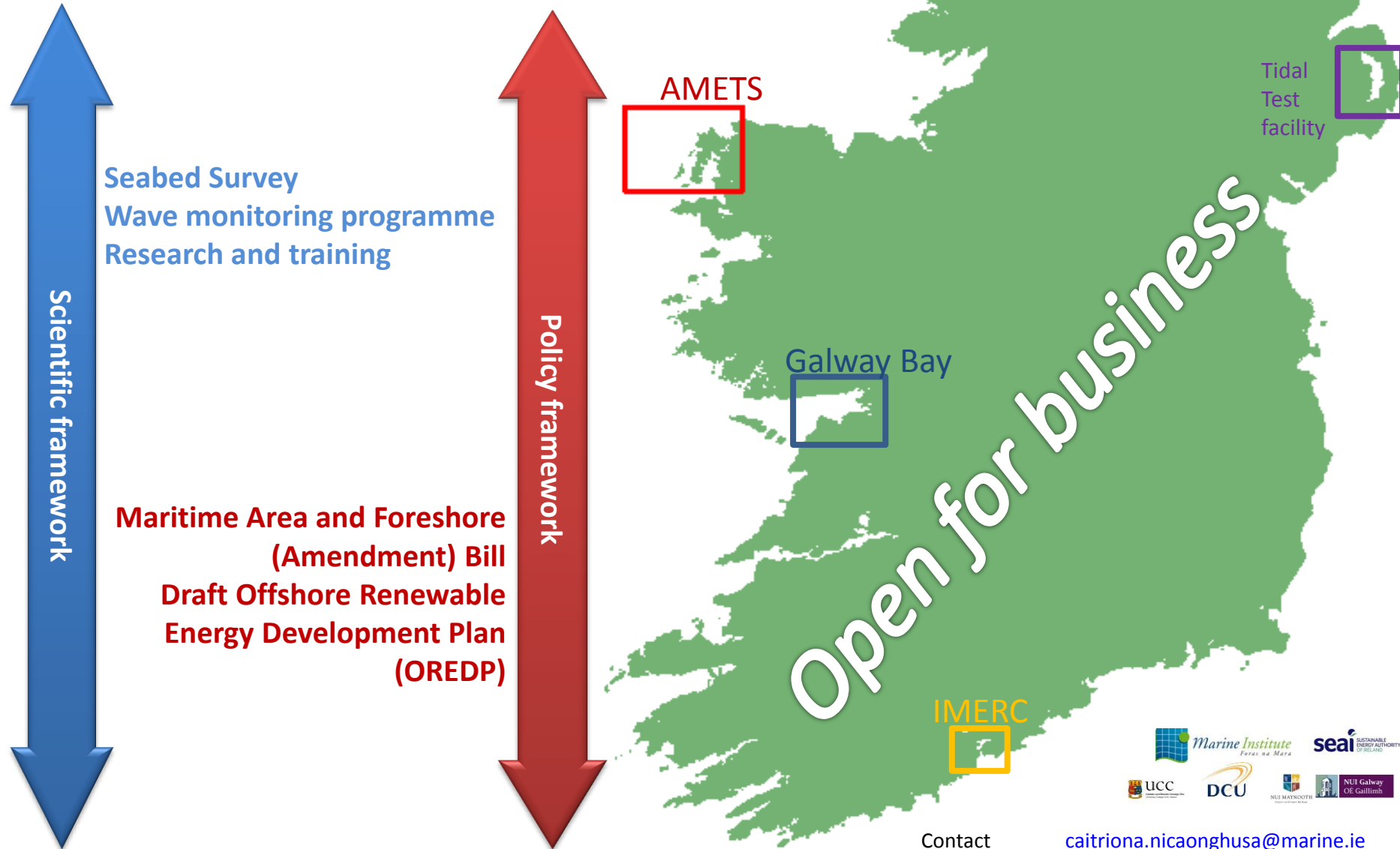
IMERC



Contact

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Ocean Energy Ireland



EMEC: Scotland, UK

Est. 2003 - the world's first and only accredited, grid connected wave and tidal test laboratory

- **Hard infrastructure**
 - 40km 11kv cables feeding national grid
 - 6 wave, 8 tidal and 4 scale test berths
- **Soft support services**
 - consents, environmental monitoring, data collection and analysis
 - over 20 research projects
- **Accredited** performance verification
- **International** consultancy
- **Self-sufficient** after initial £36m public investment



More grid-connected marine energy converters have been deployed at EMEC than any other site in the world



Wave Hub



- Grid-connected facility for large scale testing of offshore energy devices
- Suitable for 10MW wave arrays and floating wind turbines
- Onshore and offshore electrical infrastructure to operate at 11kV & 33kV
- Capacity to generate 50MW
- Purpose built marine renewable business park with harbour access
- Owned by the UK Government and part of the South West Marine Energy Park



World Leading Facilities

- **3MW Tidal Turbine Drive Train Test Facility**
- **Marine Docks Test Facility**
 - Still water tank - 75m x 26m – Depth 8.2m
 - Wave flume - 55m x 5m – Depth 7m
 - Simulated seabed - 85m x 15m
(Sediment thickness 4m covered by 3.5m water)
- **Electrical and Materials Test Laboratories**



Technical Expertise

- Equipment trials
- Accelerated lifetime tests
- Installation techniques
- Prototype development
- Factory acceptance tests & performance verification
- Partner for National and European R&D projects

'A controlled, open access, onshore saltwater environment for all stages of technology development to accelerate commercialisation of marine energy technologies'

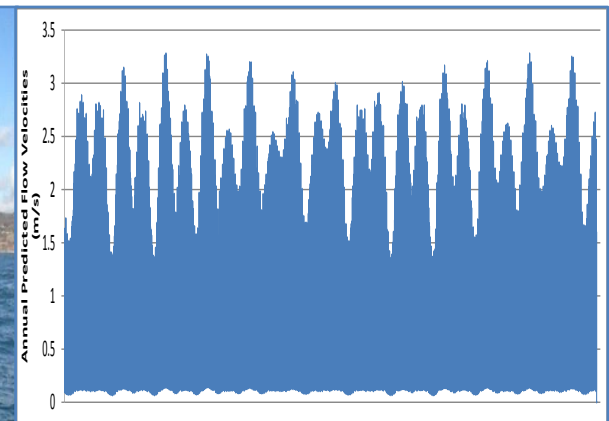
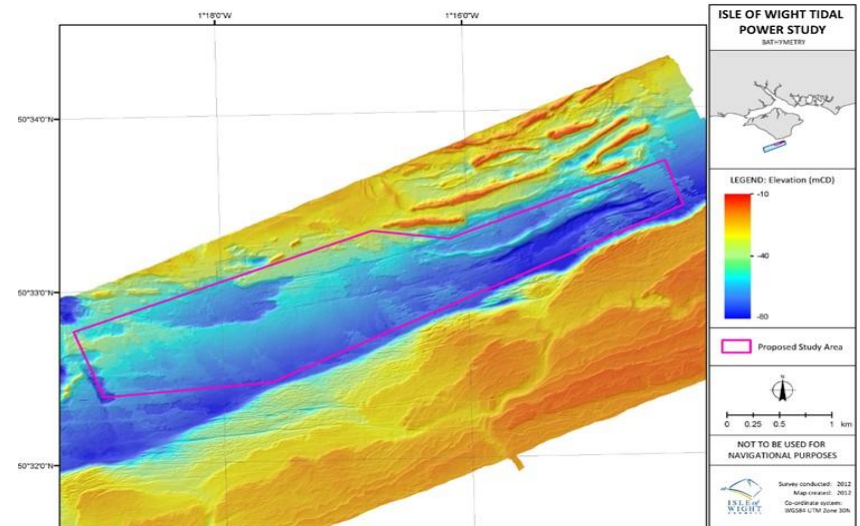
Perpetuus Tidal Energy Centre (PTEC), Isle of Wight, UK

20MW Multi-Device Tidal Demonstration Facility



PERPETUUS
energy

- Tidal stream technologies:
 - Single devices and arrays – TRL 6-9
 - Positive engagement with multiple developers
- Project delivery:
 - AfL secured 2012, consenting underway
 - Operations by 2016
- Connection to the existing IOW grid
- Dedicated project substation and control room
- Headquarters and Portside Support Centre
- Local ports for O&M and support activities
- Tenant support services



PTEC: low risk and cost commercialisation solution | advancing technology development