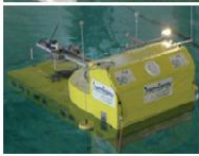
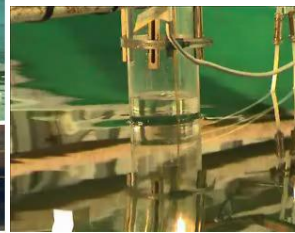
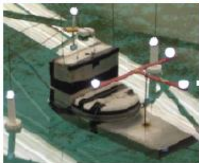


# Hydraulics & Maritime Research Centre

University College Cork

Dr Tony Lewis -  
Director



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## Ireland – Ocean Energy Development

- Marine Renewable Energy
- Wave Energy
- National Programme
- Devices
- European Projects

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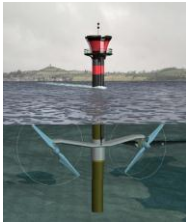




ARKLOW BANK

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Marine Current Turbines  
UK  
1.2 MW  
Strangford Lough  
Ireland



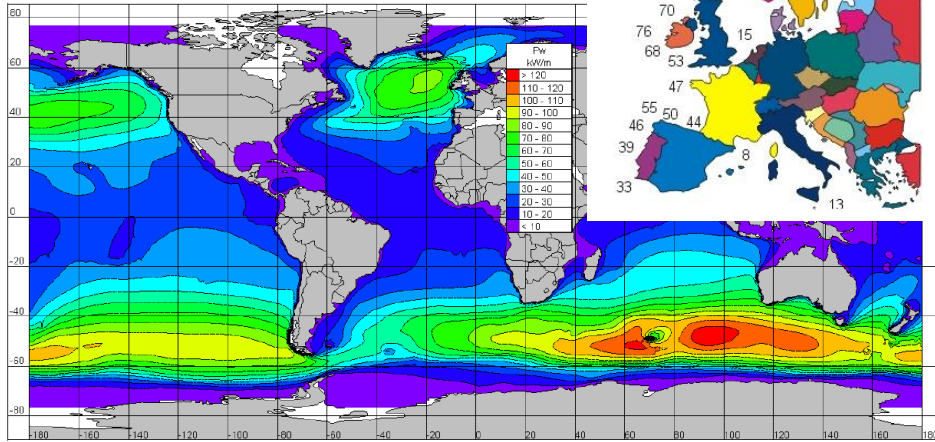
Open Hydro  
Ireland



Total Irish Resource 7% Electricity Demand

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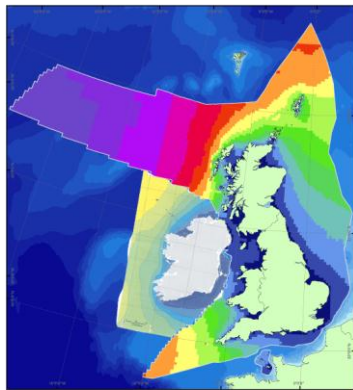
## Wave Energy kW/m



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## Ireland Wave Energy Resource



Mean Wave Power (kW/m <sup>2</sup> of wave front)	Annual Mean Wave Power
0.0 - 0.5	< 10
0.5 - 1.0	10 - 20
1.0 - 1.5	20 - 30
1.5 - 2.0	30 - 40
2.0 - 2.5	40 - 50
2.5 - 3.0	50 - 60
3.0 - 3.5	60 - 70
3.5 - 4.0	70 - 80
4.0 - 4.5	80 - 90
4.5 - 5.0	> 90

### ESBI Wave Atlas Study

Accessible Resource – up to 20 TWh/yr

Ireland Electricity usage 2006 – 25 TWh/yr

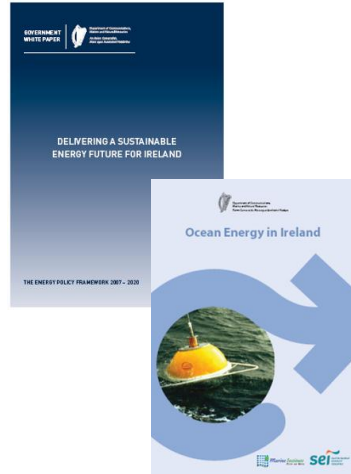
( [www.marine.ie](http://www.marine.ie) )


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# What is needed for Wave Energy Development and Utilisation



- A Plan
- A Strategy
- A Commitment

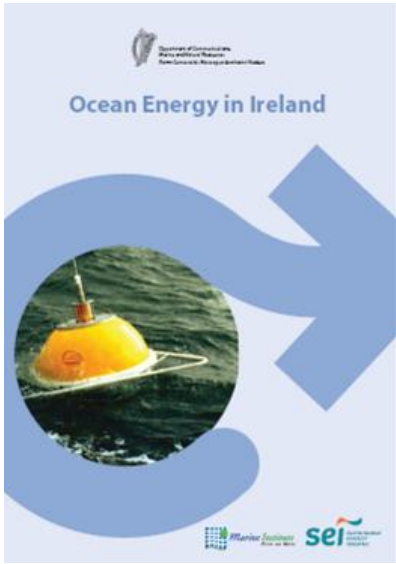


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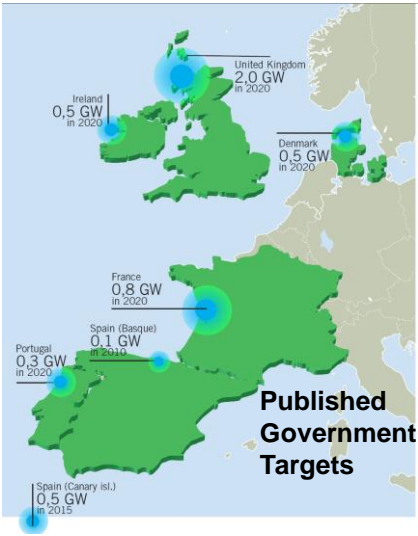
1500 MW by 2030

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**STRATEGY  
for  
DEVELOPMENT**



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**2020 NREAP**  
(National Renewable Energy Action Plans)

UK	1300 MW
Ireland	75 MW
Portugal	250 MW
Spain	100 MW
France	140 MW

**Europe Committed Investment**  
**€5 billion by 2020**

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# Ireland Energy Targets

## •Ireland Government White Paper on Energy

“Delivering a Sustainable Energy Future for Ireland”  
Energy Policy Framework 2007-2020  
pub. 12<sup>th</sup> March 2007

33% Energy from Renewables by 2020.  
500 MW Electricity from Ocean Energy.

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## The Plan - 15 Year Plan of R&D, infrastructure and industry support measures:

### Objectives:

- Support the introduction of Ocean Energy to the Renewables 'portfolio' in Ireland.
- Develop an Irish OE industry sector.

### Targets:

- 500MW installed by 2020
- 1900 jobs created by 2020.

### Three Phases:

- Development -2005-2007
- Pre-commercial (1)-2007-2010
- Pre-commercial (2)-2010-2015
- Commercial –2010-2015

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# Ocean Energy Strategy

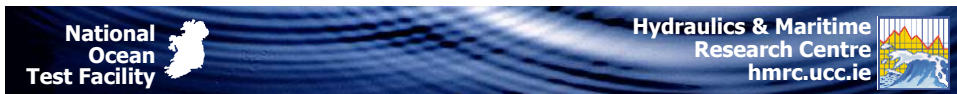
**Phase 1** – R&D Support, Device R&D up to quarter scale (2005-2007)  
**Decision Gate (+ve)**

**Phase 2** – Pre-production Single Device Testing at Sea (2008-2010)  
**Decision Gate**

**Phase 3** - Pre-production Device Array (2010-2015)  
**Decision Gate**

**Phase 4** – Commercial Devices Installed (2015-2020)

***Phase 2 Development delayed by about 2 years***



## Ocean Energy Strategy - Implementation

### **Strategy Phase 1 a** **Research and Development**

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### **Strategy Phase 1 b** **Device Support**

#### **Irish Device Development Companies**

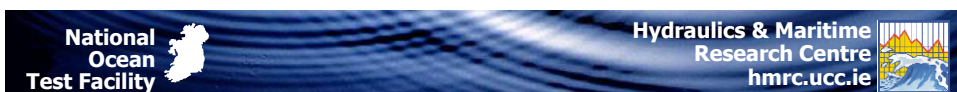
##### **Tidal Stream**

•Open Hydro – Tidal Turbine – Orkney Test Site

##### **Wave Energy**

•WaveBob Ltd. – WAVEBOB – Galway Bay Test Site

•Ocean Energy Ltd. – OE BUOY – Galway Bay Test Site





# Ocean Wave Basin

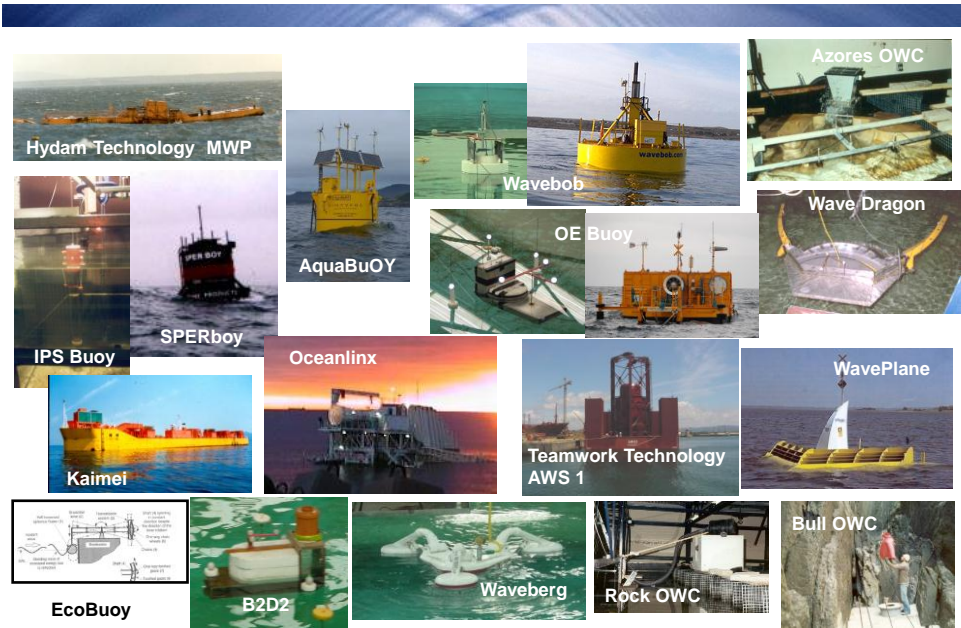


# Ocean Wave Flume

- Active absorption
- Monochromatic, panchromatic and recorded time series
- Non-contact 6 DOF motion capture camera system
- Active control NI Labview DAQ

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Hydam Technology MWP

AquaBuOY

Wavebob

Wave Dragon

Azores OWC

IPS Buoy

SPERboy

OE Buoy

WavePlane

Teamwork Technology AWS 1

Wave Dragon

Kaimet

Oceanlinx

Teamwork Technology AWS 1

WavePlane

EcoBuoy

B2D2

Waveberg

Rock OWC

Bull OWC

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# Ocean Energy Strategy - Implementation



**HMRC - National Centre of Excellence for Marine Renewable Energy**

**Funding Awards**

Marine Institute – Blue Power Initiative

DCENR – Charles Parsons Energy Research Award in Marine Renewable Energy

- Funding for Refurbishment and Facilities Enhancement

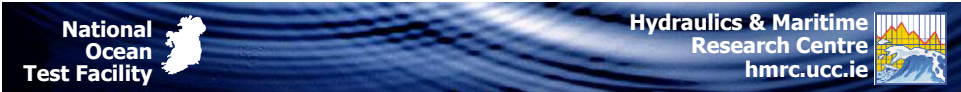
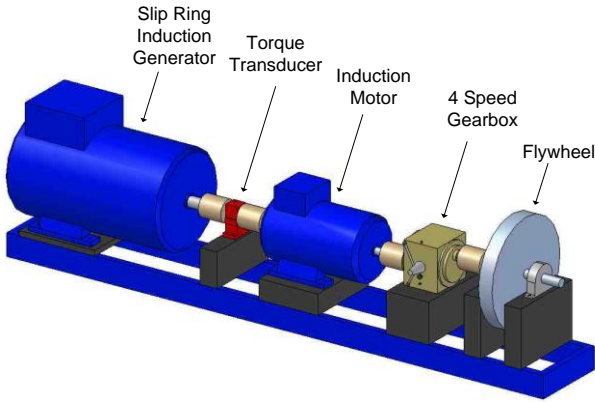
**Outcome**

Increased Staffing – Researchers and Engineers  
Research Manager

Extended Support Duration – 7 years to 2014



# 25kw Rotating PTO Test Rig



## Ocean Energy Strategy - Implementation

### Strategy Phase 1 a

#### Research and Development

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### Strategy Phase 1 b

#### Device Support

#### Irish Device Development Companies

##### Tidal Stream

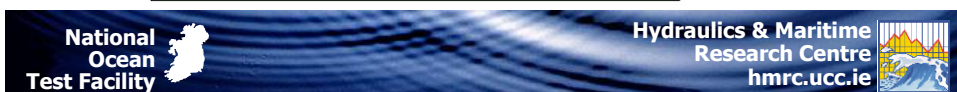
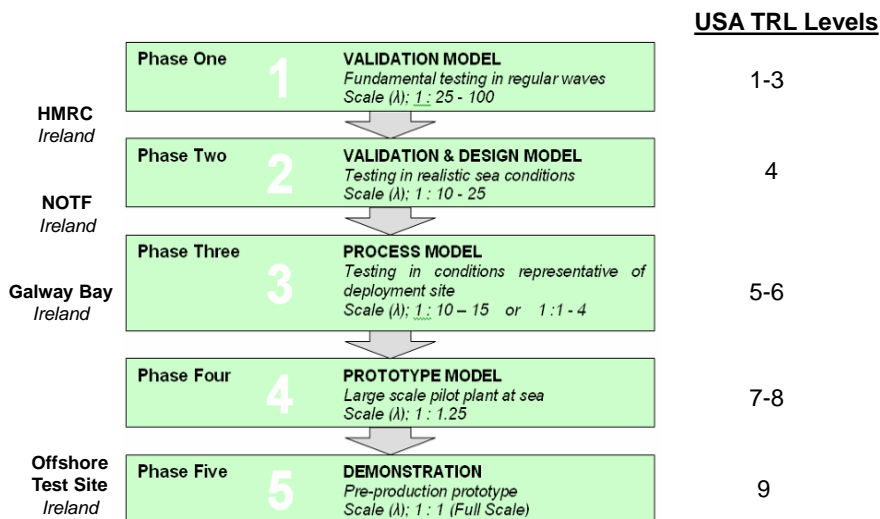
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##### Wave Energy

- WaveBob Ltd. – WAVEBOB – Galway Bay Test Site
- Ocean Energy Ltd. – OE BUOY – Galway Bay Test Site

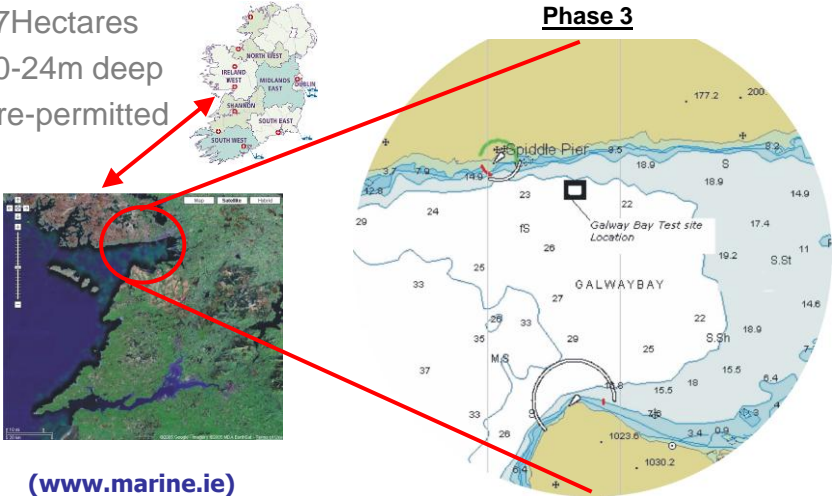


## Ireland Development and Evaluation Protocol (2004)





# Galway Bay Intermediate Scale Test Site

- 37 Hectares
- 20-24m deep
- Pre-permitted



([www.marine.ie](http://www.marine.ie))

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# Wavebob technology

- Self reacting point absorber
- Tuneable & de-tuneable
- Autonomous control
- Accessibility
- Low cost / kWh
- Optimal for ocean waves



Galway Bay 2006

Galway Bay 2008

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# OE Buoy Technology

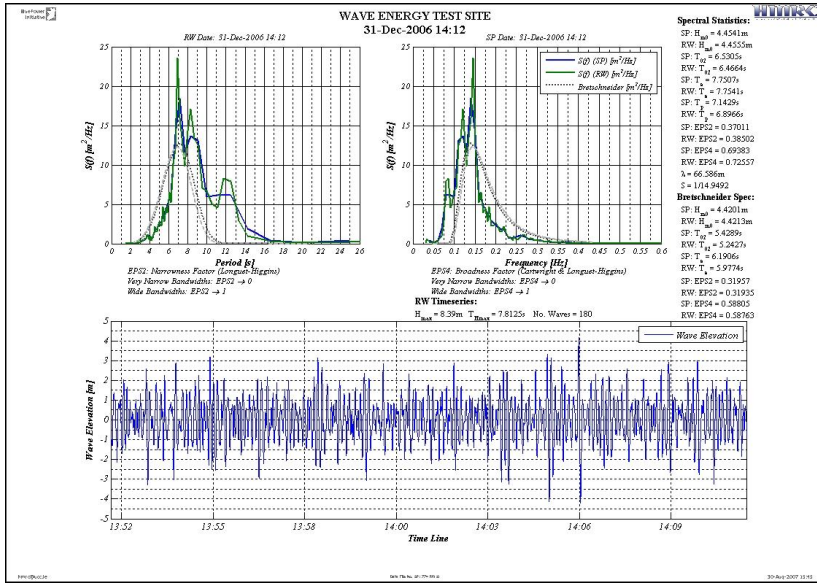
- Pneumatic Conversion Device
- Only one moving part – not in water
- Low Mooring Forces
- Stable Platform
- Predicted Cost of kWh competitive with offshore wind
- 15 months on station
- Survived 20 year storm in Galway Bay



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OE Buoy at Galway Bay Test Site

Hs = 2.5m.

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# CORES

Project Outline – Concludes April 2011

- New Components and Concepts for Ocean Energy Systems based on Floating OWC's
- 4 Work Packages
- Field Trial–OE Buoy

WP2 - Electrical

WP1 - Turbine

Air chamber

WP4 – Modelling, System Integration & Field Trials

WP3 – Moorings, Risers & Deployment

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## Ocean Energy Strategy - Implementation

### Strategy Phase 2 – 2008/2012

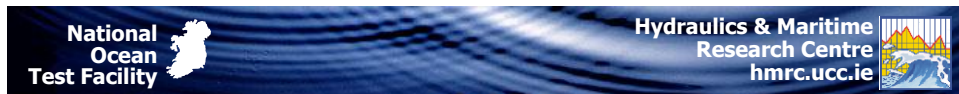
#### Passed Decision Gate for Phase 1

15<sup>th</sup> January 2008

Minister Ryan – Dept Communications, Energy and Natural Resources

€26 million commitment over 3 years

- ◆ Development of National Ocean Test Facility at HMRC
- ◆ Construction of 10MW Grid Connected Offshore Test Site
- ◆ Grant Aid Support for Irish Developers to move to Phase 4 / TRL 7-8
- ◆ Feed-in Tariff of €220/MWh



## Ocean Energy Strategy - Implementation

### Phase 2 – 2008/2012

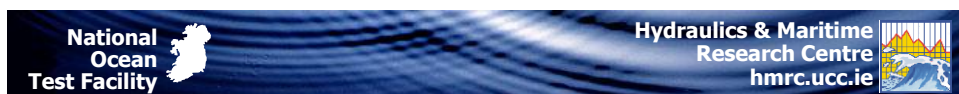
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## Maritime & Energy Research Campus & Commercial Cluster - MERC<sup>3</sup>



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## Atlantic Gateway Building

*HMRC / National Ocean Energy Test Facility - NOETF  
Sustainable Energy Research Group - SERG (Offshore Wind)  
Coastal and Marine Resources Centre - CMRC (CZM, GIS, Planning etc.)*

The UCC research infrastructure in Atlantic Gateway Building is fundamental to the realisation of the MERC<sup>3</sup> concept – anchor tenant – research element to support industry development in cluster.

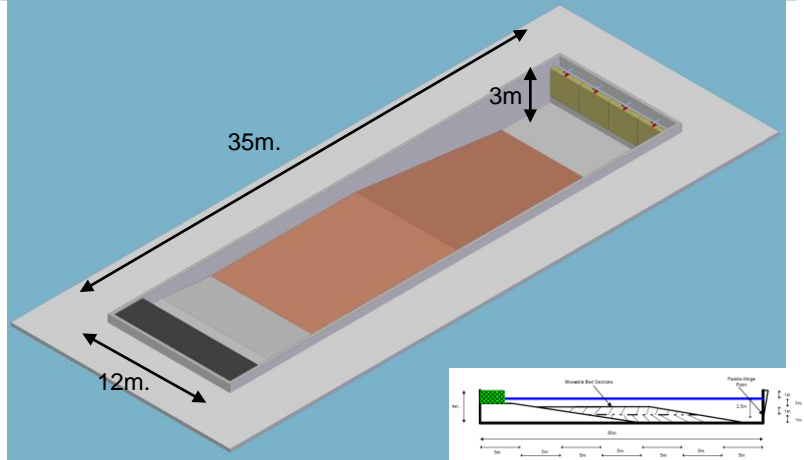
Funding €14 million granted – Govt. / Industry Funds  
Completed in Q1 2013  
Focus – Marine Renewable Energy Development

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## HMRC / National Ocean Energy Test Facility - New Facility

### Combined Large Scale Device Testing and Small Scale Survival Basin



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## Ocean Energy Strategy - Implementation

### Strategy Phase 2 – 2008/2010

#### Pass Decision Gate for Phase 1

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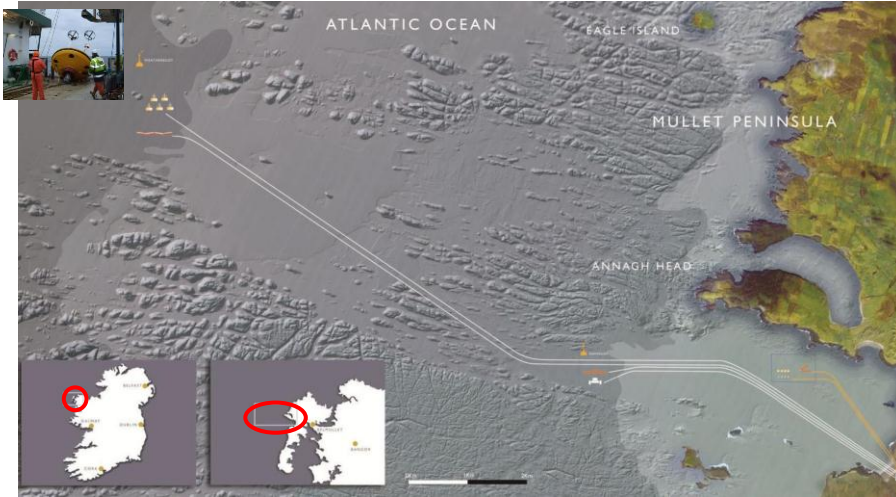
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# Belmullet Grid Connected Test Site

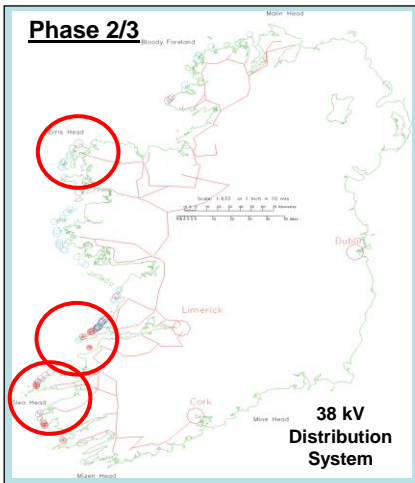



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# Ocean Energy Strategy - Implementation

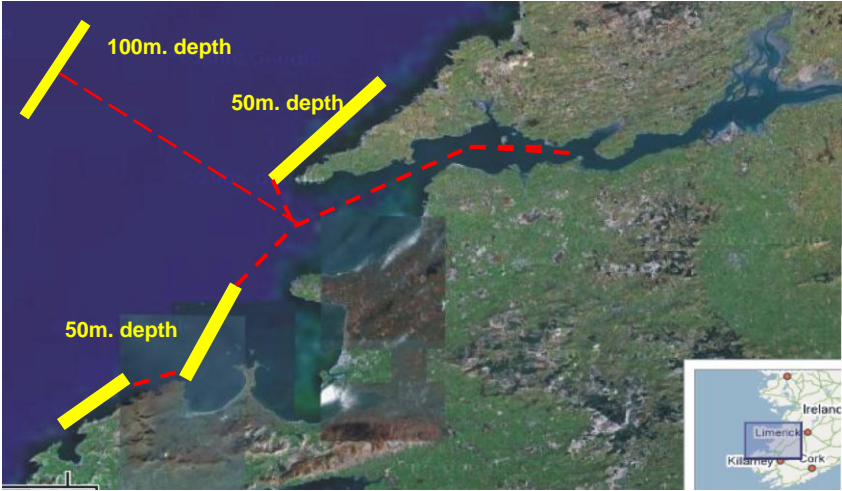
## Grid Connected Demonstrations

## Commercial Development Phase 4 ???

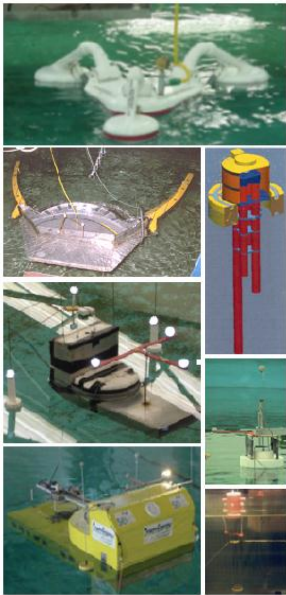


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# Potential Development Site – 500 MW





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## EU ACTIVITY

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Marine Renewable Integrated  
Application Platform

- 17 Partners from 12 Countries
- Objective
- Combining deep offshore wind with wave/tidal
- System integration and cost reduction aims
- Develop and test New designs and concepts of MRE platforms
- Establish a set of criteria transparent criteria for multi-purpose platforms for marine renewable energy (MRE) platforms
- Includes likes of Technip, Statoil Petroleum, HMRC, Uni Edinburgh, DONG Energy, Fraunhofer



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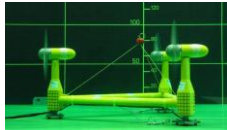
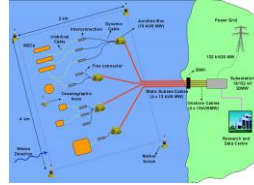


# MaRINET

Marine Renewables Infrastructure Network for Energy Technologies

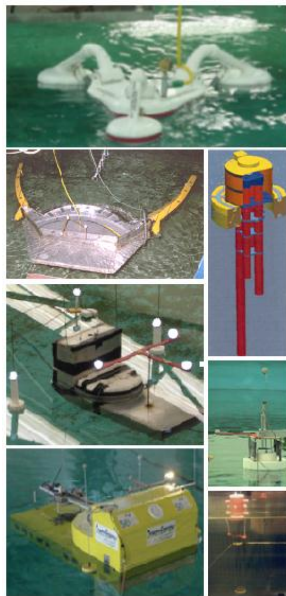


- Coordinated by HMRC and in Negotiation Phase
- Consortium of 28 Partners offering 49 Infrastructures
- Wave Tidal and Offshore Wind
- Systems and components (e.g. PTO)
- All scales of facilities from model testing to full scale
- Infrastructure Access cost will be paid for by EU to the User (e.g. a researcher/developer)



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# Hydraulics & Maritime Research Centre

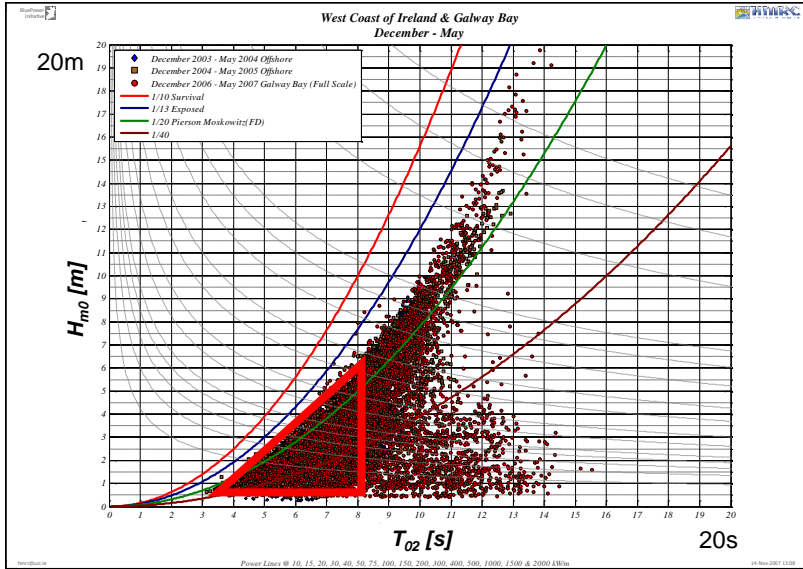
## Cork

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