An update on the market of offshore renewables in France within the European context

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INNOSEA
Offshore Renewables Engineering consultancy

- Providing global multi-physical modeling solutions
- Helping our Clients to reach reliable and profitable Offshore Renewables projects
- **UK (Scotland)** and **France** presence close to the fastest developing marine industry
- **Powerful Software solutions** for Design, Engineering and Installation of Marine Renewable Energy Farms
- **Engineering Designs** for Marines Renewables
- A team of high profiles, specialist engineers, PhDs and project managers

Marine Energy is our core business
Company introduction

- **INNOSEA, technical engineering consultancy dedicated to Marine Renewables**
  - Technical team of 30+ engineers:
    - Aerodynamics, hydrodynamics, civil engineering, structural engineering, offshore installation.
    - Offshore project engineers & managers
  - Technical advisory board:
    - Two senior expert-engineers from the offshore Oil and Gas industry (+ 20 yrs experience)
    - Strong R&D support in hydrodynamics, civil and structural engineering (3 R&D Departments)

- **Our Clients**
  - Utilities
  - WTG Manufacturers, Tower manufacturers
  - Yards (including Foundation manufacturers)
  - Engineering, EPC, EPCI companies, Foundation designers
  - Other: TSOs, BOP component manufacturers: cables, hubs, etc.
MRE Offshore Engineering

- Turbine – Foundation design support: Concept, FEED, Detail Engineering
- Installation operations engineering
- Cable route engineering and stability analysis
- CAD drawing capability
- Project certification process application
- Technical compliance

- Load analyses for offshore wind turbines
- Structural FEA
- Various hydrodynamic models
- Soil-Pile and Geotechnical analyses
- Small-scale tests & studies
- Analytical & Numerical approaches
- Offshore standards knowledge & application
Advisory, Strategy & MRE Market analysis

- **Strategy consulting and operational support**
  - Over 5 years of technical and strategic advisory references
  - 100% specialized engineers & Strategy Consultants in Marine Renewable Energies with various backgrounds

- **Key references**
  - ORE Supply Chain development in Regional Areas – Confid.
  - Ouest Normandie Energies Marines – Tidal E Strategic development
  - MERiFIC – Bretagne Développement Innovation
    Economical Strategy for Marine Energies in the Atlantic Area
  - Atlantic Power Cluster – Agence régionale Pays de la Loire
    Comparative study of European methodologies used at regional/state level to identify priority zones for the development of MRE
  - Atlantic Power Cluster – Aquitaine Region
    Analysis of the requirements for the development of the wave sector in Aquitaine

- **Our Customers**
  - Institutional players (public authorities, States, clusters, …)
  - Small/medium/large companies
  - New entrants
  - Industrials and major contractors
The French context for MRE

- French context for MRE
  - 20-20-20 initial objectives
  - Prospective Electricity law programme
  - “Grenelle de la Mer” national debate & roadmap 2009 to 2012
  - Energy Transition Bill in 2015 including **BLUE** growth

- National Maritime & Coastline strategy
- Ports & Maritime transport strategy
- Maritime safety & security strategy

“The development of this new industry will contribute to the achievement of the ambitious target to generate 40% of France's electricity from renewable sources by 2030”
Introduction

Review of MRE technologies

After 2025

Between 2000 and 2025

Before 2000

Technological readiness

Fixed Offshore Wind

Tidal range

Tidal stream

Floating Offshore Wind

Commercial arrays

Pilot farms

Wave

OTEC

Full scale prototypes

Demonstration

Start date

Salinity gradient

2015-11-16 – Wave EC Seminar - Hakim MOUSLIM
**WORLD MRE practical resource**

- **Resource > 3000 GW**
- **Resource > 1000 GW**
- **2 sectors ~100 GW**

**Floating Offshore Wind** ~4000 GW

**Fixed Offshore Wind** ~1000 GW

**Wave** ~1000 GW

**Tidal Stream** ~100 GW

**OTEC** ~150 GW*

Practical MRE resource is equivalent to world’s annual electrical consumption – 20000 TWh/y

*located in tropics

2015-11-16 – Wave EC Seminar - Hakim MOUSLIM
FRANCE MRE practical resource

Floating Offshore Wind

~140 GW based on 25 000 km²
Depth > 50m

Fixed Offshore Wind

~80 GW based on 10 000 km²
Depth < 50m

Wave

~15 GW Metropole

Tidal Stream

~3 GW

OTEC

Sources: SER, FEE, IFREMER, France Energies Marines
MRE technologies in France

- Floating Offshore Wind
- Fixed Offshore Wind
- Wave
- Tidal Stream
- OTEC

Various concepts but low TRL
France: A robust Offshore Supply Chain

Eg. Offshore wind

Strong national supply capacity

International aims (eg. Turbines, Vessels, ...)

European Market

Source: BVG Associates
France

An Overview

Pilot & Commercial Projects focus

Source: BVG Associates
The French context – an overview

LES ÉNERGIES RENOUVELABLES EN MER EN FRANCE :
PANORAMA DES PROJETS LES PLUS AVANCÉS

LÉGENDE

Site d’essai / démonstrateur
Ferme pilote
Ferme commerciale
Éolien offshore
Éolien flottant
Marénopteur
Hydroien
Hydroien estuarien
Houlomoteur
SWAC (See Water Air Conditioning)
Énergie thermique marine
The French context – an overview

Objectif 2030: 21 GW d'éolien en mer
(15 GW pose + 6 GW flottants)

Wind resource at 50 metres above ground level for five different topographic conditions.

Source: European Wind Atlas.

INNOSEA
Offshore Wind projects - France

1st Round in 2011: 4 projects launched in 2012
2 Tender Rounds closed
6 projects launched
3 GW granted
0 W in operation

Goal: 6 GW by 2020

3rd round to be launched by end of 2015

2030 objectives:
- SER: 15GW Offshore Wind
- FEE: 21GW Offshore Wind (15GW Fixed, 6 floating)
Offshore Wind projects - France

1st pilot farms tender released in 2015

4 pilot farm development zones

€150 million available

A third as subsidies and two-thirds as loans

Projects range from 45 to 100MW

Feed-in tariff bids
First Tender for Tidal Pilot projects
- Raz Blanchard
- Ouessant Fromvoeur

Two projects in Raz Blanchard:
- EDF-DCNS OpenHydro
- GDF-ALSTOM

One independent project in Fromvoeur:
- SABELLA
OTEC Pilot projects

Tender phase State

10MW base electricity production

Nautilus project – onshore ~ 5MW
# Leasing process comparison

<table>
<thead>
<tr>
<th>Country</th>
<th>Strategic Environmental Assessment for ocean energy</th>
<th>Maritime Spatial Plan in place</th>
<th>'One-stop-shop' for consenting</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Wave</td>
<td>Tidal</td>
<td></td>
</tr>
<tr>
<td>Denmark</td>
<td>No</td>
<td>No resource</td>
<td>Under development</td>
</tr>
<tr>
<td>France</td>
<td>No</td>
<td>No</td>
<td>Under development</td>
</tr>
<tr>
<td>Ireland</td>
<td>Yes</td>
<td>Near completion</td>
<td>No</td>
</tr>
<tr>
<td>Portugal</td>
<td>No</td>
<td>No resource</td>
<td>Yes</td>
</tr>
<tr>
<td>Spain</td>
<td>No</td>
<td>No resource</td>
<td>Yes**</td>
</tr>
<tr>
<td>UK – Scotland</td>
<td>Yes</td>
<td>Yes</td>
<td>Near completion***</td>
</tr>
<tr>
<td>UK – England</td>
<td>Yes</td>
<td>Yes</td>
<td>Under development</td>
</tr>
<tr>
<td>UK – Wales</td>
<td>Yes</td>
<td>Yes</td>
<td>Under development</td>
</tr>
<tr>
<td>UK – Northern Ireland</td>
<td>Yes</td>
<td>Yes</td>
<td>Under development</td>
</tr>
</tbody>
</table>

Source: SI-OCEAN
# Financial incentive comparison

<table>
<thead>
<tr>
<th>Member State</th>
<th>Market pull</th>
<th>Technology push</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.K.</td>
<td>• 20yr ROCs replaced by 15 yr CfD in 2017 CfD = €375/MWh until 2019</td>
<td>• MEAD, ETI, TSB, Crown Estate Scottish Government Grants and Equity investment (total c.€120m)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Estb. FEM (€133m for 10yrs)</td>
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<tr>
<td></td>
<td></td>
<td>• De-risk technology upfront to ensure successful projects</td>
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<tr>
<td></td>
<td></td>
<td>• ADEME (€40m Investing for the Future)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• €200m Capital support for pilot projects</td>
</tr>
<tr>
<td>FRANCE</td>
<td>• Approx. € 173/MWh</td>
<td></td>
</tr>
<tr>
<td>IRELAND</td>
<td>• €260/MWh up to 30MW from 2016</td>
<td>• SEAI Prototype Dev. Fund (€10m)</td>
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<tr>
<td></td>
<td></td>
<td>• RE RD&amp;D prgm (€3.5m)</td>
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<td></td>
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<td>• Ocean Energy Development Budget (€26.3m)</td>
</tr>
<tr>
<td>SPAIN</td>
<td>• Moratorium suspending FIT for all renewables</td>
<td>• BIMEP (€20m invested 2007-2014)</td>
</tr>
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<td></td>
<td></td>
<td>• PLOCAN (€20m for construction 2007-2014; €16m for O&amp;M between 2015 and 2021)</td>
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<tr>
<td></td>
<td></td>
<td>• Ocean Lider (€15m for R&amp;D support, 2009-2013)</td>
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<td></td>
<td></td>
<td>• EVE (€3m Demonstration support, 2014-2015)</td>
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<tr>
<td>DENMARK</td>
<td>• Approx. € 80/MWh</td>
<td>• Energinet.dk manages funds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Energy Agreement (£2.9m)</td>
</tr>
<tr>
<td>PORTUGAL</td>
<td>• Scheme halted</td>
<td>• FAI, QREN (not specific for W&amp;T)</td>
</tr>
<tr>
<td></td>
<td>• Previously €260/MWh decreasing with capacity</td>
<td></td>
</tr>
</tbody>
</table>

Source: SI-OCEAN
Thank you for your attention
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## Resource assessment

<table>
<thead>
<tr>
<th>Theoretical resource</th>
<th>Technical resource</th>
<th>Techno-economical resource</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Resource characteristics</td>
<td>• Typical system characteristics • Operable resource assessment • Electrical connection specifications • Wake effect</td>
<td>• Space occupation - Constraints • Economical project profitability • Levelized Cost Of Energy</td>
</tr>
</tbody>
</table>

**Source:** WEBER J., WEC Technology Performance Levels (TPLs) - Metric for Successful Development of Economic WEC Technology, 2013