PECC Seminar 1 on Energy Transition

Victoria, 7-8th November 2013

# Predictability and Reliability of Marine Renewable Energy:

## Building on Marine Industry Experience


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***IFREMER, The French Ocean Research Institute***

# Presentation

- ❑ Introduction
- ❑ Current technical issues
- ❑ Development possibilities
- ❑ Conclusion

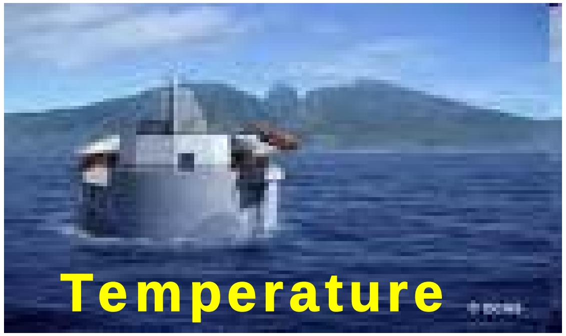
# IFREMER:
# French Ocean Research Institute

INSTITUT CARNOT
Ifremer-EDROME





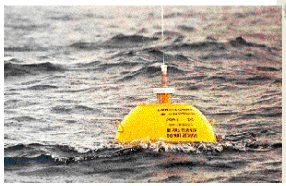
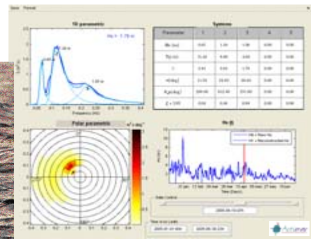
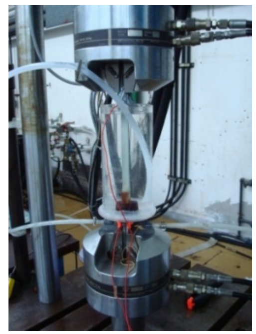
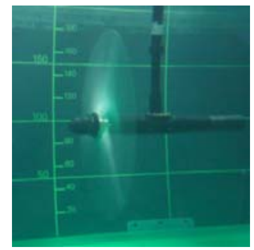
***Marine renewable energies***

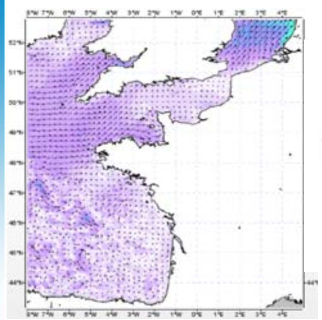
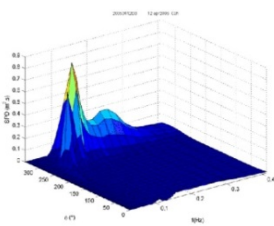
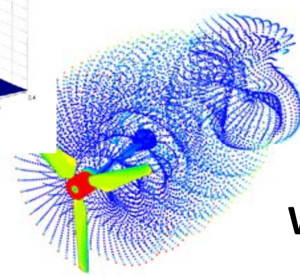
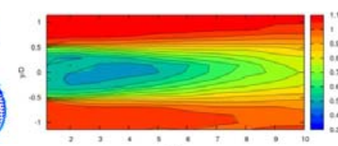





Ifremer

# IFREMER: an institute involved throughout the renewable marine energy development process

**Wave tank testing**


http://www.previmer.org/

**Resource evaluation**

**Metocean studies**

**Materials & structural testing & modelling**

**Marine operations**

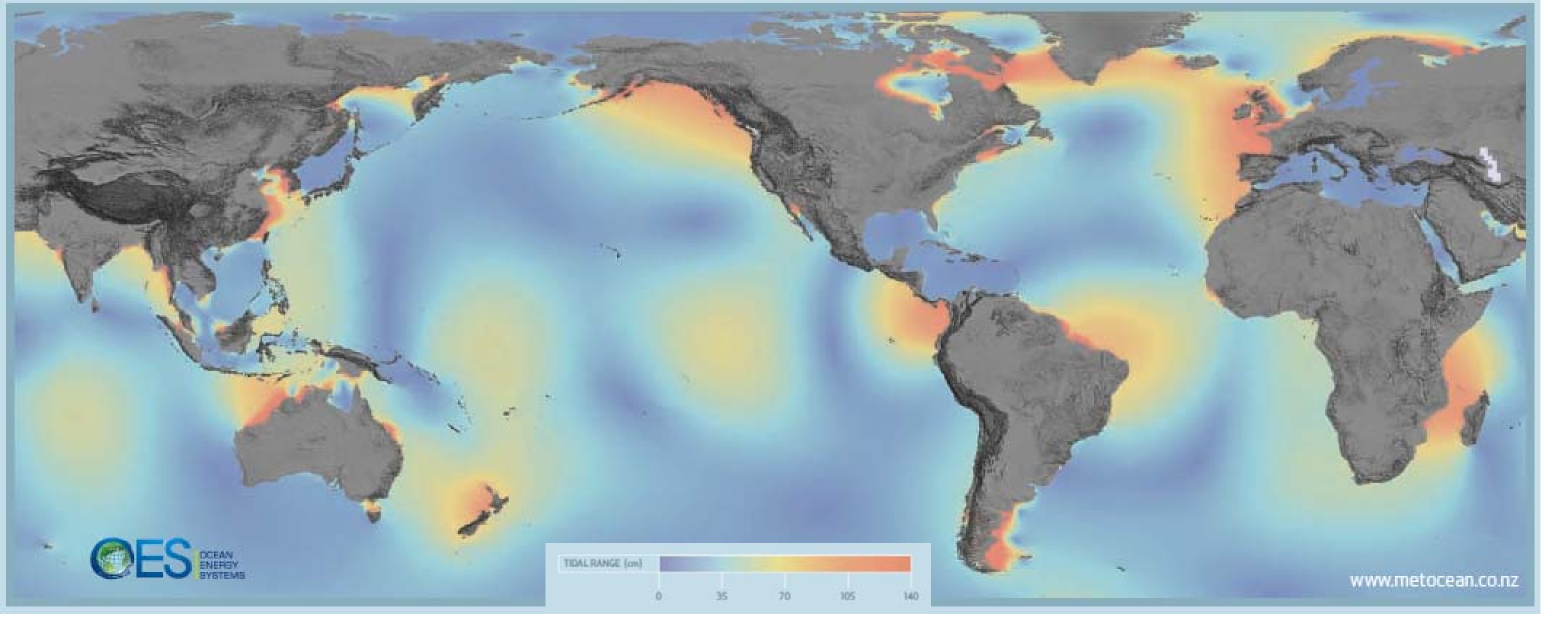
**Impact assessment**

# Presentation

- ❑ Introduction
- ❑ Current technical issues
  - Resource
  - Device
  - Marine operations
  - Environment
- ❑ Development possibilities
- ❑ Conclusion

# Resource prediction

**e.g. Tidal energy: Global locations well known**




**Oceanographic experience**

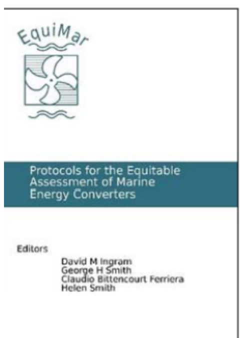
**Databases available (PREVIMER, CERSAT, …)**

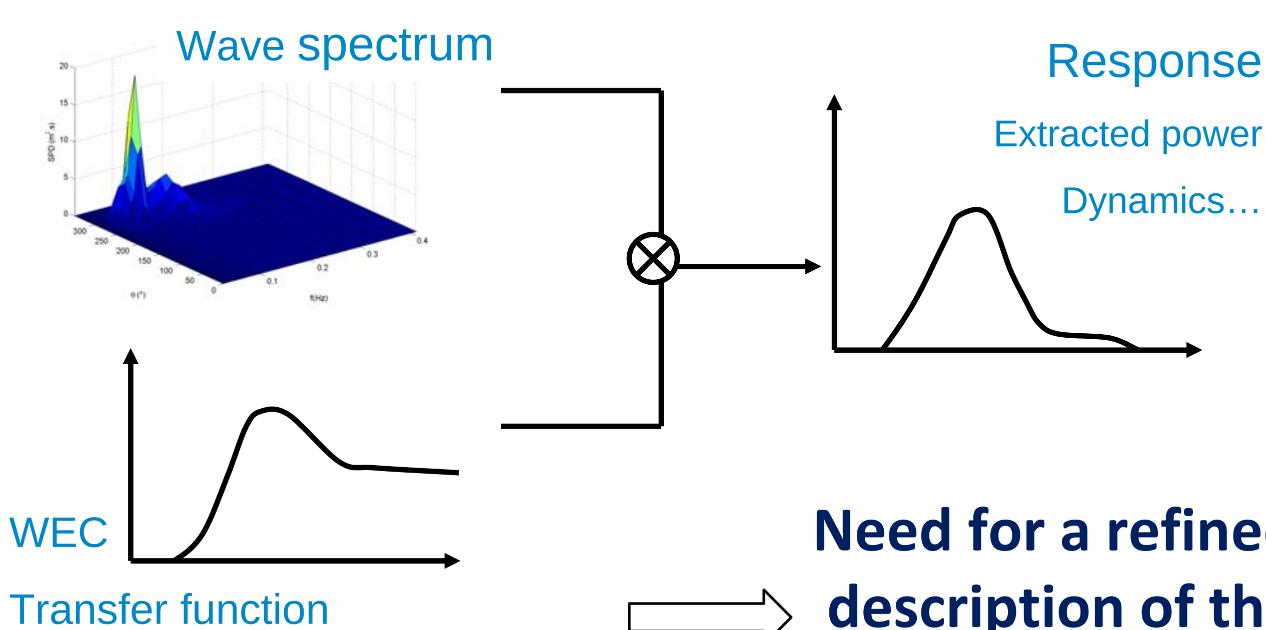
**But not always at the scale needed for reliable local estimations of energy predictability**

# Resource assessment and mapping

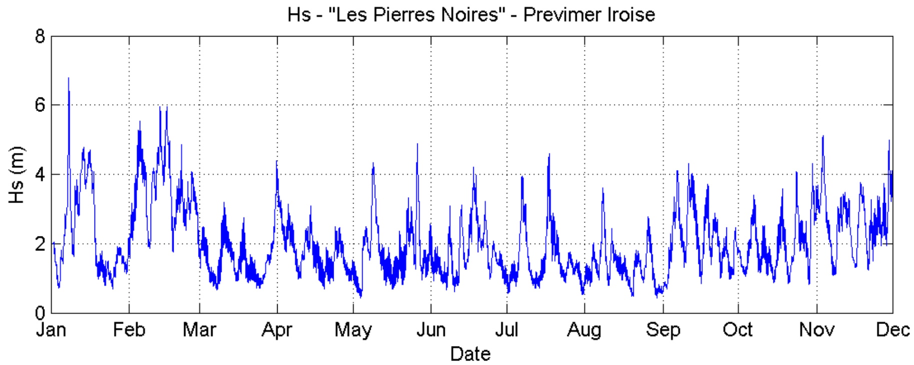
- Definition of the Energy Resource
- Design & Engineering (optimization, structural fatigue, response to extreme events)
- Marine Operations (deployment, maintenance,…)

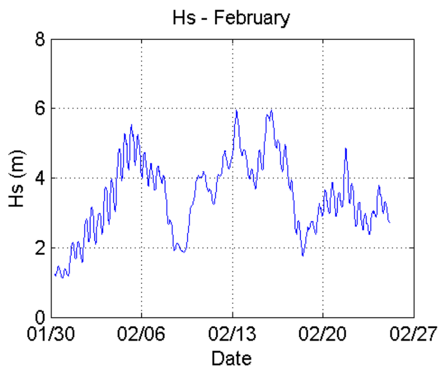
**Protocols**

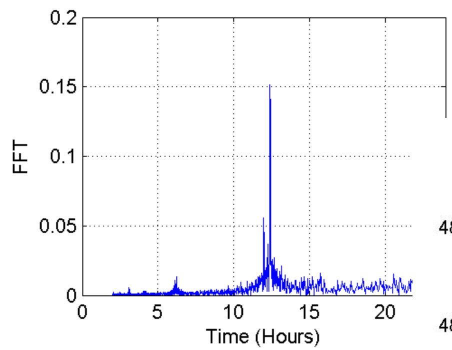

EquiMar
Protocols for the Equitable Assessment of Marine Energy Converters
Editors
David M Ingram
George H Smith
Claudio Bittencourt Ferriera
Helen Smith




**Need for a refined description of the environment**

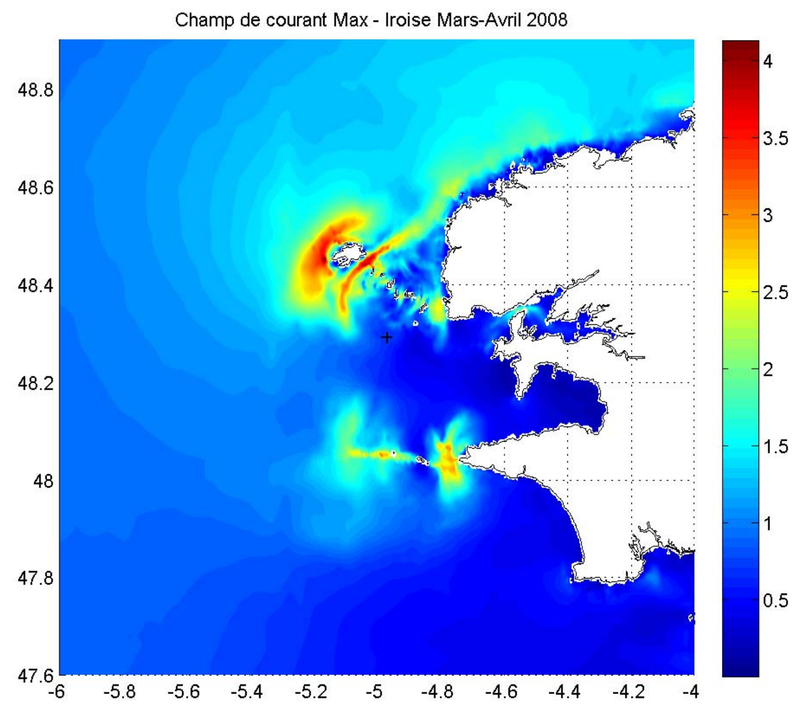



# Time and

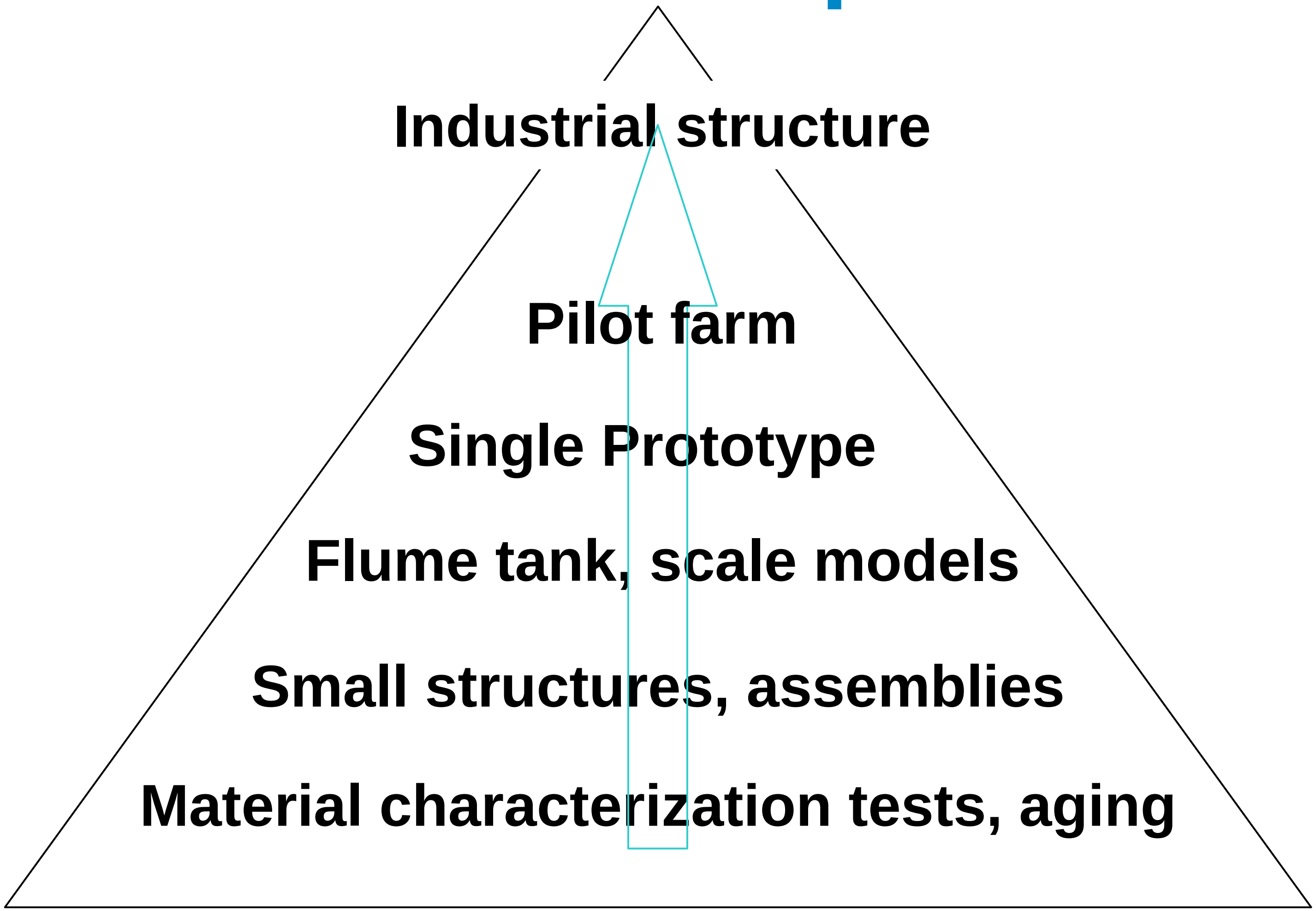
# spatial variations




## MRE devices very sensitive to frequency and direction of sea states

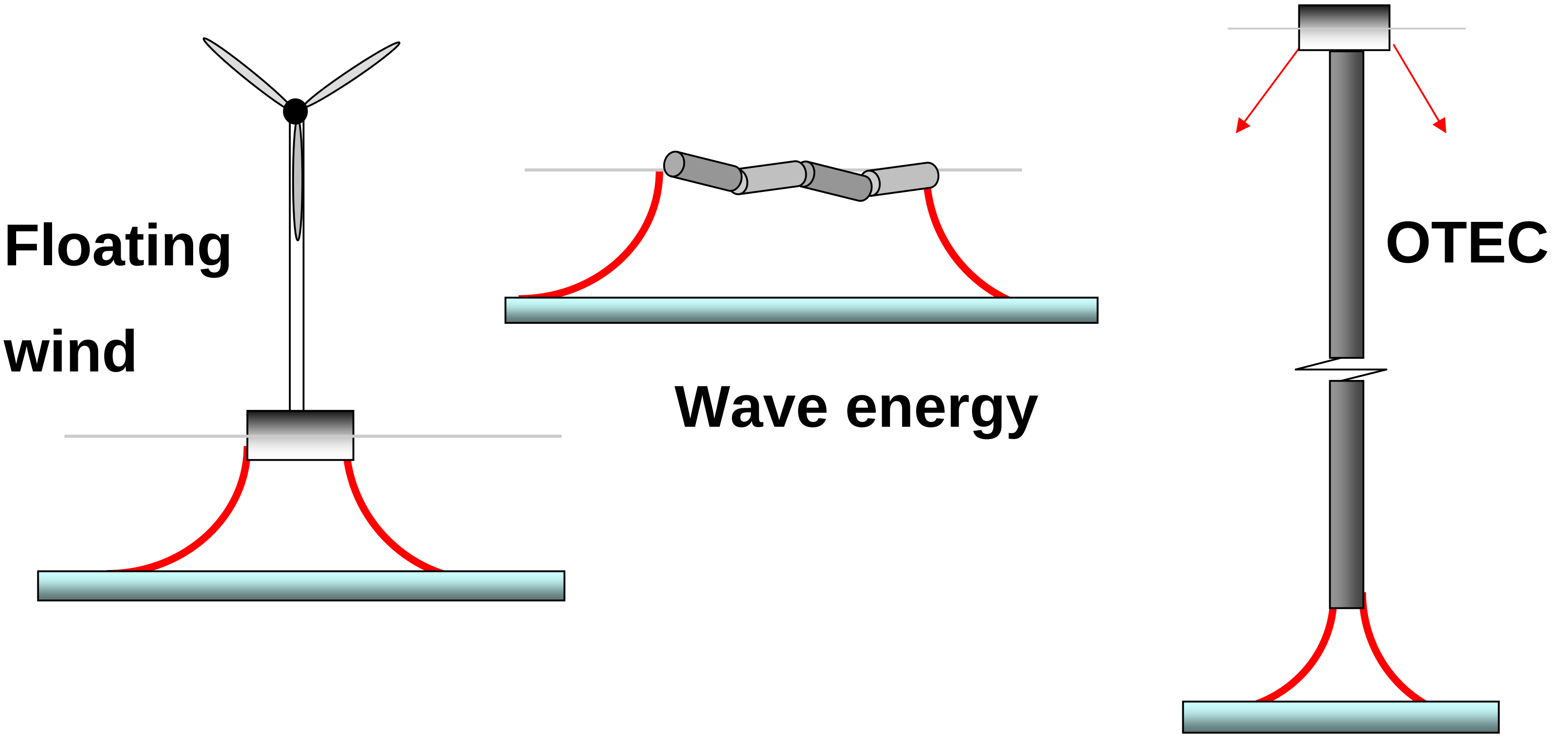
## Specific MRE developments, e.g. HOMERE, MERIFIC…

# Device development




Marine and Offshore experience ?

# Key elements for reliability (1): Mooring systems



# Key elements for reliability (1): Mooring systems

**Extensive offshore experience, Cerification and standards**

**Detailed understanding….**

**but Mooring systems still fail (**Noble Denton HSE report 2006**),**

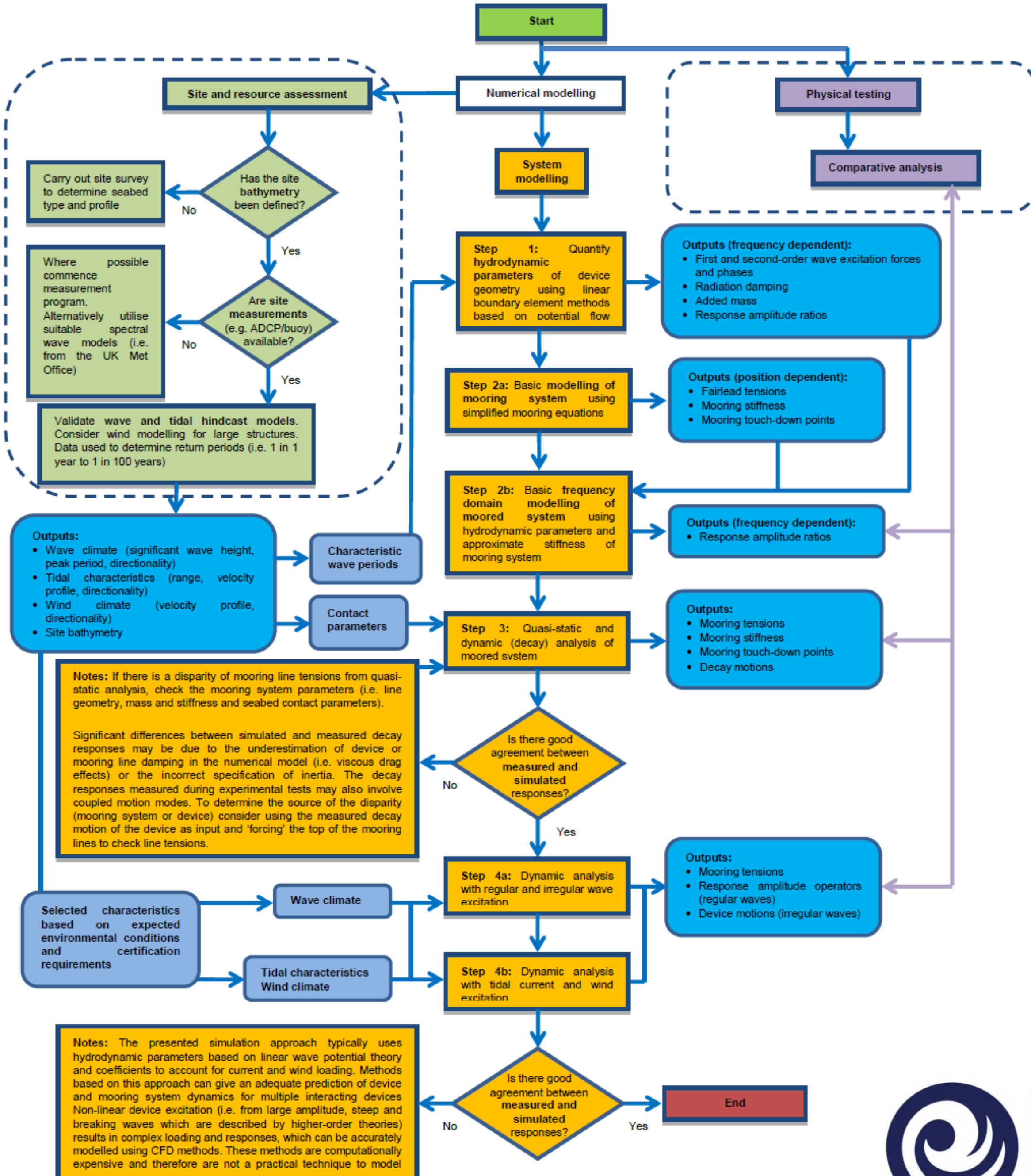
**1 failure every 3 years of operation**

**Include redundancy**

**Specific MRE requirements (eg Damping)**

**DNV-OSS-213 *Certification of Tidal and Wave Energy Converters guideline (2012)***

***IEC/TS (2013) Marine energy - Wave, tidal and other water current converters - Part 10: The assessment of mooring system for marine energy converters (MECs). IEC/TS 62600-10 Ed. 1.0 In preparation***

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MERiFIC
Marine Energy in Far Peripheral and Island Communities

# Key elements for reliability (2): Tidal turbine blades

MCT-Siemens

OpenHydro-DCNS (EDF)

TGL-Alstom

Atlantis

**Seawater Immersion**

**Fatigue**

**Impact,**

**Erosion**

**Fouling …**

# Experience of large composite structures

# at sea ( >50 years)

HMS Wilton, 1972



**Pleasure boats, military ships, submarines, …**

**Mostly low performance glass/polyester laminates**

**BUT little interest in cyclic loads**

Increased laboratory testing (diffusion, aging, coupling…) will improve material reliability


But only experience at sea will give confidence on load levels and large structure response

# Cost reduction & improved Reliability

Usage of components/methods from mature industries: e.g. offshore wind, oil & gas, marine systems and electrical/automation components

**K. Kölmel, Siemens, ICOE 2012**

# Marine operations

**Installation estimated to be 27% of lifetime cost for a tidal turbine**

**(SI Ocean Energy, 2013)**

## Marine operations experience

**Development of specific weather window software to reduce installation risks**

**Construction of special installation vessels**

**Modular systems to facilitate maintenance ….**

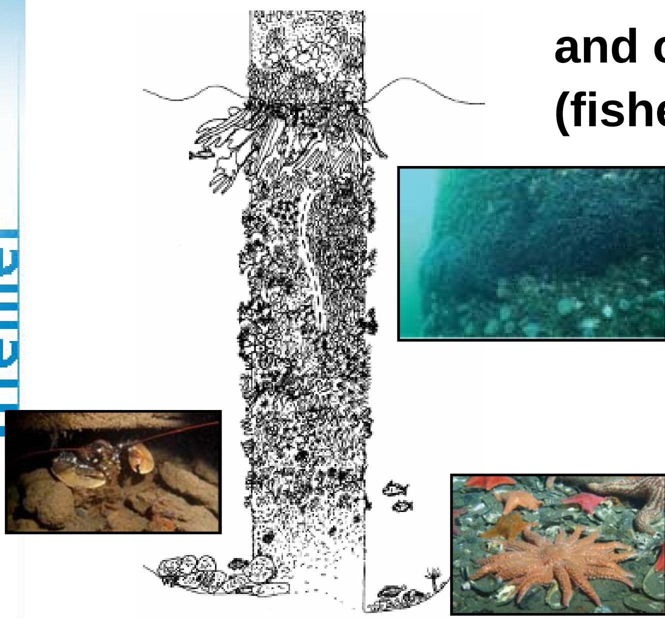
# Environmental impact

**Physics** — **modification of the resource (waves, current)**
**wake effects of current turbines on sediments**
**effects of large scale OTEC exploitation**

**Biology** — **effects of radiated noise and electromagnetic field**

**modification of the subsea ground and biotope**

**Social** — **positive and negative interactions between marine energy extraction and other sea users (fishermen, maritime transport,…)**



**What is acceptable ?**

**Need guidelines for developers**

# Presentation

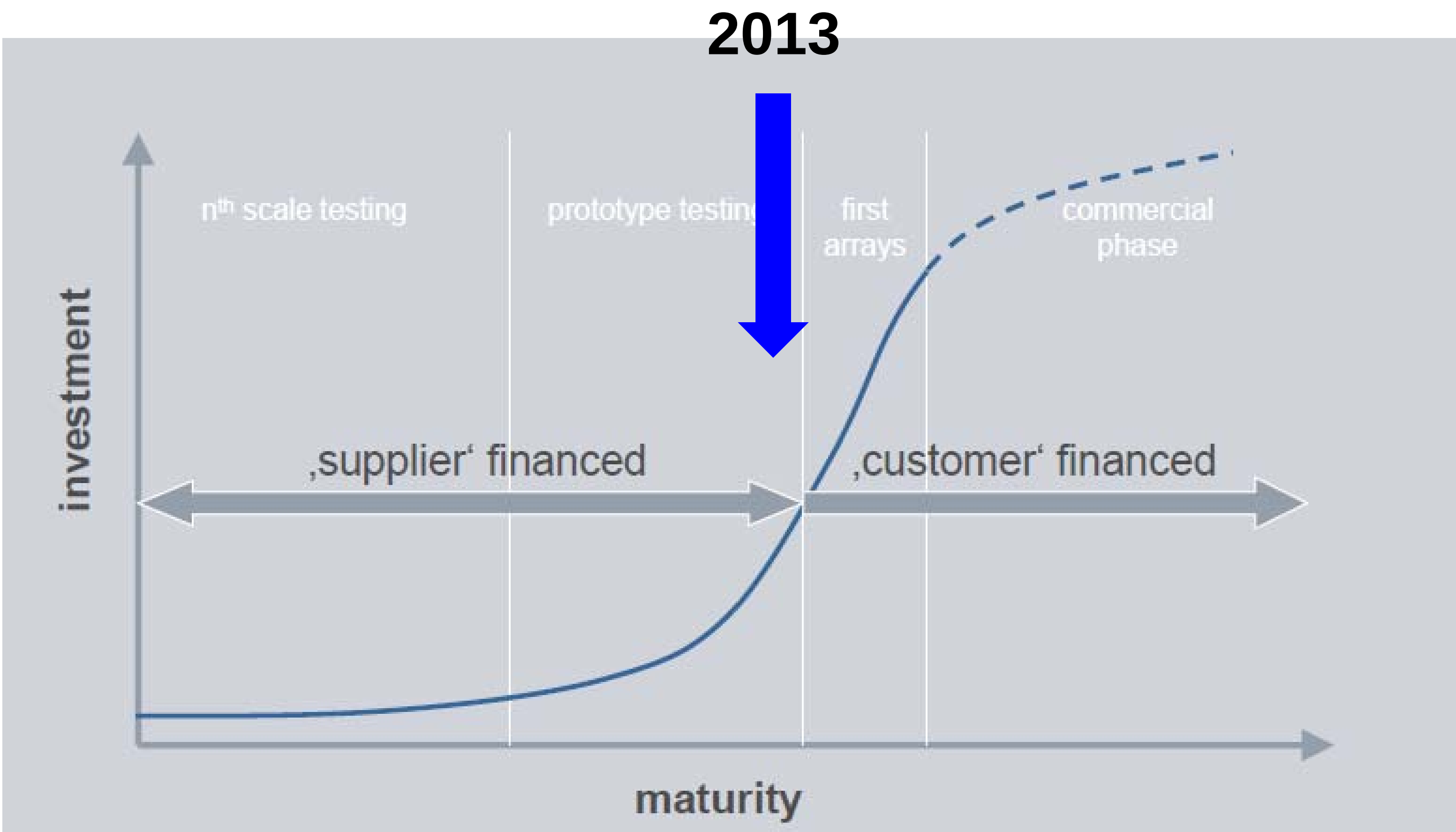
- Introduction
- Technical issues (wave and current)
  - Resource
  - Device
  - Marine operations
  - Environment
- Development possibilities
- Conclusion

Evaluate the different marine energies and their relative possibilities of reaching industrial development at an acceptable economic cost.

# Worldwide wave and tidal energy potential

| Estimatiions | 2050 |
|---|---|
| Installed capacity (GW) | 337 |
| Direct jobs | 1.2 million |
| Investment in 2050 (US$) | 61.8 billion |
| Carbon savings (tons of $CO_2$) | 1 billion |

***OES vision (2012)***




**K. Kölmel, Siemens, ICOE 2012**

# Development issues

**Ex. Tidal Turbines:**

**Very wide range of devices available,**

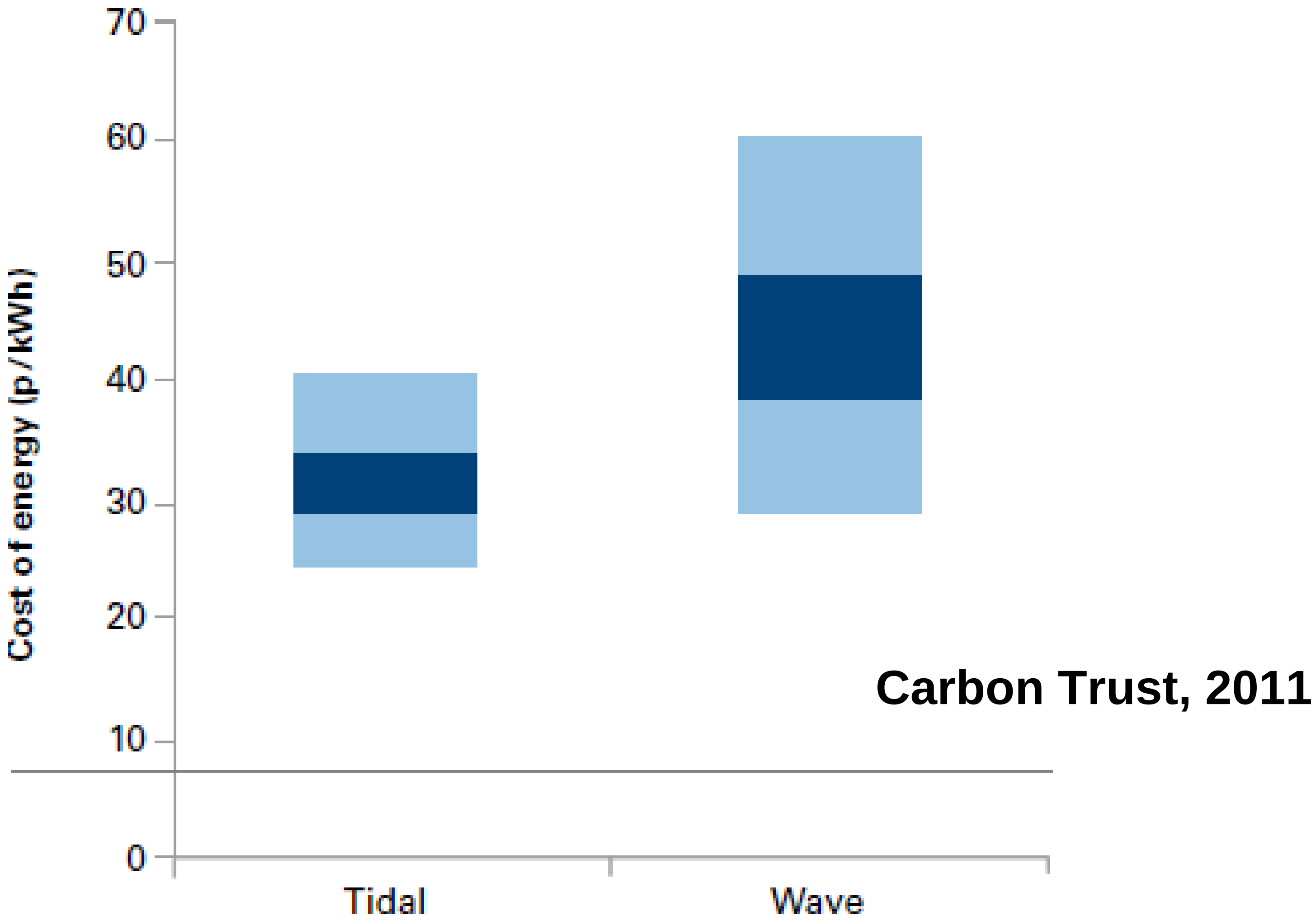
**at different stages of development.**

**No standardization, few design guidelines.**

**Investors require evidence of reliability**

**and predictability, which can only be shown**

**by demonstrator projects at sea.**

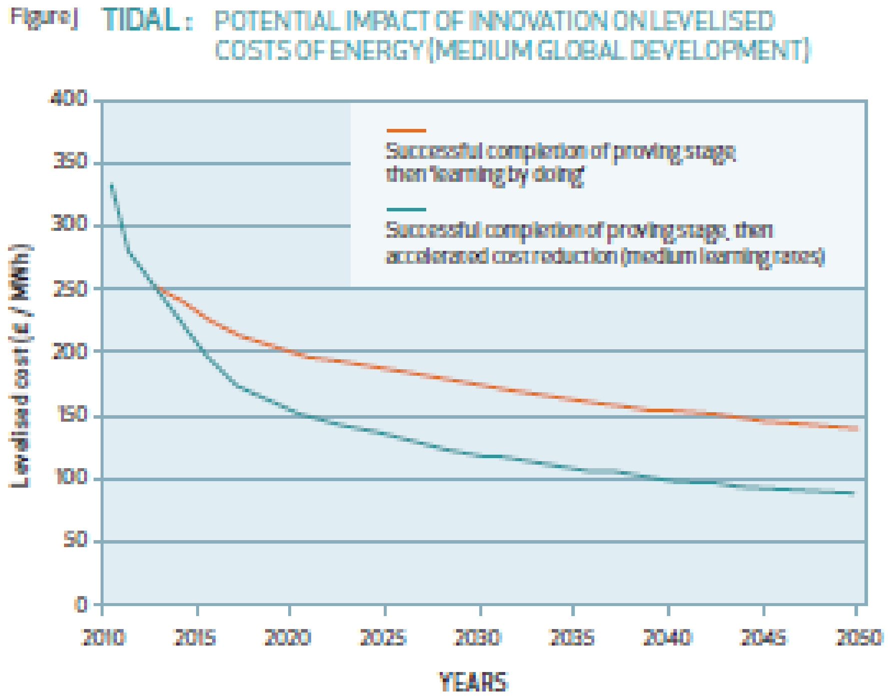



But these are prototypes and will not be economically competitive in the short term.

What was the $/MWh for the first nuclear power station prototype ?

# One objective: 10 p/kWh (£100/MWh) in 2025 i.e. reduction by 50-75%

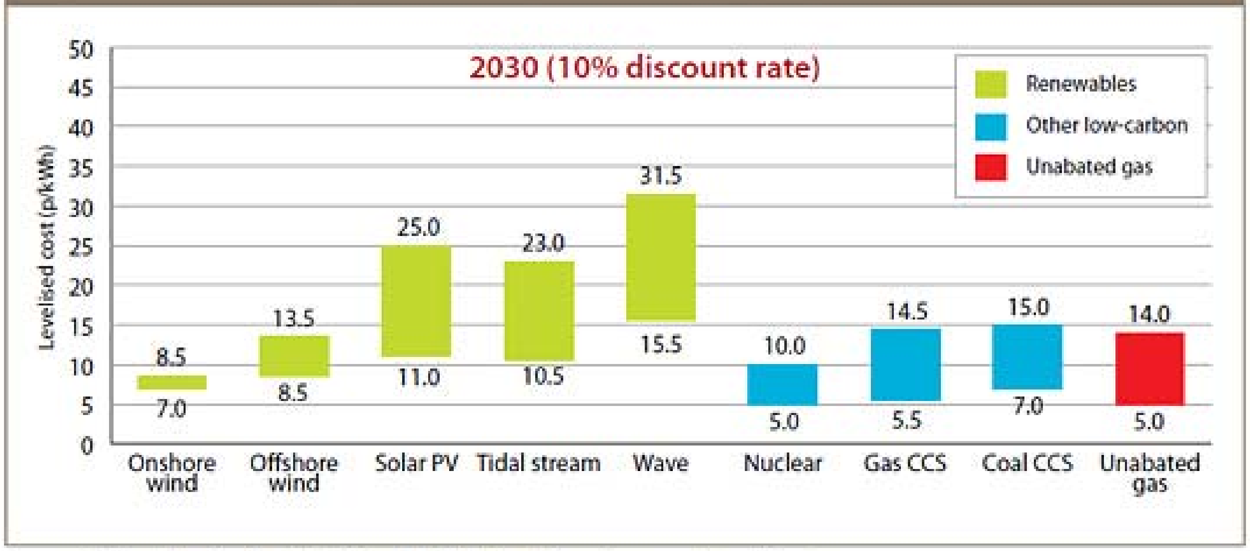
**UK Dept Energy & Climate change, 2012**




**Very dependent on solving the technical issues**

# Cost of MRE compared to other renewables

Figure 1: Estimated cost ranges for low-carbon power technologies (2030)




**Source:** CCC calculations, based on Mott MacDonald (2011) *Costs of low-carbon generation technologies.*

**Note(s):** 2010 prices, using 10% discount rate, for a project starting construction in 2030. Unabated gas includes a carbon price. Excludes additional system costs due to intermittency, e.g. back-up, interconnection. These ranges take into account capital cost and fuel/carbon price uncertainty, but do not cover all possible eventualities (e.g. they assume that CCS is successfully demonstrated).

## NB Direct Energy cost is only one factor:

**Environmental impact**

**Energy security**

**Isolated and island needs ….**

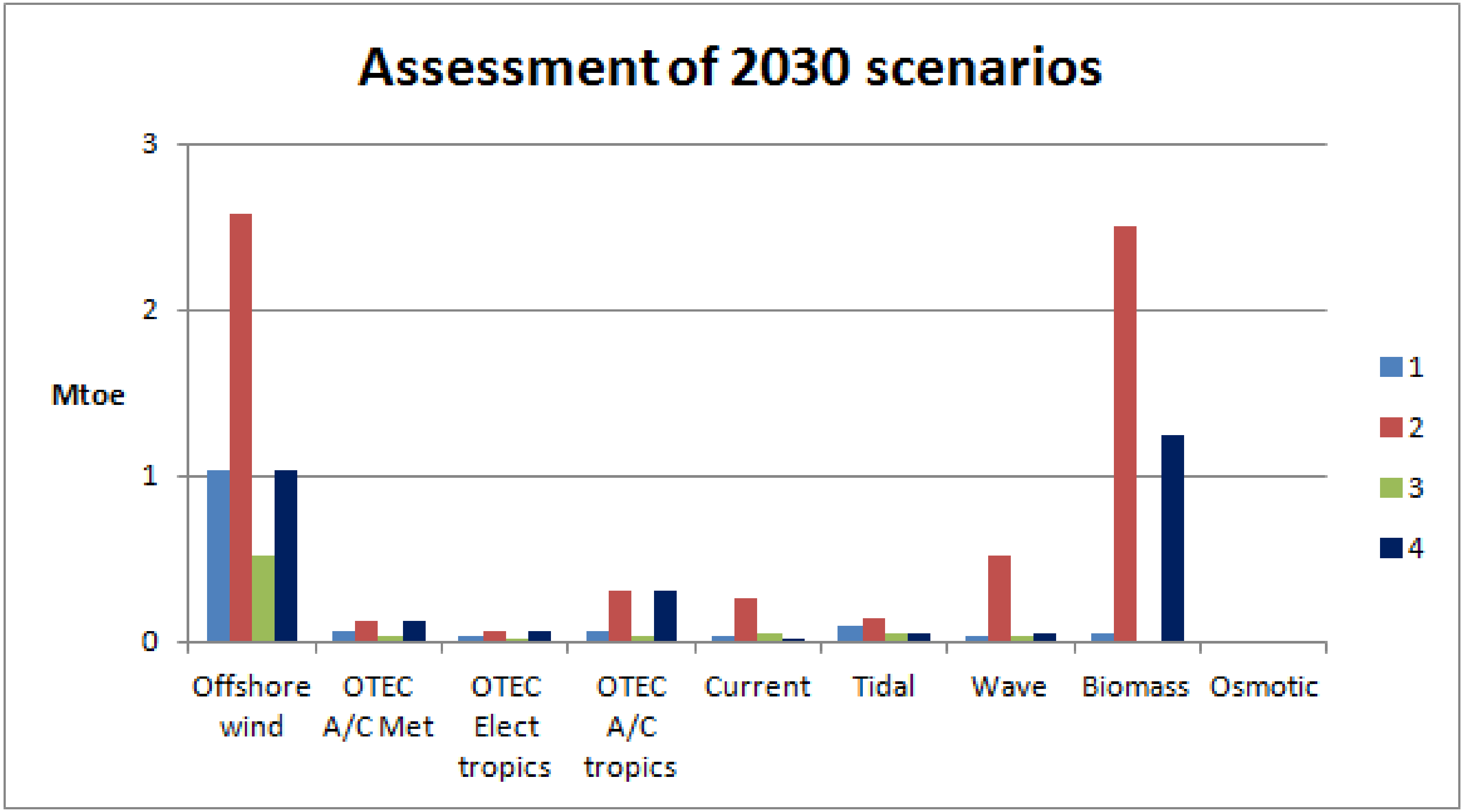
# Which marine renewables will reach commercialization first ?

## 2030 Prospective study for France

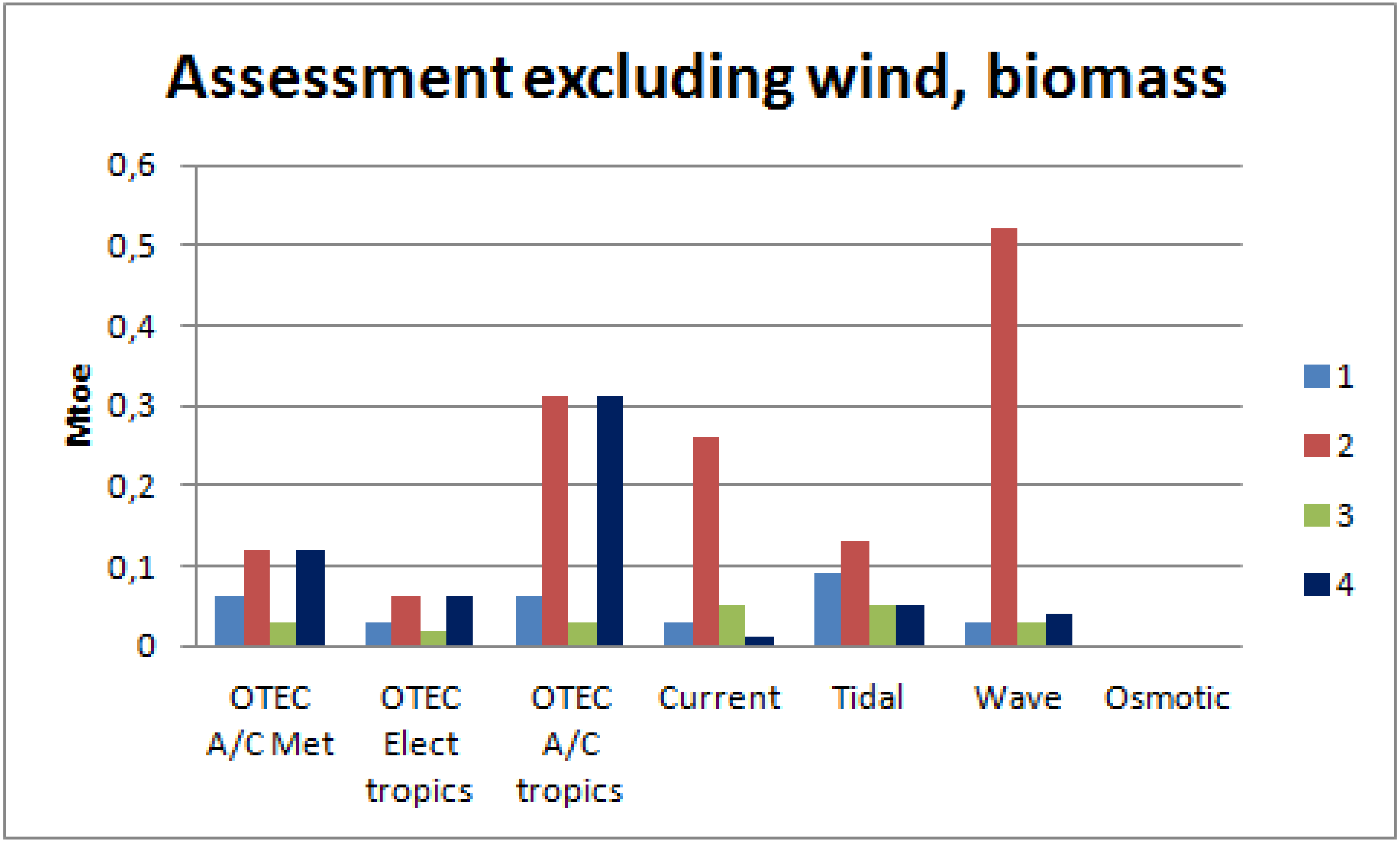
***(Paillard et al 2009)***

## 4 scenarios considered:

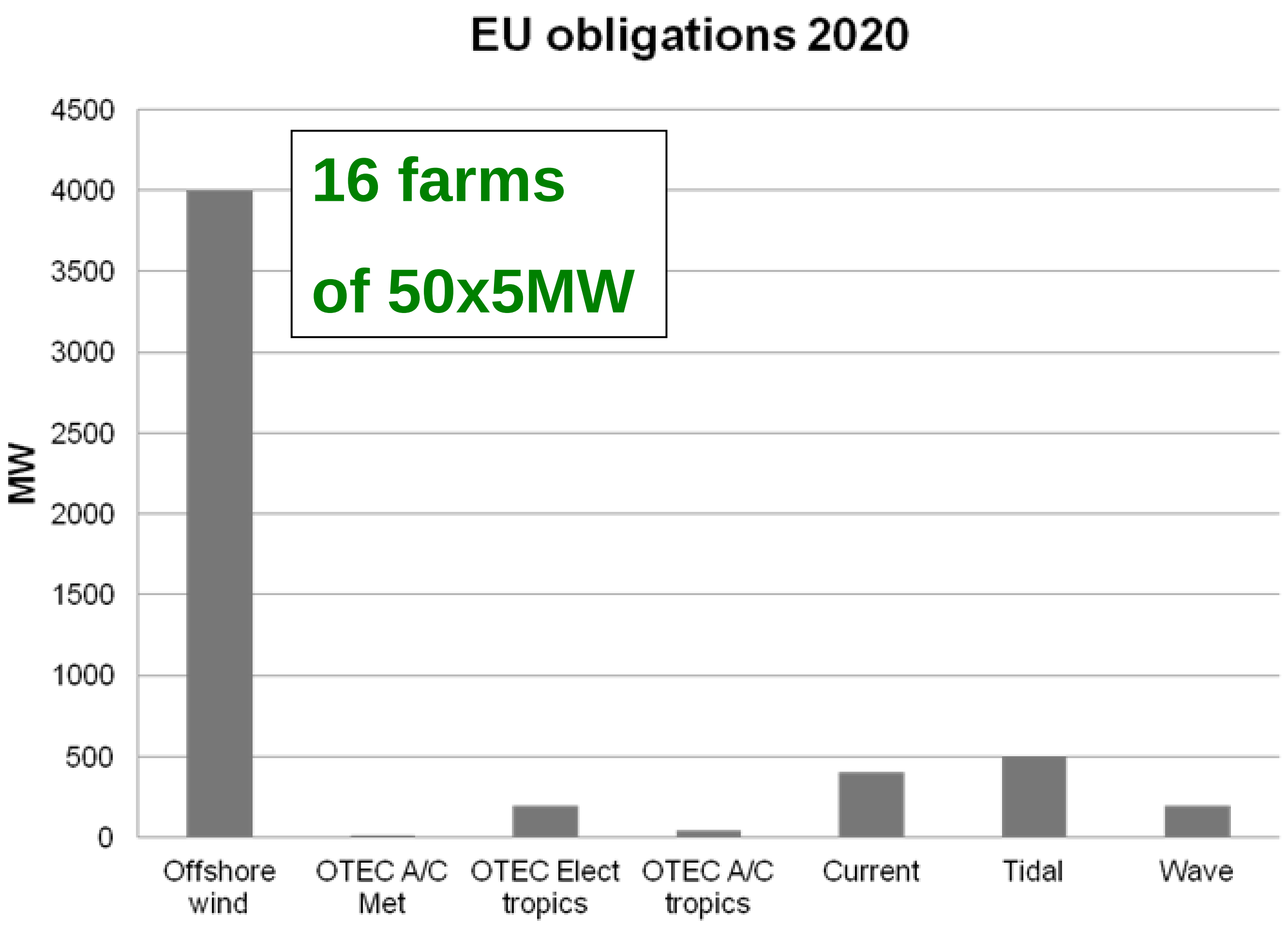
1. **Crisis & Emergency**
2. **Co-operation**
3. **Everyman for himself**
4. **Local Independence**



Assessment of 2030 scenarios
Mtoe
3
2
1
0
Offshore wind
OTEC A/C Met
OTEC Elect tropics
OTEC A/C tropics
Current
Tidal
Wave
Biomass
Osmotic
1
2
3
4



Assessment excluding wind, biomass
Mtoe
0,6
0,5
0,4
0,3
0,2
0,1
0
OTEC A/C Met
OTEC Elect tropics
OTEC A/C tropics
Current
Tidal
Wave
Osmotic
1
2
3
4




**5 tidal turbine**

**farms of 80 x 1MW**

# Some concluding remarks

- The marine and offshore industries have extensive knowledge and experience but no experience of the performance of full scale tidal and wave energy arrays at sea.

- All reliability and energy generation predictions are estimates, more or less optimistic.

- This situation should change dramatically in the next five years as the first farms start to produce.

**This is an exciting time for ocean energy….**

# References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K. Kölmel, Siemens, ICOE 2012, Dublin

Noble Denton Floating production system JIP FPS mooring integrity. H&SE Research Report 444, 2006

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Paillard , Lacroix & Lamblin, Marine Renewable Energies, Prospective Foresight study for 2030, Editions Quae, 2009

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