

France – Norway Technology Partnership
Solutions for Cleaner Energy Conference
Paris, 30th May, 2018, Universite Leonard Da Vinci

SEM-REV offshore test site
&
first Floating Wind Turbine
in France

Antoine FELIX-HENRY, SEMREV Manager,

Paris, 30 / 05 / 2018

AGENDA



1- Centrale Nantes and SEM-REV Test Site

- > LHEEA Laboratory
- > SEM-REV : test site development and infrastructure

2- Floatgen Project

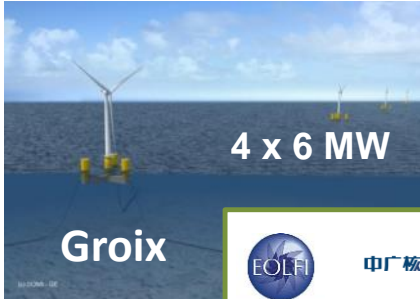
- > Floatgen Floating Wind Turbine
- > Status

3- R&D Roadmap

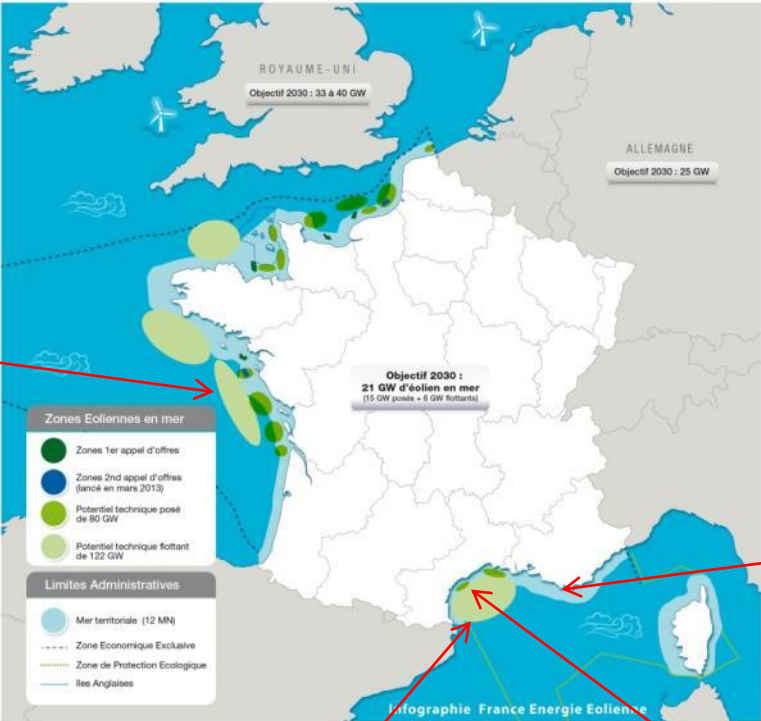
- > Research Programs
- > Feedback & Perspectives



FOW : First pre-Commercial Farms in France (EOLFLO)



Groix



Commissioning expected in 2020

3 floater technologies

Perspective: 6GW in 2030



SHAKE THE FUTURE.

Centrale Nantes & SEM-REV test site



www.semrev.fr

Centrale Nantes

- Graduate engineering programs, Masters and PhDs, to French and international students (2000 students)
- Mechanics, Materials, Energy, Cybernetics, Architecture
- 250 teaching and research staff, 38 partners countries
- 50% R&D budget in collaborative projects with industry

« Widespread recognition of the institute by firms and R&D organizations has enabled graduates to assume positions of responsibility in every sector... »



Laboratoire de recherche en Hydrodynamique, Énergétique et Environnement Atmosphérique

- **Staff : 130**

- **5 Research teams :**

- DAUC : Dynamique de l'Atmosphère Urbaine et Côtière
- EMO : Énergies Marines et Océan
- H2I : Hydrodynamique, Interfaces et Interactions
- METHRIC : Modélisation des Écoulements Turbulents à Haut Reynolds Incompressibles et Couplages
- TSM : Thermodynamique des Systèmes Moteurs

- **4 test Platforms**

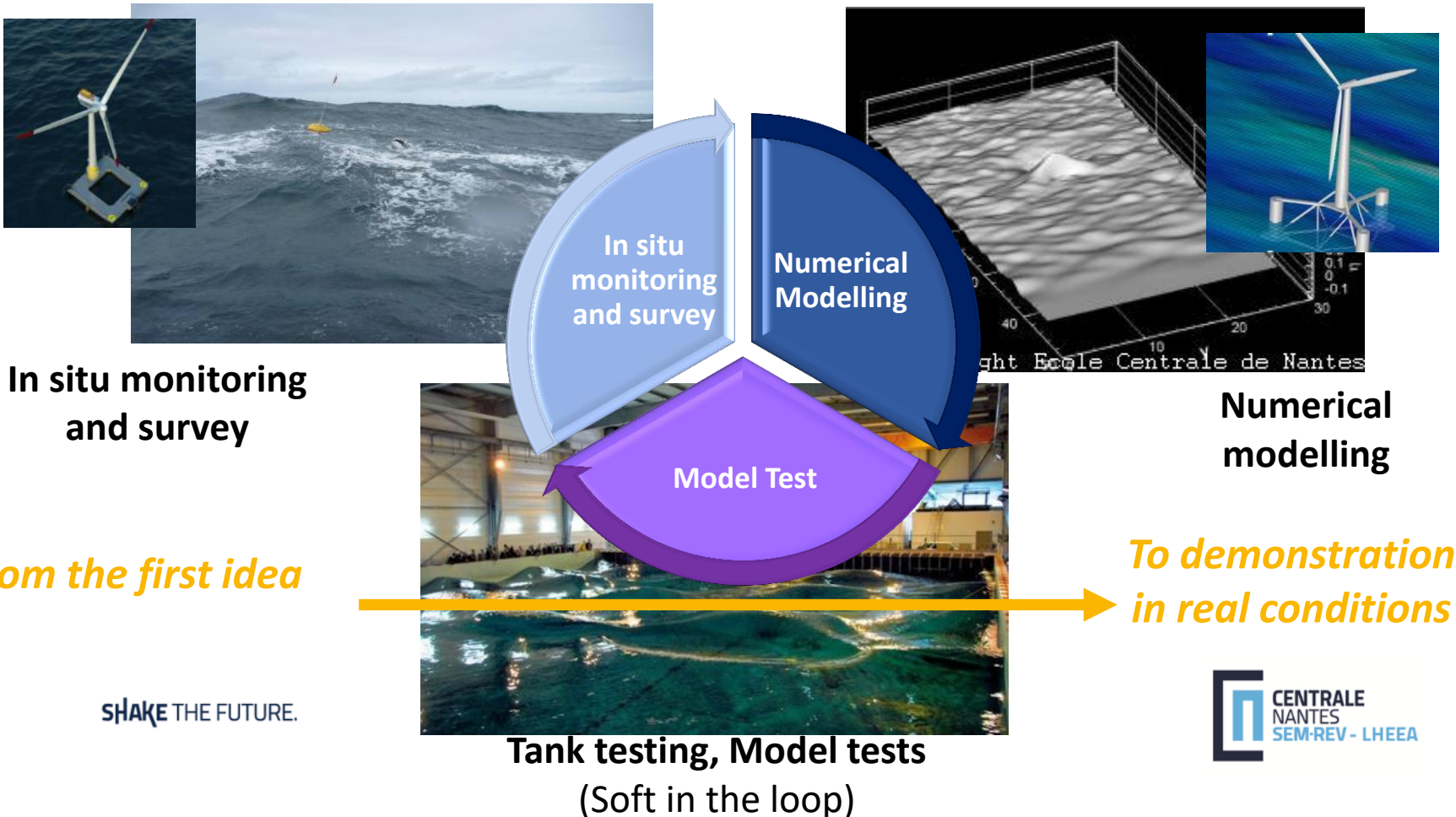
- Wave and Towing tanks
- Wind Tunnel
- **SEM-REV : offshore test site**
- Automotive engines test benches



LHEEA

Strategy to support R&D projects and technology development to make MRE economically viable

- Large scale numerical and testing facilities
- Validation of numerical methods and model tests vs results in real conditions
- Multiphysics interactions in marine environment



Hydrodynamic testing and numerical facilities for Research and Innovation in Marine and Ocean Engineering, grouping Ifremer and ECN dedicated facilities:

Test tanks

Boulogne/Mer (Ifremer)
Brest (Ifremer)
Nantes (ECN)



Test sites

SEM-REV (ECN)
Ste Anne du Portzic -
Brest (Ifremer)

- 2017 : 'Groupement d'Intérêt Scientifique' GIS between IFREMER and ECN
- 2018 : 'Très Grande Infrastructure de Recherche' TGIR label by the MESRI
- *to be announced at ICOE/Seanergy conference, 12-14 June in Cherbourg*

TheoREM
TESTING FACILITIES FOR HYDRODYNAMICS AND MARINE RENEWABLE ENERGY

SEM-REV : offshore Le Croisic – St Nazaire (Nantes area)

2017

Construction of the floating wind turbine Floatgen



2017

Pre-installation of anchor lines and dynamic cable to host Floatgen in 2018



2015

Installation of the hub



2013

2nd authorization to deploy floating wind turbines



2012

The export cable is installed and buried



2011

1st authorization to deploy Wave Energy Converters



2009

Start of environmental and resource monitoring



2007

Launch of the SEM-REV offshore test site following the signature of a 2007-2013 CPER (Government/Regional planning agreement)



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SEM-REV : Overview

12nm from Le Croisic
Open to Atlantic ocean's conditions



Milestones :

- 2009 – Test site monitoring
- 2012 – Export cable
- 2015 – Subsea Hub
- 2017 – Floatgen pre-install.

CAPEX: 20 M€ (including ERDF)
Owner and Exploitation : Centrale Nantes

SEM-REV : site offshore Le Croisic

- Support to marine social sciences : consenting, permitting, environment, safety
- Responsible for the procurement & installation of Electrical connection + Moorings (designed by IDEOL)

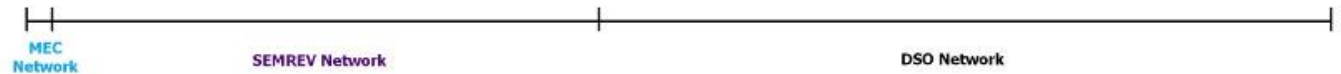
Present State

Electrical Connexion

- > Export Cable
- > Junction Box
- > Hub
- > Umbilical

Moorings (6 lines)

- > Drag embedded Anchor – chain - synthetic rope)



Legend

PCCgrid	63kV electricity gid	Dynamic cable	La Baule substation
PCCsea	20kV electricity gid	Submarine static cable	Offshore zone

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FLOATGEN is co-financed by the European Commission's 7th Framework Programme for Research and Technological Innovation.

Floatgen Project



Floatgen



Demonstrate the technical and economic feasibility of one multi-MW integrated floating-wind turbine in the Atlantic Ocean conditions

Industry-led European initiative with public support



Video

Hub height (MSL)
65 m

Blade clearance (MSL)
22m

Draught in place
250T

Displacement
5800T



Rotor
 $\varnothing = 80\text{m}$

Wind Turbine
2 MW

Floater
concrete floating foundation (Ideol Damping Pool[®])
h = 9.5m, 40m wide

Draught in place
7m

Mooring System

6 lines (drag embedded anchor-chain-synthetic rope)



Floatgen Installation

2-years testing program connected to the grid : 2018-2019



SH

Floatgen Installation



Instrumentation

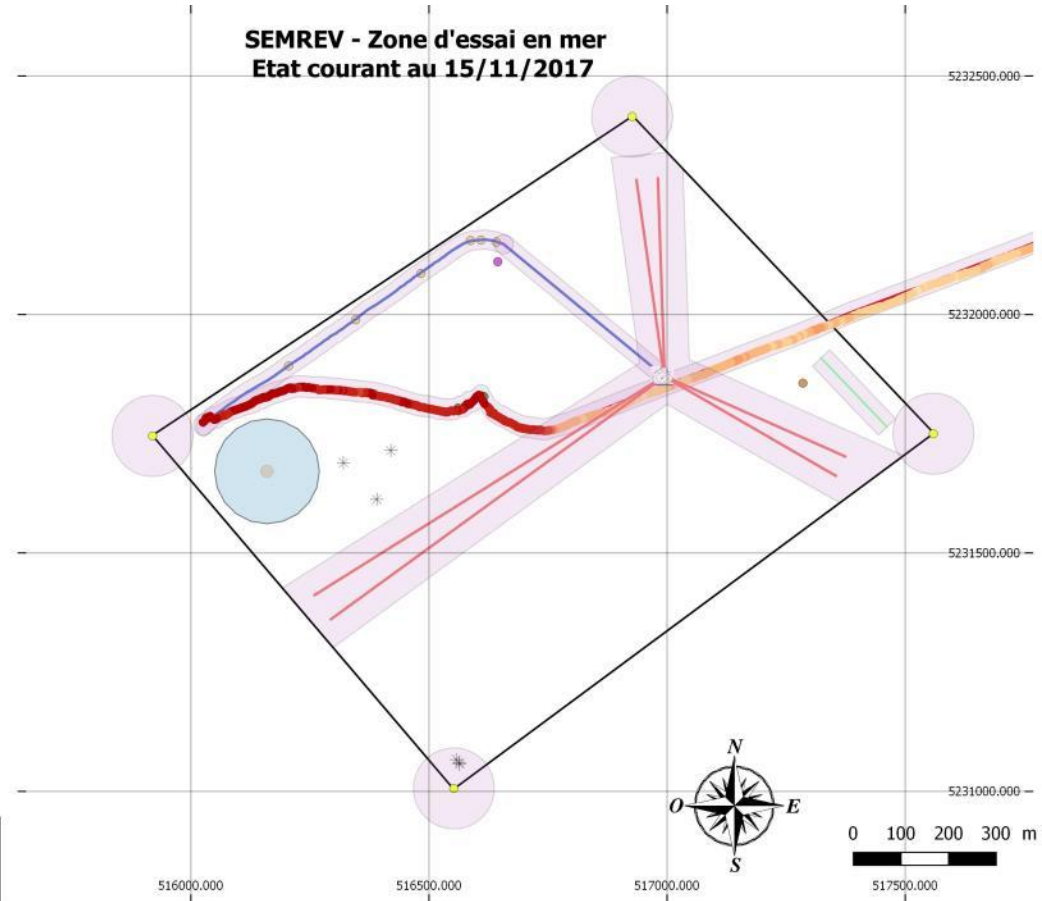
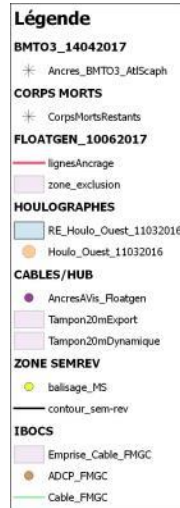
ML Hook-Up

Umb Hook-Up

Grid connection
(to be done)

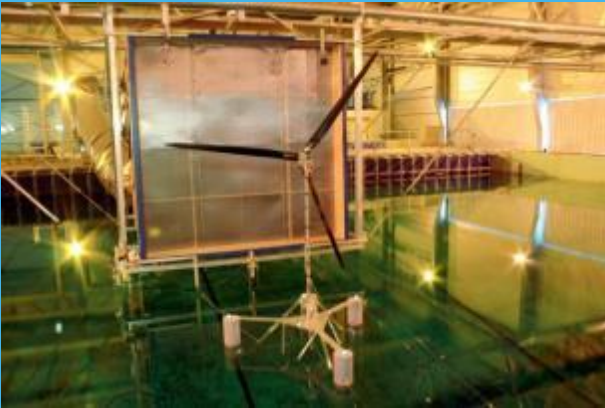
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Support to R&D on monitoring
and fatigue life survey :
moorings, cables...



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R&D @ SEM-REV



Supporting R&D

Collaborative projects with MRE industry

P1 : Marine environment and resources

- Environmental Monitoring : SEA-MON, MOSAIC
- Marine growth : ABIOP, LEHERO
- Soil mechanics : EOGP
- Environmental impacts : SPECIES

P2 : MRE Technologies (FOWT, WEC)

- Floating wind demonstration (FLOATGEN)
- FOWT components and performances (FORESEA)

P3 : Energy Conversion, Transport and Storage

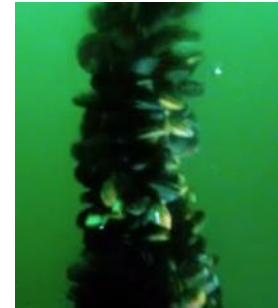
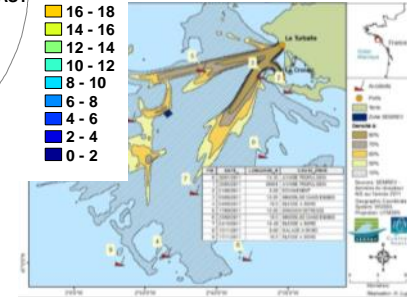
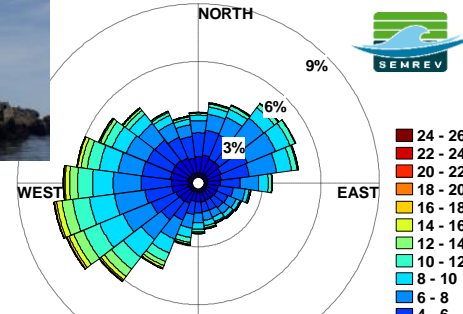
- Subsea connection units : HUB
- Export and Dynamic Cables : EMODI, OMDYN

P4 : Security, Safety, Marine operation

- Health Monitoring : MHM-EMR
- Marine operation and O&M : HUB installation



Rose of 10m-height wind speed (1979-2011)



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AGENCE NATIONALE DE LA RECHERCHE
ANR



P1 : Environmental Monitoring Plan

Compulsory or Complementary Environmental Survey

Including Physical, Biological & Human Environment

- Marine life, Birds,
- Marine Growth
- Corrosion and Abrasion
- Anodes, Paints : water
- Bathymetry, sediments
- Power cables impacts
- Marine operations, O&M
- Marine traffic (risk an.)

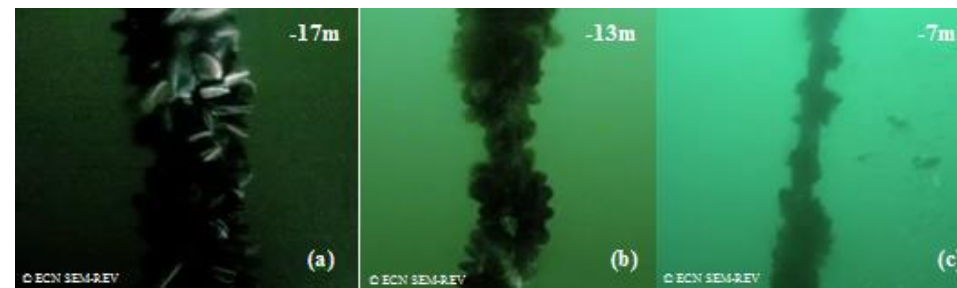
Marine growth : ABIOP, LEHERO

- Hydro ceof
- Growth & species



Applied on Electrical Cables & Connections & Protections, Site & Demonstrators

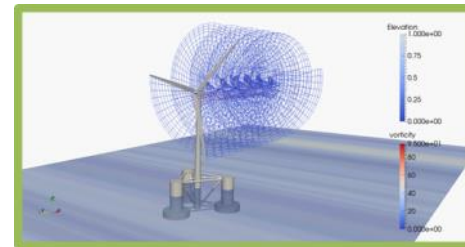
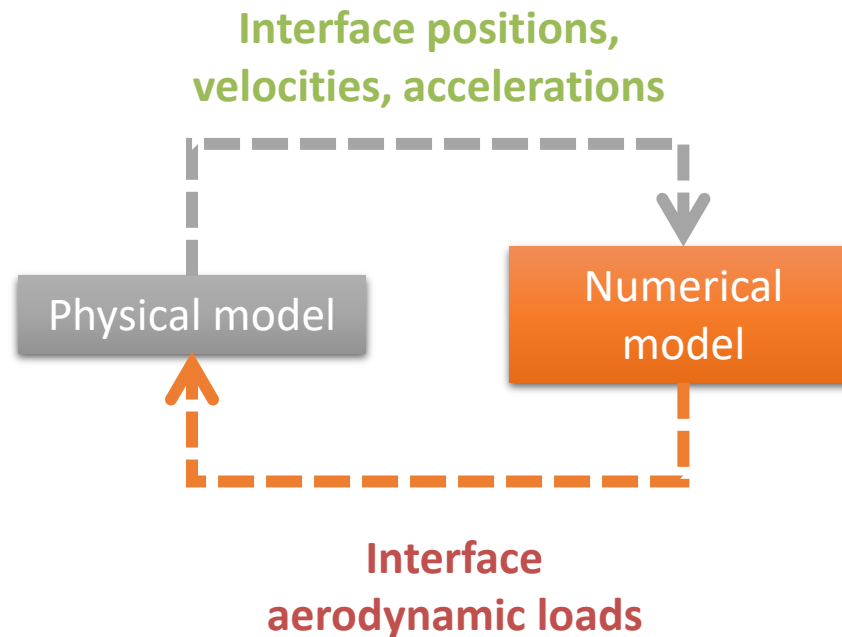
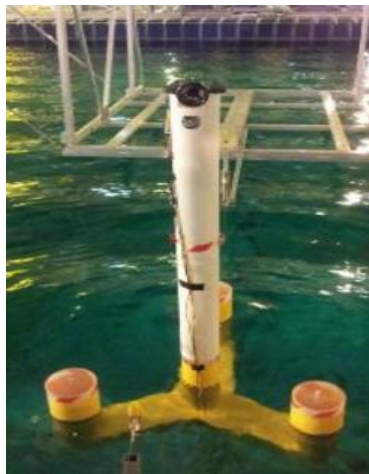
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P2 : Floating Wind Turbine modelling method

SOFTWIND project

→ Real-time coupling between hardware and software



- Allow the testing of control laws at small scale
- Overcome the inconsistency between aerodynamic / hydrodynamic similitude laws
- Allow more realistic environmental conditions (wind)

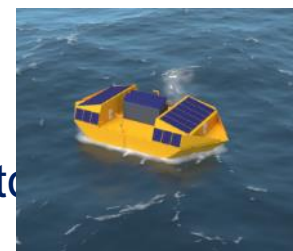
P2 : Demonstration and Access to Market

FORESEA, MARINETII projects

FORESEA under Interreg NWE program



- Supporting LCT developers to access NW Europe's test facilities
- SME / LCT : new Techno, monitoring, Mooring, Umbilicals/connectors
- Test sites benchmarking, Technologies vs market
- From 02/2016 to 12/2019
- Co-Funding of testing cost up to 60%



MARINET 2 under H2020 Program

- Supporting MRE developers to access Europe's test facilities
- Funding : 100% of the test site cost (directly to the test site)



IHES /
IBOCS

P3 : Power Cables monitoring : from cores to armors

EMODI, OMDYN projects

Dynamic cables: from cores to armors

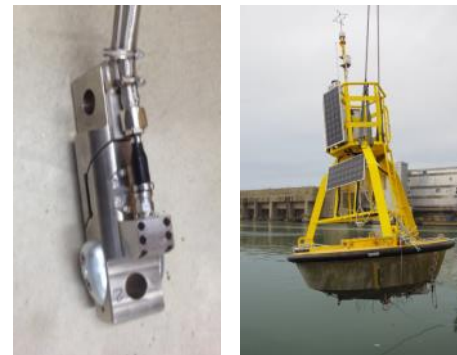
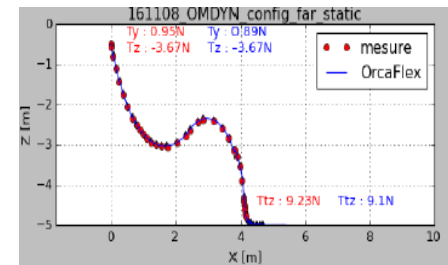
- Mechanical characteristics of cable components
- Loads, motions and deformations
- Influence of marine growth
- Default diagnostic
- Cables stabilization on sea bed

Numerical, Bench test, Model Tests

- Numerical modeling of the global configuration and cross section
- Experimental analysis of thermo-mechanical fatigue
- Forced and free dynamic response

In-situ monitoring

- Monitoring throughout the cable life cycle



P4 : Floatgen



Pre-Installation

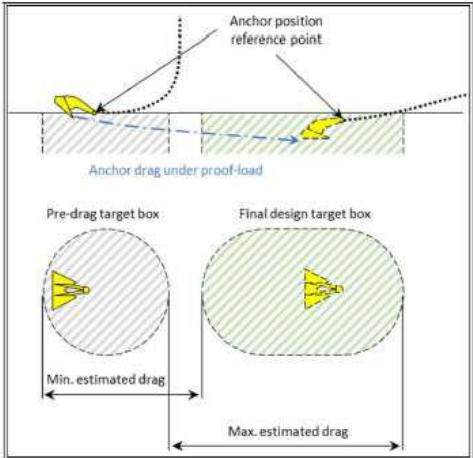


Figure 11 : Pre-drag target box principle

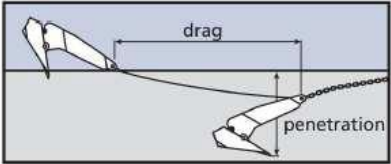


Figure 12 : Drag and penetration

Permanent Line Installation

- > Positioning
- > Deployment
- > Recovery
- > Tensioning

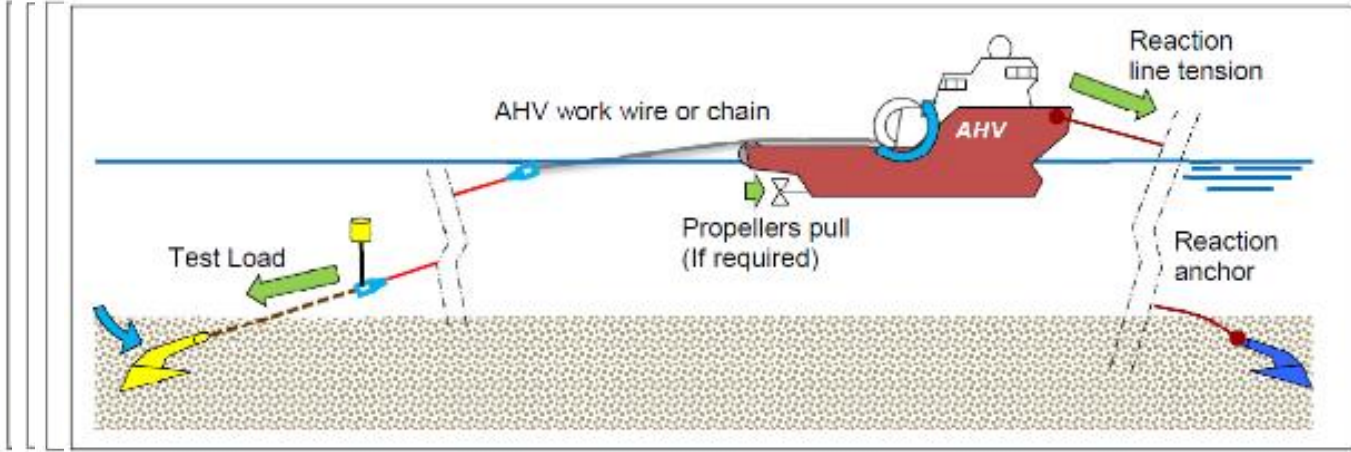


Figure 24 : Reaction line recovery



P4 : Modelling of marine operations

→40 operations in 5 years
incl major operations (cable, hub...)

FRYDOM project

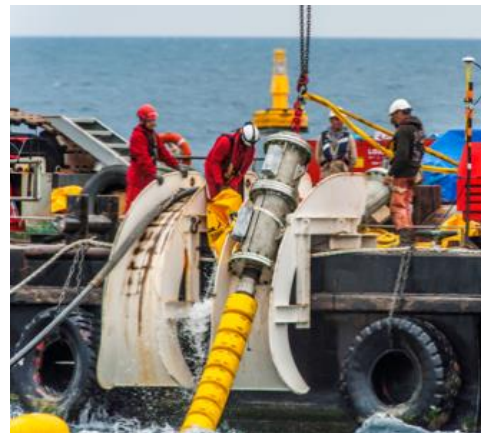
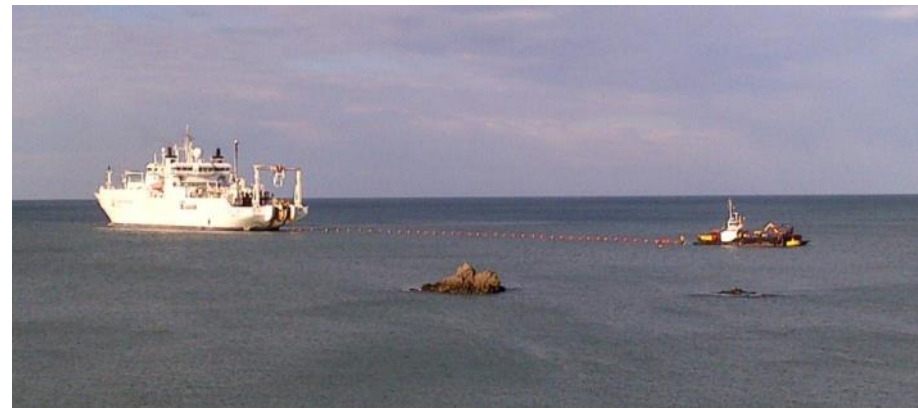
- > Multibody dynamics
- > Cable dynamics
- > Unsteady / transient responses
- > Waves and wind loads
- > Water entry/impact
- > Controllers (crane, turbine, winch)
- > Dynamic positioning

Safety/security

Risk analysis vs marine traffic
Maritime surveillance
Survey of MREs components

Marines operation

Metocean predictions
O&M Monitoring
On-board numerical models for decision making



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Thank you !



www.semrev.fr
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- Integrated in an environment of competences
- Operational multi-functions testing equipment
- A regulatory & contractual framework with ECN
 - First feedback in France from offshore

