# Bottom Fixed and Floating Wind
## INNOSEA Scope of Services

INNOSEA
Marine Energy Engineering

# AN INTRODUCTION

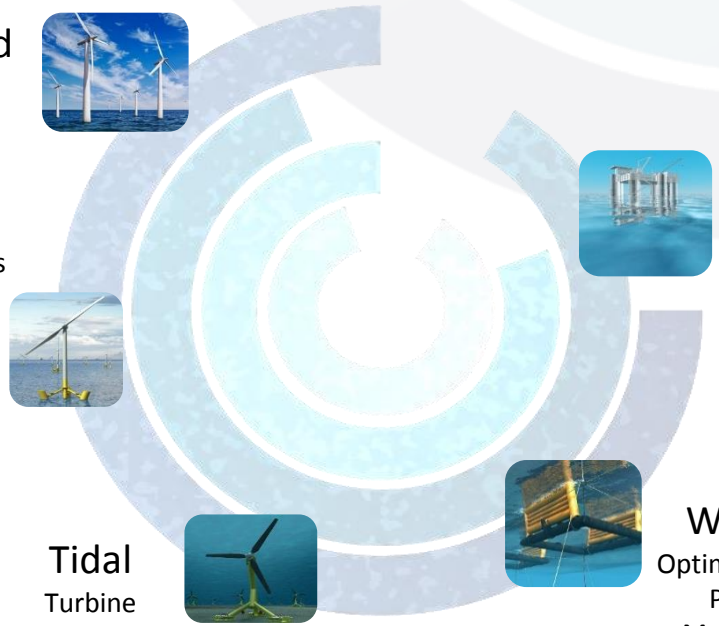
**Independent multidisciplinary engineering** company

**Flexible, Comprehensive** and **Dedicated** engineering services

Pure-player in **Marine Renewable Energies** operating **internationally**

**> 30 and growing highly-skilled and experienced** Offshore Renewable Energies specialist engineers & PhDs

**Five Key Markets**



### Offshore Wind
Turbine
WTG Foundations
OSP Foundations
Static Cables
Installation
Value chain analysis

### Floating Wind
Turbine
Floating platform
Mooring
Dynamic Cables
Installation

### Tidal
Turbine
Foundation
Installation
Static Cables

### OTEC
Optimisation
Mooring

### Wave
Optimisation
PTO
Mooring
Tests

**Corporate Core Values**

Excellence and on-time Delivery
Safety Leadership
Client's satisfaction & Dedicated Account management

# OFFICES

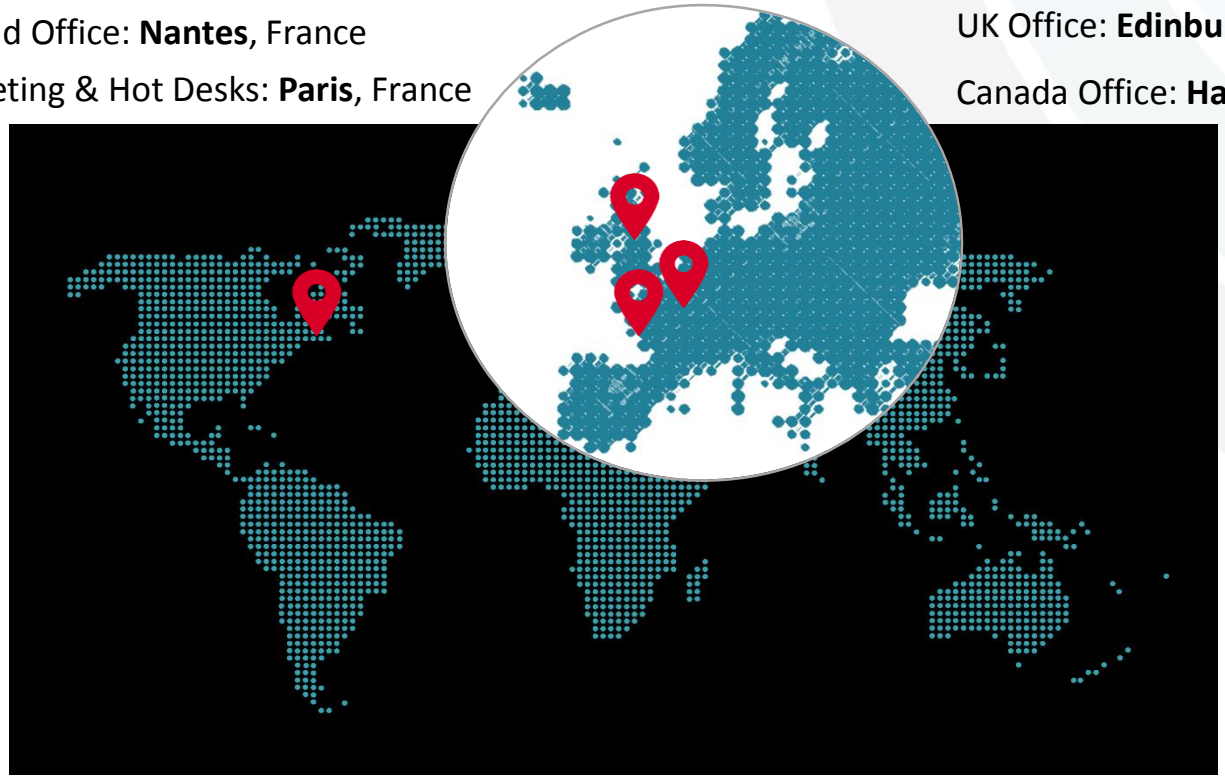
Operating **Internationally** - 4 locations in **Europe** and **North America**

Head Office: **Nantes**, France

Meeting & Hot Desks: **Paris**, France

UK Office: **Edinburgh**, Scotland

Canada Office: **Halifax**, Nova Scotia





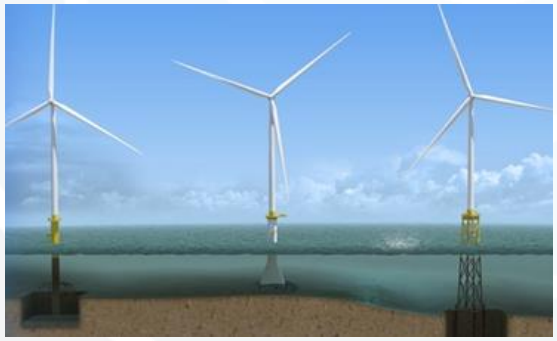
**Mobile** and flexible staff

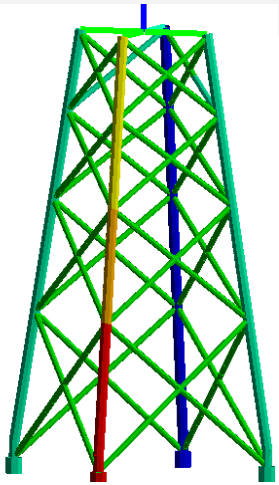
**Partnerships** with first-rate Universities and Research Departments

Privileged access to **Unique Test Facilities**

# INNOSEA activity for fixed offshore wind

- **Loads assessment (Bladed / DNV GL)**
  - As Owner Engineer for design loops : support for managing loads iteration, results checking through running of independent loads iteration
  - On WTS or foundation designer side
- **Structural design of foundations (Concept Design and Detailed Design) (ANSYS / ABAQUS)**
  - Conceptual Design of monopiles, jacket & GBS foundations
  - Structural analyses of jackets
- **Offshore installation, O&M**
  - Dynamic analysis of offshore operations; definition of workable conditions
  - Installation planning based on analysis of metocean time series and workable conditions
- **CAPEX cost estimate**
  - Cost Estimate of procurement, manufacturing, installation. Inputs from client or internal database
  - Monte-Carlo analysis to provide probabilistic distribution of costs.
- **Advisory & Strategy**
  - Assessment of local benefits of wind projects
  - Support to Regional Agencies in the definition of their Offshore Renewables policies





# INNOSEA activity for fixed offshore wind – Offshore Wind Foundation design

## INNOSEA key strengths & references

### Software, hardware & organisation capabilities

- Expert users and developers of references software tools (ANSYS, ABAQUS)
- High Power Computing capacities.
- Robust in-house organisation processes and related software tools to ensure accuracy and quality.
- Continuous internal training.

### Experience gained on complex projects

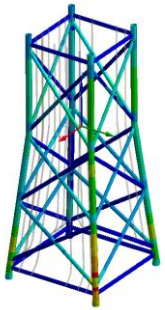
- Used to design by taking into account the complex geotech (calcarenite, drilled pile, soil liquefaction, etc.).
- Used to design innovative concept for unusual conditions
- Used to design with up-to-date methodology (time-history FLS with rainflow counting, etc.).
- Detailed knowledge of offshore wind turbine standards (DNVGL)

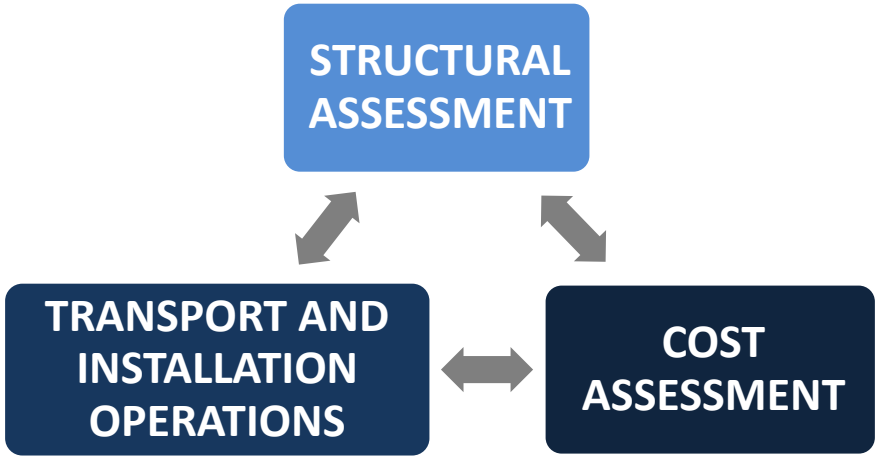
### A direct link with R&D projects

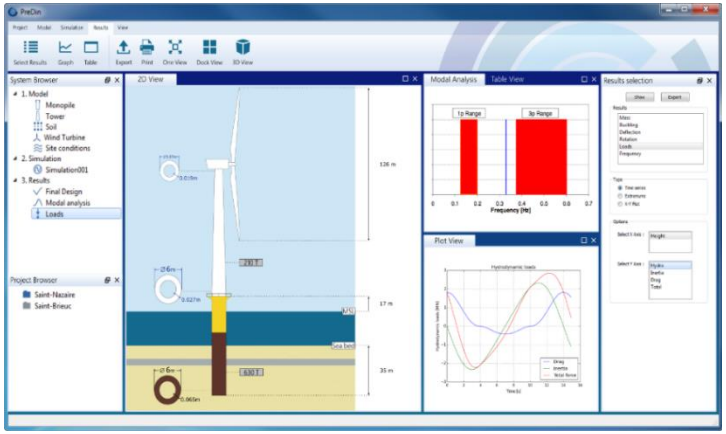
- As engineers and PhD involved in international R&D projects, we know the impact of complex phenomena on offshore substructure (cycling degradation of soil parameters, grout fatigue, etc.)

# Offshore wind turbines foundation design - PREDIN software solution

- **PREDIN presentation**
  - PREDIN is a design software tool, aiming at **rapidly providing realistic foundation and CAPEX cost** (fabrication, installation).
  - PREDIN has been developed to **facilitate tender design** phases.
  - PREDIN provides a sensitive design of the foundation, based on a simple set of site and wind turbine data.
  - PREDIN is comprehensive, and integrates ocean loads, structural analysis and code checking.

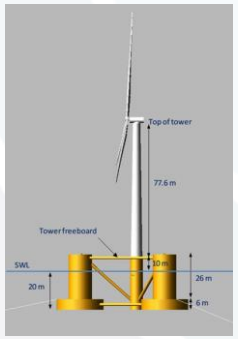


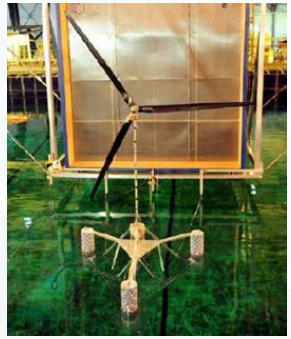


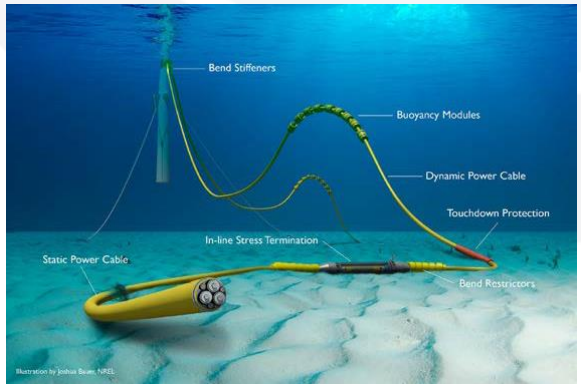
# INNOSEA activity for floating offshore wind

- **WTG Load assessment (Bladed / FAST / Orcaflex)**
  - WTG Model / orcaflex software coupling
  - Integrated FOWT dynamic analysis in situation of large movements & deflections
  - Independent loads iterations
  - Sensitivity analysis on floater/mooring design parameters
  - Assistance to management & follow-up of loads iterations
  - Wave tank testing

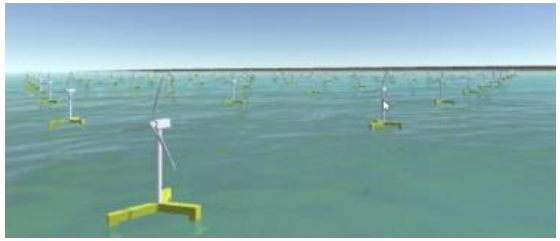


- **Dynamic Umbilical / Power Cable (Orcaflex)**
  - Cable Configuration assessment (Layout, Buoyancy sizing , Configuration Anchoring requirements)
  - Hydrodynamic coefficients assessment for dynamic riser
  - Static and Dynamic simulations (Orcaflex software)
  - Static Umbilical / Power Cable – Stability



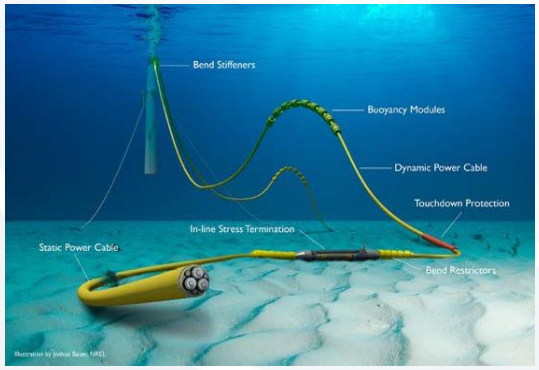

- **Mooring (Orcaflex)**
  - Mooring Configuration assessment (Layout, Anchoring requirements)
  - Installation Support / Installation analyses
  - Static and Dynamic simulations (Orcaflex software):
    - Extreme Analysis
    - Interference Analysis (Clashing study – Floater Hull and dynamic cable)
    - Fatigue Analysis

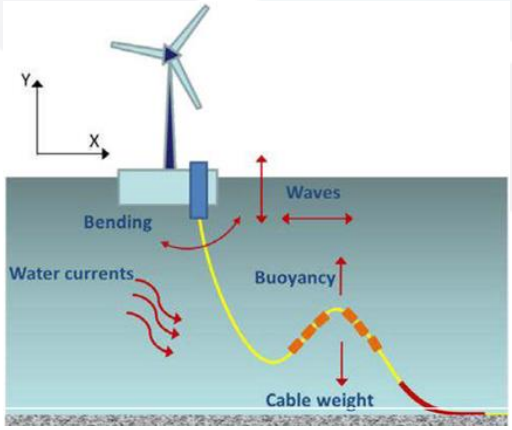


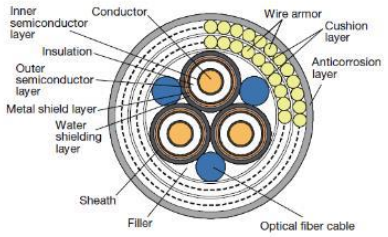
# Dynamic Power Cable – Dynamic Analyses

- **INNOSEA services**

  - Cable Configuration assessment (Layout, Buoyancy sizing , Configuration Anchoring requirements)
  - Hydrodynamic coefficients assessment for dynamic riser
  - Static and Dynamic simulations (Orcaflex software):
    - Extreme Analysis
    - Interference Analysis (Clashing study – Floater Hull and adjacent anchoring lines)
    - Fatigue Analysis (Input for Cross section components fatigue analysis)
    - Load assessment for equipment design
    - Cable / Floater interface design assessment (Bend stiffener)
    - Dynamic Cable stability assessment
  - Determination of the mechanical properties of the cable (stiffness of the cable for dynamic simulation)
  - Fatigue analysis on the cable components



# INNOSEA Implication on R&D Projects

- **H2020 Projects :**
- **WETFEET** addressees Low-carbon Energies specific challenges by targeting a set of breakthroughs for wave energy technology, an infant clean energy technology with vast potential. Specifically involved on array breakthrough via sharing of mooring and electrical connections between nearby devices
- **DEMOTIDE** / DEMOnstration for Tidal Industry Derisking. Involvement on Foundation Design and French business case development

- **France Energies Marines Projects:**
- **OMDYN** focuses on dynamic cable hydrodynamic behaviour, mechanical response and cross section fatigue assessment through the following tasks. Provide a simplified tool for cross section calculation for dynamic cables to iterate with simulation tools for global dynamic behaviour. This tool, which allows the passage of a detailed 3D modelling of a cable section to a simplified model, will also implement lifetime prediction methods of cable components (fatigue)
- **STHYF** : Cable stability and hydrodynamics at mudline

- **Collaborative / Internal Projects :**
- **InWave :** Offshore multi-body design tool developed in partnership with Ecole Centrale Nantes – LHEEA Lab. CNRS.
- **PREDIN :** Bottom Fixed Foundation Pre-Design tool
- **STATIONIS :** collaborative R&D project, developing an all-in-one software program for decision making support and pre-engineering design of mooring and electrical systems for floating offshore wind farms. Involvement regarding mooring design module (Frequency domain).

# KEY CONTACTS – MEET THE TEAM

- **Commercial & Strategy**

**Hakim Mouslim, INNOSEA**
Chief Executive Officer
hakim.mouslim@innosea.fr
+33 6 77 91 02 16

**Bruno Borgarino, INNOSEA**
Chief Operations Officer
bruno.borgarino@innosea.fr
+33 6 45 91 77 12

- **Technical contacts**

**Yves Marin, INNOSEA**
Technical Lead Offshore Structures
yves.marin@innosea.fr
+33 6 98 89 12 28

**Mattias LYNCH, INNOSEA**
Technical Lead Ocean
mattias.lynch@innosea.fr
+33 7 68 27 00 77


**INNOSEA HQ**

1 rue de la Noe
44321 Nantes - FRANCE
+33 (0) 2 50 35 50 90

www.innosea.fr

**INNOSEA Paris**

Meeting / Hot-desks
SYMBIOSE / Audencia Paris
13 avenue du Maine
Tour Montparnasse
75014 Paris - FRANCE

www.innosea.fr

**INNOSEA UK**

ETTC, Alrick Building,
Max Born Crescent
EH9 3BF Edinburgh - SCOTLAND
+44 (0) 131 472 4731

www.innosea.co.uk

**INNOSEA America**

1701 Hollis Street, Suite 800
Halifax NS B3J 3M8 - CANADA
+1 (902) 401-3377

www.innosea.co.uk