AN OVERVIEW OF R&D, CONSULTANCY AND PROJECTS ON MARINE RENEWABLE ENERGY AND SUSTAINABLE PORTS

Portugal Atlantic Conference – Potential for Growth and Internationalization of the Sea Economy Renewable Energies and Energy Sustainability of Ports 18th November 2015 - EXPONOR - Porto

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2. R&D, Consultancy and Projects
3. Potential for growth and Internationalization of the Sea Economy
01. ABOUT INEGI
Is a Research and Technology Organization focused on industry oriented research & development, innovation and advanced engineering services in the mechanical engineering and industrial management areas.

Created in 1986 as an interface Institution between the department of Mechanical Engineering and Industrial Management of Faculty of Engineering of University of Porto and industry.
MISSION

Contribute to the increase of the competitiveness of the national industry, through Research and Development, Technology Transfer and Training, in the fields of engineering design, materials, production technology, energy and environment and industrial management.

VISION

To be recognized as a National reference Institution in technology based innovation and technology transfer area and became a relevant player in the European Scientific and Technological System.

QUALITY POLICY

Promote continuous improvement of the performance of the organization in achieving its strategic and operational objectives, constantly seeking to raise the level of satisfaction of all stakeholders, and assuming the Quality Management System as an essential tool to this aim.
Knowledge creation and development of technologies, usually 100% funded by FCT (National Foundation for Science and Technology) and EC.

- R&D projects with industry co-financed by Portuguese and European funds.

- R&D and Innovation projects with industry funded by clients.

- Technical consulting and advanced engineering services.

- Training – tailor made training programs, mostly “in-company”.

55-60% of total Revenues
### HUMAN RESOURCES

<table>
<thead>
<tr>
<th>Category</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contractors</td>
<td>110</td>
</tr>
<tr>
<td>Research fellows</td>
<td>93</td>
</tr>
<tr>
<td>TOTAL FRAME</td>
<td>203</td>
</tr>
<tr>
<td>University employees</td>
<td>112</td>
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</tbody>
</table>

The pie chart shows the distribution of human resources:

- **57%** Masters/Graduate
- **17%** Degree level
- **15%** Technical
- **11%** PhD

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1. ABOUT INEGI
1. ABOUT INEGI

TOTAL TURNOVER

<table>
<thead>
<tr>
<th>Year</th>
<th>Millions of Euros</th>
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<tbody>
<tr>
<td>2010</td>
<td>5,7</td>
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<td>2011</td>
<td>5,93</td>
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<td>2012</td>
<td>5,89</td>
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<td>2013</td>
<td>6,42</td>
</tr>
<tr>
<td>2014</td>
<td>6,93</td>
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<td>2015</td>
<td>8</td>
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ACTIVITY SECTORS

- AERONAUTICS, SPACE AND DEFENCE
- AUTOMOBILE AND TRANSPORT
- ENVIRONMENT
- SEA ECONOMY
- ENERGY
- EQUIPMENT AND DURABLE GOODS
- HEALTH CARE
- METALLOMECHANIC
- SERVICES
# RESEARCH, DEVELOPMENT AND INNOVATION OFFER

## RESEARCH
- Research Projects (national and european)
- Research Under Contract for Companies

## INNOVATION AND TECHNOLOGY TRANSFER
- Product Design and Development
- Composite Structures
- Composite Materials Production Processes
- New Materials
- Equipments Development
- Ceramic Materials Production Processes
- Energy Systems
- Rapid Prototyping and Pre-series Production

## SCIENTIFIC/TECHNICAL CONSULTING & SERVICES
### CONSULTING
- Renewable Energies
- Engineering and Industrial Management
- Tailor Made Training Programmes
- Energy Efficiency and Management
- Technology Audits

### SERVICES
- Rapid Prototyping
- Materials and Structures Characterisation
- Noise and Vibration Analysis
- Environmental Consulting
- Lubricant Analysis
- Clean Room (10K – ISO7)
- Testing of Behavior of Materials and Products to Smoke and Fire

## SERVICES AND MARKETS

### MARKETS/SECTORS
- ENERGY
- METALLOMECHANIC
- EQUIPMENT AND DURABLE GOODS
- AUTOMOBILE AND TRANSPORT
- AERONAUTICS AND SPACE
- SEA ECONOMY
- ENVIRONMENT
- PUBLIC SECTOR
- SERVICES
- HEALTH CARE
- OTHERS
LABORATORIES

1. ABOUT INEGI

- Aerodynamics and Calibration
- Metrology
- Mechanical Testing
- Testing of composite parts
- Polymers
- Testing of Plastic Forming
- Rapid Prototyping
- Industrial Tribology and Maintenance
- Materialography
- Optics and Experimental Mechanics
- Combustion
- Fuel Cells
- Wind Power
- Environmental Characterization (accredited by IPAC)
- Reaction to Fire and Smoke (accredited by IPAC)
ENGINEERING TOOLS

1. ABOUT INEGI

- CAD (Computer Aided Design) 3D: modeling advanced shapes, SOLIDWORKS and CATIA
- CAE (Computer Aided Engineering): linear and nonlinear structural simulation, IDEAS, COSMOS, ABAQUS
- Simulation of production processes: casting, Polymer injection moulding, metal forming and machining.
- Simulation of atmospheric flows (WAsP and WindFarmer)
- GIS (Geographic Information System): ArcGIS
ENGINEERING TOOLS

- Design and analysis of mooring systems
- Motions analysis of FPSOs
- Determination of Air Gaps
- Breakwater structures
- Calculation of Shielding Effects of ships and barriers
- Multiple Body Interactions
- Coupled mooring line-structure interaction
- Cable Dynamics with intermediate buoys
- Splitting Force calculations for Semi-Submersibles
- TLP concept design
- TLP tether analysis
- Dynamic stability analysis of passenger vessel
- Analysis of towing & lifting vessels
1. ABOUT INEGI

PROTOTYPE AND PRE-SERIES MANUFACTURING

- Advanced Casting Processes
- Metal Working Sheet Metal
- CNC Machining by chip removal
- Production of Composite Materials
02. R&D, CONSULTANCY AND PROJECTS
SEA ECONOMY
TECMAR | SEA TECHNOLOGIES GROUP
SECTORS OF ACTIVITY

- Marine Ecosystems
- Ocean Energy
- Ocean R&D Infrastructures
- Fisheries & Aquaculture
- Harbours & Maritime Transports

Development of Innovative Technologies
SECTORS OF ACTIVITY
INEGI PROJECTS

**Synthetic Rope Roller Drum**
Partners: TEGOPI, IDMEC

**Lusitano VIP**
Portuguese Innovative Sailboat
Partners: Tony Castro, FEUP

**Remoted Operated Vehicle**
Partners: ISR, LSTS

**Hyperbaric Chamber**
Partners: CIMAR, IMAR

**Oceanographic Observatory**
Partners: INTECMAR, CETMAR, CIIMAR, INESC PORTO, FEUP, IH, UA, FCUP, IIM, U.Vigo, IEO.

**Rapid Prototyping model of a Crude Carrier**
Partners: IHRH, APDL

**Aquaculture – Waste Treatment System**
Partners: QdS, ICBAS, CIMAR

**Wave Energy Conversion**
Client: MARTIFER

**Offshore Wind Energy**
Client: CGUL, REN

**UAV - Unmanned Aerial Vehicles**
Partners: FEUP
MARINE RENEWABLE ENERGY
OTEO – Offshore Energy Technology Observatory – SIAC - establishes as strategy the portuguese and the international knowledge of offshore energy technologies as well as support technologies in order to increase the competitiveness and the entrepreneurship in this sector.

**Partners:** WavEC, EnergyIN

**Atlantic Power Cluster** - INTERREG - Building a transnational marine energy strategy in the Atlantic Area. Creating an adequate political and social environment for the marine energies. Enhancing the competitiveness and innovation capacities of the industrial community in the Atlantic regions.
OPERABILITY AND EXTREME LOADS ON OFFSHORE FLOATING WIND TURBINES

FWT – PTDC/EME-MFE/120593/2010 - Operability and extreme loads on offshore floating wind turbines. The objective of the project was to investigate the operability of floating wind turbines (FWT) in wind and waves and the extreme loads on the structure and on the mooring lines. Numerical tools and procedures were developed to calculate the related system responses.

Verification of the Normal Turbulence Model (recommended in IEC standards for offshore wind turbine design) suitability to reproduce the offshore wind behaviour, using real data sets. In addition to an overestimation of the wind turbulence, it was found that this does not correctly reproduce the behaviour of offshore wind at high speeds.

It was also investigated an alternative model, the Offshore Normal Turbulence Model, which was found to be more suitable for the offshore environment. Amendments to this model were proposed to improve its accuracy in terms of a specific location.


PARTNERS: IST, WavEC, EDP Inovação, INEGI, OneOcean
Remote sensing in non-conventional environments: advanced methods and techniques for wind characterization – Study of a SPAR buoy in the frequency and time domains, for monitoring the wind resource in offshore environment through a LiDAR.

Analyzed the feasibility and effects on the hydrodynamic response induced by the harnessing of wave energy (through the Oscillating Water Column principle) to supply power for the LiDAR system.

Special attention was given to the SPAR buoy's stability, in order to not disturb the LiDAR measurements.
**RAIA - RAIA**

RAIA is the result of a common strategy developed by the regions of the North of Portugal and Galicia in Spain with the ambition of reaching a deeper understanding of the ocean in the northwest of the Iberian Peninsula. Within the project, different partners with operational, technological and scientific background look at the issues of operational oceanography. INEGI’s role as a technology development partner is focused on innovations in marine observational buoy technology.

Partners in this project: MeteoGalicia, INTECMAR, Instituto Español de Oceanografía (IEO), Instituto de Investigaciones Mariñas (CSIC-IIM), CETMAR, Universidade Vigo, Puerto de Vigo/Puertos del Estado, CIIMAR, INESC, Universidade do Porto, Instituto Hidrográfico (IH) and Universidade de Aveiro.
SPAR BUOY

Target: 10 meters wind measurement

Design Concept

Manufacturing

Instrumentation, sensors and mooring

Assembly & Test

Project Detail

02. R&D, CONSULTANCY AND PROJECTS
Offshore structures performance designed with composite material.

Analysis of loads that influence the dynamics of floating bodies in particular those related to environmental conditions (e.g. current, wind and waves).

The project also included the assessment of the behavior of different lines and mooring system settings in order to support the activity of the Health Monitoring Composite system.

The validation of numerical results underway will contribute to increased efficiency in the design and operation of offshore structures designed with composite materials.

PORTS SUSTAINABLE ECO-EFFICIENCY
Promoting eco-efficiency at the port of Sines | Renewable Energy Integration

Role of INEGI | Consultancy in the process of installation of a photovoltaic solar plant (250 kW peak) and monitoring of solar plant operation

Activities:

- Tender process for technology selection;
- Evaluation of project;
- Monitoring of the solar plant construction;
- Monitoring and verification of the O&M conditions.
BREAKWATER AS WAVE ENERGY CONVERTER
03. POTENTIAL FOR GROWTH AND INTERNATIONALIZATION OF THE SEA ECONOMY
EXTENSION OF THE PORTUGUESE EXCLUSIVE ECONOMIC ZONE

EMAM – Estrutura de Missão para a Extensão da Plataforma Continental

EEZ Exclusive Economic Zone
Portugal Continental Portugal (327.667 Km²)
Azores (953 633 km²)
Madeira (446 108 km²)

Present = 1.727.408 Km²
Future = 3.877.408 Km²
OPPORTUNITIES AND CHALLENGES

Generic Challenges:
• Strengthen cooperation between R&D centres, creating dimension to be relevant at the level of the European Commission and major European companies;

• Strengthen mechanisms and innovation logic within corporate R & D, for example, granting these institutions people with training in innovation management;

• Strengthen mechanisms for “marketing” and “marketing” activities in R & D.

• Strengthen mechanisms for mutual consultation between R & D organizations and companies to improve communication and awareness between both;

Specific Challenges:
• Ensure an adequate level of funding for activities at sea and the corresponding infrastructure support.
OPPORTUNITIES AND CHALLENGES

Areas with significant opportunities for the technologies and support services:

- Monitoring;
- Characterization of the energy resource;
- Selection and characterization of sites for installation of marine energy parks;
- Support for Operation and Maintenance of marine parks, including:
  - Maritime Security;
  - Systems and methods for inspection;
  - Corrosion, cathodic protection;
  - Electrical Interconnection;
  - Integrated systems to support O & M;
- Numerical and experimental simulation;
- Control devices and parks in view of the efficiency and network stability, including storage systems.
OPPORTUNITIES AND CHALLENGES

How to Promote International investment in Portugal for offshore renewable energy sector from utilities, developers, operators and investors?

• Simplified licensing in particularly for Demonstration projects;
• Stability of Public Policy;
• Valuing our natural conditions (Resource, Ports and Electrical Grid, Proximity to the coast);
• Ensuring data confidentiality;
• Create incentives for R&D;
• Reinforce Infrastructures;
• Clear definition for tariffs and time horizon;
• Leverage existing know-how in various sectors of national value chain, providing developers an integrated solution, thus promoting the development of a national cluster (Eg. onshore wind sector is acquired know-how that can be transferred to the offshore sector).
OCEAN OFFSHORE ENERGY HARBOUR

- Semi Submersible System
- Desalinated Water, Oxygen and Hydrogen
- Anchor Handler Support Vessel
- OTEC (Ocean Thermal Energy Conversion)
- Support Facilities
- Control Tower
- Staff Housing
- Maintenance Remote UAV - Unmanned Aerial Vehicle
- Spar Buoy System
- Microalgae Aquaculture for Biofuels

Harbour

Wind Measuring and Wave Recorder Floating Spar
Maintenance Remote AUV - Autonomous Underwater Vehicle
Wave Energy Converters
Gravity System

INEGI - Institute of Mechanical Engineering and Industrial Management
OBRIGADO / THANK YOU