Marine Energy

Creating value from
marine energy technologies.

www.tecnalia.com

tecnalia Inspiring Business

IDEAS THAT CREATE VALUE

Inspiring Business

TECNALIA Research & Innovation is the first privately funded applied research centre in Spain and one of the leading such centres in Europe. A combination of technology, tenacity, efficiency, courage and imagination.

We identify and develop business opportunities through applied research. Inspiring Business is a different, unique vision: we visualise ideas that generate value and provide creative technological solutions to produce real results.

At TECNALIA we are organised in 7 fully interconnected Business Divisions. Cooperation works thanks to the transversality of teams, projects and clients collaborating with each other, combining expertise and commitment. Our best asset is our team, made up of more than 1,500 experts who work to transform knowledge into GDP in order to improve people's quality of life by generating business opportunities for companies.
We are committed to the future, society, our planet and our environment. This responsibility provides focus to our values and reinforces our activities.

"TECNALIA transforms Knowledge into GDP to improve people's quality of life by generating business opportunities for Companies"

VALUES

1. COMMITMENT TO THE FUTURE
2. BUSINESS PERSPECTIVE
3. RESEARCH TENACITY
4. EFFICIENT CREATIVITY
5. FLEXIBILITY
6. CONNECTIVITY

7 BUSINESS DIVISIONS

1. SUSTAINABLE CONSTRUCTION
2. ENERGY AND ENVIRONMENT
3. INNOVATION STRATEGIES
4. ICT-EUROPEAN SOFTWARE INSTITUTE
5. INDUSTRY AND TRANSPORT
6. HEALTH
7. TECHNOLOGICAL SERVICES

INTERNATIONAL PRESENCE

- SALES NETWORK
- ASSOCIATED INNOVATION CENTRES
- BRANCHES ABROAD
- ALLIANCES
- HEADQUARTERS

OUR ACTIVITY IN FIGURES

DOCUMENT PUBLISHED IN JANUARY 2016

ONE HUNDRED AND TEN

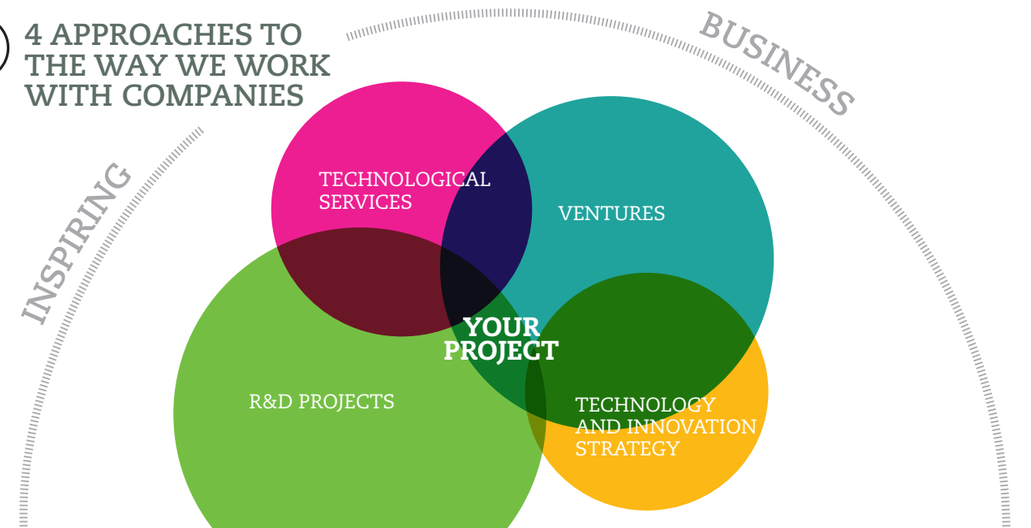
MILLION EUROS INCOME

FIRST SPANISH PRIVATE ORGANISATION IN FINANCIAL RETURN, PROJECTS APPROVED AND LED WITHIN THE EC 7FP **1st**

EXPERTS ON STAFF **1,500**

WORKING TOWARDS A COMMON GOAL: TO GENERATE BUSINESS OPPORTUNITIES THROUGH APPLIED RESEARCH.

4 APPROACHES TO THE WAY WE WORK WITH COMPANIES



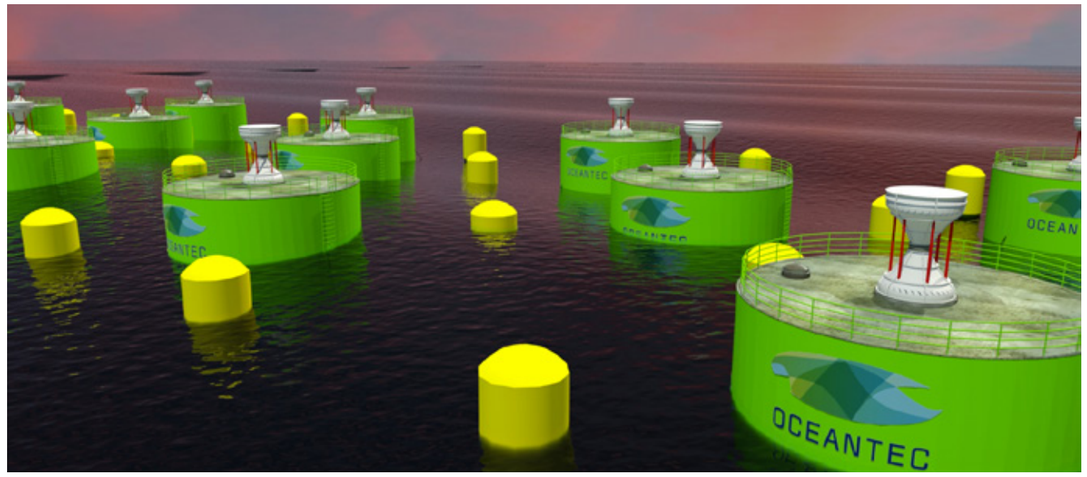
Marine Energy

The development and deployment of low-carbon energy technologies is a crucial component in providing the integrated solutions needed to reduce CO_2 emissions but also an important tool to stimulate innovation and foster economic growth while enhancing access to secure, affordable energy. Wind, wave and tidal marine renewable energy sources offer sustainable alternatives to fulfil energy demands by preserving the environment.

Twenty-four years have passed since the world's first offshore wind farm, Vindeby (5MW), was built in Denmark. Today, 8,620 MW of offshore wind power has been installed globally, and more than 90% of it is installed off northern Europe, in the North, Baltic and Irish Seas, and the English Channel. Most of the rest is in two demonstration projects off China. However, there are also great expectations placed for major deployment elsewhere; governments and companies in Japan, Korea, the United States, Canada, Taiwan and even India have shown enthusiasm for developing offshore in their waters.

Wave and tidal energy technologies are just beginning to reach viability as potential commercial power sources. While just a few small projects currently exist, the technology is advancing rapidly and has enormous worldwide potential for generating power. The UK is currently the global leader, with around 10MW of wave and tidal devices being tested in UK waters.

TECNALIA applies its knowledge using a coordinated, holistic approach, focusing on the deployment of cost effective marine renewable energy farms throughout their life cycle.



Since its establishment 10 years ago Marine Area at TECNALIA has:

- Created 2 technology-based companies.
- Transferred 4 patents to industry.
- Tested a full scale wave energy device in the open-sea.
- Participated in 10 European Research Projects.
- Collaborated with the local government on the definition of the marine energy strategy.
- Organised ICOE 2010 and other national events.
- Widely Contributed to international advisory groups.

TECNALIA offers its expertise to companies interested in:

Offshore Wind

Ocean Energy

Resource and Environment

Power Delivery to the Grid

HVDC, Power Electronics and Control Systems

Manufacturing of Mechanical and Structural Components

Materials for Mechanical and Structural Components

Condition Monitoring & Control

Infrastructures and Equipment

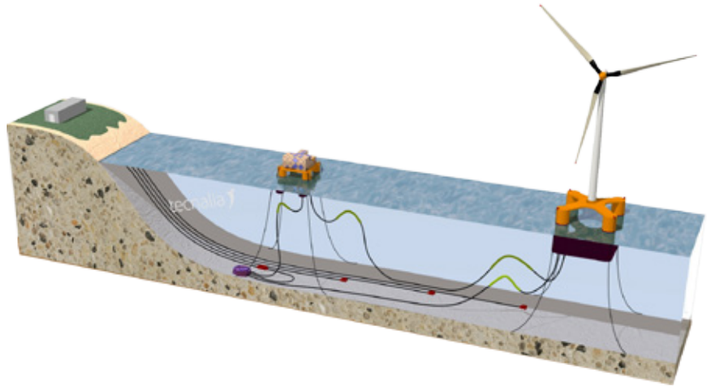
Offshore Wind

Industry action is required to help drive down offshore wind costs to secure the future of this strategically important energy source.

With **8,620 MW of offshore wind power installed globally today** and **roughly 396 GW by 2030** the exploitation of this clean and abundant energy is a reality. Moreover, **by 2050, 25% of total global wind capacity will be located at sea**, up from 6% in 2020. Investment costs for wind power will decrease by 25% on land and 45% offshore by 2050 (IEA Technology Roadmap for Wind Power 2013 Edition).

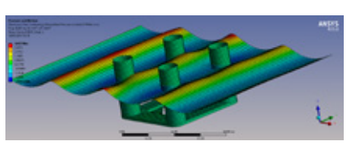
Industry action is required to help drive down offshore wind costs to secure the future of this strategically important energy source. **The greatest cost reductions result from the introduction of turbines which are larger**, have higher reliability and energy capture and lower operating costs.

Almost all of the installed capacity today is built on bottom fixed foundations. However, in many coastal areas of the world the waters are too deep for this technology. **Floating wind turbine technology offers a new opportunity to provide clean energy to countries and coastal regions with deep water coastlines**.



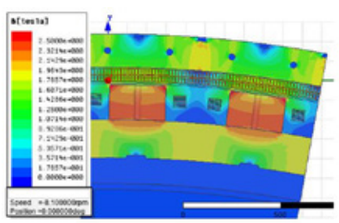
FLOATING OFFSHORE WIND COMPONENT DESIGN:

- Conceptual design and optimisation of floating platforms.
- Mooring systems and cables analysis.
- Lay-out optimisation.
- Hydrodynamic analysis and naval engineering.
- Aerodynamic-hydrodynamic coupling.
- Wave tank numerical analysis.
- Installation, commissioning and decommissioning simulations.
- O&M simulations and strategies definition.
- Life cycle and costs assessment. Techno-economic model optimisation.



GENERATORS FOR LARGE WIND TURBINES:

- Generator architecture design.
- Electromagnetic, thermal and mechanical behaviour analysis. 2D and 3D finite-element simulations.
- Prototypes construction at small scale.
- Generators testing.
- Basic and detailed calculation of generators for different applications using superconducting materials. Design and construction of superconducting coils, cryostats and cooling systems.



TECNALIA offers its expertise in generators for large offshore wind turbines and floating offshore wind components that will provide cost-effective off-shore wind energy generation.

ACHIEVEMENTS

NAUTILUS FLOATING SOLUTIONS

A joint venture to develop a floating platform for offshore wind turbines with the objective of providing the lowest cost of energy by minimizing logistics from the very early design stages.

2009. Activity in floating solutions for offshore wind started at TECNALIA.

2010. Participation in projects to analyse different technologies and collaboration in tank tests.

2011. In-house technology developed (semi-submerged solution).

2012. Search for investors started.

2013. Nautilus Floating Solutions set up (Astilleros Murueta, Tamoin, Velatia and Vicinay partnership) with the technology leadership of TECNALIA.

2014. Small scale prototype tested in a tank.

TECNALIA is currently working on the design and detailed engineering of a semi-submersible platform for a 5MW wind turbine. A full scale prototype is expected to be deployed by 2017-2018.

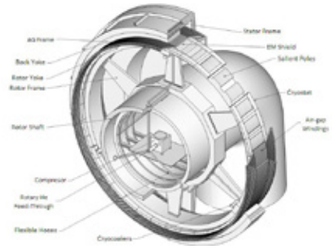
Cofunded by the European Union FP7 Grant Agreement 308793.

SUPRAPOWER (SUPERCONDUCTING, RELIABLE, LIGHTWEIGHT, AND MORE POWERFUL OFFSHORE WIND TURBINES)

EU FP7 funded research project that aims to provide an important breakthrough in offshore wind industrial solutions by designing an innovative, lightweight, robust and reliable 10 MW class offshore wind turbine based on a superconducting synchronous generator patented by TECNALIA.

Characteristics:

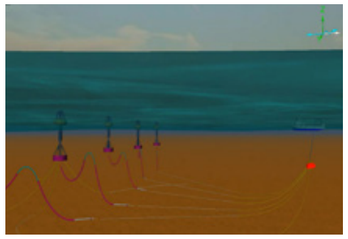
- Direct drive (no gearbox).
- Cryogen free modular cooling. Simple and low maintenance.
- 30% weight reduction compared to 10 MW permanent magnet (PM) generators.
- Rare earths free. Cost competitive compared to PM generators that contain rare earths (600% rare earths price volatility in 2011).
- MgB2 superconducting coil commercially available and very cost competitive.
- Simpler installation and lower vessels and crane costs. Reduction of mechanical requirements for foundations and floating platforms.
- Over 95 % efficiency (on-site).

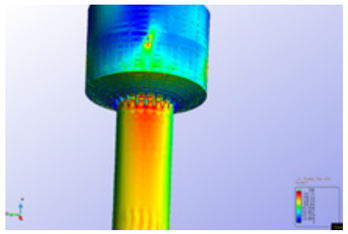


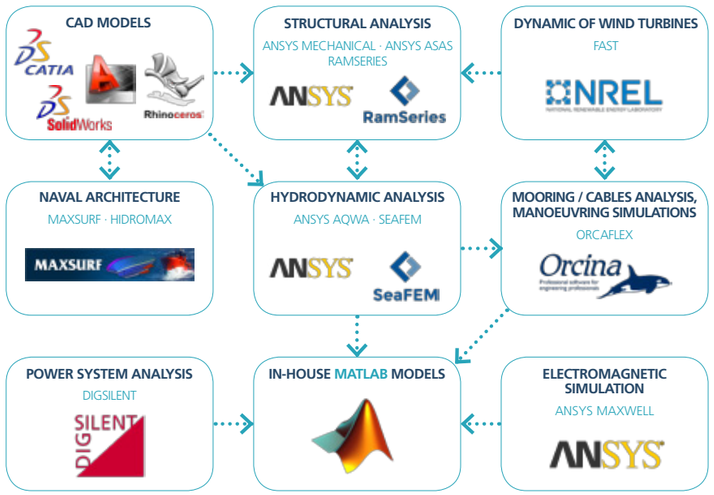
Ocean Energy

Wave and tidal energy technologies are just beginning to reach viability as potential commercial power sources. While just a few small projects currently exist, the technology is **advancing rapidly and has enormous worldwide potential for generating power**. **By 2030, a capacity of 180 GW** is to be connected to the grid according to IEA and ORECCA. **By 2050**, Wave and Tidal Energy has the potential to develop **337 GW**.

As a result of this forecast, **the industry could provide a global economic benefit of €48 billion/year by 2050**, from factors such as electricity generated, emissions reductions, security of supply, regional development and knowledge created. It could **potentially create 1.2 million direct jobs and save nearly 1.0 billion tonnes of CO_2 emissions.** (*IEA Ocean Energy Systems: Annual Report 2013*).





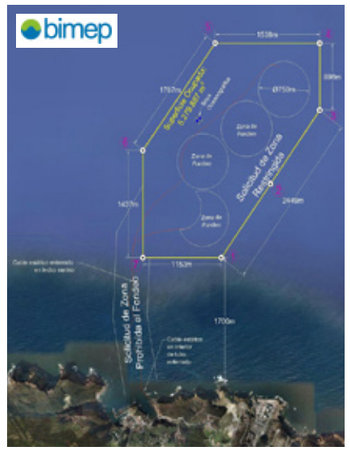


WAVE AND TIDAL ENERGY CONVERTER DESIGN:

- Hydrodynamic analysis and performance of ocean energy converters.
- Design of mooring systems and umbilical/dynamic cables.
- Structural design of foundations.
- Power Take-Off (PTO) and control systems.
- Structural analysis and optimisation.
- Wave tank numerical analysis.
- Installation, commissioning and decommissioning simulations.
- O&M simulations & strategies definition.
- Life cycle and cost assessment.
- Techno-economic model optimisation.

TECNALIA offers a holistic approach focusing on the deployment of cost effective ocean energy arrays throughout their life cycle.

ACHIEVEMENTS

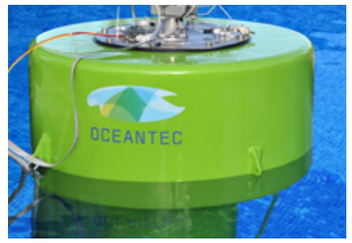


TECNALIA has worked with the Basque Energy Agency (EVE) on the **definition and development of an infrastructure for research, demonstration and exploitation of wave energy (bimep).** The tasks developed include:

- Site selection (resource and ocean-meteorological analysis, environmental, bathymetry and geotechnical studies, fisheries, etc.).
- Definition of electrical design and grid connection alternatives.
- Documents production for permit processes.
- Support in different tenders published (engineering and subsea cable tenders).
- Specification of the monitoring system and the safety protocol for navigation.
- Definition of research activities.

bimep is an open-sea test facility for research, development and demonstration of marine energy converters located in the Basque Country, Spain.

- Definition of service and product range.
- Definition and implementation of the business model.
- Definition of the strategy to promote bimep and possible lines of financial support.
- Promotion of the infrastructure (potential users, fishermen, local authorities, conferences).
- Management of scientific equipment purchase (benchmarking and selection of the meteorological buoy and software for marine renewable research).



OCEANTEC ENERGÍAS MARINAS S.L.

Joint venture with the main objective of developing a floating oscillating water column wave energy converter.

2004. Marine energy department established at TECNALIA.

2005. Designing of a wave energy converter started (attenuator type, gyroscopic PTO).

2006. First International patent registered.

2007. Technology validated by numerical models, laboratory and tank tests. OCEANTEC Energías Marinas S.L. set up (TECNALIA and IBERDROLA Partnership). 1:4 scale Prototype tested in the open-sea.

2010. Second generation wave energy converter designing started (floating offshore oscillating water column device).

2013. New device tested in a wave tank.

2014. Design of a reduced power prototype for open-sea testing.

OCEANTEC is currently working on the design and detailed engineering of a reduced-power prototype that is expected to be deployed in **2016**.

Resource and Environment

OCEAN ENERGY RESOURCE AND SITE ASSESSMENT

Offshore renewable energy farm site selection is crucial to assure cost efficiency and to avoid negative impacts in the lifecycle of the farm.

Firstly, ocean energy resources for the siting, along with feasible technology selection and pre-design are characterised. Then, energy assessment based on intermediate detailed studies is carried out. Finally, accurate systems for resource monitoring and assessment for structural engineering and installation projects are developed.

A suitable site selection is that one that tries to avoid conflicts of use between existing activities and renewable energy generation. This is undertaken by assessing social and economic impacts of the offshore renewable energy farms in the region.

OPERATIONAL OCEANOGRAPHY FOR DESIGN AND REAL TIME MANAGEMENT OF OFFSHORE RENEWABLE ENERGY FARMS

The operational downstream tools and services include innovative ocean monitoring and forecasting capabilities, which allow more cost-effective management of offshore renewable energy farms. Metocean variables, data collection strategies and analysis methodologies are also developed, focusing on the design, performance assessment and real time management of the farms.

ENVIRONMENTAL IMPACT ASSESSMENT AND MONITORING

AZTI-TECNALIA strives to guarantee environmental sustainability and efficiency in future offshore renewable energy projects by:

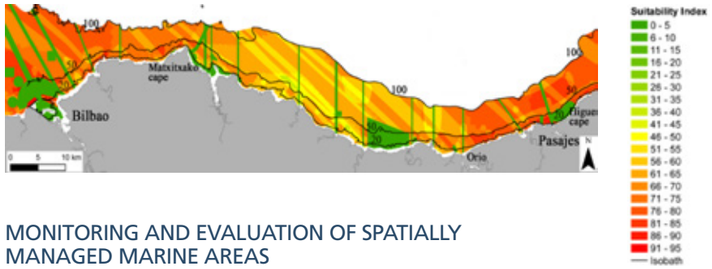
- **Modeling pressures and impacts generated by each project** of temporary or permanent occupation of the marine and coastal public domain and associated natural resources.
- **Designing and implementing Environmental Monitoring Programmes (EMP)**, adapted to aquatic transitional, coastal and ocean ecosystems.
- **Preparing Environmental Impact Assessment (EIA)** studies adapted to the specific requirements and particularities of the marine environment.

TECNALIA performs reliable weather forecasting for energy generation estimation and operation planning:

- High resolution numerical weather prediction for the wind industry: on-land, offshore and urban environments.
- Operational wind resource and power forecasting.
- Short-, medium- and long-term weather forecasting focused on wind industry operation.
- Now-casting and extreme events forecasts, which is relevant for wind industry operation, including offshore activities.
- Wind resource mapping (high resolution numerical models and geostatisical techniques).
- Wind data management.

AZTI-TECNALIA evaluates and assess offshore renewable energy resources; develops operational oceanography tools; performs Environmental Impact Assessment studies and Environmental monitoring programs adapted to the specific requirements of each customer.

ACHIEVEMENTS



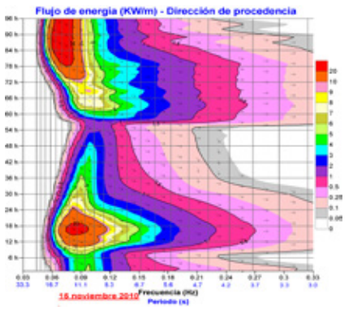
MONITORING AND EVALUATION OF SPATIALLY MANAGED MARINE AREAS

MESMA is an FP7 project that has produced guidance and tools to support the implementation of marine spatial planning in Europe's seas. It included advice, tools and information on human uses, biotope classifications/distributions (including examples of geospatial data systems), governance processes and different approaches to conflict management.

MESMA's work will benefit governments, local authorities, the whole range of stakeholders, managerial bodies for planning and decision making and the public in general.

PROGRESS IN OCEAN-METEOROLOGICAL PREDICTION IN THE BASQUE COUNTRY AND DEVELOPMENT OF PRODUCTS AND APPLICATIONS (ITSASEUS)

Operational development and implementation of ocean-meteorological prediction systems in the Basque Country.



This systems enabled Euskalmet (Basque Meteorology Agency) to provide high added value services to all the activities carried out at sea and on land.

OCEAN ENERGY RESOURCE AND SITE ASSESSMENT

- New methodologies and studies for providing spatial planning tools on the Basque Coast applied to marine energy, aquaculture and fisheries.
- Key role in the implementation of the strategy of bimep.
- Participation in numerous European projects and Technical Specification Groups for resource assessment (IECTC114).

OPERATIONAL OCEANOGRAPHY FOR DESIGN AND REAL TIME MANAGEMENT OF OFFSHORE RENEWABLE ENERGY FARMS

- Participation in different regional, national and European programs (ITSASEUS, LOREA, SPRES (INTERREG), ECOOP, JERICO (FP).
- Participation in different strategic alliances and technical working groups for Operational Oceanography (IBIROOS, HF Radar Task Team, GISLB, etc.).
- Participation in numerous European projects and Technical Specification Groups for resource assessment (IECTC114).

ENVIRONMENTAL IMPACT ASSESSMENT AND MONITORING

- Participation in different groups such as AENOR standard committees, ICES and the International Energy Agency (particularly in Annex IV for the environmental impact of projects in marine environments).
- Adviser for Basque Energy Agency on environmental aspects related to the **Biscay Marine Energy Platform (bimep)** project (EIA and EMP).

Power Delivery to the Grid

TECNALIA develops cost-effective umbilical cables and connection solutions specially designed for offshore wind, wave and tidal energy applications.

The electricity generated in an array of wind turbines or wave or tidal devices is delivered to the grid by means of other components such as umbilical cables, connectors and offshore substations.

Umbilical cables transmits electrical power from the energy generating device to the dynamic cable or junction box under the water. In addition to the characteristics to be fulfilled by any power cable, umbilicals **need to go through strict critical loads analysis verification and optimization processes based on the dynamic response and fatigue analysis and design life**.

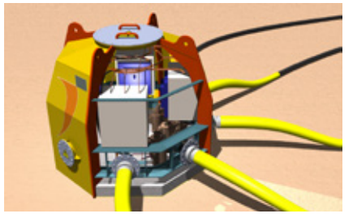
Currently, there is a wide range of low-voltage commercial subsea connectors available on the market from Oil & Gas, military and oceanographic industries. **These connectors are usually for deep water applications while in offshore wind and wave and tidal energy the water is shallower.** In shallow water the key factor is oxygen and ocean currents that lead to marine growth and corrosion.

Building **fixed jackets or complex tower type structure substations or floating platforms** in use for oil platforms is **too expensive**. **Subsea substations fixed on the sea bed** could interconnect different wind turbines, wave or tidal devices to onshore substation and also perform other functions such as stepping-up the voltage, measuring the power and protecting the devices, cables and connection components **more economically.**

TECNALIA develops cost-effective umbilical cables and connection solutions specially designed for offshore wind, wave and tidal converters that are easy to connect and disconnect, need minimum offshore working time, have less demanding meteorological requirements for the connecting/ disconnecting operations, and need low maintenance.

We also work towards incorporating smart solutions in connectors, cables and substations that add measurement, protection, location and predictive maintenance functions.

ACHIEVEMENTS



SUBMARINE HUBS

The submarine hub is a **subsea connection solution that connects up to 5 umbilical cables (13,2 kV) to one export cable**. It also connects low voltage cables for ancillary equipment and fiber optic cables for data transmission.

In service the hub lays on the sea bed. For connecting and disconnecting operations it needs to be lifted onboard.

Measurement, protection and control functions can be added.

The concept was patented by TECNALIA in 2011 and transferred to INGEINNOVA later on. Currently INGEINNOVA is leading the project and TECNALIA is collaborating in some technical tasks.

ingeinnova clean tech

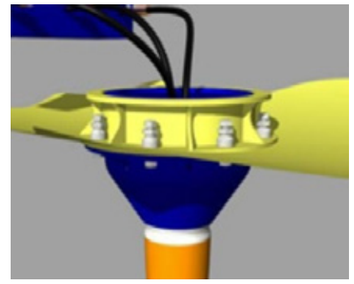
CONNECTORS FOR FLOATING DEVICES

It is a **submarine cable to device or floating platform connection solution** that includes common electrical components used in onshore applications.

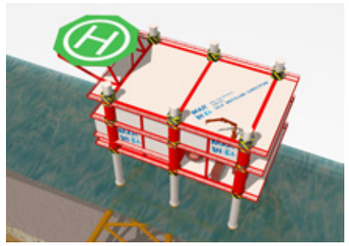
Besides the power cables (13,2 kV) the connector also connects low voltage cables for ancillary equipment and fiber optic cables for data transmission.

The connector is easy to connect and disconnect, needs minimum offshore working time, has less demanding meteorological requirements for the connecting/disconnecting operations and needs low maintenance.

The concept was patented by TECNALIA in 2013 and transferred to DITREL later on. Currently TECNALIA is collaborating with DITREL in the technical tasks.



ditrel Industrial S.L.



NEW LARGE DIMENSION OFFSHORE SELF-INSTALLING SUBSTATION (MARIN-EL)

The initiative is supported by the Basque Government and is led by Iberdrola Ingeniería y Construcción. Other companies such as Ingeteam, Ormazabal, Arteche, Incoesa, Construcciones Navales del Norte, Semantic Systems, the Basque Energy Cluster and the Maritime Basque Forum are also involved in the project.

TECNALIA is responsible for the design of the structure of the self-instalable substation, HVDC power transmission studies and eco-design and life cycle analyses.

HVDC, Power Electronics and Control Systems

Offshore wind energy deployment requires solutions for **efficient long distance transmission of massive amounts of energy. HVDC (High Voltage Direct Current)** electric energy transmission reduces significantly long distance transmission losses, permits an instantaneous power control and improves the quality of the energy, **making feasible facilities that would otherwise not be economically viable.**

On the other hand, wind turbines, converters, power cables, electrical substations, etc. will need to go a step further to be more cost-effective and face the challenges and opportunities that the growing offshore wind sector is intended to bring. Particularly electrical systems will need to provide **better power scalability, weight reduction and higher reliability**.

SOLUTIONS FOR HVDC:

- VSC-HVDC converters (MMC).
  - DC collector systems.
  - HVDC hybrid systems.
  - VSC-HVDC onshore substation.
- Development of control algorithms for:
  - Point to point (P2P).
  - Multiterminal.
- Offshore wind energy DC grids optimization (load flow simulations, stability and fault analysis…) and integration in AC grids.

OFFSHORE POWER ELECTRONICS:

- Multilevel converters.
- Development of control algorithms for wind turbines:
  - Grid side converter.
  - Generator side converter.
- Development of solutions for connecting wind turbines directly to DC collector systems (wind turbine AC/DC converter).
- Availability of a 1.5MVA/3.3kV infrastructure to test wind converters.
- Integration of offshore wind energy in AC grids (load flow simulations, stability and fault analysis…).

CONTROL SYSTEMS:

- Experience in developing products based on Control Hardware and Software: power control, predictive maintenance…
- Development of complex architectures of embedded systems: Digital Signal Procesors (DSPs) and microcontrollers, FPGAs (field-programmable gate arrays) design.
- Signal conversion and adaptation Hardware.
- Support to Hardware manufacturing.

New solutions will provide efficient energy evacuation, better power scalability, weight reduction and higher reliability.

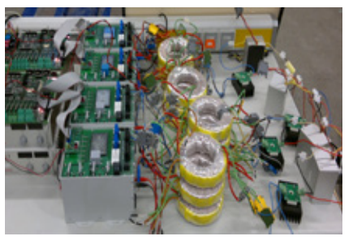
TECNALIA offers its expertise in power electronics and control systems to develop hardware and software solutions to address the issues that manufacturers and utilities demand.

ACHIEVEMENTS

BEYOND STATE-OF-THE-ART TECHNOLOGIES FOR REPOWERING AC CORRIDORS AND MULTI-TERMINAL HVDC SYSTEMS (BEST PATHS)

Innovative transmission systems and industrial solutions to connect offshore wind farms, and to improve the interconnections of the power grid.

TECNALIA is involved in the demonstration of HVDC links for offshore wind farms and offshore interconnections, models and algorithms for the analysis of multi-terminal HVDC systems applied to the delivery of offshore wind energy.



DC COLLECTOR

Validated small scale prototype focused on the energy transmission system cost reduction in the offshore wind farms through the use of DC energy collection systems.

5 MW NPC MULTILEVEL CONVERTER

- Back to back MV converter (3300 VAC) with NPC multilevel topology.
- 1.25 MW module parallelisation 5 MW maximum power.
- Variable frequency from 0 to 70 Hz.
- Functionality: voltage source, current source and DC booster.
- Applications: grid elements (active filters, FACTS, STATCOMS, etc.), wind, photovoltaic applications, energy storage, HVDC, traction, electric vehicle, marine energy, etc.

SCALE VSC-MMC SUBSTATION PROTOTYPE (96 MODULES MMC-20 KW)

- Flexible: Configurable lab set up to test multiterminal and meshed VSC- HVDC links.
- Own developed HW & SW control.
- Communications system based on a passive optical network.

Manufacturing of Mechanical and Structural Components

TECNALIA's continuous curing process monitoring; infusion filling simulation; use of flow sensors and reduction of adhesive bonds offer companies savings up to 30% on energy consumption and 50% on manufacturing time. The application of re-engineering processes and re-design of turbine key components (pitch, drive, frames, etc.) lead to savings of around 11%.

COMPOSITES FOR BLADES:

- Control of moulding, curing and infusion processes.
- Out-of-autoclave/liquid moulding process optimisation and simulation.
- Efficient heating tooling based on self-heated mould and membranes.
- New thermoplastic materials for blade design and manufacturing (liquid moulding processes).
- Carbon material on leading edges with anti-freeze and electrical dissipation effects.

METALLIC COMPONENTS AND NEW ALLOYS:

- Use of light alloys instead of standard alloys in turbine components (pitch drive, frames…) to increase turbine efficiency.
- Advanced manufacturing processes for metallic components (casting, forging, etc.) to reduce component costs.
- Mechanical engineering and simulation using CAE techniques (simulations based on Finite Element Analysis).
- Component re-engineering based on redistribution/mass reduction and improved mechanical properties.
- Process monitoring solutions for the machining of large-sized gear-box and its components in order to take actions online and reduce scrap and defective parts.

MANUFACTURE OPTIMISATION:

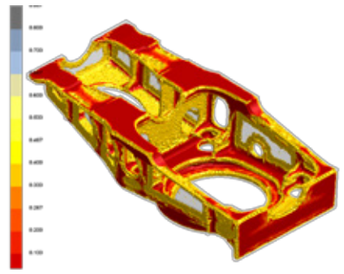
- Robotic-based approaches for high demanding continuous processes (increased accuracy, stiffness, repetitiveness): New robot models, External devices (vision, IPS) to improve accuracy, External devices and control strategies to damp vibrations, Robot controller replacing for CNC.
- New calibration techniques, position, stiffness and dynamic calibration.
- Electromechanical design of smart and flexible tools for large-parts.
- Design of proper tools and selection of manufacturing processes considering flexibility and efficiency of the manufacturing production.
- Active and flexible clamping solutions for large-parts.

Our re-engineering processes and re-design of turbine key components lead to savings of around 11%.

ACHIEVEMENTS

QUALITY CONTROL SYSTEM THAT DRASTICALLY CHANGES THE CURRENT CONCEPT OF END OF LINE QUALITY CONTROL (MUDPROD)

To prevent the generation of defects within the process at single stage and the propagation of defects between processes at multi-stage system level. It is proactive, offering different solution strategies to avoid End of Line defects.

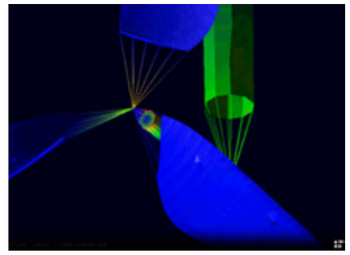


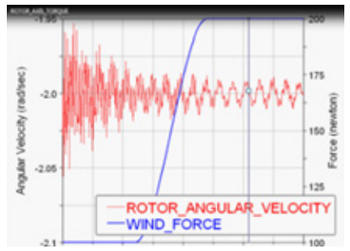
FRAME WEIGHT REDUCTION AND PROPERTIES IMPROVEMENT AT EXTREME CONDITIONS (PROTOTYPE GEOMETRY SUPPLIED BY GAMESA)

Re-engineering of a frame obtaining a relevant weight reduction (~11%) combining a reduction in mass (3%) and an improvement of the material (8%).

CONTINUOUS FIBRE THERMOPLASTIC COMPOSITE MANUFACTURING THROUGH IN-SITU POLYMERISATION

Low-cost and fast mass production continuous manufacturing process for pieces of polyamide composites with fibreglass, carbon fibre or aramid fibres. It permits to obtain big size products, products with complex geometry and structural parts.

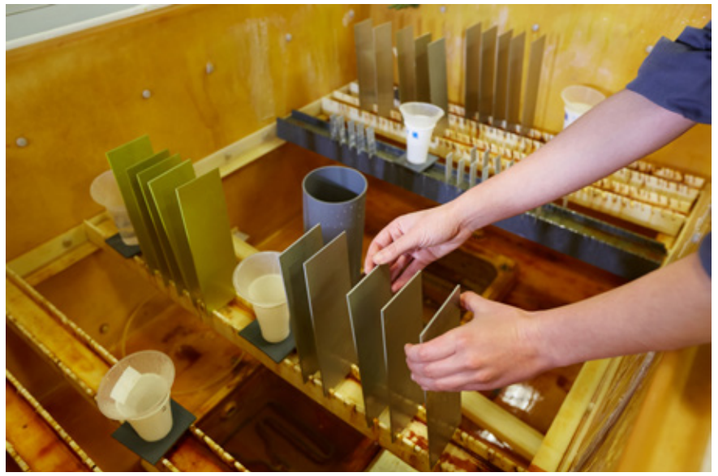




SIMULATION OF THE PERFORMANCE STRESS (TORSION DEFORMATION) OF THE BLADE ROTOR IN ACCORDANCE WITH WIND SPEED

Simulations of a real turbine behaviour under the wind loads using the software tool AeroDyn.

Materials for Mechanical and Structural Components



As regards cost reduction, there are significant technological breakthroughs for corrosion, bio-fouling, erosion, abrasion and frost protection which help to extend the service life of components and materials.

TECNALIA´s advanced treatment of materials and coatings for wind turbine components offers smart solutions to issues such as freezing, effects of UV rays, fatigue, and erosion & corrosion, to reduce operation and maintenance costs in marine environments.

ADVANCED, INNOVATIVE SURFACE TREATMENTS AND COATINGS:

- Coating and surface modification processes for wind energy industry that improve surface properties such as anti-ice, self-cleaning, UV light resistance, resistance to erosion or fatigue, etc.
- Evaluation of the performance of materials under "laboratory" and "industrial" conditions.
- Material selection and application of heat treatments and surface treatments or coatings for specific purposes.
- Tribology of offshore energy conversion technologies: Analysis & testing, assessment.

MATERIAL CHARACTERISATION AND FAILURE ANALYSIS:

- Material characterisation in mechanical tests, chemical analysis, materialography, corrosion analysis, prediction and assessment.
- Special tests: components and assembly, extensometry, residual stresses, metallographic replication...
- Paint characterisation.
- Wear and friction characterisation.
- Surface properties (roughness, coating adherence, wettability, hardness, …).
- Assessment and diagnosis: causes of non-compliance, review and definition of specifications.
- Advice on Material Selection and Manufacturing Processes (welding processes).
- Validation of prototypes: quality control of manufacturing processes such as rolled, forged or cast products, thermal treatments, coating, welding and others and assessment of accelerated testing response.
- Failure Analyses, in-service performance and residual life.

ACHIEVEMENTS

CORROSION PROTECTIVE COATINGS ON GALVANISED STEEL

Sol-Gel (SG) corrosion protective coatings on galvanised steel.

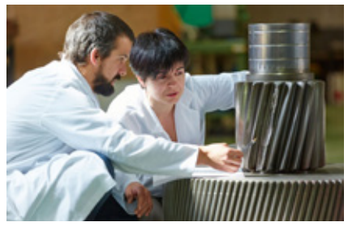
NOVEL PLASMA NITRIDING / NITROCARBURISING PROCESS FOR IMPROVING THE PROPERTIES OF STEELS AND SPECIAL ALLOYS

Cost-effective solutions for improving wear resistance, friction performance, corrosion resistance and fatigue characteristics.

MATERIAL CHARACTERISATION OF HUBS AND FRAMES

Made of nodular cast iron.

Bolts, screws and studs characterisation and nonconformity test according to EN ISO 898-1 standard.



TOOTH BREAKAGE IN INTERMEDIATE SHAFT

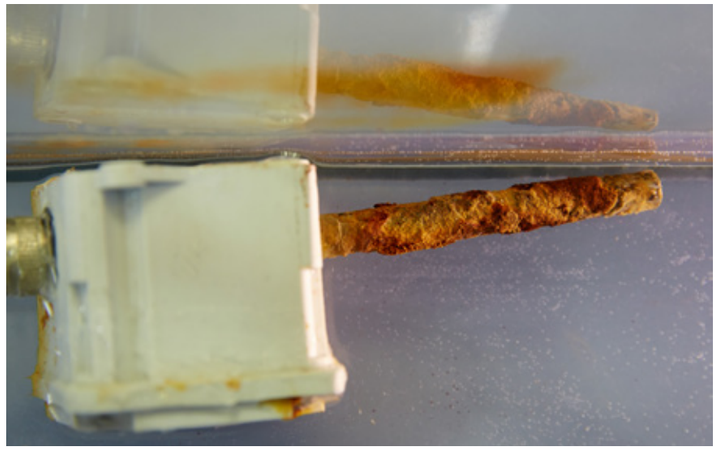
Tooth breakage derived from a fatigue mechanism under standard working conditions, and fatigue mechanism is triggered by the presence of a large alumina inclusions pool.

Advanced treatment of materials and coatings reduces operation and maintenance costs in marine environments.

Condition Monitoring and Control

TECNALIA's smart instrumentation technologies and prediction systems enable extension of wind turbines lifetime. Our robust and resilient architectures reduce maintenance costs and increase safety in communication.

Proper operation and good maintenance of wind farms are keys to achieving **optimal economic results by maximizing the performance and extending the useful life of the components**. Operational data can be leveraged via smart data-processing algorithms to perform **fault diagnosis/ prognosis and to assess the performance of a wind turbine or a whole park. Smart software** will allow an easy access to Key Performance Indicators (KPIs), energy generation and availability statistics, forecasts and other valuable information. Seamless **integration with the monitoring system**, extensibility and state-of-the-art algorithms become strategic challenges for the marine sector.



CONDITION AND STRUCTURAL HEALTH MONITORING:

Ad-hoc instrumentation technologies for specific CMS and SHM solutions /

- Development of sensors and devices for corrosion monitoring.
- Ultrasonic sensor development for structural health.
- Spectroscopy for corrosion monitoring.
- Fibre optics for blades.
- Fibre optics integration for load measurement.
- Ultrasound and vibration monitoring.
- Real-time signal processing and advanced PLC/SCADA data analysis for early failure mode detection and degradation estimation.
- On-board systems for data acquisition.
- Development of artificial intelligence-based software tools for decision-making support.

CORROSION REMOTE MONITORING:

Real-time corrosion monitoring (at fully remote systems) /

- Environmental corrosivity.
- Structure integrity.
- Passive corrosion system (coating).

Using /

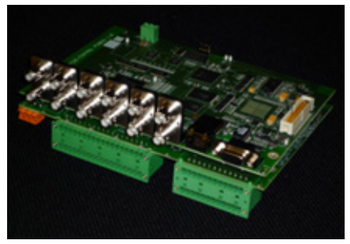
- Techniques based on sensors.
- Remote monitoring.
- Modelling and life time prediction.

CONTROL AND COMMUNICATION OPTIMISATION:

- Low cost high performance communication between the marine farm and the substation's fibre ring.
- Optimising main and redundant communication systems among the network elements (plants, substations and delegations).
- Resilient and robust architectures in electrical and wind farms domains in terms of security.
- Experience in IEC-61400/25 Protocol Stack application to standardise the control and communication of wind farms.

Our corrosion monitoring systems at marine farms represent costs savings up to 20%.

ACHIEVEMENTS



SMP CONDITION MONITORING SYSTEM

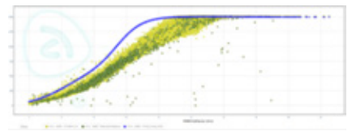
Predictive maintenance system for wind turbines. The system includes detection algorithms based on vibration analysis and information extraction, visualisation and analysis tools (GIRE-PRED).

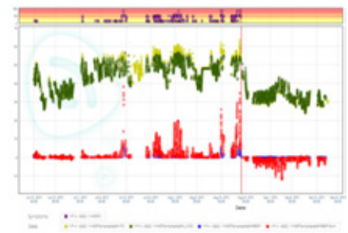
CORROSION MONITORING SYSTEM

Complete remote controlled corrosion monitoring prototype based on two techniques: i) electrical resistance (ER) of metallic sensors in order to establish the variation of the corrosion speed over the time, and ii) measurement of electrochemical impedance spectroscopy (EIS) on coupons in order to measure the degradation status of the anti-corrosion coating.

NEM SOLUTIONS' AURA DIAGNOSTIC: DIAGNOSIS AND PROGNOSIS OF FAILURE MODES BASED ON SCADA DATA

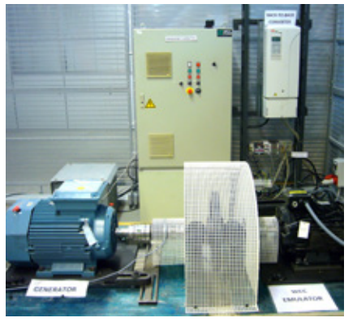
Development of algorithms with NEM Solutions for the breakdown of symptoms and failure mode prognosis based on SCADA, Osisofts' PI data and CMMS information. Performance identification in different subsystems and components, such as gearbox, hydraulic group or pitch control. The system automatically generates multi-dimensional power curves and estimated degradations deviations.





Infrastructures and Equipment

GRID CONNECTION LABORATORIES



ELECTRICAL POWER TAKE OFF (PTO) LAB:

This facility is integrated in the MaRINET European network, an EU-funded programme to accelerate the development of offshore renewable energy.

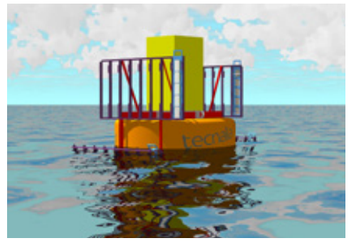
The Electrical PTO Lab is a turbine emulator that reproduces the mechanical output of an ocean energy device/wind turbine. This HIL test-bench allows us to perform dynamic tests with the real electrical equipment that is going to be used in the WEC. The viability of the concept can be analyzed from the electric point of view. Different kind of tests can be performed: electrical operation, development and validation of control algorithms, repetitive tests, etc.

FLEXIBLE ELECTRIC NETWORK (1.25 MW) FOR POWER ELECTRONIC EQUIPMENT TESTING (THOR):

THOR can be totally configured in voltage and in frequency **for supporting the integration and increased efficiency of the main energy applications and systems**: grid elements (active filters, FACTS, STATCOMS, etc.), wind, photovoltaic applications, energy storage, HVDC, traction, electric vehicle, marine energy, etc.

This electric flexible network for power electronic equipment testing is based on a multilevel converter of 3300V and 1.25MW extendable till 5MW.

CORROSION LABORATORIES



OFFSHORE EXPOSURE SITE:

This facility allows exposing different materials to a real marine environment both in immersion and sprinkled zones.

MARINE EXPOSURE SITE AT PASAIA HARBOUR:

It allows material degradation studies at classical marine environment. The samples (alloys, coated materials, polymers…) are submerged.

CORROSION LABORATORY INDOORS:

The Laboratory integrates a wide range of equipment to carry out aging tests and characterization of materials; allowing to identify and to analyze the processes of corrosion, as well as to evaluate the protection systems against it.

In addition to the traditional salt spray chambers and immersion baths, there are also climatic chambers (-70 to 180 ºC, 0 to 100% HR), humidity chambers, UV/Condensation chambers, and an erosion cabinet. Results correlation between lab corrosion tests and real conditions & early detection of corrosion degradation are made in order to reduce corrosion damage and maintenance costs.

INGRID:
SMART GRID TESTING & RESEARCH

ingrid
Smart Grids Testing & Research
by tecnalia

InGRID is a new technologically advanced experimental infrastructure designed and oriented to meet the needs of electrical equipment manufacturers and utilities in the specification, development, validation and commercialisation of innovative products for the Smart Grids market.

InGRID´s platforms and laboratories integrate the traditional electrical engineering capabilities with advanced power electronics and ICTs technologies, to cope with the needs of new "Smart" product development for the future Smart Grids.

InGRID allows electrical equipment manufacturers to validate their new developments, from the prototype stage to the final product, in specifically designed facilities. InGRID allows utilities to evaluate the equipment performance and functionality for their massive deployment into the grid ensuring their safety and reliability

InGRID meets the needs of electrical equipment manufacturers in the development and commercialisation of innovative products for Smart Grids.

The purpose of InGRID is to manage electric power more efficiently and smartly throughout the entire process - generation, transmission and distribution, until it reaches the end user.

TECNALIA's new experimental infrastructure for Smart Grids is based on a series of laboratories for cutting-edge research on electrical system technologies. They will be used **to manage electric power more efficiently and smartly throughout the entire process - generation, transmission and distribution, until it reaches the end user:**

POWER LABORATORY
Laboratory connected to the transmission network at 220 kV. The greatest independent Power Laboratory in Spain and Portugal.

HIGH VOLTAGE LABORATORY
Two Test Bays for executing dielectric tests for High Voltage Products - up to 362 kV.

LOW VOLTAGE AND ENVIRONMENTAL LABORATORY
Complementary Low Voltage, Climatic and Mechanical tests to complete full type testing.

POWER ELECTRONICS LABORATORY
Supports the integration and increased efficiency of the main energy applications and systems (PV inverters, wind converters, electrical energy storage, electric vehicle, active filters for Smart Grids…).

MICROGRID AND DISTRIBUTED GENERATION
Design and development of advanced architectures and energy management systems for the integration of small-scale generation units into the grid.

ELECTROMAGNETIC COMPATIBILITY LABORATORY
Immunity and emission testing for electric-electronic low voltage products and for communications. Measurements of radio acceptance for telecommunications equipment.

SMART METERING LABORATORY
International reference laboratory for certification for Smart Meters and Data Concentrators.

SMART GRIDS COMMUNICATIONS
Functional and interoperability assessment of products for Smart Grids. Development and evaluation of solutions for transformation centres automation and monitoring.

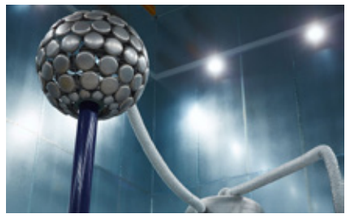
ON SITE-TESTING LABORATORY
Diagnosis and predictive maintenance of large electrical equipment -generators & power transformers, installed in power and industrial plants.

RESONANT SYSTEM FOR HIGH VOLTAGE CABLES
Variable frequency resonant system WRV 260/80 that allows to test on-site cables up to 400 kV rated voltage. Experts in on-site measurements of partial discharges.

ELECTRIC SYSTEMS FOR RENEWABLE ENERGY GENERATION
Energy generation based on renewable energy at small scale.

ENERGY STORAGE
To improve both energy storage costs and performance at all levels of the value chain.

ELECTRICAL VEHICLE-NETWORK CONNECTION
Assessment of the new different technologies and products related to EV charging as a part of a complex energy, communications and information system.



Alliances and Collaborations

www.ocean-energy-systems.org

TECNALIA is the Spanish delegate and chairman of the OES "the Implementing Agreement on Ocean Energy Systems of the International Energy Agency".

www.eu-oea.com

TECNALIA is member of the Board of Directors of EU-OEA (European Ocean Energy Association).

www.eera-set.eu

TECNALIA is the Spanish partner of EERA-Marine (Marine Renewable Energy Group of the European Energy Research Alliance).

www.icoe-conference.com

TECNALIA is member of the technical committee of the ICOE (International Conference on Ocean Energy). TECNALIA organised ICOE2010 in collaboration with the Basque Energy Agency.

TECNALIA is member of TP Ocean (Technology & Innovation Platform for Ocean Energy), which provides expert advice and analysis to support the development of a common roadmap for developing the sector.

TECNALIA participates in TPWind (The European Technology Platform for Wind Energy). A forum for the crystallisation of policy and technology research and development pathways for the wind energy sector.

TECNALIA is partner of:

- Wave energy Basque Country.
- Offshore wind Basque Country.

TECNALIA participates in standardization committees:

- IEC-TC88 "Wind Turbines".
- IEC-TC114 "Marine Energy".
- Chair of SC114 (Spanish TC114 mirror group).

TECNALIA widely contributes to international groups.

Involvement in European Projects

TECNALIA is participating or has participated in several European projects with a success rate close to 75% in the marine energy area.

SUPRAPOWER

TECNALIA is leading a European consortium to demonstrate the use of superconducting materials for the design of electrical machines for high power wind turbines (10MW or higher).

MARINA PLATFORM
Marine Renewable Integrated Application Platform

Analysis of combined solutions for offshore wind and wave & tidal energy.

HIPRWIND
High Power, high Reliability offshore wind technology

Development and validation of new solutions for large offshore wind turbines, including floating solutions.

MARINET
Marine Renewables Infrastructure Network

It is a network of research centres and organisations that are working together to accelerate the development of marine renewable energy technologies - offshore wind, wave & tidal.

DTOCEAN
Optimal Design Tools for Ocean Energy Arrays

Development of design tools for facilitating decision making for the deployment of marine energy farms (wave & tidal).

SYMBIOTRACKER

Autonomous Underwater Cable Locating System. Market analysis of acoustic devices for a rapid and efficient location of submarine cables.

RETA PROJECT
Smart Cable Development for Improved Lifecycle of Offshore Power Networks

Research and development to improve the performance of submarine electrical cables to reduce the cost of their installation, operation and maintenance.

EQUIMAR

Development of harmonised protocols for the evaluation of marine energy converters through technology matching and improved understanding of environmental and economic impacts associated with the deployment of arrays of devices.

CORES

Research project focusing on new components and concepts for ocean energy convertors.

OCEANET

A multinational Initial Training Network for training young researchers in the field of floating offshore wind and wave energy.

WAVETRAIN 2

A multinational Initial Training Network for Wave Energy Research Professionals.

WAVEPLAM
Wave Energy Planning and Marketing

Development of tools, establishment of methods and standards, and creation of conditions to speed up the introduction of ocean energy onto the European renewable energy market.

TECNALIA
Parque Científico y Tecnológico de Bizkaia
C/ Geldo, Edificio 700
E-48160 Derio-Bizkaia (Spain)
T 902 760 000*
T +34 946 430 850 (International calls)
www.tecnalia.com

JOSE LUIS VILLATE
Marine Energy Director
joseluis.villate@tecnalia.com

MARINE ENERGY

tecnalia Inspiring Business