

**TECNALIA · ENERGY AND ENVIRONMENT** 

TECHNOLOGICAL SOLUTIONS FOR THE ENERGY TRANSITION AND THE ENVIRONMENTAL SUSTAINABILITY



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## TECHNOLOGICAL SOLUTIONS TO TURN ENERGY AND ENVIRONMENTAL CHALLENGES INTO BUSINESS OPPORTUNITIES

#### OUR VALUE PROPOSAL

#### RENEWABLE/SUSTAINABLE ENERGY

- → PHOTOVOLTAIC SOLAR ENERGY
- → OFFSHORE RENEWABLE ENERGY

#### **SMART GRIDS**

- → INTEGRATION OF RENEWABLE ENERGY AND ENERGY STORAGE IN SMART GRIDS
- → ELECTRONIC DEVELOPMENTS FOR ELECTRIC AND INDUSTRIAL APPLICATIONS
- → ELECTRIC NETWORK DIGITALIZATION

#### **DIGITAL ENERGY**

#### **EFFICIENCY IN THE ENERGY END-USE**

→ EFFICIENT THERMAL SYSTEMS

## ENERGY AND DECARBONISATION PLANNING

#### ADVANCED AND SUSTAINABLE MATERIALS

- → SURFACE ENGINEERING
- → MATERIALS FOR HARSH CONDITIONS
- → SUSTAINABLE CHEMISTRY
- → MEMBRANE TECHNOLOGY AND PROCESS INTENSIFICATION
- → MATERIALS FOR EMERGING APPLICATIONS
- → WASTE VALORISATION

#### CLIMATE CHANGE AND ENVIRONMENTAL SUSTAINABILITY

- → CIRCULAR ECONOMY
- → COMFORTABLE, HEALTHY AND LIVEABLE URBAN SPACES
- → CLIMATE CHANGE ADAPTATION
- → METEOROLOGY

#### SOLUTIONS FOR AN ENERGY SYSTEM DECARBONIZED, DECENTRALIZED AND DIGITALIZED, FOR A CIRCULAR ECONOMY AND FOR THE BIOECONOMY; AND FOR SUSTAINABLE, EFFICIENT, RESILIENT, HEALTHY AND COMFORTABLE CITIES AND REGIONS



## RENEWABLE / SUSTAINABLE PHOTOVOLTAIC SOLAR ENERGY

- SOLARFACE: Structural elements with embedded photovoltaic functionalities
- ARGICOAT: Nano-scale system that provides anti-reflective and anti-soiling properties to photovoltaic modules.
- BIMSolar: Software for building integrated photovoltaic (BIPV) projects.
- HANDLE: Photovoltaicthermodynamic hybrid system for DHW and heating.
- SUNSET-HW: Multistring photovoltaic inverter with threephase energy storage option of 10 kW.
- GENIUS: MPPT algorithm set with advanced features.
- SUNSET-PLAN: Selfconsumption photovoltaic systems planning-dimensioning tool with or without energy storage.
- SUNSET-EMS: Advanced Energy Management System (EMS) based on photovoltaic generation and demand forecasting for self-consumption photovoltaic systems with storage.
- SUNSET++: Predictive optimization based on evolutionary techniques for the energy management of photovoltaic self-consumption systems with storage and manageable loads.
- BIPV DIGITAL TWIN: Digital twin of a photovoltaic system integrated into a building.
- OTTER: Photovoltaic tracker for floating photovoltaic farms.



- Characterization and reliability studies of components and systems: monitoring, indoor and outdoor testing.
- New concepts of photovoltaic farms (bifacial, floating, agro): design and evaluation, development and prototyping of components.
- → Analysis, design and simulation of: New conversion topologies, modulation techniques and control strategies for large photovoltaic converters.
- → Analysis, design and simulation of: Strategies for storage control systems for the provision of services in large photovoltaic plants.
- Development of data analytics tools for fault detection and diagnosis, and predictive maintenance.
- Development of materials and processes for durability and performance immprovement of modules and systems.

- Design, development and prototyping of products with integrated photovoltaic: buildings, infrastructures, vehicles.
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- Development of converters (MLPE, battery regulators, hybrid inverters, etc.) for distributed generation and selfconsumption.
- Design and development of complete conversion and management systems for integrated micro-generation and self-consumption systems.
- Design analysis and simulation of: Advanced management strategies for the optimization of individual or aggregate photovoltaic self-consumption.
- → Design of hybrid photovoltaicthermal systems (PVT)
- Development of materials and processes to facilitate the integration of solar cells into applications.

## RENEWABLE / SUSTAINABLE OFFSHORE RENEWABLE ENERGY



- Testing of components and equipment for offshore applications from laboratory to real conditions.
- → Development of digital twins of offshore products and components for its life extension, operation, maintenance and redesign.
- → Offshore structures and systems design and optimization, including mooring, umbilical cable, offshore operations and electrical layout.
- → Generation, modelling and assessment of innovating concepts for cost reduction in offshore renewable energy.

- HARSHLAB: Floating laboratory for the evaluation of materials and components in real offshore environment.
- SCARGO: ROV for a submarine wire installation.
- NAUTILUS: Subsumerged foating platform for offshore wind turbines.
- KONEKTA2: Device for a fast connection of umbilical cables to floating systems.

# SMARTINTEGRATION OF RENEWABLE<br/>ENERGY AND ENERGY STORAGE<br/>IN SMART GRIDS

→ Power grid interconnection impact modelling, simulation and assessment of the renewables and distributed generation, handling environments of power grids simulation as PSS/E and DigSilent PowerFactory.



- → Algorithms development for voltage and frequency control in power grids with high penetration of renewable and distributed generation, using decentralized control strategies as Web-of-Cells concept.
- → Energy storage systems analysis and design for each case of use, using propietary tools that consider technological and economical aspects
- → Development of Battery Digital Twins (Battery Twin).
- → BMS, EMS & Power Electronics design and development for energy storage systems.

- μGRID: Microgrid control system.
- ADOSA: Tools for sizing & designing energy storage systems (batteries, H2,...) for applications connected to the power grid ACT2.
- CONV\_ANPC: Multilevel converter with ANPC topology (Active Neutral Point Clamped).
- HVDC: Hybrid HVDC solution for energy evacuation in offshore wind.
- DOME: Flexible and adaptable system for the management of synchronous and nonsynchronous generators which offer to TSO's a manageable system adjusted to specific power grid codes.

#### ELECTRONIC DEVELOPMENTS FOR ELECTRIC AND INDUSTRIAL APPLICATIONS



- → Control system consultancy, design, simulation and prototyping.
- $\rightarrow$  Power system consultancy, simulation and prototyping.
- → Power converter prototypes design and development for several applications related with power grid:
  - Interconnection to the distributed generation power grid and storage, and/or service provision for quality supply.
  - HVDC offshore farms interconnection, working with MMC topologies and with diode hybrid converter.





Technical consultancy relate to Smart Grids infrastructures deployment: Smart meters & AMI systems, communications, SCADAs & control systems, automatization, substations digitalization and IEC61850 standard application.

#### Products & tools

 NOISEEK: Device for noise source detection which disturb or invalidate PLC communications among power grid devices.

- → Specifications, test books, data modelling and communication libraries development for IEDs substations, RTUs, data concentrators, metering equipment, low voltage advanced supervision devices and electrical vehicle chargers, including cybersecurity.
- Tools and application systems development to support the smart grids planification, operation, control and maintenance, using data coming from AMI infrastructure, among other sources.
- → Tools development to calculate the energy demand flexibility in different use scenarios and to provide these services to different agents as trading companies, aggregators, DSOs and TSOs.

### DIGITAL ENERGY



- → Equipment and components condition monitoring, sensor technology, edge computing and soft sensing.
- → Artificial Intelligence-based solutions for the efficient operation and predictive maintenance of energy assets: renewables (photovoltaic, wind) and distribution network (techniques based on algorithmic machine learning and data driven -based on historical data-; and development of digital twins of components, equipment and energy systems -based on hybrid models-).
- Augmented Reality solutions for remote operation and maintenance, and for training in the use of energy installations (visualization of electrical parameters of the facilities in real time, for example).
- Virtual Reality solutions for telelearning in the operation of energy assets.

- Securisation of critical facilities: risk and vulnerability assessment in energy equipment and facilities; asset management and updating; facilities protection; cyber attack detection and equipment and installation restoration.
- → Machine Learning for the digital transformation of the Oil & Gas processes.
- Data analytics for environmental applications: soft sensing for estimating environmental parameters from discrete measures.
- Blockchain and data analytics for the optimization of waste management value chains optimization and industrial symbiosis.
- Design of digital platforms to ensure traceability, reliability and/or facilitate data exchange between value chain agents in the energy sector.

- NAIA I4.0: Intelligent system for energy optimization of Industrial processes.
- CEO, NEXT24H-energy: Power management platforms and algorithms in tertiary buildings.

## EFFICIENCY IN THE EFFICIENT THERMAL SYSTEMS



- HEATPUMPDIM: Tool for Heat Pumps dimensioning for air conditioning, using thermoactivated screens (Geotool) and active flooring.
- → Design, development and validation of thermal equipment: thermo-solar systems for the building and urban environment; PVT hybrid systems (photovoltaic + thermal or thermodynamic); heat pumps, heat recovery, biomass combustion, Air Handling Units; control strategies; ORC/HP hybridization for the use of heat in ships; industrial cold with natural refrigerants...
- Design, integration, dimensioning and evaluation of thermal systems for: technologies for electrical and thermal storage in buildings, performance of energy installations, positive energy buildings, active hybrid systems (heat pipes, heat micropumps, etc.) for power electronics, waste heat valorization in industry...
- → Simulation and modeling for: digitization of thermal equipment, homogenization of measurement systems and data acquisition; dissipation of surplus energy from on-board systems; thermal modeling in Dymola and TRNSYS for white box or gray box for digital twins; among others.
- → Laboratory tests for: guarantee of energy behavior of equipment and thermal systems at building level and industry level; functional tests of equipment and thermal systems up to 300KW prior to EC certification; dynamic tests of thermal equipment according to demand curves; among others.

### ENERGY AND DECARBONISATION PLANNING



- Support for integrated energy planning for the decarbonization of the city and the region.
- → Design and integration of energy technologies to achieve buildings and districts of positive energy.
- → Development of tools for scenario generation, impact assessment, and optimization of energy management in urban and regional environments.
- → Energy diagnostics at district, city, and region scales.
- Analysis of the potential deployment of energy technologies, including the electric vehicle.
- → Evaluation and definition of energy policy strategies.

- → Development and monitoring of strategic energy plans at the city and regional level.
- → Multi-criteria impact assessment of energy technologies and systems (LCA, LCC, SLCA)

- ENERKAD: Tool for the evaluation of urban energy scenarios at building, district and city scale.
- MODISCIT: District-city scale energy modeling tools.
- ENERDEC: Support decision tool in the field of energy based on impact priorization.
- IMPSOCECON: Socio-economic impact assessment tool at national/regional level.

### ADVANCED AND SURFACE SUSTAINABLE MATERIALS ENGINEERING



- → Development and selection of coatings and treatments to improve tribological behavior and the protection against corrosion.
- → Developments of coatings and optical treatments.
- Developments and selection of functional coatings and treatments.
- $\rightarrow$  Tribological testing service.

- LUBRSOLID: Solid lubricant applied using PVD (Physical Vapor Deposition) technology.
- MAGNOLYA: Conversion coatings in Al/Mg.
- ARGICOAT: Nanoscale system based on multilayer materials that provides anti-reflective and anti-soiling properties to the surfaces used in photovoltaic modules.
- IRUCOAT: Sol-gel hybrid coatings for corrosion protection of aluminum and zinc-based coatings.
- IRUSTACK: Coating system for corrosion protection of carbon steel.

#### MATERIALS FOR HARSH CONDITIONS



- → Selection and assessment of materials and protection methods against degradation.
- → Coatings and materials tests in labs and in real media (high temperature, pressure, aggressive media as in H<sub>2</sub> transport, abrasion and erosion...). Simulation of the materials ageing in service.
- → Service life modelling, facilities smart maintenance (Degradation Digital Twin)
- $\rightarrow$  In-situ corrosion inspection and monitoring.
- → Failure analysis: mechanical-corrosion of products, infrastructures, systems, components...

- MOORSENSE: Remote corrosion monitoring system.
- iPipe: Smart sensor system for pipe state monitoring.
- HarshLab: Floating laboratory for the evaluation of materials and components in real offshore environment.

## ADVANCED AND SUSTAINABLE SUSTAINABLE MATERIALS CHEMISTRY



- Design, development and scaling up of chemical synthesis processes: monomers and intermediates for polymeric applications as polyols or isocyanate-free polyurethanes.
- → Improvement of chemical processes (optimization of the conditions of the reaction): use of milli-reactors, improvement of the catalytic system.
- → Development of processes for separation, purification and recovery of chemicals, through membrane technologies, absorption, adsorption, L-L extraction, S-L extraction and electrodialysis, among others.
- → Design, development and scaling up of biotechnological processes.
- → Chromatographic determination of chemical compounds by gas-mass chromatography and distribution of molecular weights in polymers.
- → Design of processes for  $CO_2$  capture and use.

- BIOSYNCAUCHO: Process for synthetic rubber manufacturing from biomass.
- MEKFACET: Process for the manufacture of methyl-ethyl ketone by electroreduction of acetoin.
- BIO-BDO: Process for manufacturing of 2,3 Butanediol by fermentation of lignocellulosic sugars, using our own microorganism.
- GLYCIDOL: Procedure for glycidol synthesis by catalytic decarboxylation of 4-hydroxymethyl-1,3dioxolan-2-one.
- BIO-IBMC: Isosorbide-bis-methylcarbonate manufacturing process from biomass.
- LIGN-CELU: Lignin-cellulose separation process
- MILICANALES: Micro-reactor for multiphase catalytic reactions, on continuous process, with heat transfer (exothermic or endothermal).
- MIL-BDO: Procedure for 2,3-butanediol continuous manufacturing process.
- FLOCALIGNINA: Manufacturing process of cationic flocculants derived from lignin.
- POLYLIGNOL: Process for polyols manufacturing from lignin.

#### MEMBRANE TECHNOLOGY AND PROCESS INTENSIFICATION



- → Development of carbon/Pd/MMM membranes for special applications of gas/liquid separation (high temperature, aggressive streams, high purity).
- → Characterization of membranes for gas and liquids separation (time lag).
- → Design and development of membrane reactors for chemical process intensification (e.g. for production and separation of high purity hydrogen)
- → Design and development of membrane production process: hollow fibers, tubulars...

- H<sub>2</sub>SITE: On-site generation of high purity hydrogen using membrane reactors.
- HYGRID: Hybrid and flexible separation system for the recovery of hydrogen from the natural gas networks.

### ADVANCED AND MATERIALS FOR SUSTAINABLE MATERIALS EMERGING APPLICATIONS



- → Design and development of materials and components for advanced batteries (metalair, redox flow, ion-Li).
- → Design and development of high performance thin layer micro-batteries (high voltage).
- → Electrochemical tests of electrode performance and durability for metal-air and redox flow batteries.
- → Design and development of graphene applications for water treatment.

- GRAPHESALT: Composite-metalgraphene electrodes for increasing the capacitance of capacitive deionization cells (CDI). Focused on the reduction of water desalination cost.
- SOLID ELECTROLYTES: Battery electrolytes based on soft interlayers.
- \* μBATHV: High voltage micro-battery.

#### WASTE VALORISATION



- → Advance characterisation of waste.
- Development of processes for the recovery of metals using ion- hydro- and pyrometallurgical techniques from wastes/secondary products.
- → Development of treatment processes to ensure (improve) proper waste management / reuse: before deposition in landfill, using as secondary raw materials, etc.
- Development of processes for energy valorisation of waste.

- REC\_PGM: Platinum group metal recovery process (PGM) of used automotive catalysts using ion liquid technology and Deep Eutectic Solvents (DEPs).
- REC\_RE: Process for rare earths recycling from permanent magnets using ionic liquids and Deep Eutectic Solvents (DES) technologies.
- RECUMET: Process for recycling metal waste containing impurities by a combination of thermalmechanical treatment.
- PLASIND: Thermal gas treatment using plasma system for the treatment of syngas contaminated with tars.
- RECICoBAT: Recycling process of cobalt from lithium and nickel metal hydride batteries using Deep Eutectic Solvent (DEPs).

## CLIMATE CHANGE AND<br/>ENVIRONMENTAL SUSTAINABILITYCIRCULAR<br/>ECONOMY



- → Environmental, hydric and carbon footprints analysis of technologies and industries.
- → Social Impact Assessment along the whole value chain of products ans processes.
- → Techno-economic analysis of new technologies.
- → Environmental Risk Assessment and financial guarantees calculation.
- → Development and deployment of new environmental certification schemes for especific sectors.
- → Identification and deployment of solutions for Best Practices development on the Industrial Symbiosis framework.
- → Evaluation of circularity of products and process.

- Analysis and assessment of urban metabolism, circularity and ecoefficiency of cities and regions.
- → Emissions inventory and models for the projection of emission scenarios at urban and regional scales.
- → Development of ad-hoc tools for eco-design and the sustainability evaluation of complex processes and sectors: steelmaking processes, transport infrastructures, cities, ports, railways...
- Development of tools for the digitalisation of the information related to industrial and regional sustainability (involving sensory systems, remote detection, big data, among other issues).

#### COMFORTABLE, HEALTHY AND LIVEABLE URBAN SPACES



- Strategic support for decision taking related to environmental noise management (strategy-health, methods, procedures, normative)
- → Diagnosis, planning and definition of measures for environmental noise attenuation at different scales and for different sectors: city, transport, infrastructure, industry.
- → Environmental comfort study of public spaces and valuing of soundscapes.
- Design of products with acoustic reduction and/or environmental comfort improvement functionalities (urban furniture)
- Measurement of contaminants in the atmosphere (conventional and specials as VOCs, dioxines, furanes...) and IoTs application, including noise.

- Products & tools
- SIGILO: Tool for the operation and management of environmental noise assessment and planning data (city, transport, port and industry).
- KASOUND: Kit for acoustic refinement.
- $\rightarrow$  Simulation of pollutant and odor dispersion and analysis of sources.
- → Development of customized management and visualization dashboards for environmental variables (air quality and noise).
- → Development of digital ecosystems (air quality and noise) for cooperative and interconnected mobility.

## CLIMATE CHANGE ANDCLIMATE CHANGEENVIRONMENTAL SUSTAINABILITYADAPTATION



- → Climate change risk SCREENING tool and services at sectorial and / or territorial levels.
- → Tool and services for the spatial climate change risk assessment based on indicators at regional and urban levels.
- Tool and services for an integrated assessment of the efficiency and design of measures for adaptation to climate change, involving acoustic, luminance, thermal, runoff. Integration of micro- and meso-scales. Integration/development of sensor systems.
- Methodology and services for the development of plans for climate change adaptation and flexible Roadmap design for cities (APM-Adaptation Pathway design Methodology).

- → Methodology and services for the integration of climate change measures in urban and land planning (CliP-UP · CLImate Proofing Urban Planning).
- → Climate services for the development of climate change customized dashboards for support in decision taking process in industrial and energy sectors.
- → Services on integrated analysis of climate change adaptation in hydroelectric power systems.

### METEOROLOGY



#### Development of systems and services associated with:

- → Weather analysis, surveillance and forecasting at regional and local levels.
- $\rightarrow$  Climate information for climate change assessment/adaptation.
- $\rightarrow$  Air quality modeling.
- → Monitoring and decision making in chemical accidents.
- → Forest fire risk assessment.
- → Meteo-climate intelligence for O&M processes optimization in the energy industry and the energy sector.

## TECNALIA IS A RESEARCH AND TECHNOLOGICAL DEVELOPMENT CENTRE



### MISSION

We transform Technology into GDP

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We transform technology into wealth to obtain beneficial visible results for companies, society, our environment and in short, for people.



## WE CAN DO SO MUCH **TOGETHER**

Our work cannot be understood without yours; we would Like to work together so your company can compete better. Because together, we can develop technologies which will transform the present

The future is technological, Let's share it!



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