Smart Grids Testing and Research Infrastructure

Specification, development, evaluation and certification services to support the placing on the market of innovative products for Smart Grids.
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"
InGRID: Smart Grids Testing & Research

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 placing on the market of innovative products for Smart Grids.
InGRID Laboratories

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 AND MICROGRID**
Flexible power sources and LV microgrid to simulate conditions for the testing of power electronics equipment (PV inverters, wind converters, electrical energy storage, electric vehicle, active filters for Smart Grids, ...).

**ELECTROMAGNETIC COMPATIBILITY LABORATORY**
Immunity and emission testing for 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**

**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.

InGRID is an experimental infrastructure adapted to new developments, with a forward-looking vision of development and evolution of grids and technologies, in close contact with the industry and the global scientific community.
Capabilities /
Power output: 300 MVA, 1 s.
Current at Medium Voltage (2.8 to 38 kV): Up to 40 kA (1).
• Making and breaking: inductive, capacitive and transfer currents.
• Short-circuit making capacity.
• Short-circuit breaking capacity.
• Internal arc / Short-time withstand current tests.
• Ability to withstand short circuits of distribution/power transformers.
Current at Low Voltage (from 30 to 1000 V): Up to 200 kA.
• Short time and peak withstand current tests.
• Making and breaking capacities.
• Internal arcing.

Tested Products /
• Distribution Transformers.
• Instrument Transformers.
• Transformation Centres.
• Low and Medium Voltage Switchgear.
• Low Voltage Boards.
• Fuse links and fuse bases.
• Measuring, Protection and Control Equipment.
• Safety Equipment and Materials.
• Cables and Accessories.
• Connectors.
• Power Electronic Equipment.

(1) Decreasing with voltage
02. HIGH VOLTAGE LABORATORY

Two Test Bays for executing dielectric tests:
Test Bay 1 for Medium Voltage Products (up to 72.5 kV).
Test Bay 2 for High Voltage Products (up to 362 kV).

Capabilities /
Test Bay 1:
- Power Frequency Voltage (dry and wet): 300 kV.
- Lightning Impulse Voltage: 800 kV.
- DC voltage: 100 kV.
Test Bay 2:
- Power Frequency Voltage (dry and wet): 550 kV.
- Lightning Impulse Voltage: 1,800 kV.
- DC voltage: 200 kV.

Tested Products /
- Distribution Transformers.
- Instrument Transformers.
- MV & HV Cables and Accessories.
- Medium and High Voltage Switchgear.
- Fuse links and fuse bases.
- Insulators and Bushings.
- Measuring, Protection and Control Equipment.

- Safety Equipment and Materials.
- Insulating materials.
- Capacitors.
- Power Electronic Equipment.

Fully shielded room for High Voltage Tests.
InGRID Laboratories

03. LOW VOLTAGE AND ENVIRONMENTAL LABORATORY

Low Voltage, Environmental and Mechanical tests.

Capabilities /
• Current for temperature-rise runs up to 12,000 A.
• Climatic chambers:
  - Temperature ranges from -70 to +180 °C.
  - Humidity ranges from 10 to 98%.
• Large Chamber 5.5 x 4 x 4 m.
• Dust, salt spray corrosion chambers.
• Vibration table from 1 to 2000 Hz and 70 g.

Tested Products /
• Distribution Transformers.
• Instrument Transformers.
• Transformation Centres.
• Low and Medium Voltage Switchgear.
• Low Voltage Boards.
• Fuse links and fuse bases.
• Measuring, Protection and Control Equipment.
• Cables and Accessories.
• Connectors.
• Power Electronic Equipment.

Commitment with full type testing of electrical products.
InGRID Laboratories

POWER ELECTRONICS LABORATORY AND MICROGRID

Capabilities / • Electric network management and operation.
  - Integration of Distributed Generation, storage and Electric Vehicles.
  - Active Demand Side Management.
  - Monitoring and supervision of MV/LV grid, based on AMI infrastructure.
• Advanced energy systems architecture: microgrids for energy efficiency improvement in urban areas and remote locations.
• Energy storage: power converters, control strategy and systems.
• Data analytics for network management and other smart grids applications.
• Final use of energy optimization:
  - Smart energy management in buildings.
  - MicroCHP economic dispatching.
  - Smart analytics of consumption patterns and demand flexibility.
• Economic models and cost-benefit analysis for energy markets from the perspective of different stakeholders.
• Cybersecurity and data privacy applied to Smart Grids.

Low Voltage Flexible Microgrid / Control of voltage, current and frequency, voltage dips generation, anti-islanding operation.
• AC fixed source 450 kW
• AC adjustable source 165 kW
• DC sources, 150 and 300 kW
• RCL loads for Q > 2.5

FLEXIBLE HIGH POWER CONVERTER
• Back to back MV converter (3000 VAC) with NPC multilevel topology.
• 1.2 MW module parallelisation 6 MVA maximum power.
• Variable frequency from 20 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.

TECNALIA 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…), hence offering support to designers, manufacturers, users, etc.
InGRID Laboratories

**05. ELECTROMAGNETIC COMPATIBILITY LABORATORY**

Immunity and emission testing for electric-electronic low voltage products and for communications.
Measurements of radio acceptance for telecommunications equipment.
Notified Body for EMC Directive.

**Capabilities /**
Anechoic certification chamber:
- Full compliance with CISPR 16-1-4 (NSA) in 3 m measuring distance.
- Frequency range of 50 Hz to 13 GHz.
- 2 m turntable.
Faraday chambers to measure conducted emission and immunity.
Anechoic precertification chamber for R&D.

**Tested Products /**
- Measuring, Protection and Control Equipment.
- Protection and auxiliary relays.
- Inverters and Chargers.
- Smart Meters.
- Telecommunications equipment.
- Switchgear and controlgear.
- Household appliances.
- Professional electronic equipment.

Capabilities /
- Certification tests:
  - PRIME Protocol - Official Laboratory of the PRIME Alliance.
  - DLMS Protocol and Functionality.
  - MID Compliance.
- Additional tests: CENELEC, EMC, climatic, etc.
- Interoperability Tests & Communications Performance in real environment.
- Product Development Tests.
- Development and commercialisation of testing tools: PRIME, DLMS, ...
- Technical assistance and consulting Services.

Tested Products /
- Smart Meters.
- Data Concentrators.
- Modems, chipsets, integrated circuits and evaluation boards.
- Auxiliaries: filters, attenuators, cables.

InGRID Laboratories

TECNALIA supports electrical equipment manufacturers and utilities in the development of new products and ensures compliance with:
- Standards used in electrical substation automation.
- PLC-LV and PLC-MV technologies for Smart Grid services.
- Standards used for telecontrol in electrical networks and power system automation applications.
- Protocols associated with Demand Management.
- Protocols associated with Electric Vehicle communications and network integration.
- Standards used in control and monitoring of wind farms.
- RTU functionality tests, Chargers and Control Relays for Medium Voltage installations.

Deeper studies could be completed in order to model and characterize the old grid that uses new PLC communications.

Functional and interoperability assessment of products for Smart Grids.
InGRID Laboratories

ON-SITE TESTING LABORATORY

Capabilities:
Rotating Machines:
• Dielectric insulation testing of windings: polarization index, leakage current, HIPOT at AC and DC, measurement of tan delta and partial discharges, TVA, ohmic resistance.
• Evaluation of the magnetic core; EL CID test.
• Verification of RTDs and thermocouples and instrument transformers.
• Commissioning tests of hydraulic generators: No-load, permanent and sudden short-circuit, determination of characteristic values, Mordey curves.

Power Transformers:
• Capacitance and Tan Delta of bushings.
• Capacitance and Tan Delta of windings.
• Insulation resistance and polarization index of windings.
• Ohmic resistance of windings.
• Characterization of magnetic core.
• FRA - Frequency Response Analysis.
• FDS - Frequency Domain Spectroscopy.
• Transformation ratio.
• Recovery voltage.
• Short-circuit impedance.

Tested Products:
Large rotating machines installed in:
• Nuclear power plants.
• Thermal power plants.
• Combined Cycles.
• Hydroelectric power plants.
• Industrial plants.
Power transformers in substations and Industrial plants.

20 years experience in the diagnosis and predictive maintenance of large electrical equipment installed in more than 70 power plants, industries and substations.
09. RESONANT SYSTEM FOR HIGH VOLTAGE CABLES

Capabilities /
- Maximum voltage: 260 kV.
- Maximum current: 80 A.
- Frequency Range: 20-300 Hz.
Capacity to energize cables from 45 to 400 kV rated voltage and maximum lengths up to 12 km (1).
Possibility of testing higher voltage cables and longer lengths using various resonant systems through collaborative agreements with other entities.

Test range:
- Withstand voltage tests.
- Partial discharge measurement.
- Overhead test.
- Measurement of electrical resistance of conductor and screen.
- Line impedances measurement.
- Capacitance measurement.
- Tan Delta measurement.

Tested Products /
- High Voltage Underground Cables.
- High Voltage Submarine Cables.
- Gas Insulated Substations (GIS).

(1) Depending on the actual capacitance of the cable.

Mobile Variable Frequency Resonant System WRV 260/80 for field commissioning of cables up to 400 kV. Experts in on-site measurements of partial discharges. Over 500 circuits tested in Portugal, Spain, France, Italy, Germany, Netherlands and Poland.
10. ELECTRIC SYSTEMS FOR RENEWABLE ENERGY GENERATION

Capabilities / This lab will permit the development and test related to the energy generation based on renewable energy (wind power, tidal power, photovoltaic, etc.) at small scale.

- Research in new strategies for controlling generators.
- Improvement of existing algorithms for the optimal use of obtained power.
- Validation of new concepts for superconductive generators.
- Superconductivity applied to electric machines, providing breakthrough solutions to offshore wind energy.
- Development of high and low voltage converters for PV purposes.
- Development and testing of new MPPT algorithms.
- Development of interfaces for network connection involving new quality and grid management.

Energy generation based on renewable energy at small scale.

11. ENERGY STORAGE

Capabilities /
- Materials and components. Development of electrodes, membranes, bipolar plates, electrolytes, and other components for fuel cells and batteries, with a special focus on redox flow batteries and metal-air batteries. TECNALIA’s firm commitment to metal-air batteries represents our belief that low-cost technologies are called upon to allow the massive penetration of energy storage technologies in the energy market. Nanomaterials and ionic liquids are key for these developments.
- Module development. Electrical, thermal and electrical storage module design, including battery management systems (BMS) development. Our automated energy storage test platform is the basis for our work in advanced energy storage modelling and simulation, including the development of novel algorithms for SOC (State Of Charge) and SOH (State Of Health) evaluation.
- Control and power electronics. Innovative topologies (multilevel, resonant, interleaving) and advanced control algorithms. TECNALIA has developed multilevel DC/DC and DC/AC converters providing improved efficiency as well as reduced size, weight and cost.
- Market and applications. Development of tools for techno-economic analysis: technology selection, setting, sizing, cost-benefit analysis, efficient operation strategies.

We work to improve both energy storage costs and performance at all levels of the value chain.
The new different technologies and products related to EV charging need to be assessed as a part of a complex energy, communications and information system that should be able to perform as a whole and bring new services and business models to the market.

OUR INTEROPERABILITY CENTRE FOR EV

• The intelligence of the different systems that constitute the infrastructure for EV charging and their interoperability have to be assessed, in order to guarantee that the intended performance is accomplished.

• Considering EV deployment and technological circumstances, during the following years this task will require a large effort in standardization, agreement, infrastructure investment and technical skills in order to assess the individual and, even more, the global performance of the equipment that allow EVs to be charged.

• This ambitious objective, more than convenient for a favorable EV deployment, asks for the coordinated participation of the relevant stakeholders.

ASSESSMENT FOR COMPLIANCE

TECNALIA complements the research vocation with accredited testing capabilities to measure and assess the compliance of products to Standards and Regulation. This brings the opportunity for TECNALIA to become an active Stakeholder to offer the OEMs, the Charging Point manufacturers, the Utilities, the E-mobility Service Providers and, in general, the companies around the EV charging, the infrastructure, capability and knowledge to verify that their systems perform as desired.

TECNALIA already offers some services for assessing compliance for EV and their charging infrastructure:

• Low Voltage and EMC Directives.
• IEC 61851: Charging Systems for EVs.
• IEC 15118: EV communication interface.
• EN 61439-7: Low-voltage switchgear and control gear assemblies, also for EV.
Accreditations and Recognitions

- ILAC-ENAC accreditation for:
  - Equipment for Generation, Transmission, Distribution and Use of Electric Energy, Low, Medium and High Voltage.
  - Electromagnetic Compatibility Testing (EMC) and Evaluation of Human Exposure to Electromagnetic Fields.
  - Mechanical and Climatic Tests.
- Notified Body for:
- Registered laboratory ES-02 by the European association LOYAG (Low Voltage Agreement Group).
- Laboratory recognised by LAPEM (Mexico), for the acceptance of reports according to the accreditation of ILAC-ENAC 4/LE148.

- Laboratory designated by the Basque Government:
  - To carry out the tests for type approval of instrument transformers for their use and installation in the network.
  - As verifier of electrical measurements to verify the accuracy of instrument transformers before installation.

Some Clients and Partners

Worldwide recognition of our reports enables our clients to access International Markets.

ELECTRICAL EQUIPMENT MANUFACTURERS

- ABB
- ALSTOM
- APPLUS
- ARTECHE
- ATMEL
- EFACEC
- FANOX
- GAMESA
- GENERAL ELECTRIC
- IMEFY
- INAEL
- INGETeam

UTILITIES

- LANDIS & GYR
- MESA
- ORMAZABAL
- POMMIER
- PRONUTEC
- PRYSMIAN
- SAGEMCOM
- SCHNEIDER
- SIEMENS
- SOGECAM
- URIARTE
- ZIV

- EDF
- EDP
- ENDESA
- EON
- GAS NATURAL FENOSA
- HC ENERGÍA
- IBERDROLA
- RED ELECTRICA

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IBERDROLA
RED ELECTRICA

ILAC-ENAC is a member of ILAC (International Laboratory Accreditation Cooperation) and the ENAC (Spanish National Accreditation Body) is a member of ILAC. www.enac.es
InGRID Testing... & Research

PLANGRID EV
Distribution grid planning and operational principles for EV mass roll-out while enabling DER integration.
(www.plangridev.eu/)

This project, led by RWE and funded by the EC under the FP7, aims at developing new network planning tools and methods for European DSOs for an optimised large-scale roll-out of electromobility in Europe whilst at the same time maximising the potential of DER integration. For the validation activities the project will rely on existing infrastructures of the four involved DSOs and the cooperation with OEMs.

COTEVOS
Concepts, Capacities and Methods for testing EV systems and their interoperability within the Smart Grids.
(cotevos.eu/)

TECNALIA leads this FP7 funded project that aims at developing optimal structures and capacities to test the conformance, interoperability and performance of the different systems to be included in the infrastructure for smart charging of EVs. Based on the partners’ proven experience and a decade of collaboration around their facilities, the project will address key issues such as the cross-national transparency, the interaction between grid infrastructure and vehicles and the operational reliability, while reducing the time-to-market of equipment.

ELECTRA
(www.electrairp.eu/)

ELECTRA is the Integrated Research Programme approved by the European Commission in 2013 under the FP7, as a result of the EERA Joint Programme on Smart Grids. In addition to some key activities for Coordination of Smart Grids research in Europe and International Cooperation, the project aims at developing and testing innovative solutions for increasing the observability and flexibility of distribution systems in Europe.

MUGIELEC
(mugielec.org/es)

This involves the development of systems and equipment for the optimisation of integral energy supply to Electrical Vehicles (EVs) for “Electric stations” (centralised fast charge for vehicles, similar to the existing petrol stations), for slow-medium charge in public sites (parking sites, during parking periods in the street...) and for charging processes in domestic environments (private garages, for instance).

BEST PATHS

Integration of offshore renewable energy into the electric network. It involves: the development and simulation of wind turbine models, HVDC connections, and AC-DC offshore networks; the development of algorithms and control strategies for wind energy converters; critical scenarios modelling and the improvement of existing topologies.

BIDELEK SAREAK
Iberdrola Distribución Eléctrica, together with EVE, has set in motion BIDELEK SAREAK AIE, which will become the next-generation smart grid. Bidelek Sareak is a Smart Grid demonstration project for greater support to consumers through the new smart meters and the traditional network of transformer stations, substations and MV power lines. Bidelek Sareak aims to greater integration and coordination of the entire system with electric vehicles and distributed generation.

This initiative will be deployed in the areas of Bilbao, Portugalete and the Lea-Arribai District.

DERLAB
Network of DER Laboratories and Pre-Standardisation.
(www.der-lab.net/)

DERLab will support the sustainable integration of renewable energy sources (RES) and distributed generation (DG) in the electricity supply by describing common requirements, developing quality criteria and supporting international pre-standardisation activities. DERLab will propose test and certification procedures concerning connection, safety, operation and communication of DG components and systems.

ADDRESS
Active Distribution networks with full integration of Demand and distributed energy RESources.
(www.addressfp7.org/)

ADDRESS aims to enable active participation of domestic and small commercial consumers in power system markets and provision of services to the power system participants. In addition it aims at delivering a comprehensive commercial and technical framework for the development of active demand.

InGRID is an experimental infrastructure in close contact with the industry and the global scientific community.