



RESEARCH  
DEVELOPMENT  
INNOVATION

Research Center in Trofarello



# RESEARCH DEVELOPMENT INNOVATION

Edison Research Center in Trofarello, opened in 1993, is an in-house corporate laboratory dedicated to research and technological assessment projects both in the gas and power business areas.

The most relevant areas of expertise are related to distributed and efficient power generation and storage, advanced materials for energy applications, technologies and solutions enabling after-meter services. Major research efforts also include experimental studies on rock core and fluid samples for reservoir characterization and modeling.

The Research Center extends on a 1.600 m<sup>2</sup> area. Currently it employs about 15 researchers, technicians and staff and relies on well-established collaborations with EDF R&D and academic institutions.



## ENERGY STORAGE LABORATORY

The Energy Storage Laboratory is dedicated to testing and proving the performances of commercial energy storage systems and their compatibility with the utility grid.

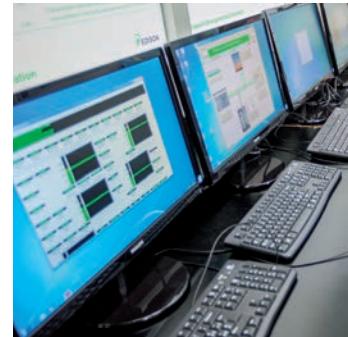
Dynamic stress tests are carried out on single commercial modules and complete systems to analyze their electrical behavior and life expectancy while cycling under simulated operating conditions. Among various technologies currently available on the market, Li-ion and Na/NiCl<sub>2</sub> batteries have been identified as the most promising ones by virtue of their high specific energy, very rapid response time and high adaptability to practically any power and energy requirement.

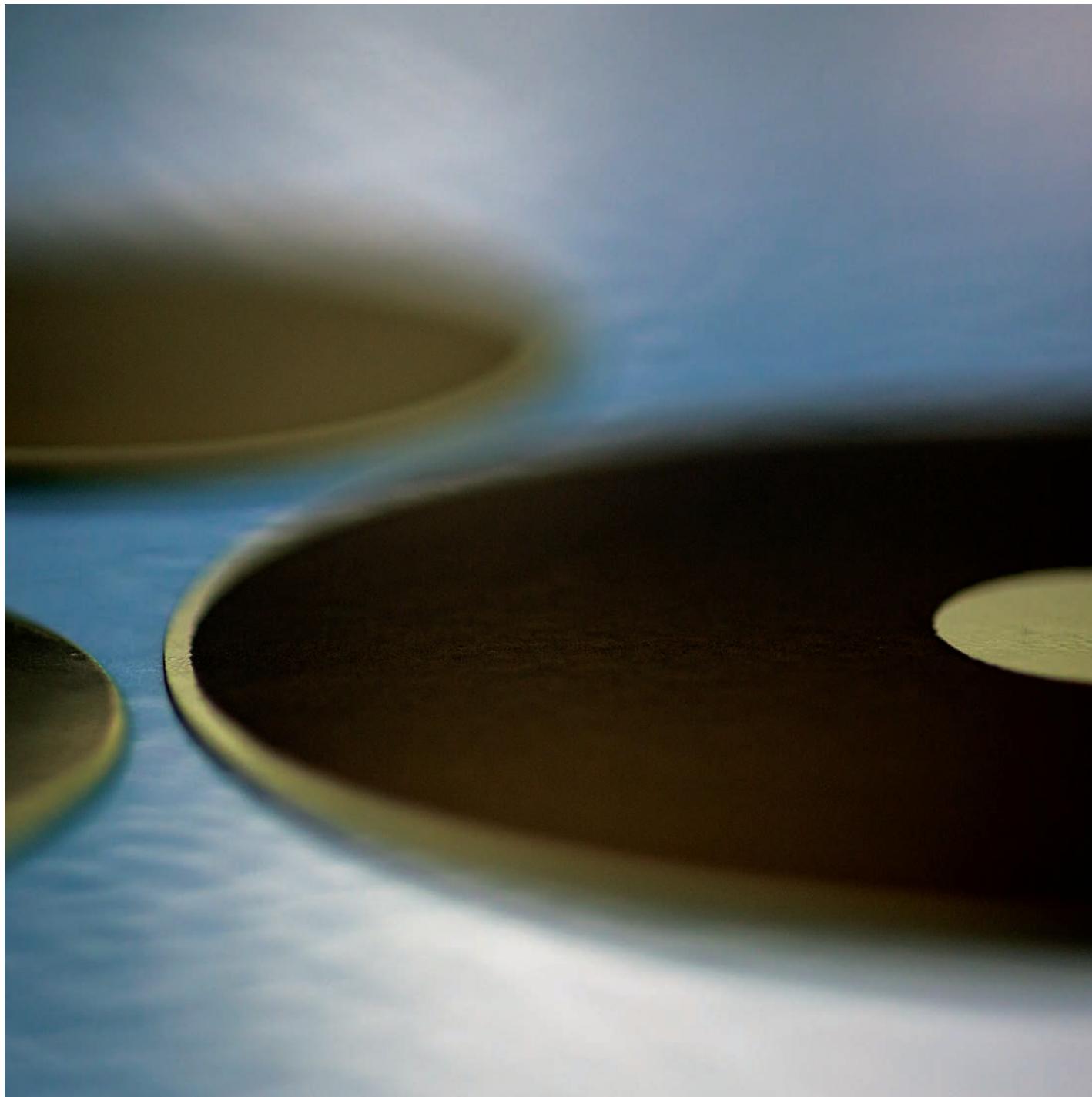
A test bench provided with remotely programmable DC load (400 V/40 A) is dedicated to basic electric characterization in order to assess modules behavior from an electrochemical point of view and assess the reliability

of the management logics implemented by battery suppliers.

A second test bench equipped with a 30-kW bi-directional inverter is intended for cycling tests reproducing real applications profiles in order to track the main electrical parameters evolution and assess performance degradation over time.

Research focuses on small scale stationary applications, enabling services for energy management and efficiency improvement at customers' site. A real application case is demonstrated in the pilot installation of a Li-ion based commercial unit connected to a 3-kW BIPV glass. This residential-size test facility simulates the typical customers' power consumption through a programmable load. Its task is to demonstrate the feasibility of operating a storage system to optimize self-consumption of distributed renewable generation.





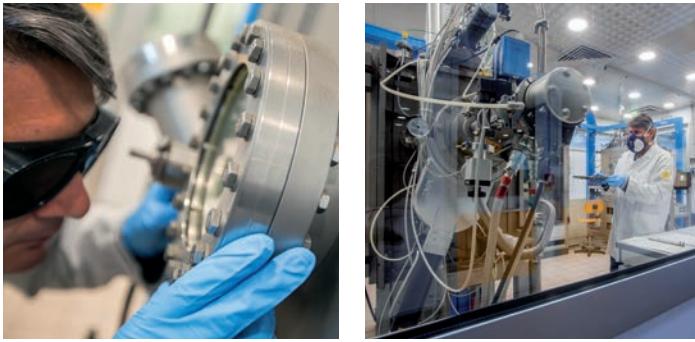
## FUEL CELL LABORATORY

The Fuel Cell Laboratory carries out studies about high-temperature fuel cells and related components, particularly Solid Oxide Fuel Cells (SOFC) which have been identified as the best fuel cell technologies for co-generation application in the residential and commercial end-use markets.

Current research topics include the assessment of commercial products and the development of home-made innovative components to overcome some key technological constraints which currently limit fuel cells large-scale applications.

The laboratory is equipped with four test benches, each providing an oven to host cells and short stacks, electric and gas supplies and a programmable electronic load to control the current set-point. Single cells and short stacks are tested with accelerated test protocols, simulating co-generation applications, under different conditions of operating temperatures, fuels and power output.

The laboratory infrastructure includes a net of sensors and safety systems (such as ventilation apparatus and safety valves) which enable testing for thousands of hours without interruption, also in unmanned operations.



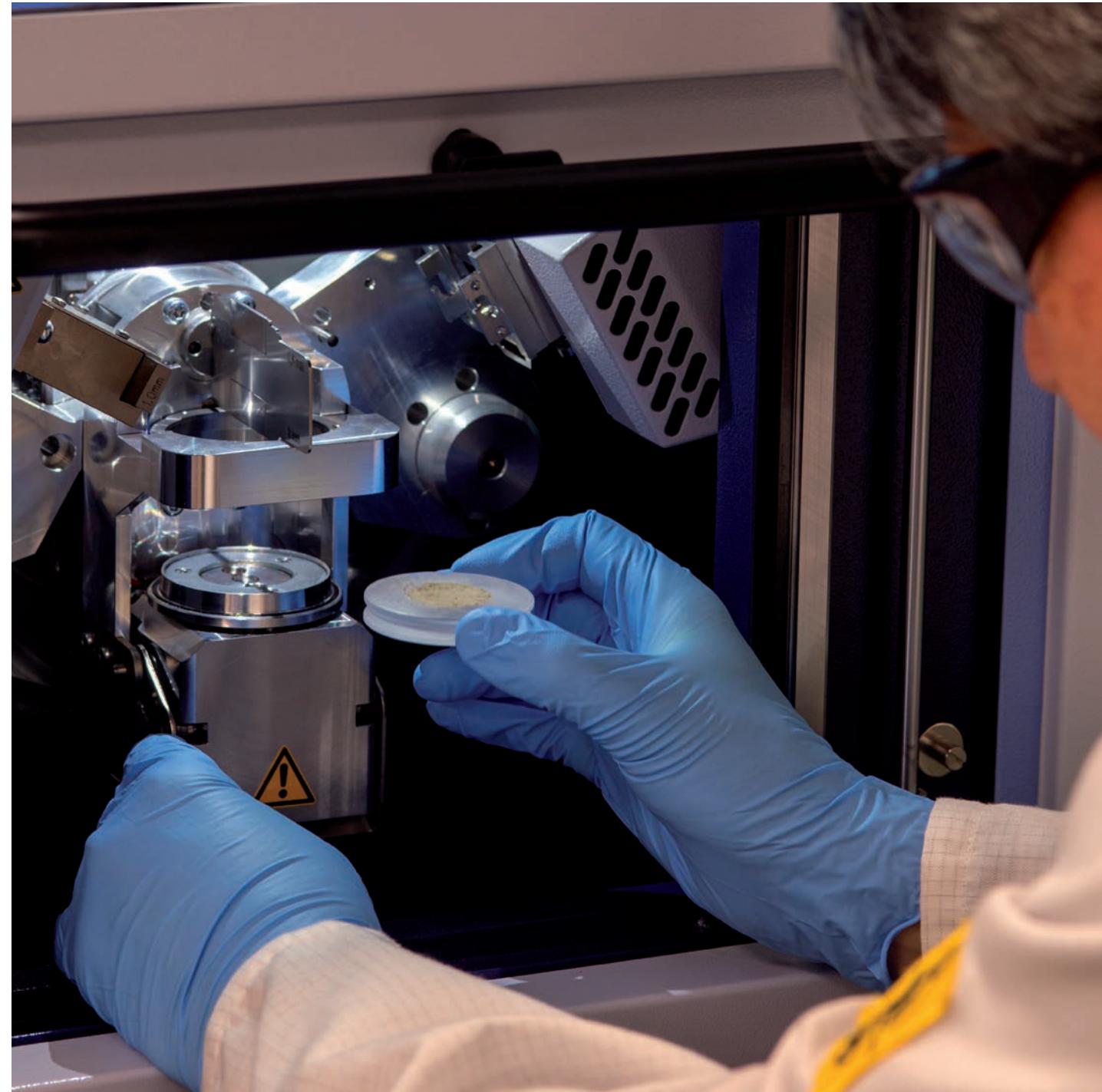
## THIN FILM DEPOSITION LABORATORY

The Thin Film Deposition Laboratory investigates fundamental mechanisms of thin-film growth using physical vapour deposition (PVD) methods.

PVD processes are studied by means of commercial high-vacuum evaporation systems with e-gun and thermal evaporators. Evaporation parameters, such as deposition rate and thickness of growing thin layers, can be computer-controlled and monitored with nanometer resolution in real time. The thin film characterization is supported by a wide range of imaging modalities and supporting equipment available at the Edison Research Center, including techniques such as X-ray diffraction,

X-ray fluorescence, scanning electron microscopy and electron probe microanalysis.

Current research topics concern the design and fabrication of thin layers of the solid electrolyte as well as the interconnection material for Solid Oxide Fuel Cell (SOFC). These processes are applied to ceramic and metallic materials in order to overcome technology bottlenecks that might stop a large scale development of fuel cells. Some of these current challenges are addressed to reduce electrolyte thickness and costs and prevent cell poisoning from other stack constituents.



## AFTER-METER SERVICES LABORATORY

The After-Meter Services Laboratory provides an experimental platform to test various early-market technologies and after-metering services, such as smart meters, smart plugs and systems for energy efficient management.

This laboratory simulates a residential house, complete of all the typical electric appliances used by families: from dish washer to lamps, from washing machine to microwave oven, from gas water heater to induction hob. The electric appliances are remotely controlled by

a PC program, which starts and stops each single device according to profiles reproducing typical consumption patterns of Italian residential customers. Control and data acquisition is also used to monitor the amount of electricity that the appliance is using in real time.

The aim of these activities is to assess the development state of smart solutions in terms of measurement precision, reliability, ease of installation, user-friendliness of software interfaces, level and importance of the information delivered to the customers.

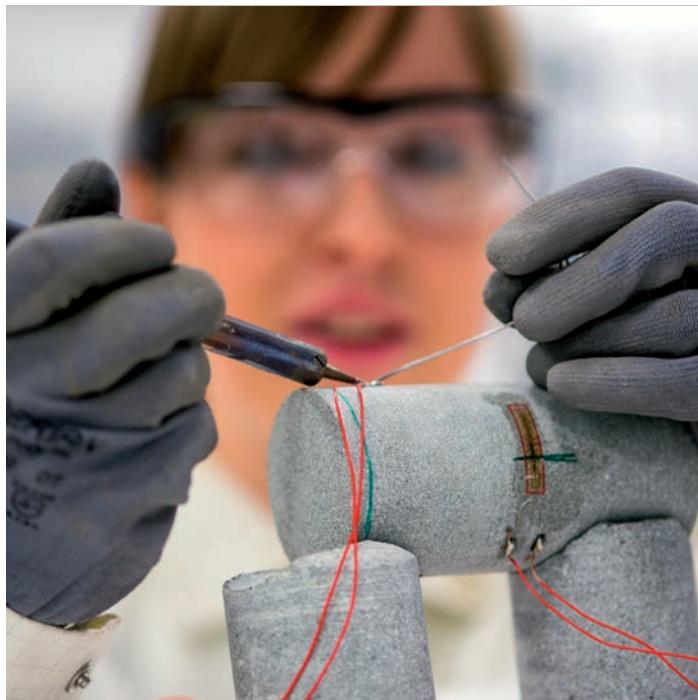




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## ROCK ANALYSIS LABORATORY

This laboratory incorporates a broad set of highly specialized equipment for the characterization of soil and rock cores sampled and recovered from the wells. Its main purpose is to provide high quality experimental data useful for exploration and reservoir studies, combined with other disciplines for geological characterization and modeling.

The experimental set-up of the lab enables a wide range of analytical characterizations including:

- soil analyses ranging from basic classification (granulometric distribution, bulk and grain density, water content, Atterberg limits) to mechanical characterization of soils (oedometric, direct shear and triaxial testing);
- rock mechanics testing for the investigation of the mechanical behavior of reservoir rocks, under overburden in-situ conditions, in terms of elastic parameters and compressive strength by means

of unconfined uniaxial testing and triaxial testing in Hoek cells;

- routine core analysis for the determination of key parameters that characterize the porous medium (porosity, fluids saturation and absolute permeability), which are at the basis of petrophysical description of reservoir;
- petrographic analysis for a detailed evaluation of rock microstructure and mineralogical composition.

The laboratory is also provided with standard equipment for samples preparation and cleaning, such as cutting and trimming saws, coring machine, grinding tools, Soxhlet extractors etc. Lined samples are preserved within a dedicated warehouse and stored throughout testing operations in a climatic chamber to protect them against environmental degradation.





## GEOCHEMISTRY LABORATORY

The Geochemistry Laboratory deals with the analysis of all three reservoir fluids (gas, oil, water) for the determination of bulk properties and composition. Analysis techniques provide critical input to reservoir simulation models and help to optimize processing facility designs. Fluid samples also provide information needed to help with flow assurance management, for example through the assessment of foam formation tendency during water-oil-gas separation or the inhibition of hydrates precipitation.

The laboratory is equipped for routine and specialized analysis of organic and inorganic compounds using procedures and analytical methods which are in compliance with internationally recognized and approved standards.

The high resolving power of Gas Chromatography makes it a major analytical tool for characterizing the very complex mixtures that constitute natural gas and petroleum products. The laboratory includes other advanced analytical equipment, such as an inductively coupled plasma atomic emission spectrophotometer for metal trace detection, an UV-Spectrophotometer and a thermogravimetric analyzer with differential scanning calorimeter.

The laboratory is also dedicated to the study of environmental issues associated with oil production, with particular attention to the characterization of oil spills remediation technologies.

Edison Spa

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10028 Trofarello (TO)

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