

# IBERDROLA'S TECHNOLOGY DEMONSTRATION CENTER NOVEL TECHNOLOGICAL PROJECTS LOCATION

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## INTRODUCTION

An open and world-wide market tendency is configuring a new socio-economic world scenario, in which technology and innovation will have an increasingly decisive role. In this background it seems obvious innovative societies will progressively occupy the leading positions in this promising future and will accordingly increase their added value, creating more and more employment and wealth, whilst improving the society's quality of life.

Regarding this new pattern, in IBERDROLA it is believed Research and Development plays an essential part in the Organization's continued existence and hence, technological innovation development and promotion is continuously guided in order to contribute to an added value in the IBERDROLA activities and, furthermore, to its international positioning, thus representing a priority topic as to assure the Spanish industry's competitiveness at the international market.

This paper describes the activities IBERDROLA is developing in the *Technology Demonstration Center*, hereafter *TDC*. As forward described it constitutes an essential support element towards the innovative technological activities carried out inside IBERDROLA, representing an important competitive positioning instigator in the scope of the new liberalized electric power generation market.

## TECHNOLOGY DEMONSTRATION CENTER

The *TDC* is a useful tool guided towards the process of Innovation and Technological Development for which an organization as IBERDROLA has bet on, by means of its Power Generation Division. An organized platform is, by these means, disposed as to shelter technological developments essential in order to respond to present-day or future problems related to Generation facilities.



Figure 1 - Technology Demonstration Center.

This Center is located at San Agustín del Guadalix, 33,5 km far from Madrid, and benefits from the necessary infrastructure as to accomplish all sorts of investigation activities and technological developments related to either of the Areas in which it is divided, **Renewable Energies, Energy Efficiency and Quality and New Power Generation Technologies**.

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An own training school, Emilio de Usaola Training School, is also located next to the *TDC*. In this training center, both personnel staff and external company members are skilled at different matters related to technical or technological electric subjects. In turn, its location permits a continuous coming together of different cultures and persons towards the facility, permitting an additional dissemination of all activities and projects developed inside the *TDC*.

The activities developed in the Center as well as all those related to Research and Technological Development are developed in the Power Generation Division as a support strategy to attain the essential mission of this Area, both related to profitability objectives (own power and energy offer at competitive prices) and opening towards new business opportunities (society strategic energy planning forecast). They are both carried out not only in conditions of maximum security, reliability, economy and quality, but also of innovation.

Therefore, the *TDC* can be considered as a common medium where, in a facility disposition, different technologies converge. The research on novel technologies, needed of a certain period of demonstration before its incursion and ultimate implantation into the market, is one of the main purposes in this viewpoint in order to fulfil the objectives referred to technological management:

- Accessible technologies evaluation.
- Technologies Initiation.
- Technological Transfer toward and from the company.
- Innovation Market setting time diminution.

It is divided into three joint great areas that act as an important framework for innovative technological project developments and that are further on described:

### **Energy Efficiency and Quality Area**

As to endow the *TDC* with wisdom and technological development related to energy rational use, IBERDROLA develops all these sort of studies at its Energy Efficiency and Quality Area. Such sector was originally focused to energy storage systems, but extended, through different strategies of the R&D Plan towards vinculum to rational and efficient use of electric energy.

In this Area of the *TDC* new ideas and projects related to energy efficiency and quality are seized, in order to adopt all those emerging market technologies seen as a future technological option, and betting on a higher technology diversity. Through different collaboration agreements with various organizations, developments aimed at advantageous appliances are being attained, as to being conceived since the own society.

The principal activities that can be highlighted in this Area can be below observed:

- Ideas and projects procurement, mainly related to efficient and diversified use of energy.
- Storage systems investigation, with appliance in the electric sector.
- Power system development studies as to apply for demand of high quality supply.
- Control and monitoring system investigation and development.
- Technological dissemination and transfer.
- Design, construction and exploitation of a 2 MW energy storage battery plant.
- Various R&D projects participation.

This Area is conceived as a stimulating tool born from Society demands. A sensitive tendency towards all those processes that upshot on a higher electricity supply can be detected in the Society. Therefore, studies related to energy efficiency and supply are and will be attained in this Area. The main goal consists in solving problems related to a high energy supply demand, due among other reasons to sensible processes and equipment. This contemplation obliges suppliers realize deep investigations related to these topics.

All of this makes the *TDC* an exemplar site in which to carry out any experimenting and development of any sort of activity or project in touch with efficient energy management, assumed by experience and qualification of a high

skill human team and developed within the framework of a leader energy generation, transport, distribution and commercializing organization such as IBERDROLA.

It is also worth remarking, in relation to distinct participation activities developed in collaboration with external organizations, agreements done with the International Energy Agency in the Annex IX program titled “Electrical Energy Storage Technologies for Utility Network Optimization”. The methodology followed in this framework is related to exhaustive studies on energy storage technologies and its use in electric systems, and relies on participation of world-wide organizations from United Kingdom, United States of America, Canada, Germany or Holland, among others. Not mentioning wide participation carried out at diverse conferences, dissemination projects developed and enhancing information and technological transfer exchange.

As formerly described, it would be really problematic carrying out a complete description of all related projects. Therefore it is considered interesting to briefly describe the most relevant of the projects carried out in this Area.

### **ESCAR Project. Battery energy storage system for appliance in load-leveling and peak-shaving modes.**

This project aims to cover two basic objectives, on one hand the feasibility study of its application, as energy storage is carried out during the night (off-peak period) for return to the grid during daytime hours (peak period), when the tariffs include surcharges, and on the other hand, the establishment of the most adequate parameters for simple characterization of battery load status under real operating conditions. For this purpose, a continuous and exhaustive data acquisition arrangement has been prepared regarding electrical parameters, temperatures, density or levels among others and, in addition, a series of improvements have been introduced in several of the elements of the system, with a view to extending their lifetime and increasing the operability of the system.



**Figure 2 - ESCAR Facility.**

The storage system itself is designed to achieve an attractive cost and provide maximum lifetime with minimum maintenance. It is made up of 768 elements (2 V; 2500 Ah in 5 h) grouped into four banks of 192 elements each, and it is capable of configuring up to 47 different connections, not interrupting the normal plant operation.

The ESCAR project converter is a 2 MW static reversible unit, constructed with four thyristor bridges operating with natural switching. The two main disadvantages of network-switched converters, harmonic distortion and the consumption of reactive energy, are considerably reduced with the configuration of this converter.

Also, the facility is automated by means of an integrated control system as to reduce the maintenance of the system. The main element of this management system is the modular programmable automatic device ELI-3003, which exchanges up to 360 signals with the system, including all necessary parameters for its ideal operation.

At the moment, the system is under operation and results are being analyzed with a view of accomplishing feasibility studies for the utilization of these systems as a compliment to the generation market .

### **New Power Generation Technologies Area**

The electricity market deregulation and the current environmental restrictions are opening up new opportunities to novel power generation technologies, such as fuel cells. In this Area of the *TDC*, the introduction of very innovative and promising power generation technologies is pursued in order to integrate them into the generation market.

This Area is in charge of looking after advanced technologies such as fuel cells, advanced thermodynamic cycles, fuel monitoring or high energetic fluid gasification, hunting for high efficiency devices and low environmental impact. It is believed the development of these promising technologies will redound on important improvements in the electric sector and thus, developments are being attained as to advance in these technologies, trying to prove their feasibility on generation processes. For this purpose, collaboration with different organizations is attained, together with own developments.

Among all carried out projects probably the most relevant is that related to *fuel cells* development. The potential interest in this technology for both energy and industrial sectors, leads IBERDROLA in 1986 to start a technological evaluation process related to fuel cell technology. This tremendous interest has continued and has been enhanced by means of collaboration schemes with other organizations as to create an Economical Interest Consortium in the Spanish Fuel Cell Program.

Looking out on a strategy development of combined power energy sources, IBERDROLA carried out, together with several partners, a demonstration plant at the *TDC*, being considered a first line development facility throughout the world. Its main nucleus corresponds to a 100 kW Molten Carbonate Fuel Cell Technology testing plant, considered as the greatest of its type in Europe, and which is pretended to be greatedened up to 500 kW by means of the use of co-generation technologies. Mainly it consists of a fuel integrated system with external manifold, that permits the opening to development of great power generation facilities based on molten carbonate fuel cells, and the utilization of natural gas and coal gas as fuels.

The testing facility is conceived as a testing bench and carries out a double functionality:

- *Initial stack arrangement.* Carried out the first time it is operated, it consists of a process of burning organic products, cathode oxidation and first electrolyte fusion.
- *Behavior characterizing.* It is attained by means of a very advanced control system, capable of operating at different power levels and considering distinct concentrations of gas.



**Figure 3 - Fuel Cell Stacks.**

The assembly and pressure testing of a 100 kW molten carbonate fuel cell and testing of 5 kW to 20 kW cells has been by now attained, and the greatest powered Molten Carbonate Fuel Cell was connected in it to grid, reaching a total power of up to 75 kW.

As aforementioned, the competitive advantages of fuel cells related to conventional technologies reside in:

- High energy efficiency.
- Operation flexibility.
- Minimum environmental impact.
- Modularity
- Fuel flexibility operation.

and in the near future this technology is believed to be fighting for market niches with figures between 500 kW and 10 MW of power.

### **Renewable Energy Area**

Since far ago IBERDROLA has taken care of a tidy Research vocation contributing to the development of new technologies relevant to the electric sector. Promoting its development and introduction, IBERDROLA takes action in the renewable energy field and in its exploitation through group companies direct or indirectly participated.

Within the Renewable Energy Area of the *TDC*, special attention relies on those energies currently in demonstration stages as a former step towards commercialization and commercial exploitation. For this purpose, biomass, solar photovoltaic and thermal energy, and hybrid systems (wind-photovoltaic) are special attention focuses and, hence, assistance is being given as for these technologies climb to points nowadays occupied by conventional generation technologies. In turn, this will help their progressive introduction into the market, promulgating environmental benefits associated to its establishment. Moreover, another renewable energies, more precisely developed at present, as minihydraulic or wind resource generated, are also being studied inside the *TDC*.

The realization of technical and economic feasibility analysis of generation systems based on renewable energies is carried out inside the *TDC* as a former study aimed at a further system implantation. On the other hand, a deep analysis of the installed systems, comprising up to 200 kVA, is attained, aimed towards the procurement of a very valuable information regarding behavior, operation and special characterizing of these sort of systems. This is intended to be of great help in amending and improving future planned installations.

The technological advice both in the technical and economic levels is also accomplished in this Area of the *TDC*, both to the own company as to any other institution. Both the experiences obtained at carrying out several number of projects as the high skill knowledge achieved by its personnel trustworthy guarantees its efficiency.

In order to ameliorate attributes of components and equipment, different tests of novel prototypes are attained under real operational conditions. Both laboratory equipment as installations assist to this realization. Last generation inverters, new photovoltaic modules, solar concentration devices or specially designed batteries as to assist these systems are some of the devices that actually are being tested and verified in the installation for this purpose located.

The main objectives of the *TDC* are those referred to technological innovation at different energy systems and market placing time reduction of acquired experiences. Therefore, the realization of different projects combining investigation, development and demonstration is one of the principal pillars where activities carried out in the *TDC* are sustained. To this effect, inside this Area, projects related to a national background such as PAEE, ATYCA, NATIONAL R&D PLAN, REGIONAL TECHNOLOGICAL PLANS or OCI-CIEMAT or to international frameworks such as JOULE, THERMIE, FEDER, ESPRIT, BRITE-EURAM, or EUROPEAN COMMISSION FRAMEWORK V, are being developed. In these various frameworks and together with different sorts of companies and entities, a technological development is pursued in the renewable energy field, in order to advance in the elimination of those barriers that impede a vast market penetration.

The detailed explanation of the developed projects would probably be motive for another paper, thus only a brief explanation of some of the most interesting projects developed in this Area is intended now to be attained:

1. **Photovoltaic School.** A 53 kW photovoltaic power generation system is disposed as an integrate structure at the top of a sportscentre court belonging to a special education school. It is grid-connected and will diminish the energy consumption by means of a high quality supply.
2. **UMSEF. Photovoltaic mobile unit.** The system involves a 3.3 kW photovoltaic power generator as to procure autonomous systems. It is associated to a battery energy storage system as to guarantee a five day autonomy. It is disposed in a compact system design and consists of a two axis trailer capable of accessing any possible site in need of electric supply.



Figure 4 - Photovoltaic mobile system.

3. **Photovoltaic Fence. Architectural and sonic barrier as to diminish visual and sonic impact.** The project deals with the integration of an 8.6 kW photovoltaic generator grid-connected fence with a high quality supply. Eight groups of modules will be series connected as to acquire an efficient inverter voltage. Special design has been envisaged taking into account an architectural fence disposition.
4. **DISS II. Direct Steam Generation.** Development of a novel generation solar thermal power station in order to accomplish electricity production by means of parabolic mirrors. It is conceived thinking of a direct steam generation, thus eliminating oil as an exchange heat fluid.
5. **BIOPOWER.** Commercial size multi-fuel biomass gasification for electricity production. It consists of a research project as to design and define medium sized commercial plants for electricity generation, by means of different sorts of biomass components. Competence of the project is also the utilization of novel environmentally integrated generation systems (zero emissions).

## CONCLUSIONS

The need for the development of novel technologies seems of the utmost importance in order to continue working for the Society's requirements. Different strategies must be followed as to acquire the advanced technologies that will lead us to a promising future and hence, the location of the IBERDROLA *Technology Demonstration Center* seems essential in order to advance in these developments, otherwise abandoned due to undesired reasons.

IBERDROLA is appreciative with the talented advances achieved and will continue supporting these developments as to defend the progress and maturity of novel technologies. These will surely be vital in the conception of a creative and futurist world.