



# DISPOWER

**Distributed  
Generation  
with  
High  
Penetration  
of  
Renewable  
Energy  
Sources**

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## Distributed Generation in Spain: Impact on Distribution System and Ancillary Services Provision

### DG & RES in Navarra

Navarra is one of the Spanish pioneer regions on RES&DG technology with more than 800 MW of wind power installed capacity, more than 150 of minihydro and over 500 of small photovoltaic units. On 2004 electricity generated from RES technologies reached the 70% share on demand.

One of the companies that has lead this trend has been EHN ([www.ehn.es](http://www.ehn.es)), a company born and based in Navarra that is one of the major players on the Spanish renewable energy scenario and with on-duty wind farm projects in France, USA, Canada, Australia and future project prospects in many other countries. EHN is 100% owned by Acciona and has broad experience on biofuel manufacturing and supply, biomass power plants, and wind turbine manufacturing among other renewable energy business and technologies.

### Results:

- > A complete overview of the regulatory framework in Spain for DG and RES has been carried out.
- > The study focuses in Navarra, where almost 70% of the electricity demand is covered by RES technologies and there are important growth prospects for wind, mini-hydro, biomass, bio-fuel and solar technologies.
- > The impact study on Iberdrola's Distribution System of actual and future DG penetrations has been performed.
- > Finally, the ancillary services provision by DG technologies is discussed and tested, focusing on the reactive power control and voltage control on EHN's wind farms by means of Ingetur Doubly Fed Induction Generators.

The company Iberdrola ([www.iberdrola.es](http://www.iberdrola.es)) is one of the biggest utilities in Spain. Iberdrola is divided in many other companies but related to this project we are mentioning that is the second energy distributor in Spain with Iberdrola Distribución and the first world player in renewable energy generation with Iberdrola Renovables. Iberdrola owns, maintains and operates most of Navarra's

electric distribution grid with the highest quality standards among Spanish utilities.

The two companies have joined on Task 7.5 of Dispower project to perform a study of the Navarra's interconnected grid with high RES generation penetration. An overview of the results of this task is given on Deliverable D 7.2 of DISPOWER „Distributed generation on European interconnected grids“.



Figure 1: 33 MW Alaitz Wind Farm.

## Technical Details

### SPANISH ELECTRIC MARKET

The first part of the project gives an overview on the Spanish electric energy business, and a review of the actual and future legislation for RES and DG generators, the so-called "Special Regime generators". The Spanish electric business has suffered a major overturning with the market liberalisation started on 1997. RES generation is still far from EU objectives but has been a growing sector especially with the wind generation boom that started on late 90's. In RES growth the major addition to the Spanish generation system have been more than 9000MW of wind energy installed in Spain and government plans give a 20000MW of installed capacity for year 2010. This increasingly important wind energy penetration has grown concerns on Transmission and Distribution system operators on how this will affect the grids they operate and maintain. For this reason a correct and optimum RES&DG technologies interconnection legislation is needed. In the report the current practices and legislation improvement prospects are explained.

### RES IN NAVARRA

The second part focuses on the situation of RES on Navarra, from the big generation and demand kwh. numbers down to the description and numbering of the technologies used: Wind, mini-hydro, photovoltaic, biomass, sun-thermal, bio-fuel and others. A study of how the Iberdrola's distribution grid has changed with this new installed capacity and a load-flow study of the grid for different future scenarios has been made. Future prospects, trends and guidelines are given at the light of the current situation and the before-mentioned studies.

### ANCILLARY SERVICES BY RES

Finally the capacity of the RES technologies to provide ancillary services to the network is discussed. The experience is focused on reactive power control by wind farms, explaining and documenting the work done to date by EHN on implementing such capability on their wind farms. The reactive power control is still under test but tests have shown the feasibility and

POWER FACTOR	ACTIVE AND REACTIVE POWER	% EQUIVALENT OF REACTIVE POWER OVER ACTIVE POWER	% OF THE REFERENCE MEAN TARIFF PAID OR DISCOUNTED		
	POWER FACTOR		SHOULDER PERIOD	FLAT PERIOD	PEAK PERIOD
Inductive	<0.95	> 33 %	-4	-4	8
	<0.96 and ≥ 0.95	29 % - 33 %	-3	0	6
	<0.97 and ≥ 0.96	25 % - 29 %	-2	0	4
	<0.98 and ≥ 0.97	15 % - 25 %	-1	0	2
	<1.00 and ≥ 0.98	> 15 %	0	2	0
Unitary	1	0	0	4	0
Capacitive	<1.00 and ≥ 0.98	> 15 %	0	2	0
	<0.98 and ≥ 0.97	15 % - 25 %	2	0	-1
	<0.97 and ≥ 0.96	25 % - 29 %	4	0	-2
	<0.96 and ≥ 0.95	29 % - 33 %	6	0	-3
	<0.95	> 33 %	8	-4	-4

Figure 2: Power factor control requirements for Special Regime generators as on Royal Decree 436/2004.

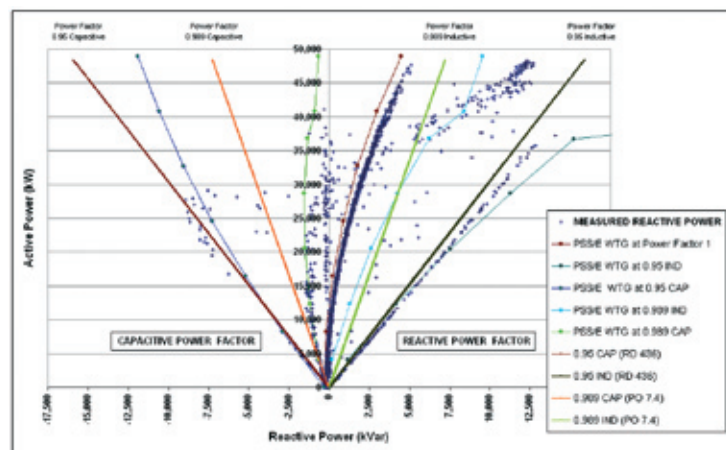


Figure 3: Power Factor regulation test at EHN's 49.5 MW wind farm at 66 kV connection point. 15-minute measurements, PSS/E simulated control capability and legislative power factor limits.

security of this practice. Further work is being done by EHN with Ingeteam Scada and control manufacturer and Ingetur wind turbine manufacturer to achieve this innovative control capability that will ease the integration of non-dispatchable wind farms on the power system.

In the Ingetur IT-1500 turbine, the power factor can be remote controlled in real time by means of the power converter. Therefore, no capacitors are needed for reactive compensation. The power factor can be adjusted between 0.95 inductive and 0.95 capacitive.

This remote controllability allows the implementation at substation level of several reactive controls associated with the voltage balanced:

- Local voltage control allows the substation to balance the line voltage in order to avoid the over voltage trip in the turbines.
- Remote voltage control. Reception of reactive power references coming from remote voltage regulators of the grid operator.
- Scheduled power factor. The power

factor of the turbines is changed periodically during the day according a scheduled program.

### CONCLUSIONS

- Today Navarra has more than 800 MW of installed wind power capacity and more than 100 MW of minihydro supplying 70% of the region's load.
- Navarra's government objective of 1450 MW of wind energy for year 2010 is achievable at current capacity installation pace and technically feasible.
- Growth prospects for other RES technologies such as photovoltaics, biomass or sun thermal-electric generation are very promising.
- At distribution level, compliance with DSO's rules and standards is necessary in order to keep good-utility-practices and enhance system security.
- Voltage control capability, voltage-ride-thru capabilities and other technical improvements on controllability and metering will improve actual RES integration and further increase the actual levels of installed capacities.

## MASTHEAD

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