Chapter 17
Spain

17.1 INTRODUCTION

The year 2002 showed continued solid growth of installation of wind energy plants in Spain, providing 1,440 megawatts (MW) of new capacity to the Spanish energy system structure.

Spain maintains a position as wind energy leader in the world, together with Germany and the United States. At the end of 2002, wind power in operation in Spain totaled 4,635 MW. Electricity generation by wind energy represents more than 3.8% of total electricity, and the goal is to have 13,000 MW grid-connected at the end of 2011.

The main reason for this growth is the existence of a stable legal framework for electricity producers that use renewable energy sources. The regulations contained in the Special Regime of the Electrical Sector Act state that electricity producers using wind have guaranteed access to the grid. The price per kilowatt-hour (kWh) generated has a bonus over the sale price of electricity.

New manufacturers, investors, producers, and researchers have been incorporated into the wind energy business in the past year.

17.2 NATIONAL POLICY

Spain is greatly dependent on external sources of energy. Table 17.1 shows the energy balance in the mainland electricity system (no data are included for the islands) during the past three years (2000 to 2002). During 2002, electricity demand was 2.3% higher than in 2001, with an amount of 210 terawatt-hours (TWh).

The Program for Promotion of Renewable Energies (PPER) was prepared by the national Diversification and Energy Saving Agency (IDAE) and is the response to the undertaking law 54/19976 on the Electricity Sector, which

Figure 17.1 Sierra del Trigo wind farm

Energy balance in the electricity system	2000	2001	2002
Source	GWh	GWh	GWh
Hydro	27,842	39,538	21,654
Nuclear	62,206	63,718	63,095
Coal	76,374	68,029	80,082
Oil/Gas	10,249	11,658	21,840
Special Regime (including renewables)	26,613	30,411	18,492
Import			5,603
Electricity Demand	194,992	205,414	21,0135

Table 17.1 Energy balance in mainland electricity system (2000 to 2002)

defines the target of achieving at least a 12% contribution to electricity demand in Spain from renewable energies by 2010.

Strategy

The strategy of the Spanish government is summarized in the PPER. The wind energy target for 2010 was to reach 8,974 MW installed, with an average production of 21.5 TWh/year (equivalent to 1,852 ktep). This target has been modified ("Electricity and Natural Gas Plant: Transmission Grid Development: 2002-2011"), and the new figure is 13,000 MW for the year 2011, contributing 28.6 TWh to the electricity demand. The new target represents an increase of 45% over the previous goal set in 1999.

The Electrical Special Regime for Renewable Energy Plants connected to the grid fixed the price and the bonus of the electricity produced by renewable energy plants. The price will be updated every year.

A complement to the PPER is the National Plan for Scientific Research, Development and Technological Innovation (2000-2003).

Progress Towards National Targets

The new target, 13,000 MW for the year 2011, looks to be realistic. On the other hand, the majority of the autonomous communities have regional wind energy programs that give a total figure of more than 30,000 MW to be installed in the next decade (exceeding the governmental target).

17.3 COMMERCIAL IMPLEMENTATION

Installed Capacity

In 2002 another 1,440 MW was installed, and the total power at 31 December 2002 was 4,635 MW.

Rates and Trends in Deployment

Annual power installed continues to grow. Figure 17.2 shows the annual power installed in Spain, and the accumulated power, in past years. The increased rate of power installed in 2002 versus 2001 was 67.2%, which is a record.

The new wind farms are of large and medium sizes and are located on the mainland. They are owned primarily by consortiums formed by utilities, regional institutions involved in

AUTONOMOUS COMMUNITY	Potential Wind Capacity in 2011 (MW)
ANDALUCIA	4,000
ARAGÓN	3,200
ASTURIAS	500
ISLAS BALEARES	49
ISLAS CANARIAS	250
CANTABRIA	300
CASTILLA Y LEÓN	6,579
CASTILLA-LA MANCHA	4,452
CATALUÑA	1,073
EXTREMADURA	-
GALICIA	4,000
MADRID	50
MURCIA	600
NAVARRA	1,536
LA RIOJA	665
VALENCIA	2,820
PAÍS VASCO	250
TOTAL	30,325

Table 17.2 Wind potential identified in the programs of the Autonomous Communities

local development, private investors (national and foreign), and, in some cases, the manufacturers. Private individuals are not taking an important role in the development of wind energy in Spain.

At the present time, almost all the Spanish autonomous communities are incorporating wind energy into their energy structures. Galicia, Castilla-La Mancha, Castilla-Leon, and Aragón are the autonomous communities that had more activity during 2002.

Contribution to National Energy Demand

The production of wind-power plants for 2002 was about 8 TWh. The increase in energy production was 40% above 2001, when the energy produced by wind-power plants was 5.69 TWh (National Energy Commission). The total electricity demand in Spain in 2002 was 210 TWh.

Wind-powered electricity reached about 3.8% of the total electricity demand in the country.

17.4 MARKET DEVELOPMENT AND STIMULATION

The main action for market stimulation is the price paid for electricity generated by RES. The price is regulated through two royal decrees (the latter approved in December 1998) obliging utilities to pay a guaranteed price to RES generators for a five-year period. These prices and the related bonus are revised and fixed every year, taking into ac-

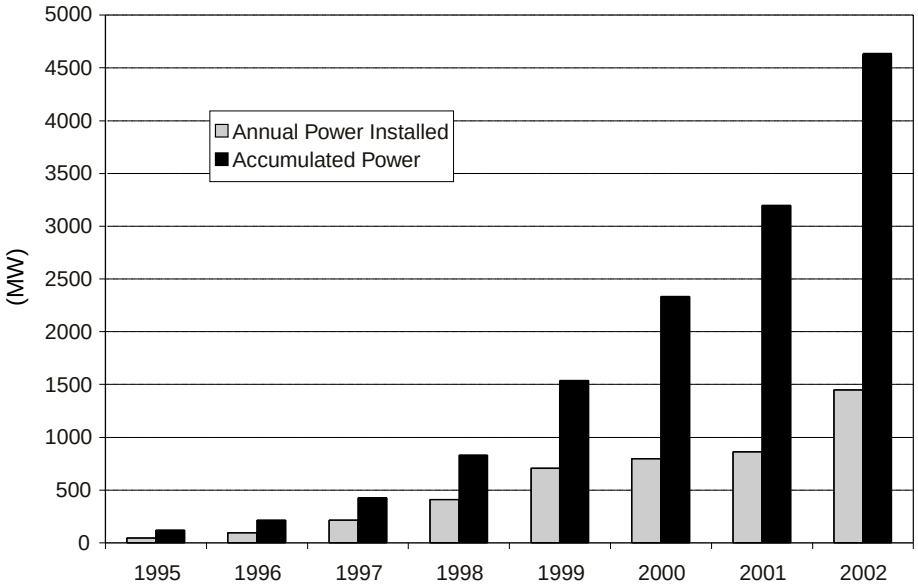

Figure 17.2 Wind power in Spain

count variation in the electricity market price and other factors.

17.5 DEPLOYMENT AND CONSTRAINTS

The strong growth of installed power is welcomed by a society that appreciates not only the contribution to environmental conservation but also industrial development and associated job creation. Job creation is the most important benefit of wind energy for the Spanish populace. Also, benefits obtained at the local level (landowners and municipalities) favor the development of new installations.

Conditions for developing wind projects in Spain are regulated under the law of the Special Regime for Electricity Production (December 1998). The grid operator (REDESA, a national public company) and the utilities are obligated to allow the connection of wind turbines to the grid. Developers must fulfill the technical require-

Year	Power Installed (MW)	Accumulated Power (MW)	Annual Growth Rate (%)
1995	46	119	-
1996	95	214	106.5
1997	213	427	124.2
1998	407	834	91.1
1999	705	1539	73.2
2000	795	2334	12.8
2001	861	3195	8.3
2002	1440	4635	67.2

Table 17.3 Accumulated wind power (1995 to 2002)

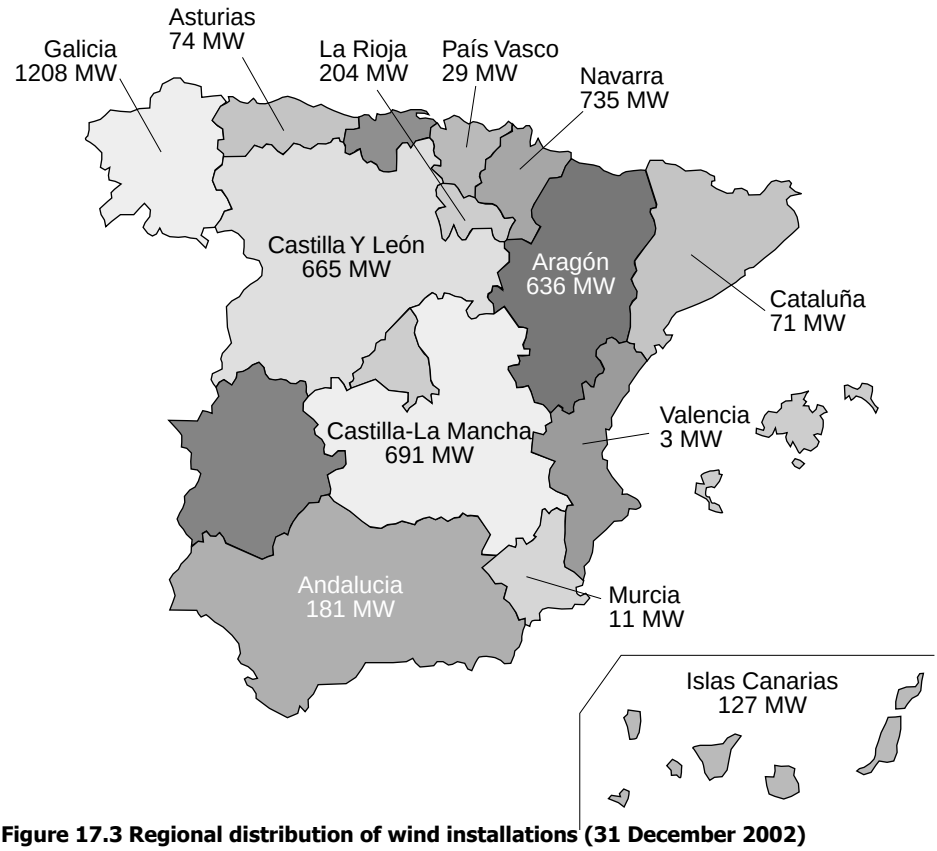

Figure 17.3 Regional distribution of wind installations (31 December 2002)

ments defined in the electrical law. The costs associated with connection are the responsibility of the plant developer. There are no widespread complaints about the process of obtaining permission to connect to the grid.

Wind Turbines Deployed

Figure 17.4 shows the share by manufacturers of the wind turbines in the Spanish market for 2002. The average size of the wind turbines installed has risen from 721 kW in 2001 to the present size of 808 kW. Table 17.4 provides a list of the wind turbines installed in the new wind farms.

Operational Experience

At the time this report was being written, information was not available about the yearly operational results of Spanish wind farms in 2002 (capacity factors, equivalent hours at rated power, cost of operation and maintenance, etc.). However, information about the instantaneous production of Spanish wind farms (and historical data of previous periods) is available on the Internet at www.ree.es.

Autonomous Communities	Total Power 31/12/2001 (MW)	Power Installed in 2002 (MW)	Total Power 31/12/2002 (MW)
Andalucía	156	25	181
Aragón	400.6	235	635.6
Canarias	117	10	127
Castilla La Mancha	421	270	691
Castilla y León	361	304	665
Cataluña	71	0	71
Galicia	888	320	1,208
Murcia	11	0	11
Navarra	639	96	735
La Rioja	74	130	204
C. Valencia	3	0	3
País Vasco	29	0	29
Principado de Asturias	24.4	50	74.4
TOTAL	3,195	1,440	4,635

Table 17.4 Wind turbines installed in the new wind farms

Main Constraints on Market Development

The main constraint on market development is the existing limitation on the capacity of the grid for energy evacuation. Generally, wind farms are located in areas with low population density, and the grids are weak grids that require reinforcement and improvement. Concerted actions to solve the problem are ongoing between utilities and developers.

Last year, some opposition emerged against the installation of new wind farms in areas with strong development. This was launched by local ecology groups concerned about impact on the landscape and the possible impact on bird life. The opposition causes delays in the permitting of wind farms.

17.6 ECONOMICS

Trends in Investment

No information available.

Trends in Unit Cost of Energy and Buy-Back Prices

Royal Law 2818/1998-23 (December 1998), about the electrical special regime for renewable energy plants connected to the grid, fixed the conditions of the plants to be included in this special regime. This law was a new step in the strategy for promoting the use of renewable energies, with the specific target that "the contribution of the renewable energies to the Spanish energetic demand will be at least 12% for the year 2010." All installations using renewable energies as the primary source, with installed power equal to or lower than 50 MW, could be included in that regime. The regime gives two choices to the producers. One is a fixed priced for the kilowatt-hours generated, and a second option is a variable price calculated from

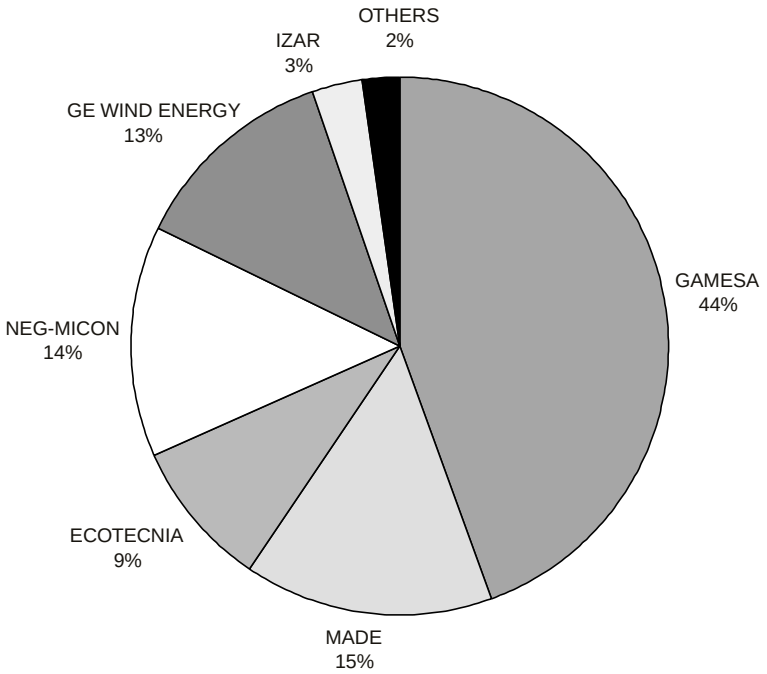

Figure 17.4 Share by manufacturers of the Spanish market in 2002

the average price of the market pool, plus a bonus per kilowatt-hour produced. The fixed price and the bonus will be updated every year by the Spanish Ministry of Economy in accordance with the annual variation of the market price.

The updated values for 2002 and 2003 are presented in Table 17.5.

To date, the fixed price has given lower returns than the premium and has not been popular. The bonus is paid on top of the market price based on the Spanish pool price. The government policy for the buy-back of the electricity produced for the wind plants is to lie between 80% and 90% of the pre-tax consumer price. Since pool prices

	2002		2003	
RENEWABLE SOURCE	**Bonus added to the base price (Euro/MWh)**	**Fixed price (Euro/MWh)**	**Bonus added to the base price (Euro/MWh)**	**Fixed price (Euro/MWh)**
Small Hydro	**30.051**	**63.827**	**29.450**	**64.849**
Wind Plants	**28.969**	**62.806**	**26.625**	**62.145**
Primary Biomass *	**27.887**	**61.724**	**33.236**	**68.515**
Secondary Biomass *:	**25.781**	**59.620**	**25.122**	**60.522**

(*)Primary Biomass: Agricultural crops
Secondary Biomass: Agricultural and Forest residues

Table 17.5 Buy-back electricity prices for RES in 2002 and 2003

have been rising, wind prices during 2002 have followed that tendency, and the buy-back price has exceeded the limit by three points (93%). As a consequence, for 2003 there is a reduction in the bonus added of 8.1% versus 2002, and a reduction of 1.1% in the fixed price.

17.7 INDUSTRY

Important activity in the wind energy field has intensely activated the development of the Spanish wind industry, covering not only the manufacture of complete wind turbines but also the manufacture of components for the wind industry: blades, generators, gear-boxes, towers, wind sensors, etc. Also, the service sector (installation, maintenance, engineering) has grown in the past year.

New factories for components manufacturing began operation during 2002 (blades, towers, and gearboxes), and a large number of jobs were created, with special emphasis in the region of Castilla-Leon.

Manufacturing

The companies that are leading the national Spanish industry are Gamesa Eólica, Ecotécnia, Made, Izar, GE Wind Energy, and Neg-Micon. Other manufacturers are initiating their activities in Spain as DeWind or Nordex. Table 17.6 shows the list of wind turbines larger than 100 kW on the Spanish market:

Gamesa Eólica is the leading company in the Spanish market, with a share in the past year of about 44% of the market. The company

MANUFACTURER	MODEL	RATED POWER (kW)
ECOTECNIA	ECOTECNIA 44	640
ECOTECNIA	ECOTECNIA 48	750
ECOTECNIA	ECOTECNIA 62	1,300
ECOTECNIA	ECOTECNIA 74	1,640
MADE	AE-46	660
MADE	AE-52/56/59	800
MADE	AE-61	1,320
GAMESA	G-47	660
GAMESA	G-52/58	850
GAMESA	G-80	2,000
IZAR		600
IZAR		1,000
IZAR		1,300
GE Wind Energy	900 s	900
GE Wind Energy	1.5 s/s1	1,500
MTORRES		1,500
NEG Micon	NM750/48	750
NEG Micon	NM900/52	900

Table 17.6 Wind turbines (>100 kW) on the Spanish market

manufactures wind turbines between 660 kW and 2 MW and also manufactures the majority of the components (blades, nacelles, gearboxes, towers, etc). There are 10 subsidiary factories from Gamesa Eólica working in the country, with a total of 1,231 employees.

Gamesa is developing new models (G52 RCC 800 kW and G80 RCC 1.8 MW) using a newly developed electronic power control system (rotor current control) to optimize the efficiency of the system according to specific site conditions.

During 2002, the company supplied 854 MW to the Spanish market for new wind farms, and another 88 MW to foreign markets. The present annual capacity production of the company is over 1,700 wind turbines.

At the present time, the company is increasing the commercialization of its products worldwide, and has opened commercial offices in several countries (United States, Canada, Germany, Italy, France, Brazil, Portugal, Greece, etc).

Ecotécnia started activities in wind technology development in 1981, having more than 20 years of experience in that field. The company has a technical staff of 60 persons and has two factories, one located in Somozas (La Coruña) and the other in Buñuel (Navarra), with a total of 267 workers. Ecotécnia was incorporated in 1999 with the MCC group, one of the world's biggest cooperatives, with activities in the industrial, distribution, and financial sectors.

The models in production are the ECO/44/640 kW, the ECO/48/750 kW, the ECO/62/1300 kW, and the ECO/74/1670 kW. The company is developing new models 80 meters (m) in diameter with rated power of 1,670 kW and 100 m in diameter model with rated power of 2,500 kW. The present annual capacity production of the company is 500 MW.

During 2002, Ecotécnia supplied 225 wind turbines with a total power of 170 MW. The company already has orders to install another 154 units during 2003, for a total of 234 MW.

Made is another pioneering company in Spain that since 1982 has developed ten

Figure 17.5 Ecotécnia 62/1300 nacelle

models of wind turbines, going from the first design (24 kW) to the most recent, AE-61, at 1,320 kW. At the present time Made is developing a new 90-m-diameter wind turbine, 2-MW rated power (Class II).

The new designs of 800-kW rated power – Made AE-52 (Class I), Made AE-56 (Class II), and Made AE-59 (Class III) – are pitch-controlled wind turbines of variable-speed design using synchronous generators. The AE-61 (Class I) is a stall-controlled, asynchronous-generator wind turbine. The present annual capacity production of the company is 750 MW.

During 2002, Made supplied 392 wind turbines with a total power of 287 MW. The company expects to install about 450 MW in 2003.

Izar is manufacturing 600-kW, 1-MW, and 1.3-MW models of Bonus technology in its factory located in El Ferrol (La Coruña). Izar is also developing two new models of 2 MW and 2.3 MW. The present annual capacity production of the company is over 200 MW.

Figure 17.6 Made AE/61 model

During 2002, the company installed 87 units of the 600-kW model and another 6 units of the 1.3-MW wind turbine. During the first quarter of 2003, another 40 units of the 1.3-MW model will be connected to the grid – 26 units on wind farms in Spain and the other 14 on a wind farm in Portugal. The company expects to install 277 MW during 2003.

GE Wind Energy is producing 900-kW and 1,500-kW models (70.5 m and 77 m rotor diameter, respectively). GE has installed the first prototype of the 3.6-MW model, designed for offshore installations, in Barrax (Albacete).

During 2002 GE Wind Energy supplied 156 wind turbines with a total power of 237,6 MW. The company expects to reach a share of 16% for the Spanish market for 2003.

NEG Micon Iberica S.A. has three factories in Spain. The company has 104 workers and is manufacturing models NM/900/52 and NM/750/48. The company is preparing to manufacture model NM/1500/62, which will be on the market at the end of 2003.

During 2002, NEG Micon Iberica S.A supplied 343 wind turbines with a total power of 266.7 MW, plus another 11 wind turbines for the Portuguese market.

M. Torres company has developed a prototype of a 1,500-kW, upwind, multi-pole generator, pitch-regulated turbine that will start commercialization during 2003. The company expects to install 20 MW during 2003.

Figure 17.7 GE Wind Energy 3.6-MW prototype (Barrax-Albacete)

In the sector of small wind turbines, Bornay is the company leader, with more than 177 units installed during 2002 in the Spanish territory, and another 34 units for the international market (Germany, Portugal, Japan, Tanzania, etc). Bornay is manufacturing six models from 60 W to 6 kW. The company is developing new models of 7.5 kW, 15 kW, 30 kW, and 50 kW.

The company Solener is also manufacturing small wind turbines with nine models on the market, going from 300 W to 15 kW. The company is already developing new prototypes of 25 kW and 40 kW. During 2002 Solener supplied 150 wind turbines to the market.

Other companies, like Aitesa and Ecotécnia, are marketing small wind turbines using foreign technologies form Vergnet (France) and Bergey (United States), respectively.

Industry Development and Structure

New Spanish manufacturers are active in the wind energy industry, using foreign technology (as Nordex or DeWind) or developing their own technology (M. Torres) that will increase the capacity of the Spanish industry to fulfill not only the internal market but also other markets.

Spanish manufacturers are very actively participating in future projects not only in the Spanish market but also in other countries. The wind industries are spread throughout the Spanish territory (almost all the autonomous communities are involved in the development of wind energy industry), and new factories manufacturing components for the industry have been inaugurated during 2002.

Table 17.7 shows the new prototypes larger than 1 MW under development by the Spanish industries.

17.8 GOVERNMENT-SPONSORED R,D&D

Priorities

The target areas defined in the National Plan for Scientific Research, Development and

Technological Innovation (2000-2003) of the Ministry of Science and Technology for wind energy projects are the following:

- Environmental impact reduction of wind systems
- Technology cost reduction
- Technology development for large wind turbines (1 MW to 2.5 MW)
- Small wind turbines for isolated applications
- Remote-control systems for grid connection
- Wind-power penetration in weak grids

During the period 2000 to 2002, more than 70 projects were submitted to the program, covering all the areas stated in the plan. The most projects were for technology cost reduction (26 projects) and large wind turbines (17 projects). Nineteen projects received the support of the program with a total budget of 3.2 million €. Projects were presented mainly by industrial companies in co-operation with engineering companies and research centers.

New R,D&D Developments

The centers and universities involved in R&D projects have continued and have increased their activities during 2002 (see Table 17.8). Utilities are also very active in the development of research projects, mainly related to specific aspects of electricity production from the wind plants and problems associated with the impact on the grid.

The main public R&D organization in the field of wind energy in Spain is CIEMAT, a center for research in the technologies and environmental aspects of energy production. Inside CIEMAT, the Department of Renewable Energies (DER) is stressing activities in the field of autonomous wind systems, with a broad field of activity from the development of components (small wind turbines, flywheel storage systems, control management units, etc.), to the testing of wind turbines, components (gearboxes, generators, and blades), and the whole system, in the test plant located in the CEDER center in Soria.

At the end of 2002, seven small wind turbines of different technologies, ranging from 1 kW to 50 kW, were in the testing phase being measured for power performance characterization, durability, and noise emissions.

During 2002 operation began of the hybrid wind-photovoltaic (PV) CICLOPS system, developed by Ecotécnia, using a 10-kW Bergey wind turbine and a 5-kW PV array.

Also, a new facility for flywheel testing was installed at CEDER. In April CEDER held a

MANUFACTURER	MODEL	RATED POWER (kW)
ECOTECNIA	ECOTECNIA 80	1,670
ECOTECNIA	ECOTECNIA 100	2,500
MADE	AE-90	2,000
GAMESA	G-83/87/90	2,000
GE Wind Energy	GE 3.2 s	3,200
GE Wind Energy	GE 3.6 s	3,600
MTORRES		2,500
NEG Micon	NM1500/62	1,500

Table 17.7 Wind turbines (>100 kW) under development by the Spanish manufacturers

Figure 17.8 CEDER-CIEMAT test plant

meeting of experts supported by Annex XI called Power Performance of Small Wind Turbines Not Connected to the Grid.

The new center Centro Nacional de Energías Renovables (CENER), located in Navarra, also participated in by CIEMAT, will cover activities in the field of large wind turbine testing, blade developments, control systems, and wind forecasting techniques.

The number of university departments working on wind projects is rapidly increasing. In particular, the Politechnical University of Madrid continues work studying wakes in wind turbines, electrical systems, and blade technology. Vigo University is developing a simplified methodology for flicker analysis and voltage and frequency variations in wind farms. The University of Las Palmas (Canary Islands) works on wind farms' impact on grid stability and on desalination plants powered by wind energy systems. The University of Navarra continues its research on lightning and wind turbines.

Other research centers are also very active; for example, ITER and ITC in the Canary Islands are both involved in R&D projects in desalination of seawater using wind energy plants.Table 17.8 lists the main research centers involved in wind R&D projects.

Author: Félix Avia Aranda, Departamento de Energías Renovables, CIEMAT, Ministerio de Ciencia y Tecnología, Spain.

Table 17.8 List of research centers involved in R&D in wind energy

CENTRE	FIELD OF RESEARCH	CONTACT PERSON
Department of Renewable Energies CIEMAT	• Autonomous Wind Systems • Small Windturbines Testing • Storage Systems • Wind Forecasting	D. Ignacio Cruz Cruz Avd. Complutense 22, 28040 Madrid Phone: +34-91-346-6254, Fax: +34-91-346-6037 E-mail: ignacio.cruz@ciemat.es
Centro Nacional de Energías Renovables (CENER-CIEMAT)	• Windturbines Testing • Components Testing • Wind Forecasting	D. Javier Sanz C/ Arcadio Maria Larraona 1, 31008 Pamplona, Navarra Phone: +34-948-25 28 00/ Fax: +34-948-27 07 74 E-mail: javiersanz@cener.com
(I.T.C.) Instituto Tecnológico de Canarias	• Hybrid Systems • Water Pumping • Sea water Desalination • Small WT	Prof. D Gonzalo Piernavieja C/ Cebrian 3, 35003-Las Palmas de Gran Canaria Phone: +34-928-452018/Fax: +34-928-452-007 E-mail: gpiernavieja@itccanarias.org
I.T.E.R. Instituto Tecnológico y de Energías Renovables Santa Cruz de Tenerife	• Hybrid Systems • Water Pumping • Water Desalination • Small WT	Ing. D. Manuel Cendagorta Polígono Industrial de Granadilla Santa Cruz de Tenerife, 38594- Tenerife Phone:+34-922 - 391000/Fax:+34-922 - 391001 E-mail: mano@iter.rcanaria.es
Politechnical University of Madrid E.T.S.I.I. Department of Fuidomechanic Engineering	• Wind Resources • Wind turbine Wakes • Wind Farm Modeling • Wind Turbulence	Prof. D. Antonio Crespo C/ Jose Gutierrez Abascal 2, 28006-Madrid Phone:+34-91-336-3152(30.23)/Fax:+34-91-336-3006 E-mail: crespo@enerflu.upm.es

Politechnical University of Madrid **E.T.S.I.I.** **Dep. of Electrical Engineering**	**• Grid Integration** **• Variable Speed Systems**	**Prof. D. Carlos Veganzones** **C/ Jose Gutierrez Abascal 2, 28006-Madrid** **Phone: +34-91-336 3060** **E-mail:cveganzones@inel.etsii.upm.es**
Politechnical University of Madrid **E.T.S.I. A.** **Departamento de Materiales**	**• Composite Blades**	**Prof.D. Alfredo Güemes Gordo** **C/ Plaza Cardenal Cisneros, 3, 28040 Madrid** **Phone:+34-91 - 3366327/Fax:** **E-mail: aguemes@dmpa.upm.es**
University of Vigo **E.T.S.I.I.** **Dep. of Electrical Engineering**	**• Grid Integration** **• Electrical Variable Speed systems**	**Prof. D. José Cidrás** **Lagoas-Marcosende, 9, 36280 VIGO** **Phone: +34-986-812-221/Fax: +34-986-812-173** **E-mail:jcidras@uvigo.es**
University Carlos III **Dep. of Electrical Engineering** **Madrid**	**• Grid Integration** **• Electrical Variable Speed systems**	**Prof. D. J. Carlos Burgos Díaz** **C/ Butarque, 15, Leganés, 28911 Madrid** **Phone: +34-91-6249900/Fax: +34-91 6249430** **E-mail: jcburgos@uc3m.es**
University of Valladolid **E.T.S.I.I.** **Dep. of Electrical and Mechanical Engineering**	**• PMG Generators**	**Prof. D: A: Frechosos Escudero** **C/ Francisco Mendizabal 1, 47014 Valladolid** **Phone: +34 983 423686** **Fax: +34 983 423490** **E-mail: frechoso@eis.uva.es**
University of Sevilla **E.T.S.I.I.** **Dep. of Fluid Dynamic**	**• Wind Turbine Control**	**Prof. D. Francisco Rodriguez Rubio** **C/ Reina Mercedes s/n, 41012 Sevilla** **Phone: +34 95 455 6876** **Fax: +34 95 455 6849** **E-mail: rubio@eis.us.es**

Continued – Table 17.8 List of research centers involved in R&D in wind energy

University of Mondragón **Dpto. de Electrónica Escuela Politécnica Superior**	**• Wind Turbine Control**	**Prof. Miguel Angel Vidal Rodriguez** **C/ Loramnedi 4, Apdo. 23, 20500 Mondragón-Guipuzkoa** **Phone: +34 943 794700** **Fax: +34 943 7911536** **E-mail: marodriguez@eps.muni.es**
Universidad Pública de Navarra	**• Lightning in WT**	**Prof. D. Blas Hermoso** **C/ Campus Arrosadía, 31006-Pamplona** **Phone:+34-948-169330/Fax:+34-948-169281** **E-mail: hermoso@unavarra.es**
University of Zaragoza **Dep. of Electrical Engineering**	**• Power Quality**	**Prof. A:A: Bayod Rújula** **C/ Maria de Luna 3** **Centro Politécnico Superior, 50015- Zaragoza** **Phone: +34 976 762152** **E-mail: aabayod@posta.unizar.es**
Fundación LEIA **Centro de Desarrollo Tecnológico**	**• Small Wind Turbines**	**D. Oscar Garay** **Parque Tecnológico de Alava** **C/Leonardo da Vinci 11, bajo, 01501 Miñano, (Alava)** **Phone: + 34 945 298144** **Fax. +34 945 298217** **E-mail: itziarv.leia@sea.es**
Fundacion FATRONIK	**• Small Wind Turbines** **• Autonomous Wind Systems**	**D. José Miguel Azkoitia** **Polígono Ibaitarte 1, Apdo. Correos 160** **20870 Elgobiar- Guipuzkoa** **Phone: +34 943 748020** **Fax: +34 943 743492** **E-mail: jmazkoitia@fatronik.com**