



EUSUSTEL

European Sustainable Electricity; Comprehensive Analysis of Future
European Demand and Generation of European Electricity and its
Security of Supply

WP1: Country-wise analysis for EU-25
Spain

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FINAL REPORT

1. Energy-related and socio-economic analysis: past, present and future

1.1 Factual Information

With an area of 505,000 km², Spain is the second largest country in Europe. It includes 85% of the Iberian Peninsula, Balearic, and Canary Islands, as well as the cities of Ceuta and Melilla in the Northern part of Africa. It is divided in 17 autonomous regions with their own competences in matters like education, public health, regional development, etc.

Around 57.7% of the land is 600m over the sea level. After Switzerland, it is the highest country in Europe. The coast extends to 7,880 km.

The average population density is 80 inhabitants/km², although it is very variable from one place to another. 22% of the population lives in the 7 main cities. With the only exception of the Madrid area, population is mainly concentrated along the coast and islands. In these areas, during summer, population may even reach three times the winter one.

Population growth seems to be surpassing forecasts, which predicted 42,5M inhabitants by 2010, mainly due to immigration. In 2004, there were already 43,1 M inhabitants.

Climatology in Spain is diverse from north to south. Frequent rains are present in only one third of the country, while other areas suffer often droughts. Annual rainfall varies from one point to other in the country (> 2.000 mm in NW, while < 200mm in SE). Average annual temperature in Spain is between 14°C and 20°C.

Economy

In 2004, **Gross Domestic Product (GDP)** was 798,000M€, 18,500 € per person. The Spanish GDP growth was 2.5%, while in the euro zone the average was 0.4%.

Industry contributes to GDP by 31% employing 28.6% of the working population; services by 65% employing 65%; and agriculture by 4% employing 5.7% of the working population.

Unemployment rate in 2003 was 11.4%, a high figure, which is over the average of the developed countries rate.

Consumer Price Index (CPI) grew a 2.7% in 2003.

Number of housings in 2001 was 21 M from which 13 M were households. In the last few years, the construction sector has grown 4% annually. In 2004, there were 650,000 new buildings in construction. A smaller growth is expected for the coming years. The average **number of people per household** in 1990 was 3.3, while in 2001 it was 2.9.

Energy

In 2004, **total primary energy consumption** was $5.95 \cdot 10^9$ GJ (141.6 Mtoe), which represented 3.7% growth related to the previous year. Coal consumption, with a 14.9% of total consumption, increased by 3%; oil, with a 50%, increased by 2.1%; and gas, with 17.3%, increased by 15.5%. Nuclear energy increased by 2.7% representing 11.7% of total primary energy consumption. Hydropower consumption, with 1.9%, suffered a big reduction of 23.2%, and the other renewables reached 4.4% of total, which represents 8.4% over the previous year.

Total final energy consumption (TFC) in 2004 was $4.38 \cdot 10^9$ GJ (104.36 Mtoe), with a growth rate of 3.5% over the previous year. In the last 10 years, total growth rate has been 40.4% with an annual growth rate of 4.2%. It is worth noting the large increase of gas and electricity, which represents 11.4% and 6.8% respectively. Cogeneration and renewables shares continue to increase.

At the sector level, industry demands 37%, transportation 35.9%, and other uses 27.1% of the total final energy consumption. Three quarters of the final energy consumption in industry account for energy uses. In 2000, 24% of this consumption corresponded to the non-metallic mineral sector, followed by the iron and steel industry as well as big melters with 17%, and the chemistry industry with 15%. Regarding transportation, 80% of the total consumption is due to road transport. There are 26 M vehicles in Spain, from which, at least, one third are older than 10 years old. Other uses include construction, agriculture as well as tertiary equipments and residential that consume 61%, 17%, and 15% respectively.

Self supply has been reduced in the last few years mainly due to the national coal production reduction, which went from 77%, in 1980, to 35.1% in 2003. Spain imports more than 75% of its energy consumption, while the average in the EU is 50%. Table I shows the self energy supply percentage by technology from 2001 to 2003:

	2001	2002	2003
Coal	40.3	35.1	32.6
Oil	0.5	0.5	0.5
Natural gas	2.9	2.5	0.9

Table I. Self energy supply percentage by technology in Spain

Security of supply is an issue of concern in Spain, and the country is facing it with a good diversification of energy sources and primary energy suppliers.

National energy production is strongly dependent on rainfall. In 2003, it reached 10^9 GJ (33 Mtoe), 3% more than in 2002. However, in 2004, due to the low rainfall, national production declined to 32.9Mtoe.

Natural gas demand in 2002 was 9.10^8 GJ (20.65 Mtoe), with an increase of 14.2% over 2001. The industry sector consumed 55.5%, followed by the domestic/commercial sector with 18% of the total natural gas demand. Nevertheless, the largest increase came from the electricity production sector, where demand doubled from one year to other.

Primary energy intensity in Spain follows a growing trend, with an accumulated increase of 4.7% between 1990 and 2000. In 2000, the primary energy intensity was 3% below the European Community level. Concerning final energy, during the last 10 years, energy intensity has grown by 3%. However, in absolute terms it still remains below the European Community average, but with a tendency to equalise it. Energy intensity for the industry sector has improved over the last few years, while this trend has not occurred for the other sectors.

Primary energy consumption per inhabitant is 100 GJ (3.2 toe). **Average consumption per household** is one of the lowest in Europe. In 2001, it was 40 GJ/household (0.93 toe), while the European average was 70 GJ/household (1.7 toe). 47.2% of this consumption accounts for heating, 20.4% for water heating, and the rest accounts for lighting, and other domestic devices. From 2001 on, air conditioning is taken into account with 0.2% of the consumption showing a fast growth tendency.

Electricity

The **electricity net consumption** in Spain during 2004 was 859,464,000GJ (238,740GWh). This represented an increase of 3.7% regarding 2003. In the last 10 years, demand has grown by 64.6%, with an average accumulated rate of 5.8%, contrasting with the 3% of the previous decade.

The production structure was: 10.8% from Hydro, 28.9% from coal, 22.7% from nuclear, 21.2% from natural gas, 8.1% from oil products, and 8.5% from renewable and wastes.

Electricity consumption per inhabitant, in 2004, was 19.8 GJ (5,500 kWh), with a growth of 38.6% in the last decade. Electricity intensity was 1,077 GJ/M€ (299 MWh/M€).

Table II shows the **electricity energy balance** in Spain for 2004.

	MWh		%
	2003	2004	
Hydro	38,774	29,978	-22.7
Thermoelectricity	108,470	127,684	17.7
Nuclear	61,875	63,153	2.1
Other renewable & wastes	21,391	23,587	10.3
Cogeneration & waste treat.	33,903	34,023	0.4
GROSS PRODUCTION	264,413	278,425	5.3
NET PRODUCTION	253,097	266,316	5.2
NET CONSUMPTION	230,298	238,730	3.7

Table II. Electricity energy balance in Spain for 2004

The largest increases are those for gas and wind power. Gas share was 12% in 2002, while in 2003 it rose to 18.7%. In the same way, production from cogeneration and other renewables grew 14.3%, accounting for 18% of the total demand. From such production, 30% was generated by wind power.

Cogeneration, including self-consumption, represents 15% of the national electricity demand. By the end of 2003, the installed capacity was 5812 MW, 1.35% greater than in 2002. At present, it seems to be at a standstill. 72% of the cogeneration utilities are fed with natural gas. At the end of 2004, the **total capacity of the electricity system** was 71,957 MW, from which 16,599 came from cogeneration and renewable. And, within renewable, 7,659 came from wind power. This year, the total capacity in the country grew by 7.7%.

Efficiency of the electricity system is improving. In 2000, 8.48 10⁹ GJ (202 toe) per gross GWh were required, while in 2011 it is estimated that only 8.06 10⁹ GJ (192 toe) will be needed.

Currently, there are 7 **nuclear power** plants with a total of 9 groups working in Spain. They all add up 7,880 MW of installed capacity, representing 12% of the total power generation. In 2004, gross production was 63,153 GWh. Working factors are excellent: a load factor of 90.3%, and an availability factor of 92.1%. There are no plans of new nuclear power plants, but, for the existing units, there is a 600 MW power increase currently planned to compensate the closing down of José Cabrera power plant (160 MWe) in 2006. From the existing 9 groups, there are 7 which will reach the end of their lifetime between 2020 and 2030.

The highest peaks of demand occurred in June 2005. They took place during three consecutive days, starting on Tuesday 21st, with 37,847 MW, and lasting until Thursday 23rd, with 38,600 MW. This meant a growth rate of 4.47% in relation to the previous summer highest peak of demand.

Transmission and distribution networks add up to 51,809 km. In 2004, lines increased in a 0.9%.

International electricity exchange is small, mainly due to a lack of interconnections. In 2003, international exchanges contributed to 7.15% to the total available energy. In 2004, the balance was positive, 2,909 GWh. Spain imported from France 5,174 GWh, and exported 1,572 GWh to Morocco, 6,254 GWh to Portugal, and 257 GWh to Andorra.

The **Spanish electricity market** is completely liberalised from January 1st, 2003. At the end of 2004, total number of consumers was 23.5 M. From those, 5.73% directly participated in the market, while in 2003, only 4.21% did. The market is operated by OMEL¹, which is in charge of the economic activities of the market, and by REE², which is responsible of the operation and maintenance of the transmission network. The National Energy Commission, CNE³, is the regulator of the activities, except for the nuclear activities, which are regulated by the Nuclear Safety Council, CSN⁴. Generation and distribution business in Spain are totally separated.

The electricity sector companies in Spain have shown a remarkable investment effort in the last years. All the big companies, joined in UNESA⁵, have invested 17,785 M€ in the last 5 years, having dedicated 59.3% to generation activities, and 40.7% to transmission and distribution.

Electricity price in Spain is one of the lowest in Europe, and remains below the CPI. Since 1997, the price has been reduced by 38%. Within the domestic sector, the electricity bill represents 2.4% of the total family expenses. This fact hinders the energy saving plans success. The liberalised electricity market prices are also very low regarding the other European countries. The electricity price is commonly used as a tool to control economy.

In the **gas market**, also completely liberalised, there are 5,6 M of consumers, from which, 22.52% directly participate in the market.

¹ http://www.omel.es/frames/en/index_eng.jsp

² http://www.ree.es/ingles/i-index_quien.html

³ <http://www.cne.es/ingles/index.html>

⁴ <http://www.csn.es/plantillas/index.jsp>

⁵ <http://www.unesa.es>

Environment

According to UNESA, CNE, OECD and the Environment and Industry Ministries, the present emissions levels for the energy sector are: 1,200 kt SO₂, 310 kt NO_x, 19 kt CO, and 9 kt NMVOC.

In 2001, **Greenhouse gases (GHG) emission** per inhabitant was 8.85 tCO₂eq. In 2004, the total amount of emissions accounted for 9.7 tCO₂eq. In 2002, total GHG emission was 401.34 MtCO₂eq, 35% higher than in 1990. Spanish commitment in Kyoto implied not to exceed 1990 GHG emissions by 15%. In 2004, it has already been exceeded by 45%. Most of them (80%) due to CO₂.

Spain has recently set up the National Allocation Plan for the allocation of greenhouse gas emission allowances. This plan shares out allowances for 504.6 Mt CO₂ for 2005-2007. This represents 40% of the total emissions in Spain. For 2005, the electricity sector accounts for 86.4 Mt CO₂ for 2005. In January, 14% of these allowances were already issued.

<i>Energy production</i>	28.7
<i>Industry combustion</i>	15.9
<i>Transport</i>	23.5
<i>Agriculture</i>	10.7
<i>Industry processes</i>	7.3
<i>Residues</i>	3.9
<i>Other combustions</i>	9.0
<i>Fuel leakage emissions</i>	1.1

Table III. CO₂ emissions per sector in percentage (2002)

In Spain, there is a repository for low and medium activity radioactivity wastes. At the end of 2003, it was at 50% of its full capacity. On the other hand, there is not a high-activity radioactivity wastes repository and these wastes are stored in the plant. The government has postponed taking any decision on this matter until 2010. All the plants are currently storing their wastes in their own pools, except for Trillo nuclear power station, which stores them in dry containers.

1.2 Trends

Economy

The Spanish economy is mainly driven by construction and private consumption. Spanish **GDP** has increased by 36% in the last 10 years. For the next decade, according to many economic forecasts, there will be an annual growth of 3%. According to OECD, this is a very optimistic and difficult to meet prediction. Other national studies forecast a more realistic growth of 2.5%.

1996	1997	1998	1999	2000	2001	2002	2003
2.4	4.0	4.3	4.1	4.1	2.9	2.2	2.5

Table IV. GDP variation rate in Spain from 1996 to 2003

For the next 10 years, domestic demand is expected to growth at a 2.8% every year, slightly lower than that of the 90's. Investment will increase an average rate of 5% annually.

The **unemployment rate** is expected to decrease to 10.35% in 2005, and even more afterwards.

It is foreseeable a relocation of part of the industry to other countries, substituting it by more added value industries. The industry sector will loose position in the GDP share.

Despite the various uncertainties regarding the construction sector, it is supposed to maintain a growth level equal to that for GDP.

Transportation and services will continue growing over the average economy level, and a continuous growth in road and plane transportation is expected.

It is foreseen a stable growth in investment due to the economy activity, competence, and low interest rates. Present rates of public investment in infrastructures will remain.

Energy

From 1975 to 1990, the **primary energy consumption** grew an average of 2.7% every year. During the 90's, it reached 3.1%, being higher in the second half of the decade. According to the "Spanish Strategy on Energy Efficiency (E4)", until 2012, primary energy consumption will

increase every year an average of 3.09%. Final energy consumption is expected to have a lower rise due to the improvement of efficiency in the electricity sector. Consumption is expected to reach 7.10^9 GJ (175 Mtoe) in 2011.

Consumption structure will change dramatically. Gas share will increase up to 18% in 2006, and 21% in 2011. This figures are still below the present European average, 23%. Renewable energies share will also increase up to 8.3% in 2006, and 12% in 2011. Coal and nuclear energy shares will decrease to 8.25% and 9.5% respectively in 2011. Oil will similarly loose share, although it will remain being the main energy source with 50.3% in 2006, and 47.5% in 2011.

Final energy consumption is expected to maintain an average growth rate of 3.48% until 2011. The rate will be lower from 2006 onwards due to the improvement in the efficiency and the market saturation.

	2000		2006		2011		06/00	11/00
	GJ	%	GJ	%	GJ	%	% annual	% annual
Coal	$1.07 \cdot 10^8$	2.8	10^8	2.1	$9.32 \cdot 10^7$	1.7	-1.13	-1.24
Oil prod.	$2.33 \cdot 10^9$	61.6	$2.8 \cdot 10^9$	59.4	$3.18 \cdot 10^9$	57.6	3.05	2.86
Gas	$5.17 \cdot 10^8$	13.6	$7.9 \cdot 10^8$	16.8	10^9	18.1	7.32	6.20
Electricity	$6.81 \cdot 10^8$	18	$8.42 \cdot 10^8$	17.9	$1.02 \cdot 10^9$	18.5	3.60	3.75
Renewable	$1.51 \cdot 10^8$	4	$1.81 \cdot 10^8$	3.8	$2.27 \cdot 10^8$	4.1	3.01	3.76
Total	$3.79 \cdot 10^9$		$4.71 \cdot 10^9$		$5.53 \cdot 10^9$		3.68	3.48

Table V. Final energy consumption in a 2000 base scenario

	1990	1995	2000	2006	2011
GDP	426205	437792	527613	625111	724676
% average annual growth		95/90=1.5	00/95=3.8	06/00=2.9	11/06=3
Population (M inhabitants)	38.9	39.2	40.1	41.6	42.5
Coal/GDP	441	259	203	160	129
Oil products/GDP	4230	4500	4430	4470	4390
Gas/GDP	468	628	981	1260	1380
Electricity/GDP	567	1200	1290	1350	1410
Renewables/GDP	373	334	287	289	314
Final energy/GDP	6650	6920	7190	7530	7620
INDEX	100	104.2	108.1	113.4	114.7

Table VI. Final energy consumption per unit of GDP (GJ/M€) in a 2000 base scenario

	2000		2006		2012		06/00	12/00
	GJ	%	GJ	%	GJ	%	% annual	% annual
Industry	$1.57 \cdot 10^9$	38	$1.7 \cdot 10^9$	36.7	$1.95 \cdot 10^9$	36.9	2.8	2.6
Transport	$1.36 \cdot 10^9$	35.8	$1.74 \cdot 10^9$	37.5	$2.02 \cdot 10^9$	38.1	4.2	3.4
Other uses	$9.93 \cdot 10^8$	26.2	$1.19 \cdot 10^9$	25.8	$1.32 \cdot 10^9$	25	3.1	2.4

Total	3.79 10 ⁹		4.63 10 ⁹		5.29 10 ⁹		3.4	2.8
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Table VII. Final energy consumption in an efficiency scenario

Transport has been the sector with the largest consumption growth. From 1995, the number of vehicles has doubled, and energy intensity has increased by 30%.

Self-supply, in a base case scenario (BS), is foreseen to be of 24.7% by 2011, mainly due to coal. In an efficiency case scenario (ES), a self-supply of 26.8% is predicted, also mainly due to coal.

Environment

From 1990 to 2001, SO_x and NO_x emissions decreased by 34.7% and 10.5% respectively. Environmental commitments for the energy sector imply a big effort in emissions reduction for the next 20 years. In 2010, the emission limits to SO₂, NO_x, NH₃ and NMVOC emissions will be 774kt, 847kt, 669kt, and 353kt respectively, which represent a reduction of 65%, 24%, 36% and 1% regarding the 1990 emissions. For the following years and up to 2018, all the combustion facilities will have to incorporate the correspondent reduction measures to fulfil the commitments.

	1990	2000	2001	(90-01)%	2001 %
<i>Energy industries</i>	77,999	105,456	99,842	28	26
<i>Construction & manuf. ind.</i>	46,247	61,822	61,817	34	16
<i>Transport</i>	58,506	87,314	91,722	57	24
<i>Other sectors</i>	27,518	35,643	35,480	29	9
<i>Fuel leakage emissions</i>	6,674	6,281	6,316	-5	2
<i>Industry processes</i>	22,561	30,698	27,850	23	7
<i>Agriculture</i>	37,374	43,643	42,988	15	11
<i>Residues</i>	9,401	14,540	15,147	61	4
<i>Dissolvent & other</i>	1,330	1,707	1,628	22	0.4
<i>Total emissions</i>	287,609	387,104	382,789	33	100

Table VIII. GHG emissions, in kt CO₂eq, by sector, 1990-2001

Regarding GHG emissions, 2004 data shows an increase of 45% in relation to 1990 levels. Between 2008 and 2012, Spain will limit its emissions to a 24% in relation to 1990. The commitment of 15%, is expected to be achieved taking into account a 2% of capture through sinks, and a 7% through international credit markets. Spain also plans to use the flexible mechanisms to attain the objectives. The results of many analyses on the subject are not optimist.

According to the OECD, the data from the Third National Communication to the UNFCCC, and assuming as feasible the 12% of demand met by renewable, according to an efficiency case scenario, it is foreseen an increase of 28% of total CO₂ emissions between 1990 and 2010. In a base scenario, the increase will be of 48%. The "Spanish Strategy on Energy Efficiency (E4)" gives the following figures for CO₂ emissions:

	1990	2012 (Base Scenario)	2012 (Efficiency Scenario)	Variation(ES-1990)%
<i>Industry</i>	45	71	66	49
<i>Transport</i>	58	134	118	105
<i>Other Uses</i>	26	51	47	80
<i>Transformation</i>	77	112	94	22
<i>Leakages</i>	4	3	3	
<i>TOTAL CO₂</i>	209.3	369.6	327.7	57

Table IX. Direct emissions of CO₂ from energy in Mt

There is a lot of uncertainty about the success of reaching the objectives.

Electricity

Between 1994 and 2004, **electricity demand** grew, in total, 64,6%. It was mainly due to the economy growth, and also in part, to the low electricity prices. However, the consumption per inhabitant (5,500 kWh) remains below the European average. Future increases are not

expected to be like those in the past. A growth of 3 to 3.5% every year for the next ten years is foreseen.

According to the "Gas and Electricity Sectors Planning", published in 2002 by the Economy Ministry, by 2011, it will be necessary to add 26,000 new MW to the system to guarantee the demand coverage. On the other hand, the environmental regulations will lead to close down or alter some plants. With an average nuclear plant technical lifetime of 40 years, it is supposed that, by 2011, total installed capacity will be maintained, and 9,000 MW from coal, fuel and fuel-gas will be lost.

Renewable		Nuclear		Coal		Oil products		Natural gas	
2000	2011	2000	2011	2000	2011	2000	2011	2000	2011
16.9	28.4	27.6	19.4	35.9	15	9.9	4.1	9.7	33.1

Table X. Structure of the electricity generation in %, by 2011, according to the Economy Ministry

In 2002 and 2003, renewable and cogeneration installed capacity increased by 17% and 16% respectively. The Renewable Promotion Plan, signed in 1999, set specific objectives for energy production from renewables. Those objectives were revised and increased in 2002. By 2011, it is foreseen a total of 35,733 MW of renewable installed capacity, and 7,100 MW of cogeneration.

	objective 2011(MW)	fulfil 2004 (MW)
<i>Small hydro (10-50MW)</i>	3151	2897
<i>Small hydro(<10MW)</i>	2380	1777
<i>Wind power</i>	13000	8155
<i>Solar thermal</i>	4841	700.4
<i>Solar PV</i>	145	36.9
<i>Biomass (electricity)</i>	3098	341
<i>Biomass (heat)(ktoe)</i>	4376	3458
<i>Biogas</i>	78	140.8
<i>Solid waste</i>	262	188.9
<i>Biofuels (toe)</i>	500	228.2

Table XI. Objectives of renewable energy generation to 2011, and present situation (2004)

In 2002, **cogeneration** installed capacity accounted for 5,580 MW, which produced, together with self-consumption, 14% of the national electricity demand. Even when cogeneration has been in a standstill during the last few years, by 2011, the association of producers, COGEN, estimates 7,550 MW of installed capacity, with a production, including self-consumption, of 17.5% of the electricity demand, very close to the EC objective of 18%.

Despite the negative Spanish public opinion towards **nuclear energy**, definitive decisions regarding its future have not yet been taken, since it is still taken into account in the energy mix for the next decades. The actual Government defends the promise to reduce progressively nuclear power in Spain, but the experts' opinion is that it may change in case the CO₂ reduction strategies fail. Spain keeps the technical capacity in nuclear power, although there is a risk of reducing it if some R+D projects do not initiate while waiting for new decisions.

The **marginal capacity stock** decreased by 75% between 1997 and 2001. This fact started a new investment cycle in the electricity sector. The main electricity companies are in favour of building new combined cycle (CCGT) and wind power facilities.

Spain is the second world **wind power** producer. By the end of 2004, the electricity power connected to the grid accounted for 8,000 MW, and the applications for new installations were over 50,000 MW. Production is heterogeneous according to the geographical situation. These figures surpass the government forecasts, thus they are thinking of extending the objective to 20,000 MW by 2012. Consequently, it will be necessary to make some improvements in the transmission and distribution grid, while problems of availability and power forecast should be solved. Wind power sector thinks the objectives will be fulfilled.

By the end of 2002, there were 2,800 MW from **CCGT plants** in the transmission grid. At the end of 2004, there were 4,400 MW. The CNE estimates that new 7,000 MW in 2005, and 23,000 MW more in 2006 and 2007 will be installed. Some actors are concerned about a too large installed capacity in future years.

1.3 Recent published studies

The most recent studies on energy forecast have been elaborated by the General Department of Energy, belonging to the Industry, Tourism and Trade Ministry. The “Gas and electricity sectors planning”, published in mid 2002, provides data up to 2011; and the “Spanish strategy on energy efficiency (E4)”, published in October 2003, provides data up to 2012. Plans to start implementing E4 are currently under work. The main forecasts presented in these documents have already been shown in the previous section.

The Observatory for Industrial Technology Foresight (OPTI), which belongs to the Industry Ministry, has undertaken many studies regarding technology innovation foresight in the energy sector. The conclusions are that Spain is now in a good position regarding scientific and technology capacity, although the situation is not so clear in the long term. On the other hand, the position in terms of innovation, production and commercialisation capacities is not good. In the short term, the main limitations for the technology advance are of economic nature, while in the long term are technological ones. The OPTI recommends to improve the collaboration between the Industry and Research and Technological organizations. The last OPTI document, published in 2004, foresees widespread use of the following technologies:

Technology	2005-2010	2010-2015	>2015
Plants repowering	X		
H ₂ fuel in gas turbines		X	
Biological advanced techniques in de-sulphuration		X	
Combined cycle with efficiency >60%		X	
Supercritical plants		X	
Coal gasification power plants			X
Fuel cells for power generation			X
CO ₂ sequestration and elimination			X
Bidirectional counters	X		
Transmission and distribution power electronics devices		X	
Flywheel for storage		X	
Fossil additives substitution by biofuels		X	
Biomass gasification for electricity production			X
Wind farms with advanced storage systems		X	
Off-shore wind farms			X
PV module of hundreds kWp grid-connected			X
PV building integration	X		
Solar thermal concentrated power stations			X

Table XII. Future technologies (OPTI)

Recently, the University Pontifical of Comillas has created the Observatory of Energy and Sustainable Development. Their first report, published in February 2005, presents a detailed analysis, based on indicators, on the present situation, as well as future advices.

1.4 Policies and critical review

In Spain, energy issues are responsibility of the General Department of Energy, dependent of the Industry, Tourism, and Trade Ministry. Similarly, the Environmental Ministry is responsible for the environment related issues regulation. Up to now, there has not been much collaboration between both Ministries in energy matters. The recently created General Department for the Pollution Prevention and Climate Change, part of the Environment Ministry, might make this collaboration easier.

The independent regulatory bodies, CNE and CSN, are run by the Industry, Tourism and Trade Ministry. Other organizations related to energy are: the Institute for Coal Mining Re-structuring, the Institute for Energy Saving and Diversification⁶ (IDAE), the Research Centre for Energy, Environment and Technology⁷ (CIEMAT), and the Strategic Oil Reserves Corporation⁸ (CORES).

The autonomous regions have management responsibilities in energy matters like permits, controls and environmental taxes.

The Spanish energy policy is based on issues like security and quality of supply, introduction of competitiveness in the markets, environment protection, as well as a strategy for controlling

⁶ <http://www.idae.es/>

⁷ <http://www.ciemat.es/eng/index.html>

⁸ <http://www.cores.es/homei.htm>

energy demand, and a deep review of the structure and legal framework of the different energy sectors. In terms of energy matters, the present Government pursues the following objectives:

- Regulation of the Coal Mining sector so that it is adapted to the European Community directives. Negotiation of a new Coal Programme, with a time horizon up to 2012, in order to reduce the existing weak competitiveness.
- Facilitate the liberalization of the liquid and gas hydrocarbon sectors, specially promoting gas.
- Renewable energies promotion, specially biofuels, solar energy and wind power.
- Nuclear energy reduction and substitution.
- Energy infrastructures planning in order to reduce uncertainties.
- Increase connections with France, Portugal, and Morocco.
- Reform the regulatory framework of electricity generation: power guarantee, transition costs to the competence (CTC), environmental external costs internalisation, location of new plants...
- Create a new regulation that establishes the payment of distribution activities and the improvement of gas distribution management.
- Demand management related actions.
- Start off the Iberian Electricity Market (MIBEL)

Last February, the Government approved the Economy and Productivity Enhancement Plan. The main measures are related to:

- Reinforcement of the detachment of the electricity suppliers from TSO.
- Internalization of radioactive wastes handling cost.
- New measures to simplify the change of supplier
- New measures to successfully develop the MIBEL.
- Review of the price determination method.
- Application of the European Community directives regarding the common energy market

The Government recently approved the elaboration of the White Paper for electricity. This report will include some reforms in the electricity generation business and market operation. The electricity companies are waiting for the Paper to redefine their position regarding the Government agreements.

It is important to highlight that, regarding environmental policies, Spain follows the committed measures adopted in the international forum to reduce the environmental impacts from the energy sector. Besides the Kyoto Protocol commitments, Spain has also signed the Multi-pollutant Multi-effect Protocol, within the Geneva Framework Convention; and the Gothenburg Protocol. Moreover, the following directives have already been applied: Directive 2001/80/CE, regarding emission limits in large combustion plants; Directive 2001/81/CE, regarding national emission ceilings; and Directive 96/62/CE, regarding the evaluation and management of air quality.

The specific objectives regarding CO₂ emissions have been detailed in the National Allocation Plan for greenhouse gas emission allowances. The Government has already announced its intention to participate in the international markets to achieve these objectives. In this direction, the first Spanish Fund of CO₂ has already been created, and the first clean development projects have been approved. Due to the pessimistic prospects about the pollution abatement objectives fulfilment, some experts believe that Spain will be one of the main actors in the international CO₂ market.

Despite energy markets are totally liberalized, still there is a high concentration of companies. Renewable energy promotion strategies are currently introducing new actors in the electricity market, but only five of such companies have a significant size. However, the current trend towards gas and electricity companies mergers could lead to a higher number of size significant companies. Moreover, the Government has announced new measures to increase competition, and has already announced that the electricity price determination policy needs to be revised.

The main part of the demand growth is expected to be covered with combined cycle plants, cogeneration (mainly with gas), and wind power. The strong dependence to one gas supplier (58% Algeria) together with the scarce interconnection between European networks, lead to a high risk of undersupply in some conditions. New storage and re-gasification infrastructures are currently being built in order to avoid the problem. It is now expected to go from the present 800000m³ of LNG to 2700000m³ by 2007. Spain is nowadays the second country in the world in terms of re-gasification.

The current insecurity on regulations hinders initiatives to develop new nuclear power stations projects. Similarly there is also a lack of relevant research programmes. Both facts involve an important risk in terms of technology capacity losses in case new nuclear generation update was required.

The present decree, which regulates the legal and economic regime of renewable and cogeneration, establishes a new regulatory framework with the main objective of promoting cogeneration within a safe legal framework and provides incentives to construct larger facilities (greater than 25 MW). Renewable energy producers want an independent operator to ease the management of this kind of energy.

The most recent official energy policy dates back to July 8th 2005, when the Spanish Government approved the "Plan de Acción 2005-2007 de la E4". One of its main objectives is to control energy demand growth, which puts the achievement of the E4 objectives in jeopardy. The target of this plan is to reduce, by 2007, the current primary energy consumption by 8.5%, as well as the oil imports by 20%. In addition, such measures would imply a 32,5 MtCO₂ emissions reduction. The Plan approves a group of urgent measures focused on the energy demand management for seven sectors: industry, transport, construction, public services, residential, agriculture, and energy transformation.

Regarding energy supply issues, among other measures, the Plan foresees, by 2007, the construction of 750MW new cogeneration plants over the initial E4 objectives.

1.5 Country peculiarities

Spain is an energy island. Connections with the neighbouring countries are scarce. At present, the Government expects to improve connections with Europe.

Based on a political compromise reached on November 2002, an International Agreement was signed between Spain and Portugal to create MIBEL on January 20th 2004. It is estimated that the Iberian market will manage 10.3 % of the total electricity generated in Europe, and account for approximately 20% of the liberalized electricity demand in the European Union. This market is based on the establishment of an only operator (OMI), the increase in the connection lines between both countries, and the adaptation of national regulations to ensure an optimal operation. Three possible contracting ways will be possible: the spot market (daily and intra-daily), the period market (up to a year), and bilateral contracts (for at least a year contract). Despite the market should have started operating on April 20th 2004, this has not yet occurred due to some delays. The Spanish government has undertaken some measures to speed up the process and it is now foreseen that the starting date will be June 30th 2005.

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1.7 Abbreviations

CCGT -	Combined cycle gas turbine
CIEMAT -	Centro de Investigaciones Energéticas Medioambientales y Tecnológicas (Research Centre for Energy, Environment and Technology)
CNE -	Comisión Nacional de Energía (National Energy Commission, the regulatory body for Spain's energy systems)
COGEN -	European Association for the Promotion of Cogeneration
CORES -	Corporación de Reservas Estratégicas de Productos Petrolíferos (Strategic Oil Reserves Corporation)
CPI -	Consumer Price Index
CSN -	Consejo de Seguridad Nuclear (Nuclear Safety Council)
CTC -	Transition Costs to the Competence
E4 -	Estrategia Española de Eficiencia energética (Spanish Strategy on Energy Efficiency)
GDP -	Gross Domestic Product
GHG -	Greenhouse gases
IDAE -	Instituto para la Diversificación y Ahorro de la Energía (Institute for Energy Saving and Diversification (IDAE))
LNG -	Liquefied Natural Gas
MIBEL -	Mercado Ibérico de la Electricidad (Iberian Electricity Market)
NMVO- C	non Methane Volatile Organic Compounds

OECD-	Organisation for Economic Co-operation and Development
OMEL -	Operador del Mercado Ibérico de Energía (market operating company)
OPTI -	Observatorio de Prospectiva Tecnológica Industrial (Observatory for Industrial Technology Foresight)
REE -	Red Eléctrica de España (company responsible for the transmission network and for operation of the Spanish electricity system)
TFC -	Total final energy consumption
TSO -	Transmission System Operator
UNESA-	Asociación Española de la Industria Eléctrica
UNFCCC -	United Nations Framework Convention on Climate Change