The Spanish Gas Market:
Demand Trends Post Recession and Consequences for the Industry

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PREFACE

Until 2008, it was assumed that whatever might happen to gas demand in the rest of Europe, the southern part of the Continent would continue growing strongly – even if not in double digits – for most of the 2010s. Recession reminded all energy researchers that there are greater forces at work which can fundamentally change straight line growth projections. At the same time as countries were suffering economic downturn, carbon reduction measures were also beginning to change the fossil fuel outlook. Both these factors require a substantial reassessment of the Spanish gas demand outlook.

Anouk Honoré's book on European gas demand, published by the OIES at the end of 2010, identified the beginning of this process but the effects were not yet clear. This study on Spain, which uses similar bottom-up methodology to that set out in her book, takes a closer look at the country which prior to 2008 was generally expected to have the fastest gas growth of all the major European gas markets. The changed outlook for the Spanish gas market has potential lessons for many other European countries, in particular the over-contracting of gas supplies as a consequence of previously (much higher) demand projections. With a significantly greater proportion of LNG supplies in total gas demand than most other countries, this means that Spanish companies must find markets for surplus LNG for several years before, as for so many other European countries, they need to contract for new supplies at the end of the decade. This paper sets out the complexities of Spanish demand and supply over different time periods showing how European gas stakeholders need to prepare for frequent changes in the supply/demand balance over the next decade.

Jonathan Stern
Oxford, August, 2011

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Anouk Honoré
Oxford, August, 2011

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ABBREVIATIONS AND ACRONYMS

ACQ	Annual contracted quantity
AGIP	Average German import price
AOC	*Almacenamiento para la operación comercial* (Balancing point)
BAU	Business as usual
Bcm	Billion cubic metres
Bcm/y	Billion cubic metres per year
CCGT	Combined cycle gas turbine
CCS	Carbon capture and storage
CHP	Combined heat and power
Cm	Cubic metres
CNE	*Comisión nacional de energía* (Energy regulator)
CO2	Carbon dioxide
CSN	*Consejo de Seguridad Nuclear* (Nuclear safety council)
DES	Delivery ex-ship
ERGEG	European Regulators' Group for Electricity and Gas
ETS	Emission trading scheme
EU	European Union
FOB	Free on board
GDP	Gross domestic product
GME	Maghreb-Europe pipeline
GWh	Gigawatt hour
GWh/d	Gigawatt hour per day
IDAE	*Instituto para la diversificación y ahorro de la energía* (Institute for energy diversification and saving)
IEA	International Energy Agency
IED	Industrial emission directive
Km/h	Kilometres per hour
Ktoe	Thousand tons oil equivalent
LCPD	Large combustion plant directive
LES	*Ley economía sostenible*
LNG	Liquefied natural gas
Mcm	Million cubic metres
MIBEL	*Mercado Ibérico de electricidad* (Iberian electricity market)
MIBGAS	*Mercado Ibérico de gas* (Iberian gas market)
Mityc	*Ministerio de Industria, Turismo y Comercio* (Ministry of industry, tourism and trade)
Mm	Millimetres
MMBtu	Million British thermal units
MS-ATR	*Mercado secundario de acceso de terceros a la red* (Secondary market – third party access)
Mtoe	Million tons of oil equivalent
Mtpa	Million tons per annum
MW	Megawatt
OECD	Organisation of economic cooperation and development

OMEL	Iberian Electricity Market Operator
OTC	Over the counter
PV	Photovoltaic
R&C	Residential and commercial
REE	*Red eléctrica de España* (Electricity transmission)
S-GRI	South Gas Regional Initiative
SL-ATR	*Sistema logístico de acceso de terceros a la red* (Web system as a part of the third party access IT system)
TOP	Take or pay
TPA	Third party access
TPES	Total primary energy supply
TSO	Transmission system operator
TUR	*Tarifa de último recurso* (Tariff of last resort)
TWh	Terawatt hour
UGS	Underground gas storage

EXECUTIVE SUMMARY

The natural gas industry in Spain experienced rapid growth in the late 1990s and 2000s in parallel with a flourishing economy. This led many observers to believe that the Spanish gas market would continue to be one of the fastest growing gas markets in Europe in the 2010s. The sharp, negative and lasting impact of the 2008-10 recession on the Spanish economy, and the continued growth of renewable energy – with record levels achieved in 2010 thanks to high levels of hydro and wind output – have created some uncertainty about the future of the gas industry and the previously optimistic scenarios for additional gas demand growth have been called into question.

In total, demand in the non-power sectors still represented two thirds of gas demand in Spain in 2010. But since 2004-2005, the level of consumption has remained relatively flat. The major changes in gas needs from one year to another have come from the power sector. This dynamic partly reflects the general European situation where the non-power sectors have reached maturity. At best, much lower growth rates, if not flat demand, can be expected in the future. At worst, a decline can be envisaged. Much lower prices would be required to trigger recovery in the industrial sector, reopening plants that have closed down during the recession and reducing relocations outside Spain, although whether price effects alone are sufficient to achieve this is an open question.

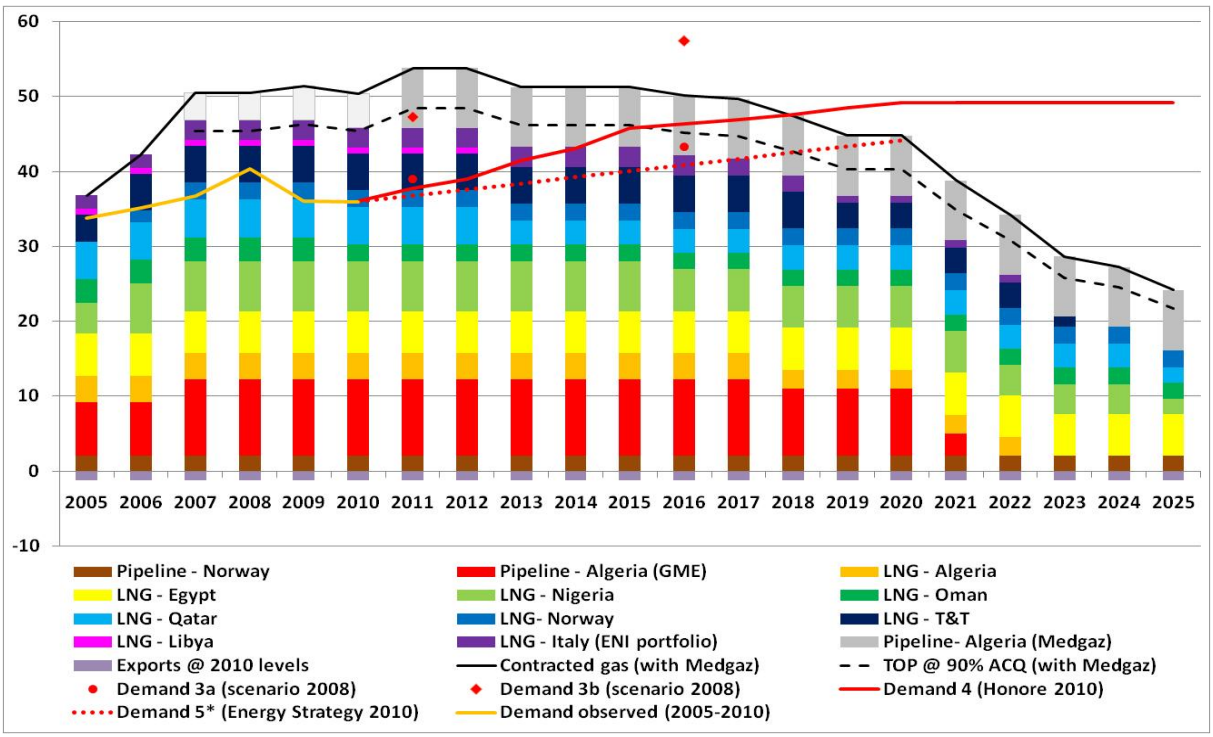
The best hope for, but also the biggest uncertainty about, future gas growth will be in the power sector. Electricity demand is recovering slowly, and will be impacted by measures to improve efficiency and energy intensity such as insulation and smart grids. In this sector, lower gas prices may only have a limited impact on additional gas use. Renewable energy is a 'must-use' technology; this is also true for large hydropower; and the nuclear plants need to be run baseload due to high capital costs. These factors leave coal and gas as the marginal fuels. But between 2011 and 2014, 23 TWh (terawatt hours) of electricity produced by plants using domestic coal will have to be included in the generation mix. The place of gas in the mix will therefore be less and less a factor of economic competitiveness, and more and more a factor of renewable and hydro availability with gas as the balancing fuel. Gas generation is and will continue to be a key tool to balance the system and intermittency of renewable generation (especially wind energy), but will also provide flexibility in times of peak demand. As a consequence, the prospects for future gas demand in Spain are for smaller increases than previously projected and higher fluctuations.

Peak demand for gas in the non-power sector coincides with peak demand for electricity. Peak demand in electricity can lead to peak demand for gas, if wind, solar and hydro generation is low. As a result, the gas market needs to be able to supply simultaneous peak demands in both the non-power and the power sectors.

Spain coped well in meeting gas (and electricity) needs despite exceptionally strong growth in the 1990s and 2000s and development of intermittent renewables in the 2000s thanks to successful development of its energy infrastructure. The country also led the way in diversifying gas transportation routes, sources of gas and LNG development. With 86 billion cubic metres (bcm) of import capacity as of June 2011 compared with 36 bcm of gas demand in 2010, and additional

projects already under construction, there will be no lack of physical entry points for gas imports to fulfil the needs of the Spanish market. Gas has been contracted (i.e. on an annual contracted quantity –ACQ- basis) in excess of projected consumption levels (demand scenario 4 in Figure 1), ranging from a surplus of 16.1 bcm/y in 2011 to 2.7 bcm/y in 2017, which corresponds to a cumulative quantity of 60 bcm between 2011 and 2017. The surplus rises to 17 bcm/y in 2011 to 0.6 bcm/y in 2020 in the case of slower demand growth (demand scenario 5 in Figure 1), for a cumulative surplus of 93.4 bcm between 2011 to 2020. Assuming a take or pay level at 90% of ACQ, the cumulative quantity in demand scenario 4 is 28.2 bcm until 2015 and 50.9 bcm in demand scenario 5 until 2018. Post 2018 or 2020, depending on the demand scenario, the Spanish gas market will need to secure additional new gas volumes, but if gas demand in Spain stays flat at 2010 levels, then the country has enough contracted gas to meet its requirements until 2021 [Figure 1].

Figure 1: Contracted gas imports as of June 2011 and gas demand scenarios in Spain, 2005-2025 (bcm)



* Demand 5: this scenario differs slightly in 2010 from that shown in Figure 11, p.26

Sources: For contracted gas: GIIGNL, The LNG industry in 2010, table on long-term and medium-term contracts in force in 2010, and author's analysis and for demand scenarios: see explanations for Figure 34, p.57

Variable sendout from regasification plants provides most of the flexibility in supply, mirroring the fluctuations of gas demand. It allows CCGTs to respond quickly to the intermittency of wind while the baseload profile of pipeline interconnections is more suited to the industrial and residential and commercial consumption sectors. In the future, it is expected that Spain will not only have to cope with periods of peak demand and tight supply for gas, but also most probably with increasingly frequent periods of low demand (typically during period of high renewable and hydro availability). During these periods, new forms of flexibility will be required to balance the system. The development of gas interconnections with France in 2013 and 2015 will add some flexibility. Further

development of electricity interconnections with France would also enhance integration of the Spanish and the European markets.

Despite a liberalization process ahead of the European timetable, there is no primary wholesale gas market in Spain, but the secondary market is fairly well developed. In 2010, the volume of gas traded in the system was equivalent to 251% of demand (90.5 bcm) via 39,203 transactions (twice as many as in 2009). Transactions are carried out on a bilateral inter-company basis, via physical swaps, for balancing purposes. As there is no spot market for gas in Spain (unlike the UK or North America), heavy dependence on LNG and a shortage of underground storage, over the counter (OTC) trade is important to enable new entrants to access gas supplies and to grow their market shares. However, prices traded in the OTC market are not public. There is no price transparency in the market. Work is being undertaken in Spain on the development of a gas hub. The main principles and the road map for the development of a hub in Spain were published by the CNE in April 2010. As a result, while the rationale for continued linkage of long-term contract gas prices to those of oil products is being seriously contested in Europe, progress is expected to be much slower in Spain.

Contrary to previous expectations, the Spanish gas market is likely to grow more slowly in the 2010s than during 1990-2008. Far from needing more gas supply during this period the Spanish market is substantially over-contracted and will need to find markets into which to sell its surplus of contracted gas. This somewhat surprising conclusion could create contractual problems for Spanish gas buyers and provide an unexpected additional source of gas for Europe, at least during the first half of the 2010s.

INTRODUCTION

The Spanish gas market is the sixth biggest market in Europe,[1] behind the UK, Germany, Italy, the Netherlands and France. The natural gas industry in Spain[2] has been marked by rapid growth in the late 1990s and 2000s in parallel with a flourishing economy. The annual average growth rate of gas consumption between 2000 and 2008 was 10.9%, while the European average was around 2% over the same period,[3] and Spain was the fastest growing market in Europe. Scenarios of future gas consumption, which were produced before or during the 2008-2010 period, anticipated the expansion continuing at a sustained rate until at least the mid-2010s. This author's scenarios, which were calculated early in 2010, presented an annual average growth rate of 0.6% for Europe and 2.4% for Spain up to 2020.[4] The additional gas demand was projected to come from both the power sector and, more interestingly, also from the non-power industrial and residential and commercial sectors.

The sharp, negative and lasting effects of the recession on the Spanish economy and the continued growth of renewable energy – with record levels achieved in 2010 due to the availability of hydro and wind – have created some uncertainty about the future of the gas industry and the scenarios have been called into question. Natural gas infrastructure and supplies were –successfully- designed to meet double digit gas market growth every year.[5] There were already 86 billion cubic metres (bcm) of import capacity in place by June 2011 and about 50 bcm of contracted gas (for a demand of 36 bcm in 2010). Although part of the European region, Spain is still a rather physically isolated gas market where small scale cross-border gas and electricity interconnections and a low level of trade (compared to total demand) lead to a situation not dissimilar to that of an island, with limited possibilities of interaction with the rest of the regional market.

With expectations for future gross domestic product (GDP) growth rates being revised downwards[6] and combined cycle gas turbines (CCGT) utilisation rates down to 33% on average in 2010 -from 52% in 2008[7], the question arises as to whether the gas market has entered a different dynamic. The objective of this paper is to investigate the state of the Spanish gas market and its potential for growth. Will the negative impacts on the gas market be short lived, or is there a need to review previous scenarios and incorporate new dynamics relative to economic growth and renewable energy use? What will be the consequence of these changes on the gas industry?

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[1] In this text, the 'European' gas market means OECD Europe: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

[2] The Kingdom of Spain covers most of the Iberian Peninsula (excluding Portugal and Gibraltar) plus the Canary Islands, Balearic Islands and cities of Ceuta and Melilla in North Africa. In this paper, we focus on Spain in the Iberian Peninsula.

[3] For more info on European gas markets (OECD Europe region plus 14 countries), see Honore A. (2010), 'European Natural gas demand, supply and prices: the impacts of cycles, seasons and LNG arbitrage'

[4] Scenarios calculated in early 2010 with the scenarios for 34 other European countries and published in Honore A. (2010), pp.293-294

[5] IEA (2008), Development of Competitive Gas Trading in Continental Europe: How to achieve workable competition in European gas markets?, p.9

[6] OECD Economic Outlook, various issues

[7] Enagás (2011), El sistema gasista Espanol, Informe 2010, p.44 (Annual report 2010)

Following this introduction, we first look at the evolution of the Spanish gas market since the early days, with a special focus on the 1990s and 2000s. We highlight trends in gas demand and present the scenarios for additional consumption. The second section questions these scenarios, and asks whether the slow down expected post 2020 could actually be seen in the 2010s as a result of the economic recession, maturity of the gas market and the rise of renewable energy in power generation. Logically, the third section considers the consequences for the natural gas industry in a market where supplies have been developed to fulfil double digit growth in gas demand. The final section draws together the various findings to form the paper's conclusions.

I/ DEVELOPMENT OF THE SPANISH NATURAL GAS MARKET

1.1. From 5.5% to 24 % of the total primary energy supply in 20 years

- **Energy demand mirrors economic growth (or decline)**

Energy demand in Spain has mirrored the nation's economic growth (or decline). From 1990 to 2009, the total primary energy supply (TPES) increased by 1.9% per year on average (2.4% between 1990 and 2008),[8] while GDP growth rates grew by 2.6% between 1990 and 2009 led by strong growth in services and construction (2.9% between 1990 and 2008).[9] In 2009, GDP fell by 3.7%.

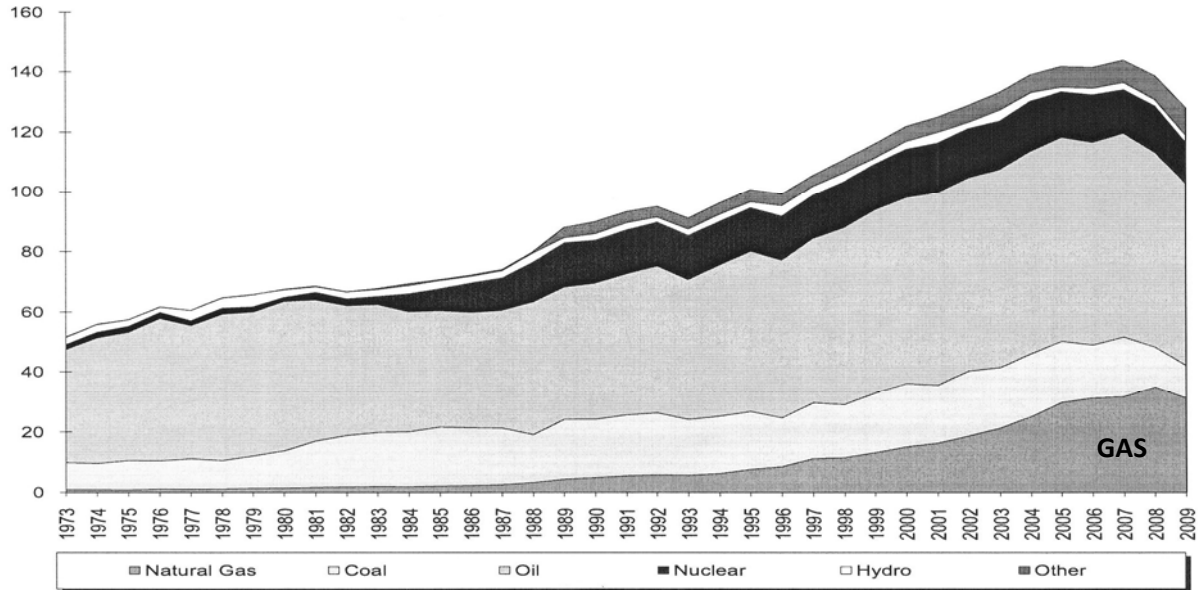
In 2009, Spain was the fifth largest energy consumer in Europe with TPES of 128 million tons of oil equivalent (Mtoe), down from 138 Mtoe in 2008.[10] The drop in 2009 reflected the change in economic conditions as a result of the international financial crisis and following economic recession. This followed a fall of 4% in 2008 for the same reasons, the first annual decline since the mid-1990s.

- **In 2009, fossil fuels accounted for 80.3% of TPES**

In 2009, fossil fuels accounted for 80.3% of TPES in Spain (compared with 76.1% in OECD Europe). Oil was the largest energy source, providing 47.3%, followed by natural gas (24.4%), nuclear energy (10.7%) and coal (8.6%). Renewable energy and waste provided 9% of TPES (1.8% from hydro) [Figure 2]. Spain's indigenous energy resources are limited and unlikely to increase significantly, with the exception of forms of renewable energy production, in particular wind.[11]

[8] Calculated from IEA, Natural Gas Information 2010, Part IV.305, table 1 and Part III.7, table 3
[9] Eurostat website
[10] IEA (2010), Natural Gas Information 2010, Part IV, national statistics, graph 1; and IEA (2009), Natural Gas Information (2009), Part IV, national statistics, graph 1
[11] IEA (2008), 'Development of Competitive Gas Trading in Continental Europe: How to achieve workable competition in European gas markets?', p.9

Figure 2: Evolution of TPES in Spain, 1973-2009 (Mtoe)



Source: International Energy Agency (IEA), Natural gas information 2010, page IV.304, graph 1

- **<u>Sharp increase in natural gas' share</u>**

The Spanish energy sector has undergone substantial changes over the past two decades. One of the major revolutions was the sharp increase of natural gas share in TPES. The percentage of gas in Spain's primary energy has increased from 5.5% to 24% between 1990 and 2009 [Table 1], while coal, oil and nuclear have fallen. Between 2000 and 2009, natural gas consumption grew from about 5 to 31.2 Mtoe (34.9 Mtoe in 2008), or by 10.5% per year on average (11.4% between 2000 and 2008) as a result of a massive increase in the use of gas to generate electricity. Another fast growing source for electricity was wind, and is included in the 'other' section in Figure 2.

Table 1: Evolution of the share of natural gas in TPES, 1985-2010 (%)

	1985	1990	1995	2000	2005	2010
Share of natural gas	3.0	5.5	7.8	12.5	21.0	24.5

Source: IEA, Natural Gas Information, various issues and Monthly Survey for 2010 data

<u>1.2. The fastest growing gas market in Europe in the 2000s</u>

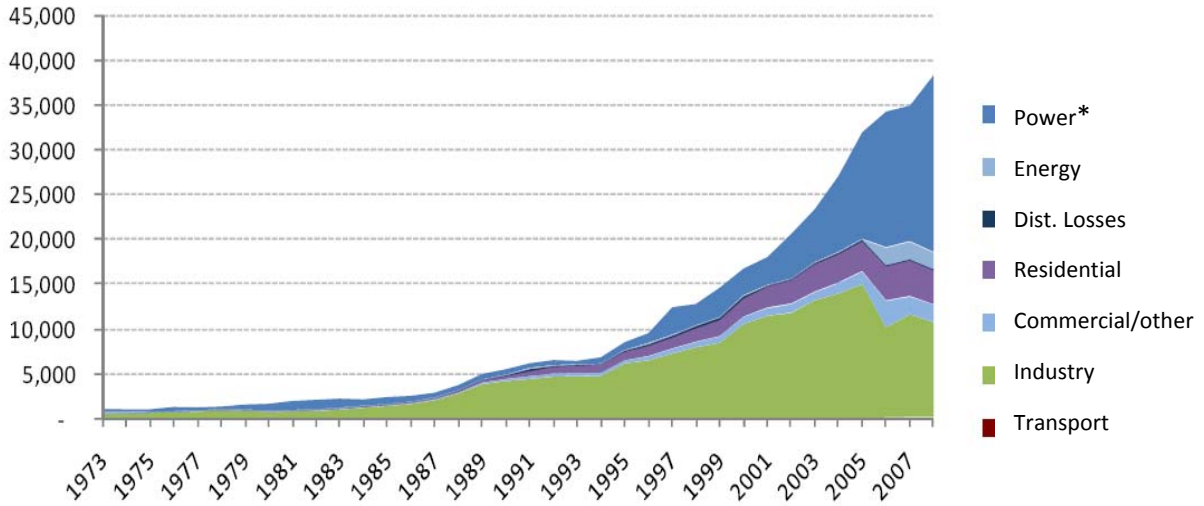
The Spanish gas market is relatively immature compared to the development of the gas industry in Europe.[12] But in the 1990s, gas consumption increased by an annual average of 11.5% (4.2% in OECD Europe) and 11.4% between 2000 and 2008 (2.1% in OECD Europe). In 2010, it was the sixth largest gas market in the region and represented 6.3% of total gas demand in OECD Europe, up from 1.7% in 1990 and 3.5% in 2000.[13]

[12] See Honore (2010), Chapter 1, pp.9-32, for more information
[13] IEA, Natural gas information, various issues, Part II, page 8, table 3

- **Growth by sectors of consumption**

The early development of the natural gas market put an emphasis on the industrial sector [Figure 3].

Figure 3: Natural gas consumption by sector in Spain, 1973-2008 (mcm)



* In the IEA statistics, the power sector is called the 'transformation' sector. It includes the gas used in electricity, combined heat and power (CHP) and heat plants, gas works, gas to liquids and other transformation.
Source: IEA, Natural gas information, various issues, page IV.306, table 3A

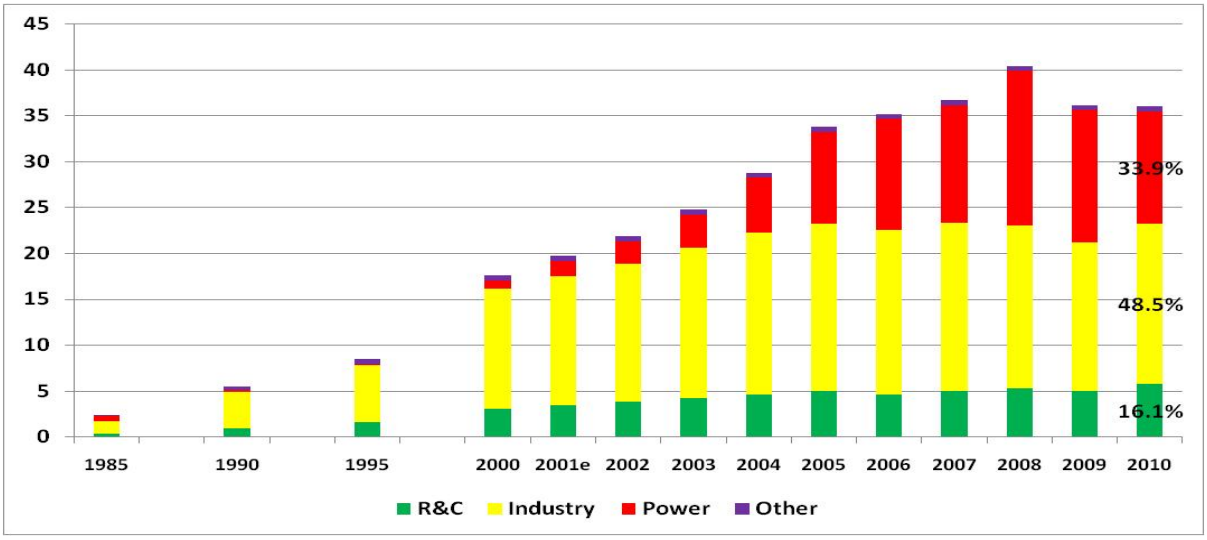
The industry sector remained the main consumer of natural gas in 2010 with a 48.5% share of total gas sales (down from 71.2% in 1990 and 73.9% in 2000) [Figure 4].The growth of this sector, albeit slower than the power sector, was sustained in the 2000s (contrary to most other European markets) thanks to strong economic growth that encouraged gas demand expansion in the industrial and commercial sectors. Sales to the residential and commercial (R&C) market have been relatively smaller but increased in the 2000s driven by population growth and grid expansion (60% more households were connected to the gas grid in 2008 than in 2000[14]) and by consumers installing gas-fired hot water supplies and central heating. In 2010, the residential and commercial sector accounted for 16.1% of gas sales.

In the 2000s, gas used for power generation -especially in CCGTs- saw double digit growth, stimulated by government support and power off-take guarantees and new areas of the country being connected to the power grid and therefore a growing customer base. In 2010, power represented 33.8% of gas demand (down from 41.8% in 2008), increasing from only 3.6% in 1990 and 5.3% in 2000.[15]

In 2010, gas consumption in the industrial and the residential and commercial sectors was back to 2008 levels. Only gas use for the power sector did not grow back to pre-crisis levels.

[14] IEA (2009), p.61
[15] CNE (2010b), Informe de Supervisión del Mercado Minorista de Gas Natural en España, Año 2009, p.20, and Enagás (2011), p.17

Figure 4: Distribution of gas sales by sectors of consumption in Spain, 2000-2010 (bcm)



Source: Sedigas, Avance estadístico, various issues, table 2 "Ventas de gas natural en España"

The residential and commercial sector

The residential and commercial sector has been, and remains, the smallest market for gas in Spain. The needs for space heating are lower than in northern Europe due to milder temperatures in the winter. Natural gas took the market shares of naphtha and butane in the 1980s, which amounted to 232.1 and 20 million cubic metres (mcm) of gas sold respectively in 1985, while natural gas sales amounted to 389.4 mcm. By 1990, naphtha was down to 47 mcm and butane to 6 mcm while natural gas increased to 916 mcm. The rise continued all along the 1990s and 2000s, triggered by the network expansion and the connection of additional regions to the grid. By 2009, natural gas demand was about 5 bcm, while butane was at a low of 40 mcm and naphtha had virtually disappeared.[16] In 2010, the residential and commercial sector represented 16.1% of total demand, down from 24% in 1985 and about 17% in 1990 and 2000 due to the faster increase of the other consuming sectors: industry and power generation [Table 2].

Table 2: Natural gas sales in the residential and commercial sector, 1985-2010 (share in % and demand in bcm)

	1985	1990	1995	2000	2005	2006	2007	2008	2009	2010
Share of R&C (%)	24.0%	17.4%	19.1%	17.7%	15.0%	13.3%	14.0%	13.3%	13.9%	16.1%
Demand R&C (bcm)	0.65	0.97	1.62	3.13	5.09	4.68	5.10	5.37	5.03	5.80
Demand total (bcm)	**2.7**	**5.6**	**8.5**	**17.7**	**33.9**	**35.2**	**36.4**	**40.4**	**36.2**	**36**

Source: Sedigas, Avance estadístico, various issues, table 2 'Ventas de gas natural en España'

[16] Sedigas, Avance estadístico, various issues, table 2 'Ventas de gas natural en España'

The industrial sector

In 2008, gas was used primarily in the 'non metallic mineral products' sector (26.9%), 'chemical including petro-chemical' (26.3%), 'pulp paper and printing' (8%), 'iron and steel' (7%), 'food processing beverages and tobacco' (5.1%), 'machinery' (4.5%), 'transport equipment' (2.9%), 'construction' (1.6%) and other sectors.[17]

The industrial sector was the first Spanish market segment to develop. About three quarters of the gas consumed in Spain in the 1990s was in the industrial sector [Table 3], but by 2010, gas sales to industry represented only 48% of total sales.

Table 3: Natural gas sales in the industrial sector, 1985-2010 (share in % and demand in bcm)

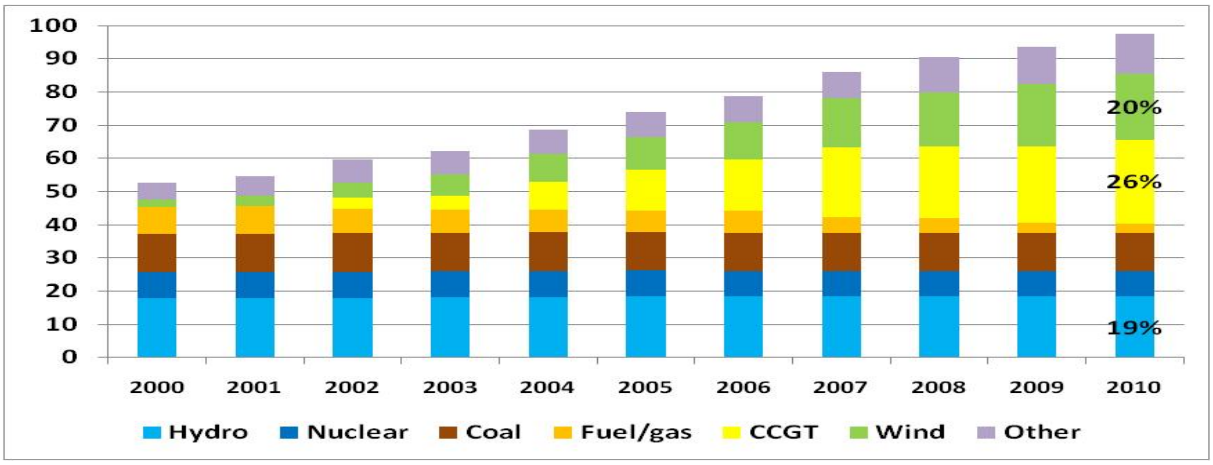
	1985	1990	1995	2000	2005	2006	2007	2008	2009	2010
Share of Industry (%)	52.2%	71.2%	73.4%	73.9%	53.8%	50.9%	50.3%	43.9%	44.8%	48.5%
Demand industry (bcm)	1.41	3.99	6.24	13.08	18.24	17.92	18.31	17.74	16.22	17.46
Demand total (bcm)	**2.7**	**5.6**	**8.5**	**17.7**	**33.9**	**35.2**	**36.4**	**40.4**	**36.2**	**36**

Source: Sedigas, Avance estadístico, various issues, table 2 'Ventas de gas natural en España'

Gas demand in the power sector

In the 1990s, the gas demand growth in the power sector was mainly due to the increased use of natural gas for co-generation by auto-producers. Gas consumption to generate electricity really started to pick up in Spain after 1995 with the construction of CCGTs [Figure 5] following liberalisation measures, increasing environmental awareness and improvement in the technical and economic efficiency of new turbines.

Figure 5: Evolution of the electricity generation capacity in Spain, 2000-2010 (GW)



Source: REE, The Spanish Electricity System, various reports

[17] IEA, Natural gas information 2010, page IV.306, table 3A.

Gas demand for power generation in Spain developed in line with other liberalised electricity markets in Europe. CCGTs have some very beneficial characteristics compared to alternative technologies: first, the investment costs are low and predictable as the technology is standardised, and second, the plant can be built in two to three years and in incremental steps and the projects do not possess significant economies of scale, which means that they can be built in relatively small units without greatly increasing the average unit cost. These developments led to the growth of gas demand in the power generation sector from 0.2 bcm in 1990 to 12.2 bcm in 2010 (about one third of total demand) [Table 4].

Table 4: Natural gas usage in the power sector, 1985-2010 (share in % and demand in bcm)

	1985	1990	1995	2000	2005	2006	2007	2008	2009	2010
Share of Power (%)	23.2%	3.6%	0.9%	5.3%	29.5%	34.4%	35.1%	41.7%	40.0%	33.9%
Demand in power (bcm)	0.63	0.20	0.08	0.94	10.00	12.11	12.78	16.85	14.48	12.20
Demand total (bcm)	**2.7**	**5.6**	**8.5**	**17.7**	**33.9**	**35.2**	**36.4**	**40.4**	**36.2**	**36**

Source: Sedigas, Avance estadístico, various issues, table 2 "Ventas de gas natural en España"

- **Natural gas flows in 2010**

In 2010, Spain consumed 36 bcm of gas, up from only 5.6 bcm in 1990 and 17.7 bcm in 2000. Supplies increased in line with the demand, by 0.4% in 2010 compared to 2009. Spain has lead the way on liquefied natural gas (LNG) development and gas diversification in Europe. The share of LNG –delivered at the six regas terminals- rose to a record level of 76% of total Spanish market gas imports over the period 1996 to 2010 (i.e. since the start of operation of the GME pipeline in October 1996[18]). The remaining 24% of total imports was delivered by pipeline mostly through the Maghreb-Europe pipeline (GME) from Algeria, but also through interconnections with France. In 2010, there were 15 suppliers of gas to the Spanish market. Exports to Portugal increased by 8.8% from 2009 levels, directed mostly to CCGTs. The natural gas flows in the Spanish system in 2010 are presented in Figure 7 (page 21).[19]

The 36 bcm of Spanish gas supply (net of exports to Portugal) was sent to the 17 autonomous regions.[20] Due to the differences in the economy, policies, population and climate, gas consumption varies greatly from one region to another. The consumption by sector is also very different from one

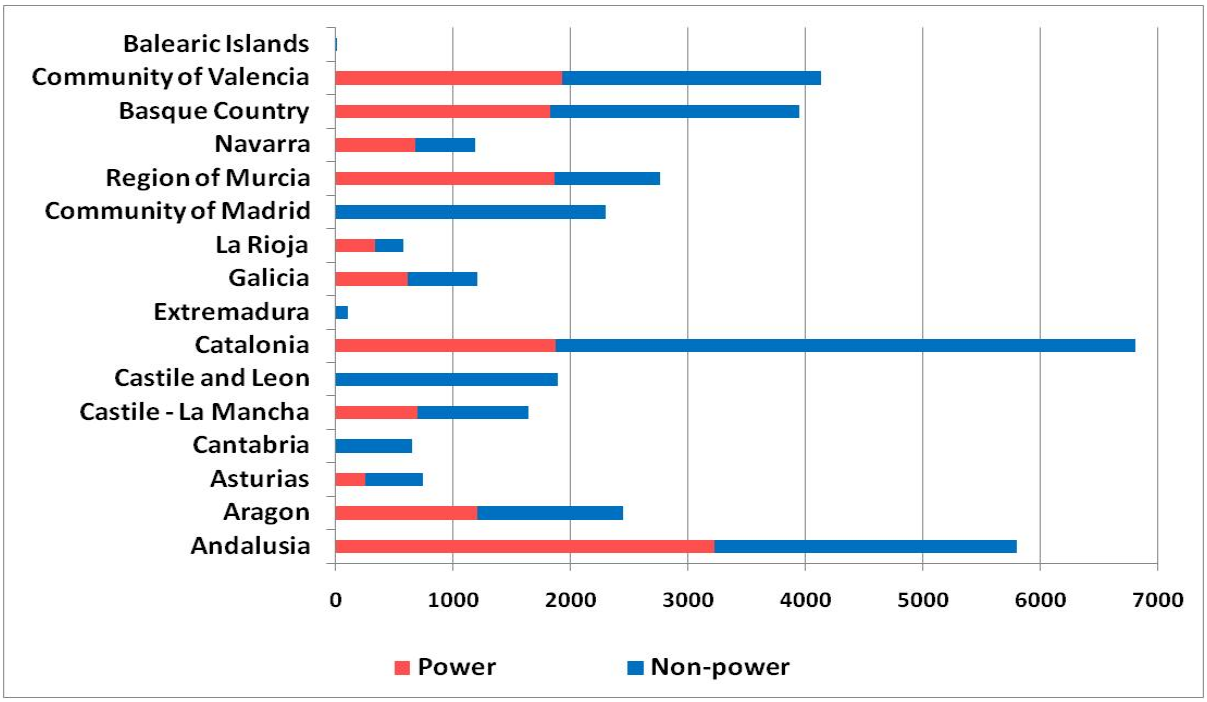
[18] GME pipeline: Maghreb-Europe pipeline from Algeria to Spain via Morocco. Enagás (2011), p.144

[19] See Section 'III/ Repercussions for the natural gas industry' for additional information on natural gas supplies to Spain

[20] Spain is divided in to 17 regions – Andalusia, Aragón, Asturias, Balearic Islands, Canary Islands, Cantabria, Castile and León, Castile-La-Mancha, Catalonia, Extremadura, Galicia, La Rioja, Community of Madrid, Region of Murcia, Basque Country, Community of Valencia, Navarra and two autonomous cities – Ceuta and Melilla. These autonomous communities have varying powers, but each has its own parliament, government and administrative apparatus. See Appendix 3 for a map of the autonomous regions.

location to another [Figure 6]. The highest consuming regions are the ones with easy access to gas supply, especially in the form of LNG. CCGTs are traditionally built near consumption centres, being the only power generation technology that it is possible to build in close proximity to population centres. The CCGTs in Spain seem to have been constructed near the points of entry in the gas system.[21]

Figure 6: Natural gas consumption by sector in the autonomous regions in 2010 (mcm)

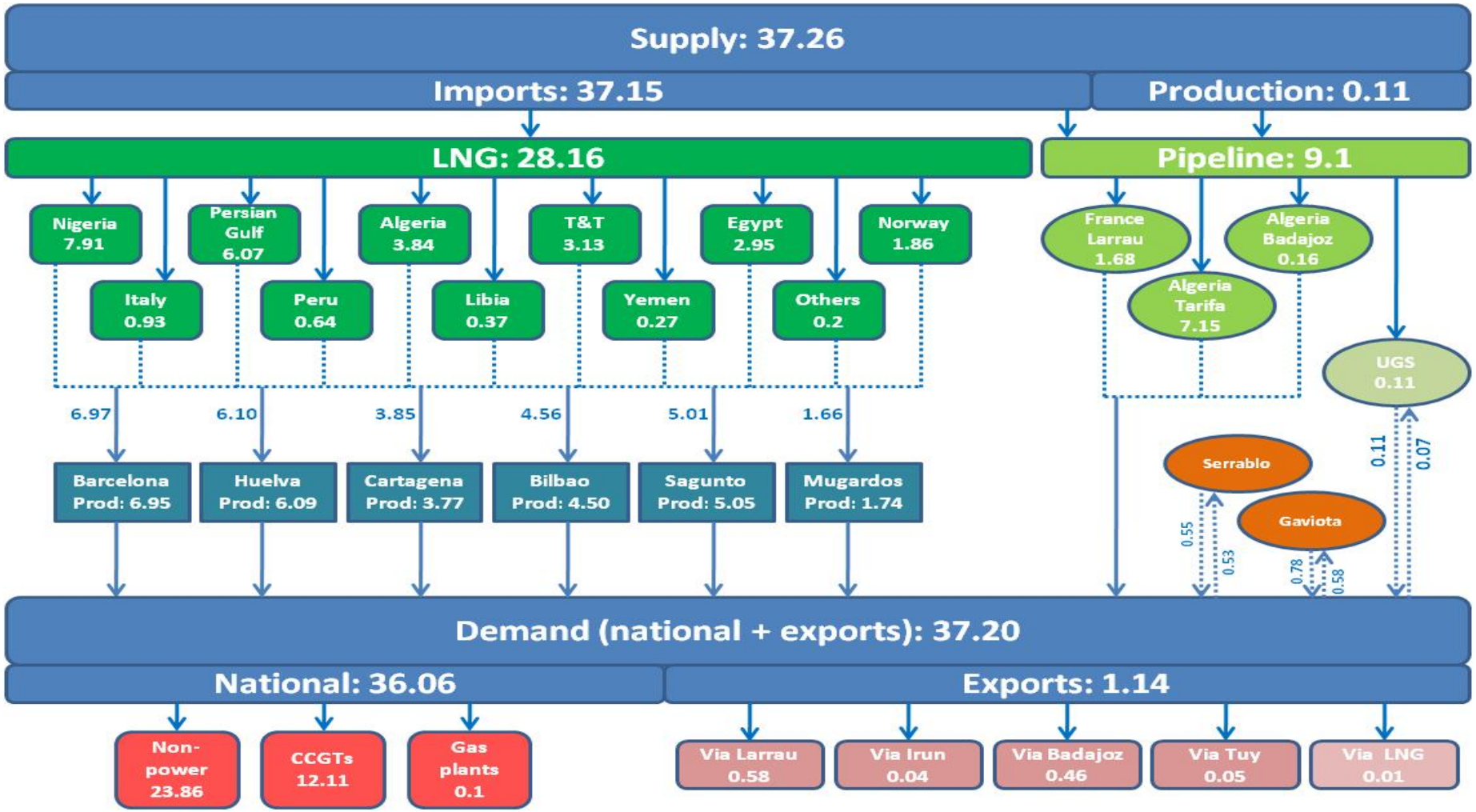


Note: there are only 16 regions represented in this Figure because there is no natural gas consumption in the Canary Islands

Source: Enagás (2011), p.31

[21] See also Appendix 5 for a map of the location of the power plants in Spain

Figure 7: Natural gas flows in Spain in 2010 (bcm)



Note 1: Gas volumes in transit to Portugal from GME are not included (2.01 bcm).

Note 2: The data in the original figure has been converted into bcm here. The original data was in GWh. Conversion factor used: 1 TWh = 0.09 bcm

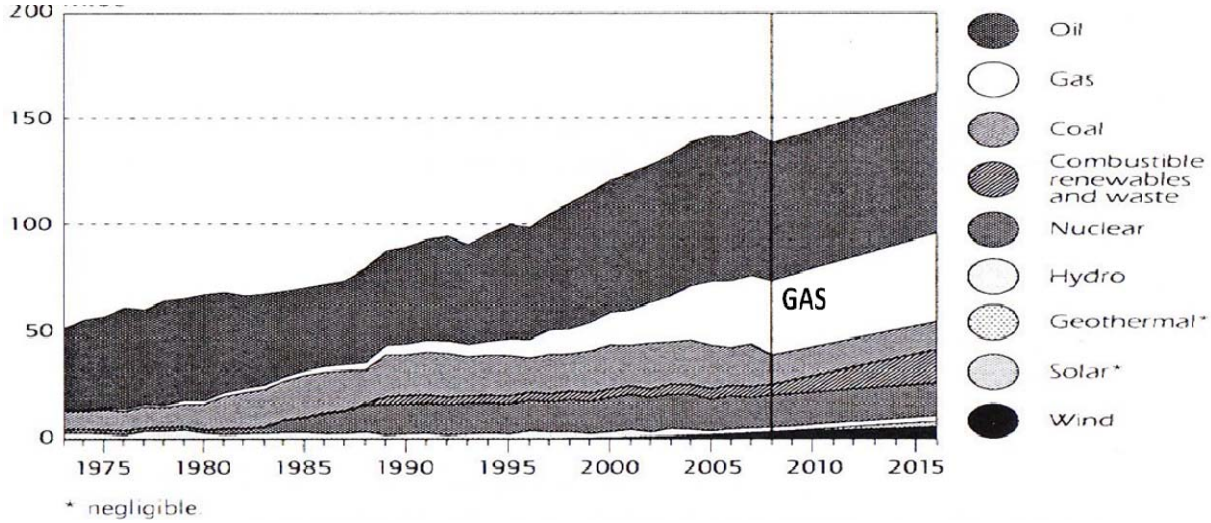
Source: Enagás (2011), p.11

1.3. Sustained growth expected, especially in the industry and the power sectors

- **Scenario published in 2008**

Before the 2008-2010 period and the economic recession, the energy and the natural gas industries were expected to continue to expand at a fairly high rate over the next few years. As shown by Spain's 2009 submission to the International Energy Agency (IEA) in Figure 8, the TPES was expected to continue rising at 1.6% per year on average until 2016, while gas demand was to grow by 2.8% to 46.1 bcm (10 bcm more than in 2010). The major development was seen in renewable energy with a 6.1% per year increase on average.

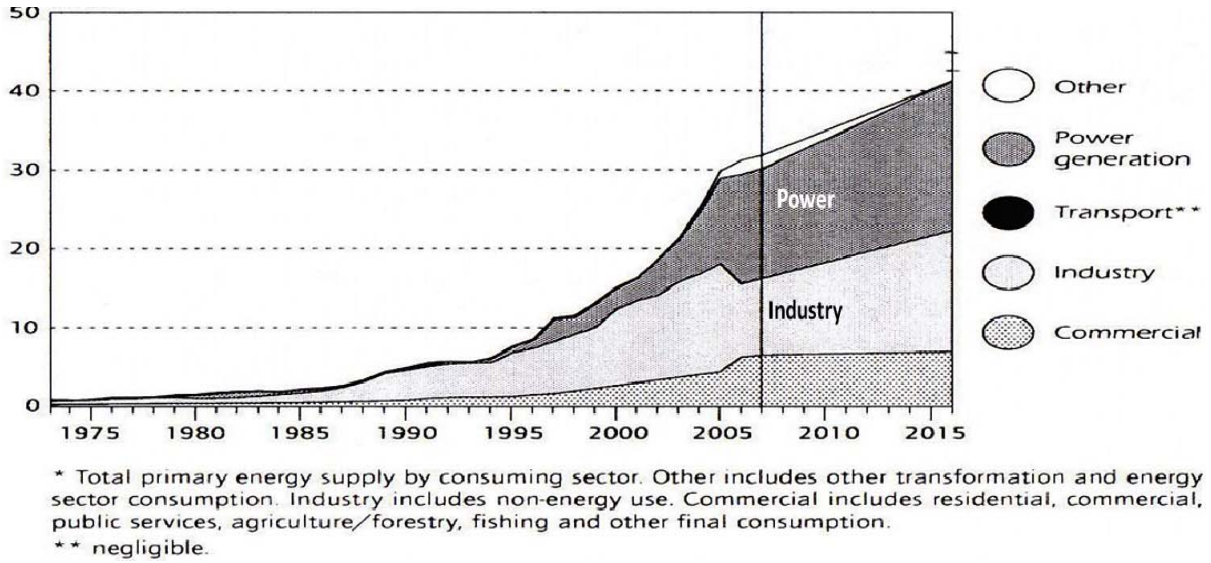
Figure 8: Evolution of TPES (2008 scenario), 1973 – 2016 (Mtoe)



Source: IEA (2009), p.15

The pre-recession scenario prepared by the Spanish government showed high expectations of sustained growth rates for gas demand in the power and in the industrial sectors [Figure 9].

Figure 9: Natural gas demand by sector (2008 scenario), 1973-2016 (Mtoe)



Source: IEA (2009), p.63

Periodically, the government publishes infrastructure plans, assessing the needs for new gas transmission pipelines and LNG regas terminals. Investment in gas infrastructure is obligatory and managed under a national infrastructure investment Plan. The Plan is prepared by the government in consultation with the gas transmission system operator (TSO)[22] Enagás and regulator (*Comisión Nacional de Energía* – CNE). It is based on projections of energy consumption and intensity in order to ensure that there is sufficient gas infrastructure in place to move gas to the required off-take point, including power stations.

The Spanish government's scenario was published by the *Secretaria General de Energía* in May 2008.[23] The 2008-2016 Plan projected that TPES would increase by 1.4% per year on average between 2011 and 2016. Natural gas was projected to grow by 2.2% per year on average, reaching 25% of TPES by 2016 ; while renewable energy increased fastest at 6.9% per year (especially biofuels for transport), this was a much lower rate than in the previous period (16.6% per year between 2006 and 2011). Renewables reach 15.8% of TPES by 2016 (up from only 6% in 2006) [Table 5]. These scenarios were made before the economic downturn and are likely to be revised in the future Plan.[24]

Table 5: Evolution of fuel shares in TPES in the Plan 2008-2016, in 2006, 2011 and 2016 (%)

	2006	2011	2016
Coal	12.8	9	8
Oil products	49	45.1	42.1
Gas	21.2	24	25
Nuclear	10.8	10	9.3
Renewable energy	6	12.1	15.8
Other	0.2	-0.2	-0.2

Source: Secretaria General de Energía (2008), Planificación de los sectores de electricidad y gas 2008-2016, p38

The 2008-2016 Plan included two additional scenarios for gas demand growth: an efficiency scenario under the hypothesis of a high response to energy efficiency and savings measures ('efficiency scenario') and a business as usual ('BAU scenario'), based on Enagás simulation models.[25] The two scenarios reflect an increase of 3% per year in the GDP. Logically, gas demand in the BAU scenario is consistently higher than in the efficiency scenario (by 8 bcm in 2011 and by 14 bcm in 2016) as shown on Figure 11, page 26.

[22] Enagás, by virtue of Royal Decree-Law 6/2009, of 30 April, is the sole transmission system operator for the primary gas transport trunk network, and is authorised to build, operate, and maintain LNG regas facilities, and to transport and to provide basic natural gas storage. Enagás is in charge of the development and expansion of the trunk network in the gas sector, guaranteeing the maintenance and improvement of the network.

[23] Secretaria General de Energía, Planificación de los sectores de electricidad y gas 2008-2016, May 2008

[24] The government is working on long term energy scenarios to 2030. The Ministry of Industry, Tourism and trade (Mityc) is leading the cross-sectoral effort.

[25] Mityc (2008), Secretaria General de Energía, *Planificación de los sectores de electricidad y gas 2008-2016,* pp. 383-387

- **Scenarios published in 2010**

By the end of 2010, there were major uncertainties about gas demand growth in Spain. The sharp and negative impacts of the economic recession, especially on the industry and the power sectors cast a long shadow on the future potential pace of development. The increased use of renewable energy in 2010, together with a large availability of hydro (but also nuclear) energy depressed the demand for gas in the power sector. With additional renewable energy projects expected to continue to be developed and with the support of other energy and environmental policies, it was unclear what kind of future gas demand growth –if any- could be expected in Spain post 2010; a significant contrast to its status as the fastest growing market in Europe in the 2000s.

The new 'Energy Strategy' published in November 2010 ('*Informe de la Subcomisión de Análisis de la Estrategia Energética Española para los Próximos 25 años'*) continued to present rather optimistic scenarios, with an annual average increase for gas demand of 2.3% between 2009 and 2020.[26] These growth rates are very similar to this author's scenarios for the period 2008-2020 (+2.4%), calculated in early 2010 (i.e. with 2009 data) and assuming a 45% load factor for the CCGTs.[27]

In the Energy Strategy, the share of natural gas in TPES is expected to grow from 23.8% in 2009 to 28.8% in 2020. Renewable energy registers the biggest increase from 9.4% in 2009 to 18.2% in 2020. Both fuels' share rises entirely at the expense of oil and in a lesser extent of coal [Table 6].

Table 6: Evolution of TPES in the 'Energy Strategy 2010', in 2009, 2015 and 2020 (%)

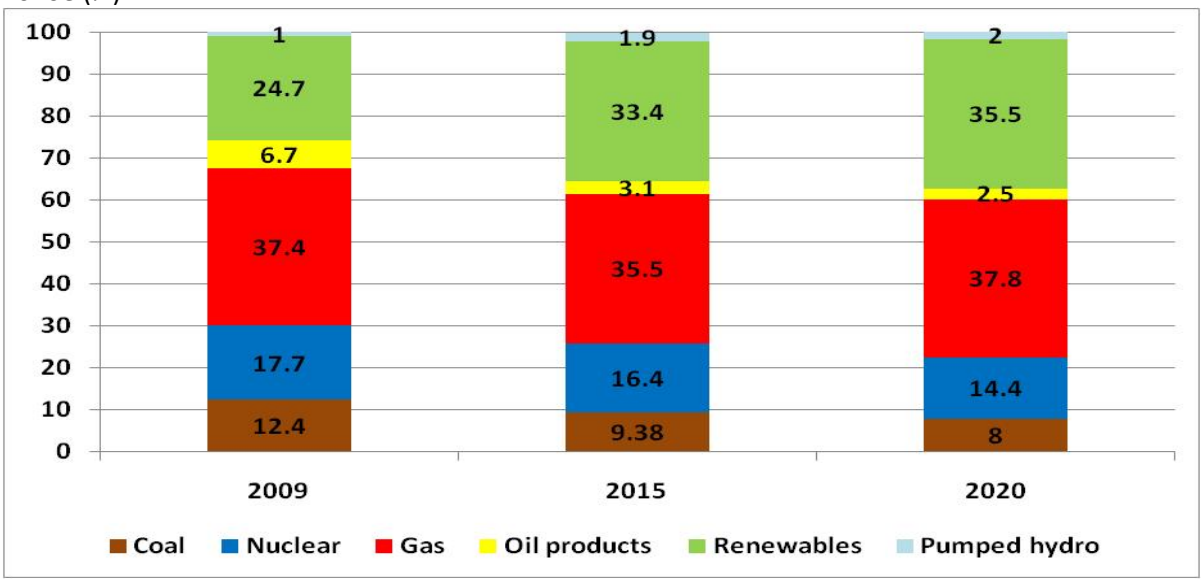
	2009	2015	2020
Coal	7.9	7.9	7.3
Oil	48.8	41.3	36.6
Gas	23.8	26.2	28.8
Nuclear	10.5	10.9	10.5
Renewables	9.4	14.5	18.2

Source: Congreso de los diputados (2010), '*Informe de la Subcomisión de Análisis de la Estrategia Energética Española para los Próximos 25 años'* ('Energy Strategy')*, p.88*

Total (net) electricity generation increases by about 100 GWh, from 286 GWh in 2009 to 384 GWh in 2020. Renewable energy (including hydro) accounts for 35.5% of the electricity production by 2020 (up from 24.7% in 2009). In absolute terms, the electricity generation from renewable doubles to 139.6 Terawatt hour (TWh). The share of natural gas rises slightly from 37.4% to 37.8%, which represents an increase of about 38.5 TWh from 2009 to reach 148.5 TWh by 2020, the biggest source of electricity generation. Nuclear and coal both decline slightly by 3 or 4 percentage points (but nuclear net generation grows by 3 GWh) [Figure 10].[28]

[26] *Escenario de banda eficiencia* = scenario including measures and policies to help reach environmental targets. Informe de la Subcomisión de Análisis de la Estrategia Energética Española para los Próximos 25 Años (November 2010), p. 88.
[27] Methodology and assumptions for gas demand scenarios are detailed in Honore (2010), Part 1, pp. 9-113.
[28] Energy Strategy (2010), p.91

Figure 10: Evolution of electricity generation mix in the 'Energy Strategy 2010', in 2009, 2015e and 2020e (%)

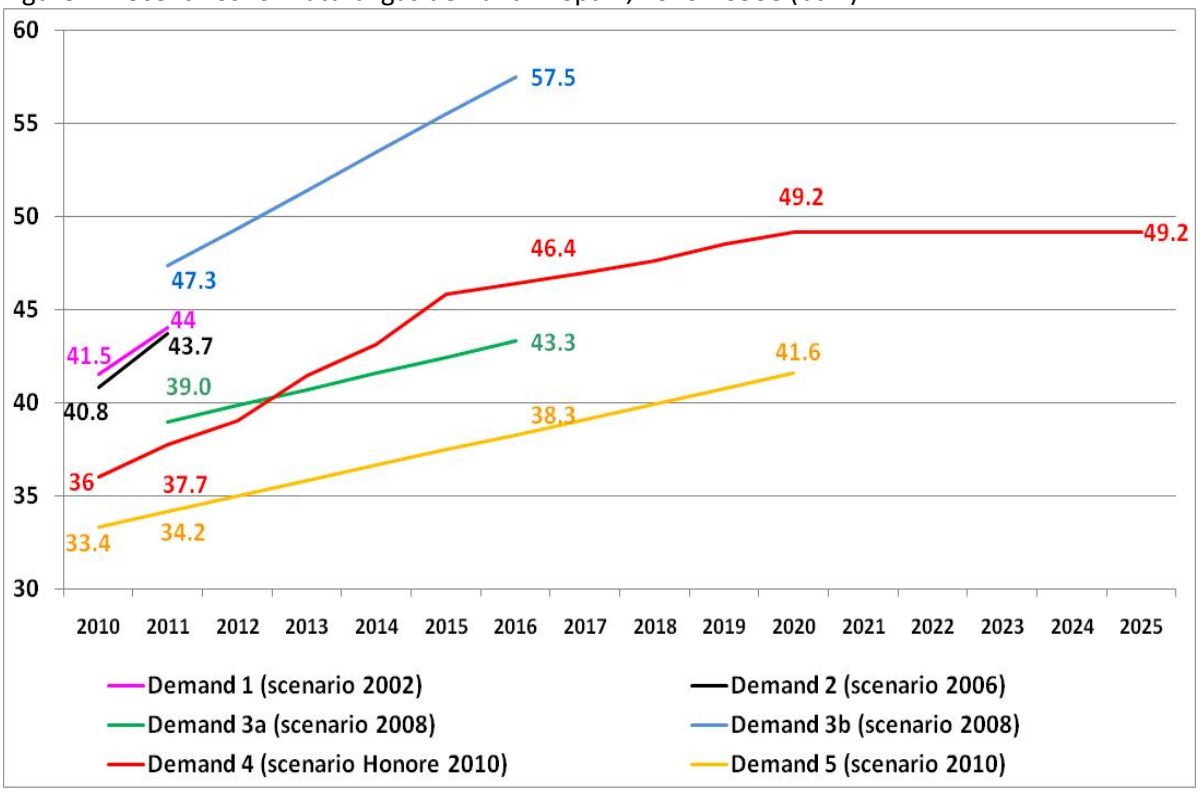


Source: Congreso de los diputados (2010), 'Energy Strategy', *p.91*

The scenarios on gas demand growth remains rather positive for the period up to 2020, albeit showing lower growth rates than in the previous period (2000-2008). The period between 2020 and 2035, presented in the Energy Strategy, registers the main changes in gas demand trends, with a flat demand at best, and even possibly a gradual decline in favour of additional renewable energy in the energy mix.

Figure 11 presents a summary of the scenarios proposed in the Plans published in 2002, 2006 and 2008, in the Energy Strategy published in 2010 and in this author's book published also in 2010.

Figure 11: Scenarios for natural gas demand in Spain, 2010-2030e (bcm)



Sources:

- Demand 1: Mityc[29] (2002), Plan 2002-2011, p.12
- Demand 2: Mityc (2006), Plan 2002-2011 revision, p.274
- Demand 3a: Mityc (2008), Plan 2008-2016, p.385, 'efficiency scenario'
  Conversion factor: 1 TWh = 0.09 bcm
- Demand 3b: Mityc (2008), Plan 2008-2016, p.386, 'BAU scenario'
  Conversion factor: 1 TWh = 0.09 bcm
- Demand 4: Honore (2010), 'Probable scenario', p.293
- Demand 5: Congreso de los diputados (2010), 'Energy Strategy', p.88
  Conversion factor: 1 Mtoe = 1.047 bcm[30]

Following the period of 2008-2010 and lasting effects even in 2011, it is fair to say that the Spanish gas market has been going through a period of considerable turmoil and uncertainty. The logical follow up, is to consider the possibility that the slow down expected post 2020 may actually happen during the 2010s as a result of the economic recession, the maturity of the market and the rise of renewable energy in power generation. This question is examined in the next section.

[29] Mityc: Ministry of Industry, Tourism and Trade
[30] IEA, Natural gas information (2010), p.xxviii, table on "conversion factor for natural gas flow rates".

II/ TOWARDS A RADICAL CHANGE IN THE DYNAMICS IN THE 2010S?

2.1. Long and lasting impacts of the economic recession

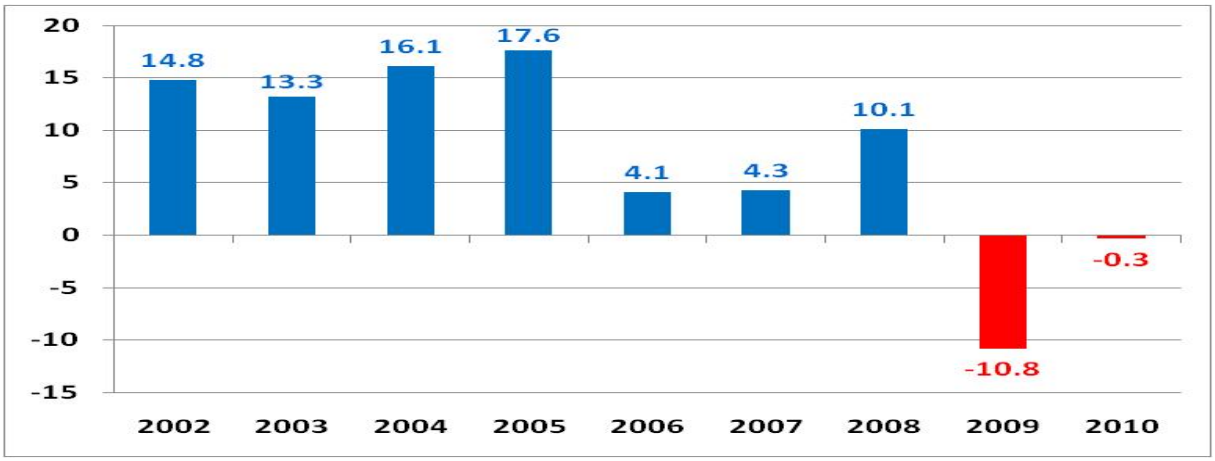
- **Natural gas consumption, economic recession and GDP growth**

The energy world, and therefore the gas industry, is not isolated from what happens in the rest of the economy. In 2009, Spanish energy demand dropped by 9% compared with 2008. This affected all sectors, except renewables (+12%). Natural gas' share in TPES remained at 23.8%. Electricity demand declined by 4.5%.[31]

In 2009, as a result of the recession in the country's economy, the steady upward trend of gas demand came to an abrupt stop with a registered decline of an unprecedented 10.8% in 2009 year-on-year [Figure 12]. This was more than twice the European average (-5.3%).[32] The major impact was felt in the demand for gas in the power sector (-14.5%) due to a drop in electricity demand, higher hydro levels, increased wind generation output, better availability of nuclear stations and improved price competitiveness of coal.[33] The gas consumption in the industry sector was also hard hit (-9.2%)[34] as a result of a decline of industrial production, which affected especially the construction sector (production of tiles, bricks, etc., in which sector, natural gas represents two thirds of the fuel costs), but also in the chemical, textile and paper sectors.[35] The residential and commercial sector was down by 4.6% due to warmer than usual temperatures [Figure 13].[36] The total decline in gas consumed in the non-power sectors amounted to 8% in 2009.

[31] CNE (2010b), p.17
[32] CNE (2010b), p.10 and IEA website, Monthly Gas Survey for the European data
[33] The average monthly price of international coal (API2 - ARA in $/ton) in 2009 was about half than the average price seen in 2008. Source: Enagás (2011), p.27.
Electricity demand in 2009 was down by -4.7% compared to 2008. Source: REE (2010), The Spanish Electricity System 2009
[34] CNE (2010b), p.10
[35] CNE (2010b), p.18
[36] AEMET (2009)

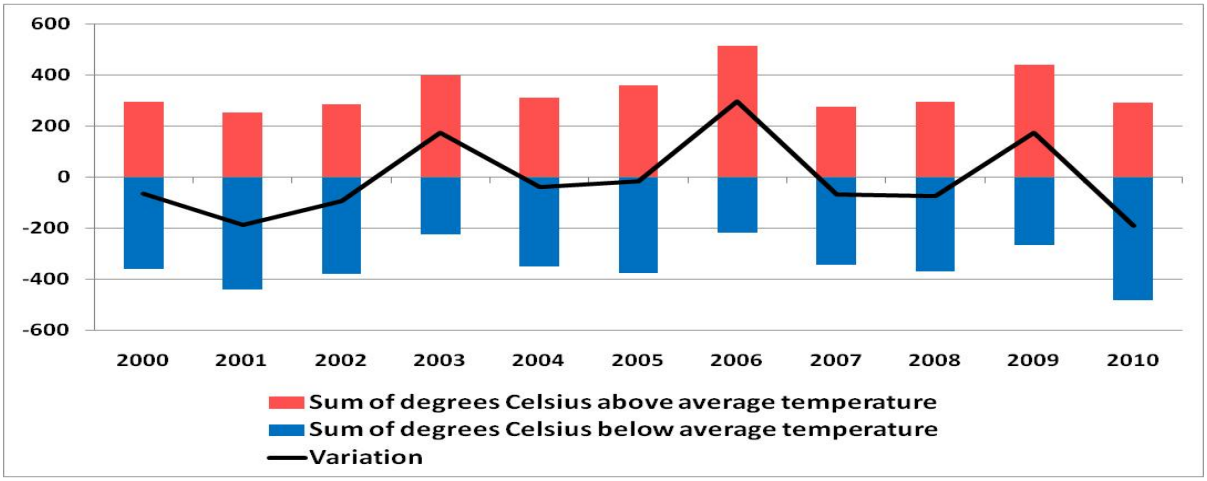
Figure 12: Natural gas growth rate, 2002-2010 (%)



Sources: Data for 2002 to 2009: CNE (2010b), p.21 and Data for 2010: Enagás (2011), p.17

In 2010, data show that gas consumption remained almost flat at about 36 bcm.[37] However, demand in the various sectors grew at surprising rates. There was a sharp recovery of consumption in the non-power sectors,[38] which was back at the pre-crisis level of 23.9 bcm[39] (and more than 10% higher than in 2009). This growth was the result of additional demand in the industrial sector and also in the residential sector for heating in a colder than usual winter periods [Figure 13]. December 2010 was a period of cold temperatures in Spain and on December 16 2010, gas demand for the non-power sectors peaked for the second time in the year at 105 mcm[40], 1.4% higher than the previous record on January 12 2010.

Figure 13: Variation in temperatures in Spain, 2000-2010 (degrees Celsius)



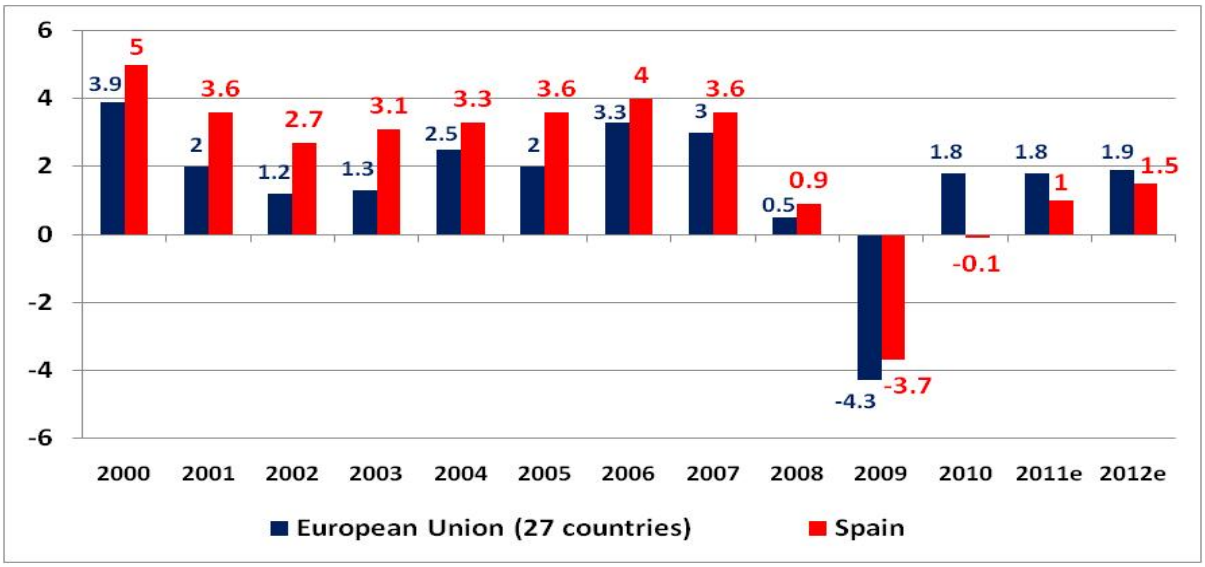
Source: Enagás (2011), p.23

[37] Enagás (2011), p.145
The statistics presented in this section are from the annual report on the Spanish gas market produced by Enagás (*Informe 2010)*. At the time of writing (June 2011), this was the only source with detailed gas demand data on the Spanish market for 2010.
[38] When using IEA data, 'non-power sectors' means total demand minus gas used for power generation. When using Enagás data, consumption in the non-power corresponds to the demand in the residential and commercial, industry and co-generation sectors (what Enagás calls 'consumo convencional').
[39] Enagás (2011), p.8
[40] Ibid

The Spanish gas market is going through a period of considerable uncertainty as a result of the economic recession. After more than a decade of economic growth, the outlook has changed. The bursting of the construction bubble and the international credit crunch have hit the Spanish economy badly. This has raised questions on whether the gas demand scenarios have any chance of materialising, because gas demand in the non-power sectors (industry) and electricity consumption tend to follow the pattern of GDP growth or decline.[41]

In the 2000s, GDP in Spain grew at an average annual growth rate of 3.5%.[42] After more than a decade of rapid growth, GDP growth was still 3.6% in 2007, but slowed to 0.9% in 2008 and declined by 3.7% in 2009 [Figure 14].

Figure 14: Real GDP growth rates in Spain and EU 27, 2000-2012 (%)



Source: Eurostat website (2000-2010) and OECD Economic outlook (25 May 2011) for 2011 and 2012

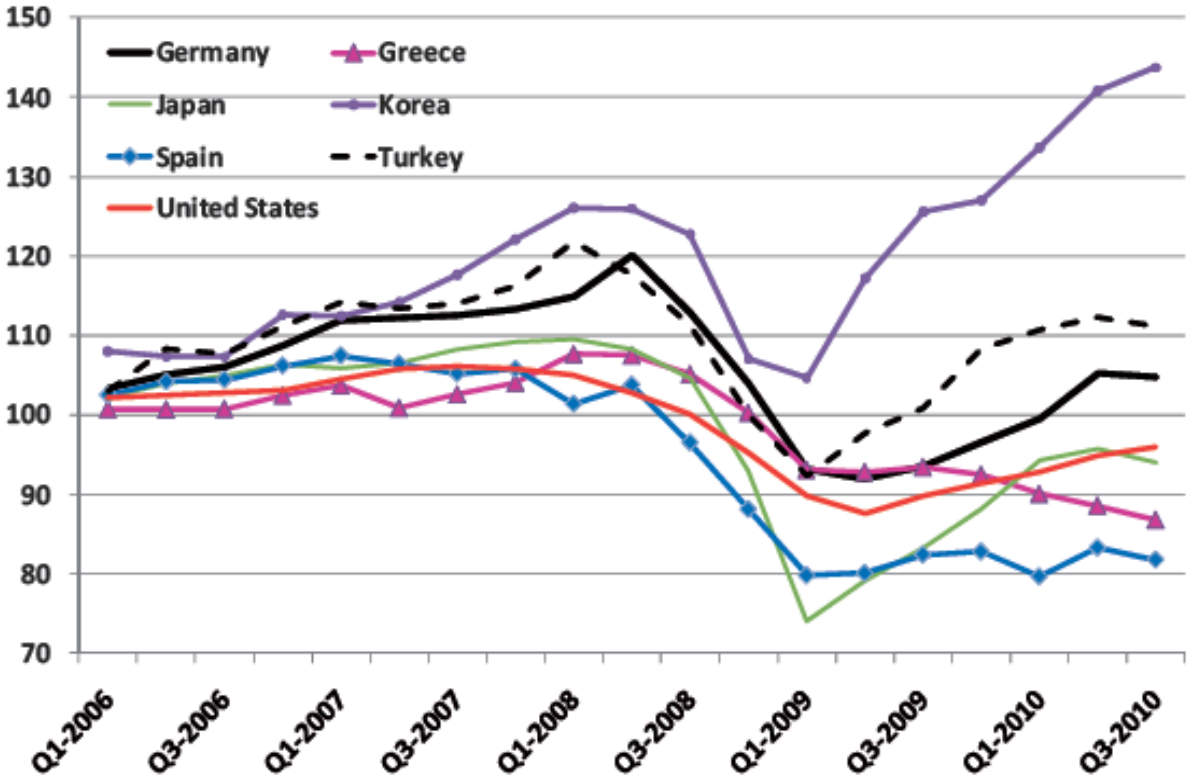
On average, the European markets were out of recession by the third quarter of 2009, while the Spanish economy took much longer, only starting to recover six months later. The country's GDP started to grow again in the first quarter of 2010 but the growth rate remained slightly negative for the year.[43] Economic growth is projected to strengthen gradually, reaching 1% in 2011 and 1.5% in 2012 [Figure 14], as the damping impact of downsizing in residential construction diminishes and the international environment improves. However, it is highly unlikely that the economy will be back to strong economic growth soon. In the scenarios of the Energy Strategy published in November 2010, the assumptions on the annual average GDP growth rate are slightly higher for 2011 and 2012, even going up to 2.7% in 2013 and then flattening to 2.3% between 2014 and 2020. These assumptions are still showing positive trends for the economy, but they are lower than in the 2000s.

[41] Enagás (2011), p.22 for non-power demand and REE (2010), p.8 for electricity consumption
[42] CNE (2010b), p.16
[43] Honore A. (2011), Economic recession and natural gas demand in Europe: what happened in 2008-2010?, p.17, table 2

- **Industry sector**

While scenarios on GDP growth show that the Spanish economy will finally pick up in 2011, the outlook presented by the indices of industrial production look more worrying. Following plunging industrial output between the first quarter of 2008 and the first quarter of 2009 (from indices of 100-105 to 80), the situation seems to have been one of a status quo, and by the end of 2010, the sector had not yet recovered [Figure 15]. Other production indices published by Eurostat for monthly industry production in Spain showed levels at 50 for April 2011 (base 100 in 2005) and around 80 for monthly construction output.[44]

Figure 15: Indices for manufacturing industry (base 100 in 2005)

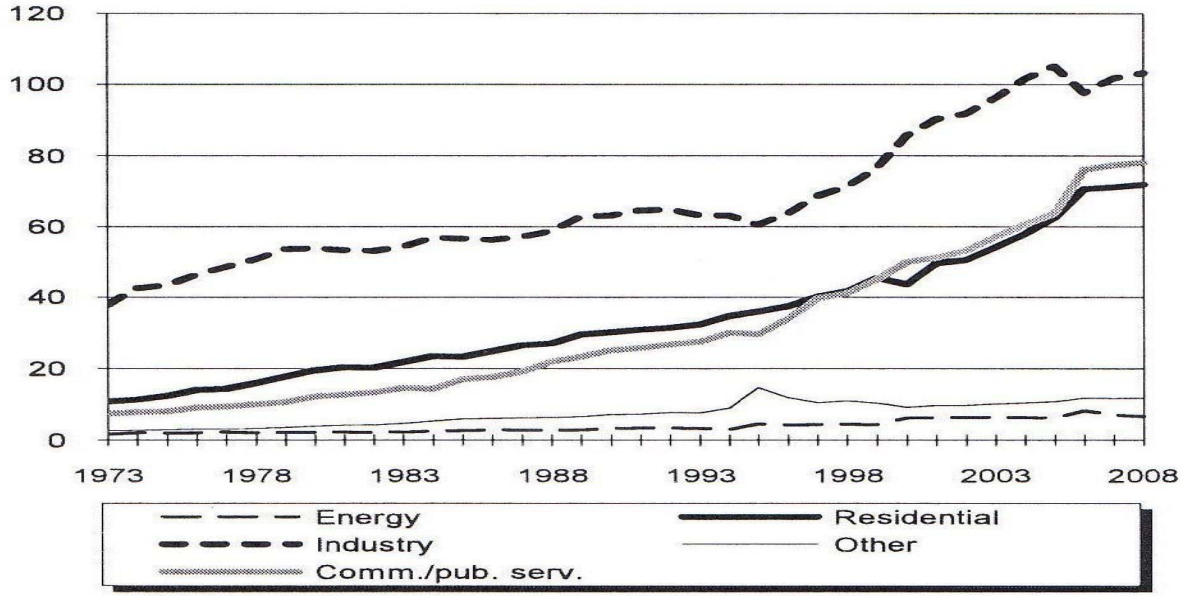


Source: IEA (2011), Medium term oil and gas markets 2011, p.151

Lower industrial production will have a direct impact on gas consumption in the sector, but it will also impact electricity demand as industry is the principal consumer of electricity [Figure 16].

[44] Eurostat, Newsrelease, EuroIndicators, Construction output and Eurostat, Newsrelease, EuroIndicators, Industrial Production

Figure 16: Electricity consumption by sector in Spain, 1973-2008 (TWh)

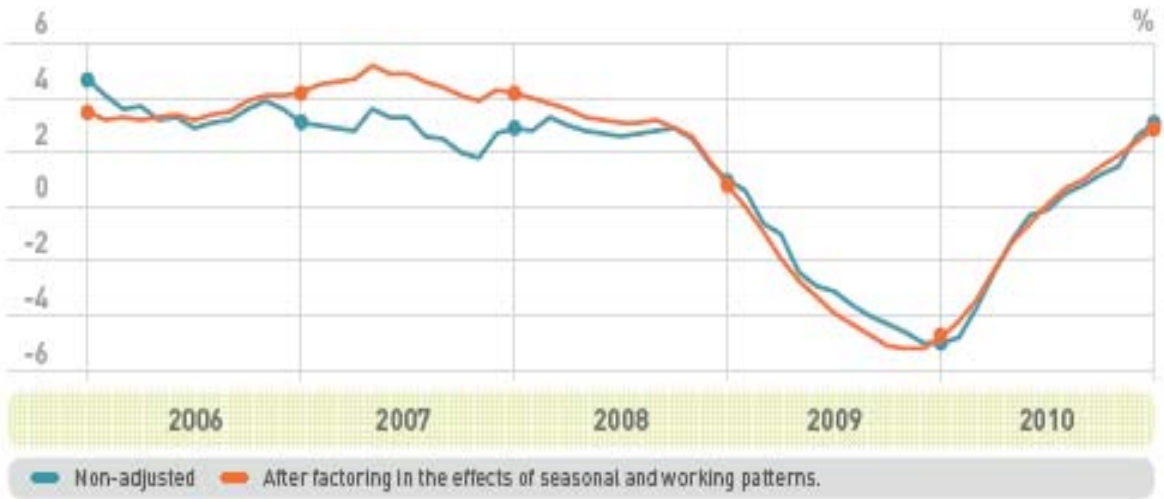


Source: IEA, Electricity Information 2010, Part IV, IV.545, Figure 3

- **<u>Electricity demand</u>**

Electricity demand has increased quickly since the mid 1990s, driven by economic growth. In 2009, the demand for electricity in Spain declined by 5% (-4.8% adjusted for workdays and temperature effects) as a result of the economic crisis and the 3.6% drop in GDP. It was up by 3.2% in 2010 compared to 2009 (+2.9% adjusted for workdays and temperature effects) [Figure 17].

Figure 17: Annual electricity growth rates in Spain, 2006-2010 (%)



Source: REE (2011), The Spanish Electricity Market 2010, p.8

The scenarios published even before the recession forecast a slowdown of annual electricity production in the 2010s and especially post 2020, accounted for by the market reaching maturity and better efficiency measures. Table 7 shows the scenarios published by Eurelectric as an

example.[45] Electricity produced from gas was the fastest growing segment in the 2000s and in the 2010s. Post 2020, the growth will come from wind generation (20 TWh) and nuclear (20 TWh). However, the latter presumably depended on some new nuclear build in the country, which is a less than likely option in Spain, and had been even before the Fukushima disaster.[46]

Table 7: Scenario on annual electricity production from all primary fuels and from gas in Spain up to 2030 (TWh)

	1980	1990	2000	2010e	2020e	2030e
Production	105.1	146.8	215.1	327.6	412.5	473.6
Net increase	-	41.7	68.3	112.5	84.9	61.1
Production gas	3.4	4.1	19.6	118.8	188.9	199.5
Net increase gas	-	0.7	15.5	99.2	70.1	10.6

Source: Eurelectric, Eurprog 2008, p.107, table 3.3.1A.8

2.2. A young market but showing signs of maturity

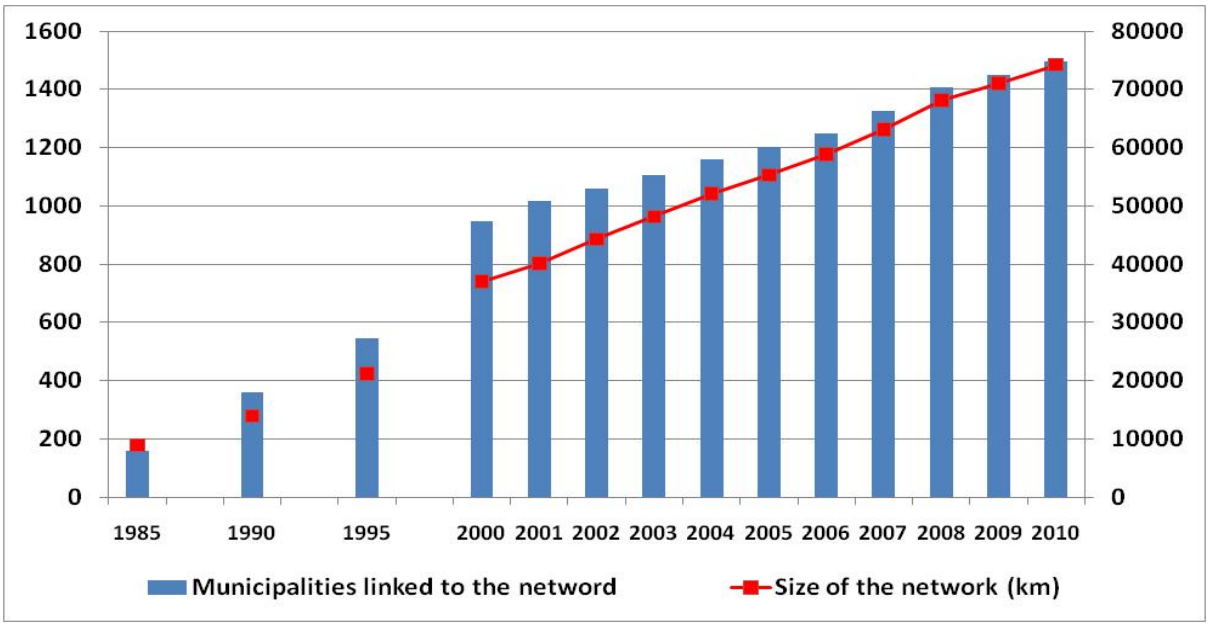
- **Good network coverage**

The Spanish gas market was developed quickly and infrastructure and supplies were designed to meet the needs of a gas market growing at double digits every year.[47] Thanks to this, the energy industry coped well in satisfying the rapidly increasing demand for energy in the 2000s.[48] The Plan adopted in May 2008, which applies to investments from 2008 to 2016, advocates annual average investments of 1 billion Euros in the natural gas infrastructure (and the same in electricity) over the period. Additional pipelines could in theory increase the number of consumers, and therefore sustain gas demand growth, but the gas pipeline infrastructure already covers most of the main population areas in Spain [Map 1, page 34, left]. The grid is based on three north-south trunk lines, which have subsequently been expanded with inter linkages and additional capacity.[49] Once new infrastructure is built [Map 1, page 34, right], the gas network will be shaped by three basic South-North axes (Ruta de la Plata, Central Axis and Mediterranean Axis), interconnected by three West-East axes (Ebro axis, Galicia axis and transversal axis Alcázar-Montesa), which will make it possible to supply the needs of the peninsula centre from any entry point. This will strengthen the flexibility of the gas network, but may not add a considerable amount of new consumers.[50]

[45] Scenarios published by Mityc before the recession end in 2016, which is a too short time frame for this argument.
[46] See section '2.3. Impact of the Fukushima disaster?'
[47] The regulated system, which allows for full cost recovery by the developer and full third party access, has an incentive to develop the gas transmission network in Spain (it is possible to build new infrastructure outside the regulated system too). The investments are guaranteed a return, which was around 7% net of tax per year in 2009. Source: IEA (2009), p.20
[48] IEA (2008), p.9
[49] For an interactive map of the gradual increase in gas infrastructure since 1975 (and regularly updated with one month time lag in 2011), go to Enagás website, 'development of infrastructure' http://www.Enagás.es/cs/Satellite?cid=1146233263521&language=en&pagename=ENAGAS%2FPage%2FENAG_pintarContenidoFinal
[50] Mityc (2009), Overview of the Spanish gas market in year 2008, p.5

In 2010, the Spanish gas grid was 74,200 kilometres (km) long (up from less than 14,000 km in 1990),[51] which included 7,700 km of transmission grid operated at 70.20 bar (10,067 km in 2010[52]) [Figure 18]. It covered 1,497 municipalities, up from only 360 in 1990. There were 8,112 municipalities in 2010,[53] so natural gas coverage was about 18.5%. This number could again suggest a potential for additional demand with network expansion. However, in 2010, 77% of the population lived in cities and the municipalities not yet covered are mainly small and located in rural areas.

Figure 18: Length of the gas network (right axis, km) and number of municipalities linked to the network (left axis) in Spain, 1985-2010

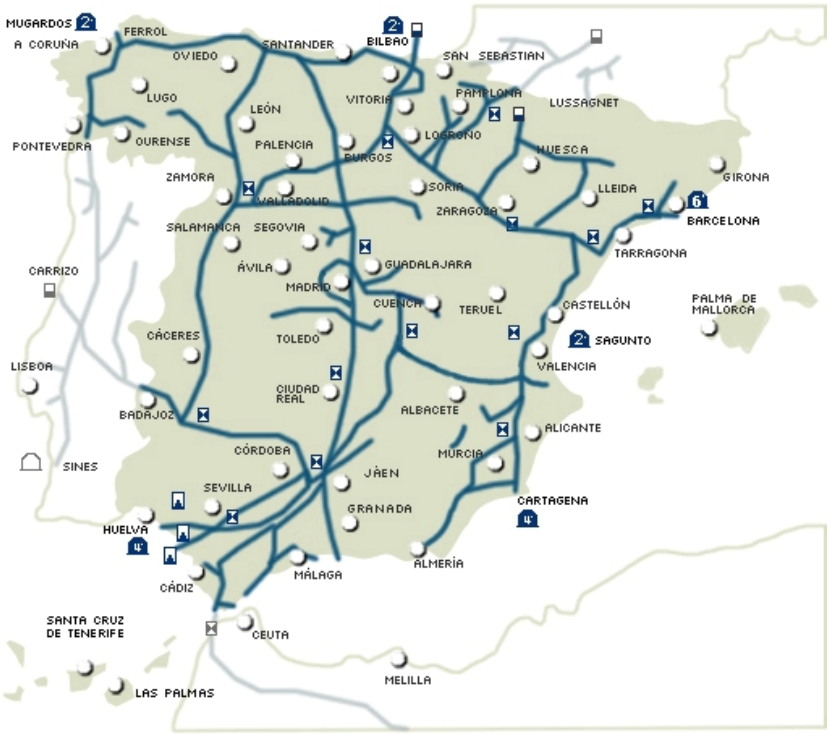


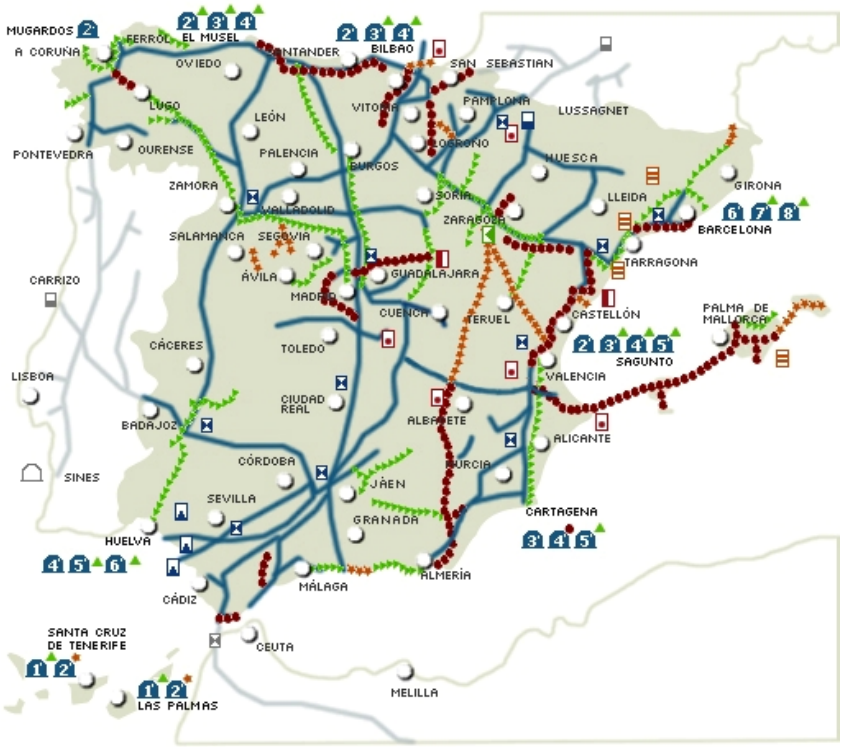
Source: Sedigas, Avance estadístico, various issues

On March 2011, there were 7,206,119 consumers (95% in the residential and commercial sector[54]). Since 2005, there has been a slowdown in net connections of consumers: in 2007, they increased by 320,000, in 2008 by 193,000, and in 2009 by 124,000 [Figure 19].[55] Despite the possible population increase of one million inhabitants between 2010 and 2020 (reaching 47.7 million in 2020),[56] there is limited growth expected in the residential and commercial sector, especially if additional measures of energy efficiency in buildings are put in place.

[51] Sedigaz (2011), Avance estadístico 2010, p.3
[52] Enagás (2011), p.112
[53] http://en.wikipedia.org/wiki/List_of_municipalities_of_Spain. The rate of urbanization is expected to be 1% per year between 2010 and 2015.
[54] IEA (2009), p.87
[55] CNE (2010b), p.12
[56] Energy Strategy (2010), p.85

Map 1: Infrastructure – gas transport planned in Plan 2008-2016

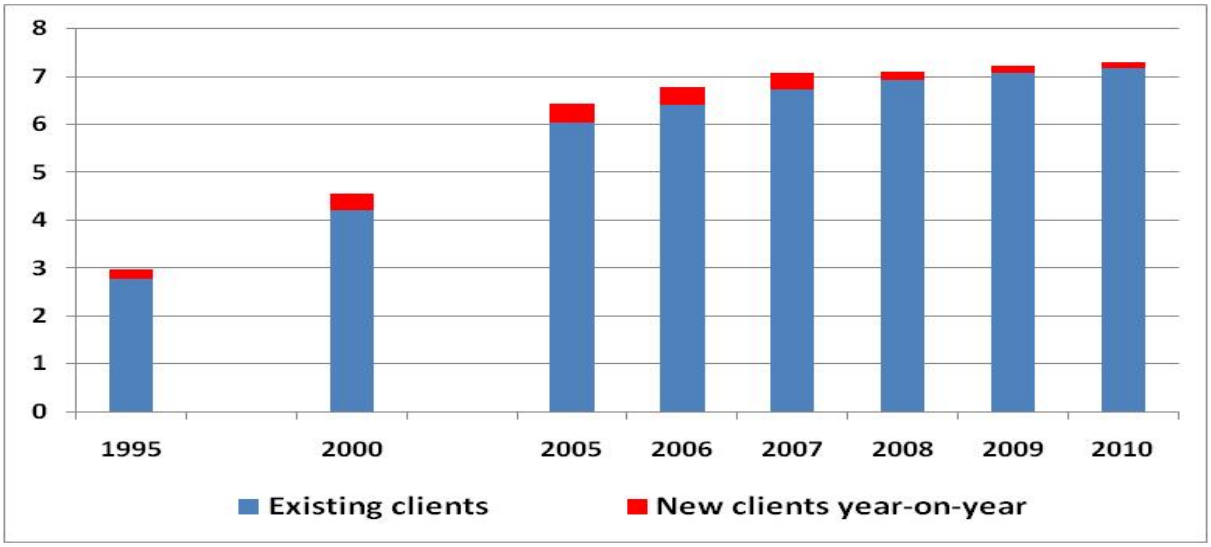




- LNG Regas plants - existing
- Compressor stations - existing
- Compressor stations - urgent
- Compressor stations – group A
- Compressor stations – group B
- Underground gas storage - existing
- Underground gas storage – urgent
- Underground gas storage - group A
- Underground gas storage - group B
- Reserves
- Infrastructure – existing
- Urgent
- Group A
- Group B

Source: http://www.enagas.es/cs/Satellite?cid=1142417697953&language=es&pagename=ENAGAS/Page/ENAG_mapaInfraestructuras

Figure 19: Existing consumers and annual growth of new consumers of natural gas in Spain, 1995-2010 (in millions of consumers)

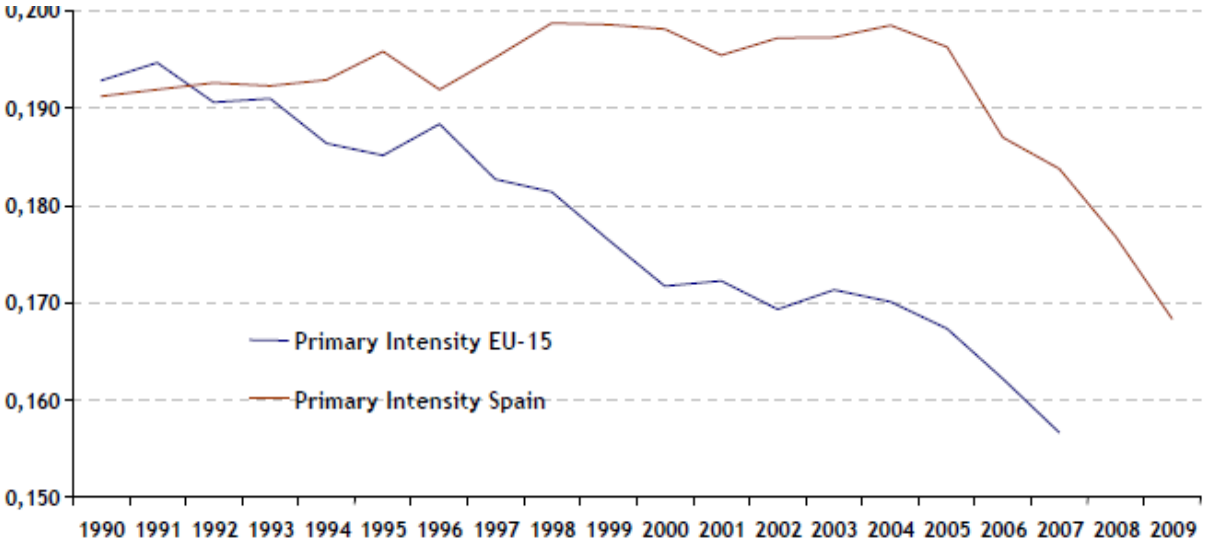


Source: Sedigas, Avance estadístico, various issues

- **<u>Efficiency / intensity</u>**

Before the 2008-2010 recession, one of the main objectives for the country was to continue to decouple economic growth from the growth of energy demand, if it was to meet environmental objectives. Energy intensity in Spain only started to decline in 2005, later than in most European countries, as economic growth and the increased volume of energy use have crowded improvements in specific energy intensities [Figure 20].[57] In the 2010s, the country will be putting more and more emphasis on encouraging better energy efficiency.

Figure 20: Development of primary energy intensity in Spain and in EU-15 (ktoe/€00)



Source: EnR/IDAE (Institute for Energy Diversification and Saving) in Mityc[58] (2010), p.15

[57] IEA (2009), p.22

[58] Mityc: *Ministerio de Industria, Turismo y Comercio* - Ministry of Industry, Tourism and Trade), the Ministry in charge of energy issues

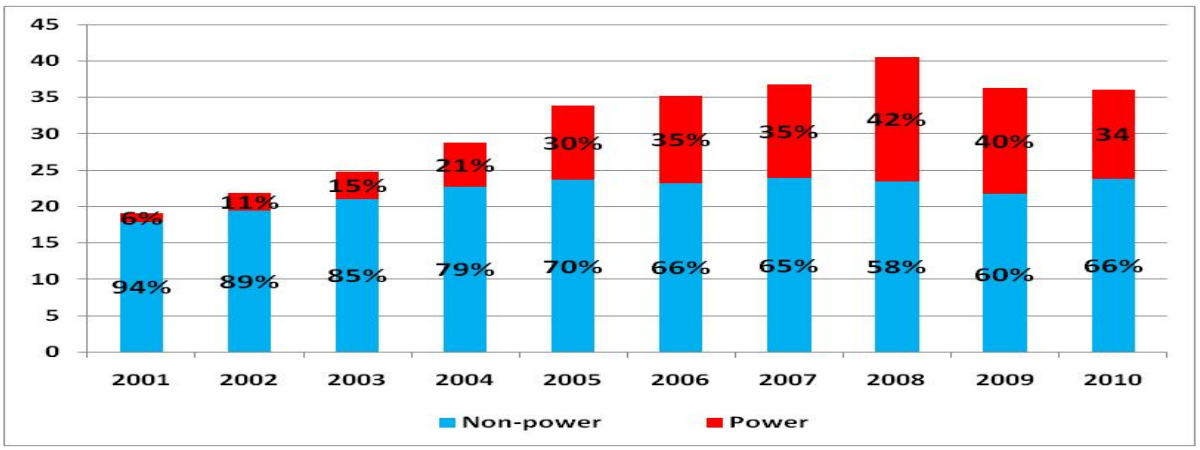
Energy efficiency measures could help reduce peak demand in both electricity and gas markets.[59] Electricity/power demand peaks at times of high use of air-conditioning systems or electric heaters, when temperatures rise or drop to extremes. This is usually during periods of meteorological high pressure characterised by low wind speeds. All these lead toward greater fluctuations in natural gas demand. Better efficiency could be achieved by more efficient heating and cooling appliances and better building insulation. Increased use of electric cars and pumped storage are also being considered to ensure that maximum wind generation can be used at any given time (the government has set a target of one million hybrid and electric cars by 2014[60]).

In addition to the EU Directives,[61] Spain's energy efficiency policy is already laid out in a number of documents such as the Energy saving and Efficiency Action Plans.[62] Even if it is unclear if these plans will have had a significant impact on energy efficiency by 2012, the country's determination to improve its efficiency needs to be taken into account in the scenarios on gas demand with impacts in all sectors of consumption, most certainly in the time frame post 2020.

- **Where is the potential for gas demand growth?**

In total, natural gas demand in the non-power sectors still represented two third of gas demand in Spain in 2010. But since 2004-2005, the level of gas consumed has remained relatively flat. The major changes in gas needs from one year to another have come from the power sector [Figure 21]. This dynamic partly reflects the European situation where the non-power sectors have reached maturity. At best, much lower growth rates can be expected in the future, if not a flat demand. At worst, a decline can be envisaged (effects of efficiency measures). Only lower prices could trigger some recovery in the industry sector, reopening plants that have closed down during the recession and reducing relocations outside Spain.

Figure 21: Evolution of natural gas demand by sector, 2001-2010 (bcm)



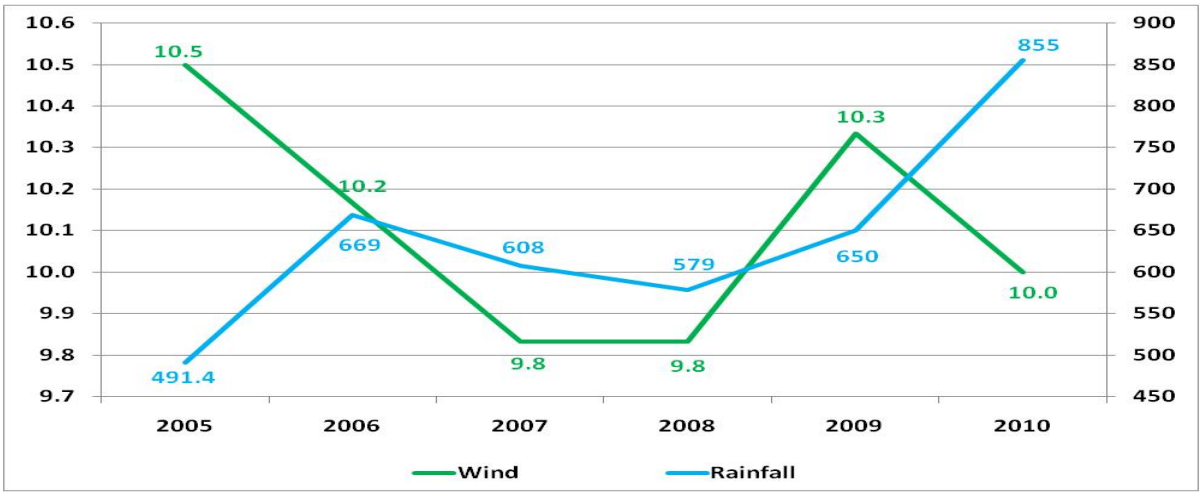
Source: Data from 2001 to 2009: CNE (2010), p.20 and Data for 2010: Enagás (2011), p.17

[59] New interconnections will also help, allowing more exports in times of high wind generation.
[60] IEA (2009), p.7
[61] Such as the EU Directive on Energy End-Use Efficiency and Energy services (2006/32/EC), which contains an indicative national energy target of 9% to 2016 for Spain; and the EU Directive on the Energy Performance of Buildings (2002/91/EC), which sets requirements for a more energy-efficient building code.
[62] See the IDAE (Institute for Energy Diversification and Saving)website for more information: http://www.idae.es/index.php/idpag.17/relcategoria.1022/relmenu.42/mod.pags/mem.detalle

The best hope but also the biggest uncertainty for future gas growth will be in the power sector. Electricity demand is recovering slowly, and will also be impacted by measures to improve efficiency and energy intensity (insulation, smart grids, etc). In this sector, lower gas prices may only have a limited impact on additional gas use. Renewable energy is a must-use technology. This is also true for hydro energy. The nuclear plants need to be run baseload due to high capital costs. These factors leave coal and gas as the marginal fuels. But from 2011 and until 2014, there is an obligation to include certain volumes of electricity produced from domestic coal in the electricity mix.[63] The place of gas in the generation mix is therefore less and less a factor of economic competitiveness and more and more a factor of renewable and hydro availability as gas is the balancing fuel. This was seen in 2010 for instance when the gas consumed for power generation declined by 15.7% compared to 2009.

Were there abnormally favourable conditions for renewable energy in 2010? Data shows indeed a much higher than usual level of rainfall in Spain [Figure 22], which explains some displacement of gas volumes due to better availability of hydro energy. On the other hand, the average wind speed was actually slower than in 2009. However, installed capacity is growing and even a lower than average wind speed could result in additional availability of wind energy from one year to another. Wind energy shows structural growth while this is not the case for hydro. 2010 production was exceptional but installed capacity is not growing [Figure 5, p.18]. There will be some additional pumped storage capacity [see Figure 30, page 46], which will provide flexibility in the system, but it will not increase annual hydro production. There are no more possibilities of significant increase of hydro energy in Spain[64], while wind energy is expected to continue to grow in the 2010s and beyond.

Figure 22: Evolution of annual average rainfall (right axis in mm) and average wind speed (left axis in km/h) in Spain, 2005-2010



Sources: Average wind speed was calculated from the Weather Underground website from six locations in Spain where wind turbines are located; the average rainfall is from Aemet, *Resumen anual climatológico* (various issues)

[63] See section '2.3. domestic coal'
[64] CNE (2008), Precios y costes de la generación de electricidad, p.2

2.3. Growth of renewable energy in the power sector

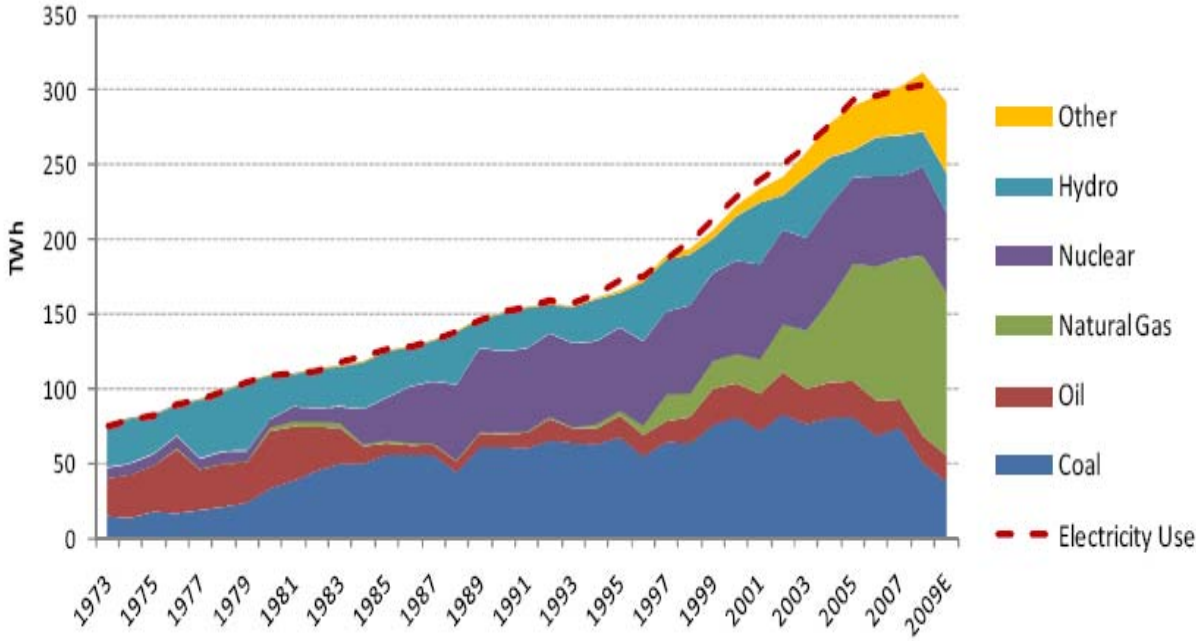
National political agendas and geographical constraints have fashioned the electricity and gas industries. In the future, Spain's energy policy and objectives will be increasingly derived from -and in line with European Union policies, such as the European Emission Trading Scheme (EU ETS), the Large Combustion Plant Directive (LCPD),[65] the Industrial Emission Directive (IED) or the 20/20/20 targets.[66]

- **Electricity generation**

Toward a low-carbon electricity generation

As in many other countries, natural gas became the fuel of choice for power generation in the mid 1990s and continued in the 2000s [Figure 23]. Much remains to be done in the transition toward a low-carbon electricity generation, but Spain is well under way with increasing renewable capacity, especially wind power.

Figure 23: Electricity generation by fuel in Spain, 1973-2009 (TWh)



Source: IEA, Electricity Information 2010, Part IV, IV.545, Figure 2

In 2010, despite the decline of electricity produced from CCGTs as a result of better availability of hydro, wind and nuclear [Table 8], it was still the main contributor with 23% of electricity

[65] 35 large coal plants and 5 other units are covered by the LCPD, while 5 units have opted out totalling 807 MW of capacity or 7% of coal generation. Source: IEA (2009), p.81

[66] See Honore (2010), Chapter 2, pp.60-66 for details of each of these measures

generation.[67] The Spanish wind power output reached 42,976 GWh. Spain took the first place in Europe for the first time, exceeding German output of 36,500 GWh.[68] In March 2011, wind power was for the first time the technology that brought the most electricity to the system on average for a full month.[69]

Table 8: Electricity generation by main fuel source in 2009-2010 (%)

	2009	2010
Hydro	11.1	14
Nuclear	19	21
Coal	12	8
Fuel/gas	1	1
CCGT	29	23
Wind	13.3	16
Solar	2.6	2
Other (such as cogeneration and other renewable)	12	15

Source: REE, The Spanish Electricity System 2010 and 2009

Spain is committed to the development renewable energy.[70] The legislation provides for a special regime, under which, all generation is subsidised above the market price. The special regime includes most renewable sources (with the exception of conventional hydro) and co-generation plants (primarily based on gas).[71] The Special Regime was first established in 1994, before the opening of the electricity market to competition. The rapid development of wind and more recently of solar power is a result of this legislative framework, coupled with favourable market conditions such as rising electricity prices, low interest rates and falling equipment costs.[72] The increase in renewable generation has come at a cost, as shown by the level of subsidies paid to renewable generation facilities. The total amount of subsidy paid to the special regime increased from 1.2 billion euros in 2005 to over 6 billion euros in 2009 [Figure 24] as a result of the growth of total special regime generation and the rising impact of solar PV. The feed-in tariff proved too successful: the government had expected that there would be 400MW of solar capacity in the country by 2010, but more than seven times that was installed.[73]

[67] Enagás (2011), p.144. Other gas-fired plants only play a minor role in electricity generation, and gas used in these plants amounted to 100 mcm in 2010 (Ibid, p.28).

[68] Wind met 16.4% of Spanish demand in 2010 compared to 6.2% in Germany.
Wind levels were much higher in Spain than Germany, and this situation could continue as Spain has a lower long run cost of generation (its wind farms tend to operate more hours per year -higher send-out-), has more modern turbines than in Germany and has a better network. Source: Power in Europe, 18 April 2011, p.20

[69] REE website

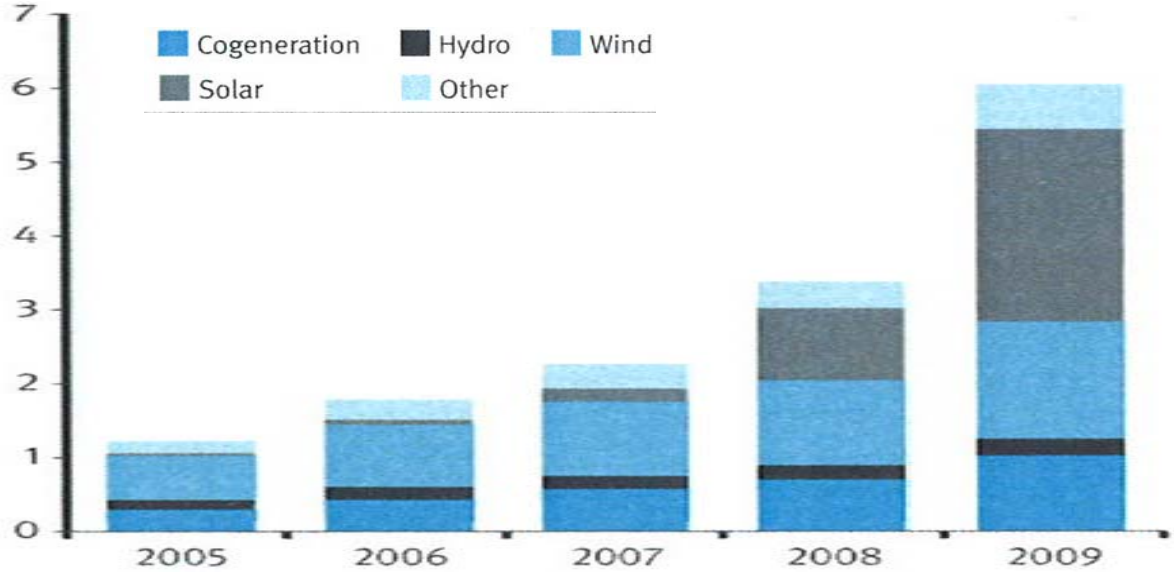
[70] See (list non exhaustive): Action Plan 2008-2012 (Plan de acción 2008 – 2012), Planificación de los sectores de Electricidad y gas 2008-2016, 2005-2010 Renewable Energy Plan, Plan de Energías Renovables 2011-2020 (Informe de previsión), Plan de Acción Nacional de Energías Renovables (PANER) 2010-2020.

[71] In 2007, there were only 6.1 GWe of installed CHP capacity and 90% were industry-related. The Action Plan 2008-2012 had a target to raise CHP capacity to 8.4 GWe by 2012, but Spain's mild climate limits the needs for CHP outside the industrial sector. Source: IEA (2009), p.42

[72] Federico (2010), p.95

[73] Financial Times, 'Renewables: Design of subsidy systems is crucial to their success', 29 October 2010

Figure 24: Evolution of subsidies for special regime generation, 2005-2009 (billion euros)



Source: CNE in Federico (2010), The Spanish Energy Sector, p.96

In 2010, the government recognised the need to reduce the cost of renewable support. On 23 December 2010, the Royal Decree Law 14/2010, which aimed at reducing the costs in the electricity sector, was published and effectively binding. The most dramatic impact will be in the solar PV generation sector. The Decree has the potential to reduce solar subsidies by up to 30%, and works by retroactively limiting the hours of production eligible to receive the government's feed-in tariffs.[74] As of June 2011, the wind energy support scheme was provided by Royal Decree 661/2007, which expires at the end of 2012. Wind farms registered in the Pre-Allocation Register for commissioning before the end of 2012 did have the right to receive an economic incentive, but this was not the case for projects that would come on line from 2013 onwards. By June 2011, Mityc still had yet to release details of incentives for wind plants that would come on line after that date.[75] But a new support scheme was unlikely to be adopted before the general elections in November 2011, and as a result, there may not be new regulation in place before mid-2012. In addition, in December 2010, Spain's government approved cuts to windpower subsidies totalling 35% between then and 2012. The cuts were expected to save 1.1 billion euros up to 2013.[76] The development of renewables is costly, and has already slowed down as a consequence of the economic crisis and of the regulatory uncertainty. It may continue to slow down in the future, especially if the economy does not get back to growth rates seen in the 2000s.

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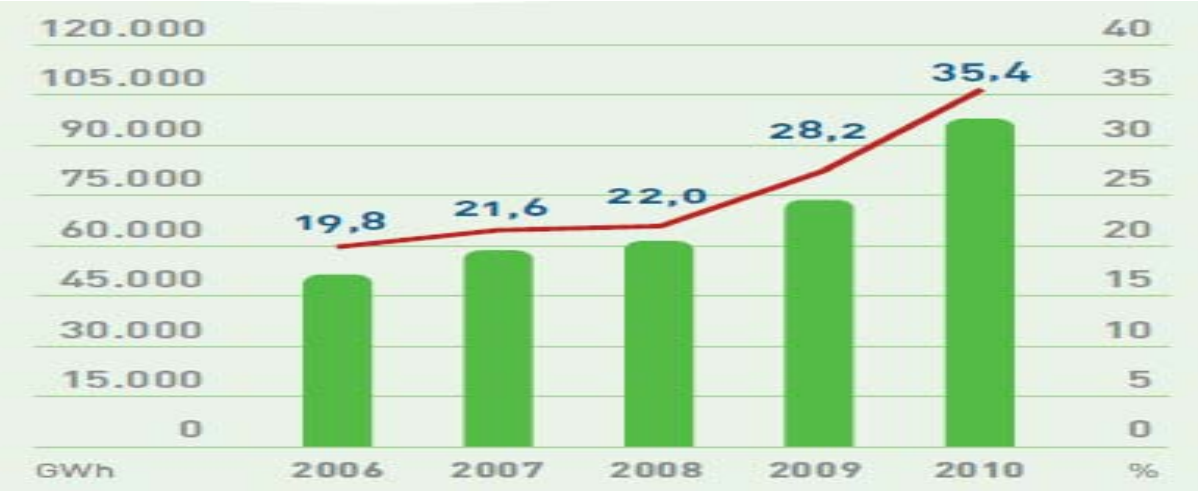
[74] Power in Europe, 7 February 2011, p.17 ; Royal Decree-Law (*Real Decreto-ley*) 14/2010 of 23 December 2010: http://noticias.juridicas.com/base_datos/Admin/rdl14-2010.html
The retroactive effect of the measure has been contested by PV trade bodies, solar investors, some Spanish regional authorities and the European Commission. European Energy Commissioner Gunter Oettinger also expressed his dissatisfaction with the law, warning that "forward-looking changes [to tariffs] may be understandable and necessary, but the European Commission will not accept retroactive amendments". See Infrastructure Investor, 11 March 2011, 'Parliament reinstates retroactive cuts for Spanish solar'.
[75] Power in Europe, 30 May 2011, p.9
[76] Reuters, Spain approves wind-power subsidy cuts of 35%, 3 December 2010

The rapid growth of renewable energy in electricity generation in Spain is illustrated in Figure 25. The share of electricity produced from renewable energy grew from below 20% in 2006 to more than 35% in 2010, while the total output doubled. Subsidies for renewable energy have accelerated this development of intermittent power.

Figure 25: Renewable energy in electricity generation, 2006-2010 (GWh and %)



Source: REE (2011), The Spanish Electricity System in 2010, p.11

Security of electricity is linked to variations in intermittent renewable generation, especially wind. Spain has successfully developed wind and solar generation, and more importantly, achieved the integration of a large amount of intermittent power into a well-integrated electricity grid to balance the unavoidable variations in wind power generation. Electricity generation cannot be 100% from renewable. The presence of flexible thermal power sources is essential, with CCGTs being the first choice thanks to low capex and flexibility, in addition to being cleaner and more publicly acceptable than coal and nuclear. With renewables increasing in the mix, conventional power stations that are backing up these plants, run fewer hours. The fewer hours they run, the more economic CCGTs become in comparison to other thermal sources because of lower up-front costs.

Intermittency of renewable and back up from gas

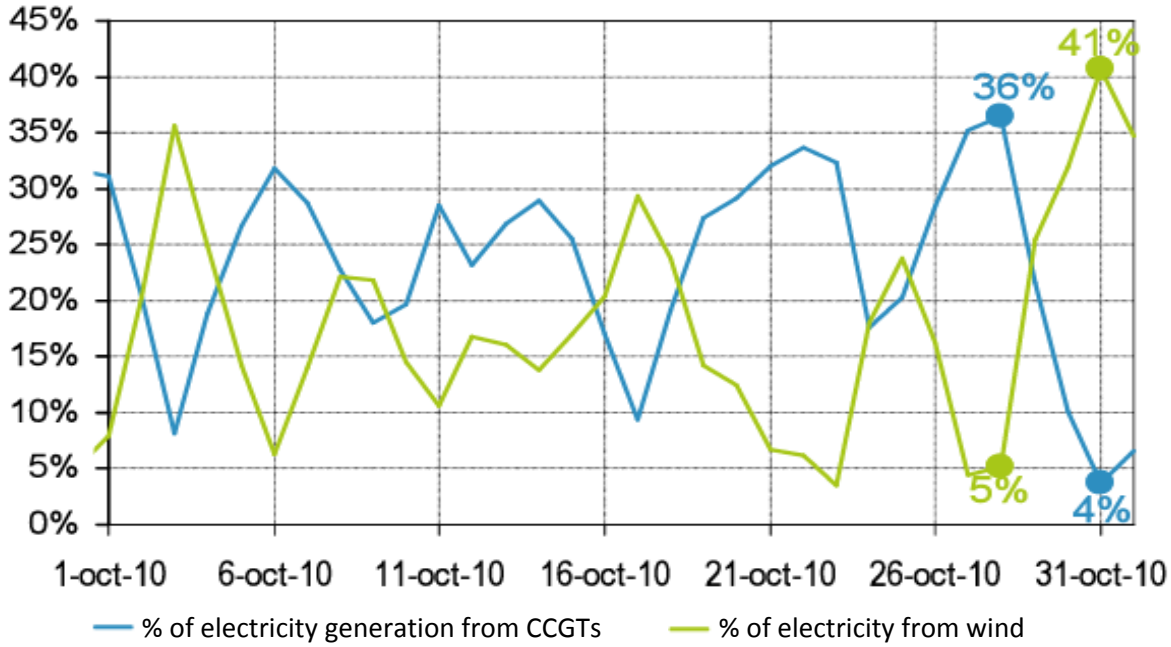
Hourly profiles of the different technologies are defined by the economics of each technology and by their availability. Technologies with low variable costs and higher fixed costs, such as nuclear, tend to operate in baseload mode. Special regime capacities, such as wind or solar for instance, also operate on baseload when they are available. However, they are volatile on an hourly/daily basis due to their inherent intermittency profile. Federico calculated that in 2009, special regime generation accounted for 14% of the flexibility requirement, which he defined as the difference between generation in time of peak and low demand. On other hand, thermal and hydro generation

provided the largest shares of the flexibility: CCGTs supplied 47%, hydro generation 19% and coal 17%.[77]

Power demand peaks when temperatures rise or drop to their extremes, which usually happens in times of high pressure, and therefore, when there is little or no wind, leading to increased use of air-conditioners or electric heaters. The system therefore needs to be backed up by other plants (to compensate for the lack of availability and intermittency of renewable energy), typically gas-fired with also some contribution from other fuels as shown on Figure 26, p.43.[78]

Figure 27 below shows the close relationship between the daily volatility of wind generation and CCGTs generation in October 2010. Electricity generation from gas varied from 36% to only 4% on October 28 and 31, 2010 due to variable wind generation (5% and 41% respectively).[79] On October 31 2010, wind generation in Spain reached record levels with 41% of electricity needs (3 days only after the CCGTs record level of 36%). On November 9, a record level of generation from wind was reached with 315 GWh/d, which is 16 times more than the minimum generation on September 2nd with 20 GWh/d.

Figure 26: Share of electricity generation from wind and CCGTs during October 2010 (%)



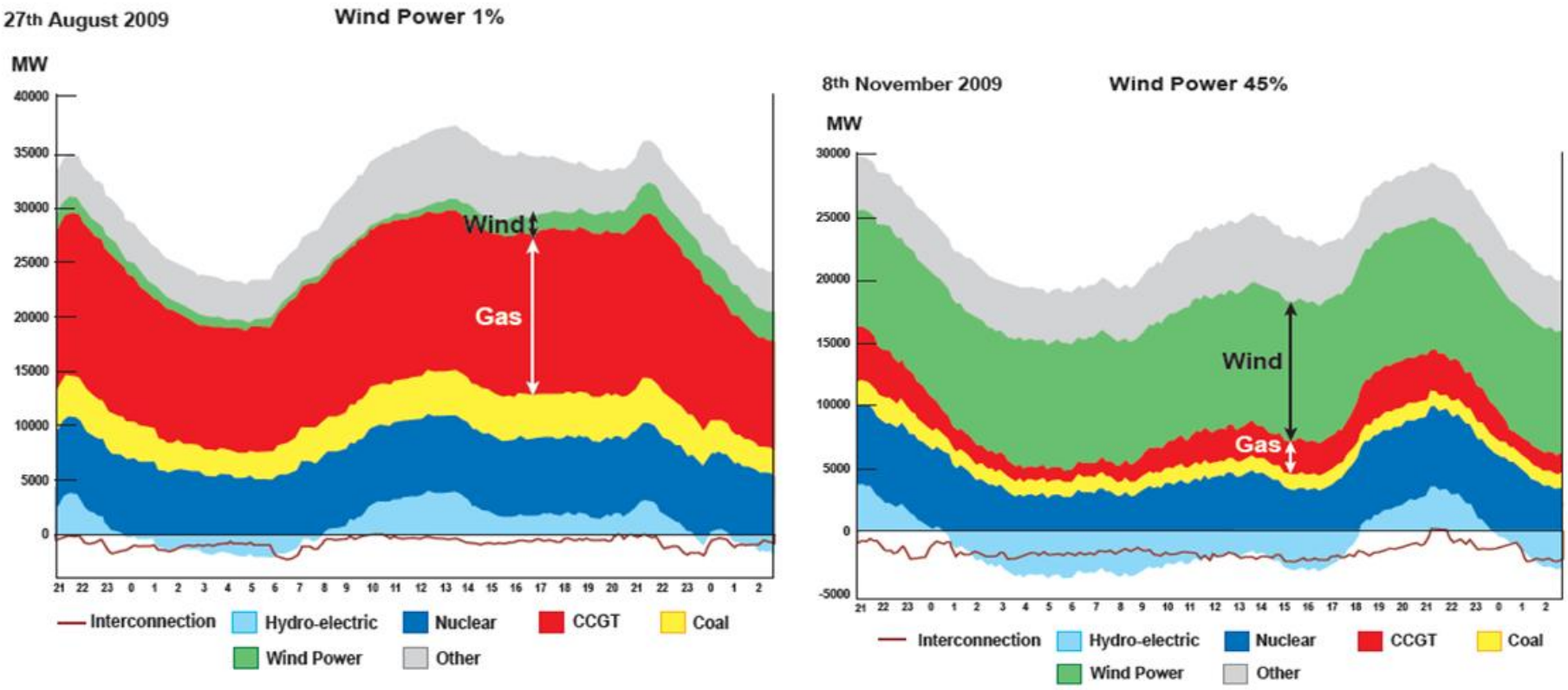
Source: Enagás (2011), p.26

[77] For more information, see Federico G. (2010), The Spanish gas and electricity sector: regulation, markets and environmental policies, pp.38-39

[78] See also Appendix 6. In addition, details of the control of renewable production by the system operator can be found on the Red Eléctrica website: http://www.ree.es/ingles/operacion/regimen_especial.asp

[79] Enagás (2011), p.41

Figure 27: Electricity generation in Spain on 27th August 2009 and on 8th November 2009



Source: REE, website statistics

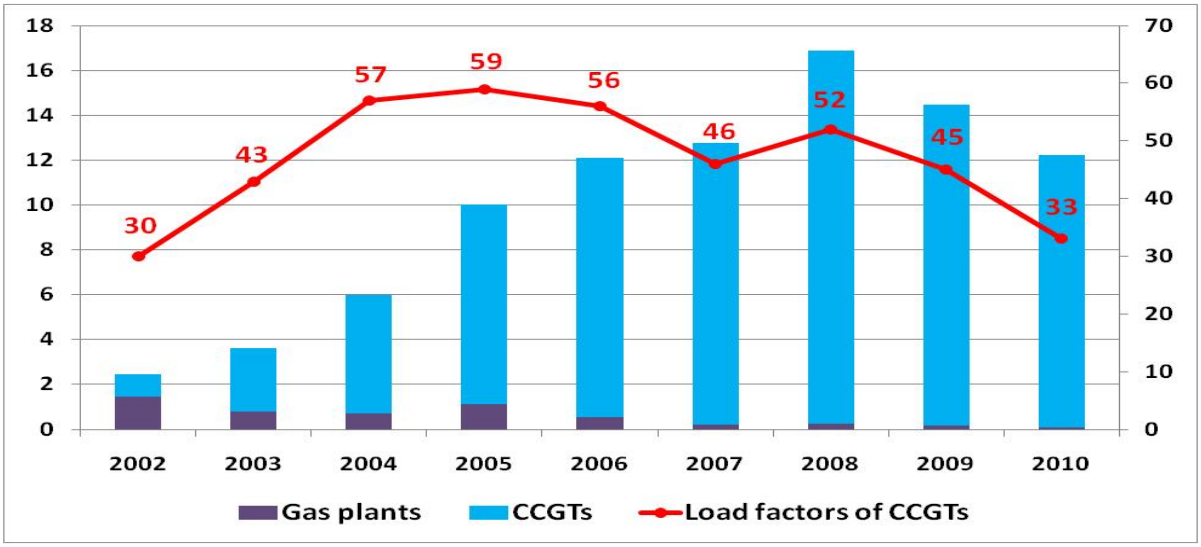
In addition to being used as back-up for wind intermittency, gas generation also plays an important role in times of peak demand. For instance, on January 11th 2010, the maximum peak load demand was 44 122 MW (7-8 pm), 36% of which came from CCGTs (19% hydro, 12% nuclear, 11% coal, 1% fuel/gas, 11% wind and 10% other).[80] CCGTs are the main technology used to relieve technical constraints (often transmission related) in the day-ahead market, accounting for 88% of increases in production and 79% of reductions in production. There is a 'technical restriction' market in which the CCGTs are chosen to overcome the problems related to the constraints. In the real time ancillary services market (after the day ahead market and the technical restrictions market are 'closed'), CCGTs are also the main technology used to provide tertiary reserve (up within 15 minutes and stay on for 2 hours) and to provide system balancing support, whereas in the secondary reserve market (up in 15 seconds and stay up for 15 minutes), CCGTs are the second most important technology after hydro.[81]

Impact on the load factors of gas plants and gas demand

Originally, Spain's CCGTs were expected to provide baseload power, and indeed the load factors were 50-60% for most of 2004-2008.[82] But CCGT running times have fallen from an average 3,618 hours of output between 2007 and 2009 (already lower than in the 2004-2006 period), to 2563 hours in 2010 or 33% of capacity [Figure 28].[83] In the first four months of 2011, the average running time was about 22%.[84] Lower load factors for gas plants have an important impact on gas demand.[85] A CCGT running at 35% load factor consumes about half the amount of gas than a plant running at 75% load factor. Under the country's 2011-2020 renewable plan, intermittent renewable energy is projected to increase further, making CCGT back-up even more important for balancing the system, and therefore potentially keeping annual gas volumes in the power sector low, but volatility of gas demand high.

[80] REE (2011), p.11. The maximum load coverage from the CCGTs was in line with the 2009 experience (44,440 MW, of which 37% came from CCGTs on January 13th) and in the 2007 experience (44,876 MW, of which 36% came from CCGTs on December 17th). In 2008, CCGTs covered only 27% of the 42,961 MW of peak load demand as wind generation was up to 18%. Source: REE, The Spanish Electricity System, various issues.
[81] Enagás (2011), pp.26-27
[82] At their peak in July 2008, load factors were at 60%. Source: REE website, statistics.
[83] See Appendix 12 for an evolution of the load factors of the various power plants in Spain between 2003 and 2010
[84] REE website, statistics
[85] For more info, see Honore (2010), pp.278-279

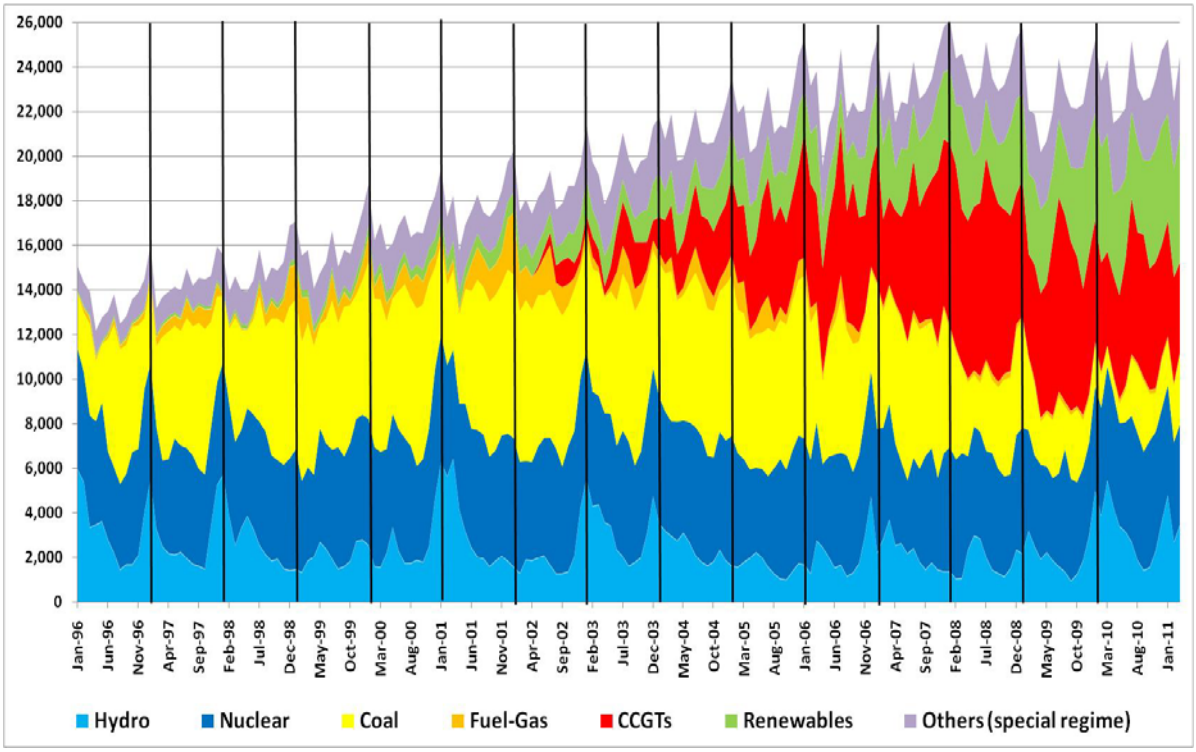
Figure 28: Natural gas consumption in gas plants and CCGTs (left axis, bcm) and CCGT load factors, 2002-2010 (right axis, %)



Source: Enagás (2011), pp.29-30

Peaks of electricity generation happen in the winter for heating purposes, which are covered by additional production from a wide range of technologies. On the contrary, peaks in the summer for cooling purposes are mostly covered by thermal technology, mostly CCGTs, as hydro and wind energy seem to be less available during July-August[86] [Figure 29].

Figure 29: Electricity generation by fuel in Spain, 1996-2011 (GWh)



Source: REE, Boletín Mensual, March 2011 (N.51) with data updated on 14 June 2011

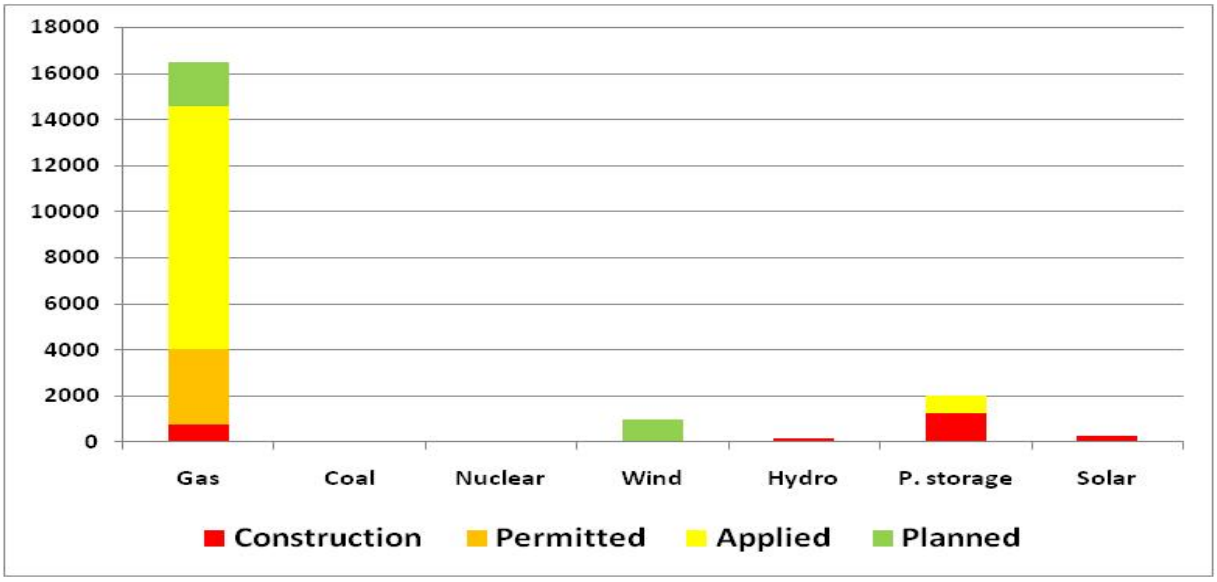
[86] REE (2011), p.6; p.9; p.11

- **Prospects for gas demand in the power sector**

Additional CCGTs to provide back-up for renewable energy

In 2010, there were about 100 GW of installed capacity in Spain, of which CCGTs represented 25% and wind turbine about 20%. Even if electricity demand does not increase significantly, additional plants with high flexibility will be needed to provide for back up of renewable energy.[87] This is reflected in power projects. As of June 2011, 1.3 GW of CCGTs had started operation since the beginning of the year. Gas is still very much the fuel of choice for new capacity, reflected in the capacity of new gas projects [Figure 30]. Other projects included hydro, pumped storage, solar and wind energy. It is difficult to track down all of the renewable projects, some of which are sometimes very small projects (less than 50 MW). So the capacity of renewable energy to be added could be higher than shown below.

Figure 30: Capacity of power plant projects in Spain, as of June 2011, in MW



Source: Platts (Power plants trackers) and author's additions

In the Energy Strategy,[88] it is expected that the capacity of gas power plants will increase from 26.8 GW in 2009[89] to 37.9 GW in 2020 (including gas-cogen).[90] For comparison, 2.2 GW have started operation in 2010, and 0.7 GW were under construction as of June 2011. 38 GW of gas fired capacity

[87] The Spanish electricity market is connected to the Portuguese market and the two countries form the MIBEL (Iberian Electricity Market). However, due to the size of the Portuguese market, we do not expect it to exert a major influence in the future on the gas plant load factors. Spain is also linked to the French market, but the interconnection capacity is limited [see Appendix 4]. Connections with these neighbouring markets are restricted and will remain so for the time being. As a result, the variations of renewable generation have to be dealt with nationally.

[88] Congreso de los diputados (2010)

[89] REE (2011), p.7

[90] Enagás (2011), p.113

Electricity generation at CHP plants accounted for about 12% of total electricity supply in 2008. Spain's mild climate limits the demand for heat outside industry. Source: IEA (2009), p.42

by 2020 would translate into 30.4 bcm of gas demand at 50% load factor, 25.1 bcm at 40% load factor and 19 bcm at 30% load factor. Significant additions of gas fired capacity will not automatically translate into higher gas demand given that renewable will operate in preference to CCGTs.

In mid 2011, the Mityc[91] submitted an order to the CNE to increase the amount generators are paid to build and operate gas and coal-fired plants. The document highlights a proposed increase in incentives for construction of generating capacity as well as a capacity payment for CCGT and coal plants to incentivise their operation as backup supply.[92] Capacity payments compensate fossil fuel-fired plants for providing backup power at times of either peak demand or low renewable output. If wind levels fall, CCGTs can be brought almost instantly into action to ensure continuity of generation within the national grid. The report mentions that the majority of the payments will go to CCGT plants as well as coal plants, which have seen production decrease since 2008 due to the growing renewable energy.

The capacity payment mechanism in Spain is thought to be insufficient to encourage new entry and may not even be able to prevent some of the existing thermal plants being decommissioned prematurely.[93] The UNESA, the Utilities Association of the Electricity Industry, advocates that market prices have been too low to compensate for the costs of production.[94] Their comparison between revenues per technology and costs show that coal and CCGTs do not cover operational costs, getting negative returns, while hydro and nuclear get returns lower than the capital costs.[95]

Interestingly, around the same time, another document ('Indicative energy planning') was published by the Mityc which stipulated that no new generation capacity was needed to meet peak demand for at least 10 years in Spain.[96] In other words, while the government proposes stronger incentives to build new plants, it is also predicting that there will be no need for new plants for ten years. This will probably contribute to increased uncertainty for the power generators. The proposed payments will not constitute a 'stable' price signals as they are subject to administrative adjustments. In addition, the result of the growing share of zero-marginal cost plants (hydro, wind, solar, and even nuclear) is an increasing number of zero-price periods, which will increase volatility of electricity prices. It may also lower the average level of prices earned by a CCGT plant, which will sell more and more of its output into other wholesale markets, including the markets for technical restrictions, intra-day sales, ancillary services and term contracts in order to respond to the system's need for more flexibility and to earn more.

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[91] The gas industry, as part of the energy sector, is regulated by the State Secretariat of Energy, Mityc and the CNE. The Secretariat is in charge of energy policy. It is supported in its role by the CNE, the regulator for electricity, natural gas and oil markets, but only as a consultative body as final decisions on regulations and on tariffs must be approved by the Mityc. The autonomous regions have vast powers relating to energy, especially in the authorisation of installations, but also in implementing climate change, energy efficiency and renewable energy policies at the regional level.

[92] Power in Europe, 13 June 2011, p.5.

[93] For additional information, see Federico (2010), pp.102-104 ; UNESA (2010) and Power in Europe, 13 June 2011, p.5

[94] Utilities association Unesa has five members: Endesa, Iberdrola, Gas Natural Fenosa, HC Energía and E.On España

[95] UNESA (2010), La situación económico-financiera de la actividad eléctrica en España: 1998-2009, pp.10-11

[96] Ibid

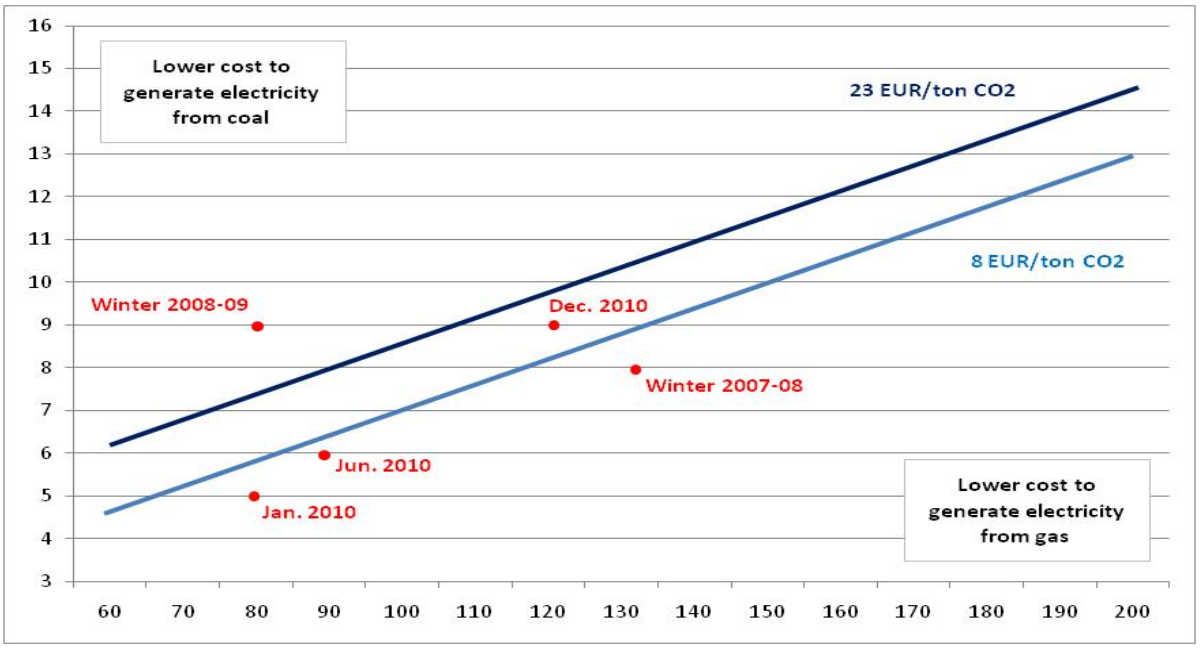
The heavy financial burden of renewable energy on the Spanish system, along with the continued economic downturn and the existence of excess generation capacity, could lead to political pressure to slow-down the growth of renewable capacity.[97] Revision of subsidies for solar and to a lesser extent wind may be the first signs of such trends.

Uncertainties also exist on coal and nuclear capacity in the Spanish system. Environmental targets could reduce coal-fired capacity and post-Fukushima uncertainties could pose problems for life-extensions of nuclear reactors. If some coal and nuclear baseload capacity declines, then part of it could be replaced by hydro and renewable when the wind blows and the sun shines, but it will also inevitably have positive impacts on gas demand, with CCGTs potentially running longer times on baseload mode.

Domestic coal policies

Regarding fossil fuels, CCGTs are in theory in competition with coal. The utilisation rate of each technology depends on natural gas and coal prices, but also on the prices of CO_2 permits [Figure 31].

Figure 31: Coal, gas and CO_2 prices and electricity generation



Source: Enagás (2011), p.28

But domestic coal production continues to receive large subsidies. Operating aid to coal mines is gradually declining but remains considerable. In 2005, it amounted to 503 million euros. In 2007, it was down to 450 million euros.[98] In February 2010, the government introduced Royal decree

[97] According to UNESA, on a bill of 100 euros, 22.5 euros are for renewable premiums. The rest is split between the cost of generation (24.8 euros), transport (4.6 euros), distribution (16.2 euros), taxes (18.7 euros), previous deficits (6.1 euros), extra-peninsular compensation (3 euros) and other (4.1 euros). Source: UNESA (2010), slide '*El coste de suministro y la facture eléctrica*'

[98] International Energy Agency (IEA), OPEC, OECD, World Bank (2010)

134/2010 aimed at guaranteeing a minimum level of output at ten plants that burn domestic coal, representing 9.5 GW of capacity.[99] The scheme sets a financial compensation to be paid to the owners of the ten power plants and mandates the dispatching of these plants.[100] The merit order established by the day-ahead market will be amended via a 'preferential dispatch mechanism' to the extent necessary to ensure that the ten plants can place pre-defined volumes of electricity generated from indigenous coal on that market.[101] As a consequence, subsidized domestic coal plants will be included in the merit order at the expense of other plants initially accepted in the market. The excluded plants will be chosen based on their emissions levels.[102] As a result, coal plants burning imported coal will first be excluded, followed by gas plants. The maximum volumes of electricity generated from the ten domestic coal plants will be around 23 TWh in the period 2011-2014.[103] The scheme will expire on 31 December 2014 at the latest.[104] The guaranteed income will go alongside annual operating aid for the mines. In total, it is expected to involve about 2 billion euros-worth of government aid over a four-year period.[105]

All domestic coal is used for power generation, where it contributed to 7.6% of power supply in 2010, and Decree 134/2010 will ensure that it continues to remain part of the generation picture in the foreseeable future. The greater part of 23 TWh reserved for domestic coal until 2014 will reduce the output of plant operating on imported coal, while the impact on CCGTs would be only about 7-8 TWh.[106] In other words, the domestic coal requirement will not take a major share of gas generation; however, for a maximum of another three years until end-2014, it imposes a minimum amount of coal generation, which cannot be replaced by gas, even in periods when gas is more competitive.

Impact of the Fukushima disaster?

In 2011, Spain had eight nuclear reactors including the first commercial nuclear power reactor which began operating in 1968. The nuclear power fleet produced 62 TWh in 2010, which represented some 20.2% of electricity consumed in the country. On average, the reactors operated for 7,946 hours each, or over 90% load factor. Three reactors have licences requiring renewal in 2011, and another is due in 2014.

The Socialist government in place in 2011 came to power on an anti-nuclear platform, but has been increasingly positive about nuclear power. In 2011 the responsible minister said that nuclear plants were 'essential for the supply of electricity in Spain' and that almost all nuclear power units 'will be open, operating and even repowering' until 2021 and that 'nuclear energy will be useful as a source of electricity for cars,' which the government is promoting, hoping to have one million on the road by 2014.

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[99] An amended version of this legislation (Royal Decree 1221/2010) was authorised by the European Commission in September 2010 under the state aid rule and promulgated on 2 October 2010.
[100] World Gas Intelligence, 6 January 2010, p.4
[101] European Commission (2010), State Aid No. N 178/2010 Spain, paragraph 12
[102] Federico (2010), p.101
[103] European Commission (2010), paragraph 62, table 4
[104] Ibid, paragraph 34
[105] Financial Times, Spain to win EU approval for coal state aid, 27 September 2010
[106] European Daily Electricity Markets, Spanish law boosts coal-fired output over gas, 28 February 2011

Spanish policy in 2011 was to gradually reduce the share of nuclear power in the energy mix, but keeping the existing plants running for the course of their life time. In February 2011, Article 79 of the Sustainable Economy Law (LES) was amended by the Congress to allow an undefined extension to the 'useful lives' of the country's eight nuclear reactors. All political parties except the minority left supported the amendment. The LES originally maintained a nuclear plant operating life of 40 years (for which most plants were originally designed), but the amendment eliminates any set time reference for existing plants.[107]

Post-Fukushima, this situation seems unchanged. The Mityc approved a 10-year extension of the operating licence for Iberdrola's 1,095 MW Cofrentes nuclear power plant in Valencia on June 2011. The reactor will be 37 years old when the new permit expires in March, 2021.[108] On the other hand, on July 2011, the Supreme Tribunal backed the industry ministry decision to close the 466-MW Garoña nuclear plant in July 2013, while the Nuclear Safety Council (CSN) had issued a report stating that the plant was in condition to continue functioning until 2019.[109] This decision could in theory open the way for nuclear closures for reasons of political concerns above and beyond safety issues. The plant was 40 year old in April 2011 and its reactor was identical to the one at Japan's Fukushima plant.

While existing plants are expected to remain in operation until the end of their operating lifetimes, there is a moratorium on new nuclear plants in the country, which was decided in 1983 (and confirmed in 1994)and led to the abandonment of several construction projects. It remains in place for the time being, with no intention from the government to cancel it.[110] There were no plans for new nuclear plant construction even before March 2011.

Phasing out nuclear capacity will make the power sector more carbon-intensive and therefore increase the difficulty of achieving carbon reduction targets. In addition, it is very difficult to obtain administrative consent for coal-fired plants and the development of the carbon capture and storage (CCS) technology on a commercial basis is still uncertain. As a consequence, almost all the new capacity will continue to be gas-fired, hydro and renewable. When nuclear plants retire post 2020-2025, if CCS technology is not yet ready, then we may see a renewal of gas demand in order to produce baseload generation, as least as a transition fuel (but how long is undetermined).

[107] Power in Europe, 21 February 2011, p.20
[108] Power in Europe, 13 June 2011, p.17
[109] Power in Europe, 25 July 2011, pp.19-20
[110] http://www.world-nuclear.org/info/inf85.html

III/ REPERCUSSIONS FOR THE NATURAL GAS INDUSTRY

3.1. Rapid development of infrastructure to suit double digit growth of gas demand

Indigenous gas production is negligible and represented 13 mcm in 2009 (0.04% of the national consumption and 0.004% of the production in OECD Europe).[111] Since the mid 1990s, it has played a limited –and declining- role in meeting the country's gas needs [Table 9]. As a consequence, Spain imports more than 99% of its gas needs both via pipelines and as LNG. Looking ahead, there are limited prospects for any substantial increase in indigenous gas output due to the lack of gas resources.

Table 9: Rising gas import dependence in Spain, 1985-2010

	1985	1990	1995	2000	2005	2010
Import dependency	89.30%	74.40%	95.10%	99%	99.50%	99.90%

Source: IEA, Natural Gas Information, various issues and Monthly Survey for 2010 data

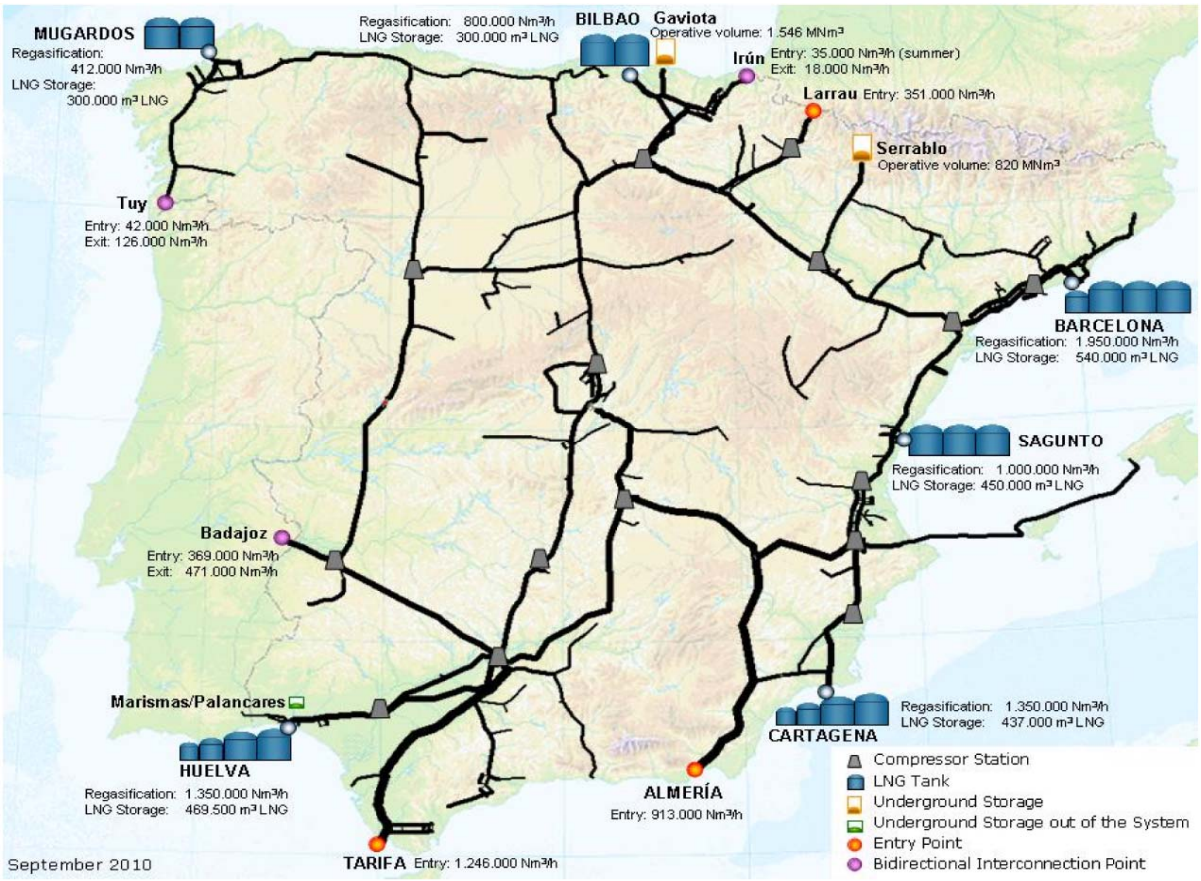
- **Import capacity**

Spain is situated in southern Europe bordered to the south and east by the Mediterranean Sea; to the north by France, Andorra and the Bay of Biscay; and to northwest and west by Portugal and the Atlantic Ocean. The country has more regas capacity than any other country in Europe. It also receives gas via pipeline from Algeria and Norway, via interconnections with France [Map 2].

Spain has traditionally been the largest importer of LNG in Europe and it was still Europe's largest and the world's third largest LNG importer after South Korea and Japan in 2010. In the first four months of 2011, the first place was taken by the UK, the fastest growing LNG market in Europe since imports restarted in 2005.[112] Spanish natural gas supplies are well diversified thanks to heavy investment in LNG infrastructure. By December 2010, there were six LNG regas terminals around the country, accounting for 60 bcm/y of import capacity, with a seventh plant under construction in Asturias (El Musel) on the north coast, which is expected to start operation by the end of 2012 [Table 10].[113] All regas plants are subject to regulated TPA allowing all market players (including new entrants) the access to new capacity.[114]

[111] IEA, Natural gas information statistics
[112] Waterbone LNG, statistical data
[113] Enagás (2011), p.58. See also 'Appendix 7: List existing and planned capacity (LNG, interconnections and storage) in the Plan 2008-2016'
[114] CNE (2010d), *Spanish Energy regulators annual report to the European Commission*, p.73

Map 2: Points of entry to the Spanish gas market in 2010: LNG regas terminals and pipeline interconnections



Source: Enagás website, September 2010[115]

Table 10: LNG regas capacity in Spain as of June 2011

	Location	Start-up date	cm/h	bcm/y	Storage cm (liq)	Company
Existing	Barcelona	1969	1950000	17.1	540000	Enagás
	Huelva	1988	1350000	11.8	460000	Enagás
	Cartagena	1989	1350000	11.8	437000	Enagás
	Bilbao	2003	1400000	7	300000	Bahia de Bizkaia (BBG)
	Sagunto	2006	1000000	8.8	450000	Saggas
	Mugardos/El Ferrol	2007	413000	3.6	300000	Reganosa
Under construction	El Musel (expected in 2012)	2012	800000	7	300000	Enagás
TOTAL		-	8263000	67.1	2787000	

Sources: GIIGNL Report 2010, p.25 and Enagás website for El Musel

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http://www.enagas.es/cs/Satellite?blobcol=urldata&blobheader=application%2Fpdf&blobkey=id&blobtable=MungoBlobs&blobwhere=1146251514017&ssbinary=true. See also 'Appendix 1: Map of the West-European natural gas market' and 'Appendix 2: Map of the Spanish natural gas market in 2010'

In 2010, Spain imported 24% of its gas needs. The country has five gas import pipelines from Algeria (via Morocco), Norway (via France) and Portugal [Map 2]. The total import capacity was 52 mcm/d or about 18 bcm per year [Table 11]. The Medgaz pipeline, which links Algeria directly to Spain, added 8 bcm of annual import capacity when it started operation in March 2011.[116] In addition, all the interconnections to Portugal and France are reversible.[117]

Table 11: Capacity of gas interconnectors, in 2011

	Connection point	Starting date	Capacity (mcm/d)	
			Imports	Exports
France	Larrau	1993	9	2.7 (winter) 4.5 (summer)
	Irun	1998	0 (winter) 0.9 (summer)	0.45 (winter) 0.81 (summer)
Morocco	Tarifa (GME)	1996	32	-
Portugal	Badajoz	1996	9.5	12.1**
	Tuy	1996	1.1	5.1
Algeria	Almeria (Medgaz)	2009*	23.9	
TOTAL			75.5 (winter) 76.4 (summer)	20.4 (winter) 22.5 (summer)

* Physical flows of gas imports started in March 2011

** 8 mcm/d are reserved for the Portuguese market, therefore only 4.1 mcm/d are destined for the Spanish market

Source: Enagás (2011), p.92

By June 2011, there was 86 bcm of import capacity, which represented 2.4 times the level of demand in 2010 (36 bcm). The cost of infrastructures is becoming an important issue. Since the costs are regulated, the transport, regas and distribution costs have to be high enough to cover investment plus a return.[118] This results in high tolls and tariffs, potentially penalising the economics of the CCGTs against other fuels especially in the power sector where gas has to compete with coal or in the residential sector where gas competes with gas-oil for heating purposes. It could also potentially increase the costs of exports to other (European) countries.[119]

- **Natural gas flows**

In 2010, natural gas supplied increased by 0.4% compared to 2009. LNG represented 76% of gas imports [Figure 32 and Table 12], a record since the start of operation of the GME in October 1996. The rest (24%) was delivered by pipeline via interconnections at Larrau, Tarifa, Badajoz and Tuy.

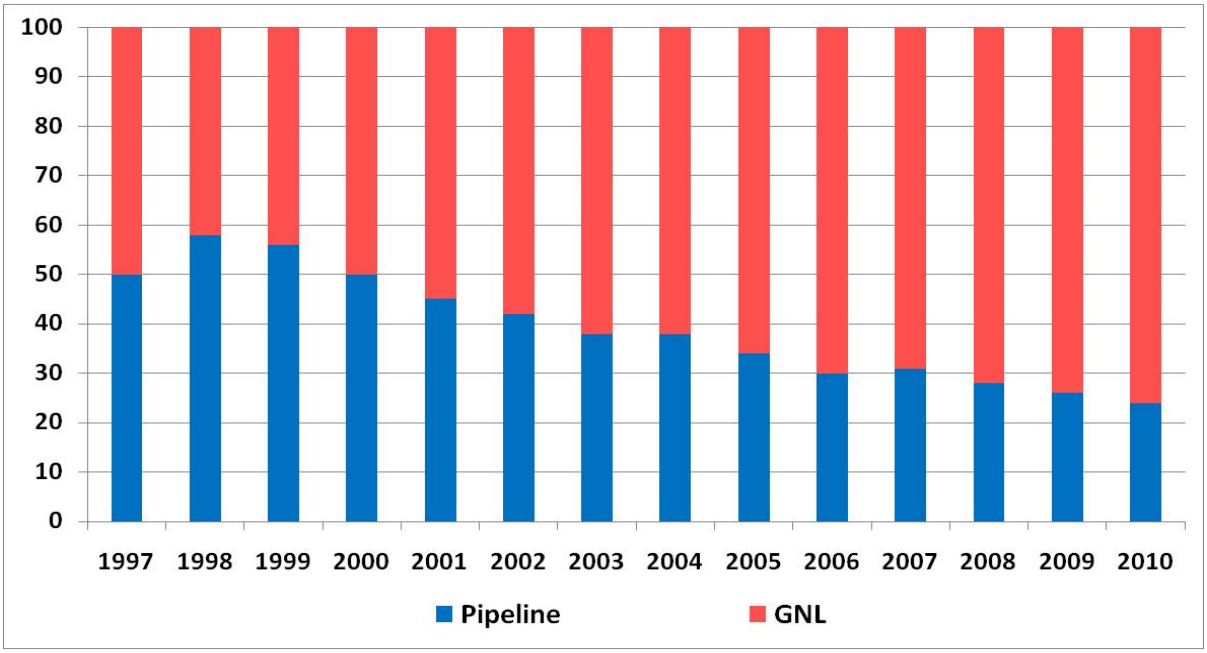
[116] World Gas Intelligence, 06 April 2011, p.5

[117] IEA (2010), p.15

[118] The government approves rates, tolls and fees for natural gas and publishes them in the Official Spanish Gazette. In an annual rate exercise, variations to be applied to sale rates, tolls and levies of natural gas are determined so as to cover the regulated costs of the system. The tariff model applied in Spain is the entry-exist model with a single balancing area. Source: CNE (2011d), pp.62-63

[119] See also section '3.3. Developing supply and demand flexibility of the internal gas market'

Figure 32: Natural gas imports: pipeline versus LNG, 1997-2010 (%)



Source: Enagás (2011), p.41

Table 12: Natural gas supply by point of entry and indigenous production in 2010

		mcm	%
LNG	Barcelona	6 973.6	18.7
	Cartagena	3 846.4	10.3
	Huelva	6 104.5	16.4
	Bilbao	4 559.4	12.2
	Sagunto	5 014.2	13.5
	Mugardos	1 664.0	4.5
Pipeline	Tarifa (GME)	7 145.8	19.2
	Larrau	1 677.3	4.5
	Badajoz	163.4	0.4
Indigenous production		108.1	0.3
TOTAL		37 256.7	100

Source: Enagás (2011), p.40

Delivered volumes of LNG increased by 2% in 2010, due to the arrival of 435 tankers. This was 35 tankers less than in 2009, but the average size of cargos was larger. 1.5% more gas was produced from the regas plants and the storage levels in tanks in the six regas facilities was 47% of capacity on average (7% less than the year before).[120]

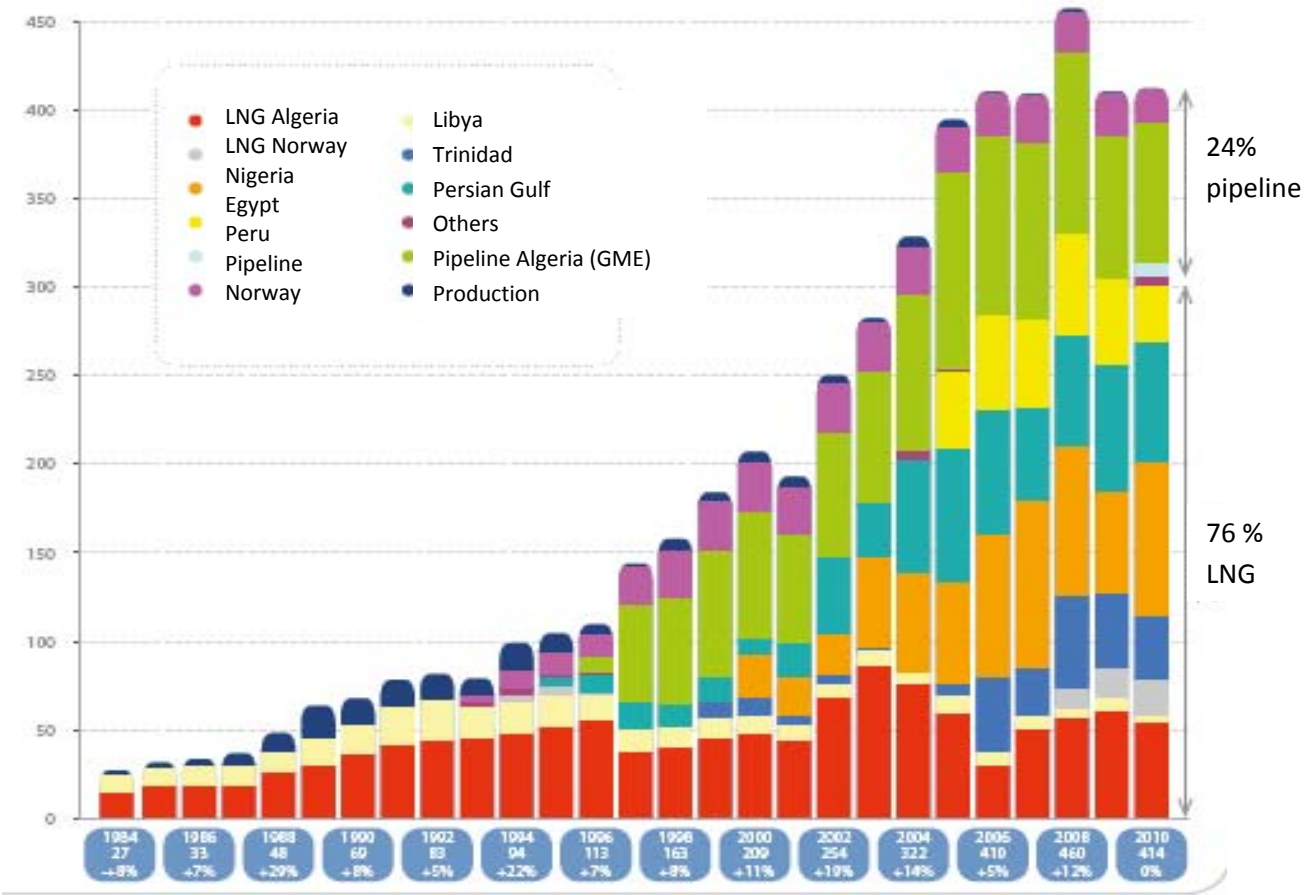
[120] Enagás (2011), p.9 & p.145

- **Diversity of suppliers**

Spain has coped well in meeting gas (and electricity) needs despite exceptionally strong growth in the 1990s and 2000s, and the development of intermittent renewables in the 2000s, thanks to the rapid development of its energy infrastructure. The country has also been leading the way in gas diversification (routes, origins) and LNG development.

In 2010, there were 15 exporters of gas to Spain [Figure 33],[121] one more than in 2009, with the addition of imports from the new liquefaction plant at Pampa Melchorita in Peru. This diversity of supply sources and routes is especially important to the Spanish market, which is almost entirely dependent on imports to fulfil its gas needs and, as shown above [Table 9], has limited interconnections with the rest of the European market.

Figure 33: Evolution of natural gas imports by origins, 1984-2010 (TWh/y)



Source: Enagás (2011), p.13

By June 2011, the country had a large import flexibility margin. However, export flexibility seemed to be much lower. In 2010, exports increased by 8.8% versus 2009. Most volumes were sent to Portugal via pipeline to supply CCGTs [Table 13][122] Some LNG volumes were also re-directed.[123]

[121] Enagás (2011), p.8.
[122] Enagás (2011), p.9

Table 13: Flows of pipeline gas in 2010 (mcm)

	Imports	Exports	Balance
Tarifa GME	7,145.82	-	7,145.82
Larrau	1,677.33	-582.39	1,094.94
Poseidon+Marismas	108.09	-72.54	35.55
Tuy	-	-54.99	-54.99
Badajoz	163.44	-456.57	-293.13
Irun	-	-37.89	-37.89
Total	9,094.68	-1,204.38	7,890.30

Source: Enagás (2011), p.50

- **Annual supply and demand balances**

With import capacity representing more than twice the level of demand, there will be no lack of physical entry points to import gas to fulfil the needs of the Spanish market. As a result, to gain a better understanding of supply and demand balances up to 2025, we compare contracted gas volumes (as of June 2011) and demand scenarios [Figure 34].

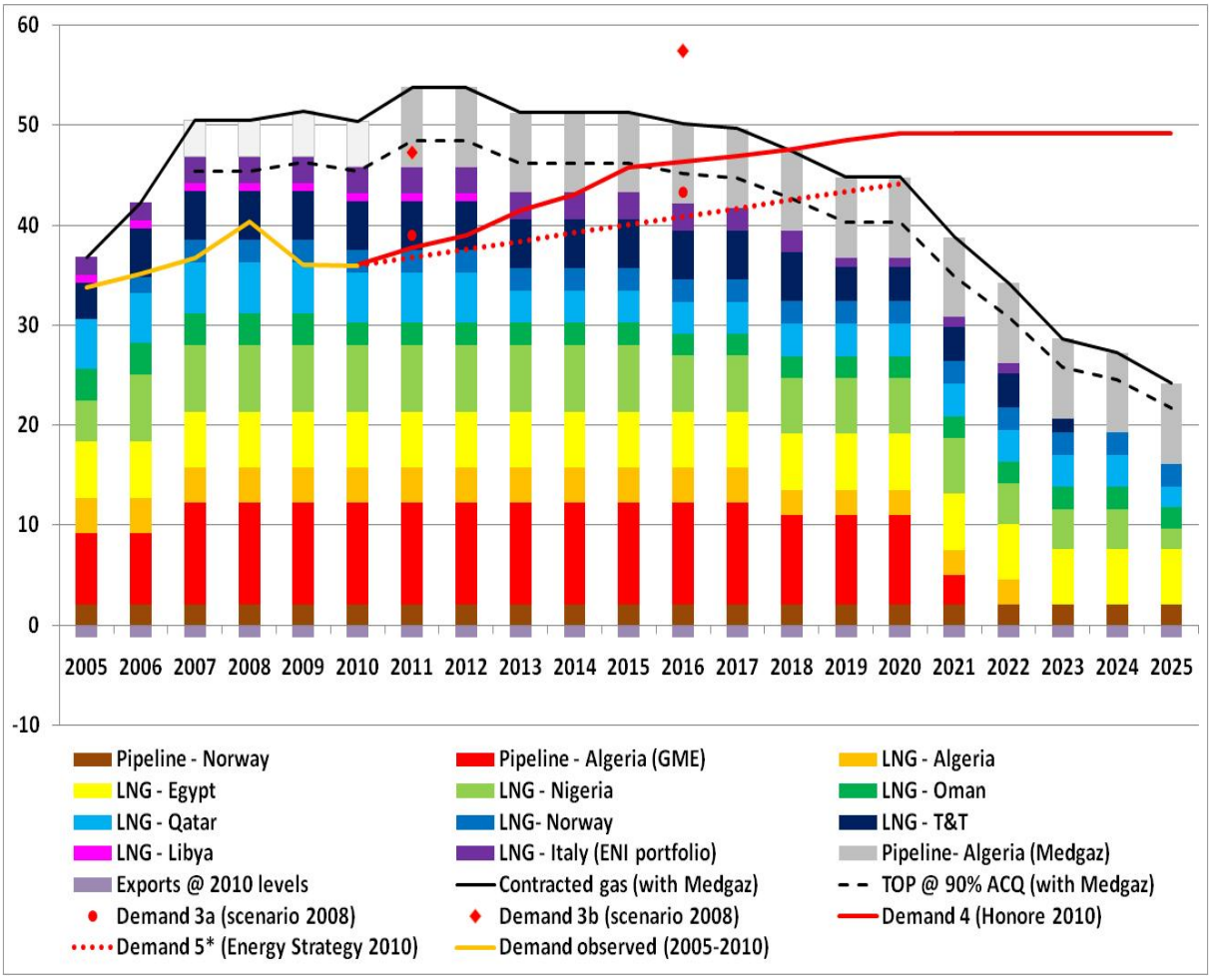
The market has been in a situation of oversupply for the major part of the 2000s.[124] The gas contracts portfolios of the different operators were big enough to guarantee market supply safety and also take into account the possibility that some operators could divert gas from their contracts if the price offered in other markets was more attractive. In addition, following the gas market liberalisation and the surge in demand in the 2000s, companies signed gas supply contracts on a long term basis in order to secure market shares in the rapidly growing Spanish gas market. A major part of these volumes was dedicated for CCGTs. However, as explained earlier, the rapid development of renewable energy has reduced the need for baseload generation from gas plants, especially when large hydro reserves are available. During the 2000s, the excess contracted volumes have not reached Spain, as a result of first, force majeure declared by the producers or delays in construction of liquefaction plants, and second, contractual flexibility that allowed the diversion of cargoes towards other markets.[125]

Developments in the power sector coupled with the 2008-10 economic crisis and the slow recovery, explain why Spain is long in gas. Gas has been contracted (i.e. on an annual contracted quantity – ACQ- basis) in excess of projected consumption levels (demand scenario 4 in Figure 1), ranging from a surplus of 16.1 bcm/y in 2011 to 2.7 bcm/y in 2017, which corresponds to a cumulative quantity of 60 bcm between 2011 and 2017. The surpluses rise to 17 bcm/y in 2011 to 0.6 bcm/y in 2020 in the case of slower demand growth (demand scenario 5 in Figure 1), for a cumulative quantity of 93.4

[123] For instance, Iberdrola signed a 10-year contract with DONG Energy of Denmark in 2010. Iberdrola agreed to supply 1bcm/y of LNG at the Gate terminal in the Netherlands, which is expected to start operation in autumn 2011. Source: Global LNG Markets, 3 June 2011, p.7.22.
[124] Yaceh (2010), Long-term LNG contracts flexibility, p.8
[125] Ibid

bcm between 2011 to 2020. Assuming a take or pay level at 90% of ACQ, the cumulative surplus in demand scenario 4 is 28.2 bcm until 2015 and 50.9 bcm in demand scenario 5 until 2018. Post 2018 or 2020, depending on the demand scenario, the Spanish gas market will need to secure additional gas volumes, but if gas demand in Spain stays flat at 2010 levels, then the country has enough contracted gas to meet its requirements until 2021 [Figure 34]. Post 2020, contracts start to expire, and volumes decline rapidly.

Figure 34: Contracted gas for imports as of June 2011 and gas demand scenarios in Spain, 2005-2025 (bcm)



* Demand 5: scenario between 2010 and 2020 has been revised upward by this author to start at 36 bcm in 2010 (observed demand). The other scenarios for gas demand have been left identical to those presented in Figure 11, p.26.

Sources:

- Contracted gas: GIIGNL, The LNG industry in 2010, table on long-term and medium-term contracts in force in 2010, and author's analysis
- Demand scenarios:

⇨ demand 3a: Plan 2008-2016 published in 2008, p.385 (conversion factor: 1 TWh = 0.09 bcm) ;

⇨ demand 3b: Plan 2008-2016 published in 2008, p.386 (conversion factor: 1 TWh = 0.09 bcm) ;

⇨ demand 4: Honore (2010), p.293 ;

⇨ demand 5: Energy Strategy published in 2010, p.88. (conversion factor: 1 Mtoe = 1.047 bcm and revised upward by this author to start at 36 bcm in 2010)

The Medgaz pipeline finally started commercial operation in 2011, after several delays. Some contracts for gas delivered via the pipeline seemed to have a starting date in 2007 and 2009.[126] It is unclear whether the delivery of these volumes has been delayed until 2011 or if they have been delivered in the form of LNG. Medgaz's owners,[127] who officially signed their supply contracts in April 2011, are expected to have negotiated a level of flexibility in their contracts - some of which are known to be 20 years in length, but for reasons of confidentiality, sources are reluctant to discuss the details of their deals.[128] It was too soon to make any definitive analysis at the time of writing (June 2011), but it appears that swaps between LNG and pipeline volumes may have happened in April and May 2011 as the share of LNG in the import mix fell while Algerian pipeline exports to Spain increased.[129] There were also signs that the pipeline was not being fully utilised, and expectations are that it will not be any time soon.[130] It is therefore expected that Medgaz will not oversupply the market further, since most of those signed-up for capacity through the pipe already have LNG supply portfolios.

Some LNG contracted to Spain has flexibility of destination FOB (Free On Board) such as the contracts with Egypt, Libya, one contract with Trinidad and Tobago and some contracts with Qatar; or can divert cargoes to alternative markets within DES (Delivery Ex-Ship) contracts providing a profit sharing between parties, such as the contracts with Algeria, Nigeria and Norway.[131] However, despite being more easily redirected than pipeline gas, some restrictions on LNG cargoes diversion may exist for various reasons such as vessel sizes and LNG quality (Libyan LNG), or destination clauses to non EU markets (such as Qatar FOB contracts that are not necessarily divertible to all markets just because they are FOB).[132] Companies such as Gas Natural, Repsol and Unión Fenosa Gas have global market portfolios and can sell their LNG outside Spain. Iberdrola acquired some regas capacity in Phase III of the Isle of Grain terminal in UK in 2007.[133] Another solution would be to increase exports, especially towards France and the rest of Europe, but this would require additional physical interconnections.

3.2. Coping with growing fluctuations of gas demand

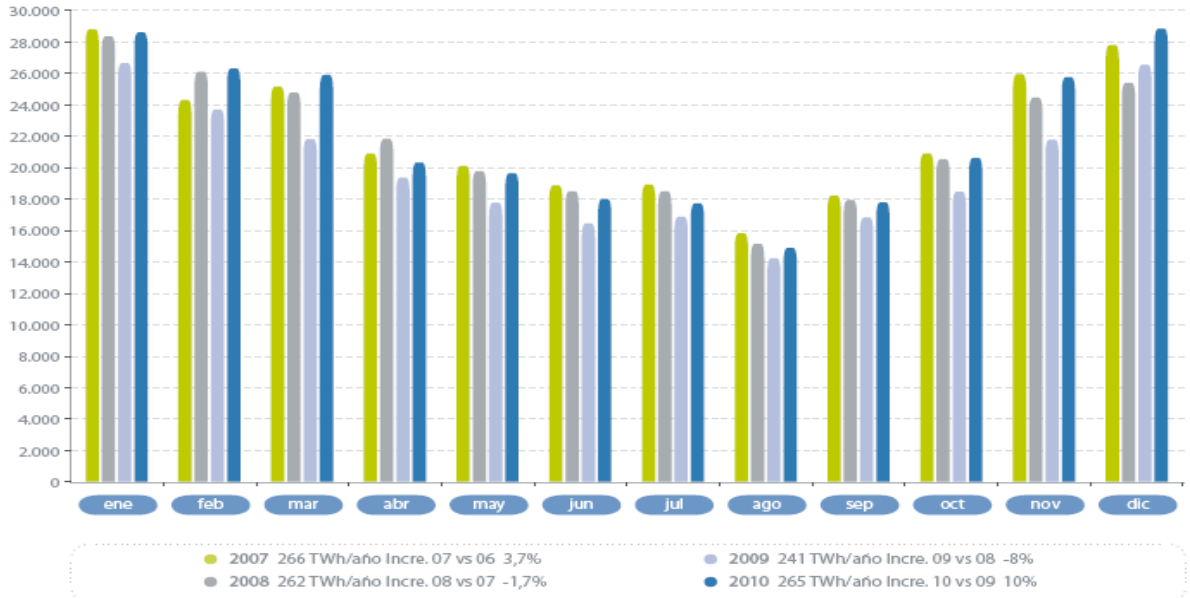
- **Fluctuations of demand: seasonality and peaks**

Spain has a different demand pattern compared to the other European markets, with a higher proportion of industrial and electrical demand (CCGTs) and lower seasonal variations, due to warmer weather in winter and use of air conditioning in summer, which renders the annual gas consumption

[126] See Gas Matters, January 2006, 'Sonatrach signs Medgaz supply contracts with Cepsa and Inberdrola', p.33
[127] The Medgaz operating company is owned by the five companies involved in the gas supply agreements. The five hold equity stakes in the venture in the same proportion as the new gas supply deals, with Sonatrach holding a 36% stake, Iberdrola and Cepsa 20% each and Endesa 12% and GDF Suez 12% each. Source: International Gas report, 11 April 2011, p.23
[128] European Gas Markets, 26 May 2011, p.4
[129] Global LNG Markets, 13 May 2011, p.12, Global LNG Markets, 17 June 2011, p.8
[130] European Gas Markets, 26 May 2011, p.4
[131] GIIGNL (2011), pp.15-17
[132] Destination clauses in European contracts have been suppressed but restrictions can be added in contracts for re-exports to non-EU markets.
[133] Iberdrola and Centrica acquired the third phase of 5 mtpa of LNG in May 2007. Source: http://www.nationalgrid.com/uk/grainlng

much flatter than in the rest of Europe.[134] Nonetheless, some seasonality patterns exist. Gas demand in the non-power sector is higher in winter due to gas used for heating [Figure 35].

Figure 35: Monthly natural gas demand variations in the non-power sectors, 2007-2010 (GWh/m)



Source: Enagás (2011)

In 2010, a record level for gas consumption in the non-power sector was reached on 16 December with 104.9 mcm/d.[135] There were five cold spells which led to gas demand peaks and five operational alerts (*notas de operación*[136]) were published in the period from January 7 to 15 (9 days), February 10 to 18 (9 days), March 5 to 18 (14 days), November 26 to December 5 (10 days) and December 15 to 20 (6 days). There was however no interruption in supplies to customers. 24 January 2011 set a new record daily level of demand of 106.1 mcm during a cold spell.[137]

Gas use for power generation, however, has considerable swings in demand as it depends on the availability of wind, hydro and nuclear power, with gas being used as the balancing fuel. In addition to being used as back-up for wind intermittency,[138] CCGTs also play an important role in times of peak demand as CCGTs are the main technology used to provide tertiary reserve (start up within 15 minutes and stay on for 2 hours) and to provide system balancing support. As a result, natural gas

[134] See Honore (2010), Chapter 8, pp. 193-225 for comments on seasonal variations of gas demand in Europe and Honore (2011) for comments on temperature-corrected statistics, Appendix 1, pp.37-42

[135] Enagás (2011), p.16

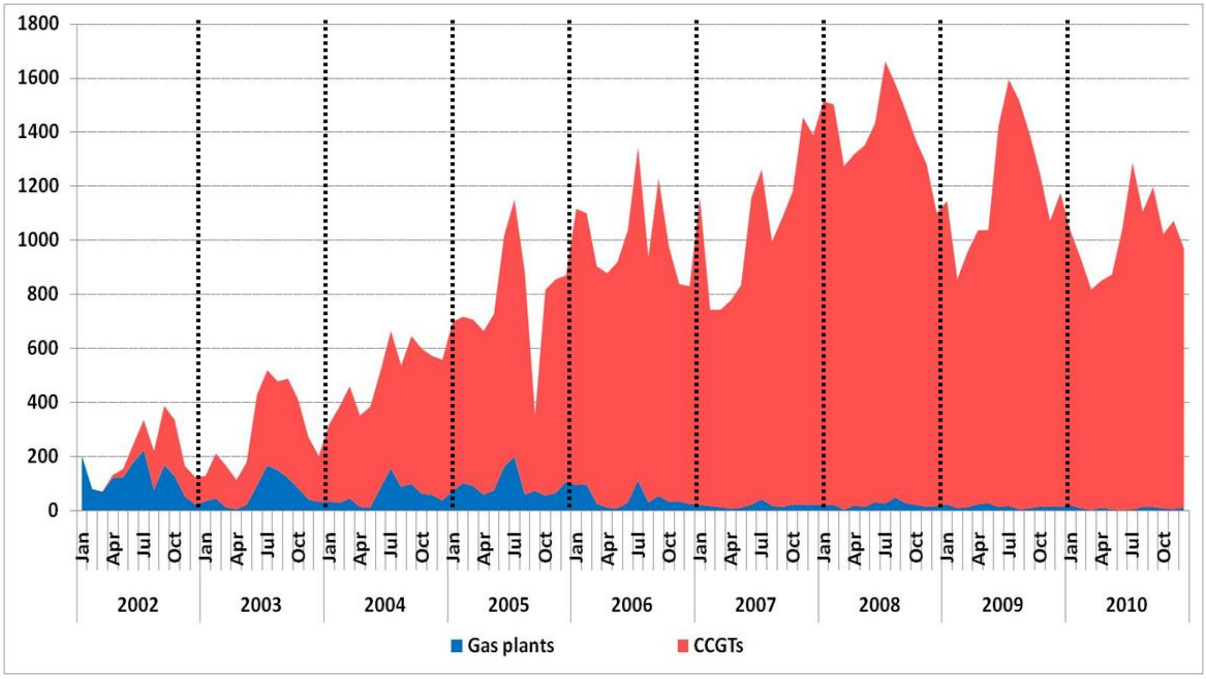
[136] The operational alerts (*notas de operación*) are published by Enagás to inform the market players of possible constraints in the network. They are a formal way of communicating notice of expected exceptional situations such as cold weather or LNG cargoes being redirected to other markets and therefore of a need to watch minimum levels at a regas facility and of the impact of past incidents on the transport/distribution network. The operation notes are published on the Enagás website: http://www.enagas.es/cs/Satellite?cid=1146231702495&language=en&pagename=ENAGAS%2FPage%2FENAG_listadoComboAnio. Source: Enagás (2011), p.163

[137] Enagás (2011), p.24.
The record level for total gas demand was on 17 December 2007 with 167.7 mcm/d (Enagás 2011).

[138] See section '2.3. Growth of renewable energy in the power sector'

demand for CCGTs is highly volatile, with peaks in winter and in summer (which is when wind speeds are lower) and significant variations not notably seasonally linked [Figure 36].

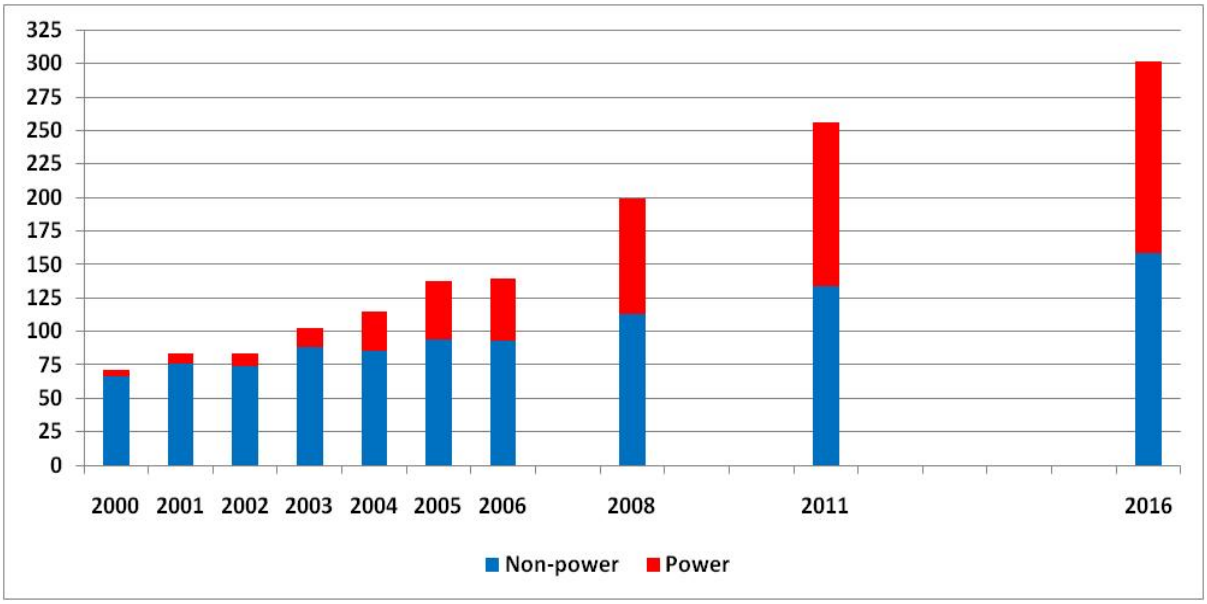
Figure 36: Natural gas used in CCGTs and other gas plants by month, 2002-2010 (mcm)



Source: Enagás (2011), pp.29-30

With the development of gas demand in the power sector and the increasing need for back-up technology to balance the electricity system, gas demand is expected to continue to display large fluctuations in the future, even with the development of efficiency measures, as suggested by the Plan 2008-2016 (published in 2008) as shown in Figure 37.

Figure 37: Peak gas demand in the non-power and in the power sector, 2000-2016 (mcm/d)



Source: Secretaria General de Energía, Planificación de los sectores de electricidad y gas 2008-2016, p.389 (original unit in GWh/d, conversion factor: 1 GWh/d = 0.09 mcm/d)

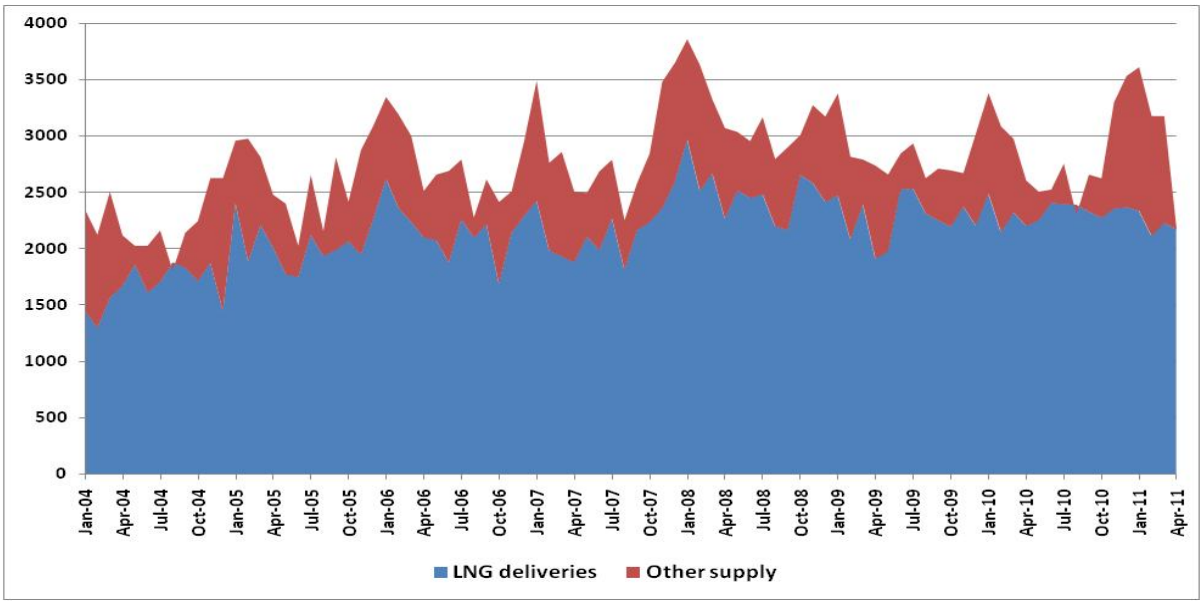
Peak demands for gas in the non power sector coincide with higher demand for electricity and therefore, potentially higher demand for gas in the power sector (i.e. gas used for power generation). As a result, the gas market needs to be able to supply simultaneous peak demands in both the non-power and the power sectors. High demand volatility means high supply flexibility. The system needs to be able to cope with instantaneous requirements of additional gas.

- **Flexible supply capacity**

Utilisation rate of regas terminals

The need for flexibility tools for the management of the system had already increased with the expansion of the gas grid and of residential gas consumption. Spain has been able to attract many spot LNG cargoes to respond to demand peaks thanks to third party access (TPA) to key infrastructure. LNG is providing most of the flexibility in supply, mirroring the fluctuations of gas demand [Figure 38]. Most of Spain's CCGTs are located near Spain's LNG terminals, which means that these CCGTs can be ramped up quickly to react to drops in wind power generation by regasifying stored LNG in the rapid-cycle LNG tanks. LNG offers the flexibility to respond quickly to the intermittency of wind for CCGTs while the baseload profile of pipeline interconnections (including Medgaz) seems to be more suited to the industrial and conventional consumption sectors.[139]

Figure 38: Monthly natural gas demand and LNG deliveries in Spain, 2004-2011 (mcm)



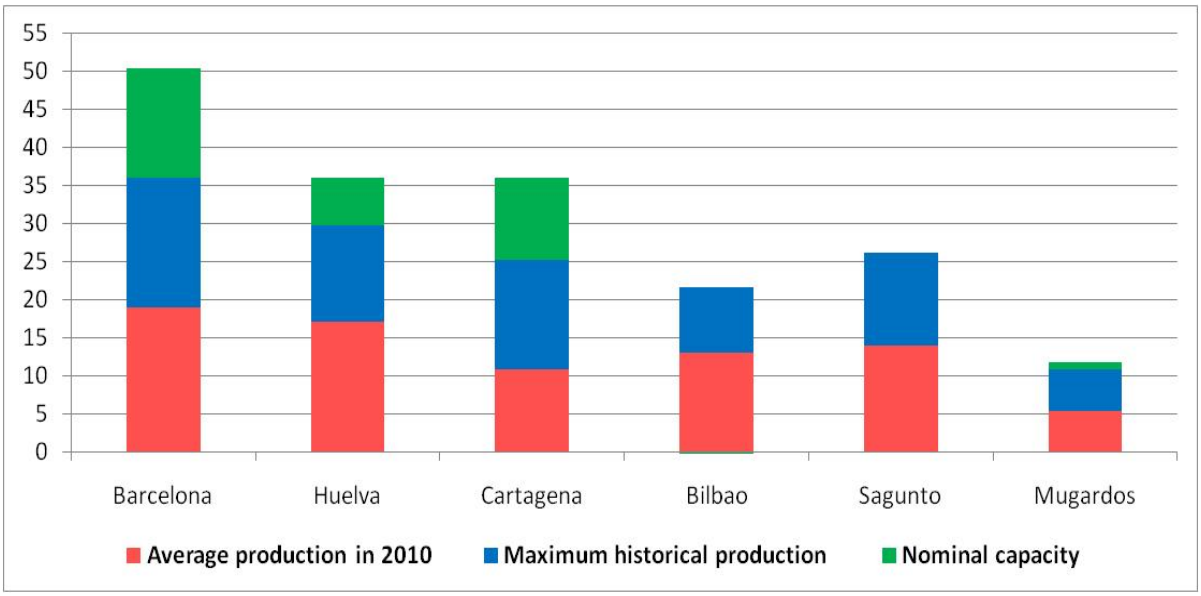
Sources: IEA, Monthly statistics and Waterbone LNG

A quarter of regas capacity, and capacity in the storage, transportation and distribution system is reserved for short term contracts (i.e. less than two years) to respond to peaks in gas demand.[140] This results in an apparent under-utilisation of the LNG terminals [Figure 39]. For instance, in 2010,

[139] See Appendix 9 and Appendix 10 for utilisation rates of installed LNG and pipeline import capacity in 2010.
[140] IEA (2009), p.70

the utilisation rate of the regas plants was 43% of the nominal capacity and 67% of contracted quantity.[141] On the other hand, during the cold spell on 30 November 2010, production at the Barcelona regas plant reached a record level of 36 mcm/d,[142] (which was still significantly below nominal capacity).

Figure 39: Regas capacity and utilisation in 2010 (mcm/d)



Source: Enagás (2011), p.61

Utilisation of the network

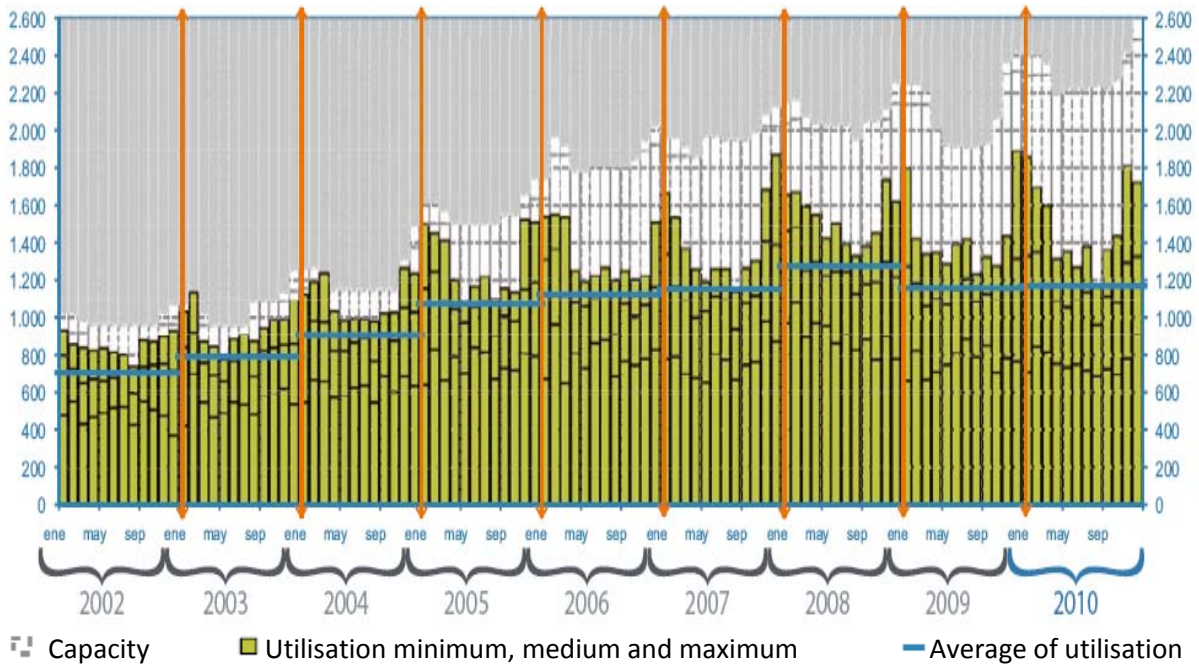
As already mentioned in Section 1.3 (page 22), the network is planned according to scenarios of gas demand. Investment in gas infrastructure is obligatory and managed by the government under a national infrastructure investment plan in a non-discriminatory, transparent manner. At the time of witting (June 2011), the 2008-2016 Infrastructure Investment Plan was in force.

The Spanish gas network has been designed according to many factors, among which was secure supply in case of simultaneous demand peaks in the non-power and the power sectors. The Plan ensures that there is sufficient gas infrastructure in place to move gas to the required off-take points, including power stations.

The government publishes annual revisions of its mandatory planning in order to ensure the necessary infrastructure is built in accordance with demand scenarios. Mandatory planning is based on a system of guaranteed returns and imposes no risk for investors. As a consequence, the gas network has been successfully expanded in parallel with the fast increase in gas demand. Although this system comes at a cost, the capacity has been developed ahead of need and in 2010, there was enough flexibility to cope with potentially tight situations [Figure 40].

[141] Enagás (2011), p.61
[142] This was 7% more than the previous record on 27 January 2005. Source: Enagás (2011), p.9

Figure 40: Network capacity and utilisation in Spain, 2002-2010 (GWh/day)



Source: Enagás (2011), p. 119

The network code regulates the normal operation of the system but also its operation in case of special situations (i.e. supply disruptions, peak demand, etc.).

Storage

Spain has two underground storage (UGS) facilities, operated by Enagás. They are both old natural gas fields which have been depleted and contained a total working gas capacity of 2.37 bcm in 2010,[143] which represent and only 7.5% of annual gas demand. Storage is complicated in Spain by the challenging geology, which increases the cost of storage and lead times for bringing new projects on line.[144]

The Serrablo gas field is located between the towns of Jaca and Sabiñánigo (Huesca) with a working gas capacity of 0.82 bcm. Gaviota is an "off-shore" gas field located near Bermeo (Vizcaya) with 1.55 bcm of working gas capacity. New underground facilities are planned at Yela in the Guadalajara region, which will be the third UGS (1.05 bcm by 2011) and Castor in the Castellon region (1.8 bcm by 2012). In March 2010, a total of 4.6 bcm of additional working gas capacity were under construction and 1.3 bcm was in the permitting phase.[145]

Thanks to its investments in LNG technology, Spain also has LNG storage capacity located all around the coastline with a total working gas capacity of 1.8 bcm [Table 14]. In 2010, three new LNG tanks, representing 150 000 cubic metres (cm) of LNG of new storage capacity, were added in the last three

[143] Enagás (2011)
[144] IEA (2005), Country Review, Spain, p.101
[145] GSE investment database on GSE website, March 2010 (retrieved on March 2011)

months of the year at the Barcelona, Cartagena and Huelva regas plants.[146] There will be two more LNG storage tanks of 150000 cm each at the El Musel terminal.

Table 14: Capacity of LNG storage as of 31 December 2010

	LNG (cm)	Gas (mcm)
Barcelona	690000	424.4
Cartagena	587000	361.0
Huelva	619500	381.0
Bilbao	300000	184.5
Sagunto	450000	276.8
Mugardos	300000	184.5
TOTAL	2946500	1812.2

Source: Enagás (2011), p.59

In 2010, the average level of LNG storage capacity in use was 47% [Table 15], down by 7% compared with 2009 and accumulated extraction and injection of the UGS increased by 44% and 61% respectively.[147]

Table 15: LNG storage level in 2010

	Level of storage		Days less than 50% full
Barcelona	47%	Average = 47%	216
Huelva	51%		178
Cartagena	45%		245
Sagunto	42%		266
Bilbao	55%		142
Mugardos	43%		238

Source: Enagás (2011), p.61

- **<u>Security of supply measures</u>**

Because Spain is almost 100% dependant on gas imports (which is expected to continue), security of supply is very important issue for the country. In addition to the EU Regulation on security of supply,[148] Spain has developed its own set of rules.

The Hydrocarbons Act of 1998 established the first principles of security of supply, namely the requirement for natural gas companies to store minimum security stocks. The Royal Decrees of July 2004 and December 2007 strengthened the measures with requirements to maintain minimum stocks of natural gas.

⇨ The shippers have to keep strategic stocks all the time. Because the stocks are strategic, they are controlled by the government and must equal ten days of their previous year's sales

[146] Enagás (2011), p.10
[147] Ibid. See also Appendix 11.
[148] See EU Regulation 994/2010 of 20 October 2010 on security of gas supply.

- ⇨ The shippers also need to keep commercial stocks (equal to two days of previous year's sales)
- ⇨ In October of every year, they have to keep an additional eight days of commercial stocks for the winter period.[149]

The TSO allocates storage volumes to the companies, which in return pay regulated tariffs.
The Royal Decrees of July 2004 and December 2007 also provided rules on diversification of sources of imported gas, which are possible thanks to heavy investment in LNG infrastructure. Large companies (more than a 7% share of the market) cannot import more than 50% of their gas sales from one source or country.

Each year, the Mityc updates the Winter Action Plan, which includes mandatory provisions for all shippers in order to strengthen security of supply in winter, when demand for power and for residential use increases. The Plan typically includes a minimum entry flow in the Spain-France interconnector at Larrau, mandatory minimum stock levels in LNG terminals and limitations on the use of underground storage to preserve stock levels.[150]

The Spanish system has been designed to be highly flexible. As a consequence, demand management measures have not been a priority, even if interruptible clients exist (usually power generators).

Spain appears to have excess security of supply at the cost of having to divert contracted cargoes, potentially at a loss relative to contract price. In the future, it is expected that Spain's main problem will not be having to cope with peak demand and tight supply only, but rather increasing periods of low demand for gas (typically in times of high renewable and hydro availability). During this time, it will need to find ways to balance the system, which will require new forms of flexibility. One of these would be to develop a liquid gas market (hub) interconnected with the rest of Europe.

3.3. Developing supply and demand flexibility of the internal gas market

- **Liberalisation of the market**

The development of a successful gas hub requires the liberalisation of the market with third party access (TPA) to infrastructure, and the introduction of competition between market players. As a general rule, the greater the number of market participants, the more liquid the market.

The Spanish gas market differs from others in Europe in many ways, one of which was its rapid pace of market liberalisation, four years before the 2007 target date set by the EU directives.[151] The Hydrocarbons Act (Law 34/1998) started the liberalisation process with the progressive removal of regulated tariffs for end-users, starting with the opening to competition to the industrial sector in 1999. All Spanish customers have been eligible to choose their gas supplier since January 2003. On

[149] IEA (2009), p.73.
[150] IEA (2009), p.73
[151] Enagás (2011), p.55

July 1st 2008, all regulated tariffs were removed.[152] To protect smaller consumers,[153] a cost-covering Last-Resort Tariff (TUR[154]) was created, which is the maximum price that the last resort suppliers can charge small customers. The Hydrocarbons Act (article 63) also required the legal unbundling of activities: regulated tasks such as operating LNG plants, storage, transmission and distribution should be separated from liberalised activities. Law 12/2007 amending the Spanish Hydrocarbons Act was adopted in July 2007 in order to comply with the provisions of the gas directive 2003/55/EC and introduces new unbundling requirements, but companies had already adapted their structures according to legal unbundling requirements.[155]

The structure of the Spanish wholesale gas market remains characterised by the pre-eminent position of the incumbent company Gas Natural, but as a result of the liberalisation process, the market share of Gas Natural has decreased over the past few years[156] and other companies have consolidated their positions. Despite the still existing concentration, the Spanish wholesale gas market remains less concentrated than those of most European countries.[157] The TPA to the entry capacity of LNG terminals has proven to be crucial for the development of competition.

As of 28 April 2011, there were 54 companies authorised to sell gas in the national market.[158] Gas Natural, the traditional incumbent, has seen its retail market share fall from 70% in 2000 to less than 40% by the end of the decade [Figure 41]. This has been driven by new companies (primarily power companies) entering the gas market to secure their own gas supplies.

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[152] Boletín Oficial del Estado, n.158, 3 July 2007, Ley 12/2007 (see also CNE (2010b), p.28 and Orden ITC/2309/2007)

[153] Small consumers are defined as those taking gas from the low-pressure network (4 bar or less) with an annual use of 50,000 kWh or less (50 cm). Source: Boletín Oficial del Estado, n.137, 29 June 2010

[154] Tarifa de último recurso: TUR

[155] CNE (2010d), p.63

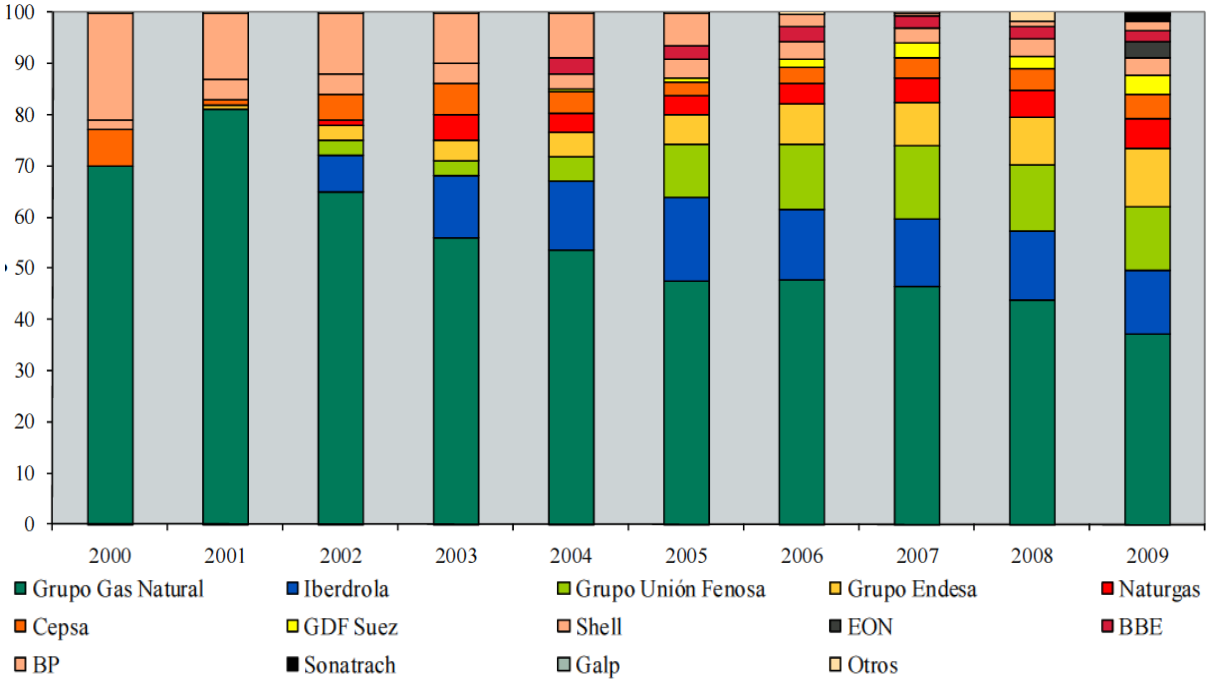
As of July 2010, it is reported that the CNE was examining whether there was a need to introduce further changes to Spanish legislation in order to comply with the requirements set by the European Directive 2009/73/EC in the field of unbundling. Ibid, p.65

[156] This was partially reversed in 2009 with the acquisition by Gas Natural of joint control of Unión Fenosa Gas (UFG) with ENI. For more information on the acquisition, see CNC (2009), 'Pliego de Concreción de Hechos Expediente C/0098/08 Gas Natural / Unión Fenosa'.

[157] For more information on other markets, see European Commission (2010), Technical annex to the communication from the Commission to the Council and the European Parliament. Report on progress in creating the internal gas and electricity market

[158] CNE, as of 3 May 2011. http://www.cne.es/cne/doc/publicaciones/ListComerGasAct_03052011.pdf

Figure 41: Company market shares by volumes of natural gas sold in Spain, 2000-2009 (%)



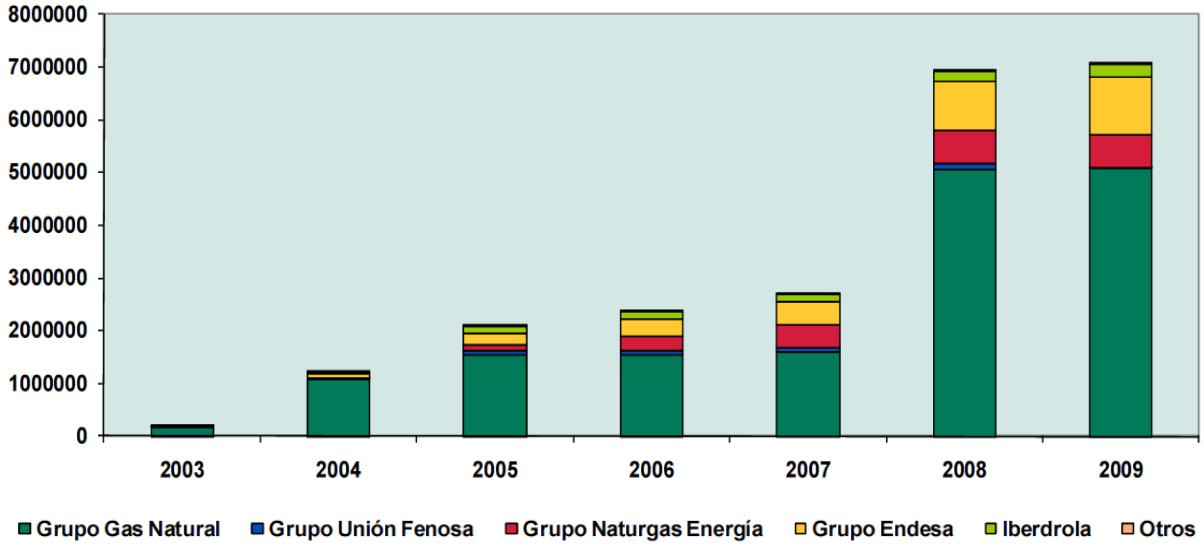
Note: In 2009, the share for 'Grupo Gas Natural' corresponds to 'Gas Natural Fenosa'[159] and the share for 'Grupo Unión Fenosa' corresponds to 'Unión Fenosa Gas Comercializadora'
Source: CNE (2010), p.22

In the first trimester of 2011, Gas Natural Fenosa was still the leading company with a share of 38.8% of the total volumes of natural gas sold in Spain. Endesa, Union Fenosa Gas Comercializadora and Iberdrola were next with market shares of 14.7%, 12.9% and 9.4% respectively. Lagging behind were Naturgas (7%), Cepsa (5.5%), GDF Suez (2.3%), EON (2.2%), Galp (2.2%), BP (1.8%), Shell (1.8%), Sonatrach (1,0 %), and a group of companies including BBE, Incogas, Molgas, Liquid Natural Gaz and Nexus (less than 0.5%).[160]

On 31 March 2011, there were 7,206,119 consumers of natural gas in Spain according to the CNE. The latest report does not give details of gas consumption per sector, but in 2009, the power sector consumed 40% of total gas supplied. With 5,000 customers, the share of industry was 45%. New companies have entered this market, which is characterised by lower barriers to entry and in 2009; it was already competitive with 16 active sellers.[161] The residential sector, with about seven million customers, represented 15% of total gas consumption. It was much more concentrated, with four sellers accounting for 99.6% of total sales in the liberalised market [Figure 42].

[159] With the takeover completed by 2009, Gas Natural has considerably strengthened its position in the power market. The Spanish competition authorities approved the acquisition on the condition that Gas Natural sold 2,000 MW of its power capacity and around 9 percent of its gas supply points in Spain and that it transfers 600,000 smaller clients to its competitors. Source: CNE (2010b)
[160] CNE (2011a), Informe trimestral de supervisión del mercado minorista de gas natural en España, p.2
[161] CNE (2010b), p.11

Figure 42: Evolution of the number of natural gas customers in the liberalised market, per supplier, in 2003-2009



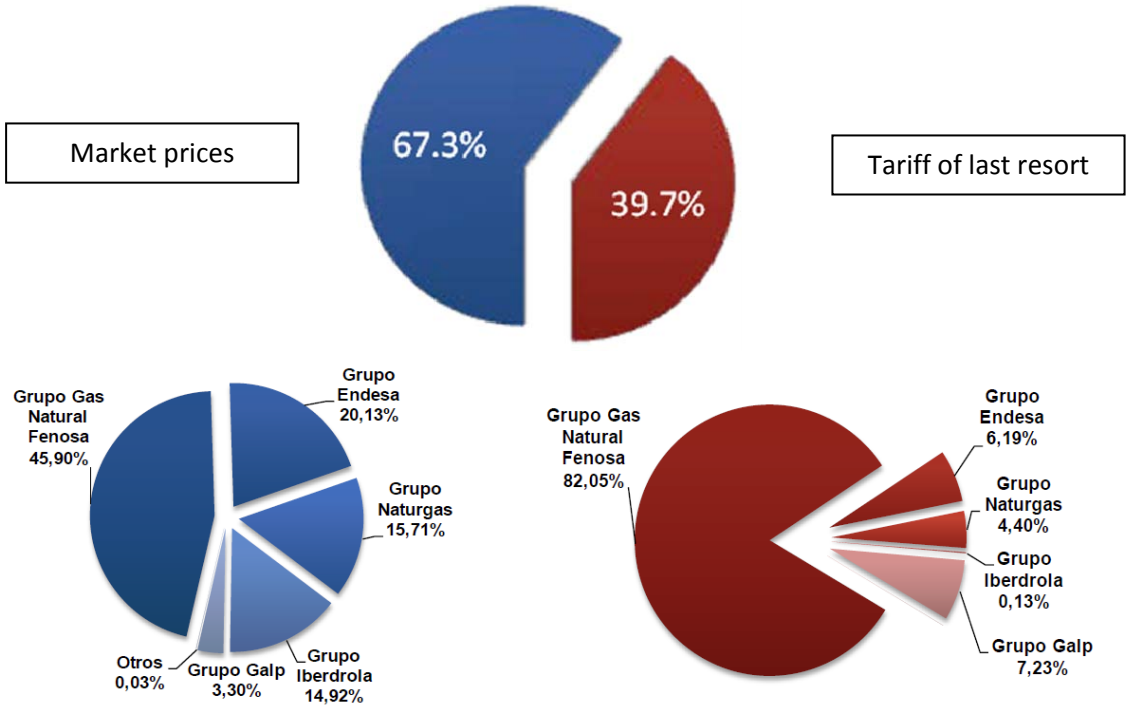
Note 1: In 2009, the share for 'Grupo Gas Natural' corresponds to 'Gas Natural Fenosa'
Note 2: Consumers supplied by distribution companies at regulated tariff are excluded
Source: CNE (2010), p.28

In the first trimester of 2011, Gas Natural Fenosa had the largest number of consumers - 4,341,342 (60.3%) with other competitors far behind (Endesa 14.6%, Naturgas 11.2% and Iberdrola 9.1% and Galp 4.9%).[162] This is explained by significant barriers to entry, high customer acquisition costs and large economies of scale in customer management which have limited opportunities for new entrants.[163] As in other European countries, householders have remained loyal to existing suppliers and the bundling of gas and power sales by the large companies such as Gas Natural, Endesa, Iberdrola and Unión Fenosa, has enabled them to retain their market shares.

As explained earlier, small consumers have been able to choose between market prices and a last-resort tariff. In the first trimester of 2011, those who selected market prices accounted for 60.3% of consumers (4,346.013) and consumers who chose the last-resort tariff accounted for the remaining 39.7% (2 860 106 customers).[164] The government nominated Gas Natural S.U.R. SDG, S.A.; Endesa Energía XXI; HC Naturgas Comercializadora de Último Recurso, S.A.U ; Iberdrola Comercialización de Último Recurso, S.A.U and Madrileña Suministro de Gas S.U.R. 2010, S.L. to apply such a tariff. The TUR is set by the Mityc.[165] The variable part of the tariffs is set for three months at a time by reference to an auction and to future market prices for Henry Hub and NBP, keeping a reference to markets levels.[166] The group Gas Natural Fenosa the market had by far the largest share with 82% of the consumers at tariff of last resort [Figure 43].

[162] CNE (2011a), p.4
[163] CNE (2010b), p.12
[164] CNE (2011a), p.4
[165] CNE, 'Guia Informativa para los consumidores de gas natural', website, retrieved on May 5 2011. http://www.cne.es/consumidores/pdf/gas/CNE_Consumidores_Gas_EpigV301.pdf
[166] Boletín Oficial del Estado, n.157, 29 June 2010

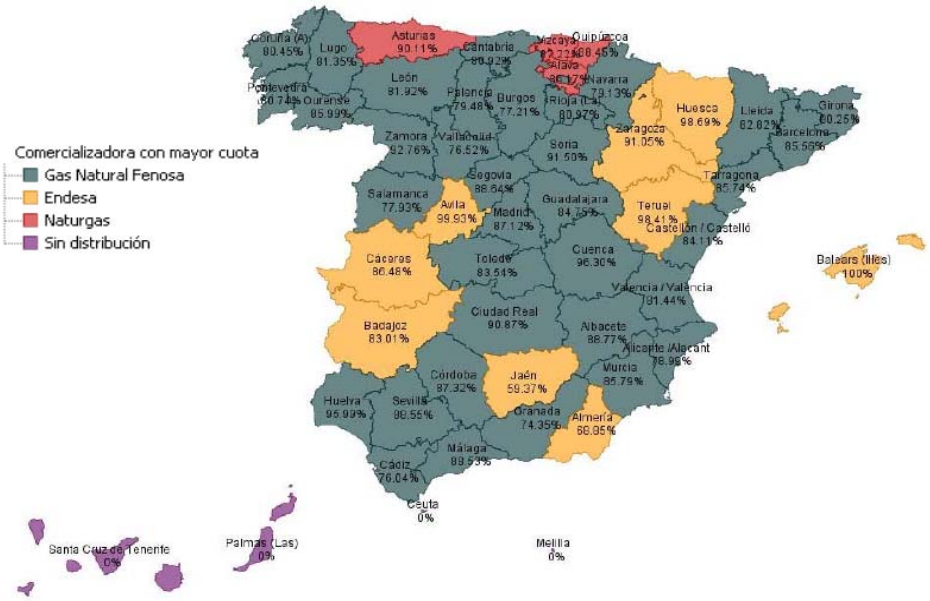
Figure 43: Companies' market share of customers paying market prices and tariffs of last resort in the first trimester 2011 (%)



Source: CNE (2011), p.5

The vertically integrated companies that still control the distribution network in specific autonomous regions continue to have significant market share in distribution and commercial activities. To put it differently, the leader company in terms of number of customers was part of the traditional distribution company, showing an important role of loyalty from the residential sector [Map 3].

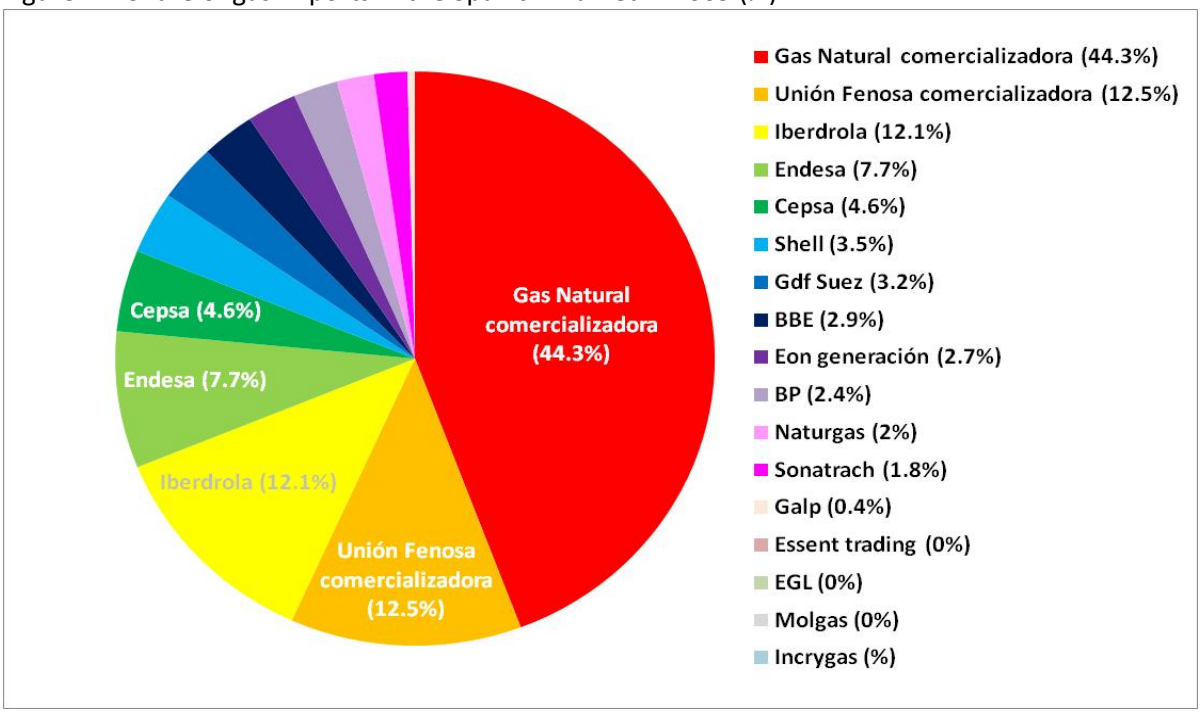
Map 3: Natural gas sale companies with largest share of customers per province, 2009



Source: CNE (2010), p.13

Finally, it is important to note that Gas Natural Fenosa also has a high share of Spanish gas imports. In 2007, for instance, the competition authority (CNC) reported that Gas Natural and Unión Fenosa accounted for 63% of gas imports into Spain.[167] The CNC also reported that Gas Natural had numerous contracts with other companies at the Spanish border (i.e. the imports may show up under another company's name), including Iberdrola.[168] In 2009, Gas Natural and Unión Fenosa still had predominant positions [Figure 44].

Figure 44: Share of gas imports in the Spanish market in 2009 (%)



Source: CNE (2010d), p.77, Figure 18

In 2010, there were 33 distribution companies, 15 transport companies and 48 suppliers on the primary and on the secondary markets[169] operating in the Spanish gas market.

- **<u>Natural gas trading</u>**

Eight balancing points

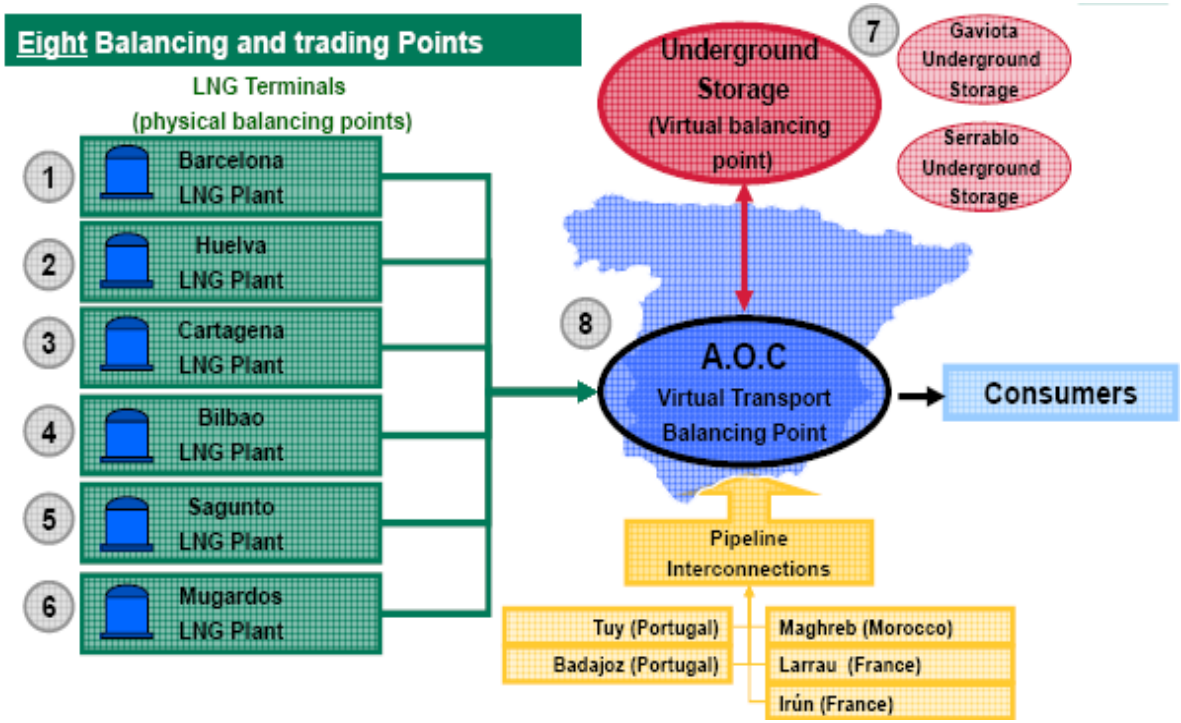
Despite a liberalization process ahead of the European timetable, there is no primary wholesale gas market in Spain, but the secondary market is fairly well developed. Wholesale gas market trading is organized at the Spanish single balancing point (AOC: *Almacenamiento operativo comercial*) and at the LNG terminals. The gas trade is carried out by a platform developed by Enagás, named MS-ATR (*Mercado Secundario de Acceso de Terceros a la Red*). The MS-ATR was implemented by late 2005 in order to organize the huge number of gas exchanges. It was developed on a web system basis as a part of the TPA IT System (SL-ATR: *Sistema Logístico de Acceso de Terceros a la Red*). The MS-ATR has several activities and functions: 1/ It allows the organization of over the counter (OTC) bilateral

[167] CNC (2009), p.38.
[168] Ibid, p.39.
[169] Enagás (2011), p.146

exchanges ; 2/ It allows the gas transport services to receive offers to manage imbalances and 3/ It allows the negotiation of gas prices between users, on an anonymous basis. Shippers having access to MS-ATR trading platform are able to choose the infrastructure where they want to trade gas and to accept or refuse offers from other users. There were 29 active traders in 2009.[170]

As of June 2011, Spain had eight balancing and trading points, with gas balancing on a daily basis (i.e. suppliers and buyers must balance their gas positions daily) [Figure 45].

Figure 45: Trading points in the Spanish natural gas market in 2010



Source: CNE website: http://www.cne.es/cne/doc/publicaciones/cne50_10.pdf

In 2010, the volume of gas traded in the system was equivalent to 251% of demand (90.5 bcm) via 39,203 transactions (twice as much as in 2009).[171] Transactions are carried out on a bilateral inter-company basis, via physical swaps, for balancing purposes. As there is no spot market for gas in Spain (unlike in the UK or North America), heavy dependence on LNG and the shortage of underground storage, OTC is important to enable new entrants to access gas supplies and to grow their market shares. Bilateral OTC trade is the main source of flexibility for smaller gas traders. In 2010, trades took place at all the points, but the majority of the transactions happened at the balancing point (AOC) with 61.5%, while the majority of the volume of gas exchanged happened at the regas plants with 92.2% [Table 16].[172] The OTC platform MS-ATR allows for free trading through direct gas exchanges, without a price. Prices traded in the OTC are therefore not public; and there is no public information on OTC prices and as a consequence no price transparency in the market.

[170] CNE Report, (2010d), p.80, Figure 22
[171] Enagás (2011), p.145
[172] See also 'Appendix 13: Monthly natural gas volumes traded at the balancing points and number of transactions in Spain for the period July 2009 – April 2011'

Table 16: Number of transactions and gas volumes at balancing points in 2010

	Number of transactions		Gas volumes		Churn rate
	No.	%	bcm	%	
Regas plants	14955	38.1	83.4	92.2	2.2
Barcelona	4271	10.9	20.62	22.8	2.2
Cartagena	1808	4.6	8.44	9.3	0.9
Huelva	5956	15.2	29.83	33	3.9
Bilbao	1569	4	13.37	14.8	2.9
Sagunto	698	1.8	5.35	5.9	0.9
Mugardos	653	1.7	5.78	6.4	2.7
AOC (TUR included)	24095	61.5	6.6	7.3	0.3
Underground storage	153	0.4	0.42	0.5	
Total	**39203**	**100**	**90.42**	**100**	**1.8**

Source: Enagás (2011), p.157 and CNE (2010d) for the churn rate, p.80

These OTC trades are mostly physical swaps of storage capacity for different periods of time, within a regas terminal in order to optimize and manage the flow of gas arriving in tankers, its storage in the regas tanks and then the transport of gas to customers. These swaps enable traders to avoid penalties for storing gas longer than the maximum period allowed by current regulation.[173] There is therefore an incentive for traders to swap capacity in each regas plant.

This is especially important for smaller companies. Larger companies receive LNG tankers more frequently, at a number of different LNG terminals and have a larger customer bases, which enables them to manage the logistics of their business internally (i.e. without relying much on OTC swaps). Smaller companies receive LNG shipments less frequently and they rely far more on swaps and therefore on the willingness of large competitors with less incentives to trade with them within regas terminals. The high level of concentration in each regas sub-market is therefore a potential barrier to entry for smaller traders [Table 17]. Each regas terminal acts as a 'sub market' for swaps with high levels of market concentration. The barrier for small traders would be lower if these submarkets were less concentrated, or if there was a liquid spot market for gas in Spain.

[173] See Enagás (2011), p.62 for additional information

Table 17: Number of active traders and market share of three main traders at each balancing points in 2009[174]

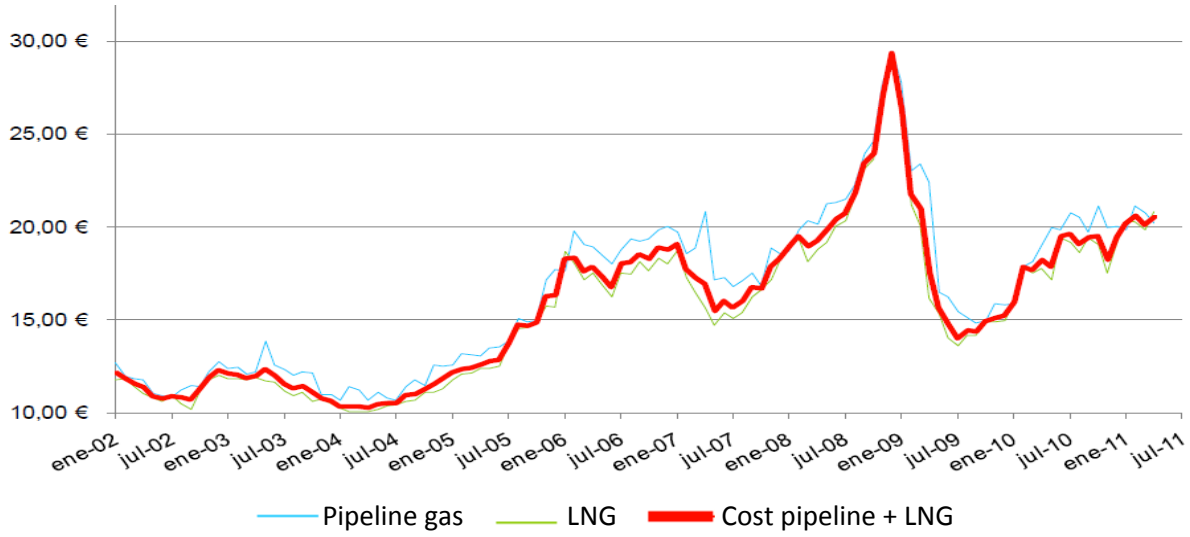
	Number of active traders	Market share of 3 main traders
Regas plants		
Barcelona	15	55%
Cartagena	12	73%
Huelva	14	46%
Bilbao	12	72%
Sagunto	4	100%
Mugardos	4	100%
AOC (TUR included)	22	49%
Underground storage	15	80%
Total	**29**	**41%**

Source: CNE Report, (2010d), p.80, Figure 22

Level of gas prices

Prices traded in the OTC are not public and there is no organised gas hub to provide a price reference for gas in Spain. As a result, CNE has developed an index for natural gas border prices, out of gas imports data which are available on the website of the office of economics and export control (AEAT). As shown in Figure 46, prices reached their peak values in 2008, and have since averaged at around 20 euros/MWh for the first half of 2011.

Figure 46: Cost of natural gas supply at the Spanish border (euro/MWh)



Source: CNE (2011b), p.17

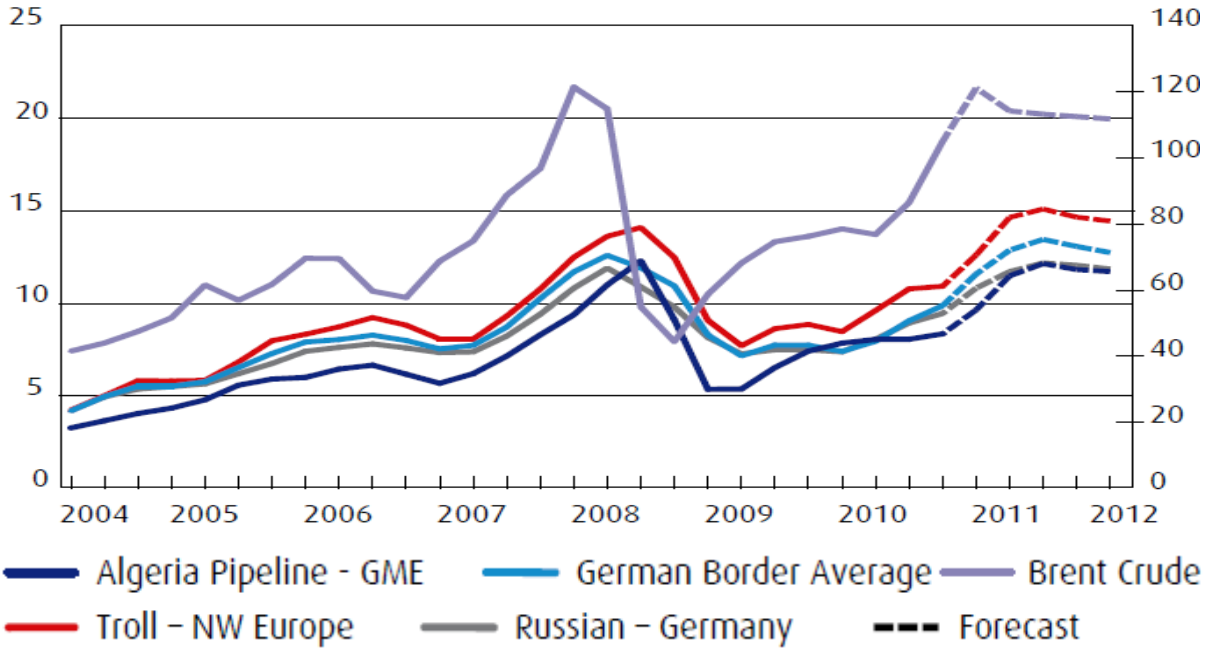
Peaks in demand have sometimes led to period of very high import gas prices in Spain when spot cargoes had to be purchased in the face of competition from other markets. This was the case in the winter 2005-2006, which was marked by low hydro energy availability [see Figure 22, p.37] and cold

[174] Data from CNE Report, (2010), *Spanish Energy Regulator's Annual Report to the European Commission 2010*, Figure 22, p. 80.

temperatures [see Figure 13, p.28], which led to sustained demand for CCGT production (load factors reached 55-60% [see Figure 28, p.45]). This period corresponded to high demand for LNG in North America, which created some arbitrage opportunity accross the Atlantic and Spanish buyers ended up competing with high Henry Hub prices [Figure 48, p.75] for spot cargoes to meet peak demand.

Spanish gas buyers most often purchase long-term LNG and pipeline gas on an oil-related pricing basis (Brent crude oil, gas oil or fuel oil related).[175] This indexation makes it possible to calculate an approximation to Spanish gas import prices. Despite a general consensus that Spanish gas prices are among the highest in Europe, a comparison between natural gas volumes imported via long-term contracts in Spain and in the rest of Europe shows a different result [Figure 47].

Figure 47: Long term contract gas prices in Europe, 2004-2012e (left axis $/MMBtu ; right axis Brent Crude $/bbl)



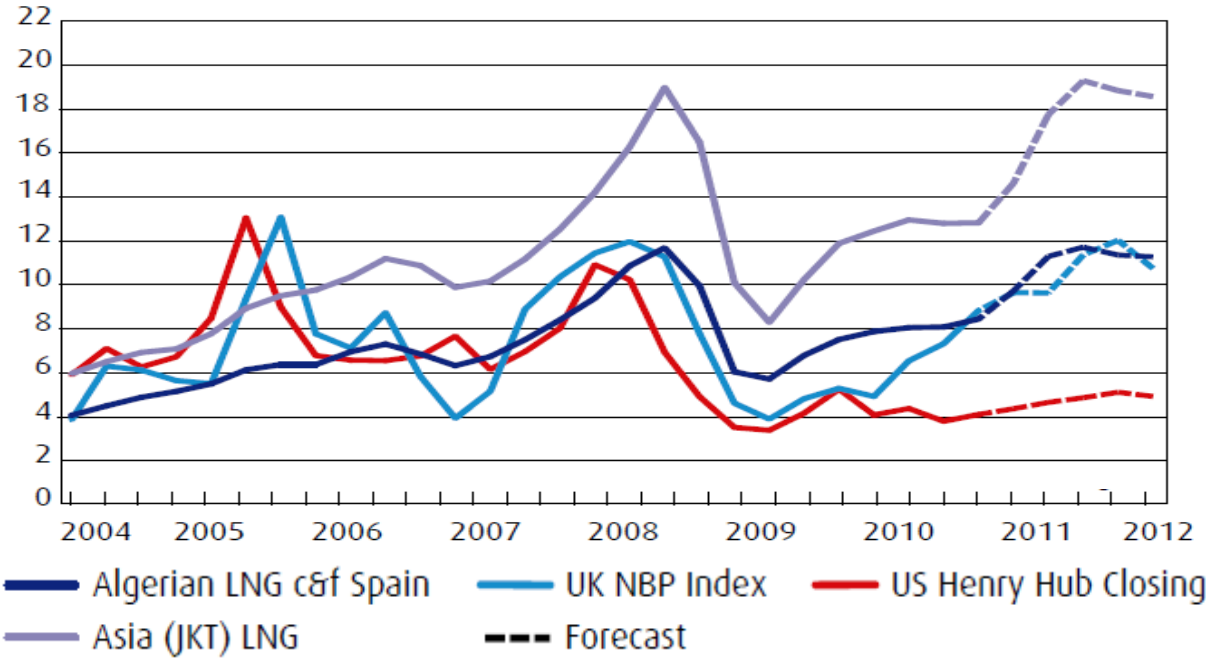
Source: Gas Matters, June 2011, p.29

Major changes are under way in the major Continental European countries following the gap between hub-based and oil-linked prices which developed during the period 2008-2010. While this gap first widened and then narrowed, the average spread between the UK NBP index and the average German import price (BAFA) in 2010 remained high at about 22% (despite a 6% fall in BAFA).[176] Spanish prices were then higher than spot prices for the major part of 2008 and 2010 [Figure 48].

[175] In 2007, more than 80% of gas was supplied under long-term TOP contracts (with more than 10 years until expiry) with a price indexation to oil. Source: IEA (2009), p.70

[176] Global LNG markets, 2011, 25 February 2011, p.14 ; Global LNG markets, 20 May 2011, p.14

Figure 48: LNG and traded gas prices, 2004-2012e ($/MMBtu)



Source: Gas Matters, June 2011, p.29

The rationale for continued linkage of long-term contract gas prices to those of oil products is being seriously contested.[177] However, progress is expected to be much slower in Spain than in the other Continental countries of Western Europe. The first reason is that Spain is essentially still a peripheral country in the European landscape with low cross-border capacity with the rest of Europe. Second, the Sonatrach – Gas Natural Fenosa arbitration illustrates the potential cost/risk of going to court or to binding arbitration to resolve a dispute over long-term contract prices.[178]

On the other hand, while most Spanish buyers purchase gas on long-term contracts with prices linked to oil products, some large power sector buyers of gas have indexed some or all of their purchases to wholesale electricity market prices (and coal prices). If, as already mentioned,[179] electricity prices become more volatile and under downward pressure due to the combined effects of the recession and an increased share of zero-marginal cost and intermittent renewable generation, there will be a need to rethink the gas indexation mechanism for power sector companies. The development of an organised gas market (hub) with transparent gas prices reflecting supply and demand balances would solve the soon-to-come problem.

[177] The argument is well made in Stern and Rogers (2011), 'The transition to hub-based gas pricing in Continental Europe'

[178] Sonatrach and Gas Natural were in arbitration for some time over gas prices in their contracts. Sonatrach had long argued that Gas Natural should have paid higher prices for a contract to receive gas pumped through the Maghreb pipeline since 2007. In August 2010, an arbitration panel ruled that Gas Natural should pay Sonatrach a higher price for the gas it was receiving. Although Gas Natural argued that the decision was unfair it agreed to pay $1.89bn, which is slightly lower than an initial compensation figure of $1.97bn called for in 2010, and covers a four-and-a-half year time frame. Source: The Financial Times, 'Gas Natural calls time on Sonatrach dispute', 15 June 2011

[179] See section '2.3. Growth of renewable energy in the power sector', sub-section 'Additional CCGTs to provide back up for renewable energy'

Developing natural gas hub(s)

- A gas trading hub in the Basque region

Liquid and transparent gas hubs are an important foundation for the development of efficient market. A hub allows gas to gas competition to set a market price reflecting supply and demand. Work is being undertaken in Spain on the development of a gas hub. The main principles and the road map for the development of a hub in Spain were published by the CNE in April 2010.[180]

In October 2010, the CNE described the main problems of the OTC market, which was also portrayed as being the principal tool to modulate LNG stocks.[181] The problems were fivefold: 1/ the OTC market in Spain is not a unique market, but eight submarkets; 2/ at various points (i.e. Mugardos, Bilbao), the number of possible counterparties is very reduced and the hubs are effectively closed; 3/ it is not a transparent market, and does not provide price signals, 4/ there is a no standard contract and 5/ the organization rules of the platform MS-ATR are not in the public domain and are only available in Spanish.[182] As a consequence, access to the OTC market for consumers or external suppliers is not easy. The objective was therefore to create a gas hub in the Spanish gas system in order to increase competition and transparency. The roadmap proposed by the CNE showed several steps between April 2010 and December 2012.[183]

At the Sedigas[184] meeting in May 2011, the industry pleaded for the creation of an organized gas market, a hub, in order to create price signals decoupled from oil prices. The Energy secretary declared that the creation of a hub would be a tool to develop short term transactions, increase the transparency of the market and facilitate the arrival of new players.[185] In July 2011, the basis for the creation of an organized gas market was established in the draft legislation for the Hydrocarbon Law, which will translate the European legislation on common rules for the internal gas market into national legislation.[186]

In February 2011, Enagás was reported to be in talks with bodies in the Basque country to start up and operate a gas trading hub in the region.[187] If this was to be the location of a future gas hub in the Iberian market, it would be well served by existing infrastructure. There is already a 7 bcm/y LNG terminal in Bilbao, and the El Musel LNG terminal is planned not far down the coast at Gijon. The

[180] CNE (2010a), Principios generales y hoja de ruta para el desarrollo de un Mercado de gas organizado en España
[181] A supplier which receives a cargo has incentives to sell part of the LNG to other suppliers in order to avoid excess storage costs. CNE (2010c), El mercado secundario de gas natural en España, p.7
[182] Ibid, p.9
[183] Ibid, pp.12-13
[184] Sedigas, the Spanish Gas Association, is a non-profit organization established in 1970 on the initiative of Spain's pipeline gas companies, and all corporations, bodies and individuals committed to the development of the pipeline gas industry. http://www.sedigas.es/
[185] Europa Press, Industria aboga por un Mercado organizado de gas con precios 'desacoplados' del petróleo, 24 May 2011
[186] Mityc (2011b), El Gobierno aprueba para su envío al Parlamento el anteproyecto de ley del sector de hidrocarburos, p.4
[187] European Gas Markets, 10 February 2011, p.3

Reganosa LNG terminal is also within reach. In addition, the region is served by two bidirectional interconnectors with France (Larrau pipeline and Euskadour pipeline). The capacity of the pipeline equaled 5.7 bcm/y in 2011 and will be increased by 2015.[188] On top of this, the Gaviota underground gas storage (2.5 bcm/y) is also plugged into the system.

- MIBGAS and the Iberian hub

Interdependence between the gas and power sectors is growing, and this requires close coordination and optimisation of networks and appropriate risk management. Portugal and Spain set up the common Iberian Electricity Market –MIBEL- in 2007. With the creation of MIBEL, it became possible for any consumer in the Iberian zone to acquire electricity under a free competition regime, from any producer or retailer in Portugal or Spain. The management of the Iberian spot electricity market is the responsibility of OMEL – Iberian Electricity Market Operator – Spanish division. Following this example, the countries have been working to build a common Iberian gas market, the counterpart of MIBEL. On November 24th and 25th 2006, during the XXII Portuguese-Spanish Summit in Badajoz, the Governments of Portugal and Spain reiterated their commitment to expanding MIBEL, to extending the Iberian Natural Gas Market (MIBGAS) and to establishing an agreement that would allow the formation of oil and natural gas reserves within the Iberian zone and the creation of an Iberian hub of 'international standards'. [189]

The creation of the MIBGAS would also open the door to potentially higher gas demand growth in the Portuguese market, which is still fairly small (5 bcm in 2010). But considering the economic difficulties of the country, the prospects for rising gas consumption are probably even more uncertain than in Spain. Increasing interconnection to France, via additional pipelines or capacity extensions on existing pipelines, would allow Spain to have a physical possibility to access further supply and storage sources and additional consumers. While the two interconnectors with Portugal at Tuy and Badajoz have spare capacity, the two interconnectors with France at Larrau and Biriatou are congested. The capacity of these interconnections needs to be increased in order for a regional hub to develop in Spain.

- **Interconnections: The South Gas Regional Initiative**

In April 2006, the European Regulators' Group for Electricity and Gas (ERGEG) launched the Gas Regional Initiative[190] to speed up the integration of Europe's national gas markets. This created three regional gas markets in Europe (North-West; South-East and South regions) as an interim step to creating a single-EU gas market. The South Gas Regional Initiative (S-GRI) is led by the CNE and aims to integrate Portugal, Southern France and Spain into a single regional market, in order to enhance both security of energy supply and diversification of energy sources. The region is one of the main entry points for natural gas coming from North Africa, and for LNG coming from a variety of origins. Interconnection capacity, interoperability and transparency issues are the three key

[188] See the following section on the South Regional Gas Initiative for additional information
[189] http://www.omip.pt/OMIP/MIBEL/tabid/72/language/en-GB/Default.aspx
[190] http://www.energy-regulators.eu/portal/page/portal/EER_HOME/EER_INITIATIVES/GRI/South

priorities of the S-GRI. Increasing interconnection to France via additional pipelines or capacity extensions on existing pipelines will allow Spain to have a physical possibility to access further supply and storage sources but also additional consumers. While the two interconnections with Portugal at Tuy and Badajoz have spare capacity, the two interconnections with France at Larrau and Biriatou are congested.

Plans for additional capacity between Spain and France are progressing well after two open seasons procedures (for 2013 and 2015) to foster new investments. The open season 2013 triggered the development of the interconnection point of Larrau, which will amount to 5.5 bcm in both directions in 2013.[191] Capacity was allocated to eight shippers. The open season 2015 closed on 16 July 2010. The interconnection capacity at Irun/Biriatou in the direction Spain to France will increase by 2 bcm by 2015. Capacity has been allocated to three shippers on the whole route from Spain to GRTgaz North [Map 4].[192] The Midcat pipeline, a 6.5 bcm two-way pipeline, was planned from Barcelona to France, but plans for it were scrapped as there was insufficient interest from market participants.[193] By 2015, the total interconnection capacity will reach 7.5 bcm from Spain to France (or about 20.8% of Spanish gas consumption in 2010 or 16% of gas demand in 2015 in the scenario 'Honore 2010'). It will reach 5.5 bcm from France to Spain.[194]

Map 4: Market structure in Spain and in France: four market zones

Source: http://transporte.naturgasenergia.com/uploads/pdf/information_memorandum2.pdf, p.5

In addition, Portugal and Spain have developed a study on the legal changes that are required in both countries to implement a common trading licensing process.[195] The final goal for the SGRI for 2014 would be to contribute to the development of hub-to-hub gas trading in the region, which

[191] South Gas Regional Initiative (2010), Press release, Open season 2015 increases the gas interconnection capacity between Spain and France at Irun/Biriatou
[192] Ibid
[193] International gas report, 14 March 2011, p.2
[194] ACER (Agency for the Cooperation of Energy Regulators) (2011), South Gas Regional Initiative, Work Plan 2011-2014, p.1
[195] Ibid

would promote liquidity and competition.[196] Once greater pipeline links have been established with France, it can be expected that Spain may follow the move in the rest of Europe, such as in Germany, France and to a lesser extent Italy, towards the inclusion of greater market-related pricing in gas supply contracts.

While additional gas interconnections are under way, electricity interconnections are lagging behind. Electricity prices in Spain are often lower than electricity prices in France or Germany,[197] but electricity doesn't flow due to the lack of capacity. There is a project to increase capacity to 2.800 MW[198] but this may be too small a quantity to allow market integration between Spain and the more liquid markets of Northern Europe. Additional capacity with neighboring markets would facilitate additional renewable integration and potentially allow more gas demand in the power sector in Spain by increasing clean electricity exports.

CONCLUSIONS

The sharp, negative and lasting effects of the recession on the Spanish economy and the continued growth of renewable energy –with record levels achieved in 2010 due to the large availability of hydro and wind energy– have created uncertainty over the future of the gas industry in the country and the optimistic scenarios for additional gas demand growth formulated prior to the 2008 – 2009 recession have been called into question. The power sector holds the best potential for demand growth but also presents the scope for variability both year to year and over shorter time periods due to the intermittency of renewable generation.

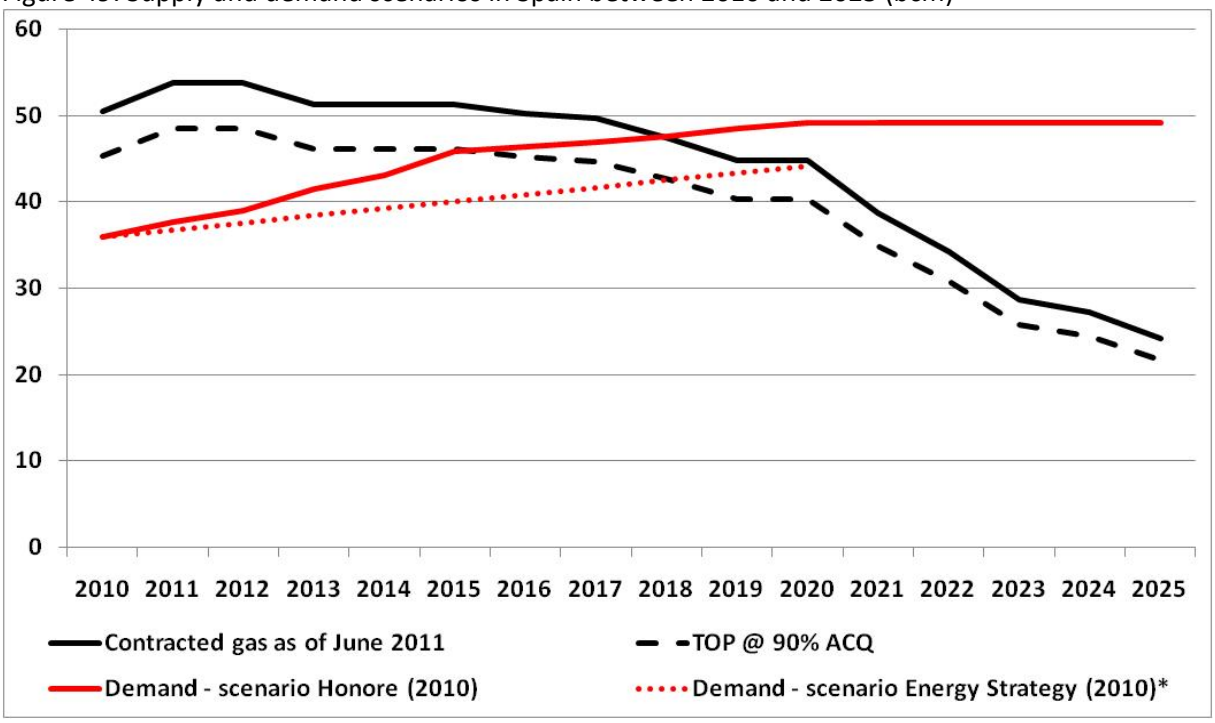
The place of gas in the Spanish electricity system is less and less a function of economic competitiveness and more and more a function of renewable and hydro availability. Natural gas is the balancing fuel thanks to the flexibility of CCGTs, which allows the integration of renewable energy with a relatively low-carbon emission rate. Intermittent generation is backed-up by CCGT for which daily output is strongly inversely correlated to wind output. But CCGTs are also a key instrument for meeting peaks. The Spanish electricity market will continue to need CCGT generation for system reliability and flexibility, but the plants will go from running on baseload to running on peak load. As a consequence, the prospects for future gas demand in Spain are for smaller demand increases than previously projected but higher demand fluctuations. When nuclear plants retire post 2020-2025, if CCS technology is not yet ready, then we may see an increase gas demand for baseload generation, at least temporarily as a transition fuel (but for how long is unclear).

With 86 bcm of import capacity as of June 2011, and other projects already under construction, there will be no lack of physical entry points to import gas to fulfil the needs of the Spanish market.
Regarding contracted volumes of gas, the market has been in a situation of oversupply for the major part of the 2000s. The economic crisis and the slow recovery explain why this situation will continue until at least 2018 (demand scenario Honore) as shown in Figure 49, and possibly until 2020 if

[196] Ibid, p.10
[197] Platts, Power in Europe, tables on 'Base power assessment', various issues
[198] Mityc, 23 May 2011, 'Miguel Sebastián y Eric Besson anuncian que la nueva línea de interconexión eléctrica entre España y Francia estará operativa en 2014'

demand increases more slowly (demand scenario Energy Strategy), which is a strong possibility. Take-or-pay commitments -including the gas to be delivered via Medgaz- will be above demand levels until 2015-2018, depending on the scenarios shown in Figure 49.

Figure 49: Supply and demand scenarios in Spain between 2010 and 2025 (bcm)



* Demand scenario Energy Strategy: between 2010 and 2020, data has been revised upward by this author to start at 36 bcm in 2010 (observed demand). The other scenarios for gas demand have been left identical to the ones presented in Figure 11, p.26.

Sources:

- Contracted gas: GIIGNL, The LNG industry in 2010, table on long-term and medium-term contracts in force in 2010, and author's analysis
- Demand scenarios: Honore (2010), p.293 ; Energy Strategy published in 2010, p.88

Spanish energy policy has simultaneously tacitly approved an aggressive gas contracting policy while at the same time strongly supporting the development of renewable energy. The economic recession produced a situation that would probably have happened anyway in time. Spain has an excess of 'security of supply' at the price of having to divert contracted supply to other markets, which is an interesting concept to highlight as it is the opposite of the usual European obsession. In the short term, Spain will continue to divert LNG cargoes to manage its supply and demand balances. In the medium term, the development of both gas and electricity interconnections with France will help to alleviate the problem. It will also set more favourable conditions for the development of a liquid and transparent gas hub in Spain and/or the Iberian Peninsula. As peak demand for gas is expected to continue rising in the coming years, this would also create additional flexibility in the system. Re-exports of over-contracted Spanish gas towards other European markets will be mostly available in large quantities in the first half of the 2010s although on current

analysis,[199] it is not clear that the rest of Europe will have the ability to absorb this surplus. As of June 2011, the already contracted gas volumes cover demand needs at least until 2016 and maybe until 2020 depending on the trajectory of future demand growth. Spain will need to secure additional gas at a time when other European markets will also be looking for additional volumes. This may be further complicated by uncertainties on the availability of new LNG due to delays in final investment decisions during the recession period.[200]

[199] See Honore (2010), p.176 and also' Appendix 14: Natural gas supply and demand balances in Europe, 2008-2020 (bcm)'
[200] Rogers (2010), 'LNG trade flows in the Atlantic basin: trends and discontinuities', pp.120-122

APPENDICES

Appendix 1: Map of the West-European natural gas market

Source: Updated from Honore A. (2010)

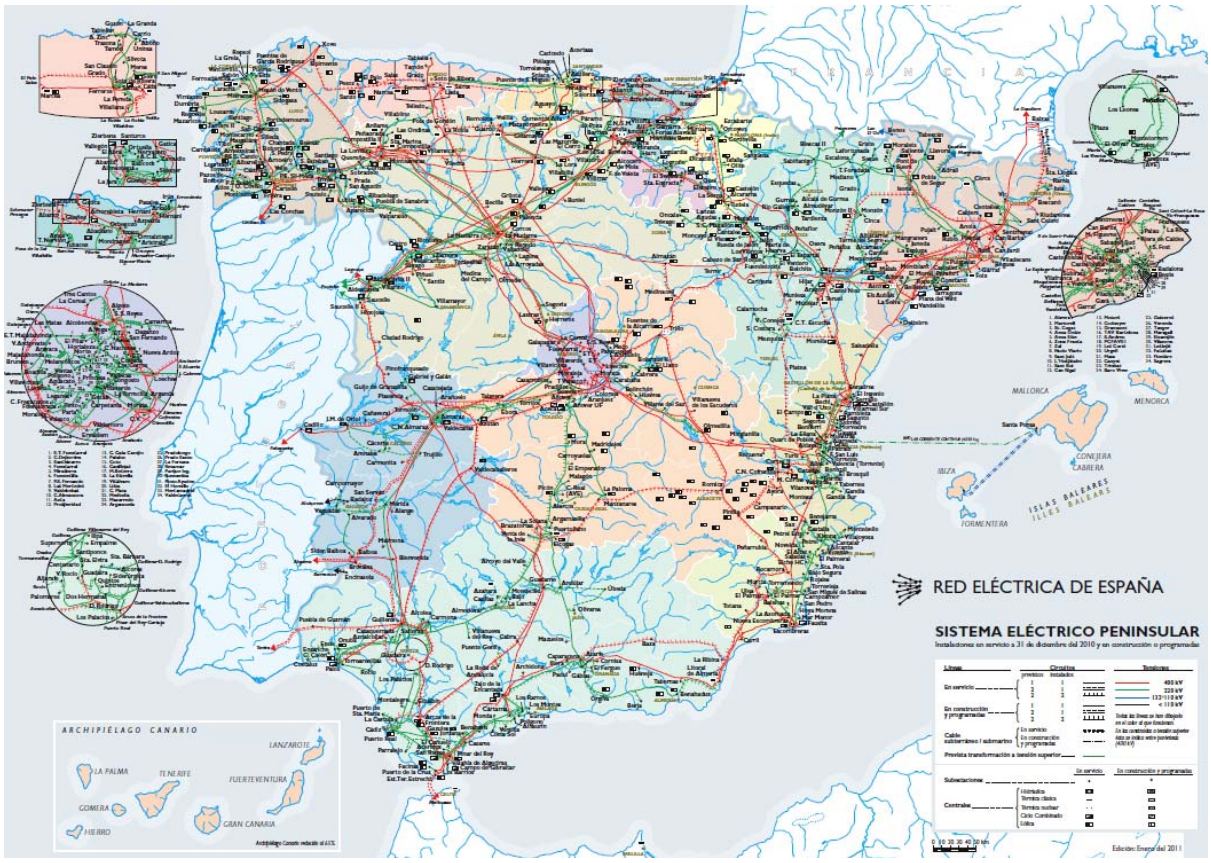
Appendix 2: Map of the Spanish natural gas market in 2010

Source: IEA, Oil and gas security, Emergency response of IEA countries, Spain, p.16 and author's update

Appendix 3: Share of total natural gas consumption by autonomous regions in 2010

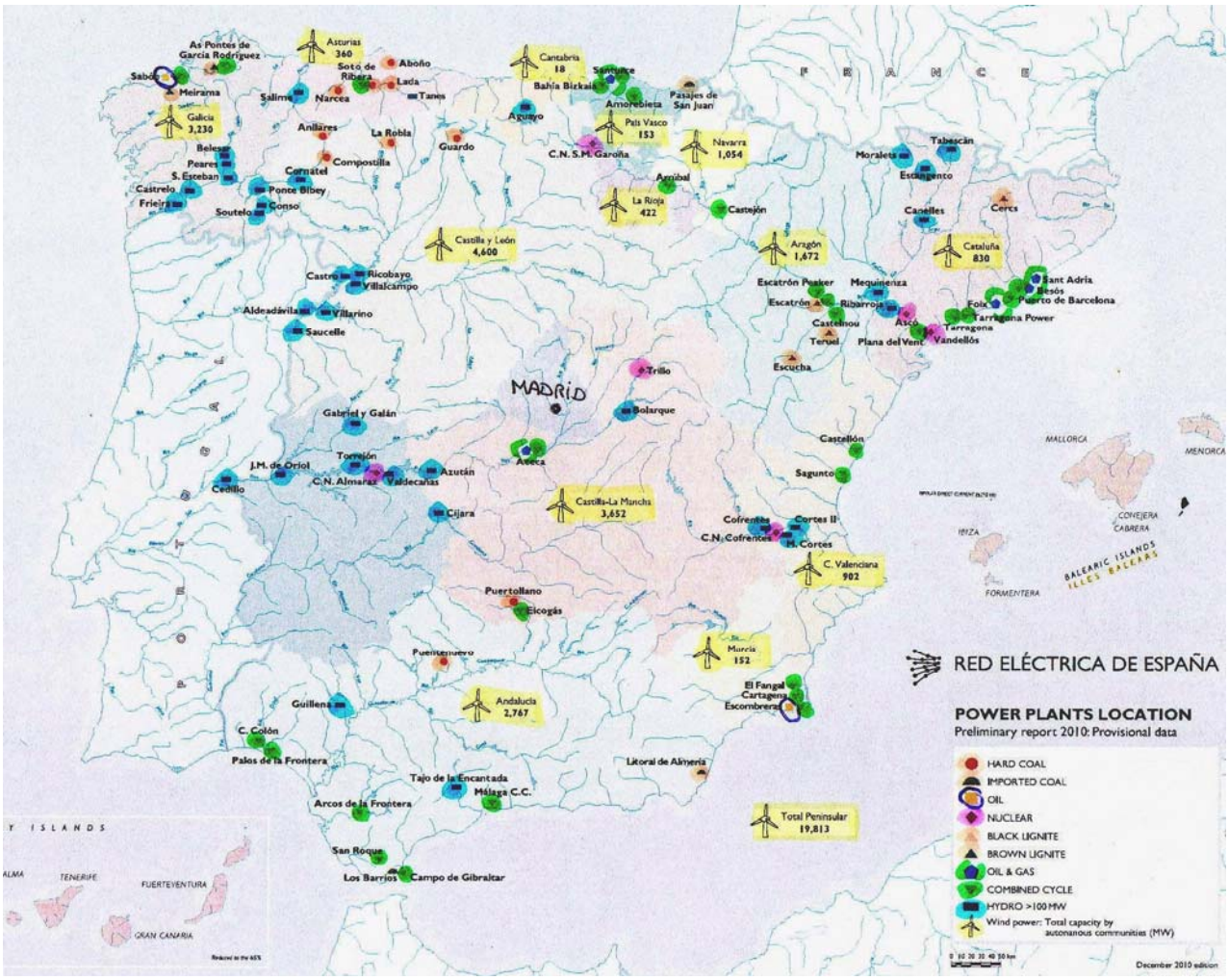
Source: Enagás (2011), p.18

Appendix 4: Map of the Spanish electricity network in 2010



Source: REE website: http://www.ree.es/transporte/pdf/mapa_transporte_peninsular_2010.pdf

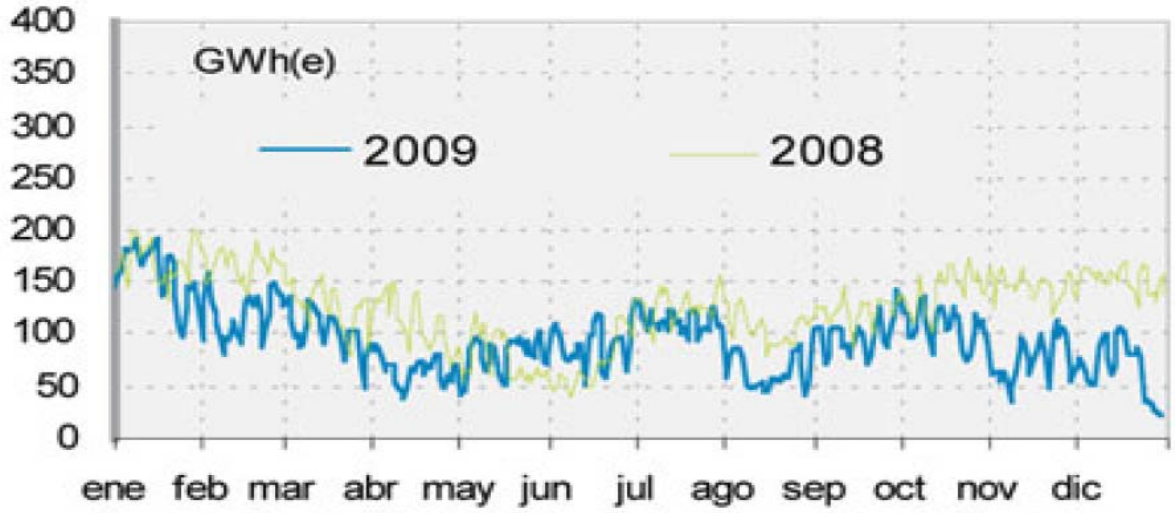
Appendix 5: Map of the location of the power plants location in Spain (2010)



Source: Red Electrica, preliminary report 2010

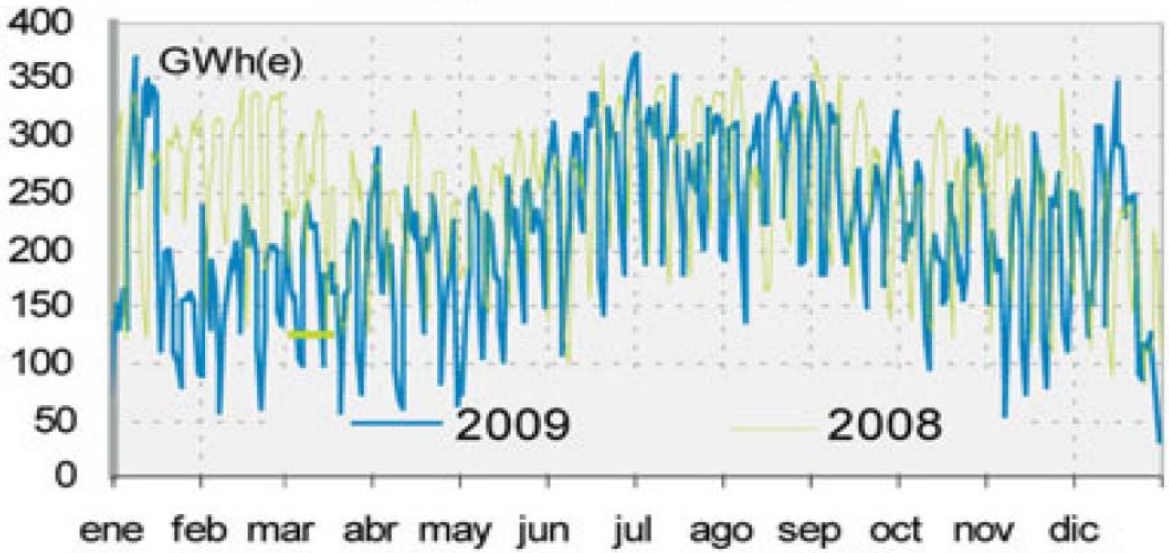
Appendix 6: Daily fluctuations of electricity generation from coal and from gas in 2008 and 2009

Figure 50: Daily electricity generation from coal, 2008-2009 (GWh)



Source: Enagás, Annual report 2009, p.91

Figure 51: Daily electricity generation from gas, 2008-2009 (GWh)



Source: Enagás, Annual report 2009, p.91

Appendix 7: List existing and planned capacity (LNG, interconnections and storage) in the Plan 2008-2016

Capacidades actuales de las plantas de regasificación

Terminal	Capacidad almacenamiento final 2009		Capacidad Emisión final 2009	
	Nº Tanques GNL	m3	m3/hora	bcm/año
Barcelona	6	540.000	1.950.000	17,08
Cartagena	4	437.000	1.350.000	11,83
Huelva	4	460.000	1.350.000	11,83
Bilbao	2	300.000	800.000	7,01
Sagunto	3	450.000	1.200.000	10,51
Mugardos	2	300.000	412.800	3,62
Musel				
TOTAL	**21**	**2.487.000**	**7.062.800**	**62**

Capacidades futuras de las plantas de regasificación previstas al final del período de la Planificación 2008-2016 (categoría A)

Terminal	Capacidad de Almacenamiento		Capacidad de emisión	
	Nº LNG Tanks	m3	m3/hour	bcm/year
Barcelona	5	680.000	1.950.000	17,08
Cartagena	5	587.000	1.350.000	11,83
Huelva	6	760.000	1.650.000	14,45
Bilbao	4	600.000	1.200.000	10,51
Sagunto	5	750.000	1.400.000	12,26
Mugardos	2	300.000	825.600	7,23
Musel	4	600.000	1.000.000	8,76
Tenerife	1	150.000	150.000	1,31
Gran Canaria	1	150.000	150.000	1,31
TOTAL	**31**	**4.277.000**	**9.375.600**	**82**

Source: CNE website, retrieved February 2011, http://www.cne.es/cne/doc/mer_ener/capacidadesgasistas.pdf

Capacidades actuales de los almacenamientos subterráneos

Almacenamiento	Capacidad Almacenamiento Mm3(n)			Capacidad de vehiculación Mm3(n)/día	
	Gas Colchón	Gas Útil	Gas Total	Inyección	Extracción
SERRABLO	420	680	1100	4	7
GAVIOTA	1700	979	2679	5	6
TOTAL	**2120**	**1659**	**3779**	**8**	**13**

Capacidades futuras de los almacenamientos subterráneos previstos al final del período de la Planificación 2008-2016 (categoría A)

Almacenamiento	Promotor	Volumen Operativo (Mm^3 (n))	Fecha de entrada prevista en el último informe de seguimiento de infraestructuras
Castor	Escal UGS	1.300	2012
Gaviota	Repsol	1.558	2015
Marismas (Phase I)	Gas Natural	300	2011
Marismas (Phase II)	Gas Natural	600	2013
Poseidon	Repsol	250	2010
Yela	Enagás	1.050	2011
Las Barreras	Unión Fenosa	72	2014
El Ruedo	Unión Fenosa	90	2015

Source: CNE website, retrieved February 2011, http://www.cne.es/cne/doc/mer_ener/capacidadesgasistas.pdf

Capacidades actuales de las conexiones internacionales

Interconexión	Sentido Flujo	Capacidad Nominal GWh/día	Capacidad Nominal bcm /año
C.I. Marruecos - Tarifa		354	11
C.I. Argelia – Medgaz *		266	8
C.I. Francia - Larrau	Sentido E→F	0	0
	Sentido F→E	100	3,1
C.I. Francia – Irún	Sentido E→F	5	0,2
	Sentido F→E	10	0,3
C.I. Portugal – Badajoz	Sentido E→P	134	4,3
	Sentido P→E	105	3,4
C.I. Portugal - Tuy	Sentido E→P	36	1,2
	Sentido P→E	12	0,4

* Puesta en marcha prevista Julio de 2010

Capacidades futuras previstas en las conexiones internacionales a 2016

Interconexión	Sentido Flujo	Capacidad Nominal GWh/día	Capacidad Nominal bcm /año
C.I. Marruecos - Tarifa		354	11
C.I. Argelia - Medgaz		266	8
C.I. Francia – Larrau *	Sentido E→F	165	5,3
	Sentido F→E	165	5,3
C.I. Francia – Irún	Sentido E→F	9	0,3
	Sentido F→E	10	0,3
C.I. Portugal – Badajoz	Sentido E→P	134	4,3
	Sentido P→E	105	3,4
C.I. Portugal - Tuy	Sentido E→P	57	1,8
	Sentido P→E	12	0,4

* Capacidades comprometidas para 2013, tras los resultados de la primera fase del proceso de asignación de capacidades de interconexión entre España y Francia, *Open Season*.

Source: CNE website, retrieved February 2011,
http://www.cne.es/cne/doc/mer_ener/capacidadesgasistas.pdf

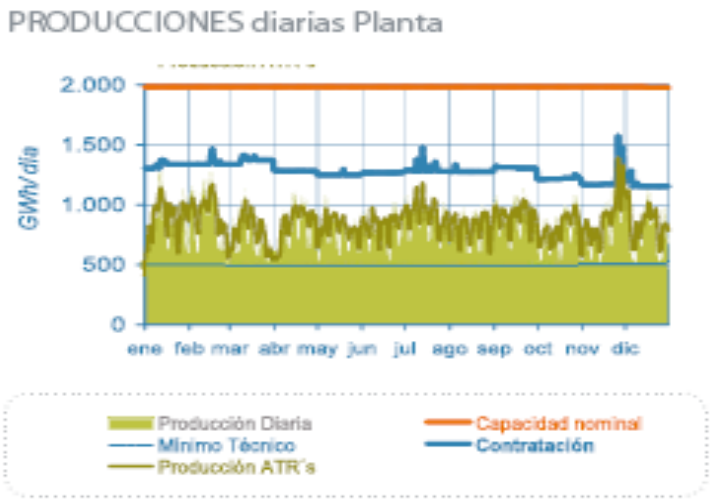
Appendix 8: List of natural gas exporting countries to Spain, in 2010

	mcm	%
Algeria pp	7145.8	19.2
Algeria LNG	**3838.4**	**10.3**
Nigeria LNG	**7907.9**	**21.2**
Qatar LNG	**5898.0**	**15.8**
T&T LNG	**3131.0**	**8.4**
Egypt LNG	**2945.5**	**7.9**
Norway LNG	**1861.2**	**5.0**
France pp	1677.3	4.5
Italia LNG*	**926.2**	**2.5**
Peru LNG	**644.8**	**1.7**
Libya LNG	**371.5**	**1.0**
Yemen LNG	**267.1**	**0.7**
Oman LNG	**173.8**	**0.5**
Portugal pp	163.4	0.4
USA LNG*	**118.0**	**0.3**
Belgium LNG*	**78.8**	**0.2**
Production	108.1	0.3
Total	37256.9	100

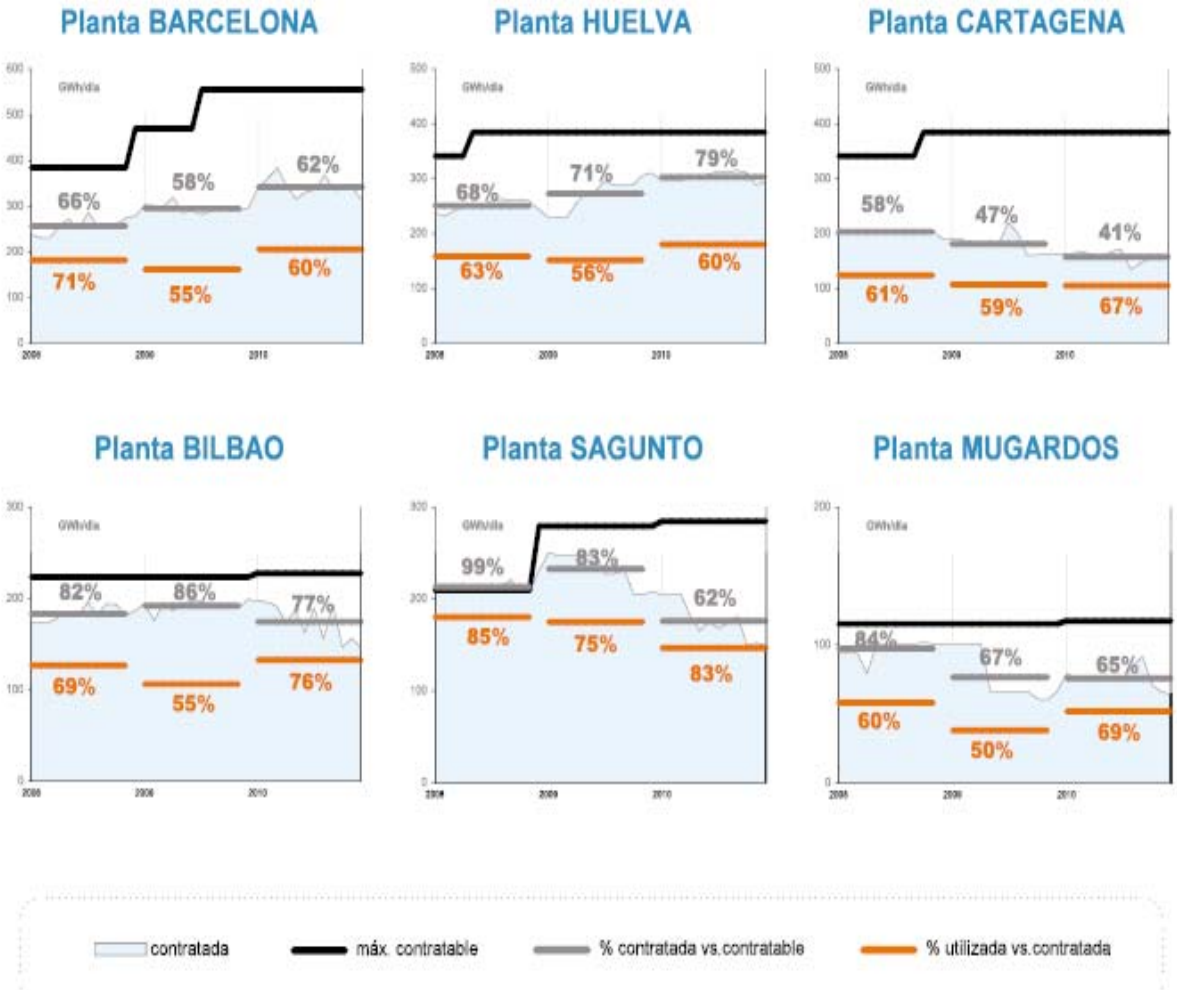
* Commercial origin

Source: Enagás (2011), p.42

Appendix 9: Utilisation of installed and contracted import capacity at the LNG regas terminals in 2008-2010 (GWh/d)

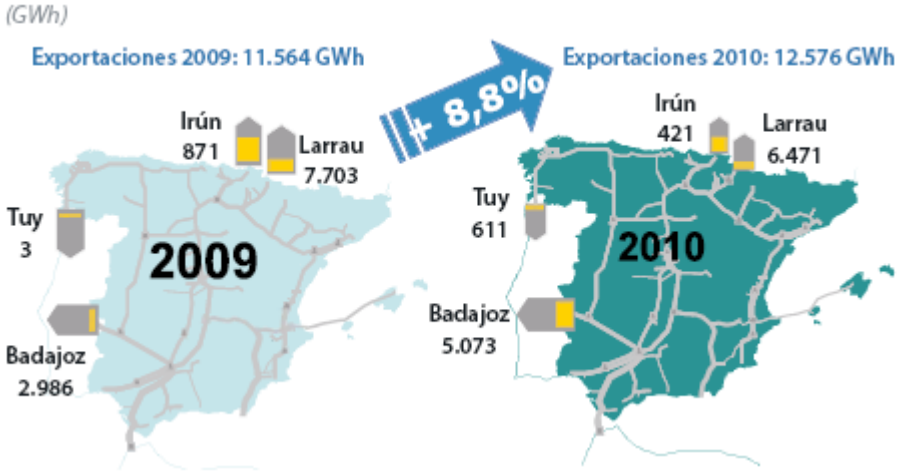


Source: Enagás (2011), p.74

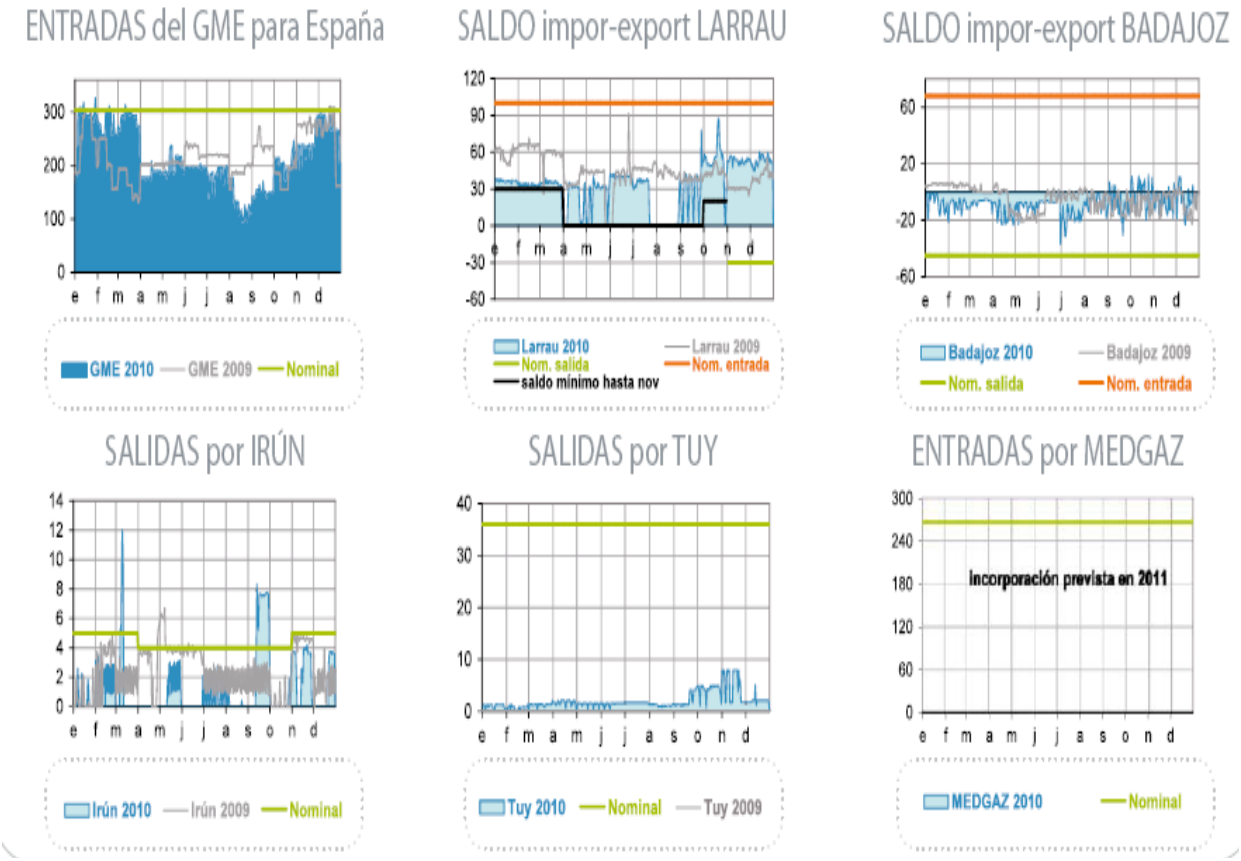


Source: Enagás (2011), p.65

Appendix 10: Utilisation of installed and contracted import capacity at the interconnections in 2010 (GWh/d)



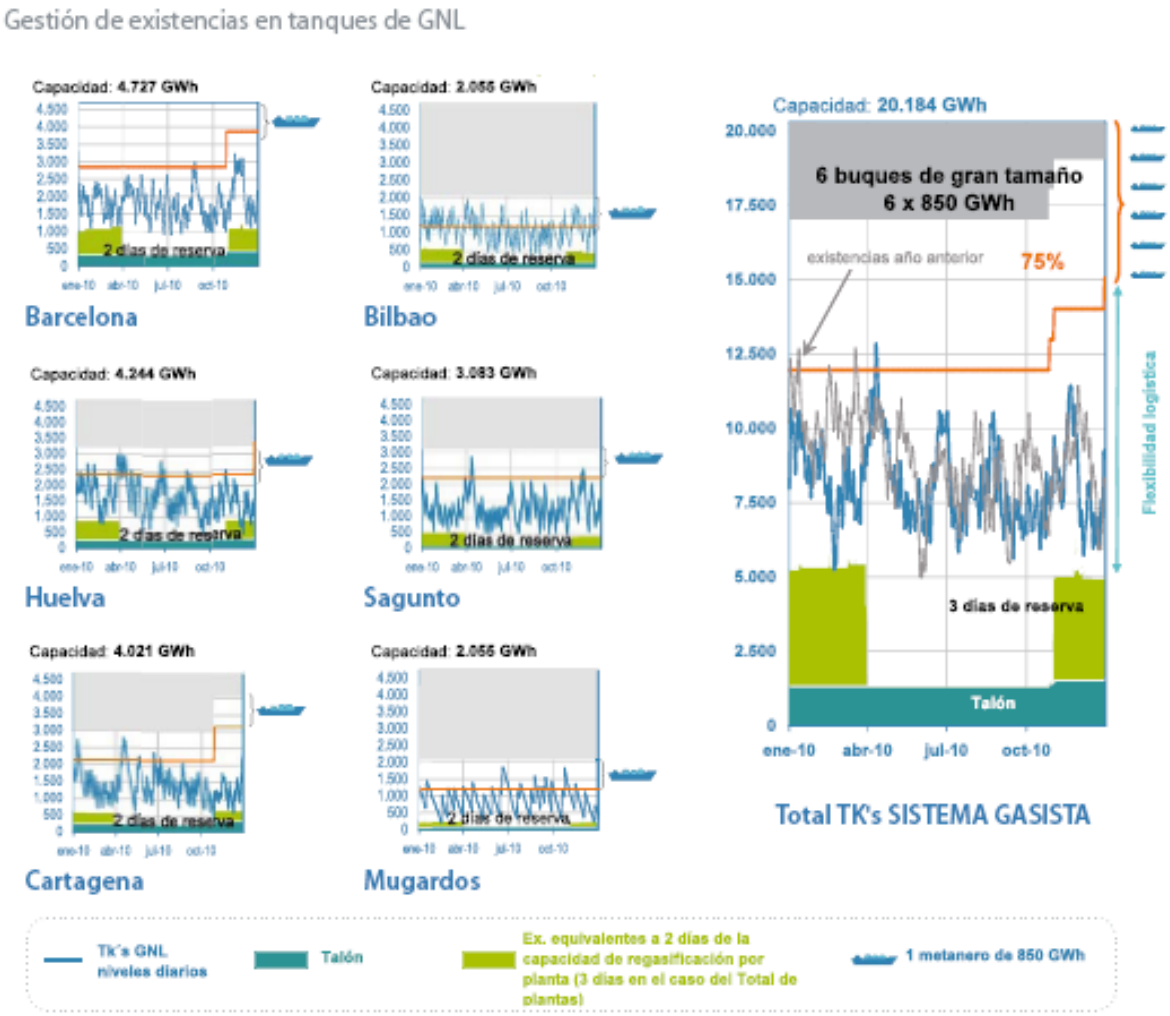
Source: Enagás (2011), p.78



Source: Enagás (2011), p.79

Appendix 11: Daily levels of gas in LNG storage units in 2010

Enagás (2011), p.74



Enagás (2011), p.64

Appendix 12: Evolution of the load factors of the power plants by fuel in Spain, 2003-2010 (%)

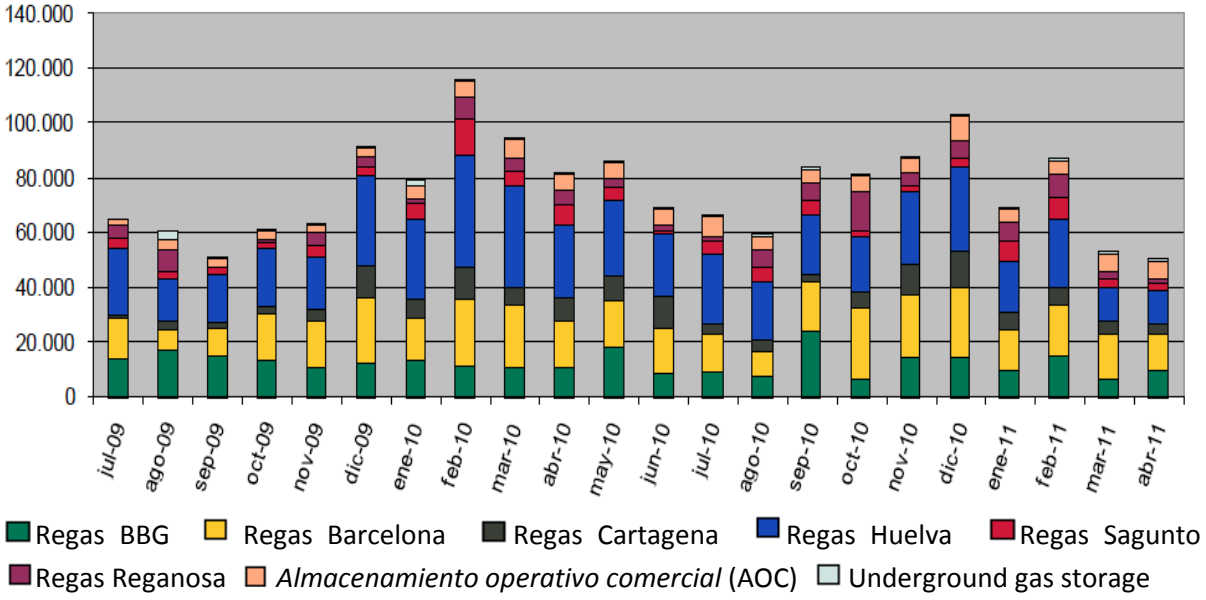
	Load factors								Capacity	Generation
	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2010**	**2010**
Hydro	**26.6**	**20.4**	**13.1**	**17.4**	**18.1**	**14.7**	**16.4**	**25.1**	**17.7**	**13.8**
Nuclear	89.7	92.2	83.4	89.0	81.5	87.2	78.1	91.0	7.9	22.1
Coal	71.3	75.4	77.3	66.0	72.2	46.5	34.0	22.2	11.5	7.9
Fuel/gas	13.2	12.7	17.2	10.1	5.7	6.1	7.9	7.3	2.9	0.7
CCGTs	**38.9**	**39.9**	**45.6**	**46.8**	**37.1**	**48.1**	**38.7**	**29.2**	**25.5**	**23.1**
SR hydro	37.6	32.4	23.7	25.1	23.7	25.5	31.7	39.1	2.0	2.4
SR wind	**25.1**	**21.3**	**23.7**	**23.2**	**22.1**	**22.6**	**22.3**	**24.7**	**20.3**	**15.5**
SR other REN	54.6	50.1	48.7	42.4	36.9	20.2	29.1	25.7	5.2	4.2
SR other non-REN	36.1	39.0	38.4	33.0	34.2	37.3	46.3	47.4	7.1	10.4

Source: Load factors calculated from REE, The Spanish Electricity System (various issues)

Note: The load factors in Table 18 au-dessus do not exactly correspond to the data in Figure 28 on page 45 due to the difference of sources (Enagás for Figure 28 and REE for Table 18).

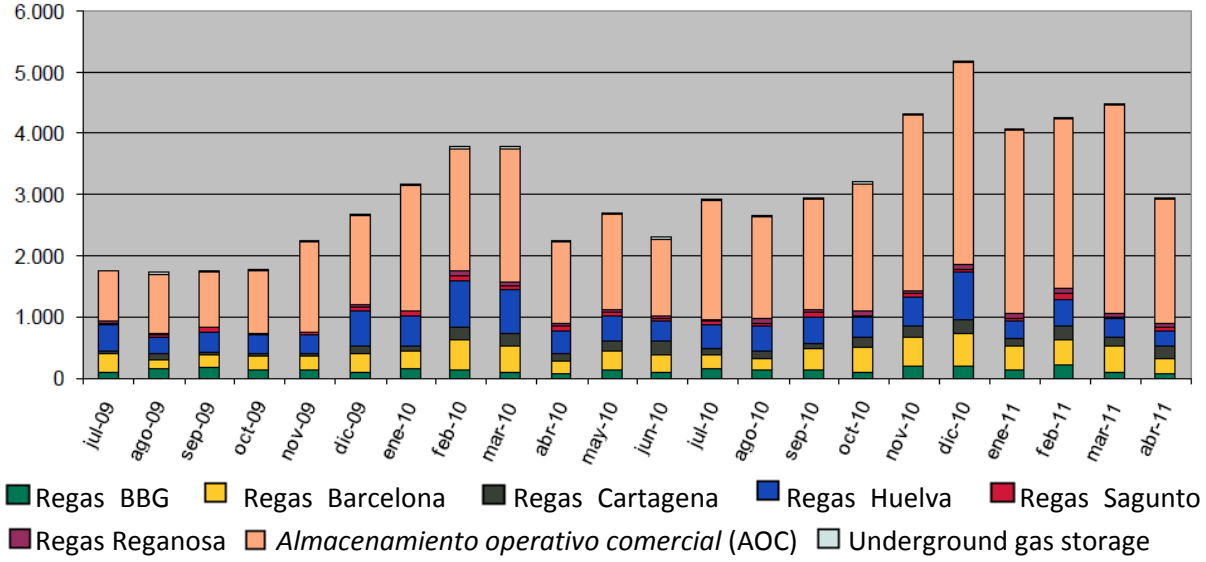
Appendix 13: Monthly natural gas volumes traded at the balancing points and number of transactions in Spain for the period July 2009 – April 2011

Figure 52: Natural gas volumes traded at balancing points, July 2009-April 2011 (GWh/month)



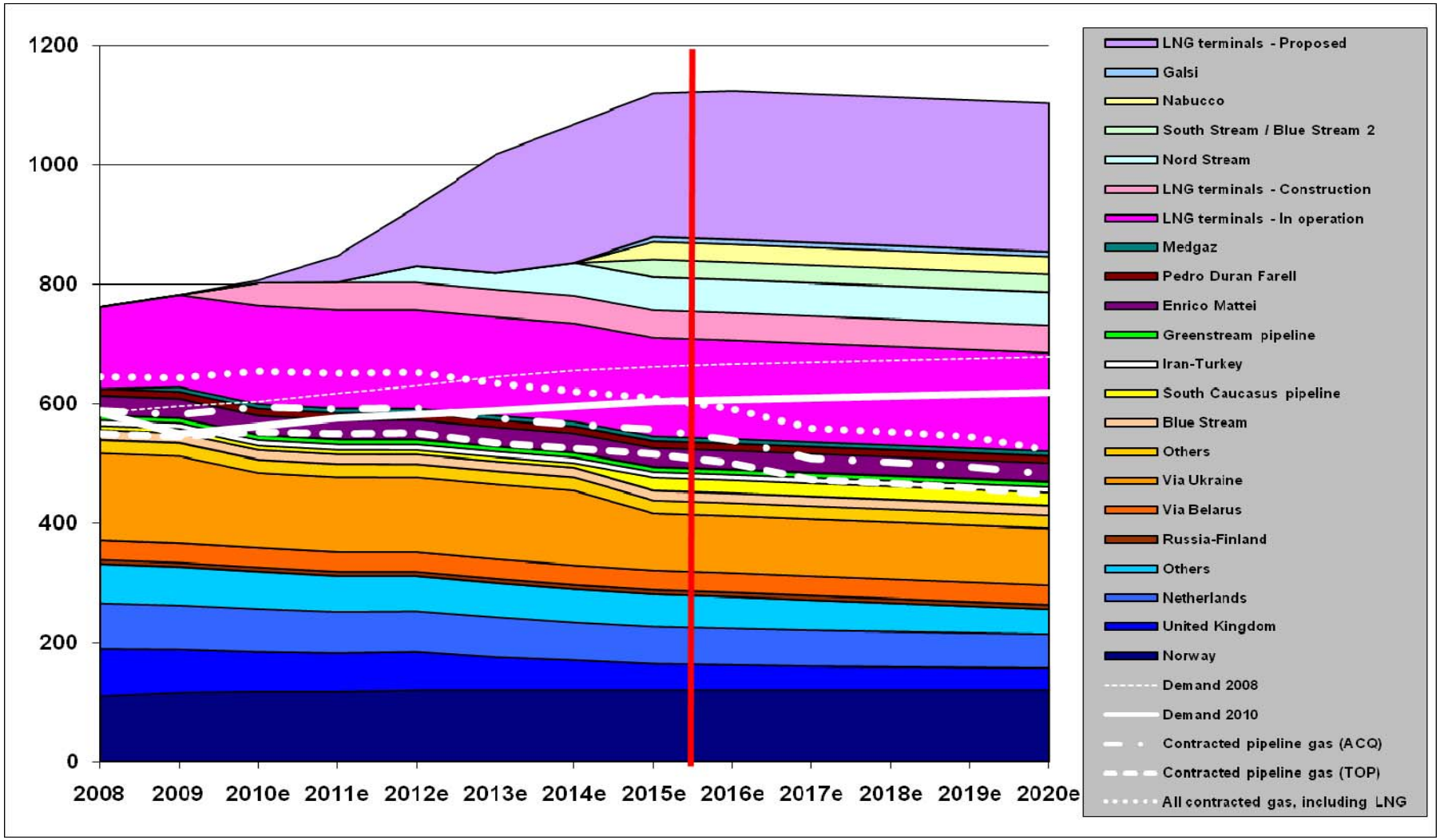
Source: CNE (2011), Supervisión del mercado mayorista de gas, p.15

Figure 53: Number of natural gas transactions, July 2009-April 2011 (number/month)



Source: CNE (2011), Supervisión del mercado mayorista de gas, p.16

Appendix 14: Natural gas demand, contracted volumes and existing and planned import capacity in Europe, 2008-2020 (bcm)



Source: Adapted from Honore A. (2010), p.176

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