Natural Gas Research Programme

FUTURE NATURAL GAS DEMAND IN EUROPE

The Importance of the Power Sector

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January 2006

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ISBN 1-901795-42-X

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Acknowledgements

First, I want to thank the Sponsors of the Natural Gas Research Programme for their generosity, and also for providing valuable comments during the research process. Second, I would like to express gratitude to everyone who helped me during my research, especially Malcolm Keay (*Oxford Institute*), Doug Cook (*International Energy Agency*), and Esa Hakkarainen (*Vattenfall*). Our conversations have been helpful. I would also like to thank three persons in particular: Mieke Reece (*International Energy Agency)*, Henry Edwardes-Evans (*Platts)* and Juho Lipponen (*Eurelectric)*. Last but not least, I would like to thank Jonathan Stern for his help, support and all his very useful comments as the paper progressed.

FUTURE NATURAL GAS DEMAND IN EUROPE

The importance of the power sector

Energy forecasts predict natural gas to be the fastest growing fossil fuel source in the next 2−3 decades in Europe. However, projections of European gas demand are being revised downwards. Certainty about future gas demand in the European Union (EU25) has changed over the past few years. Are oil-linked gas prices too high for new power plants to be developed? Will there be a huge increase in gas for power or are we already moving away from this type of future? This paper looks at gas demand in Europe in the next decade. It focuses on the power generation sector, using a bottom-up approach. The questions we had when we started this research were: do we currently see the power station construction to support projected levels of gas demand; if not, when might we see such construction, what are the main drivers of construction, and what are the consequences for gas demand of stations being built in different time frames and running at different load factors? We look at what is being built and the projects that are planned, and proceed to calculate the equivalent gas demand with different load factor assumptions.

Comments/questions on this study are welcome:

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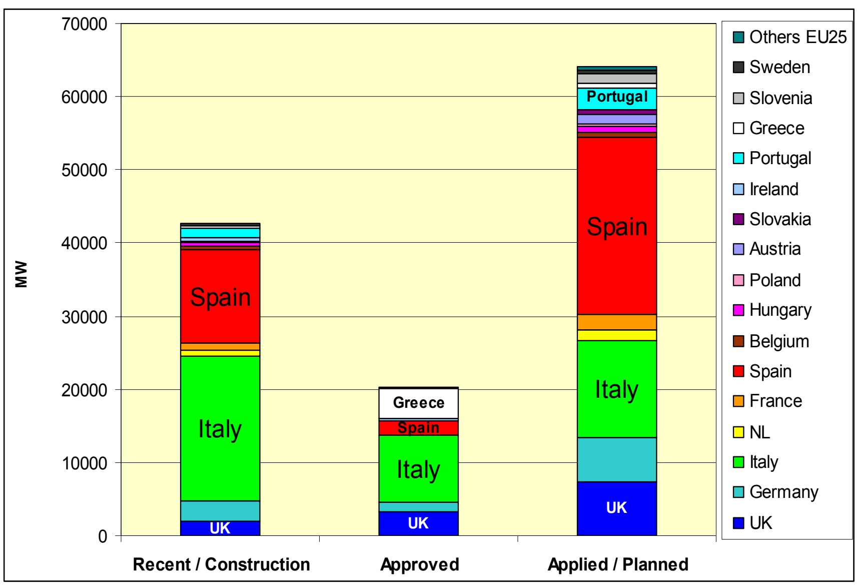
SUMMARY AND CONCLUSIONS

Publicly available projections[1] agree that natural gas will be the fastest growing fossil fuel source in Europe over the next two decades, driven mainly by the demand from the power sector. This paper poses three key questions regarding gas demand in Europe by 2015: how much, for which countries and by when? Investors making decisions on the basis of possible demand over two decades need to know how much of that demand will arrive in ten, 15 or 25 years time.

From a survey of gas-fired power plants in Europe 25 (EU25) gas markets, our main conclusion is that, *yes*, the use of natural gas for power generation will increase substantially in Europe, *but* probably not as much and not as fast as is generally believed. It mainly shows that there is a very different story to tell about the various countries/regions of Europe regarding the future of gas to power, and that different time frames provide different stories. Increases in gas demand for the power generation sector in EU25 are highly sensitive to the development of gas-fired generation in two countries: Italy and Spain.

Figure A1: Gas-fired power plants projects in EU 25, "utilities" only[2], in megawatt (MW)



Source: Platts *Power in Europe*, Platts *Energy in East Europe,* Governments, Regulators, Companies

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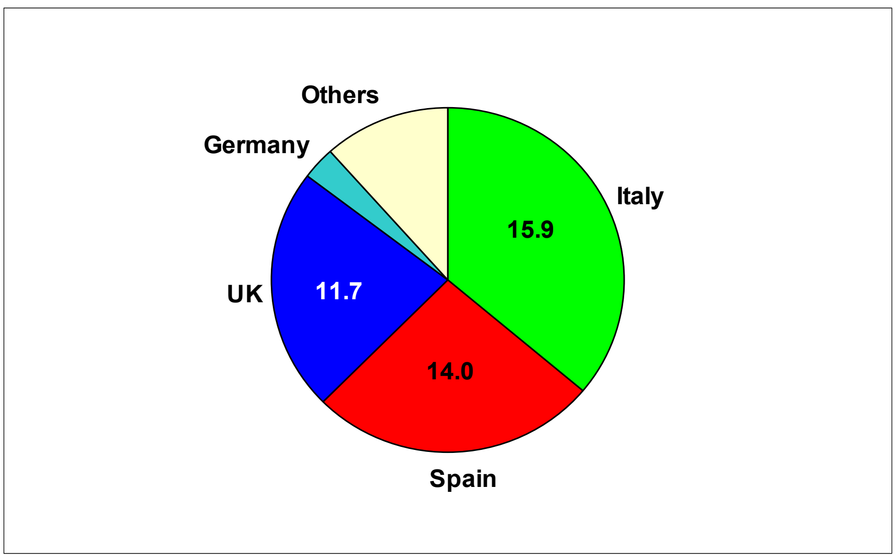
[1] International Energy Agency, US Energy Information Administration, Eurogas, etc.
[2] Excluding the "auto-producers".

The 2003−2005 increase in gas prices makes it difficult to sustain a decision to invest in gas-fired generation in most countries in Europe. If high gas prices remain, it will delay new combined cycle gas turbine (CCGTs) power plants from being built and come in full production by 2015. It will also prevent the existing ones from running on baseload, and differences in load factors have a huge impact on gas demand. This is never shown in gas-demand-for-power-generation forecasts, but depending on whether gas-fired plants run on baseload[2] (75 percent) or on a lower load factor (20 percent), will produce a difference of 60 billion cubic metres (bcm) in gas demand for power in EU25 by 2015 in our probable scenario. Only lower gas prices up to 2015 will lead to a huge increase in gas demand.

Our most likely scenario[3] is that compared to 2005, the power sector in EU25 will require about 49 bcm of additional gas by 2015, depending on operating load factors. The main result is that 84 percent of the possible increase in gas demand for power generation by 2015 in EU25 will come from three countries only: Italy, Spain and the United Kingdom (UK).

Figure A2: Increase in gas demand for the power generation sector, between 2005 and 2015, in bcm



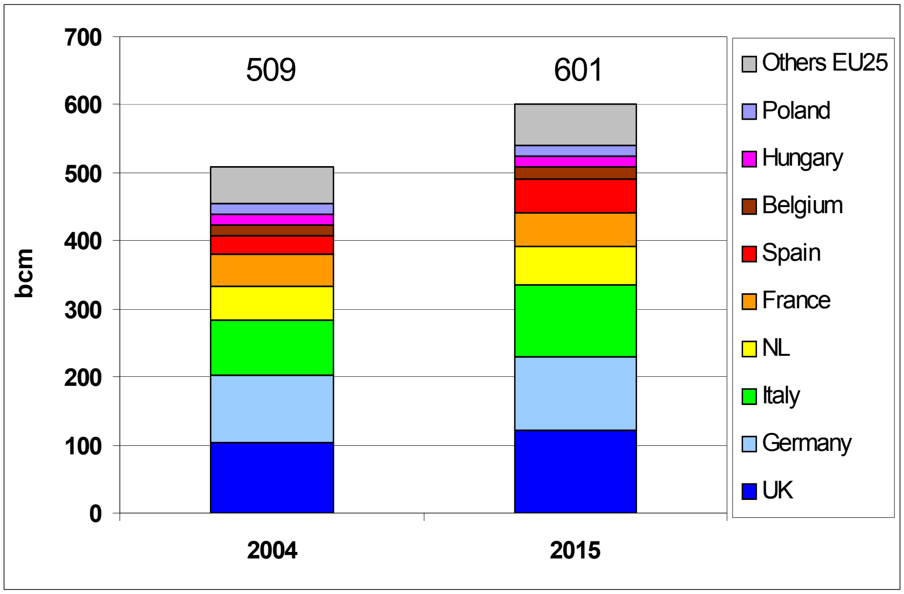
Source: Author's assumptions

If significant numbers of currently anticipated CCGT power plants in Spain, Italy and the UK are either delayed or abandoned, increases in gas demand will be correspondingly reduced. Without significant numbers of new CCGT plants, it is hard to see where the major gas markets of Europe will use substantial additional gas supplies. The UK requirements are already covered by projects under construction. The only two other markets where we see significant growth are Spain and Italy.

[3] See Chapter 2: Methodology and Assumptions.

Our total gas demand by 2015 for EU25 is 601 bcm. Our results are slightly lower than the forecasts published in the public domain. The International Energy Agency (IEA) projects 225 bcm of gas demand for power generation in EU25 by 2015 in its base-case scenario published in the *World Energy Outlook 2004*. With our methodology,[2] and assuming a load factor for each country (based on historical data and future trends), we project 195 bcm for the power sector[4], and 406 bcm for the non-power sector.

Figure A3: Gas demand by country in EU25, by 2015, in bcm



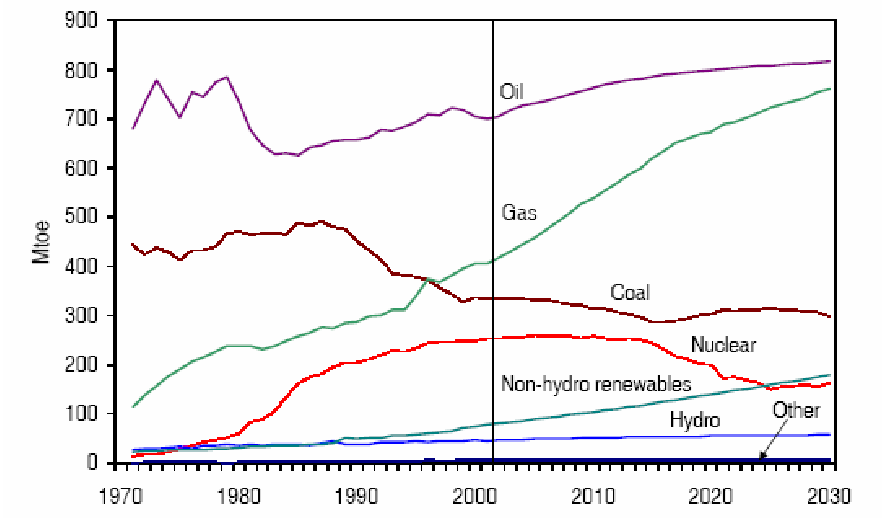
Source: Author's assumptions

[4] Go to "Methodology" and/or "Appendix 4" for further details on the calculations.

1. INTRODUCTION: WHY GAS DEMAND?

Why do we need a study on gas demand? First, because energy forecasts predict natural gas to be the fastest growing primary energy source in Europe in the next 2−3 decades. Gas demand forecasts commonly show optimistic trends increasing gently or steeply, as shown in Figure 1. The reasons for this expected 'dash for gas' are well known: the economics and efficiency of the new combined cycle gas turbine (CCGT) power plants, the environmental qualities of gas, and the adaptability, flexibility and availability of gas in an open power sector.

Figure 1: International Energy Agency forecasts of primary energy demand in Europe 30

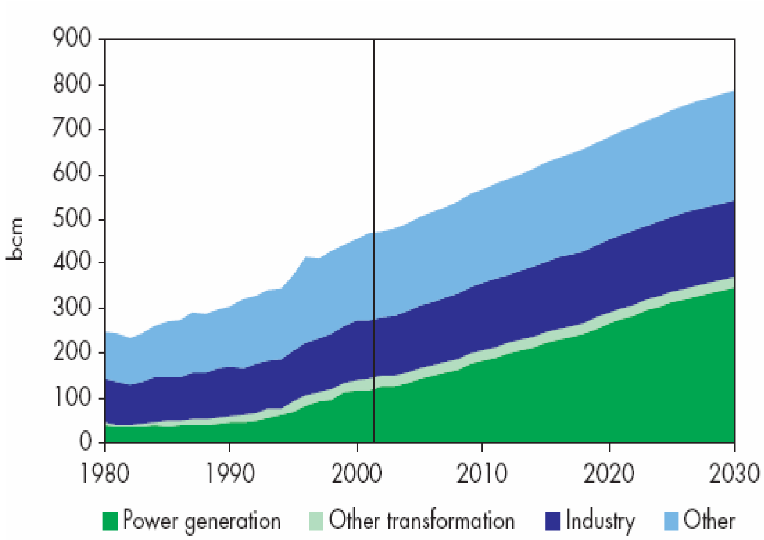


Source: *World Energy Outlook 2004* Reference Scenario

The second reason is because gas demand is a very under-researched subject in comparison to supply. Powerpoint presentations in conferences usually focus on the gas demand/supply gap over the next three decades, followed by slides focusing on the supply projects without any more details on demand. Statements about global European gas demand increasing by 1.5−3 percent per annum up to 2030 may prove to be correct *by the end of* the period, but so many factors can change in 20−30 years time that these predictions really tell us very little about the evolution of gas demand *during* the next 25 years, and whether there is a different story to tell about different countries/regions of Europe for different time frames. Or whether there is a scenario in which gas demand projections of 1.5−3 percent per annum for the next 20−25 years are not realised?

The power generation sector is seen to be the main driver for gas consumption in the next 20−30 years, as shown in Figure 2. The International Energy Agency (IEA) and other projections suggest that roughly 70 percent of the projected demand increase will be coming from the power sector.[5]

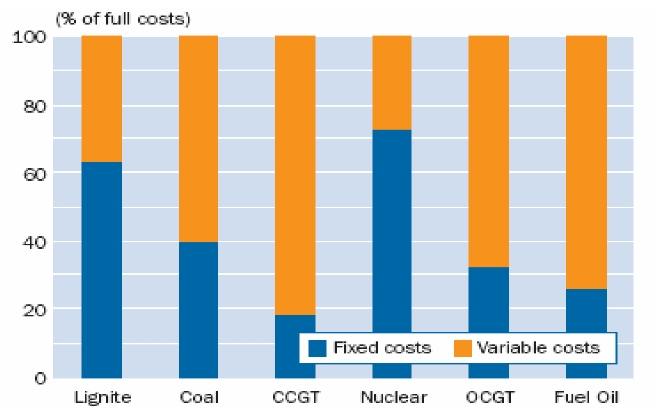
Figure 2: Example of gas demand forecast in EU25, in bcm



Source: International Energy Agency, *World Energy Outlook 2004*

However, the increase in gas prices since 2003 has put a major question mark over the growth of gas for power generation. Given the large share of fuel costs in CCGT plants (see Figure 3) high gas prices make it difficult to sustain a decision to invest in new gas-fired plants in most countries in Europe, and may have already started to delay gas demand growth in the mid 2000s.

Figure 3: Fixed versus variable costs in generation



Source: UBS

[5] The IEA 'reference scenario' (*World Energy Outlook 2004*) projects an increase in the use of natural gas for power generation in OECD Europe of 4.2%/y between 2002 and 2010 and only some 1.4%/y for the non-power-sectors. Other forecasts (European Union, UK Department of Trade and Industry, NationalGrid) for European gas markets show a more modest increase per year than the IEA, but still significant with natural gas markets.

After a cursory examination of the literature on natural gas demand, we realised that this is a poorly understood issue, with little transparency in the assumptions used to develop scenarios and projections. Historical data are hard to reconcile and it is difficult to obtain a consistent series across countries due to end-user classifications, calorific value/temperature/pressure, a variety of units/different conversion factors, and different regional areas considered: EU15, EU25, OECD Europe, EGTA (European Gas Trading Area) and others. Examples of gas demand forecasts are shown in Table 1.

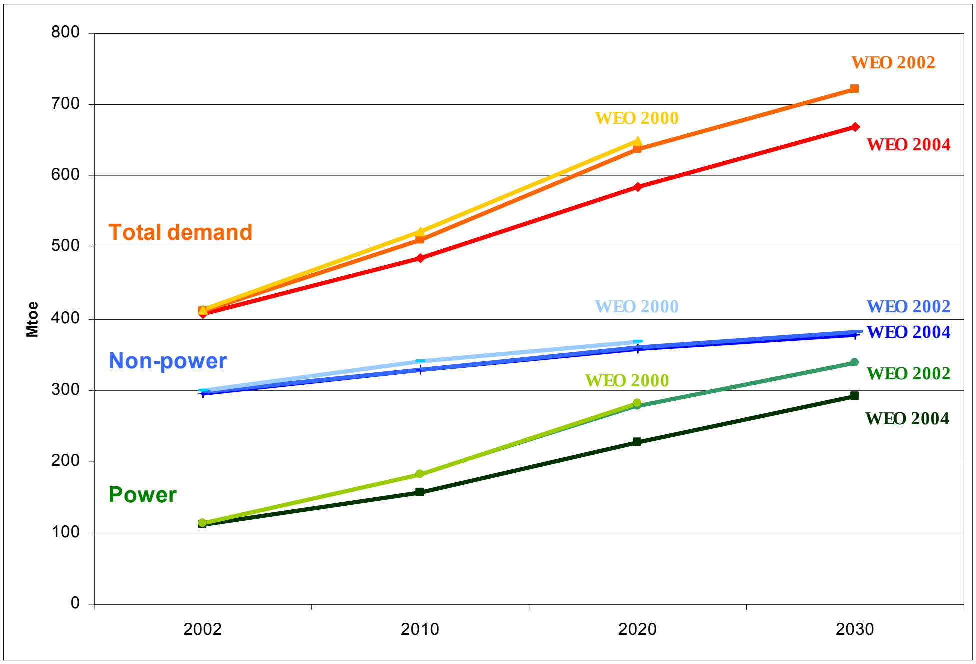
Table 1: Examples of gas demand forecasts available in the public domain in 2004 (unit as stated in the table)

Source	Regional coverage	Sectors	Time frame	Unit	Demand
International Energy Agency	EU25	All	2015	bcm	620
	EU25	Power	2015	bcm	220
	EU25	Non-Power	2015	bcm	400
Eurogas	EU15	All	2015	Mtoe	450
	EU15	Power	2015	Mtoe	120
	EU15	Non-Power	2015	Mtoe	330
Cedigaz	7 major markets in EU15	All	2010	bcm	458-474
(US) Energy Information Administration	"Western Europe"	All	2015	bcm	550
International Gas Union	Western and Central Europe	All	2010	bcm	622
	Western and Central Europe	All	2020	bcm	718
	Western and Central Europe	Power	2010	bcm	189
	Western and Central Europe	Power	2020	bcm	331
Eurelectric	Europe13 (without Germany and France)	Power	2010	bcm	148

Sources: Various

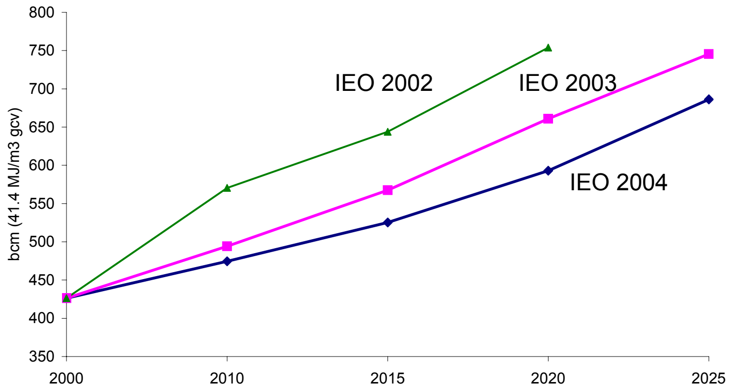
It is also very difficult to see any price sensitivity in the published scenarios. With a one/two year time lag in obtaining data, projections are currently based on too low a price for oil, therefore underestimating the price of gas and the potential negative impact on demand. Interestingly, projections of European gas demand, which has been universally expected to increase in a steep, straight line for the next 25 years, are being revised downwards. Projections are still relatively optimistic, but certainty about future gas demand in Europe 25 (EU25) has changed over the past few years. The IEA and the US Energy Information Administration for instance, which publish gas demand forecasts every year or every two years, have reviewed their past predictions on demand and have progressively lowered them over the years as shown in Figures 4 and 5. The downward revision of the IEA forecasts clearly comes from a reduction of gas demand growth in the power generation sector.

Figure 4: OECD Europe gas demand forecasts in 2000, 2002 and 2004



Source: *World Energy Outlook* 2000, 2002 and 2004

Figure 5: US EIA European gas demand forecasts in 2002, 2003 and 2004



Source: *International Energy Outlook* 2002, 2003 and 2004

It is not clear whether this is a result of fundamental analysis, assuming lower demand because of high gas prices, lower gross domestic product (GDP) growth, increased role of other fuels in power generation (coal, renewables) or better energy conservation. It is also not obvious how far companies are willing to publicly acknowledge this trend, given that steep demand growth is excellent news for industry stakeholders.

These are our reasons for undertaking research on European gas demand. This paper examines possible future developments, particularly for the power generation sector, in Europe. The objective is to shed some light on: *how quickly* gas demand for power in Europe can be expected to increase, *in which* countries and *how much?* Our methodology and assumptions are described in the next section.

2. METHODOLOGY AND ASSUMPTIONS

We adopted a pragmatic methodology to examine gas demand for power generation by 2015: a bottom-up approach. It appears to us to be the most easily understandable and verifiable methodology, as opposed to econometric models which are harder to understand and are difficult to replicate independently.

We asked the following question: do we currently see the power station construction to support projected levels of gas demand; if not, when might we see such construction, what are the main drivers of construction, and what are the consequences for gas demand of stations being built in different time frames and running at different load factors? We look at what is being built and the projects that are planned, and proceed to calculate the equivalent gas demand with different load factor assumptions.

In liberalised markets, it is much more difficult to get access to information on gas-fired plants. So before building our scenarios for gas demand growth in the power sector, we adopted the following definitions and assumptions.

2.1 Geographical coverage: 'Europe'

Nine major gas markets represent about 90 percent of the EU25[6] gas demand: the United Kingdom (UK), Germany, Italy, the Netherlands (NL), France, Spain, Belgium, Poland and Hungary. We look at these markets in Chapter 5.

We wanted to have a wider picture of what the gas demand could be in 'Europe', and therefore decided to look at countries stretching from the Atlantic Ocean in the west almost to the CIS countries in the east. Our definition of 'Europe 35' includes: Albania, *Austria, Belgium*, Bosnia and Herzegovina, Bulgaria, Croatia, *Czech Republic, Cyprus, Denmark, Estonia*, *Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands,* Norway, *Poland*, Republic of Macedonia,

[6] European Union members include: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, The Netherlands, Portugal, Spain, Sweden, and the United Kingdom. On May 1, 2004, the membership expanded from 15 to 25 countries. The new members include: Poland, the Czech Republic, Slovakia, Hungary, Estonia, Latvia, Lithuania, Slovenia, Malta, and Cyprus.

Romania, *Portugal,* Serbia and Montenegro, *Slovakia, Slovenia, Spain, Sweden,* Switzerland, Turkey *and the United Kingdom*. These 35 markets are not studied in detail, but we provide gas demand scenarios for each of them in the Appendix. Gas consumption in our 'Europe 35' in 2004 can be found in Table 2.

Table 2: 'Europe 35' gas demand in 2004, in bcm

	2004	Percent	Cumulated percent
United Kingdom	102.55	18.0	18.0
Germany	101.25	17.8	35.8
Italy	80.61	14.1	49.9
Netherlands	51.30	9.0	58.9
France	45.58	8.0	66.9
Spain	27.01	4.7	71.7
Turkey	22.44	3.9	75.6
Romania	18.89	3.3	78.9
Belgium	17.06	3.0	81.9
Poland	15.67	2.8	84.7
Hungary	14.46	2.5	87.2
Czech Republic	9.60	1.7	88.9
Austria	8.98	1.6	90.5
Slovakia	6.72	1.2	91.6
Norway	5.55	1.0	92.6
Denmark	5.17	0.9	93.5
Finland	4.86	0.9	94.4
Ireland	4.30	0.8	95.1
Bulgaria	3.77	0.7	96.8
Portugal	3.74	0.7	97.5
Switzerland	3.31	0.6	96.2
Croatia	2.60	0.5	95.6
Serbia and Montenegro	2.09	0.4	97.8
Lithuania	2.94	0.5	98.4
Greece	2.69	0.5	98.8
Latvia	1.75	0.3	99.1
Luxembourg	1.36	0.2	99.4
Slovenia	1.10	0.2	99.6
Sweden	0.98	0.2	99.7
Estonia	0.85	0.1	99.9
Bosnia and Herzegovina	0.62	0.1	100
Albania	0.01	0.0	100
Republic of Macedonia	0.00	0.0	100
Cyprus	0.00	0.0	100
Malta	0.00	0.0	100
TOTAL 35 countries	569.81	100	100

Source: International Energy Agency, *Natural Gas Information 2005*

2.2 Sectors studied

As already mentioned, we focus on the power generation sector, which every forecast sees as the main driver for gas demand in the future. However, we also include gas demand growth for the non-power sectors in order to get a complete picture of demand.

We are using the IEA statistical data for our gas consumption for 2004. Their power generation sector includes electricity generation and heat production, however, only the electricity and the heat produced in combined heat and power (CHP) plants will be considered in our scenarios. Gas consumed by "heat plants" represented 4.5 percent of the gas demand from power generation sector in 2004, down from 8.2 percent in 1990. We expect that this share will continue to decrease in the future.

The IEA definition of the power generation sector includes the utilities and the auto-producers. "*Utilities"* or *"main activity producers"* refers to entities whose primary activity is to generate electricity and/or heat for supply to third parties. "*Auto-producers"* refers to entities that generate electricity and/or heat, wholly or partly for their own use as an activity that supports their primary activity. This study only considers the power generation from the utilities. The information on power plants projects from the auto-producers is –most of the time- not publicly available.

2.3 Time frame

'Time' is one of the most important factors in studying gas demand growth. There are so many factors that influence gas consumption that we decided to focus on the next ten years, where we think we can obtain a more confident reading of the likely outcome. Over a longer period, many more factors enter the picture and call into question the usefulness of projections which cover a 20–30 year time frame. We consider annual demand for gas, which means that the very important issue of seasonality of gas demand is not examined in this paper.

2.4 Lead-time for construction of a gas-fired power plant

We assume that it takes at least four to five years from the idea of building a gas-fired power plant to run at maximum capacity. We have estimated the lead time for new gas-fired power plants using the following assumptions:

- 1 year for consent procedures (though this may take longer in some countries),
- 2 years for construction (though three years is not rare)
- 1 year to reach maximum capacity

This means that, even with an optimistic point of view, it takes at least four years from idea to power plant running at full capacity. So, it will be very difficult for any plant which is not currently under construction to be operating at full capacity before the end of the decade. This also means that a project without administrative consent in 2005 probably cannot be operating at maximum capacity before 2010. With this methodology, when looking at gas demand for the power generation sector by 2015, we really look at the projects that can start construction by 2011/12 at the very latest.

Lead-time construction varies from one project to another, depending on the size of the plant, the site of construction or the (non-) existing connections with the network. However, after discussions with generators, we feel confident that our time frame is representative enough.

2.5 Probability of being built

Deciding on the probability of a project actually being built is another problem. A retrospective analysis of the principal countries would have probably revealed significant variance between plans versus reality. However, it is unclear how useful such an analysis would be for developing future projections. Finding ‘representative time periods’ is difficult e.g. the UK dash for gas, followed by virtually no new CCGT plant build. We have decided to build our scenarios on assumptions based on discussions with people with knowledge of the industry. We have developed two scenarios for gas demand in the power sector in the coming decade: one probable and one maximum possible. Our scenarios give information on potential gas demand by 2015 from a today’s perspective. The data on new power plants was finalised in September 2005. This study does not consider additional projects that have been proposed since then.

2.6 Scenarios

In order to estimate gas demand by 2015, we have divided the next decade into two periods: 2005−2010 and 2010−2015.

We have two scenarios for gas demand in 2010: a probable and a possible scenario. The probable scenario includes all the projects recently operational which should run at full capacity by the end of 2005 or beginning of 2006, and all the projects that are under construction. The plants that have received administrative consent could in theory be in production by 2010, therefore our possible scenario adds all the projects with administrative consent.

We again have two scenarios for gas demand up to 2015: a probable and a maximum possible scenario. The probable scenario takes into account factors that could slow

down gas consumption for power generation by 2015 (such as high gas prices, emissions targets, non nuclear phase-out, favourable treatment of renewables and so on). However, this is not a study on electricity generation, and we are only interested in the impact of these measures on gas demand. We have looked – briefly − at the other fuels only to understand gas' position in the power generation sector.
The maximum possible scenario includes all the projects that are at different stages of development, but could be in production by 2015. The projects that have been abandoned recently are not included. Table 3 summarises our scenarios.

Table 3: Author's scenarios for gas demand in the power generation sector by 2015

Time frame	Scenario	Gas-fired power plants projects which:
2005−2010	Probable scenario	− Are recently operational (and will run at full capacity in 2005/2006) − Are under construction − Some rare projects with administrative consent that we think are going to be built and run at maximum capacity by 2010
	Possible scenario	− Are recently operational (and will run at full capacity in 2005/2006) − Are under construction − Have received administrative consent and could therefore – in theory − be in production by 2010
2010−2015	Probable	− Have received administrative consent, but were not counted in the probable scenario by 2010 and *are likely to be built by 2015* − Have applied for administrative consent *and/or are likely to be built by 2015*
	Maximum possible	− Have received administrative consent, but were not counted in the probable scenario by 2010 − Have applied for administrative consent − Have been proposed = ALL the projects not counted in the probable scenario for 2005−2010

For the period *2005−2015*, our probable scenario adds together the two probable scenarios. Our maximum scenario includes all the gas-fired projects at different stages of development. However, we do not believe that it is correct to take into account all the projects that are planned but have little likelihood of coming into operation. We should not forget that projects may not be built for a variety of reasons. Taking just the case of the UK, 5 gigawatts (GW) of new capacity projects, with administrative consent, are on hold or have been scrapped. The possible reasons for this are:

- uncertainty over gas prices
- uncertainty over the role of coal

- uncertainty caused by low electricity wholesale prices post-NETA (New Electricity Trading Arrangements)

Other examples are Italy, where about 5GW of projects have also been abandoned recently, or Spain where several projects are clearly in competition. Then, projects which are completed may not run even on middle load; there are many examples of new gas-fired plant running on peak load only or being mothballed due to unfavourable commercial circumstances.

Once we have made our scenarios on gas-fired power plants, we then convert the megawatts (MW) of additional gas-fired capacity into cubic metres of gas used as an input to generate electricity (and heat for cogeneration (CHP) plants).

One important remark: It should be noted that we do not take into account the potential decommissioning of old gas-fired power plants that could occur in the next decade. This is only due to a lack of information, but it means that our projections on gas demand for power could be correspondingly lower if many megawatt of gas-fired capacity are decommissioned by 2015.

It was also difficult to obtain information on the decommissioning of other power plants such as old coal-fired plants for instance. However, our methodology is to look at the gas-fired power plant projects. We can safely assume that the companies have studied the decommissioning of the existing plants before planning their new investments in gas-fired plants (or in other generating capacities). Therefore, we believe that our methodology captures the impacts of the decommissioning of old plants on the construction of new gas-fired generation.

2.7 Load factors

Load factors have not been specified for each type of plant. Actual load factors depend on merit order of operation, on the nature of gas contracts, on gas and electricity prices and whether the plant is dispatched. Following these observations, we have used three load factor scenarios to account for a likely range of gas demand: 75 percent, 50 percent and 20 percent. Not many CCGT plants will operate as low as 20 percent load factor and some may operate more than 75 percent (financing assumptions have been as high as 85 percent but these have sometimes proven to be over-optimistic). We are considering all the gas-fired power plants for one country during one year. These load factor scenarios are representative enough of actual operating plants. This wide range (75 percent to 20 percent) also demonstrates the importance of load factors assumptions when considering gas demand for the power generation sector.

To give an indication of the load factor at which the gas-fired plants are run, we indicate the load factors for the gas-fired capacity for the years 2000, 2001, 2002 and 2003 using the IEA statistical data. To calculate these load factors, we use the electricity generated from gas by the utilities only[7] and the net maximum electricity generating gas-fired capacity owned by the utilities, single and multi-fired. The IEA data do not give details on the share of gas-fired capacity in the multi-fired plants, therefore the load factor calculated could be a little lower than the real load factor for gas-fired plants. This is the reason why we indicate the percentage of single and multi-fired capacity.

2.8 Efficiency

New plant tends to have higher efficiency than existing plant and therefore will tend to generate ahead of older plant. The same electrical output necessitates less gas than with old plants, and an increase in power demand may not translate into more gas consumed because the efficiencies of the plants are higher. We assume an efficiency of 58 percent for the new CCGT plants running baseload (75 percent), but CCGT plants may be a bit higher, with one in South Wales claiming close to 60 percent. We assume 55 percent efficiency for mid merit (50 percent) and 52 percent efficiency for peak load (20 percent). We assume 40 percent efficiency for conventional steam turbine plant fired by gas. Table 4 summarises our assumptions.

Table 4: Conversion efficiencies for gas-fired power plants (percent)

Plant type	Old (> 10 years)	5–10 years old	New
Large CCGT plants, condensing units:			
− baseload	53	55	58
− mid merit	51	53	55
− peak load	49	51	52
CHP plants with CCGT technology (power/heat ratio 1.1)	45	46	48
Conventional gas turbine	36	37	40

Source: EU Commission, Vattenfall

Overall CHP plants efficiencies can be in the 80−90 percent or even higher. However, heat being a by-product we only take into account electrical efficiency to calculate the gas input. A CHP plant based on CCGT technology will operate with an electrical (net) efficiency of at least 40 percent, and could be much higher. We assume an efficiency of 48 percent for the new plants.

[7] *Utilities* refers to entities whose primary activity is to generate electricity and/or heat for supply to third parties. *Auto-producers* would refer to entities that generate electricity and/or heat, wholly or partly for their own use as an activity that supports their primary activity.

These values are the plant net efficiencies (i.e. power delivered to the grid at power plant gate versus gas delivered to the plant) and based on the lower heating value for gas.

2.9 Conversion factors

Table 5 gives the conversion factors we have used for 100MW of capacity for one year of production[8].

Table 5: Conversion factors used for this study

		Load factors		
	Efficiency	75 percent	50 percent	20 percent
CCGT	58 percent	0.111 bcm	-	-
	55 percent	-	0.080 bcm	-
	52 percent	-	-	0.032 bcm
CHP	48 percent	0.135 bcm	0.086 bcm	0.035 bcm
Gas turbine	40 percent	0.165 bcm	0.115 bcm	0.041 bcm

Source: Author's assumptions, Shell

For instance, at 75 percent load factor, a CCGT plant has an efficiency of 58 percent, and consumes 0.111 bcm of gas per year per 100MW of capacity. At 50 percent load factor, this plant has an efficiency of 55 percent and consumes 0.080 bcm per year per 100MW of capacity. Etc.

3. GAS DEMAND IN EUROPE BY 2015: KEY FACTORS

Gas demand is expected to continue to grow at a lower rate than experienced in the past, but still the highest among energy sources after renewables. Some key factors impacting on demand can be specific to the country, but many are common across Europe. High oil prices and therefore gas prices, security of supply and climate change are seen as the main challenges.

So what are the factors driving investment decisions in gas-fired power generation plant in European electricity markets? We are looking principally at three sets of issues that can have a positive or a negative impact on new investment in gas-fired generation capacity:

- economic drivers: gas/electricity prices
- commercial and political incentives
- environmental policy impacts

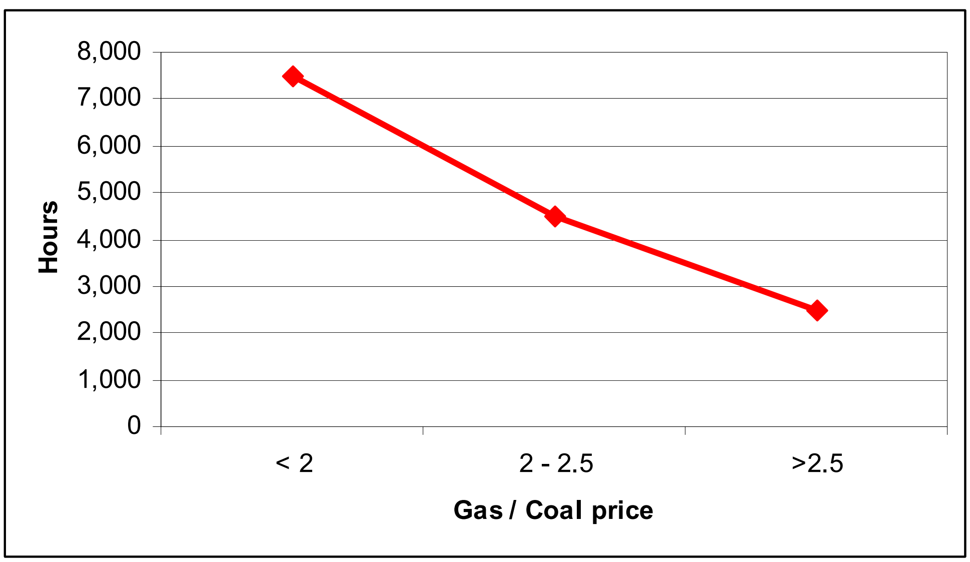
[8] See Appendix 1 for a detailed table of conversion factors.

3.1 Economic drivers: gas prices

One of the major uncertainties about the projected rate of growth for gas consumption in the power sector relates to the development of gas prices. In 2005, forward natural gas prices in Europe have reached record levels, making gas an expensive choice for power generators. Continued high oil-linked prices are expected to slow down the general level of demand, especially in the power generation sector where CCGT plants will be delayed and/or will not run on baseload. In recent years, rising natural gas prices have worsened the competitive position of newly built CCGT plants for baseload relative to coal-fired power plants.

To invest in new gas-fired plants, power generators need gas prices to be below a certain level, let's say 3 euros per million British thermal units (3 €/MBtu), but they also need to be confident that prices will remain at this level and that the seller will agree to changes in price indexation. When making an investment, power generators base their decisions on projected relative prices between coal and gas (in addition to investment cost and operation and maintenance (O&M) costs) which need to include CO_2 emission prices (as well as the allocation mechanism in different countries). Due to lower investment costs and higher conversion efficiencies (up to 60 percent for gas-fired plants compared with some 45 percent for coal-fired) the gas price can be roughly twice the coal price (assuming a CO_2 price ~ 10 €/tonne) for baseload plants. With gas prices 100–150 percent higher than coal prices, gas-fired plant would be used only as mid merit. With gas prices 150 percent higher than coal prices, gas-fired units could only be operated for peak load. The relation between the relative gas/coal price and type of plant and their utilisation times are illustrated in Figure 6.

Figure 6: Utilisation time and relative fuel price



Source: Vattenfall

When in operation the plant will only be run if it is able to cover its variable costs (mainly fuel for gas-fired plants). Annual utilisation times will therefore vary for different plants, depending on the actual fuel prices. These variations are also dependent on the power generators mix of plants and contractual commitments. High CO_2 prices tend to favour gas and low CO_2 prices to favour coal. Prices at the North European fuel markets have for the last few years pushed gas-fired plants increasingly into peak load operation. This is a consequence of the gas pricing principle where gas price is (to a large extent) indexed to oil product prices, which have increased rapidly, with a negative impact on gas demand for power. North European power generators believe that gas prices need to be indexed to power wholesale prices or coal prices (or a mix of them) before gas can be used to generate baseload power. In Mediterranean countries gas is more widely used for baseload generation due to a different mix of power plants (less nuclear, lignite and coal) and higher power prices.

This means that only lower gas prices would increase the competitive position of gas-fired plants relative to coal, and a decoupling of gas prices from oil prices would trigger more investments in new generation. Gas-to-gas competition could provide lower gas prices for a while in the late 2000s which would provide a boost to gas demand by increasing the load factor at which gas-fired power plants are run and with new investment in gas-fired power plants. If, as some anticipate, the UK starts to be oversupplied by 2008, two possibilities suggest themselves:

1. The UK exports gas via the Interconnector to continental Europe by pipeline; these additional supplies could create gas-to-gas competition with lower gas prices which in turn would increase gas demand for power generation. The merit-order in generation would be changed, opening the possibility of running the existing gas-fired capacity on baseload and, provided that investors were confident in low gas prices in the long term, this could trigger substantial investment in gas-fired power generation. However, investments in new capacity will not have an impact on gas demand until well after 2010 because of power generation lead times.

2. Suppliers redirect their liquefied natural gas (LNG) cargos to the United States (USA) where gas prices are higher than in Europe; gas supplies remain balanced in Europe, with high oil-linked prices, and there is little incentive to develop new CCGT power plants.

Forecasts showing a huge increase in gas demand must assume a price of oil, and incidentally, a price for gas lower than the 2003−2005 levels. As we have not built a model, we do not project a price for future gas supplies – but we do assume some trends. This is why our assumptions on load factors are crucial. We capture the changes in gas prices in our load factor assumptions; high gas prices leading to a lower load factor (peak load), and low gas prices to a higher load factor (baseload).

The price of coal, which is the main competitor to gas in power generation, is an important factor, but also the cost of nuclear and renewables and electricity prices themselves. Of course, other basic economic prospects like GDP growth and delocalisation of gas/electricity-consuming industries also have an impact on gas demand.

3.2 Commercial and political incentives

In the centrally planned, vertically integrated world of electricity monopolies, operational economies of scale and engineering decisions determined investment and hence new additions of capacity tended to be large (and remotely located) to maximise economies of scale. The risks and volatility that are inherent to electricity were masked and passed through to end consumers. Unbundling has brought transparency, leading to the risk of being quarantined at each step in the value chain. Unbundling has also brought independent decision-making. Together these have created a new set of incentives and exposed risks that cannot simply be passed down the value chain to consumers. It has also led to coordination being managed through price signals. Industry has responded to the new environment with a move to incremental capacity investment. Gas-fired plant has been preferred because of its inherent flexibility, which permits more effective risk management and allows generators to respond quickly to profitable opportunities. In a sense the risk-return trade-off has replaced economies of scale as the principal factor influencing investment decisions. The technological advantages of gas-fired plant combined with the need to rebalance existing portfolios to permit more effective risk management will probably continue to drive investment in gas-fired plant in competitive electricity markets in the short/medium term. However, does the general assumption that CCGT plants will be the most economic choice for new power plants lead to overestimated gas demand?

The choice of a specific generation technology and a specific fuel is preceded by the decision whether to invest at all in power generation. In a situation of high gas prices (2003−2005 levels), why would a generator build new (gas-fired) power plants right away while old, fully amortised coal-fired or nuclear plants, are very lucrative? The commercial incentive for power generators to build new power plants is very important as it may explain/project a delay in the construction of large-scale new CCGT plants and other gas-fired plant.

Governments have adopted a variety of policies to influence fuel choices of power generators. In Germany, France and Italy natural gas use in power generation is taxed. Obviously a removal of this tax would help the competitive position of natural gas.

Investment can be further encouraged by providing attractive rates of return for regulated assets, as well as a clear and stable tax regime, and by appropriate exemption from Third Party Access (TPA) obligations when the market is contestable. Indirectly, better access to networks and storage could help the development of gas for power generation. Fostering the development of fully liquid gas and electricity markets should also satisfy power generators and encourage complementary development of gas and power markets.

With falling indigenous production and increase in demand, governments are concerned by rising import-dependence from non-OECD countries and more distant sources. Political opposition to more gas-fired generation using imported gas on 'security' grounds is also a potential obstacle. The main concern is not lack of availability, but the price of available gas. Using security justifications, governments do favour and actively support renewables, or even nuclear and coal. Government intervention with respect to the fuel mix exists in France and to a lesser extent in Germany and Spain. In most European countries the composition of generation is left to the market, and large power generators generally prefer to maintain a balanced generation portfolio from a company, as well as from a national, perspective for technical reasons and to manage security of supply risks.

The choice between fuel types varies from country to country according to its domestic resources, the access to foreign resources and its national regulations. The coal sector is very important in Germany for instance, and will continue to be partly because of the government concerns on security of supply and the employment of domestic coal supplies. The Italian and the Spanish governments are making it very difficult to get administrative consent for coal-fired plants, and therefore almost all their new capacity will be gas-fired. Many countries are also actively promoting renewables for environmental reasons, while almost none of them are promoting gas-fired power generation. Some are promoting the construction of CHP plants.

3.3 Environmental policy impact

Natural gas has inherent environmental advantages over other fossil fuels, including lower carbon content and fewer emissions of noxious gases. Its clean combustion properties make gas an attractive fuel as it provides an 'insurance' against possible future costs associated with CO_2 emissions. Because of these qualities, environmental policies could benefit gas for future power generation.

3.3.1 EU Large Combustion Plant Directive (LCPD)

Over the past decade, natural gas has been the fastest growing fuel source in the EU, mainly at the expense of coal**.** One reason for coal's decline is environmental considerations. The revised version of the EU Large Combustion Plant Directive (which will come into force on 1 January 2008) dictates that all thermal power generators, with at least 50MW of capacity, will have to reduce their nitrogen oxides (NOx) and sulphur dioxide (SO_2) emissions or face closure after 20,000 hours derogation starting from 1 January 2008, or at the end of 2015, whichever comes first. Natural gas for instance emits much less NOx and SO_2 than coal, which makes meeting emissions standards much easier and thus cheaper.

The EU countries with the most important capacity to generate electricity from coal- and oil-fired plants are Germany, Greece, Spain, Italy, the UK, Czech Republic and Poland. However, most countries have already invested in retrofitting existing coal-stations. The potential – small − decrease in coal-fired generation could be compensated by gas, but also partly by renewables and nuclear power. This Directive will probably not have a great impact, with one big exception for the UK where 18GW of oil- and coal-fired generation plants are currently at risk (out of a total of 31GW for these fuels). The Department of Trade and Industry (DTI) is now putting money into modernizing coal power to develop cleaner coal technologies.

Several new Member States have received derogation allowances under the LCPD. Those with the most extensive derogation allowances, as well as the only countries with derogation allowances beyond 2008, include Estonia, Lithuania and Poland. Poland has, by far, the greatest number of plants with derogation allowances.

3.3.2 CO2 emissions trading: impacts on gas to power/higher non-carbon environmental standards

Coal-fired plants can expect further limitations with the EU emissions trading scheme (EU ETS) which came into effect in 2005. The perspective of assigning costs to the emissions of CO_2 could have a significant impact on the use of various fossil fuels in power generation, and in theory support the use of natural gas in power generation. This does not only hold for newly built power plants but also for existing plants because costs for CO_2 emission permits might significantly alter the merit order of dispatching. However, this is not as simple and variations in different fuel prices also need to be looked at. Costs on emissions of CO_2 may not always favour gas.

The price of these emission permits depends on the cap national governments set for the issuing of these permits, fixed in the so-called national allocation plans (NAP). However, NAPs are different in each EU country and therefore have different consequences for the relative competition between different power generation fuels.

The allocation of emission permits for the first round (2005−2007) is believed to be rather generous, and will not have a positive impact on investment in CCGT plants. Even with relatively high prices for emissions allocation (22 €/tonne CO_2 in mid-September 2005), high gas prices have ensured that the gas-coal differential remains wide enough to favour coal as a fuel for power generators. The next round of allocations (2008−2012) could be less generous, but this would delay decisions to invest to 2008, and additional capacity would not appear before 2013. And there is a long-term uncertainty for after 2012, not knowing what will happen after the second allocation round.

Five-year rounds give high uncertainty for twenty-year investment decisions in new capacity. And 2012 is largely outside companies' investments horizon. It is unlikely that the EU ETS alone will boost investments in new CCGT plants, at least in the coming decade. Whether they are right or not, power generators are primarily concerned by gas prices rather than by emission allocations prices to take decisions on investments.

EU ETS may have an impact on the load factor of gas-fired plants though. But the price of the EU allowances would need to climb to 27−33 €/tonne CO_2[9] before generators had economic incentives to switch from coal- to gas-fired generation, but again, fuel prices also need to be considered. The switching price differs from country to country. For instance, if UK prices remain high into 2006, carbon prices might have to go well above 40 €/tonne for fuel-switching to take place.[10] This is the same situation in Spain with dry weather conditions and little possibility of hydro-electricity production. Moreover, high gas prices may counterbalance the impact of the EU ETS on gas relative to coal, as unlike gas and emission permits prices, coal prices have fallen in 2005.

3.3.3 Nuclear phase out

Political agreements to phase out nuclear power have been concluded in Germany, Belgium, or Sweden but in some cases the timing of closure remains subject to discussion. Lifetime closure will also be an important factor in the UK, where more than 4.5GW of nuclear capacity is scheduled to shut down in the next decade.

However, security of supply considerations and the Kyoto protocol have helped to renew interest in nuclear power. Nuclear phase-out agreements might be reconsidered as a whole, especially given political changes in the respective countries, for instance in Germany or the UK. Gas-fired generation, though cleaner than coal, produces carbon emissions alongside electricity, while nuclear power generation does not. The life extensions of nuclear plants may dampen gas-fired plants build prospects, and should be considered as a credible threat to new gas build. Extreme pressure on gas demand from nuclear phase out may not be seen before 2015 at the earliest.

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[9] Per Lekandler, analyst at investment bank UBS, declaration on 8 September 2005.
[10] Deutsche Bank, *What if?* 1 November 2005.

3.3.4 Renewables policies

Renewable sources of energy have received a significant boost as a result of policy and technology progress. The political sensitivity of programmes promoting renewable energy sources and possible requirements for conventional back-up generation capacity add to the uncertainty around investment needs. All these measures may produce a different demand outcome; but probably not dramatically different until 2015.

4. GAS DEMAND FOR THE NON-POWER SECTOR IN EU25 BY 2015

It is common knowledge that gas demand in the non-power sectors[11] will not show a striking increase over the coming years. These are well-developed markets in most countries − especially in the major markets of North-West Europe where they have been developed since the 1960s − and are approaching saturation. Their growth should remain relatively modest at around 0.8−1 percent increase per year, largely depending on historical trends and GDP forecasts. There is a slightly different story in individual countries in South Europe (Spain, Portugal, Greece and even Italy) in which these sectors may grow faster, but this will have a relatively small impact on total European gas demand.

5. GAS DEMAND FOR THE POWER SECTOR IN EU 25 BY 2015: OVERVIEW OF KEY COUNTRIES

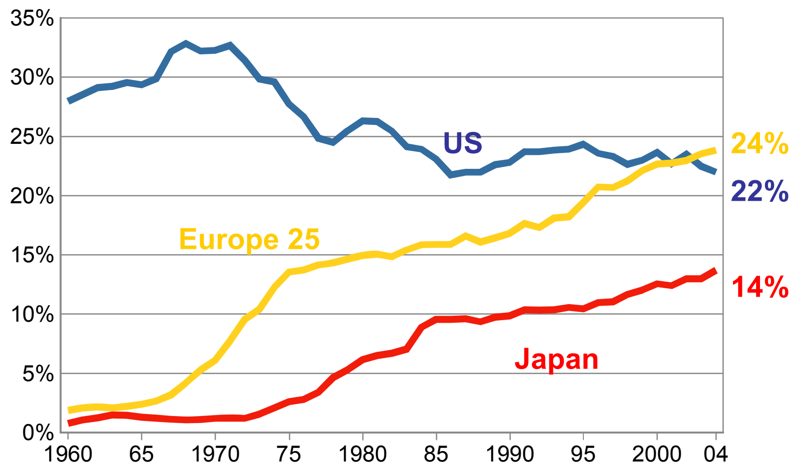
This section focuses on our scenarios for gas demand growth in the power generation sector in Europe by 2015. After a brief presentation of the European gas market(s), we have a closer look at the nine major markets, which represented about nine-tenths of the total gas consumption in EU25 in 2004.

5.1 Background information on EU25

The European Union is the world's second-largest energy consumer behind the United States. The share of natural gas in the total primary energy supply (TPES) has increased steeply over the last 40 years as shown in Figure 7.

[11] i.e. mainly the residential, commercial and industrial sectors.

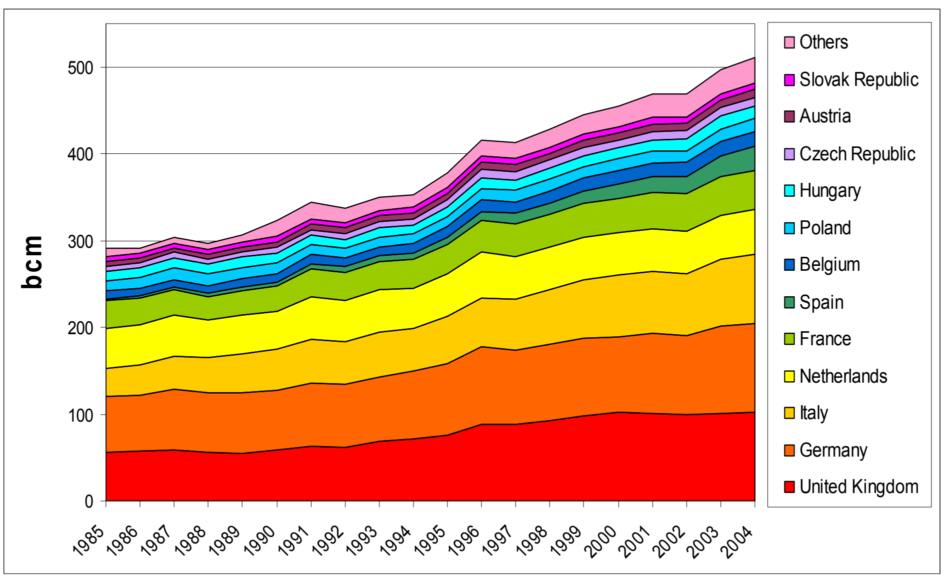
Figure 7: Share of natural gas in the TPES of Europe, the USA and Japan, since 1960



Source: E.ON

Gas demand in the 25 countries of the EU has increased by 175 percent over the last two decades from 291 bcm in 1985 to 510 bcm in 2004 (Figure 8).

Figure 8: Gas demand in EU 15 + 10 from 1985 to 2004, in bcm

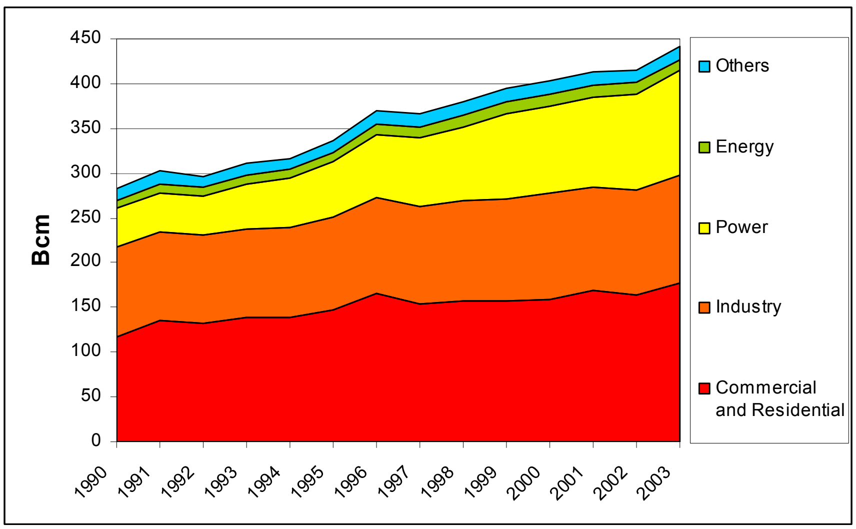


Source: International Energy Agency, *Natural Gas Information 2005*

There are big disparities between countries. The demand picture is not easy to generalise across different countries or regions. Gas demand is mainly concentrated in North-West Europe, where gas markets developed 40 years ago, plus Italy and Spain. Seven of the 25 members represented 83 percent of the European gas demand in 2004: the UK, Germany, Italy, the Netherlands, France, Spain and Belgium. The biggest increases in gas demand are expected in two fast growing gas markets − Italy and Spain − driven by growth in the power generation sector. After the recent enlargement of the European Union, two other large markets must be taken into account: Poland and Hungary. These nine countries represented almost 90 percent of the gas demand in 2004. The UK is the biggest natural gas market, followed by Germany and Italy; these three countries accounted for more than half of EU25 gas demand in 2004.

In 2003, the residential sector was still the largest consumer in EU25, followed by the industrial sector. Power was the third largest sector and the fastest growing one with a 6.8 percent increase per year from 1985 to 2002, and 8.5 percent per year between 1990 and 2003. Figure 9 shows the gas demand by sector in the nine major markets of EU25.

Figure 9: Gas demand by sector in the nine major markets of EU25, from 1990 to 2003, in bcm



Source: International Energy Agency, *Natural Gas Information 2005*

In EU25, power generated from gas-fired plants increased by roughly 230 percent since the beginning of the 1990s mainly driven by the addition of CCGT plants. As shown in Table 6, the Netherlands, the UK, Italy, and to a lesser extent Hungary, rely heavily on natural gas for their production of electricity. Spain is the fastest growing market for gas-fired power generation.

Table 6: Electricity generated by gas in the nine major markets of EU25, 2003 vs. 1990

	1990		2003		Average annual percent change 1990-2003
	TWh	percent of total generation	TWH	percent of total generation	
Belgium	5.4	7.7	21.6	25.8	11.3
France	3	0.7	17.1	3.1	14.4
Germany	40.5	7.4	58.5	9.8	2.9
Hungary	4.5	15.7	11.9	34.8	7.8
Italy	39.7	18.6	117.3	41.4	8.8
NL	36.7	50.9	56.9	58.8	3.4
Poland	0.14	0.1	2.4	1.6	25
Spain	1.5	1	39.4	15.3	29.1
UK	5	1.6	158.5	41.6	17.9

Source: International Energy Agency, *Electricity Information 2005*

5.2 EU25: Nine major markets

This section takes a closer look at the nine major gas markets of EU25. It provides brief reviews of their gas demand by sector and their electricity generation, and then considers the gas-fired power plant projects in each country, and their impacts on gas demand for power.

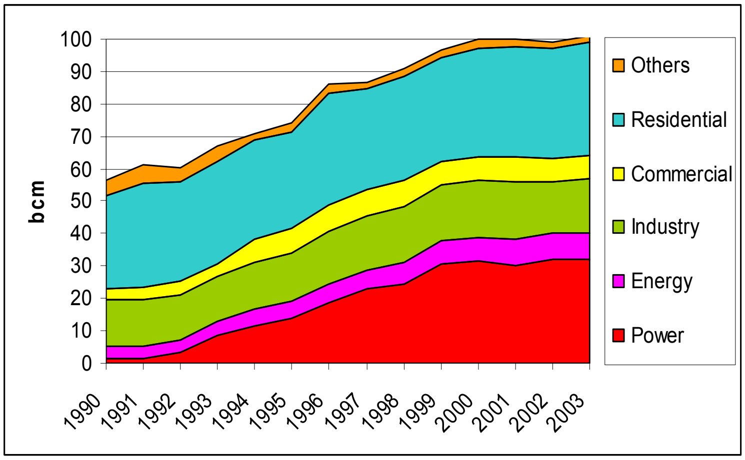
5.2.1 The United Kingdom

Background information

The period since 1990 has seen a significant increase in UK demand for natural gas, dominated by construction of gas-fired power plants replacing coal generation, exports to Ireland and Continental Europe, and falling prices due to supply surplus and increased gas-on-gas competition. In a liberalized market, the low capital cost of gas-fired power plants was very attractive. The huge UK gas reserves were another factor that boosted the construction of new plants during the 1990s. Gas-fired plants also provided an insurance against possible changes in environmental policies.

In 2004, gas consumption reached 102.5 bcm. The residential sector is the main gas user in the UK, followed by the power sector (Figure 10). However, gas demand is largely static in the commercial, industrial and residential sectors as market penetration rates are already very high.

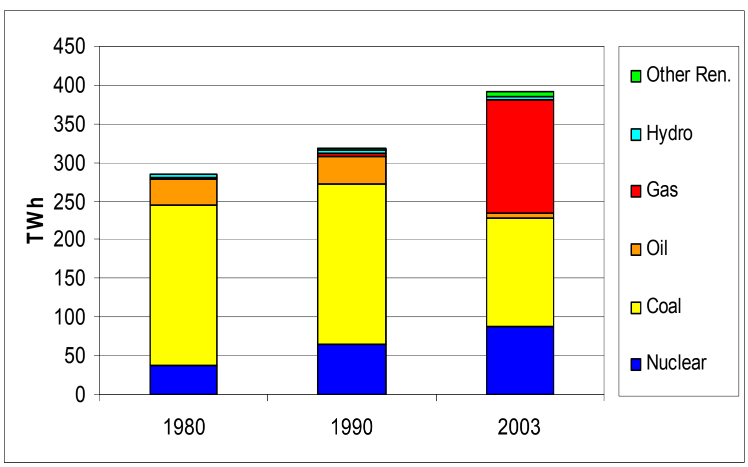
Figure 10: UK gas demand by sector, in bcm



Source: International Energy Agency, *Natural Gas Information 2005*

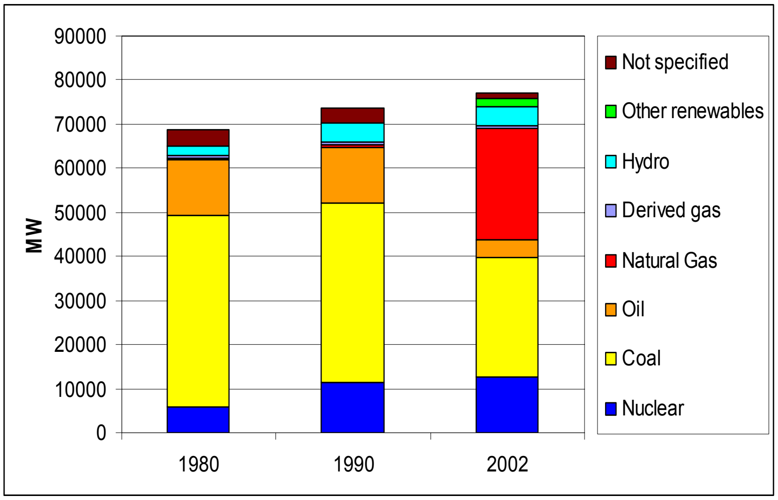
In 2004, natural gas accounted for 40 percent of the electricity generated in the UK, followed by coal and nuclear (Figure 11). Electricity generation from natural gas increased by 4.5 percent per year between 1974 and 1990, and 29.6 percent per year between 1990 and 2003.

Figure 11: UK electricity generation in electricity and CHPs plants, in TWh



Source: International Energy Agency, *Electricity Information 2005*

Figure 12: UK electricity generation capacity, in MW



Source: Eurelectric 'Eurprog 2004'

In 2003, 32.8 percent of generating capacity was gas-fired (Figure 12), with 23.6GW for the utilities (only single-fired capacity) and 3GW for the auto-producers.

Table 7 gives the load factors of gas-fired power plants, for the utilities only. Between 2000 and 2003, these gas-fired plants ran at an average load factor of 68.5 percent, which is high compared to other European countries.

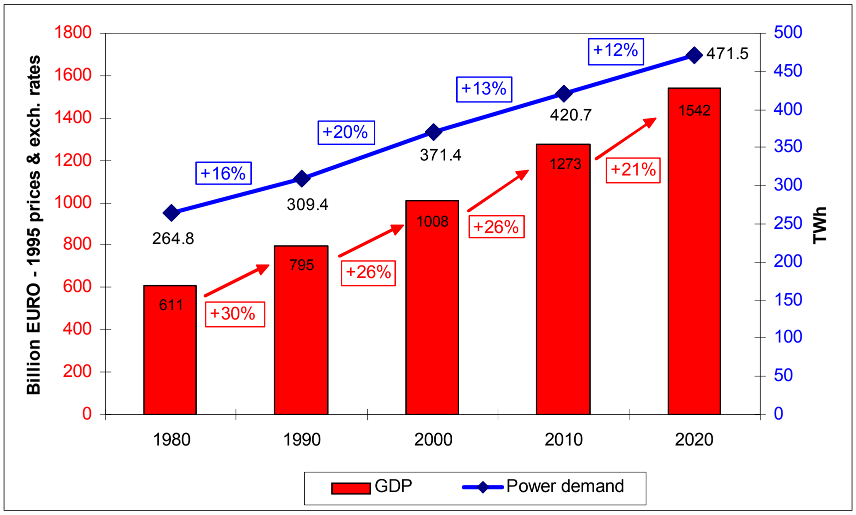
Table 7: Load factors of gas-fired power plants in the UK (utilities only)

	2000	2001	2002	2003
Load (percent)	74.3	69.1	68.9	61.7

Source: International Energy Agency, *Electricity Information 2005*

Figure 13 gives some information on the past and projected increase in GDP and electricity demand in the UK.

Figure 13: Past and projected increase in GDP and in electricity demand in the UK



Source: Eurelectric “Eurprog 2004”

Key factors for gas demand in the power generation sector

There are three main drivers in the UK for gas demand growth in the power generation sector. Firstly, the UK government's key policies are the reduction of carbon emissions under the Kyoto Protocol. The aim is to achieve this largely through an expansion of renewable energy, but given the environmental advantages of natural gas, the cleanest of the fossil fuels may also have a role to play. The Renewable Obligation introduced in April 2002 requires licensed electricity suppliers in England and Wales to generate a share of their electricity from renewables: in 2003, it was 3 percent, but this share will increase to 10.4 percent in 2010 and to 15.4 percent in 2015. However, this should mainly replace old coal-fired generation, and should not impact on gas-fired generation. Gas should be the fuel of choice for power generation due to climate change regulation arising from a commitment to reduce greenhouse gas emissions, and increase in demand.

Secondly, coal-fired power generators have not yet invested enough to comply with the new rules such as the LCPD, and up to 18GW (out of 31GW) of coal-fired and oil-fired generation are at risk when the revised directive enters into force in 2008. With half the capacity allowed to run at 2,500 hours per year (which is about half the current use), this leaves the UK with a huge gap to produce electricity. And gas-fired plants should replace this coal-fired capacity. The DTI is putting money into modernising coal power to develop cleaner coal technologies. Coal is seen as a security of supply in case of nuclear disruption and high gas prices. But there is some scope for new investment in gas-fired power generation in the UK.

The third driver for significant demand growth in the power generation sector is because gas-fired plants in the UK operate on baseload. The next section gives possible gas demand in the power sector at different load factors, which illustrates the huge impact of load factors on fuel input. Even a relatively small increase in gas-fired capacity could have big impacts on gas demand when used on a high load factor.

Another key factor often mentioned is the nuclear phase out. In 2005, more than half of the 9.5GW of British Energy's nuclear capacity does not have a licence to operate in ten years time. However, the challenge of climate change as well as rising power demand, and security of gas supplies concerns have put nuclear energy back on the government's agenda. Dungeness B plant life got a ten-year extension to 2018, and other plants will most probably get an authorisation to continue their production after their current date of decommissioning. Nuclear phase out in the UK may not have any significant impact on new investment in gas-fired generation, at least in the decade.

Additional gas-fired capacity (as of September 2005)

The plants mothballed because of excess capacity after the introduction of the NETA have already been progressively reintroduced into the market. There are 2,020MW of gas-fired capacity recently operational or currently under construction. This additional capacity will be available to run at full capacity by 2010. There are 3,351MW with administrative consent which could be available to run at full capacity by 2010. Some 6,140MW have applied for administrative consent and a further 1,168MW are planned. These plants could be available to run at full capacity by 2015.

Table 8: Summary of additional gas-fired capacity operated by the utilities in the UK (as of Sept. 2005), in MW

2005−2010		2010−2015		2005−2015	
Probable	Possible	Probable	Maximum possible	Probable	Maximum possible
2020	5371	9491	10649	11511	12669

Source: Platts *Power in Europe*, Government, Companies

Table 9 gives the increase in gas demand from the additional capacity, at different load factors.

Table 9: UK additional gas demand for the power sector from the additional capacity operated by the utilities (as of Sept. 2005), at different load factors, in bcm

		Load factors		
		75 percent	50 percent	20 percent
2005−2010	Probable	2.34	1.57	0.62
	Possible	5.95	4.12	1.63
2010−2015	Probable	10.21	7.22	2.85
	Maximum possible	11.55	8.14	3.21
2005−2015	Probable	12.55	8.79	3.47
	Maximum possible	13.89	9.70	3.84

Source: Author's assumptions

In 2003, gas demand for power generation was 31 bcm. Between 2005 and 2010, assuming gas-fired power plants continue to run baseload (75 percent), additional demand would be a minimum of 2.6 bcm and a maximum of 6.6 bcm. From 2010 to 2015, the range of additional demand would be 9.3−10.9 bcm.

Assuming a load factor of 65 percent for the new gas-fired plants in our probable scenario, additional demand would be 2.15 bcm by 2010 and 11.77 bcm by 2015 (Table 10). Because of the impact of the LCPD, the load factor for gas fired plants could be higher, even in a situation of high gas prices.

Table 10: UK additional gas demand for the power sector from the additional capacity operated by the utilities (as of Sept. 2005), at 65 percent load factor, in bcm

		Load factor 65 percent
2005−2010	Probable	2.15
	Possible	5.55
2010−2015	Probable	9.62
	Maximum possible	10.81
2005−2015	Probable	11.77
	Maximum possible	12.97

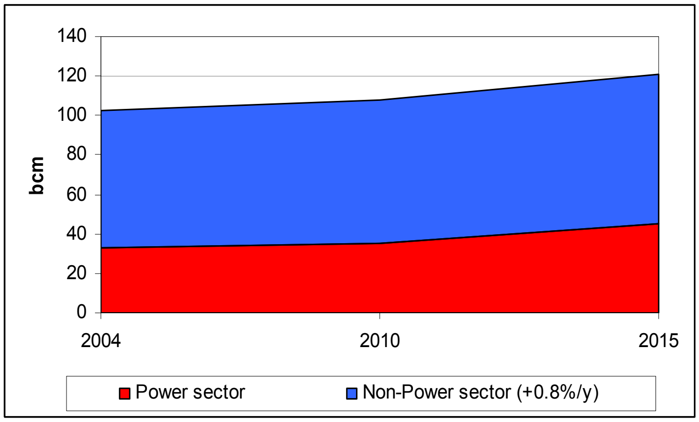
Source: Author's assumptions

Table 11: UK gas demand by 2015
(at 65 percent load factor for the new gas-fired capacity operated by the utilities and 0.8 percent of annual increase in the non-power sectors), in bcm

	2004	2010	2015
Power sector	33.20	35.35	44.97
Non-Power sector (+0.8 percent/y)	69.40	72.8	75.8
Total	102.60	108.15	120.77

Source: Author's assumptions

Figure 14: UK gas demand by 2015
(at 65 percent load factor for the new gas-fired capacity operated by the utilities and 0.8 percent of annual increase in the non-power sectors), in bcm



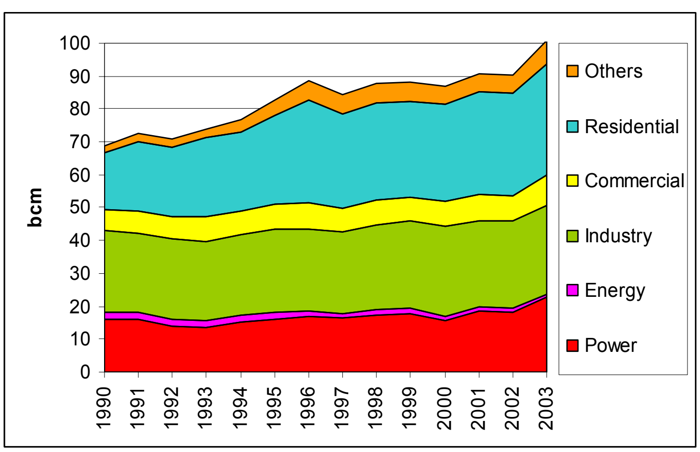
Source: Author’s assumptions

5.2.2 Germany

Background information

Germany is the largest gas market in continental Europe with consumption of 94 bcm in 2004, of which 43 percent was used in the residential and services sectors and 27 percent in the industry sector (Figure 15). Residential and commercial sectors are highly weather dependent. The increase in efficiency means that a slight damper can be expected, though there are strong environment concerns. Growth in gas demand for the industrial sector relies on growing awareness of the environmental issue and technology improvements. Natural gas use for electricity generation and heat production accounted for 23 percent of total gas demand. Over the past decade, natural gas consumption in Germany has increased steadily.

Figure 15: German gas demand by sector, in bcm

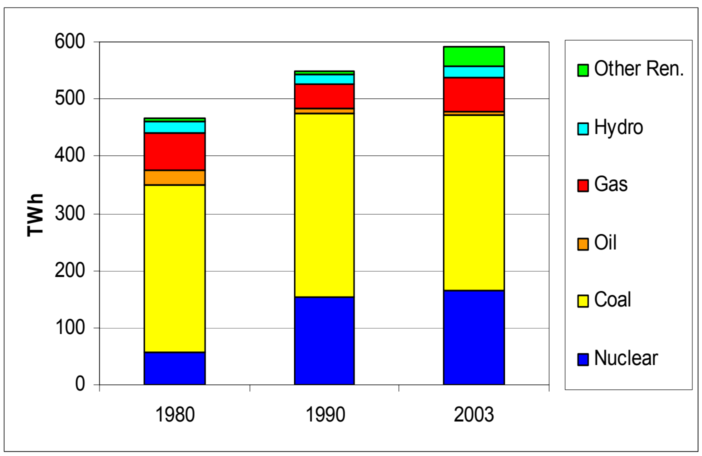


Source: International Energy Agency, *Natural Gas Information 2005*

Germany has Europe's largest electricity market. In 2003, 26 percent of generating capacity was gas-fired. Coal and nuclear power plants are the pillars of power generation. Nuclear and lignite plants run on baseload, and hard coal plants operate in both baseload and mid-merit. The remaining sources (gas, hydro and others) operate only when both demand and prices are comparatively high.The biggest increase in generation came from wind (wind power and other renewables enjoy a favourable dispatch regime for environmental reasons and receive guaranteed return), but only provided a small share of the total gross electricity generated for 2002. With limited domestic hydrocarbon reserves, other than coal, Germany relies on imports to meet most of its energy needs.

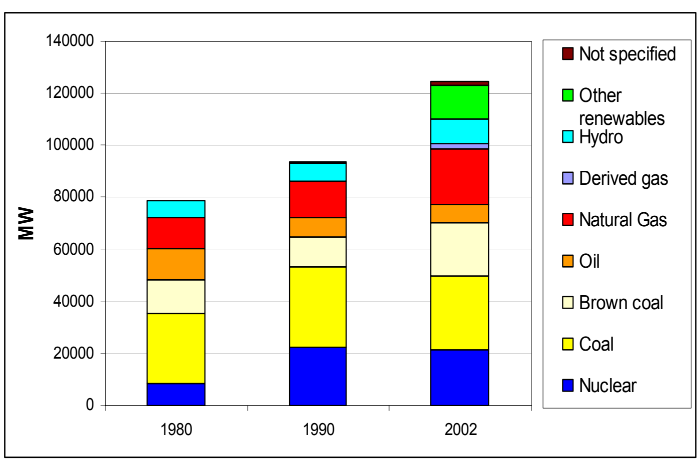
Electricity generation from natural gas decreased by 2.5 percent per year between 1974 and 1990, but increased by 2.9 percent per year between 1990 and 2003 (Figure 16).

Figure 16: German electricity generation in electricity and CHP plants, in TWh



Source: International Energy Agency, E*lectricity Information 2005*

Figure 17: German electricity generation capacity, in MW



Source: Eurelectric 'Eurprog 2004'

In 2001[12], there was 32.2 GW of gas-fired power plants capacity, 27.11GW for the utilities (9.66GW single-fired and 18.05GW multi-fired), and 5.1GW for the auto-producers.

Between 2000 and 2001, gas-fired plants operated by the utilities ran at an average load factor of 15.6 percent (Table 12).

Table 12: Load factors of gas-fired power plants in Germany (utilities only)

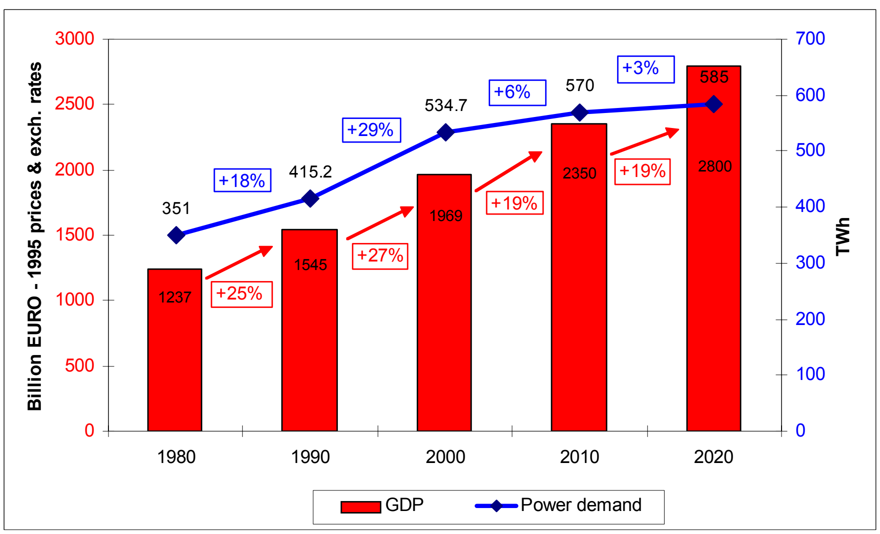
	2000	2001
Load (percent)	14.8	16.3

Source: International Energy Agency, *Electricity Information 2005*

The load-factor for the utilities is rather low. This may be explained by the 18GW of multi-fired capacity, all of which are not gas-fired. The load-factor for the auto-producers was 34 percent in 2001.

Figure 18 gives some information on the past and projected increase in GDP and electricity demand in Germany.

Figure 18: Past and projected increase in GDP and in electricity demand in Germany



Source: Eurelectric ‘Eurprog 2004’

[12] The IEA *Electricity Information 2005* does not give any data for 2002 or 2003

Key factors for gas demand in the power generation sector

There is a huge uncertainty about the future of gas demand for power in Germany. There will be new gas-fired capacity, but mainly to help maintain a balanced generation mix. It is difficult to forecast when gas will have a significant share of the generation market.

Current gas prices are too high and consequently gas-fired generation plants are not competitive, making the probability of construction of new gas-fired plants fairly slim in the short term. In the medium term the utilities will have to replace plants reaching the end of their useful life and are therefore certainly already considering their options. Whether this will have an impact on gas demand by 2015 is fairly improbable. The surge of natural gas prices over the last few years has made it even more difficult for gas-fired electricity generation to compete with nuclear and coal power plants for baseload.

The current allocation of CO_2 emission rights favours lignite as a fuel for base-load power plants and does not even create a clear advantage for gas as a fuel for power stations in the middle of the merit order. Germany's allocation rules state, that if an operator commissions a new power station within three months of the closure of an old one (or obtains an extension), the replacement plant gets the free certificate allocation of the old plant for a four-year period. After that, the plant gets full free allocation for 14 years. This means that replacement plants have no CO_2 trading risk for 18 years.

The government intends to continue hard coal subsidies after 2005, albeit at a declining level. Abundant lignite resources provide a very competitive alternative to natural gas, especially in a scenario of persistent high gas prices and security of supply concerns. Lignite receives little in the way of direct subsidy but does get indirect aid in several forms. Lignite is not subject to energy tax, unlike gas and oil. Germany has invested significantly to reduce sulphur emissions from coal-fired power plants, and it is active in developing clean coal technologies. Coal is more competitive than gas in the German market even with a relatively high cost of carbon.

The German government does not want to be highly dependent on natural gas in electricity generation. It considers the price risk of natural gas to be significant. In order to achieve energy policy objectives, Germany provides financial support to promote certain energy sources, including domestic coal, renewables and co-generation. To address energy security issues, Germany is focusing on the development of domestic fuels and renewables, energy end-use efficiency. These means are also in accordance with the government's strong commitment to protecting the environment. According to the country's Renewable Energy Sources Act, Germany aims to increase the share of power covered by renewables to 12.5 percent by 2010, and to 20 percent by 2020. Offshore wind could have a load factor as high as 50 percent, compared with just 15 percent for onshore wind. Consequently, the annual running time of a reserve fossil fuel station backing an offshore wind station could be reduced.

Finally, it is also highly unlikely that nuclear will be phased out as fast as planned, and production for some plants will probably be extended.

All these factors do not favour a huge growth in gas for power generation in Germany, by 2015 at least.

Additional gas-fired capacity (as of September 2005)

There are 2,787MW of gas-fired plant recently operational or currently under construction which will be available to run at full capacity by 2010. There are 1,200MW with administrative consent. In July 2004, the EU Commission cleared the German extension deadline for the five-year tax exemption for highly efficient CCGT projects. The deadline for full operation is 10 September 2007. It is believed that the Lubmin and Huerth Knapsack plants will start operation in 2007 to benefit from the tax exemption. Therefore, we consider that these plants will be available to run at full capacity by 2010.

The plants mothballed in recent years in Germany are not expected to come on line in the near future, as they have not been granted ETS permits. This is an important factor, but it is not clear how much mothballed plant exists. As an example, E.ON has as much as 1,500MW of mothballed generation units.

There are 6,180MW of gas-fired capacity that have been proposed and planned, which could be available to run at full capacity by 2015.

Table 13: Summary of additional capacity operated by the utilities, in Germany, as of September 2005, in MW

2005−2010		2010−2015		2005−2015	
Probable	Possible	Probable	Maximum Possible	Probable	Maximum Possible
3987	3987	3380	6180	7367	10167

Source: Platts *Power in Europe*, Government, Companies

Table 14: German additional gas demand for the power sector from the additional capacity operated by the utilities (as of Sept. 2005), at different load factors, in TWh

		Load factors		
		75 percent	50 percent	20 percent
2005−2010	Probable	4.75	3.12	1.24
	Possible	4.75	3.12	1.24
2010−2015	Probable	3.82	2.66	1.05
	Maximum Possible	6.81	4.79	1.89
2005−2015	Probable	8.56	5.78	2.29
	Maximum Possible	11.56	7.91	3.13

Source: Author's assumptions

In 2003, gas demand for power generation was 22.8 bcm. Between 2005 and 2010, assuming gas-fired power plants continue to run at 20 percent load factor, minimum additional demand would be 1.2 bcm. From 2010 to 2015, minimum additional demand would be 1.05 bcm and, the maximum demand would be 1.9 bcm.

Assuming a load factor of 20 percent for the new gas-fired plants in our probable scenario, additional demand would be 1.24 bcm by 2010 and 2.29 by 2015 (Table 15).

Table 15: German additional gas demand for the power sector from the additional capacity operated by the utilities (as of Sept. 2005), at 20 percent load factor, in TWh

		Load factor 20 percent
2005−2010	Probable	1.24
	Possible	1.24
2010−2015	Probable	1.05
	Maximum possible	1.89
2005−2015	Probable	2.29
	Maximum possible	3.13

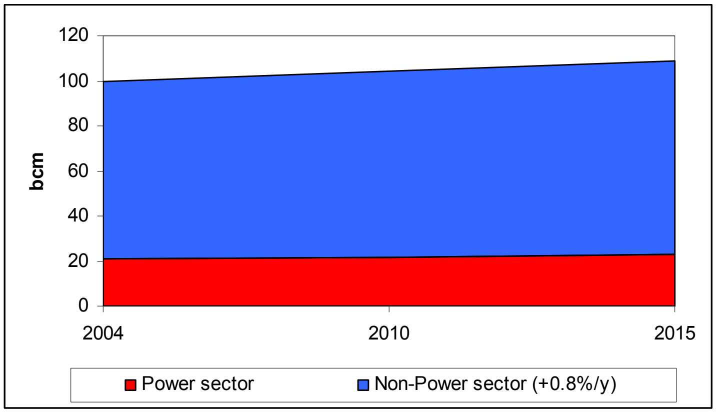
Source: Author's assumptions

Table 16: German gas demand by 2015
(at 20 percent load factor for the new gas-fired capacity operated by the utilities and 0.8 percent of annual increase in the non-power sectors), in bcm

	2004	2010	2015
Power sector	20.70	21.94	22.99
Non-power sector (+0.8 percent/y)	78.70	82.6	85.9
Total	99.40	104.54	108.89

Source: Author's assumptions

Figure 19: German gas demand by 2015
(at 65 percent load factor for the new gas-fired capacity operated by the utilities and 0.8 percent of annual increase in the non-power sectors), in bcm



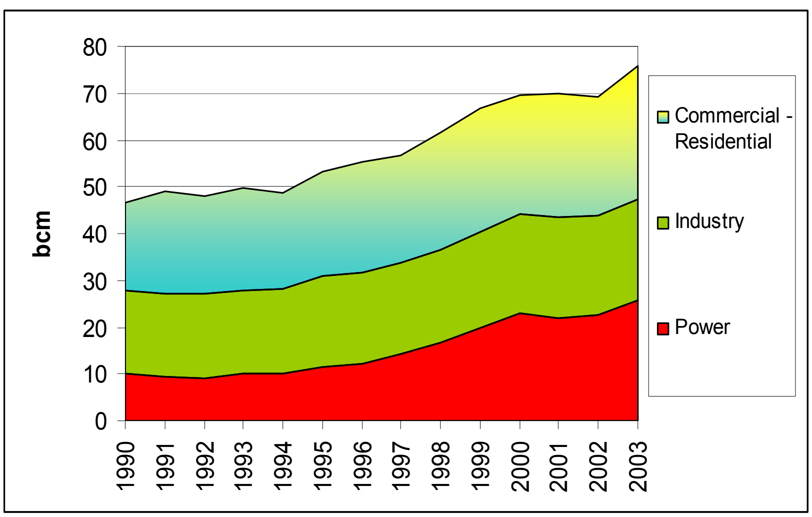
Source: Author's assumptions

5.2.3 Italy

Background information

In 2004, Italy was the third largest gas market in the European Union, with a gas demand of 80 bcm (Figure 20). The non-power sector still represents 66 percent of the demand, but the fastest growing sector is the power sector which consumed 26 bcm of gas in 2003 (+7.5 percent per year since 1990), mainly due to construction of combined cycle gas-fired generation in the last decade.

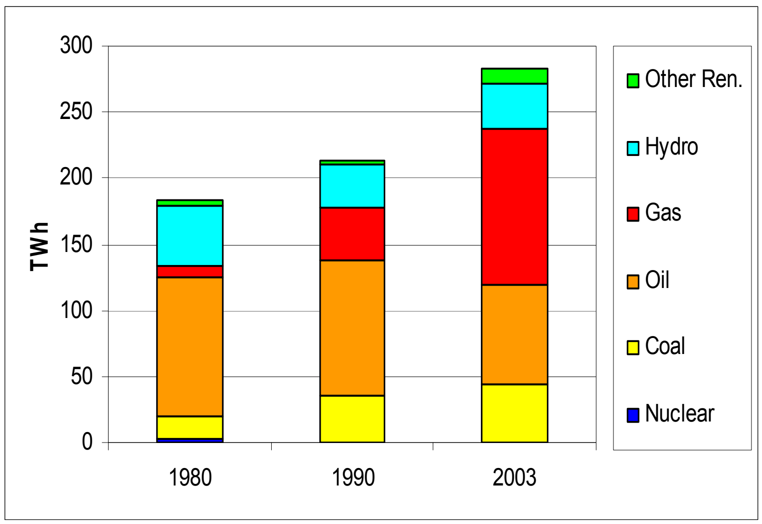
Figure 20: Italian gas demand by sector in bcm



Source: International Energy Agency, *Natural Gas Information 2005*

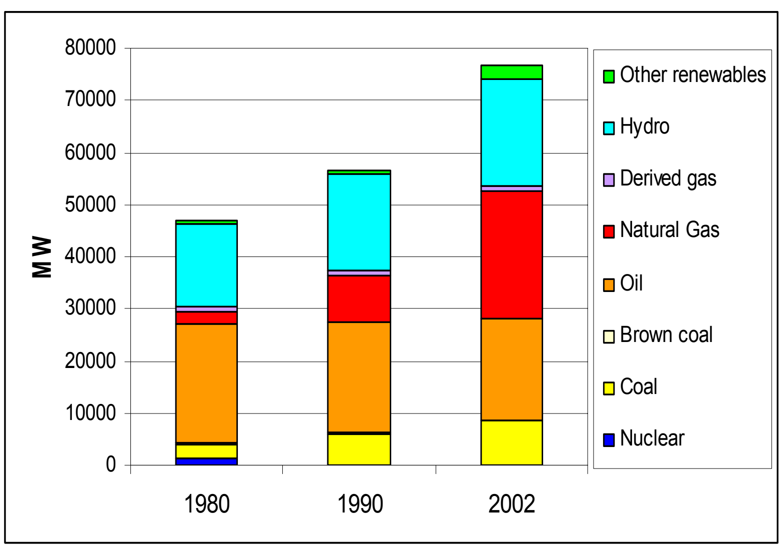
Italy does not have significant amounts of natural resources (including little natural gas) and therefore is dependent on the import of both electricity and fuel sources for electricity generation. Italy is shifting away from oil towards natural gas and renewables to produce electricity. In 2003, gas produced 41 percent of electricity generation, up from 18 percent in 1990 and increased by 2.9 percent per year between 1990 and 2003 (Figure 21). Forty-one percent could be seen as a bit high in a country that imports a large share (84 percent) of its gas consumption, but Italy has no other domestic fuels or nuclear power. Oil produced 27 percent, coal 16 percent and hydro 12 percent. Renewables accounted for the remaining part.

Figure 21: Italian electricity generation in electricity and CHPs plants, in TWh



Source: International Energy Agency, *Electricity Information 2005*

Figure 22: Italian electricity generation capacity MW



Source: Eurelectric 'Eurprog 2004'

In 2003, there was 40GW of gas-fired power plant capacity, but this number is increasing rapidly. 7.5GW were single-fired, and 32.5GW were multi-fired. The IEA does not give any statistics regarding the auto-producers.

Between 2000 and 2003, gas-fired plants operated by the utilities ran at an average load factor of 37 percent.

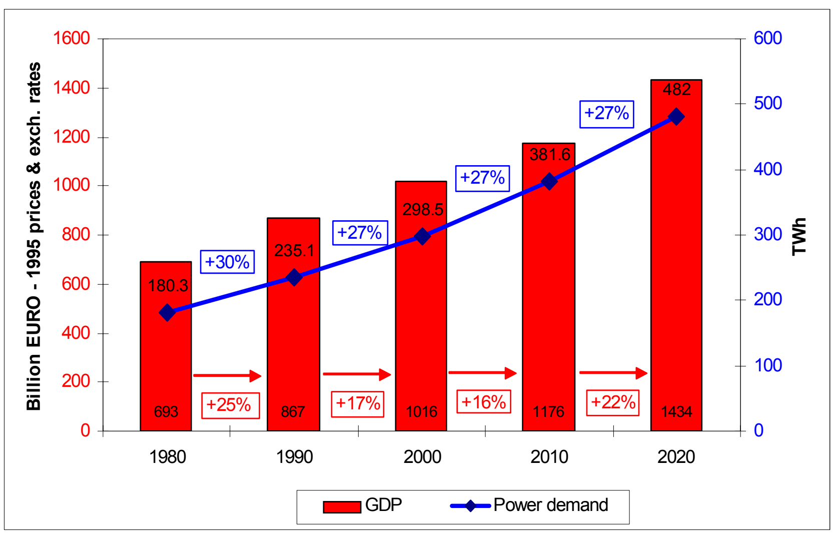
Table 17: Load factors of gas-fired power plants in Italy (utilities only)

	2000	2001	2002	2003
Load (percent)	36.9	37.4	34.8	35.7

Source: International Energy Agency, *Electricity Information 2005*

Figure 23 gives some information on the past and projected increase in GDP and electricity demand.

Figure 23: Past and projected increase in electricity demand and GDP in Italy



Source: Eurelectric 'Eurprog 2004'

Key factors for gas demand in the power generation sector

Three main factors explain the 40GW of gas-fired projects. First, over the past decade Italy's installed electricity generation has not been able to keep up with demand, and the country still lacks adequate levels of domestic generation. The cancellation of nuclear supply in the early 1990s worsened the situation. Power consumption is rising across the industrial, commercial and residential sectors.

Second, after the 2003 blackouts, security of electricity supply became a dominant concern in Italy, and the country is now looking at decreasing its electricity imports, which are considered less secure than domestic generation. Fast-track procedures have helped projects to gain administrative consent more easily for gas-fired plants, and this explains the large number of already 'approved projects'.

And third, in response to the high cost of oil compared to other sources of thermal generation, power generators have begun to switch to alternative fuel sources, especially natural gas. As noted before, administrative approval for coal-fired projects is difficult to obtain for environmental reasons. Looking at the projects, it is clear that almost all the new generating capacity in Italy will be gas-fired. Assoelettrica, the National Association of Electricity Enterprises, projects that nearly half of the power will come from CCGT by 2010 as shown in Table 18.

Table 18: Projected Italian generation mix in 2010

	Percent
CCGT	47
Renewables	18
Coal	16
Imports	14
Simple-cycle oil and gas	5

Source: Assoelettrica

However, many of the gas-fired plant projects do not have a completion date, and it is unlikely that all these projects will be built and/or run at full capacity in the coming decade. For instance, roughly 5GW of gas-fired capacity with administrative consent has already been scrapped. And even if a large number of gas-fired plants are indeed built in Italy, these projects will not run at the 60 percent load factor that was initially planned. And a lower annual load factor has a huge impact on fuel inputs. Gas demand for the power generation sector in Italy will increase significantly, but probably not as much as generally believed and if the gas suppliers' projections were based on the high case scenario, there could be a gas bubble in Italy within the decade.

Additional gas-fired capacity (as of September 2005)

There are 19,703MW of gas-fired capacity recently operational or currently under construction. This additional capacity will be available to run at full capacity by 2010. There are 9,147MW with administrative consent. This additional capacity could be available to run at full capacity by 2010.

In the case of a further 13,137MW administrative consent has been applied for. This could be available to run at full capacity by 2015, but many of these projects do not have a completion date, and it is unlikely that all the projects will be built. A good share may also encounter delays due to local opposition to gas-fired plant construction.

Table 19: Summary of additional gas-fired capacity operated by the utilities (as of Sept. 2005) in Italy, in MW

2005−2010		2010−2015		2005−2015	
Probable	Possible	Probable	Maximum Possible	Probable	Maximum Possible
19703	28850	4890	22283	24593	41986

Source: Platts *Power in Europe*, Government, Companies

Table 20: Italian additional gas demand for the power sector from the additional gas-fired capacity operated by the utilities, at different load factors, as of Sept. 2005, in bcm

		Load factors		
		75 percent	50 percent	20 percent
2005−2010	Probable	21.08	14.97	5.91
	Possible	30.87	22.05	8.96
2010−2015	Probable	5.23	3.84	1.78
	Maximum Possible	23.84	17.06	6.99
2005−2015	Probable	26.31	18.81	7.69
	Maximum Possible	44.93	32.03	12.90

Source: Author's assumptions

In 2003, gas demand for power generation was 25.7 bcm. Between 2005 and 2010, assuming gas-fired power plants continue to run at 40 percent load factor, additional demand would be a minimum of 15 bcm and a maximum of 22 bcm. From 2010 to 2015, the range of additional demand would be 3.8−17 bcm.

Assuming a load factor of 40 percent for the new plants in our probable scenario, additional demand would be 12.8 bcm by 2010 and 16 bcm by 2015 (Table 21).

Table 21: Italian additional gas demand for the power sector from the additional gas-fired capacity operated by the utilities, at 40 percent load factor, as of Sept. 2005, in bcm

		Load factor 40 percent
2005−2010	Probable	12.81
	Possible	18.75
2010−2015	Probable	3.17
	Maximum possible	14.48
2005−2015	Probable	15.99
	Maximum possible	33.24

Source: Author's assumptions

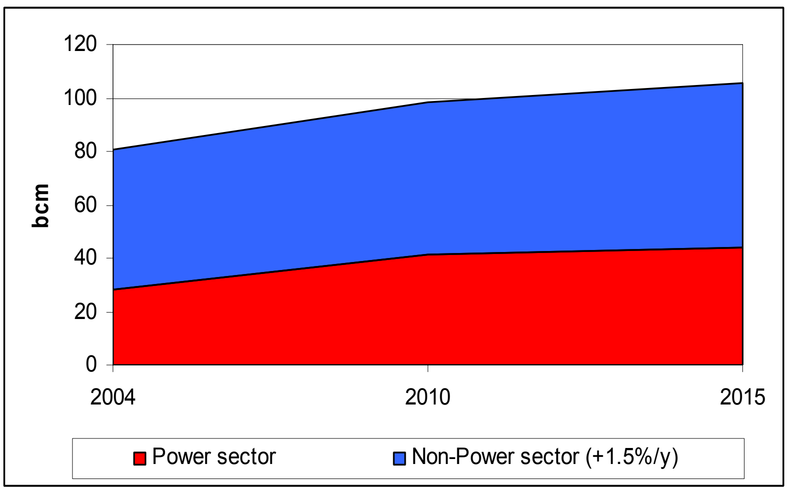
Table 22: Italian gas demand by 2015n in bcm
(at 40 percent load factor for the new gas-fired capacity operated by the utilities and 1.5 percent of annual increase in the non-power sectors)

	2004	2010	2015
Power sector	28.21	41.02	44.2
Non-power sector (+1.5 percent/y)	52.40	57.3	61.7
Total	80.61	98.32	105.9

Source: Author's assumptions

Residential and commercial sectors are also expected to increase. We consider a higher growth rate for gas demand in the non-power sector in Italy: +1.5 percent per year.

Figure 24: Italian gas demand by 2015, in bcm
(at 40 percent load factor for the new gas-fired capacity operated by the utilities and 1.5 percent of annual increase in the non-power sectors)



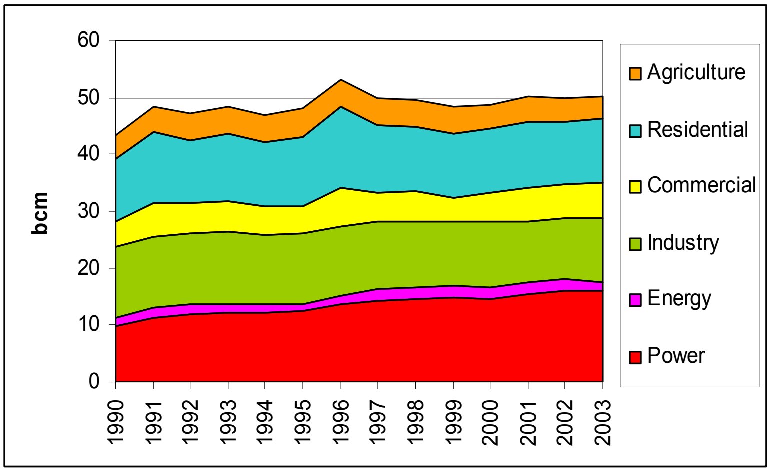
Source: Author's assumptions

5.2.4 The Netherlands

Background information

The Netherlands is one of Europe's largest producers and exporters of natural gas, although production has been falling since 2000.

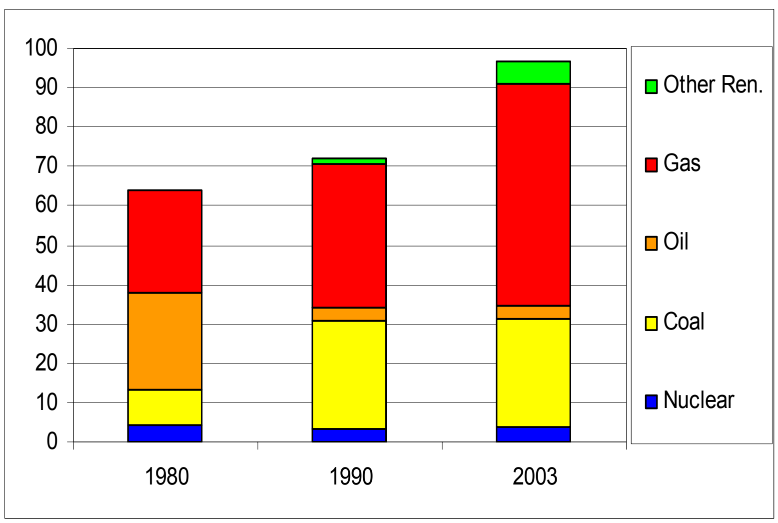
Figure 25: Dutch gas demand by sector in bcm



Source: International Energy Agency, Natural Gas Information 2005

Electricity generation from natural gas increased by 3.4 percent per year between 1990 and 2003, and accounted for 57 percent of the total in 2003.

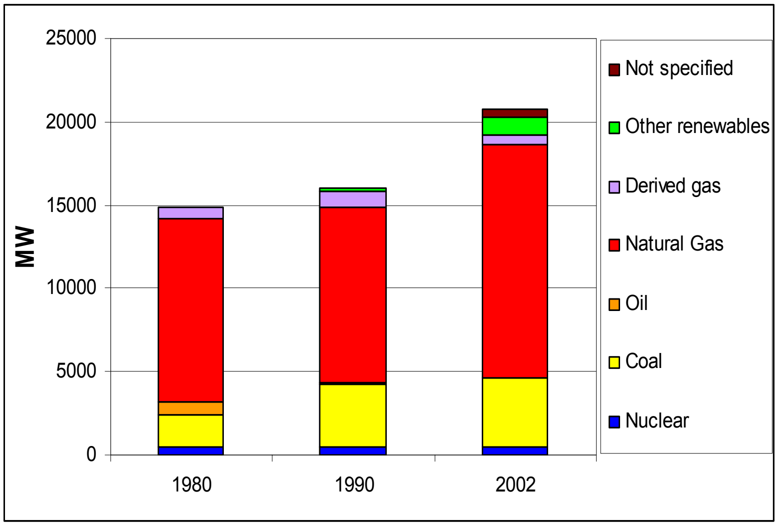
Figure 26: Dutch electricity generation in electricity and CHPs plants, in TWh



Source: International Energy Agency, *Electricity Information 2005*

Gas-fired plant accounted for 60 percent of the total generation capacity in 2002, up from 51 percent in 1990.

Figure 27: Dutch electricity generation capacity in MW



Source: Eurelectric 'Eurprog 2004'

In 2003, there was 18.7GW of gas-fired power plant capacity operated by the utilities (11.4 single-fired and 7.3 multi-fired), and almost none by auto-producers.

Between 2000 and 2003, gas-fired plants ran at an average load factor of 33 percent, which is somewhat surprising, as it seems rather low for 60 percent of the total capacity.

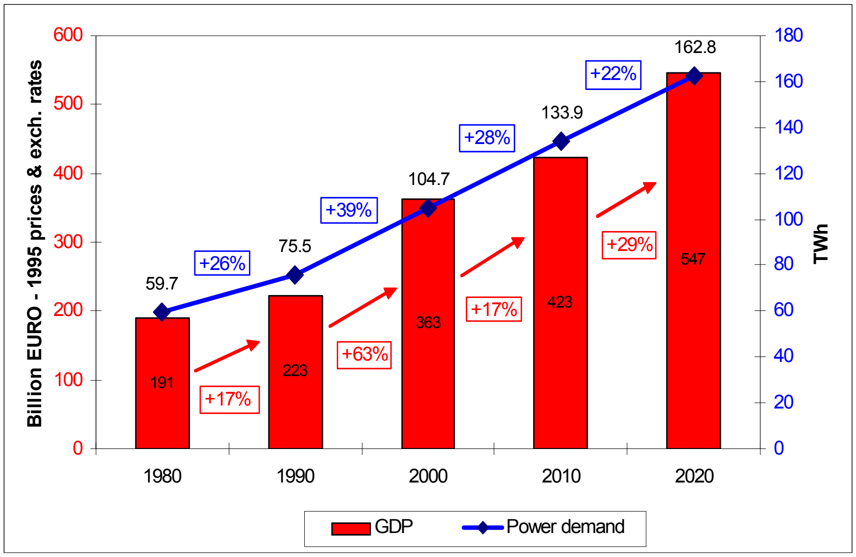
Table 23: Load factors of gas-fired power plants in the NL (utilities only)

	2000	2001	2002	2003
Load (percent)	30.1	33.2	34.3	34.9

Source: International Energy Agency, *Electricity Information 2005*

Figure 28 gives some information on the past and projected increase in GDP and electricity demand in the Netherlands from Eurelectric.

Figure 28: Past and projected increase in electricity demand and GDP in the NL



Source: Eurelectric 'Eurprog 2004'

Key factors for gas demand in the power generation sector

There is already a high penetration of natural gas in the Dutch economy, particularly in the power generation sector and it will be difficult to increase its market share in the future. Slower economic growth compared to the 1990s and continued energy conservation policies will add to the slowdown in gas demand growth. Electricity demand growth is slowing down too, and there is already an excess of power-generation capacity due to the unexpectedly strong growth of cogeneration. Furthermore, in May 2003, the closure of the only nuclear power plant, Borssele, was postponed until 2013.

Additional gas-fired capacity (as of September 2005)

There are 795MW recently operational which will run at full capacity by 2010. 1,100MW of additional gas-fired capacity have been applied for administrative consent. And 400MW are planned. This additional capacity could be available to run at full capacity by 2015.

Table 24: Summary of additional gas-fired capacity operated by the utilities, as of September 2005, in the NL, in MW

2005−2010		2010−2015		2005−2015	
Probable	Possible	Probable	Maximum Possible	Probable	Maximum Possible
795	795	300	1500	1095	2295

Source: Platts *Power in Europe*, Government, Companies

Table 25: Dutch additional gas demand for the power sector from the additional gas-fired capacity operated by the utilities, at different load factors, as of Sept. 2005, in bcm

		Load factors		
		75 percent	50 percent	20 percent
2005−2010	Probable	1.03	0.64	0.25
	Possible	1.03	0.64	0.25
2010−2015	Probable	0.82	0.54	0.22
	Maximum Possible	1.67	1.15	0.46
2005−2015	Probable	1.85	1.18	0.47
	Maximum Possible	2.71	1.79	0.71

Source: Author's assumptions

In 2004, gas demand for power generation was 16 bcm. Between 2005 and 2010, assuming gas-fired power plants continue to run at 33 percent load factor, additional demand could be around 0.5 bcm. From 2010 to 2015, the range of additional demand would be 0.4−1 bcm.

Assuming a load factor of 35 percent for the new gas-fired plants in our probable scenario, additional demand would be 0.41 bcm by 2010 and 0.76 bcm by 2015 (Table 26).

Table 26: Dutch additional gas demand for the power sector from the additional capacity operated by the utilities, at 35 percent load factor, as of Sept. 2005, in bcm

		Load factor 35 percent
2005−2010	Probable	0.41
	Possible	0.41
2010−2015	Probable	0.36
	Maximum possible	0.77
2005−2015	Probable	0.76
	Maximum possible	1.17

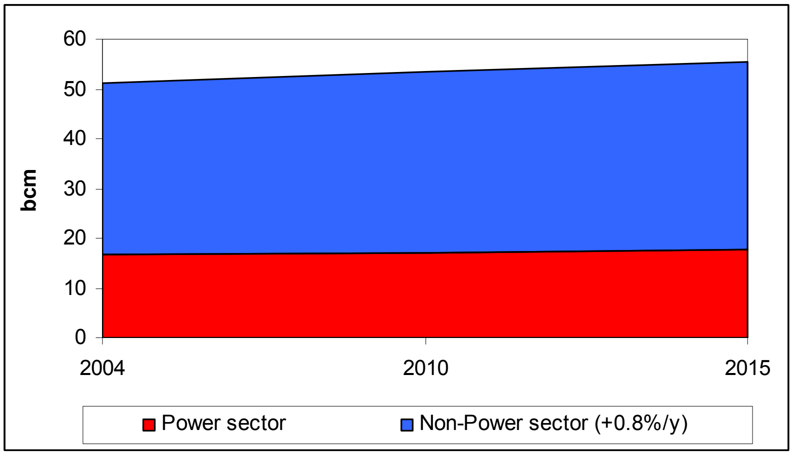
Source: Author's assumptions

Table 27: Dutch gas demand by 2015 in bcm
(at 35 percent load factor for the new gas-fired capacity operated by the utilities and 0.8 percent of annual increase in the non-power sectors)

	2004	2010	2015
Power sector	16.80	17.21	17.56
Non-power sector (+0.8 percent/y)	34.50	36.2	37.7
Total	51.30	53.41	55.26

Source: Author's assumptions

Figure 29: Dutch gas demand by 2015
(at 35 percent load factor for the new gas-fired capacity operated by the utilities and 0.8 percent of annual increase in the non-power sectors)



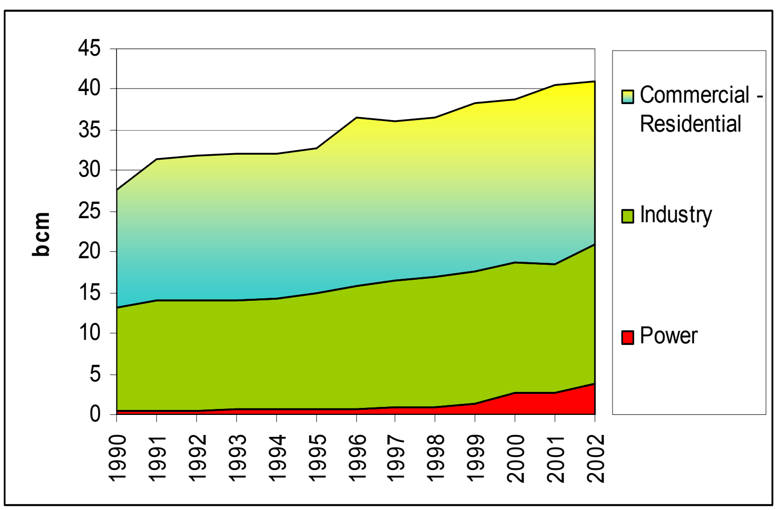
Source: Author's assumptions

5.2.5 France

Background information

The gas penetration in France is low. Electricity generated from natural gas decreased by 7.6 percent per year between 1974 and 1990, but increased by 17.2 percent per year between 1990 and 2003.

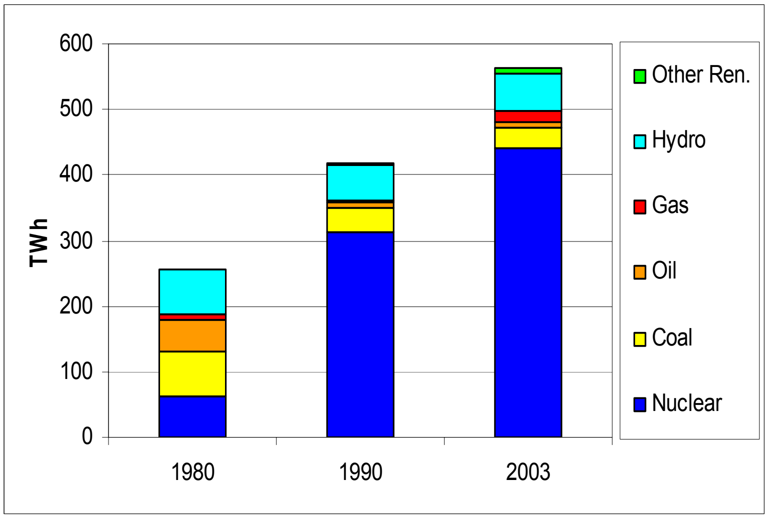
Figure 30: French gas demand by sector in bcm



Source: International Energy Agency, Natural Gas Information 2005

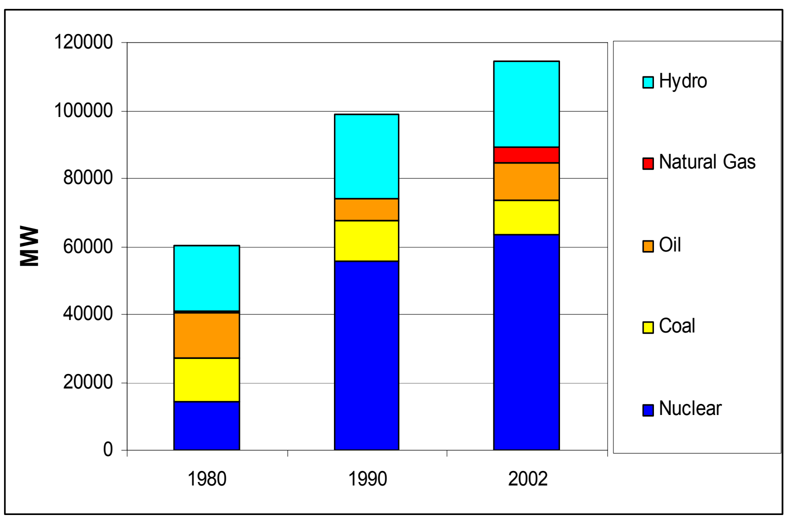
The use of gas in the power generation sector is limited. France is one of the world's leading producers and consumers of nuclear power, and will continue to rely on nuclear for the majority of its power production.

Figure 31: French electricity generation in electricity and CHPs plants, in TWh



Source: International Energy Agency, *Electricity Information 2005*

Figure 32: French electricity generation capacity in MW



Source: Eurelectric 'Eurprog 2004'

In 2003, there was 3.4GW of gas-fired power capacity. 1.16GW operated by the utilities (0.08GW of single-fired and 1.08GW of multi-fired).

Between 2000 and 2003, gas-fired plants ran at 2.5 percent load factors on average (utilities only) (table 28).

Table 28: Load factors of gas-fired power plants in France (utilities only)

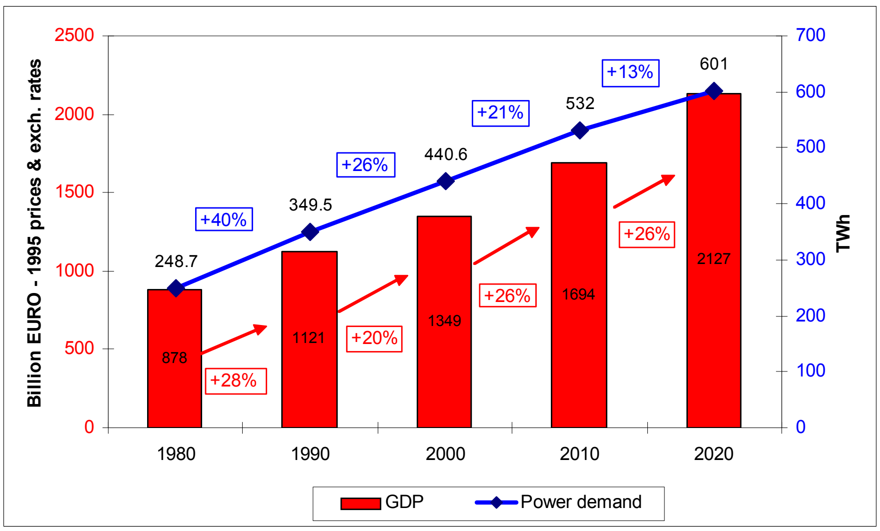
	2000	2001	2002	2003
Load (percent)	2.5	2.5	2.5	2.5

Source: International Energy Agency, *Electricity Information 2005*

In France, gas for power generation is mainly used by auto-producers. Electricity generation from natural gas by utilities was less than 1 TWh in 2003, while the auto-producers generated 17 TWh for their own-use (86 percent load factor).

Figure 33 gives some information on the past and projected increase in GDP and electricity demand in France.

Figure 33: Past and projected increase in electricity demand and GDP in France



Source: Eurelectric 'Eurprog 2004'

Key factors for gas demand in the power generation sector

In the short and middle term, France needs new power capacity. But nuclear power is cheap, and there is limited scope for the use of gas in the power-generation sector by 2015. Some CCGTs will be added here and there (for instance along the Italian frontier to supply the Italian market), but there will not be a significant increase in gas for power in France, at least for the main electricity producers. There is probably a different story to tell for the auto-producers in France, where the main increase in gas-for-power will come from. This study only focuses on the power generated –and the gas consumed- by the utilities.

Additional gas-fired capacity (as of September 2005)

There are 660MW recently operational or currently under construction which will be available to run at full capacity by 2010. 2,136MW are planned and this additional capacity could be available to run at full capacity by 2015.

Table 29: Summary of additional gas-fired capacity operated by the utilities as of September 2005, in France, in MW

2005−2010		2010−2015		2005−2015	
Probable	Possible	Low	High	Low	High
660	660	0	2136	660	2796

Source: Platts *Power in Europe*, Government, Companies

Table 30: French additional gas demand for the power sector from the additional capacity operated by the utilities, at different load factors, as of September 2005, in bcm

		Load factors		
		75 percent	50 percent	20 percent
2005−2010	Probable	1.12	0.80	0.31
	Possible	1.12	0.80	0.31
2010−2015	Low	0.00	0.00	0.00
	High	2.29	1.62	0.64
2005−2015	Low	1.12	0.80	0.31
	High	3.41	2.42	0.96

Source: Author's assumptions

In 2004, gas demand for power generation was 4.2 bcm. By 2015, even if all additional capacity was running at 75 percent capacity, this would only amount to 3.4 bcm of gas.

Assuming a load factor of 20 percent[13] for the new gas-fired plants in our probable scenario, additional demand would be 0.3 bcm by 2010 and 0.9 bcm by 2015 (Table 31).

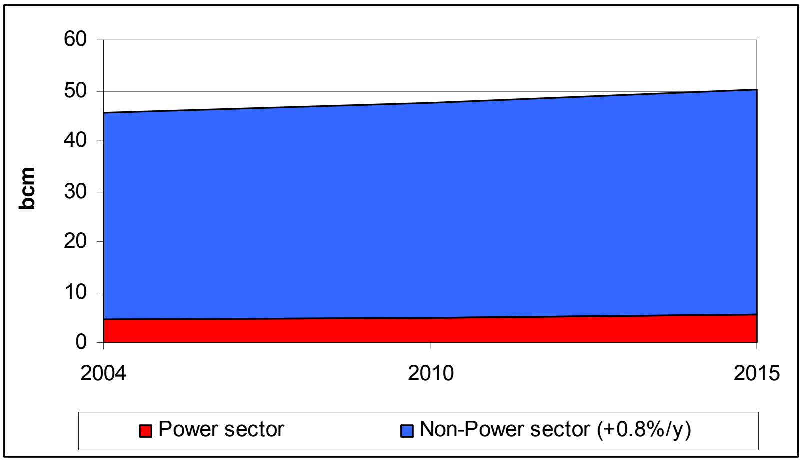
Table 31: French gas demand by 2015 in bcm
(at 20 percent load factor for the new gas-fired capacity operated by the utilities and 0.8 percent of annual increase in the non-power sectors)

	2004	2010	2015
Power sector	4.70	5	5.6
Non-power sector (+0.8 percent/y)	40.80	42.7	44.5
Total	45.50	47.7	50.1

Source: Author's assumptions

[13] This load factor is used as a minimum, but as we have seen in the section above, the load factor of the gas-fired plants operated by the utilities is currently much lower.

Figure 34: French gas demand by 2015 in bcm
(at 20 percent load factor for the new gas-fired capacity operated by the utilities and 0.8 percent of annual increase in the non-power sectors)



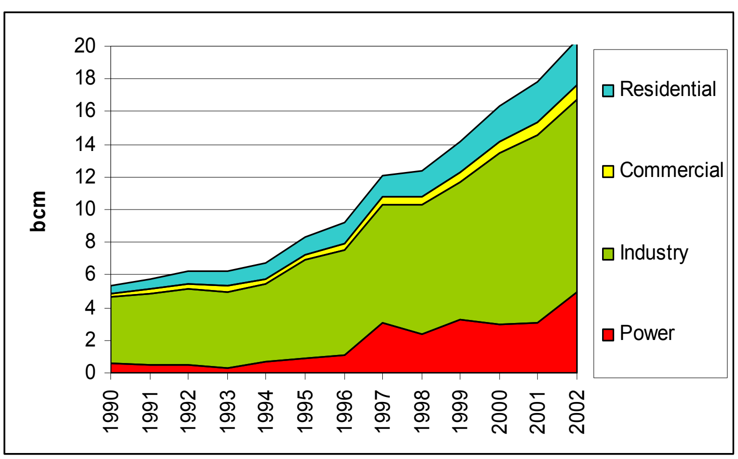
Source: Author's assumptions

5.2.6 Spain

Background information

The Iberian market remains one of the most attractive gas markets in Western Europe due to its fast growing demand. Spain is in fact the fastest growing natural gas market, led by important construction of new gas-fired power plants. In 2004, Spain consumed 27 bcm of gas, up from 5.4 bcm in 1990. Industry is by far the largest consumer, but gas for power demand has been increasing continuously over the past decade, and represented 25 percent of the demand in 2004.

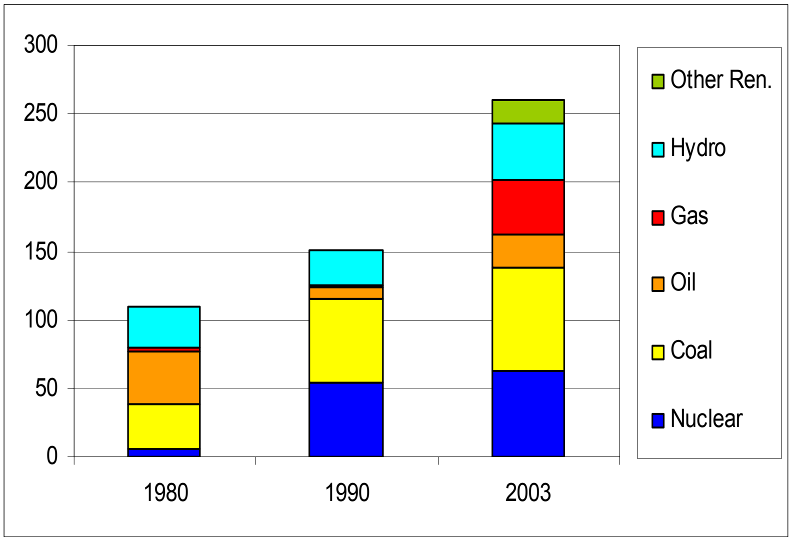
Figure 35: Spanish gas demand by sector in bcm



Source: International Energy Agency, *Natural Gas Information 2005*

Electricity generation from natural gas increased by 8 percent per year between 1974 and 1990, and by 28.7 percent per year between 1990 and 2003 − a huge acceleration in the last 15 years. In 2003, 15 percent of electricity was generated from gas, up from only 1 percent in 1990. Nuclear produced 24 percent, coal 29 percent, hydro 16 percent, oil 9 percent and renewables 7 percent.

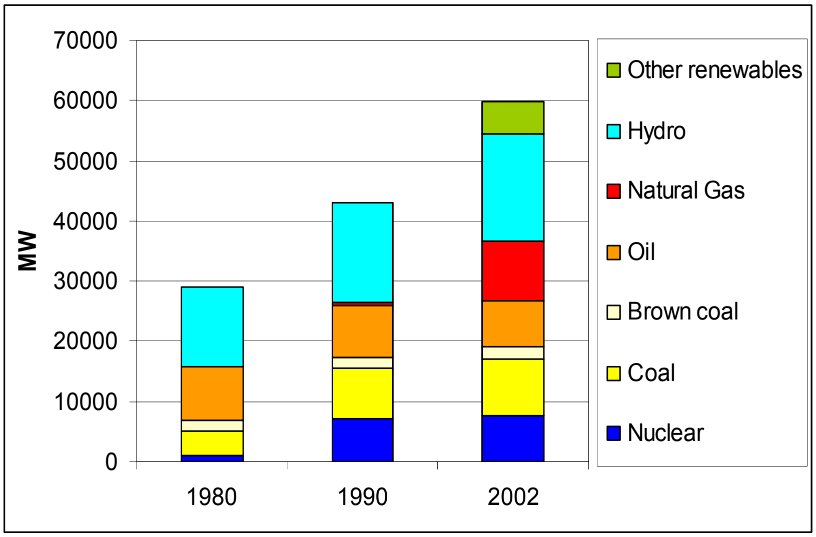
Figure 36: Spain electricity generation in electricity and CHPs plants, in TWh



Source: International Energy Agency, *Electricity Information 2005*

In 2002, there was 9.45GW of gas-fired power plant capacity. 5.76GW was operated by the utilities (2.64GW single-fired and 3.1GW multi-fired). However, the gas-fired generating capacity in Spain is increasing very rapidly.

Figure 37: Spanish electricity generation capacity in MW



Source: Eurelectric 'Eurprog 2004'

Between 2000 and 2002, gas-fired plants ran at an average load factor of 15 percent. Dry weather conditions in 2004 and 2005 (and a continued increase in electricity demand) have boosted the load factor for gas-fired plants these last months.

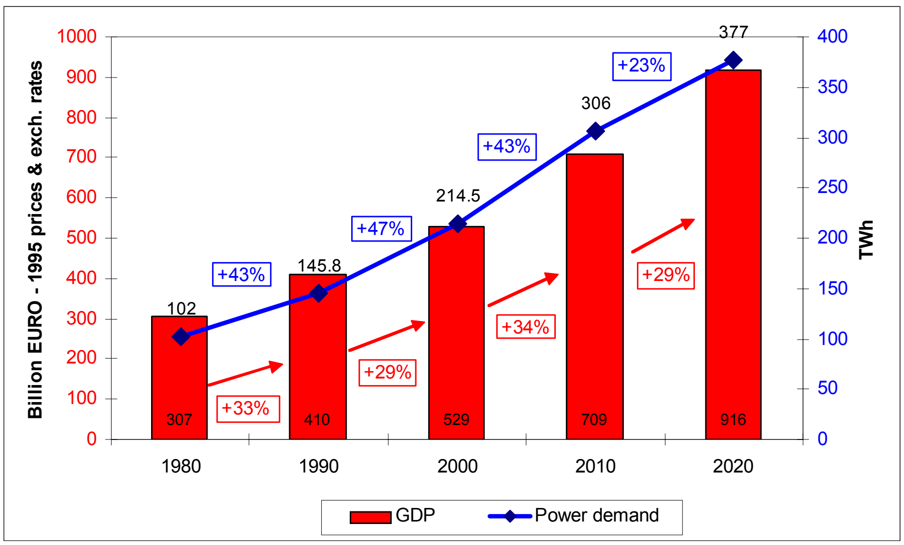
Table 32: Load factors of gas-fired power plants in Spain (utilities only)

	2000	2001	2002
Load (percent)	13.2	14.8	20.8

Source: International Energy Agency, *Electricity Information 2005*

Figure 38 gives some information on the past and projected increase in GDP and electricity demand.

Figure 38: Past and projected increase in electricity demand and GDP in Spain



Source: Eurelectric 'Eurprog 2004'

Key factors for gas demand in the power generation sector

First, electricity demand is growing steadily in Spain. Electricity generation and consumption have grown at nearly twice the growth rate experienced in other countries of Western Europe in recent years. For instance, from 1998 to 2002, electricity consumption in Spain increased on average 6 percent annually.

Second, Spain needs to face the consequences of structural past under-investment in electricity generation, and third, the limited connections with neighbouring France prevent huge electricity imports.

Finally, dry weather conditions – and therefore lower availability of hydroelectric generation − have had catastrophic consequences on the electricity sector, as seen in March 2005. All these factors make it necessary to add new capacities rapidly. Official projections show that natural gas and renewables will increase their share of electric generation considerably by 2011, while nuclear, coal and oil are expected to account for smaller percentages. Gas demand is expected to rise quickly in response to CCGT construction.

Another significant factor is the sharp projected increase in the non-power sectors. The government plans that the residential and commercial sectors will increase by 88 percent by 2011 (up to 6.5 bcm). The industry sector will grow by 50 percent by 2011 (up to 22.8 bcm). These figures will contribute to the increase in gas demand in Spain, and a dash for gas is probable in the next decade.

Additional gas-fired capacity (as of September 2005)

There are 12,780MW recently operational or currently under construction which will be available to run at full capacity by 2010. There are 2,370MW with administrative consent which could be available to run at full capacity by 2010.

Administrative consent has been applied for in the case of 9,485MW of plant. However, some of these projects are clearly in competition – around Madrid for instance − and not all of them will be constructed. Some of the projects will also be delayed due to fierce local opposition. However, 40GW of gas-fired projects is still an impressive number for the Spanish market. A further 15,135MW are planned which could be available to run at full capacity by 2015.

Table 33: Summary of additional gas-fired capacity operated by the utilities in Spain, as of Sept. 2005, in MW

2005−2010		2010−2015		2005−2015	
Probable	Possible	Probable	Maximum Possible	Probable	Maximum Possible
12780	14750	8770	26190	21150	38970

Source: Platts *Power in Europe*, Government, Companies

Table 34: Spanish additional gas demand for the power sector from the additional gas-fired capacity operated by the utilities, at different load factors, as of Sept. 2005, in bcm

		Load factors		
		75 percent	50 percent	20 percent
2005−2010	Probable	13.67	9.71	3.83
	Possible	15.78	11.21	4.43
2010−2015	Probable	6.82	4.84	1.91
	Maximum Possible	26.74	18.99	7.50
2005−2015	Probable	20.49	14.55	5.75
	Maximum Possible	40.41	28.71	11.33

Source: Author's assumptions

In 2003, gas demand for power generation was 5.8 bcm. Between 2005 and 2010, assuming gas-fired power plants continue to run at 20 percent load factor (to follow the increase in electricity demand), additional demand would be a minimum of 3.8 bcm and a maximum of 4.4 bcm. From 2010 to 2015, the range of additional demand would be 1.9−7.5 bcm. However, the load factor for gas-fired plants in Spain will probably increase in the coming years and this would further increase demand.

Assuming a load factor of 40 percent for the new gas-fired plants in our probable scenario, additional demand would be 8.3 bcm by 2010 and 14 bcm by 2015 (Table 35).

Table 35: Spanish additional gas demand for the power sector from the additional gas-fired capacity operated by the utilities, at 40 percent load factor, as of Sept. 2005, in bcm

		Load factor 40 percent
2005−2010	Probable	8.31
	Possible	9.59
2010−2015	Probable	5.70
	Maximum possible	17.02
2005−2015	Probable	14.01
	Maximum possible	26.61

Source: Author's assumptions

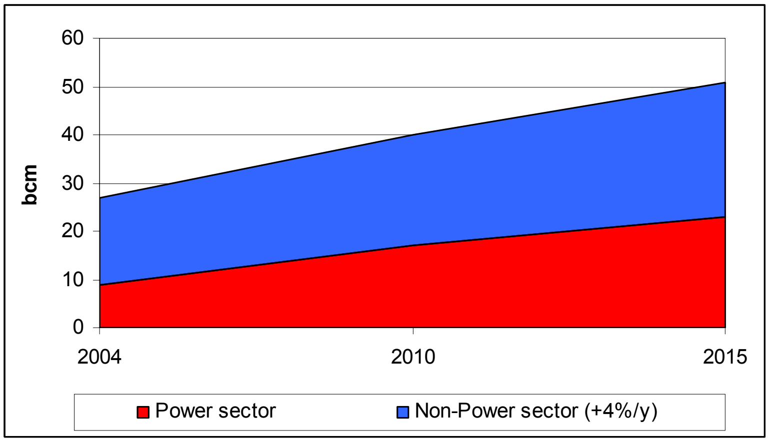
Table 36: Spanish gas demand by 2015
(at 40 percent load factor for the new gas-fired capacity operated by the utilities and 4 percent of annual increase in the non-power sectors)

	2004	2010	2015
Power sector	8.90	17.2	22.9
Non-power sector (+4 percent/y)	18.10	22.9	27.8
Total	27.00	40.1	50.7

Source: Author's assumptions

The government plans that the residential and commercial sectors will increase by 88 percent from 3.7 bcm in 2002 to 6.5 bcm in 2011. The industry sector will grow by 50 percent from 18.3 bcm in 2005 and 22.8 bcm in 2011. We use an annual increase of 4 percent for the non-power sectors between 2005 and 2015.

Figure 39: Spanish gas demand by 2015 in bcm
(at 40 percent load factor for the new gas-fired capacity operated by the utilities and 4 percent of annual increase in the non-power sectors)



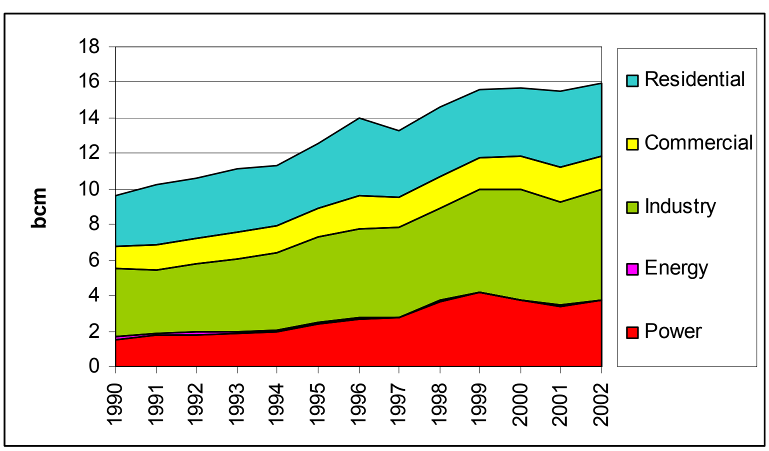
Source: Author's assumptions

5.2.7 Belgium

Background information

Belgian gas demand increased to 16.9 bcm in 2004, from 9.6 bcm in 1990.

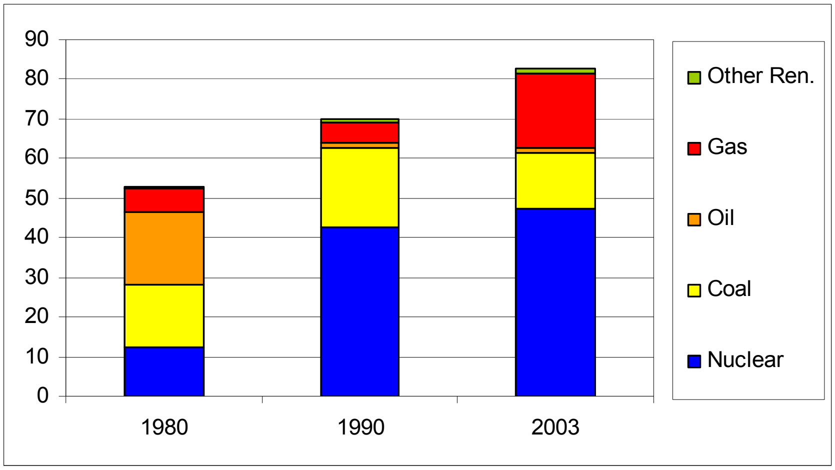
Figure 40: Belgian gas demand by sector in bcm



Source: International Energy Agency, *Natural Gas Information 2005*

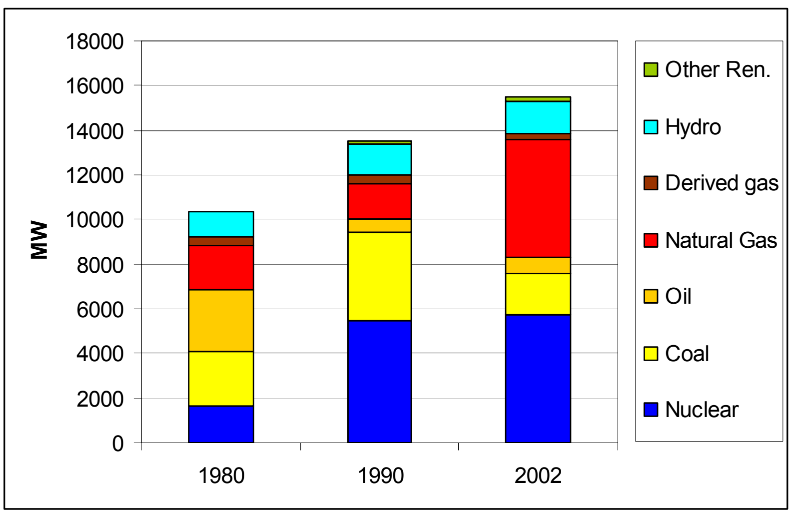
The power sector represented 23 percent of gas demand in 2002: 3.7 bcm of gas, up from 1.5 bcm in 1990. Twenty-two percent of electricity was generated from gas in 2002 (7.7 percent in 1990).

Figure 41: Belgian electricity generation in electricity and CHPs plants, in TWh



Source: International Energy Agency, *Electricity Information 2005*

Figure 42: Belgian electricity generation capacity in MW



Source: Eurelectric 'Eurprog 2004'

In 2003, there was 7.4GW of gas-fired power plant capacity. 7.16GW were operated by the utilities (2.1GW single-fired and 5.06GW multi-fired).

Between 2000 and 2003, gas-fired plants ran at an average load factor of 25 percent (table 37).

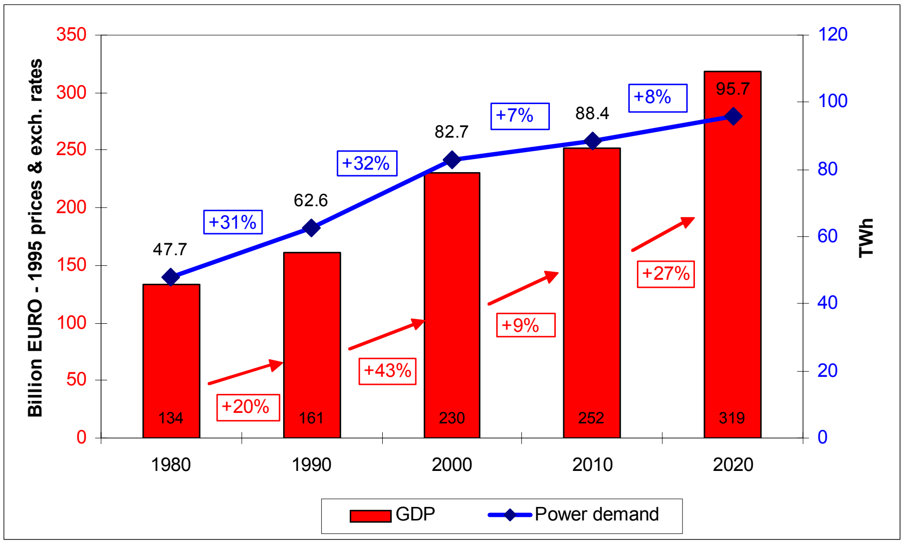
Table 37: Load factors of gas-fired power plants in Belgium (utilities only)

	2000	2001	2002	2003
Load (percent)	24.5	24.7	28.1	33.6

Source: International Energy Agency, *Electricity Information 2005*

Figure 43 gives some information on the past and projected increase in GDP and electricity demand.

Figure 43: Past and projected increase in electricity demand and GDP in Belgium



Source: Eurelectric 'Eurprog 2004'

Key factors for gas demand in the power generation sector

In January 2003, the government decided to phase out the seven nuclear reactors by 2025. Even if these are replaced by gas-fired capacity; there will only be an impact on gas demand in 20 years time. Prospects for gas demand in the power (and non-power) sectors are low.

Additional gas-fired capacity (as of September 2005)

There are 505MW recently operational or currently under construction. This additional capacity will be fully available by 2010. There are 700MW planned which could be fully available by 2015.

Table 38: Summary of additional gas-fired capacity operated by the utilities, as of Sept. 2005, in MW

2005−2010		2010−2015		2005−2015	
Probable	Possible	Low	High	Low	High
505	505	0	700	505	1205

Source: Platts *Power in Europe*, Government, Companies

Table 39: Belgian additional gas demand for the power sector from the additional gas-fired capacity operated by the utilities, at different load factors, as of Sept. 2005, in bcm

		Load factors		
		75 percent	50 percent	20 percent
2005−2010	Probable	0.66	0.40	0.16
	Possible	0.66	0.40	0.16
2010−2015	Low	0.00	0.00	0.00
	High	0.75	0.53	0.21
2005−2015	Low	0.66	0.40	0.16
	High	1.41	0.94	0.37

Source: Author's assumptions

In 2003, gas demand for power generation was 4.6 bcm. Assuming a load factor of 35 percent for the new gas-fired plants in our probable scenario, additional demand would be 8.3 bcm by 2010 and 14 bcm by 2015 (Table 40).

Table 40: Belgian additional gas demand for the power sector from the additional gas-fired capacity operated by the utilities, at 35 percent load factor, as of Sept. 2005, in bcm

		Load factor 35 percent
2005−2010	Probable	0.26
	Possible	0.26
2010−2015	Probable	0.00
	Maximum possible	0.36
2005−2015	Probable	0.26
	Maximum possible	0.61

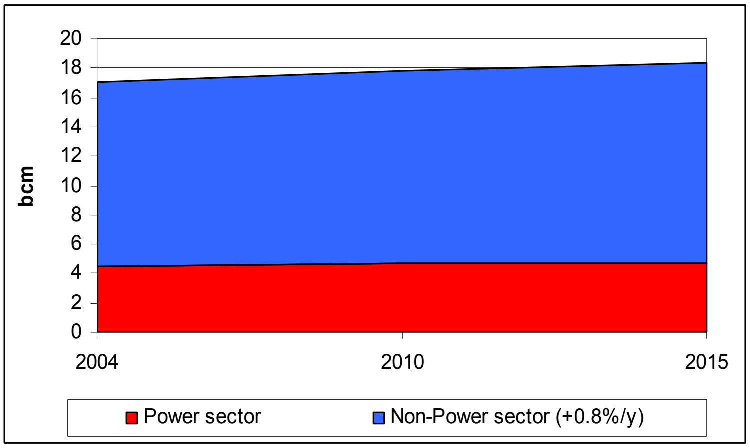
Source: Author's assumptions

Table 41: Belgian gas demand by 2015 in bcm
(at 40 percent load factor for the new gas-fired capacity operated by the utilities and 0.8 percent of annual increase in the non-power sectors)

	2004	2010	2015
Power sector	4.50	4.74	4.74
Non-power sector (+0.8 percent/y)	12.50	13.08	13.61
Total	17.00	17.82	18.35

Source: Author's assumptions

Figure 44: Belgian gas demand by 2015 in bcm
(at 40 percent load factor for the new gas-fired capacity operated by the utilities and 0.8 percent of annual increase in the non-power sectors)

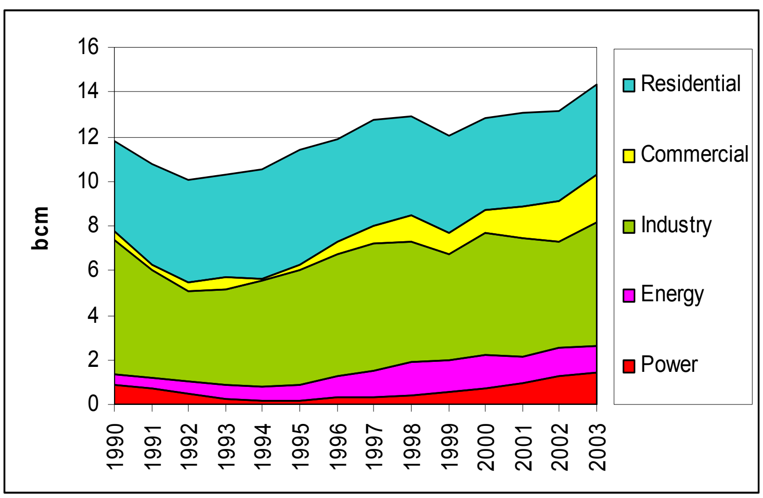


Source: Author's assumptions

5.2.8 New entrants: Poland

Background information

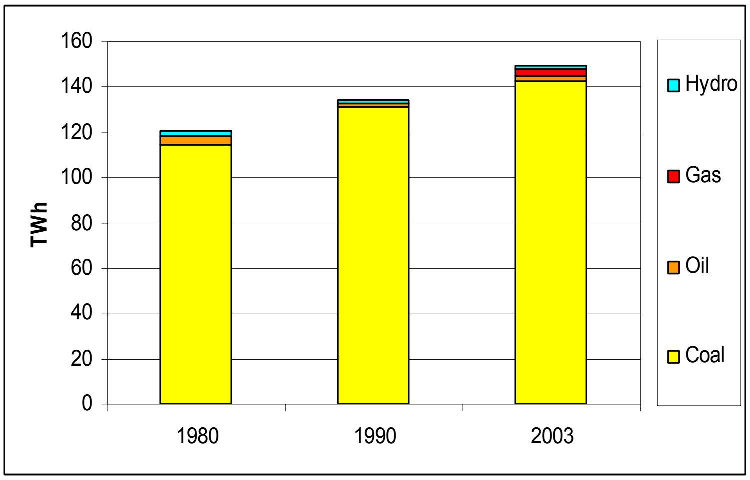
Figure 45: Polish gas demand by sector in bcm



Source: International Energy Agency, *Natural Gas Information 2005*

In 2004, Poland consumed 15.6 bcm of gas. Over 97 percent of power generation is coal-fired. In 2003, there were 0.6GW of gas-fired power plants, consuming 1.4 bcm of gas.

Figure 46: Polish electricity generation in electricity and CHPs plants, in TWh



Source: International Energy Agency, *Electricity Information 2005*

Additional gas-fired capacity (as of September 2005)

There are very few gas-fired power plant projects. Investments in new CCGTs are not planned before at least 2012−13, and because of construction lead-time these plants will not be in production by 2015. The reason is simple; energy from gas-fired power plants is still more expensive than energy produced from hard and brown coal. And Poland has received derogation allowances under the LCPD.

Table 42: Summary of additional gas-fired capacity operated by the utilities in Poland, as of Sept. 2005, in MW

2005−2010		2010−2015		2005−2015	
Probable	Possible	Low	High	Low	High
190	190	0	300	190	490

Source: Platts *Energy in East Europe*, Government

Table 43: Polish additional gas demand for the power sector from the additional gas-fired capacity operated by the utilities, at different load factors, as of Sept. 2005, in bcm

		Load factors		
		75 percent	50 percent	20 percent
2005−2010	Probable	0.25	0.15	0.06
	Possible	0.25	0.15	0.06
2010−2015	Maximum Possible	0.00	0.00	0.00
	High	0.39	0.24	0.10
2005−2015	Probable	0.25	0.15	0.06
	Maximum Possible	0.64	0.39	0.16

Source: Author's assumptions

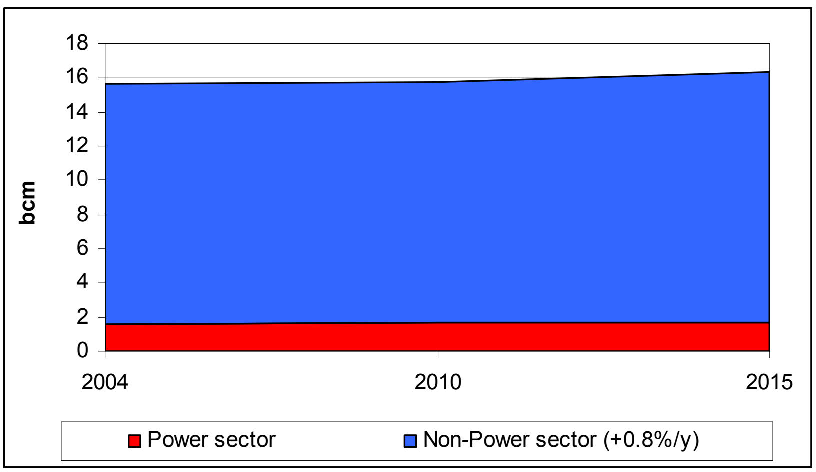
Assuming a load factor of 20 percent for the new gas-fired plants in our probable scenario, additional demand would be 0.06 bcm by 2010 and by 2015 (Table 44).

Table 44: Polish gas demand by 2015 in bcm
(at 20 percent load factor for the new gas-fired capacity operated by the utilities and 0.8 percent of annual increase in the non-power sectors)

	2004	2010	2015
Power sector	1.60	1.66	1.66
Non-power sector (+0.8 percent/y)	14.07	14.11	14.7
Total	15.67	15.77	16.36

Source: Author's assumptions

Figure 47: Polish gas demand by 2015 in bcm
(at 20 percent load factor for the new gas-fired capacity operated by the utilities and 0.8 percent of annual increase in the non-power sectors)



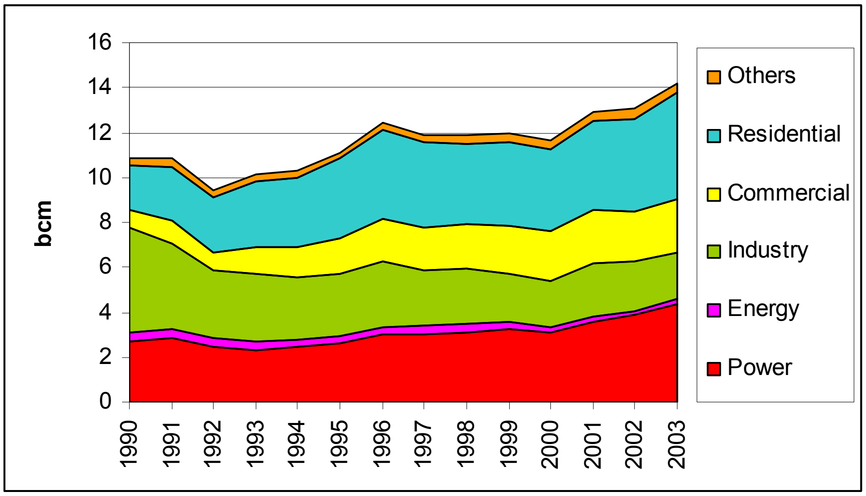
Source: Author's assumptions

5.2.9 New entrants: Hungary

Background information

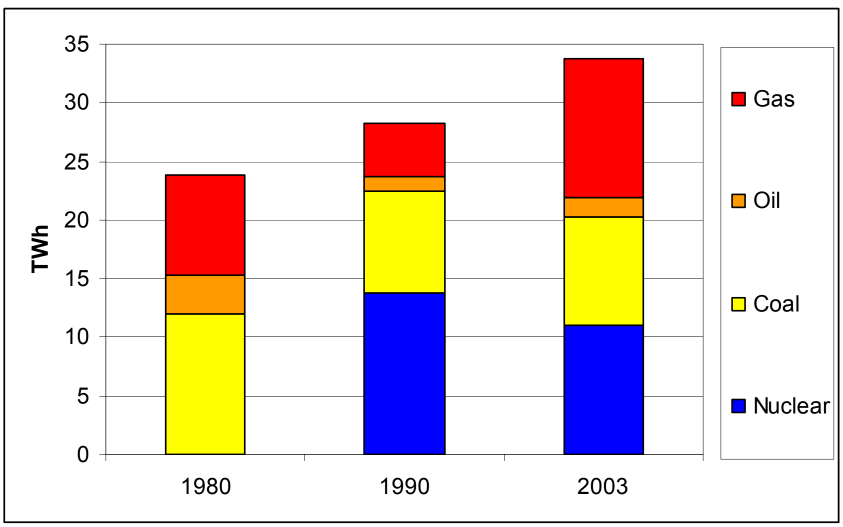
Gas demand has grown steadily in the past decade but the growth rate of the Hungarian gas market is slowing. In 2004, Hungary consumed 14.6 bcm of gas, of which 4.4 for the power sector.

Figure 48: Hungarian gas demand by sector in bcm



Source: International Energy Agency, *Natural Gas Information 2005*

Figure 49: Hungarian electricity generation in electricity and CHPs plants, in TWh



Source: International Energy Agency, *Electricity Information 2005*

In 2003, there was 4GW of gas-fired power plant capacity and gas-fired plants ran at an average load factor of 34 percent.

Key factors for gas demand in the power generation sector

The coal-fired conventional power plants are very old and have environmental problems, except lignite-fired units, which have been retrofitted recently. Hungary is a unique country in Eastern Europe as it has announced at least four new projects over the last six months. However, natural gas prices are currently too high to allow new capacity before 2008−2012 at the earliest. After 2012, Hungary will need to replace some conventional power plants and extend the life of the nuclear units or replace them.

Additional gas-fired capacity (as of September 2005)

There are 386MW currently under construction, which will be fully available by 2010. 835MW are planned and these could be fully available by 2015.

Table 45: Summary of additional gas-fired capacity operated by the utilities in Hungary, as of Sept. 2005, in MW

2005−2010		2010−2015		2005−2015	
Probable	Possible	Probable	Maximum Possible	Probable	Maximum Possible
386.5	386.5	150	835	536.5	1221.5

Source: Platts *Energy in East Europe*, Government

Table 46: Hungarian additional gas demand for the power sector from the additional gas-fired capacity operated by the utilities, at different load factors, as of Sept. 2005, in bcm

		Load factors		
		75 percent	50 percent	20 percent
2005−2010	Probable	0.46	0.30	0.12
	Possible	0.46	0.30	0.12
2010−2015	Probable	0.17	0.12	0.05
	Maximum Possible	0.98	0.65	0.26
2005−2015	Probable	0.64	0.42	0.17
	Maximum Possible	1.45	0.95	0.38

Source: Author's assumptions

In 2003, gas demand for power generation was 4.4 bcm. Assuming a load factor of 35 percent for the new gas-fired plants in our probable scenario, additional demand would be 0.19 bcm by 2010 and 0.27 bcm by 2015 (Table 47).

Table 47: Hungarian additional gas demand for the power sector from the additional gas-fired capacity, at 35 percent load factor, as of Sept. 2005, in bcm

		Load factor 35 percent
2005−2010	Probable	0.19
	Possible	0.19
2010−2015	Probable	0.08
	Maximum possible	0.43
2005−2015	Probable	0.27
	Maximum possible	0.62

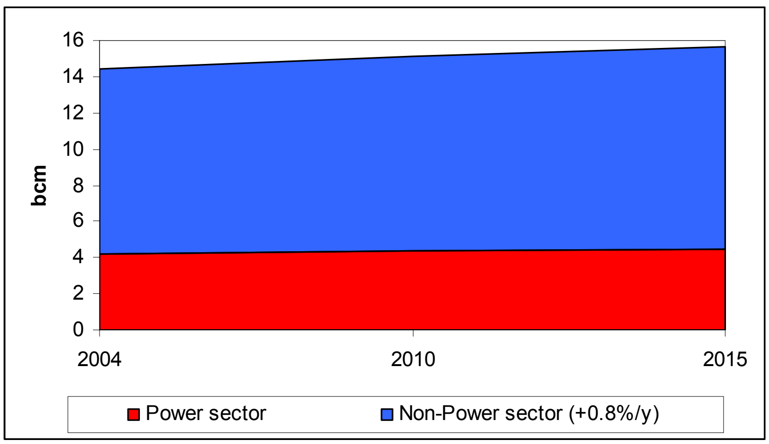
Source: Author's assumptions

Table 48: Hungarian gas demand by 2015, in bcm
(at 35 percent load factor for the new gas-fired capacity operated by the utilities and 0.8 percent of annual increase in the non-power sectors)

	2004	2010	2015
Power sector	4.16	4.35	4.43
Non-power sector (+0.8 percent/y)	10.30	10.8	11.21
Total	14.46	15.15	15.64

Source: Author's assumptions

Figure 50: Hungarian gas demand by 2015 in bcm
(at 35 percent load factor for the new gas-fired capacity operated by the utilities and 0.8 percent of annual increase in the non-power sectors)



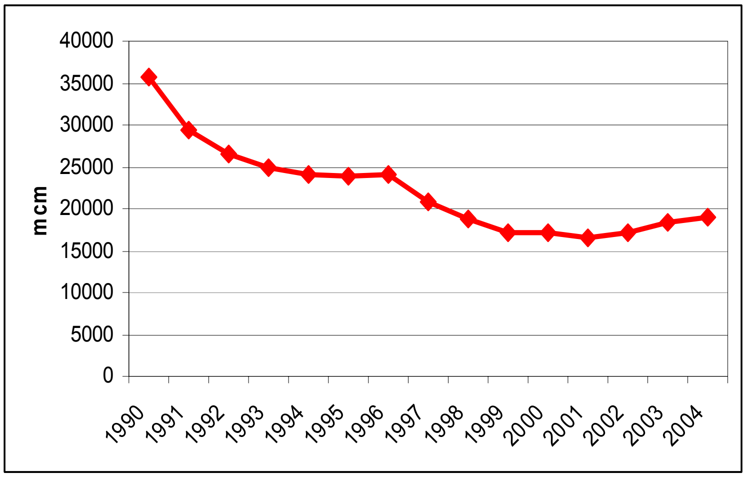
Source: Author's assumptions

5.3 Europe 35: two major markets

5.3.1 Romania

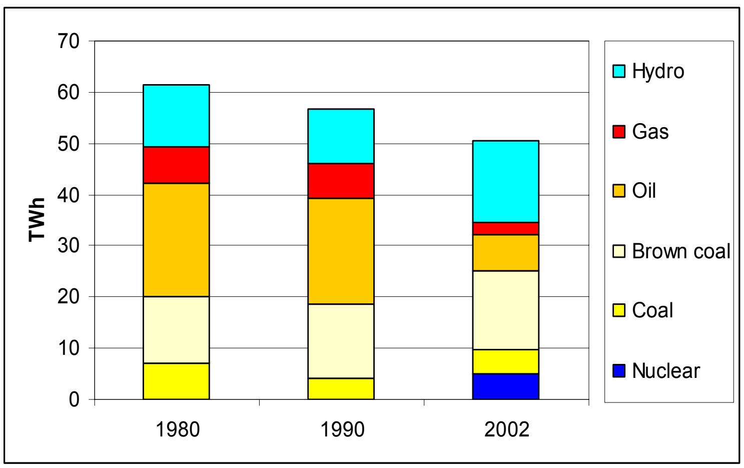
In 2004, Romania consumed 18.9 bcm of gas. Romania's natural gas demand is the highest in Central and Eastern Europe, but gas consumption in Romania has fallen harshly since 1990, and the demand for electricity has been flat during the same period.

Figure 51: Romanian gas demand, in mcm



Source: International Energy Agency, *Natural Gas Information 2005*

Figure 52: Romanian electricity generation in electricity and CHPs plants, in TWh



Source: Eurelectric 'Eurprog 2004'

Following a series of blackouts in 2002, the government plans to develop new generation facilities. Because of high gas prices, it is concentrating on nuclear and hydroelectric facilities. Electricity generation from coal would also be a cheaper option. However, up to 1GW of new gas-fired plant is planned in Romania.

Table 49: Summary of additional gas-fired capacity operated by the utilities in Romania, as of Sept. 2005, in MW

2005−2010		2010−2015		2005−2015	
Probable	Possible	Probable	Maximum Possible	Probable	Maximum Possible
186	186	0	858	186	1044

Source: Platts *Energy in East Europe*

Table 50: Romanian additional gas demand for the power sector from the additional gas-fired capacity operated by the utilities, at different load factors, as of Sept. 2005, in bcm

		Load factors		
		75 percent	50 percent	20 percent
2005−2010	Probable	0.24	0.15	0.06
	Possible	0.24	0.15	0.06
2010−2015	Probable	0.00	0.00	0.00
	Maximum Possible	1.12	0.69	0.27
2005−2015	Probable	0.24	0.15	0.06
	Maximum Possible	1.36	0.84	0.33

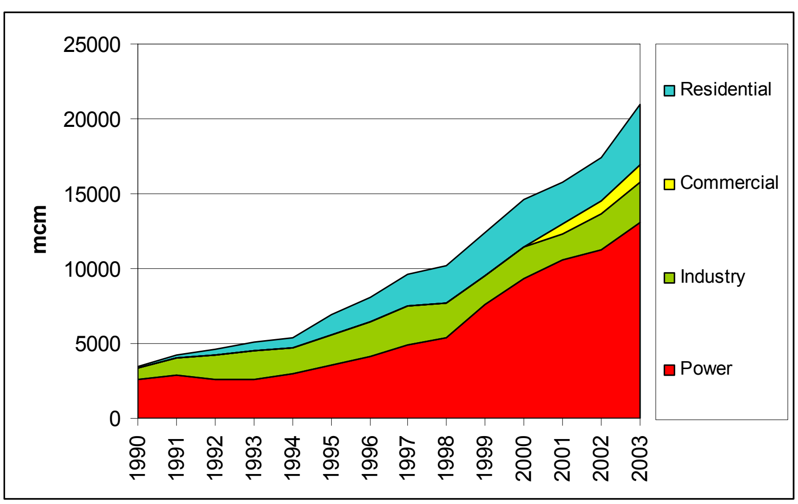
Source: Author's assumptions

5.3.2 Turkey

Turkey is a big question mark. Before the economic crisis in 2001, gas demand had been projected to grow very rapidly, mainly driven by power generation and the industrial sectors. However, gas demand projections have been revised downward since then. Following forecasts prior to 2001, Turkey has now signed contracts for far more natural gas than it is expected to need in the next 5−10 years.

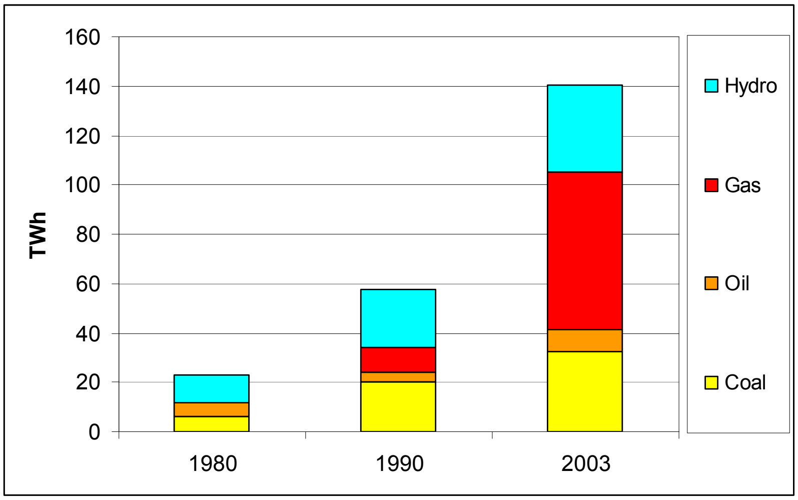
Official predictions show a possible shortfall between electricity generation and demand as early as 2009−10. Options discussed are hydro, domestic lignite and hard coal, electricity imports and perhaps restarting a nuclear programme. It seems that current gas prices are also too high for power generation in Turkey.

Figure 53: Turkish gas demand by sector in mcm



Source: International Energy Agency, *Natural Gas Information 2005*

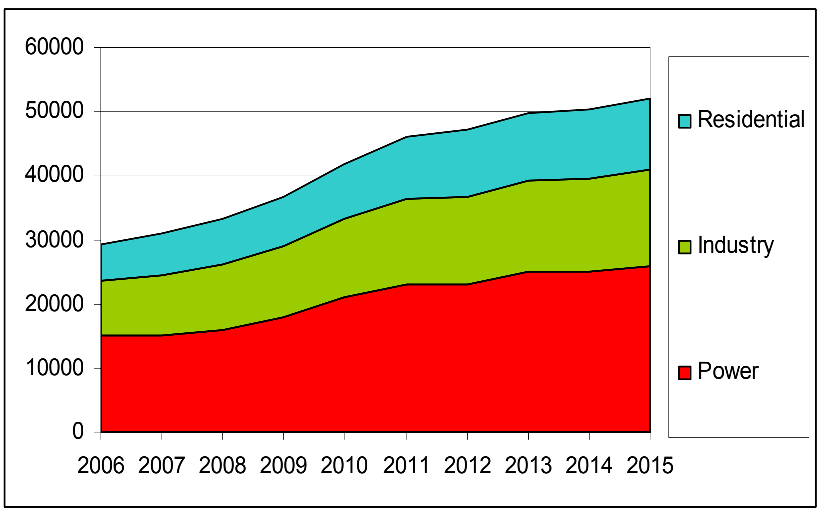
Figure 54: Turkish electricity generation in electricity and CHPs plants, in TWh



Source: International Energy Agency, *Electricity Information 2005*

Since we could not find a list of future projected gas-fired power plant projects for Turkey we will not produce scenarios. Figure 55 represents EMRA's assumptions (EMRA is the Energy Market Regulatory Authority in Turkey).

Figure 55: Natural gas demand projections in Turkey (2006–2015) in bcm



Source: EMRA, 2005

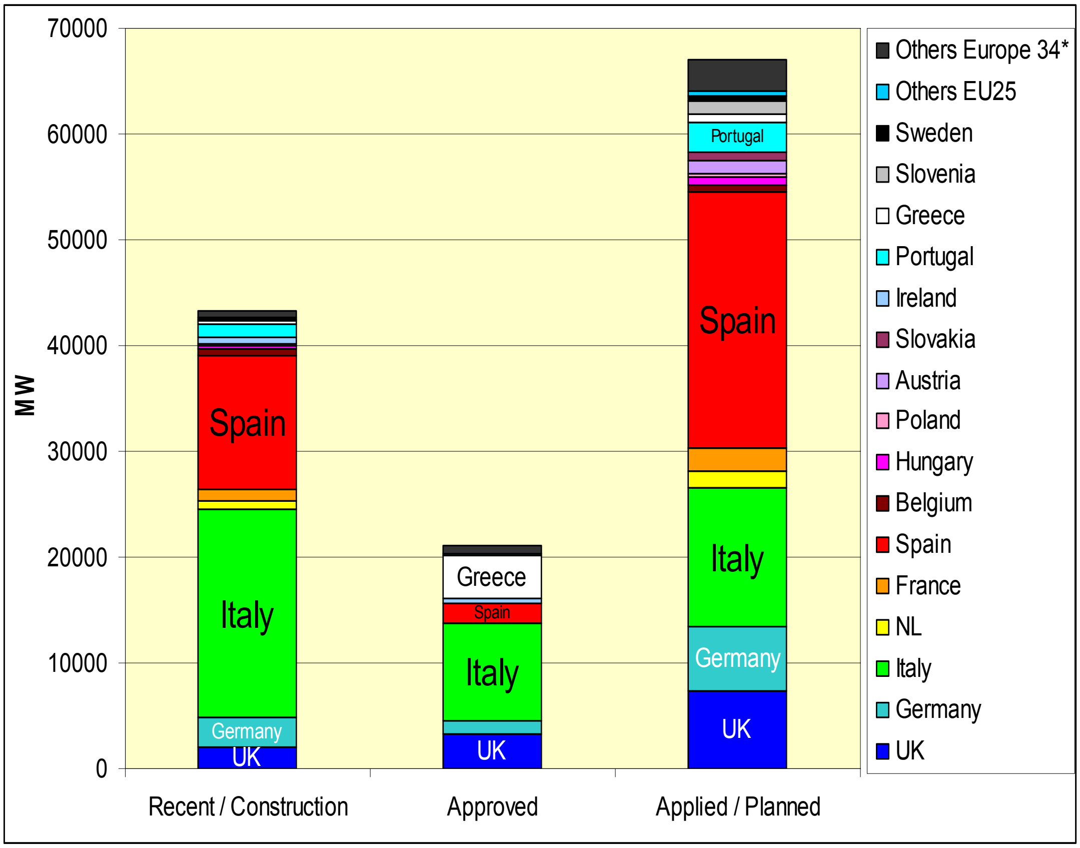
6. RESULTS

We are in a period of great uncertainty. The 2003−2005 increase in gas prices makes it difficult to sustain a decision to invest in gas-fired generation in most countries in Europe. However, our bottom-up methodology tells us that there are many gas-fired power plant projects, at different stages of development. Of course, it may happen that none of the projects are built, or they could be delayed. The load factor at which the plants run will depend on the level of gas prices. The most interesting outcome is the high concentration of these projects in two countries: Italy and Spain.

6.1 Additional gas-fired capacity in Europe by 2015

Figure 56 shows that two countries alone account for 76 percent of the projects under construction or recently operational in EU25: Spain and Italy. If we add the projects with administrative consent, they still represent 69 percent of the total (and 64 percent of all the projects). Building permits for coal-fired power plants are almost impossible to obtain in these two countries, and both need new generation capacity: Italy needs to increase gas-fired generating capacity to decrease its import dependence and to move away from oil-fired generation. Spain needs new capacity to meet its growing demand and has limited connections with neighbouring France to import electricity. Several gas-fired projects are also planned in the UK, which is expected to lose coal-fired capacity after the LCPD enters into force. Germany also has several gas-fired projects, but it is hard to see them running at base or even middle load by 2015. The Netherlands, France, Belgium, Hungary and Poland will not have much new gas-fired capacity in the coming years.

Figure 56: Gas-fired power plants projects (utilities only), in Europe 34, in MW of capacity



* Turkey is not included

Source: Platts *Power in Europe*, Platts *Energy in East Europe*, Governments, Regulators, Companies

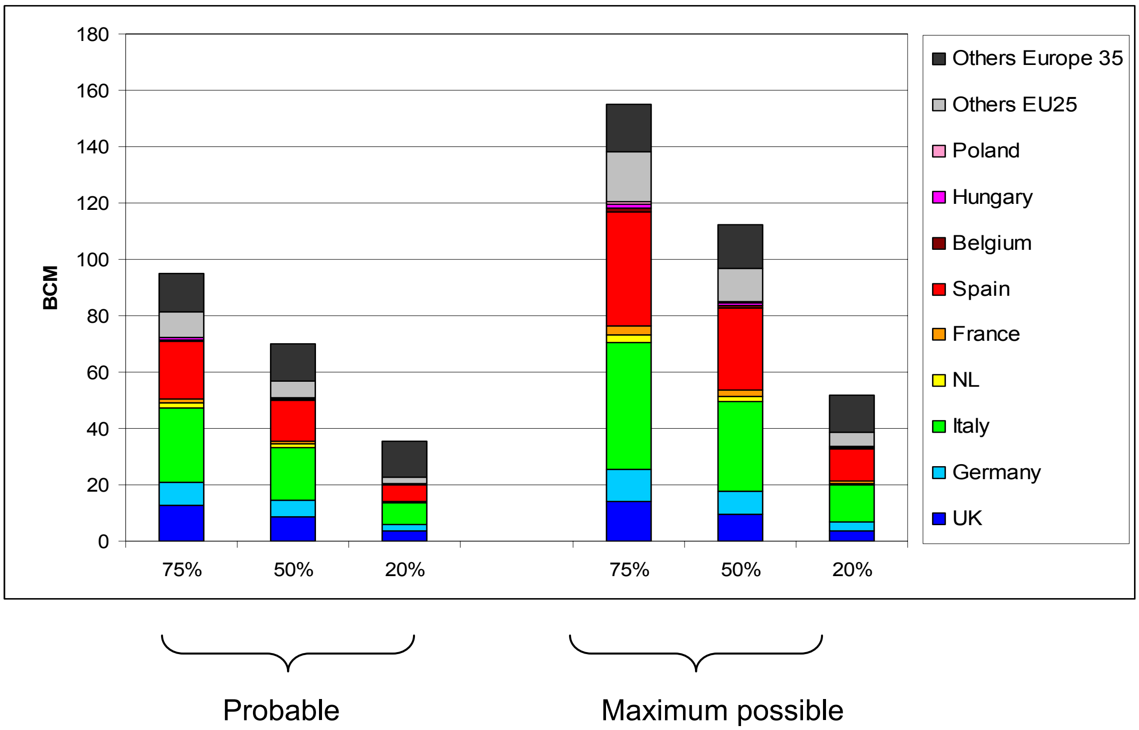
Outside the nine big markets, Greece, Portugal, Norway, Austria and Ireland are of the most interest, with several gas-fired power plant projects at different stages of development.[14] However, these countries have small gas markets, and even with a possible huge increase in gas-fired capacity in the next decade (Greece, Portugal), gas demand for power will remain relatively small.

6.2 Additional demand in the power generation sector by 2015 with our scenarios

Figure 57 shows the additional gas demand in power generation between 2005 and 2015 for Europe 35 (Turkey is included using EMRA's assumptions on gas demand growth for power).

[14] For details see Appendix 1.

Figure 57: Additional gas demand for the power generation sector from the additional gas-fired capacity operated by the utilities, at different load factors, as of Sept. 2005, in bcm. Probable and maximum possible scenarios



Source: Author's assumptions

As seen in Figure 57, load factor assumptions are extremely important as they have a huge impact on gas demand. In our probable scenario, there is a difference of 60 bcm of gas consumption between the baseload (75 percent) and the peak load (20 percent) factors. In the maximum possible scenario, it seems that the difference increases to 100 bcm. These load factor assumptions are never given in the gas demand forecasts available in the public domain. To calculate our probable demand, we have assumed an annual load factor to the new gas-fired plants based on historical data and future trends of electricity demand. Our load factor assumptions are detailed in Table 51.[15]

Table 51: Annual load-factors assumptions for new gas-fired capacity (utilities)

	Load-factor		Load-factor
UK	65 percent	Spain	40 percent
Germany	20 percent	Belgium	35 percent
Italy	40 percent	Hungary	35 percent
NL	35 percent	Poland	20 percent
France	20 percent	Other EU25	20 percent to 40 percent

Source: Author's assumptions

[15] The detailed tables in the Appendix 1 allow the readers to calculate gas demand for the power sector at other load factors.

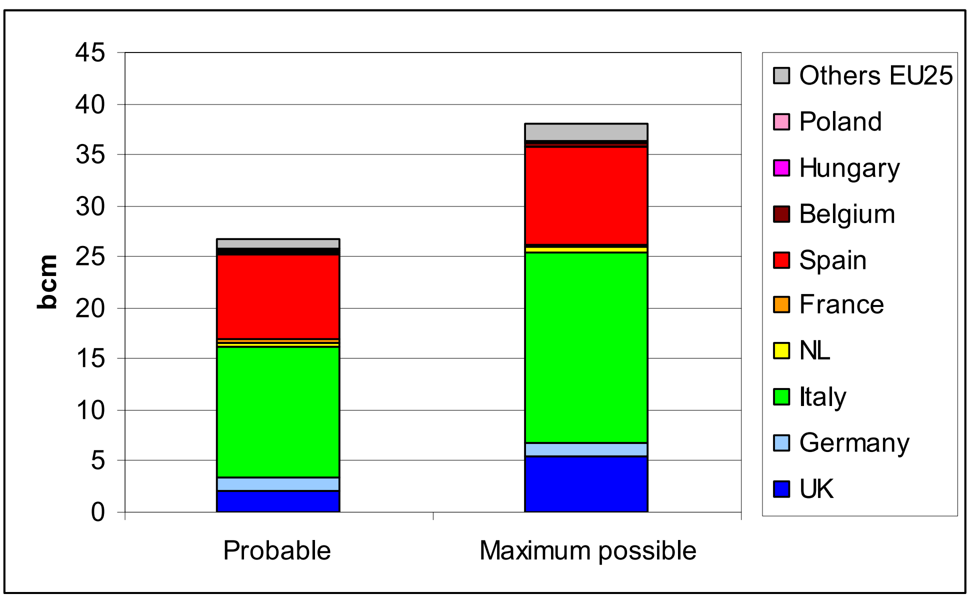
Gas-fired power plants will not run baseload in North-West continental Europe, nor in East Europe, mainly due to high gas prices. Baseload generation from gas is possible in the UK and in Southern European countries only.

Table 52: Increase in gas demand for the power generation sector between **2005 and 2010**, in bcm

	Probable	Maximum possible
UK	2.15	5.55
Germany	1.24	1.24
Italy	12.8	18.7
NL	0.41	0.41
France	0.31	0.31
Spain	8.31	9.59
Belgium	0.26	0.26
Hungary	0.2	0.2
Poland	0.06	0.06
Other EU25	1	1.8
TOTAL	26.74	38.12

Source: Author's assumptions

Figure 58: Increase in gas demand for the power generation sector between **2005 and 2010**, in bcm



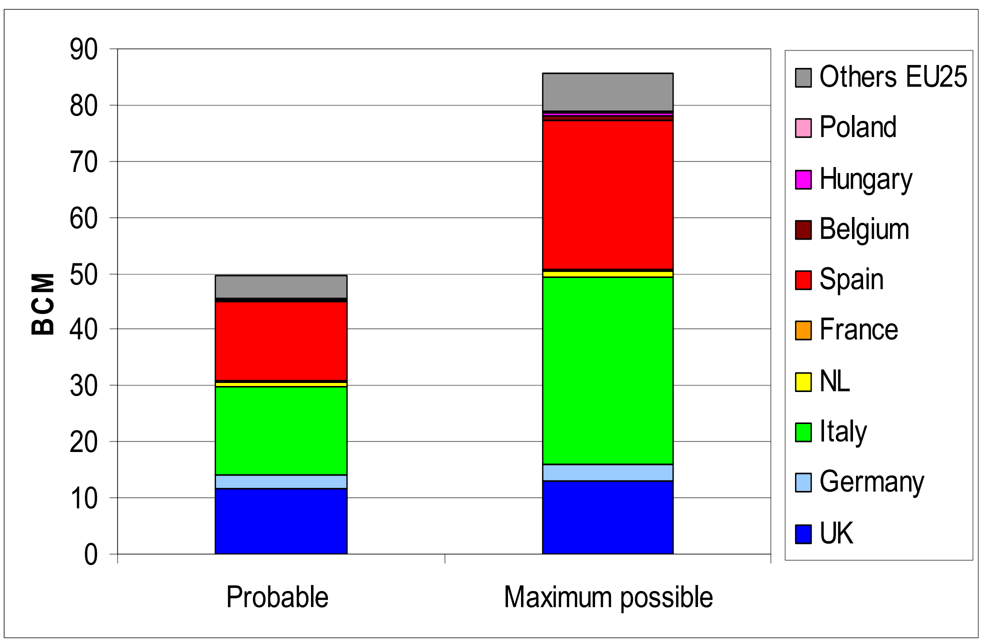
Source: Author's assumptions

Table 53: Increase in gas demand for the power generation sector between **2005 and 2015**, in bcm

	Probable	Maximum possible
UK	11.7	12.9
Germany	2.29	3.13
Italy	15.9	33.24
NL	0.7	1.2
France	0.3	0.3
Spain	14.01	26.61
Belgium	0.25	0.6
Hungary	0.27	0.62
Poland	0.06	0.16
Other EU25	4	7
TOTAL	49.48	86.36

Source: Author's assumptions

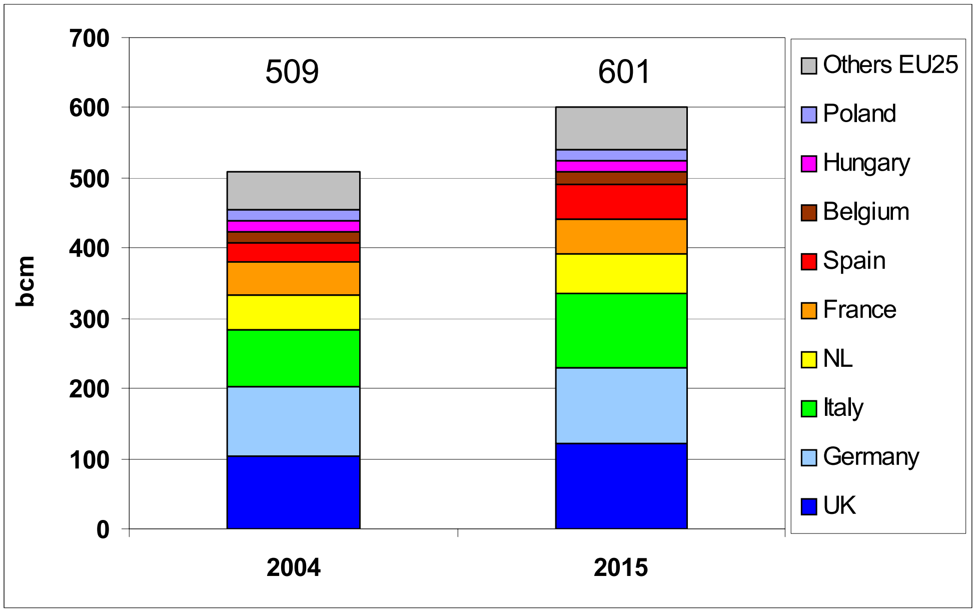
Figure 59: Increase in gas demand for the power generation sector between **2005 and 2015**, in bcm



Source: Author's assumptions

Increases in gas demand for the power generation sector in EU25 are highly sensitive to the development of gas-fired generation in three countries: Spain, Italy and to a lesser extent, the UK. The latter runs its gas-fired plants baseload, which explains the relatively high gas demand compared to the additional gas-fired capacity. These three countries alone account for 84 percent of the probable gas demand growth in the power generation sector in EU25 between 2005 and 2015. This raises the question as to where new gas supply is needed. UK requirements are already covered by projects under construction. The only other two markets where we see significant growth are Spain and Italy. But despite their increasing demand, they are already pretty well supply in terms of (planned) capacity.

Figure 60: Total gas demand by country in EU25 by 2015, in bcm



Source: Author's assumptions

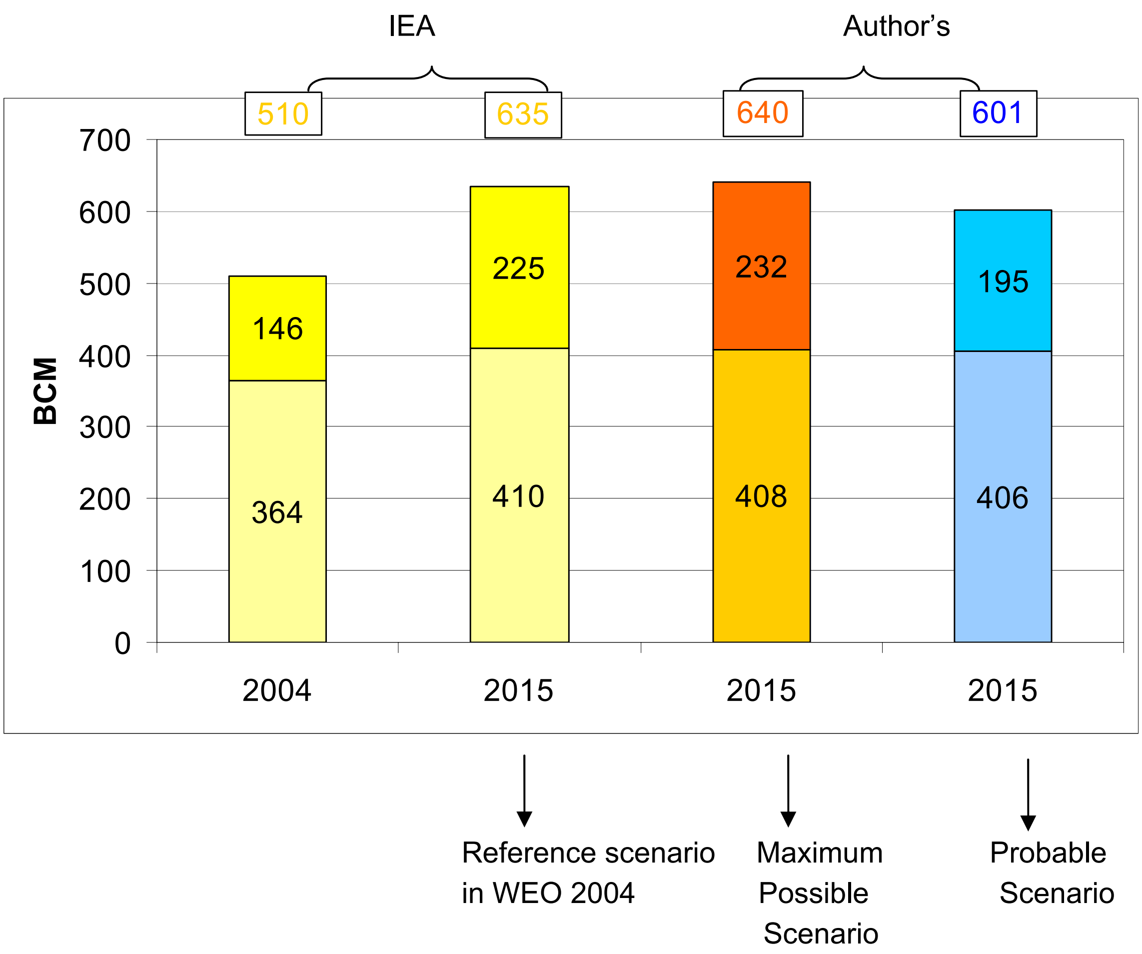
Table 54: Total gas demand by country in EU25 by 2015, in bcm

	Bcm		Increase
	2004	2015	(percent per year)
UK	102.6	120.7	1.5
Germany	99.4	108.07	0.76
Italy	80.6	107.1	2.63
NL	51.3	55.05	0.65
France	45.5	49.4	0.75
Spain	27	49.4	5.7
Belgium	17	18.4	0.7
Hungary	14.5	15.6	0.7
Poland	15.7	16.3	0.4
Others 25	55	60.9	0.9
TOTAL Gas Demand	509	601	1.5
SUB-TOTAL Gas for power	146	195	2.7
SUB-TOTAL Non-power	364	406	1

Source: Author's assumptions

It is not easy to compare scenarios published by different organisations because of differences in definitions, regional groupings, time frame, conversion factors, and efficiency assumptions. However, our preliminary conclusions are a little less optimistic than other publicly available projections of gas demand. Compared with the IEA, our most probable scenario is 30 bcm less for the power generation sector by 2015. Our forecasts for the non-power sector are relatively similar (only 4 bcm less in our forecasts). Figure 61 shows our projections and the IEA projections.

Figure 61: IEA and author's gas demand forecasts for EU25 by 2015



Source: IEA *World Energy Outlook 2004*, Author's assumptions

The impact of continued high gas prices is still not known, and the projections of gas demand for power remain relatively optimistic. Even our own scenarios could be too optimistic if gas prices remain at 2005 levels; therefore, we will up-date our scenarios on gas demand in 2006. The lower levels of gas demand in Europe – at least up to 2015 – which have been anticipated in this study should cause all market players to adjust their future plans and recheck the viability of their investment programmes.

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APPENDIX 1: CONVERSION FACTORS

The tables below present the conversion factors for 100MW of gas-fired capacity for one year of production.

The amounts of gas are in bcm.

	Load factors					
Efficiency	**75%**	**70%**	**65%**	**60%**	**55%**	**50%**
58%	0.111	0.106	0.096	0.089		
55%					0.085	0.08
52%						
48%	0.135	0.128	0.116	0.11	0.098	0.086
40%	0.165	0.151	0.14	0.13	0.12	0.115

	Load factors					
Efficiency	**45%**	**40%**	**35%**	**30%**	**25%**	**20%**
58%						
55%	0.072	0.066	0.055			
52%				0.05	0.04	0.032
48%	0.082	0.071	0.062	0.052	0.045	0.035
40%	0.1	0.088	0.072	0.062	0.052	0.041

APPENDIX 2: ADDITIONAL GAS-FIRED CAPACITY BY 2015

Table A1: Gas-fired power plants projects in Europe 35, at different stages of development
Potential additional capacity in MW, as of September 2005

	Recently operational / under construction	Approved	Applied / Planned	Total
UK	2020	3351	7298	12669
Germany	2787	1200	6180	10167
Italy	19703	9147	13136	41986
NL	795	0	1500	2295
France	1048	0	2136	3184
Spain	12780	1970	24220	38970
Belgium	505	0	700	1205
Hungary	387	0	835	1222
Poland	190	0	300	490
Total big 9	**40215**	**15668**	**56305**	**112188**
Czech Republic	0	0	45	45
Austria	0	0	1200	1200
Slovakia	0	0	785	785
Denmark	0	0	0	0
Finland	0	100	0	100
Ireland	550	400	0	950
Portugal	1200	0	2810	4010
Lithuania	0	0	485	485
Greece	390	4110	800	5300
Latvia	190	0	420	610
Luxembourg	0	0	0	0
Slovenia	86	0	1266	1352
Sweden	260	0	400	660
Estonia	0	0	0	0
Cyprus	0	0	200	200
Malta	0	0	0	0
Total EU25	**42891**	**20278**	**64716**	**127885**
Turkey	n-a	n-a	n-a	n-a
Romania	186	0	858	1044
Norway	400	800	1140	2340
Bulgaria	18	0	235	253
Switzerland	0	0	0	0
Croatia	0	0	350	350
Serbia and Montenegro	0	0	0	0
Bosnia and Herzegovina	0	0	0	0
Albania	0	0	0	0
Rpc of Macedonia	0	0	410	410
TOTAL Europe 35	**43495**	**21078**	**67709**	**132282**

Source: Platts *Power in Europe* and *Energy in East Europe;* Governments

Table A2: Author's scenarios for potential additional gas-fired capacity in Europe 35 by 2015, in MW, as of September 2005

	2005-2010		2010-2015		2005-2015	
	Probable	Possible	Probable	Maximum Possible	Probable	Maximum Possible
UK	2020	5371	9491	10649	11511	12669
Germany	3987	3987	3380	6180	7367	10167
Italy	19703	28850	4890	22283	24,593	41,986
NL	795	795	300	1500	1095	2295
France	660	660	0	2136	660	2796
Spain	12780	14750	8770	26190	21150	38970
Belgium	505	505	0	700	505	1205
Hungary	387	387	150	835	536.5	1221.5
Poland	190	190	0	300	190	490
Total big 9	**41027**	**55495**	**26981**	**70773**	**67608**	**111800**
Czech Republic	0	0	0	45	0	40
Austria	0	0	0	1200	0	1200
Slovakia	0	0	0	785	0	785
Denmark	0	0	0	0	0	0
Finland	0	100	0	0	0	100
Ireland	550	950	0	0	550	950
Portugal	1200	1200	1220	2810	2420	4010
Lithuania	0	0	0	485	0	485
Greece	390	4500	4110	4910	4500	5300
Latvia	190	190	0	420	190	610
Luxembourg	0	0	0	0	0	0
Slovenia	86	86	0	1266	86	1352
Sweden	260	260	0	400	260	660
Estonia	0	0	0	0	0	0
Cyprus	0	0	0	200	0	200
Malta	0	0	0	0	0	0
Total EU25	**43703**	**62781**	**32311**	**83294**	**75614**	**127492**
Turkey	n-a	n-a	n-a	n-a	n-a	n-a
Romania	186	186	0	858	186	1044
Norway	400	1200	800	1940	1200	2340
Bulgaria	18	18	0	235	18	253
Switzerland	0	0	0	0	0	0
Croatia	0	350	0	0	0	350
Serbia and Montenegro	0	0	0	0	0	0
Bosnia and Herzegovina	0	0	0	0	0	0
Albania	0	0	0	0	0	0
Rpc of Macedonia	0	0	0	410	0	410
TOTAL Europe 35	**44307**	**64535**	**33111**	**86737**	**77018**	**131889**

Source: Author's assumptions

APPENDIX 3: ADDITIONAL GAS DEMAND IN THE POWER GENERATION SECTOR (2005−2015)

Table A3: Additional gas demand in the power sector, calculated from the potential additional gas-fired capacity (as of Sept. 2005), at different load factors, **2005–2010**, in bcm

Scenarios	Probable			Possible		
Load Factors	**75%**	**50%**	**20%**	**75%**	**50%**	**20%**
UK	2.34	1.57	0.62	5.95	4.12	1.63
Germany	4.75	3.12	1.24	4.75	3.12	1.24
Italy	21.08	14.97	5.91	30.87	22.05	8.96
NL	1.03	0.64	0.25	1.03	0.64	0.25
France	0.71	0.50	0.20	0.71	0.50	0.20
Spain	13.67	9.71	3.83	15.78	11.21	4.43
Belgium	0.66	0.40	0.16	0.66	0.40	0.16
Hungary	0.46	0.30	0.12	0.46	0.30	0.12
Poland	0.25	0.15	0.06	0.25	0.15	0.06
TOTAL big 9	**44.95**	**31.37**	**12.40**	**60.45**	**42.50**	**17.05**
Czech Republic	0.00	0.00	0.00	0.07	0.05	0.02
Austria	0.00	0.00	0.00	0.00	0.00	0.00
Slovakia	0.00	0.00	0.00	0.00	0.00	0.00
Denmark	0.00	0.00	0.00	0.00	0.00	0.00
Finland	0.00	0.00	0.00	0.11	0.08	0.03
Ireland	0.62	0.42	0.17	1.05	0.73	0.29
Portugal	1.28	0.91	0.36	1.28	0.91	0.36
Lithuania	0.00	0.00	0.00	0.00	0.00	0.00
Greece	0.51	0.31	0.12	5.11	3.44	1.36
Latvia	0.25	0.15	0.06	0.25	0.15	0.06
Luxembourg	0.00	0.00	0.00	0.00	0.00	0.00
Slovenia	0.11	0.07	0.03	0.11	0.07	0.03
Sweden	0.34	0.21	0.08	0.34	0.21	0.08
Estonia	0.00	0.00	0.00	0.00	0.00	0.00
Cyprus	0.00	0.00	0.00	0.00	0.00	0.00
Malta	0.00	0.00	0.00	0.00	0.00	0.00
Total EU25	**48.06**	**33.45**	**13.23**	**68.77**	**48.12**	**19.28**
Turkey *	7.10	7.10	7.10	7.10	7.10	7.10
Romania	0.24	0.15	0.06	0.24	0.15	0.06
Norway	0.43	0.30	0.12	1.28	0.91	0.36
Bulgaria	0.02	0.01	0.01	0.02	0.01	0.01
Switzerland	0.00	0.00	0.00	0.00	0.00	0.00
Croatia	0.00	0.00	0.00	0.37	0.27	0.11
Serbia and Montenegro	0.00	0.00	0.00	0.00	0.00	0.00
Bosnia and Herzegovina	0.00	0.00	0.00	0.00	0.00	0.00
Albania	0.00	0.00	0.00	0.00	0.00	0.00
Rpc of Macedonia	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL 35	**55.85**	**41.02**	**20.51**	**77.79**	**56.56**	**26.91**

* Not based on the same methodology. Sources: EMRA and Author's Assumptions

Table A4: Additional gas demand in the power sector, calculated from the potential additional gas-fired capacity (as of Sept. 2005), at different load factors, **2010-2015**, in bcm

Scenarios	Low			High		
Load Factors	**75%**	**50%**	**20%**	**75%**	**50%**	**20%**
UK	10.21	7.22	2.85	11.55	8.14	3.21
Germany	3.82	2.66	1.05	6.81	4.79	1.89
Italy	5.23	3.84	1.78	23.84	17.06	6.99
NL	0.82	0.54	0.22	1.67	1.15	0.46
France	0.00	0.00	0.00	2.29	1.62	0.64
Spain	6.82	4.84	1.91	26.74	18.99	7.50
Belgium	0.00	0.00	0.00	0.75	0.53	0.21
Hungary	0.17	0.12	0.05	0.98	0.65	0.26
Poland	0.00	0.00	0.00	0.39	0.24	0.10
TOTAL big 9	**27.07**	**19.23**	**7.85**	**75.03**	**53.17**	**21.26**
Czech Republic	0.00	0.00	0.00	0.00	0.00	0.00
Austria	0.00	0.00	0.00	1.38	0.93	0.37
Slovakia	0.00	0.00	0.00	0.84	0.60	0.24
Denmark	0.00	0.00	0.00	0.00	0.00	0.00
Finland	0.00	0.00	0.00	0.00	0.00	0.00
Ireland	0.00	0.00	0.00	0.00	0.00	0.00
Portugal	1.31	0.93	0.37	3.01	2.14	0.84
Lithuania	0.00	0.00	0.00	0.62	0.39	0.15
Greece	4.60	3.12	1.23	5.46	3.73	1.47
Latvia	0.00	0.00	0.00	0.55	0.34	0.13
Luxembourg	0.00	0.00	0.00	0.00	0.00	0.00
Slovenia	0.00	0.00	0.00	1.55	1.00	0.40
Sweden	0.00	0.00	0.00	0.43	0.30	0.12
Estonia	0.00	0.00	0.00	0.00	0.00	0.00
Cyprus	0.00	0.00	0.00	0.21	0.15	0.06
Malta	0.00	0.00	0.00	0.00	0.00	0.00
Total EU25	**32.97**	**23.28**	**9.45**	**89.07**	**62.74**	**25.04**
Turkey *	5.00	5.00	5.00	5.00	5.00	5.00
Romania	0.00	0.00	0.00	1.12	0.69	0.27
Norway	0.86	0.61	0.24	1.28	0.88	0.35
Bulgaria	0.00	0.00	0.00	0.31	0.19	0.08
Switzerland	0.00	0.00	0.00	0.00	0.00	0.00
Croatia	0.00	0.00	0.00	0.00	0.00	0.00
Serbia and Montenegro	0.00	0.00	0.00	0.00	0.00	0.00
Bosnia and Herzegovina	0.00	0.00	0.00	0.00	0.00	0.00
Albania	0.00	0.00	0.00	0.00	0.00	0.00
Rpc of Macedonia	0.00	0.00	0.00	0.48	0.32	0.13
TOTAL 35 (- Turkey)	**38.83**	**28.88**	**14.69**	**97.26**	**69.81**	**30.87**

* Not based on the same methodology.
Sources: EMRA and Author's Assumptions

Table A5: Additional gas demand in the power sector, calculated from the potential additional gas-fired capacity (as of Sept. 2005), at different load factors, **2005–2015**, in bcm

Scenarios	Low			High		
Load Factors	**75%**	**50%**	**20%**	**75%**	**50%**	**20%**
UK	12.55	8.79	3.47	13.89	9.70	3.84
Germany	8.56	5.78	2.29	11.56	7.91	3.13
Italy	26.31	18.81	7.69	44.93	32.03	12.90
NL	1.85	1.18	0.47	2.71	1.79	0.71
France	0.71	0.50	0.20	2.99	2.12	0.84
Spain	20.49	14.55	5.75	40.41	28.71	11.33
Belgium	0.66	0.40	0.16	1.41	0.94	0.37
Hungary	0.64	0.42	0.17	1.45	0.95	0.38
Poland	0.25	0.15	0.06	0.64	0.39	0.16
TOTAL big 9	**72.02**	**50.60**	**20.26**	**119.98**	**84.55**	**33.66**
Czech Republic	0.00	0.00	0.00	0.07	0.05	0.02
Austria	0.00	0.00	0.00	1.38	0.93	0.37
Slovakia	0.00	0.00	0.00	0.84	0.60	0.24
Denmark	0.00	0.00	0.00	0.00	0.00	0.00
Finland	0.00	0.00	0.00	0.11	0.08	0.03
Ireland	0.62	0.42	0.17	1.05	0.73	0.29
Portugal	2.59	1.84	0.73	4.29	3.05	1.20
Lithuania	0.00	0.00	0.00	0.62	0.39	0.15
Greece	5.11	3.44	1.36	5.96	4.04	1.60
Latvia	0.25	0.15	0.06	0.79	0.49	0.20
Luxembourg	0.00	0.00	0.00	0.00	0.00	0.00
Slovenia	0.11	0.07	0.03	1.66	1.06	0.42
Sweden	0.34	0.21	0.08	0.77	0.51	0.20
Estonia	0.00	0.00	0.00	0.00	0.00	0.00
Cyprus	0.00	0.00	0.00	0.21	0.15	0.06
Malta	0.00	0.00	0.00	0.00	0.00	0.00
Total EU25	**81.03**	**56.73**	**22.68**	**137.74**	**96.62**	**38.44**
Turkey *	12.10	12.10	12.10	12.10	12.10	12.10
Romania	0.24	0.15	0.06	1.36	0.84	0.33
Norway	1.28	0.91	0.36	2.57	1.79	0.71
Bulgaria	0.02	0.01	0.01	0.00	0.00	0.00
Switzerland	0.00	0.00	0.00	0.00	0.00	0.00
Croatia	0.00	0.00	0.00	0.37	0.27	0.11
Serbia and Montenegro	0.00	0.00	0.00	0.00	0.00	0.00
Bosnia and Herzegovina	0.00	0.00	0.00	0.00	0.00	0.00
Albania	0.00	0.00	0.00	0.00	0.00	0.00
Rpc of Macedonia	0.00	0.00	0.00	0.48	0.32	0.13
TOTAL 35 (- Turkey)	**94.68**	**69.90**	**35.20**	**154.62**	**111.93**	**51.81**

* Not based on the same methodology.
Sources: EMRA and Author's Assumptions

APPENDIX 4: TOTAL GAS DEMAND IN EUROPE (2005−2015)

Methodology: In the IEA *Natural Gas Information 2005*, gas consumption in 2004 is only available for the total gas demand, with no sector-by-sector breakdown. We had to calculate the demand by sector from the 2003 data. We apply a percentage[16] of increase for the non-power sector to find to gas consumption in the non-power sector for 2004. We then subtract this number to the total gas consumption to find the gas demand in the power sector in 2004.

Power sector: The additional gas demand in the power sector is calculated from the potential additional gas-fired capacity that could be in full production by 2010 and by 2015, and operated by the utilities. We are not taking into account the additional gas demand in the power sector by the auto-producers.

Auto-producers represented about 20 percent of the gas demand in the "IEA power generation sector" in EU25 in 2004. This share has been relatively stable since 1990. Their gas consumption is important in three main countries: Germany (34 percent of the total gas demand for the power generation sector), Italy (22 percent) and the UK (20 percent). We have no indication on the future evolution of this demand.

In EU25, if the share of the gas consumed by the auto-producers remains roughly the same than in 2003 (about 20 percent of the total gas demand for the power sector), the auto-producers would consume about 15 bcm more in 2015 than in 2004.
These 15 bcm are not counted in our total gas demand in EU25 by 2015 shown in the table A6.

Turkey: the increase in gas demand for Turkey is based on EMRA data.

In the following pages (pp 96-103), **Table A6** shows the total gas demand in Europe 35 (on a country by country basis) by 2010 and by 2015, in bcm.
- The probable scenario and the maximum possible scenario for the power sector are presented at different load factors.
- The non-power sector is included.

[16] See table pp 96-103

Period		2004	2010						2015					
Scenario		IEA data (+OIES update)	Probable			Possible			Probable			All projects		
Load Factor			75%	50%	20%	75%	50%	20%	75%	50%	20%	75%	50%	20%
UK														
	Power sector	33.2	35.5	34.8	33.8	39.1	37.3	34.8	45.8	42.0	36.7	47.1	42.9	37.0
	Non-Power sector (0.8%/y)	69.4	72.8	72.8	72.8	72.8	72.8	72.8	75.8	75.8	75.8	75.8	75.8	75.8
	Non-Power sector (1%/y)	69.4	73.7	73.7	73.7	73.7	73.7	73.7	77.4	77.4	77.4	77.4	77.4	77.4
	TOTAL (with Non-Power 0.8%/y)	**102.6**	**108.3**	**107.6**	**106.6**	**111.9**	**110.1**	**107.6**	**121.6**	**117.8**	**112.5**	**122.9**	**118.7**	**112.8**
	TOTAL (with Non-Power 1%/y)	**102.6**	**109.2**	**108.5**	**107.5**	**112.8**	**111.0**	**108.5**	**123.2**	**119.4**	**114.1**	**124.5**	**120.3**	**114.4**
Germany														
	Power sector	20.7	25.4	23.8	21.9	25.4	23.8	21.9	29.3	26.5	23.0	32.3	28.6	23.8
	Non-Power sector (0.8%/y)	78.7	82.6	82.6	82.6	82.6	82.6	82.6	85.9	85.9	85.9	85.9	85.9	85.9
	Non-Power sector (1%/y)	78.7	83.7	83.7	83.7	83.7	83.7	83.7	88.0	88.0	88.0	88.0	88.0	88.0
	TOTAL (with Non-Power 0.8%/y)	**99.4**	**108.0**	**106.4**	**104.5**	**108.0**	**106.4**	**104.5**	**115.2**	**112.4**	**108.9**	**118.2**	**114.5**	**109.7**
	TOTAL (with Non-Power 1%/y)	**99.4**	**109.1**	**107.5**	**105.6**	**109.1**	**107.5**	**105.6**	**117.3**	**114.5**	**111.0**	**120.3**	**116.6**	**111.8**
Italy														
	Power sector	28.21	49.3	43.2	34.1	59.1	50.3	37.2	54.5	47.0	35.9	73.1	60.2	41.1
	Non-Power sector (1%/y)	52.4	55.3	55.3	55.3	55.3	55.3	55.3	58.1	58.1	58.1	58.1	58.1	58.1
	Non-Power sector (1.5%/y)	52.4	57.3	57.3	57.3	57.3	57.3	57.3	61.7	61.7	61.7	61.7	61.7	61.7
	TOTAL (with Non-Power 1%/y)	**80.61**	**104.6**	**98.5**	**89.4**	**114.4**	**105.6**	**92.5**	**112.6**	**105.1**	**94.0**	**131.2**	**118.3**	**99.2**
	TOTAL (with non-Power 1.5%/y)	**80.61**	**106.6**	**100.5**	**91.4**	**116.4**	**107.6**	**94.5**	**116.2**	**108.7**	**97.6**	**134.8**	**121.9**	**102.8**
NL														
	Power sector	16.8	17.8	17.4	17.1	17.8	17.4	17.1	18.7	18.0	17.3	19.5	18.6	17.5
	Non-Power sector (0.8%/y)	34.5	36.2	36.2	36.2	36.2	36.2	36.2	37.7	37.7	37.7	37.7	37.7	37.7
	Non-Power sector (1%/y)	34.5	36.7	36.7	36.7	36.7	36.7	36.7	38.6	38.6	38.6	38.6	38.6	38.6
	TOTAL (with Non-Power 0.8%/y)	**51.3**	**54.0**	**53.6**	**53.3**	**54.0**	**53.6**	**53.3**	**56.4**	**55.7**	**55.0**	**57.2**	**56.3**	**55.2**
	TOTAL (with Non-Power 1%/y)	**51.3**	**54.5**	**54.1**	**53.8**	**54.5**	**54.1**	**53.8**	**57.3**	**56.6**	**55.9**	**58.1**	**57.2**	**56.1**

Period		2004	2010						2015					
Scenario		**IEA data (+OIES update)**	**Probable**			**Possible**			**Probable**			**All projects**		
Load Factor			**75%**	**50%**	**20%**	**75%**	**50%**	**20%**	**75%**	**50%**	**20%**	**75%**	**50%**	**20%**
France														
	Power sector	4.7	5.8	5.5	5.0	5.8	5.5	5.0	5.8	5.5	5.0	8.1	7.1	5.7
	Non-Power sector (0.8%/y)	40.8	42.7	42.7	42.7	42.7	42.7	42.7	44.5	44.5	44.5	44.5	44.5	44.5
	Non-Power sector (1%/y)	40.8	43.3	43.3	43.3	43.3	43.3	43.3	45.6	45.6	45.6	45.6	45.6	45.6
	TOTAL (with Non-Power 0.8%/y)	**45.5**	**48.5**	**48.2**	**47.7**	**48.5**	**48.2**	**47.7**	**50.3**	**50.0**	**49.5**	**52.6**	**51.6**	**50.2**
	TOTAL (with Non-Power 1%/y)	**45.5**	**49.1**	**48.8**	**48.3**	**49.1**	**48.8**	**48.3**	**51.4**	**51.1**	**50.6**	**53.7**	**52.7**	**51.3**
Spain														
	Power sector	8.9	22.6	18.6	12.7	24.7	20.1	13.3	29.4	23.5	14.6	49.3	37.6	20.2
	Non-Power sector (4%/y)	18.1	22.9	22.9	22.9	22.9	22.9	22.9	27.8	27.8	27.8	27.8	27.8	27.8
	Non-Power sector (4.5%/y)	18.1	23.6	23.6	23.6	23.6	23.6	23.6	29.5	29.5	29.5	29.5	29.5	29.5
	TOTAL (with Non-Power 4%/y)	**27**	**45.5**	**41.5**	**35.6**	**47.6**	**43.0**	**36.2**	**57.2**	**51.3**	**42.4**	**77.1**	**65.4**	**48.0**
	TOTAL (with Non-Power 4.5%/y)	**27**	**46.2**	**42.2**	**36.3**	**48.3**	**43.7**	**36.9**	**58.9**	**53.0**	**44.1**	**78.8**	**67.1**	**49.7**
Belgium														
	Power sector	4.5	5.2	4.9	4.7	5.2	4.9	4.7	5.2	4.9	4.7	5.9	5.4	4.9
	Non-Power sector (0.8%/y)	12.5	13.1	13.1	13.1	13.1	13.1	13.1	13.6	13.6	13.6	13.6	13.6	13.6
	Non-Power sector (1%/y)	12.5	13.3	13.3	13.3	13.3	13.3	13.3	13.9	13.9	13.9	13.9	13.9	13.9
	TOTAL (with Non-Power 0.8%/y)	**17**	**18.2**	**18.0**	**17.7**	**18.2**	**18.0**	**17.7**	**18.8**	**18.5**	**18.3**	**19.5**	**19.0**	**18.5**
	TOTAL (with Non-Power 1%/y)	**17**	**18.5**	**18.2**	**18.0**	**18.5**	**18.2**	**18.0**	**19.1**	**18.8**	**18.6**	**19.8**	**19.3**	**18.8**
Hungary														
	Power sector	4.16	4.6	4.5	4.3	4.6	4.5	4.3	4.8	4.6	4.3	5.6	5.1	4.5
	Non-Power sector (0.8%/y)	10.3	10.8	10.8	10.8	10.8	10.8	10.8	11.2	11.2	11.2	11.2	11.2	11.2
	Non-Power sector (1%/y)	10.3	10.9	10.9	10.9	10.9	10.9	10.9	11.5	11.5	11.5	11.5	11.5	11.5
	TOTAL (with Non-Power 0.8%/y)	**14.46**	**15.4**	**15.3**	**15.1**	**15.4**	**15.3**	**15.1**	**16.0**	**15.8**	**15.5**	**16.8**	**16.3**	**15.7**
	TOTAL (with Non-Power 1%/y)	**14.46**	**15.5**	**15.4**	**15.2**	**15.5**	**15.4**	**15.2**	**16.3**	**16.0**	**15.8**	**17.1**	**16.6**	**16.0**

Period		2004	2010						2015					
Scenario		**IEA data (+OIES update)**	**Probable**			**Possible**			**Probable**			**All projects**		
Load Factor			**75%**	**50%**	**20%**	**75%**	**50%**	**20%**	**75%**	**50%**	**20%**	**75%**	**50%**	**20%**
Poland														
	Power sector	1.6	1.8	1.8	1.7	1.8	1.8	1.7	1.8	1.8	1.7	2.2	2.0	1.8
	Non-Power sector (0.8%/y)	14.07	14.1	14.1	14.1	14.1	14.1	14.1	14.7	14.7	14.7	14.7	14.7	14.7
	Non-Power sector (1%/y)	14.07	14.3	14.3	14.3	14.3	14.3	14.3	15.0	15.0	15.0	15.0	15.0	15.0
	TOTAL (with Non-Power 0.8%/y)	**15.67**	**16.0**	**15.9**	**15.8**	**16.0**	**15.9**	**15.8**	**16.5**	**16.5**	**16.4**	**16.9**	**16.7**	**16.5**
	TOTAL (with Non-Power 1%/y)	**15.67**	**16.1**	**16.1**	**16.0**	**16.1**	**16.1**	**16.0**	**16.9**	**16.8**	**16.7**	**17.3**	**17.0**	**16.8**
Total big 9														
	Power	122.77	168.1	154.4	135.3	183.6	165.6	139.9	195.2	173.7	143.1	243.2	207.6	156.5
	Non-Power sector (low)	330.77	350.5	350.5	350.5	350.5	350.5	350.5	369.3	369.3	369.3	369.3	369.3	369.3
	Non-Power sector (high)	330.77	356.8	356.8	356.8	356.8	356.8	356.8	381.2	381.2	381.2	381.2	381.2	381.2
	TOTAL (with Non-Power low)	**453.54**	**518.6**	**504.9**	**485.8**	**534.1**	**516.1**	**490.4**	**564.5**	**543.0**	**512.5**	**612.5**	**576.9**	**525.9**
	TOTAL (with Non-Power high)	**453.54**	**524.9**	**511.2**	**492.1**	**540.4**	**522.4**	**496.7**	**576.4**	**554.9**	**524.4**	**624.4**	**588.8**	**537.8**

Period		2004	2010						2015					
Scenario		IEA data (+OIES update)	Probable			Possible			Probable			All projects		
Load Factor			75%	50%	20%	75%	50%	20%	75%	50%	20%	75%	50%	20%
Czech Rpc	Power	1.43	1.4	1.4	1.4	1.5	1.5	1.4	1.4	1.4	1.4	1.5	1.5	1.4
	Non-Power (1%/y)	8.17	8.7	8.7	8.7	8.7	8.7	8.7	9.1	9.1	9.1	9.1	9.1	9.1
	TOTAL	**9.6**	**10.1**	**10.1**	**10.1**	**10.2**	**10.1**	**10.1**	**10.6**	**10.6**	**10.6**	**10.6**	**10.6**	**10.6**
Austria	Power	2.99	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	4.4	3.9	3.4
	Non-Power (1%/y)	5.99	6.4	6.4	6.4	6.4	6.4	6.4	6.7	6.7	6.7	6.7	6.7	6.7
	TOTAL	**8.98**	**9.4**	**9.4**	**9.4**	**9.4**	**9.4**	**9.4**	**9.7**	**9.7**	**9.7**	**11.0**	**10.6**	**10.0**
Slovakia	Power	1.37	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	2.2	2.0	1.6
	Non-Power (1%/y)	5.35	5.7	5.7	5.7	5.7	5.7	5.7	6.0	6.0	6.0	6.0	6.0	6.0
	TOTAL	**6.72**	**7.1**	**7.1**	**7.1**	**7.1**	**7.1**	**7.1**	**7.3**	**7.3**	**7.3**	**8.2**	**7.9**	**7.6**
Denmark	Power	2.55	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
	Non-Power (1%/y)	2.62	2.8	2.8	2.8	2.8	2.8	2.8	2.9	2.9	2.9	2.9	2.9	2.9
	TOTAL	**5.17**	**5.3**	**5.3**	**5.3**	**5.3**	**5.3**	**5.3**	**5.5**	**5.5**	**5.5**	**5.5**	**5.5**	**5.5**
Finland	Power	3.52	3.5	3.5	3.5	3.6	3.6	3.6	3.5	3.5	3.5	3.6	3.6	3.6
	Non-Power (1%/y)	1.34	1.4	1.4	1.4	1.4	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.5
	TOTAL	**4.86**	**5.0**	**5.0**	**5.0**	**5.1**	**5.0**	**5.0**	**5.0**	**5.0**	**5.0**	**5.1**	**5.1**	**5.1**
Ireland	Power	2.74	3.4	3.2	2.9	3.8	3.5	3.0	3.4	3.2	2.9	3.8	3.5	3.0
	Non-Power (1%/y)	1.56	1.7	1.7	1.7	1.7	1.7	1.7	1.8	1.8	1.8	1.8	1.8	1.8
	TOTAL	**4.3**	**5.0**	**4.8**	**4.6**	**5.5**	**5.1**	**4.7**	**5.1**	**4.9**	**4.7**	**5.6**	**5.2**	**4.8**
Portugal	Power	2.1	3.4	3.0	2.5	3.4	3.0	2.5	4.7	3.9	2.8	6.4	5.1	3.3
	Non-Power (3%/y)	1.46	1.7	1.7	1.7	1.7	1.7	1.7	2.0	2.0	2.0	2.0	2.0	2.0
	TOTAL	**3.74**	**5.1**	**4.8**	**4.2**	**5.1**	**4.8**	**4.2**	**6.7**	**6.0**	**4.8**	**8.4**	**7.2**	**5.3**

Period		2004	2010						2015					
Scenario		**IEA data (+OIES update)**	**Probable**			**Possible**			**Probable**			**All projects**		
Load Factor			**75%**	**50%**	**20%**	**75%**	**50%**	**20%**	**75%**	**50%**	**20%**	**75%**	**50%**	**20%**
Lithuania	Power	1.57	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	1.6	2.2	2.0	1.7
	Non-Power (1%/y)	1.37	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	TOTAL	**2.94**	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**	**3.0**	**3.1**	**3.1**	**3.1**	**3.7**	**3.5**	**3.3**
Greece	Power	1.75	2.3	2.1	1.9	6.9	5.2	3.1	6.9	5.2	3.1	7.7	5.8	3.3
	Non-Power (3%/y)	0.94	1.1	1.1	1.1	1.1	1.1	1.1	1.3	1.3	1.3	1.3	1.3	1.3
	TOTAL	**2.69**	**3.4**	**3.2**	**3.0**	**8.0**	**6.3**	**4.2**	**8.2**	**6.5**	**4.4**	**9.0**	**7.1**	**4.6**
Latvia	Power	1.11	1.4	1.3	1.2	1.4	1.3	1.2	1.4	1.3	1.2	1.9	1.6	1.3
	Non-Power (1%/y)	0.64	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
	TOTAL	**1.75**	**2.0**	**1.9**	**1.8**	**2.0**	**1.9**	**1.8**	**2.1**	**2.0**	**1.9**	**2.6**	**2.3**	**2.0**
Luxembourg	Power	0.64	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	Non-Power (1%/y)	0.72	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
	TOTAL	**1.36**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	**1.4**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**	**1.5**
Slovenia	Power	0.16	0.3	0.2	0.2	0.3	0.2	0.2	0.3	0.2	0.2	1.8	1.2	0.6
	Non-Power (1%/y)	0.94	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.1	1.1	1.1	1.1	1.1
	TOTAL	**1.1**	**1.3**	**1.2**	**1.2**	**1.3**	**1.2**	**1.2**	**1.3**	**1.3**	**1.2**	**2.9**	**2.3**	**1.6**
Sweden	Power	0.42	0.8	0.6	0.5	0.8	0.6	0.5	0.8	0.6	0.5	1.2	0.9	0.6
	Non-Power (1%/y)	0.56	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	TOTAL	**0.98**	**1.4**	**1.2**	**1.1**	**1.4**	**1.2**	**1.1**	**1.4**	**1.3**	**1.1**	**1.8**	**1.6**	**1.3**
Estonia	Power	0.42	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
	Non-Power (1%/y)	0.43	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
	TOTAL	**0.85**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**	**0.9**

Period		2004	2010						2015					
Scenario		**IEA data (+OIES update)**	**Probable**			**Possible**			**Probable**			**All projects**		
Load Factor			**75%**	**50%**	**20%**	**75%**	**50%**	**20%**	**75%**	**50%**	**20%**	**75%**	**50%**	**20%**
Cyprus	Power	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.1
	Non-Power	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOTAL	**0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.2**	**0.2**	**0.1**
Malta	Power	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Non-Power	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOTAL	**0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Total EU25	Power	145.54	194.0	179.3	158.9	214.7	194.0	164.9	227.0	202.6	168.3	283.7	242.4	184.1
	Non-Power sector (low)	362.86	384.9	384.9	384.9	384.9	384.9	384.9	405.8	405.8	405.8	405.8	405.8	405.8
	Non-Power sector (high)	362.86	391.2	391.2	391.2	391.2	391.2	391.2	417.7	417.7	417.7	417.7	417.7	417.7
	TOTAL (with Non-Power low)	**508.58**	**578.9**	**564.2**	**543.8**	**599.6**	**578.8**	**549.8**	**632.8**	**608.4**	**574.1**	**689.5**	**648.2**	**589.9**
	TOTAL (with Non-Power high)	**508.58**	**585.2**	**570.5**	**550.1**	**605.9**	**585.1**	**556.1**	**644.7**	**620.2**	**586.0**	**701.4**	**660.1**	**601.8**

Period		2004	2010						2015					
Scenario		**IEA data (+OIES update)**	**Probable**			**Possible**			**Probable**			**All projects**		
Load Factor			**75%**	**50%**	**20%**	**75%**	**50%**	**20%**	**75%**	**50%**	**20%**	**75%**	**50%**	**20%**
Turkey	Power	13.9	21.0	21.0	21.0	21.0	21.0	21.0	26.0	26.0	26.0	26.0	26.0	26.0
	Non-Power	8.5	20.7	20.7	20.7	20.7	20.7	20.7	25.9	25.9	25.9	25.9	25.9	25.9
	TOTAL	**22.44**	**41.7**	**41.7**	**41.7**	**41.7**	**41.7**	**41.7**	**51.9**	**51.9**	**51.9**	**51.9**	**51.9**	**51.9**
Romania	Power	6.2	6.4	6.3	6.3	6.4	6.3	6.3	6.4	6.3	6.3	7.6	7.0	6.5
	Non-Power (1%/y)	12.69	13.5	13.5	13.5	13.5	13.5	13.5	14.2	14.2	14.2	14.2	14.2	14.2
	TOTAL	**18.89**	**19.9**	**19.8**	**19.7**	**19.9**	**19.8**	**19.7**	**20.6**	**20.5**	**20.4**	**21.7**	**21.2**	**20.7**
Norway	Power	0.051	0.5	0.4	0.2	1.3	1.0	0.4	1.3	1.0	0.4	2.6	1.8	0.8
	Non-Power (1%/y)	5.5	5.9	5.9	5.9	5.9	5.9	5.9	6.2	6.2	6.2	6.2	6.2	6.2
	TOTAL	**5.55**	**6.4**	**6.2**	**6.1**	**7.2**	**6.9**	**6.3**	**7.5**	**7.2**	**6.6**	**8.8**	**8.0**	**6.9**
Bulgaria	Power	1.89	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	2.2	2.1	2.0
	Non-Power (1%/y)	1.88	2.0	2.0	2.0	2.0	2.0	2.0	2.1	2.1	2.1	2.1	2.1	2.1
	TOTAL	**3.77**	**3.9**	**3.9**	**3.9**	**3.9**	**3.9**	**3.9**	**4.0**	**4.0**	**4.0**	**4.3**	**4.2**	**4.1**
Switzerland	Power	0.32	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
	Non-Power (1%/y)	2.98	3.2	3.2	3.2	3.2	3.2	3.2	3.3	3.3	3.3	3.3	3.3	3.3
	TOTAL	**3.3**	**3.5**	**3.5**	**3.5**	**3.5**	**3.5**	**3.5**	**3.7**	**3.7**	**3.7**	**3.7**	**3.7**	**3.7**
Croatia	Power	0.49	0.5	0.5	0.5	0.9	0.8	0.6	0.5	0.5	0.5	0.9	0.8	0.6
	Non-Power (1%/y)	2.11	2.3	2.3	2.3	2.3	2.3	2.3	2.4	2.4	2.4	2.4	2.4	2.4
	TOTAL	**2.6**	**2.8**	**2.8**	**2.8**	**3.1**	**3.0**	**2.9**	**2.9**	**2.9**	**2.9**	**3.2**	**3.1**	**3.0**
Serbia and Montenegro	Power	0.71	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
	Non-Power (1%/y)	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.5	1.5	1.5	1.5	1.5	1.5
	TOTAL	**2.01**	**2.1**	**2.1**	**2.1**	**2.1**	**2.1**	**2.1**	**2.2**	**2.2**	**2.2**	**2.2**	**2.2**	**2.2**

Period		2004	2010						2015					
Scenario		IEA data (+OIES update)	Probable			Possible			Probable			All projects		
Load Factor			75%	50%	20%	75%	50%	20%	75%	50%	20%	75%	50%	20%
Bosnia and Herzegovina	Power	0.25	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
	Non-Power (1%/y)	0.37	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
	TOTAL	**0.62**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**	**0.7**
Albania	Power	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Non-Power	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOTAL	**0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Rpc of Macedonia	Power	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.3	0.1
	Non-Power	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	TOTAL	**0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.5**	**0.3**	**0.1**
Total Europe35	Power	169.351	225.6	210.7	190.0	247.6	226.2	196.4	264.4	239.5	204.7	324.7	281.8	221.4
	Non-Power sector (low)	398.19	434.2	434.2	434.2	434.2	434.2	434.2	461.8	461.8	461.8	461.8	461.8	461.8
	Non-Power sector (high)	398.19	440.5	440.5	440.5	440.5	440.5	440.5	473.6	473.6	473.6	473.6	473.6	473.6
	TOTAL (with Non-Power low)	**567.76**	**659.8**	**644.8**	**624.1**	**681.7**	**660.4**	**630.5**	**726.2**	**701.3**	**666.4**	**786.5**	**743.5**	**683.1**
	TOTAL (with Non-Power high)	**567.76**	**666.1**	**651.1**	**630.4**	**688.0**	**666.7**	**636.8**	**738.1**	**713.2**	**678.3**	**798.4**	**755.4**	**695.0**

Source: Author's assumptions