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INGENIERO INDUSTRIAL

PROYECTO FIN DE CARRERA

ANÁLISIS DE LA INTEGRACIÓN VERTICAL ENTRE LOS MERCADOS DE ELECTRICIDAD Y GAS

AUTOR: PATRICIA BLANCO FERNÁNDEZ

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Autorizada la entrega del proyecto al alumno:

Patricia Blanco Fernández

EL DIRECTOR DEL PROYECTO

Julián Barquín Gil

Fdo: Fecha:

Vº Bº del Coordinador de Proyectos

Tomás Gómez San Román

Fdo: Fecha:

Resumen

Recientes sucesos empresariales relacionados con la fusión de compañías de energía (Gas Natural- Endesa, E.ON – Endesa, Suez – Gaz de France, ...) han sido objeto de intenso debate. De los muchos temas en discusión, existe uno que, hasta el momento, no ha recibido excesiva atención en la literatura: los problemas de competencia derivados de realizar actividades de forma simultánea en los mercados de electricidad y gas.

El objeto principal del proyecto es analizar un modelo de equilibrio conjunto de electricidad y gas que permita cuantificar los incentivos que los agentes pudieran percibir para hacer uso de un posible poder de mercado, influyendo en el precio de la electricidad utilizando sus decisiones en el mercado del gas. Específicamente, se busca la consecución de los siguientes objetivos parciales:

1. Estudio de los problemas de competencia posibles en los mercados convergentes de gas y electricidad.
2. Estudio y clasificación del estado del arte en la simulación de mercados convergentes de gas y electricidad.
3. Planteamiento de un modelo conceptual de análisis de mercado.
4. Realización de un análisis con parámetros numéricos que se ajuste al modelo conceptual.
5. Análisis de los resultados obtenidos y conclusiones

El proyecto, por lo tanto, consta de dos partes diferenciadas.

En primer lugar se incluye una fase teórica, donde se ha estudiado la literatura relevante y se han extraído diversas conclusiones, que se presentan en los primeros capítulos de este proyecto. En concreto:

- Se ha caracterizado el mercado eléctrico y gasístico español.
- Se ha estudiado y diferenciado el mercado internacional del mercado doméstico, con los tipos de contratos que rigen sus transacciones.
- Se mencionan las distintas instituciones españolas y europeas relevantes en la toma de decisiones de este tipo de fusiones y los problemas de competitividad

que estudian para su toma de decisiones, así como las herramientas de simulación que tienen a su disposición.

- Se ha caracterizado la integración vertical con las teorías de diversos autores relevantes, derivadas de la teoría económica industrial, teoría de juegos y optimización.
- Se describe el cierre de mercado, la mayor amenaza competitiva en este tipo de fusiones que incluyen integración vertical, y se enumeran las posibilidades de reducirla o eliminarla.
- Se analizaron dos modelos de simulación existentes hasta la fecha que integran el mercado eléctrico con el gasístico, así como un modelo exclusivo de gas, comentando sus hipótesis de trabajo y sus distintas conclusiones extraídas.

En segundo lugar, se realizó un análisis conceptual y numérico de la situación posible ante una fusión del tipo Gas Natural – Endesa, en la que se integran activos de gas y de electricidad. Para ello, se utilizó el programa Marape, desarrollado en el IIT, de simulación de mercados eléctricos. El modelo se utilizó en condiciones de competencia perfecta, de inexistencia de mercados de emisión de gases de efecto de invernadero o mecanismos similares, e inexistencia de congestiones de transporte. El horizonte de análisis fue anual, dividido en bloques de diez horas de duración.

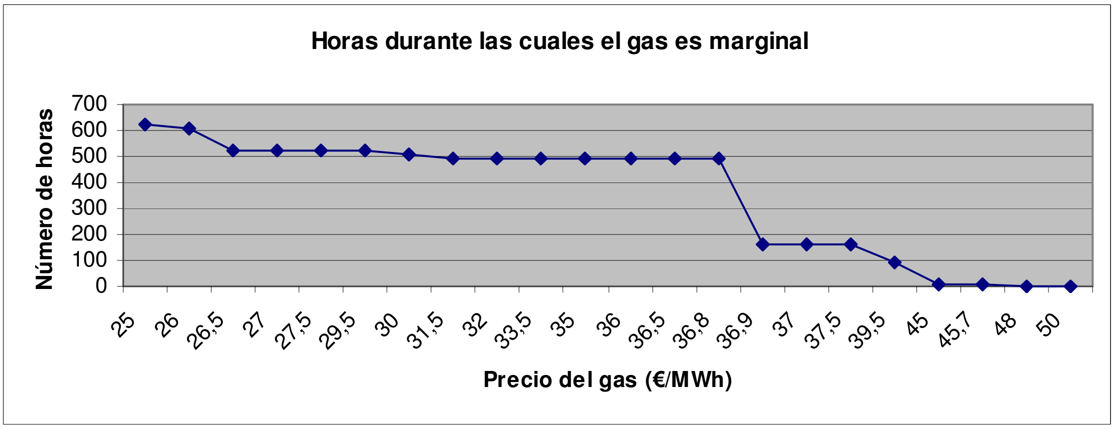
La existencia de poder de mercado por parte del principal agente gasista se podría manifestar mediante precios del gas doméstico distintos y superiores al precio de mercado internacional. Por tanto, se han analizado diferentes escenarios de precios domésticos del gas, para simular el poder de mercado del nuevo ente, y se han analizado las consecuencias que esto supone en el mercado eléctrico. Esto ha constituido la última parte del proyecto, la caracterización de los efectos oligopolistas de la integración vertical, proporcionando cierta descripción de las nuevas estrategias que se pueden esperar en futuros casos.

Mediante el análisis con Marape, se obtuvieron tres curvas que resumen la respuesta del mercado eléctrico:

- Número de horas en las cuales las plantas de ciclo combinado que producen electricidad gracias al gas como materia prima son marginales, es decir, marcan el precio de coste de las demás tecnologías.

- Cantidad de electricidad (en MWh) producida por estas plantas durante esas determinadas horas.
- Cantidad de electricidad en (MWh) producida por las plantas térmicas inframarginales que operan durante esas horas bajo los ciclos combinados.

La primera curva resultó fundamental para la determinación de los puntos de estudio, por lo que se incluye a continuación:



A la vista de esta gráfica, se puede apreciar la existencia de cuatro zonas diferenciadas que se corresponden a diferentes órdenes de mérito de las tecnologías de generación. Por ello se decidió analizar cuatro casos representativos correspondientes a precios de 26, 27’5, 36’5 y 37’5 €/MWh. Para cada uno de estos precios se valoraron los beneficios de las diferentes plantas de generación. A partir de estos datos se calculó el beneficio de operación de una hipotética compañía que poseyera una fracción dada (0, 5, 10, …, 100%) de la capacidad total de generación. Dicho beneficio es una función creciente del precio doméstico del gas hasta el momento en que estas plantas dejan de ser marginales, debido al mayor precio cobrado por las centrales inframarginales.

Para analizar la respuesta en el mercado del gas se utilizaron dos parámetros. El primero es la elasticidad de la demanda no eléctrica de gas natural. El segundo, el nivel de contratación a largo plazo de esta demanda, que varía de 0 (ninguna contratación a largo) a 1 (todo el consumo está contratado a largo plazo). Dicha contratación a largo plazo representa los contratos propiamente dichos así como posibles consideraciones regulatorias o de política estratégica.

Debido al incremento de gas doméstico, Gas Natural podría tener dos fuentes de coste adicional:

1. El debido a una menor demanda de gas no doméstico, decremento que depende de la elasticidad y del nivel de contratación a largo.
2. El debido a la competencia adicional por la parte de gas que, debido a su precio doméstico más atractivo, las demás empresas eléctricas no emplean en sus plantas de generación, sino que venden a otros clientes. Nótese que existe aquí una hipótesis: que las empresas eléctricas se suministran con contratos de largo plazo y no son capaces de importar gas adicional. Estas hipótesis se justifican de manera más detallada en la memoria. Este segundo efecto se modela mediante contratos efectivos de “buy-back”.

Un primer resultado es que, en el caso de que Gas Natural tuviera posición de dominio en el mercado del gas, se requieren niveles de contratación a largo muy elevados para que el precio doméstico no sea muy superior al internacional. Por ello, las simulaciones de mercado conjuntas se realizaron suponiendo contratación completa de la demanda.

Con esta hipótesis, se puede observar que la adquisición por parte de Gas Natural de fracciones tan pequeñas como el 5% de capacidad de generación no basada en gas ya proporciona incentivos para el ejercicio de poder de mercado. La tabla adjunta muestra el beneficio total estimado en función del precio doméstico y la proporción de la capacidad de generación adquirida.

Precio/ % capacidad generación mercado eléctrico	**0%**	**5%**	**10%**	**15%**	**25%**	**50%**	**75%**	**100%**
37,5	-1,66E+06	1,26E+07	2,69E+07	4,12E+07	6,98E+07	1,41E+08	2,13E+08	2,84E+08
36,5	-1,14E+06	1,29E+07	2,69E+07	4,09E+07	6,89E+07	1,39E+08	2,09E+08	2,79E+08
27,5	-1,38E+05	9,22E+06	1,86E+07	2,79E+07	4,66E+07	9,34E+07	1,40E+08	1,87E+08
26	0,00E+00	8,56E+06	1,71E+07	2,57E+07	4,28E+07	8,56E+07	1,28E+08	1,71E+08

Summary

Recent enterprise events related to the merger of energy companies (Natural Gas ENDESA, E.ON - ENDESA, Suez - Gaz de France,…) have been object of intense debate. Among the many subjects in discussion, there is one that until the moment, has not received excessive attention in literature: the competition problems because of having activities simultaneously in the electricity and gas markets.

The main object of this project is to analyze an equilibrium model of electricity and gas that allows to explain the expected behavior of the market and to describe the ability of the players to influence in the electricity price using their decisions in the gas market.

Specifically, the achievement of the following individual objectives is required:

1. Study of the possible problems of competition in the convergent gas markets and electricity.
2. Study and classification of the state-of-the-art in the simulation of convergent gas and electricity markets.
3. Exposition of a conceptual model of market analysis.
4. Accomplishment of an analysis with numerical parameters that adjusts to the conceptual model.
5. Analysis of the obtained results and conclusions

The project, therefore, consists of two differentiated parts.

On the one hand, a theoretical phase is included, where literature has been studied and varied conclusions, that have been extracted, appear in the first chapters of this project. In particular:

- Characterization of the electrical and gas Spanish market.

- Study and differentiation between the international market and the domestic market, with the different kinds of contracts that govern their transactions.

- The different Spanish and European institutions in the decision making of this type of mergers and the competition problems that they study for their decision making, as well as the tools of simulation that they have to do their work.

- Characterization of the vertical integration with the theories of some relevant authors, from the industrial economic theory, games theory and optimization.

- Description of input foreclosure, the greatest competitive threat in this type of mergers that include vertical integration. Different possibilities to reduce this competitive problem or to eliminate it are enumerated.

- Two existing models of simulation were analyzed that integrate the electrical market with the gas market, as well as an exclusive gas model, describing their work hypotheses and their different conclusions.

On the other hand, a conceptual and numerical analysis of the expected Spanish situation was realized for a merger like Gas Natural - ENDESA, in which electricity and gas assets are integrated. For it, Marape program developed in the IIT was used, to simulate electricity markets. The model was used in perfect competition, single bus system, no emission trading or CO_2 quotas and no forward markets. The analysis horizon was a year, divided in blocks of ten hours.

The existence of market power for the main gas agent could be manifested by different and higher domestic prices from the international price. Therefore, it has been analyzed different scenarios of domestic gas prices to simulate the market power of the new firm and its consequences in the electricity market have been analyzed. This has been the last part of the project, the characterization of the oligopolistic effects of vertical integration, providing a description of new strategies that can be expected in future cases.

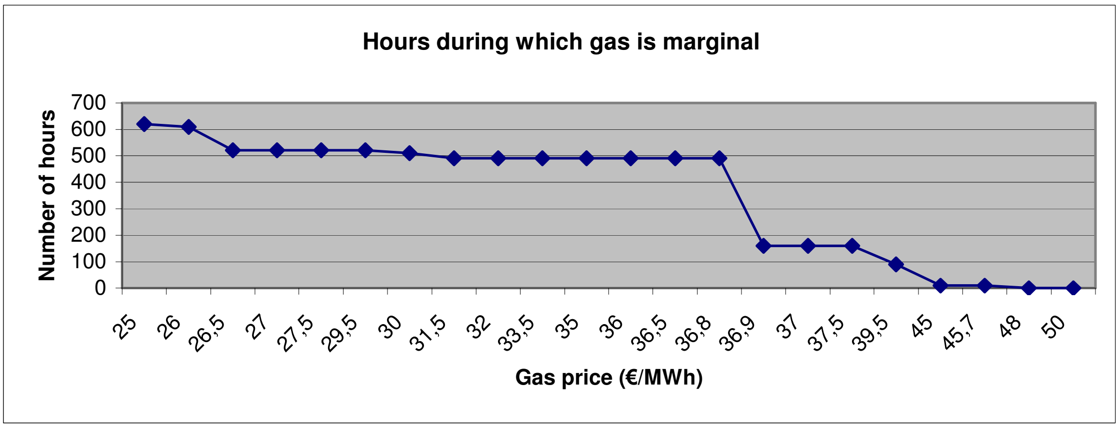
With the Marape analysis, three curves were obtained to resume the answer in the electricity market:

- Number of hours in which combined cycled plants that produce electricity thanks to the gas as raw material are marginal, which means that they are fixing the cost price of the other technologies.

- Amount of electricity (in MWh) produced by these plants during those hours.

- Amount of electricity in (MWh) produced by the inframarginal thermal plants that operate during those hours under the combined cycles.

The first curve was fundamental for the determination of the different study points, reason why it is included next:



Viewing this graph, it is noticed that there exist four different zones that correspond to different merit orders for generation technologies. Because of that, it was decided to analyze four representative cases corresponding to prices 26, 27'5, 36'5, 37'5 €/MWh. For each one of these prices profits were evaluated for different generation plants. Using this data, profit for an hypothetical company owner of a known fraction (0, 5, 10, …, 100%) of generation capacity was calculated. That profit is an increasing function of the domestic gas price until the moment that plants stop being marginal, due to the higher price charged for the inframarginal technologies.

To analyze the answer in the electricity market two parameters were used. The first one was the elasticity of non electrical demand of natural gas. The second one, the long-term contracting level in this demand, which varies from 0 (no long-term contracting) to 1 (all the consumption is already contracted in long-term). This long-term contracting represents the long-term contracts and possible regulatory considerations or strategic policy.

Due to the increase of the domestic price, Gas Natural could have two additional cost sources:

1. One due to the lower not domestic gas demand, decrease that depends on the elasticity and the long-term contracting level.
2. Another due to the additional competition of gas that, because of its attractive domestic price, electricity companies do not use to burn in their generation plants but to sell it to other customers. Here it appears a hypothesis: electricity companies supply themselves by long-term contracts and they are not able to import additional gas. These hypotheses are justified more detailed in the memory. This second effect is modelled by effective "buy-back" contracts.

The first result is that, in the case of Gas Natural in a dominant position in the gas market, very high contracting levels are necessary to not increase extremely the domestic price over the international one. For that reason, simulation in electricity and gas markets simultaneously was made supposing a complete demand contracting.

With this hypothesis, it can be observed that the acquisition from Gas Natural of small fractions of 5% of generation capacity not based in gas implies already profits to practice market power. The table below shows the total profit esteemed based in domestic gas price and the proportion of generation capacity acquired.

Price/ % generation capacity in electricity sector	**0**	**5%**	**10%**	**15%**	**25%**	**50%**	**75%**	**100%**
37,5	-1,66E+06	1,26E+07	2,69E+07	4,12E+07	6,98E+07	1,41E+08	2,13E+08	2,84E+08
36,5	-1,14E+06	1,29E+07	2,69E+07	4,09E+07	6,89E+07	1,39E+08	2,09E+08	2,79E+08
27,5	-1,38E+05	9,22E+06	1,86E+07	2,79E+07	4,66E+07	9,34E+07	1,40E+08	1,87E+08
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FINAL STUDIES PROJECT

ELECTRICITY AND GAS MARKETS VERTICAL INTEGRATION ANALYSIS

AUTHOR: PATRICIA BLANCO FERNÁNDEZ

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The Spanish Market

1 The Spanish Market

1.1 Introduction

The Spanish electricity and gas markets are part of the Internal European Market, and therefore they are regulated by both the European Commission and the Spanish Authorities. Its geographic situation makes Spain to be almost an island in the energy market, connected with France in the North, Portugal in the West and Algeria in the South. Electricity supply in the Balearic and Canary Islands are not supplied by a liberalized market, but by an "old-fashioned" regulated system.

It is worth to give some details about deregulation process that have taken place in energy sectors in the world to understand the context of the Spanish market. The Spanish case is quite peculiar because it came with a higher concentration in this industry. This is the subject of the first section of this chapter.

In the third section, two energy markets are presented. Two energy markets in Spain can be identified: the spot market (or domestic one) and the international market (a long-term one). They are going to have a very important role in this study, because of their prices and the relationship between them. For electricity, only the domestic market has sense, it is a non storable commodity. For gas, both of them have a role: In the international market, prices are competitive. In the spot market, only if the company has power market is possible to have a domestic price different from the international one.

But before presenting them, in the second section electricity and gas sectors in Spain are introduced, as well as electricity and gas as commodities and the new impact of LNG (Liquefied Natural Gas). This section is based on the ideas presented in [GEMA05].

Finally, contracts in different kinds of market operations and the merger itself are introduced in its context.

1.2 Deregulation process in energy markets

The structure of electricity supply industry existing until recent deregulation process started after the Second World War. In some countries, electricity supply was nationalized (France, UK, Italy, Eastern Europe countries and the Soviet Union). In countries were the nationalization process did not exist, as Spain, Germany or the USA, links between enterprises and the government become stronger. This industry became one of the most regulated ones. To establish prices for consumers, negotiations in "closed doors" between enterprises and the government took place in Europe, or judiciary audiences in the USA.

Oil crisis in 1973 stop the growth of electricity demand and implied a change in technologies to produce electricity.

Until the 80s, electricity industry in the world was formed by national companies or private companies, all of them with a huge volume and strongly regulated. This situation was explained by many reasons; one of them was the existence of a natural monopoly. In distribution, there is no sense in having several connections to each consumer, and in generation economies of scale favoured big sizes in electricity plants, owned by very big (and a small number of) companies.

However, starting in 1982 in Chile and continuing very fast in the rest of the world after changes in the UK in 1989, there is an extended deregulation process which has affected South America, Europe and a big part of the USA. There are some reasons to explain this process:

- Deregulation is mainly generation deregulation. Transport and distribution remain as natural monopolies, strongly regulated in every part of the world. Notwithstanding that in many countries they were the same companies who were in charge of generation and distribution. Deregulation has allowed a clear differentiation between both activities even inside the same company.

- Deregulation in generation has been possible because scale economies are not as big as they used to be. Nowadays, the cheaper technology is Combined Cycle Gas Turbines, with maximal efficiencies about 200MW, under 1000MW of a nuclear plant. This allows fragmentation and more competition in the generation sector.

- A perception was extended that private management would be more efficient that a public one. This factor, strictly related to dissatisfaction to regulation, was particularly high in the USA.

- To attract private capital, particularly from abroad. Governments had limited resources. A private company must charge all its clients to survive and it normally is going to try to be really efficient in its activity. But an organisation as a government, in the time of elections, is able to not charge for commodities to gain votes to be re-elected. Moreover, if a country is in development and governments do not have enough capacity to finance, social security, education and infrastructures appear as principals before energy efficiency.

- Political reasons, helped by the conservatory mood of the 80s, exemplified by the Reagan and Thatcher administrations.

- In Europe, it has been an important factor the creation of a unique market that allowed competition among electricity companies. The European Commission looked for a liberalization of the sector, arguing that benefits in efficiency would be greater with more competition. However, Member States tried to protect its own national industries, so liberalization was not as far-reaching as proposed.

1.3 Electricity as a commodity

The recent introduction of competition in the electricity industry worldwide followed in a natural manner the process that had already taken place in the gas industry and in the telecom industry. In all three, deregulation was justified by the perceived benefits of introducing market forces in an industry previously viewed as a monopoly. However, the design of efficiently functioning electricity markets has proven to be a difficult exercise.

Electricity among all commodities is characterized by some unique features:

- It is an essential commodity, some would say vital.
- It is mostly non-storable (except for hydro, which represents a small fraction of the electricity produced worldwide), entailing the necessary real-time balancing of supply and demand.
- It has to be transported in a transmission network, with no alternative existing today to physical high-voltage lines, in contrast to the telecom industry where satellites may replace underground cables.

Electricity, which can act as a substitute for oil and gas and can be generated by either fuel, shares with these two commodities the need to invest high amounts of capital; consequently, the electricity industry used to be organized in many cases as a state-owned monopoly. When we combine all these elements it is easy to understand why deregulation of the electricity industry was no easy matter in any part of the world.

Regarding Europe, the consequences of deregulation are puzzling at the present time: the two countries with the lowest cost of producing electricity in April 2004 were:

1. The most deregulated one, the UK, with a cost of production of €0,048 per kilowatt-hour
2. The most centralized one, France, with a cost of production of €0,051 per kilowatt-hour

These numbers express the complexity of the issue of deregulation and the impossibility, at this date, to draw clear conclusions on its virtues for consumers and for economic growth as a whole in countries where deregulation has been introduced.

Another fundamental feature of electricity, related to the properties described before and explaining the risks and rewards in the deregulated electricity industry, is the presence of spikes in price trajectories (very sharp movements upwards shortly followed by drops of the same amplitude). The order of magnitude of these jumps which have been known to take prices from normal levels of $30 per megawatt-hour to

$1000 or more is totally absent from other commodity markets, even the more volatile ones like oil and gas. Usually, price volatility is an inverse function of inventory level. In total absence of inventory, price volatility may be unbounded. From an economic standpoint, this is explained by the following facts:

- An equilibrium between supply and demand needs to be secured at any time
- Demand is a fairly inelastic function of price. Residential customers must be serviced at all times. Interruption rights may be exercised by the utility in the direction of some industrial customers but not all of them. High-tech companies, for instance, are adversely affected by power blackouts.
- Supply may abruptly change in the case of a plant outage or a failure in the transmission network. The non-existence of the buffering effect of inventory as in the case of oil and gas explains the price spikes regulatory observed in power markets worldwide.

1.4 Electricity sector

The electricity sector is a transformation industry which can be simply described by:

- Generators burn fuels such as coal, natural gas or enriched uranium in power plants, or use the gravitational energy liberated by water from rivers of mountain lakes, or capture the wind force to activate alternators that inject electricity into a high-voltage network.
- Marketing companies and distributors get the electricity from the high-voltage network, cascade it down to network distributions with lower voltage and sell it to industrial or residential consumers and handle the metering and billing.
- The network operator (an Independent System Operator or ISO) is responsible for global balance – as much electricity must come into the system as the quantity that exists – and makes sure there is no local

congestion. It maintains the system software that allows merchants to exchange electricity on the high-voltage network, which is the natural place for wholesale trading.

In the former organization of electricity markets, utilities typically undertook at the same time the generation, transmission and distribution of electricity over a wide geographical area. Each utility included a center for the monitoring of equipment and dispatching of electricity, with a power management system executing such functions as automatic generation control, reactive power control and preventive and emergency security control – one important regulation activity being system frequency. For many years, the generation part of the electricity industry was organized as a natural monopoly because of the economies of scale that could be obtained by using large power plants, and, until the early 1980s, the optimal size of generating units increased continuously.

Unbundling vertically integrated utilities means identifying and separating the different tasks attached to a single entity in the traditional organization, so that these tasks could be open to competition whenever feasible and profitable. Previously, when these tasks were coordinated by a unique operational center, cost minimization under the constraint of reliability was the sole optimization criterion. The vertically integrated utility was able to change the rates it could charge after negotiations with an independent regulatory body, comprising representatives of consumers, local municipalities and government agencies. As already mentioned, the transport of electricity takes place through the grid. High-voltage network operation is usually in the hands of a single entity, the Transmission System Operator (TSO or ISO), for the obvious purpose of unicity of management. Flows of electricity present some important features:

- They have to follow the laws of physics called “Kirchoff laws”.
- Particular flows from hub A to hub B cannot be identified.
- When generators change their production schedule or experience plant failure, the entire high-voltage system is affected and action needs to be taken immediately to avoid a general collapse.

Managing the grid system means ensuring that:

- Generation and load are balanced at any time under whatever transmission constraints.
- The electrical flow over the system is controlled in such a way that the system is continuously in equilibrium in each part of the network.

1.4.1 Electricity sector in Spain

Electricity sector in Spain is headed by two companies: Endesa and Iberdrola. The third most important is Unión Fenosa, and they control practically all the market. Endesa and Iberdrola jointly produce about two thirds (2/3) of the total electricity generation in Spain.

Endesa S.A. is the main Spanish electric company and the first private electric company in South America. Endesa is presented in Spanish Stock Exchange, in New York Stock Exchange and in Chile Off-Shore Stock Exchange. Its main activity is generation, distribution and trade of electrical energy in Spain, Italy, France, Portugal, Poland, Morocco, Turkey and South America, being present in the gas natural sector, commercializing and distributing. It has also participations in renewable technologies.

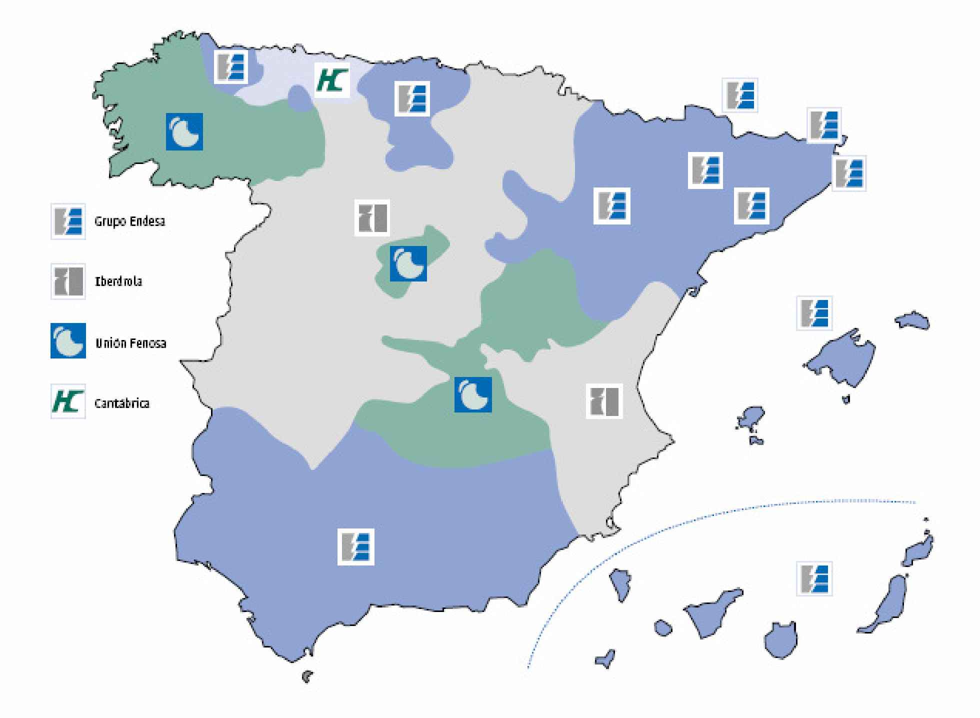

Figure 1: Geographic distribution of electricity companies in Spain

The electricity market in Spain is centralized by a system operator and managed by a market operator, organized in the form of a power exchange. This market leaves to the agents the responsibility of deciding their strategy to sell or buy electricity.

The enactment of law 54/1997, in November 1997, establishes a fully competitive framework for the generation of electricity. There are two main Spanish institutions. The market operator, OMEL (Compañía Operadora del Mercado Eléctrico) is in charge of the series of voluntary short-term market mechanisms through which the majority of physical transactions take place, even if the volume is still low. The system operator since 1984 is REE (Red Eléctrica Española), which is the owner of the high-voltage transmission network. A careful coordination must be established between the market and the system operator to guarantee that transactions made through the power exchange are feasible.

1.5 Gas as a commodity

Gas in its natural state is a mixture of hydrocarbon gases, carbon dioxide and nitrogen. Among hydrocarbon gases, methane (CH_4) is the major constituent (a proportion between 82% and 95%), then ethane (C_2H_6, between 2,5% and 7,5%). Propane and butane are presented in smaller fractions. The component of carbon dioxide (CO_2) varies between 0,2 and 1% of the volume, and nitrogen (N_2) between 1,5% and 15%.

Gas is the fastest growing energy commodity today. There are three main reasons: The virtues of gas in its own right, the increasing use of gas in power generation worldwide (see paragraph 1.6.1.) and that the state of gas reserves remains remarkably promising. Because of reduced emissions, the share of gas in power generation will increase from 100 billion m^3 in 1995 to more than 200 billion m^3 projected in 2010, an increase of 4,8% a year. If this rate is compared to an increase of 1,4% a year in gas consumption for other uses, importance of gas in energy industry is clear.

Price volatility is higher in gas markets than in oil markets. In this respect, gas is more similar to electricity. Trading of Liquefied Natural Gas (LNG) is starting, with gasification plants being built along various shores: for the major players, the possibility of rerouting methane tankers is certainly a way of taking immediate advantage of gas shortage in a given region and exploiting arbitrage opportunities between continents. The supply of gas in countries as Spain takes place through long-term contracts, with Take Or Pay (TOP) clauses. It means that there are penalties if a minimum volume is not purchased at any time over the contract period.

Reserves of natural gas around the world are abundant. They have more than doubled in 20 years and amounted to more than 176 million m^3 at the end of 2003. In contrast to oil, gas is not a global market. One of the reasons is that electricity is restricted to local markets because of its unique non-storability. Another one is that in transport losses of gas are produced. An increase in LNG transport should help to break down the current world segmentation.

Natural gas is traded in contracts for physical delivery in the spot market or through long-term contracts. As the world market for natural gas is fragmented into different regional markets, it is not possible to talk about a world price for natural gas, in sharp contrast to oil.

Natural gas prices may be measured at different stages of the supply chain, starting with the wellhead price. Natural gas prices in the market will reflect a number of components: Wellhead price (the cost of natural gas itself), long-distance transportation cost and local distribution cost. In Western Europe cost of transportation does not increase with distance but with the number of zones crossed between the two end points. When long distances are covered because gas needs to be regularly repressurized in dedicated and costly stations, this is not the case.

The major demand factors are weather and economic activity. Due to the importance of the weather factor, natural gas demand is highly seasonal. Other factors affecting demand are population and trend changes. New legislation concerning air pollution control may lead to increased demand for this cleaner fuel.

In Europe, gas prices reflect competition with alternative sources of energy. In a given market segment, competition takes place between gas and oil products used in the manufacturing industry. Hence, gasoil and crude oil become the indexing parameters for gas prices. For a given project, gas competes with coal and the indexing parameters become coal, inflation and consumer price index.

1.6 Gas sector

In this gas sector, there is one important player in Spain: Gas Natural. It heads the market for final costumers, with a market share near 80% on distribution assets and about 65% on supply at the free market.

Gas Natural SDG, S.A. is a holding formed by a number of different societies, in the activities of providing, distributing and commercializing natural gas and Liquefied Natural Gas mainly in Spain, Italy and South America (Argentine, Brazil, Colombia and Mexico)

1.6.1 Combined Cycle Gas Turbine (CCGT)

Today, gas represents 25% of the world total energy balance and will amount to 30% in 2020, by which time it should represent one-half of all new electricity production, reducing the contribution of coal, although coal will remain the most common energy source.

Recently, under the combined effect of ecologists who question the nuclear solution, and other "green" groups represented in international organizations and pushing for treaties such as the Kyoto Protocol which demand the limitation of emissions (carbon dioxide, sulfur-derived gases), Combined Cycle Gas Turbines (CCGTs) are becoming increasingly popular and in many countries are the only type of plants that are currently built. These generating units are smaller and cheaper; hence, they reduce the difficulties of finding large amounts of long-term investment capital and diminish the barriers to entry in this industry. Moreover, their remarkable flexibility allows plants to be switched on when power market prices are high, thus explaining their name of "peakers"

Gas – fired combined cycle generators supplied 14% of the total demand in 2004 and close to 20% in 2005, and their participation is expected to increase in the following years.

Gas Natural produces around 7% of the total generated power by using Combined Cycle Gas Turbine (CCGT) plants. Endesa, Iberdrola and other firms have smaller participations, none of them greater than 5%.

In this particular technology, Iberdrola has nowadays 4000 MW of installed capacity, which is significantly higher than the 1200 MW of Endesa. Gas Natural has 2800 MW in operation, representing more than 90% of its production. Unión Fenosa nowadays has 2000 MW. Both of them are also opting aggressively for gas - fired production facilities.

1.6.2 Enagas and gas facilities in Spain

Enagas is the independent system operator who manages the transmission, re-gasification and storage facilities. It enables the firms to buy LNG (Liquified Natural Gas) independently.

There is almost no gas production in Spain. Imports come mainly through the North African gas duct (Algeria), Norway (by tube also) and the less important Larrau gas duct from France, and as LNG. They are managed by Enagas as well, but most of them are locked-in with old long-term contracts. In particular, the main contract with Algeria is mostly used to supply the regulated customers. Therefore, for the electricity generators, nowadays the most relevant part of the gas market is associated with LNG deals. However, a number of small practical details complicate their activity. Some examples include the very rigid operation of the regasification facilities, the scarce storage capacity and the lack of a formal balancing market to adjust their final schedules.

1.7 The spot or domestic market[1]

This market is a short-term one. It is considered as a market mechanism that helps carefully to guarantee competition between participants. Prices in this market are public and even if the size of this market is shorter than the international one, it is important because is the price that enterprises pay for the energy they buy.

Even in a competitive environment, the first role of a spot market is to ensure that total generation meets demand (and, obviously, the regulatory authority has to oversee its well-functioning). Second, the transmission system operator will arrange the physical aspects of delivery. It is characterized by:

a) The transparency of the rules governing energy trade.

[1] Ideas presented here can be found more extended in [BAIL02].

b) The flexibility of operation conferred to participants.

c) The degree of decentralization achieved in decision – making.

d) The degree of integration between spot market mechanisms through which different products are traded: energy, generation capacity, transmission, capacity, ancillary services.

e) The particular manner in which spot market mechanisms are cleared, products are priced and financial settlement is reached.

The ultimate role of a spot market is to ensure that total generation meets demand. It is worth to note that an ISO (Independent System Operator) does not own generation and is only responsible for supplying total demand efficiently. However, there is no guarantee that demand will be completely met at any point in time. Hence, a mechanism which is termed reserves capacity is necessary to provide additional generation and bring about a balance between supply and demand.

There are three basic spot markets organizational paradigms identified by experts. One of these is the pool with a single buyer, organized as a system, mandatory or not, where generators place their bids in terms of prices and quantities for each hour of the following day. The second one is the power exchange, and it is the Spanish case.

1.7.1 The spot electricity market

Spain, which was the first country in Continental Europe to open its electricity market, created a power exchange called Compañía Operadora del Mercado Español de Electricidad (OMEL) where electricity is also traded on a day-ahead basis. The Spanish power exchange is a voluntary market, but bilateral trade is discouraged since capacity payments (rewards for providing capacity) are not granted to the bilateral market. Hence, most Spanish consumption trades on OMEL.

The Spanish spot market (the Spanish pool) is similar to the ones implemented in Scandinavia and not any longer in California. This power exchange is a competitive wholesale trading facility for electricity. It is a private entity owned by market participants, which include generators, distribution companies, traders and large consumers. The day-ahead market consists of 24 hourly auctions based on the complex hourly offers presented by generators and the simple hourly bids submitted by energy buyers. It assumes a single-bus situation and yields a unique reference spot price for each hour of the following day. In spite of the possibility of tendering complex sell offers, the market outcome is essentially the result of matching the aggregate offer and demand curves. Complex conditions include a minimum daily payment required by each generator to operate either as a fixed amount or dependant of its total sale of energy, upward and downward ramp-rate limits and others. All agents are asked to indicate the generating unit that corresponds to each offer (it means that portfolio offering is not possible). After the day-ahead market clears, a congestion management process is carried out by REE (Red Eléctrica Española), which results in modifications of the previous schedule. Generators that are forced to decrease their output to alleviate transmission constraints receive no compensation, while those that are required to increase their production receive the price they offered in the day-ahead market. Participants can adjust their physical positions in subsequent sessions of the on-day market until one hour prior to physical delivery. In addition, markets for ancillary services such as frequency control or spinning reserve also take place.

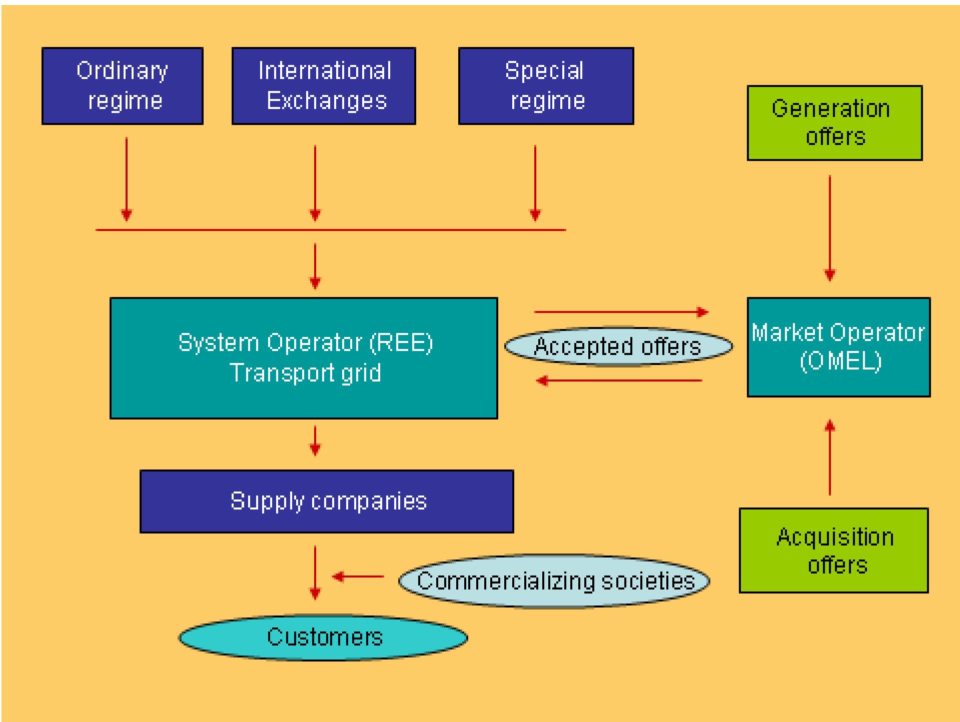

Figure 2: Description of the spot electricity market in Spain

The release of information relative to the transactions performed through the wholesale market mechanism is an issue of great concern for regulatory authorities. General agreement exists on the convenience of making publicly available the volume of energy transactions and the market clearing price for each market mechanism in every trading period. In Spain, OMEL (Compañía Operadora del Mercado Eléctrico) publishes the hourly energy sold in the spot market by each type of generation technology with a three-day delay. OMEL makes aggregate bidding data publicly available after each spot market session, whereas detailed information about the offers and bids submitted by each participant is published with a three-month delay since May 2001. Before this date, information was not accessible to the general public.

1.7.2 The spot gas market

Gas spot markets are more active in countries where the gas industry has been deregulated for a number of years. These countries normally share the common feature of having vast amounts of indigenous supply (US, UK, the Netherlands and Norway). In these countries, gas markets are located in areas where there is a concentration of buyers and sellers and where there are arrival points of major pipelines or interconnectors.

LNG spot markets are developing and bringing flexibility to world gas supply. They increased by 42% in 2001, representing 182 cargoes (10,8 billion m^3). Swap contracts allow arbitrage positions to be built between different geographical zones according to price differentials.

1.7.3 Development of physical flexibility tools

As physical delivery mature, the value of market flexibility gets higher, as well as the number of available instruments. Typical developments include the following tools:

- Storage: All downstream gas supply systems are designed with some storage capacity to meet the structural fluctuations in gas demand.

Moreover, as short-term trading expands, the flexibility offered by gas storage facilities by independent storage providers, and the sale of virtual storage services.

- Swing: The value of swing optionality in daily supply increases with the liquidity of spot markets, leading to a pronounced request for swing in contract negotiations.
- Basis trades: These allow prices at one location to be based on prices at another location where there is a more liquid market, with a premium or discount determined by the price differential between the two markets.
- Physical swaps: These allow both parties to reduce transportation costs by swapping gas deliveries with another party.

1.7.4 The growing interest in LNG

Liquefied Natural Gas is the result of cooling natural gas to about -162ºC at normal pressure, which has a liquid form. Besides the gain in transportability, liquefaction has the merit of removing oxygen, carbon dioxide and sulfur, resulting in a type of gas whose emissions are much lower if fired later in a power plant.

LNG offers an alternative to long-distance transmission pipelines and brings more options to supply since cargoes may come from different sources. The flexibility provided by LNG explains its increasing role in international trade. The size of tankers is growing, as well as the distance they can cover. Today they are capable of traveling more than 7000 miles without refueling.

Innovations have also been found for the financing of infrastructure, that bring together producing countries, oil and gas companies, transporters and distributors.

Globalization of the LNG market is on the way. With the multiplication of projects, there is a strong competition between countries owning reserves that can be exported as LNG.

Analyzing transportation of natural gas and LNG, some numbers are important:

- Natural gas fills a volume that is 1000 times greater than oil for the same energy content. Liquid gas occupies a volume 600 times lower than gas itself.
- The cost of transportation of gas over long distances is 5 to 10 times higher than in the case of oil.

LNG-receiving terminals have the inherent capacity of operating as a form of gas storage while they take delivery of large quantities of liquid gas from LNG tankers and then release it slowly into the gas supply system. Unlike other forms of storage that depend on geological formations, above-ground LNG tanks can be constructed anywhere. LNG storage sites allow high deliverability and occupy comparatively little space. However, the process of liquefaction is expensive and limits the use of LNG storage capacity that is typically dedicated to peak storage.

The LNG chain includes costs related to the liquefaction step, transportation and finally regasification.

1.7.5 The future of LNG

A major meeting about LNG took place in Washington in December 2003, showing the massive interest of the USA Administration and energy industry for this new form of gas.

The world demand for LNG should increase by 7% per year between now and 2020, compared with 1,7% for all energies, 1,6% for oil and 2,4% for all types of natural gas. LNG trading should reach 546000 million m^3 in 2020 and the oil majors such us Exxon, Chevron, Texaco and Total are investing large sums in this new energy. Moreover, new technologies are emerging. GTL (Gas To Liquids) allows the transformation of natural gas into fuel and will enlarge the offer of oil products. In the case of smaller and distant natural gas fields, new techniques are being conceived: floating barges to carry the liquefaction equipment for gas to be then transferred into methane tankers. Among the methane tankers that are being built, some are reserved for long-term contracts but a number will be available for short-term trading, increasing gas-to-gas competition.

1.8 The international market

This market works with long-term contracts which include huge volumes of energy. Prices are indexed to the Brent Petrol Barrel, are accorded before the transport and they are no public.

1.9 Contracts

Europe needs gas in high amounts and is trying to diversify its supply. The rate of increase in gas consumption varies from one year to the next, and depends on the evolution of other energy prices. However, the trend is clearly positive for domestic use and for electricity production, largely because of increasing limits on nuclear energy production. Deregulation of most European gas markets should be completed within a few years, but it is not clear whether the opening of competitive markets will be sufficient to avoid any disruption risk.

In the gas market, Gas Natural sells about two thirds of the total consumption. There are four main regasification facilities. Import capacity is allocated by "first come, first served" contracts. Cost of regasification contracts is low, although there are penalties if reserved capacity is not fully used. However, it is allowed to be somewhat below (15%) of contracted capacity without charges. On the other hand, regulations require that 25% of total capacity to be allocated for short-term contracts (less than 2 years in advance)

Presently, electricity companies have long-terms contracts with foreign suppliers that cover their needs, mainly for electricity production but as well for selling to other industrial and non-industrial costumers. There are, besides the electricity companies, other agents in the gas market that also own long-term supply contracts. A balancing market, based on swap agreements, is presently developing among all these minor agents, as physical operation of regasification facilities is very rigid and there is scarce storage capacity.

The situation is different for the purchases made by the combined-cycle generators of the gas they need for their electricity production. Most of them have negotiated long-term contracts in the international market.

A relevant exception is Endesa. Most of the gas used by its CCGT is supplied by Gas Natural, under a medium-term contract with a price resembling a rolling average of international gas prices. Contract establishes that the gas bought under this agreement can be only used for electricity generation in Spain only.

Gas consumers can be divided in three groups: electricity generators, other huge consumers (over 100GWh/year) and all the rest. There is a regulated price that effectively competes with the market price. Huge consumers who has switched form regulated price to market price or viceversa must remain in the new regime for at least 3 years and all the other consumers at least for 1 year.

1.9.1 Risk in long-term gas contracts[2]

Since its emergence in the 1960s, gas in Western Europe has been founded on the use of long-term contracts between integrated natural gas companies, such as British Gas, Ruhrgas or Gaz de France, and major producing countries, such as Russia or Algeria, represented by Gazprom and Sonatrach. In the process of restructuring of the energy industry, some of these companies have disappeared: Ruhrgas has been absorbed by the German electricity giant E.ON; British Gas demerged in 1997 into two groups, BG and Centrica. BG got the ownership and operation of the British pipeline system and Centrica the British Gas supply business. Despite the growth of spot markets allowing for greater flexibility, most of the gas that is internationally traded is till today in the form of long-term contracts. The producing countries are thus ensured a steady flow of revenues securing the high capital investment necessary to develop, produce, transport and supply gas. Optimization of a short-term/long-term supply and service contracts portfolio is conducted at the level of the major gas or energy companies.

[2] Extracted also from [GEMA05]

There are some key considerations to not forget:

- The risk and opportunities arise from the number of actors in the market under analysis: producers, transporters, distributors, industrial consumers.
- Long-term contracts with TOP provisions have so far permitted the financing of very costly infrastructures. They involve long durations and large volumes, made necessary by the cost of the transmission infrastructure (the cost of gas transportation is five times higher than oil)
- In these long-term contracts, both parties have obligations concerning the duration of the contract, price, reliability of supply and volume taken.
- The producer makes sure his production is sold by signing long-term contracts. The TOP clause protects him against volume risk. TOP describes a buyer's obligation to pay for a certain percentage of the annual contracted volume whether or not he takes delivery of this gas. Typical TOP levels would be 90% of contracted volume. A real translation of a Take Or Pay clause is "pay, and then, take it if you want".
- The distributor, on the other hand, faces volume risk since he has purchased long-term TOP contracts and demand will fluctuate with weather conditions and cycles in economic growth. But he is protected against price risk since the selling price to customers is also indexed to oil products.
- Deregulation of the gas industry is becoming effective in many European countries, together with concentration and restructuring.
- The European gas industry is experiencing fundamental changes with the emergence of short-term contracts, while the Zeebrugge-Bacton Interconnector tends to bring about convergence between competitive gas prices in the British market and oil related prices in Western Continental Europe.
- The increasing share of power generation in the gas balance could cause a break between the gas price and the crude oil price in favour of the gas industry.

- New gas projects (particularly in Russia) consume such vast amounts of capital that long-term contracts are no longer sufficient and production-sharing agreements are signed to bring some security to investors (such as those signed between Gazprom and international oil companies)

1.10 The merger

According to the European Commission, the merging firm's turnover in Spain is higher than two thirds of the Community - wide turnover. As the consequence the European Community has no legal power to review the case.

Gas and electricity are both substitutes and complements. They are substitutes on the final market for certain energy uses (central heating, water heating, cooking) whenever consumers have to change their equipment. They are complements when power is produced by gas turbines and CCGT's. In fact in Spain, as in other countries such us the UK, the growth of demand for natural gas is fuelled by power generation. Note also that gas and electricity supply to final consumers may present redundant costs (billing costs, search costs) that may be eliminated in trying the two energies in a dual fuel offer.

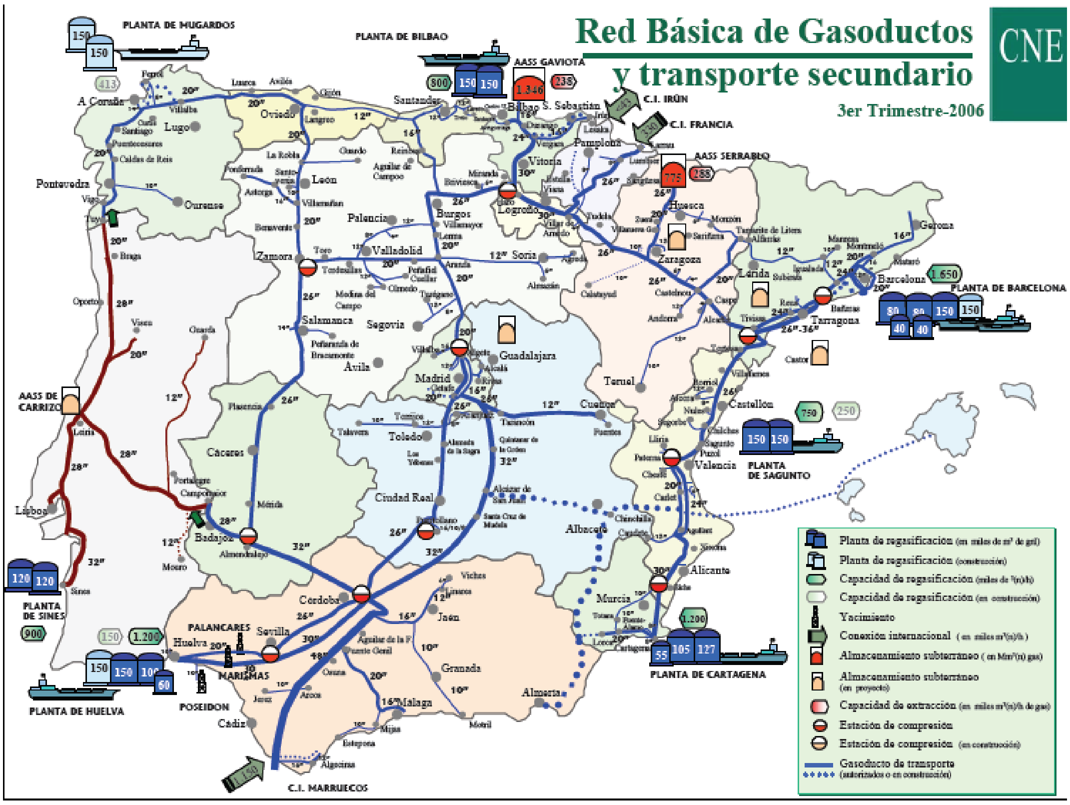

Figura 3: Gas distribution in Spain

2

The Administrative Procedure

2 The Administrative Procedure

2.1 Introduction

Regulatory commissions, regional administrations, national governments and supra-national institutions, in the case of the European Union, are involved when a process of reform is launched in a market. These regulatory authorities have an important role supervising the process and the fulfillment of the law, also determining new rules if necessary.

In particular, regulatory authorities pay special attention to the possible exercise of market power, which is defined as the ability of a firm to raise prices profitably above competitive levels for a significant period of time. This exercise is normally attributed to large generation companies able to increase the price of its commodity well above its marginal cost. In the case of the merger between Gas Natural and Endesa this exercise is analyzed by the competent authorities, as well as possible defects in quality, security or reliability in the supply of energy.

The basic principles that rule the regulatory reform process of the electricity industry in the European Union were established by Directive 96/92/EC. The development of an internal market for electricity among the EU member states is promoted in it. The Directive dictates rules that guarantee a non-discriminatory access to the European transmission networks and requires the unbundling of electricity services. It became effective in February 1997. Member nations were called to open at least 26% of their national markets to competition by February 1999, 30% by year 2000 and 35% by 2003.

The article 14.1 of the law 16/1989, in July 17th, about Competition Defence establishes that it must be notified to the Competition Defence Service all the projects related to economic concentration when:

1. In the operation, it will be acquired or increased an equivalent quota or a quota bigger than 25% of the national market or a geographic one situated inside of it for a product or service.

2. The global sales volume in Spain of the participants is bigger than 240.404,841,75 euros (40.000 million of pesetas) in the last economic exercise, only if at least two participants have individually a sales volume bigger than 60.101.210,44 euros (10.000 million of pesetas)

At least, there is a specific sectorial norm which includes an evaluation of the operation, in concrete, the law 54/1997, in November 27th, about Electric sector and the law 34/1998, in October 7th, for Hydrocarbon sector.

2.2 The Operation: a description[3]

The concentration operation notified involves the acquisition of the control of Endesa by Gas Natural using a takeover bid. The offer looks for the 100% of the social capital of Endesa and consists in an exchange of shares and a cash payment in proportion 65,5% and 34,5%, respectively. Endesa shareholders will receive for each share 7,34 euros in cash and 0,560 shares of Gas Natural.

Endesa has been valued in 22.549 million of euros and with the prices at the cloture of 2nd September of 2005, the exchange and the payment means a value of 21,30 euros for each share.

The presented offer is conditioned to reach the 75% of Endesa's shares and needs the Board of Directors to modify some articles in the company Statute.

From the first announcement in September 5th, 2005, until the opening of the acquisition period in March 6th, 2006, a series of administrative steps were taken by Gas Natural in order to fulfill legal requirements. Shortly after the announcement, Endesa management declared that the unsolicited bid was inadequate, arguing that the price was "insufficient", the payment as a mix of cash and Gas Natural shares "not attractive" and that there were significant regulatory risks in case that Endesa shareholders accepted the bid. Furthermore, Endesa declared that the merger authorization was competence of the European Commission, whereas Gas Natural and

[3] Based on ideas in [BARQ06c]

the Spanish government claimed that it was exclusive competence of Spanish authorities. The arguments revolved on accountability issues related to Endesa's business (*the merger would be competence of European authorities if more than two thirds of the EU income of any of the two companies were in other EU country than Spain*). In November 15, the Commission declared that the merger was under the jurisdiction of Spanish Authorities.

Two Spanish Commissions are particularly relevant: the National Energy Commission (Comisión Nacional de la Energía, or CNE) and the Competition Commission (Tribunal de la Competencia, TdC).

2.3 The National Energy Commission (CNE)

In the context of the bid for the acquisition of Endesa, there are opinions strictly related to competition policy and some of them not strictly related to them. Opinions and remedies resumed here appear in [BARQ06c].

Not strictly related to them:

- 14th function of the CNE: To manage properly the regulated distribution business.

Strictly related to them:

- 15th function of the CNE: The market power implications of the proposed acquisition.

That is the reason why the CNE had to issue two reports. The first one was related to make sure the long-term viability of the regulated activities, mainly gas and electricity distribution as well as supply in the Spanish archipelagos of the Balearic and Canary islands. This report was of obliged fulfillment. The CNE ruled in November 8th to allow the merger, subject to conditions. Maybe the most relevant one was related to the amount of leverage that the new entity could have as consequence of the operation. It was also required the segregation of electricity and gas regulated activities. The second report dealt with competition issues. However, in this case the government could rule in other sense than the recommended one. In any case, in December 20 the

CNE decides to allow the merger, subject to the fulfillment a series of remedies. Specifically:

- The new entity was required to auction the Algerian gas coming through the Maghreb gas duct and not having as destination the consumption by customers in the regulated price regime.
- The sell of 4,300 MW of electricity generation capacity was required. It was forbidden that Iberdrola was the buyer. Additionally, conditions on the technology and geographical location of the plants were also included.
- It was required that the new entity would renounce to service 1,500,000 gas customers. In addition, limits to the simultaneous ownership of electricity and gas distribution networks were also established.
- The new entity should sell their assets in two re-gasification facilities, as well as most of their shares in the Independent Gas Operator (Enagas).

2.4 The Competition Commission (TdC)

The TdC has also jurisdiction in competition matters. Again, its rulings can be overturned by the government that has, however, the legal requirement to explain the reasons.

The Competition Commission revises allegations from a lot of different companies in the electric or gas sector that could be affected by this merger. It makes an analysis of the relevant markets. The relevant market, studied in both perspectives, the product and the geographic area, allows the TdC to determine if the merger is going to prevent the effective competition, by identifying competitors presented in the merger. That is the way it uses to determine the market power, analyzing participation quotas in physical units and in invoicing volume.

The Competition Commission results about structure and effects in the market esteem that the variety of agents that operates in the different gas markets and the specificity in the demand (and sometimes in the supply), makes an individualized analysis of each market essential.

The TdC esteem that in the supplying market the group Gas Natural is the main supplier of the national territory, with a quota around 70% of the gas destined Spain. In the gas transport, activity regulated as a natural monopoly, the merger would make appear a carrier with 9.4% of the network of transport gas pipelines, without reinforcing the Gas Natural position in this activity.

In the transport market, infrastructures destined to the natural gas import, there is already a high level of concentration by Gas Natural that would be reinforced after the merger.

In distribution, Gas Natural provides 82.4% of the gas consumed in Spain. Endesa distributes 5.7%. Calculating the previous HHI[4] and the present HHI (7887), ΔHHI of 940 is obtained. This increase in the concentration level signalizes the possible existence of competition problems.

The TdC esteem that the strengthening of Natural Gas position in the market of supplying and access to basic infrastructures of import (gas pipelines and refineries) can prevent the competition in other markets related vertically. In addition, when the group of the distributing gas company is also active in the market provision (commercialization), the information about consumption of the final clients at the disposal of the distributors allows that the power benefits in this market have effects in the provision market. The increase of the presence of the resulting group in gas distribution implies a greater vertical integration in these two markets and originates that the information with which counts the distributor to realize its regulated function turns into valuable asymmetric information in front of its competitors in commercialization. These effects are foreseeable even considering that the distribution activity is regulated due to its character of natural monopoly.

[4] HHI is the Herfindhal-Hirschmann Index. In Economic Theory, the indicator of market power is the margin between the marginal price and the marginal cost which indicates the difference between market prices and marginal costs. Normally, Lerner index is used to analyze it, but because of confidential problems, competition authorities use HHI to measure offer concentration, that is strictly related to market power. If some hypothesis are verified (constant marginal costs and inexistence of capacity limitations fundamentally), HHI divided by demand elasticity equals Lerner index in Cournot equilibrium.

A market can be considered not concentrated if HHI<1000. A market is reasonably concentrated if 1000<HHI<1800. For HHI>1800 market is considered really concentrated.

Vertical integration in the electrical sector of the related enterprise groups causes that, economically, companies are indifferent between perceiving the total margin through a single activity or perceiving it on a separated form. However, because the new entrants do not participate normally in all the phases of the electrical provision, integrated groups have incentives to concentrate the total amount of the margins in those activities in which they do not have competition, being able to reduce the enterprise margins in the activities in which some competitor has realized the entrance, until forcing the retirement of this entrant.

Although law 54/1997, of the Electrical Sector, forces the companies to legally separate the regulated activities, transport and distribution, of not regulated, generation and commercialization, to avoid the existence of crossed subsidies, these companies can belong to a same enterprise group, allowing the compensation of losses in the consolidated balance of the group.

In the market, this has been translated, in fact, in the maintenance of the high vertical integration in the Spanish electrical sector, maintaining the great electrical companies very similar quotas in each one of the activities of production and provision.

On the other hand, companies integrated vertically have asymmetric information against the incoming potentials, since the distributors know the amounts and the prices engaged by each one of the clients, information of great value to the offers made by the commercializing part of the groups. The economic incentives lead to discriminate the access to this information in favor of the commercializing part of the groups.

This process takes equally place in the gas sector.

After these conclusions, in January 2nd, the TdC ruled that the merger should be unconditionally forbidden.

2.5 The Spanish Government

In February 2nd, the Spanish Government decides to allow the merger. Its reasons are related to the “general interest” and the “strategic character” of the energy sector.

The notion of "general interest" constitutes an undetermined legal concept which is mentioned in several occasions by the legal ordering like a governing principle of the activity of the public power. In concrete, it involves the norm to the "Protection of the general interest in the energetic sector and, particularly, the guarantee of a correct maintenance of sectorial politics objectives, with special attention to the actives considered as strategic ones. They will be considered as strategic actives in the energetic supply those who can affect the guarantee and the security of the gas and electricity supply".

Law 54/1997, in November 27th does not mention explicitly the notion of "general interest" but it declares that "Electric energy supply is essential to the development of our society. Its price is a decisive factor in competition and in a big part of our economy. Technological development of electrical industry and its raw materials supply structure is going to determinate the evolution of other industrial sectors"

After this explanation, the notion of "general interest" might be identified with a supply guarantee of energetic products.

However, even if the government allowed the merger, a set of remedies were also asked for. Conditions were similar to those suggested by the CNE, although no mention was done about the Iberdrola intent to buy electricity generation assets, but to refer the possible authorization to a future decision. The 17 conditions imposed by the government can be summarized as follows:[5]

The resulting firm must:

a) re-sell some of his gas acquisitions contracts, for a volume larger than the contracts owned by Endesa – therefore the final volume of the merged firm will be lower than the pre-existing position of Gas Natural
b) divest some of electricity generation plants, up to 4300 MW – so the aggregated firm will be "electrically" smaller than Endesa
c) divest part of his retailing business, both in electricity, up to the market share of Gas Natural, and in gas, up to the market share to Endesa

[5] Ideas presented in [BARQ06c]

d) sell some gas distribution assets, summing up 1,5 million customers – note that Endesa has very few gas distribution facilities
e) separate more strictly gas distribution from retailing, and allow for the creation of an independent switching agency for gas customers

At the end, the merged firm will be smaller than Endesa in the power market and smaller than Gas Natural in the gas market. If some concerns remain, they must be predominantly related to vertical integration.

Gas Natural accepts the conditions in February 6th. After obtaining the Stock Market Commission authorization in February 27th, the period for the shareholders to accept the bid begins in March 6th.

Finally, after having the German E.On as a new player in the acquisition of Endesa, Gas Natural took back its offer.

3

Vertical Integration

3 Vertical Integration

3.1 Introduction

Merger analysis of recent acquisition offers, such as the Gas Natural over Endesa or Suez over Gaz de France, is greatly complicated because of the existence of vertical effects, that disallows a more focused analysis in either the electricity or the gas markets. Regulatory authorities must to quantify vertical effects. There seems to be a lack of tools to do that. Regulatory decisions are going to be biased, either because these effects are ignored (underestimated market power of the merged company) or because they are going to be considered of paramount importance (overestimated market power of the merged company)

One particular vertical effect is known as “input foreclosure”. This kind of market power exercise is present whenever the merged company raises the costs of an input required by the competitors (gas) or otherwise restricts its access in order to damage competitors’ performance in other market (electricity). Input foreclosure consists in raising prices and damaging competitor’s performances by restricting access to a key input or a key purchaser.

In our case, a gas – electricity merger, input foreclosure means that the key input candidate is the gas produced by upstream company and used by the rivals of the downstream company, who generate power with gas. The costumer foreclosure in a gas – electricity merger means that the key purchaser is the electrical company of the new entity. Its sourcing of gas for power plants and final dual fuel consumers may ensured by the upstream gas division and therefore may be withdrawn from the market.

Input foreclosure in this merger is going to be analyzed after a description of input foreclosure theory. Anticompetitive effects in this merger are mentioned, followed by effects in the European energy context.

3.2 Input Foreclosure theory

According to [ORDO90], the central issue in the debate about competition effects of vertical mergers is vertical foreclosure, defined before.

While foreclosure has been accepted in leading court decisions and policy guidelines, critics maintain that the theory itself is logically flawed, as a vertically integrated firm will have no incentive to exclude its rivals, and if it did try to exclude them, rivals could protect themselves by contracting with other unintegrated firms.

This controversy can be seen more clearly by making the vertical foreclosure theory more specific. According to the theory, a single vertical merger can disadvantage downstream rivals as follows: Consider a market in which the supply of inputs is competitive before the merger and there are no production efficiency benefits gained from vertical integration. After the merger, suppose the upstream division of the now-integrated firm refuses to supply inputs to the rivals of its downstream division.

This foreclosure of rivals from these supplies means that remaining suppliers will face less competition. As a result, they may be able to increase their profits by raising their input prices to the unintegrated downstream firms. These higher prices benefit the vertically integrated firm. If rivals costs of inputs are increased, they will be forced to reduce their production and raise the prices they charge in the downstream market. This reduction in competition allows the downstream division of the integrated firm to increase its market share and its price. Thus the profits if the vertically integrated firm can rise, even if there are no production efficiency benefits flowing from the vertical integration.

The critics of vertical foreclosure raise a number of objections to these assertions. Each of these objections implies that the strategy of vertical integration and foreclosure of supply will not increase the overall profitability of the integrated firm. The objections deny the ability to use power in one market to “leverage” into a position of power in a second market.

There are six main objections to the foreclosure theory:

1. The supply of inputs available to rivals is not necessarily reduced as a result of a vertical merger. This is because the integrated firm also

reduces its demand for inputs produced by unintegrated suppliers. For example, if a firm with 10% of the output market purchases a supplier that accounts for 10% of the input market, it will not reduce the net supply available to rivals. Instead, it merely will necessitate a rearrangement in supply relationships.

2. Second, critics assert that it may not be profitable for the integrated firm to foreclosure its downstream rivals. Although the profits of the downstream division rise, the upstream division of the integrated firm loses input sales from its refusal to deal with rival downstream firms. These lost upstream profits may exceed the increased downstream profits. As a result, it does not follow necessarily that it is in the interest of the vertically integrated firm to foreclose downstream rivals.

3. Remaining suppliers may not have the incentive to raise their input prices. The foreclosure theory relies on the incentive of remaining suppliers to increase their input prices after no longer face competition in the input market from the integrated supplier. But this reduction in competition is more apparent than real. If the remaining suppliers raise their input prices, downstream firms often can begin to produce the input themselves. Even if such entry is assumed to be impossible, raising prices may still be unprofitable. If the remaining suppliers raise prices, their downstream customers will be placed at a cost disadvantage vis-à-vis the integrated firm and will be forced to reduce their input purchases. Stated more directly, unintegrated firms' input demands are highly elastic. Consequently, suppliers' incentives to increase prices even after the integrated firm forecloses those rivals from its input production are low.

4. The foreclosed rivals have available a number of alternative counterstrategies to battle their exclusion. In particular, they can respond by vertically integrating with the remaining unintegrated input producers. This will enable them to obtain the inputs at the competitive price, thereby eliminating their cost disadvantage. Thus, the first firm to integrate will gain no market power.

5. It is not obvious that the first downstream firm's bid to integrate with an upstream firm will succeed to begin with. The vertical foreclosure theory

suffers from a potential holdout problem. Assuming that remaining input producers gain the power to increase their input prices to unintegrated downstream buyers, a holdout supplier would gain an advantage by remaining unintegrated. Unless the downstream firm bids enough to compensate its potential merger partner for this lost opportunity, its bid will fail. Each firm will hold out, in the anticipation that another supplier will merge and give it the ability to profitably raise its input price. If the downstream firm does try to compensate its potential merger partner for this lost opportunity, the profitability of the merger is decreased, possibly to the point that no merger will occur.

6. The vertical foreclosure theory suffers from one last potential flaw. Since the firm that is foreclosed is placed at a disadvantage, it ought itself to participate in the bidding for the scarce upstream resource. While this flaw is somewhat different from the earlier criticisms, in that it does not amount to a claim that vertical foreclosure will fail, it does make the theory incomplete. [6]

3.3 Gas Natural – Endesa input foreclosure case

In [BARQ6b] the proposed Gas Natural – Endesa merger is analyzed. This section is mostly based in it. Input foreclosure is only possible if Gas Natural can raise the gas price or otherwise, restrict its access to the competitors. Therefore, it is required that Gas Natural can make exercise of market power in the gas market. There are possibly several ways.

Gas infrastructure is operated in a very rigid way, even more than usual in Europe because of the relatively low underground storage capacity and high proportion of gas imported as LNG. As it was explained in chapter one, contracts with foreign suppliers are also rigid: from the beginning of the negotiation to the arrival of the first boat, two or three years are not unusual. Contracts are usually long-term ones, and specify purchased volumes rather huge. They very often include “take or pay” clauses as well.

[6] If more information about vertical integration theory is required, see [JOSK05]

Regasification capacity reservation is cheap but rigid because or the “use it or lose it” clause.

Therefore, risk can be very high for agents who intend to play speculative strategies. For instance, let us assume that an electricity generator thinks that Gas Natural intends in the future to withhold gas from the market, raising the domestic gas price. Then, the electricity company could consider the possibility of buying additional gas in the international markets in order to resell it in the domestic market. Because of the long lead times and the required early procedures to reserve regasification capacity, this move will be known by the other players long before the first boat arrives. So, Gas Natural could decide, after all, to do not try to raise the domestic price and the electricity company will be forced to sell at a discount to customers previously serviced by other companies, mainly Gas Natural itself.

Gas Natural could be possibly subject to these constraints in a much lesser degree, mainly for three reasons.

1. Because of their international activities, it could possibly divert part of the gas from Spain to foreign markets, which is difficult to do for the electricity companies (although not for most of the other companies with small quotas in the gas market)
2. Because of the possibility of not making use without penalties of a fraction of reserved capacity. Gas Natural has more room to manoeuvre because of its much greater size, its balancing costs could be significantly lower than those of its competitors, which could allow a credible “price war” threat.

So, it could be expected that electricity companies are going to follow a “prudent” strategy, buying the gas needed for the operation of its CCGT plants, meet their long-term commitments and possibly keeping a foothold in the wider domestic gas market.

Gas Natural acting as an oligopolist must balance three effects:

1. The decrease of gas demand because of the higher prices.
2. The increase of gas sold by electricity companies in the domestic gas market. Because of the higher domestic price, they will divert gas initially intended for use in the CCGT to the domestic market.

3. The increase of profits coming form a higher electricity price. This is because the electricity companies internalize the higher domestic gas price as the gas opportunity cost when bidding.

3.4 Anticompetitive effects of Gas – Electricity mergers

The bid arises a number of competition concerns. In [BARQ06c] these possible effects are sorted in the following categories:

- *Horizontal effects in the wholesale electricity market*. Operation was designed in order that the market share of the new entity will be below the current market share of Endesa. On the other hand, more similar leading companies could lead to an increased risk of collusive behavior. Finally, Gas Natural has behaved in the last years as a "maverick" in the electricity market, contributing to a more dynamic system. Its conversion in one of the two majors incumbents could end this situation.

- *Horizontal effects in the gas procurement market.* It is argued that as consequence of the operation, Gas Natural share in this market would increase. More significantly, Gas Natural decreasing share trend could be put in hold for a number of years. In addition, logistic costs could increase, as an agent would disappear of the balancing market above described. Entry barriers could be higher as consequence of decreased competition.

- *Vertical effects in the wholesale electricity market*. Presently Gas Natural only owns gas fired electricity plants. The new entity would also own a sizable amount of other technologies' capacity and, therefore, could have an incentive to induce electricity price rises in order to increase the revenue of its non-gas plants, as they all are paid at the same marginal price. Conceivably, the new entity could make use of its gas market power in order to pursue this end, by rising gas price in the domestic gas market in order to increase costs and bids of gas fired plants, that are often the marginal ones.

- *Vertical effects in the gas procurement market.* It has been also argued that Endesa has behaved as a "maverick" in the wholesale gas market, and that this sort of behavior is likely to continue in the future because of its growing need for electricity generation and other purposes. Obviously, the success of the acquisition offer would end this situation.

• *Effects in the retailing market.* One of the most aggressive competitors of Endesa in electricity retailing is Gas Natural, and one of the most aggressive competitors of Gas Natural in gas retailing is Endesa. This could be due in an important extent to the fact that both companies have local customers basis, established reputations and presumably relatively low bundling costs, as incumbent distribution companies. The merger would create local dual distribution monopolies, as Gas Natural would acquire Endesa electricity distribution assets and would sell to Iberdrola gas distribution assets in zones where the last company is already the electricity distributor.

Of course, not all of these concerns are equally important. However, it is clear that merger valuation is a complex task, and that it should not be surprising that Competition Authorities would recommend remedies aimed to solve, or at least mitigate, some of these problems.

One important absent issue in the previous list is the effect of transportation bottlenecks. Actually, there are local "pockets" in the Spanish system, but generally electricity network is well meshed and the system can be approximately considered a single-bus one. Moreover, the existence of electricity and natural gas Independent Operators is also a factor that decreases fears.

3.5 The merger in the internal electricity market and the European context

In the paper [BARQ06a] authors consider three types of effects for this merger: the contribution of the Spanish market to the European internal market, the Europeanization of the energy companies operating in the different Member States, and the cooperation among national institutions (regulatory authorities) in the building of the European internal market.

3.5.1 The contribution of the Spanish market to the European internal market

They established that transaction may slow down the building of the internal electricity market. Common sense invite to accept that, as risk errors in the electricity sector are high, it is better to protect consumers by overestimating anticompetitive effects than underestimating them. In economics perfect competition is mainly approached as the number of competitors becomes very large, while competition between two giants is a duopoly.

There are two routes to effective competition in electricity and gas markets: the direct route is to ensure that production capacities are divided between a sufficient number of competing companies so that no one has much influence over the price; the indirect route is to expose incumbent operators to a credible threat of entry if the price rises above the competitive level. But given the important and still growing concentration of both gas and electricity industries in many EU countries and given the constrained cross-border interconnections, the last door open for an electricity company to enter into a foreign market is often to generate electricity with gas bought from an "open door to electricity" national gas company who could, in addition, offer its forces in the retail market to sell dual fuel services. Reciprocally, a foreign gas supplier could expect to enter the gas market by selling gas to an "open door to gas" national electricity generator, with a possible cooperation in the retail market to sell dual fuel offers. Furthermore, even relatively small entries in gas and electricity could encourage each other because the size of an efficient gas-fired plant can be relatively small. Lastly, contestable entry and gas liberalization reduce transmission constraints.

In contrast, the GN/Endesa merger transaction would render the Spanish structure more vertically compact and subsequently more closed to foreign initiative. Electricity generation, being the biggest and fastest-growing customer of the gas industry, would be vertically embedded in the gas industry. The leading electricity and gas incumbent companies would instantly become dual-fuel operators before any other existing or potential competitor has a chance to do so. Then, the barriers to enter the market from abroad would be higher and the risk taken by entrants would be higher too. If such an industrial structure was to be generalized in the EU, the dual-fuel barriers to entry would make the corresponding markets much tougher for outsiders. This would dramatically affect the growth possibilities for the competitive fringe (consisting of small new entries in countries' incumbent yards). As a result, the European internal market would be made smaller and not bigger, with adverse effects for all European consumers. It would be reduced to very small spots and thin shores. It is important to keep in mind that the size of the internal market is not equal to the sum of all national markets but only to the parts that are truly open to competition in each national market.

3.5.2 *The Europeanization of the energy companies*

Once each country is dominated by a national giant that integrates gas and electricity, it will be rare to find these champions engaging in cross-border competition. From this perspective, it is important not to fail to differentiate European energy firms competing on several regional and national markets without being dominant, and national champions dominating their national markets.

The reasons for lower incentives are threefold:

1. Firstly, their incentives to compete against each other are lower. With all countries having higher barriers to entry and tougher markets for entrants, why would be a reasonable manager of any national gas-electricity champion spend time and money and take entry risks to challenge another giant in its closed foreign territory?
2. Secondly, the bigger players are not necessarily the more agile in playing outside their home markets. It is true that size matters in order to increase economies of scale and scope. Moreover, an overly small company cannot expect to play an important role on the European scene because investigating and managing risky foreign scenarios consume time, money, people and skills that are all scarce resources. However, it is not so obvious that Spanish players are too small at present, seeing the size of Endesa, for example.
3. Furthermore, following a merger between GN and Endesa, much of these companies' time and skill will be concentrated on making the acquisition work. As a result, there is a serious concern that the resources of the merged company available to acquire a truly European dimension would not grow after the merger, but could rather decline for some years. The proposed

divestitures to Iberdrola of Endesa's existing activities in other EU countries may merely signal the national tropism of the merged company.

3.5.3 The cooperation among national institutions

Authors concern is that the clearance of anticompetitive mergers may decrease the willingness and the ability to cooperate in the making of the European internal energy market.

The current EU legal framework for building the internal energy market is not elaborated enough to ensure that the goal will be achieved. Moreover, no common European regulatory agency has been created to coordinate the required actions to enhance congested interconnections and favor cross-border trades. Cooperation, especially at regional level, has appeared as a necessary supplementary ingredient. Some European scholars pointed recently that the future of the internal energy market crucially depends on collective actions among national regulatory authorities, transmission system operators and power exchanges.

3.5.4 Errors and remedies

According to a widely accepted legal and economic standard, mergers and acquisitions can only be authorized if consumers' welfare does not decrease as a result of the transaction. The economic assessment consists of weighing the efficiency gains from the transaction that will be passed on the consumers against the anticompetitive effects of the transaction. If the latter are larger than the former, the transaction should be prohibited. However, because competition authorities face informational constraints, errors are inevitable. Certain procompetitive transactions are prohibited whereas certain anticompetitive transactions are approved.

Competition law empowers antitrust authorities to clear mergers with conditions. If a remedy eliminates the anticompetitive effect raised by a transaction, a clearance under condition is a way to get the good (efficiency gains) without the bad (anticompetitive effects) whereas a merger control based on a pure "yes" or "no" decision would lead to a welfare-decreasing clearance or prohibition.

However, more errors can appear whenever a merger is cleared with remedies that are ineffective in eliminating the anticompetitive effects.

In the USA, a Federal Trade Commission study shows that 25% of divestitures have not been successful in reestablishing the pre-merger level of competition. The problem is probably worse in markets recently opened to competition such as electricity and gas markets, because competition authorities have to make guesses not only on the effects of the merger and on the effects of the remedies, but also on future modes of competition and market boundaries before they are stabilized.

Again, insofar as efficiency is difficult to achieve in mergers related to the electricity sector, the cost of anticompetitive effects can be massive for consumers.

It follows, then, that in the electricity sector the use of merger remedies is a risky game to play. To protect consumers, economics recommends merger controls to be more cautious and stringent than in other sectors, that is, to take the risk of being wrong in prohibiting a merger or imposing severe procompetitive remedies rather than to take the risk of being wrong in clearing a merger with possibly ineffective remedies.

3.6 Conclusion

"Vertical merger does not create or increase the firm's power to restrict output. The ability to restrict output depends on the share of the market occupied by the firm. Horizontal mergers increase market share, but vertical mergers do not"

Robert Bork (1978, p.231)

Some authors agree in the critics to the vertical integration theory, but the measure of its effects is complicated, and nowadays competition authorities do not have the correct tools to measure it. To develop this kind of tools should be an objective to achieve in Europe, because this kind of mergers will appear commonly in the market.

Other authors emphasize their analysis in the internal and European market. They consider that the internal market would be smaller after this kind of transaction because the part of the market in truly national competition would be smaller. Moreover, they appreciate fewer incentives for the Europeanization of energy companies and it seems to be a decrease in cooperation to achieve the construction of the European internal market.

They insist that vertical integration in markets recently opened to competition is worse to analyze, because authorities do not have clues about the effects of the merger, the effects of the remedies and also about future modes of competition and market boundaries before they are stabilized.

4

Simulation Models

4 Simulation Models

4.1 Introduction

According to [BAIL02], the operation of a deregulated power industry is the result of the interaction of a number of agents with different objectives, and this interaction must be somehow incorporated into models so that they adequately represent the decision making-process.

If until this date, simulation models are based in electricity markets or gas markets independently, now Europe is suffering a process which includes mergers with vertical integration, for which electricity and gas simulations have to be done together.

Two papers analyzing simulation models were developed in the IIT (Instituto de Investigación Técnica) about vertical integration in this kind of mergers, which are [VAZQ06] and [BARQ06]. Both of them are explained.

In gas aspects, GASMOD simulation is presented based in all the information found in [HOLZ06].

4.2 The role of simulation models[7]

The power industry has traditionally been subject to close analysis by practitioners, regulatory authorities and different research communities including economists, electrical engineers and experts on operations research (OR).

A wide range of modeling approaches has been adopted to analyze competition in wholesale electricity markets. Differences between models can be identified in a variety of attributes, such as the hypotheses formulated by the analyst about the agents' behavior, the specific purpose of the ongoing analysis, the characteristics of the underlying power system, the detail with which the elements of the power system are

[7] These ideas can be found more extended in [BARQ06].

represented, the organization of the corresponding wholesale electricity market or the technique used to obtain numerical results.

The problem of modeling the behavior of a finite number of agents that try to maximize their profits in a competitive setting is a ground where a variety of fields of knowledge get mixed up, providing different perspectives that significantly enrich the analysis.

Research has extensively shown that simple indexes, as HHI[8], are generally unable to capture the degree of market power in these markets. The shortcomings are probably more relevant in the electricity case, and can be ultimately traced to the fact it is uneconomical to store great amounts of electrical energy. Therefore, short-term demand elasticity is very low and consequently a number of suppliers could become essential even with a relatively low market quota, especially during peak hours. This is at odds with most economic analysis that usually assumes a significant demand elasticity. New indexes, such as the Pivotal Supplier Index or the Residual Supply Index, have been proposed to address these shortcomings. Both indexes compute the degree in which any generator capacity is required to avoid unserved energy. However, they are ill-suited to address issues of collective dominance. Additionally, some National Authorities have tried to circumvent these problems by computing dynamic indexes.

A further problem is that in many countries, and particularly in the "European Platform" (roughly EU countries but Britain, Italy, Iberia and Scandinavia) definition of the relevant geographical market can be not all obvious.

Perhaps it is worth to explain that the same word "model" is used in slightly different ways in the Economics and the Engineering. For an economist, a model is usually a mathematical formalization of an economic insight. They usually consist of a relatively small set of equations that are thoroughly analyzed. On the other hand, for an engineer or an OR practitioner, a model is usually a rather big (sometimes very big) set of equations aimed to make realistic predictions. Competition Commissions are

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[8] HHI is the Herfindhal-Hirschmann Index. It sums the squares of the market share of all firms in the relevant market to arrive at a statistical measure of concentration.

mainly populated by economists and lawyers, although there are significant engineering and OR communities in the Energy Commissions.

These models require assumptions regarding the strategic behavior of the agents.

4.2.1 *Equilibrium models vs simulation models*

In his thesis, [BAIL02] explains that two main models can be identified according to the approach adopted to obtain numerical results: equilibrium models and simulation models.

Equilibrium models have been extensively applied to the case of the power industry during the last few years in order to predict its evolution under the new regulatory framework. In particular, they have been used to explore possible market outcomes that may result under an industrial structure with a limited number of relevant agents, an oligopoly. In an equilibrium model, a problem is formulated in which each agent is assumed to choose his best strategy based on certain conjectures about the behavior of the relevant rest of the world. To search for a solution, the modeler must either enumerate all the possible combinations of strategies or deriving the optimality conditions is that their interpretation reveals the incentives that drive the agents' decisions.

This way of modeling, using a form of a system of algebraic and/or differential equations, imposes limitations because there are certain strategic decisions that cannot be easily expressed in terms of equations. Additionally, if it could be characterized through a mathematical model, the resulting set of equations, if it has a solution, is frequently too hard to solve. These are some if the reasons why simulation models are an alternative to equilibrium models when the problem under consideration is too complex to be addressed within a formal equilibrium framework.

In recent years, the number of simulation models proposed in the technical literature has significantly increased. Simulation models typically represent each agent's strategic decision dynamics by a set of sequential rules that can range from scheduling generation units to constructing offer curves that include a reaction to previous offers submitted by competitors. The great advantage of a simulation approach lies in the flexibility it provides to implement almost any kind of strategic behavior. However, this freedom also requires that the assumptions embedded in the simulation be theoretically justified.

It is also frequent that simulation models involve iterative solution procedures that emulate repetitive interaction between participants: agents learn form past experience, they improve their decision making and they adapt to changes of the environment. Simulation models can also incorporate a representation of the transmission network. A simulation framework does not impose, in principle, limitations on the complexity of the power flow model used. This permits a more detailed analysis of the influence of transmission constraints.

There are several possibilities according to [BARQ06], ranging from relatively unsophisticated Cournot models[9] to much richer Supply Function Equilibrium (SFE) models. Particularly, SFE models have received much attention due to the fact that many of the wholesale electricity market mechanisms are organized as auctions in which each participant submits a supply curve so as to maximize its profits in the context of an uncertain demand curve. Calculating an SFE requires solving a set of differential equations, instead of the typical set of algebraic equations that arises in traditional equilibrium models. Nevertheless, SFE models have thus considerable limitations concerning their numerical tractability. They provide a more flexible framework to examine a wider range of strategies that simultaneously incorporate quantity decisions and price-setting tactics. The possibility of obtaining reasonable medium-term price estimations with the SFE approach is considerably attractive. Indeed, the SFE framework does not require the residual demand curve neither to be elastic nor to be known in advance.

It is also possible to model network constraints (easing concerns about proper relevant geographic market definition) as well as hydro management conditions (very important in countries like Spain, with a significant hydro production) and other inter-temporal constraints. Unfortunately, it is computationally infeasible to model at the same time SFE, network and hydro constraints, and realistic cost functions. A popular

[9] The Cournot model is a simultaneous move game in which the strategy of each firm i is its output level q of a homogeneous good. Moreover, each firm correctly estimates the output q, decide by each of its rivals j. Demand is represented by means of a curve $q(p)$ that indicates the amount of that good q that is consumed at each price p.

alternative is to use a generalization of Cournot models known as conjectural variation models that, however, require prior estimation of these conjectural variations, which is not an easy task. Main problem is that model output is sometimes very sensitive to the assumed strategic behavior, as well as the precise assumed parameters value (although not always this is the case). In addition, some of these models sometimes lack pure strategies equilibria, being mixed strategies equilibria at moment computationally intractable but in very simple models. Main advantage is that they can provide very rich insights in the way that agents could exploit market power.

4.3 The use of simulation models in the Gas Natural / Endesa merger

4.3.1 Simulation models in this merger: view by Julián Barquín

Spanish competition authorities have consistently argued to consider Spanish peninsular market as the geographically relevant one. At the moment, interconnection capacity is widely considered as too small to consider that an effective Iberian market does exist.

Models could have been used to try to asses the importance of the previously discussed effects. Essentially, there are established sort of models for only two of the above concerns:

- "Static" effects in the electricity market can be assessed by using oligopolistic electricity markets simulation models
- Electricity and natural gas retail markets are, possibly, the ones more similar to other sectors ones.

There are other effects that, even if there are not currently well-established models to deal with, it is likely that they could be developed along the lines of the two previous ones. Specifically:

- "Static" effects in the natural gas procurement market.
- "Static" vertical effects linking electricity and natural gas markets.

Finally, there are other effects that, in Julián Barquín view, lack a generally accepted theory or analysis practice, not to speak of specific tools. Among them:

- "Dynamic" effects related to the investment process in electricity and natural gas markets. Some simulation models have been developed. However, many issues remain open, and there is not a consensus on the significance of models outputs.
- The assessment of the advantages provided by the ownership of distribution networks.
- Aspects related to the sustainability of collusive agreements in a dynamic framework, possibly including futures markets influence. There is an extensive literature on this issue, but it has not found its place in simulation models yet.

It is concluded that simulation models have had no place in the decision process by Competition Authorities. It implies that a long way is going to be needed by simulation models to become standard tools in merger analysis. Their ancillary character and the essential need of good economic analysis should be always taken into account. However, they are gaining a place in the analysis of energy, as well as other sectors. In order that they can fulfill their potential, researchers should possibly be very attentive to their adaptation or generalization to a fast-changing area.

Some “reference” models could be made public, according to open source rules. These developments could facilitate both theoretical discussions on “realistic”, although non-existent markets; and to gain a shared confidence on the models outputs, very important if we intend them to be used to inform administrative or legal decisions.

4.3.2 *Simulation models in this merger: view by Carlos Vázquez, Miguel Vázquez and Ana Berzosa*

An investigation about if the regulator should consider separately the electricity and gas markets when analyzing the market share of the company after the merger is done in this paper. The target is to determine if some kind of electricity and gas analysis would be relevant. Using an equilibrium model of both markets it is described the ability of the players to influence the electricity price using their gas decisions. It is obtained a description of the kind of new oligopolistic strategies that may be expected after the merger. They find out that results depend very much on regulatory details.

Model is based on several hypotheses:

- It is assumed that there is a long-term gas international market where players in Spanish market can buy their gas supplies.
- There is a short –term international gas market with significantly higher entry costs, where only two players in the Spanish market can afford to play there. These entry costs are approximately equivalent to a minimum size requirement.
- There are additional entry barriers that prelude most of the large players that are actually trading in the short-term international market to gain access to the national market and sell to the smaller firms.

The market is made up of three consecutive stages:

1. All agents go to the long term international gas market to purchase their basic gas contracts. They act as pure price-takers. From the equilibrium model point of view, this stage will be irrelevant for us.
2. The national gas market takes place. All gas final consumers buy their energy in this market and there is a price-elasticity associated with them. Price in this market results to be higher than the international price. Suppliers have to decide how much they would sell at this stage, considering both that they are playing Cournot strategies in this market.
3. The electricity market takes place. Each gas-fired generator may use the remaining part of his contracted gas with no additional cost. Uncertainty is high (purchases are made many years in advance) and additional amounts of gas may be required. They have to buy this extra gas to the few larger national firms that do trade there.

It is assumed that this extra amount of gas cannot be negative; firms cannot have their spare gas sold at the international market. This is a result of risk aversion: Firms prefer to buy less gas than required and is a kind of punishment strategy by larger firms, intended to deter other players from growing too much in the domestic gas market.

Moreover, it is assumed that gas purchases are sold at same price that resulted from the national gas market. Therefore, the extra gas will be sold at least at the national gas price. It is likely that it will be approximately the retail gas price plus some mark-up, depending on the willingness to pay of the buyers and other characteristics of this market. The remaining alternatives would result in higher vertically-related market power problems.

Size of the Spanish gas firms are reduced compared to the international market. Interaction between electricity and gas markets is described as a two-stage game, where the electricity market players decide their output in the electricity market once the gas market has cleared.

Model uses two markets non-cooperative games in quantities, two Nash-Cournot games. Market operators of both electricity and gas are expressed as “marginal utility is equal to market price”, and marginal utility is assumed to be linear.

Analyzing results, if there is no opportunity gas consumption, there is no input foreclosure in the market. The more opportunity gas consumers, the more additional market power for a firm.

The usual horizontal effect of the market power appears, withholding gas output forces the gas price to rise. On the other hand, it shows one of the effects of vertical integration: when the firm rise the gas price, the marginal cost of her electricity production is risen as well. This would tend to lower gas prices. And finally, the ability of gas suppliers to affect the behaviour of other players in the electricity market and obtain a benefit from it. This is exactly input foreclosure and, with the model adopted, seems to be present in the gas and electricity market.

An expert in the details of gas regulation would be needed to identify the obstacles that firms are facing when managing their gas. However, impression is that there are several regulatory measures that could improve significantly the opportunities for the firms to buy gas internationally and manage their contracts more efficiently.

Most of the potential for input foreclosure is based on the idea that a part of the gas for these combined cycles has to be bought, away from the international markets, in a small market controlled by the incumbents, due to logistic constraints. This creates a local oligopoly for these sales that results in the conflictive incentives. More flexibility in the operation could allow for a better access to global markets and avoid the market power concerns.

Some useful remedies for vertical integration problems are linked to an improvement in the regulation of the gas operation.

4.4 Gas models

The natural gas market in the European Union is changing. Three main challenges for the next decades can be identified:

- The liberalization of the industry initiated by the European Commission
- An increasing demand for gas natural
- An increasing import dependency on gas supplied from outside the European Union

4.4.1 State of the literature

There are a number of other modeling attempts of the European gas sector. Its structure suggests modeling the market with oligopolistic competition in a game theoretic framework. When models reach computational limits with their large-scale simulation in terms of data inputs, appear a number of linear programming models of the European, the North American or the global natural gas markets. Their main assumption is the perfect competition which is not satisfying at least in Europe. Generally, these models optimize social welfare which seems to be unrealistic abstraction of a market where oligopolistic firms determine supply and prices. This kind of models appears in 2002.

Two tables are included with a resume of the authors and their models:

<table>
<tr><th>Date</th><th>Authors</th><th>Model</th></tr>
<tr><td>1987</td><td>Mathiesen et al.</td><td>Study of the market power in the European natural gas market</td></tr>
<tr><td>1995</td><td rowspan="2">Golombek et al.</td><td rowspan="2">Analyze the effects of liberalizing the natural gas market in Western Europe, distinguishing between upstream (producers) and downstream (traders) agents of the gas market.
Liberalization of the European gas market is defined as the situation where downstream traders can exploit arbitrage possibilities between countries as well as between market segments (industry, and local distribution companies for households). Liberalization increases upstream competition and thus welfare.
(1995) have had a lasting influence because they suggested marginal costs curves for several natural gas producers which have been widely used since.</td></tr>
<tr><td>1998</td></tr>
<tr><td>2002</td><td>Perner</td><td rowspan="2">EUGAS model
Dynamic model of long-term optimization of European gas supply, taking into account production and transport capacities, but treating gas demand exogenously</td></tr>
<tr><td>2004</td><td>Perner and Seeliger</td></tr>
<tr><td>2005</td><td>Perner and Seeliger</td><td>EUGAS model combined with electricity market models</td></tr>
<tr><td>2005</td><td>Düweke and Hamacher</td><td>EUGAS model with global gas reserves</td></tr>
</table>

Table 1: Simulation models I

Date	Authors	Model
2004	Hartley and Medlock	World Gas Trade Model Equilibrium model with a high disaggregation for the gas sector. Assumption of perfect competition, less appropriate for studying the European market
2004	Boots et al.	GASTALE model The first attempt to apply the structure of successive oligopoly in gas production and trading in a large-scale simulation model. It assumes the domestic production to be an exogenous value and symmetry of traders, diminishing the generalit
2005	Lise et al.	GASTALE model Dynamic version which includes investments in scarce transport and production infrastructure
2005	Mulder and Zwart	NATGAS model Oligopolistic producer market where a small number of strategic natural gas producers are facing price-taking arbitrages (traders) on the downstream market.
2006		GASMOD model Its underlying structure is a two-stage game (similar to GASTALE model) It includes domestic production in the optimization It changes the approach of cost functions and linear demand functions from Golombek et al.
Forthcoming	Egging and Gabriel	Strategic producers bid with conjectural supply functions, similar to NATGAS market setting

Table 2: Simulation models II

4.5 GASMOD model

This gas simulation model structures the European natural gas market as a two-stage-game of successive imports to Europe (fist stage, upstream) and trade within Europe (second stage, downstream).

First, gas producing companies decide on their exports, mostly from countries outside Europe, to European countries. Simultaneously, indigenous producers in Europe decide about their production quantities. Thus, indigenous producers and exporters are directly competing with each other.

On the second stage, gas trading companies in Europe which have imported gas and which have bought indigenously produced gas sell this gas in the European countries, including their own country. Authors implicitly assume a liberalized, but oligopolistic market in Europe: TPA (Third Party Access) to the gas network is ensured for each exporter and each European trading company. There is no destination clause which means that consumers are free to choose their supplier which may well come from abroad.

Authors do not distinguish between several market segments because they focus on the strategic relations between the producers on the first stage, and between the traders on the second stage. Furthermore, they implicitly assume that there is no vertical integration between the two stages; this assumption goes hand in hand with the aggregation of one player per country that they use.

GASMOD can be characterized as a game theoretic model assuming perfect information. The producers on the first stage have perfect information about the demand situation on the second stage and decide on their production quantities by taking into account the downstream market situation.

According to standard game theory the appropriate method of determining equilibrium prices and quantities is backwards induction.

On each stage, the players play a non-cooperative game and maximize their individual payoffs. Following the literature of energy market modeling, they model the oligopolistic markets on both stages with Cournot competition instead of Bertrand competition[10]. By assuming an oligopolistic market structure on both stages the problem of double marginalization is represented: upstream and downstream markets are imperfectly competitive and suppliers on both markets exert market power, their price includes a margin. The downstream oligopoly leads to an additional price distortion and hence to an even less efficient allocation compared to the situation of a single oligopoly.

The equilibrium on each stage is the solution of the non-linear profit optimization program of each player. On each stage, each player maximizes his profits.

Each player is restricted by capacity limitations such as transport infrastructure constraints and production capacities. On the first stage of exports to Europe, gas trade is restricted by the export infrastructure of each producer and the import capacity of each wholesale trader. In addition, the indigenous (domestic) production capacity in each European country is limited. On the second stage, the supply by each trader is restricted by the transport capacity of the pipeline grid between him and each end-user market.

Equilibrium is reached at the intersection of demand and supply. The demand coming from the downstream (end consumer) market is addressed to the traders who forward it to the exporters.

The model is run for three different scenarios. It is analyzed a double marginalization structure, it is simulated the scenario of perfect competition on both markets and on the downstream market only. Whereas the scenario of perfect competition on both markets stages seems very unrealistic, the liberalization of the

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[10] Cournot competition is based in the quantity, Bertrand competition is based in the price.

Bertrand equilibrium is also known as a Nash equilibrium of prices. It consists of a sequential game in which firms simultaneously choose the prices they want to receive for their production, followed by consumers choosing how much to purchase, with full information about each firm's posted price.

Traditional Cournot equilibrium implies that two companies choose quantities or capacities simultaneously. Each company maximizes its benefit when it knows the quantity chosen by the other. See also note 2. For more extended information about strategic interaction, see [TIROL90]

European gas sector is supposed to lead to competitive downstream market in the future.

GASMOD is a static model which structures the natural gas market as a two stage game of successive

i. Exports to Europe

ii. Trading with Europe

In contrast to other models in the literature, authors have applied a two-stage structure and have incorporated an endogenous determination of domestic production. Infrastructure capacities which are important characteristic of a network industry and which may be binding are explicitly taken into account in the model. Three model scenarios are modelled: Cournot competition on both the upstream and the downstream market, perfect competition on both markets, and Cournot competition on the upstream market with a downstream market in perfect competition.

It is found that the scenario of Cournot competition is the most realistic representation of the European natural gas market with total export and consumption quantities close to the reference data. However, our results present a more diversified picture of supplies to Europe, with newly emerging LNG exporters gaining market shares in Europe. This indicates currently, other factors are at play determining the supply relations in the real world (long-term factors, destination clauses,…) Results in the Cournot competition scenario are strongly influenced by infrastructure capacities since a limited access to a market reduces the number of players which can then exert more market power. With no surprise are found the highest prices, lowest quantities and lowest welfare in this scenario, thereby confirming the welfare-reducing effect of double marginalization.

Whereas the scenario of perfect competition is only simulated to benchmark the results of the Cournot competition on the downstream market in the presence of an oligopoly on the upstream market merits closer attention. Indeed this is a situation which could be enforced by the regulation authorities in Europe. It is discovered that this case has an ambiguous welfare-enhancing effect compared to double marginalization. This contradicts the widespread thesis than an oligopolistic downstream market is the best response to an oligopolistic upstream market. These results also point to more diversified supplies that in the Cournot scenario, which is another objective of European energy policy.

The comparison with real world data indicates that current state of the European natural gas market is best represented by a scenario of Cournot competition. Deviations for some countries suggest that modeling their market with competitive behavior might be more appropriate, be it in a competitive fringe for smaller exporters or traders, or as competitive market because of limited access to the market (which leads to unrealistically high mark-ups) or in the case of the UK because of its already successful market liberalization. There are several improvements which should be included in GASMOD, notably, the infrastructure bottlenecks that we have identified should be the basis for further investigation and for modeling the dynamics of the natural gas market and of investment in its infrastructure.

4.6 Conclusion about simulation models

Simulations models become very popular in market operations such as mergers. They constitute a base for Competition Authorities to determine competition concerns, market share and power market.

However, they do not have an established role. Operations nowadays imply more hypothesis and difficult integrations, such the vertical one, and models are not able to run with this kind of huge scenarios.

Indexes mentioned in the first part of this chapter are the quantitative measures more often used in assessing merger effects in the sector. There are, perhaps, two main reasons. The first one is that HHI has been extensively used in other sectors, so there are abundant precedents. Moreover, it is sometimes explicitly considered in the relevant regulations. Secondly, the same complexity that makes research attractive is a drawback for applying it. Complex models are not easily understood, and irrespective of assurances there might be a lingering suspicion of model manipulation. This is especially true if Competition Authorities personnel are limited or non-specialized in energy markets, and simulations are mainly provided by the merging companies. Therefore, even incremental improvements (such as the use of Pivotal Supplier Index, or the Residual Supply Index for electricity markets) are not so extensively applied as it might be desirable.

Cournot models present computational advantages, but show a critical dependence on demand elasticity, a factor that is not easy to estimate. In contrast, SFE models represent more accurately the interaction of participants in the market and the process of price formation, but have important shortcoming concerning numerical tractability.

Ideally, simulation models should use as input a rich data set, and their results should be validated by using statistical techniques. In short, simulation models are ancillary tools.

Some authors conclude that only a good regulation activity is the way of avoiding anticompetitive concerns, while simulation tools are not enough developed to determinate them.

5

Analysis of vertical integration: a study case

5 Analysis of vertical integration: a study case

5.1 Introduction

This section analyzes possible vertical effects of abuse of market power, by simulating an operating case based on the Spanish system situation in January, 2005. Electricity market simulation was done by using the Marape code, developed at IIT. Gas market representation was a simpler one, as explained in the sequel. Section provides numerical results that can clarify the proposed methodology in more general scenarios.

5.2 Simulation methodology

The proposed procedure was based in increasing domestic gas prices to represent possible market power of the natural gas incumbent. This new and high price was internalized by all generators in the electricity sector. At certain critical domestic gas price, generation plants merit order changed, being physical operation between this break prices fairly constant. In the sequel, we call these regions of almost constant operation, gas prices zones.

In order to increase domestic gas prices, Natural Gas must exercise any possible market power that may have in the gas market. Therefore, it is needed to model the gas market. The model (a much simpler one than the electricity model) includes two parameters: the gas market elasticity and the gas long-term contracting. The model and the parameters meaning are discussed below.

The sequel of this chapter is organized as follows.

5.3 Electricity market simulation: Marape model

This computer model, based in production costs, has its origin in a thesis by Carlos Batlle, an engineer working at IIT.

Nowadays production costing models are not enough in oligopolistic electricity markets, because market participants seize their dominant position looking for higher profits. Because of that, Marape uses marginal costs and considers also bid prices. Thus, the merit order composition is considered in this model to represent the agents'strategic bidding. It provides the system price-duration curve as well as the income and expected costs of every generating agent. In addition, it offers potential computational speed, the main advantage of the strategic production costing model.

It is worth to explain briefly how it is organized. Its input data appears in an excel folder that can be easily modified and it is run in Matlab. As outputs, it is able to give the user production costs, demand values, name of the firms producing, fuel which is producing, which kind of technology is marginal,… all the different inputs that are needed for this analysis.

Some input hypotheses were modified to adapt the program to analysis objectives. These were:

- Perfect competition
- Single bus system
- No emission trading, or CO2 quotas
- No forward markets
- Reduced scale factor, blocks were chosen to have 10 hours

To find the natural gas price zones, different curves had to be determined. With Marape three curves were extracted: hours while CCGT's are marginal, total energy supplied by this gas technology and inframarginal energy supplied under the marginal CCGT's. The input data was the change in the price of gas, from 25€/MWh to 50€/MWh. It is worth to mentioned that after 45,7€/MWh the use of gas as fuel is not longer the marginal technology.

Knowing this data, curves were obtained and the four zone studies determined.

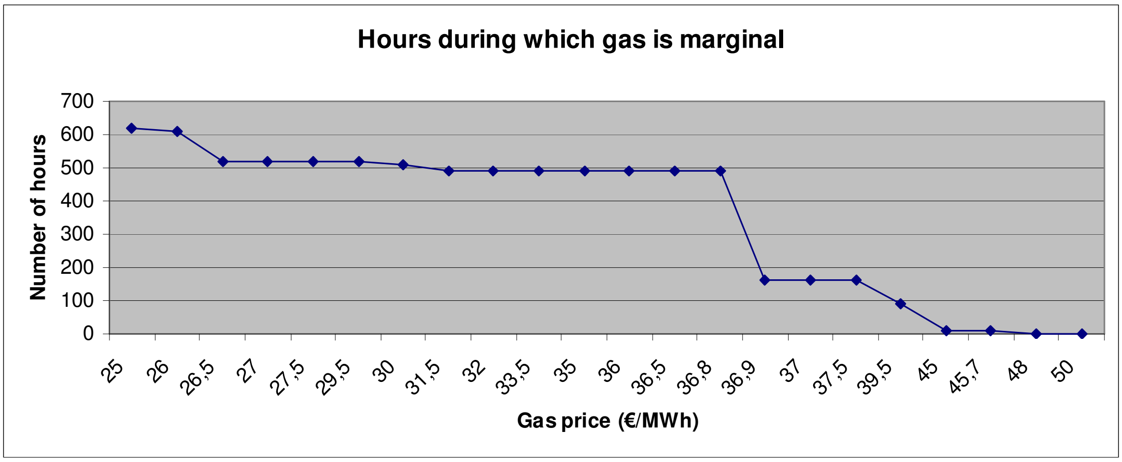

Figura 4: Hours during which gas is marginal

Fours different zones were selected, with prices: 26 – 27,5 – 36,5 – 37,5. These zones correspond to the different merit order of generation technologies. After that characterization, two other curves were extracted.

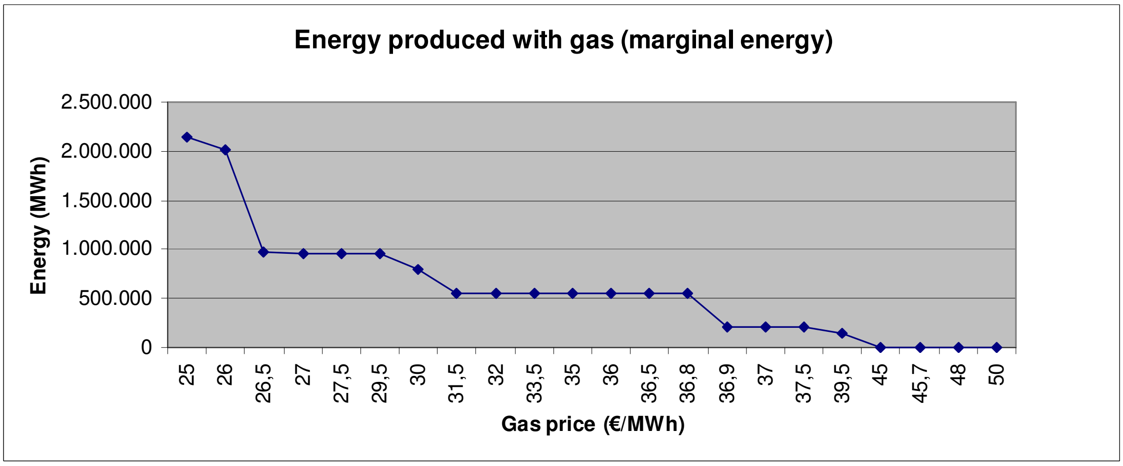

Figure 5: Energy produced with gas (marginal energy)

This curve was calculated considering only marginal energy that was completely produced with CCGT, natural gas as fuel.

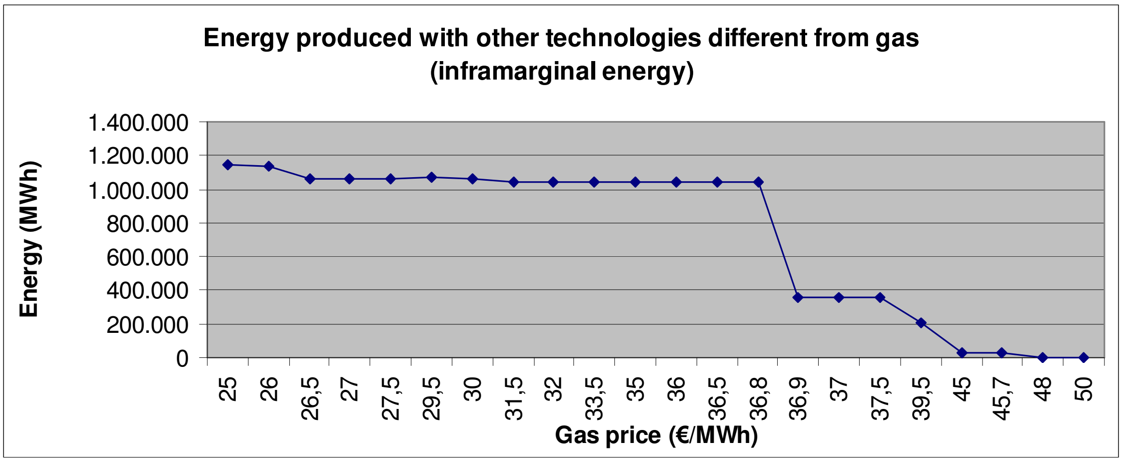

Figure 6: Energy produced with other Technologies different from gas (inframarginal energy)

This curve shows the energy produced under CCGT plants, the inframarginal energy. It was produced by other thermal plants, with fuel different from gas.

It is important to understand that after these selected zones, different calculus and numbers were calculated. The interest is only illustrative, there are not real numbers, because to simulate a real gas and electricity markets with real parameters and considerations was not the objective of a final studies project.

For each price determined, profits in generation plants were calculated considering all the different technologies.

	Natural Gas - CCGT	Nuclear	mixed	Fuel-oil	Domestic coal	Hard coal	Imported coal	Bituminous coal	Hydraulic	Gen - France
Price 37,5										
Income	7,77E+06	1,89E+08	5,63E+06	1,28E+07	1,27E+08	3,14E+07	8,31E+07	4,24E+07	9,79E+06	2,14E+07
Costs	7,77E+06	1,90E+07	4,58E+06	1,27E+07	7,56E+07	2,18E+07	5,37E+07	2,89E+07	0,00E+00	7,48E+06
Profit	*0,00E+00*	*1,70E+08*	*1,05E+06*	*1,14E+05*	*5,18E+07*	*9,63E+06*	*2,94E+07*	*1,36E+07*	*9,79E+06*	*1,39E+07*
	20%	*3,41E+07*	*2,10E+05*	*2,28E+04*	*1,04E+07*	*1,93E+06*	*5,87E+06*	*2,72E+06*	*1,96E+06*	*2,78E+06*
Price 36,5										
Income	2,02E+07	1,87E+08	5,55E+06	0	1,26E+08	3,11E+07	8,21E+07	4,20E+07	9,64E+06	2,11E+07
Costs	2,02E+07	1,90E+07	4,58E+06	0	7,56E+07	2,18E+07	5,37E+07	2,89E+07	0,00E+00	7,48E+06
Profit	*0,00E+00*	*1,68E+08*	*9,74E+05*	*0,00E+00*	*5,04E+07*	*9,27E+06*	*2,84E+07*	*1,31E+07*	*9,64E+06*	*1,37E+07*
	20%	*3,37E+07*	*1,95E+05*	*0,00E+00*	*1,01E+07*	*1,85E+06*	*5,68E+06*	*2,62E+06*	*1,93E+06*	*2,73E+06*
Price 27,5										
Income	2,63E+07	1,53E+08	0	0	1,02E+08	2,48E+07	6,54E+07	3,37E+07	7,29E+06	9,83E+06
Costs	2,63E+07	1,90E+07	0	0	7,56E+07	2,18E+07	5,37E+07	2,89E+07	0,00E+00	0
Profit	*0,00E+00*	*1,34E+08*	*0,00E+00*	*0,00E+00*	*2,66E+07*	*3,04E+06*	*1,16E+07*	*4,86E+06*	*7,29E+06*	*9,83E+06*
	20%	*2,67E+07*	*0,00E+00*	*0,00E+00*	*5,33E+06*	*6,08E+05*	*2,32E+06*	*9,72E+05*	*1,46E+06*	*1,97E+06*
Price 26										
Income	5,23E+07	1,47E+08	0	0	9,73E+07	2,38E+07	3,58E+07	3,23E+07	6,90E+06	9,44E+06
Costs	5,23E+07	1,90E+07	0	0	7,47E+07	2,18E+07	2,71E+07	2,89E+07	0,00E+00	0
Profit	*0,00E+00*	*1,28E+08*	*0,00E+00*	*0,00E+00*	*2,25E+07*	*1,96E+06*	*8,69E+06*	*3,42E+06*	*6,90E+06*	*9,44E+06*
	20%	*2,55E+07*	*0,00E+00*	*0,00E+00*	*4,51E+06*	*3,92E+05*	*1,74E+06*	*6,85E+05*	*1,38E+06*	*1,89E+06*

Table 3: Income and costs in different generation technologies

Income and costs for the different technologies were calculated with Marape. Generation in France also appears, but it does not have interest in this study. The cost of hydraulic technology is zero, as it was expected. The profit, the difference between the income and cost of each technology was calculated. One of the first parameters of the study appears on it, the percentage of participation of the gas company in generation production, considering that the new entity will try to share its capacity between different technologies and not only in gas. The parameter, was changed from 0% (a firm that only has no participation in electricity generation, it only has gas production without electricity objectives) to 100% (a firm with all generation capacity). In equation form,

ΔBelec= $\sum \alpha$ * profit with the different technologies

It is also needed to have data on the amount of natural gas used for electricity production:

	Gas burned (MWh) from GN	Gas burned (MWh) from other firms	Total Gas burned (MWh)
Price 37,5	5.505	15.222	20.726
Price 36,5	3.669	51.612	55.281
Price 27,5	27.329	68.213	95.542
Price 26	41.251	159.926	201.177

Table 4: MWh of gas burned at different prices and from different companies

In this table, for each price, appears the gas burned from Gas Natural and from other firms. As it was expected, when the gas price rises, the quantity of gas burned is reduced. It is going to have an important relevance to quantify the “buy-back” effect, explained below.

5.4 Natural gas market simulation

The market gas data are based in information obtained from different CNE informs about 2005 Spanish situation.

The total gas consumption was 368.141 GWh, with 61.414 GWh in the regulated market and 306.727 GWh it was gas consumed in the liberalized market. It means 17% of the natural gas consumption in the regulated market and more than 83% in the liberalized market[11]. Considering the part of the liberalized market that goes to the electricity generation, in the electricity inform from CNE it is found that the part of the liberalized electricity market is 84.804 GWh[12].

Therefore:

306.727 GWh – 84.804 GWh (for electricity generation) = 221.923 GWh.

Total gas = 221.923 GWh + 61.404 GWh = 283.327.000 MWh

That's the total for a year, for 2005. To calculate the demand just for January, the month selected to perform the simulations, data was taken from another CNE inform[13].

36.000 GWh of natural gas were consumed in January 2005. Among them, 8.000 GWh were used to generate electricity. It results a total of 28.000 GWh in January 2005 in the gas sector. It is assumed, as a stylized hypothesis, that all the non-electric demand is supplied by Natural Gas.

It means to divide by ten the total of the year that was calculated before. It seems reasonable enough, knowing that January is a month with a very high demand, so to divide by ten the total and not by twelve, the number of moths, can be considered as a good approach. The first data used in equations is this quantity, the quantity of gas consumed at an international price, 26€/MWh. Equations are going to differentiate domestic prices (the four prices calculated before) from it, considered equals to the first

[11] Extracted from [CNE06b]

[12] Extracted from [CNE06c]

[13] Inform [CNE06d]

domestic price. Therefore, writing non-electric gas consumption as a function of price, it yields

Qgas(26)= 28.000 GWh = 28.000.000 MWh

As domestic gas price increases, no-electric gas consumption decreases according to the assumed demand price elasticity. However, not all the gas demand responds to the price increase, but only the fraction not covered by long-term contracts. These contracts can represent either standard supply contracts or regulatory or strategic commitments to supply a certain segment of the demand. In mathematical form, if *e* is the demand elasticity and *f* the fraction of gas supply under long term contract, it can be written:

$$\Delta Qgas = - e * (\text{domestic gas price} - 26)/26 * Qgas(26) * (1-f)$$

e is a model assumption, being several scenarios (0'1, 0'2, …1) analyzed. *f*, the fraction of long-term gas already contracted, varies from 0 (no long-term contracts for gas) to 1 (all gas already bought in long-term contract.

Actually, simulation show that in our model Natural Gas only lacks of incentives to increase domestic gas price, assuming that market power is a real concern, if the contracting level is very high. Therefore, it is assumed in the study that the level of contracting is 1, which means that every agent but possible a very small fringe is able to buy natural gas at the competitive long-term international price. Other assumptions can be, however, accommodated in our model.

Finally, a last effect must be included in our simulations. As consequence of the increase in the domestic gas price, generation plants will burn less gas than in the reference (no market power exercise) scenario. This gas, imported in the Spanish market, will finally find its way to the domestic consumers. A way to model this effect is to think that Natural Gas buys the excess gas at the domestic price to supply with it the non-electricity market. It is worth to emphasize that specific mechanisms could be quite different. In formal terms,

QgasInt = Qgas(26) + Δ Qgas - (MWh of gas burned by other electricity firms at 26 €/MWh – MWh of gas burned by other electricity firms at the domestic price) being QgasInt is the quantity of gas purchased in the international market, so it is always bought at 26€/MWh. This equation shows that QgasInt decreases because of the change of the elasticity and the factor f (reflected in Δ Qgas) and the "buy-back" effect. This effect is quantified in table 2.

Looking to the costs, it is clear that

Cost of gas in the international market = QgasInt * 26

On the other gas, Gas Natural income in the gas market is

ΔIgas = domestic price * (Qgas(26) + Δ Qgas – f* Qgas(26)) + 26*f* Qgas(26) – 26 * Qgas(26))

Variation in the income for gas consumed reflects: price of gas multiplied by (the initial quantity needed for the period – variation of gas because of the "buy-back" – fraction of gas already bought in long-term contracts) + price paid for the gas bought with a long-term contract – quantity needed for the period that was bought in the international market. Therefore

ΔBgas = ΔIgas - Δ Cost of gas = ΔIgas – 26 * (QgasInt - Qgas(26))

Variation in benefit it he gas sector uses the economic definition for it, income variation minus cost variation. It equations, the income was calculated with the precedent expression and variation in costs are the quantity of gas needed in the period minus the gas already bought in the international market.

5.5 Putting all together

Let us consider a specific scenario

- Domestic price: 36,5€/MWh; International price: 26€/MWh
- α = 20% (percentage of generation production)
- Elacticity: 0'2

- Factor f: 1
- Qgas(26)= 28.000.000 MWh

In the **electricity sector,**

ΔBelec= ∑ 20%profit with the different technologies = 5,61E+07 (sum of the last row showed in the table)

Price 36,5	Natural Gas	Nuclear	mixed	Fuel-oil	Domestic coal	Hard coal	Imported coal	Bituminous coal	Hydraulic
Income	2,02E+07	1,87E+08	5,55E+06	0	1,26E+08	3,11E+07	8,21E+07	4,20E+07	9,64E+06
Costs	2,02E+07	1,90E+07	4,58E+06	0	7,56E+07	2,18E+07	5,37E+07	2,89E+07	0,00E+00
Profit	*0,00E+00*	*1,68E+08*	*9,74E+05*	*0,00E+00*	*5,04E+07*	*9,27E+06*	*2,84E+07*	*1,31E+07*	*9,64E+06*
	20%	*3,37E+07*	*1,95E+05*	*0,00E+00*	*1,01E+07*	*1,85E+06*	*5,68E+06*	*2,62E+06*	*1,93E+06*

In the **gas sector**

Δ Cost of repurchasing = (159.926 – 51.612) * 36,5= 3,95E+06

	Gas burned (MWh) from GN	Gas burned (MWh) from other firms	Total Gas burned (MWh)
Price 36,5	3.669	51.612	55.281
Price 26	41.251	159.926	201.177

Δ Qgas = - 0,2 * (36,5 - 26)/26 * Qgas(26)* (1-1)= 0

QgasInt = Qgas(26) + Δ Qgas - (159.926 – 51.612)= 2,79E+07

Cost of gas in the international market = QgasInt * 26= 7,24E+08

ΔIgas = 36,5 * (Qgas(26) + ΔQgas – 1*Qgas(26)) + 26*1*Qgas(26) – 26 * Qgas(26))= 0

ΔBgas = ΔIgas – 26 * (QgasInt - Qgas(26)) = 3,76E+06

In **both sectors**

ΔBtotal= 5,61E+07 - 3,95E+06 + = 3,76E+06= 5,49E+07

It is evident that to have participation in electricity generation having gas assets provides a market power incentive to the firm. The table below shows this tendency:

Price/ % generation capacity in electricity sector	**0**	**5%**	**10%**	**15%**	**25%**	**50%**	**75%**	**100%**
37,5	-1,66E+06	1,26E+07	2,69E+07	4,12E+07	6,98E+07	1,41E+08	2,13E+08	2,84E+08
36,5	-1,14E+06	1,29E+07	2,69E+07	4,09E+07	6,89E+07	1,39E+08	2,09E+08	2,79E+08
27,5	-1,38E+05	9,22E+06	1,86E+07	2,79E+07	4,66E+07	9,34E+07	1,40E+08	1,87E+08
26	0,00E+00	8,56E+06	1,71E+07	2,57E+07	4,28E+07	8,56E+07	1,28E+08	1,71E+08

Table 5: Total esteemed benefit for different domestic prices and different % in generation capacity

6
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