CHAPTER 6

Wholesale markets — regulation of electricity and gas industry

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1. Introduction

This chapter is dedicated to analysing the functioning of the gas and electricity markets. Both sectors have undergone profound changes in the last three decades due as much to technical progress — that has affected the sources of electricity generation, the role of the consumer, the appearance of new supply markets for gas and the whole network of transport and distribution — as to the introduction of mechanisms of competition rather than public and private monopolies. Price signals permit an efficient allocation of resources benefitting competitiveness in the sector and consumers.

Since the beginning of the 80s, a model of competition has been introduced into markets that had traditionally acquired a monopolistic character, either because of the predominance of the conditions for natural monopoly or because of the existence of monopolies established by law — transport, telecommunications or electricity. In this context, the energy sector, recognised for its strategic nature as an indispensable input factor for the correct functioning of the productive system of countries, also found itself immersed in this process of structural change and consequently demanded the strategic design of a new system with a legal framework for its functioning that would guarantee its long-term viability and ensure competitiveness, the security of the electricity supply and environmental sustainability.

Traditionally the energy sector has been subject to both a high level of public intervention, with the purpose of guaranteeing basic services to the population, and a monopolistic structure. Basically, the system consisted of a vertical business structure in the electricity industry in which the various activities in the value chain — generation, transport, distribution and retailing — took place under a monopoly. Nevertheless, the development of a new market approach doctrine, the emergence of technological innovations in generation, the

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appearance of new materials and improvements in services due to Information and Communications Technologies, together with the low interest rates present internationally in the financial world (Pérez Arriaga et al., 2010) led to a generalised restructuring and liberalisation process in the energy sector in numerous developed and developing countries. The aim of this structural change lay in stimulating competition, improving business efficiency and increasing investment and innovation rates in the firms.

The first experience of this liberalisation and reform process can be found in 1982 in the Chilean electricity industry and later in the domestic gas supply industry in the United Kingdom (1986), Argentina (1992) and in other Latin American countries, New Zealand and various American states. In Europe, although some member states had gone ahead first, the first steps towards liberalisation were not taken until 1996, guided institutionally by the authorities of the European Union (EU) through a series of reforming directives. The objective of these directives was to construct a single European market for electricity and gas (Glachant and Ruester, 2014; Meeus et al., 2005). Meanwhile the main Asian power did not want on the margin of sidelines in this liberalisation process, and in 2002, a significant analogous reform of the Chinese electricity market took place (Gao and Van Biesebroeck, 2014).

The liberalisation of the energy market has been mainly characterised by the introduction of competition and the establishment of independent regulators. The new programme of liberalisation contemplates the elimination of subsidies, the vertical unbundling of competitive activities that go over to working under a market regime — such as in the case of generation in the electricity sector and retail, for electricity as well as gas, and for those considered to be natural monopolies — transport and distribution, free access for all potential users to network infrastructures and installations, the horizontal separation of established operators with the purpose of creating viable competitors and the creation of a set of independent regulating organisations to ensure that the energy market would always function efficiently and in a manner compatible with the maximisation of social welfare.

The liberalisation processes in the electricity and gas sectors have been comparable between the electricity and gas sectors as they share a set of characteristics — network industries, significant technical restrictions and so on — although with some particular exceptions for each type of energy that determines different models and development. Essentially, the electricity sector is made up of a wholesale market that closes its purchase operations fundamentally through simultaneous short-term matching mechanisms, as against the mechanisms of bilateral matching of supply and demand that belong more to the wholesale markets for natural gas.

A market that works well is a tool that permits affordable prices to be guaranteed, greater transparency to be offered and the welfare of consumers to be improved as they have the option of choosing freely between the various offers presented by retailers. This is without forgetting that transport and distribution are, on the other hand, considered to be natural monopolies and are regulated and subject to the principle of free access to the network for third parties, a fundamental requisite for all the operators to work freely.

To conclude this introduction, it should be pointed out that, in general, the process of transforming a vertically integrated sector into a sector under competition has been taking place for several years in different continents and at asymmetric rhythms (Erdogdu, 2011; Pérez Arriaga et al., 2010). In the literature, there is currently a broad debate about the benefits of this liberalisation process that started more than 20 years ago (Fabrizio et al., 2007; Jamasb and Pollitt, 2005; Joskow, 2008; Rasines García, 2006). Although the empirical evidence is not conclusive, international experience has demonstrated that the design and implementation of suitable reforms results in a significant improvement of the energy system, giving it greater competitiveness and innovation, security of supply and quality in the policy instruments for controlling environmental sustainability. However, during recent years, a certain abatement of the initial euphoria of liberalisation has also been observed due to various events — the crisis in California of 2000—01, successive blackouts in countries with liberalised systems and the irruption of renewable energies that present new challenges to the matching mechanisms — so that in some countries the process has suffered a certain deceleration that has affected the reforms or they have not been fully completed (Pollitt, 2012).

Nevertheless, with some particularities, the different countries have shared the common objective of creating a more intense competitive environment that provides firms with incentives to reduce costs and improve efficiency in relation to monopoly. This in turn induces firms to invest in innovation as a way to gain market share and generate a competitive advantage that is sustainable over time. On the supply side, the opening up of energy markets to competition means there are more offers available to consumers, lower prices and better quality products and services.

After this introduction, this chapter deals with, in the second section, the role of regulation in the energy markets and the European experience of liberalisation. In the third section, we analyse the workings of the electricity and gas markets. This analysis is accompanied by two case studies, the Iberian Electricity Market (MIBEL) and the natural gas hub in Europe, paying special attention to the Iberian Gas Market (Mibgas). Finally, the last section presents the main conclusions.

2. Liberalisation process: transforming the energy market landscape

2.1 Principles of regulation: regulation of monopolies and markets

The supply electricity and gas were for a long time clear examples of monopoly markets. Transportation and distribution required suitable infrastructures for their technical characteristics — electricity networks and gas pipelines — because both of them are considered natural monopolies. The construction of parallel systems is neither technically reasonable nor economically practicable. Natural monopolies exist for economic and technical reasons such as high capital costs, economies of scale and other barriers to entry of such a size that one single company is capable of satisfying demand more efficiently than a group of companies in competition. In other words, a company is a natural monopoly when the capital costs are so high that it is no longer viable for a second firm to enter the market and compete (Mankiw and Taylor, 2006). For this reason, it is economically more efficient that there is one single firm responsible for constructing and operating a network — electricity or gas — instead of two or more firms in competition.

A firm that carries out its business activity in a natural monopoly situation, as is so, in the majority of monopolistic situations, can use its market power to behave abusively, which turns into a loss of social welfare. In these circumstances, the intervention of public authorities is necessary — governments in the case of Europe and Regulatory Commissions in the United States — through regulation, especially when the power of the market is considerable and the industry, as in the case of the energy industry, is essential and it is intended to ensure universal access to the service.

In a context of great market power, the theory of regulation becomes very important. According to Lasheras (2010:p.149), this theory is understood as the '*part of industrial economics that studies how to determine which tariffs are compatible with the economic incentives that bring efficiency, which are the economic effects of business structure and behaviour in sectors that have traditionally been run as monopolies, basically those that use single transmission and distribution networks*'. So in general terms, the theory of regulation refers to the set of mechanisms and legal instruments that regulators have at their disposal to be able to influence and stimulate the economic activity of firms in a market so they act efficiently, through the setting of quantities, prices, levels of quality or investment (OCDE, 1997; Train, 1991).

Historically, before the liberalization, a fundamental question in regulation consisted in determining the correct regulated price for the electricity and gas supply sectors organised as monopolies. In the majority of countries, initially, the setting of prices guaranteed the firms sufficient income to cover the costs of

operation and maintenance and a regulated rate of return. These costs of operation and maintenance incurred by firms were accepted directly as regulatory assets value. This model did not provide any incentive for efficiency in the firms as all their costs were transferred directly to consumer tariffs.

Given these circumstances, any investment decisions (erroneous or not) authorised by the regulator were then socialised and paid for by the consumers in the form of increases in tariffs, as the firms always had the coverage of costs assured. In any case it is necessary to mention that besides the lack of productive efficiency associated with regulation based on the costs of production of the firm, these traditional methods were subject to wide-ranging information requirements, generating great asymmetry of information between the regulator and the regulated firm.

It can be seen that in the traditional scheme of organising the electricity and gas markets, the resulting cost to the consumer was secondary, ceding priority to the objective of guaranteeing the supply.

2.2 Second wave of energy markets regulations: in search of efficiency

Nevertheless, during the 90s and as a consequence of the oil crisis at the end of the 70s, the price of energy became a priority on the political agenda, giving rise to new regulatory measures that reflected the cost of investment and efficient operation through various forms of regulation by incentives known as '*incentive-based regulation*' — price cap, benchmarking and yardstick — instead of the initial and strict coverage of costs. These clear and simple models of incentives for efficiency through the reduction of costs were oriented towards creating a set of 'advantages' or 'disadvantages' similar to the pressures of competitive markets. Although these measures required less information from the firms and had a lower cost of regulation compared to the traditional cost of service regulation, they were criticised as they were not considered to be optimal because in some circumstances they did not take changing conditions in the conjuncture in the activity into account, possibly damaging the security and quality of supply.

It was obvious that the traditional system in the energy sector suffered from considerable problems of efficiency, with the regulation of tariffs based on high average costs, far from any criteria of marginal or competitive costs. As a result, in the decade of the 90s, a set of generalised restructuring measures appeared on both sides of the Atlantic, which, to a greater or lesser extent, were focused on liberalising the market and bringing substantial improvements in the global efficiency of the energy sector. To be brief, this process towards a liberalised market was possible, thanks to technical progress and the appearance of new technologies and materials that allowed significant reductions in

economies of scale, the optimal size of generating installations, the high costs of investment and the technological and social complexity that had initially characterised the electricity and gas sector.

The main measures in the reform of a vertically integrated energy market that was publicly owned into a privately owned competitive industry consisted of a restructuration of the sector by separating the vertically integrated activities — vertical unbundling. As a result, the transmission and distribution activities continued to be regulated, maintaining their character of natural monopolies, while generation and retail activities were organised to be competitive. In addition to this, incentives were provided for the introduction of market mechanisms to reduce horizontal concentration — horizontal unbundling — thereby creating sufficient effective competition in generation and the retail business. In addition, special regulation was created, which led to the establishment of an independent regulator and access for third parties to the networks; finally, these measures became changes in the ownership of the companies by fostering the privatisation of the existing public companies (Jamasb and Pollitt, 2005).

Thanks to the long learning process undergone during the liberalisation of the electricity market, significant continual change and progress can be seen in the focus and the recommendations proposed by the theory of regulation (Jamasb and Pollitt (2005) and Lasheras (2010)). In the beginning, there was notably considerable attention to the power of the market, asymmetric information and structural measures. In recent years, on the contrary, and not because problems of market concentration are less important, a change in strategy can be detected prioritising the institutional design of the market and regulatory practice (Lasheras, 2010).[1]

At the beginning of the liberalisation process, there was a broad consensus about the many benefits this restructuring meant, such as greater allocative and productive efficiency, freedom of entry for firms, an increase in innovative capacity, competitiveness, better services and quality and so on. However, considering the experience of the last 20 years or more, the academic literature has demonstrated the difficulty of arriving at an optimal market system (Joskow, 2008). The main challenges for the liberalisation of the energy sector

[1] Nowadays important steps towards the convergence of regulation have been taken as result of the different platforms of regulatory bodies, at the continental and international levels, integrated into the International Confederation of Energy Regulators (ICER). http://icer-regulators.net/icer-members/.

are related, on the one hand, with the difficulty of putting forward regulation that leads to an optimal market design that produces a set of economic signals that are ideal for the various agents in the market and, on the other hand, developing a regulation of regulated activities that generate sufficient incentives for efficiency in investment decision-making.

2.3 The European experience: from the first energy package to clean energy for all Europeans

Historically energy networks in Europe have been constructed and operated at national level by vertically integrated monopolies, generally totally or partly state-owned. In this way, energy policy has been based mainly on the national ambit, with limited cross-border trade. In addition, the European gas sector exhibited a set of risks — security of supply and high levels of capital-intensive investments — due to a high level of dependency and a lack of diversification of supply. This was added to a certain amount of opacity in the wholesale markets in some member states.

With the aim of correcting this situation, it is not surprising that one of the main challenges for the EU in the last 30 years has consisted in improving cooperation and integration between members in energy networks, with the ultimate objective of developing an internal energy market — for electricity and gas — that will generate opportunities and foster efficiency, competitive prices, security of supply and increase service quality and energy sustainability.

The strategy of the EU to achieve this transformation of the energy market has been based on the implementation of four sets of measures taken between 1996 and 2016 (see below). In particular, during the last decade, the energy sector has been characterized by great dynamism, largely because of the introduction of the environmental issue into the energy agenda to achieve a sustainable, low carbon, resource efficient and competitive system. In other words, there has been coordination between the energy and climate policies of the EU. The first package included directives on common rules for the interior electricity and gas market (EU Directive 96/92/CE and EU Directive 98/30/CE, respectively), and these were the first steps away from the regulated model that had existed until then towards the introduction of market mechanisms into the European energy sector.

- *The First package*: The first legislative package laid the basis for the liberalisation process in the energy sector in the EU and introduced

important structural changes in the markets. One was vertical unbundling, which was the breaking up of the vertically integrated structures of the firms through the legal separation of transport and distribution activities from production and retail, and another was the establishment of third party access (TPA) systems to networks. Although these measures were the first stimulus for market mechanisms in the majority of EU countries, their impact was limited and important questions such as the disconnection of vertical integration, cross-border trading of energy and the supranational integration of energy markets remain ambiguous and have a long way to go.

- *The Second package*: After the first limited legislative package and with this opening-up seen with a certain amount of suspicion by many member states, as well as little accumulated regulatory experience until that time, the Council of Europe that took place in March 2002 agreed to continue to make progress with the liberalisation process in the energy markets. In 2003, a new legislative package was passed (EU Directive, 2003/54/CE and EU Directive, 2003/55/CE, about common rules for the electricity and gas markets, respectively, Directive, 2004/67/CE with measures to guarantee the gas supply and two regulations concerning the conditions of access to the transport network). This second package was a small advance in the effective liberalisation process and the creation of a common internal European market, with stricter provisions regarding the rules for TPA to the network, the distribution of vertically integrated services, the security of supply and consumer protection. In parallel, the directives established the right of consumers to freely choose their supplier.

In the face of the considerable reticence of national governments to abandon control over energy, it became necessary to create an institutional mechanism to coordinate regulation at a European level, the European Regulators' Group for Electricity and Gas (ERGEG), with the purpose of facilitating '*consultation, coordination, and cooperation of national regulatory authorities, contributing to a consistent application in all Members States*' (EU Decision, 2003/796/EC).

Nevertheless, although the first and second packages of EU Directives on the energy market took the first steps towards the unbundling of the industry and the gradual opening-up of national markets, its impulse was not sufficient to reach the final goal of constituting a single European market for gas and electricity. There was still a high level of concentration that limited competition, meagre integration of national markets, vertical integration between network

activities and the liberalised activities, national regulators with few competences and a lack of domestic consumers' rights.

- *The Third package*: A third legislative package was passed in April 2009 to respond to these problems, covering three regulations and two directives (EU Directive, 2009/72/CE for the electricity sector and EU Directive, 2009/73/CE for the gas sector). The object of these was to provide a definitive impulse to the creation of an internal energy market through a set of mechanisms. The effective separation of retail and production activities from those of managing the networks was established with three different models: through the total separation of the ownership, through independent network management and finally through the independent management of transport.[2] In addition, this package of rules fostered the integration of the different internal markets of the member states, the coordination of cross-border transport operations and reinforced the regulatory bodies and their independence.

A significant contribution to this package was the inclusion of a proposal for the creation of a regulating agency for the EU to be in charge of supervising market integration and coordinating cross-border regulation and to be known as the Agency for the Cooperation of Energy Regulators (ACER). It also attempted to strengthen consumer rights and the most vulnerable consumers, as well as to offer a guaranteed universal electricity service at a reasonable price that would be transparent, nondiscriminatory and easily comparable.

The third energy package allowed a set of considerable advances to be achieved, from greater liquidity, transparency and competitiveness in the European electricity and gas markets to a significant increase in cross-border trade and the welfare of consumers in the EU. It can be seen that EU policy in energy has been evolving over the years going from a strategy based exclusively on liberalisation and on the development of an interior market to, recently, a more transversal focus, in which climate change and sustainability, the security of the energy supply and the role of the consumer present a challenge in this development process.

[2] The three models that introduced important changes in the separation of transport activity are: TSO (*Transmission System Operator*) where the operation of the system and the transport of electricity or gas are carried out by a single agent, the ISO (*Independent System Operator*) when an independent body takes on the technical operation and coordination of the electricity or gas system, and the ITO (*Independent Transmission Operator*) that allows the vertically integrated firms to continue the activities of transport and system operation as long as adequate functional separation is guaranteed.

- *The Green package*: The EU, in its global fight against climate change and to meet its acquired commitments — the Kyoto Protocol of the United Nations Framework Convention on Climate Change — agreed in March 2007 through the Council of Europe on a new strategy in energy and environmental issues named 20/20/20. This stated that by 2020, 20% of energy produced must be produced from renewable sources, energy efficiency must be improved in the EU by 20%, opposing present trends, and greenhouse gas emissions must be reduced by 20%. In this context, the EU developed a set of new directives known as the Green Package. Among these measures can be highlighted EU Directive 2009/28/CE regarding the use of energy produced by renewable sources and the decision on the effort of member states to reduce their greenhouse gas emissions (EU Decision 406/2009).
- *The Winter package*: Finally, taking the environmental commitments of the Paris agreement as a starting point, on 30 November 2016, the European Commission presented the last legislative proposal, which was called Clean Energy for all Europeans and known popularly as the winter package. The package proposes to transform the future of European energy by advancing towards a change in the business model that will accelerate the energy transition and permit the creation of employment.

The proposals in the package have three fundamental objectives: prioritise energy efficiency, convert the EU into a world leader in the field of renewable energies and, finally, offer a fair deal to energy consumers. To achieve these objectives, the eight legislative proposals encompass energy efficiency, renewable energies, the design of the electricity market, the security of supply of electricity and the governance rules of the EU. These legislative proposals were approved by the European Parliament and the Council of Europe in 2018 and early 2019. Now, EU countries have 1—2 years to transpose the new directives into national law (EU Directive, 2018/844; EU Directive, 2018/2001; EU Directive, 2018/2002; EU Regulation, 2018/1999; EU Regulation, 2019/943; EU Directive, 2019/944; EU Regulation, 2019/941; EU Regulation, 2019/942).

Regarding the markets, these proposals imply a certain redefinition of models according to important advances associated with digital technology — smart meters and demand response — with the growing share of renewable energies and with the empowerment of consumers (EU Directive, 2019/944).

The rhythm of growth of renewable energies during recent years has highlighted the inclusion of changes in market rules to facilitate the efficient development of renewables, provide investors with stability, simplify administrative

procedures, develop the potential of the heating and refrigeration sector, promote innovation in the decarbonisation of transport, increase the flexibility of the system and guarantee the security of supply that these energies can make difficult. To do so, the EU aims to improve cross-border interconnections and trade to consolidate the single European market in a definitive manner.

Lastly, the new role of the consumer should be highlighted as an active agent and fundamental pillar of the energy transition. The Commission has presented a set of initiatives to empower consumers and allow them greater control over their decisions with regard to energy. They will be allowed to change supplier more easily, access information on their consumption of energy and its cost and have access to more transparent markets with price comparison tools, as well as the possibility of producing and selling their own electricity. The new role of the consumer justifies a revision of the working of the markets.

Given the initial diversity of the energy sectors in the EU, the various legislative packages passed over the last 20 years have allowed a degree of standardisation to be achieved with regard to structures, institutions and rules in national markets. Nevertheless, liberalisation and integration of the single electricity and gas markets in the EU is a continuous process and requires constant work coordinated between the European Commission and the governments of the member states, the firms and consumers to achieve a good outcome.

3. Electricity and natural gas wholesale markets

Having presented the development of the liberalisation process for gas and electricity sector in the previous sections, in this section we enter into the actual functioning and characteristics of the organised markets for electricity as well as natural gas, paying particular attention to aspects of their design and future challenges, these not necessarily being the same given their different degrees of maturity.

3.1 Electricity wholesale market

In this section we will focus on the wholesale electricity market. In the first part, the different elements of the market design are explained in detail. This is followed by a description of the evolution of the market integration process and by an analysis of the future challenges facing the electricity market. Lastly, the integration of the Iberian electricity market is presented as a case study.

3.1.1 Markets design

Nowadays liberalised electricity markets, at the wholesale level, are arranged into a sequence of (organised and/or nonorganised) markets in which economic agents exchange energy for different periods. First, in the long-term markets, the transactions take place at different moments in time, from the week before delivery of the electricity to years ahead. Second, a spot market takes place the day before delivery, and this is also called the day-ahead market. The first schedule of the electricity programme for the next day is usually built with the results of this market. And third, the short-term markets operate from the day before delivery — after the spot market closes — until the day of delivery, including real-time transactions. Although differences exist between countries on specific elements, given the nature of the economic activity encompassed — immediate need and non—large-scale storability — in general, the wholesale electricity markets are characterised by the above into a sequence of markets (summarised in Fig. 6.1).

On the spot market, operative during the day before delivery, buyers and sellers exchange electricity for each hour — or half-hour — of the next day. Hence, the transactions on this market are based on 24 (or 48) different products — the electricity for each of the 24 h or 48 half-hours of the next day. The sellers — generators, importers, traders and other intermediaries — present their offers

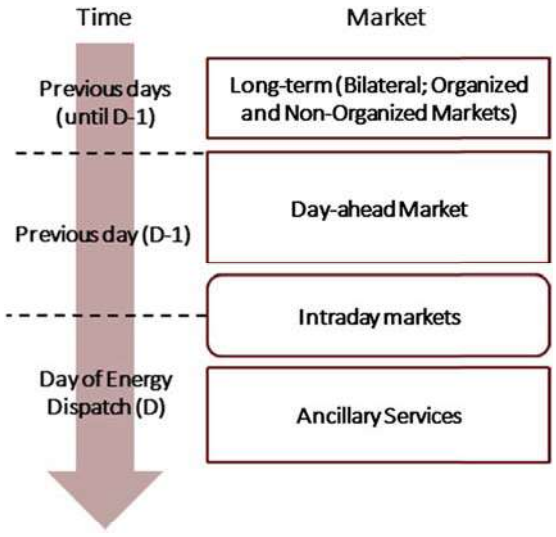

FIGURE 6.1
Sequence of wholesale markets. *Source: Own elaboration.*

and the buyers — suppliers, final consumers, exporters, traders and other intermediaries — present their bids to the market operator, for each of the next day hours. With these bids and offers, the market operator constructs the demand and supply curves for each hour of the next day. The hourly price is the result of the intersection of the demand and supply curves, and the matched positions become firm commitments to deliver electricity.

Offers made by generators are the amount of electricity they are willing to sell at a price equal or above a minimum price. Therefore, the competitive offers a generator makes reveal important information for the market. The amount of electricity offered reveals information on the physical constrains that the plant has, including the available power, the minimum power at which the plant needs to operate to be stable and secure (technical minimum), the availability of fuel or water reservoirs and the speed at which it can increase or decrease its production from 1 h to the next, among other things. Likewise, the price offered reveals, first, the opportunity cost to the plant of the generation activity including the costs that would be avoided by not producing as the initial start-up cost and the variable operational and maintenance costs associated with the production, etc., and, second, the forgone revenues from the decision to produce like reselling the fuel or the CO_2 emission rights to a third party, in the case of a thermal plant, or using the reservoir water now or later at a possible higher market price, in the case of a hydropower plant. Given that different technologies have different opportunity costs and potential for revenues, different technologies offer different prices.

After the sellers present their offers to the market for each hour of the next day, these are aggregated and sorted in ascending order by the market operator, and the wholesale supply curve is obtained from this. The demand curve is obtained by the market operator in an analogous manner using the behaviour of factors such as the temperature and work patterns. The market operator settles the equilibrium price at the intersection of the demand and supply curves (see Fig. 6.2) and this price is uniform for all the matched units. This is called a marginal pricing market, where all technologies receive the same — equilibrium — price. The fact that the agents build their offers from marginal costs is what makes this market an efficient assignation mechanism. Hence, the market design ensures the optimal use of available resources.

On the wholesale electricity market, in the medium and long term (before the spot market), agents exchange different types of contracts with delivery periods of different lengths (from weeks to years). These transactions take place in various organised and nonorganised derivatives markets. The derivative markets play a crucial role in the context of a liberalised and mature market, when sufficiently deep and liquid, as they facilitate both the risk management of agents and competition on the wholesale and retail markets. A supplier

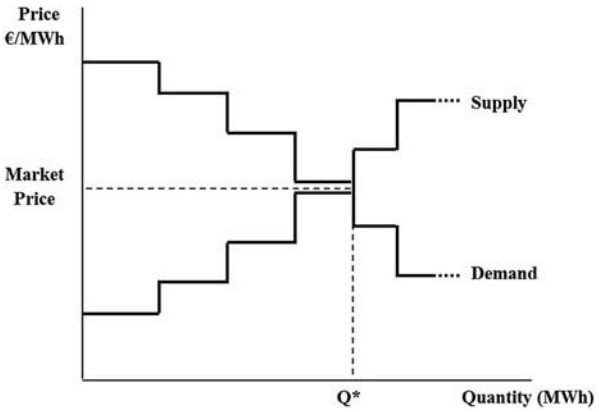

FIGURE 6.2
Spot market. *Source: Own elaboration.*

needs to buy electricity to meet its clients' demands. In the absence of deep derivatives markets, the supplier would have to acquire most of the energy on the spot market and would then be subject to an unknown price by the time energy needs to be delivered. In such circumstances, the supplier would be exposed to the risk of the spot market price being higher than that quoted to its clients and would face the risk of incurring financial losses. From the generators perspective, a deep and liquid derivatives market facilitates coverage of the risks associated with revenue volatility by setting the price at which its production will be sold. In general, the derivative markets ease the entry of new agents into the overall market by reducing price risk exposure.

In the short term electricity markets, generators and suppliers adjust their trading positions by selling and buying electricity, including transactions during the same day of delivery. The short-term markets allow buyers and sellers to adapt their production and consumption programmes based on better forecasts of what they will actually need in real time (Box 6.1).

3.1.2 European market integration process

As has been stated in the introduction, the electrical system has undergone an unprecedented process of change. Going specifically into the field of markets in depth, the European single market programme aims to reduce physical, legal and fiscal obstacles between member states to accomplish the free movement of goods, services, capital and labour in the EU, and electricity, as a good, is a part of the free movement objective to be implemented in the single market. The creation of an internal electricity market is expected to increase competition as a result of expanded interconnection capacity and hence a reduction in concentration at the national and regional level. Actors in an integrated energy market trade electricity on an equal basis. The single energy market

Box 6.1 Short-term markets.

Short-term markets are important tools in dealing with demand variability in the system, in which the need for flexibility is clear and providing it is of great value. Due to the ongoing integration of renewable sources into the generation mix, the system's variability is increasing as a result of the intermittency of those resources. Because of this, these markets are becoming increasingly important, and it is foreseen they will be key elements in the future wholesale electricity market.

The *intraday market* for electricity allows for the trading of energy after the spot market and until shortly before delivery. This provides market participants with the possibility of reducing their expected imbalances and of offering their own unused flexibility. There are two predominant forms of intraday trading: discrete auctions and continuous trading. Continuous trading implies that trades can be settled whenever a market participant accepts an offer from another market participant. Therefore, prices vary from trade to trade. That is a substantial difference from auction-based intraday markets that are cleared at discrete times. Countries decide on which one to use depending on the advantages and disadvantages perceived in each specific case, conditioned by the system characteristics and market design preferences.

After gate closure of the intraday market, the transmission system operator (TSO) takes over responsibility for keeping the system balanced and guaranteeing a constant equilibrium between generation and consumption. The *ancillary services* fulfil that purpose in a sequence of actions comprising both market and/or nonmarket solutions, depending on the specific institutional design of the wholesale market in each country. In general, the ancillary services handled by the TSOs include technical constraints, secondary control, tertiary control, power reserve, imbalance management and real-time constraints.

improves the security of supply and facilitates the integration of renewable sources (Bahar and Sauvage, 2013). In an integrated market, efficiency is enhanced by greater interconnection because the increase in available resources decreases the need for spare capacity. The lower the level of spare capacity for each country, the lower the need for costly power plants and the greater the use of cheaper inframarginal power plants available at times of peak demand.

Energy interconnections allow interregional and cross-border transport of electricity and are a prerequisite for the functioning of the internal energy market. Fürsch et al. (2013) suggest that to achieve optimal trading within the EU, it would be necessary to significantly increase the transmission capacity. While significant progress has been made in recent years, the development of networks, especially those for cross-border interconnection, remains insufficient.

Conscious of the importance of the development of interconnections for the creation of a competitive and efficient internal market for energy, the EU has recently developed a series of policies in support of the development of energy infrastructures in Europe, aimed at providing the European environment with

an appropriate regulatory framework for the promotion of investment in interconnection and the efficient management of interconnection investment that will foster optimal use of the existing interconnection capacity (for empirical assessments of the evolution of European market integration, see Zachmann, 2018; Bunn and Gianfreda, 2010; Menezes and Houllier, 2016).

From the perspective of institutional economics, the European Commission (EC) proposed a bottom-up regional approach to integration for the creation of the European Internal Electricity Market, starting from regional integration between countries with similar features and moving on to the integrated electricity market as a way to boost integration. This strategy has coexisted with a more structured approach, where from a top-down design the basic regulation at European level has been defined (including Community Directives and Regulations of mandatory compliance). With these two complementary approaches in place, the detailed rules are being developed with the aim of facilitating the requirements for regulatory harmonisation, essential to attaining the internal market.

3.1.3 Future electricity challenges

The growing volume of renewables in the electricity generation mix on a worldwide scale poses the need for change in the current functioning of liberalised electricity markets. The problem resides, as identified in various articles (Sioshansi, 2017), in the fact that the market that was configured according to new assumptions in the 1980s and especially in the 1990s is not efficient in economic terms as new technologies have variable costs close to zero and generation that is intermittent and difficult to predict. The volume of the supply of renewables changes market conditions independently of the incentives it may receive. This change in the supply affects the wholesale market, the entrance of conventional generation and the recovery of investment in all technologies, including renewable ones.

The specific effects revolve around the reduction of the average wholesale market price, the reduction in the number of hours of operation in which thermal generation plants offer support and the reduction of peaks in demand. First, the impact on price and the displacement of conventional generation are caused by the workings of the marginal market as it was originally designed. Second, plants with higher variable costs are displaced out of the market — when they continue to be necessary for support — by the entry of renewable generation plants that can offer a lower price, either because of their lower marginal cost of generation — which determines the price of the offer — or because they receive incentives. The third effect is caused by the pattern of generation of the main renewable technologies — solar and wind — which, as it coincides with peaks in demand, softens them. This effect reinforces the previous ones as it

reduces the price and the hours in which the conventional generation technologies operate even more.

To sum up, the design of the market is what produces these effects by choosing the generation with the lowest cost in the short term, affecting the recovery of investment and the economic viability of all the technologies. This problem becomes more acute when the proportion of renewable energies in the energy mix is greater because of their intermittent character. From all the above, it can be inferred that questions are being raised about the current design of the market. Its effects affect the security of supply and the viability of the renewable energies themselves, key objectives in the energy transition.

In addition to the problems pointed out, the existence in some markets of a ceiling on spot market prices can go so far as to prevent the type of generation that offers stability in moments of high demand from obtaining the remuneration necessary to recover their investment costs. While support mechanisms allow renewable energies to recover investment costs, the design of the wholesale market hinders generators that in moments of peak demand or the inexistence of renewable supply offer support with a stable supply, from recovering their investment, in spite of the availability demanded of them.

Another problem arises in relation to the short-term markets (balance and adjustment). Before the widespread entry of renewables, adjustments between supply and demand were only required because of failures in plants or errors in the prediction of demand or retransmission because of technical restrictions. In any case, these mismatches were of little significance. Currently, with the high level of entry of renewables, these mismatches between the matching of the day-ahead market and operations have increased. The intermittency and the difficulty in predicting these sources of generation cause deviations from planned generation. These deviations place in many cases an additional cost on the final price of the energy because of the balance of the position of the generator on the intraday markets or because of the activity of the system operator on the adjustment markets. This has the opposite effect to that of the renewables on the day-ahead market, reducing potential savings for final consumers.

As has already been noted, the problems described affect all the technologies, including renewable energies, especially when incentives are no longer provided and they do not receive support. If they are preponderant on the market, the deterioration of spot prices continues to exist. From what they extract from the market, they would not be able to send the investment signals necessary to maintain either the security of supply or the achievement of the objectives set by the energy transition. In the same way, these matching prices on the day-ahead market limit the active participation of demand (*demand response*) that the new technologies (smart metres and networks) allow. At a moment

when greater flexibility is necessary due to the intermittency of renewable generation, the market should facilitate the participation of the consumer.

To sum up, the problems that appear with the current structure of the market can be summarised as follows:

- Reduction of day-ahead market prices.
- The long-term sustainability of the system is not guaranteed, as it is not possible to recover all the investment.
- The effect of intermittency and errors in prediction affect balance and adjustment markets, increasing the final price of the energy.
- The regulations make demand participation difficult when there is a growing need for flexibility.

3.1.3.1 Case study: Spain and Portugal electricity market integration

The Iberian Electricity Market, MIBEL, fully launched in July 2007, was a result of cooperation between the Portuguese and Spanish Governments aimed at promoting the integration of both countries' electricity systems. The consequences thereof made a significant contribution not only towards establishing an electricity market at the Iberian level but also at the European level as an important step towards establishing an internal energy market.

The creation of the Iberian electricity market was an ambitious project that integrated two energy markets. The most significant milestone was reached on 1 October 2004, when the Governments of Spain and Portugal signed the Agreement of Santiago de Compostela, in which the roadmap to follow for the effective execution of MIBEL was agreed. That agreement completed the first phase of a process of cooperation initiated in 1997, when the Spanish and Portuguese authorities anticipated the creation of an internal energy market in the EU within the framework of the newly adopted Directive 96/92/EEC on the internal electricity market, representing a new set of opportunities and challenges that needed to be addressed.

The magnitude of the figures, both from the supply and the demand side of the market, highlights the importance of the Iberian market. The establishment of the MIBEL in 2007 led, from the supply side, to the integration of 10.3% of the electricity produced in the EU, approximately 8.6% in Spain and 1.7% in Portugal. On the demand side, the MIBEL created a market of almost 30 million domestic consumers and businesses. Spain has 24 million customers, of which approximately 3 million are businesses. In Portugal, the number of customers is 6 million, of which 700,000 are businesses. Therefore, this market integrated around 3.5 million businesses, mostly small and medium, and about 26.5 million domestic consumers.

FIGURE 6.3
Percentage of price differences (Portugal minus Spain). *Source: Own elaboration based on monthly arithmetic price produced by OMIE.*

If at a certain time in the day the capacity of the interconnection is such that it permits the flow of the electricity traded by the agents, the price of electricity for that hour will be the same for Spain and Portugal. If, on the other hand, the interconnection is fully utilised at that time, the price-setting algorithm is run separately so that there is a price difference between the two countries. The mechanism described for setting the price of electricity on the daily market in Spain and Portugal is referred to as 'market splitting', being the same mechanism as that used all over Europe. Fig. 6.3 shows the electricity price differences between Spain and Portugal (in percent) since the MIBEL was created. A decreasing trend is apparent. Moreover, in 2017, the price of electricity was the same in Spain and Portugal for more than 97% of the time, which confirms that the capacity of the interconnection is close to the required level and that the integration of the Iberian market is working properly.

3.2 Natural gas wholesale market

Having analysed the functioning of the wholesale electricity market, in this section, we focus on the gas markets and the different types of contract that allow a response to be made to the growing demand for natural gas.

In as far as there exist different ways in which these purchasing operations materialise, each of them with their own characteristics, before entering into the organised markets as such, we review in the following section the various contracting options available in wholesale gas markets and their evolution over time as a result of the process of liberalisation and the new objectives and demands of the agents that participate. All has to be done without losing sight of the retail market or the supply to end consumers, though these are not the objects of analysis in this chapter. Afterwards, we will focus on the specific case of Europe and the advances that have occurred since the regulation of the

process of configuring the internal energy market, in which the organised markets and in particular the gas hubs (case study) are called upon to play a key role. The third section focuses on an analysis of the future challenges for these organised markets, specifically on the question of how to give sufficient liquidity to this type of market in order that they will be able to offer correct price signals to the agents.

3.2.1 Market design: from long-term contract to organised markets

The geographical distribution itself of the production and consumption of gas on a worldwide scale requires in many cases purchase and international transport operations to be carried out to successfully supply natural gas from production centres to consumption centres, generating a set of trade flows. The volume of gas traded in 2018 reached 943 bcm — 55% through gas pipelines and the remaining 45% in the form of liquefied natural gas (LNG) — 43.6% of exports having Europe as a destination (BP, 2019). This is a paradigmatic example of international commerce from net exporting areas (Eastern Europe, Africa and the Middle East) to importing areas (Europe, the OECD and Asia-Oceania) as a consequence of the differing locations of supply and demand. As a result of great increases made worldwide in new liquefaction capacity, LNG will become the main impulse to growth in demand for natural gas and in the trade flows that are expected in coming years. According to these estimations, trading in LNG is expected to rise above 500 bcm in 2023 with three big players on a global level: Australia, Qatar and the United States. The development of the market for LNG will without doubt change the panorama of the global gas trade advancing towards interregional flows with greater interdependence between buying and selling agents.

At this time, as can be seen from the figures corresponding to trade flows, there are three large regional markets for gas in the world: North America, Europe and Asia, each of them with a different structure related with their degrees of maturity, the source of supply, their dependence on imports and other geographical and political factors.

In the North American market, the new technologies of nonconventional gas extraction (shale gas) have permitted a significant reduction in production costs and the consequent decoupling of the price of gas from that of oil. Since 2010, the price of gas in the United States has consistently remained at levels below those of other regions of the world, at the same time as increasing gas production, permitting the region to reach the point of self-sufficiency and to

begin to construct liquefaction plants for the exportation of LNG to other regions. In the next few years, this will convert the United States into one of the main global exporters of LNG, with the consequent geostrategic and economic implications, and change the traditional distinction between exporting and importing areas. On the Asian market, the main gas markets depend on supplies of LNG totally — Korea and Japan — or partially — China — and therefore its price is associated with the price evolution of LNG on the international market. Finally, the European markets are mainly supplied by Russia and the North Sea deposits and have intermediate prices between the North American and Asian markets.

This primary supply market is traditionally based on long-term physical contracts lasting between 20 and 30 years. These long-term contracts contain adjustment mechanisms for the risks for all the participating agents inherent in any project in transporting natural gas. These contracts guarantee that the exporting countries obtain a reasonable profitability that allows recovery of the investment costs incurred — through gas pipelines or gas pipelines from the well and the liquefaction plant — with a significantly long period to maturity and high levels of sunk costs and that the buying countries have security of supply and a final price.

The historical trend in long-term contracts indexed to the price of oil seems to be changing due to the liberalisation of the market in the United States and Europe, the evolution of the markets themselves and the expansion of LNG (Stern, 2012; Heather, 2015; Corbeau and Ledesma, 2016; Rogers, 2017). All aspects have influenced the creation of a new order for global gas markets in as far as:

- The liberalisation of the gas markets in the United States and Europe has caused the creation of over-the-counter (OTC) markets and the appearance of organised markets such as gas hubs where gas prices based on the interaction of supply and demand are generated, in other words attending to the fundamentals of the market (gas-to-gas competition pricing).
- Around 90% of the projected growth in the long distance trade in natural gas, from the present to 2023 (IEA, 2018c), will be covered by LNG, a change is being made towards a more flexible global market that is liquid and has more diverse origins. The capacity and the number of points of liquefaction at a global level will increase significantly in coming years, with the entrance of new agents guaranteeing broader-based gas markets.

As a result of these trends, the types of contract for natural gas (see Box 6.2) have undergone significant changes in recent years as new types have appeared that respond to new requirements and in which indexing to the evolution of crude oil as a mechanism in forming the prices of natural gas is losing

Box 6.2 Types of contract and organised natural gas markets.

The way to set the market price in gas contracts and the types of contract have been evolving over time, responding to the different needs of the participating agents — satisfaction of direct energy needs, gas balancing operations that guarantee the correct use and functioning of the gas system, coverage and risk management and pure speculative trading, as well as the development of new types of market. In this sense and considering the duration and the contracting mechanism, the types of contract can be grouped as follows:

Long-term bilateral contracts

This type of trading characterised by purchasing and international transport operations for managing the supply of natural gas from centres of production to centres of consumption results in individually negotiated long-term contracts with nonstandard terms and clauses. Given their natures of substitute goods in many industrial processes, the indexing of the price of natural gas to oil has constituted the main mechanism of price formation in this type of contract ever since the decade of the 60s in the last century (IEA, 2008; Hulshof et al., 2016). Similarly, in addition to it being indexed to the evolution of oil prices on international markets, this type of contract included in the majority of cases very restrictive clauses guaranteeing consumption (take or pay), in which a constant income is assured for the seller irrespective of the gas actually delivered, destination clauses (no possibility of being diverted to other markets) and formulas for revising prices periodically to adjust to the evolution of the markets in the long term. In this type of contract, the risk is shared between the seller (price risk) and the buyer (volume risk) and the price is not public, giving the contracts a markedly opaque character.

Short-term contracts

The need to respond to the new demands for balance in the system derived from the necessary adjustments to balance pressures as well as limitations of capacity for the movements of large masses of natural gas over long distances from a large part of the new commercial agents produced by the liberalisation process resulted in the appearance of short-term wholesale contracts, using as points of delivery for the completion of the contracts large capacity nodes in the gas networks capable of connecting various transport routes (hubs). The execution of this type of purchasing operation can be carried out with different mechanisms:

Over-the-counter contracts

OTC negotiation, also being a direct bilateral negotiation between agents as in the previous type, is characterised by contracts with standard conditions and previously defined specifications (Álvarez et al., 2013). This type of contract facilitates negotiation in as far as it is based on contracts with a greater homogeneity, without being exempt, as in all types of bilateral contract, from counterparty risk.

Contracts on organised markets

Differing from OTC contracts, the creation of an organised market facilitates carrying out purchasing operations in as far as there is an entity responsible for setting the rules for its functioning and the management of operations, facilitating price transparency, ensuring the anonymity of participating agents and assuming the counterparty risk through a clearing house. On this type of market, agents exchange property rights to gas without it being necessary that the participants are final consumers and even without the necessity that a physical gas transaction exists (virtual markets). Differently from the electricity market, as was explained in the introduction, the wholesale gas market usually has a more constrained character, in the sense that it is a market for transactions where the trading has the object of covering adjustments to the flexibility of the supply or the demand and gas balancing. It is because of this that, in spite of there being different degrees of maturity in the various organised markets that exist, in the majority of them trades in products with short delivery times — daily or intraday — are the majority.

Each of these wholesale gas markets has its own particularities in attending to the needs for which they attempt to provide coverage. The main parameters that allow a description of the various existing wholesale markets are noted below:

Types of product	Duration	Price	Point of delivery	Relation between agents	Guarantees and payment
Standard Non-standard	Spot Week Month Quarter Year Long term	Over-the-counter (OTC) Set in organised markets	Physical location (regasification plant, interconnection, etc.) Virtual (*hub*)	Bilateral (OTC) Organised market (*Exchange*)	Between counterparties Clearing house

Source: *Álvarez, E., 2017. Los mercados de gas natural en Europa. Elementos relevantes para su desarrollo. Revista Información Comercial Española (ICE) 895, 33—45.*

importance in favour of mechanisms that are more and more based on competition between various sources of gas — gas-to-gas competition.

In this new context, natural gas hubs have appeared that refer to a physical or virtual location in the transport network, in which a group of users of the network can exchange products and services at a specific point — spot or future — that are physical as well as financial — that use as a basis the short-term price-related with gas transactions — physical transactions, gas transport and storage capacity. These agents can exchange gas through an anonymous organised market in which there are regulations that normalize contracts and the closure of operations between agents or also through an unregulated market that is purely bilateral where negotiations are carried out between the parties involved — bilateral contracts or OTC, the latter being the gas market with the most liquidity (Fig. 6.4).

These organised gas markets with short-term wholesale contracts appeared as a response to the adjustments necessary to balance pressures and limitations of capacity in the movements of large masses of gas over long distances, using for this large capacity nodes in the gas networks capable of connecting various transport routes — hubs — as delivery points for the completion of the contracts (FUNSEAM, 2012).

Similarly, these short-term flexibility needs were joined by the needs of new agents connected to the nonconventional uses of natural gas, as in the case of combined cycle electricity generation. For the coverage of the demand for gas for electricity generation, proceeding for the greater part from combined cycle plants, the contracts are usually made to measure for the needs of each cycle and their duration is between 15 and 20 years, with the purpose of guaranteeing technical viability and security of supply to the plant. Similarly, to provide greater flexibility, given the variability of the demand for electricity from gas that characterises these types of technology that should mould their production profiles to existing energy gaps — residual demand not covered by renewables and other technologies that function as base supply systems — it is usual that the generators combine long-term contracts with spot contracts.

The consolidation of the different hubs existing at a European level, in part thanks to the rise of LNG, is changing the present mechanism and conditions of the setting of prices in the supply contracts for natural gas and the types of contract (Stern and Rogers, 2012).

From this new evolution of the market, it is possible to expect that the law of supply and demand will be reflected in the cash prices of natural gas and these will be connected, through arbitration, with increasing integration between the existing markets (Heather, 2015). Reality shows that the inclination towards the indexing of contracts and their duration differs between regions. In Europe

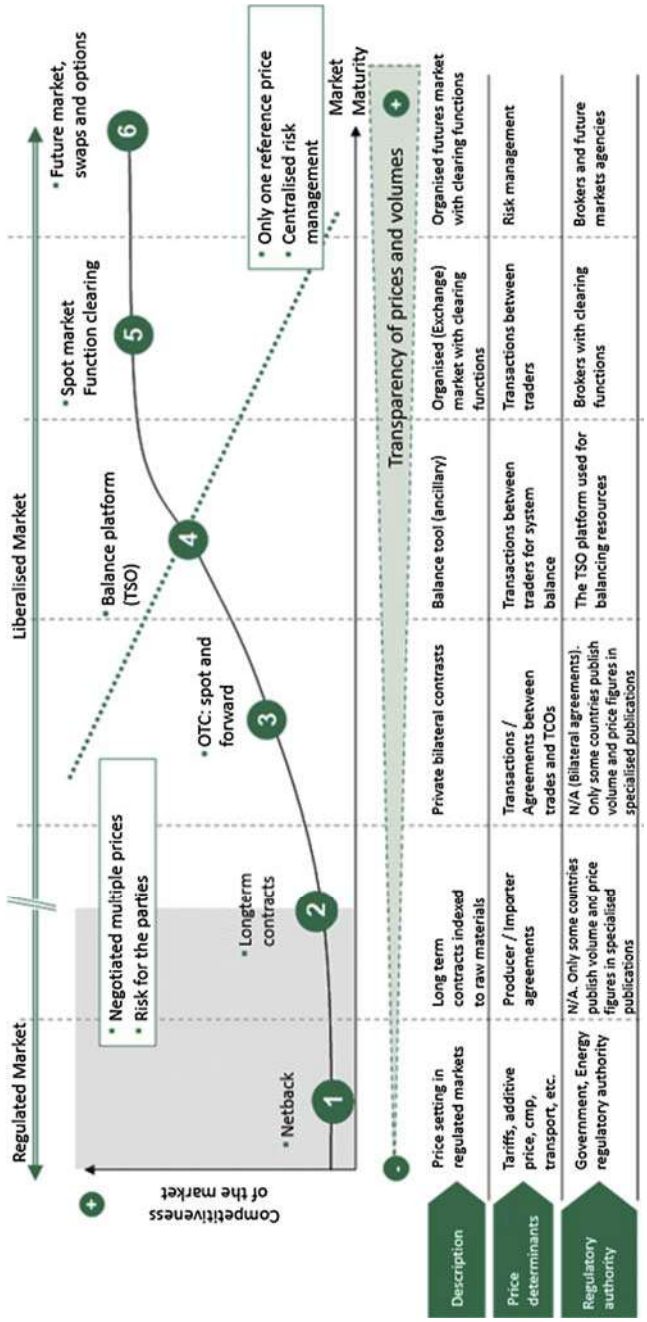

FIGURE 6.4
Evolution of the wholesale natural gas markets. *Source: FUNSEAM, 2019. Perspectivas de los mercados organizados del gas natural en Europa y su desarrollo en España.*

and the United States, it seems clear that contracts tend towards the short- and medium term and that prices are indexed to their respective hubs, while in other geographical areas outside Europe such as the Asian markets, contracts indexed to the evolution of crude oil combined with short-term price references maintain their preeminence, with a certain degree of decoupling between the prices in each region which is diminishing with time (IEA, 2018c). This is due to the fact that their organised markets do not yet have enough of a degree of maturity and depth to be a reference in the setting of prices.

Although there are no official estimates, given the private nature of the majority of these supply contracts, some estimations (IGU, 2014) note that while in 2005, 72% of gas supplied to Western Europe was through long-term contracts indexed to prices quoted on international oil markets, in 2013, it was already only 20%. With this reduction organised natural gas markets appear on which growing volumes are traded.

3.2.2 European market integration process

In recent years, in the setting of the creation of an internal energy market, a structural change has been made of great importance in the field of natural gas. As was mentioned in the introductory section, as there has been an energy policy within the framework of the liberalisation process, advances have been made in the development of a European gas market with the purpose of guaranteeing the security of supply by diversifying the sources of supply and promoting cooperation between the different member states.

Without trying to be exhaustive, over recent years, a complete legislative stock has been produced — explicitly through three complementary legislative packages, between 1996 and 2009 — based on the principals of unbundling and TPA with the purpose of constructing an internal natural gas market on the premise that an organised market should have a very positive influence on increasing competition in the sector and in the economy as a whole, benefitting final consumers. For this it is necessary that the European gas system be provided with sufficient interconnection capacity, as well as that member states dispose of adequate national market structures based on hubs.

The regional integration process that has brought with it a gradual harmonisation of regulations has culminated in the 'Third Energy Package' of measures, adopted with the purpose of improving the working of the interior energy market, solving the present structural problems to guarantee it functions correctly and harmonising the rules between member states. This package of measures develops network codes (NCs) that tackle questions such as Congestion Management Procedures (CMP), Capacity Allocation Mechanisms (CAM), Gas Balance in Transport Networks, the Interoperability and Exchange of data and transparency and the harmonisation of the tariff structure.

The need for common technical norms as well as structural changes and new reforms for the harmonisation and integration of these markets into a single natural gas market fosters the creation of efficient national and supranational gas wholesale markets that permit the reduction of barriers to entry, foster competition and transparency and that can cover direct energy needs guaranteeing the supply of gas, the security of supply in the long term, daily gas balancing operations, risk management or mere speculative trading. At a European level the development of these wholesale markets has brought with it the concept of hubs, these being understood as real or virtual points within the gas system where it is possible to transfer the ownership of the gas between different agents on the market. There is also a third entity — apart from the buyer and seller — that is in charge of the management.

The creation of the European gas market has received significant support with the implantation of the European gas market model (Gas Target Model — GTM) (ACER, 2015), developing a common vision for this market. The importance of GTM lies in its creation of a high-level nonbinding framework, with a description of the principles and characteristics of the future development of a European market. According to the GTM, the European gas market would be made up of entry—exit balancing areas interconnected with virtual wholesale gas markets (virtual hubs). At an operational level, this vision of the different stages in the evolution of the gas market offered by the GTM has been transformed into new harmonised rules defined in the NCs, in which the rules are set out for the operation of the cross-border transport networks that are legally binding and applied to all cross-border gas transactions.

All these efforts that are being made in Europe, at the country and regional level, are already bearing fruit and this is reflected in the fact that liquidity in the European hubs continues its systematic growth at a good pace: between 2008 and 2016, the volume of gas traded in these hubs increased by 400%, which means that currently an average of 120 TWh/day of gas is traded in Europe, thereby fostering competition between markets — gas-to-gas competition (for more details, see Case Study). In fact the increasingly important presence of this competition has been the cause of, in Europe, indexing the price of gas to that of oil falling from 85% in 2005 to 30% in 2015 (IGU, 2016).

3.2.3 Future challenges for natural gas

In spite of the important progress made in recent years, the gas market faces considerable challenges in coming years because of technological advances and strategic and geopolitical questions such as the appearance of nonconventional gas sources, the globalisation of gas markets with LNG, the impact of the evolution of the price of oil and its impact on gas supply contracts and the role of gas in a low-carbon emission economy. Similarly, in the case of Europe itself, the gradual diminishment of its capacity to produce natural gas has brought

with it an increase in dependence on the importation of gas — through pipelines as well as LNG — which represents a challenge in terms of security of supply.

Although there are many issues that can influence the future of natural gas, in the specific case of the organised markets, it is possible to note that an essential challenge for this type of market to function correctly is the development of liquidity in futures. As the market acquires more liquidity, expanding its depth and breadth, it becomes a stable and trustworthy reference capable of transferring effectively variations in market forces to the final price of the product (Heather, 2015).

An organised futures market can act as a traction motor to generate additional liquidity in all products with different time horizons. An initial requirement for an organised futures market is that there is a liquid spot market that produces reliable price signals. Nevertheless, this is a complex process that requires a period of maturity between 10 and 15 years (ACER, 2016) that has not yet been completed by the majority of the existing organised markets in Europe, as is shown in the Case Study, although they are making progress along the path to higher levels of liquidity. It is to be hoped this path will continue in coming years.

In the short term, it is to be expected that the development of new gas infrastructures will facilitate the convergence of prices among the different regional markets and that the LNG coming from the Atlantic Basin will continue to be the main motor of the liquidity of the European hubs (Erías, 2017).

A structural change of enormous importance has been made in the European gas market that has rearranged itself into regional markets with sure alternatives of supply, guaranteed physically by the recognition of access to the infrastructures of transport, storage and regasification, where consumers demand price-setting formulas that correspond to this new reality that are more open and much more competitive.

The consolidation of this new situation, nevertheless, demands significant progress in those factors that foster market liquidity and one in which regulation is called upon to play a decisive role in as far as the incentives to exchange energy generated by the regulatory framework can and should generate liquidity in the market. In this sense the changes in the design of gas markets as a consequence of the development of the GTM, regional initiatives or the NCs themselves — issues analysed in the previous section — generate powerful incentives to voluntarily buy and sell products, thereby increasing the breadth and depth of the market.

3.2.3.1 Case study: natural gas hubs in Europe and the Spanish experience (MIBGAS)

Since the beginning of the liberalisation process in Europe, the gas system has undergone an important transformation process and the gas wholesale markets are not an exception. Although wholesale gas markets in continental Europe have started to work with a certain delay in relation to the United States or the United Kingdom, in recent years they have experienced significant growth in the volume of traded gas as well as in the number of working hubs.

Prompted by the structural changes and the new European regulatory framework, new wholesale gas markets have appeared all over the continent. In 2002, the only markets that existed were the British National Balancing Point (NBP), created in 1996, and the Belgian Zeebruge (ZEE), created in 2000, and the German HubCo had just been set up, which became the seed of what is currently GasPool. From then on, the markets that have been created are the Dutch Title Transfer Facility (TTF) and the Italian Punto di Scambio Virtuale (PSV) in 2003, the French Points d'Echange de Gaz (PEGs) in 2004, the Austrian Central European Gas Hub (CEGH) in 2005 and the German EGT in 2006 (later integrated into NetConnect Germany), the German GasPool Balancing Services (GBL) and NetConnect Germany (NCG) in 2009 and, more recently, as we will see in greater detail below, MIBGAS in 2015.

The proliferation of this type of market at a European level is not homogenous as it includes organised markets that have been working for a long time and others that have entered more recently. Considering different basic parameters for evaluating the functioning of the markets (ACER, 2016; EFET, 2016; Heather, 2015) such as traded volume, number of agents, time horizons, products traded and churn rates, it is possible to describe the degree of maturity of the various hubs that there are in Europe.

A first look at these hubs, following this characterisation, allows us to see, on the one hand, mature hubs, based on virtual transaction points, with high levels of transparency and a large and growing number of participants, in which not only take place physical, spot or future exchanges but also feature financial instruments covering risk, such as the British NBP and the Dutch TTF, and on the other hand hubs with a lesser degree of maturity that are used principally as balancing markets, such as the German GBL and NCG, the French PEGs and the Italian PSV; and finally those hubs the main function of which is to serve the transit of large volumes of gas for its later storage and transport, such as the Belgian ZEE and the Austrian CEGH, although the last two have recently added virtual traded hubs (FUNSEAM, 2019).

	Established hubs	- Broad liquidity - Sizeable forward markets which contribute to supply hedging - Price reference for other EU hubs and for long-term contracts indexation
	Advanced hubs	- High liquidity - More reliant comparatively on spot products - Progress on supply hedging role but relatively lower liquidity levels of longer-term products
	Emerging hubs	- Improving liquidity from a lower base taking advantage of enhanced interconnectivity and regulatory interventions - High reliance on long-term contracts and bilateral deals
	Illiquid-incipient hubs	- Embryonic liquidity at a low level and mainly focused on spot - Core reliance on long-term contracts and bilateral deals - Diverse group with some jurisdictions having organised markets in early stage to develop entry-exit systems

EU natural gas hubs, 2016 *Source: FUNSEAM, 2019. Perspectivas de los mercados organizados del gas natural en Europa y su desarrollo en España.*

All these indicators of the development of markets concur in pointing to the Dutch hub Title Transfer Facility (TTF) and the British NBP as completely established with liquidity over all the supply curves. This fact is corroborated if the volumes of traded gas are taken into consideration, where the TTF and NBP represented more than 80% in 2017, making them references for the formation of the price of gas in Europe, which is being transposed to growing levels of correlation in prices between the different continental hubs (Petrovich, 2014).

In conclusion, the vigorous development of LNG, regulatory progress and the entrance of new agents into the market have had a powerful influence on contracts and on the selection of mechanisms for the formation their price. Although there are different organised markets that can be references in setting the price of a contract, evidence indicates that the expectations of natural gas prices in North East Europe are unmistakably determined by the reference prices set by hubs such as the NBP and TTF, although it cannot be ruled out that as time passes other hubs can become references in as far as they acquire greater levels of liquidity and/or are linked to the presence of interconnections.

In the specific case of Spain, until the creation of the Iberian gas market, *Mercado Ibérico de Gas* (MIBGAS) trades were exclusively carried out on an unregulated bilateral market (OTC) that was enormously opaque[3] about the price of natural gas, in as far as the only obligation concerning information referred to the notification for purposes of balance of the volume of transactions to the technical manager of the system, the *Gestor Técnico del Sistema* (ENAGAS).

In December of 2015 the organised gas market in Spain began to function with the objectives of providing greater transparency to markets -especially to the process of price formation, generating short-term price signals- and fostering competition in the sector -facilitating the participation of new agents to whom were offered new instruments for the flexibility to manage their supply portfolio independently of its size. After years of work and adaptation of the regulatory framework, the starting of MIBGAS was a milestone in the process of developing a wholesale market that allows the formation of a reference price in the Iberian area — Spain and Portugal.

The market trades four types of product: within-day (WD), day-ahead (DA), balance of month (BOM) and month-ahead (MA), although according to data for 2016 more than 75% of the traded volume corresponded to short-term products (within-day and day-ahead) consolidating the spot character of MIBGAS and its use by participating agents in the market as an adjustment tool. Over and above the possibility of offering the agents a flexibility tool at a reasonable cost, the value of MIBGAS also resides in offering short-term natural gas price signals, fostering transparency.

4. Conclusions

The energy business as a whole and the electricity and gas sectors in particular have undergone a transformation process without precedent over the last decades. Electricity and natural gas need to confront a new scene full of uncertainties. The appearance of new technologies, the active participation of the consumer and demand management, the new role of the distributor due to the rise of digitalisation and the capture and storage of carbon are some of the issues to be confronted in the immediate present, where the only thing that seems clear is the growing importance of these two energy sources in covering the demand for energy which is going to increase on a global scale in coming decades.

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[3] The opacity of the price of gas in Spain was almost complete as to find any reference it was necessary to turn to prices at the border -declared to Customs-, to the regulated auctions -corresponding to the acquisition of Operational gas and Heel Gas by transporters as well as by the Technical System Manager, and Cushion gas necessary for the functioning of underground storage-, or those relating to the *Tarifa de Último Recurso* (TUR), a price set for domestic consumers.

In 2017, with a global demand of 3740 billion cubic metres (bcm), natural gas covered 22% of the demand for primary energy (IEA, 2017 and 2018a), this being concentrated in the United States and Europe. However, according to current estimations, there will be an increase in demand in the Asian market. China will be responsible for 37% of the increase in global demand between the present time and 2040 (IEA, 2018c). In 2019, China will become the main importer of gas in the world with 45% of global imports and in 2023 it is expected that China will be the first importer of LNG, overtaking Japan.

Electricity is the main source of final energy consumption worldwide. Final electricity consumption has shown a strong positive trend since the 70s with an average growth rate of 3.3% over the last four decades (IEA, 2018a). In addition, massive electrification is envisaged in the transport sector in coming years — road transport has experienced double-digit growth rates each year since 2012 — and a further electrification of heating and cooling systems is predicted. With low-carbon technologies on the rise and electricity demand set to grow at twice the pace of energy demand as a whole (IEA, 2018b), the future is electrifying.

This process of transition towards low-emissions generation, which ensures supply and competitiveness in the economy at the same time, brings with it the mobilisation of a volume of resources without precedent in which the organised markets will play a leading role. To fulfil the global objective of limiting the increase in global temperature to below 2°C by 2050 means a profound reorientation of the current model, as well as a significant increase in economic investments, the correct working of the markets being necessary for them to be able to offer opportune signals to investment and the recovery of the costs incurred that allows such an important volume of economic resources to be mobilised.

Energy markets not only should offer the right signals to investment but also permit greater interaction with the consumers to guarantee economic competitiveness.

Given their different natures, the gas and electricity markets, each of them with different mechanisms, dynamics of price formation and determining factors that explain their evolution, they have each been approached in different ways in this chapter in contributing a first approach to their functioning and future challenges.

5. Exam or assignment questions

We present below a number of questions relating to electricity and natural gas wholesale markets to help students: