Introduction

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OPENING THE GAS INDUSTRY: USA VERSUS EU, AN OVERVIEW

Gas is a commodity and goes to the market. This should not astonish anyone since coal and oil, the two other fossil fuels, have been delivered by markets for ages. Natural gas is, however, less easily marketed because it flows inside closed pipes that have a 'big' efficient size and are very costly to replicate. The infrastructure of the gas network then operates as a barrier to open trade. With a small nascent gas demand the gas network is likely to be a natural monopoly and gas sources only one or very few. With a large, mature gas demand the gas network should encompass numerous facilities with alternative routes and several rival gas sources should candidate to feed consumption. In the latter case, opening demand to alternative suppliers is more easily feasible and makes sense. With nearly 600 million inhabitants and decades of gas usage in most of the Member States, the EU gas industry is not on average an infant industry and opening gas trade at the continental scale is not wrong, however, with different maturity levels of gas networks, gas sources and gas demand the grand opening of gas trade in the EU will not be simple. In practice, the institutional arrangements to opening trade in the gas industry are themselves various and numerous, and, unsurprisingly, the process for opening the gas sector has been significantly different among different regions of the world. Notably, the latecomer EU is not following the pioneering USA.

Opening Up US Gas Trade

The pioneer of gas liberalization decades ago was the USA. The liberalization was markedly characterized by the reliance on business forces to drive decisions in the production chain. Broadly speaking, the US gas sector is mainly organized around private companies who are in charge of deciding on upstream production, transportation, storage and downstream delivery of gas (while distribution to consumers can be regulated or public). In this context, gas transmission network investments and operations are mainly decided on by non-regulated agents, even if closely monitored in Washington by the Federal Energy Regulatory Commission (FERC).

This most liberalized setting has, by definition, the lowest requirements with regard to the design of the market. Hence, in such a setting, US wholesale gas markets are fundamentally based on bilateral contracts among producers and suppliers, without the need for any mandatory organized market to trade. These private contracts, in addition, are long term (10 or 20 years are usual horizons), which is related to significant aversion of bilateral traders to the risks of not injecting/withdrawing gas according to their initial business plan and capacity investment.

Following the same logic, transmission rights are also purchased long in advance. In this kind of transaction, producers and suppliers enter into contracts that provide the right to use the network to transport gas from one point to another, and whose counterparts are the owners of the infrastructure involved in the path between both points. In this regard, shippers decide on the physical path that the gas will follow, and pay for the use of the associated infrastructure. In addition, under this organization, the investment in network infrastructure is largely driven by those long-term contracts, and hence decisions on network planning are directly taken in the interaction between non-regulated network investors on the one hand and consumers and suppliers on the other.

Nonetheless, gas supply and demand patterns are highly volatile, and the balance of flows in the gas system must be coordinated in shorter terms. Hence, in the short term, shippers will face frequent imbalances, which must be dealt with by considerably complex combinations of gas trade arrangements and the associated transmission rights changes. Consequently, the above wholesale markets are typically associated with the definition of a place where the physical delivery of the commodity takes place: the physical hub. A hub is a place where gas wholesale trading is facilitated by the conjunction of several transmission facilities and services. It is, under this scheme, a junction of pipelines where a significant number of gas sales and purchases take place, and where sellers and buyers can also obtain storage and flexibility services. Serving as marketplaces, hubs have often been seen as a prerequisite for gas pricing through gas-to-gas competition in the sense that they are a key element to facilitating the coordination of gas systems in the short term.

These particular transactions largely aim at adjusting shippers' portfolios in the short term. They can be thought of as secondary transactions, as most gas trading is done in the long term. But these secondary short-term transactions are 'central' in the functioning of gas markets, as many delicate technical issues concerning the allocation of physical transmission rights are organized around them.

As in the case of long-term contracting, the US gas sector has not considered it necessary to centralize these transactions and has left them to bilateral arrangements. In that situation, the coordination of players in the short-term operation of the gas networks is facilitated by bilateral agreements between gas arbitrageurs and network operators (who are often owners of the infrastructures). These kinds of arrangements and trade platforms arise as a 'natural' need of the market participants, without particular push for a reference market design or for standardized contracts.

Finally, in this 'spontaneous market' context the price coordination between long- and short-term decisions is completed through financial contracts, where the underlying asset is usually the gas delivered in the hub. Such trades are often made in organized financial markets (NYMEX being the biggest in the USA). The function of these organized markets is to contribute to the inter-temporal coordination of the gas industry.

Opening Up EU Gas Trade

The liberalization of gas industries in Europe came after liberalization in the USA, so one might think that the USA was somehow the model for the European liberalization. However, when looking at the previous elements of US gas industry organization, EU and US markets have few common factors. In fact, the design of EU gas markets seems to be closer to the design of EU electricity markets than to the US gas markets. It is very likely that these differences arise largely from the fact that the EU prefers to organize gas network activities in each Member State as a 'nationally centralized' and regulated business.

The logic for this decision might have been the consideration that EU gas network activities have the structure of a natural monopoly or a too-concentrated oligopoly and thus were recognized as the main barrier to the opening of the commodity market. In such a situation, as in the electricity sector, the activities related to production and supply are considered as open businesses that may benefit from a market arrangement, whereas network activities must remain subject to public regulation regarding their operation and investment. From a different viewpoint, it might also be possible to support a regulation of network activities, arguing that too decentralized decisions in the operation of the network would lead to inefficiencies. The efficient option is then to design a centralized operation by means of a Transmission System Operator (TSO), coordinating the gas system interactions as much as possible. In practice, so far, it has been centralized only at the national level, even if some countries such as France and Germany still have several separated areas. This suggests that European Member States' institutional powers (i.e., their veto power in any EU common gas arrangement) heavily influenced the EU choice set.

In any case, new markets created in Europe rely on the regulation of network activities (from capacity booking and allocation to congestion management, from cross-border trade to entry/exit pricing). In practice, these EU markets build on the strong separation – unbundling – of the business of transmission networks from the business of trade in the commodity market (again, in this regard, closely related to electricity market rationale). With such a choice, the regulation of the rights of commodity buyers and sellers for using the regulated network becomes a central part of the market design.

From a long-term perspective, the rights for using the network closely interact with the negotiation and implementation of any long-term commodity contract between suppliers and demanders. The contracts that allocate transmission capacity and frame the actual capacity usage become a platform of interactions between market players and a central architecture in this 'centralized' gas system. Thus, the market design must contain enough elements to coordinate the contracts of capacity with the commodity contracts. From a short-term perspective, where the arrangements to manage congestion or imbalances take place, the market design must take into account the way in which the regulated network operator allocates transmission rights among market players. It is in the process of designing those mechanisms where most of the differences between US and EU gas markets appear.

THE LOGIC FOR VIRTUAL HUB REGULATION IN THE EU

In the EU the seller of transmission rights is a regulated player. Thus, a first choice for the market designer arises: should allocation of transmission rights be explicit (capacity only) or implicit (capacity and commodity are traded together)? The advocates of implicit allocation build their case on two ideas. The first is that combining two trades (capacity and commodity) made separately in a very short period of time (day or intra-day) causes significant transaction costs for traders, ending in an inefficient use of transmission capacity signalled by significant trade in the 'wrong' direction. The second is that gas market structure is characterized by significant horizontal concentration and vertical integration. Consequently the market designer must take potential strategic behaviour into account.

A key is the strategic use of network 'congestion': incumbents may have the incentive to over-contract network capacity to foreclose short-term markets for small competitors, and hence to induce effective entry barriers. When the commodity market 'implicitly' allocates the rights to use the network, the gas can be traded without the need for ex ante contracting of network services. Thus, the opportunities to foreclose contracting of network capacity disappear (Joskow, 2003). Although other measures to mitigate this kind of strategic behaviour have been considered, the implicit auctioning has been favoured as a solution to deal with strategic behaviour in network capacity contracting.

The comprehensive approach to implementing the implicit allocation would have been to consider the physical network in full detail, where all physical injection and withdrawal points may have a potentially different gas price. These detailed pricing points would also correspond to the actual gas network flows. However, following the design in the UK, EU gas markets did not go so far into the network details and favour organizing gas transactions around a virtual hub.[1] Such a virtual hub is not a physical junction of pipelines, but instead a regulated set of delivery points with a very simplified representation of the actual physical characteristics of the network. Virtual hubs avoid consideration of the actual physical network that will be ultimately used by the commodity transactions. To do so the market designer defines a 'commercial' network, that is, a few network characteristics that will be taken into account in wholesale commercial transactions. That market design is close to that of European electricity markets, where detailed market clearing based on nodal pricing (with the representation of all nodes of the physical network) was substituted by relatively simple commercial networks (in most cases, made up of a single node). The fundamental logic for virtual hubs is to increase the market liquidity associated with the simplification of the network. As the number of delivery points is highly reduced, the network specificities of the commodity are markedly reduced and thus the gas-to-gas competition is enhanced at the expense of a more efficient operation of the network.

VIRTUAL HUBS IN THE SHORT RUN

The virtual hub approach implies that the market uses a commercial network for most of the transactions of the commodity, which is different from the physical network. The European standard approach to the definition of the commercial network is entry/exit regulation. There the market players have the right to inject gas in a gas system at any entry point, and to withdraw gas from any exit point. Therefore, this market design requires a set of additional elements to bridge the gap between the commercial and the physical gas networks, which are usually grouped under the header of balancing mechanisms. When the design of the market is built on the definition of a commercial network, additional transmission activities arise in the short term to coordinate the operation of the commercial and the physical networks.

In a system like the USA's, with network services directly organized by competition, market forces determine the kind of contract that can be found, according to the preferences of players. In the EU regulated environment, it is, on the contrary, necessary to define by means of a set of centralized rules how the network can be used by gas commodity players. This necessity is amplified by the potentially conflicting usages that users may back on their 'Third Party Access' (TPA) rights to the same infrastructure. Therefore, the rules governing these usages influence market outcomes and their potential efficiency. The effects of such design rules are at the core of market activity, as they implicitly pre-define the network services made available to market participants.

In the short term on the one hand, market players must make arrangements to manage their gas injection/withdrawal imbalances; on the other hand, the network operator must allocate network rights in a way that will make all commercial commodity transactions physically feasible.[2] The usual approach in the EU electricity market is defining a gate closure as a certain time horizon after which the commodity market has no further decision right on network capacity allocation. Hence, a regulation defines a certain time scope (such as hour ahead, day ahead, or week ahead) where the role of the commodity market to manage its own imbalances ends. In EU natural gas markets the right of players to change their physical portfolio is defined by the re-nomination right.[3] As the players can re-nominate within the balancing period, in the current regulatory frame there is no clear period separation between the TSO balancing actions and the shippers' secondary arrangements.

In this context, the obligation of the TSO is to allow real time flow and the obligation of the shippers is to have equal injection and withdrawal at the end of the balancing period. The guarantee of physical flows is, thus, the responsibility of network operators, and the cost to keep the flows balanced is taken by the network if at the end of the balancing period the shippers' portfolios are balanced. Nevertheless, if at the end of balancing period the shipper has an open position, they are obliged to pay the cost or even some penalties.[4]

In the entry/exit regime most gas transactions are determined with reference to the commercial network. However, the process of actual network service allocation is the responsibility of the transmission operator. Of course, the rules governing network usage should allow the efficient use of the transmission network. This, conversely, is not straightforward in an entry/exit scheme as the network operator is obliged to take a bunch of 'ex ante' decisions to be able to allow the physical flow in real time. However, as the flow decisions taken by shippers are unknown to the TSOs, it is difficult to guarantee an efficient use of the infrastructures.

In an entry/exit system the commercial network capacity is a calculation made by the transmission operator. In this calculation, the transmission operator must take into account the fact that market participants own the right to carry gas from the entry points to any exit point. Hence, the operator must reserve not only the network required to carry gas from an entry to a defined exit, but also the network required to carry gas to all other exit points of the system. Therefore, a congestion in the network from an entry point and one exit point might cause congestion in the network to other exit points. This problem is often called 'contractual congestion'[5] (the network is not necessarily congested, but the system operator cannot allow more injections into the system given the existing set of rights). The direct consequence of contractual congestions is that the network is not efficiently used.

The design of other rules for possible network services may have consequences on the ability of market players to express their preferences. A typical case is the allocation of line-pack. Pipeline line-pack is the possibility of storing (de-storing) gas inside the pipes by decreasing (increasing) the pressure differential between successive compressors. As the gas pressure differential is the factor making both the gas move and be stored, it determines the resulting transport capacity and pipe congestion. In fact the line-pack of a pipeline is a substitute service of its transportation capacity. However, as 'entry/exit' markets refer to commercial networks without any accurate representation of the physical pipelines, these markets cannot reveal any order of preferences regarding the various possible combinations of line-pack and transportation capacity. The fact that the ultimate decision on such combinations is taken unilaterally by the regulated transmission operators may have a significant impact on market outcomes.

Another important consequence of the current EU regime is that the costs of the network cannot be allocated according to the detailed actual use of the network (for instance, precise locational signals cannot be given in the short run). The costs of the decisions taken by the transmission operators in the process of matching commercial and physical networks within the balancing period are socialized among network users. The use of different prices for certain entry and exit points of the commercial network cannot reproduce the real flow paths, just an approximation of network costs based on flow simulations.

The actual consequence of simplifying the physical network in a commercial network depends markedly on the nature of the gas transactions in the corresponding wholesale market. Actually, the rules to allocate network services in current EU regulations are somehow conceived for relatively flat patterns of gas flows. The logic for this is that, when flow patterns, or equivalently, the market participants' needs for variable injection and withdrawal patterns (both time and spatial variability), are relatively flat the rules for using the network are easier to define, as the simulation of cost sharing just takes into account the location of the players. However, if the need for a different and more flexible use of the network increases, the gap between the commercial and the physical network has a larger impact on market outcomes. Hence, the simulation of cost should take into account the diverse patterns of network use to better evaluate the trade-off between line-pack storage and the available transport capacity.

This fundamental change in usages of the gas network happened on the demand side with the massive introduction of CCGT (combined cycle gas turbine) gas-fired power plants, as well as with the flexible gas supply brought through LNG (liquefied natural gas). A massive introduction of gas-fired power plants in electricity generation created a new group of gas consumers in the gas market. On the supply side, LNG trade has increased in volume and in flexibility, allowing more arbitrage between players. LNG flexibility allows the gas supply to change according to gas price arbitrages, playing a key role in this world where demand (including CCGT) has a higher elasticity. Moreover, LNG has also been a new type of gas supply, responding easily to gas demand increases as re-gasification technology is modular and has lower scale economies (Jarlsby, 2004). The delay between investment decisions and infrastructure operation is lower than with most other gas sources.

As a consequence of growth of the gas industry centred on LNG and gas-fired power plants, supply and demand patterns are dramatically changing and both are more volatile than in the past. Thus, the storage component of the gas system has dramatically increased its technical and economic value. Today, among gas system users, some key players would give a high value to system flexibility while other key players would give it a much lower value. It becomes more difficult to use simple regulations that do not reflect what real network use has become.

VIRTUAL HUBS IN THE LONG RUN

From a long-term standpoint, assuming that most of the commodity transactions take place through bilateral contracts, a commercial network reduces transaction costs. As with short-term transactions, the number of contracts associated with the network is reduced, as the commercial network is simpler than the physical network. Reduced transaction costs in turn provide increased liquidity. Implicitly, this approach leaves the matching between commercial and physical networks for the short term. This implies that fewer transactions can take place in the long term, as many of the contracts associated with transmission rights will be left to short-term capacity allocation. Consequently, many of the signals associated with the inter-temporal allocation of network rights are distorted.

Closely related to this is the organization of investment decisions, as they strongly depend on the signals associated with the use of network services. Traditionally, the most important investments in gas systems are network and field investments. Actually, both businesses are closely related as the value of a gas field changes significantly according to its access to networks. Correspondingly, network investments are affected by the actual requirements of producers to have their gas delivered to certain consumption points. For decades investment in transmission facilities has largely been driven by the needs of gas producers. Lastly, this link between gas production and transmission investment has notably weakened. A key factor is a marked increase in demand uncertainty, the best example of which is the uncertainty associated with the actual consumption of gas-fired power plants. Massive renewables with priority of dispatch amplify the uncertainty of gas demand. In this new context, the combination of the requirements for network services of both sides of the gas industry (the upstream and the downstream) is a challenge.

In a market like the USA's where network activities are themselves liberalized, all investments, including those corresponding to network infrastructures, are decided by market forces through long-term contracts. In the EU where the network is regulated under TPA (Third Party Access), a kind of network planning is needed. Of course, any central planner is likely less informed than producers and consumers about the possible future gas flows and the various business models that support them. The most direct way for the planner to decide on the required investment is to look at market outcomes to identify the actual system needs. In a market characterized by long-term, bilateral contracts this task is not always straightforward. Moreover, in a commodity market that refers to a virtual commercial network, as with entry/exit schemes, the investment signals delivered by the market are necessarily limited. In this case, an important signal for the planner is the outcome of the commodity balancing market (including congestion management). It is where the commercial network is confronted with the requirements of the physical network. Therefore, the design of the balancing mechanism is not only key from a short-term standpoint, but also to providing the planner with information required for investing in gas networks.

SECURITY OF SUPPLY

Security of supply is the most controversial aspect from the viewpoint of market design because it fundamentally encompasses different issues, including economic and non-economic ones, that cannot all be easily or clearly defined in engineering or economics. In our view, there are two different levels of regulatory intervention under the heading of security of supply. On the one hand, in many gas systems some key players or public decision-makers advocate having some particular geopolitical profile to build some bargaining positions in external relationships. This has little to do with European market design, except for the fact that all measures targeted at choosing some suppliers above the rest may significantly impact the market. Therefore, the decisions regarding political or political economy aspects of security of supply are exogenous to the market design, and thus are constraints put on the possible market solutions. On the other hand, from an economic perspective, when one has a well-functioning market, security of supply is in fact a part of bearing market risk. If the European Union has an efficient internal gas market it means the gas may flow among the EU players according to their preferences. As a result the risk of any individual player having a physical supply disruption decreases. That is, the security of supply discussion regarding the main effect of an external disruption is about price risk. However, the determination of the market willingness to bear risk may not be an efficient process (Grossman and Stiglitz, 1980). This is closely related to problems of information. Markets may fail to coordinate inter-temporal decisions given the difficulty of market players to deal with a highly complex and uncertain future. In turn this means that they do not have (or do not reveal) clear preferences about highly uncertain events, and therefore markets are often incomplete (as they cannot cope with all possible contingencies).

In the case of gas industry security of supply one would assume that consumers are poorly informed about the characteristics of the supply patterns in wholesale gas markets, and thus cannot provide the market with their risk aversion profiles. This would result in inefficient market risk bearing. The solution could be to complete these markets, using the fact that the regulator can be better informed about possible contingencies of gas supplies. The role of regulated security of supply measures is to complete the wholesale gas markets with an estimation by the regulator of the risk preferences of gas consumers.

In summary, one might say that markets are not the best adapted mechanism to deal with 'un-contractual' scenarios (i.e., scenarios of cold or hot war, or any other international diplomatic concern) where there is no enforcement mechanism or self-enforcement corresponding to the obligations to be fulfilled in such rare occurrences. However, a well-functioning European market will always decrease the existing informational risk. It should also decrease many minor disruption risks, transforming them into mundane price risk.

INTEGRATION OF SEVERAL ENTRY/EXIT SYSTEMS

The logic for a single European market based on entry/exit regulation is the rationale behind gas market design in the EU. The integration of numerous 'entry/exit markets' has no analogue in international experience (ERGEG, 2010; ACER, 2011a). In practice, however, in the task of integrating these numerous markets, the design decisions to be taken follow a sequence similar to a single entry/exit market.

One of the very first decisions to be taken is whether an explicit allocation or an implicit allocation of the interconnection capacity should be used. The same arguments already seen may be applied: the transaction costs of combining capacity and commodity traded separately, and the possible strategic use of interconnection contracts. In this context, the design for integrating the European markets could be radical: a single entry/exit market in the whole EU and the definition of a single EU commercial network as distinct from the various existing physical networks. This single entry/exit system would contain all existing national markets that are interconnected. With this approach, however, the difficulties and the costs of the decisions required to bridge the gap between commercial and physical networks would be extensive.

An alternative approach would be to design the pan-EU commercial network with more keys: as a representation of all the critical physical characteristics of actual interconnections, leaving the existing national markets unchanged. In this approach, one can rely on the explicit allocation of the interconnection capacity. This would require, in addition, some effective measures aimed at preventing the possible strategic behaviour (for instance, it is not clear that the use-it-or-lose-it conditions could effectively prevent this kind of behaviour).

It is also possible to implement the implicit allocation with much less simplification in the definition of the commercial network. One could implicitly allocate the interconnection capacity without simplifying the physical characteristics of existing interconnections too much. Such a 'detailed' implicit allocation would come from the combination of the gas pricing of the connected markets by means of an algorithm of zonal pricing (such as 'market splitting', 'market coupling'). Moreover, when this solution is adopted, it is possible to reach a halfway point between implicit and explicit allocation. The 'strategic behaviour' problems of explicit network allocation has to do with the strategy of contracting large amounts of capacity that foreclose the short-term capacity market in the long term. But as soon as the short-term capacity is implicitly allocated by the commodity market, this strategy is no longer possible. However, the long-term allocation of interconnections can still alternatively be done through explicit auctions.

One faces two opposite forces when confronting a tight single entry/exit market for Europe with a loose and light wholesale market made up of interconnections between existing national entry/exit markets. On the one hand, with tight single entry/exit the gap between commercial and physical networks may be too large in terms of both efficient use of the network and cost allocation to beneficiaries. On the other hand, its opposite, being the coexistence of several entry/exit zones, creates other cost allocation problems related to cross-border transactions. It is because, besides the cost of the interconnection, cross-border transactions need to pay the entry and exit price of each corresponding zone. Therefore, some trades that would be economically efficient between the two ends of the interconnection, from the one with lower gas prices to the one with higher prices, will not occur if this price difference cannot compensate for the extra cost associated with the entry and exit prices (which represented the network price of each entry/exit zone). Ultimately, when the interconnection capacity is contracted in advance, this may result in reversed flows (from the high- to the low-price zones).

From the investment viewpoint, a single EU entry/exit market would share the characteristics described for the case of a national entry/exit market, except that the hypothetical European planner would face a larger number of missing market signals. Conversely, the loose integration scenario between existing national markets would require additional mechanisms to decide on and build the required interconnections. Interconnections are the core gates of the European Internal Energy Market, but who will develop them, why and how? This could typically involve some kind of public consultation, in either an auction or an open season process.[6] Would it be enough to build a competitive and open bridge between the existing key EU markets? Would it compromise the vested interests of the existing incumbents too much?

OVERVIEW OF THE BOOK

This book focuses on market design issues common to most EU gas markets, and especially the European integration of those markets. National gas markets in Europe are already built as virtual hubs based on entry/exit schemes. This is made legally binding by European law (Third Energy Package) and therefore already enacted by the new European regulatory agency ACER (Agency for the Cooperation of Energy Regulators) in its Framework Guidelines (ERGEG, 2010; ACER, 2011b). Thus this book takes this as a given for European gas market integration, and examines the subsequent characteristics and requirements of such a European design strategy.

A sensible way to begin an analysis of the design of a European gas market is to identify the current characteristics of the gas flow patterns in European gas systems. This is, hence, the motivation for the first part of the book. After the introductory chapter, in Chapters 2 and 3, Michelle Hallack and Sophia Ruester, respectively, analyse the demand and supply patterns in the EU, showing that both have changed after the introduction of the growth of gas-fired power plants on the demand side and liquefied natural gas on the supply side.

One of the main features of the 'new' demand and supply in the EU is the larger variability of injections and withdrawals (hence the gas flows) and the higher flexibility required from gas systems. These characteristics are already impacting the integrated European market. On the one hand, the range of possible suppliers has increased significantly. Consequently, the formerly efficient contracting patterns and the currently efficient combination of gas suppliers should not be the same any more. This is why (and where) markets may be of help: to reconfigure all this accordingly. On the other hand, the expansion of gas-fired power plants (the main factor in gas demand growth) increases the time variability of gas demand. Actually, gas-fired power plants often create both higher peak demands and lower annual cycles, and both these changes bring new usages of infrastructure. In that view, again, markets are useful tools to implement all the needed adaptation.

European integration is targeting national gas markets that are already being organized around entry/exit zones. It is thus necessary to have a close look at the repeated interactions between transmission operators' activity and gas commodity markets. This is done in the second part of the book. After the introductory chapter, in Chapter 5 Michelle Hallack addresses the actual design of commercial networks in EU markets. How does the relationship between the commercial and the physical networks work regarding the 'new' flexibility requirements of network users? In practice they are the existing operation rules applied to the existing infrastructure that frame the flow's variation management. Consequently the precise design of the bridge between the commercial and the physical networks is at the core of the functioning of gas markets already being based on entry/exit regulation.

The last part of the book presents two proposals for the EU gas target model. These two models tackle the fundamental questions (from the standpoint of the overview provided above). They regard both the organization of short-term transactions and the mechanisms for investment in new long-life infrastructure needed to integrate the EU markets. Both models build on the idea of designing gas markets around an implicit allocation of network capacity in the short run. Following the EU Third Energy Package, they start from an entry/exit regulation as the basis for European market organization. Under this scheme, several integration issues must be addressed. From the short-term perspective, the most important elements for market integration are the coordination of several entry/exit markets and the organization of cross-border transactions.

Several possibilities are investigated. After the introductory chapter, in Chapter 7 the director of the Florence School of Regulation, Jean-Michel Glachant, proposes an option aiming at merging neighbouring markets to obtain competitively viable and tightly unified entry/exit zones. He reveals another option that leaves other markets as independent entry/exit zones connected by means of an implicit auction algorithm, along the lines of market coupling. To implement the network allocation in cross-border transactions, both options propose relying on hybrid mechanisms (explicit and implicit). In particular, both propose using implicit allocation in the short term, and leaving the long-term allocation to explicit auctions.

The gas sector advisor of the Florence School of Regulation, Sergio Ascari, offers a third possibility in Chapter 8. It is a 'free' market option that does not prescribe any size or shape for the virtual hubs. Market forces are left free to ultimately decide the most convenient number, location and size of European hubs.

When it comes to defining a set of more closely unified entry/exit zones or to using some algorithm for looser zonal pricing, Jean-Michel's model leaves the choice to a public authority, as both strategies are possible. Nonetheless, Jean-Michel gives criteria as the gas volume traded (around 20 billion cubic metres) and the number of alternative gas sources (at least three). Sergio, for his part, claims that a tight coordination of short-term transactions is not especially important in the design of the target model, as a more spontaneous coordination will emerge from market interactions.

These two target models are less convergent when it comes to the design of investment mechanisms in new infrastructure. Jean-Michel relies on a planning scheme where TSOs call for auction to organize new investments and regulators can intervene to review. Sergio highlights the benefits of a purely merchant investment scheme.

Security of supply is dealt with by Jean-Michel by giving a say to regulators in supply infrastructure diversification. Sergio does not give any particular recommendation in this regard. Building his proposal on a wider reliance on market forces, he assumes that the security of the European gas markets will be ultimately determined by the preferences of market players.

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NOTES

1. It is worth highlighting that the regulation of network operation does not require the design of a virtual hub, but it is just a design choice aimed at allocating the network implicitly.
2. In a pure liberalized environment, infeasible transactions are not offered in the market. When there are several non-regulated operators competing among them, it is not necessary to organize markets to combine the technical characteristics of the network and market preferences.
3. The re-nomination is the last moment when the shipper is allowed to inform the network operator of how much gas it will actually inject into the determined entry point.
4. It is important to note that some countries, such as the Netherlands, Belgium and Germany have some kind of hybrid balancing period. In these cases other obligations to keep flows balanced are established inside the balancing period.
5. It is worth noting that the Third Directive (EC, 2009b) states that contractual congestion means 'a situation where the level of firm capacity demand exceeds the technical capacity' and physical congestion as 'a situation where the level of demand for actual deliveries exceeds the technical capacity at some point in time'.
6. The differences between open seasons and auctions strongly depend on the definition of open seasons. Here, an open season is a consultation that does not imply firm contracts.