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## The development of gas hubs in Europe

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## HIGHLIGHTS

- The paper illustrates development paths for natural gas hubs in Europe.
- Wholesale trade increases with competition.
- The regulatory settings of UK, Netherlands, Germany and Italy are reviewed.
- Each country is located into the evolutionary path highlighted in the analytical framework.

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## ABSTRACT

This paper investigates the development of wholesale markets for natural gas at the different stages of market liberalization. We identify three steps in the process: wholesale trade initially develops to cope with balancing needs when the shippers and suppliers segments become more fragmented; once the market becomes more liquid, it turns out to be a second source of gas procurement in alternative to long term contracts; finally, to manage price risk financial instruments are traded. We review in detail the different regulatory measures that must be introduced to create an efficient and functioning wholesale gas market. Finally, we analyze the evolution of gas hubs in the UK, the Netherlands, Germany and Italy in terms of market rules and market liquidity. We argue that each of these country cases can be easily located into the evolutionary path we have highlighted at the beginning, with the UK and the Netherlands leading the process, Germany and Italy constrained by limited supply; Italy is also showing an interesting counterfactual.

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## 1. Introduction

In the last decade, wholesale gas markets have developed in several European countries, with very different volumes and liquidity. This diversified landscape suggests interesting research questions: what determines the emergence of gas hubs? Is there a predictable pattern of development that helps interpreting the different situations as part of a common process?

In the European liberalization design the successful development of a liquid wholesale gas market has required the definition of a set of rules and mechanisms addressing the choice of a transmission system model, the design of the balancing rules and the set-up of transparency requirements. Within these market rules, a growing demand for wholesale gas, pushed by industry

fragmentation, has been in our view the driving force in the process.

We argue that balancing needs to clear individual portfolios in a liberalized and fragmented market have been the initial motivation to trade. As wholesale transactions developed, operators had the opportunity to purchase gas at the hubs as an alternative to long-term contracts. Moreover, domestic producers, when significant, could sell at the hub in parallel with their long-term provision contracts, giving a push to liquidity. We argue this process has characterized the development of national gas hubs in each European country, with a more dynamic process in the gas systems where domestic production plays a significant role. The need to hedge price risk has led to introduce financial instruments, that may be traded even in market venues distant from the

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location of physical trades. We expect them to concentrate in a few number of market venues.

We apply this analytical framework to the evolution of the wholesale natural gas markets in Germany, Italy, the Netherlands and UK<sup>1</sup>, analyzing their balancing systems and tools for physical and commercial flexibility, and the development of market liquidity. We focus on these countries as, in our view, each of them represents a different evolutionary stage in the process depicted above.

Although the dynamics of gas markets is receiving increasing attention, a comprehensive analysis of the development of wholesale gas markets in Europe and the related regulatory issues is in our view still missing in the literature. NERA and TPA (2005) review and evaluate balancing rules in some EU countries, but the report is by now outdated. Migliavacca (2009) surveys some aspects of the Italian balancing system, highlighting the contacts with the electricity sector, while KEMA (2009) offers an interesting report that deals nonetheless only briefly with balancing and flexibility, being concerned with transmission tariffs. Lapuerta (2010) examines some balancing mechanisms and analyzes the balancing system in the UK and Germany and Keyaerts et al. (2011) deal with flexibility issues focusing on line-pack. Many studies deal with the impact of European integration on gas market: recently, Neumann and Cullmann (2012) measured the degree of integration of gas markets based on the prices of eight European hubs, finding a significant level of convergence. Asche et al. (2013) analyzed the degree of market integration between the British NPB, the Dutch TTF and the Belgian Zeebrugge, also finding a high integration. Petrovich (2013) studies hubs integration verifying the reliability of hub prices as reference price signals. A large literature deals with the implications of the entry-exit model and, more in general, with the European Gas Target Model (also GTM). Among others, it is worth recalling the works by Hunt (2008) that explores the implications of having an entry-exit model on integration and wholesale markets and by Vazquez and Hallack (2013), that identify the central significance that balancing markets assume within the entry-exit framework. Glachant et al. (2013) further discuss the GTM with a special focus on the regulation of network capacity. Finally, KEMA/COWI (2013) analyze the different role of long and short term contracts on EU competition and security of supply. Heather (2012) accurately describes and categorizes the main European gas hubs and their liquidity. We move alongside this line of study, but focusing rather on balancing mechanisms and rules, and viewing liquidity as a result of growing demand and of the rules set by each country's regulator.

The contribution of this paper is threefold. First, we build an analytical framework to study the balancing issue and the related development of wholesale demand; second, we review the EU regulation on wholesale gas markets and the balancing regimes adopted by four countries; third, we provide supporting data and indicators to confirm our line of reasoning.

The paper is organized as follows. Section 2 offers an analytical framework of the increase in liquidity stemming from market liberalization and the role of balancing. Section 3 reviews the EU regulation on balancing and transmission, reviewing the balancing mechanisms and flexibility tools available for UK, the Netherlands, Germany and Italy. Section 4 follows the evolution of the hubs of the four selected countries as trading platforms and evaluates their performance according to their liquidity and physical endowment. Section 5 discusses the main results and concludes.

<sup>1</sup> A more detailed study that includes also France, Spain, Belgium and Austria is Dickx et al. (2014).

## 2. Methods

In this section we show through a simple analytical framework how the liberalization process creates a demand for wholesale gas to balance individual positions of the operators.

### 2.1. Liberalization and the development of wholesale transactions

With the progresses of gas market liberalization in Europe, gas systems moved from a monopolistic to a more fragmented environment. In the former, a single vertically integrated company managed most of the injections and withdrawals, balancing the ex-post shocks in supply or demand by adjusting flows within its portfolio of contracts. In the latter, instead, different agents each cover a smaller share of the aggregate traded gas volumes, increasing the fraction of shocks that cannot be compensated within individual portfolios and the number of associated imbalances. Wholesale trade, then, offers a way to clear individual positions, easing the need to balance physical injections and withdrawals. In turn, as wholesale trade and liquidity develop, price signals become more reliable and a wholesale market offers a second source of gas provision in alternative to the traditional long-term contracts. Price variability still remains, due to aggregate shocks, and requires financial instruments to hedge the price risk. We argue that this process, with balancing, second sourcing and financial instruments as the three steps, characterize the development of wholesale trade in the liberalized European markets.

### 2.2. The balancing issue

Flows in the gas transmission system (GTS) occur from one point to another in the network by virtue of the differential in pressure existing between those two points. Pressure fluctuations stemming from market parties' injections and off-takes to and from the network can threaten the system integrity.<sup>2</sup> It is therefore crucial to design a balancing system that ensures that pressure in the system remains within safe operational limits.<sup>3</sup> Demand and supply shocks make this task challenging.

Inflow and outflow decisions are taken by a set of economic agents or institutional bodies within contractual frameworks that usually define ex-ante a certain flow and adjust ex-post to the realized volumes. Outflows, for example, depend on the decisions of final users, who contract their gas provisions according to their predictable needs, and can further withdraw gas adjusting and paying ex-post their off-takes. These latter are mirrored by a corresponding decision of inflow (e.g. import) by upstream agents as shippers. Hence, the flows in the GTS depend on a large set of demand and supply decisions by different agents, and reflect their underlying choices. Supply and demand shocks may create imbalances between planned and realized inflows and outflows, with a variation in the pressure into the system. Balancing ex-post inflows and outflows is therefore a crucial activity in the management of a GTS.

<sup>2</sup> From Keyaerts et al. (2008 p. 2) "system integrity" is defined as "each situation of a transport system where the pressure [and the quality of the natural gas] remain within the lower and upper limits set by the system operator such that the transport of natural Gas is guaranteed".

<sup>3</sup> The sources of inflows in the GTS are imports (by pipeline or LNG terminals), domestic production and withdrawals from the storage facilities (depleted gas fields, aquifers, salt caverns, facilities at LNG terminals), each characterized by some capacity constraint. Outflows correspond to withdrawals from the GTS. They can take different forms: final demand by end users directly connected to the GTS or to the distribution networks, exports to foreign GTS's by pipelines or LNG, and injections into storage facilities.

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