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Value chain analysis of the natural gas industry— Lessons from the US regulatory success and opportunities for Europe

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A R T I C L E I N F O

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A B S T R A C T

The aim of any value chain & network analysis is to understand the systemic factors and conditions through which a value framework and its firms can achieve higher levels of performance. The upstream oil & gas business is increasingly stimulated for growth by federal legislation (e.g. tax credits unconventional gas plays), while the corporate earnings in the US midstream and downstream energy segments remain strictly regulated and constrained by FERC and state regulators. This study concisely describes the physical and the financial value chains of the US natural gas business in a systemic fashion. The value chains of the natural gas industry are governed and interconnected by a regulatory decision-making framework. Legislation and regulation by the US Congress for the upstream energy value chain traditionally aim to facilitate the development of domestic natural gas fields. Likewise, FERC regulation maximizes access to the midstream gas transmission segment and provisions for fair tariffs for all shippers. State regulators protect the end-consumers in the downstream value chain by providing guidelines and rulings in rate cases. Corporate energy development decisions are critically impacted by such energy policies and regulations. Long-term, mid-term and short-term measures are distinguished based upon the duration of their impact on the performance of the US natural gas market. The present analysis of the physical and financial value chains and the regulatory framework that governs the US natural gas market provides new insights on appropriate policies and regulatory strategies that could improve both the liquidity and security of supply in the European gas market. Strategic and tactical instruments for maximizing returns on investment for regulated energy utilities are also formulated.

1. Introduction

The concept of value chain analysis as a generic business management tool was introduced by Porter (1985). Numerous studies on value chain analysis and value networks have been published since (e.g., Allee, 2003; and review in Weijermars, 2008). Industry stakeholders commonly benefit from a systemic value network analysis because it identifies key areas in the value network where constraints occur and opportunities for improvements arise. The global oil & gas industry is under considerable pressure to meet the world's demand for affordable and secure energy supply. Environmental concerns have intensified the interfuel competition and this battle can be prolonged in favour of optimum utility for the remaining global reserves of oil and gas.

In spite of the differences in regulatory regimes, inter-fuel competition tends to converge the prices for oil and natural gas into a narrow band. Fig. 1 shows the oil and gas price correlation over the period 2002–September 2009 (this study's closure), at which time the USD price per Mcf of natural gas stood at roughly 1/10 the USD price paid for 1 bbl of oil. Oil has historically been priced at a premium to gas, trading on the spot market about one-and-a-half times on a heat-equivalent basis since 1993. Oil is usually priced at a premium because it is globally traded commodity, many inexpensive options exist for transportation and storage, and its chemical constituents are a valued feedstock to the petrochemical and refining industry. The heat-equivalence of 6 Mcf natural gas is about 1 bbl of oil (or boe) and that correlates their caloric price volumes as indicated in Fig. 1. The price elasticity range for each fuel source is controlled by different dynamics, where regulatory issues can play a large role in the price-setting for natural gas, but less so for oil. Oil prices, unlike natural gas, are not regulated and broadly follow global supply and demand cycles.

To many oil and gas professionals the natural gas value chain is foremost a physical supply line of natural gas connecting production centers (wellhead) and end-consumers (burner pit). The global expansion of natural gas production has interconnected what were originally local markets into a global network of energy supply and

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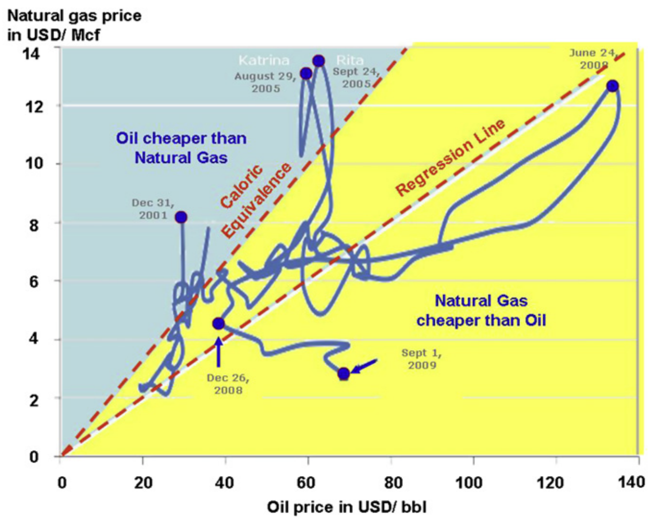

Fig. 1. Development of daily averaged Henry Hub spot market prices versus western crude as of December 2001 till September 2009 (All data from DOE/IEA).

demand. Most professionals are aware that the further development of natural gas infrastructure networks is also subject to political agenda's, complex legislation and strategic directioning (e.g., Economides and Wood, 2009). The natural gas value chain analysis summarized in the present study provides a basis for enhanced competitiveness and formulates hints for policy and strategy optimization, as well as operational performance excellence.

Large sections of the US natural gas industry are tightly regulated. The aim is to provide ground rules for the economic decision-making process in the energy industry. This paper outlines the decision-making and rate-making frameworks that govern and integrate the physical and the financial value chains of the natural gas business. The value adding and earning potential along the value chain within the interconnected decision-making framework are analyzed. The analysis reveals how regulatory and energy policy instruments have supported and - at times - depressed natural gas prices (both wellhead & retail prices). Different measures may effectuate an impact on natural gas price-making at different time-scales. The relationships between regulatory, policy and corporate investment decisions on one hand, and the price of natural gas on the other hand, provide room for tactical instruments to enhance earnings in the natural gas business.

This paper is organized as follows: Section 2 briefly outlines the emergence of the global market for natural gas. Sections 3 and 4 then depict the physical and financial value chains, respectively. The governing economic and liberalization principles are summarized in Sections 5 and 6. Decision-making steps and the critical role of regulations and policy measures for the natural gas value chain are discussed in Section 7. Examples of corporate portfolio strategies are detailed for US energy utilities in Section 8. Implications for Europe and recommendations and conclusions are formulated in Sections 9 and 10.

This paper expresses US natural gas prices in concise USD/Mcf notation. Henry Hub prices are formally posted in USD/mmBtu. The alternative price measure for 1 USD/mmBtu is 1 USD/Mcf, where mmBtu stands for a caloric value of million British thermal units and Mcf for a volume of thousand cubic feet. The caloric value of 1000 cf (1 Mcf) natural gas is about 1 mmBTu. More detailed examples of the fractional variations in caloric values of natural gas resources are included in a recent review by Foss (2007).

2. Brief historical outline

Natural gas resources are unevenly distributed around the world, which means that pipelines and LNG shipping routes connect production regions with consumption markets (Fig. 2). In 2009, the US holds 278,000 miles of major transmission pipelines (Miesner, 2009) and Europe 18,542 km (equivalent to 11,521 miles; Makholm, 2007). The growing imbalance between local demand markets and local production regions requires major increases in global transport capacity (Hartley and Medlock, 2006a, b; Berkel and Roodhart, 2008). Natural gas sourced from multiple sources is transported via a dedicated global network toward the world's principal market regions. Within these market regions, local distribution companies grid into the end-consumer locations (households, offices, factories, and power plants).

The natural gas market has grown fast from an early market for methane that was created first in the UK by heating locally mined coal, producing so-called manufactured gas for lighting factories and cities in the 1800s. The US pioneered long-distance natural gas transmission systems with a 40 km pipeline at Rochester in 1870, and the first high-pressure transmission system was built in 1891 over 198 km from an Indiana natural gas field to Chicago (Busby, 1999). Long-distance interstate gas transmission began to become profitable in the 1920s and by 1931 several long-distance transmission systems had been constructed across the US (Hilt, 1950).

Crucial in determining the cost of new transmission pipelines is the relative capital outlay on building, operating and maintenance cost of the pipe and of the compressor stations. It is necessary to account for the costs of construction of the line and the compressor stations, as well as the cost of running all the equipment. Models for efficient gas transmission focus on the two basic capital inputs for the asset: pipes and compressors (e.g. Chenery, 1949). Compressors are required to provide pressure for the gas transport, which decreases gradually due to frictional losses of energy when gas is moved along the pipe. The energy loss in the pipe due to friction in transmission is a decreasing function of pipe size. It follows that greater pipe diameters require less compressor capacity to pump any given amount of gas over a specific distance. The conclusion is that cost optimization uses a substitution between pipes and compressors, based on calculations of energy loss and the effect of equipment's capacity size in reducing this loss (Robinson, 1972).

Since the mid-1950s experimentation began with LNG plants and liquefied natural gas was shipped over distances that made pipelines uneconomic. The LNG market is still under development and has gained global momentum since the turn of the Millennium. A further, massive expansion of the global LNG transport infrastructure is nearing completion, with the bulk of delivery capacity coming

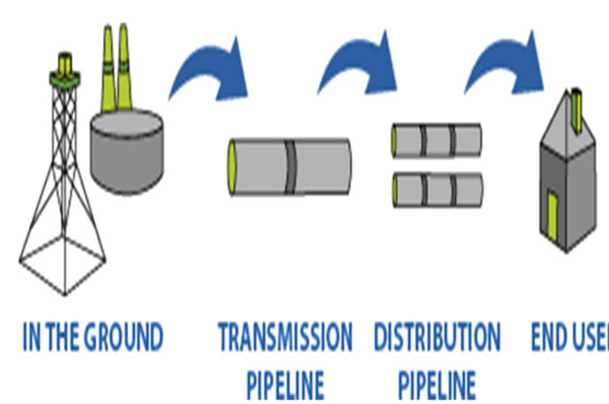

Fig. 2. Typical cartoon for value chain of natural gas business is replaced in this study by a more sophisticated workflow breakdown in Fig. 3.