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ANALYSIS

Investigating the potential effects of U.S. LNG exports on global natural gas markets

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ABSTRACT

There have been increasing debates regarding whether the United States should export liquefied natural gas (LNG) to the global market. Using the World Gas Model, a large-scale game theoretic model, this paper investigates the potential effects of U.S. LNG exports on the domestic and global markets. U.S. LNG export scenarios relate to a Global 20/20/20 policy and competition with new pipeline projects (e.g., Nord Stream, South Stream, and Southern Corridor projects) are also considered. We find that the average U.S. domestic natural gas prices increase approximately 10.9% given 123 billion cubic meters of LNG exports and that natural gas prices in Europe and Asia decrease significantly. In addition, less expensive U.S. LNG is competitive in European and Asian gas markets and displaces more expensive suppliers in European and Asian gas markets. Under the European pipeline scenario, Russia is expected to reduce natural gas flows to transit countries by more than 50% when the Nord Stream and South Stream pipelines become available.

1. Introduction

The United States became a large natural gas importer in the early 2000s and continued as such until the mid-2000s [1]. Many liquefied natural gas (LNG) import terminals and regasification terminals were built, but the demand never reached the total import capacity [2]. The import of natural gas in the United States began to decline after 2007 [3] because of the development of unconventional domestic gas, particularly shale gas, of which the United States has abundant resources. According to the U.S. Energy Information Agency (EIA) [4], 862 trillion cubic feet (Tcf) or equivalently 24,411 billion cubic meters (Bcm) of technically recoverable shale gas resources—or approximately 40 times the annual U.S. consumption in 2010—are distributed throughout the contiguous 48 states. With advanced drilling technology, shale gas production has increased fivefold from 2006 to 2010 and accounted for 23% of the total U.S. natural gas production in 2010 [5]. Shale gas production in the U.S. is projected to reach 12 Tcf/y (339.84 Bcm/y) by 2030, constituting 46% of the total U.S. production [5]. The evolution of shale gas in the U.S. creates export opportunities for natural gas producers when the anticipated domestic production exceeds the domestic consumption requirement [6].

The emergence of shale gas has shifted the U.S. from a natural gas importer to LNG exporters. U.S. natural gas companies are motivated to export for several reasons. First, natural gas prices in the U.S. are substantially lower than in other natural gas markets. The prices at Henry Hub were between $3–4 per million British thermal units (MMBtu) in 2012, which is relatively low compared with Asian prices ($15–16/MMBtu) and European prices ($9–11/MMBtu), as indicated in Fig. 1 [7]. Asian natural gas prices continue to increase, particularly the LNG prices, which are among the highest prices in the world [8]. Thus, the substantial price differences create arbitrage opportunities for natural gas exporters. As a result, a number of natural gas producers are eager to apply for natural gas export licenses [9].

Second, because natural gas is considered a key fuel source that exhibits the lowest carbon content among fossil fuels [10], its demand is rapidly growing, especially in Asia due in part to current or anticipated environmental advantages over other fossil fuels [11]. Of these markets, Japan is the largest LNG importer. An upswing in LNG imports has been driven by the Fukushima nuclear disaster in 2011 since that

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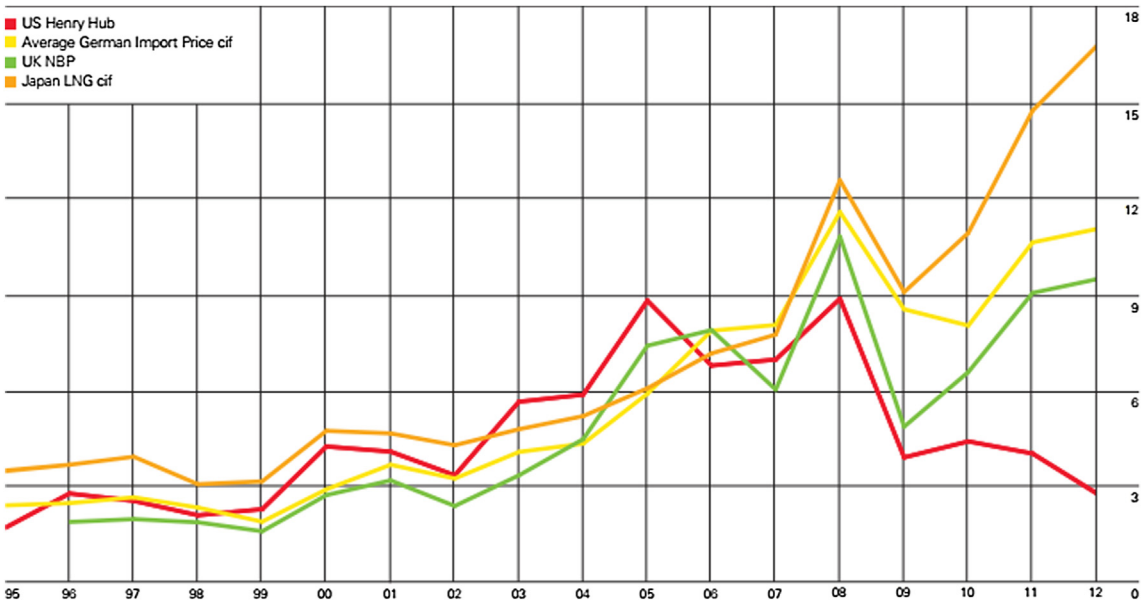

Fig. 1. Comparison of prices from 1996 to 2012 ($/MMBtu) [7],.

country has required additional LNG to compensate for the lost nuclear power, leading to a 12% increase in natural gas consumption between 2010 and 2011 [12]. Likewise, the Chinese government aims to increase the use of natural gas as the country's primary source of energy by 8.3% by 2025 [13]. According to forecasts from the China National Petroleum Cooperation [14], the projected Chinese natural gas consumption based on its 12th five-year energy plan will reach 400 Bcm/year by 2030. Furthermore, the Chinese National Petroleum Cooperation has proposed promoting the use of natural gas in at least 200,000 vehicles for the transportation sector by expanding LNG import terminals [15]. Moreover, European natural gas usage is encouraged because of environmental considerations. Also, with the requirement for renewable portfolio standards in Europe, intermittent renewable power such as wind and solar, require natural gas as a thermal backup source since natural gas combined cycle turbines ramp up quickly and allow more flexible grid integration in addition to their environmental benefits. The International Energy Outlook (IEO) [16] expects an average growth of 0.7% per year for OECD European natural gas consumption and the IEO projects reaching 23.2 Tcf (657 Bcm) in 2035 because of increasing demand in the power sectors of Europe. Although a small rate of demand growth is predicted, Europe will still require more imports because there is a considerable gap between the declining endogenous supply and the demand. Europe currently imports natural gas from five sources: Russia, Norway, Africa, Central Asia and overseas LNG imports. Therefore, U.S. LNG exports from the East Coast and the Gulf of Mexico would provide an alternative for Europe because of the close proximity, reliability, and political considerations.

A third reason for the emergence of the U.S. as an LNG exporter is that in the past many European countries have experienced negative consequences resulting from the Russia–Ukraine gas price disputes in 2006 and 2009 [17]. Supply security has led the European Union (EU) to try to mitigate these situations and to assist EU members in diversifying their natural gas suppliers by proposing a number of pipeline projects to deliver more gas to Europe [18]. Many rival European pipeline projects are competing with one another. The Southern Corridor project provides an option to import natural gas from the Caspian Sea area. Nord Steam and South Stream are two underwater pipelines that will supply gas directly from Russia to Europe without requiring transit countries such as Ukraine. The total capacity of these two Russian projects is larger than the current volume of gas flowing through Ukraine into Europe. These projects should increase natural gas flows to Europe, but the market power of Russia over Europe cannot be underestimated. In addition to the aforementioned pipeline projects, numbers of large LNG import terminals are in the process of construction, such as the GATE Terminal in the Netherlands and the Polskie terminal in Poland. The routing of LNG cargoes not only provides flexibility, but also allows for rapid responses to uncertain demands [19]. Proposed LNG projects enable more LNG to be distributed throughout Europe as well as an export opportunity for LNG exporters. Any volumes of LNG exported from the U.S. potentially provide an additional option for European supply diversity to mitigate Russian market power.

Finally, U.S. LNG import facilities can be readily converted into LNG export terminals. Construction costs for LNG terminals have increased greatly due to the high price of steel. It costs approximately $1000 per ton per annum (tpa) in 2012 as compared to $200 in the early 2000s to build a new liquefaction plant. However, the cost of converting an LNG import terminal to one that can export is approximately half of building a new terminal, at $625 per tpa, as indicated by the Sabine Pass project ($5 billion for a capacity of 8 Mtpa) [20]. There are twelve LNG import terminals in the United States, with a total capacity of 19.1 billion cubic feet per day (Bcfd) [2]. In the recent past, most of these terminals have been used for natural gas imports. After the great increase in shale gas resources, most LNG import terminals have been redundant because of the rapid growth of the U.S. domestic shale gas production. To maintain their operation, there have been a number of re-export applications filed with the U.S. Department of Energy (DOE). In these cases, natural gas companies can use LNG import terminals to receive LNG cargo from different sources; they will then wait for higher prices and sell back to the LNG spot markets [9]. However, some of the terminals have also been developed to export domestic natural gas to import countries such as Sabine Pass Terminal. As of March 2012, the DOE had approved a total export capacity of 84 Bcm/y, accounting for approximately 15% of the total U.S. consumption in 2011. Seven export terminals will be fully operational by 2018 [2]. With this capacity, the U.S. will be the third largest exporter of LNG behind Qatar and Australia.

Although natural gas producers are considering exporting U.S. LNG for a number of reasons and in spite of already approved export licenses, this issue of U.S. LNG exports remains a subject of debate. The topic has gained special attention from Americans, as it has raised concerns regarding the influence of U.S. LNG exports on domestic gas