Stefan Lochner[1], Caroline Dieckhoener[1], Dietmar Lindenberger[1]*

ECONOMIC VALUATION OF INFRASTRUCTURE CAPACITIES AND BOTTLENECKS IN THE EUROPEAN GAS MARKET

[1]Institute of Energy Economics at the University of Cologne (EWI), Germany
*Corresponding Author: +49-221-27729-303, Stefan.Lochner @uni-koeln.de

OVERVIEW

The European Union's rising import dependency on natural gas requires additional investments in import infrastructure and natural gas storages. At the same time, the Third Energy Package addresses, amongst other things, the strengthening of the single European market and the facilitation of cross-border energy trade which implies increased (and better coordinated) investments in gas transportation capacities between member states. In this context, the Institute of Energy Economics at the University of Cologne (EWI) was commissioned by the European Regulators' Group for Electricity and Gas to perform a model-based analysis of infrastructure projects and market integration including a focus on security of supply scenarios [1]. This paper outlines the methodological background and selected results of the study with a focus on the identification and valuation of (potential) bottlenecks in the European natural gas infrastructure system.

METHODOLOGY

Generally, the value of a transportation service between two locations *A* and *B* is determined by the value the respective good has in *B* in excess to its value in *A*. As the value of natural gas in a market is determined by its price, the value of a transportation capacity between two locations is represented by the price difference between the two locations [2]. If these locations (markets) are separated geographically but connected by sufficient transport capacities, arbitrage can take place; if there is no or insufficient capacity, prices will form in residual regional markets [3]. With respect to market integration, it is then concluded that the two markets are considered to be integrated if the Law of One Price holds, i.e. the price difference between the two does not exceed the parity bounds determined by transaction costs [4]. If this is not true, the two markets are not fully integrated physically and there is an infrastructure bottleneck (abstracting from other transaction costs and presuming the market works otherwise efficiently). The shadow cost of this bottleneck or the value of an additional unit of transport capacity is then determined by the aggregated and discounted price difference in excess of transport costs over the considered time period.

In order to investigate physical market integration in 2019, we apply the European natural gas infrastructure and dispatch model TIGER (see [1]) in a scenario analysis. With a high temporal and areal granularity, the model-based approach takes into account intertemporal elements (gas storages) and interdependencies resulting from the interconnection of grids and transit flows. The linear optimization model minimises the total cost of the gas dispatch subject to the relevant infrastructure, gas supply and demand constraints. The modelling approach, hence, assumes that the gas transportation is organised efficiently and that all possible gas swaps are realised. Considering different variations of demand, supply and infrastructure, we compute locational marginal supply costs for locations in each country which can be interpreted as estimators for wholesale gas prices. Evaluating differences between countries depending on the scenario and the time of the year allows an assessment of physical market integration and (temporal) bottlenecks.

RESULTS & CONCLUSIONS

Generally, the gas grids of most European countries are found to be well integrated in 2019 with some exceptions: Applying the demand, supply and infrastructure assumptions of network operators, a structural and costly bottleneck is identified between Germany and the region of Sweden and Denmark. In eastern Europe, some bottlenecks are identified in the winter months, mainly regarding import capacity into Hungary and the countries in the Balkans with a gas sector. In western Europe, temporal bottlenecks arise only on the concurrent peak demand day (coldest winter day if it happens to be in each country on the same day). This appears to be due to a relatively high availability of storages in central Europe relative to France, Belgium and the Netherlands. The latter group of countries also sees a high peak day demand relative to average daily demand. Generally, however, market integration amongst western European countries and between western and central Europe is fairly advanced. In the case of high LNG imports (due to low prices as was the case in 2009), the simulations imply that more gas transport from the terminals in western Europe to central Europe would be economically feasible if more transport capacity were available. However, the aggregated economic costs of these bottlenecks seem to be low. Some of the mentioned bottlenecks are visualised in Fig. 1; see [1] for all the study's findings.

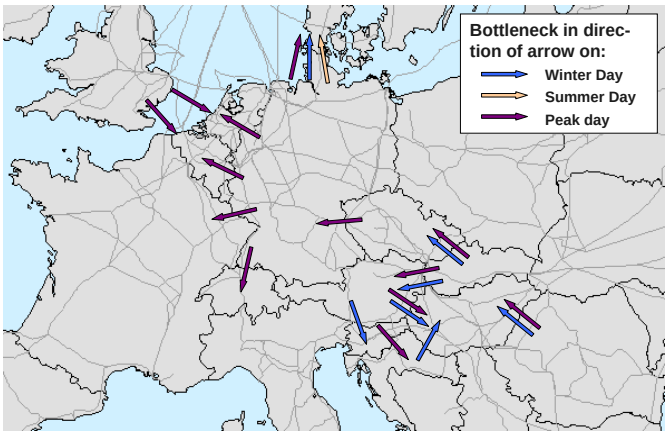

Fig. 1. Selected bottlenecks identified in a Reference simulation for 2019 (Source: [1])

The analysis demonstrates that a model-based approach is required to adequately capture all relevant interdependencies in a complex system such as the gas infrastructure. The study identified a number of potential physical bottlenecks which is important for regulators and the industry. However, it needs to be noted that the results presented neither imply that markets without bottlenecks are necessarily fully integrated (as the non-existence of bottlenecks is merely a prerequisite) nor that an identified bottleneck should necessarily be removed. In the latter case, the economic cost of the bottleneck might be low relative to the capital expenditures required to remove the bottleneck. In this case, making the investment would not be efficient. (See [1] and [3].)

REFERENCES

1. EWI (2010). Model-based Analysis of Infrastructure Projects and Market Integration in Europe with Special Focus on Security of Supply Scenarios. Cologne/Germany (forthcoming).
2. Cremer, H., Gasmi, F., and Laffont, J.-J. (2003). Access to pipelines in competitive gas markets. *Journal of Regulatory Economics*, Vol. 24, No 1, 5-33.
3. Lochner, S. (2009). Nodal prices, capacity valuation and investments in natural gas markets - Overview and Analytical Framework. *EWI Working Paper*, 09/2.
4. Baulch, B. (1997). Transfer Costs, Spatial Arbitrage, and Testing for Food Market Integration. *American Journal of Agricultural Economics*, Vol. 79 No 2, 477-487.