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**A COMPLEMENTARITY MODEL FOR THE EUROPEAN NATURAL  
GAS MARKET**

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**Overview**

In this paper, we present a detailed equilibrium model for the European natural gas market. We distinguish the optimization problem of each market player in the supply chain, that are the natural gas producers and their marketing arms, the "transmitters", pipeline and storage operators, marketers, liquefiers, regasifiers, LNG tankers, and three end-use consumption sectors. We model the producers via their transmitters as strategic players with the possibility to exert market power on the European natural gas market. We distinguish three seasons with low, medium and high demand, and with storage providing seasonal swing. The model is run on a data set which covers 52 countries that produce, consume, or ship gas to Europe. We also include LNG consuming countries outside Europe to allow for a realistic representation of the global LNG market and its interaction with the European continental market. Several case studies highlight the capabilities of the model, including a simulation of the natural gas dispute between Russia and the Ukraine in January 2006.

**Methods**

We develop a detailed and comprehensive static complementarity model for computing market equilibrium values in the European natural gas system. Market players include producers and their marketing arms which we call "transmitters", pipeline and storage operators, marketers, liquefiers, regasifiers, LNG tankers, and three end-use consumption sectors. The economic behavior of producers, transmitters, pipeline and storage operators, liquefiers and regasifiers are modeled via optimization problems whose Karush-Kuhn-Tucker (KKT) optimality conditions in combination with market-clearing conditions make up the complementarity system. The LNG tankers, marketers and consumption sectors are modeled implicitly via appropriate costs, aggregate demand curves, and ex-post calculations respectively. The transmitters are exerting market power on the European natural gas market via their influence on the marketers' demand function.

**Results**

The model is run on several case studies to verify its correctness and to reveal insights about the European and global natural gas market. These cases are the strategic base case (SBC) as a benchmark scenario of our reference year 2005, the case of perfectly competitive market (PCM), the scenario of disruption of transit through Ukraine (UKR) a scenario of disruption of Algerian production and exports (ALG), and a scenario of extended pipeline and LNG capacities as expected for 2011 (2011). The scenario results in Figure 1 confirm that market power reduces the consumption of natural gas in Europe. They also show the dependence on Russian exports through Ukraine and on Algerian exports for the European market as their disruption considerably reduces the consumption in Europe. Moreover, the importance of infrastructure availability to Europe and between European countries is highlighted by the 2011 scenario.

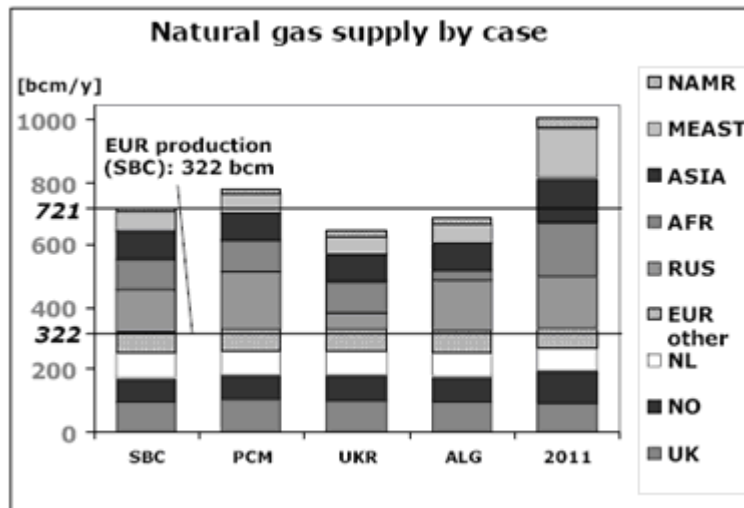


Fig. 1: Natural Gas Supply by Scenario (in bcm per year)

### Conclusions

The scenario results indicate that transport infrastructure availability is a major determinant of the current market patterns. The lack of interconnectedness of many national markets in Europe is a major problem because it prevents the full compensation of missing exports from one exporter by higher exports from another producer. For example, disrupted Algerian exports to Spain and Italy can only partially be compensated by higher imports from Russia or Norway, thereby leading to lower consumption. The results of the capacity expansion scenario (2011) confirm this finding with a large increase of the natural gas supplies to Europe as soon as the transport capacities allow for more shipments.