

# ***THE EVOLVING DYNAMICS OF EURASIAN SUPPLY AND DEMAND IN THE INCREASINGLY INTEGRATED GLOBAL GAS MARKET***

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## **Overview**

Ten years ago the buzz in the energy industry was largely focused on the emerging global market for natural gas. This market integration was coming about as a result of down-trending gas production in North America which was expected to be a permanent condition. Many tens of billions of dollars were invested in designing and building LNG liquefaction terminals worldwide and scores of import terminals along the North American Pacific, Atlantic, and Gulf Coasts in preparation for massive imports to make up the deficit.

This integration, however, never took place. While all of these preparations were being made, George Mitchell and his team were working under most people's radar creating the North American shale gas revolution. Once it became clear that gas supply was no longer the issue, the LNG terminals were not built, terribly underutilized, or not utilized at all. Desperation provided a means for a possible solution. Cheniere, a small but ambitious firm which had built a huge LNG import facility named Sabine Pass, began promoting the idea that there was now so much gas supply that the industry should become exporters rather than importers of LNG. Once they began to have success in getting commitments from mostly Asian customers who were looking for both LNG and greater diversity of supply, many of the other US and Canadian import terminal owners began to develop their own export plans.

So now, in 2016, the world is again set for global integration, but this time North America is poised to play a different role, that of a major LNG supplier to the world. However it is not a given that North America will be successful in this endeavor. Major competition from Australia, Qatar and Russian LNG, as well as pipeline gas from the greater Caspian region make this a wide open game. Adding to this a great deal of disagreement regarding the role of natural gas in reducing the threat of climate change and a diminishing appetite for LNG in Asia make the outcome of the game even more uncertain. Designing the potential scenarios and projecting the possible outcomes requires a sophisticated modelling system.

G2M2 is a modelling system used to analyze and forecast the future of global gas integration. Similar in many ways to its predecessor, GPCM, the North American Natural Gas Market Forecasting System, G2M2 is a system which allows users to run a wide variety of scenarios under assumptions of their own choosing. But G2M2 is also different from GPCM because it is modelling an amalgam of natural gas markets, some of which are competitive like the US and Canada, some of which are slowly liberalizing like Europe, and many in which the government and its national companies are decidedly non-competitive. Thus G2M2 has been designed to both handle this current mix of very different systems in a global arena as well as to envision possibilities for evolution to other more integrated markets.

## **Methods**

G2M2 has been modelled using the AMPL mathematical programming language with Gurobi for linear and linearized models and with the PATH program for mixed complementarity models. The latter is generally an effective approach when modelling mixed markets with both competitive and non-competitive components.

The AMPL code has been designed using a unique set of principles which allow it to be transformed into an equivalent representation in a database table. Using this representation we programmatically generate a separate input-output database along with AMPL scripts for reading the input data and writing output results to the database. We also automatically generate sample problems of various levels of complexity for testing. This procedure has allowed for rapid interactive development between the mathematical model and the database. It also led to a set of principles for definition and naming of instances of AMPL's objects (index sets, parameters, variables, constraints) which create a transparent and easily understood one-to-one correspondence with the automatically generated relational database

## **Results**

The final paper and presentation will discuss results of several scenario sets. One important scenario set will focus on the availability of North American LNG exports and the ability of Eurasian markets to absorb them in competition with incumbents in Russia, Norway, Qatar, and Australia and new challengers in Azerbaijan, Iraq, Iran, and the Eastern Mediterranean..

The presentation will also show the principles of G2M2's unique development approach and obstacles overcome in achieving a realistic and useful modelling system.

## **Conclusions**

Conclusions will include a preliminary estimate for realistic levels of North American LNG exports, the evolution of market prices in the increasingly integrated global market, and assessment of the expected utilization and impact of several major pipeline projects sourced out of the Caspian region destined for markets in Europe and/or Asia.