

# ***HOW GREAT AN IMPACT CAN NORTH AMERICAN LNG AND LPG HAVE IN ENERGY ACCESS FOR THE UNDER-DEVELOPED WORLD?***

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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 because 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.

The predicted integration, however, never took place. While these preparations were being made, independent Mitchell Energy & Development Corporation was 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.

An important side-effect of the shale gas revolution was an explosion in production of natural gas liquids. The volumetric increase in production of ethane, propane, butanes, and natural gasoline had the same effect on North America that it had had on natural gas; it changed from an importer to a major exporter of these valuable materials. One of these natural gas liquids, propane, has an especially important role to play in enabling clean cooking to areas which have little or no access to natural gas. This is often referred to as LPG, a combination of propane and butane.

So now, in 2018, we are seeing a new wave of global integration, but this time North America is playing the role of major LNG and LPG supplier to the world. North America is not the only player in this game. Intense competition from Australia, Qatar and Russia in the near term and East Africa and the Eastern Mediterranean in the longer term make global LNG and LPG a wide-open game. However, the stakes are high, and not just for energy producers.

“In 2015, 193 Member States of the United Nations agreed upon a specific target on ensuring access to affordable, reliable and modern energy for all by 2030 called SDG 7.1 – universal access to electricity and clean cooking. Achieving SDG 7.1 would require bringing electricity to the remaining 1.1 billion who are still without electricity and reaching the 2.8 billion currently without access to clean cooking facilities.” (<https://www.iea.org/energyaccess/>)

What is the role of North American LNG and LPG in helping to achieving the dream of universal access to electricity and clean cooking by 2030? Designing the scenarios and projecting the possible outcomes requires sophisticated modelling systems such as G2M2 and NGL-NA. G2M2 is a modelling system used to analyze and forecast the future of global gas integration. NGL-NA is a highly granular and sophisticated modelling system for the North American Natural Gas Liquids market.

## **Methods**

Similar in many ways to its predecessor, GPCM, the North American Natural Gas Market Forecasting System, G2M2 is a modelling 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.

NGL-NA is a highly granular and sophisticated modelling system for the North American Natural Gas Liquids market. Using natural gas production forecasts as its starting point, it models production of mixed NGL in gas processing plants, fractionation of those mixes into purity products, transportation and storage of mixes and products, and demand at petrochemical plants, refineries, and downstream residential, commercial, industrial and transportation markets.

Both G2M2 and NGL-NA have been modelled using the AMPL mathematical programming language with Gurobi as the solver for linear and linearized models.

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 programmatically generated relational database.

## **Results**

The paper and presentation will discuss results of scenarios projecting the availability of North American LNG and LPG exports and the ability of overseas markets to absorb them in competition with other near-term sources such as Australia, Qatar, Russia and longer-term potential sources such as may develop in East Africa.

A primary focus will be on those countries with limited energy access: the 1.1 billion without electricity and 2.8 billion without clean cooking. Will increased availability from North America keep prices low enough to allow these products to be affordable to areas with limited energy access? How much can increased LNG and LPG availability address these needs?

## **Conclusions**

Conclusions will include a preliminary estimate for realistic levels of North American LNG exports, the evolution of market prices for LNG and LPG, and assessment of the expected penetration of these energy sources into the developing economies of limited energy access.