Key Messages from AMF Research

Annex 48 **December 2018**

Value Proposition Study on Natural Gas Pathways for Road Vehicles

Operating Agent: FEEC, USA
Partners: Canada, China, Denmark, Finland, Israel

Major Conclusion

The goal of this study was to identify the cost-effective and technically feasible ways to use natural gas (NG) in transportation, so that it may have the potential to emerge into the mainstream market. Although country-specific results varied across NG fuel pathways due to differing upstream operations, fuel production and transport conditions, and vehicle operation, analysis showed multiple NG pathways to potentially be “clear winners” for both light- and heavy-duty vehicles in individual countries.

Background

Compressed natural gas (CNG) vehicles, which hold potential to reduce greenhouse gas (GHG) emissions and air pollutant emissions relative to conventional vehicles, have achieved moderate popularity throughout the world; however, they continue to suffer from limited range and, possibly, excessive weight. Liquefied natural gas (LNG) has demonstrated some practicality for use in heavy-duty vehicles (HDVs), but it is currently too heavy to store onboard in light-duty vehicles (LDVs). A third candidate, synthetic fuels derived from natural gas (synfuels), possibly represents another feasible utilization of available energy; to date, however, such fuels have typically been more expensive to produce than CNG or LNG. Electricity derived from NG offers a fourth candidate for fuelling vehicles, especially with the current emergence of electric vehicles (EVs) and their accompanying infrastructure worldwide.

For the benefits of NG-derived fuels to be realized, the resultant fuels would have to be produced, delivered, and used in vehicles at prices that are competitive with those of petroleum-based fuels. Balancing the trade-offs between economics and envirionmental effects will help drive the selection of fuels for road transportation. In particular, emphasis should be placed on the environmental benefits, energy consumption, and energy security, as well as costs, that each fuel pathway can offer to a particular nation.

Annex partners investigated these different NG pathways for on-road vehicles to assess the advantages and disadvantages of the various options. Aspects studied included, but were not limited to, cost, life-cycle emissions, energy consumption, and societal implications of each individual pathway.

Research Protocol

Six country-specific case studies — Canada, China, Denmark, Finland, Israel, and the United States — were conducted in this study to demonstrate the widely varying scenarios for using NG as the basis for transportation fuels. Key factors that play a role in the feasibility of NG or a NG-derived transportation fuel include:

- Natural gas production, consumption, reserves, and trade levels/practices;
- Size of natural gas vehicle (NGV) fleet and supporting infrastructure;
- Presence of fuel production plants (for domestic production);
- Electricity generation mix;
- Governmental stance, through policy support and regulations;
- Market accelerators and barriers; and
- Price of natural gas relative to traditional fuels.

The Canadian-based GHGenius was selected as the primary modeling tool used to address the environmental and economic data needed to compare the variety of transportation fuels due to its extensive emissions analysis capabilities across multiple vehicle and fuel combinations, including heavy duty vehicles; coverage of segments that span the entire fuel cycle; and economic tools and data for calculating cost effectiveness of the various transportation fuel pathways. The team worked closely with the model developers to create a modified version of GHGenius that accommodated additional countries and fuel pathways.

Key Findings

Key findings from the project are summarized as follows:

- **A "one-size-fits-all" solution is not applicable for the viability of natural gas in a country's transportation system**. Each variable applied in this study has the potential to significantly impact fuel transitions; therefore, comprehensive analysis to address unique features of each country is needed.
- Modeling tools enabled the investigation of environmental and economic impacts for the various fuel pathways consistently, but **literature reviews and discussions with country representatives were also critical in understanding and applying the qualitative aspects that modeling simulations cannot fully assess** (e.g., policy trends, consumer behaviors, energy security considerations, extent of infrastructure, and geographical factors).