CANADIAN ENERGY RESEARCH INSTITUTE

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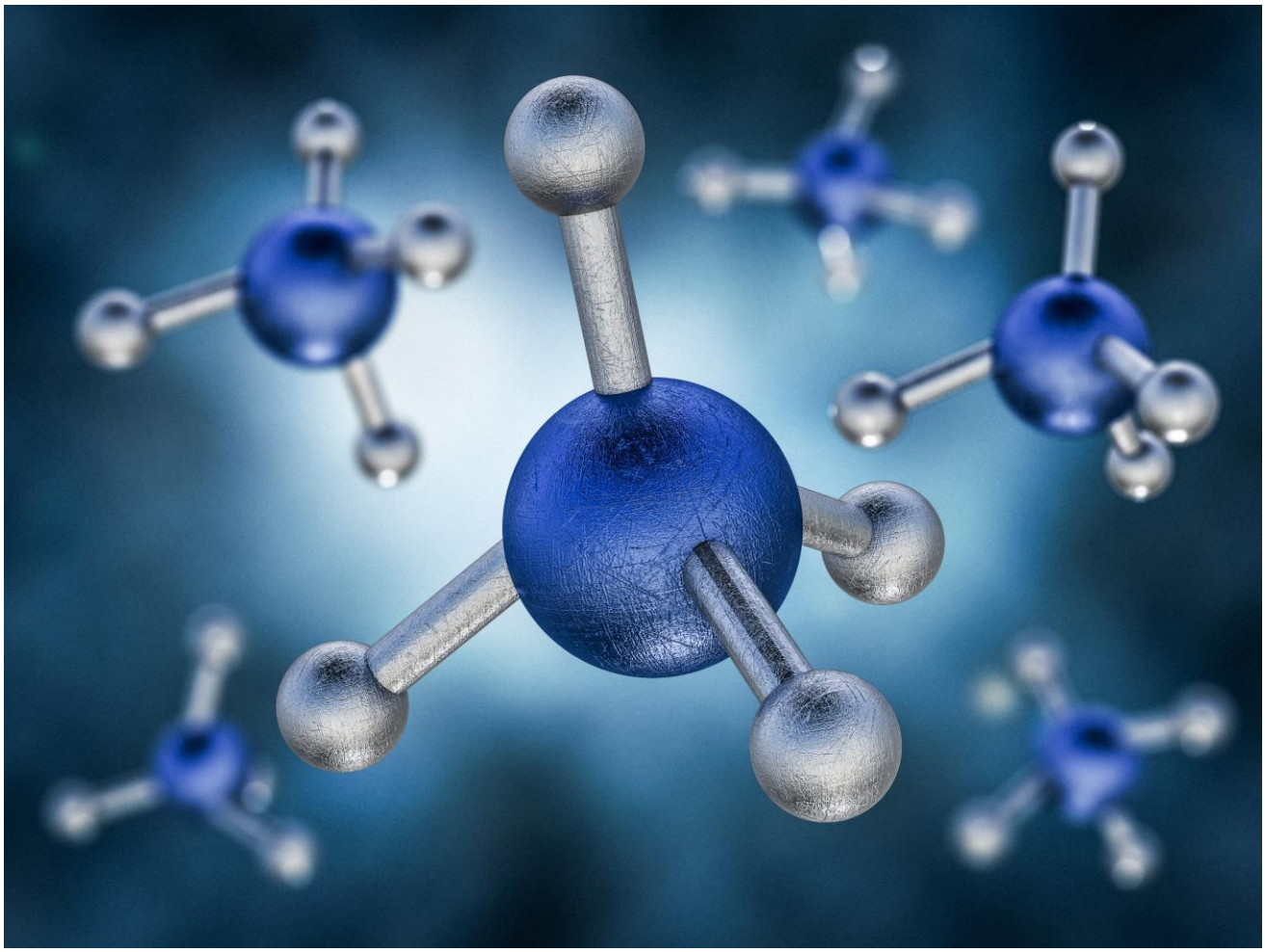
ECONOMIC IMPACTS AND MARKET CHALLENGES FOR THE METHANE TO DERIVATIVES PETROCHEMICAL SUB-SECTOR



Executive Summary

The demand for petrochemical products is substantial. There is a common assumption that the growth of petrochemical products correlates with world GDP which was 2.4 percent in 2016 (IMF, 2017). The role petrochemicals play in society is a reason for a continuous surge in the demand and supply of petrochemical products experienced over many years.

The North American petrochemical market is almost saturated for some petrochemical products because of recent and planned capacity buildups; however, there is growing demand in Asia, particularly, China and India, and other emerging countries. Although Asia is a predominant demand centre, effort is being deployed to increase local production capacities in China and India, but feedstock availability and costs remain the main challenge. This has led to the increasing use of coal-derived feedstock for petrochemical production.

Asia's burgeoning petrochemical demand growth and feedstock dilemma presents an economic opportunity to North America, particularly, Canada and the United States which have cheap and abundant natural gas feedstock. Canada is the fifth largest producer of natural gas with 4.3 percent of the world's production. Canadian natural gas supply was 13.9 billion cubic feet per day (Bcfd) in 2016 and is forecast to rise to 21 Bcfd in 2036. This outlook relies on uses of natural gas as liquefied natural gas (LNG) and petrochemicals, Canadian domestic demand (9.75 Bcfd) and the United States export market. In recent years, exports to the United States continue to shrink due to increases in US domestic production. As a result, the North American market is oversupplied, and growth in Canadian natural gas production is only possible by considering other markets such as LNG and petrochemicals.

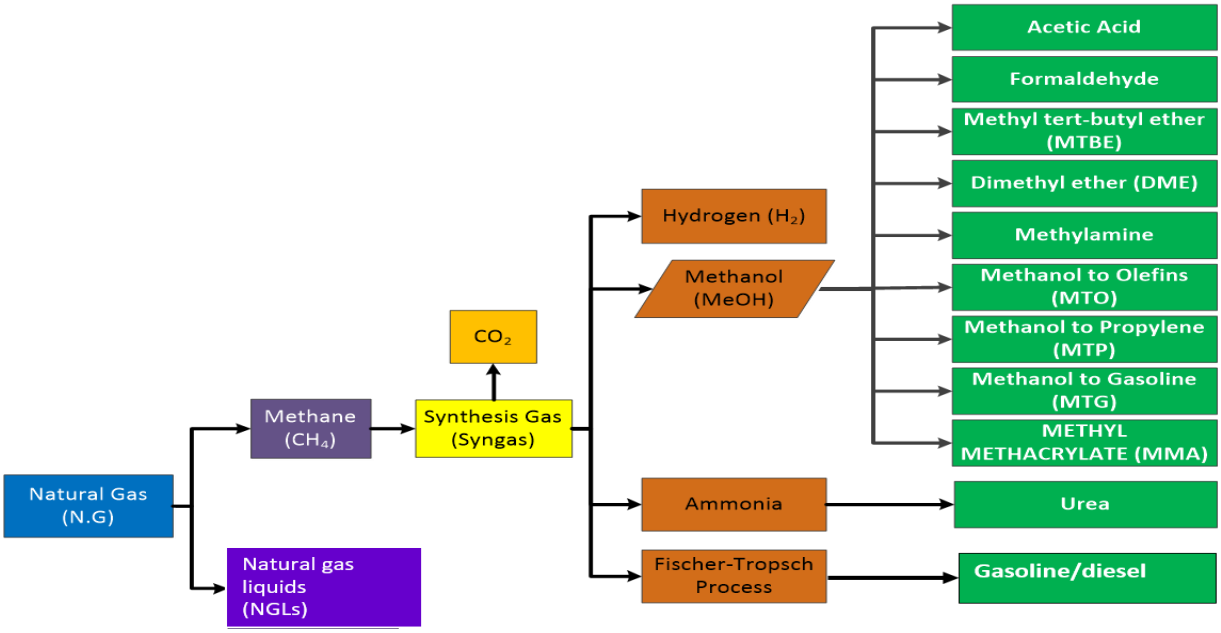
Can the natural gas glut situation in Canada be turned into an economic advantage by converting methane in natural gas to petrochemicals and exporting the products to Asia? That is the question this study sets outs to answer.

This study evaluates the opportunities and challenges of utilizing low cost and abundant Canadian natural gas resources as petrochemical feedstock for producing methane derivatives in Alberta and Ontario. The study also considers the competitiveness of these regions to the United States Gulf Coast. The Canadian Energy Research Institute (CERI) assessed the following methane derivatives:

- Hydrogen
- Methanol
- Formaldehyde
- Methanol-to-Olefin (MTO)
- Methanol-to-Propylene (MTP)
- Methanol-to-Gasoline (MTG)
- Fischer–Tropsch Synthesis (FTS) products
- Ammonia
- Urea

Major petrochemical process links to methane feedstock are illustrated in Figure E.1.

Figure E1: Methane Derivative Value Chain

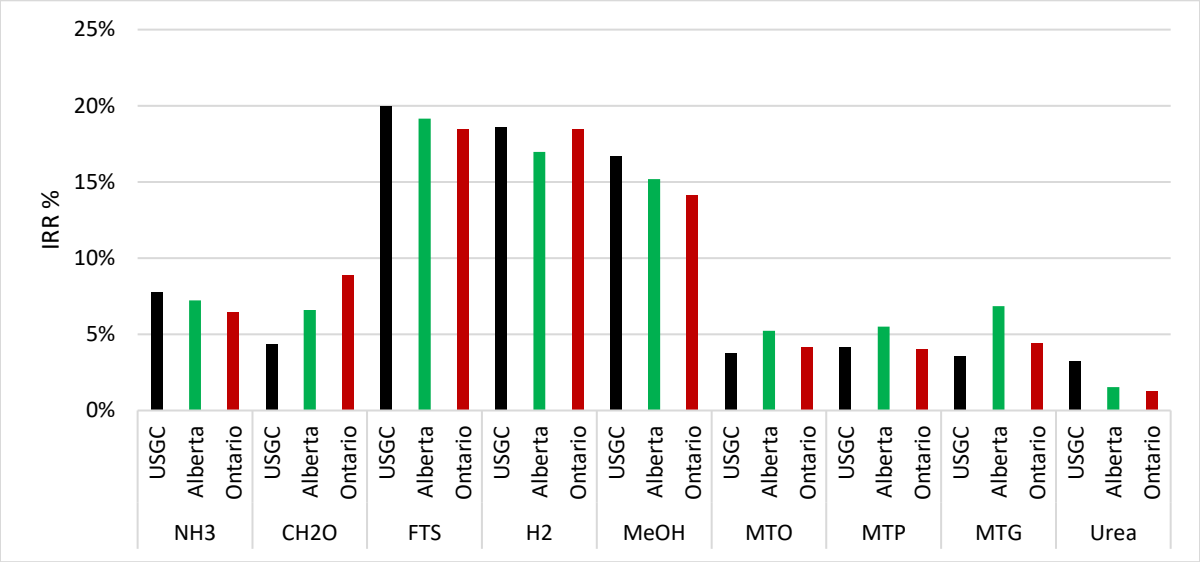


Market opportunity is the starting point for assessing the project viability of methane derivatives. This assumption of increased market demand for petrochemical products does not necessarily apply homogeneously to all methane derivatives.

The optimistic market outlook of hydrogen, methanol, formaldehyde and MTP is based on emerging growth areas for these petrochemicals in industry. Hydrogen is used in refineries and upgrading, welding or transportation fuel. Methanol is used for olefins production and fuel blending. MTO growth is fueled by the increase in plastic demand. Finally, the formaldehyde outlook is driven by the global resin demand for wood products and general manufacturing.

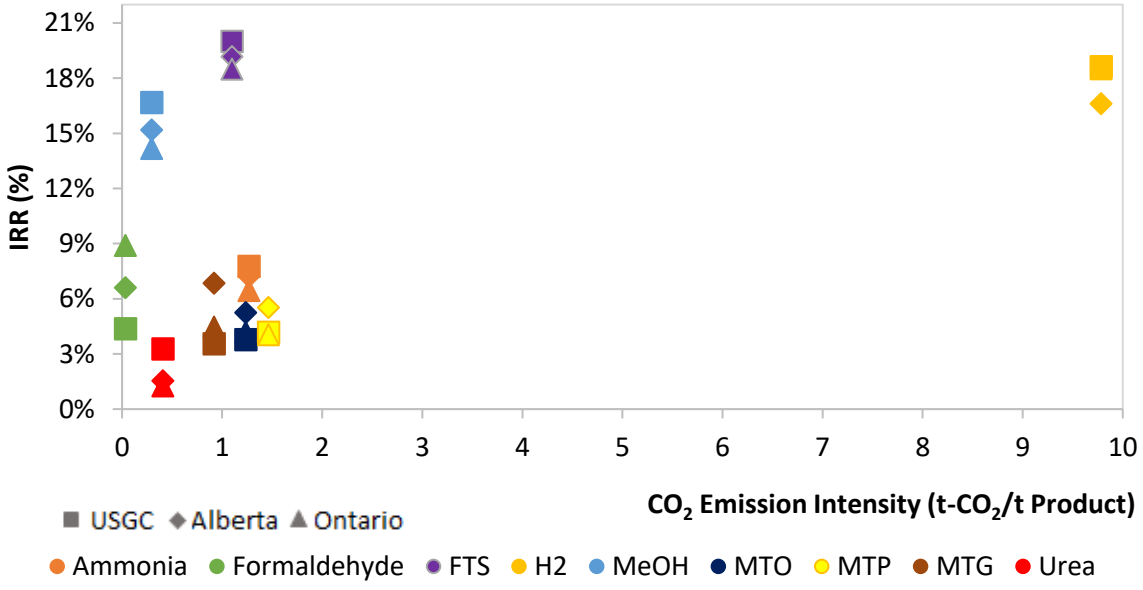
CERI developed Internal Rates of Return (IRR) to rank the different options for methane derivatives (see Figure E.2). The results show that the economic performance of the production processes varies. The top performers include methanol, FTS and hydrogen, with IRRs between 14.2 percent and 20 percent for all jurisdictions considered. The group of moderate performers have IRRs close to the current industry average cost of capital of 6.1 percent to 8.8 percent. However, this falls short of the 10 percent IRR benchmark that we consider here for processes deemed economical.

Figure E.2: IRR of Methane Derivative Projects



Carbon emission intensities are increasingly becoming a consideration that might affect the IRR and market outlook for industrial operations. Carbon policies are being implemented in Canada to help achieve its emissions reduction goals. These policies are broadly implemented across the economy with customized elements applying to energy-intensive trade-exposed industries such as petrochemicals. Figure E.3 shows the relationship between economic potential and carbon dioxide intensity for the methane derivatives assessed in this study.

Figure E.3: Economic and Environmental Performance of Methane Derivative Products



The emissions intensity of hydrogen is an order of magnitude higher than those of other products. The highest economic benefit for the lowest carbon intensity is in the top left quadrant of Figure E.3. The manufacture of methanol meets these criteria.

Different jurisdictional factors such as corporate tax, government incentives to attract investment, market access, and logistical issues are important considerations in the siting and viability of petrochemical projects. Overall, when these factors are considered, the US Gulf Coast is more cost competitive than either Alberta or Ontario.

The principal reason for this is the new tax code changes (see Table E.1). The recent changes have eliminated the cost advantage of either Canadian jurisdiction. The Net Present Value (NPV) benefits that will occur range from US$1 million to US$371 million depending on the product. For the three products we have identified as having positive IRRs, the tax change benefits are methanol (US$231 million), FTS (US$371 million) and hydrogen (US$2 million). This is an order of magnitude greater than other considerations of competitiveness including environmental policies. Alberta and Ontario have addressed concerns that might be expressed over carbon management policies through the customized exemptions for trade exposed industries.

Table E.1: NPV Impact of the US Tax Code Change

Product	NPV Advantage to USGC Compared to Canadian Jurisdictions Due to Tax Code Change (US$ Million)
Ammonia	24.0
Formaldehyde	0.6
FTS	370.6
Hydrogen	1.7
Methanol	231.1
MTO	28.9
MTG	33.7
MTG	14.3
Urea	17.6