



Expert Commentary

Monetisation of natural gas through the development of value-added petrochemicals

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Gas Exporting Countries Forum (GECF)**

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Introduction

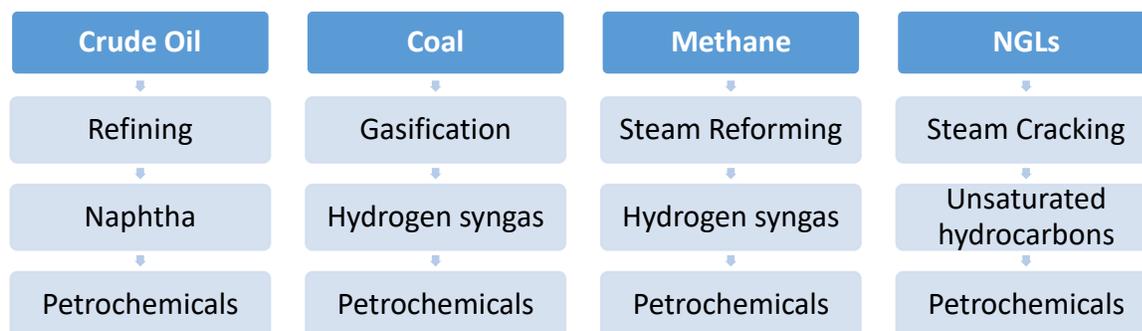
Global natural gas consumption continues to be dominated by the power generation, industrial and residential sectors, where it is used as an energy fuel source. In the meantime, non-energy use of natural gas, mainly in the petrochemical industry, represents only 6% of global natural gas consumption - around 230 billion cubic meters (bcm) per year. In this context, there is plenty of room for further penetration of natural gas in the petrochemical sector, with natural gas used as a feedstock to make higher value-added products. GECF Member Countries (MCs), endowed with the world's largest proven natural gas reserves, have a prominent potential to monetise their natural gas resources through developing higher value-added petrochemical products.

Natural gas and petrochemical industry

Petrochemical products have become ubiquitous and irreplaceable in modern society, with a plethora of industrial and consumer goods applications. These include fuels, fertilisers, pharmaceuticals, textiles, electronics, and packaging. China, United States, and Middle East are driving the growth in the petrochemical industry.

Petrochemical manufacture commences with raw material feedstock, mainly hydrocarbons (Table 1). The building blocks for petrochemicals can be derived from crude oil, coal, and natural gas and other associated petroleum gases and liquids, through different specialised processes. In the case of crude oil, the process of refining is used to obtain chemicals such as naphtha. The process of coal gasification has been extremely popular in countries such as China, which possesses vast reserves of coal. With respect to natural gas, feedstock for petrochemicals exists as the primary gaseous component, methane, as well as other light hydrocarbon components such as ethane, propane, butane, and pentanes (NGLs). The major primary pathway for natural gas in the petrochemical industry is the production of methanol and ammonia.

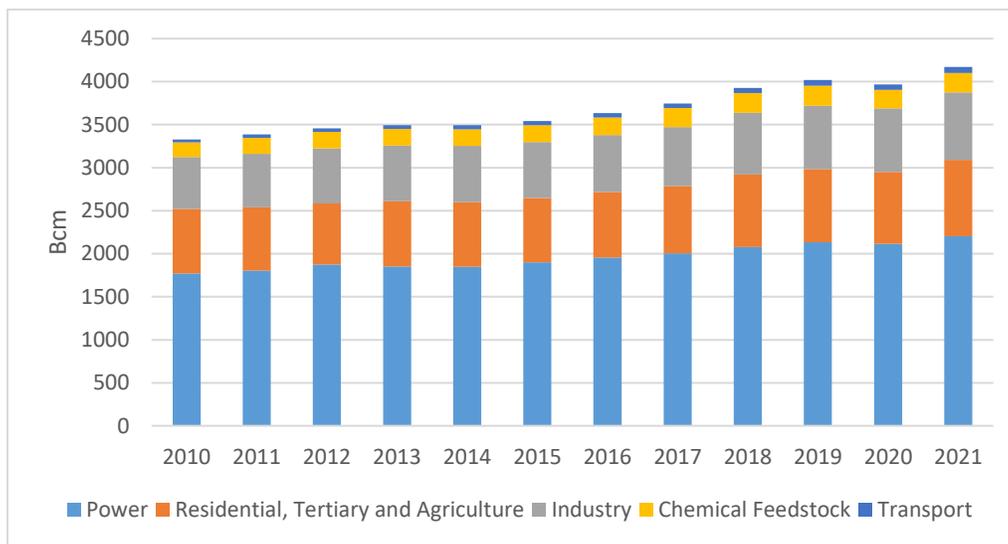
Table 1: Different pathways for petrochemicals production



Source: GECF Secretariat

Consumption of natural gas as a chemical feedstock represents a small fraction of the total gas consumption, averaging around 6% (Figure 1). However, the sector has shown a significant growth, increasing 35% overall since 2010 to 2021 to reach 230 bcm. In comparison, consumption of oil and coal as a chemical feedstock accounts for 10% and 2% of their respective total consumption. In addition, consumption of NGLs as a chemical feedstock accounts for 25% of their total consumption.

Figure 1: Natural gas final consumption by sector



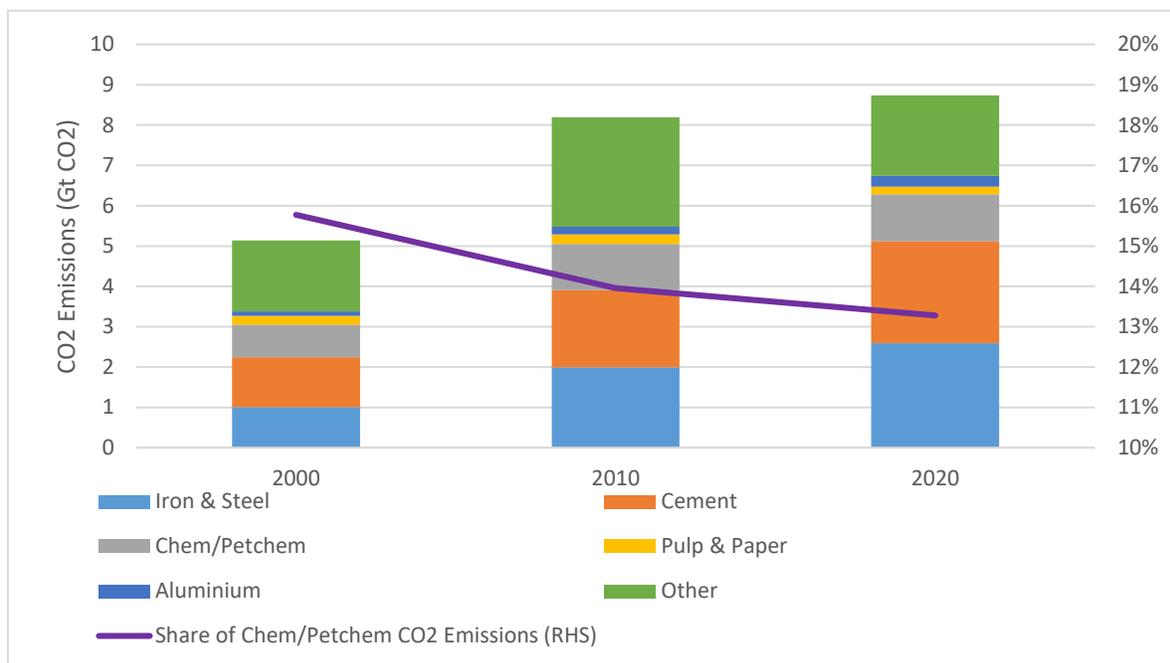
Source: GECF Secretariat, based on data from Enerdata (www.enerdata.net)

Environmental agenda and decarbonisation of the petrochemical industry

The chemical and petrochemical (chem/petchem) industry is the largest oil and gas consumer in the industrial sector, accounting for 70% and 45% of oil and gas consumption respectively.

Despite the leading role of the chem/petchem industry in the industrial sector in terms of energy, oil and gas consumption, it sits only at the third place in terms of CO₂ emissions in the industrial sector, with a share of 13% (1.16 Gt CO₂) in 2020 compared to 16% (0.81 Gt CO₂) in 2000 (Figure 2). The low contribution of the chem/petchem industry to CO₂ emissions is attributed to the fact that a significant portion of oil and gas is used as a chemical feedstock and is not consumed in the form of energy. Over the last two decades, CO₂ emissions from the chem/petchem industry increased by 43%, while total industrial CO₂ emissions from the industrial sector rose by 71%.

Figure 2: Trend in CO₂ emissions from the industrial sector



Source: GECF Secretariat, based on data from IEA Tracking Industry 2021

Looking specifically at primary chem/petchem products, including ammonia, methanol and high-value chemicals, CO₂ emissions from the production of these chem/petchem products were estimated at 0.92 Gt CO₂ in 2020. This represents 11% of the total industrial CO₂ emissions and 80% of the CO₂ emissions from the chem/petchem sector. The ammonia industry contributes to the bulk of CO₂ emissions, followed by the methanol and high-value chemical industries. The share of CO₂ emissions from ammonia production in the chem/petchem industry was stable at 35-40% between 2000 and 2020. Meanwhile, the share of CO₂ emissions from methanol production in the chem/petchem sector rose sharply from 9% in 2000 to 19% in 2020, which was driven by a stronger growth in methanol production.

As the global energy transition accelerates, there have been several recent developments related to the decarbonisation of the chem/petchem industry. The main strategies for decarbonising the industry are as follows: use of CCS/CCUS technology; electrification of processes; synergies of industrial hubs through the utilisation of unwanted CO₂ from some industrial plants to manufacture low-carbon petrochemicals in the same industrial hub.

However, these strategies would add significant costs to the production of chem/petchem products, which could affect the future prices of petrochemicals for consumers globally.

Investment in the petrochemical industry

According to the IEA World Energy Investments, investment in the petrochemical industry has been increasing since 2014. It is estimated that US\$ 120 billion was invested in the industry from 2014 to 2019, with China and the U.S. alone accounting for 70%. In 2020, a decline in investment in the petrochemical industry was attributed to the lockdowns imposed amidst the COVID-19 pandemic. The global chemical production index provided by ICIS declined by 7% between the end of 2019 and April 2020, caused by a drop in demand. However, the petrochemical industry started recovering after April 2021 driven by economic recovery after the shock of the pandemic.

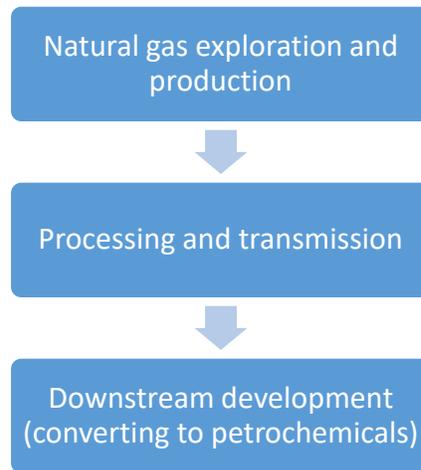
Petrochemical projects are capital intensive with long lead time and payback period. Price volatility may pose a risk to investment plans of GECF member countries in the petrochemical industry. Moreover, the cyclical behaviour of oil and natural gas markets has a noticeable impact on the petrochemical plants' economics. Understanding this cyclical behaviour will help decision-makers optimise their investment plans based on market fundamentals. In this context, securing timely funding for new petrochemical projects requires a risk-hedging approach.

State-owned companies have traditionally financed petrochemical projects in GECF member countries; however recently the share of private sector and foreign investment in financing petrochemical projects has been increasing.

Business model: vertically integrated companies vs. independent businesses

Vertical integration in the oil and gas industry is defined as a company's participation in developing the full value chain from upstream to downstream. This business model is opposed to the one where independent businesses are involved in upstream and downstream activities. Figure 3 illustrates the vertical integration in the natural gas industry.

Figure 3: Vertical integration in the natural gas industry



Source: GECF Secretariat

Several studies have been conducted on the possible impacts of vertical integration on a company’s function. Available studies on the subject suggest that the earnings of oil and gas companies concentrating only on upstream highly fluctuate due to volatile oil and gas prices and high risk of exploration activities. At the same time, vertically integrated oil and gas companies exhibit more stable earnings due to diversified sources of assets from upstream to downstream (Misund, 2016).

Position of the petrochemical industry in national economies of GECF Member Countries

Having access to abundant sources of natural gas as a feedstock for petrochemical plants expand the GECF member countries' competitive advantages and strengthen their position in the global production and trade of petrochemical products. The petrochemical industry provides social and economic benefits to the countries due to job creation and industrial development.

In 2021, the export value of selected petrochemicals (methanol, ammonia, ethylene, propylene, polyethylene, and polypropylene) from GECF member countries was estimated at US\$28.8 billion, which represented 0.55% of the total GDP of all GECF member countries. Polyethylene exports from GECF member countries accounted for the bulk of the petrochemical export value with a share of 44%, followed by methanol (21%), ammonia (19%), polypropylene (13%), ethylene (2%), and propylene (1%). Given the petrochemical sector expansion plans in the GECF member countries and their competitive advantages, it is expected that the value of petrochemicals exports will increase in the upcoming years.

Moreover, a significant portion of petrochemicals and fertilisers are consumed domestically in GECF member countries. Some endogenous factors are critical for determining whether to export or domestically consume petrochemical products. For example, geographic location, access to the export infrastructure such as seaports, economy's structure, climate, and agriculture sector's potential impact decision-making on whether to consume petrochemical products domestically or export them.

Potential benefits of developing the petrochemical industry for GECF Member Countries

For many countries, the establishment of a petrochemical value chain can secure a number of potential benefits for their economies and societies:

- diversification of the national economy away from one major source of export revenues;
- growth of the national economy, mainly through the addition of value to raw materials;
- sustainable export revenues amidst the volatility of oil and gas prices;
- potential socio-economic benefits on the state level (job creation, higher wages);
- potential environmental advantages of developing the petrochemical industry.

Conclusions

The petrochemical industry has shown significant growth in recent years, and GECF member countries continued to be the leaders in the global petrochemical industry. While each GECF member country has its own specific strengths, they have some common advantages.

Firstly, the major advantage of GECF member countries is the availability of natural gas resources which is one of the key feedstock in the industry, with more than 70% of global proven natural gas reserves concentrated there. Secondly, petrochemical producers in GECF member countries are likely to enjoy low-cost feedstock, and in this context they have a competitive advantage compared to other producers, particularly in Europe and Asia, when gas prices are relatively lower than oil and coal prices. Thirdly, GECF member countries also have the relevant infrastructure and integrated supply networks. In addition, they have the well-established expertise in the managerial and technical aspects of the industry. Moreover, the Forum presents GECF member countries with a unique opportunity to collaborate and share knowledge and best practices.

The GECF analysis shows that there is a great potential for its member countries to monetise their natural gas through the petrochemical industry. This is supported by their leading role as a reliable supplier of petrochemicals globally, abundance of untapped natural gas reserves and a bright outlook for demand for petrochemicals.

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