OCP Phosphate mining

Low-cost commercial CO_2 sources

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Ammonia production has traditionally been one of the main sources of commercial CO_2 (carbon dioxide) because CO_2 is captured within the ammonia synthesis process. Investment in CO_2 liquefaction represents only a small additional operating and capital cost.

Similarly, corn ethanol fermentation yields a high-purity CO_2 stream which is readily liquefied. This is a common CO_2 source in the US and is also used in Europe. For example, Messer France has exploited a bioethanol CO_2 source at Vertex Bioenergy at Lacq.

CO_2 shortages are increasingly common during the summer months. At this time of year, demand for CO_2 in chilled beverages spikes. Simultaneously, ammonia production falls after the spring and corn ethanol production eases off, awaiting the new harvest.

Furthermore, ammonia plant closures by CF Fertilizers in the UK and BASF in Germany have removed some large commercial CO_2 sources. Merchant CO_2 supply and demand is finely balanced.

Diversification to biogas and refineries

In recent years, refinery steam methane reformers (SMRs) and biogas-to-biomethane upgrades have been used to diversify commercial CO_2 sources. As an example, in 2016, BOC started up a 50,000 tonne per year CO_2 capture and liquefaction plant at Refining NZ's Marsden Point refinery in New Zealand.

However, smaller local refineries are progressively closing as larger, modern regional refineries come on-stream. In line with this trend, the Marsden Point refinery closed in 2022 and the required refined products are now imported from other Asian refineries. Investments in CO_2 capture and liquefaction from refinery SMRs will become increasingly risky.

Biogas to biomethane upgrades are done to ensure the biomethane is of sufficient quality to be injected into the natural gas distribution and transmission pipeline network. CO_2 must be removed to achieve a suitably high calorific value for the biomethane. Liquefaction of the captured biogenic CO_2 is low-cost because it requires minimal additional capex and opex.

This biogenic CO_2 has been used as a local, diversified source of merchant CO2 in Western Europe. As examples, Bright Renewables has installed food-grade liquid CO_2 production plants at the biogas facilities at Heek and Brandis in Germany.

However, biogenic CO_2 is now prized for its ability to permanently remove CO_2 from the atmosphere and there is now tremendous competition for biogas-derived CO_2, driving up prices.

Alternative CO_2 sources must be found to enable industrial gases operators to serve their customers reliably and protect their merchant CO_2 revenue streams.

Intensified competition for biogenic CO_2

Since 2020, a vibrant Voluntary Carbon Market (VCM) has emerged. The main buyers of so-called carbon dioxide removal credits, or CDR certificates in the VCR are cash-rich consulting firms and IT companies. Their vision is to offset the CO_2 emissions from their business activities.

Capture and sequestration of biogenic CO_2 is one of the favoured methods to generate high-quality CDR certificates. As an example, in November 2025, the German clean-tech start-up Reverion signed an agreement whereby Frontier (a trader of CDR certificates) will purchase 96,000 tonnes of CDR certificates for a cost of $41m. This values each tonne of removed CO_2 at $427 (circa €370) per tonne.

Reverion has developed an innovative technology to convert biogas to heat and power. Their process does not require that CO_2 is separated from the biogas prior to entering their equipment. And, it produces a high-purity biogenic CO_2 stream ready for low-cost liquefaction.

Considering that €370 per tonne must cover the full value chain cost and the cost of transportation and sequestration from German is in the order of €170 per tonne, the willingness to pay for biogenic CO_2 from a biogas facility is up to €200 per tonne. This new, competing offtake market is pushing up the price of biogenic CO_2 to a level that is forcing merchant CO_2 businesses to reconsider their sourcing options.

The search for new low-cost CO_2 sources

For decades, commercial CO_2 sourcing has been driven by economics and reliable supply availability. Industrial gases operators have sought to access the lowest cost CO_2 sources, with minimal seasonality that can easily be purified to food and beverage grade CO_2.

This triad of drivers will remain relevant, but now that the biogenic CO_2 market is being targeted for CDR, the most attractive merchant CO_2 sources will shift to other industry sectors.

Several sectors fit the requirements of merchant CO_2 sourcing. But to avoid competition with CDR, these will be geogenic and fossil CO_2 sources.

Phostphate processing

Dry bulk carrier loading with phosphate fertilizer at Gdansk

a) Diammonium phosphate fertiliser production

Phosphate fertiliser production is a low-cost source of geogenic CO_2. The most common phosphate fertiliser is di-ammonium phosphate (DAP). DAP is produced from apatite, a phosphorus-bearing ore, which is mixed with sulphuric acid, to yield gypsum and phosphoric acid. The phosphoric acid is reacted with ammonia, then granulated to produce DAP.

Apatite ore is excavated with a high proportion of calcite, silica, and clay. During the reaction between calcite and sulphuric acid, CO_2 is released. Separation of CO_2 can easily be achieved using condensation. The resultant dry, pure CO_2 can then be liquefied at low marginal cost.

The idea to capture CO_2 rom phosphate fertiliser production will be implemented by OCP Nutricrops at their Jorf Lasfar industrial platform in Marocco. Applications for the CO_2 include pH adjustment in water in support of a local reverse osmosis desalination plant.

b) Ethylene oxide production

CO_2 capture is essential in ethylene oxide (EO) production to avoid an accumulation of CO_2 in the reactor gas recycle loop. The gas captured from the process is rich in CO_2, with water vapour being the main additional component. Much of the water vapour can be removed simply by cooling the gas stream to condense the humidity to water. The incondensable CO_2 stream can be fed directly to a liquefier.

Gulf Cryo, a leading industrial gases company in the GCC region, obtains CO_2 from one of Equate Petrochemical Company's EO plants in Kuwait's Shuaiba Industrial Area. This CO_2 capture and liquefaction scheme was commissioned in October of 2014 with the capacity of 55,000 tonnes of CO_2 per year.

Following on from the Kuwait project, Gulf Cryo implemented a similar scheme at the EO plant operated by Petro Rabigh in Saudi Arabia. This plant came on-stream in 2023 with an annual capacity of 100,000 tonnes of merchant liquid CO_2. ▸

Phosphate fertilizer in Pakistan


Diammonium phosphate fertilizer granules

c) Town gas production

Hong Kong's Tai Po Towngas plant commenced operation in 1986, producing hydrogen-rich town gas on four Catalytic Rich Gas (CRG) steam reforming trains. Town gas is distributed to 1.9 million industrial, commercial, and domestic users through a 3,500km pipeline grid.

CO_2 is removed during the process so that the town gas has a high energy content so that it can be used for heating or cooking. At present, the CO_2 loaded gas stream is emitted to atmosphere. However, this flue gas stream could easily be dried and the remaining CO_2 could be liquefied to be utilised.

Singapore also runs on town gas. City Energy's Senoko Gasworks supplies 0.9 million commercial and domestic offtakers who use town gas for heating and cooking. Like Hong Kong's Tai Po facility, it is fuelled by a mixture naphtha from local refineries and imported LNG.

d) Natural gas processing

Natural gas processing is like crude oil refining: it converts raw gas a usable commercial product. When natural gas rises from the reservoir, the methane contains CO_2 which must be removed for operational reasons.

The costs of CO_2 removal are borne by the natural gas processing. However, in most cases, the CO_2 is vented to the atmosphere. CO_2 from natural gas processing has also been identified as a low-cost source of merchant CO_2.

Air Liquide Australia and BOC recover CO_2 from the Longford Gas Conditioning plant east of Melbourne. Air Liquide Australia started up their liquefier to produce food and beverage grade merchant CO_2 in 2021. BOC followed with a 60,000 tonnes per year plant in 2024.

e) Waste to Energy – the next frontier

Waste to energy (WtE) facilities incinerate municipal solid waste (MSW). MSW contains between 40 and 60% biogenic material, even after paper has been sorted for recycling and food and garden waste has been removed for conversion to biomethane.

Since MSW facilities can only monetise the biogenic fraction of their captured CO_2 for CDR in the VCM, they will be keen to monetise the fossil fraction to support the CO_2 capture investment business case.

The fossil CO_2 fraction of WtE CO_2 capture schemes will be a major opportunity for industrial gases companies to source low-cost CO_2 for their merchant businesses. gw

On the agenda – Keynote

Look out for Stephen B. Harrison speaking in more detail on the low-cost CO_2 sources today and tomorrow as the Day 2 Keynote speaker at the CO_2 Summit in Rotterdam.

Day 2 Opening Keynote
19 March, 09:15am

Geogenic CO2 Capture from Phosphoric Acid and DAP Fertiliser Production