Global Alliance
Powerfuels

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Feedstocks for the chemical industry

Petrochemicals, which turn crude oil and natural gas into all sorts of daily products, are integral to modern societies. The growing role of petrochemicals is one of the key "blind spots" in the global climate mitigation debate.[1]

The chemical industry is unique in its fossil fuels use. While most industries use fossil fuels as energy source, the chemical industry uses about half of the sector's demand as feedstock: The fossil resources are used as raw material for a variety of widely used products like plastics, fertilisers, detergents or tyres. The chemical industry accounts for 14 per cent of the total primary demand for crude oil and 8 per cent for natural gas. Ammonia, methanol, ethylene, and propylene are the most important basic chemicals used as the starting materials for a large number of industrial downstream products. For example, nitrogen-based fertilisers are produced from ammonia, formaldehyde from methanol, and plastics using ethylene and propylene. In 2016, crude oil and natural gas represented 87 per cent of feedstocks in the carbon-based chemical industry.

All of these uses do also cause carbon emissions – during manufacturing, utilization, and/or at the end of useful life of these products. Thus, climate neutral substitutes are required to replace fossil fuels in the chemical industry in order to reach the overall goal of net-zero carbon emissions. Powerfuels can replace today's demand for fossil resources[2]. For some of the globally most widely used raw materials for the chemical industry like methanol, there already exist specific power-to-chemicals processes. Hence, powerfuels can significantly reduce the direct and indirect CO_2 emissions of many different product groups.

14 % of crude oil and 8 per cent of natural gas are globally consumed by the chemical industry, making it the largest industrial energy consumer[1]

1,5 gigatonnes of carbon emissions were emitted by the chemical industry in 2018 globally, making it the third-largest industrial CO_2 emitter[1]

Chances and challenges

- **Synthetic Ammonia**
- **Synthetic Methanol**
- **Synthetic Ethylene**
- **Synthetic Propylene**

✓ Easy integration into existing production processes, technical devices, and infrastructures

✓ Continued use of mature technologies and proven industrial-scale processes

✓ Ensuring security of supply by increasing independency from by-products of fossil fuels refining

! Has still high overall costs: cost drivers are investment costs and cost of (renewable) electricity

! CO_2-neutrality depends on use of renewable electricity and renewable carbon sources

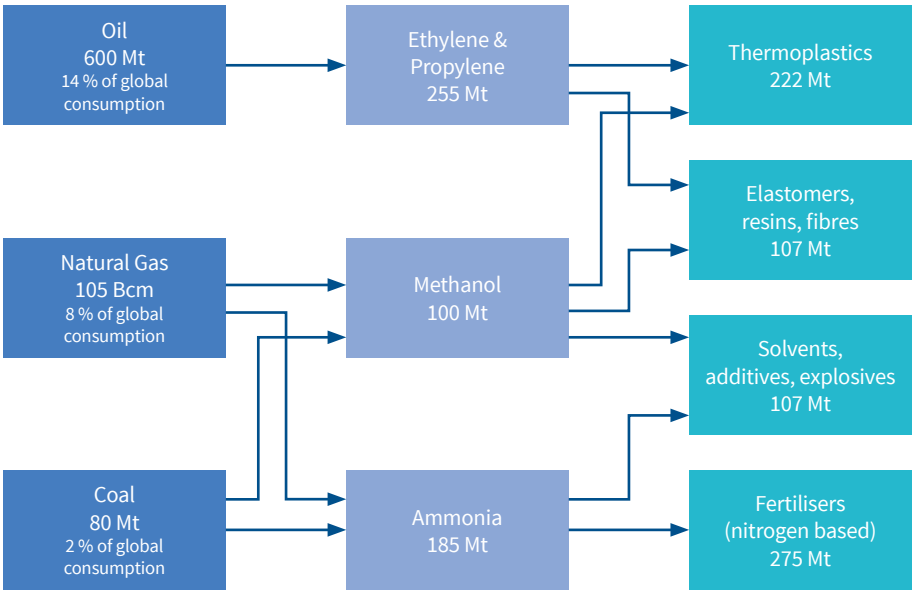
Alternative technologies

The synthesis processes currently used for the production of ammonia and methanol require hydrogen as basic material. Today, hydrogen primarily stems from CO_2-intensive steam reforming of natural gas. This can be substituted by green hydrogen, which is produced by electrolysers using renewable electricity. Ethylene and propylene, on the other hand, are mostly obtained in steam crackers by the thermal decomposition of hydrocarbon mixtures, such as those produced during conventional crude oil processing. Methanol produced from green hydrogen, can be catalytically converted into ethylene and propylene using the methanol-to-olefins (MTO) process, thus providing a green alternative to conventional ethylene and propylene. By using powerfuels, considerable amounts of CO_2 emissions can be reduced in the chemical industry.

About 60 per cent of global fertilisers are ammonia-based. As over 90 per cent of worldwide ammonia production is used for fertilisers and ammonia significantly consists of hydrogen, the world's agricultural industry depends heavily on hydrogen: 55 per cent of worldwide hydrogen demand is currently used for ammonia production.

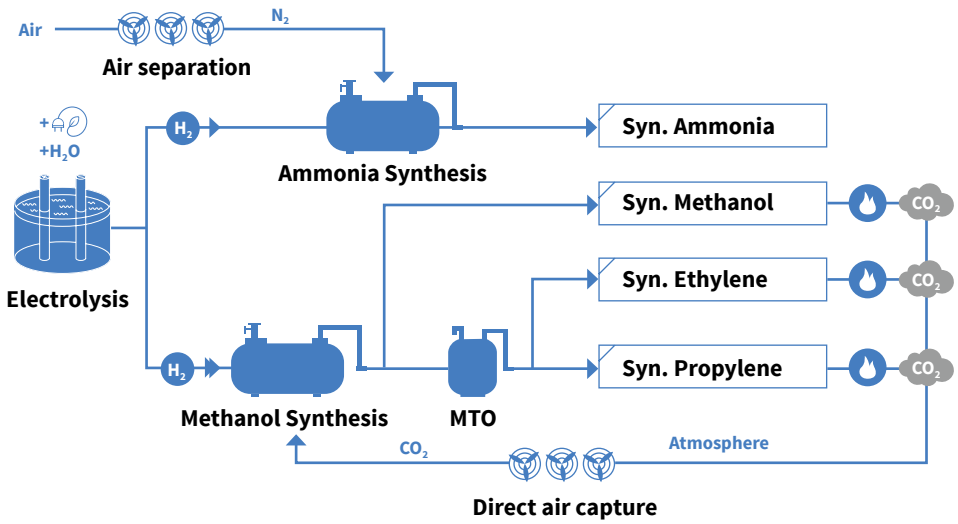
Another 10 per cent of worldwide hydrogen demand is currently used in methanol production, which has broad application areas. Almost 70 per cent of feedstock methanol is further processed into formaldehyde which is mainly used to produce synthetic resins.[3]

The four most-important basic chemicals are feedstock for the majority of all chemical products, thus having great relevance for both various industries and private life. Petrochemical products are everywhere and have become the fastest-growing source of oil consumption. Therefore, powerfuels have to play a major role in the decarbonisation of the chemical industry.



Source: IEA, 2018

Synthetic production processes



1 IEA 2018. **2** Further details of technologies described here can be found in [1, pp. 55–70]. **3** Hydrogen Europe **References:** A. Bazzanella and F. Ausfelder, Low carbon energy and feedstock for the European chemical industry. DECHEMA, Gesellschaft für Chemische Technik und Biotechnologie eV, 2017; IEA, "The Future of Petrochemicals: Towards more sustainable plastics and fertilisers", International Energy Agency (IEA), 2018; Hydrogen Europe (https://hydrogeneurope.eu/hydrogen-industry).

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