Green Hydrogen at Work™

Plug Electrolyzers Key to Creating Low-Carbon Methanol

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With decades of experience under its belt, Plug's team is equipped with the products and knowledge to safely produce cleaner, more sustainable methanol.

With 100 million metric tons of methanol consumption, creating $55 billion in economic activity and supporting nearly 100,000 jobs around the world per year — methanol has proven to be key to supporting critical industries including chemical feedstock and transportation fuels, according to the Methanol Institute.

However, the cost of supporting these industries has been high. Nearly all methanol is produced from fossil fuels such as coal and natural gas with a dangerously high carbon intensity. In contrast, methanol can reduce CO, NOx, SOx, and particulate combustion emissions and carries a similar toxicity rating to gasoline or diesel in the case of accidents or spills, according to a 2019 report in ChemBioEng, making it an attractive alternative to traditional fuels, especially if produced from non-fossil sources.

Moreover, methanol demand is expected to grow to 120 million metric tons per year by 2025, and 500 million tons by 2050, according to 2021 report by the International Renewable Energy Agency.

How Green Hydrogen Can Decarbonize Methanol Production

Traditional Methanol

Enrich synthesis gas, co-feed during coal gasification and provide heat source using green hydrogen.

E-Methanol

Co-locate near a carbon dioxide emitting plant, capture carbon from flue gases or direct air and react with green hydrogen.

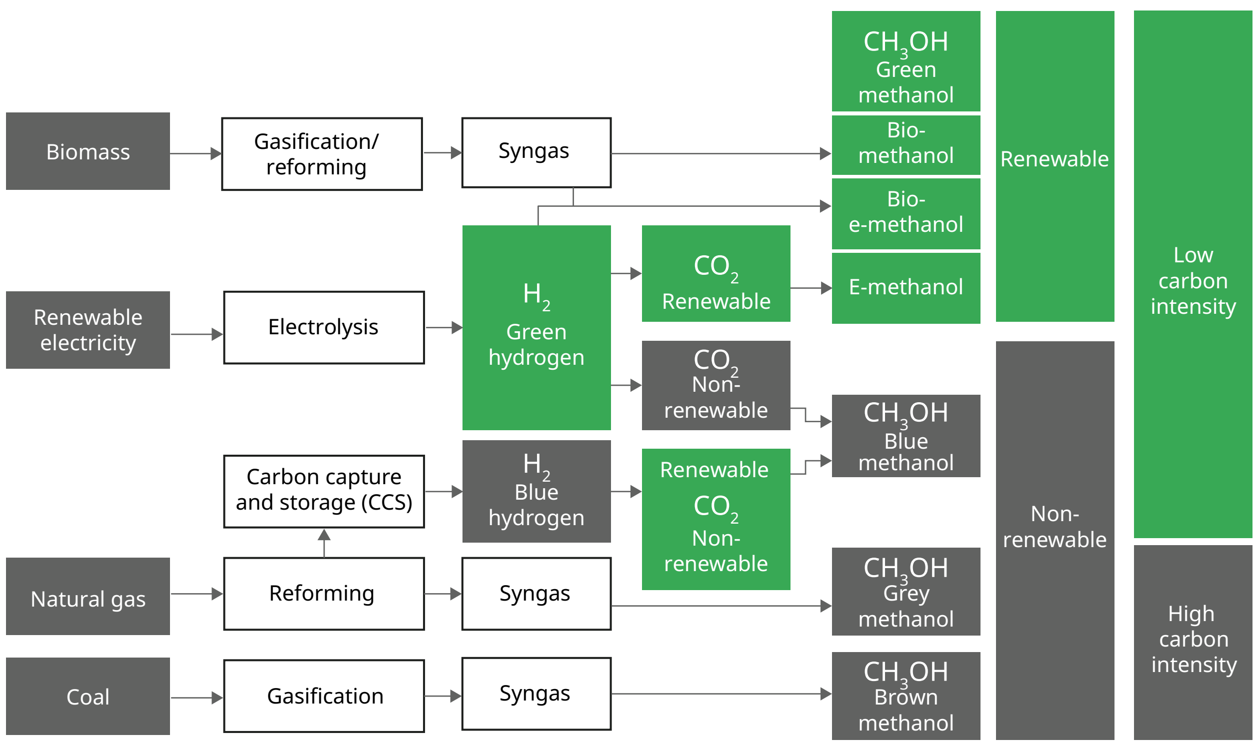
Bio and E-Methanol Hybrid

Maximize carbon conversion by reacting excess carbon dioxide from bio-methanol production with green hydrogen.

A Low-Carbon Methanol

Methanol (CH_3OH) can be efficiently produced through several low-carbon processes, dramatically lowering emissions and creating a more sustainable future.

This diagram shows the various methods of methanol production. Traditionally methanol has been produced from fossil fuels, and this continues to make up about 98% of all methanol consumed worldwide. This form of methanol burns cleaner than gasoline or diesel in regard to criteria pollutants such as NOx, SOx, and particulate matter, but still results in about 0.3 gigatons of CO_2 per year being released to atmosphere.



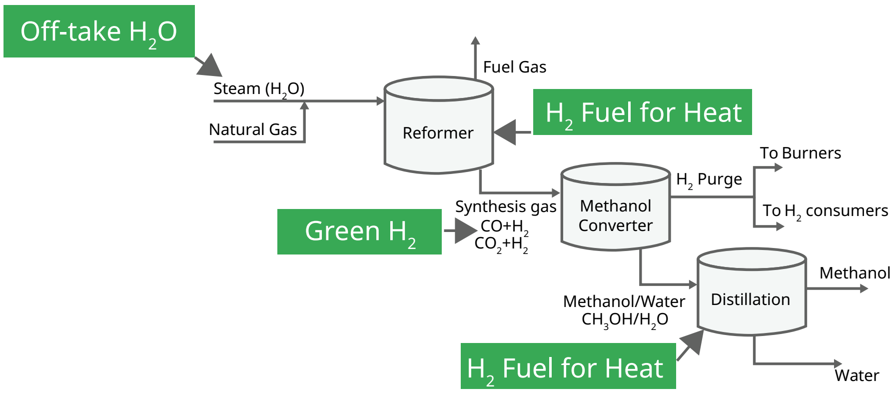
Source: IRENA innovation Outlook Renewable Methanol

Traditional Methanol

For example, in traditional methanol plants, green hydrogen could be fed into the Pre-reformers to help maintain appropriate gas mixture compositions.

Similarly, in the coal gasification step, a mixture of hydrogen (from fossil sources), oxygen and steam are fed into the processor. Green hydrogen and green oxygen can be co-fed to partially decarbonize the process.

Also, the formation of synthesis gas requires a signification amount of heat. Typically, natural gas and steam are heated inside nickel catalyst filled reactor tubes. It is possible that these reactors could be converted to burn hydrogen instead of several million cubic feet of natural gas per day to generate steam and high temperatures.



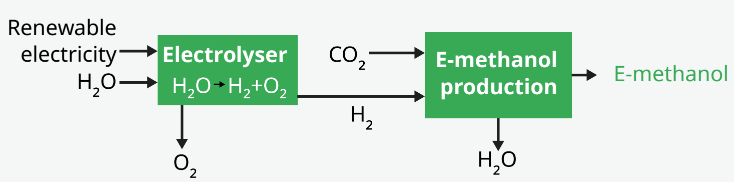
Schematic adapted from the Methanol Institute

E-Methanol

Another example is e-methanol, a liquid product easily obtained from CO_2 and green hydrogen through a one-step catalytic process. Produced through a Power-to-X technology, e-methanol is considered an electrofuel (e-fuel) and electrochemical. However, e-methanol production requires CO_2 sourced from bioenergy with carbon capture and storage (BECCS) or direct air capture (DAC), both of which can be expensive ways to produce CO_2 today.

Thus, many e-methanol project developers are looking to collocate with or achieve their critical renewable CO_2 supply from low-cost industrial byproduct CO_2. This could be from facilities with high-concentration CO_2 by-product streams like as ammonia, ethanol, or metals processing plants. These facilities require a source of green hydrogen.

Electrolysis of water to hydrogen followed by catalytic methanol synthesis

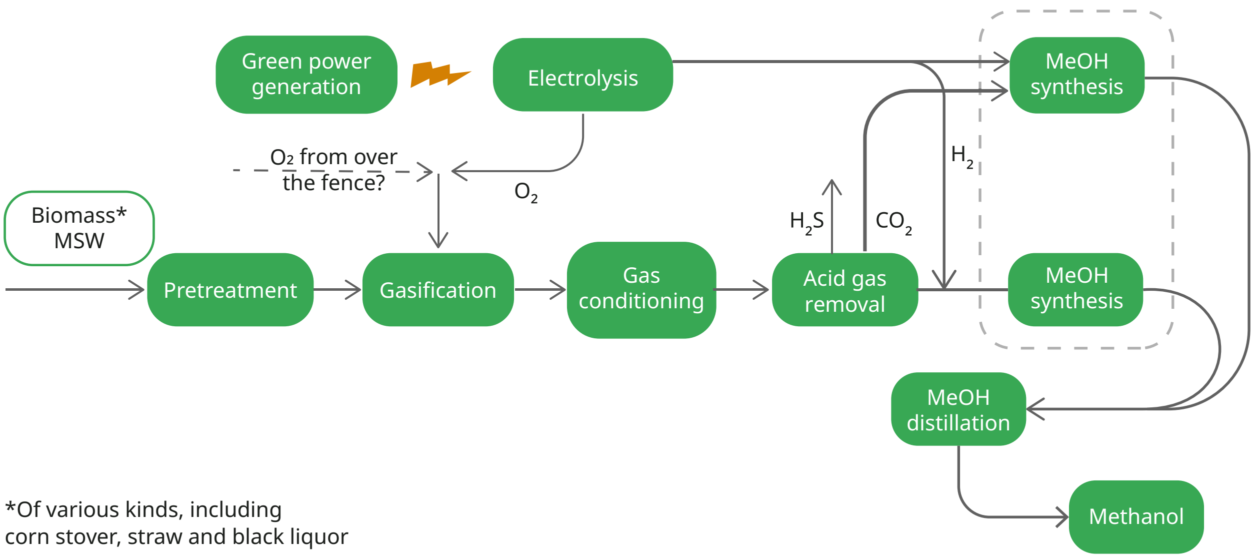


Source: IRENA innovation Outlook Renewable Methanol

Bio and E-Methanol Hybrid

Bio-methanol production is carried out in a similar way to its production from fossil sources; however, the difference is that the feedstock comes from biomass waste. The carbon emissions are much lower than with traditional production methods, but not as low as with eMethanol. Furthermore, sustainable biomass supply is limited, making it difficult to produce enough bio-methanol to supply the growing demand.

An attractive possibility is to react the stoichiometric excess of carbon dioxide from bio-methanol production with supplemental green hydrogen to drive process conversion to methanol. This can be achieved by combining the bio-methanol scheme and part of the e-methanol scheme into a hybrid process where nearly 100% of the carbon in the biomass ends up as carbon in the methanol product, maximizing conversion of all feedstocks, lowering cost, and achieving maximum decarbonization.



*Of various kinds, including corn stover, straw and black liquor

Source: IRENA innovation Outlook Renewable Methanol

The green hydrogen required for these processes is provided through water electrolysis, powered by renewable energy. As the top electrolyzer supplier in the world, Plug can provide feedstock though its expansive green hydrogen offering and seamlessly lower emissions per unit of output, regardless of the methanol production process. Furthermore, a supply of green hydrogen can be leveraged to decarbonize other sources of process emissions, such as process heating needs.

The Time to Act is Now

Producing sustainable fuels is no longer a goal of the past — it's a critical objective today as the world looks to government and business leaders to achieve net zero carbon emissions. In April 2022, the SEC proposed mandatory Scope 1 and 2 emissions disclosure rules that would have an impact on methanol producers in the U.S. Influenced by investor and customer pressures, nearly 70% of the world's heaviest carbon emitters have set a net-zero carbon emissions target, which accounts for more than 80% of global industrial GHG emissions. Aside from the Emissions Trading Systems in the European Union and China's growing ETS coverage, other countries are following in reducing carbon emissions.

Aside from reducing carbon emissions, there are also economic drivers to creating a low-carbon form of methanol. For example, reduced feedstock cost, reduced pricing risk of natural gas and coal, decoupling plant siting from fossil fuel availability and improved flexibility in plant scale can all improve production economics. With feedstock being the Number 1 portion of production costs, having more control and predictability of supply and cost is crucial. In addition, end-users are becoming increasingly willing to pay a premium for low carbon fuels.

With growing demand for methanol from existing markets such as chemicals and plastics, as well as the potential for a boom in demand as an e-fuel for shipping, it's imperative the demand is met with cleaner methanol. Consumers and suppliers both recognize this, and Plug is already engaged in multiple electrolyzer projects for e-Methanol across the world.

Ready to learn more about how the Plug Electrolyzer Team, which has nearly five decades of experience, can help your business?

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