Sustainable Fuels from Renewable Energies

Workshop Statement

The international workshop “Sustainable Fuels from Renewable Energies” organised at IASS on November 19th-20th 2013 provided an opportunity for leading scientists and industrialists to exchange ideas and discuss possible technological pathways to sustainable fuels production and utilisation. The theme followed on from the concept of synthetic methanol and the “Methanol Economy” defined in the 1990’s by Nobel Laureate George Olah. Methanol (and its dehydrated counterpart, dimethyl ether (DME)) can be directly integrated into existing fuel delivery/use infrastructure without excessive investment costs, as an excellent fuel for internal combustion engines. Using similar synthetic chemistry (e.g. syn-gas based routes), higher (octane or cetane) fuels can also be produced whilst methanol itself can be also be transformed into a variety of commercially relevant compounds (e.g. olefins for polymer production) (Scheme 1). The advantages of sustainable fuels including methanol, dimethyl ether and potentially synthetic gasoline are now reaching a well-documented maturity (e.g. liquid energy carrier, combustion efficiencies, drop-in-fuels, and greenhouse gas emission mitigation, etc.). Moreover from a technical point of view, aside from carbon dioxide from the air, their introduction appears on a prima facie basis an accessible goal. The capability to store (intermittent) renewable electrical energy (e.g. wind, solar) in the production of such fuels is also a considered necessity with regard to a reduction in greenhouse gases and carbon footprint – a sustainable alternative to Carbon Capture and Sequestration.

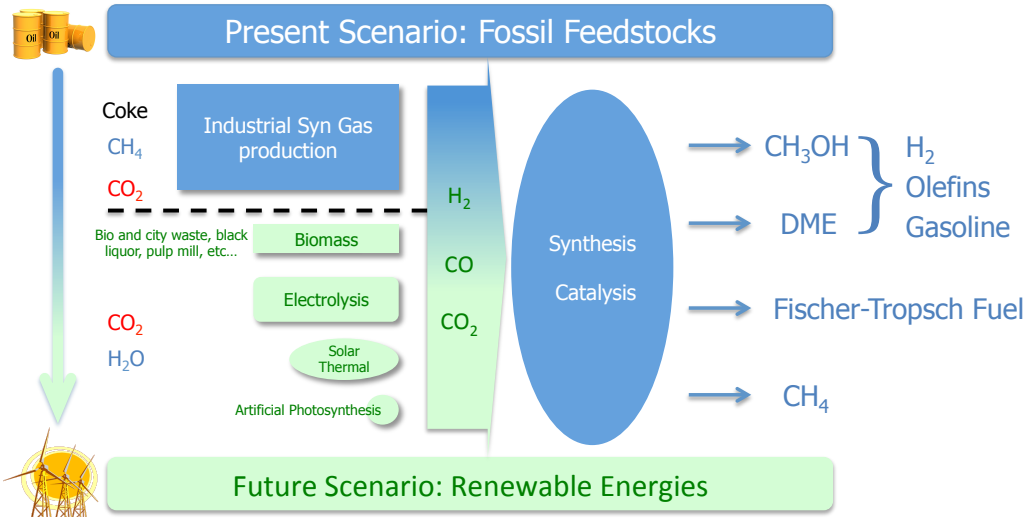
During the course of the workshop, chemical technologies associated with the highly efficient generation of hydrogen (e.g. necessary for the hydrogenation of carbon dioxide) and syn-gas were discussed including those under substantial market consideration (i.e. solid oxide electrolyzers), nearing commercialisation (e.g. solar thermal cycles) and future blue sky approaches (i.e. photochemical catalysis based on semiconductor/hydrogenase hybrids). The concept of “met-gas” was also introduced as a route to synthesis methanol from the combination of CH_4, H_2O, and recycled CO_2. Mechanistic discussion and (industrial) catalyst characterisation was also discussed in the context of CO_2 hydrogenation to CH_3OH (and formic acid) and the reverse process to evolve “on-demand” H_2 (for use in fuel cell applications);

demonstrating the potential of CO_2 to act as a H_2 energy vector. The latest commercialisation efforts regarding the “power-to-liquid” and “power-to-gas” concepts in the energy mixes of Germany and Denmark were introduced, as was a Swedish approach to methanol production utilising paper mill waste as the syn-gas precursor. The interest of power train and marine vehicle companies in sustainable fuels (e.g. methanol and DME) to curb not only CO_2 but SO_2 to urban and boundary layers was also highlighted.

During discussions and in particular during a final round-table, workshop participants reached a common consensus on a number of highly significant points. There is no one solve-all solution to the question of energy/fuel demand. Specific geographic and socio-economic conditions may encourage the adoption of particular routes to synthetic fuel and chemical production (e.g. abundance of wind energy in Denmark, shale gas in the USA, limited fossil resources in Germany, etc.). However, there is a general theme underlying all these scenarios. If fuel and chemicals are to be produced synthetically, it must be done with as minimal (ideally neutral or negative) a carbon footprint as possible, with the incorporation of renewable electrical energy and recycled CO_2 highly desirable. With comparison to other fuels and chemical precursors, a number of developing “sustainable” (with a particular accent on the flexible base compound methanol) fuel enterprises were highlighted in the course of the workshop, each with their individual merits. Whilst markets are currently in the progress of opening (e.g. as a marine fuel), the overall demand and penetration of sustainable fuels (excluding bioethanol in Brazil) and chemical precursors for transportation, industry and power generation is still relatively limited. With this in mind, the increased market uptake of sustainable fuels (e.g. renewable methanol, synthetic gasoline) will largely be determined by a number of critical socio-economic and political factors.

The production of sustainable fuels must be demonstrated at increasingly large volume, commercially viable production pathways, which have a beneficial economic attraction as compared to conventional or other renewable fuels. This can in part be achieved by well-designed, highly efficient, integrated processes (assisted by the introduction of new chemical technologies) but on the short term further statutory instruments (e.g. directives, regulations, etc.) or financial incentives (e.g. tax breaks, subsidies, feed-in-tariff equivalents, etc.) must be introduced to support the utilisation of recycled CO_2 and sustainable fuels. Such measures will ultimately be enhanced in efficacy if associated markets (e.g. the chemical industry) are also in turn encouraged to adopt sustainable feedstock based processes.

While optimistic on the future of synthetic fuels from renewable energies, the participants highlighted a perceived gap between the strength of scientific argument and technology development on one hand, and the lack of political awareness and action on the other hand. Therefore, increased advocacy efforts directed to enhance the awareness of policy makers and indeed the general public needs to be conducted if there is to be a true, long term adoption of a sustainable fuel concept in Germany, the European Union and beyond.



Scheme 1: *Transition from a fossil fuel-based to a renewable energy-based provision of transportation fuels and chemical feedstocks coupled with renewable electrical energy storgage*".