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Task 64

Technology Collaboration Programme
by iea

Task 64: E-fuels and End-use Perspectives

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Participants **Task sharing** **Cost sharing**	 Brazil, China, Denmark, Finland, Germany, Japan, Switzerland, USA None
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Purpose, Objectives, and Key Question

The focus within Task 64 is an informative exchange on the production and application of different e-fuels as well as the corresponding regulatory framework and standards. The output of the Task is a concise report addressing the following topics:

- Demo sites/pilot programmes: Consideration of different demo sites in different countries that focus on the development and improvement of e-fuel production technologies, including consideration of technology pathways, technological maturity, and case studies.
- CO_2 and H_2 resources: The availability of CO_2,water resources, and electricity sources in different countries, with assessment of national feedstock potential for e-fuel production.
- Application side: Experiences and challenges in the application of e-fuels, especially with regard to the use of e-fuels in aviation, maritime, and road transport.
- Regulations and standards: Norms, standards, and/or regulations for the use of e-fuels in various countries. Incentives and regulations that promote the production and use of e-fuels.
- Life-cycle assessments (LCA)/well-to-wheel (WTW): Methods for LCA and WTW in the different countries/regions (e.g., REDII in the EU). Typical and expected net GHG effects as well as other environmental impacts (e.g., water consumption) of e-fuel production and use.
- Techno-economic assessments (TEA): Costs of the different e-fuel production value chains in various countries, and methodology for economic calculation. Costs on the application side of the switch to e-fuels.
- Stakeholders: Actors from research, industry, and administration along the value chain (raw material supply, conversion technologies, e-fuel suppliers, e-fuel consumers) as well as bioenergy research centres and academic institutions.

Based on these questions and topics, workshops are organised in which key messages and joint conclusions are formulated. These will be incorporated into a final report, which will provide an overview of ongoing activities worldwide as well as past and present technical, economic, and regulatory challenges and best-practice examples. Next to information sharing, the report is to support increased awareness concerning the importance and the global activities in the e-fuels field.

Activities

In the E-fuels Task, workshops are held four times a year on specific issues and (if possible) pilot plants are visited. The output of each workshop is a summary of common findings, which are then included in the final report. At the end of the Task, the main findings are presented at a web seminar. The duration of the Task is two years.

Key Findings

In 2022, two workshops were carried out within AMF Task 64. The key messages from these workshops are summarized in this section.

Resources

- Energy systems will follow a process of carbon intensity reduction, in an energy transition branded by strong competition (among different technological alternatives).
- The climate agenda will increasingly influence international trade and international relations.
- The global energy mix will be the most diverse the world has ever seen by 2050.
- There is a global technological race, with several routes and alternatives capable of assuming a relevant role in the energy transition, and we will probably face emerging industries coexisting and eventually replacing traditional technologies.
- Considering the importance of flexible paths for the energy transition (avoiding technological locks), Brazil, given all its potential, has great opportunities in the hydrogen economy.
- Countries like Brazil, which presents a great supply of renewable energy resources, will promote a greater international insertion and participation in the global decisions regarding energy.

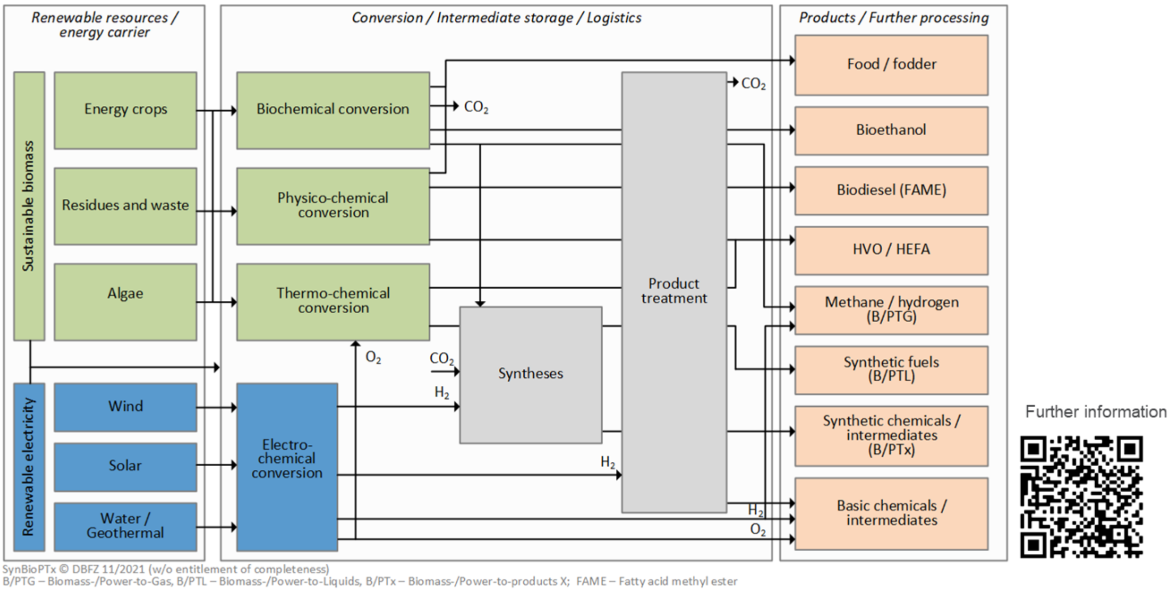

Fig. 1. Source: https://www.dbfz.de/Monitoring-EE-im-Verkehr/technologien

Strategic Elements to Push E-fuels into the Market

- Brazil: Brazil's goal is to increase the amount of e-fuels in general, but a commercial status has not been reached yet. There is a project with Thyssen-Krupp technologies in which electrolysers with a total capacity of 60 MW are installed. The plant will feed one of the largest green ammonia plants by capacity when production begins.
- Finland: The focus is placed on e-methane, e-methanol, paraffinic fuels, and e-diesel. Furthermore, carbon capture and utilization (CCU) is regarded as much more positive than CCS, given difficulties with the storage.
- Germany: Research and development on synthetic fuels is emphasized, especially for aviation. A platform to produce power-to-liquid with a production of 10,000 t/y is under development, with the goal of establishing hybrid multi-fuel refineries. With fuel synthesis (e.g., Fischer-Tropsch), usually multiple products are produced and all of them need to be used for economic reasons. Additionally, for the order of magnitude of renewable fuels needed, both biofuels and e-fuels will play an important role.
- Japan: Several kinds of national projects have recently started (SOEC, FT, and methanation).
- Switzerland: Sustainable aviation fuels (SAF) are promoted, in a collaboration of the federal offices for energy and civil aviation. The goal is to scale-up SAF in Switzerland.
- United States: SAF is regarded as an important e-fuel (mainly produced by alcohol-to-jet technologies). Otherwise, e-fuels aren't assumed to play a major role in the near future as their production is too small compared to other projects. In the United States, the Inflation Reduction Act (IRA) promotes the production of green hydrogen. The legislation goes into effect in 2024 and lasts for ten years. An SAF credit begins in 2023 and continues until 2027; to receive the incentive, an emissions reduction of 50% must be demonstrated. More initiatives for clean fuels will follow, which are expected to lead to many more activities.

Techno-economic Assessments

- Some electro-fuels, such as FT fuels or methanol, can be produced from high TRL or mature technologies.
- The key cost driver for electro-fuel production is the production cost of H_2, or syngas. The U.S. IRA provides a maximum $3/kg tax credit for green H_2 production (depending on GHG emissions), providing a significant economic incentive to produce electro-fuels.
- In the United States, high-purity CO_2 from industrial sources serves as low-cost feedstock for electro-fuels production. With industrial CO_2, the potential electro-fuels production volume can exceed current demand for U.S. jet fuel and meet over one-third of diesel demand.

Life-cycle Assessments

- Setting up a consistent LCA system boundary for e-fuel production is important.
- Argonne has evaluated multiple e-fuel production (CO_2 utilization) pathways of various CO_2 feedstocks and conversion technologies using Argonne's GREET® model with the support of the U.S. Department of Energy.
- LCA results show that using renewable electricity and hydrogen is key to having low-carbon e-fuels.
- Regional distribution of CO_2 sources, renewable electricity, and renewable hydrogen (and/or freshwater) need further consideration.

E-fuel Projects in China

- Demonstration and pilot-scale e-fuel projects have been operated in China. However, firsthand operational data are rarely available for detailed sustainability and economic accounting.
- Methanol, gasoline, and aviation fuels are seen as products in the e-fuel projects, with methanol the most common product.
- Currently, the sources of hydrogen and CO_2 are not necessarily in the context of green energy (i.e., renewable H_2 and CCUS-CO_2). For example, COG-H_2 is regarded as feedstock.
- From a technological perspective, many research efforts have been concentrated in the development of catalyst systems – for example, improving the selectivity of methanol of CO_2 hydro-conversion technology.
- Educational institutions, chemical and energy enterprises, and automotive companies have participated in the track of e-fuel demonstration as well as H_2 equipment and CO_2 producers.
- China currently has no standard set specifically for e-fuel, although clear regulations exist with respect to the standards of various products contained in e-fuels.
- The high cost of e-fuels is still a challenge faced by the hydrogenation of CO_2 to methanol.
- Appropriate carbon pricing and low renewable power cost are critical to enhance the economic competitiveness of e-fuels in China.

Key Messages of E-methanol

- The driver of this fast implementation of e-methanol in the shipping industry stems from a strong customer pull.
- Demand for methanol will increase by five times until 2050, which will be met by using e-methanol, bio-methanol, and fossil-based methanol. The chemical industry is responsible for half of this demand.
- E-methanol has the lowest total cost of ownership (TOC) compared to other e-fuels, such as e-diesel, e-DME, or ammonia.

Main Conclusions

Various countries offer incentives to promote the production of e-fuels or hydrogen. In the United States, the Inflation Reduction Act could accelerate the development of e-fuels. Additionally, several countries promote SAF research and development.