Renewable transportation fuels from water and carbon dioxide

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Heliostat tracking at SUN-to-LIQUID facility at IMDEA (Photo: Erik Koepf) © ETH Zürich 2017

The transition from fossil to renewable fuels is one of the most important challenges of the future. The SUN-to-LIQUID project takes

on this challenge by producing renewable transportation fuels from water and CO_2 with concentrated sunlight: The project, which is funded by the EU and Switzerland, now succeeded to demonstrate the first synthesis of solar kerosene. "The SUN-to-LIQUID core solar technology and the integrated chemical plant were experimentally validated under real field conditions relevant to industrial implementation," said Prof. Aldo Steinfeld of ETH Zurich, who leads the solar thermochemical reactor development. "This technological demonstration can have important implications for the transportation sectors, especially for the long-haul aviation and shipping sectors which are strongly dependent on drop-in hydrocarbon fuels," announced project coordinator Dr. Andreas Sizmann of Bauhaus Luftfahrt, "we are now a step closer to living on a renewable 'energy income' instead of burning our fossil 'energy heritage." This is a necessary step to protect our environment."

From the laboratory to the field

The preceding EU-project SOLAR-JET developed the technology and achieved the first-ever production of solar jet fuel in a laboratory environment. The SUN-to-LIQUID project scaled up this technology for on-sun testing at a solar tower. For that purpose, a unique solar concentrating plant was built at the IMDEA Energy Institute in Móstoles, Spain. "A sun-tracking field of heliostats concentrates sunlight by a factor of 2,500—three times higher than current solar tower plants used for electricity generation," explains Dr. Manuel Romero of IMDEA Energy. This intense solar flux, verified by the flux measurement system developed by project partner DLR, allows to reach reaction temperatures of more than 1,500°C within the solar reactor positioned at the top of the tower. The solar reactor, developed by project partner ETH Zurich, produces synthesis gas, a mixture of hydrogen and carbon monoxide, from water and CO_2 via a thermochemical redox cycle. An on-site gas-to-liquid plant that was developed by the project partner HyGear processes this gas to kerosene.

Unlimited supply of sustainable fuel

Compared to conventional fossil-derived jet fuel, the net CO_2 emissions to the atmosphere can be reduced by more than 90%. Furthermore, since the solar energy-driven process relies on abundant feedstock and does not compete with food production, it can thus meet the future fuel demand at the global scale without the need to replace the existing worldwide infrastructure for fuel distribution, storage, and utilization.

Project background

SUN-to-LIQUID is a four-year project supported by the European Union's Horizon 2020 research and innovation programme and the Swiss State Secretariat for Education, Research and Innovation (SERI). It started in January 2016 and will end on 31 December 2019. SUN-to-LIQUID joins leading European research organizations and companies in the field of solar thermochemical fuel research, namely ETH Zurich, IMDEA Energy, DLR, Abengoa Energía and HyGear Technology & Services B.V. The coordinator Bauhaus Luftfahrt e.V. is also responsible for technology and system analyses. ARTTIC supports the Research Consortium with project management and communication.

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