



Press release
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Solar fuel breakthrough SUN-to-LIQUID produces solar kerosene from sunlight, water and CO₂

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 CO₂ 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 CO₂ 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 CO₂ 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.

For more information, visit <https://www.sun-to-liquid.eu/>

Bauhaus Luftfahrt (project coordinator)



Bauhaus Luftfahrt is an interdisciplinary research institution funded by the four aerospace companies Airbus Group, Industrieanlagen-Betriebsgesellschaft (IABG), Liebherr-Aerospace and MTU Aero Engines as well as grants of the Bavarian Ministry for Economic Affairs, Media, Energy and Technology. The non-profit association is an internationally-oriented think tank. The team of around 50 employees deals with the future of mobility in general and with the future of air travel in particular. The goal of the research work is to consider the complex system of aviation from different points of view. In every project, the technical, economic, social and ecological aspects are considered holistically. www.bauhaus-luftfahrt.net

Deutsches Zentrum für Luft- und Raumfahrt (DLR)

The German Aerospace Center (DLR) is the national aeronautics and space research centre of the Federal Republic of Germany. Its extensive research and development work in aeronautics, space, energy, transport, security and digitalisation is integrated into national and international cooperative ventures. In addition to its own research, as Germany's space agency, DLR has been given responsibility by the federal government for the planning and implementation of the German space programme. DLR is also the umbrella organisation for one of the nation's largest project management agencies.

DLR has approximately 8,000 employees at 20 locations in Germany: Cologne (headquarters), Augsburg, Berlin, Bonn, Braunschweig, Bremen, Bremerhaven, Dresden, Goettingen, Hamburg, Jena, Juelich, Lampoldshausen, Neustrelitz, Oberpfaffenhofen, Oldenburg, Stade, Stuttgart, Trauen, and Weilheim. DLR also has offices in Brussels, Paris, Tokyo and Washington D.C. www.DLR.de

ETH Zurich (Swiss Federal Institute of Technology, Zurich)

Freedom and individual responsibility, entrepreneurial spirit and open-mindedness: ETH Zurich stands on a bedrock of true Swiss values. Our university for science and technology dates back to the year 1855, when the founders of modern-day Switzerland created it as a centre of innovation and knowledge. Some 530 professors teach around 21,400 students – including nearly 4,200 doctoral students – from over 120 countries. Their collective research embraces many disciplines: natural sciences and engineering sciences, architecture, mathematics, system-oriented natural sciences, as well as management and social sciences. The results and innovations produced by ETH researchers are channelled into some of Switzerland's most high-tech sectors: from computer science through to micro- and nanotechnology and cutting-edge medicine. Every year ETH registers around 100 patents and 200 inventions on average. Since 1996, the university has produced a total of 407 commercial spin-offs. ETH also has an excellent reputation in scientific circles: 21 Nobel laureates have studied, taught or researched here, and in international league tables ETH Zurich regularly ranks as one of the world's top universities. www.ethz.ch

IMDEA Energy Institute

The IMDEA Energy Foundation was created in November of 2006 by the regional government of Comunidad de Madrid with the aim to promote energy-related R&D activities. The ultimate goal of the Foundation is to achieve and transfer outstanding scientific and technological results that could contribute to the development of a sustainable energy system, establishing strong links with the main companies in the energy sector. The research, development and innovation activities developed at IMDEA Energy are within the scope of renewable energy and clean energy technologies. The Institute at present focuses on the production of sustainable fuels; solar energy advanced technologies; energy storage; smart management of electricity demand; energy saving and the confinement and valorization of CO₂ emissions. The research on solar energy has as main objective the development of modular, efficient, dispatchable and cost-effective high temperature solar concentrating technologies for power generation, industrial process heat and production of solar fuels and chemicals. www.energy.imdea.org

Abengoa

Abengoa is an international company that applies innovative technology solutions for sustainable development in the infrastructures, energy and water sectors.

Abengoa has extensive experience in engineering, construction, assembly and commissioning of power generation plants with open cycle technologies, combined cycles, cogeneration, wind farms, solar thermal and photovoltaic plants, and biomass plants that together exceed 12,800 MW installed capacity. Abengoa is carrying out turnkey projects in all these areas that encompass the entire value-chain: development, engineering, purchasing, construction, plant commissioning, in addition to offering operation and maintenance. Abengoa has its own solar thermal technology and has become a world leader in the construction of solar thermal plants, with 34% of the installed capacity worldwide. Technological development continues to be Abengoa's key competitive advantage in the undertaking of high added value projects. The company continues to develop R&D and Innovation projects, which improve both the performance of current products and services and the acquisition of new skills. Till 2018, the accumulated investment in R&D has reached more than 800 M€ and 342 granted patents. www.abengoa.es



HyGear

HyGear Technology & Services B.V. is a SME based in Arnhem, The Netherlands, with focus on development and manufacturing of small-scale gas processing plants and purification systems. The company has developed proprietary technologies for on-site hydrogen generators (Hy.GEN), and gas purification systems (Hy.REC) for industrial applications. HyGear offers these systems commercially within its Gas-as-a-Service contracts to supply cost effective on-site produced gases like hydrogen, oxygen and nitrogen. It is HyGear's mission is to move more small-scale chemical plants to market entry. Several new technologies development like small scale Gas-to-Liquid units and ultra-purification of gases (Gas.PURE) are under way. www.hygear.com

ARTTIC

Created in 1987, ARTTIC is an independent European provider of management services, especially in the area of large international collaborative R&D projects. ARTTIC is a set of companies based in France, Belgium, Germany and Israel. ARTTIC is an SME with a total workforce of about 60 persons.

ARTTIC provides specific and practical help with all aspects of international R&D projects. Services include establishing project feasibility; finding partners; establishing consortia; managing the proposal development activities; helping negotiate contracts; in charge of all management aspects of live projects and helping to disseminate and exploit successfully project results. www.arttic.eu

Partner logos



ABENGOA



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