Solar Towers for Fuel Production from CO_2 and Water

Martin Roeb[1], Manuel Romero[2],

[1] German Aerospace Center (DLR), Linder Höhe, 51147 Cologne, Germany

[2] IMDEA Energy, Avda. Ramón de la Sagra 3, 28935 Móstoles, Spain

The technology presented, Sunlight to Liquid or StL, has as main achievement the demonstration, for the first time, of a fully integrated system producing liquid fuels from concentrated sunlight, water and carbon dioxide under real on-sun conditions provided by a modular heliostat field and therefore promoting the StL technology to a readiness level (TRL) of 5. The main objective driving this development is the decarbonization of transport sector, with particular emphasis on aviation. For this purpose, a solar fuel research facility comprising a high-flux solar concentrating heliostat field and tower, a solar thermochemical reactor system, and a gas-to-liquid conversion plant have been installed at a sunny site in Móstoles, Spain. Ceria is used as the reactive material in the solar reactor, which undergoes a temperature and pressure swing in a redox cycle, splitting water and carbon dioxide into hydrogen and carbon monoxide. This synthesis gas is then converted into hydrocarbons downstream via a Fischer-Tropsch conversion plant. The stable cyclic operation of the solar reactor was shown in multiple consecutive redox cycles. High-quality syngas suitable for FT synthesis was produced with total selectivity by simultaneous co-splitting of H_2O and CO_2. The customized heliostat field has been able to provide irradiances above 3000 kW/m^2 onto the small aperture of the 50kW solar reactor, producing up to 150 L/h solar syngas subsequently converted into liquid fuel. The further scale-up of the technology could provide, on a large scale, solar fuels with considerably reduced CO_2 emissions over their life cycle compared to conventional fuels.

Acknowledgments:
The SUN-to-LIQUID Project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654408. This work was supported by the Swiss State Secretariat for Education, Research and Innovation (SERI) under contract number 15.0330.

Keywords: Solar Fuels, Sunlight-to-Liquid, CSP, Central Receiver Systems, Solar Thermochemical Conversion