Solar Towers for Fuel Production from CO\textsubscript{2} and Water

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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\textsubscript{2}O and CO\textsubscript{2}. The customized heliostat field has been able to provide irradiances above 3000 kW/m\textsuperscript{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\textsubscript{2} emissions over their life cycle compared to conventional fuels.

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