



European
Commission

Technology factsheet: **Competitiveness of clean energy technology – Direct Solar Fuels**

December 2023

Key emerging technologies and uses

While demonstration projects already exist, this technology is not yet available commercially, with the exception of some pilot projects.

tech 1

Technological Readiness Level (TRL) 3-5:
Photosynthetic devices; Solar microbial cell factories; solar-thermochemical conversion; sustainable ammonia (electrochemical and plasma-assisted ammonia synthesis, solar microbial cell factories); direct electro-reduction of CO₂; direct solar-thermochemical conversion of water and CO₂

tech 2

TRL 6-7: Two stage electrochemical water splitting; thermoelectric conversion

tech 3

TRL 8-9: Advanced electrolysis

Key facts

Fact 1

Solar fuel technologies are still at a relatively early stage of development, and no commercial systems are available. Solar fuels, and more generally “sunlight-to-X” technologies, are an emerging class of sustainable alternative fuels and chemicals that are set to play an important long-term role in all net-zero carbon scenarios for the energy system.



Fact 2

Laboratory solar-to-hydrogen (STH) efficiency of solar-to-hydrogen photoelectrochemical devices is 10 to 15%. This value would need to increase to near the 22% theoretical limit.

Fact 3

The SUNERGY initiative on fossil-free fuels and chemicals brings together 300+ stakeholders from academia, industry, public institutions, and civil society in Europe and provides a strategic lead on planning research and innovation activities. The project's overnight investment costs will decrease significantly in the coming decade. By 2035, a decrease of around 60% is foreseen for gaseous syngases and about 65% for liquid syngases compared to 2020.



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