Sunrise

SOLAR ENERGY FOR A CIRCULAR ECONOMY

Fossil fuels and chemicals
What's the current situation like?

MODERN CIVILIZATION THRIVES ON A CONSTANT FLOW OF ENERGY AND MATERIAL GOODS, OBTAINED FROM NATURAL RESOURCES SUCH AS FOSSIL FUELS, MINERALS AND BIOMASS. THIS LEADS TO THE PRODUCTION OF LARGE AMOUNTS OF WASTE, WHICH BECOMES DIFFICULT TO HANDLE. SUCH A LINEAR ECONOMIC SYSTEM IS NOT SUSTAINABLE HAVING NEGATIVE EFFECTS FOR OUR PLANET.

1. ENERGY SUPPLY

80% of our energy supply is provided by fossil hydrocarbons. Their combustion or oxidation releases almost 33 GTons of CO_2 every year in the atmosphere.

2. NET OIL IMPORTS

87% of the EU's oil consumption is imported. The production of fuels for the transport sector consumes about 4000 megatons per year of crude oil.

3. MOST POLLUTING SECTORS

8.8 tons of CO_2 per capita were emitted in the EU in 2017. Being the energy (54%) and transport (24%) the two sectors that generate the major part of the emissions.

4. ELECTRICITY SOURCES

30.7% share of gross electricity consumption in the EU was generated from renewable sources in 2017. Its levelized cost has decreased down 81% for solar photovoltaics and 46% for onshore wind since 2009.

5. HYDROGEN PRODUCTION

Around 830 million/year of CO_2 emissions are generated by the production of hydrogen. Current production comes from natural gas (76%), coal (22%) and water electrolysis (2%).

6. AMMONIA PRODUCTION

Ammonia is the most used fertilizer. Its annual production amounts to more than 150 Mtons, where 1 ton of produced ammonia generates 1.5 tons of carbon dioxide emissions.

7. ELECTRICITY ACCESS

In 2018, 1 billion people still lived without access to electricity and 3 billion had no access to clean cooking fuels.

8. LINEAR ECONOMY

The World's population is expected to reach 9.7 billion by 2050. Following the current linear economy system, demands for plastics, pharmaceuticals, agrochemicals and many goods of daily life will increase accordingly.

9. LAND USE

With up to 80%, Europe has the highest proportion of land used for settlement, production systems (in particular agriculture and forestry) and infrastructure.

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SUNRISE's roadmap towards a circular, fossil-free economy by 2050

SOLAR ENERGY FOR A CIRCULAR ECONOMY

SUNRISE AIMS AT ENABLING THE TRANSITION TO A CIRCULAR ECONOMY AND A CARBON-NEUTRAL SOCIETY TO MITIGATE GLOBAL WARMING AND CLIMATE CHANGE. DISRUPTIVE ENERGY TECHNOLOGIES WILL TRANSFORM CARBON DIOXIDE, WATER AND NITROGEN FEEDSTOCKS INTO FUELS, COMMODITY CHEMICALS AND AGROCHEMICALS WITH THE USE OF SUNLIGHT.

1. RENEWABLE ENERGY SOURCES

Enable a sustainable, low-emission production of chemicals and fuels, by taking inspiration from nature: the artificial photosynthesis, including: electrochemical conversion with renewable power, direct conversion via (photo)electrochemical systems[a], and biological & biohybrid systems[b].

2. IMPORT-INDEPENDENT ENERGY PRODUCTION

For EU autonomy and sovereignty, energy security and energy resilience. Displace fossil fuels by renewable ones based on abundantly available materials and resources.

3. SUSTAINABLE CARBON-BASED CHEMICALS AND FUELS

Foster a large-scale deployment of technologies for negative emissions in long distance air and sea transport by capturing and turning CO_2 from a waste and threat into a useful resource like methanol or jet fuels, combined with a long-term carbon storage.

4. DEFOSSILIZATION OF THE CHEMICAL INDUSTRY

Achieve cost-competitiveness of renewable fuels to reach a complete defossilization of the chemical industry, for instance by providing cost effective (100e/kw) and efficient electrolyzers to supply all the hydrogen that is needed to decarbonize.

5. SUSTAINABLE HYDROGEN PRODUCTION

Reach a large-scale and sustainable production of hydrogen with low carbon emissions. With a 2030 target of an operational system of 1000 hectares to produce the equivalent to more than 90 tons per hectare per year of molecular hydrogen.

6. RENEWABLE AMMONIA PRODUCTION

Replace >80% ammonia produced from fossil resources by renewable ammonia, using solar hydrogen.

7. ENERGY DECENTRALIZATION

Promote a decentralized production system based on resources available everywhere by the deployment of individual house roofs or solar fuel farms and a completely local and autonomous hydrogen production.

8. CIRCULAR ECONOMY

To provide enough energy to everyone on Earth, more efficient processes are deeply needed. Optimized CO_2 capture technologies will improve the performance of the solar-to-fuel conversion, contributing to acircular economy where everything is reused and nothing is wasted.

9. DISRUPTIVE TECHNOLOGIES

Convert solar into chemical energy highly efficiently, with a limited land and water use. Estimation of the impact of SUNRISE technologies in land and water use:

	Today global production [Mt / y]	Production potential [tons ha^{-1} y^{-1}]	Land use [km^2]	Freshwater use [Mt / y]
Hydrogen	70	52 -130	13 500 - 5130	630
Formic Acid	< 1	1 182 - 2 956	8 - 3	< 0.5
Formaldehyde	52	386 - 964	1 350 - 540	30
Methanol	75	274 - 686	2 700 - 1 100	85
Ethanol	95	197 - 494	4 800 - 1 900	110
Ammonia	176	308 - 772	5 700 - 2 300	280

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NOTES:

a Direct conversion via photo(electro)chemical systems follows a process in which the solar energy is absorbed and converted directly into fuels or other chemical compounds.

b Direct conversion via biological and biohybrid systems uses microorganisms equipped with biosynthetic pathways to directly produce fuels and chemicals from sunlight and CO_2