European Research & Innovation Policy on Solar Fuels

Workshop Hydrogen and Beyond: How solar fuels and chemicals will decarbonize the world - November 2021

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Policy Officer – Principal Administrator

European Commission, DG Research & Innovation

RTD.C.1- Clean Energy Transition

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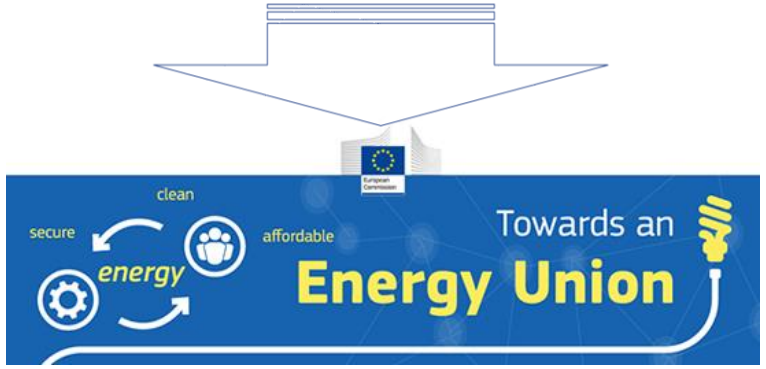
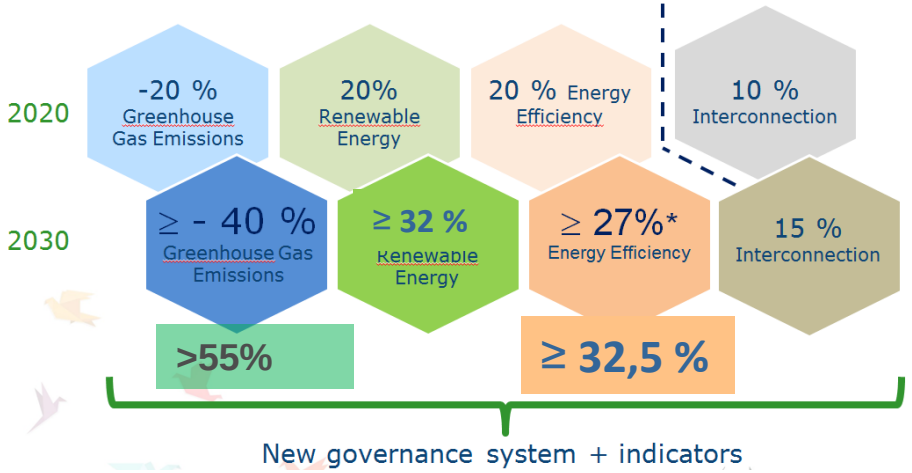
Policy Framework

"European Green Deal"



"Clean Energy for all Europeans"

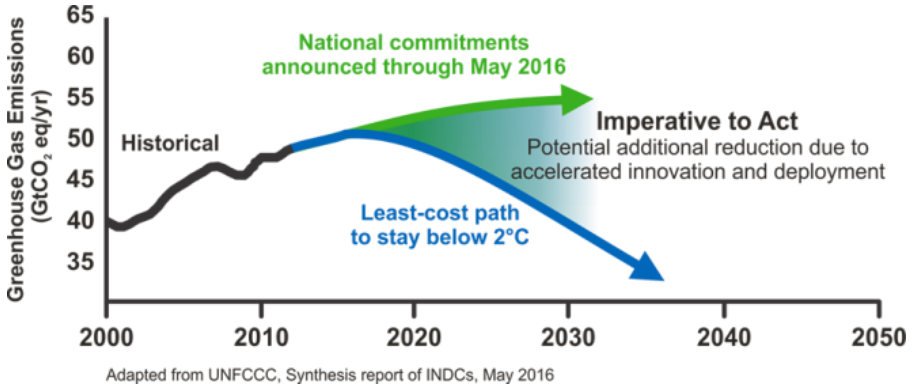
Agreed headline targets



Paris Agreement

*Holding global average temperature to **well below 2°C** and limit its increase to **1.5°C***

*Accelerating, encouraging and enabling **innovation** is crucial...*



Other EU policy priorities

- Digital Single Market
- Jobs, Growth and Investments
- EU as a strong global actor
- Sustainable Development
- …

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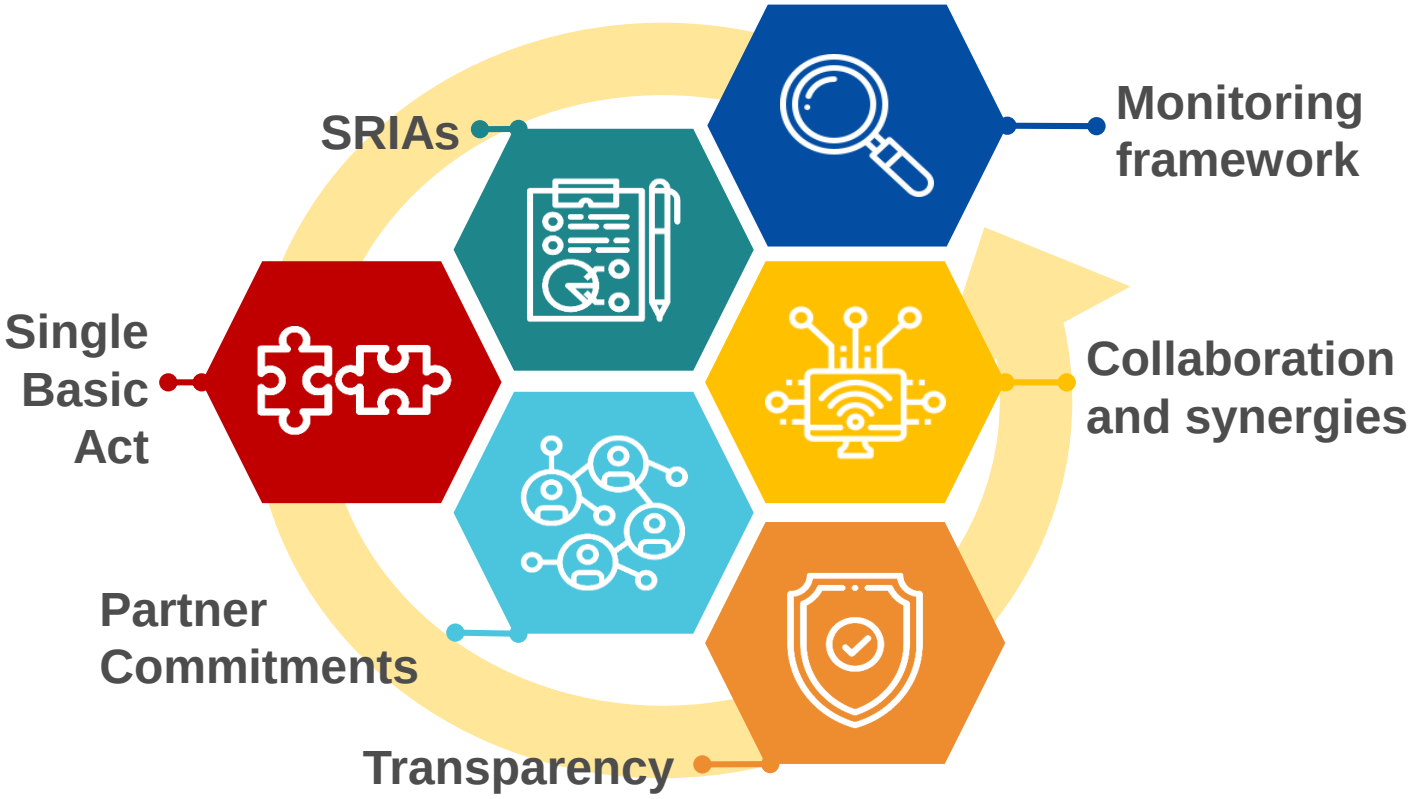
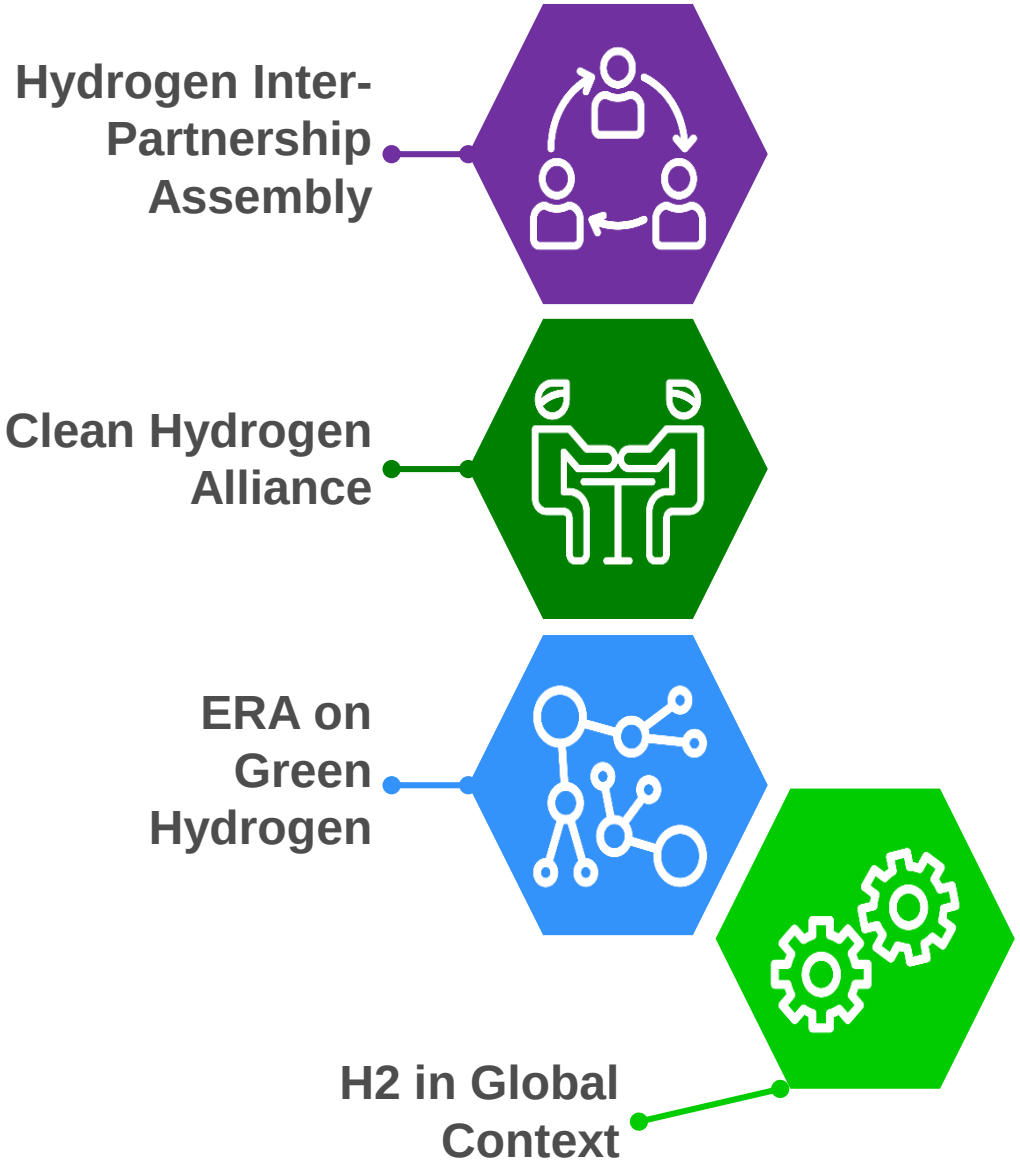
Hydrogen



Clean Hydrogen Joint Undertaking



R&I Action Plan on Hydrogen

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Mission Innovation

CLEAN HYDROGEN MISSION

IC5: CONVERTING SUNLIGHT

| Our work | Innovation Challenges | IC5: Converting Sunlight

Our objective: To discover affordable ways to convert sunlight into storable solar fuels.

IC 5 Roadmap available at: www. mission-innovation.net

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A Roadmap for Direct Sunlight Conversion Technologies

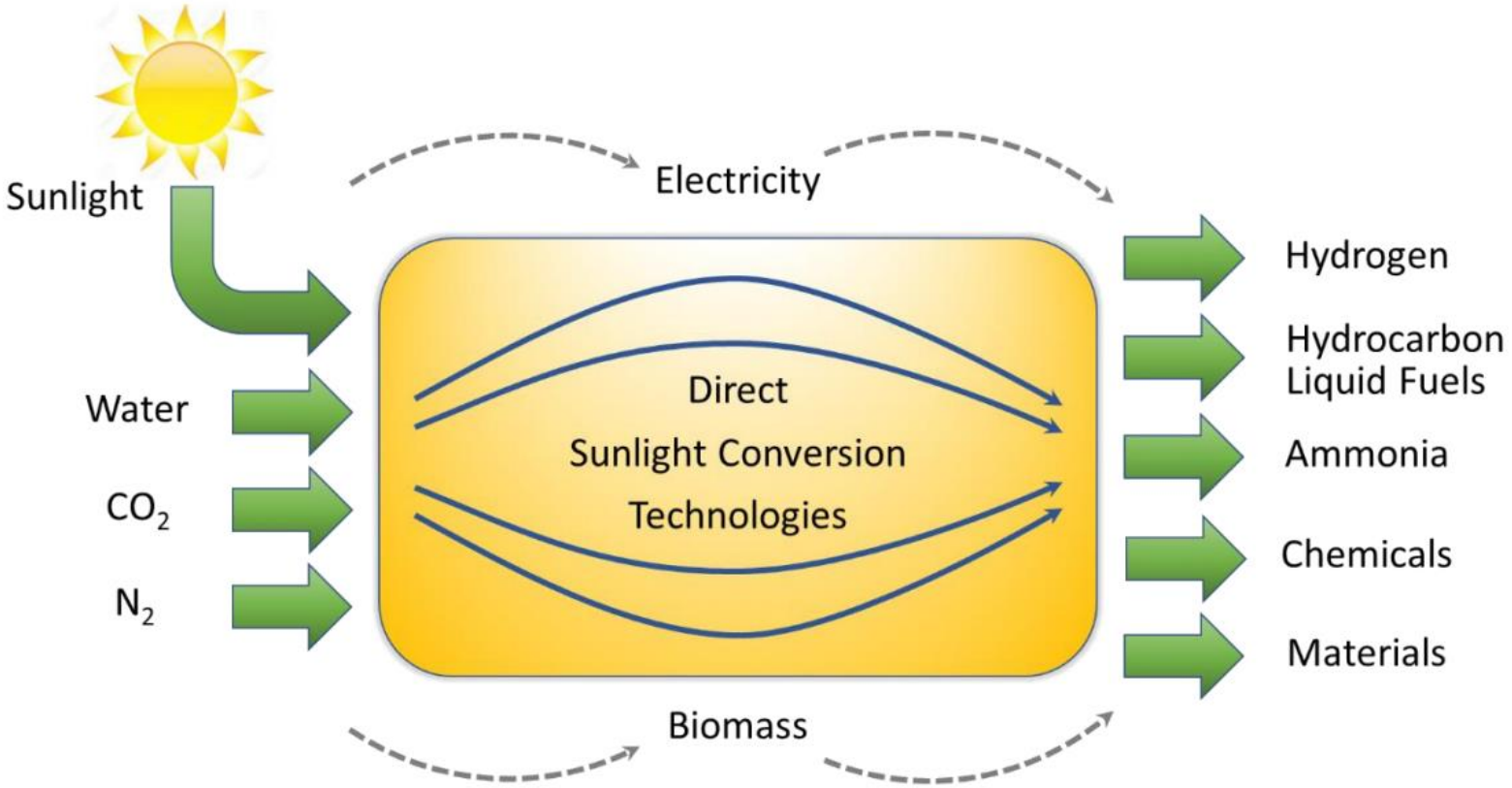

Figure 1.2. *Overview of the conversion of abundant water, CO_2, and N_2 into useful fuels and chemicals using sunlight. The focus of this roadmap is the direct conversion technologies (yellow box), which have the potential to, in a single process, perform the necessary conversion steps to obtain these desirable products.*

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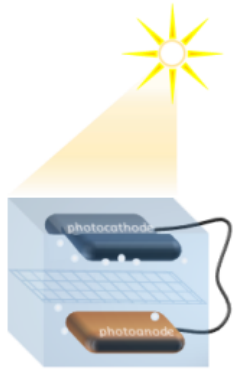
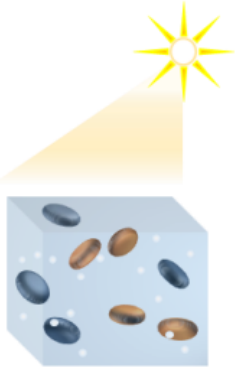
CONVERSION TECHNOLOGIES

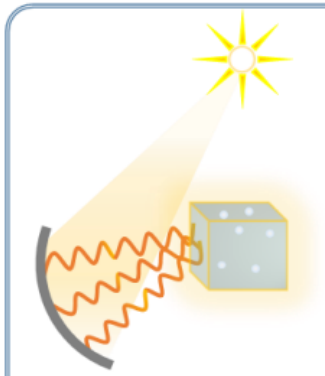
PV + Electrolysis



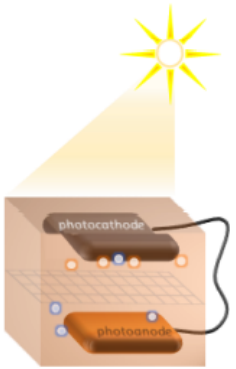
PEC Water Splitting



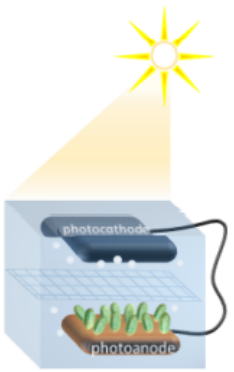
Photocatalysis



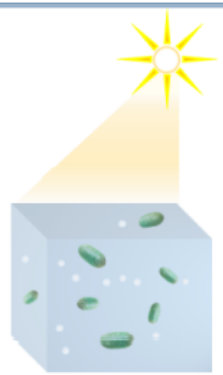
Thermochemical approach



(PEC) Photoreforming



Bio-hybrid approach



Photobiological approach

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The Converting Sunlight Value Chain

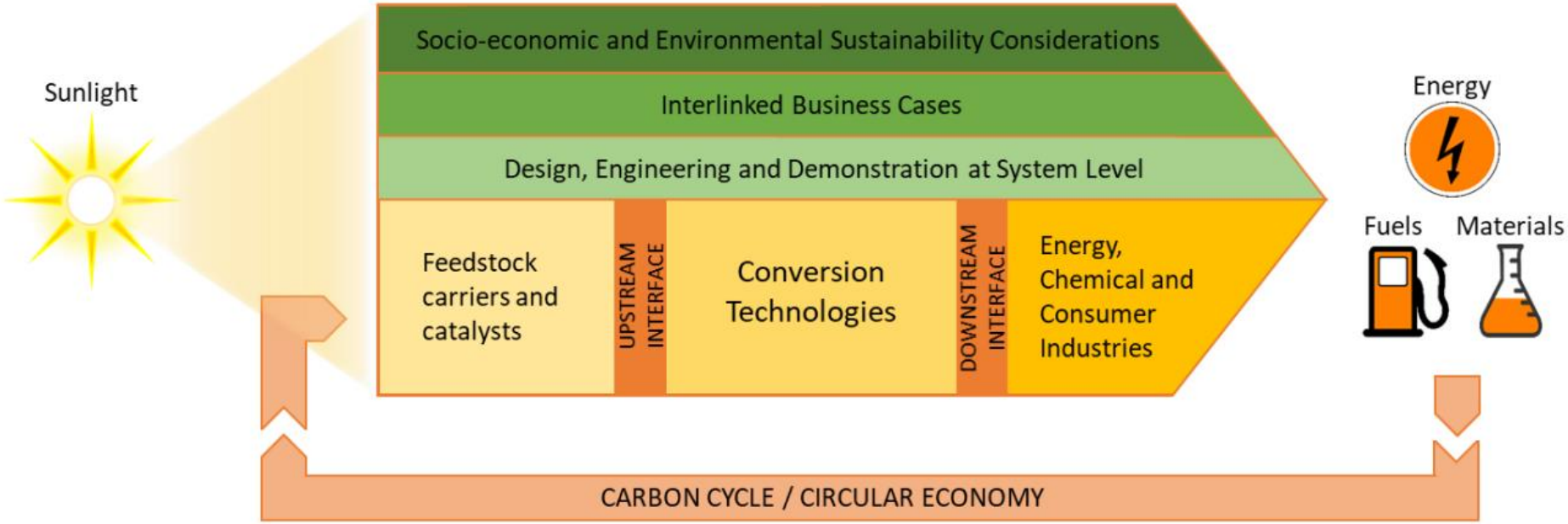

Figure 2.1. *The Converting Sunlight Value Chain. Primary processes and interfaces are given in orange, with ongoing support activities shown in green. It should be noted that several elements of this value chain are currently covered primarily by research and development programs.*

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Study: Solar Fuels Research & Invest: Defining and developing the global solar fuel value chain: techno-economic analysis and pathways for sustainable implementation

International Solar Fuel Forum

Key study results

2020

De Rose et al. 2020
available at Publications Office of the European Union
ISBN: 978-92-76-20007-9

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EY

imec

RINA

CEPS

Publication: 2021, Contract 2019/RTD/SC/PP-07541-2018

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Study: Solar Fuels Research and Invest

Defining and developing the global solar fuel value chain: techno-economic analysis and pathways for sustainable implementation

Solar Fuels are **fuels** produced from using **sunlight energy** to drive chemical reactions, ultimately resulting in the production of fuels, such as **methanol** or **hydrogen**.

With their **low carbon footprint**, solar fuels could play a key **role in decarbonisation** efforts in Europe and worldwide.

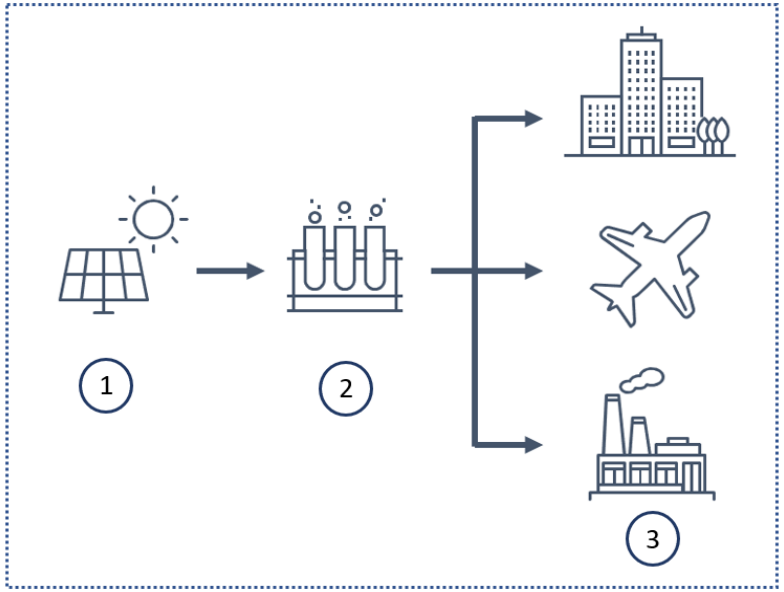
Solar Fuels can be produced from different technological routes including **electrochemical**, **thermochemical**, **chemical** and **biochemical** pathways.

Technological pathways for producing solar fuels differ in their **nature**, their expected **applications**, and their expected **time market**. Some pathways rely on **traditional solar photovoltaic cells** to produce electricity which then **drives chemical reactions**, while others combine **both steps in one reactor**. Some pathways produce **hydrogen**, some pathways transform this hydrogen into **hydrocarbon fuels**, while others produce hydrocarbon fuels directly. Solar fuel pathways are all expected to **contribute to different markets**, and will reach **market maturity at different times**, some as early as 2040, depending on factors including the **expected price for specific fossil fuels** against which they will compete, as well as technological improvements driven by investments in **R&D.**

Overall, solar fuels are expected to contribute to approximately **4 to 6% of our energy needs in 2050**, in an average scenario, and up to **6 to 10% in 2100**. They will likely contribute to the **transport sector**, as well as to **industry** and **buildings**, as presented in figure 1.

For this to occur, significant **investments** are needed for the **deployment of solar fuel technologies**, in order to develop the capacity required for them to play a significant role in our energy systems. These investments will spur the synergistic **growth of solar fuel value chains**, including additional solar farms to power solar fuel production.

Additionally, significant **investments in R&D** and a **strong carbon price** are needed to drive the development of solar fuel value chains worldwide.



1. Sunlight energy is harvested through a number of means including solar photovoltaic cells, photo-electrochemical cells, or microalgae
2. The energy is turned into fuels
3. The resulting fuels are used in a range of applications including building energy demand, transport, and industrial processes

Figure 1 – Solar Fuel Value Chain

Written by EY, IMEC, RINA and CEPS; Publication: 2021. Contract 2019/RTD/SC/PP-07541-2018

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Task 1 results: Definition of Solar Fuel Value Chains
Value Chain Analysis

Value chain analysis (LCOE decomposition) for all technologies for 2020 in Europe – stable investment scenario (€/kWh)

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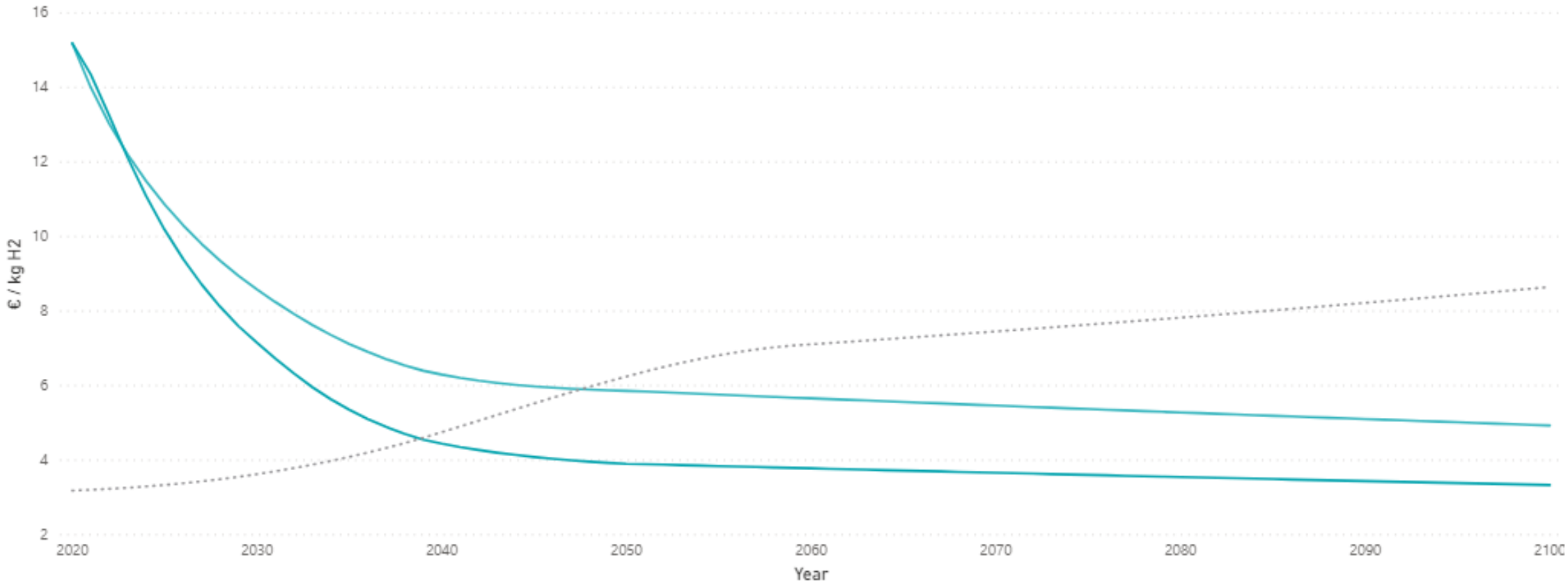
Task 2 results: Roadmap and outlook for Solar Fuels
Economic Roadmap through 2100

Proton Exchange Membrane Electrolysis Cell (PEMEC) – LCOE evolution in Europe – stable and scale investment scenarios (€/kg H_2)



Africa | Asia | Australia | **Europe** | North-America | South-America

Year

2020 2100

Range

High | Low | **Normal**

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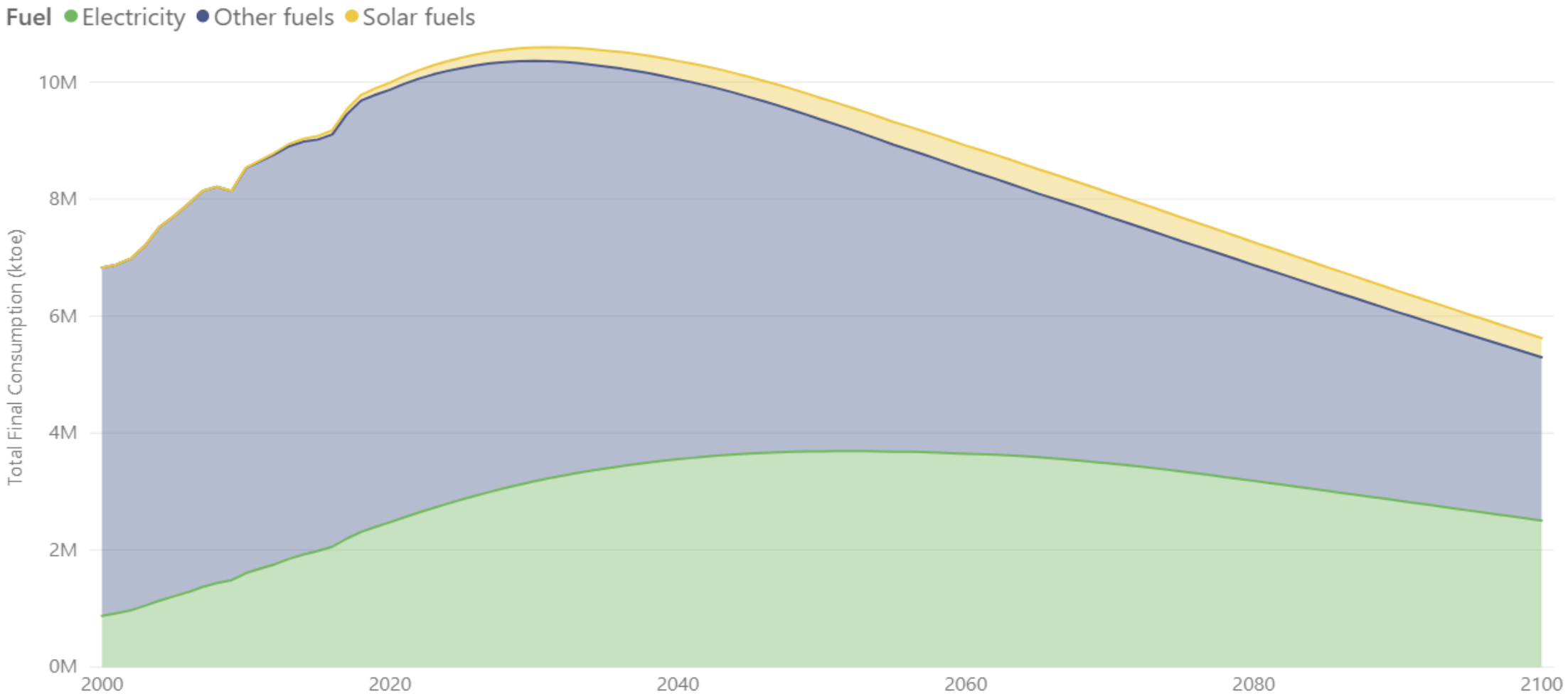
Task 2 results: Roadmap and outlook for Solar Fuels
Market outlook for 2050 and 2100

Solar Fuel potential demand, 2°C scenario



Scenario

1.5C | 2C | Reference

Sector

Buildings | Industry | Other | Transport

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#HorizonEU

THE EU RESEARCH & INNOVATION PROGRAMME 2021 – 27

This presentation is based on the political agreement of 11 December 2020 on the Horizon Europe. Information on some parts is pending revision.

19 March 2021

Research and Innovation

HORIZON EUROPE

EURATOM

SPECIFIC PROGRAMME: EUROPEAN DEFENCE FUND

Exclusive focus on defence research & development

- Research actions
- Development actions

SPECIFIC PROGRAMME IMPLEMENTING HORIZON EUROPE & EIT*

Exclusive focus on civil applications

Pillar I
EXCELLENT SCIENCE

- European Research Council
- Marie Skłodowska-Curie
- Research Infrastructures

Pillar II
GLOBAL CHALLENGES & EUROPEAN INDUSTRIAL COMPETITIVENESS

Clusters

- Health
- Culture, Creativity & Inclusive Society
- Civil Security for Society
- Digital, Industry & Space
- Climate, Energy & Mobility
- Food, Bioeconomy, Natural Resources, Agriculture & Environment

Joint Research Centre

Pillar III
INNOVATIVE EUROPE

- European Innovation Council
- European Innovation Ecosystems
- European Institute of Innovation & Technology*

WIDENING PARTICIPATION AND STRENGTHENING THE EUROPEAN RESEARCH AREA

- Widening participation & spreading excellence
- Reforming & Enhancing the European R&I system

EURATOM

- Fusion
- Fission
- Joint Research Center

* The European Institute of Innovation & Technology (EIT) is not part of the Specific Programme

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HORIZON-CL5-2022-D3-03-03

Efficient and circular artificial photosynthesis

Scope

Development of novel artificial photosynthesis technologies, which allow for improved efficiency of light harvesting, conversion to electrochemical potential and energy fixation to carriers with strictly implementing circularity by design and efficient use of carrier and (photo)catalyst materials through novel photoelectrochemical or bio-based (bio-hybrid) or biological pathways for solar fuel production with increased efficiency in comparison to light and dark reactions of natural photosynthesis. Production of hydrogen as a final product is not envisaged.
Synergies are possible with topic HORIZON-CL4-2021-RESILIENCE-01-16 Creation of an innovation community for solar fuels and chemicals (CSA) and respective cooperation activities are encouraged.

Opening: 06 Sep 2022

Deadline: 10 Jan 2023

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HORIZON-CL5-2022-D3-02-06

Direct renewable energy integration into process energy demands of the chemical industry

Scope

Development of the technology and the methodology of integrating renewable energy in chemical processing by substituting fossil process energy in chemical industry, which has a high carbon footprint due to processing relative to the mass of the final product. Pursued technology developments are expected to directly target renewable energy integration into process energy demands of the chemical industry beyond electricity (targeting e.g. electrochemical potential of artificial photosynthesis to chemical reduction processes and/or e.g. direct solar thermochemical conversion) and should improve GHG balance and sustainability of the targeted process.
Possible synergies exist with topic: HORIZON-CL4-2021-TWIN-TRANSITION-01-21:
Design and optimisation of energy flexible industrial processes (IA).

Opening: 26 May 2022

Deadline: 27 Oct 2022

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Thank you

Keep in touch

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