Sustainable fuels
from disruptive technologies to demonstration projects

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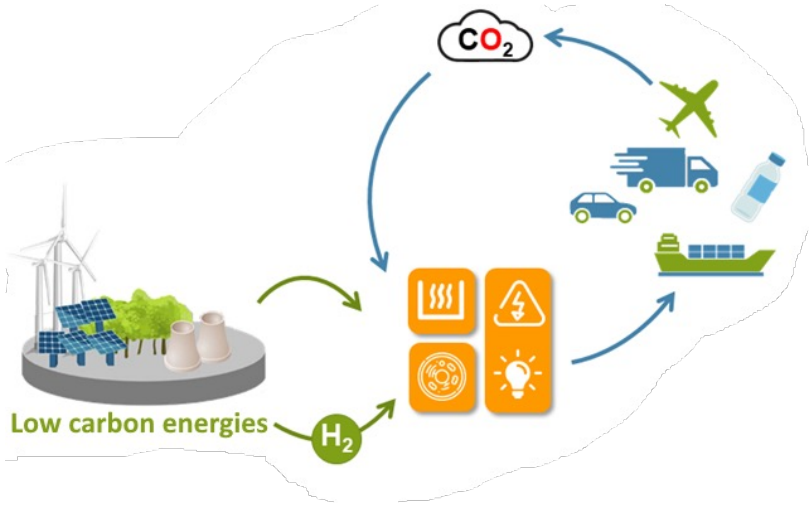


Carbon based products are at the core of energy systems

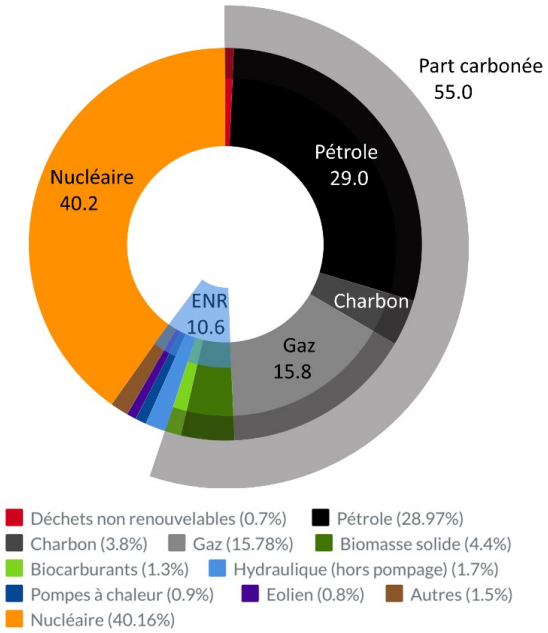
What is the place of carbon products in the French energy system?

The consumption of primary energy in France (2900 TWh) relies for 40% on nuclear energy (for the production of electricity) and for 55% on carbon fuels

A third (1/3) of the uses of carbon products cannot be substituted with carbon-free alternatives such as electrification, H_2 or batteries technologies

46 Mtoe of carbon-based products will need to be produced from renewable energy and carbon sources to ensure services dealing with:

- Liquid fuels for long range transportation
- Production of materials (steel, cast iron, cements)
- Production of chemicals (plastics, agrochemicals, solvents, etc,)

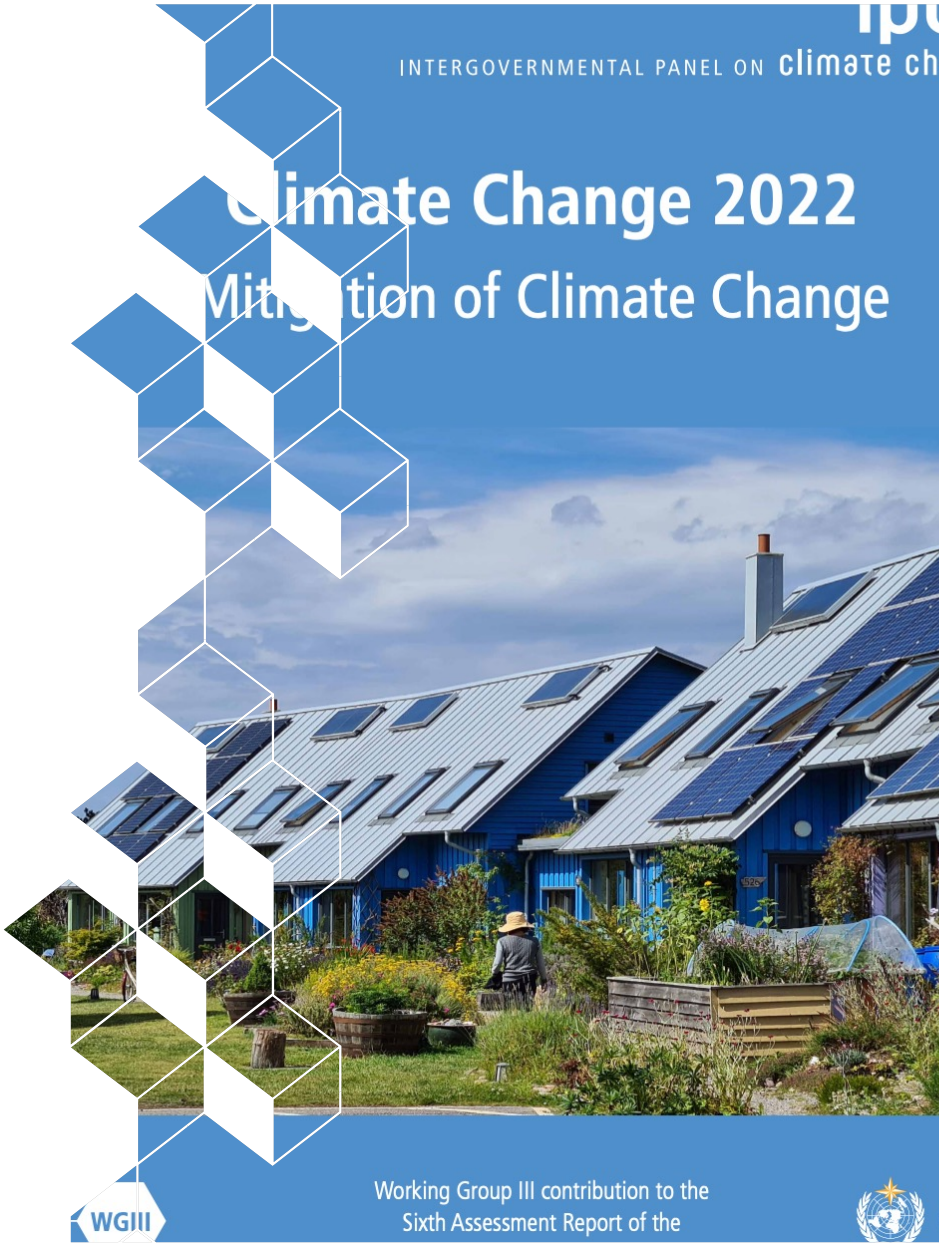


Répartition de la consommation d'énergie primaire en France, pour un total de 2900 TWh, en 2018. Données exprimées en % (données non corrigées de variations climatiques) ; ENR = énergies renouvelables ; d'après « Chiffres clés de l'énergie - Edition 2018 », données SDES; Commissariat général au développement durable.

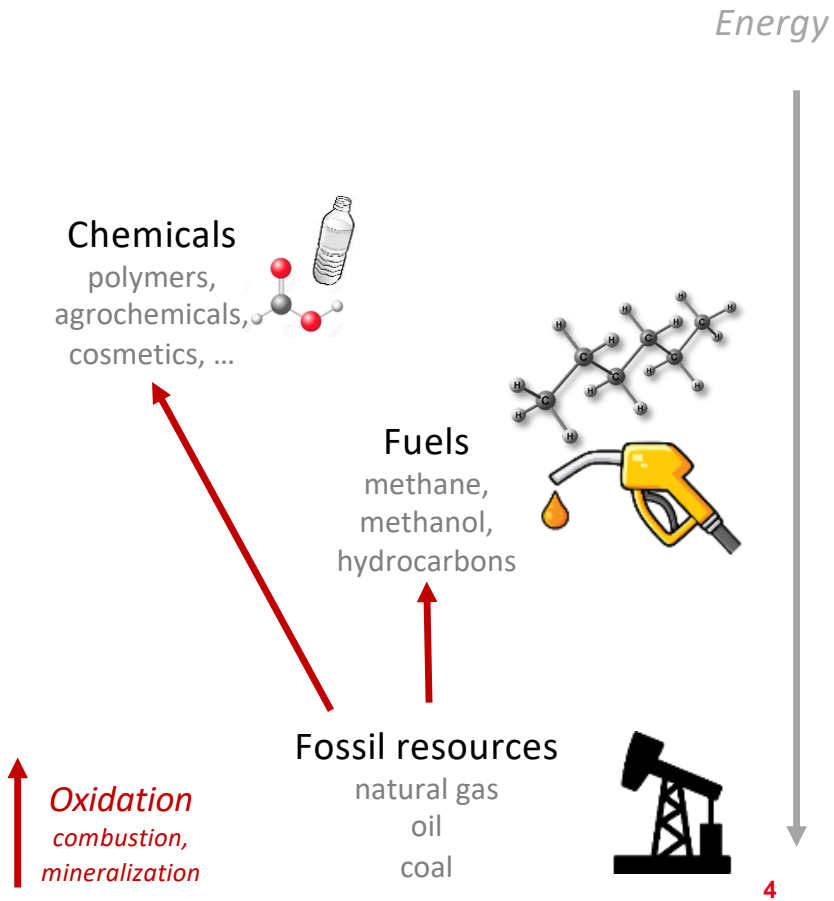
The circular carbon economy appears in the IPCC reports

“Carbon is a key building block in organic chemicals, fuels and materials and will remain important (high confidence).”

*“There is growing interest in “circular bioeconomy” concepts applied to bio-based and even a “**circular carbon economy**”, wherein carbon captured via CCU or CDR is converted into reusable materials, which is especially relevant for the transitions of economies dependent on fossil fuel revenue.”*



A linear carbon economy assisted with carbon capture and storage?



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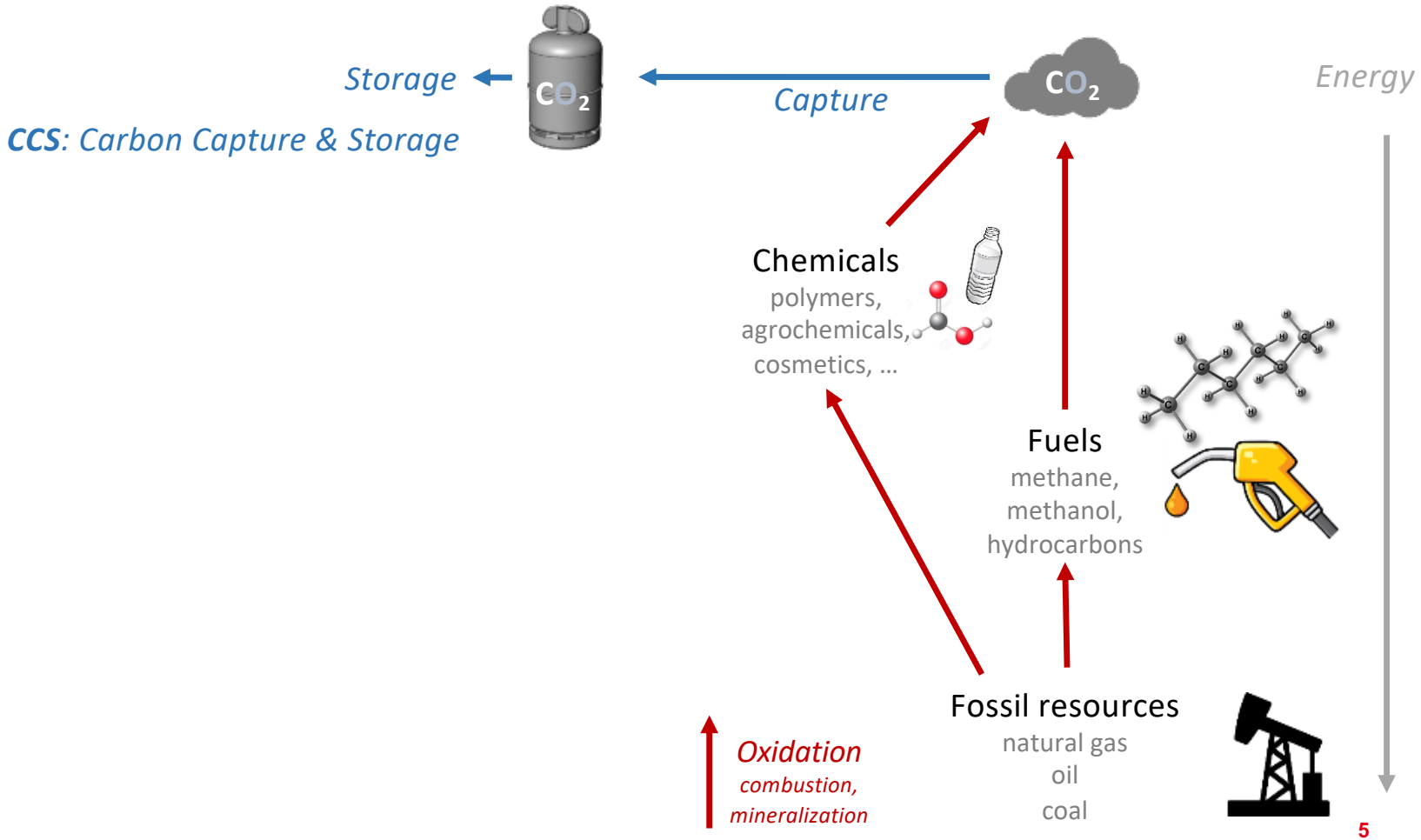
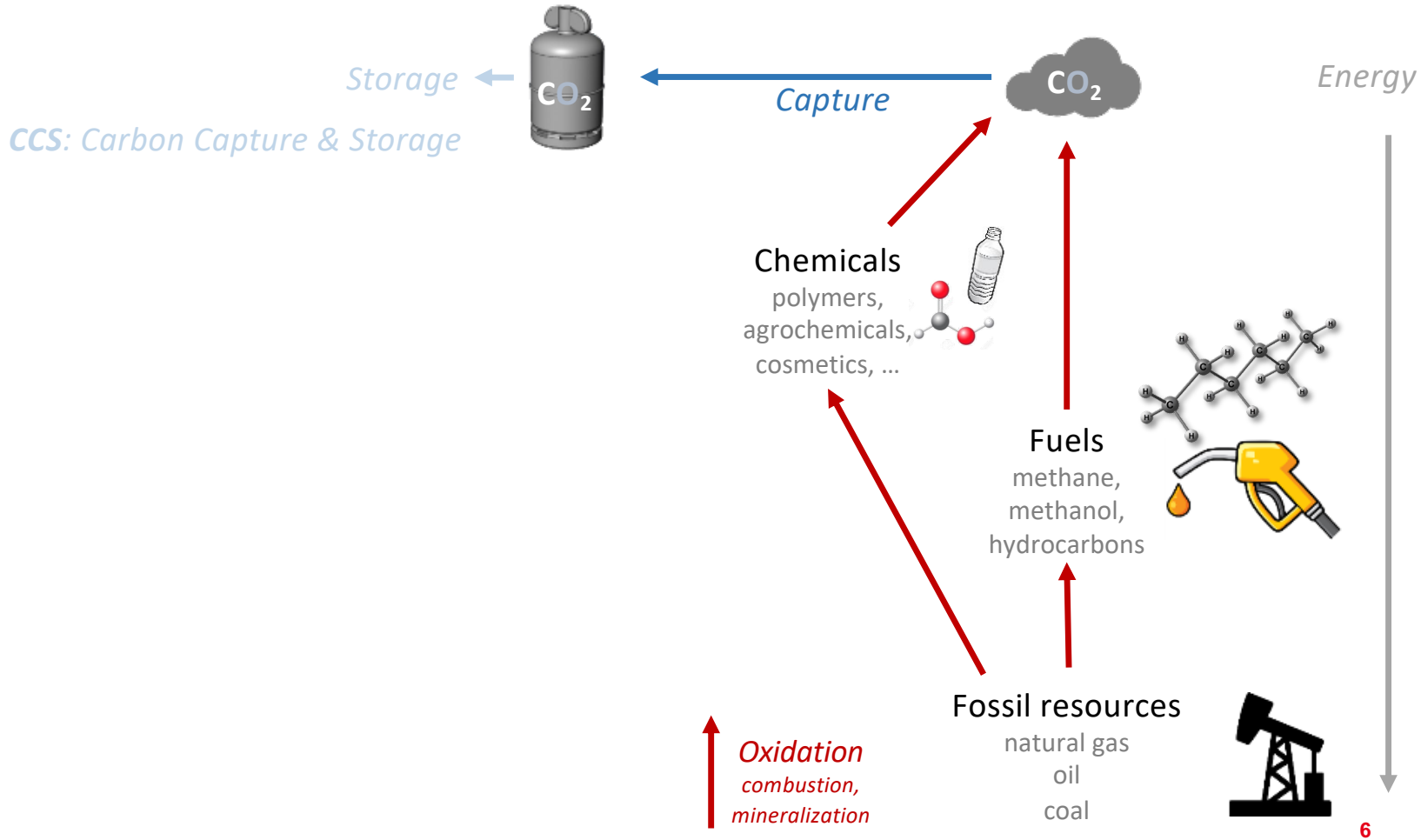


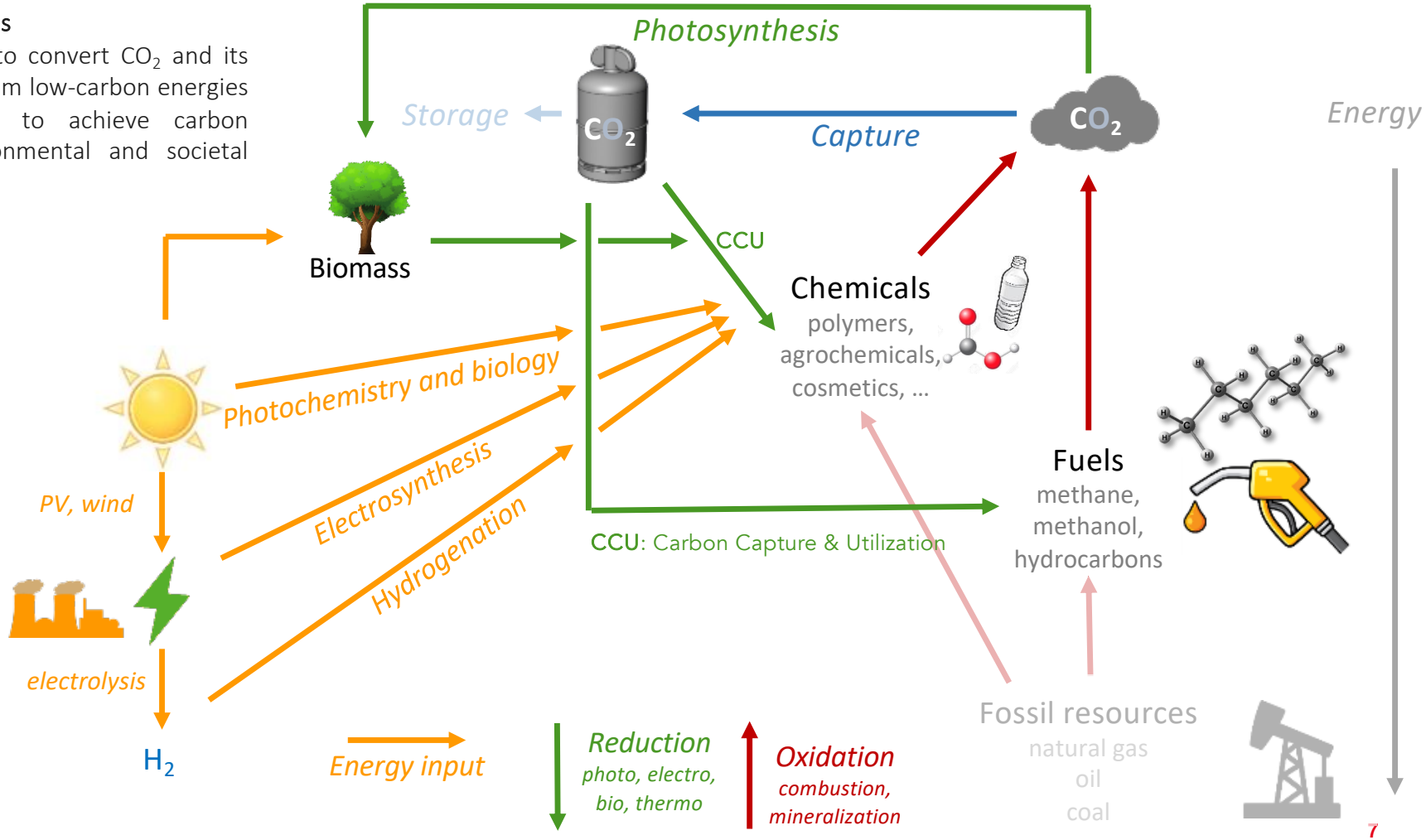
Towards a carbon circular economy



Towards a carbon circular economy

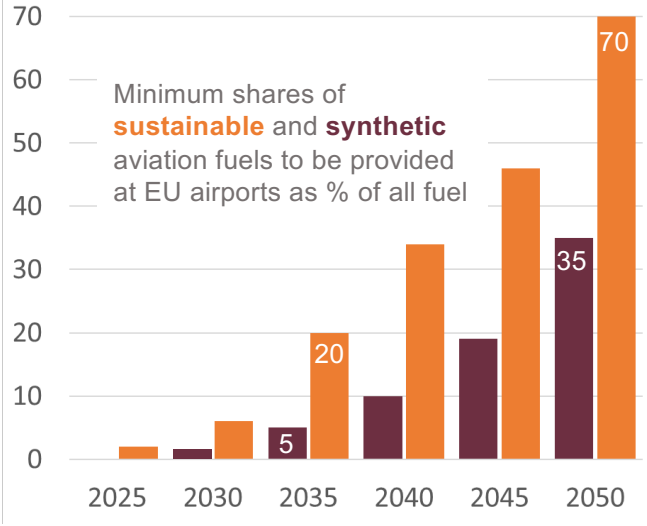
A circular carbon economy involves

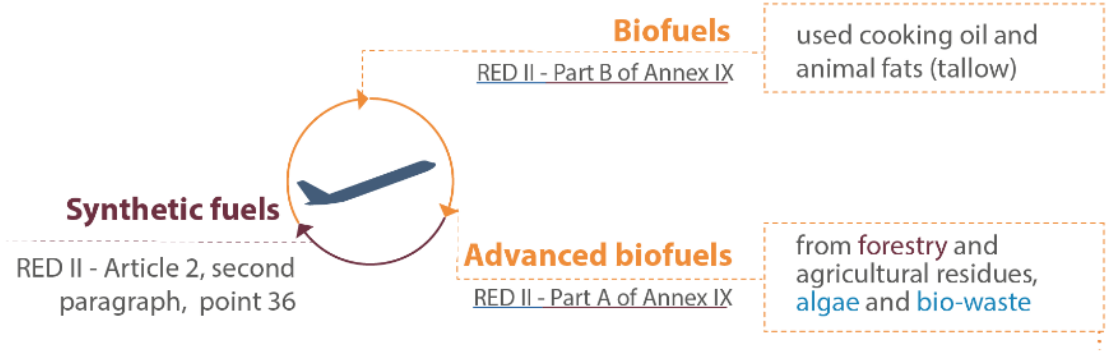
A collection of technologies able to convert CO_2 and its derivatives into useful products, from low-carbon energies (incl. nuclear and renewables), to achieve carbon neutrality with a positive environmental and societal impact.



A stronger raison d'être

- The Fit-for-55 regulation package sets a trajectory
  - For aviation





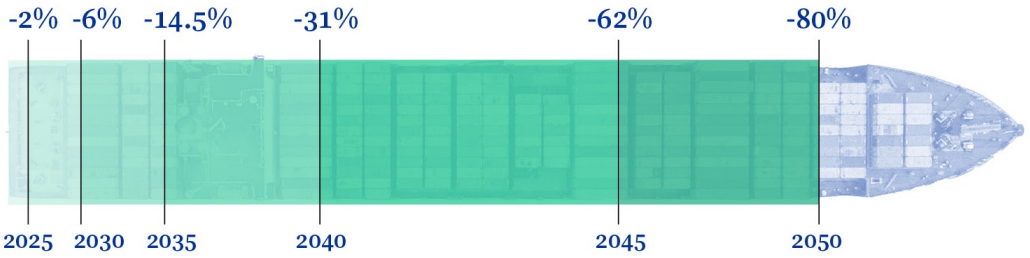
Source: Sustainable aviation fuels, EPRS, March 2022.

  - For maritime

The FuelEU maritime regulation will oblige vessels above 5000 gross tonnes calling at European ports (with exceptions such as fishing ships):

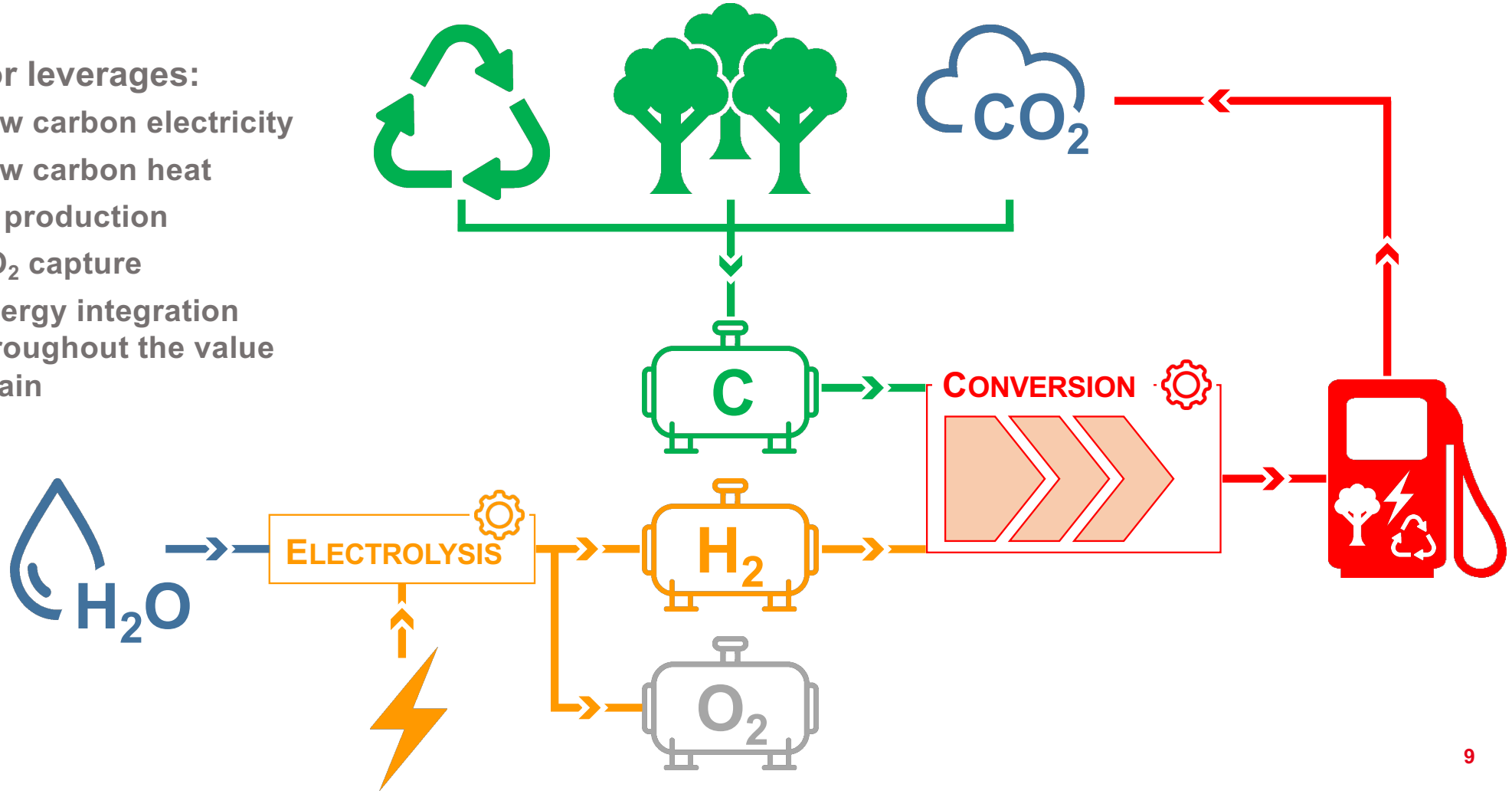
→ to **reduce** the **greenhouse gas intensity** of the energy used on board as follows

Annual average carbon intensity reduction compared to the average in 2020



Synthesis of low carbon fuels and chemicals

- Major leverages:
  - Low carbon electricity
  - Low carbon heat
  - H_2 production
  - CO_2 capture
  - Energy integration throughout the value chain



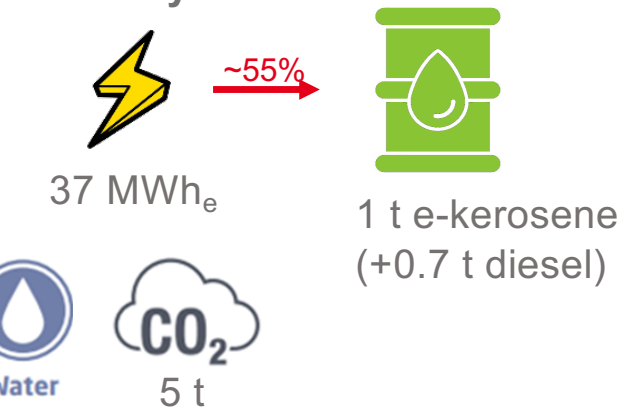
Key figures in France and in Europe

- In France, the aviation sector
  - emits 21 $MtCO_2$/yr
    - 6.8% of the total emissions
    - 83% of the sector's emissions are due to medium and long-haul flights
  - consummes 7 Mt/yr of kerosene
    - based on fossil oil
    - steady increase of 4%/yr
  - For Charles de Gaulle + Orly airports
    - 5 Mt of kerosene consummed every year

PARIS AÉROPORT

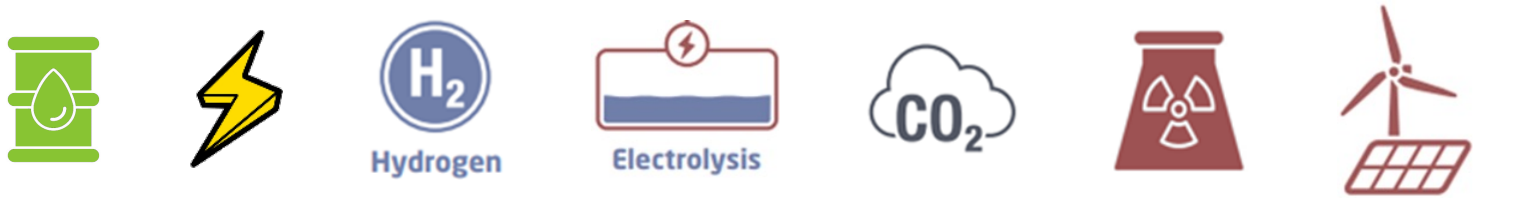
- In Europe, the aviation sector consummes 50 Mt/yr of kerosene

- A massive need for low carbon electricity



A first generation of e-fuels utilizing low carbon H_2

- The **minimum** annual need for low carbon electricity is massive for synthetic fuels



		E-kerosene	Low carbon electricity	Low carbon H_2	Electrolyzers	CO_2 captured	REP 900MW	Windmills 8MW 45% capacity factor
PARIS AÉROPORT	**2035** 5%	**0.25 Mt**	**9.3 TWh**	**180 kt**	**1.1 GW**	**1.3 Mt**	**1.5**	**300**
	2050 35%	1.8 Mt	65 TWh	1.3 Mt	8.0 GW	8.8 Mt	11	2100
								x7
x10	2035 5%	2.5 Mt	93 TWh	1.8 Mt	11 GW	13 Mt	15	3000
	2050 35%	18 Mt	650 TWh	13 Mt	80 GW	88 Mt	110	21000

A production cost of ca. 2 to 4 €/L
depending on the hypotheses (>50 €/MWh_e, sources of CO_2, etc.)

Projects for the production of SAFs in France

EXXON

HEFA
Gravenchon
2025
200 kT *(part de SAF à confirmer)*

VERSO energy

Power to Liquid
Rouen
2029
75 KT

ENGIE

Power to Liquid KerEauZen	Power to Liquid Reuze
HAROPA	Dunkerque
2028	2030
70kT	**100kT**

EDF

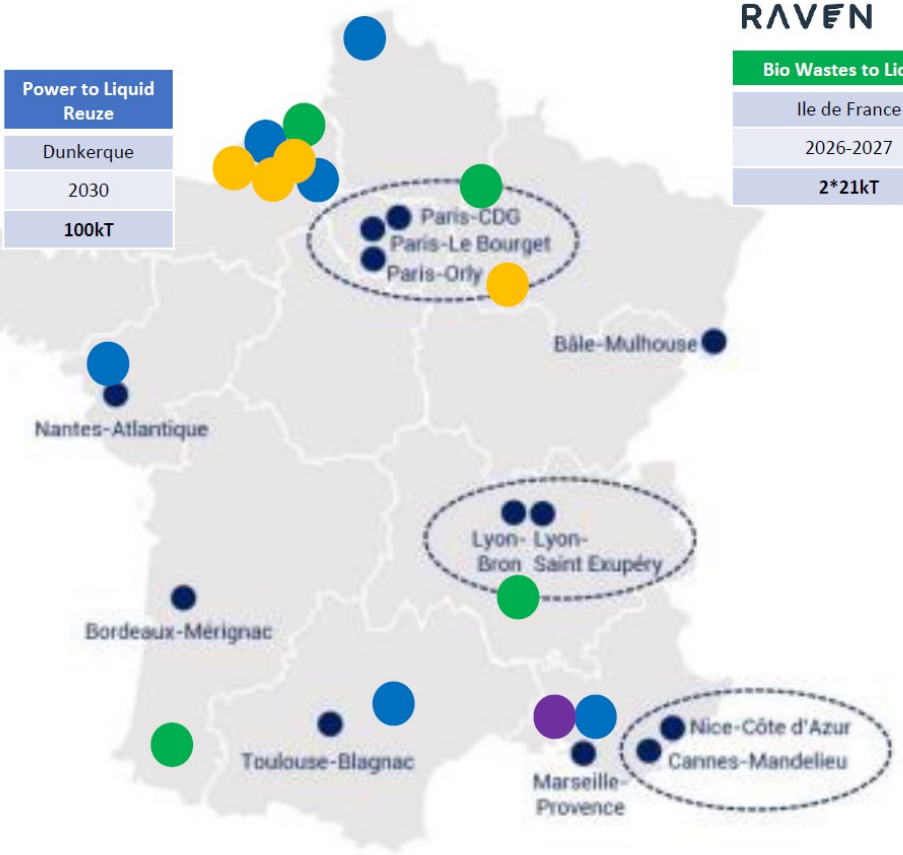
Power to Liquid Take Kair
Montoir, Loire Atlantique
2029
35kT

Elyse

E-Bio to Liquid
Lacq
2028
75kT

MGH energy

Power to Liquid
Occitanie
2030
70kT



HEFA
BTL / E-BTL
PTL

Aérodromes ou systèmes d'aérodromes régulés par l'Autorité

RAVEN

Bio Wastes to Liquid
Ile de France
2026-2027
2*21kT

TotalEnergies

HEFA	Co-Processing
Grandpuits + Oudalle	Normandie
2025-2028 + 2022	2025-2028
210kT-285kT + 25kT	**130kT – 180kT**

Haffner Energy
Making Hydrogen Super Green

Bio to Liquid
Est Parisien - Champagne Rhône Alpes - Martinique
2027 – 2028 – 2029
65 kT *2 + 43kT

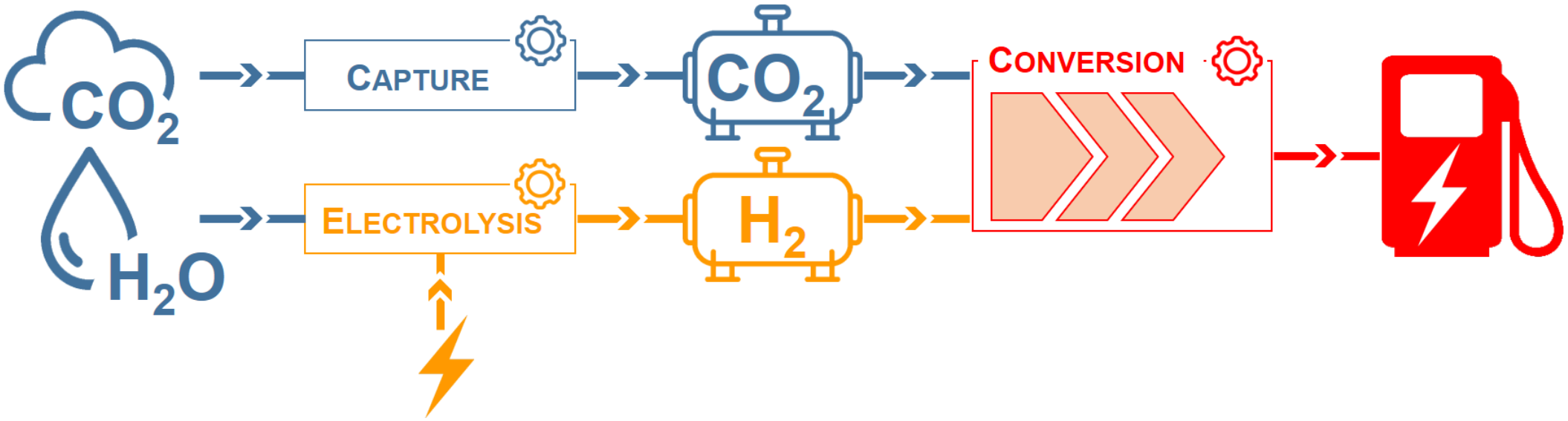
SAF+ CONSORTIUM

Power to Liquid
FOS Marseille
2029
80 kT

HY2GEN

Power to Liquid Hynovera
Gardanne-Meyreuil
2029
32kT

P2G - Jupiter1000: a methanation unit



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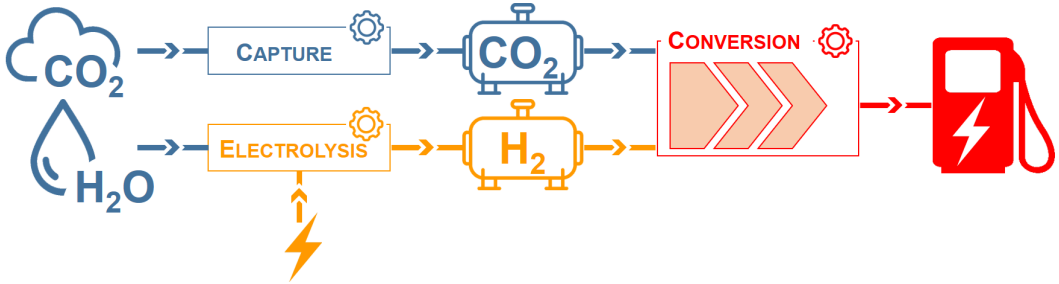
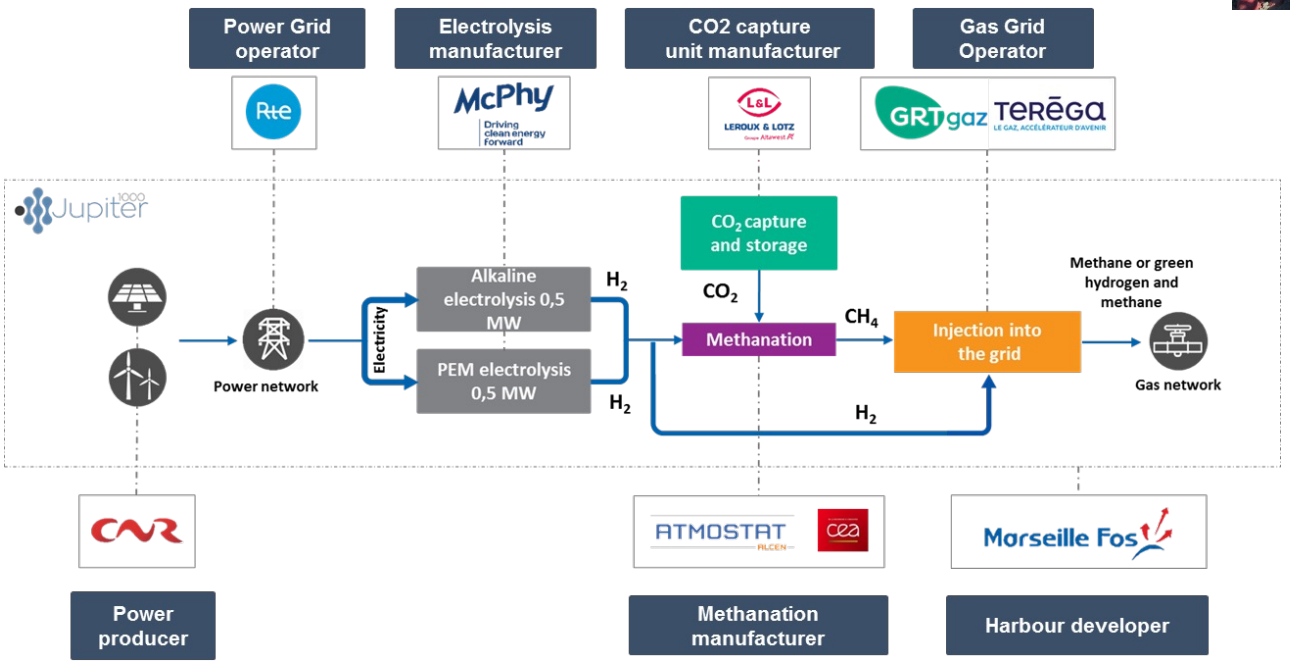
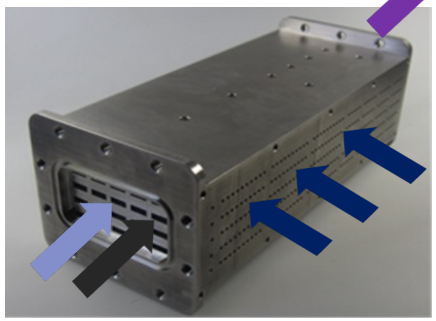


Key figures :

- 500 KWe
  ~ 22 m³/h methane
- Capture 25 Nm³/h CO_2
- Electrolysis : 2x 500 kW
- H_2 -Prod 200 Nm3/h



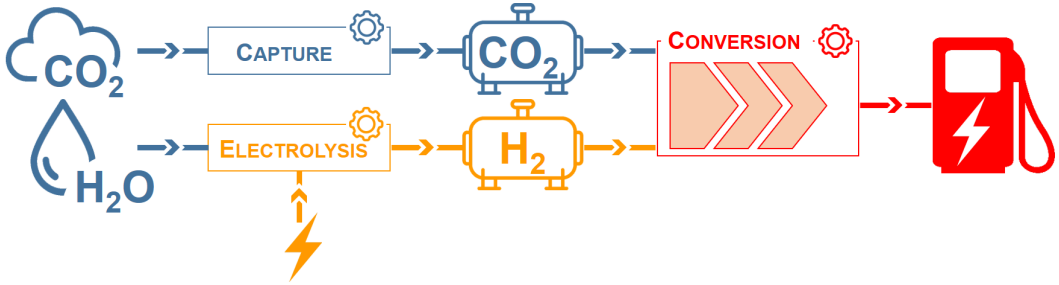
CEA/Khimod methanation unit



Reactive channels: $CO_2 + H_2$

$$4H_2 + CO_2 \rightarrow 2H_2O + CH_4$$

P2L – KerEauZen, Take Kair, etc.

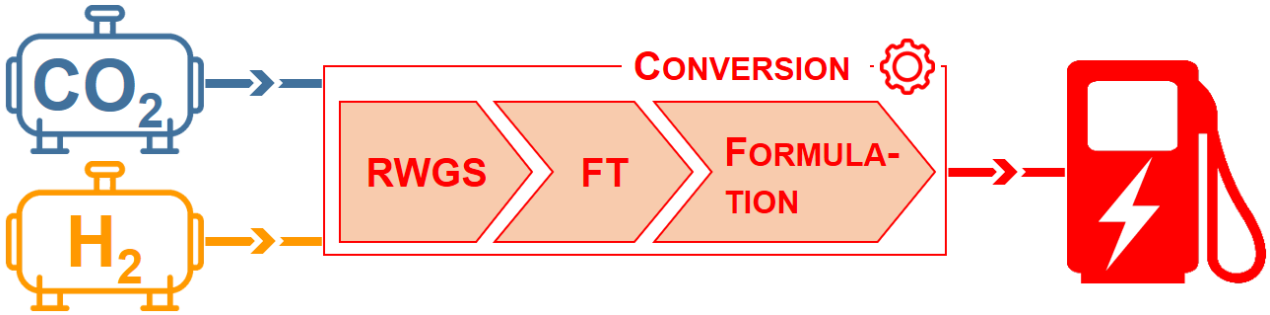


- KerEauZen: e-kerosene from CO_2 and electrolytic H_2

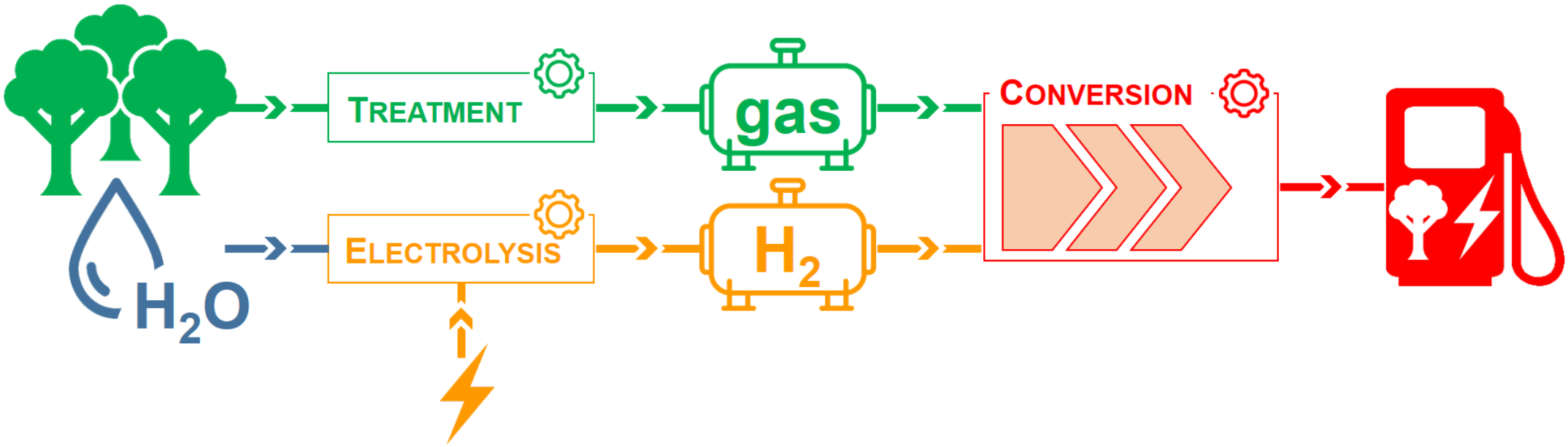
- 70 kt e-kerosene/yr (2028)

- Take Kair: e-kerosene from CO_2 and electrolytic H_2

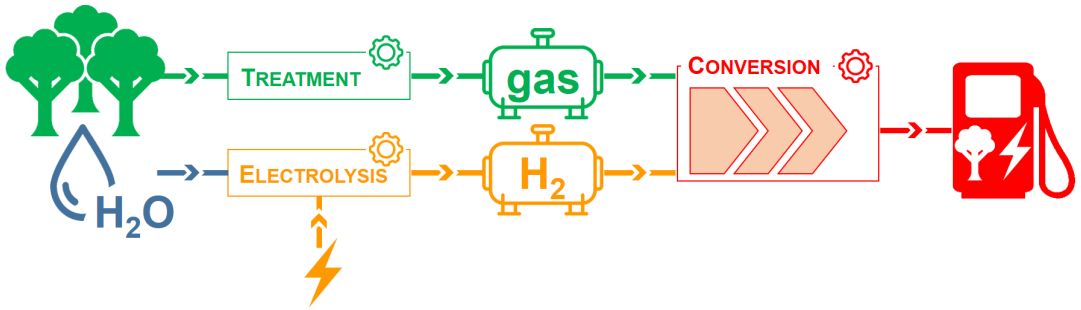
- 35 kt e-kerosene/yr (2029)



PB2X - Metharen



PB2X - Metharen

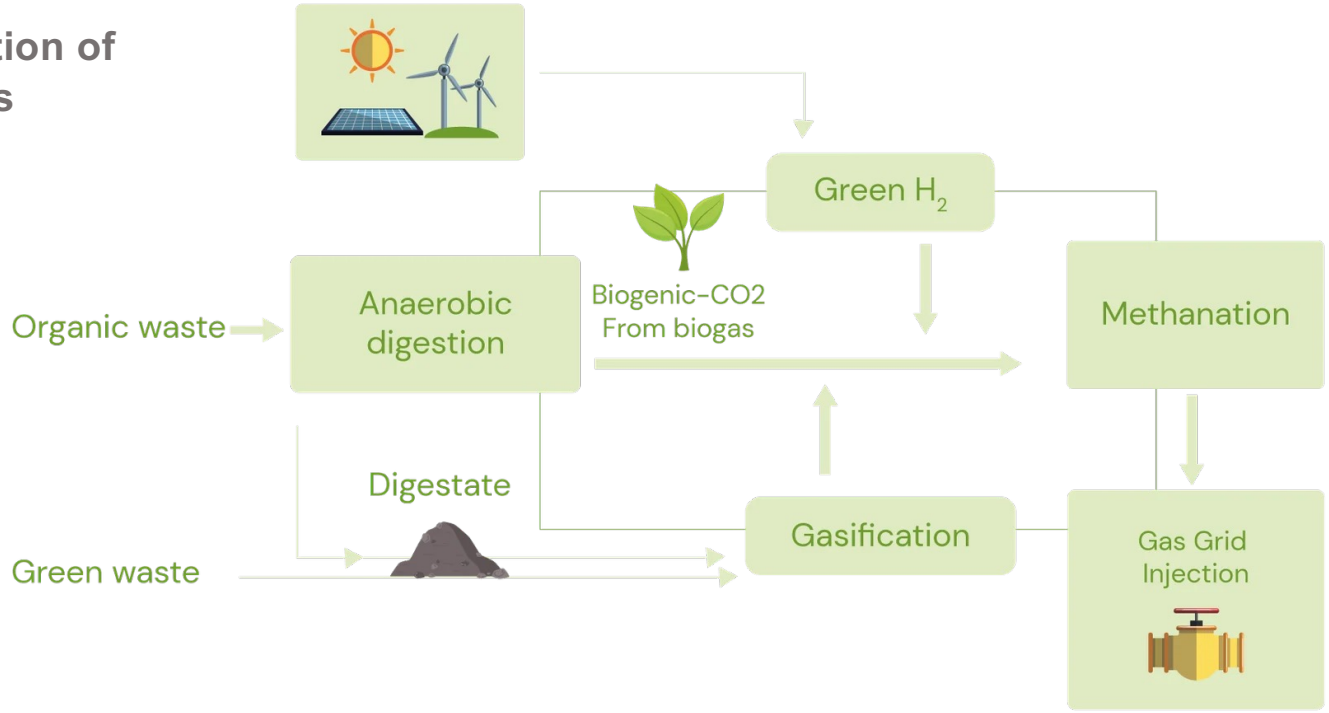


METHAREN

(17 partners, 7 countries)
2022-2027

Co-funded by the European Union

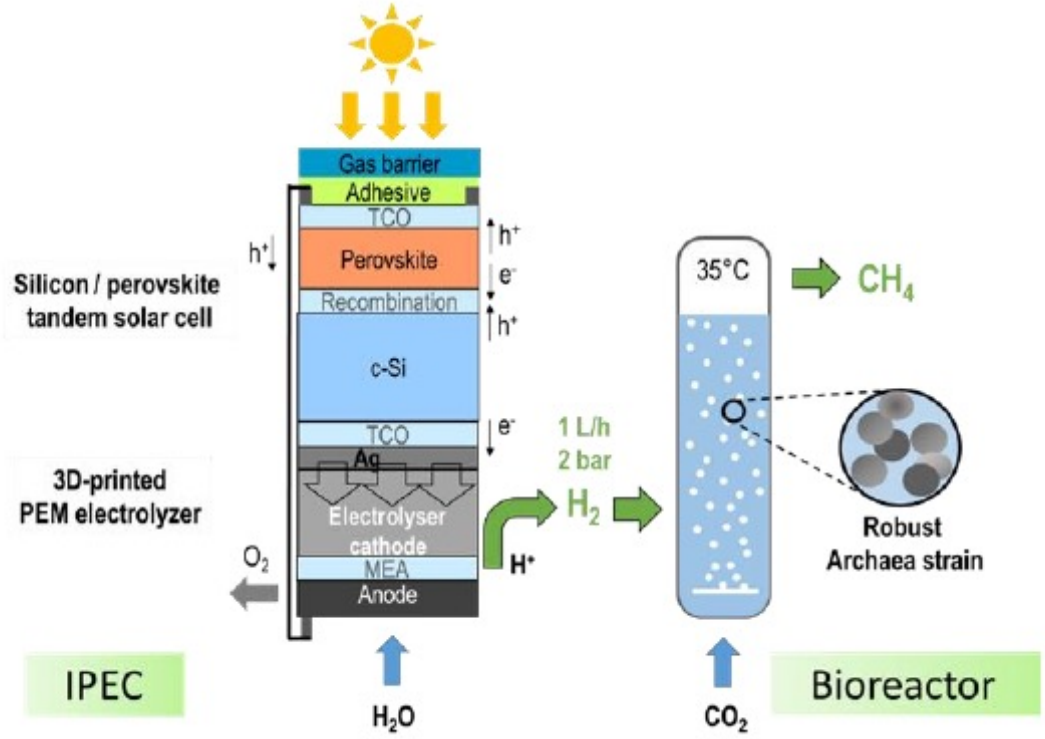
- **Metharen: boosting the production of biomethane from carbon wastes**
- Power and biomass to gas
- Conversion of >80% of carbon
- Detailed presentation by
  G. Geffraye – 3:30 pm
  Power to methane technologies



Disruptive technologies: solar fuels

EIC Horizon Prize 2022
Artificial Photosynthesis:
Fuel from the Sun

EASI Fuel: a CEA demonstrator for the production of solar fuels



About Liten days

Together, let's build our net-zero future

The second Liten Days will be held on March 13th and 14th, 2024 in Grenoble, France.

This major international event is for anyone interested in energy, and not just scientists. More than 350 energy stakeholders representing government agencies, nonprofits, research organizations, educational institutions, and businesses are expected to attend. The event will provide opportunities to share knowledge and insights and network with the broader energy community. Together, we will help speed up the energy transition and lay the foundations for our Net Zero future.

And, because 2024 marks CEA-Liten's 20th anniversary, this edition of Liten Days will include a gala celebration on the evening of March 13th, 2024.

REGISTRATION FEES

(Ex. Tax)

- 2 days: €500 per person
- 1 day: €300 per person
- 20th anniversary Gala: €120 per personn

2 DAYS

March 13 and 14, 2024

MAISON MINATEC

Grenoble, France

EVENTS

Conferences , technological platform visits, startups'pitches, business meeting area...

20TH ANNIVERSARY

Evening party celebration
March 13th 2024

KEY FIGURES

2 days
~ 350 attendees
~ 30 speakers
~ 20 sponsors and partners

TARGETS

CEOs, CTOs, CSOs, experts, scientists, engineers, R&D managers, technology scouts, collaborative research and R&D project managers, business developers, startup founders…

Thank you for your attention

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