REPSOL

Leveraging technology to accelerate the energy transition

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The Repsol Commitment
Net Zero Emissions
by 2050

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REPSOL

01.

Why do we need disruptive

Technologies to support the Energy Transition?

02.

What are our capabilities:

Technology & Corporate Ventures in Repsol

03.

Key examples of disruptive technology developments

- Hydrogen
- Renewable fuels
- Circular chemicals
- Renewable electricity supply 24/7

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01.
Why technology?

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Main challenges to boost the Energy Transition

Extend the limits of what is possible

Improve economics

Improve added value of products

Minimize energy consumption and GHG footprint

Optimize CAPEX holistically along the value chain

Manage renewable resources (quantity, availability and variability)

Make sustainable products available to users

02.

What are Repsol capabilities?

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Repsol Technology and Corporate Ventures

Our internal R&D

233 Experts
of 17 Nationalities

+64 million euros
invested in 2021

Capabilities
in multiple fields such as:

Advanced Mobility
Bio-Energy and Low Emissions
Advanced Mathematics
Geophysics
Process Design

+

Repsol Deep Tech Fund

Endowed with
50 million euros
for investment
in startups

Investment in
20 startups
with disruptive
Technologies

Open Innovation
Our door is open
to innovation in
the Energy Sector

=

9 new patents
families registered
in 2021

We are focused on working on
70 new
Technology Products

We provide more than
180 technology
solutions

+200 alliances
with partners around the world to transform the energy sector

+50,000 m^2 dedicated to innovation around the world
+20 Specialized Laboratories and 35 pilot plants

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03.

Key examples of disruptive tech developments

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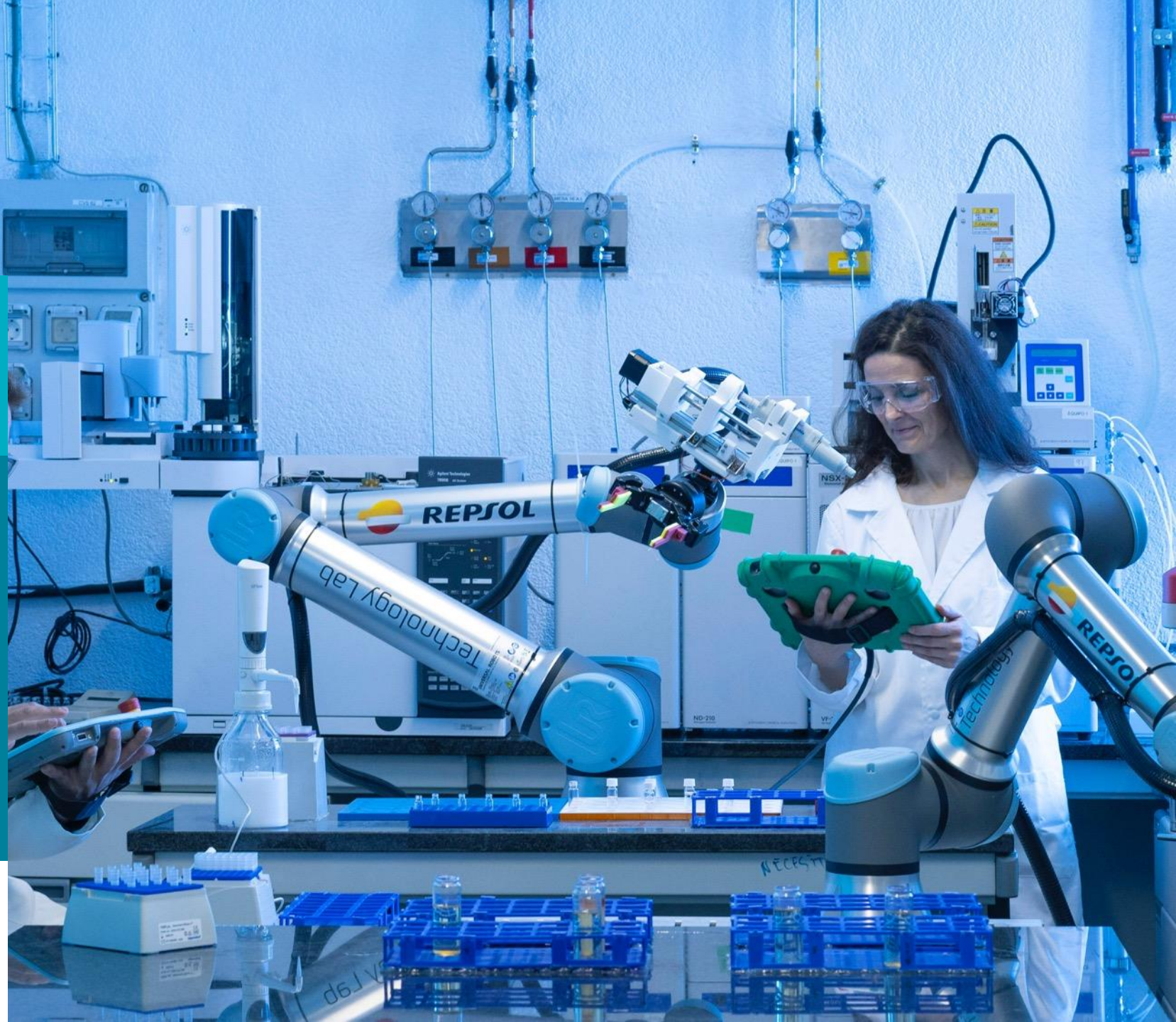
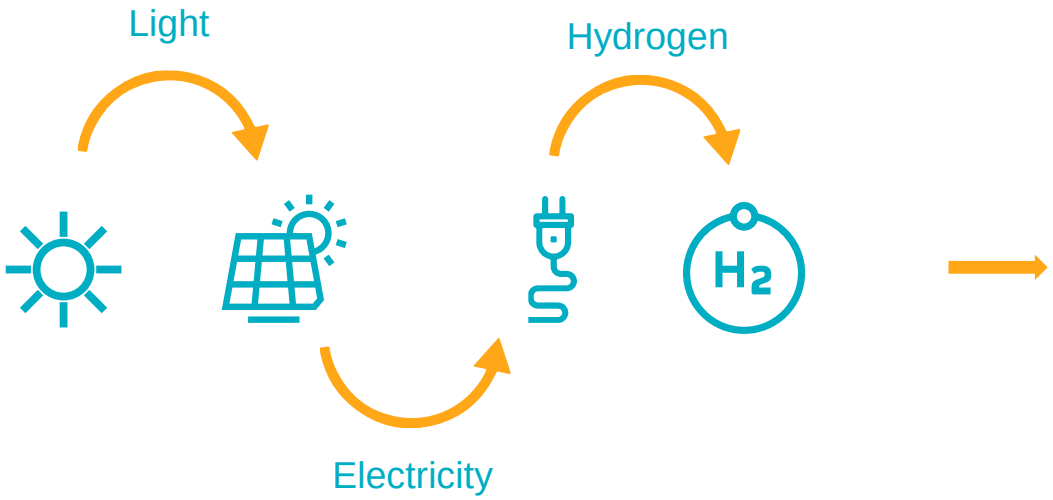


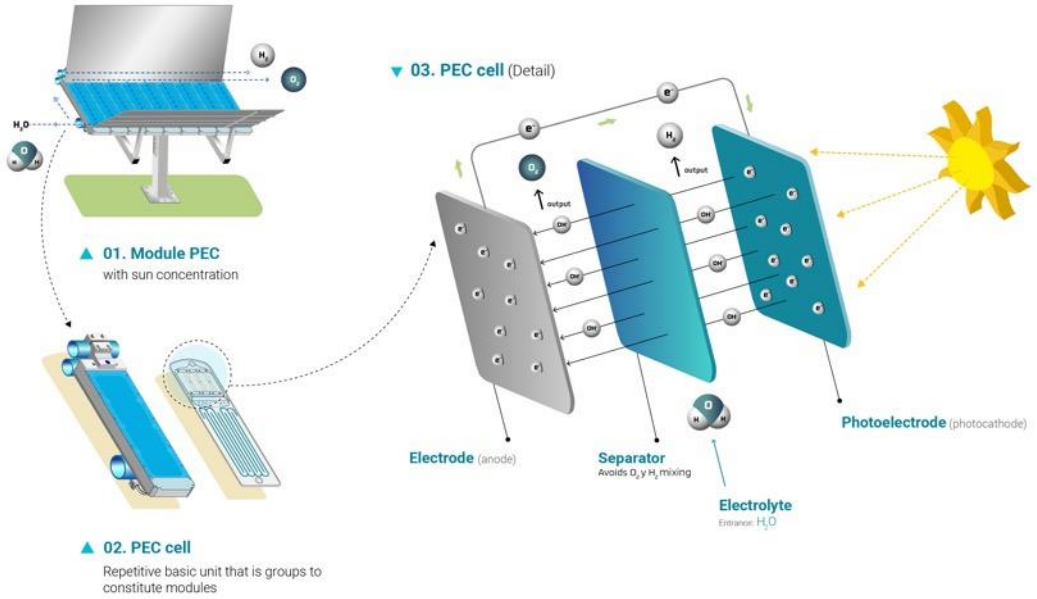
Hydrogen by photoelectrocatalysis

How is electrolytic hydrogen produced?



Challenges for the current scheme:
- Improving overall efficiency.
- Reducing complexity and CAPEX.
- Leading to a reduction of production cost.

Photoelectrocatalysis



- Combines established high-performance PV cell and alkaline electrolyzer technologies into a single panel.
- Proprietary photoelectrode and PEC cell technology.
- No need for rare or scarce materials.

Photoelectrocatalysis. Where are we?

LAB SCALE PROTOTYPE | cm² scale I TRL 1-4 I 2012 - 2018

PILOT PLANT | m² scale I TRL4-6 I 2019 - 2021

DEMO PLANT

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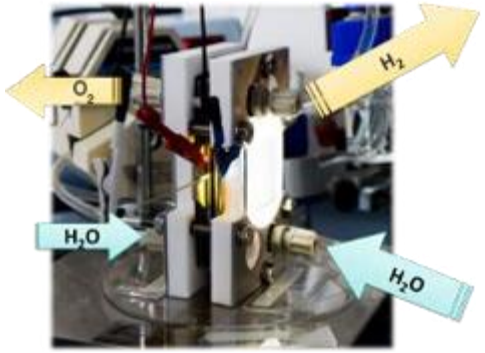

- Proof of concept
- Photoelectrochemical cell design and optimization
- Photoelectrode optimization
- Lab scale validation

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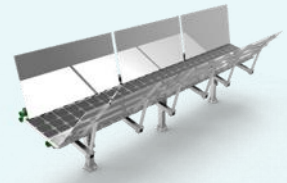
- Optimization and fabrication of pilot plant-size photoelectrodes
- Cell design, construction and validation
- Module design
- Pilot plant design, construction, commission and start-up
- Cost estimation of base materials for next stages

sunrgyze

~1 ha scale TRL 6-9
100kg of H_2 per day
2021 - 2025



- Incorporate learnings from Pilot plant
- Employ industrial manufacturing process
- Pre-commercial validation

€4.5M
Innovation Funds Small Scale

GLOBAL COMMERCIALISATION

2025: MEDIUM SCALE
- Commercial roll out
- Medium size plants

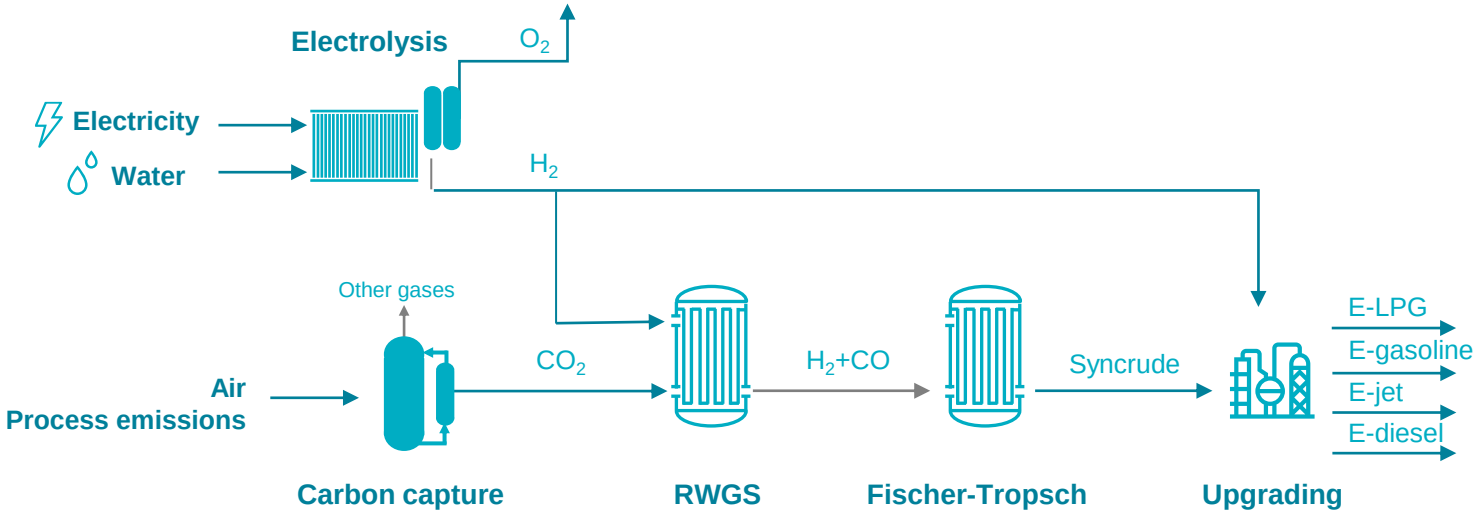
2028: LARGE SCALE
- Commercial roll out
- Large size plants 600 ha scale

Synthetic fuels

Context:

- Demand for renewable liquid drop-in fuels
- Limited biowaste to produce advanced biofuels
- Objectives based on net GHG emissions of marketed fuels

Synfuels through Fischer-Tropsch route

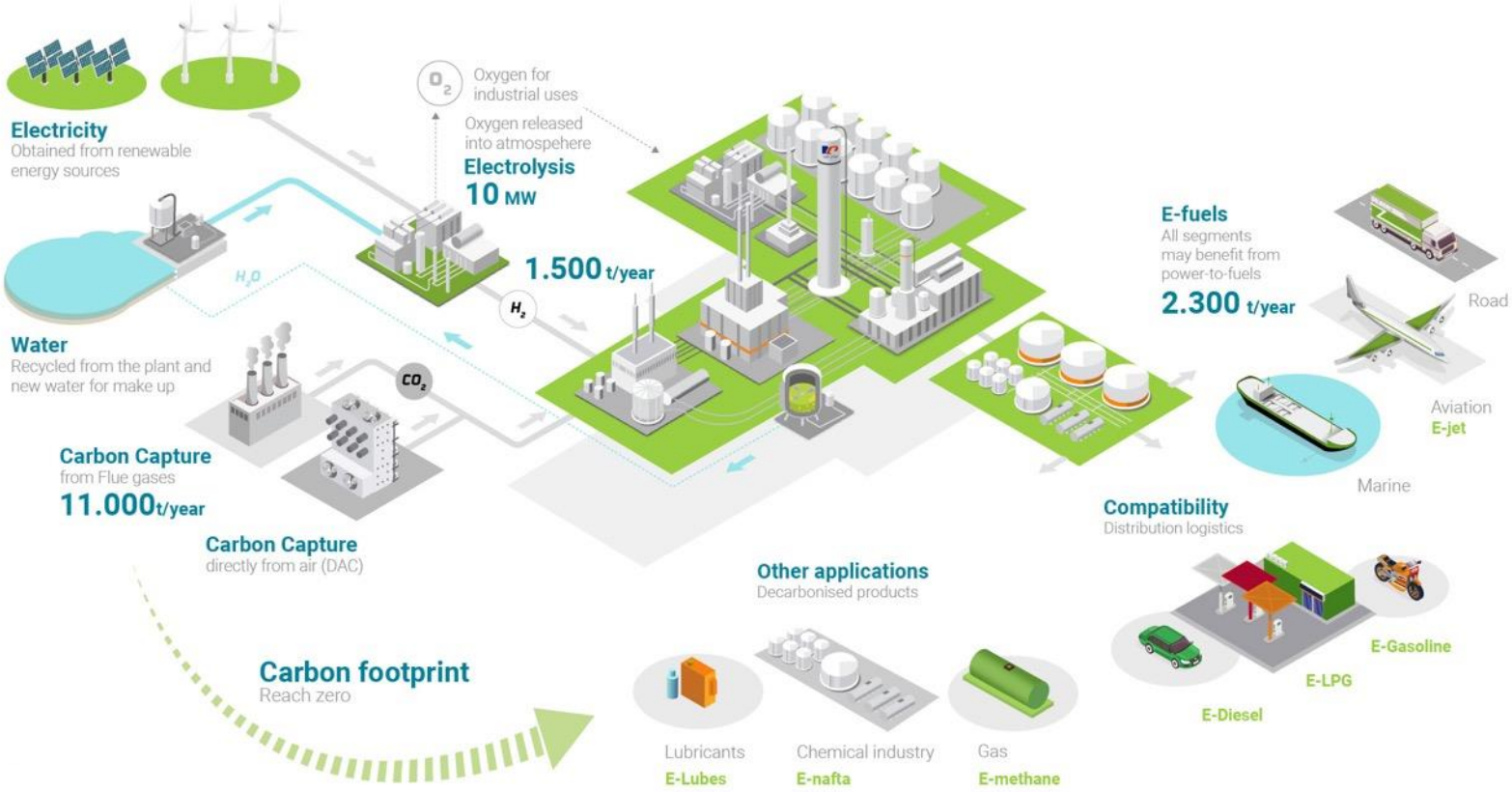


Challenges:

- Scale up RWGS technology.
- Integrate the complete scheme.
- Demonstrate product quality and competitive cost.
- Validate products in real field tests.

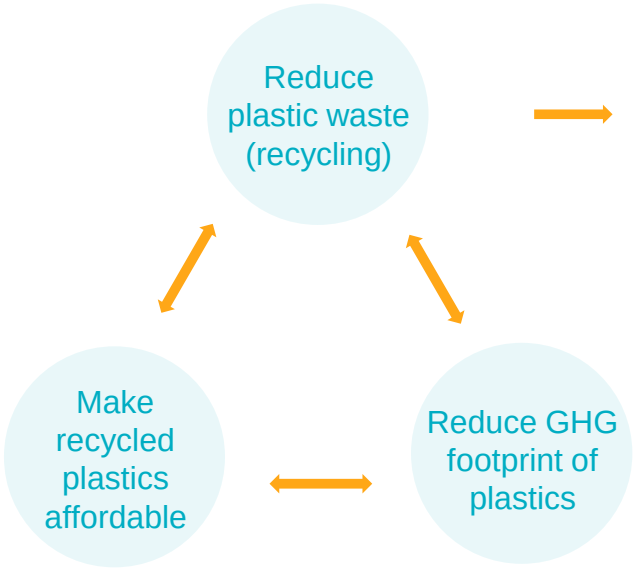
Synfuels. Where are we?

- Partnering with Aramco
- Demo plant in Bilbao with 50 bbl/d capacity (2.3 kt/a)
- Basic engineering on going with FID in early 2023
- Expected start-up date in 2024
- CAPEX €103M



Direct production of circular olefins

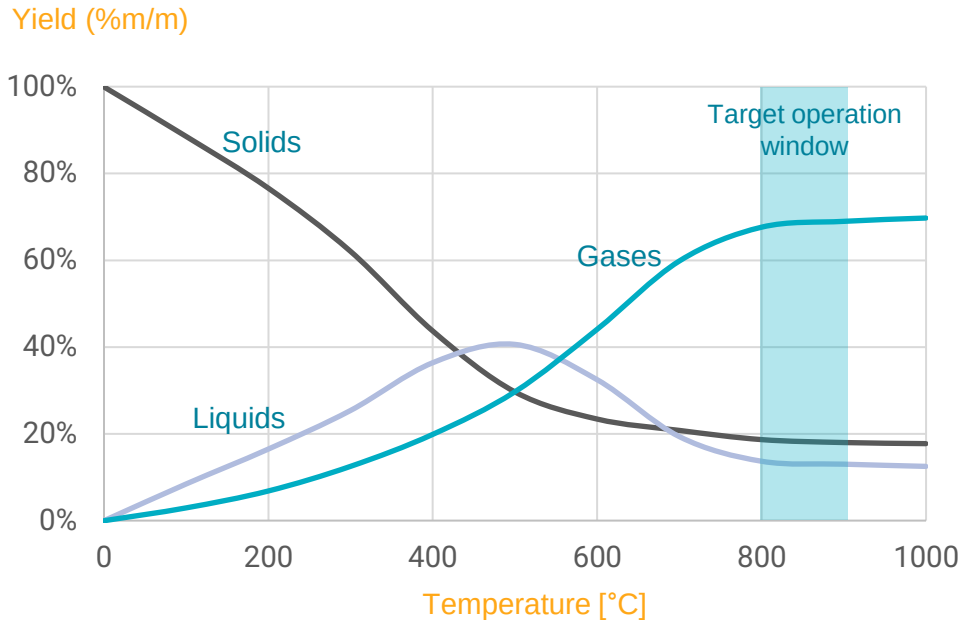
Context in plastics:



Physical recycling of plastics limited by:
- Stringent requirements on sorting of plastic waste (quality of feedstock)
- Penalty on quality of final product

Need for chemical recycling:
- Gasification well suited for big plants
- Pyrolysis suited for smaller plants, but current technology (low temperature) requires upgrading of pyrolysis oil to feed the cracker

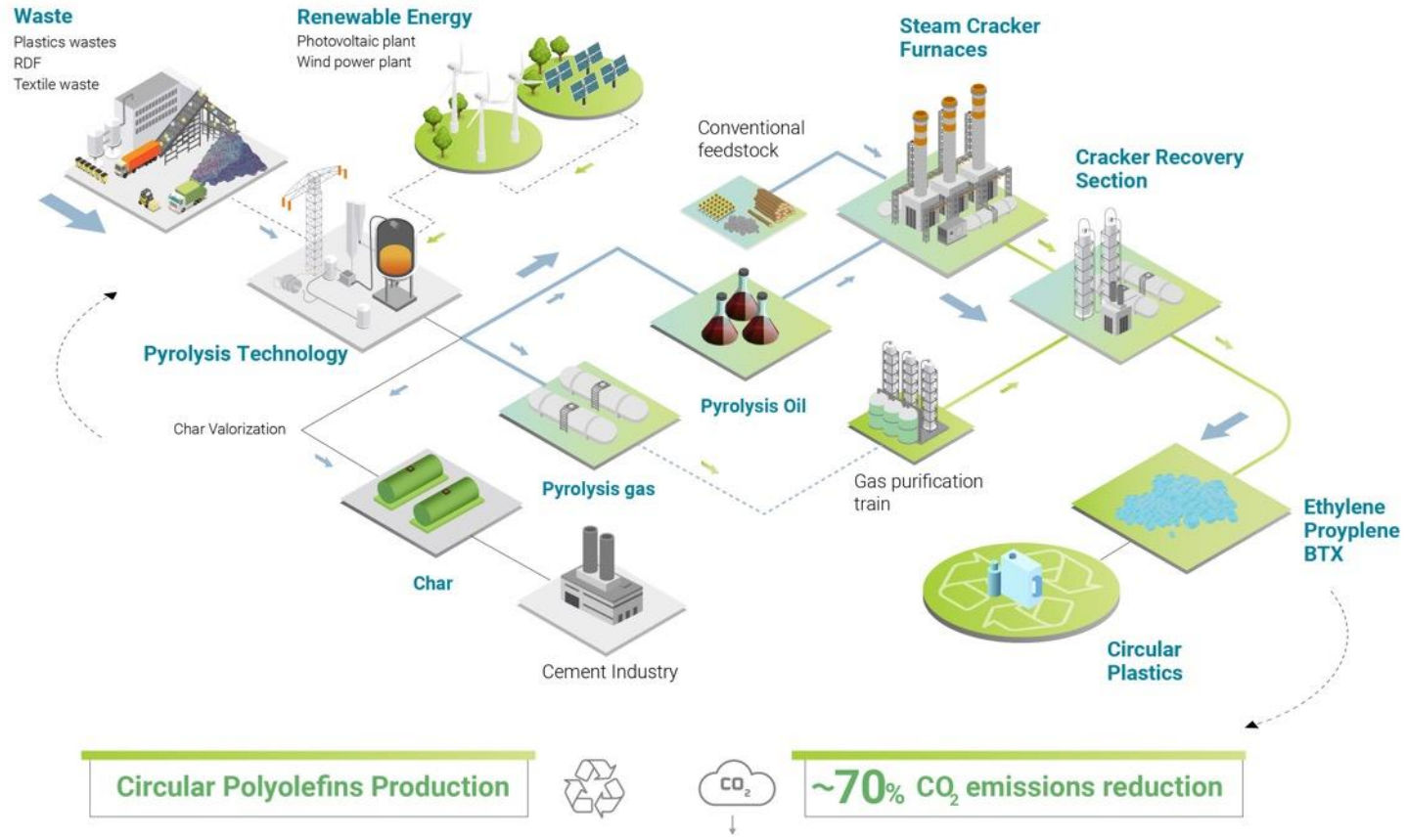
High temperature pyrolysis



- Direct production of ethylene in the gas phase.
- Possibility to use unsorted plastic waste.
- Electrical heating for a fine control of temperature and enabling the decarbonization of energy supply.
- Modular technology adaptable to plastic waste availability.

Plastics2Olefins project

- Horizon Europe call granted
- Core partners ETIA and Técnicas Reunidas
- Extended international consortium*
- Pilot plant commissioned in 2023 in Tech Lab
- Demo plant (8 kt/a) planned for 2027 in one of our petrochemical sites
- Budget 33 M€



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* CESPA, VTT, CIEMAT, DTU, SIN, LafargeHolcim, SCG Chemicals, UCLM

Supply of renewable electricity 24/7

Emerging requirements from legislation:

The proposed European delegated regulation for electrolytic hydrogen establishes strict requirements for renewable electricity supply from remote plants:

- Dedicated newly built plants (additionality).
- Electricity generation and electrolyzer+storage in the same bidding zone (with some exceptions).
- Energy balance of production, storage and consumption of electricity in 1 h periods from 2027.

Requirements under revision within the context of the Renewable Energy Directive update.

EUROPEAN COMMISSION

Brussels, XXX
[…](2022) XXX draft

COMMISSION DELEGATED REGULATION (EU) …/...

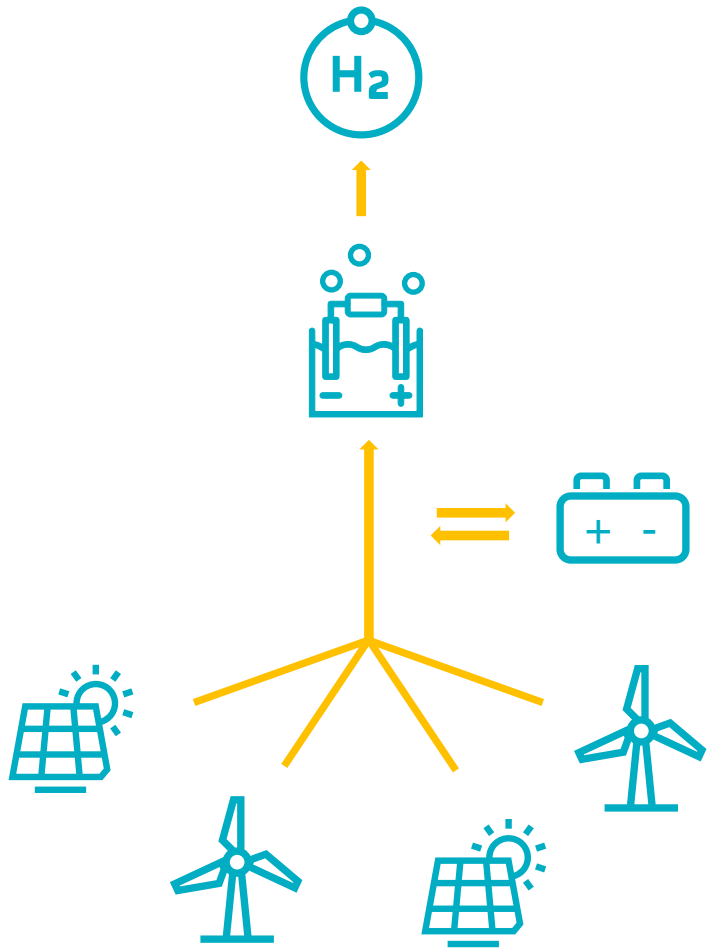
of XXX

supplementing Directive (EU) 2018/2001 of the European Parliament and of the Council by establishing a Union methodology setting out detailed rules for the production of renewable liquid and gaseous transport fuels of non-biological origin

Supply of renewable electricity 24/7

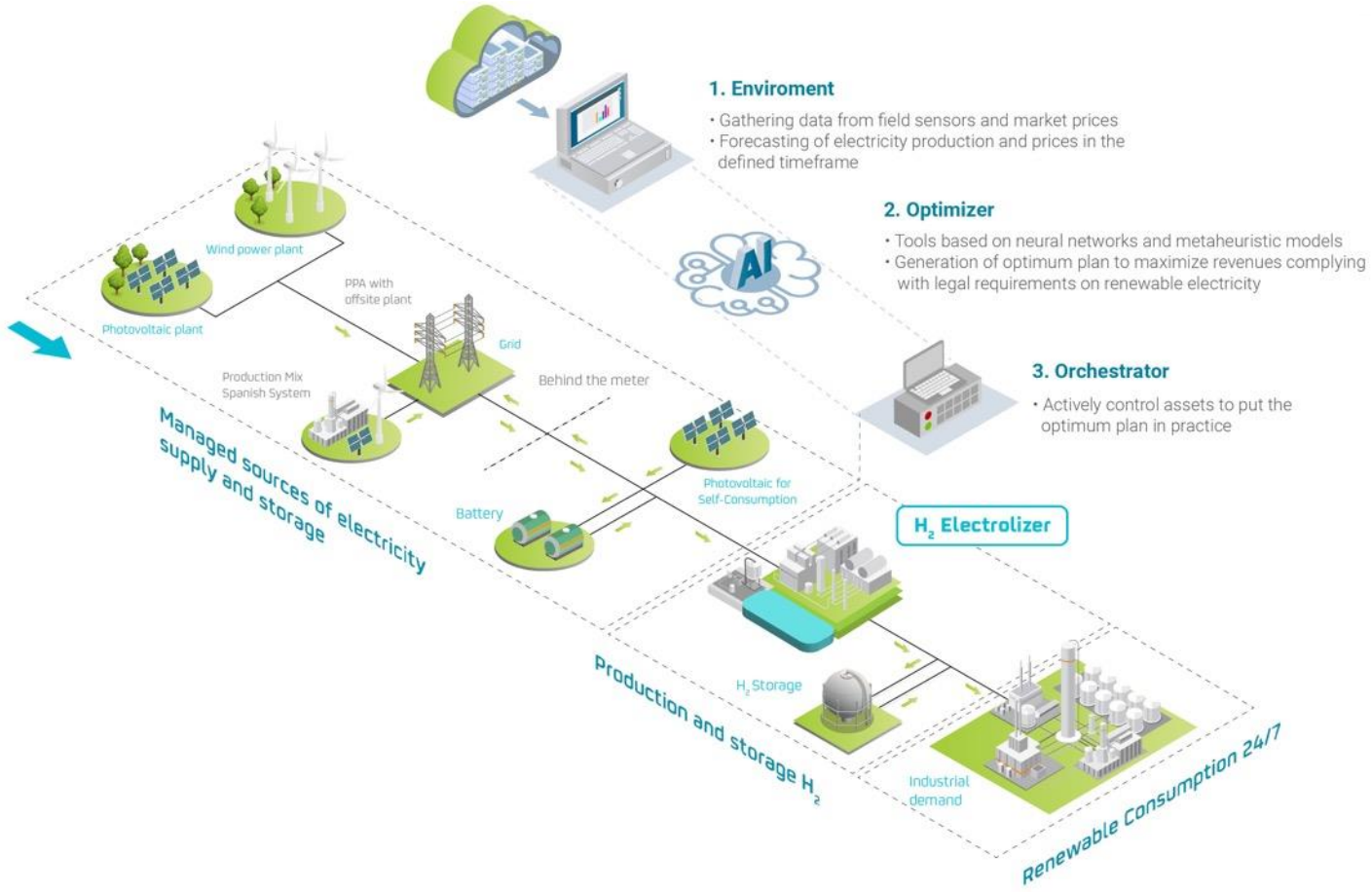
Boundary conditions of the problem:

- Industrial processes (e.g., RFNBO) need to operate 24/7.
- Wind and solar PV production is not firm and cannot be forecasted with total accuracy.
- To use the electrical grid to exchange electricity, a production-consumption plan must be submitted 24-48 h in advance to identify and eliminate restrictions (bottlenecks).
- To satisfy the 1 h energy balance condition, accurate short-term forecast of electrical production is required accounting for local conditions at the plant (e.g., clouds, gusts of wind).
- Storage of electricity introduces flexibility (buffering) but comes at a high investment cost.
- Excess electrical production can be sold to third parties.



H2 Opera project

- Internal development based on modelling and optimization expertise
- Flexible algorithms to cover different balance periods (from 3 months to 1 hour)
- Automated system designed to maximize economic revenues while ensuring legal and technical requirements
- Deployment synchronized with electrolyzers commissioning:
  - MVP by end of 2022
  - Fully operational by end of 2024
  - Optimized in real operation by 2027



The role of technology in Repsol´s approach to Energy Transition

Technology is key to boost the energy transition and reach decarbonization

Repsol is at the forefront of technology tackling the biggest challenges

Combining internal expertise and partnerships with the best

Developing world-scale projects to mature the technology and quickly reach the final user

Maintaining technology neutrality and pursuing different alternatives to minimize risks and adapt to different situations

ESG Day

October 4th, 2022

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