CDTI-NEDO online Joint Workshop on Hydrogen Technology
- Green Hydrogen Production & Mobility -

SUN2HY Project: ***From sunlight to green hydrogen***

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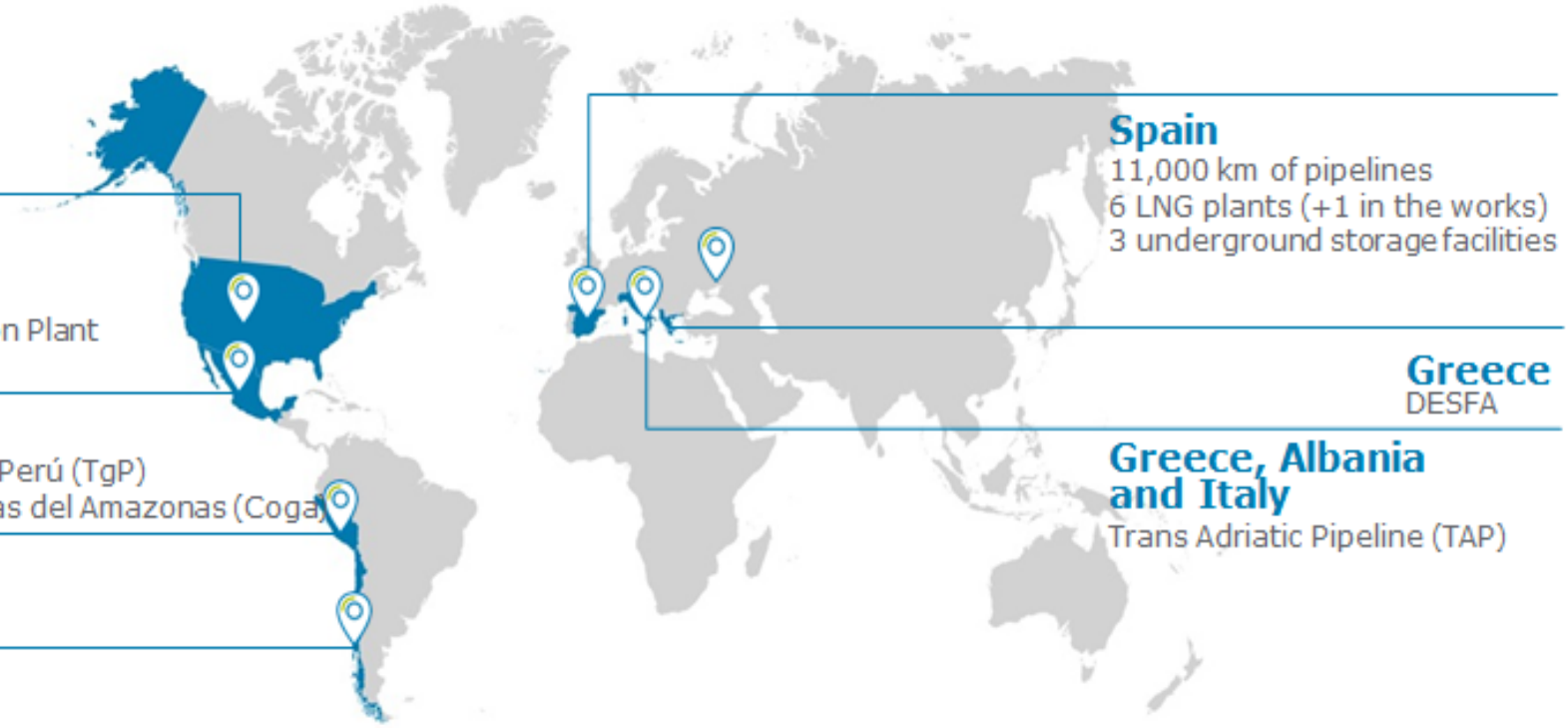
NEDO

AeH2 ASOCIACIÓN ESPAÑOLA DEL HIDRÓGENO

ENAGAS: Leader in natural gas infrastructure

ENAGAS: Presence in 8 countries



USA
Tallgrass Energy

Mexico
TLA Altamira plant
Soto La Marina Compression Plant
Morelos Gas Pipeline

Peru
Transportadora de Gas del Perú (TgP)
Compañía Operadora de Gas del Amazonas (Coga)

Chile
Quintero LNG Plant

Spain
11,000 km of pipelines
6 LNG plants (+1 in the works)
3 underground storage facilities

Greece
DESFA

Greece, Albania and Italy
Trans Adriatic Pipeline (TAP)

What we do — Storage · LNG · Transport

ENAGAS: Renewable gases

Renewable gases

For technology neutrality

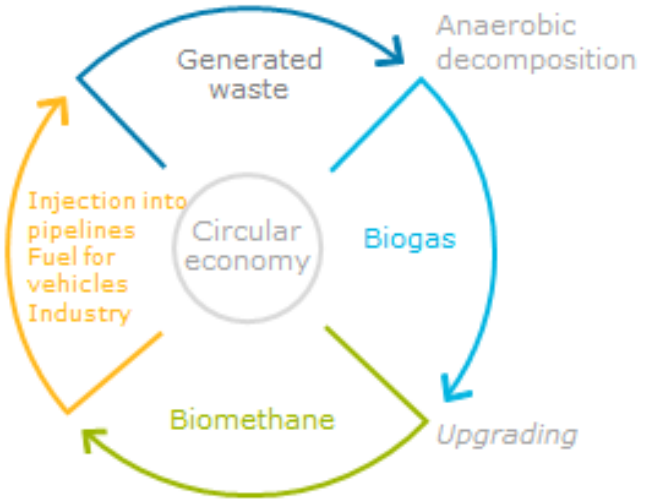
Hydrogen

Electricity from renewable sources

H2

- Mobility
- Power generation
- Industry
- Tertiary/household use

Biomethane



enagas renovable

They allow **decarbonization** of sectors where electrification is not an option.

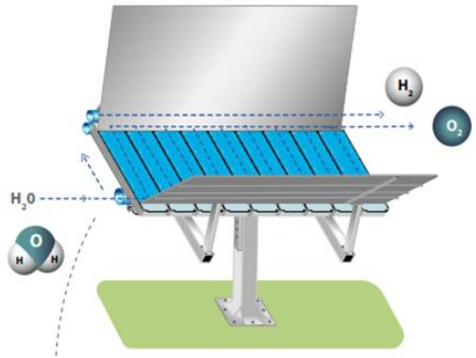
The **use of existing gas infrastructures** is essential to make progress at the lowest cost.

ENAGAS: Commitment towards green hydrogen

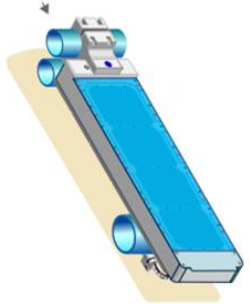
SUN2HY Project: Technology Overview

Direct conversion of the sun's energy into chemical energy (H_2)

- Photoelectrocatalytic (PEC) technology uses solar energy to dissociate water into hydrogen and oxygen, at ambient pressure and temperature
- It involves a single step in a single device, which improves the efficiency of the process
- It combines established high-performance Interdigitated Back Contact (IBC) photovoltaic cell and alkaline electrolyser technologies into a single panel

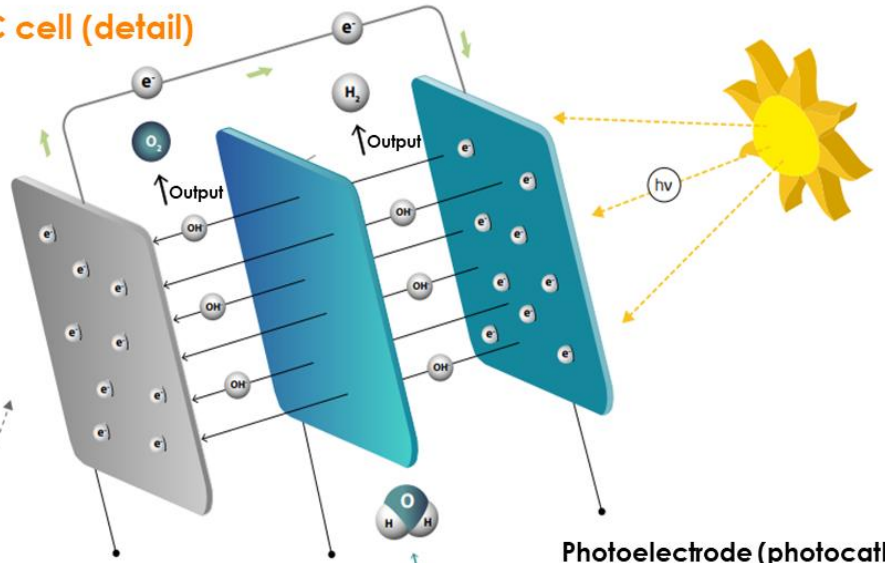


PEC module



PEC cell
A single unit that is repeated in series to form a module

PEC cell (detail)



Electrode (anode)
H^+ is used to produce O_2

$2OH^- > ½O^2 + H_2O + 2e^-$

Separator
Prevents mixing of O_2 and H_2

Electrode
H_2O input

Photoelectrode (photocathode)
Converts photons to electrons that are used to produce H_2

$2H_2O + 2e^- > H_2 + 2OH^-$

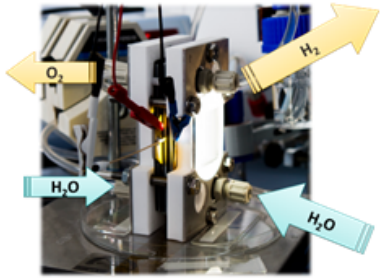
SUN2HY Project: Main Challenges

SUN2HY

1	**Bias-free operation**	Photoelectrocatalysis (PEC) enables the direct conversion of the sun's energy into chemical energy (H_2)
2	**High efficiency**	Twice as efficient (>20% STH),
3	**Stability**	>3,000 hours of operation, 100L/hr/m2 hydrogen produced, 99.995% purity
5	**Lower cost hydrogen than separate PV panels and electrolyser**	Integration of solar energy collection and water electrolysis into a single and modular device
6	**Easily industrialization**	Can be manufactured by adapting existing solar cell manufacturing lines.
6	**Scale-up and commercialization**	TRL6 achieved successfully

SUN2HY Project: Pilot plan phase objectives

cm^2 scale



TRL 1- 4

cm^2-scale bias free cell

Already achieved:

- ✓ Photoelectrochemical cell prototype
- ✓ High current density photoelectrodes
- ✓ Bias free operation
- ✓ Photoelectrode with more than 100h operation
- ✓ Faradaic efficiency: >95% (H_2)
- ✓ Preliminar techno-economic analyses

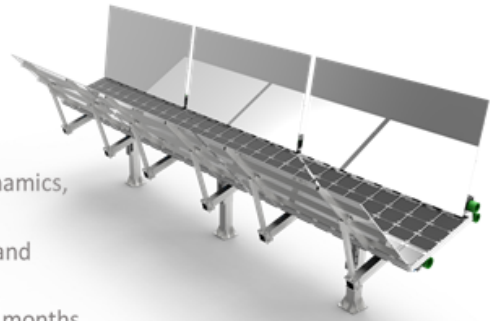
m^2 scale

TRL 4 - 6

m^2-scale plant

Goals:

- ➢ Photoelectrode optimization
- ➢ System simulation and modeling (fluid-dynamics, temperature, mechanics…)
- ➢ Optics management, prototyping, scaling and testing under real environment.
- ➢ Pilot plant control strategies. Operation: 6 months
- ➢ Techno-economic analysis



Moving from TRL 4 to TRL 6

Si-based high efficiency photoelectrodes in an **optimized integrated system**, paving the road to plausible and cost-effective scaling up

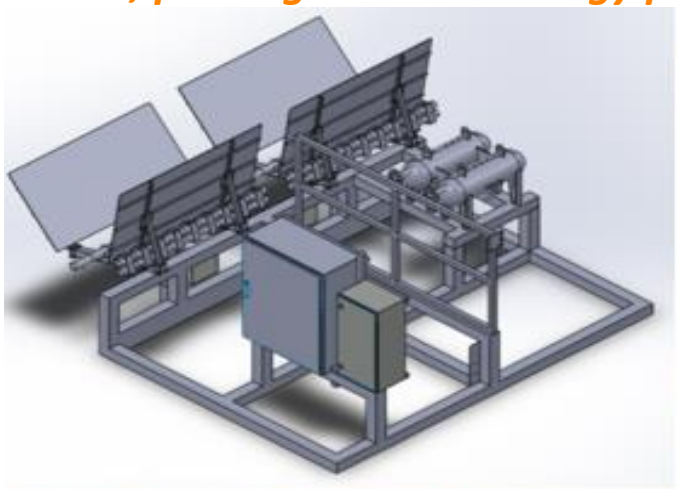
SUN2HY Project: Pilot Plant

Commissioned in November 2020, proving core technology performance

3
SUNRGYZE MODULES

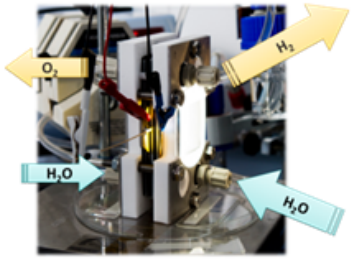
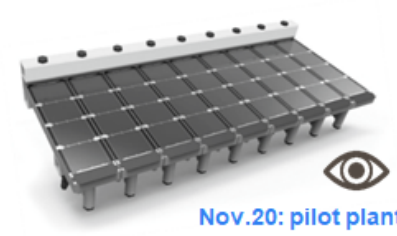
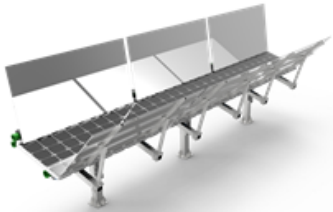
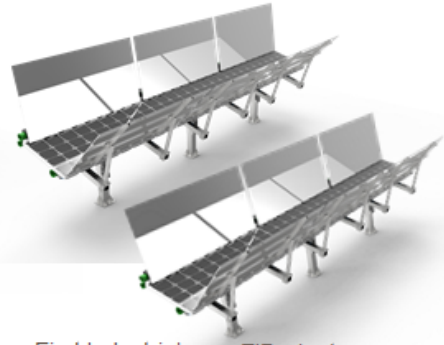
100 L/ hr/m²
HYDROGEN PRODUCTION

>3000 hr
OPERATION



3 PATENT FAMILIES PROTECT: 60+ APPLICATIONS IN 30 COUNTRIES

SUN2HY Project: Roadmap

LAB SCALE PROTOTYPE	PILOT PLANT	DEMO PLANT	FID PLANT	FULL SCALE DEPLOYMENT
cm^2 scale **TRL 1-4**	m^2 scale **TRL 4-6**	0,5 ha scale **TRL 6-8**	60 ha scale **TRL 8-9**	600 ha scale **TRL 9**
2012-2018	**2019 -2021**	**2021-2025**	**2025-2028**	**2028 onwards**
				
TRANSFORMACO2 + LUXHOR projects. Proof of concept. Photoelectrochemical cell design and optimization. Photoelectrode optimization. Lab scale validation	Optimization and fabrication of pilot plant-size photoelectrodes. Cell design, construction and validation. Module and pilot plant design	**Nov.20: pilot plant commissioning and bring into operation** **Pilot plant** design, construction, commission and start-up: base materials for next stages costs estimation	DEMO plant design and construction DEMO plant commissioning Pre-commercial validation	First Industrial Deployment (FID) plant design and permitting. FID plant construction and pre-commercial validation	Industrial plants Business case

Possibilities for a Japan – Spain collaboration

sunrgyze

REPSOL enagas

- Sunrgyze was created on April 2021 and is owned equally by Repsol (50%) and Enagas (50%)
- Sunrgyze is raising new equity to fund the investment plan for 2022-2025
- A new shareholders' agreement will be put in place to accommodate incoming investors in this round
- Exploring collaboration with:
  - Solar cells (IBC- Interdigitated Back Conctac Cells) manufacturers
  - Engineering companies
  - Industrial companies
- Potential Client

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