European Hydrogen Week

BioRoburPlus

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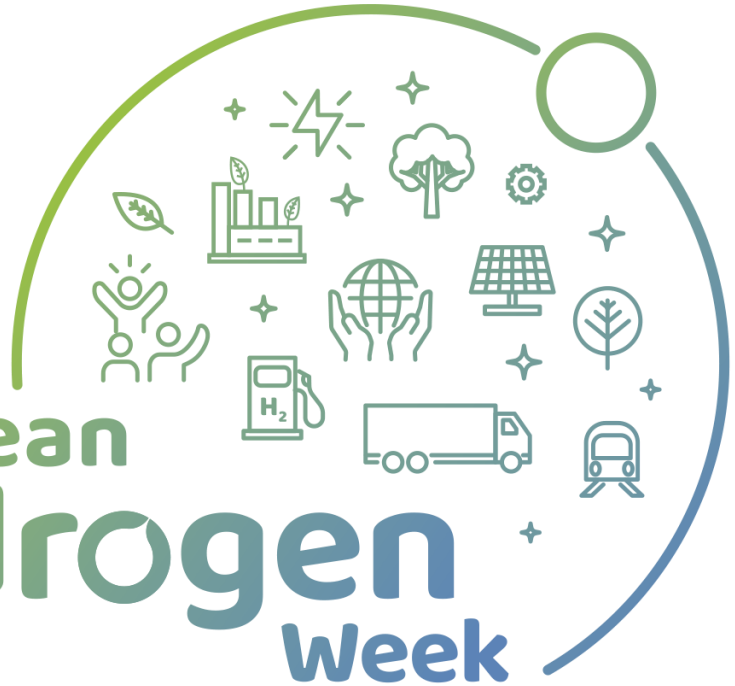
BioRoburPlus

Advanced direct biogas fuel processor for robust and cost-effective decentralized hydrogen production



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#PRD2021
#CleanHydrogen

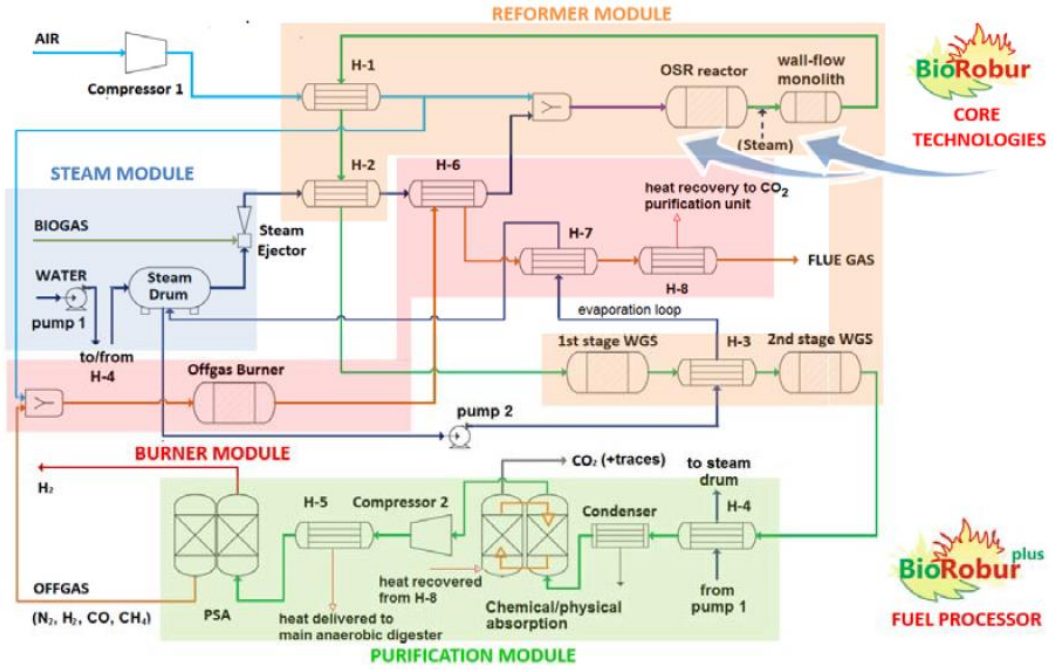
European Commission

Project Overview

- Call year: 2016
- Call topic: H2020-JTI-FCH-2016-1 - FCH-02-2-2016 - Development of compact reformers for distributed bio-hydrogen production
- Project dates: 01/07/2017– end date
- % stage of implementation 30/11/2021: 100 %
- Total project budget: 3.813.536 €
- FCH JU max. contribution: 3.813.536 €
- Partners: POLITECNICO DI TORINO, KARLSRUHER INSTITUT, SCUOLA UNIVERSITARIA PROFESSIONALE DELLA SVIZZERA ITALIANA, CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE, ETHNIKO KENTRO EREVNAS, DBI – GASTECHNOLOGISCHES INSTITUT, ENGICER SA, HYSYTECH SRL, UAB MODERNIOS ETECHNOLOGIJOS, ACEA PINEROLESE, JOHNSON MATTHEY PLC.

Objectives

- Design and manufacturing of an integrated processor consisting of:
  - REFORMER module
  - Purification module
  - Off-gas burner module
  - Steam module
- Cost-effective GREEN H2 production
- Minimization of the different environmental category impacts assessed through LCA



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Example And Explanation of Project Progress/Actions – Catalyst performance

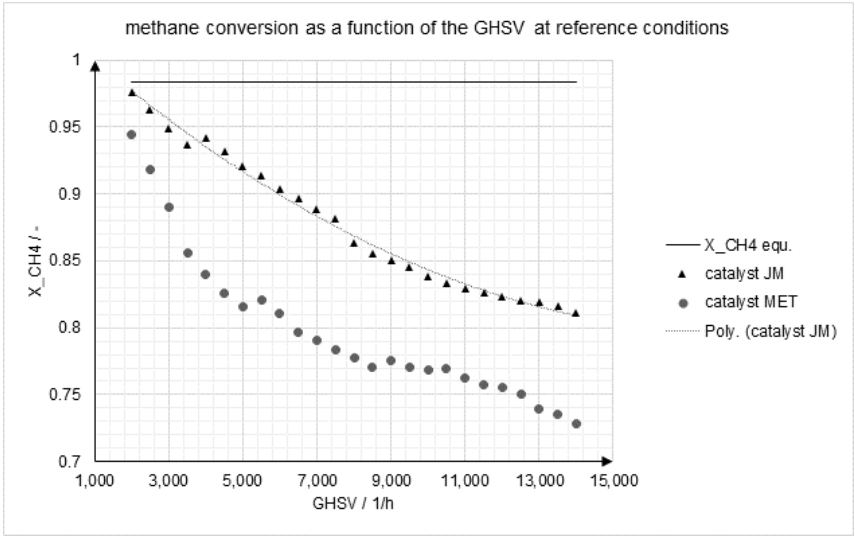
Achievement to-date

>98% of conversion

92% of conversion

25% 50% 75%

Status at month 54of a 54 months project at date 30/11/2021



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Example And Explanation of Project Progress/Actions - Prototype productivity

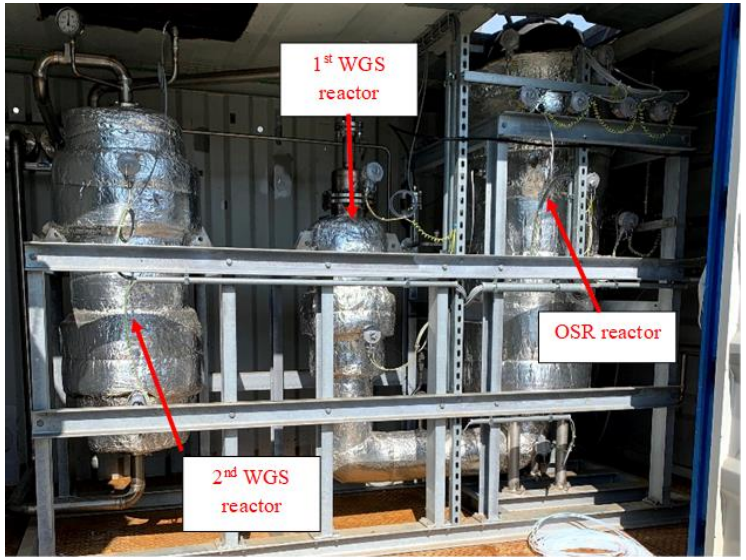
Achievement to-date

30 $Nm^3/H_2/h$
99.9 % purity

25% 50% 75%

30 $Nm^3/H_2/h$
99.9 % purity

Status at month 54of a 54 months project at date 30/11/2021



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Risks, Challenges and Lessons Learned

Exploitation Result from Table 1	Type of risk	Description of risk. Severity?	Mitigation strategy	Who is responsible	Outcome: Risk contained? Yes/No
1	Performance not improved compared to state of the art porous ceramics	Medium	Re-design	SUPSI	Yes
2	Catalyst is too expensive	Medium	Additional catalyst development to reduce PGM loading if necessary	JM	Yes
2	Catalyst does not meet customer requirements	Low	Additional catalyst development based on customer requirements	JM	Yes
2	No (biogas reforming) market for catalyst	Medium	Look for alternative markets for catalyst	JM	Yes
3	Performance not improved compared to the state of the art	Medium	Evaluation of further adsorbent materials and/or better design of heat integration.	HST POLITO	Yes
4	Non-competitive production costs within the EU market of H_2.	Medium	Evaluation of varying the process parameters according to the sensitivity analysis of costs.	HST	Yes

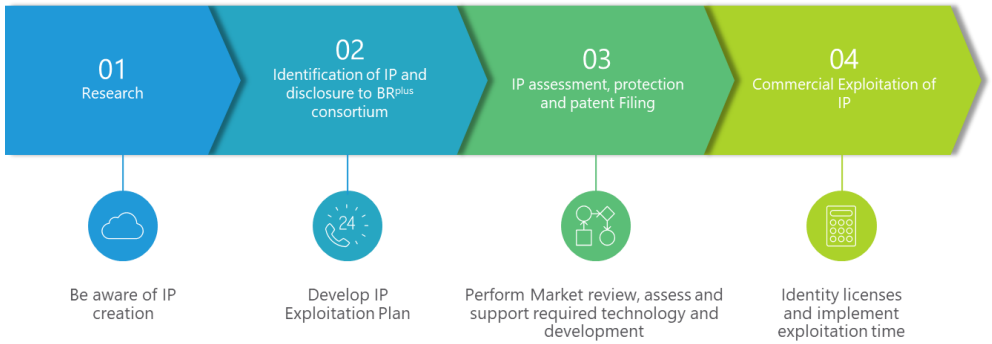
Exploitation Plan/Expected Impact

Exploitation

The Exploitation Plan (EP), included in the PUEF, will be designed to multiply the impact of the proposed solutions and prepare the transition towards industrial and commercial uptake to fully achieve the expected impact.

Exploitable results:

- Ceramic media with continuous porosity gradient
- Reforming catalyst stable under biogas reforming conditions
- Cost-effective and efficient PSA technology for hydrogen purification

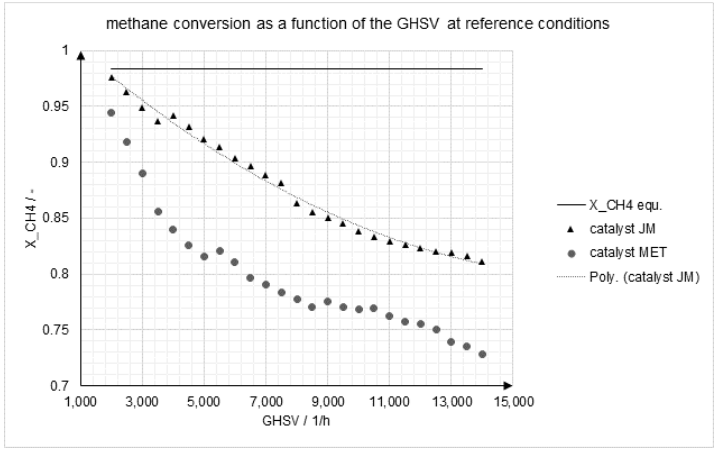


Impact

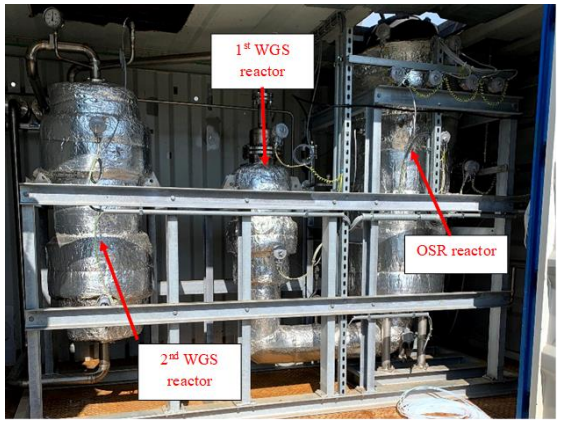
- New sales
- More sustainable process
- Higher revenues

Catalyst development

- From lab scale



- To pilot scale



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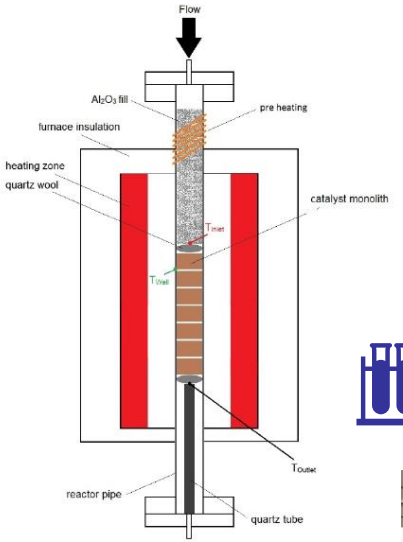
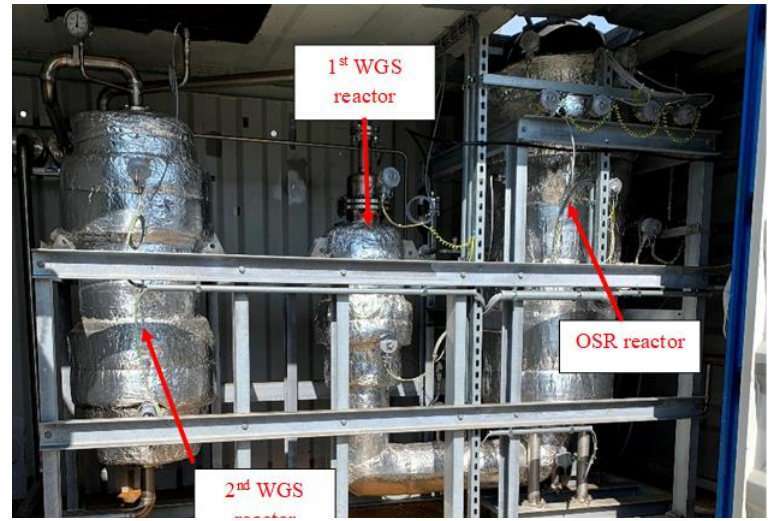
Scale up - Design

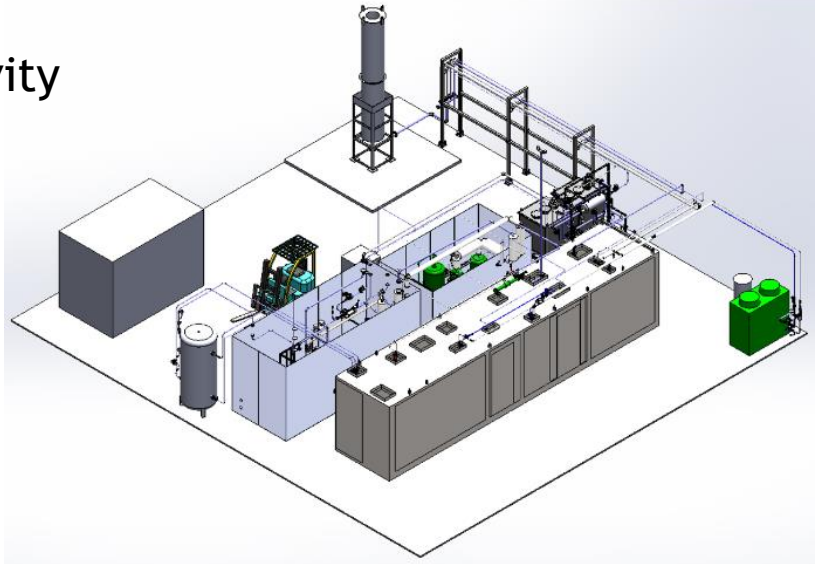


Scale up



Lab scale H_2 productivity 0.5 m^3/h

Prototype
Pure H_2 productivity
50 m^3/h



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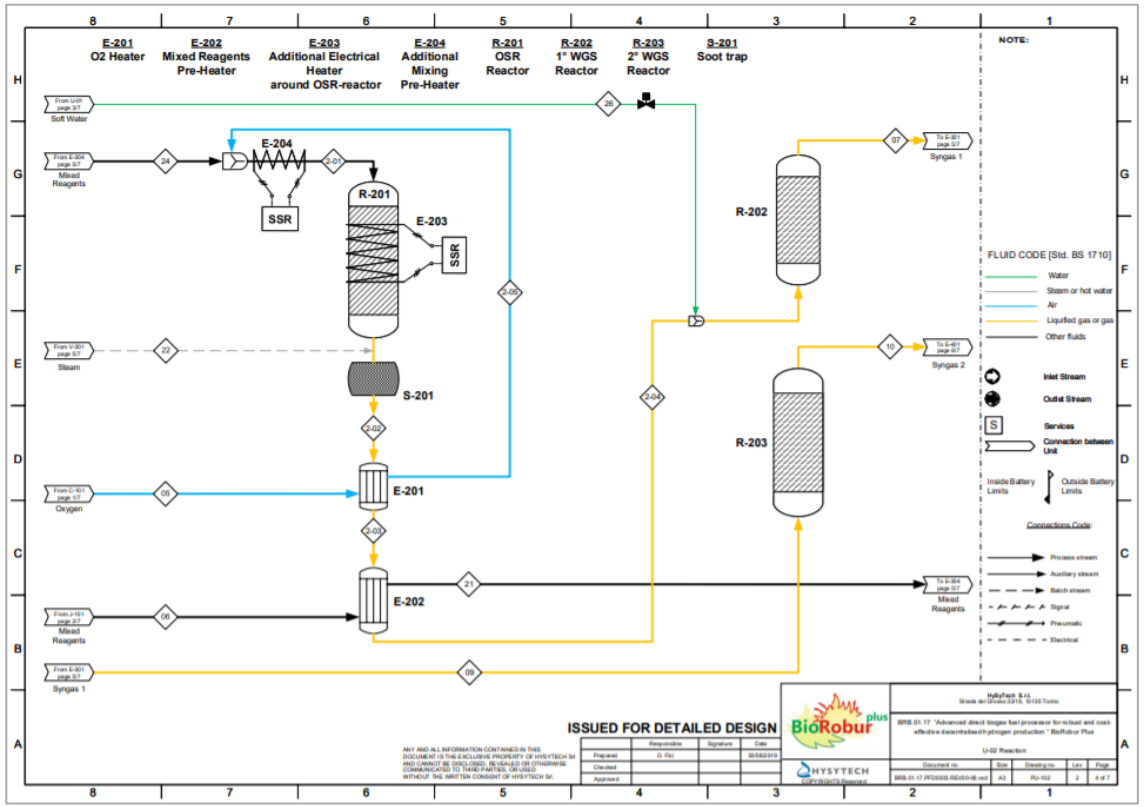
Design and Manufacturing

Feeding Section



Water Softening System

Sulphur removal

Air buffer

Air compressor

Oxygen Generator

Steam ejector

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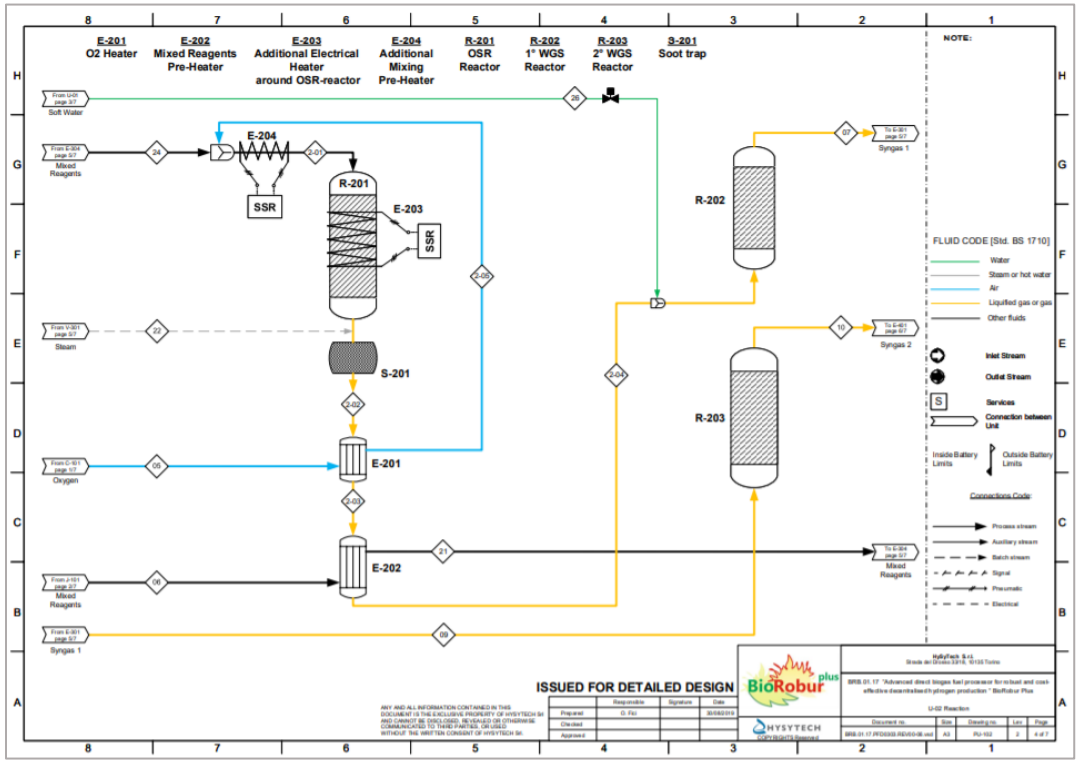
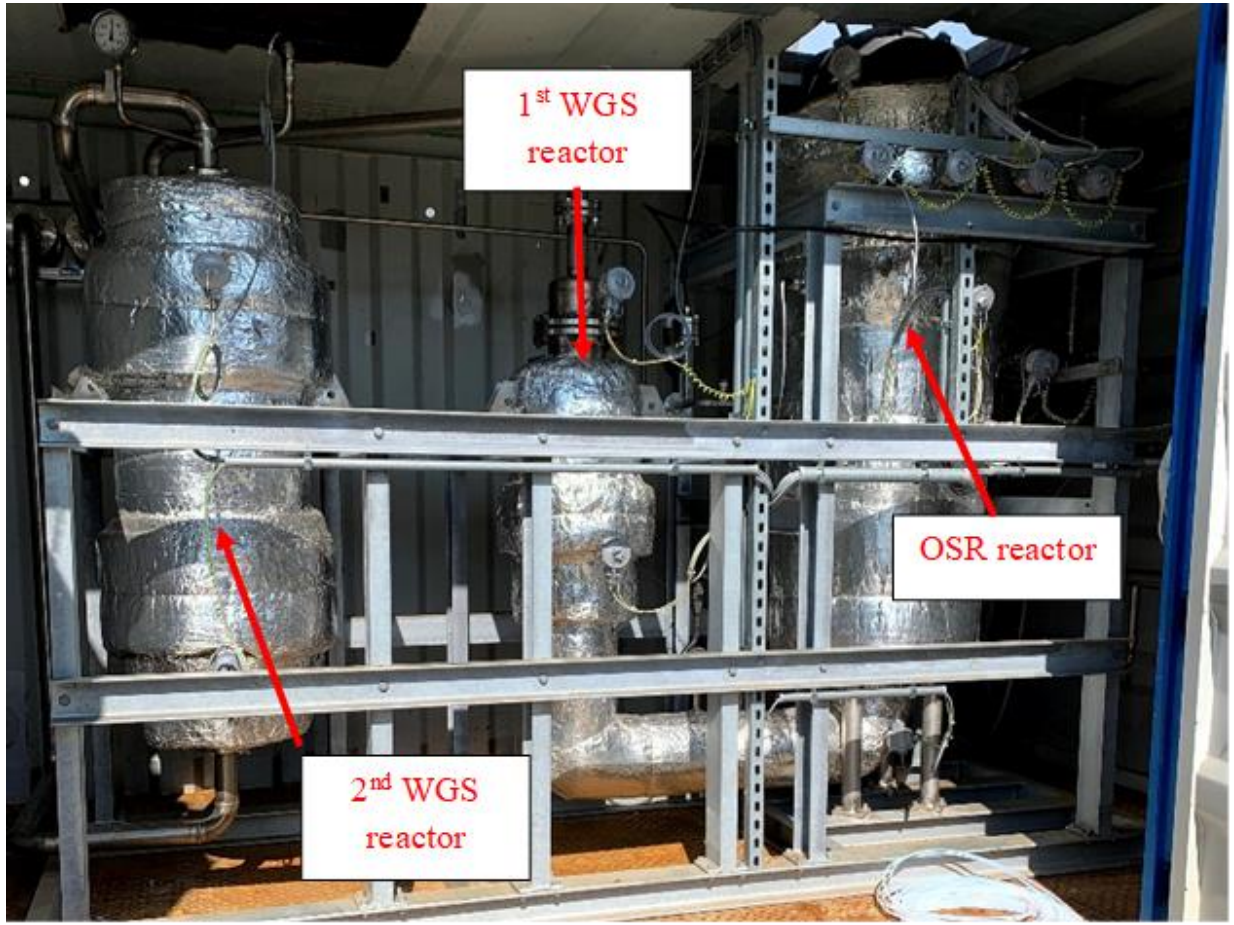
Design and Manufacturing

Reaction Section





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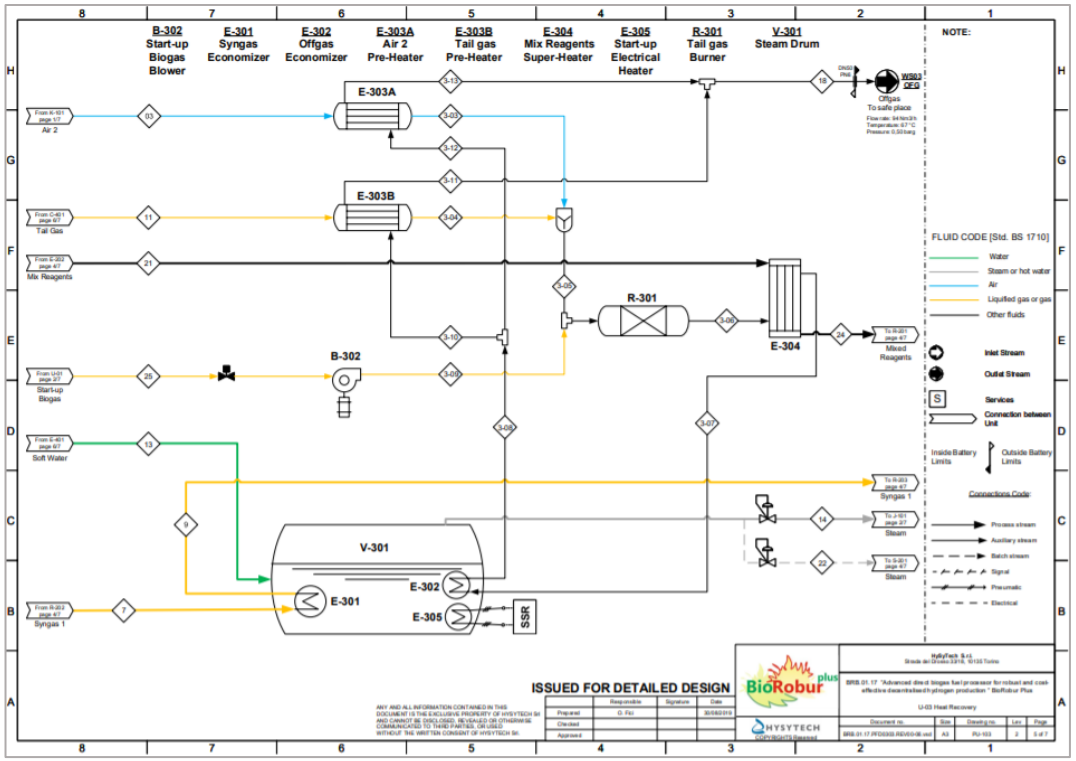
Design and Manufacturing

Steam Drum and Burner System



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FCH

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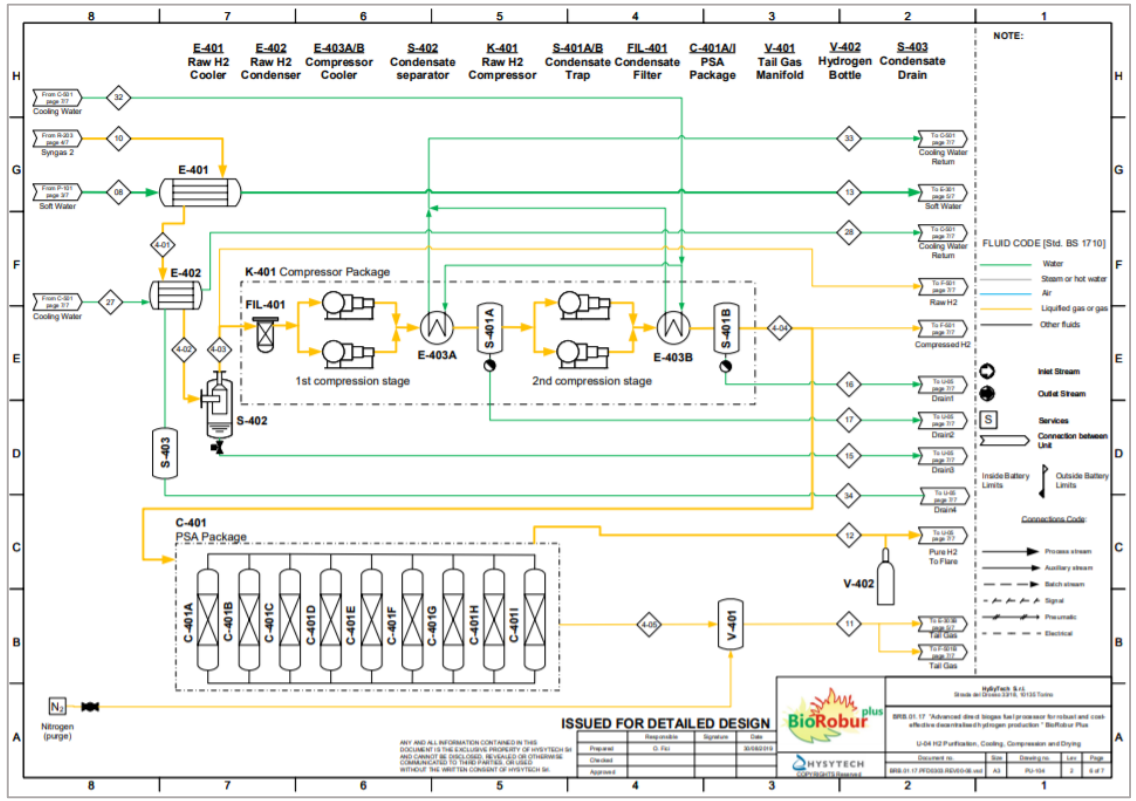
Design and Manufacturing

H_2 Compressor and PSA Section



H_2 Compressor

PSA columns

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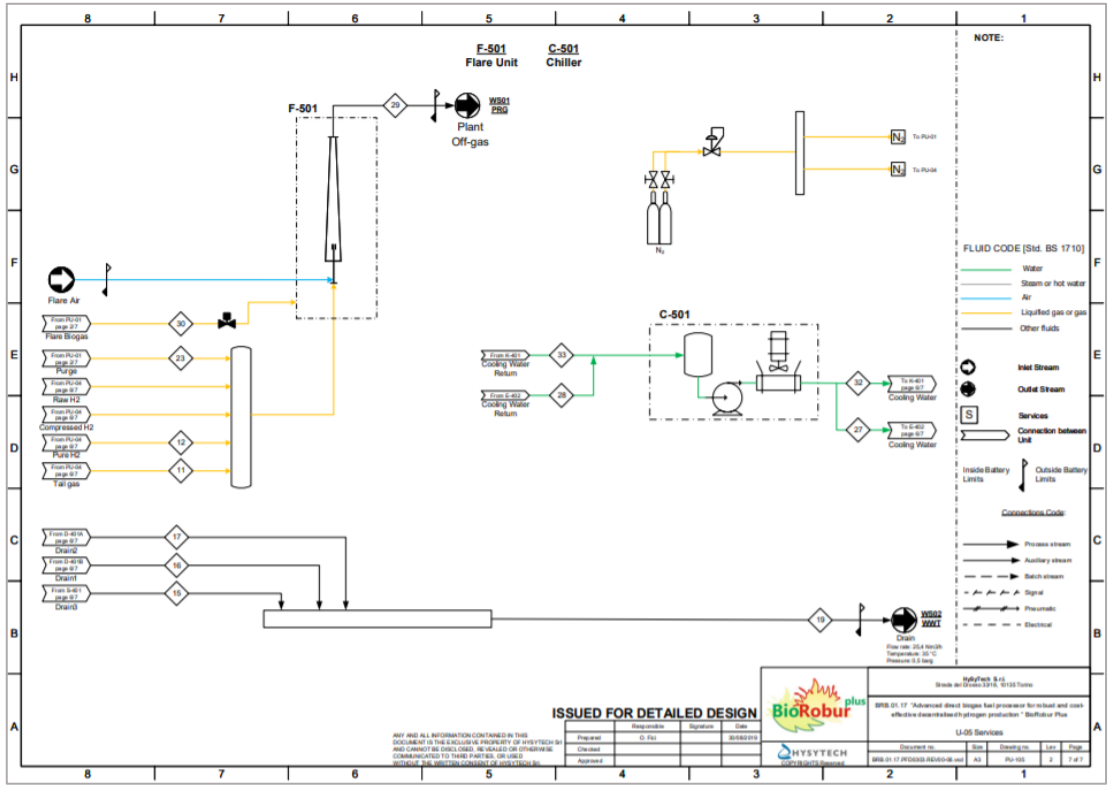
Utilities Section



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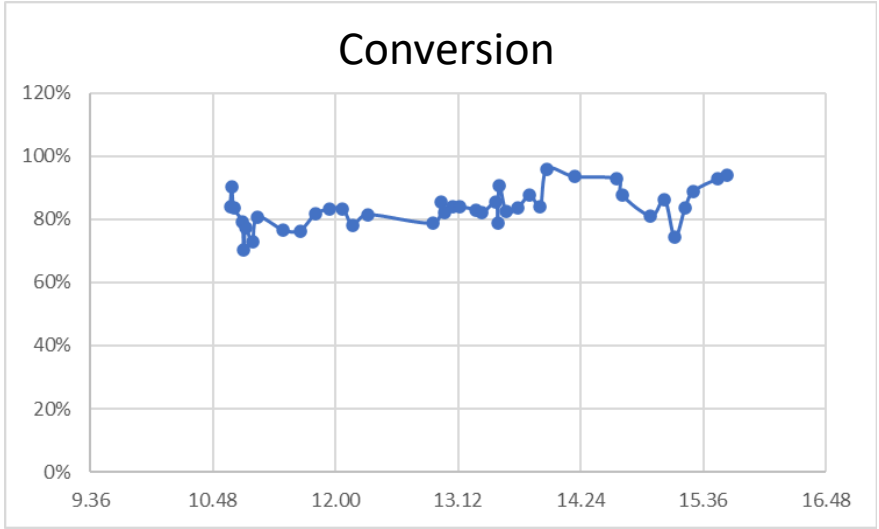
Prototype testing campaign

Biogas treated:
Up to 50 Nm^3/h

Component	Biogas feed
CH4 [% vol]	56.7
H2S [ppm]	327
CO2 [% vol]	42.84
O2 [% vol]	0.1



Pressure and Temperature of the reaction conditions:
>600 °C ; 0.5 barg

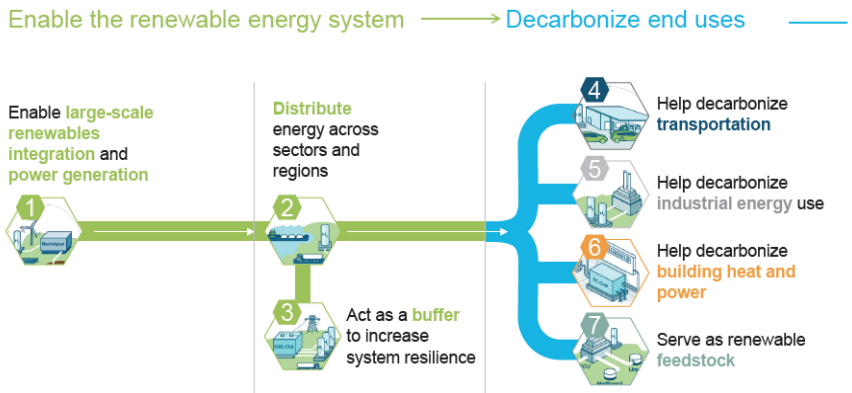
PSA conditions:
Feed : 12 barg
Temperature: 35 °C

50 Nm^3/h

Purity: 99.9%

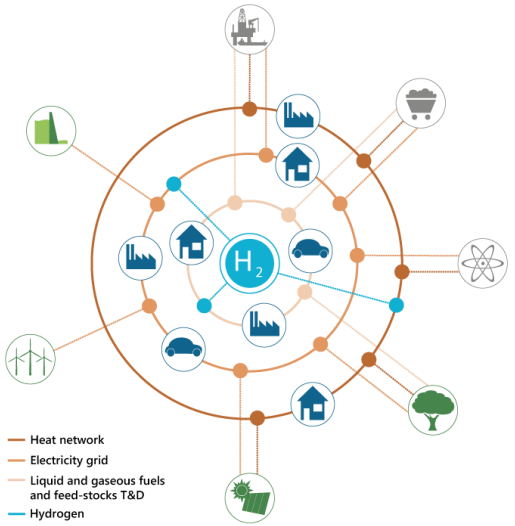
Hydrogen market vision

- Hydrogen can link different energy sectors and energy transmission and distribution networks,
- It is a flexible energy carrier that can be produced from any regionally-prevalent primary energy source.
- It can be effectively transformed into any form of energy for diverse end-use applications
- Hydrogen has been identified as a central pillar of the required energy transition [1].



[1] Hydrogen scaling up (Hydrogen Council, 2016)

H_2 has a portfolio end-uses.



Hydrogen vision for 2050 [1].

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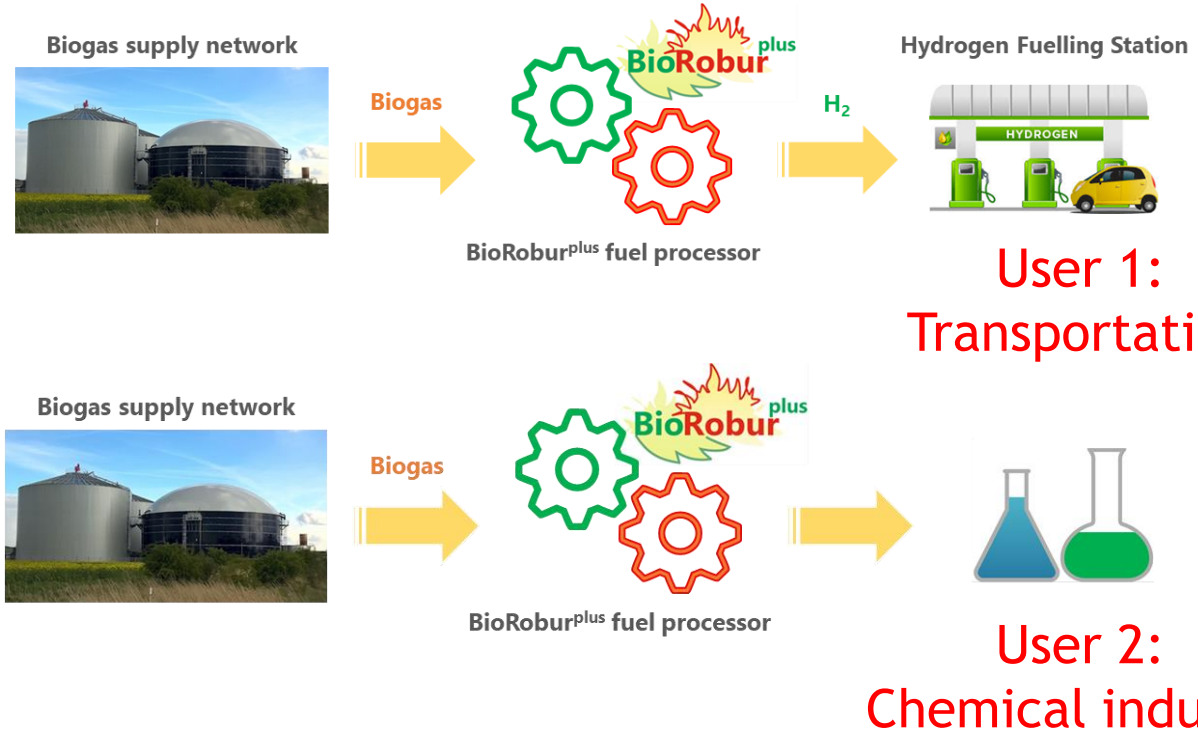
Distributed Hydrogen Production



- ✓ H_2 cost at different sizes application

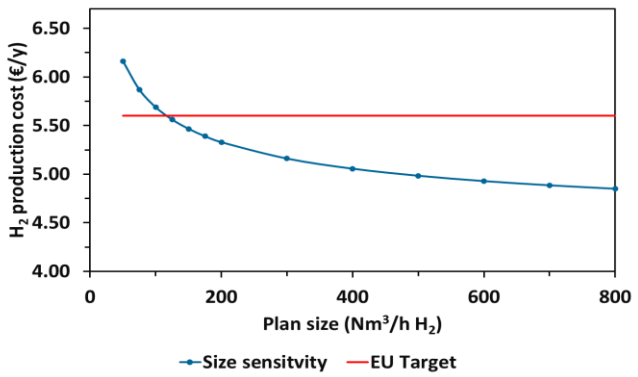
Economic feasibility of the process

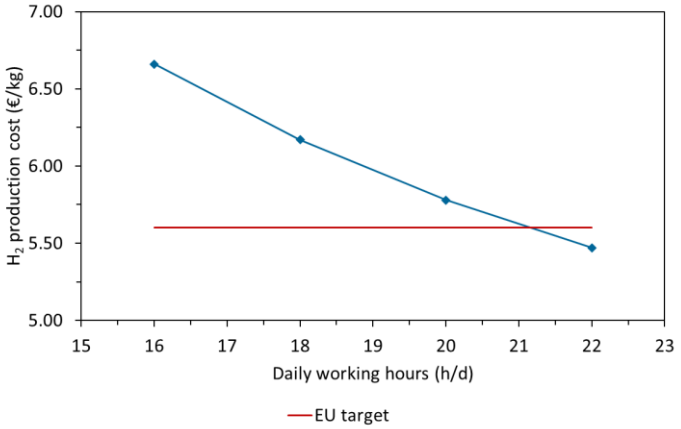
Proof of concept:
Prototype case (50 Nm^3 H_2/h)

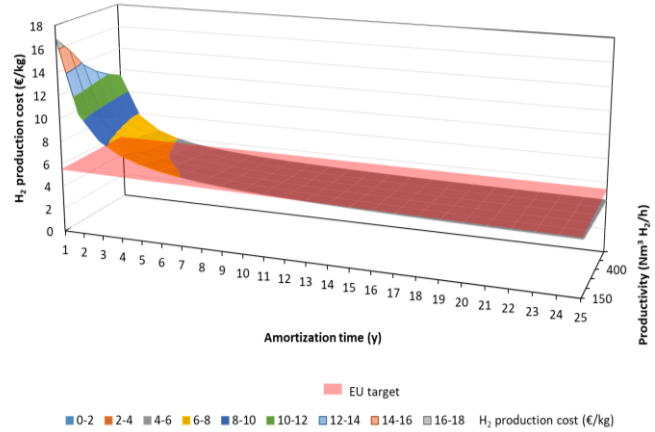
CAPEX	OPEX	H_2 cost
700 k€	150 k€/y	6.16 €/kg

EU target:
5.6 €/kg H_2

Sensitivities



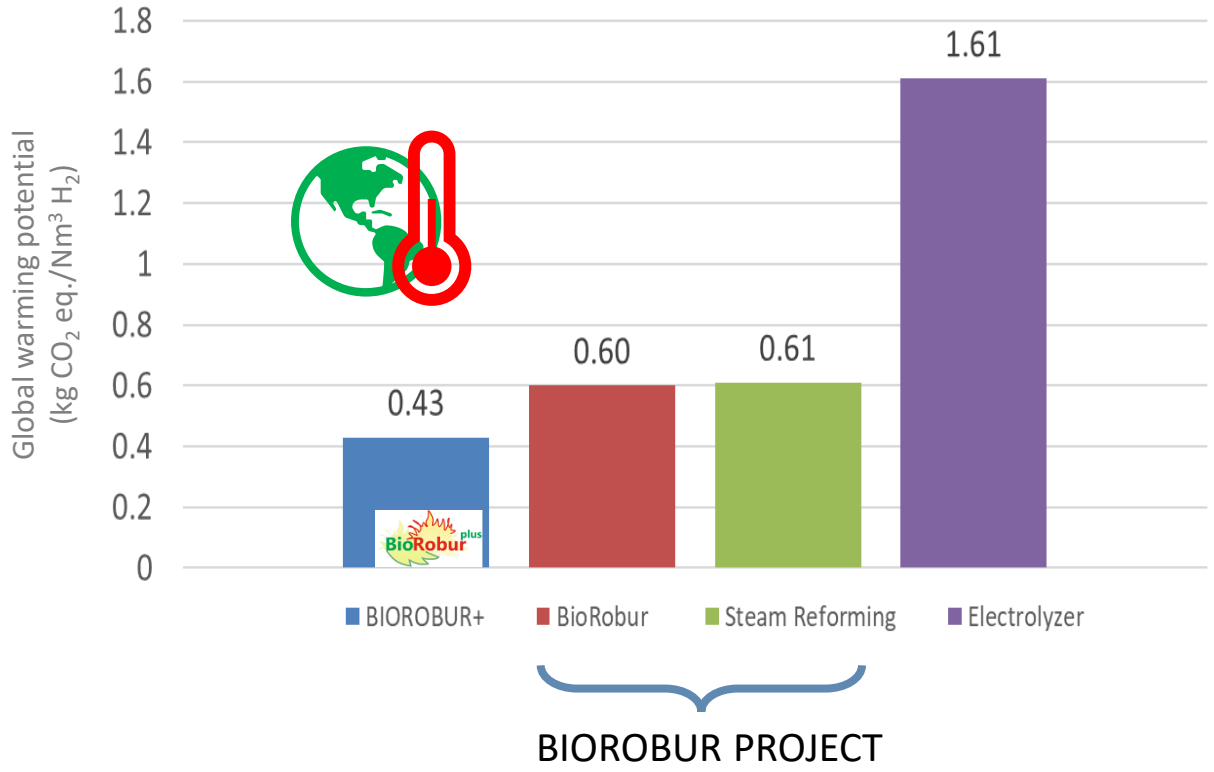




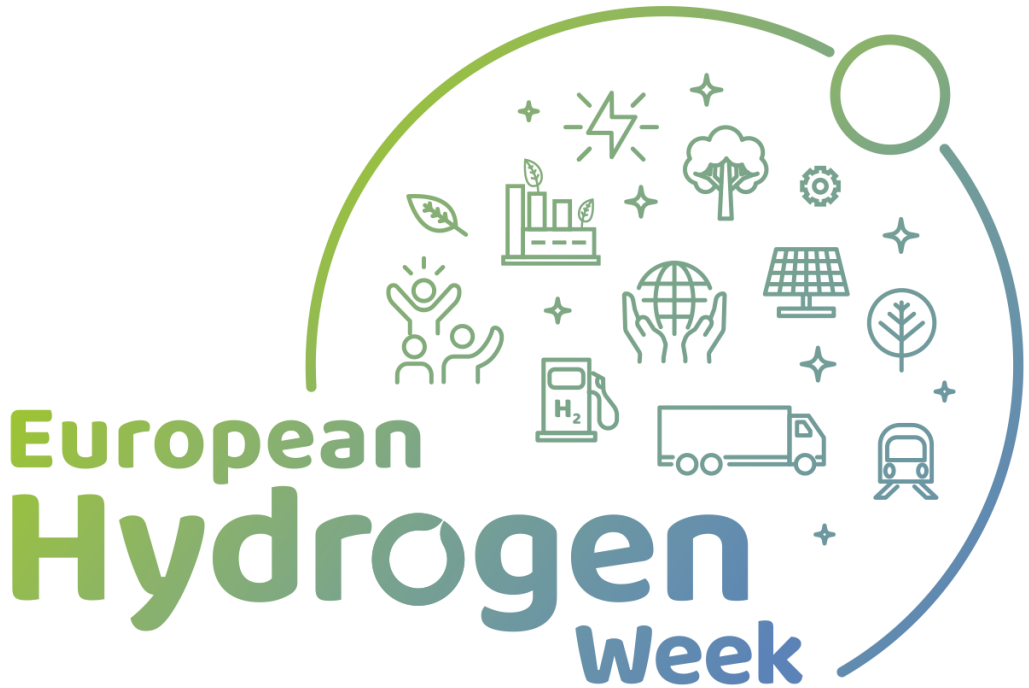
Environmental feasibility of the process

Life Cycle Assessment

Lower impact than previous innovative actions



F. Battista, Y.S. Montenegro Camacho, S. Hernández, S. Bensaid, A. Herrmann, H. Krause, D. Trimis, D. Fino, LCA evaluation for the hydrogen production from biogas through the innovative BioRobur project concept, International Journal of Hydrogen Energy, Volume 42, Issue 19, 2017.



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