POLITECNICO
MILANO 1863

CONVERGE

CarbON Valorisation in Energy-efficient Green fuels

The CONVERGE project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 818135

Presentation outline

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818135

Main objectives
The consortium
The process
Main components

- Catalytic cracker of tars
- Recovery of refinery products)
- Sorption-Enhanced Reforming
- Electrochemical Hydrogen compression
- Enhanced Methanol Membrane

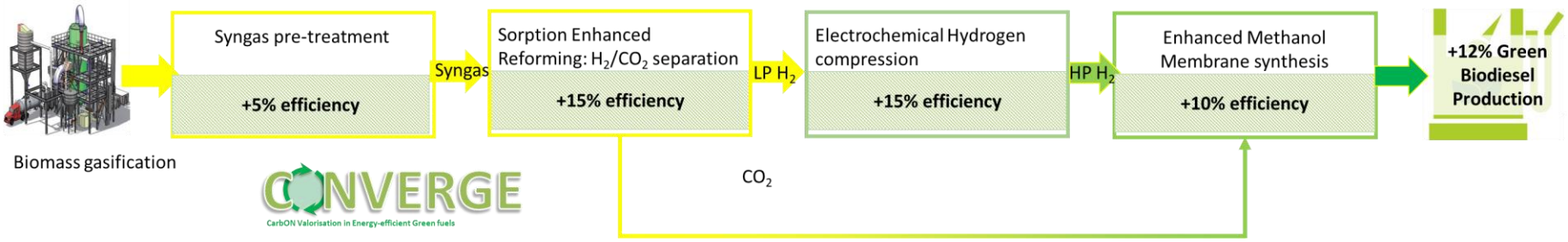
Smart targets
Methodology

Project objectives

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818135

The **CONVERGE project will validate an innovative process** which will **increase the biodiesel production by 12%** per secondary biomass unit used and **reduce the CAPEX by 10%**

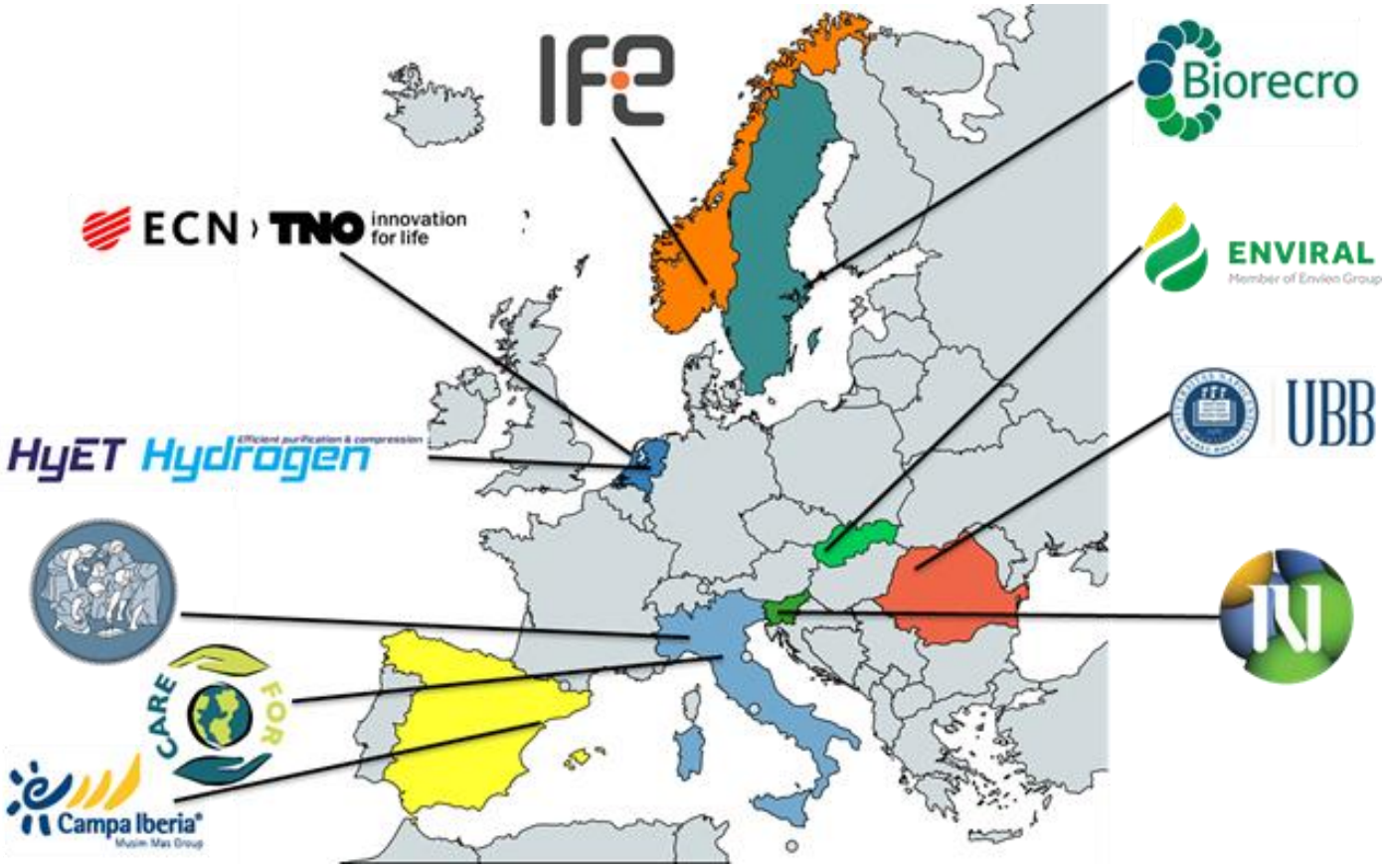
The **CONVERGE technologies will be validated** for more than **2000 cumulated hours** taking these from the discovery stage (TRL3) to development stage (TRL5).



The project started 7 months ago on November 1st 2018

Consortium

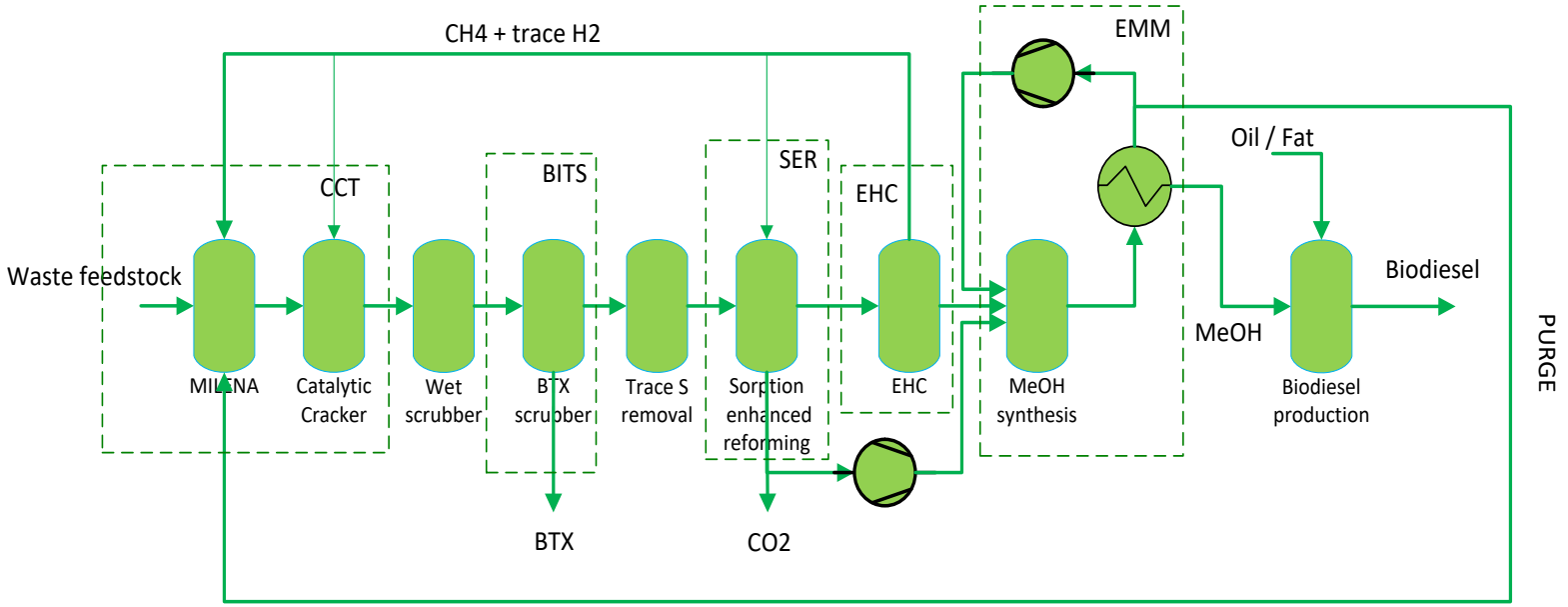
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818135



Two universities (POLIMI and UBB), three research organizations (ECN, IFE, and NIC), two SMEs (BioRecro and HyET), two large companies (Enviral and Campa Iberia) and a professional association (CFE)

Process

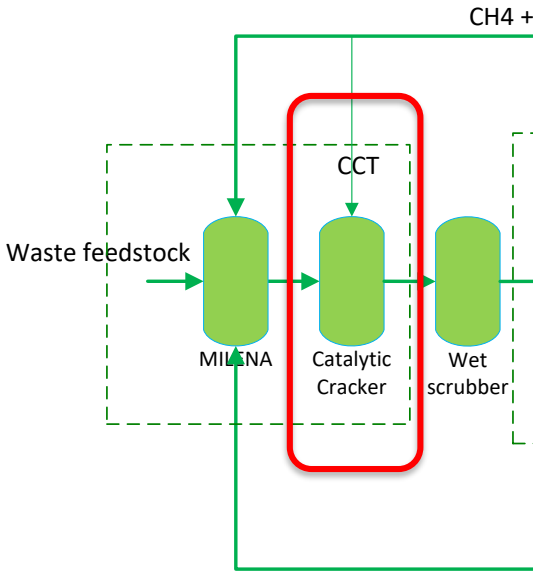
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818135

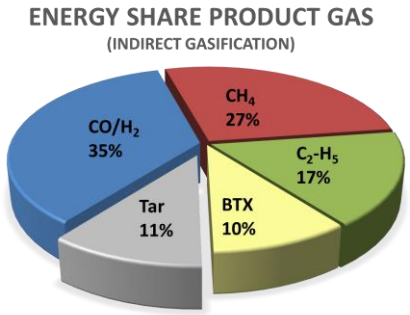


- CCT: Catalytic cracking of tars from an indirectly heated gasifier to below green C_8
- BITS: Recovery of refinery products including aromatics for green C_6-C_8 fraction (BTX)
- SER: Sorption-Enhanced Reforming of C_1-C_6 for excess-carbon removal, and H_2 production
- EHC: Highly efficient electrochemical compression of green H_2 with by-product fuel
- EMM: Enhanced Methanol Membrane to ensure efficient green biodiesel production

Catalytic Cracking

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818135



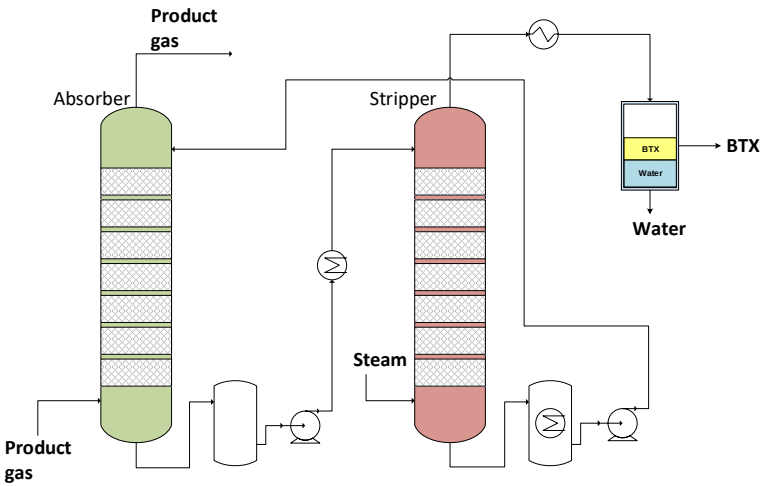


- Conversion of C_{9+} species from the producer gas at similar temperature to the gasification, avoiding exergy destruction
- **NIC will develop a catalyst** that cracks tars to molecules **smaller than C_8**, maximizing the BTX productivity
- **ECN part of TNO**, based on the optimum catalyst, will **design and build a system for the conversion of tar compounds**, without cracking the BTX fraction
- **The syngas treatment process** will guarantee a **carbon/hydrogen purity above 99%** which is 5% higher than current technologies, allowing 17% larger overall carbon usage

Recovery of BTX

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818135

- BTX represents valuable component in the product gas
  - Benzene market price >18 €/GJ, >700 €/ton (fossil based)
- ECN.TNO has developed a BTX scrubbing technology based on a proprietary liquid, suitable for any producer gas
- BioBTX product increases the overall process efficiency
- Mini pilot unit able to process 5 Nm^3/h dry product gas
  - BTX removal > 95 vol%
  - Quantitative removal of higher aromatic compounds

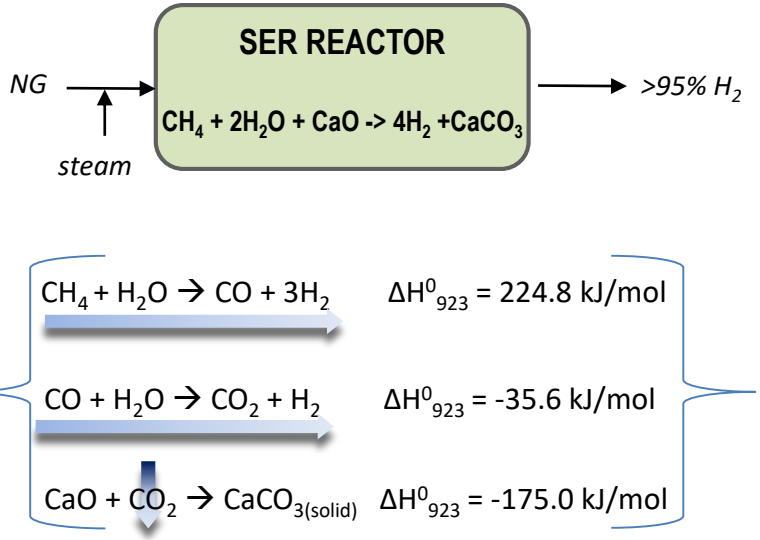


Sorption Enhanced reforming (SER)

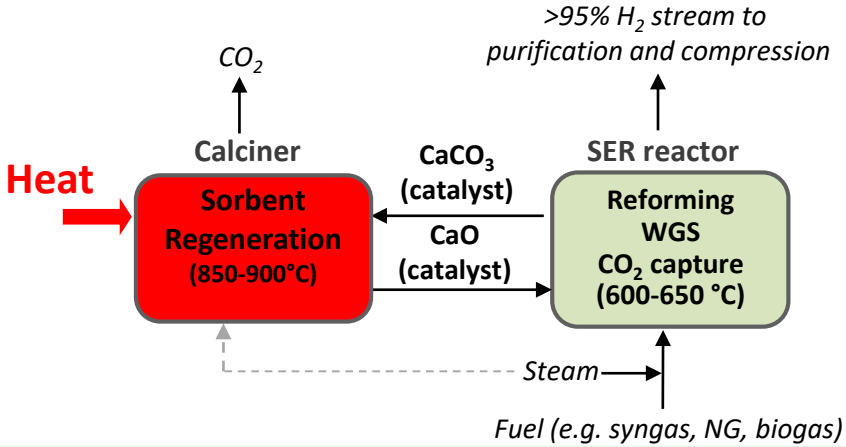
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818135

Combination of Reforming, Water Gas Shift (WGS) and CO_2 capture by CaO carbonation in a single step

- Equilibrium shifts towards H_2 production (approx. 95 vol% dry)
- Lower temperature of reforming (≈ 650°C instead of ≈ 900°C)
- Need to regenerate the sorbent by high temperature calcination (900 °C)
- Process intensification: no additional pre-reformer / WGS / CO_2 capture reactors
- A reaction system which in sum is nearly autothermic (no need of external burners in the reformer)



SER Concept scheme



CONVERGE objective

The adoption of **Sorption Enhanced Reforming will reduce the H_2 production** and CO_2 separation **from 2 MJ/kg_{CO2}** of current technologies down **to 1.2 MJ/kg_{CO2}**

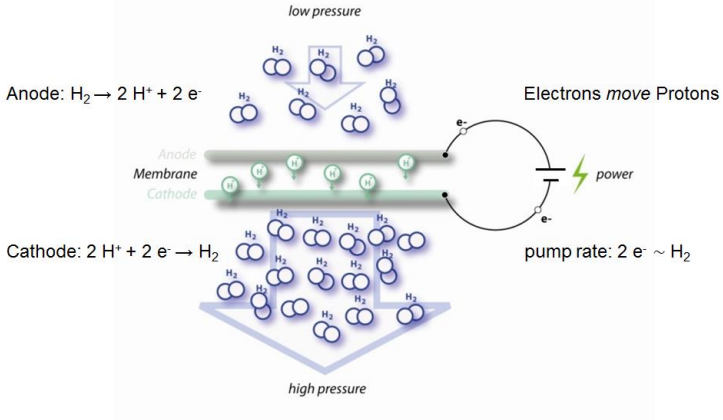
WP3: electrochemical H_2 compressor

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818135

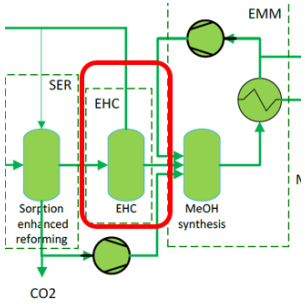
HyET Hydrogen *Efficient purification & compression*

- HyET Hydrogen will design and build a system (EHC) that **extracts** and **compresses H_2 at >99.5%** purity to **50 bar in a single step** and at a primary energy consumption down to **12 MJ/kg H_2**, at a **10 Nm^3/hr H_2 (20 kg H_2/day)** output.

Electrochemical Hydrogen Compression working principle



- IFE and HyET will integrate and test the Sorption Enhanced Reformer and EHC system (TRL5). The H_2 output should feed a MeOH synthesis membrane reactor in the CONVERGE process chain.

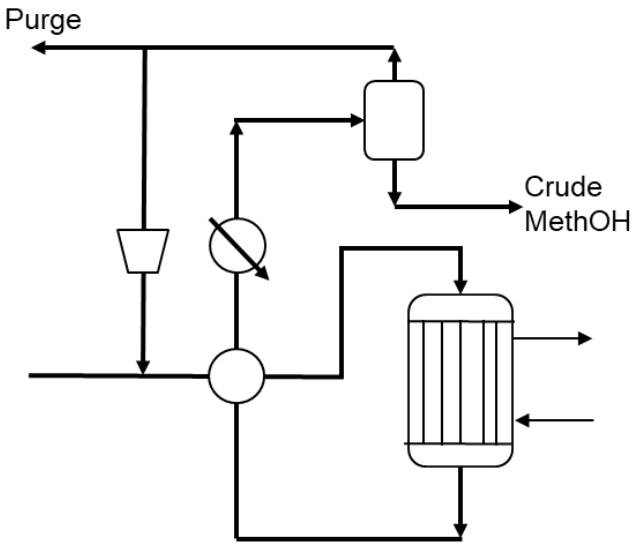


Enhanced Methanol Membrane

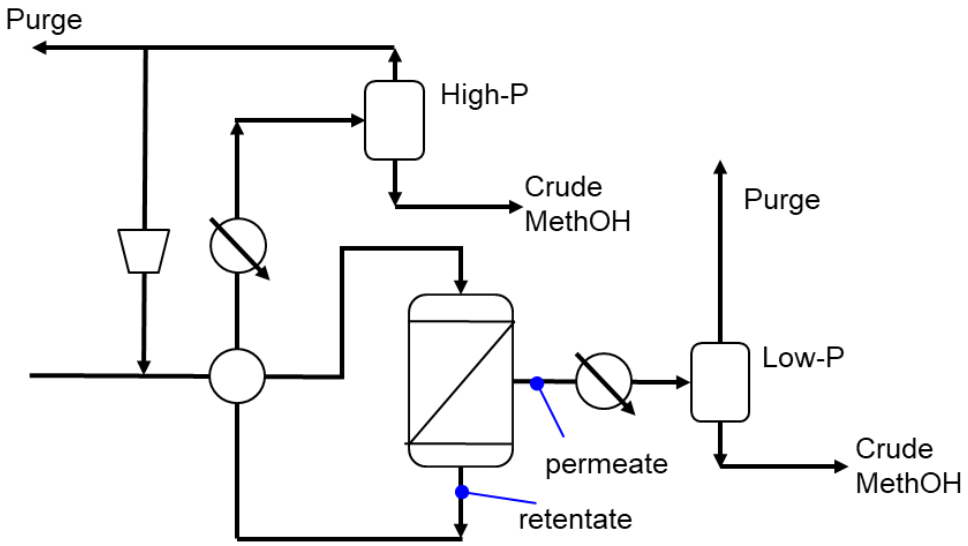
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818135

- By incorporating a membrane into the methanol reactor, the selective removal of methanol and water boosts the driving force for methanol synthesis
- **Goal for WP4: Validate the Enhanced Membrane Methanol** synthesis with **single pass conversion > 33%** reducing the size of the methanol reactor

conventional



membrane assisted



SMART economic and environmental targets

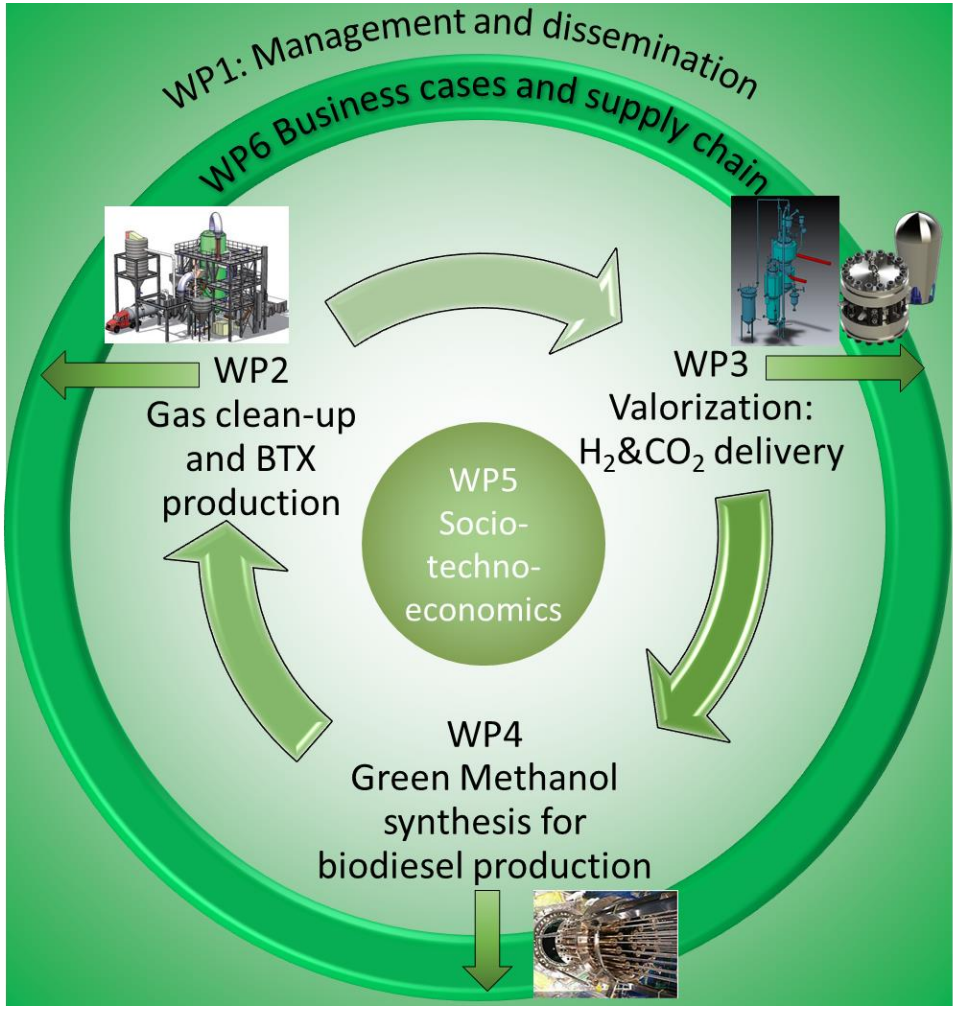
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818135

- **Reduce the CAPEX** of the overall process from biomass to methanol **by 15%** thanks to the equipment reduction;
- **Reduce the OPEX** as consequence of the more efficient production **by 10%;**
- **Reduction of CO_2 emissions by 0.2 kg_{CO2}/kg_{MeOH}** as consequence of higher production efficiency;
- **Specifically target the valorisation of remaining biogenic and purified CO_2** produced from the SER either in BeCCS type applications, and as a green carbon source for other applications requiring non-fossil fuel-based carbon.

BeCCS = Bio-Energy with Carbon Capture and Storage

WP structure and leaders

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818135



Acknowledgments

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 818135

Get in touch with us

Website: www.converge-h2020.eu

Researchgate: **CONVERGE: CarbON Valorisation in Energy-efficient Green fuels**

CONVERGE
CarbON Valorisation in Energy-efficient Green fuels

The CONVERGE project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 818135