The FLEDGED project: DME production from biomass gasification with flexible Sorption-Enhanced processes

M.C. Romano[1]; J. Aparicio[2]; M. Astolfi[1]; J. Boon[3]; A. Dauriat[5]; R. Garcia[2]; G. Grasa[6]; G. Groppi[1]; G.Guandalini[1]; S. Hafner[7]; T. Hyppänen[8]; T. Jayabalan[9]; I. Martínez[6]; R. Murillo[6]; J. Pacheco[2]; J. Palonen[4]; G. Rexwinkel[10]; J. Ritvanen[8]; S. Rojas[11]; M. Schmid[7]; J. Vente[3]

[1] Politecnico di Milano; [2] Econward; [3] ECN part of TNO; [4] Sumitomo SHI FW; [5]QUANTIS; [6]Instituto de Carboquímica (ICB-CSIC); [7]University of Stuttgart (IFK); [8]Lappeenranta University of Technology; [9]INERIS; [10]Frames Renewable Energy Solutions B.V.; [11]Instituto de Catálisis y Petroleoquímica (ICP-CSIC)

OBJECTIVE

FLEDGED project **develops a highly intensified and flexible process for DME production from biomass** and validates it in industrially relevant environment (TRL 5).

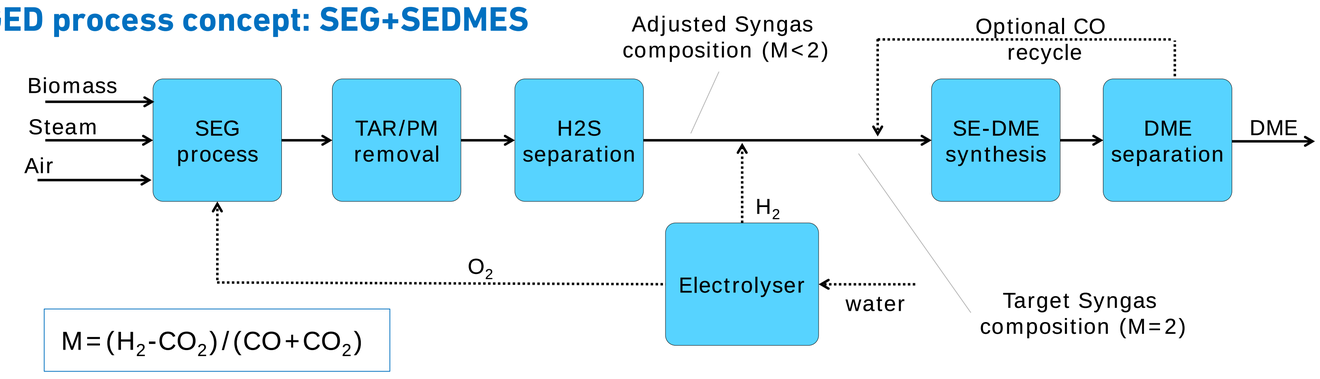
WHY DME

DME is recognized by stakeholders as one of the most promising future **biofuels**, due to the **easy adaptability** of car engines and **reduced life-cycle environmental impact**.

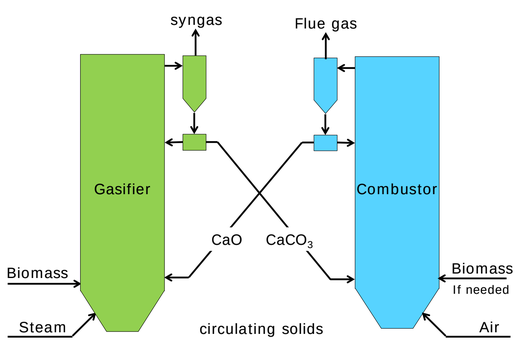
OUTCOME

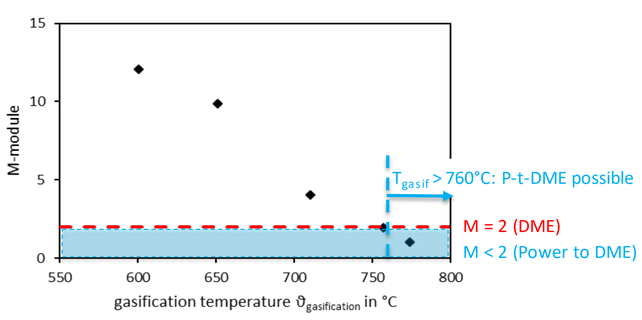
The outcome of the FLEDGED project will be a **highly competitive** concept for both small-medium scale plants serving regional markets and large scale plants.

FLEDGED process concept: SEG+SEDMES



FLEDGED system is based on the flexible **Sorption-Enhanced Gasification (SEG)** process, able to provide a tailored producer gas composition for the downstream **Sorption-Enhanced DME synthesis (SEDMES)** process.
No ASU, dedicated WGS and CO_2 separation units are needed, resulting in a compact and process-intensified plant.





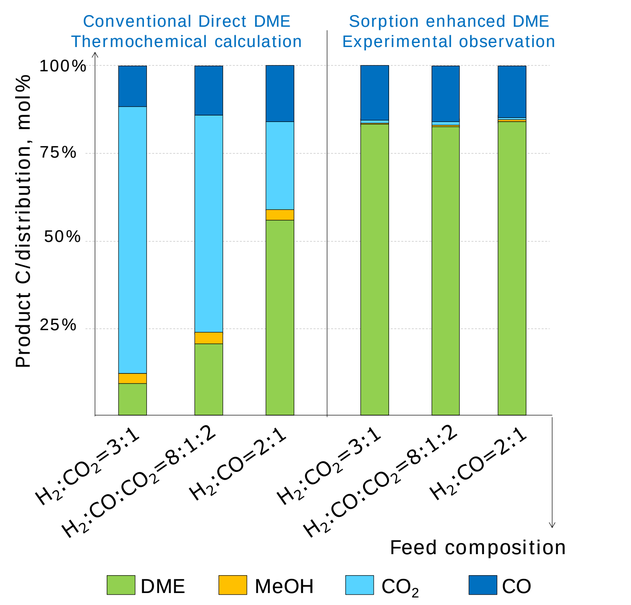
Sorption-Enhanced Gasification validation

In a 200 kW_{th} dual fluidized bed facility, gasification tests with wood pellets and CaO-$CaCO_3$ bed material have been conducted at different gasification temperatures and different steam-to-carbon ratios. **Tests have demonstrated the capability of the system of producing syngas with M-module between 12 and 1 by changing the solids circulation rate.** Sorption-Enhanced gasification of residual biomass from agricultural activities has been successfully achieved also in the 10-30 kW_{th} bubbling fluidized bed (BFB) facility.

Sorption-Enhanced DME synthesis validation

Tests are ongoing to find the optimal operating conditions and regeneration procedures for the SEDMES process. Preliminary tests of the DME production phase showed **much higher product yields and much lower dependency of product distribution on the CO/CO_2 ratio** in the feed with respect to conventional processes, making SEDMES process highly suitable to be coupled with SEG system.

Conventional direct DME synthesis vs. SEDMES
Experimental tests at ECN at 40 bar, 275 °C



TRIPLY FLEXIBILE

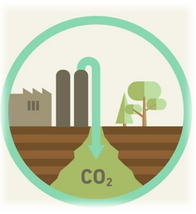
FUEL FLEXIBILITY

Different types of 2nd generation biomass feedstocks can be processed by FLEDGED gasifier, ranging from woody biomass to the organic fraction of municipal solid wastes.

RES INTEGRATION

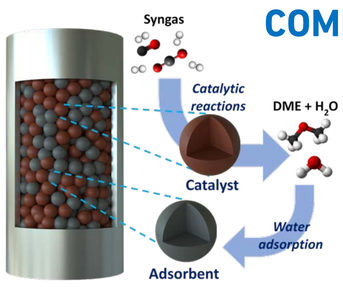
By adjusting the process parameters of the SEG system, syngas composition can be modified to maintain the optimum M module for the DME synthesis when hydrogen from an electrolysis unit is fed to the plant. In this way, the FLEDGED process can support the electric grid in regions with increasing share of intermittent renewable energies through a Power-to-Liquid process.

CCS



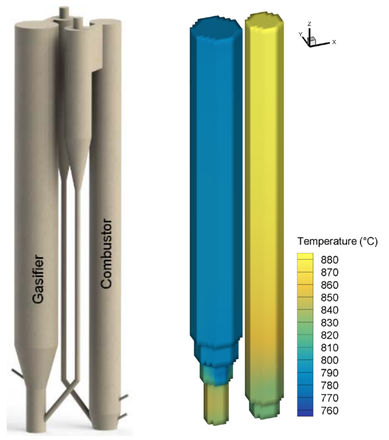
SEG process also allows an easy retrofitting into a CO_2 capture configuration by oxyfuel combustion in the SEG combustor. This allows capturing the biogenic carbon, obtaining a negative CO_2 emissions system.

COMPONENTS MODELLING ACTIVITIES



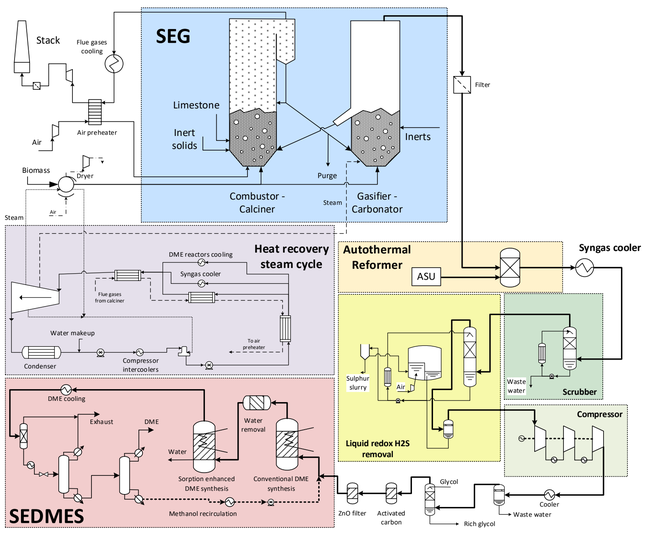
A dynamic heterogeneous model of a single tube of the SEDMES converter has been developed, considering mass and energy balances for the gas phase, coupled with the catalyst and adsorbent phases.

A CFD model, based on an original semi-empirical modelling concept, has been developed for 3D simulation of the interconnected gasifier-combustor fluidized beds of the SEG system.



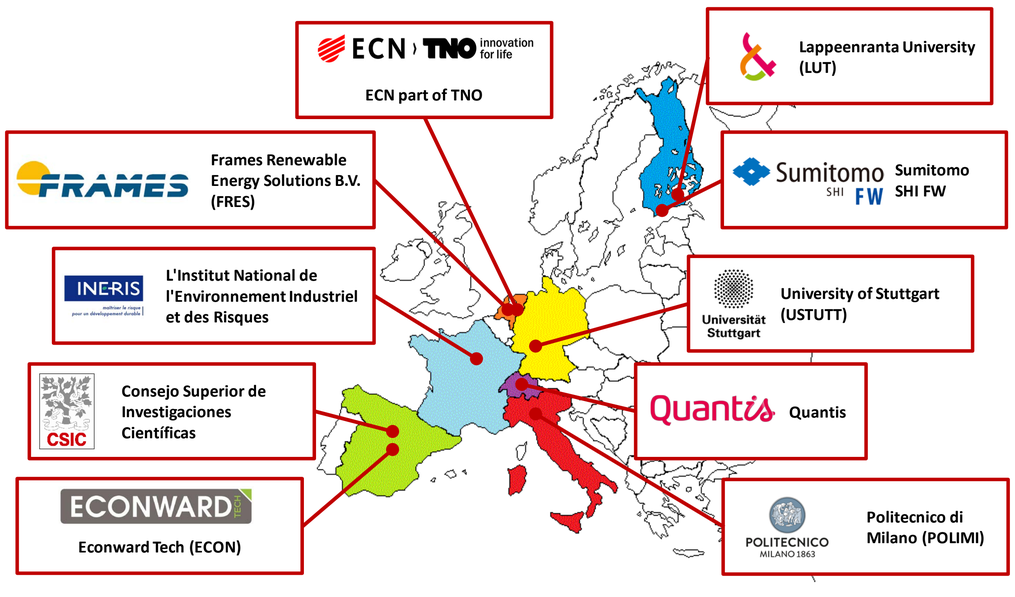
OVERALL SYSTEM ANALYSIS

A **preliminary integration of the complete FLEDGED system** has been simulated, providing energy and mass balances for Life Cycle Assessment, risk evaluation and business cases definition.



- A stepwise methodology is implemented to identify process hazards, supported by experiments for materials characterization.
- Evaluation of the environmental LCA, air quality and socio-economic impacts will be provided for the whole value chain.
- Business cases are focused on both large scale plants fed with lignin and woody biomass, as well as smaller system gasifying Organic Fraction of Municipal Solid Waste.

FLEDGED CONSORTIUM



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info@fledged.eu

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