BIONICO

BIOGAS MEMBRANE REFORMER FOR DECENTRALIZED H_2 PRODUCTION

Call: H2020-JTI-FCH-2014-1 Topic: FCH-02.2-2014 Decentralized hydrogen production from clean CO_2-containing biogas

SUMMARY

BIONICO **aims** at developing a **novel reactor** configuration at a **larger scale** to produce **H_2** from **biogas** production power plant based on:

- Design, develop and test a **new concept** reactor integrating hydrogen **production** and **purification** on a **single unit**
- Design, develop and testing of a **catalytic membrane reactor** for the production of highly-purity hydrogen from biogas, scaling up new H_2 selective **membranes** and **catalyst** production
- Develop a **flexible system** (including the advance control and BoP components) capable of producing pure hydrogen from **biogas of different compositions** in a unique reactor system.

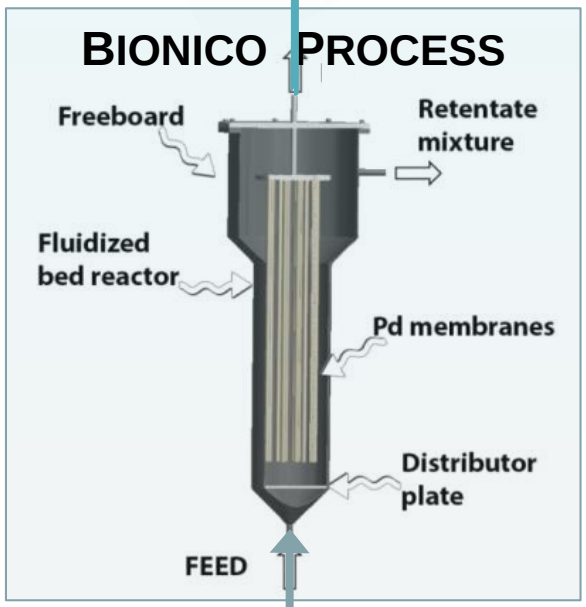
The main idea of BIONICO is to design and demonstrate an **efficient biogas-to-hydrogen conversion system** at real plant conditions (in the ENC Landfill plant at Chamusca, Santarém, Portugal) using process intensification.

CONCEPT

Biogas plant

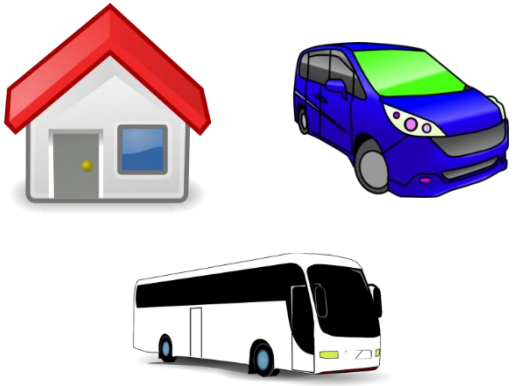
Raw Biogas

Sulfur Removal



Pure H_2

End Users



PARTNERSHIP

Multidisciplinary and complementary team: 8 top level European organisations from 7 countries including: 3 Research Institutes and Universities and 4 representative top industries in different sectors (from catalyst to membranes to chemical and process engineering, etc.)

- POLIMI, Italy
- TU/e, The Netherlands
- Abengoa, Spain
- Tecnalia, Spain
- Johnson Matthey, UK
- ENC Energy, Portugal
- Rauschert, Germany
- Quantis, Switzerland

Project Objectives

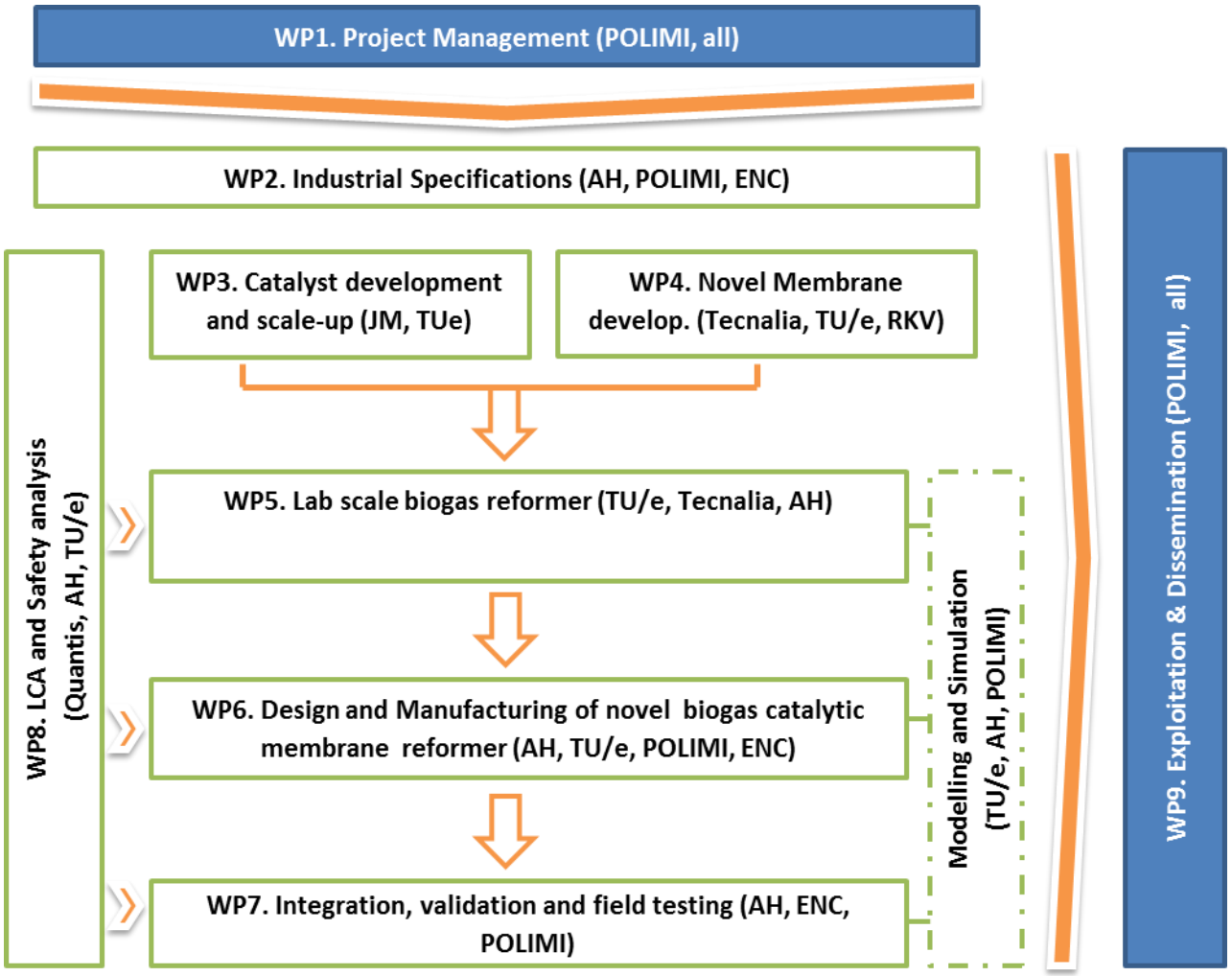
Technical Objectives

- Design, develop, demonstrate and optimize advanced cost-effective catalytic MR for the production of approximately 100 kg/day of highly-purity hydrogen from biogas.
- Develop a flexible system (including the advance control and BoP components) capable of producing pure hydrogen from biogas of different compositions in a unique reactor system.
- Increase the overall efficiency of biogas-to-hydrogen conversion by using process intensification.
- Develop a flexible process capable of producing hydrogen with various biogas compositions.
- Demonstrate at real plant conditions of the BIONICO system at one of the biogas production sites (either biogas from Landfill or Anaerobic digestion).

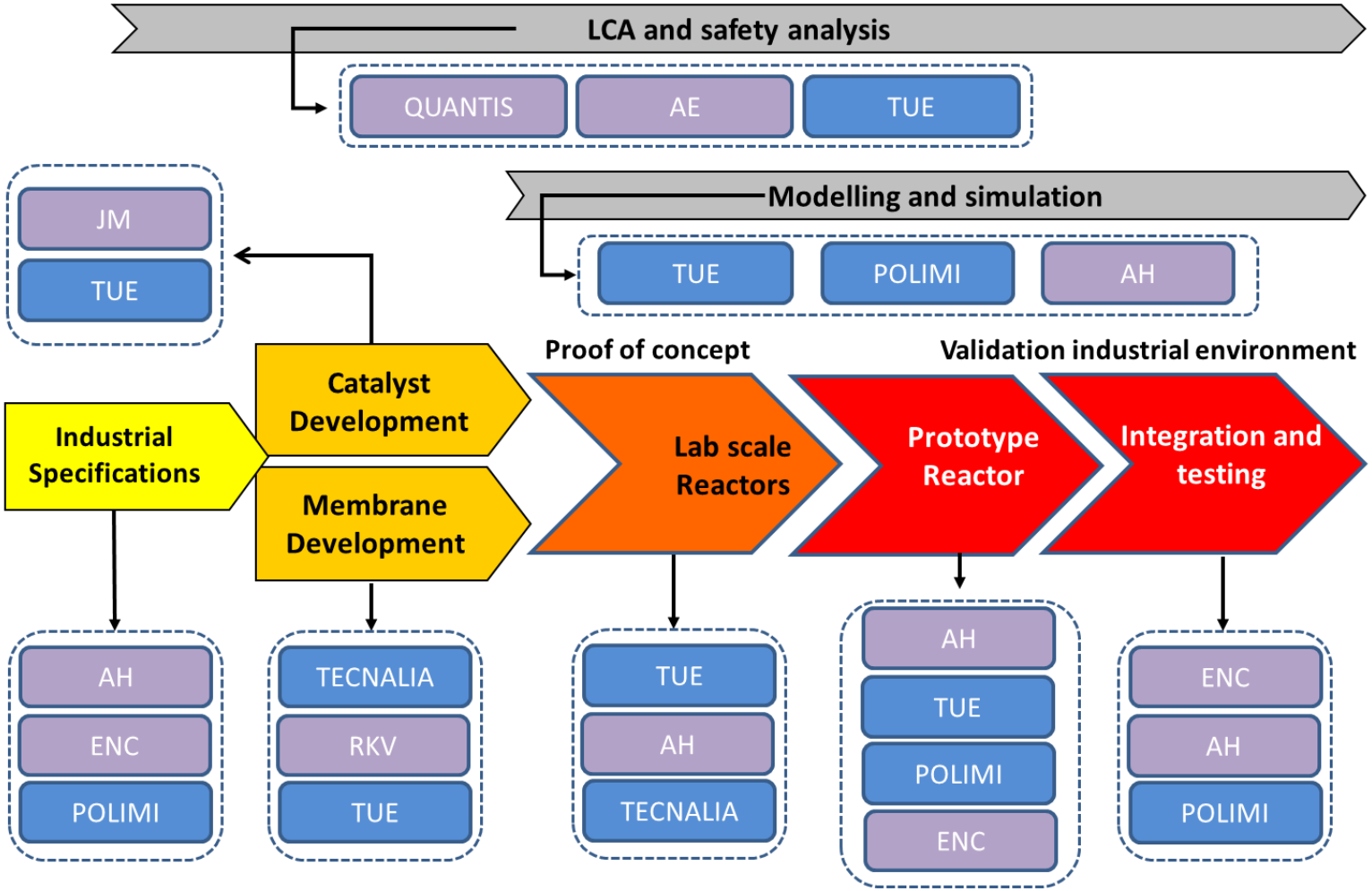
Environmental & Socio-Economic Objectives

- Set the basis for a higher incorporation of Hydrogen produced from biogas, an environmentally friendly source.
- Quantify the economic impact (CAPEX and OPEX) of the new holistic solutions. The information will contribute to decision-making about the commercial exploitation of the holistic solutions.

WORK STRUCTURE



PARTNERSHIP SYNERGIES



CATALYST DEVELOPMENT

Development of highly active reforming catalysts to produce hydrogen from diverse biogas mixture coupled with steam (and air).

- The catalyst needs to be mechanically durable and suitable for operate in a fluidised bed regime
- The catalyst needs to maintain its activity under membrane reactor operating conditions
- Scale-up of catalyst production for real demonstration in a biogas plant

Membrane development

Development of Pd based tubular supported membranes, for application in biogas reforming catalytic membrane reactors

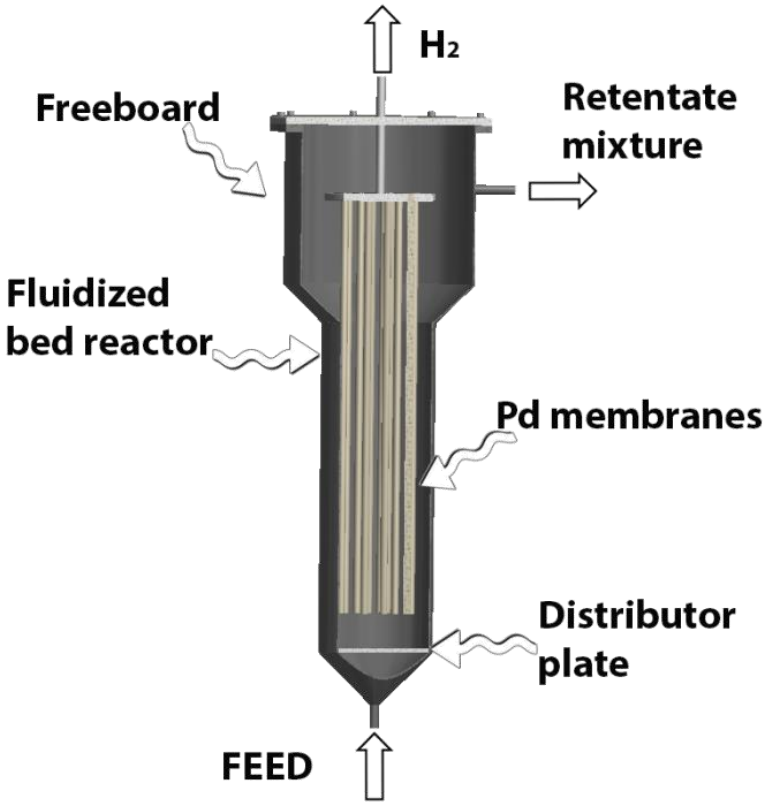
- Membranes needs to be selective to H_2 with an high permeation flux
- Membranes needs to be stable at under membrane reactor operating conditions and fluidization regime
- Sealing and mechanical stability of the support
- Improve sulphur resistance
- Scale-up for real demonstration in a biogas plant

Thin film Pd-alloy (< 5 µm) supported membranes

Lab Scale Reactor

Definition of the lab scale reactors performances and identification of the best design for prototype pilot.

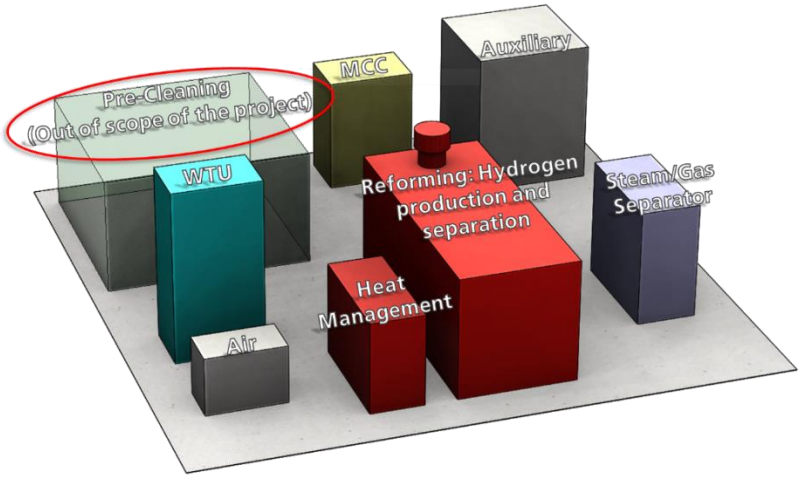
- Selection of Membrane Reactor components: catalysts, supported membranes and sealing
- Design of the lab scale reactor
- Integration of the components in the lab scale reactor
- Experimental evaluation of the membrane reactor performances



Prototype Reactor

Final design and construction of MR prototype for the production of approximately 100 kg/day of pure hydrogen

- Design and construction of the prototype catalytic membrane reactor at large scale (>100 membranes) including control system design
- Design and manufacturing of the balance of plant
- Definition of the BIONICO operating conditions and performances
- Perform functionality tests before integration in the overall system



INTEGRATION&TESTING AT BIOGAS PRODUCTION SITE

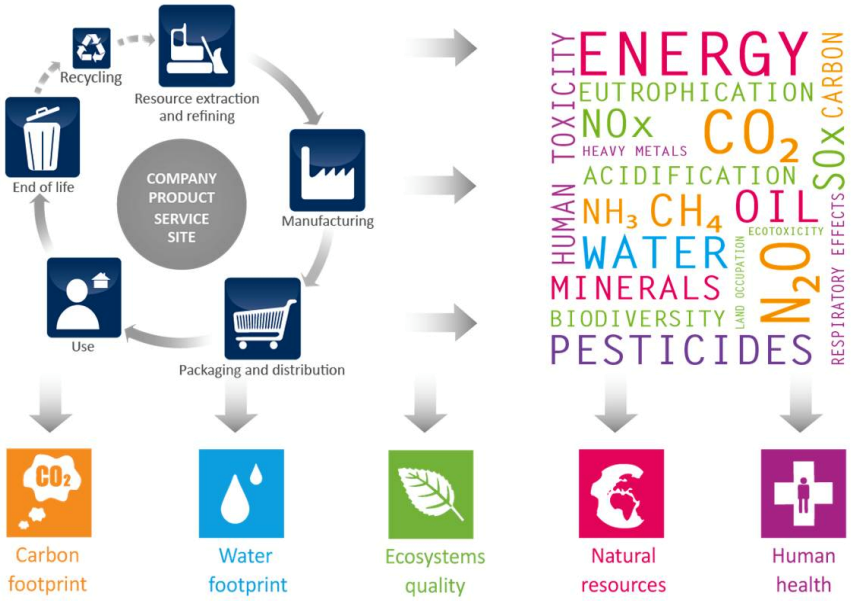
Final evaluation of the innovative process to directly produce pure hydrogen in a real biogas production site (ENC Landfill plant in Chamusca)

- Definition of the system layout model evaluating the impact of the operating conditions to optimize the overall performances
- Integration of the prototype reactor in the overall BIONICO system at biogas production site
- Validation of the system model with test results
- Perform techno-economic analysis
- BIONICO Industrial roadmap

Life Cycle Assessment & Safety Issues

Development strategy towards sustainable solutions and provide guidance on how operate the reactor prototype under safe conditions

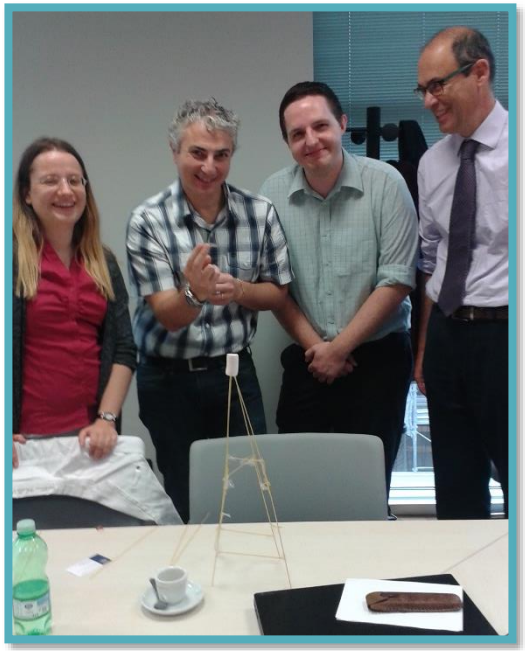
- Environmental Life Cycle Assessment analysis of the novel CMR technology and guiding the development towards more environmentally-friendly design
- Safety analysis of the developed CMR prototype and proposal of recommendations for the safe operation of the BIONICO system



First Steps of the BIONICO Project – M1

The BIONICO Kick off meeting was held at Politecnico di Milano on the 16th September 2015. The Consortium people has known each other!

Team bulding at the kick-off meeting: a succesful project needs a close-knit team!

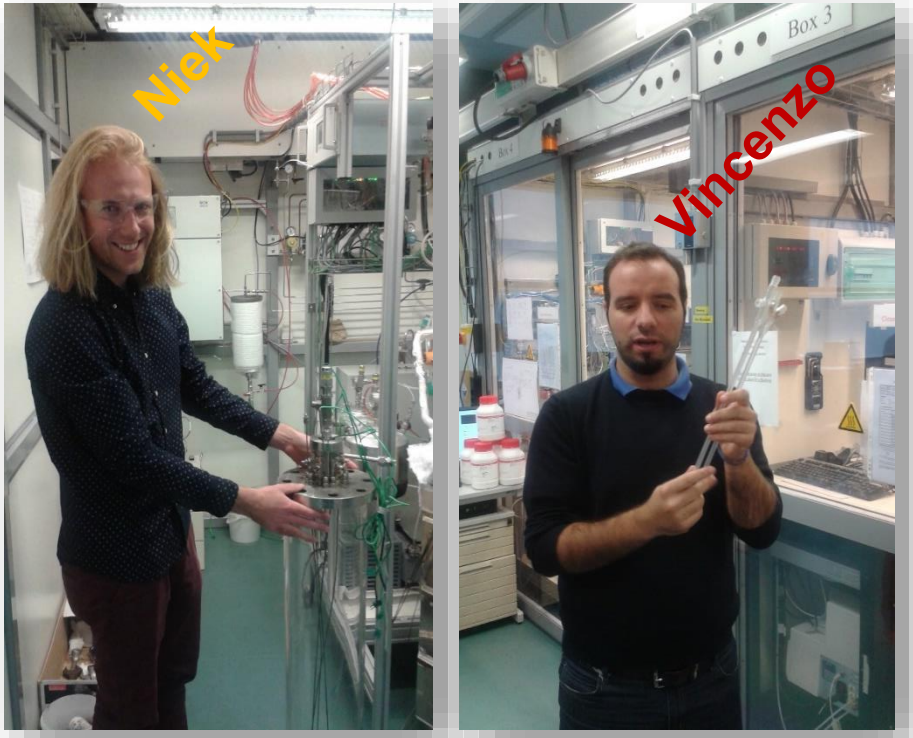


Coordinator and dissemination manager ready to welcome the BIONICO team

After the first meeting a special social event: a visit to EXPO 2015!!

First Steps of the Bionico Project – M6

The Sixth month BIONICO meeting was held at TU/e (Eindhoven) on the 31st of March 2016. It was the chance to update all the consortium on the single WP progresses, to take important decisions for the project and to Visit TUE labs.



Niek and Vincenzo show BIONICO people TU/e labs

After a long meeting…. Nothing better than a good dinner!

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No 671459. This Joint Undertaking receives support from the European Union's Horizon 2020 Research and Innovation programme Hydrogen Europe and N.ERGHY.

Thank you for your attention

For more information visit: www.bionicoproject.eu