



# BIOGAS MEMBRANE REFORMER FOR DECENTRALIZED H<sub>2</sub> PRODUCTION

M. Binotti<sup>1</sup>, G. Di Marcoberardino<sup>1</sup>, G. Manzolini<sup>1</sup>, F. Gallucci<sup>2</sup>, N. Ibanez Lirio<sup>3</sup>

<sup>1</sup> Department of Energy - Politecnico di Milano, Milano, Italy - <sup>2</sup> Eindhoven University of Technology, Eindhoven, The Netherlands

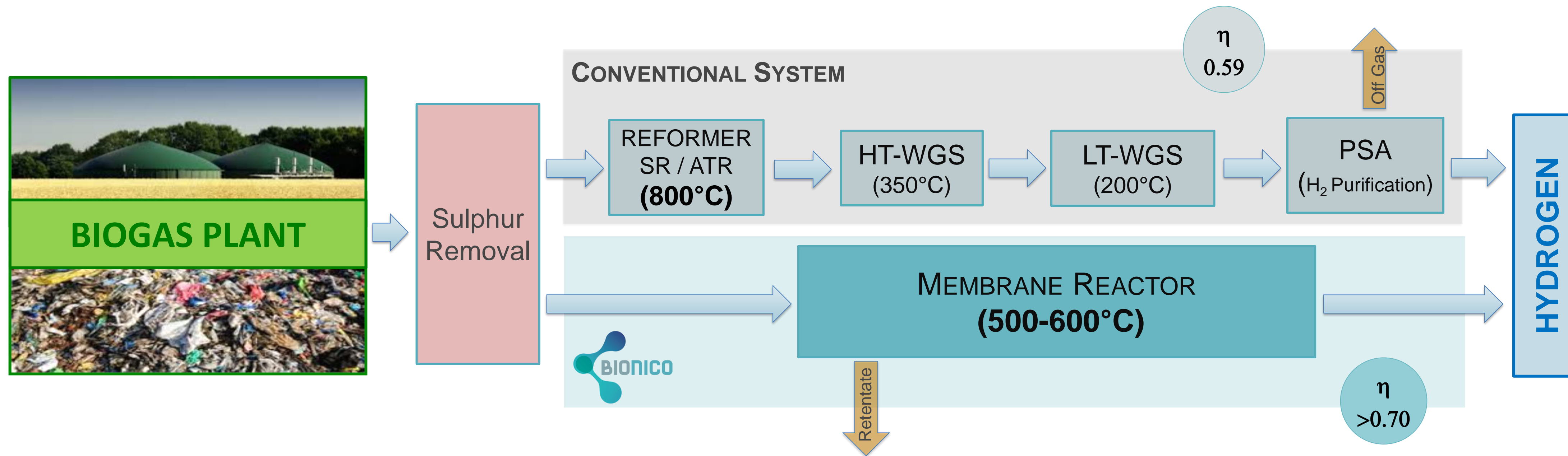
<sup>3</sup> Abengoa Hidrogeno SA, Seville, Spain

[info@bionicoproject.eu](mailto:info@bionicoproject.eu) - [www.bionicoproject.eu](http://www.bionicoproject.eu)



## SUMMARY & CONCEPT

The BIONICO project will develop, build and demonstrate a novel reactor concept integrating H<sub>2</sub> production and separation in a single vessel in a biogas production plant. The hydrogen production capacity will be of **100 kg/day**, with target **purity > 99.99%**. By using the novel intensified reactor, direct conversion of biogas to pure hydrogen is achieved in a single step, which results in an increase of the **overall efficiency (> 70%)** and component savings and potential cost reduction.



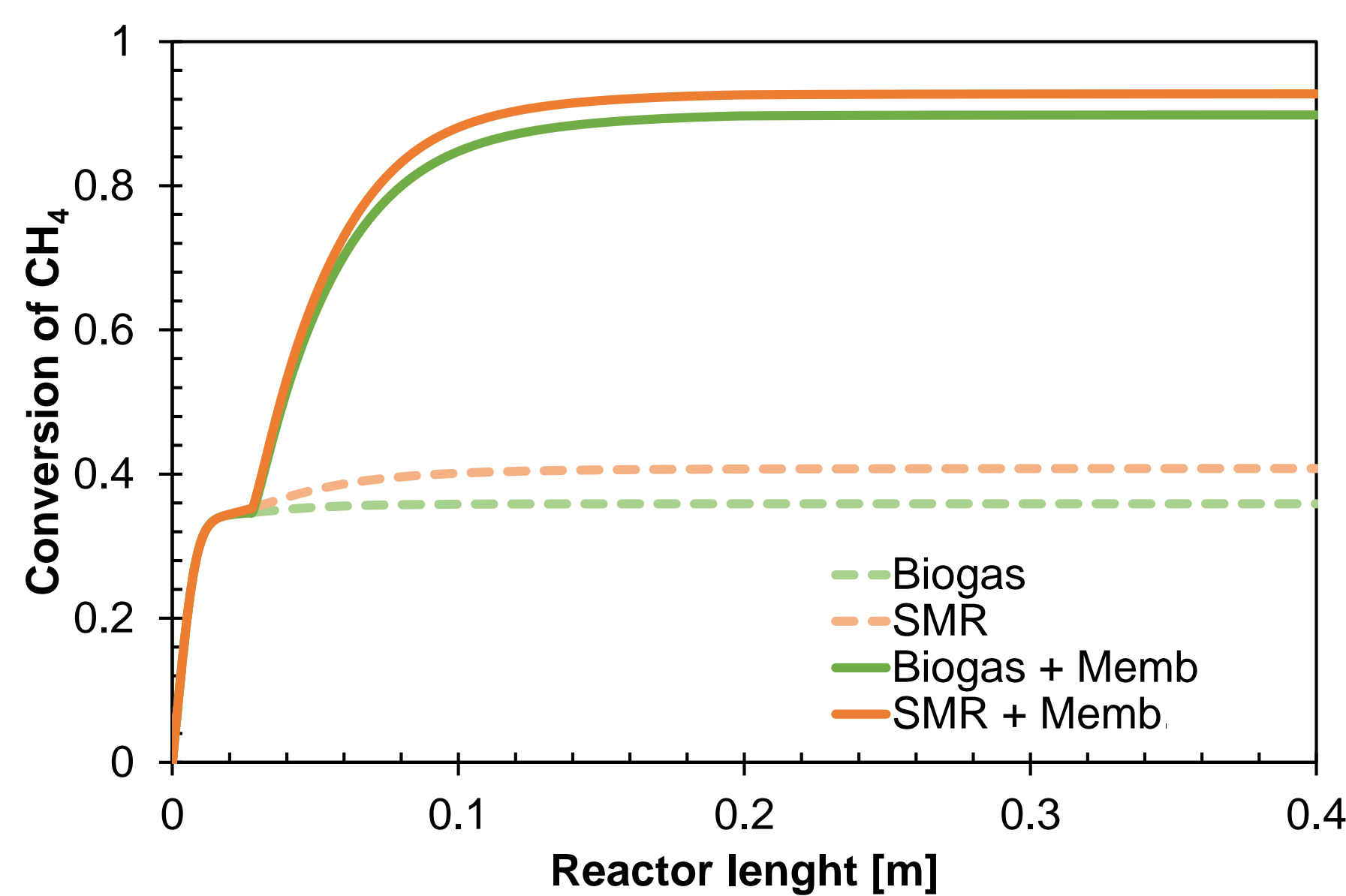
8 Partners (3 RES, 3 IND, 2 SME)  
 7 Countries (IT, ES, NL, DE, UK, PT, CH)  
 3.4 ME project (3.1 ME funded)  
 36 months  
 ✓ Sept. 2015 Project STARTS  
 ✓ Dec. 2017 Reactor prototype ready  
 ✓ Feb. 2018 Pilot plant start-up

## CATALYST

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 to operate in a fluidised bed regime maintaining its activity under membrane reactor operating conditions. PGM doped alumina catalysts have been tested under biogas reforming conditions for both steam and dry reforming.

## LAB SCALE REACTOR

Definition of the lab scale reactor performances and identification of the best design for prototype pilot. The objective is the selection and the integration of the membrane reactor components: catalysts, supported membranes and sealing. Pd-Ag membranes have been tested at lab scale to identify the sealing method to be used in BIONICO and assess the effect of different contaminants on the membrane stability. In parallel, dry and wet reforming are being tested on the catalyst.

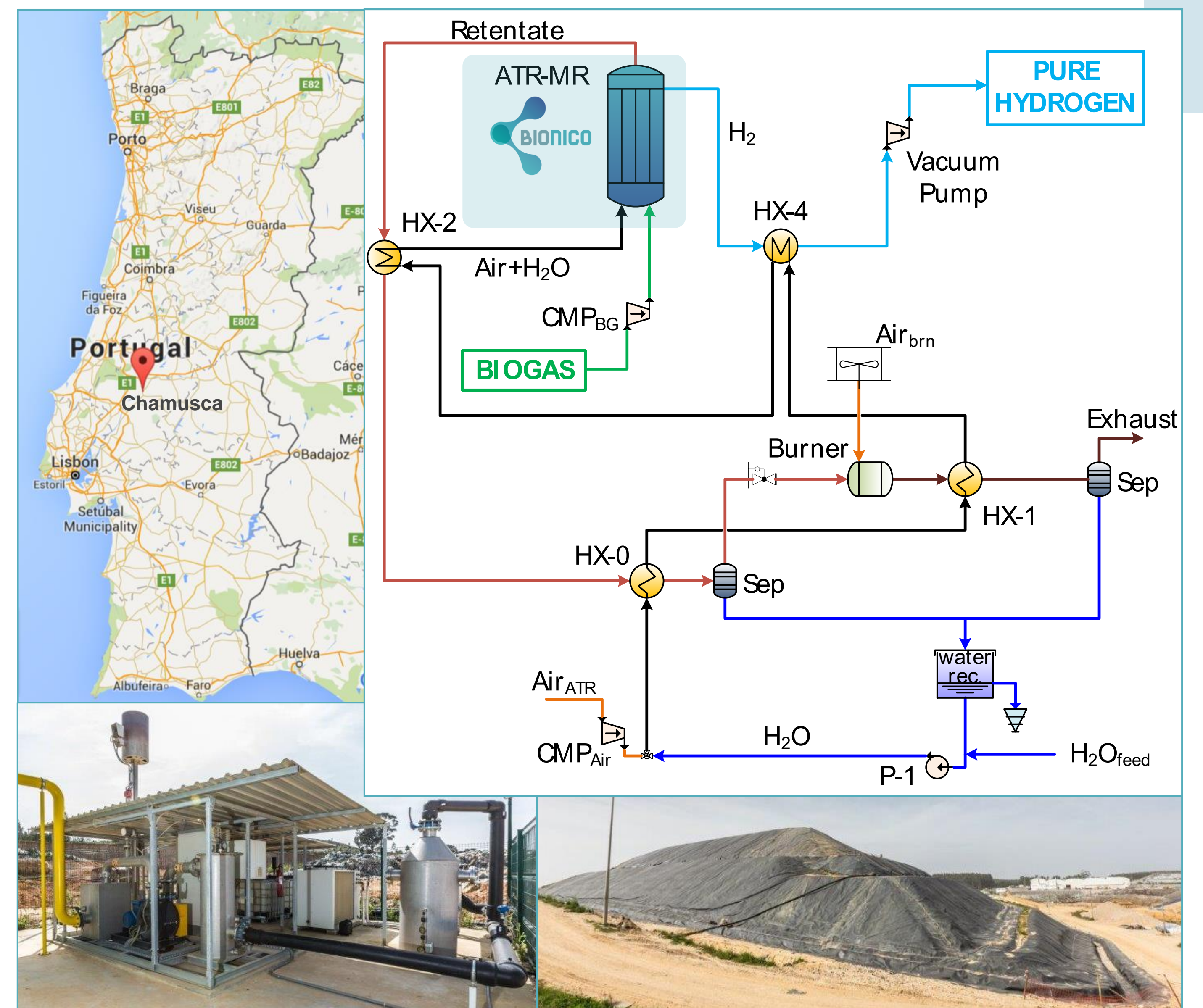


## MEMBRANE DEVELOPMENT

Development of Pd based tubular supported membranes, for application in biogas reforming catalytic membrane reactors. The objective for the membranes is to have high H<sub>2</sub> permeance and selectivity, good stability at high temperature (550-600 °C) and enhanced sulphur resistance and durability in a fluidization regime.

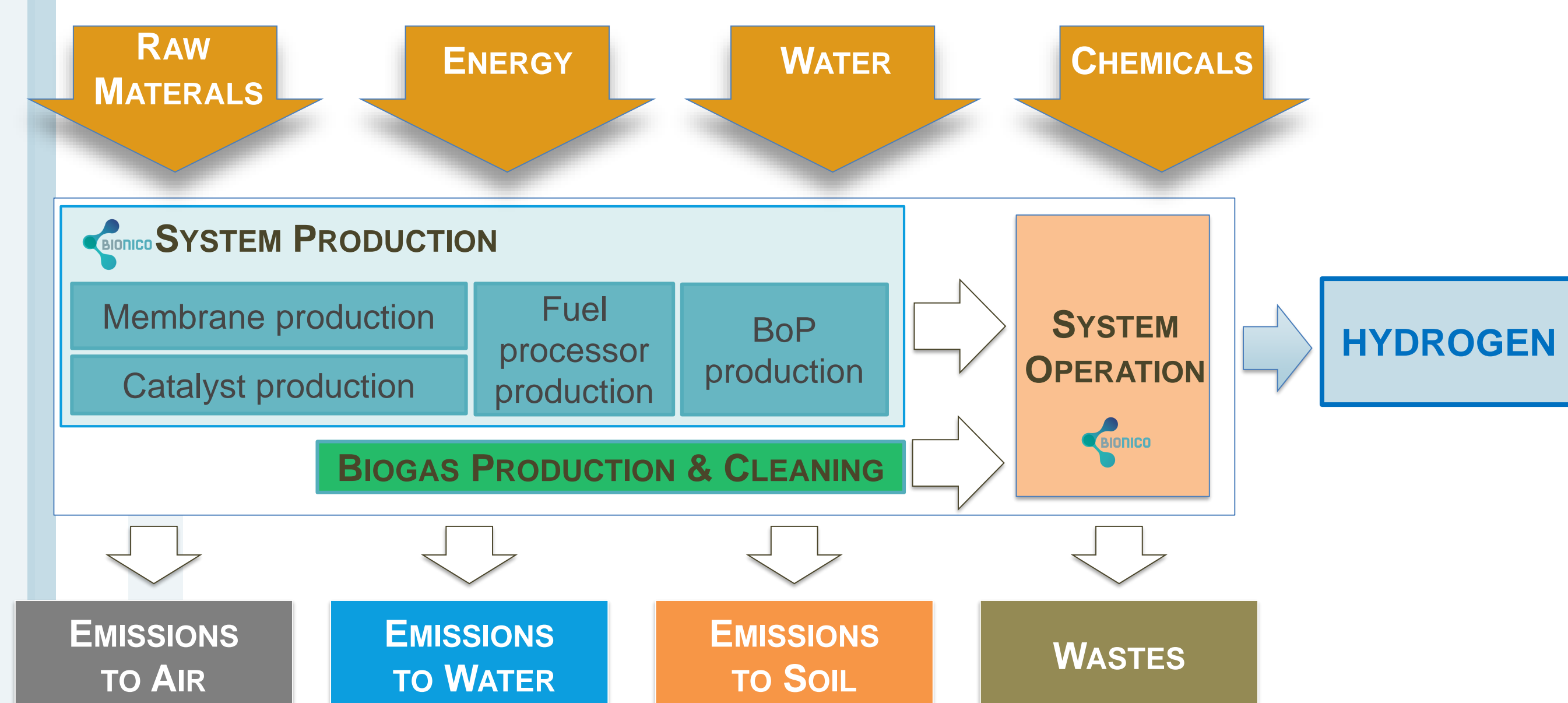
## PROTOTYPE REACTOR AND PILOT PLANT

The membrane reactor prototype based on ATR fluidised bed configuration will include more than 100 membranes. The prototype reactor, the control system and BoP will be designed and integrated in a real biogas production site at ENC Landfill plant in Chamusca, Portugal. A system model will be validated with test results and a final techno-economic analysis will be assessed.

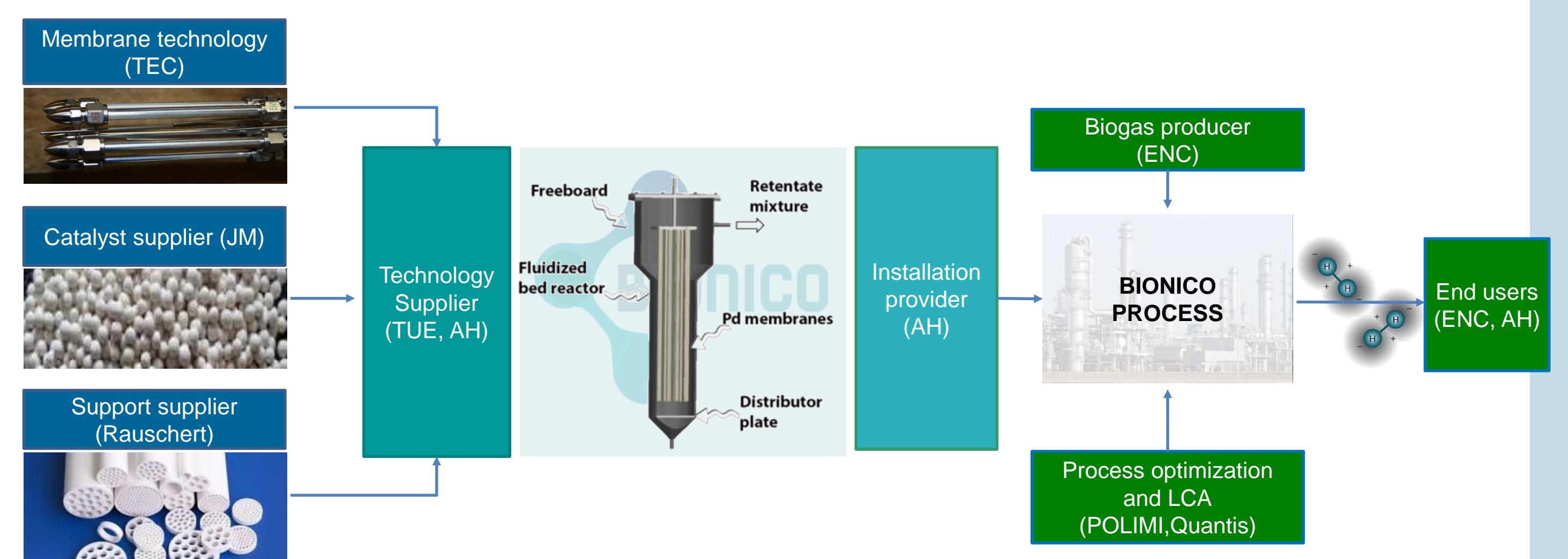


## LIFE CYCLE ASSESSMENT & SAFETY ISSUES

The novel system based on CMR technology will be evaluated through an Environmental Life Cycle Assessment analysis to develop a strategy towards a more environmentally-friendly design. The safety analysis of the developed CMR prototype will be assessed and it will produce proposals of recommendations for the safe operation of the BIONICO system.



## BIONICO VALUE CHAIN



EUROPEAN BIOGAS ASSOCIATION CONFERENCE – 27-29 SEPTEMBER 2016, GHENT, BELGIUM



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.