HyTIME
(278855)

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DLO-Food and Biobased Research

Project & Partnership description

General Overview

- Full title: Low temperature hydrogen production from 2nd generation biomass
- Duration: 3 years from Jan 1, 2012
- Budget: Total budget M€ 2.92; FCH-JU grant M€ 1.32
- Partners: 6 industries, 2 universities, 1 research organisation

Partners in the EU

HyTIME

FOOD & BIOBASED RESEARCH
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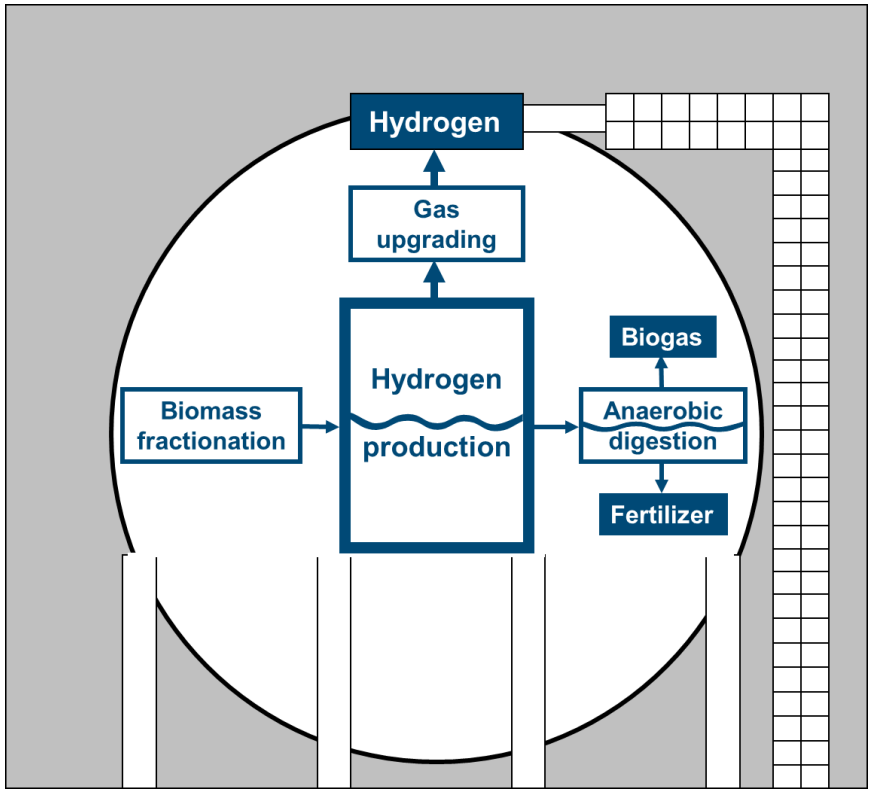


Projectplan of HyTIME

Hydrogen production:

$C_6H_{12}O_6 + 2H_2O \rightarrow 2CH_3COOH + 2CO_2 + 4H_2$

Anaerobic digestion:

$2CH_3COOH \rightarrow 2CO_2 + 2CH_4$

Project goals, targets, milestones

Overall objective: To accelerate the implementation of an industrial bioprocess for decentral hydrogen production systems using 2nd generation biomass

Overall target: Construction of a prototype fermentation for production of 1-10 kg hydrogen/day

WP 2 Biomass supply and fractionation

Goal: Optimization of supply ánd fractionation of 2nd generation biomass

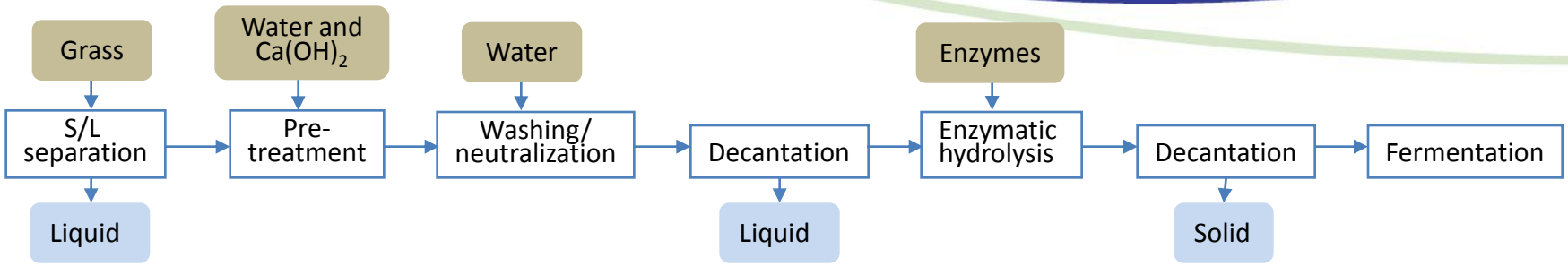
Milestones

- Security of biomass supply M12
- Mobilization of sugars M15
- Validation of dedicated fractionation technology M21

Approach

- Sustainable 2nd generation biomass: straw, grass and unsold fruits and vegetables
- Logistics of selected biomass
- Pretreatment and hydrolysis of biomass
- Validation of fractionation in fermentation

WP 2 Biomass supply and fractionation



Pretreatment at DLO-FBR of verge grass collected in NL by Heijmans

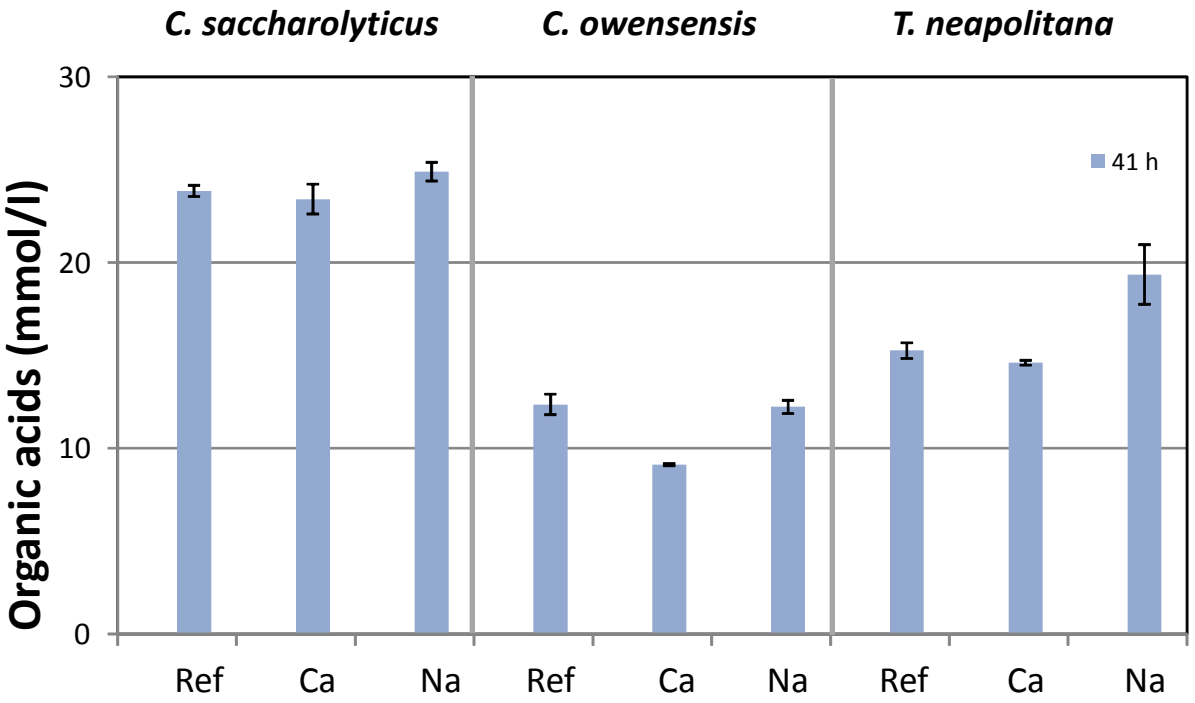
Grass and herbs from roadside

Extrusion for solid/liquid separation at circa 100 kWh/tonne dry matter

$Ca(OH)_2$-pretreatment at 85-100 C, 7.5% on dry matter for increased accessibility

WP 2 Biomass fermentability

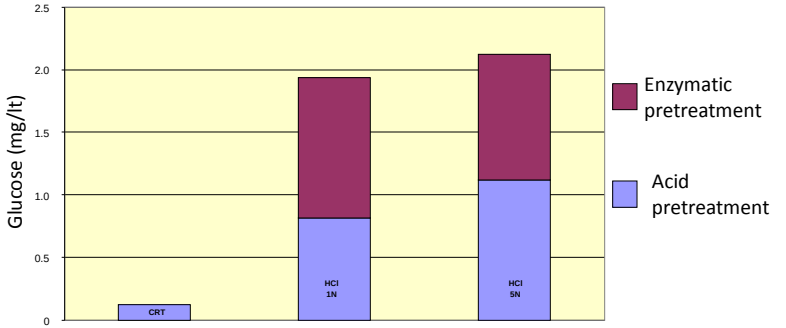
Acid production by thermophiles from hydrolysates of pretreated grass



WP 2 Biomass supply and fractionation

Pretreatment and hydrolysis of fruit and vegetable peels collected in the canteen of Envipark

Acid pretreatment (HCl 1-5N at 50 C for 1h)
Enzymatic pretreatment (cellulase+cellobiase 1mg/g biomass) at 37 C for 24h



Final glucose concentration in the hydrolysate was 2.3 g/L

WP 3 Thermophilic hydrogen fermentation

Goal: Fermentative hydrogen production at 1-10 kg/day from 2nd generation biomass

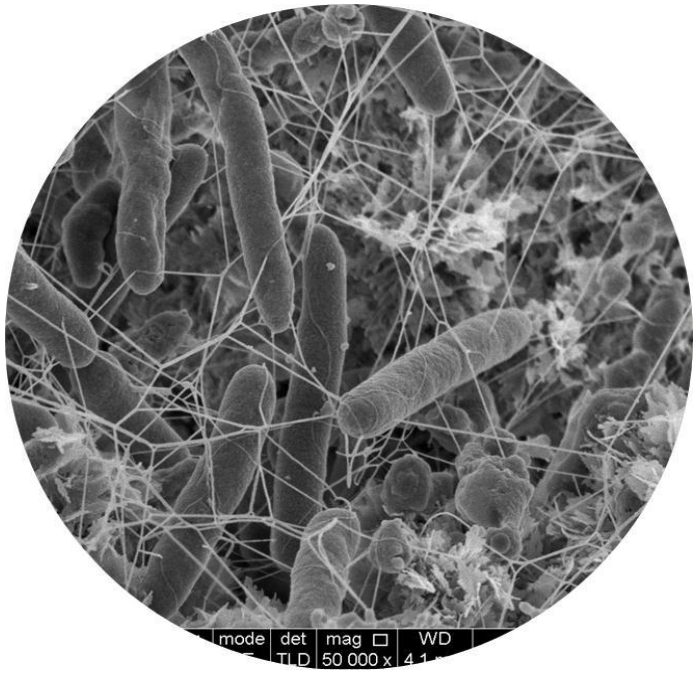
Milestones

- Security of biomass supply M12
- Efficient H_2 production at 50 L scale M18
- 50 g H_2 /day and 80% yield at 50 L scale M24
- Construction of prototype high rate bioreactor M30
- 1-10 kg H_2/day and 80% yield from 2nd generation biomass

Approach

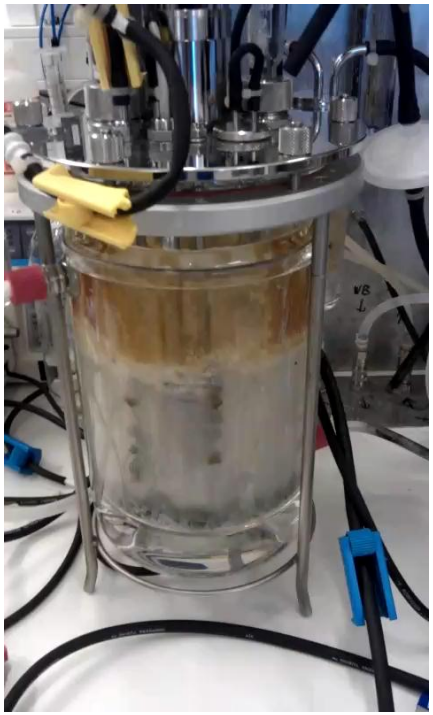
- Evaluation of high rate H_2 production
- Critical parameters for upscaling
- Design and construction of a 50 L reactor
- Optimization and stability of H_2 production
- Construction of process control system
- Implementation of fuzzy logic automation
- Construction of high rate pilot reactor for 1-10 kg H_2 /day

WP 3 Thermophilic hydrogen fermentation

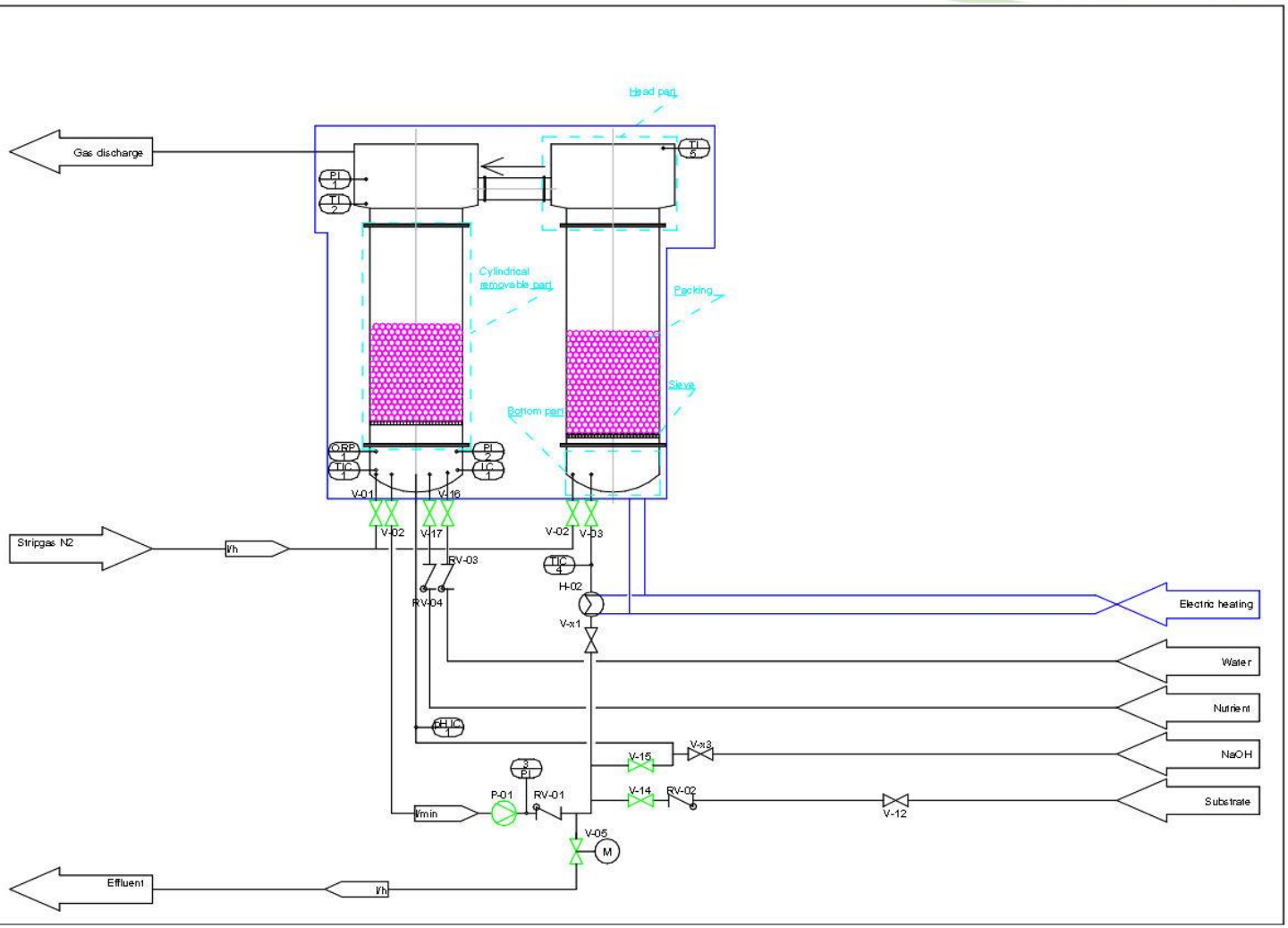


Caldicellulosiruptor sp. on zeolite for immobilization of biocatalyst

CSTR for H_2 production at 0.5-1 g/day

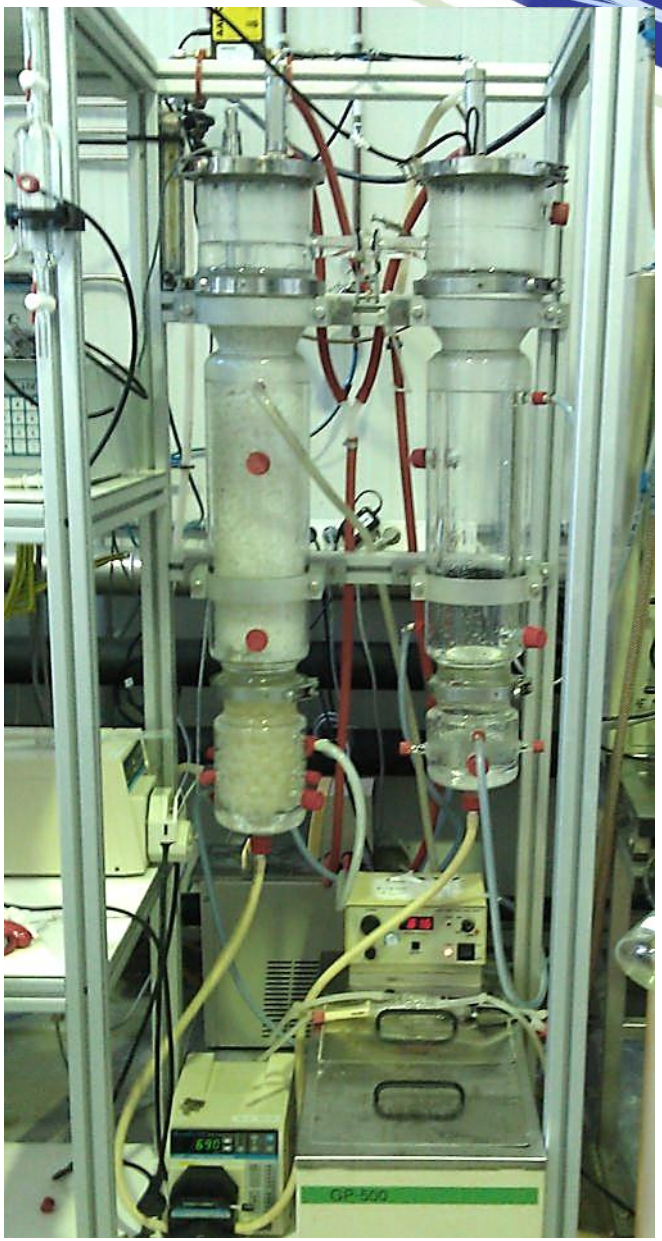


WP 3 Thermophilic hydrogen fermentation



Design of 50 L pilot plant for hydrogen fermentation

WP 3 Thermophilic hydrogen fermentation



6L fixed bed bioreactor

with gas disengager

WP 4 Gas upgrading

Goal: Hydrogen recovery and purification

Milestones

- Definition of in-and output gas composition M6
- Definition of gas upgrading process for upscaling M21
- Design of the pilot scale gas upgrading unit completed M30

Approach

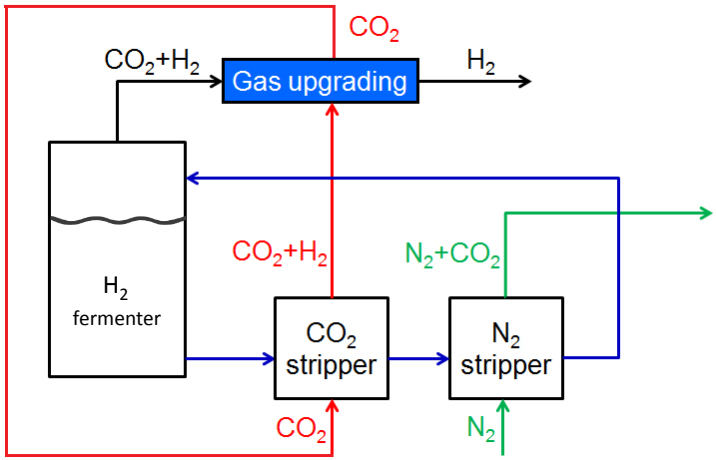
- Identification of boundary conditions
- Development of low P and T H_2 upgrading
- Test of an integrated upgrading system
- Recovery of H_2 from liquid phase
- Development of innovative analyzers for process control

WP 4 Gas upgrading

Major components: H_2 10-50%; CO_2 10-40%; H_2O 10-60%)

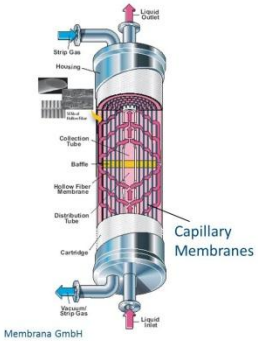
Minor components:

- H_2S: 600 - 1500 ppm (Schnitzhofer et. al., 2010)
- CH_4: not detected (van Groenestijn et al., 2008)
- other disturbing components (no data available yet, ammonia, formic acid, acetic acid, formaldehyde, halogenated compounds, inert gases, particulates



Gas upgrading system

- PSA
- MC



Envelope MC

Hollow fibre MC

WP 5 System integration

Goal: Maximum product output at minimum energy demand

Milestones

- Basic balances for process steps M15
- AD treatment for biogas M30
- PFD of biological system at pre-commercial scale M33

Approach

- Mass and energy balances
- Anaerobic digestion of liquid effluent
- Design of a biosystem for 10-100 kg H_2/d
- Techno-economic evaluation

Achievements versus AIP 2010 targets

Topic SP1-JTI-FCH.2010.2.4:

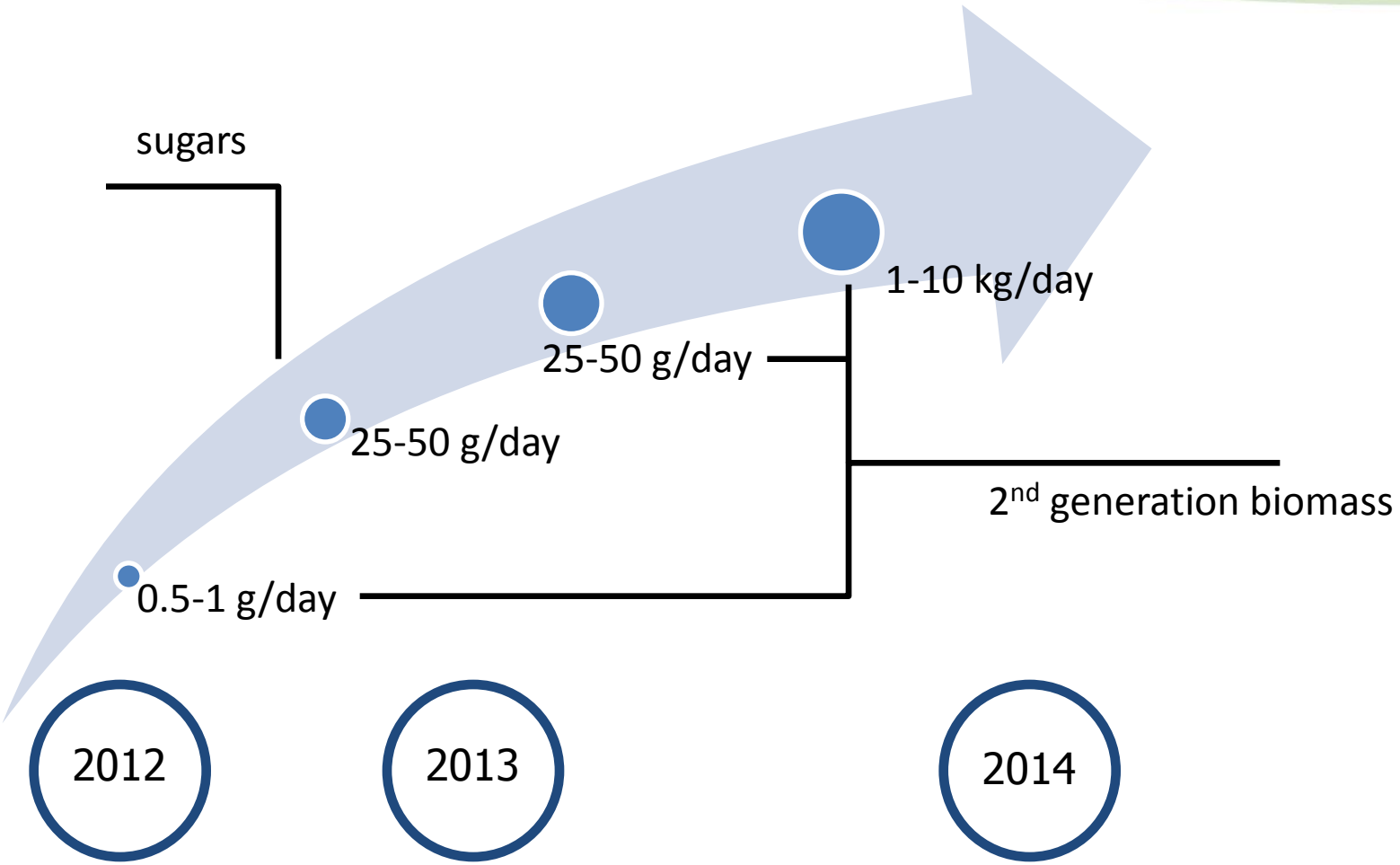
Low temperature H_2 production processes

Expected outcomes:

2. Biological fermentation technologies

- Biological hydrogen producing digestion systems based on 2nd generation biomassfeedstock
- Production of hydrogen utilizing different waste biomass focusing on those that allow a sufficient productivity (1-10 kg/d H_2)
- Develop bio-hydrogen production systems as a stepping stone for pre-commercial applications (expected to reach production rates of 10-100 kg/d H_2)
- Setting up and testing of a continuous process prototype (1-10 kg/d H_2)

Time-scale of achievements



Training and education

Lectures

- Biofuels for transport. Postgraduate course Wageningen Business School, March 2012 (DLO-FBR)
- Conventional biofuels and 2nd Generation biomass pretreatment. Summerschool University of Foggia, July 2012 (DLO-FBR)
- Fractionation of lignocellulosic biomass for the integrated biorefinery. Biorefinery training course Wageningen, October 2012 (DLO-FBR)

Training

- Students from Spain through the Leonardo network on pretreatment of biomass (DLO-FBR)
- Internship in collaboration with University of Turin on pretreatment and fractionation of biomass and production of biohydrogen (ENVIPARK)
- PhD and MSc students on modelling in biogas utilisation (TUW)
- High school students for demonstration of research facilities for hydrogen fermentation and analysis (DLO-FBR)

Dissemination

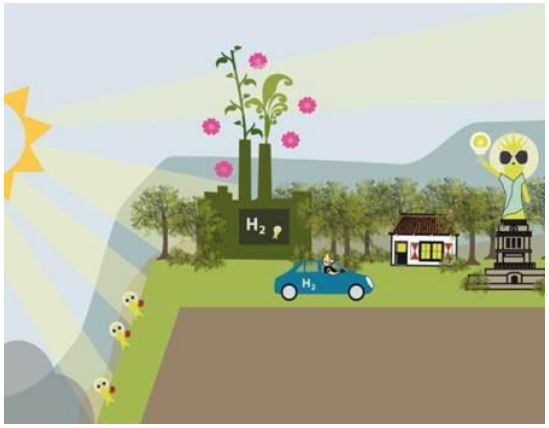
- Press release “Start of HyTIME” by DLO-FBR and ENVIPARK, March, 2012
- HyTIME website: www.hy-time.eu
- Link to HyTime website on ENVIPARK website: http://www.envipark.com/area-stampa/prosegue-il-progetto-europeo-hy-time-per-la-produzione-del-bioidrogeno/

- Workshop for the biobased economy Terneuzen, February 2012 (DLO-FBR)
- World Hydrogen Energy International Conference and Exhibition: WHEC Toronto, June 2012 (WIED-PP)
- World Exhibition Congress on Chemical Engineering, Environmental Protection and Biotechnology: ACHEMA Frankfurt, June 2012 (TUW)
- 17th International Conference on Oil Palm Cartagena, Colombia, September 2012 (DLO-FBR)

Technology transfer

- Thai-German Graduate School of Engineering (TGGS): Development of integrative biogas production process from rice straw for sustainable industrial applications (RWTH)
- Dutch Ministry of Economics, Agriculture and Innovation: Participation in Dutch policy-supporting project to set a research agenda for using verge grass and nature grass in the Biobased Economy (DLO-FBR)
- Central Europe Programme SEBE project: A pilot action dedicated to the pretreatment/fractionation of lignocellulosic biomasses (ENVIPARK)
- Regional Programme BioH_2 project: Biohydrogen production (ENVIPARK)
- Regional Programme HyStrem project: Pretreatment of agro-industrial wastes and dark anaerobic fermentation in mesophilic conditions (ENVIPARK)
- National University of Malaysia (UKM): Sustainable development in the palm oil industry (DLO-FBR)

Questions?



Thank you for the attention