ELYGRID

Improvements to Integrate High Pressure Alkaline Electrolyzers for Electricity/H2 production from Renewable Energies to Balance the GRID

FCH JU Water Electrolysis Day

Pablo Marcuello

Foundation for the Development of New Hydrogen Technologies in Aragon (Spain)

Brussels 3 of April 2014

PROJECT: FUNDED BY: PARYNERS: COORDINATOR:

Grant nº 278824

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ELYGRID – Project & Consortium

- **Elygrid**, Improvements to Integrate High Pressure Alkaline Electrolysers for Electricity/H_2 production from Renewable Energies to Balance the Grid (**www.elygrid.com**)
- Duration 36 months, from 01/11/2011 to 30/10/2014
- Budget: 3.752.760,80 € / Funding: 2.105.017,00 €
- 10 project partners from 5 countries (D, F, ES, CH, B): 4 large industry partners, 1 SME, 5 Research Centres.

COORDINATOR:

Inycom Ingeteam cea Ha

iht EMPA HELION JÜLICH vito lapesa

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State of the Art – IHT technology

High pressure alkaline water electrolysis developed by Zdansky for Lonza (Switzerland) in the 40s-50s

High pressure (32 bar)

Large scale (760 Nm3/h H2 per unit)

4.0 MVA – 3.5MW

Consumption 4.3 – 4.6 kWh/Nm3

Proven technology (decades), high reliability and lifespan

Flexible operation (25% - 100%)

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ELYGRID – Project & Consortium

State of the Art – IHT technology

Zimbabwe (1975) 21,000 Nm3/h H2
28 x 3.5 MW – 100MW

Peru (1965) 5,200 Nm3/h H2
7 x 3.5 MW – 25MW

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ELYGRID – Motivation & Goals

Contributing to the **reduction of the total cost** of hydrogen produced via electrolysis coupled to renewable energy sources (mainly wind turbines), and focusing on **mega watt size electrolyzers** (from 0,5 MW and up).

MAIN DRIVERS:

Big size alkaline electrolyzers

Leitmotiv: reduction of Total Cost of Ownership (TCO)

Prototyping and testing with intermittent feeding

Industrialization and market oriented approach

IHT electrolyser – 3.5MW – 760Nm^3/h H_2

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ELYGRID – Motivation & Goals

Correlation to MAIP (AA2):

- ***Quantitative targets in MAIP***

AA2 - Production: Distributed production of hydrogen by water electrolysis	2010 baseline	2015 mid-term	2020 long-term	ELYGRID goals 1st 2015
Unit capacity (Ton/d)	1,5	1,5	3	3,5 - 4
Efficiency (%)	65	68	70	>70% stack efficiency
Cost (M€/(t/d))	3,1	2,8	1,9	In progress

- ***Priorities of the MAIP application areas – Hydrogen Production & Distribution***

  "Main emphasis […] on research and development of mature production and storage technologies […] cost-efficient low-temperature electrolysers adapted for the large-scale use of carbon free electricity"

- ***Long term vision***

  "In the 2050 vision, […] hydrogen will be used as an "energy buffer" to balance the production and demand cycles of intermittent power sources integrating large volumes of renewable energy in the energy system."

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ELYGRID – Motivation & Goals

S/T Goals

Double current density + lower cell voltage

Redesign and optimize AC/DC converter

Optimize stack components and BOP (incl. control)

Test and validate

Detect cost improvements and adapt manufacturing

Analysis the future market and communicate

Avoid future stoppers (RCS, LCA)

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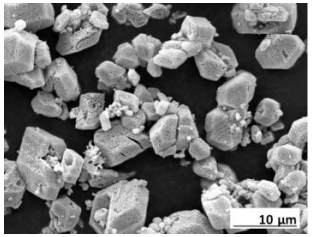
ELYGRID – Motivation & Goals

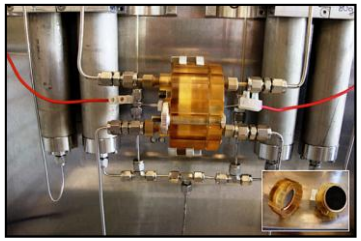
Validation Strategy



Materials

Test bench130 mm
(real conditions)

Concept validation
(real size – except power)



Functionality
(lab conditions)

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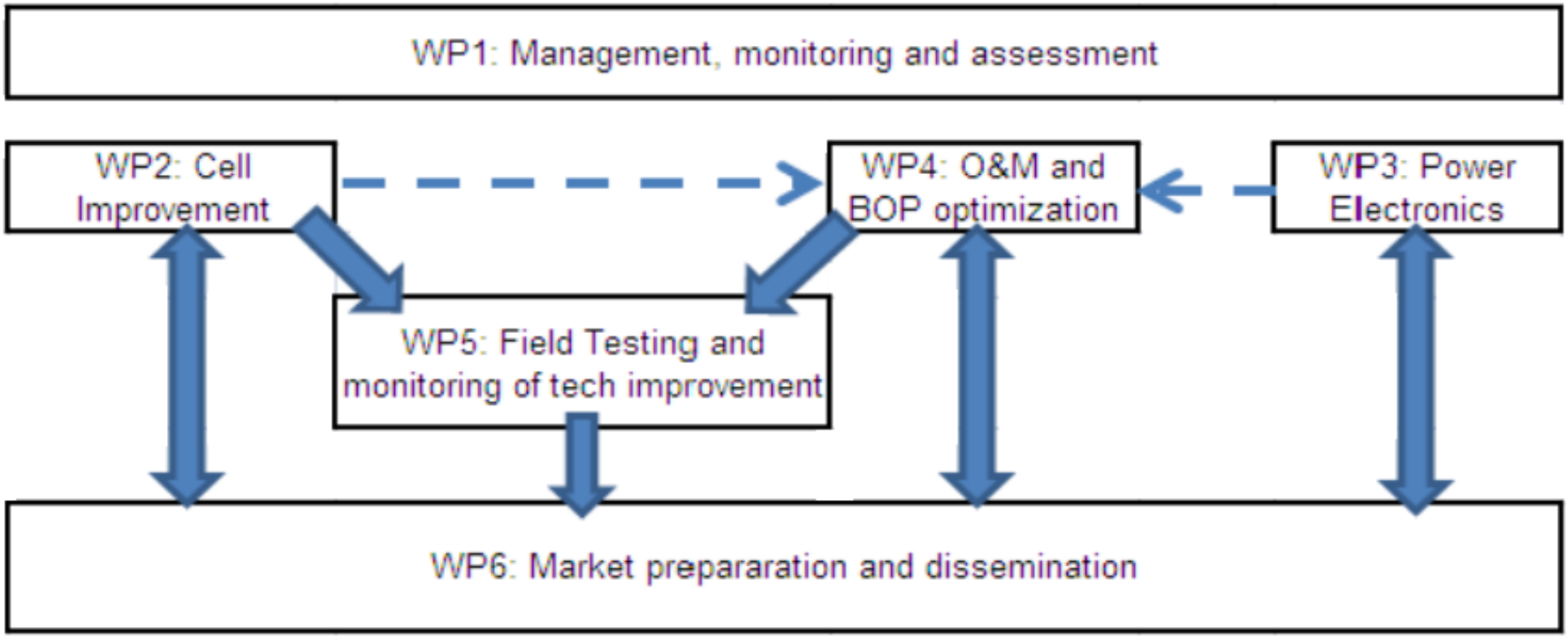
ELYGRID – Work package development

WP structure



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ELYGRID – WP development. WP 2 – Cell Improvement

Goal: Develop materials for increased KOH temperature and concentration and increase current density (-> decrease cell voltage and increase efficiency). Identification of the critical factors for the membrane efficiency.

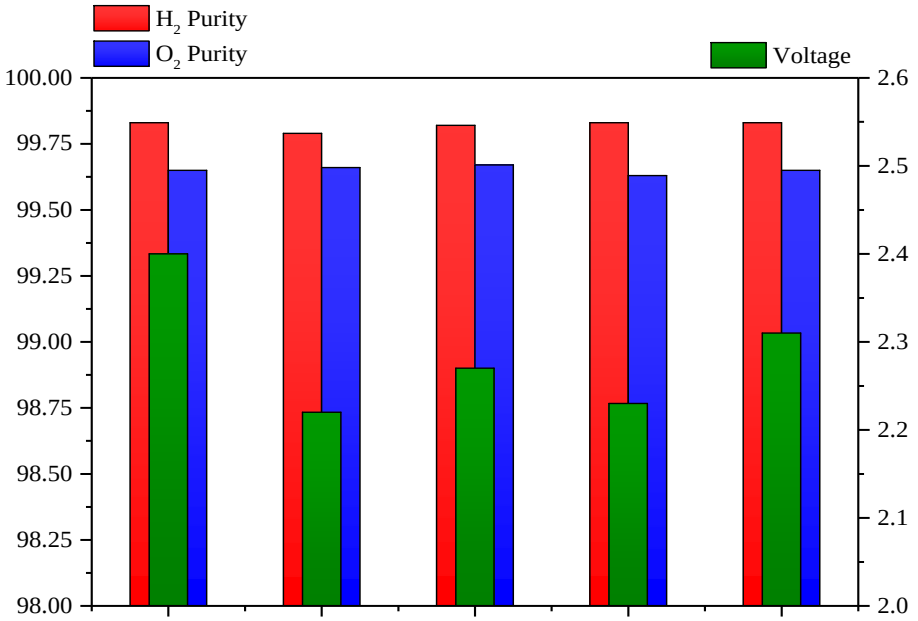
Progress:

Down selection on materials. Cost and manufacturability assessment.

Membrane characterization.

Next Steps:

Further experiments (corrosion and electrochemical at operation T and P) in 130 mm.



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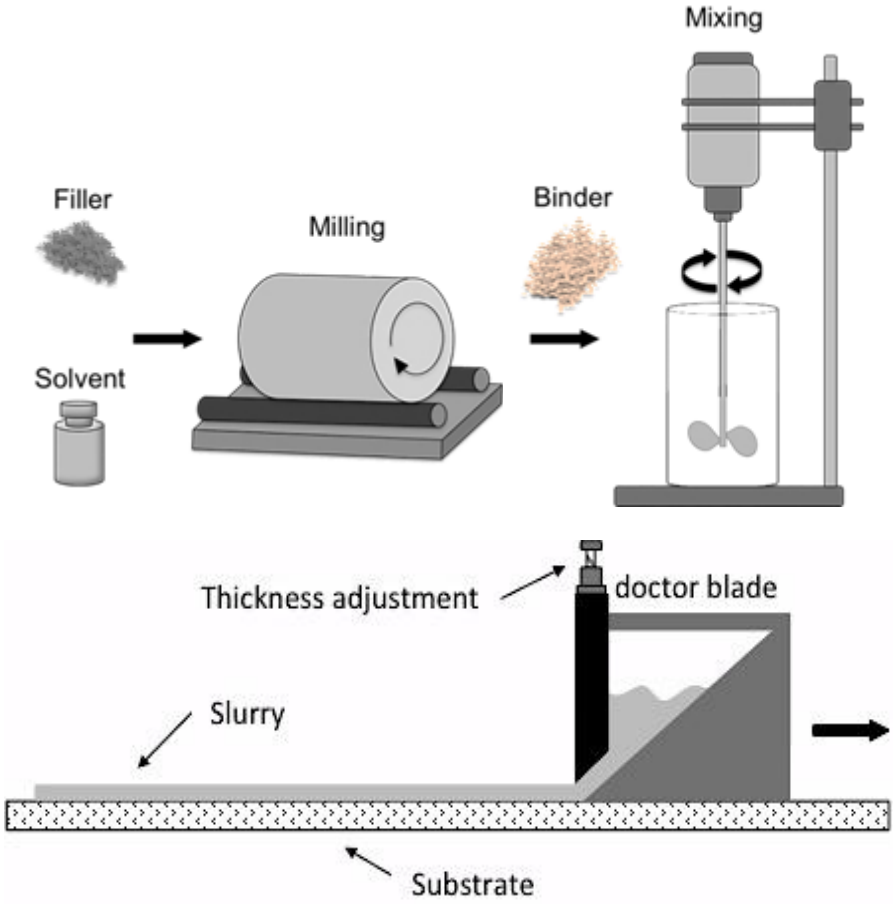

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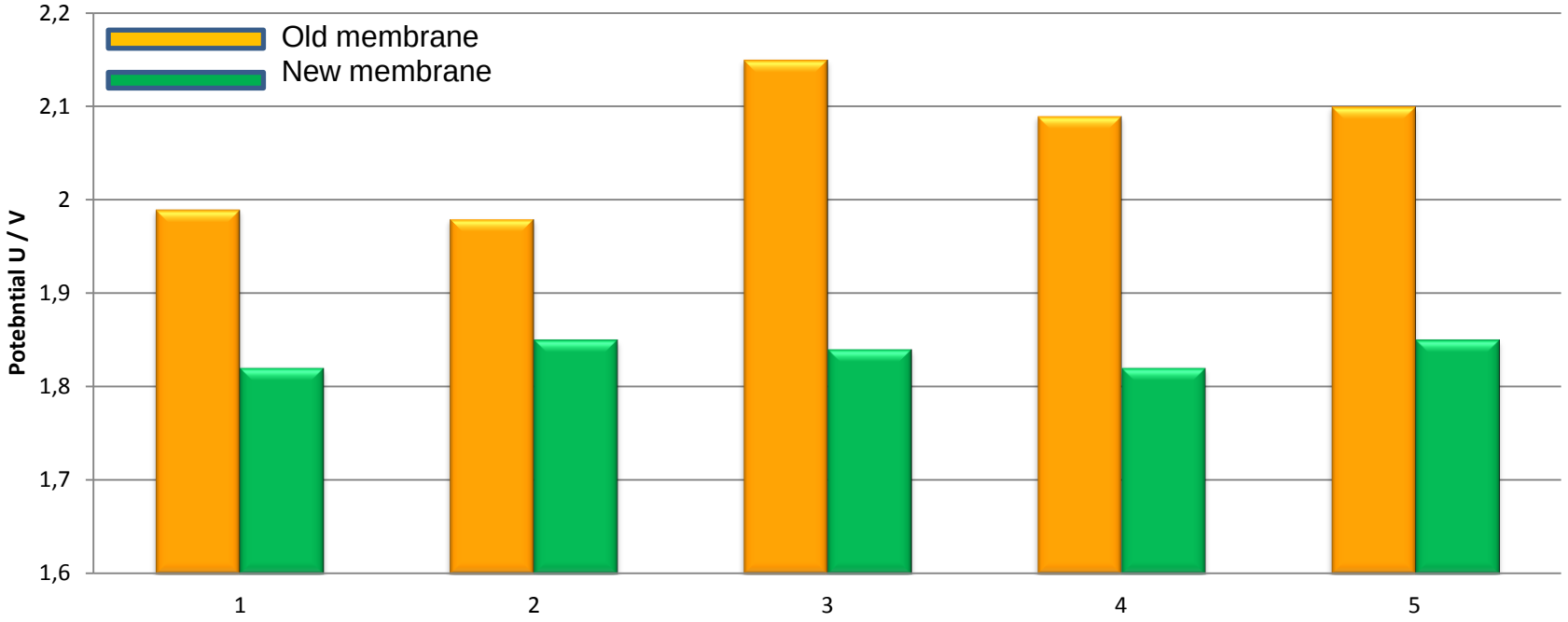
ELYGRID – WP development. WP 2 – Cell Improvement

Old vs new cell technology at working conditions (30 bar, ~ 80 ºC)



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ELYGRID – WP development. WP 3 – Power electronics

Goal: Study effect of electric power supply topology on the electrolyzer efficiency at full and partial loads. Analysis of different topologies of power supplies. Technical requirements to build an electrolyzer power supply emulator/prototype able to match renewable energy electricity

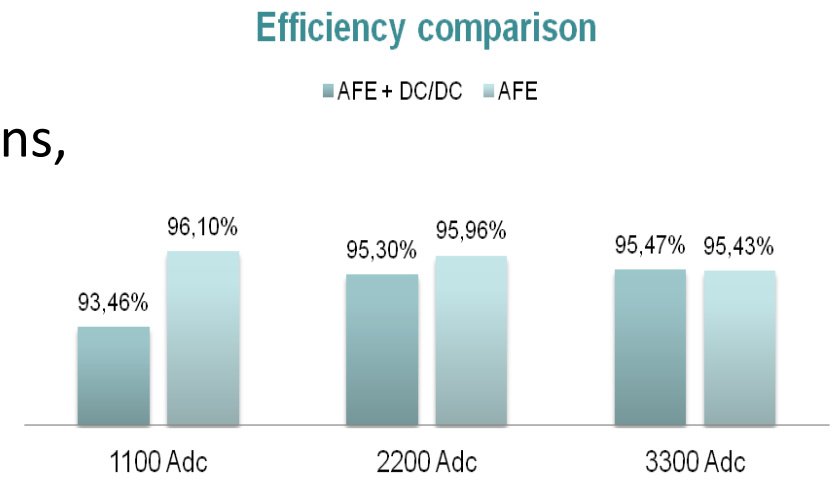
Progress

Definition, analysis and simulation of
8 different power electronic configurations,
3 retained, 1 selected.

Prototyping completed

Next Steps

Full scale (MW) validation in lab conditions



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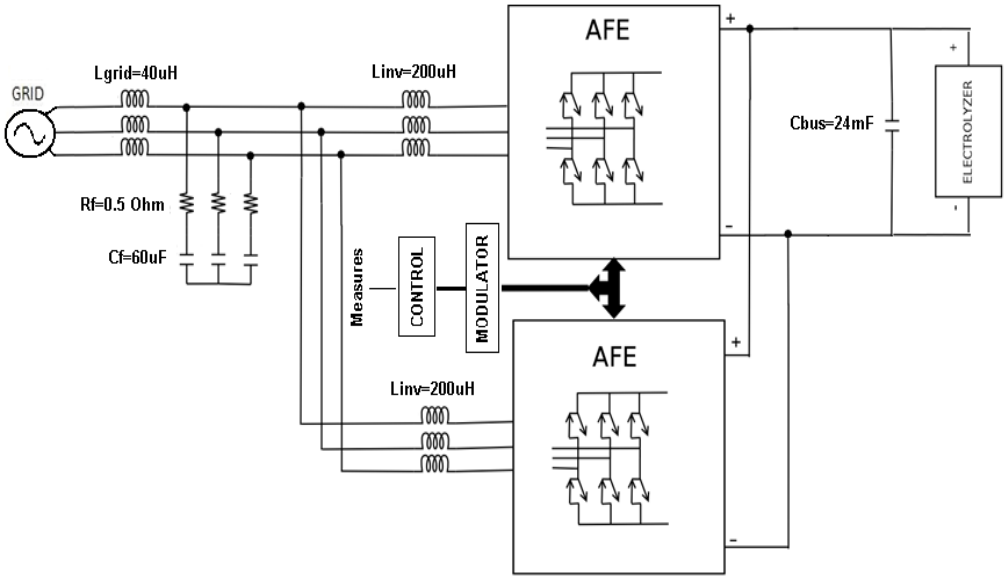

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ELYGRID – WP development. WP 4 – O&M and BOP optimization

Goal: Identify technical improvements related to Balance of Plant (BOP). Improvements on regular O&M actions. Re-design BOP with the objective to reduce the total cost with better functionality.

Progress:

Tests in different operating conditions. QRA.

Models developed

Redesign of main components

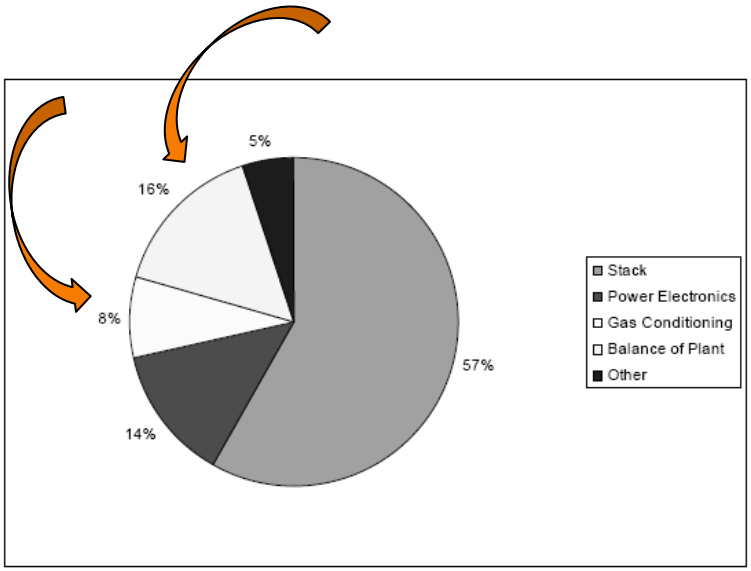
Dimensioning and pre-design of modular design

New control system

Next Steps:

Test new control system in real operation

Complete redesign of MW electrolyser



NREL (National Renewable Energy Laboratories, USA) entitled "Wind-To-Hydrogen Project: Electrolyzer Capital Cost Study. Technical Report December 2008"

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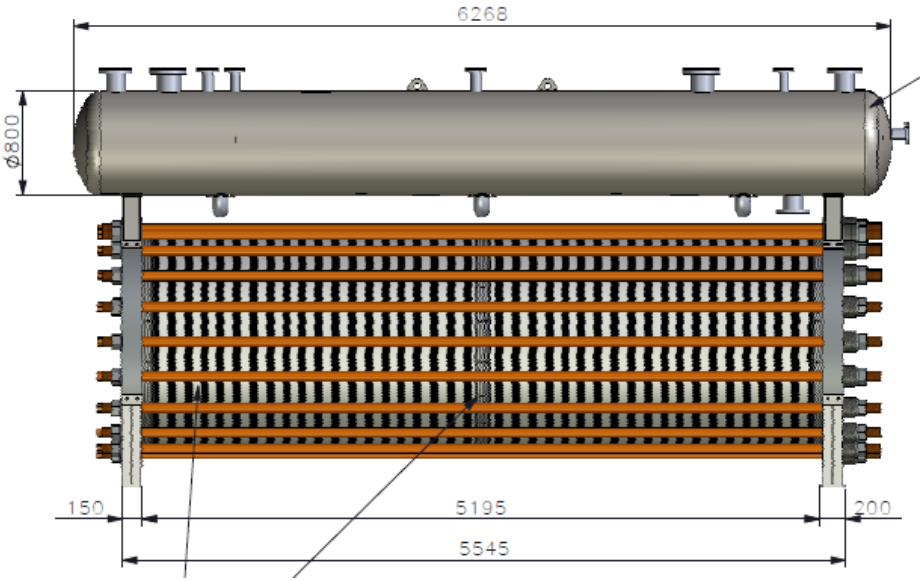
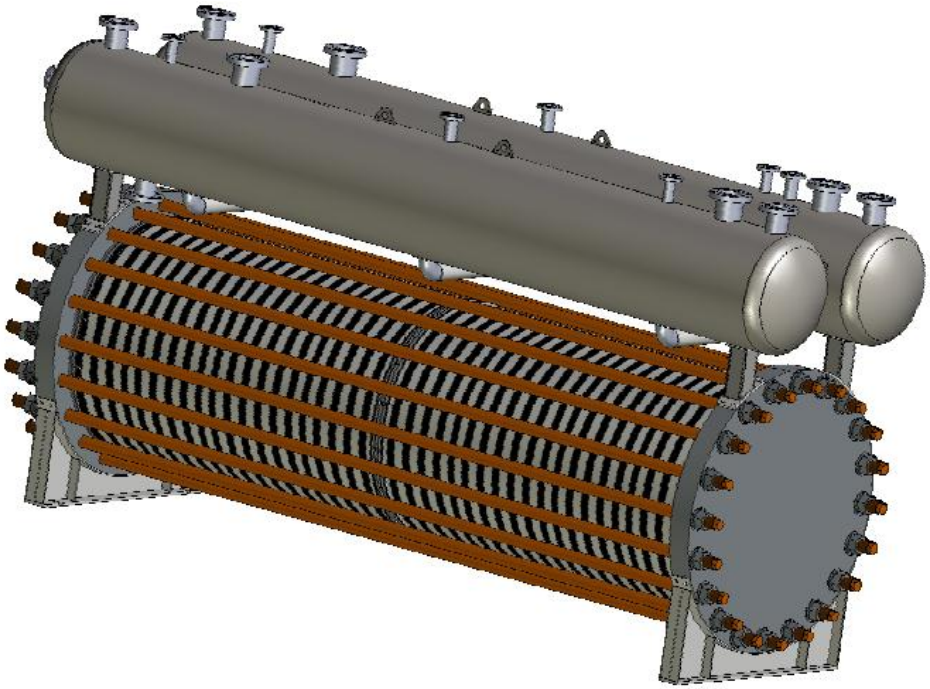
ELYGRID – WP development. WP 4 – O&M and BOP optimization

New mechanical redesign





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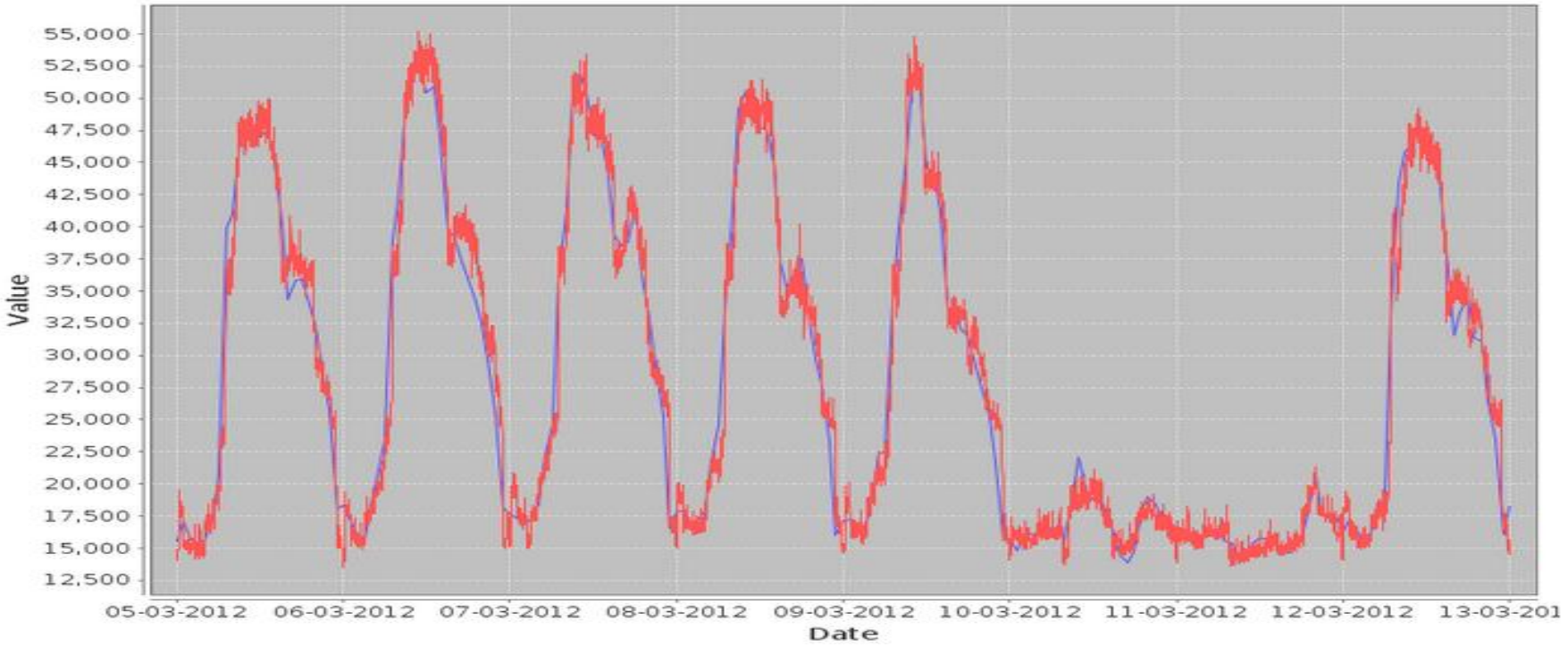
New control system – integration with RREE



Consumption estimation (KW)

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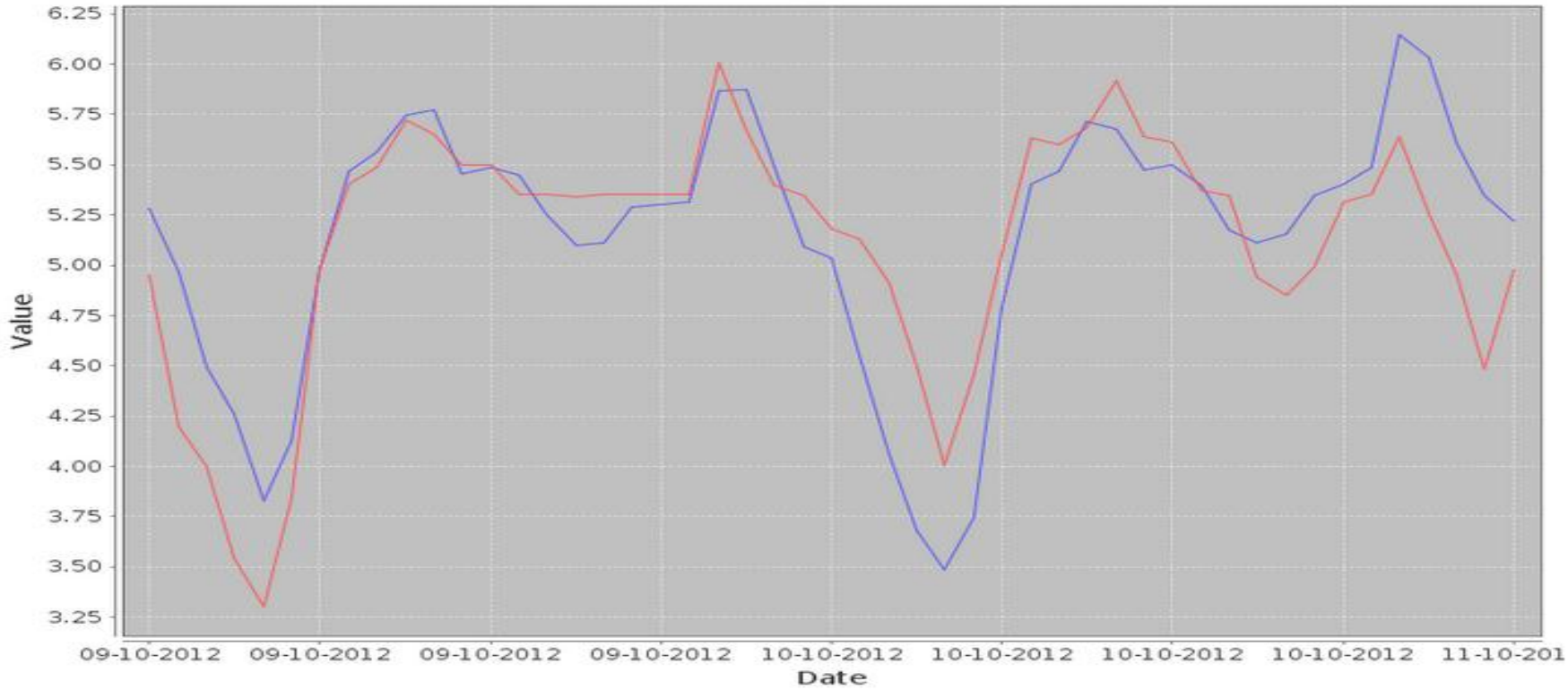

Price estimation (cEur/kWh)

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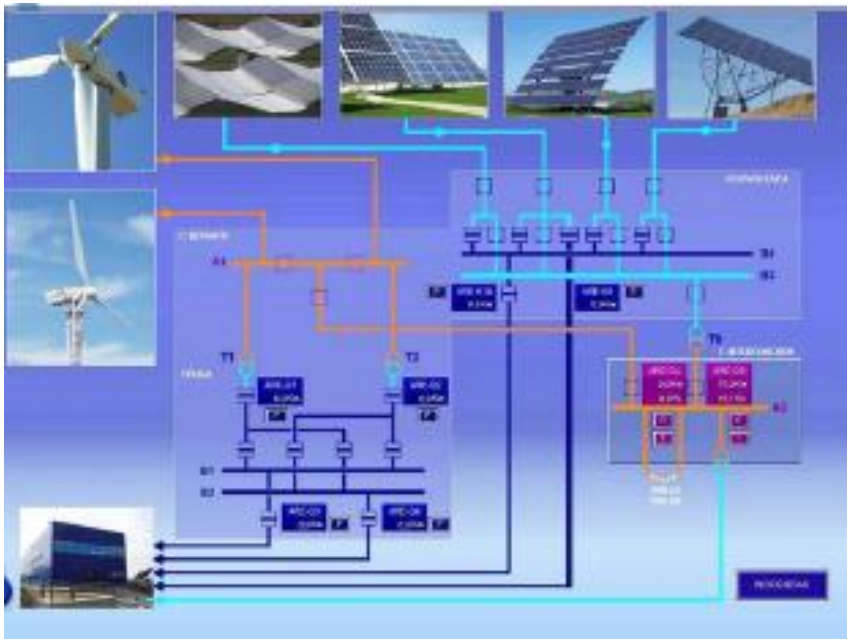
ELYGRID – WP development. WP 5 – Field testing

Goal	Implementation of field trials for electrolyzer integrated with RES.
Progress	New cell technology tested at 1:1 scale with promising results (current density/gas production x 2, lower consumption)
Next steps	More tests coupled to RES



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ELYGRID – WP development. WP 6 – Market preparation&dissemination

Goal

Business cases development + identification of potential uses & specifications

Standardization & identification of barriers to commercialization

LCA, RCS and homologation

Cost reduction potential & industrialization

General dissemination & conveying marketing message to the potential users

Progress

RCS activities explore specifically the need (or not) of new codes

LAC/LCI analysis points out the weight of the electricity consumption

Techno-economic and market studies (the “crystal ball”)

Communication activities

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ELYGRID – Expected results

“go-to-market”

- *Target: validation of improved technology*

…with a several MW electrolyser unit size

- *Target: double current density*

…at an attractive level of price

- *Target: reducing of CAPEX (-25% according to DoW)*

…offering a competitive level of OPEX

- *Target: reducing energy consumption (-20% according to DoW)*
- *TCO as tool to solve the trade-offs between CAPEX/OPEX*

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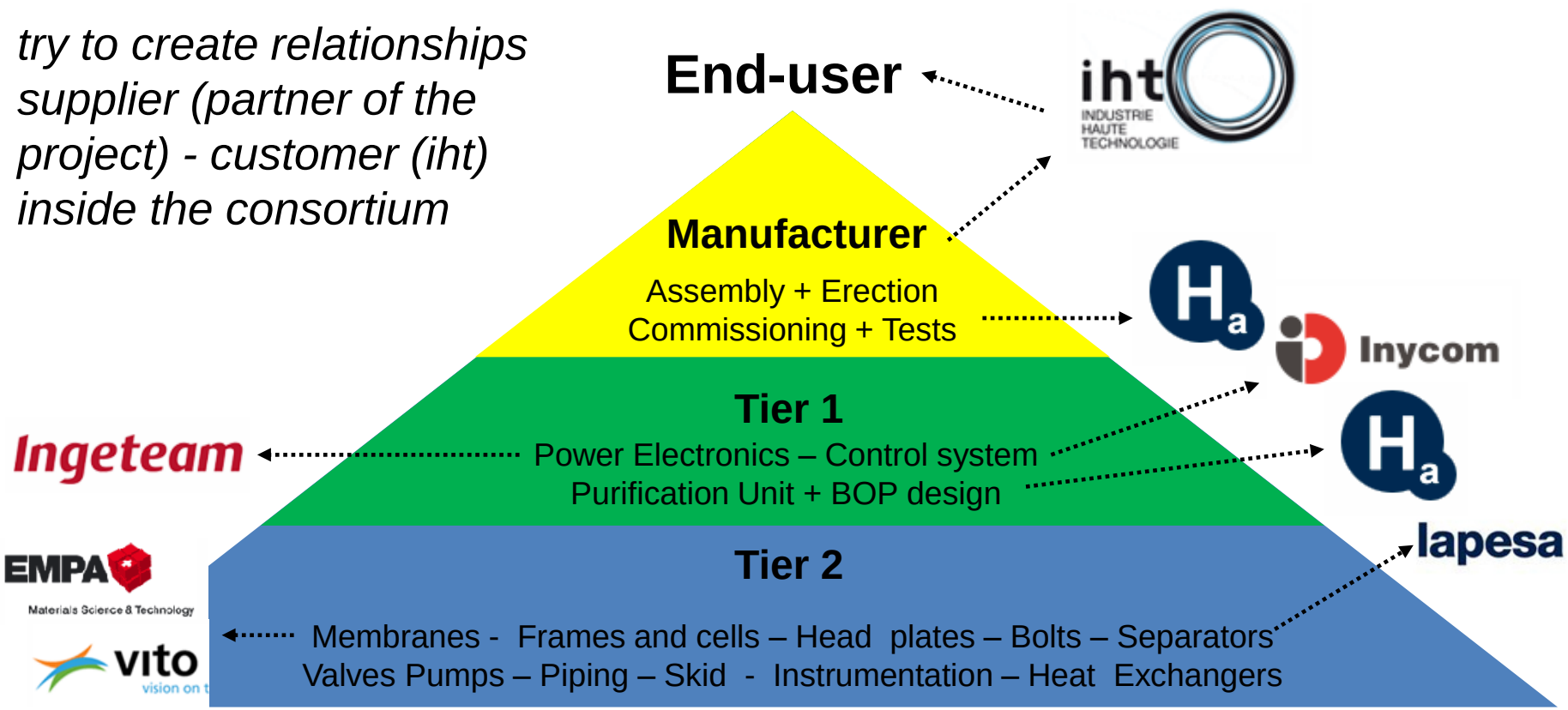
ELYGRID – Expected results

Added Value Chain Structure

try to create relationships supplier (partner of the project) - customer (iht) inside the consortium



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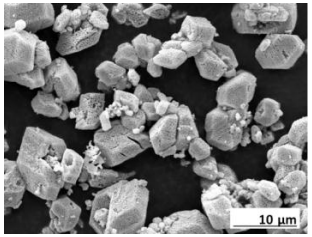
ELYGRID – Continuation plan

Future projects



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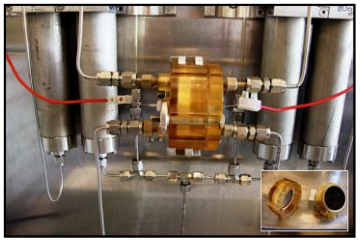

Functionality
(lab conditions)

Demo trials
(outside Elygrid)

Market

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ELYGRID – Continuation plan

Exploitation and Post-Project Activities: ***already exploring possibilities for a full scale demo (several MW)***

Starting date: ***beginning 2015***

Looking for potential customers: ***transport use, industry, utility, network operators, H2 system operators…***

Demonstration of the current ***SOA electrolysers***

Looking for ***new business models*** *to increase revenues of H2 produced by electrolysis*

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http://www.elygrid.com/
http://www.hidrogenoaragon.org

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THANK YOU FOR YOUR ATTENTION

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