Hydrogen Energy in Brazil
2020

AB
H2
ASSOCIAÇÃO
BRASILEIRA DO
HIDROGÊNIO

ASSOCIAÇÃO BRASILEIRA DO HIDROGÊNIO

About ABH2

The Brazilian Hydrogen Association (ABH2) was founded in April 2017 with the objective of fostering hydrogen within Brazil. The association actively brings together main Brazilian players involved in the hydrogen and fuel technologies, including scientists, companies and legal entities interested in matters related to research, innovation and professional development of the hydrogen industry.

What we do

Encourage scientific, technological and innovation research, training programs, development of technology-based companies

Support and advise the entities and programs related to scientific and technological research, professional training, as well as contributing to codes, standards, regulations and safety procedures

Plan, organize, advise, promote events such as congresses, webinars, lectures, courses and symposia of a scientific or industrial nature

Increase national and international cooperation among companies, governments, funding agencies and the scientific community to promote the dawning of the hydrogen market in Brazilian territory

Produce, foster, and disseminate new knowledge and innovations related to hydrogen technologies and fuel cells

Become a Member of ABH2

Contact us at contato.abh2@gmail.com!

Paulo Emílio Valadão de Miranda

Chief Executive Officer

Dr. Paulo Emílio Valadão de Miranda is the president of ABH2, member of the Board of Directors of the International Association for Hydrogen Energy (IAHE), Brazilian representative at the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE), member of Engie's scientific committee, scientific adviser to European Fuel Cell Forum, Editor-in-Chief of scientific journal Matéria.

Dr. Paulo Emílio is a Full Professor at Federal University of Rio de Janeiro in the Department of Metallurgical and Materials Engineering and in the Department of Transport Engineering. He lectures at the Instituto Alberto Luiz Coimbra de Pós-Graduação e Pesquisa em Engenharia (Coppe / UFRJ) and at the Polytechnic School.

He holds a bachelor's, master's and doctorate in Metallurgical and Materials Engineering from the Federal University of Rio de Janeiro and postdoctoral degrees in Metallurgical and Materials Engineering at the École Centrale de Paris and at the Université de Paris-Sud, France.

He is head of the Hydrogen Laboratory (LabH2 - Coppe / UFRJ), which carries out R&D in areas related to hydrogen usage including: Solid Oxide Fuel Cells and development of buses and boats with electric traction in a hybrid system with fuel cell.

1st Brazilian Hydrogen Congress

Delegates at the 1st congress of the Brazilian Hydrogen Association, ABH2

The 1st Congress of the Brazilian Hydrogen Association was held with great success on November 7th and 8th, 2019, at COPPE/UFRJ, in Rio de Janeiro.
The event featured six blocks of activities with face-to-face and remote participation, which included three technical-scientific presentations, followed by a round table on the highlighted theme.

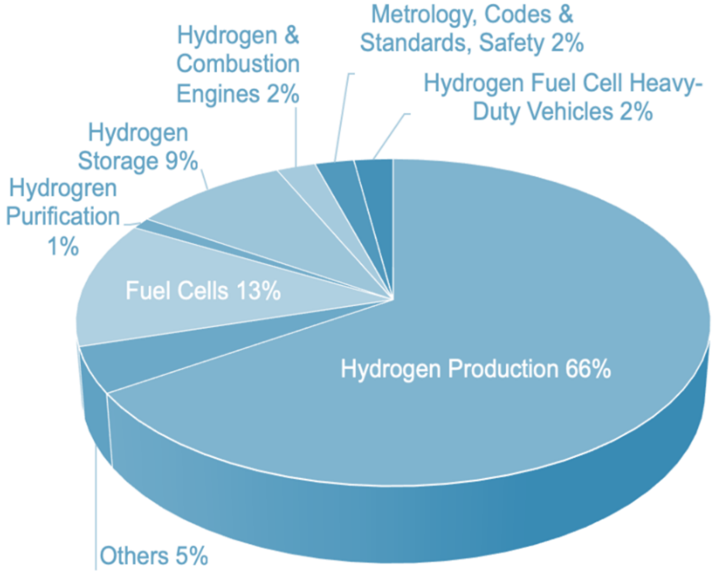
The themes addressed were: Hydrogen Energy, Energy Mix and Climate Change; Projects and Innovations in Hydrogen Energy; Routes for Hydrogen Production; Industry / Services and Insertion of Hydrogen Based Technologies in the Market; Regulations, Transport and Hydrogen Logistics and Fuel cells.

The event also had poster sessions, a demonstration of the Coppe/UFRJ's hybrid electric-hydrogen bus and an Event Conclusion session, presenting a public letter on Hydrogen Energy and Society. Multiple stakeholders participated in the demonstration and had the opportunity to ride the bus. The event also provided a platform for ABH2 and the Brazilian Energy Research Office and relevant stakeholders to discuss the potential to incorporate hydrogen in the Brazilian energy mix

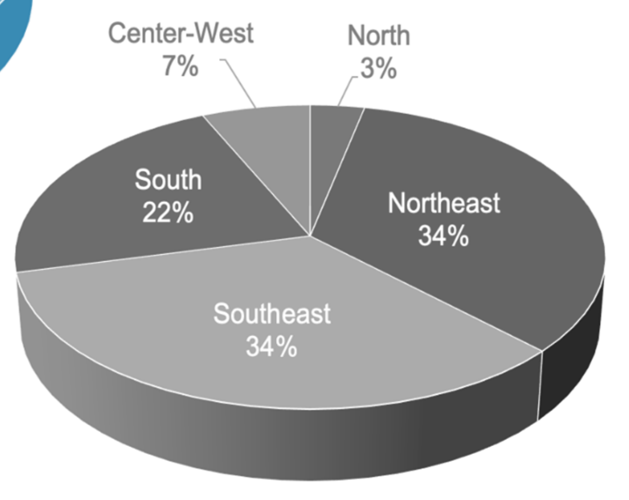
A remarkable, interesting and spontaneous event that occurred on the 1st ABH2 Congress was that almost half of all articles presented in the form of posters regarded Hydrogen Production, mainly from bio-hydrogen and hydrogen produced from biomass, which demonstrates a strong trend for this field in Brazil.

Brazil R&D in H_2 and Fuel Cells

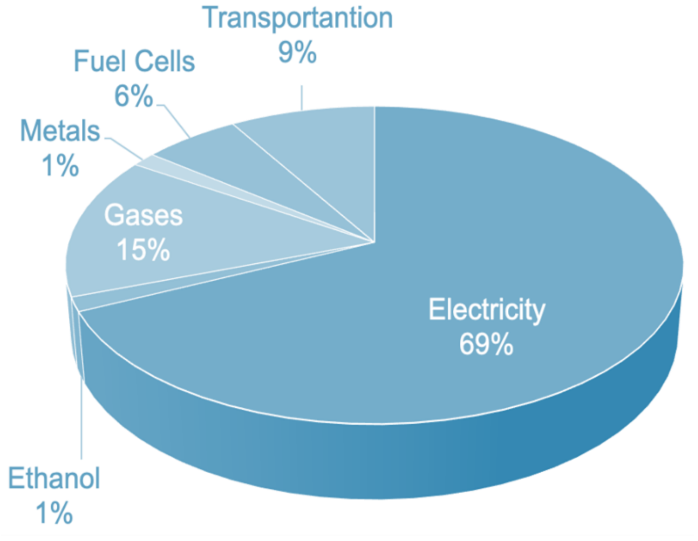
Development of H_2 and fuel cells in Brazil



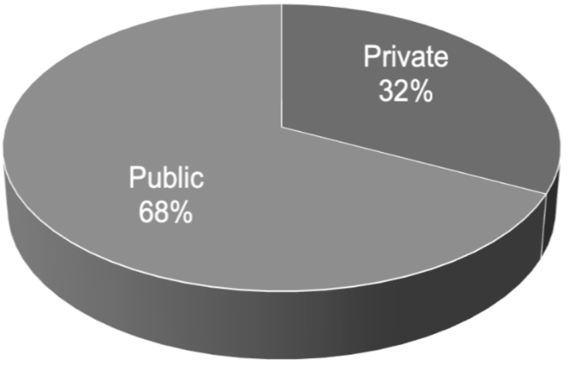
Hydrogen Technologies R&D centers by region in Brazil



Share of Brazilian Companies Developing Hydrogen Energy Technologies per Sector



Share of Brazilian Companies Developing Hydrogen Energy Technologies per Ownership



Regulations, Codes and Standards in Brazil

Issued technical standard:

ABNT IEC/TS 62282-1:2018 - "Fuel cell technologies Part 1: Terminology"

On going processes:

- Application to become an ISO TC-197 P-member;
- Issuing the following new standards:
    - ISO/TC 197/WG 05 Gaseous hydrogen land vehicle refueling connection devices;
    - ISO/TC 197/WG 15 Gaseous hydrogen - Cylinders and tubes for stationary storage
    - ISO/TC 197/WG 18 Gaseous hydrogen land vehicle fuel tanks and TPRDs
    - ISO/TC 197/WG 19 Gaseous hydrogen fueling station dispensers
    - ISO/TC 197/WG 20 Gaseous hydrogen fueling station valves
    - ISO/TC 197/WG 23 Gaseous hydrogen fueling station fittings
    - ISO/TC 197/WG 24 Gaseous hydrogen fueling stations – General requirements
    - ISO/TC 197/WG 25 Hydrogen absorbed in reversible metal hydride
    - ISO/TC 197/WG 26 Hydrogen generators using water electrolysis
    - ISO/TC 197/WG 27 Hydrogen fuel quality
    - ISO/TC 197/WG 28 Hydrogen quality control.

Brazilian hydrogen potential

Technology development cases

Hybrid Electric-Hydrogen Fuel Cell Bus

Plug-in Type Electrical Vehicle

Powered by:

Hydrogen & Fuel Cells

Battery Packs

Range: 330 km

Consumption: 6.7 kg H_2/100 km

- 1st Prototype: June 2010 - Challenge Bibendum in Rio
- 2nd Prototype: June 2010 - Rio +20
- 3rd Prototype: July 2016 - Olympic Games Rio de Janeiro

Development Stage: Pre-Commercial Version

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P.E.V. de Miranda, E.S. Carreira, U.A. Icardi, G.S. Nunes, "Brazilian hybrid electric-hydrogen fuel cell bus: Improved on-board energy management system", International Journal of Hydrogen Energy, Vol. 42, pp. 13949 -13959, 2017.

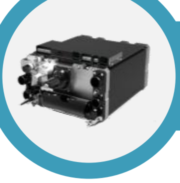
Ship with Electrical Propulsion

Plug-in type Triptych Catamaran

Type	Catamaran
Hull	Aluminum
Length	20.15 m
Breadth	7.80 m
Draught	1.50 m
Passengers	100

FURNAS-ANEEL
project 2020 - 2022

Powered by:



Hydrogen & Fuel Cells

Battery Packs

CESE-Ethanol: Ethanol Fuelled Efficiency Tracker Energy Converter

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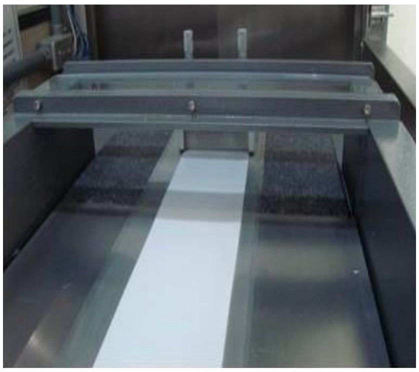
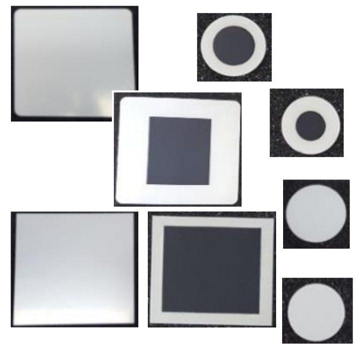
COPPE UFRJ

Solid Oxide Fuel Cells

Multifunctional anodes for the direct utilization of carbonaceous fuels



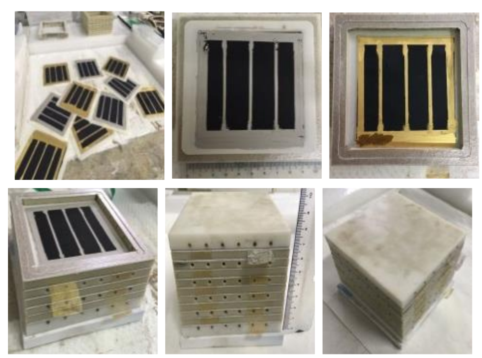


Projects

- BNDES-Funtec-Oxiteno-Energiah (2011-2021)
- Oxiteno-Finep (2006-2010)
- PaCOS-Oxiteno (2006)
- PaCOS Network (2004-2008)
- CTPetro-Finep- Oxisol (2001-2004)

SOFC Production

Stack Assembly and Test



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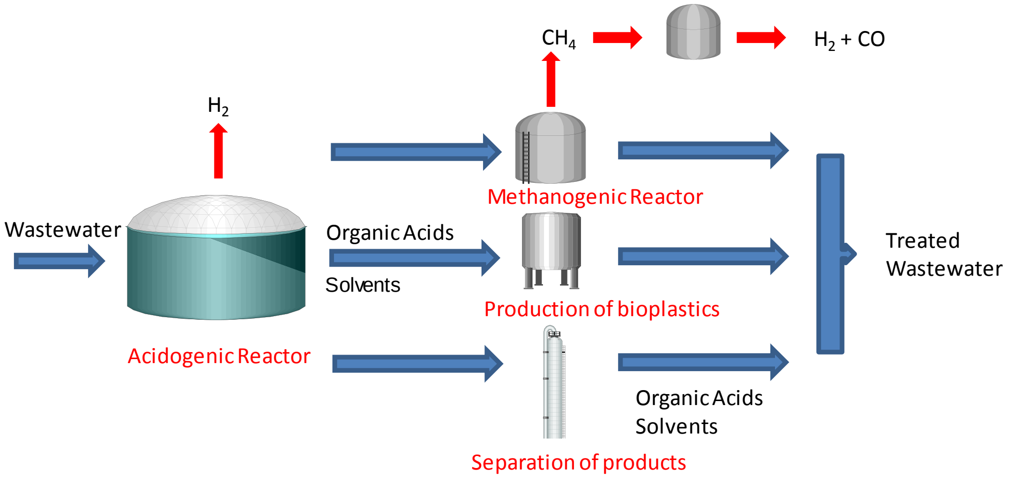
Miranda, P. E. V., Editor, "Science and Engineering of Hydrogen-Based Energy Technologies", 1st Edition, ELSEVIER, Academic Press, 438 p, 2019.

Sarruf, B. J. M., Hong, J-E., Steinberger-Wilckens, R., Miranda, P. E. V., “Influence of novel anode design on the performance and coke resistance towards methane directly-fed solid oxide fuel cells” Ceramics International, 45, pp. 538-5379, 2020.

Biorefinery Concept Applied to Biological Wastewater Treatment Plants

Project's main goal:

Apply biorefinery concept to a biological wastewater treatment plant, with generation of bioenergy and high value-added products



Anaerobic reactors are a core technology in a wastewater treatment plant as the process generates a broad spectrum of organic acids and solvents in the liquid phase besides hydrogen and methane in the biogas

Challenges

Low concentrations of organic matter in wastewater, leading to low concentration of intermediates and end products, and the complex composition of wastewater, with spatial and temporal variations

Mixed microbial cultures, though important and beneficial for anaerobic process, is another drawback for the biorefinery concept, since process control tends to be difficult

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Fuel Cell Laboratory - LaMPaC

Pioneer Brazilian laboratory assembling and characterizing Solid Oxide Fuel Cell

Since the 1990s, LaMPaC has developed studies in this research area with public and private funding

Projects

2004-2009	▶	50W SOFC	CEMIG
2011-2016	▶	1KW SOFC	CEMIG
2016-2018	▶	Aircraft architecture	Embraer

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COPEL Pura Energia

LABMATER LABORATÓRIO DE MATERIAIS E ENERGIAS RENOVÁVEIS

UFPR UNIVERSIDADE FEDERAL DO PARANÁ

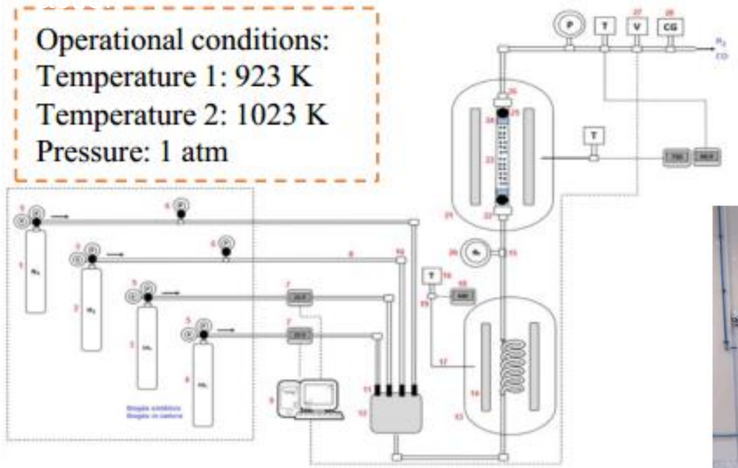
Renewable H2 from biogas dry reforming

Coke and sintering resistant catalysts for dry reform

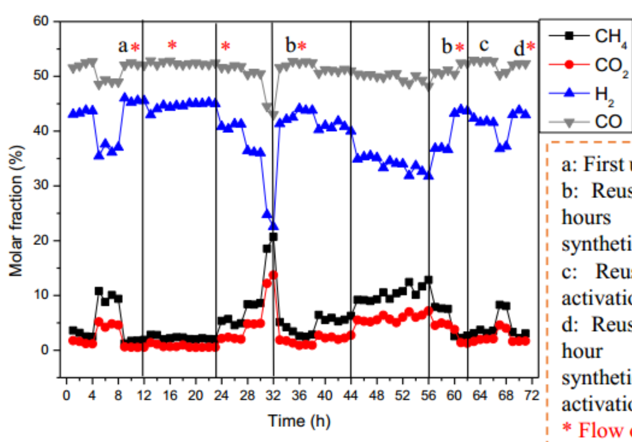
The dry reform of biogas involves the conversion of two greenhouse gases (CH_4 and CO_2) into H_2 and CO (syngas), and requires high temperatures (923 K to 1073 K), atmospheric pressure and a catalyst

20Ni / Si-MCM-41 catalyst resistant to coke and sintering, with excellent performance in converting biogas into renewable hydrogen

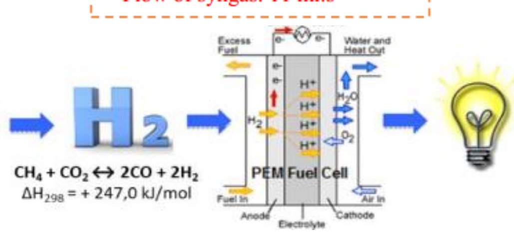
Operational conditions:
Temperature 1: 923 K
Temperature 2: 1023 K
Pressure: 1 atm



Biogas pilot unit



a: First use of the catalyst;
b: Reuse of the catalyst after 3 hours of regeneration with synthetic air;
c: Reuse of the catalyst after activation with 1 hour of H_2
d: Reuse of the catalyst after 1 hour of regeneration with synthetic air and 1 more hour of activation with H_2
* Flow of syngas: 11 ml.s^{-1}



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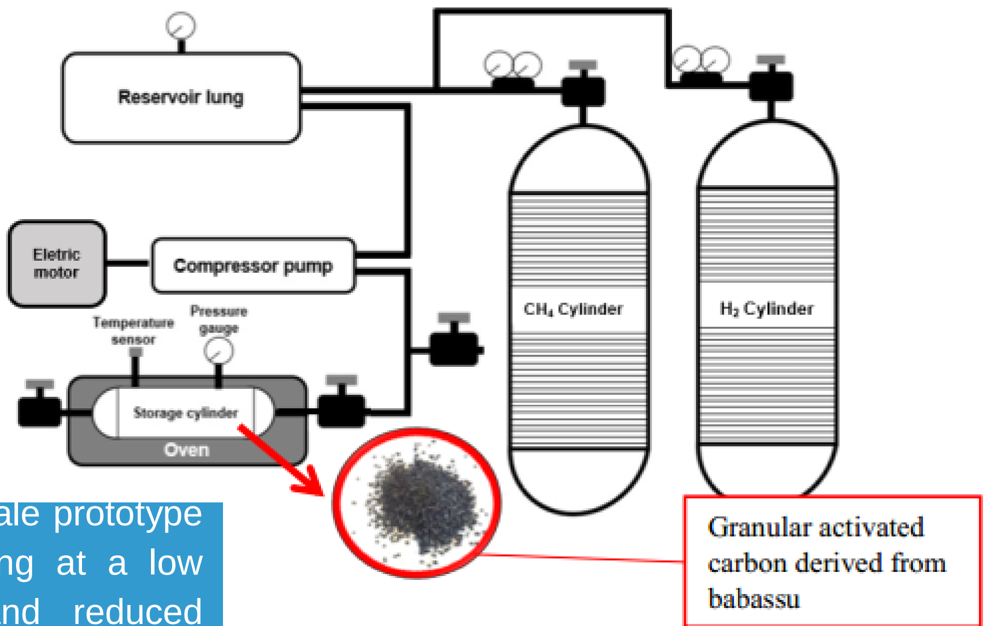
Low energy storage of hythane

Hythane (mixtures of CH_4 & H_2) storage via adsorption on commercial activated carbon



Lab-scale prototype operating at a low flow and reduced energy consumption

CH_4 (%)	H_2 (%)	Total volume adsorbed hythane ($V_{hythane}$ $V^{-1}_{Cylinder}$)
50	50	159.7
60	40	170.5
70	30	157.5
80	20	144.9
90	10	114.1

Adsorbent and the prototype system best performance storing hythane

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SOBRATEMA

BW EXPO | SUMMIT | DIGITAL 17-19 NOV. 2020

BW Expo Summit Digital 2020

In January 2020 the 3rd Biosphere World (BW EXPO 2020), a multidisciplinary event of technologies for sustainability of the environment, organized by SOBRATEMA (the Brazilian Association of Technology for Construction and Mining) in São Paulo, has included a new curator topic called “Energy Transformation – Hydrogen” among others such as sustainable agribusiness, conservation of water resources, sustainable construction, recycling, waste to energy, strengthening of degraded areas and circular economy. The event will take place from November 17th to 19th of this year.

Organization of several online events such webinars and lives with local stakeholders, associations and governmental representatives

Information and updates about the worldwide H_2 economy status

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SAE Brasil & Ballard Student H2 Challenge

The student challenge SAE Brasil & Ballard Student H2 Challenge is the first worldwide competition for Baja and Fórmula SAE fuel cell with the objective to transfer knowledge to the engineering students, promoting national and international industry interaction.

Selected universities at the digital phase:

1) Universidade Estadual de Campinas
2) Universidade Federal do Rio de Janeiro
3) Centro Universitário FEI
4) Instituto Mauá de Tecnologia
5) Universidade Federal de Itajubá
6) Universidade Federal do ABC UFABC
7) Centro Universitário Facens - B'Energy Racing
8) SENAI CIMATEC - TEC H2-Racing

The teams will develop 4 Bajas and 4 Fórmula SAE hybrid fuel cell

Final Digital Phase at the BW Expo Summit Digital 2020: The teams will present their virtual concept for the vehicles from November 17th to 19th

Track competition is being planned according to the COVID 19 scenario

SAE Brasil – Organization and coaching

Ballard Power Systems – donation of 10 fuel cell stacks 2,1 kW air cooled

Air Products – donation of H_2 cylinders

CNPq – components import process

WEG – components and powertrain concept validation at a test bench

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Sector mapping hydrogen Brazil

Brazilian/German Industry and Commerce Association (AHK RJ) GIZ and the Ministry of Mines and Energy

Preparation of the study “Sector mapping Hydrogen Brazil”

- Analyze the strategic potential and benefits for the country to export green hydrogen to Europe
- Identify the main stakeholders for a Brazilian Green Hydrogen Roadmap
- Provide a general vision about the main technologies for green hydrogen production and Power-to-X, and its status in Brazil

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Hydrogen Production via Alkaline Electrolysis

2011

Investments:
Itaipu R$ 3.396.000,00
Eletrobrás R$ 3.196.000,00
FPTI-BR R$ 411.437,33

H_2 life cycle and H_2 power plant

2016

Investments:
Itaipu R$ 1.400.000,00
FPTI-BR R$ 207.049,,25

Operation and maintenance of H_2 power plant

2020

Investments:
Itaipu R$ 3.994.950,00
FPTI-BR R$ 777.454,29

Technical consolidation and business and project generation

R&D in alkaline electrodes

Human resources

R&D in FC and vehicle charge

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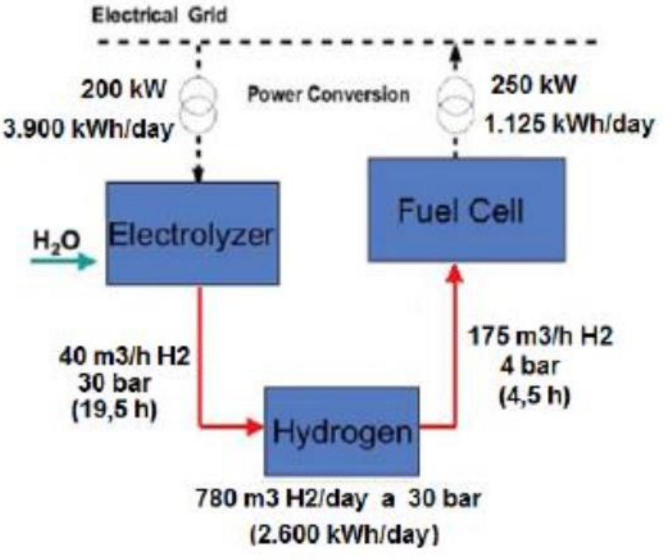
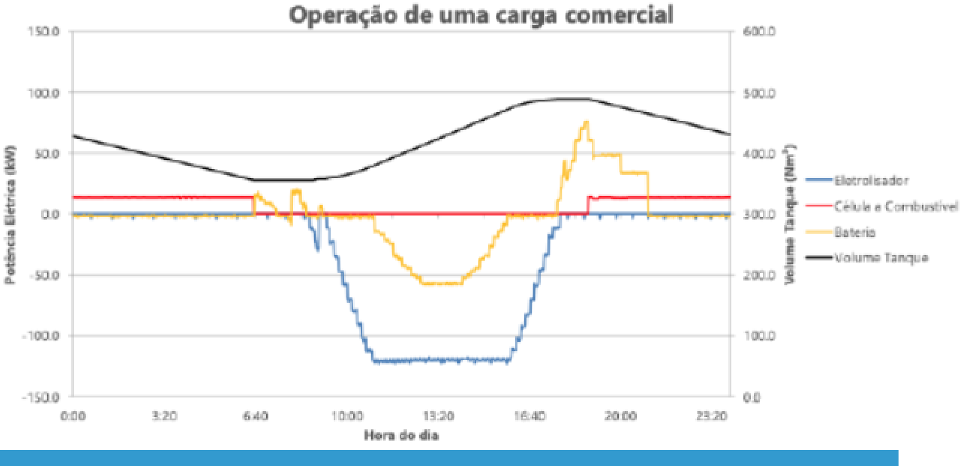
Hydro & solar energy synergy for H_2 storage

H_2 is stored in tanks during the dry season and peak times





- ✓ PEM electrolyser of 20 Nm^3/h
- ✓ storage cylinders of 600 Nm^3 at a pressure of 25 bar
- ✓ 100 kW fuel cell system is used to convert H_2 into electricity

Total investment ~ €8 million

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Hydro & solar energy synergy for H2 storage

Demonstration of the synergy between hydroelectric and solar energy (built in the areas around thedam and also floating plates in the reservoirs) connected from a single source.

Hydrogen is produced during times of low demand and a lot of electricity production through the interconnection of both plants in a single system

- ✓ H_2 production through a 50 Nm^3/h alkaline electrolyser
- ✓ Storage capacity of 900 Nm^3 at a pressure of 27 bar
- ✓ 300 kW fuel cell system is used to convert H_2 into electricity

Total investment ~ €12 million

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Potential for Hydrogen Production in Brazil

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