INTERNATIONAL PARTNERSHIP FOR
HYDROGEN AND FUEL CELLS IN THE ECONOMY

IPHE Country Report May 2018: Brazil

Name	Paulo Emílio Valadão de Miranda
Contact Information	Hydrogen Laboratory - COPPE | UFRJ Tel: +55 (21) 3938-8791 pmiranda@labh2.coppe.ufrj.br www.labh2.coppe.ufrj.br
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1. New Policy Initiatives on Hydrogen and Fuel Cells

- The Ministry of Science, Technology, Innovation and Communications (MCTIC) has established a bilateral cooperation with Germany for the joint development of hydrogen-based advanced fuels for aviation. The objective of the project is to create an international reference model for the production of alternative fuels from renewable energies for aviation. The implementing partners are MCTIC and the German Aerospace Center (DLR).

- The Center for Strategic Studies and Management (CGEE) has stated that between 2007 and 2016 12% of Energy Generation and Energy Storage Brazilian publications concerned hydrogen and fuel cells. In Brazil, more than 60% of the human resources dedicated to the thematic "Hydrogen and Fuel Cells" hold a PhD degree. Currently, 756 PhD researchers are allocated in 46 graduate centers in the area.

2. Hydrogen and Fuel Cell R&D Update

- The B3 Shipyard (B3 Shipyard: http://www.estaleirob3.com.br), located in Salvador, Bahia, is progressing on the construction of a catamaran with capacity for 100 passengers, which will be powered by hydrogen and will have electric propulsion. The hull of the ship is already assembled. This activity is part of a project from the Hydrogen Laboratory of the Post-graduation and Engineering Research Institute Alberto Luiz Coimbra (COPPE) (www.coppe.ufrj.br), at the Federal University of Rio de Janeiro (UFRJ) and is financed by Furnas Energy Company, under the R&D Program regulated by the National Regulatory Agency for Electric Energy (Aneel);

- Natural Hydrogen:

Geological structure composed of a circular depression on a craton zone formation in Brazil where hydrogen gas is detected flowing out.

3. Demonstration and Deployments Update

Given that the Brazilian electricity supply is 84.3% renewable (Hydro: 68.1 %; Biomass: 8.2%; Wind: 5.4%; Nuclear: 2.6%), there is significant opportunities for the production of green hydrogen. Examples of hydrogen production option in Brazil today include:

- Itaipu Hydroelectric Power Plant produces hydrogen by electrolysis using energy that would otherwise be spilled. Actions are being taken in Eletrobras (the Public Holding Co. of the electric sector) to expand this initiative to other Brazilian hydropower plants.
- Hydropower and wind power production dominate in different seasons. This complementary nature of these energy systems means that renewable energy is available for hydrogen production throughout the year.
- Brazil consumes the equivalent of 876 TWh/year of biomass for energy production The total Brazilian energy consumption is 3,183 TWh/year, of which 43.5% is renewable. As there is more biomass available, this opens the possibility for gasification or bio-digestion of biomass for hydrogen production and an opportunity to increase the percentage of renewable energy in the Brazilian energy system.
- Ethanol production in 2016 was 28.3 billion litres from a total sugarcane output of 39 million tons. Ethanol may serve both as biofuel and eventually for hydrogen production, feeding into the hydrogen economy.

The average production of natural gas in 2016 was 103.8 million m^3/day, representing another significant potential for hydrogen production from steam/dry reforming.

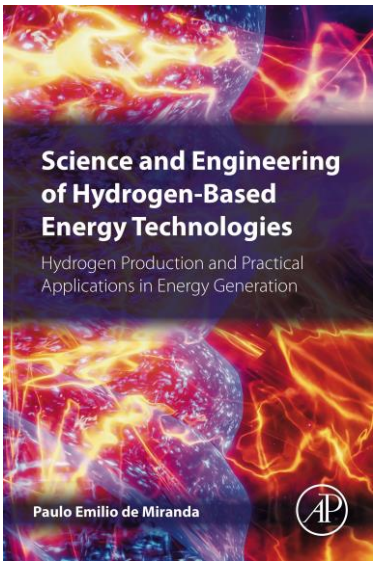
4. Events and Solicitations

The World Hydrogen Energy Conference 2018, WHEC2018 (http://www.whec2018.com), will be held in Rio de Janeiro (June 17th to June 22nd 2018), hosted by the Engineering Graduate Research Institute Alberto Luiz Coimbra (COPPE), at the Federal University of Rio de Janeiro (UFRJ). The event has accepted the following abstracts, from 50 countries, in the different areas described:

Topic	No. of Abstracts	%
1. Hydrogen energy	46	8
2. Fuel cells	117	22
3. Science and technologies of hydrogen and hydrogen-rich fuels production from biomass	148	27
4. Energy storage using hydrogen produced from excess renewable electricity: Power to hydrogen	108	20
5. Hydrogen energy engineering application and products	74	14
6. Market, commercialization and deployment: Total owner cost of hydrogen energy technologies	22	4
7. Regulatory framework, safety aspects, public policies, and social acceptance of hydrogen energy technologies	24	4
8. Others	5	1
TOTAL	**544**	**100**

Hydrogen Energy Book

- The book, **Science and Engineering of Hydrogen-Based Energy Technologies**, will be launched by Elsevier during the WHEC2018:



Ministries, Agencies and Regulatory Organizations Referenced in the Book include:

Aneel: Brazilian Electricity Regulatory Agency, www.aneel.gov.br
ANP: National Agency of Petroleum, Natural Gas and Biofuels, www.anp.gov.br
B3 Shipyard: http://www.estaleirob3.com.br
BNDES: Brazilian Development Bank, www.bndes.gov.br/
CEMIG: electricity utility company, http://www.cemig.com.br/
CGEE: Center for Strategic Studies and Management, www.cgee.org.br
Coppe: Post-graduation and Engineering Research Institute Alberto Luiz Coimbra, www.coppe.ufrj.br
DLR: German Aerospace Center, http://www.dlr.de/
Finep: Brazilian Company of Innovation and Research, www.finep.gov.br
Furnas: electricity utility company, http://www.furnas.com.br
Hydrogen Laboratory: http://www.labh2.coppe.ufrj.br
Itaipu: electricity utility company, www.itaipu.gov.br
MICTIC: Ministry of Science, Technology, Innovation and Communications, www.mctic.gov.br/portal
Oxiteno: Chemical Manufacturing Company, http://www.oxiteno.com.br
PEMFC: polymer membrane electrolyte fuel cell
Petrobras: petroleum industry company, http://www.petrobras.com.br
UFRJ: Federal University of Rio de Janeiro, www.ufrj.br

5. Investments: Government and Collaborative Hydrogen and Fuel Cell Funding

In 2017, there were on-going projects financed by MCTIC, Finep, BNDES, ANP and Aneel, as well as companies such as Oxiteno, CEMIG, Furnas, Itaipu and Petrobras on hydrogen and fuel cells countrywide with values amounting over US$41 million. The main focus was on hydrogen production from renewables, heavy-duty vehicles, SOFC, PEMFC and reforming.

6. Regulations, Codes & Standards Update

Nothing to report this period.

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Summary Country Update May 2018: Brazil

Transportation	Target Number	Current Status	Partnerships, Strategic Approach	Policy Support
Fuel Cell Vehicles[1]				
FC Bus		4 HFC buses and 1 hybrid HFC bus		
Fuel Cell Trucks[2]				
Forklifts				
H_2 Refueling Stations	**Target Number**	**Current Status**	**Partnerships, Strategic Approach**	**Policy Support**
70 MPa On-Site Production				
70 MPa Delivered				
35 MPa On-Site Production		1 hydrogen production and refuelling station. Another refuelling		

[1] Includes Fuel Cell Electric Vehicles with Range Extenders

[2] As above

		station is under construction.		
35 MPa Delivered				
Stationary	**Target Number[3]**	**Current Status**	**Partnerships, Strategic Approach**	**Policy Support**
Small[4]				
Medium[5]				
Large[6]				
District Grid[7]				
Regional Grid[8]				
Telecom backup				
H_2 Production	**Target[9]**	**Current Status**	**Partnerships, Strategic Approach**	**Policy Support**
Fossil Fuels[10]		2 fuel processors under construction		

[3] Targets can be units installed and/or total installed capacity in the size range indicated
[4] <5 kW (e.g., Residential Use)
[5] 5kW – 400 kW (e.g., Distributed Residential Use)
[6] 0.3MW – 10 MW (e.g., Industrial Use)
[7] 1MW – 30 MW (e.g., Grid Stability, Ancillary Services)
[8] 30MW plus (e.g., Grid Storage and Systems Management)
[9] Target can be by quantity (Nm^3, kg, t) and by percentage of total production; also, reference to efficiency capabilities can be a target
[10] Hydrogen produced by reforming processes

		(one using ethanol and another one using natural gas)		
Water Electrolysis[11] (PEM, Alkaline, SOEC)		1 hydrogen production (water electrolysis) and refueling station.		
By-product H_2				
Energy Storage from Renewables	**Target[12]**	**Current Status**	**Partnership, Strategic Approach**	**Policy Support**
Power to Power[13] Capacity				
Power to Gas[14] Capacity				

[11] Please indicate if targets relate to a specific technology (PEM, Alkaline, SOEC)
[12] Can be expressed in MW of Installed Capacity to use the electricity from renewable energy generation, and Annual MWh of stored energy capacity
[13] Operator has an obligation to return the electricity stored through the use of hydrogen back to electricity
[14] Operator has the opportunity to provide the stored energy in the form of hydrogen back to the energy system through multiple channels (e.g., merchant product, enriched natural gas, synthetic methane for transportation, heating, electricity)