IEA Bioenergy
Technology Collaboration Programme

Pioneering initiative to produce renewable hydrogen from ethanol in Brazil

São Paulo, Brazil

Best Practices on flexible bioenergy

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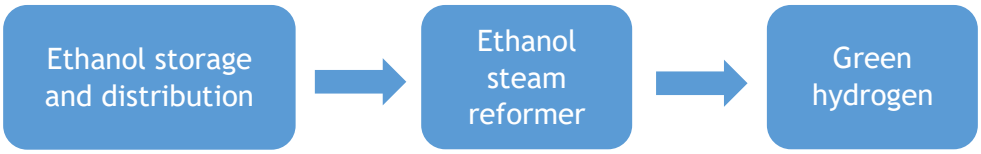
Project description

The University of São Paulo (USP), Hytron[1], Shell Brazil, Raízen[2], and the SENAI Innovation Institute for Biosynthetics and Fibers (CETIQT)[3] have put together a pioneering initiative to produce renewable hydrogen from ethanol and signed a cooperation agreement for the development of two production plants in the city of São Paulo in Brazil. The agreement includes a hydrogen refuelling station (HRS) at the campus of the University of São Paulo. One of the buses used by students and visitors to Cidade Universitária will stop using diesel and start using hydrogen produced from ethanol and fuel cell engines instead of the traditional diesel combustion engines. Hydrogen reforming from ethanol enables local production of hydrogen close to consumption from ethanol that is easy to transport. Thus, the solution creates temporal and spatial flexibility through intermediate bioenergy carrier.



Base information	
Link for more information	https://hydrogen-central.com/shell-raizen-hytron-usp-senai-partnership-convert-ethanol-renewable-hydrogen/
Contact person	Mateus Shreiner, Director of Energetic Transition and Investments, Raizen Marcelo Veneroso, CEO, Hytron
Location	São Paulo, Brazil
Owner/Operator	A reformer and refueling station will be placed at the USP
Technology supplier	Hytron[4], belongs to the German Neuman & Esser Group (NEA Group)
Project Period	From 2022 to 2025

[1] https://www.hytron.com.br/about-us
[2] https://www.raizen.com.br/en
[3] https://senaicetiqt.com/innovation/
[4] The technology utilized is developed by Hytron and supported by the CETIQT-SENAI

Start-up year	2023
Status	Pilot Project
Feedstock	Bioethanol
Products	Renewable hydrogen for transport fuel and power production
Type of flexibility provided	Feedstock flexibility; temporal and spatial flexibility through storability of ethanol
Plant Production	
First Phase	5 kg/h H_2 (50 Nm^3/h)
Second Phase	44.5 kg/h H_2 (500 Nm^3/h)
Project Investment Cost	Approx. EUR 9,000,000 (First Phase)

Technical and commercial details

- In this project, hydrogen from ethanol will be innovatively produced with biofuel supplied by Raízen. The ethanol steam reformer technology is developed and manufactured by Hytron, currently owned by the German Neuman & Esser Group (NEA Group). Hytron will also be supported by the SENAI-CETIQT. The project is financed by Shell Brazil, through the National Agency of Petroleum, Natural Gas and Biofuels (ANP) R&D.

- The project will develop a device called 'reformer', which breaks down the biofuel molecule to turn it into hydrogen. The reformer produces 1 kg of hydrogen from 7.6 litres of ethanol. In addition, CO_2 is produced as a by-product. Hytron has a prototype of the device, but the technology still needs to be improved to ensure reliability, scale, and efficiency to the process.

- The reformer will be installed at the USP, which will also receive a hydrogen refuelling station. The idea is to develop a solution capable of overcoming the challenges involved in the (i) production, (ii) transportation, and (iii) storage of green hydrogen, until the end of the project.

- Transportation of hydrogen is more complex and expensive compared to ethanol. In the project, instead of transporting the hydrogen, the reformer will be installed at the gas station to produce the fuel locally from ethanol. In Brazil, ethanol has a well-developed infrastructure, and the entire value chain is established. Thus, the solution utilizes storable and transportable ethanol to provide temporal and spatial flexibility.

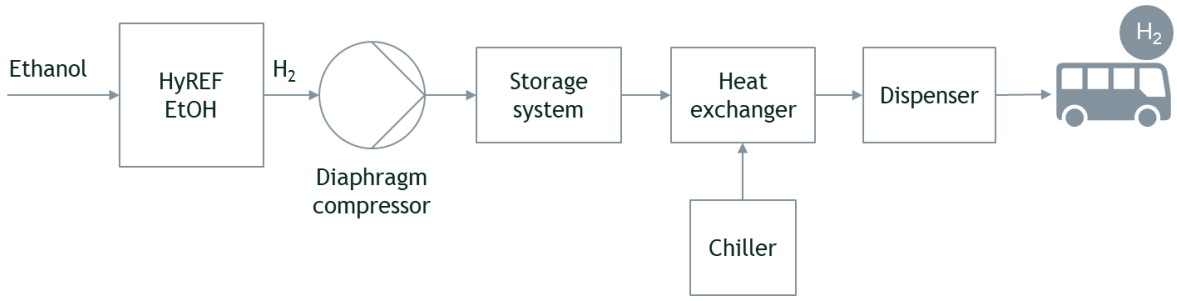
- In the first phase of the project, a bus that operates in the USP will be modified to be compatible with hydrogen. The idea is that the vehicle will start using the sustainable fuel in the first half of 2023. The initiative emerges as a low-carbon solution for heavy transportation, including trucks and buses.

- The bus will not be equipped with a diesel fuel engine, but instead with a fuel cell and a battery. Hydrogen is in compressed form in the bus and thus work as a chemical energy storage. The fuel cell converts the hydrogen into electricity that supplies a very small battery that is responsible for the bus' motive power.

- There will be a supply station, similar to the current petrol stations, to support the bus. Instead of having diesel to supply the bus there will be hydrogen produced from ethanol. It will be the first ethanol-derived hydrogen station in Brazil and in the world.

- In the second phase of the project, a larger plant to produce hydrogen from ethanol will be developed towards the realization of industrial purposes. The planned date for the start of this phase is between one and two years.

- Raízen is already looking for strategic partners, that could have interest in applying the technology for decarbonization of other sectors (e.g., steel, mining, and agribusiness).



Process chart. (Adapted from NEA Group)

Market opportunities

- Currently, hydrogen is predominantly used in the chemical industry and is produced from natural gas in industrial units in near-by refineries. In the future, it is expected that hydrogen produced from renewable electricity, such as solar and wind power, will play an important role in the decarbonization of various industrial and heavy transport sectors.

- The project shows a new application for ethanol, as well as its flexibility. The partners involved want to demonstrate the technical and economic feasibility of the technology. From that point, they can scale up to bigger and more ambitious projects.

- The solution could leave even to negative emissions if carbon capture and storage (CCS) would be applied.

- The project aims to bring an additional alternative to the market, with a vision of complementarity. Then, we could have multiple technologies co-existing to solve this big problem of energy transition, and climate change.

- Transportation of hydrogen is complex. It requires compression or liquefaction for storage in cylinders, making the logistics expensive. In this scenario, the production of hydrogen via ethanol conversion represents an advance in the availability of renewable fuels through a new technological route for the expansion of sustainable solutions in Brazil and in the world.

- The local, decentralized, and low-investment production of green hydrogen from ethanol is an interesting alternative for sectors such as heavy transport. The solution, which has good availability and scalability, has a good growth potential in heavy transport sector.

- Through the agreement to produce green hydrogen, the companies involved begin a new stage in the production of renewables, contributing to the decarbonization of the economy and expanding their product portfolios.

- The technology can be easily installed at conventional fuel stations, which would not require changes in the distribution infrastructure, ensuring that hydrogen will be ready to fuel vehicles quickly and safely. After the project, the solution will be scalable to other cities as well.

- The use of hydrogen will not be restricted to the transportation sector. It will benefit also other sectors in the country in terms of replacement of fossil energy sources. In the future vision of Hytron, reformer technology will be further scaled-up for industrial uses and it utilizes globally shipped ethanol.

Lessons learned

- This disruptive project involves diverse stakeholders, since several competencies from (i) start-ups, (ii) universities, (iii) research institutes, and (iv) companies are needed. This is not only a challenge, but also an opportunity to understand different perspectives. The outcome is a great synergy generated between the stakeholders.

A bus circulating in USP in São Paulo in Brazil. (Source: USP Images)