



Green Hydrogen and Fuel Cell Technology in the Philippines:

POTENTIAL FOR URBAN AND REMOTE APPLICATIONS



About

This brochure has been developed on behalf of the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) Manila to promote the use of renewable energy in the Philippines as a prerequisite to explore green hydrogen applications in the country. Its content is based on a study the German-Philippine Chamber of Commerce and Industry (GPCCI) conducted on behalf of the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) in 2022. Said study researched the market potential of green hydrogen generation and its reconversion through fuel cell technology into electricity in the Philippines and included the identification of potential early technology adopters. The focus was to identify the potential to replace emergency diesel generators in urban areas and diesel generators in off-grid areas with hydrogen and fuel cell technology.

In Partnership with



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Green Hydrogen and Fuel Cell Technology in the Philippines

BACKGROUND

As an archipelago in the Pacific, the Philippines is vulnerable to climate catastrophes such as storms and rising sea levels. At the same time the country is depending on climate-harming fossil fuels to meet its increasing energy demand.

To address the effects of climate change, the government has committed to reduce greenhouse gas emissions by 75% by 2030 and expanding the use of renewable energy sources to 35% at the same time. This opens possibilities for the public and private sector to explore zero-carbon energy alternatives and to unlock green market potentials.

CURRENT ENERGY SITUATION

The Philippines is facing a dilemma on how to address the rising energy demand and costs. At the same time, 1.63 million Filipino households are still not connected to the grid. This is mostly due to the Philippines' dispersed geography of more than 7,000 islands.

This widening gap between supply and demand has forced many Filipinos to rely on diesel generators for power generation and for emergency backup power, especially in remote areas.

According to experts, the country's natural gas supply will dwindle around the year 2026. The Coal Moratorium of 2020 will additionally lessen the use of fossil fuels to generate power.

The Philippines needs to address the widening gap between electricity supply and demand.

The country's abundant natural resources such as geothermal, wind, and solar energy, are already sustainable energy alternatives. Currently, renewables contribute about 21% of the energy mix with the government's National Renewable Energy Plan aiming to reach 15,304 MW by 2030, especially with solar rooftop installations becoming an accessible solution in commercial and household use.

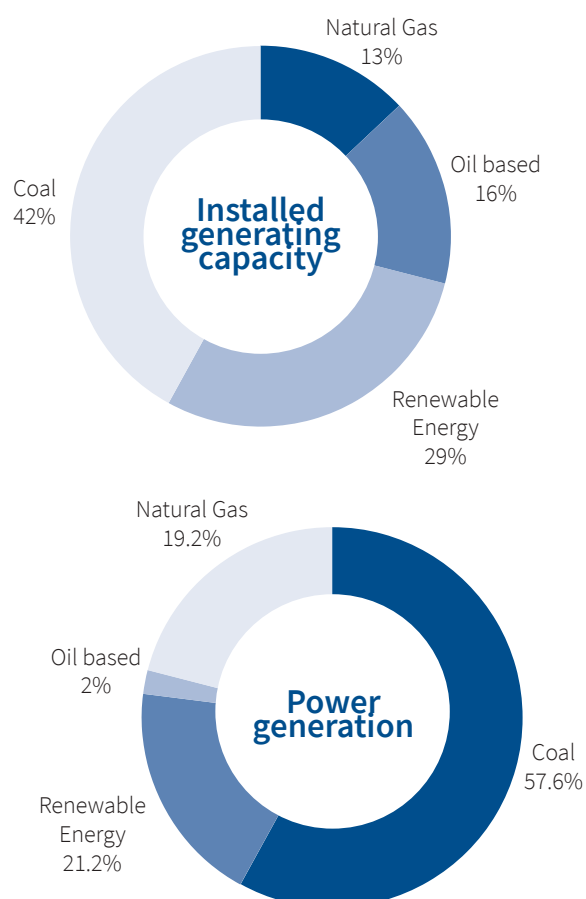


Figure 1 The Philippine Energy Mix
Source: Department of Energy (DOE), Energy Transition Talk 2021



TECHNOLOGY – GREEN HYDROGEN AND FUEL CELLS

The Philippines' current power generation capacity from fossil fuels cannot realize the country's energy needs in an environmentally friendly manner. Nor is it in line with the government's climate goals. Its goal of energy self-sufficiency also requires new ways of generating and distributing electricity. The Department of Energy is therefore intensifying efforts to use renewable energy sources and modernize the main grids. It is also focusing on energy storage systems for more weather-independent power supply.

Green hydrogen is yet another emerging carbon-neutral alternative with considerable benefits and applications. Hydrogen is the most abundant element in the universe. It is widely used in the production of fertilizers, petroleum refining, and energy storage among others.

Through fuel cell technology, it can produce power, heat, and electricity. This opens new possibilities for hydrogen use in transportation, manufacturing, and commercial applications.

The Hydrogen Color Spectrum

What makes green hydrogen green? To use hydrogen it must first be separated from other elements it usually binds to. This process requires energy. Only if the energy used to generate hydrogen comes from a renewable energy source, it is then considered “green”. To identify the energy source that generated hydrogen in the first place, a color spectrum has been established.

A quick guide to the Hydrogen color spectrum



Black/Grey Hydrogen

Originates from fossil energy sources in an environmentally-damaging process that involves releasing carbon dioxide and carbon monoxide into the atmosphere.



Blue Hydrogen

Sourced from natural gas and produced through steam methane reforming, but carbon dioxide is trapped instead of released.



Red Hydrogen

Produced through electrolysis using electricity generated from nuclear energy.



Green Hydrogen

The only zero-carbon and environmentally-friendly variant of hydrogen that is derived from renewable energy sources.

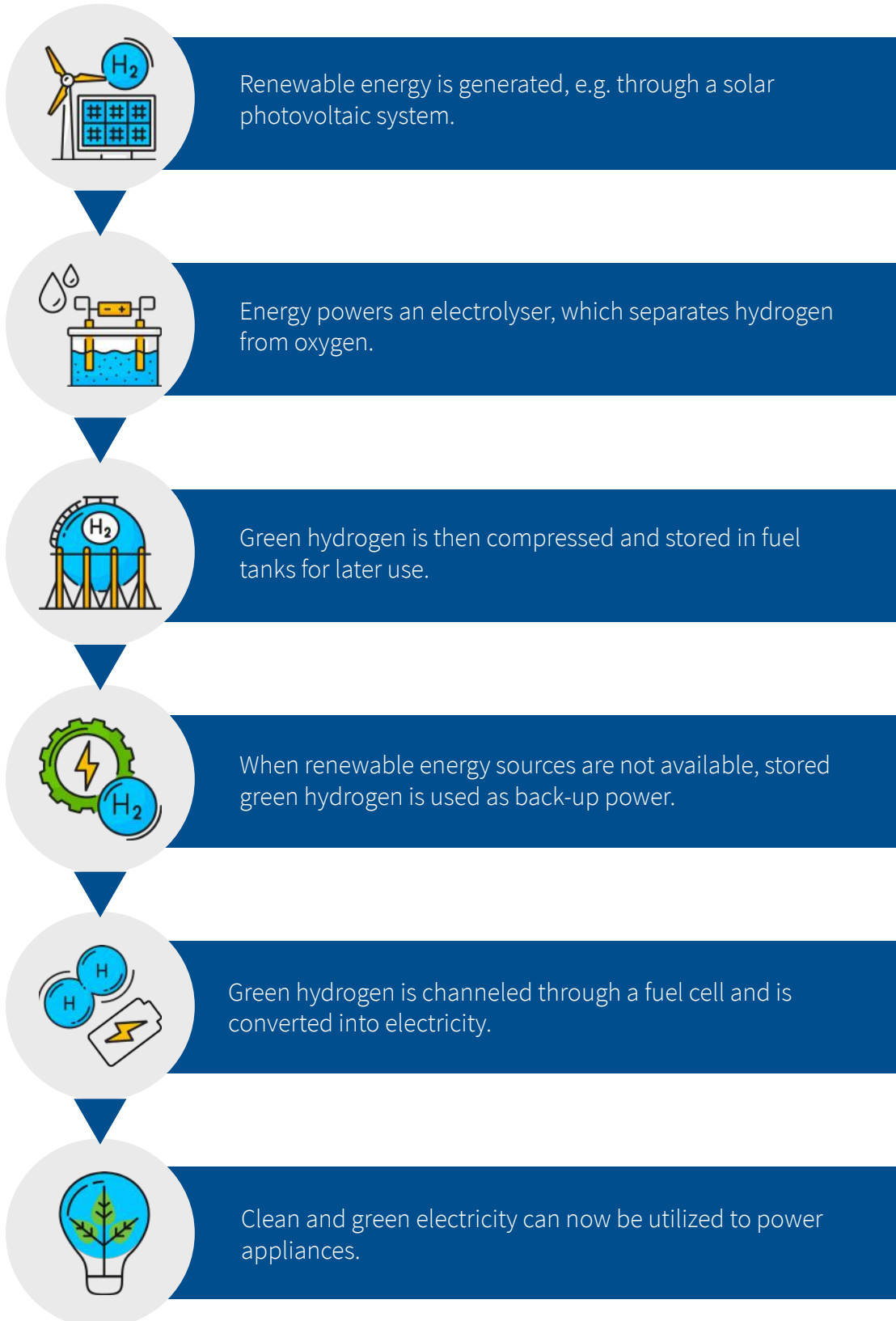
Sources: National Grid, “The Hydrogen Colour Spectrum”
World Economic Forum, “Grey, Blue, Green – Why are there So Many Colours of Hydrogen?”, 2021

Black and Grey hydrogen is produced using fossil fuels and is considered to be the most environmentally harmful variant.

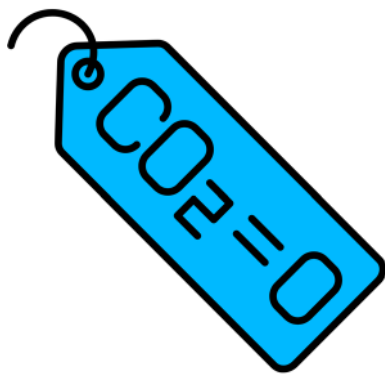
Blue hydrogen is generated using natural gas, but the carbon dioxide has been trapped.

In contrast, **green** hydrogen is the only carbon-neutral variant because it is generated through non-carbon emitting renewable energy sources like wind and solar. Green hydrogen functions as a carrier of clean energy, aiding the goal of decarbonizing our industries.

But how is Green Hydrogen produced?



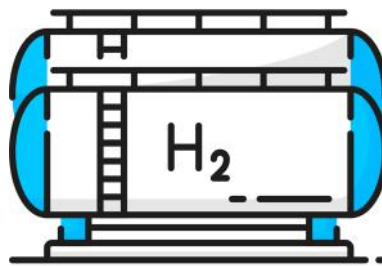
Green Hydrogen Advantages



01

A ZERO-CARBON ENERGY CARRIER

When generated through renewable energy sources, green hydrogen becomes a carbon-free energy carrier that can be stored in fuel tanks.

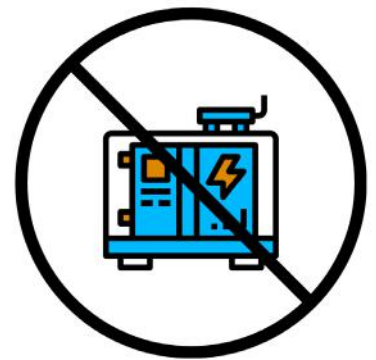


02

LONG-TERM STORAGE SOLUTION

Hydrogen tanks have a larger storage capacity than lithium-ion batteries and are easy to scale.

Through fuel cell technology, green hydrogen can then be converted back into electricity when renewables are not available, e.g. at night or during adverse weather conditions.

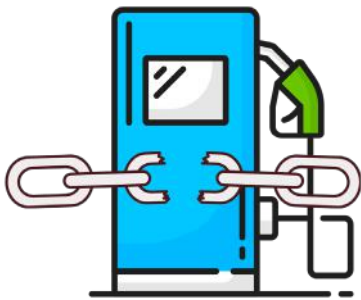


03

AN ALTERNATIVE TO DIESEL BACKUP POWER

Green hydrogen and fuel cells are an environmentally-friendly alternative to diesel generators that are often used to power remote areas or for backup power.

It is especially viable when renewable energy is already being harnessed, e.g. through rooftop solar installations.



04

FUEL PRICE INDEPENDENCE

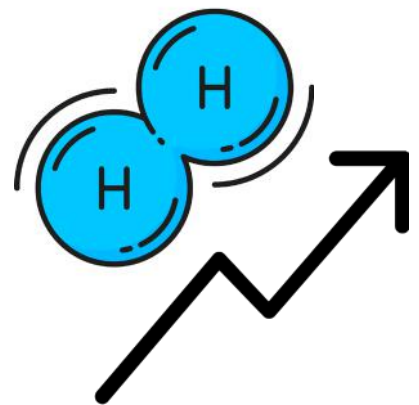
Especially when used in remote areas that require extensive logistics to receive diesel, green hydrogen and fuel cell technology are independent from fuel price uncertainty and added logistics costs.



05

NO NOISE AND SMELL POLLUTION

Harnessing renewable energy sources to generate green hydrogen and its reconversion through fuel cell technology into electricity omits the noise and smell pollution that is associated with diesel generators.



06

PROMISING MARKET POTENTIAL

The worldwide green hydrogen market is projected to reach around \$90 billion by 2030. In the Philippines, major telecom operators are already using methanol reformers and fuel cells to power remote telco towers.

Potential and Current Applications in the Philippines

Green hydrogen and fuel cell technology are still in the pre-commercial phase in the Philippines. No market-ready applications were identified during research conducted by the German-Philippine Chamber of Commerce and Industry (GPCCI) on behalf of the Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) in 2022.

However, especially off-grid areas that use diesel generators for electricity generation and are generally poorly serviced could potentially benefit from fuel cell technology. The new microgrid law could facilitate market entry in this regard. The introduction of the Renewable Portfolio Standard also provides more opportunities to integrate new technologies.

The Philippines is one of the countries with the most diesel generators. About 5% of the country's diesel and 2% of its gasoline consumption is used to power diesel gensets. Increasing foreign investment, projected economic growth, and infrastructure strengthening will further expand the use of diesel generators in the absence of economically feasible alternatives.

According to the Institute for Energy Economics and Financial Analysis, the Philippines could save USD 66 million to USD 82 million within the next 10 years if the country shifted to alternative energy sources to generate power and thus eliminated diesel transportation costs.

It is anticipated that the cost of green hydrogen production will fall rapidly as the necessary technology, e.g. electrolyzers and renewables, become less expensive as they are commercialized. The increase in the cost of CO₂ emissions from fossil fuels could further improve the competitiveness of green hydrogen.



A diesel generator typically used in the Philippines

Government Initiatives

The Philippine government considers hydrogen as “fuel of the future”, as another alternative and clean energy source.

HYDROGEN POTENTIAL ASSESSMENT

The country’s energy plan recognizes the wide range of applications of hydrogen from distributed power to emergency power, portable power, and as fuel for cars and trucks. In November 2020 the Hydrogen and Fusion Energy Committee (HFEC) was established and a study initiated to explore hydrogen’s potential use. The analysis examined how hydrogen and fusion energy could be incorporated into the energy mix and what applications might be appropriate for the country. The following three scenarios were analyzed:

Scenario 1	Hydrogen for Power Generation - As backup power for the electric grid and as an alternative power supply option for off-grid areas, especially with variable renewable energy sources (solar and wind) for power plants;
Scenario 2	Hydrogen for Transportation - Approximately 10% penetration rate for hydrogen as a replacement for gasoline and diesel vehicles; and,
Scenario 3	Combining Energy and Transportation - Using energy and transportation based on optimal hydrogen production.

For the hydrogen production, three options were identified:



According to the Philippine Energy Plan, the first study was completed in February 2021. The results showed the potential benefits of using hydrogen as an alternative energy source, provided non-fossil fuels are used as source material. It was recommended to continue working with interested stakeholders to explore the inclusion of hydrogen in the country’s energy mix and to address current gaps and challenges, especially related to infrastructure and regulatory framework.

DEVELOPMENT PARTNERSHIPS

On January 29, 2021, the Australian hydrogen research and development company Star Scientific Limited has signed a memorandum of understanding with the Philippine Department of Energy (DOE) to advance the development of green hydrogen. Cooperation goals include investigating the potential to retrofit existing plants, utilizing offshore wind resources, exploring uninhabited islands as sites for energy systems, and using the Star Scientific-branded HERO (Hydrogen Energy Release Optimizer) system for seawater desalination.



Memorandum of Understanding signing between Star Scientific Limited and the Philippine Department of Energy

The same year, the DOE signed a second memorandum of understanding on hydrogen with the Japanese company Hydrogen Technology Inc (HTI) to research the use of hydrogen in power generation. The collaboration is intended to advance hydrogen research and development activities. According to the Energy Plan 2020-2040, Israel has also expressed interest in studying the islands' power supply.

In 2018, the National Electrification Administration (NEA), signed a memorandum of understanding (MoU) with Toshiba Energy Systems and Solutions Corporation to implement H2One™. H2One™ is an integrated system that uses a renewable energy source to electrolyze water to produce hydrogen and uses fuel cells to enable reverse power generation. An independent, distributed energy system is envisioned to provide clean and stable energy to islands, replacing diesel generators. The MOU includes the identification of potential installation sites, optimal system specifications, operating systems, and maintenance parameters.

The Philippine government continues to reaffirm its goal of being energy self-sufficient in the face of growing energy challenges. The Department of Energy is working to promote the use of renewable energy and the modernization of the main grids. It is also focusing on energy storage systems for weather-independent power supply. The directive on integrating hydrogen into the Philippine energy mix makes it clear that the priority is to ensure the country's energy security, not the imminent export of hydrogen.

In addition to power supply, the potential of hydrogen fuel cells to power cars, trucks, buildings, and for emergency power systems will also be investigated. Fuel cells can be used off-grid. This makes them an attractive option for critical load functions such as data centers and telecom towers.

LEGAL FRAMEWORK

There are currently no laws in the Philippines that specifically address hydrogen, fuel cells, and electrochemical energy storage. However, there are initiatives or draft laws to make hydrogen more attractive. The table lists relevant draft legislation on hydrogen and related areas, based on a research paper published by the University of the Philippines.

NR.	YEAR	NAME	OBJECTIVE
1	2010	Senate Bill 2593 Hydrogen Research Promotion and Development	Establishment of the Philippine Hydrogen Research and Development Center; Promoting the use and research of hydrogen as an alternative energy source
2	2013	Senate Bill 408 Further developed and newly submitted draft legislation based on SB 2593	Establishment of the Philippine Hydrogen Research and Development Center
3	2013	House Bill 387 Electric, hybrid and other alternative fuel vehicles incentives act	Support to explore alternative mobility; incentives for manufacturers of batteries, fuel cells and related technologies
4	2018	House Bill 4366 Green Motor vehicles	Incentives for the production and import of alternative fuel / green vehicles
5	2019	House Bill 1432 Electric, hybrid and other alternative fuel vehicles incentives act	Incentives for the production and import of alternative fuel / green vehicles; excluded are biofuel-powered vehicles

Figure 1. List of draft legislations on hydrogen and related areas

ACADEMIC ADVANCES

In July 2021, then President Duterte signed a law creating the Philippine Energy Research and Policy Institute (PERPI), a think tank attached to the University of the Philippines (UP). This evaluates innovations, research and development of energy issues and promotes training programs and degree programs on energy.

Furthermore, research centers and universities in the Philippines are needed to acquire expertise and competence and to train technical personnel focused on hydrogen and fuel cell technology. To date, academic institutions have conducted a few research projects on hydrogen.

Figure 2 shows a list of research institutions with research experience in hydrogen and fuel cell technology and their expertise based on published results.

YEAR	RESEARCH INSTITUTE	PROJECT NAME	FUNDING AGENCY
2014	University of Santo Tomas	Nanostructured Electrocatalyst Composites for Direct Ethanol Fuel Cell: Preparation, Characterization and Performance Evaluation	Philippine Council for Industry, Energy and Emerging Technology Research Development (DOST-PCIEERD)
2016		Green Power: Generating Renewable Energy via Electrolysis of Water using New Power Hybrid Systems (1) Hydrogen generation using SOEC (2) Energy production using PEMFC	Commission of Higher Education, Philippine-California Advanced Research Institute (CHED-PCARI)
2021	University of the Philippines – Diliman	Development of High-performance and Low-cost Membrane Electrode Assembly for Alkaline Fuel Cells based on Ion/ electron Dual Conducting Catalyst Layers	Philippine Department of Science and Technology and China Ministry of Science and Technology (DOST-MOST) Joint Research
2021		Clean and Vertically integrated Pure / Applied Hydrogen Research for Next Generation Power Systems, Sustainable and Renewable Fuel and Electrolysis Cell Energy Device Technology	Commission of Higher Education, Philippine-California Advanced Research Institute (CHED-PCARI)

Figure 2. Publicly funded fuel cell technology research projects

Private Sector Initiatives

In recent years, private companies have expanded the infrastructure to generate their own electricity with renewable energy technology. For example, solar PV is already being used as an alternative energy source. In large cities and industrial parks, this is done through rooftop installations. There is also an increasing number of companies that are striving for climate neutrality by buying from renewable energy providers. Theoretically, these companies could use green hydrogen in conjunction with fuel cell technology as emergency power systems, primarily to replace diesel-powered emergency generators. Especially commercial and industrial players, including those in the manufacturing or tourism sectors, could be interesting early adopters. However, the private sector is waiting for pilot projects to illustrate the technology and demonstrate economic viability.

The use of methanol reformers to power telecom towers is already an interesting starting point that proves the applicability for fuel cell technology in the Philippines. Telecom providers are looking for solutions to better serve rural areas. They also try to replace diesel generators in urban areas to eliminate disruptive factors such as vibration, noise, and harmful emissions. The company Advent Technologies sold more than 100 methanol reformer units to Globe and PLDT/Smart. Here, the methanol fuel cells with about 5-15kw power are used as emergency generators to replace diesel generators. It is estimated that about 3,000 diesel generators will be replaced in the future. However, the production of the required hydrogen-methanol mixture would have to be localized in the Philippines for sustainable operation.

Market leaders in the Philippines' energy sector are often innovators and pioneers with sustainability strategies that go beyond the country's energy policy.

In 2019, Pilipinas Shell partnered with Air Liquide Philippines to build a hydrogen production plant at Shell's Tabangao refinery in Batangas City, south Luzon. This plant will produce hydrogen, which the company can use to process other types of crude oil into higher-quality fuels. With the new technology, Pilipinas Shell will be able to capture and liquefy the resulting carbon dioxide for use as fuel on-site or to sell to dry ice or carbonated beverage producers. Completion was expected in late 2020 but was delayed due to the pandemic.

One of the largest energy companies, First Gen of the Lopez family, announced in 2022 the conversion of their gas power plants to produce "clean" hydrogen. AC Energy, another relevant player in the energy sector as well as MetroPacific Investment Group are also evaluating the potential of green hydrogen.

According to the Philippine Green Building Council, shopping mall operators and local industries are eager to reduce their electricity costs. Many do so through rooftop photovoltaic systems. So far, 20 climate-neutral buildings have been certified, and around 70 additional buildings are to be certified by 2022. Other industrial players in the country, for example the energy-intensive cold chain industry which has a projected growth potential of between 8-10%, has a strong interest in using renewable energy sources as well as energy efficiency solutions to power their operations.

Germany's Initiatives Abroad

WAY FORWARD – H2-UPPP PROGRAM

Germany has taken huge strides toward a comprehensive hydrogen economy that will support the decarbonization of its industries. While Germany's hydrogen strategy includes other forms of hydrogen, green hydrogen is emphasized as a renewable and sustainable long-term solution.

The International Hydrogen Ramp-Up Program (H2-Uppp), implemented by the GIZ in cooperation with the German Chambers Abroad, accompanies and supports Germany's efforts to ramp-up the market for green hydrogen (H2) and power-to-X (PtX) applications in selected developing countries and emerging economies in cooperation with the private sector. Commissioned by the German Federal Ministry for Economic Affairs and Climate Action, H2-Uppp focuses on the early stages of green hydrogen project development.

The H2-Uppp program helps to identify, prepare, and accompany the implementation of projects for the production and use of green H2 and PtX application. It also aims to raise awareness and promote knowledge transfer for the development of projects relating to green H2. This approach will help identify cost-effective production paths and uses, pinpoint project opportunities along the value chain, and develop sustainable business models.

H2-UPPP FOCUSES ON THREE AREAS:

Networking & Project Scouting

H2-Uppp supports companies in identifying project ideas and building networks, for example with project partners or potential off-takers. Partners from the private and financial sectors are also offered training on green hydrogen, and public-private dialogue is strengthened through conferences and trade fairs.

Public-Private Partnerships (PPP)

H2-Uppp works with private companies to jointly implement pilot projects in the field of green H2 and PtX. Formal PPPs are set up for this purpose.

Know-How and Capacity Development

H2-Uppp accompanies the various project ideas with in-depth studies and technical trainings. Through specialist conferences, the activities of local institutions are further strengthened, and joint measures are developed to ensure a successful market launch.



Support is provided for PPPs along the entire H2 value chain (production, storage, conversion, transportation, and usage) if they focus on public-benefit activities and contributes to the promotion of sustainable development in the project country. The initiatives must have a positive impact on society and the environment in the project country. The content and results of projects must be published. No grants are issued for investments that are to remain the property of the private sector partner.

Criteria for PPP support

01

Companies must contribute at least 50% of the volume of the PPP project

02

Minimum volume of public contribution: EUR 100,000; minimum volume of overall PPP measure: EUR 200,000

03

Compliance with sustainability standards during project, based on a checklist

For more information on H2-Uppp, on support opportunities or to receive the PPP application form, please contact H2Uppp@giz.de.

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