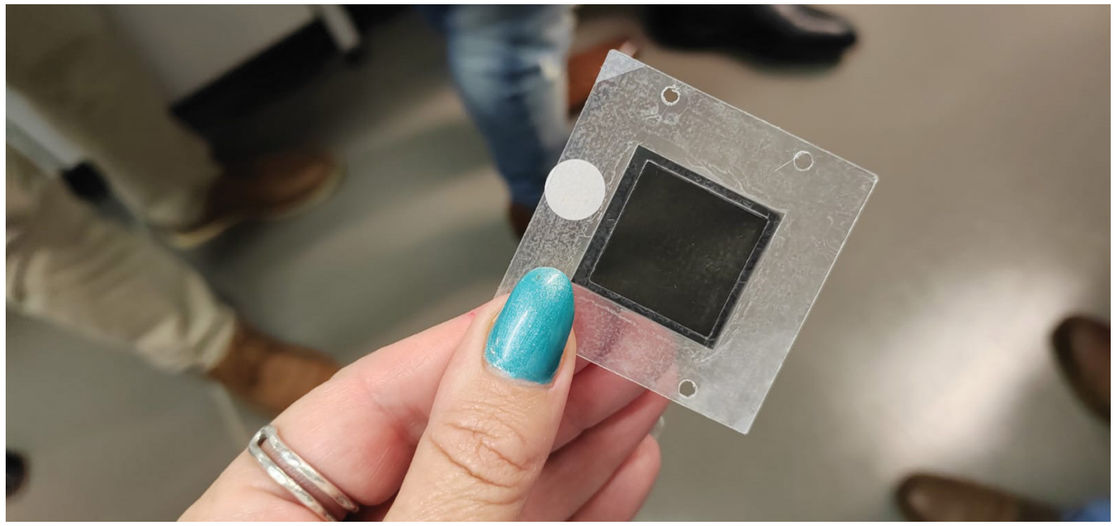
Why green hydrogen for SA?

Karen Surridge, project manager for renewable energy and cleaner fossil fuels at SANEDI, talks about hydrogen, hydrogen fuel cells and green hydrogen production, and argues the case for incorporating hydrogen into South Africa's future energy mix.



At the heart of a hydrogen fuel cell is a stack of proton exchange membranes (PEMs) which, with the help of a PGM-based catalyst, are used to split each hydrogen gas molecule (H_2) into protons (2H+) and electrons (2e-). The protons can pass through the PEM, while the electrons are conducted through an external electrical circuit for power generation.

Hydrogen fuel cell technology was invented by Welsh scientist William Robert Grove in 1839 but had to wait until the 1960s for NASA to put it to commercial use to power its probes, satellites and space capsules. These days, much of the world is pinning its energy-transition hopes on green hydrogen as a fuel source. Why is this important for South Africa? The reasons are many, varied and compelling.

In extremely simple terms, hydrogen is produced when an electric charge splits water molecules into hydrogen and oxygen in an electrolyser. Hydrogen is an energy carrier that can be used to generate electricity either indirectly by generating heat through combustion, or directly through an electrochemical process that takes place in a fuel cell. In both cases, water is the only by-product of the energy generation process.

Hydrogen is not in itself a green or renewable energy because the process to produce it is electricity intensive. Green hydrogen, therefore, is hydrogen produced using electricity from any renewable energy source, such as wind, solar, hydro, etc.

The media and literature refer to multiple colours of hydrogen across the spectrum. This has nothing to do with the colour of hydrogen gas, which is colourless, it has to do with the source of energy used to produce the electricity for the water splitting process. Thus, depending on the type of energy used, different colour names are assigned to the hydrogen produced, for example hydrogen produced using steam reforming from natural gas (methane) is called 'grey hydrogen'. It is currently the most common 'colour' of the hydrogen used in industry.

Hydrogen is a highly versatile energy carrier that can be used in a wide range of applications. It is also well understood how to safely store and transport the gas. As such, it has the potential to decarbonise traditionally 'hard-to-abate' sectors, such as heavy-duty transport, aviation and shipping, and industries such as steel, cement and ammonia manufacturing that cannot be fully decarbonised through renewable energy and direct electrification or through renewable energy with battery storage.

Why should South Africa focus on green hydrogen? Firstly, because it is technology that can help the country towards achieving net-zero carbon status by the 2050 target date, and because South Africa already has well-developed expertise in the Fischer-Tropsch technology.

Secondly, and at least as important, are the opportunities to industrialise the economy that green hydrogen can create, given that South Africa is home to some of the most important raw materials needed to produce it. These include platinum group metals (PGMs), along with abundant sun- and wind-energy resources and the land on which to establish industrial-scale renewable energy (RE) plants.

PGMs are used extensively in the manufacture of the membranes and catalysts in electrolysers – and South Africa has the world's largest resources of these metals. South Africa can also be a major exporter of green ammonia (NH_3, a carrier of green hydrogen) to Europe and the Far East.

The combination of these resources, as well as the anticipated local demand for green hydrogen created by carbon-intensive industries, makes the country an attractive base for OEMs (Original Equipment Manufacturers) to establish manufacturing plants for the components needed to build RE plants and produce green hydrogen.

In addition, South Africa has an established manufacturing industry, expertise in the production of synthetic fuels and a vast labour force that is 'completely trainable', in the words of the country's Green Hydrogen Commercialisation Strategy.

Local manufacturing creates jobs, energy self-sufficiency and security, and export opportunities: all of which are needed to ensure an energy transition that is not only just but delivers tangible socio-economic benefits for all South Africans.

Green hydrogen state of play

Global demand for hydrogen reached an estimated 90-million tonnes in 2020 and is expected to grow to between 500-million and 680-million tonnes by 2050. Of this, the export market will account for 100- to 180-million tonnes. Given this potential, South Africa's nascent green hydrogen economy is being studied and structured from different angles.

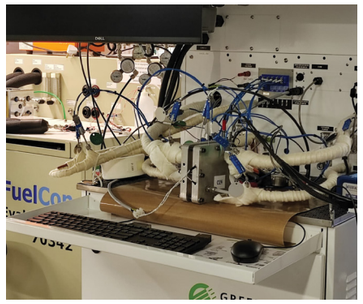
In June 2021 the Minister of Trade, Industry and Competition established the Green Hydrogen (GH_2) Commercialisation Panel, which is led by the Industrial Development Corporation (IDC). The panel has private and public sector members and, drawing on the Hydrogen South Africa (HySA) programme and the Hydrogen Society Road Map (HSRM), developed South Africa's Green Hydrogen Commercialisation Strategy and Action Plan, which was approved by Cabinet in 2022.

Over the past few months, Infrastructure SA, a programme within the ministry of public works, identified a pipeline of 19 green hydrogen projects valued at more than R300-billion. The IDC also secured €23-million in grant funds from the German government to support the development of South Africa's green hydrogen economy and help accelerate the country's transition to renewable energy.

For our nation, the notion that, through this process, we could grow into a significant supplier of the raw materials, technology, and product the world needs to clean up its energy act, is an exciting and inspiring goal to unite behind.

sanedi.org.za

A proof-of-concept green hydrogen facility, which creates hydrogen fuel using electrolysis – the process of using electricity to split water (H_2O) into hydrogen and oxygen gas (H_2 and O_2). The electricity required is generated using solar PV panels, which is why the hydrogen produced can be labelled 'green'.



A hydrogen fuel cell under test using Greenlight Innovation's testing and assembly equipment.

The role of electric vehicles in SA's energy transition

Titus Mathe, SANEDI CEO, unpacked the role that electric vehicles can play to facilitate the country's much-needed energy transition.

The driving force behind the world's best-known electric vehicle company, Tesla, is a South African. However, for most of Elon Musk's compatriots the technology is so far out of reach as to feel almost irrelevant. In addition, electric vehicles seem counterintuitive in a country that doesn't have enough electricity as it is. Adding energy-hungry vehicles to the grid will surely make matters worse.

Not, SANEDI believes, if it is done smartly. In fact, studies in the UK, US and Germany have shown that charging electric vehicles in off-peak hours can contribute tremendously to balancing out electricity demand and supply during a 24-hour period. Avoiding significant fluctuations is critical to grid stability and makes planning for new capacity easier and more effective.

To achieve this, the Electric Vehicle-to-Grid (V2G) model comes into play. In simple terms, it means that electric vehicles are in communication with the grid so that they can be charged during off-peak hours, which are typically in the middle of the day and during the night when household and commercial consumption, respectively, are at their lowest.

The V2G model integrates electric vehicles, charging stations, other energy providers, grid connections and smart metering. Smart charging enables communication and interaction among all connected elements on the system, and this turns electric vehicles into providers of energy services rather than simple users of electricity. If implemented correctly, consumers can provide energy to the grid through bidirectional charging stations, while generation, transmission, distribution, energy usage and storage are optimised across all actors.

Who, however, will buy enough electric vehicles to make this potentially beneficial impact a reality? The existing exorbitant import duties on vehicles and components alike put electric vehicles beyond the reach of most South Africans.

SANEDI sees a three-pronged solution.

- First, import duties must be reconsidered and incentives put in place for households and fleet managers to consider electric vehicles.
- Second, original equipment manufacturers, fleet operators and municipalities must focus on transport in the public sphere, such as buses, taxis and sedans used in ride-share services. Not only is the market enormous, but public transportation will also make electric vehicles relevant to the majority of South Africans.
- Third, the manufacturing of at least some EV components must be localised, urgently. While a measure of importation will always be needed, much can be done to decrease our import dependency and, in the process, create the jobs that will sustain the transition to a new energy future.

For SANEDI, the energy transition must be seen in the context of South Africa's socioeconomic realities. Therefore, as we introduce electric vehicles into the grid, we must ask how it's going to help us create employment, even out inequality and deal with poverty. With V2G technology these outcomes are possible. ❑