HYDROGEN and fuel cell technologies in South Africa

The hydrogen economy is undergoing serious consideration in South Africa, in an effort to develop safe, clean and reliable alternative energy sources to fossil fuels. Hydrogen is an energy carrier and is used to store and distribute energy and can be combined with the use of fuel cell technologies to produce electricity. Another driving force behind this technology is the prevalence of platinum reserves found in South Africa. Platinum group metals (PGMs) are the key catalytic materials used in most fuel cells, and with more than 75% of the world's known platinum reserves found within South African borders, there is great potential for socio-economic benefits to be obtained from these natural resources.

Fuel cells were invented about 150 years ago and directly convert chemical energy into electrical energy in a clean, environmentally friendly way, with no harmful carbon dioxide (CO_2) emissions at the point of use. Converting hydrogen gas to electricity in fuel cells does not "destroy" the hydrogen, but transforms it into water. Hydrogen can be produced from any hydrocarbon compounds, including fossil fuels, but the emphasis in South Africa is upon developing hydrogen from renewable energy sources in the long term. Fuel cell technology is more efficient, reliable, quieter and compact, and if the hydrogen used is from a renewable source, this technology is also cleaner and better for the environment.

Concept for a hydrogen fuel cell battery

The commitment to energy security is identified as one of the five priority areas or "grand challenges" in the Department of Science and Technology's (DST) Ten-Year Innovation Plan. Reflecting the shift in national priorities from the extraction of natural resources to the development of a knowledge based economy, these strategic outcomes indicate where South Africa wants to be in 2018.

The five grand challenges include:

- The farmer to pharma value chain to strengthen the bio-economy;
- Space science and technology;
- Energy security;
- Global-change science with a focus on climate change; and
- Human and social dynamics.

Collecting solar energy

Although hydrogen and fuel cell technology falls squarely under the energy security grand challenge, it also has implications for global-change science with the potential to help mitigate the effects of climate change through reduced emissions and improved adaptation through use of cleaner energy technologies.

Within the DST's grand challenge on energy security, this interest in hydrogen falls under the National Hydrogen and Fuel Cell Technologies Research, Development and Innovation strategy, branded as Hydrogen South Africa (HySA) in 2008. The strategy stimulates and guides innovation along the value chain of hydrogen and fuel cell technologies in South Africa, aiming to position the country to drive and optimise local benefits from supplying high value-added products (i.e. PGMs) to the potentially increasing international markets. These local benefits should include economic benefit, through job, wealth and new industries creation; the development of appropriate skills and human resources capital; and an improved quality of life for all South Africans.

Concept for a computer server fuelled by hydrogen

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Department:
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NRF National Research Foundation | SAASTA South African Agency for Science and Technology Advancement

HySA Public Awareness
Hydrogen South Africa

Solar and wind energy

Three Centres of Competence (CoC) have been established by DST to implement the HySA strategy, and are charged with unique responsibilities collectively geared towards attaining the goal of supplying 25% of global PGM based catalyst demand by 2020.

The three CoCs are:

- *HySA Systems:* CoC on hydrogen systems integration and technology validation, hosted by the University of the Western Cape.
- *HySA Catalysis:* CoC on hydrogen catalysis; co-hosted by the University of Cape Town and MINTEK.
- *HySA Infrastructure:* CoC on hydrogen generation, storage and distribution, co-hosted by the North West University and the Council for Scientific and Industrial Research (CSIR).

Wind turbines generating electricity

The combined efforts of these three CoCs are aiming towards the research and development (R&D) of a variety of hydrogen fuel cell technologies so that fuel cells can be "tailor-made" for specific uses and applications. Potential products being championed by the CoCs include a portable power source for use as a back-up power source as a quieter and cleaner alternative to generators. The second potential product is a combined heat and power (CHP) source based on fuel cells, to supply decentralised power and heating for buildings and industries. Popular in colder countries, these CHP systems offer high efficiency and low emissions, and can operate from existing natural gas distribution networks, providing up to 10kw power for domestic and up to 150kw for industrial buildings. South African R&D is focusing on developing internationally competitive and marketable CHP systems and critical CHP system components, to meet the needs of the international market.

The third potential product is fuel cell powered vehicles that could provide another alternative to hybrid and pure electric vehicles. Using Proton Exchange Membrane (PEM) technology, research over the next 20 years will focus on hydrogen storage density and extending fuel cell life. A more immediate possibility is utility vehicles, which require lower energy dense storage, making these a real possibility. In the words of Dr Dmitri Bessabarov, Director of HySA Infrastructure, "what is so exciting about this technology is that by using our natural resources, everyday products can be made that are not only environmentally friendly, but can ultimately impact on and improve the lives of not only South Africans, but millions around the world".

Fabrication of fuel cell

South Africa is also exploring other energy options, and it is intended that by 2018, that of the total energy produced, 5% would be from renewables, 20% from nuclear and 70% from coal (of which 30% based on clean coal technologies, where the harmful environmental effects can be reduced and the emissions contained). HySA also aims to demonstrate hydrogen production by splitting water at a pilot scale, using nuclear or solar power as the primary power source.

Key challenges facing HySA include the high cost of producing fuel cells and components which will need to be considerably reduced if this technology is to be competitive. South Africa has a strong potential to achieve this cost reduction through development of local PGM-based technology. Making this technology truly "green and clean" is the other main challenge, as "hydrogen is only as clean as it is made". Issues around the storage and distribution of hydrogen also need to be resolved before the technology can be scaled up and commercialised.

A biogas plant

The Department of Science and Technology's (DST) Hydrogen South Africa (HySA) Public Awareness Platform is hosted by the South African Agency for Science and Technology Advancement (SAASTA). More information on HySA and the CoCs can be found at www.hydrogen.org.za.