

# **HYDROGEN** and Fuel Cell Technologies

**In line with the global trend, South Africa is researching alternative energy sources to fossil fuel, to both reduce the level of dependency on these diminishing resources, and to find cleaner, more sustainable alternatives.**

The hydrogen economy is one approach undergoing serious consideration in South Africa. This involves the use of hydrogen as a carrier of energy – to store and distribute energy, combined with the use of fuel cell technologies to produce electricity. 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 CO<sub>2</sub> emissions at the point of use. Converting hydrogen gas to electricity in fuel cells does not “destroy” the hydrogen, but transforms it into water. Although hydrogen can be produced from energy from any hydrocarbons, including fossil fuels, the emphasis in South Africa is upon developing hydrogen from renewable energy sources.

South Africa possesses several competitive advantages in the field of hydrogen and fuel cell technologies:

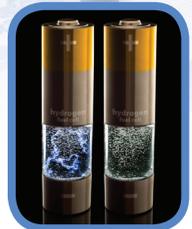
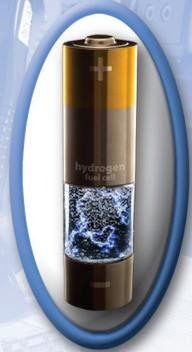
- ◆ Platinum group metals (PGM) are the key catalytic materials used in most fuel cells. With 75% of the worlds known PGM reserves found in South Africa, this is a significant driver towards the hydrogen economy, due to the immense socio-economic potential benefit to be obtained from adding value to natural resources, such as platinum, as well as increased demands for PGMs with the global uptake of such an economy.
- ◆ The extensive expertise in catalysis required for research and development of this type has been developed in South Africa through industry investment.
- ◆ The pebble bed modular reactor (PBMR) could also provide a “clean” method (non-GHG emissions) to produce hydrogen.

In May 2007, the Department of Science and Technology (DST) approved 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. It also aims to position the country to drive and optimize local benefits from supplying high value-added products (indigenous metals) to the potentially large international markets expected to arise in the medium to longer term. These local benefits should include economic benefit, through job and wealth creation, the development of appropriate skills and human resources capital, and an improved quality of life for all South Africans. A specific goal (of HySA) is for South Africa to supply 25% of the future global fuel cell market with novel, locally developed and fabricated PGM by 2020.

Three Centres of Competence (CoC) have been established by DST to implement the HySA strategy, and are charged with unique responsibilities to develop future industries in the field of hydrogen and fuel cell technologies.

The three CoC are:

- ◆ **HySA Systems** for systems integration and technology validation, hosted by the University of the Western Cape.



*Concept for a hydrogen fuel cell battery*



*Hydrogen fueling station for vehicles*



*Lab work*



*A biogas plant*



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South African Agency for Science  
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**HySA** Public Awareness  
Hydrogen South Africa



- ◆ **HySA Catalysis**, co-hosted by the University of Cape Town and MINTEK.
- ◆ **HySA Infrastructure**, co-hosted by the North West University and the Council for Scientific and Industrial Research (CSIR).

Each CoC has a unique responsibility, but all three are complementary within the common vision of fostering proactive innovation and developing the human resources required to undertake competitive research and development activities in the field of hydrogen and fuel cell technologies. The first five years of funding focus on developing infrastructure at each CoC and there is also a major emphasis upon human capacity development (HCD), with 30% of the total funds for this flagship HySA programme going towards HCD. Relevant international expertise has also been recruited by each CoC to access detailed technical support and well-established implementation networks, and also to ensure the programme and its deliverables remain market related and world class. To date these include Dr Oystein Ulleberg from Norway, Director of HySA Systems and Dr Dmitri Bessabarov, from Canada, Director of HySA Infrastructure.

### HySA Systems



Moisture-free glove box for fabrication of components and cells

HySA Systems mainly focus on the development of membrane electrode assemblies (MEAs) and fuel cell stacks for high temperature polymer electrolyte membrane fuel cells (HTPEMs), and solid state hydrogen storage systems. HySA Systems has the overall responsibility for technology validation (e.g. validation of complete fuel cell systems) and system integration involving end-users (e.g. testing of integrated CHP-systems). HySA Systems HCD-programme includes the education of post graduate science students in the area of materials for hydrogen and fuel cells technology, and training of engineers.

### HySA Catalysis



Fabrication of components in glove box

HySA Catalysis focus mainly on the development of fuel cell catalysts, membrane electrode assemblies (MEAs) for low temperature polymer electrolyte membranes (PEM) fuel cells, and fuel processors. The mandate of the Centre is to focus on catalysis and catalytic devices associated with the other CoCs. The Catalysis CoC takes particularly responsibility for the establishment of a national competency in hydrocarbon fuel processors for the production of hydrogen as well as catalytic fuel cell components, viz. electrocatalysts, (MEA) and fuel cell stacks. Given the need for compact fuel processor technologies, substantial focus will be on PGM catalysts and reactors, as well as MEA's.

### HySA Infrastructure



Fabrication of fuel cell

HySA Infrastructure mainly focus on small to medium scale hydrogen production technologies (e.g. water electrolysis and thermo-chemical processes), hydrogen distribution, and hydrogen storage technologies (except solid state hydrogen storage). Research will focus on the production of hydrogen from renewable energy sources such as biomass, solar and wind. The mission of the Infrastructure CoC is to deliver technologies for hydrogen generation, storage and distribution infrastructure that meet the set cost targets and provide the best balance of safety, reliability, robustness, quality and functionality.



Solar and wind energy

*The South African Agency for Science and Technology Advancement (SAASTA) has been appointed by DST to implement a public awareness, demonstration and education platform, and to develop information channels to keep the public informed about hydrogen and fuel cell technologies. More information on HySA and the CoCs can be found at [www.hydrogen.org.za](http://www.hydrogen.org.za).*