Home-grown science to resuscitate South African economy

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With declining commodity prices and the dwindling demand for natural resources, the work of South Africa's Department of Science and Technology (DST) is focused on shaping a knowledge economy. The DST has identified research and development (R&D)-driven new industries which, although not necessarily new internationally, are nevertheless new in South Africa.

One of these "home-grown" industries is the Hydrogen Fuel Cell Technology (HFCT) Program, which is yielding exciting results with the launch of prototypes using HFCT in sectors like mining, according to DST. The government embarked on the program in 2008 with the launch of Hydrogen South Africa (HySA). The vision was to add value to South Africa's Platinum Group Metals. At the time DST realized that hydrogen fuel-cell technology is an industry that is nascent and that, globally, people are trying to grow knowledge in this field. In addition, it is also a source of alternative energy.

Three centers of competence (CoCs) were established through the Cabinet-approved HySA Strategy. The CoCs drive R&D work in HFCT technology. The first CoC was established at the University of Cape Town and Mintek to do research in catalysis; another was established at the University of the Western Cape, focusing on hydrogen and fuel-cell system integration and technology validation; and the third is a joint CoC hosted by the government agency CSIR and North-West University, focusing on infrastructure for hydrogen production, distribution, and storage.

A three-phase program began in 2008, where the first phase started from scratch by establishing R&D capabilities. The DST provided the infrastructure, which included supporting postgraduate students to do the research.

The second phase, which runs from 2014 to 2019, focuses on technology demonstration and testing, as well as delivering products to the market. Creating jobs and establishing spin-off companies is another byproduct of phase two. Recent results from this phase can be seen in the mining industry, where DST Minister Naledi Pandor unveiled a HFCT-powered forklift and refueling station for local industry. These technology demonstrators were launched by the DST, together with Impala Platinum in Springs and HySA Systems, based at the University of the Western Cape. Impala will use the locally developed HFCT components for their underground utility vehicles.

The fuel-cell-powered forklift and the 200-bar refueling station (comprising a compressor with a metal-hydride extension tank developed by HySA Systems) has been in operation at the Impala Platinum Refinery since October 2015. The metal-hydride compressor and direct hydrogen feed make this a very unique system, which could be replicated in other materials-handling industries. The third phase will focus on sales, the number of jobs created, export revenue, and the market share created.

According to the Annual Fuel Cell Review 2015, the total revenue of companies operating in the HFCT sector was just short of USD$200 million in 2013, which corresponded to global fuel-cell shipments of 67,200 fuel-cell systems. As far back as 2014, global fuel-cell shipments grew to 104,900, which was projected to grow to 158,600 in 2015. Research also shows that the platinum-based catalyst market is expected to be worth $555 million by 2020. Capturing 25% of this market would result in revenue of $139 million for the country.

A similar initiative with potentially significant economic impact is the Titanium Metal Powder Project, which is a flagship project under the Titanium Centre of Competence. According to DST, breakthroughs in this area would complete a local beneficiation value chain of a globally strategic metal. The ability to produce titanium powder directly is considered to be a radical innovation and the process that is being developed will be a world first, according to the DST.

Titanium powder is widely used in industries such as aerospace, medical applications, transport, and chemical processing to create high-performance, lightweight parts. However, titanium powder has become even more important because of its use in three-dimensional (3D) printing, which is establishing itself as an alternative mode of manufacturing.

The DST is funding the CSIR on this project, and the main aim of the titanium powder initiative is to demonstrate and pilot a novel and more cost-effective process for the direct production of primary titanium powder, with a particle morphology and size suitable for compaction into either semi-finished articles or near-net-shape components via 3D printing. In addition, it is intended to be a continuous process, in contrast to the current batch-operated processes used elsewhere in the world.

A laboratory-scale pilot plant was launched in 2013 and test campaigns commenced in the following year. Due to new process requirements, the reactors are currently being upgraded and it is expected that the test campaigns will commence by December 2016. Following the successful laboratory-scale testing and validation, an industrial pilot plant is envisaged by 2019, followed by a full commercial plant in 2023.

Revenue of approximately USD$400 million per annum is expected from the titanium powder production once the commercial plant is operational in ~2023. Revenue could increase by almost USD$100 million per annum once a downstream titanium industry is developed.

According to the DST, these kinds of locally grown new industries hold the potential to create jobs by producing thousands of knowledge workers with postgraduate qualifications; this would have a socioeconomic impact and start to transform South Africa from a resource economy into a knowledge economy. □

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