SCIENCE AND
INDUSTRY
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FUND

Hydrogen generator for refuelling fuel-cell electric vehicles

Growing global demand for clean hydrogen (H_2) fuel represents a significant opportunity to establish an Australian renewable hydrogen export industry. Using ammonia (NH_3) as a carrier, renewable hydrogen produced in Australia can be readily distributed, at large scale, to emerging markets in Japan, Korea and Europe while using existing infrastructure for ammonia transport. The gap in this supply chain is a technology that can efficiently and inexpensively convert ammonia into high-purity hydrogen at or near the point of use for fuel-cell electric vehicles (FCEVs).

The challenge

Transportation and storage are the critical challenges faced by the hydrogen fuel industry; the current available technologies are complex and expensive.

The response

CSIRO developed a H_2 generating system that allows H_2 in the form of liquid ammonia (NH_3) to be transported economically and efficiently. Liquid ammonia stores 35 per cent more energy than liquid hydrogen, is easier to ship and distribute, and can use the existing logistics chains for this purpose. Our solution addresses the conversion of ammonia back to high-purity hydrogen at, or near, the point of use. This opens up the possibility for a renewable energy export market.

SIEF's support enabled the demonstration of this concept on a 5–15 kilogram per day H_2 pilot-production scale, operating over 1,000 hours with more than 80 per cent NH3 'cracking' efficiency and more than 80 per cent H_2 extraction rate. The world's first demonstration of fuel-cell vehicles refuelled with hydrogen derived directly from ammonia was held in August 2018 with two commercial FCEVs (Toyota Mirai and Hyundai Nexo).

The impact

Summary of impacts as per CSIRO's triple-bottom-line benefit classification impacts

ECONOMIC

- Establishment of a sustainable hydrogen export industry in Australia
- Improved national fuel security
- New industries, jobs and market niches

ENVIRONMENTAL

- Reduction in national and global emissions across sectors
- Improvements to air quality through the reduction in particulate emissions from internal combustion engine vehicles

SOCIAL

- Better health and wellbeing through the use of hydrogen as a clean energy source
- Revitalisation of regional communities through employment in hydrogen-based industries

Industry partners

Experimental Development Program project – co-funded by SIEF.

Major Project Partners – BOC, Toyota, Hyundai.

Other Partners: Queensland Department of Environment and Science.

Commercialisation: Subsequent to the completion of the SIEF project, an agreement was developed between Fortescue Metals Group Ltd (Fortescue) and CSIRO for Fortescue to provide support for the next stage of this work, which is the demonstration of a pilot-scale CSIRO H_2 generator capable of producing approximately 200 kilograms per day of hydrogen.

Domestic and global application

A successful ammonia-to-hydrogen technology will play a critical role to demonstrate a viable solution. To move to a commercial undertaking, the team is developing internationally linked demonstration projects. Any longer-term outcomes will require the ability to plan and deliver these projects with our government and industrial partners.

The final step for commercialisation of this technology requires engagement with H_2 and fuel cell vehicles industries that can facilitate the incorporation of commercial-scale CSIRO H_2 generating system, and provide validation of the first step, for refuelling to day-to-day FCEVs for real-life customers.

Financial investment

In this $3.4 million project, 50 per cent of the project cost ($1.7 million) was funded by SIEF as an Experimental Developmental Program and the remainder by CSIRO. Partner BOC also contributed over $100,000 of in-kind gas products, equipment and technical expertise.

SIEF case study
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Image: Refuelling a hydrogen fuel cell electric vehicle by the Hon Keith Pitt MP, former Assistant Minister to the Deputy Prime Minister, with Dr Larry Marshall.

B&M | 20-00284