NEW ZEALAND

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INTRODUCTION AND BACKGROUND

New Zealand joined the IEA HIA in mid-2005. The New Zealand Council for Sustainable Business Development (NZBCSD) was then the contracting agent on behalf of the New Zealand government. This role has now been taken over by Solid Energy Limited. The Ministry for Economic development (MED) administers New Zealand’s involvement in the IEA HIA. The New Zealand government in 2008 released a New Zealand Energy Strategy that set a target of 50% reduction in transport related emissions by 2040, and sees hydrogen as a potential contributor in the long term towards meeting that target.

Eleven projects have been undertaken since New Zealand became a member of HIA, and are underway or recently completed. Projects are funded from government and private expenditure and have involved hydrogen production, storage, demonstration, and education. The majority of the research has been conducted by Industrial Research Limited (IRL) and CRL Energy Limited (CRL Energy). The major government funding agency is the Ministry for Science and Innovation (formerly The Foundation for Research Science and Technology), which is currently investing in aggregate about NZ$2 million per year to a reduced number of projects.

UPDATE ON MEMBER’S ENERGY FRAMEWORK

UPDATE OVERVIEW ON RELEVANT PROGRAMS AND PROJECTS

Hydrogen Production

The largest project relates to hydrogen production. This is the Hydrogen and Clean Energy programme being jointly carried out by IRL and CRL Energy. It is a successor to the recently concluded Hydrogen Energy for the Future of New Zealand programme which demonstrated the production of high quality hydrogen from New Zealand’s abundant reserves of low rank coal and converted it to electricity using a hydrogen fuel cell. The programme also evaluated the generation of hydrogen from distributed renewable energy sources via electrolysis, with particular emphasis on wind based generation which is growing rapidly in New Zealand. The new programme brings together these hydrogen production routes by

Figure 1: The low rank coal gasifier and hydrogen production line.
Exports

Total Exports: 179 PJ (Gross)

- Oil: 114 PJ (64%)
- Coal: 65 PJ (36%)

Consumption

Energy Consumption 523 PJ (Gross)

- Oil: 245 PJ (47%)
- Gas: 138 PJ (26%)
- Electricity: 59 PJ (11%)
- Wood: 50 PJ (10%)
- Coal: 21 PJ (4%)
- Geothermal: 10 PJ (2%)


Electicity 2009

Production

- Hydro: 23,962 GWh (57%)
- Gas: 8,385 GWh (20%)
- Geothermal: 4,542 GWh (11%)
- Coal: 3,079 GWh (7%)
- Other renewable: 5 GWh (1%)
- Wind: 1,456 GWh (3%)
- Other: 586 GWh (1%)

Imports

None

Exports

None


Focusing on oxygen blown fluidized bed co-gasification of lignite coal and biomass for co-production of syngas and hydrogen. In the laboratory-scale technology demonstration planned under the project, electrolysis is used as the source of oxygen and hydrogen. The oxygen is used in the advanced gasification process, and the hydrogen is available as both a transport fuel and for upgrading the syngas from the low H:CO ratio obtained from lignite gasification to a ratio better suited for liquid fuel production. New Zealand has a high level of renewable electricity generation from its hydro resources, and wind energy increasingly offers a substantial renewable energy input to the process which is not available in other countries.

The Nanomaterials for Energy programme involves research into the development of new, more efficient and lower cost separation membranes for hydrogen purification. Alumina substrates with highly regular porous structures developed through electrochemical etching processes are being coated with a range of materials with an aim to produce cost effective high temperature and low pressure separation systems suitable for hydrogen and other gas purification. See photos below.

A project to identify ways of purifying micro-algal hydrogenase for development of a hydrogenase electrode has also recently been initiated, as has research into the preparation of highly active electro-catalytic particles for use in proton exchange membrane electrolysis. Other hydrogen production projects now completed related to small-scale steam reformation of bio-methanol and bioethanol, and the use of a biomass based iron oxide reduction and steam oxidation cycle.

Hydrogen Storage

There are no active storage projects following the completion of a chemical hydride storage project (regeneration routes for sodium borohydride and storage in amino-borane systems).

Hydrogen Energy System Demonstrations

Demonstrations to date have been restricted to small-scale stationary applications. A current project involves a hydrogen energy storage system being developed to support a renewable energy system at Matiu/Somes Island in Wellington Harbour. This project builds on the experience gained in the Totara Valley project mentioned below. While still a very low power project, it will use a large diameter polymer pipe for low pressure hydrogen energy storage. The project contributes to IEA HIA Annex 29 - Distributed and...
Community Hydrogen (DISCO-H2) research outputs, which will be used to evaluate the commercialization status of such remote area energy systems.

Figure 4: Somes Island, Wellington Harbour: A hydrogen energy storage system will be installed to contribute to a reduction in diesel fuel use on the island.

A number of earlier technology demonstrations have also been undertaken. The best known relates to a remote rural wind-hydrogen power link and alkaline fuel cell grid connected demonstration at Totara Valley near Palmerston North in the North Island of New Zealand. In this demonstration wind-sourced hydrogen (obtained using an electrolyser) is transmitted from a hilltop wind turbine site to the farmhouse in the valley 2km below. The system provides daily buffer storage of up to 5kWh of wind energy supply within the low cost polymer fuel pipe while a 1 kW fuel cell converts the hydrogen energy to electricity at the farmhouse. This project was analyzed as a case study in IEA Annex 18 Evaluation of Integrated Hydrogen Energy Systems. A concluded demonstration related to a range of options for providing hydrogen to a US Department of defence PEM Fuel Cell at the Antarctic Centre in Christchurch. This programme ran successfully over a 12 month period during which 10,500 cubic meters of hydrogen were supplied.

Hydrogen Education

Past activity in this area resulted in the series of reports produced by CRL Energy and IRL under the “Transitioning to a Hydrogen Economy” programme. This programme identifies likely scenarios for the uptake of hydrogen in the future New Zealand energy system and the research needed to facilitate the uptake. The programme included a significant scenario modeling component (performed by Unitec, Auckland) to highlight the contributions of a range of well to wheels and source to user hydrogen supply chains, as well as to identify critical knowledge gaps.
Hydrogen Road-Mapping Activities in New Zealand

Road mapping work is continuing under the Hydrogen and Clean Energy for New Zealand programme. This includes developing model scenarios to assess the uptake of hydrogen fueled cars in a competitive market which includes various degrees of vehicle hybridization and plug-in batteries, in addition to biofuels and more efficient petrol/diesel vehicles.

![Figure 5: An output from the Unitec UniSyD system dynamic model of the New Zealand energy system based on a scenario of modest oil prices, carbon taxes, and encouragement for uptake of electric/fuel cell vehicles.](image)

Past work in the Transitioning to Hydrogen project analysed potential hydrogen supply chains and identified the most favorable in terms of economics, energy requirement and emissions footprint (E3 analysis). The end result of this modeling stage showed that four production chains -- electrolysis, natural gas reforming, coal gasification with carbon capture and sequestration (CCS) and biomass gasification -- competed to meet the hydrogen demands associated with the 12 future scenarios. Knowledge gaps associated with these chains were identified as was means for filling these gaps (either through a New Zealand led programme of research, or through international linkages) and a corresponding research strategy identified.