NEW ZEALAND UPDATE

IEA - HYDROGEN IMPLEMENTING AGREEMENT MEETING
PETTEN 10-12 Feb 2015

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Outline

1. Location
2. History of H₂ events to date in New Zealand
3. Industry links
4. Proposed organisational structure.
5. Unitec Centre for Hydrogen Energy Technologies in Industry (HETI)
6. Three H₂ focussed projects
7. Conclusion
Location of New Zealand

Population 4.4 million, area 268,000 sq. km. 32% live in Auckland City

Source: http://en.wikipedia.org/
History

- 2002 – Govt awards $6 million over 6 years to examine production of hydrogen from coal by gasification and model scenarios for the national economy.

- 2007 – Govt awards $1.3 million Energyscape project to examine resource potential of all energy sources in New Zealand.

- 2007 – 1st demonstration project of renewable electricity from wind via H\(_2\) commences at the rural location of Totara Valley

- 2008 – Govt funds study into H\(_2\) production by gasification using biomass and coal mixed and extends scenario modelling.

- 2011 – 2nd demonstration project commences on Matiu Island

- 2013 – Private sector became interested in potentially commercially viable applications e.g. UniSyD model, Quad bike, HyLink, energy independent farming.
Proposed organisational structure for H₂ Deployment

### New Zealand Association for Hydrogen Energy
- Leadership in advocacy and science for hydrogen technologies
- Enhancement of education and skills for understanding and applying hydrogen technologies
- Facilitation of networking with other renewable energy associations
- Facilitation of information exchange
- Organisation of special events such as conferences, exhibitions and forums

### Hydrogen Technology Development Committee
- Implementation of projects within New Zealand

### Hydrogen Technology Development Partnership (HTDP)

#### H2NZ
- Seed funding for potentially viable H₂ technologies
- Integration of component technologies into energy independent farming systems
- Engaging with cornerstone industry partners for component system technologies

#### Current Projects
1. Energy Economic Modelling: UniSyD5.2
2. HyLink Renewables to Hydrogen: Matiu Island.
3. Energy Independent Farming
   - Renewable on site generation, wind, PV, micro-hydro
   - Electrolyser (H₂ generation)
   - Low pressure H₂ storage HDPE, bladder.
   - Hydrogen califont
4. UniQuad H₂ powered electric Quad bike.
5. Hydrogen fuelled house
6. Mobile refuelling station

#### Future Projects
1. Fuel cell forklifts with onsite H₂ production from PV.
2. Fertiliser production

### Innovation Funding Agencies
- KiwiNet [http://www.kiwinet.org](http://www.kiwinet.org)
- Callaghan Innovation

### Other Associations
- Unitec Centre for Hydrogen Energy Technologies in Industry (HETI)
  - Educational courses
  - Research including funding
  - Facilitating industry and academic collaboration
1. Improve understanding of practical application of hydrogen technologies via demonstration projects with industry. e.g.
   - Energy independent farm (on site generation and low pressure storage of renewable hydrogen for powering farm equipment, peak electricity generation, heating and cooking)

2. Develop tools and techniques to support industry, Government and community decision making; e.g.
   - UniSyD: Develop global application for countrywide techno-economic modelling of energy economies
   - New Zealand Hydrogen Highway: Develop a strategy for the establishment of a national hydrogen refuelling infrastructure
   - Renewable H2 exports: Determine the business case and viability of hydrogen production from geothermal resources including export of ‘green’ hydrogen to major international markets
   - Power to hydrogen – exploring opportunities to store surplus renewable electricity using bulk hydrogen storage in conjunction with fuel cells as an alternative to chemical battery storage.

3. Develop novel new technologies to support industry uptake and/or export. e.g.
   - Mobile hydrogen refuelling, hydrogen califont, low cost - low pressure electrolysis of water.
Key Projects

1. Energy Economic Modelling: UniSyD5.2
2. HyLink Renewables to Hydrogen: Matiu Island.
3. Energy Independent Farm
   (Renewable on site generation, wind, PV, micro-hydro)
   a. UniQuad H₂ powered electric Quad bike.
   b. Mobile low volume refuelling station.
   c. Hydrogen fuelled house with on-site storage.
History

- Developed under contract at Unitec in collaboration with 3 interns from Stanford University
- Adopted by the NordStar Consortium of 6 universities and 3 research institutes [http://www.nord-star.info/](http://www.nord-star.info/) for modelling the Icelandic energy system
- Under development for application in Japan at Kanagawa University.

Journal papers:

• Multi-regional
• 2 week time steps.
• Primary Markets
  o Electricity,
  o Hydrogen,
  o Lignocellulose,
  o Vehicle fleets
Project 1: UniSyD Demonstration

PRIMARY VARIABLES
ALL PRICES IN 2014 NZD

SECONDARY VARIABLES
Project 1: UniSyD5.2 Output Samples
Project 1: UniSyD Iceland Results – Net Supply Benefit

Source: Ehsan Shafiei
Project 2: HyLink: Renewable Hydrogen Demonstration
Matiu Island, Wellington, New Zealand
Project 2: HyLink: Process Diagram

Energy Sources:
- Wind turbine 6 kW
- Solar PV 3.8 kW
- Diesel Generator 16 kW

Energy Conversion:
- Rectifiers
- Converters

Energy Storage:
- Battery
  - Lead acid
  - 2400 Ah, 48 V

Energy Production and Use:
- Electrolyser System
  - 110A 14 V
  - 250 litres/hour (STP) at 80 A
  - Oxygen to atmosphere
  - H₂ storage 730 litres @ 3.25 bars gauge
  - Hydrogen BBQ + water heating

Auto Start/Stop signal:
- Island Mains

Additional Information:
- Water

Location:
- Engine generator shed

Overall System:
- Hydrogen energy system
• On Matiu Island the first priority is to provide electricity.
• Surplus power (when batteries are full) is used to make hydrogen.
• Hydrogen is stored in two underground 6 m x 300 mm HDPE cylinders, capacity 730 litres.
• In 12 months over 2 GWh of $H_2$ produced
Project 3: Energy Independent Farm: Taupo

- Renewable on site generation, wind, PV, micro-hydro
- 5 kW Electrolyser (H₂ generation)
- Low pressure H₂ storage HDPE, bladder.
- Hydrogen for farm equipment, heating (28 kW) and cooking for accommodation
- Fertiliser production (in future)
- Zero nitrogen stock management
Sub-project 3A: UniQuad H₂ Electric Quad

http://www.unitec.ac.nz/uniquad/
Sub-project 3A: UniQuad: Specification

- Self-levelling suspension that can sidle along slopes at angles of up to 40 degrees.
- 4x5 kW electric hub motors
- 3 kW fuel cell
- 1 kWh Li-ion battery
- 1 kg 350 bar $\text{H}_2$ fuel tank

Showcase: World Hydrogen Technologies Convention, October 2015, Sydney, Australia.

Solid Works rendering by Simon Hartley
Sub-project 3A: UniQuad: Utility focus

- Longer range than a battery powered electric quad.
- Provide educational opportunities in the development of the first $H_2$ powered fuel cell vehicle in NZ.
- Raise awareness of the potential for zero emission energy independent farming.
- Engage industry with a range of equipment suppliers who are participating in hydrogen based technology developments overseas.
- Raise awareness of the need for government policy to include a hydrogen focused future as an optional energy pathway.
- Have the potential to reduce both greenhouse gas emissions and engine noise levels due to the use of renewable hydrogen fuel.
- Provide an option for improved security of operation in the farming sector with a quad that can be fuelled on the farm without being dependent on imported fossil fuels.
  - Reduce quad bike injuries and fatalities that constitute 28% of all work-related farm deaths in New Zealand.
Sub-project 3B: Mobile Refuelling Station

- Trailer mounted
- 900 bar 2 stage compression
- Robust PEM electrolyser
- Commercial vehicle refuelling capability
- Production min. 2 kg/day H₂
- Trailer storage min. 6 kg H₂ at either 150 or 875 bar subject to regulatory environment.
• Passive solar, PV, solar thermal.
• Hydrogen califont hot water heating.
• Hydrogen gas fuelled cooking and water heating booster.
• On site low pressure hydrogen storage (HDPE)
• Advanced energy management system to utilise on-site energy resources (solar PV, stored hydrogen energy).
• New Zealand is ideally positioned to take advantage of the unique features of hydrogen as a renewable energy carrier with about 3 times its current electricity generation available from wind at less than 10 USc/kWh\(^1\).

• Unitec’s proposed Centre for Hydrogen Energy Technologies in Industry (HETI) in conjunction with the Hydrogen Technology Development Partnership (HTDP) aims to provide commercially viable renewable hydrogen based energy solutions in the deployment of hydrogen technologies initially encompassing farming applications in transport, stationary equipment and heating.

• The New Zealand HTDP is seeking further international engagement and collaboration to enhance the global deployment of hydrogen technologies.

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Lake Pukaki & Mt Aoraki (Cook)
3,754 metres, 12,316 ft

Pohutu Geyser, Rotorua

Akaroa, South Island

Kereru
(Native Wood Pigeon)

Thank you

Photos: Jonathan Leaver