Hydrogen and Fuel Cell RD & D Activities in No

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Hydrogen RD & D Programmes

Production

- Fuel cell grade hydrogen from coal
- Using an ironsand oxidation/reduction based process

Storage

Using boron hydrides

Scenario Modeling

Utilisation

- Alkaline fuel cell demonstrations
- Renewables based distributed generation demonstrations
- PEM and Solid Oxide fuel cell demonstrations and trials

Hydrogen Roadmap for Coal Industry

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Where in the World Are We?





Population: 4 million

Land Area: 265,600 sq km

1920 km from Australia

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New Zealand



Background

Imported transport fuels cost \$1 to 4.5 billion per annum

Desire to meet energy needs using indigenous resources

Electricity grid system to undergo upgrade

Potential for increased DG applications

Kyoto signatory



Current Energy Supply

Electricity supply dominated by renewables - hydro (62%)

- Exposed to dry year shortages
- Large scale hydro options limited

Large single source of low cost natural gas (Maui Gasfield)

- Depleted by 2008
- No comparable sized replacement presently available

Vast under-utilised economically recoverable reserves of coal

Very well suited to fluidised bed gasification



Recoverable Energy Reserves

Oil and condensate – 402 PJ

Natural Gas - 2300 PJ

Future discoveries estimated at 80 PJ pa

Coal – 150,000 PJ

- Sufficient to meet energy demands for 100s of years
- 10 times more coal per capita than world average



How Much Hydrogen will New Zealand need and Where Will it Come From?

 1.2 – 1.75 million tonnes of hydrogen (144-210 PJ) p.a. by 2050 to meet predicted land transport demand

Primary domestic energy sources

- Coal
- Natural Gas
- Renewables



Energy Required for Hydrogen in 2050



Years of Resource at 2050 Demand Prediction



Coal to Fuel Cell Grade Hydrogen Technology Package

- Develop knowledge and expertise to facilitate New Zealand's transition to a hydrogen economy
- 6 year (2002-2008) government project (\$8M)
- CRL Energy producing alkaline fuel cell grade hydrogen from coal



IRL using that hydrogen in an alkaline fuel cell

Coal to Hydrogen Technology Package







Gasification Pilot Plant at CRL Energy

Research Goal
Coal (lignite) to fuel cell grade Hydrogen
Test bed for hydrogen separation technologies

IRL Hydrogen Energy RD&D

Utilisation

- Alkaline fuel cells
 - System integration
 - Balance of plant
 - Electrodes
- Distributed generation applications
 - Microscale CHP
 - Alcohol fuel reformers





Coal to Fuel Cell Grade Hydrogen Technology Package

- Meeting the needs of remote communities small scale DG application
- Meeting the needs of larger scale industrial complexes (tri-generation plant)
- Meeting the needs of transport fleet (large scale centralised plant)



Roadmap for the Coal Industry

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Laying the Foundation	Gasification Uptake	Zero Emisions Power Plants	Building the Hydrogen Infrastructure	Hydrogen Economy
Establish the link betw een coal and hydrogen	First large-scale gasification plant built	Demonstrate large scale coal-hydrogen capability	Several large-scale zero- emission coal based	Nationw ide hydrogen
(decision makers and the public)	First large-scale industrial	First large-scale	energy plants producing hydrogen	distribution netw ork to support 3.5 million
Small demonstration co-	tri-generation plant built	electricity) capable plant	Significant hydrogen	vehicles
production plant built (H ₂ /electricity)	Increased use of small- scale DG plant	w ith CCS (zero emissions)	distribution infrastructure in place	>10 million tonnes of coal used annually for pow er and H2 production
Fechno-economic studies (sites & technologies)	Cabon sequestration verification trials	National hydrogen infrastructure development	Significant and rapidly grow ing demand for	
National carbon sequestration	Initial use of carbon capture technologies	Initial consumer up-take of	2035: 2 million H ₂ vehicles (55% of fleet)	
site survey Identify site for first		hydrogen fuelled vehicles	<u> </u>	
large-scale CS project				
orm international alliances				/
Establish NZ as a technology test-bed				
	Coal Use			
			Hydrogen Production	(Data based on Unitec scenario modelling 2004)

Hydrogen production using Ironsand

Production



Boron Hydride Storage



Fuel Cell Demonstrations and Field Tria

IRL Experimental Alkaline fuel cell system -2003

- Delivered to Murdoch University, Perth, Western Australia
 - Fully monitored wind based RAPS system in a container
 - Fuel cell upgrade currently under way





Totara Valley Farming Community, New Zealand - 2004

- Grid connection of hydrogen distributed energy at the consumer level
 - Integration of hydrogen technologies
 - Wind-electrolyser-pipeline H2 storage and delivery of household energy services
 - Electricity H2 fuel cell
 - Water heating H2 combustion







Totara Valley Farming Community, New Zealand – system configuration





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- International Antarctic Centre, Christchurch, New Zealand -2005
 - US DoD Residential PEM Fuel Cell Demonstration project
 - 2kWe ReliOn fuel cell providing battery charging and yard lighting
 - Dual Fuel methanol reformer with hydrogen cylinder backup
 - Contract management, systems engineering, installation and monitoring by Industrial Research Limited

Gracefield Research Centre, Wellington, New Zealand – 2005

- CFCL-POWERCO residential SOFC demonstration
 - 1kWe grid connected integrated CHP energy system
 - User host site, installation and monitoring contracted to Industrial Research Limited





 Fuel Cell Based Residential microCHP: Timeline for Deployment in New Zealand

Stage	1	2	3	4
Date	2006	2008	2010	2012
# of sites	10	100	1,000	10,000
Fuel	H2/MeOH	+ EtOH	+ LPG	+ NG
Installed	10kW	100kW	1MW	10MW
Capacity impact	16kW	160kW	1.6MW	16MW
Status	Demo/PR	Pilot	Prototype	Commercial

