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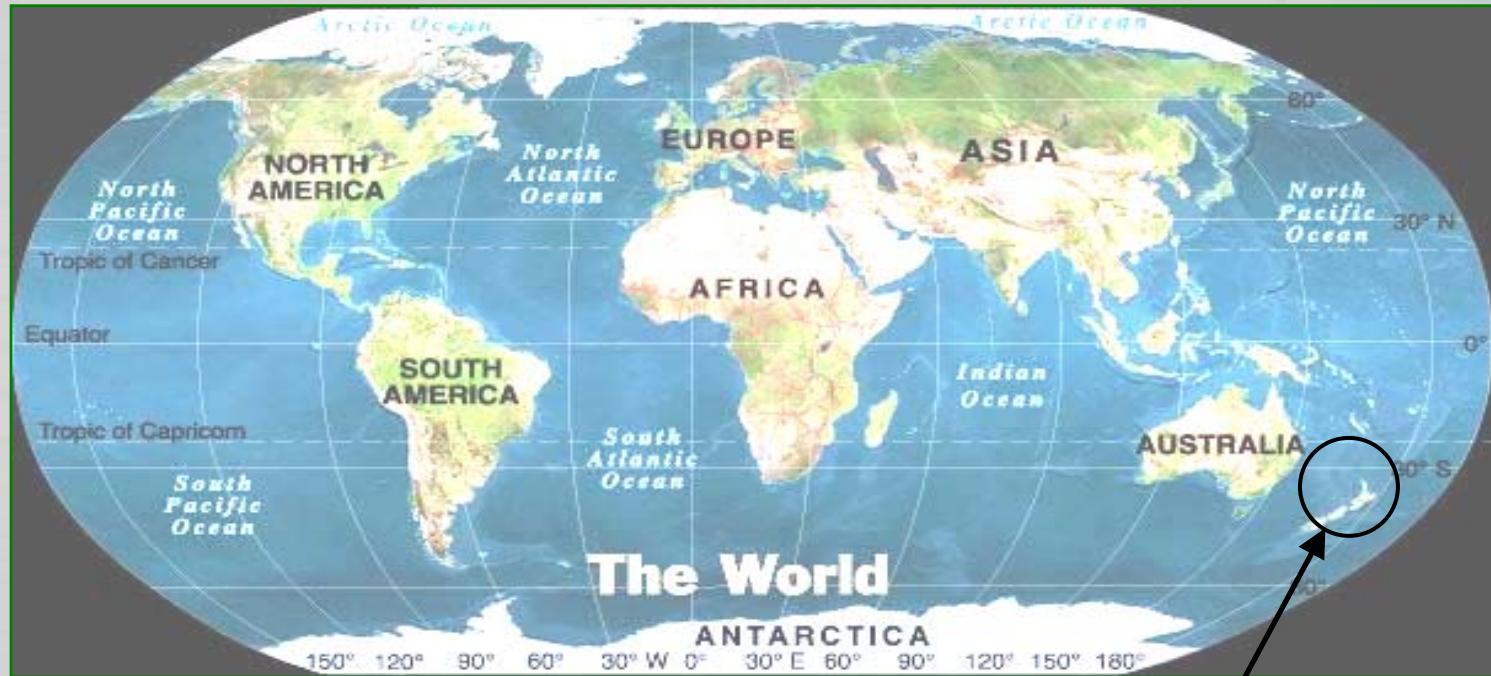


Hydrogen RD & D Programmes

- **Production**
 - Fuel cell grade hydrogen from coal
 - Using an ironsand oxidation/reduction based process
- **Storage**
 - Using boron hydrides
- **Utilisation**
 - Alkaline fuel cell demonstrations
 - Renewables based distributed generation demonstrations
 - PEM and Solid Oxide fuel cell demonstrations and trials
- **Hydrogen Roadmap for Coal Industry**
 - Scenario Modeling



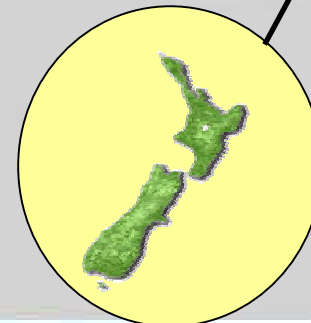
Where in the World Are We?



Population: 4 million

Land Area: 265,600 sq km

1920 km from Australia



New Zealand



New Zealand Energy Sources





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

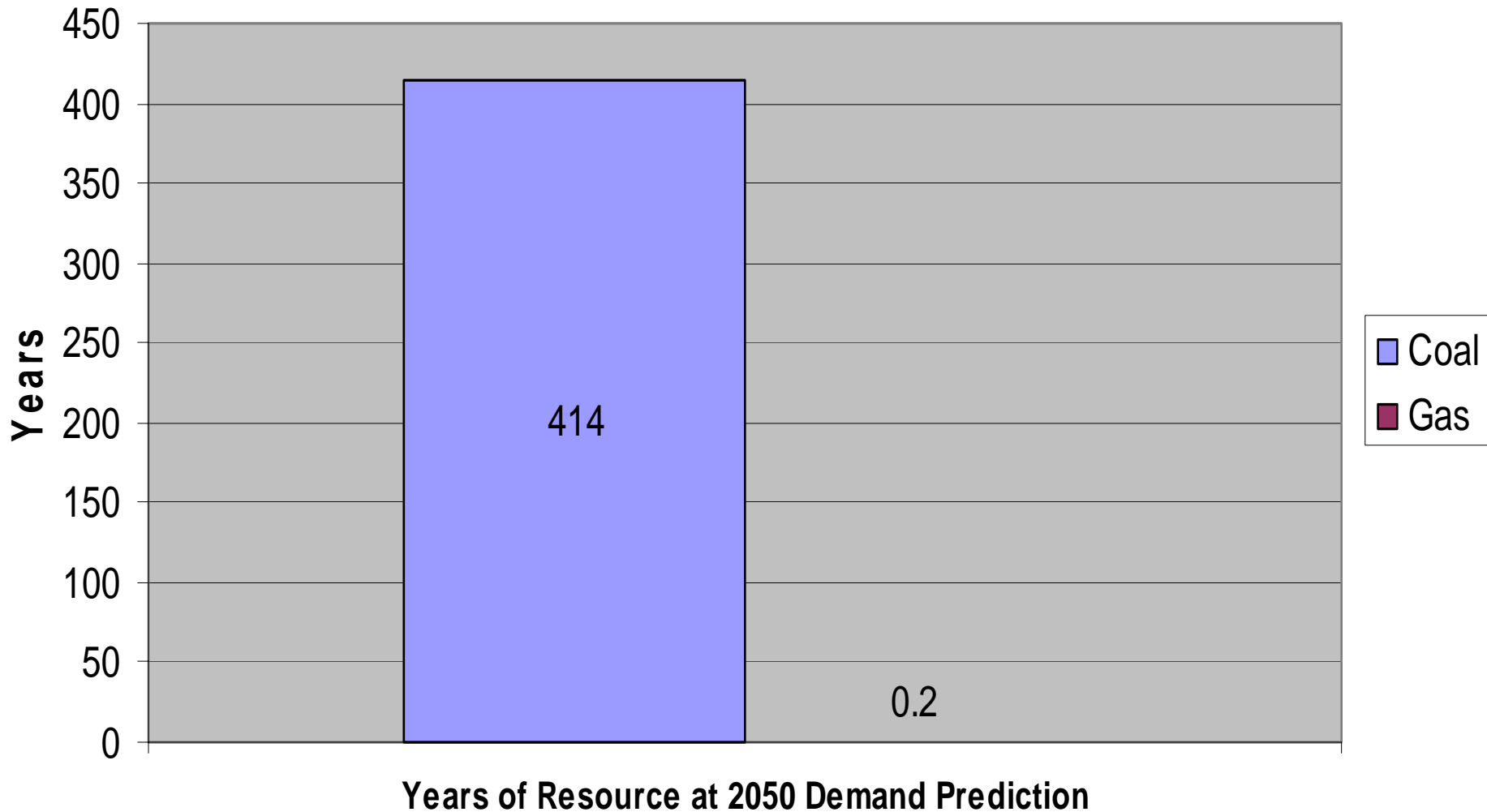


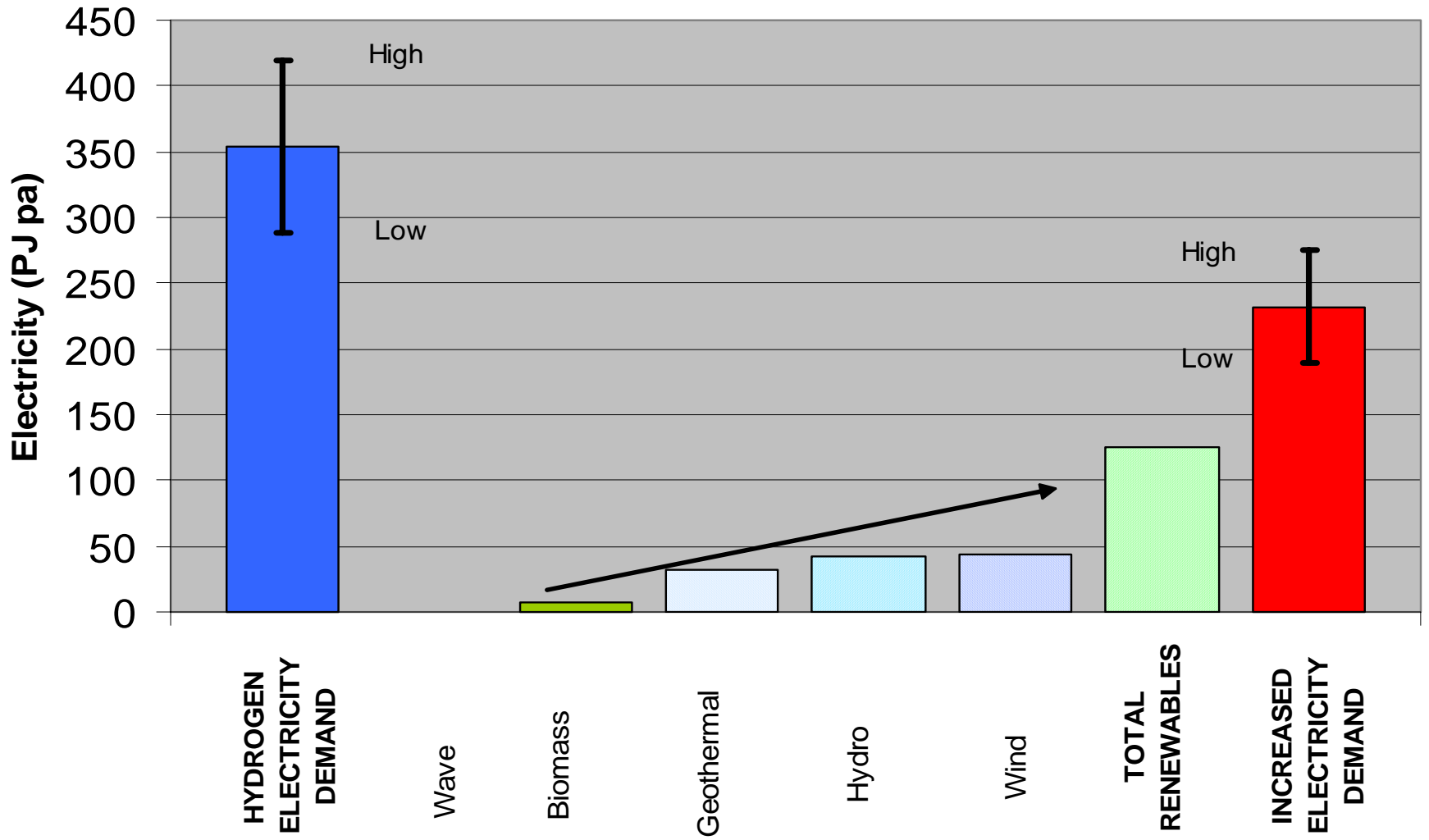
How Much Hydrogen will New Zealand need and Where Will it Come From?

- **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





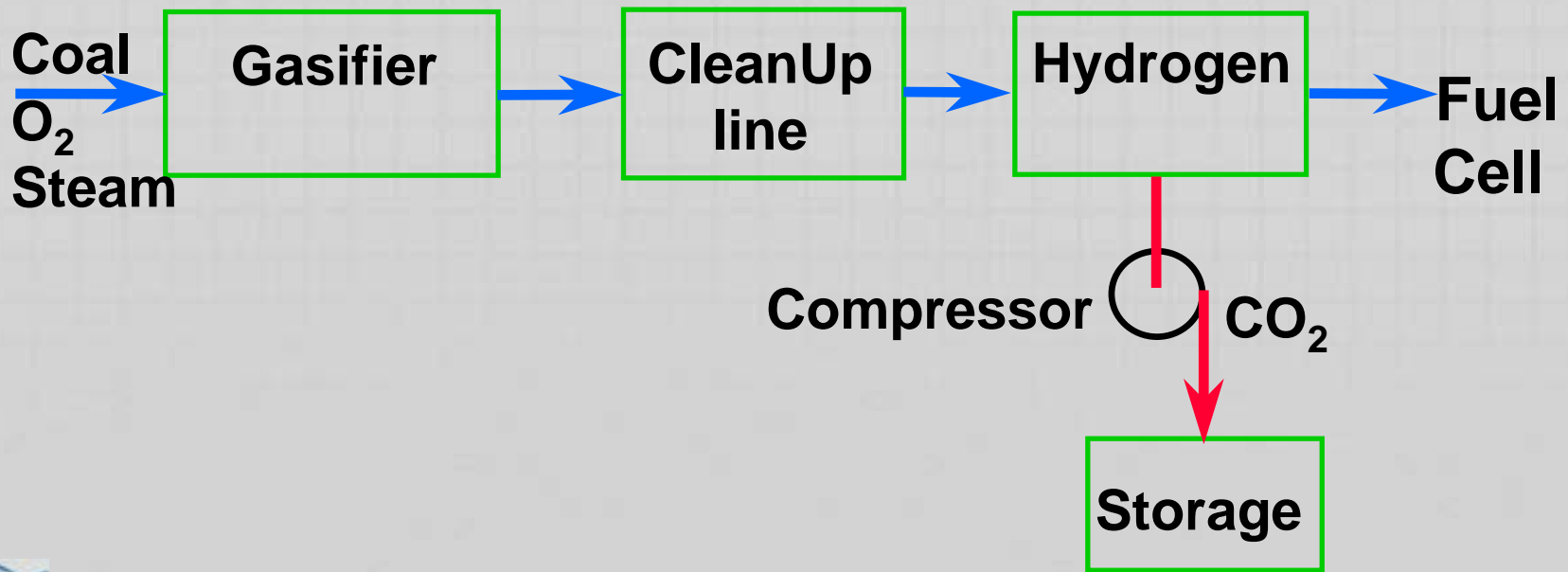


Coal to Fuel Cell Grade Hydrogen Technology Package

- 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



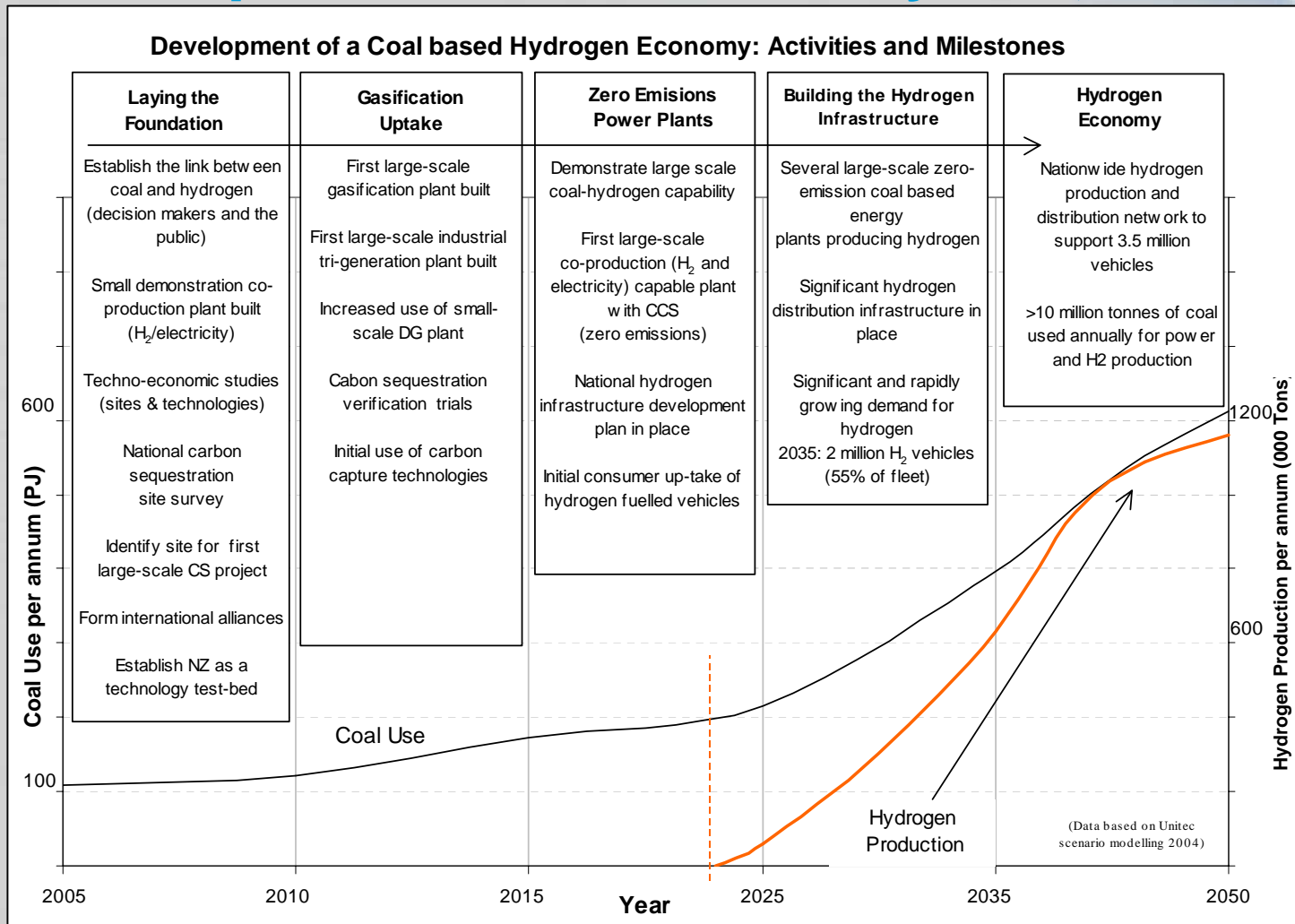


Coal to Fuel Cell Grade Hydrogen Technology Package

- 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

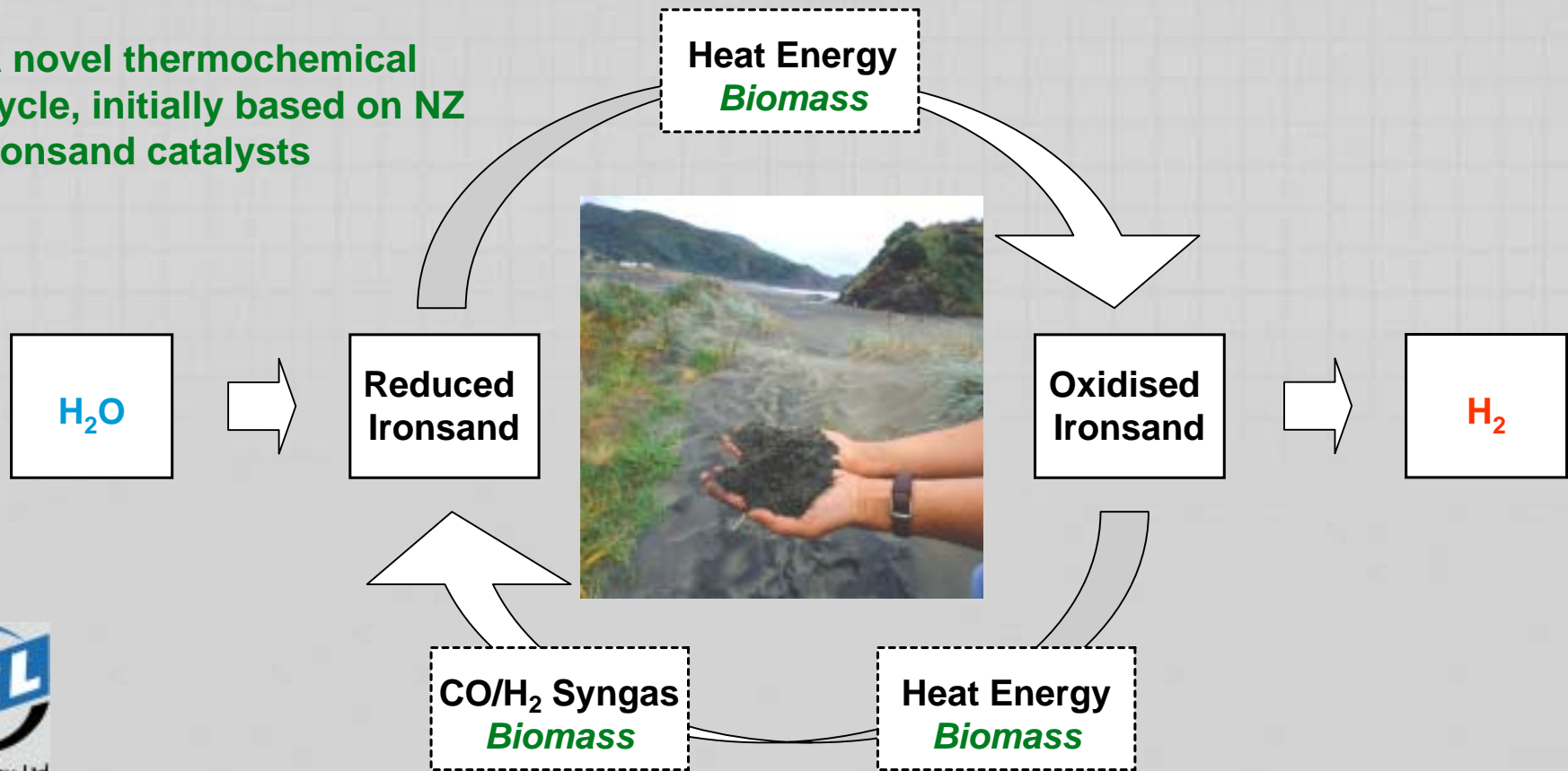




Hydrogen production using Ironsand

■ Production

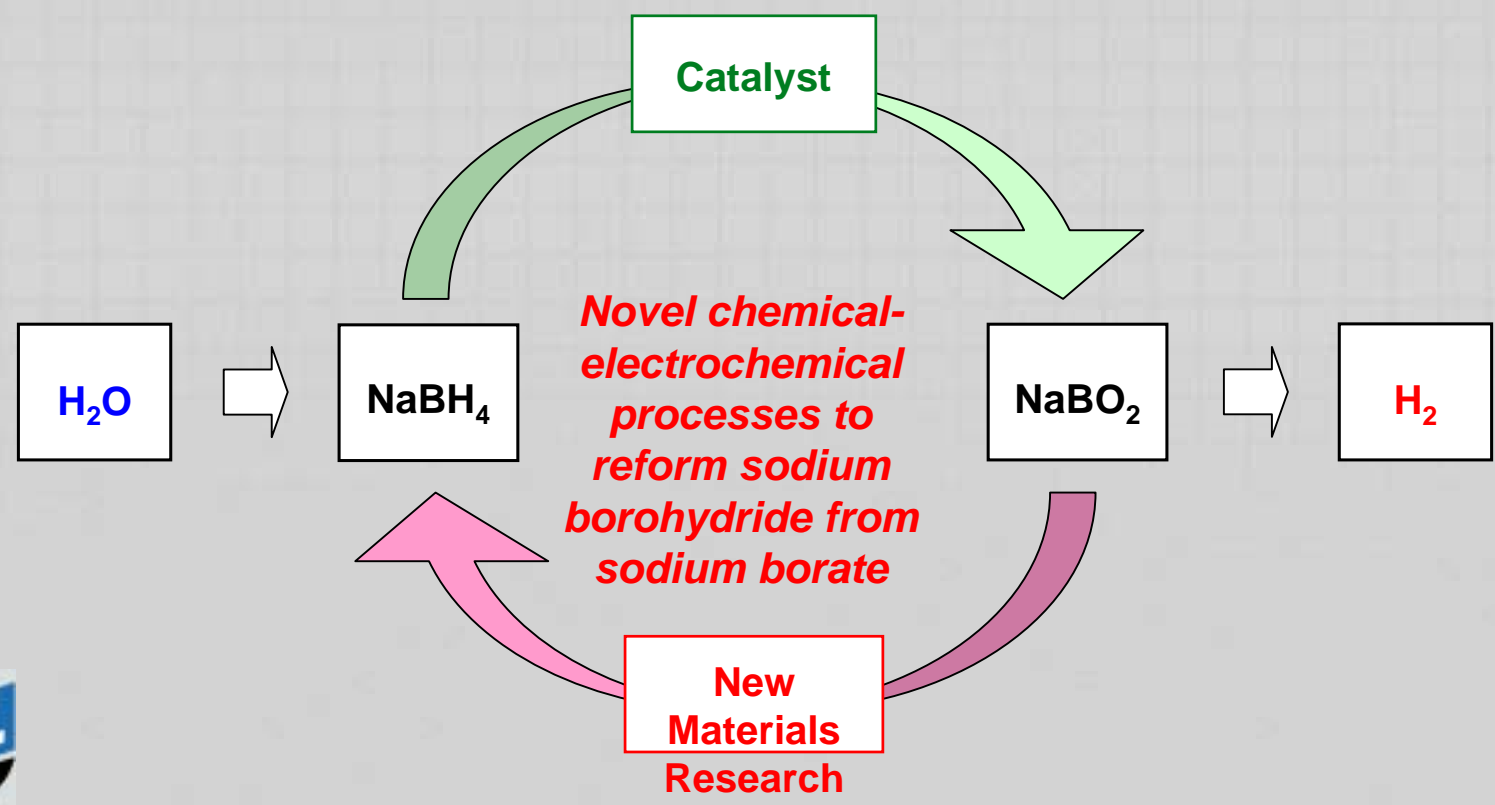
A novel thermochemical cycle, initially based on NZ ironsand catalysts

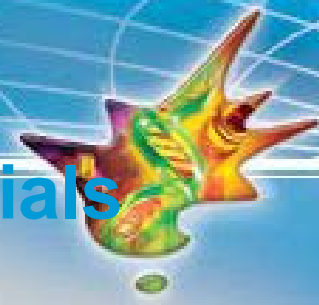




Boron Hydride Storage

- Storage





Fuel Cell Demonstrations and Field Trials

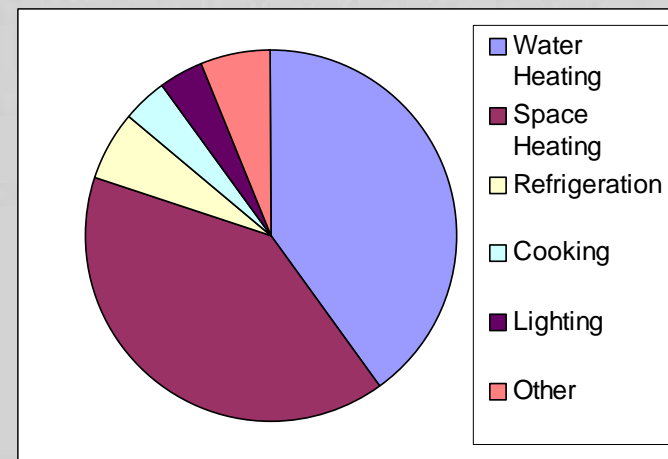
- **IRL Experimental Alkaline fuel cell system - 2003**
 - Delivered to Murdoch University, Perth, Western Australia
 - Fully monitored wind based RAPS system in a container
 - Fuel cell upgrade currently under way

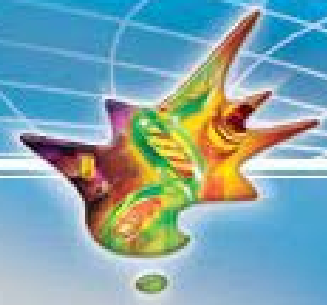




Demonstrations and Field Trials

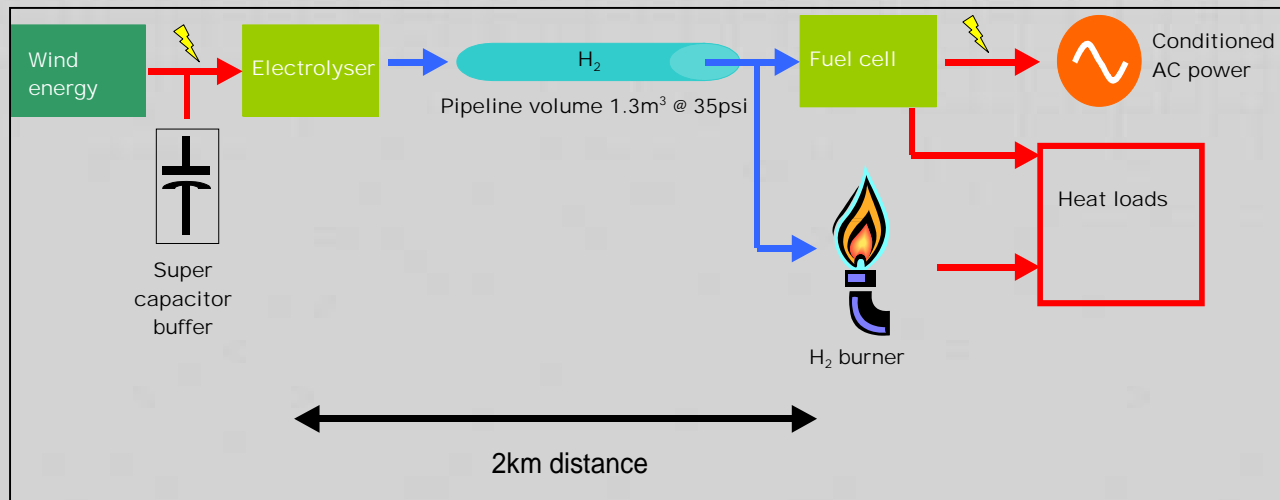
- **Totara Valley Farming Community, New Zealand - 2004**
 - Grid connection of hydrogen distributed energy at the consumer level
 - Integration of hydrogen technologies
 - Wind-electrolyser-pipeline H2 storage and delivery of household energy services
 - Electricity – H2 fuel cell
 - Water heating – H2 combustion





Demonstrations and Field Trials

- Totara Valley Farming Community, New Zealand – system configuration





Demonstrations and Field Trials

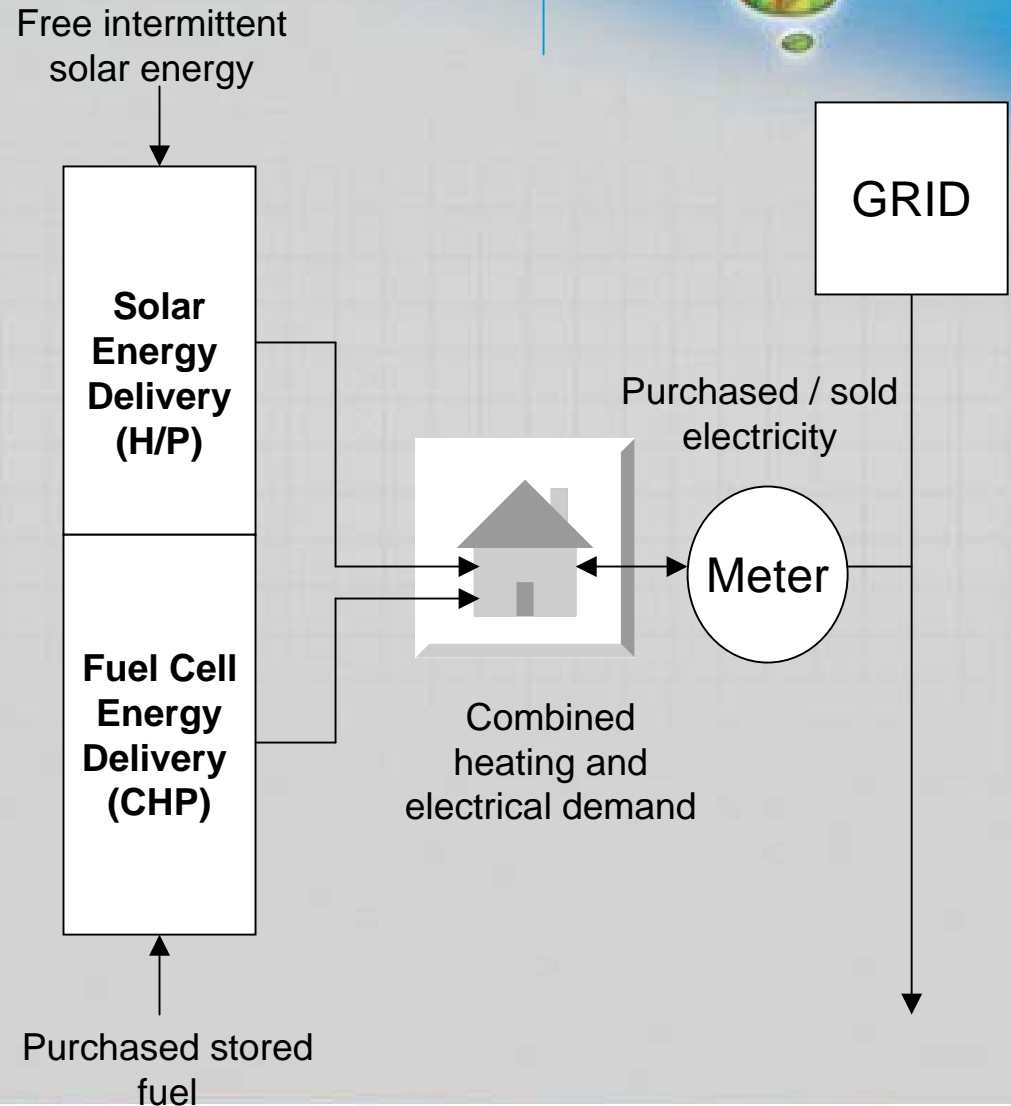
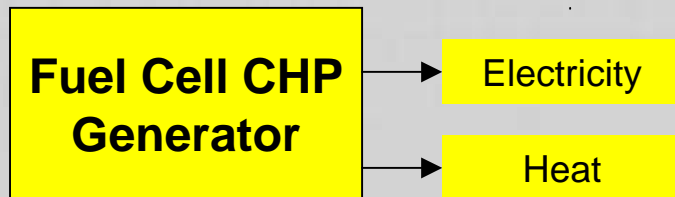
- **International Antarctic Centre, Christchurch, New Zealand - 2005**
 - US DoD Residential PEM Fuel Cell Demonstration project
 - 2kWe ReliOn fuel cell providing battery charging and yard lighting
 - Dual Fuel – methanol reformer with hydrogen cylinder backup
 - Contract management, systems engineering,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



Demonstrations and Field Trials

- Proposed New Initiative: Fuel Cell Based Residential microCHP





Demonstrations and Field Trials

- **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