

Update on Biomass Gasification in New Zealand

IEA Bioenergy Task 33 Meeting, Sweden
November 2013

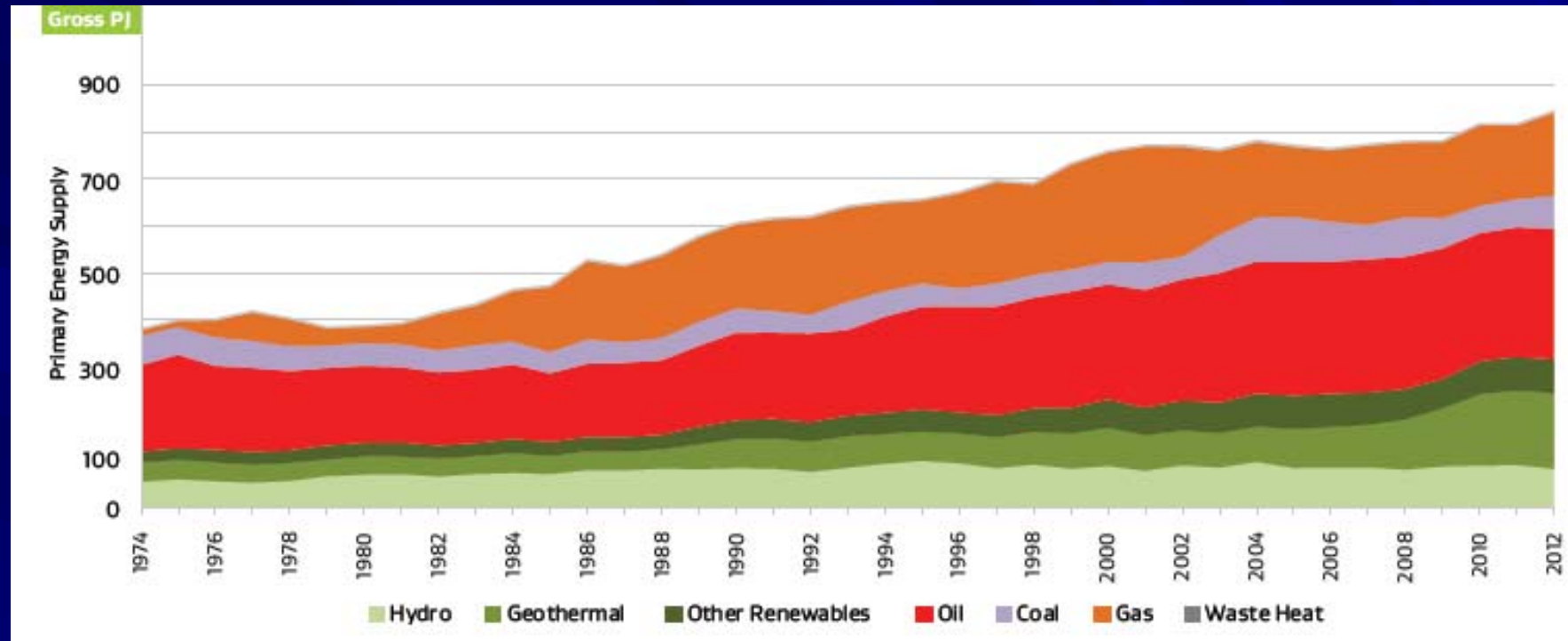
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Presentation outline

- Renewable energy position.
- The Government energy strategies and policies.
- National status of development and commercialisation.
- R&D progress.

NZ Total Primary Energy Supply

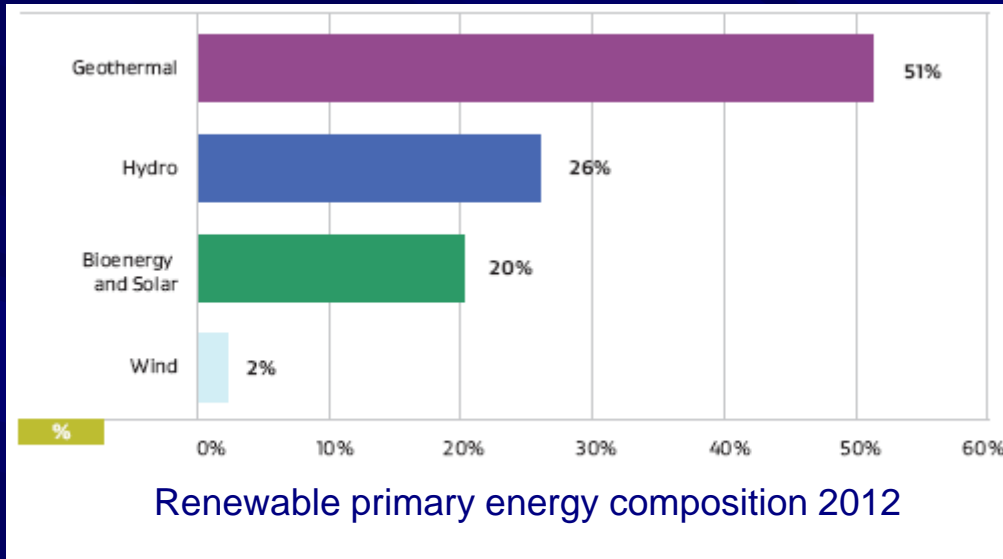
(www.med.govt.nz/sectors-industries/energy/energy-modelling/publications/energy-in-new-zealand-2013)



- Renewable energy made up 37% in 2012.
- It placed NZ in the third highest in the OECD after Iceland and Norway.
- Oil self sufficiency was 31% in 2012.

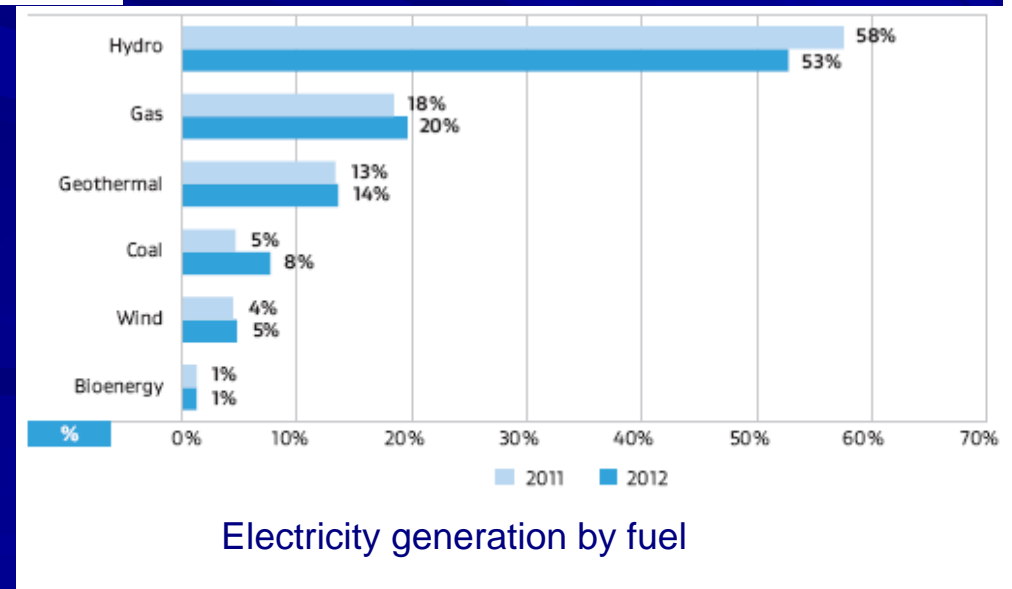
Characteristics of Renewable Energy

(www.med.govt.nz/sectors-industries/energy/energy-modelling/publications/energy-in-new-zealand-2013)



- Direct use for heating from geothermal and woody biomass.
- Liquid biofuel production from tallow, oilseeds and used cooking oil.
- Electricity generation.

- The lower hydro generation in 2012 was due to low rainfall, which led to an increase in gas and coal generation.
- As a result, the share of generation from renewable sources decreased to 73% in 2012 from 77% in 2011.



NZ Energy Strategy 2011-2021

(www.med.govt.nz/sectors-industries/energy/strategies)



New Zealand Energy Strategy 2011-2021

Developing
our energy
potential

and the New Zealand Energy Efficiency
and Conservation Strategy 2011-2016



Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

- The Government released two energy strategies on 30 August 2011 to replace the 2007 version.
- The goal is to make the most of its abundant energy potential and efficient use of the country's diverse energy resources.
- The aim is to achieve a 50% reduction in our greenhouse gas emissions from 1990 levels by 2050.



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NZ Renewable Energy Strategy

(www.med.govt.nz/sectors-industries/energy/strategies)



New Zealand Energy Strategy 2011–2021

Developing
our energy
potential

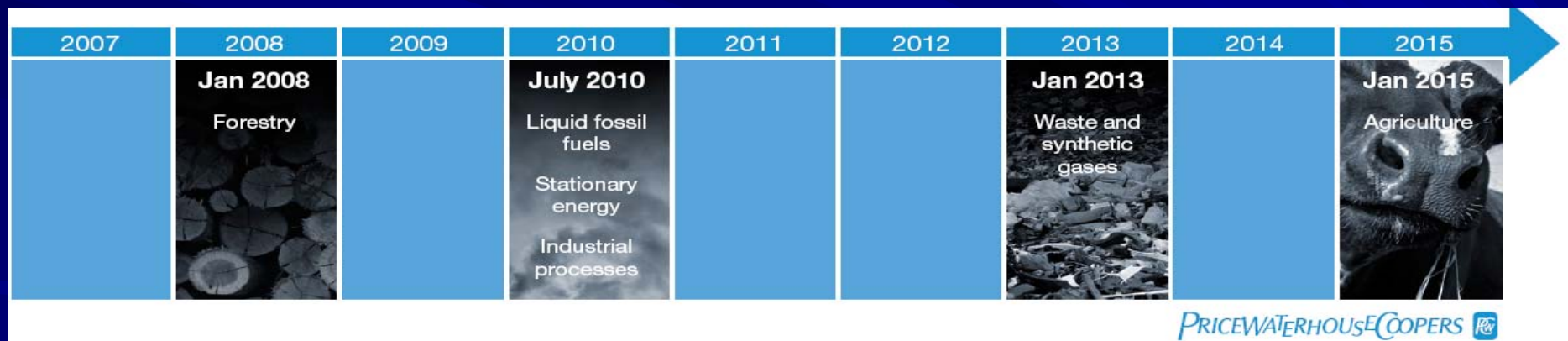
and the New Zealand Energy Efficiency
and Conservation Strategy 2011–2016



- Target: 90% of the electricity from renewable resources by 2015.

Climate Change Response (Emissions Trading and Other Matters) Amendment Bill

- Emission trading scheme 2009 was a way of meeting our international obligations around climate change.
- It put a price on greenhouse gases to provide an incentive to reduce emission and to encourage tree planting.
- The amendment bill 2012 was passed into law in April 2013.



NZ Bioenergy Strategy 2010

- Proposed by Bioenergy Association New Zealand (BANZ) in corporation with industry.
- Aims for economic growth by increasing production and use of biomass based energy and biofuels in New Zealand.
- Targets by 2040: biomass energy will contribute 25% of national consuming energy including 30% transport fuels.



Commercial Biomass Gasification: Fluidyne Gasification

Fluidyne is active in overseas with its downdraft gasifiers (100kWe-2MWe).

- 100kWe Andes Class development programme in California, to replace LPG to heat the CalForests Forestry Tree Nursery.
- Gasifiers with larger gas outputs of 250-500 kWe are to be built 2013-15.
- One example is the gasifier in West Biofuels, Woodland, California (shown here).



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Demonstration of Biomass Gasification: Windsor Engineering

- Windsor™ is a manufacturer of wood processing equipment, mainly timber drying kilns.
- A 1.5MW Agder Biocom (Norway) gasifier is in operation in Rotorua, NZ, through a joint venture of Waiariki Institute of Technology (WIT) and EECA. It will be used as:
 - A training facility for wood processing students at the WIT.
 - R&D test facility.
 - To replace natural gas for existing boiler to generate steam for two Windsor timber drying kilns.



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Windsor Engineering Gasifier

■ The gasifier specification

- Updraft type
- Thermal output: 1.17 MW with 78% energy efficiency
- Fuel: wood processing residues (sawdust, barks, chips, shaving) with MC of up to 35%.
- Particulate emissions: less than 50mg/Nm³.



Others

- Norske Skog and Z energy (Shell NZ) are doing feasibility studies on bioliquid fuels from wood. Norske Skog closed down one pulp mill in New Zealand and plans to invest on new products.
- LanzaTech is a New Zealand based company who invested heavily in China and US, on fermentation of H₂ and CO₂ or H₂ and CO to ethanol. Initially they developed technology for steel plants or coal power stations to convert CO₂ to ethanol. Now they apply the technology in biomass gasification syngas (USA).

R&D on Biomass Gasification: CRL Energy

- It has constructed a 200kW bubbling fluidized bed gasifier with gas cleaning system on gasification of coal and biomass for hydrogen.
- It is currently collaborating with UC research team on co-gasification of biomass and coal.
 - Making coal-biomass blend pellets.
 - Lab scale test of co-gasification.



R&D on Biomass Gasification: University of Canterbury (UC)

- Government funded program from 2008 to 2014.
- A 100kW_{in} (20kg/hr dry biomass) DFB gasifier.
- Optimisation of the DFB gasifier operation conditions.
- Co-gasification of pine wood and lignite.
- Development of gas cleaning technologies.
- Feasibility analysis of technology, economic and sustainability.



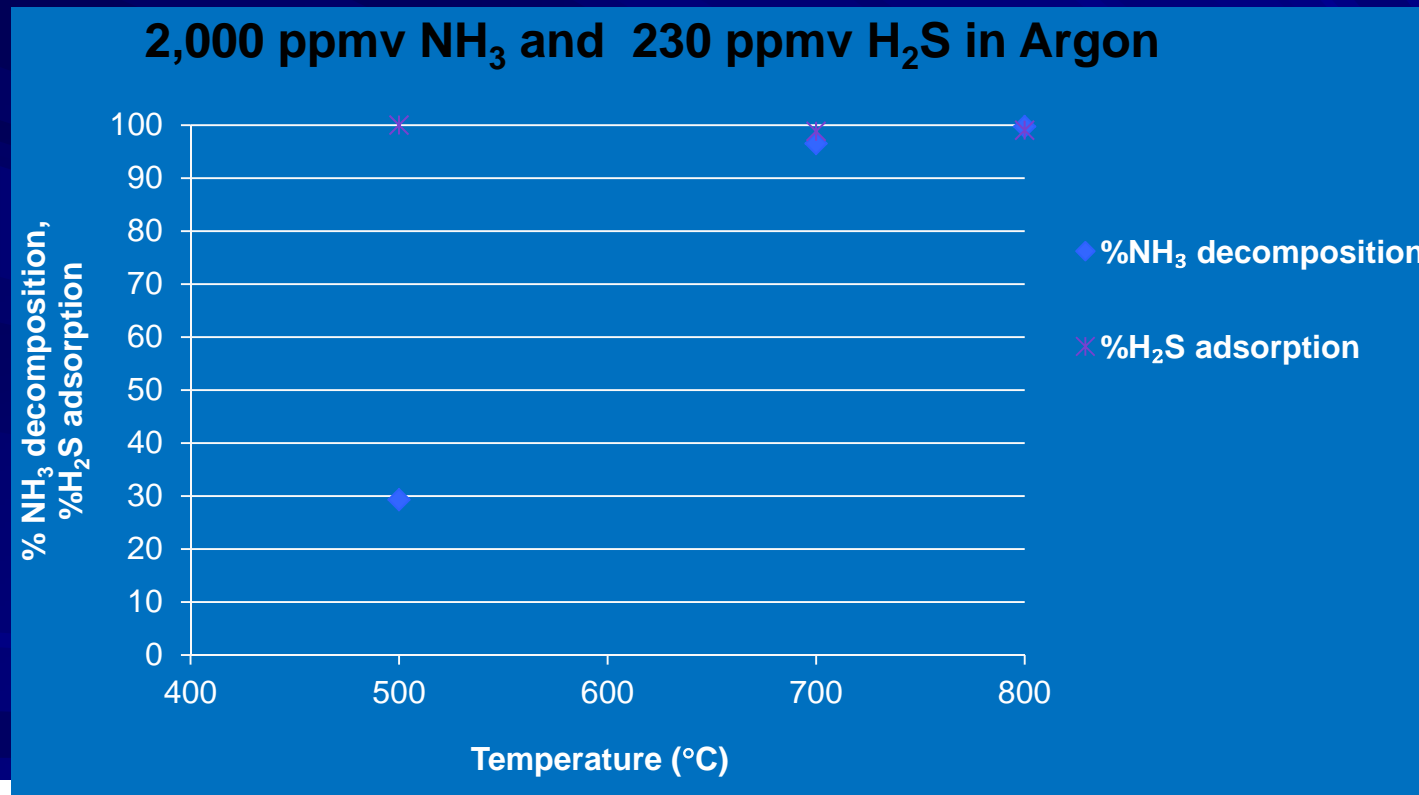
Hot Catalytic Reactor to Clean NH_3 and H_2S

- Bubbling fluidized bed (fixed bed)
- The reactor has double functions
 - Cracker to crack NH_3
 - Adsorber to adsorb H_2S
- Catalytic bed materials
 - Silica
 - Calcined iron sand
 - Other catalysts.
- Bed inventory – 250g (initial bed height ~ 85-90mm)
- Gas residence time
 - Bed – 0.4-0.5 s
 - Freeboard – 2.5-3.8 s



Results of NH₃ and H₂S Removal

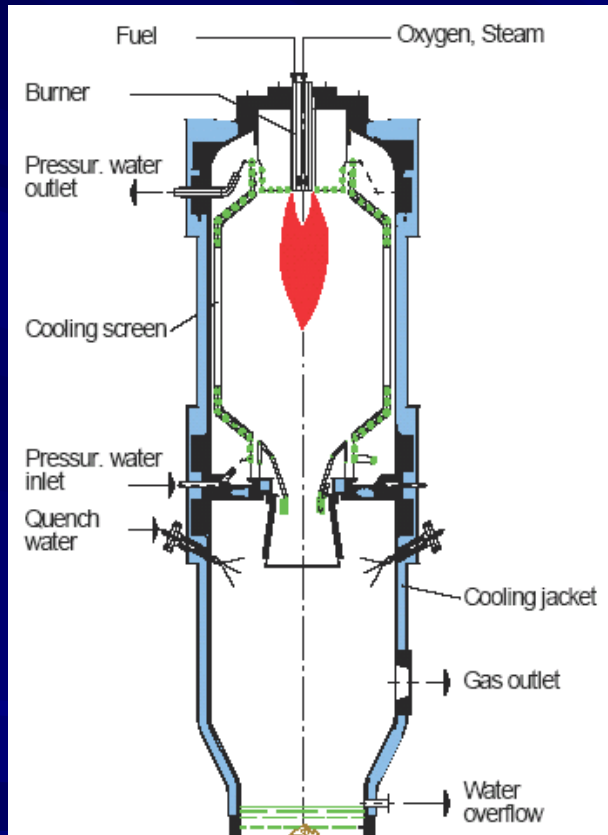
- NH₃ removal efficiency >90% on calcined iron sand.



Other Work at UC

- Development of entrained flow gasifier.
- Micro-channel FT synthesis.
- Pyrolysis of biomass and oil upgrading.
- Mathematical modelling of the gasification, co-gasification in DFB gasifier.
- System modelling for sustainability analysis and feasibility studies.

Development of Entrained flow gasifier at Canterbury University



Fischer -Tropsch synthesis of liquid fuel using biomass gasification syngas

- Developed a microchannel F-T reactor and catalyst
 - High conversion of syngas
 - High selectivity to diesel fuels
 - More suitable for smaller scale than current technology (slurry reactor)
 - Easy for scale-up
- To incorporate the F-T process into the CAPE gasifier to demonstrate a complete biomass to liquid fuel process.



Biomass pyrolysis

- It is an endothermic process to decompose biomass in the absence of O_2 at 300-600°C to generate oil, combustible gas and char.
- Fluidised bed reactor with a N_2 pre-heater and condensation system.
- Capacity: dry sawdust feed at a capacity of 5kW_{th} or 1kg/h.
- Objectives
 - To densify biomass into bio-oil for big scale of gasification.
 - To produce high grade liquid fuel with biomass pre-treatment, catalytic pyrolysis and upgrading.

