

2000

2005

2030

2050

Bioenergy Options for New Zealand

Peter Hall

SCION 
Next generation biomaterials

New Zealand's EnergyScape



Three Phases

2000 2005 2030 2050

1. Situation analysis (published)

- § Resources
- § Conversion
- § Workable pathways

2. Pathways Analysis (drafted)

- § LCA of pathways
- § Regional demand
- § Economics

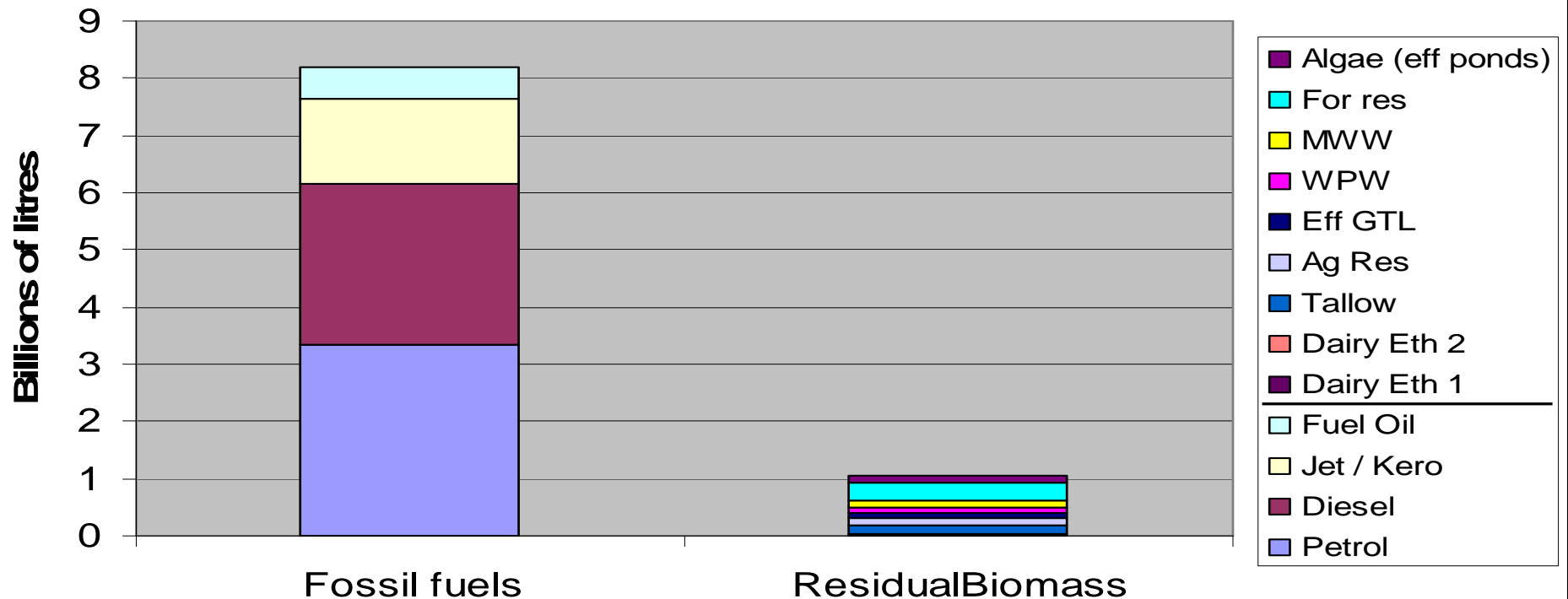
3. Bioenergy Research Strategy (being drafted)

Situation Analysis

2000 2005 2030 2050

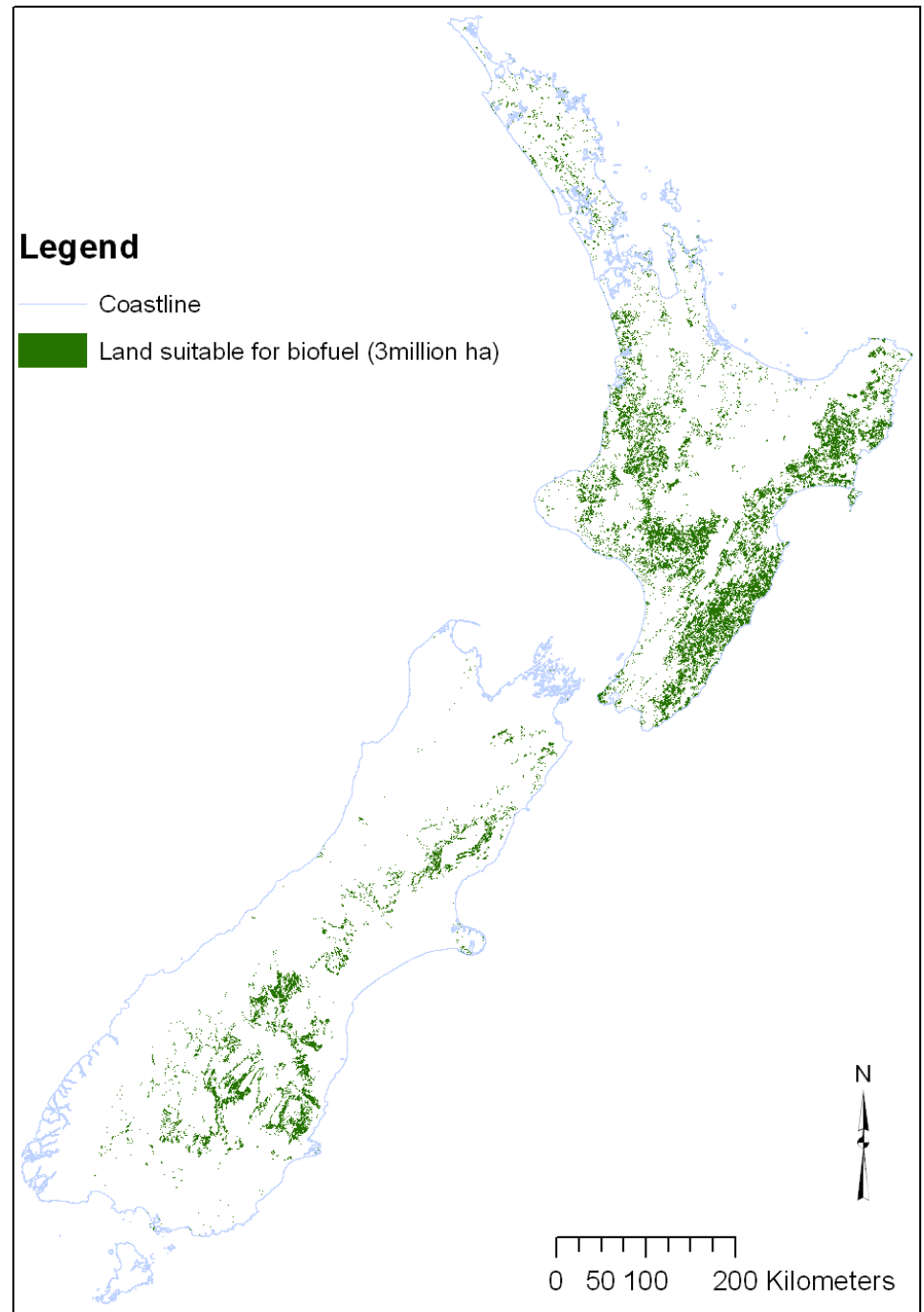
- Wood is the largest residual resource & potentially the largest energy crop
- All residuals will not meet more than a few % of energy demand

Liquid fossil fuels demand vs potential residual biomass supply



Potential for forest as energy crop

New Zealand's EnergyScape



Situation Analysis

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Straws

- § niche / regional

Effluents and biosolids

- § significant environmental benefits
- § highly distributed

Algae

- § uncertainty - cost and yield

Pathways Analysis

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- § Regional demand
- § Life Cycle Assessments
- § Pathways evaluation
- § Economics of purpose-grown forest to biofuels

Regional demand vs. residues to heat

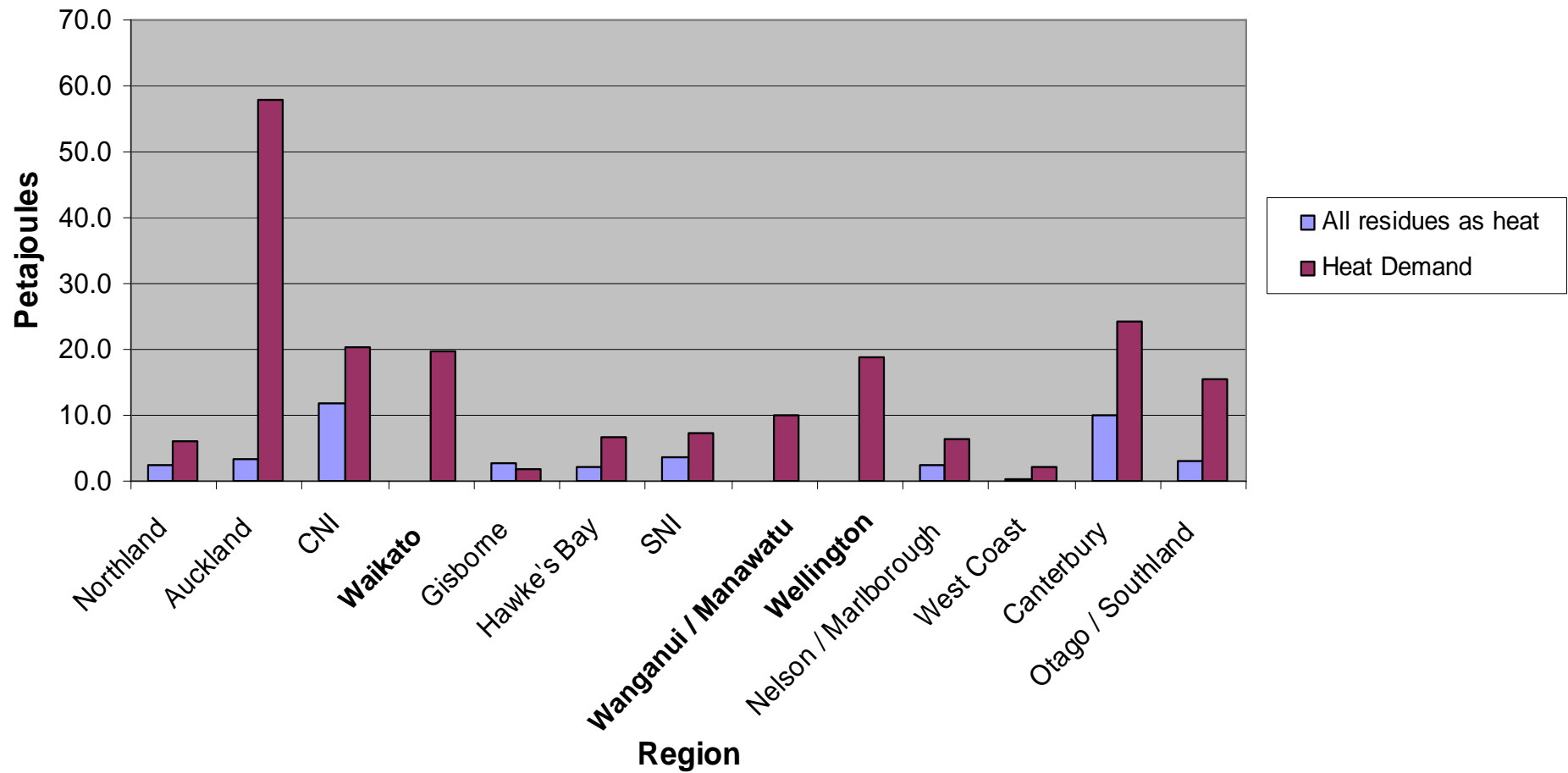
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All Residues as heat versus heat demand



Life cycle assessments

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- Anaerobic digestion of effluent
- Combustion of straw to heat and heat & power
- Anaerobic digestion of fruit rejects
- Canola crop to biodiesel
- Wood residues to heat, CHP, ethanol, biodiesel
- Purpose grown wood to heat, CHP, ethanol, biodiesel

LCA – Anaerobic Digestion, Effluent

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Key Points:

- § GHG benefits (~80% less)
- § Other environmental benefits (80 % less waste)

- § With meat and dairy sectors together, could supply 1 PJ of methane biofuel

LCA Combustion of Straw

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Key Points:

- § Potential of 2 PJ/yr
- § Not currently cost competitive
- § Highly regionalised – Canterbury, Waikato
- § Niche opportunities – e.g., food processing plant that needs heat

LCA Oil Rapeseed Crop to Biodiesel

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Key Points:

- § Economic at current prices, c.f., fossil diesel
- § Reduction in GHG emissions of 50%-65%
- § Energy balance (energy out : energy in) of 2.2:1

LCA Anaerobic Digestion of Kiwifruit Rejects

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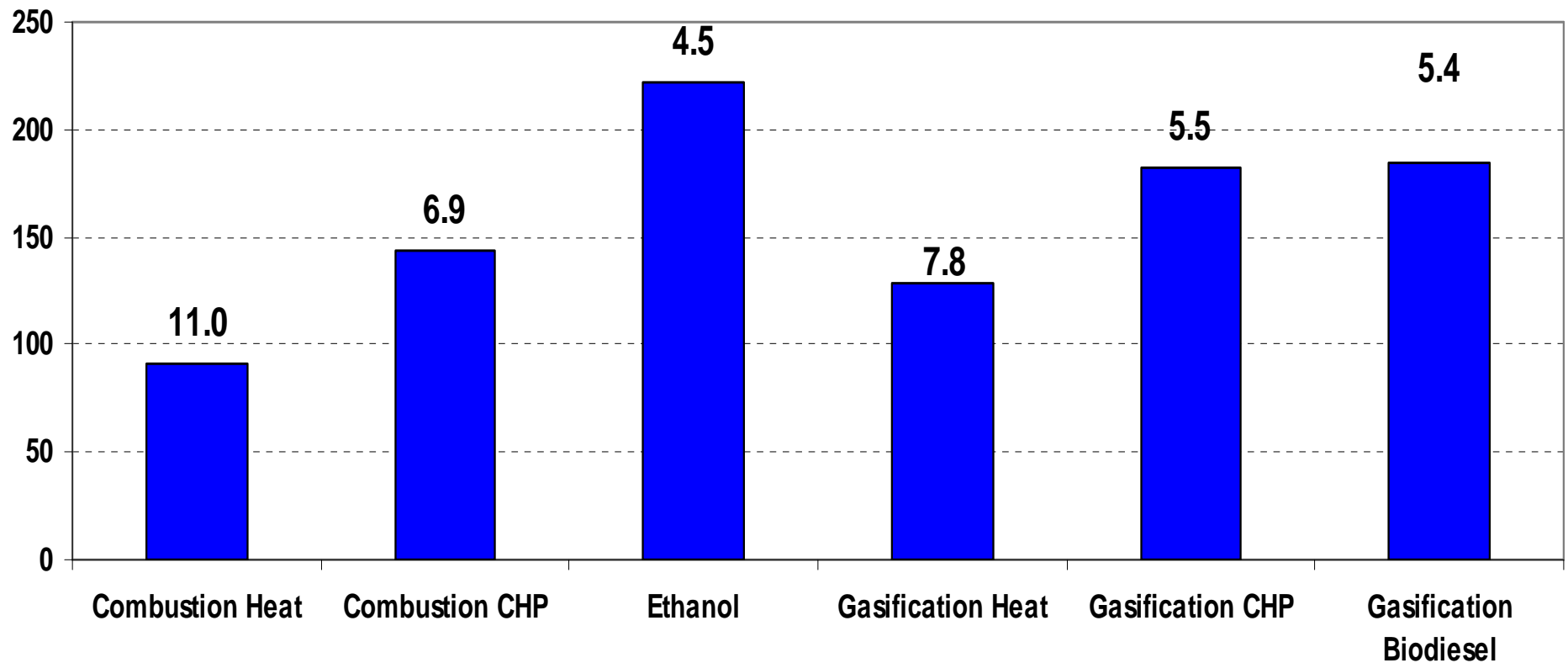
Key Points:

- § Gas used for CHP
- § Currently unattractive economics
- § 90% reduction in GHG emissions compared
- § Potential of 0.2 PJ/yr
- § Competing use for reject fruit as stock food

LCA wood to user energy

2000 2005 2030 2050

MJ in per GJ out & EROEI



Contributors to embodied energy

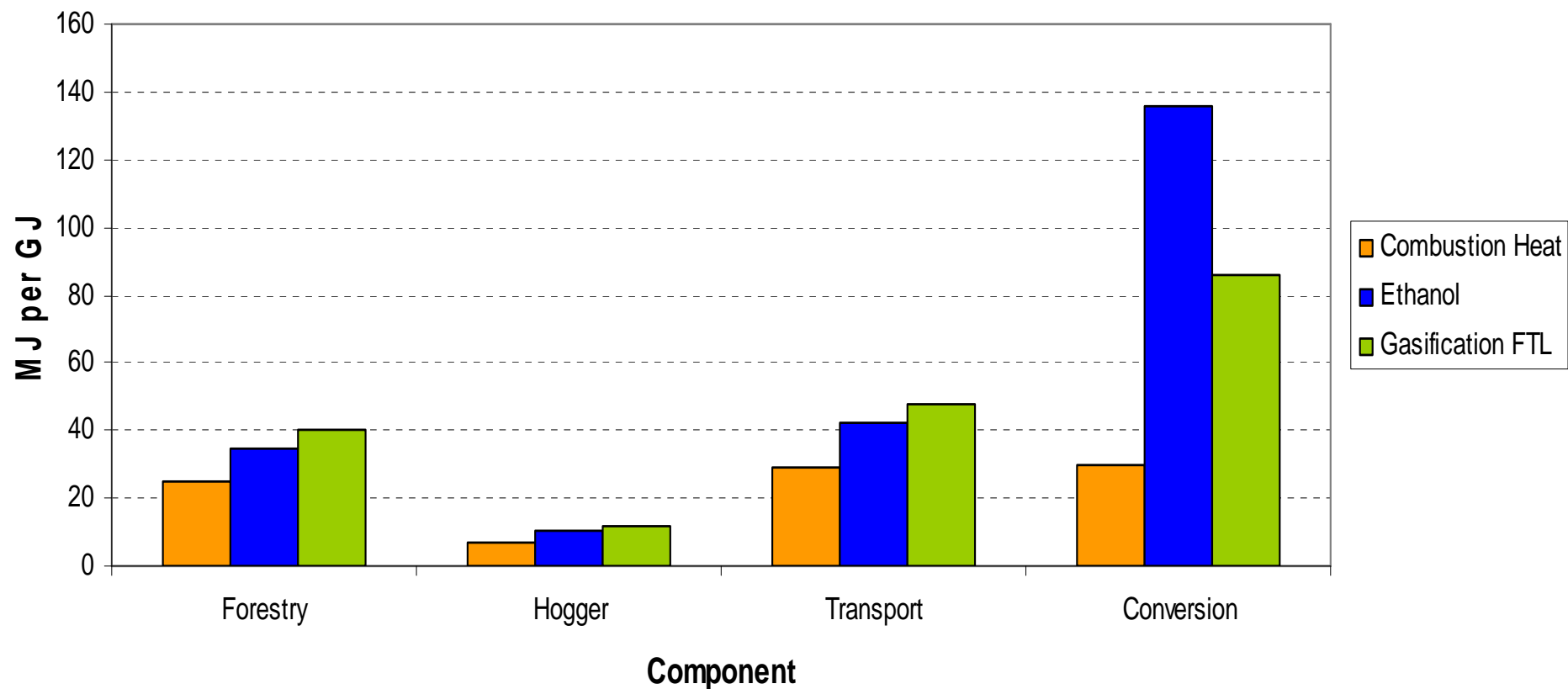
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Embodied energy by pathway component



Conclusions

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- § Residues will only provide a few % of demand, distributed, small scale
- § Must look at a large-sized purpose grown energy crop to make a significant contribution towards meeting demand (realistic options, forests, canola, algae)
- § Plantation forests appear most appropriate large-scale energy crop option for New Zealand (land resource, carbon, GHG, options, storage)

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Questions

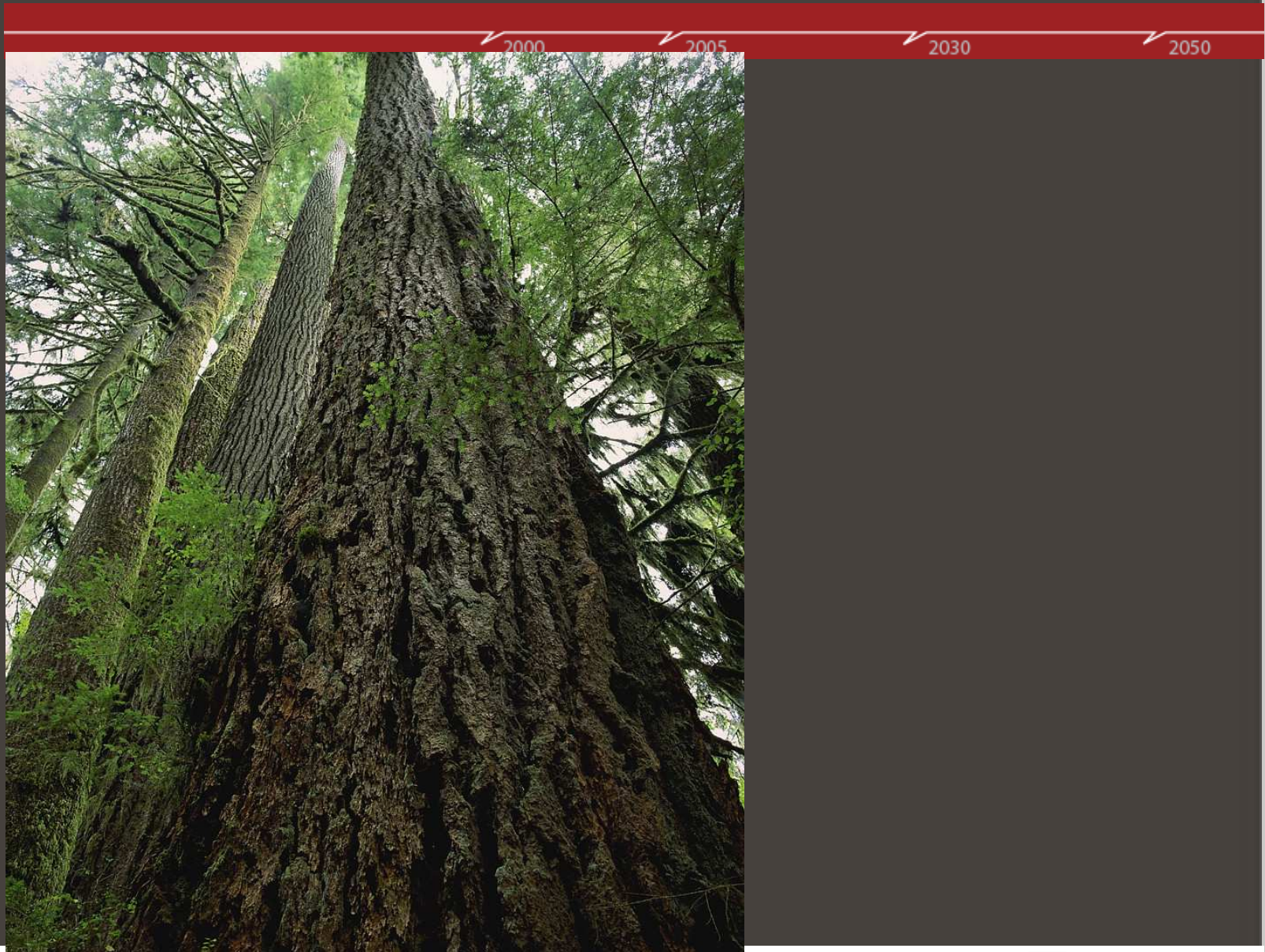
Comments

Discussion

New Zealand's EnergyScape



What is this ?



New Zealand's EnergyScape



What is this ?



2000

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30 years
of
stored
solar
energy

New Zealand's EnergyScape



Solution for liquid fuels? (8.1 billion litres)

	2000	2005	2030	2050
Efficiency				
Conservation				
	} Cap consumption growth			
	} which is 1 to 1.5 % pa.			
Residues, effluents, wastes		(5%)		(10%)
Canola		(5%)		(10%)
Algae		(5%) 405 m/l		(10%)
Electric Vehicles		(15-20%)		(25%)
Other?		(2- 5%)		(5%)

5.3 billion litres from wood/forests? = 2.2 million ha

3.6 billion litres from wood/forests? = 1.5 million ha

Total liquid fuel, litres of diesel equivalent

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Which could be generated - utilising forest residues, export logs, 50% of industrial wood and PGEF at varying %s, now and over time

PGEF Hectares	% to energy	2010	2030	2050
1.0 million	25	1,316,140,000	3,791,620,000	3,172,260,000
	50	-	4,379,620,000	4,338,460,000
	100	-	5,555,620,000	5,514,460,000
2.0 million	25	-	-	4,338,460,000
	50	-	-	5,514,460,000
	100	-	-	7,856,660,000
3.0 million	25	-	-	4,926,460,000
	50	-	-	6,680,660,000
	100	-	-	10,198,860,000

The Bioenergy Research priorities identified are:

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Energy derived from forest crops:

- § conventional, medium- and short-rotation forests (species/regimes/yields, multiple products)
- § land use and productivity
- § forest harvesting (steep terrain)
- § supply chain logistics

Research, continued

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§ Anaerobic digestion of wastes

- National level research and demonstration programme to identify implementation sites

§ Enzymic hydrolysis of biomass to liquid fuels

- Ethanol
- Butanol
- Includes significant collaboration with overseas research and development agencies

Research, continued

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§ Gasification of woody biomass

- Detailed review of retrofitting bio-gasification to existing natural-gas heat plant
- Gasification to biodiesel (includes significant collaboration with overseas research and development agencies)

§ Pyrolysis of woody biomass

- Bio-oil production and refining
- Biochar and biofuels co-production

§ Biorefineries (co-products to improve economics)

Research, continued

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§ Economic and Environmental impact of large-scale bioenergy (forests derived)

- Detailed study covering land use, competition, production displacement, regions, drivers

§ Energy storage from large-scale bioenergy forests

- Value and significance to New Zealand (potential for carbon-neutral liquid fuels in the future)

Research, continued

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§ Algae

- Widespread trialling (climate and effluents)
- Algal extraction from water
- Algae conversion (to liquid fuels)

§ Combination of anaerobic digestion of effluent with algal production

§ Small-scale combined heat and power for distributed generation

§ Biomass combustion for domestic heat to meet local authority specifications

EnergyScape II – Bioenergy

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Large-scale bioenergy:

- § forest
- § crops (canola / miscanthus)
- § algae

Implications for:

- § the national economy
- § sustainable land use and the environment
- § energy infrastructure (including vehicle fleet)