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Next generation biomaterials

Large-scale Bioenergy from Forestry

Peter Hall, et. al.

Scion

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Landcare

Donna Giltrap, Anne-Gaelle Aussiel, Jagath Ekanayake, Peter Newsome, John Dymond

Motu

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Infometrics

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Bioenergy Options for NZ

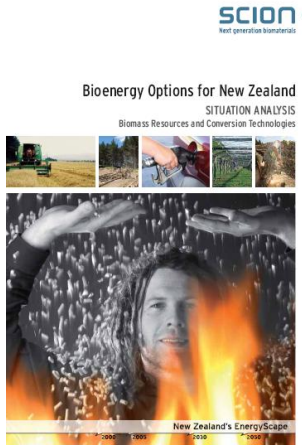
Situation Analysis

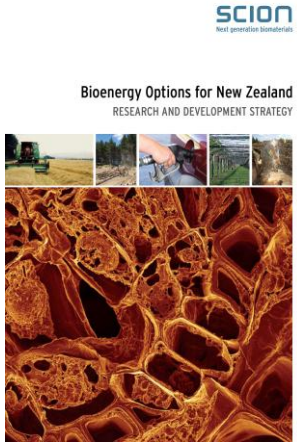
Pathways Analysis

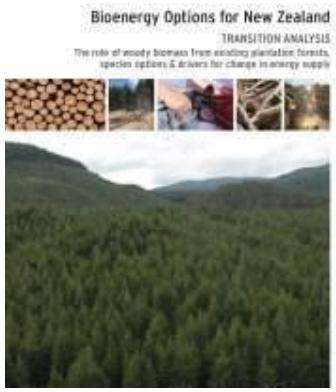
Bioenergy R&D Strategy

Analysis of large-scale bioenergy from Forestry

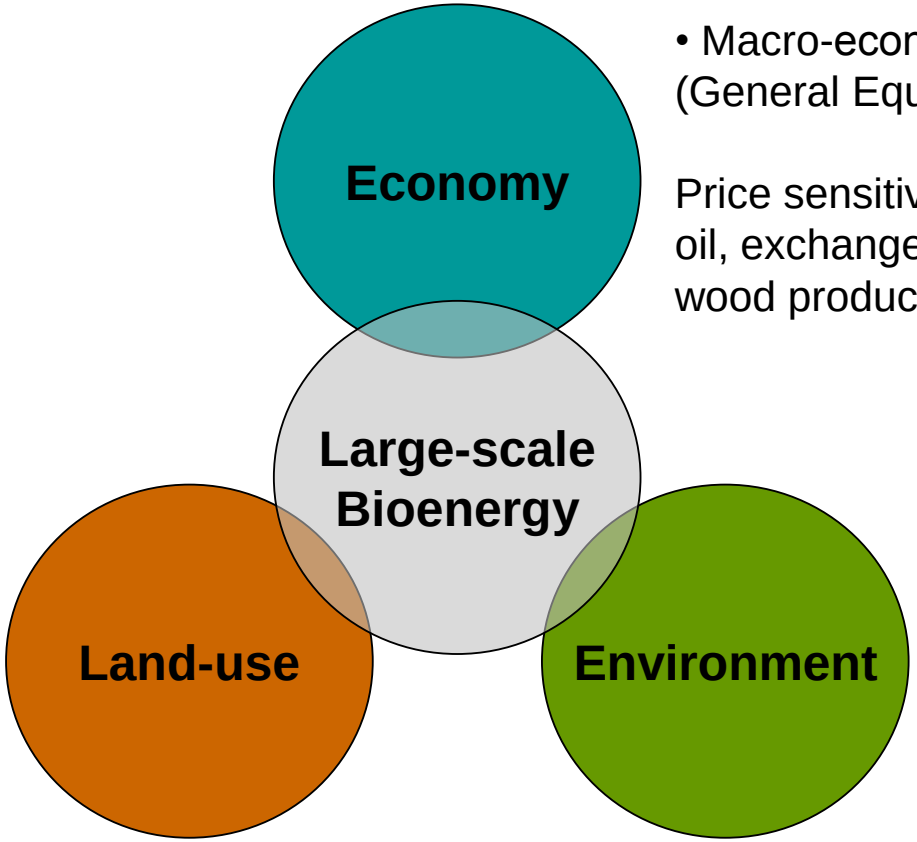
Transition Analysis







Phase II: Implications of National-scale Energy Forests



• Macro-economic impacts on NZ's GDP (General Equilibrium Model)

Price sensitivities: biofuel production, oil, exchange rate, agricultural products, wood products, land

INFOMETRICS

• 4 future land-use scenarios (2030, 2050)
• Site productivity overlay, future scenarios
• Land-use change

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Motu

• Carbon sequestration/mitigation
• Erosion/sedimentation
• Water quality
• Water yield
• Biodiversity

Landcare Research
Manaaki Whenua

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Focus of this talk

Energy forest scenarios

- **Where**
- **How much land**
- **How much wood / energy**
- **Cost**

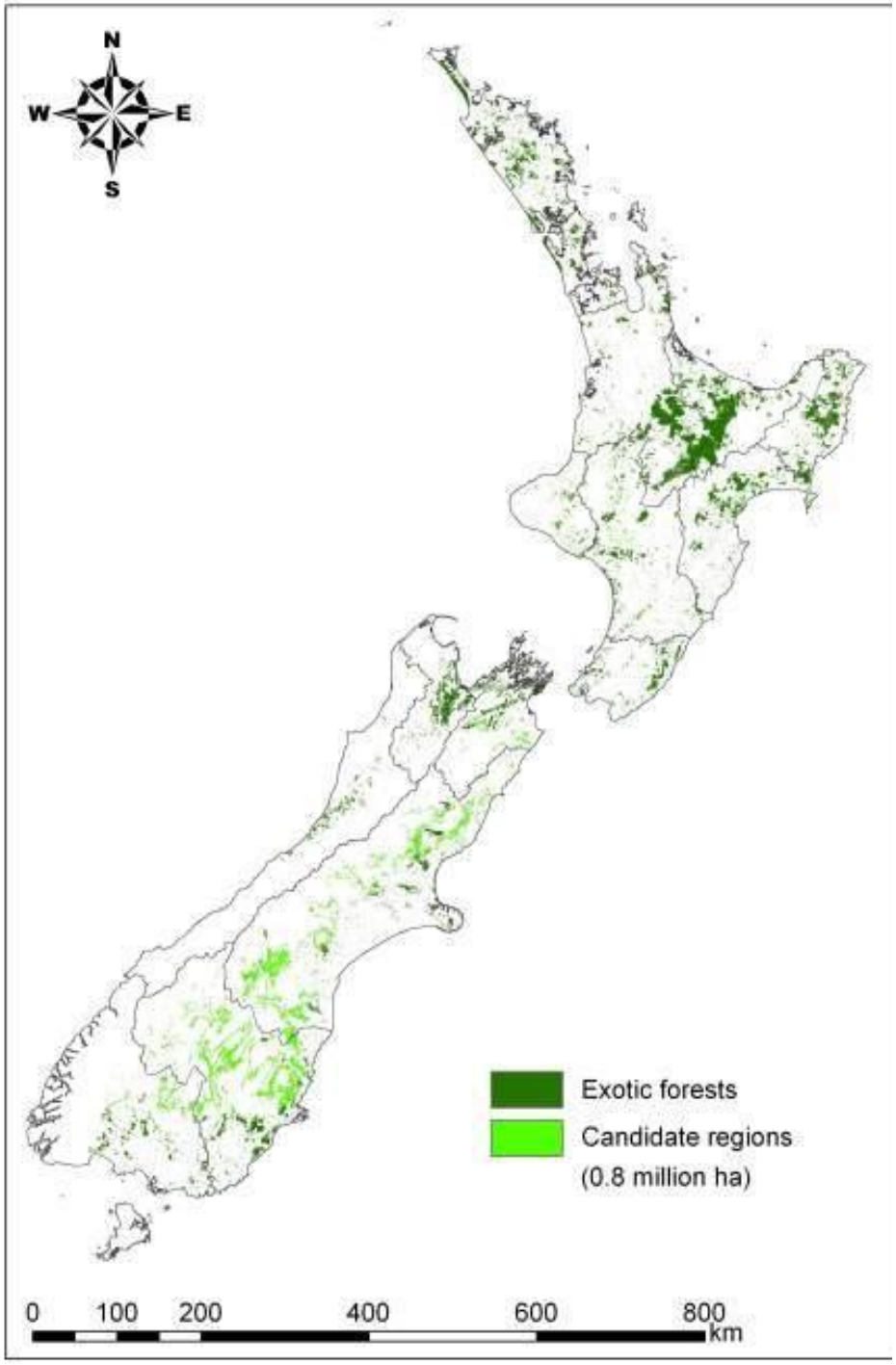
- **Transition from residues to new energy forests**

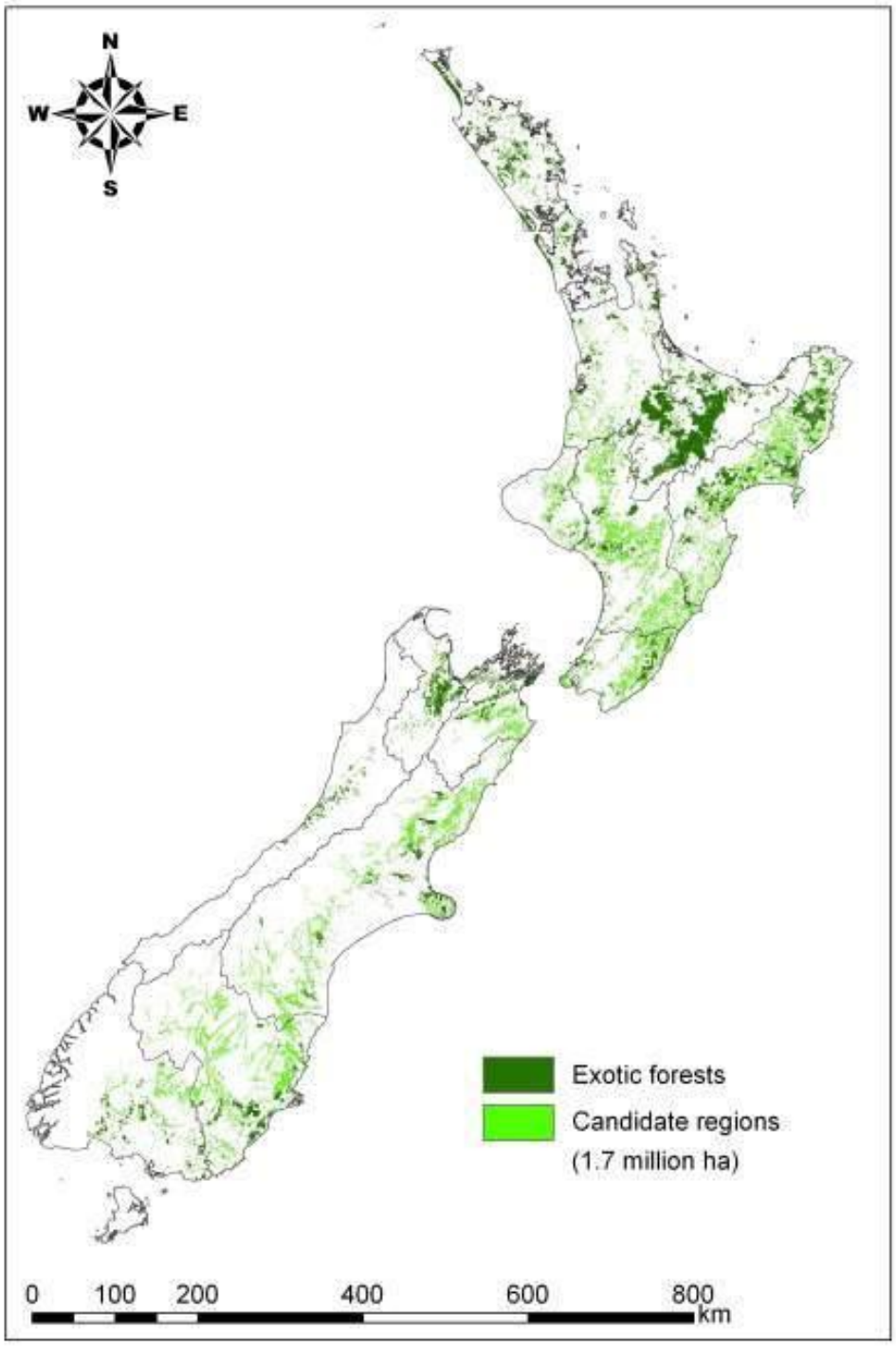
Afforestation Scenarios

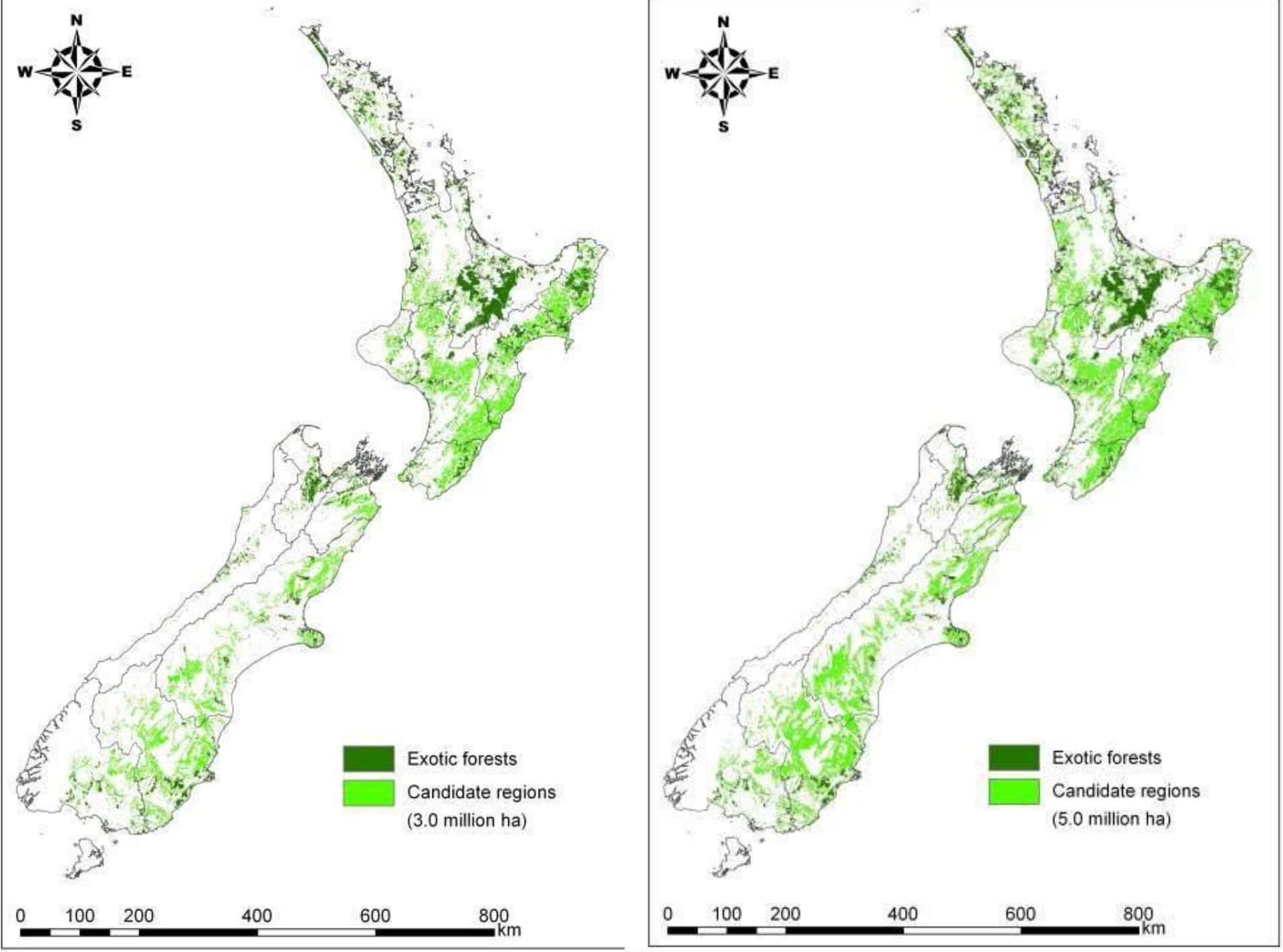
Scenario	Area	Energy supply
1	0.8 M ha	20% of liquid fuels
2	1.8 M ha	72% of liquid fuels
3	3.3 M ha	100% of liquid fuels and 100% of heat
4	4.9 M ha	100% of liquid fuels and heat and 85% of electricity

Land selected by GIS analysis using LCDB2 and land use classes + slope and altitude limits; - worst first

Marginal Land – New Zealand


N
W
E
S
Exotic forests
Candidate regions
(0.8 million ha)
0
100
200
400
600
800
km


N
W
E
S
Exotic forests
Candidate regions
(1.7 million ha)
0
100
200
400
600
800
km


N
W
E
S
Exotic forests
Candidate regions
(3.0 million ha)
0
100
200
400
600
800
km
N
W
E
S
Exotic forests
Candidate regions
(5.0 million ha)
0
100
200
400
600
800
km

Productivity of potential bioenergy species for new forests

	Species	Stem volume MAI m3/ha/yr	Basic wood density(kg/m3)	Stemwood oven-dry t/ha/yr
1	*Pinus radiata*	60.1	420	25.2
2	*Eucalyptus fastigata*	46.0	500	23.0
3	*Eucalyptus nitens*	42.5	520	22.1
4	*Eucalyptus regnans*	45.7	460	21.0
5	*Eucalyptus saligna*	33.8	610	20.6
6	*S sempervirens*	57.9	340	19.7
7	*Eucalyptus maidenii*	31.4	561	17.6
8	*Acacia dealbata*	33.5	510	17.1
9	*Euc botryoides*	23.7	620	14.7
10	*Acacia melanoxylon*	22.0	590	13.0
11	*Euc globoidea*	19.8	630	12.5
12	*Euc delegatensis*	24.5	470	11.5
13	*C macrocarpa*	27.3	400	10.9
14	*C lusitanica*	27.4	380	10.4
15	*Douglas Fir*	23.9	400	10.1

Potential production

	Scenario 1 / 0.8		Scenario 2 / 1.8		Scenario 3 / 3.3		Scenario 4 / 4.9	
Region	**TEB p.a. m^3 millions**	**LPe, p.a. millions**	**TEB p.a. m^3 millions**	**LPe, p.a. millions**	**TEB p.a. m^3 millions**	**LPe, p.a. millions**	**TEB p.a. m^3 millions**	**LPe, p.a. millions**
Northland	0.29	25.2	1.08	94.2	3.07	267.1	8.38	728.8
Auckland	0.01	0.9	0.51	44.3	1.15	100.6	2.47	214.8
Waikato	0.23	20.4	4.39	382.0	11.35	987.4	16.88	1,468.3
Bay of Plenty	0.02	2.3	0.44	39.4	1.24	107.8	2.29	199.2
Gisborne	0.26	22.9	6.26	544.8	10.93	950.7	13.26	1153.6
Hawke's Bay	0.51	44.9	8.47	736.8	16.86	1,466.3	20.12	1,750.1
New Plymouth	0.52	45.4	2.60	226.5	3.83	333.6	4.84	421.5
Manawatu-Wanganui	1.35	117.7	16.08	1,389.2	25.93	2,252.2	29.80	2,591.4
Wellington	0.36	31.4	5.73	499.0	7.97	693.2	9.76	849.4
Tasman	0.10	8.8	0.81	710.4	1.24	108.3	1.70	148.4
Nelson	0.00	0.1	0.11	9.3	0.13	11.7	0.14	12.9
Marlborough	0.88	77.2	3.24	288.1	4.16	362.0	5.58	485.7
West Coast	0.14	12.5	0.34	30.1	0.94	81.9	1.29	112.5
Canterbury	9.90	861.2	12.14	1055.7	18.86	1,640.2	27.16	2,361.7
Otago	6.47	563.4	8.27	714.3	13.12	1,141.5	17.54	1,525.4
Southland	1.49	129.9	3.00	261.0	5.79	503.7	7.39	642.9
Total	**22.59**	**1,964**	**73.55**	**7,039**	**126.63**	**11,011**	**168.67**	**14,666**

Summary

Potential production from the four scenarios analyses

	M odt p.a.	M lPe p.a.	Costs per m^3	Stored energy
Scenario 1	8.25	1,964	$71 - $87	2,094 PJ
Scenario 2	26.85	7,039	$64 - $76	6,129 PJ
Scenario 3	46.25	11,011	$64 - $76	11,188 PJ
Scenario 4	61.60	14,666	$64 - $77	19,200 PJ

lPe = litres of petrol equivalent

Biodiversity

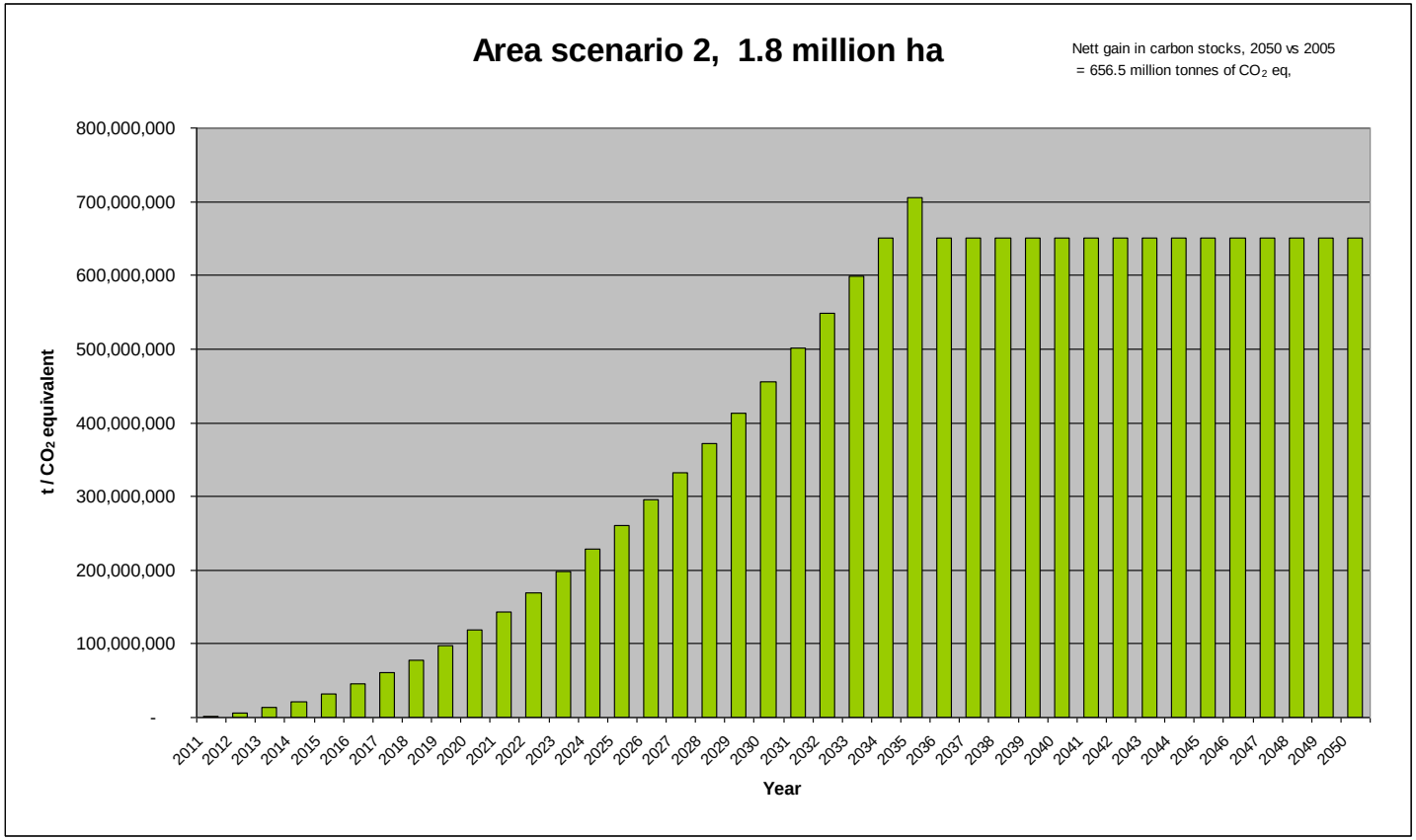
Forests vs Grasslands

Establishing plantations on eroding pastoral and exotic scrub lands;

- improves species richness of plants, birds and insects
- they also benefit native species (forest connectivity)
- improved water quality improves native fish habitat
- returns forest to previously forested land
- the greater the area = greater benefits; landscape level

Carbon Sequestration, millions tonnes CO2 equiv.

Scenario 1	Scenario 2	Scenario 3	Scenario 4
208	647	1183	2034



NZ CO2-e Emissions = 77.5 M t

Nett Emissions 44 M t (2006)

CO2 equivalent of carbon stock increase for forest area Scenario 2

Land use competition

3.4 million hectare scenario, area of land by potential sheep and beef farm returns (EBIT) without ETS and with ETS and CO_2 price of $25 per tonne

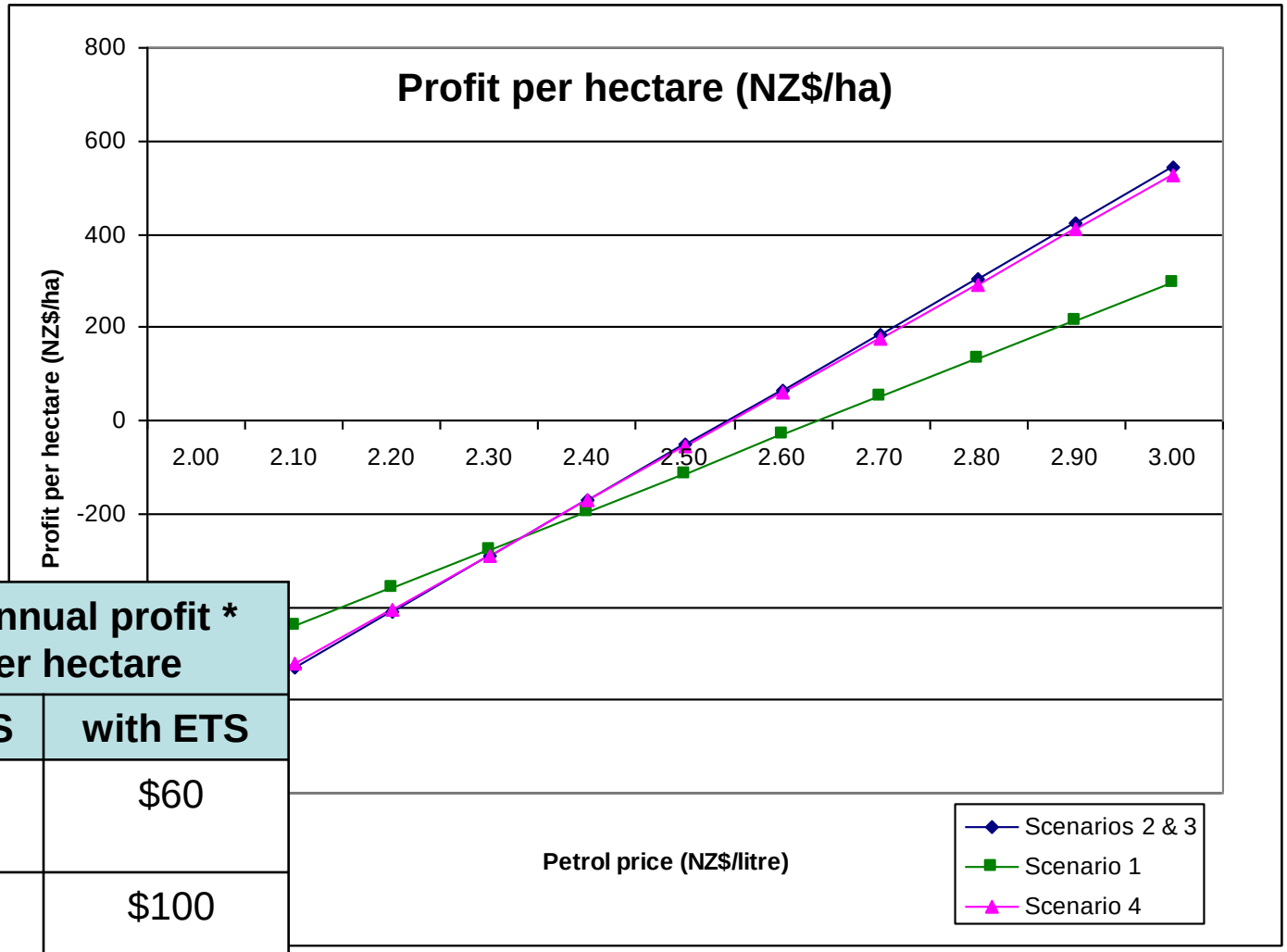
	Area of land in hectares by returns per ha in 2007$ without ETS					Total area for conversion
	$0-100	$100-200	$200-300	$300-400	$400-500	All values
North Island	69,700	725,575	1,148,475	6,500	25	1,950,275
South Island	883,425	157,850	482,775	0	800	1,524,850
NZ	953,125	883,425	1,631,250	6,500	825	3,475,125

1.836 M ha

	Area of land in hectares by returns per ha in 2007$ with ETS					Total area for conversion
	$0 - 100	$100-200	$200-300	$300-400	$400-500	All values
North Island	795,275	377,725	777,250	25	0	1,950,275
South Island	1,041,275	482,775	0	0	800	1,524,850
NZ	1,836,550	860,500	777,250	25	800	3,475,125

2.696 M ha

Land use impacts: Competitive with sheep and beef?



	Average annual profit * (ebit) per hectare	
Scenario	**without ETS**	**with ETS**
1 (0.8 mill)	$94	$60
2 (1.8 mill)	$144	$100
3 (3.4 mill)	$162	$114
4 (4.9 mill)	$160	$108

*average 2000-2008

Summary

Environmental

Excellent land use option from an environmental perspective, especially for steep hill country with erosion issues.

Parts of inland Otago and South Canterbury which have historically never been forested or where water availability is an issue should probably be avoided.

Summary

Land use

- impact on sheep and beef farming and meat production

- if the price of oil is high, more profitable land use than sheep or beef farming on low productivity grazing lands

- historical trends suggest that land use change will be slow to occur despite potential for increased profit

Economic

- if domestically produced biofuels are cheaper than fuel from imported oil then all measures of national welfare and macro economic indicators are positive

- if domestically produced biofuels are more expensive there could still be benefit to NZ from improved terms of trade

Key finding

Original proposition was that the new forests would be 100% energy focussed.

The economic analysis suggests that a more likely outcome is a forest estate that produces a mix of solid wood (sawlog) products and energy, unless the cost of energy from sources such as oil and gas rise dramatically.

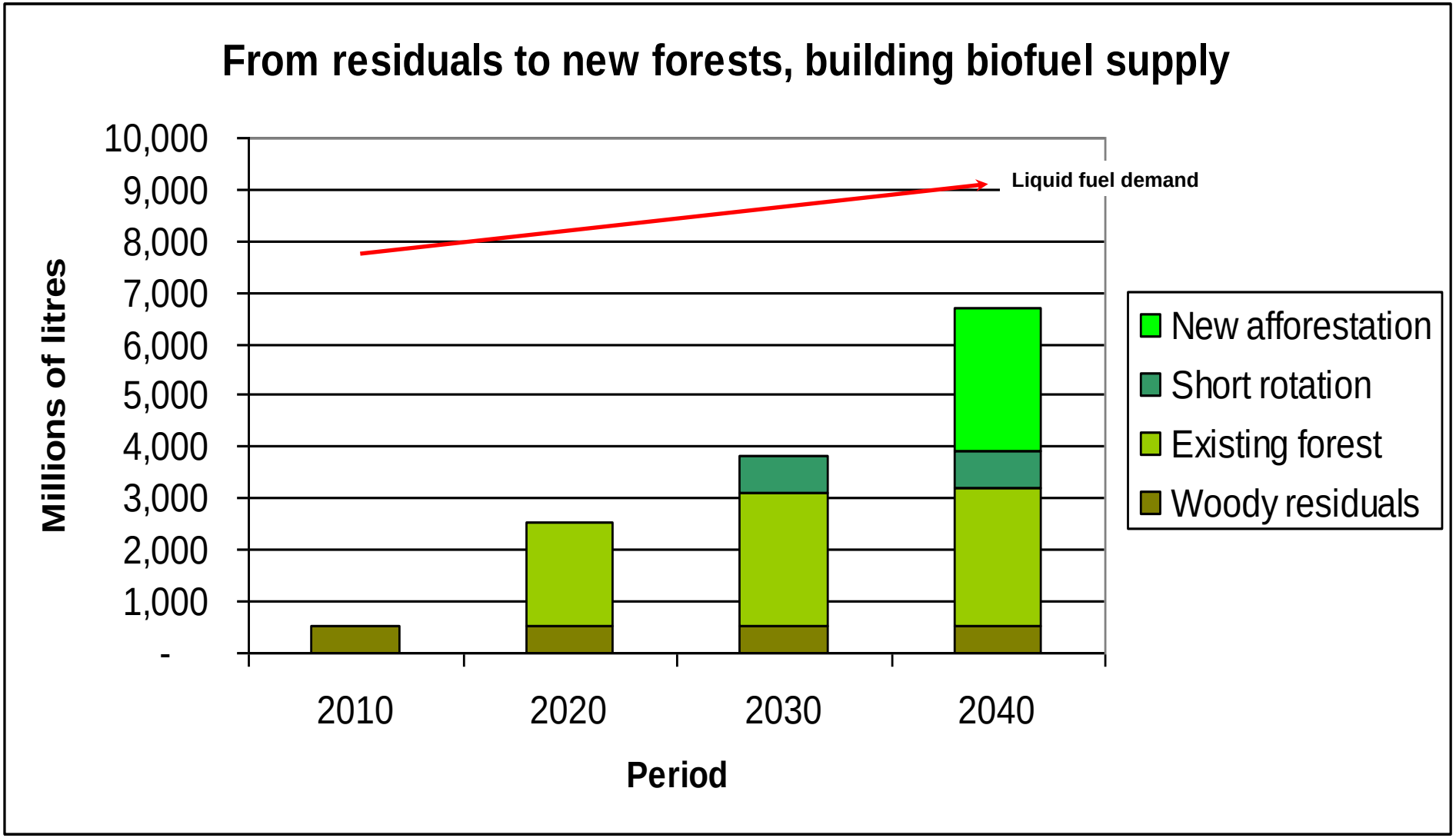
Transition – from residues to large scale bioenergy

Residues = 5% to 8% of Lf, available now

New Forests = 100% of Lf?, available in 25 to 28 years

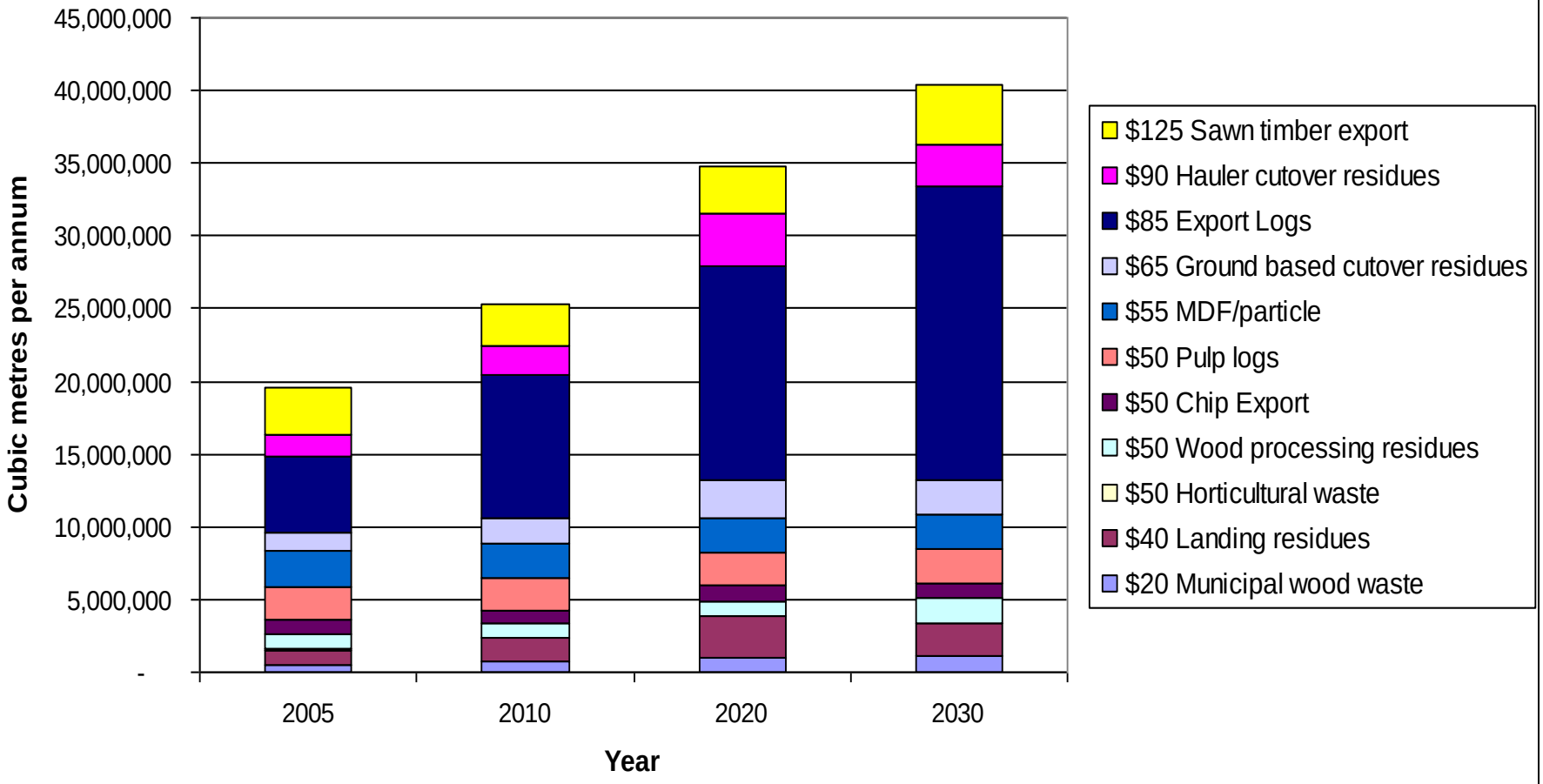
How do we manage the step change?

Existing Forests (1.7 million ha) = intermediate supply.



*** New afforestation figure is taking 45% of the wood volume available from the 1.8 M ha scenario**

Potential supply of wood for energy, (above domestic demand for wood)



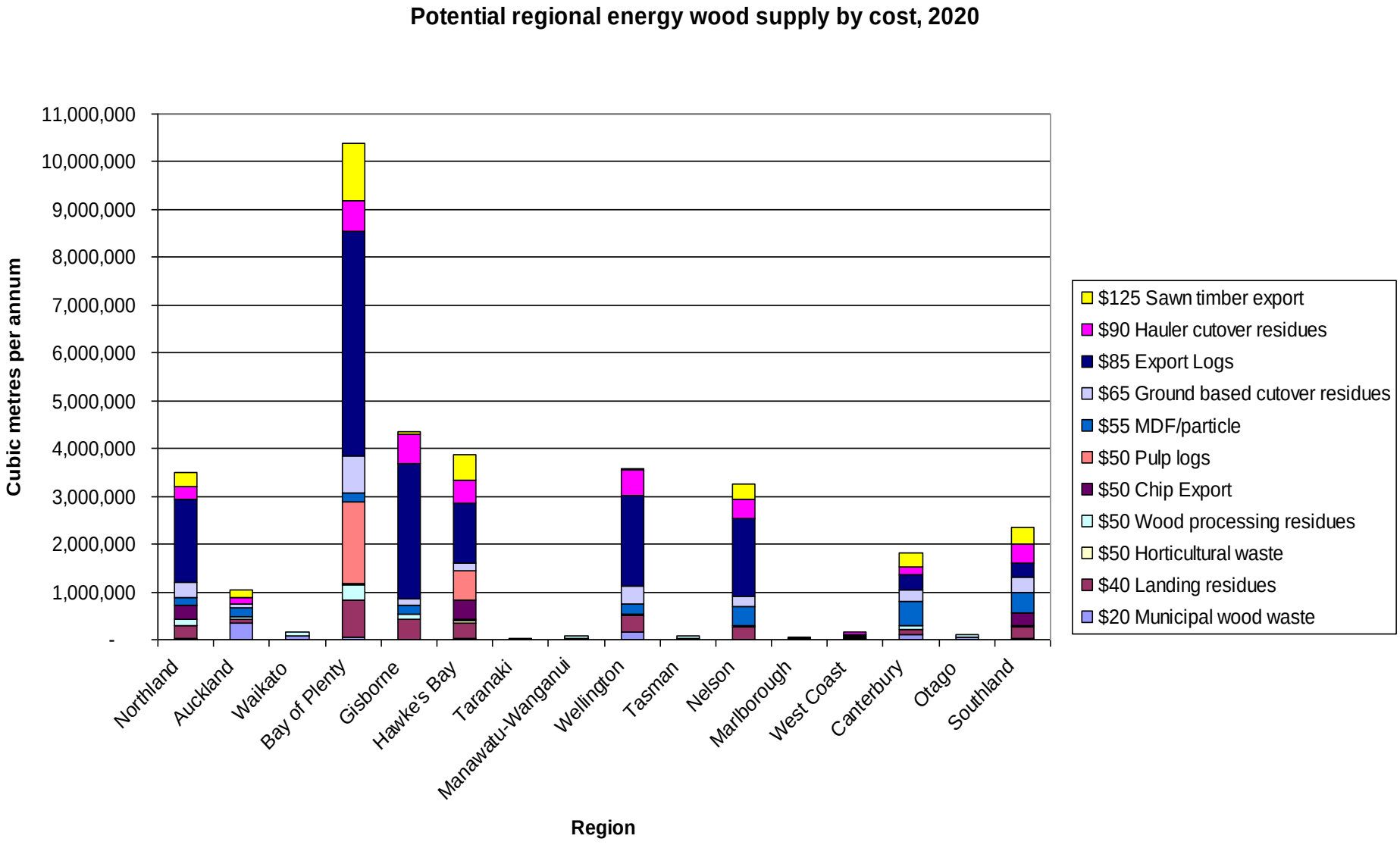
10 Mt = 930 M litres of petrol equivalent

The quantity of wood actually available for energy will depend on energy prices relative to that of other products, but liquid fuels from wood could compete with fossil fuels at US$115 to US$236 per barrel, depending on the tax regime, currency exchange rate and carbon price.

Oil price (US$) required to make biofuels competitive with petrol

	Tax + GST		GST Only	
Exchange Rate NZ$:US$	**Wood price at $75/m3**	**Wood price at $55/m3**	**Wood price at $75/m3**	**Wood price at $55/m3**
0.5	**169**	**150**	**134**	**115**
0.6	**203**	**180**	**161**	**138**
0.7	**236**	**209**	**187**	**161**

Regional wood supply, 2020, by material type, and approximate cost



In a future of volatile energy prices, there is also merit in the capacity of wood to store energy.

Trees do not need to be harvested at any particular date but can be left standing, and growing;

- continue to accumulate energy (and Carbon).

Reduce harvest during periods of low prices; this energy can be called upon during price spikes.

Transition - from what to what?

This can be described simply as;

- from, dependence on imported oil with a high carbon footprint
- to, domestic production of low carbon heat and transport energy;

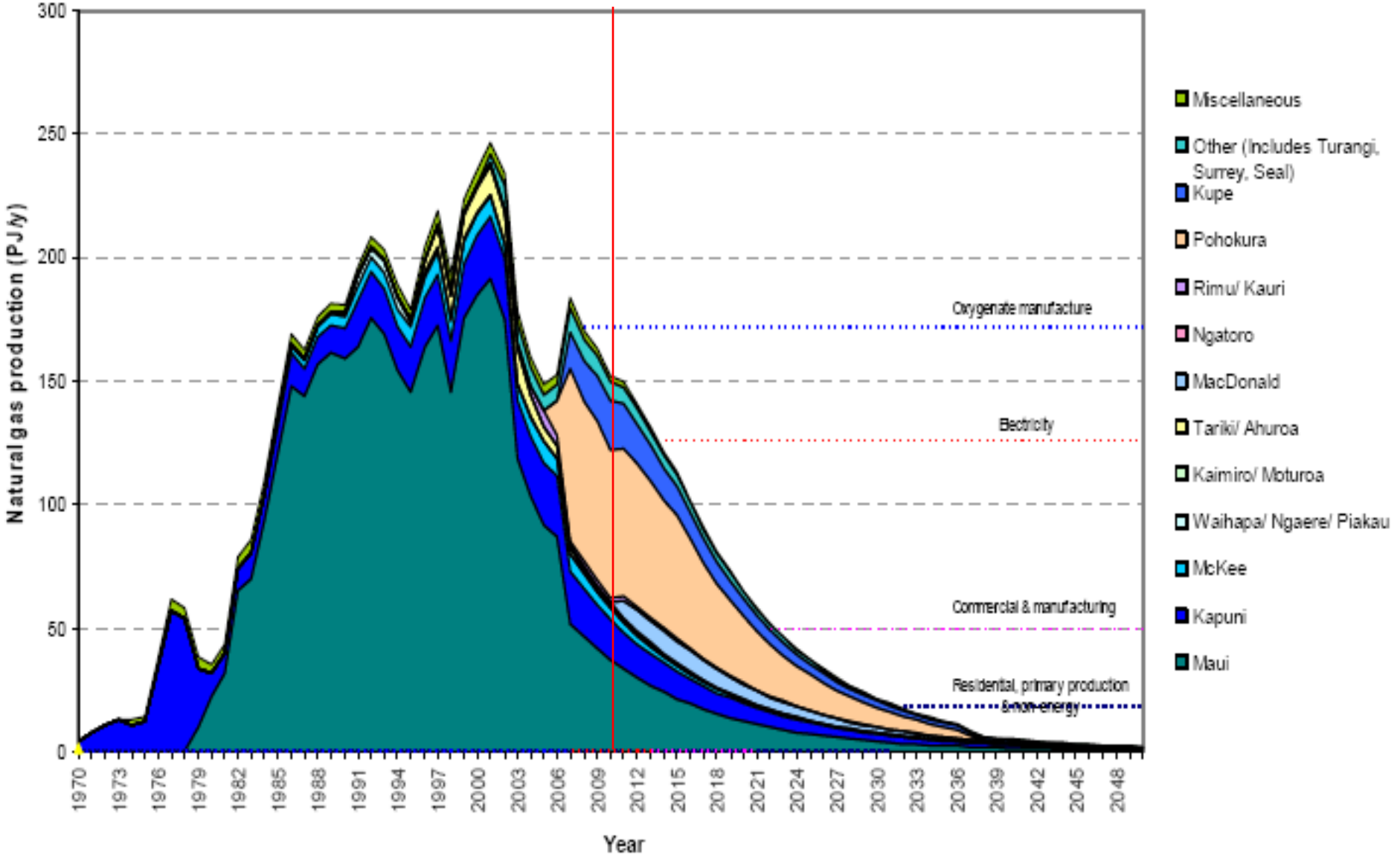
Via the use of woody biomass from existing forests and the development of a new large forest estate with an energy focus.

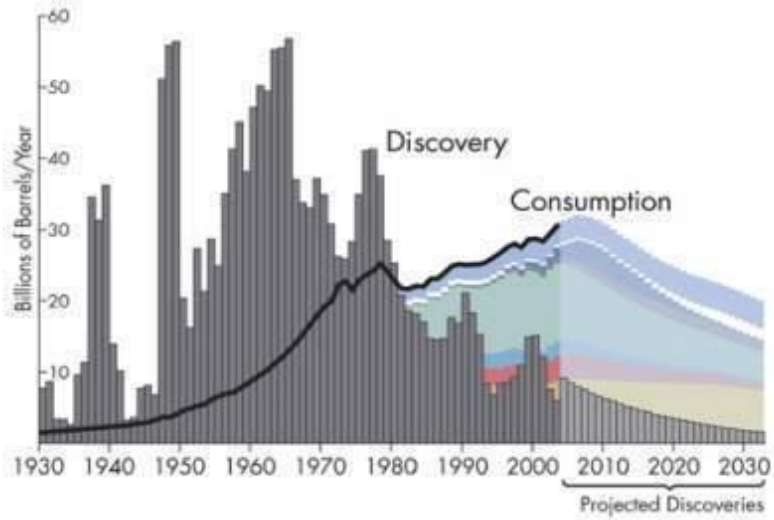
Why?

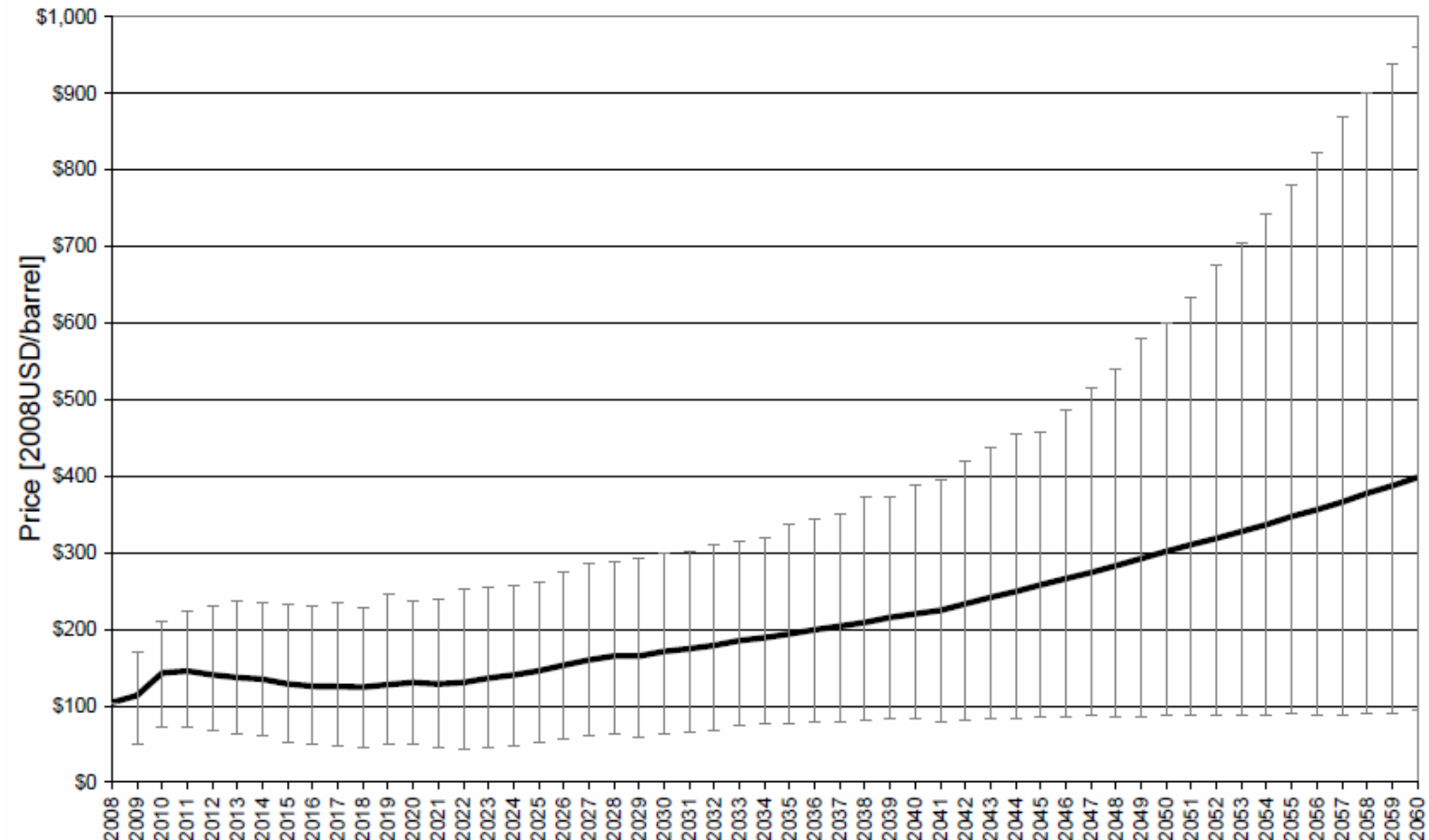
Based on a long term (30 year) view of global energy supply and consumption it appears likely that in the medium term we will need to transition away from fossil (especially oil for transport) energy to other forms of transport energy as there are risks associated with this oil dependency;

- economic risk
- environmental risk
- strategic (and security) risk

Natural gas production from existing developments




Billions of Barrels/Year
60
50
40
30
20
10
Discovery
Consumption
1930 1940 1950 1960 1970 1980 1990 2000 2010 2020 2030
Projected Discoveries


Price [2008USD/barrel]
$1,000
$900
$800
$700
$600
$500
$400
$300
$200
$100
$0
2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056 2057 2058 2059 2060

A substantial biomass resource is critical to making bioenergy, especially liquid biofuels, viable.

Biomass supply from residues, and existing & new Plantation forests can provide a continuum of increasing biomass supply that builds over time from 2010 to 2050.

This is a potential means of transitioning from a fossil based energy supply to a truly renewable and stable domestic transport energy supply.

Requirements to make it happen

Vision

Plan

Policy

Investment

Questions ?

Bioenergy Options Reports are available from;

Hard copy

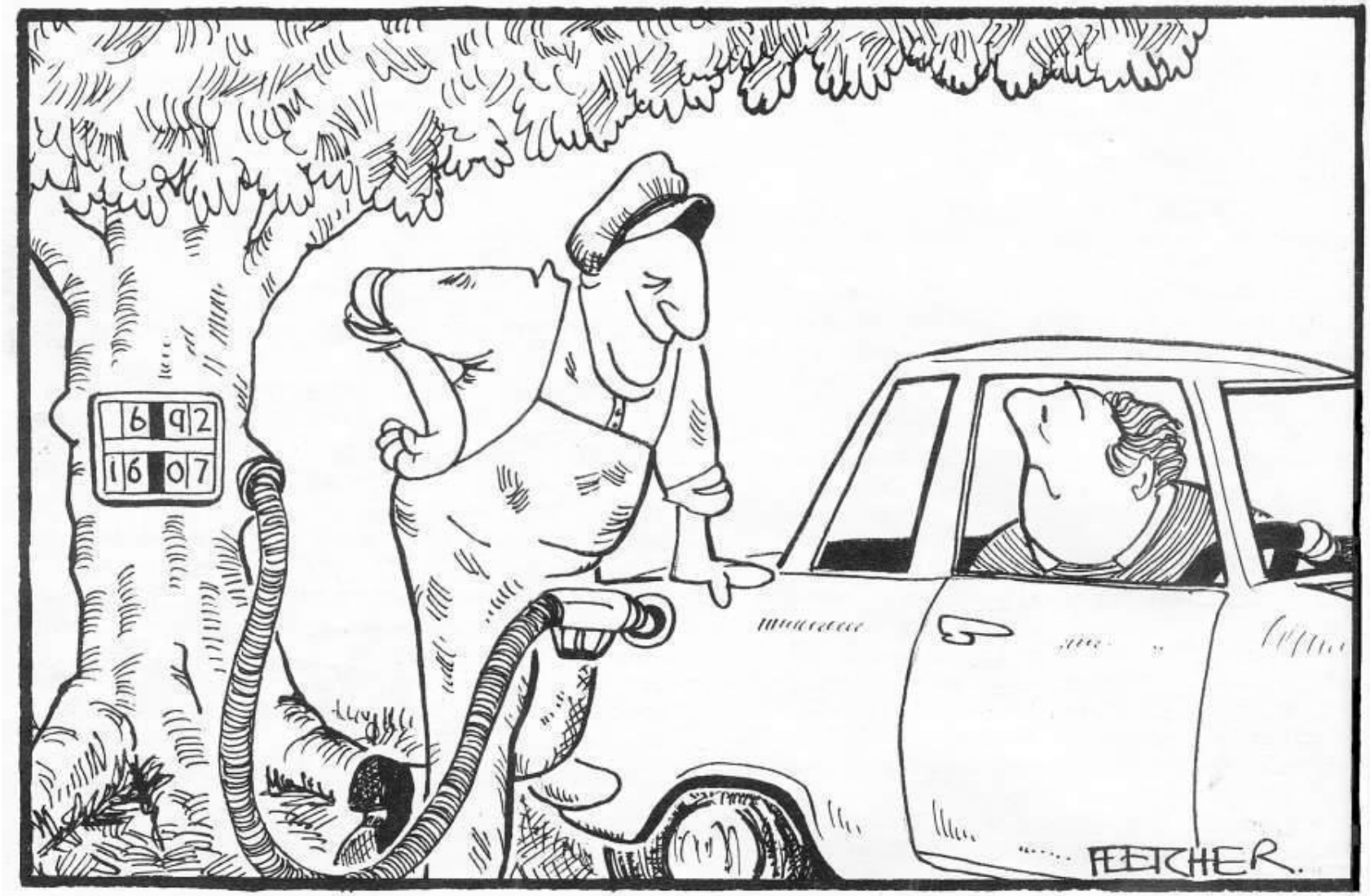
Scion Publications (publications@scionresearch.com)

Soft copy

http://www.scionresearch.com/bioenergy+report.aspx

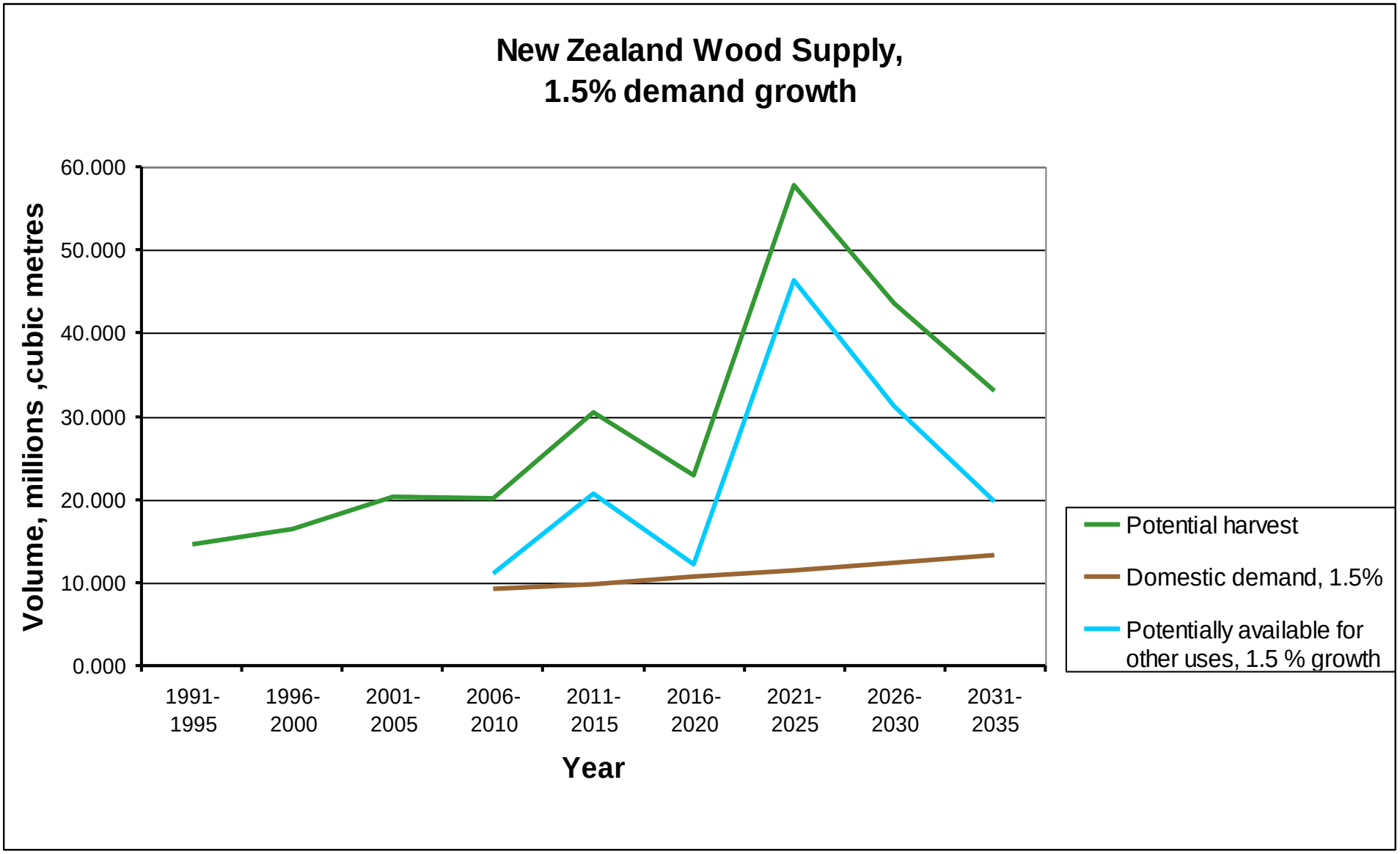
or

http://www.bkc.co.nz/Reports/Publications/BioenergyOptions/tabid/143/Default.aspx


6 9 2
16 0 7
FLETCHER.


$100
CRUDE
DON'T JUST STAND THERE- SOW SOME CORN OR SOMETHING!
trees


one day all this will be yours
OIL
BIO MASS


New Zealand Wood Supply,
1.5% demand growth
Volume, millions ,cubic metres
60.000
50.000
40.000
30.000
20.000
10.000
0.000
1991-1995
1996-2000
2001-2005
2006-2010
2011-2015
2016-2020
2021-2025
2026-2030
2031-2035
Year
Potential harvest
Domestic demand, 1.5%
Potentially available for other uses, 1.5 % growth