Biofuel Options – Solid and Liquid
Global Primary Energy Sources

Exajoules per Year

1820 1840 1860 1880 1900 1920 1940 1960 1980 2000

- Nuclear
- Hydro-Elect
- Nat Gas
- Oil
- Coal
- Biofuels
Return to a Bio-economy
How rapidly things can change

Easter morning 1900: 5th Ave, New York City. Spot the automobile.

Easter morning 1913: 5th Ave, New York City. Spot the horse.

Source: US National Archives.

Source: George Grantham Bain Collection.
Rudolph Diesel

First Diesel Engine ran on peanut oil at 1900 Paris World Fair
The fuel of the future is going to come from fruit like that sumach out by the road, or from apples, weeds, sawdust — almost anything. There is fuel in every bit of vegetable matter that can be fermented.
NZ Flashback
Liquid Fuels Trust Board

Focus on fuel self sufficiency in NZ
LFTB Analysis

- Onshore fuel options
- Volume & Cost
- Agricultural conversion ruled out
- Significant forest resource
- Technology maturity and Feedstock competition barriers

Figure 2: Transport Fuels Supplies, Demand and Costs
(from LFTB report No. LF6020 – note logarithmic scale)
NZ Synfuels Corp (75% Gov)
First of kind plant
NZ$2.25B Capex
~35% of NZ Petrol
1987-1997
NZFRI (Scion)
Bioethanol Research

- 1980’s
- Wood to Bioethanol
- Pilot-scale development
NZ Bioenergy Options Study 2007-9

- Pathways analysis for NZ biomass feedstocks
- Highlighted “Marginal Land” opportunity
- Forests are our biggest biomass resource and the one with the most potential to expand
- 3.3M ha of forests could provide enough biomass to make all our liquid fuels with some left over for displacing coal and gas
  - 1.8M ha current forest estate
Solid Energy
Biodiesel NZ

- Major losses >$60m
- Operated 2007 - 2013
- Government biofuel subsidy 2008 - 2012
2008 -NZ Lignocellulosic Bioethanol Initiative

- Second generation biofuels
- Research program funded in Government Advanced Biofuels targeted funding round 
  together with Lanzatech
- Scion led, partnered with global bioethanol leaders
- Focus on wood - sugar conversion
- Biotech pathway continuously improving
- Radiata pine challenges
‘Some Biofuels are better than others’

PCE Report 2010

1. Current NZ biofuel feedstocks cannot take us far
2. Current NZ biofuels can only supplement – Blend walls
3. Focus on substitutes for diesel rather than petrol
4. No environmental sense to import “bad” biofuels – Unethical but technically possible

Target drop-in biodiesel from wood
2012 Wood Energy Industrial Symbiosis

Research Program identifying opportunities for wood and integrating process heat
2013
Stump to Pump

- Norske Skog, Z Energy Partnership
- Investigate forestry waste to liquid biofuels
- Total $3.6m, 50% Gov funded
- Conclusions
  - Sufficient feedstock availability
  - Technically feasible
  - Meeting fuel standards takes time
  - Softening global energy outlook
- Parked!
2015 Z Energy Bio Diesel

- 20 million litres per annum
- Tallow based
- ~$26m investment
- No subsidies, mandates or grants!
- Power of brand
Serious biofuels interest
• How do you provide security of investment with a backdrop of global volatility?

• Will it take another crisis to effect change in fuels?

• Can the NZ free market approach work?

• Will we see a disruptive shift in transport fuel?
Why Biofuels in NZ
Productive Land and Low Population

 Nobody Lives Here

[Map of New Zealand showing regions with no inhabitants living per one square kilometer]

[Pie chart showing land use percentages:
- Grassland, 51%
- Natural forest, 30%
- Exotic forest, 8%
- Grass and scrub, 5%
- Urban, 0.4%
- Cropland, 1%
- Horticulture, 0.4%
- Other, 4%]
New Zealand Energy Profile

![Graph showing energy use in PJ/year for different sectors: Electricity, Transport, Residential heat, Industrial heat (wood, geothermal, gas, coal etc).]

Source: MBIE 2014
Potential NZ Biofuel Drivers
Objective

To inform and stimulate debate on large-scale production and use of liquid biofuels in New Zealand

Understand what a large-scale biofuels industry could look like here, e.g.

- Which crops and where to grow them?
- Which technologies?
- Which fuels?
- Key cross-sectoral industry considerations and implications.
Must consider the whole value chain
Feedstocks

• Crops
  – Corn - whole plant & maize
  – Sugar beet
  – Oilseed rape (canola seed)
  – Willow
  – Miscanthus

• Forestry
  – Conventional forests – new & existing (30-year rotation)
  – Energy forest (15-year rotation)
  – Sawmill chips

• Wastes
  – Municipal solid waste
  – Wood waste
  – Tallow
Many potential pathways
Biofuel Cost Reduction

- Brazil bioethanol industry
- Supply chain optimisation
- Technology learning
- Economies of scale
Bioenergy Value Chain Model

- Optimisation of low cost routes to large scale biofuels in New Zealand.
  - 5 land classes
  - 20+ Feedstocks
  - 3+ Feedstock transport
  - 25+ Conversion technologies
  - Biofuels classified in 4 families (petrol, diesel, marine, aviation)

- Which feedstock should we grow? Where? When?
- What technology should we use? Where? When?
Drop-in biofuels from woody biomass grown on non-arable land is optimum solution for large scale biofuels in New Zealand

- Offers 88% GHG reduction vs fossil fuels over entire value chain
- Eg 30% substitution would deliver 5 Mte of GHG emissions reduction
- Target hard to decarbonise transport sectors – heavy trucks, marine and aviation. (EVs for petrol fleet)
Roadmap Outputs

- Focus on drop-in biofuels
- Focus on marine, jet and heavy equipment fuels
- Focus on feedstocks grown on non-arable land
- Long term, plantation forests are New Zealand’s best large-scale biofuel feedstock option
- Northland, Eastland and CNI favoured feedstock
- Market forces will not be sufficient

What's Next
NZ Biojet Consortium

- Air NZ, Z Energy, Refining NZ, & Scion
- Business case development
- Coordinated Government discussion
- Initial target domestic jet fuel
Marine Biofuels Opportunities

- 80% Global Goods Movement
  - 87% of NZ exports
  - 76% NZ imports
- 3% of Global GHG emissions
- 9% of Global Sulphur dioxide emissions
  - Urban port air quality
Global Momentum
Sweden
Pyrocell
Sawdust to Biocrude

- JV between Setra (wood processor) and Preem (Oil Refiner)
- 35,000 t/y sawdust to 25,000 t/y ‘biocrude’
- Feed Preem oil refinery for liquid fuels
- Commissioning 2021
United States
Gevo
Sustainable Aviation Fuels

- US based biofuel pioneer
- First generation Alcohol to Jet process
- Circular principles
- Significant airline offtake agreements
Finland
Neste
Renewable Fuels

• From local oil company to global renewable fuel and chemicals leader
• Decade of transformation
• Largest renewable diesel producer in the world
  – 3.3m t/y to 4.5m in 2022
• Animal fats and vegetable oil feedstocks
Final Thoughts
Hierarchy of Wood Use
Oil Economy to a Bioeconomy = Biofuels plus............
Disrupters

- Will EV tipping point (S curve) crash crude oil price?
- Will carbon price hit crisis point?
- What Else???
Diversification  Protection  Security  Brand