



New Zealand's EnergyScape

National Energy Research
Institute (NERI)
Energy Conference

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23rd November 2007



EnergyScape question?

2000

2005

2030

2050

What is wrong with New Zealand's Energy system?

- Insufficient investment?
- Dependence on imports?
- Regulation?
- Lack of planning?
- Mixed signals?
- Risk averse?
- Lack of knowledge?
- Access to technology?
- Skills & capacity?
- Enthusiasm?
- Limited demand?
- Limited capital?



Lack of ...

Collaboration & consensus

EnergyScape project

2000

2005

2030

2050

Common / shared filing system...

- Provide a framework for NZ to analyse options against objectives.
In a way that enables:
 - Identify gaps and development strategies
 - Understanding forces of uncertainty and world market
 - Ongoing development

Seeking:

An unbiased basis for informing
policy and research direction ...

**Hydrogen
economy**
12 months
\$0.65 million
CRL lead

**Carbon
storage &
sequestration**
16 months
\$1.42 million
GNS lead

**Bioenergy
opportunities**
18 months
\$1.1 million
SCION lead

**18 months
\$1.33 million
NIWA lead**

EnergyScape

New Zealand's EnergyScape



Solution?

2000

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More than carrying capacity!

- GHG, water, land, \$, η , risk ...

• Built with an understanding of end-use

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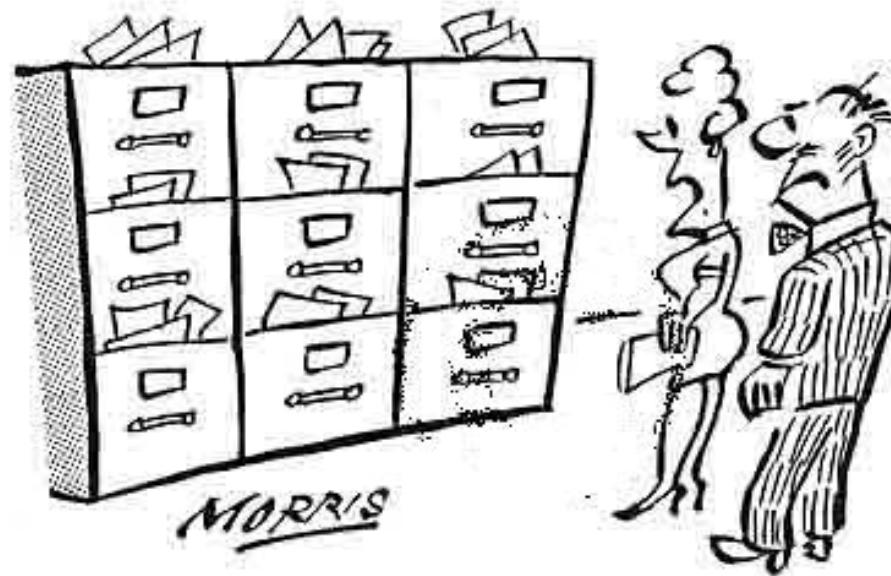
w

ost, GHG, risk

tions

- Accessible & ...
 - Self explanatory
 - Modifiable
 - Transparent

LEAP software v
databases



uncertainty

– Infrastructure limitation

New Zealand's EnergyScape



EnergyScape framework

2000

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Resources



- Imports
- Exports

- Renewable
 - Hydro
 - Wind
 - Solar
 - Marine
- “Earth”
 - Geothermal
 - Gas
 - Oil
 - Coal
- Biofuels
- Dist. Generation

Infrastructure



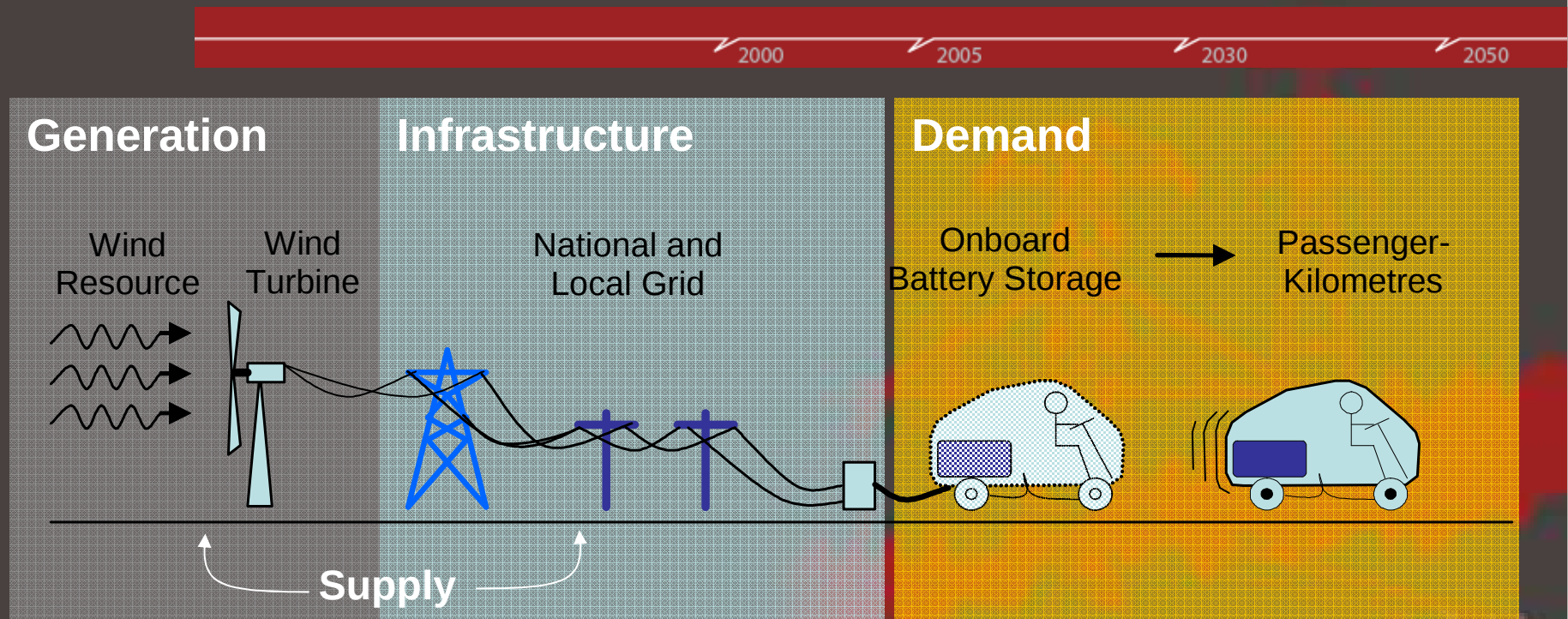
- Traditional
 - Road
 - Elec. grid / network
 - Gas distrib.
- Transport
- Conversion
 - Fertilizer
 - Coal to liquids
 - Sequestration
 - Waste → biogas
- Hydrogen

Demand



- Behavior
- Efficiency
- Mobility
 - Aviation
 - Shipping / rail
 - Heavy trans.
 - Passenger
- High grade heat
 - Cooking
 - Distillation
- Low grade heat
 - Space heating
 - Water heating
- Electricity
 - Appliances

Pathway capture ...



Fertiliser	Wood pellets	Comb Heat Power	Algae liquids	Electric rail	Landfill gas
Distributed Gen	Fisher Tropp	Solar Tower	MSW gassifier	Waste biodigestion	Bio refinery
Coal to Liquids	Hydrogen Ref	Hydrazine	Wind dam	REDOX batteries	Sequestration
CNG /LNG	MeOH fuel cells	Thermo-elec	Methane hydrates	Organic PV	Hot dry rock
1°, 2° & 3° biofuels	Electric vehicles	Petroleum refinery	Solar Hot Water	Supercritical water	Wave energy

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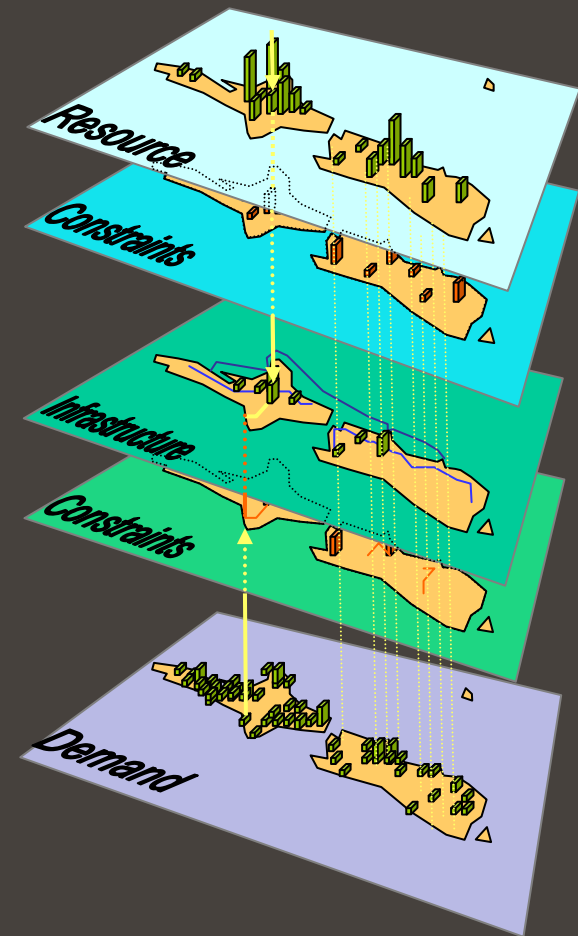


Interim results ...

2000 2005 2030 2050

EnergyScape

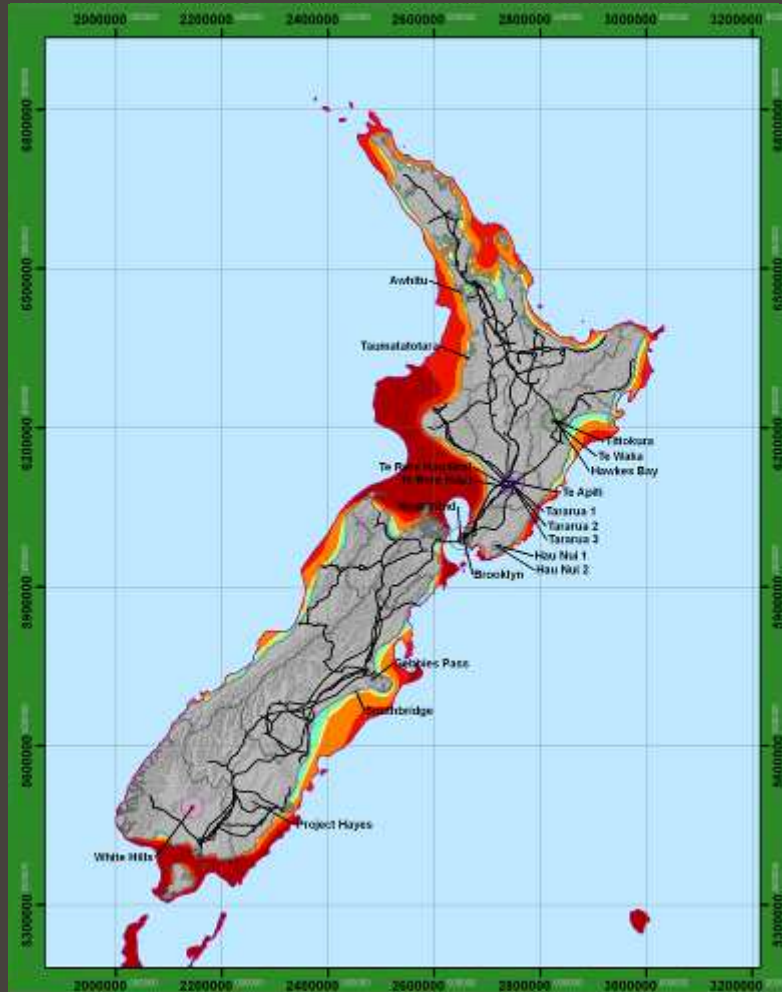
- Indigenous resources
- Earth resources
- Infrastructure
- Demand
- Global outputs
- LEAP



New Zealand's EnergyScape



EnergyScape – Indigenous resources



A universal technology, just looking for appropriate price!

- Existing asset register
 - Peak capacity
 - MED, EHMS & NZWEA
 - Firm capacity
 - EC dataset?
- Potential resource
 - NIWA climate network
 - NZLAM output
 - Vestas V63 curve
- Realisable

Even though only need order of magnitude
... good data is always appreciated!!

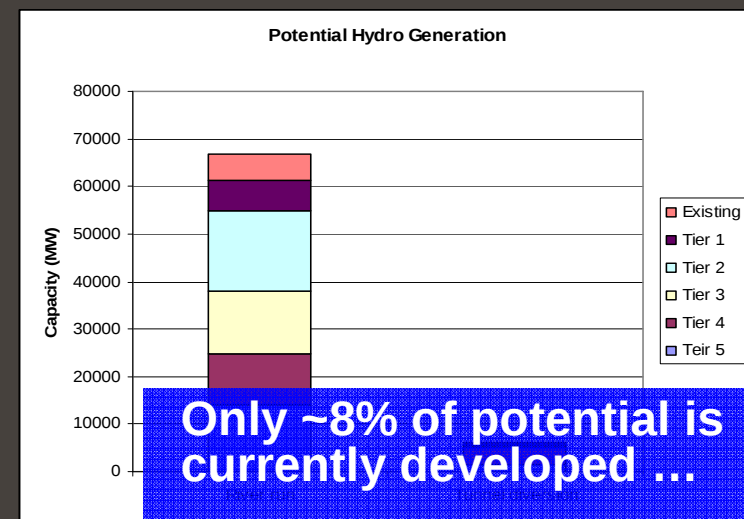
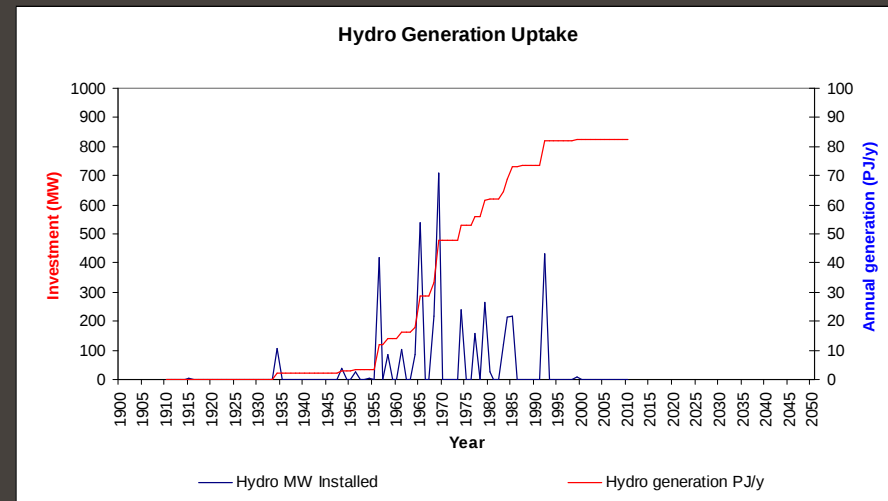
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EnergyScape – Indigenous resources

2000 2005 2030 2050

- Delays
 - 1 year research
 - 1 year consent
 - 2 years finance & construction
- Risk
 - 0 stars in research
 - 3 stars in consent phase
 - 0 star in construction finance and operation phases
- GHG
 - Minimal GHG emissions from collection of sediments. Considered to be zero for EnergyScape



New Zealand's EnergyScape



EnergyScape – Earth resources

2000

2005

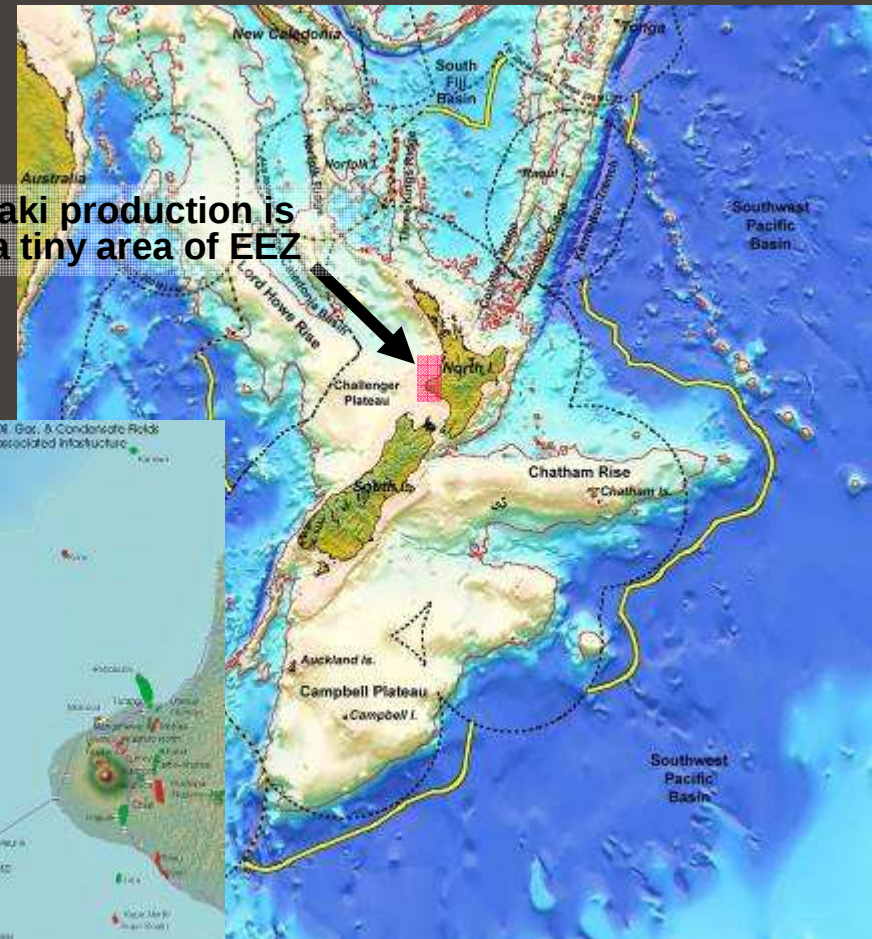
2030

2050

New Zealand is currently locked in an
“Energy Security” mindset ...

- Significant gas potential
 - “Relatively unexplored”
 - High success rate
 - Exploitation is scale dependent
- Significant oil potential
 - Tui’s relief of import bill is temporary

Taranaki production is
from a tiny area of EEZ



A \$25/bbl future

Yeah right.

Tui

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EnergyScape – Earth resources

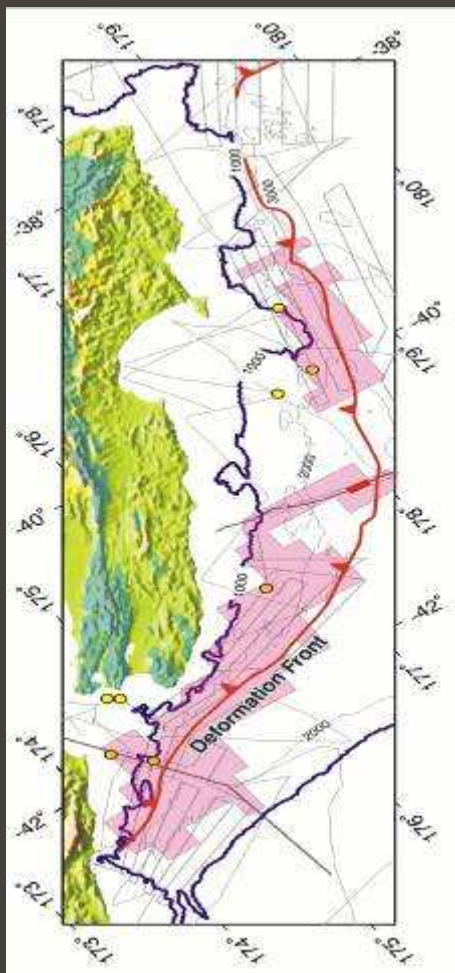
2000

2005

2030

2050

Many unique endowments that can / have helped
make us prosper ...



- Unique high temperature geothermal resources
 - Heat pumps, HDR, Enhanced geothermal ...
 - '000s of MW (high & low grade) to recover
- Enviable 'per capita' coal reserves
 - Sufficient to sustain liquid fuels demand?
- International scale methane hydrate resources
 - East Coast alone has 813 TCF ... 5% recovery
≡ 10 × Maui

New Zealand's EnergyScape



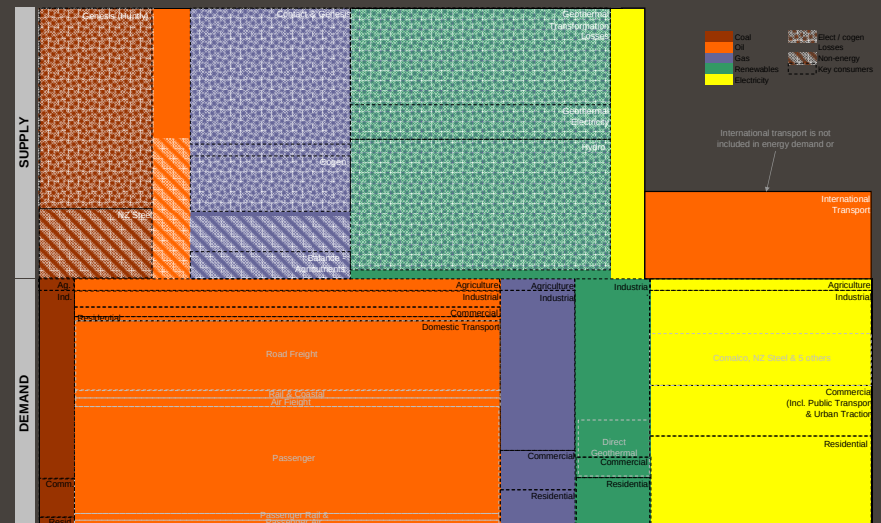
Global outputs

2000

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- **Extended EDF type data**
 - **Focus on transport & absolutes**
 - **GHG and consumer cost profiles**

- **Box plot**

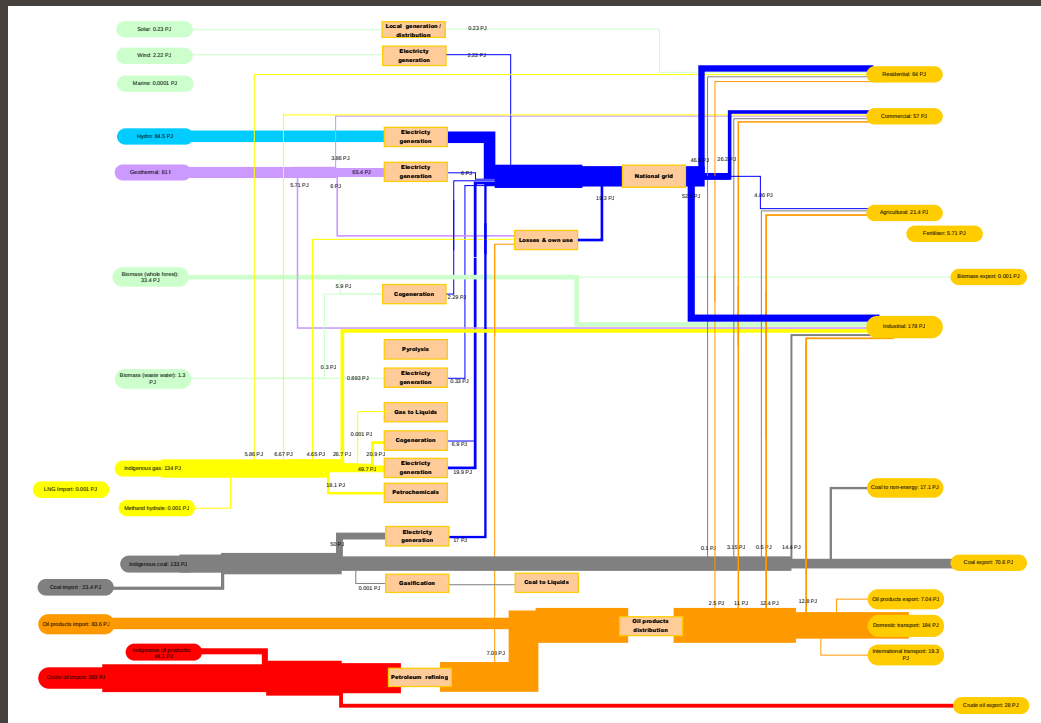


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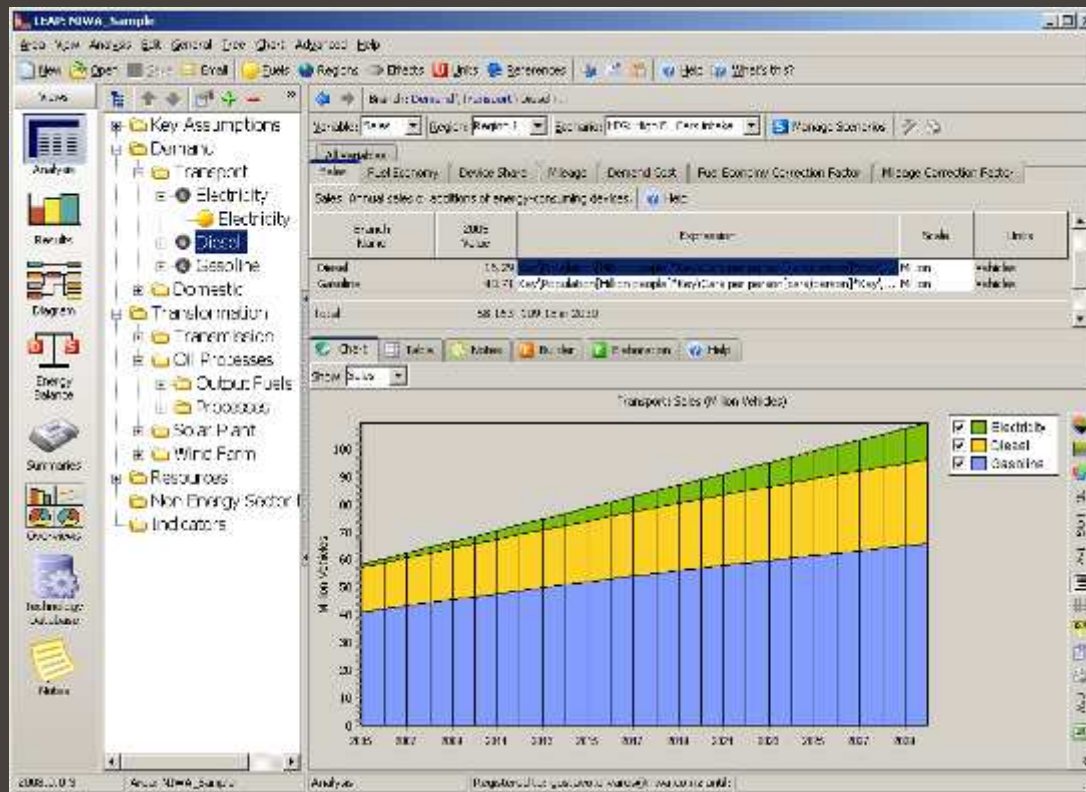
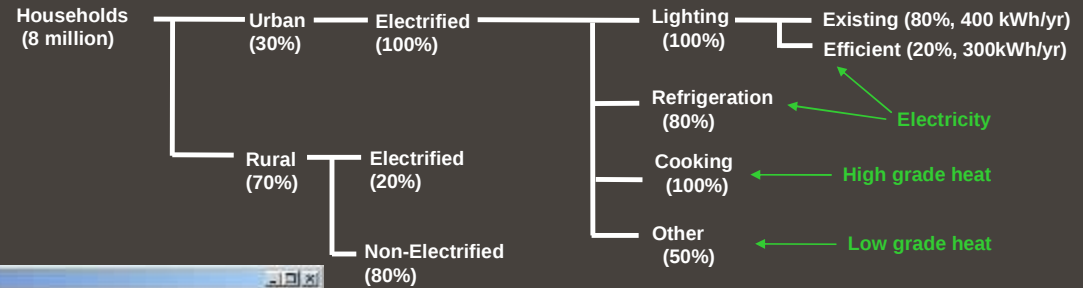
Global outputs

- Sankey diagrams
- Scenario visualisation



Long Range Energy Alternatives Planning (LEAP)

- Free (read-only) & intuitive data storage and visualisation package



- Simplified national model provided at:

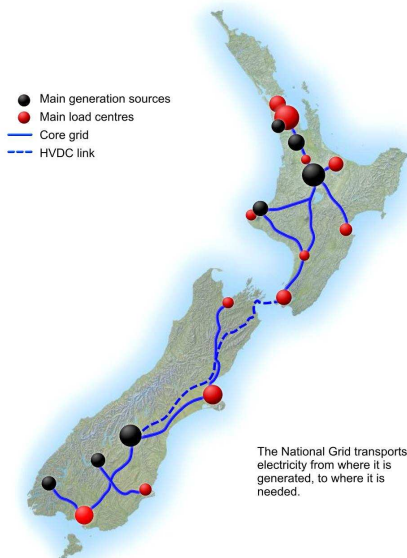
www.energyscape.co.nz

- Demand & supply balances are manually achieved.

New Zealand's EnergyScape



Bringing it all together



2000

2005

2030

2050

- Updating asset register via. web
- Each scenario includes:
 - Import / export price assumptions
 - GDP / Population growth assumptions
 - Transport (heavy / light) characterisation
 - High / low grade heat characterisation
 - Industry status
 - Electricity make-up philosophy
- Report on 2005, 2030 & 2050
 - Tables & sankey diagram
 - Risk, GHG, Total cost profile
- Increase awareness of energy substitution losses.
- Comment on the role of feed in tariffs / tax breaks & carbon tax

Interim results ...

2000

2005

2030

2050

Bioenergy opportunities



Grow

Extract

Transport

Convert

Distribute

End use



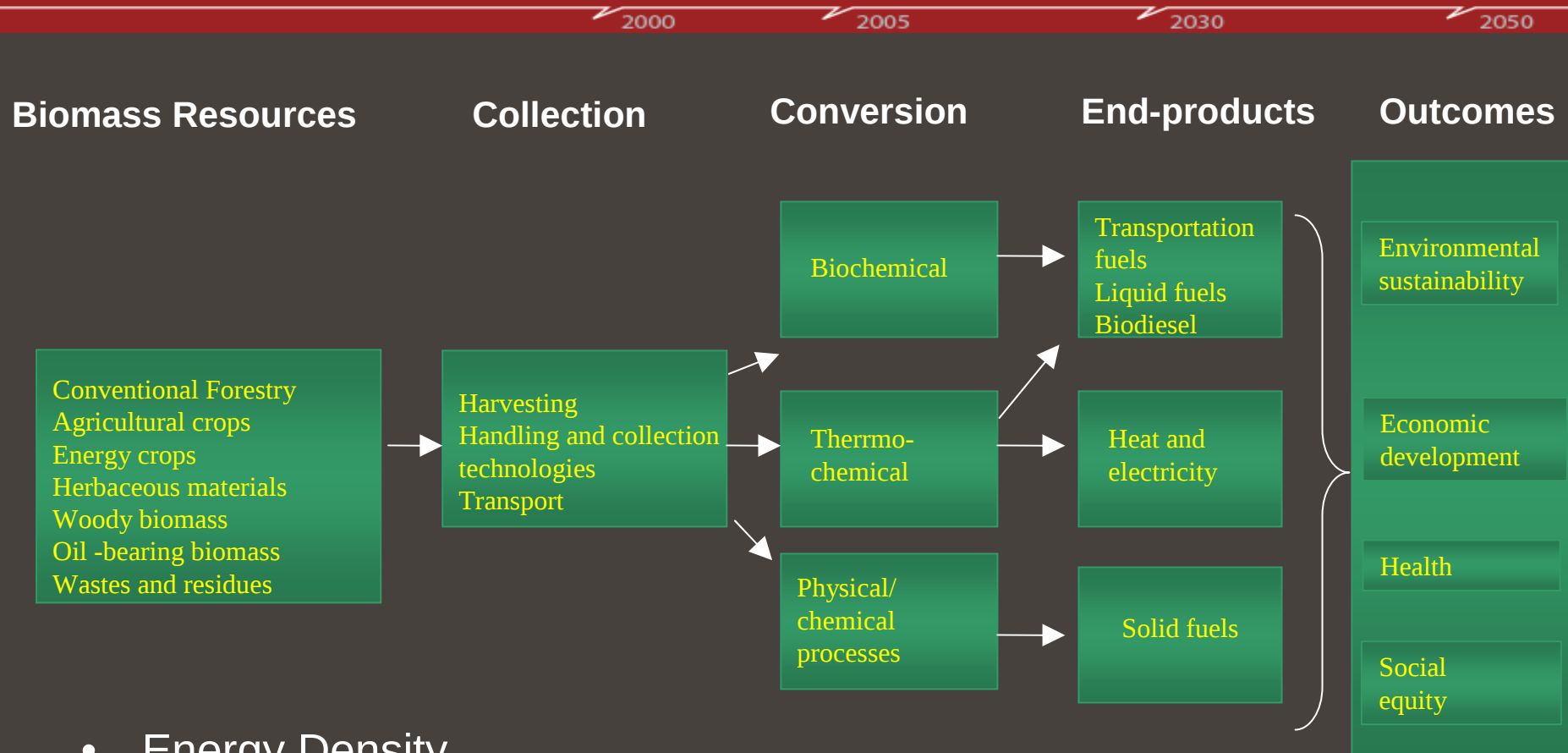
Reuse

Organic, Variable, Purpose Grown or Residual and Renewable

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Bioenergy opportunities

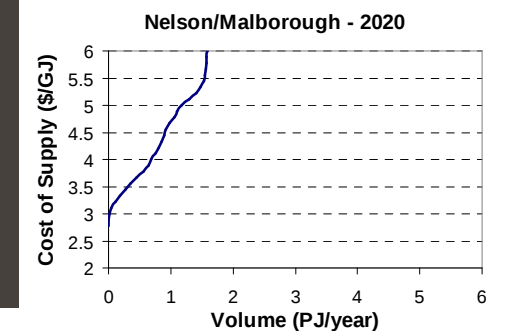
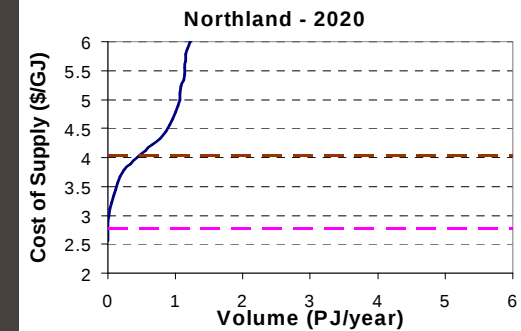
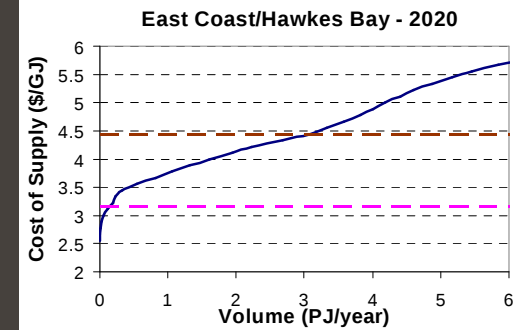
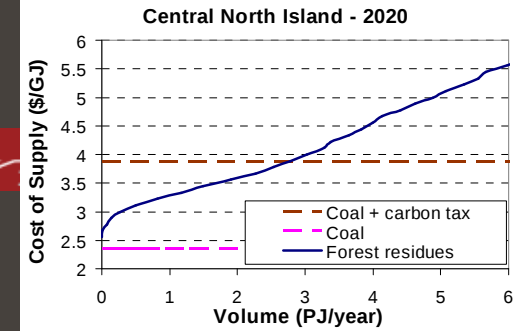
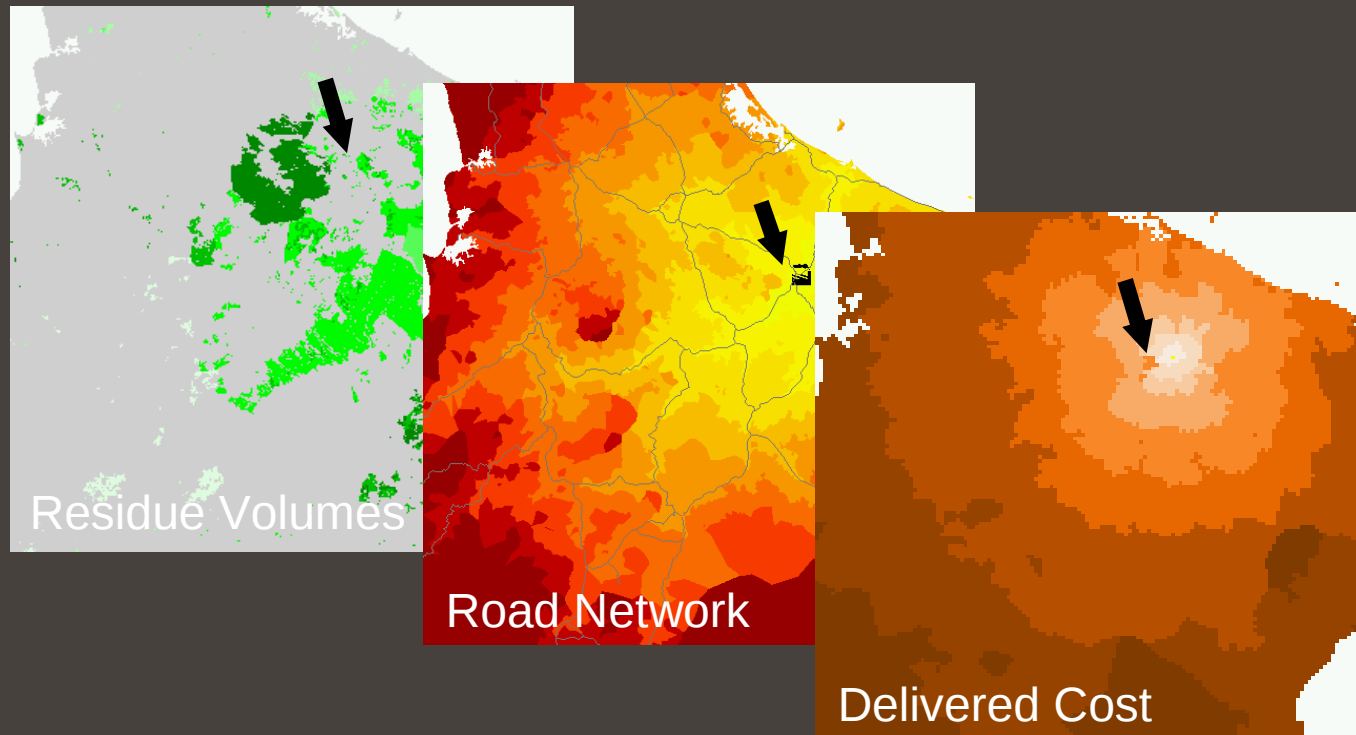


- Energy Density
 - Petrol
 - Natural Gas
 - Wood chips

34 MJ/kg
37 MJ/kg
17 MJ/k

- Highly variable
- Distributed
- Suitable for storage

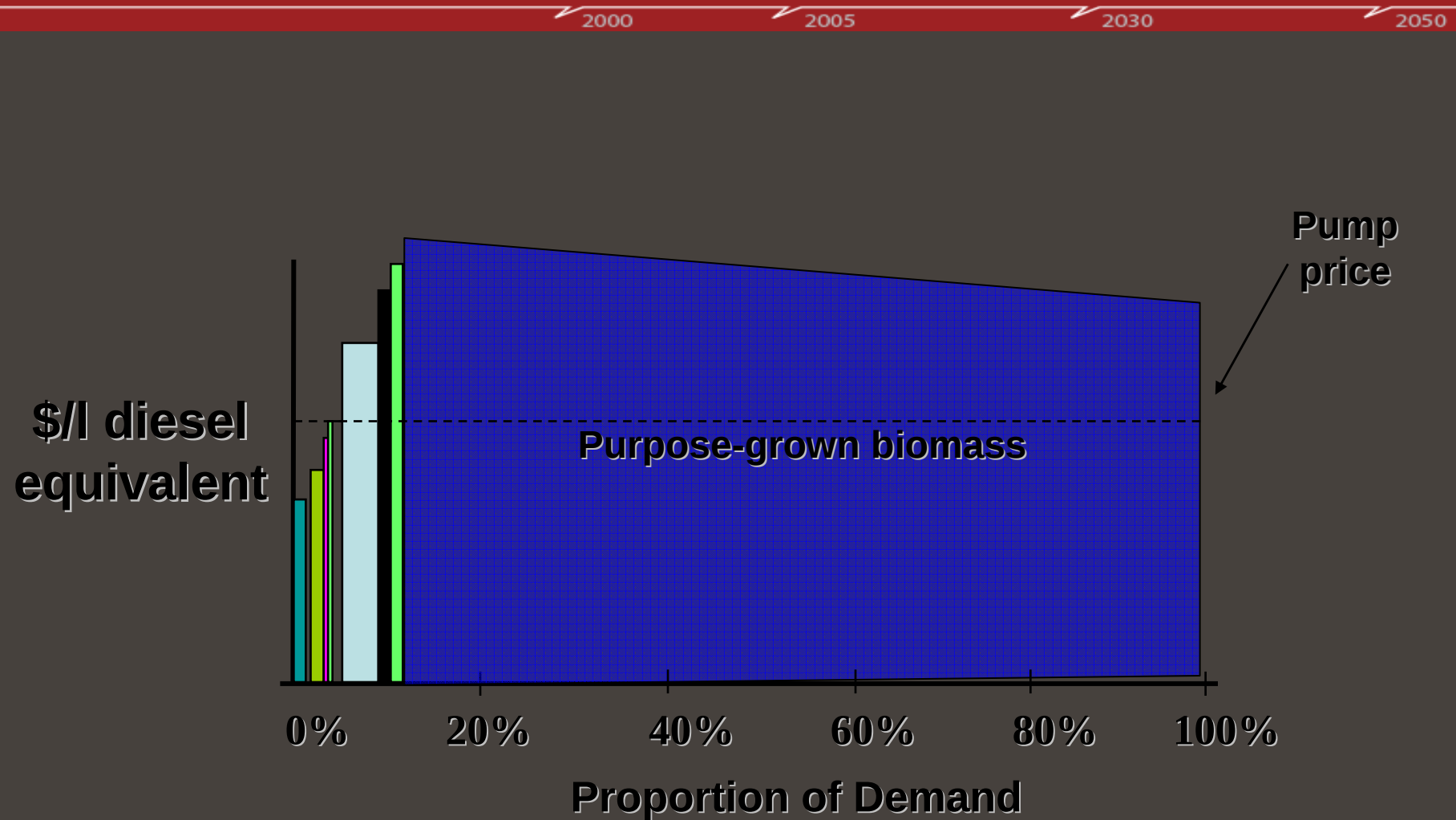
Forest residues GIS model



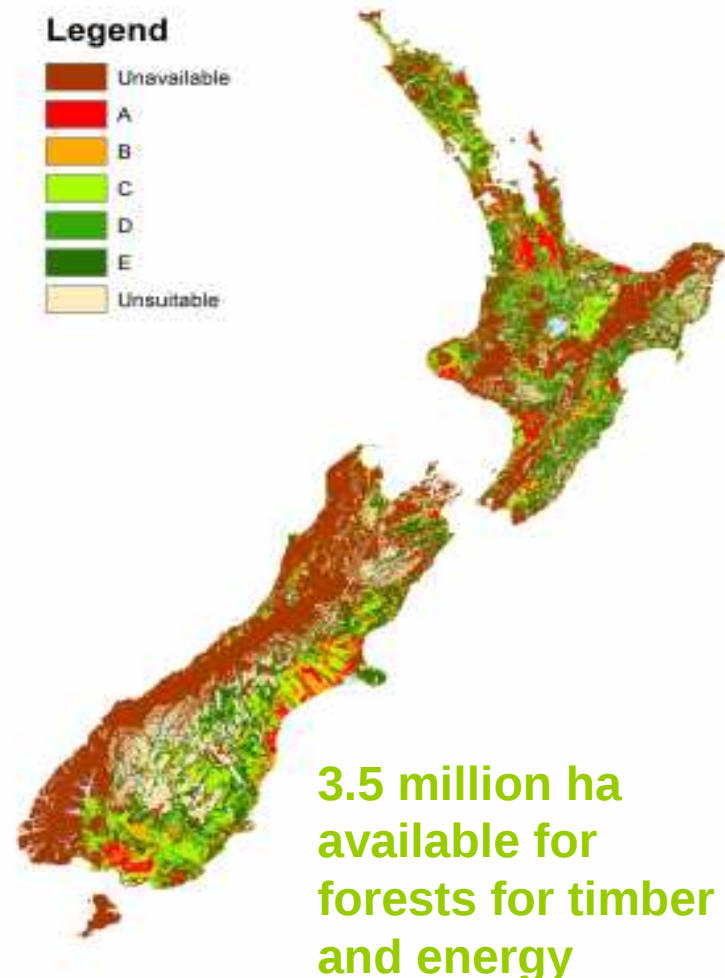
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Bioenergy for transport



New Zealand land area suitable for different energy crop types (Landcare Research)



Category	LUC class	Total area (ha)	Description
A	I, II	1,336,900	Highly Suitable for cropping or pasture.
B	IIIa, IIIc	1,038,700	Some cropping possible, also suitable for pasture.
C	IIIe, IIIw, IV	3,675,100	More suitable to pasture. Some cropping in rotation possible.
D	V	180,400	Unsuitable for cropping. Suitable for pasture
E	VI	5,432,900	Unsuitable for cropping. Moderate limitations under perennial pasture.
F	VII, VIII	3,674,900	Unsuitable for cropping or pasture.
Unavailable	Urban areas and areas still under natural land cover	11,385,600	Land not available for farming (e.g., urban, indigenous forest)

New Zealand's EnergyScape



Interim results ...

2000

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Hydrogen roadmap



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Hydrogen roadmap ...

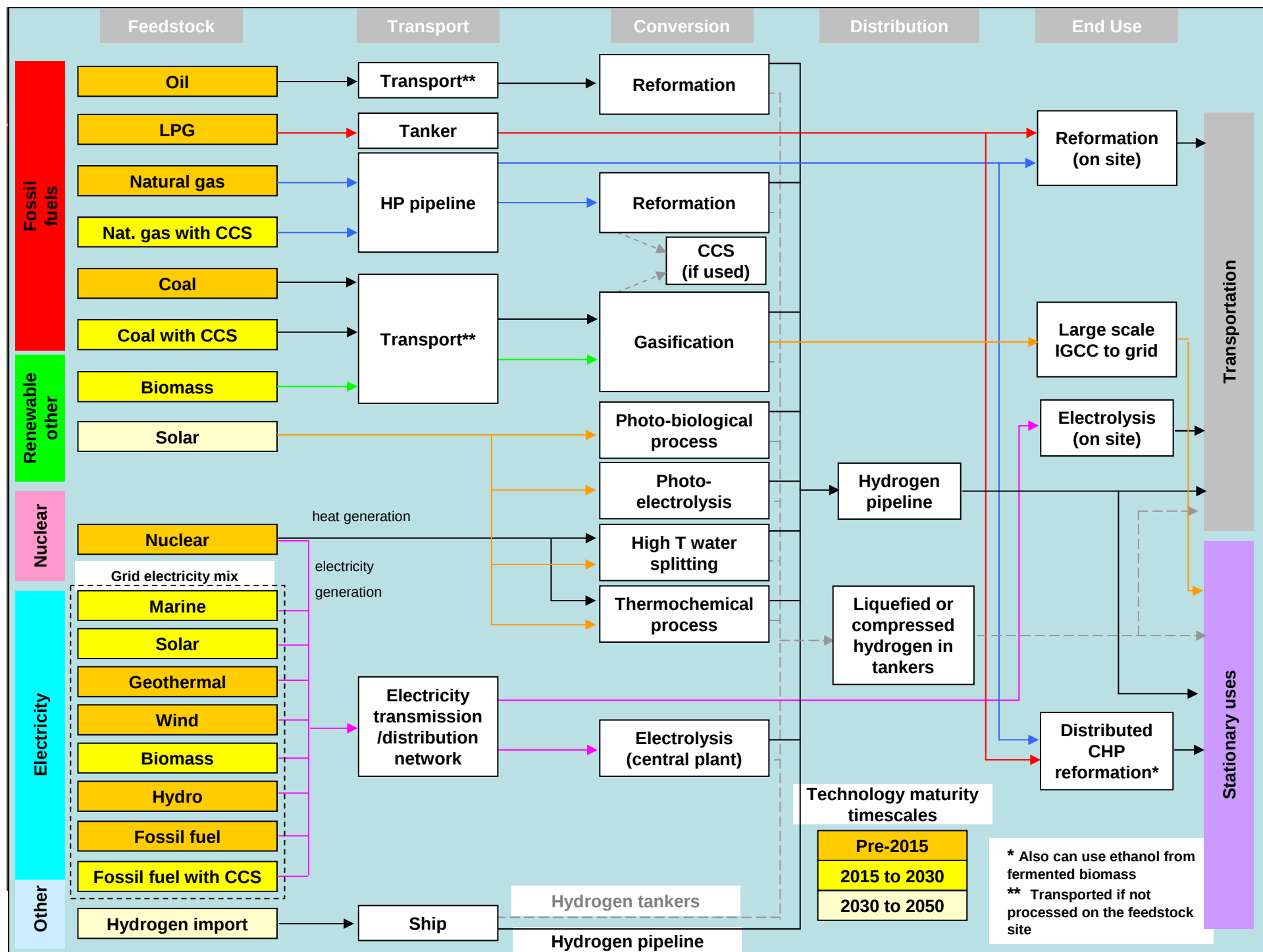
2000 2005 2030 2050

- Potential paradigm shift
 - Flexibility
 - **Efficiency**
 - **Storage**
 - Energy density?
 - Carbon footprint?
- Situation – Globally:
 - 138 refuelling stations in 25 countries.
 - 63 planned for 2007
 - 600 FC vehicles

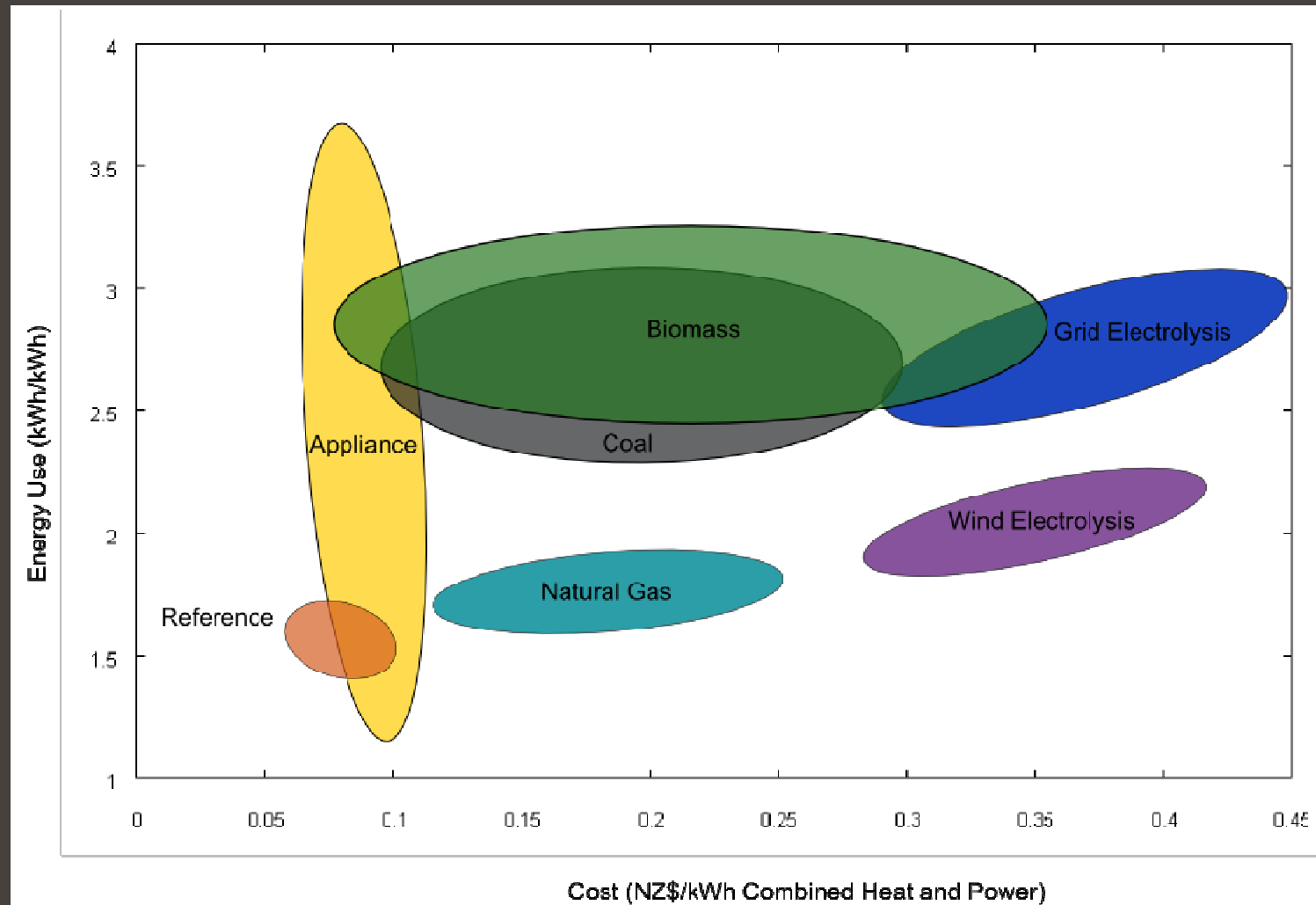


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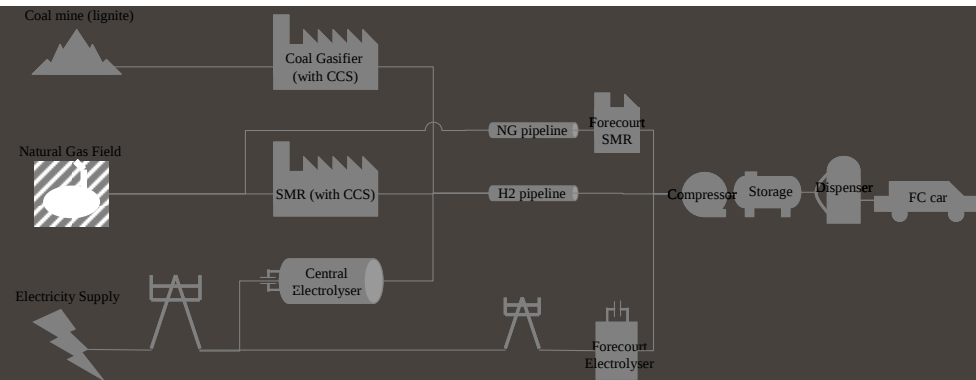
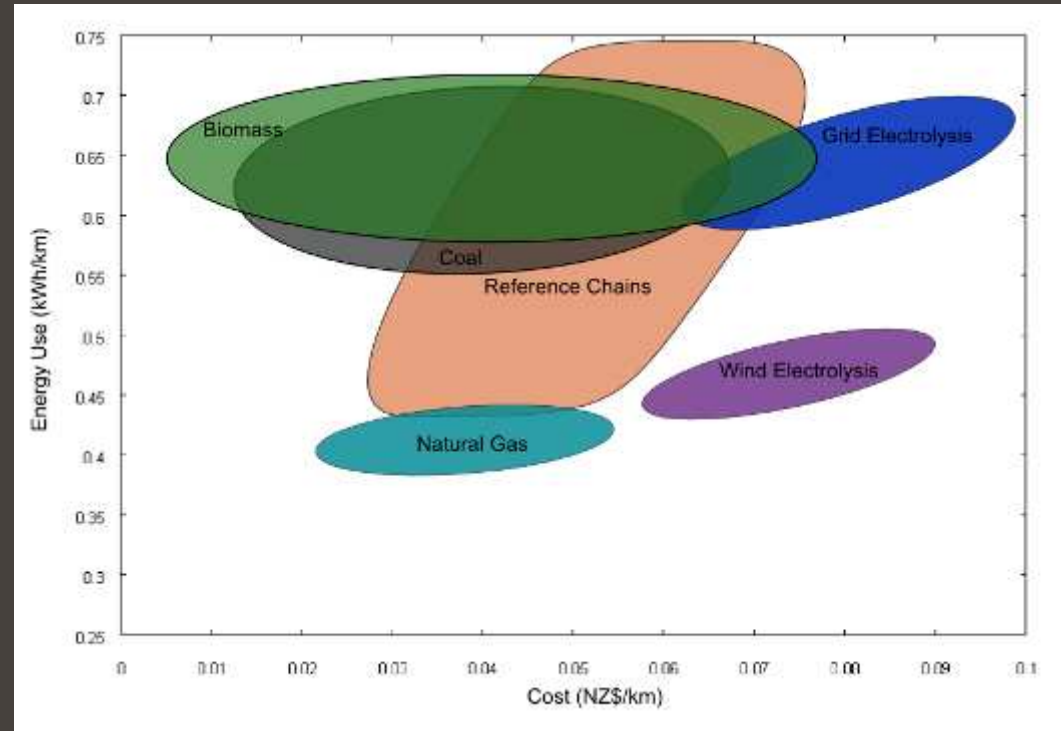
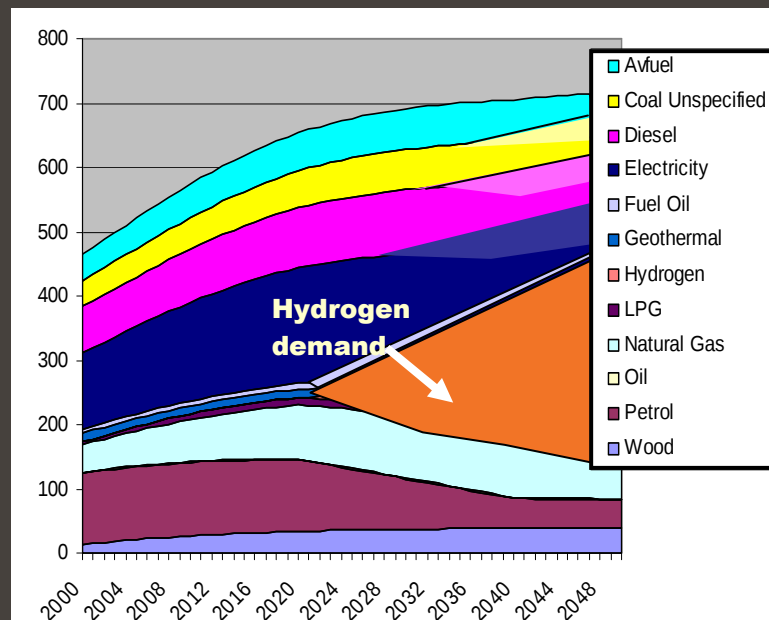
Stationary applications



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Transport applications



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2000

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