New Zealand's EnergyScape

1st Stakeholder Workshop

An Introduction to Energyscape

9 August 2007

Agenda

2000 2005 2030 2050

- **Overview of overall project.**
- **Overviews from individual projects:**
  - **Hydrogen Economy.**
  - **Bioenergy Options.**
  - **Indigenous Energy Options and Energyscape.**
- **Questions and feedback.**

We are developing a high level process to develop strategy …

Have we got it right?

Overall Project Overview – Andrew Campbell

2000 2005 2030 2050

- **Background.**
- **The linked projects**
- **Project stages and timing.**
- **Where to from here.**

Background

2000 2005 2030 2050

- **National Energy Strategy: "… two major long term energy challenges …"**
  - **Responding to climate change …**

    → low carbon energy options.
  - **Delivering secure, clean, affordable, energy while being environmentally responsible.**

… but for New Zealand:

- **What are our indigenous energy options?**
- **How can we best use them?**
- **What will New Zealand's future "energyscape" look like?**
- **Need a high level tool to assess those futures.**

→ To identify the priority research to best prepare us.

Four Linked Projects

2000 2005 2030 2050

- **Hydrogen Economy**
- **Bioenergy Options**
- **Indigenous Resources**
- **(… and now) CCS**

… to a consortium of CRL Energy, IRL, Scion, GNS, NIWA and associates

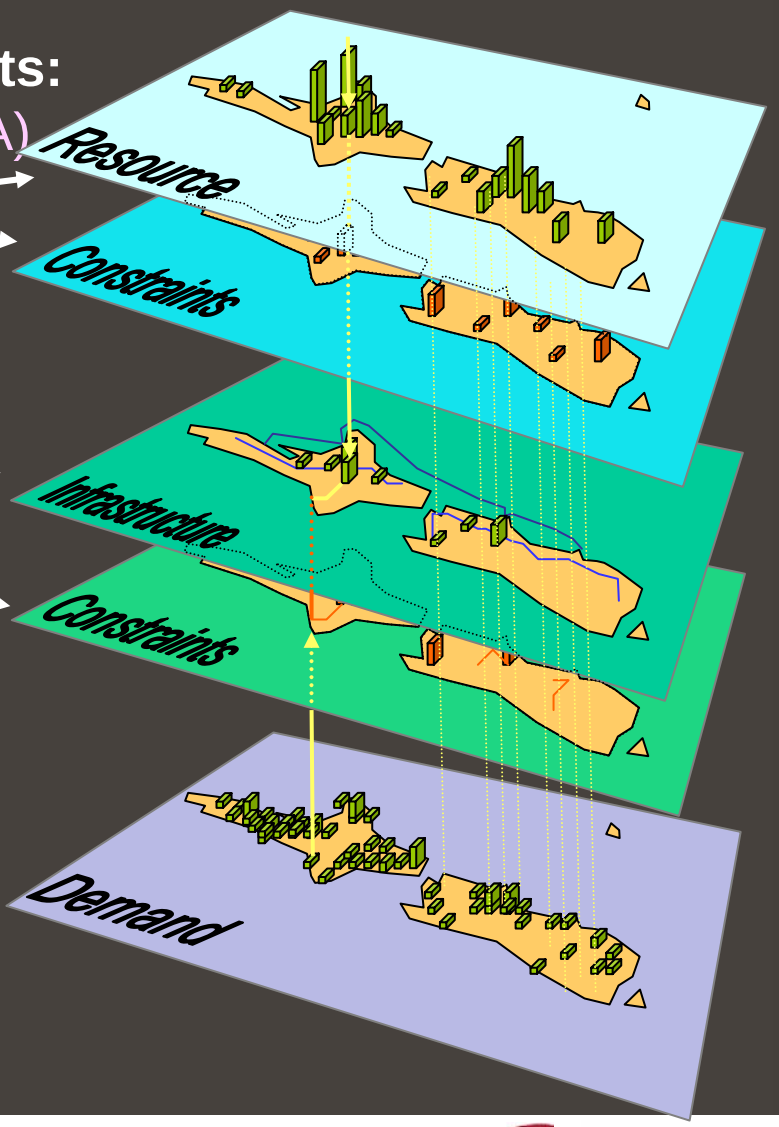
Overall Linked Energyscape Project (lead by NIWA)

2000 2005 2030 2050

Resource maps and related constraints:
- Climate-driven (wind, hydro, etc., NIWA)
- Earth (coal, oil, gas, etc., NIWA)
- Bioenergy (lead by Scion)
- CCS (lead by GNS)
- Constraints

Infrastructure maps:
- Current
- Potential
- Imported energy use
- Hydrogen (lead by CRL)
- Constraints

Demand maps (lead by CRL):
- Current
- Forecast



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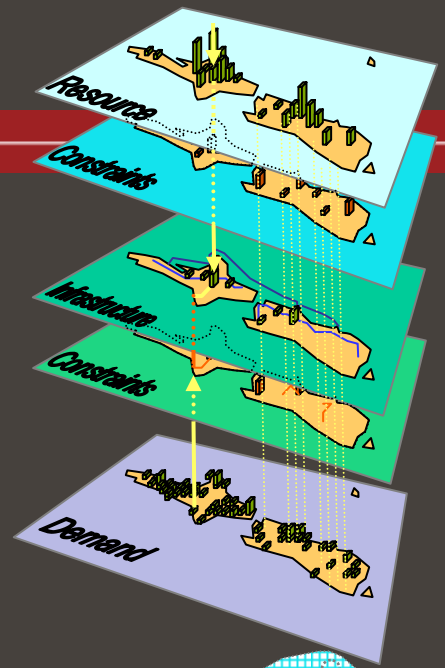
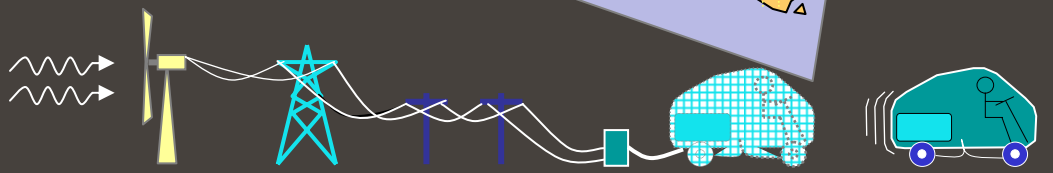
Project Outputs



1. Multiple spatial maps:
- Resource and constraints → gaps
- Infrastructure and constraints
- Demand

2. Single energy pathway calculations:
- Energy
- Economic
- Emissions
- → gaps in knowledge.



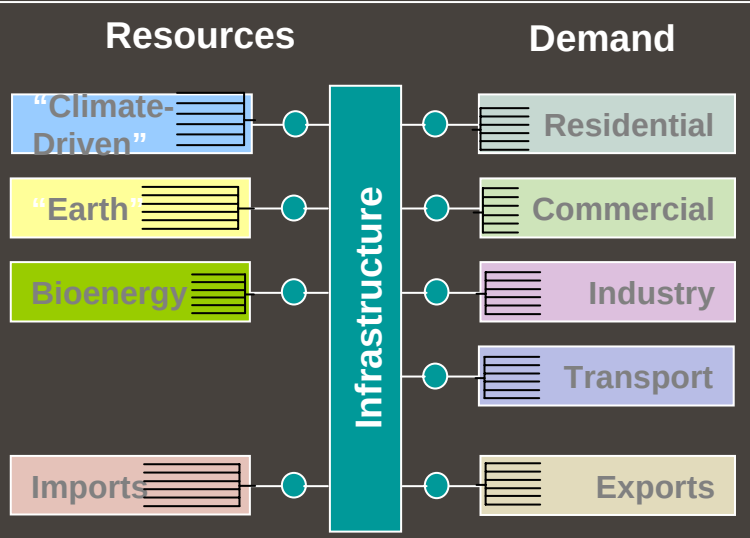
3. Future scenario, multi-pathway analysis:
- Development of analysis framework.

→ identify NZ's possible future EnergyScape

→ further gaps

→ research plan to get us there

4. Stakeholder and public "outreach"



Framework Capabilities

2000 2005 2030 2050

- **Flexible – able to test various energy futures, whatever the drivers:**
  - **energy security?**
  - **climate change?**
  - **… or will there be a new calamity? … water?**
- **Working at a high level – paradigm shifts.**
- **To identify the show-stoppers.**
- **To consider physical attributes, not demand side behaviour change.**
- **Able to be updated.**
- **Accessible.**

Future Scenarios

2000 2005 2030 2050

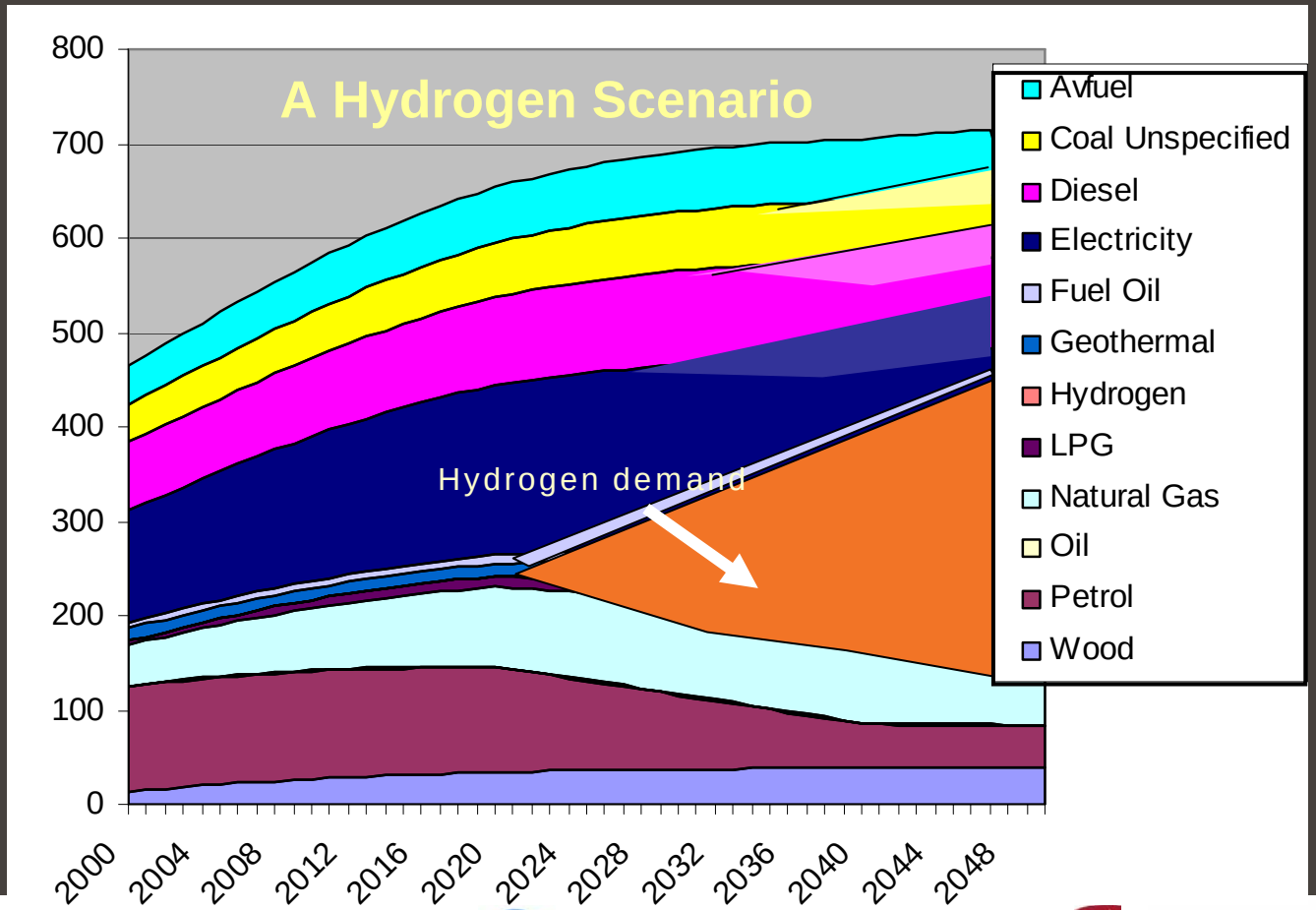
- **Used to test limits …**
  - **What will the drivers be?**
  - **What breaks under these drivers and why?**
- **For example:**
  - **All vehicles biofuelled by 2050.**
  - **100% renewable energy system by 2050.**
  - **All light vehicles fuelled by ethanol by 2030.**
  - **50% light vehicles electric by 2030.**

→ Identify where the risks are.

→ And where the research $$$ would optimally go.

Future Scenarios

2000 2005 2030 2050



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Gaps in Understanding and Research Types

2000 2005 2030 2050

- **“Mainstream” and likely to come from overseas.**
- **New Zealand-specific (e.g., climate, land use-related, etc.).**
- **Mainstream but a business case for New Zealand research.**
- **A range of research providers including: industry; CRIs/CRL; and universities.**

Process Validation

2000 2005 2030 2050

- **“Steering” Committee**
  - **Leaders in industry and government.**
- **“Government Group”**
  - **MED, MoT/MfE, EECA and linkages to “whole of government”.**
- **Stakeholders**
  - **Today’s introduction.**
  - **Two ½-day workshops – Nov ’07 and March ’08.**
  - **Specific meetings/requests for information/input.**
- **Other**
  - **Conferences and seminars.**

Timetable ...

2000 2005 2030 2050

Stage 1: Provision of Situation Analysis
- Resources and issues maps.
- Infrastructure and issues maps
- First pathway assessments

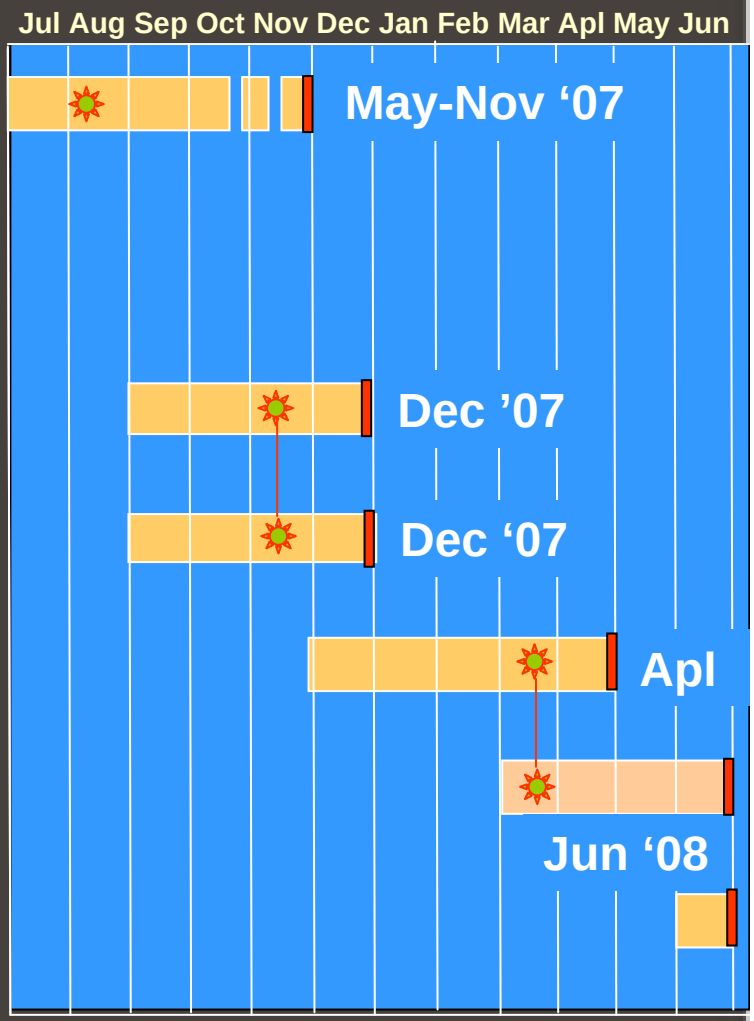
Stage 2: Selection of Favoured Pathways

Stage 2-3: Theme/Scenario Development

Stage 3: Theme/Scenario Analysis

Stage 4: Gap Analysis

Final Report



Have we got it right?

2000 2005 2030 2050

We are developing a high level process to develop strategy ... including for the identification of energy research priorities for New Zealand:

- **Have we got the methodology right? …**
- **Have we got the scope right?**
- **What do you see as the priority outputs?**
- **Have we got the level of stakeholder engagement right?**
- **What changes would you suggest?**

Short Questions?

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1st Stakeholder Workshop

Hydrogen Economy

Tony Clemens (CRL Energy)

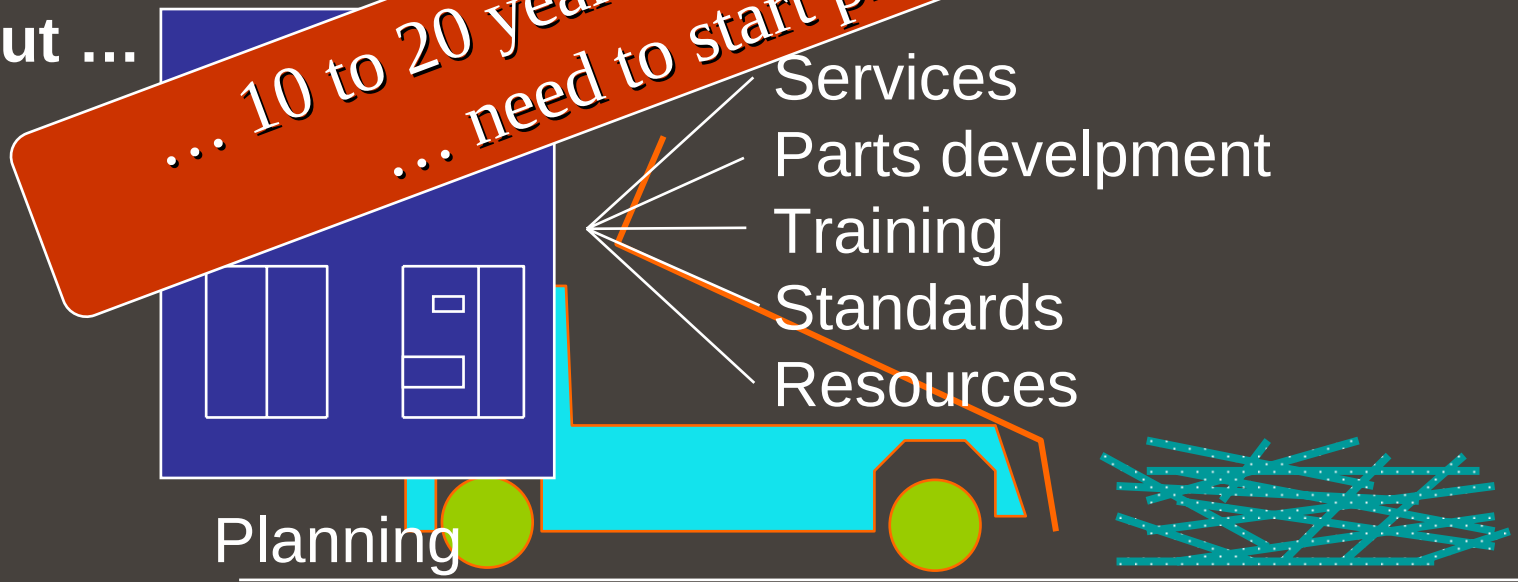
9 August 2007

Why Think About Hydrogen Now?

2000 2005 2030 2050

- **What will tomorrow's targets be?**
  - **Low carbon?**
  - **Energy security?**
  - **Efficient energy chains?**
  - **Affordable?**
- **Hydrogen has the p… …these in the future.**
- **But …**

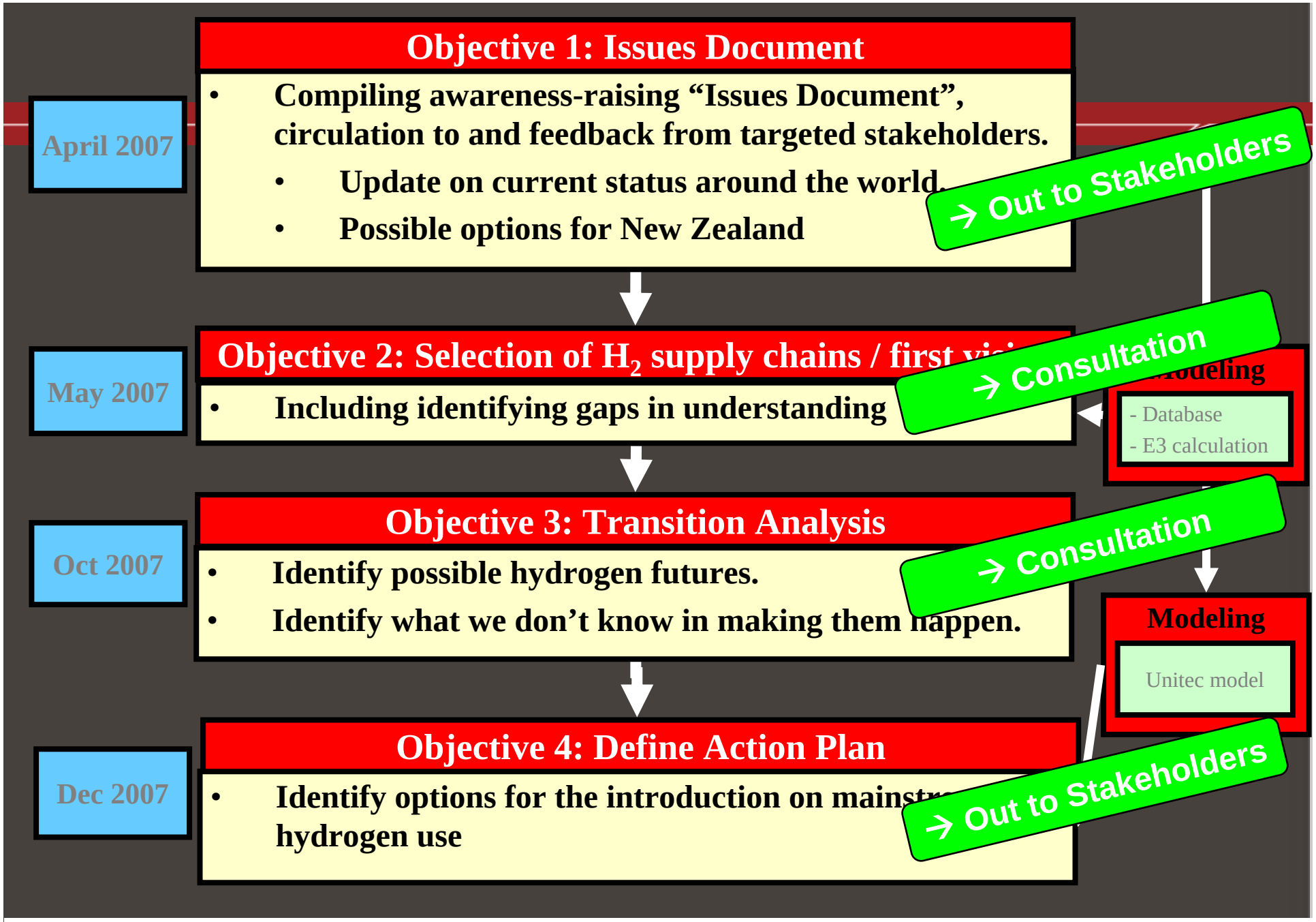
… 10 to 20 years from planning to building
… need to start planning now.



Other Advantages ...

2000 2005 2030 2050

- **Extremely flexible**
  - **Can be sourced from a wide range of energy resources.**
  - **Can be stored easily anywhere along the "energy chain" → flexibility beyond our current mindset.**


Objective 1: Issues Document
• Compiling awareness-raising "Issues Document", circulation to and feedback from targeted stakeholders.
• Update on current status around the world.
• Possible options for New Zealand
April 2007
→ Out to Stakeholders
Objective 2: Selection of H_2 supply chains / first vi
• Including identifying gaps in understanding
May 2007
→ Consultation
odeling
- Database
- E3 calculation
Objective 3: Transition Analysis
• Identify possible hydrogen futures.
• Identify what we don't know in making them happen.
Oct 2007
→ Consultation
Modeling
Unitec model
Objective 4: Define Action Plan
• Identify options for the introduction on mainst
hydrogen use
Dec 2007
→ Out to Stakeholders

Robust process ...

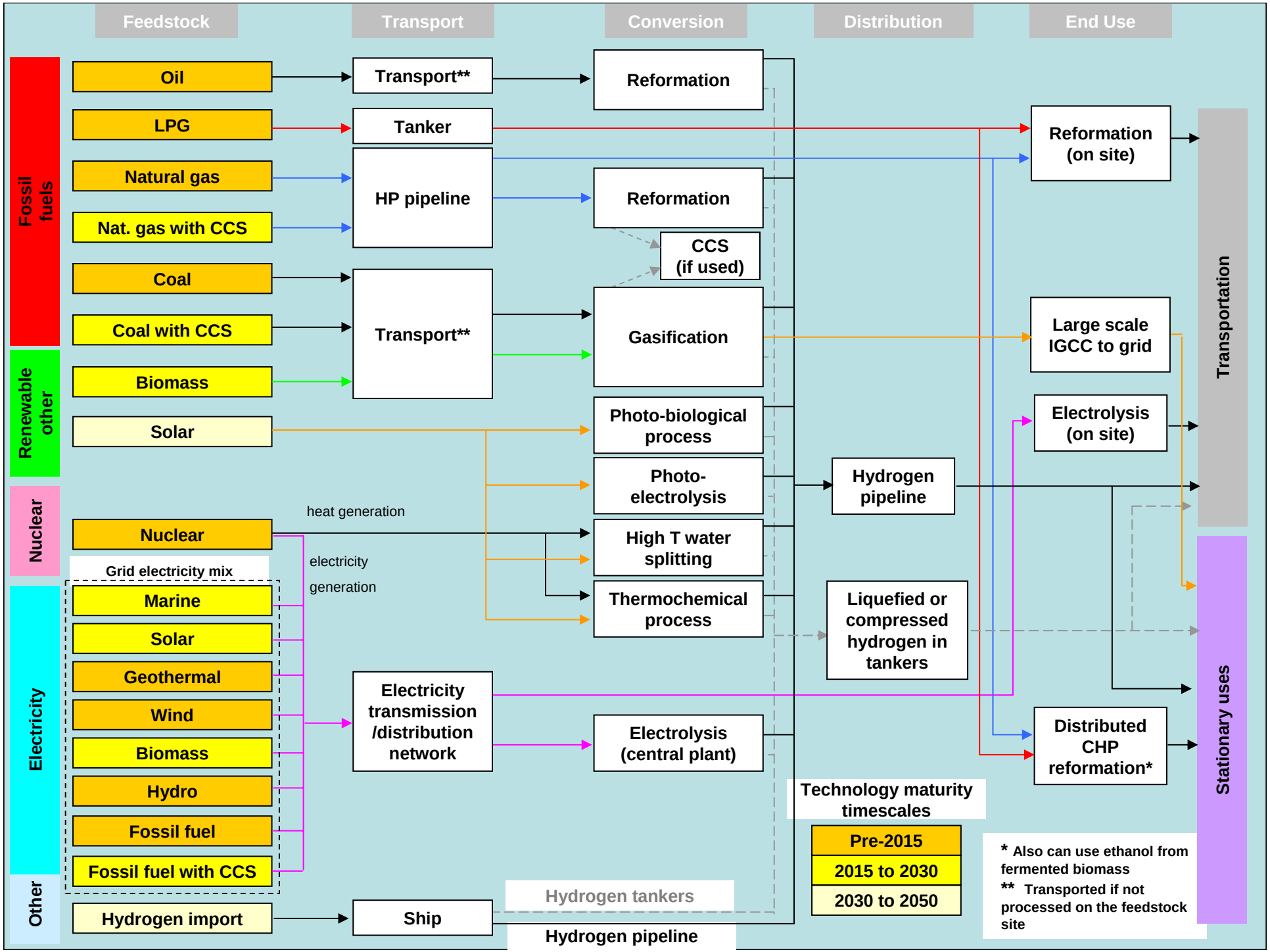
2000 2005 2030 2050

- **Based on EU "HyWays" process:**
  - **Process used in the EU for 300 million people, 12 countries.**
  - **Customised for New Zealand situation.**

Current Status

2000 2005 2030 2050

- **“Issues Document” providing background on energy pathways has been produced and issued.**
- **Considered:**
  - **Feedstocks:** natural gas; coal; biomass; wind; “grid”; LPG; and ethanol.
  - **Conversion processes:** reformation; gasification; electrolysis; integrated gasification combined cycle; and fuel cell CHP.
  - **Distribution:** pipeline; compressed; and liquid tanker.
  - **End use:** Fuel cell vehicle; ICE vehicle; small scale fuel cell CHP; distributed generation fuel cell; and steam turbine.
  - **Worldwide hydrogen research.**


Feedstock
Transport
Conversion
Distribution
End Use
Fossil fuels
Renewable other
Nuclear
Electricity
Other
Oil
LPG
Natural gas
Nat. gas with CCS
Coal
Coal with CCS
Biomass
Solar
Nuclear
Grid electricity mix
Marine
Solar
Geothermal
Wind
Biomass
Hydro
Fossil fuel
Fossil fuel with CCS
Hydrogen import
Transport**
Tanker
HP pipeline
Transport**
Ship
heat generation
electricity generation
Electricity transmission /distribution network
Reformation
Reformation
CCS (if used)
Gasification
Photo-biological process
Photo-electrolysis
High T water splitting
Thermochemical process
Electrolysis (central plant)
Hydrogen tankers
Hydrogen pipeline
Hydrogen pipeline
Liquefied or compressed hydrogen in tankers
Technology maturity timescales
Pre-2015
2015 to 2030
2030 to 2050
Reformation (on site)
Large scale IGCC to grid
Electrolysis (on site)
Distributed CHP reformation*
Transportation
Stationary uses
* Also can use ethanol from fermented biomass
** Transported if not processed on the feedstock site

Big Issues Identified

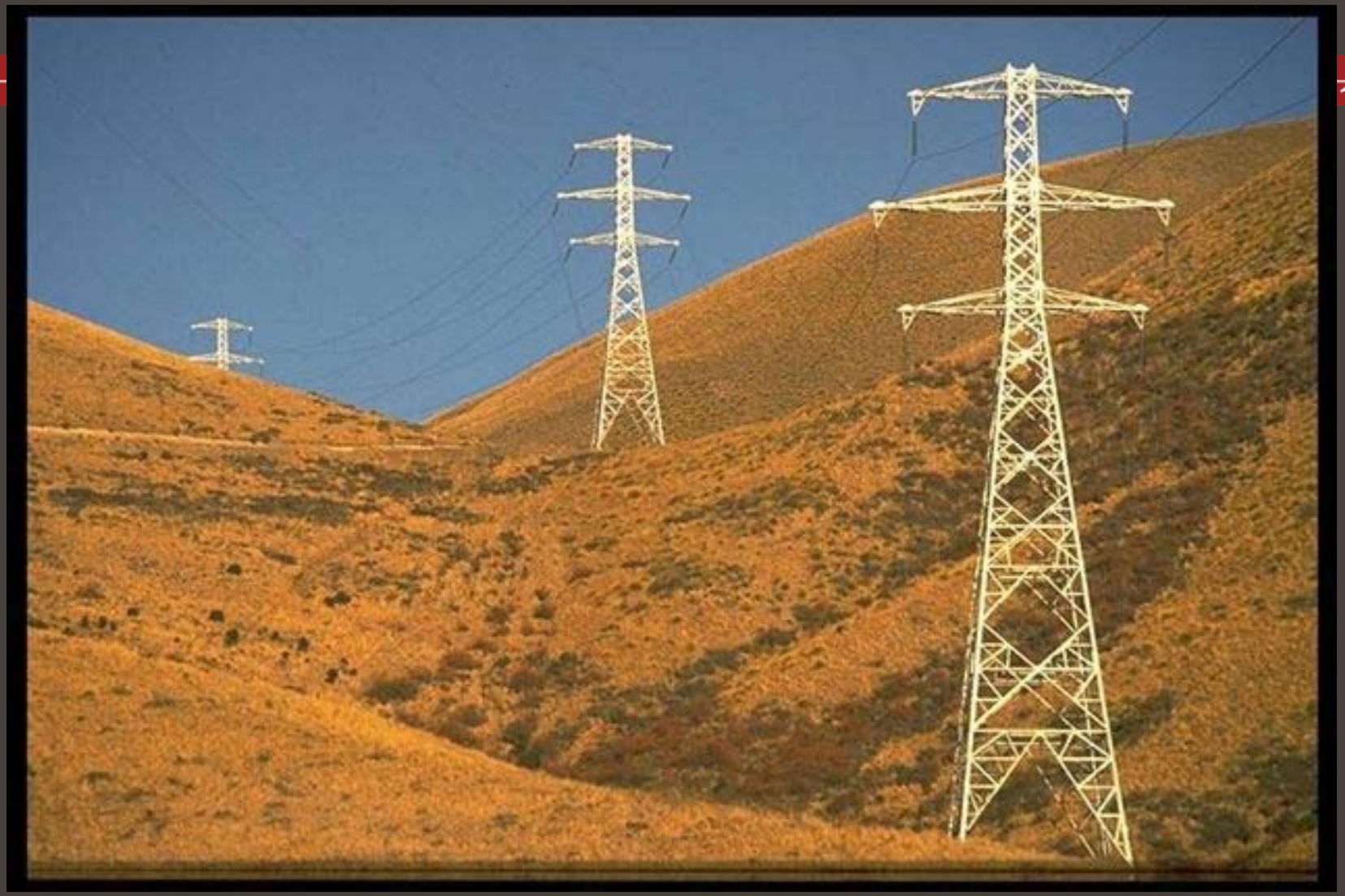
2000 2005 2030 2050

- **Hydrogen Production**
- **Hydrogen Storage**
- **Hydrogen Delivery**
- **Hydrogen Utilisation**
- **Education and Public Outreach**
- **Regulations and Codes**
- **Cross Cutting**
  - **Stranded Assets**
  - **Competing technolgies**
  - **Competition for resources**

Where to from here …

2000 2005 2030 2050

- **Energy, Economics and Emissions modelling of preferred chains to identify best options.**
- **Integrated modelling and scenario analysis.**
- **→ Identifying the gaps in knowledge.**
- **Integrate with overall Energyscape framework.**



Short Questions?

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1st Stakeholder Workshop

Bioenergy Options

John Gifford (Scion)

9 August 2007

FRST RFP / Contract

2000 2005 2030 2050

- **Stationary and transport uses of Bioenergy and Biomass**
- **Include fuel life-cycle analysis with costings and risks**
- **Maps of potential and existing land use**
- **Identify the international research and possible NZ links**

Overview of Programme

Stage	1. Situation Analysis	2. Integration	3. Options Assessment	4. Amalgamation
	▪ Resource assessment ▪ Review Conversion technologies ▪ Define Energy products • National and International Peer Review • Costings of options • Maps of areas available for energy crop / feedstock production • International activities • Initial Energy Pathway options	▪ Decision support framework: LEAP-EERA ▪ Critical interdependencies ▪ Integration of demand (Renewables and non-renewables) ▪ Development of bioenergy scenarios ▪ Link to key end-user strategies ▪ End-user/stakeholder critique + analysis ▪ Decision support framework ▪ NZ priorities	▪ Options criteria to employ? ▪ Critical market and project uncertainties ▪ Potential options for bioenergy systems ▪ Potential for bioenergy for New Zealand ▪ Barriers to uptake / uncertainties ▪ Critical international leverage	▪ Opportunities and uncertainties for bioenergy deployment in New Zealand ▪ Framework to review options ▪ Impact of investment spend on creating bioenergy options ▪ Mechanism to incorporate ▪ International learnings
Timing	Sept. 07 44%	March 08 30%	April. 08 26%	June 08

Collaborators

2000 2005 2030 2050

CRL	**- Combustion and Gasification**
NIWA	**- Algae**
Landcare	**- Agricultural crop & residues, Land Use**
Crop & Food	**- Horticultural crop & residues**
Waste Solutions	**- Effluents, Anaerobic Digestion**
Process Developments	**- Plant costs, case study**

Scion – Forests, Residues, SRF, Pyrolysis, Enzyme – Ethanol, Municipal wood waste, wood processing waste, Land use, Resource maps, Project management

International Programmes; IEA – 21 countries, $ millions of R&D, NZ in two tasks (of 13) and on Executive Committee

BIOENERGY What is it ?

2000 2005 2030 2050

Organic, Variable, Purpose Grown or Residual, Low energy density, Renewable

Supply Chain










Grow **Extract** **Transport** **Convert** **Distribute** **End use**

Reuse

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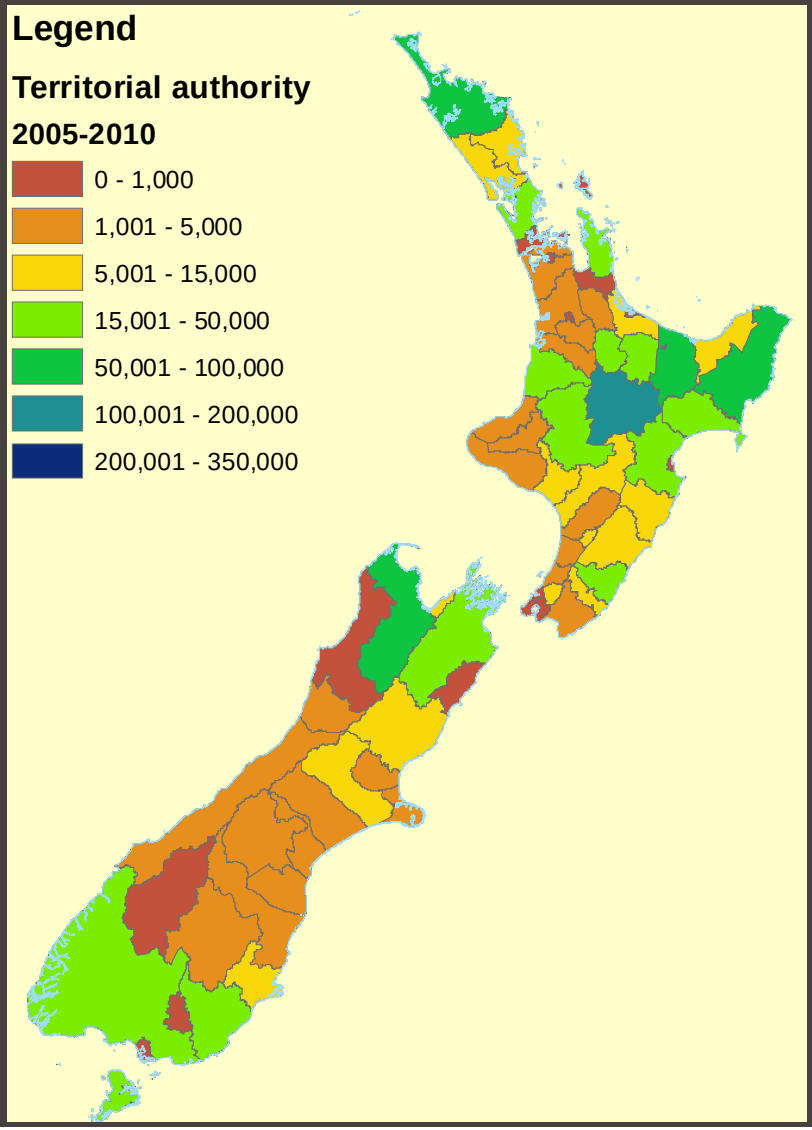
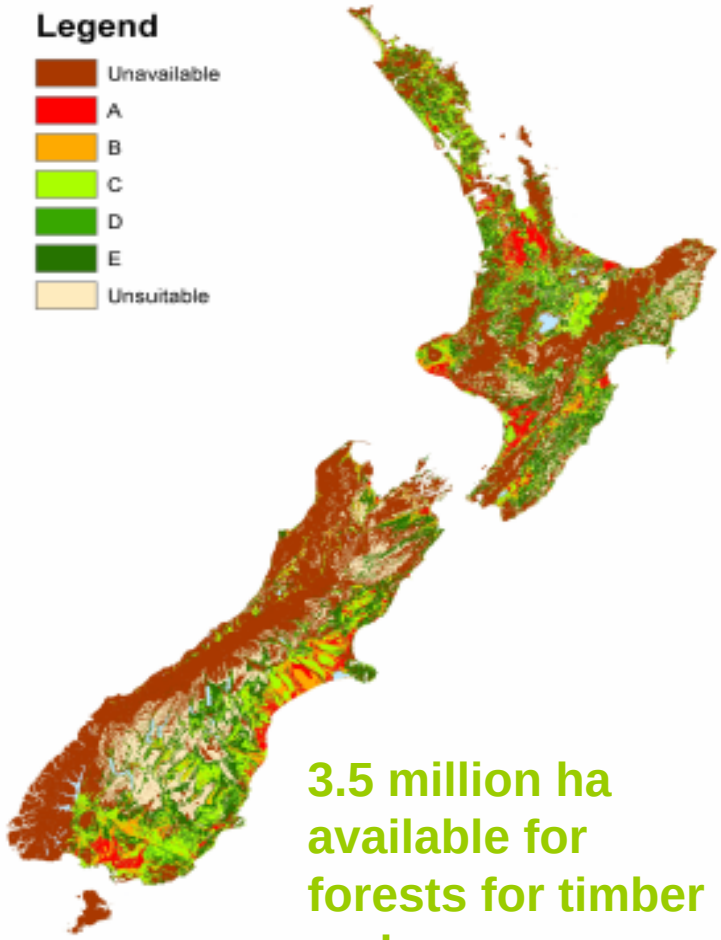
Forestry Residues by Territorial Authority

2000 2005 2030 2050



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

2000 2005 2030 2050

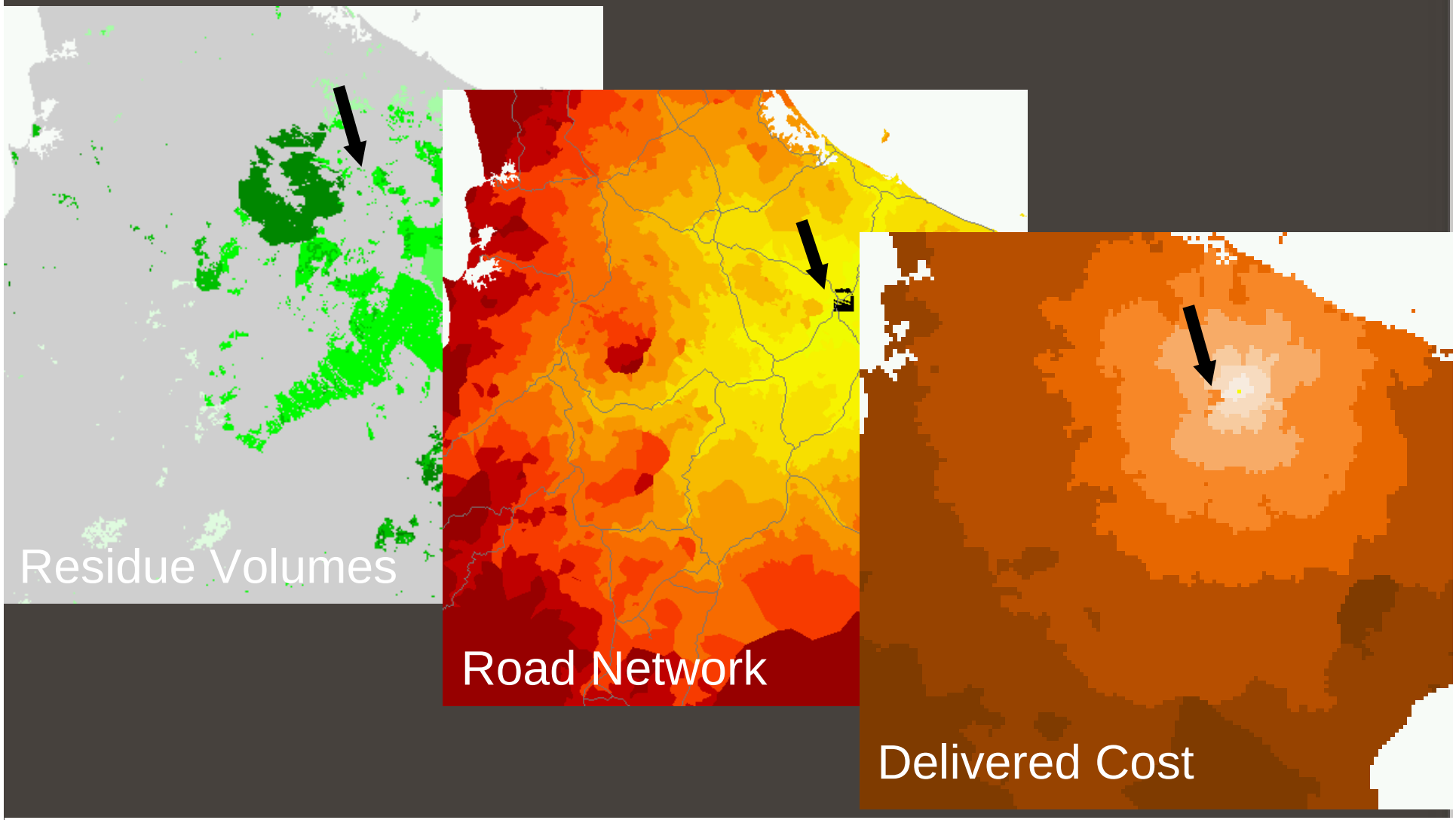


3.5 million ha available for forests for timber and energy

Category	LUC class	Total area (ha)	Description
A	I, II	1,336,900	Highly Suitable for cropping or pasture.
B	IIIs, 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)

GIS Model

2000 2005 2030 2050



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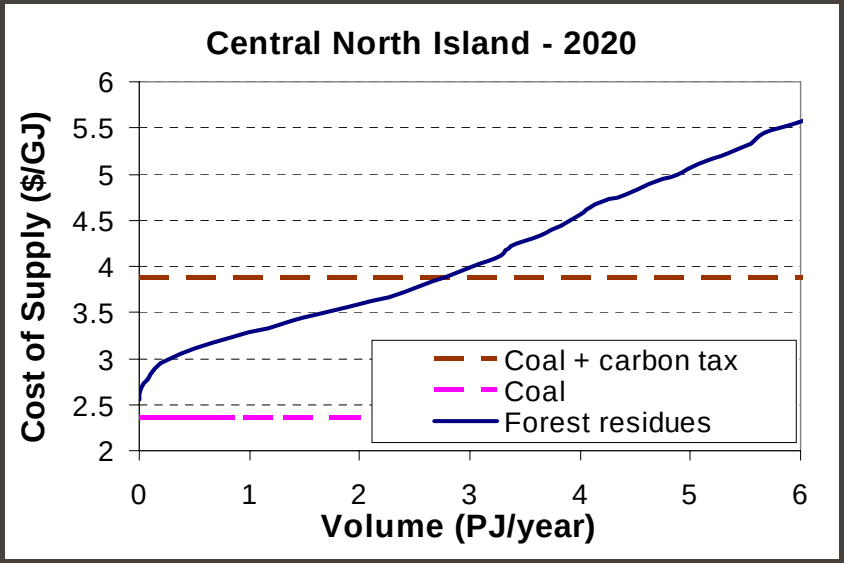
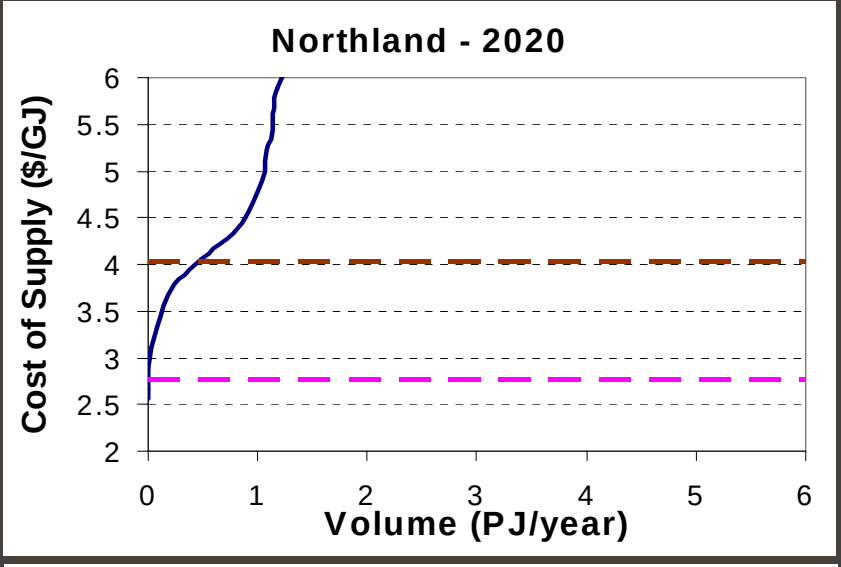
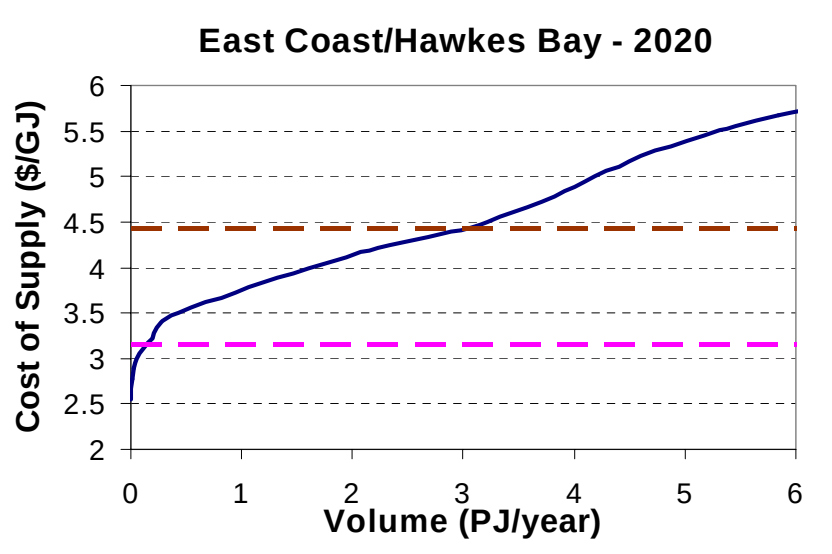
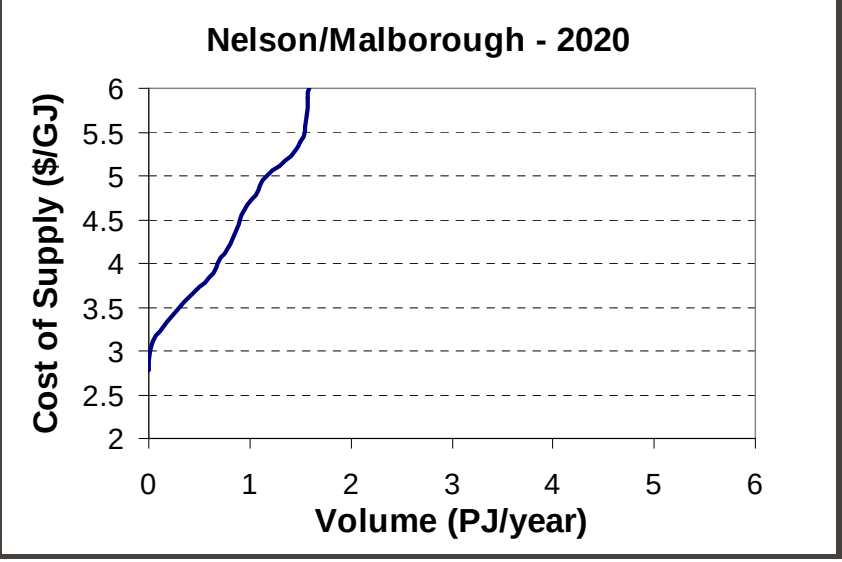
Regional Comparison - GIS Model

2000 2005 2030 2050









Conclusions

2000 2005 2030 2050

- Complex
- Huge Potential – for energy and environmental outcomes
- No silver bullet technology
- Co-products and by-products will be important to economic success

Further Questions?

New Zealand's EnergyScape

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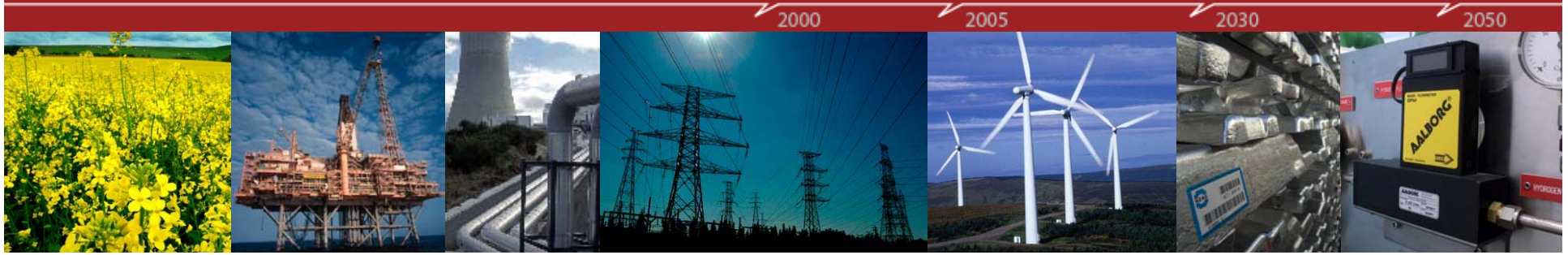
Indigenous Resources and Energyscape

Rilke de Vos (NIWA)

9 August 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

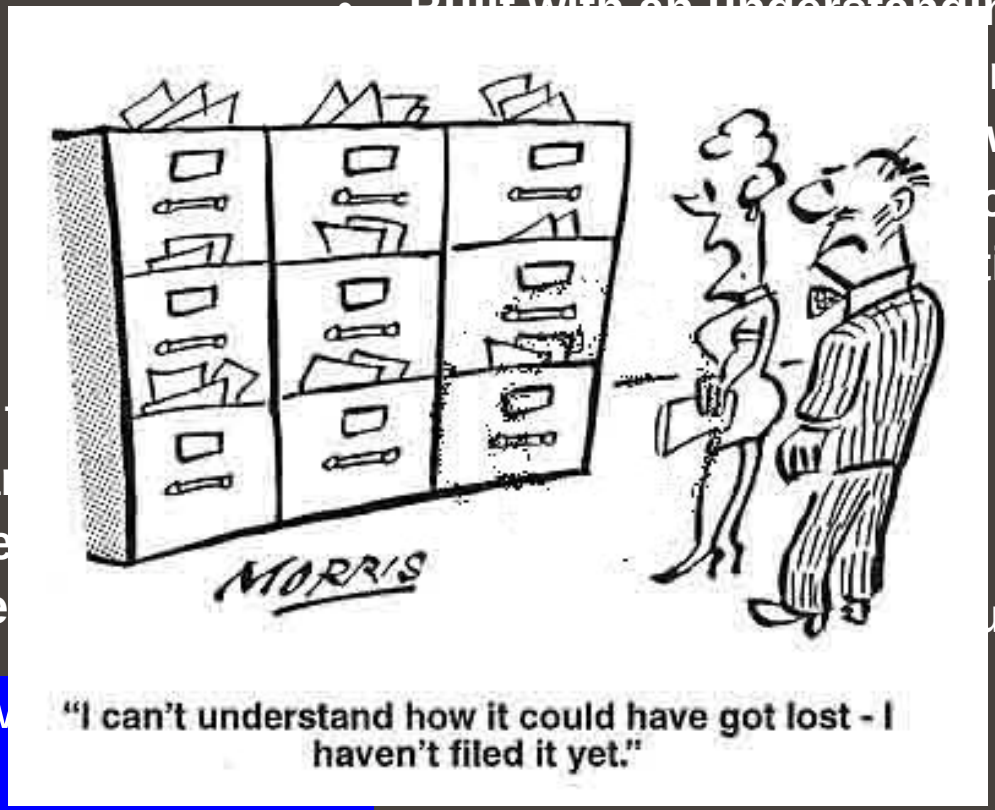
Solution?

2000 2005 2030 2050

Common / shared filing system…

- Built with an understanding of end-use
  - ng
  - w
  - ost, GHG, risk
  - tions
- Accessible & t
  - Self explan
  - Modifiable
  - Transpare
    - uncertainty

LEAP software w
databases



"I can't understand how it could have got lost - I haven't filed it yet."

- Infrastructure limitation

EnergyScape framework

2000 2005 2030 2050

- **Imports**
- **Exports**

Resources

- **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

- **Mobility**
  - **Aviation**
  - **Shipping / rail**
  - **Heavy trans.**
  - **Passenger**
- **High grade heat**
  - **Cooking**
  - **Distillation**

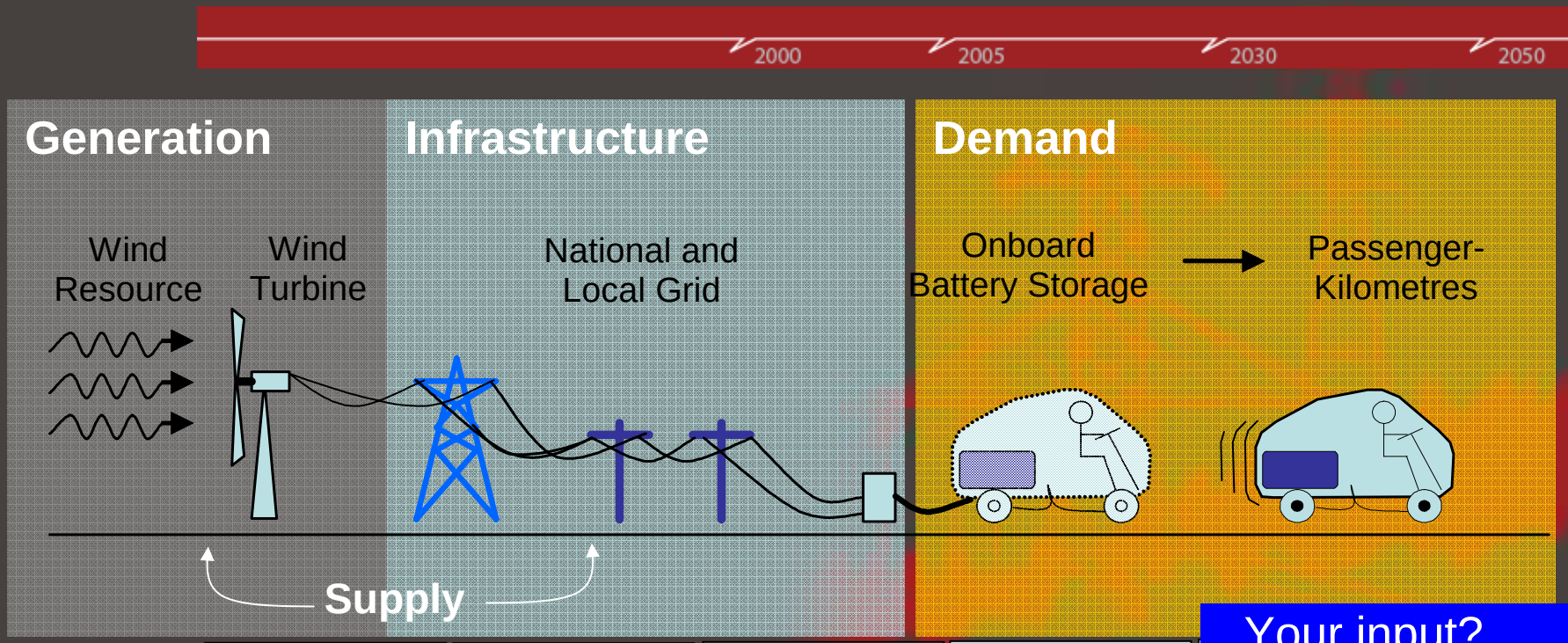
Low grade heat

- **Space heating**
- **Water heating**

- **Electricity**
  - **Appliances**

- **Behavior**
- **Efficiency**

Pathways ...



Your input?

Fertiliser	Wood pellets	Comb Heat Power	Algae liquids	Electric rail	
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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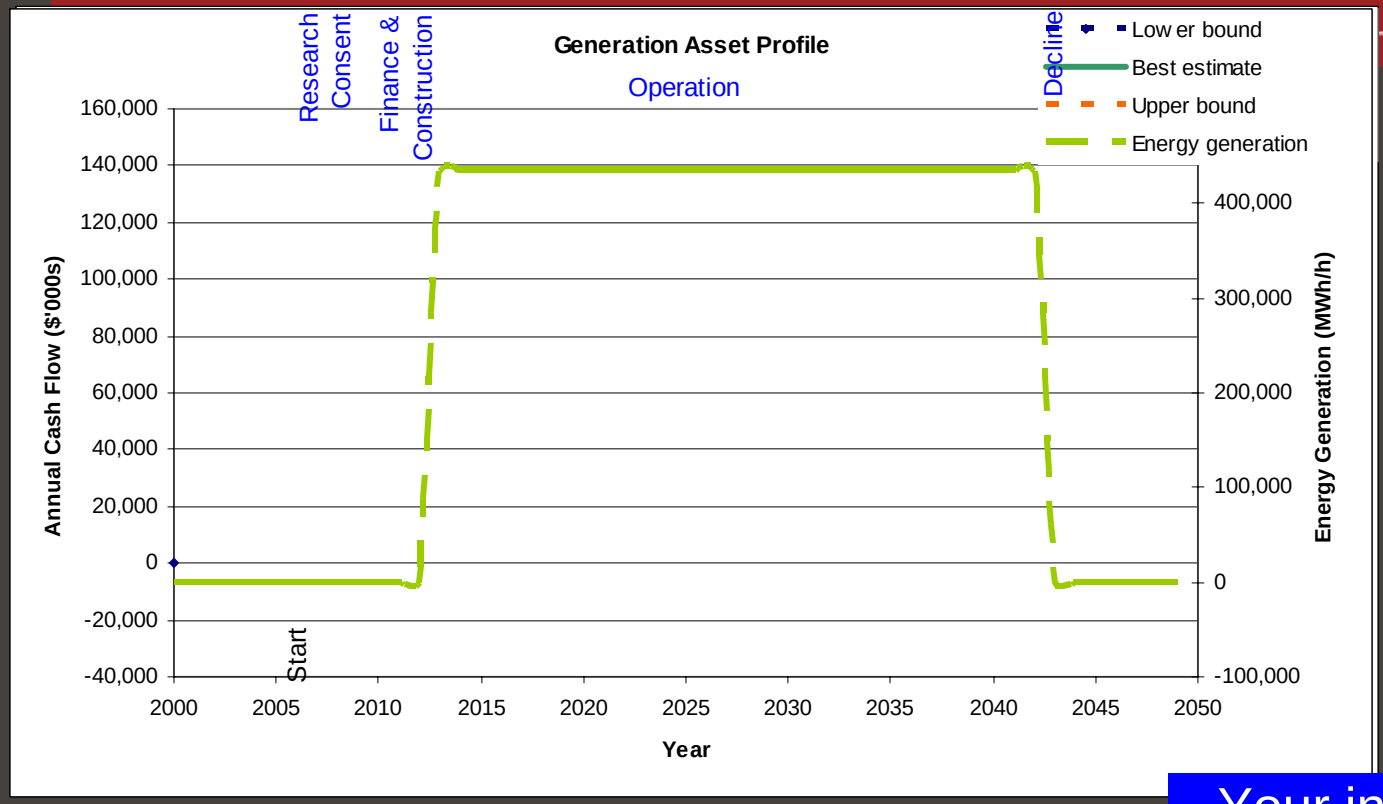
Resource & infrastructure data

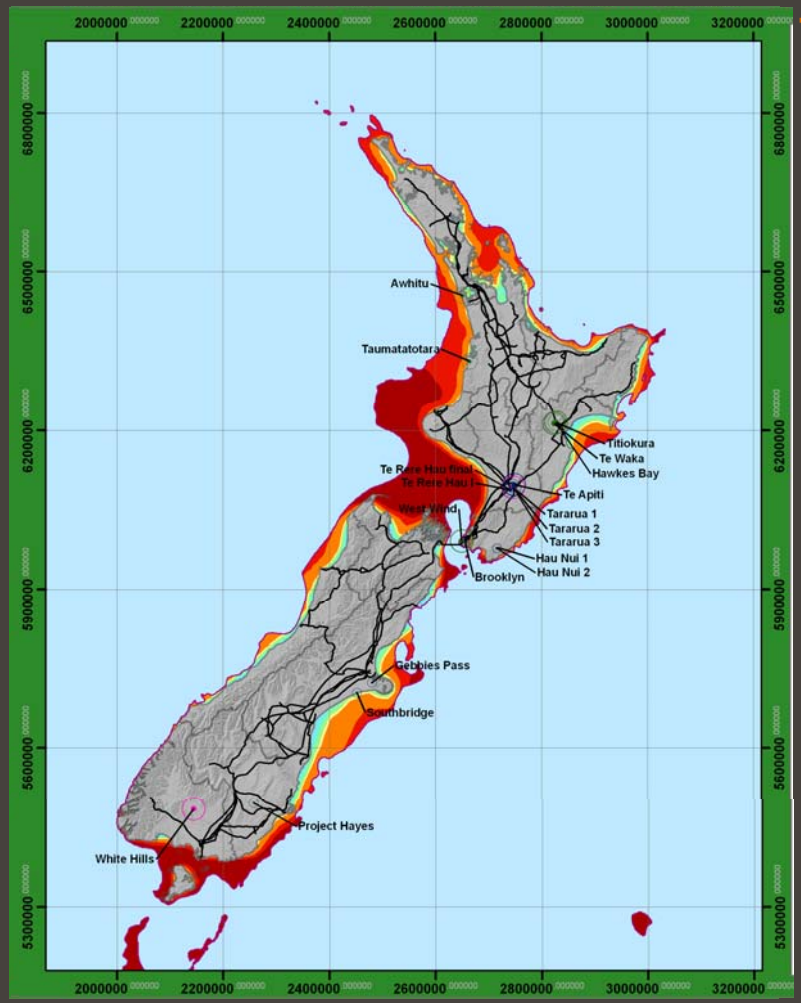


Your input?

- **Asset parameters**
  - Start / commission date
  - Project & research delay
  - Longevity
  - Capacity – Firm; Peak
  - Efficiency
  - Geo –location
- **Detail per phase**
  - Duration
  - Cost (capital / operating)
  - Risk (0-5 stars)
  - GHG
  - Water demand

Example - wind resource

2000 2005 2030 2050



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
  - Urban areas / local opposition
  - DOC / Maori lands
  - Slope & elevation

Populate the database with good data!!

Wind resource

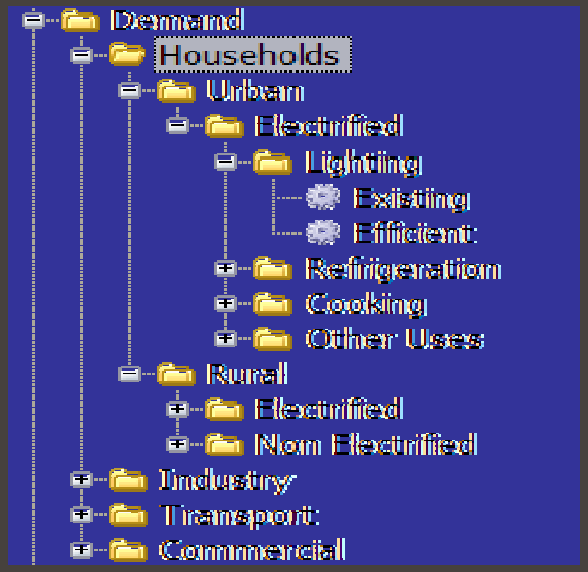
2000 2005 2030 2050

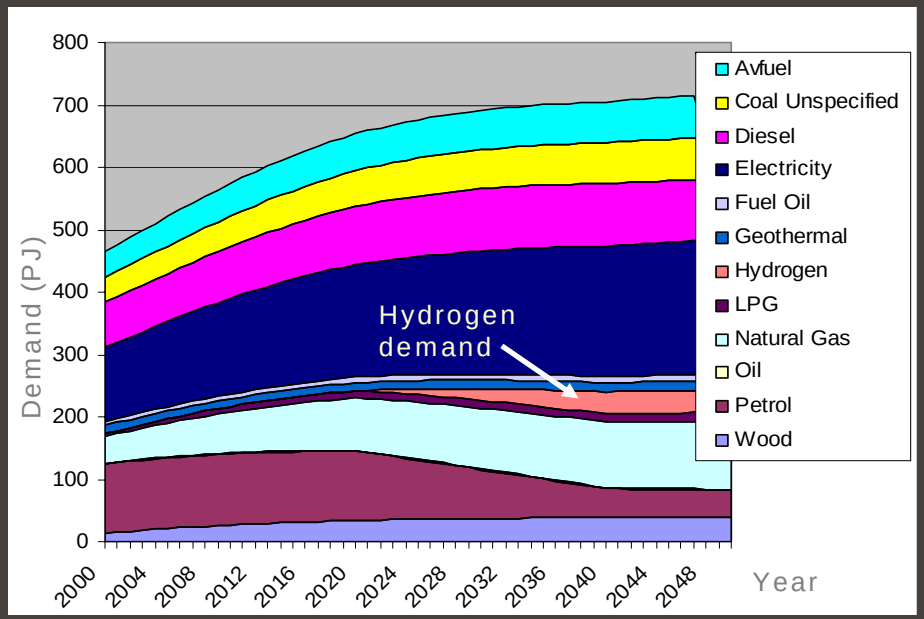
- **Delays**
  - **1 year research**
  - **1 year consent**
  - **2 year finance & construction**
- **Risk**
  - **2 star consent**
  - **0 stars in all other phases**
- **Longevity**
  - **20 - 30 years**
- **Cost**
  - **Typically €1.18±0.35 million/MW**
- **GHG**
  - **Minimal GHG emissions except land clearance & emergy**

Example - LEAP demand

2000 2005 2030 2050

Households (8 million)
- Urban (30%)
  - Electrified (100%)
    - Lighting (100%)
      - Existing (80%, 400 kWh/yr)
      - Efficient (20%, 300kWh/yr)
    - Refrigeration (80%) ← Electricity
    - Cooking (100%) ← High grade heat
    - Other (50%) ← Low grade heat
- Rural (70%)
  - Electrified (20%)
  - Non-Electrified (80%)



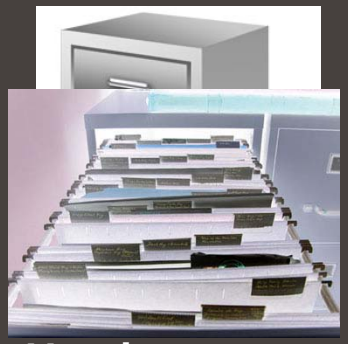


Forecasting ...

2000 2005 2030 2050

Resources

- Commodity prices
- NZ dollar

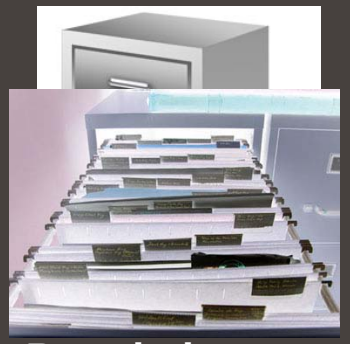


- Uptake rates
  - SHW / PV
  - Elect. Vech.
  - Industrial CHP
- Larger assets
  - Cost
  - GHG impact
  - Env. impact
  - Regulatory signals

Infrastructure

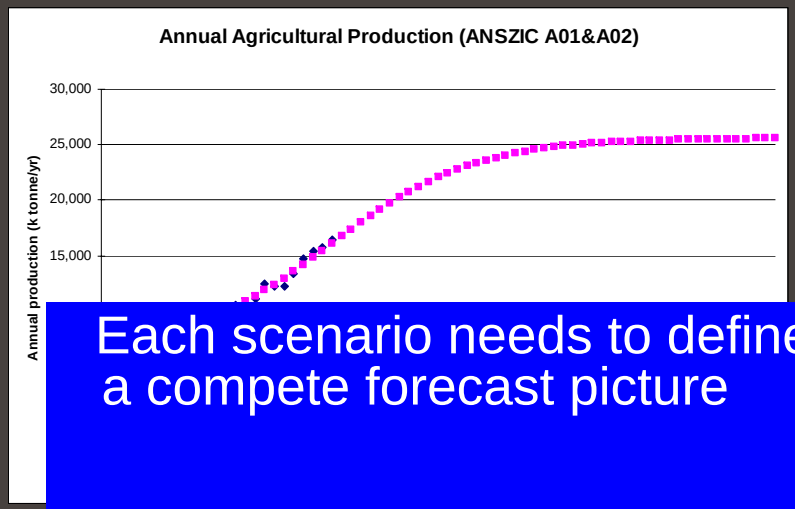
- Demand following
- Planning
- Absolutes eg. Glenbrooke Steel

Demand



- Population proxies
- Commercial proxies & logistic growth

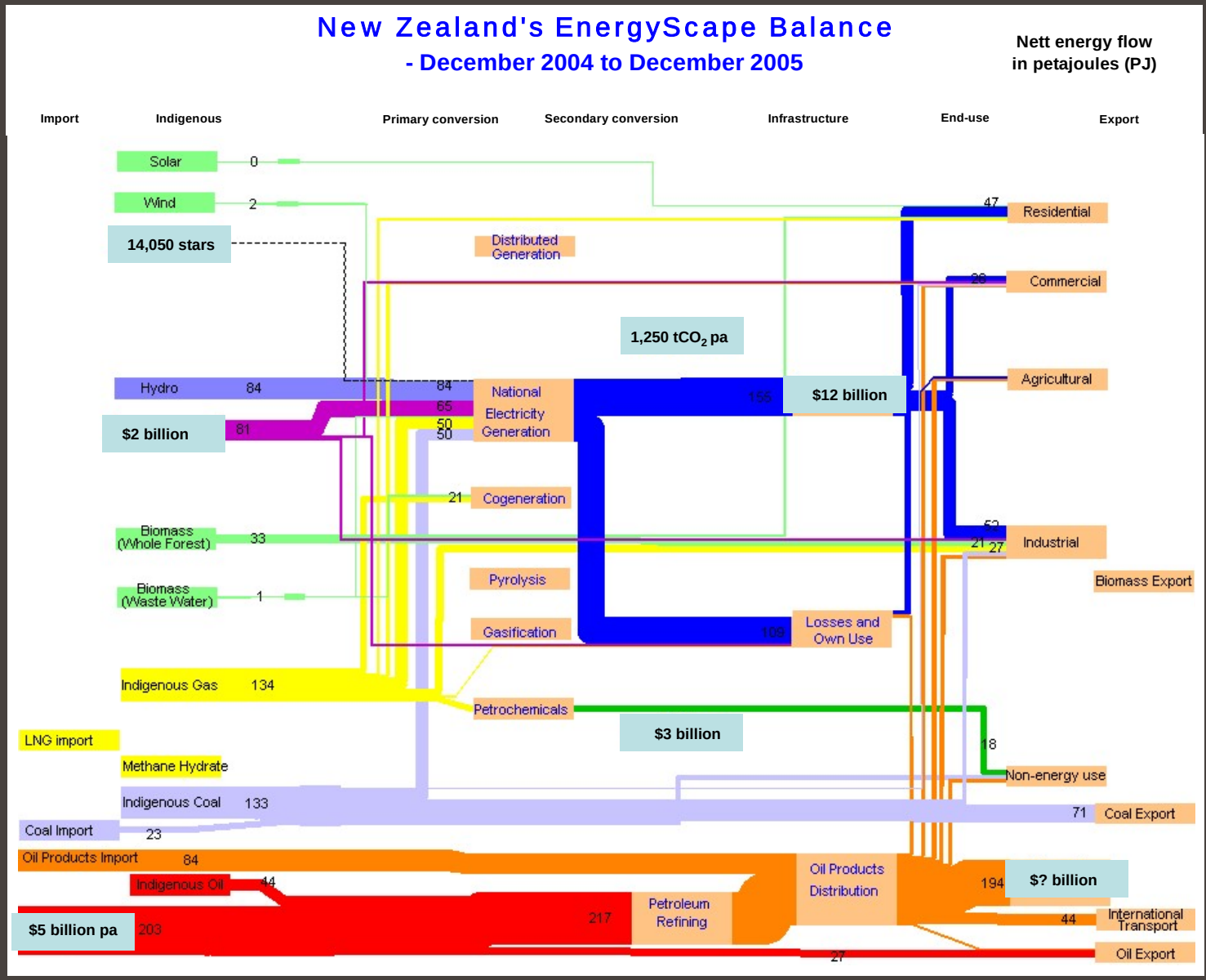
- Population
- GDP
- Behavior
- Efficiency



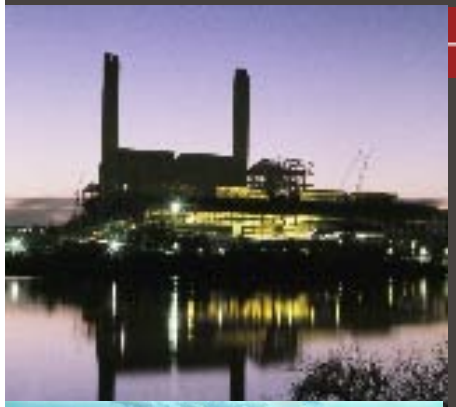
Each scenario needs to define a compete forecast picture

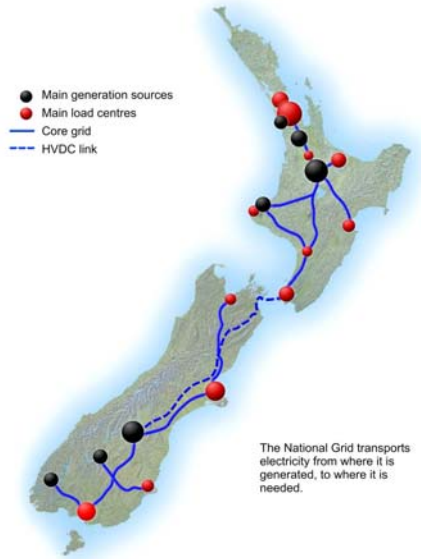
Sankey outputs

2000 2005 2030 2050



Bringing it all together





2000 2005 2030 2050

- **Bridging a need**
  - Framework for common communication
  - Identifying complete set of pathways
  - Progressive data input / scenario runs
  - Tools to review potential impact of policy
  - Identifying variability / uncertainty
  - Myth busting
- **Improving energy information**
  - Not just awareness
  - Order of magnitude
  - Relationships with GHG, water
  - Climate change surveys (Nielson & BBC)
- **Regionalising for councils & Maori**
- **Energy community can play a role in development**

Short Questions?

2000 2005 2030 2050

Panel questions?

Have we got it right?

2000 2005 2030 2050

A high level process to develop strategy …

1. **Have we got the methodology right?**
2. **Have we got the scope right?**
3. **What do you see as the priority outputs?**
4. **Have we got the level of stakeholder engagement right?**
5. **What changes would you suggest?**

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New Zealand's EnergyScape

2000 2005 2030 2050

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