



# New Zealand's EnergyScape

## EnergyScape

Rilke de Vos – NIWA

16<sup>th</sup> July 2008



# The future

## What will it look like?

- ✓ Technology
- ✓ Behaviour
- ✓ Paradigm shift
- ✓ Resources

## How might it shape us?

2000



2050



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# The future

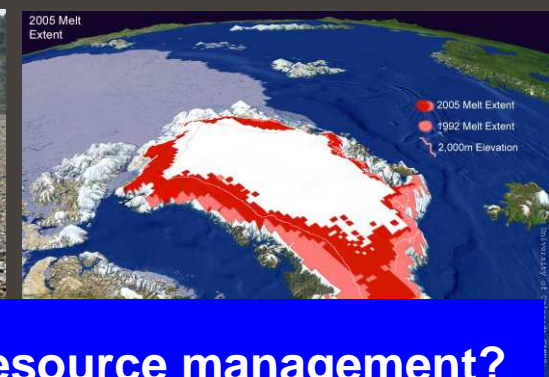
2000 2005 2030 2050

## What will it look like?

- ✓ Technologies
- ✓ Behaviour
- ✓ Paradigm shift
- ✓ Resources

## How might it shape us?

- ✓ Resource depletion
- ✓ Environmental change
- ✓ Social change



Era of resource management?

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# The future cont.

2000 2005 2030 2050

## How should we shape it?

- ✓ National objectives
- ✓ Consensus of opinion
- ✓ Trade objectives

## Alternatives to government vision?

- ✓ Carbon neutral
- ✓ Renewable electricity
- ✓ Energy efficiency
- ✓ Electric vehicles



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# Outline

2000

2005

2030

2050

Future vision  
Shaping us  
Shape the future  
Alternative visions  
Conclusions



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# Framing thoughts

2000 2005 2030 2050



- ✓ **2030 & 2050 is the far horizon!**  
Plenty of scope for radical change
- ✓ **Framework must facilitate DSM**  
Behavior change  
Energy inequality / poverty  
Use of personal equity
- ✓ **Physical / thermodynamic reason for cost differences**  
Price has cost & scarcity value!
- ✓ **Limited recognition of resource depletion**  
Stimulate exploration

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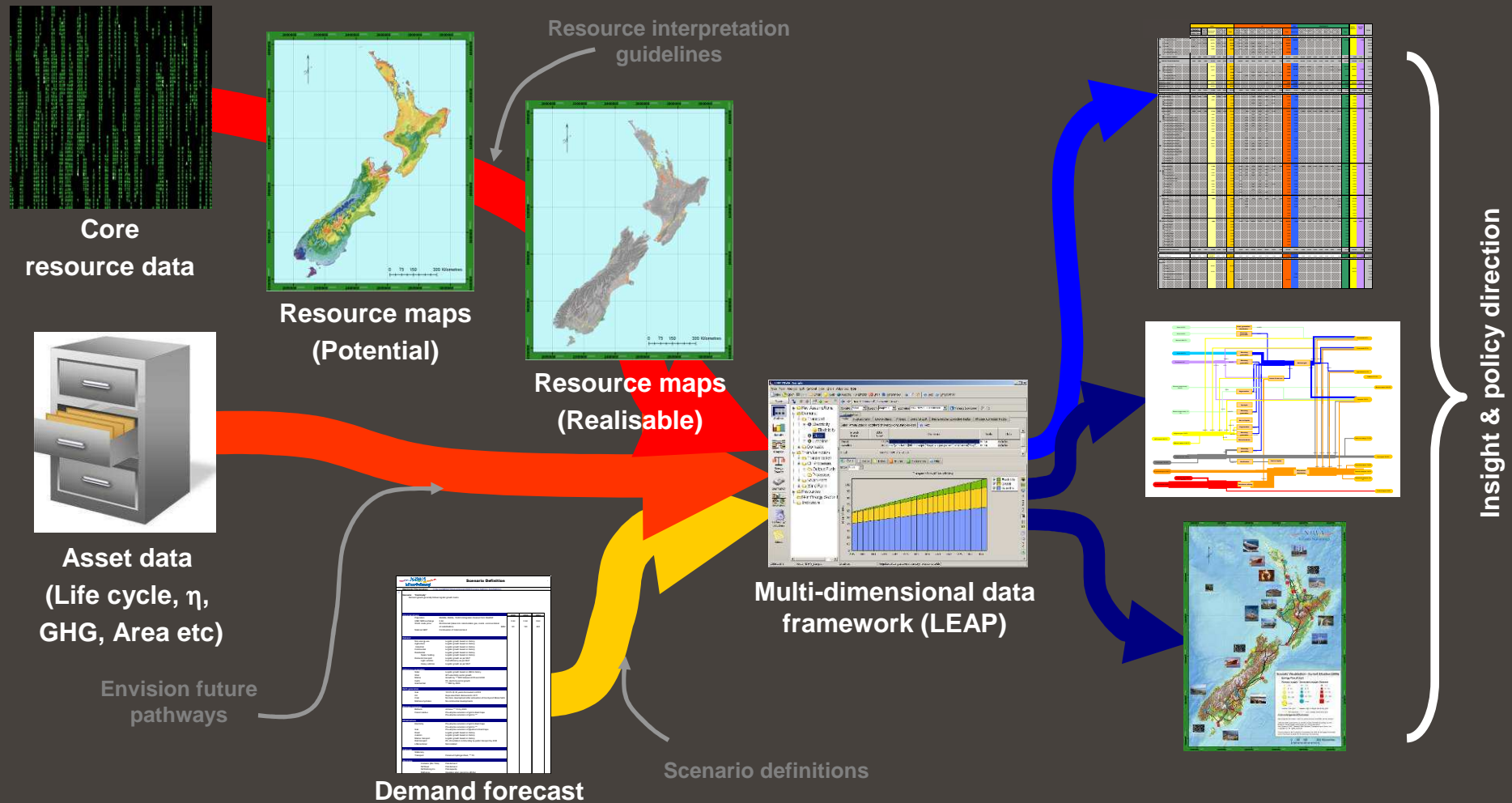
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# EnergyScape framework

A user friendly “pivot” table, where ...  
all data has time, scenario and regional dimensions



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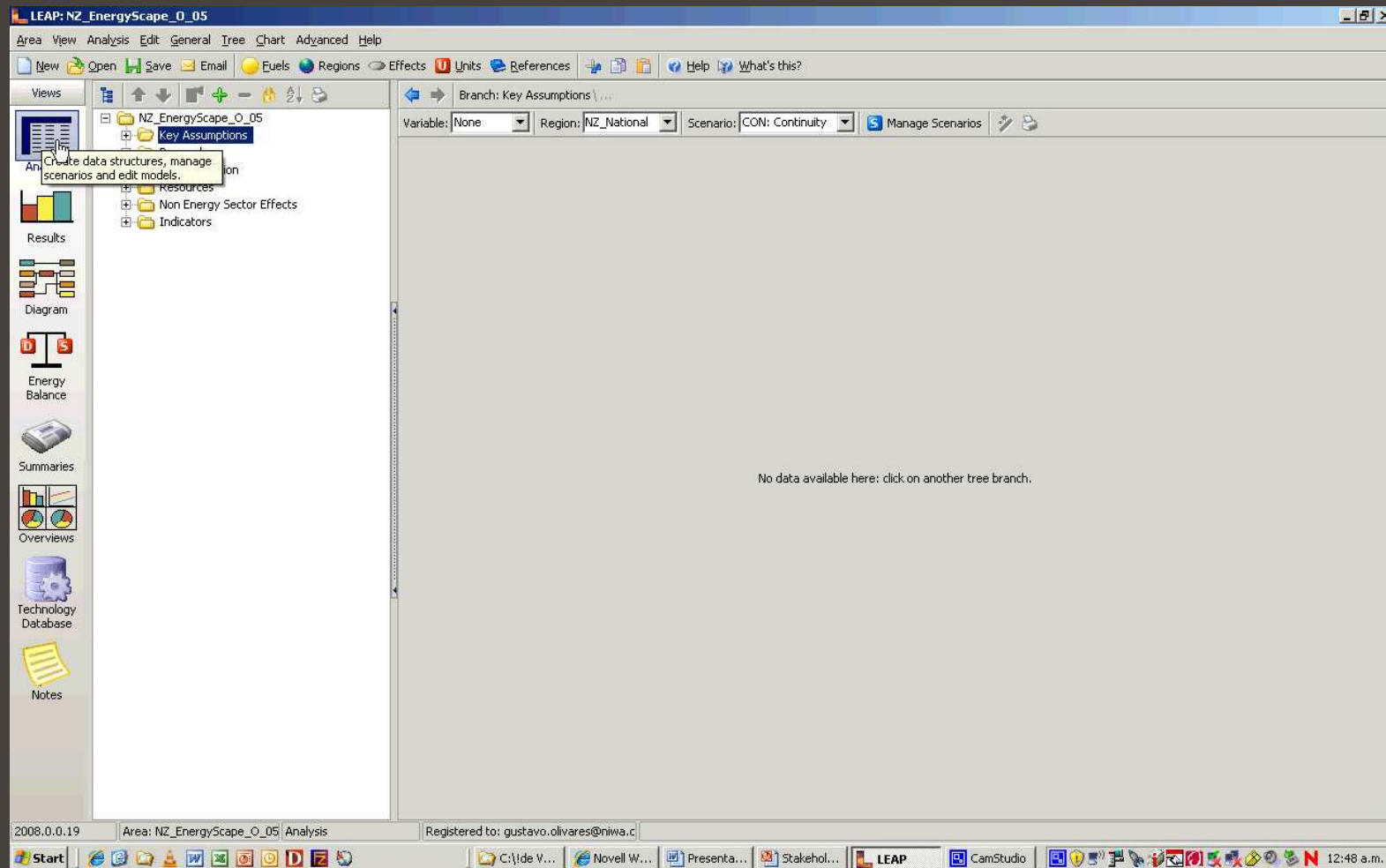


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# LEAP framework

Optimising tools has been disabled ...

Want users to 'learn' about the system



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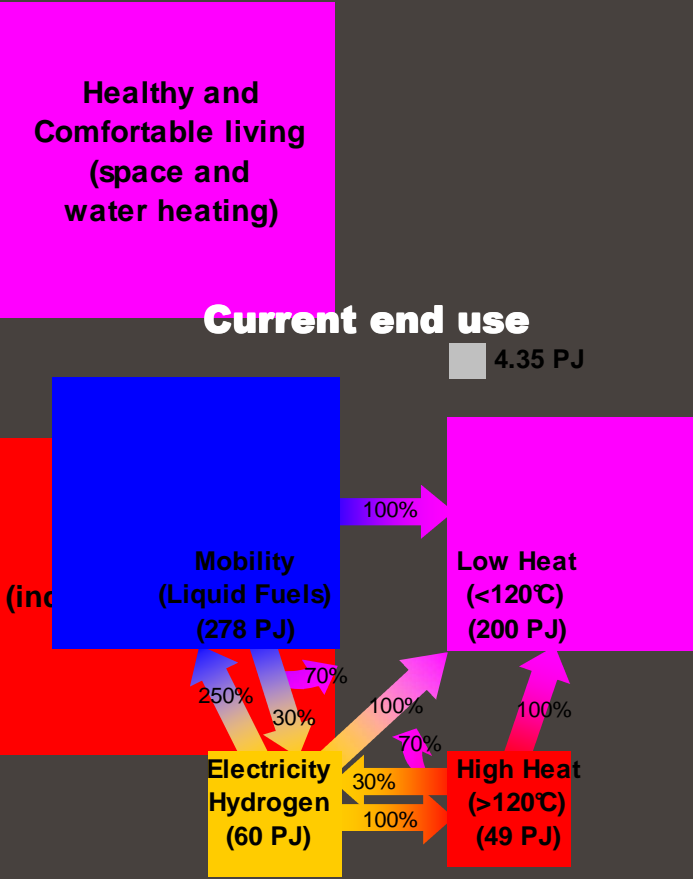
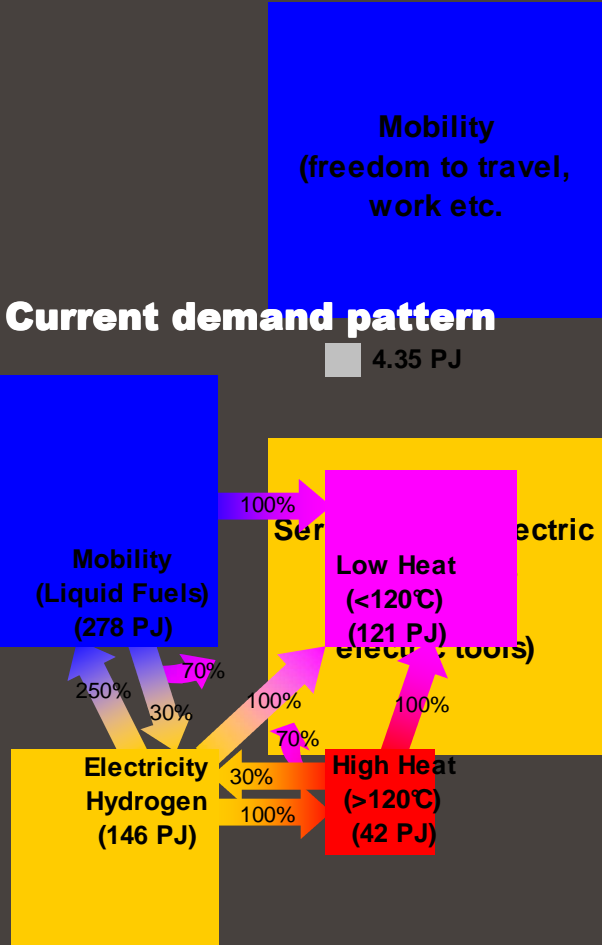


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# End-use demand

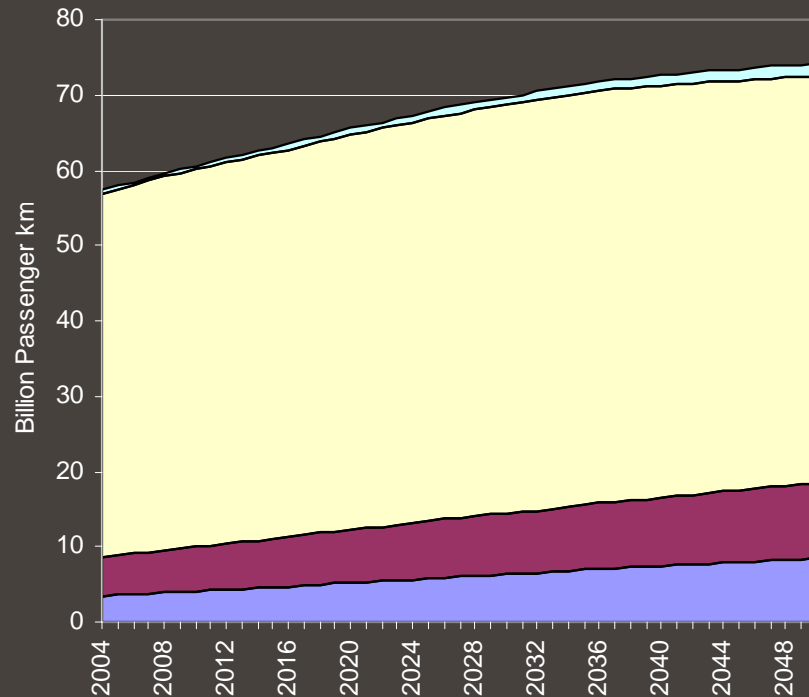


# Pathway perspective

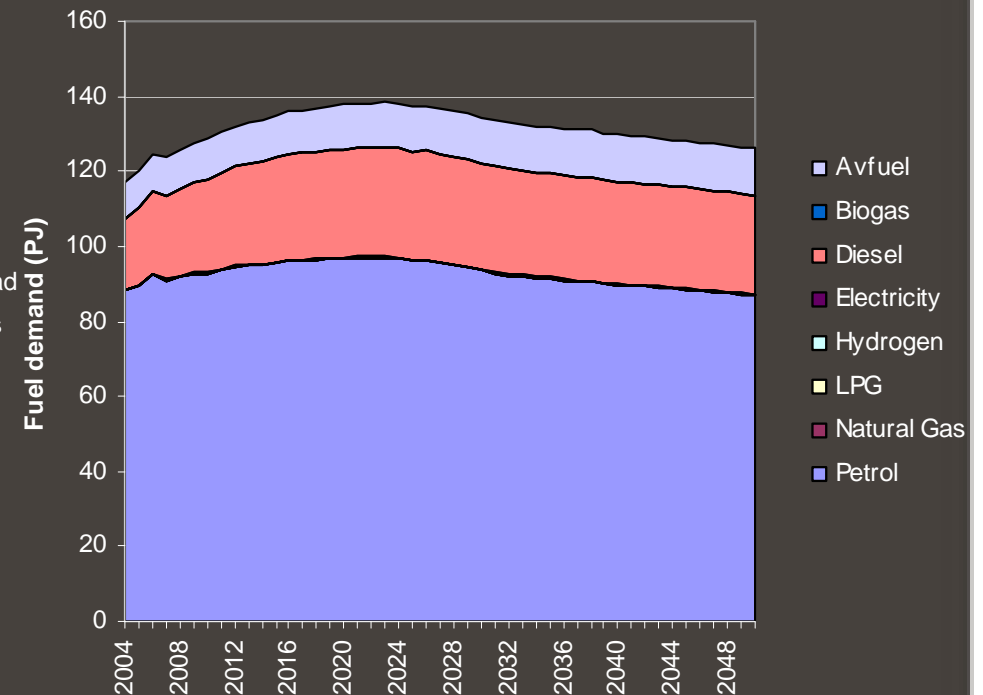
2000 2005 2030 2050

$$\text{Demand} = \text{Sub-sector activity} \times \text{Technology fraction} \times \text{Energy intensity}$$

Passenger end-use (activity)



Passenger end-use (fuel use)



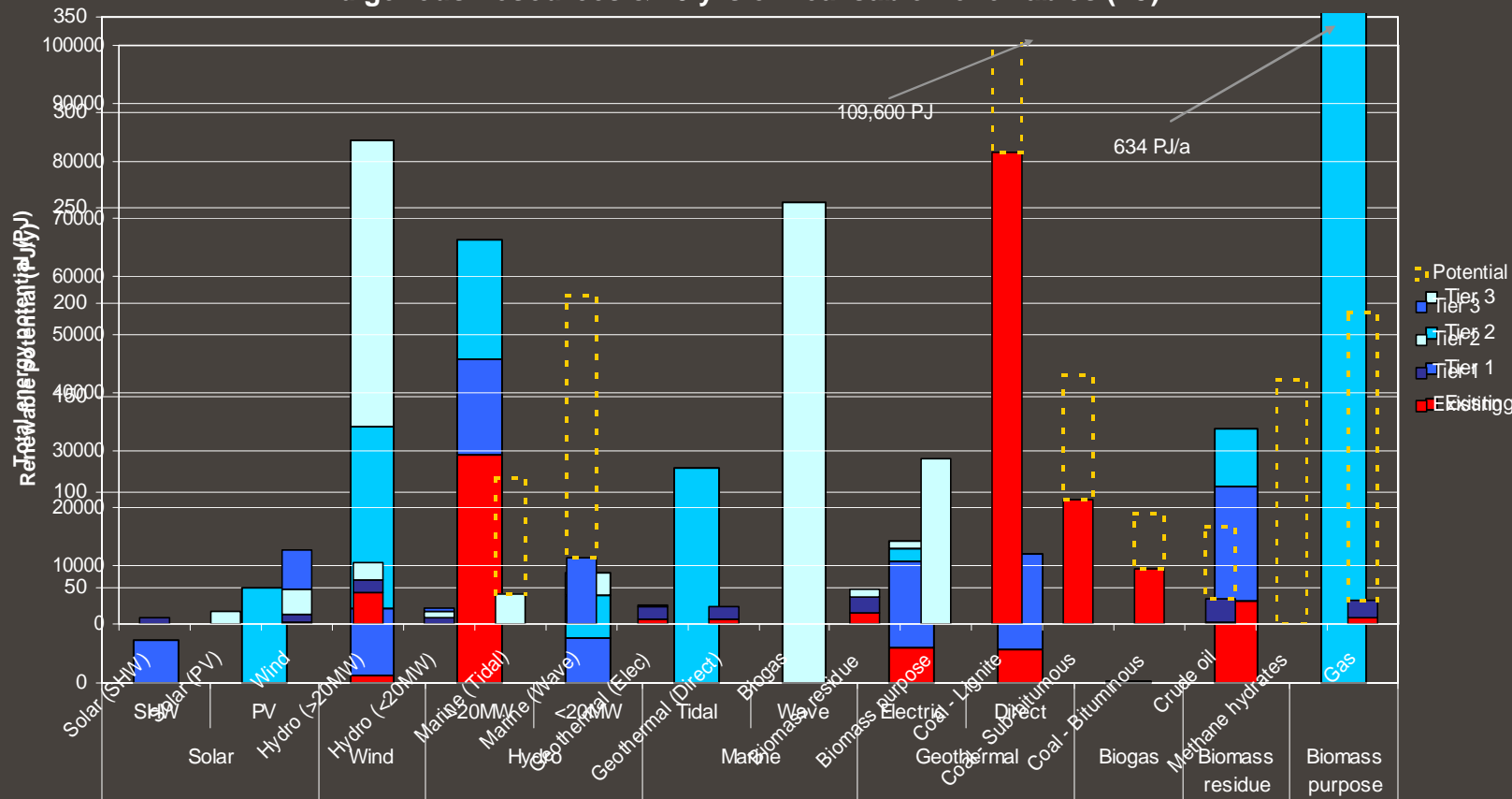
✓ Broad base of 'outline' data

✓ Elasticity (i.e. price response) of demand is poorly understood

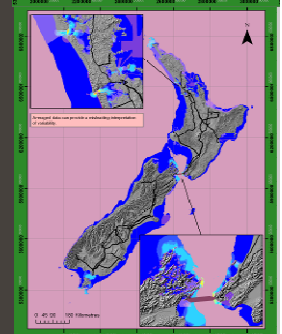
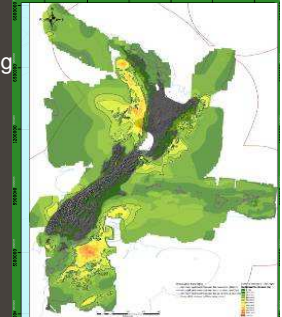
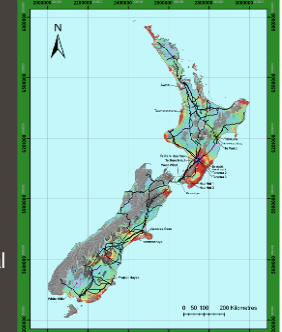
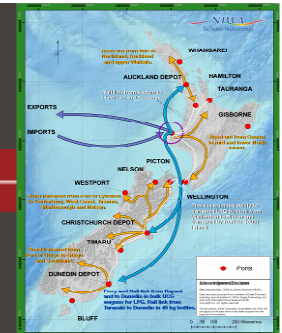
New Zealand's Energy Future: Large unknowns in future demand for services ...

# Resource and their constraints

Potential Realisable Renewable Generation Overview (PJ/y)  
Indigenous Resources & 45 yrs of Realisable Renewables (PJ)



**“We have sufficient resources for electricity and heat ... it is transport that is a problem”**

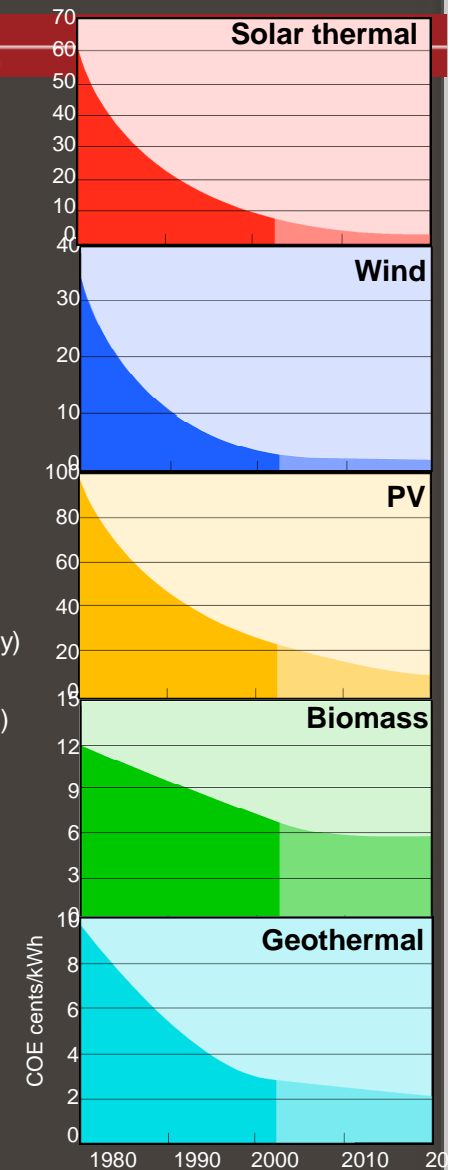
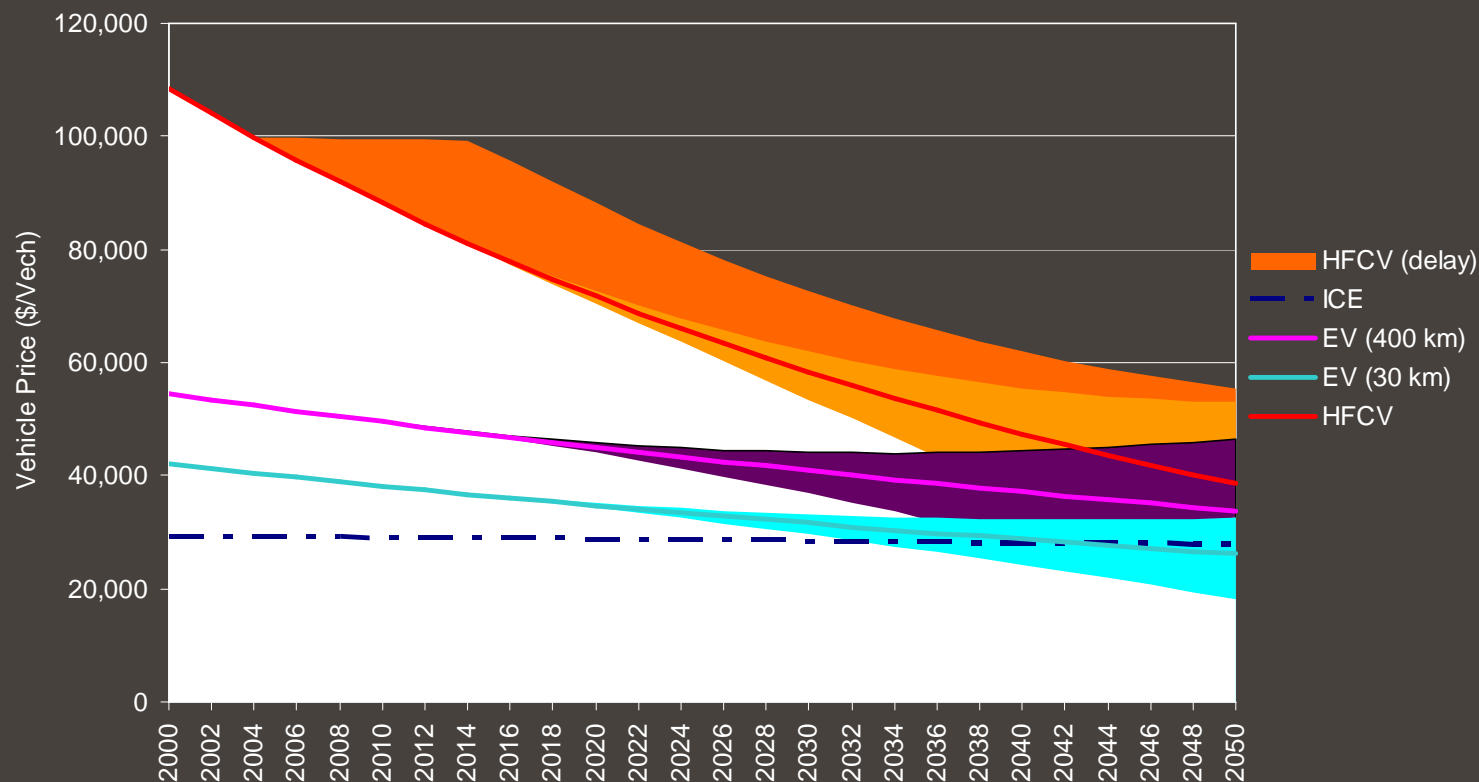


# Conversion technology data

Many technologies have large uncertainties:

✓ Cost, efficiency and environmental impact

Vehicle Price Curves



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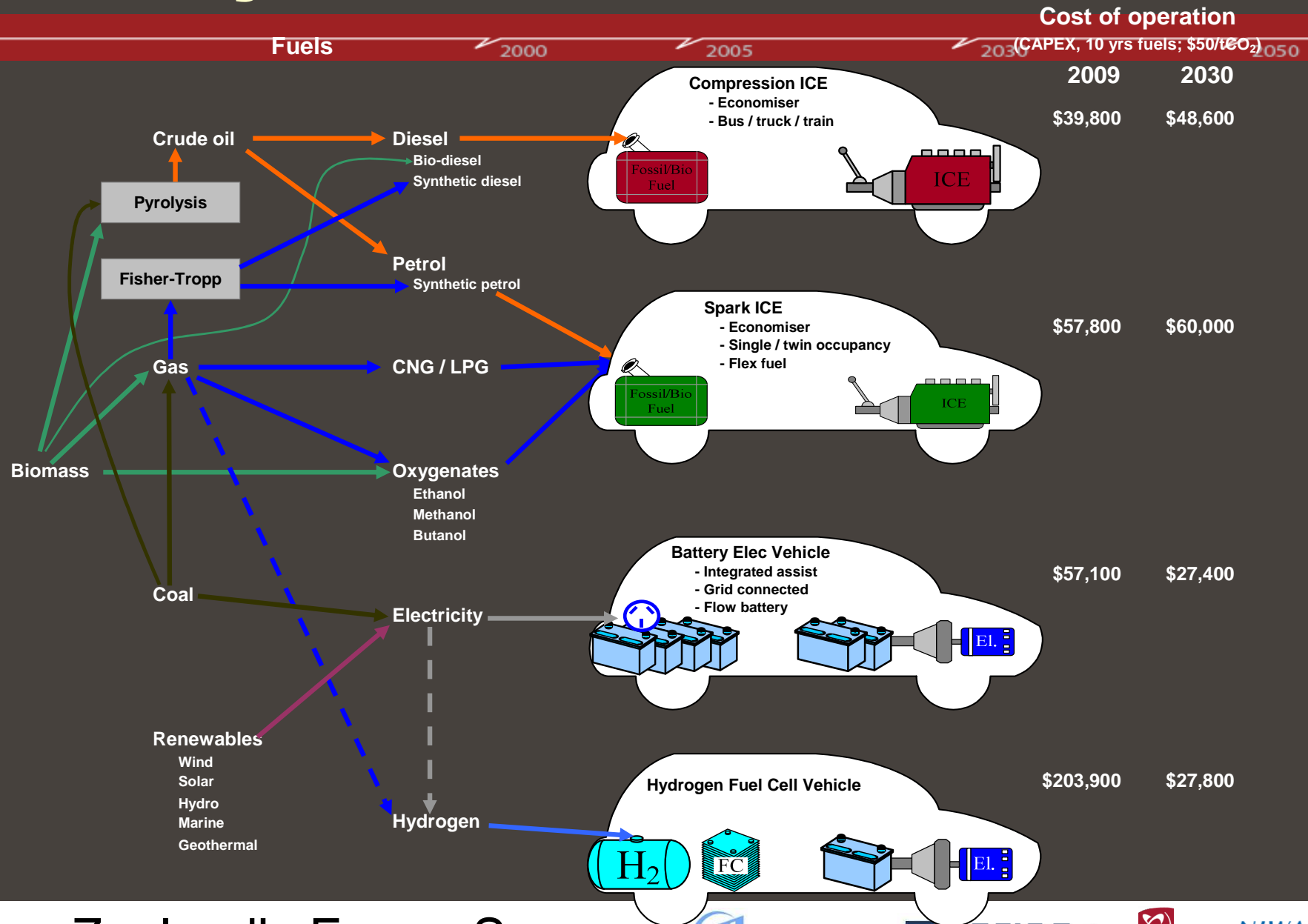
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# Pathways focus



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# Shell energy scenarios

4

## Scenario timeline

### Three hard truths

- 1 Step-change in energy use
- 2 Supply will struggle to keep pace
- 3 Environmental stresses are increasing

### What can we expect from the future?



The present to 2015



Turbulence 2015-2030



The future 2030-2055

### Blueprints



Worldwide emission trading scheme evolving post Kyoto

Nuclear slowdown



Global CO<sub>2</sub> trading scheme  
CCS deployed commercially

Electric vehicles enter mass market



Nuclear revival



Centralised solar PV

Non-OECD reaches two-thirds of world primary energy demand

A fifth of all coal and gas fired power generation equipped with CCS



50% of all new vehicles sales are electric or hydrogen

Moderate uptake in unconventional

Electrification of the transport sector

Decoupling of world GDP & energy growth

Continued growth in unconventional

30% of transportation needs are met by alternative fuels



2015



2020



2030



2040



World population passes 9 billion

2050

Blueprints need 13% less primary energy than Scramble

2055



### Scramble

China overtakes U.S. as major CO<sub>2</sub> emitter

Flight into coal

Strong growth in CO<sub>2</sub> emissions

Wind takes off

Mandated biofuels

Strong growth in unconventional

Modest nuclear growth

Coal hits constraints

CO<sub>2</sub> emissions moderate

Further rise in biofuels

CO<sub>2</sub> emissions on the rise again

Solar expansion

Nuclear comeback

India overtakes U.S. as major CO<sub>2</sub> emitter

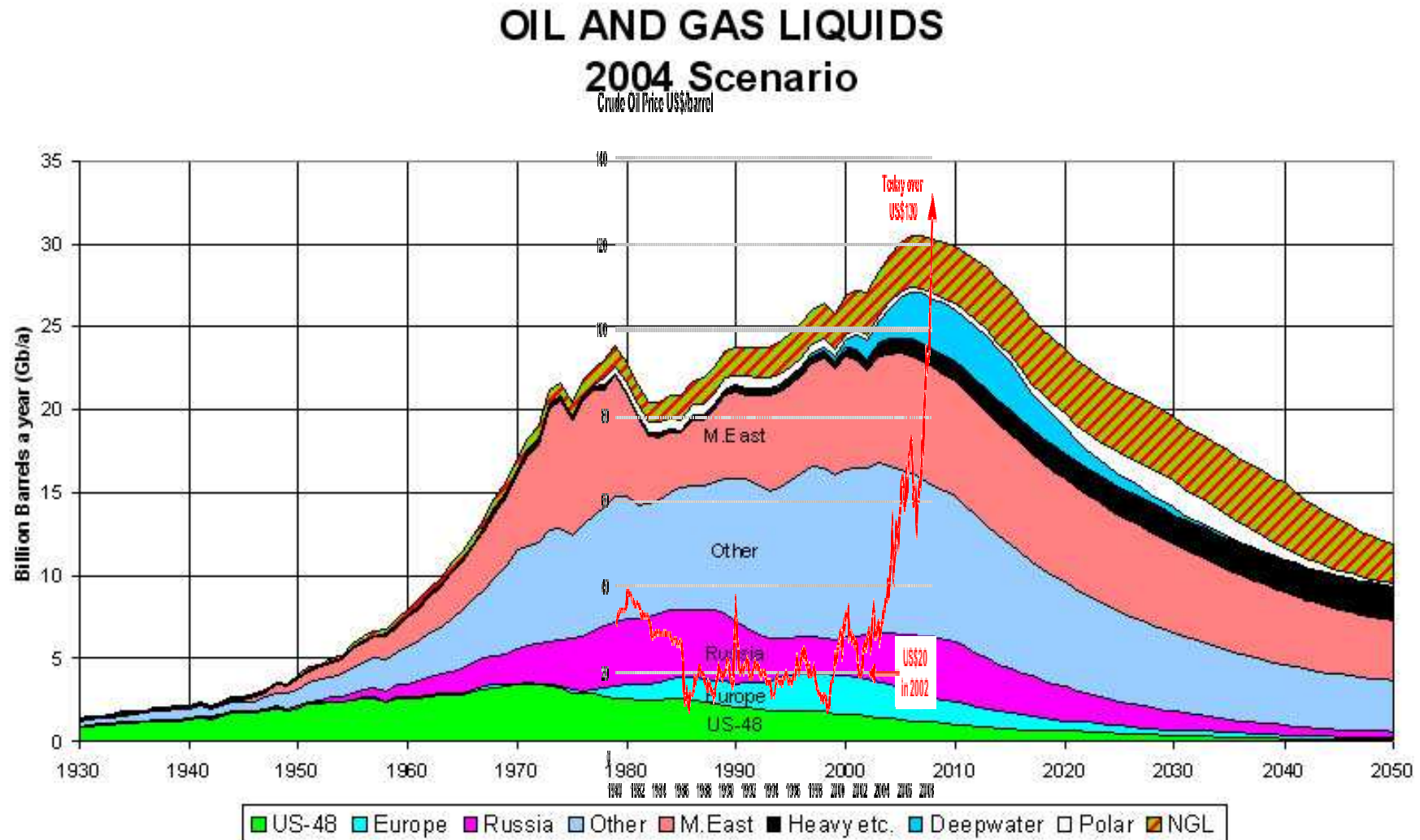
Slowdown in unconventional

Energy related CO<sub>2</sub> emissions decline but atmospheric concentrations continue to rise

Climate adaption measures begin

Biofuels ~ 30% of liquid fuels

# Fossil fuel plateau



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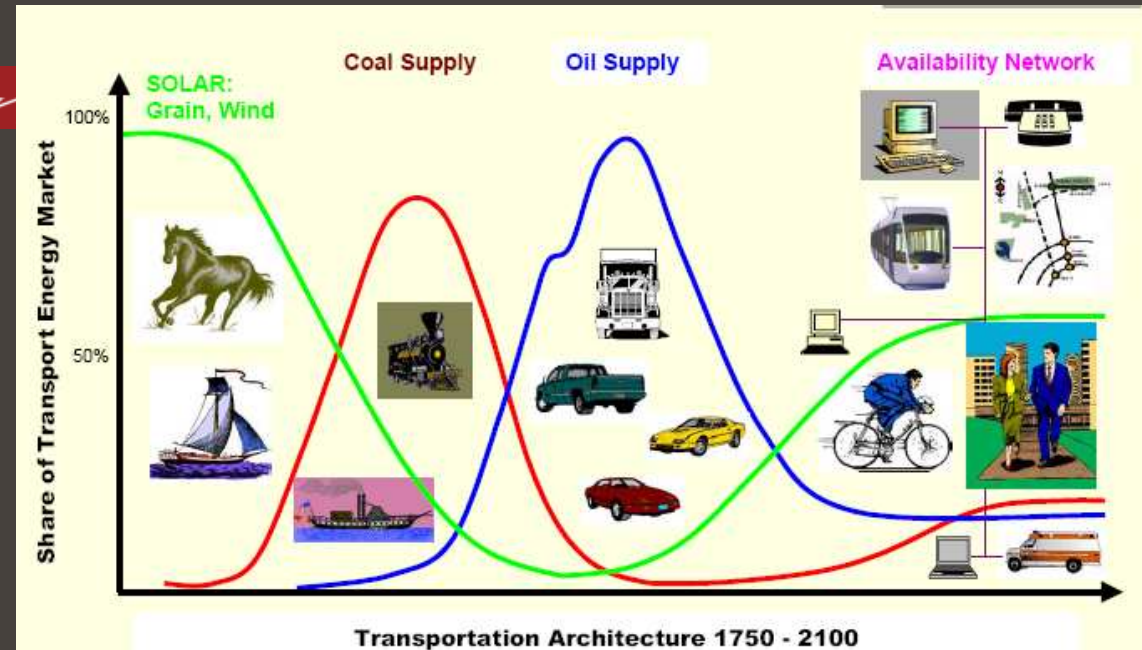
# Megatrends

## Past movements:

- ✓ Agricultural society
- ✓ Industrial revolution
- ✓ Information technology
- ✓ Resource management

## Megatrends:

- ✓ Increasing 'mobile' urbanisation
- ✓ Renewables I/P race
- ✓ Permeation of inflation
- ✓ Exploration rush
- ✓ Increased market reliance
- ✓ Global action?



Source: Susan Krumdieck

## Symptoms:

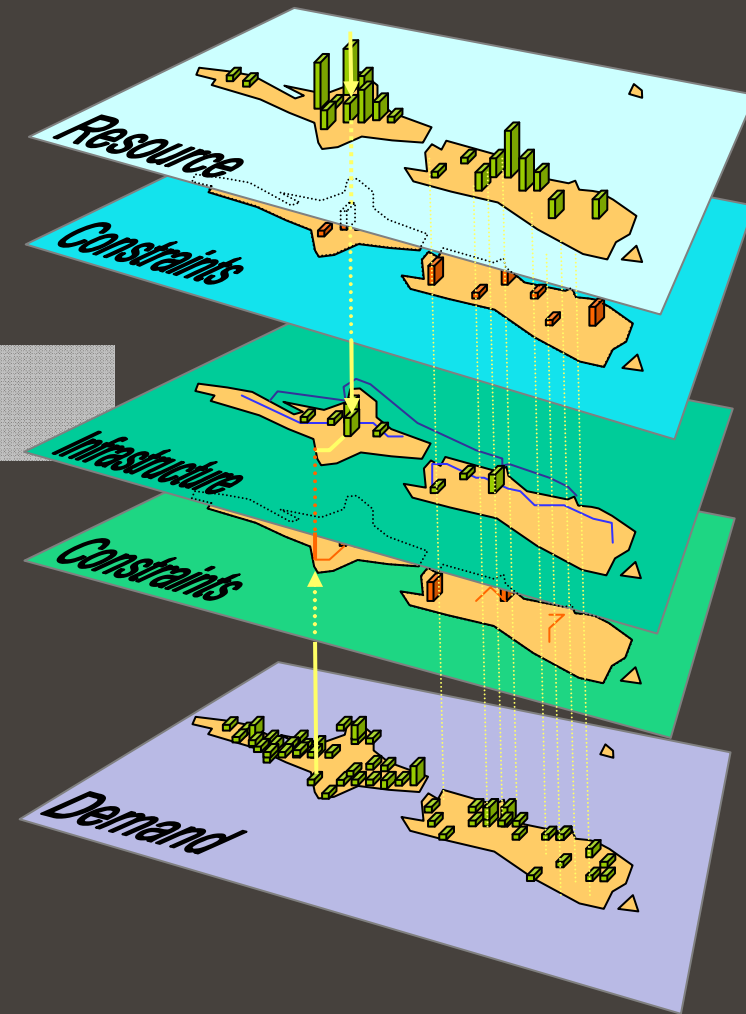
- ✓ Approaching the earth's limits
  - Resource depletion
  - Atmospheric, land and water pollution
  - Environmental degradation

**Problem of receding horizons ...**

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# National objectives

2000

2005

2050

## ✓ Stated 'energy' objectives

Energy prices are efficient and fair

Energy system is reliable and resilient

Environmentally responsible production and use

Pluralist  $\equiv$  Keeping options open

## ✓ Recognised national objectives

✓ Economic transformation

✓ Climate change impact abatement

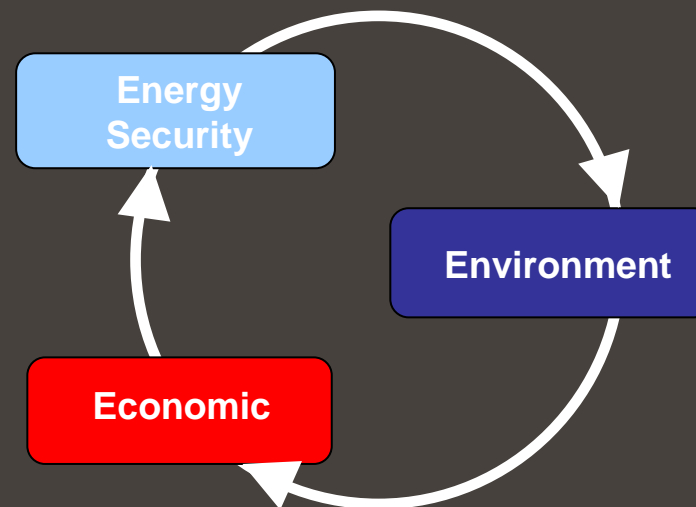
✓ Sustainability

? Quality of life

? Equality

✗ Resource constraints

Inspiring vision ...  
World class leadership ...



Have objectives been  
quantified / prioritised?

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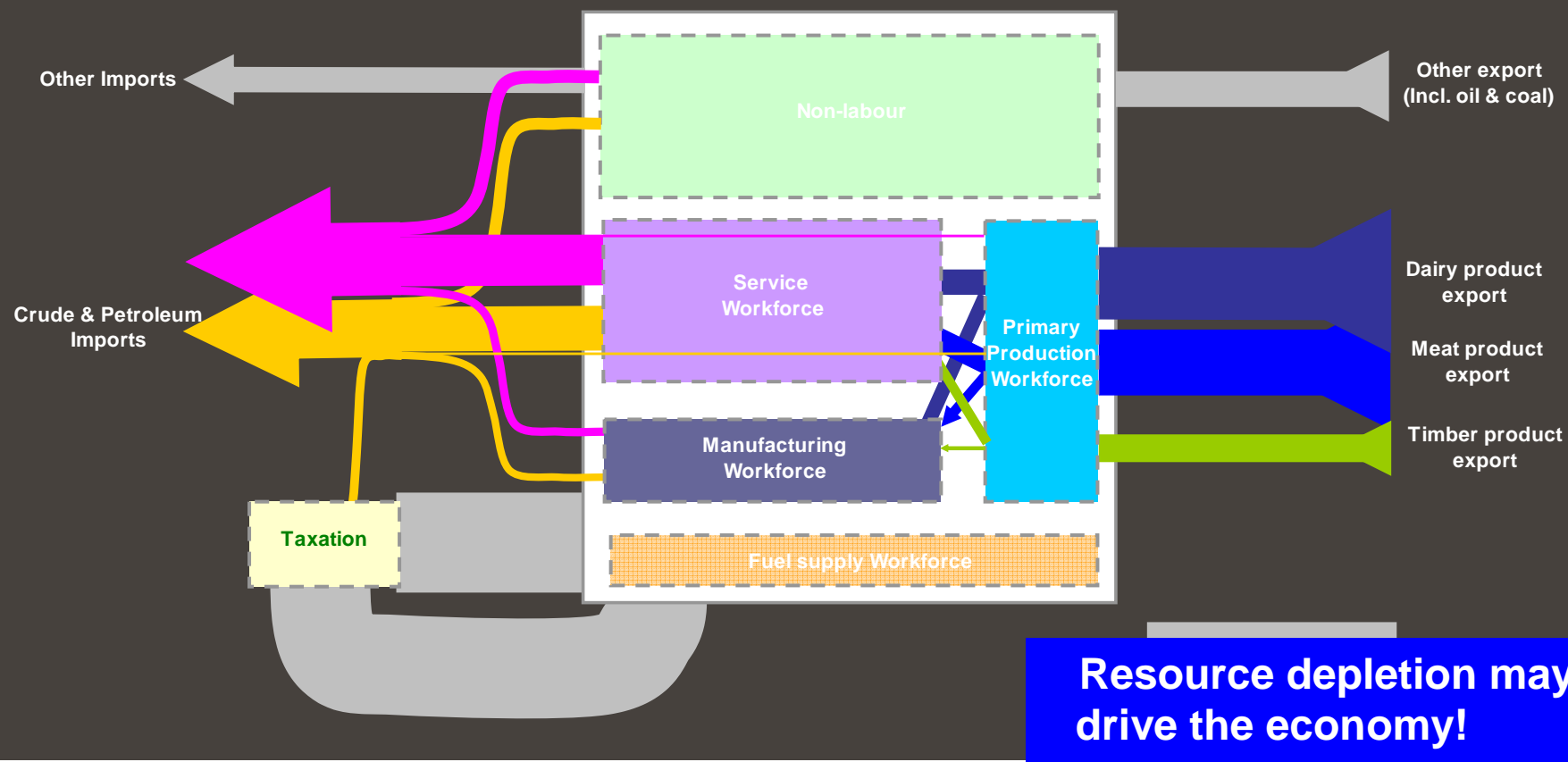
# Economy drives everything?

2000 2005 2030 2050

## ✓ Scope of action

Trade arrangements

Trade emphasis - Agriculture? Skills?



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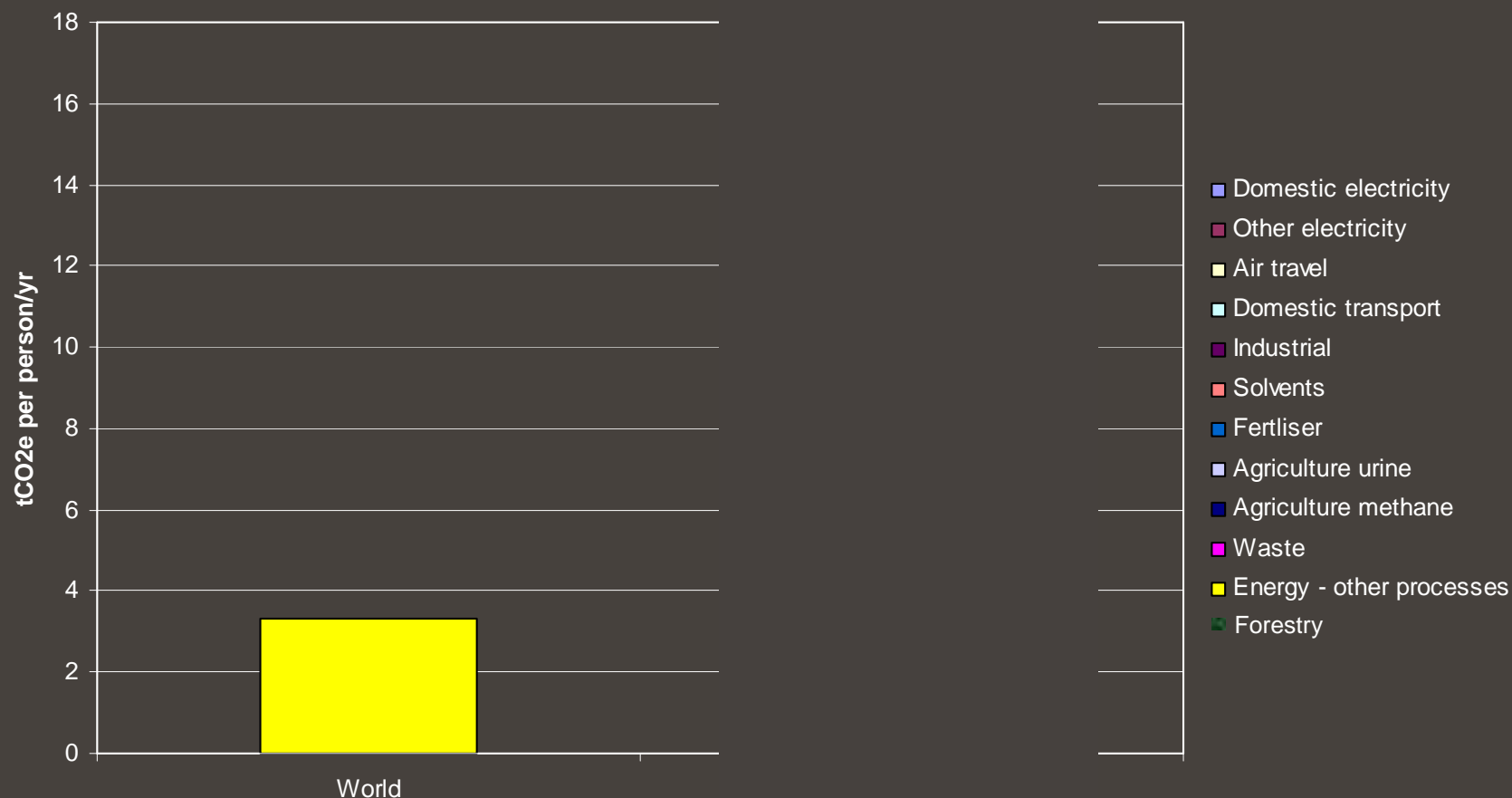
# Climate change abatement

2000

2005



✓ Actions need to be considered in context of outcomes ...



✓ Magnitude and timing (urgency) of response must be quantified.

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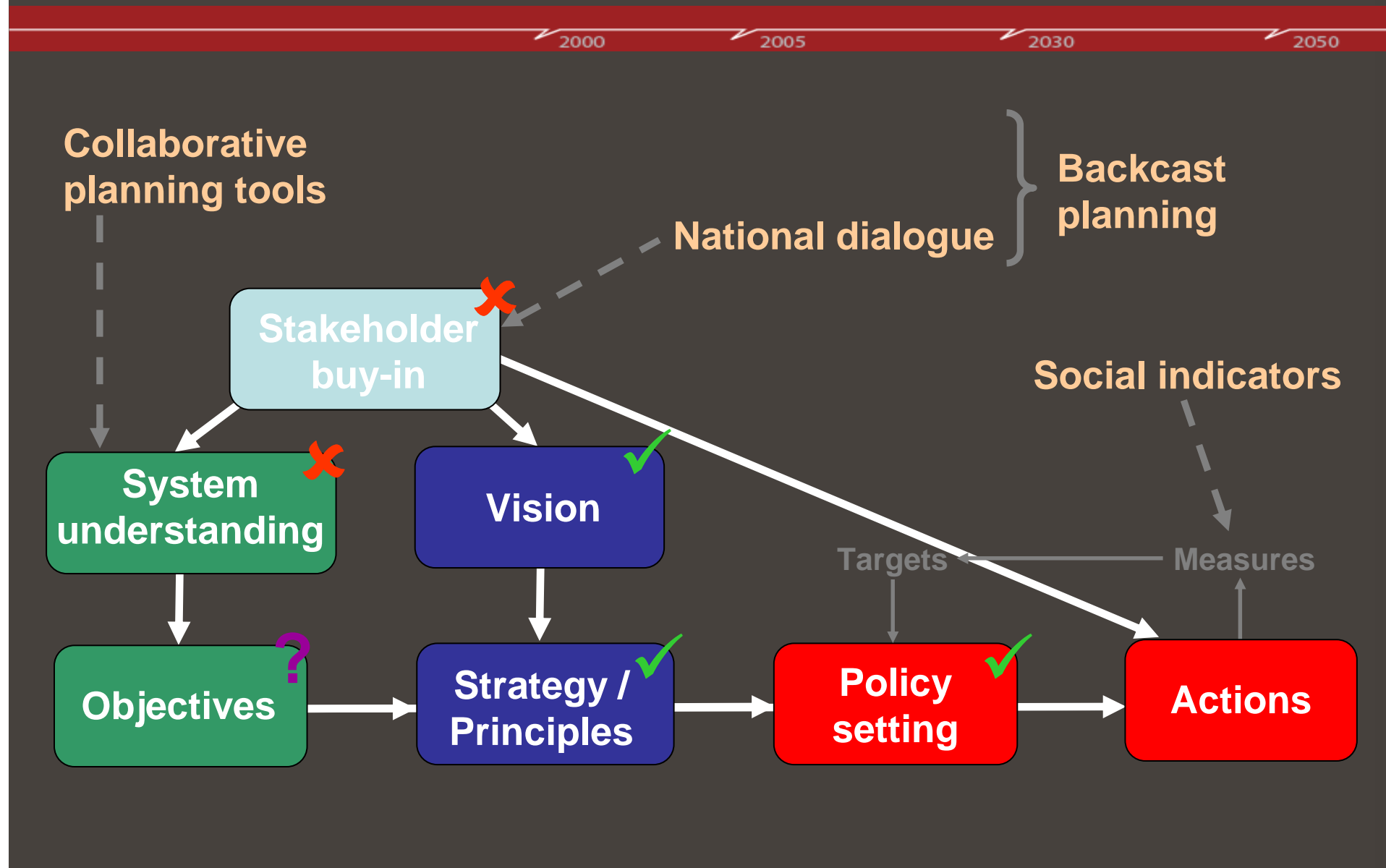


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# Change pathway



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# Transportation market

Mobility

Low Heat  
( $<120^{\circ}\text{C}$ )

2000

2005

2030

Electricity

High Heat  
( $>120^{\circ}\text{C}$ )

## Reliability and market structure

- ✓ Larger financial sector than electricity, with much greater levers!
- ✓ Many market risks
  - Air quality
  - Climate change
  - Fuel prices etc.
- ✓ The market responds to long term planning
  - Fails without it!
- ✓ Major investments need underwriting
  - Technical research e.g Safety of EV retrofit, methanol in tanks
  - Financial e.g Lignite F-T; Forest planting
  - Sentiment change e.g Teleworking, EV

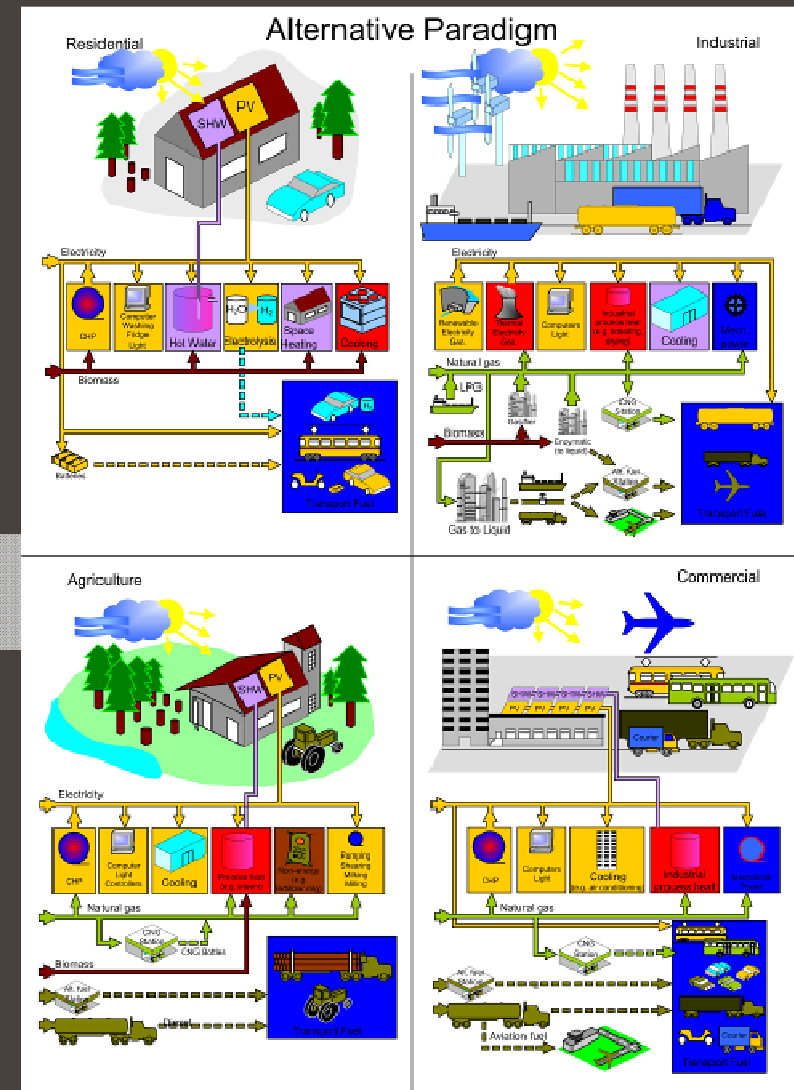
Need research to define: Risks of inaction, integrated opportunities, conversion, storage, efficiency, unique NZ I/P etc.



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2000 2005 2030 2050



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# Alternative vision

## ✓ Vision lends stability?

Appropriate enforcement?

Pluralist Vs Pick a winner ...

Impact of government sentiment

## ✓ Integrated / collaborative planning ...

Principled risk abatement

- Understood objectives
- Understood limitations
- Understanding of potential action

Appropriate emphasis ... Urgency?

National / regional / local scope

## ✓ Defined by national objectives ...

Clear objectives ... How much are we willing to pay:

- for energy security?
- to reduce GHG?
- for level of service?



Government believes  
the energy market will  
follow the economy!

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# Alternative visions

2000

2005

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## ✓ Scope of action



Trade arrangements e.g. environmental tax

Market reform e.g. tariffs

Centralised planning

Behaviour management e.g. vegetarianism

Regulation e.g. building standards

Extended Producer Responsibility (EPR)

Urban planning & highway spending

Budget allocation review

Huntly on gas or POx

Cap petroleum import

Reduced agriculture?

Skills leakage

Impacts on

**Compared with “Think Big”,  
this is “Dreaming Small”**

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Country	2000 (%)	2005 (%)
Argentina	10.5	11.5
Australia	14.5	15.5
Belgium	16.5	17.5
Brazil	7.5	8.5
Canada	13.5	14.5
China	6.5	7.5
Denmark	15.5	16.5
France	16.5	17.5
Germany	17.5	18.5
Greece	14.5	15.5
India	5.5	6.5
Italy	18.5	19.5
Japan	20.5	21.5
Korea	7.5	8.5
Mexico	6.5	7.5
Netherlands	15.5	16.5
Norway	14.5	15.5
Poland	13.5	14.5
Portugal	11.5	12.5
Russia	10.5	11.5
Spain	15.5	16.5
Sweden	16.5	17.5
Switzerland	15.5	16.5
Taiwan	10.5	11.5
Thailand	8.5	9.5
United Kingdom	15.5	16.5
United States	13.5	14.5

## ✓ Technology

## Mobility efficiency

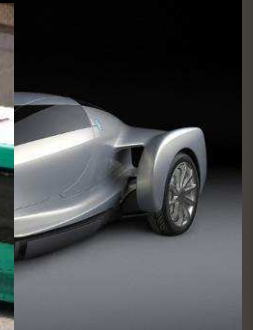
## “Off the radar” e.g. CNG

## Renewable generation e.g. Biomass

## Basic efficiency e.g. SHW, insulation

## Local / community scale

## Environmental risky



# Alternative visions

2000

2005

2030

2050

## ✓ Building sentiment with “real” media



Need for national dialogue ...



20 years behind on sustainability

Economic drivers

Fossil fuel plateau

“Individual” responsibility

Behaviour management e.g. vegetarianism

Speed / magnitude & impacts of climate change

NIMBY response ...

Sunk assets ...

Impact of fossil fuel plateau

Freight vs personal mobility

Diesel impacts on air quality

Scope and appetite for behaviour management is dependent upon “interpretation of urgency for change”.

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# Alternative visions

## ✓ Research status

Very diffuse provider market  
Limited trust / reliance  
Limited strategic direction

## ✓ Research needs

Continuity & collaboration  
Broader scope

- Economic / trade
- Social

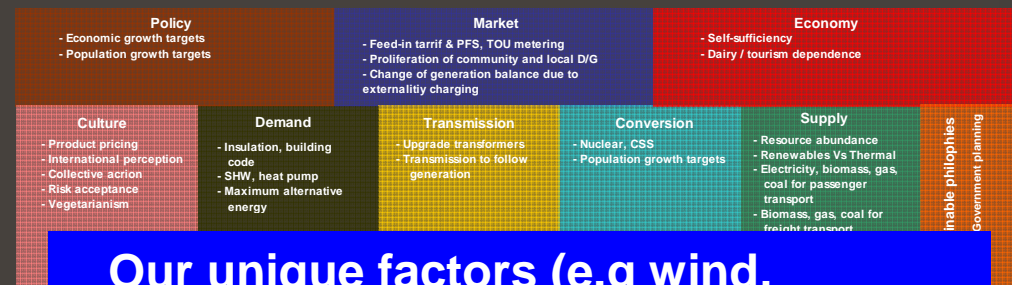
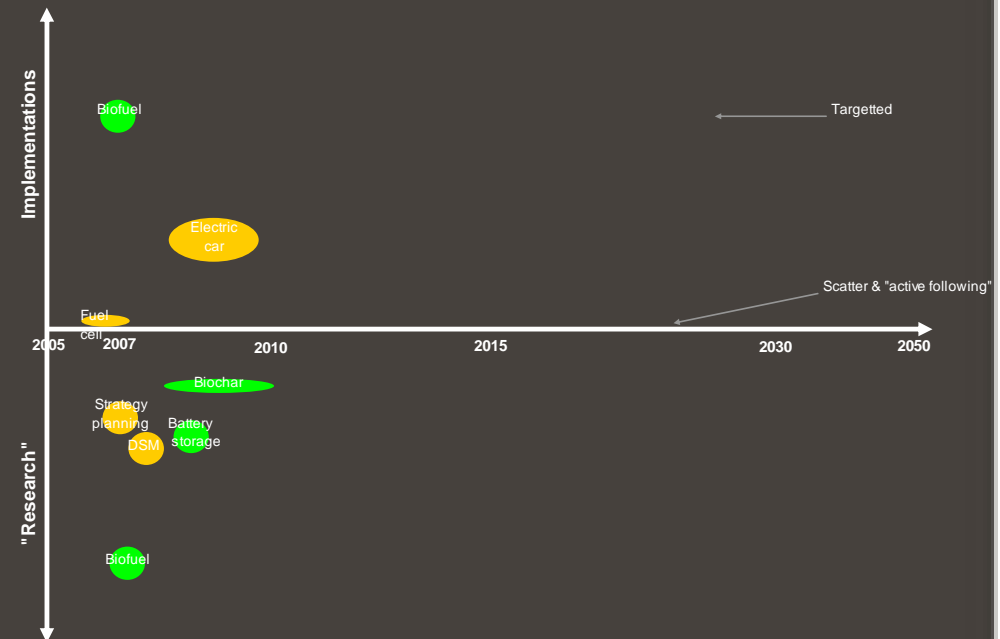
Stronger stakeholder base

- Media
- Local government

“Gap filling” against criteria

- Maintain list of topics

Multi-media outputs

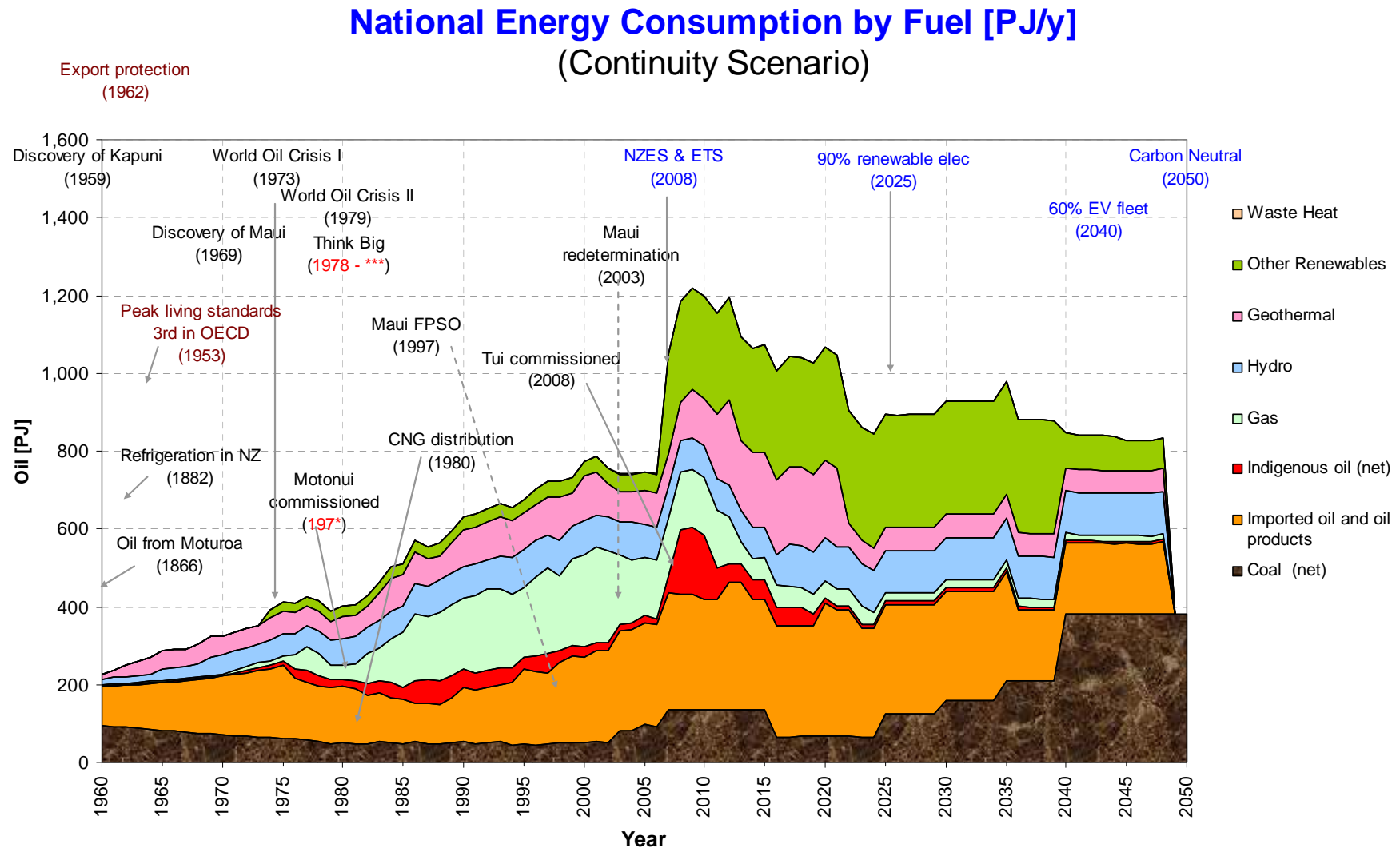


Our unique factors (e.g wind, methane hydrates) should be levered for innovation & investment.

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# Plotted history

# NZES future



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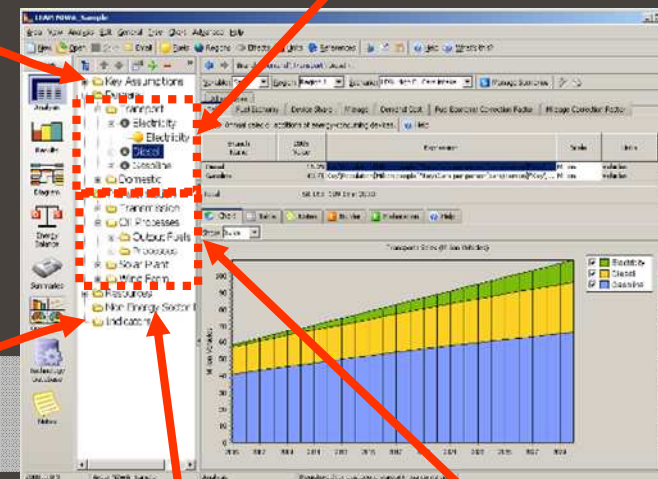
# Outline

Future vision  
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2000 2005 2030 2050

Assumptions  
Common inputs

Demand  
Multi-dimensional  
- Appliance  
- Service  
- Fuel



Indicies  
Calculation tools

Resources  
What is available

Transformation  
- Connections set by calculation order  
- Iterations for auxiliary demand

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# Conclusions

- 
- 2000      2005      2030      2050
- ✓ **There is a need for change**
    - Define 'sustainability' and 'quality of life'
    - Incremental or step?
  - ✓ **National objectives**
    - Lack quantification / prioritisation?
    - Long term 'quality of life' is most important
    - System understanding is unclear
    - Consensus forming can reveal opportunity
  - ✓ **Possible improvements**
    - National dialogue
    - Collaborative planning tools
    - Social measure collection
    - Backcast planning
      - Principled risk abatement
      - Avoid economic disruptions
      - Quantify policy implications

# The future ...

2000

2005

2030

2050



## Open to opportunity ...

Low carbon impact  
Equitable, attractive  
Reliable



## BUT ...

Needs to be planned  
Considerate of resource depletion  
Strategic steps required  
Considerate of economic / market  
Endorsed by consensus



## Targeted technology reviews

Electric vehicles, methane hydrates, F-T,  
Pyrolysis, Gasification, PV cost decline,  
Urban form, Local generation  
Purpose grown biomass → etOH & H<sub>2</sub>



## Continue to encourage national dialogue

**SCIENCE CAN AND SHOULD FACILITATE PLANNING**

# Our future ...

How much are we willing to pay:

- For energy security?
- To reduce GHG?
- For level of service?

2005

2030

2050



**Questions?**  
**Comments**  
**Discussion**

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