Energy Pathways for New Zealand

George Hooper

Centre for Advanced Engineering

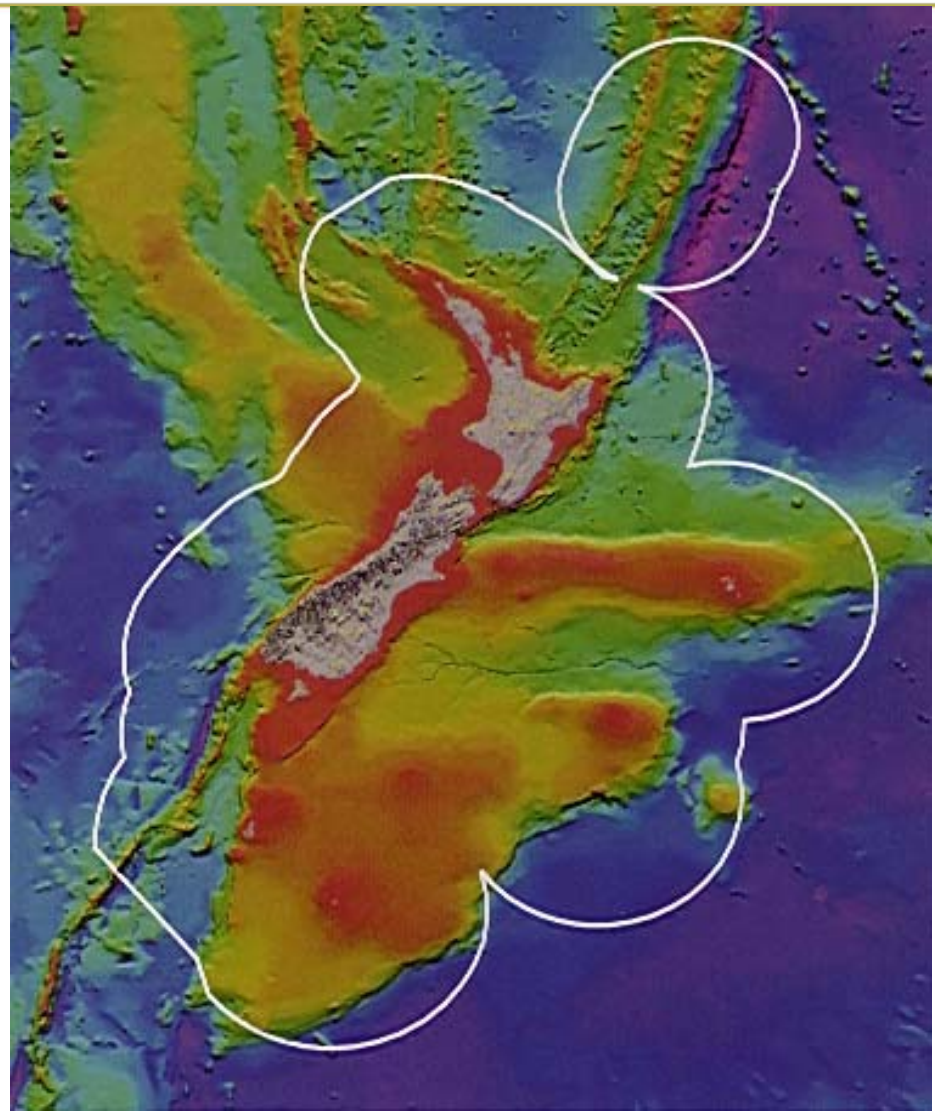
EMAN410 - August 2007

NZ's energy pathways…

All our energy sources ultimately derive from our primary resource base.

The question for today is:-

"Should this country with a small population and a large resource-rich territory be a net consumer or a net supplier of energy commodities"?



NZ's energy pathways…

NZ Energy supply and demand has been characterised by:

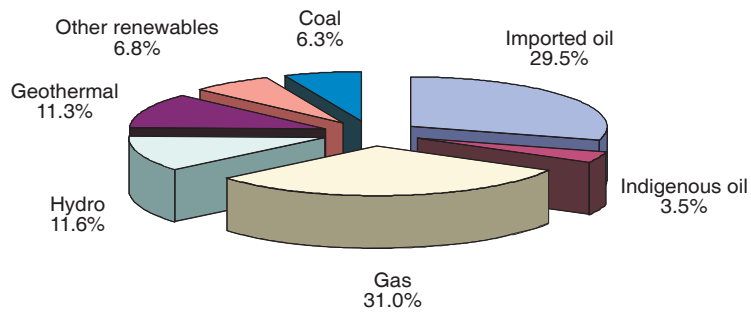
- Secure energy supply
- Low energy costs
- Modest environmental impacts
- High energy intensity

Our strong recent economic growth has continued to bring strong energy demand growth - yet despite government policies for sustainable energy action there are NO signs that economic and energy growth are decoupling significantly.

New Zealand's Energy Profile

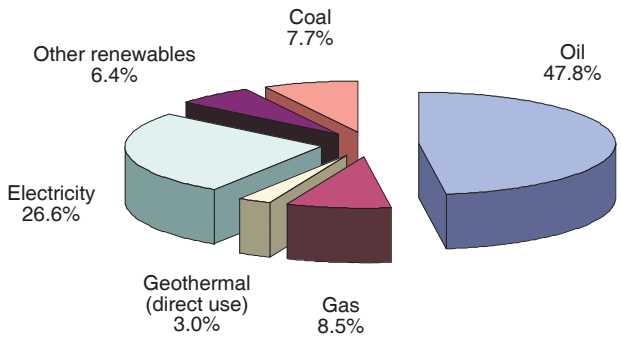
- **Primary energy supply is around 760PJ/y - dominated by our thermal fuels market**
- **As a country we are self sufficient in all energy forms apart from oil.**
  - **most indigeneous product is exported**
  - **20% self suficent in oil products**
  - **Shift towards distillate fuels to replace gas is further reducing self sufficiency**
- **NZ consumer energy (460PJ/y) dominated by domestic transport - which accounts for about 180PJ/y.**
  - **Transport demand projected to grow strongly at around 2%/y**
  - **Electricity consumption increasing at about 2% /y**
  - **Energy efficiency improvement targets remain ambitious.**

Figure 1: Primary energy supply



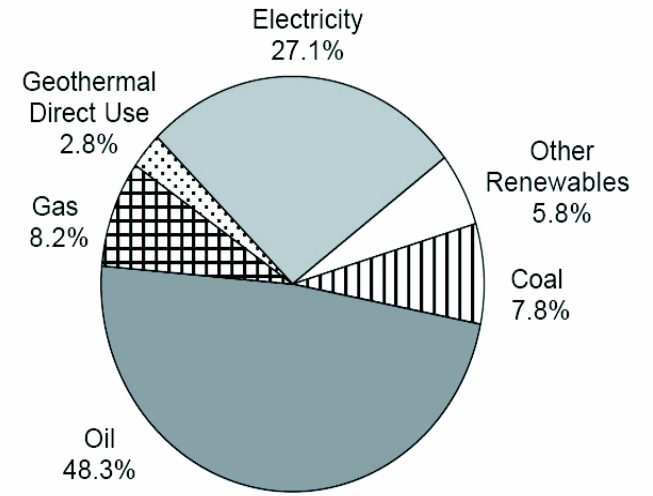
Source: Energy Data file, January 2002 (MED)

Figure 2: Total consumer energy by fuel

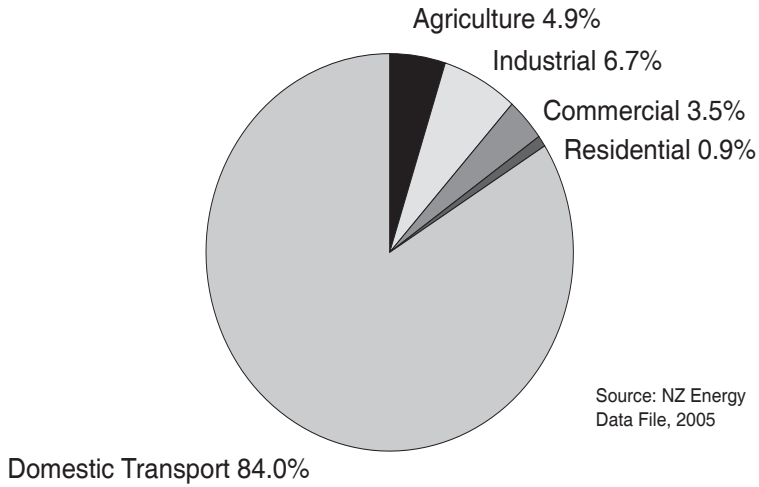


Source: Energy Data file, January 2002 (MED)

Transport is the dominant factor…



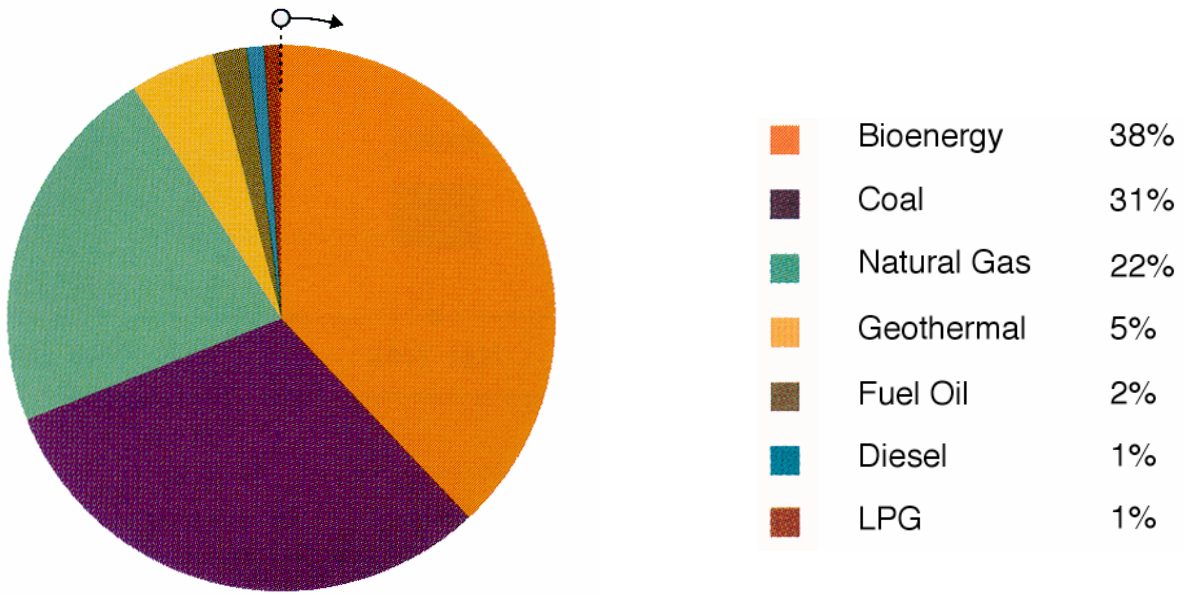
Total consumer energy by fuel 2004 (NZ Energy Data File, 2005)



Oil use by sectors (exc. International transport) (NZ Energy Data File, 2005)

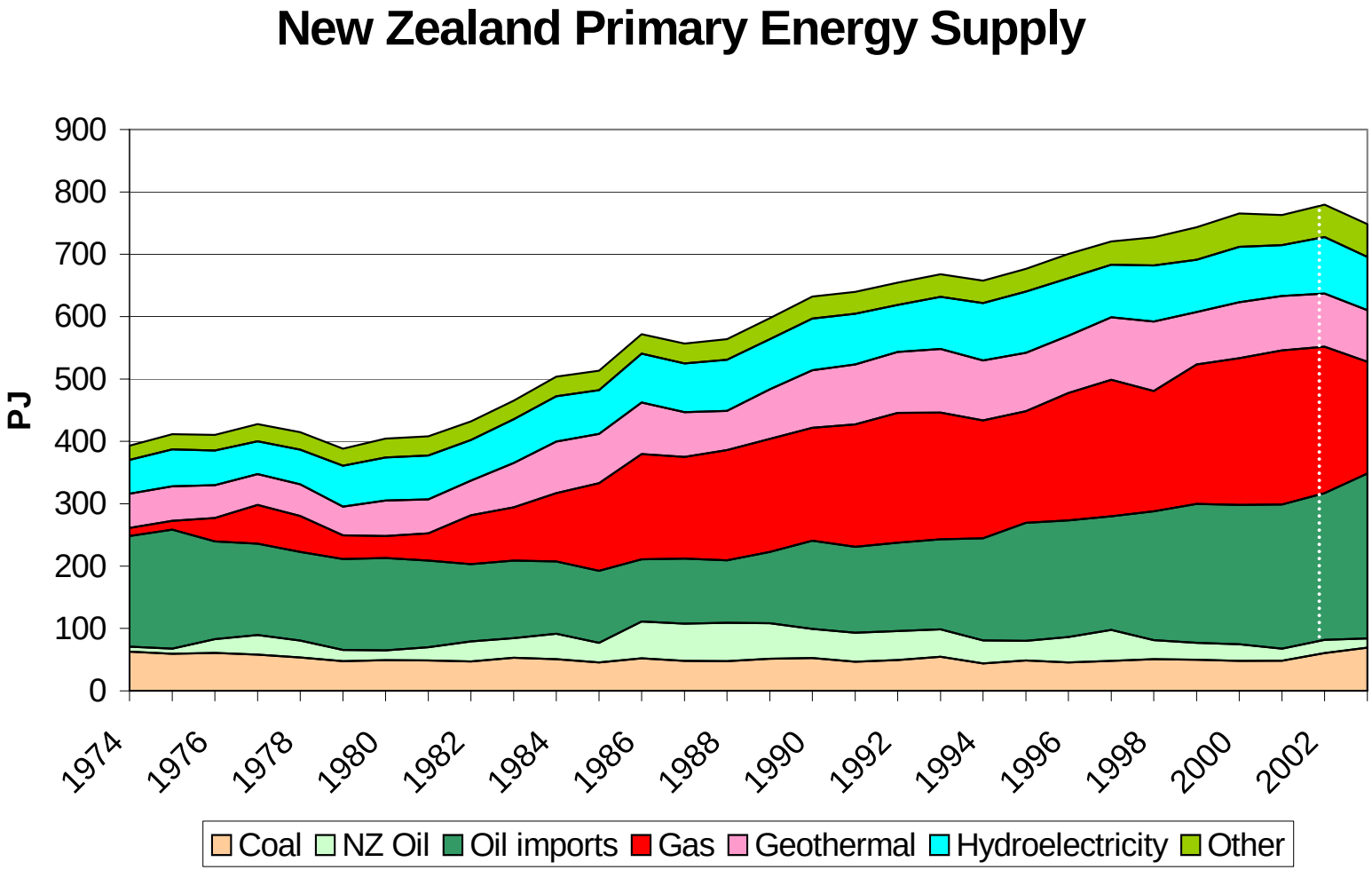
Transport accounted for 47.5% of the 2004 year carbon dioxide emissions

Industrial energy supply…



Energy use by fuel for industrial process heat in New Zealand (electricity excluded, March year 2002)

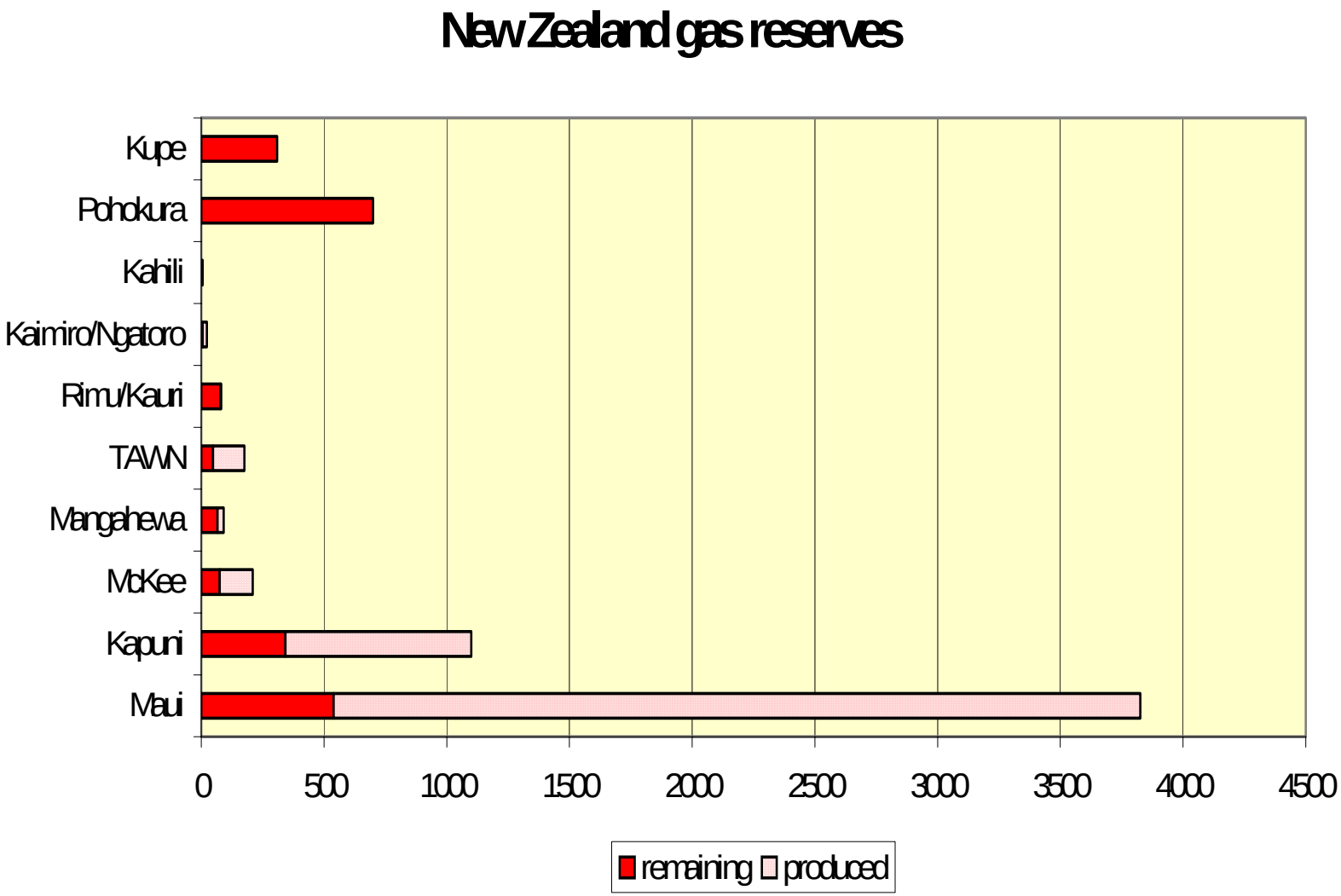
NZ's primary energy supply…



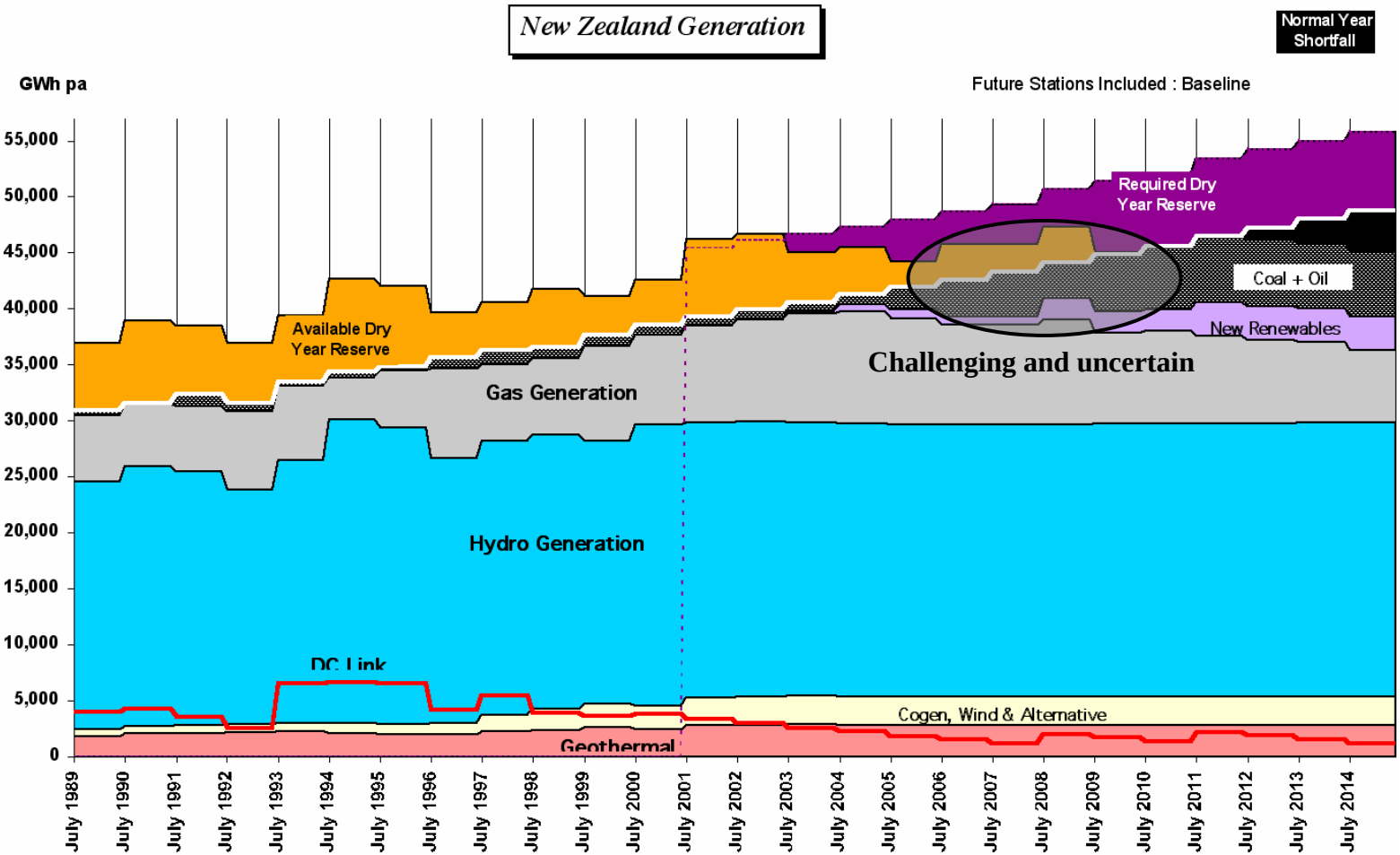
Primary energy supply:

- Gas reserves are not being replaced at their rate of consumption due to inadequate levels of exploration investment
- Past failure to secure sufficient gas reserves to maintain at least partial methanol production makes the gas market vulnerable to price volatility
- NZ exploration opportunities are skewed towards the high-risk, high-capital end of global opportunities
- If additional new gas reserves are not developed soon coal or distillates are the only realistic fossil fuel alternatives
- In the absence of forward supply planning, NZ will become reliant on imported fuels

Gas reserves are not sufficient…



NZ electricity generation in a normal year



Electricity:

- Economy highly vulnerable to power shortages
- Potential for significant economic cost and lost opportunity from supply interruption or system failure
- Emerging opportunity cost to New Zealand from deferred investment in new manufacturing or industrial plant
- A fragmented and incomplete governance framework is not delivering demand-side solutions for electricity supply
- A focus on transmission upgrades has potential to strand regional energy development opportunities

What are our options?

ENERGY SOURCE	ANNUAL REQUIREMENT TO MEET 2% ELECTRICITY GROWTH
gas	22.5 billion cubic feet
coal	380,000 tonnes of sub-bituminous
oil	15 million barrels
geothermal	unconstrained development of an average geothermal field
wind	300 new wind turbines
hydro	new hydro stations equivalent to the Aviemore dam
solar	360,000 domestic solar water heaters

Developing a NZ energy strategy…

- We are an energy-rich country, yet unless we change our thinking we are facing a shock as severe as the oil crises of the 1970s
- The critical constraint facing New Zealand is to manage the transition from dependence on Maui gas to other forms of energy
- Our energy strategy needs to focus on providing a secure supply of reliable and affordable energy
- If we get the strategy wrong, New Zealand will revert to being dependent on global; oil markets; limiting our options; raising costs and stunting economic growth.

Our Energy Future — Prioritising Effort

The three essential strands essential to secure investment in our critical energy infrastructure:

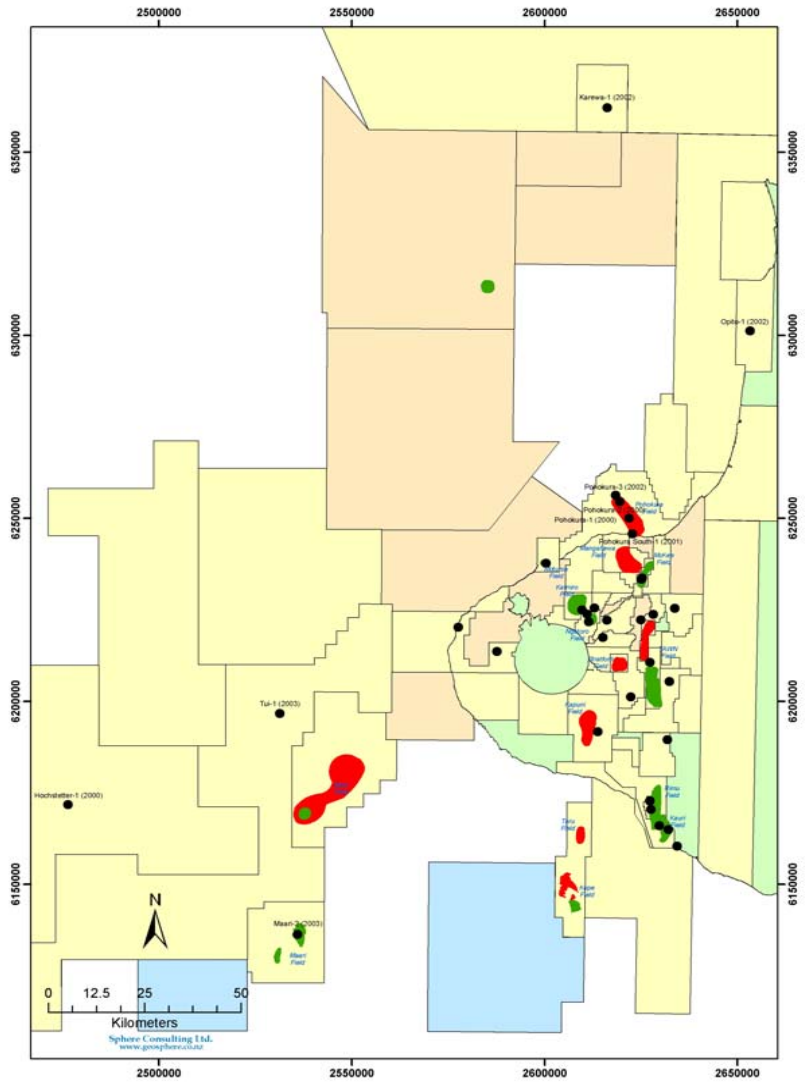
- **Extending New Zealand's primary resources**
- **Development of a strategic energy reserve capacity**
- **Long term investment in alternative solutions**

Outlook for Fossil Fuels

- Exploration investment too low to sustain gas requirements
- Coal resources ample but requires both mine developments and new investment in modern generating plant
- The lignites of the South Island are an important strategic resource suitable for conversion to chemicals and fuels
- Long-term potential or gas and gas hydrate in remote offshore situations
- Imported fuels
  - Coal
  - Distillate
  - LNG?

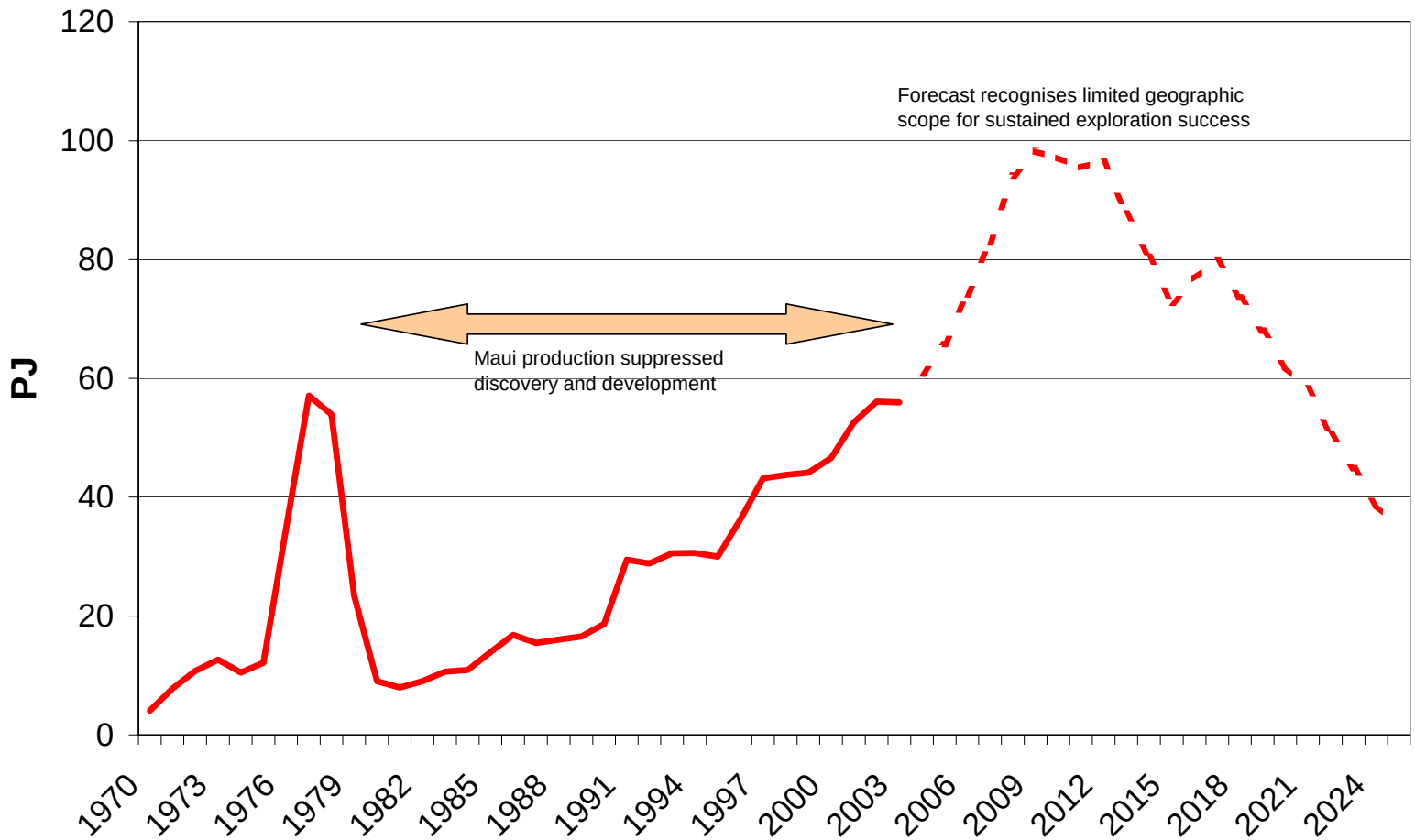
What options offshore Taranaki…

- Excellent recent success rate
  - Pohokura
  - Oil fields – Maari, Tui
  - Karewa
- Key permits just awarded
- Karewa commerciality dependent on additional fields on trend
- Production from new offshore Taranaki fields unlikely before 2009 at the very earliest (2012?)
- Minimum scale likely to be at least 30 PJ/year, probably >50

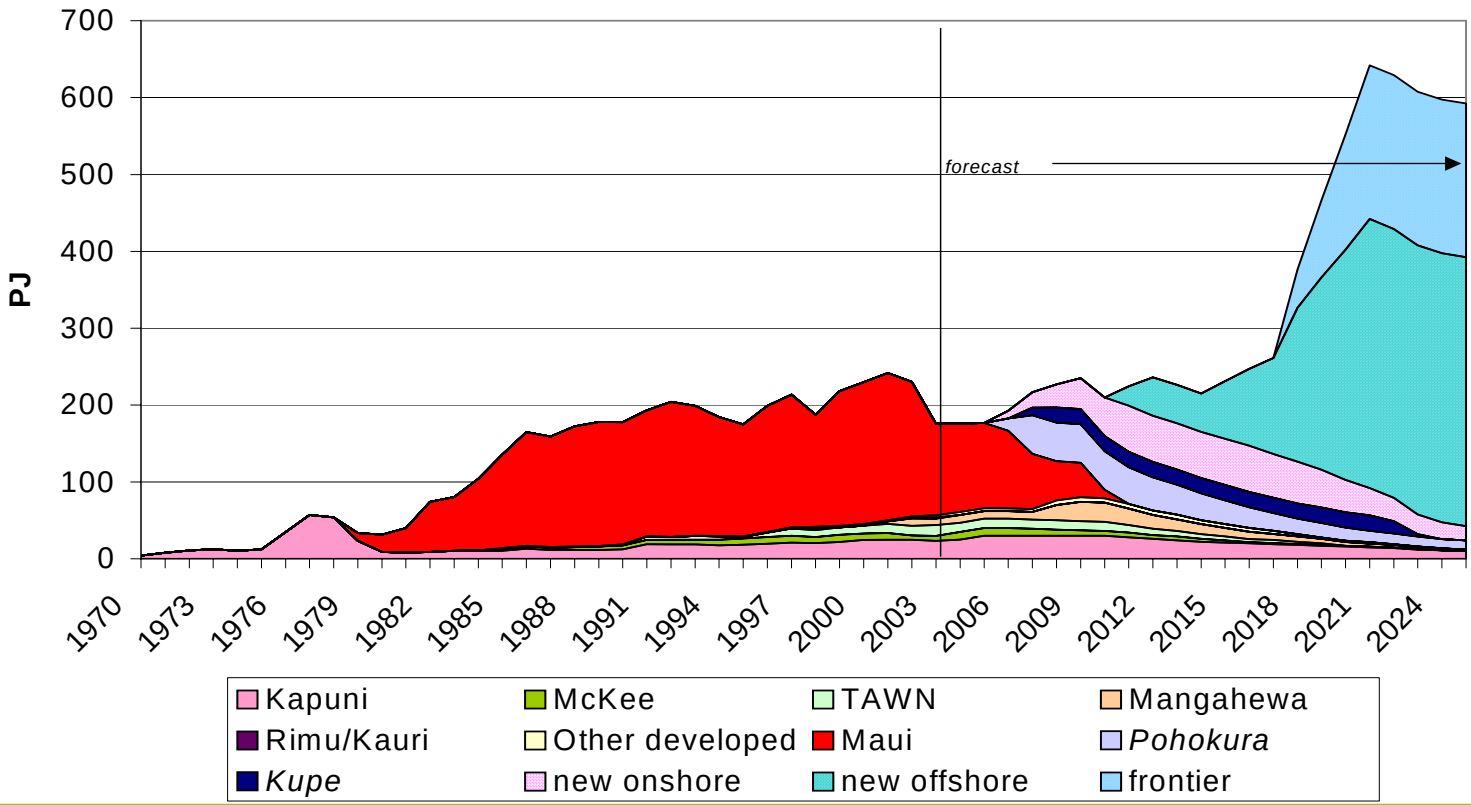


What scope for discovery and development…

Onshore Taranaki gas production



An optimistic scenario for New Zealand gas production given successful and aggressive exploration investment



Coal dominates NZ's energy inventory

- Waikato: 714 M tonnes
- N Taranaki: 174 M tonnes
- West Coast: 343 M tonnes
- Otago: 1154 M tonnes
- Southland: 6256 M tonnes

New Zealand's Lignite Resources…

- **World Class Lignite Resources:**
  - **~30x the energy content of the Maui Gas Field.**
  - **~100,000PJ**
- **Good understanding though National Coal Resources Survey (NCRS) 1970's – 80's.**
- **High quality properties, low sulphur, low ash.**
- **Estimates of recoverable coal are dependant on utilisation assumptions.**
- **The South Island lignite resources dominate New Zealand's coal resource, at ~80%.**
- **In ground lignite resources in Southland and Otago are estimated at ~11 billion tonnes, of which 7 billion is estimated to be recoverable.**

New Zealand's Renewable Resources

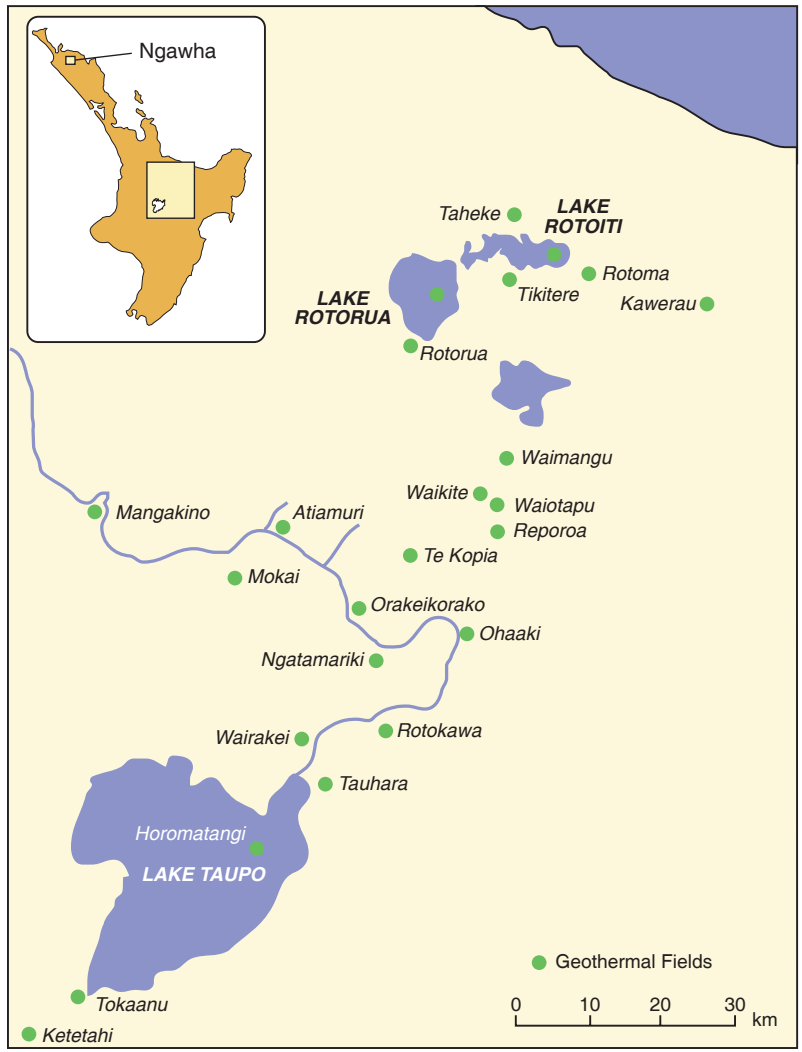
- Hydropower will add capacity but with the same geographic and hydrologic weaknesses as existing system
- Geothermal could be expanded depending on resource consents and field performance risks
- Wind has a long way to go before making a significant scale of contribution
- Biomass recovery from NZ forestry potentially significant, but the dominant use will be for direct heat

Geothermal Potential

Geothermal energy is largely underdeveloped-

- Ownership
- RMA issues

Opportunities essentially limited to large scale centralised power plant



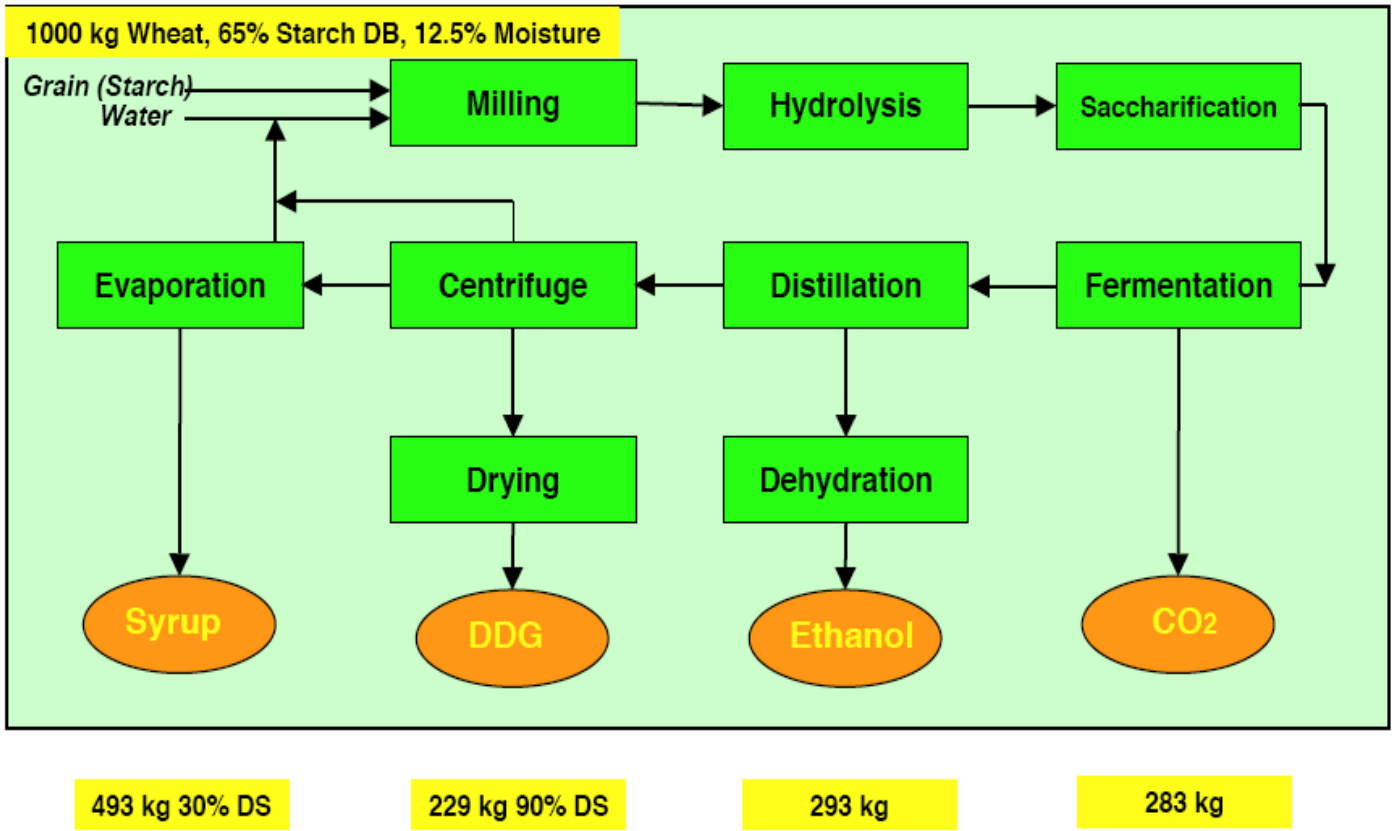
Wind Potential

Up to 13 general areas identifies as suitable for wind farms

The main barriers to development of wind are capacity, economic and system reliability

Characteristics of wind energy limits potential contribution to about 12% of electricity demand

Biofuels?…



Ethanol from grain
(Source: Lurgi)

Commercial ethanol...

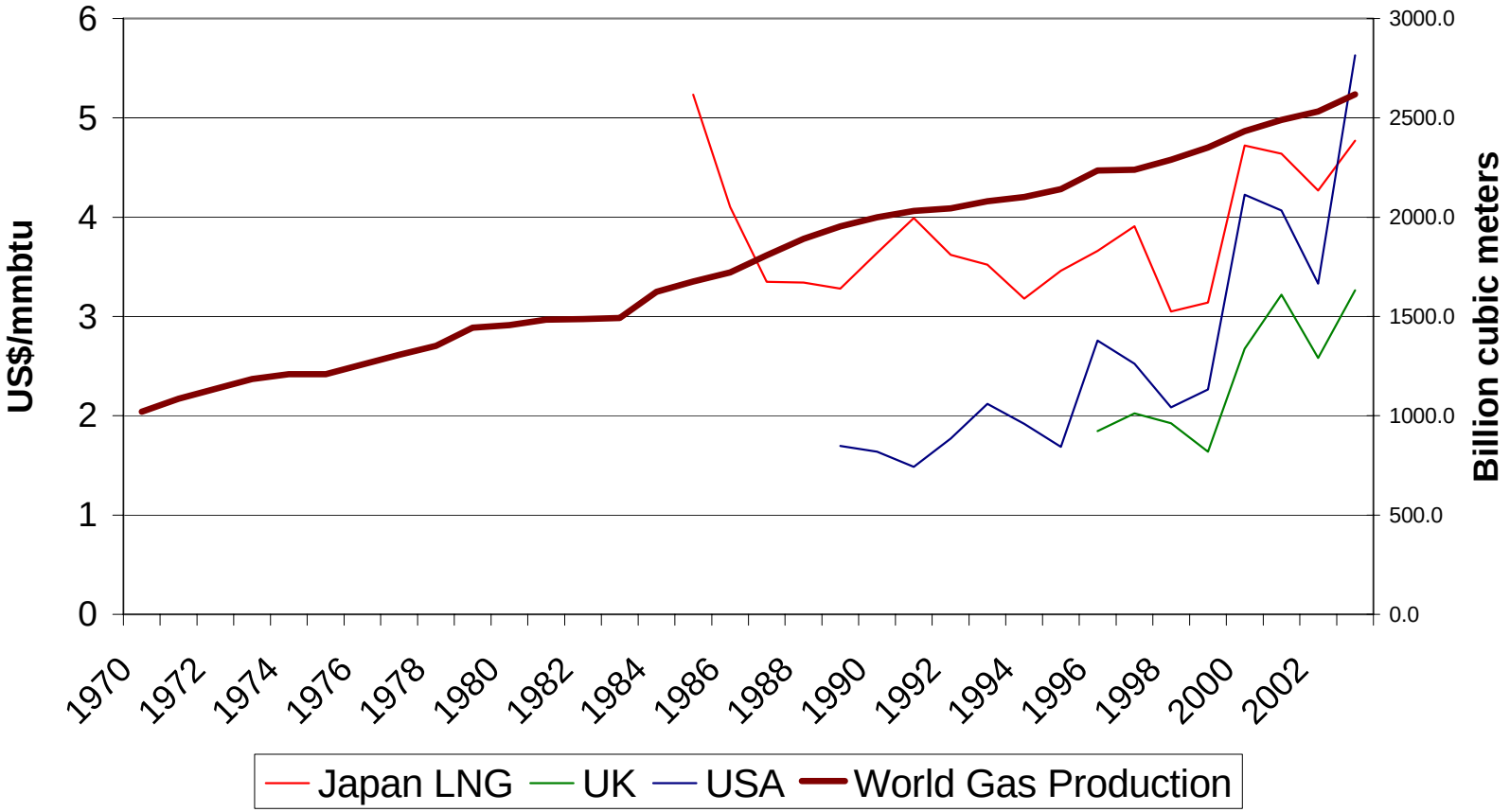
Commercial bioethanol plant
(Source: Lurgi)

Security of Supply does not require NZ to lock into any one option:

- The inherent difficulty face by the NZ energy market is one of scale.
- In a small market the likelihood of dominance is high. The paradox of striving for economies of scale has too often resulted in a reliance on a single dominant energy source
- The fundamentals for further gas exploration success are good. NZ thus has a window of opportunity available to it of several years before decisions need to be made on importation of natural gas - or other fuel types
- For major energy users the price of energy will be critical - higher costs will adversely impact on NZ international competitiveness and hence on the economy as a whole
- The importance of diversity of energy supply on security needs to be underlined.

LNG - the "no" risk option….

Gas prices and production



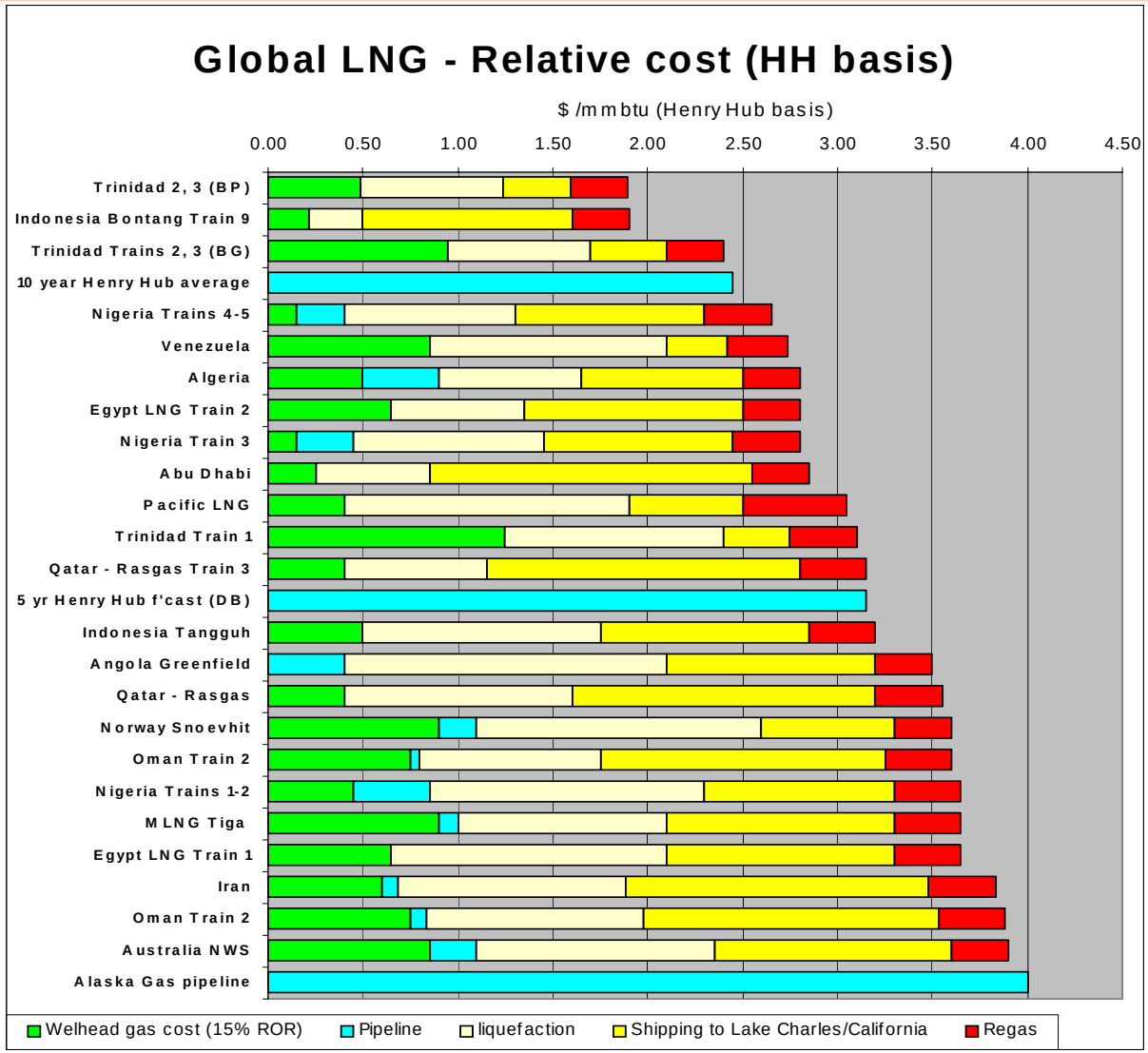
BP Statistical Summary 2004

Global LNG Cost Competitiveness (HH)….

- Low Wellhead gas cost (< $0.50 /mmbtu) :
  - Trinidad T2, T3
  - Bontang
  - Nigeria
  - Algeria
  - Abu Dhabi
  - Rasgas T2
  - Pacific LNG
  - Tangguh

- Low Liquefaction cost ($0.50-$1.00 /mmbtu)
  - Bontang
  - Trinidad
  - Egypt LNG
  - Abu Dhabi
  - Algeria
  - Qatar
  - Oman

Source – Deutsche Bank April 2003

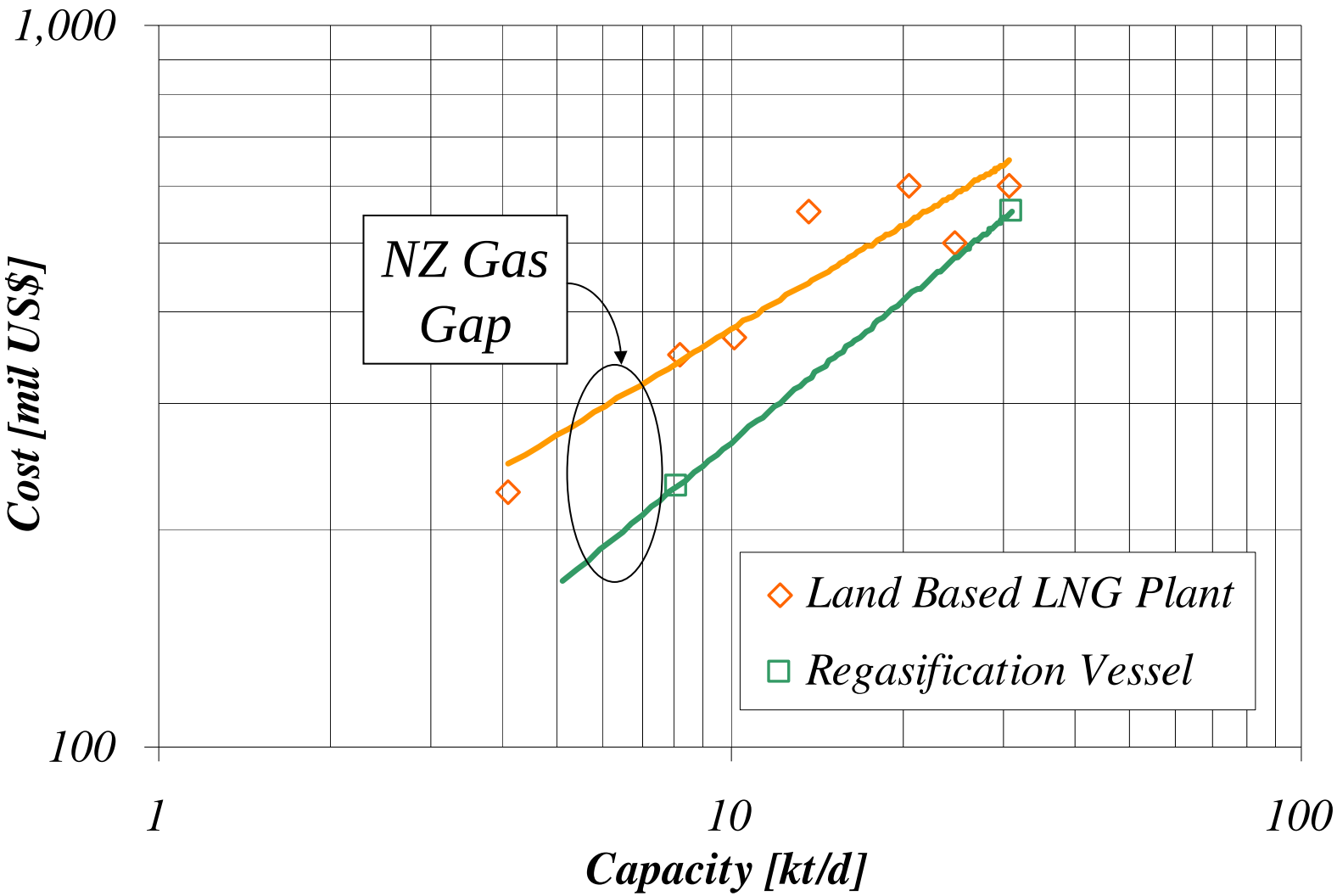


A New Zealand LNG Project - assumptions

Conventional land-based receiving, storage terminal and regasification plant:

- Standard size tanker of 145,000 m3
- Turn-around time 15 days
- Storage 2 x 108,000 m3
- On-stream Factor of 83%
- Maximum Dalily Delivery 0.25 bscf
- Annual Quantity 1.56 mt (80 PJ)

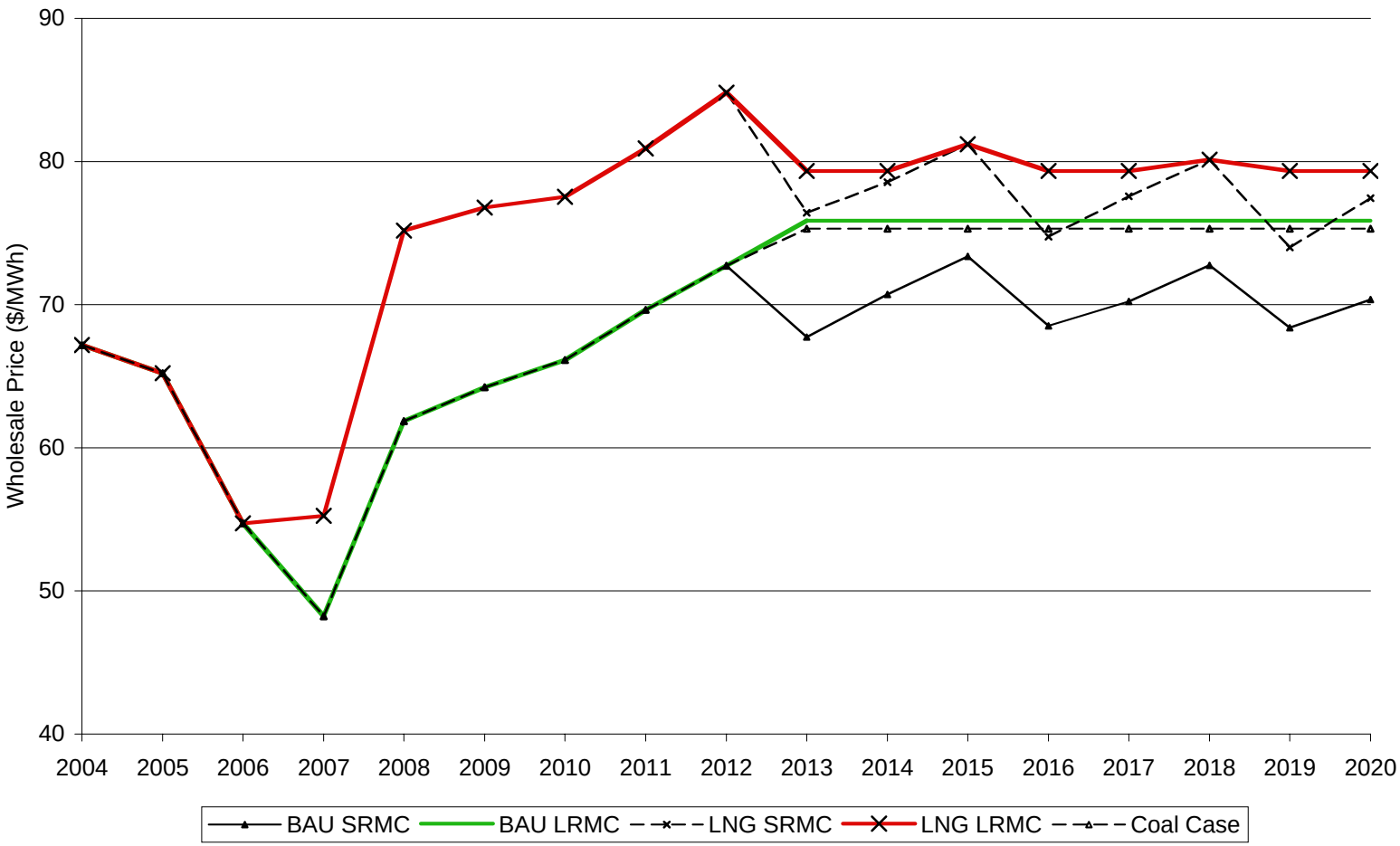
LNG: Capital Costs…



Forecast LNG prices…

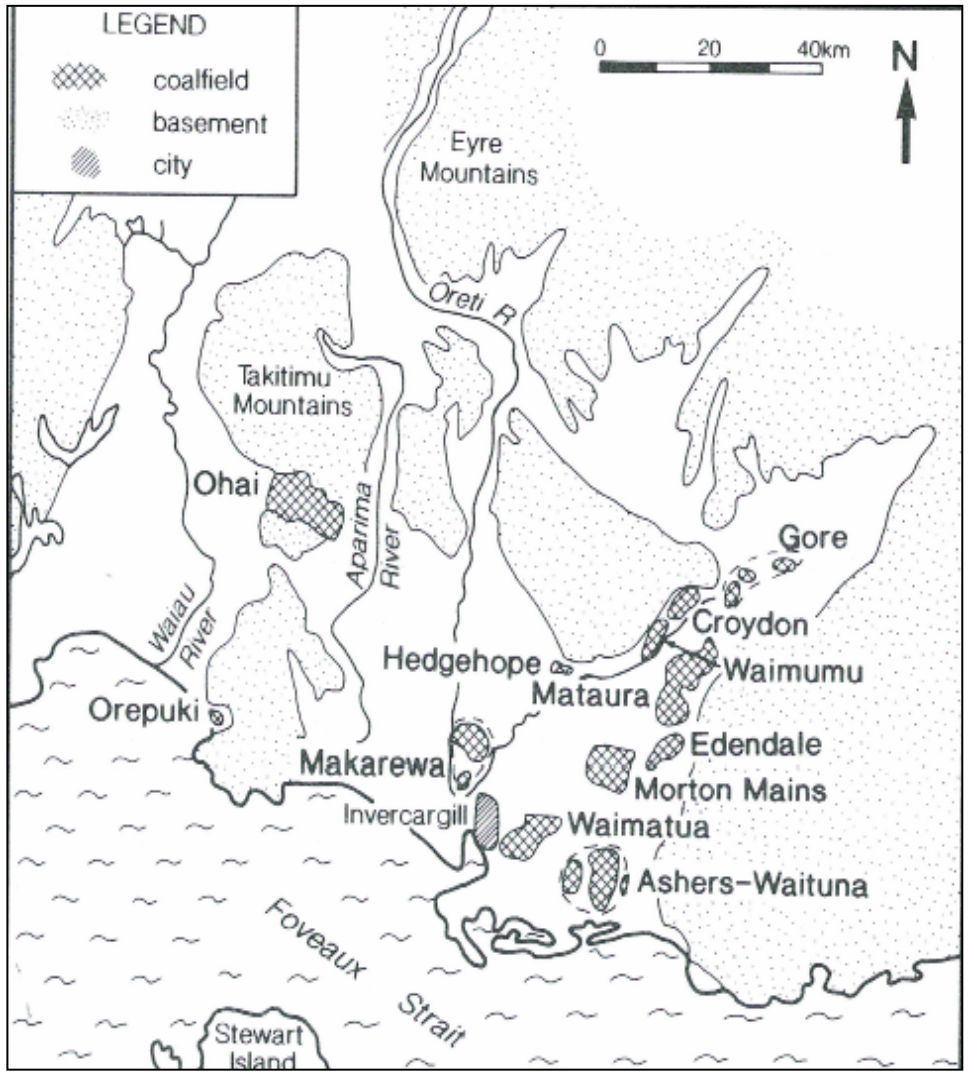
Oil price US$/bbl	Posted LNG price US$/GJ	Delivered LNG price		
		NZ$/GJ @45c/US$1	NZ$/GJ @55c/US$1	NZ$/GJ @65c/US$1
20	2.84	9.60	7.85	6.65
25	3.08	10.13	8.29	7.02
30	3.31	10.64	8.70	7.37
35	3.55	11.18	9.15	7.74
40	3.79	11.71	9.58	8.11
45	4.03	12.24	10.02	8.48
50	4.26	12.76	10.44	8.83

What price pathways…

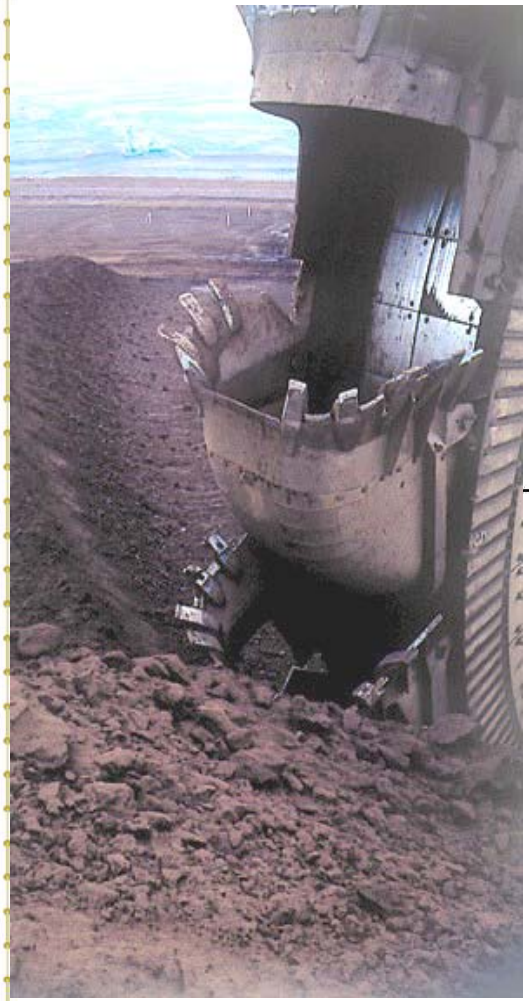


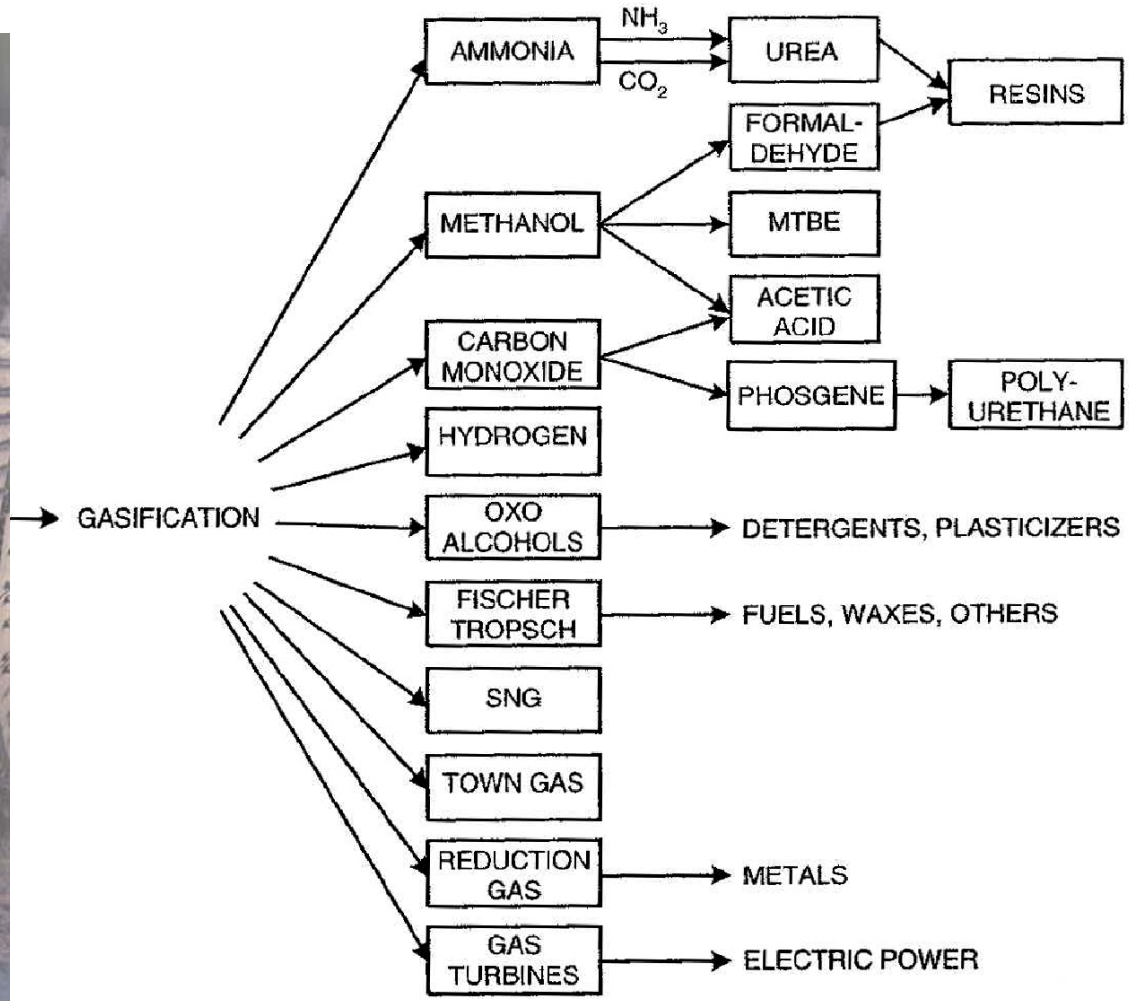
Southland lignite resources - an alternative option?

- **All lignite fields are multi seamed**
- **Majority of lignite resource is in seams greater than 10 m think**
- **Geologically amenable to large scale open pit mining**
- **Indicative in-ground properties (Ashers-Waituna)**
  - **55% moisture**
  - **5.5% ash**
  - **0.49% sulphur**
  - **10.26 MJ/kg specific energy**

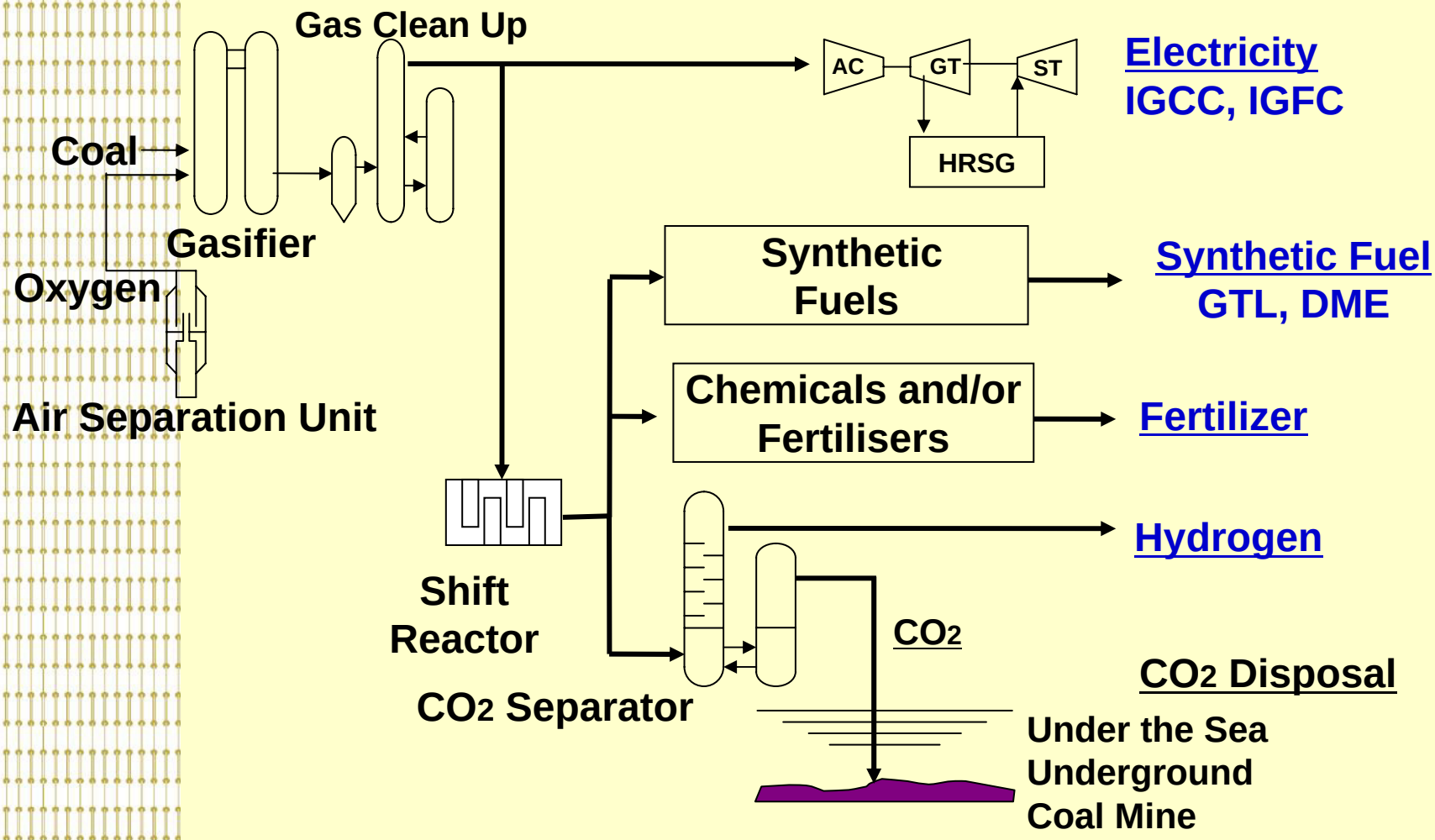


Perhaps we should think big?….





Coal gasification technology…



FT-Liquids Industry now emerging:

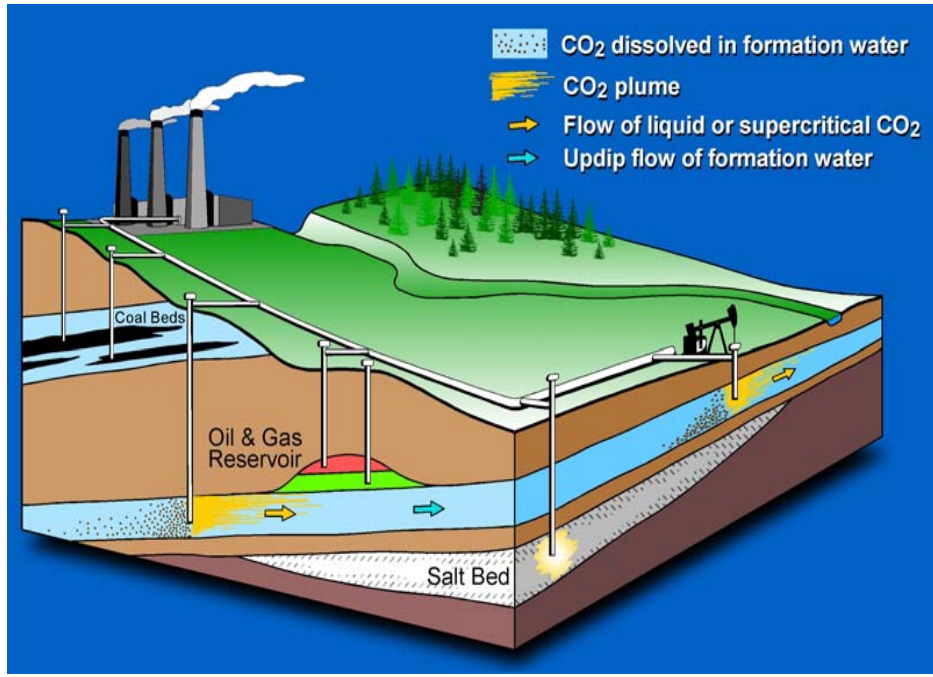
- Five FT Liquids plants in operation, both NG and coal
- Environmental pressures leading to an increased demand for ultra-low sulphur fuel oils
- Market price of crude now above where GTL diesel is competitive to refinery diesel
- Next plant on stream, Qatar Petroleum 34,0000 bbl/day

Attributes for a New Zealand facility?

- Resource risk low
- Coal quality indicates good conversion potential
- Gasification route superior in environmental performance
- Co-production offers swing capacity to mitigate dry year hydro risk
- Global GTL synthetic diesel production expected to grow to as much as 800,000 BPD within he next decade

CO_2 injection and geological storage…

- **Sedimentary basins are the best sites for CO2 injection and storage**
- **Long term**
- **Porous and Permeable rocks**
- **Same location as we find hydrocarbons**



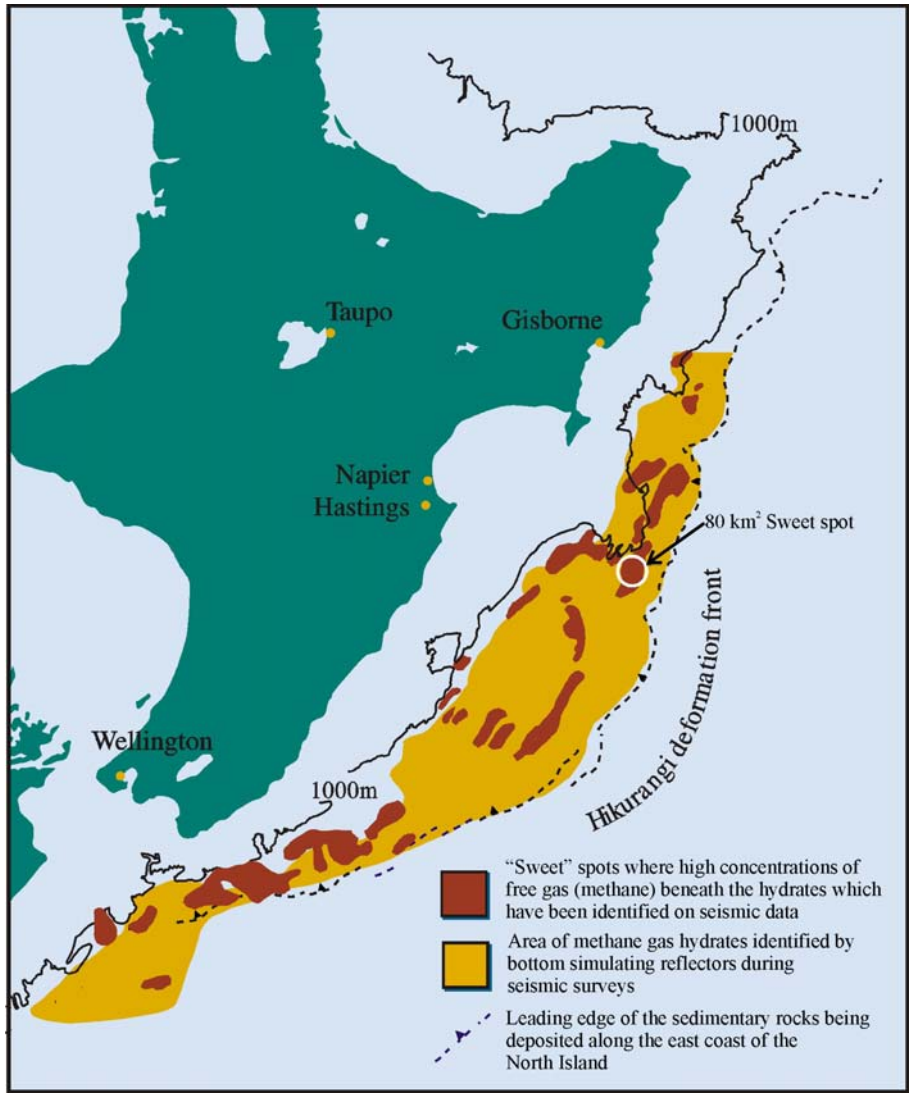
Our energy future — prioritising effort

Achieving a sustainable and energy supply remains one of the most intractable problems for New Zealand:

- **Critical is securing future energy reserves and new investment in national capacity to deliver affordable energy solutions - *economic resilience***
- **Our national energy strategy needs to keep pace with global trends in energy supply and energy innovation - *safeguarding NZ's competitive position***
- **Long term investment in alternative solutions to reduce the adverse impacts of continued reliance on fossil fuels - *sustainability***

And what about investment in alternatives?..

Understand - and recognise - the macroeconomic value to New Zealand of supply diversity.



Gas hydrate 2015?