UNSW Energy Systems Seminar Program

The Australian Electricity Industry and Climate Change: *What role for geosequestration?*

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The answer up front

- We don't know yet!
  - ..and we need a process to find out that reduces risks and maximises our opportunities through a *portfolio* of technology options
  - supported by a coherent innovation strategy
  - carefully integrated within a wider energy and climate policy framework

Presentation outline

- The policy challenge of climate change
- The Australian policy response to date
- What are our technology options
- Coal-fired electricity generation with geosequestration
  - potential costs
  - potential scale
- Possible scenarios for coal + geosequestration
- Rational policy directions
  - a coherent innovation strategy
  - carefully integrated into a wider energy + climate policy framework

The policy challenge of climate change

- Great risk of irreversible damage to ecosystems, very unlikely to resolve itself without policy
- Developing such policy
  - long time frame and global nature – both climate impacts and in developing and maintaining a policy response
  - many uncertainties both in the types and scale of adverse impacts and most appropriate responses
  - transformation of our society likely to be required, particularly in our dependence on fossil fuels
  - many other important economic, environmental and societal factors associated with our present, and possible future energy systems – economic development, other environmental impacts, resource management, energy security and equity concerns

Guidance for policy development

- Scale + timeline of emissions reductions likely required is global 50-60% cut over century (IPCC, 2001)
  - developed countries potentially obliged to take greater cuts over shorter time frame (UK DTI, 2003)
- Most reductions have to come from reducing fossil fuels (IPCC, 2001)
- Wide range of options for reducing energy emissions
  - end-use energy efficiency shows particular promise
  - lower emission and renewable energy supply,
- Infrastructure investment is key
  - frames societal energy use, long capital stock-turnover means poor choices now will drive continued emissions for decades (IEA, 2003)
- **Technical innovation and progress essential as present technology options inadequate for scale of change required**
- **Transitions in infrastructure and technical innovation have important time lags; therefore need urgent attention**

Innovation policy for climate change

– IPCC identifies "technology as a more important determinant of future greenhouse gas emissions and possible climate change than all other driving forces put together"

How to determine?

– technology sectors to focus on:
  • Energy efficiency, fossil fuel generation, renewables
– technologies with particular promise
– types of innovation of greatest value
  • Improving existing technologies, novel break-throughs
– **policies to support such innovation**

Guidance for innovation policy

- Focusing efforts
  - uncertainties mean risks in trying to *pick winners*
  - however, can't *just* use economy wide price mechanisms (eg. emissions trading)
- Technology options: risk- based assessment of
  - costs now, possible future costs
  - potential abatement scale, and costs with this
  - other related societal outcomes; eg. energy security, health risks
- Innovation process:
  - Invention: *R&D is key* … and there is a clear government role
  - Application: *demonstration and commercialisation* are key
    - The greatest challenge for innovation (IIASA, 2002) …and government roles in both supply-push, and demand-pull polices

Australia and the climate change challenge

BCSE (2003)

"By the end of the 21st century, if we are effectively going to address the issue of global warming, we will need to see a global reduction in greenhouse gas emissions of between 50 and 60 per cent."

The Hon Dr David Kemp, MP

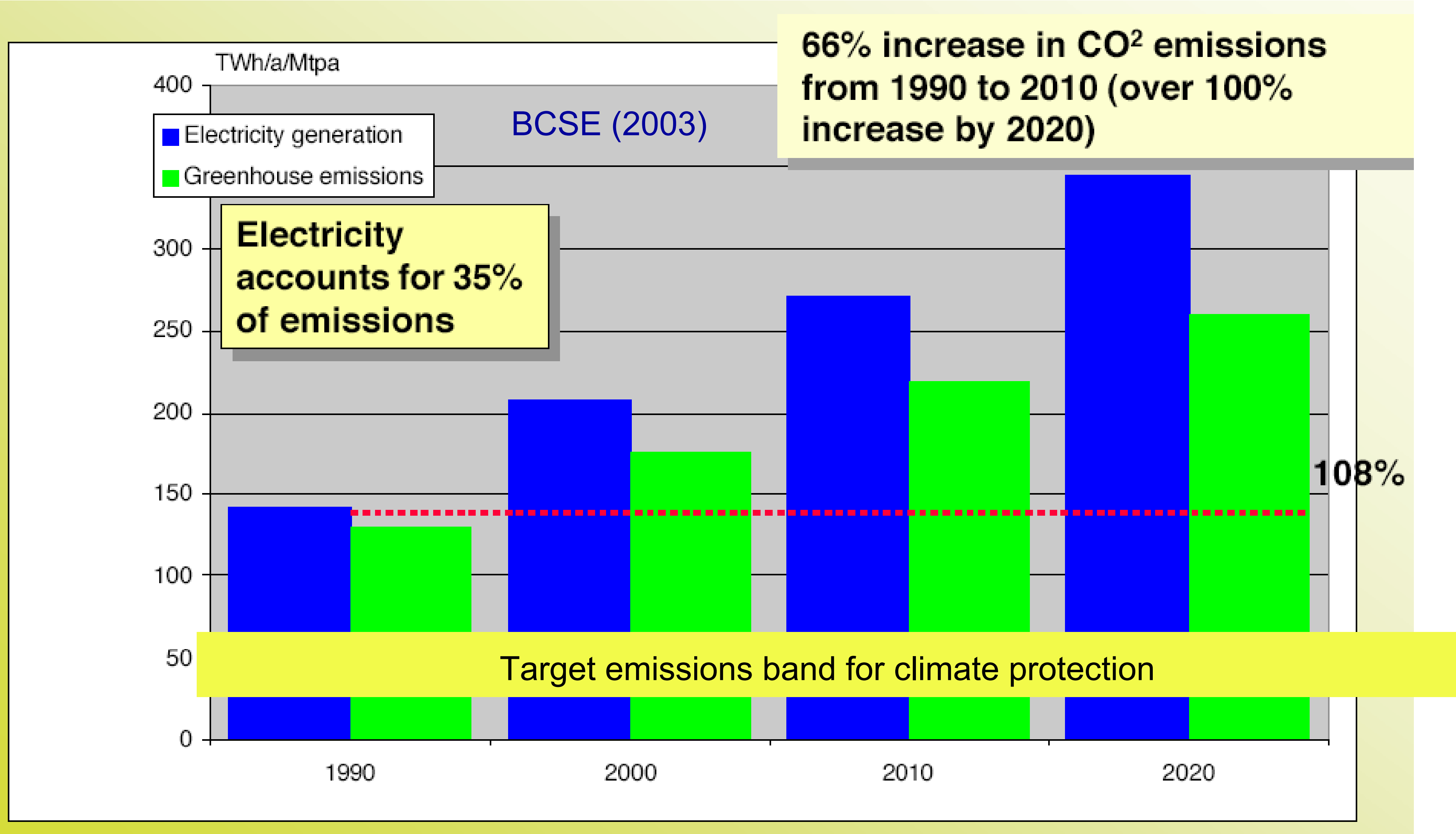
House of Representatives, 20 August 2002.

Even with deep cuts the best we can do is stabilise at a level significantly higher than today

Australian climate change policy

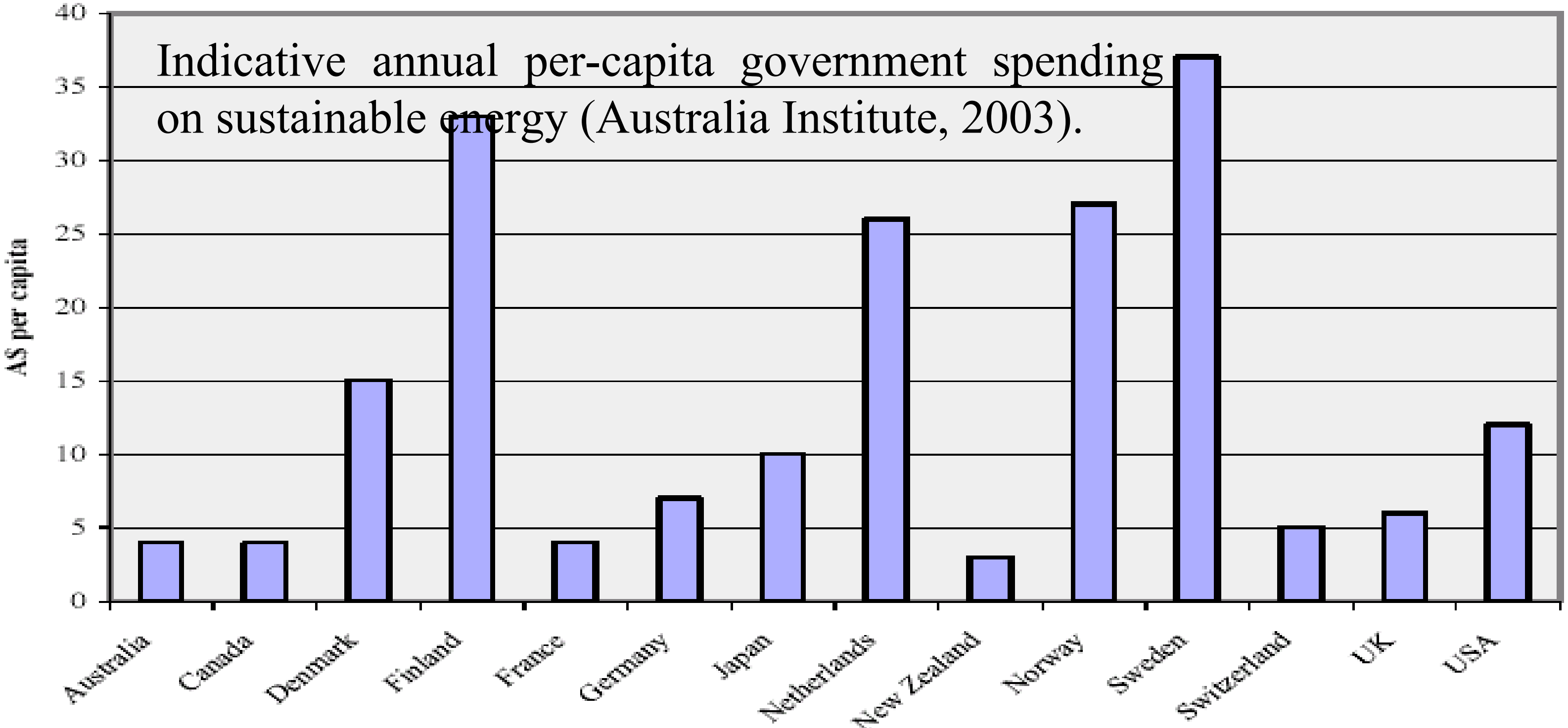
- Target – meet Kyoto and prepare for large scale emissions reductions required over coming century (Australian Government, 2002)
- Mix of educational, voluntary, incentive and modest mandatory measures
  eg. AGO information, greenhouse challenge, GGAP and RECP, MRET and MEPS
- However, present measures almost certain not to deliver targets

Actual & projected emissions from Aust. EI



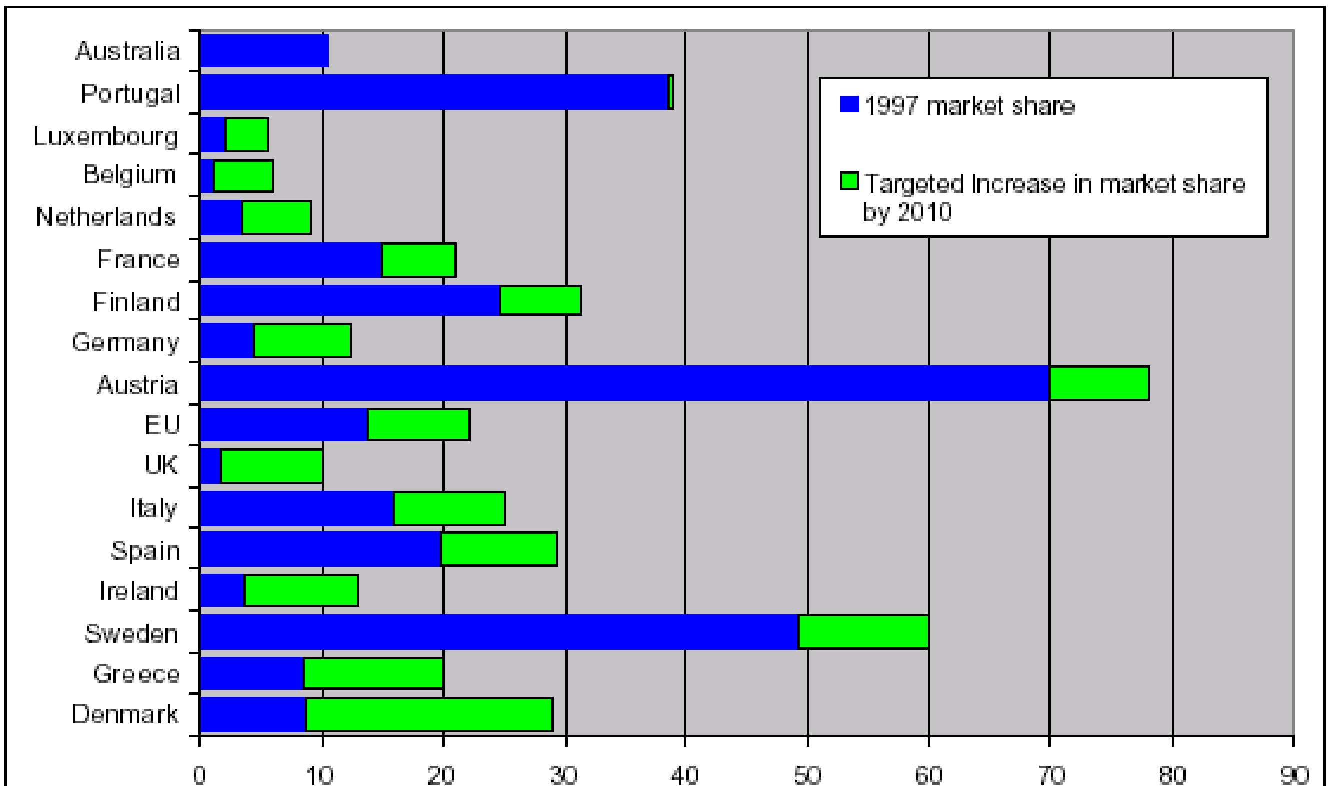
Aust. Climate Change Innovation policy

– R&D (& demonstration/commercialisation)
  - General R&D funding
  - CRCs: Coal + sustainable development, clean power from lignite, **geosequestration** + eco-sequestration (no renewables CRC, UNSW PV)



Aust. Climate Change Innovation policy

- Commercialisation
  - CRCs, RECP, REID etc..
  - **MRET:** mandatory renewables market, however low target, future?



BCSE (2003)

Aust. Climate innovation - geosequestration

- One of Australia's National Research Priorities is 'capture and sequestration of carbon dioxide
- New CRC for geosequestration
- US / Australia Climate Action Partnership
  - features "separation, capture and geological storage of CO2 " (one of only 3 tech. development projects) (Tarlo, 2003)
- Government minister support in public statements
- **PMSEIC**
  - ***Beyond Kyoto* Report – recommends "Establish a national program to scope, develop, demonstrate and implement near zero emissions coal based electricity generation"**
  - Chief Scientist, Dr Robin Batterham giving strong support

Assessing geosequestration

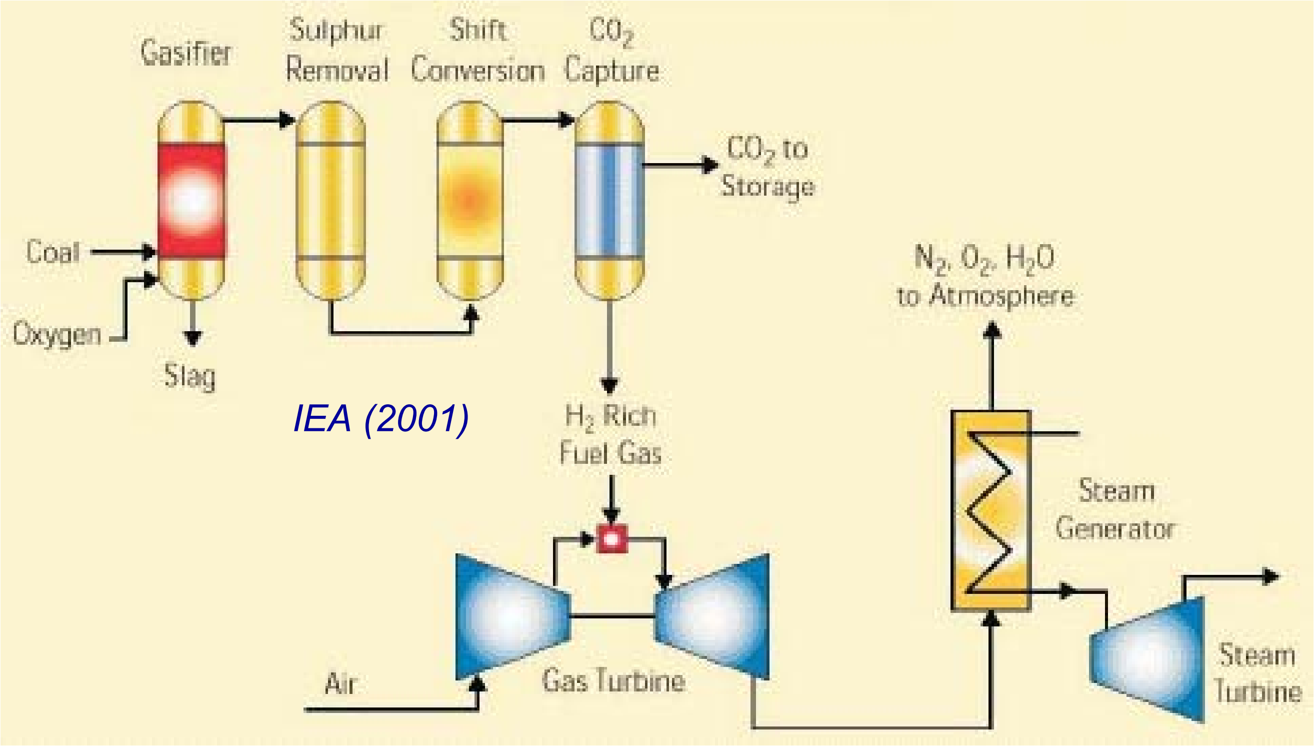
Requires risk-based assessment of

- Technical feasibility
- Costs now, possible future costs
- Potential scale of abatement, possible future reassessments
- Other risk possibilities

- This presentation has some very preliminary work on this

Capturing CO2 from power stations

- CO2 capture technologies well established in oil + chemical industries
  - Limitations with present solvent scrubbing, active research area for improvements
- For power stations
  - post combustion capture from flue gases (14% CO2)
  - IGCC with pre-combustion capture



IEA (2001)

IGCC with pre-combustion capture

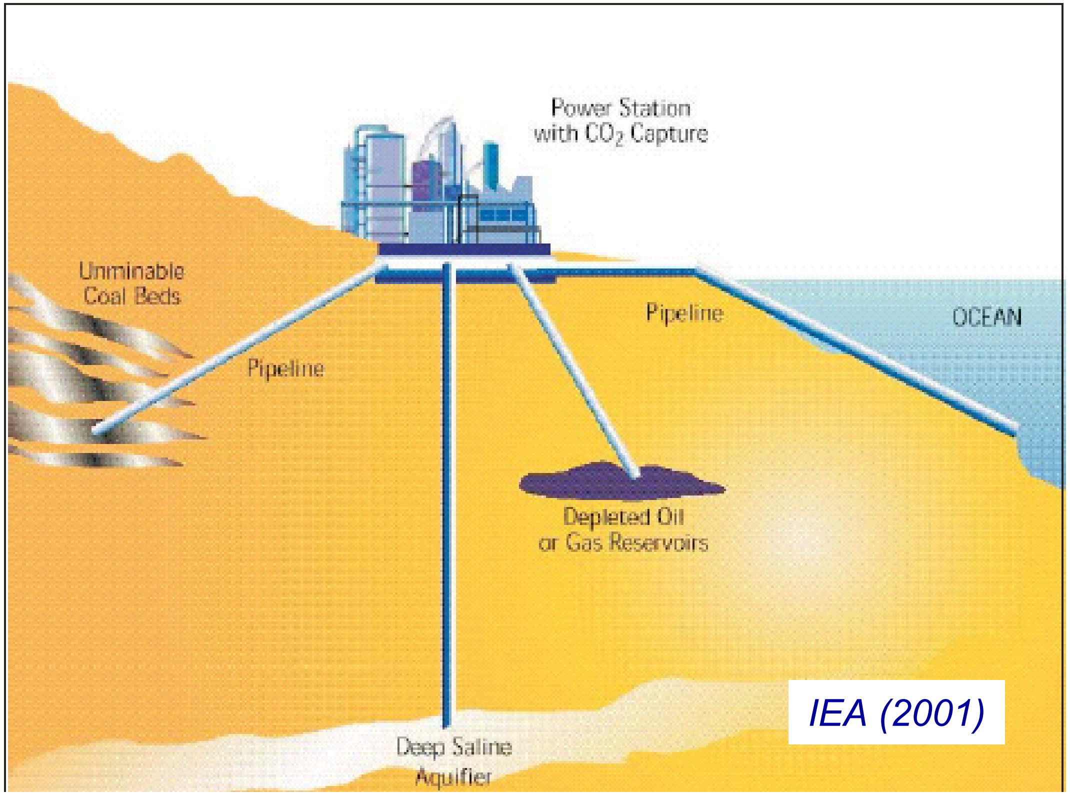
- PMSEIC *Beyond Kyoto* Report - IGCC shows greatest potential for cost-effective electricity generation with CO2 capture

- Considerable experience with gasification
  - 300 gasifiers, some running on coal
  - Most produce syngas with CO, H2 and CO2

- Commercial-scale coal IGCC demonstration plants in the USA, Netherlands and Spain.

- "IGCC has been successfully demonstrated but the capital cost needs to be reduced and the reliability and operating flexibility needs to be improved to make it widely competitive in the electricity market"
- Also Need to commercially prove up 'H2 rich' gas turbine technology (IEA, 2001)

Geosequestration sinks



– Knowledge and experience with Enhanced Oil Recovery on depleting reservoirs with injected CO2
– Limited knowledge and experience with Enhanced Coal Bed Methane through injected CO2 (New Mexico, Alberta)
– Very limited knowledge and experience with saline aquifers (one project in Norway) – not commercially important until now

Transport of CO2

- CO2 largely inert and easily handled
- Already some CO2 pipelines (650km pipeline in US)
- Typically cheaper to pipe CO2 than transmit electricity

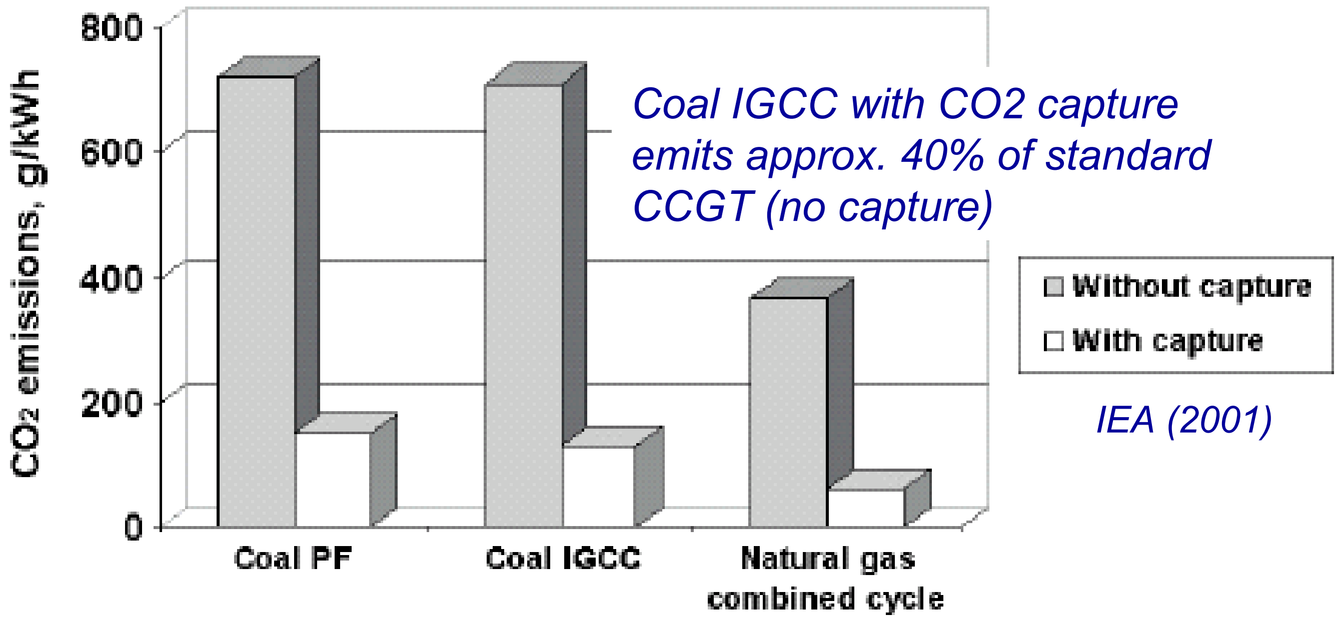
IEA (2001)

Environmental risks

- Some identified risks
- More work required, particularly with saline aquifer storage

Zero… or near zero emissions

- IGCC with geosequestration will still have CO2 emissions
  - Energy and cost tradeoff in CO2 capture from flue / gasifier stream; also energy for transport and pumping underground

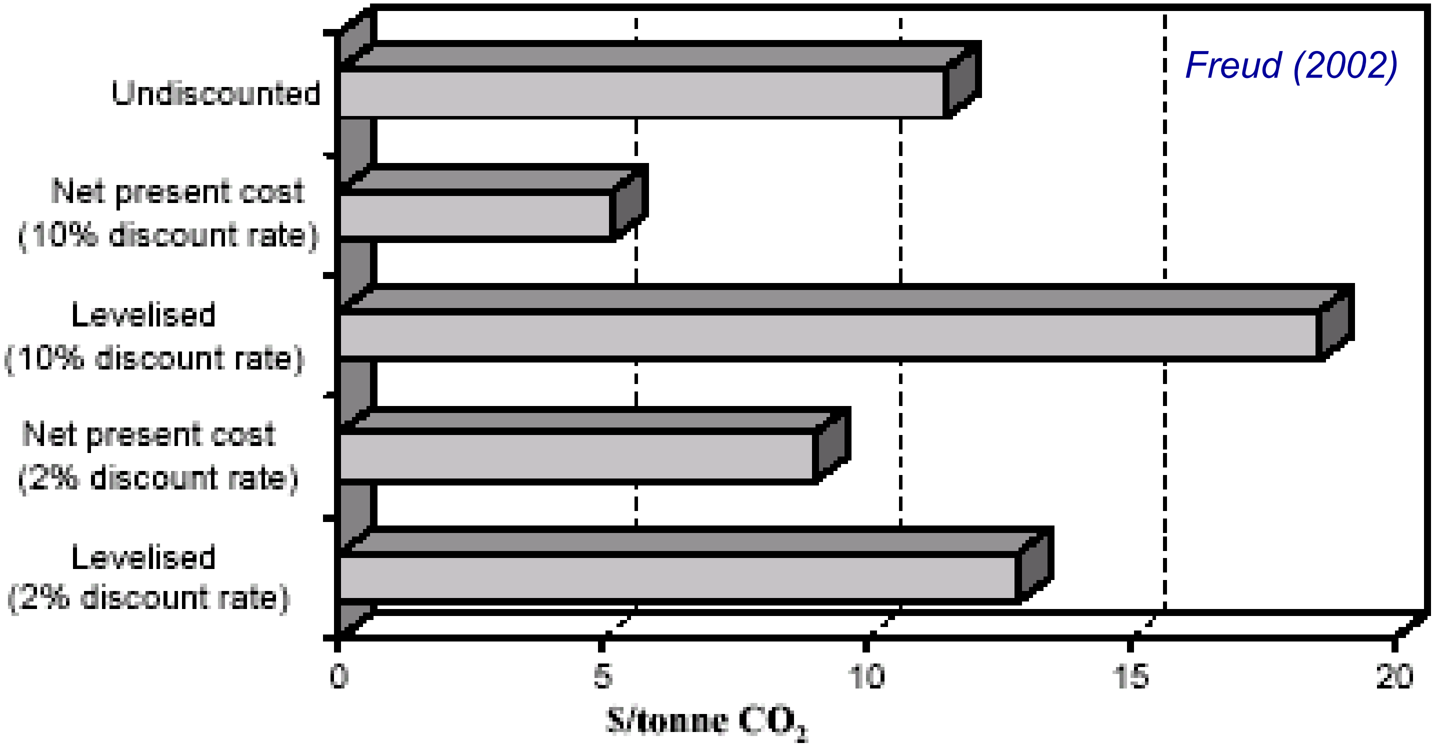


Coal IGCC with CO2 capture emits approx. 40% of standard CCGT (no capture)

IEA (2001)

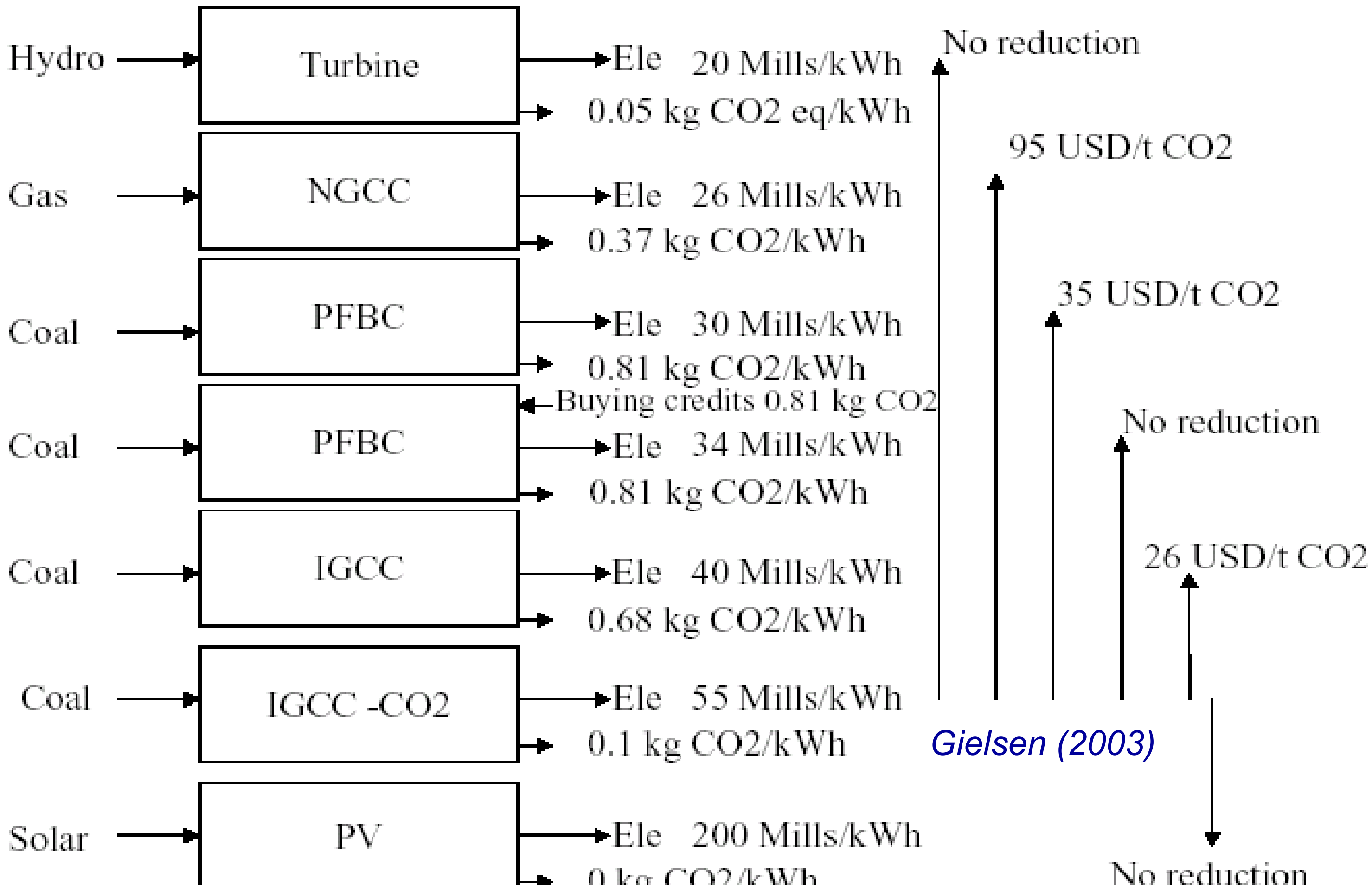
The challenges of cost estimates

- Discount rates and NPC vs Levelised
  - Levelised: costs discounted to time of sequestration
  - Net present costs discounted to start of scheme



The challenges of cost estimates

- Choice of different references for comparison



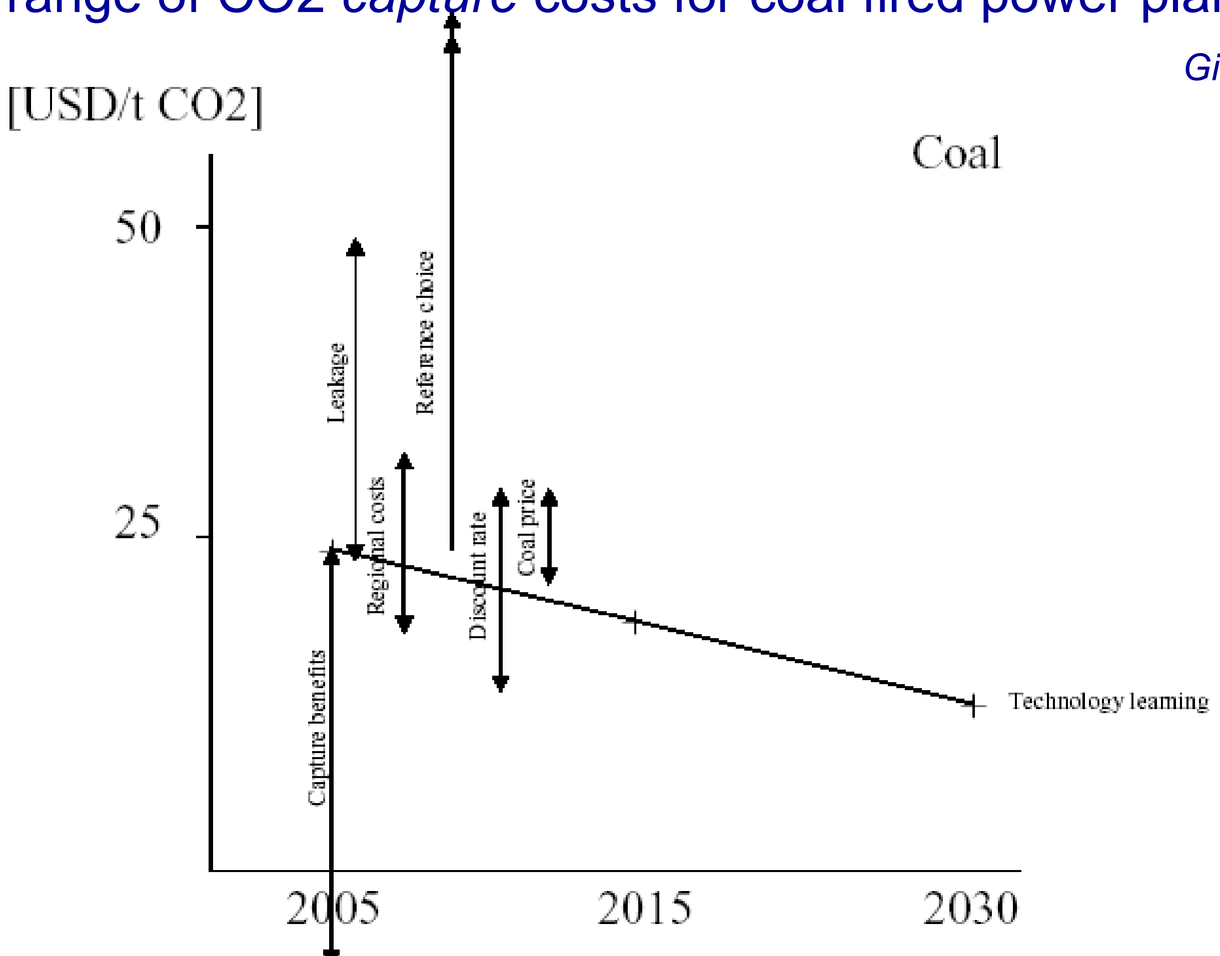
Gielsen (2003)

The challenges of cost estimates

- The role of uncertainties is very important

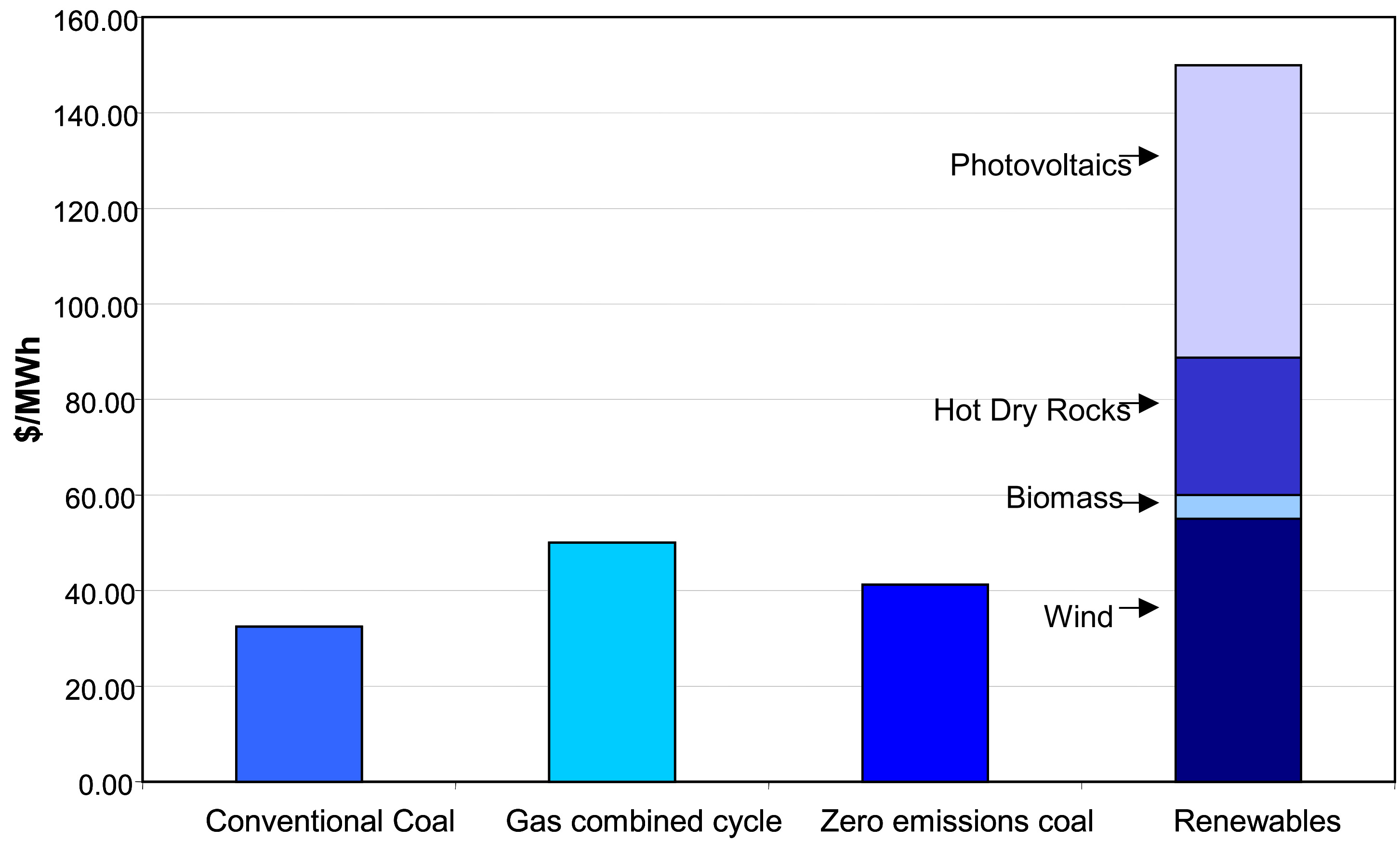
  eg. range of CO_2 *capture* costs for coal fired power plants

Gielsen (2003)



Australian cost estimates

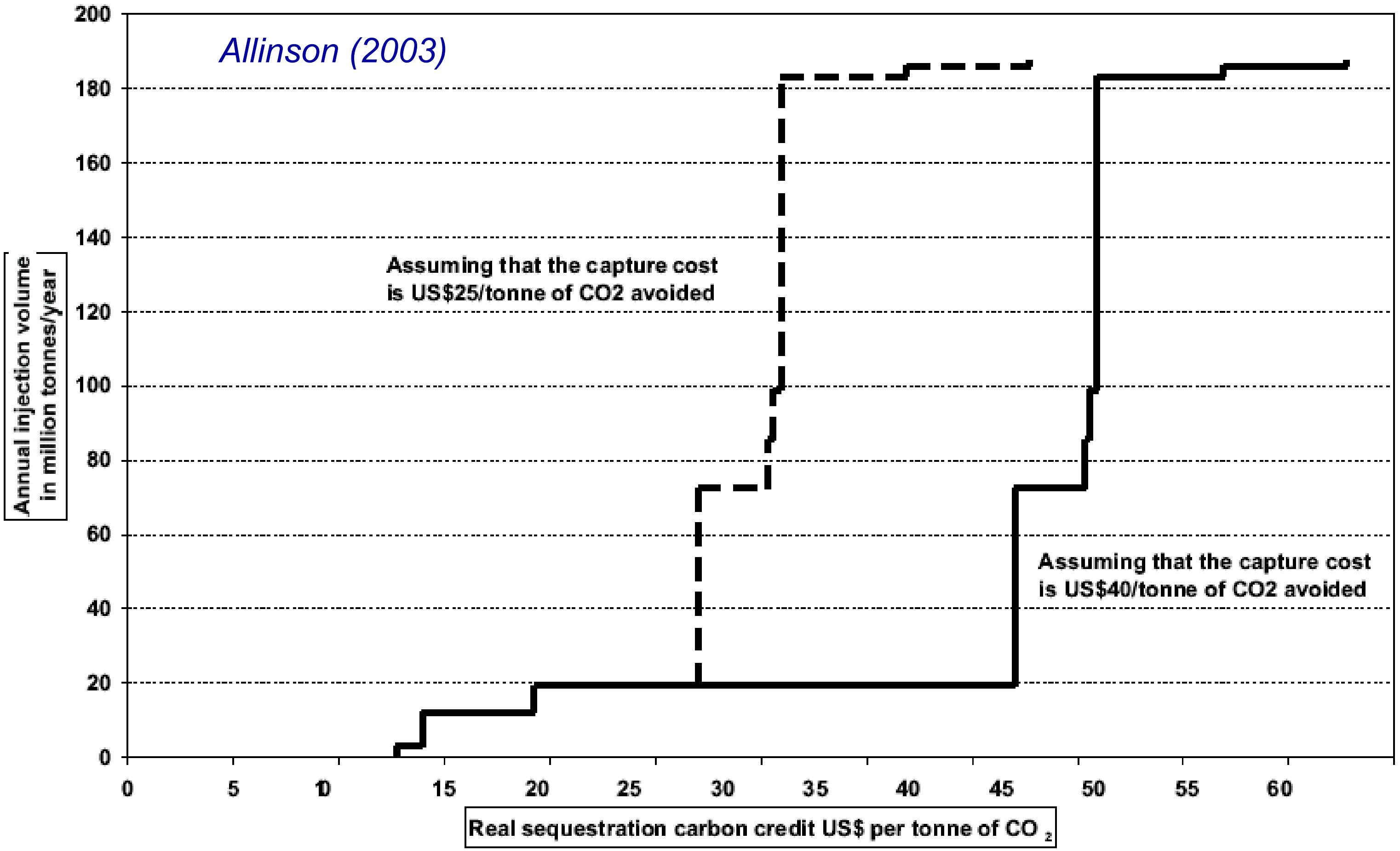
PMSEIC Beyond Kyoto Report



(Source: Roam Consulting – unpublished data 2002)

Australian cost estimates

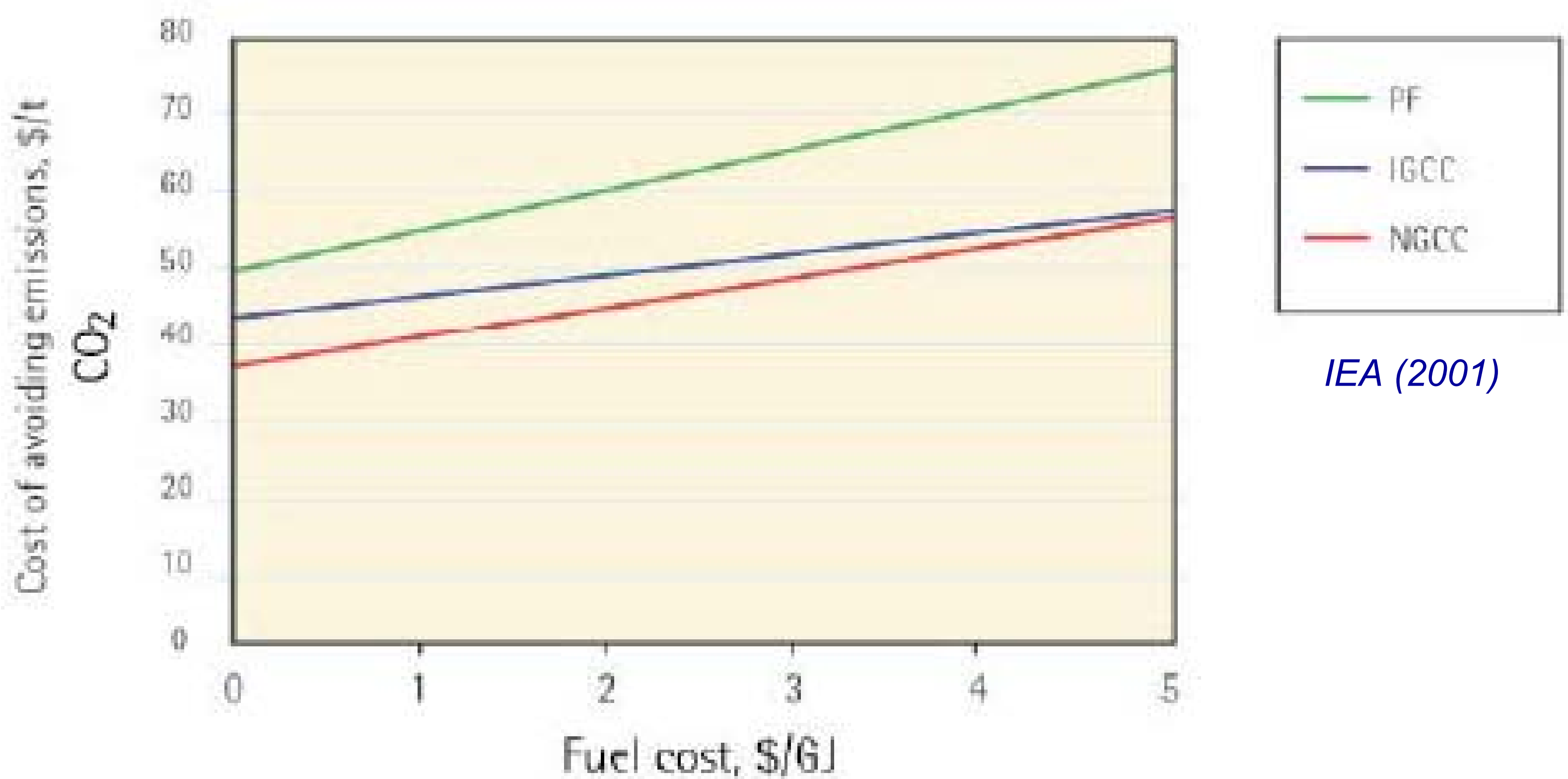
GEODISC "illustrative economic CO2 storage potential of all Aust. Reservoirs"



International cost estimates

Estimated costs of avoided emissions US$/tCO2-e referenced to the same technology without capture

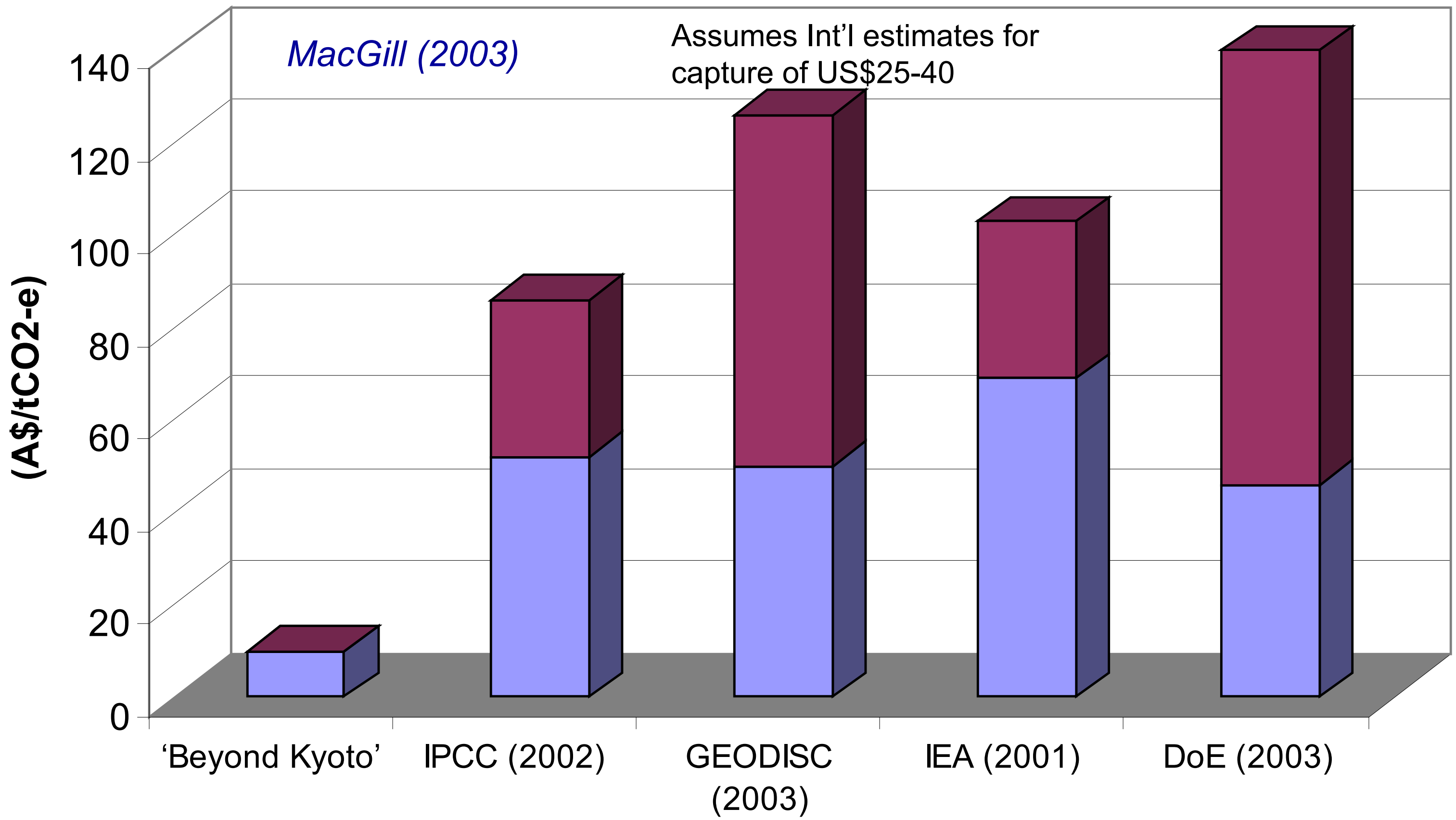
- Pulverised fuel, IGCC and Natural Gas Combined Cycle (NGCC)



IEA (2001)

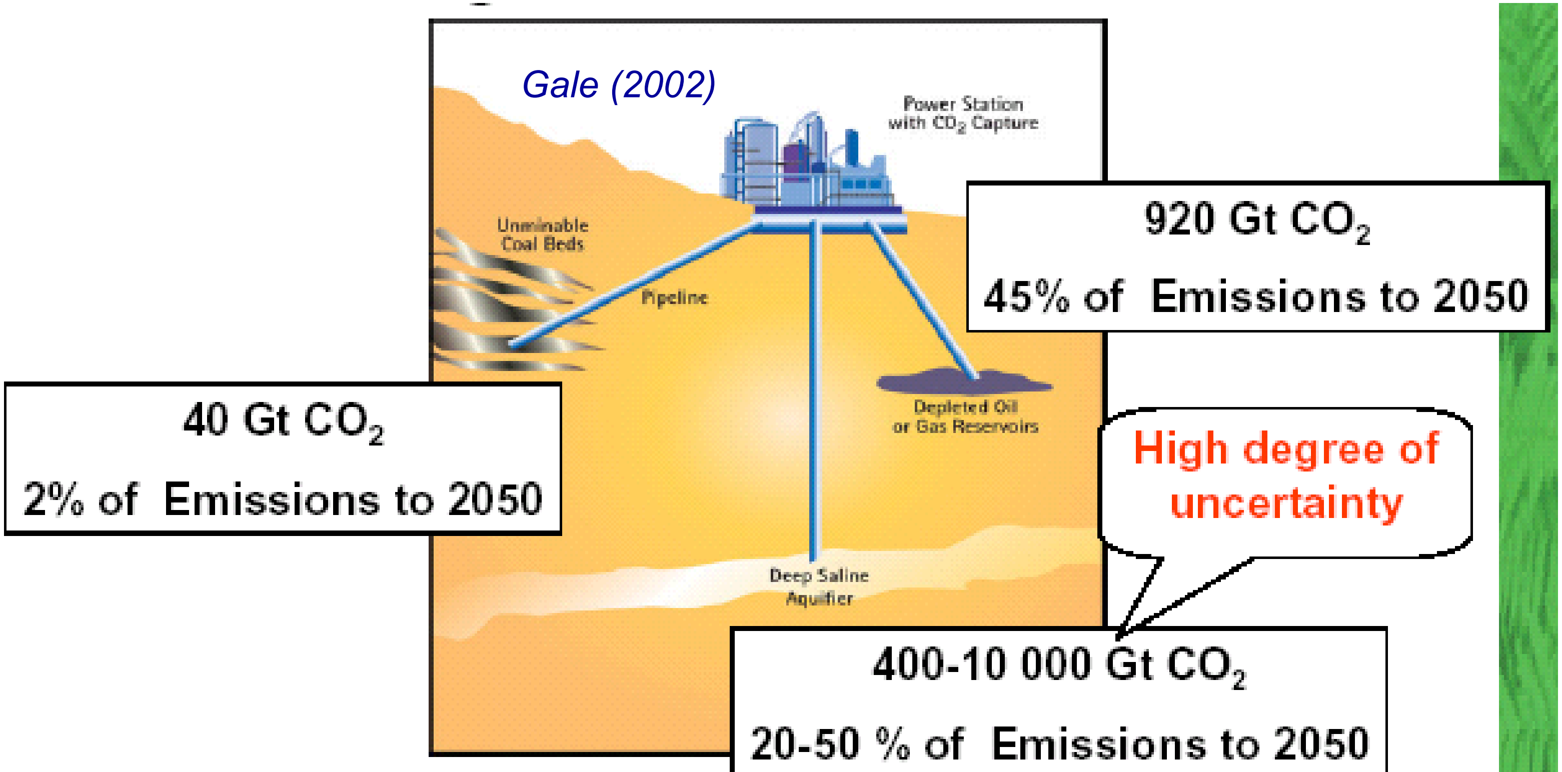
International cost estimates

Estimated abatement costs from different International studies (including uncertainty ranges)



International storage estimates

Very promising opportunities for some regions
Considerable uncertainties – particularly in Deep Saline Aquifers
Possibly a very large (1000 years) storage capacity



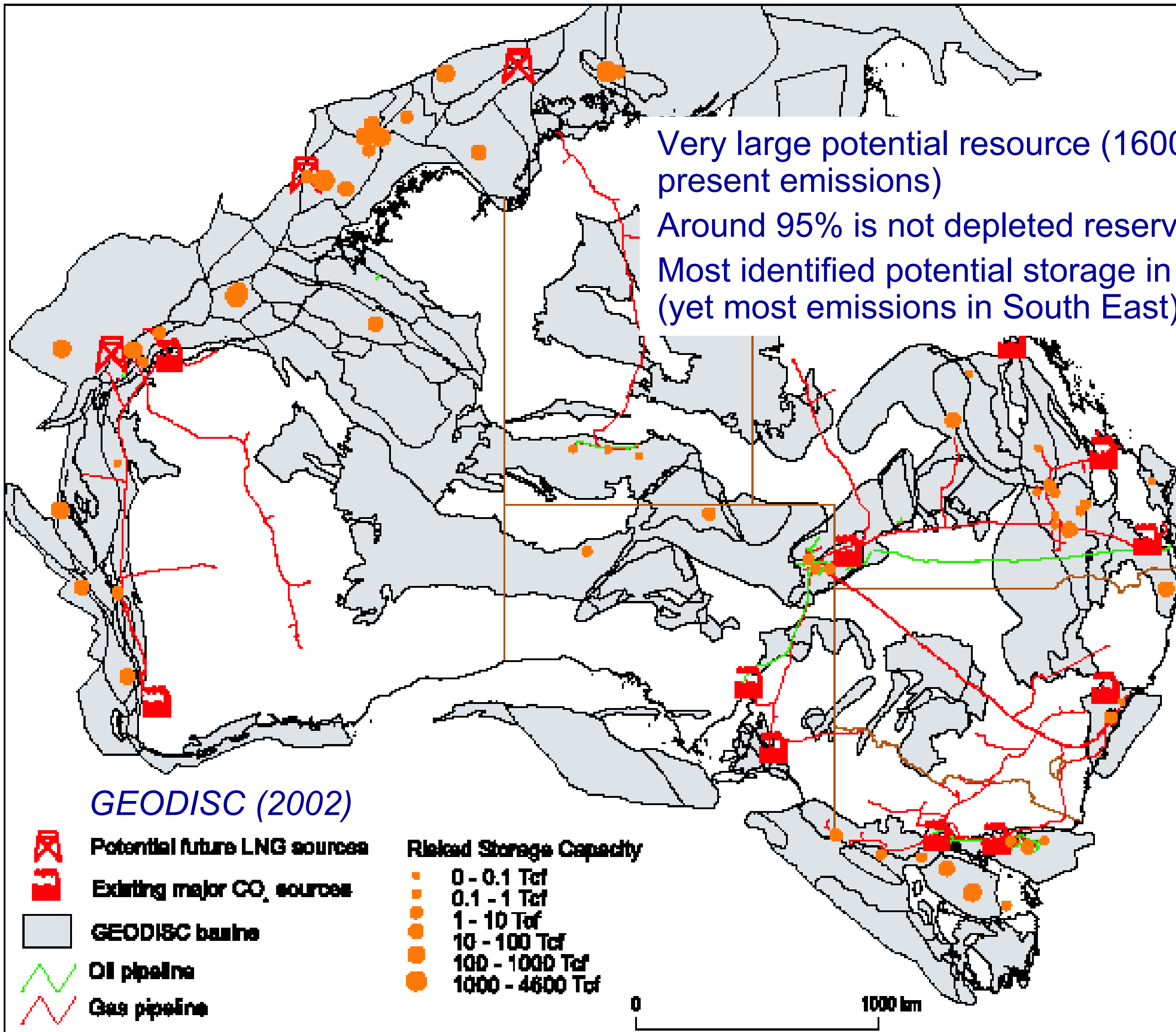
Comparative potentials at storage costs of up to \$20/t CO_2

Preliminary Aust. storage estimates

Very large potential resource (1600 years of present emissions)

Around 95% is not depleted reservoir, coal seams

Most identified potential storage in the North-west (yet most emissions in South East)



GEODISC (2002)

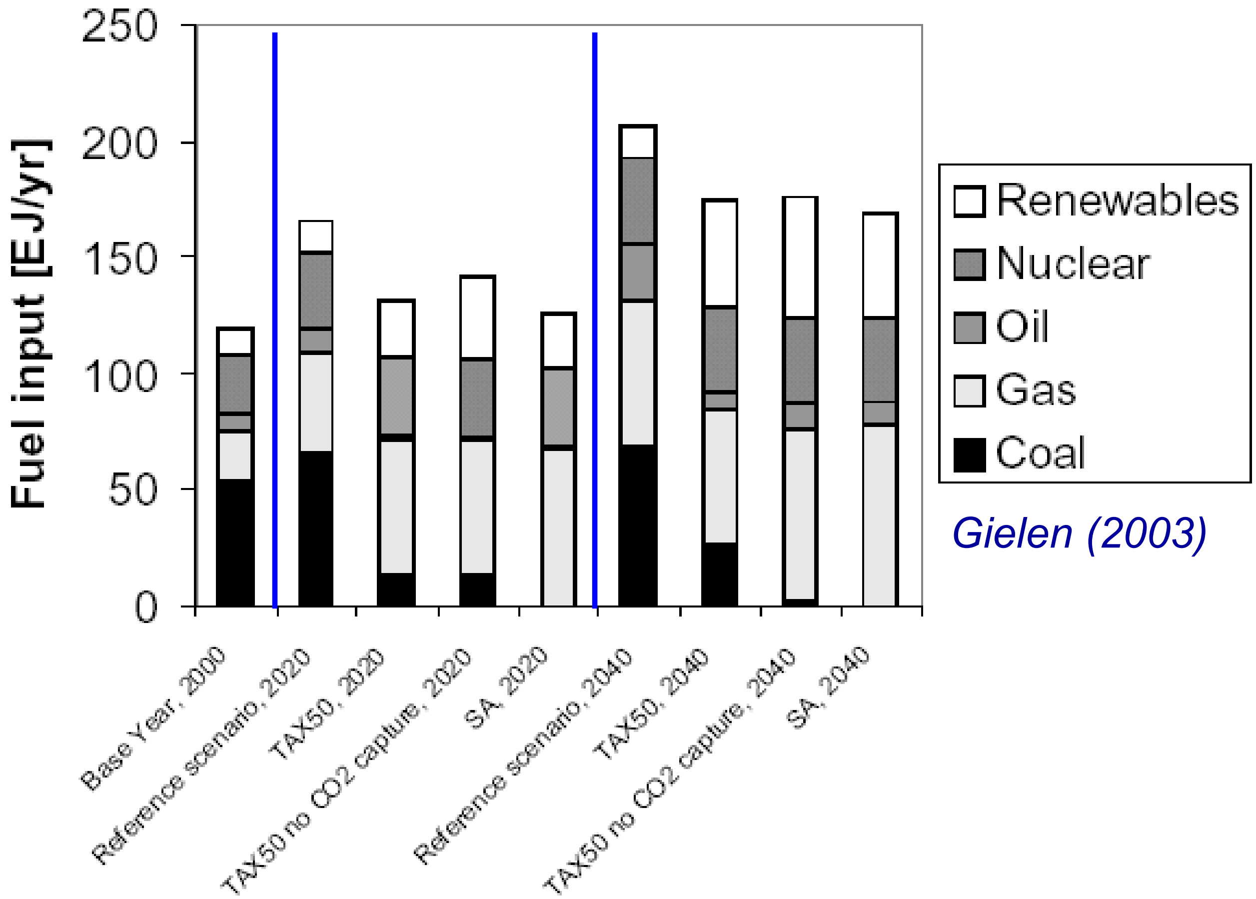
Australian storage

- "Opportunities for CO_2 EOR and CO_2 storage in deep unminable coal seams are limited – niche opportunities may occur
- Immaturity of oil and gas production in Australia means storage of CO_2 in depleted gas fields is not a near term opportunity
- Storage in deep saline aquifers is the most likely route for storing large volumes of CO_2" *(Gale, 2002)*

Global energy scenarios with Geoseq

Preliminary IEA Energy Technology Perspectives (ETP) modelling

- Reference case (no CO2 policies)
- Tax of US$50/tCO2-e from 2010, CO_2 capture + IGCC-SOFC tech.
- Tax but no CO2 capture options
- Tax but no IGCC-SOFC



Gielen (2003)

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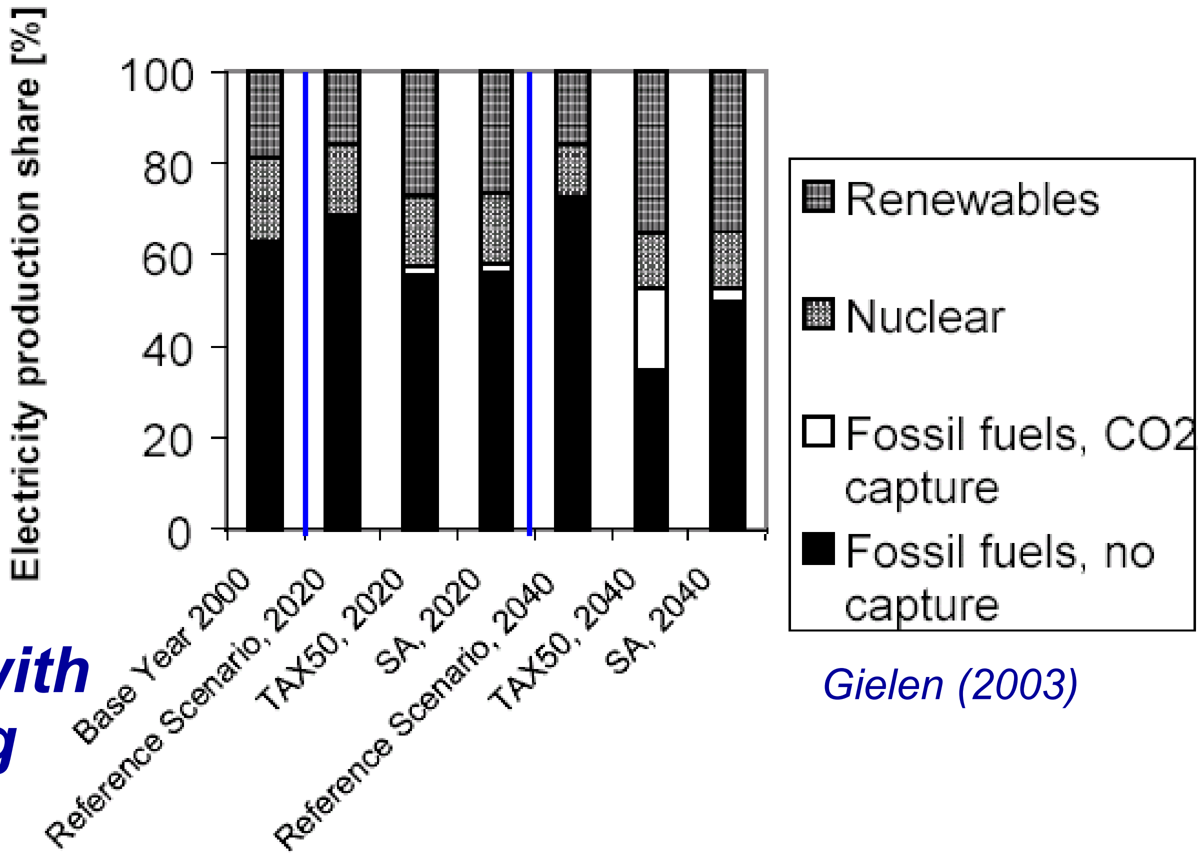
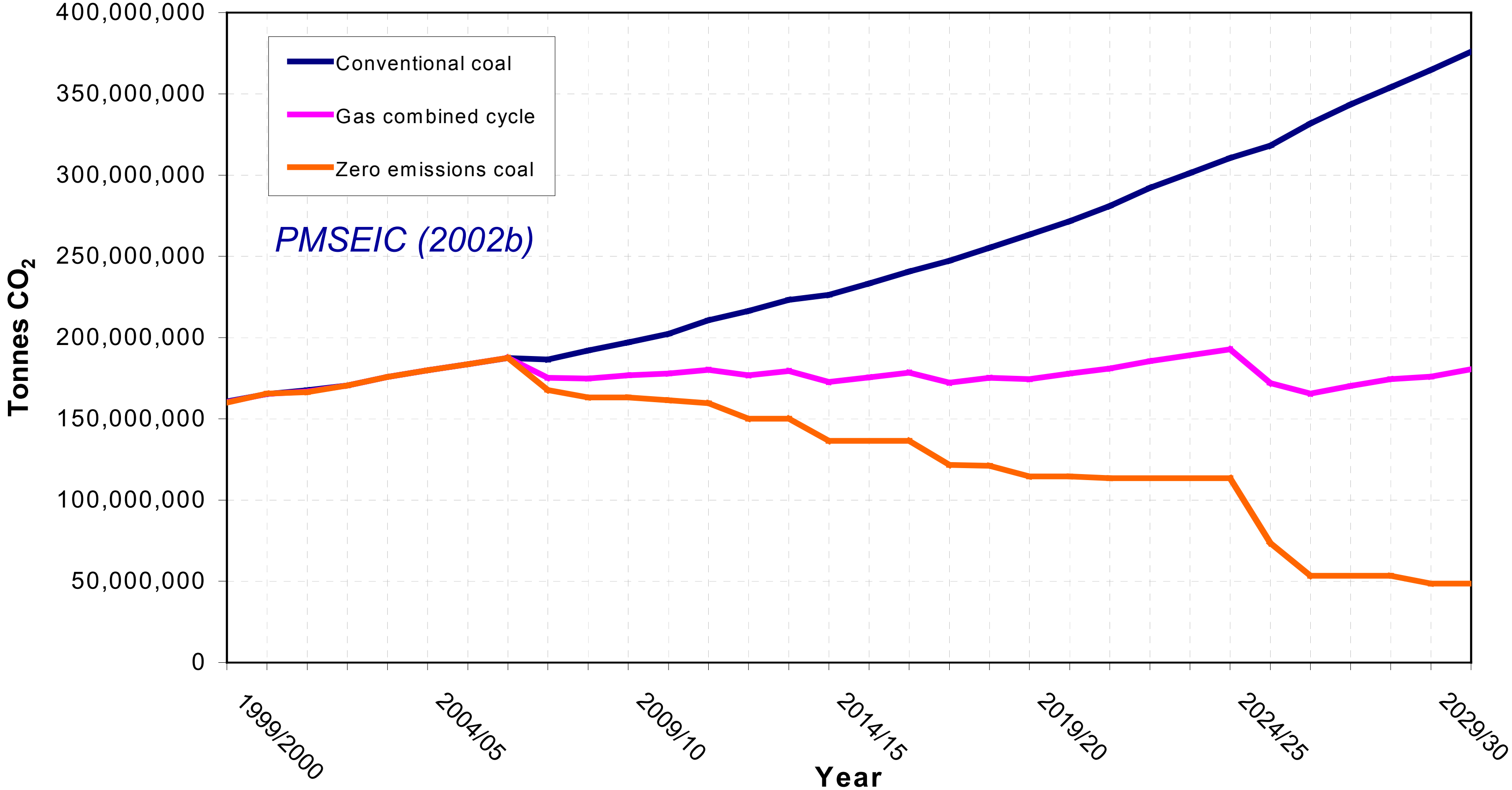


Gielen (2003)

Important caveats with this (+ all) modelling

Aust electricity scenarios with Geoseq

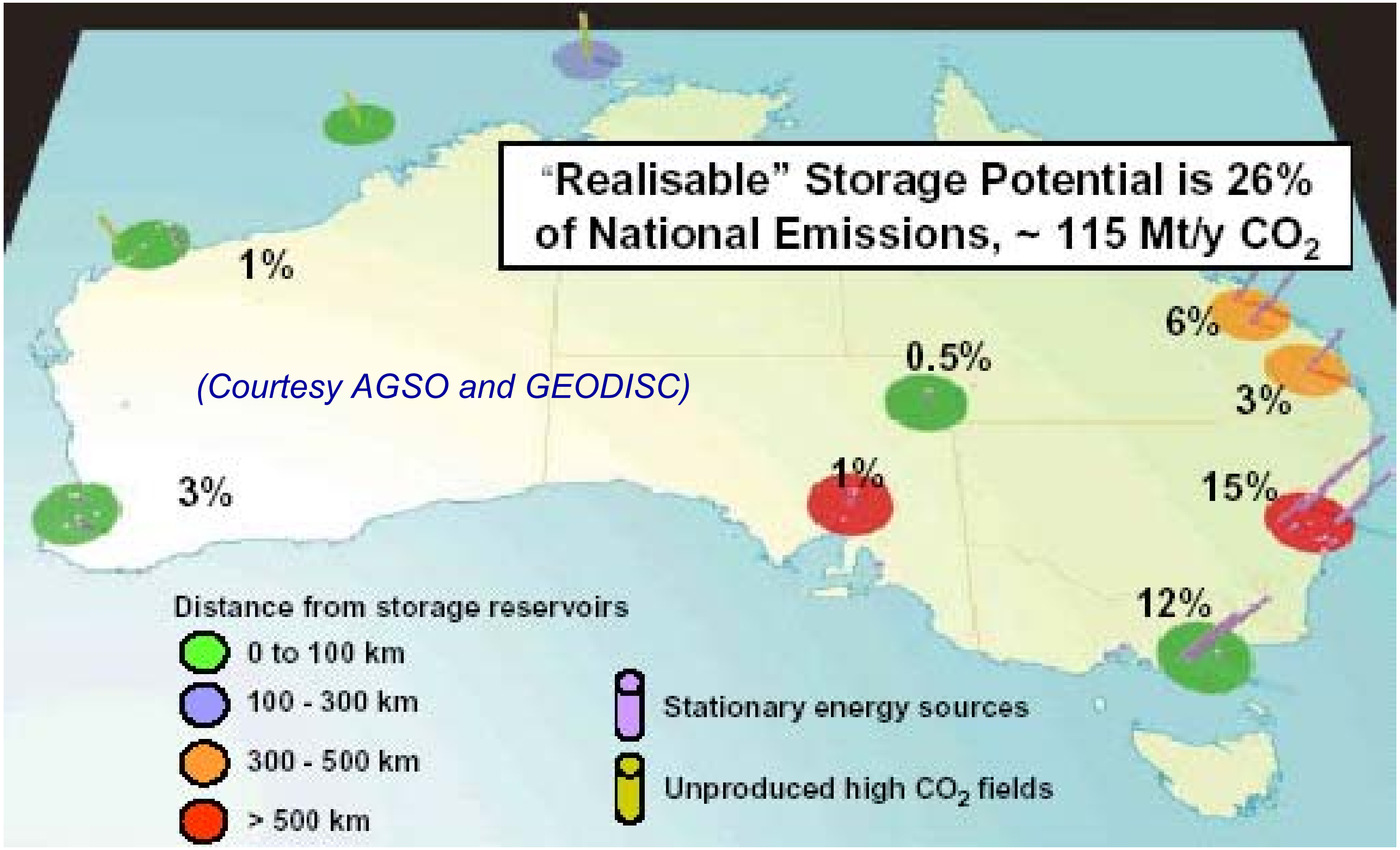
PMSEIC *Beyond Kyoto* report – Abatement potential of technology options



(Source: Roam Consulting – unpublished data 2002)

Aust electricity scenarios with Geoseq

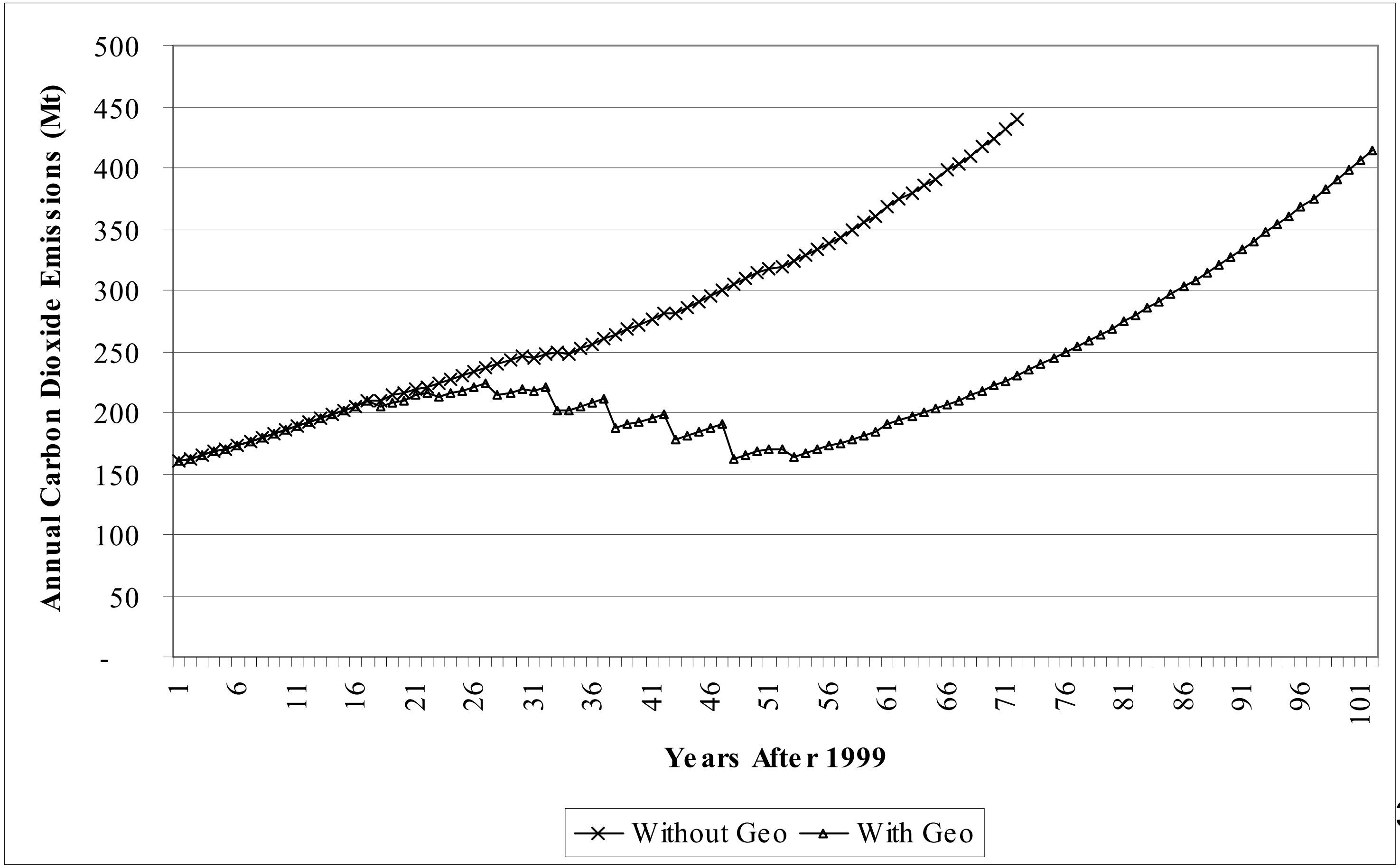
Preliminary estimates from GEODISC project (now CO2CRC)



(Courtesy AGSO and GEODISC)

Very preliminary scenarios

- Assume full technical feasibility, coal business-as-usual but sequestration everywhere except NSW, SA



Aust: assessing technology options

- Technical feasibility
  - IGCC + geosequestration in saline aquifers the least understood of geosequestration options => risks
  - Key technologies have been demonstrated at small / medium scale, but integration required => risks
  - Many energy efficiency options - “what exists is possible”
  - Many proven renewables technologies – “what exists is possible”

Aust: assessing technology options

Generation technology costs - now?

Geosequestration appears to be more expensive than some renewables (eg wind and biomass) and considerable uncertainty - almost certainly more expensive than energy efficiency options

Generation technology costs possible future costs?

Difficulty in estimating future costs for technology with such uncertainties

Costs continuing to fall for renewables

Aust: assessing potential scale

- IGCC + geosequestration can potentially provide very significant abatement
  - NSW doesn't appear to have good options
  - Considerable uncertainties
- Renewables have large potential abatement
  - eg. Denmark heading for 20% of elec. from wind (Australia has very large wind resource), however land-use issues
- Energy efficiency has very great potential
  - 50% cuts in energy use possible (IPCC, 2001; UK, 2003)

Aust innovation policy needs

- Need to support broad range of options with coherent innovation strategy
- Geosequestration an important area of R&D &Demonstration/Commercialisation
- Renewables needs both R&D but also, critically, market-demand support => expanded MRET
- Energy efficiency has been woefully neglected – R&D and targeted (often regulatory) drivers: “learn by having to”

References

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