institutional design and innovation issues

in achieving deep cuts in Australian emissions

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CSIRO Integration Network

Centre of Energy and Environmental Markets
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Modelling deep cuts - *innovation issues*

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Context

- The scale of our environmental challenges
- The role of science in public policy

Policy issues and responses

- What processes and policy interventions are we trying to model?

Modelling issues

- Representing changes in behaviour, investment, and technology
- Structure of the MMRF-Green model
- Potential supply of low emissions energy

Modelling results

- Economic and social impacts
- Decoupling emissions, energy, and economic growth

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Context – our environmental challenges

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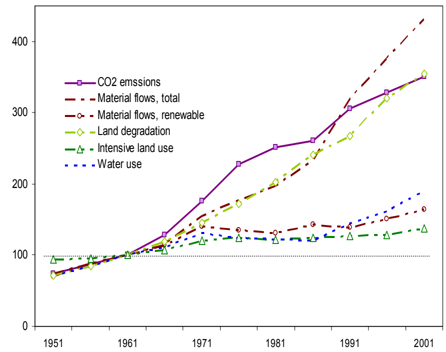
- **environmental quality and ecological resilience are declining on almost all fronts around the world**
- **environmental pressure is rising**

  climate change, coastal development, forestry and agriculture, water diversion, industrial pollution, over-fishing and marine impacts



Australian environmental pressure, 1951-2001

Material flows (tonnes)	+ 450%
Land degradation (area)	+ 350%
Greenhouse gases (CO_2)	+ 340%
Water use (Ml)	+ 125%
Renewable resources (t)	+ 120%
Intensive land use (area)	+ 40%

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Context – Australia's greenhouse challenge

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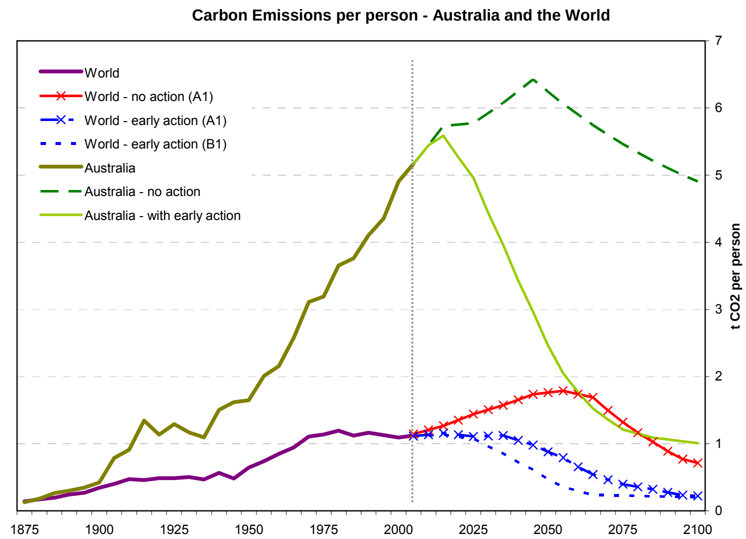

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Insights from 'adaptive governance'

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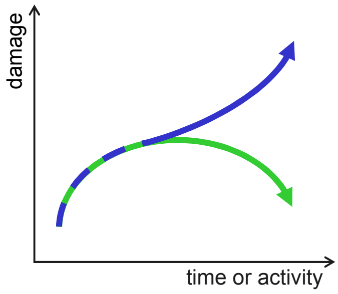
When do policy and institutions evolve in response to changing information and circumstances?



- distant impacts
  - ~ time
  - ~ location
  - ~ communities
- complex, poorly understood
- irreversible

- local impacts
- visible and understood
- reversible

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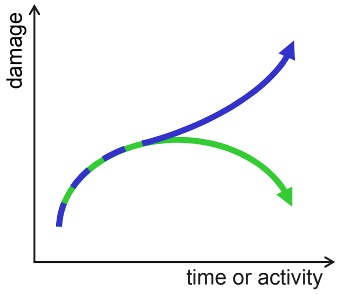

Collective action is most effective when:

(1) **We know what is happening**
… major determinants of resource condition and resilience are well known (including key cause-effect relationships)

(2) **We can do something about it**
… resource condition is subject to human influence, damage is reversible

(3) **We want to act**
… formal or informal arrangements can be crafted that deliver results perceived to be valuable by key constituencies

Arrow et al 1995 *Science* 268
Dietz el al 2003 *Science* 302

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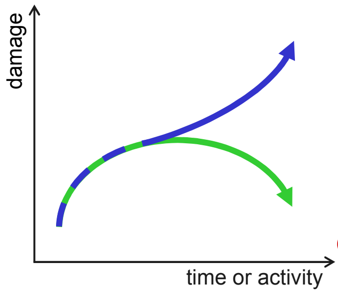
Knowledge and ‘knowledge creators’ have central roles in the evolution of environmental policy

… and different disciplines contribute in different ways:



(1) **Understanding the climate system**

(2) **Developing ‘low impact’ technologies**
… decoupling energy services from environmental pressure

(3a) **Designing policy options and ‘collective action strategies’**

(3b) **Assessing the impacts and merits of options and pathways**

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Underlying processes – *energy sector*

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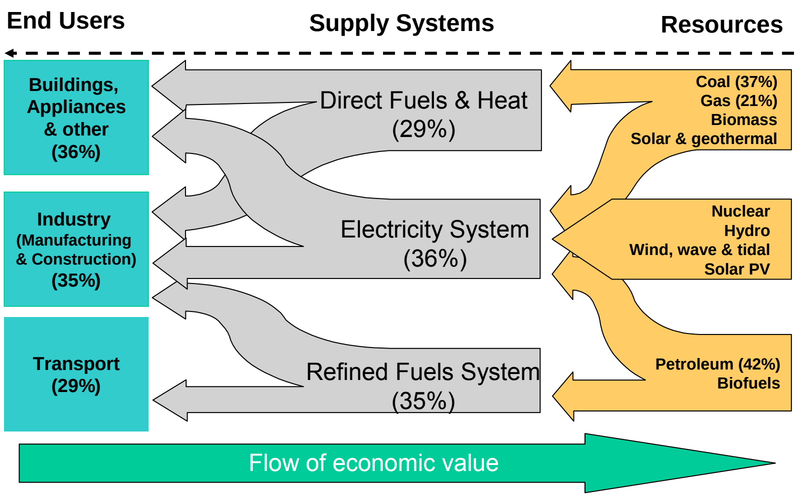

Source: Michael Grubb (2006) Climate change responses, economic instruments and innovation. Seminar at Australia National University, Canberra, 20 Oct 2006

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Underlying impediments – *policy tools*

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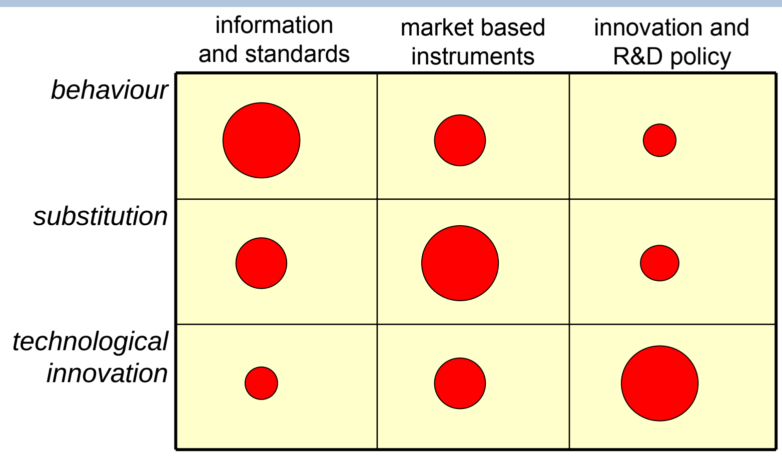

Source: Michael Grubb (2006) Climate change responses, economic instruments and innovation. Seminar at Australia National University, Canberra, 20 Oct 2006

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Underlying impediments – *policy tools*

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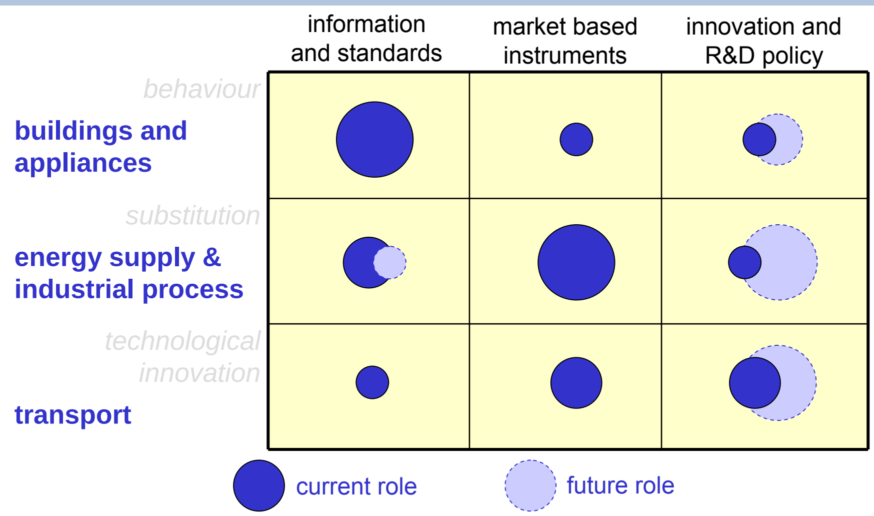

- **emissions segments are subject to different market failures,** implying a mix of policy tools is required

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Policy levers and options

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Voluntary action – *information and education*

- energy labelling for consumer appliances, green marketing
- industry programs and accreditation (eg 'greenhouse challenge')
- niche 'beyond compliance' products – green power, voluntary offsets

Economic incentives

- Emissions taxes
- Tradable emissions permits
- Special taxes and 'feebates'

Regulation

- Building codes and standards
- Environmental laws and regulation (energy and emissions intensive)

Technology policy

- Direct funding and incentives
- Adressing soverign risk

Policy leverage points:

- **Current use of energy using assets** *Will I drive today?*
- **Choice of future assets** *What type of car will I buy?*
- **Infrastructure and public services** *How busy is the road? How good is the bus? How safe is the bike?*
- **Technology development** *What opportunities could be created through low emission technologies? What risks could be managed? What would the future need to be like for this to be worthwhile?*

Modelling deep cuts - *innovation issues*

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Modelling deep cuts – *logic*

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Direct emitters …

- Move to less emissions intensive options where this is cost effective (compared to other options)
  - change fuel mix towards natural gas and renewables
  - use more efficient technologies and equipment
  - capture emissions as 'carbon price' rises and technology demonstrated
- Purchase emissions offsets
- Pay the tax (and pass most of it on to customers)

Consumers and other businesses …

- Reduce energy use (relative to the base case) through:
  - changing consumption patterns
  - choosing more energy efficient appliances and technologies

➢ ***change driven by scarcity, reflected in emissions price***

➢ ***increase in autonomous efficiency mimics education and awareness***

➢ ***endogenous technological change not yet well represented***

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Modelling deep cuts – *structure*

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MMRF-Green (Centre for Policy Studies, Monash University)

- national multi-regional model built to explore greenhouse policy issues
- forty-nine industry sectors, including over 30 ‘greenhouse exposed’:
  - four fossil fuel electricity generators (black and brown coal, gas, and oil)
  - five renewable generators (hydro, biomass, biogas, solar and wind)
  - four upstream mining and extraction energy sectors
  - electricity and gas distribution sectors
  - eight transport sectors (road, rail, water and air)
  - agriculture and forestry
  - six energy intensive industry sectors (including aluminium, steel, cement)

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Modelling deep cuts – *substitution possibilities*

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MMRF-Green (Centre for Policy Studies, Monash University)

- regional supply costs and quantities were estimated for renewable sectors: hydro, biomass, biogas, solar and wind
  - estimated likely cost reductions from global ‘learning by doing’ through implementation of these technologies at scale
  - cost results were very similar to existing base case assumptions
  - confirmed the physical feasibility of large scale uptake within Australia
- carbon capture and storage (CSS) assumed to be feasible
  - limited to three quarters of electricity emissions (due to regional storage)
  - able to capture up to 85% of power plant emissions (due to process limits)
  - cost in 2010 estimated at $43 to $57 per tonne of CO2–e
  - cost falls to $14 to $22 per tonne of CO2–e in 2050 with global action
- ➢ **supply options imply energy substitution driven by relative costs, rather than quantify constraints**
- other emerging technologies not included (waste–to–energy, geothermal)
- nuclear electricity generation not included

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Modelling deep cuts - *innovation issues*

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Economic and social impacts

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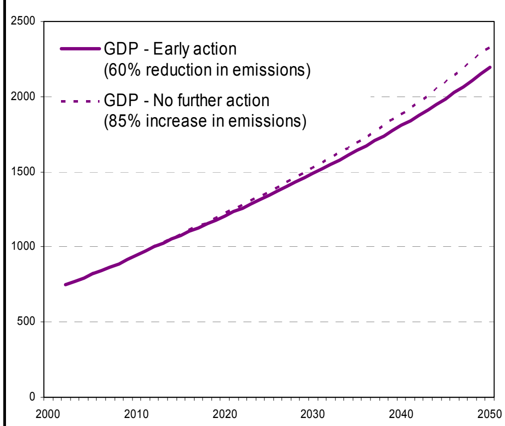
Economic Impacts - real GDP ($b 2005)



The Business Case for Early Action (April 2006)
www.businessroundtable.com.au

Early action scenario –
- Australian emission reductions of 60% by 2050, with global action
- tradable emission permits from 2013 (fully auctioned from 2023)
- carbon capture and storage
- no international permit trading

Deep cuts in emissions are compatible with strong economic growth

GDP increases
- 2.1% pa with early action
- 2.2% pa without action
- 167% over the period, from $820 billion in 2005 to $2,190 billion in 2050

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Economic and social impacts

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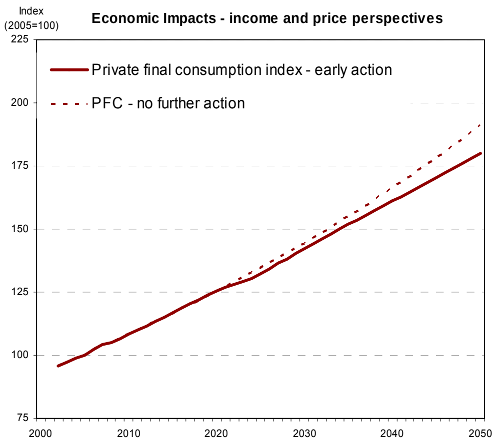

Real average income increases 80% over the period

real income per person in 2050 is:

- $15,450 higher than in 2005 with policy action
- $2,150 lower than it would be 2050 without action

private consumption per person

- increases $340 pa with action
- increases $390 pa without action

(all figures are ‘real’, adjusting for inflation)

The Business Case for Early Action (April 2006)
www.businessroundtable.com.au

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Economic and social impacts

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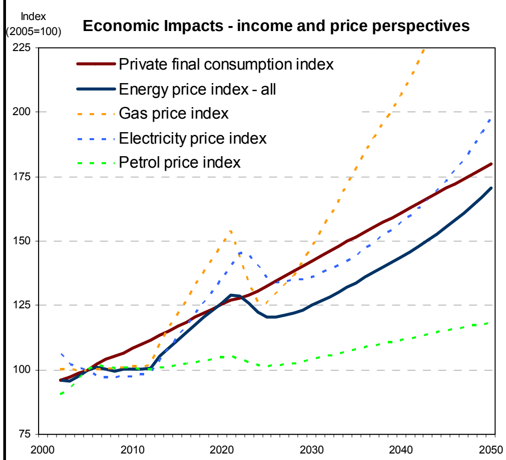

Real energy prices rise

- **energy prices** increase around 70% above inflation
  - electricity +100%
  - gas +185%
  - petrol +20% (assuming current world oil price)
- real income increases 80%

Hatfield-Dodds and Adams (forthcoming)

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Economic and social impacts

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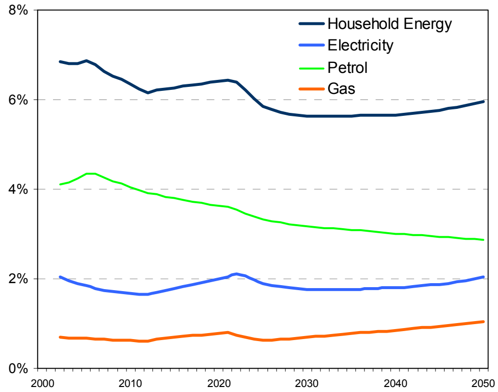
Economic Impacts - energy affordability

Share of income required to purchase 2005 energy bundle



Hatfield-Dodds and Adams (forthcoming)

Real energy prices rise

- **energy prices** increase around 70% above inflation
  - electricity +100%
  - gas +185%
  - petrol +20% (assuming current world oil price)
- real income increases 80%

Affordability does not decline

- current energy bundle requires smaller share of household income over period

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Other modelling results

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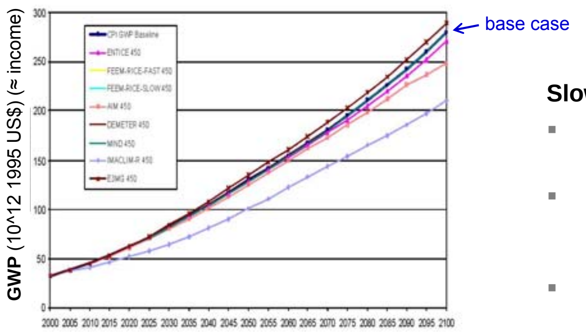
Economic impact of stabilisation at 450ppm CO_2
as indicated by Gross World Product (GWP)



Source: Innovation modeling comparison project (Energy Journal, forthcoming 2006)

Note: The charts show GWP under the "Common Poles-Image" baseline, and the relative impacts of stabilization across the participating models. Different models have different absolute baselines.

Slower positive GDP growth

- consistent with other national and international studies
- models do not account for climate impacts
  (important to base case)
- Australian impacts relatively high

Grubb et al (2005) 'Framing the Economics of Climate Change: An international perspective'. Submission to the Stern Review on the Economics of Climate Change

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Other modelling results

www.csiro.au/
integration

Comparison with ABARE

- scenarios for deep cuts by 2100, with economic results for 2050

Scenarios 2a and 3

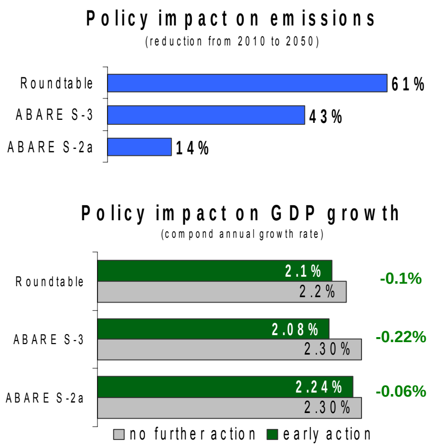
- carbon capture and storage (CSS)
- no nuclear used in Australia

2a uniform global action from 2010

3 developed nations act from 2010, developing nations from 2020

ABARE results:

- smaller emissions reductions
- similar economic impacts
- larger policy impact on GDP relative to emissions reduction achieved



The Economic Impact of Climate Change Policy (July 2006) – www.abare.gov.au

Environmental effectiveness

www.csiro.au/
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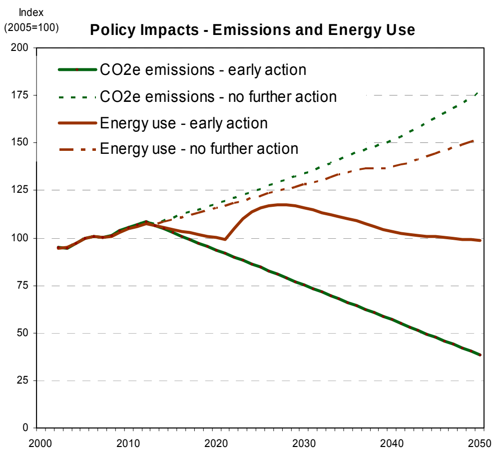

Policy decouples energy and emissions from economic growth

- **emissions fall 60%**
  (rather than increasing 85%)
  per capita emissions fall 74%
- **energy use plateaus**
  total energy use effectively flat (rather than rising around 50%)
  per capita energy use falls 33%

The Business Case for Early Action (April 2006)
www.businessroundtable.com.au

Electricity – energy mix

www.csiro.au/
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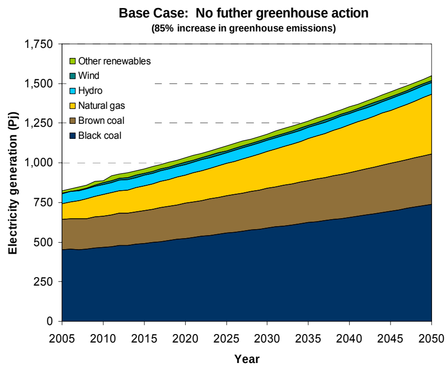
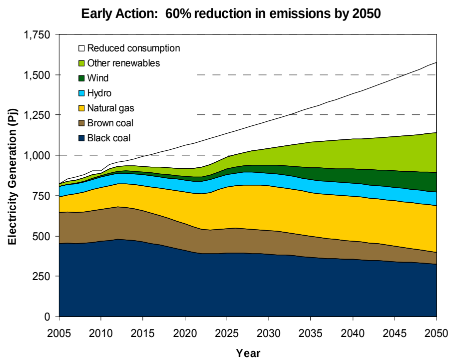
Impact of policy action on electricity sector





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Environmental effectiveness

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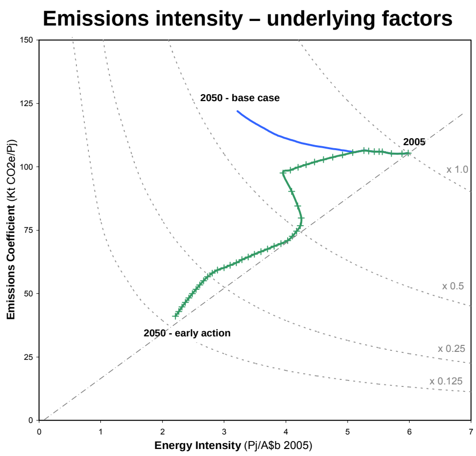

Policy decouples energy and emissions from economic growth

- **emissions fall 60%**
- **energy use plateaus**
- energy efficiency and emissions coefficient of energy are both important
  - CCS crucial, but not sufficient
  - technology and innovation underpin both improved energy efficiency and reduced emissions per unit of energy

Calculated from data from *The Business Case for Early Action* (April 2006) www.businessroundtable.com.au

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Environmental effectiveness

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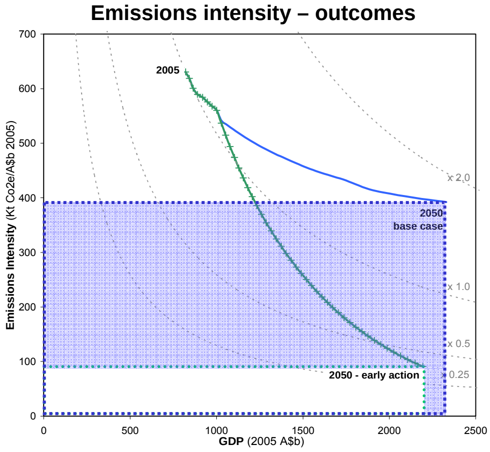
Emissions intensity – outcomes



Policy decouples energy and emissions from economic growth

- **emissions fall 60%**
- **energy use plateaus**

- energy efficiency and emissions coefficient of energy are both important
- together these make a massive difference

Calculated from data from *The Business Case for Early Action* (April 2006) www.businessroundtable.com.au

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Pathways forward …

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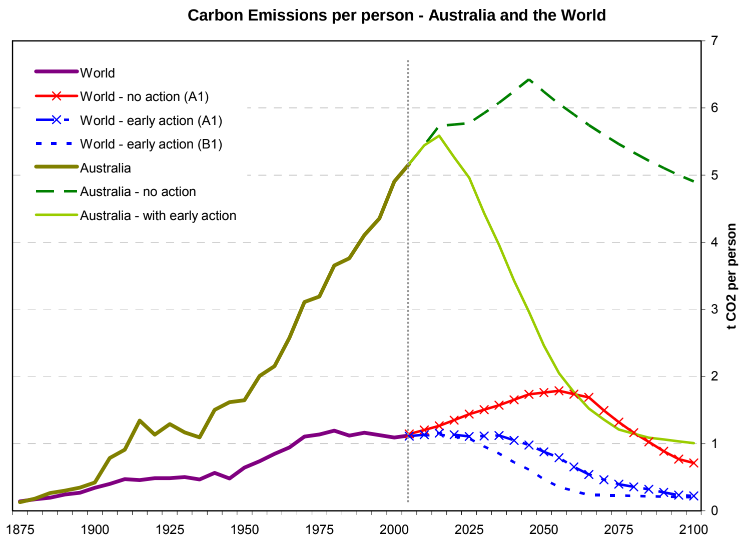

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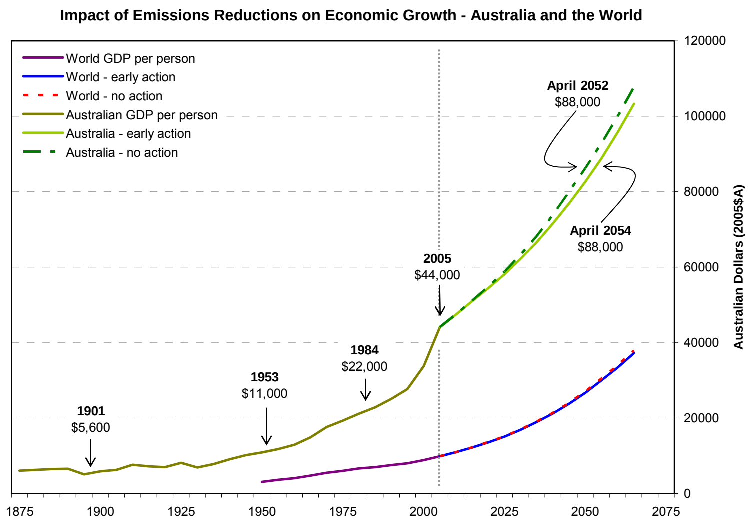

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Pathways forward …

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Thinking about 'technology options'

Ehrlich's "impact formula"

Pressure = population * affluence * technology *(as an accounting identity)*

Emissions = population * income * energy intensity * GHG coefficient

	income	energy intensity	GHG coefficient
	GDP / population	energy use / GDP	emissions / energy use
	≠ living standard	*efficiency*	*'fuel mix'*

technology

institutions and norms

(= technology in Ehrlich's teminology)

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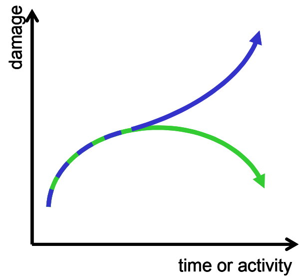
Conclusions and key messages

Effective collective action requires

❶ sound scientific understanding of what is happening
… climate processes and risks

❷ identification of what we can do
… technologies and policy options

❸ attention to what we value
… public understanding of issues and potential impacts



- **climate modelling** is sufficient to indicate risks associated with inaction, assisting informed public choice and policy development
- **economic modelling** is less well developed, but
(i) indicates economic impacts of emission reductions are manageable, and (ii) can add considerable value to the development of policy options
- **innovation is crucial**, even if we can't model it very well yet

References and further information

www.csiro.au/
integration

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