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# Climate Change & the Electricity Industry

Hugh Outhred

*Sustainable Energy Research Group*

*School of Electrical Engineering and Telecommunications*

*The University of New South Wales*

*Sydney, Australia*

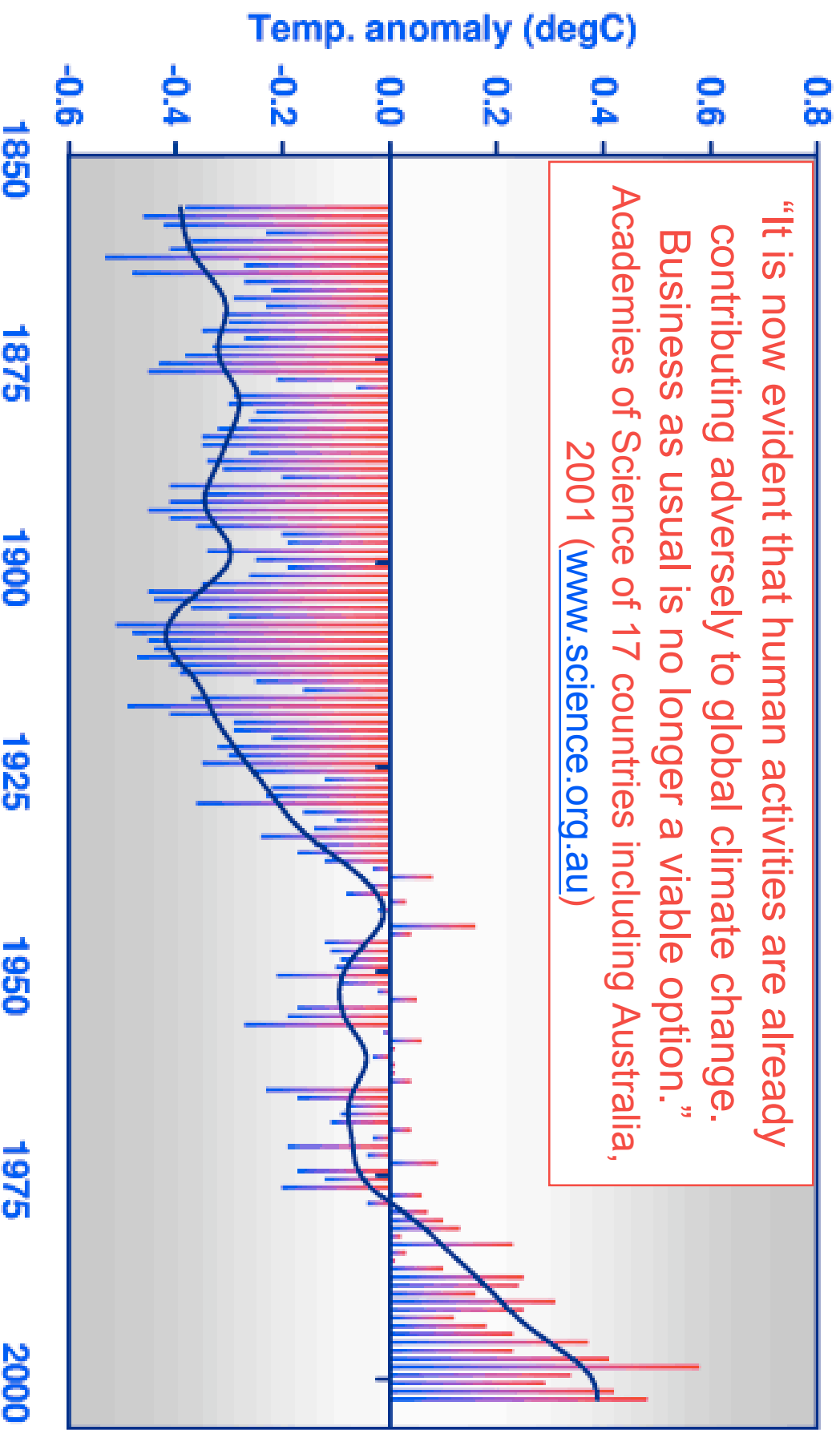
*Tel: +61 2 9385 4035; Fax: +61 2 9385 5993;*

*Email: [h.outhred@unsw.edu.au](mailto:h.outhred@unsw.edu.au)*

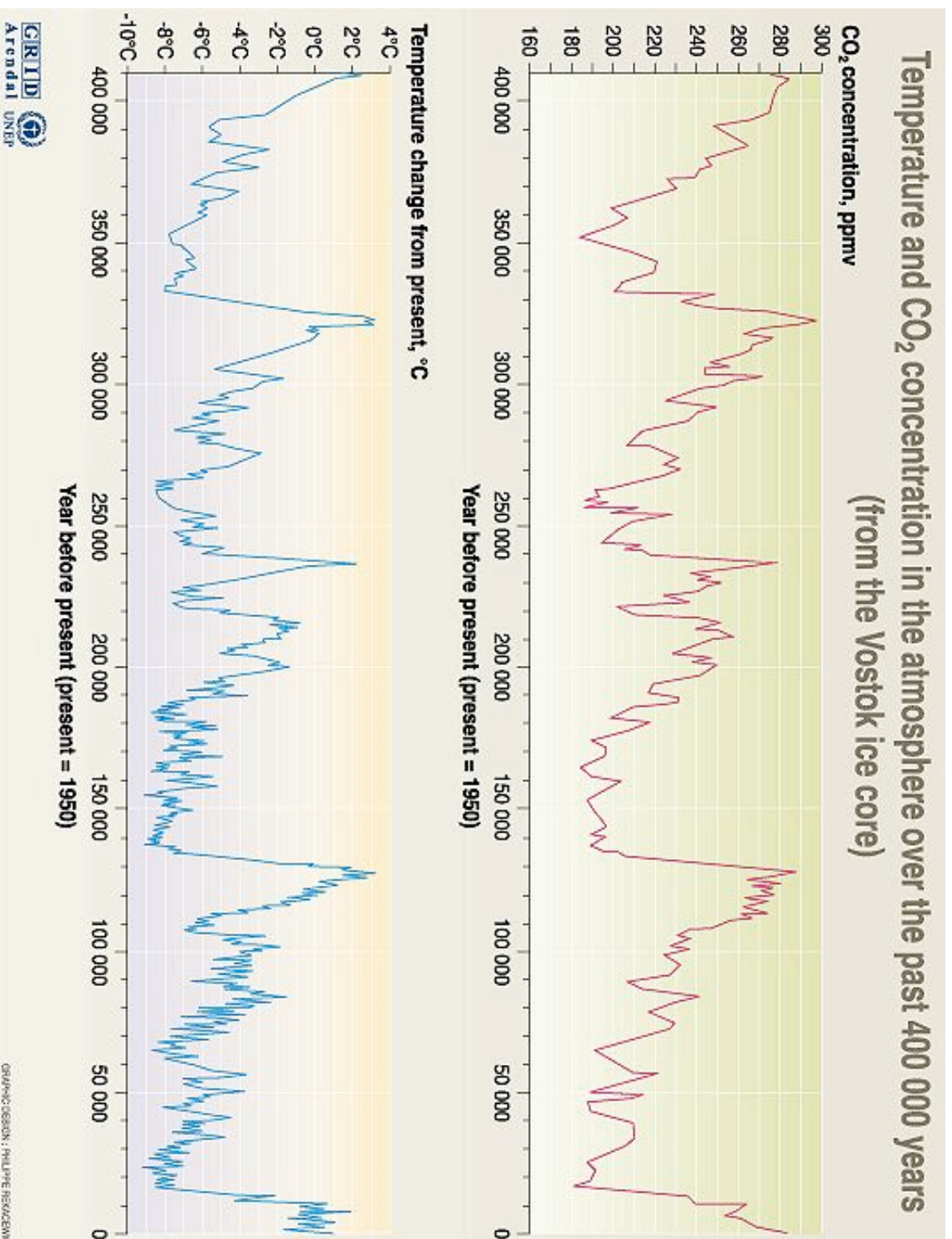
*[www.sergo.ee.unsw.edu.au](http://www.sergo.ee.unsw.edu.au)*

# Global air temperature records

(<http://www.cru.uea.ac.uk/cru/info/warming/>)



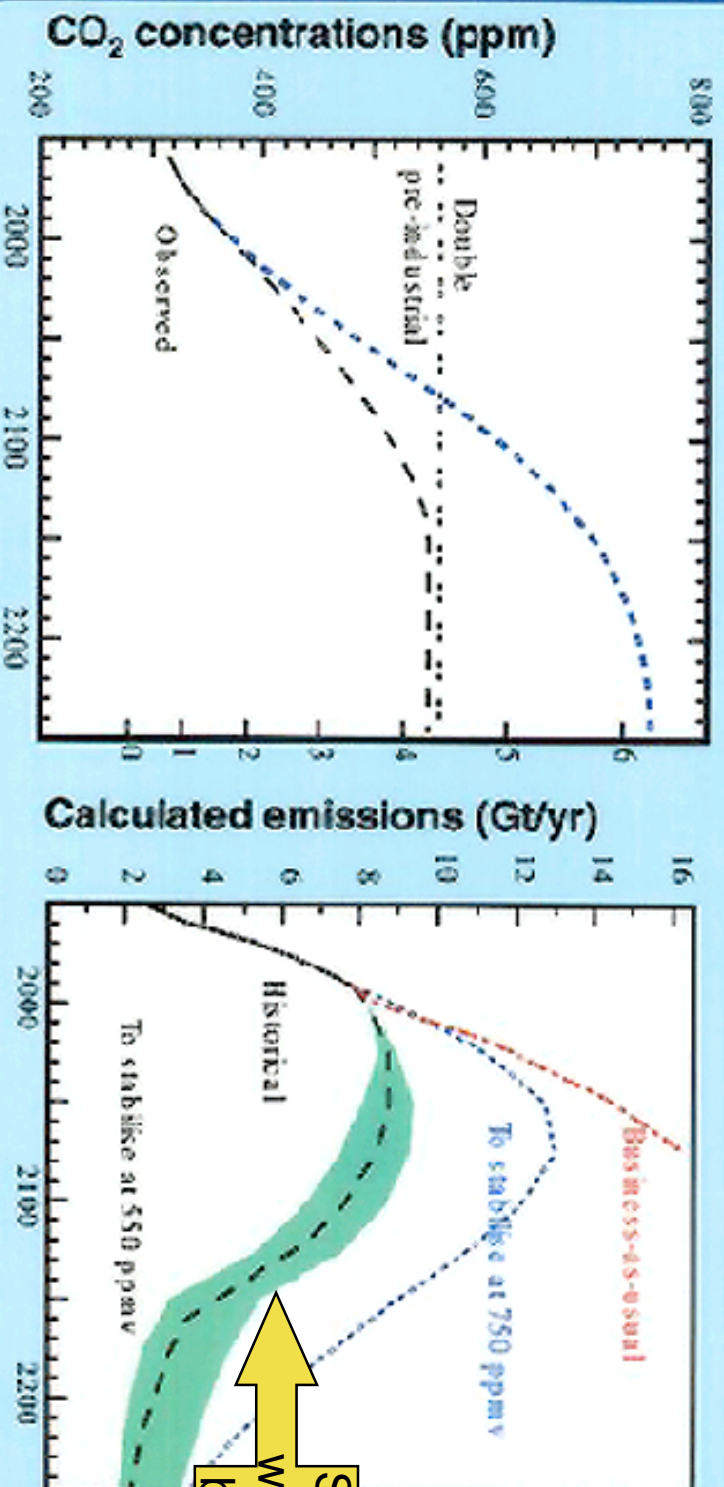
Source: <http://www.grida.no/climate/vital/>



Source: J.R. Petit, J. Jouzel, et al, Climate and atmospheric history of the past 420 000 years from the Vostok ice core in Antarctica, Nature 399 (3AJune), pp 429-436, 1996.

Climate change & the electricity industry

## Emissions required to achieve stabilisation of CO<sub>2</sub> concentrations



Studies suggest  
we should reduce  
by 60% by 2050

Meteorology CRC

Source: CRC for Southern Hemisphere Meteorology, Monash University,  
quoted in "The Heat is On: Australia's Greenhouse Future",  
Parliament of the Commonwealth of Australia, 2001

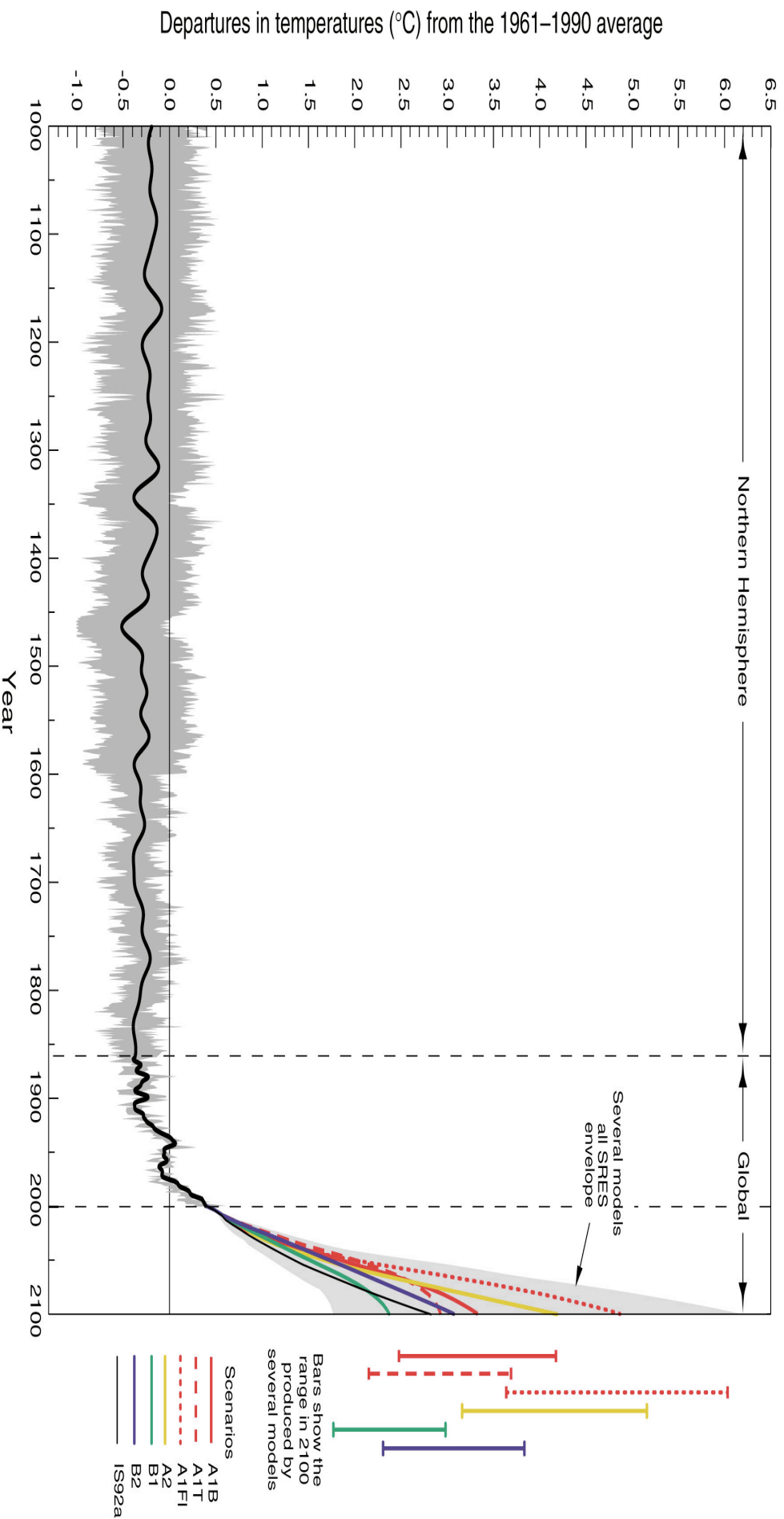


# IPCC Special Report on Emission Scenarios, 2000

([www.ipcc.ch](http://www.ipcc.ch))

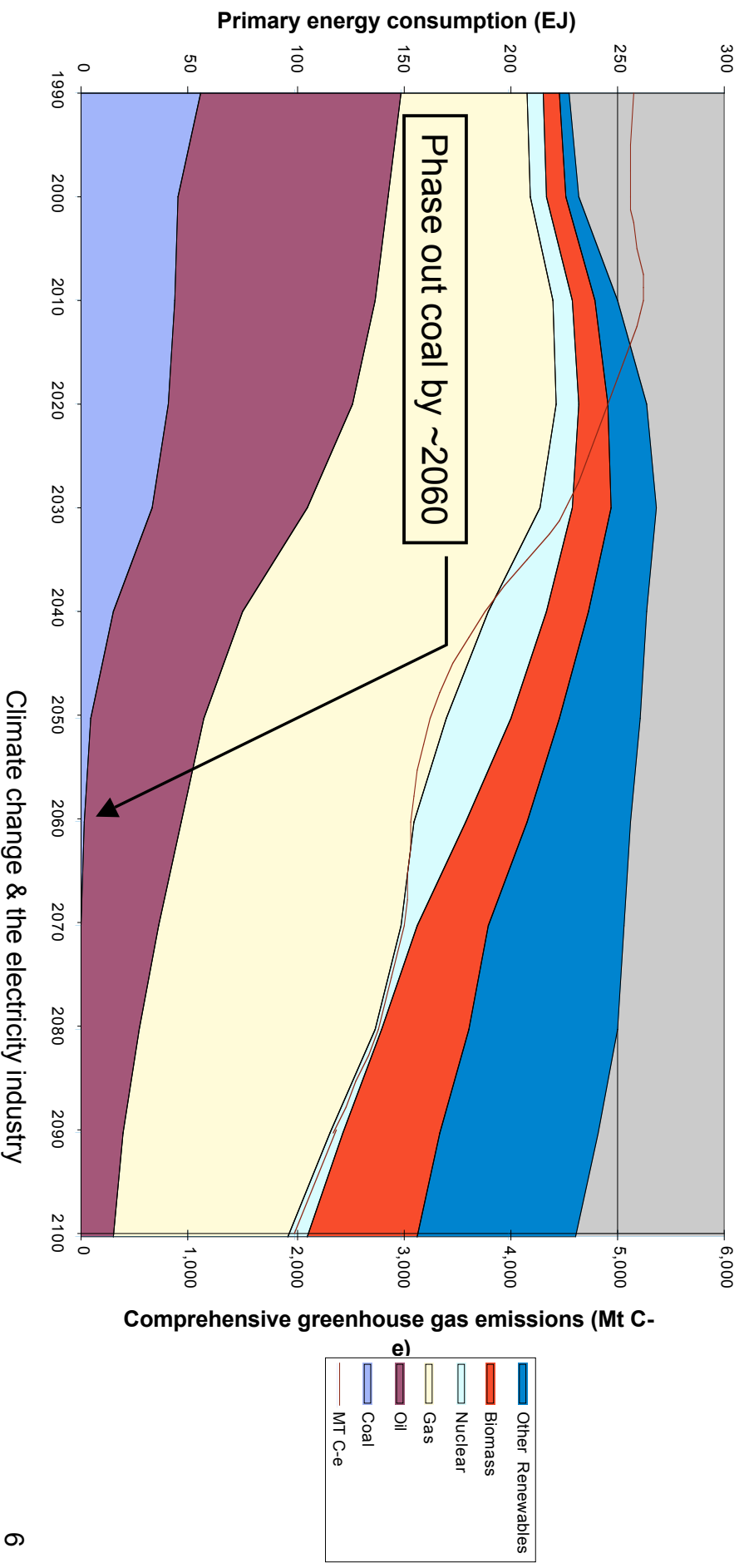
## Variations of the Earth's surface temperature: 1000 to 2100.

1000 to 1861, N.Hemisphere, proxy data; 1861 to 2000 Global, Instrumental;  
2000 to 2100, SRES projections



“high environmental & social consciousness, with globally coherent, technology-intensive strategy”  
(IPCC, 2000: Scenario B1T as quoted in Australia Institute, 2003)

Annex B (OECD plus EIT) projected energy demand and greenhouse gas emissions, 1990-2100  
(IPCC B1T-MESSAGE scenario)



# Ethical issues raised by climate change

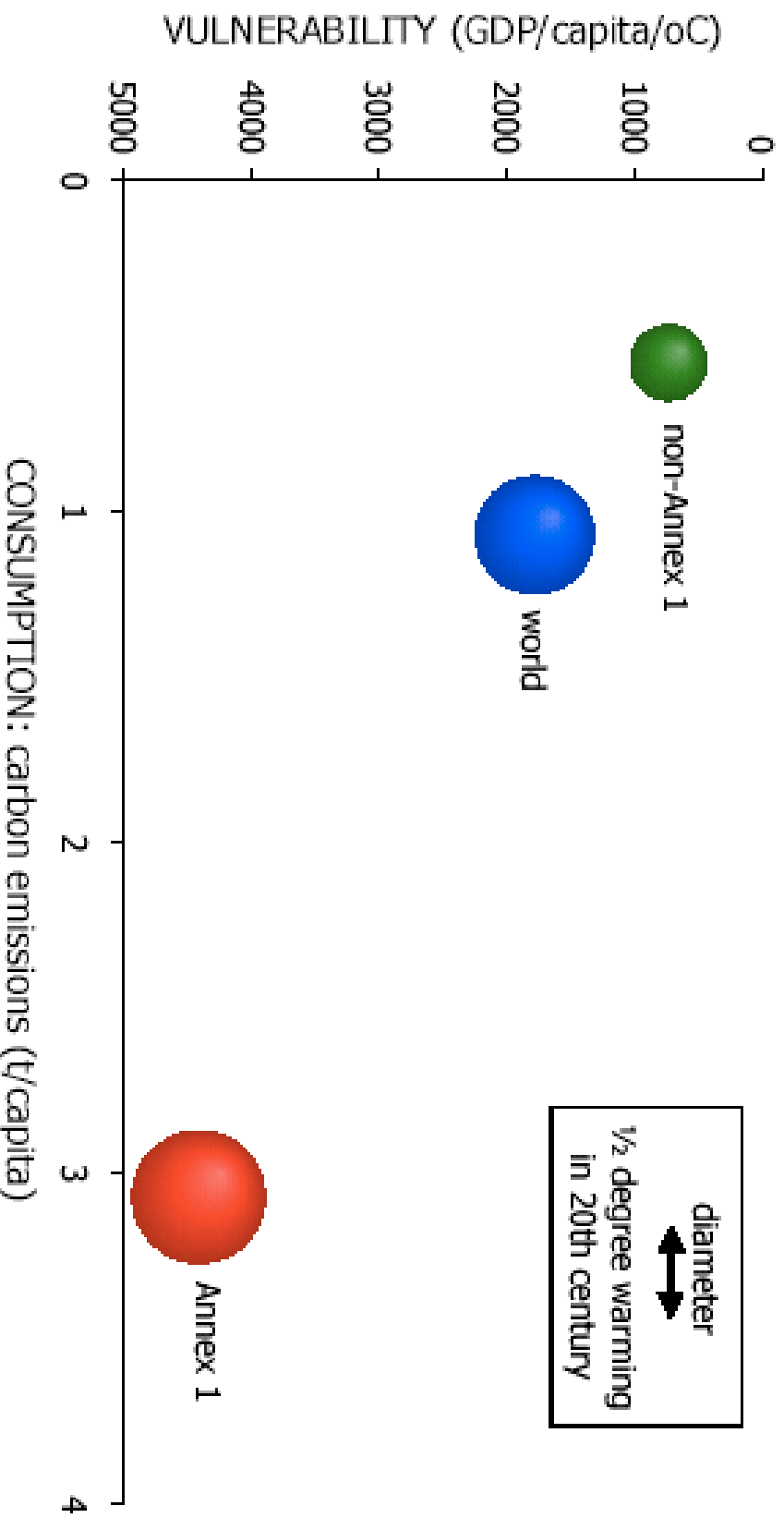
- Uncertain implications but:
  - Climate change will probably accelerate
  - Ecosystem impacts likely to be significant
- Costs & benefits distributed differently:
  - “use fossil fuels now, pay later”
    - Intergenerational equity
    - OECD vs “developing” countries
- Moral obligation on rich countries to lead:
  - Prudent avoidance; safe exits

# GDP per capita vs Tonnes Carbon per capita,

[www.tyndall.ac.uk/publications/working\\_papers/wp1\\_summary.shtml](http://www.tyndall.ac.uk/publications/working_papers/wp1_summary.shtml)  
(1997 data)

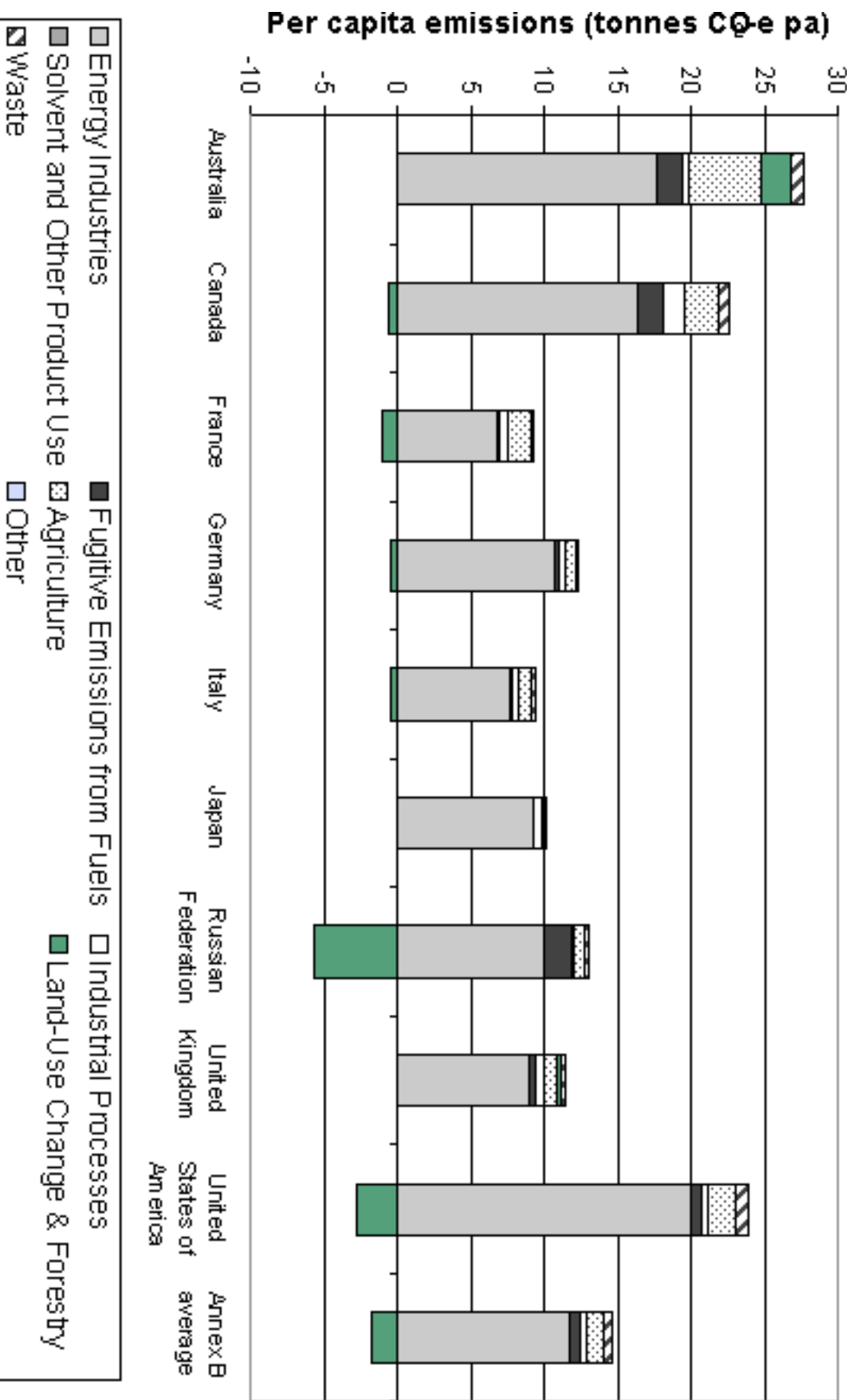
*There is a strong moral argument for “contraction and convergence”*

## Consumption and Vulnerability





# Tonnes per-capita CO<sub>2</sub> equivalent for selected countries (Australia Institute, 2001)



# 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

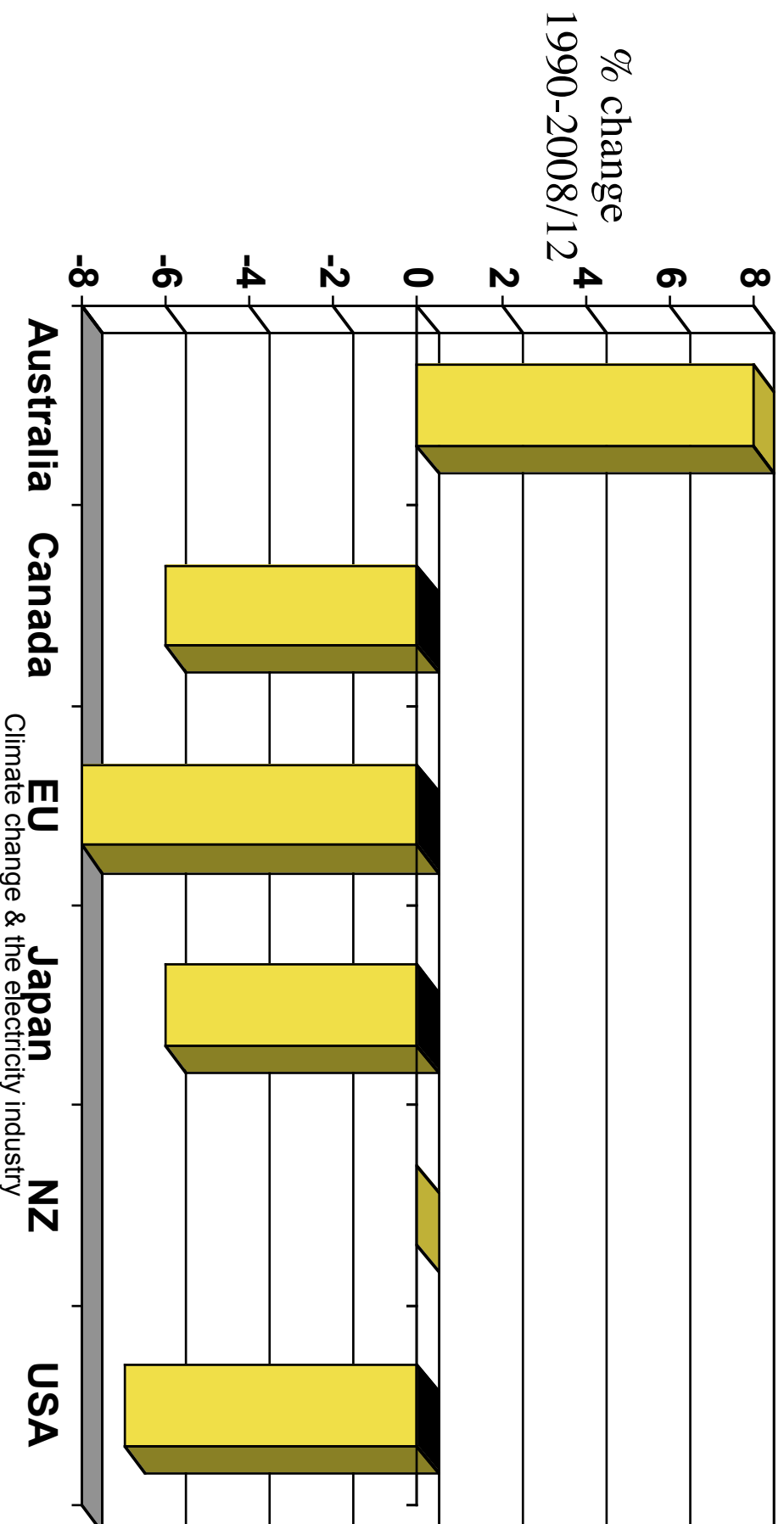
House of Representatives, 20 August 2002.

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

# Kyoto Protocol emission targets for selected 'Annex B' countries

(-5.2% overall for Annex B countries & yet to enter force, Dobe (ed), 1998)

(-60% needed by 2050 to stabilise climate change, UK Govt Cttee, 2000)



# Expected impacts on Australia

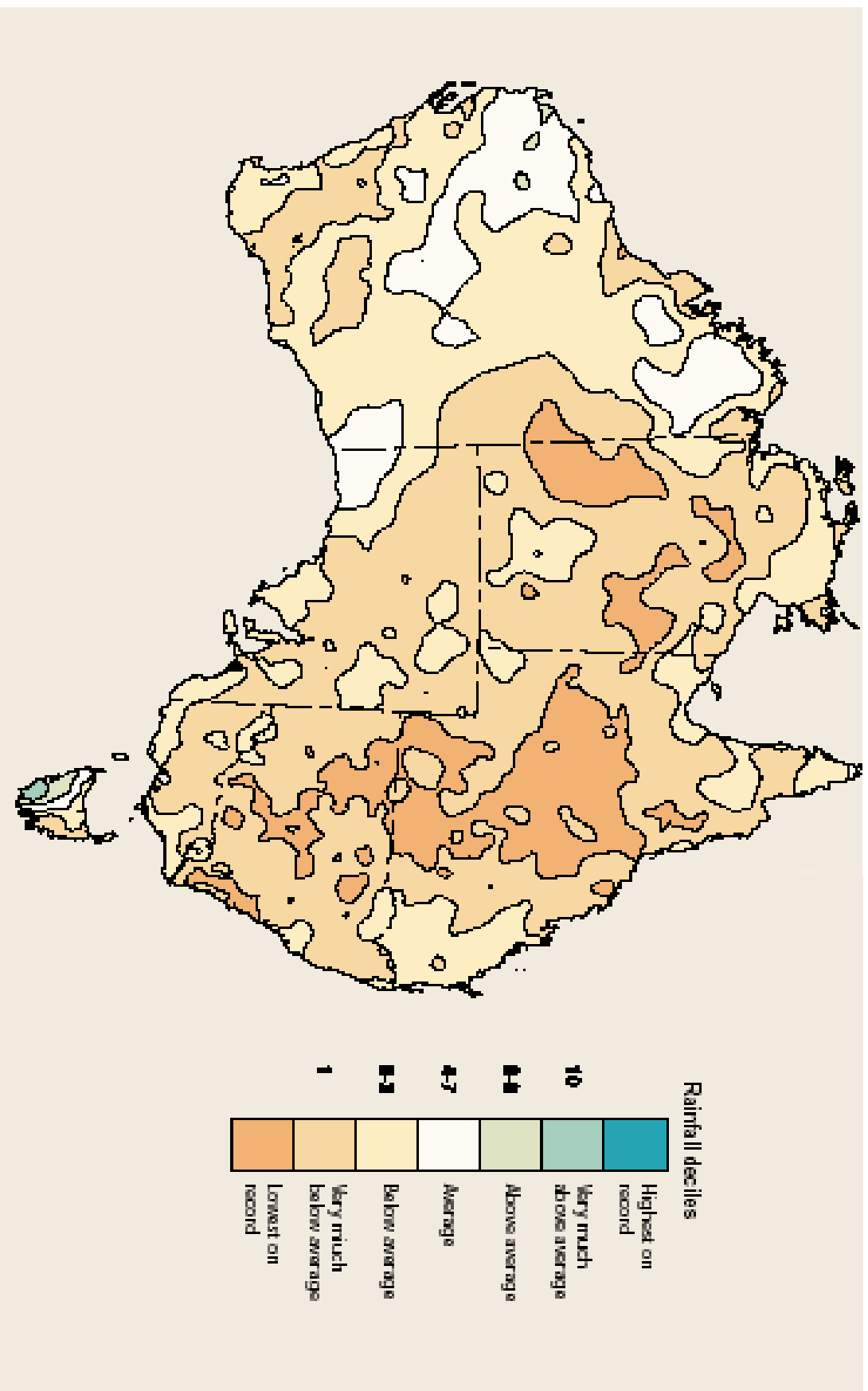
(Senate Environment Committee, 2000)

- Australia probably “very negatively affected”:
  - Large size, long coastline, soil salinity, exposure to cyclones & El Nino/La Nina cycle, economic dependence on agriculture & tourism
- Likely changes in next 50 years:
  - Higher temperatures, more frequent extreme weather events, reduced available water resources, reduced area of arable land, reduced crop & livestock yield & quality, severe damage to coral reefs

# The drought risk: rainfall in Australia, 2002

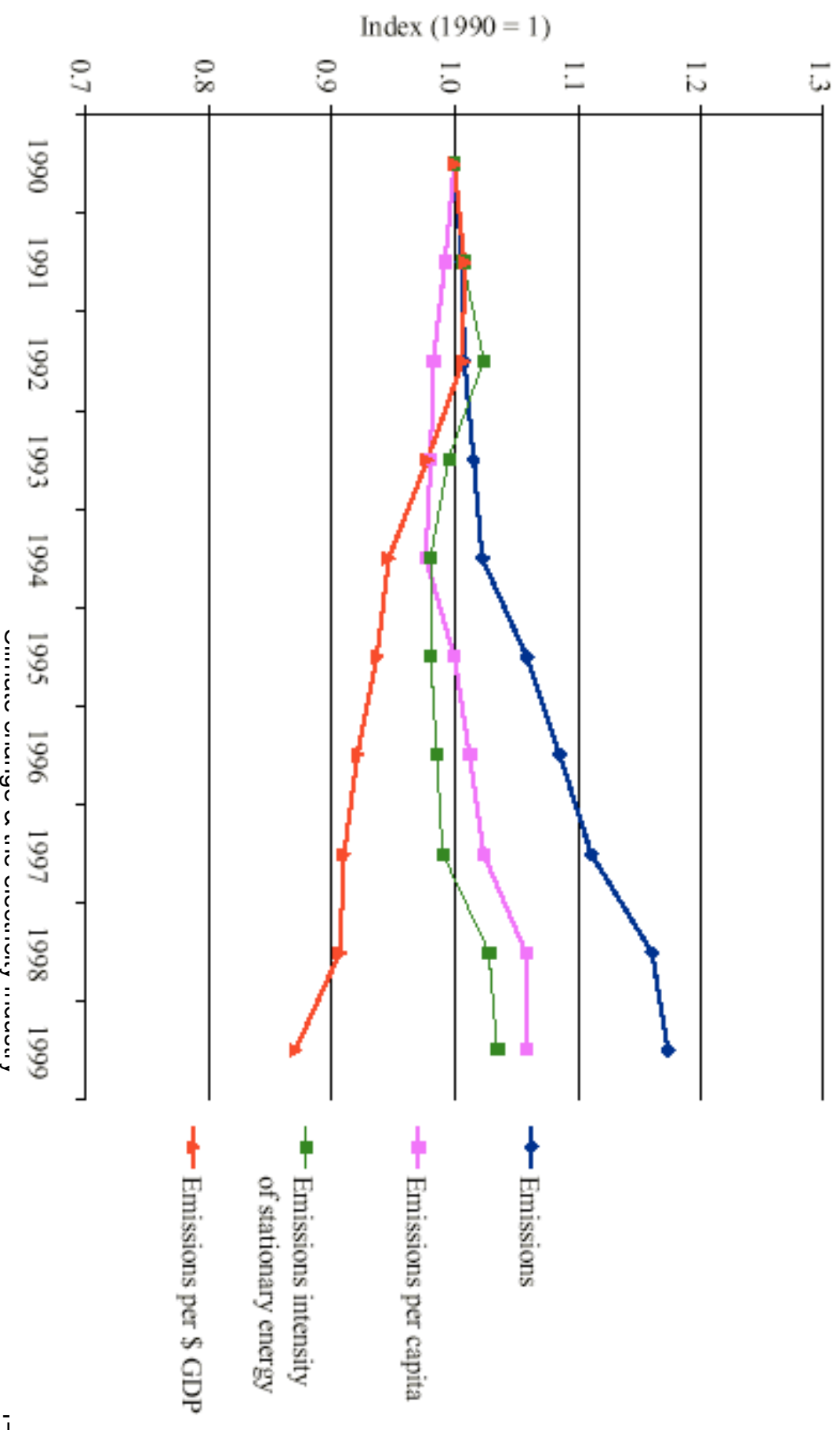
(WMO Annual Report 2002)

To learn more, watch ABC TV Catalyst Program, “Drought Vortex”, 8pm, 18/9/03



# Macro-indicators for Australian greenhouse emissions

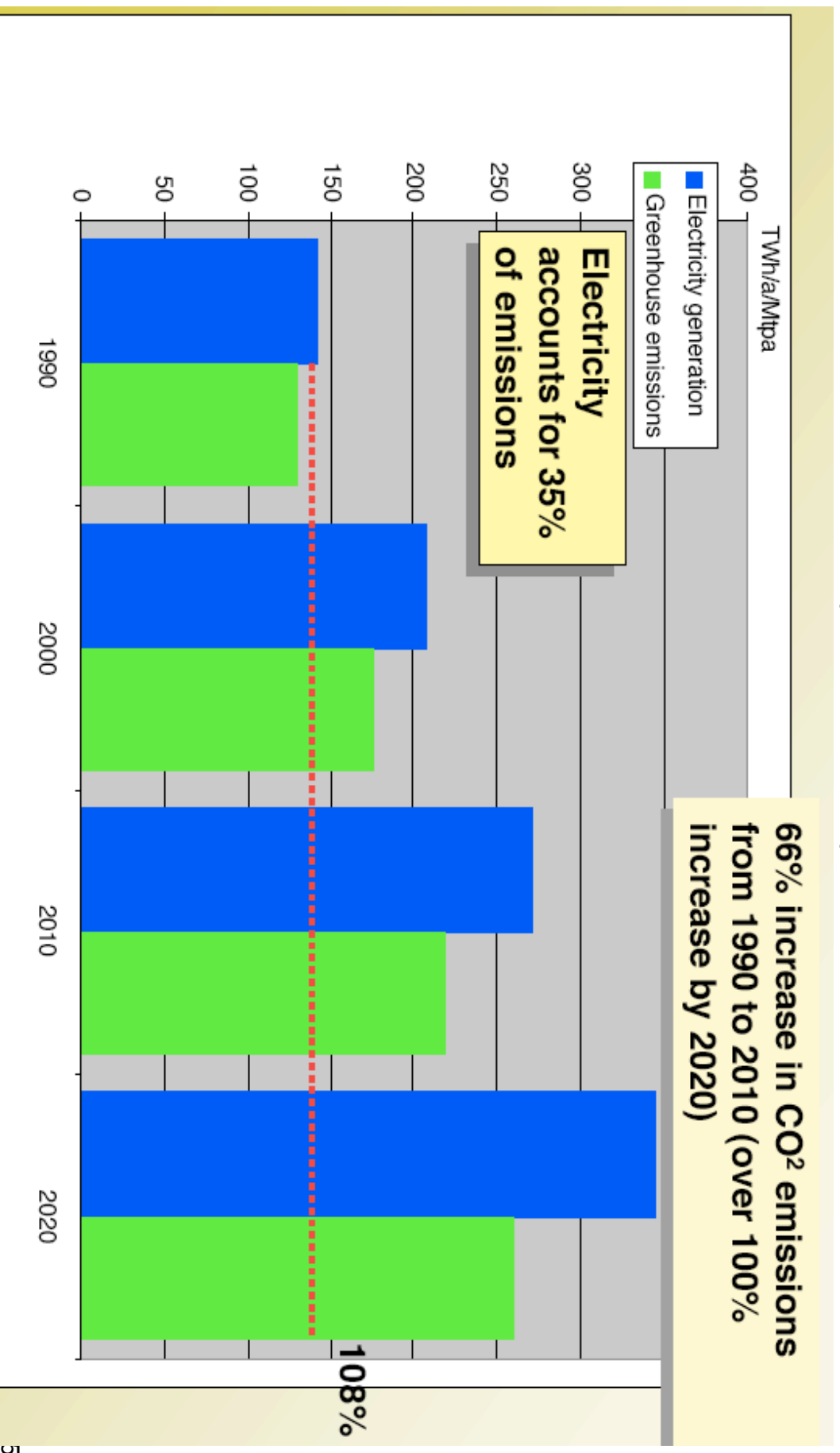
(source: [www.greenhouse.gov.au/inventory](http://www.greenhouse.gov.au/inventory), 2001)





# Actual & projected emissions from the Australian electricity industry

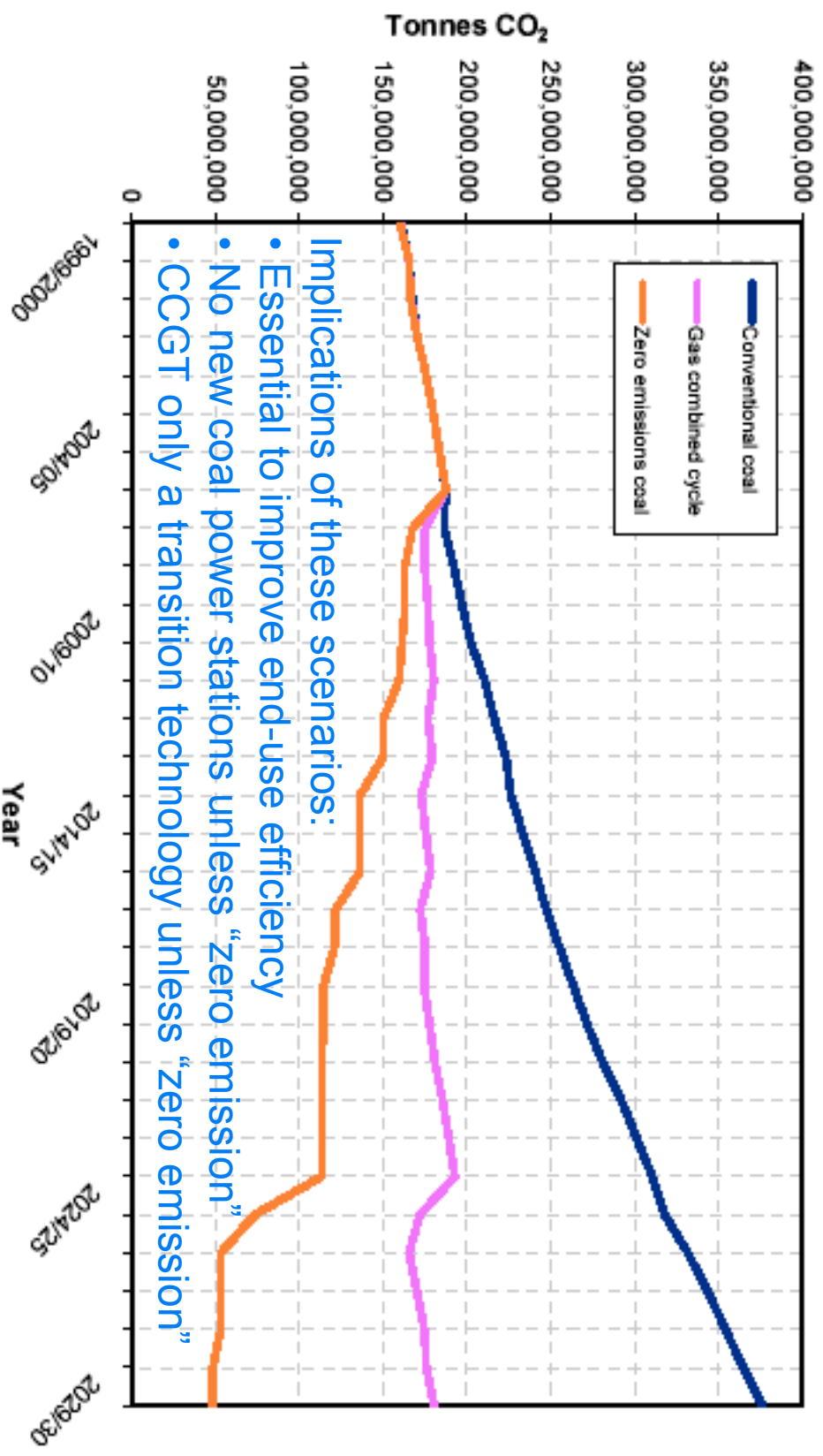
(BCSE, 2003)



# ABARE reference case projection for Australian GH emissions, 1990-2010

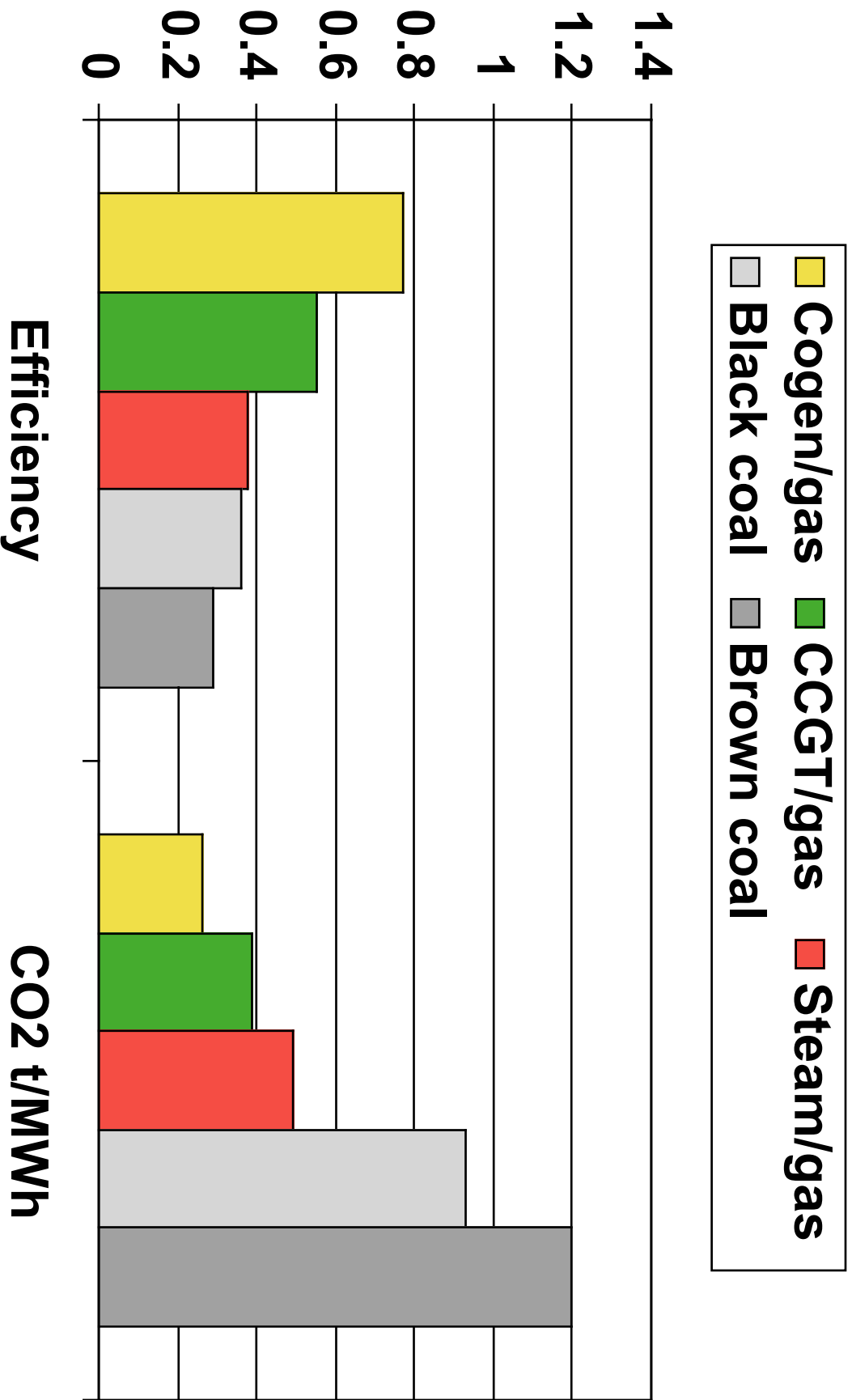
- Emissions to grow by 1.8% pa, 42% overall
  - Expected to be highest among OECD countries
- Important contributing factors:
  - Per capita emissions to grow by 0.6% pa:
    - Similar to other OECD countries
  - Population growth of 1.2% pa or 26% overall
    - Considerably higher than other OECD countries
  - Strong reliance on coal in electricity generation
  - Strong growth in energy-intensive exports
- Relatively high economic growth

# Australian electricity industry emissions scenarios to 2030 (PMSEIC Report, “Beyond Kyoto, 2002)

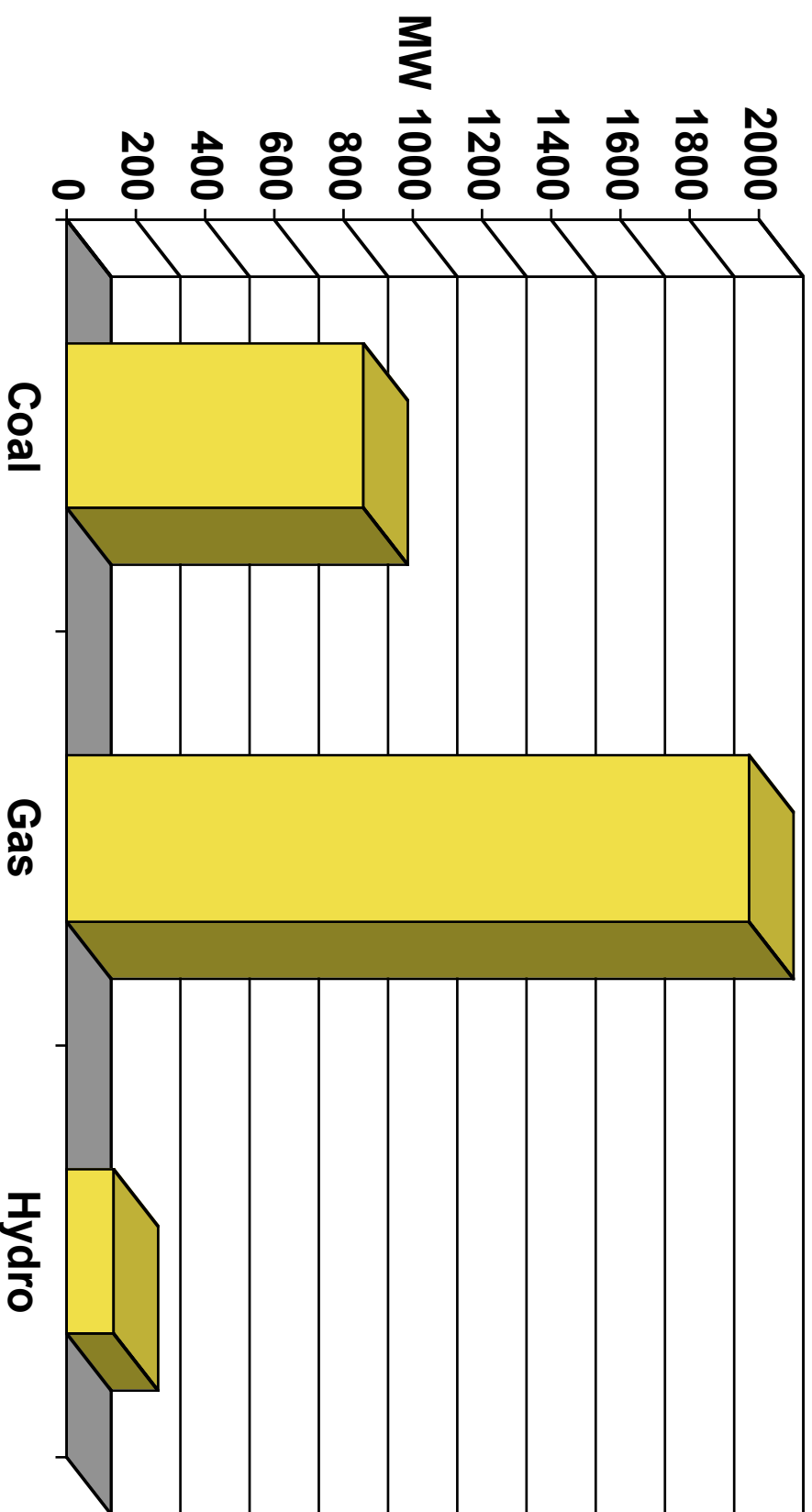


# Fossil fuel power station

efficiency & emission coefficients



## Advanced or publicly announced new power station projects for the Australian National Electricity Market (NEMMCO SOO 2003)



# Policy response options

- Increased demand-side participation:
  - End-use efficiency, frugality, flexibility
  - Importance of information & decision making
  - Problem of multiple decision makers
- Low emission generation:
  - Renewables, “zero emission” coal, nuclear,
    - ...
    - No “magic bullet”
  - Importance of appropriate innovation



# AGO “technology roadmap”

(Harrison, October 2002)

**2010**

Cattle Vaccine  
Fuel efficient cars  
End-use efficiency  
Carbon accounting tools  
Waste gas capture  
Land management  
Bio fuels & sinks  
Co-generation  
Wind power

**2020 ?**

Distributed energy  
Gas geosequestration  
Hybrid/fuel cell vehicles  
Coal gasification/sequestration  
New renewables  
- new generation PV  
- solar thermal  
- geothermal power  
- fuel crops

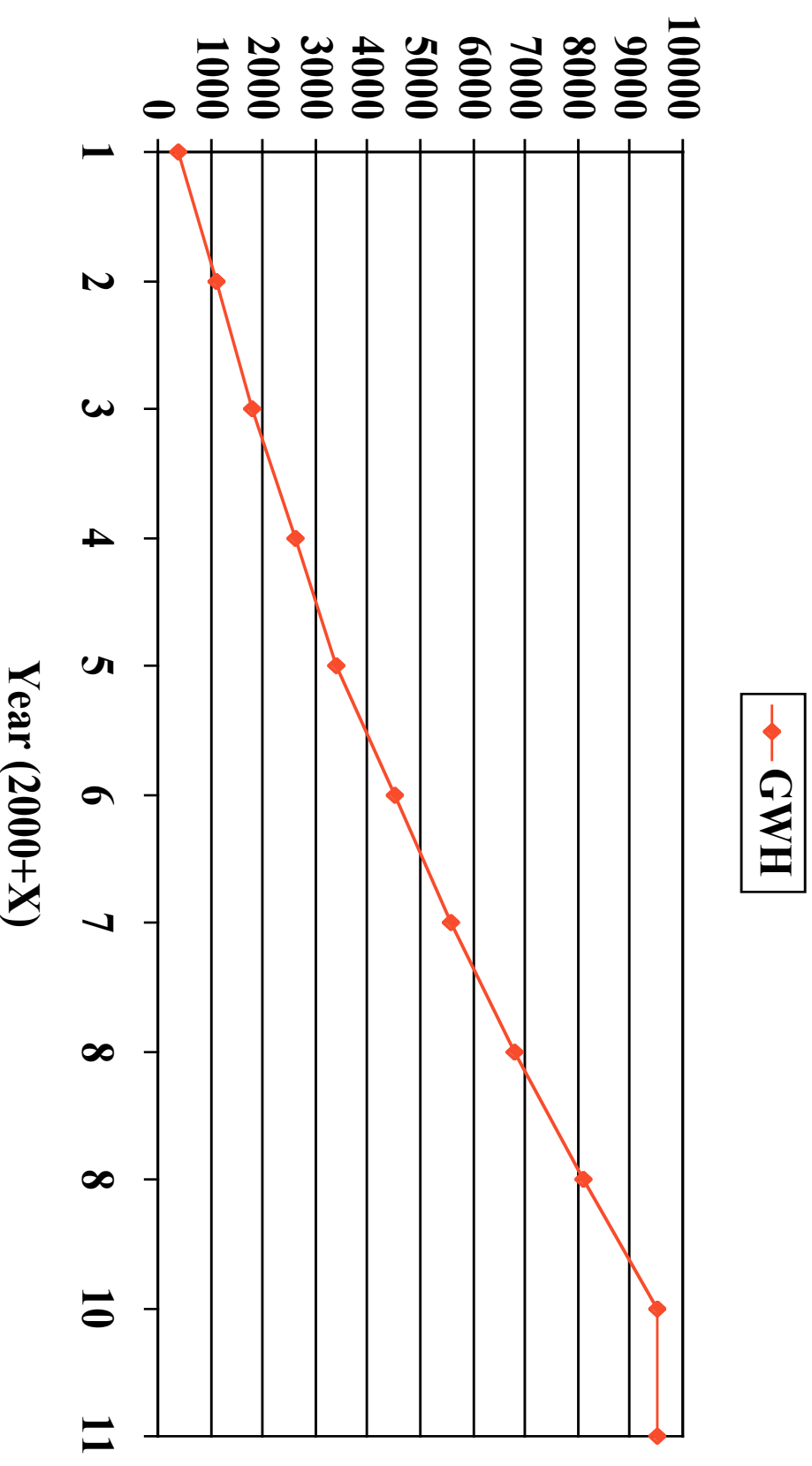
**2040 ?**

The hydrogen economy  
based on zero emissions  
fossil fuels and  
renewable energy

# AGO climate change programs

- Appliance & equipment energy standards
- Building energy codes & standards
- Fossil fuel power station efficiency targets
- Renewable energy:
  - Additional 2% target for retailers (9500 GWh/yr)
  - Showcase & commercialisation program
- Preparation for emission trading
- Vehicles - fuel targets & labelling, CNG
- Greenhouse challenge

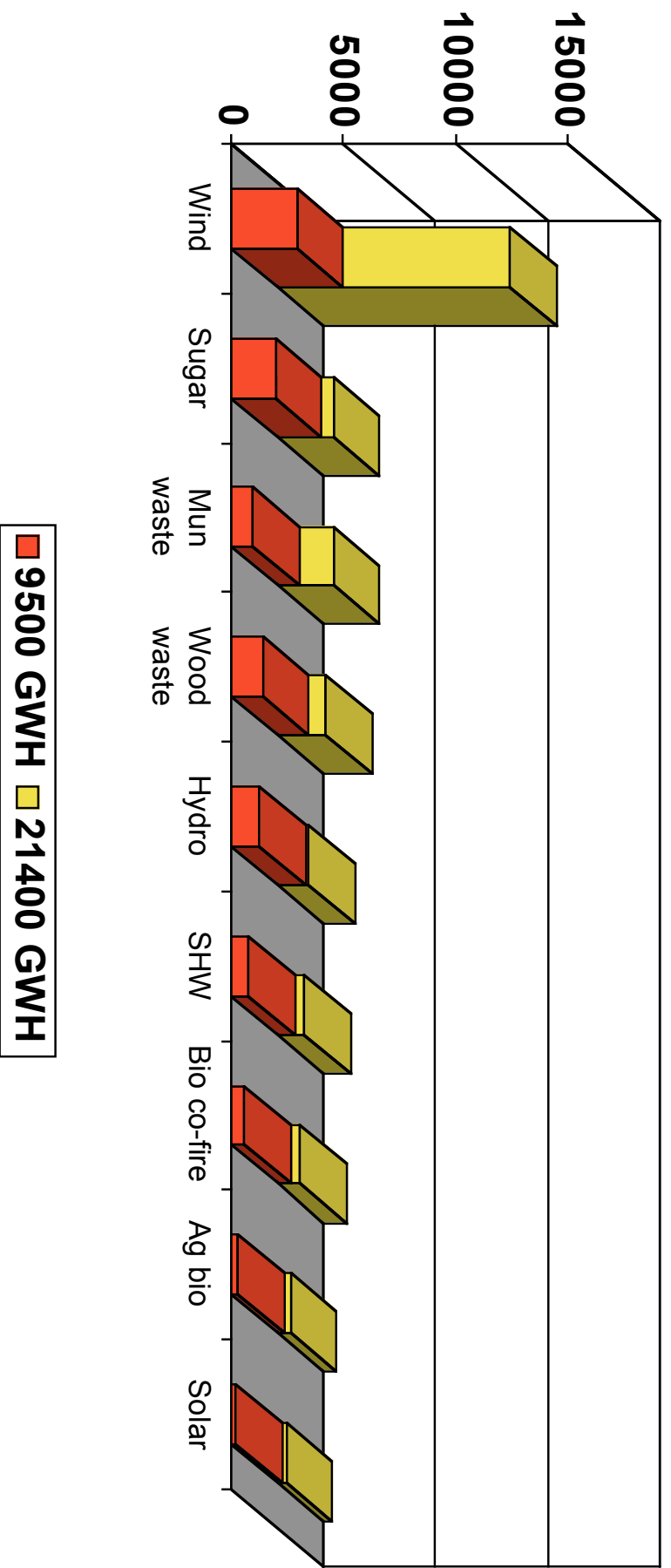
# Annual targets for electricity from “new” renewable energy



# AEA prediction of renewable energy supplied to meet MRET target of 9500 GWH pa & larger target of 21400 GWH pa

(Australian Ecogeneration Association, “Ecogeneration”, Oct/Nov 2001)

*(2% is only the start of a credible climate-change response)*



# Albany wind farm, WA

(source: Western Power)



Storm front can cause a dramatic increase in wind farm power output

Climate change & the electricity industry



# Solar energy - photovoltaics

- PV cells produce DC electricity
  - Use inverter to create AC
- Stand-alone or building integrated



200kW, Singleton  
(Energy Australia)



650 kW, Newington  
(Pacific Power)



# Summary

- Humans “discernibly” affecting the climate:
  - To stop this, must reduce fossil fuel combustion
- Australia has high per-capita emissions:
  - Moral obligation on rich countries
- The electricity industry is the biggest emitter:
  - Competition favours coal over gas & renewables unless external impacts are considered
- Key options:
  - Policies such as emission trading or taxes
  - Innovation in renewable energy generation & efficient electricity use

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Columbia accident report: No safe exits; complexity; organisational failure  
([www.nasa.gov](http://www.nasa.gov)) What about the trip we are all on: planet earth?



The launch of STS-107 on January 16, 2003.

## IN MEMORIAM

Rick D. Husband  
*Commander*

William C. McCool  
*Pilot*

Michael P. Anderson  
*Payload Commander*

David M. Brown  
*Mission Specialist*

Kuljarna Chawla  
*Mission Specialist*

Laurel Blair Salton Clark  
*Mission Specialist*

Ilan Ramon  
*Payload Specialist*

Jules E. Miller, Jr.  
*Debris Search Pilot*

Charles Krennek  
*Debris Search Aviation Specialist*



# For more information on our work in the sustainable energy research group

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- Email: [h.outhred@unsw.edu.au](mailto:h.outhred@unsw.edu.au)
- This presentation will be available from the ELEC4011 web site as a pdf file