

Whitlam Institute Series on
Climate Stabilisation & Energy Security

4. Sustainable Energy

Dr Mark Diesendorf

Institute of Environmental Studies

UNSW

m.diesendorf@unsw.edu.au

The 3 Drivers of Environmental Impact

(Paul Ehrlich & John Holdren)

$$I = PAT$$

Impact = Population x Affluence x Technology impact

where Affluence = Consumption \$ /person

and Technology impact = Impact/Consumption

Apply to greenhouse gas emissions from energy use E :

$$Emissions = P \times (E/P) \times (Emissions/E)$$

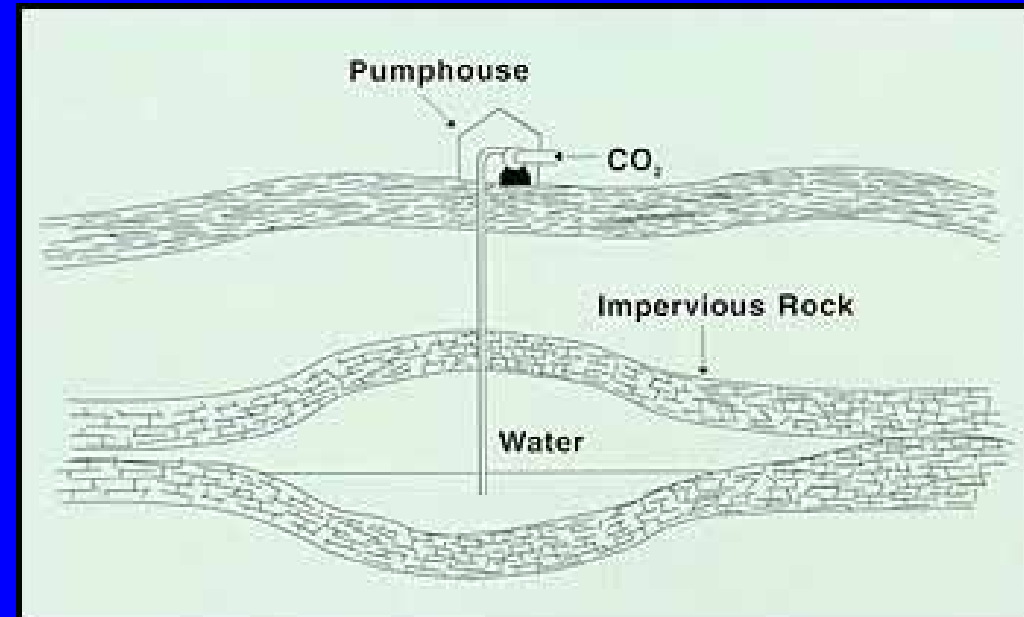
So, the formula is identically true, by definition.

The Drivers of Environmental Impact

- ☀ All 3 drivers - population, consumption per person and technology impact - must be addressed by government policy
- ☀ Hugh Saddler discussed consumption in the context of efficient energy use
- ☀ Technologies discussed so far were fossil fuels and nuclear power
- ☀ Today I'll discuss another set of technologies: renewable energy
- ☀ Remaining gaps: the population driver and forces underlying the 3 drivers: industrialism and human greed

Federal Government's Main Solution: Coal Power with Capture & Burial of CO₂ (CCS)

- ★ Unlikely to be *commercially* available before 2020
- ★ Risks of escape of buried gas
- ★ Will cost more than wind power and bioenergy from crop residues
- ★ Necessary and cheaper at NW Shelf gas fields
- ★ "Australia will develop CCS and save the world". A delusion of grandeur.



'Clean Coal' is Misleading 'Spin'

It still has:

- ★ Air and water pollution
- ★ Health hazards to coal miners
- ★ Land degradation
- ★ Risks of CO₂ escape





Nuclear Power



Chernobyl

Technology of 1970s, still has all the old problems:

- ★ Proliferation of nuclear weapons
- ★ Superb terrorist target
- ★ Rare but devastating accidents
- ★ Still no long-term dump for high-level nuclear wastes
- ★ More expensive than wind power and some bioelectricity

Is Nuclear Power Part of the Greenhouse Solution?

- ★ Too slow to build, so it's not a short-term solution
- ★ Emits increasing amounts of CO₂ as uranium ore grade decreases, so it's not a long-term solution
- ★ Therefore, based on existing technologies, nuclear power is a dead-end alley, a diversion from genuine action.

The Genuine Solution

Sustainable Energy Future for Australia
based energy efficiency, renewable energy and,
for a transitional period,
gas (the cleanest fossil fuel)



Bioenergy, Rocky Point, Qld



Wind, Albany, WA



Christie Walk, Adelaide



Concentrated solar



- Energy efficiency
- Wind
- Biomass
- Solar, Geothermal

SUSTAINABLE ENERGY



PV Solar tiles

The Principal Contributors Pre-2020



Energy Efficiency: Residential, Commercial, Industrial

Cheapest and Fastest Technologies

Economic savings from EE can pay for much of additional costs of RE

- ★ Solar efficient design in new buildings & retrofits
- ★ Efficient heating, ventilation & cooling
- ★ Efficient appliances, equipment & lighting
- ★ Efficient industrial processes



Christie Walk, Adelaide City

Solar Hot Water

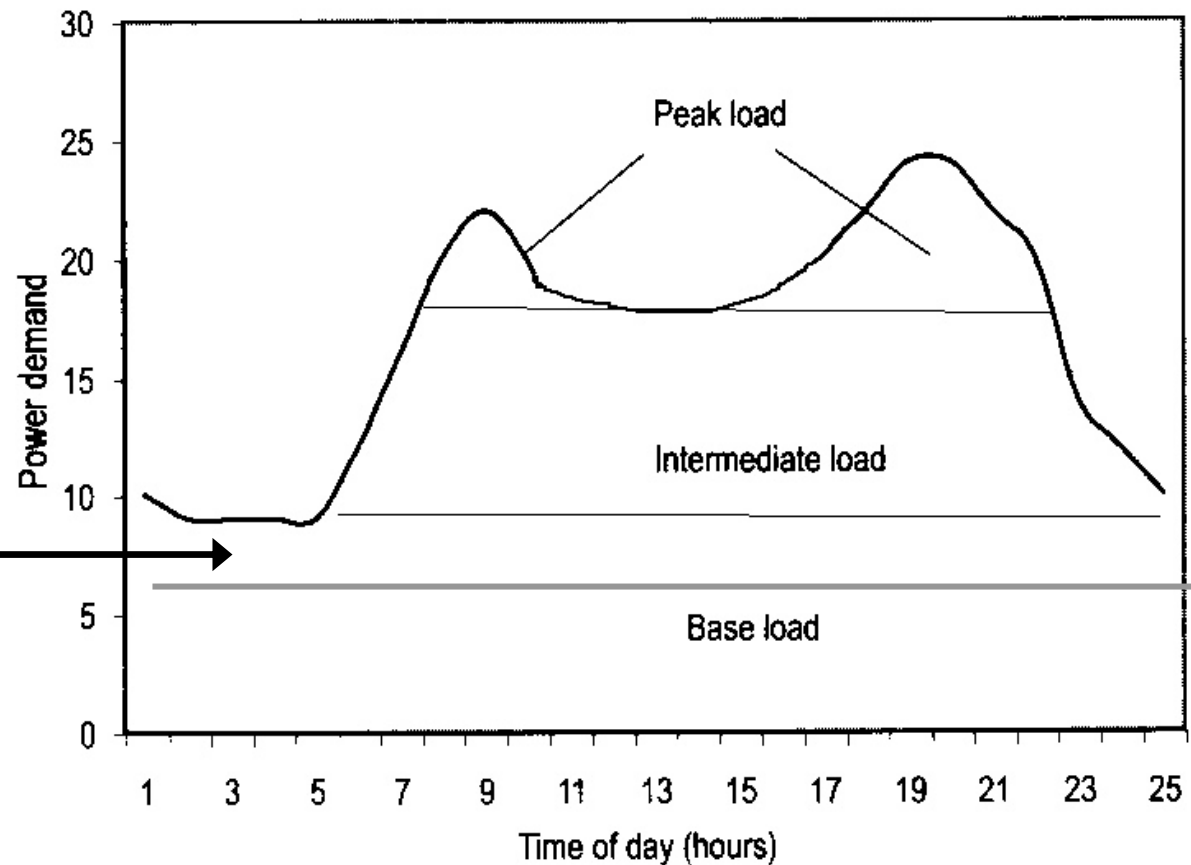
- ★ Solar-gas has lowest GHG emissions and highest price
- ★ Solar-electric hot water, gas hot water and electric heat pump have next lowest emissions
- ★ Potential savings in Aust: 4600 MW of coal power and 7 Mt p.a net of CO₂



Substituting Solar Hot Water & Intermediate-Load Gas for Base-Load Coal

'Base-load' is artificial construct to justify inflexibility of coal & nuclear.

Coal-fired off-peak hot water artificially boosts demand for base-load coal power. Shut down this component of coal power and substitute with solar, gas & electric heat pump hot water and intermediate-load electricity.





Energy Supply

Wind could generate 10% of Australia's electricity in 2020 and 20% in 2030

- ★ 20% of electricity achieved in Denmark, 25% planned for 2010
- ★ Changes to transmission network are needed
- ★ Large-scale dispersed wind + gas turbines can substitute for coal in grid = base-load



Albany wind farm, W.A.

Opposition based on Misinformation from Vested Interests

- ☀ Visual impact: personal taste
- ☀ Bird kills: rare
- ☀ Noise problems: rare, managed by licence conditions
- ☀ Land-use: small on farmland
- ☀ Property values: no long-term impact
- ☀ Bushfires: never
- ☀ Flicker: rare
- ☀ Intermittency: minor problem from geographically dispersed sites





Large-Scale, Dispersed Wind is *not* 'Intermittent'

- ★ Single wind turbines are intermittent (they switch on and off frequently in low winds)
- ★ Multiple wind farms, located in geographically separated locations, are not intermittent. In general, their total output varies slowly.
- ★ At windy sites, about 2600 MW of wind power can substitute for the electricity generation of a 1000 MW coal power station, which can be retired.
- ★ The wind farms can be made as reliable as coal, by adding a little peak-load plant, such as gas turbines.
- ★ Since the peak-load plant has low capital cost and is operated infrequently, it provides reliability insurance with a low premium.



Energy Supply

Biomass residues could supply 8% Australia's electricity in 2020; 30% in 2040

- ★ Fuels include wheat stubble, sugar cane residues & plantation forest residues.
- ★ Residues & organic wastes cheapest & fastest, but resource limited.
- ★ Price depends on distance that fuel is transported
- ★ Generates base-load power
- ★ Biomass residues don't compete with food



Burning sawmill & sugar cane residues at Rocky Point, Qld

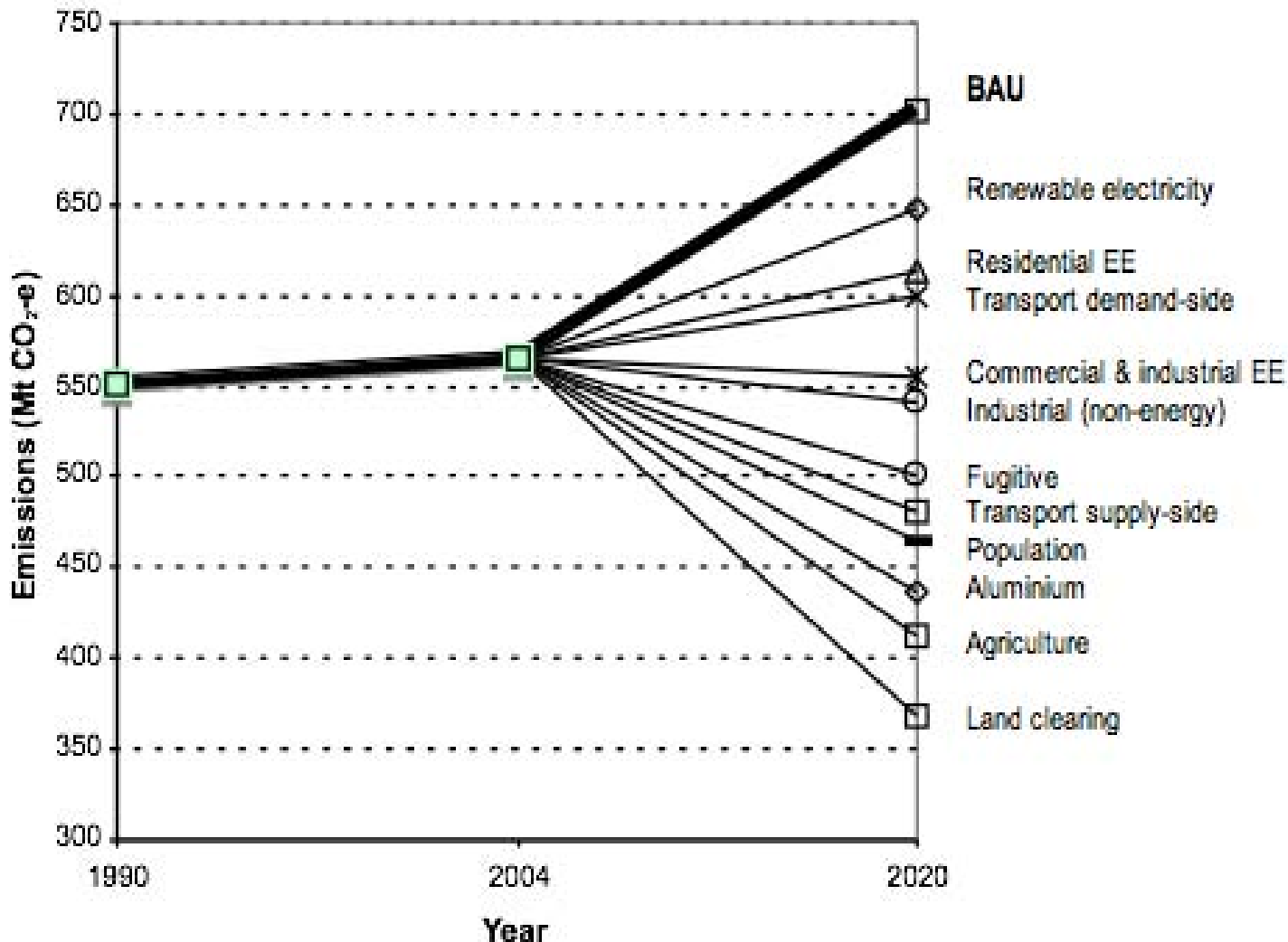


Gas as a Transitional Fuel

- ★ Combined cycle power stations: 30% of electricity by 2040
- ★ Cogeneration of electricity and heat, especially in industrial & commercial sectors
- ★ Back-up for solar hot water, solar space heating & solar thermal electricity
- ★ Back-up for wind power with peak-load gas turbines
- ★ Post-2050, gas gradually replaced by solar (both PV and STE) and biofuels produced sustainably

Scenario for 2020: Energy, Transport and Beyond

[Diesendorf (2007) *Paths to a Low-Carbon Future*, Greenpeace]



- ★ Emissions 33% below 1990 level by 2020

- ★ Biggest reductions from EE and RE

- ★ Stop land clearing & deforestation 45 Mt p.a;

- ★ Cut fugitive emissions 40 Mt p.a.

- ★ Aluminium 28 Mt p.a.;

- ★ Agriculture 23 Mt



Cleaner Energy Mix: Direct Local Jobs per Unit of Electricity Generated

Source of electricity	Employment in Australia (in units of 64 job-years/TWh)
Coal electricity + coal mining	1
Wind power with 50% Australian content	2–3
Bio-electricity with 50% Australian content	Approx. 3.5 (mostly rural)
Wind power with 80% Australian content	3.5–5

Principal source: MacGill, Watt & Passey (2002)

The Principal Contributors Post-2020

Solar Photovoltaic (PV)

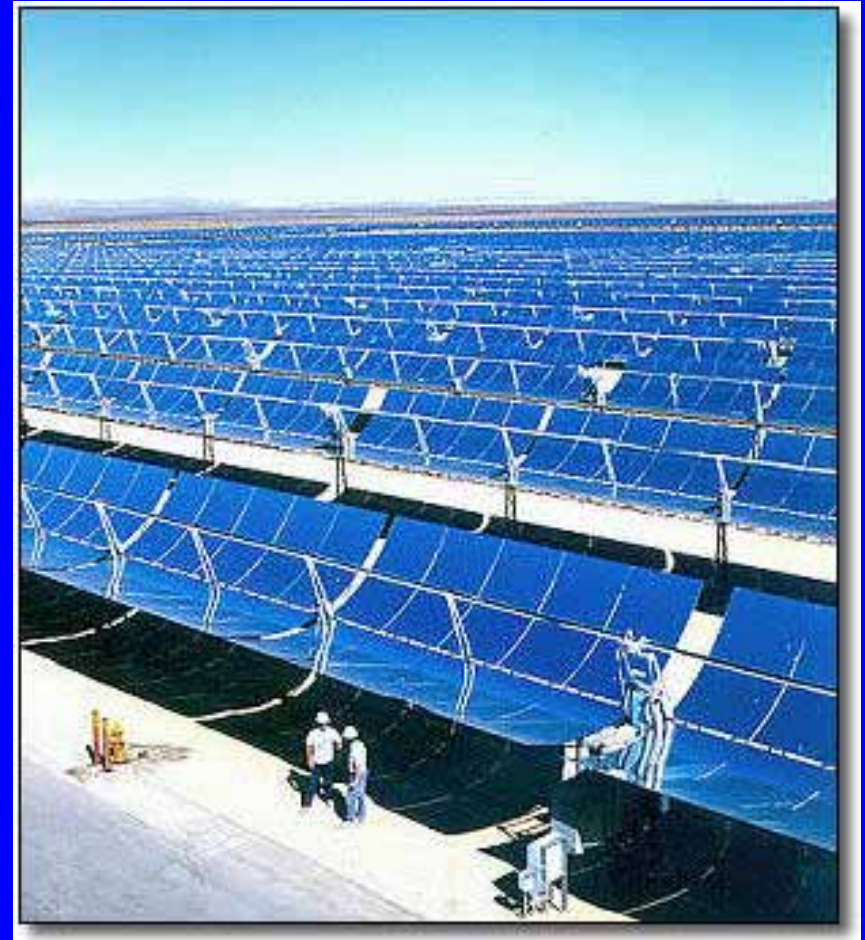
- ★ Electrical storage is still expensive
- ★ So PV is daytime power:
intermediate- & peak-load
- ★ More important than base-load
- ★ Technological advances will reduce
cost of PV panels
- ★ Needs R&D funding and market
stimulus





Solar Thermal Electricity with Thermal Storage

- ★ Thermal storage in water, rock bed, salts, ammonia
- ★ Needs additional collectors
- ★ Thermal much cheaper than electrical storage
- ★ Base-load (24-hour) power
- ★ Cloncurry Qld, baseload power 2010



Hot Rock Geothermal Power

- ★ Under development in France and Australia
- ★ In Australia, huge potential in n-e S.A and s-w Qld
- ★ Base-load power
- ★ Low water use and low pollution
- ★ First electricity around January 2009



Hydro and Marine Power

Technology	Current status	Additional potential in Australia
Hydro	Commercial, 8% of electricity	Low (conservation areas, drought)
Tidal barrage	Commercial	Only in north-west.
Ocean current (water turbine)	Prototype	Low-medium?
Wave	Several different prototypes	Medium-high, but long-term

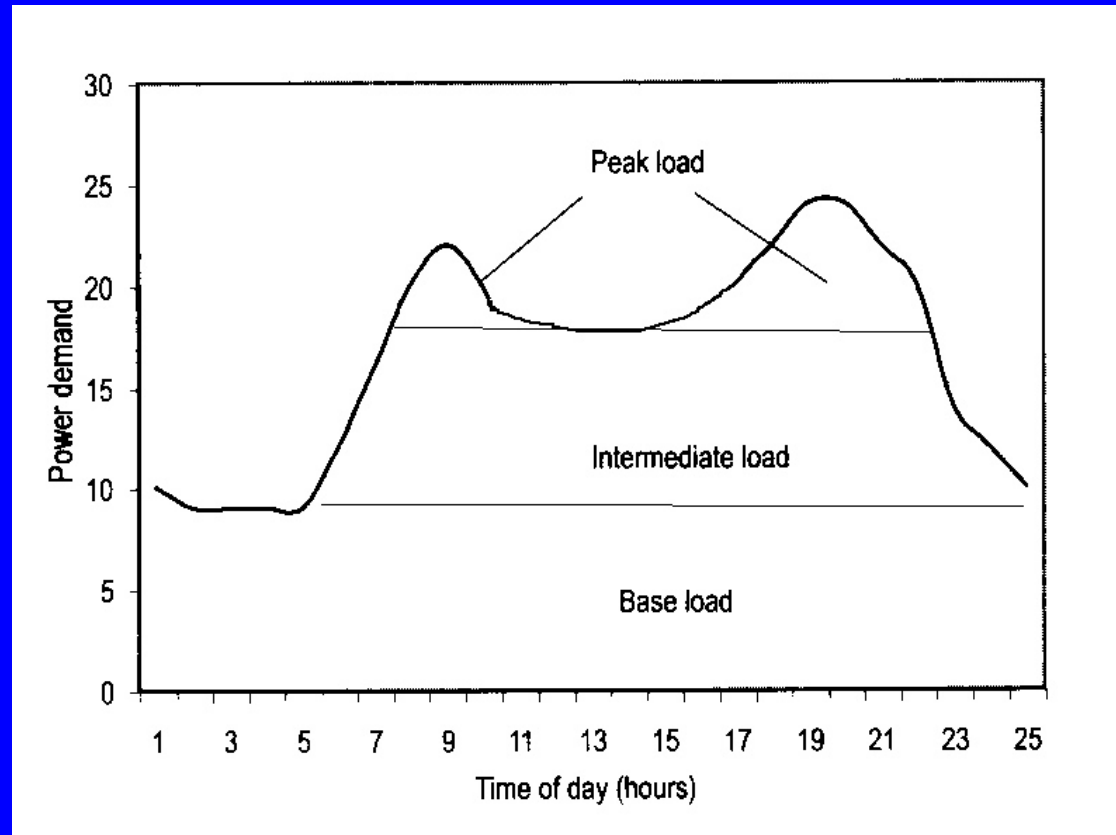
Matching Demand and Supply for daily Electricity Demand

Conventional

Hydro & gas turbines

Coal & gas combined cycle

Coal



Renewable & gas

Hydro, gas turbine, biomass

Solar PV, gas combined cycle

Gas, biomass, wind, solar thermal + storage, geothermal

Base-load reduced by energy efficiency & solar hot water

Policies Needed for Sustainable Energy

Status of Rudd Federal Gov't Election Promises

- ★ Ratified Kyoto Protocol immediately, but failed to support strong short-term international target at Bali
- ★ Set long-term Australian greenhouse target of 60% reduction in emissions by 2050 (80-90% needed)
- ★ Promised \$500 million to renewable energy development & deployment over 6 years, but allocated zero in 2008-09 budget
- ★ Promised \$150 million for renewable energy research, especially solar, but only geothermal drilling received allocation in 2008-09 budget
- ★ Promised to increase Mandatory Renewable Energy Target to 20% of electricity by 2020, but implementation delayed until 2009.
- ★ Undermined residential solar electricity market with a \$100,000 means test for the \$8000 rebate.
- ★ Distanced itself from draft recommendations of its own Garnaut Climate Change Review

Federal Government Policies Still Needed

- ★ Fix shortcomings in existing policies and stop delays.
- ★ Set short-term greenhouse targets, e.g. 30% reduction by 2020
- ★ Ensure forthcoming emissions trading scheme is effective, by setting tight cap on emissions, auctioning 100% of permits and not making permits property rights
- ★ Ban new conventional coal-fired power stations (**with States**)
- ★ Fund a more geographically distributed transmission system (**with States**)
- ★ Remove subsidies to production & use of fossil fuels (>\$10 billion p.a.)
- ★ Fund urban public transport and intercity rail equally with roads
- ★ Assist low income earners to reduce their emissions & energy bills



Additional Key State Gov't Policies Needed

- ✦ Set energy ratings & minimum energy performance standards for all buildings, appliances & equipment
- ✦ Assist low-income earners to reduce their emissions
- ✦ Charge realistic prices for fresh water used by power stations
- ✦ Charge users of air conditioners realistic prices for infrastructure
- ✦ Ban off-peak electric hot water tariffs and new electric resistance hot water
- ✦ Foster solar hot water, clothes drying, space heating and low-temperature industrial process heat
- ✦ Ensure locations of major travel destinations are supplied by public transport, preferably rail
- ✦ Stop building major roads; limit parking places in urban centres & subcentres



What we can do in response to delays by governments, Federal & State

- ★ Individual family actions are necessary. They set precedents and have limited educational value.
- ★ Individual & family actions are not sufficient. Governments make the laws, collect taxation revenue and make infrastructure decisions.
- ★ The majority of emissions comes from industry, not directly from households
- ★ A social movement is essential for changing Government and Opposition policies and for changing business practices and products.
- ★ In USA and Australia, social movements are growing. They involve local governments, some businesses, environmental NGOs, faith groups, trade unions and concerned citizens.

Further Reading

- ★ Diesendorf M (2007a) *Greenhouse Solutions with Sustainable Energy*, UNSW Press
- ★ Diesendorf M (2007b) *The Base-Load Fallacy*, <www.energyscience.org.au>, briefing paper No. 16
- ★ Diesendorf (2007c) *Paths to a Low Carbon Future: Reducing Australia's Greenhouse gas Emissions by 30% by 2020*. Greenpeace Australia Pacific
- ★ Diesendorf (2007d) *Submission to Garnaut Review*. <www.sustainabilitycentre.com.au/popular.html>