# Can Australia's consumer society reduce climate emissions to safe levels?

## *QUESTIONS FOR THE INTERIM GARNAUT REPORT*

Can Australia reduce its greenhouse emissions to safe levels, as the Interim Garnaut Report claims, with little effect on the economy? **TED TRAINER** looks into the report and wonders how it will be possible to cut dependence on fossil fuels by 90% and move to alternative energy sources while the economy becomes four times as big by 2050, without significant consequences for the commitment to affluent living standards and limitless economic growth. As the report gives no indication where the energy to replace fossil fuels is to come from in such quantities, Trainer makes generous assumptions, and estimates but finds it would not be possible to draw up a 2050 Australian energy budget for anticipated demand within safe $CO_2$ limits, let alone a 2100 budget. He challenges Professor Garnaut and critics to check his data and show where it's wrong. With a stable economy and much less affluent ways, we can resolve the ecological crisis.

In 2007 Professor Ross Garnaut was asked by the Australian Labor Party to review the greenhouse problem and suggest policy options. The interim report published in 2008[1] is valuable in stressing the need to go well beyond the commonly stated target of a 60% cut in $CO_2$ emissions by 2050. Yet the report fails to discuss the two most important issues: whether or not it will be possible to bring $CO_2$ emissions down to "safe" levels, and the cost to the economy of attempting to do so. Garnaut has said publicly the problem can be solved without significant economic cost. I believe these conclusions are wrong, and that a consumer society cannot cut greenhouse emissions to safe levels at any cost.

The Stern Reports[2,3] from the UK and the International Panel on Climate Change (2007)[4] assert the same conclusions as Garnaut and they have become universally taken for granted as a basis for global policy and action. I have made detailed criticism of these analyses[5,6] and will briefly draw on these to define the issues and difficulties Garnaut has not considered. It should be stressed here that the Interim Report gives no space at all to whether it's technically possible to solve the greenhouse problem, or the cost of trying to do so. The following discussion does not question the conclusions the IPCC makes on the nature and seriousness of the greenhouse problem; it's only concerned with its conclusions on mitigation and costs.

### The reduction target

Garnaut supports the IPCC's emission targets for 2050, for a 50–80% reduction to 5–15 GT/y, for a 450 ppm atmospheric concentration.[7] Importantly, he says if the highest value in the 2050 range was shared among the nine billion people expected by then, the per capita amount would be 1.4 tonnes, which is 7% of Australia's current amount (excluding the land-clearing contribution). Note: if he had taken the mid-range target the reduction would have to be 96%. Garnaut should have made it clear that the IPCC scenario for 2100, at the mid-point of the permissible range, is a minus value; which means we will probably have to take large quantities of $CO_2$ out of the atmosphere every year.

Garnaut is to be commended for analysing the situation including its implications for a world of nine billion people. Few have thought beyond implications

the 450 ppm target still runs a 50% risk of producing more than a 2-degree rise, as Garnaut notes – a 50% risk is really highly unacceptable for the rich world. For instance, the commonly stated goal of cutting UK and Australian emissions by 60% can sound impressive, until it's realised this would leave Australia on a per capita rate of 10.4 tonnes p.a. and if nine billion people had that amount then global emissions (from energy alone) would be 3.5 times as great as they are now. In other words a 60% cut is nowhere near enough. Also, there can be little doubt the 450 ppm target will soon be generally regarded as too high, because currently observed effects of warming are already running ahead of IPCC expectations, and the oceans' absorptive capacity is declining, as Garnaut notes.

Additionally, the 450 ppm target still runs a 50% risk of producing more than a 2-degree rise, as Garnaut notes – a 50% risk is really highly unacceptable. Garnaut in effect is accepting that in this century, in a period when economic output is expected to rise to 16 times its current level (3% p.a. growth for 92 years), that we must largely if not entirely eliminate use of carbon fuels, unless geo-sequestration is proven to be effective (see below). Yet he evidently sees no need to explain how this can be done. He simply assumes it will be possible to move to alternative energy sources capable of meeting the vastly increased energy demand, at a cost that won't disrupt the economy. Below are reasons for thinking these are very mistaken assumptions.

**Examining assumptions**

Garnaut's expectations for the $CO_2$ emission trend (Figure 4, p.20; see also Figure 2 where a larger multiple is represented) indicate the world is heading for an alarming business-as-usual energy demand 3.7 times as great as it is now by 2050. Most growth will be in "developing" countries. The Australian Bureau of Agriculture and Resource Economics (ABARE), projects a 70% increase in Australian energy use by 2030, when growth is expected to be down to 1.9% annually.[7] This suggests a 2.5× increase between now and 2050. I will assume only a doubling, to c 11 EJ. The Australian Bureau of Statistics, puts 2005 consumption at 5.64 EJ, and also assumes 25% of this can be saved by energy conservation developments,[8] much more than Stern assumed.

Therefore the target will be taken as providing 8 EJ of energy "services," i.e., electricity, transport fuel etc, as distinct from the primary energy these forms might be derived from. If current proportions apply we will need approximately 1.76 EJ as electricity, and

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3 EJ, as transport fuel. But how might these quantities be provided with little use of carbon fuels?

**Possible sources and quantities**

Let's assume one quarter of the 8 EJ budget, i.e., 2 EJ, is for low-temperature space and water heating, derived from solar sources (although this is uncertain in winter), leaving 6 EJ to be found.

*Geo-sequestration* of $CO_2$. This is only applicable to stationary sources, and more importantly can only capture 80–90% of the $CO_2$ produced. Note; by 2100 it's likely no emissions will be permissible, meaning geo-sequestration could not be used.

However, let's take Garnaut's 1.4 tonnes/person/year corresponding to the highest value in the IPCC's 2050 range. If 80% of $CO_2$ is captured this would correspond to about 2.8 tonnes of coal fuel use per capita annually, and as this is primary energy it would yield about 20 GJ/person of electricity, or .42 EJ for Australia's current population. This will be added to the budget below. If geo-sequestration at this rate was applied to the planet, all available sites and all coal resources would be exhausted fairly quickly. At 2.8 tonnes/person, nine billion people would be using 25 billion tonnes of coal a year, around four to five times the early 2000s world production rate. Some estimates show even with current use rates, coal supply could peak within 15 years,[9,10] although the common estimate is maybe five times as great.

If deep-sea burial of very large quantities of $CO_2$ is rejected as an ecologically unacceptable risk, the best estimate of land $CO_2$ geo-sequestration capacity, is that 1700 GT, would be used up in 34 years.[11]

*Biomass.* It would be optimistic to assume Australia could find 30 million ha for biomass energy production, at 7 t/ha yield, especially given the advent of dryer conditions. All Australian cropland amounts to a little over 20 million ha. If used to produce ethanol at 7 GJ/t net plus 1 GJ of electricity, this would produce 1.5 EJ of ethanol, half the transport demand, and .21 EJ of electricity. Ignore the facts almost no ethanol has yet been produced from cellulose commercially and that some doubt the process is viable,[12] also, that such electricity yield assumes lignin residue can be dried.

*Nuclear* Energy: How much could we get from nuclear energy? Uranium resources are commonly estimated at two to four million tonnes.[13,14] At current global use rates, generating c. 8 EJ of electricity p.a., it might last 70 years. However over that period it would provide nine billion people with an average of less than 1 GJ/y of electricity, about 3% Australia's consumption rate, which is increasing at more than 2% annually. If nine billion people were supplied with this amount of electricity from nuclear reactors then uranium would last about 2 years. So nuclear energy is of almost no significance for the long-term global energy problem, unless breeders or fusion are assumed. I will assume (until later) that Australia gets its fair share of the global uranium resource, which means almost all the remaining approximately 1.13 EJ of electricity would have to come from sun and wind. Let's begin by dividing the task between them.

To provide .565 EJ of electricity from wind Australia would need about 52,000 mills of 1.5 MW capacity, assuming current world average capacity of .23 as stated by the IPCC. Are there enough good sites for this number, if not, what would average capacity fall to? How far would the electricity have to be transmitted and how much energy would be lost in transmission? In 2005 the Sustainable Energy Development Authority's website estimated that, in NSW, 1 GW, .032 EJ/y, could be derived from wind. Trieb,[15] p.48, estimates total European on-shore potential would be less than 2 EJ. Australia's narrow shelves provide little off-shore potential.

*Photovoltaic:* On average flat plate solar panels probably produce 13% of 5kWh/m/day in southern Australia, or .85 GJ/m/y. To provide .565 EJ we would need 667 million square metres, and would have to replace about 27 million metres per year, to provide 6.5% of national energy. This capacity would provide no energy for about 12 hours a day. (The possible solar thermal contribution is considered below.)

**Integration problems**

These quantities of wind and solar energy might be collectable and affordable, but the main problems are in integration and storage. No matter how much wind and PV capacity we build they can provide no energy at all on a calm night. In other words wind and solar sources set huge problems of storage and integration into the electricity supply system. Their output rises and falls markedly, and can do so quickly. All PV capacity would come on stream within a couple of hours, but it can take many hours to ramp-up a coal-fired plant to full output. These are not difficult problems when wind and sun contribute a small proportion of demand, say up to 15%, because adjusting the surplus coal/nuclear generating capacity can accommodate their varying output.

Very large quantities of electricity cannot be stored. Pumped hydro systems are the best option, but can cope with only a small fraction of demand. Hydroelectricity makes up only about 6% of Australian electricity supply. To store as hydrogen means possibly 75% of the electrical energy generated would be lost, excluding the embodied energy cost of building the elaborate hydrogen generating, processing, storing and electricity regenerating plant.[16] This is why a number of people believe we will never have a large scale "hydrogen economy."

The fact renewable energy sources must be understood as alternative, not as additive, is easily overlooked. If you build X GW of wind generating capacity and X GW of PV, you can't have the capacity to generate 2X GW. There will be times when the plant gives you no capacity to generate any electricity, on calm nights. So in a largely or wholly renewable supply system we might need wind, PV and solar thermal systems each capable of meeting a large fraction or all of demand, plus a coal–nuclear system also capable of meeting all demand if/when none of the others are working. As capital costs per kW of PV, wind and Solar thermal could be 10, four, and seven times that of coal, respectively (taking delivered not peak output), the total capital cost of the system would be very high.

We should also realise that if the wind sector is large, for every 1000 MW of wind capacity added, almost 1000 MW of coal or nuclear power might also have to be built, to use when the wind is not blowing. This would add greatly to the capital cost of the new system, and clash with greenhouse goals. So if the Eastern Australian states fall from 100% to 0 % of the .565 EJ of PV capacity within a 1-hour period at the end of the day,

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what would pick up this load, equivalent to 23 power stations of 1000MW capacity … when thermal plant cannot ramp up in such a period? (Gas plant can ramp-up quicker than coal, but gas use will not be a significant component in a renewable world, because it emits $CO_2$, and this will be largely exhausted later this century.)

It can be argued it will make sense to have considerably less wind or PV in a system than corresponds to their average capacity factor, because of the over-sizing and dumping. problem. If a system's demand was X GW and we installed X GW (peak) of PV, then on average it would produce .2X GW (PV's capacity factor is about .2), but at times it would operate close to its X GW peak and therefore meet almost all demand, meaning that energy from other sources operating at the time would have to be dumped, or stored very inefficiently as hydrogen. So in a system with a number of renewable components it's likely we would not want any to contribute a proportion equal to its average capacity factor. This suggests that wind plus PV combined might provide considerably less than 40% of electricity, because of over-sizing, dumping and integration issues.

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But let's assume wind and PV combined account for 40% of the 1.76 EJ electricity demand, i.e., .7 EJ. Adding geo-sequestration (.42 EJ) and biomass (.21 EJ) would leave .43 EJ of electricity to be accounted for (along with 1.5 EJ of transport energy, and another 1.24 EJ n.e.i of the 8 EJ target.)

**Solar thermal?**

Because solar thermal systems have capacity to store heat to use later they will be very valuable contributors in a renewable energy world. Yet it appears even in Central Australia, possibly the best solar thermal site in the world, these systems will not provide significant quantities of electricity over the three winter months.[17] Research in 2003 by Odeh, Behnia and Morrison[18] seems to show clearly that trough systems in Central Australia would not be viable in winter. Dishes would be more effective than troughs, but they mean more dollar, materials and costly energy. Plots from the US Mod dish systems show output corresponding to a continual flow of 18 W/metre over a winter month. But this figure applies to use of efficient Stirling engines generating electricity at the focus of each dish and are not applicable for our purpose, which requires heat storage. To store heat from dishes before generating would lower efficiency markedly.

A group from Australian National University are exploring the use of ammonia dissociation as a way of storing heat from dishes.[19] They believe the energy efficiency of the chemical process could be .7, and half the energy entering the dish should be available for generating electricity after storage. From the resulting gross output must be subtracted the cost in embodied energy of building the collection plant, the heat storage plant involving large, heavy-pressurised tanks for the ammonia process, and very long-distance transmission lines, and the energy loss in those lines. The last factor might account for 15% of energy sent to North-West Europe from Western Egypt, the best proposed site for European supply.

There's also a major problem regarding the need for several days storage. For instance the Australian Solar Radiation Data Handbook (2006)[20] says there's a 100% chance radiation will be under 4.86 kWh/m/d on average for a nine-day period in Central Australia in June. Heat storage capacity capable of coping with such winter events would be extremely costly in terms of dollars and embodied energy, especially if it's assumed solar thermal is going to solve the intermittency problem. This would require solar thermal plant to be equipped with capacity to generate, accumulate, and store energy output from perhaps three times as much wind plus PV plant etc as there is solar thermal plant, for several days. In the budget under discussion this corresponds to output of perhaps 45 large power stations. Put another way, if the solar thermal 25% of the supply system was to meet 75% of demand for four days, its heat storage capacity would have to be 24 times as great as the 12-hour storage envisaged and costed into normal solar thermal plant.

For these reasons, although solar thermal systems will probably be the most valuable contributors to a renewable energy world, it seems they will not be able to guarantee electricity supply in winter even in Australia.

However let's assume that wind, PV and solar thermal meet electricity demand for three-quarters of the year and that when the two solar components largely phase-out in winter, the geo-sequestration component makes its contribution. Its .42 EJ is equal to one-quarter of electricity demand and therefore equivalent to three months demand. (This is not a satisfactory set of assumptions because CCS would also have to be used to plug gaps in wind and solar supply.) This would explain electricity, although a number of questionable assumptions have been made, about the amount of biomass that could be harvested, the amount of wind and PV that could be integrated, the rate at which coal/nuclear sources could be ramped-up, and the acceptability of geo-sequestration. If these assumptions were valid, solar thermal input would enable combined renewables to provide more than enough electricity for most of the year.

At this point we would have explained possible sources for the 1.76 EJ of electricity, half the 3 EJ of transport energy, and 2 EJ of low temperature heat. This leaves 2.74 EJ to be found.

**The conversion problem**

Discussions about potential renewable energy sources usually fail to take into account the need to convert energy from available forms to forms that are needed. Conversion is typically energy-inefficient, meaning much more energy needs to be generated than appears to be the case. If the 2.74 EJ yet to be provided was to come from wind and solar energy stored as hydrogen, via a process that is say .33 energy-efficient, then these sources would have to generate 8 EJ. This is 11 times Australia's current electricity generation, and around one-eighth of the world's present electricity generation, just to top up one-third of the energy demand and it would have to be added to the cost of the two-thirds previously accounted for.

However let's assume electrical power for all transport and other unaccounted uses, cutting the 8 EJ task in half.[15] But electricity cannot power shipping or air transport, so these cannot be added here to the CO2 budget because all geo-sequestration capacity has been prior allocated to electricity. Nor is it plausible that air and sea transport can be fuelled by ethanol or hydrogen. Let's now assume nuclear reactors generate 4 EJ/year. Australia would need about 133 large (1000 MW) reactors, corresponding to about half the world's current nuclear-generating capacity. If other countries took a similar option uranium would be exhausted in a matter of months.

If provision of the n.e.i 2.74 EJ came from wind and solar via conversion from electricity at .5 energy efficiency, these would have to generate 5.6 EJ. This would multiply by five the task they were allocated above, i.e., the task of meeting direct electricity demand. (Again a .5 efficiency assumption is unrealistic because around 1.3 J of current Australian energy consumption is oil plus gas in addition to the amount of these fuels used for transport, and to produce this from sun and wind via hydrogen would involve an efficiency closer to .25 and the 1.3 EJ is likely to be 2.6 EJ by 2050.

It seems clear from these figures and estimates that it would not be possible to draw up a 2050 Australian energy budget for anticipated demand within safe $CO_2$ limits, let alone a 2100 budget when geo-sequestration is unlikely to be used, and when economic output is supposed to be 16 times as great and therefore energy demand would be much greater. In my 2007 critique of the IPCC,[6] I calculated a similar energy budget for the world as a whole, i.e., aimed at achieving a safe $CO_2$ emission target via alternative energy resources, and came much more emphatically to the same conclusion: this cannot be done. Growth in world energy use is much more rapid than Australia's.

Australia is in a far better situation than most countries to derive energy from renewable sources, having good solar and wind resources and perhaps five times the rich-world average productive land per person for biomass production. Yet the argument in my new book *Renewable Energy Cannot Sustain A Consumer Society*[21] is that even Australia cannot expect to sustain a consumer society on renewables, especially given its commitment to limitless economic growth. Its electricity demand is now growing at over 3% annually. It should be stressed, these are not arguments against renewable energy, they are arguments against the capacity of renewables to support a consumer society.

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We must move to total dependence on renewables as quickly as possible and we can all live well on them, but not in a consumer-capitalist society.

**Energy conclusions**

Some elements in this critical study are uncertain and imprecise, but it shows there are several important issues to be addressed, which Garnaut has not considered at all. It indicates considerable support for concluding Australia will not be able to solve the greenhouse problem if it remains committed to affluence and growth. Those who do not like this conclusion should check the data and estimates and show where the analysis is mistaken. Garnaut's final report will have no credibility unless it includes a detailed, numerical and convincing analysis dealing with the issues raised in this critique. The interim report makes no reference to these factors.

In my view any plausible figures and assumptions will lead to the conclusion it will not be possible to find sufficient energy sources to sustain a consumer-capitalist society. Note that given 3% p.a. economic growth which Garnaut rightly notes is essential to the consumer society, economic output is going to be 16 times as great by 2100 as it is now, and according to growth theory it's going to double every 23 years thereafter … forever! The problem is not whether it's

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possible to substitute renewables for *current* carbon-emitting energy sources, it's whether we can get off carbon completely and run a society blindly obsessed with limitless growth.

**The 'limits to growth' position**

For 50 years a 'limits to growth' analysis of our situation has been accumulating, taking into account much more than energy issues. Its core point is, consumer society is grossly unsustainable, because production and consumption levels are far higher than can be kept up for long or than all could ever achieve. The quest for affluence and growth is the direct cause of the many alarming global problems now accelerating. Another of these powerful lines of argument, is the Australian per capita footprint, around 7 ha of productive land, is about 10 times the amount of productive land that will be available on the planet by 2050, even ignoring land losses.

It's difficult to imagine how anyone who understands the general 'limits to growth' case can avoid concluding that consumer–capitalist society is not just grossly unsustainable, *it simply cannot be made sustainable*. It's inconceivable that a way of life which is rapidly destroying its ecosystems, depleting its resources, and shared by only one-fifth of the world's people, but which all the rest are striving for, and which insists on doubling consumption every 23 years, and is possible for a few only because they are taking far more than their fair share and which condemns five billion to poverty, can be made sustainable or just! The problem, the over-shoot, the degree of unsustainability, is too great for credible assumptions about technical advances to enable the continuation of consumer society, let alone make it possible for all. So the only credible conclusion is that radical change is essential to much less affluent ways and a stable economy.

Evidently Garnaut does not think these issues warrant consideration. At least Stern and the IPCC recognised their importance and made some effort to discuss them. Garnaut seems to think we can cut our dependence on fossil fuels by 90% while the economy becomes four times as big (to 2050) without any significant consequences for the economy or the commitment to affluent living standards and limitless economic growth. He does not appear to think about what the alternative energy sources might be, whether they can be afforded, or whether technically they can be provided in such quantity.

For several decades some of us have been saying the only way out of our global predicament is by huge, radical transition to some form of a Simpler Way of living, core elements being non-affluent lifestyles, mostly small local economies under participatory social control, not driven by market forces, profit, or growth.[22] Such a society would not be possible without an equally radical change away from the competitive, acquisitive values that have driven Western culture for several hundred years. The prospects for such a transition are negligible while governments, media, bureaucracies, people in general, even the intelligentsia fail or refuse to recognise any need to question the commitment to limitless affluence and growth. Lack of enquiry into these concerns is the greatest threat to survival, peace and sustainability on planet Earth. PE

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## Notes


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