

## Attachment 1

Extract from: ABARE (1991)

*Projections of Energy Demand and Supply: 1990-91 to 2004-05*, pp 31-37.

*“4. Greenhouse gas reduction: an illustrative scenario”*

Below I attach a chapter “Greenhouse gas reductions: an illustrative scenario” extracted from the 1991 ABARE report. It makes fascinating reading. It shows:

1. how much we knew back then;
2. how little has changed;
3. we knew the targets were impossible given the policies being advocated;
4. we knew that renewable energy and energy efficiency could not make significant improvement over and above what was already included in the Business as Usual (BAU) projections;
5. we knew then that if we wanted to really cut GHG emissions we had to go nuclear.

But politics dictated nuclear could not be on the agenda. The reason was Labor needed the Green vote to hold onto power.

Many conclude the Greens have been the cause of the delay all along!!

Extract from: ABARE (1991)

*Projections of Energy Demand and Supply: 1990-91 to 2004-05*, pp 31-37.

## **4. Greenhouse gas reduction: an illustrative scenario**

The 'business-as-usual' scenario discussed in chapter 3 would result in energy sector carbon dioxide emissions in 2004-05 of 379 Mt, representing an annual average growth rate of 2.0 per cent from the 1989-90 level. If the energy sector is assumed to contribute proportionately to the achievement of the government's 'interim planning target', carbon dioxide emissions in 2004-05 would have to be reduced to about 206 Mt – that is 46 per cent below the business-as-usual outcome.

The purpose in this chapter is to indicate the implications for the energy sector of achieving such a reduction in carbon dioxide emissions. The options available can be broadly classified as:

- increasing the efficiency with which energy is used;
- inter-fuel substitution toward fuels with lower carbon dioxide emission per unit energy;
- reducing the demand for the services which energy provides; and
- trapping emissions at source to prevent them entering the atmosphere.

Here, the emphasis is on determining the potential of the first two of these options. Reducing the demand for energy services, whether by regulation (such as mandatory new car fuel efficiency standards) or by changing energy prices, would entail fundamental changes to the structure of the economy and could impose substantial costs on society. It is obviously preferable if greenhouse gas emissions can be reduced without diminishing the level of services supplied to consumers. Carbon trapping technology is not yet well developed, and is therefore not considered in this report.

### **4.1 Method and assumptions**

There have been several major studies of the potential for reducing greenhouse gas emissions from the Australian energy sector, and many more dealing with individual sub-sectors such as electricity generation or energy use in the manufacturing sector. As regards what is feasible by way of efficiency gains or energy conservation, the approach taken here is to use the results of these other studies rather than deriving original estimates. The central assumption is that the most energy-efficient technologies currently reported to be applicable and cost-effective are universally adopted in Australia. In contrast, the business-as-usual scenario is based on survey participants' stated plans and expectations and on econometric models estimated using historical data.

Judgments have been made as to the extent to which efficiency gains claimed in some studies could be achieved in the time frame to 2004-05. Only those measures which appear to be cost-effective from a new purchaser's viewpoint without tax or regulatory changes are included. (Even where measures are cost-effective in this sense, there might be a net cost to individual consumers and to society from implementing them fully in the period to 2004-05. For example, due to the cost of the new equipment

it may not be economic to bring forward the replacement of long-lived capital equipment which is less energy efficient than the best available.)

The business-as-usual scenario for the year 2004-05 was used as the starting point for the analysis. Estimates were made of the energy conservation or energy efficiency improvements which are feasible on a cost-effective basis in the residential, commercial services, manufacturing and transport sectors, in addition to those improvements already implicit in the business-as-usual scenario. Possible gains in other sectors were ignored, as their overall contribution would be relatively small.

In addition to the above changes in energy efficiency, some limited interfuel substitution toward lower carbon fuels was also assumed in these sectors. Fuel substitution, in this context, is the replacement of fuels from which relatively high levels of greenhouse gases are emitted in combustion by those giving low emission or none. Natural gas is the fossil fuel with the lowest level of greenhouse gas emissions per unit of energy produced. Energy sources which do not directly involve greenhouse gas emissions are uranium and renewables such as wind, solar and hydropower. Renewable fuels such as wood and other plants may also be included here: they emit gases when they are burnt, but if grown at the same rate at which they are harvested, no net carbon dioxide emissions result except to the extent that other forms of energy are used in operations such as harvesting.

The assumptions made concerning the efficiency potential available (beyond that assumed in the business-as-usual scenario) were based on those in Walker (1990) and Wilkenfeld *et al.* (1991). These are generally well below the potential assumed to exist by Greene, Gavin, Armstrong, O'Dwyer and Braddick (1990). Greene *et al.* give little detail of how their assumptions were derived, but seem to assume the universal adoption of the best technology available overseas. Adoption of the best available technology may not always be economic, however, and can reduce the level of energy service. For example, measures included by Greene *et al.* include downsizing of cars, which involves a distinct change from current consumer preferences, and the replacement of incandescent lighting by compact fluorescent lights, which are not particularly suited to, nor economic in, many low use household applications. The building improvement program envisaged by Greene *et al.* would involve very large expenditures. Overall, Greene *et al.*'s measures were considered to go beyond the concept of cost-effectiveness used here.

In the residential sector, all black coal used directly, briquettes and most petroleum products were assumed to be substituted by natural gas, and about 80 per cent of hot water heating was assumed to be by solar energy. An efficiency improvement of 25 per cent was assumed for other residential appliances. In the commercial sector, across-the board efficiency improvements of 40 per cent were assumed. These assumptions imply that more efficient technology and practices will be universally adopted. The manufacturing sector was examined on an industry-by-industry basis. In the iron and steel and clay and clay products industries, 10 percent efficiency improvements were assumed. In the basic non-ferrous metals and basic chemicals industries, a 10 per cent improvement was assumed for use of primary fuels, and 5 per cent for electricity use. The cement and basic non-ferrous metals industries are the only two for which significant potential for fuel substitution exists, and it was assumed that 80 per cent of the black coal currently used in these industries is

substituted by natural gas. For all other industries, efficiency improvements of 30 per cent for primary fuels and 20 per cent for electricity were assumed.

Following these assumed efficiency improvements, electricity consumption projected for 2004-05 fell. Accordingly, fuel inputs to electricity generation in the business-as-usual scenario for that year were reduced by slightly more than the proportional reduction in electricity demand (since the business-as-usual hydroelectric contribution could be retained), keeping the market shares of the fuels unchanged.

The fleet average car fuel efficiency figure for 2004-05 implicit in the business-as-usual scenario is about 10.9 L/100 km, compared with about 11.8 L/100 km at present. It was assumed that a further 20 per cent improvement in the fleet fuel efficiency could be achieved by 2004-05 without radical downsizing. The fleet average fuel efficiency would then be 8.7 L/100 km, a little below the present new car average fuel consumption. This estimate is broadly consistent with the potential identified in Cronin (1990). The same proportionate fuel efficiency improvement was assumed for other segments of the road transport sector. The effect of fuel substitution on greenhouse gas emissions from road transport is uncertain. Le Cornu (1990) concludes that there is little net benefit from fuel switching to compressed natural gas or LNG, and Walker (1990) concludes similarly in regard to methanol. Other alternative fuels are not cost-effective (Cronin 1990).

Finally, the assumption was made that no new black-coal-fired electricity generating capacity would be commissioned after 1989-90, and that all additional electricity demand would be met by natural gas combined-cycle units. (Brown coal use in power stations in 2004-05 would be less than the present level even without such an assumption. )

## **4.2 Results**

The assumed conservation and fuel substitution measures in the residential, commercial manufacturing and transport sectors result in a reduction in greenhouse gas emissions of about 22 per cent in 2004-05 (table 7). These energy efficiency and conservation measures could thus achieve about half of the target level of reduction. Of the total 22 per cent, road transport fuel efficiency improvements account for 6 percentage points. The assumption that no new black-coal-fired electricity generating capacity be constructed reduces the emissions by only about 2 per cent. This is largely because, in the business-as-usual scenario, much of the new electricity generating capacity is gas-fired and little new black-coal-fired capacity is needed.

It is not clear why efficiency measures which are said to be both available and cost-effective are not currently being implemented. It may be that there is some form of energy market failure, so that either consumers are not aware of the potential benefits from adopting more energy-efficient technologies and practices, or that they do not know the full costs of continuing to use inefficient technologies and practices. On the other hand, it may be that not all of the measures referred to in the literature as cost-effective in fact are. This would appear to be an important area for further research. But even if these measures were adopted, they would go only halfway to meeting the government's target.

**Table 7:** Energy supply and disposal, 2004-05: greenhouse gas reduction

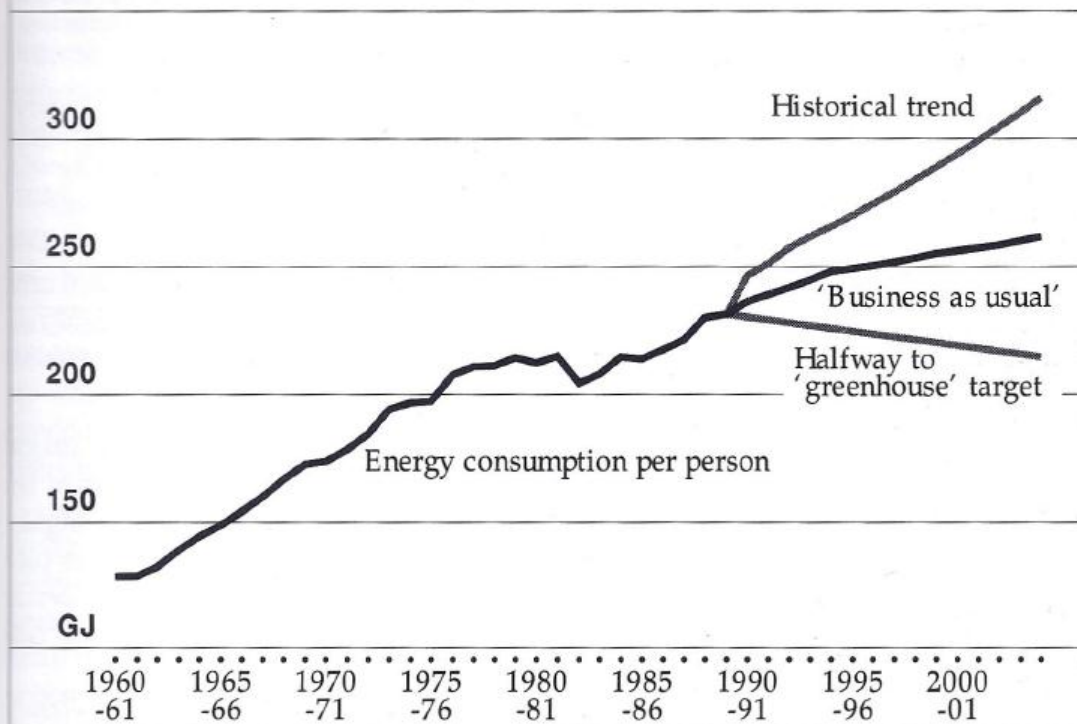
End use	Unit	Black coal (a)	Brown coal (b)	Renewables (c)	Oil	Gas	Electricity (d)	Total
Iron and steel	PJ	56.1		0.2	1.4	27.5	20.3	105.5
Chemical	PJ	11.3	4.0		55.1	70.0	17.8	158.2
Other industry	PJ	48.7	7.3	133.5	103.9	320.0	198.4	811.8
Commercial	PJ			0.5		44.9	101.5	146.9
Residential	PJ			162.3		93.5	123.0	378.8
Road transport	PJ				804.8	29.5		834.3
Other	PJ	11.7			528.2	115.2	61.3	716.4
Total final energy consumption	PJ	127.8	11.3	296.5	1493.4	700.6	522.3	3151.9
Change from 'business-as-usual' case	%	-42.3	-18.7	27.0	-14.2	-7.6	-25.5	-14.1
<i>Conversion industry</i>								
Electricity generation	PJ	950.2	343.8		22.6	192.4	-520.4	988.6
Other conversion	PJ	100.7	0.1		81.5	27.0	67.0	276.3
Total energy consumption	PJ	1178.7	355.2	296.5	1597.5	920.0	68.9	4416.8
CO2 emissions	Mt	105.4	33.5		107.4	51.9		298.2
Change from 'business-as-usual' case	%	-29.0	-28.3		-14.8	-12.9		-21.7
Change from 1987-88	%	+15.8	-16.0		+17.2	+50.9		+16.1

(a) Includes coke and coal by-products. (b) Includes brown coal and briquettes. (c) Includes wood, woodwaste, bagasse and solar. (d) Includes contribution from hydroelectricity of 68.9 PJ, unchanged from business-as-usual case.

It should also be noted that even these 'halfway' measures involve an unprecedented rate of change in the way energy is used in Australia. For example, the level of energy consumption in 2004-05 consistent with the 22 per cent reduction in greenhouse emissions is 12 per cent below the 1989-90 level on a per person basis (figure 13). Yet the only occasions in the past when Australian energy consumption per person has fallen have been associated with major economic shocks, such as the energy price increases of 1980, the recession of 1982-83 and the currency fluctuations of 1985-86. Indeed, it has been noted in chapter 3 that the moderate rate of per person energy consumption growth projected in the business-as-usual scenario is itself well below what would be predicted solely on the basis of expected income growth (the 'historical trend' in figures 13 and 14). Similarly, the average annual rate of decrease in the energy intensity of the economy over the period to 2004-05 implied by the 'halfway' greenhouse measures is about 55 per cent greater than that over the period 1977-78 to 1985-86, the previous most pronounced period of decrease (figure 14). Here again, previous decreases in energy intensity have been associated only with economic slowdowns or energy price increases, or both, and the rate of decrease in the business-as-usual scenario is higher than that predicted solely on the basis of income growth.

On the basis of historical experience, then, achieving the rate of increase in energy efficiency necessary to go even halfway toward meeting the government's interim

### 13 Projected energy consumption per person



### 14 Projected energy intensity



**Table 8: Effect on carbon dioxide emissions of large scale natural gas substitution in electricity generation**

	<b>Natural gas consumption</b>	<b>Total carbon dioxide emissions</b>
	<b>PJ</b>	<b>Mt</b>
2004-05		
• business-as-usual case	1056	379
• 'halfway' scenario (a)	920	298
• natural gas as sole fuel for electricity generation (b)	1987	239
1987-88	611	257
Target level of emissions (c)		206

(a) Incorporating efficiency and substitution gains outlined in the text. (b) Assuming all electricity demand in the 'halfway' scenario is met by natural gas combined-cycle plant. (c) 20 per cent reduction from actual 1987-88 emission level.

target for greenhouse gas reductions would appear to be difficult in the absence of major price changes or other government intervention. Achievement of the full target by relying on cost-effective gains in energy efficiency alone would seem to be highly improbable. The results of this analysis seem to indicate that major efforts at fuel substitution, or pricing or regulatory measures to reduce demand for energy services or to induce further changes in energy intensity, would be required to meet the full greenhouse target.

As an illustration of the extent to which fuel substitution, in addition to efficiency gains, would have to occur in order for the greenhouse target to be achieved, the scenario developed above was supplemented by the assumption that by 2004-05 all electricity demand would be met by natural gas combined-cycle plant. That is, it was assumed that all existing black- and brown-coal-fired power stations were closed, together with existing natural-gas-fired stations, and replaced with more efficient units burning natural gas. Even under this extreme assumption, the level of carbon dioxide emissions in 2004-05 would be 239 Mt - that is, 16 per cent above the target level (table 8).

There are several points to note in considering this 'greenhouse' scenario. First, the underlying population and income growth expected for Australia creates a basic pressure for energy consumption to rise over time, which will prevail unless there are continual efficiency improvements sufficient to offset this tendency. Second, efficiency improvements in themselves will reduce the amount that consumers in aggregate must spend on energy for a given level of services. This reduction in effective energy costs, in turn, could be expected to lead to consumers increasing their demand for energy services, as energy is then perceived to be a lower cost commodity. Thus, efficiency improvements alone are unlikely to reduce energy consumption per person proportionately, as has been assumed above. Finally, no assessment has been made of the effects on Australia's energy exports of actions taken by other countries toward 'greenhouse' targets. The potential effects of such actions are considerable.

## 5. Conclusions

Australian energy consumption has grown strongly in recent years, and this trend is expected to continue in the medium term. Among primary fuels, natural gas has shown the highest rates of consumption growth in recent years. Use of black coal has also grown strongly, as a result of continuing high demand growth for electricity.

Environmental factors, and in particular concern over possible climate change due to increasing concentrations of greenhouse gases in the atmosphere, are becoming much more important in the outlook for the energy sector. In October 1990 the Australian government adopted an interim planning target of a 20 per cent reduction in greenhouse gas emissions from the 1988 level, to be achieved by 2005. While the means by which such a reduction might be achieved are not yet clear, any measures adopted could be expected to have major effects on the pattern and level of Australian energy demand and exports.

In a scenario in which it is assumed such a target had not been adopted, Australian energy consumption is projected to grow by an average of 2.1 per cent a year between 1989-90 and 2004-05. Only small changes to the structure of the Australian energy sector are expected in this scenario. Petroleum products are projected to remain the most widely used fuels, with consumption growth concentrated in the transport sector where they dominate energy consumption. The consumption growth rate projected for petroleum products is, however, less than those for both natural gas and black coal. The growth rate of natural gas consumption is projected to be well down from its historical average, but still higher than those for other primary fuels. Particularly strong growth in natural gas consumption is projected for the early years of next century, when much new electricity generating capacity is assumed to be gas fired. The projected growth in brown coal consumption is quite low. The overall share of renewable forms of energy in total consumption is projected to fall in this scenario.

Conceptually, at least, there are several ways in which a greenhouse gas target can be met by an energy sector. The costs of those various methods are still highly uncertain, but the least costly route is likely to be one in which available opportunities for improving efficiencies of energy use are exploited without altering demand for the services which energy provides. Several studies have analysed the potential for efficiency gains; but it appears that even the universal adoption of measures to improve energy efficiency using apparently cost-effective technologies and practices will only go about halfway to meeting the government's target for greenhouse gas emission reductions. It is not clear whether such gains can be achieved without government action, as they represent a substantial change from historical experience and previous expectations regarding the relationship of energy consumption to population and income. Achieving the target would seem to require major changes to the structure of the Australian energy sector and economy, involving large scale fuel substitution or considerable changes to energy markets and pricing regimes. There is a clear need for further research into how a greenhouse gas emission target can be achieved, and the consequences of meeting such a target.