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# Greenhouse gas emissions from Australia 1990-97: key trends

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## 1. Changes in emissions, 1990 to 1997

Analysis of data in the National Greenhouse Gas Inventory (NGGI) of changes in Australia's emissions between 1990 and 1997 shows that the overall change is very small, when account is taken of emissions associated with land use change. Reductions in emissions from this latter source, and a couple of other smaller sources, almost exactly balanced increases from other sources. The overall picture is shown in Table 1.

**Table 1: Changes in Australian greenhouse gas emissions, 1990 to 1997, by key sectors**

| **Sector** | **Change in emissions (Mt $CO_2$-e)** |
|---|---|
| Energy combustion, *of which*: | +38.3 |
| Electricity generation | +23.6 |
| Other energy industries | +3.9 |
| Manufacturing and construction | +0.9 |
| Road transport | +8.9 |
| Other transport | +2.1 |
| Commercial, residential, agriculture etc. | +2.8 |
| Fugitive energy, *of which* | +0.2 |
| Coal mining | +1.1 |
| Oil and gas | -0.9 |
| Agriculture | +2.1 |
| Waste | +0.8 |
| Industrial processes | -3.1 |
| Forestry etc. (net including storage) | +1.2 |
| Land use change (net including storage) | -39.5 |
| TOTAL NET EMISSIONS | +4.9 |

Two points emerge very clearly from Table 1:

1) Emissions attributable to the use of energy (energy combustion) accounted for almost all (93% to be precise) of all the emission increase.
2) These increases were almost completely offset by the decrease in emissions attributable to the land use change sector, with the result that up to 1997, compared with the 1990 base year, Australia's total net emission showed only a small increase.

A more detailed analysis of the energy combustion increases shows that a small number of sectors are responsible for most of the emissions increase, as Table 2 shows. Many of the sectors grouped under "All other" in fact showed a decrease in emission over the period, e.g. Iron and steel and Non-metallic mineral products (cement, bricks, glass etc.). This can be attributed to a mixture of fuels switching (from coal to natural gas), increased energy efficiency and reduced levels of activity. This analysis suggests that policies to reduce emissions need to concentrate in particular on the sectors where the increasing trends are strongest.

**Table 2: Sectors contributing to increase in energy combustion emissions, 1990 to 1997**

| | |
|---|---|
| Electricity generation | 55.2% |
| Road transport | 20.5% |
| Natural gas processing | 6.2% |
| Air transport | 5.8% |
| Residential | 3.9% |
| Non-ferrous metals production | 3.8% |
| Mining of non-energy minerals | 3.4% |
| All other sectors | 3.2% |

## 2. Analysis of trends in electricity sector emissions

It is important to appreciate that in some respects the above figures give a somewhat misleading picture of the trends which lie behind the overall increase in emissions, since the increase attributable to the electricity sector could perhaps be more justly attributed to the many other sectors of the economy which have shown a steadily increasing demand for electricity. This includes the commercial sector, the residential sector and various sectors of manufacturing, whose direct emissions from the combustion of fuels (mainly natural gas) is quite modest compared with their indirect emissions, attributable to consumption of electricity. However, increasing demand is not the only process driving the rapid rise in electricity generation emissions, as Table 3 shows. This Table shows data taken from various issues of the annual statistical publication of the Electricity Supply Association of Australia, which covers roughly 95% of Australian electricity generation. Statistics for 1998 were published last year, which makes it possible to include an additional year's data.

**Table 3: Key trends in the electricity sector, 1990 to 1998**

| | **Electricity generated** | **Electricity sold** | **Fuels consumed (PJ)** | | | | | **Greenhouse gas emissions** |
|---|---|---|---|---|---|---|---|---|
| | | | **Black coal** | **Brown coal** | **Oil** | **Natural gas** | **Total** | |
| **Increase 1990-97** | +17.9% | +20.9% | +22.2% | +23.9% | -58% | -33% | +15.9 % | +18.4% (1) |
| **Increase 1997-98** | +6.1% | +5.4% | +7.1% | +11.5% | +4% | +5% | +8.4% | +9% (2) |

NOTES: (1) From NGGI
(2) Estimated using default emission factors

The main factors apparent from 1990 to 1997 are:

- strong growth in demand for electricity (electricity sold);
- stronger growth in electricity sold than in electricity generated, implying a reduction in own use and losses in the electricity supply industry;
- total fuel consumed growing more slowly than electricity generated, implying an increase in thermal efficiency of electricity generation;

- consumption of coal growing faster than total fuel consumption, implying an increase in the share of coal in total generation fuel (coal was 88.3% of total fuel in 1990 and 93.5% in 1997).

Between 1997 and 1998 the main factors were as follows:

- growth in demand *greatly exceeding* the average annual rate from 1990 to 1997;
- stronger growth in generation than in sales, implying an *increase* in own use and losses;
- total fuel consumed growing more quickly than electricity generated, implying a *decrease* in thermal efficiency of electricity generation;
- consumption of coal continuing to grow faster than total fuel (coal was 93.7% of total fuel in 1998);
- consumption of brown coal, the most greenhouse gas intensive of all fuels, growing fastest of all (brown coal was 29.9% of all fuel in 1990, 31.9% in 1997, and 32.9% in 1998).

The above factors imply a very large increase in emissions from 1997 to 1998.

The trends shown in Table 3, particularly from 1997 to 1998, are almost entirely attributable to the workings of the National Electricity Market (at wholesale) and the associated retail competition in electricity supply.

In the wholesale market the most important driving forces have been the following.

- The overhang of surplus generating capacity in N.S.W. and Victoria (a legacy of bad investment decisions by the relevant State governments in the 1979-82 period) has ensured that average pool prices have been well below the long run marginal cost of supply, thereby rendering uneconomic the construction of new, lower emission generating plant, such as combined cycle gas turbine and gas fired cogeneration.

- In this market, brown coal power stations have the lowest short run marginal cost of supply, because of the extremely low cost of extracting brown coal, and hence have been able to capture an increasing share of the market.

- Transmission and distribution pricing structures and other market rules are strongly biased towards the established, centralised generators and discriminate against potential entry of new, low emission distributed generation technologies.

In the retail market, competition has ensured that the low wholesale prices have flowed through to industrial and commercial customers. Consequently, average prices to these customers, which account for about 70% electricity consumption, fell by nearly 22% between 1991-92 and 1997-98 (Electricity Supply Association of Australia, n.d.). Demand for electricity, like almost every other product and service, is responsive to price; if the price falls, consumers buy more. Strong economic growth over recent years has also contributed to the increase in demand for electricity.

## 3. Analysis of trends in other sectors

### Sectors showing emissions increase

**Road transport**
It has long been recognised that road transport has been and could well remain a major source of growth in emissions. A study by the (then) Bureau of Transport and Communication Economics suggested that light commercial vehicles are likely to be a particularly large source of growth. Policy makers have long recognised the difficulty of curbing this trend, given predominant public support for ever greater use of private cars, the investment costs of providing alternative means of transport, and the long life of existing infrastructure favouring car use, including the layout of our cities and towns.

**Natural gas processing**
The increase in this sector has been caused, firstly, by the growth of the North West shelf LNG export project at Dampier to full capacity in the early 1990s (liquefaction of natural gas is an energy intensive process), and, secondly, by continuing growth in domestic demand for natural gas (considerable quantities of energy are used in processing raw gas at Longford, Moomba, Dampier and other locations).

**Air transport**
Emissions from domestic air transport grew faster, in relative terms, than those from road transport, but are much smaller in absolute terms. Emissions almost doubled from 1990 to 1997, making it the fastest growing of all the fuel combustion sub-sectors.

**Residential**
Energy use in the residential sector grew relatively rapidly. This sector is relatively less important in terms of direct emissions for two reasons:

- electricity is the largest source of energy used, with associated emissions showing up against electricity generation;
- natural gas supplies most of the direct combustion energy use in this sector.

Nevertheless, growth in demand for (mainly) natural gas shows up as a significant increase in emissions. Moreover, the sector is extremely important as one of the main contributors to growth in demand for electricity and hence, indirectly, to emissions from electricity generation.

**Non-ferrous metals**
The increase in this sector is largely attributable to the increase in production of alumina, which uses large quantities of coal, fuel oil and natural gas.

**Mining (non energy minerals)**
Although mining is not a particularly energy intensive process, the very great increase in activity was associated with a large increase in energy consumption (62% from 1990 to 1997), mainly in the form of diesel fuel.

**Commercial/institutional**
This sector contributed a relatively small increase in direct emissions, through growth in demand for natural gas, partly offset by a fall in consumption of coal. However, like the residential sector, it is a major driver of the growth in electricity demand, and has major policy relevance for that reason.

**Fugitive energy: coal mining**
Emissions in this category are attributable to the methane released from coal seams as they are mined. The growth in emissions is attributable to the large increase in the total quantity of coal mined, including an increase in coal mined from gassy underground mines, which contribute most of the emissions. So far, only two companies at three mines have taken action to mitigate these emissions, either by burning the methane to extract useful energy or by flaring. The implementation of these projects has significantly offset the underlying growth trend, but has not been sufficient to fully offset it. Note also that the NGGI methodology does not as yet include estimates of carbon dioxide mixed with methane from some underground mines and also emitted from open cut mines in particular as a result of the oxidation of waste coal and coaliferous overburden material.

### Other sectors

**Manufacturing, mining and construction**
Emissions from all other sub-sectors, i.e. excluding non-ferrous metals and mining, in this broad category actually fell from 1990 to 1997, despite and increase in output and value of production. This can be attributed to a number of factors:

- a small decrease in total energy consumption;
- some improvement in energy use efficiency;
- a fuel shift mix from coal to natural gas (which is a much less emissions intensive fuel) – use of coal actually decreased;
- a fuel shift mix towards electricity (remembering that the NGGI only reports direct emissions from the sector, with the emissions indirectly attributable to electricity consumption being shown against the electricity generation sector).

**Fugitive energy: oil and gas**
Despite an increase in output, the oil and gas industry has managed to reduce its fugitive emissions, mainly by means of a significant reduction in the volume of associated gas flared at oil fields, and an increased use of gas reinjection and other approaches. Gas distribution companies have also upgraded their gas mains to reduce leakage.

## 4. Implications for Australian greenhouse policy

The above analysis shows that:

- energy combustion emissions accounted for almost all the growth in greenhouse gas emissions from Australia between 1990 and 1997, and
- in turn, a small number of energy combustion sub-sectors, of which electricity generation and road transport are the most important, accounted for most of this growth.

Electricity generation alone accounted for over half the total emission increase. Moreover, on the basis of analysis of published electricity industry statistics, emissions from this activity are likely to show a further very large increase when the NGGI for 1997-98 becomes available.

The increase in electricity sector emissions is almost entirely attributable to the introduction of competitive markets for electricity, and to the particular context in which competition was introduced in the two largest States (accounting for nearly 60% of national electricity consumption), viz. a situation of significant excess generating capacity. While it is true that competitive pressures have resulted in appreciable cost reductions across the industry, there can be no argument that prices are below full cost in N.S.W. and Victoria, i.e. the owners of generating plant in those States are not receiving a commercial return on the value of their capital investment. Had, hypothetically, introduction of a competitive electricity market been delayed until this surplus capacity had been absorbed (by generating plant retirement and/or demand growth), a far smaller impact on emissions would have been experienced.

Competitive electricity markets do not necessarily result in increased emissions; it depends on the circumstances under which competition is introduced. As is well known, introduction of competition to the electricity market in England and Wales resulted in the so-called "dash for gas", with major emission reduction benefits. It was perhaps poorly informed comparisons with the English experience, then just emerging, which led the then Australian Government to state, in Australia's first National Report under the Framework Convention on Climate Change (Commonwealth of Australia, 1994).

> "The move to a competitive market will allow a range of specific energy benefits to be realised. A competitive market will provide the right price signals which will ensure that efficiency measures, renewable energy options and demand side measures are adopted where they are more cost effective."

In fact, none of these expectations have been realised. Indeed, the competitive electricity market has had almost the opposite effect of that quoted above. This was in fact a quite widely held expectation at the time. For example, in a conference paper delivered in 1994, just as the National Communication was released, though not published until 1996, I concluded that "implementation of the competitive national market in electricity, in the form presently envisaged, will make it more difficult for Australia to reduce greenhouse gas emissions" (Saddler, 1996).

A more recent detailed analysis has concluded that the national electricity has increased emissions by about 6 Mt $CO_2$-e per annum, relative to the level which would have been experienced had the previous electricity industry structure been retained (Allen Consulting Group and McLennan Magasanik Associates, 1999). This effect is expected to persist until 2005.

Within this overwhelming context, the measures currently being implemented by the Commonwealth and State/Territory governments with the intention of reducing emissions can do no more than slightly moderate, and not reverse, the strong upward trend in emissions. It would be unreasonable and unfair to the Australian Greenhouse Office and the other agencies involved to expect otherwise. The only way in which this situation

could be changed would be to introduce a policy which would transform the markets for electricity and for transport fuels on the same scale as the introduction of the competitive electricity market. This probably means a cap and permit emissions trading system.

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