MMRF-Green Projections of Greenhouse Gas Emissions for the Stationary Energy Sector

Report prepared by

Philip D. Adams, and Yin H. Mai
Centre of Policy Studies

For

The Australian Greenhouse Office

26 March 2002

The Centre of Policy Studies

Centre of Policy Studies
PO Box 11E
Monash University
Victoria 3800
Australia

Contact person:	Dr. Philip Adams
Telephone:	(61-3) 9905 5094
Facsimile:	(61-3) 9905 2426
Email:	philip.adams@buseco.monash.edu.au
Web address:	http://www.monash.edu.au/policy/

CONTENTS

1. Introduction

The Centre of Policy Studies (CoPS) has been commissioned by the Australian Greenhouse Office (AGO) to conduct projections of greenhouse gas emissions for the stationary energy sector to 2020. The analysis is being undertaken using MMRF-Green, a multi-sector dynamic model of Australia's six states and two territories.

In this draft report we present projections for the following four scenarios requested by the AGO:

- Baseline (no measures);
- Baseline with measures;
- High emission scenario with measures; and
- Low emission scenario with measures.

The first scenario is treated as the central case, and is the primary focus in our explanation of results. Our explanation of the remaining scenarios concentrates on highlighting the main differences between them and the central case.

The remainder of the paper is organized as follows. MMRF-Green is described in Section 2. In Section 3, we discuss key baseline assumptions and present projections for the baseline (no measures) case. In Section 4, we report and discuss projections for the three alternative scenarios. Appendix A gives an explanation of the uncertainty in the projections relating to data, model structure and values for exogenous variables.

2. Forecasting with the MMRF-Green model

MMRF-Green is a dynamic, multi-sectoral, multi-regional model of Australia, with enhanced capabilities for analysis of environmental policies. It is very detailed, distinguishing up to 45 industries, 50 commodities, 8 states/territories and 56 sub-state regions.

MMRF-Green is founded on the MMR model.[1] The current version of MMRF-Green was built in three stages. In the first stage, MMR was transformed into a dynamic system by the inclusion of dynamic mechanisms taken from the MONASH model. These were added as self-contained blocks, allowing MMRF-Green to include MMR as a special case. The second stage involved a range of developments designed to enhance the model's capacity for environmental analysis. In the third stage, a regional disaggregation facility was added, which allows state-level results to be disaggregated down to sub-state regions.

2.1 Overview of MMR

MMR divides Australia into the six states and two territories. There are five types of agents in the model: industries, capital creators, households, governments, and foreigners. The number of industries is limited by computational constraints. Currently, MMRF-Green identifies 37 sectors (see Table 1). These are aggregates of the 116 individual industries

[1] A progress report on the development of the MMR model is given in Meagher and Parmenter (1993). In 1996, MMR was adapted for forecasting by the inclusion of enough dynamics to accumulate variables such as capital stocks and foreign debt over medium-run periods. This version was called the MMR Forecasting (MMRF) model. A detailed description of MMRF is given in Peter *et al* (forthcoming, 2001).

recognised in the primary database (see Peter *et. al.*, forthcoming 2001). For each sector in each region there is an associated capital creator. The sectors each produce a single commodity and the capital creators each produce units of capital that are specific to the associated sector. Each region in MMR has a single household and a regional government. There is also a federal government. Finally, there are foreigners, whose behaviour is summarised by export demand curves for the products of each region and by supply curves for international imports to each region.

MMR determines regional supplies and demands of commodities through optimising behaviour of agents in competitive markets. Optimising behaviour also determines industry demands for labour and capital. Labour supply at the national level is determined by demographic factors, while national capital supply responds to rates of return. Labour and capital can cross regional borders so that each region's stock of productive resources reflects regional employment opportunities and relative rates of return.

The specifications of supply and demand behaviour co-ordinated through market clearing equations comprise the general equilibrium (GE) core of the model. There are two blocks of equations in addition to the core. They describe regional and federal government finances and regional labour markets.

Data requirements for MMR

The GE core of MMR requires a multi-regional input-output table together with values for the elasticities of substitution in the CES nests of the specifications of technologies and preferences. The government finance block requires data on regional and Federal government revenues and outlays. The regional labour market block requires regional demographic, employment and labour force data.

The Australian Bureau of Statistics (ABS) (see Peter *et. al*, forthcoming 2001) publishes suitable regional data for the government finance and labour market blocks. However, it does not compile multi-regional input-output (IO) tables. Disaggregating the national IO table used in the national GE model, MONASH, created IO data for the GE core. The regional disaggregation of the national IO table involved three steps: (i) splitting of columns using regional proportions of industry outputs and final demands; (ii) splitting of rows using inter-regional trade data available from published sources (e.g., Quinlan, 1991); and (iii) application of RAS procedures to ensure equality in the multi-regional input-output table between the outputs and sales of regional sectors.

For values of primary-factor and domestic-import substitution elasticities, MMR relies on the MONASH national database. There are no reliable estimates of substitution elasticities between domestic products from different regional sources. High numbers are assumed to be appropriate - five times the values for domestic/import substitution elasticities. This means that different domestic varieties of a good are closer substitutes than are domestic and imported varieties.

Computing solutions for MMR

MMR is a system of non-linear equations. It is solved using GEMPACK, a suite of programs for implementing and solving economic models. A linear, differential version of the MMR equation system is specified in syntax similar to ordinary algebra. GEMPACK then solves the system of non-linear equations as an Initial Value problem, using a standard method, such as Euler or midpoint. For details of the algorithms available in GEMPACK, see Harrison and Pearson (1996).

2.2 From MMR to MMRF-Green: Inclusion of MONASH dynamics

There are two main types of inter-temporal links incorporated into MMRF-Green: physical capital accumulation and lagged adjustment processes.

Physical capital accumulation

It is assumed that investment undertaken in year t becomes operational at the start of year t+1. Under this assumption, capital in industry i in state/territory s accumulates according to:

$$K^s_{t+1}(i) = (1 - DEP^s(i)) \times K^s_t(i) + I^s_t(i) \qquad (1)$$

where:

$K^s_t(i)$ is the quantity of capital available in industry i located in s at the start of year t;

$I^s_t(i)$ is the quantity of new capital created for industry i during year t; and

$DEP^s(i)$ is the rate of depreciation in industry i, treated as a fixed parameter.

Given a starting point value for capital in t=0, and with a mechanism for explaining investment through time, equation (1) can be used to trace out the time paths of industry capital stocks.

Investment in industry i in state/territory s in year t is explained via a mechanism of the form

$$\frac{K^s_{t+1}(i)}{K^s_t(i)} - 1 = F^s_{it}[EROR^s_t(i)] \qquad (2)$$

where

$EROR^s_t(i)$ is the expected rate of return on investment in industry i in s in year t; and

$F^s_{it}[\ ]$ is an increasing function of the expected rate of return with a finite slope.

The expected rate of return in year t can be specified in a variety of ways. As in MONASH, in MMRF-Green two possibilities are allowed for, static expectations and forward-looking model-consistent expectations. Under static expectations, it is assumed that investors take account only of current rentals and asset prices when forming current expectations about rates of return. Under rational expectations the expected rate of return is set equal to the present value in year t of investing $1 in industry i in region r, taking account of both the rental earnings and depreciated asset value of this investment in year t+1 as calculated in the model.

Lagged adjustment processes

MONASH contains a number of lagged adjustment processes, but just one is included in MMRF-Green. This relates to the operation of the labour market in year-to-year policy simulations.

In comparative static analysis, one of the following two assumptions is made about the national real wage rate and national employment:

1. the national real wage rate adjusts so that any policy shock has no effect on aggregate employment; or

2. the national real wage rate is unaffected by the shock and employment adjusts.

MONASH's treatment of the labour market allows for a third, intermediate position, in which real wages can be sticky in the short run but flexible in the long-run and employment can be flexible in the short-run but sticky in the long-run. The same idea is applied in MMRF-Green. For year-to-year policy simulations, it is assumed that the deviation in the national real wage rate increases through time in proportion to the deviation in aggregate employment from its basecase-forecast level. The coefficient of adjustment is chosen so that the employment effects of a shock are largely eliminated after about ten years. This is consistent with macroeconomic modelling in which the NAIRU is exogenous.

2.3 MMRF-Green: Environmental enhancements

MMRF-Green has been enhanced in a number of areas to improve its capability for environmental analysis. These enhancements include:

1. an energy and gas emission accounting module, which accounts explicitly for each of the 45 industries and eight regions recognised in the model;
2. equations that allow for inter-fuel substitution in electricity generation by region; and
3. mechanisms that allow for the endogenous take-up of abatement measures in response to greenhouse policy measures.

Emissions accounting

MMRF-Green tracks emissions of greenhouse gases at a detailed level. It breaks down emissions according to:

1. emitting agent (45 industries and residential);
2. emitting state or territory (8); and
3. emitting activity (5).

Most of the emitting activities are the burning of fuels (black coal, natural gas, brown coal or petroleum products[2]). A residual category, named Activity, covers emissions such as fugitives and agricultural emissions not arising from fuel burning.

The resulting 45 x 8 x 5 matrix of emissions is designed to include all emissions except those arising from land clearing. Emissions are measured in terms of carbon dioxide equivalents, $C0_2$-e. The main source of data for the matrix of emissions is the 1999 National Greenhouse Gas Inventory published by AGO.

Inter-fuel substitution

Inter-fuel substitution in electricity generated is handled using the "technology bundle" approach (e.g., Hinchy and Hanslow, 1996). Five power-generating industries are distinguished based on the type of fuel used (see Table 1). There is also an end-use supplier (*Electricity Supply*). The electricity generated in each state/territory flows directly to the local end-use supplier, which then distributes electricity to local and inter-state users. The end-use supplier can substitute between the five technologies in response to changes in their production costs. For example, the Electricity supply industry in NSW might reduce the amount of power sourced from coal-using generators and increase the amount sourced from

[2] Each of these fuels is identified as a separate commodity within the model (see Table 1).

gas-fired plants. Such substitution is price-induced; the elasticity of substitution between the various types of electricity used by the Electricity supply industry in each state is set to 5.

For other energy-intensive commodities used in industry, MMRF-Green allows for substitution possibilities by including a weak form of input-substitution specification. If the price of say, Cement, rises by 10 per cent relative to other inputs to construction, the Construction industry will use 1 per cent less Cement and, to compensate, a little more of labour, capital and other materials. In most cases, as in the Cement example, we have imposed a substitution elasticity of 0.1. For important energy goods, Petroleum products, Electricity supply, and Urban gas distribution, the substitution elasticity in industrial use is 0.25. This input substitution is driven by price changes, and so is especially important in emission-policy scenarios, which makes outputs of emitting industries more expensive.

Endogenous take-up of abatement measures in response to greenhouse policy measures

In basecase simulations, non-combustion emissions are modelled as directly proportional to the output of the related industries. In the policy scenarios, we allow for abatement of these emissions. The amount of abatement is directly related to the price of emissions permits (or the level of the carbon penalty). The constants of proportionality are derived from point estimates, from various sources, of the extent of abatement that might arise at a particular tax level.

3. Baseline (no measures)

3.1 Assumptions Used in the Baseline

In forecasting with MMRF-Green, we impose on the model a large amount of information from specialist external forecasting agencies. The model is then used to trace out the implications of the external forecasts and policies changes at a level of detail consistent with the requirements of AGO.

In generating the Baseline (no measures) forecasts, we use :

1. State/territory macroeconomic forecasts from Access Economics;
2. National-level assumptions for changes in industry production technologies and in household preferences from CoPS; and
3. Forecasts for the quantities of agricultural and mineral exports, and estimates of capital expenditure on major minerals and energy projects from various sources, such as state government agencies, the Australian Bureau of Agricultural and Resource Economics (ABARE), and the National Electricity Market Management Company (NEMCO).

3.1.1 Macroeconomic Inputs (Table 2)

Table 2 shows the assumptions for selected macroeconomic variables in terms of average annual growth rates over the period 1999 to 2020.

Real GDP is assumed to grow at an average annual rate of 3.0 per cent (row 8). The states/territories with the best growth potential are NT (4.1 per cent per annum annual growth in real GSP) and WA (4.0 per cent). The states with the worst growth potential are TAS (1.6 per cent) and SA (2.0 per cent). In general, the forecast growth rates are in line with the long-run growth potential for each economy. Note, however that for QLD and WA the forecast growth rates are below the average rates of the last five years. Factors such as the prospect of

a prolonged period of slow growth in Japan and slower long-term growth in the US economy, make it unlikely that the foreign-export-oriented states like QLD and WA can sustain their recent strong performance.

Over recent years, real private consumption has grown faster than real GSP in most regions. However, this trend is not expected to continue. As can be seen by comparing rows 1 and 8 in Table 2, we expect that real consumption will grow roughly in line with real GSP in each region over the forecast period.

Growth in real investment (row 2) at the national level is forecast to be a fairly modest 3.3 per cent. This reflects initial conditions. 1999 was a very strong year for investment, and only modest investment growth is required to maintain the historically normal economy-wide investment/capital ratio of three per cent. Forecast differences across regions reflect a combination of different initial conditions, different industrial compositions and specific assumptions about large projects such as the Comalco aluminium plant in QLD.

Over the past fifteen years real international exports (row 6) and real international imports (row 7) have grown rapidly relative to real value added (row 8) in each region. This reflects several factors: declining transport costs; improvements in communications; reductions in protection in Australia and in our major trading partners; and technological changes favouring the use of import-intensive goods such as computers and communication equipment. All these factors are expected to continue through the forecast period, leading to further increases in the ratios of the volume of international trade to real value added.

Employment (row 9) in each region is assumed to grow at rates that are consistent with long-run productivity trends. For Australia as a whole, long-run productivity growth is set at 1.8 per cent. For the states/territories we assume long-run productivity growth rates of: 1.8 per cent (NSW), 1.7 per cent (VIC), 1.6 per cent (QLD), 1.5 per cent (SA), 2.0 per cent (WA), 1.3 per cent (TAS), 2.3 per cent (NT) and 1.0 per cent (TAS).

In some cases, we depart from the Access story. For example, we assume that foreign-import growth will be stronger in all states/territories than Access is forecasting for the years 2000 to 2002. This results from the check that our microeconomic model puts on the macroeconomic forecasts. When we impose the macroeconomic forecasts, MMRF-Green must produce a microeconomic story that is consistent with the macroeconomics. Import growth in MMRF-Green is explained primarily by growth in the level and structure of domestic demand and by relative price movements. For example, if investment growth is strong, our model wants to project strong import growth because investment is an import-intensive activity. Similarly, the model will want to project strong import growth if the real exchange rate appreciates, because this lowers the prices of imports relative to the prices of locally produced goods. In the forecasting simulations, any tension between the standard MMRF-Green mechanisms and the exogenous forecasts for foreign imports is reconciled by allowing twists in domestic purchasers' import/domestic preferences. But we are careful to ensure that these twists are plausible relative to historical experience.

We judge that the twists required to accommodate the low import growth forecast by Access for the years 2000 to 2002 were implausible. Hence, we made upward adjustments, assuming that import growth would be as slow as is compatible with the largest twist in preferences against imports that we thought plausible.

Note on Population

A somewhat surprising omission from the list of macro variables in Table 2 is population. This suggests, correctly, that population is endogenously determined. We assume that over the projection period, state/territory unemployment rates converge to long-run values, with SA and TAS having slightly higher long-term rates than QLD and WA. This assumption, along with the assumed rates of growth for employment, drive our projections for the labour force in each state. These in turn drive our population projections, with allowance for pro-cyclical movements in the participation rate (i.e., in the ratio of labour force to population). In general our forecasts for population are in line with the high scenarios projected by the ABS.

3.1.2 Assumptions for Changes in Technology and Tastes (Table 3)

Table 3 shows our assumptions for changes in the preferences of households and for changes in the production technologies of industries. These are applied uniformly across regions. The numbers are based on extrapolated trends calculated from a MONASH simulation for the period 1986-87 to 1996-97.

Our assumptions for household tastes are summarised in the first column of numbers in Table 3. A positive (negative) number indicates that we are assuming the household usage of the relevant commodity will increase (decrease) relative to the movements that are implied in the forecasts by changes in household aggregate expenditure and by changes in relative prices. For example, we assume that consumption of *Financial and business services* will increase at a rate 1.9 per cent a year faster than can be explained on the basis of changes in prices and changes in the average budget of households.

The second column of numbers in Table 3 shows our initial assumptions for the average annual rates of change in the usage of commodities as intermediate inputs per unit of production in industries, and as inputs per unit of capital creation. Negative numbers indicate that technological change is commodity-saving. Positive numbers indicate that it is commodity-using. For example, we assume initially that in each year industries will increase their usage of *Communication services* by 5.0 per cent more than their outputs.

The exogenous shocks to produced-input technologies impose a cost/saving on the industries that use the inputs. For example, industries that utilise communication services will suffer a cost increase when forced to use 5.0 per cent more of those services per unit of output. To offset these cost effects, we make a simultaneous uniform adjustment to the technology coefficients applying to all the user's inputs (produced and primary) so that there is no net effect on the user's costs.

The assumptions in the second column for energy commodities are of special importance to this study. They show that, based on historical trends, through the forecast period industries will become more intensive in their use of natural gas and less intensive in

their use of black and brown coal.[3] The intensity with which industries use crude oil is assumed not to change. For derived fuels, industries will become more intensive in their use of LPG, and less intensive in their use of other petroleum products. We assume zero change in the intensity of use of electricity: increased electricity efficiency for electrical equipment is offset by more intensive usage of electrical equipment. To understand the numbers for the electricity-generator products, note that these products are sold only to the electricity supply industry. Thus our assumptions for the generator products are indicative of historical trends in the fuel mix of electricity supply.

Our initial assumptions for each industry concerning average annual changes in primary-factor usage per unit of output are shown in the final column of Table 3. Primary-factor inputs in MMRF-Green comprise labour, capital and agricultural land. For example, our initial assumption for *Agriculture* is that output will increase on average by 1.2 per cent a year relative to the industry's overall usage of primary factors.

For the electricity industries, we assume improvements in the efficiency of use of primary factors at an average annual rate of 1.0 per cent. This is less than the historical trend of 1.5 per cent. The difference of 0.5 percentage points is our estimate of the contribution made by Energy Market Reform (EMF) to productivity growth in electricity prior to 2000.

Note that, in Table 3, the first two columns have the dimension of the commodities of the model, while the final column has the dimension of the industries of the model. In MMRF-Green, the number of commodities can be different from the number of industries, because some industries produce more than one commodity. Currently, the only multi-product industry is *Petroleum products* which produces six commodities: *Petrol, Aviation gasoline, Aviation turbine fuel, Diesel, LPG and Other petroleum products*.

3.1.3 Assumptions for Exports (Table 4), and for Large Projects in the Resource and Electricity Industries

Table 4 shows assumptions for the quantities of agricultural and mineral exports. These reflect ABARE projections to 2005, and exogenously imposed long-term trends for the remaining years to 2015.

MMRF-Green's theory of investment relates year-to-year changes in capital expenditure to year-to-year changes in rates of return. This is adequate for most industries where the evolution of investment through time is relatively smooth. However, for industries in the resource and electricity sectors, investment is seldom smooth. Accordingly, in forecasting we complement the standard MMRF-Green investment theory with extraneous information relating to incremental investment changes in the resource and electricity industries. Currently, our primary source of information for planned projects in the resource sector is ABARE (2001), "Minerals and Energy: Major Development Projects" *Australian Commodities*, 8(4), December quarter, pp. 647-666. Our primary source of information for future electricity investments is NEMCO, which provides data via personal communication. Information from these sources covers the years through to 2006. Thereafter, we impose long-term trends based partly on trends projected for the years 1995 to 2006.

Notable projects accommodated for in our Baseline (no measures) scenario are:

- the Victoria-Tasmania natural gas interconnection, which is assumed to begin operation in 2004;

[3] We assume that there is more scope for improved efficiency in the use of black coal than for brown coal based on improvements already achieved.

- the Victoria-Tasmania electricity connection (Basslink);
- the PNG-QLD natural gas pipeline;
- the expansion of both aluminium smelting and alumina refining capacity in QLD, WA and the NT; and
- several new gas-fired electricity plants, mainly in QLD, NSW and WA.

A fuller, but still partial, list of projects is provided in Appendix B.

3.2. Baseline (no measures) Projections

We report eight tables of detailed projections:

Table 5.1: Macroeconomic indicators (repeat of Table 2, included for sake of completeness)

Table 5.2: Output by industry

Table 5.3: Emissions by state and major source category

Table 5.4: Emissions from the stationary energy sector by state and sub-sector

Table 5.5: Primary energy consumption in electricity generation by fuel and state

Table 5.6: Shares of generated electricity by fuel type

Table 5.7: Energy efficiency improvements

Table 5.8: National emissions from the stationary energy sector, calibrated to the 2000 NGGI

3.2.1 Output of Electricity and Other Industries (Table 5.2)

Table 5.2 gives baseline (no measures) projections for the 45 industries distinguished in the model. At the Australia-wide level, *Communication services* is the fastest growing industry. This reflects our assumption that changes in technology through the projection period will strongly favour intermediate usage of these services (column 2 of Table 3), and that rapid productivity growth (column 3 of Table 3) will reduce their price relative to consumer prices in general. Similar factors explain the relatively strong growth forecast for *Financial and business services*.

Another fast growing industry is *Electricity generation - gas*. This reflects, in the main, announced and planned construction of new plants. Strong growth in gas-fired electricity capacity lowers the price of gas-fired electricity relative to coal-fired electricity. This restricts the growth prospects for other types of electricity generation, especially *Electricity generation – black coal*.

Other industries with relatively strong growth forecasts include *Air passenger transportation, other transport services* and *Other metal products*. These industries participate heavily in the strong growth forecast for international tourism and manufactured exports. In addition, changes in technology are assumed to favour intermediate usage of *Other metal products* (column 2 of Table 3).

Forecasts for *Agriculture*, the mining industries, *Petroleum products* and *Alumina and aluminium* are, in the main, based on extrapolations of the current views of the ABARE (see Table 4). These include slow growth for *Crude oil* in VIC, reflecting the run down of the Bass Straight reserves (Table 4). The prospects for *Brown Coal* reflect those of brown-coal electricity generation with an allowance for greater efficiency of fuel use in power generation.

The manufacturing industries with the weakest growth prospects (other than petroleum) are *Water transport services - freight* and *Cement*. The weak prospects for the *Water transport services - freight* industry reflect weak prospects for commodity exports and the water front reform that has improved the productivity of handling the shipment of bulk commodities. Cement is restricted by adverse shifts in technology in the construction sector.

In all regions, forecast growth of *Electricity supply* lags behind forecast GSP growth. At the Australia-wide level, electricity supply is forecast to grow at an average annual rate of 2.3 per cent, which is 0.7 percentage points less than forecast growth in real GDP. Our below-average forecast for growth in electricity is explained by the interaction of three forces. First, we are projecting quite strong growth in all-factor productivity for the industry (see the final column of Table 3). This makes its products relatively cheaper and encourages substitution towards electricity by customers. Second, we assume no change in the efficiency with which industries use electricity, and negligible change in consumer tastes (Table 3). This means that technological and taste changes have little direct influence on the industry's growth prospects. Against these two forces is weak growth in household demand due to a low income elasticity. Household consumption makes up around 35 per cent of sales of electricity. The income elasticity applied to those sales is around 0.2. Thus even though aggregate consumption is projected to growth at an average annual rate of 3.0 per cent, household demand for electricity increases at an average annual rate of less than 1.0 per cent.

Most of the remaining industries have close to average growth prospects.[4] Two offsetting forces - strong export growth and increasing import competition, affect *Food, beverages and tobacco*. The same forces strongly influence the prospects of *Chemical products (excl petrol)*, *Motor vehicles and parts* and *Other manufacturing*. The prospects of *Non-metal construction materials excl Cement* are governed by those for *Construction services* (industry 29). These, in turn, reflect our macro assumptions for investment (Table 2). *Wholesale, retail trade and accommodation* sells widely throughout the economy. Its growth rate, though, is slightly below that of GDP because of adverse taste and technology shifts against its products (Table 3). *Dwelling ownership*, *Public services* and *Other services* are very consumption oriented. Accordingly, their prospects are explained by appropriate weighted averages of the growth rates assumed for private and public consumption (Table 2). Strong reliance on public consumption explains the relatively poor prospects for *Public services*.

For most industries, especially services, regional differences in growth forecasts mirror regional differences in the GSP forecasts in Table 2. Hence, growth tends to be relatively strong in WA and NT and relatively weak in TAS and SA.

3.2.2 Projections for $C0_2$-e Emissions by Major Source Category (Table 5.3)

Table 5.3 presents baseline (no measures) projections for CO_2-equivalent emissions by state and major source category. The table includes the average annual growth rate of emissions from 1999 to 2020 and the levels of emissions (Mt) in 1999 and 2020.

Total emissions are projected to grow at an average annual rate of 1.7 per cent, 1.3 percentage points less than the projected GDP growth rate. This is in line with recent history. The main reasons why growth in aggregate emissions is forecast to be less than GDP growth are:

[4] Recall from Table 2 that the average annual rate of GDP growth is 3.0 per cent

- a forecast growth rate for Agriculture (a major contributor) which is less than our forecast growth rate for real GDP[5];
- the shift towards Natural Gas and away from coal for electric power generation (see Table 5.6);
- improvements in electricity-supply efficiency (see Table 5.7[6]); and
- faster-than-average growth of the service sectors, which do not emit much.

In 2020, the national total for all emissions (excluding land clearing) is projected to be 659 Mt.

Table 5.3 also shows projections for emissions in a number of sub-categories. The category for which emissions grow slowest is the energy sector, with average growth of 1.5 per cent per annum. Within the energy sector, emissions from fuel combustion are forecast to grow at an average annual rate of 0.9 per cent, while fugitive emissions are forecast to grow at an annual rate of 1.7 per cent. The relatively slow growth from fuel combustion reflects, in the main, the relatively slow growth in emissions from electricity (average annual growth of just 0.9 per cent). The weak growth in electricity emissions is explained by a combination of increased fuel efficiency in generation (Table 5.7), slow growth in electricity supply (Table 5.2), and a trend throughout the forecast period towards relatively clean gas-fired electricity (Table 5.6). Table 5.7 shows that in our forecast, electricity generating industries will reduce their requirement for fuel per unit of output at an average annual rate of 0.6 per cent. According to Table 5.2, electricity supply grows at an annual average rate of 2.3 per cent. Combining this with the assumed improvement in fuels efficiency, suggest a growth rate of 1.7 per cent for emissions from electricity. The difference between this and the final projection for emissions growth (0.9 per cent per annum) reflects the effects of fuel switching. According to Table 5.6, the share of gas generated electricity in total electricity supply rises from 10.7 per cent in 1999 to 15.0 per cent in 2020, while the combined share of brown and black coal generation falls from 79.5 per cent in 1999 to 77.6 per cent in 2020. As noted in Section 3.2.1, the gas share is projected to increase in line with announced and planned increases in gas-fired electricity capacity.

Of the other major categories shown in Table 5.3, emissions from industrial processes are forecast to grow by 2.2 per cent per annum, and emissions from waste are forecast to grow by 1.7 per cent per annum. The forestry sink is forecast to increase at an average annual rate of 2.7 per cent, in line with growth in forestry output (Table 5.2).

At the state/territory level, we find that aggregate emissions are projected to grow fastest in the states with the highest projected growth rates - NT, WA and QLD. Emissions in TAS are projected to fall. The reason is clear when we compare the level values of emissions in 1999 and 2020. TAS has a large forest sector and uses hydroelectricity, which emits nothing. The bulk of TAS's emissions come from Agriculture. In 1999, the large forestry sink in TAS outweighed emissions from agriculture. Through the projection period, the increase in

[5] Our projection for growth in agricultural emissions is in line with our projection for growth in agricultural output. The modelling of agricultural emissions in MMRF-Green is under review.

[6] As indicated in our footnote to Table 5.7, we define supply efficiency as a weighted average of the use of primary fuels per unit of electricity generation. Our assumptions for improvements in the use of individual fuel are given in the second column of numbers in Table 3. For example, the black coal electrricity generation industry uses 1.1 per cent less black coal per unit of production in each year. Table 5.7 shows that for Australia as a whole, the average of those improvements is 0.6 per cent per annum, implying that electricity generating industries use annually 0.6 per cent less primary fuels per unit of output.

the forestry sink is larger than the increase in emissions from agriculture. This causes the fall in gross emissions in TAS (Table 5.3).

3.2.3 Projections for $C0_2$-e Emissions from the Stationary Energy Sector (Table 5.4)

Table 5.4 gives projections for emissions from the stationary energy sector. As in Table 5.3, the table includes the average annual growth rate of emissions from 1999 to 2020 and the levels of emissions (Mt) in 1999 and 2020. Projections are also provided by state and by the major components: combustion in electricity generation, and the combustion of gas, coal and liquid fuels outside the electricity sector.

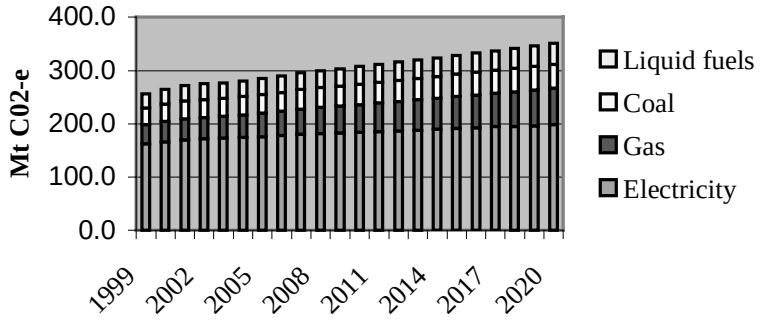
In aggregate, emissions from stationary energy are projected to grow by 1.4 per cent per annum, 0.3 percentage points less than average annual growth in total emissions. The below-average forecast for emissions from stationary energy is largely explained by our forecast of 0.9 per cent annual growth in emissions from electricity generation. This is explained in Section 3.2.2. By contrast, emissions from the combustion of gas for reasons other than electricity generation are forecast to grow by 3.9 per cent. This reflects two positive factors: a favourable sales pattern, and our assumption based on recent history that all industries (other than electricity generation) will increase their usage of gas per unit of output by 0.5 per cent per year (Table 3). Aside from electricity, the major users of gas are the metal manufacturers (*Iron and steel, Alumina and aluminium and Other metal products*), which together comprise around 22 per cent of total sales, and the urban gas distribution industry[7], which makes up around 25 per cent of sales. All these industries have strong growth prospects (see Table 5.2), which combined with increased gas usage per unit of their output results in a contribution of around 3 percentage points to the overall rate of growth of 3.9 per cent.

Emissions from fuels other than gas by non-electricity industries are forecast to grow at around 1.7 per cent per annum. This is less than the average growth rates in production of the using industries, reflecting our assumptions of increasing fuel efficiency for coal and liquid fuels (Table 3).

Chart 1 shows the projected time path for stationary energy emissions.

[7] The urban gas distribution industy supplies town gas to residential and commerical customers, mainly in and around the major cities.

Chart 1: Projected time path for stationary-energy emissions



The chart shows that in all years total emissions increase, rising from just over 250 Mt in 1999 to 350 Mt in 2020. The average annual growth rate for aggregate emissions between 1999 and 2010 is 1.4 per cent. This is the same as the growth rate between 2010 and 2020. The rates are similar, because in the second 10-year period the values for exogenous inputs are, for the most part, set in line with trends revealed in the first 10-year period.

The chart also clearly shows the slow growth in emissions from electricity relative to growth in emissions from other sources. As for the aggregate, the growth rates of the components in the second 10-year period are similar to the growth rates in the first 10-year period.

3.2.4 Projections for Primary Energy Consumption in Electricity Generation (Table 5.5)

Table 5.5 presents projections for primary energy consumption for electricity generation by fuel and state. As in Tables 5.3 and 5.4, the table includes average annual growth rates from 1999 to 2020 and the levels of usage in 1999 and 2020. For Biomass and Other renewable/hydro we report projections for energy produced.

The numbers in Table 5.5 clearly shows the forecast trend, explained in Section 3.2.1, against coal and towards gas as a fuel for electricity generation. The amount of energy produced by black coal for electricity generation is forecast to grow at an average annual rate of 0.5 per cent, and that of brown coal by 1.0 per cent. In contrast the growth rate in energy from gas is expected to grow by 3.4 per cent. The pattern is repeated across the states, but most notably in SA where energy from coal in electricity generation is forecast to fall by 4.0 per cent per annum.

The share of gas fuelled electricity generation is projected to increase from about 11 per cent in 1999 to 15 per cent in 2020 (Table 5.6). As a result, the share of coal fuelled electricity generation falls by more than 2 percentage points.

The fastest growing source of energy for electricity shown in Table 5.5 is Biomass, with a forecast average annual growth rate of 3.8 per cent. Our forecast for Biomass used in electricity generation is exogenously imposed, based on information provided by the QLD government on likely growth in Biomass as a fuel source in QLD. This information suggests rapid growth in the first half of the forecast period, levelling-off in the second half of the

period. Note too, that the average growth rate forecast for the entire period is consistent with the trends reported in ABARE's latest set of forecasts for the electricity industry.

3.2.5 Projections for the stationary energy sector, calibrated to the 2000 NGGI (Table 5.8)

The initial data for emissions (Kt) and energy (Pj) used for our projections are calibrated using information from the 1999 and 2000 (preliminary) NGGI and from ABARE (2001) "Australian Energy: Projections to 2019-20". *ABARE Research Report No. 0111.* From these sources we obtain national-level data for total emissions and energy usage by primary and secondary fuels. These are apportioned across fuel users and regions recognised in MMRF-Green using data from the model's core input/output file. For example, if the core data show that 50 per cent of black coal produced in Australia is produced in NSW for use in NSW electricity generation, then 50 per cent of total emissions from black coal (a NGGI control total) is allocated to the use of NSW produced coal in the NSW electricity industry.

This procedure preserves the national totals for emissions and energy usage by fuels as given in the NGGI and by ABARE. However, it can lead to an allocation across users that is different from that implied by the extraneous data. For example, our estimates for total emissions from stationary energy in 2000 are very close to the NGGI's estimates, but the distribution of that total between sub-sectors differs, as shown below.

		NGGI		CoPS	
		1999	2000	1999	2000
Total	Mt CO2-e	259.82	263.95	256.30	264.80
Electricity	Mt CO2-e	171.84	175.07	162.1	166.3
Gas	Mt CO2-e	33.32	34.95	36.2	38.1
Coal	Mt CO2-e	24.65	23.35	31.5	32.7
Liquid fuels	Mt CO2-e	28.00	29.18	26.5	27.7
Biomass	Mt CO2-e	2.01	1.40	0.0	0.0

Overall, we think that our procedure is a reasonable trade-off in terms of the benefits of achieving base year consistency and the resource costs of adjusting the model to match exactly the NGGI. Generally, any difference will be of second order, and will have negligible impact on our projections for aggregate emissions from the stationary energy sector. This is confirmed in Table 5.8, where we show estimates of national-level emissions from stationary energy that are calibrated exactly to the NGGI estimates for 2000. These were derived by applying the annual growth rates projected by MMRF-Green to the 2000 NGGI estimates given above. The implied average annual growth rate for total emissions between 2000 and 2020 is 1.4 per cent, the same as the growth rate given in Table 5.4.

4. With-measure Scenarios: Baseline, High and Low

4.1 Methodology

In computing the Baseline (no measures) scenario, we took on board forecasts and information available from outside sources, such as Access Economics. To accommodate this information, numerous naturally endogenous variables were exogenised. These included the volumes of agricultural exports and most macro variables.

To allow such naturally endogenous variables to be exogenous, an equal number of naturally exogenous variables were made endogenous. For example, to accommodate forecasts for the volumes of agricultural exports we made endogenous variables that locate the positions of foreign demand curves. To accommodate forecasts for macro variables, we made endogenous various macro coefficients such as the average propensity to consume.

However, when accommodating the effects of policy measures or changes to the general economic environment, the naturally endogenous variables, such as the volumes of agricultural exports and macro variables, which were exogenous in the baseline (no measures) must be made endogenous. This allows them to respond to the exogenous changes under consideration. Correspondingly, naturally exogenous variables, such as the positions of foreign demand curves and macro coefficients, must be exogenous. They are set at the values revealed in the baseline (no measures) case.

In making these closure changes we make the following assumptions regarding important aspects of the economy.

Labour markets

At the national level, we assume that the deviation in the consumer's real wage rate (i.e., the nominal wage rate deflated by the CPI) from its baseline (no measures) level

increases in proportion to the deviation in employment from its baseline (no measures) level. The coefficient of proportionality is chosen so that the employment effects of a shock to the economy are largely eliminated after five years. In other words, after about five years, the costs of an unfavourable shock are realised almost entirely as a fall in the national real wage rate, rather than a fall in employment. This labour market assumption reflects the idea that in the long-run national employment is determined by demographic factors, which are largely unaffected by the exogenous shocks under consideration here. It is also consistent with conventional macro-economic modelling in which the NAIRU is exogenous.

At the regional level, we assume that labour is mobile between state economies. Labour is assumed to move between regions so as to maintain inter-state wage and unemployment rate differentials at their levels in the baseline (no measures) case. Accordingly, regions that are favourably affected by a shock will experience increased employment and population at the expense of regions that are less favourably affected.

Private consumption and investment

Consumption expenditure of the regional household is determined by Household Disposable Income (HDI) Since budget constraints are not imposed on the business sector or on governments, regional economies' will run trade deficits/ surpluses to the extent that aggregate regional expenditure levels are greater than/less than aggregate regional incomes. The deficits or surpluses can be held with other agents in other regions, with foreigners or with both regional agents and foreigners.

We assume that in each year, investment in each regional industry will deviate from its value in the baseline (no measures) in line with the deviation in the expected rate of return on the industry's capital stock. Investors are assumed to be myopic, implying that expected rates of return move with contemporaneously observed rates of return.

Rates of return on capital

In deviation simulations, MMRF-Green allows for short-run divergences in rates of return on industry capital stocks from their levels in the baseline (no measures) forecasts. Such divergences cause divergences in investment and hence capital stocks. The divergences in capital stocks gradually erode the divergences in rates of return, so that in the long-run rates of return on capital over all regional industries return to their baseline (no measures) levels.

Production technologies

MMRF-Green contains many types of technical change variables. In the deviation simulation we assume that all technology variables, other than those used in the implementation of shocks, have the same values as in the baseline (no measures) simulation.

4.2 Description of the With-measures Scenarios

The following five policy measures are included in the with-measures scenarios.

1. Energy Market Reform (EMR). We assume that EMR will bring an extra 0.5 per cent per annum increase in primary factor productivity in the electricity industries. In the baseline (no measures) scenario we assume that productivity increases at the rate of 1.0 per cent per annum (Table 3). Thus in the with-measures scenarios, productivity increases by 1.5 per cent per annum. The additional growth is our estimate of the effects of EMR activities post 1999. It does not take account of the EMR changes implemented prior to 1999.

2. Mandatory Renewable Energy Target (MRET). We assume that electricity generated from Biomass, hydro and other renewable means will increase from around 62 Pj in 1999 to around 94 Pj in 2010. This is equivalent to an increase of 9500 GWh on 1997 levels.
3. Generator Efficiency Standard (GES). We assume that efforts in updating generators will result in a reduction (relative to baseline (no measures) levels) of 2 million tonnes of emissions from black coal generators, of 2 million tonnes from brown coal generators, and of 1 million tonnes from gas generators. This was implemented endogenously via increases in the fuel efficiencies of the affected generators.
4. Greenhouse Gas Abatement Programs (GGAP). We assume that GGAP will lead to reductions (relative to baseline (no measures) levels) in emissions from the stationary energy sector in each state as listed in the GGAP spreadsheet provided by AGO.
5. Queensland state government initiatives. We assume that from 2005 the share of electricity generated from black coal in Queensland will be reduced to less than 85 per cent. This is based on the announced policy that Queensland government will require retailers to buy 15 per cent of electricity from gas and renewable sources from 2005.

In simulating the high emission scenario, we also assume:

- Average annual growth of GDP will be 4 per cent as opposed to 3 per cent in the baseline (no measures) scenario[8];
- Energy technical efficiency will improve at the rate of 0.6 per cent per annum (Table 7.7) as opposed to 0.5 per cent per annum in the baseline(no measures) scenario; and
- Supply efficiency will improve at the rate of 0.5 per cent per annum (Table 7.7) as opposed to 0.6 per cent per annum in the baseline (no measures) scenario.

In simulating the low emission scenario, we also assume:

- Average annual growth of GDP will be 2 per cent[9];
- Energy technical efficiency will improve at the rate of 0.8 per cent per annum (Table 8.7); and
- Supply efficiency will improve at the rate of 0.5 per cent per annum (Table 8.7).

In the workshop it was also agreed to target, if possible, the growth of electricity demand and the gas share in electricity as part of the high and low scenarios. However, in our modelling, values for both variables are determined endogenously, not exogenously. The reason is that the main instruments that could be used to target these variables are technological change variables that are themselves being targeted via values imposed for energy technical efficiency and supply efficiency. In other words, we do not have enough instruments to hit all the targets agreed too in the workshop.

[8] We induce the extra GDP in each year via an improvement in all-primary factor technological change affecting all industries except the electricity generators. The rate of primary-factor technological improvement in electricity generation is tied down by our assumption about EMR.

[9] GDP is reduced via an economy-wide deterioration in all-primary factor technological change affecting all industries except the electricity generators (see the previous footnote).

4.3 With-measure projections

Tables 6.1 to 6.7 present projections for the baseline (with measures) scenario. Similarly, Tables 7.1 to 7.7 show projections for the high emission scenario, and 8.1 to 8.7 for the low emission scenario.

4.3.1 Baseline (with measures)

Table 6.1 shows that the policy measures for emission reduction have limited impact on macroeconomic variables. However, output of electricity from renewable sources grows much faster compared to the baseline (no measures). This is mainly due to the effects of the MRET policy (Table 5.2 and 6.2). The introduction of the MRET into our simulations causes the share of electricity generated from Biomass to rise from 0.6 per cent in 1999 to 2.7 per cent in 2020 (Table 6.6).

The growth rate of electricity demand is also slightly higher (up by 0.1 percentage point) (Table 5.2 *c.f.* Table 6.2). This mainly reflects the reduction (relative to the no measures case) in the price of electricity arising from the EMR.

Due to the policy measures, the growth rate of total emissions falls to 1.6 per cent per annum, compared with 1.7 per cent in baseline (no measures). With the policy measures implemented, the level of total emission is 651 million tonnes instead of 659 million tonnes at the end of the period (Tables 5.3 and 6.3). The average annual growth rate of emissions from the stationary energy sector is 1.3 per cent instead of 1.4 per cent (Tables 5.4 and 6.4). This reflects a lower growth rate of emissions from the electricity sub-sector than in the baseline (no measures). With policy measures, the growth rate of emission from electricity sub-sector is 0.7 per cent instead of 0.9 per cent in baseline (no measures) (Tables 5.4 and 6.4).

4.3.2 High emission scenario

In the high emission scenario, national GDP grows at an average annual rate of 4 per cent instead of 3 per cent, resulting in higher growth in consumption, investment, public consumption, and international trade. Aggregate employment and capital stock also grow faster under the high emission scenario (Tables 5.1 and 7.1).

The higher GDP growth results in a higher growth in electricity demand (Tables 5.2 and 7.2). Improvement in energy technical efficiency also has an impact on electricity demand. Under the high emission scenario, energy technical efficiency is assumed to improve at an average annual rate of 0.6 per cent (Table 7.7). This is slightly higher than the rate in the baseline (no measures), 0.5 per cent (Table 5.7). The higher rate of improvement in energy technical efficiency in the high emission scenario, relative to the baseline (no measures) scenario, causes the ratio of electricity demand to GDP to increase by less in the high emissions scenario.

The policy measures, especially the MRET and the Queensland government initiatives, tend to change the shares of electricity generated by different fuels. The gas share in electricity generation is determined endogenously in the model. In the high emission scenario, the gas share in electricity generation is projected to increase from 10.7 per cent in 1999 to 14.7 per cent in 2020 (Table 7.6).

Total emissions are projected to grow at an average annual rate of 2.5 per cent, 0.8 percentage points higher than in the baseline (no measures). The level of total emission is projected to reach 798 million tonnes by 2020 as compared with 659 million tonnes in the baseline (no measures) (Tables 5.3 and 7.3).

Emissions from the stationary energy sector are projected to grow at an average annual rate of 2.3 per cent, 0.9 percentage points higher than in baseline (no measures). The level of emissions from the stationary energy sector is projected to reach 425 million tonnes as compared with 351 million tonnes in baseline (no measures) (Tables 5.4 and 7.4).

4.3.3 Low emission scenario

In the low emission scenario, we assume that national GDP grows at an average annual rate of 2 per cent, compared with 3 per cent in the Baseline (no measures) case. This results in lower growth in consumption, investment, public consumption, and international trade. Aggregate employment and capital stock also grow slower under the low emission scenario (Tables 5.1 and 8.1).

As a result of lower GDP growth, demand for electricity grows by less than in the baseline (no measures) case (Table 5.2 and 8.2). A higher rate of improvement in energy technical efficiency (Table 5.7 and 8.7) re-enforces the effects of a lower GDP growth, leading to a one percentage point reduction in the rate of growth in electricity demand as compared with baseline (no measures).

The gas share in electricity generation that is determined endogenously increases from 10.7 per cent in 1999 to 13.5 per cent in 2020.

In the low emission scenario, total emissions are projected to grow at an average annual rate of 0.6 per cent, 1.1 percentage points lower than in the baseline (no measures). The level of total emission is projected to reach 528 million tonnes by 2020 as compared with 659 million tonnes in baseline (no measures) (Tables 5.3 and 8.3).

Emissions from the stationary energy sector are projected to grow at an average annual rate of 0.3 per cent, 1.1 percentage points lower than in baseline (no measures). The level of emissions from the stationary energy sector is projected to reach 277 million tonnes as compared with 351 million tonnes in the baseline (no measures) case (Tables 5.4 and 8.4).

References

Adams, P.D., J.M. Horridge and B.R. Parmenter (2000a), "Report on Modelling for a Consultancy Examining the Microeconomic and Regional Impacts of a Domestic Trading Scheme for Carbon Permits", for Allen Consulting and the Victorian Treasury, January, 46 pages.

Adams, P.D., J.M. Horridge and B.R. Parmenter (2000b), "Report on Modelling for a Consultancy Examining the Microeconomic Impacts of Global Emissions Trading", for Allen Consulting and the Australian Greenhouse Office, August, 30 pages.

Adams, P.D. and B.R. Parmenter (2000), "Forecasting the Australian Economy: The Role of the MONASH Model", chapter 5 in Abelson, P. and R. Joyeux (eds.), *Economic Forecasting*, Allen and Unwin, Sydney.

Adams, P.D. (2002), "MMRF-Green: A Dynamic Multi-Regional Applied General Equilibrium Model of the Australian Economy, based on the MMR and MONASH models", in preparation, Centre of Policy Studies, PO Box 11E, Monash University, Victoria, 3800, Australia.

Dixon, P.B. and M. Rimmer (2001), *MONASH: A Dynamic Multi-sectoral Model of the Australian Economy*, in preparation, Centre of Policy Studies, PO Box 11E, Monash University, Victoria 3800, Australia.

Dixon, P.B., B.R. Parmenter, J. Sutton and D.P. Vincent (1982), *ORANI: A Multisectoral Model of the Australian Economy*, North-Holland, Amsterdam.

Fry, J.M. (1997), "Calculating Implied $C0_2$-Equivalent Emissions Factors for Greenhouse Gases", *mimeo*, Centre of Policy Studies, PO Box 11E, Monash University, Victoria 2800, Australia.

Harrison W.J. and K.R. Pearson (1996) "Computing solutions for Large General Equilibrium Models Using GEMPACK", *Computational Economics*, Vol. 9, pp. 83-127.

Hinchy, M. and K. Hanslow (1996), *The MEGABARE Model: Interim Documentation*, Australian Bureau of Agricultural and Resource Economics, Canberra.

Meagher, G.A. and Brian R. Parmenter (1993), "Monash-MR: A Multiregional CGE Model of Australia", *mimeo*, paper presented to the Venice Workshop on Transportation and Spatial CGE Models, Venice, 18-20 May, pp. 25.

Pearson, K.R. (1998), "Automating the Computation of Solutions of Large Economic Models", *Economic Modelling*, Vol. 7, pp. 385-395.

Peter, M.W., J.M. Horridge, G.A. Meagher, F. Naqvi, B.R. Parmenter and P.D. Adams (forthcoming, 2001) MONASH-MRF: A Multi-sectoral, Multi-regional Model of the Australian Economy, in preparation, Centre of Policy Studies, PO Box 11E, Monash University, Victoria 3800, Australia.

Pezzey, Jack and Ross Lambie (2001), "CGE Models for Evaluating Domestic Greenhouse Policies in Australia: A Comparative Analysis", *Consultancy Report*, Productivity Commission, April.

Quinlan, H. (1991), *Australia's Domestic Freight, 1986-87*, Centre for Transportation Policy Analysis, Wollongong University, Wollongong.

Table 1: Sectors Recognised in MMRF-Green

Name	Description
1. Agriculture	All primary agricultural activities plus fishing
2. Forestry	All forestry activities, including logging and management
3. Iron ore	Mining of iron ore
4. Non-iron ore	Mining of non-iron ores, including gold and base ores
5. Black coal	Mining of black coal - thermal and metallurgical
6. Crude oil	Production of crude oil
7. Natural gas	Production of natural gas at well
8. Brown coal	Mining of brown coal
9. Food, beverages and tobacco	All secondary agricultural activities
10. Textiles, clothing, footwear	Manufacture of textiles, clothing and footwear
11. Wood and paper products	Manufacture of wood (including pulp) and paper products
12. Chemical prods. excl. petrol	Manufacture of basic chemicals and paints
13. Petroleum products	Manufacture of petroleum products
14. Building prods (not cement & metal)	Manufacture of non-metallic building products excl. cement
15. Cement	Manufacture of cement
16. Iron and steel	Manufacture of primary iron and steel.
17. Alumina and aluminium	Manufacture of alumina and aluminium
18. Other metal products	Manufacture of other metal products
19. Motor vehicles and parts	Manufacture of motor vehicles and parts
20. Other manufacturing	Other manufacturing including electronic equipment
21. Electricity – black coal	Electricity generation from black coal thermal plants
22. Electricity – brown coal	Electricity generation from brown coal thermal plants
23. Electricity – gas	Electricity generation from natural gas thermal plants
24. Electricity – oil prods.	Electricity generation from oil products thermal plants
25. Electricity – other	Electricity generation from other sources (mainly hydro)
26. Electricity supply	Distribution of electricity from generator to user
27. Urban gas distribution	Urban distribution of natural gas
28. Water and sewerage services	Provision of water and sewerage services
29. Construction services	Residential building and other construction services
30. Trade services	Provision of wholesale and retail trade services
31. Road transport services – passenger	Provision of road passenger transport services
32. Road transport services – freight	Provision of road freight transport services
33. Rail transport services – passenger	Provision of rail passenger transport services
34. Rail transport services – freight	Provision of rail freight transport services
35. Water transport services – passenger	Provision of water passenger transport services
36. Water transport services – freight	Provision of water freight transport services
37. Air transport services – passenger	Provision of air passenger transport services
38. Air transport services – freight	Provision of air freight transport services
39. Other transport services	Provision of water, air and rail transport services
40. Communication services	Provision of communication services
41. Financial/business services	Provision of financial and business services
42. Dwelling ownership	Services of dwellings
43. Public services	Provision of public services
44. Other services	Provision of all other services
45. Private motor vehicle ownership	Services of private motor vehicles

.

Table 2: Macroeconomic Assumptions for the Baseline (no measures) scenario (average annual growth rates, 1999-2020)

	Variable		NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
1.	Real private consumption		2.8	2.8	3.6	2.1	3.7	1.5	4.5	2.5	3.0
2.	Real investment		3.1	2.1	4.3	1.8	4.8	2.0	6.1	2.8	3.3
3.	Real public consumption	-- total	2.8	2.4	3.6	1.8	4.2	1.4	4.6	2.6	2.9
4.		-- regional	2.8	2.4	3.6	1.8	4.2	1.4	4.6	2.1	2.9
5.		-- federal	2.8	2.4	3.6	1.8	4.2	1.4	4.6	2.6	2.9
6.	International export volumes		5.4	7.2	5.0	5.1	6.0	4.5	6.3	7.1	5.9
7.	International import volumes		5.2	5.9	5.9	3.3	7.0	3.0	8.5	8.0	5.7
8.	Real GDP/GSP		2.9	2.8	3.4	2.0	4.0	1.6	4.1	2.3	3.0
9.	Aggregate employment		1.1	1.1	1.8	0.5	2.0	0.3	1.8	1.3	1.3
10.	Aggregate capital stock		4.5	4.2	4.6	3.5	5.5	2.3	8.3	4.2	4.5
11.	Consumer real wage		0.2	-0.1	0.1	0.2	-0.2	0.2	-0.9	-0.5	0.0
12.	Producer real wage		-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
13.	CPI		2.1	2.1	2.5	2.6	1.8	2.5	2.4	2.1	2.2
14.	GDP/GSP deflator		2.5	2.3	2.9	3.0	1.8	2.9	1.1	1.5	2.4

Table 3: Industry Technology and Household Taste Assumptions for the Baseline (no measures) scenario (average annual percentage changes)*

Commodities	Household Preferences[a]	Technology:		Industries
		Intermediate input-using[b]	Primary-factor using[c]	
Agriculture	#	0.0	-1.2	Agriculture
Forestry	#	1.7	0.0	Forestry
Iron ore	#	-0.3	-2.0	Iron ore
Non-iron ore	#	-1.6	-1.2	Non-iron ore
Black coal	#	-1.1	0.0	Black coal
Crude oil	#	0.0	0.0	Crude oil
Natural gas	-1.3	0.5	0.0	Natural gas
Brown coal	#	-0.5	0.0	Brown coal
Food, beverages and tobacco	0.6	0.2	-0.6	Food, beverages and tobacco
Textiles, clothing and footwear	-2.7	-0.4	-0.9	Textiles, clothing and footwear
Wood and paper products	0.1	0.1	-0.1	Wood and paper products
Chemical products excl. Petrol	2.1	2.6	0.0	Chemical products excl. Petrol
Petrol	0.0	-1.0	0.0	Petroleum products
Aviation gasoline	0.0	-1.0		
Aviation turbine fuel	0.0	-1.0		
Diesel	0.0	-1.0		
LPG	0.0	0.5		
Other petroleum products	-2.7	-1.0		
Building prods (not cement & metal)	0.1	0.5	-0.6	Building prods (not cement & metal)
Cement	#	-1.2	-0.2	Cement
Iron and steel	#	1.3	-0.7	Iron and steel
Alumina and aluminium	#	2.0	-1.2	Alumina and aluminium
Other metal products	-1.3	1.3	0.0	Other metal products
Motor vehicles and parts	0.0	2.5	-0.2	Motor vehicles and parts
Other manufacturing	0.7	3.7	-0.9	Other manufacturing
Electricity – black coal	#	0.0	-1.0	Electricity – black coal
Electricity – brown coal	#	0.0	-1.0	Electricity – brown coal
Electricity – gas	#	4.0	-1.0	Electricity – gas
Electricity – oil prods.	#	0.0	0.0	Electricity – oil prods.
Electricity – other	#	0.5	-0.9	Electricity – other
Electricity supply	0.3	0.0	-1.0	Electricity supply
Urban gas distribution	0.3	0.6	-1.4	Urban gas distribution
Water and sewerage services	-0.5	-0.2	-1.2	Water and sewerage services
Construction services	0.0	1.8	0.0	Construction services
Wholesale trade, retail trade, accommodation	-2.1	-1.8	0.0	Wholesale trade, retail trade, accommodation
Road transport services – passenger	-1.6	0.5	-0.4	Road transport services – passenger
Road transport services – freight	#	0.5	-0.4	Road transport services – freight
Rail transport services – passenger	-0.1	-0.2	-1.1	Rail transport services – passenger
Rail transport services – freight	#	-0.2	-1.1	Rail transport services – freight
Water transport services – passenger	-6.2	-5.0	-0.6	Water transport services – passenger

Table 3 (continued): Industry Technology and Household Taste Assumptions for the Baseline (no measures) scenario (average annual percentage changes)

Commodities	Household preferences[a]	Technology:		Industries
		Intermediate input-using[b]	Primary-factor using[c]	
Water transport services – freight	#	-5.0	-0.6	Water transport services – freight
Air transport services – passenger	1.7	-2.1	-1.8	Air transport services – passenger
Air transport services – freight	#	-2.1	-1.8	Air transport services – freight
Other transport services	-0.3	0.8	0.0	Other transport services
Communication services	0.0	5.0	-2.2	Communication services
Financial and business services	1.9	3.3	-0.9	Financial and business services
Dwelling ownership	0.0	0.0	-0.8	Dwelling ownership
Public services	0.1	0.0	-0.2	Public services
Other services	1.2	1.6	0.0	Other services
Private motor vehicle ownership	-0.9	0.0	0.0	Private motor vehicle ownership

* The symbol # indicates that the underlying flow is negligible.

(a) Annual rate of shift of consumption function.

(b) Annual rate of change of use of the commodity identified on the left-hand panel per unit of output of industries using the commodity.

(c) Annual rate of change of use of all primary factors (labour, capital and agricultural land) per unit of production of the industry identified in the right-hand panel.

End of Table 3

Table 4: Assumptions for Exports for the Baseline (no measures) Scenario (average annual percentage changes) *

Variable	NSW	VIC	QLD	SA	WA	TAS	NT	ACT
Export volumes:								
Agriculture	2.2	2.9	1.9	1.6	3.3	3.3	1.8	#
Iron ore	#	#	#	-2.6	3.0	-3.4	#	#
Non-iron ore	-2.1	31	-0.4	-2.2	4.5	-2.5	3.3	#
Black coal	2.4	#	3.1	#	#	#	#	#
Crude oil	#	-0.5	#	#	1.5	#	1.5	#
Natural gas	#	#	#	#	4.0	#	#	#
Petroleum products	1.5	1.5	1.5	#	1.5	#	#	#
Alumina and aluminium	2.0	3.1	7.9	#	4.6	1.5	4.9	#

* The symbol # indicates that the underlying flow is negligible.

Table 5.1 Baseline (no measures): macroeconomic indicators (average annual growth rates, 1999-2020)

Variable	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Real private consumption	2.8	2.8	3.6	2.1	3.7	1.5	4.5	2.5	3.0
Real investment	3.1	2.1	4.3	1.8	4.8	2.0	6.1	2.8	3.3
Real public consumption	2.8	2.4	3.6	1.8	4.2	1.4	4.6	2.6	2.9
International export volumes	5.4	7.2	5.0	5.1	6.0	4.5	6.3	7.1	5.8
International import volumes	5.2	5.9	5.9	3.3	7.0	3.0	8.5	8.0	5.7
Real GDP/GSP	2.9	2.8	3.4	2.0	4.0	1.6	4.1	2.3	3.0
Aggregate employment	1.1	1.1	1.8	0.5	2.0	0.3	1.8	1.3	1.3
Aggregate capital stock	4.5	4.2	4.6	3.5	5.5	2.3	8.3	4.2	4.5
CPI	2.1	2.1	2.5	2.6	1.8	2.5	2.4	2.1	2.2
Population	1.1	1.1	1.8	0.5	2.0	0.3	1.8	1.3	1.3

Table 5.2: Baseline (no measures): output by industry (average annual growth rates, 1999-2020)

Industry	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Agriculture	2.3	2.9	2.9	1.7	3.7	3.3	1.8	3.6	2.7
Forestry	2.9	3.0	3.1	2.1	3.8	2.8	0.0	2.8	3.0
Iron ore	0.0	0.0	0.0	-2.3	2.7	1.2	0.0	0.0	2.7
Non-iron ore	-1.9	-0.4	-0.3	-1.7	3.5	-2.4	1.6	0.1	2.0
Black coal	2.1	0.0	2.9	-2.3	2.2	-0.1	0.0	0.0	2.5
Crude oil	0.0	-0.5	0.0	0.0	1.5	0.0	1.5	0.0	0.0
Natural gas	0.0	2.5	3.8	4.2	4.0	0.0	2.8	0.0	3.5
Brown coal	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	1.1
Food, beverages and tobacco	3.3	4.1	4.5	3.1	5.0	2.9	3.8	3.8	3.9
Textiles, clothing and footwear	2.2	3.6	2.0	1.3	5.7	0.7	-0.3	2.6	3.0
Wood and paper products	2.1	2.5	1.7	1.0	3.5	1.8	1.0	3.0	2.2
Chemical products excl. Petrol	3.7	4.1	3.9	3.3	6.5	3.3	4.5	5.8	4.1
Petroleum products	0.9	1.3	1.6	1.4	2.1	0.0	0.0	0.0	1.2
Building prods (not cement & metal)	2.3	1.8	3.2	1.3	3.9	0.8	3.2	0.8	2.5
Cement	0.2	0.2	1.3	0.1	1.5	-0.9	0.4	0.0	0.5
Iron and steel	3.8	4.6	3.6	4.1	4.4	4.4	8.3	6.0	4.0
Alumina and aluminium	2.2	3.2	5.2	0.0	4.8	1.7	3.5	0.0	4.1
Other metal products	3.8	4.7	4.1	3.3	7.1	1.7	2.1	3.2	4.6
Motor vehicles and parts	1.5	2.4	2.4	1.6	4.0	0.0	0.0	0.0	2.2
Other manufacturing	4.8	4.3	4.5	4.1	5.5	3.7	3.4	4.6	4.6
Electricity – black coal	2.1	0.0	2.6	-2.3	3.2	0.0	0.0	0.0	2.2
Electricity – brown coal	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	2.2
Electricity – gas	4.7	2.4	4.9	3.1	4.1	0.0	3.6	0.0	3.9
Electricity – oil prods.	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.2
Electricity – other	0.6	0.6	3.4	0.0	2.9	0.8	0.0	0.0	0.9
Electricity supply	2.2	2.2	2.7	1.4	3.1	0.8	2.8	1.8	2.3
Urban gas distribution	3.0	3.1	3.9	2.3	4.5	1.7	3.9	2.7	3.1
Water and sewerage services	2.9	2.8	3.1	2.0	3.7	1.3	3.8	2.1	2.9
Construction services	3.1	2.0	4.4	1.8	4.7	1.9	5.7	2.9	3.3
Wholesale trade, retail trade, accommodation	1.8	2.0	2.6	1.0	3.0	0.9	3.7	1.5	2.1
Road transport services – passenger	2.1	2.1	2.4	1.9	2.9	1.2	2.8	2.0	2.2
Road transport services – freight	3.5	3.9	4.2	3.0	5.1	3.0	4.6	3.4	3.9
Rail transport services – passenger	2.0	2.0	2.3	2.0	0.0	0.0	0.0	0.0	2.1
Rail transport services – freight	2.5	2.7	3.0	1.9	3.4	2.3	2.0	2.2	2.7
Water transport services – passenger	1.3	2.7	2.0	1.4	4.0	0.3	3.3	4.1	1.6
Water transport services – freight	0.0	0.6	0.5	0.1	1.0	-0.3	0.9	0.9	0.5
Air transport services – passenger	4.0	6.0	6.2	4.3	6.8	4.8	7.1	5.3	5.3
Air transport services – freight	2.6	2.5	2.9	1.5	3.5	1.0	4.2	2.8	2.7

Table 5.2 (continued) Baseline (no measures): output by industry (average annual growth rates, 1999-2020)

Industry	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Other transport services	3.1	3.6	3.9	2.7	4.7	2.5	4.7	3.3	3.5
Communication services	7.7	7.9	7.9	7.1	8.5	6.6	8.5	8.2	7.8
Financial and business services	5.6	5.6	6.1	5.0	6.3	4.4	6.5	4.8	5.7
Dwelling ownership	4.1	3.7	3.7	2.7	5.1	1.9	5.1	2.8	3.8
Public services	2.7	2.5	3.6	1.8	4.0	1.4	4.6	2.7	2.8
Other services	3.7	3.8	4.5	3.6	4.2	3.1	4.5	3.6	3.9
Private motor vehicle ownership	1.3	1.4	2.8	0.4	2.5	0.1	3.7	1.4	1.7

End of Table 5.2

Table 5.3 Baseline (no measures): $C0_2$-e Emissions by Major Source Category

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Average annual growth rates (1999-2020)									
Energy sector, total	1.1	1.4	1.8	0.1	2.7	0.5	2.3	1.1	1.5
Fuel combustion	1.1	1.4	1.7	0.0	2.7	0.6	2.5	1.1	1.4
Electricity	0.6	1.1	1.1	-2.3	1.9	0.0	2.9	0.0	0.9
Transport	1.1	1.5	2.0	0.5	2.4	0.2	3.1	0.7	1.5
Other industries	1.7	2.3	2.4	1.4	3.8	0.8	1.6	1.6	2.2
Household consumption	1.6	1.5	3.1	1.4	2.8	0.5	4.6	1.3	1.9
Fugitive emissions from fuels	2.0	0.5	2.8	2.9	2.9	-0.2	1.5	0.0	1.7
Industrial processes	1.3	2.1	3.3	0.2	3.5	-0.6	1.5	1.2	2.2
Agriculture	2.1	2.7	2.7	1.5	3.4	3.1	1.6	3.4	2.5
Waste	1.6	1.6	2.3	1.4	2.0	1.0	2.3	1.4	1.7
LUCF	2.6	2.8	2.8	1.9	3.5	2.5	0.0	2.6	2.7
Total	1.3	1.5	2.0	0.5	2.9	0.0	2.0	1.0	1.7

Table 5.3 (continued) Baseline (no measures): $C0_2$-e Emissions by Major Source Category

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Levels(Mt CO2-e) (1999)									
Energy sector, total	113.9	124.1	64.0	17.0	36.8	3.4	2.3	2.1	363.6
Fuel combustion	108.4	110.3	57.7	16.6	33.1	3.4	1.8	2.1	333.5
Electricity	49.1	63.6	29.1	6.1	14.0	0.0	0.1	0.0	162.1
Transport	28.4	19.4	13.4	4.9	7.4	1.4	0.9	1.3	77.2
Other industries	29.7	26.2	14.7	5.3	11.5	1.9	0.7	0.7	90.8
Household consumption	1.1	1.1	0.5	0.2	0.2	0.1	0.0	0.1	3.4
Fugitive emissions from fuels	5.5	13.8	6.3	0.3	3.7	0.0	0.6	0.0	30.1
Industrial processes	2.2	1.4	2.0	1.1	2.3	0.7	0.8	0.0	10.4
Agriculture	29.9	18.1	21.6	8.0	13.2	3.2	1.2	0.1	95.2
Waste	5.5	4.8	2.3	1.3	1.2	0.3	0.2	0.6	16.3
LUCF	-5.2	-5.3	-4.1	-2.4	-2.5	-6.7	0.0	-0.3	-26.5
Total	146.2	143.0	85.9	25.1	51.0	0.9	4.5	2.5	459.0
Levels (Mt CO2-e) (2020)									
Energy sector, total	145.2	166.8	94.8	17.4	66.8	3.9	3.8	2.7	501.4
Fuel combustion	136.7	151.4	83.1	16.8	59.8	3.8	3.0	2.7	457.4
Electricity	55.7	80.1	37.0	3.7	21.2	0.0	0.2	0.0	197.9
Transport	36.3	26.9	20.6	5.5	12.3	1.5	1.8	1.6	106.4
Other industries	43.1	42.9	24.5	7.3	25.9	2.2	1.0	1.1	148.0
Household consumption	1.6	1.6	1.0	0.3	0.5	0.1	0.1	0.1	5.1
Fugitive emissions from fuels	8.5	15.4	11.7	0.6	7.0	0.0	0.8	0.0	43.9
Industrial processes	2.8	2.1	4.2	1.2	4.8	0.6	1.1	0.0	16.8
Agriculture	47.1	32.2	38.5	11.2	27.5	6.2	1.6	0.2	164.6
Waste	7.7	6.8	3.8	1.8	1.9	0.3	0.4	0.8	23.5
LUCF	-9.2	-9.8	-7.5	-3.6	-5.2	-11.6	0.0	-0.5	-47.4
Total	193.7	198.2	133.7	28.0	95.8	-0.5	6.9	3.2	659.0

End of Table 5.3

Table 5.4 Baseline (no measures): $C0_2$-e Emissions from the Stationary Energy Sector

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Average annual growth rates (1999-2020)									
Total emissions for stationary energy	1.0	1.4	1.6	-0.2	2.8	2.3	1.9	1.6	1.4
Electricity	0.6	1.1	1.1	-2.3	1.9	0.0	2.9	0.0	0.9
Gas	2.7	2.8	3.4	2.1	4.4	0.0	2.6	2.2	3.0
Coal	1.2	1.7	1.8	0.7	3.3	0.2	0.4	0.4	1.7
Liquid fuels	1.2	1.5	1.8	0.9	3.4	1.0	1.5	1.1	1.8
Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Levels (Mt CO2-e) (1999)									
Total emissions for stationary energy	80.0	90.9	44.3	11.7	25.8	1.4	0.8	0.8	256.3
Electricity	49.1	63.6	29.1	6.1	14.0	0.0	0.1	0.0	162.1
Gas	9.5	14.0	4.9	2.5	4.1	0.0	0.3	0.4	36.2
Coal	12.2	7.3	5.4	1.7	3.8	0.7	0.2	0.2	31.5
Liquid fuels	9.2	6.1	4.9	1.4	3.8	0.7	0.2	0.2	26.5
Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Levels (Mt CO2-e) (2020)									
Total emissions for stationary energy	100.4	124.5	62.5	11.3	47.6	2.3	1.3	1.1	351.0
Electricity	55.7	80.1	37.0	3.7	21.2	0.0	0.2	0.0	197.9
Gas	17.0	25.6	10.1	3.9	10.5	0.7	0.5	0.7	69.0
Coal	15.8	10.5	8.1	2.0	7.9	0.7	0.2	0.2	45.3
Liquid fuels	11.9	8.4	7.3	1.7	8.0	0.9	0.3	0.3	38.9
Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 5.5 Baseline (no measures): Primary Energy Consumption for Electricity Generation, by Fuel and State

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Average annual growth rates (1999-2020)									
Brown coal	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0
Black coal	0.4	0.0	0.8	-4.0	1.4	0.0	0.0	0.0	0.5
Gas	4.7	2.2	4.7	1.9	3.5	0.0	3.1	0.0	3.4
Liquid fuel	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	-0.1
Biomass	2.7	1.1	6.0	0.0	2.9	0.8	0.0	0.0	3.8
Other renewable/ hydro	0.5	0.5	0.5	0.0	0.5	0.8	0.0	0.0	0.6
Total fuel used for electricity generation	0.6	1.0	1.0	-0.8	2.3	0.8	2.5	0.0	0.9
Levels (PJ) (1999)									
Brown coal	0.0	638.6	0.0	0.0	0.0	0.0	0.0	0.0	638.6
Black coal	518.6	0.0	344.8	44.7	76.3	0.0	0.0	0.0	984.4
Gas	16.0	6.2	12.7	29.0	47.8	0.0	4.2	0.0	116.0
Liquid fuel	0.4	1.2	1.2	0.4	2.2	0.0	1.8	0.0	6.1
Biomass	0.9	0.9	1.6	0.2	0.9	0.1	0.0	0.0	4.6
Other renewable/ hydro	23.8	4.5	2.7	0.0	0.0	27.6	0.0	0.0	58.7
Total fuel used for electricity generation	559.8	651.4	363.0	74.3	127.3	27.7	6.0	0.0	1808.4
Levels (PJ) (2020)									
Brown coal	0.0	802.3	0.0	0.0	0.0	0.0	0.0	0.0	802.3
Black coal	561.2	0.0	410.7	18.3	103.6	0.0	0.0	0.0	1093.9
Gas	43.9	10.0	34.7	43.4	102.6	0.0	8.3	0.0	242.8
Liquid fuel	0.4	1.2	1.2	0.4	2.2	0.0	2.0	0.0	6.0
Biomass	1.6	1.1	5.8	0.2	1.7	0.1	0.0	0.0	10.5
Other renewable/ hydro	26.5	5.0	3.0	0.0	0.0	32.8	0.0	0.0	67.4
Total fuel used for electricity generation	633.5	819.6	455.4	62.4	210.1	32.9	10.3	0.0	2222.8

Table 5.6 Baseline (no measures): Share of Generated Electricity by Fuel Type

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Levels(%) (1999)									
Brown coal	0.0	95.6	0.0	0.0	0.0	0.0	0.0	0.0	24.6
Black coal	87.9	0.0	87.5	49.0	47.7	0.0	0.0	0.0	54.9
Gas	2.6	1.5	7.9	49.8	45.3	0.0	83.0	0.0	10.7
Liquid fuel	0.2	0.0	1.3	0.6	5.7	0.0	17.0	0.0	1.1
Biomass	0.3	0.5	1.2	0.6	1.2	0.4	0.0	0.0	0.6
Other renewable/ hydro	9.0	2.4	2.1	0.0	0.1	99.6	0.0	0.0	8.1
Levels (%) (2020)									
Brown coal	0.0	96.3	0.0	0.0	0.0	0.0	0.0	0.0	24.0
Black coal	88.4	0.0	83.3	23.6	44.8	0.0	0.0	0.0	53.6
Gas	4.6	1.6	12.2	75.5	51.3	0.0	89.6	0.0	15.0
Liquid fuel	0.1	0.0	0.7	0.5	2.8	0.0	10.4	0.0	0.7
Biomass	0.4	0.4	2.5	0.5	1.1	0.4	0.0	0.0	0.9
Other renewable/ hydro	6.5	1.7	1.3	0.0	0.0	99.6	0.0	0.0	5.7

Table 5.7: Baseline (no measures): Efficiencies
(Average annual percentage growth rates 1999-2020)

States	Energy technical efficiency improvement[(a)]	Supply efficiency improvement[(b)]
AUS	-0.5	-0.6
NSW	-0.5	-0.9
VIC	-0.4	-0.5
QLD	-0.5	-0.7
SA	-0.4	-0.2
WA	-0.5	-0.3
TAS	-0.4	0.0
NT	-0.5	-0.1
ACT	-0.4	0.0

(a) We define energy technical efficiency as a weighted average of the use of primary and derived fuels per unit of output in all industries using those fuels other than electricity. Thus a value of –0.5 per cent per annum implies that industries other than electricity use annually 0.5 per cent less fuels (primary and derived) per unit of output.

(b) We define supply efficiency as a weighted average of the use of primary fuels per unit of electricity generation. Thus a value of –0.6 per cent per annum implies that electricity-generating industries use annually 0.6 per cent less primary fuels per unit of output.

Table 5.8: Baseline (no measures): National emissions from the stationary energy sector, calibrated to the 2000 NGGI

Category	Units	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	20010
Electricity	Mt CO2-e	175.07	178.86	180.35	181.84	183.72	185.28	187.22	189.64	191.09	192.49	193.81
Non elect and heat sub total	Mt CO2-e	88.78	92.04	93.81	94.20	95.85	98.82	101.26	104.47	106.68	108.88	111.14
Gas	Mt CO2-e	34.85	35.98	37.26	37.91	38.87	40.26	41.80	43.75	45.00	46.26	47.57
Coal	Mt CO2-e	23.35	24.26	24.30	23.88	24.15	25.03	25.38	25.95	26.41	26.83	27.27
Liquid fuels	Mt CO2-e	29.18	30.41	30.85	31.01	31.43	32.13	32.68	33.37	33.88	34.38	34.90
Biomass	Mt CO2-e	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40

		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Electricity	Mt CO2-e	195.26	196.76	198.35	199.88	201.39	202.85	204.29	205.66	207.03	208.31
Non elect and heat sub total	Mt CO2-e	113.47	115.87	118.34	120.88	123.49	126.18	128.94	131.79	134.72	137.74
Gas	Mt CO2-e	48.92	50.31	51.74	53.22	54.74	56.30	57.91	59.58	61.29	63.06
Coal	Mt CO2-e	27.73	28.19	28.67	29.15	29.65	30.16	30.69	31.22	31.78	32.34
Liquid fuels	Mt CO2-e	35.43	35.97	36.53	37.11	37.70	38.31	38.94	39.59	40.25	40.94
Biomass	Mt CO2-e	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40

Table 6.1 Baseline (with measures): macroeconomic indicators (average annual growth rates, 1999-2020)

Variable	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Real private consumption	2.8	2.8	3.7	2.1	3.7	1.5	4.5	2.5	3.0
Real investment	3.1	2.1	4.3	1.8	4.8	2.0	6.1	2.8	3.3
Real public consumption	2.8	2.4	3.6	1.8	4.2	1.4	4.6	2.6	2.9
International export volumes	5.4	7.2	5.1	5.1	6.0	4.5	6.3	7.1	5.8
International import volumes	5.2	5.9	5.9	3.3	7.0	3.0	8.5	8.0	5.7
Real GDP/GSP	2.9	2.8	3.4	2.0	4.0	1.6	4.1	2.3	3.0
Aggregate employment	1.1	1.1	1.8	0.5	2.0	0.3	1.8	1.3	1.3
Aggregate capital stock	4.5	4.2	4.6	3.5	5.5	2.3	8.2	4.2	4.5
CPI	2.1	2.1	2.5	2.6	1.8	2.5	2.4	2.1	2.2
Population	1.1	1.1	1.8	0.5	2.0	0.3	1.8	1.3	1.3

Table 6.2 Baseline (with measures): output by industry (average annual growth rates, 1999-2020)

Industry	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Agriculture	2.3	2.9	2.9	1.7	3.7	3.3	1.8	3.6	2.7
Forestry	2.9	3.0	3.1	2.1	3.8	2.8	0.0	2.8	3.0
Iron ore	0.0	0.0	0.0	-2.3	2.8	1.2	0.0	0.0	2.7
Non-iron ore	-1.9	-0.4	-0.3	-1.7	3.6	-2.4	1.6	0.2	2.0
Black coal	2.1	0.0	3.0	-2.3	2.1	-0.1	0.0	0.0	2.5
Crude oil	0.0	-0.5	0.0	0.0	1.5	0.0	1.5	0.0	0.0
Natural gas	0.0	2.4	3.6	4.1	4.1	0.0	2.6	0.0	3.5
Brown coal	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.9
Food, beverages and tobacco	3.3	4.1	4.5	3.1	5.0	2.9	3.7	3.8	3.9
Textiles, clothing and footwear	2.2	3.6	2.0	1.3	5.7	0.7	-0.4	2.6	3.0
Wood and paper products	2.1	2.5	1.7	1.0	3.5	1.8	0.9	3.0	2.2
Chemical products excl. Petrol	3.7	4.1	3.9	3.3	6.5	3.3	4.4	5.8	4.1
Petroleum products	0.9	1.3	1.6	1.4	2.1	0.0	0.0	0.0	1.2
Building prods (not cement & metal)	2.3	1.8	3.2	1.3	3.9	0.8	3.1	0.8	2.5
Cement	0.2	0.2	1.3	0.1	1.5	-0.9	0.4	0.0	0.5
Iron and steel	3.9	4.6	3.6	4.1	4.4	4.4	8.3	6.0	4.0
Alumina and aluminium	2.4	3.2	5.3	0.0	4.8	1.7	3.4	0.0	4.1
Other metal products	3.8	4.7	4.1	3.3	7.1	1.7	2.0	3.2	4.6
Motor vehicles and parts	1.5	2.4	2.4	1.6	4.0	0.0	0.0	0.0	2.2
Other manufacturing	4.8	4.3	4.5	4.1	5.5	3.7	3.3	4.5	4.6
Electricity – black coal	2.1	0.0	2.7	-2.2	3.3	0.0	0.0	0.0	2.3
Electricity – brown coal	0.0	2.2	0.0	0.0	0.0	0.0	0.0	0.0	2.2
Electricity – gas	3.6	1.9	4.5	3.1	4.2	0.0	3.6	0.0	3.8
Electricity – oil prods.	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Electricity – other	2.4	2.3	5.2	0.0	4.4	0.9	0.0	0.0	2.0
Electricity supply	2.2	2.2	2.7	1.5	3.1	0.9	2.9	1.9	2.4
Urban gas distribution	3.0	3.1	3.9	2.3	4.5	1.7	3.9	2.7	3.1
Water and sewerage services	2.9	2.8	3.1	2.0	3.7	1.3	3.7	2.1	2.9
Construction services	3.1	2.0	4.4	1.8	4.7	1.9	5.7	2.9	3.3
Wholesale trade, retail trade, accommodation	1.8	2.0	2.6	1.0	3.0	0.9	3.7	1.5	2.1
Road transport services – passenger	2.1	2.1	2.4	1.9	2.9	1.2	2.7	2.0	2.2
Road transport services – freight	3.5	3.9	4.2	3.0	5.1	3.0	4.6	3.4	3.9
Rail transport services – passenger	2.0	2.0	2.3	2.0	0.0	0.0	0.0	0.0	2.1
Rail transport services – freight	2.5	2.7	3.0	1.9	3.4	2.3	2.0	2.2	2.7
Water transport services – passenger	1.3	2.7	2.0	1.4	4.1	0.3	3.2	4.1	1.6
Water transport services – freight	0.0	0.6	0.5	0.1	1.1	-0.3	0.9	0.9	0.5
Air transport services – passenger	4.1	6.0	6.2	4.3	6.8	4.8	7.1	5.3	5.3
Air transport services – freight	2.6	2.5	2.9	1.5	3.5	1.0	4.2	2.8	2.7

Table6 .2 (continued) Baseline (with measures): output by industry (average annual growth rates, 1999-2020)

Industry	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Other transport services	3.1	3.6	3.9	2.8	4.7	2.5	4.7	3.3	3.5
Communication services	7.7	8.0	7.9	7.1	8.5	6.6	8.5	8.2	7.8
Financial and business services	5.6	5.6	6.1	5.0	6.3	4.4	6.5	4.8	5.7
Dwelling ownership	4.1	3.7	3.7	2.7	5.1	1.9	5.1	2.8	3.8
Public services	2.7	2.5	3.6	1.8	4.0	1.4	4.6	2.7	2.8
Other services	3.7	3.8	4.5	3.6	4.2	3.1	4.5	3.6	3.9
Private motor vehicle ownership	1.3	1.4	2.8	0.4	2.5	0.1	3.8	1.4	1.7

End of Table 6.2

Table 6.3 Baseline (with measures): $C0_2$-e Emissions by Major Source Category

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Average annual growth rates (1999-2020)									
Energy sector, total	1.1	1.3	1.7	0.0	2.7	0.6	2.2	1.1	1.4
Fuel combustion	1.0	1.4	1.6	0.0	2.6	0.6	2.5	1.1	1.4
Electricity	0.5	0.9	0.9	-2.6	1.6	0.0	2.1	0.0	0.7
Transport	1.1	1.5	2.0	0.5	2.4	0.2	3.0	0.7	1.5
Other industries	1.7	2.3	2.4	1.4	3.8	0.8	1.5	1.6	2.2
Household consumption	1.6	1.5	3.1	1.4	2.8	0.5	4.5	1.3	1.9
Fugitive emissions from fuels	2.0	0.4	2.9	2.8	3.0	-0.2	1.5	0.0	1.7
Industrial processes	1.3	2.1	3.4	0.2	3.5	-0.6	1.5	1.2	2.2
Agriculture	2.1	2.7	2.7	1.5	3.4	3.1	1.6	3.3	2.5
Waste	1.6	1.6	2.3	1.4	2.0	1.0	2.3	1.4	1.7
LUCF	2.6	2.8	2.8	1.9	3.5	2.5	0.0	2.6	2.7
Total	1.3	1.4	2.0	0.4	2.8	0.0	1.9	1.0	1.6

Table 6.3 (continued) Baseline (with measures): $C0_2$-e Emissions by Major Source Category

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Levels(Mt CO2-e) (1999)									
Energy sector, total	113.9	124.1	64.0	17.0	36.8	3.4	2.3	2.1	363.6
Fuel combustion	108.4	110.3	57.7	16.6	33.1	3.4	1.8	2.1	333.5
Electricity	49.1	63.6	29.1	6.1	14.0	0.0	0.1	0.0	162.1
Transport	28.4	19.4	13.4	4.9	7.4	1.4	0.9	1.3	77.2
Other industries	29.7	26.2	14.7	5.3	11.5	1.9	0.7	0.7	90.8
Household consumption	1.1	1.1	0.5	0.2	0.2	0.1	0.0	0.1	3.4
Fugitive emissions from fuels	5.5	13.8	6.3	0.3	3.7	0.0	0.6	0.0	30.1
Industrial processes	2.2	1.4	2.0	1.1	2.3	0.7	0.8	0.0	10.4
Agriculture	29.9	18.1	21.6	8.0	13.2	3.2	1.2	0.1	95.2
Waste	5.5	4.8	2.3	1.3	1.2	0.3	0.2	0.6	16.3
LUCF	-5.2	-5.3	-4.1	-2.4	-2.5	-6.7	0.0	-0.3	-26.5
Total	146.2	143.0	85.9	25.1	51.0	0.9	4.5	2.5	459.0
Levels (Mt CO2-e) (2020)									
Energy sector, total	144.2	164.1	93.6	17.1	65.5	3.9	3.8	2.7	493.4
Fuel combustion	135.7	148.9	81.9	16.5	58.5	3.8	3.0	2.7	449.6
Electricity	54.7	77.6	35.8	3.4	19.8	0.0	0.2	0.0	189.9
Transport	36.3	26.9	20.6	5.5	12.3	1.5	1.8	1.6	106.5
Other industries	43.2	42.8	24.6	7.3	26.0	2.2	1.0	1.1	148.1
Household consumption	1.6	1.6	1.0	0.3	0.5	0.1	0.1	0.1	5.1
Fugitive emissions from fuels	8.5	15.2	11.7	0.6	7.0	0.0	0.8	0.0	43.7
Industrial processes	2.9	2.1	4.2	1.2	4.8	0.6	1.1	0.0	16.9
Agriculture	47.1	32.2	38.5	11.2	27.5	6.2	1.6	0.2	164.6
Waste	7.7	6.8	3.8	1.8	1.9	0.3	0.4	0.8	23.6
LUCF	-9.2	-9.8	-7.5	-3.6	-5.2	-11.6	0.0	-0.5	-47.4
Total	192.8	195.4	132.6	27.7	94.5	-0.5	6.8	3.2	651.1

End of Table 6.3

Table 6.4: Baseline (with measures): $C0_2$-e Emissions from the Stationary Energy Sector

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Average annual growth rates (1999-2020)									
Total emissions for stationary energy	1.0	1.3	1.5	-0.3	2.7	2.3	1.7	1.6	1.3
Electricity	0.5	0.9	0.9	-2.6	1.6	0.0	2.1	0.0	0.7
Gas	2.7	2.8	3.4	2.0	4.4	0.0	2.5	2.2	3.0
Coal	1.2	1.7	1.8	0.7	3.3	0.2	0.4	0.4	1.7
Liquid fuels	1.2	1.5	1.9	0.9	3.4	1.0	1.5	1.1	1.8
Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Levels (Mt CO2-e) (1999)									
Total emissions for stationary energy	80.0	90.9	44.3	11.7	25.8	1.4	0.8	0.8	256.3
Electricity	49.1	63.6	29.1	6.1	14.0	0.0	0.1	0.0	162.1
Gas	9.5	14.0	4.9	2.5	4.1	0.0	0.3	0.4	36.2
Coal	12.2	7.3	5.4	1.7	3.8	0.7	0.2	0.2	31.5
Liquid fuels	9.2	6.1	4.9	1.4	3.8	0.7	0.2	0.2	26.5
Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Levels (Mt CO2-e) (2020)									
Total emissions for stationary energy	99.4	122.0	61.3	11.0	46.2	2.3	1.2	1.1	343.2
Electricity	54.7	77.6	35.8	3.4	19.8	0.0	0.2	0.0	189.9
Gas	17.0	25.5	10.2	3.9	10.5	0.7	0.5	0.7	69.0
Coal	15.8	10.5	8.1	2.0	7.9	0.7	0.2	0.2	45.3
Liquid fuels	11.9	8.4	7.3	1.7	8.0	0.9	0.3	0.3	38.9
Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 6.5 Baseline (with measures): Primary Energy Consumption for Electricity Generation, by Fuel and State

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Average annual growth rates (1999-2020)									
Brown coal	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.9
Black coal	0.3	0.0	0.7	-4.0	1.2	0.0	0.0	0.0	0.4
Gas	3.6	1.3	3.8	1.1	2.8	0.0	2.4	0.0	2.6
Liquid fuel	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	-0.2
Biomass	13.8	6.9	8.7	0.0	4.5	0.8	0.0	0.0	9.2
Other renewable/ hydro	0.5	0.5	0.5	0.0	0.5	0.8	0.0	0.0	0.6
Total fuel used for electricity generation	0.6	0.9	1.0	-1.3	1.9	0.8	1.7	0.0	0.8
Levels (PJ) (1999)									
Brown coal	0.0	638.6	0.0	0.0	0.0	0.0	0.0	0.0	638.6
Black coal	518.6	0.0	344.8	44.7	76.3	0.0	0.0	0.0	984.4
Gas	16.0	6.2	12.7	29.0	47.8	0.0	4.2	0.0	116.0
Liquid fuel	0.4	1.2	1.2	0.4	2.2	0.0	1.8	0.0	6.1
Biomass	0.9	0.9	1.6	0.2	0.9	0.1	0.0	0.0	4.6
Other renewable/ hydro	23.8	4.5	2.7	0.0	0.0	27.6	0.0	0.0	58.7
Total fuel used for electricity generation	559.8	651.4	363.0	74.3	127.3	27.7	6.0	0.0	1808.4
Levels (PJ) (2020)									
Brown coal	0.0	778.9	0.0	0.0	0.0	0.0	0.0	0.0	778.9
Black coal	559.3	0.0	404.0	18.1	100.2	0.0	0.0	0.0	1081.6
Gas	34.7	8.2	28.9	36.8	87.2	0.0	7.0	0.0	202.8
Liquid fuel	0.4	1.2	1.2	0.4	2.2	0.0	1.8	0.0	5.8
Biomass	15.6	3.9	10.0	0.2	2.4	0.1	0.0	0.0	32.1
Other renewable/ hydro	26.5	5.0	3.0	0.0	0.0	33.0	0.0	0.0	67.6
Total fuel used for electricity generation	636.5	797.2	447.1	55.4	192.0	33.1	8.8	0.0	2168.8

Table 6.6 Baseline (with measures): Share of Generated Electricity by Fuel Type

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Levels(%) (1999)									
Brown coal	0.0	95.6	0.0	0.0	0.0	0.0	0.0	0.0	24.6
Black coal	87.9	0.0	87.5	49.0	47.7	0.0	0.0	0.0	54.9
Gas	2.6	1.5	7.9	49.8	45.3	0.0	83.0	0.0	10.7
Liquid fuel	0.2	0.0	1.3	0.6	5.7	0.0	17.0	0.0	1.1
Biomass	0.3	0.5	1.2	0.6	1.2	0.4	0.0	0.0	0.6
Other renewable/ hydro	9.0	2.4	2.1	0.0	0.1	99.6	0.0	0.0	8.1
Levels (%) (2020)									
Brown coal	0.0	95.6	0.0	0.0	0.0	0.0	0.0	0.0	23.7
Black coal	86.3	0.0	82.9	24.0	44.7	0.0	0.0	0.0	53.0
Gas	3.5	1.4	11.0	75.1	51.0	0.0	91.0	0.0	14.3
Liquid fuel	0.1	0.0	0.7	0.5	2.7	0.0	9.0	0.0	0.7
Biomass	3.7	1.3	4.2	0.4	1.6	0.4	0.0	0.0	2.7
Other renewable/ hydro	6.3	1.7	1.3	0.0	0.0	99.6	0.0	0.0	5.6

Table 6.7 Baseline (with measures): Efficiencies
(Average annual percentage growth rates 1999-2020)

States	Energy technical efficiency improvement[(a)]	Supply efficiency improvement[(b)]
AUS	-0.5	-0.7
NSW	-0.5	-0.9
VIC	-0.4	-0.5
QLD	-0.5	-0.8
SA	-0.5	-0.3
WA	-0.5	-0.3
TAS	-0.4	0.0
NT	-0.5	-0.1
ACT	-0.4	0.0

(a) We define energy technical efficiency as a weighted average of the use of primary and derived fuels per unit of output in all industries using those fuels other than electricity. Thus a value of –0.5 per cent per annum implies that industries other than electricity use annually 0.5 per cent less fuels (primary and derived) per unit of output.

(b) We define supply efficiency as a weighted average of the use of primary fuels per unit of electricity generation. Thus a value of –0.6 per cent per annum implies that electricity generating industries use annually 0.6 per cent less primary fuels per unit of output.

Table 6.8: Baseline (with measures): National emissions from the stationary energy sector, calibrated to the 2000 NGGI

Category	Units	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	20010
Electricity	Mt CO2-e	175.07	178.25	178.71	179.16	179.98	180.48	181.71	183.39	184.10	184.74	185.29
Non elect and heat sub total	Mt CO2-e	88.78	92.03	93.81	94.19	95.86	98.80	101.24	104.44	106.66	108.83	111.13
Gas	Mt CO2-e	34.85	35.97	37.25	37.90	38.86	40.23	41.78	43.71	44.96	46.21	47.53
Coal	Mt CO2-e	23.35	24.25	24.30	23.89	24.16	25.04	25.39	25.95	26.41	26.83	27.29
Liquid fuels	Mt CO2-e	29.18	30.41	30.86	31.01	31.44	32.14	32.68	33.38	33.89	34.39	34.91
Biomass	Mt CO2-e	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40

		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Electricity	Mt CO2-e	187.33	188.49	189.99	191.45	192.97	194.37	195.81	197.11	198.47	199.65
Non elect and heat sub total	Mt CO2-e	113.46	115.88	118.35	120.89	123.50	126.20	128.97	131.83	134.76	137.80
Gas	Mt CO2-e	48.88	50.27	51.70	53.18	54.70	56.26	57.88	59.54	61.26	63.03
Coal	Mt CO2-e	27.74	28.22	28.69	29.18	29.68	30.20	30.72	31.27	31.82	32.39
Liquid fuels	Mt CO2-e	35.44	35.99	36.55	37.13	37.72	38.34	38.97	39.62	40.29	40.98
Biomass	Mt CO2-e	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40

Table 7.1 High emission scenario: macroeconomic indicators (average annual growth rates, 1999-2020)

Variable	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Real private consumption	3.8	3.8	4.7	3.2	4.7	2.6	5.3	3.5	4.0
Real investment	4.0	2.9	5.2	3.0	5.7	3.1	6.7	3.5	4.0
Real public consumption	3.7	3.3	4.6	2.9	5.0	2.5	5.5	3.5	3.8
International export volumes	6.8	8.5	6.5	6.6	7.1	6.0	7.4	8.2	7.1
International import volumes	6.2	6.8	6.8	4.4	7.7	4.1	9.3	8.9	6.6
Real GDP/GSP	3.9	3.8	4.5	3.2	4.7	2.8	4.9	3.2	4.0
Aggregate employment	1.2	1.2	2.0	0.9	1.9	0.6	1.8	1.4	1.4
Aggregate capital stock	4.9	4.6	5.0	4.1	5.8	2.9	8.5	4.5	4.9
CPI	2.1	2.1	2.5	2.6	1.8	2.5	2.4	2.1	2.2
Population	1.2	1.2	2.0	0.9	1.9	0.6	1.8	1.4	1.4

Table 7. 2 High emission scenario: output by industry (average annual growth rates, 1999-2020)

Industry	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Agriculture	3.3	3.8	3.9	2.8	4.6	4.4	2.8	4.6	3.7
Forestry	3.9	3.9	4.1	3.2	4.6	3.9	0.0	3.6	4.0
Iron ore	0.0	0.0	0.0	-1.1	4.0	2.5	0.0	0.0	4.0
Non-iron ore	-0.9	0.7	0.9	-0.5	4.9	-1.2	2.9	1.1	3.3
Black coal	3.5	0.0	4.5	-1.2	3.2	1.1	0.0	0.0	4.0
Crude oil	0.0	-0.5	0.0	0.0	1.5	0.0	1.5	0.0	0.0
Natural gas	0.0	3.4	4.9	5.8	2.9	0.0	3.7	0.0	3.3
Brown coal	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	1.9
Food, beverages and tobacco	4.3	5.0	5.7	4.3	5.9	4.1	4.3	4.6	5.0
Textiles, clothing and footwear	3.5	4.7	3.2	2.7	6.9	2.2	-0.1	3.3	4.2
Wood and paper products	3.2	3.6	2.7	2.4	4.5	3.1	1.9	3.8	3.3
Chemical products excl. Petrol	5.0	5.4	5.1	4.8	7.6	4.9	4.9	6.9	5.3
Petroleum products	1.9	2.2	2.6	2.8	3.0	0.0	0.0	0.0	2.2
Building prods (not cement & metal)	3.4	2.8	4.3	2.7	4.6	2.0	3.9	1.5	3.5
Cement	1.2	1.2	2.3	1.4	2.1	0.2	1.2	0.7	1.5
Iron and steel	5.1	5.8	4.9	5.6	5.3	5.9	8.1	7.2	5.3
Alumina and aluminium	3.8	4.7	6.7	0.0	6.0	3.3	4.9	0.0	5.5
Other metal products	5.1	5.8	5.3	4.7	8.2	2.9	2.8	3.9	5.8
Motor vehicles and parts	2.5	3.5	3.4	3.1	4.7	0.0	0.0	0.0	3.3
Other manufacturing	6.1	5.4	5.7	5.5	6.4	5.1	4.0	5.6	5.8
Electricity – black coal	2.9	0.0	3.6	-1.6	4.2	0.0	0.0	0.0	3.1
Electricity – brown coal	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0
Electricity – gas	5.5	3.1	5.9	4.2	4.9	0.0	4.6	0.0	4.8
Electricity – oil prods.	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.2
Electricity – other	4.1	3.7	7.0	0.0	6.3	2.4	0.0	0.0	3.6
Electricity supply	3.1	3.0	3.7	2.5	3.8	1.8	3.7	2.6	3.2
Urban gas distribution	4.2	4.2	5.2	3.6	5.3	3.1	4.9	3.8	4.3
Water and sewerage services	4.0	3.8	4.3	3.2	4.6	2.5	4.7	3.1	3.9
Construction services	4.0	2.9	5.3	3.1	5.1	3.1	6.4	3.6	4.1
Wholesale trade, retail trade, accommodation	2.8	3.0	3.6	2.2	3.8	2.2	4.6	2.4	3.1
Road transport services – passenger	3.0	3.0	3.3	2.9	3.8	2.2	3.7	2.9	3.1
Road transport services – freight	4.6	4.8	5.3	4.2	5.9	4.2	5.4	4.1	4.9
Rail transport services – passenger	2.6	2.6	2.9	2.6	0.0	0.0	0.0	0.0	2.7
Rail transport services – freight	3.7	3.6	4.4	3.1	3.8	3.5	2.5	3.0	3.9
Water transport services – passenger	2.6	3.9	3.5	2.5	5.0	1.6	4.8	5.1	2.9
Water transport services – freight	1.2	1.6	1.7	1.4	2.2	1.0	1.9	1.7	1.7
Air transport services – passenger	5.6	7.5	7.8	6.2	8.1	6.7	8.6	6.6	6.8
Air transport services – freight	3.6	3.5	3.9	2.7	4.2	2.1	5.0	3.7	3.6

Table 7.2 (continued) High emission scenario: output by industry (average annual growth rates, 1999-2020)

Industry	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Other transport services	4.3	4.8	5.2	4.0	5.7	3.8	5.8	4.5	4.7
Communication services	8.8	9.0	9.0	8.3	9.4	7.8	9.4	9.2	8.9
Financial and business services	6.7	6.6	7.2	6.3	7.2	5.6	7.4	5.7	6.8
Dwelling ownership	5.2	4.8	4.9	3.9	6.0	3.1	6.1	3.9	5.0
Public services	3.7	3.5	4.6	3.0	4.8	2.5	5.4	3.7	3.8
Other services	4.8	4.9	5.6	4.8	5.1	4.4	5.5	4.6	5.0
Private motor vehicle ownership	2.3	2.4	3.8	1.5	3.2	1.2	4.7	2.4	2.7

End of Table 7.2

Table 7.3 High emission scenario: $C0_2$-e Emissions by Major Source Category

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Average annual growth rates (1999-2020)									
Energy sector, total	2.0	2.2	2.8	1.2	3.4	1.6	3.0	1.8	2.3
Fuel combustion	2.0	2.3	2.7	1.1	3.5	1.6	3.4	1.8	2.3
Electricity	1.4	1.9	2.1	-1.4	2.9	0.0	3.9	0.0	1.7
Transport	2.0	2.3	2.9	1.5	3.1	1.2	4.0	1.4	2.3
Other industries	2.7	3.2	3.4	2.6	4.5	1.9	2.3	2.4	3.2
Household consumption	2.8	2.6	4.4	2.9	3.5	2.0	5.7	2.7	3.1
Fugitive emissions from fuels	3.4	1.0	4.3	4.4	2.3	1.0	1.5	0.0	2.5
Industrial processes	2.4	3.2	4.5	1.3	4.5	0.5	2.5	1.9	3.3
Agriculture	3.0	3.5	3.5	2.5	4.2	4.1	2.4	4.2	3.4
Waste	2.5	2.6	3.3	2.5	2.9	2.1	3.2	2.4	2.7
LUCF	3.5	3.6	3.7	2.9	4.2	3.5	0.0	3.3	3.6
Total	2.2	2.3	3.0	1.6	3.6	0.0	2.8	1.9	2.5

Table 7.3 (continued) High emission scenario: $C0_2$-e Emissions by Major Source Category

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Levels(Mt CO2-e) (1999)									
Energy sector, total	113.9	124.1	64.0	17.0	36.8	3.4	2.3	2.1	363.6
Fuel combustion	108.4	110.3	57.7	16.6	33.1	3.4	1.8	2.1	333.5
Electricity	49.1	63.6	29.1	6.1	14.0	0.0	0.1	0.0	162.1
Transport	28.4	19.4	13.4	4.9	7.4	1.4	0.9	1.3	77.2
Other industries	29.7	26.2	14.7	5.3	11.5	1.9	0.7	0.7	90.8
Household consumption	1.1	1.1	0.5	0.2	0.2	0.1	0.0	0.1	3.4
Fugitive emissions from fuels	5.5	13.8	6.3	0.3	3.7	0.0	0.6	0.0	30.1
Industrial processes	2.2	1.4	2.0	1.1	2.3	0.7	0.8	0.0	10.4
Agriculture	29.9	18.1	21.6	8.0	13.2	3.2	1.2	0.1	95.2
Waste	5.5	4.8	2.3	1.3	1.2	0.3	0.2	0.6	16.3
LUCF	-5.2	-5.3	-4.1	-2.4	-2.5	-6.7	0.0	-0.3	-26.5
Total	146.2	143.0	85.9	25.1	51.0	0.9	4.5	2.5	459.0
Levels (Mt CO2-e) (2020)									
Energy sector, total	177.2	199.9	118.7	21.9	77.1	4.9	4.5	3.2	605.9
Fuel combustion	165.9	182.6	102.9	21.1	71.0	4.8	3.6	3.2	553.7
Electricity	66.1	95.8	45.7	4.5	26.0	0.0	0.2	0.0	236.9
Transport	44.0	32.3	25.3	6.9	14.3	1.9	2.1	1.8	128.5
Other industries	53.8	52.5	30.6	9.3	30.2	2.8	1.2	1.3	181.7
Household consumption	2.0	2.0	1.3	0.5	0.5	0.1	0.1	0.1	6.6
Fugitive emissions from fuels	11.3	17.3	15.9	0.8	6.1	0.0	0.8	0.0	52.2
Industrial processes	3.6	2.7	5.4	1.5	5.9	0.8	1.3	0.0	21.3
Agriculture	57.4	38.6	46.4	13.9	32.7	7.6	2.0	0.2	198.9
Waste	9.6	8.4	4.7	2.3	2.3	0.4	0.4	1.0	29.1
LUCF	-11.1	-11.5	-9.0	-4.4	-6.0	-14.3	0.0	-0.6	-57.0
Total	236.8	238.0	166.3	35.3	111.9	-0.6	8.2	3.8	798.2

End of Table 7.3

Table 7.4 High emission scenario: $C0_2$-e Emissions from the Stationary Energy Sector

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Average annual growth rates (1999-2020)									
Total emissions for stationary energy	1.9	2.3	2.6	0.9	3.7	3.4	2.7	2.4	2.3
Electricity	1.4	1.9	2.1	-1.4	2.9	0.0	3.9	0.0	1.7
Gas	3.8	3.8	4.5	3.2	4.9	0.0	3.3	3.1	3.9
Coal	2.2	2.6	2.9	1.9	4.2	1.4	1.2	1.1	2.7
Liquid fuels	2.1	2.4	2.8	2.0	4.2	2.0	2.3	1.8	2.7
Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Levels (Mt CO2-e) (1999)									
Total emissions for stationary energy	80.0	90.9	44.3	11.7	25.8	1.4	0.8	0.8	256.3
Electricity	49.1	63.6	29.1	6.1	14.0	0.0	0.1	0.0	162.1
Gas	9.5	14.0	4.9	2.5	4.1	0.0	0.3	0.4	36.2
Coal	12.2	7.3	5.4	1.7	3.8	0.7	0.2	0.2	31.5
Liquid fuels	9.2	6.1	4.9	1.4	3.8	0.7	0.2	0.2	26.5
Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Levels (Mt CO2-e) (2020)									
Total emissions for stationary energy	121.9	150.3	77.6	14.3	56.8	3.0	1.5	1.4	425.2
Electricity	66.1	95.8	45.7	4.5	26.0	0.0	0.2	0.0	236.9
Gas	21.4	31.5	12.8	5.1	11.6	0.9	0.6	0.8	84.7
Coal	19.8	12.9	10.1	2.6	9.5	0.9	0.3	0.2	56.3
Liquid fuels	14.6	10.2	9.0	2.1	9.6	1.1	0.4	0.3	47.3
Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 7.5 High emission scenario: Primary Energy Consumption for Electricity Generation, by Fuel and State

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Average annual growth rates (1999-2020)									
Brown coal	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	1.9
Black coal	1.1	0.0	1.8	-3.2	2.4	0.0	0.0	0.0	1.4
Gas	5.4	2.9	5.7	3.0	4.3	0.0	4.2	0.0	4.3
Liquid fuel	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0
Biomass	17.5	9.6	10.8	0.0	6.2	2.3	0.0	0.0	12.1
Other renewable/ hydro	0.5	0.5	0.5	0.0	0.5	2.3	0.0	0.0	1.4
Total fuel used for electricity generation	1.5	1.9	2.1	0.2	3.2	2.3	3.4	0.0	1.9
Levels (PJ) (1999)									
Brown coal	0.0	638.6	0.0	0.0	0.0	0.0	0.0	0.0	638.6
Black coal	518.6	0.0	344.8	44.7	76.3	0.0	0.0	0.0	984.4
Gas	16.0	6.2	12.7	29.0	47.8	0.0	4.2	0.0	116.0
Liquid fuel	0.4	1.2	1.2	0.4	2.2	0.0	1.8	0.0	6.1
Biomass	0.9	0.9	1.6	0.2	0.9	0.1	0.0	0.0	4.6
Other renewable/ hydro	23.8	4.5	2.7	0.0	0.0	27.6	0.0	0.0	58.7
Total fuel used for electricity generation	559.8	651.4	363.0	74.3	127.3	27.7	6.0	0.0	1808.4
Levels (PJ) (2020)									
Brown coal	0.0	960.0	0.0	0.0	0.0	0.0	0.0	0.0	960.0
Black coal	666.4	0.0	507.9	21.9	129.6	0.0	0.0	0.0	1325.8
Gas	50.9	11.6	42.7	55.2	119.6	0.0	10.5	0.0	290.5
Liquid fuel	0.4	1.2	1.2	0.4	2.2	0.0	2.1	0.0	6.0
Biomass	31.4	6.8	15.2	0.2	3.4	0.2	0.0	0.0	57.1
Other renewable/ hydro	26.5	5.0	3.0	0.0	0.0	45.4	0.0	0.0	79.9
Total fuel used for electricity generation	775.5	984.6	570.1	77.7	254.9	45.5	12.5	0.0	2719.4

Table 7.6 High emission scenario: Share of Generated Electricity by Fuel Type

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Levels(%) (1999)									
Brown coal	0.0	95.6	0.0	0.0	0.0	0.0	0.0	0.0	24.6
Black coal	87.9	0.0	87.5	49.0	47.7	0.0	0.0	0.0	54.9
Gas	2.6	1.5	7.9	49.8	45.3	0.0	83.0	0.0	10.7
Liquid fuel	0.2	0.0	1.3	0.6	5.7	0.0	17.0	0.0	1.1
Biomass	0.3	0.5	1.2	0.6	1.2	0.4	0.0	0.0	0.6
Other renewable/ hydro	9.0	2.4	2.1	0.0	0.1	99.6	0.0	0.0	8.1
Levels (%) (2020)									
Brown coal	0.0	95.1	0.0	0.0	0.0	0.0	0.0	0.0	23.1
Black coal	84.1	0.0	81.3	22.6	45.9	0.0	0.0	0.0	52.2
Gas	4.3	1.5	12.0	76.6	49.8	0.0	91.2	0.0	14.7
Liquid fuel	0.1	0.0	0.6	0.4	2.3	0.0	8.8	0.0	0.6
Biomass	6.2	1.9	5.2	0.4	1.9	0.4	0.0	0.0	3.9
Other renewable/ hydro	5.2	1.4	1.0	0.0	0.0	99.6	0.0	0.0	5.5

Table 7.7 High emission scenario: Efficiencies
(Average annual percentage growth rates 1999-2020)

States	Energy technical efficiency improvement[(a)]	Supply efficiency improvement[(b)]
AUS	-0.6	-0.5
NSW	-0.6	-0.8
VIC	-0.6	-0.3
QLD	-0.6	-0.6
SA	-0.6	-0.1
WA	-0.6	-0.1
TAS	-0.6	0.0
NT	-0.7	0.0
ACT	-0.5	0.0

(a) We define energy technical efficiency as a weighted average of the use of primary and derived fuels per unit of output in all industries using those fuels other than electricity. Thus a value of –0.5 per cent per annum implies that industries other than electricity use annually 0.5 per cent less fuels (primary and derived) per unit of output.

(b) We define supply efficiency as a weighted average of the use of primary fuels per unit of electricity generation. Thus a value of –0.6 per cent per annum implies that electricity generating industries use annually 0.6 per cent less primary fuels per unit of output.

Table 7.8: High Emissions Scenario: National emissions from the stationary energy sector, calibrated to the 2000 NGGI

Category	Units	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	20010
Electricity	Mt CO2-e	175.07	181.00	183.92	187.11	190.33	193.31	196.90	201.45	200.52	204.18	206.63
Non elect and heat sub total	Mt CO2-e	88.78	93.00	95.82	97.37	100.16	104.18	107.90	112.55	113.09	116.68	120.45
Gas	Mt CO2-e	34.85	36.35	38.06	39.17	40.61	42.47	44.57	47.15	47.75	49.62	51.59
Coal	Mt CO2-e	23.35	24.54	24.88	24.79	25.37	26.52	27.21	28.15	28.11	28.90	29.74
Liquid fuels	Mt CO2-e	29.18	30.71	31.48	32.00	32.78	33.79	34.72	35.84	35.83	36.76	37.72
Biomass	Mt CO2-e	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40

		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Electricity	Mt CO2-e	210.41	213.96	217.89	221.76	225.80	229.81	233.98	238.10	242.39	246.63
Non elect and heat sub total	Mt CO2-e	124.35	128.41	132.60	136.95	141.48	146.19	151.08	156.17	161.46	167.00
Gas	Mt CO2-e	53.65	55.80	58.03	60.36	62.78	65.32	67.96	70.71	73.59	76.60
Coal	Mt CO2-e	30.60	31.49	32.39	33.33	34.30	35.30	36.34	37.41	38.53	39.69
Liquid fuels	Mt CO2-e	38.70	39.72	40.77	41.86	42.99	44.17	45.38	46.64	47.95	49.32
Biomass	Mt CO2-e	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40

Table 8.1 Low emission scenario: macroeconomic indicators (average annual growth rates, 1999-2020)

Variable	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Real private consumption	2.0	2.0	2.7	1.1	2.9	0.5	3.8	1.7	2.2
Real investment	2.4	1.4	3.6	0.8	4.0	1.1	5.6	2.3	2.6
Real public consumption	1.9	1.6	2.7	0.8	3.6	0.5	3.9	1.7	2.0
International export volumes	4.1	6.0	3.7	3.6	5.1	3.1	5.3	6.0	4.6
International import volumes	4.4	5.1	5.0	2.3	6.5	2.1	7.9	7.3	4.9
Real GDP/GSP	2.0	2.0	2.4	0.9	3.3	0.6	3.3	1.5	2.1
Aggregate employment	1.0	1.1	1.7	0.3	2.2	0.1	1.9	1.2	1.2
Aggregate capital stock	4.1	3.8	4.1	3.0	5.3	1.8	8.0	3.9	4.1
CPI	2.1	2.1	2.5	2.7	1.7	2.5	2.4	2.1	2.2
Population	1.0	1.1	1.7	0.3	2.2	0.1	1.9	1.2	1.2

Table 8.2 Low emission scenario: output by industry (average annual growth rates, 1999-2020)

Industry	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Agriculture	1.3	2.0	2.0	0.6	2.8	2.3	0.9	2.7	1.8
Forestry	2.0	2.3	2.3	1.2	3.1	1.8	0.0	2.1	2.2
Iron ore	0.0	0.0	0.0	-3.4	1.5	-0.1	0.0	0.0	1.4
Non-iron ore	-2.9	-1.4	-1.5	-2.9	2.3	-3.4	0.3	-0.7	0.8
Black coal	0.7	0.0	1.5	-3.4	1.1	-1.5	0.0	0.0	1.0
Crude oil	0.0	-0.5	0.0	0.0	1.5	0.0	1.5	0.0	0.0
Natural gas	0.0	1.1	2.2	2.1	5.4	0.0	1.7	0.0	3.6
Brown coal	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Food, beverages and tobacco	2.3	3.2	3.4	2.0	4.2	1.9	3.3	3.1	3.0
Textiles, clothing and footwear	1.0	2.5	0.9	-0.1	4.6	-0.6	-0.6	1.9	1.8
Wood and paper products	1.0	1.5	0.8	-0.3	2.7	0.6	-0.1	2.3	1.2
Chemical products excl. Petrol	2.4	3.0	2.8	1.9	5.5	1.9	4.1	4.8	2.9
Petroleum products	-0.4	0.1	0.3	-0.1	1.0	0.0	0.0	0.0	0.0
Building prods (not cement & metal)	1.4	0.9	2.3	0.1	3.2	-0.3	2.5	0.2	1.6
Cement	-0.7	-0.7	0.4	-1.0	0.9	-1.8	-0.4	-0.5	-0.3
Iron and steel	2.7	3.4	2.5	2.7	3.5	3.1	8.5	4.9	2.9
Alumina and aluminium	0.9	1.8	3.9	0.0	3.7	-0.1	2.0	0.0	2.8
Other metal products	2.7	3.6	3.0	2.0	6.1	0.6	1.3	2.6	3.5
Motor vehicles and parts	0.6	1.5	1.5	0.2	3.3	0.0	0.0	0.0	1.1
Other manufacturing	3.6	3.2	3.4	2.8	4.6	2.4	2.7	3.6	3.5
Electricity – black coal	1.1	0.0	1.6	-3.0	2.1	0.0	0.0	0.0	1.2
Electricity – brown coal	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	1.3
Electricity – gas	0.3	0.0	2.8	1.8	3.4	0.0	2.5	0.0	2.7
Electricity – oil prods.	0.0	0.0	0.0	0.0	0.0	0.0	-0.9	0.0	-0.1
Electricity – other	2.2	2.6	5.1	0.0	4.4	0.4	0.0	0.0	1.8
Electricity supply	1.2	1.3	1.6	0.3	2.2	-0.2	1.9	0.8	1.3
Urban gas distribution	1.8	2.1	2.8	1.0	3.7	0.5	2.9	1.8	2.0
Water and sewerage services	1.9	1.8	2.1	0.9	2.9	0.2	2.9	1.2	1.9
Construction services	2.3	1.2	3.5	0.8	4.3	0.9	5.2	2.3	2.5
Wholesale trade, retail trade, accommodation	0.9	1.2	1.6	0.0	2.3	-0.1	2.9	0.8	1.2
Road transport services – passenger	1.3	1.3	1.5	1.1	2.2	0.4	1.9	1.2	1.4
Road transport services – freight	2.6	3.0	3.2	1.8	4.5	1.9	4.0	2.7	3.0
Rail transport services – passenger	1.6	1.6	1.9	1.7	0.0	0.0	0.0	0.0	1.7
Rail transport services – freight	1.2	1.8	1.7	0.7	3.3	1.1	1.6	1.3	1.7
Water transport services – passenger	0.0	1.5	0.6	0.2	3.3	-1.0	1.7	3.0	0.3
Water transport services – freight	-1.1	-0.4	-0.7	-1.1	0.0	-1.6	0.0	0.2	-0.6
Air transport services – passenger	2.6	4.5	4.7	2.4	5.4	3.0	5.5	4.0	3.8
Air transport services – freight	1.7	1.7	2.0	0.4	3.0	0.0	3.6	2.1	1.8

Table 8.2 (continued) Low emission scenario: output by industry (average annual growth rates, 1999-2020)

Industry	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Other transport services	1.9	2.5	2.7	1.6	3.9	1.3	3.5	2.3	2.4
Communication services	6.7	7.0	6.9	6.0	7.7	5.6	7.6	7.3	6.9
Financial and business services	4.6	4.6	5.0	3.8	5.6	3.2	5.7	3.9	4.7
Dwelling ownership	3.0	2.7	2.6	1.6	4.2	0.9	4.2	1.8	2.8
Public services	1.8	1.7	2.6	0.8	3.3	0.4	3.9	1.8	2.0
Other services	2.7	2.8	3.4	2.5	3.4	2.1	3.6	2.6	2.9
Private motor vehicle ownership	0.5	0.6	1.8	-0.6	1.8	-0.9	2.8	0.6	0.8

End of Table 8.2

Table 8.3 Low emission scenario: $C0_2$-e Emissions by Major Source Category

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Average annual growth rates (1999-2020)									
Energy sector, total	-0.1	0.4	0.6	-1.2	2.0	-0.8	1.4	0.0	0.4
Fuel combustion	-0.1	0.4	0.5	-1.2	1.8	-0.8	1.3	0.0	0.3
Electricity	-0.5	0.2	0.1	-3.1	1.0	0.0	1.8	0.0	-0.1
Transport	0.0	0.4	0.7	-0.7	1.4	-1.1	1.8	-0.3	0.3
Other industries	0.4	1.0	1.0	-0.1	2.8	-0.6	0.5	0.5	1.0
Household consumption	0.5	0.4	1.8	-0.1	2.3	-1.0	3.4	-0.1	0.8
Fugitive emissions from fuels	0.7	0.0	1.4	1.0	3.8	-1.5	1.4	0.0	1.1
Industrial processes	0.2	1.0	2.3	-0.9	2.6	-1.5	0.5	0.6	1.2
Agriculture	1.2	1.9	1.8	0.5	2.6	2.2	0.8	2.6	1.7
Waste	0.6	0.7	1.3	0.4	1.3	0.0	1.5	0.5	0.8
LUCF	1.8	2.1	2.1	1.1	2.9	1.6	0.0	2.0	1.9
Total	0.2	0.6	0.9	-0.7	2.2	0.0	1.1	0.0	0.6

Table 8.3 (continued) Low emission scenario: $C0_2$-e Emissions by Major Source Category

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Levels(Mt CO2-e) (1999)									
Energy sector, total	113.9	124.1	64.0	17.0	36.8	3.4	2.3	2.1	363.6
Fuel combustion	108.4	110.3	57.7	16.6	33.1	3.4	1.8	2.1	333.5
Electricity	49.1	63.6	29.1	6.1	14.0	0.0	0.1	0.0	162.1
Transport	28.4	19.4	13.4	4.9	7.4	1.4	0.9	1.3	77.2
Other industries	29.7	26.2	14.7	5.3	11.5	1.9	0.7	0.7	90.8
Household consumption	1.1	1.1	0.5	0.2	0.2	0.1	0.0	0.1	3.4
Fugitive emissions from fuels	5.5	13.8	6.3	0.3	3.7	0.0	0.6	0.0	30.1
Industrial processes	2.2	1.4	2.0	1.1	2.3	0.7	0.8	0.0	10.4
Agriculture	29.9	18.1	21.6	8.0	13.2	3.2	1.2	0.1	95.2
Waste	5.5	4.8	2.3	1.3	1.2	0.3	0.2	0.6	16.3
LUCF	-5.2	-5.3	-4.1	-2.4	-2.5	-6.7	0.0	-0.3	-26.5
Total	146.2	143.0	85.9	25.1	51.0	0.9	4.5	2.5	459.0
Levels (Mt CO2-e) (2020)									
Energy sector, total	112.0	135.4	73.3	13.1	57.2	2.9	3.1	2.1	397.6
Fuel combustion	105.6	121.7	64.7	12.7	48.9	2.9	2.4	2.1	359.4
Electricity	44.1	67.0	29.9	3.0	17.5	0.0	0.2	0.0	160.2
Transport	28.1	21.0	15.8	4.2	10.0	1.1	1.4	1.3	82.9
Other industries	32.1	32.3	18.3	5.3	21.0	1.7	0.8	0.8	112.3
Household consumption	1.2	1.2	0.7	0.2	0.4	0.1	0.0	0.0	4.0
Fugitive emissions from fuels	6.4	13.7	8.6	0.4	8.3	0.0	0.8	0.0	38.2
Industrial processes	2.3	1.7	3.3	0.9	4.0	0.5	0.9	0.0	13.6
Agriculture	39.1	27.2	32.2	9.1	23.3	5.1	1.4	0.2	137.5
Waste	6.3	5.6	3.1	1.5	1.6	0.3	0.3	0.7	19.3
LUCF	-7.7	-8.4	-6.3	-3.0	-4.6	-9.5	0.0	-0.4	-40.0
Total	152.0	161.4	105.5	21.6	81.5	-0.7	5.7	2.5	528.0

End of Table 8.3

Table 8.4 Low emission scenario: $C0_2$-e Emissions from the Stationary Energy Sector

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Average annual growth rates (1999-2020)									
Total emissions for stationary energy	-0.1	0.5	0.5	-1.4	1.9	0.8	0.8	0.4	0.3
Electricity	-0.5	0.2	0.1	-3.1	1.0	0.0	1.8	0.0	-0.1
Gas	1.3	1.4	2.0	0.5	3.7	0.0	1.5	1.0	1.7
Coal	-0.2	0.4	0.5	-0.8	2.1	-1.2	-0.7	-0.7	0.3
Liquid fuels	-0.1	0.3	0.6	-0.4	2.2	-0.3	0.4	0.0	0.5
Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Levels (Mt CO2-e) (1999)									
Total emissions for stationary energy	80.0	90.9	44.3	11.7	25.8	1.4	0.8	0.8	256.3
Electricity	49.1	63.6	29.1	6.1	14.0	0.0	0.1	0.0	162.1
Gas	9.5	14.0	4.9	2.5	4.1	0.0	0.3	0.4	36.2
Coal	12.2	7.3	5.4	1.7	3.8	0.7	0.2	0.2	31.5
Liquid fuels	9.2	6.1	4.9	1.4	3.8	0.7	0.2	0.2	26.5
Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Levels (Mt CO2-e) (2020)									
Total emissions for stationary energy	77.5	100.6	48.9	8.5	38.9	1.7	1.0	0.9	276.6
Electricity	44.1	67.0	29.9	3.0	17.5	0.0	0.2	0.0	160.2
Gas	12.7	19.2	7.5	2.8	9.1	0.5	0.4	0.5	52.7
Coal	11.7	7.9	6.0	1.4	6.0	0.5	0.2	0.1	33.9
Liquid fuels	9.0	6.5	5.5	1.3	6.3	0.7	0.3	0.2	29.7
Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 8.5 Low emission scenario: Primary Energy Consumption for Electricity Generation, by Fuel and State

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Average annual growth rates (1999-2020)									
Brown coal	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Black coal	-0.5	0.0	-0.1	-4.6	0.4	0.0	0.0	0.0	-0.4
Gas	0.6	0.1	2.8	0.7	2.9	0.0	2.1	0.0	2.0
Liquid fuel	0.0	0.0	0.0	0.0	0.0	0.0	-1.1	0.0	-0.4
Biomass	13.0	7.5	8.5	0.0	4.4	0.4	0.0	0.0	8.9
Other renewable/ hydro	0.5	0.5	0.5	0.0	0.5	0.4	0.0	0.0	0.4
Total fuel used for electricity generation	-0.3	0.3	0.2	-1.8	1.5	0.4	1.3	0.0	0.1
Levels (PJ) (1999)									
Brown coal	0.0	638.6	0.0	0.0	0.0	0.0	0.0	0.0	638.6
Black coal	518.6	0.0	344.8	44.7	76.3	0.0	0.0	0.0	984.4
Gas	16.0	6.2	12.7	29.0	47.8	0.0	4.2	0.0	116.0
Liquid fuel	0.4	1.2	1.2	0.4	2.2	0.0	1.8	0.0	6.1
Biomass	0.9	0.9	1.6	0.2	0.9	0.1	0.0	0.0	4.6
Other renewable/ hydro	23.8	4.5	2.7	0.0	0.0	27.6	0.0	0.0	58.7
Total fuel used for electricity generation	559.8	651.4	363.0	74.3	127.3	27.7	6.0	0.0	1808.4
Levels (PJ) (2020)									
Brown coal	0.0	673.2	0.0	0.0	0.0	0.0	0.0	0.0	673.2
Black coal	461.7	0.0	338.6	16.1	83.6	0.0	0.0	0.0	900.0
Gas	18.4	6.3	23.2	33.4	89.6	0.0	6.7	0.0	177.6
Liquid fuel	0.4	1.2	1.2	0.4	2.2	0.0	1.4	0.0	5.6
Biomass	13.4	4.5	9.7	0.2	2.3	0.1	0.0	0.0	30.1
Other renewable/ hydro	26.5	5.0	3.0	0.0	0.0	30.2	0.0	0.0	64.8
Total fuel used for electricity generation	520.3	690.1	375.7	50.1	177.9	30.3	8.1	0.0	1851.2

Table 8.6 Low emission scenario: Share of Generated Electricity by Fuel Type

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Levels(%) (1999)									
Brown coal	0.0	95.6	0.0	0.0	0.0	0.0	0.0	0.0	24.6
Black coal	87.9	0.0	87.5	49.0	47.7	0.0	0.0	0.0	54.9
Gas	2.6	1.5	7.9	49.8	45.3	0.0	83.0	0.0	10.7
Liquid fuel	0.2	0.0	1.3	0.6	5.7	0.0	17.0	0.0	1.1
Biomass	0.3	0.5	1.2	0.6	1.2	0.4	0.0	0.0	0.6
Other renewable/ hydro	9.0	2.4	2.1	0.0	0.1	99.6	0.0	0.0	8.1
Levels (%) (2020)									
Brown coal	0.0	95.0	0.0	0.0	0.0	0.0	0.0	0.0	23.9
Black coal	85.9	0.0	82.7	25.5	42.5	0.0	0.0	0.0	52.1
Gas	2.2	1.2	9.8	73.3	52.3	0.0	90.8	0.0	13.5
Liquid fuel	0.2	0.0	0.9	0.6	3.3	0.0	9.2	0.0	0.8
Biomass	3.9	1.8	5.1	0.6	1.9	0.4	0.0	0.0	3.1
Other renewable/ hydro	7.8	2.0	1.6	0.0	0.0	99.6	0.0	0.0	6.6

Table 8.7 Low emission scenario: Efficiencies
(Average annual percentage growth rates 1999-2020)

States	Energy technical efficiency improvement[(a)]	Supply efficiency improvement[(b)]
AUS	-0.8	-0.5
NSW	-0.8	-0.8
VIC	-0.7	-0.3
QLD	-0.8	-0.6
SA	-0.8	-0.1
WA	-0.8	-0.2
TAS	-0.7	0.0
NT	-0.8	0.1
ACT	-0.7	0.0

(a) We define energy technical efficiency as a weighted average of the use of primary and derived fuels per unit of output in all industries using those fuels other than electricity. Thus a value of –0.5 per cent per annum implies that industries other than electricity use annually 0.5 per cent less fuels (primary and derived) per unit of output.

(b) We define supply efficiency as a weighted average of the use of primary fuels per unit of electricity generation. Thus a value of –0.6 per cent per annum implies that electricity generating industries use annually 0.6 per cent less primary fuels per unit of output.

Table 8.8: Low Emissions Scenario: National emissions from the stationary energy sector, calibrated to the 2000 NGGI

Category	Units	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Electricity	Mt CO2-e	175.07	177.58	176.95	176.41	176.01	175.50	175.35	175.83	175.11	174.78	173.75
Non elect and heat sub total	Mt CO2-e	88.78	90.73	91.11	90.06	90.41	92.10	93.09	94.72	95.48	96.20	96.97
Gas	Mt CO2-e	34.85	35.47	36.20	36.28	36.69	37.52	38.44	39.69	40.30	40.90	41.53
Coal	Mt CO2-e	23.35	23.88	23.53	22.72	22.63	23.19	23.17	23.33	23.42	23.47	23.55
Liquid fuels	Mt CO2-e	29.18	29.98	29.98	29.67	29.68	29.99	30.08	30.30	30.36	30.42	30.49
Biomass	Mt CO2-e	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40

		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Electricity	Mt CO2-e	173.33	172.84	172.57	172.22	171.93	171.57	171.27	170.88	170.57	170.11
Non elect and heat sub total	Mt CO2-e	97.77	98.62	99.49	100.40	101.35	102.34	103.37	104.45	105.56	106.72
Gas	Mt CO2-e	42.17	42.84	43.52	44.23	44.95	45.70	46.46	47.26	48.07	48.91
Coal	Mt CO2-e	23.63	23.72	23.81	23.90	24.01	24.12	24.24	24.37	24.50	24.64
Liquid fuels	Mt CO2-e	30.57	30.66	30.76	30.87	30.99	31.13	31.27	31.43	31.59	31.77
Biomass	Mt CO2-e	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40

Appendix A: Uncertainty

There are three broad sources of uncertainty affecting the projections reported in this paper. These relate to:

1. Model specification;
2. Initial data and settings for time-invariant parameters; and
3. Values for exogenous variables

A1 Uncertainty relating to model specification

Like all economic models, MMRF-Green is an imperfect representation of the real world. This imperfection leads to uncertainty, which varies directly with the degree of practical detail included in the model's specification.

In MMRF-Green, considerable effort has been made to incorporate the real world. This includes:

- a comprehensive coverage of regions, industries, final users, and international and inter-state trade;
- the use of nested production and utility functions with detailed representations of technical change and changes in consumer preferences;
- a detailed representation of regional labour markets, including regional wage differentials, unemployment rates and regional labour supply;
- different specifications of foreign demand for regional exports of primary products, manufactures, tourism, communications and transport services;
- the modelling of investment by industry with static and forward-looking expectations;
- a detailed treatment of indirect taxes, including the modelling of the GST;
- comprehensive accounting for all combustion and non-combustion emissions (see Section 2.3 of the main report);
- the modelling of inter-fuel substitution in electricity generation, in manufacturing (including metal smelting and refining), and in freight and passenger transport;
- allowance for a multi-product petroleum refining industry producing six separate refinery products; and
- the modelling of public sector budgets, the current account of the balance of payments and household disposable income.

Further details can be found in Adams (2002).

It is almost impossible to gauge quantitatively the contribution of model structure to the overall level of uncertainty associated with the projections in this report. We are confident, however, that our on-going effort to include as much practical detail as possible minimises this contribution, absolutely and relatively when compared to the contributions of specification in other model-based projections (see Pezzey and Lambie, 2001).

A2 Uncertainty relating to initial data and settings for time-invariant parameters

MMRF-Green's database for the base year 1998-99 comprises:

1. Core regional input/output data;
2. Physical data for greenhouse emissions and energy usage; and
3. Econometrically-estimated values for capital/labour substitution elasticities, for export demand elasticities, and for import substitution elasticities (the so-called Armington elasticities).

Elements of uncertainty are associated with each of these items.

Input/output data

In forecasting, it is essential that we have up-to-date input-output data. This is especially true for investment-related industries. For example, from projections for income and demographic variables, we might be confident that a state's housing capital stock would grow by three per cent per year over the next decade. However, unless our initial input-output data reflects the current-year's investment activity, we have little basis for projecting whether three per cent housing growth implies strong or weak growth in housing investment and hence in the demand for construction and related industries.

Unfortunately, the most recent input/output data from official sources are many years out of date. Indeed, on average over the past two decades, the latest official tables have been about five years out-of-date. To rectify this problem, we have adopted a simulation-based procedure for updating input/output data to the current year that was developed for the MONASH model (see Dixon and Rimmer, 2001). Relative to other input-output techniques, updating by historical simulation has three attractive features. First, rather than requiring and using particular data inputs (e.g., values of final demand and value added by commodity), historical simulations make use of whatever data are available on macro variables, on taxes, and on prices, quantities and values of factor inputs and commodity flows. Second, the assumptions underlying historical simulations are interpretable in simple economy terms. Thus they can be discussed, challenged and improved. Finally, historical simulations produce as by-product detailed and interpretable estimates of changes in household preferences and industry technologies (see Table 3 in the main body of the report). This by-product has become a central input to MMRF-Green's forecast simulations.

Using the MONASH methodology, we have built for MMRF-Green a 1999 input/output core that incorporates most of the known statistical information for that year. This has minimised the level of uncertainty in our projections arising from out-of-date input-output data.

Physical data for greenhouse gas emissions and energy usage

Our data requirements for emissions and energy usage are huge. Our greenhouse and energy database comprises two matrices (one for emissions, the other for energy). The dimensions of these matrices are:

- User (46 = 45 industries + residential), by
- Region of use (8 states and territories), by
- Energy source (12 = 4 primary fuels + 7 secondary fuels + "other" (non-combustion source of emissions), by
- Region of source (9 = 8 states and territories + foreign).

For the projections in this paper, the emissions and energy matrices are calibrated using information from the 1999 and 2000 (preliminary) NGGI and from ABARE (2001) "Australian Energy: Projections to 2019-20". *ABARE Research Report No. 0111.* From these sources we obtain national-level data for total emissions and energy usage by primary and secondary fuels. These are apportioned through each matrix using data from the core input/output file. For example, if the core data show that 50 per cent of black coal produced in Australia is produced in NSW for use in NSW electricity generation, then 50 per cent of total emissions from black coal (a NGGI control total) is allocated to the use of NSW produced coal in the NSW electricity industry.

This procedure preserves the national totals for fuels as given in the NGGI and by ABARE. However, it can lead to an allocation across users that is different from that given in the extraneous data. Thus, for example, our estimates for total emissions from stationary energy in 2000 are very close to the NGGI's estimates, but the distribution of that total between sub-sectors differs, as shown in Section 3.2.5.

There is little uncertainty associated with the NGGI and ABARE control totals. However, there is some associated with our apportioning technique. Essentially, it is based on the idea that for each fuel the ratio of emissions (Mt) or energy (PJ) to the dollar value of the underlying input/output flow is constant across all users and regions. To the extent that this is not true, the technique will lead to error and thus to uncertainty.

Time-invariant parameters

MMRF-Green's database contains a number of time-invariant parameters. These include capital/labour substitution elasticities; export demand elasticities, and import substitution elasticities (the so-called Armington elasticities). These parameters are important in many policy applications of the model. They are also importance in forecasting applications. Unfortunately, little convincing econometric work has been undertaken on these parameters in Australia since the 1980s. Accordingly, the values adopted for MMRF-Green represent a mix of relatively old econometric evidence adjusted, in the most part, by hand to reflect more recent evidence. For example, early evidence for export demand elasticities for Australia's traditional mining exports suggested values of around –20. Later work suggests that this is too high. In the current MMRF-Green data, we use values that average around –5.

Compared with the uncertainty arising from other areas of the database, the uncertainty from this element is quite high.

A3 Uncertainty relating to values for exogenous variables

As noted in Dixon and Rimmer (2001), the key to generating believable forecasts from a CGE model like MMRF-Green is to use in the model detailed information available from groups specialising in the analysis of different aspects of the economy. In this study (see Section 3.1 of the main report) we use:

1. State/territory macroeconomic forecasts from Access Economics;
2. National-level assumptions for changes in industry production technologies and in household preferences from CoPS; and
3. Forecasts for the quantities of agricultural and mineral exports, and estimates of capital expenditure on major minerals and energy projects from various sources, such as state government agencies, the Australian Bureau of Agricultural and Resource Economics (ABARE), and the National Electricity Market Management Company (NEMCO).

There is a degree of uncertainty associated with all these inputs. The following table is a guide to the degree of variability of the model's projections to changes in input values. It shows the sensitivity of the "with measures" projections of total emissions from the stationary energy sector to the following variations in assumptions:

1. An increase/a fall in GDP growth from 2005 onwards by 0.5 percentage points per annum;
2. An increase/a fall in population growth from 2005 onwards of 0.1 percentage points per annum;
3. An increase/a fall of 2 percentage points in the share of gas used in electricity generation in 2010; and
4. An increase/a fall in the rate of energy efficiency improvement of 0.3 percentage points per annum.

Table A: Sensitivity of Emissions from the Stationary Energy Sector to Changes in Values for Key Exogenous Variables

	Average annual growth in emissions from the stationary energy sector		
	1999 to 2010	2010 to 2020	1999 to 2020
1. Real GDP growth			
Unchanged	1.4	1.4	1.4
Increase of 0.5 percentage points from 2005	1.7	1.9	1.8
Decrease of 0.5 percentage points from 2005	1.1	0.9	1.0
2. Population growth			
Unchanged	1.4	1.4	1.4
Increase of 0.1 percentage points from 2005	1.4	1.5	1.5
Decrease of 0.1 percentage points from 2005	1.4	1.3	1.3
3. Gas share in electricity generation			
Unchanged	1.4	1.4	1.4
Increase of 2.0 percentage points in 2010	1.4	1.3	1.4
Decrease of 2.0 percentage points in 2010	1.4	1.5	1.4
4. Energy efficiency improvement			
Unchanged	1.4	1.4	1.4
Increased improvement of 0.3 percentage points	1.1	1.1	1.1
Reduced improvement of 0.3 percentage points	1.7	1.7	1.7

Table A shows that the elasticity of emissions from the stationary energy sector with respect to real GDP is close to one. In other words, if real GDP growth is increased by 0.5 percentage points per annum, then growth in emissions increases by roughly the same percentage amount. Note that in our sensitivity simulations we assume that the GDP increase occurs from 2005 onwards, thus the average growth rate in emissions between 1999 to 2020 is elevated by 0.4 percentage points, not 0.5 percentage points.

Table A shows that the elasticity of emissions growth with respect to population growth increases through time to reach a value equivalent to the elasticity with respect o GDP growth. This is consistent with the idea that, in the short-run, increased population leads to

higher unemployment rather than higher employment. However, in the long run increased population leads to increased employment, and hence to increased GDP and increased emissions.

The sensitivity of emissions to the share of gas in electricity generation is weak. This is because the increased share of gas-fired electricity reduces the share of clean electricity from renewable sources as well as the share of dirty electricity from coal. Thus, overall, there is relatively little change in emissions.

Table A shows that the elasticity of emissions with respect to energy efficiency is similar to the elasticity with respect to real GDP, but with opposite sign. Accordingly, if the annual rate of efficiency improvement increases by 0.3 percentage points, then growth in emissions from stationary energy falls by roughly 0.3 percentage points.

A4 Summary

Our analysis of uncertainty falls well short of a statistical text. Instead, it consists of a qualitative assessment, supported by some quantitative analysis in Section A3. Overall, our analysis suggests that the inherent uncertainty associated with model structure is being minimised, but that uncertainty associated with initial data may still be a problem. There will always be uncertainty associated with the values imposed on exogenous variables. However, the approach adopted with MMRF-Green of using values obtained from specialist groups minimises this source of uncertainty.

Appendix B: Future Projects

Table A: Committed Generation developments in National Electricity Market States for the years 1999 to 2003

States	project name	type of fuel	On-line date	Size
NSW	Redbank	Coal	2001	150MW
QLD	Callide Power Plant	Coal	2001	2x420MW
QLD	Milmerran	Coal	2002	2x431MW
QLD	Tarong North	Coal	2003	450MW
QLD	Swanbank E	Gas	2002	355MW
QLD	Oakey GT	Gas	2000	2x138MW
SA	Quarantine	Gas	2002	95MW
SA	Pelican Point	Gas	2001	487/450MW
SA	Ladbroke Grove	Gas	2000	43MW
VIC	Loy Yang	Gas	2002	6x50MW
VIC	Bairnsdale	Gas	2002	43MW
VIC	Somerton	Gas	2001	150MW
VIC	Bairnsdale	Gas	2001	43MW
WA	Kwinana (Tiwest)	Gas	1999	36MW
WA	Onslow	Gas	1999	6x0.6MW
WA	Windimurra	Gas	1999	4x3.2MW
WA	Leonora	Gas	2000	5x0.63MW
WA	Worsley	Gas	2000	120 MW/30MW
WA	Hill 60 (Mt Magnet)	Gas	2001	3MW
WA	Broome	Gas	2002	30MW
WA	Fitzroy Crossing	Gas	2002	3MW
WA	Halls Creek	Gas	2002	3MW
WA	Camballin/Looma	Gas	2002	0.75MW

Sources: NEMMCO, Statement of Opportunities and Addendums 1999, 2000, and 2001.
Office of Energy, 2001, *Energy 2001 Western Australia*, State of Western Australia.

Table B: Other projects for the years 1999 to 2005

Project	Company	Location	Status	Expected startup	New capacity	Capital expenditure
Tasmanian Gas Pipeline	Duke Energy	Longford, Vic to Tasmania	New project, under construction	mid-2002	40PJ pa	$440m
Darwin-Moonmba gas pipeline	Epic Energy	Darwin, NT to Moomba, SA	New project, under review	2004	Na	>$1b
PNG-Qld gas pipeline	Exxon/Mobile	PNG to Qld	New project, feasibility study underway	2006	300PJ pa	Around $2b (first stage)
Comalco alumina refinery project	Comalco	Gladstone, Qld	New project, committed	2005	1400 kt alumina	$1.5b
Stanwell magnesium project	Australian Magnesium Corporation	Stanwell, near Rockhampton, Qld	New project, committed	2004	97kt magnesium metal	$1.3b

Source: ABARE, 2001, *Australian Commodities*, no.4, vol.8.