ECONOMIC IMPACTS OF KYOTO-COMPLIANCE

Report by the Centre of Policy Studies to support a project undertaken by the Allen Consulting Group

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1. INTRODUCTION

This report deals with the economic effects of compliance with the Kyoto protocol. The analysis is undertaken using the MMRF-Green model.[1] We report deviations from an underlying basecase for the following eight scenarios.

Scenario	Description	Key Assumptions
1	Australia ratifies Kyoto and meets targets: Standard Land Clearing/Low Permit Price	• current domestic measures continue until 2012 • 'gap' met through international emissions trading between 2008–2012; global permit price is US$13.60 (p/t C) in 2010 • Australia's exports and imports impacted as per earlier ABARE work pro–rated for global permit price of US$13.60 (p/t C) • emissions from land clearing are 60Mt in 2010 and sinks reduce target by 21Mt in 2010
2	Australia ratifies Kyoto and meets targets: Reduced Land Clearing/Low Permit Price	• current domestic measures continue until 2012 • 'gap' met through international emissions trading from 2008–2012; global permit price is US$13.60 (p/t C) in 2010 • Australia's exports and imports impacted as per earlier ABARE work pro–rated for global permit price of US$13.60 (p/t C). • emissions from land clearing are 35Mt in 2010 and sinks reduce target by 21 Mt in 2010 • $200m from Commonwealth budget to rural sector in Queensland to compensate for reduced land clearing
3	Australia does not ratify Kyoto and meets targets: Standard Land Clearing/Low Permit Price	• current domestic measures continue until 2012 • 'gap' met via domestic emissions trading • Australia's exports and imports impacted as per earlier ABARE work pro–rated for global permit price of US$13.60 (p/t C). • emissions from land clearing are 60Mt in 2010 and sinks reduce target by 21Mt in 2010
4	Australia does not ratify Kyoto and meets targets: Reduced Land Clearing/Low Permit Price	• current domestic measures continue until 2012 • 'gap' met via domestic emissions trading • Australia's exports and imports impacted as per earlier ABARE work pro–rated for global permit price of US$13.60 (p/t C). • emissions from land clearing are 35Mt in 2010 and sinks reduce target by 21 Mt in 2010. • $200m from Commonwealth budget to rural sector in Queensland to compensate for reduced land clearing
5, 6, 7 and 8	As for 1, 2, 3 and 4, but with high permit price	• As for Scenarios 1, 2, 3 and 4, but global permit price is US$27(p/t C) in 2010.

For the international-trading scheme scenarios, we assume that:

[1] MMRF-Green is a dynamic, multi-regional, multi-sectoral model of the Australian economy. In its basic form, it produces projections for the annual time paths of variables describing: macroeconomic conditions for the national economy and for the economies of the six states and two territories; activity in region-specific industries; and greenhouse gas emissions disaggregated by region-specific source. Recently, a sub-state disaggregation facility has been added to the model. This allows state-level projections for employment, output and gas emitted to be disaggregated down to projections for sub-state regions.

1. domestic industries are free to buy permits from the international market or to sell permits there; and
2. the permit price is set on the international market and is unaffected by the sales or purchases of Australian industries.

In all scenarios, we assume that:

3. emission permits consistent with Australia's commitments if it were to ratify the Kyoto protocol are auctioned, and that the revenue is returned via a reduction in the GST.

The remainder of this report is organised as follows. MMRF-Green is described in Section 2. In making projections of the impacts of greenhouse strategies, we first produce a basecase, ie., a business-as-usual forecast for the development of the Australian economy and its regions between 2000 and 2012. Details of the basecase are given in Section 3. Next we produce revised forecasts, including shocks through time to represent the various scenarios being studied. The effects of these shocks are reported in Section 4 as deviations between the values of variables in the revised forecast and their values in the basecase.

2. THE MODEL

MMRF-Green is a multi-sector dynamic model of the Australian economy covering the six states and two territories. It models each region as an economy in its own right, with region-specific prices, region-specific consumers, region-specific industries, and so on. Since MMRF-Green is dynamic, it is able to produce sequences of annual solutions connected by dynamic relationships. The model also includes enhanced capabilities for environmental analysis.

As each state and territory is modelled as a mini-economy, MMRF-Green is ideally suited to determining the impact of region-specific economic shocks. It has already been used to address a wide range of issues, including the economic impacts of large export-oriented projects, the effects of global trading in greenhouse emission permits, and the effects of changes in state and federal tax rates.

Capability for environmental analysis

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 49 industries (see Table A) and eight regions recognised in the model;
2. equations that allow for inter-fuel substitution in electricity generation by region; and
3. a detailed treatment of renewable generation possibilities.

Emissions accounting

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

1. emitting agent (49 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 49 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 developed at the Australian Bureau of Agricultural and Resource Economics (ABARE). A variety of power-generating industries are distinguished based on the type of fuel used (see Table A). 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 different generation 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 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.

Renewable generation

Up to recent times, MMRF-Green had just one renewable generating industry in each state. The cost structure of this generic industry was modelled on the cost structure of the average hydro plant. Accordingly, sales of this industry were concentrated in the states in which hydro generation was present (TAS, VIC, NSW and to a small extent QLD).

Recently, we have incorporated a more detailed treatment of renewable technologies. Instead of one industry, we now have five separate industries each producing electricity from a specific renewable source. The five sources are hydro, biomass, biogas, solar and wind. In broad terms, the production technologies for biomass and biogas generation are more labour intensive than for solar and wind generation, and less intensive in the usage of machinery and equipment. The production technology for hydro generation is about halfway between each of these extremes.

The regional distribution of renewable generation is shown in the table below. Also shown, for sake of comparison, is the regional pattern of fossil-fuel generation.

[2] Each of these fuels is identified as a separate commodity within the model.

Electricity Generation by Fuel (PJ) in 1999*

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT
Electricity generated by:								
Black coal	233.8	0.0	113.7	17.0	34.4	0.0	0.0	0.0
Brown coal	0.0	178.8	0.0	0.0	0.0	0.0	0.0	0.0
Natural gas	7.0	2.8	10.3	17.3	32.7	0.0	7.7	0.0
Oil products	0.6	0.1	1.6	0.2	4.1	0.0	1.6	0.0
Hydro	24.2	3.3	1.4	0.0	0.0	29.8	0.0	0.0
Biomass	1.5	1.3	1.7	0.0	0.0	0.3	0.0	0.0
Biogas	0.6	0.7	0.0	0.0	0.0	0.0	0.0	0.0
Solar	0.6	0.1	0.1	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
Total	268.3	187.4	128.9	34.6	71.3	30.0	9.3	0.0

Source: MMRF-Green database for 1999.

3. 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 the user.

This section has two parts. In Section 3.1, we describe the key inputs to the Baseline projection. Model-generated forecasts are discussed in Section 3.2.

3.1 Assumptions Used in the Baseline

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;
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); and
4. Estimates of the impacts of current measures designed to reduce greenhouse gas emissions.

The energy-related measures included in the Baseline are as follows.

Supply-side

1. *QLD cleaner energy strategy*. This is modelled as autonomous annual shifts towards gas-fired electricity generation and away from coal-fired generation in QLD sufficient to increase the share of gas-fired generation in total generation in QLD to 13.1 per cent by 2010 and to keep it at that level through to 2012.
2. *Generator efficiency standards (GES)*. We assume that efforts in updating generators will result in a reduction in 2010 of 2 Mt of emissions from black coal generation, of 2 Mt from brown coal generation, and of 1 Mt from gas generation.

3. *Mandatory renewable energy targets (MRET) and extension to greenpower*. The MRET target obliges wholesale purchasers of electricity to proportionately contribute towards the generation of an additional 9.500 GWh of renewable energy per year by 2010. This translates to an additional 34.2 PJ of generated electricity. We implement the scheme via autonomous annual shifts towards renewable electricity generation and away from fossil-fuel generation, sufficient to hit the renewable target in 2010.
4. *Greenhouse gas abatement program (GGAP) and greenhouse friendly certification program*. This program provides support to activities that are likely to result in substantial emission reductions or substantial sink enhancement up to 2012. We assume that the GGAP will reduce emissions in line with estimates given in the GGAP spreadsheet provided by the AGO.
5. *NSW electricity retailer benchmark scheme*. Under the benchmarks, NSW electricity retailers are required to reduce per capita C02-e emissions to 7.27 tonnes by 2007. The scheme allows electricity retailers to comply with their benchmark obligations by: reducing the greenhouse intensity of electricity purchased from generators; improving the energy efficiency of their customers through the promotion of demand management; and offsetting emissions through the purchase of forest sequestration credits. We implement the scheme via a combination of autonomous annual shifts towards gas-fired and renewable electricity generation and away from coal generation, combined with allowance for increased demand management and increased forestry sequestration.

Demand-side

6. *Greenhouse challenge program (GCP).* This is described as a co-operative program between industry and government whereby companies undertake action to abate their greenhouse gas emissions through no regrets energy efficiency and other measures. It is modelled as a combination of improved (relative to baseline levels) generation efficiency and improved energy efficiency in industrial usage targeted to achieve an Australia-wide reduction in emissions of 5.8 Mt. This is the estimate of the measure's impact based on data provided by GCP participants and published in the Greenhouse Challenge, February 2002.
7. *Energy efficiency standards for residential and commercial buildings (PM 1997 statement).* The measure has a technical effect that increases the energy of residential and commercial buildings. The AGO estimates that the measure will reduce total emissions by 1.6 Mt in 2010. It is modelled as cost-neutral annual increases in the efficiency with which energy is used in buildings.
8. *Energy performance codes and standards for domestic appliances and commercial and industrial equipment (PM 1997 statement).* The measure increased the effectiveness of existing energy labelling by developing minimum energy performance standards for a broad range of new appliances and equipment. The AGO estimates that the measure will reduce total emissions by 6.1 Mt in 2010. The measure is modelled as a combination of cost-neutral annual shifts in industry technologies and consumer tastes against the usage of electricity and gas.
9. Energy efficiency best practice program (PM 1997 statement).This measure encourages industries to become more efficient in the use of energy via innovative investments and changes in technologies. The AGO estimates that the measure will reduce total emissions by 1.5 Mt in 2020. It is modelled via cost-neutral annual shifts in industry technologies against the usage of electricity and gas.

Macroeconomic Inputs (Table B)

Table B shows the assumptions for selected macroeconomic variables in terms of average annual growth rates over the period 1999 to 2012. These are discussed more fully in Section 3.2.

Assumptions for Changes in Technology and Tastes (Tables C and D)

Table C shows our assumptions for changes in the preferences of households and for changes in the production technologies of industries that are imposed in the absence of the measures described above.[3] 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 initial assumptions for household tastes are summarised in the first column of numbers in Table C. The second column of numbers 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. The assumptions in the second column for energy commodities are of special importance to this study. They show that 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.[4] 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 supply: 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.

Table D summarises our technical assumptions for the usage of fuels per unit of industrial output and for the usage of fuels per unit of electricity generation in terms of two commonly used measures of efficiency – energy technical efficiency and supply efficiency. We define energy technical efficiency as minus a weighted average of the use of primary and derived fuels per unit of output in all industries using those fuels other than the electricity generators. For Australia as a whole, we assume a value of 0.5 per cent per annum, implying that in each year industries other than electricity generators will use 0.5 per cent less fuel (primary and derived) per unit of output. We define supply efficiency as minus a weighted average of the use of primary fuels per unit of electricity generation. For Australia as a whole, we assume a value of 0.6 per cent per annum, implying that in each year electricity-generating industries will use 0.6 per cent less primary fuels per unit of output.

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 C. Primary-factor inputs in MMRF-Green comprise labour, capital and agricultural land. For the electricity industries, we assume annual improvements in the rate of factor-saving technological change of 1.0 per cent for the fossil fuel generators and of 2.0 per cent for the renewable generators.

Assumptions for Exports (Table E), and for Large Resource and Electricity Projects

Table E shows assumptions for the quantities of agricultural and mineral exports. These reflect ABARE projections to 2006, and exogenously imposed long-term trends for the remaining years to 2012.

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 appropriate 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

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[3] Some of the measures are modelled via exogenous changes to household taste and industry technology variables. The numbers in Tables C and D show our technological and taste assumptions before the changes are imposed.

[4] 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.

changes in the resource and electricity industries. Currently, our primary source of information for planned projects in the resource sector is ABARE. Our primary source of information for future electricity investments is NEMCO, which provides data via personal communication.

3.2 Baseline Projections

We report two tables of projections:

Table F: Output by industry

Table G Greenhouse gas emissions by state and major source category

Macroeconomic variables (Table B)

Our baseline projection for the years 1999 to 2012 features:

- robust growth in real GDP of 3.0 per cent per annum, with NT, QLD and WA the fastest growing states, and SA and TAS the slowest growing;
- average annual growth for real private consumption and for real investment in line with growth in real GDP;
- international trade expanding strongly relative to GDP; and
- aggregate employment growth of 1.3 per cent per annum.

Industry outputs (Table F)

- Renewable electricity generation is the fastest growing sector of the economy, reflecting the effects of the MRET.
- Most other fast growing industries typically are favoured by technological and taste changes, and/or are export-oriented, and/or have strong connections to international tourism.
- The slowest growing industries typically face unfavourable technological and taste trends, and/or face strong competition from international imports.
- Gas-fired electricity generation has better prospects than coal-fired generation.
- Electricity supply is forecast to increase at an annual rate of 2.1 per cent, 0.9 percentage points less than forecast GDP growth.

Emissions of $C0_2$-e (Table G)

- Australia-wide, emissions of $C0_2$-e are forecast to increase at an average annual rate of 0.9 per cent (cf. growth in real GDP of 3.0 per cent). Emissions rise from 464 Mt in 1999 to 517 Mt in 2012.
- Emissions from electricity generation increase at an average annual rate of just 0.1 per cent, from 179.2 Mt in 1999 to 181 Mt in 2012.

4. Alternative Scenarios

4.1 Methodology for producing alternative scenarios

In computing the Baseline 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 the shocks embodied in Scenarios 1 to 8, the naturally endogenous variables, such as the volumes of agricultural exports and macro variables, which were exogenous in the baseline scenario 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, which were endogenous in the baseline scenario must be exogenous. They are set at the values revealed in the baseline 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 (ie., the nominal wage rate deflated by the CPI) from its baseline level increases in proportion to the deviation in employment from its baseline 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.

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 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 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 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 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 simulation.

4.2 Scenario 1

The main effects of Scenario 1 are shown in Tables 1.1 to 1.5. These show, for the period 2001 to 2012, deviations of a range of variables in the Scenario 1 simulation from their values in the Baseline simulation.

Below is a listing of the tables and their titles.

Table 1.1: Macroeconomic variables (% deviations from base)

Table 1.2: Macroeconomic variables (absolute deviations from base)

Table 1.3: Industry output - Australia (% deviations from base)

Table 1.4: Emissions by major source category (deviations from base)

Table 1.5: Emissions (Kyoto accounting).

Real GDP and GNP

In Tables 1.1 and 1.2, we report changes in real GDP and real GNP. Real GNP equals real GDP plus residents' real income from overseas property or productive activity less real income paid to overseas residents. Real GNP can easily be derived by subtracting real net income paid overseas from real GDP.

In the international-trading scheme scenarios (1, 2, 5 and 6), changes in real GNP relative to GDP reflect, in the main, payments for permits purchased overseas. When Australia's emissions are above the assigned level, permits must be purchased from overseas. Payments for these permits increase real net income paid overseas, and hence reduce real GNP relative to real GDP. Conversely, when Australia's emissions are below the assigned level, permits can be sold to overseas. Income from these sales reduces real net income paid overseas, and hence increases real GNP relative to real GDP.

Table A: Industries in MMRF-Green*

Name	Description of major activity
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	Alumina refining and aluminium smelting
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
23. Electricity – gas	Electricity generation from natural gas
24. Electricity – oil prods.	Electricity generation from oil products thermal plants
25. Electricity – hydro	Electricity generation from renewable sources – hydro
26. Electricity – biomass	Electricity generation from renewable sources – biomass
27. Electricity – biogas	Electricity generation from renewable sources – biogas
28. Electricity – solar	Electricity generation from renewable sources – solar
29. Electricity – wind	Electricity generation from renewable sources – wind
30. Electricity supply	Distribution of electricity from generator to user
31. Urban gas distribution	Urban distribution of natural gas
32. Water and sewerage services	Provision of water and sewerage services
33. Construction services	Residential building and other construction services
34. Trade services	Provision of wholesale and retail trade services
35. Road transport services – direct	Provision of road passenger transport services
36. Road transport services – freight	Provision of road freight transport services
37. Rail transport services – direct	Provision of rail passenger transport services
38. Rail transport services – freight	Provision of rail freight transport services
39. Water transport services – direct	Provision of water transport for international freight and passenger carriage.
40. Water transport services – freight	Provision of water freight transport services within Australia
41. Air transport services – passenger	Provision of air transport services for international freight and passenger carriage.
42. Air transport services – freight	Provision of air freight transport services within Australia
43. Other transport services	Provision of water, air and rail transport services
44. Communication services	Provision of communication services
45. Financial/business services	Provision of financial and business services
46. Dwelling ownership	Services of dwellings
47. Public services	Provision of public services
48. Other services	Provision of all other services
49. Private motor vehicle ownership	Services of private motor vehicles

* For most of the products identified in this table there is an obvious correspondence to one or more standard categories in the Australian and New Zealand Standard Industrial Classification (ANZSIC). The exceptions are: industries 21 to 30, which together comprise ANZSIC 3610 *Electricity Supply*; industry 46, which is equivalent to the *Ownership of dwellings* industry in the industrial classification of the official Input/Output statistics; and industry 49 which is unique to MMRF-Green. Industry 49 produces the services of the stock of private motor vehicles. It is analogous to industry 49, which produces the services of the stock of dwellings.

Table B: Macroeconomic Assumptions for the Baseline scenario (average annual growth rates, 1999-2012)

	Variable		NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
1.	Real private consumption		2.8	2.8	3.7	2.1	3.7	1.5	4.5	2.5	3.0
2.	Real investment		3.1	2.1	4.4	1.8	4.8	2.0	6.2	2.8	3.3
3.	Real public consumption	-- total	2.8	2.4	3.6	1.8	4.2	1.4	4.6	2.5	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		5.5	7.3	5.2	5.2	5.9	4.5	9.2	7.1	5.9
7.	International import volumes		5.2	5.9	5.9	3.3	7.0	3.0	8.6	8.1	5.7
8.	Real GDP/GSP		2.9	2.9	3.4	2.0	4.0	1.6	5.6	2.3	3.0
9.	Aggregate employment		1.1	1.1	1.8	0.6	2.0	0.3	1.8	1.3	1.3
10.	Aggregate capital stock		4.5	4.2	4.6	3.5	5.6	2.3	8.3	4.3	4.5
11.	CPI		2.1	2.1	2.5	2.7	1.7	2.5	1.4	2.1	2.2
12.	GDP/GSP deflator		2.6	2.2	2.8	3.1	1.8	3.0	0.7	2.7	2.5

Table C: Initial Industry Technology and Household Taste Assumptions for the Baseline 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 – hydro	#	0.5	-2.0	Electricity – other
Electricity – biomass	#	0.5	-2.0	Electricity – hydro
Electricity – biogas	#	0.5	-2.0	Electricity – biomass
Electricity – solar	#	0.5	-2.0	Electricity – biogas
Electricity - wind	#	0.5	-2.0	Electricity – solar
Electricity supply	0.3	0.0	-1.0	Electricity – wind

Table continued on next page.

Table C (continued):Initial Industry Technology and Household Taste Assumptions for the Baseline scenario (average annual percentage changes)

Commodities	Household preferences[a]	Technology:		Industries
		Intermediate input-using[b]	Primary-factor using[c]	
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
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 C

Table D: Initial Baseline Assumptions for Energy Efficiency
(Average annual percentage growth rates 1999-2012)

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 minus 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 minus 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 E: Assumptions for Exports for the Baseline (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	3.1	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 F: Baseline: output by industry (average annual growth rates, 1999-2012)

Industry	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Agriculture	2.3	2.1	3.4	0.6	4.2	3.6	3.9	-0.1	2.7
Forestry	2.7	2.4	3.1	1.6	3.8	2.5	0.0	5.8	2.7
Iron ore	0.0	0.0	0.0	-3.9	2.8	1.1	0.0	0.0	2.7
Non-iron ore	-2.8	-0.5	-0.5	-2.8	3.6	-2.9	3.0	-3.2	2.0
Black coal	1.5	0.0	2.4	-3.1	2.4	-1.2	0.0	0.0	1.9
Crude oil	0.0	-0.5	0.0	9.9	1.5	0.0	8.0	0.0	0.9
Natural gas	0.0	1.7	3.4	2.6	3.7	0.0	5.0	0.0	2.9
Brown coal	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.5
Food, beverages and tobacco	3.4	3.4	5.1	2.5	5.4	3.0	5.5	-0.3	3.9
Textiles, clothing and footwear	2.1	2.0	2.7	-0.3	6.1	2.0	4.5	2.2	2.2
Wood and paper products	2.3	1.9	2.0	0.3	4.1	1.4	6.1	-1.1	2.1
Chemical products excl. Petrol	4.1	3.7	4.7	3.0	7.2	4.0	7.4	1.5	4.2
Petroleum products	0.8	0.9	1.5	1.4	2.0	0.0	0.0	0.0	1.0
Building prods (not cement & metal)	2.4	2.0	2.7	1.4	3.4	1.1	3.5	-1.7	2.4
Cement	0.0	0.1	1.1	-0.4	1.5	-0.5	2.2	-4.6	0.5
Iron and steel	4.2	3.9	4.0	3.7	5.1	4.7	7.9	3.1	4.2
Alumina and aluminium	-0.2	2.2	2.5	3.8	1.8	0.9	6.1	0.0	2.2
Other metal products	4.3	3.8	4.7	3.0	7.4	1.7	5.4	1.2	4.6
Motor vehicles and parts	2.6	1.3	3.6	0.2	5.2	0.0	0.0	0.0	1.7
Other manufacturing	5.1	4.1	4.7	4.1	5.6	4.2	6.3	1.1	4.6
Electricity – black coal	1.2	0.0	1.6	-1.8	4.4	0.0	0.0	0.0	1.6
Electricity – brown coal	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	1.7
Electricity – gas	7.8	3.2	6.3	2.8	2.0	0.0	3.8	0.0	3.3
Electricity – oil prods.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity – hydro	1.0	1.0	1.0	0.0	0.0	0.3	0.0	0.0	0.7
Electricity – biomass	14.2	12.4	16.1	10.1	10.4	15.5	0.0	0.0	14.6
Electricity – biogas	14.2	12.4	13.4	10.1	10.4	0.0	0.0	0.0	13.2
Electricity – solar	16.1	14.9	13.9	11.4	12.0	0.0	0.0	0.0	15.5
Electricity - wind	16.1	14.9	13.9	11.4	12.0	0.0	0.0	0.0	14.9
Electricity supply	2.0	2.1	2.5	0.6	3.0	0.7	3.1	-3.4	2.1
Urban gas distribution	2.5	2.5	3.9	1.3	4.4	1.0	4.0	-3.9	2.6
Water and sewerage services	2.8	2.6	2.7	1.8	3.3	1.2	3.8	-2.8	2.7
Construction services	2.9	2.6	3.5	2.4	3.3	2.3	3.3	0.6	2.9
Wholesale trade, retail trade, accommodation	1.6	1.6	2.3	0.7	2.7	0.5	3.0	-1.3	1.8
Road transport services – passenger	1.8	1.7	2.1	1.6	2.8	0.9	2.9	-1.8	1.9
Road transport services – freight	3.4	3.4	4.2	2.6	5.0	2.9	4.9	-0.8	3.7
Rail transport services – passenger	2.0	1.9	2.4	2.0	0.0	0.0	0.0	0.0	2.1
Rail transport services – freight	2.1	2.0	2.7	1.1	3.3	2.1	6.0	0.5	2.3

Table continued on next page.

Table F (continued) Baseline: output by industry (average annual growth rates, 1999-2012)

Industry	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Water transport services – passenger	0.4	1.6	1.6	0.3	3.8	-0.3	6.0	1.4	0.8
Water transport services – freight	-0.1	0.3	0.2	-0.3	1.0	-0.6	2.6	-0.7	0.3
Air transport services – passenger	4.0	5.3	6.5	3.9	6.3	4.2	8.5	3.9	5.0
Air transport services – freight	2.5	2.4	2.6	1.1	3.1	0.8	3.5	-1.6	2.4
Other transport services	2.9	3.1	3.6	2.4	4.5	2.1	5.3	-0.5	3.2
Communication services	7.5	7.6	7.7	6.7	8.4	6.3	8.7	-0.2	7.6
Financial and business services	5.6	5.4	5.9	4.8	6.1	4.3	6.8	-0.5	5.5
Dwelling ownership	3.7	3.5	2.5	2.7	3.4	1.9	4.5	-4.4	3.2
Public services	2.6	2.2	3.3	1.6	3.9	1.2	4.3	2.1	2.6
Other services	3.8	3.8	4.4	3.6	4.4	3.0	4.5	1.2	3.9
Private motor vehicle ownership	1.1	1.0	2.7	-0.3	2.5	-0.3	3.6	0.0	1.4

End of Table F

Table G Baseline: $C0_2$-e Emissions by Major Source Category

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Average annual growth rates (1999-2012)									
Energy sector, total	0.4	0.7	1.0	-0.8	2.4	0.3	4.6	1.1	0.8
Fuel combustion	0.3	0.8	0.9	-0.9	2.4	0.3	3.8	1.1	0.8
Electricity	-0.6	0.4	-0.1	-3.0	2.2	0.0	2.0	0.0	0.1
Transport	1.0	1.1	1.8	0.2	2.3	-0.1	3.5	0.9	1.3
Other industries	1.6	1.5	2.1	0.8	2.8	0.8	4.2	1.6	1.9
Household consumption	-0.5	-0.7	1.1	-1.2	1.6	-2.1	1.4	-0.8	-0.2
Fugitive emissions from fuels	1.3	0.1	2.2	1.1	2.6	-1.1	7.2	0.0	1.4
Industrial processes	0.5	1.6	1.8	-0.3	1.7	-0.2	3.7	0.8	1.3
Agriculture	0.7	0.6	1.7	-0.7	2.4	1.8	2.2	1.7	1.1
Waste	1.7	1.6	2.2	1.4	2.1	0.9	2.3	1.6	1.7
LUCF	2.5	2.2	2.8	1.4	3.5	2.2	0.0	2.1	2.4
Total	0.4	0.7	1.2	-0.9	2.4	-205.5	3.9	1.1	0.9

Table continued on next page.

Table G (continued) Baseline: $C0_2$-e Emissions by Major Source Category

	NSW	VIC	QLD	SA	WA	TAS	NT	ACT	AUS
Levels(Mt CO2-e) (1999)									
Energy sector, total	116.3	118.7	67.1	16.7	40.4	3.1	3.2	2.0	367.5
Fuel combustion	110.7	105.0	60.6	16.4	36.6	3.1	2.5	2.0	336.9
Electricity	57.7	64.1	33.9	7.1	16.2	0.0	0.1	0.0	179.2
Transport	28.8	19.6	13.8	4.9	7.5	1.4	0.9	1.4	78.2
Other industries	23.2	20.3	12.4	4.2	12.7	1.6	1.5	0.6	76.4
Household consumption	1.0	1.0	0.5	0.2	0.2	0.1	0.0	0.0	3.1
Fugitive emissions from fuels	5.6	13.7	6.6	0.3	3.8	0.0	0.7	0.0	30.6
Industrial processes	2.2	1.5	2.1	1.1	2.1	0.8	0.8	0.0	10.6
Agriculture	30.0	18.1	22.0	7.9	13.5	3.3	1.2	0.1	96.1
Waste	5.6	4.9	2.4	1.4	1.3	0.3	0.2	0.6	16.5
LUCF	-5.4	-5.5	-4.2	-2.4	-2.6	-6.9	0.0	-0.3	-27.2
Total	148.7	137.6	89.4	24.7	54.7	0.4	5.4	2.4	463.5
Levels (Mt CO2-e) (2010)									
Energy sector, total	120.6	127.6	75.1	15.1	52.4	3.2	5.3	2.3	401.6
Fuel combustion	114.1	113.7	66.7	14.8	47.4	3.2	3.9	2.3	366.1
Electricity	53.8	67.0	33.9	5.0	20.7	0.0	0.1	0.0	180.5
Transport	32.1	22.0	16.8	5.0	9.5	1.4	1.4	1.5	89.7
Other industries	27.4	23.8	15.5	4.5	17.0	1.7	2.4	0.7	93.0
Household consumption	0.9	0.9	0.5	0.2	0.3	0.1	0.0	0.0	3.0
Fugitive emissions from fuels	6.5	13.8	8.4	0.3	5.0	0.0	1.4	0.0	35.4
Industrial processes	2.4	1.8	2.5	1.1	2.5	0.7	1.2	0.0	12.2
Agriculture	32.3	19.1	26.5	7.2	17.6	4.0	1.5	0.1	108.3
Waste	6.7	5.8	3.0	1.6	1.6	0.3	0.3	0.7	19.9
LUCF	-7.0	-7.0	-5.6	-2.8	-3.7	-8.8	0.0	-0.4	-35.4
Total	154.9	147.2	101.5	22.2	70.3	-0.6	8.3	2.7	506.6
Levels (Mt CO2-e) (2012)									
Energy sector, total	122.1	129.8	76.6	15.0	55.3	3.2	5.8	2.3	410.0
Fuel combustion	115.5	115.9	67.9	14.6	50.0	3.2	4.1	2.3	373.5
Electricity	53.3	67.8	33.5	4.8	21.6	0.0	0.1	0.0	181.1
Transport	32.8	22.6	17.4	5.1	10.0	1.4	1.5	1.5	92.3
Other industries	28.4	24.6	16.4	4.6	18.1	1.7	2.5	0.8	97.1
Household consumption	0.9	0.9	0.5	0.2	0.3	0.1	0.0	0.0	3.0
Fugitive emissions from fuels	6.7	13.9	8.7	0.4	5.3	0.0	1.6	0.0	36.5
Industrial processes	2.4	1.8	2.6	1.1	2.6	0.7	1.3	0.0	12.5
Agriculture	32.9	19.4	27.5	7.2	18.5	4.1	1.6	0.1	111.3
Waste	6.9	6.0	3.1	1.6	1.7	0.3	0.3	0.7	20.7
LUCF	-7.4	-7.3	-6.0	-2.9	-4.0	-9.2	0.0	-0.4	-37.1
Total	156.9	149.8	103.9	22.0	74.0	-0.9	8.9	2.8	517.4