CHAPTER 6: MITIGATION SCENARIOS — AUSTRALIAN RESULTS

Key points

Large reductions in emissions do not require reductions in economic activity because the economy restructures in response to emission pricing.

Australia's aggregate economic costs of mitigation are small. Costs to sectors and regions vary widely: growth in emission-intensive sectors slows, and growth in low and negative emission sectors accelerates.

Real household incomes continue to grow, although households face higher prices for emission-intensive products, such as electricity and gas.

Some costs are unavoidable and would arise regardless of whether Australia chooses to participate in the global mitigation effort. These costs arise from other economies' actions, particularly through trade in energy- and emission-intensive commodities.

Australia's mitigation costs are higher than most developed economies due to its large share of emission intensive industries.

International trade in permits reduces the cost of Australia's contribution to the global mitigation effort. Australia's emissions fall significantly once new low-emission electricity generation technologies become cost-effective.

Allocation of some free permits to emission-intensive trade-exposed sectors, as the Government proposes, eases their transition to a low-emission economy in the initial years. Shielding redistributes costs from shielded to unshielded sectors, and could redistribute costs amongst shielded sectors.

Australia's comparative advantage will change in a low-emission world. Impacts on Australian producers will depend largely on their emission-intensity relative to other producers.

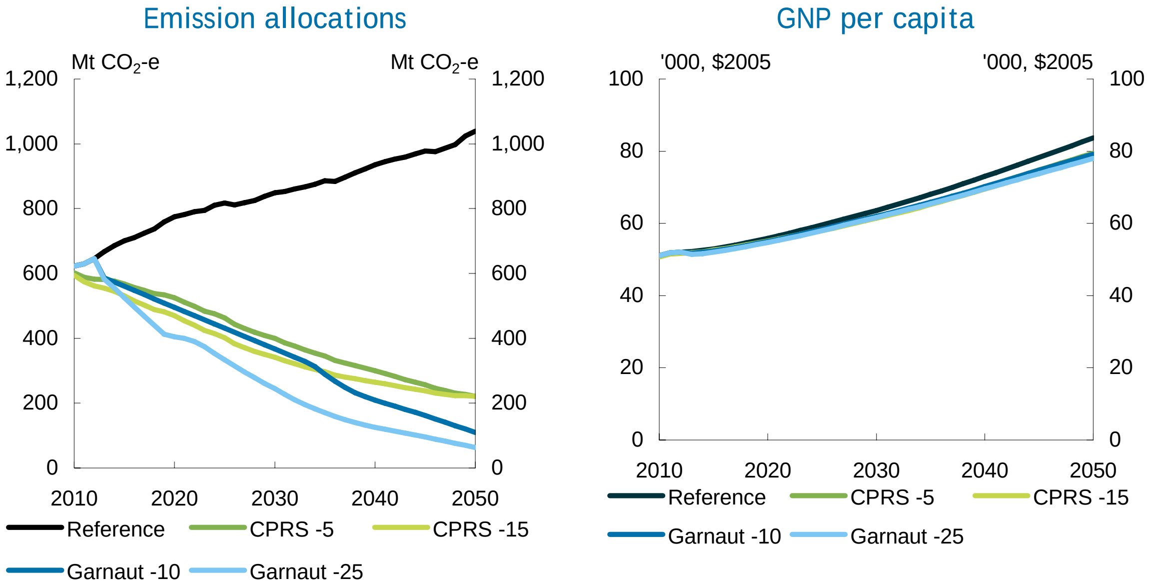
Lower demand for Australia's emission-intensive commodity exports could generate benefits for other export-oriented and import-competing industries through its impact on Australia's exchange rate.

All scenarios show Australia, at the-whole-of-economy level, can achieve substantial emission reductions with relatively small reductions in economic growth (Chart 6.1). From 2010 to 2050, Australia's real GNP per capita grows at an average annual rate of 1.1 per cent in the policy scenarios, compared to 1.2 per cent in the reference scenario.[1] By 2020, real GNP per capita is around 9 per cent above current levels, compared to around 11 per cent in the reference scenario. By 2050, real GNP per capita is 55-57 per cent above current levels, compared to 66 per cent in the reference scenario.

1 GNP (Gross national product) measures the total output of the Australian economy and international income transfers. It is a more complete measure of the current and future consumption possibilities available to Australians than GDP (Gross Domestic Product) (Box 2.3).

Emission pricing has a slightly smaller impact on Australia's GDP, as GDP does not include income transfers associated with international emissions trading. From 2010 to 2050, real GDP per capita grows at an average annual rate of 1.2-1.3 per cent in the policy scenarios, compared to 1.4 per cent in the reference scenario.

Chart 6.1: Australian emission allocations and GNP per capita



Note: Emission allocations will differ from actual emissions due to banking of permits and international trade in permits. Comparable Australian results were obtained in GTEM and G-Cubed.
Source: Treasury estimates from MMRF.

While mitigation policies impose relatively small aggregate costs on Australia, impacts will vary widely across sectors and regions. Putting a price on emissions drives a structural shift in the economy, from emission-intensive goods, technologies and processes, towards low-emission goods, technologies and processes. As a result, growth in emission-intensive sectors slows, and growth in low and negative-emission sectors accelerates. This transformation will shift investment and employment between sectors.

This chapter explores how Australia could manage the transformation to a low-emission economy. In particular, this chapter reports the extent of emission reductions and the economic impact at the national, regional, sectoral and household levels of the Australian economy for four alternative policy scenarios. In doing so it draws on the MMRF, GTEM, G-cubed and PRISMOD models.

6.1 IMPACT ON EMISSIONS

6.1.1 Emission allocation

Australia can meet its allocated emission target either through domestic mitigation, such as adopting low-emission technologies, or the purchase of permits from overseas or a combination of both.

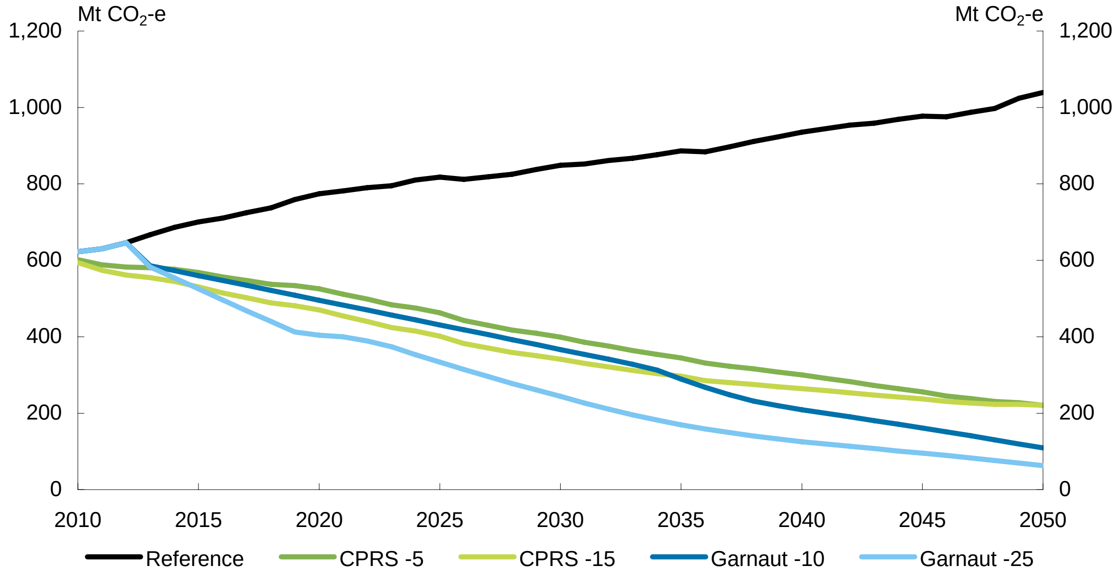
Each policy scenario has a different emission allocation for all countries, including Australia, (Table 6.1 and Chart 6.2).[2] Generally, the more stringent the environmental target the lower Australia's and other countries' allocations. As in Chapter 5, emission allocations in the Garnaut scenarios use the contraction and convergence approach. And, allocations in the CPRS scenarios use the multi-stage approach. Australia's emission allocation significantly affects mitigation costs as measured by the impact on GNP. Allocations influence the number of emission permits bought or sold in the international market.

Table 6.1: Mitigation scenarios

	CPRS -5	CPRS -15	Garnaut -10	Garnaut -25
Emission stabilisation goal (CO_2-e ppm)	550	510	550	450
Emission target (per cent change from 2000 levels)				
2020	-5	-15	-10	-25
2050	-60	-60	-80	-90
Australian permit price (CO_2-e)				
Start of scheme ($nominal)	23	32	30	52
2020 ($2005 prices)	35	50	35	60
2050 ($2005 prices)	115	158	114	197

Note: The CPRS scenarios start in 2010. The Garnaut scenarios start in 2013. The CPRS -5 price is A$30 in 2013, the same as the Garnaut -10 scenario.
Source: Treasury estimates from MMRF.

Chart 6.2: Australia's emission allocation



Source: Treasury estimates from MMRF.

6.1.2 Emission prices

International markets set the global emission price. Australia's emission price will equal this global price, adjusted for exchange rate changes, if there are no binding restrictions on international emissions trade. Changes to Australia's actual emission level will change the number of permits Australians buy or sell, rather than the price of permits in Australia.

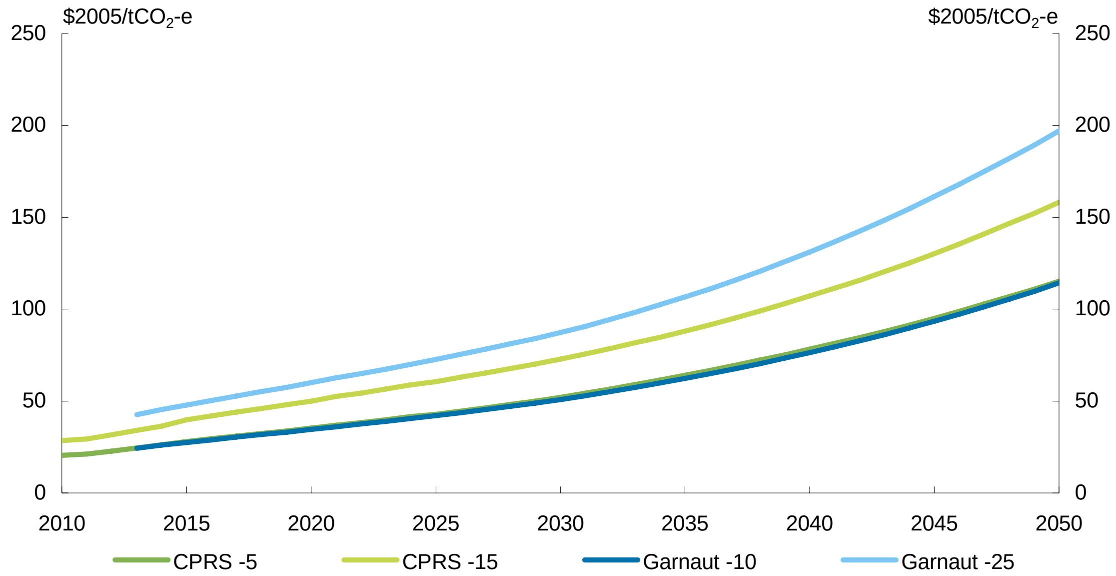
As discussed in Chapters 4, the global price is assumed to be set efficiently. With unlimited banking and an allocation approach that requires no borrowing, firms will allocate the finite

2 Chapters 4 and 5 describe the allocation of emission rights to Australia under alterative scenarios in detail.

global emissions budget efficiently through time. Emission prices (in global currency terms) rise exponentially at a real rate of 4 per cent per year.

More stringent stabilisation targets require higher emission prices (Table 6.1 and Chart 6.3). The CPRS -5 scenario has a very similar price path to the Garnaut -10 scenario, as they have the same greenhouse gas concentration stabilisation target. The CPRS -15 scenario, which has a stabilisation level at around 510 ppm, has emission prices between the Garnaut -25 and CPRS -5 scenarios.

Chart 6.3: Australian emission price



Note: Prices are in 2005 Australian dollars.
Source: Treasury estimates from MMRF.

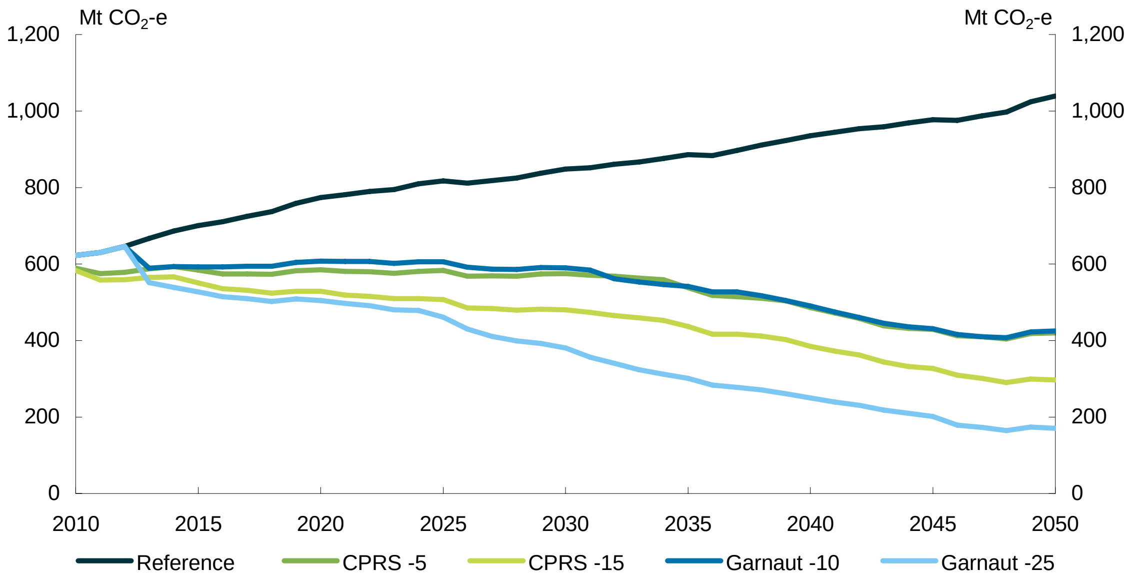
6.1.3 Domestic mitigation

Putting a price on emissions breaks the link between economic activity and emissions. It allows for significant cuts in emissions without large economic costs. In all policy scenarios, the emission intensity of GDP falls significantly. New technologies and production processes increase the emissions efficiency of production and demand for low-emission-intensive products, such as consumers choosing to use public transport. This moves the composition of the Australian economy towards low-emission industries.

Emission reductions occur at different rates across sectors and over time. The ability to reduce emissions when it is cheap to do so, through a market-based mechanism, keeps mitigation costs as low as possible.

Australia's actual greenhouse gas emissions are reduced significantly across all policy scenarios (Chart 6.4). In the CPRS -5 scenario, while emissions in 2020 are broadly the same as current levels, they are 25 per cent lower than the reference scenario, before falling to 60 per cent below the reference scenario in 2050.

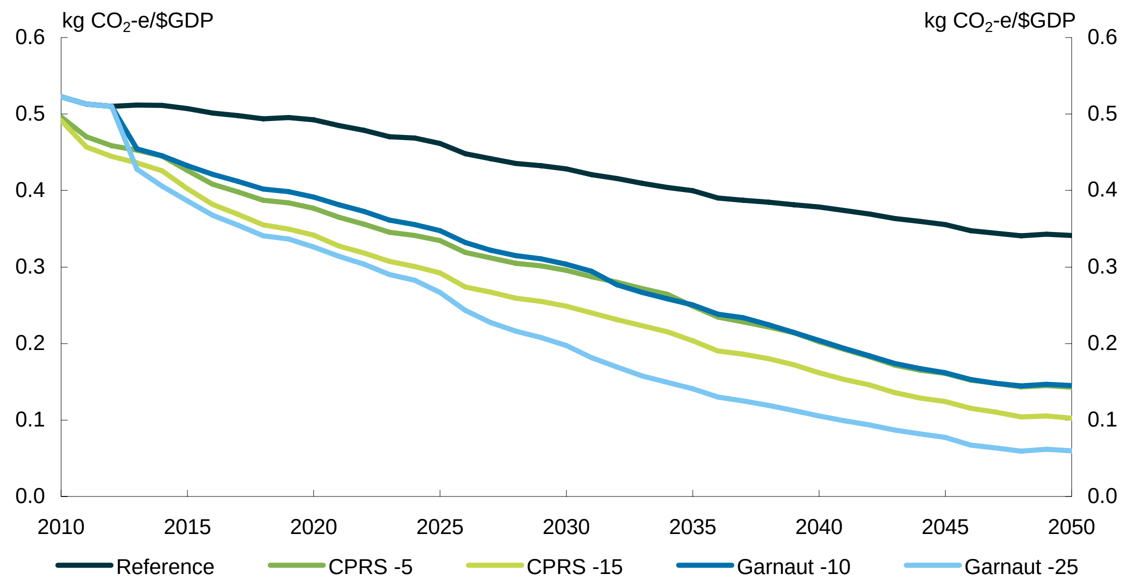
Chart 6.4: Australia's emission pathways



Source: Treasury estimates from MMRF.

Australia's emission reductions result primarily from a reduction in the emission intensity of GDP rather than reductions in actual GDP (Chart 6.5). The emission intensity of the Australian economy is reduced from around 0.6 kg CO_2-e/$GDP in 2005 to less 0.15 kg CO_2-e/$GDP in 2050.

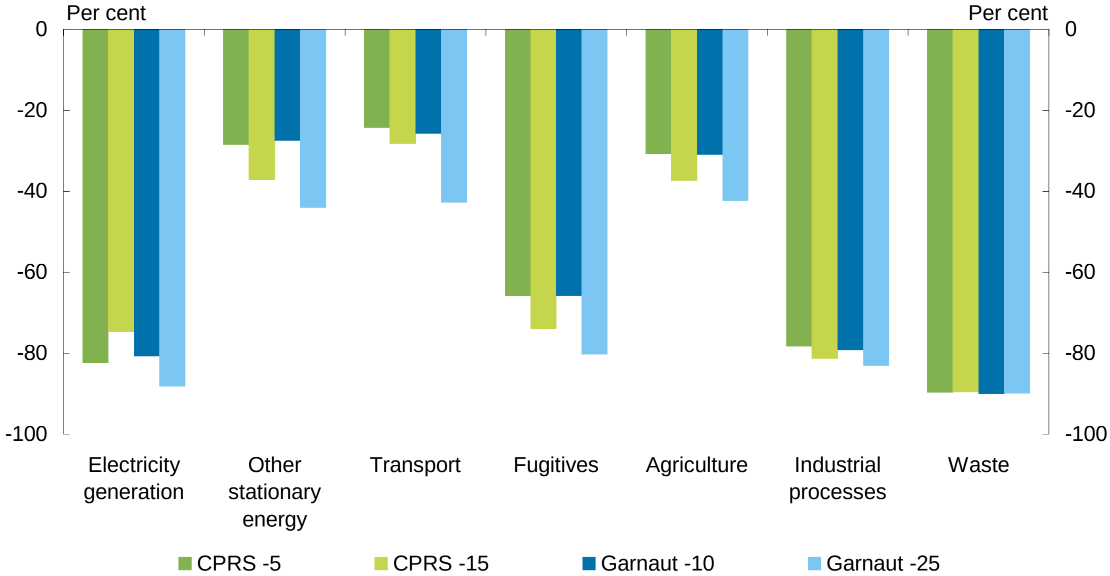
Chart 6.5: Emission intensity of GDP



Source: Treasury estimates from MMRF.

Mitigation opportunities vary greatly across sectors and over time. All sectors reduce emissions relative to the reference scenario in all the policy scenarios. By 2050, the greatest percentage reduction in emissions occurs in the waste, industrial process and electricity generation sectors relative to the reference case (Chart 6.6). Emissions from fugitives are reduced by over 60 per cent. Less mitigation is achieved in the other stationary energy, transport and agriculture sectors. Mitigation in these sectors is more costly and household demand is more inelastic.

Chart 6.6: Sector emissions
Change from reference scenario, 2050



Source: Treasury estimates from MMRF.

The shares of emission reductions across sectors reflect the quantity of emissions (with sectors having more emissions better able to reduce emissions) and the potential mitigation costs within each sector (Chart 6.7).

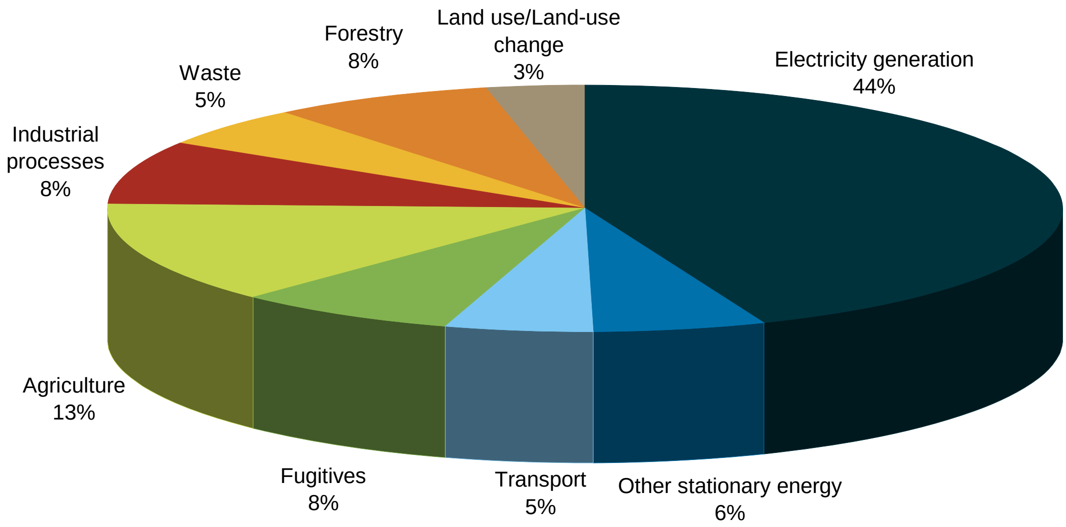
The electricity generation sector provides the largest share of emission reductions; 44 per cent by 2050. This sector moves towards low-emission technologies, such as carbon capture and storage and renewable sources including wind, solar and geothermal. Reduced emissions in the electricity sector drive reductions in energy-related emissions in other sectors, as fossil fuel users switch to electricity, particularly in transport where the share of hybrid and full electric plug-in motor vehicles increases over time.

Agriculture has more costly mitigation than other sectors, as most emissions occur naturally and fewer technological options are available. Mitigation options currently available include changes in land and animal management, and substitution between activities within agriculture.

Emissions from the transport sector are reduced from weakening demand for transport, fuel switching and purchases of more fuel-efficient vehicles in the road transport sector. Opportunities for water and air transport mitigation are more costly, and demand in these sectors remains strong, in line with higher incomes.

The forestry sector also responds to emission pricing, particularly through the establishment of sequestration forests, which provide a source of relatively low-cost mitigation.

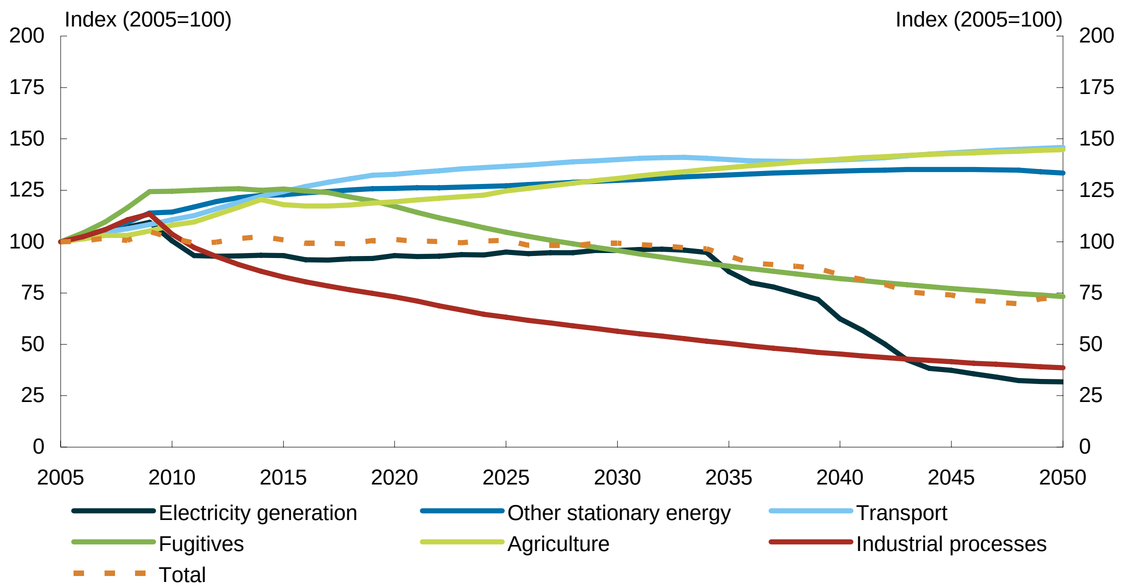
Chart 6.7: Share of cumulative emission reductions by sector
CPRS -5 scenario, 2010-2050



Source: Treasury estimates from MMRF.

Although all sectors show mitigation relative to the reference scenario, reductions in emission intensities are slower where mitigation costs are higher. Emissions in some sectors continue to grow reflecting output growth, and relatively high mitigation costs. In the electricity generation sector emissions do not fall significantly, relative to current levels, until the mid-2030s when additional technology options become available (Chart 6.8). This spread of mitigation across sectors highlights the value of market-based mechanisms, which allow abatement to occur where mitigation costs are lowest.

Chart 6.8: Sector emissions
CPRS -5 scenario



Note: Emissions from forestry are not reported.
Source: Treasury estimates from MMRF.

Australian emissions plateau until the emission price facilitates large-scale commercial deployment of carbon capture and storage in the electricity sector. In the CPRS -5 scenario, Australia's emissions remain at around 2005 levels until the mid 2030s, with Australia meeting its reduction targets by purchasing lower cost global permits. Australia's emissions fall significantly beyond this time as carbon capture and storage technology is adopted. In the Garnaut -25 scenario, higher emission prices associated with larger global emission reductions cause commercial deployment of carbon capture and storage earlier, from around 2026.

While the modelling suggests carbon capture and storage technologies become a commercial alternative for electricity generation, this is not crucial for the aggregate mitigation cost results. If alternative technologies are adopted at similar emission prices, overall mitigation costs would be broadly unchanged. However, global adoption of carbon capture and storage technology will affect significantly the long-term viability of Australian's coal industry.

6.2 IMPACT ON THE AUSTRALIAN MACROECONOMY

6.2.1 Gross national product

The introduction of emission pricing will reduce Australia's GNP per capita compared with the reference scenario, but GNP per capita continues to grow across all the mitigation scenarios (Table 6.2 and Chart 6.9).

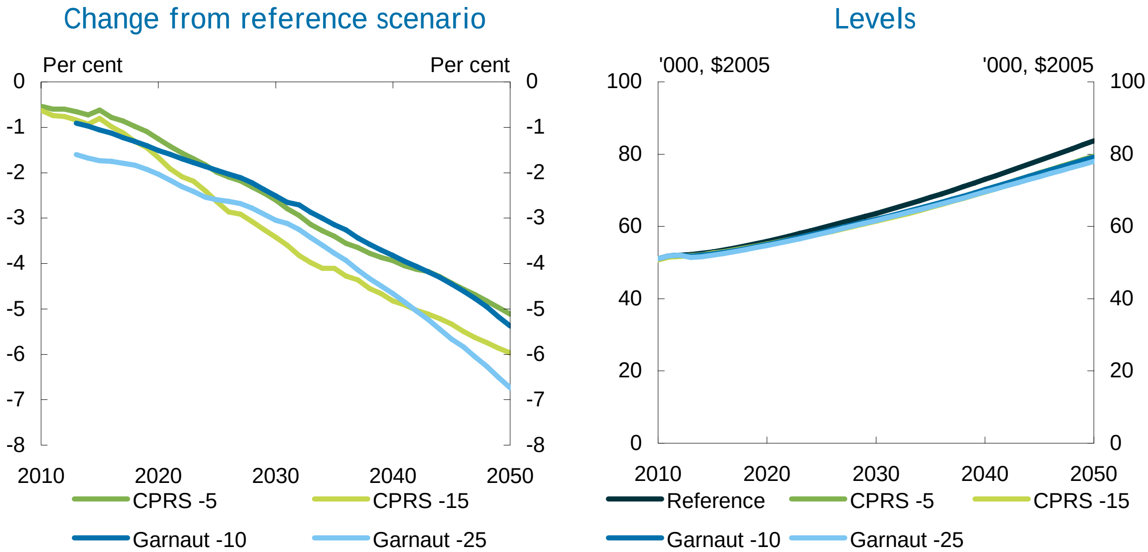
Table 6.2: GNP per capita annual growth rates

	Reference Per cent	CPRS -5 Per cent	CPRS -15 Per cent	Garnaut -10 Per cent	Garnaut -25 Per cent
2010s	0.9	0.8	0.8	0.7	0.7
2020s	1.3	1.2	1.1	1.2	1.2
2030s	1.4	1.3	1.2	1.3	1.2
2040s	1.4	1.3	1.3	1.2	1.2
Average	1.2	1.1	1.1	1.1	1.1

Source: Treasury estimates from MMRF.

The reduction in GNP in 2050 relative to the reference scenario level is around 5.1 per cent in the CPRS -5 scenario and 6.7 per cent in the Garnaut -25 scenario; however, GNP per capita is roughly 1.5 times larger in 2050 than in 2008 (Chart 6.9).

Chart 6.9: GNP per capita



Source: Treasury estimates from MMRF.

GNP is reduced partially through reductions in production (GDP) in Australia, increased income transfers to overseas associated with international permits and reductions in the terms of trade, but is also affected by changes in interest payments on foreign borrowing, and changes in equity payments made to foreign investors.

Australian GNP costs are higher than those in other developed economies, because Australia is a relatively emission-intensive economy. Australia has developed a comparative advantage in high energy and emission-intensive industries such as mining, resource processing industries fossil fuels and agriculture.

6.2.2 Gross domestic product

The impact on output, or GDP, is similar to GNP. From 2010 to 2050, growth in the mitigation scenarios is 2.2-2.3 per cent, slightly slower than the 2.4 per cent in the reference scenario (Table 6.3).

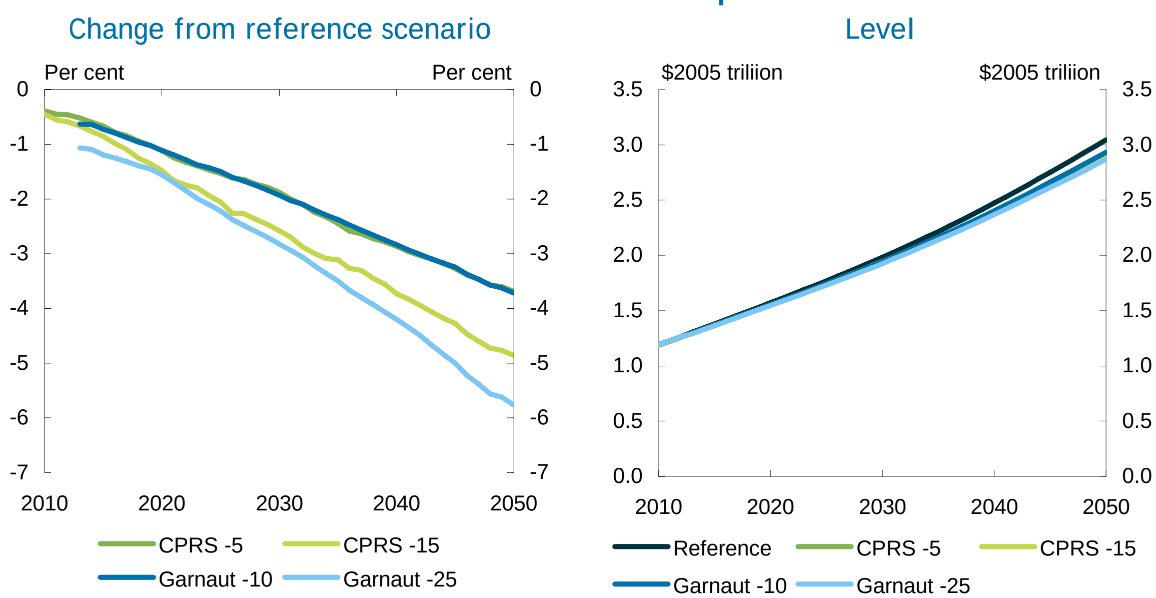
Table 6.3: GDP annual growth rates

	Reference Per cent	CPRS -5 Per cent	CPRS -15 Per cent	Garnaut -10 Per cent	Garnaut -25 Per cent
2010s	2.8	2.7	2.7	2.7	2.6
2020s	2.3	2.3	2.2	2.3	2.2
2030s	2.2	2.1	2.1	2.1	2.1
2040s	2.1	2.0	2.0	2.0	1.9
Average	2.4	2.3	2.3	2.3	2.2

Source: Treasury estimates from MMRF.

The reduction in the level of GDP in 2050 relative to the reference scenario ranges from 3.7-5.8 per cent across the scenarios; however, GDP is roughly three times larger in 2050 than in 2005 (Chart 6.10).

Chart 6.10: Gross domestic product



Source: Treasury estimates from MMRF.

Table 6.4: Headline national indicators

	2020					2050				
	Reference	CPRS -5	CPRS -15	Garnaut -10	Garnaut -25	Reference	CPRS -5	CPRS -15	Garnaut -10	Garnaut -25
Emissions response										
Emission allowance per cent change from 2000 level	n/a	-5.0	-15.0	-10.0	-25.0	n/a	-60.0	-60.0	-80.0	-90.0
Australian emissions price, real A$2005/tCO2e	n/a	35	50	35	60	n/a	115	158	114	197
Actual emissions (pre-trade), Mt $C0_2$-e										
MMRF	774	585	529	608	505	1039	420	297	425	171
GTEM	716	568	507	568	472	958	322	161	337	126
G-cubed	818	661	609	694	629	1007	247	16	393	76
Emissions intensity of GDP kg CO_2-e per $										
MMRF	0.5	0.4	0.3	0.4	0.3	0.3	0.1	0.1	0.1	0.1
GTEM	0.6	0.5	0.4	0.5	0.4	0.4	0.1	0.1	0.2	0.1
G-cubed	0.7	0.4	0.4	0.5	0.4	0.4	0.1	0.0	0.1	0.0
Global macroeconomic impacts										
GWP level, percentage deviation from reference										
GTEM	n/a	-0.7	-0.9	-0.7	-1.3	n/a	-2.8	-3.5	-2.7	-4.3
G-cubed	n/a	-2.3	-2.8	-2.2	-3.3	n/a	-3.3	-3.8	-3.2	-4.2
Macroeconomic impacts - Australia										
GNP per capita level, per cent change from reference										
MMRF	n/a	-1.3	-1.7	-1.5	-2.0	n/a	-5.1	-6.0	-5.4	-6.7
GTEM	n/a	-1.1	-1.6	-1.3	-2.1	n/a	-3.8	-3.2	-4.8	-5.2
G-cubed	n/a	-1.9	-2.5	-1.7	-2.6	n/a	-4.2	-4.7	-3.8	-4.8
GNP per capita, average growth per year from 2010										
MMRF	0.9	0.8	0.8	0.7	0.7	1.2	1.1	1.1	1.1	1.1
GTEM	1.6	1.5	1.5	1.5	1.4	1.5	1.4	1.4	1.3	1.3
G-cubed	1.5	1.4	1.4	1.4	1.3	1.4	1.3	1.3	1.3	1.2
GNP average growth per year from 2010										
MMRF	2.2	2.1	2.1	2.0	2.0	2.2	2.1	2.1	2.1	2.1
GTEM	2.9	2.8	2.8	2.8	2.7	2.5	2.4	2.4	2.4	2.3
G-cubed	2.8	2.7	2.7	2.6	2.6	2.4	2.3	2.3	2.3	2.3
GDP per capita level, per cent change from reference										
MMRF	n/a	-1.1	-1.5	-1.1	-1.6	n/a	-3.7	-4.9	-3.7	-5.8
GTEM	n/a	-0.9	-1.2	-0.8	-1.4	n/a	-2.9	-3.5	-3.2	-4.6
G-cubed	n/a	-2.2	-2.8	-1.8	-2.6	n/a	-5.3	-6.3	-3.9	-5.5
GDP per capita, average growth per year from 2010										
MMRF	1.5	1.5	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.2
GTEM	1.5	1.5	1.5	1.5	1.4	1.4	1.3	1.3	1.3	1.2
G-cubed	1.5	1.5	1.4	1.4	1.3	1.4	1.3	1.3	1.3	1.2
GDP average growth per year from 2010										
MMRF	2.8	2.7	2.7	2.7	2.6	2.4	2.3	2.3	2.3	2.2
GTEM	2.8	2.8	2.8	2.7	2.7	2.4	2.3	2.3	2.3	2.3
G-cubed	2.8	2.8	2.7	2.7	2.6	2.4	2.3	2.3	2.3	2.3

Note: Targets for Garnaut scenarios correspond to the smoothed global emissions pathway.

Source: Treasury estimates from MMRF, GTEM and G-Cubed.

Table 6.5:

Other national indicators

	2020				2050			
	CPRS -5	CPRS -15	Garnaut -10	Garnaut -25	CPRS -5	CPRS -15	Garnaut -10	Garnaut -25
Consumption level, per cent change from reference								
MMRF	-1.2	-1.5	-1.3	-1.9	-4.8	-5.7	-5.2	-6.5
GTEM(a)	-1.1	-1.6	-1.3	-2.1	-3.8	-3.2	-4.8	-5.2
G-cubed	-0.4	-0.5	-0.2	-0.2	0.7	1.1	0.1	0.5
Real wages level, per cent change from reference								
MMRF	-2.6	-3.1	-3.1	-4.2	-7.6	-9.1	-7.9	-10.3
GTEM	-2.4	-3.2	-2.9	-4.7	-5.4	-5.7	-6.0	-7.4
G-cubed	-4.2	-5.1	-3.1	-4.4	-10.7	-12.4	-8.0	-11.0
Investment level, per cent change from reference								
MMRF	-2.6	-3.3	-3.1	-4.0	-6.7	-8.1	-6.7	-9.2
GTEM	-0.5	-0.9	-0.7	-1.4	-2.7	-2.5	-3.5	-4.2
G-cubed	-3.8	-4.9	-3.1	-4.5	-9.2	-9.9	-5.8	-7.4
Terms of trade, per cent change from reference								
MMRF	-0.3	-0.4	-0.4	-0.2	-2.9	-3.1	-2.5	-2.1
GTEM	-0.5	-0.7	-0.5	-1.0	-2.2	-0.6	-2.7	-1.3
G-cubed	-1.6	-2.0	-1.4	-1.8	-3.3	-4.2	-2.0	-1.6

(a) GNP is presented. GNP is a proxy for consumption in GTEM as the savings rate is fixed.
Note: Targets for Garnaut scenarios correspond to the smoothed global emissions pathway.
Source: Treasury estimates from MMRF, GTEM and G-Cubed.

6.1.1

Box 6.1: Difference in GNP and GDP impacts across models

Despite using the same global and national allocations, Australian GNP and GDP impacts are different across the models because the structure and databases of the models vary (Table 6.3).

GTEM does not cost the mitigation effort to reduce fugitive emissions, whereas MMRF allows for additional inputs to implement new processes or technologies. GTEM does not do this; it is an international model and data on the likely costs of fugitive emission mitigation technologies in developing economies are very limited. G-Cubed has lower mitigation potential in non-combustion emissions; consequently the model requires greater proportional combustion emission reductions to achieve a given allocation and therefore greater adjustment in sectors that combust emissions.

Differences in databases and aggregation between models can influence mitigation costs. MMRF's database suggests that the resources required to produce a unit of conventional coal electricity is less than in the GTEM database. Switching from coal generation to alternative cleaner technologies requires a greater proportional increase in resources in MMRF than in GTEM. Switching from conventional coal fired generation therefore costs more in MMRF.

The GTEM data are based on a year (2001) when the Australian exchange rate appeared undervalued, while the MMRF data are based on 2005. This results in Australia's emission intensity (measured in 2001 US dollars) being higher in GTEM than in MMRF, potentially making the mitigation costs in GTEM higher than in MMRF.

Aggregate employment adjusts gradually to emission pricing in MMRF and G-Cubed. As emission prices changes over time and the models are either, not forward looking (MMRF), or only partly forward looking (G-Cubed), employment continues to adjust through time, adding to GDP costs. In contrast, GTEM adjusts labour fully each year, so aggregate employment remains unchanged between the reference scenario and policy scenarios, lowering GDP costs.

GTEM does not allow substitution from emission-intensive intermediate inputs in some sectors in response to the emission prices; whereas, MMRF and G-Cubed have some intermediate substitution across all sectors. MMRF disaggregates petroleum into cleaner fuels, such as biofuels or diesel, while GTEM does not.

The overall net effect of these differences is that Australian GDP impacts tend to be lowest in GTEM, higher in MMRF, and higher still in G-Cubed. GNP, however, not only differs across the models because of the GDP impacts, but also because of differences in impacts on international income transfers.

The main difference in income transfer impacts is due to the number of emission permits purchased in the international market. The number of permits purchased (and therefore the income outflows from these purchases) is considerably higher in MMRF than in GTEM and G-Cubed. This is because the economy can reduce emissions at lower cost in both GTEM and G-Cubed than in MMRF.

In G-Cubed, in the CPRS scenarios, Australia's GNP falls by less than GDP, despite a loss of income from permit purchases. In G-Cubed, lower foreign interest payments offset the outflow of income from buying permits. Australia's trade balance improves as imports fall by more than exports. Imports fall as consumption and investment fall. Australian exports fall, but are partially held up by demand from China and other economies initially not in the trading scheme. The trade balance reduces the current account deficit, reducing Australia's foreign debt and foreign interest payments, leading to a higher GNP. In contrast, GNP in MMRF is lower, as these dynamic trade impacts are not captured.

6.2.3 Decomposing the impact on GNP

Climate change mitigation policy can affect economic welfare in three ways (Harberger, 1971) (Table 6.6.).[3]

- Changes in deadweight loss that arise from reallocating existing resources within the economy.
- Changes in the supply or productivity of factors, such as increases or decreases in the amount of land, labour, capital and natural resources or improved productivity of existing resources.
- Changes in foreign income transfers and the terms of trade.

The first two of these sources decompose the impact on GDP, and when the impact on international income transfers and the terms of trade is added, the result is the impact on GNP.

Table 6.6: Contributions to GNP
Change from reference scenario

	CPRS -5	CPRS -15	Garnaut -10	Garnaut -25
	Per cent	Per cent	Per cent	Per cent
2020				
Allocative efficiency	-0.1	-0.2	-0.1	-0.4
Capital and labour supply and productivity	-1.1	-1.3	-1.0	-1.2
GDP	-1.2	-1.6	-1.1	-1.6
Terms of trade	-0.2	-0.2	-0.2	-0.2
Permit trading	-0.1	-0.2	-0.4	-0.6
Other foreign transfers	0.2	0.2	0.2	0.3
GNP	-1.3	-1.7	-1.5	-2.0
2050				
Allocative efficiency	-0.5	-1.2	-0.5	-2.1
Capital and labour supply and productivity	-3.2	-3.8	-3.1	-4.0
GDP	-3.7	-5.0	-3.6	-6.1
Terms of trade	-0.8	-0.9	-0.7	-0.7
Permit trading	-1.3	-0.9	-1.7	-1.0
Other foreign transfers	0.5	0.6	0.5	0.8
GNP	-5.1	-6.0	-5.4	-6.7

Note: Contributions may not add due to rounding. GDP contribution is not equivalent to the GDP change from reference scenario.
Source: Treasury estimates from MMRF.

Allocative efficiency

When emissions are priced, existing resources are reallocated in the economy. The more emission intensive the economy, the greater the proportion of deadweight losses to GDP and the greater the adjustment costs.

In response to emission pricing Australia's resources shift from sectors where they currently have a comparative advantage to sectors that will have a comparative advantage in a low-emission economy.

3 Huff and Hertel (1996) and Pant et al. (2000) use this framework to derive a decomposition of the equivalent variation measure of the change in welfare within the context of a CGE model.

Energy related emissions are reduced by switching from emission-intensive fuels to less energy-intensive technologies. These adjustments come at a cost, as they result in a reallocation of existing resources.

In addition, substitution occurs to cleaner, but initially more expensive technologies. Changing production technologies (such as using solar hot water heaters rather than electric water heaters, using gas-fired and renewable electricity generation rather than coal-fired, and using steel recycling rather than blast furnace smelting) significantly reduces emissions.

Other industries can reduce the emission intensity of production for non-combustion/non-energy emissions. Non-combustion emissions include fugitive emissions from coal mining or gas extraction, and process emissions from cement production or agriculture. Mitigation opportunities for non-combustion emissions were modelled, drawing on relevant information from the bottom-up modelling, international research and sectoral experts.

In general, reducing non-combustion emissions increases the cost of production, as firms pay more for capital, labour or business inputs (or a combination of all three) to lower their emission intensity. This increases costs as resources are reallocated in the economy and is equivalent to a permanent loss in factors from the economy.

Capital and labour supply and productivity

Changes in the quantity of factors (labour and capital) used in production is the other primary source of GDP costs in response to emission pricing. In particular, reduced capital use significantly contributes to reductions in real GDP in MMRF relative to the reference scenario.

An emission price reduces the incentive for producers to employ variable factors of production — particularly capital in the latter years.

In all scenarios, and across all models, an important driver of the long-run reduction in GDP is the reduction in capital inputs. In MMRF, the capital stock reduction is caused by:

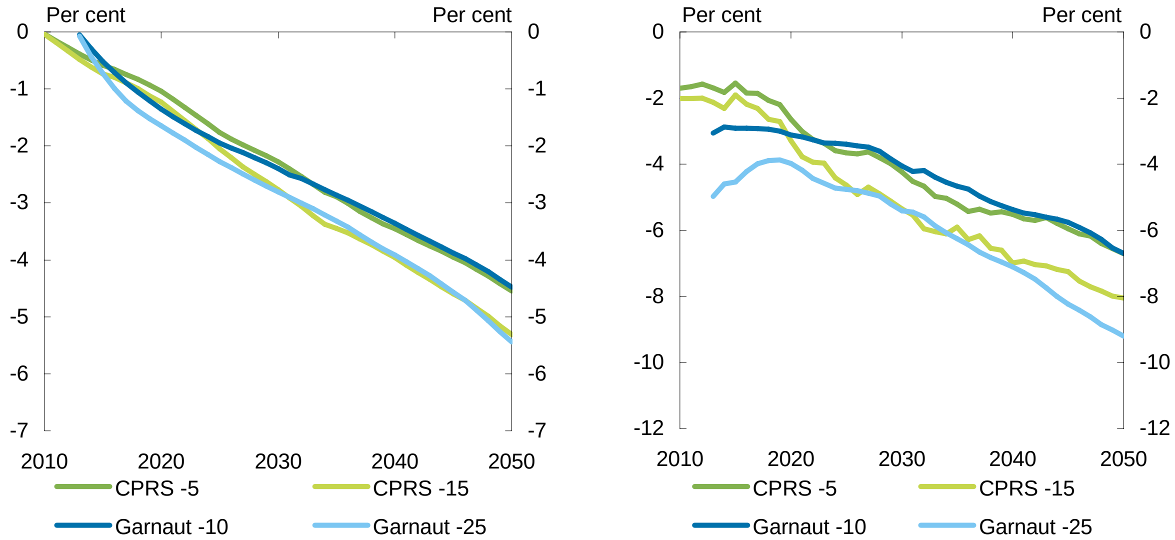
- a decrease in the economy-wide capital to labour ratio in response to an increase in the cost of capital relative to the price of labour; and
- a shift towards low-emission labour intensive sectors (such as services).

An emission price raises the cost of constructing a unit of capital relative to the price of aggregate production as capital goods are relatively emissions and energy intensive. In MMRF, the rate of return on capital is assumed to be fixed by the operation of global capital markets. Therefore, the rental price of capital is effectively indexed to the investment price. Both the investment price and rental price of capital rise relative to the price of production, reducing the incentive for firms to employ capital (relative to other factors, labour and land). As a result, the amount of capital per unit of GDP in the Australian economy falls (capital shallowing), and the aggregate level of investment also falls, relative to the reference scenario (Chart 6.11).

As a consequence, the economy is more labour intensive than in the reference scenario: the greater the mitigation effort, the more pronounced these effects.

Chart 6.11: Capital Stock and Investment

Capital stock — Change from reference scenario | Investment — Change from reference scenario



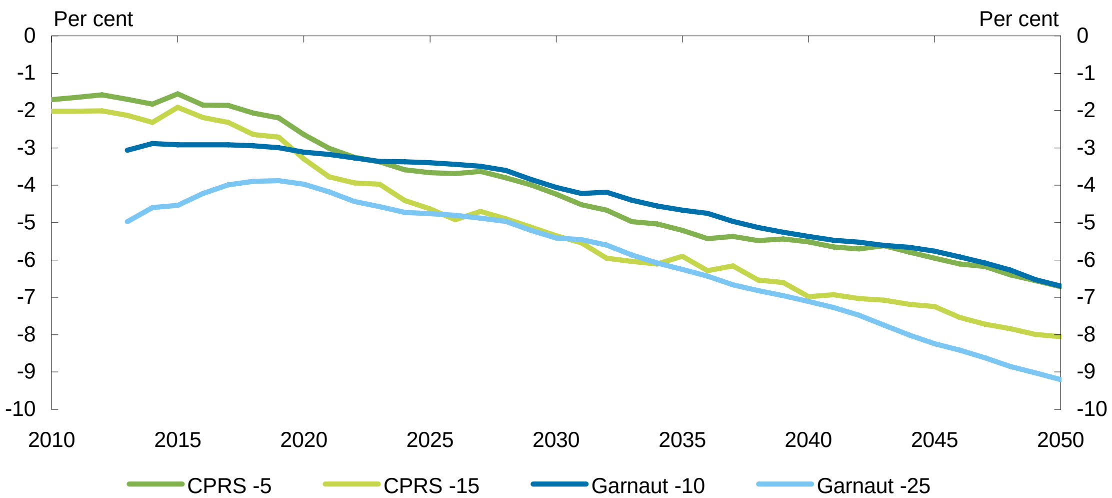
Note: These charts show changes from the reference scenario. The aggregate capital stock and investment continue to grow under all scenarios.
Source: Treasury estimates from MMRF.

In MMRF, real wages are assumed to adjust in the long run to ensure the labour market remains in equilibrium. As output slows slightly in response to emission pricing, firms' demand for labour also slows slightly. In the short run, real wages are assumed to be sticky, taking up to 10 years to adjust, resulting in some temporary unemployment. However over time, real wage growth slows, demand for labour increases, returning employment to reference case levels (Chart 6.12). The progressive increase in the permit price requires steadily increasing real wage adjustments.

Aggregate output is also lower due to compositional changes in the economy. Emission pricing shifts demand to low-emission, labour-intensive sectors. These sectors typically have lower levels and growth of labour productivity, gradually reducing growth in aggregate productivity.

Chart 6.12: Real wages

Change from reference scenario



Note: These charts show changes from the reference scenario. Real wages continue to grow under all scenarios.
Source: Treasury estimates from MMRF.

The effect on investment and capital stocks varies across sectors. Australia's emission and energy-intensive sectors, particularly the mining, metal production and transport sectors, experience a significant decline in rates of return, reflecting lower demand and profitability in an emission-constrained world. As a result, investment in these sectors falls significantly (Table 6.7).

Table 6.7: Industry investment

Change from reference scenario

	CPRS -5 Per cent	CPRS -15 Per cent	Garnaut -10 Per cent	Garnaut -25 Per cent	Reference growth 2010 - 2020
2020					
Agriculture	0.3	0.6	-1.0	-1.2	5.3
Coal Mining	-12.8	-18.1	-8.0	-19.1	-3.6
Other Mining	-2.0	-2.6	-1.1	-2.7	-3.4
Manufacturing	-3.1	-3.6	-3.1	-1.6	0.1
Utilities	-0.8	-1.3	-1.6	-1.9	0.3
Trade	-2.3	-2.7	-2.6	-2.5	1.0
Construction	-4.3	-5.5	-4.9	-6.2	0.3
Transport	-1.6	-2.1	-1.8	-2.9	2.1
Services	-2.3	-2.8	-3.0	-3.8	2.4
2050					
Agriculture	-1.8	-3.0	-1.7	0.9	2.8
Coal Mining	-30.0	-37.1	-25.7	-42.3	1.6
Other Mining	-9.5	-11.2	-7.1	-13.2	0.8
Manufacturing	-1.6	-3.4	-1.3	-2.7	0.6
Utilities	-3.5	-5.1	-3.6	-6.0	1.3
Trade	-4.8	-5.0	-4.8	-4.3	1.5
Construction	-9.1	-10.3	-9.6	-12.6	1.8
Transport	-2.7	-4.0	-2.2	-4.9	1.9
Services	-5.7	-6.7	-6.3	-8.1	2.3

Source: Treasury estimates from MMRF.

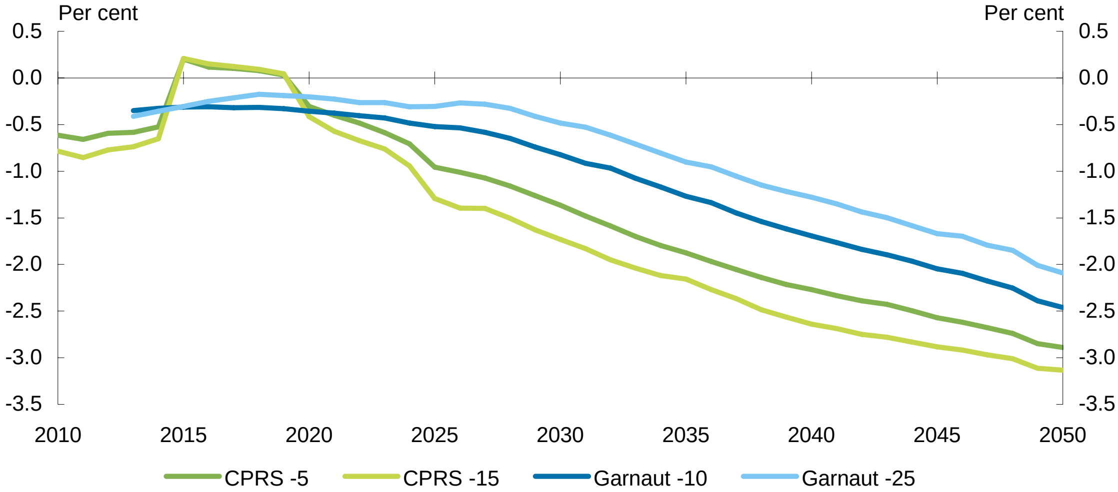
Terms of trade and foreign income transfers

Terms of trade

A decline in Australia's terms of trade relative to the reference scenario — which measure the price of Australia's exports relative to the price of Australia's imports — reduces Australia's income. Global mitigation is likely to lower Australia's terms of trade, through lower world demand for Australia's abundant fossil-fuel resources, particularly coal.

In the Garnaut scenarios, Australia's competitors and trading partners all price emissions. This reduces world demand for energy-intensive exports, most notably coal and natural gas. Australian export prices fall. This, coupled with higher import prices, leads to a fall in Australia's terms of trade. Lower world demand for Australia's energy exports reduces Australia's terms of trade till 2050. The terms of trade stay higher in the Garnaut -25 scenario than the Garnaut -10 scenario because the higher emission price causes earlier and more widespread uptake of carbon capture and storage, boosting world demand for Australian coal exports (Chart 6.13).

Chart 6.13: Terms of trade
Change from reference scenario



Source: Treasury estimates from MMRF.

In the CPRS scenarios, the terms of trade initially decline. However, when China and India join the international coalition this materially affects Australia's terms of trade — the Garnaut scenarios do not show this because all countries are assumed to start together in 2013. In the CPRS scenarios, China's assumed entry into the scheme in 2015 causes global coal prices to jump (as China, a major coal producer, consumer and exporter, prices emissions). Australia's terms of trade then drop when India and the rest of the world join the scheme in 2020, and world demand falls. Australia's terms of trade decline gradually to 2050, reflecting lower world demand for Australia's energy exports. In the CPRS -15 scenario, emissions and electricity are priced higher, so the decline in the terms of trade is larger than in the CPRS -5 scenario.

Some of Australia's declining terms of trade, relative to the reference scenario, would occur if a global scheme was introduced, regardless of whether Australia participated (Box 6.2).

The real exchange rate across all models reflects the terms of trade.

Box 6.2: Unavoidable mitigation cost impacts

Trade effects from other economies' climate change policies mean Australia would face costs even if it did not adopt national emission reduction targets. These costs arise from external factors as a result of other economies' actions, particularly their trade in energy and emission-intensive commodities.

Sensitivity analysis explored this with all economies, except Australia, adopting emission targets (so Australia free rides).

When Australia free rides, the modelled economic costs to Australia are lower. Initially, when fossil fuels dominate energy sources, Australia benefits from a higher terms of trade effect, relative to the reference scenario, resulting from the cost competitive advantage of its commodities. However, by around 2020, Australia's terms of trade fall relative to the reference scenario largely because of reduced global demand for Australia's emission-intensive exports, such as coal and gas.

By 2050, Australian GNP is 0.6 per cent lower than the reference scenario, This estimated cost is much less than the 3.2-5.2 per cent mitigation costs for the policy scenarios.

Source: Treasury estimates from GTEM.

Permit sales

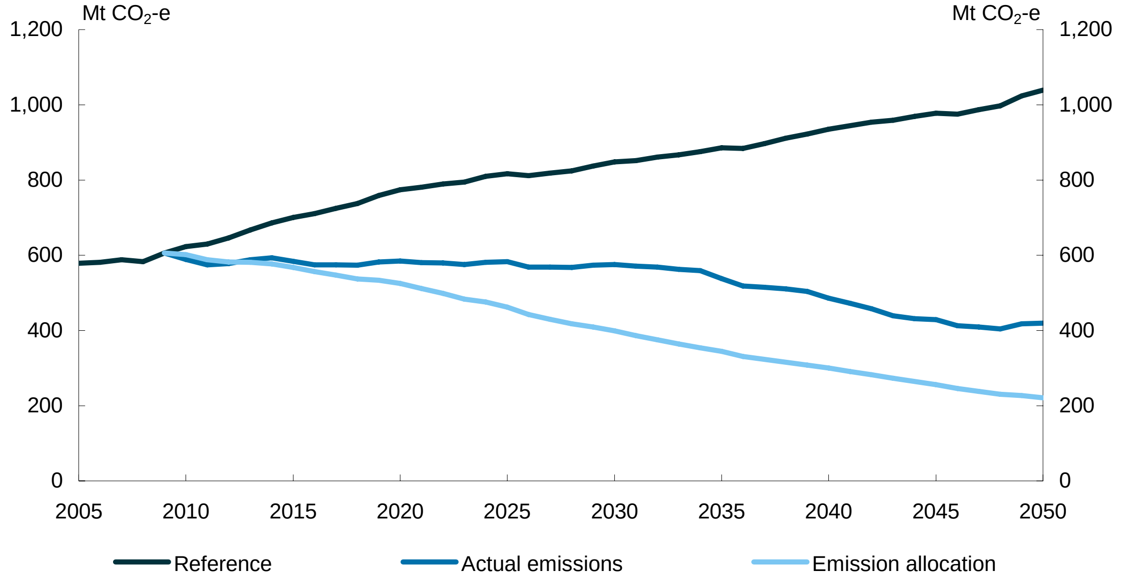
Australia imports permits in all policy scenarios (Chart 6.14 and Table 6.8). Purchasing permits from the international market does not compromise the environmental objective because there is an aggregate global emissions cap. However, Australia's allocation in a global agreement, and any resulting trade in permits significantly affects Australia's mitigation costs.[4]

The cost of purchasing emission permits from overseas results in an income transfer from Australia to other economies. This transfer is determined by Australia's allocation of permits. For a given global emissions trajectory, the greater Australia's initial allocation, the lower the cost faced by Australians and the greater the cost faced by other economies.

Permit allocation and the associated international trade in permits helps explain the difference in costs between the CPRS -5 scenario and Garnaut -10 scenario. The emission price is roughly the same in both scenarios; as a small economy, Australia cannot influence the global emission price. The Garnaut -10 scenario implies a long-term reduction target for Australia of over 80 per cent below 2000 levels (compared to 60 per cent in CPRS -5). Consequently, Australia needs to purchase more permits from overseas in the Garnaut -10 scenario.

4 For a given mitigation task, different emission allocations across economies will result in different income transfers and hence economic cost, while achieving the same environmental goals.

Chart 6.14: Australia's actual emissions, allocations and permit trading
CPRS -5 scenario



Source: Treasury estimates from MMRF.

Table 6.8: Australian allocation, emissions, trade and banking

	Allocation	Emissions	Trade	Banked permits
	Mt CO_2-e	Mt CO_2-e	Mt CO_2-e	Mt CO_2-e
2020				
CPRS -5	525	585	46	63
CPRS -15	470	529	46	48
Garnaut -10	496	608	112	0
Garnaut -25	405	505	100	0
2050				
CPRS -5	221	420	199	0
CPRS -15	221	297	76	0
Garnaut -10	109	425	316	0
Garnaut -25	63	171	108	0

Source: Treasury estimates from MMRF.

Australia purchases fewer overseas permits in the Garnaut -25 scenario than in the Garnaut -10 scenario. In the Garnaut -25 scenario, higher emission prices result in a disproportionate increase in land converted to forestry, resulting in more low-cost mitigation.

The CPRS scenarios constrain international trade in permits, capped at 50 per cent of the national mitigation effort up to 2020. This constraint is not binding in either scenario in either MMRF or GTEM.

Foreign interest payments

Foreign interest payments are affected by changes in exchange rates and the savings to investment ratio. A depreciating exchange rate and/or decreasing savings to investment ratio increase foreign interest payments, reducing GNP. In MMRF the savings to investment ratio increases in the policy scenarios, decreasing foreign debt payments compared with the reference scenario, offsetting GNP losses. In contrast, foreign debt payments in GTEM increase in the policy scenarios as the depreciating exchange rate leads to an increase in foreign interest payments.

Box 6.3: Impact on domestic consumption

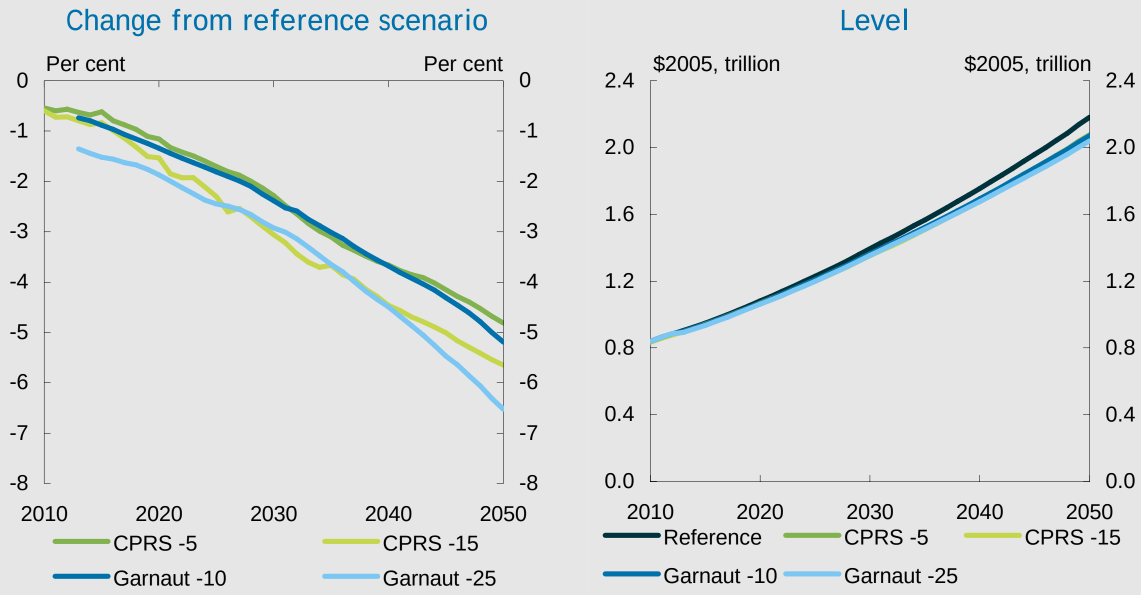
The introduction of an emission price will affect consumption. Consumption is another measure of economic welfare. Domestic consumption is the sum of private consumption and government expenditure on goods and services on behalf of households.

From 2010 to 2050, average annual growth in domestic consumption slows from 2.4 per cent in the reference scenario to between 2.2-2.3 per cent in the policy scenarios.

Domestic consumption falls relative to the reference scenario, but rises strongly through time in all policy scenarios (Chart 6.15).

Private consumption moves in line with GNP. The reduction in private consumption relative to the reference scenario, which results from lower labour and capital income, would be larger if remaining permit revenue were not returned to households.

Chart 6.15: Domestic consumption



Source: Treasury estimates from MMRF.

Box 6.4: Revenue recycling

The Government has committed to return to the community all the revenue raised from the sale of emission permits. The manner of its return is still being considered. Some will be returned to business through shielding emission-intensive trade-exposed industries and assisting other strongly affected industries to partially offset the initial effects of the Carbon Pollution Reduction Scheme (DCC, 2008).

In the modelling it is assumed that the remainder is returned to households through lump-sum transfers.

This is a conservative assumption that assumes no productivity or labour supply benefit from the revenue recycling. Final decisions on how revenue is returned could change the GDP and GNP impacts reported.

6.3 TECHNOLOGY SENSITIVITY ANALYSIS

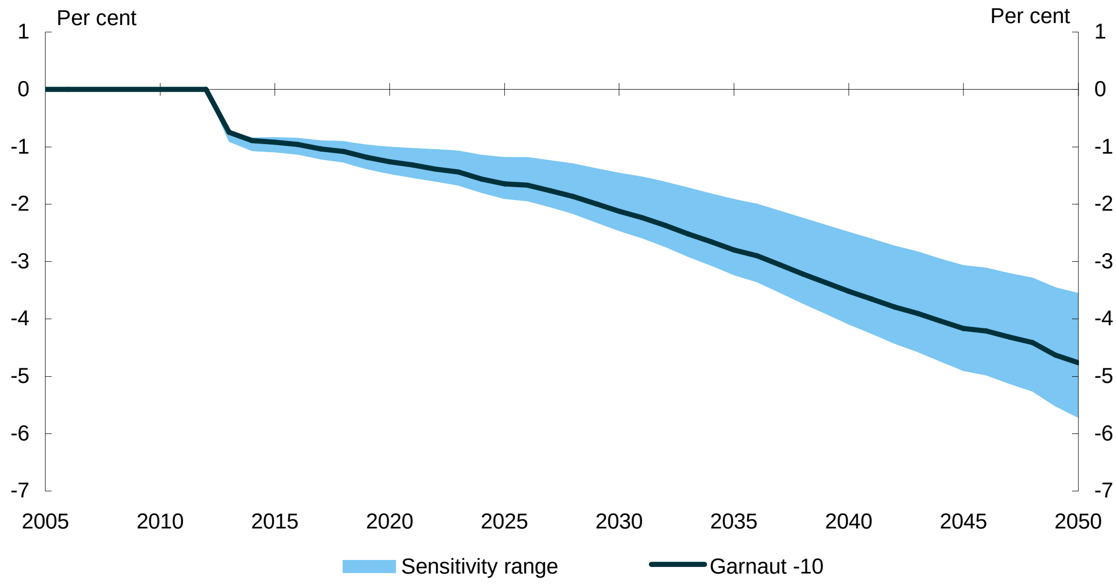
Modelling emission reductions over long timeframes is uncertain. How fast efficiency improvements occur; what low-emissions technologies will be available; when, at what cost, and how effective they will be are sources of uncertainty. Predictions of what mix of technologies will be most cost effective cannot be accurate. This underscores the importance of policies that create incentives for mitigation across all sectors and all technologies, without specifying precise technological pathways.

Progress in developing low-emission technologies is important for global and Australian mitigation costs. Greater technological progress will reduce costs; slower progress will increase costs. Greater technological progress is possible if real emission prices are sustained over time. However, currently uncommercial technological options, such as carbon capture and storage, may prove technically impossible. Sensitivity analysis explores some of these aspects.

The cost of mitigation is highly speculative over time and many of the modelling results in the literature report only to 2030-2050. Many of the more speculative technological sensitivities do not have a major influence on mitigation costs until the emission prices reach high levels, usually after 2050.[5]

The range established by these sensitivity scenarios does not establish firm bounds on the likely eventual cost of global mitigation. Technological progress could be faster than in the optimistic technology cases or slower than in the pessimistic ones. The sensitivities show a wide range of outcomes are possible. In 2050, Australia's GNP loss ranges from 3.6 per cent to 5.7 per cent (Chart 6.16 and Table 6.9). By 2100, the range has widened, from 2.7 per cent to 12.2 per cent.

Chart 6.16: Australian gross national product
Change from reference scenario



Source: Treasury estimates from GTEM.

5 This is the case for the 'backstop' technology options explored by Garnaut (2008).

Table 6.9: Technology sensitivities

Change from reference scenario	2020 Per cent	2050 Per cent	2100 Per cent
Gross World Product			
Garnaut -10 scenario	-0.8	-2.7	-4.1
1) Improved carbon capture and storage technology	-0.8	-2.7	-3.6
2) Extra energy-efficiency improvements	-0.6	-2.3	-3.8
3) Higher learning rates	-0.7	-2.6	-3.1
4) Agricultural backstop	-0.8	-2.7	-3.7
5) Enhanced technology scenario, fully costed	-0.6	-2.2	-4.3
6) Enhanced technology scenario, partly costed	-0.6	-2.1	-2.5
7) Costed MAC curves	-1.1	-4.4	-10.8
8) No carbon capture and storage technology	-0.9	-3.0	-4.7
9) Zero emission carbon capture and storage technology	-0.8	-2.5	-3.5
Australian GNP			
Garnaut -10 scenario	-1.3	-4.8	-7.1
1) Improved carbon capture and storage technology	-1.2	-4.4	-4.4
2) Extra energy-efficiency improvements	-1.0	-3.9	-6.5
3) Higher learning rates	-1.2	-4.1	-5.7
4) Agricultural backstop	-1.2	-4.5	-5.5
5) Enhanced technology scenario, fully costed	-1.0	-3.6	-4.3
6) Enhanced technology scenario, partly costed	-1.0	-3.6	-2.7
7) Costed MAC curves	-1.5	-5.7	-12.2
8) No carbon capture and storage technology	-1.5	-5.7	-8.8
9) Zero emission carbon capture and storage technology	-1.3	-4.4	-4.3

Note: The box on the next page outlines the assumptions used for this table. Weighted in 2005 US dollar purchasing power parity units.
Source: Treasury estimates from GTEM.

Box 6.5: Technology sensitivity details

Nine technology assumptions were tested (Table 6.9).

1. Carbon capture and storage technologies could improve in response to higher emission prices. The CO_2 captured from the combustion of gas or coal increases from 90 per cent to 99 per cent when emission prices rise above US$140/t CO_2-e. This increased capture does not incur any extra cost.

2. Energy-efficiency improvements could expand by an additional 1 per cent per year from 2013 to 2030, with an extra 0.5 per cent from 2031 to 2040 and then no extra improvements. (In the central case, the energy-efficiency improvement rate is 0.5 per cent per year.) Energy-efficiency for households could improve at the rate of 1 per cent from 2013 to 2030, at 0.5 per cent from 2031 to 2040, and then cease to improve. In the central case, the energy efficiency improvement rate for households is set at zero. However, households respond to relative prices by substituting to lower emission-intensive goods. These extra efficiency improvements are costed.

3. A boost to learning rates for electricity and transport technologies occurs by increasing learning parameters by 50 per cent relative to the central assumptions over the whole period. Higher learning rates are costed.

4. Non-combustion agricultural emissions are eliminated when the emission price exceeds US$250/t CO_2-e. This elimination does not incur any costs.

5. Improved carbon capture and storage technology, extra energy-efficiency improvements, higher learning rates and elimination of non-combustion agricultural emissions combine, forming an 'enhanced technology' sensitivity, where all technological changes are costed.

6. The same technology components as in the fully costed enhanced technology are used, but only the higher learning rates and extra efficiency improvements are costed. The improved carbon capture and storage and non-combustion agricultural emissions technologies are not costed.

7. In the central case, the marginal abatement curves (MAC) are not costed. All MACs are costed in an input-neutral way; the benefits from paying for lower emissions due to the MACs being offset by increased primary factor costs.

8. Carbon capture and storage technology does not prove to be viable.

9. Carbon capture and storage technology has zero emissions from the start.

6.4 Impact across states

Real gross state product (GSP) falls in most states/territories (Chart 6.17 and 6.18). Generally, the faster growing states, Queensland and Western Australia, face the greatest impacts from emission pricing. The impacts on real GSP across all mitigation scenarios are broadly comparable, although larger for lower stabilisation levels.

The impact of emission pricing on GSP is heavily influenced by differences in industry composition and the degree of export orientation across states. Without differences in industry structure, real GSP in each region would be expected to move with GDP.

Forestry sequestration provides a significant benefit to the South Australian and Tasmanian economies. In the Garnaut -25 scenario, South Australian GSP is higher than in the reference scenario. In Tasmania, the expansion of forestry results in a decrease in production by other agricultural industries as a result of increased competition for scarce productive land. These states also benefit from growth in low-emission technologies, such as renewable electricity.

The industrial composition of New South Wales is similar to Australia as a whole, so its proportionate loss in GSP is similar to the aggregate GDP impacts.

Victoria is relatively reliant on emission-intensive industries — coal-fired generation, aluminium and gas. Adverse impacts on these industries are, at least partially, offset by improvements in export-oriented or import-competing manufacturing.

In the CPRS scenarios, as the most export orientated state, Western Australia initially is relatively unaffected by emission pricing, as it continues to experience strong demand from developing economies outside the international permit trading scheme, most notably China. The decline in Western Australian GSP reflects the heavy influence of gas production, which eventually declines relative to the reference scenario, due to reduced domestic and foreign demand.

Queensland is projected to experience the largest percentage decline in GSP by 2050 of around 6-8 per cent relative to the reference scenario. Queensland has a heavy reliance on coal-fired electricity and has the highest national share of coal mining production, which is primarily for export. Queensland also accounts for a significant amount of Australia's aluminium production.

Chart 6.17: Gross State Product

CPRS -5 scenario

Change from reference scenario | Level

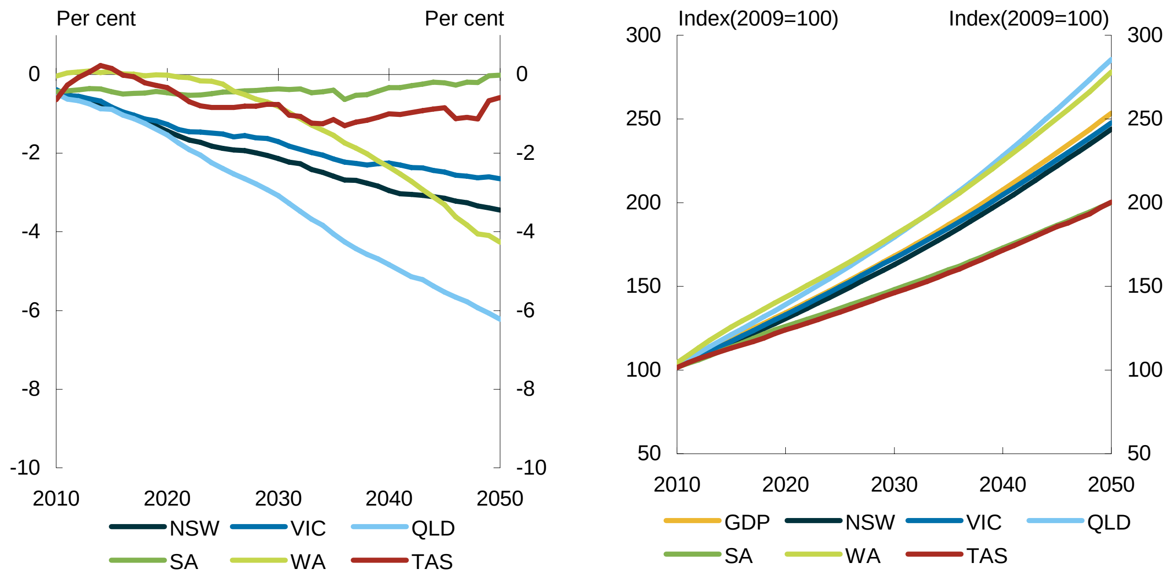
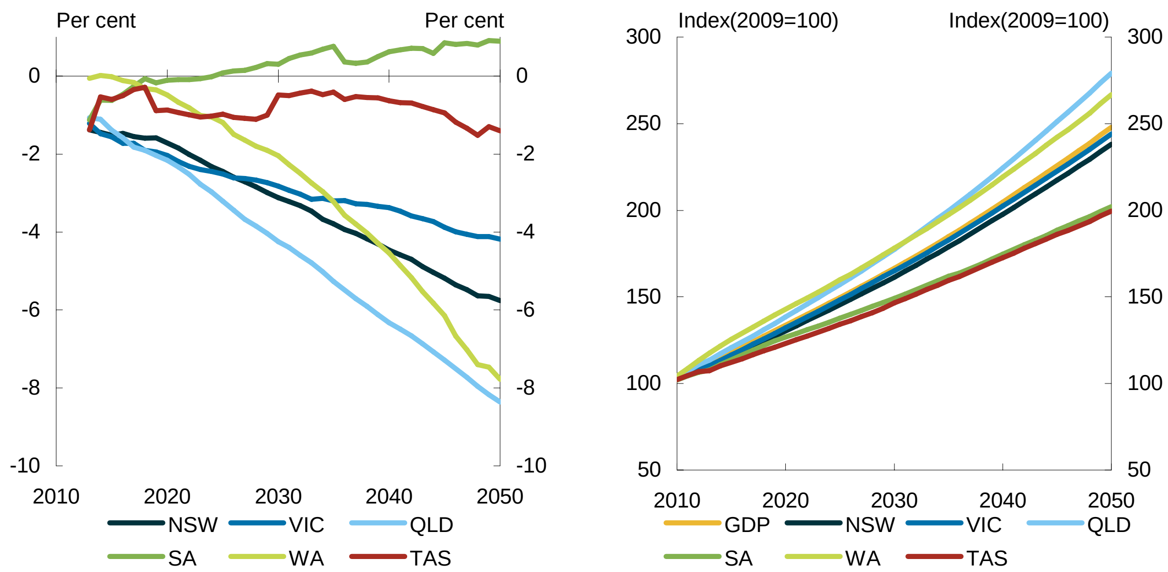


Chart 6.18: Gross State Product

Garnaut -25 scenario

Change from reference scenario | Level



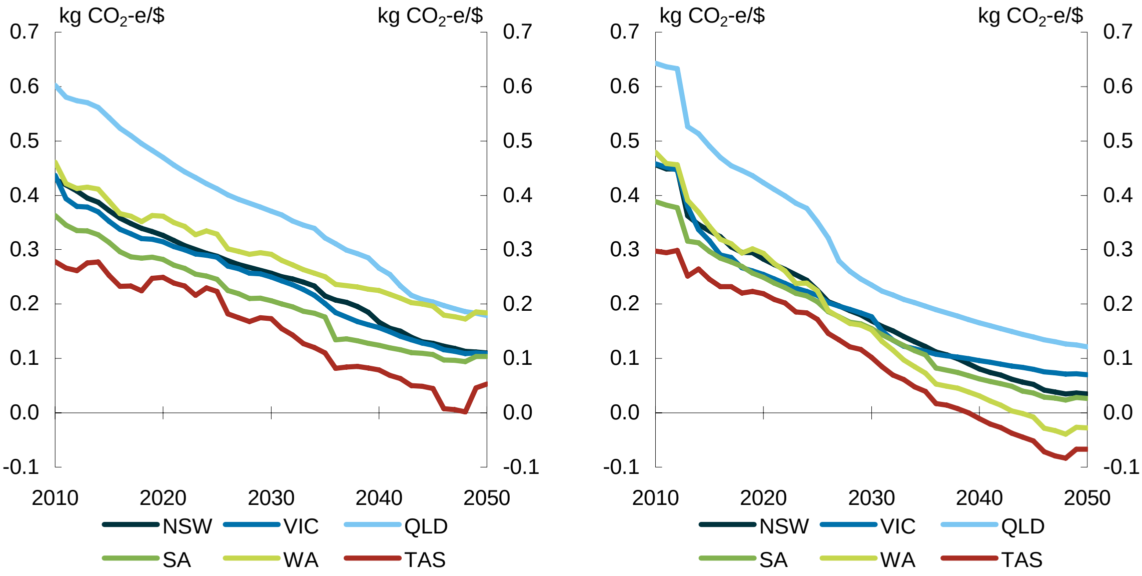
Source: Treasury estimates from MMRF.

6.4.2 Emission intensity

The reduction in emission intensity across sectors is broadly comparable across states. Although the emission intensity of GSP declines across all scenarios and for all states and territories, the rate of decline is different (Chart 6.19). This is due to changes in the composition of industries within the states and changing relative competitiveness of industries. In high mitigation scenarios, such as the Garnaut -25, Tasmania has negative emission intensity due to sequestration from the forestry sector.

Chart 6.19: Emission intensity

CPRS -5 scenario / Garnaut -25 scenario



6.5 IMPACTS AT THE SECTORAL LEVEL

While mitigation policies impose relatively small aggregate costs on Australia, impacts vary widely across sectors.

Sectoral impacts are largely determined by the relative emission intensity of goods and services; degree of trade exposure; the relative emission intensity of production across economies (how Australia compares with other producers); potential mitigation options; and the relative price elasticity of demand (whether consumers substitute away as prices rise) (Table 6.10).

Table 6.10: Impacts at the sectoral level
Change from reference scenario

	Trade-exposed	Non-traded
Emission-intensive	Face reduced world demand, and without unified global action, unable to pass through the increase in costs. Sectors include: metal manufacturing, petroleum refining and agriculture.	Able to pass through some of increased costs but faces reduced domestic demand from higher prices. Sectors include: fossil fuel electricity generation, gas supply and transport.
Low-emission	May benefit from changes in Australia's exchange rate and rising world demand. Sectors include: other manufacturing.	May experience relative price fall or benefit from an emission price due to the creation of new markets. Sectors include: forestry, services and renewable electricity generation.

Pricing emissions drives a structural shift in the economy, from emission-intensive goods, technologies and processes, towards low-emission goods, technologies and processes. As a result, growth slows for emission-intensive sectors, such as coal, gas, iron and steel, and livestock. Growth accelerates for low and negative-emission sectors, such as forestry, renewable energy, and rail transport (Table 6.11).

This structural shift requires a reallocation of resources across the economy. Employment shifts broadly reflect movements in industrial output (Table 6.12).

Pricing emissions also changes Australia's comparative advantage. Australia maintains or improves competitiveness where local production is less energy- or emission-intensive than production of the same good in other countries, such as for coal, and loses competitiveness where local production is more emission-intensive, such as for aluminium.

Lower demand for Australia's emission-intensive commodity exports is projected to generate benefits for other export-oriented and import-competing industries through its impact on Australia's exchange rate.

Non trade-exposed emission-intensive sectors will have a greater ability to pass through at least some of the increase in costs as higher prices. The key sectors are those related to energy production and transport. Over time, these sectors will transform towards lower emission and energy-efficient technologies.

Impacts on non-traded low-emission sectors, such as services, broadly reflect the aggregate impact on the whole economy.

With the exception of electricity generation, the modelling of sectors is aggregated to an industry level so that the impacts on individual firms are not explored. The following section discusses the main results across sectors, followed by more detailed analysis of the electricity, transport and forestry sectors where bottom-up modelling was used.

Effects are broadly consistent across all the scenarios, although sectoral gains and losses are generally larger for lower stabilisation levels.

Table 6.11: Gross output, by sector, 2050

Industry	Change from reference scenario				Change from 2008
	CPRS -5	CPRS -15	Garnaut -10	Garnaut -25	CPRS -5
	Per cent	Per cent	Per cent	Per cent	Per cent
Sheep and cattle	-6.7	-10.2	-6.2	-12.7	88
Dairy cattle	3.9	2.9	4.3	7.9	116
Other animals	2.2	1.7	1.8	4.6	144
Grains	1.5	0.9	1.8	1.7	120
Other agriculture	-0.2	-1.0	0.3	-2.4	211
Agricultural services and fisheries	2.1	2.7	2.4	17.1	189
Forestry	150.1	584.5	166.2	874.9	484
Coal mining	-30.1	-38.0	-25.8	-42.4	66
Oil	-0.4	-0.6	-0.4	-0.6	-75
Gas mining	-17.0	-19.6	-16.5	-21.7	59
Iron ore mining	5.1	6.2	7.5	4.5	234
Non-ferrous ore mining	-5.6	-7.5	-3.8	-9.4	93
Other mining	0.0	-0.7	3.2	-1.8	120
Meat products	-4.8	-7.7	-4.5	-6.9	134
Other food	5.7	5.1	6.2	11.5	140
Textiles, clothing and footwear	5.3	2.8	4.2	-2.4	33
Wood products	8.8	11.9	8.3	10.5	124
Paper products	3.1	2.6	2.9	2.3	87
Printing	1.2	0.8	1.0	0.2	139
Refinery	-37.7	-45.3	-35.0	-52.2	88
Chemicals	1.6	3.8	2.2	6.4	-7
Rubber and plastic products	2.2	2.2	2.5	3.2	39
Non-metal construction products	4.2	6.1	4.6	7.8	92
Cement	-6.0	-6.4	-5.9	-6.9	106
Iron and steel	0.7	-0.2	1.1	-0.6	12
Alumina	-16.8	-24.2	-15.2	-21.3	73
Aluminium	-45.2	-56.3	-48.9	-61.9	-7
Other metals manufacturing	21.1	20.9	22.8	33.5	-71
Metal products	-2.5	-2.8	-2.7	-3.0	54
Motor vehicles and parts	7.8	7.9	7.3	7.3	45
Other manufacturing	5.7	5.1	5.6	4.2	55
Electricity: coal-fired	-71.5	-68.3	-56.3	-65.9	-38
Electricity: gas-fired	12.0	6.8	-1.2	-33.8	132
Electricity: hydro	24.6	-0.6	9.2	31.1	71
Electricity: other	1735.4	1534.8	1302.6	1692.5	2960
Electricity supply	-12.8	-17.4	-13.6	-18.1	71
Gas supply	-2.8	-5.0	-3.2	-8.2	107
Water supply	-2.8	-3.6	-3.1	-4.2	100
Construction	-6.4	-7.6	-6.5	-8.9	145
Trade	-1.8	-1.8	-1.8	-1.1	158
Accommodation and hotels	-3.8	-5.3	-4.4	-7.7	187
Road transport: passenger	-3.4	-5.6	-4.1	-8.5	245
Road transport: freight	-0.5	0.8	-0.3	1.8	189
Rail transport: passenger	10.4	9.5	9.9	6.7	359
Rail transport: freight	-0.1	-1.5	1.2	-4.0	222
Water transport	-1.8	-2.5	-1.6	-2.5	174
Air transport	-1.1	-3.4	-1.7	-7.0	592
Communication services	-3.1	-3.6	-3.4	-4.0	321
Financial services	-1.1	-1.4	-1.3	-1.8	242
Business services	-0.8	-1.2	-0.8	-1.6	327
Ownership of dwellings	-4.2	-5.0	-4.4	-5.2	161
Public services	-0.8	-1.2	-0.9	-1.7	229
Other services	-4.2	-4.8	-4.5	-5.5	170

Note: Output of the forestry sector is based on land area.
Source: Treasury estimates from MMRF.

Table 6.12: Employment, by sector, 2050

Industry	Employment shares				
	Reference	CPRS -5	CPRS -15	Garnaut -10	Garnaut -25
	Per cent	Per cent	Per cent	Per cent	Per cent
Sheep and cattle	1.0	1.0	0.9	0.9	0.9
Dairy cattle	0.2	0.3	0.3	0.3	0.3
Other animals	0.1	0.1	0.1	0.1	0.1
Grains	0.9	1.0	1.0	1.0	1.0
Other agriculture	1.0	1.0	1.0	1.0	1.0
Agricultural services and fisheries	0.5	0.5	0.5	0.5	0.6
Forestry	0.1	0.2	0.6	0.2	1.0
Coal mining	0.2	0.1	0.1	0.1	0.1
Oil	0.0	0.0	0.0	0.0	0.0
Gas mining	0.1	0.0	0.0	0.0	0.0
Iron ore mining	0.1	0.1	0.1	0.1	0.1
Non-ferrous ore mining	0.2	0.2	0.2	0.2	0.2
Other mining	0.1	0.1	0.1	0.1	0.1
Meat products	0.3	0.3	0.3	0.3	0.3
Other food	0.7	0.8	0.8	0.8	0.9
Textiles, clothing and footwear	0.2	0.2	0.2	0.2	0.2
Wood products	0.3	0.3	0.3	0.3	0.3
Paper products	0.1	0.1	0.1	0.1	0.1
Printing	0.6	0.6	0.6	0.6	0.6
Refinery	0.1	0.0	0.0	0.0	0.0
Chemicals	0.1	0.1	0.1	0.1	0.1
Rubber and plastic products	0.1	0.1	0.1	0.1	0.1
Non-metal construction products	0.1	0.1	0.1	0.1	0.1
Cement	0.1	0.1	0.1	0.1	0.1
Iron and steel	0.1	0.1	0.1	0.1	0.1
Alumina	0.0	0.0	0.0	0.0	0.0
Aluminium	0.1	0.0	0.0	0.0	0.0
Other metals manufacturing	0.0	0.0	0.0	0.0	0.0
Metal products	0.3	0.3	0.3	0.3	0.3
Motor vehicles and parts	0.2	0.2	0.2	0.2	0.2
Other manufacturing	0.7	0.8	0.8	0.8	0.8
Electricity: coal-fired	0.1	0.0	0.0	0.0	0.0
Electricity: gas-fired	0.0	0.0	0.0	0.0	0.0
Electricity: hydro	0.0	0.0	0.0	0.0	0.0
Electricity: other	0.0	0.1	0.1	0.1	0.1
Electricity supply	0.1	0.1	0.1	0.1	0.1
Gas supply	0.0	0.0	0.0	0.0	0.0
Water supply	0.1	0.1	0.1	0.1	0.1
Construction	6.8	6.6	6.5	6.6	6.4
Trade	13.7	13.7	13.8	13.8	13.9
Accommodation and hotels	6.5	6.4	6.3	6.4	6.1
Road transport: passenger	0.4	0.4	0.4	0.4	0.4
Road transport: freight	0.7	0.7	0.7	0.7	0.7
Rail transport: passenger	0.0	0.0	0.0	0.0	0.0
Rail transport: freight	0.2	0.2	0.2	0.2	0.2
Water transport	0.7	0.7	0.7	0.7	0.7
Air transport	0.7	0.7	0.7	0.7	0.7
Communication services	0.6	0.6	0.6	0.6	0.6
Financial services	3.2	3.2	3.2	3.2	3.2
Business services	23.3	23.5	23.4	23.5	23.3
Ownership of dwellings	0.0	0.0	0.0	0.0	0.0
Public services	21.1	21.2	21.1	21.2	21.0
Other services	12.9	12.6	12.5	12.6	12.4

Source: Treasury estimates from MMRF.

6.5.1 Impacts on trade-exposed emission-intensive sectors

Australian output of some exports, such as mining (particularly coal and gas), resource processing (including metal manufacturing and refining), manufacturing (including chemicals, rubber and plastic products) and agriculture (particularly sheep and cattle), generally grows more slowly in the policy scenarios, as world demand slows and consumers across the world substitute towards lower-emission commodities.

Where Australia has relatively low-emission intensity of production, emission pricing improves Australia's competitiveness and is likely to increase its share of global trade in that commodity. This could partially or wholly offset the effect of slowing global demand growth. Where Australia has relatively high-emission intensity, competitiveness declines and Australia's share of global trade is likely to fall (Box 6.6).

Australia's share of global trade increases for coal, and is broadly maintained for iron and steel. Australia's share of global trade falls for aluminium, given its relatively higher emission intensity of production in Australia.

Box 6.6: Sectoral impacts and structural adjustment

The difference between changes relative to the reference scenario, and changes relative to the level of current activity, is important in assessing structural adjustment needs.

The economy will adjust from its current structure. Mitigation policies will change the pattern of future economic activity, so the reference scenario economy of 2050 will not eventuate. Today's economy, therefore, provides a useful reference point.

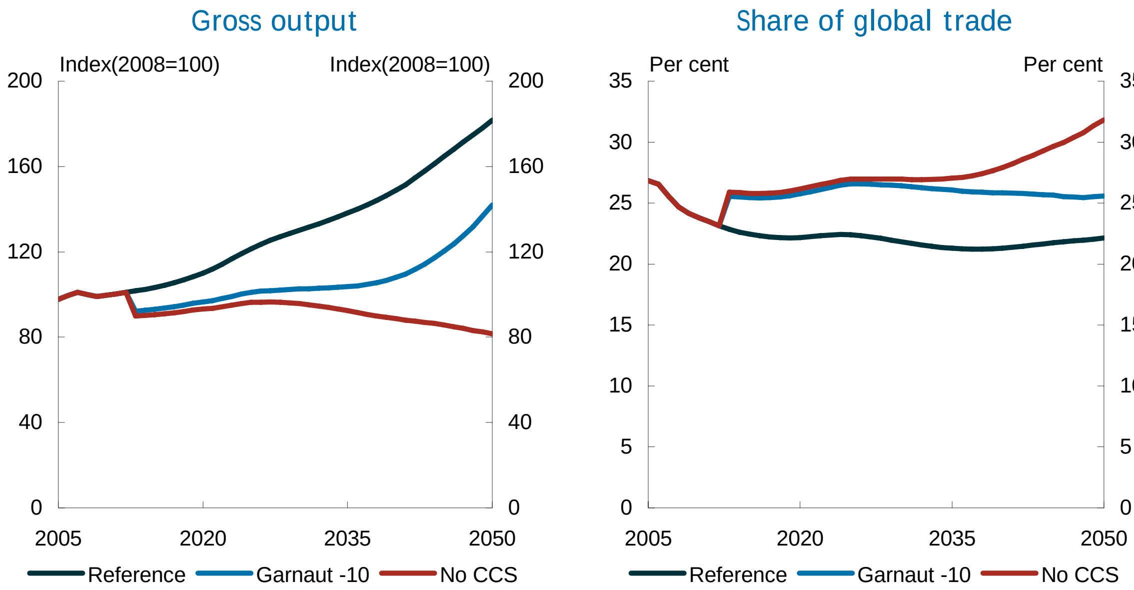
The policy scenarios project large reductions in the output of some sectors relative to the reference scenario. However, output from most of these sectors is projected to grow from current levels; the reductions relative to the reference scenario mean they grow more slowly than they would in a world without climate change (Table 6.11).

Within sectors, some firms and regions could face a serious adjustment task, including early plant closures. The transition will need careful management. The Government is committed to supporting affected workers and regions where required, and has proposed special measures to manage impacts on emission-intensive trade-exposed sectors and coal-fired generators (DCC, 2008a).

In the medium to long term, employment and investment will move to other lower-emission sectors (Table 6.12).

The future of coal depends heavily on the development of carbon capture and storage technologies. Without such technologies, Australia's coal production could fall to 4 per cent below current (2008) levels by 2030, and 18 per cent below by 2050. Overall, across the four scenarios (which assume this technology is viable) Australia's coal output falls relative to the reference scenario, but grows relative to current levels. If carbon capture and storage is not viable, coal output falls below current levels (Chart 6.20).

Chart 6.20: Australia's coal sector



Source: Treasury estimates from GTEM.

Without unified global action, such as in the CPRS scenarios, an emission price may distort the international competitiveness of Australia's emission-intensive trade-exposed sectors. Free allocation of some permits to these sectors, in accordance with the shielding arrangements proposed in the *Carbon Pollution Reduction Scheme Green Paper*, partially offsets any loss of competitiveness while maintaining incentives for these sectors to reduce emissions. Shielding imposes modest costs on other (unshielded) sectors, particularly through its impact on permit trading, electricity prices and capital and labour (Box 6.8).

All trade-exposed emission-intensive sectors reduce emissions relative to the reference scenario. Emission reductions in the Garnaut -25 scenario are greatest, reflecting the higher emission price (Chart 6.21). The Garnaut -25 scenario also employed very flexible marginal abatement curves (MACs); whereas, the CPRS -5 scenario adopts a smoother transition consistent with the multi-staged entry of economies into the scheme.

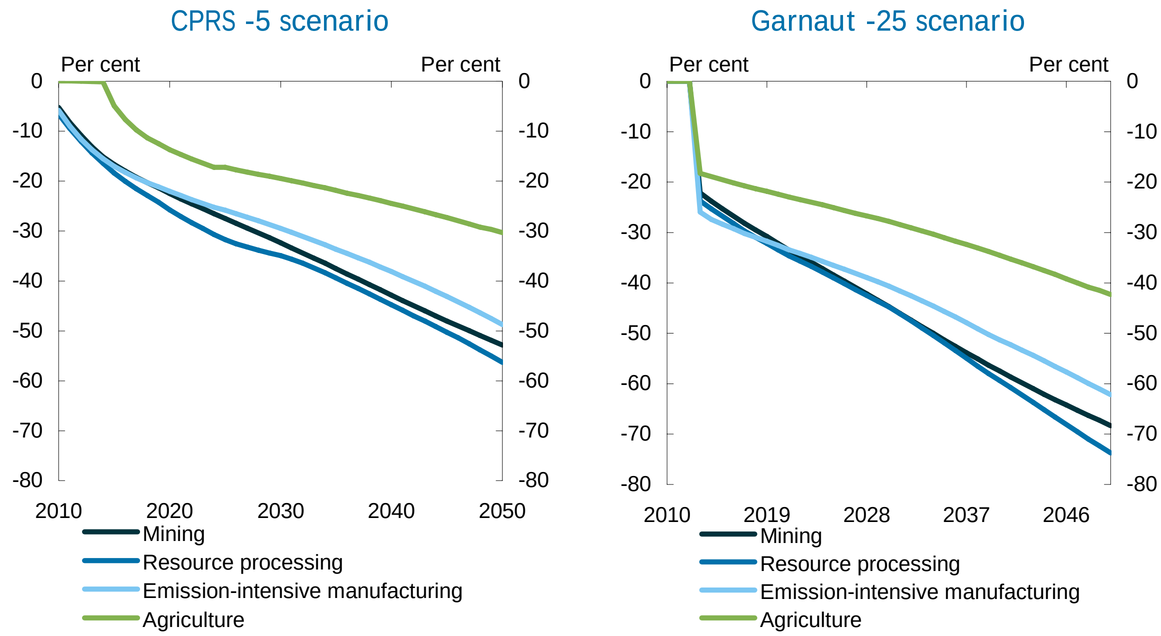
Differences in mitigation across sectors largely reflect differences in marginal costs of mitigation. Mitigation in mining and resource processing is the largest, while in agriculture it is the smallest, but still significant, with around a 30 per cent reduction relative to the reference scenario in 2050.

In the CPRS scenarios, deferring coverage of agriculture until 2015 delays emission reductions from this sector. Once agriculture joins the scheme, it is expected to have fewer mitigation options than other sectors. Australia retains a comparative advantage in agriculture in a low-emission world, so it tends to maintain agricultural output.

The fall in output in the mining and resource processing industries, as a result of lower world demand, also contributes to the fall in emissions in these sectors, especially after 2025.

Chart 6.21: Trade-exposed emission-intensive industries - emissions

Change from reference scenario



Source: Treasury estimates from MMRF.

Many large industrial processes rely heavily on energy as an input into production, and comprise a significant share of stationary energy emissions. The switch away from high-emission energy sources for industrial processes will occur over a long timeframe, and may not start until sectors can substitute towards low-emission electricity.

Box 6.7: Impact on competitiveness in a multi-stage world: the role of shielding

Coordinated global efforts help ensure any changes in Australia's comparative advantage arise from real differences in the emission intensity of production, rather than from uncoordinated policy action. Competitiveness distortions may arise where Australia prices emissions before other economies: emission-intensive trade-exposed sectors (EITES) could move to other locations that are more emission intensive than Australia, but not yet pricing emissions. As a result, global emissions could rise, a process called 'carbon leakage'.

The Government proposes transitional assistance for EITES when it introduces the Carbon Pollution Reduction Scheme, to reduce carbon leakage and support the transition to a low-emission economy (DCC, 2008a). This transitional assistance 'shields' EITES from the full effect of emission pricing. Crucial features of the proposed shielding are that shielded firms face a strong incentive to reduce emissions, even if they obtain free emission permits, and that the level of shielding gradually declines.

The risk of carbon leakage and cost of shielding is explored in the CPRS scenarios, which assume Australia prices emissions ahead of many other regions.[6]

The results show little evidence of carbon leakage. Where shielding is not applied, there is a small change in the emissions and output from EITES in non-participating regions. This suggests the emission prices in these scenarios are not high enough to induce significant industry relocation. Noticeable impacts only occur at higher emission prices (roughly double the price of the CPRS -5 scenario).

Nevertheless, shielding does reduce the impact of emission pricing on shielded sectors in the initial years of the scheme. When shielding is applied, output of EITES falls at a more gradual rate, relative to the reference scenario (reflecting the contraction in world demand). This suggests the shielding arrangements proposed in the *Carbon Pollution Reduction Scheme Green Paper* could ease the transition to a low-pollution future for the shielded sectors.

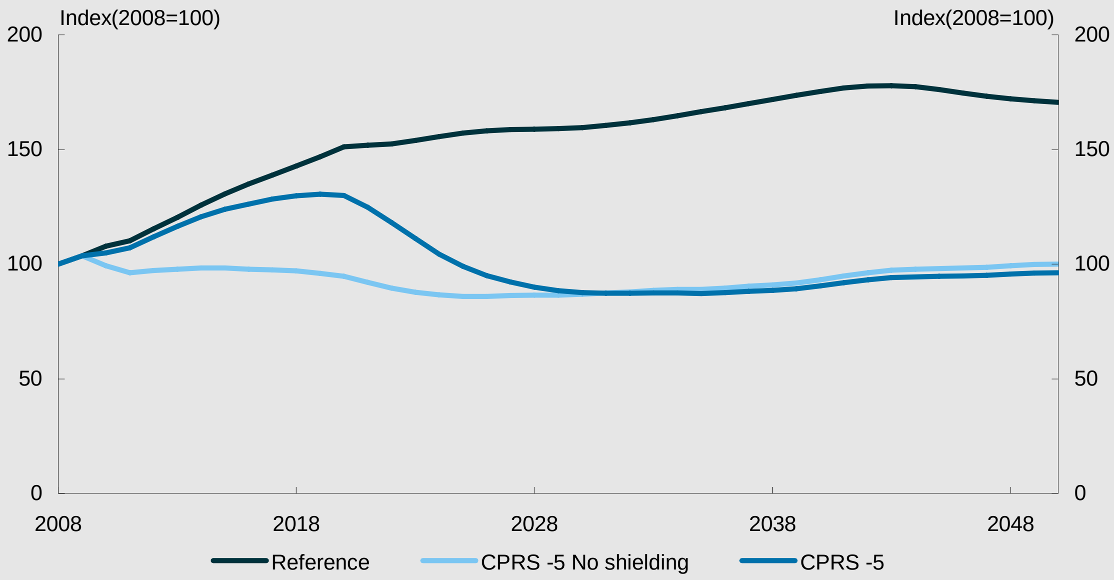
The very emission-intensive non-ferrous metals sector (aluminium) benefits most from shielding, and there is some evidence of benefits to other very emission-intensive sectors (such as sheep and beef cattle, once agriculture is included in the scheme). The aluminium sector's significant emission cost increases are offset when shielding is applied (Chart 6.22). However, once the sector is no longer shielded, as the rest of the world joins the scheme, aluminium sector output falls.

Shielding redistributes costs from shielded to unshielded sectors, through its impact on electricity prices (higher output in EITES brings greater demand for electricity and higher prices), and affects permit trading. Higher output in EITES means that Australia imports more permits to meet its emission target. Shielding also redistributes costs among shielded sectors, by diverting labour and capital from more to less competitive EITES.

6 The Garnaut scenarios assume emission pricing is introduced in all economies at the same time, so no carbon leakage occurs.

Box 6.7: Impact on competitiveness in a multi-stage world: the role of shielding (continued)

Chart 6.22: Australian aluminium output relative to current levels
Shielding and no shielding



Source: Treasury estimates from MMRF.

Redistribution effects would be greater if shielding mutes mitigation incentives, if a greater proportion of permit revenue is devoted to shielding, or if more permits could not be imported (because international permit trade was more limited).

Both GTEM and MMRF are likely to overestimate carbon leakage and the relocation of production activities: the models are not forward-looking (so firms are assumed to take no account of the possibility of future emission prices in the new location), and do not account for adjustment costs associated with relocation. In reality, industry location reflects multiple factors, including access to skilled labour, legal and political stability, access to resources and quality of infrastructure.

These results suggest that fears of carbon leakage, for the emission prices explored in the CPRS scenarios, may be overplayed.

6.5.2 Non-traded emission-intensive sectors

Firms producing non-traded emission-intensive commodities, such as electricity, gas, and transport services, are able to pass on much of the increase in costs to consumers as higher prices. This leads to a fall in demand, particularly where alternative low-emission commodities are available, or in the case of energy, opportunities to improve efficiency. Over time, firms will face competitive pressure to transform towards low-emission and energy-efficient technologies.

Output from the construction sector grows more slowly in the policy scenarios owing to slowing demand for dwellings, non-residential buildings and infrastructure.

6.5.3 Non-traded low-emission sectors

Demand for low-emission commodities increases, particularly where they provide an alternative to higher-emission commodities, or the emissions trading market creates a new source of revenue.

These effects are evident in the forestry sector. Consumers substitute towards wood products (a low-emission good) and forests sequester carbon and generate credits for sale in an emissions trading scheme.[7]

Forestry's expansion has flow-on effects for some agricultural sectors, particularly cattle and sheep grazing. These activities compete for land, so as forestry expands, livestock production contracts (relative to the reference scenario). This effect strengthens in the scenarios with lower stabilisation levels, as the higher emission prices make forestry even more profitable than competing land uses.

The modelling may overstate impacts on agriculture, as the MMRF model does not differentiate between different land types (high quality agricultural land versus marginal land). If forest expansion occurs predominantly on marginal land, agricultural output may be relatively less affected.

Output from the services sector grows, but more slowly than in the reference scenario, reflecting the effect of reduced consumption due to lower incomes (Table 6.11).

6.5.4 Traded low-emission sectors

Global demand for Australia's coal and aluminium falls in a low-emission world. As a result, Australia's terms of trade fall relative to the reference scenario. This in turn causes Australia's exchange rate to depreciate, which improves the competitiveness of many other export-oriented and import-competing industries, including manufacturing. Wood products; textiles, clothing and footwear; and non-meat food benefit from the lower exchange rate, and increase output relative to the reference scenario. Chemical manufacturing, iron ore mining, dairy and grains also benefit from the lower exchange rate (Table 6.11).

6.5.5 Electricity sector

Electricity generation accounts for the largest share of Australia's current emissions, so Australia's transition to a low-emission future will require a significant transformation in this sector. Australia has a range of options available to assist with this transition, including significant gas, wind, solar and geothermal resources. Furthermore, Australia's significant coal resources could play an important role in an emission-constrained world if carbon capture and storage technology proves commercial.

To explore how Australia's electricity sector could respond to emission reduction policies, bottom-up modelling was integrated into MMRF to capture the interactions between the electricity sector and the broader economy.[8]

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7 The *Carbon Pollution Reduction Scheme Green Paper* proposes allowing reforestation activities to opt into the scheme from its start in 2010 (DCC, 2008a).

8 Annex A describes the process for linking MMA's bottom-up electricity model with MMRF.

Electricity generation was analysed in the context of a national and international mitigation framework by imposing the emission price path. This approach to modelling the electricity sector did not impose a specific emission reduction target on the electricity generation sector alone.[9]

The modelling also examined the interaction of the emission price with pre-existing and proposed national and state electricity sector policies, including the Government's proposed Mandatory Renewable Energy Target, the Victorian Renewable Energy Target (VRET) and the Queensland Gas Scheme. In the Garnaut scenarios, all such policies ceased once emission pricing began in 2013. In contrast, the CPRS scenarios included the Government's proposed expanded Renewable Energy Target and continued the Queensland Gas Scheme.[10]

Emissions

The emission price drives significant changes in the mix of technologies and fuels used in the electricity sector in all policy scenarios. The emission price makes gas and renewable energy sources more competitive against coal, leading to a progressive transition away from conventional coal-fired generation. However, coal continues to play a role in electricity generation with the adoption of carbon capture and storage.

The sector is almost decarbonised by 2050 (Table 6.13). By 2050, the remaining emissions come from carbon capture and storage, and remaining efficient coal and gas power plants, some of which provide back up to solar thermal plants.[11]

Table 6.13: Electricity sector emissions reductions

	CPRS -5	CPRS -15	Garnaut -10	Garnaut -25
	Per cent	Per cent	Per cent	Per cent
2020 emissions				
Relative to 2000	3.8	1.1	15.2	-11.1
Relative to reference	-31.7	-33.4	-23.8	-35.9
2050 emissions				
Relative to 2000	-64.6	-49.3	-61.6	-73.8
Relative to reference	-82.3	-74.6	-80.7	-87.8

Source: Treasury estimates from MMRF.

Output

In all sectors, electricity demand falls relative to the reference scenario after an emission price is introduced. Contraction in economic activity (relative to the reference scenario) and increased electricity prices subdue demand. The reduction in electricity demand leads to immediate emissions mitigation.

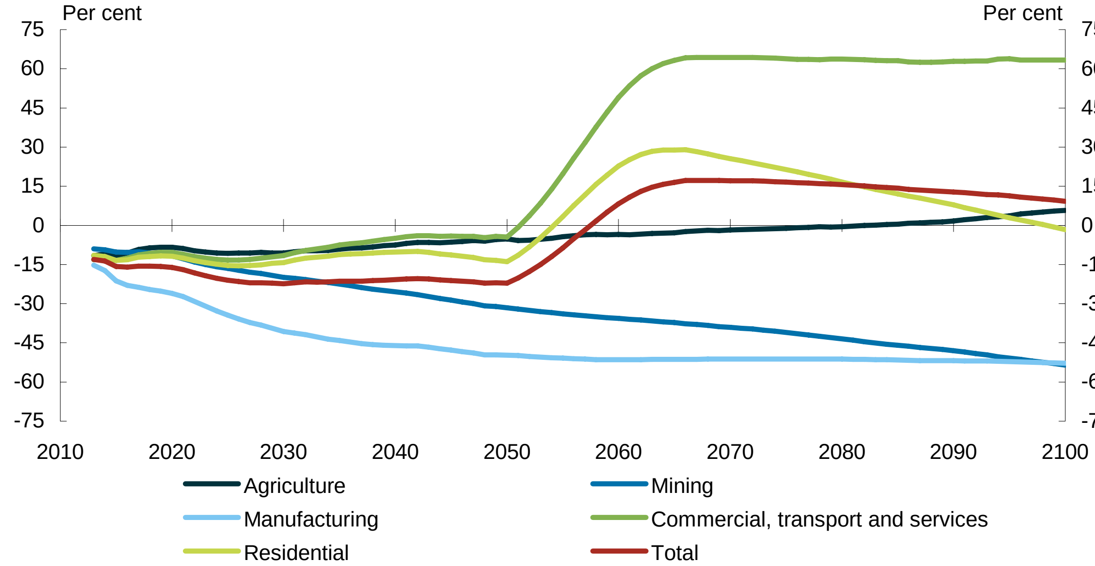
In 2050, electricity demand is around 22 per cent below the reference scenario in the Garnaut -25 scenario (Chart 6.23). Manufacturing declines are mostly driven by aluminium.

The Garnaut -25 scenario, which was extended to 2100, shows an aggregate rise in electricity demand after 2050. This reflects the transport fleet and other energy users switching to low-emission electricity for energy.

9 For an example of where emission constraints were imposed, see Energy Supply Association of Australia (2008).
10 Annex A describes the treatment of the state and national policies in the scenarios.
11 Carbon capture and storage is not assumed to capture all emissions in the MMA modelling.

Chart 6.23: Electricity demand

Change from reference scenario, Garnaut -25 scenario



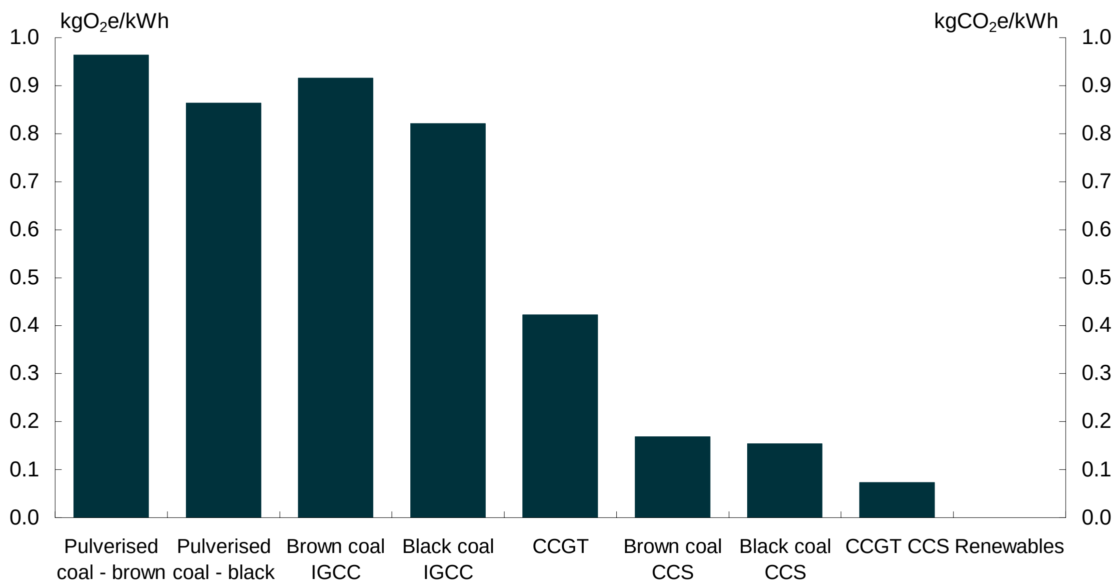
Source: Treasury estimates from MMRF.

Transformation of the electricity sector

In the reference scenario, coal continues to dominate Australia's electricity generation. In the policy scenarios, the emission price stimulates a transformation towards low and zero emission sources of electricity.

In the short term, the electricity sector switches from coal to gas, which has around half the emission intensity of coal, and renewables, which are emissions free (Chart 6.24). In the CPRS scenarios, the transition to renewables, primarily wind, is more rapid owing to the requirements of the expanded Renewable Energy Target.

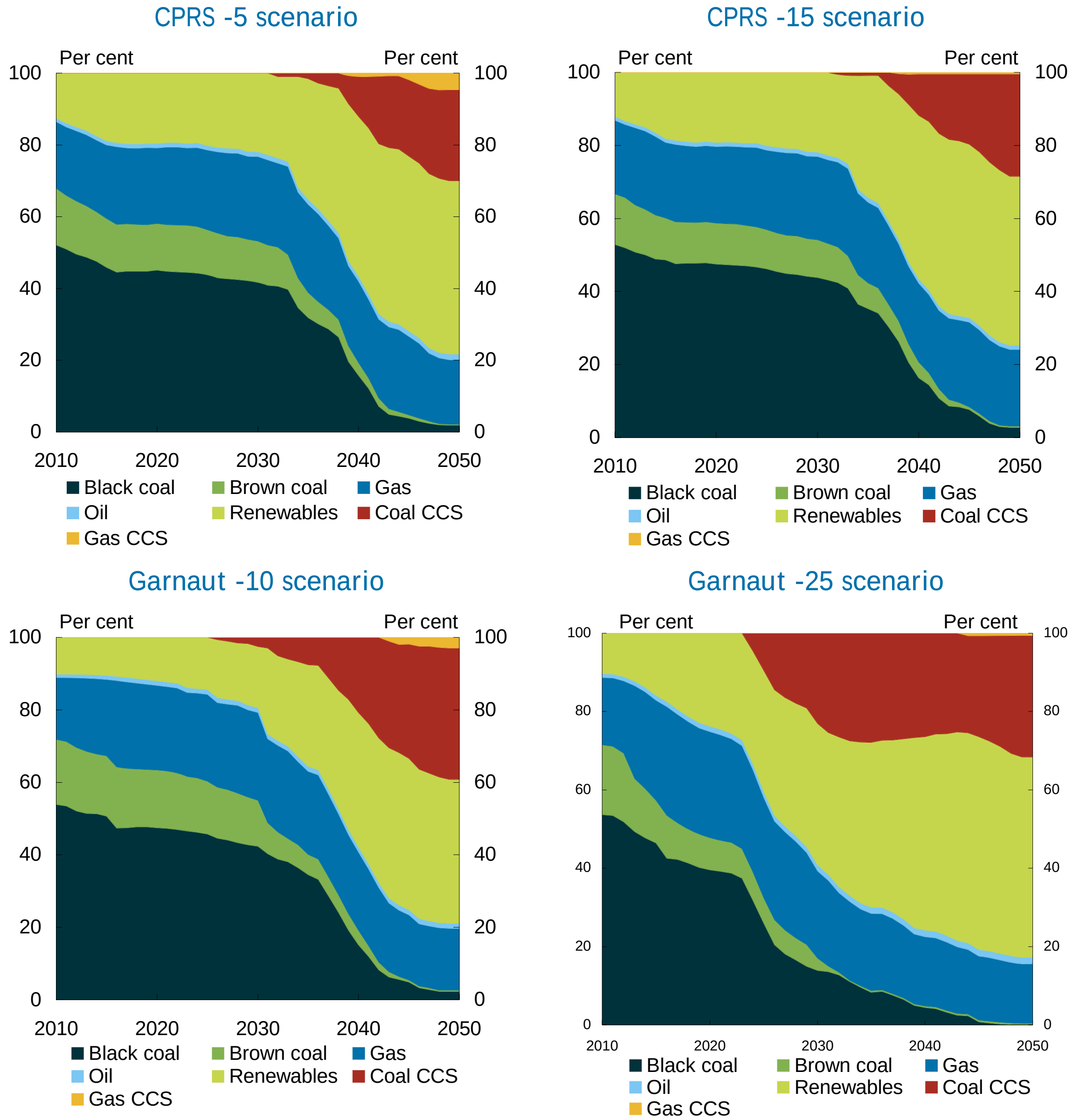
Chart 6.24: Emission intensity of electricity technologies



Note: Emission intensities are for new capacity in 2010. IGCC: Integrated gasification combined cycle; CCGT: combined cycle gas turbine; and CCS: carbon capture and storage.
Source: MMA.

During the 2020s and 2030s, carbon capture and storage technology starts to be deployed, and some existing power plants retrofit carbon capture technologies. By 2050, the share of electricity generated by carbon capture and storage ranges from 28 per cent in the CPRS -15 scenario to 39 per cent in the Garnaut -15 scenario. The share of renewables continues to rise strongly through the 2020s and 2030s. By 2050, the share of renewables is 40-51 per cent in the policy scenarios, compared with just over 5 per cent in the reference scenario (Chart 6.25).

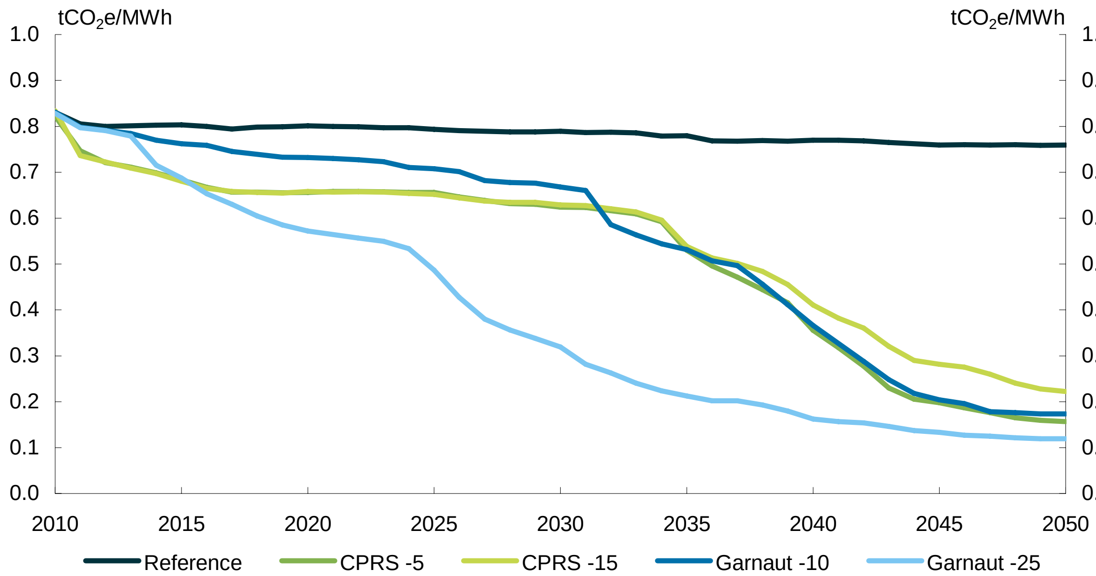
Chart 6.25: Technology shares of generation



Source: MMA.

Transforming the fuel and technology mix reduces the emission-intensity of electricity supply (Chart 6.26). While electricity demand drops in the policy scenarios compared with the reference scenario, most emission reductions are achieved through reduced emission intensity. Emission intensity falls most in the Garnaut -25 scenario, reflecting the faster uptake of renewables and carbon capture and storage owing to higher emission prices. By 2050, in the Garnaut -25 scenario, the emission intensity of electricity generation is around 0.1 tCO_2-e/MWh, around 85 per cent less than in the reference scenario.

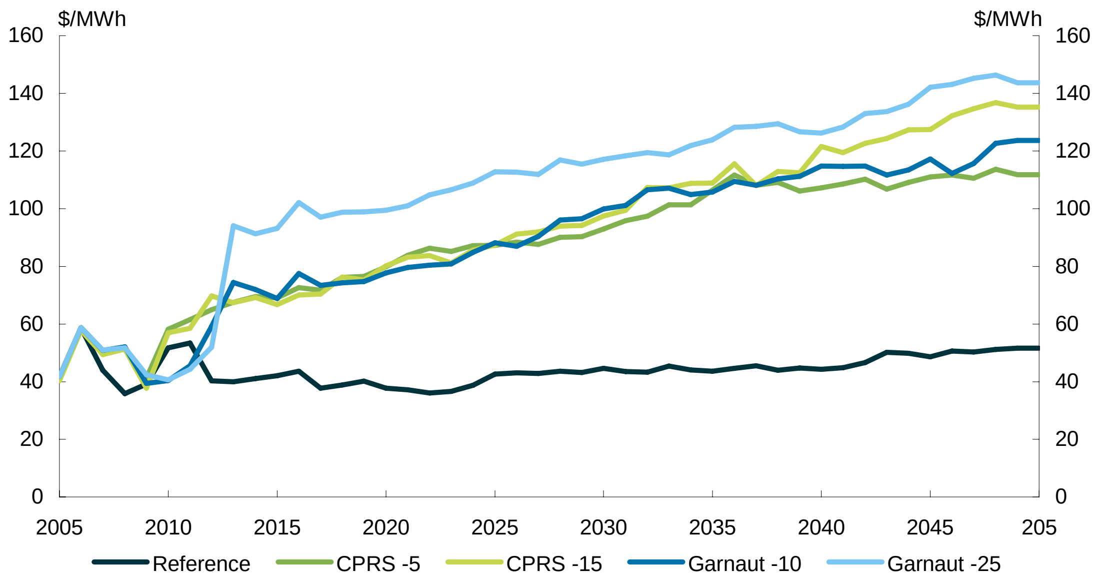
Chart 6.26: Emission intensity of electricity generation



Source: Treasury estimates from MMRF and MMA.

Pricing emissions and adopting low-emission technologies increase the cost of electricity for consumers. The short-term cost of the emission price on existing fossil fuel power plants feeds into electricity prices, making Australian wholesale electricity prices around 50-130 per cent higher (in real terms) than in the reference scenario (Chart 6.27). The medium and longer term deployment of more expensive low-emission technologies causes electricity prices to continue to increase, although by less than the increase in the cost of electricity from coal-fired sources, as low-emission technologies increase market share. By 2020 average wholesale prices could be 80-150 per cent higher, rising to 120-190 per cent higher by 2050 (Table 6.14)

Chart 6.27: Average Australian wholesale electricity prices



Note: Prices in mid-2007 dollars.
Source: MMA.

Table 6.14: Average wholesale electricity price increase
Change from reference scenario

	CPRS -5			CPRS -15			Garnaut -10			Garnaut -25		
	2010-15	2015-20	2045-50	2010-15	2015-20	2045-50	2013-15	2015-20	2045-50	2013-15	2015-20	2045-50
	Per cent			Per cent			Per cent			Per cent		
NSW	65	108	128	69	111	185	93	106	156	145	170	199
VIC	57	120	144	56	121	201	87	113	133	157	197	225
QLD	66	109	159	73	107	192	116	112	190	194	195	218
SA	50	72	62	49	69	116	83	85	83	125	126	104
TAS	40	96	74	44	102	112	76	91	70	144	166	127
SWIS	22	37	104	22	31	118	26	40	100	52	71	143
NT	10	10	27	14	15	39	6	10	36	17	24	84
Avg	48	86	122	48	84	164	75	86	134	126	146	186

Note: SWIS is the South-West Interconnected System in Western Australia. Projected increases in 2010-15 in the CPRS scenarios are muted by a projected spike in reference scenario prices early in that period. Values shown are averages across each period.
Source: MMA.

Higher wholesale electricity prices flow into retail prices which are faced by households (Table 6.15). In the initial years of emission pricing, average electricity prices faced by households increase by 20 per cent for the CPRS -5 scenario and 38 per cent for the Garnaut -25. The effect on households is muted by rising real incomes over time.

Table 6.15: Average household electricity price increases
Change from reference scenario

	CPRS -5			CPRS-15			Garnaut -10			Garnaut -25		
	2010-15	2015-20	2045-50	2010-15	2015-20	2045-50	2013-15	2015-20	2045-50	2013-15	2015-20	2045-50
	Per cent			Per cent			Per cent			Per cent		
NSW	23	27	33	25	29	48	25	24	41	38	39	52
VIC	23	30	37	23	31	52	25	26	35	44	46	59
QLD	21	25	37	24	26	45	26	24	44	44	41	51
SA	21	22	20	21	22	38	26	23	27	39	35	34
TAS	16	25	22	18	27	33	21	21	21	40	39	38
SWIS	11	14	34	12	13	39	10	13	33	20	23	47
NT	5	5	12	7	7	17	3	5	16	9	11	37
Avg	20	25	34	22	26	46	23	23	38	38	38	51

Note: SWIS is the South-West Interconnected System in Western Australia. The modelling assumes that wholesale price increases are passed through into retail prices. Values shown are averages across each period.
Source: MMA.

A key difference between the GDP impacts in GTEM and MMRF is the modelling of the electricity sector (Box 6.8).

Box 6.8: Modelling of electricity generation in GTEM and MMRF

Modelling of the Australian electricity sector is different in GTEM and MMRF; MMRF uses bottom-up modelling from MMA. The crucial difference is the level of detail. MMA modelling replicates actual short- and long-term market conditions; GTEM modelling is stylised to capture the long-term, high level trends.

MMA models the establishment, operation and retirement of individual electricity generating units in Australia, with specific assumptions about cost, performance and fuel use. It incorporates transmission between states and network infrastructure. In contrast, GTEM aggregates 12 technologies (three conventional fossil fuels, seven renewables and two carbon capture and storage). The share of electricity from each technology in GTEM is largely determined by technology price changes.

Demand for electricity from MMRF was divided by MMA into grid and off-grid, and modulated into base-load, intermediate and peak demand. GTEM can model fuel switching, but does not differentiate types of demand. The pre-existing and proposed national and state policies modelled by MMA were either not included in GTEM or modelled in a stylised fashion.

An important difference affecting the aggregate GDP impact in GTEM and MMRF is the wholesale electricity price. MMA sets wholesale electricity prices through the marginal generator, modelling strategic bidding behaviour by individual generators, consistent with the operation of the National Electricity Market. In contrast, GTEM determines wholesale electricity prices using the weighted average of the long-term marginal costs of all technologies. This approach produces significantly lower electricity prices and mitigation costs in GTEM.

In the longer term, as a result, energy consumers within GTEM substitute from fossil fuels towards electricity as it becomes more competitive. Electricity is competitive because its price is decoupled from the emission price through the uptake of clean generation technologies. As a result, electricity generation expands considerably in GTEM in the long term relative to the reference case. The substitution away from fossil fuels to electricity within industry and households enables the economy to significantly reduce emissions, resulting in lower economic costs per unit of mitigation in GTEM.

While the emission price adds to the cost of electricity from fossil fuels, both gas and coal continue to play important roles in the sector. Coal-fired electricity's share declines after emission pricing is introduced, with several existing fossil fuel power plants retiring earlier than in the reference scenario (Box 6.9). However, with electricity prices increasing due to the emission price, most existing power plants continue to operate. The assumed convergence of east coast gas prices to export parity also helps coal-fired electricity maintain its competitiveness for base-load generation.

Despite this, gas generation benefits from emission pricing, as it has a lower emission intensity (Chart 6.28). The share of gas in total generation at 2030 ranges from 22-24 per cent in the policy scenarios compared with 17 per cent in the reference scenario. In the Garnaut -25 scenario, gas generation declines in the longer term because of the high emission prices, lower electricity demand and the greater uptake of renewables.

Box 6.9: Early retirement of power plants

The retirement of several existing fossil fuel power plants, either fully or partially, owing to reduced profitability, does not lead to power shortages. The reduced demand for electricity and new investment in lower-emission sources ensures demand for electricity is met.

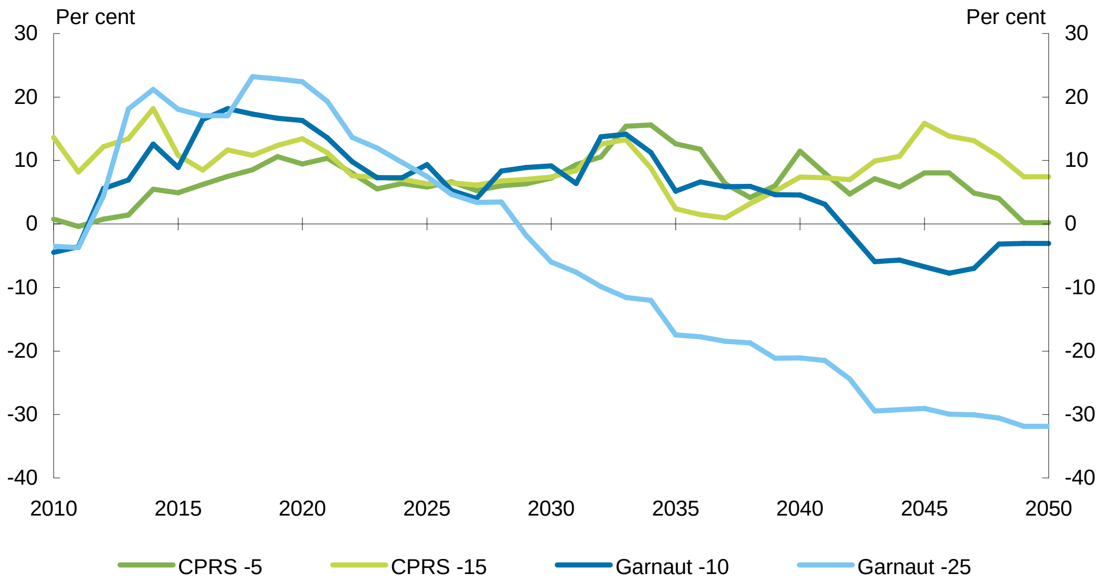
As with all industries adversely affected by emission pricing, the early retirement of power plants could lead to adjustment costs for firms and employees, such as through retraining and relocation.

Early retirement is most significant in the Garnaut -25 scenario, where the starting emission price is highest and reduction in demand for electricity is greatest. Electricity sector emissions in 2020 are 42 per cent below the reference scenario and 12 per cent below 2000 levels. Full or partial early retirement before 2020 could occur in Victoria, New South Wales, Queensland and South Australia.

This report projects retirement of electricity generation units by modelling them as physical economic assets. It does not take account of the impact of financial considerations, such as debt-equity ratios or ownership structures, on retirement decisions. In reality, these may be interrelated. The *Carbon Pollution Reduction Scheme Green Paper* identified the coal-fired generation sector as a strongly affected industry and proposed support comprising three elements: (1) direct assistance; (2) support for the development and deployment of carbon capture and storage technologies, including through existing programs; and (3) commitments to address particular impacts of the scheme on workers, communities and regions through various structural adjustment assistance packages as required (DCC,2008a). The modelling in this report does not account for this commitment.

Chart 6.28: Gas-fired electricity generation

Change from reference scenario

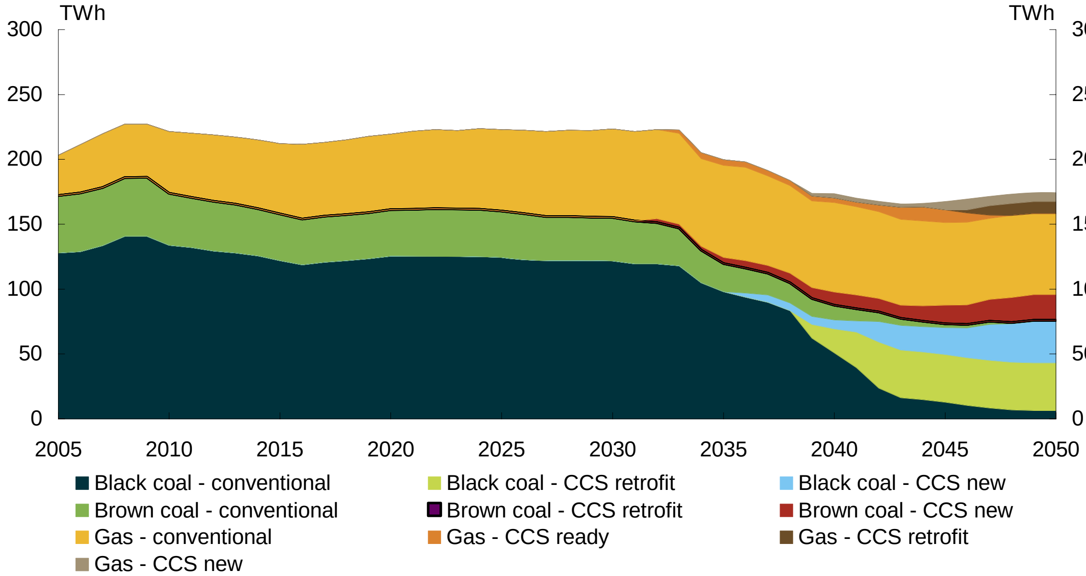


Source: MMA.

The longer-term role of coal depends on the development and deployment of carbon capture and storage. Carbon capture and storage is taken up by the electricity sector through building new carbon capture and storage power plants, building power plants 'capture ready' then installing carbon capture and storage operations, and retrofitting existing power plants.

Chart 6.29: Coal and gas generation

CPRS -5 scenario



Source: MMA.

Carbon capture and storage reduces emissions but adds to the capital and operating costs of generating electricity. Installation will only occur when the additional costs are more than covered by savings on emission permits. The earliest year when carbon capture and storage is deployed in the scenarios will depend on when the investment is profitable (Table 6.16).

Table 6.16: Carbon capture and storage, estimated deployment year and emission price

	CPRS -5	CPRS -15	Garnaut -10	Garnaut -25
Year	2033	2033	2027	2026
Emission price (A$2005/t$CO_2$-e)	59	82	45	75

Source: MMA.

Carbon capture and storage requires the transport of significant quantities of carbon dioxide to sites for sequestration, and infrastructure and regulatory frameworks. It will create new industries and employment opportunities. In the CPRS -5 scenario, the annual rate of carbon capture and storage sequestration rises to around 128 Mt CO_2 by 2050. The total amount of CO_2 stored in 2050 is 945 Mt, distributed across Queensland (38 per cent), Victoria (35 per cent) and New South Wales (27 per cent).

The expanded Renewable Energy Target

The Carbon Pollution Reduction Scheme provides incentives to increase deployment of renewable electricity generation technologies. The emission price increases the cost of generating fossil fuel-fired electricity, which in turn raises the cost relative to renewables, which are emission free.

The Government is committed to providing additional support to deploy renewable energy beyond the Carbon Pollution Reduction Scheme with an expanded Renewable Energy Target. To assess the impact of an expanded Renewable Energy Target on the electricity sector and the economy more broadly, a sensitivity scenario around the CPRS -5 scenario was explored. This sensitivity excluded the expanded Renewable Energy Target.

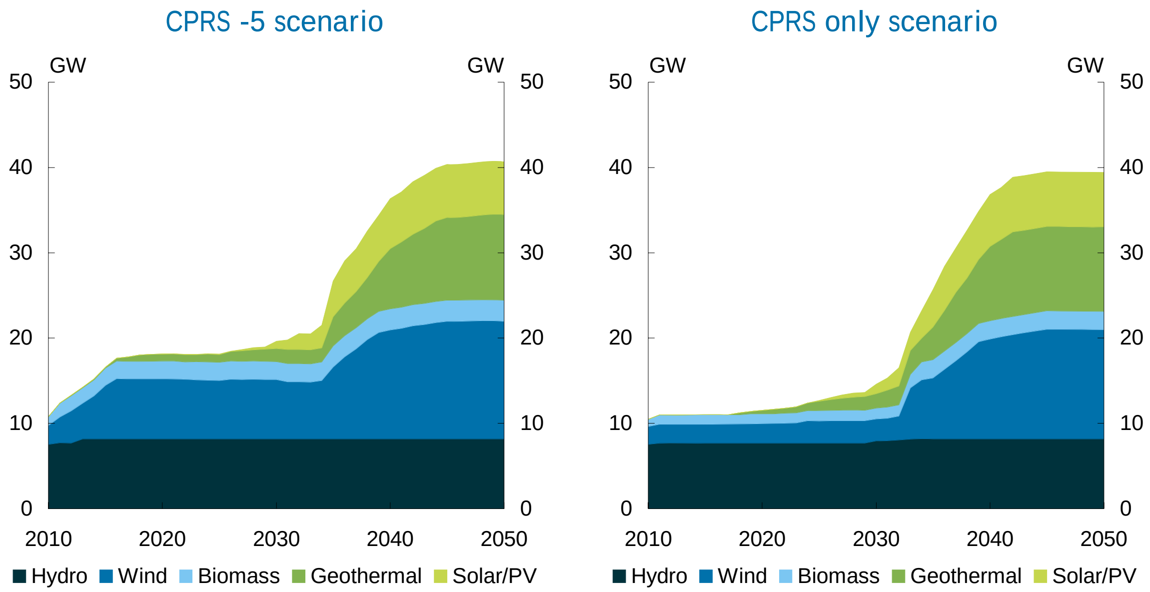
Box 6.10: The expanded Renewable Energy Target

The Mandatory Renewable Energy Target scheme started in 2001. It aims to increase the deployment of renewable energy in Australia's electricity supply by guaranteeing a market for additional renewables-based generation. Parties who buy wholesale electricity (retailers and large users) must source an increasing percentage of their electricity purchases from renewables-based generation. This is implemented through tradeable renewable energy certificates, where one certificate equals one megawatt-hour (MWh) of renewable energy.

In 2007, the Government committed to ensuring that 20 per cent of Australia's electricity supply — approximately 60,000 gigawatt-hours (GWh) — comes from renewable energy sources by 2020. To implement this, the Government will expand the Renewable Energy Target to 45,000 GWh by 2020 to help ensure that, together with the approximately 15,000 GWh of existing renewable capacity, Australia reaches the 20 per cent target by 2020. The Government also will bring the national Renewable Energy Target and existing state-based targets into a single national scheme (DCC, 2008b).

The expanded Renewable Energy Target provides additional support for the renewable electricity sector and lowers emissions from the electricity sector (Chart 6.30). With the expanded Renewable Energy Target in place, investment in renewables is higher between 2010 and 2030. Most of the additional renewables are wind and biomass; these account for 72 per cent and 14 per cent of the additional renewable capacity in 2020. The amount and timing of geothermal and solar thermal deployment are only marginally affected by this policy, since they are more expensive than other low-emission options.

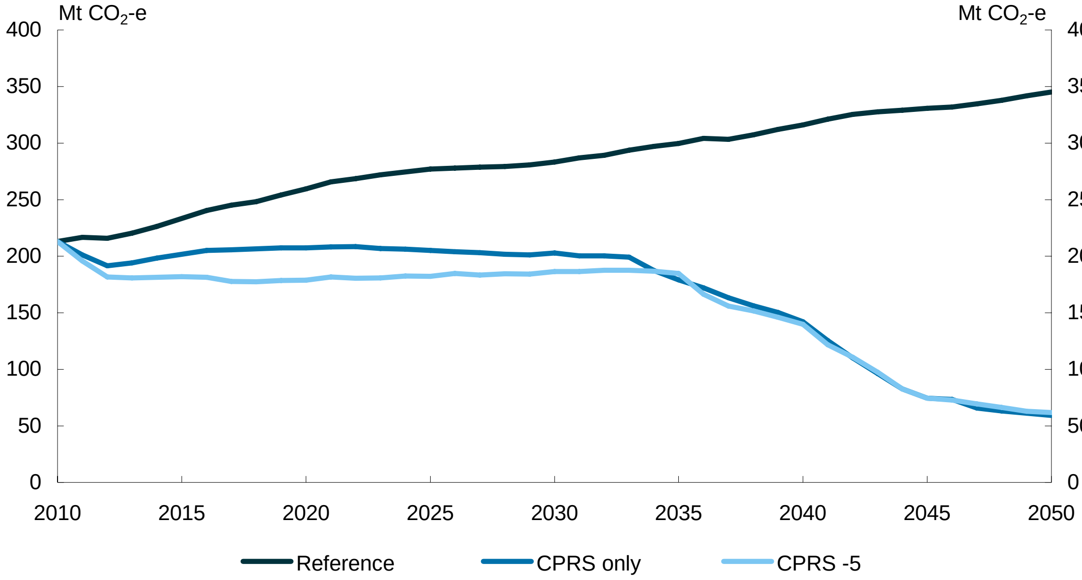
Chart 6.30: Renewables capacity



Source: MMA.

The cumulative mitigation attributed to the expanded Renewable Energy Target from 2010 to 2050 is 308 Mt CO_2-e, just over 5 per cent of the total mitigation undertaken in the CPRS -5 scenario (Chart 6.31).

Chart 6.31: Electricity sector emissions



Note: CPRS only scenario excludes the expanded Renewable Energy Target.
Source: Treasury estimates from MMRF.

Expanding the renewable energy target affects the rest of the electricity sector. Adoption of more renewables crowds out gas-fired generation and accelerates the transition away from coal, resulting in additional early retirement of existing fossil fuel power stations.

The expanded Renewable Energy Target also affects the broader economy as electricity retailers purchase renewable energy certificates from eligible renewable electricity generators. The certificate prices reflect the additional resource costs, in terms of capital, labour and other inputs, required to generate electricity from the new renewable sources. The cost of the renewable certificates is assumed to be passed on to customers as higher retail electricity prices: these rise by 2-4 per cent from 2010 to 2020. These higher resource costs would increase GDP costs. By 2020, GDP costs could be around 0.1 per cent higher than from an emission price alone.

Additional mitigation in the renewable energy target will not lower domestic emission prices if the Australian emission price is linked to the global price. Instead, fewer permits will be bought from the world market, reducing the income Australia transfers overseas.

The impact on GNP of the expanded Renewable Energy Target, taking into account both the increased GDP costs and the reductions in international income transfers, is $5.0-5.5 billion, when estimated as a net present value using real discount rates of 4-8 per cent. The average cost of the mitigation (per tonne of CO_2-e) from expanding the renewable energy target is around three times the average permit price from 2010 to 2020.

6.3.2 Transport sector

Emission pricing drives significant reductions in the emission intensity of transport, through changing fuel mix, vehicle types and transport modes. The transport sector has relatively high mitigation costs, and delivers less mitigation in the short term.

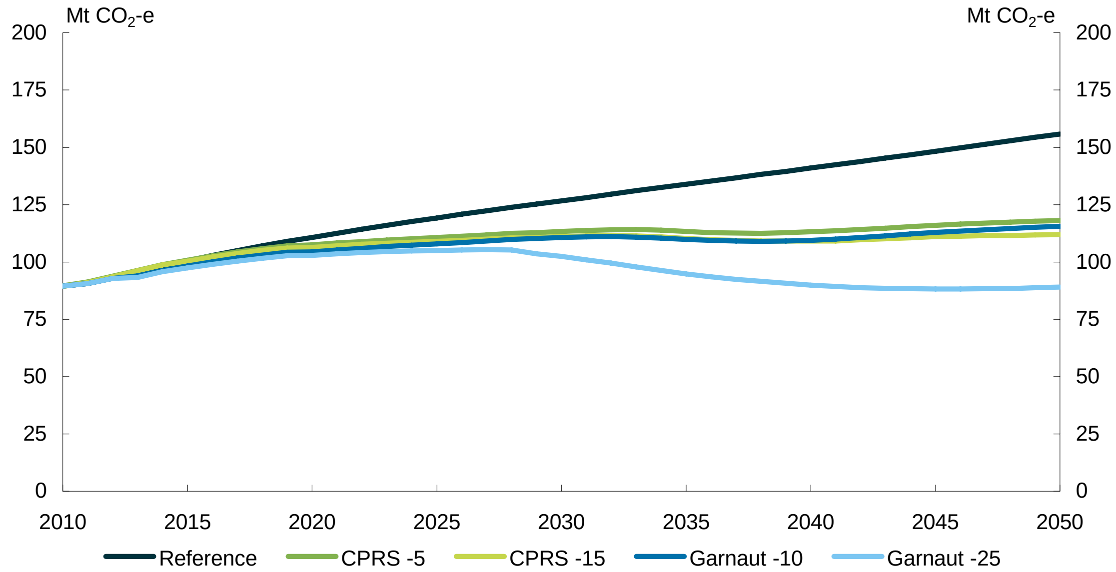
Three forces transform the transport sector: (1) lower demand; (2) less energy used per trip; and (3) fewer emissions per unit of energy used. Reduced demand comes from reduced economic activity and substitution from transport into other areas of economic activity. Less energy use per unit of transport comes from consumers choosing smaller and/or more fuel-efficient vehicles. Fewer emissions per unit of energy come from substitution to lower emission fuels.

The responsiveness of different transport activities to emission pricing varies. Road passenger transport responds most strongly; water transport is least affected.

6.3.2.1 Emissions

Emissions fall substantially across all transport modes relative to the reference scenario (Chart 6.32). In 2050, emissions are around 30 per cent lower than the reference scenario and around 5 per cent lower than 2006 levels in all scenarios except the Garnaut -25. In the Garnaut -25, emissions are around 40 per cent lower than the reference scenario.

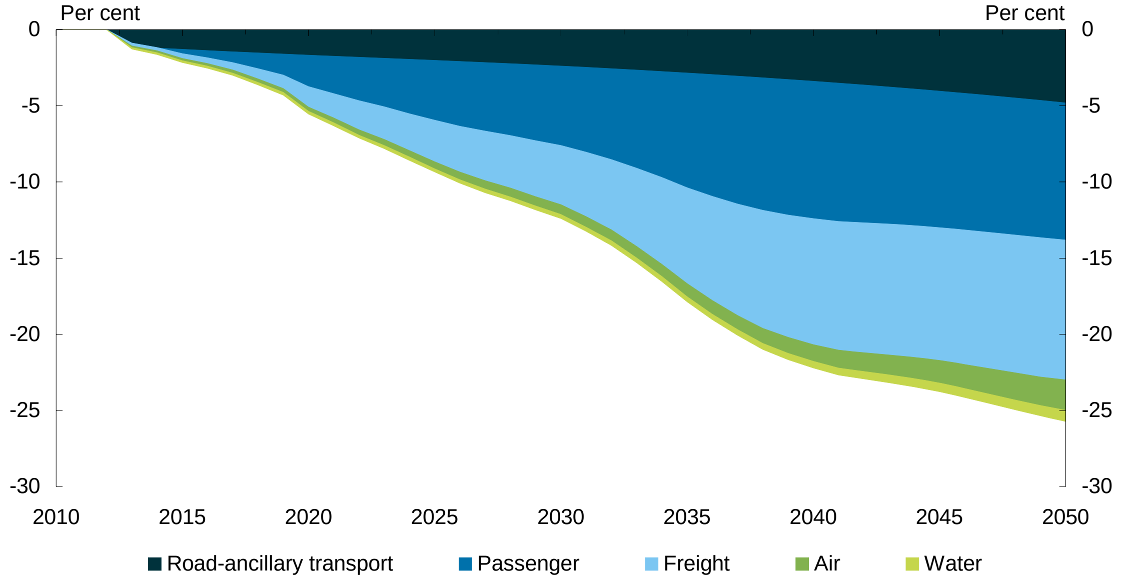
Chart 6.32: Transport sector emissions



Source: Treasury, BITRE and CSIRO.

Road passenger transport emissions fall throughout the projection period, while air and water transport emissions increase in absolute terms (but fall relative to the reference scenario) to 2050, then begin to fall after 2050. By 2050, passenger transport emissions are around 25 per cent below 2005 levels, while water transport emissions are 70 per cent higher, and air transport emissions are 300 per cent higher than 2005 levels for the Garnaut -10 scenario (Chart 6.33).

Chart 6.33: Contribution to transport mitigation
Change from reference scenario, Garnaut -10 scenario



Source: Treasury, BITRE and CSIRO.

Mitigation in the road transport sector in the CPRS -5 scenario is slightly less than in Garnaut -10 scenario despite a higher price on emissions. The difference is due to policy settings. In the CPRS -5 scenario, the road transport sector is exempted from emission pricing for three years, reflecting the Government's Green Paper commitment to provide a transitional period to allow motorists time to adjust to the scheme.

Output

Demand for private road transport falls, relative to the reference scenario, with the introduction of an emission price (Table 6.17 and Chart 6.34). Fuel costs are higher; vehicle sharing is greater; trips are fewer and/or distances travelled are shorter. Some substitution to public transport also occurs: passenger rail transport grows faster than in the reference scenario by around 0.2 per cent per year.

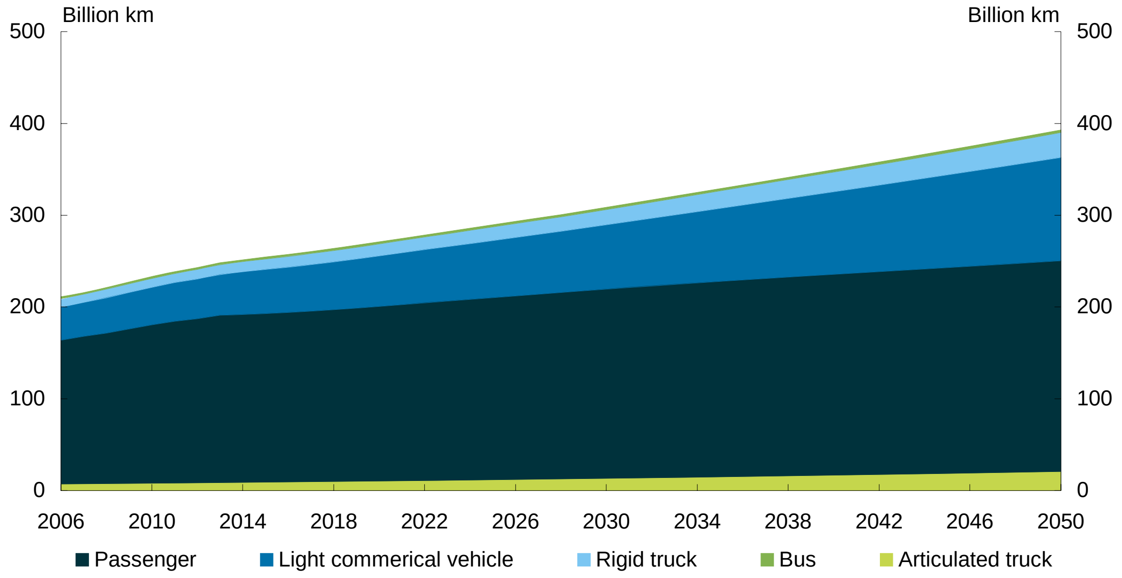
Output from the air transport falls by around -1.1 to -7.0 per cent in the policy scenarios relative to the reference scenario by 2050.

Table 6.17: Transport output
Change from reference scenario

	CPRS -5		CPRS -15		Garnaut -10		Garnaut -25	
	2020	2050	2020	2050	2020	2050	2020	2050
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
Road								
Passenger	-0.9	-4.5	-1.2	-5.1	-1.8	-5.1	-3.0	-6.9
Freight	-0.3	-0.5	-0.1	0.8	-0.4	-0.3	-0.2	1.8
Rail								
Passenger	1.5	10.4	1.7	9.5	1.8	9.9	1.1	6.7
Freight	-0.6	-0.1	-0.9	-1.5	0.4	1.2	-0.5	-4.0
Water	-0.6	-1.8	-0.8	-2.5	-0.4	-1.6	-0.3	-2.5
Air	-1.4	-1.1	-2.2	-3.4	-1.3	-1.7	-3.6	-7.0

Source: Treasury estimates from MMRF.

Chart 6.34: Distance travelled by mode of road transport
Garnaut -10 scenario

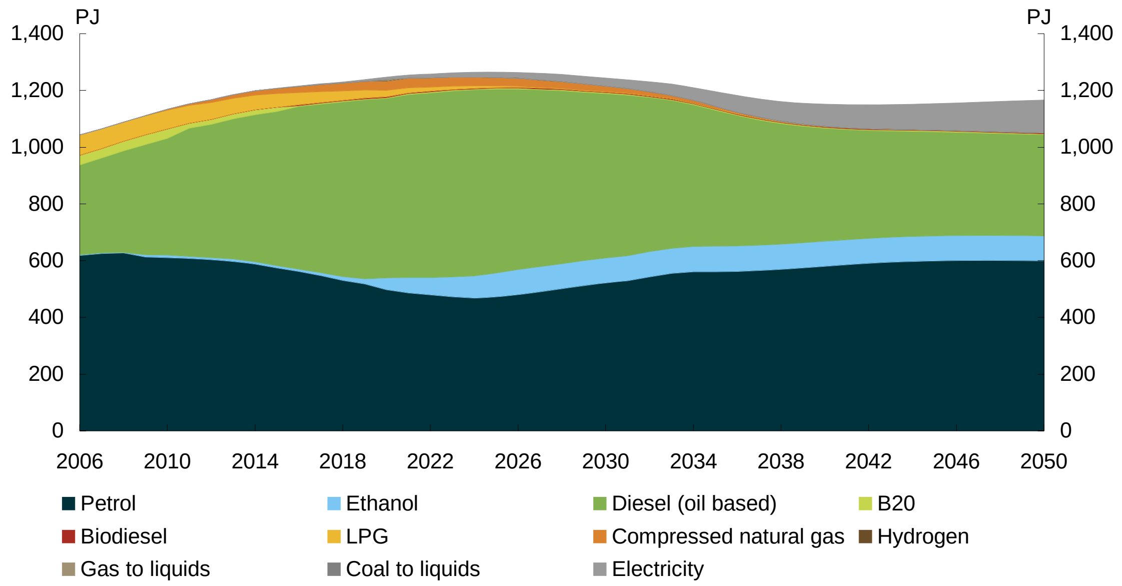


Source: Treasury, CSIRO and BITRE.

Transformation of the road transport sector

Fuel consumption falls relative to the reference scenario once emissions are priced. Lower fuel intensity and lower activity levels reduce total road fuel consumption in 2050 by around 20 per cent in the CPRS -5 scenario compared with the reference scenario. Traditional petrol fuel use falls most, while electric vehicles and hybrid electric cars boost electricity's share in the road transport sector to around 10 per cent in 2050.

Chart 6.35: Road transport fuel mix
CPRS -5 scenario



Note: B20 is diesel with 20 per cent biodiesel.
Source: CSIRO, BITRE and Treasury.

Fuel diversification is more limited in all the policy scenarios than in the reference scenario. An emission price makes non-conventional oil sources, such as coal-to-liquids and gas-to-liquids diesel, uncompetitive owing to their high life-cycle emissions.

6.5.6 Forestry and land-use change

Demand for low-emission goods and services increases, particularly where they substitute for higher emission commodities or where the emissions trading market creates a new source of revenue.

Both effects are important in the forestry sector. Consumers substitute towards wood products (a low-emission good, which can be used instead of other inputs in some processes). In addition, forests sequester carbon, generating credits for sale in an emissions trading scheme.

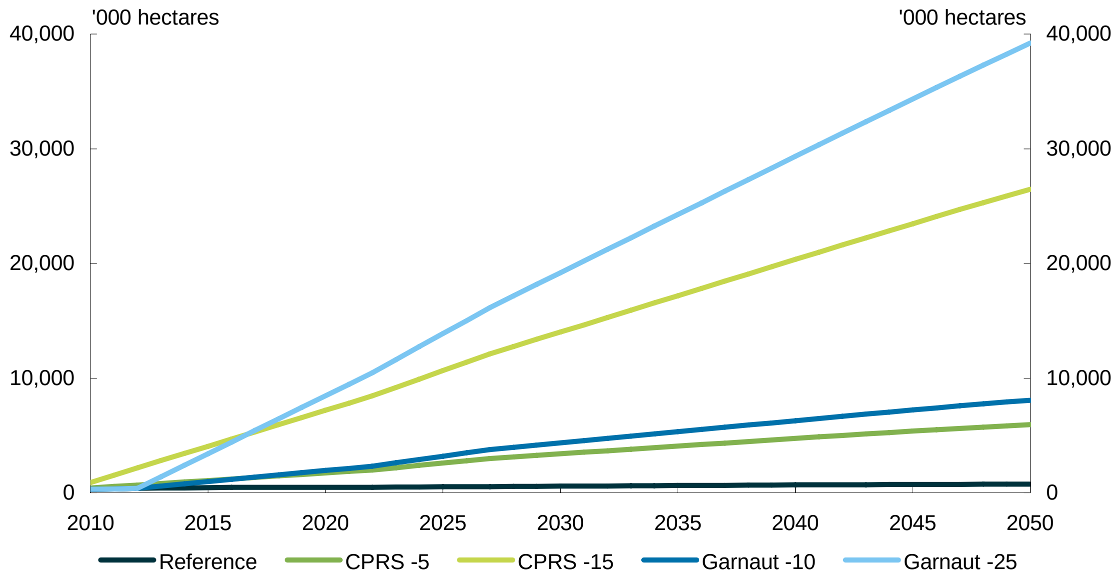
Carbon sequestration could offset substantial domestic emissions relatively cheaply. Realising a substantial part of this potential would greatly reduce the costs of climate change mitigation in Australia.[12]

Forestry's expansion may have flow-on effects for some agricultural sectors, particularly cattle and sheep grazing. These activities compete for land, so as forestry expands, livestock production contracts (relative to the reference scenario). This effect is even stronger in the lower stabilisation level scenarios, because the higher emission prices make forestry even more profitable than competing land uses.

Land under forestry

In all scenarios, substantial forestry or environmental plantations of 5-40 million hectares are established, from 2005 to 2050 (Chart 6.36).

Chart 6.36: Australian additional land under forestry



Note: New land under forestry is cumulative since 2005.
Source: ABARE, DCC, BRS.

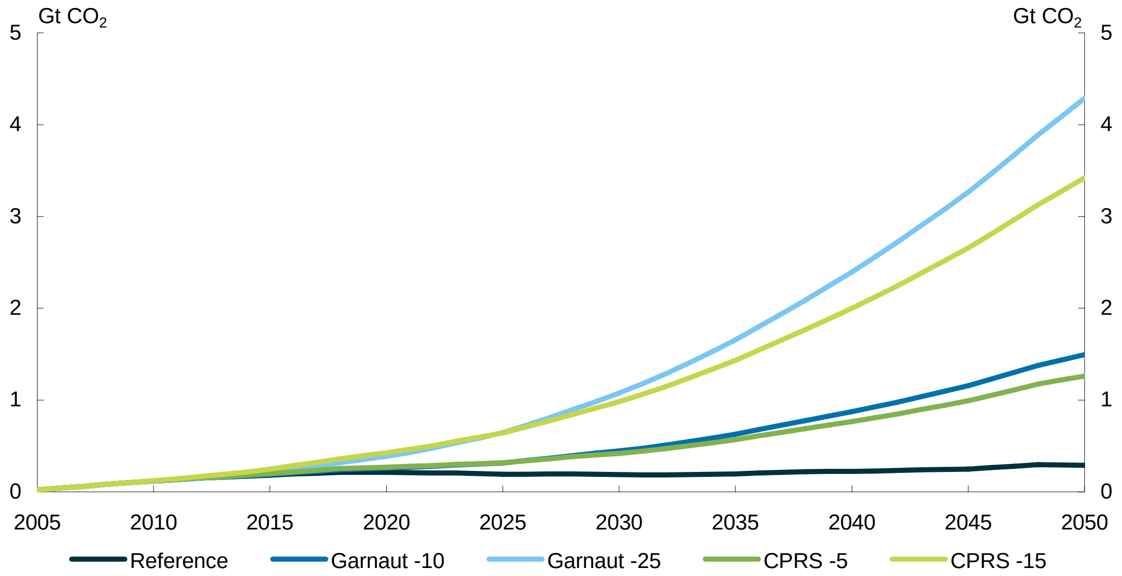
12 The *Carbon Pollution Reduction Scheme Green Paper* proposes allowing reforestation activities to opt-in to the scheme from its start in 2010 (DCC, 2008a).

The Garnaut -25 scenario sees around 40 million hectares of new forestry plantations established from 2005 to 2050, almost five times more than in the Garnaut -10 scenario. Over 80 per cent of these new plantings occur in Queensland and New South Wales, reflecting a change in the relative competitiveness of different land uses from a higher emission price. In the Garnaut -25 scenario, forestry delivers higher returns than other agricultural activities, such as grazing. By the time the emission price reaches the same level in the Garnaut -10 scenario (in the 2020s), agricultural land has appreciated in value, so prospective forestry investors face a much higher opportunity cost than they did in 2013. For the Garnaut -25 and CPRS -15 scenarios the majority of afforestation is environmental plantings.

Carbon sequestration

The growth in land under forestry provides a cumulative net carbon sink of 1.3-4.3 Gt CO_2 from 2005 to 2050 (Chart 6.37). Sequestration rates vary from year to year, depending on the amount of land planted, growth rates, harvesting and other factors.

Chart 6.37: Australian forestry sequestration



Note: Estimates are cumulative from 2005.
Source: ABARE, DCC, BRS.

Land-use change emissions in Australia continue at the rate of 44 Mt CO_2 per year until the introduction of emission pricing, then are assumed to decline gradually. While emissions from land use are not intended to be included in the Carbon Pollution Reduction Scheme, alternative policy instruments could be used to encourage emission reductions from this sector.

6.6 IMPACTS ON HOUSEHOLDS

Real household income continues to grow strongly. Households face higher prices for emission-intensive products, such as electricity and gas. However, the share of household income spent on these goods is likely to fall over time.

6.6.1 Aggregate impacts over time

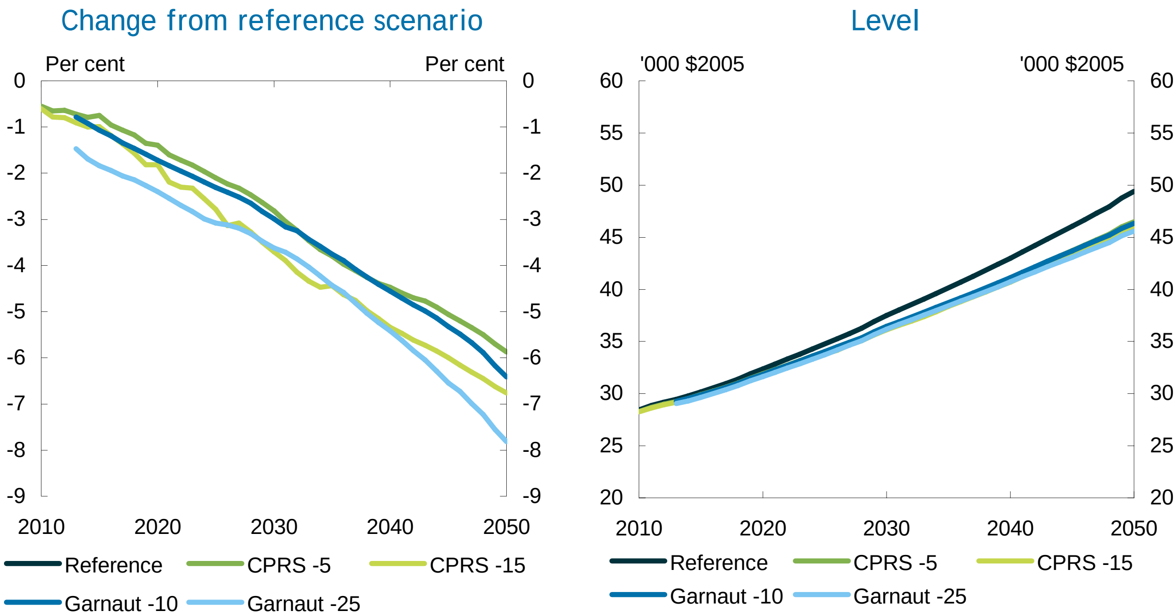
Real household disposable income grows strongly over time in all policy scenarios. Real disposable per capita income grows at an average annual rate of around 1.0 per cent in the policy scenarios, compared to around 1.2 per cent in the reference scenario. As a result, real disposable income per capita is about 8-9 per cent higher than current levels by 2020, and about 50 per cent higher by 2050 (compared with 10 and 60 per cent in the reference scenario).

Household income growth slows mostly due to slower labour income growth. Although real returns to both capital and labour are reduced, labour income growth slows more than capital income. Capital is allowed to retire and the economy experiences capital shallowing. The modelling assumes that real wages adjust over the medium term to return the labour market to equilibrium.

The return of all remaining permit revenue as a lump-sum transfer to households, after the provision for shielding, partially offsets the reduction in household labour and capital income.

Aggregate household consumption moves in line with real household income and grows in all policy scenarios, although at a slower rate than in the reference scenario (Chart 6.38).

Chart 6.38: Private per capita consumption



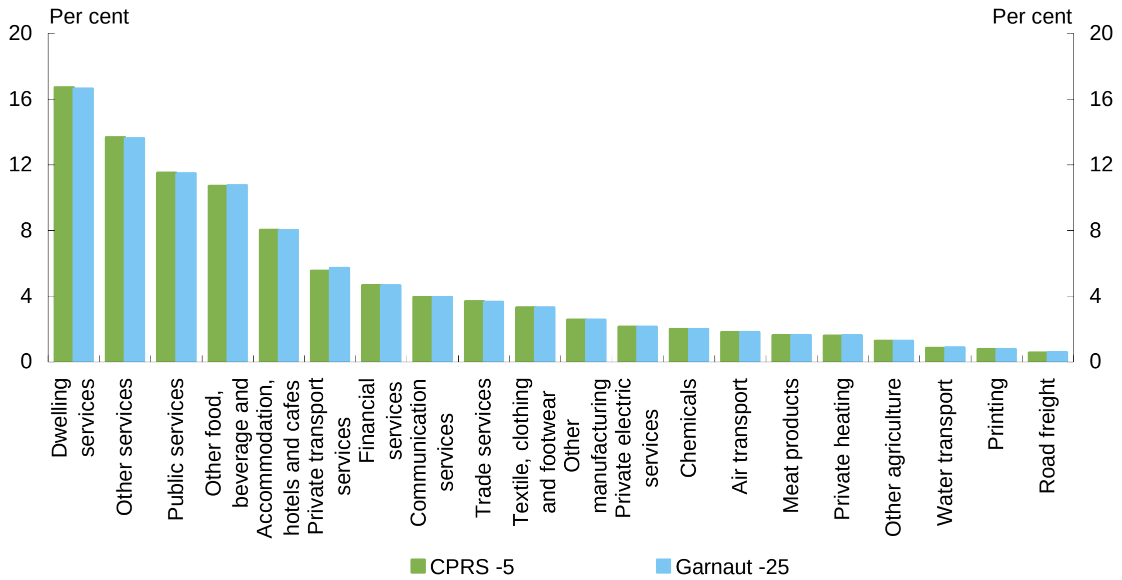
Source: Treasury estimates from MMRF

While aggregate consumption continues to grow, emission pricing changes the relative price of different consumer goods. The impact of emission pricing on particular goods and services will depend on the emission-intensity of the goods and how sensitive consumer demand is to price changes. If a good experiences a rise in relative prices, consumers tend to substitute away from this good. However, if substitution possibilities are limited (demand is inelastic) consumers may not change their demand by much, if at all, despite higher prices.

The largest relative price increases occur for emission-intensive goods such as road and air transport, electricity, and gas used for heating. For example, in the CPRS scenarios, real residential electricity prices increase by 35-50 per cent in 2045-2050, relative to the reference scenario, leading to a fall in electricity consumption of around 15 per cent. The relative prices of most products in the household basket fall, such as services, communication, accommodation and housing.

Households adjust their consumption patterns over time. By 2020, the variation in the price impacts from emission pricing across the policy scenarios is minimal. The Garnaut -25 scenario implies almost no additional change in the relative prices above those seen in the CPRS -5 scenario, except for a small set of emission-intensive products. As consumers substitute between consumption goods, away from those that experience price increases, and towards those that experience price falls, household expenditure shares do not change significantly across the scenarios (Chart 6.39).

Chart 6.39: Household expenditure shares in 2020



Source: Treasury estimates from MMRF.

6.6.2 Distributional impacts on introduction of emission pricing

Putting a price on emissions will make emission-intensive goods more expensive. Households that continue to consume more emission-intensive products face higher costs than households that change their consumption patterns. This has implications for the distributional impact of emission prices based on the initial emission-intensity of consumption by different household groups and their relative ability to alter consumption.

The distributional effects of emission pricing outlined in this section are based on the starting emission prices in the CPRS scenarios and update the preliminary analysis in the *Carbon Pollution Reduction Scheme Green Paper*. The Green Paper estimates were based on an indicative A$20 emission price in 2010. Some minor modelling enhancements and newly available data have since been incorporated.[13] However, flow-on effects from the Government's expanded Renewable Energy Target are not included.

The distributional analysis is based on estimates derived from linking models that have differing assumptions. The emission price from MMRF, which incorporates substitution effects and the

13 2004-05 ABS Input-output tables (Cat.no. 5209.0.55.001) and 2007-08 consumer price index expenditure class data.

return of permit revenue to the household sector, is inputted into PRISMOD. PRISMOD assumes full pass through of the emission price to households without allowing for substitution. Consequently, the distributional modelling tends to overestimate the impact of emission pricing on households. This is likely to be greatest in higher income households, as these households are expected to be more able to shift consumption towards less emission-intensive goods through product substitution.

The distributional modelling thus presents a 'morning-after' picture of the effects of putting a price on emissions and the corresponding increase in the price level. The distributional modelling does not explicitly factor in changes in emission prices over time and/or the price impact of the subsequent inclusion of additional sectors (such as the possible inclusion of agriculture from 2015).

In the CPRS scenarios (where emission pricing is introduced in 2010), a one-off rise in the price level of around 1-1.5 per cent is expected, with minimal implications for ongoing inflation (Box 6.11).

For the average household, emission prices in the CPRS scenarios lead to an extra $4-5 per week spending on electricity and $2 per week on gas and other household fuels in 2010.[14] This corresponds to increases in electricity prices of around 17-24 per cent, and a rise in gas and other household fuel prices by around 11-15 per cent. In the CPRS -5 scenario, most other commodity prices increase by an average of one per cent or less.[15]

The Government plans to offset the impact of emission prices on emission-intensive petroleum fuel products through cuts in fuel taxes, so the price of petrol does not increase when the scheme starts (DCC, 2008a).

Low-income households are disproportionately affected by emission prices as they spend a higher proportion of their disposable income on emission-intensive goods, such as electricity and gas (Tables 6.18 and 6.19). They are also less likely to be able to substitute towards low-emission products. For example, low income households may find it more difficult to purchase insulation, which would reduce consumption of gas or electricity for heating. In the CPRS -5 scenario, the average price impact for a single pensioner household in the bottom quintile is 1.3 per cent, while for a one-income household with no children in the highest quintile, the average price impact is 0.8 per cent.

The inclusion of agriculture from 2015 would produce a further increase in the price of many food products. This inclusion also is likely to have a disproportionate effect on lower-income households, as these households spend a higher proportion of their income on food products.

As outlined in the *Carbon Pollution Reduction Scheme Green Paper*, the Government is committed to helping households adjust to emission pricing, including by increasing benefit payments and other assistance to low-income households through the tax and payment system, and other assistance to middle-income households (DCC, 2008a). These measures, together with the automatic indexation of benefits to reflect changes in the CPI, will help minimise household impacts.

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14 These are estimated increases for those households who consume these commodities. The gas and other household fuels category also includes firewood, coal and kerosene.

15 These estimates are averages. Actual household expenditure may vary substantially (depending on household size, composition, preferences and energy sources).

The 'morning-after' impact analysis outlined in this section does not incorporate the Government's commitment to provide direct financial assistance to households, nor the mitigating impact stemming from the automatic indexation of transfer payments.

Table 6.18: Estimated price impacts by household type
CPRS -5 scenario in 2010

Household type – primary source of income	Household income quintile(a)					
	All	First	Second	Third	Fourth	Fifth
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
All	1.0	1.2	1.1	1.0	1.0	0.9
Two income household, no children(b)	0.9	**	1.2	1.0	0.9	0.9
Two income household, with children(b)	1.0	**	1.0	1.0	0.9	1.0
One income household, no children(b)	0.9	0.9	1.0	1.0	1.0	0.8
One income household, with children(b)	1.0	**	1.1	1.0	1.0	0.9
One income single person household(b)	1.0	**	1.1	1.0	1.0	1.0
Self-employed household	1.0	1.2	1.0	1.1	1.0	1.0
Household with primary income source from Commonwealth allowances (e.g Newstart Allowance, Youth Allowance)	1.2	1.2	1.2	**	**	**
Married pensioner household	1.1	1.2	1.0	**	**	**
Single pensioner household	1.3	1.3	1.2	**	**	**
Sole parent pensioner household	1.2	1.3	1.2	**	**	**
Part-pension and self-funded retiree households	1.0	1.0	1.0	1.0	1.0	0.9

(b) Income quintiles rank households from the lowest 20 per cent of disposable income to the highest 20 per cent. Modified OECD equivalence scales apply to household disposable incomes to allow for comparisons across households of different sizes.
(c) Principal source of income from wages and salaries.
** Represents those results for which the sample size is too small to produce statistically reliable results.
Source*:* Treasury.

Table 6.19: Estimated price impacts by household type
CPRS -15 scenario in 2010

Household type – primary source of income	Household income quintile(a)					
	All	First	Second	Third	Fourth	Fifth
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
All	1.4	1.6	1.5	1.4	1.3	1.3
Two income household, no children(b)	1.3	**	1.6	1.4	1.3	1.3
Two income household, with children(b)	1.3	**	1.4	1.4	1.3	1.3
One income household, no children(b)	1.3	1.3	1.4	1.3	1.4	1.2
One income household, with children(b)	1.4	**	1.5	1.4	1.3	1.3
One income single person household(b)	1.4	**	1.5	1.4	1.4	1.3
Self-employed household	1.4	1.6	1.4	1.5	1.4	1.4
Household with primary income source from Commonwealth allowances (e.g Newstart Allowance, Youth Allowance)	1.6	1.6	1.6	**	**	**
Married pensioner household	1.6	1.7	1.4	**	**	**
Single pensioner household	1.8	1.8	1.7	**	**	**
Sole parent pensioner household	1.7	1.8	1.7	**	**	**
Part-pension and self-funded retiree households	1.4	1.4	1.4	1.4	1.3	1.3

(a) Income quintiles rank households from the lowest 20 per cent of disposable income to the highest 20 per cent. Modified OECD equivalence scales apply to household disposable incomes to allow for comparisons across households of different sizes.
(b) Principal source of income from wages and salaries.
** Represents those results for which the sample size is too small to produce statistically reliable results.
Source: Treasury.

Spending on energy varies across regions, so the impact of emission pricing would be expected to also vary across regions. However, the Government's commitment to cut fuel taxes to offset the emission price impacts on fuel will ameliorate some of the differences between regions. The estimated average price impacts for households not located in a capital city are only slightly higher than for those located in a capital city (Tables 6.20 and 6.21).

Table 6.20: Estimated price impacts by region in 2010
CPRS -5

	Household income quintile(a)					
Area of usual residence(b)	All	First	Second	Third	Fourth	Fifth
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
All	1.0	1.2	1.1	1.0	1.0	0.9
Capital city	1.0	1.2	1.1	1.0	0.9	0.9
Balance of state	1.1	1.2	1.1	1.0	1.0	1.0
ACT/NT	1.0	1.3	1.1	1.1	1.0	1.0

(a) Income quintiles rank households from the lowest 20 per cent of disposable income to the highest 20 per cent. Modified OECD equivalence scales have been applied to household disposable incomes to allow for comparisons across households of different sizes.
(b) Capital city/balance of state breakdown is available for all states except ACT and NT.
Source*:* Treasury.

Table 6.21: Estimated price impacts by region in 2010
CPRS -15

	Household income quintile(a)					
Area of usual residence(b)	All	First	Second	Third	Fourth	Fifth
	Per cent	Per cent	Per cent	Per cent	Per cent	Per cent
All	1.4	1.6	1.5	1.4	1.3	1.3
Capital City	1.4	1.6	1.5	1.4	1.3	1.3
Balance of state	1.5	1.7	1.5	1.4	1.4	1.4
ACT/NT	1.4	1.8	1.6	1.5	1.4	1.3

(a) Income quintiles rank households from the lowest 20 per cent of disposable income to the highest 20 per cent. Modified OECD equivalence scales have been applied to household disposable incomes to allow for comparisons across households of different sizes.
(b) Capital city/balance of state breakdown is available for all states except ACT and NT.
Source: Treasury.

Box 6.11: Mitigation policy and inflation

G-Cubed models the nominal economy, including price variables, while other models only generate results in real terms. As a result, G-Cubed indicates what might happen to the CPI and the GDP deflator following the introduction of emission pricing. In G-Cubed, the central bank responds to changes in consumer prices and output from desired rates by changing interest rates.

G-Cubed uses a modified Henderson-McKibbin rule for monetary policy. Changes in the interest rate are determined by:

- differences between the inflation rate and the monetary authorities' desired inflation rate;
- differences between the rate of GDP growth and what the model assumes is the economy's rate of growth of potential GDP; and
- for some developing economies, changes in the exchange rate from the desired level (reflecting the fixed exchange rates of, for example, China).

In this report, monetary authorities are assumed to be equally concerned about deviations in inflation and growth. For most regions, the growth effect dominates, leading the monetary authority to lower interest rates to stimulate the economy.

There is a one-off rise in consumer prices in 2010 when emission prices are introduced. In the CPRS -5 scenario, the rise in the CPI ranges from around 0.3 per cent in Japan and Europe to 1.4 per cent in the rest-of-the-world region.

In Australia, the CPI rises by 0.7 per cent in 2010 in the CPRS -5 scenario and by around 1.1 per cent in the CPRS -15 scenario. These initial price rises modelled in G-Cubed are broadly consistent with the estimated price rises modelled in PRISMOD. However, unlike PRISMOD, G-Cubed accounts for changes in consumer and firm behaviour.

After the initial spike, inflation continues to be slightly higher than the reference scenario. This is not purely a result of emission pricing, as the monetary policy chosen by the monetary authority in the model will affect ongoing inflation.

6.7

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