Complementary policies for greenhouse gas emission abatement and their national and regional employment consequences

A report for the
Australian Conservation Foundation and
Australian Council of Trade Unions

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Disclaimer: The macro-economic scenarios, as well as the combination of climate change technologies and policies utilised in this NIEIR report, represent just some of the possible pathways to a lower carbon world in the 2010-2030 period. As such, their use in this NIEIR report should not be construed as a specific endorsement of all such approaches by the ACF or the ACTU.

While the National Institute endeavours to provide reliable forecasts and believes the material is accurate it will not be liable for any claim by any party acting on such information.

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Study objectives and report structure

The study objective is to assess a range of policies for greenhouse gas reduction, concentrating on the difference between relatively passive and highly aggressive policies. Two detailed policy scenarios are developed and their national and regional consequences, particularly their employment consequences, are compared using NIEIR's econometric models of the national and regional economies.

Executive summary	Summarises the employment outcomes at the national and regional level.
Chapter 1	Argues that the report takes a new approach to the economics of greenhouse gas abatement.
Chapter 2	Outlines the three scenarios on which the report is based.
Chapter 3	Provides an overview of the essential steps in the argument.
Chapter 4	Reviews international negotiations on climate change and justifies the target adopted for Australia in the report.
Chapter 5	Explains the background issues which apply in all three scenarios.
Chapter 6	Describes the Weak action scenario with an emphasis on its macroeconomics.
Chapter 7	Describes the Intermediate scenario, emphasising the argument for a combination of carbon pricing and sector-specific policies.
Chapter 8	Describes the Strong action scenario, emphasising the benefits of industry policy in combination with greenhouse gas emission abatement.
Chapter 9	Estimates the Green Job potential for the Strong action scenario
Chapter 10	Outlines the reasons for the regional employment outcomes.
Chapter 11	Describes the models used to generate the scenarios in this report, including a brief comparison with the Treasury methodology.

Detailed methodology and model results are presented in appendices to the report.

Executive summary

E.1 Study objectives

The Australian Government has a policy target of 25 per cent reduction of carbon dioxide equivalent (CO_2e) emissions by 2020, in the context of a comprehensive and co-ordinated international action agenda. The objective of this study is to explore alternative ways of achieving this target and also of achieving the further target of a 50 per cent reduction below 1990 levels by 2030.[1]

E.2 Report headline outcome

This study finds that a strong response to climate change (complementing the 25% target) will deliver better employment growth by 2030 than a weak response, not only for the country as a whole but for all regions across Australia. In this context a strong response will combine comprehensive sector-specific policies with carbon pricing, efficient macro-economic policies and industry development initiatives. By contrast, a weak response would rely on carbon pricing, permit imports and ad hoc specific sector initiatives and would also lack macro-economic planning.

E.3 The research team

This report was commissioned by the Australian Conservation Foundation and the Australian Council of Trade Unions to examine the costs and benefits for Australia if we choose to take Strong or Weak action on climate change over the 2010-2030 period. The modelling was undertaken by the National Institute of Economic and Industry Research (NIEIR)[2] in Melbourne.

E.4 What is the current Australian Government policy?

The Commonwealth government will adopt a 25 per cent abatement target only as part of an ambitious international agreement involving comprehensive global action capable of stabilising greenhouse cases in the atmosphere at 450 ppm CO_2e or lower.

E.5 What is the current status of international developments towards the achievement of the Australian conditions?

Over the last six months there have been considerable movement towards establishing comprehensive global action, as required by Australia before it will commit to Strong action.

As of mid March 2010, 108 countries, covering 81.6 per cent of world emissions, have pledged or aspired to cuts that will mean emissions will peak before 2020.

The conditional and unconditional post-Copenhagen pledges for 2020 in terms of 1990 levels include percentage reductions of:

- 20-30 per cent for the EU;
- 34 per cent for the United Kingdom; and
- 25 per cent for Japan.

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[1] Australian emissions in 1990 and 2000 were similar. The Government's 25 per cent reduction target below 2000 levels translates to an approximate 24 per cent reduction on 1990 levels.

[2] www.nieir.com.au

For the United States the pledges are 17 per cent reduction compared to 2005 levels by 2020 and 30 per cent by 2025.

In terms of leading developing countries, the aspirations in terms of CO_2 reductions per unit of GDP include:

- 40 to 45 per cent for China;
- 20 to 25 per cent for India; and
- 30 per cent for South Korea.

Brazil has adopted an aspiration of 36 to 39 per cent below business-as-usual by 2020.

E.6 Why was this study undertaken?

One of the primary reasons for commissioning this report was to assess the impact of policies aimed at tackling climate change on employment levels in the very different regions that comprise Australia.

The report provides a comprehensive economic evaluation of the CO_2 abatement policies which have potential to contribute to Australia achieving a 25 per cent reduction in emissions by 2020. For a given CO_2 national target this comprehensive evaluation must include, inter alia, the following steps:

1. list all possible initiatives across all sectors that are available to increase energy efficiency and/or CO_2 reduction;
2. determine the investment cost (expenditure implementation cost), petajoule and CO_2 savings, dollar cost of savings and payback period for each initiative in the absence of a CO_2 price;
3. determine the optimum combination of CO_2 prices, regulations and financial inducements that are efficient (least cost) and also ensure for each year the necessary take-up of initiatives to reach the target for a given year. This involves nominating realistic business/household payback periods that will trigger CO_2 abatement investment decisions;
4. design a macroeconomic implementation policy strategy that minimises the cost on the economy of the relocation of resources from other uses to support the investment in CO_2 reduction;
5. calculate the long run economic benefits (that is, living standard gains) that come from gains in energy efficiency, avoided CO_2 emission permit costs, reduced oil imports, etc.; and
6. highlight the opportunities to expand overall economic activity and employment created by CO_2 abatement investments.

This study contains all six components. The Australian Treasury's study "*Australia's Low Pollution Future*" (2008) did not.

This study also breaks new ground by considering alternative strategies for achieving the abatement target. For any given target there are in fact many possible approaches. The crucial issue is to select the policy combination which minimises the short-term costs of CO_2 abatement and maximises the long-run benefits.

E.7 What are the scenarios in this report?

Two dimensions determine the costs and benefits of any given approach to a given CO_2 reduction target. The dimensions are:

(i) the trade-off between domestic emission reductions and the import of permits; and

(ii) the degree to which the opportunities created by climate change abatement investments are leveraged to expand productive capacity in the economy.

The two dimensions are covered by three scenarios, namely:

- Weak action;
- Intermediate action; and
- Strong action.

A brief description of each scenario is as follows.

- A ***'Weak action'*** scenario – Australia takes a "wait and see" approach. It signs up to international agreements as they are negotiated but relies largely on market forces (chiefly carbon pricing and permit imports). The Weak action scenario could alternatively be designated the **Markets scenario** since it reflects the current market-oriented approach to CO_2 reduction. In this scenario non-market policies are limited, in line with the current policy effort.
- The ***'Intermediate'*** scenario – Australia takes a strong and fast approach to domestic CO_2 reduction with the objective of reducing domestic emissions in line with the target and so maintaining permit imports at zero. With a similar CO_2 price as the Weak action scenario (carbon prices are determined in the longer term on an import parity basis) this requires the roll-out of detailed sector targets backed up by the mobilisation of capital, labour and financial resources and complementary regulation initiatives, as required to achieve the policy target each year.
- A ***'Strong action'*** scenario – Australia takes a strong and fast approach to action on climate change, as per the Intermediate case, plus additional elements which integrate industrial development policies with comprehensive climate change policies. China, Japan and South Korea, among others, are already following this approach.

Table E.1 profiles the CO_2 emission trajectories for each scenario, with limited data from the Treasury (2008) report provided for comparison. The important point is that the Weak action scenario, in common with the Treasury 25% reduction case, relies heavily on imported permits. The clear inference from the Treasury report is that this high reliance is optimal and that reductions in permit imports increase economic cost. This study demonstrates the reverse to be the case.

Table E.1 Australian CO_2 emissions outcome

	2008	2015	2020	2025	2030
Weak action scenario					
Domestic emissions (million tonnes)	566	582	585	583	579
Compared to 1990 levels (per cent)	104	107	107	107	106
Imported permits (million tonnes)	0	0	174	248	305
Intermediate scenario					
Domestic emissions (million tonnes)	566	500	410	335	273
Compared to 1990 levels (per cent)	104	92	75	61	50
Imported permits (million tonnes)	0	0	-1	0	-1
Strong action					
Domestic emissions (million tonnes)	566	500	410	335	273
Compared to 1990 levels (per cent)	104	92	75	61	50
Imported permits (million tonnes)	0	0	-1	0	-1
Treasury Garnaut-25 scenario					
Domestic emissions (million tonnes)	566		505		
Compared to 1990 levels (per cent)	104		93		
Imported permits (million tonnes)	0		100		

Source: NIEIR modelling. Treasury estimates from *Australia's Low Pollution Future* Table 6.8. Estimates published for 2020 only.

E.8 What are the specific instruments used to achieve the CO_2 targets?

The specific policy instruments used to achieve the abatement targets in the Intermediate and Strong action scenarios include the following.

- ***Household energy efficiency strategy*** – roll out a national residential retrofitting program that reduces emissions and household bills, and results in thousands of new jobs.
- ***Commercial building & industrial energy efficiency strategy*** – use existing and expanded programs to achieve the significant savings from energy efficiency in buildings, large and small industry, and community organisations with additional transitional financial incentives, the shift to low carbon intensive industrial process technologies, the installation of mining/manufacturing carbon capture and sequestration, etc.
- ***Rapid expansion of low CO_2 intensive electricity infrastructure –*** with incentives such as an expanded renewable energy target, an effective carbon price, investment in a smart grid and funding for research, development and deployment of low emissions energy.
- ***Carbon pricing that achieves a proportional cut over all covered sectors*** – and distributes revenues to clean energy development, clean industry and innovation hubs and appropriate compensation for low and middle income households and emissions-intensive trade-exposed industries.
- ***Targeted regional investment and industry planning*** – including investment in clean industry and innovation hubs particularly focused on regional areas and strong green up-skilling of the workforce.
- ***Investment in a cleaner vehicle fleet*** - including expansion of hybrid and electric car fleet, freight modal shifts to lower emissions transport and biodiesel production on marginal agricultural land and the rapid roll out of electric vehicles.
- ***A national 'green carbon' initiative*** - to reduce emissions from land use and build climate change resilience in Australian ecosystems.
- ***Federally led low carbon transport infrastructure plan –*** Federal government investment into low carbon public and active transport infrastructure.

E.9 Emission abatement will make a significant call on national savings for decades to come

Emission abatement requires substantial change in the technologies used in the energy and transport sectors as well as in rural industries. The required technological change cannot take place without the replacement of existing high-emission equipment (like coal-fired power stations) with low-emission equipment (like renewable electricity generation).

It is normal for equipment to be replaced as it wears out or becomes obsolete. The accounting rule is that businesses should not declare a profit till they have provided for equipment replacement and prudent households likewise replace their white goods and cars on a regular basis.

In economic terms, all purchases of equipment and buildings are known as 'gross investment'. Replacement investment is deducted from gross investment to obtain net investment, which adds to the capital stock and so adds to the capacity to produce. In similar vein, allowances for equipment replacement are part of 'gross savings' and are deducted to estimate net savings.

Abatement is essentially about replacement investment – gross rather than net investment. There would be no problem if it could be financed from existing provisions for equipment replacement, but existing provisions are likely to be insufficient, for two reasons.

- Low-emission equipment is generally more costly, up-front, than the equipment it replaces.
- A concerted abatement campaign will require the most emission-intensive equipment to be replaced before the end of its expected economic life.

Accordingly, emission abatement will require a burst of gross investment. The amount required is substantial – the gross investment required to achieve the emission abatement targets used in this report are shown in Table E.2. The gross investment required is significantly greater than can be financed from the replacement allowances generated for the equipment concerned.

If the required abatement investment is too large to be financed from replacement allowances, it might be possible to switch investment from other uses, but this has the cost of reducing national productive capacity. Theoretically it is possible to use overseas finance, but given Australia's overseas debt this is not currently advisable. The conclusion is inescapable that there will be a call on the combined national savings of the business, government and household sectors, implying an increase in saving and reduction in consumption. This is particularly so in the Intermediate and Strong action scenarios, which essentially require a burst of Gross Investment to kick-start the abatement process. The benefits of this increase in saving accrue within a few years as greater job generation.

In this context, it is worth remembering that the Australian national savings rate is currently low by historical standards, with the household savings rate particularly low. The Intermediate and Strong action scenarios require a small bounce-back in the household savings rate, which is quite likely to take place as households take stock of their debt position.

Table E.2	Gross investment required for CO_2 abatement (percentage of GDP, average for five year spans)			
Scenario	**2010-15**	**2015-20**	**2020-25**	**2025-30**
Weak action	1.6	1.3	0.9	0.6
Intermediate	3.2	2.7	2.1	1.8
Strong action	3.2	3.0	2.1	1.8

E.10 What are the macroeconomic outcomes in terms of employment and living standards?

The Intermediate and Strong action scenarios allow total employment to be increased compared to the Weak scenario (Table E.3). The stronger the action, the greater will be the increase in employment. By 2030 the Strong action scenario allows 770,000 more employment positions to be created compared to the 2030 outcome for the Weak action scenario.

Just as important, living standards will be higher over the longer term. In 2030 private and public non-energy consumption expenditures are

- 6 per cent above the Weak action case in the Intermediate scenario and
- 9 per cent above in the Strong action scenario.

On an undiscounted cumulative basis the increase in non-energy consumption is:

- $250 billion for the Intermediate scenario; and
- $650 billion for the Strong action scenario.

However, these benefits will not be generated unless over the 2010 to 2020 period there is a re-allocation of resources from general expenditures (excluding capacity/productivity expanding investment expenditures) to gross investment in CO_2 abatement, requiring an increase in saving and a reduction in the proportion of income devoted to consumption. By contrast, the Weak action scenario requires a smaller increase in saving.

The benefits of the increase in saving in the Strong action scenario mean that, by 2020, living standards will be higher than the Weak scenario on an annual basis and by 2024 will be higher on a cumulative basis. The Intermediate scenario, because of the lesser commitment to protecting living standards, delays these milestone years by between 2 and 3 years.

Table E.3 Increase in employment in thousands compared to Weak action scenario

	2015	2020	2025	2030
Intermediate	23	98	267	430
Strong action	53	237	562	770

Table E.4 Employment 2030 compared to 2009 by scenario

		Weak scenario		Intermediate scenario		Strong scenario	
	Industry employment 2009	Change 2009 to 2030 ('000)	Change 2009 to 2030 (%)	Change 2009 to 2030 ('000)	Change 2009 to 2030 (%)	Change 2009 to 2030 ('000)	Change 2009 to 2030 (%)
Total	**10527297**	**2980.5**	**28**	**3411.6**	**32**	**3751.7**	**36**

E.11 Comprehensive and efficient public policy is a key driver of the outcome

One reason for the outcome is that public policy is both comprehensive and efficient. The Treasury analysis was not comprehensive in terms of policy instruments. Its reliance on a small number of market based instruments resulted in a relatively high-cost response since the impact of CO_2 abatement was channelled into reduced investment and hence into lower installed capacity and employment.

In this study all the instruments of public policy are brought to bear, including exchange rates, income tax rates, superannuation contributions, current expenditures, investment expenditures, subsidies, investment allowances, depreciation allowances, governance resources and real income trade-off instruments so that a wide range of instruments is available to achieve a wide range of targets. The targets include capacity installed (to protect employment), balance of payments outcomes, corporate and household financial stability and inflation rates. This allows resources to be reallocated in the economy to protect capacity expansion investment and hence employment, productivity, etc.

The net expansion in employment occurs because policy is both comprehensive and efficient. The efficiency of the Strong action scenario has a number of aspects.

- part of the gross investment directed at CO_2 abatement will also lift aggregate productivity and raise expectations of future growth. This is true of the investment in transport infrastructure and the investment in the new industries created in the Strong scenario.
- The inflationary consequences of CO_2 abatement policies are anticipated and ameliorated.
- By maintaining balance of payments and private sector financial stability more financial resources are available to support investment expansion and thereby lift aggregate employment.

E.12 The other core driver is the benefits which accumulate over time from gains in energy efficiency and reductions in permit imports

The energy efficiency enhancement expenditure component of gross investment in CO_2 abatement represents a once-off investment in reducing energy and transport costs which will yield returns well into the future. Although energy and transport costs are part of private consumption expenditure, they make no contribution to economic welfare *per se*, provided the same tasks (heating, cooking, mobility) can be maintained. Hence, lowering energy and transport costs allows other expenditures which directly increase welfare (entertainment, health, etc.) to be increased.

Investment in energy efficiency and more directly in CO_2 abatement will reduce permit imports and oil imports. Given that the Australian economy is constrained by its capacity to pay for imports, this will allow an increase in welfare-enhancing consumption expenditures as well as an increase in investment to increase capacity and employment.

Finally, the industry development dimension of the Strong scenario has a similar positive impact on the economy in terms of increasing the potential for gains in living standards.

These mechanisms, complemented by comprehensive and efficient policy, are the drivers of the improvement in the employment and living standard outcomes for the Intermediate and Strong scenarios compared to the Weak scenario.

It is also clear that, with Strong action policies, no region need suffer loss. The fears currently held for coal-dependent regions like the Hunter Valley and La Trobe Valley are needless provided a strategic and proactive regional industry planning approach is adopted.

E.13 What are the core issues from the scenarios?

In essence, Australia will need to make a smart and strategic investment of the revenues from carbon pricing as well as those from the current “once in a generation” mining boom.

The key question is: Are we prepared to invest now in building a diversified economy that is sustainable and internationally competitive in the long term?

What if we don’t? – The risks of Weak action

The answer is quite simple. Australia will be left behind and left out in the global transition to a low carbon economy.

The choice for Australia is clear - either invest now to secure the long term future or pay the price. If we seek short term benefits, trading them off against significantly greater long term benefits, the economic and environmental outcomes will be dire.

The world's major countries are adopting CO_2 strategies and implementing them now in a process that decarbonises their economies. Before 2015, it is likely there will be a more comprehensive and stronger global action agenda for CO_2 reductions and the targets will become more ambitious over time. As a result, the base case of 'no action' on climate change is no longer a realistic scenario.

The climate science is unambiguous and evidence shows that the world is already taking action on climate change: Globally, governments committed US$432 billion on green stimulus investments as part of the response to the global financial crisis in 2009 (including over US$128 billion in the US);[3]

China is moving ahead rapidly with emissions reductions programs, and is likely to quickly become a global leader in energy efficiency and renewable energy technologies. For example, China is on target to achieve:

- over 300 million tonnes of emissions reductions through an industrial energy efficiency program across its largest 1000 companies;
- a 15 per cent renewable energy target by 2020 (resulting in a 40 per cent market share of the global Solar PV manufacturing industry) although a minimum 20% target appears to be the real objective;
- a 40 to 45 per cent energy intensity reduction target by 2020 (energy per unit of GDP) compared to 2010 ;
- has shut down 34GW of old, small and inefficient coal-fired power plants as newer, more efficient plants are installed; and
- is subsidising the purchase of 100 million energy efficiency light bulbs in 2009 (62 million in 2008).[4]

China emerged from the Copenhagen climate change summit as the power to be reckoned with in climate policy.

There is no way of avoiding economic costs and job losses if Australia doesn't act; and as noted below a failure to act will increase the risk of a serious economic meltdown. There are two main risks in delay.

- If action is postponed, it becomes much more costly to achieve any given target, because the equipment replacement campaign has to be sped up.
- The more that Australia postpones action, the more CO_2 that it will pump into the atmosphere. Nations that are taking action on climate change will notice this, and are likely to tighten Australia's internationally-accepted targets as a result.

So the debate is not about doing "too much too soon" on climate change. The real debate is about the cost to Australian jobs, our economy and the quality of life in this country if we do "too little, too late".

Additional costs will also emerge after 2030. If Australia fails to act decisively, it will forfeit the wealth and jobs that come from the new technologies for generating clean energy and more environmentally friendly goods and services.

In the Weak action scenario the Australian government clearly lets the nation and the global community down through inaction on climate change. Australia adopts carbon pricing, but takes little further action. Domestic emissions in the Weak action scenario are stabilised at 2006 levels by 2030, but to meet the target Australia is forced to import emission permits.

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[3] HSBC, *The Green Rebound: clean energy to become an important component of global recovery plans,* 19 January 2009.

[4] Centre for American Progress, *China begins its transition to a clean energy economy,* 4 June 2009.

In the Strong action scenario, targeted policies which focus on emissions reductions within Australia (rather than the import of international permits) result in strong investment in emissions reduction and positive employment outcomes across all regions. The suite of policies also achieves the target of 25 per cent emissions reductions by 2020 and 50 per cent by 2030.

Table E.5 presents the employment impacts of the Strong action scenario against Weak action, demonstrating that the nearly 800 000 additional jobs are distributed across all sectors of the economy. The industry pattern of job creation in the Strong action scenario reflects the pattern of gross investment under the scenario, its multiplier effects and its export-increasing effects. Because the policies in the Strong action scenario address the balance of payments deficit, employment increases relatively rapidly in the industries producing tradeable goods. It also increases relatively rapidly in construction, since gross investment in abatement utilises the services of this sector.

Table E.5 Employment increases in the Strong action scenario compared to Weak action, 2010-2030, by industry

Industry	Increase (no)	Per cent	Cf 2010 industry structure
Primary (agriculture, forests, fishing, mining)	+102422	13	6
Manufacturing	+140684	18	12
Construction	+115532	15	12
Services and other	+412525	53	70
Total	**+771163**	**100**	**100**

Source: NIEIR modelling.

The bottom-line conclusion is that the living standards of Australians will be higher by doing more rather than doing less - by between six and nine percent by 2030. The important conclusion from the study is this:

> "***Australia will create more wealth and jobs by taking strong action to reduce emissions by 25% (2020) and 50% (2030) than by standing still (the Weak action scenario) and doing very little*.**"

So how do we get there? – Winning by taking strong action

Contrary to often-cited arguments, the modelling demonstrates that a "wait-and-see" approach to climate change has severe negative outcomes for Australia both environmentally and economically. The key to achieving better outcomes is strong Government investment targeting complementary industrial and climate change programs. This will require strong political leadership and an increase of around 1.5 per cent in the proportion of GDP committed to investment. However, the benefits of this additional investment are substantial.

A recent release by the International Energy Agency highlights the risks in the global context of delaying strong action. The IEA reported that globally, each year of delay in implementing the investment program required to achieve a 450 ppm outcome "adds an extra USD 500 billion to the investment needed between 2010 and 2030 in the energy sector."[5]

[5] International Energy Agency, *From financial crisis to 450 ppm: the IEA maps out the energy sector transformation and its financial consequences under a global climate agreement,* Press Release, 6 October 2009.

Australia will also face costs from delay. In the Intermediate and Strong action scenarios much of the required increase in gross investment is due to the capital-intensive nature of low-emission technologies. In a delayed action scenario these costs would still have to be borne, plus additional gross investment costs due to the need to replace high-emission equipment more quickly.

Rather than waiting, strong action on climate change requires a full basket of policies and substantial investment (public and private) in clean energy infrastructure across the nation to maximise the benefits.

E.14 Can we do without carbon pricing?

The Strong action and Intermediate scenarios differ from the Weak action scenario by adding sector-specific measures, the essential role of which is to hasten the price response. This raises the question as to whether the same benefits could be achieved by sector-specific measures alone. To address this question, NIEIR developed a variant scenario which achieved similar domestic abatement to the Intermediate action scenario using sector-specific measures alone, without specific carbon pricing.

The variant scenario substituted general tax increases for the resource-raising role of the carbon price. It also accepted that, as sector-specific measures were implemented, there would be resulting price rises – for example, the price of electricity would rise, not because of carbon pricing but to generate a capital return on mandated investment in renewable generation. The end result was that the variant scenario, while still a major improvement on Weak action, required a higher level of investment and hence a larger increase in saving. The higher level of investment was due to the loss of the energy-efficiency improvements which in the Intermediate and Strong action scenarios are directly triggered by carbon pricing.

E.15 Do the results vary by target?

The three scenarios developed in this report have a common target of 25 per cent emission reduction by 2020 and 50 per cent by 2030. It is quite possible that the debate over emission abatement will, in time, focus on different targets – either less or more. Does this affect the general policy conclusions from the present study?

The principle conclusions of the study are as follows.

- Early action on domestic abatement is vastly preferable to delayed action and to reliance on permit imports.
- Action should involve both carbon pricing and sector-specific measures, with both components requiring considerable administrative effort. The required investment in sophisticated administration will be complemented by investment in abatement technologies.
- Abatement policies will require complementary macroeconomic policies to ensure that the required investment is appropriately financed.

These conclusions hold whatever the target. If the abatement target is raised or lowered, brought forward or postponed, the main effect is on the timing of abatement investment, not on the strategies required for its implementation.

E.16 Politically the Weak action scenario is not an option for Australia

Under the Weak action scenario there is a high probability that Australia will become an outcast in international forums. This would happen because, by 2020, its domestic CO_2 emissions reduction per unit of GDP would be significantly less than the indicated reductions

of China and little better than India. The CO_2 intensity decline is 34 percent. Though the target would be achieved technically from permit imports, the abatement effort is likely to be far from acceptable to nations championing abatement.

E.17 Economically the Weak scenario is not an option for Australia

For decades now, Australia has coasted along, keeping its planning horizons short and allowing problems to accumulate. We have become heavily dependent on overseas goodwill to finance our balance of payments deficit, and now increasingly to overlook our high level of greenhouse gas emissions per capita. If we do not wake up of our own accord, we will be woken – resulting in costly action. The Weak scenario includes such action in the form of purchases of emission permits in large quantities, but this addresses only the problem of excess emissions, and does not take the level of overseas debt into account. The costs of panic action to address emissions abatement in the context of a balance of payments crisis do not bear thinking about.

E.18 Regional impacts – case studies

The following reflect the regional results from NIEIR modelling.

Coal producing regions:

Illawarra and the Hunter Valley – NSW

Includes Maitland, Newcastle, & Wollongong

Job growth in these two regions occurs across all sectors, with mining jobs continuing to grow and a significant increase in the Services sector. These jobs primarily grow from policies including:

- household and industry energy efficiency improvement
- transport infrastructure investment and benefits
- industry policies to maximise the local content of CO_2 abatement expenditures stimulating production of transport equipment and construction materials
- employment created from higher living standards

The Green Jobs Illawarra Action Plan is a good example of how these jobs will be maintained and grown under strong climate action.[6]

Total Employment: 2009		**2030**
A – Weak Action	470,000	519,800
B - Strong Action	470,000	551,249
Difference:		***+31,449***

Net additional Jobs (Strong compared to Weak action):		**2030**
Agriculture, mining, forestry and fisheries		1,577
Manufacturing		6,257
Construction		6,795
Services		16,821

[6] http://www.sclc.com.au/content/greenjobs.php

Emissions intensive trade exposed industrial (EITE) regions:

Fitzroy – Queensland

Includes Gladstone and Rockhampton

Jobs growth in this region occurs across all sectors, with jobs continuing to grow in the key sectors of the region. The additional 10,000 jobs under a Strong action scenario are predominantly due to benefits from policies including:

- low emissions electricity production (gas)
- biodiesel production and enhanced agriculture supply
- enhanced industrial capacity in chemicals etc. to support expansion of Australian manufacturing industry

Total Employment: 2009		**2030**
A – Weak Action	102,000	142,707
B - Strong Action	102,000	152,781
Difference:		***+10,073***

Net additional Jobs (Strong action compared to Weak action):		**2030**
Agriculture, mining, forestry and fisheries		1,836
Manufacturing		1,651
Construction		2,207
Services		4,379

Rural Australia:

Bendigo – Victoria

Includes Greater Bendigo

Jobs continue to grow in the key sectors of the region. The additional 9,000 jobs under a Strong action scenario are predominantly due to benefits from policies including:

- clean energy infrastructure investment
- biomass agriculture on marginal farming land
- land use management to minimise emissions
- commercial services activities supporting expansion of agriculture and renewable energy in wider Victorian region

Total Employment: 2009		**2030**
A – Weak Action	106,000	132,276
B - Strong Action	106,000	141,037
Difference:		***+8,761***

Net additional Jobs (Scenario B compared to A):		**2030**
Agriculture, mining, forestry and fisheries		1,513
Manufacturing		1,383
Construction		1,561
Services		4,304

Urban manufacturing centres:

Outer South-Western Sydney – NSW

Includes Liverpool and Campbelltown

Jobs are 20,000 higher under a Strong action scenario for Western Sydney, with an additional 12,000 jobs in the services sector. Manufacturing continues to play a key role in this region, with an additional 5,000 jobs. The main drivers of employment growth are:

- employment created from higher expenditures stemming from higher living standards
- general energy efficiency programs (industrial, commercial and residential)
- strengthening of manufacturing
- research and development activities

Total Employment: 2009		**2030**
A – Weak Action	201,000	297,580
B - Strong Action	201,000	317,174
Difference:		***+19,594***

Net additional Jobs (Scenario B compared to A):		**2030**
Agriculture, mining, forestry and fisheries		640
Manufacturing		5,256
Construction		1,525
Services		12,174

1. The contribution of this report to the CO_2 abatement debate

Over the past few years, the scientific case that drastic action needs to take place to avert disastrous climate change has become more urgent. Citizens, businesses and governments have begun to respond – not nearly quickly enough from a climate science point of view, but sufficiently to make it clear that business as usual is no longer possible. As the science moves the debate towards more stringent abatement targets the priority is no longer whether to reduce emissions, but how much, how soon and how. This report develops a realistic policy response to the target agreed in principle at Copenhagen.

1.1 How much abatement, how soon?

When NIEIR prepared its first major report into emissions abatement (*Measuring the Economic Impact of Reducing Greenhouse Gas Emissions* for the Electricity Supply Association of Australia, September 1994) the scientists studying climate change had found that the concentration of greenhouse gases in the atmosphere was increasing. They strongly suspected that the increase was man-made and feared that the increase would have serious consequences. Calamity was considered probable rather than certain and was thought to be many decades ahead rather than immediate, but prudence demanded action. The key finding of NIEIR's report was that a package of measures was desirable.

The present report is predicated on the assumption that an effective world abatement program aimed at the 2^o target (or less) will be under way within the foreseeable future. By an effective program, we do not necessarily mean a treaty ratified through the United Nations nor do we necessarily mean an international agreement signed by Australia. For the purposes of Australian policy, it will be sufficient that Australia's major trading partners and major sources of overseas finance agree on a 2^oC abatement program which includes incentives to join, backed up by the threat of trade and capital flow sanctions against countries which do not join.

Though Australia is not an overwhelming contributor to global emissions, its 1.5-2.5 per cent (depending on whether it is debited with emissions from its coal exports and bushfires) is significant enough to be noticed, particularly when translated into a very high level of emissions per capita. Other considerations which will influence international negotiations on an abatement target for Australia include:

1. the level of national wealth (Australia is rich enough to afford abatement);
2. Australia's poor abatement performance to date (the 2010 Climate Change Performance Index prepared by Germanwatch insert reference and widely circulated in Europe ranks Australia's performance on global warming since 1990 as among the worst in the world, 54^{th} out of 57 countries assessed);
3. the view that Australia has more opportunities than most to abate at low cost; and
4. a view that Australia stands to gain more than most countries from averting climate change.

As seen from overseas, it is natural to conclude that fair – indeed generous – abatement targets for Australia in 2020 are 25 per cent below 1990, and 50 per cent below in 2030, based on the 2^oC objective. It is testimony to the rate at which the international scene is moving that these targets approximate the most ambitious abatement scenario developed in the Garnaut report less than two years ago and adopted as an ambitious target by the present government.

The targets could easily turn out to be more stringent, as could happen if the target temperature increase is revised downwards or international agreement is reached that Australia should progress more rapidly towards world average per-capita emissions. Alternatively, international bickering over the distribution of abatement could result in a weak target at world level, or maybe countries will agree to targets then do nothing about them. Either of these weak alternatives will see climate change resulting in serious adjustment costs, probably sooner than we at present expect. This study is built on the assumption that the world will pursue sufficient abatement to avoid the worst climate change effects, hence limiting both deadweight losses and adjustment costs. Whether that abatement level turns out for Australia to be more or less than the targets assumed in the study is a secondary consideration, the major consideration being: what policies should be adopted to bring about significant abatement?

1.2 Two analytical traditions

Two decades ago the first attempts to assess the likely impact of abatement policies calculated the emission-intensity of different industries and applied the simple hypothesis that the most severe adjustments would be visited on the most emission-intensive industries. By extension, the major opportunities for abatement were identified as where low-emission substitutes existed for high-emission goods and services. It was soon realised that the various expansions, contractions and substitutions interacted with each other and the investigators were forced to adopt economic modelling to assess the potential for abatement. These studies took two very different approaches.

Economists working within the neo-classical tradition continued their emphasis on the optimality of market solutions whatever the problem addressed. Not surprisingly given their pro-market views they concluded that a single policy instrument – carbon pricing, whether by taxation or emissions trading – was the appropriate policy response. As this approach developed, the scope for carbon pricing came to be assessed through 'top down' analysis which treated abatement as a set of abstract price responses by which low-emission techniques of production were substituted for high-emission techniques and the remaining high-emission industries contracted.

From a different point of view, engineers and energy-sector specialists looked at the lists of abatement opportunities and noticed the considerable scope for negative-cost abatement. From this they concluded that energy markets were not sufficiently price-responsive for a carbon price to be the sole or dominant policy instrument. Instead they suggested that policy should address abatement opportunities one by one using a variety of policy instruments including efficiency standards (e.g. fuel efficiency in vehicles, building regulations), marketing techniques (e.g. star ratings), finance (e.g. funds for research, development and demonstration; funds for the replacement of energy-inefficient equipment), infrastructure investment (e.g. railway lines) and direct action (e.g. replacement of coal-fired by gas-fired generation within government-owned electricity generation systems). The scope for sector-specific measures was commonly assessed through 'bottom up' analysis, which looks at opportunities for abatement at the level of individual households and businesses and endeavours to generalise from these to the broader picture. In this process of generalisation it was common to argue that it would be helpful to put a price on carbon. The main difference between the two approaches was accordingly that the neo-classical analysts argued for carbon pricing as the sole policy response to climate change while the sector-specific analysts argued that the price mechanism needed to be supplemented with sector-specific policy measures.

With the two approaches adopting different modelling techniques the policy debate became a slanging match. The neo-classical economists accused the sector-specific analysts as follows:

- putting together a rag-bag of policies, some of which would not be at all cost-effective in reducing emissions;

- not having sufficient analytical rigour in establishing criteria for the various combinations of policies advocated; and
- not specifying a fair distribution of abatement effort across sectors.

The sector-specific analysts replied that a pricing-only response would not deliver sufficient abatement, due to a long list of market malfunctions most of which cause tardy rather than perverse price responses. They argued that there simply is not time to indulge in the luxury of a pure pricing approach to abatement.

In the heat of this argument an important point was missed: The sector-specific analysts had identified the key to the debate. To the extent that price responses are slow but not perverse, carbon pricing and sector-specific measures are complementary. Without sector-specific measures, price responses are slow and may also be wasteful of resources through failure to coordinate the investment program required for abatement. However, without price expectations as a guide, there is a risk that high-cost sector-specific policies will be favoured over those with better returns and that disproportionate losses will be imposed on particular sectors.

When NIEIR originally approached this problem in a study completed in 1994 it began with two papers outlining a comprehensive list of policy instruments for responses to environmental concerns. The present study does not repeat this exercise, but addresses the case that complementary pricing and sector-specific policies will be required if abatement is to be pursued at anything like a satisfactory pace. This case can only be properly adjudicated if top-down and bottom-up modelling are reconciled and incorporated into the same modelling system. In its 1994 report and all subsequent work in the area NIEIR incorporated bottom-up modelling into its macroeconomic models. Industries and sectors are modelled in terms of the abatement opportunities, costs, restraints and decision rules appropriate in each industry and sector, using bottom-up methodology. The results are added to the macroeconomic level, which in turn generates feedbacks to the microeconomic level.

It is now commonly acknowledged that emission abatement can only be satisfactorily analysed by combining the macroeconomic and microeconomic; the top-down and the bottom-up. This was indeed attempted by the Treasury in 2008, but in NIEIR's judgement the Treasury's approach has remained essentially 'top down' modelling of the kind which automatically justifies a primarily pricing approach to abatement. A full discussion of these methodological differences is undertaken in Appendix A. Meanwhile an important contribution of the current report is its integration of top-down and bottom-up modelling; macroeconomics and microeconomics. In the next few sections we outline the way in which this is achieved.

1.3 Abandonment of the 'business as usual' base case

An obvious consequence of the increased urgency of abatement is that it no longer makes sense to assess alternative abatement policies against a 'business as usual' base case. A scenario in which no country and no business take any action to reduce emissions is no longer believable. Already the emphasis in modelling is on comparisons between scenarios with different degrees of divergence from 'business as usual'. The time has come when abatement action has to be included in all feasible future scenarios and to concentrate on comparing abatement scenarios rather than treating them as deviations from an unattainable base case.

Since abatement action is inevitable, scenarios for Australia have to be developed against specific backgrounds of world abatement action. The world background may be expressed in terms of agreed treaty targets but may alternatively take the form of ad-hoc political agreement in which countries which are concerned about climate change not only take national abatement action but attempt to extend this action to others. Either way a high-income, high-emission country like Australia will be under heavy international pressure to

abate – which in this study is expressed in the form of an agreed set of targets which can be met either by domestic abatement or by importing emission permits.

Abatement has both costs and benefits. The point is not to pretend that the costs do not exist but to seek ways to minimise costs and maximise benefits.

1.4 A concentration on jobs

An important aim of abatement policy is that it should be fair in the curbs it places on each of the wide variety of human activities which generate greenhouse gas emissions. Following the traditions of economics, three rules may be proposed:

1. that the policy mix should be low cost (even if least-cost is an unattainable holy grail);
2. that it should not have unintended distorting impacts which counteract the desired policy direction; and
3. that it should safeguard the interests of people with low incomes and wealth.

Since employment is the main source of income of working-age low and middle income households, this study concentrates on the employment consequences of alternative policies. This concentration on employment also provides a means of tackling the least-cost rule – a policy is preferable when it generates more jobs, with a proviso that these jobs should generate reasonable incomes.

The major restructuring of economies which is required by emission abatement will necessarily generate both opportunities and losses, and allowance has been made for the assistance necessary to transition from the industry structure we have today to one more appropriate in a carbon constrained world.

This concentration on employment effects involves placing relatively little emphasis on the changes in income. One reason for this is that income can be unequally distributed but the main one is that people do not always have full control over their incomes – taxes are imposed, mortgage payments have to be paid and so on. As an alternative the study tracks the effect of abatement policies on consumption, which thus takes the role of an economic welfare indicator. For this purpose, the best definition of consumption covers those expenditures which directly yield benefits to households, excluding expenditures which yield benefits only indirectly, in particular energy and transport expenditures. Nobody gets any utility from consuming a kilowatt hour of electricity or a megajoule of gas; the benefit arises from the services that accrue from the application of energy, namely comfort and cooking. When the efficiency of energy use is increased, the same services can be produced with less energy impact. Similarly transport is not usually an end in itself, but rather a means of accessing activities conducted in different places. For these reasons, energy and transport expenditures are excluded from consumption when it is calculated as a welfare indicator.

In calculating the employment and other welfare effects of emission abatement policies, the first step is to admit that the policies have complex and necessarily interactive effects – hence the necessity to employ economic models to assess the effectiveness of alternative policies in generating jobs and income. We employ NIEIR's modelling system, which is a combined top-down bottom-up modelling system quite different from the essentially top-down models used by the Commonwealth Treasury and others. Many of the differences of policy recommendation between this report and other recent reports reflect differences in the models used, which makes it all too easy for policy discussions to degenerate into highly technical comparisons of model attributes. We indeed provide such a discussion in Appendix A, but meanwhile believe that argument should be expressed in common-sense terms with the underlying models kept in the background.

1.5 The significance of regions

It has often been argued that emission abatement will have regionally inequitable effects. If emissions are to be reduced, high-emission industries will either have to change to low-emission technologies or close down. The burden of adjustment will then fall on the regions where these industries are concentrated.

A major contribution of this study is that it takes these arguments seriously.

To assess the significance of industry change at the regional level, NIEIR included industry detail in each national-level projection. For this purpose industries which are expected to change technologies in response to abatement policies were modelled in some detail, particularly electric power generation. The technicalities of this are explained in Appendix A.

The consequences of change in relative industry fortunes were then mapped down to the regional level using detailed information on current local industry mix and input-output relationships. This provided an assessment of how national trends would affect industry fortunes at the regional level. The assessments abstracted from that other major driver of local economic development – infrastructure investment and service provision decisions by the Commonwealth and state governments. The general result was that the national conclusion of the study – that abatement generates jobs – is replicated at the regional level, particularly if the states and Commonwealth use their discretion to provide additional infrastructure to support the restructuring of the regions affected most directly.

1.6 Taking costs seriously

In general terms there are two routes to emission abatement. One is to transfer demand from emission-intensive goods and services to emission-light goods and services, cutting down on, for example, transport and increasing consumption of, for example, education. The other is to find low-emission ways of producing what were previously high-emission goods and services, for example substituting renewable electricity for that previously generated from coal. In very general terms, the switch to low-emission production involves the substitution of capital for fuel inputs. In this process:

- existing capital equipment complementary with hitherto low-cost energy (e.g. coal burning generation plants) becomes obsolete before the end of its design life, and must be written off;
- low-emission equipment must be acquired in lieu; and
- as a result of these two processes, the aggregate capital stock required to produce a given level of GDP increases, with the amount of the increase depending on the ease with which low-emission production can be substituted for high-emission and on the scope for low-cost energy-efficiency improvements.

The increase in the aggregate capital stock required to produce a given level of GDP can be thought about as a reduction in the productivity of capital, which can be returned to previous levels only by technological progress. Until the rate of innovation catches up, the reduction in the productivity of capital can be interpreted as either a reduction in the GDP yield per unit of capital invested or as an increase in the investment required to generate a unit of GDP. These two interpretations of the same phenomenon can easily lead to vastly different forecasts.

- An emphasis on the reduction in the yield on capital translates into a reduction in the rate of return on capital. Those who believe that prices determine economic behaviour argue that the reduction in the rate of return means that less should be invested. This will result in a reduction of the rate of growth of GDP and heavy reliance on switching to low-emission, low-capital goods and services as a response to the need for abatement.

- By contrast, those whose eyes are fixed on quantities rather than prices translate the increased capital required to generate a unit of GDP into a need for a capital-reconstruction campaign in order to maintain standards of living.

The former interpretation belongs in the world of neo-classical macroeconomists, and we will encounter it again when we consider the Australian Treasury modelling of emission abatement. The latter interpretation is general among the proponents of sector-specific policies and for the time being it is helpful to follow their line of reasoning. To get emissions down, high-emission equipment has to be replaced by low-emission equipment. This is obvious to householders who find themselves replacing light-bulbs and refrigerators and installing insulation. It is utterly compelling to energy-intensive businesses which are faced with the prospect of replacing whole power stations and smelters. From this point of view, it is unassailable that substantial investment will be required if abatement is to be pursued at a satisfactory pace, and that this investment program will include the replacement of emission-intensive equipment with low-emission equipment, generally at enhanced capital cost. It will also be necessary to replace a significant amount of emission-intensive equipment before the end of the economically useful life it would have had in the absence of the need for emission abatement.

Though it is never stated, an implication of the neo-classical interpretation is that technologies can be switched without the messy and painful process of scrapping high-emission equipment and replacing it with low-emission equipment. This assumption ignores the main area of cost incurred by abatement programs. The reasoning behind this remarkable assumption is explored in Appendix A; here we will merely claim that it is unrealistic. The costs of scrapping and replacement are unavoidable. They can be interpreted as the cost of the imperfect foresight which led businesses to invest in emission-intensive equipment.

The need to replace a lot of equipment implies a burst of investment. For the most part this will be replacement investment; that is, investment required to maintain productive capacity rather than to enhance it – in the jargon of the National Accounts, an increase in gross investment without an increase in net investment. Because the increase in investment is largely for replacement, it is immaterial whether the required capital stock goes up or down as measured in terms of its productive capacity. Because a burst of (gross) investment is required to maintain capacity without adding to it, the neo-classical economists are likely to be right that the rate of return on capital will go down. What they overlook is the cost incurred in maintaining capacity while rectifying the poor investment decisions which resulted in the incorporation of high-emission equipment into the current capital stock.

Once it is admitted that a burst of capital stock updating is required, the question arises as to how the update is to be resourced. It is no use pretending that updated capital can simply materialise; real resources have to be devoted to the reconstruction of the capital stock. These resources have to be diverted from other uses, so forgoing alternative production. To some extent the foregone alternative production will be replacement investment in established emission-intensive equipment, for example building wind power instead of replacing an old coal-burning power station. However, we have argued that this will not yield enough resources to finance the required investment program, the essence of which is accelerated replacement of high-emission equipment. A major contribution of this study is to take the capital updating requirements of emission abatement seriously. By contrast, some recent studies neglect this fundamental requirement.

An important consequence of taking capital reconstruction seriously is the need for information on which to base the updating campaign. A primary element in the information set is the carbon price. If a believable carbon price trajectory can be established early, industry will be able to plan the abatement campaign rationally – not cobble it together in a wasteful last-minute rush. This study contributes to the arguments for ensuring that the carbon price plays a central role in updating the capital stock, complementary to the arguments that it should be backed up by supporting policies.

1.7 The importance of macroeconomic policy

The fact that abatement requires the raising and deployment of resources for capital reconstruction raises the important question of where the resources are to come from. If the economy is at less than full employment, resources can in principle be found – but these resources still have a cost, because they could alternatively have been directed to other ends such as increased government expenditure on health or education services. Accordingly this study treats expenditure on capital reconstruction for abatement as a real sacrifice – expenditures which would otherwise have been made must be curtailed. This is where macroeconomic policy comes in.

When resources have to be found, the underlying choice is a reduction in consumption or a reduction in investment of the kind which will yield future returns. This reduces to a choice between consumption now and consumption in the future – we use the economic definition of investment, which is the forgoing of consumption now in order to increase future consumption. Since the purpose of capital reconstruction expenditures is to safeguard future consumption, we have assumed in this study that the necessary resources will be generated at the expense of current consumption. As regards government consumption, resources can be diverted by rebalancing the budget from current government services to abatement expenditures, while as regards private consumption resources can be generated by policies which increase household and business savings. The obvious policy change at the household level would be switch from policies which favour borrowing to policies which encourage saving. Other policy changes are possible such as wage/superannuation tradeoffs. In fact, as will be argued in Chapter 3, major policy changes may not be necessary – it is quite possible that households will of their own accord begin to rebuild the savings ravaged by two decades of heavy borrowing. This has potential to raise savings rates sufficiently to finance the decarbonisation of the economy.

Though resources must be generated to finance capital reconstruction, many of the projects involved will yield efficiency benefits in addition to abatement. We will see in the report that, as soon as these benefits start to flow, reconstruction can become self-financing. It is therefore of the utmost importance to include the efficiency benefits of abatement in the analysis in addition to the resource costs and abatement benefits. Such balanced assessment, including all costs, the need for savings and the potential for benefits in addition to abatement constitutes a further major contribution of this report.

1.8 The importance of overall assessment

A fundamental principle is that abatement policies should be assessed not only for their effectiveness in hastening abatement, but for their overall balance of benefits and costs, and in particular their overall effect on employment after taking distributional and macroeconomic factors into account. One of the concerns with carbon pricing is its distributional effects, and sector-specific measures require similar assessment – some sector-specific measures may raise costs for low-income people (e.g. vehicle emission standards which raise purchase costs) while others may counter distributional concerns (e.g. subsidised retrofit of improved insulation in low-rent housing). Similarly many sector-specific measures have efficiency-improving side effects which should be taken into account when evaluating their costs and benefits (e.g. improved building insulation of business premises reduces production costs). Both carbon-pricing and sector-specific policies inevitably affect the fortunes of different industries, which in turn have ramifications for industries which deal with those industries. The total effect of abatement policies on employment and consumption is the sum of all these effects.

By their nature, abatement policies generate costs, benefits and distributional effects in addition to their abatement effects (e.g. policies to switch travel from motoring to public transport are expected to reduce emissions and also to reduce congestion, collision costs and the petroleum import bill, and in addition to have differential effects on low-income

versus high-income households). Policy development should take these costs/benefits and distributional effects into account. A major contribution of this study is that it includes these effects at both the microeconomic and macroeconomic level.

1.9 Time and decision-making

In assessing policy packages we necessarily encounter the general problem of the time horizon. It has often been pointed out that the costs of climate change are underestimated at normal market discount rates, and similarly energy-using equipment tends to be in use for long periods of time (many decades in the case of power stations, two or three decades in the case of transport equipment) so that decisions need to take a long time period into account. Concern for one's children's welfare implies low (some would say zero) discount rates, but within a conventional financial system these concerns cannot easily be translated into investment decisions. In project assessment terms, the position translates into the familiar dichotomy between prospective economic and financial rates of return – after allowance for external costs (carbon costs, other side effects, switching to a low discount rate) low-emission investments improve in relation to high-emission. In abstract form we have here one of the fundamental arguments for government intervention to reduce emissions.

On a more practical level, if pricing is to be used as a guide both to private decisions to update the capital stock and as a guide to the selection and evaluation of sector-specific policies, it is crucial that realistic price expectations should be generated over long time horizons and that finance should be available to support decisions taken on the basis of these expectations. It is also important that price expectations should be validated by experience, at least over the medium-term of a decade or two – for if realised prices are out of kilter with expected prices, windfall profits and losses will be generated which reinforce market tendencies towards short time horizons and hence poor abatement decisions.

Fluctuating carbon prices will discourage investment in abatement, since there is always a risk that the price will fluctuate downwards when the investment comes on stream. This report emphasises the importance of a policy of predictable carbon prices, which should be set in relation to a national abatement target (in turn related to world targets) on the basis of reasonable expectations of price responses augmented by a complementary sector-specific program. If the price responses turn out to be slower than anticipated, the sector-specific program can be tightened to meet the target.

Compared to some assessments, this study uses a short time horizon (only to 2030), on the grounds that, beyond this point, developments in relevant technology are very difficult to predict, to say nothing of the background of world negotiations on emission abatement. However, up to 2030 the study is fully dynamic, with results generated for each year and feeding on to the next year. These explicit dynamics are an important contribution of the report.

1.10 Imported permits

Among the potential abatement policies is the proposal that Australia can meet its targets by financing emission abatement overseas, generally assumed to take the form of importing emission permits. This is an important component of the emission abatement program proposed by Garnaut in 2007 and Treasury in 2008. The proposal that Australians should be free to buy and sell permits on the international market (or on some quality-approved subset of that market) implies that the Australian carbon price should not only be implemented by an emission permit system (rather than a tax) but that the price should be set by the international price, mediated by the exchange rate. Under these rules there is a serious risk that carbon prices will be highly volatile. The reasons for expecting volatile world prices include the scope for international debate as to what constitutes an acceptable tradable permit and the scope for gaming inherent in financial derivative markets. To these reasons

one may add the volatility of the Australian dollar exchange rate, which over the past twenty years has varied from nearly at par to the US dollar down to 50 US cents. This prospective volatility will discourage abatement-related investment because of the possibility of severe cash-flow problems if the investment comes on stream at a time of low permit prices.

This report accordingly argues that Australian and international carbon prices should be separated, meaning that the import and export of permits will become a government monopoly and, further, that the Commonwealth will do all in its power to establish a credible permit price trajectory. If this is done, NIEIR argues that there will be a substantial investment response to domestic carbon pricing; if it is not done, a much more cautious response is to be expected.

One of the scenarios developed in this report includes a considerable permit import trade; in the other two the necessity to import permits is avoided apart from small imports which are targeted essentially as overseas aid to low-income countries which would otherwise find abatement difficult to finance.

The question of imported permits once again brings us hard up against the macroeconomics of abatement. The argument for free trade in permits is essentially that such trades will ensure that abatement is carried out wherever it is least-cost, here or overseas. Whatever the theoretical attractions of this argument, it should not be taken for granted. A major contribution of this study is to assess emission abatement policies, and permit import policies in particular, in the context of Australian trading relationships and capital-flow relationships with the rest of the world.

1.11 The distinctiveness of this report

To summarise, this report begins a new generation of policy comparisons.

- It takes climate change seriously, responding to the latest scientific findings and the in-principle commitments made at Copenhagen.
- It takes the variety of policies available to address emission abatement seriously. In particular, its combination of ‘top down’ and ‘bottom up’ modelling allows the unbiased assessment of the contribution which sector-specific policies can make to efficient abatement.
- It acknowledges that abatement policies have benefits and costs. It takes the need to reconstruct the capital stock seriously and covers the macroeconomics of making resources available to finance reconstruction. It explicitly allows the necessary time for reconstruction to take place.
- It also acknowledges that abatement policies can have benefits in addition to their abatement benefit – principally energy-efficiency benefits and benefits in overseas trade through efficiently substituting domestic production for imports and also by improving export competitiveness. It includes these benefits in the analysis.
- It highlights the importance of macroeconomic policy to support the diversion of resources to abatement, and in the process recognises a number of other constraints currently affecting the Australian economy, notably the high level of overseas debt. This recognition provides background for a critique of the proposal to import permits.
- It includes analysis at the regional level.

In these respects the report invites comparison with the influential Treasury report *Australia’s Low Pollution Future* (2008), which is considered in Chapter 12 and at greater length in Appendix A.

The fundamental difference from the current report arises because the Treasury report sits squarely in the neo-classical analytical tradition, whereas the current report takes a more eclectic approach to economics. Treasury modelling is extremely abstract and ignores the

core problem of financing the reconstruction of Australia's capital stock. The CO_2 reduction technologies are assumed to appear like 'manna from heaven' in the capital stock and that all that had to be done to achieve this is to set an appropriate price for CO_2. The assumption that reconstruction costs can be ignored harms the credibility of the Treasury modelling. More importantly, the methodology let the Government down, in that a coherent and transparent strategy could not be charted.

A second shortcoming is that dynamic benefits from CO_2 abatement are assumed away. This means that capital reconstruction is assumed not to yield benefits through increased efficiency and a reduction in permit imports. It is further assumed in the Treasury modelling that employment is fixed, productivity is fixed and savings are a fixed proportion of income. The net effect of this pile of assumptions is that there can be no scope for efficiency improvements to offset the costs of abatement.

These differences of approach account for the difference between the major conclusion of the present report and the major conclusion of its Treasury counterpart. In the Treasury analysis abatement always comes at a cost, and the more the abatement, the more the cost. Even though the NIEIR analysis recognises costs that the Treasury assumes away, the final conclusion of the present report is that strong abatement policies can be designed which not only yield abatement, but do so with a stronger economy than results from the policies which Treasury advocated. However, delay and procrastination in implementing a combination of carbon pricing and sector-specific policies will only increase the cost that must be paid.

Like ClimateWorks Australia in their recent report *Low Carbon Growth Plan for Australia* (2010), but on a much broader canvas, the present report accordingly argues for the integration of carbon pricing with sector-specific measures.

In the following chapter we introduce the methodology which underlies the conclusion that abatement is best pursued by a range of policies. This methodology also underlines the conclusions that taking abatement seriously will generate rather than destroy jobs, even in those regions which are believed to be most exposed to economic restructuring as a result of abatement policies. A further conclusion is that abatement will require an increase in savings, but that this will be a good investment in terms of increased consumption as soon as abatement gets under way.

In Chapter 2 the methodology is introduced in its own terms. A brief comparison with Treasury methodology is given in Chapter 9, and a more extended comparison in Appendix A.

2. Study structure

Assessing alternative policy responses to the need for greenhouse gas emission abatement is no simple matter. The candidate policies are numerous and varied. They include pricing policies, taxation policies, financial policies, regulatory standards, the provision of information and more. They interact, and there is always the possibility that policies may counteract each other. We resort to economic modelling to aid our search for low-cost policies. Even then, the complexities are such that it is not possible to model all possible policy combinations and we therefore proceed by comparing a limited number of combinations. These comparisons are carried out by constructing scenarios in which different policy combinations are brought into play. Though these scenarios are built using economic modelling (and it helps to have NIEIR's combined top-down bottom-up model to hand) their worth does not depend primarily on the model which assisted with their construction. Instead, they should be judged for internal coherence and plausibility: fundamentally, each scenario should tell a believable story.

2.1 The three-scenario strategy

To address our question of the usefulness of policy instruments, we develop three alternative Australian scenarios against the background of a single global projection in which world abatement gradually accelerates and Australia is obliged to accept emission targets of 412 $MtCO_2e$ (25 per cent below 1990 levels) in 2020 and 275 $MtCO_2e$ (50 per cent below 1990 levels) in 2030. As noticed in Chapter 1, there is no 'business as usual' scenario. Despite the noise made by the climate change denialists, NIEIR argues that the time for such scenarios is past.

We develop three scenarios to meet the common target. These scenarios achieve the abatement target by different means, as follows.

- In the Weak action scenario Australia relies mainly on emission pricing and permit imports to meet its targets, though the scenario also includes the continuation of existing policies such as the renewable energy target.
- In the Intermediate scenario Australia augments emission pricing with sector-specific measures.
- In the Strong action scenario Australia adds policies to integrate emission abatement and industry development to the mix of emission pricing and sector-specific measures developed in the Intermediate scenario.

The scenarios thus encompass two steps.

- From Weak action to Intermediate: addition of sector-specific measures to carbon pricing.
- From Intermediate to Strong action: addition of industry development measures.

The scenarios are designed to assess the minimum return to the addition of sector-specific policies to carbon pricing (intermediate) and the maximum return when the effect of carbon pricing plus sector-specific policies is amplified by complementary industry development policies. It is argued that the addition of sector-specific measures to carbon pricing will achieve the target without resort to permit imports while the addition of industry development measures will multiply the jobs created.

The three scenarios are selected from an almost infinite variety of plausible policy scenarios. The following decisions were made in selecting a manageable number of scenarios.

- The three scenarios were based on a single world scenario – a scenario which represents a compromise between current scientific advice and the delays and

compromises of politics. This world background is open to attack from both directions: from the science on the grounds that it promises too little too late and from self-styled political realists who argue that the world simply cannot get its act together. This world background is based on the commitments made at Copenhagen, augmented by a discussion of how world commitment is likely to be translated into a target for Australia. This discussion will be found in Chapter 4.

- The considerable number of government policies with emission-abating effects were reduced to two packages – a policy with heavy reliance on carbon pricing (though with some sector-specific measures as currently applied) and a policy package including sufficient complementary sector-specific measures to avoid the necessity to import permits. The Strong action scenario was derived by adding industry development policy to the mix.

Those who have been immersed in the climate change debate in Australia will note that the target on which the scenarios are based are at the top end of current Government commitments. We have two reasons for selecting abatement of 25 per cent below 1990 by 2020 and 50 per cent by 2030.

- These targets are based on a minimal Australian commitment to preventing global temperatures from rising by more than two degrees, as agreed at Copenhagen. Given its high level of emissions per capita and high income, Australia could well be asked to do better than this. Despite current political views, the target is conservative.
- Australia is very unlikely to have the luxury of selecting a weak target in the context of international action. As a trading nation with a high level of international debt requiring continual refinancing, coupled with a balance of payments deficit, Australia will not be in a position to stand out against international agreement without trade, debt-financing and diplomatic repercussions.

This said, two further points are in order. First, precise numbers apart, the results of the study are independent of the target selected. In particular, the arguments in favour of policy packages as against the single-instrument carbon-price approach and against reliance on permit imports apply whether the target is abatement of -5 per cent or -50 per cent.

Second, the Weak action scenario has been designed to resemble current policy proposals in a number of respects. It confines abatement policy to carbon pricing and permit imports and settles on a carbon price which will maintain Australian domestic emissions at approximately current levels. The gap between current emissions and the abatement target is met by permit imports. The Weak action scenario thus resembles a ‘business as usual’ case, with the significant difference that the same target as in the intermediate and Strong action scenarios is imposed. The result is that Australia is forced to import many more permits than currently expected by the proponents of Weak action.

Because it is confined to three scenarios, this study makes no claim to have defined an optimum policy configuration. However, it does argue that emissions pricing is most effective when augmented by complementary policies designed to increase and hasten the price response. In order to pursue this argument, it makes a methodological break with previous macroeconomic modelling of emission abatement in Australia. Recent studies, notably for the Treasury, relied on top-down modelling of a kind which cannot realistically be used to assess policies other than price changes – indeed, we argue in Chapter 11 that the Treasury’s preferred model is of dubious applicability even to these policies. The present study employs an alternative model structure that can consistently incorporate a wide variety of policy packages. An important additional benefit of using our modelling approach is that it can be extended to provide a basic geography of loss and gain.

2.2 Policy definitions

In Chapter 1 we identified two main policy approaches to emission abatement: carbon pricing and sector-specific policies.

By carbon pricing we mean policies which impose a cost on emissions and simultaneously raise government revenue. The cost is assumed to be imposed at a flat rate per tonne CO_2e, covering as wide a range of emissions as possible – broadly those of the energy sector. The report does not enter into the debate as to whether this cost is best imposed domestically by a carbon tax or by emissions trading. However, it is assumed that an international emissions trading scheme is available, at least at inter-government level. It is also assumed that costs imposed by carbon pricing are rebated to exporters, and that a compensation package is developed at moderate cost to assist low-income households affected by carbon pricing. In both these respects the comparison is with the GST.

Sector-specific measures are harder to define, consisting as they do of a wide range of policy opportunities. Some of the work in identifying these measures has been carried out by ClimateWorks (2010) and others working in the tradition pioneered by McKinsey and Co. However, these policy identifications are incomplete, since they disregard implementation costs, dynamics and side-benefits. For the purpose of scenario development we have therefore started from lists of potential policies developed in countries where abatement strategy development is at a more advanced stage than it is in Australia. We then brought together carbon pricing with a sector-specific measures selected on the basis of currently-available cost and output information. Completion of the above process of policy development will doubtless change the content of the combined pricing and sector-specific strategy, but will not change its basic character as here modelled.

2.3 The mechanism of CO_2 reduction in the Intermediate and Strong action scenarios

For this study of CO_2 reduction, a wide range of instruments was incorporated into the NIEIR modelling system, as per Table 2.1. In the modelling the CO_2 emission target is specified for each year, for example it might be 400 million tonnes in year t, whereas the previous year the target was 410 million tonnes. This means that if GDP growth is 2.5 per cent a combination of new measures must be implemented in year t that will reduce CO_2 intensity in the economy by 2.5 per cent plus the extra 10 million tonnes. The model then calculates the structure of initiatives (that is the weight given to each initiative), making the effort as broad-based as possible, subject to an upper constraint of a 15 year payback period for each investment and the constraint of a minimum effort for each initiative. An example of minimum effort would be the minimum amount of renewable electricity capacity installed in each year. It is only when a particular initiative reaches its saturation point, such as the retrofit of all existing dwellings with ceiling insulation, that the minimum effort is reduced to a marginal increment. In the case of ceiling insulation, the post-saturation minimum level would be set by the number of new dwellings. Given the structure of effort the model then works out the level of investment required across all initiatives to meet the target after taking into account the impact of the CO_2 abatement investment impact in the current level and structure of economic activity.

2.3.1 Mandated initiatives

The methodology was data-intensive, requiring information on the investment requirements of each technology, its operating cost characteristics and the scope for replacement of existing equipment, in addition to its emission intensity. Data was gathered for a variety of technologies, much of it uncertain due to the developing nature of the technologies. It is expected that there will be unpleasant surprises (technologies not developing) but that there will also be pleasant surprises (technologies turning out to be lower-cost and more widely

applicable than expected at present). Provided policy is adjusted to take advantage of the pleasant surprises and not to pursue the disappointments, the cost-benefit assessment should be reasonably correct in general terms.

The mandated initiatives modelled for the Intermediate scenario consisted of the following measures.

(i) Renewable generation (solar, wind, wave, geothermal) was mandated to replace brown and black coal electricity generation as rapidly as practicable while maintaining grid stability.

(ii) Carbon capture and sequestration (CCS) was applied to fossil fuel power stations – it was assumed for the sake of argument that it becomes available on a cost-effective basis.

(iii) Combined cycle gas turbine stations with CCS replaced the remaining non-CCS coal-fired base load stations to minimise the risk profile of supply given that approximately half the CO_2 reduction will come from renewables.

(iv) Mandated biodiesel production.

The initiatives were funded by electricity prices increasing to whatever was required to generate the required rate of return. A subsidy was provided if necessary for biodiesel production if the cost rose above the oil price.

2.3.2 Direct public sector expenditure initiatives

Examples of direct expenditure initiatives were focussed on the transport sector.

1. Reduce demand for travel by reducing distances between housing, work, shops, entertainment, etc. by the development of urban densification, relocation of services and construction of mixed-use activity centres, all supported by increasing public transport density.
2. Mode shift from car to walking and cycling by the development of foot and cycle access infrastructure in conjunction with measure (1).
3. Mode shift from car to public transport by the development of rail, tram and bus infrastructure.
4. Encouragement of increased car-occupancy rates.
5. Improve freight efficiency by development of strategic logistic centres, larger trucks and shifting freight from road to rail.

A high level of direct expenditures was assumed to generate CO_2 reduction from land use changes, especially in forestry management.

Like mandated changes, the cost of operation of direct expenditure initiatives was assumed to be paid for by the users. There were no additional financial support costs, and price effects were counterbalanced at the macroeconomic level.

2.3.3 Incentive-based initiatives

For the household sector this class of initiatives included:

- ceiling insulation;
- wall insulation;
- air sealing around doors, windows, walls, etc;
- replacement of electric resistant water heaters;
- off-peak conversions from electricity to gas;

- conversion of off-peak to solar-gas; and
- electric or hybrid-electric car purchase.

For commercial buildings the same initiatives applied as for households, with the additional features of changing the layout and inter-relationships between the heating, ventilation and cooling systems and in the longer terms the benefits of design change of the shell of buildings.

For tradeable goods industries incentive based initiatives included:

- carbon capture and storage (iron and steel, cement, mining);
- radical change in production and process technologies; and
- changes in technologies embedded in final products.

For each incentive-based initiative the following information was collected as per 2008-2010:

(i) the petajoule per $m of expenditure reduction in electricity or gas use;

(ii) CO_2 reduction per $m of expenditure on capital reconstruction;

(iii) The energy savings $m per $m expenditure; and

(iv) The payback period, or the number of years it takes for cumulative energy savings to equal reconstruction expenditure.

From 2010 the following were projected for each initiative:

(i) the rate of decline expected in the $m expended per petajoule saved from technological change; and

(ii) the energy price relevant for each initiative, including the carbon price component.

This allowed the payback period to be automatically changed as the technology, costs and carbon prices changed. The sources of data are given in the methodological appendix.

The next concept that needs to be introduced is the average payback period and the distribution around the average payback period.

2.3.4 Incentive-based activities: the role of the payback period in the modelling

Decisions by households and businesses as to whether or not to invest in energy efficiency/abatement technologies are focussed on the payback period. The literature suggests that businesses make energy efficiency decisions based on payback periods of between three and five years. In the early years from 2010 a four year payback period is assumed. For households a 2.7 year payback period is assumed. These payback periods are an average around which there will be some take-up for higher payback periods as well as lower payback periods. For more detail on how this is modelled, see Appendix A.10.

Table 2.1 Decarbonisation instruments		
Sectors	**Instruments**	**Implementation Initiatives**
Agriculture Forestry Mining Manufacturing Government services Transport Households Electricity Core products Commercial	Building insulation Heat capture and cogeneration Biomass fuel production Protection of native forests, new plantations Agricultural carbon sequestration from no-till farming, mulching, cover cropping and crop rotation Renewable energy capacity Electric or hybrid cars Accelerated energy efficient equipment replacement Carbon capture and storage for industrial and electricity plants Fuel substitution for low CO_2 intensive fuel (gas versus electricity, biomass versus the rest) Expenditure on infrastructure (transport)	Regulation – narrow product selection Price incentives Subsidies Loans Interest support Demand merit order supply solution Marketing and administration support Accelerated depreciation Tax credits Investment allowances Direct government expenditures

In terms of the future, for most industries (shown in Table 9.6) the rate of energy efficiency improvement is assumed to accelerate by 0.8 per cent per annum. For household dwellings the acceleration is 1.3 per cent per annum and for motor vehicles it is 3.0 per cent per annum. These accelerations are justified on the basis that of the acceptance of the rest of the developed world of aggressive CO_2 reduction targets.

2.4 Conclusion

By adoption of a modelling system which incorporates bottom-up constraints into an essentially bottom-up macroeconomics, NIEIR is forced to the conclusion that abatement requires an investment program. Investment in turn requires resources – it has a cost. However, that cost will be reduced if carbon pricing is complemented by sector-specific measures selected and evaluated for their contribution to speeding the price response and reducing its cost.

The report now proceeds as follows.

- In Chapter 3 we present an overview of the argument and the results.
- In Chapter 4 we defend the abatement target of 25 per cent below 2000 by 2020 and 50 per cent below in 2030.
- In Chapter 5 we provide background to all three scenarios.
- Chapters 6, 7 and 8 provide detailed results for each of the three scenarios.
- Chapter 9 covers the estimates of green jobs.
- Chapter 10 describes regional effects.
- Chapter 11 provides a brief comparison with alternative methodologies, which is expanded in Appendix A.

3. A brief explanation of the results

The economics of climate change abatement are complex. Abatement can be promoted by a wide variety of policies, each of which achieves its portion of abatement in different and sometimes contradictory ways. Many abatement policies have side benefits, and all have costs of one sort or another. There is therefore no simple answer to the question of what is the best abatement policy.

The complex of interactions and side-effects means that the costs and benefits of abatement policies can best be addressed through economic modelling, which attempts to assess the strength of abatement effects, weigh the counter-effects and count the costs. Even then the complexity is such that the modelling cannot be exhaustive, and has to be simplified by constructing scenarios – coherent stories, informed by modelling, as to the effects of implementing abatement policies. Though this is necessary methodology, the important elements are the arguments that lie behind the scenarios. In this Chapter we stress the arguments.

3.1 The scenarios and outcomes: An overview

The three national scenarios in this study are designated:

- Weak action
- Intermediate; and
- Strong action.

A brief specification of the scenarios is given in Table 3.1.

Table 3.1 The three scenarios – overview

Scenario	Intensity of CO_2 reduction effort	CO_2 target	Imported permits	Other
Weak action	Current trends. Enough done to maintain domestic emissions constant at current levels to 2030 chiefly by carbon pricing.	25 per cent reduction below 1990 levels by 2020 and 50 per cent reduction below 1990 levels by 2030.	Difference between domestic emissions and target emissions.	–
Intermediate	Carbon prices initially above the Weak action scenario plus sector-specific measures.	25 per cent reduction below 1990 levels by 2020 and 50 per cent reduction below 1990 levels by 2030.	Minimal	-
Strong action	Carbon prices initially above the Weak action scenario plus sector-specific measures.	25 per cent reduction below 1990 levels by 2020 and 50 per cent reduction below 1990 levels by 2030.	Minimal	Complementary industry development, infrastructure expansion and income policies to offset negative macroeconomic aspects of Weak action and Intermediate scenarios.

Because this is primarily a study of alternative abatement policy packages, it differs from previous studies in that it does not attempt to evaluate the cost of meeting alternative targets. Instead.

1. All scenarios have the same CO_2 reduction target.

Each scenario has the same CO_2 reduction targets, namely:

(i) 25 per cent decline in emissions compared to 1990 levels; and

(ii) 50 per cent decline in emissions compared to 1990 levels by 2030.

In policy terms, the major difference between the Weak action and Intermediate and Strong action scenarios is that the Weak action scenario relies mainly on carbon pricing and permit imports, whereas the two latter scenarios supplement carbon pricing with a considerable list of sector-specific measures. Reliance on carbon pricing results in a crucial difference between the Weak action and Intermediate scenarios, namely the heavy reliance on permit imports under Weak action. Such reliance could result from three decisions, made in the near future, as follows.

- A decision to lock-in a carbon price which generates a low level of domestic abatement.
- A decision to lock-out sector-specific measures.
- A decision to rely on permit imports to make up the difference between domestic emissions and whatever target is required of Australia.

In the Weak action scenario permits are imported for 305 million tonnes by 2030, representing the difference between domestic emissions (which are similar to current levels) and target emissions. In the Intermediate scenario the actual reduction in domestic emissions is the same as the target so that there is no need to import permits (Table 3.2). To bring about this higher level of abatement the Intermediate scenario complements emissions pricing with additional policy measures designed to speed abatement.

The Strong action scenario adds further measures to address industry policy, productivity enhancement and income distribution issues arising out of the Intermediate scenario. It is therefore wider in scope than the Intermediate scenario and takes advantage of opportunities for industry development arising from the additional policy measures required to speed abatement above the levels generated by carbon pricing alone.

Table 3.2 Australian CO_2 emissions outcome	2008	2015	2020	2025	2030
Weak action scenario					
Domestic emissions (million tonnes)	566	582	585	583	579
Compared to 1990 levels (per cent)	104	107	107	107	106
Imported permits (million tonnes)	0	0	174	248	305
Intermediate scenario					
Domestic emissions (million tonnes)	566	500	410	335	273
Compared to 1990 levels (per cent)	104	92	75	61	50
Imported permits (million tonnes)	0	0	-1	0	-1
Strong action					
Domestic emissions (million tonnes)	566	500	410	335	273
Compared to 1990 levels (per cent)	104	92	75	61	50
Imported permits (million tonnes)	0	0	-1	0	-1

Source: NIEIR modelling.

2. Total employment in 2030 is considerably greater in the Strong action than in the Weak action scenario.

Table 3.3 indicates total economy-wide employment increases in each five-year period to 2030. By 2030 the increase in total employment is 430,000 jobs greater in the Intermediate scenario compared to the Weak action scenario. In the Strong action scenario the increase is even larger. The message is simple. The more aggressive the approach to CO_2 reduction, the greater the increase in employment, and the increase in employment will be greater still if CO_2 abatement policy is complemented by strong industry development and infrastructure expansion policies.

This conclusion will be surprising to those who believe that the weaker the abatement action, the less the cost. However, remember that the target is the same in all three scenarios. In the Weak action scenario the government misses many of the opportunities for low-cost abatement. The underlying logic is that there's work to be done, and the intermediate and Strong action policy packages are more effective at getting it done.

This simple message re-iterates NIEIR's 1994 finding that packages have the potential to work better than single-instrument approaches to emission abatement.

Table 3.3 Increase in employment in thousands compared to Weak action scenario	2015	2020	2025	2030
Intermediate	23	98	267	430
Strong action	53	237	562	770

Source: NIEIR modelling.

3.2 The economics of capital reconstruction

3. Opportunities for emission abatement are of two main types.

Apart from our emissions as breathing animals, greenhouse gas emissions do not contribute directly to human welfare. Instead they arise during the production of goods and services, most of which can be produced using alternative technologies with either zero emissions or with much lower emissions than the technologies currently in use. As explained in section 1.7 above, policies for emission abatement are therefore of two kinds: they can encourage people to derive their satisfactions from low-emission goods and services instead of high-emission, and they can reduce the emission-intensity of existing goods and services.

A couple of examples may be helpful. As an example of the first kind, education has one of the lowest emission-intensities of all goods and services. An increase in education services at the expense of (say) transport would reduce emissions. Examples of the second kind - technological substitution – include switching electricity production from coal-fired power stations to renewable sources and switching from motoring to public transport. Policies for abatement, including the policies assessed in the current report, tend to emphasise technological substitution because they require minimal rearrangement of people's consumption choices.

4. Carbon pricing will encourage a general switch to low-emission goods and services, but this will not be enough to meet the target.

One of the chief virtues of carbon pricing is that it encourages demand for low-emission goods and services. This demand is likely to be spread over a large number of providers, who will notice the increase in demand and make plans to increase their capacity to produce by making capital investments and training suitable workers. As a counterpart, high-emission industries whose products and services are no longer in demand will reduce their capital investments and maybe even run down their capital stock. These responses are included in all scenarios, and are a prominent mechanism in the Weak action scenario. As can be seen from that scenario they can help to stabilise emissions, but cannot be expected to yield nearly enough abatement to reach the target.

Because broad-brush switching from emission-intensive goods and services to low-emission goods and services cannot be expected to yield target abatement, attention has to turn to reducing emission-intensities.

5. Abatement requires technological change. This requires costly investment as new equipment replaces old.

The gradual process of upgrading the emission-efficiency (usually also the energy-efficiency) of goods and services occurs continuously, but has not succeeded in countering the emission-increasing effects of economic growth, let alone reducing emissions. It is therefore necessary to face the fact that substitution of low-emission technologies for high-emission technologies usually requires the scrapping of fully-operational equipment, whose only fault is that it belches CO_2, matched by investment in replacement low-emission equipment. The obvious case is power stations, but the same necessity applies for transport equipment. Investment in fixed capital is required.

Scrapping and replacement is not always necessary – sometimes retrofitting is an option. An example is home insulation to reduce heating and cooling requirements. Though retrofit campaigns do not involve scrapping or demolishing, they once again require investment in fixed capital.

6. The investment required is essentially replacement investment – gross investment which does not count as net investment

It is at this point that accounting conventions can easily cause confusion. The necessity to 'maintain capital intact' is brought into business accounts through the concept of depreciation. This reflects a theoretical distinction between investment which replaces worn-out equipment and investment which extends the productive capacity of the business. The problem with the investment required to accelerate abatement is that it neither replaces worn-out equipment nor extends the productive capacity of the business. It is, rather, a cost which was not expected when the original decision was made to purchase high-emission equipment. If the business is to keep going, the unexpected cost has to be borne and financing resources have to be found, either from the firm's internal sources (depreciation allowances, retained profits) or by borrowing.

At the business level, it is a commonplace that equipment frequently continues to provide good service well beyond its accounting life. An outstanding example is the investment the Australian state electricity utilities made in coal-fired power stations during the decades from 1960 to 1990. Technologically speaking these proved to be remarkably good investments and, with refurbishment, are still working efficiently well beyond their accounting lives. Their only fault is that they are emission-intensive and will be obsolete in a carbon-constrained world. In other words, from being assessed as remarkably successful investments they can now be seen as serious mistakes. This applies even if carbon capture and storage proves to be feasible, since either existing power stations will have to be retrofitted at substantial (though at present unknown) cost or they will have to be scrapped and replaced by new carbon-capture stations.

A more homely example is the household electric water heater. In the absence of abatement policy, Australia's thousands of electric water heaters will continue to render good service. However, because they (indirectly) have high emission levels, households will be forced to scrap them and bear the cost of the replacement solar heaters.

Similarly, at the macroeconomic level the National Accounts maintain a distinction between gross and net saving; gross and net investment. The difference between the two is called 'consumption of fixed capital' and is an allowance for the fact that machines and buildings gradually wear out and have to be replaced. It is important to take this allowance into account when estimating National Income – that is, the amount which citizens can spend without eating into national capital. Similarly, when attempting to keep track on the national capital stock, net investment (the addition to the stock) is the relevant concept.

The effect of abatement policies on the national capital stock is to render some of it prematurely redundant and in need of replacement, with a further tranche which is allowed to live out its expected asset life but which then requires replacement at enhanced cost. This increases the consumption of fixed capital, reducing National Income and requiring an increase in the level of gross investment to make good the loss. Gross investment rises without any increase in net investment. As at the business level, this is a cost which has to be financed, either from the country's internal sources (national gross saving) or from overseas (overseas borrowing).

7. Serious problems arise in financing unexpected gross (replacement) investment

At the business level, when an investment turns out to be a mistake accounting rules require that it has to be written off. When abatement policies require businesses to scrap equipment, the businesses concerned will be obliged to write off the relevant values. Except where the equipment concerned has already been fully written off this reduces profits and hence the income generated by the business. In addition to these formal costs, business expectations are disappointed. At worst the business will be destroyed, at best it will have to revise its business plans.

In the case of investments which are assessed as mistakes because of their CO_2 output, scrapping the equipment reduces capacity. If production is to be maintained, costs arise not only because equipment has to be written-off but because it has to be replaced. The many precedents in business history for such processes of writing-off obsolescent equipment and investing in its replacements often involve the entry of new firms as bearers of the replacement technology.

Moving up to the macroeconomic level, a surge of writing-off equipment rendered obsolete because it produces too many emissions should, if the statisticians are doing their job, result in a surge of 'consumption of fixed capital' in the national accounts. This reduces national income compared with what it would have been with more prescient investment patterns. On top of this, a burst of unexpected gross investment is required merely to maintain national productive capacity. Because this is replacement investment, it does not raise expectations of growth in production and incomes; it merely reinstates the expectations disappointed by the investment mistakes. The campaign to curb climate change requires an allocation of resources which does not yield any short-term improvement in welfare. This is because the new equipment merely replaces equipment which was perfectly good apart from its unacceptable emission-intensity.

8. Investment can only be resourced from savings, which can only be increased by consuming less

The cost of national gross investment is that, overseas borrowing apart, it must be matched by national gross saving, of which there are many potential sources. An attractive source is an increase in income, but in Australia's case at the moment there are various factors which prevent this, including infrastructure limitations, skill shortages and limitations to the ability to pay for the imports which would result from income increases. If the scope for income increases is limited, additional savings require an increase in the ratio of savings to income.

In the gross saving sense, businesses save through depreciation and retained profits and also when they write assets off, provided there are gross profits for them to be written off against. Governments save by spending less on interest and current services than they raise in taxes. Leaving aside complications to do with unincorporated business and the ownership of dwellings, households save by spending less on consumption than they receive in incomes. In each case immediately-pleasing expenditures must be foregone: in the business case, profit distributions; in the government case, current services for the people; in the household case, current spending on consumption goods and services.

Countries faced with the need to increase gross investment can avoid the need to increase national savings by borrowing overseas. However, we argue that Australia is not in a position to do this, if only because of the already high level of overseas debt.

In a similar vein, if international negotiations for trade in emission permits succeed it will be possible to postpone the date at which high-emission equipment must be replaced. The attraction of this, apart from allowing affected businesses greater adjustment time, is that the need to increase saving can also be postponed. However, we argue that Australia would be unwise to rely on permit imports, for two reasons. The first is the effect on a balance of payments already seriously in deficit and is strongly associated with the inadvisability of relying directly on overseas savings. The second is that some (not all) of the required replacement investment is projected to yield productivity improvements in addition to its role in replacing lost capacity. Relying on permit imports forgoes these benefits.

Readers who are satisfied with this brief explanation as to why the required increase in gross investment must be balanced by an increase in gross saving, and only want the bottom line, can skip to Section 3.4. Those who wish to understand the underlying

drivers of the results must take the following detour, which describes the macroeconomics of the scenarios.

3.3 Macroeconomic policy: Objectives, instruments, sustainability and efficiency

The microeconomics of emission abatement revolve around responses to carbon pricing, including responses accelerated by deliberate policy action. In virtually all cases an increase in gross investment is required to implement the microeconomic changes, and these increases must be balanced by increases in gross saving.

9. In major countries outside the Anglo-sphere economies, economic policy focuses on a comprehensive list of objectives and policy instruments in both the short and long run.

For those economies (Continental Europe/North Asia) that adopt a comprehensive approach to economic policy formulation the framework is outlined in Table 3.4. All policy objectives and policy instruments are taken into account, although the relative importance of policies and instruments varies from time to time.

10. The rise of neo-liberalism in Anglo-sphere economies, in particular since the 1980s, led to a narrow macroeconomic framework under which much of the responsibility for stabilisation and growth sustainability was delegated to the private sector – particularly the financial sector. This delegation was directly responsible for the Global Finance Crisis.

Up until the 1980s the Anglo-sphere economies (United Kingdom, United States, Canada, Australia, New Zealand) paid at least lip service to the policy framework outlined in Table 3.4. The rise of neo-liberalism led to the discounting of a number of key objectives, either because they were considered no longer important or that the private sector via market forces would be more effective in achieving the objectives.

Table 3.4 The target-instrument approach to macroeconomic policy

Policy objective	Policy	Comments
1. Maintain long-run business expectations of growth at the level required for "full employment". Encourage businesses to invest two to four years ahead of demand.	All policy instruments coordinated to support target.	Maintain sustainability structure parameters at required levels. Reasonable balance of payments deficits, household savings rates, inflation outcomes, financial sector stability, stable actual growth profile near required levels.
2. A desired level of capacity utilisation is maintained in the economy (around 80 per cent) to avoid excessive inflation or unemployment.	Fiscal and monetary policy instruments (interest rates, tax rates, government expenditures, transfer payments, etc.).	The level of demand is maintained at near 80 per cent of capacity installed over the economic cycle.
3. Household financial stability. Ensure that household debt to income ratio is maintained at sustainable levels.	Incentives to save.	Financial regulation: minimum housing deposits, restrictions on equity withdrawal, limited ability to go on public pension if superannuation assets at retirement are adequate. Consumption falls in relation to income due to rising debt service costs.
4. Private sector return adequate for required capacity expansion effort. Business investment to cash flow ratio kept at around 75 to 80 per cent.	Wages policy, capital grants (fiscal policy), investment incentives, plus flow-on effects of targets (6) and (7).	The wages share in GDP is at the required level for desired business cash flow at the desired inflation rate.
5. Desired inflation rate.	All instruments.	Hold inflation to between 2 and 3 per cent per annum.
6. Balance of payments and financial sector stability. The balance of payments deficit and share of foreign debt in financial sector are maintained at stable levels.	Exchange rate and industry policy to achieve required level of export growth relative to import growth.	Exchange rate fixed (North Asia) at required level to impact on long-term decision making. Aggressive use of industry policy.
7. Infrastructure and technological competitiveness.	Public sector (or PPP) infrastructure expenditures, R&D policies scale and quality of education sector.	Urban labour markets are efficient, minimum transport costs, productivity of successful innovation is comparable to foreign competition.
8. Human capital competitiveness.	Expenditure per capita (population 0-29) on school and tertiary education.	The right skill quantity and quality is available to ensure targets (1), (2) and (5) can be achieved in the context of foreign competition.
9. Reasonable equality distribution of income and wealth.	Progressive tax rates and tax instruments. Expenditure support for low income households.	Reasonable economic opportunities for all households. Social and political conflict minimised.
Implicit public sector borrowing requirement (PSBR) objective	If the private, corporate, household and foreign accounts have settings for long-run stability, then the public sector borrowing requirement must also be sustainable. Hence there is no need for a 10^{th} target.	Over the last two decades in neoliberal economies the direct PSBR objective has been given primacy as the objective of financial balance across all sectors has been abandoned. Indeed at times the policy objectives of neoliberal economies were reduced to the PSBR and inflation objectives.

Key objectives discarded were:

- (1) full employment, including the need for government to have a credible vision, to plan and to develop resource accumulation strategies for the achievement of medium-term growth objectives: this was to be left to the private sector.
- (3) household savings and debt levels were deemed unimportant to economic stability and growth sustainability (governments should not interfere with private choices).
- (4) business capacity expansion was to be left to the market, including deregulated financial and labour markets.
- (6) the balance of payments and exchange rates were likewise to be left to the market.

Objectives (7), (8) and (9), while not completely discarded, were downgraded in importance. These discards left objectives (5) and (2): the inflation objective became dominant. A new objective was also introduced, namely a narrow short-run focus on keeping the public sector borrowing requirement to zero. This latter objective deprived the government of means to counter instability generated overseas or in other sectors, it being assumed that the market prevented instability.

The result of this approach to policy was the increasing structural disequilibrium in neo-liberal economies which led directly to the Global Financial Crisis. In 2008-09 the UK and USA incurred the full costs inherent in this approach to economic policy. Australia has so far escaped. Whether Australia continues to avoid the need for financial reconstruction is the elephant in the room. The balance sheets of the Australian financial and household sectors look reasonably sound at the moment, but could easily be plunged into disarray by a fall in the exchange rate or a rise in world interest rates or, for that matter, a fall in Australian house prices. Given these vulnerabilities it is crucial that macro-economic policy associated with CO_2 abatement resourcing should be at the highest level of efficiency. It needs to be to avoid adding to existing instability.

The need for careful macroeconomic administration of abatement implies that the Anglo-sphere economies should return to the multi-objective multi-instrument policy framework outlined in Table 3.4 – as may in any case occur in response to the short-run costs of the financial crisis. In any case, Table 3.4 is the only appropriate, realistic and transparent framework for analysing the macroeconomic consequences of CO_2 abatement policies.

Failure to check each of the nine policy areas outlined in Table 3.4 can lead to false optimism about abatement. In particular, the need to devote real resources to the reconstruction of the capital stock is not a problem within the neo-liberal framework because the private sector is assumed to have such perfect foresight that such needs do not arise. The time has come to abandon unrealistic assumptions and return to the complete list of objectives and instruments.

11. If macroeconomic policy does not assist with the generation of savings to match the gross investment required for CO_2 abatement there will be an unnecessary increase in unemployment.

If as part of its emission abatement program Australia disregards any of the policy objectives (1) to (6) in Table 3.4 there will be undesirable outcomes in terms of lower growth with higher unemployment. It will not be enough to pursue just one or two objectives; balanced pursuit is required of the whole list.

The most inefficient policy responses rely on market forces while disregarding market imbalances. The current situation is particularly dangerous in view of the inheritance of two decades of neo-liberal policy – high levels of household and net foreign debt. As a result of these policies, the economy is running near to capacity. Extra gross

investment for CO_2 abatement cannot be added onto an economy that is near full capacity without complementary policy settings to increase saving.

The evidence that the Australian economy is running at or near its productive capacity arises in three main areas.

(i) The current account deficit is already high. An addition to gross investment demand divorced from an increase in saving will increase imports more than exports and will therefore widen the deficit further, accelerating the rate of growth of the net foreign debt to GDP ratio. Countries which have experienced financial crises initiated by overseas debt can testify that a point is reached when foreign investors lose confidence in the currency, triggering a sharp drop in the exchange rate, a resulting banking crisis and a sharp increase in unemployment, typically 5 to 10 percentage points.

(ii) Inflation is currently restrained by low-cost imports. However, there is a danger that an increase in gross investment, divorced from an increase in saving, will take the economy above capacity, particularly as regards skilled labour. Inflation will accelerate, squeezing profit margins and forcing up interest rates. At best this will reduce investment and at worst trigger a recession and a permanent loss in capacity and employment potential.

(iii) Households have been increasing their consumption by large-scale borrowing. If they attempt to maintain their standards of living in the face of a macroeconomic requirement to increase savings, the household debt to income ratio will increase to the point where large scale loan defaults trigger a financial shock (similar to the recent sub-prime lending crisis in the USA), leading to a credit squeeze, a sharp increase in household savings ratio, a reduction in borrowings and a deep recession with again permanent loss in capacity and employment.

The current structural weaknesses in the Australia economy could generate a balance of payments crisis at any time over the next decade. Such a crisis could also be triggered by failure to generate the savings required to match the gross investment required for abatement, or indeed simply by ignoring the policy framework outlined in Table 3.4.

12. The model closure conditions (the links between policy objectives and instruments) used for the analysis of this study follow the requirements of Table 3.4, including appropriate responses as the macroeconomic story develops.

The macroeconomic policy responses to rapid CO_2 abatement may be efficient or inefficient in minimising welfare losses. The Brotherhood of St Laurence (2009) report explains the outcome where policy is explicitly inefficient. In all scenarios in the present study the assumption is that policy will be efficient, which means that feedback rules are included which allow policy to adjust to changes in the general macroeconomic environment.

Firstly, objective two (Table 3.4: capacity utilisation) is allowed to fall below 80 per cent if the inflation rate is above 3 per cent with the decline being in accordance with historical practice. This also has the effect of lowering the expectations of objective one (growth expectations), leading to a permanent loss in capacity until inflation falls into a lower 2.0 to 2.5 per cent range. When the rate of inflation falls on a sustained basis to low levels, capacity utilisation and growth expectation objectives are reset upwards. This rule is required because of the potential for conflict between the objective-instruments measures numbered (4) (capacity utilisation) and (5) (inflation). In developing the scenarios priority was always given to objective (4), that is, sufficient private sector cash flow to enable desired employment-creating capacity expansion to proceed. If this also resulted in excess inflation, the increase in the price level was countered in the medium-term by lower levels of growth.

As a result of the intelligent application of the policies listed in Table 3.4 in all scenarios including Weak action, **not one job was lost in any scenario from the short-term direct effects of CO_2 abatement and carbon pricing.**

This is as it should be. An increase in gross investment means that there is work to be done; the macroeconomic challenge is to arrange for it to be done, and this requires the full use of the range of macroeconomic policy instruments. If policy is inefficient or if conflict over the distribution of income occurs, employment will be lost. The inclusion of a degree of conflict over income distribution in the Intermediate scenario, resulting in inflation, is part of the difference between this scenario and the Strong action scenario.

The investments in infrastructure directly required by rapid CO_2 abatement have the side benefit of raising the potential of the economy. This is recognised in the Intermediate scenario and even more in the Strong action scenario.

Finally, in the Weak action scenario permit imports crowd-out a modest amount of capital inflow and hence reduce investment in capacity expansion.

As a result of these mechanisms, total employment outcomes vary between the scenarios where they would not vary if there was no feedback from the macroeconomic environment to desired targets. See BSL(2009) for the outcomes where there are no feedback loops.

3.4 The macroeconomics of the scenarios

We turn now from the general principles of macroeconomic management to the requirements when accelerating abatement through additional gross investment matched by additional savings.

13. The ways in which savings can be generated depend on current economic circumstances.

In a report such as this it would be very pleasant to treat emission abatement in isolation from all the other problems facing the Australian economy. This is essentially the approach taken by previous studies of abatement. However, in real-world economies, policy can only be implemented starting from the present outlook and not from some ideal position. The current macroeconomic outlook circumscribes the range of possible policy and hence determines much of the macroeconomics of the scenarios.

As always, in describing the current macroeconomic outlook it is necessary to take many factors into account, particularly the state of that world economy which is the destination of Australia's exports, the source of its imports and the source of its overseas borrowings. It is fair to state that the world economy is still undergoing reconstruction after the shock of the 2008 financial crisis.

Within Australia, the government reacted with alacrity to the financial crisis. The combination of stimulus and unexpected mineral sales to China allowed business to continue almost as usual. In particular, two trends have continued.

- Households have continued to accumulate debt to the banks.
- The balance of payments deficit is once again increasing, financed as before largely by bank borrowing overseas.

The next two subsections elaborate on the consequences of these two trends.

14. Household saving is currently at a low ebb, due to the high level of household borrowing and debt accumulation. A turnaround would increase the household savings rate, but also reduce aggregate demand.

The significance of household borrowing for Australian prosperity is that it has been a major source of demand, expressing itself in demand for both housing and consumers' goods. However, as borrowing increases so do debt-servicing costs, and the increase in these costs gradually squeezes household expenditure. The temptation has been to maintain high levels of expenditure by borrowing to cover debt-servicing, a process which can easily accelerate. Some of these debt-servicing costs return to the household sector in interest on savings and in dividends on bank shares, but many do not – they leave the country to service bank overseas borrowing.

The gradual increase in household reliance on borrowing can be traced in the decline of the Australian household sector's gross savings rate from 16-17 per cent of GDP in the years prior to bank deregulation to the current figure of around 6 per cent. (Table 3.5. Note: the commonly quoted trend is that net household saving has declined from around 10 per cent of GDP to zero – the difference is that gross saving includes an allowance for the depreciation of household assets, principally houses.) The result is that Australian households, as a whole, now have debt liabilities and associated debt servicing obligations which are limiting current consumption possibilities and which will further reduce consumption with every increase in interest rates. The proportion of households which have reached their debt-servicing limit is increasing – these being households which cannot borrow any more and who have little option but to save, as required by their debt-repayment contracts. In addition, households which still have spare borrowing capacity are likely to observe what happens to households which become over-indebted and decide to rebuild their savings. The combined effects of debt-servicing and a return to voluntary saving will reduce consumption and so total demand. This could easily cause a future recession.

15. In addition to high demand for consumer's goods, recent Australian prosperity has been underpinned by borrowing from overseas – by drawing on overseas savings in partial replacement for low domestic savings.

The significance of overseas borrowing for Australian prosperity has been as a major source of finance for the supply of both consumption' and investment goods. As with consumer borrowing, it has its costs – an increased flow of debt-servicing to overseas creditors – and a similar temptation to borrow more to maintain the accustomed level of imports. If current trends continue the balance of payments deficit is set to increase, if only as a consequence of Australia maintaining a relatively high rate of growth in a world still recovering from recession coupled with a domestic savings rate well below that necessary to finance the capital investment required to support the growth. The revival of mineral sales to China, while welcome, does not have the potential to increase export revenue enough to fill the gap. An increasing balance of payments deficit raises the question of finance: will overseas lenders be willing to continue their present high rate of lending to Australian banks?

Leaving aside current trends and reviving expectations, the uncomfortable historical fact is that booms generate busts. If it does not come to an end from household debt saturation, the Australian boom from 1993 to date could easily end in a crisis in financing the balance of payments deficit. This would rebound on the household sector by raising prices (through increased costs of imported consumers' goods due to devaluation) and by raising interest rates as well. The resulting fall in household incomes would reduce demand and generate unemployment.

Recession is not inevitable, but its avoidance will involve adroit macroeconomic management covering all the policy aims listed in Table 3.4. In designing the scenarios it has been assumed that this is forthcoming.

16. The limitations on Australian economic policy caused by low household savings rates and high reliance on overseas savings have been incorporated into all three scenarios.

The continuity of the scenarios with the past two decades can be seen in the maintenance of gross fixed capital expenditure at 25-26 per cent of GDP, a figure with ample past precedent and indeed rather low by the standards of the 1960s and 1970s. However, a break from business as usual is triggered by a change in the trajectory of the household savings rate. The National Accounts estimates show a spectacular decline in household gross savings from around 17 per cent of GDP before financial deregulation to less than 6 per cent now. Even allowing for the transfer of significant household savings from households' own account to the financial sector (a result of National Superannuation) the decline is of the order of 18 per cent to 10 per cent. The change of trend incorporated into the Weak action scenario is that the steady decline in the household gross savings rate from 1985 onwards is halted, while it is gently reversed in the intermediate and Strong action scenarios. In no scenario does the household savings rate return anywhere near the levels normal up to 1984. In all scenarios the financial sector savings rate is also maintained or increased.

These small changes of trend have the major consequence of limiting the ability of the banks to finance the balance of payments deficit. If households ease back on borrowing from the banks, the banks will borrow less from overseas. In the 1960s and 1970s the then-small balance of payments deficit was covered mainly by non-financial business borrowing, but non-financial business has been reluctant to cover more recent deficits and there is no reason to expect it to be any more willing in future. Accordingly the only other Australian institution available to cover the deficit is the Commonwealth government and in all scenarios it moves from a net saver to a borrower. This transition is doubly important because all three scenarios include the high level of overseas borrowing required to sustain Australian incomes during a period when the economic structure is being rebuilt.

17. All three scenarios require households to rebuild their savings, with a slightly higher initial requirement in the intermediate and Strong action scenarios

The small increase in the household savings rate has further implications for demand and job generation. It is here that the scenarios illustrate the options, which are as follows.

- Maintain a shadow of the boom by keeping consumption and consumption-related capital investment as high as possible given the balance of payments and household debt constraints (Weak action scenario).
- Allow household savings to rise a little higher, using the resources released to invest in industry reconstruction including decarbonisation (Intermediate scenario, and more so in the Strong action scenario).

If the household voluntary gross savings rate rises over 6 per cent of GDP there is no question that the second set of options is best – it safeguards the future while maintaining full resource utilisation in the present. If the household voluntary gross savings rate merely stabilises at the floor determined by household indebtedness, a choice exists.

18. Gross investment in abatement will make substantial, but manageable, calls on national savings.

The gross investment required in each scenario to reduce the emission-intensity of the Australian capital stock is outlined in Table 3.6. This gross investment has to be matched by saving. Two points should be made.

- Even the Weak action scenario makes significant calls on national savings. In the main this is to finance the equipment replacement response to carbon pricing.

- The intermediate and Strong action scenarios make roughly twice the call on national savings as the Weak action scenario. The cost of meeting the abatement targets from domestic sources, rather than by importing permits, is thus gross investment of around 1.5 per cent of GDP in the 2010s, falling to 1 per cent in the 2020s.

As Table 3.5 indicates, not all of this has to be met from increases in household saving. The difference in the household savings rate between the Weak action scenario and the intermediate and strong scenarios is around 0.7 per cent of GDP, which means that household savings will be called on to meet about half the additional gross investment requirements. The rest is met by business saving and by a re-arrangement of patterns within business investment (less on retail and entertainment, more on emission abatement and export industries).

Though the calls on household saving are significant, they do not pre-empt a gradual increase in consumption. During the first five years of application of abatement policies in the intermediate and Strong action scenarios the requirement for savings pushes the rate of growth of consumption below that in the Weak action scenario, but after this kick-start the rate of growth of consumption bounces back and rises above the Weak action scenario (Table 3.7). The reason is that the gross investment undertaken in the intermediate and Strong action scenarios starts to yield efficiency benefits: it turns out not to be pure replacement investment, but to offer more than this. It yields productivity increases.

Table 3.5 Components of Australian saving (percentage of GDP)

	Household saving							
	Net	Depreciation	Total	Other Australian	Total Australian	Overseas	Total resources	Gross fixed capital invest-ment
1959-69	9.2	8.4	17.7	13.2	30.8	1.9	32.7	30.8
1970-84	10.2	5.9	16.1	9.7	25.9	2.5	28.3	27.0
1985-89	6.9	5.9	12.7	11.8	24.6	6.6	31.1	27.6
1990-93	4.1	5.7	9.7	10.1	19.9	3.5	23.4	23.6
1994-02	3.0	5.3	8.3	12.7	21.0	4.0	25.0	24.3
2003-09	0.2	5.6	5.7	16.3	22.1	5.0	27.0	27.6
2010-30 weak			5.9	10.4	16.3	8.7	25.0	24.9
Intermediate			6.6	10.8	17.4	8.4	25.8	25.8
Strong			6.6	10.9	17.5	8.3	25.8	25.9

Source: ABS National Accounts, NIEIR modelling.

Table 3.6 Gross investment required for CO_2 abatement (percentage of GDP, average for five-year spans)

Scenario	2010-15	2015-20	2020-25	2025-30
Weak action	1.6	1.3	0.9	0.6
Intermediate	3.2	2.7	2.1	1.8
Strong action	3.2	3.0	2.1	1.8

Source: NIEIR modelling.

Table 3.7	Rate of growth of household consumption excluding energy (per cent a year, average for five-year spans)			
Scenario	**2010-15**	**2015-20**	**2020-25**	**2025-30**
Weak action	1.5	1.0	2.6	1.6
Intermediate	0.5	2.5	2.9	2.6
Strong action	0.5	2.7	3.5	2.7

Note: Consumption defined excluding energy.
Source: NIEIR modelling.

19. In order to ensure that the required gross investment actually takes place substantial financial inducements will be required.

The public sector financial support required for private sector gross investments on emission abatement will depend on the emissions reduction target and the domestic CO_2 price – the stronger the emissions target, the more the required expenditure, but the higher the CO_2 price the easier it will be to finance that investment privately. Under both the intermediate and Strong action scenarios the government is more aggressive in reducing domestic emissions and, as can be seen from Table 3.8, this has the effect of driving a higher domestic CO_2 price to 2020. After 2020 the domestic emissions price is set at the same level across all scenarios.

The relatively low carbon price assumed during the 2010s in the Weak action scenario is insufficient to stabilise emissions are current levels. The scenario therefore includes a continuation and slight expansion of current public sector abatement programs, such as the renewable energy target, to the extent of around half of gross investment required to stabilise emissions at current levels. Total financial support of $32 billion to 2020 may appear low, but it should be noted that investment requiring financial public sector support is a minority of total gross investment. This is because the large expenditure items, such as low CO_2 intensive electricity generation and transport infrastructure, are self-financing – the required funds can be generated by increases in domestic price levels including the price of electricity and the prices of transport fuels. The rate of financial assistance required falls to very low levels by 2030 as the carbon price increases.

To achieve the emissions objectives of the Intermediate scenario, an additional $38-39 Billion in financial assistance has to be offered by the public sector despite higher CO_2 prices during the 2010s. As can be seen, an aggressive CO_2 emissions reduction target not only requires the assembly of large resources to decarbonise the economy but also means that substantial financial assistance is required so that the private businesses which have to reconstruct their capital can find the resources to do so.

In Table 3.9 it is noticeable that the public sector support requirements in the Strong action scenario are not much greater than in the Intermediate scenario. This is because a number of big ticket gross investments which are difficult for the private sector to finance (mainly transport infrastructure) are included in the Intermediate scenario. The industry development policies which make the difference between the intermediate and Strong action scenarios require relatively little public expenditure.

Table 3.8	Domestic emissions price – $2007 per tonne			
	2015	**2020**	**2025**	**2030**
Weak action	41	55	106	158
Intermediate	54	86	106	156
Strong action	54	87	107	159

Source: NIEIR modelling.

Table 3.9	Public sector financial assistance required to ensure CO_2 emissions targets are met – per cent of GDP for five years ended			
	2015	**2020**	**2025**	**2030**
Weak action				
Total financial assistance	0.29	0.18	0.07	0.03
Cumulative subsidy support (per cent of gross investment)	53	46	39	33
Intermediate				
Total financial assistance	0.53	0.34	0.13	0.08
Cumulative subsidy support (per cent of gross investment)	47	36	29	23
Strong action				
Total financial assistance	0.53	0.35	0.13	0.07
Cumulative subsidy support (per cent of gross investment)	47	36	29	23

Source: NIEIR modelling.

20. After a kick-start in which the household savings rate increases, the Strong action scenario yields a higher standard of living than Weak action.

The key comparison is between the Weak action and Strong action scenarios. Table 3.10 gives the difference between the two scenarios for those indicators that are key drivers of goods and services which directly benefit households. The differences are added year by year, in order to show cumulative effects.

The first line of the table shows the cumulative difference in gross abatement investment between the scenarios. By 2030 an extra $463 billion has been invested, in 2007 prices. If abatement expenditures and consumption are simple alternatives, this would require that savings (private plus government) should rise by $463 billion to release the resources to finance the CO_2 reduction expenditures. However, by 2030 the reverse has taken place, with a cumulative reduction in required savings of $249 billion. What's the story?

Certainly in the early years there is a one to one relationship between the increase in gross investment on abatement of $101 billion and the increase in savings. However, the productivity-increasing component of the CO_2 abatement investments gradually yields efficiency gains which release resources which in turn increasingly offset the savings increases necessary to finance continued investment in abatement. A major contribution to this is the build-up in energy and transport cost savings. Secondly, as petroleum product consumption declines and fossil petroleum products are replaced by biofuels and/or electric vehicles the reduction in oil imports allows, by 2030, $\$_{2007}273$ billion of oil imports to be replaced by general imports to reduce the need for domestic savings. Finally, the savings in permit imports means that resources which in the Weak action scenario are allocated to exports and import replacement (to pay for the permit imports) can be released to support consumption expenditures and hence reduce the savings requirement.

Figure 3.1: The model responses to increased resource requirements

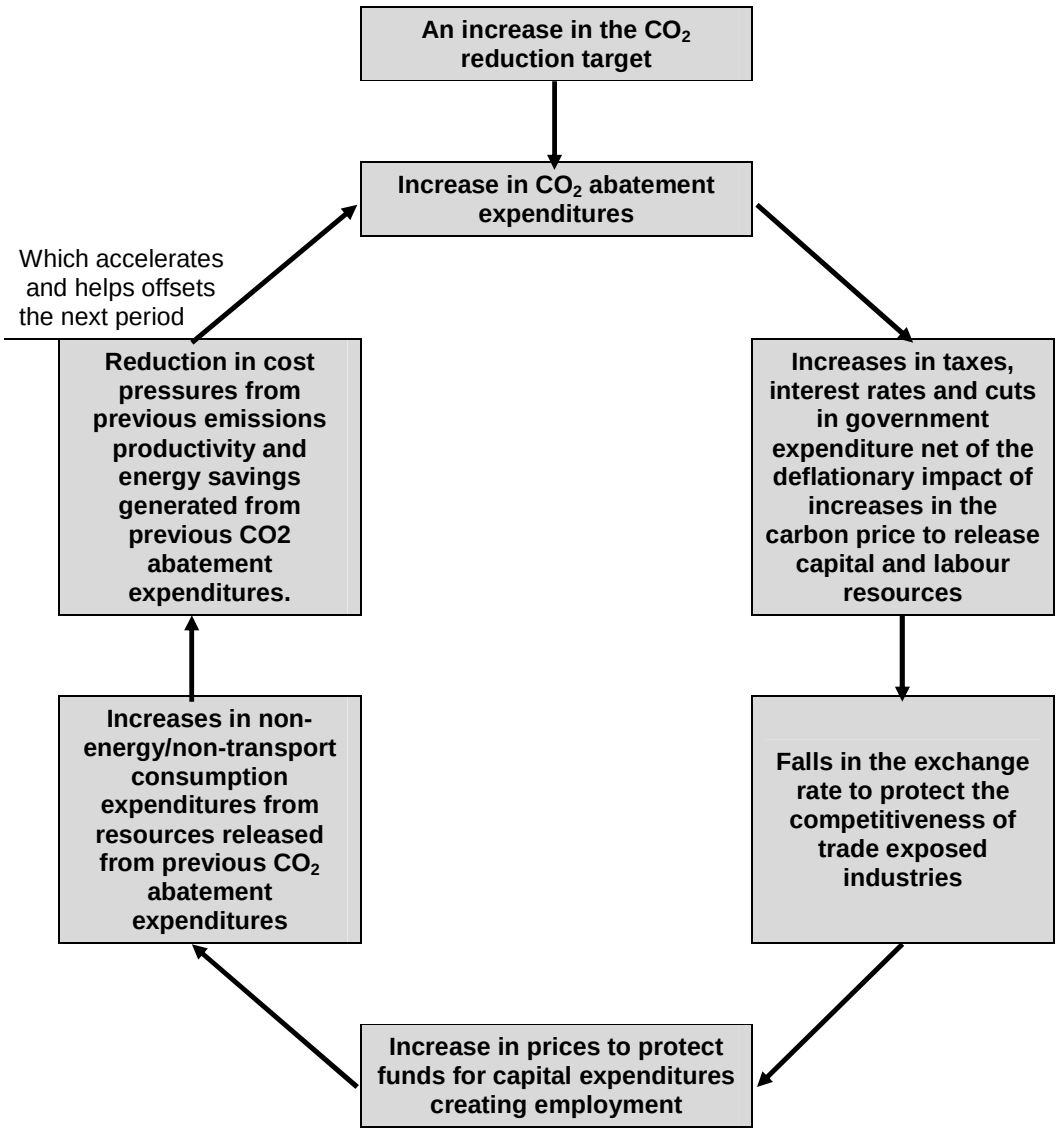


Table 3.10 The relationship between gross investment and welfare gain: Weak action versus the Intermediate scenario (cumulative change $2007b)					
	2006	**2015**	**2020**	**2025**	**2030**
Gross investment on abatement	0	100.9	228.8	332.8	463.1
Benefit offsets (negative indicates benefit)					
Household energy and transport cost consumption		-3.6	-21.3	-46.1	-74.2
Imports of oil products	0	-8.0	-58.8	-133.5	-239.5
Imports of permits	0	0	-33.7	-112.6	-273.4
Other (price relativities, capital intensity)	0	14.0	77.1	28.9	-124.9
Increase in government and household saving	0	103.3	192.1	69.5	-248.8

Source: NIEIR modelling.

Table 3.11 The relationship between gross investment and welfare gain: Strong versus Weak action (cumulative change $2007b)					
	2006	**2015**	**2020**	**2025**	**2030**
Gross investment on abatement	0	102.6	234.7	343.2	474.7
Benefit offsets (negative indicates benefit)					
Household energy and transport cost consumption		-3.6	-21.6	-46.2	-72.2
Imports of oil products	0	-8.0	-58.7	-132.0	-236.8
Imports of permits	0	0	-32.5	-109.6	-268.1
Other (price relativities, capital intensity)	0	0	0	0	0
Increase in government and household saving	0	106.5	187.2	-84.3	-650.9

Source: NIEIR modelling.

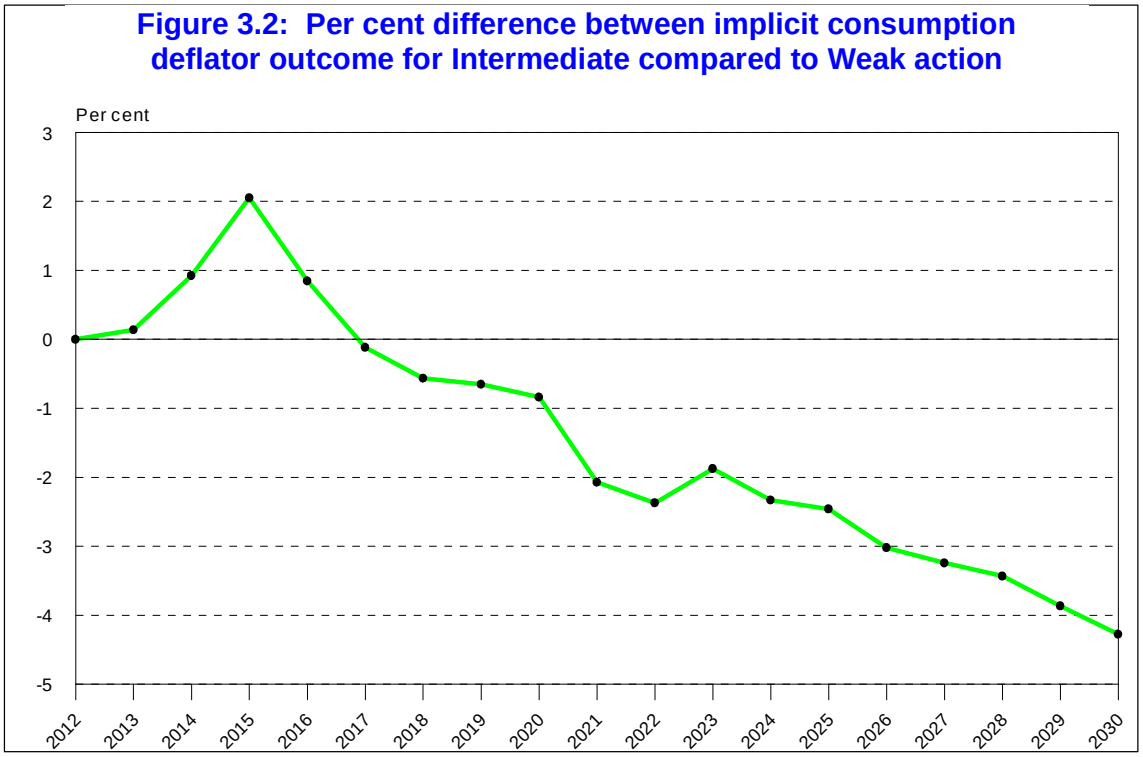
When an increase in savings is followed by rewards in terms of increases in disposable income an internal rate of return can be calculated. The internal rate of return for additional savings in the 2010s rewarded by increased real income in the 2020s is 10.5 per cent, even when the analysis is cut short at 2030. Increasing saving in the short term yields large income benefits in the not too distant future at a rate of return that would give the go-ahead for most private sector projects. There is no excuse for not moving early in the CO_2 reduction effort at a high level of intensity.

21. Real income gains and reductions in import permit costs are not the only reasons for the employment gains in the intermediate and Strong action scenarios compared to the Weak action. The inflationary impact is also a key driver of this outcome.

Figure 3.2 gives the percentage difference between the implicit consumption deflator for the Intermediate scenario compared to the Weak action scenario. In the early years, due to the higher CO_2 price and aggregated gross investment the price level is higher for the intermediate compared to the Weak action scenario and this reduces total employment. However, by 2030 the price level is 4 per cent lower in the Intermediate scenario due to the higher decarbonisation of the economy and energy cost savings which means that costs fall since both scenarios have the same carbon price. We shall see below that the reduction in inflation is even more marked in the Strong action scenario.

An important conclusion is thus that the productivity benefits of abatement action mean that it yields less inflation. The lower inflation environment allows general policy to be more expansionary, lifting the overall growth rate in the economy. This makes an important contribution to the extra 430,000 employment positions created by 2030 in the Intermediate scenario compared to the Weak action scenario.

Figure 3.2: Per cent difference between implicit consumption deflator outcome for Intermediate compared to Weak action



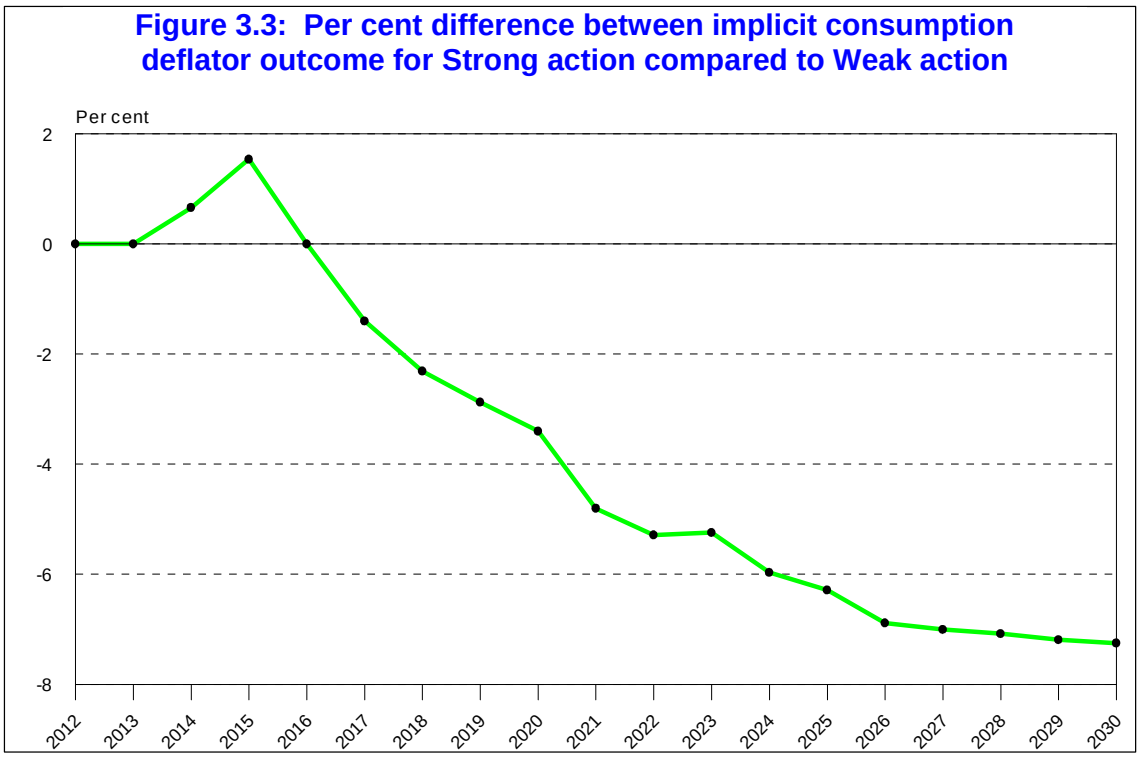
22. The Strong action scenario shows what can be done when approaches like those currently being applied in China, Japan and South Korea complement direct CO_2 reduction efforts.

The Strong action scenario applies where government-wide policy complements CO_2 reduction.

Firstly, an incomes policy is agreed between the major stakeholder groups in the Australian economy via tax/wage, tax/superannuation or wage pause agreements to limit the inflationary consequences of the aggressive CO_2 reduction strategy incorporated into the Intermediate scenario for the key period from 2013 to 2017 (see policy objectives 4 and 9 in Table 3.4). From Figure 3.3, in 2015 the increase in the price level compared to the Intermediate scenario is considerably less and by 2017 the price level is well under the Weak action scenario and also the Intermediate scenario.

Another main feature of the Strong action scenario compared to the Intermediate scenario is explicit policy to target higher local content of the equipment components of CO_2 reduction expenditures, for example by supporting domestic R&D and by supporting investment in capacity to produce abatement equipment. Instead of the domestic component falling within the 10 to 20 per cent range, the Strong action scenario brings the domestic content share to 40 to 60 per cent.

Figure 3.3: Per cent difference between implicit consumption deflator outcome for Strong action compared to Weak action



Finally, the third major component of the Strong action scenario is the more aggressive use of infrastructure expenditures (urban design, etc.) to reduce CO_2 emissions and to increase the production capacity of the economy.

The benefits of the Strong action strategy compared to Weak action are clearly seen from Table 3.11. **The increase in welfare-relevant expenditures is $651 billion more than under Weak action policies and $402 billion more than in the Intermediate scenario.**

The increase in consumption compared to the Intermediate scenario is due to the three strategic policy measures noted above. Strong action strategies are self evident in the high green component in the stimulus packages applied in China, Japan and South Korea over the past twelve months

23. Aggressive CO_2 reduction without a carbon price simply increases the costs of adjustment.

NIEIR's has long stated that carbon pricing is a fundamental but by no means a sufficient condition for success. It is a framework on which a wide range of complementary policies can be built.

Aggressive CO_2 reduction can be achieved without carbon pricing, however it will be inefficient. General taxation increases, or at worst interest rate increases, will have to replace the initial fund-raising role of the carbon price, while the incentive effects of carbon pricing will be lost since there are no sector-specific measures to reward changes in personal behaviour (like switching off lights when not needed) and switching expenditure to low-emission goods and services. Again, carbon pricing provides an incentive which will be important in marketing sector-specific measures. If carbon pricing is deleted from the policy mix, to achieve the same CO_2 reduction target more will have to be done in terms of gross investment – even apart from the role of the carbon price in project design and selection (which, admittedly, can be performed by a shadow price).

It might be thought that the absence of a carbon price would reduce inflation and also reduce the pressure on consumer budgets. However, the loss of the price response means that the selected sector-specific measures have to be pushed more aggressively, resulting in a less efficient response. A capital return is also required on the sector-specific investments, and this results in selective price increases which, taken together, push real disposable incomes down just as surely as carbon pricing.

To demonstrate this, the intermediate case was rerun with a zero domestic carbon price. Table 3.12 gives the outcomes compared to the standard Intermediate scenario. The outcomes would be much the same if the Strong action case were rerun.

Table 3.12 Aggressive CO_2 reduction without a carbon price – Intermediate (2007 $b)

	Accumulated additional gross investment	Accumulated increase in government and household saving with no carbon price
2015	39.0	55
2020	56.5	96
2025	71.1	117
2030	91.2	126

Source: NIEIR modelling.

As Table 3.12 makes clear, using general taxation and interest rates instead of a carbon price imposes considerable costs on the economy over and above what would otherwise be necessary (compare with Table 3.11). The Intermediate scenario shorn of specific carbon pricing is still considerably superior to the Weak action scenario, but is less effective than the Intermediate scenario including carbon pricing. The differences are an addition of about 20 per cent to cumulative investment required above Weak action, and a matching increase of about 20 per cent in cumulated additional savings compared to Weak action.

24. Where there are unemployed resources, it may be possible to increase consumption and emission abatement expenditures at the same time, but the trade-off still applies in the longer term.

Clearly in early 2009 Australia, like most countries, was inside its production possibility frontier, with underemployed resources. In these circumstances expenditures on CO_2 abatement had potential to increase both abatement and consumption – though in the event, and by contrast with the North Asian countries, Australia chose to stimulate general consumption rather than abatement. In other words, even when there are unemployed resources the choice is still between abatement and consumption.

Over the longer term it is even more difficult to sustain the assumption that otherwise unemployed resources can be found to devote to abatement. This is also the case when debt and balance of payments constraints hold the economy inside its production possibility frontier for reasons that simply cannot be overcome by increasing expenditures in the economy – a problem to which Australia is vulnerable. To be effective expenditure increases are going to have to be complemented by policy measures that overcome these other constraints. These restrictions have been respected in NIEIR's three scenarios.

4. The Australian abatement target

The Australian allocation for CO_2 emissions is taken as a given for this study. Some would view the assumed target as unrealistically weak, others unrealistically strong and requiring unattainable abatement. In response to the latter point of view it is useful to consider the current momentum towards a global arrangement, if not in 2010 then within a few years. The sticking point at Copenhagen was not so much the global target, but the allocation of that target.

4.1 Scenarios for the world response to climate change

The global allocation assumed in this study represents one of many possible scenarios. The possible options are classified according to the 2 x 2 box diagram of Figure 4.1. The vertical axis reflects the degree of political will to reduce CO_2, while the horizontal axis measures the degree of international cooperation in the approach to climate change.

The inference from the diagram is that the possible scenarios for global approaches to climate change can be grouped into four scenario types designated as:

- **Global fragmentation**, where the perceived urgency of CO_2 reduction is high but international cooperation is low;
- **National independence**, where the perceived need for decarbonisation is low and the degree of international cooperation is low;
- **National circumstance**, where international cooperation is high based on relatively low perceived need for decarbonisation; and
- **Global equity**, where the perceived urgency of emission abatement is high and international cooperation is high.

The national independence scenario reflects the approaches to climate change proposed in the 1990s when the world assumed that the cost of climate change would be lower than is now feared and also assumed that the trigger point for run-away climate change would be higher than is now expected in terms of the atmospheric concentration of CO_2. It reflects the approach of the United States and Australia until the recent recognition by these two countries of the increased urgency of CO_2 reduction. The central feature of the national independence group of scenarios is that each country sets its own target and moves to that target independently of what other countries are doing.

The national circumstance group of scenarios includes country quotas set with reference to existing emissions. It includes provisions by which countries which meet their quota targets can penalise those which do not. The basic feature of this group of scenarios is that existing inequalities in per capita emissions are maintained for a considerable period of time.

The global equity group of scenarios reflects a movement towards country emissions allocations on an equal per-capita basis, this being the allocation which is most easily justified on ethical grounds. The scenarios again include disciplinary measures against countries which fail to comply.

The global fragmentation group of scenarios reflect the adoption of national independence strategies where it is agreed that action is urgent but agreement cannot be reached on quota allocation between countries.

4.2 The international allocation of emissions and abatement

It is often claimed that the Copenhagen conference failed, but in fact it succeeded in two important respects: it produced an Accord which respected the 2^oC target and it refused to agree to a system of national targets which would lock-in much greater emissions than are consistent with the 2^0C target. Having signed the agreement, Australia is committed in principle to this global target. More generally, the countries attending the Copenhagen conference acknowledged that the world is operating in the high climate risk half of Figure 4.1. With high risk acknowledged but without agreement as to the distribution of quotas between countries, the world is currently floundering in the global fragmentation quadrant.

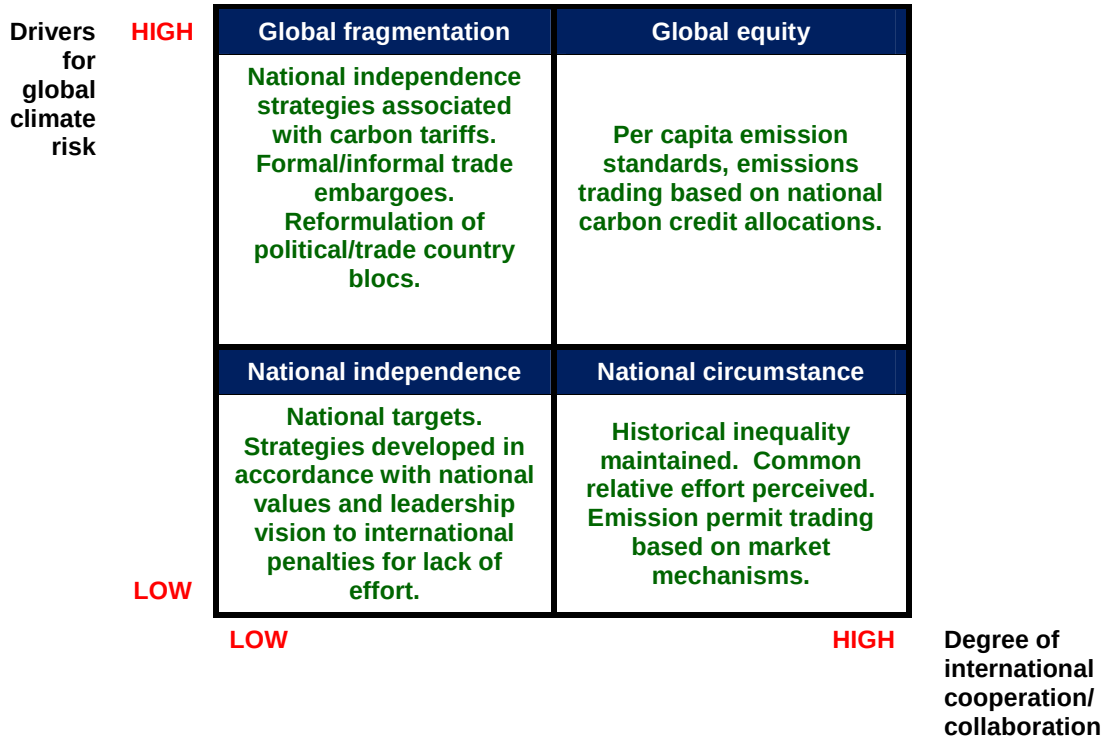
A move to the global equity quadrant would require agreement on the distribution of abatement targets. The guiding principle here – as recognised in the Garnaut report – is that world net emissions have to be reduced to zero within a century or less, or perhaps to less than zero (sequestration exceeding emissions may be required to reduce the CO_2 concentration back towards its level before the industrial revolution). The sound and fury of argument is therefore about transition paths and about the short to medium term future, not about the eventual goal. The transition paths are, however, important because they concern the next few decades.

Acknowledgement that global permissible emissions are most equitably allocated on an equal per capita basis sounds like bad news for Australia, and indeed it is, but the news could be worse. It has been pointed out that China's accumulated responsibility for CO_2 in the atmosphere since 1800 is only approximately 5 per cent of United States on a per capita basis. If equity were defined in relation to historical responsibility, Australia, like the US, would be assigned the task of reducing to zero emissions almost overnight. Not surprisingly, the high-emission countries have favoured rules which give them more time to adjust, favouring 'equality of sacrifice' by which they mean equal percentage reductions in emissions. This rule has been rejected by the low-emission countries, and a more likely compromise would be that countries with high emissions per capita would commit to significant percentage reductions while moderate-emission countries level off their emissions and low-emission low-income countries are allowed moderate increases.

Accepting this rule, in this study we assume that, over the next few years, emission targets will be set for Australia somewhere between equality of percentage reductions and demographic responsibility; in other words, a moving target which gives Australia several decades to adjust to a world of equal per capita emissions. Ultimately, this target is likely to track to zero net emissions across the globe, in which case all emissions will have to be counterbalanced by sequestration. Indeed, if it becomes necessary to reduce the global CO_2 concentration to below 400 ppm, a future in which sequestration exceeds emissions is required.

This implies that, for the purposes of scenario development, we assume that Australia is obliged to meet targets of 412 $MtCO_2e$ (25 per cent below 1990 levels) in 2020 and 275 $MtCO_2e$ (50 per cent below 1990 levels) in 2030. It is further assumed that any shortfall in meeting these targets from domestic abatement can be made up by purchase of permits from overseas, and finally assumed that failure to achieve the target, whether by domestic abatement or the purchase of permits, precipitates sanctions which are worse than paying the permit cost.

Figure 4.1: Scenarios for the international approach to CO_2 reduction



4.3 Alternatives to the assumed abatement targets

The aim of many of those attending the Copenhagen conference in December 2009 was to set up a world emissions trading system, complete with quotas for each country, provision for international trade in permits and penalties for non-compliance. Though there was agreement as to the 2^0C target and hence as to the total world quota, agreement was not reached on the distribution of the world quota between countries or on many of the other details of a world emissions trading system.

After Copenhagen, it is possible that the dominant trend will be for nations to back off from their commitment to the 2^oC target. However there has been no reduction in the urgency of abatement and a more likely sequence is that some nations will emerge as the champions of emission abatement, willing not only to reduce their domestic emissions but also to pressure other nations to reduce theirs. The identity of these champions is not certain, but the current emphasis on investment for abatement in East Asia and the advanced abatement planning of some of the European countries indicates potential candidates. A further factor is the changing balance of world power resulting from high economic growth rates in Asia, the 2008 financial crisis being but one incident in the unpredictable rise and fall of nations. A decision by China or Japan to become a champion of emission abatement would be more significant in the post-Lehman world than it would have been a decade ago. Without identifying parties, let us say that there will be champions and recalcitrants. As for most countries, it is not decided which Australia will be.

Much depends on the power of the champions and there methods of pushing for stronger global action. The emphasis is likely to be on the wielding of economic power and a champion strategy will count for little unless it rests on the foundation of a strong domestic economy. Potential champions will not only generate low domestic emissions but will so

structure their industry that they stand to benefit directly from a low-emission world economy, in addition to benefiting from the avoidance of climate change. This fundamental requirement directs attention away from abatement policy per se to the requirements for prosperity in a low-emission world. At this point we can usefully consider the investment-oriented abatement policies of the East Asian countries.

4.4 The centrality of investment to abatement

China, South Korea and Japan are already well advanced in adapting their economies to a low-emission world, using as their chief tool direct investment in industries likely to flourish in such a world. Not only does this help bring domestic emissions under control; it promises the development of export industries as the basis of future economic power and living standards. In the words of a recent American report:

> *"Government investments will be crucial to helping China, Japan and South Korea gain a 'first mover' advantage over the United States in key clean energy sectors. Firms that can establish economies of scale and capture learning-by-doing and experience effects ahead of competitors can achieve lower cost production and/or higher quality products, effectively limiting their competitors' market share and making it hard for new entrants to break into the market. This first-mover advantage accrues to nations as well as firms. Where firms gain a first-mover advantage by being the quickest to develop, commercialise and widely produce emerging technologies, nations can gain first-mover advantages by making investments to attract and grow leading firms, by fostering relationships between local firms, research labs and universities, and by developing the associated infrastructure, human capital, and expertise that help firms become more competitive.*
>
> *Direct government investments will help Asia's clean tech tigers form industry clusters... where inventors, investors, manufacturers, suppliers, universities and others can establish a dense network of relationships. Even in an era of increasingly globalised commerce, enduring competitive advantages lie increasingly in the structure of these regional economies....*
>
> *Clusters provide cost and innovation advantages, including access to specialised labour, materials, and equipment at lower operating costs, as well as lower search costs, economics of scale and price competition. Clusters provide members with preferred access to market, technical and competitive information, creating knowledge spillovers that can accelerate the pace of innovation. Relationships between companies are leveraged to help them learn about new technologies as well as new market opportunities. Workforce mobility further facilitates knowledge spillovers that can enhance the rate of innovation for the whole cluster.*
>
> *Continual investment in innovation is also critical..."*
>
> (Breakthrough Institute and the Information Technology and Innovation Foundation, *Rising tigers sleeping giant,* Nov 2009, pp 13-14)

The importance of first mover advantages, of industry clusters and innovation are all familiar in an industry development context, even if they have not much entered the debate about climate change. However, the critical words in the above quotation are the first two: the East Asian countries have governments which recognise the importance of investment and are willing to take a lead role themselves. By so doing, they address four barriers which hamper the adoption of large-scale clean energy technologies in North America (and by implication Australia, since many current Australian policies have been copied from US practice).

- Governments, including those in North America, East Asia and Australia, have been unwilling to raise the price of fossil fuels high enough for most clean energy technologies to become cost competitive, even though a much higher price would be justified if the climate costs of fossil fuels were taken into account. The East Asian

economies get over this with selective countervailing subsidies, mostly directed towards assisting investment.

- Private businesses under-invest in research and development because they have no guarantee that they will capture the benefits of their investment – it is likely to be copied by other firms. To overcome this failure of incentives, it is a general policy of the East Asian governments to invest heavily in research and development. It might be added that there is no field where public investment in research and widespread dissemination of research results is more justified than emission abatement, since the whole world benefits as abatement technologies are adopted.
- Clean energy projects tend to be both big and long-lived. These attributes combine with considerable market and technological uncertainty to make it very difficult for private firms to assess expected rates of return. When markets dominate investment allocation, high-risk, high-reward investment is discouraged in favour of short-term research and incremental product development. Government commitment can address these problems.
- The energy industries depend on pipe, wire and other transport infrastructure, not to speak of vehicle refuelling infrastructure. The existing systems suit existing technologies and problems of coordination arise when new technology investments require complementary infrastructure investment. Within a purely private system it is very difficult to conclude all necessary contracts and arrange interdependent financing in an efficient time sequence. The East Asian countries are not afraid to use government investment to cut this Gordian knot.

Japan, South Korea and China are not making the mistake of treating carbon pricing as the sole efficient instrument of abatement policy. They recognise that it has the following deficiencies.

- As clean-energy technologies undergo forced development, costs are coming down – but nobody yet knows which will become the standard technologies of the future. Until that happens, carbon pricing gives insufficient incentive for the development of some, and maybe too much for others. (An Australian case is the renewable energy target, which gives plentiful encouragement to the installation of solar hot water but not enough to cover costs for promising technologies such as wave and geothermal power.)
- Carbon pricing does not solve non-price barriers to the adoption of clean energy.
- Similarly carbon pricing does not solve the problem of under-investment in research and development due to leakage of benefits away from the firm which did the research.

The economies of East Asia reacted to the threatened recession of 2009 by stimulus packages which included considerable investment in emission abatement and related technologies. The East Asian countries are thus readying themselves for a low-emission world. Should they succeed in establishing dominance in the abatement-related industries, they are likely to profit mightily.

Not only this, but the East Asian countries are noted for high savings rates combined with balance of payments surpluses. Countries with structural balance of payments deficits, such as Australia and the US, depend on these surpluses to finance their deficits. When the East Asian countries are confident that they have established competitive advantage in low-emission production, it would be natural for them to use their financial power to require other countries to buy emission-abatement equipment from them. They would be able to do this by putting conditions on their overseas loans – the East Asian countries are not restrained by scruples against using their financial sectors as instruments of policy. As a country with the need to finance a structural balance of payments deficit, Australia is in a very poor position to become a recalcitrant in a world in which there are self-appointed champions of emission abatement.

Though the real action is likely to emphasise capital flows, much of the noise in international negotiations on emission abatement will continue to be generated by questions of trade.

4.5 Trade and abatement

In a world lost in the global fragmentation quadrant of Figure 4.1, nations which champion global abatement will wish not only to set their own house in order but to impose sanctions on recalcitrant nations. In the absence of a Treaty covering abatement, champion nations are likely to come into conflict with the World Trade Organisation (WTO), whose free-trade rules not only prevent champion nations from imposing sanctions on the exports of recalcitrant nations but make it difficult for the champion nations to pursue abatement in their own country.

The fundamental reason why the WTO hinders abatement action in any one country is the fact that emission abatement has necessary costs, at least in the short run. In a world which does not recognise emissions as a cost, trade-exposed industries in countries which engage in emission abatement are likely to incur greater cash costs than their counterparts in countries which do not abate, at least initially – as we found in section 4.4, the question is not quite so clear once the investments have been made and the technologies developed. From the abating country's point of view, the obvious measure is to protect its trade-exposed emission-intensive industries at least while they go through the capital reconstruction required to reduce emissions, and perhaps indefinitely if it turns out that they have cost disadvantages compared to their equivalents in recalcitrant countries. If production using high-carbon technologies continues to have cost advantages in recalcitrant countries and there is no protection for industries in champion countries, carbon leakage may occur and the abatement intentions of the champion countries will be circumvented. In a global fragmentation world which respects the WTO, action to address climate change becomes difficult if carbon leakage occurs and countries which take action lose some part of their industries to countries which do not. This re-iterates the point that to generate the world-wide benefits of avoiding climate change, world-wide action would be ideal.

In the absence of a global emissions trading system set up under its own rules and operating independently of the WTO system, the problem arises of how emission-abating countries will protect their trade-exposed emission-intensive industries in order to prevent them moving offshore. One possibility for protection, applicable to countries which set up domestic emissions trading schemes, would be to require importers to obtain import permits tied to the climate costs of imported products. This would violate Article XI of the General Agreement on Tariffs and Trade (GATT). Article XI requires the elimination of all quantitative restrictions on trade, including non-tariff restrictions such as import and export license requirements.

An alternative suggestion, applicable for countries which implement carbon pricing by way of a carbon tax, would be to impose a climate tariff (tax) equivalent to the climate costs of all imported products at the point of import. This measure would, however, be in violation article I of GATT. Article I requires that Most Favoured Nation status be accorded to like products from all WTO member countries. A climate tariff would inevitably treat like products from different countries differently, according to the different climate costs of the same product from different parts of the world. This would be true even if the climate tariff was waived for imports deemed to have paid carbon taxes in another jurisdiction.

Nor would it work to impose a climate tax on all goods at the point of sale inside the importing country – similar to a GST or VAT. One aim of such a tax would be to adjust the shelf price of carbon-intensive products (whether imported or domestically produced) so that prices reflect the true climate costs of what is being sold. It would not be possible for such a tax to treat all domestic products the same as all imported like products. To impose such a tax would therefore necessarily be a violation of the National Treatment rule in article III of GATT. A similar rule in the General Agreement on Trade in Services (GATS) requires National treatment in respect of services sourced from overseas.

These free-trade rules make it very difficult, prima facie, for a country to go it alone on abatement. However, nations which champion abatement are not entirely bereft of ways to stem carbon leakage. In its discussion of cement clinker and steel the Grattan Institute (2010 pp 44 and 54) argues that a carbon price imposed by domestic excise, or conceivably through a permit system, can be mirrored by a tariff or 'border tax adjustment'. This would be within WTO rules provided that it is imposed at the same rate as the domestic tax and does not discriminate between imports by source country. Imports from carbon-pricing countries must pay the same tax as those from countries without carbon prices. A major defect of this alternative is that the tax has to be based on the quantity or value of the product traded, not on an input to the product such as carbon content. Prohibition of differentiation by carbon content defeats the purpose of carbon pricing.

It might be possible to justify more specific discrimination against imports from countries which fail to price carbon if the WTO accepts the argument that governments which fail to take climate change action are providing an indirect subsidy to local industries through their failure to impose on local industries the costs of adjustment to a carbon-neutral world. Article XVI of GATT requires that the details of all such subsides (including any form of income or price support) be notified to the WTO. Article VI of GATT then recognises that importing countries may impose a countervailing duty on imported products equivalent to the value of the estimated bounty or subsidy determined to have been granted, directly or indirectly, on the manufacture, production or export of the product in the country of origin. So Article VI could conceivably be used to justify imposing a climate tariff on imported products, but only if WTO jurisprudence defines 'subsidy' broadly enough to include a country's failure to impose climate change costs on its local export-oriented industries. Article VI also restricts the imposition of countervailing duties to cases where harm is caused or likely to be caused to an established industry in the importing country.

A second possibility under Article VI would allow the imposition of an anti-dumping tariff on imported products sourced from emission-intensive countries. Article VI recognises that dumping, 'by which products of one country are introduced into the commerce of another country at less than the normal value of the products', is to be condemned if it causes or threatens material injury to an established industry in the territory of a contracting (GATT member) country. The question is whether the 'normal value' of a product should include its climate costs. A product is priced at less than normal value if the price when exported to another country:

(a) in the absence of a comparable price, in the ordinary course of trade, for the like product in the exporting country, is less than

(b) the cost of production of the product in the country of origin plus a reasonable addition for selling cost and profit.

If, and only if, the cost of production in the country of origin is defined to include 'hidden costs' (externalities), a product which fails to incorporate such costs into its price could be considered as having been sold at below its normal value. So far, however, WTO and national dumping jurisprudence has yet to take such hidden costs into account when calculating normal value.

A final WTO rule that may be relevant would be article XX, which provides for 'General Exceptions' to the normal GATT free-trade rules. In particular, Article XX(b) allows WTO members to adopt protective measures if such measures are necessary to protect human, animal or plant life or health. A measure (e.g. a carbon tax which includes imports) imposed as necessary to protect the local population of the country adopting the measure from the deleterious effects of emissions produced by recalcitrant nations is, however, unlikely to be easy to justify under article XX. It must be shown that the measure is 'not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries where the same conditions prevail, or a disguised restriction on international trade'. (the above paragraphs drafted by Dr Alice de Jonge, Department of Business Law and Taxation, Monash University).

In other words, the WTO rules outlaw sanctions applied by abatement champions against abatement recalcitrants and make it difficult but not impossible for champions to defend their industries against recalcitrants. The arguments for tariffs to protect industries in countries with carbon taxes against carbon leakage have yet to be tested before the WTO panels, and it is to be expected that recalcitrant nations and industries will strongly defend carbon leakage in the name of free trade.

If the WTO panels accept the arguments for countervailing tariffs, it can be expected that any abatement-champion nations which still favour emissions trading as a means of pricing carbon will switch to whatever carbon tax meets WTO specifications. This is likely to be the end of the dream of a world emissions trading system. If, on the other hand, the WTO panels refuse to allow champion nations to prevent carbon leakage the future of the WTO itself may be jeopardised.

Provided that the science of climate change continues to require a global target of 450 ppm or less, global fragmentation scenarios are the true reference scenario at the global level, not the business as usual scenarios hitherto in use. The implications of global fragmentation for world economic and political stability would be severe and would certainly not be in Australia's longer term interests. If a global agreement is achieved in the near term, it will be in part because the alternative is global fragmentation.

4.6 International permit prices

Among the chaos of international negotiations on climate change international trade in emissions permits has been strongly promoted. This is not the place to consider the politics, but merely to record that, for the purposes of scenario development, we assume that an international emissions trading system is set in place which allows the Australian government to cover any excess emissions over those allowed by the quota by purchase overseas of permits. The penalty for failure to purchase permits will be unspecified trade or capital flow sanctions which are sufficiently severe to ensure that the government indeed buys the required permits. From Chapter 2 it will be recalled that the Weak action scenario includes imports of permits as a major abatement action.

If permits are to be imported, their price is of the utmost importance. There is considerable debate internationally as to what the price of permits would be, were a trading scheme to be established. In its report *Australia's Low Pollution Future* the Treasury developed its own forecasts of permit prices, including a 2020 forecast of USD52 (2005 values) per tonne CO_2e for their Garnaut -25 scenario (p93) – say AUD64 (2007 values). In the present report, however, we prefer a forecast by the British government which yields a price of AUD_{2007} 55 in 2020. The next value published by Treasury is for 2050, but is sufficiently low to show that the IEA forecast rises much more quickly in the 2020s than the Treasury forecast. The point of this comparison is to show that the international permit prices adopted in this report are in line with current international estimates, and are not a likely source of divergence from Treasury modelling.

This said, it is emphasised that a very high degree of uncertainty attaches to forecasts of international permit prices. The uncertainty affects both the supply of permits (how many are generated; hence the rules for permit generation) and the demand (how many nations adopt, in effect, 'Weak action' policies which depend on permit imports). It has also been argued that permit prices could easily be affected by derivative trades and financial gaming, though this could be prevented by organising the market very tightly on the basis of inter-government current trade. Suffice to say that reliance on permit imports, as in the Weak action scenario, is risky. In this report the risk has been disregarded and conservative assumptions adopted.

4.7 Conclusion

This Chapter was not written to comfort those who believe that Australia can set its own minimal abatement target and continue with business as usual. Instead, it argues that the emission targets on which this report is based are conservative and are probably as high as can be adopted and still be on friendly and cooperative terms with countries concerned about climate change.

This chapter has outlined several scenarios for international negotiations post Copenhagen. There are broadly three alternatives.

- An emission abatement treaty is negotiated. As made clear in section 4.2 above, such a treaty is likely to set abatement targets for Australia which are as stringent as those assumed in this report, or maybe more so. However, it is also likely to include an international emissions trading system.
- If there is no emission abatement treaty but the WTO permits action by carbon-taxing countries to counter carbon leakage, Australia may find itself obliged to follow the policies of its major trading partners and capital suppliers. It is likely that at least some of these will be abatement champions. It is unlikely that there will be an effective international emissions trading system in this scenario, and an Australian attempt to get away with low levels of abatement may be expected to generate tariff disadvantages and difficulties in financing the balance of payments deficit.
- If there is no emission abatement treaty and the WTO insists on including carbon leakage within its definition of free trade, international mayhem may be expected.

Of the three alternatives, the first is the most compatible with the continuation of international trading arrangements in their present form. This is the reason why it is assumed as the background international scenario for this report. The probability of this happening is almost certainly higher than is currently rated by many commentators and more generally by vested interests in Anglo-sphere countries who assume that the disfunctionality of the world political economy will prevent rapid adjustment. In a few short years the East Asian economies, particularly China, will have a vested economic interest, based on comparative advantage, in driving a rapid adjustment to a low-emission world economy. They are currently betting hundreds of billions of dollars annually that the latest reports from the science of climate change will not only prove correct but conservative.

Thus, the champions of emission abatement could well be a coalition of North Asian countries and Europe with China in a key leadership role. Potentially recalcitrant economies such as the United States and Australia may have little choice but to join in.

Finally, as background to the Weak action scenario it is assumed that nations which fail to meet their abatement targets by domestic action can make up the difference by importing permits. A conservative price has been assumed for these permits.

5. Background to the scenarios

The scenarios presented in this report compare the effectiveness of three different policy packages in achieving the emissions abatement profile developed in Chapters 1 and 4. The primary criterion of effectiveness is the number of jobs generated, with the proviso that all jobs pay reasonable wages. Attention is also paid to GDP, incomes and consumption. The three policy packages:

1. are a Weak action package, in which the emission reduction target is met mainly through carbon pricing and international free trade in permits;
2. an intermediate package in which the target is met through carbon pricing supplemented by sector-specific measures designed primarily to speed the response of households and business to the price incentives; and
3. a Strong action package which also includes additional measures to increase Australian domestic participation in the new industries created as part of the response to climate change.

The sector-specific measures included in the intermediate and strong-action scenarios include:

- the co-ordination of responses (which is particularly important in areas where the reconstruction of capital involves complementary decisions on equipment purchases, as in the decarbonisation of electricity and the electrification of transport); and
- the generation or speeding of responses in areas where market stimuli are ineffective (e.g. overcoming barriers to price-response due to the limited borrowing capacity and/or other expenditure priorities of households and businesses).

The scenarios were constructed to compare the impact of the three policy packages over the next twenty years. NIEIR is well aware that various other abatement policy assessments have considered longer time periods, but prefers to concentrate on the relatively near future over which economic possibilities and technological choices are more or less clear, at least in broad outline. This relatively medium-term focus also accords with the science, which demands prompt action.

The primary purpose being to compare to policy packages, the three scenarios have a common abatement profile and a number of other common features. In this chapter we concentrate on the common features, leaving the divergences to Chapters 6-8.

5.1 Abatement profile

As Table 5.1 indicates, the abatement profile common to the three scenarios is a little less stringent than that assumed by Treasury in preparing its Garnaut-25 scenario, but is more ambitious than all the other Treasury scenarios.

Table 5.1 Target emission profile (Mt CO_2e), Australia

Year	NIEIR	Treasury: CPRS-15	Treasury: Garnaut-25
2006	566	566	566
2015	500	535	525
2020	411	475	400
2025	335	400	325
2030	274	340	235

Source: NIEIR modelling, Treasury (2008) Chart 6.2.

5.2 Population growth

In all three scenarios the Australian population growth rate is assumed to average 1.5 per cent a year from 2010 to 2030, with a gradual slow-down over the period. Largely owing to population ageing, average household size is projected to fall and the number of households to grow by 2.2 per cent a year. These conventional assumptions prepare the ground for the real work of scenario comparison.

5.3 Household debt

An important distinguishing feature of the present study is that it has no business-as-usual base case. In Chapters 1 and 4 it was argued that the progress of international emission abatement negotiations means that emission-intensive economic growth as practised in the 1990s and 2000s cannot continue, hence the deletion of business-as-usual and the concentration on alternative policies by which significant abatement may be attained.

In addition to international acknowledgement of the significance of climate change, the deletion of business-as-usual reflects a second important reason why the pattern of economic activity in Australia during the 1990s and 2000s cannot form a base case. The impossibility of continuing to sustain high levels of consumer demand by continued household borrowing was explained in Chapter 3. In this report NIEIR makes the judgement that the ratio of household debt to gross disposable income will stabilise at around 200 per cent – a very high ratio by historic standards. This assumption is common to all scenarios and implies that approaching 30 per cent of household disposable incomes (after income tax) will be spent on debt servicing and that the aggregate household sector gross savings rate will increase, though not to the historically normal range of 10-15 per cent of disposable income. Though the general trend to high debt-servicing costs and normal savings rates applies in all scenarios, the Intermediate and Strong action scenarios require slightly higher household savings rates.

5.4 Low income compensation

The three scenarios include moderate compensation for low-income households adversely affected by changed price patterns. This takes two forms, income compensation and assistance with capital investments required to improve energy efficiency. In the Weak action scenario, the emphasis is on income compensation – carbon pricing is treated as an impost similar to the GST, and a compensatory program of social security increases is implemented similar to that which compensated for the introduction of the GST. In the Intermediate and Strong action scenarios much greater emphasis is placed on assisting low-income households to improve energy efficiency, but a Commonwealth budget allocation is still set aside for a residual program of social security compensation.

5.5 Public sector finances

An important potential means of reducing emissions would be to switch production from the current mix of goods and services towards education and health services, both of which are low-emission. This could be accomplished quite simply by raising taxes and spending the proceeds on education and health services. However, the three scenarios eschew this option, taking the view that Australian political choices will continue to favour private-sector goods and services. In all three scenarios tax rates have been set so that taxes decline as a percentage of GDP, though it would not be hard to revise the scenarios so that taxes rise and consumption is transferred from households to government services.

The constraints on public sector expenditure are initially not as severe as indicated by the falling tax rate, since Australia's circumstances make it inevitable that there will be increased public sector borrowing over the next decade or two (see also Section 5.7 below). The reality

across all scenarios is that as the household savings ratio has to increase for debt saturation reasons. To maintain the targeted GDP growth rate, public sector spending will have to increase. That is, the public sector will have to go into sustained deficit to offset the negative effects on the economy from a rise in the household savings ratio.

The only other option to reduce the deterioration in public sector finances would be to reduce the foreign savings component of Australian savings by reducing the current account deficit so that more of domestic demand comes from net exports. However, this would require a commitment to industry policy that has not been evident since the 1960s. To maintain continuity with recent policy, in all three scenarios the current account deficit is driven as high as the rest of the world is likely to be willing to finance. The risks of high current account deficits, which are common to all scenarios, show the importance of maximising the local content of CO_2 reduction expenditures and leveraging from the expansion of productive capacity to drive export expansion. If this does not happen, the risk in all scenarios is that Australia's public sector finance imbalances will become a major constraint to growth. In the scenarios the problem is mitigated by the assumption that policy is efficient and the trajectory for all key indicators avoids a balance of payments crisis.

The reversal in the finances for the public sector over the next twenty years is what should be expected. The improvement in the public sector financial position over the last twenty years was largely the result of unsustainably low household savings ratios which allowed the public sector to increase its savings rate and still produce acceptable economic growth. This unsustainable dynamic will be reversed within the next few years.

5.6 Tradable goods producers

All three scenarios include measures to maintain the competitiveness of trade-exposed industries vis-a-vis producers in countries with lower effective emission prices. In recent Australian discussions there have been two approaches to competitiveness effects. One, adopted in most of the Garnaut analysis, has been to assume that world trade moves more or less quickly to carbon-inclusive prices.

Following the discussion of Chapter 4, it would be very optimistic to adopt the assumption that world trade moves to a carbon-inclusive basis, at least over the two-decade projection period. The scenarios therefore assume that world trade continues at prices which exclude carbon, with the competitiveness of trade-exposed industries maintained by a system of bounties and tariffs (which under emissions trading translates into permit rebates for exports and permit purchase requirements for imports). However, it is also assumed that world trade gradually moves to a carbon-inclusive basis, most likely as a result of bilateral agreements between countries with similar levels of carbon pricing. In all scenarios public sector finances include allowance for maintaining the competitiveness of trade-exposed industry. Needless to say the design of a compensation scheme for tradeable producers is controversial, particularly in a world where transfer pricing is prevalent. However, the study was not able to include a detailed assessment of the possibilities. It is sufficient to say that problems in reconciling national commitments and international responsibilities occur under all emission abatement policies.

5.7 Trade and the balance of payments

This study does not challenge the analysis underlying the orthodox account of the benefits of trade – trade enables producers to specialise regionally, so increasing productivity. However, it does challenge the orthodox assumption that national balances of payments are equilibriated by the exchange rate. (The balance of payments is the balance of trade – earnings from exports less payments for imports – plus international debt servicing costs but excluding net capital inflow.) This point is not at issue in short-term economic forecasting, where balances of payments and exchange rates can easily be upset by flows of 'hot

money'; neither should it be over the period of two decades under consideration in this study (see Appendix A). Instead two assumptions underlie all three scenarios.

- The Australian terms of trade goes through a gentle cycle, from an average of 1.75 in the period 2010-15, down to 1.72 then back to 1.74 in the period 2025-30. This is against the background of assumed growth in world gross product of around 3 per cent a year – not as rapid as in the heady days of 2003-08, but quietly optimistic given the structural imbalances revealed in the world economy by the financial crisis. It will be noted that the pattern of price changes in tradable goods neither favours nor disfavours Australia – the price of Australian exports keeps up overall (even if some prices go down, others to up) and similarly for Australian imports.
- The exchange rate continues to behave much as it has since the currency was floated in the 1980s – that is, the Australian dollar continues to be a 'commodity currency', implying that the exchange rate follows the terms of trade. The projection of reasonable stability in the terms of trade implies stability in the exchange rate. In both scenarios the US dollar exchange rate first falls then rises, but much of this is due to the anticipated behaviour of the US dollar. The trade-weighted index declines gently.

Under these assumptions, an acute question arises: what is to be the course of the Australian balance of payments deficit? Australia currently runs a substantial balance of payments deficit, meaning that overseas borrowing is required to cover net debt servicing costs incurred on past borrowings plus additional borrowing to fund an excess of payments for imports over earnings from exports. Views as to the balance of payments deficit vary widely. Australia has a long tradition of overseas borrowing, and current views express a mixture of historical experience and current ideology. Following the depressions of the 1890s and 1930s it was widely held that borrowing could only be justified if it was used in ways which would increase exports and so earn the foreign exchange to service the debts. However, during the 1995-2008 boom this sense of caution evaporated and it became much more common to hear the complacent view that a deficit which results from private market transactions is fine, since markets always generate optimal results. Australia's deficit was financed by private institutions (the trading banks) which were believed to have taken all relevant risks into account when they borrowed from overseas.

Needless to say, after the financial crisis of 2008 this view was not heard nearly so frequently. Commentators were quick to point out that Australian bank assets were largely denominated in Australian dollars while many bank liabilities were denominated in overseas currencies. This mismatch would send the banks broke if the Australian dollar plunged against the currencies in which the banks had borrowed, and remained low after the plunge. (Hedging might make a downwards spike manageable, but hedge positions eventually unwind.) Such a fall in the exchange rate would be unlikely if the borrowing had been spent in ways which generated exports, but the evidence is that much of it supported consumption. The problem is that a return to the old rule (no borrowing unless invested in export capacity), let alone a return to balance in the balance of payments (export revenue to exceed import payments sufficiently to service debts) would require wrenching structural change in the Australian economy with attendant high unemployment.

By assuming that the exchange rate continues to be determined by 'commodity currency' expectations in all scenarios, we have ruled out the prospect of a plunge in the rate brought about by loss of confidence among overseas lenders. However, both scenarios recognise that two conditions will have to be satisfied if Australia is to maintain its balance of payments deficit at levels which allow measured rather than catastrophic structural change.

- To attract funds, Australian interest rates will have to be above world rates – as they have been for decades now.
- Increasingly, Australia will have to demonstrate to lenders that it is using borrowed funds in ways which will guarantee repayment.

Concerning the latter point, all three scenarios assume that the ratio of net foreign debt to GDP is constrained. In the Weak action scenario it increases from the 2010 level of 55 per cent to 85 per cent for the five years 2025-30 while in the two other scenarios it increases to less than 80 per cent. These ratios underline the difficulties which are likely to arise in financing the balance of payments deficit and the importance of maintaining confidence. In the past, countries with lower ratios than these have had difficulty financing their debt and have suffered from plunging exchange rates, IMF discipline or both. Following the international financial crisis of 2008 it is probable that international arrangements will be a little more flexible towards indebted countries, but even so the ratio is pushing the envelope, particularly in the Weak action scenario where borrowing is not accompanied by a strategy for repayment. While flagging exchange rate meltdown as one of the danger points in the scenarios, we nevertheless assume that Australia's creditors will grant it time to turn its balance of payments round.

During the 1995-08 boom the balance of payments deficit was financed largely by bank borrowing from overseas for on-lending to households. We have already noted that this pattern cannot be repeated – households have reached debt saturation while the banks are uncomfortably exposed to liabilities denominated in overseas currencies. In all scenarios overseas borrowing by the banks becomes more prudent. As a result, gross foreign obligations decline as a percentage of financial sector assets. Who, then, is to borrow to finance the balance of payments deficit? One possible borrower is the private corporate sector, the other is the Commonwealth government. The scenarios are therefore constructed so that the balance of payments deficit is financed by private corporate borrowing to the extent that there are prospectively profitable projects to finance and borrowing is cheaper than equity finance, while in all scenarios the Commonwealth acts as borrower of last resort. This rule generates differences between scenarios in the ratio of corporate and government borrowing required to finance the deficit.

5.8 The capital output ratio and capacity utilisation

A further parameter which is the same in all scenarios is the capital-output ratio, which rises steadily. By 2030 the ratio is approximately 20 per cent above its 2010 level. This provides a measure of the extent to which it is necessary to substitute capital for hitherto-cheap energy in the process of reducing emissions. The substitution process involves several stages.

- Capital which becomes obsolescent as a result of carbon pricing is kept in use till its previously-expected retirement date, except where explicitly targeted for early replacement by sector-specific abatement polices. Where feasible its retention is financed by pass-through of cost increases but in the case of export-oriented capital it is financed by rebating the carbon price. Though the equipment remains available for use, its utilisation rate may fall.
- Where obsolescent capital equipment reaches the end of its life as expected in the absence of abatement policy, it is replaced by less emission-intensive equipment.
- Where equipment is replaced before the end of its expected life, its remaining value is written off as a dead loss and it is replaced by less emission-intensive equipment.

The cost of low-emission equipment depends on the particular technology (hence it is a bottom-up matter) but in general requires greater gross investment than the equipment it replaces. As a result, the capital stock measured in terms of the resources required to construct it increases more rapidly than the capital stock measured in terms of its productive capacity. As a result, the modelling has required two definitions of the capital stock of each industry: capital as invested and capital in relation to capacity. A second result in all scenarios is that gross investment grows more rapidly than GDP – a fundamental necessity discussed in Chapter 3.

The capital output ratio applies to capital which is in use. The desired capacity utilisation rate is set at 80 per cent, but both actual and target GDP can diverge from this. When divergence takes place a process of adjustment of aggregate demand tends to bring it back to the desired capacity utilisation rate.

If the inflation rate exceeds 3 per cent, the desired capacity utilisation rate for the period is decreased by 0.5 times the difference between the actual inflation rate and 3 per cent. If the inflation rate is below 3 per cent the desired capacity rate remains at 80 per cent, unless it is below this rate due to past inflation. In the first year in which the inflation rate falls below 3 per cent, the desired capacity utilisation rate is adjusted upwards by 10 per cent of the difference between the inherited rate and 80 per cent. As long as the inflation rate remains below 3 per cent, these adjustments continue in equal instalments till 80 per cent is reached, thus reflecting the gradual waning of inflationary expectations. These rules accord, approximately, with historical practice.

The Intermediate and Strong action scenarios include policies to expand capacity. These are described in Chapters 7 and 8.

5.9 Employment

All scenarios assume that macroeconomic policy is directed towards job and income generation. However, as explained in Chapter 3 (especially Table 3.4) macroeconomic policy involves multiple policy objectives. Fortunately multiple policy instruments are to address the objectives, and employment is therefore assumed to be maximised subject to the attainment of the other objectives.

The macroeconomic background to the study is that high household debt and high overseas debt will prevent a return to the 1995-2008 boom based as it was on overseas borrowing to finance the import of consumer goods, and household borrowing to finance the purchase of them. On top of this, the rising capital-output ratio dictated by the need for capital reconstruction makes it difficult to generate additional employment and additional labour incomes. In all scenarios the wage and salary share in GDP falls and the non-wage share rises, where the non-wage share comprises the gross operating surplus of incorporated businesses plus the mixed income of proprietary businesses plus government obligations overseas. A significant proportion of this increase is required to pay overseas lenders and is a consequence of Australia's reliance on overseas savings. Despite the handicap of increasing non-wage claims on GDP, all scenarios avoid recession, where this is defined as a sustained and major increase in the unemployment rate. However there are significant differences between scenarios in employment generation.

5.10 Conclusion

Business-as-usual as experienced in the 1995-2008 boom is simply not on the cards. Not only is it incompatible with world trends in emission abatement policy, it would require households to continue borrowing past debt saturation and banks to continue overseas borrowing well past prudent levels. Accordingly we compare three policy packages which address emission abatement within current financial constraints, the most significant of which is the balance of payments constraint. In all three scenarios Australia avoids an exchange-rate crisis by capping overseas borrowing so that the overseas debt to GDP ratio is kept manageable, if only just.

6. The Weak action scenario

The Weak action, Intermediate and Strong action scenarios were introduced in Chapter 2 and in Table 3.1. The abatement target they address in common was justified in Chapter 4, and a number of other factors which the scenarios hold in common were considered in Chapter 5. We now give a much more detailed account of the first of the three scenarios.

6.1 The process of abatement

In all three scenarios, abatement requires a major change in the structure of the economy. Accordingly abatement cannot be analysed without a basic understanding of the process of structural change – a process which necessarily takes place in real time.

In Chapter 3 we argued that abatement requires a burst of gross investment backed by equivalent savings. We showed that decarbonisation requires costly action, as for example when buildings have to be insulated and equipment has to be written off and replaced before it is fully depreciated. This is true even when the action is overall cost-negative (i.e. where the discounted present value of energy cost savings outweighs the initial investment cost), but is especially true when buildings, equipment and earthworks have to be written off and new operating and construction skills have to be acquired. The process can be considerably assisted by innovation, but this in itself requires investment in research, development, technology selection and implementation.

A crucial question for the Weak action scenario, with its heavy dependence on carbon pricing, is the response to higher carbon prices of:

- household consumption and savings behaviour;
- household investment behaviour;
- business investment behaviour; and
- business innovation.

These responses have been extensively studied, especially by modellers working in the bottom-up tradition. Bottom-up modellers have also documented experience with non-price and regulatory incentives to abatement. We rely on their experience in the present study.

6.2 Abatement policies in the Weak action scenario

In the absence of a business-as-usual scenario, the Weak action scenario takes on the aura of a base case, if only because it remains true to the policy paradigm which has dominated government policy in the Anglo countries over the past three decades. In addition to the continuation of current policies such as the renewable energy target, the Weak action scenario is based on the implementation of two simple abatement policies: carbon pricing to reduce domestic emissions and international trade in emission permits to cover the difference between domestic emissions and the abatement required by the emissions target. This package is very similar to the policies proposed for Australia by Treasury in 2008. The most obvious difference is that the Weak action scenario is developed in relation to a tighter emissions target than all bar one of the Treasury proposals.

In the present study it is assumed in all three scenarios that cost increases due to carbon pricing are rebated to exporters. In a recent study (*Restructuring the Australian Economy to Emit Less Carbon, 2010)* the Grattan Institute has challenged this assumption, arguing that instead of rebating the carbon price it could be more efficient to allow high-emission plants to close. Unfortunately the Grattan Institute study is limited to the industry level and has no macroeconomic component; it therefore does not take into account the effects of loss of exports in a balance of payments constrained economy. In cases where very large rebates

are required to maintain the flow of exports of it might be possible to divert the funds to investments which yield replacement export revenues, but at best this will take time. NIEIR concludes that it will be safer to maintain export rebates for the expected economic life of existing export-oriented plant, while ensuring that such rebates are not extended to new or replacement plant. This gives time for gradual adjustment.

It should be added that the three scenarios do not include any form of rebate or compensation for industries which are not export-exposed. These industries are obliged to write-off the value of obsolete capital, but the scenarios include the product price increases which are necessary to finance the burst of gross investment required by the unexpected obsolescence of their plant. In this respect NIEIR concurs with the Grattan Institute.

6.3 The role of price certainty

A less obvious difference of specification between the Treasury scenarios and the Weak action scenario lies in the role of international trade in permits. Treasury proposed a system of tradeable emission permits the price of which would be tied (via the exchange rate) to whatever price is formed in international permit markets (it being assumed that a market in suitably certificated and audited permits develops). In this system the price of permits in Australia would be tied to the world price, and Australia would import permits because other countries have lower-cost abatement opportunities. We will consider this argument at greater length in Chapter 7, the point here being that the Australian permit price would be tied to a world price which is in itself inherently unpredictable, with further unpredictability introduced through the medium of the exchange rate.

When businesses are considering the purchase of new equipment, and particularly when the equipment concerned is long-lived, the decision is dominated by perceptions of risk and uncertainty. The mechanism by which carbon pricing encourages abatement is by changing the relative rates of return on high-emission and low-emission equipment, but this is unlikely to be very effective if the change in rates of return is swamped by high levels of risk. To technological risk, demand risk and all the other inevitable forms of risk the proposal for internationally tradeable carbon permits adds exchange-rate risk and all the risks inherent in the operation of world markets. The recent financial crisis has shown clearly that prices in financial derivative markets are especially unstable – and carbon permits are a financial derivative. Exposing a carbon-pricing policy to these markets is therefore likely to seriously reduce the effectiveness of the policy compared to a guaranteed future carbon price. To put the same point another way, heavy reliance on carbon pricing subject to speculative fluctuations directs attention to the short-term, and away from the long-term equipment-updating decisions which are necessary if emissions are to be reduced.

Since the purpose of this report is to compare Weak action concentrating on carbon pricing with policy mixes which include sector-specific policies, it is desirable to give the best possible account of the Weak action option. We accordingly assume that Australian carbon prices are administered in such a way that investors have confidence in them and base their equipment purchase decisions upon them. For a world market in emission permits to develop prices on which the owners of emission-producing plant and equipment can confidently base their plant update purchases would require major efforts in international abatement permit administration and audit, coupled with the exclusion of speculative and double-derivative trade – all desirable, but unlikely to develop rapidly. NIEIR accordingly assumed that the Australian emissions price would follow a smooth and predictable trajectory. To ensure this predictability, it was assumed that the Australian carbon price would not necessarily follow the world price, and that any required trade in international permits would be carried out on Commonwealth government account. The domestic carbon price could then be run either as a permit system (with the Commonwealth selling permits at the pre-ordained price) or as a carbon tax, and the Commonwealth would bear the exchange-rate and permit-price risks inherent in a policy of relying on trade in permits. If the Weak action scenario were re-specified with free trade in permits, the result would be even heavier reliance on permit

imports due to the dampening effect of higher levels of risk on the reconstruction of the capital stock. This should be remembered in any comparison with the Treasury modelling.

As recommended by Treasury, the carbon price would be imposed on as wide a range of emissions as practicable, but there would inevitably be emissions which would remain unpriced because they are too diffuse or too difficult to hold to the account of particular responsible parties. The policy would be implemented as a guaranteed emission price, which means that investors relying for profitability on the announced carbon price trajectory would be guaranteed these prices.

Though the Weak action policy would be implemented as a guaranteed domestic emission price, which would therefore be likely to diverge from the world price, the simplifying assumption was made that the two would in practice coincide. The purpose of this assumption was simply to determine the Australian dollar value of permit imports, which were treated as a charge on the Commonwealth budget with offset from Commonwealth permit revenues.

The carbon price trajectory selected for the Weak action scenario is given in Table 6.1. It was based on current British Government expectations of world carbon prices, the assumption being that the Australian government will adopt, and maintain, a carbon price trajectory which accords with current expectations. Not only does the Weak action scenario use mechanisms which reflect current government proposals, its claim to be a base case is strengthened by the fact that the projected emission prices are close to NIEIR's estimates of the most probable Australian carbon prices to 2020, assuming that carbon pricing is in place by 2015.

6.4 Macroeconomics of the Weak action scenario

The macroeconomics of the Weak action scenario can be described in terms of the objectives outlined in Table 3.4.

- As already noted in Chapter 5, objective 6 (the balance of payments) provides the fundamental constraint. To finance the balance of payments deficit, interest rates have to be kept high, implying a tight monetary policy. This impacts on households (whose disposable incomes are squeezed by debt servicing, causing them to increase savings and curtail consumption) and on business (causing them to curtail investment in capacity creation, as distinct from the capital reconstruction generated by the carbon price). The demand for imports has also to be constrained, implying tight fiscal policy, and the import of permits also causes overseas investment in Australia to diminish. As noted in Chapter 5, the balance of payments deficit is increasingly financed by government borrowing.
- As also discussed in Chapter 5, objective 3 (household financial stability) is barely maintained in the face of high interest rates. This is bad for household welfare, but assists with one of the imperatives of the scenario – an increase in household savings to yield resources for capital reconstruction particularly during the 2010s, and to yield resources to pay for permit imports, particularly during the 2020s. If the rise in interest rates is not sufficient to generate the necessary savings, the remainder would be generated by monetary and/or fiscal policy to encourage savings (possibly tax rebates for saving, financed by a rise in tax on income which is not saved) and/or to discourage consumption (for example, a quantitative credit squeeze which reduces the availability of loans for consumption purposes).
- Reflecting the difficulty of living within these constraints, objective 5 (inflation) is not met during the 2010s, resulting in further tightening of monetary policy. Fiscal policy is also tighter than it would have been in the absence of inflation. The unsatisfactory rate of inflation reduces business capacity-expanding investment (the Taylor rule).

- The high interest rates and constrained fiscal policy result in failure to meet objective 2, capacity utilisation, particularly during the 2010s. The government borrowing required to finance the balance of payments deficit translates into an expansionary fiscal policy, but this has to be strictly controlled in order to keep the balance of payments deficit manageable (a constraint from objective 6). The economy generates jobs, but not enough to keep up with workforce growth.
- The tightening of monetary policy (including the high interest rate) and the unsatisfactory rate of inflation result in a failure to meet objective 4 – business investment is below the target relationship with cash flow. A further factor contributing to this result is the absence of policies to encourage investment. The failure to meet this target in the 2010s results in a low rate of growth of productive capacity, which feeds back to objective 2, capacity utilisation, which is relatively high in the 2020s. However this is high utilisation of low capacity, and the economy fails to generate enough jobs to keep up with workforce growth.
- As a result of the failure to meet objectives 5, 2 and 4, there is a further failure to meet objective 1 (long term business expectations).

This seems like an unhappy list, but it in fact reflects a very high quality of macroeconomic management given the constraints. To the extent that it assumes high quality of macroeconomic management, the weak policy scenario is optimistic.

6.5 Results

The headline result is that the carbon pricing scheme succeeds in restraining domestic emissions to 2010 levels. The abatement target is met by permit imports, which are substantial. In 2020 the target is met by the import of 174 Mt of imported permits at a cost of $\$_{2007}$ 9.6 billion, the target itself being 411 Mt, and by 2030 the import level has risen to 305 Mt by comparison with a target of 274 Mt, an accelerating burden on the balance of payments of (optimistically) $\$_{2007}$ 48 billion a year. This raises the question of whether such a burden can be managed, but the scenario is coherent – as outlined, macroeconomic policy is up to the task. Whether the burden could be managed beyond 2030 is a different and unanswered question.

Despite the abatement effort and the additional burden of permit imports on the balance of payments, GDP continues to grow at an average rate of 3.1 per cent a year in the 2010s and 2.6 per cent in the 2020s. In terms of jobs, employment grows by 1.2 per cent a year in the 2010s and 0.9 per cent a year in the 2020s, but (continuing the recent trend) much of this growth is in part-time jobs, and employment growth measured in hours is less impressive at 0.9 per cent a year in the 2010s and 0.5 per cent in the 2020s. These rates are insufficient to keep up with workforce growth.

Because of the necessity to increase household saving and to remit an increased proportion of GDP overseas as a result of the balance of payments deficit, consumption (excluding energy and transport) grows less rapidly than GDP. It rises by 1.3 per cent a year during the 2010s rising to 2.2 per cent in the 2020s. These rates are insufficient to keep up with population growth, and private consumption per capita declines by 0.2 per cent a year in the 2010s, recovering to growth of 0.6 per cent a year in the 2020s.

We reiterate that these results depend on two important assumptions.

- The effectiveness of carbon pricing in encouraging abatement is maximised by the assumed certainty of future carbon prices. If this certainty cannot be generated, the domestic abatement response will be less, the need to import permits more, and the dampening effect on GDP more severe.
- The quality of macroeconomic management is high, in the sense that all instruments are brought into play and there is balanced pursuit of all objectives.

6.6 Comparison with the Treasury results

Because the abatement policy instruments assumed in the Weak action scenario are very similar to the instruments assumed in the previous Treasury studies, a comparison is possible for the limited number of variables for which Treasury has provided data.

Table 6.1 shows that the Weak action scenario achieves approximately the same domestic emissions in 2020 and 2030 as the Treasury calculates will be achieved under its CPRS-5 and Garnaut -10 scenarios. However, there is a major difference in the carbon price, which is 45 per cent over the price in the Treasury scenarios in 2020 and well over double the Treasury prices in 2030. The carbon price in the Weak action scenario is within the range of Treasury modelling in 2020 (it is roughly the same as in their CPRS -15 scenario) but by 2030 is way above anything Treasury has contemplated.

A second comparison concerns the rate of growth of GDP. In both the Weak action scenario and the Treasury scenarios the rate of growth declines in the 2020s compared with the 2010s, but otherwise the Weak action scenario is notable for higher rates of growth than in any of the Treasury scenarios.

The Treasury has not published any data which allows direct comparison between employment and living standards in their scenarios and NIEIR's. However, it has published a limited number of results for 2020 in terms of deviation from its reference case. If we assume that consumption in the reference case grows at the same rate as Gross National Product, the rate of growth of consumption in its policy cases can be estimated at around 0.7-0.8 per cent a year during the 2010s, significantly less than the 1.3 per cent a year in the Weak action case. This lower rate of growth aligns with the lower rate of growth of GDP.

Table 6.1 The Weak action scenario and Treasury scenarios

	2020		2010s	2030		2020s
Scenario	CO_2 price ($2007)	Domestic emissions (Mt)	GDP growth rate (per cent)	CO_2 price ($2007)	Domestic emissions (Mt)	GDP growth rate (per cent)
Treasury CPRS -5	38	600	2.7	60	580	2.3
Treasury CPRS -15	55	530	2.7	75	500	2.2
Garnaut -10	38	600	2.7	55	580	2.3
Garnaut -25	65	500	2.6	90	490	2.2
NIEIR weak action	55	585	3.0	158	579	2.7

Source: Treasury 2008 (approximate – some numbers had to be read from graphs) and NIEIR modelling.

One other comparison is possible for 2020 – the level of permit imports (Table 6.2). Among the Treasury scenarios, only the Garnaut-25 scenario has an abatement target comparable to the Weak action scenario, and these high emission targets tend to reduce the required level of permit imports. However, the important similarity is that all these scenarios require substantial permit imports.

Partly because of their high emission targets, and partly because of their more optimistic calculations as to the effectiveness of carbon pricing policies, the Treasury scenarios with one exception (Garnaut -25 in 2020) report lower levels of permit imports than are required in the Weak action scenario. If permit imports are recalculated to the Weak action target, the required permit imports in the Treasury CPRS -5 scenario rise to the same level as the Weak action scenario. Superficially, then, the CPRS -5 scenario and the Weak action scenario have a similar outcome. One might even propose that the Weak action scenario provides an

idea of what would happen if Australia locked in a price-only abatement policy aimed at a weak abatement target and found itself confronted with a stronger target.

The NIEIR scenarios assume import parity CO_2 pricing by 2030. So what is relevant here is what is currently being assumed by international agencies for the CO_2 price based on similar world scenarios to those which background the NIEIR scenarios for Australia.

The UK Committee on Climate Change states a desired median CO_2 price for 2030 of US$130 and a high of US$192 in 2009 prices for investment evaluation purposes. For a 50 per cent CO_2 reduction target the International Energy Agency indicates a minimum CO_2 price of US$200 and as much as US$500 by 2050 (IEA Energy Technology, *Perspectives: Scenario and Strategies to 2050*, 2008). Other IEA studies quote estimates of around US$180 a tonne of CO_2 by 2030.

The CO_2 price profile adopted here is, therefore, well within the range of current forecasts for aggressive CO_2 reduction. The US$ price which corresponds to the AU$154 a tonne CO_2 domestic price is $US136 a tonne.

Table 6.2 Emissions and imports in 2020 (Mt), Weak action and Treasury scenarios

Scenario	Target	Net imports to meet scenario target	Net imports to meet Weak action target
Treasury CPRS -5	525	60	174
Treasury CPRS -15	470	59	118
Garnaut -10	496	112	197
Garnaut -25	405	100	94
Weak action	411	174	174

Source: Treasury Table 6.8, NIEIR modelling.

These comparisons raise three issues. First, why does the Weak action scenario require a higher carbon price for any given level of abatement? Second, why are the rates of growth of GDP lower in the Treasury scenarios? Third, can the Australian economy sustain large permit imports? We leave discussion of the third question till the next chapter, and address the other two. Definitive answers are not possible due to a lack of detail underpinning Treasury's assumptions. For example, all scenarios involve assumptions about the effect of abatement policy on world trade and it could be that some of Treasury's results reflect different assumptions in this area. However, it would appear that the crucial assumption – that permits can be imported at the Australian domestic carbon price – is similar between the Treasury and Weak action scenarios.

6.7 Why does Treasury get more abatement for each dollar of carbon price?

Estimates of price responsiveness (technically elasticities) are fundamental to economics but are notoriously debatable. This is because it is simple to observe changes in prices and quantities sold, but very hard to disaggregate them into supply and demand side influences – and the essence of a price response is that it belongs to one side or the other. A simplistic explanation would be that Treasury have made an optimistic estimate of the elasticity and NIEIR a pessimistic estimate. If this were the case, it would just be a difference of judgement and one could take one's pick.

But it's more complex. As explained in Chapters 1 and 3, abatement requires the replacement of vast array of capital equipment, ranging in scale from light bulbs to coal-fired power stations. The response to carbon pricing hence depends on many complex factors –

the prices, operating costs and emission savings of all the items in the whole array of potential replacement equipment. It also depends on time, because it takes time to select, buy and install the equipment, and it depends on resources being available to buy the replacement equipment. NEIR has taken the factors affecting equipment choice into account, both in the household sector and in business industry by industry, using bottom-up modelling. It has also allowed for the macroeconomics of making resources available for capital reconstruction. Yet Treasury appear to assume that a campaign of capital reconstruction is not necessary. If the capital stock can be reconfigured costlessly to that which is appropriate to the new carbon price, it should not be surprising that the response can be quicker. In all probability this provides the underlying reason for the difference of response, but differential treatment of side-effects and feedbacks will also affect the results.

6.8 Why does Treasury get lower rates of growth of GDP?

As was emphasised in section 6.4 above, the Weak action scenario involves a very high standard of macroeconomic policy implementation, in which nine objectives are pursued using more than nine policy instruments. The obvious answer to why Treasury gets a lower rate of growth of GDP than in the Weak action scenario is that it assumes a lower standard of macroeconomic performance – nothing to do with abatement, and everything to do with Treasury's expectations of its own future performance.

Evidence for this answer lies in the rate of growth of GDP in Treasury's 'reference' scenario. Because a comparable business-as-usual scenario has been deleted from the NIEIR set of scenarios there is no NIEIR business as usual scenario with which the Treasury reference scenario can be compared. However, the rate of growth of GDP in the Treasury reference scenario, at a little less than 2.6 per cent a year average for 2010-30, is less than the rate of growth of GDP in the Weak action scenario at 2.8 per cent a year for the same period. Were there a NIEIR business as usual scenario, the difference would presumably be greater – indeed in projections prepared for the Brotherhood of St Laurence the estimate is -0.4 per cent a year (BSL report, 2009). We can conclude that some of the difference between rates of growth of GDP is due to general macroeconomic assumptions and not to differences in the assessed effect of abatement policies.

This said, it appears that Treasury have not taken into account the important side benefits of abatement expenditures. These include improvements in energy efficiency and reductions in imports – both imports of petroleum and imports of permits. In NIEIR's modelling these side benefits result in significant relaxation of macroeconomic constraints, particularly during the 2030s. Further discussion would take us into a comparison of models, and is reserved for Chapter 11.

6.9 Conclusion

In the Weak action scenario Australia succeeds in meeting its target, but only by importing permits. To market-oriented economists this would be a satisfactory result – if markets work perfectly, Australia will only be importing permits if emission abatement is cheaper overseas than it is in Australia. But markets do not work perfectly, and we therefore move to the Intermediate scenario and see whether it might be possible to improve on the Weak action result by adding sector-specific policies.

7. The Intermediate scenario

The Intermediate scenario is central to this study, since it makes the case for adding sector-specific measures to carbon pricing policies. This involves giving much more emphasis to the bottom-up approach.

7.1 The bottom up approach – Step one: The technological possibilities

The first step in the construction of a scenario which takes sector-specific policies seriously is to document the technological possibilities for either direct or indirect CO_2 abatement across all economic sectors. Rather than compile our own list, we start with candidate lists developed in more advanced jurisdictions overseas. Table 7.1 shows a summary of possibilities considered useful in Japan.

Table 7.1 Core technological options for decarbonisation

Sector	Technology
Residential and commercial	Efficient air conditioner, Efficient electric water heater, Efficient gas/oil water heater, Solar water heater, Efficient gas cooking appliances, Efficient electric cooling appliances, Efficient lights, Efficient visual display, Efficient refrigerator, Efficient cool/hot carrier system, Fuel cell cogeneration, Photovoltaic, Building energy management system (BEMS), Efficient insulation, Eco-life navigation, Electronic newspaper/magazine, etc.
Transportation	Efficient reciprocating engine vehicle, Hybrid engine vehicle, Bio-alcohol vehicle, Electric vehicle, Plug-in hybrid vehicle, Natural gas vehicle, Fuel cell vehicle, Weight reduction of vehicle, Friction and drag reduction in vehicle, Efficient railways, Efficient ships, Efficient airplanes, Intelligent traffic system (ITS), Real-time and security traffic system, Supply chain management, Virtual communication system, etc.
Industrial	Efficient technologies for boiler, industrial furnace, Independent Power Plant (IPP), coke oven, and other innovations like Eco-cement, Fluidised catalytic cracking of naphtha, Methane coupling, and Gasification of black liquid.
Energy transformation	Efficient coal fired generation (co-combustion with biomass, etc.), Efficient gas fired generation, Efficient biomass fired generation, Wind generation (on-shore, offshore), Nuclear power generation, Hydro power generation, By-product hydrogen, Natural gas reforming hydrogen production, Biomass reforming hydrogen production, Electrolysis hydrogen production, Hydrogen station, Hydrogen pipeline, Hydrogen tanker, CCS (Carbon Capture and Storage), Solar, etc.

Source: "*2050 Japan Low Carbon Society*", National Institute for Environmental Studies, Kyoto University, June 2008, page 11.

Table 7.1 was prepared for Japanese conditions, and the list for Australia will differ. An Australian list will (for example) give greater prominence to solar/hybrid water heating and give a larger role to heat pumps. In transport there would be a role for road pricing, and in energy transformation for carbon capture and sequestration and for smart grids. The table is, however, typical of the lists being compiled across the globe.

7.2 The bottom up approach – Step two: The CO_2 reduction possibilities by sector, a UK example

The next step is to translate the technological possibilities into what is possible by a given date in terms of CO_2 reduction. To illustrate this, the most recent draft of a proposed United Kingdom plan will be taken as an example. The report is: Committee on Climate Change, "*Meeting Carbon Budgets – the need for a step change*", 12 October 2009. The UK developed the following process for designing a national abatement strategy.

1. Determine national emissions reduction targets/quotas and set up a mechanism (for example, an emission trading scheme) to convert these into carbon prices.
2. Set a minimum CO_2e price extending out at least a decade.
3. Assess CO_2 reduction potential across all areas of the economy, for example
   (i) agriculture and land use;
   (ii) manufacturing/mining investment modernisation;
   (iii) commercial buildings;
   (iv) electricity generation low CO_2 intensity capacity;
   (v) gas substitution;
   (vi) the emissions-efficiency of transport modes and vehicles;
   (vii) transport infrastructure and its management;
   (viii) urban design;
   (ix) cogeneration of heat;
   (x) insulation of the building stock; and
   (xi) the efficiency of household appliances etc.

   As recent Australian experience attests, an important limitation to abatement potential is the administrative capacity to implement sector-specific policies efficiently. In the Intermediate scenario NIEIR assumes that full use is made of available administrative capacity, disregarding whether it is available in federal, state or local government or indeed by contracting out.
4. Assess resource requirements (i.e. direct expenditures) across all sectors per tonne abated and in total.
5. Allocate expenditures across all sectors to achieve the overall CO_2e reduction target for each year in accordance with CO_2e reduction potential and the unit cost of CO_2e reductions.
6. Set the total level of expenditures to achieve each year's target/quota.
7. Given resource requirements for each sector, for each year on the planning horizon determine:
   (i) the resources which will be provided by the private sector given the CO_2 price and private sector decision criteria and
   (ii) the residual resource requirements to be created by policy changes.
8. Determine how the residual resource requirements are to be created by policy, including the use of
   (i) subsidies, tax incentives, capital grants, bonuses;
   (ii) regulations restricting options to the most efficient CO_2 reduction option;
   (iii) rules concerning energy supply market order; and

(iv) public enterprise supply mandation.

9. Given the resource costs, require the central agencies (Treasuries, Reserve Banks) to operate the macroeconomic policy instruments (that is, interest rates, the exchange rate, tax rates, CO_2 oriented public expenditures) that:

   (i) enable the economy to operate sustainably at the designated employment level;

   (ii) minimise the costs of resource reallocation; and

   (iii) protect the growth potential of the economy.

In April 2009 the United Kingdom government legislated for legally binding carbon budgets to be eventually designed based on a 34 per cent cut in United Kingdom emissions relative to 1990 by 2020. The UKCCC recommendations are to form the basis of final legislated budgets. The October draft is a progress report on the budget design.

The draft (sector) carbon budgets are based on three scenarios. They are:

(i) Current Ambition;

(ii) Extended Ambition; and

(iii) Stretched Ambition.

The components of each scenario are as follows.

- The **Current Ambition** scenario included identified measures that would cost less per tonne than the projected carbon price, and/or which were covered by policies already in place. It also included significant progress towards low carbon electricity generation and some progress on improving fuel efficiency in new cars. Some policy strengthening would be required to deliver the Current Ambition scenario.
- The **Extended Ambition** scenario incorporated more ambitious, but still reasonable, assumptions on penetration of energy efficiency improvements and a number of measures which would cost more per tonne than the projected carbon price, but which were important stepping stones on the path to 2050. It was broadly in line with policies to which the Government is committed in principle, but where precise definition and implementation of policy is required. It included, for instance, a significant penetration of renewable heat, more ambitious energy efficiency improvement in cars and some lifestyle changes in home and transport. Delivery of the Extended Ambition would require both strengthening of existing policies and introduction of new policies.
- The **Stretch Ambition** scenario added further feasible abatement opportunities for which no policy commitment was in place, including emissions reduction in agriculture, more radical new technology deployment and more significant lifestyle adjustments.

The conclusions were that the extended and stretched ambition scenarios would achieve the objectives of the interim budget (at 34 per cent decline in emissions by 2020) for the non-traded sector without the need for imported permits, and the stretched ambition scenario would almost achieve the objective overall. (page 82)

Table 7.2 outlines what the sector budgets look like for the non-traded sector. For the traded sector the Extended Ambition scenario involves a budget calling for a 53 per cent reduction in emissions by 2020 from expansion of wind power, nuclear capacity and CCS coal generation. By 2020 two thirds of the reduction will be achieved by wind capacity, 30 per cent by nuclear capacity expansion and the small residual by CCS coal stations (the UK government having, somewhat optimistically, assumed that carbon capture and storage becomes economic by 2020).

Table 7.2 United Kingdom Interim Budget: Targets by sector by secured non-traded sector					
	Abatement potential in 2020 (Mt CO_2)			Abatement potential in 2020 (Mt CO_2)	
	Extended Ambition	Stretch Ambition		Extended Ambition	Stretch Ambition
Domestic buildings			**Road transport**		
Cavity wall, solid wall and loft insulation	6	8	Biofuels	5	5
Other insulation measures	1	1	Car technology	10	10
Heating efficiency	<1	2	Van technology	2	2
Lights and appliances	5	6	HGV technology	1	1
Lifestyle measures	4	4	Rail – efficiency measures	1	1
Zero carbon homes	1	1	Demand – smarter choices	3	3
Total	*17*	*22*	Demand – Eco driving – vans and HGVs	1	1
			Speed limiting (at 70 mph in Extended, 60 mph in Stretch)	1	3
Non-domestic buildings and industry			Road pricing		6
Total	*16*	*16*	*Total*	*23*	*32*
Renewable heat			**Agriculture**		
Total	*18*	*18*	*Total*	*3*	*3*
Waste					
Total	*1*	*1*	**TOTAL**	**79**	**92**

Source: UK Committee on Climate Change.

The difference between Stretched Ambition and Current Ambition provides a guide to the gap between expected market-driven take-up given the projected CO_2 price and the budget targets, hence the need for government intervention beyond carbon pricing. The proposed interventions cover a wide range of instruments from guaranteed prices in power markets to regulation and government subsidies to overcome the gap between investor requirements and the market determined investment paybacks on investment.

Unfortunately, as the UKCCC acknowledges, much work remains to fill out the detail for the sectors in terms of the additional expenditure requirements to install the CO_2 technology and financing requirements to close the gap between market driven take-up and target take-up. Where the government can directly influence outcomes by additional expenditures such estimates are given. In the case of the power sector, there is extended discussion of the likelihood that even if new power capacity is profitable at a given carbon price, it will not proceed because of price uncertainty, existing competition restrictions and technological risk arising from possible technological developments over the next five to ten years. The report suggests that further interventions will be required to reduce risks (e.g. price guarantees, investment subsidies, etc.) to ensure the investment is made. At this stage it fails to explicitly spell out the implementation strategy, though a detailed costing and implementation strategy is given in the draft budget in the case of the hybrid and full electric vehicles.

The UKCCC draft plan calls for 1.7 million electric cars by 2020. The question is how to get the cars taken up, including the consequences for electricity production and distribution. The draft report recognises that there is a price premium between electric cars and conventional vehicles that mainly reflects the additional battery cost. Since the operating cost is much lower for electric vehicles, the whole-of-life costs may well be favourable if consumers took this into account. They note, however, that while some consumers are rational many are myopic in the sense of only looking at the difference in the purchase price. Indeed, the majority of consumers appear to adopt very short payback periods in assessing expenditure decisions. The UKCCC notes that the United Kingdom Government has already decided to provide price support of between £2,000 and £5,000 per vehicle. It notes that this level of subsidy is only sufficient if consumers are rational and take into account fuel savings. It suggests that if this is not the case the level of support may have to double to significantly reduce the purchase price differentials so that the take-up target can be achieved. This would take the resources required to average the target of up to £1.5 billion.

7.3 Sector-specific policies in Australia

The Intermediate scenario combines carbon pricing, as implemented in the Weak action case (but more stringent in the 2010s) with sector-specific policies. The primary function of sector-specific measures is to accelerate responses to the emissions price. A secondary function is to provide an additional policy measure to assist in meeting targets while maintaining a steady trajectory for the emission price. As in the Weak action scenario, permit imports by the Commonwealth are included as a backstop for use if required.

As the UK case makes clear, in overseas discussions of abatement policy it is generally accepted that complementary policies are required to enhance the effectiveness of carbon pricing. However, in Australia the Commonwealth is still strongly attracted to the idea that abatement policy need not go beyond carbon pricing. NIEIR has addressed this issue by constructing a Weak action scenario in which domestic abatement depends mainly on carbon pricing and contrasting this with an Intermediate scenario which includes a wide range of sector-specific policies. The underlying hypothesis is that the potential for sector-specific measures is considerable.

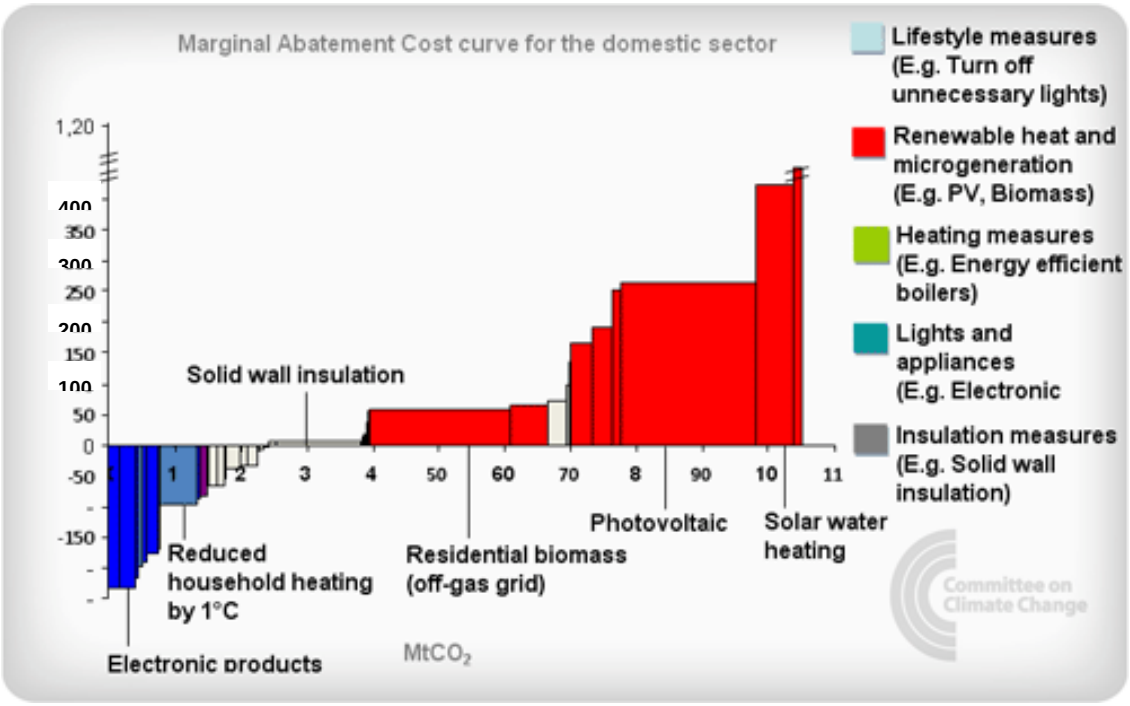
The potential for sector-specific abatement policies is commonly summarised by marginal abatement cost curves (for example, IEA, McKinsey, ClimateWorks and Fig 7.1). The present report uses much of the data which underlies the marginal abatement cost curve studies, but differs in that it allows for implementation costs and includes both explicit dynamics and indirect benefits. These latter are particularly important in transport.

The finding of the marginal abatement curve studies that there is a substantial tranche of negative cost abatement is a challenge to the theory that abatement is highly price-responsive, and leads to discussion as to why this should be so. Opportunities for negative-cost abatement generally arise when energy-efficient equipment is available to replace current equipment. An outlay is required, but this cost can be recouped more or less quickly from energy savings. At commercial discount rates, any equipment replacement where the cost is recouped within a decade or so is theoretically profitable, but the evidence is that households and small businesses often require very short payback periods before they will act.

Various experimental programs have been designed to encourage negative-cost and other low-cost abatement, and their degree of success provides empirical insight into the barriers to price-response. In the construction of the Intermediate scenario and in conjunction with ACF, NIEIR reviewed the possibilities as currently appraised in Australia and selected a number for incorporation in the scenario. It is emphasised that the present selection of sector-specific policies represents a judgement taken in the current state of knowledge, and that further work is expected to revise expectations and costs for the sector-specific policies included in the scenario. It will also revise expectations and costs for sector-specific policies

which have not been included, some of which are likely to be substituted for the listed policies as the policy package is developed and reviewed in the light of experience.

Figure 7.1: Marginal abatement cost curve for the domestic sector



Source: UK, Committee on Climate Change.

The Intermediate scenario incorporates the following sector-specific abatement policies which are, on present knowledge, considered likely to accelerate the response to emission pricing.

- ***Household energy efficiency strategy*** – roll out a national residential retrofitting program.

  Rationale: Residential energy efficiency is notoriously slow to respond to price changes. Reasons for the slowness include split incentives between landlords and tenants (this implies that rents do not adjust for residential energy efficiency), financial constraints (not all households have the cash or borrowing capacity available to upgrade their energy-using equipment) and general household inertia.

  Program content: The envisaged program will have marketing content and a financial element to overcome the financial and incentive barriers – including a redistributive component which will be tied in with compensation to low-income households. Most elements in the program have already been piloted.

  Benefits: The program will allow households to maintain their standards of comfort (heating and cooling) and many other domestic energy-using activities (cooking, refrigeration etc) with smaller and less emission-intensive energy inputs. There will be a side benefit in a reduction in household energy expenditures.

- ***Commercial building and industrial energy efficiency strategy*** – use existing and expanded programs to achieve the significant savings from energy efficiency in commercial buildings and in large and small industry. The program will be extended to community organisations including additional transitional financial incentives.

  Rationale: Though business is likely to be conscious of opportunities to reduce costs, the factors hindering energy efficiency improvement in the residential sector also apply, particularly to small business, NGOs and businesses where cash flow constraints limit spending.

  Program content: Likely to be similar to the residential sector, shorn of redistributive components (though some NGOs might be eligible for redistributive action). It is recognised that energy efficiency improvements are notoriously difficult to achieve in energy-intensive industries, where existing prices provide strong incentives to energy efficiency, so the modelling does not include any major benefits from these industries apart from responses to the extension of Best Practice Networks.

  Benefits: As for residential sector.

- ***Rapid expansion of low CO_2 intensive electricity infrastructure and coordination of electricity industry restructuring***

  Rationale: The electricity supply industry comprises large businesses which are both commercial and capable of prompt response to price incentives, particularly where the future course of carbon pricing is reasonably certain. Indeed, when the industry was largely in public ownership it could be instructed to reduce emissions, provided the instructing government was willing to provide finance and/or defend the consequent electricity price increases – this is the path currently being taken by the Province of Ontario in Canada. In Australia, as a result of privatisation, much greater reliance will have to be placed on the carbon price incentive, though government can help by accepting the resulting price increases and compensating low-income households affected by them. Carbon pricing (whether the general carbon price or renewable energy target schemes) should be sufficient to guide the transition from coal to gas fired power, so no subsidies are proposed (as distinct from price increases to recoup costs). However, it is expected that public investment will be required to ensure that relevant capacity is available in the gas supply and electricity distribution grids. There is also a case for additional funding for new technologies (to assist with research, development and demonstration and to pursue economies of scale) and for funding of co-ordination as new power sources are phased in and old phased out.

  Program content: incentives such as an expanded renewable energy target, investment in a smart grid and funding for research, development and deployment of low emissions energy. The investments must be coordinated to be mutually supportive and maintain continuity of supply during the transition process. Significant investment is provided for expanding, upgrading and smartening the distribution networks. Certainty of future carbon prices is a basic requirement of the program, and it may be desirable to back up the announced carbon price profile with price guarantees to investors in gas and renewable capacity – guarantees which will only be activated in the case that the announced price fails to eventuate.

  Benefits: The main benefit is speeding the change-over in electricity supply. It will be important to monitor these programs with reference to the emission price.

- ***Federally led low carbon transport infrastructure plan complemented by investment in a cleaner vehicle fleet***

  Rationale: The transport sector is notoriously slow to respond to carbon price incentives, yet has considerable scope for low to medium cost emission abatement particularly when indirect benefits are taken into account such as reduced demand for petroleum.

Program content: Federal government investment in low carbon public and active transport infrastructure; expansion of the hybrid and electric car fleet (perhaps through standards and targets, as in California), implementation of vehicle efficiency standards (though here Australia is likely to be a free-rider on overseas developments), freight modal shifts to lower emissions transport (mainly reflecting revised infrastructure investment priorities expedited by road pricing) and biodiesel production on marginal agricultural land. The program would be integrated with the regional investment plan, one of the aims of which would be to reduce the need for long-distance commuting. Investment in telecommunications will also have a role in bringing workplaces closer to where people live.

Benefits: In addition to lower emissions, the benefits to households would include maintenance of access to travel destinations at lower energy cost, the benefits to business will include maintenance of input-output relationships in the face of increasing carbon and oil prices, and the benefits nationally will include less reliance on imported petroleum.

- ***A national 'green carbon' initiative*** – to reduce emissions from land use and build climate change resilience into Australian rural areas.

  Rationale: The potential contribution of rural industries to emission abatement is considerable, but the sector is difficult to include within a carbon pricing scheme because of problems of emission measurement and attribution. Accordingly a sector-specific plan would be developed which provides incentives to abatement and equally discourages land management which increases emissions. An important aspect of this plan will be the need to gain international recognition for abatement via the land use and forestry sector, which in turn requires improved measurement and attribution of emissions sequestrated.

  Program content: For modelling purposes, the program content is a budgetary provision to be distributed across promising policy initiatives in accordance with further work on their capacity to reduce emissions. There is no shortage of initiatives.

  Benefits: The main benefits anticipated are relatively low cost emission abatement and sequestration. Other benefits may arise according to sub-program, for example conservation of forests and biodiversity and improvements in soil fertility and water management.

The primary role of sector-specific policies as accelerators of the response to carbon pricing implies that these policies should be selected ex ante by their expected contribution to this acceleration and evaluated ex post by their success in speeding abatement. We reiterate that this ex-post evaluation, combined with research and the development of new technologies, will constantly change the list of sector-specific policies which qualify for inclusion in an efficient abatement policy package. The point here is that carbon pricing and sector specific policies are complementary: carbon pricing (and the responses to it, and the opportunities it creates) is fundamental to the selection and evaluation of sector-specific policies, but sector-specific policies are vital if the response to carbon pricing is to be rapid and effective.

Though in policy terms the difference between the weak and Intermediate scenarios is that the latter makes much more use of sector-specific policies, the difference between the policies implemented in the two scenarios may be summarised in one figure: the Intermediate scenario involves more than a doubling of gross investment on emission abatement over the two decades. Instead of cumulative spending of $328 billion in 2007 dollars, we have $791 billion – an average of approximately 2.7 per cent of GDP over the two decades, compared with 1.1 per cent under the Weak action scenario. The difference represents a major national effort. The question is whether this effort is likely to be worthwhile.

7.4 Crucial requirements for modelling sector-specific policies

At this point we return to the association between sector-specific policies and bottom-up modelling. The opportunities for sector-specific policies have been spotted and assessed at the microeconomic level by bottom-up modellers, and it is essential to incorporate their insights into any unbiased assessment of the potential for such policies.

Because abatement so frequently involves changing capital equipment, sometimes quite radically, the bottom-up part of the assessment methodology concentrates on investment decisions. A prime example of bottom-up modelling is the ACF/ACTU paper entitled *Green Gold Rush*, but there is a lot of other evidence such as George Wilkenfeld's current work on water heaters. Relevant material at the firm level has been reviewed, including as an example the NIEIR study of stationary energy investment decisions in NSW. Similarly decisions in the electricity supply industry have been reviewed, though we should note the lack of long-term experience with the privatised industry.

The modelling respects the extreme importance of equipment replacement in abatement. This importance is due not only to the necessity to install new equipment in order to generate emission abatement, it derives also from the importance of equipment replacement in implementing innovation. As a result of these two factors the rate of improvement in industry energy efficiency depends on the rate at which new equipment is installed, a rate which is largely determined by industry prospects. However, some sector-specific policy instruments act directly on equipment updating including equipment standards, tax incentives, concessionary financing, infrastructure assistance and investment coordination.

The Intermediate scenario also includes substantial investment in transport infrastructure. It has been demonstrated in previous work that investment in transport infrastructure not only improves the productivity of the transport industry, but spills over into increased effective capacity in the industries which depend on transport. In the present study this return is estimated at 20 per cent a year on the on the cumulated additional gross investment in installed transport infrastructure capital stock. This amount is calculated, and spread across the effective capacity of the transport-using industries. The estimate of 20 per cent is conservative – the literature gives examples of effective returns of up to 100 per cent.

7.5 Abatement results

The Intermediate scenario generates much greater spending on decarbonisation than the Weak action scenario. The difference to the pattern of emission abatement is outlined in Table 7.3.

Table 7.3 Intermediate scenario, targets, domestic emissions and permit imports ($Mt CO_2e$)

	Allocation	Intermediate: domestic emissions	Intermediate permit imports	Weak action: domestic emissions	Weak action permit imports
2006	566	566	0	566	0
2015	500	500	0	582	82
2020	411	410	1	585	174
2025	335	335	0	583	248
2030	274	273	-1	579	305

Source: NIER modelling.

Both policy packages meet the abatement goal, but with a major difference: the Intermediate scenario is projected to meet the target without resort to permit imports, whereas the Weak action scenario requires permit imports which in 2030 run at the rate of nearly 2 per cent of GDP each year. This makes a substantial difference in a country which is running a balance of payments deficit of the order of 8 per cent of GDP each year. In addition, the Intermediate scenario moderates the demand for petroleum through its sector-specific policies for transport, which involve electrification (whether powered by gas or renewables), biodiesel and improvements in energy efficiency including a switch to rail coupled with main-line electrification, all of which reduce imports and benefit the balance of payments.

A comparison of key indicators is worthwhile. Under the Intermediate scenario, in 2030 47 percent of electricity is generated from renewable sources as compared with 18 per cent under Weak action. Coal fired electricity generation remains, but 100 per cent of the CO_2 so generated is captured and sequestrated, compared to 29 per cent under Weak action. Electric vehicles rise to 48 per cent of the vehicle stock (compared to 25 per cent) and 31 per cent of fuel sales are biodiesel (compared to 10 per cent).

7.6 The difference in domestic abatement between the Weak action and Intermediate scenarios

The reason for the high reliance on imported permits in the Weak action case is the lack of domestic abatement. The difference between domestic abatement in the Weak action and Intermediate scenarios reflects the following differences of response.

- Electricity generation: even with future emission prices known, there is a need for co-ordination of investment, particularly supporting investments in bulk transmission and system control, but also to ensure that new power sources are brought in and high emission sources scrapped without interruption of supply. Under the Weak action scenario there are substantial delays while generators make up their minds on investment and engage in strategic behaviour while bargaining for compensation. It is estimated that the acceleration of abatement in the electricity supply industry will account for approximately 60 per cent of the reduction in emissions in the intermediate as compared with the Weak action scenario.
- Domestic emissions: the slow market response to domestic energy efficiency opportunities can be much sped up by efficiency programs. Similarly for business emissions where the emission is incidental to business activity, as in offices. This accounts for around 10 per cent of the difference, and is important for yielding energy-efficiency benefits which increase household real incomes.
- Transport is an area which is notoriously unresponsive to price incentives, and where infrastructure investments and management are crucial – including roads and road management, rail lines, infrastructure for handling biodiesel crops, infrastructure for charging batteries on battery-electric vehicles. This accounts for around 6 per cent of the difference in abatement – but a crucial 6 per cent, since as will be explained below it reduces dependence on petroleum imports.
- There are difficulties in applying carbon pricing in a number of sectors, particularly land management and administration, yet these sectors have a number of promising sector-specific policies. Inclusion of these policies in the package accounts for over 15 per cent of the difference in abatement.

These reasons do not detract from the importance of carbon pricing, for three reasons:

- pricing undergirds the sector-specific measures – savings in carbon-price expenditures are an important practical selling point for most sector-specific measures;
- it provides an important criterion for assessing the costs and benefits of sector-specific measures; and

- it precipitates responses in areas not covered by sector-specific programs. For example, it is possible that the major effect of the price changes will be at a very general level in switching consumption from high-emission to low-emission activities, such as less transport and more telecommunications; less overseas travel and more education and local entertainment.

The two great benefits of accelerating domestic response in the Intermediate scenario are that it increases household real incomes and that it reduces reliance on imports of permits and petroleum. The increase in household real incomes from improved energy efficiency is immediate and real while the saving from reduced petroleum imports is macroeconomic in nature but crucial, given the balance of payments deficit. The saving in permit imports is also very important, and requires further discussion.

7.7 Risks in relying on permit imports

Despite significant restructuring in response to price changes, there is extreme reliance on imported permits in the Weak action case, compared to negligible reliance in the Intermediate scenario.

Not all governments are as relaxed about permit imports as the Australian government appears to be. For example, the UK Committee on Climate Change (UKCCC) in its report to Parliament in October 2009, recommended that emission targets from the non-traded sector (buildings, transport and less energy intensive industries) be planned not to be met from offset credits, that is imported permits (page 32). The Committee noted the EU policy framework allows up to 50 per cent of imported permits for the traded sector (energy intensive industries including power generation) but infers that any imported permits should be used as a buffer in the adjustment process and not to undermine the long term strategy of reducing domestic emissions.

The major argument for importing permits is the same as the argument for free trade. It does not matter where in the world abatement takes place, and countries where abatement is costly will find it advantageous to finance abatement in countries where abatement is low-cost – always provided that there is no double-counting (that is, that the abatement is counted only once in working out global abatement). By extension, countries with tight abatement targets may find it advantageous to buy permits from countries with relaxed abatement targets – though if the relaxed country has emissions below target these trades can take place without any emission abatement actually being achieved.

The first two arguments against relying on imported permits are macroeconomic in nature.

- Permit imports do not yield goods or services and are hence more akin to interest payments on debt than they are to regular imports. In order to pay for them, either export production must be increased (so crowding out production for domestic use) or imports of goods and services must be curtailed. In other words, they depress living standards. One has to be very sure that the domestic emissions which are thus bought are worth this price.
- The macroeconomic case against permit imports is particularly strong in countries subject to balance of payments constraint – in other words, countries like Australia. This point was argued in section 5.7, and is also reflected in the list of macroeconomic objectives (Table 3.4). Structural excess of this nature cannot be eliminated by a market-determined exchange rate but imposes a constraint on the level of income in afflicted economies – for a technical discussion of this see Appendix A. In such economies, relaxing the balance of payments constraint requires policies specifically directed towards increasing exports or curtailing imports. A policy of relying on permit imports is the precise opposite of this requirement.

In addition to the macroeconomic arguments, there are a number of concerns with permit imports which apply even in countries with balance of payments surpluses. These arguments are most acute in the circumstances contemplated in Chapter 4, where there is no international agreement on emissions trading but countries concerned about climate change are feeling their way towards a program of domestic abatement accompanied by trade and capital flow penalties for countries which do not, in their opinion, implement satisfactory abatement policies. As argued in Chapter 4, an indebted trade-dependent country like Australia will not be able to ignore the policies of such countries – and these policies include whether or not permit imports will be recognised as contributions to abatement status. Even if permit imports are recognised, it may turn out that the permits so recognised are limited in number.

Present experience with international trade in permits is not encouraging. Currently there are two trades, the semi-official trade under the Clean Development Mechanism of the Kyoto protocol and unregulated private trade. Permits in the latter trade are purchased chiefly by private businesses wishing to convince conservationist customers that their emissions have been offset and seem to be generated mainly by sequestration programs involving forests. There have been many allegations of malpractice in these programs and they are unlikely to be acceptable to pro-abatement countries unless the auditing can be much improved.

The Clean Development Mechanism was instituted as a trial form of international trade in permits, by which countries subject to Kyoto protocol caps could buy permits from lower-income countries which were not subject to emission caps by financing abatement projects. The chief problem here was that of additionality – were the projects actually abatement projects, or would they have taken place anyway? This question is in fact unanswerable, and the lack of an answer meant that the Clean Development Mechanism was not extended at the Copenhagen conference, and also that it is unlikely to be included in the approved programs of pro-abatement countries.

The position would change if a world treaty were concluded with abatement targets for all countries, complete with an international organisation to supervise the attainment of the targets. The treaty would not necessarily provide for international trade in permits – there is still opinion which favours each country attaining its own target – but if it did it nobody at this stage can predict the balance of supply and demand in such a market. This means that the international permit price is extremely uncertain. In particular, if a large number of developed countries opt to import permits rather than to implement domestic abatement, they could find the price climbing up a near-vertical supply curve.

In summary, both the price and availability of internationally-acceptable permits are highly uncertain. In the absence of a treaty, the question of permit trade will be decided by those nations which take the lead on abatement policy – and these nations may or may not allow permit trade to enter into their calculations of whether or not to impose sanctions. It is quite probable that, on the precedent of the EU tradable permit scheme, trade will be limited to the participating nations – in which case the price will depend on target achievement by the nations concerned. If Australia remains outside the group, it will be subject to whatever trade and capital flow disadvantages the group imposes; if it enters, it will have to accept an abatement target (and we have argued that the targets in this report are optimistically high) and also pay the emission price generated with the group.

In the presence of a treaty, the supply of permits may be a little more predictable, but is still highly uncertain. Prices could easily be volatile. However, there is an argument for including trade in permits in an international treaty as a means for transferring resources from the wealthy countries (with their accumulated responsibility for past emissions) to the low-income countries.

In short, Intermediate scenario policies reduce the cost of abatement by speeding otherwise lethargic market responses to the abatement opportunities opened up by carbon pricing. As modelled, the difference is considerable and avoids the substantial (though slightly deferred) cost of catch-up action.

7.8 The macroeconomics of the Intermediate scenario

The obvious use of the reduction in import requirements under the Intermediate scenario would be to reduce the balance of payments deficit. The chief argument for this would be the resulting reduction in the extent to which Australia has to accept the dictates of overseas financiers – remembering that in future such financiers are less likely to be American or British than they were over the past two centuries, and hence less likely to be sympathetic to Australian aspirations. However, in the present study we are comparing policy packages and have adopted the rule that, in all scenarios, the balance of payments should target the ratio of international debt to GDP. The reduced import requirement under the Intermediate scenario has several important consequences.

- In view of the improvement in the underlying balance of payments, overseas lenders will have greater confidence in lending to Australia, and the terms and conditions of lending are likely to be less severe. In particular, the Australian real interest rate can be slightly lower.
- After the first few years, the slightly easier availability of imports will assist in producing a lower inflation rate, hence permitting a less restrictive fiscal policy and monetary policy.
- The rate of growth of incomes is not quite so constrained by the necessity to curb non-permit imports so as to maintain a sustainable balance of payments. This will permit household incomes to grow more rapidly than under the Weak action scenario, and similarly employment.
- Not only this. A greater proportion of the abatement effort can be financed from overseas investment.
- The combination of slightly faster economic growth and slightly lower interest rates improves business profitability, and so encourages private business investment, contributing in its turn towards the higher rate of GDP growth.
- Similarly, the greater improvement in household energy efficiency releases resources for consumption.

These consequences are of the utmost importance for the financing of the Intermediate scenario program. Remember that the program envisages additional expenditures on decarbonisation of $463 billion over and above the expenditures of $328 billion expected to be committed as a result of carbon pricing in the Weak action case. Table 7.4 shows how it is envisaged that these expenditures will be financed in the Intermediate scenario.

Table 7.4 Sources of finance for decarbonisation, $bn

Source of finance	2011-2020	2021-2030
Reduction in household energy expenditures	21	53
Increase in household saving	160	-428
Decrease in government non-decarbonisation expenditures	32	-13
Reduction in oil imports	59	181
Reduction in permit imports	34	240
Other including price effects, investment diversion and overseas resourcing	-77	202
Total gross investment	**229**	**234**

Source: NIEIR modelling.

The additional decarbonisation investment envisaged in the Intermediate scenario is more or less equally distributed between the 2010s and 2020s. In both decades it is to a degree self-financing from three sources:

- a reduction in household energy expenditures. The various sector-specific programs mean that, compared to the Weak action case, households do not have to spend as much on energy (remembering that energy prices are similar in the two scenarios);
- a reduction in oil imports. The sector-specific programs reduce expenditure on oil, which releases resources via an improvement in the balance of payments. This also reduces Australia's exposure to the risks inherent in world oil markets; and
- a reduction in permit imports. The sector-specific programs reduce permit imports to negligible levels, which not only reduces Australia's exposure to the risks inherent in permit markets, but releases resources via an improvement in the balance of payments. In the 2020s this release of resources is significant – indeed, it can fund the whole investment program during that decade.

Despite this inbuilt self-financing, the program of decarbonisation investment has to be kick-started. In the Intermediate scenario two sources of funding are envisaged.

- Diversion of government funds to the decarbonisation program involves a cutback in other government expenditures. However, by the 2020s this kick-start funding can be paid back out of the higher rate of income growth and government non-decarbonisation expenditures increase to a higher level than in the Weak action scenario (hence the negative sign in Table 7.4).
- More important, a decrease in household non-energy non-decarbonisation expenditures can be roughly paraphrased as an increase in household savings, in addition to the increase which already occurs in the Weak action scenario. It is arguable that this increase in household savings will occur as a consequence of the present high level of household debt. In this case, it is a strength of the scenario that it provides an outlet for the expected increased level of savings which is likely to occur – for example, by a combination of continued contributions to National Superannuation, debt repayments and a reduction in household borrowing. On this interpretation, the higher level of consumption during the 2010s in the Weak action scenario may be hard to attain, even though it is necessary to maintain aggregate demand in that scenario. Alternatively, if consumers attempt to return to the buoyant demand patterns of the 2000s, an increase in saving could be imposed by rationing of consumer finance. Whether or not the increase in household savings during the 2010s occurs as natural household behaviour or is perceived as a sacrifice, it has its reward: during the 2020s the higher rate of income growth in the Strong action scenario means that the need for kick-start funding will abate and consumers will be able to increase their expenditures significantly.

One further factor is required to balance the resourcing of decarbonisation in the Intermediate scenario.

- During the kick-start phase the Intermediate scenario generates a small increase in inflation, which is quickly moderated so that over most of the projection period the inflation rate is less than in the Weak action scenario. Similarly it generates a small initial increase in international debt, which again is quickly turned round. As a result of these changes, the overseas sector and pricing effects make a negative contribution to the kick-start, but during the 2020s turn around and make a substantial contribution to the financing of decarbonisation.

By the nature of the policy package, the Intermediate scenario includes a higher level of gross investment than the Weak action scenario. Some of this is financed as part of the intermediate policy package, but (particularly in the 2020s) much of it is induced by improved profitability and also by the reduction in inflation and interest rates which jointly result from

the reduction of the balance of payments deficit in the Strong action scenario. This follows the 'Taylor rule', by which business investment reflects retained profits adjusted for inflation expectations.

An important result, deriving largely from the lower level of permit imports under the Intermediate scenario, is that the combination of sector-specific policies with carbon pricing is expected to generate more jobs and more hours of work than Weak action. It is true that neither scenario yields an increase in the jobs to population ratio – fundamentally this reflects the overhang of the boom and the depressive effect of large debt accumulations, neither of which are directly relevant to the policy choice regarding emission abatement. However, it is also true that the task of job-generation is relatively hard in when expenditures switch towards industries with low job to value added ratios, as on balance they have to do to provide the investment program required by emission abatement. In these circumstances the important result is that Strong action offers more jobs than Weak action, especially after the kick-start phase, or from 2015 on.

7.9 Sector-specific policies without carbon pricing?

The superior performance of the Intermediate scenario over the Weak action scenario again raises the question of whether it is necessary to include carbon pricing in the package. We have already alluded to the reasons, which may be summarised as follows.

- In the context of a policy package which includes sector-specific measures, carbon pricing provides an incentive to abatement in areas not covered by sector-specific policies, and reinforces the incentive in areas that are covered.
- Carbon pricing also provides a standard for the assessment of sector-specific policies, so that policies which are not cost-effective at the going emission price can be abandoned and those which are cost-effective promoted.
- Most – perhaps all – sector-specific measures depend for their effectiveness on the existence of carbon-pricing in the background. Thus an important consideration in selling energy-efficiency measures to households and small business is the avoidance of carbon price costs. Similarly negotiations for the restructuring of the electricity supply industry will crucially depend on expectations of the carbon price.
- As international negotiations progress, it is quite likely that the domestic carbon price will be adopted as indicator of a country's seriousness about emission abatement and hence as a criterion for trade sanctions or benefits. If this happens, Australia will have little option but to impose carbon pricing.

In theory it might be possible to come close to replicating the Intermediate scenario using only sector-specific policies – after all, this is how total mobilisation was managed during World War II. However, carbon pricing and sector specific policies are in practice so highly complementary that it makes little sense to try one without the other (see also 3.22 above).

7.10 Employment

Comparing the Weak action and Intermediate scenarios, the period from 2010 to 2015 is one of structural adjustment with employment gains in green industries offsetting losses mainly in services – for example, retail employment will grow less rapidly as households rebuild their savings and so make fewer consumer purchases than they would under the Weak action scenario. Employment growth is projected to average 1 per cent a year in terms of hours, or 1.3 per cent a year in terms of jobs (less overtime, more part-time) – the same as in the Weak action scenario. The Intermediate scenario also features a real wage pause – money wages go up as rapidly as in the Weak action scenario, but inflation is a little higher. In the Weak action scenario the average real wage rate in 2015 is approximately 2 per cent above 2010, whereas in the Intermediate scenario it is approximately 2 per cent below. This divergence reflects the cost of kick-starting the abatement program.

From 2015 onwards the benefits of structural adjustment start to accrue, and employment grows more rapidly in the Intermediate scenario – slowly at first, but rapidly in the decade from 2020 to 2030. By 2030 employment is 28 per cent greater than in 2010, as compared to 23 per cent greater under the Weak action scenario. This extra growth in employment is accompanied by growth in real wage rates. In the Intermediate scenario, the average real wage rate also starts to rise in 2015. It increases rapidly at first in order to restore wages to 2010 levels (this is achieved by 2017 or so) and later to surpass the real wage levels achieved in the Weak action scenario, which is achieved in 2020. From 2020 to 2030 real wages grow more rapidly in the Intermediate scenario, and by 2030 the average real wage rate is 4 per cent above that applying in the Weak action scenario. The Intermediate scenario generates both higher employment and higher real wages than the Weak action scenario. These increases are a minimum – in the Strong action scenario we will demonstrate that larger increases are possible in both employment and real wages.

7.11 Comparison with other studies

Chapter 6 included a detailed comparison of the Weak action scenario with various previous Australian studies, prepared by the Treasury. Despite the existence of good bottom-up studies, they do not extend to the macroeconomic level, and to our knowledge there have been no Australian studies comparable with the Intermediate scenario, or with the Strong action scenario to follow in Chapter 8.

7.12 Conclusion

Given the complementary nature of carbon pricing and sector-specific policies, it should occasion no surprise that the performance of a policy package which combines both is considerably superior to reliance on carbon pricing alone. Admittedly the combined policy package requires investment in a kick-start, but once this is accomplished it yields more rapid growth in both incomes and consumption. It also avoids the pitfalls of reliance on permit imports – a reliance which detracts directly from domestic demand (hence reduces incomes) and is also highly risky, given the uncertainties of international developments.

8. The Strong action scenario

In the Weak action scenario the carbon price provides the main motive for emission abatement. In the Intermediate scenario we added sector-specific programs which address the need for investment in abatement. We found that, after an initial pause, the policy package assessed in the Intermediate scenario generates significantly higher employment and incomes than the Weak action scenario.

As was pointed out in Chapter 7, sector-specific policies represent a departure from the principle which has dominated Australian economic policy over the past thirty years – the principle that economic choices, particularly investment choices, should be 'left to the market'. Five groups of sector specific policies were included in the Intermediate scenario – household energy efficiency, commercial building energy efficiency, electricity industry strategy, transport strategy and the land use and rural program. Each sector-specific policy package included measures to counter adverse distributional consequences of carbon pricing and, more important, to speed market responses. The packages relied on the market – carbon pricing was still central – but assisted it by countering various problems of information, agency, co-ordination and risk-allocation. However, in the Intermediate scenario the departures from present market-centred abatement policies were limited to the opportunities revealed by the bottom-up analysis of abatement potential, complemented and supported by a return to multi-objective macroeconomic policy. This raises the question of whether the principle of assisting the market should be extended more generally.

This report is not the place for a thoroughgoing critique of the economic policies pursued in Australia over the past three decades. It has perforce concentrated on the limitations of the market-only approach to emission abatement. However it is worthwhile to consider two areas in which reform is urgently needed and how these areas are related to emission abatement. The two areas are production policy and financial sector reform.

8.1 Production policy reform

By production policy we mean measures which affect the industry composition of the economy, particularly changes in this composition – and hence the main means by which changes are brought about, investment in equipment, buildings, technologies and people. The principle evidence for the deficiencies of Australian production policy is the balance of payments deficit, which indicates weakness in the production of tradeable goods and services and corresponding excessive concentration in the production of non-tradeable goods and services. This is a matter of balance, and the world has instances of economies which are in trouble from excessive export-orientation, notably Japan and potentially China. It also has economies which are in trouble from excessive import orientation, notably the USA. Though Australia kids itself that it is borrowing to support resource development, the real reason for the high level of international borrowing is to support consumption – and this, to say the least, is imprudent, and is linked to the low level of national saving.

The touch-stone of production policy over the past three decades has been competition policy, the assumption being that all will be well if markets are competitive. Much effort has been expended on competition reviews, which have usually been directed against government regulation rather than against private monopolies or oligopolies. The bias of competition policy against regulation rather than against oligopoly is not surprising, since the most significant private institutions which restrict competition are multi-national corporations. Australian governments are not in a position to split such corporations and instruct them to compete. This is not to argue that competition policy has been completely misguided, but rather that it has been a distraction from the main game, which is how to get a foothold in emerging tradeable-goods industries. Competition policy has encouraged a static view of the economy, according to which everybody knows what they are doing and will do it more efficiently if they are required to compete. By contrast, production policy should take a

dynamic view, in which industries are preparing for an uncertain future – one which is all the more uncertain due to climate change.

In this uncertain world, tradeable goods and services are of particular concern, since it is here that competition is intense. There is no need for competition policy when small businesses based in different countries are competing; similarly competition policy does not address the terms under which the national subsidiaries of multi-national corporations compete with equivalent units in other jurisdictions for a place in the overall production strategy of the corporation – with many in-between types of competition. What is required here is a shift from competition policy to a concentration on measures well-known at the local level – the type of measures familiar to every shire-council economic development officer, yet strangely overlooked by policy-makers at the national level. The measures concern transport, utility and telecommunications infrastructure, production sites, finance and the availability of skilled workers at a fair wage.

Production policy is highly relevant to emissions abatement, since the investment required for abatement will be roughly equally divided between non-tradeable construction and highly tradeable equipment and service technologies. Major new world industries are going to grow based on emission abatement technologies – industries which Australia cannot conceivably dominate, but in which it can hope to find more than a few profitable niches. Production policy is of particular importance in the fostering of new industries, hence the opportunities which are arising as a result of emission abatement.

It is notable in this context that China, South Korea and Japan have each instituted production policies which will result in their dominating world production in many of the abatement technologies. The USA has lost its technological leadership in many of these areas and is so mired in financial crisis that it will be very difficult for it to regain its lead. Australia had a promising research base in several of the areas, but is conspicuously failing to foster this base or to grow even small parts of it into world-class production.

This report makes no attempt to assess the benefits of refocussing production policy from the statics of competition to the dynamics of fostering new industries, except for measures directly related to emission abatement. The proposal is accordingly that the opportunities for production of tradeable goods and services inherent in the sector-specific measures should be assessed and production policy applied. The intention would not be to reserve the production of tradeable inputs to emission abatement investment for domestic producers, but rather to develop a limited number of world-competitive production units, either as locally owned firms or as units within multi-national businesses. The means employed would be essentially local – a national underwriting of the economic development policies pursued by local and state governments.

Expenditure on industry policy is treated as an investment with a return of 10 per cent a year, calculated on cumulated gross investment. This is allocated to capacity increases in the target industries.

8.2 The industry policy dimension of the Strong action scenario

The difference between the Weak and Intermediate scenarios revolves around the issue of imported permits. The Intermediate scenario has zero import of permits, while the Weak action scenario relies on an import of permits to achieve the same CO_2 target.

The Strong Action scenario relies on aggressive use of income trade-offs, tax policy and superannuation policy to mitigate the inflationary impacts which are prominent in the Intermediate scenario, in particular in the early years. The extent of success of the policy can be seen in the different inflation rates in the two scenarios.

The other policy difference in the Strong Action scenario is the integration of industry policy into the direct CO_2 abatement expenditure effort to ensure maximum local content and export leverage flow-on, much along the same lines as is currently being implemented by the North

Asian economies and by China in particular. Competition from these countries will be intense but with world markets expanding rapidly Australia will have opportunities to secure niche markets for very high value added technologies.

The key to understanding the difference between the Intermediate and Strong Action scenarios is the additional stimulus given to specific industries. This is shown in Table 8.1, divided into import replacement and export expansion investment. The total additional investment is $340 billion in 2007 prices, $190 million of which is for import replacement. The result is a decrease in the import share of abatement gross investment of approximately 20 percentage points compared to the Intermediate scenario. The leveraged flow-on in terms of exports is achieved at the rate of 80 cents in the dollar for import replacement investments.

To achieve this all relevant Australian research institutions would have to become involved to ensure sufficient potential Australian innovation to take advantage of the commercial opportunities included in the Strong Action scenario. This would require the total commitment of a whole of Government approach.

Table 8.1 Additional direct CO_2 abatement expenditures allocated to domestic industry – $2007m

	Import replacement				Export expansion				Total			
	2015	**2020**	**2025**	**2030**	**2015**	**2020**	**2025**	**2030**	**2015**	**2020**	**2025**	**2030**
Basic chemical manufacturing	153.2	485.1	510.6	514.7	1.0	87.9	273.9	306.4	154.1	573.0	784.6	821.1
Other chemical product manufacturing	153.2	485.1	510.6	498.4	1.0	87.9	273.9	306.4	154.1	573.0	784.6	804.7
Structural metal products manufacturing	153.2	485.1	510.6	522.9	1.0	87.9	273.9	306.4	154.1	573.0	784.6	829.3
Sheet metal product manufacturing	153.2	485.1	510.6	514.7	1.0	87.9	273.9	306.4	154.1	573.0	784.6	821.1
Fabricated metal product manufacturing	245.1	776.1	817.0	830.1	1.5	140.6	438.3	490.2	246.6	916.8	1255.3	1320.3
Motor vehicle and part manufacturing	1147.5	3633.8	3825.0	3702.6	11.5	705.7	2052.1	2295.0	1159.0	4339.5	5877.1	5997.6
Photo and scientific equipment manufacturing	153.2	485.1	510.6	502.5	1.0	87.9	273.9	306.4	154.1	573.0	784.6	808.8
Electronic equipment manufacturing	245.1	776.1	817.0	810.5	1.5	140.6	438.3	490.2	246.6	916.8	1255.3	1300.7
Electrical equipment and appliance manufacturing	306.4	970.2	1021.2	1051.9	1.9	175.8	547.9	612.7	308.3	1146.0	1569.1	1664.6
Industrial machinery and equipment manufacturing	704.7	2231.4	2348.9	2372.4	4.4	404.3	1260.2	1409.3	709.1	2635.7	3609.0	3781.7
Wholesale trade	183.8	582.1	612.7	612.7	1.1	105.5	328.7	367.6	185.0	687.6	941.5	980.4
Business services	612.7	1940.4	2042.5	2022.1	3.8	351.6	1095.8	1225.5	616.6	2291.9	3138.3	3247.6
Total	**4211.2**	**13335.6**	**14037.4**	**13955.3**	**30.6**	**2463.6**	**7531.1**	**8422.5**	**4241.9**	**15799.1**	**21568.5**	**22377.8**

Note: Zero allocations assumed for other industries.
Source: NIEIR modelling.

8.3 Financial sector reform

In advanced economies, the financial sector has two major roles.

- Arranging and accounting for the transactions which take place as goods and services are bought and sold.
- Acting as an intermediary between savers and investors, where both saving and investment are defined in their economic sense. (People and institutions save when they forgo expenditures which they could finance from current income; people and institutions invest when they acquire buildings, equipment, technologies or any other physical or intellectual assets which are expected to yield future income.)

The main complaints against the performance of the Australian financial sector in facilitating transactions concern bank fees, and are relatively minor. There is much greater cause for concern about the financial sector's performance as an intermediary. The evidence for poor performance is as follows.

- The low level of household saving. In particular, the National Superannuation Scheme was supposed to increase household saving to generate funds for investment (in the economic sense) but manifestly failed to do so, since households maintained their consumption by borrowing.
- The high level of household debt. Much of this debt was incurred on mortgage, and so is associated with the purchase of housing. Though better shelter contributes to well-being, an important effect of the high level of mortgage lending has been an increase in the price of residential land. Not only has this led to a crisis of housing affordability; home-owning households have interpreted the increase as a capital gain, hence an increase in wealth, hence a justification for increased consumption and therefore a contributing cause of the low level of saving.
- The high level of international debt on finance sector balance sheets, which results from finance sector institutions borrowing overseas and thus financing the balance of payments deficit. In the process, the sector has failed to foster domestic saving, and has come to rely on overseas lenders at levels which are scarcely prudent. This reliance generates high interest rates.
- The low flow of funds to investment (in the economic sense). The finance sector will claim that this is due to lack of demand, but business will reply that interest rates are too high to justify borrowing. It is also relevant that governments have scaled back their infrastructure investments, largely for ideological reasons (see production policy, above) but also because interest rates are too high to finance infrastructure investments.

In other words, the financial sector has not been performing its primary intermediary role. Instead, it has been facilitating the flow of funds from overseas lenders to Australian consumers. It is worth pointing out that this failure is not the result of misbehaviour of any particular financial institution. It has instead resulted from the system design introduced with financial deregulation. The Commonwealth has failed to counter this downside of deregulation due to the short-term political benefits of allowing consumption to rise above income while kidding the population that this is safe because it is supported by asset values.

It may seem churlish to accuse the Australian financial system (as a whole, not any particular component) of failing in its fundamental rationale at a time when it is congratulating itself that it survived the 2008 financial crisis without the need for a government bailout. However, it will be noted that the proximate cause of the US/UK financial meltdown – indulgence in derivatives – is not on the list of problems outlined above. It should also be remembered that the list of problems is not dissimilar to some aspects of the recent performance of the US financial sector, where overseas borrowing has also flowed through to consumption. During the boom there were two differences between Australia and the US – the role of derivatives

and the heavy American reliance on government overseas borrowing as contrasted with the Australian reliance on borrowing by private banks. However, the similarities, in particular the high level of overseas debt, will mean that the Australian financial system cannot be isolated from any international financial reforms which take place.

As at the time of writing, the system is in suspended animation. Within the US and Australian financial systems, the high levels of anxiety generated in 2008 have been converted by government stimulus into a revival of confidence and an expectation that business can continue as usual. However, the fundamental question as to whether the financial system is earning its keep by gathering savings and distributing them to worthwhile investments is still open. What's more, the balance of power has changed, and China is in a much better position to dictate terms. Nobody yet knows what its terms will be, but it is certain that the restructuring of international finance which began in 2008 is not yet played out.

In these delicate international circumstances, there is a strong case for reorienting the Australian financial sector back towards its fundamental task of gathering domestic savings and lending to finance domestic investment, including investment in infrastructure. This will involve solving the conundrum that high interest rates are required by the balance of payments deficit, but low rates are appropriate to infrastructure lending – a problem which is not for a report on emission abatement. The relevant point here is that necessary financial sector reforms may be expected to improve the flow of funds to investments in production complementary with emission abatement. In this report we confine ourselves to financial measures to underpin the response to investment opportunities created by the abatement program.

8.4 Specification of the Strong action scenario

The Strong action scenario comprises all the policy programs incorporated into the Intermediate scenario (carbon pricing and the five groups of sector-specific policies) plus one more.

- ***Targeted regional investment and industry planning***

  Rationale: For most of its two centuries of economic development, Australia followed a mild form of targeted regional investment and industry planning, mainly through the planning of infrastructure investment and education policies at the state and territory level. Over the past thirty years this tradition was abandoned on the grounds that competition plus the oversight of the finance sector would provide a superior result. The emphasis on competition undervalued the returns from cooperation between businesses and authorities at the regional level, and the capacity of the finance sector to manage risks was overestimated – hence the case for a return to an updated form of the traditional policies.

  Program content: public investment in infrastructure for clean industry and innovation hubs particularly focused on regional areas and strong green up-skilling of the workforce. The public investment will be conducted in conjunction with private investment and may take forms such as incentives and sharing of risks.

  Benefits: This program is not expected to yield direct abatement benefits, but is included in the Strong action scenario because it is complementary to both the sector-specific and the carbon pricing policies. It is expected to have particular benefits in reducing import requirements and increasing export opportunities (both important in the context of a constrained balance of payments) and also in maximising job generation from the business opportunities arising in the course of abatement.

The aim of the program would be to generate employment and wage income in Australia from the opportunities arising as a result of the other abatement policies. In the Intermediate scenario it was assumed that inputs required for emission abatement would be sourced as they are now – in other words, construction activity would be sourced locally but items such

as renewable electricity generation equipment, electric vehicles and operational software would in the main be imported, as they are now. Essentially the scenario adds jobs and wage income by reducing the net import content of the abatement program – a task which may be achieved not so much by reducing imports as by increasing the exports which spin off from the abatement program.

The opportunity arises because the Australian abatement program, in the context of similar programs proceeding more or less rapidly in all countries overseas, will give rise to new industries and new technologies. The history of industries and technologies points to the existence of first-mover advantages. It is not for governments to spot these opportunities, but they can improve the chances that businesses which spot the opportunities will locate in their jurisdictions and generate employment and income by measures such as the following.

- Support for research, development and demonstration, including support for the development of export markets. Support can be provided in cash (subsidies, tax incentives) or by services.
- Provision of infrastructure – transport, utilities, telecommunications.
- Provision of an appropriately-educated workforce though education and training.
- Attraction of appropriately-educated workforce to locations where they can work together by provision of urban and rural infrastructure.
- Ensuring that finance is available for developing industries, particularly those associated with abatement. Provision of such finance is primarily a duty of the finance sector, as is the encouragement of national saving. As the recent financial crisis has demonstrated, the finance sector has a special relationship with government. The suggestion here is that the relationship should be re-thought to improve the financing of industry development opportunities.

These issues have been debated in Australia ever since the mid nineteenth century. As pointed out at the beginning of this chapter, policy in this area is a matter of balance. In the past there have been occasions when export industries were over-promoted – as occurred with some of the irrigation projects of last century. Similarly there have been occasions when import-competing industries were over-protected. However, the balance has now swung the other way, and Australia has failed to generate new trade-exposed industries to the extent necessary to keep its balance of payments under control.

As with sector-specific policies, it is possible to point to experience as justification for targeted regional investment and industry planning. Cases in point are as follows.

- The experiences of the Australian states, especially their investments in education, transport and utilities up to the 1960s.
- The experience of the ‘corporatist’ countries. Though there is no guaranteed approach, industry development has assisted in generating jobs and incomes in a great many countries.

Like the sector-specific measures, regional investment and industry planning has a kick-start cost which must be provided by governments. However, much of the program could be implemented by reallocation within existing budgets and by regulation without budgetary cost. An example of rebalancing would be tax encouragement for research, development and demonstration in industries producing tradeable goods and services, financed by increased taxation of industries outside the tradeable sector. The scenario requires an increase of approximately 1 per cent in expenditure on industry support, compared with the intermediate case, over the decade 2010 to 2020. Expenditure on household support is also required, over a slightly longer period (2010 to 2025).

8.5 Scenario macroeconomics

A government kick-start and an ongoing increase in planning and industry development activity underpin an increase in equipment and construction gross investment compared to the Intermediate scenario, largely in manufacturing and particularly in the period 2015-20. Much of the equipment is imported, and imports therefore increase compared to the Intermediate scenario in the period 2015-20. However, the investment generates an increase in exports, particularly from 2020 onwards. The result is less stress on the balance of payments, with a number of benefits.

- As a result of the improved balance of payments position, government does not have to borrow as heavily as in the Intermediate scenario.
- The inflation rate falls, which assists in generating further investment.
- Interest rates fall, with similar effect.
- Both household and government consumption can increase more rapidly than in the intermediate case.

8.6 Employment effects

As in the intermediate case, the benefits to the workforce are divided between real wages and employment. The benefit to employment is most pronounced during the decade from 2015 to 2025. During this decade, growth in total employment in the Strong action scenario results in jobs and hours worked in 2025 rising to 2 per cent above the Intermediate scenario, which in turn is 2 per cent above the Weak action scenario. For this period, the Strong action scenario thus generates over 4 per cent more jobs than the Weak action scenario.

In the same vein, from 2015 to 2025 the Intermediate scenario generates a rise in real wages of nearly 3 per cent above the Intermediate scenario, on top of the 5 per cent difference between the Weak action scenario and the Intermediate scenario. For this period, the Strong action scenario thus generates increases in the average real wage approximately 7.5 per cent above the Weak action scenario. As a result of the combined increase in real wages and employment, households are able to increase both their savings and their consumption, which during the decade 2015-2025 increases by 5 per cent more than in the Intermediate scenario and by 16 per cent more than in the Weak action scenario.

As already noted, the Strong action scenario does not do away with the need to kick start the abatement process during the period from 2010 to 2015. However, it increases employment growth during that period, and hastens the time when consumption exceeds the levels attained under the Weak action scenario.

8.7 Conclusion

As in the Intermediate scenario, we do not compare with business as usual. All scenarios have the same global emissions allocation for Australia and the difference between the runs is purely how we respond. Weak action involves the passive imposition of carbon pricing with the inevitable shortfalls in abatement met by importing the required permits along with continued high oil imports. Strong action involves adaptation as quickly as possible to the required low carbon world including spending an extra 0.5 trillion to transform the economy. Will some regions lose employment compared to the case where climate change wasn't a reality? – certainly. But this is not reality. There is no reason to bother with it.

Will Australia's key exporting regions lose employment compared to recent expectations? Maybe, but this will be because of what happens overseas, not because of domestic policies. In all scenarios these industries get back all direct and indirect carbon price costs. Whatever happens to these industries is in the Weak action case and therefore lies outside the impacts measured in this study.

This report comes to a very simple, common-sense conclusion: a Strong action emission abatement strategy, in which carbon pricing is augmented by sector-specific policies and strengthened by policies to help citizens take advantage of the resulting opportunities will generate more jobs than a Weak action strategy which confines itself to carbon pricing and permit imports. Economic restructuring is necessary, and it is better to tackle it head-on, with determination. There will be immediate costs, but the Strong action set of policies can be relied on to yield returns remarkably quickly – not only nationally, but in all regions.

These conclusions should not surprise anybody. When it is necessary to carry out structural change, the cost is minimised when all relevant policies are melded into a consistent package. In the augmented and Strong action scenarios, melding is accomplished by reference to a carbon price, which becomes the driver of policy design. This does not preclude carbon pricing from having a direct influence on business and household decisions, but allows the adoption of a range of cost-effective sector-specific policies designed to speed the response.

9. Green employment creation from CO_2 emissions reduction expenditures

Over the recent past many studies have produced claims of large scale green employment creation potential that stem from aggressive CO_2 reduction.

The objective of this section is to develop and apply a transparent methodology for estimating green employment generation.

9.1 Net additional versus gross increase in green employment

Most studies calculating the green jobs created from CO_2 abatement assume that all the expenditure increases add to both demand and production, so that expenditures on abatement simply add to existing consumption and investment expenditures. However, for many economies constraints over the longer haul at least will require increases in gross investment financed by increases in saving.

If all expenditures are net additional, the green jobs created can simply be obtained from input-output multipliers. There are two types of multipliers. Firstly, Type I multipliers which apply the expenditures to an investment input-output table of the economy and work out the total employment increases that will result from industry supply chain support for the expenditures. Type II multipliers incorporate the consumption flow-on benefits that are created from the household income generated from industry supply chain expansion to support the CO_2 reduction expenditures.

In this study a clear distinction is made between gross green employment and net additional employment. Whatever the constraints on the economy, it is a fact that if the CO_2 reduction expenditures are to be realised, the Type I employment multipliers must represent the increase in green employment that is generated by the CO_2 reduction expenditures. Whether or not this gross green employment represents a net addition is another matter, depending on the macroeconomic constraints in the economy in which the CO_2 reduction expenditures are inserted. Where there are capacity constraints, additional green employment will tend to crowd out other employment.

9.2 Gross green employment estimates: The methodological framework

Instead of the traditional input-output analysis specified in value terms, the analysis of this section is constrained on the basis of employment flows. It uses average employment output ratios from the Australian Bureau of Statistics' latest input-output tables. An input-output matrix is created along the following lines.

$$\begin{pmatrix} e_{1,1} & \cdots & e_{1,106} & e_{1,107} \\ \vdots & & \vdots & \vdots \\ \vdots & & \vdots & \vdots \\ \vdots & & \vdots & \vdots \\ \vdots & & \vdots & \vdots \\ e_{106,1} & \cdots & e_{106,106} & e_{106,107} \end{pmatrix}$$

Where:

$e_{i,j}$ = employment created in industry i and a result of sales generated by industry j for industry i.

There are 106 indicators in the input-output table and in this study with the 107th industry representing fund demands (household and government consumption, investment, etc.).

If:

$$ec_{i,j} = e_{i,j} / e^{t}_{i}$$

Where:

e^{t}_{i} = total employment in industry i,

Then the gross green employment generated by the CO_2 reduction expenditures is given by:

$$\boldsymbol{eg} = [I - \boldsymbol{E}]^{-1}\, \boldsymbol{egd} \qquad (9.1)$$

Where:

eg = 106 * 1 vector of gross green employment.

egd = 106 * 1 vector of direct employment creation by the CO_2 reduction expenditures.

E = 106 * 106 vector of the $ec_{i,j}$.

Table B.2 gives the direct assignment of employment for 2025 that is directly generated by the CO_2 reduction expenditures in each scenario as well as the gross increase estimated by applying equation (9.1).

It should be noted that the Strong scenario includes the direct import replacement and export flow-on expenditures which are directly related to industry enhancement built on the platform of the CO_2 reduction expenditures.

This process was applied at a detailed level, and the resulting tables are long. They will be found in Appendix B: Table B.2 gives green employment by occupation and Table B.1 gives results by scenario.

9.3 Gross green jobs and net additional employment

A comparison of Table 9.1 with Table 3.3 shows the extent to which additional gross green employment represents net additional employment. For the Intermediate scenario, by 2030 from Table 3.3, net additional employment is 420,000 as against 368,000 gross green employment. This means for the Intermediate and Strong scenarios all gross green employment is net additional.

However, as Table 9.2 indicates, this is not the case in the early years when very little of the gross green employment is net additional. It is only when the productivity, energy savings and cost saving benefits of earlier expenditures are realised that high levels of additional green employment also represents high levels of net additional employment.

Table 9.1 Time series employment for total green employment income ('000)

	2015	2020	2025	2030
Weak scenario	149	168	135	137
Intermediate scenario	324	279	361	368
Strong scenario	361	447	626	655

Source: NIEIR modelling.

Table 9.2 Gross green employment – net additional ratio (per cent)				
	2015	**2020**	**2025**	**2030**
Intermediate scenario	7.1	35.2	73.9	100.0
Strong scenario	14.7	53.0	89.8	100.0

Source: NIEIR modelling.

10. Regional effects

The results of the regional model are given in Appendix G. Major results for selected regions are given in the Executive Summary.

The first step in preparing the regional projections was to allocate a share of all the additional gross investment and associated green employment, as per the last chapter, to each region. Household gross investment was allocated to regions on the basis of the CO_2 intensity of households as estimated in the NIEIR/ALGA "*State of the Regions*" report for 2008-09. Similarly, the analysis in the same *State of the Regions* report estimated the direct and indirect CO_2 content of production by industry by region. This was used to allocate national gross investment on CO_2 abatement for each industry.

Additional renewable energy capacity was allocated to regions on the basis of the Climate Institute/MMA report into the regional employment consequences of renewable energy production of March 2009. Biodiesel production was allocated to marginal agricultural regions stretching from Queensland to South Australia. Land management expenditures were allocated to regions on the basis of the suitability of current agricultural production to soil management and their suitability for forestry activity.

Industry demand was allocated on the basis of current and projected regional concentrations of clusters of the relevant industries. Special regional development initiatives were assumed for regions adversely affected by CO_2 abatement, including effects from domestic markets (such as the loss of coal-powered power stations) and foreign drivers such as loss of export markets.

Finally, the macro-economic benefits were allocated to regions in accordance with:

(i) the price impact on household disposable incomes;

(ii) energy cost savings as per CO_2 intensity;

(iii) the specific industry impact of exchange rate changes etc. ; and

(iv) tax and interest rate changes through their effect on regional incomes.

The total outcome was based on the impact of these direct effects on each individual region modified to take into account the regional input-output structure and the trade flows between regions for each industry.

The Strong action scenario generated more employment than the Weak action scenario. This employment was widespread – all regions could benefit, for two reasons.

- Opportunities for investment in abatement occur in all regions.
- The sector-specific programs and the targeted regional investment and industry planning programs generate a large amount of footloose investment which can be directed to regions where it is needed to replace employment in industries which decline as a result of the abatement policies.

The Strong action scenario, in particular, generates 770,000 more jobs (and corresponding income, including capital returns) than the Weak action scenario, which makes it most unlikely that any major region will generate less employment. It should, however, be acknowledged that isolated local government areas may be negatively impacted. A precedent would be the negative impacts on towns like Junee, NSW and Peterborough, SA, when Australia changed over from rail to road transport. These impacts were locally severe, but the towns concerned were not major regional centres. Instead they were dependent on a single employer and so hostage to the fortunes of a particular industry. No Australian region is so specialised as to be hostage to this kind of fortune.

On the other hand, there will be regions which benefit considerably. Some of these are regions which have experienced slow income growth in the recent past; for example the policies included in both the intermediate and Strong action scenarios are particularly helpful in generating employment in regions with capacity to produce biodiesel by using presently under-utilised land – the marginal agricultural regions which have lately suffered gradual depopulation. The additional policies included in the Strong action scenario also benefit these regions as well as established manufacturing areas.

Increased transport costs provide an incentive (backed up by regional planning) to reduce commuting by better balancing of workplaces and residences. This will tend to limit employment growth in the city centres and enhance it in the outer suburbs, where the jobs are most needed. A second contribution to this trend will come directly from abatement policies, which generate employment in renewable energy production and in investment to adapt to emission abatement and therefore generate relatively little employment in activities closely associated with central business districts – entertainment, finance and government.

Some regions deserve additional comment. Gippsland will generate fewer jobs in the Intermediate scenario compared to the Weak action scenario, but under the Strong action scenario the addition of extra renewable capacity and one or two major projects will counter this. For the Hunter Valley the difference between the Weak action and Intermediate scenarios will be a small positive or negative and relatively easily fixed in the Strong action scenario. The fact of the matter is that even allowing for indirect employment the number of jobs associated with coal-based power stations in the 2006 census was not large. Even so, it must be admitted that the medium-term prospects for the coal mining regions (especially export coal) depend heavily on the carbon capture and sequestration becoming economic.

For country Australia the benefits in selected regions will be large. Renewable capacity will be relatively widely spread (as per the MMA Climate Institute study) and for inland NSW and Queensland there will be $10 billion worth of weed/algae growing for biodiesel on marginal lands or on relatively poor lands not in production for any other purpose. There is also annual $6-$8 billion for land management that will offset the negatives for forestry areas.

The manufacturing regions get a good boost under Strong action with an extra $16 billion of import replacement and export of green equipment. It is assumed that Australia will be making 120,000 electric cars by 2030, though there will still be one company making conventional cars.

Table 10.1 shows the change in employment from 2009 levels by scenario. The key point is that none of the major resource regions are projected to suffer a contraction in employment from 2009 levels. Indeed, in the Strong action scenario only one region suffers a decline in employment – NSW Far West, where the decline continues a trend which began with the end of the 1950s wool boom. This region also suffers from the adverse impacts of climate change and from failure to discover new mineral resources to replace those currently becoming worked out. Prospects for the Far West would improve if replacement mines were discovered or if it turned out that it was suitable for biodiesel production. Similar arguments apply in a number of other rural regions which are presently suffering declining population and which generate only modest employment increases in the projections.

Table 10.1 Regional employment outcomes 2030 compared to 2009 by scenario

		Weak scenario		Intermediate scenario		Strong scenario	
	Industry employment 2009	Change 2009 to 2030 (no.)	Change 2009 to 2030 (%)	Change 2009 to 2030 (no.)	Change 2009 to 2030 (%)	Change 2009 to 2030 (no.)	Change 2009 to 2030 (%)
ACT	189278	65093	34	71688	38	74589	39
Adelaide Inner	307041	42674	14	50655	16	53468	17
Adelaide North	212965	36138	17	43393	20	57818	27
Adelaide South	99264	11791	12	15912	16	20074	20
Melbourne Central	632659	274737	43	294392	47	301019	48
Melbourne East	253366	69404	27	77801	31	87500	35
Melbourne North	211781	93384	44	102290	48	120236	57
Melbourne North East	181403	61589	34	69380	38	75662	42
Melbourne Outer South East	172404	50730	29	58785	34	66590	39
Melbourne South East	311515	87326	28	97101	31	115180	37
Melbourne West	214755	139419	65	149155	69	166291	77
NSW Central Coast	109955	28345	26	31738	29	33060	30
NSW Central West	121415	-2656	-2	3875	3	8247	7
NSW Far West	40950	-7237	-18	-5838	-14	-5410	-13
NSW Hunter	282545	42013	15	53082	19	64320	23
NSW Illawarra	157122	38120	24	44012	28	47262	30
NSW Mid North Coast	114293	16797	15	21012	18	23160	20
NSW North	82226	-11600	-14	-4247	-5	1372	2
NSW Richmond Tweed	97592	15180	16	18759	19	20441	21
NSW Riverina	105591	-2925	-3	3135	3	7374	7
NSW Southern Tablelands	91215	10306	11	15575	17	19030	21
NT Darwin	75205	52065	69	54778	73	55185	73
NT Lingiari	43961	-1500	-3	1473	3	3433	8
Perth Central	487045	131837	27	146601	30	151809	31
Perth Outer North	182548	53106	29	59832	33	67595	37
Perth Outer South	174116	40073	23	47878	27	56061	32
QLD Cairns	109155	21120	19	26629	24	29760	27
QLD Darling Downs	105103	29959	29	35500	34	39272	37
QLD Fitzroy	102729	39978	39	45599	44	50052	49
QLD Mackay	90229	31298	35	36927	41	40974	45
QLD North	117020	23993	21	33787	29	40892	35
QLD Resource region	48267	2386	5	5005	10	6614	14
QLD Wide Bay Burnett	106308	30118	28	37358	35	42242	40
SA Mallee South East	47017	3166	7	7887	17	11399	24
SA Mid North Riverland	57541	1604	3	5185	9	7482	13
SA Spencer Gulf	51499	-305	-1	2299	4	4282	8
SEQ Brisbane City	741226	253611	34	277639	37	289852	39
SEQ Brisbane South	150730	68102	45	74760	50	82092	54
SEQ Gold Coast	248086	94652	38	103925	42	109543	44
SEQ Moreton Bay	112180	39431	35	44420	40	48570	43
SEQ Sunshine Coast	140701	56581	40	61830	44	64384	46
SEQ West Moreton	100587	113670	113	120289	120	126107	125

Table 10.1 Regional employment outcomes 2030 compared to 2009 by scenario (continued)

		Weak scenario		Intermediate scenario		Strong scenario	
	Industry employment 2009	Change 2009 to 2030 (no.)	Change 2009 to 2030 (%)	Change 2009 to 2030 (no.)	Change 2009 to 2030 (%)	Change 2009 to 2030 (no.)	Change 2009 to 2030 (%)
Sydney Central	819600	202988	25	225283	27	232533	28
Sydney Eastern Beaches	88327	19758	22	22624	26	23723	27
Sydney Northern Beaches	103283	18581	18	21993	21	23750	23
Sydney Old West	104892	25558	24	29466	28	31734	30
Sydney Outer North	152866	25516	17	31310	20	36800	24
Sydney Outer South West	150851	84767	56	92396	61	102447	68
Sydney Outer West	216175	81405	38	90503	42	100999	47
Sydney Parramatta-Bankstown	347377	97352	28	108518	31	116853	34
Sydney South	135561	22012	16	26972	20	29952	22
TAS Hobart-South	118099	18313	16	23093	20	25665	22
TAS North	62409	10320	17	14234	23	17194	28
TAS North West	48012	8872	18	12288	26	15238	32
VIC Ballarat	67373	24777	37	28540	42	32016	48
VIC Bendigo	96025	36250	38	41192	43	45011	47
VIC Geelong	99947	31040	31	30931	31	34378	34
VIC Gippsland	103927	19487	19	25634	25	29680	29
VIC Mallee Wimmera	62509	-3561	-6	1803	3	5795	9
VIC North East	101790	17812	17	22321	22	24819	24
VIC West	71905	16024	22	22148	31	26541	37
WA Gascoyne Goldfields	64600	7985	12	11702	18	13856	21
WA Peel South West	111886	42244	38	48077	43	51781	46
WA Pilbara Kimberley	58947	16564	28	19951	34	21968	37
WA Wheatbelt Great Southern	60349	12877	21	19340	32	24061	40
Total	**10527297**	**2980518**	**28**	**3411577**	**32**	**3751682**	**36**

Note: Regions defined as in NIEIR *State of the Regions* report 2008.
Source: NIEIR modelling. Industry employment 2009 from NIEIR *State of the Regions supplementary report 2008-09.*

11. Methodology

As highlighted in Chapter 1, a major contribution of this report has been to combine bottom-up modelling, with its detailed documentation of abatement opportunities, and macroeconomic modelling with its careful weighing of the consequences of policy decisions at national level. It is this combination which has allowed us to consider the benefits of policy packages which incorporate but go beyond carbon pricing.

The modelling system used was that developed by NIEIR for the assessment of policy impacts with long-term consequences. This modelling system is adapted from NIEIR's forecasting models, and is best introduced via these models.

11.1 Modelling philosophy

In preparing economic forecasts, NIEIR endeavours to be as accurate as possible, with the aim of providing unbiased forecasts with as high a chance of fulfilment as possible. Accordingly the philosophy underlying its forecasting models is practical and eclectic. If a causal relationship is assessed as important enough to influence the forecast, it is included in the modelling. Considerable emphasis is placed on learning from forecasting successes and failures and on incorporating advances in econometric estimation as they became available.

The essence of a forecasting model is that it must generate time sequences. The fundamental mode of operation is therefore as follows.

- Forecasting begins with the present. Given that the statistics on which forecasts are based are published with a lag and are subject to revision, the 'present' is in practice a medley of current best estimates.
- Forecasts are then prepared time-period by time-period. The forecast for each time period is completed and signed-off before the forecast for the next time period is prepared.

Moving from time t_0 to time t_1 involves two types of operation.

- Dependent variables in time t_1 are calculated from the values of driver variables in t_o and periods prior to t_0, which in turn may be dependent on other drivers. Causation is therefore modelled though lagged difference equations.
- After the equation system has been run and t_1 values derived for all dependent variables, a check is carried out to ensure that all definitional identities are observed. Depending on the variables concerned, this may require parameter modification and iteration or may involve appeal to the Keynesian distinction between ex ante and ex post values. In this latter case the difference is carried over as a driver for the next period's forecast.

A forecasting system comprising lagged drivers and current consistency checks has the great technical advantage that complex chains of causation can be modelled without generating serious mathematical problems in solving the model (i.e. in applying the consistency checks).

The extensive use of lagged difference equations has the further advantage of realism. Economic decisions tend to lag the stimuli which precipitate them. Even at the individual level, decision-makers take time to make a decision and having done so take time to implement it. These intervals vary between decision-makers, resulting in a gradual surge of delayed decisions in response to changed values in a driver variable. A further reason for gradual surges is the role of expectations, with some actors making decisions in advance of the documented stimulus and others following the fashion. The typical speed of response varies from market to market, driver to driver. At the one extreme, financial markets are noted for their speedy responses and chimerical expectations; at the other extreme the accumulation of major items of equipment and responses to technological change are slow processes.

After 35 years experience in economic forecasting, NIEIR has confirmed the value of dealing always in explicit time sequences. This allows not only for the modelling of causation involving driver and driven variables but for the insertion of response lags and for the inclusion of lagged feedbacks. Though it is still necessary to check that all forecast variables are mutually consistent for each forecast time period, this time-driven structure of causation means that considerable complexity can be handled.

A second benefit of experience is that NIEIR has developed a sense of relevance and used it to identify the drivers which have had major influence on the major forecast variables over the past six decades and more. These drivers have all been incorporated into the forecasting models in ways which reflect their perceived causative role. This is not to claim that a new wild card might not emerge (NIEIR continually scans the horizon in case one does) nor is it to claim that influences are constant in direction or strength, but it is to claim that the Institute has incorporated all historically-relevant drivers into its models and, further, has endeavoured to ensure that their influence is determined by the data and not by assumption. Incorporation in the model is not the last word – historical behaviour is never completely replicated, especially the capricious historical behaviour of exchange rates and other variables strongly influenced by speculative financial markets or political decisions. Even when econometric relationships can provide evidence of causation, this evidence is never conclusive and the estimates of the strength of influence are not always stable. However, model specification emphasising lags and feedbacks provides a structure in which the complexities revealed by econometric analysis of historical experience can be formalised and brought into logical relationship for forecasting purposes.

In the course of model development, NIEIR has learnt the benefit of a major simplifying device – the geographic layering of forecasting models. The reason is that some of the prices, flows and balance sheet values relevant to Australian forecasts are determined primarily on world markets, some are determined primarily at the all-Australia level, some at the level of large city-regions (which approximate to states in Australia) and some at the regional level. The Institute has thus evolved a tiered structure of models.

- Forecasts generally require a World background, which is developed as required for each particular forecast or study.
- The primary model in the suite is the National model, which is of particular importance in determining the values of variables influenced by imports, exports and the balance of payments and variables influenced by Commonwealth policy – broadly the variables emphasised in the National Accounts. It is also important as a means of ensuring that all-Australia markets add up.
- The state models include their own range of National Accounts variables and have their own city-region dynamics, but are individually constrained to national values for variables such as the exchange rate and inflation rate, and (subject to feedbacks) are constrained to national totals for a wide range of macroeconomic variables. Within these constraints there is scope for divergence from national trends, some brought about by differences in demography or by differences in industry mix, some by policy effects (particularly state effects) and some by differences between states in the operation of markets – particularly such markets as housing.
- The regional (LGA) models again have their own dynamics, but are even more constrained by state and national totals. To a considerable extent the regional models work out the local consequences of state and national forecasts.

11.2 From forecasting to policy analysis

Major changes in national economic strategy, such as those required to reduce greenhouse gas emissions, involve complex series of policy changes implemented over many years and generating responses over even more years. Because the policy changes involve time sequences, lagged responses and feedbacks, they are expressed in terms which are readily incorporated into forecasting models. After all, an important element in successful forecasting is the prediction of government policy settings and their incorporation into the forecast.

Where forecasting models are used for policy analysis the procedure comprises two steps:

- production of a 'base case' forecast; and
- production of one or more policy scenarios for comparison with the base case.

Most commonly the base case is a 'business as usual' forecast, but as the present study demonstrates this need not be so. Policy analysis aims to assess the differential impact of policies, usually with regard to 'target' variables – in the present study, primarily employment and consumption. A 'business as usual' base case may contain elements which are not helpful to this comparison. However, it is important that the realism which is the primary asset of forecasting models is retained.

A limitation of forecasting is that it becomes increasingly difficult as the time horizon recedes. Policy assumptions become increasingly heroic and the likelihood increases that the forecast will be wrong due to unexpected technological change or political events. Accordingly NIEIR prefers to restrict its forecasts to five or at the most ten years ahead. By contrast, where policies have long-term effects it is desirable to project them ahead for decades, using scenarios which are prepared similarly to forecasts but which prolong the comparison between base and policy cases well beyond the forecastable future. By extension the range of uncertainty can be explored by using multiple base scenarios each with its corresponding policy scenario(s).

This difference of purpose between forecasting and policy analysis has the important practical consequence that NIEIR uses different models for forecasting and the assessment of policies with complex, long-term dynamic impacts. In forecasting, with a time horizon of at most a decade, it is very important to get the time sequences exactly right and hence NIEIR uses models in which the time-increments are quarterly – the shortest period supported by ABS National Accounts data. To prepare the longer-term projections required for policy assessment NIEIR uses annual time-increments. This has the drawback that the complex patterns of causation which are readily incorporated into quarterly models have to be somewhat simplified, but this is not as great a disadvantage as it may seem, since many of the data which drive long-term trends are documented at long time intervals (for example, the national balance sheet is produced annually and the Census every five years). Annual data have the further advantage that it is not necessary to make explicit allowance for seasonality.

11.3 The National model

For operational and conceptual convenience NIEIR's integrated system of models for policy analysis is divided into modules. The most convenient point of entry to the system as a whole is the National model, since this model is most readily explained in relation to academic economics. It is also important to understand the National model since it determines many of the drivers which operate at the more detailed levels and also guarantees the coherence of results at those levels.

11.3.1 Macroeconomics

The main data source at the macroeconomic level is the ABS System of National Accounts. The National Accounts comprise three main segments.

- Estimates of national income, expenditure and production.
- Financial or flow-of-funds accounts.
- The national balance sheet.

Though there is a tendency to regard the first of these as the most important, the other two provide information which is essential to forecasting growth in national income, expenditure and production. In particular, the national balance sheet includes important information on capital stocks translated into assets and liabilities.

The National Accounts are of fundamental importance for economic forecasting, for several reasons. They provide the following.

- A guide for average or typical experience – if aggregate income is rising, individual incomes will on average also be rising.
- Consistency checks not only (by definition) within the National Accounts themselves, but checks useful in more detailed analysis, often expressed as column and row totals.
- Driver variables for more detailed analysis.
- A variable set within which relationships between a number of important driver variables can be determined – particularly such variables as GDP, inflation, the exchange rate and the unemployment rate. Needless to say these drivers are also the subject of multiple feedbacks.
- A set of variables which is very attractive for econometric analysis, because data quality is high and virtually all the variables are the product of highly decentralised decision-making (the major variables affected by centralised decisions are government expenditure and taxation).

By longstanding practice, scenarios developed using the National Accounts have been 'top down' – that is, the National Accounts variables, which are either aggregates or conceptually broad indices, are determined in terms of other aggregates and indices most of which also occur in the National Accounts or are easily related to the Accounts – like, for example, national population. When developing a scenario in top-down mode, variables at regional and industry level are in large part driven by the national totals and, as a methodological principle, are reconciled to these totals.

Though the 'top down' approach is standard, it is possible to move in the opposite direction and work from scenarios developed at the industry and regional level back to the national aggregates – and then down again to a further round of industry and regional detail. The present report avails itself of this flexibility.

11.3.2 Keynesian macroeconomics

National Accounts were first prepared after the Keynesian revolution and their basic structure continues to support Keynesian analysis. The familiar categories of aggregate demand are there, divided into consumption, investment (gross fixed capital accumulation), government demand and net exports. The National Accounts therefore lend themselves to calibrating simple Keynesian models in which national income and GDP are determined by the sum of the three main components of aggregate demand – consumption, gross investment and net exports. As explained in university classes in elementary macroeconomics, this model is inherently dynamic. The consumption multiplier which raises GDP following an exogenous increase in (say) investment is usually explained as taking place in a series of steps, each step following one time period after its predecessor. This model is far too simple for use in policy assessment, but it makes two important points.

- Demand is very important underlying concept in economics. Marketed goods and services will not be produced unless they can be sold somewhere. Demand limits production.
- Though the Keynesian multiplier can be explained as governing the transition from one steady state to another, it does not take much imagination to see it operating in conditions where exogenous shocks are occurring continuously. These do not prevent the multiplier from operating, but do prevent it from ever yielding a steady state.

Crude, demand-dominated Keynesian models were common in the early days of National Accounting. However, from its beginning in the 1970s the Institute recognised the importance of Keynesian microeconomics and also the importance of explicit growth theory.

11.3.3 Keynesian microeconomics

Keynesian macroeconomics is founded on Keynesian microeconomics, summarised as import parity pricing for trade-exposed goods and services and cost-plus pricing for all others.

The microeconomics of import-parity and cost-plus is not standard economics as taught in first year courses. Economic doctrine privileges pricing at the equilibrium of demand (which increases as price falls) and supply (which reduces). The fundamental reason for teaching this doctrine is its association with the normative defence of competitive markets. This apart, the equilibrium theory of price formation has been variously defended, for example on the grounds that it follows from the logic of optimisation in conditions of diffused economic power, or that it is approximated in at least some markets. The reasons for not using it in policy analysis are as follows.

- The demand/supply concept is closely bound up with the concept of perfectly competitive markets. In practice very few if any Australian product and service markets meet the onerous conditions required if competition is to be perfect. Instead competition is generally restricted to a limited number of firms, each of which has incentives to adopt strategic pricing behaviour. In these circumstances cost-plus subject to an import-parity maximum provides a reasonably accurate approximation to actual price formation.
- A particular case where demand/supply pricing is inadequate is that of increasing returns to scale, which generate downward-sloping supply curves and indeterminate price. This is no small problem, since increasing returns to scale are endemic in manufacturing and possibly in other industries such as retailing. Once again import parity/cost plus yields determinate prices.
- Even if competitive equilibrium provides a reasonably accurate account of price formation in some of the markets of an economy, the existence of cost-plus import-parity pricing in significant sectors is sufficient to generate Keynesian macroeconomic behaviour.

The disaggregation of the Institute's modelling system by industry has made it possible to vary the approach to price formation by industry. For the manufacturing industries, NIEIR's developed models use the cost-plus approach with the mark-up a function of unit capital costs and export and import prices. Demand in relation to capacity is included as a short-period influence to allow for profit-taking during booms and price-cutting to generate cash flow during recessions.

11.3.4 Growth theory

In the 1950s Keynesian macroeconomic theory was developed into a series of growth models (Harrod, Domar, Hicks, Robinson). These models recognised that investment (in the Keynesian sense of gross fixed capital formation) not only adds to current demand but generally exceeds consumption of fixed capital and so adds to the capital stock, resulting in increased productivity of labour and increased incomes for both workers and the owners of capital.

The existence of a capital stock, not to speak of a finite population of workers, implies that production is constrained on the supply side, and it is possible for ex ante aggregate demand to exceed the aggregate supply capacity of the economy. Three relationships are posited.

- A quick-working relationship by which demand which cannot be satisfied due to limits to productive capacity spills over into inflation – conventionally known as excess demand inflation.
- A quick-working relationship by which demand spills over into imports and also, less spectacularly, into reductions in exports. These relationships raise the whole question of the treatment of international trade in policy assessment.

- A slow-working relationship by which excess demand for goods and services creates additional demand for capacity-creating investment.

The primary focus of growth theory is on capital accumulation, but the two quick-working relationships considerably influence the dynamics of accumulation.

11.3.5 Investment

In its modelling of the slow-moving relationship between demand and capital accumulation NIEIR makes use of the Flow of Funds statistics, which show that there is very little lending from Australian financial intermediaries to businesses making major investments in fixed capital: funding is generally from internal sources backed up by direct access to international equity markets. In these circumstances the Taylor rule is generally appropriate – fixed capital accumulation depends on industry retained surpluses with inflationary expectations taken into account through a downward adjustment when the inflation rate rises. This rule has the technical advantage of ease of econometric estimation at the industry level.

As explained in Chapters 1 and 3 above, in the present study it has been necessary to insert greater detail to the treatment of gross and net investment. This will be considered below.

11.3.6 Inflation

Demand in excess of capacity (which in this context moves from an engineering to an economic concept) provides one of the drivers of inflation in NIEIR's policy models. However, there are three other sets of inflation drivers:

- cost-push (fundamentally a result of incompatible income claims);
- imported (reflecting the net effect of inflation overseas and movements in the exchange rate); and
- monetary (fundamentally a result of lack of control in the financial sector, public and private).

Though the analysis of long-run growth is conveniently carried out in values adjusted for inflation, it is still important to include the inflation rate in forecasts, partly because it is a policy target (hence a determinant of RBA behaviour and in some policy eras of Treasury behaviour as well) and partly because of its influence on economic behaviour, for example the behaviour of firms when assessing investment in fixed capital.

11.3.7 The overseas sector

There is a sense in which the overseas sector fits neatly and naturally into the Keynesian variables of the National Accounts. Exports add to demand and imports add to supply. Australian export earnings can be modelled as essentially demand-driven, industry by industry, from projections of world growth. Allowance can also made for domestic supply constraints. Imports can likewise be modelled, industry by industry, by estimating domestic supply at the world-parity price and calculating imports as domestic demand less domestic supply and exports.

Turning to the financial components of the balance of payments, earnings on Australian overseas investments can be calculated from the value of these investments and the rate of return, which is influenced by world growth and monetary conditions. Likewise the earnings of overseas investors in Australia can be calculated from the value of their investments and the rate of return, as influenced (for equity investments) by the profitability of businesses in Australia and (for debt) by the Australian interest rate.

It is agreed by all analysts that imports and net debt servicing have to be paid for and the ultimate source of foreign exchange with which to pay is export revenue. However, imports can also be paid for from capital inflow – known as a deficit on the balance of payments. Capital inflow increases net debt servicing costs. The question for analysts contemplating the typical Australian balance of payments deficit is how long it can be sustained by continued

capital inflow and how far it will blow out. This requires assumptions about overseas willingness to lend to Australia and Australian willingness to borrow on the terms offered by overseas lenders.

Analysing Australian experience up to 1990, NIEIR employed the concept of the balance of payments constraint to growth. When the balance of payments deficit threatened to become excessive, three mechanisms came into play. First, the high interest rates required to attract overseas loans cut into Australian demand, reducing incomes and so reducing imports. Second, when alarmed over the deficit the Reserve Bank imposed credit squeezes – quantitative controls over borrowing which acted to reduce incomes and imports. If these were not enough, the Treasury would (third) tighten fiscal policy, further reducing incomes and imports. In the era of exchange and interest rate controls, up to the 1980s, the Commonwealth institutions alternated between periods when they used 'high' interest rates to support a 'high' exchange rate in the hope that low-priced imports would curtail inflation and periods when they used 'low' interest rates to support a 'low' exchange rate to encourage export and import-competing industries.

At deregulation the Reserve Bank forswore the quantitative regulation of the banks and the Treasury forswore active fiscal policy. The balance of payments constraint seemed to evaporate as the banks demonstrated a hitherto unsuspected capacity to absorb overseas loans, which they on-lent to the household sector. The national balance sheet chronicled an increase in bank liabilities to overseas and in household liabilities to the banks. The policy authorities regarded the resulting balance of payments deficit as benign – it was incurred between private parties and imports of low-cost consumers' goods were welcome because they kept inflation down. The question is how long this pattern of household and bank debt accumulation can last. There was a severe wobble during the Global Financial Crisis and the indications are for a return to balance of payments constrained growth – but when, and with how much of a bump, is a crucial element in any analytic projection. The scenarios in this report assume that the balance of payments constraint revives.

When deregulation was being pursued, one of its expected benefits was that market determination of the exchange rate would ensure appropriate pricing of imports and exports and so deal with the balance of payments. In the event, since 1990 the AUD/USD exchange rate has fluctuated between near parity to two AUD for each USD without any commensurate relationship to economic fundamentals. The exchange rate matters for analysis – it affects the AUD values of all entries in the balance of payments and so finds its way into GDP – but has turned out to be very difficult to model accurately. This would not have surprised Keynes, who had sufficient experience of financial markets to know their speculative jitteriness.

11.3.8 Taking industries into account

The national model deals not only in Keynesian aggregates but includes inter-industry accounting as pioneered by Leontieff. As perceived by Leontieff, the industries of any region take inputs and create outputs. The inputs comprise capital, labour and 'materials' – the outputs of other industries in the region plus imports from other regions. The outputs of each industry are divided between inputs to other industries in the region, exports to other regions and consumption of final products by households in the region. This classification elaborates the Keynesian aggregates. For example, aggregate consumption is the total of industry outputs sold to consumers plus imports sold to consumers, while gross domestic product is the sum across all industries of the cost of capital and labour inputs. For this reason it fits very neatly into NIEIR's modelling system.

To actualise this scheme, data are required on the values, by industry, of output, labour inputs, capital inputs, inputs from each other industry, inputs from imports, outputs sold to each other industry, outputs sold as exports, outputs sold to consumers and taxes paid less subsidies received. Price series are also required for all inputs and outputs. At the national level all of these values are either directly estimated by the ABS or can be derived from ABS data. The input-output matrix is a central element in this. Unfortunately it is not produced as frequently as the other data but after allowing for this it is possible to develop time series for

all the variables required to describe activity in Australian industries as classified by the ABS – over a hundred in the input/output table.

A crucial element in the analysis of this plethora of data is the functional form of the relationship between inputs and output. Since there are several inputs, the functional form must also be able to deal with the choice of inputs. Assuming standard qualities for each input, this amounts to the substitution of input for input when the ratio of input prices changes. Leontieff responded to this problem by letting the data speak for itself. He specified a relationship in which outputs increased with inputs, but inputs could be either substitutes or complements – substitutes when purchases increased when relative price fell; complements when purchases increased when the relative price of the complementary input fell. Apart from these limited priors, Leontieff allowed the data to determine the parameters, including lagged changes. Applying this approach to Australian manufacturing industry data, NIEIR found that the response to an increase in demand is indeed dynamic, with capital and labour tending to be harder worked initially followed by an adjustment as capacity was increased. The effect of working inputs harder shows up as a short-term increase in productivity, or returns to scale, and the effect of increasing capacity is to remove at least some of these economies of scale, but even after five years of adjustment there were many industries in which increasing returns to scale persisted. Similarly industries were identified in which at least some inputs were complementary – most commonly capital and inputs purchased from other industries ('material' broadly defined to include services). All of these estimates, including the dynamics, were well suited to incorporation into the model outlined above. Incorporation allowed the drivers of many of the macroeconomic variables (demand for labour, capital accumulation, value of output, imports, exports) to be calculated by aggregation from the industry level, subject to consistency conditions (e.g. total sales of consumption goods must equal total demand for consumption goods as determined by household incomes, wealth and the like).

11.4 Greenhouse gas emissions

The National Greenhouse Gas Inventory is the authoritative source of data on emissions. Using Kyoto rules, the inventory estimates emissions from a range of activities. Some of these are directly tied to particular industries (particularly agriculture, forestry and waste management) but the major component derives from the combustion of fossil fuels. NIEIR has allocated these energy-related emissions to households and industries.

Additional sources of information are essentially bottom-up. Much of the relevant information concerns stocks of capital equipment and their design-determined emission-intensity, as well as information on replacement values, operating costs and typical usage. Crucially, this bottom-up information is available for all the energy industries and for a great deal of household energy-using equipment. Equipment characteristics are also well documented in the transport sector for both household and commercial activities. In the present study this detailed information is marshalled on an industry and household-activity basis. In all cases emissions can be calculated as the product of the emission-intensity of the equipment used and the extent to which the equipment is used.

As explained above, to some extent carbon pricing works by changing the utilisation patterns of the existing equipment stock. This is modelled in the conventional way, as a lagged price response. However, the main source of abatement is equipment replacement. This may be precipitated when the equipment breaks down or otherwise reaches the end of its useful life, but many policies rely on accelerated replacement and/or retrofitting. The model incorporates the whole range of abatement policies enumerated in Chapter 2, all in the context of a carbon price. The modelling of initiative selection was described in section 2.3, with a more detailed technical account in Appendix A.10.

Carbon pricing, along with many of the sector-specific initiatives, requires equipment replacement. This is phased in over the duration of the scenarios, having respect for capacity limitations in equipment replacement. For each combination of initiative and industry, and similarly for each combination of initiative and household activity, we estimate the gross investment in replacement equipment. This feeds back to the macroeconomics. We also

estimate the change in industry capacity; any investment which increases this capacity can be counted as net investment. Because so much of the gross investment is replacement investment, the ratio of net investment to gross investment is much lower than for the regular run of gross investment.

As argued in Chapter 3, resources have to be provided to finance the burst of gross investment generated by abatement policies. These resources are ultimately savings, which may be applied directly by households as they purchase replacement equipment or may be transferred to the energy industries through price increases or a flow of funds through the financial system.

For each year of each scenario, once the equipment stock has been updated the year's emissions can be calculated from the new stock, its efficiency and its rate of utilisation.

11.5 The state and regional models

Australia is geographically a large country, and the growth rates of economic variables generally diverge regionally.

11.5.1 State activity

The ABS publishes most National Accounts data at the state and territory level, so providing the basis for constructing similar models to the NIEIR national model at the state/territory level. The main differences are as follows.

- A number of drivers are determined at the national level and applied across the board to the states. These include the exchange rate, financial variables such as the interest rate and variables reflecting Commonwealth policy.
- Capacity constraints are a little more flexible. For example, a state which is growing faster than the others will be able to attract skilled labour, allowing its skilled labour supply to grow more rapidly than the national total.
- Some of the statistical detail used in the national model is not available at the state level, and has to be estimated. This is particularly true of the input-output table, which NIEIR estimates at the state level using methodology similar to that used by the ABS for the national table, subject to national-level constraints.
- Scenarios may include assumptions about particular investments which are important at the state level.

State data are constrained to add to the national data series.

Though state models remain relevant to the assessment of state-level policies, their main role in the present study is to provide control totals for the regional modelling system. These align the regional models with National Accounts data, the state being the smallest jurisdiction for which these data are published.

11.5.2 Regional models

The logic which applies in the state models, by which a state is recognised as a geographic unit with its own demand and production characteristics nested within the national unit, is also applied to sub-state regions. The main problems in estimating models at the regional level are due to data availability. We therefore name the major sources utilised.

- At five yearly intervals the Census provides detailed information on household demography, incomes, occupations, industry of employment and even basic information on asset ownership and indebtedness by small area.
- The Census also provides detailed information on the location of employment by industry and occupation. This is derived from the Census 'journey to work' question, and requires manipulation before it can be reconciled with Census data on employment by place of residence.

- The Taxation Office provides detailed information on taxpayer characteristics by postcode.
- Centrelink likewise provides postcode data on the take-up of pensions and benefits.
- At a variety of time intervals (generally getting longer) the ABS has conducted censuses of tourist accommodation, retail activity, manufacturing, mining and agriculture. For many years the ABS conducted a very basic census of businesses, known as the business register, but this has been abandoned. Substitute information, of lower quality for NIEIR's purposes, is sourced from Dun and Bradstreet.
- Sample surveys rarely yield valid data at regional level, the partial exception being the labour force surveys of employment and unemployment produced by the Commonwealth Department of Education Employment and Workforce Relations. However data from a variety of ABS surveys have been incorporated into NIEIR's regional modelling.
- Building approvals data.
- The Real Estate and Stock Institute provides data on dwelling sales and values.
- Various other sources, mostly administrative data from state and local governments, are from time to time relevant.

Many of these data are costly and their use is limited by agreements to safeguard privacy and commercial confidentiality.

The model estimated for each region is structurally similar to those estimated at the national and state levels. However regions are particularly open economies. Typically a large proportion of total output is exported (to other regions, to overseas) while a large proportion of total supply is imported. The lack of self-containment of at regional level also expresses itself in the flow of incomes from outside the region. These may be commuter incomes (earnings of residents who work outside the region), private asset incomes and government pensions and benefits. Residents also contribute to taxation, and receive health, education and other publicly-financed services. These in turn involve employment which is located at the discretion of governments. Though fixed capital capacity constraints apply strongly at the regional level, labour can be imported relatively readily, subject to national constraints. However, labour imports may require incentive payments, particularly if the regional housing market is tight.

The household sector in the National Accounts includes households in their domestic activities plus unincorporated businesses and not-for-profit organisations. The incomes of the household sector at regional level are estimated from all available sources, including Census, Tax Office and Centrelink plus Institute calculations for the activities of unincorporated business, all adding to the National Accounts state total. Consumption expenditures are estimated by microsimulation by matching the Household Expenditure Survey with the characteristics of the households of the region. Consumption expenditures are initially classified by consumption item as in the Expenditure Survey, but these are translated into industry outputs (including imports from overseas by industry). Balance sheets are estimated by microsimulation from the balance sheet portion of the Household Expenditure Survey coupled with the limited Census data on assets and debts and data from other sources on dwelling prices and household debt. All estimates for the regions within a state are pro-rated to control totals from the State model.

Estimates of the quantum of agricultural output are available by region. For other industries the value of output is estimated primarily from employment data by industry multiplied by regional labour productivity differentials based on postcode income tax data. The estimates for knowledge-based industries are further modified to take into account the productivity effects of regional industry clusters. Once again all estimates are pro-rated to control totals from the State model.

A separate input-output table is estimated for each region by matching industry input requirements to industry outputs in the same region, given the total outputs of each and the patterns revealed in the national input-output table. Similarly local output is matched to local consumption demand. This process generates the imports and exports of each region by industry. Imports and exports are then converted to flows between regions by a gravity model. For services these remain financial flows, but for goods the flows can be converted into tonnes and compared with observed freight flows.

11.6 A brief comparison with Computable General Equilibrium methodology

In Australia the main alternative to the modelling system used in this report is the so-called Computerised General Equilibrium (CGE) model used by the Australian Treasury. The two models yield very different results, as indicated by the comparisons in Chapters 3 and 6 between the scenarios developed in this report and those in *Australia's Low Pollution Future*. The differences arise for two reasons.

- The two reports address completely different questions. The Treasury report asked how the costs of abatement would vary as emission targets were raised or lowered, using a single policy instrument – emissions trading. The present report asks how the costs of abatement would vary for a single emissions target, applying three different packages of policy instruments. Because they address different questions, there is very little overlap between the reports and only very broad comparisons of results have been possible (see Sections 6.6, 6.7 and 6.8 above).
- The Treasury and NIEIR used different economic models. Not only did the NIEIR model allow the assessment of a wider range of policy packages including sector-specific measures; it also allowed the benefits of abatement policy to be offset against the costs.

Reflecting their differences of scope and methodology, the two reports come to different policy conclusions.

- The Treasury calculated the costs of various emissions targets and left the choice of target to the government. The present report argues that Australia will not have the luxury of choosing a weak abatement target.
- The Treasury proposed that abatement should be addressed by a single policy instrument – emissions trading. The present report argues that carbon pricing (whether by emissions trading or carbon taxation) should be complemented by other abatement policies designed to speed the response to increases in carbon prices.
- Treasury implied, though they did not specifically argue, that it will be optimal for Australia to meet a substantial proportion of its abatement requirements by importing permits from other countries. The present report argues that reliance on permit imports would impose high costs.

The difference of view regarding the urgency of abatement action reflects the accumulation of scientific evidence on climate change and the progress of international negotiations since the Treasury report was prepared. The other two policy differences are tied in with the choice of economic model.

In *Australia's Low Pollution Future* Treasury offers very little defence of its recommendation that emissions trading should be the sole policy instrument to achieve abatement, relying on the Productivity Commission's view that 'Other policy options are available to reduce emissions, such as more command and control style regulations, that prescribe technology standards or ban certain types of activity that lead to emissions. However, these generally will be more costly than a market-based policy mechanism, because regulators do not have perfect knowledge of mitigation opportunities, costs and preferences of firms and households. Non-market policies have often obscured less transparent costs and welfare consequences.' (p9) This statement offers assertion rather than proof and fails to address the market failures documented by the advocates of sector-specific policies, but it accords

strongly with the assumptions and policy preferences that underlie CGE modelling. To account for the different recommendations in the present report and *Australia's Low Pollution Future* it is therefore necessary to delve into CGE methodology.

CGE models came into prominence in the 1970s, and were designed to reflect neo-classical economic theory, according to which economic stabilisation and growth are best left to markets with crucial roles played by prices such as exchange rates, interest rates, relative returns, etc. The theory also includes the proposition that governments can do little to influence the total level of investment in the economy. These models were designed to underpin the argument for free trade, deregulation and competition policy. They were not designed to assess the policies which are required to rectify the failure of markets to take environmental costs into account.

From the standpoint of the present report, Treasury over-estimated the costs of abatement in the following ways.

1. They limited themselves to a single market-based policy instrument, emissions trading, and made no attempt to assess the merits of complementary approaches. They did not consider the many lower-cost strategies available to government, perhaps because they did not believe they would be effective and perhaps because they could not readily be incorporated into the CGE model.

2. More importantly, the Treasury chose to rely on a model where the major drivers run from the macro-economy to the micro-economy, instead of a non-CGE model where the macro-economy is the sum of its micro-economic elements. By this decision the Treasury overlooked the long-run increases in welfare that flow from the improvements in energy efficiency associated with emission abatement. These benefits include lower oil imports, lower resource costs in the energy industries and lower overall real energy demands. These lower demands directly benefit households and firms by providing the same or better energy services at lower cost.

3. The cost estimates which resulted from this failure to take efficiency benefits into account were further increased by an undefended decision taken in the course of operating the CGE model. In previous work by the Treasury and the Productivity Commission it was assumed that the exchange rate would be kept flexible, which in turn would maximise the benefits from microeconomic reform. In *Australia's Low Pollution Future* the Treasury inexplicably chose to fix the exchange rate so that it followed the terms of trade. This assumption had the effect of further increasing the CGE estimate of costs, the mechanism being that carbon pricing increases operating costs in industries producing tradeable goods and services. The fixed exchange rate gives these industries no compensation, so they contract, and likewise investment in capacity expansion is reduced. Since capital-intensive industries and those producing tradeable goods and services have relatively high productivity, the net result is a fall in national output and income. By contrast, in non-CGE models abatement can be modelled as an investment proposition, financed by an increase in saving without unfavourable effects on high-productivity industries.

We thus have three reasons why the Treasury modelling is likely to assess higher costs of emission abatement than NIEIR's modelling. However, there are two important offsetting factors.

1. Costs were under-estimated by assuming that international permits can be purchased at a fixed price including a fixed exchange rate with no macroeconomic penalty. In a non-CGE model, or even perhaps in a CGE model with variable exchange rates, permit imports have high opportunity costs.

2. More important, costs were underestimated due to an assumption embedded in the CGE model. By design, CGE models assume that the structure of the capital stock is always appropriate to prevailing price patterns. They therefore omit the reconstruction costs incurred when low carbon technologies are installed in the capital stock (they are assumed to be embedded in the capital stock like "manna from heaven"). Resources do not have to be found to finance capital reconstruction; there need be no increase in

saving. This is completely unrealistic, but produces a reduction in costs compared to a non-CGE model.

The net effect of these three cost-increasing and two cost-decreasing factors is that the Treasury methodology over-estimates the costs of abatement by comparison with NIEIR's results. The net effect in NIEIR's models is that the cost of extra saving to finance capital reconstruction dominates initially, but efficiency and trade benefits arise quickly and proceed to dominate – hence the net lower costs.

These arguments are pursued in more detail in Appendix A, which follows.

To summarise, the analysis and conclusions in this report are fundamentally different from those in *Australia's Low Pollution Future* because the two reports address different questions using different methodologies. The present report claims to be more realistic on four main counts:

(i) the costs of implementing CO_2 abatement strategies are fully incorporated into the analysis;

(ii) the full benefits of energy efficiency gains are captured by the use of a model where the macro outcomes are the sum of the micro outcomes;

(iii) a much wider set of policy instruments is brought to bear which minimises the opportunity resource costs of CO_2 abatement, again by the use of a non-CGE model; and

(iv) the benefits of reducing imports of CO_2 permits within a given CO_2 target reduction scenario are fully evaluated.

Appendix A: Methodology – the Post-Keynesian and Computable General Equilibrium approaches compared

Economists reading this report will recognise that the modelling system used in the analysis is basically Keynesian – a development of the Keynesian models first constructed during the 1950s and used ever since for short-term macroeconomic forecasting. These models, including the NIEIR model, have been continuously improved ever since as analysts have learnt from the inevitable forecasting failures. Further, in NIEIR's case the model has been greatly augmented using insights from economic growth theory and capital theory. As described in Chapter 12, the NIEIR model incorporates industry detail and input-output relationships and tracks capital accumulation through its effects on the National Balance Sheet.

For the benefit of economists who are not familiar with this style of modelling but are instead familiar with Computable General Equilibrium (CGE) we append a detailed comparison between the NIER modelling system and the CGE model used by Treasury in *Australia's Low Pollution Future.*

A.1 Some comparisons

So far the Australian policy debate has been dominated by results generated with the MMRF CGE model. The model has not been used to compare policies (despite attempts to integrate it with bottom-up modelling, it lacks the bottom-up detail for this to be possible) but has been applied to comparisons between business as usual and policy cases in which a carbon tax or emissions trading results in significant abatement. According to these studies, carbon pricing will result in very considerable abatement at low cost in terms of jobs and consumption.

Example 1: The Climate Institute study

The December 2007 the Climate Institute published a study of the costs of abatement carried out using the MMRF model (Hatfield-Dodds, Jackson, Adams and Gerardi, *Leader, Follower or Free Rider, the economic impacts of different Australian emission targets.*)

To achieve emissions 20 per cent below 1990 in 2020, the Climate Institute reported a cost of around 0.2 per cent of GDP compared to business as usual. When abatement rose to approximately 47 per cent below 1990 in 2030 the cost was 2 per cent of GDP. These results are not comparable with the NIEIR comparison between Weak action and Strong action, since Weak action is not a business as usual case and indeed includes carbon pricing. However an important feature of the Climate Institute projections is that, contrary to the NIEIR results, in the process of abatement consumption is much less affected than GDP. This means that abatement is achieved without any increase in household savings. The written report does not report investment, but we may conclude that abatement is achieved without an investment campaign. Rather, it is achieved by costless reconfiguration of capital accompanied by high household and business responsiveness to carbon pricing. High price responsiveness means that no opportunity to reduce costs (maximise profits/household utility) is foregone when carbon pricing is introduced. There are no financing requirements to stand in the way of reconfiguring the capital stock, which is costlessly adjusted in accordance with a marginal abatement cost curve calculated as a generalisation from bottom-up evidence (with omission of the negative-cost tranche, which is incompatible with the assumptions of the model).

The Climate Institute reports a small employment gain to 2030, after which there are employment losses vis-a-vis business as usual. The eventual employment loss is an unusual finding for a GE model, where it is usually assumed that changes in real wages equilibriate the labour market. Perhaps the reasoning is that lower real wages cause voluntary withdrawal from work.

Example 2: Treasury/Garnaut

In *Australia's Low Pollution Future* (2008) the Commonwealth Treasury published an overview of its calculations of the costs of emission abatement. It used the MMRF model supplemented by other similar models and marginally extended with bottom-up data. The modelling most nearly comparable with the Climate Institute work is its Garnaut-25 scenario, which like the Climate Institute run is a comparison with business as usual. A rough comparison of the two MMRF scenarios is as follows.

Table A.1 Climate Institute and Treasury projections using MMRF

	Climate Institute			Treasury/Garnaut		
	Target	GDP	Private p.c. consumption	Target	GDP	Private p.c. consumption
2020	-20	0		-25	-2%	-2.6%
2030	-47	-2%	-0.3%	-47	-3%	-3.6%

Source: Climate Institute *Leader, Follower or Free Rider?* and Treasury *Australia's Low Pollution Future.*

The targets are not quite the same and the business as usual scenarios are not quite the same, but it is noticeable that the GDP cost in Treasury/Garnaut is significantly greater than in the Climate Institute run, especially in 2020. Again, the Climate Institute reports a far smaller reduction in private consumption per capita than Treasury/Garnaut. The Treasury report, which followed that from the Climate Institute, does not comment on this difference but NIEIR believes that it is probably due to the Treasury assumption indexing the exchange rate to the terms of trade rather than following the established CGE methodology of assuming a flexible exchange rate. As explained in section A.6 below, in the CGE context this increases costs.

The Treasury does not give any results for employment, which probably declines in response to a decline in real wages (which it does report). The decline in real wages, whether or not exacerbated by a decline in employment, reduces household disposable incomes, which are not directly affected by the introduction of emission permits since all permit sales revenue is returned to households in annual lump sums. Since the Treasury assumes that household saving and consumption are constant percentages of household disposable incomes, we can infer that household disposable income declines much less than earned income. By 2030 it may be inferred that household saving has declined by around 2.3 per cent.

The Treasury has not documented its results concerning the public account, but has released an estimate of the decline in total consumption (public + private) which, taken with the decline in private consumption, implies that government consumption is less than business as usual by around 6 per cent in 2030. Estimates are not provided for government revenue, save for the assumption that all revenue from permit sales is returned to households. It is likely, however, that revenue will decline, and the outcome for government saving is therefore uncertain.

The Treasury reports a considerable decline in investment vis a vis business as usual, but remarks that reliance on overseas saving falls (there is a decline in 'other foreign transfers' of about 1 per cent of GDP in 2030), implying that there is a relative increase in national saving. The decline in investment in 2030 is 5.5 per cent against business as usual, as compared to a decline in household saving of 2.3 per cent and an uncertain change in government saving.

The Treasury argues that the decline in investment reflects two factors:

- reconfiguration of the economy to less energy-intensive, hence (it argues) less capital-intensive industries which require less investment to generate a given amount of income; and

- an increase in the cost of capital vis-a-vis labour, so that businesses invest in less capital-intensive projects with resulting declines in investment requirements.

The first reason is most likely the result of a failure to include human capital in total capital – a reconfiguration of the economy towards services does not automatically reduce investment requirements once one takes education and training requirements into account.

The increase in the cost of capital vis-a-vis labour is the product of declining real wages and increasing cost per unit of capital. This brings us to the counterintuitive result that, instead of increasing investment to maintain output in the face of the increased cost of capital (or the need to reconfigure capital), investment is cut back.

A barrage of economic modelling is produced to justify this counter-intuitive result. We therefore examine this modelling.

A.2 CGE versus post-Keynesian models

It is not commonly remembered that the so-called computable general equilibrium models were originally built to justify the introduction of pro-market policies. They responded to the question: What would happen in an economy which operated according to neo-classical economic theory?

The result of this effort has been a range of CGE models which, superficially, do not differ very much from other models. They are built around input-output tables and have consumption, price, employment, etc. functions. They may or may not have lag structures (P.J. Brain, 1988). However, they cannot tolerate increasing returns to scale by industry, because these prevent the attainment of equilibrium. They also differ in 'closure conditions', which are basic assumptions which must be specified if the model is to generate results. It is sometimes claimed that the user can specify the closure conditions relevant to the problem at hand, but most applications of CGE models specify a set of closure conditions which not only accord with neo-classical theory but are mathematically convenient. Table A.2 contrasts the usual CGE model closure conditions with the closure practices of other models (i.e. Keynesian and augmented bottom-up models incorporating input-output tables). These unique closure assumptions cause the CGE models to generate different results from Keynesian type models as used by NIEIR.

CGE models incorporate two crucial closure assumptions:

(i) markets work; and

(ii) governments cannot influence the economy for the better in any way other than by fostering markets.

Market-determined exchange rates and real wage rates are assumed to keep the labour market and balance of payments in equilibrium, while the efficient market hypothesis and the associated rational expectations doctrine are assumed to keep taxes constant and the public sector deficit fixed at market-desired levels. Governments cannot influence investment in the economy because this is funded by savings which governments cannot influence; nor can they influence market allocation of investment to industry. At the heart of GCE model design is the assumption that actual market outcomes are always optimal unless there are specific market imperfections.

There is no empirical evidence to support any of these closure conditions. Similarly practical experience with how economies work fails to support them. For example, labour markets generate unemployment or sometimes over-full employment; foreign exchange markets generate speculative flows, governments change tax rates and alter their deficits and sometimes print money and in the process change their own savings rates and those of businesses and households. And governments can influence investment in a very wide variety of ways, including taxes, subsidies and infrastructure provision. In other words, the CGE closure assumptions are nonsense, derived from market ideology. Intensity of belief is no substitute for empirical relevance.

Table A.2	Closure rules of the two models	
	CGE model claim	**Post-Keynesian models**
Private balance: investment and saving	**Neoclassical investment:** investment adjusts to savings, a function of income and a set of parameters. *Investment is savings-driven, following the standard neoclassical presumption that all funds available are channelled into productive investment.*	**Keynesian investment:** investment is exogenous (constant). *Investment is decided upon by the industry level and, following Keynesian theory, generates the savings necessary to finance itself from increased income, subject to capacity constraints.*
Public balance: government deficit and tax revenue	The deficit is constant, and taxes adjust to guarantee that. *There is neither an economic theory nor actual country experience that supports this kind of adjustment. Governments cannot spontaneously increase taxes to balance the budget; that is why current Doha negotiations deal with adjustment funds for developing countries which rely heavily on tariff revenue to finance expenditure.*	Lump-sum taxes are proportional to income and the government deficit adjusts to balance the difference between public expenditures and revenue. *Governments across the globe use automatic stabilisers and public works programs to counter the negative effects of economic downturns – meaning the deficit (and not tax revenue) is endogenous.*
Foreign balance: exchange rate and current account	**Price adjustment to the balance of payments:** the exchange rate adjusts to hold the current account constant. *A constant current account corresponds to the idea of balanced trade; an exchange rate change combined with the 'right' price responses (elasticities) ensures that an increase in the value of imports is met by an equivalent increase in the value of exports.*	**Income or absorption adjustment to the balance of payments:** the current account adjusts according to demand shifts, and the exchange rate is exogenous. *Real-world import and export elasticities do not allow the exchange rate by itself to correct current account deficits. Given a relatively constant exchange rate and the elasticities, trade flows and consequently income accommodate exogenous shocks – including the price changes wrought by liberalisation.*
Labour markets: employment and wages	**Neoclassical labour market:** employment is constant, and the wage endogenous. *Wages adjust to a given (fixed, or full) level of employment, which corresponds to the neoclassical conviction that if only wages are flexible enough, everybody will find work.*	**'Keynesian' labour market:** the wage is "sticky" and employment endogenous. *If the wage is rigid due to institutional arrangements (e.g. unions), or represents a subsistence wage, unemployment is possible, as firms might not hire all labour supplied at this wage.*

Source: Adapted from Lance Taylor and Rudiger von Arnim (New School for Social Research, New York), "*Modelling the Impact of Trade Liberalisation – A Critique of Computable General Equilibrium Models*", Oxfam International, 2007.

A.3 The real wage closure assumption

While most economists would accept that real wage closure for labour markets may have some validity for the long run, many who accept this would argue that it is in practice irrelevant since the lags are lengthy and policy makers cannot wait until the market corrects itself. Because of this, in the absence of excessive inflation the Keynesian closure conditions are the only practical assumptions.

A second reason for preferring the Keynesian closure conditions is the weak evidence for real wage closure condition. If real wages were a powerful instrument for producing full employment, it would be expected that, within countries, the higher a region's real wage rate the higher would be the region's unemployment rate. The higher regional wage rate the more employers will shift to lower wage regions, thereby driving unemployment up in high wage regions and driving it down the low wage regions.

As NIEIR has argued in its "*State of the Regions 2008-09*" report and its predecessors, the evidence from the 65 regions in Australia is contrary. Average real incomes from work (wages plus unincorporated enterprise income) are inversely proportional to each region's unemployment rate. This should be of no surprise. D.G. Blanchflower and A.J. Oswald (1994) found more or less the same relationship across many regions of the world. Further, they found that the relationship was reasonably stable across regions and that the unemployment rate had a -0.1 elasticity with respect to the wage rate. CGE models assume that this elasticity is positive and high.

The reason for this disequilibriating finding is simply that the world has moved on from the 19th century world of CGE models. In the knowledge economy era it is skills, knowledge clusters and economies of scope that drive innovation and development. Regions which have these characteristics can sustain high wages, which, in a virtuous circle, attract skilled resources and enable the region to maintain its competitiveness.

Currently, with increasing mobility of skilled labour, the same mechanisms are beginning to apply to inter-country economic development.

A.4 The public sector financing closure assumption

The public sector closure assumption reflects the extreme neo-liberal doctrine of 'rational expectations' which has been used to limit government involvement in the economy since the 1970s. Basically the doctrine argues that if governments increase expenditure rational private sector decision makers will expect tax rates to rise in the future and therefore reduce current expenditures to a degree which completely nullifies government action – and vice versa for falls in government expenditure.

The rapid increases in public sector deficits that are currently accruing as a consequence of the GFC provide sufficient witness to the impracticality of this closure assumption. The current stimulus packages have the inevitable long term outcome of much increased public sector debt. If the 'rational expectations' doctrine had any validity the AU$4 trillion stimulus packages governments have put in place around the world would now be pushing economies towards depression, as in 1933. Instead the stimulus packages are putting a floor under economic activity and diverting economies back to stability, if not to a resumption of the 2005-08 boom.

It is self evident that public sector deficits are exogenous as assumed by Keynesian models and government fiscal policy can play an important role in driving economic growth.

A.5 From savings to investment causality

CGE models envisage that all savings in the economy enter the financial system, which proceeds to allocate them to investments on the basis of potential profitability. The cut-off line is set by the interest rate. If the flow of savings increases, the interest rate is reduced which allows more investment to proceed, and at the same time diminishes the incentive to save.

If the CGE model closure assumptions for the savings-investment mechanism had any validity, it would be expected that firm-specific factors would have a weak influence on the investment undertaken by each business. Aggregate and relative rates of return would be the key driver of investment. Unfortunately for CGE models, the overwhelming weight of empirical evidence at both the macro and micro levels concludes that firm/industry cash flow is the core driver of firm/industry investment. As an example, in the Mills *et. al.* (1994) study, a pooled time series cross section statistical analysis was undertaken for 66 companies listed on the Australian stock exchange for the period 1982 to 1992. While other drivers were included (sales, debt, etc.) and other general variables to test the CGE model hypothesis, the dominant driver of investment was firm cash flow, which is very different from national savings. This result has been validated countless times before and since.

A.6 The exchange rate closure assumption

In the standard applications of CGE models it is assumed that the exchange rate varies to maintain balance in the balance of payments. The argument is as follows. A deficit on the balance of payments means that export revenues plus earnings on overseas assets are less than expenditures on imports and income due to overseas investors. The resulting shortage of foreign exchange is assumed to lead to a devaluation of the deficit-country's currency, which discourages imports (they become more expensive) and encourages exports (they become more competitive).

For the exchange rate closure condition to be practical, both the export volume price elasticities and the import volume price elasticities need to be high. Thus the closure condition assumes that devaluation results in an improvement in the trade balance. However, a necessary effect of devaluation is an increase in the price of imports, and if the resulting reduction in purchases is small the importing country can end up spending more on imports than previously. Similarly, if the devaluation fails to spur export sales, export earnings can decrease, again worsening the balance. The CGE models avoid this problem by assuming commodity export supply elasticities of between 4 (the MMRF model) and up to 10 in other models. (The corresponding import volume price elasticities are generally in the range 0.5 to 1.0 which are acceptable – high export supply elasticities alone are sufficient to guarantee the desired result.) NIEIR has claimed over the last 30 years that there is not a shred of evidence to support these export volume price elasticity assumptions and the latest empirical evidence (Table A.3) from the IMF shows that this is still the case with non-oil commodity export elasticities (of the type required as input for CGE models) being very low.

This means that the initial impact of a devaluation is a deterioration in the current account balance, followed some time later by an improvement (a phenomenon popularised by Paul Keating as the J-curve). This slow and initially perverse reaction means not only that the exchange rate cannot fulfil the role it is assigned in CGE models; it is also of limited use as an instrument of public control because the authorities have to sit out a long period of perverse outcomes before a devaluation eventually achieves the desired long run current account outcome. In any case, floating exchange rates are not controlled by governments. Since deregulation the Australian dollar exchange rate has fluctuated considerably with a tendency to move in the exact opposite direction to that assumed by CGE models.

Table A.3 Export and import volumes: Coefficient estimates and implied elasticities (long run elasticities)

	Oil exporters (supply)	Non-oil commodity exporters (supply)	Manufacturing exporters (demand)	Import volume implied elasticities
Relative price	0.25	0.21	-0.83**	-0.43**
Income effects (GDP)	0.93*	2.45***	2.10**	1.55

Notes: Australia is not included in the non-oil commodity sample, but the markets covered by the sample operate in the same way as assumed by the GCE modellers.
* Significant at 10 per cent level.
** Significant at 5 per cent level.
*** Significant at 1 per cent level; estimation with intercept.

Source: Atish Ghosh, Alun Thomas, Juan Zalduendo, Luis Catao, Bikas Joshi, Uma Ramakrishnan, and Lupin Rahman, "*Exchange Rates and Trade Balance Adjustment in Emerging Market Economies*", International Monetary Fund, 2008.

In their modelling of emission abatement the Treasury, however, appear to have abandoned the usual exchange rate closure assumption, and instead assumed that the exchange rate tracks the terms of trade. The consequences of this change to the closure assumptions are not fully documented in the published report, but it appears that the balance of trade is constant (neither exports nor imports other than permits appear in the table of contributions to changes in GNP). It is hard to explain why the Treasury chose this methodological

reversal from the standard approach to the use of CGE models by itself and allied government agencies (such as the Productivity Commission). The standard approach allows the exchange rate to vary as required to ensure that the balance of payments remains balanced. If the Treasury had adopted the standard CGE approach by letting the exchange rate vary, the CGE-assessed costs of decarbonisation under the Garnaut-25 scenario compared to a business-as-usual case would have been substantially less and, at least for the short term and with realistic CO_2 abatement opportunities, their analysis should have shown that the economy would have been better off. This could help to explain the difference between the Climate Institute and Treasury assessments reported in Table 9.1. The adoption of a relatively fixed exchange rate in the Treasury assessment of carbon pricing is welcome as a step towards realism on Treasury's part, but calls into question previous macroeconomic policy assessments based on CGE modelling with fluctuating exchange rates.

The questionability of past policy assessments based on CGE modelling is relevant to the present study, since CGE modelling has provided the chief justification for the policy of leaving the development of trade-exposed industries to the market. If the exchange rate does not move so as to equilibriate the balance of payments, scope appears for government interventions designed to create competitiveness, scope which broadens if investment in the tradeable industries is discouraged by the risks inherent in fluctuating exchange rates. The exchange rate assumption in the Treasury modelling thus opens the way to the industry development measures included in the Strong Action scenario.

Treasury cannot have it both ways. If it wants to fix the exchange rate when it is analysing CO_2 abatement, it should redo all its past work on tariffs and micro-economic reform using this assumption. It would no doubt obtain results much closer to the assessments provided by NIEIR over the last 30 years. Alternatively, it should revise its CO_2 abatement assessment assuming a flexible exchange rate and so obtain considerably lower costs of adjustment. If Treasury does nothing, it lays itself open to the charge that it selects the model and model closure conditions that will give it the result it wants, having already made an a priori policy judgement.

NIEIR indeed uses the exchange rate as a policy instrument in this study. However what NIEIR is doing is calculating what the exchange rate has to be if sustainable macro-economic outcomes are to be produced. This does not mean that the exchange rate will necessarily assume these values. There is no guarantee that countries with balance of payments surpluses will continue to support the Australian dollar. After all, it is clear that the inability of the exchange rate to take "optimum" values over the last 25 years is one of the reasons for Australia's high debts, both external and internal. This is to be expected as there is no reason whatsoever to expect why foreign exchange markets should determine an exchange rate which is in line with desired macro-economic objectives.

It follows that, for sustainable growth in the future, the policy authorities will have to intervene to ensure that the exchange rate takes values near required values. This can be done as the Asian economies already do by directly controlling the impact of capital inflows on the domestic economy. The trick is to "sterilise" capital inflows when they are tending to appreciate the currency by offsetting capital outflow placements. If this is not done, Australia will almost certainly experience an exchange rate/banking crisis which will force it to fix the exchange rate at levels well below desired, with resulting rapid falls in Australian incomes and wealth. Once again we return to the need for intelligent macroeconomic policy, as outlined in Table 3.4 above.

A.7 Decarbonisation: The planning process

In addition to their closure assumptions, a fundamental feature of CGE models is that, in essence, they compare equilibria. The fundamental impulse is to compare an abstract economy with perfectly competitive markets dimensioned to the current position in a country such as Australia with the same abstract market economy as it would be now were specified control variables changed – for example, the abstract economy can be dimensioned to Australia now and then the dimensioning variables recalculated as they would be now were

there a carbon price. It is not for nothing that CGE models are happiest with small percentage changes that do not take the economy very far from its present position.

This said, strenuous efforts have been made to dynamise CGE models. There are two strategies:

- drive the CGE model with an external macroeconomic model; and
- insert adjustment delays into the attainment of the CGE solution.

There are, however, serious limits to the extent to which these strategies can be applied without rendering the CGE model insoluble. The basic mechanism is that CGE models determine the final outcome in period t_n based on the application of profit maximising decisions made on prices at t_0 on the factor prices prevailing at period t_0. Applying external macroeconomics very quickly results in inconsistent price patterns, while adjustment delays mean little unless there is a possibility of reconsideration of decisions in response to new information. Either way there is little that can be done without generating inconsistency or insolubility.

By contrast, post-Keynesian models are constructed in real time, and are open-ended as to the future. Whatever long run state is reached will be determined by the adjustment path, not by the theoretical target defined by the application of abstract theory in some long-past moment of decision. That is, in post-Keynesian models future states are determined by the process of cumulative causation where each short term decision based on the environment of the time combines with past decisions to determine the next decision process. Sometimes a state of steady economic growth is reached, but this cannot be guaranteed.

This lack of attention to decisions made over time means that CGE models cannot incorporate or analyse the practical issues associated with decarbonisation. A test of any model being used to evaluate decarbonisation is that it should be able to incorporate the implementation strategies now being applied around the world in a transparent manner. This is a simple, straightforward requirement.

The next question is: What does this requirement mean in practice? To understand this all that needs to be done is to look at, for example, the United Kingdom's planning framework for decarbonisation. Figure A.1 shows the typical planning stages for a given sector.

The starting point is the national CO_2 targets, for example, 25 per cent down from 1990 levels by 2020 and 30 per cent down by 2030, or the adjusted targets for domestic abatement after allowing for imported permits. The next step is to look across the CO_2 emitting sectors in the economy and allocate abatement to each sector so as to define its role in reaching the national target. This allocation is carried out on the basis of:

- CO_2 reduction per unit of expenditure;
- the sector's share of the national total;
- the sector's new technological possibilities for emission reduction; and
- the scope for the decarbonisation process to be planned and controlled.

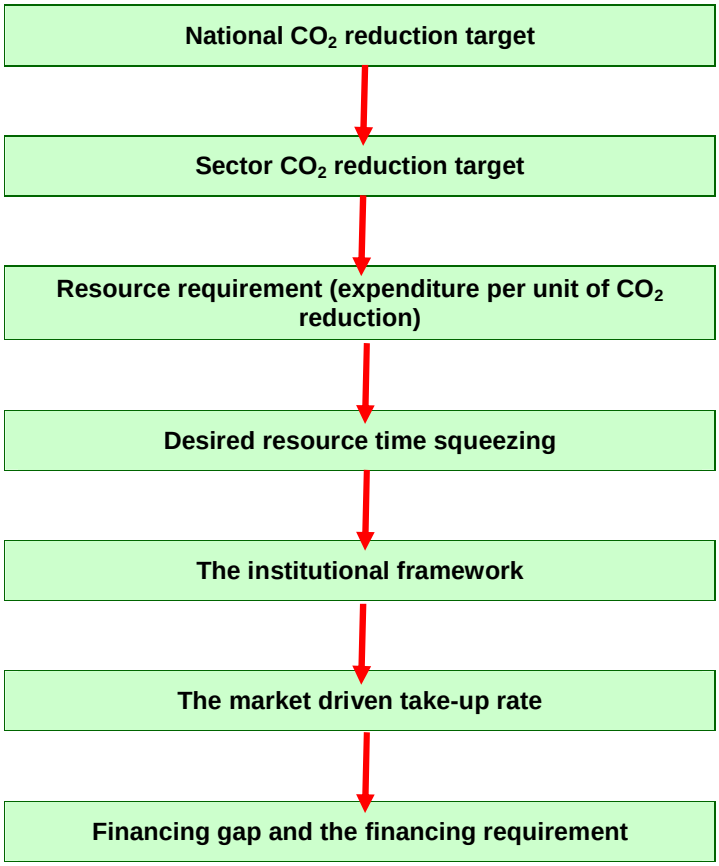
Having set the CO_2 reduction target for the sector on a year by year basis to the target year the next step is to calculate the resource requirement in terms of the optimal combination of decarbonisation instruments listed in Table 7.1 that are appropriate for the sector. This will be translated into a year by year expenditure profile that would have to be undertaken by businesses, households and governments in order to achieve the targeted CO_2 reduction.

All jurisdictions, including developing countries, will have a carbon price or carbon tax to provide incentives and revenues for the decarbonisation effort. The annual CO_2 price resulting from planning projections in the United Kingdom is listed in Table 3.7 (Weak action) converted into Australian dollars at exchange rates of mid-2008. Therefore, given the expenditure profile and the incentive provided by the carbon price, the next step is to work out the take-up rate of the decarbonisation investment expenditure by the private sector including both households and businesses. This in turn will depend on the initial payback period applied by households and businesses in making their decisions. The difference

between the required take-up rate to achieve the planned reduction and the market driven take-up rate will represent the "financing gap" where governments and their associated policy agencies will have to apply implementation instruments to close the gap. The implementation instruments are listed in Table A.3 and range from the low (government cost) instrument of regulation or limiting market availability of products with the lowest carbon intensity to the high expenditure instrument of grants to businesses and households to close the financing gap.

The modelling undertaken in this study explicitly follows this methodology which in turn because of the link between the micro and macro outcomes drives the overall results.

Figure A.1: The steps in the planning process for a decarbonising sector



A.8 The top down approach: The use of marginal abatement cost curves

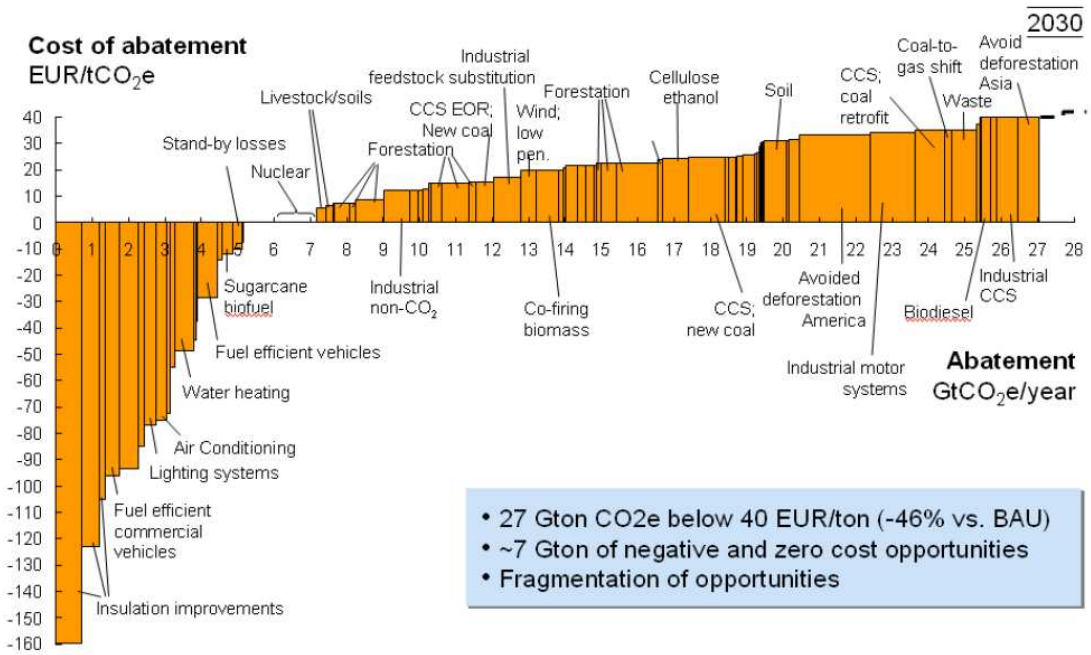
As can be seen, the bottom up approach requires a great deal of detail, high uncertainties, multiple implementation strategies and attention to implementation costs. Most importantly, it forces explicit recognition that the market is unlikely to deliver the take-up required despite a carbon price that the text book says should deliver bucketfuls of abatement.

In contrast the top down approach involving the use of marginal cost abatement curves (MAC) is pure text book.

Figure A.2 shows a specimen MAC curve for CO_2e reduction and its key driver energy efficiency improvement for United Kingdom households. It is ranked by measure and shows the CO_2e price required to induce adoption of the measure and the total CO_2e savings if the measure is fully implemented. Thus, the width of the bar for a measure (for example,

substituting for more efficient electronic products such as refrigerators) shows the scope for abatement while the height represents the unit cost of the measure in terms of price for CO_2e. A negative CO_2e cost of abatement indicates that the measure would be a net benefit at a zero CO_2e price. Thus, switching to more efficient electronic products now in the market compared to the stock installed would generate savings for households of over 150 euros per tonne of CO_2e saved. As the price of CO_2e rises, more and more measures become negative-cost and so become good prospective investments at the assumed discount rate, and the net benefits increase. It should, however, be admitted that the cost curve is simplified: the returns for many of the measures depend on the actual circumstances of each installation, and again some measures can vary in intensity – for example, as the carbon price rises it becomes economic to increase the thickness of home insulation. Figure A.2 also shows how the MAC abatement curve is applied to estimate the gains in CO_2e reduction which would be achieved at 40 Euro a tonne by 2030.

Figure A.2: Global cost curve for GHG abatement opportunities in 2030 from McKinsey – MAC curve 40 Euro a tonne CO_2 – 2030



Source: T. Wall, Asia-Pacific Partnership on Clean Development and Climate, University of Newcastle.

The key results from the analysis are that based on a 40 Euro a tonne of CO_2e (around AUD 65) there would be a 27 gigatonne CO_2e (or 46 per cent below business-as-usual) reduction by 2030, of which 25 per cent could be secured at zero CO_2e prices. Reasoning of this kind will be familiar from the Australian McKinsey and ClimateWorks studies, which, however, make no attempt at macroeconomic assessment.

A.9 MAC curves and Treasury modelling

In the CGE modelling reported in the *Economics of Climate Change* the Treasury made extensive, but not complete, use of MAC curves.

MAC curves were estimated for each sector. For incorporation into the MMRF model two or three basic curves were assessed for all sectors. MAC curves are designed as summaries of known technological opportunities for abatement, as in Figure A.2. However, the technological possibilities included at industry level in the Treasury's MAC curves are not documented and one suspects that detailed analysis would find empirical relevance lacking, at least in certain sectors (e.g. the beef cattle sector, where the implementation of emissions

pricing results in a reduction in methane emissions without any mechanism for reductions being proposed). Certainly the MAC curves assumed were all positive and the extensive literature on negative cost technology options does not seem to have been incorporated into the analysis or (more likely) was assumed to be incorporated into the reference case. In any short term sense this is implausible.

The Treasury discussion at this point is somewhat opaque, but it seems that an attempt was made to incorporate bottom-up modelling in the electricity, transport and land-use sectors by allowing the bottom-up analysis to influence the shape of the MAC curve. The result for each industry was that each CO_2e price gives the abatement technologies which will be installed, which in turn gives the CO_2e abatement and the increase in the cost of capital. The increase in the cost of capital has macroeconomic consequences.

What is important here is that the top down MAC approach adopts the "manna from heaven" assumption of technological change that is standard in the neoclassical economic literature where there is no formal description of the mechanisms by which the CO_2 abatement technologies are in fact installed. They are simply assumed to be installed if the price is right in accordance with the slope of the MAC schedule.

Therefore, the MAC curves approach in the context of GCE modelling ignores half the problem associated with decarbonisation strategies. The problem is that households, firms and governments are going to have to spend billions of real dollars over and above what would otherwise have been the case. The key question in a constrained economy like Australia is how these additional expenditures are to be resourced in terms of foregone expenditure, and what their effect will be on constraints such as the balance of payments. A bottom up approach, where the implementation expenditures are specified year by year forces the resourcing issue to front stage.

In CGE modelling the key outcome driver is the relative increase in the nominal cost of capital due to the additional expense of using low-CO_2 technology.

The problems with the use of MAC schedules in assessing the economics of climate change are immediately seen from the way they are constructed.

The curves are calculated by:

(i) adopting a discount rate, for example 10 per cent;

(ii) working out the energy cost savings from the project excluding CO_2 prices;

(iii) calculating the net present value (NPV) of the project over the project life and multiply by -1; and

(iv) dividing the result in (iii) by the CO_2 savings on the project, discounted according to (i).

In reality, households and firms generally use a much higher discount rate – indeed the UKCCC notes that the rate can go as high as 100 per cent. In addition, the MAC approach ignores an essential element in the analysis, namely the opportunity cost of the alternative use of the resources, which often provides a strong rationale for high effective discount rates. These realities are evidenced by the continued existence of negative cost decarbonisation options that are not taken up despite the very high returns for doing so. The evidence is that firms and households do not install new technologies simply because the MAC schedules say they should. The reasons for this are many and varied, including financing constraints which force short payback periods, the opportunity costs of alternative use of the resources when these are higher than energy cost savings, and lack of information and inertia, all of which are missing from the mechanical application of MAC curves.

NIEIR in reports for the Brotherhood of St Laurence (2008) and *State of the Regions* (2008) explored this issue in detail. An important issue was the need, in the majority of instances, to replace a whole unit of capital (such as a truck or a computer) when installing new CO_2 abatement technology. When this was necessary, the opportunity cost is production lost because the enterprise forgoes buying one additional unit of capital for capacity expansion – capacity has been held constant since the new unit of capital (such as a truck) has simply replaced an older inefficient one. The cost of lost sales could offset the energy savings gain.

It is the same for consumer goods. The current position is that Australian households could replace around 1.5 million fridges aged ten years and over, save 1,100 gigawatt hours of electricity and so save $180 million a year in energy bills at a payback of 9.5 years. However, they would have to spend $1.8 billion. Under a $100 a tonne carbon price the payback period would be reduced to nearer seven years. However, the opportunity cost in terms of additional utility of purchasing something else, such as a plasma television screen, would no doubt far outweigh the monetary cost savings perceived by many households. Households generally will only replace fridges when they have to and will continue to do so irrespective of carbon prices, except at extremely high price levels.

In summary, the MAC top down approach ignores two key obstacles that heavily influence the economics of climate change, namely the:

(i) resources that have to be applied to install the technologies; and

(ii) the opportunity cost of the use of the resources.

The differences in the Australian Treasury analysis in this regard render it as an implausible gamble for the economies of decarbonisation. This mistake is not made in this study.

A.10 The mechanism of CO_2 reduction in the NIEIR model (Intermediate and Strong action scenarios)

For this study of CO_2 reduction, a wide range of instruments is incorporated in the model, as per Table 2.1. The methodology for modelling mandated initiatives and direct government expenditures has been described in section 2.3 above. For complete documentation it is, however, necessary to add the following detail concerning the role of payback periods in NIEIR's modelling of the effectiveness of incentive-based policies.

Decisions by households and businesses as to whether or not to invest in energy efficiency/abatement technologies are focussed on the payback period. The literature suggests that businesses make energy efficiency decisions based on payback periods of between three and five years. In the early years from 2010 a four year payback period is assumed. For households a 2.7 year payback period is assumed.

These payback periods are an average around which there will be some take-up for higher payback periods as well as lower payback periods. For businesses the part of the population that will initiate an investment for a given payback period is:

$$pb_i = 1/(1 + exp\ (+2.287 + 0.731\ .\ i) \qquad \text{(A.1)}$$

Where:

pb_i =cumulative percentage of population that will implement investment decisions with a payback period of i given an overall average payback period of four years.

For households around the 2.7 year average payback period the calculation distribution is:

$$ph_i = 1/(1 + esp\ (+2.087\ and\ 1.200\ i) \qquad \text{(A.2)}$$

Where:

ph_i = proportion of households that will implement an investment decision for payback period i given an overall payback average of 2.7 years.

By using these payback assumptions in conjunction with prices and technical opportunities, the model works out the total expenditure required for each initiative to reach the CO_2 target for a given year along with the average payback period for each initiative. Equations (A.1) and (A.2) work out how much of the required top-up will occur by stand-alone household or business decision making. This allows calculation of the additional subsidy that would be necessary for the total expenditure required for each initiative (if the emission target is to be met) to be generated subject to the constraint that the post-subsidy average payback rate for business is four years and 2.7 years for households. The subsidy rate is then discounted by 50 per cent to reflect the influence of marketing, peer pressure, leverage, etc. that Government can bring to programs to reduce costs.

Table A.4	Sources of data per initiative costs and benefits in terms of energy savings and payback periods
Household sector	Many sources are used. The estimates are summarised in NIEIR/ALGA "*State of the Regions – 2008-09*", December 2009, Chapter 10.
Mandated energy	Technology assumptions from Australian Treasury "*Australia's Low Pollution Future*", page 251. On the grounds of conservatism, that is to bias the costs upwards, no allowance is made for net expenditure savings in replacement of existing electricity capacity.
Transport sector initiatives	"*Climate Change and Local Transport: Achieving Emissions Reductions*", BusVic, July 2008.
Biofuels	Initially plants based on canola oil then in the 2020 plants based on weeds and algae.
Electric cars	"Meeting Carbon Budgets – the need for a stop change", The United Kingdom Committee on Climate Change, October 2009. The recommended electric car subsidy is adopted in this report.
Industry	Estimates based on data from Sustainable Energy Authority of Victoria, as per Table 9.5.
Administration and marketing cost (public sector expenditures)	A once-off $80 a tonne for each tonne reduction in emissions.
Land use initiatives	Initially around $20 a tonne for each tonne reduction in emissions. For each additional 10 million CO_2 reduction from land use changes the marginal cost increases by $5.6 a tonne.

Table A.5 Energy efficiency potential improvement (EEIP) from 2010-2035

Aggressive carbon pricing			Business as usual plus low carbon pricing		
	Energy efficiency improvement – 4-year average payback			Energy efficiency improvement – 4-year average payback	
Sector	**2020 %**	**2035 %**	**Sector case study**	**2020 %**	**2035 %**
Industrial sector					
A. Agriculture	20.0	40	A. Agriculture – est.	12.0	25
B. Mining	20.0	40	B. Mining	3.8	10
C. Manufacturing (overall average)	23.0	45	C. Manufacturing	14.5	30
21 Food, beverage	25.0	50		19.5	35
22 Textile, clothing	25.0	50		15.0	25
23-24 Wood, paper	20.0	40		14.8	25
252-6 Chemicals	25.0	40		17.7	30
26 Non-metallic minerals	30.0	50		21.2	35
271 Iron and steel	30.0	50		14.5	20
272-3 Basic non-ferrous metals	15.0	25		7.8	15
274-6 Other metals	20.0	35		10.0	20
28 Machinery and equip.	25.0	45		15.0	25
29 Other manufacturing	25.0	45		15.0	25
E. Construction	20.0	40		12.0	20
Commercial sector (overall average)	28.0	55		21.5	35
Offices (J, K, L, M)	28.0	55		10.0	35
				12.8	25
Wholesale & retail (F,G,O)	26.0	50		25.4	40
Health & community (O)	29.0	55		17.7	35
Education (N)	28.0	55			
Accommodation and restaurants (H)	29.0	60		19.8	35
Culture & recreation (P)	28.0	55		18.7	35

Source: NIEIR based on data from Sustainable Energy Authority of Victoria.

Finally, for each dollar rise in the CO_2 price above $40, the percentage of households using a five year payback period increases, as does the percentage of businesses using a ten year payback period.

The energy demand function in the NIEIR model

The modelling of energy demand in the model used for this study takes the form:

$$\sum_{i,t} = [(ut_{i,t,\,i-1} \sum^{n} ef_{i,t-j} \,.\, IV_{i,t-j}) \,.\, (IEF_{i,t})] \,.II_{i,t}$$

i = 1, ... 60

Where:

$\sum_{i,t}$ = energy demand in petajoules by industry i;

$ut_{i,t}$ = capacity utilisation rate of industry i in period t;

$ef_{i,t}$ = petajoules per dollar of investment for industry i in period t;

$IV_{i,t}$ = gross investment in $1999 million by industry i in period t;

$IEF_{i,t}$ = index reflecting zero cost energy efficiency savings that could be made in industry i in period t; and

$II_{i,t}$ = impact on energy demand of initiatives, $II_{i,\,2010} = 1.0$.

In addition:

$$IEF_{i,t} = IEF_{i,\,2006} \,.\, (Pe_{i,t} / Pe_{i,\,2006})^{a_1} \qquad (9.3)$$

Where:

$Pe_{i,t}$ = real price of energy for industry i in period t, including the carbon price,

with $IEF_{i,t}$ set between 1.15 and $i,\,2006$ 1.25 and a_1 set around -0.9.

Table A.6 Average annual change in energy per dollar of investment – 1976-2005	
Agriculture	2.5
Mining	2.7
Food	-2.2
Textiles	-2.7
Wood and paper	-2.2
Petroleum	-2.3
Basic chemicals	-0.8
Other chemicals	1.3
Glass	-6.0
Ceramics	-0.7
Cement	-2.7
Other non-metallic minerals	-0.8
Iron and steel	-1.5
Basic non-ferrous metals	0.9
Fabricated metal products	-1.1
Machinery	-2.1
Other manufacturing	3.5
Construction	-6.2
Transport	-0.4
Commercial services	-1.4
Motor vehicles	-0.4
Household durables	-0.8

Source: NIEIR.

Table A.6 shows the trend value of change in ef_i over the last 30 years.

Up until now the value of rate of change of ef_i was largely set by overseas manufacturers because the key driver of energy efficiency changes was the energy efficiency gains embodied in the newly installed equipment capital stock. For Australia, equipment is either manufactured overseas or uses core components manufactured or designed overseas. Thus, in the past the rate of ef_i would have been largely exogenous.

In terms of the future, for most industries (shown in Table A.6) the rate of energy efficiency improvement is assumed to accelerate by 0.8 per cent per annum. For household dwellings the acceleration is 1.3 per cent per annum and for motor vehicles it is 3.0 per cent per annum. These accelerations are justified on the basis that of the acceptance of the rest of the developed world of aggressive CO_2 reduction targets.

Each initiative, in so far as it is industry specific, will also impact on energy demand. These initiatives will have an impact over and above the energy efficiency embodied in the equipment used. However, compared to the past, the impact of the initiatives is assumed to take place via the II_i indices, which are driven by the cumulative effect of the take-up of each initiative and the energy saving characteristics of each initiative at the time of take-up. This means that energy demand functions in the future will be quite different from those of the immediate past.

A.11 CGE models and comparative statics

As already noted in Section A.7 CGE models lack dynamics; they are essentially comparative static in nature. 'Comparative statics' may be defined as a methodology by which one equilibrium position of the economy is compared with another. The process begins by calibrating the model with current values for each variable, then imposing a shock, for example a carbon price, and calculating the resulting alternative equilibrium with changed utilisation of capital and labour. The modelling takes into account the carbon price, changed factor prices and changes in input utilisation and output patterns compatible with the new set of prices. The model results derive from a comparison of the two equilibrium positions, without and with the carbon price.

The so-called dynamic CGE models are not really dynamic, since the same equilibrium end point is the target. They simply chart out a time path for adjustment. The real problem with the comparative static approach is that it cannot incorporate the planning dynamics outlined in the previous sections. Given the carbon price, the marginal abatement cost curve gives the CO_2 reduction and the increase in the cost of capital which in turn gives the change to factor prices and the overall outcome.

Most important of all is that the central economic problem associated with decarbonisation is generating and applying the resources to achieve the targets, given that expenditure is required over and above the level that would otherwise have been applied in the sectors being decarbonised. This is ignored in CGE models because the capital is already there; it only requires reconfiguration, which is assumed to be undertaken without additional expenditure. There is an argument that this might be possible for short-life equipment which is frequently replaced, but is not accurate otherwise. The comparative static approach allows this vital adjustment mechanism to be ignored completely.

The macroeconomic structure of CGE models renders them unsuitable to provide any insight into the economy-wide issues which arise in planning and implementing plans for a decarbonising world.

A.12 Model selection: What does it mean for the results obtained?

The above discussion is background. The core issue is: How does model selection influence the assessment of the costs and benefits of CO_2 abatement? This assessment is outlined in Figure A.3.

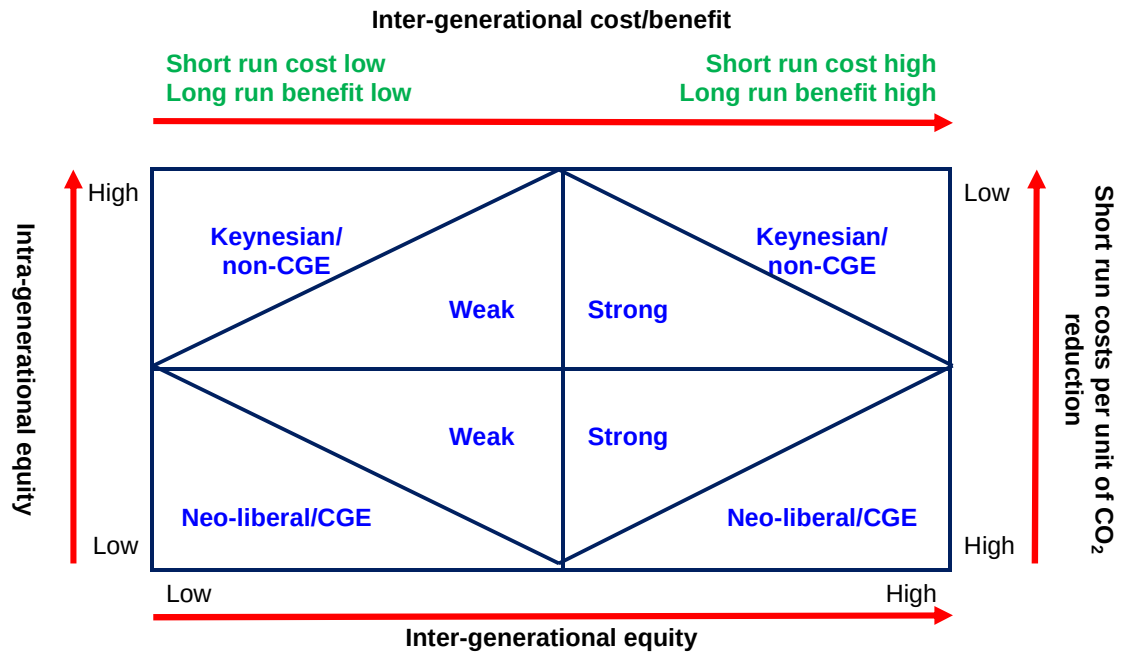
In non-CGE models that use a Keynesian policy framework in which all policy instruments are available it is always possible to target industries for resource release so that the only impact is on consumption expenditures, and then only on consumption expenditures that

involve minimum opportunity costs for the macro economy. In theory, if it is feasible (for example) for Governments by technological innovation to release resources from public administration (by definition part of consumption expenditure) which in terms of welfare foregone would have no impact on the macro-economy.

Secondly, CGE models impose high intra-generational equity costs. If, for example, interest rates are assigned a large role in the adjustment (at least implicitly since the adjustment path is not assessed), this imposes high cost on those of the current generation who have high debts, first home owners, etc. to the benefit of the high net asset households. This can also happen when constructing scenarios using non-CGE models, but is not a necessary result because a much wider range of instruments is available to target intra-generational equity.

As regards the longer term, the failure of CGE models to capture the feedback from energy efficiency improvements and reductions in imports to the macro-economy again means that many of the long run benefits of CO_2 abatement are assumed away. The fully-developed two-way interaction between top-down and bottom-up elements in non-CGE models allows scenarios to be developed which fully capture the benefits of CO_2 abatement.

Figure A.3: Cost-benefit trade-offs in model selection to evaluate CO_2 abatement



Note: Same CO_2 reduction target assumed for all quadrants. Strong implies no imported permits. Weak implies high level of imported permits.

A.13 Conclusion

By adoption of a modelling system which incorporates bottom-up opportunities and constraints into an essentially bottom-up macroeconomics, NIEIR is forced to the conclusion that abatement requires an investment program and this requires resources – it has a cost. However, that cost will be reduced if carbon pricing is complemented by sector-specific measures selected and evaluated for their potential to generate low-cost abatement, including the net cost reductions available from offsetting benefits.

NOTE: Appendices B to G comprise detailed tables of results. They are available in pdf versions of this report, or may be downloaded separately from the ACF website.

Appendix B: Green jobs by industry

This is the first of a series of appendices giving detailed modelling results. The results are published to allow readers to satisfy themselves that detailed modelling work has been done, and to make their own checks of modelling consistency – remembering that the mechanisms at work are as described in this report.

The publication of these appendices also constitutes a challenge to other analysts who claim to have done detailed work to publish in similar detail.

The table in this Appendix is appended to Chapter 9.

Table B.1 Direct and indirect employment from CO_2 reduction expenditures by input-output industry categories – 2025

	Direct employment			Direct and indirect employment (gross green employment)		
Industry	**Weak scenario**	**Intermediate scenario**	**Strong scenario**	**Weak scenario**	**Intermediate scenario**	**Strong scenario**
Sheep	0	0	0	82	205	338
Grains	8165	28420	26735	8017	28887	28279
Beef cattle	0	0	0	494	1145	1610
Dairy cattle	0	0	0	60	147	220
Pigs	0	0	0	40	94	131
Poultry	0	0	0	36	83	118
Other agriculture	0	0	0	1901	6470	7279
Services to agriculture; hunting and trapping	3180	11069	11387	3147	11286	12084
Forestry and logging	7699	26797	27569	7825	28092	30224
Commercial fishing	0	0	0	31	80	146
Coal; oil and gas	0	0	0	1661	3159	3661
Iron ores	0	0	0	21	51	174
Non-ferrous metal ores	0	0	0	44	106	365
Other mining	0	0	0	214	523	805
Services to mining	0	0	0	204	397	535
Meat and meat products	0	0	0	311	721	1010
Dairy products	0	0	0	29	70	104
Fruit and vegetable products	0	0	0	5	12	22
Oils and fats	1342	2848	2896	1298	2861	3027
Flour mill products and cereal foods	0	0	0	18	46	73
Bakery products	0	0	0	50	125	222
Confectionery	0	0	0	6	17	31
Other food products	0	0	0	146	385	509
Soft drinks, cordials and syrups	0	0	0	7	15	20
Beer and malt	0	0	0	1	1	3
Wine and spirits	0	0	0	35	97	169
Tobacco products	0	0	0	0	0	0
Textile fibres, yarns and woven fabrics	0	0	0	24	62	134
Textile products	0	0	0	158	428	729
Knitting mill products	0	0	0	5	14	25
Clothing	0	0	0	67	179	349
Footwear	0	0	0	8	17	32
Leather and leather products	0	0	0	4	9	25
Sawmill products	0	0	0	269	674	883
Other wood products	0	0	0	469	1180	1522
Pulp, paper and paperboard	0	0	0	55	145	269
Paper containers and products	0	0	0	251	593	963
Printing and services to printing	0	0	0	679	1820	3536
Publishing; recorded media etc	0	0	0	371	1022	2079
Petroleum and coal products	0	0	0	82	203	291
Basic chemicals	293	691	3553	659	1704	5853
Paints	55	129	664	224	554	1713
Medicinal and pharmaceutical products, pesticides	27	65	332	145	450	873

Table B.1 Direct and indirect employment from CO_2 reduction expenditures by input-output industry categories – 2025 (continued)

Industry	Direct employment			Direct and indirect employment (gross green employment)		
	Weak scenario	Intermediate scenario	Strong scenario	Weak scenario	Intermediate scenario	Strong scenario
Soap and detergents	55	129	664	64	163	713
Cosmetics and toiletry preparations	55	129	664	54	133	650
Other chemical products	82	194	996	170	421	1388
Rubber products	0	0	0	198	455	992
Plastic products	0	0	0	610	1457	2834
Glass and glass products	0	0	0	129	319	740
Ceramic products	0	0	0	331	811	1071
Cement, lime and concrete slurry	0	0	0	335	812	941
Plaster and other concrete products	0	0	0	663	1567	1750
Other non-metallic mineral products	0	0	0	159	414	592
Iron and steel	0	0	0	1012	2454	8608
Basic non-ferrous metal and products	0	0	0	143	344	1248
Structural metal products	487	1149	5908	1793	4355	12943
Sheet metal products	573	1353	6955	748	1819	7937
Fabricated metal products	1518	3584	18430	2615	6376	23538
Motor vehicles and parts; other transport equipment	3106	7336	37720	3415	8400	41933
Ships and boats	0	0	0	4	11	19
Railway equipment	346	816	4196	374	908	4587
Aircraft	0	0	0	40	103	171
Photographic and scientific equipment	438	1034	5318	395	972	5094
Electronic equipment	622	1469	7554	840	2085	8501
Household appliances	355	837	4305	358	878	4320
Other electrical equipment	355	837	4305	1029	2346	7209
Agricultural, mining etc machinery	185	437	2245	663	1682	4080
Other machinery and equipment	1664	3931	20209	1902	4666	21487
Prefabricated buildings	0	0	0	85	179	269
Furniture	0	0	0	114	316	718
Other manufacturing	0	0	0	83	204	411
Electricity supply	14969	26668	27043	14793	27605	30127
Gas supply	0	0	0	405	786	967
Water supply; sewerage and drainage services	0	0	0	340	858	1240
Residential building	4076	9626	9976	3592	8809	9498
Other construction	21737	51340	53203	19951	48826	53196
Wholesale trade	1021	2412	10612	6554	16122	35086
Retail trade	0	0	0	1428	3531	8307
Mechanical repairs	0	0	0	2452	6191	9230
Other repairs	0	0	0	1515	3813	6197
Accommodation, cafes and restaurants	0	0	0	2702	7018	13348
Road transport	0	0	0	2641	6880	10808
Rail, pipeline and other transport	0	0	0	1204	2533	3521
Water transport	0	0	0	84	192	328
Air and space transport	0	0	0	298	753	1437
Services to transport; storage	0	0	0	1289	3350	6281

Table B.1 Direct and indirect employment from CO_2 reduction expenditures by input-output industry categories – 2025 (continued)

	Direct employment			Direct and indirect employment (gross green employment)		
Industry	**Weak scenario**	**Intermediate scenario**	**Strong scenario**	**Weak scenario**	**Intermediate scenario**	**Strong scenario**
Communication services	0	0	0	1387	3535	6654
Banking	0	0	0	2203	5004	7208
Non-bank finance	0	0	0	887	2020	3135
Insurance	0	0	0	286	735	1212
Services to finance, investment and insurance	0	0	0	854	2136	3242
Ownership of dwellings	0	0	0	0	0	0
Other property services	0	0	0	1945	4832	8811
Scientific research, technical and computer services	3835	12048	18365	6515	19142	32401
Legal, accounting, marketing and business management services	1406	3321	15356	5442	13823	34276
Other business services	1617	11379	23409	5337	20237	43028
Government administration	183	5562	5726	1043	7730	10208
Defence	0	0	0	0	0	0
Education	0	0	0	1143	2740	4806
Health services	0	0	0	153	437	846
Community services	0	0	0	0	0	0
Motion picture, radio and television services	0	0	0	366	1024	2179
Libraries, museums and the arts	0	0	0	126	341	686
Sport, gambling and recreational services	0	0	0	16	46	95
Personal services	0	0	0	189	509	1092
Other services	0	0	0	353	864	1737
Total	**79440**	**215608**	**356295**	**134974**	**361201**	**626368**

Table B.2 Gross green skills and green employment increase

	Gross (green skills or supporting green skills)				Green employment increase compared to 2010 (excludes displaced skills, e.g. in black coal stations)			
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Chief Executives and Managing Directors	1193.3	879.9	1957.6	2438.6	3462.6	4963.9	1193.3	879.9
General Managers	818.6	632.6	1363.7	1705.4	2324.4	3334.2	818.6	632.6
Legislators	7.5	7.1	42.9	39.2	37.4	67.1	7.5	7.1
Aquaculture Farmers	15.5	16.3	30.2	48.2	45.9	76.2	15.5	16.3
Crop Farmers	1766.4	3249.4	5385.7	13466.1	5613.0	14456.6	1766.4	3249.4
Livestock Farmers	863.1	1269.2	2073.2	4326.5	2463.8	5140.7	863.1	1269.2
Mixed Crop and Livestock Farmers	3343.2	6607.9	10803.4	27915.9	10615.2	28940.3	3343.2	6607.9
Advertising, Public Relations and Sales Managers	2044.2	1640.7	3256.8	3889.9	6110.8	8635.8	2044.2	1640.7
Corporate Services Managers	466.7	346.6	806.1	1024.2	1302.3	1886.4	466.7	346.6
Finance Managers	923.2	745.8	1560.7	1930.4	2583.1	3690.9	923.2	745.8
Human Resource Managers	687.0	569.0	1246.3	1474.4	2010.8	2803.7	687.0	569.0
Policy and Planning Managers	173.9	178.2	487.0	571.1	558.6	906.8	173.9	178.2
Research and Development Managers	186.6	167.5	343.3	466.8	570.4	875.2	186.6	167.5
Construction Managers	2864.7	418.2	3428.4	2918.1	4119.7	3710.8	2864.7	418.2
Engineering Managers	696.1	563.9	1074.6	1302.2	1965.0	2784.4	696.1	563.9
Importers, Exporters and Wholesalers	343.9	280.5	519.5	640.7	1006.7	1443.9	343.9	280.5
Manufacturers	800.4	559.4	1057.3	1098.0	2678.5	3736.9	800.4	559.4
Production Managers	1864.0	1575.8	2881.4	3918.9	6028.9	9118.3	1864.0	1575.8
Supply and Distribution Managers	610.1	517.8	975.4	1246.9	1754.8	2550.0	610.1	517.8
Child Care Centre Managers	7.7	6.4	22.5	21.8	26.1	39.5	7.7	6.4
Health and Welfare Services Managers	21.3	16.8	54.8	55.6	74.8	108.3	21.3	16.8
School Principals	34.8	32.6	65.2	78.5	99.1	141.9	34.8	32.6
Other Education Managers	23.7	21.9	53.6	59.7	76.3	110.8	23.7	21.9
ICT Managers	510.9	460.2	925.4	1137.9	1460.8	2103.7	510.9	460.2
Commissioned Officers (Management)	7.7	6.2	13.7	16.3	21.8	31.1	7.7	6.2
Senior Non-commissioned Defence Force Members	0.4	0.4	0.9	1.1	1.4	2.0	0.4	0.4
Other Specialist Managers	927.2	842.6	1598.6	2038.5	2590.0	3769.3	927.2	842.6
Cafe and Restaurant Managers	248.5	212.3	435.0	533.2	747.1	1071.4	248.5	212.3
Caravan Park and Camping Ground Managers	31.8	34.1	65.9	110.0	96.6	166.3	31.8	34.1
Hotel and Motel Managers	119.2	101.1	206.8	254.5	350.2	501.0	119.2	101.1
Licensed Club Managers	31.8	26.9	55.0	67.8	93.9	134.8	31.8	26.9

Table B.2 Gross green skills and green employment increase (continued)

	Gross (green skills or supporting green skills)				Green employment increase compared to 2010 (excludes displaced skills, e.g. in black coal stations)			
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Other Accommodation and Hospitality Managers	51.9	40.9	89.5	108.2	146.7	206.5	51.9	40.9
Retail Managers	1077.7	837.2	1702.4	2142.4	3063.4	4409.1	1077.7	837.2
Amusement, Fitness and Sports Centre Managers	18.7	12.6	41.5	40.8	59.0	81.7	18.7	12.6
Call or Contact Centre and Customer Service Managers	590.6	468.9	986.3	1159.1	1663.7	2319.0	590.6	468.9
Conference and Event Organisers	149.4	122.3	341.5	337.1	576.6	746.4	149.4	122.3
Transport Services Managers	267.6	220.7	452.1	625.6	665.4	990.8	267.6	220.7
Other Hospitality, Retail and Service Managers	689.1	542.1	1214.3	1474.9	1792.9	2505.9	689.1	542.1
Actors, Dancers and Other Entertainers	25.3	20.9	46.4	55.5	81.2	115.0	25.3	20.9
Music Professionals	34.3	28.1	60.8	72.5	105.5	149.4	34.3	28.1
Photographers	34.4	27.5	57.0	67.9	106.3	152.4	34.4	27.5
Visual Arts and Crafts Professionals	92.4	46.9	133.6	143.2	228.2	299.5	92.4	46.9
Artistic Directors, and Media Producers and Presenters	117.3	100.5	203.9	253.6	389.3	567.3	117.3	100.5
Authors, and Book and Script Editors	32.1	27.1	61.2	73.1	104.9	150.5	32.1	27.1
Film, Television, Radio and Stage Directors	86.2	71.9	152.9	184.1	290.0	416.1	86.2	71.9
Journalists and Other Writers	235.3	196.0	423.3	497.3	742.8	1061.2	235.3	196.0
Accountants	3295.3	2734.5	5284.7	6259.3	9932.0	14100.9	3295.3	2734.5
Auditors, Company Secretaries and Corporate Treasurers	283.0	261.9	525.6	641.5	815.2	1193.4	283.0	261.9
Financial Brokers	239.3	232.2	433.2	592.0	605.9	904.6	239.3	232.2
Financial Dealers	269.2	258.1	519.0	676.5	695.9	1036.5	269.2	258.1
Financial Investment Advisers and Managers	411.8	368.2	743.7	943.0	1069.6	1535.0	411.8	368.2
Human Resource Professionals	877.4	748.9	2094.3	2079.0	3477.8	4451.7	877.4	748.9
ICT Trainers	28.1	23.2	50.3	56.5	87.3	121.2	28.1	23.2
Training and Development Professionals	293.1	269.5	557.1	647.4	864.2	1204.7	293.1	269.5
Actuaries, Mathematicians and Statisticians	63.7	58.3	120.6	153.5	200.0	298.7	63.7	58.3
Archivists, Curators and Records Managers	47.7	45.9	107.2	133.5	149.8	229.2	47.7	45.9
Economists	53.5	52.7	121.2	146.5	166.5	246.1	53.5	52.7
Intelligence and Policy Analysts	69.3	70.7	275.8	286.3	282.6	481.2	69.3	70.7

Table B.2 Gross green skills and green employment increase (continued)

	Gross (green skills or supporting green skills)				Green employment increase compared to 2010 (excludes displaced skills, e.g. in black coal stations)			
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Land Economists and Valuers	306.1	135.9	447.8	472.2	619.4	755.7	306.1	135.9
Librarians	57.1	50.2	144.4	157.6	196.9	304.1	57.1	50.2
Management and Organisation Analysts	798.7	734.3	1614.5	1845.1	2579.5	3513.1	798.7	734.3
Other Information and Organisation Professionals	139.7	133.2	325.8	379.8	436.0	663.5	139.7	133.2
Advertising and Marketing Professionals	778.7	663.1	1303.4	1599.8	2440.3	3518.4	778.7	663.1
ICT Sales Professionals	160.4	125.5	249.2	286.9	494.8	694.8	160.4	125.5
Public Relations Professionals	216.5	199.4	469.4	552.4	715.1	1016.4	216.5	199.4
Technical Sales Representatives	516.8	432.0	766.8	916.3	1638.7	2349.7	516.8	432.0
Air Transport Professionals	120.0	148.3	265.4	500.8	367.7	692.6	120.0	148.3
Marine Transport Professionals	97.1	84.5	172.0	229.3	265.4	393.2	97.1	84.5
Architects and Landscape Architects	689.6	603.5	1248.0	2010.9	1958.2	3249.4	689.6	603.5
Surveyors and Spatial Scientists	370.9	359.1	732.0	1178.1	986.9	1671.5	370.9	359.1
Fashion, Industrial and Jewellery Designers	160.2	129.7	235.4	279.7	550.6	799.5	160.2	129.7
Graphic and Web Designers, and Illustrators	648.8	598.9	1165.7	1737.6	2031.8	3235.2	648.8	598.9
Interior Designers	217.6	166.3	364.4	543.6	598.4	939.3	217.6	166.3
Urban and Regional Planners	154.2	150.6	369.9	540.4	481.2	830.5	154.2	150.6
Chemical and Materials Engineers	105.0	91.1	165.9	218.4	332.6	495.9	105.0	91.1
Civil Engineering Professionals	1072.6	747.8	1823.0	2535.4	2681.8	4074.1	1072.6	747.8
Electrical Engineers	1229.8	1275.1	2096.7	2711.3	2686.5	3723.4	1229.8	1275.1
Electronics Engineers	170.2	137.1	243.4	279.2	601.4	868.5	170.2	137.1
Industrial, Mechanical and Production Engineers	1055.5	868.2	1493.5	1700.0	3706.0	5336.6	1055.5	868.2
Mining Engineers	178.4	170.7	311.4	445.0	455.4	691.3	178.4	170.7
Other Engineering Professionals	209.4	189.8	353.2	476.0	664.3	1002.0	209.4	189.8
Agricultural and Forestry Scientists	769.7	1397.2	2361.6	5821.4	2597.7	6494.5	769.7	1397.2
Chemists, and Food and Wine Scientists	173.5	169.4	301.7	437.2	552.2	863.5	173.5	169.4
Environmental Scientists	290.1	317.1	702.1	1018.1	932.7	1524.3	290.1	317.1
Geologists and Geophysicists	143.0	144.3	275.4	403.5	404.9	640.1	143.0	144.3
Life Scientists	116.5	125.5	252.7	424.6	378.2	666.8	116.5	125.5
Medical Laboratory Scientists	169.9	170.2	321.9	534.0	533.4	904.4	169.9	170.2

Table B.2 Gross green skills and green employment increase (continued)

	Gross (green skills or supporting green skills)				Green employment increase compared to 2010 (excludes displaced skills, e.g. in black coal stations)			
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Veterinarians	11.5	14.5	31.0	54.5	38.7	75.5	11.5	14.5
Other Natural and Physical Science Professionals	66.6	59.3	115.9	164.1	213.8	333.5	66.6	59.3
Early Childhood (Pre-primary School) Teachers	27.2	25.1	58.4	65.4	83.7	120.6	27.2	25.1
Primary School Teachers	258.3	243.7	478.5	586.6	737.2	1056.7	258.3	243.7
Middle School Teachers (Aus) / Intermediate School Teachers (NZ)	2.5	2.4	4.7	5.7	7.3	10.3	2.5	2.4
Secondary School Teachers	246.5	230.5	446.6	546.1	692.7	986.2	246.5	230.5
Special Education Teachers	30.0	27.8	56.9	68.2	87.1	124.1	30.0	27.8
University Lecturers and Tutors	84.5	79.5	150.4	188.8	238.4	341.9	84.5	79.5
Vocational Education Teachers (Aus) / Polytechnic Teachers (NZ)	178.7	171.7	336.4	424.6	513.6	733.4	178.7	171.7
Education Advisers and Reviewers	36.1	32.5	93.2	99.1	134.6	194.4	36.1	32.5
Private Tutors and Teachers	65.8	59.5	122.6	152.9	190.5	274.9	65.8	59.5
Teachers of English to Speakers of Other Languages	12.2	11.3	22.6	27.0	35.7	50.2	12.2	11.3
Dieticians	5.4	5.8	12.5	19.6	17.9	31.1	5.4	5.8
Medical Imaging Professionals	6.0	5.6	12.8	17.7	20.1	31.9	6.0	5.6
Occupational and Environmental Health Professionals	212.1	163.1	400.3	466.1	570.6	803.9	212.1	163.1
Optometrists and Orthotists	5.5	7.7	13.7	28.3	19.0	38.4	5.5	7.7
Pharmacists	46.7	36.6	76.2	97.4	143.7	212.2	46.7	36.6
Other Health Diagnostic and Promotion Professionals	12.0	10.4	24.9	27.2	45.5	68.3	12.0	10.4
Chiropractors and Osteopaths	1.4	1.3	2.7	3.7	4.7	7.3	1.4	1.3
Complementary Health Therapists	5.9	5.0	11.1	13.5	19.3	28.4	5.9	5.0
Dental Practitioners	5.7	5.0	10.5	13.5	19.3	29.2	5.7	5.0
Occupational Therapists	10.0	9.2	26.2	27.3	36.1	51.8	10.0	9.2
Physiotherapists	7.8	6.9	18.0	20.8	27.7	41.7	7.8	6.9
Podiatrists	0.9	0.8	1.7	2.3	2.8	4.5	0.9	0.8
Speech Professionals and Audiologists	5.8	5.2	14.0	15.3	21.9	34.1	5.8	5.2
Generalist Medical Practitioners	21.4	19.8	45.1	57.9	73.8	113.5	21.4	19.8
Anaesthetists	1.3	1.3	2.9	3.8	4.7	7.3	1.3	1.3

Table B.2 Gross green skills and green employment increase (continued)

	Gross (green skills or supporting green skills)				Green employment increase compared to 2010 (excludes displaced skills, e.g. in black coal stations)			
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Specialist Physicians	3.6	3.4	7.6	10.5	12.3	19.3	3.6	3.4
Psychiatrists	1.2	1.1	3.1	3.5	4.4	7.0	1.2	1.1
Surgeons	2.8	2.4	5.7	6.9	9.7	14.1	2.8	2.4
Other Medical Practitioners	6.5	5.7	12.8	15.7	22.7	33.4	6.5	5.7
Midwives	8.1	7.2	19.5	21.6	31.6	44.9	8.1	7.2
Nurse Educators and Researchers	9.0	8.8	18.3	26.9	29.4	47.3	9.0	8.8
Nurse Managers	10.2	9.2	24.6	27.4	36.6	52.6	10.2	9.2
Registered Nurses	157.7	137.6	405.4	413.1	642.9	883.3	157.7	137.6
ICT Business and Systems Analysts	306.1	288.9	556.8	669.4	845.1	1190.7	306.1	288.9
Multimedia Specialists and Web Developers	48.8	40.1	88.4	103.0	155.6	223.9	48.8	40.1
Software and Applications Programmers	790.3	703.4	1385.9	1696.7	2428.4	3516.4	790.3	703.4
Database and Systems Administrators, and ICT Security Specialists	405.6	376.4	740.8	918.8	1138.6	1644.2	405.6	376.4
Computer Network Professionals	288.9	247.7	490.6	591.7	847.7	1208.2	288.9	247.7
ICT Support and Test Engineers	123.2	108.4	212.0	251.0	358.4	508.0	123.2	108.4
Telecommunications Engineering Professionals	152.4	130.6	263.2	329.0	433.0	621.7	152.4	130.6
Barristers	134.7	110.8	214.8	237.2	446.1	637.5	134.7	110.8
Judicial and Other Legal Professionals	156.0	136.1	317.8	352.6	522.1	777.7	156.0	136.1
Solicitors	1074.9	893.3	1674.3	1898.3	3472.6	4942.2	1074.9	893.3
Counsellors	53.0	45.6	134.8	131.1	198.7	270.3	53.0	45.6
Ministers of Religion	36.9	32.8	63.8	78.8	110.8	159.0	36.9	32.8
Psychologists	31.8	28.2	90.5	91.3	129.4	183.9	31.8	28.2
Social Professionals	62.7	59.1	138.0	179.3	215.9	332.4	62.7	59.1
Social Workers	19.9	17.4	83.2	73.2	91.8	144.3	19.9	17.4
Welfare, Recreation and Community Arts Workers	41.4	35.8	160.1	142.6	174.8	274.7	41.4	35.8
Agricultural Technicians	71.7	98.4	182.1	368.1	230.8	477.3	71.7	98.4
Medical Technicians	53.9	49.7	93.1	130.1	185.1	287.3	53.9	49.7
Primary Products Inspectors	32.2	44.1	111.7	179.0	122.9	246.2	32.2	44.1
Science Technicians	409.0	494.3	871.2	1609.9	1283.4	2361.4	409.0	494.3
Architectural, Building and Surveying Technicians	1816.8	771.7	2576.6	2981.2	3547.8	4538.6	1816.8	771.7
Civil Engineering Draftspersons and Technicians	347.5	268.4	606.9	868.9	917.0	1427.6	347.5	268.4
Electrical Engineering Draftspersons and Technicians	857.0	831.5	1417.3	1767.5	1820.3	2446.1	857.0	831.5

Table B.2 Gross green skills and green employment increase (continued)

	Gross (green skills or supporting green skills)				Green employment increase compared to 2010 (excludes displaced skills, e.g. in black coal stations)			
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Electronic Engineering Draftspersons and Technicians	189.1	149.2	268.4	285.1	647.8	910.9	189.1	149.2
Mechanical Engineering Draftspersons and Technicians	261.1	221.1	392.7	492.1	869.7	1281.4	261.1	221.1
Safety Inspectors	187.1	145.5	327.0	383.6	447.5	616.7	187.1	145.5
Other Building and Engineering Technicians	431.2	370.2	677.2	833.9	1128.8	1583.1	431.2	370.2
ICT Support Technicians	483.6	431.9	890.9	1085.6	1423.4	2053.9	483.6	431.9
Telecommunications Technical Specialists	105.0	81.6	166.4	195.9	273.2	376.9	105.0	81.6
Automotive Electricians	192.1	154.2	297.8	384.0	540.8	785.0	192.1	154.2
Motor Mechanics	1827.6	1627.3	3066.1	4311.8	5173.4	7863.8	1827.6	1627.3
Metal Casting, Forging and Finishing Trades Workers	269.4	323.6	532.9	1025.5	994.4	1815.0	269.4	323.6
Sheetmetal Trades Workers	399.8	273.3	489.3	426.4	1435.8	1962.4	399.8	273.3
Structural Steel and Welding Trades Workers	3329.9	2153.1	4214.4	3991.7	11008.5	14994.8	3329.9	2153.1
Aircraft Maintenance Engineers	102.1	96.7	180.0	242.4	344.5	521.4	102.1	96.7
Metal Fitters and Machinists	3298.3	2646.3	4834.0	5672.7	10206.2	14489.9	3298.3	2646.3
Precision Metal Trades Workers	199.2	162.0	303.4	364.6	577.2	815.6	199.2	162.0
Toolmakers and Engineering Patternmakers	407.9	318.9	506.8	461.4	1641.4	2313.5	407.9	318.9
Panel beaters	361.5	328.8	619.9	898.7	946.0	1449.7	361.5	328.8
Vehicle Body Builders and Trimmers	329.4	276.3	403.6	353.9	1418.5	2013.0	329.4	276.3
Vehicle Painters	295.6	249.7	469.6	626.8	845.0	1248.7	295.6	249.7
Bricklayers and Stonemasons	1159.5	86.2	1315.9	1018.8	1516.6	1180.8	1159.5	86.2
Carpenters and Joiners	4061.1	434.5	4657.8	3593.6	5912.3	5106.2	4061.1	434.5
Floor Finishers	355.8	26.5	404.9	309.9	468.3	362.3	355.8	26.5
Painting Trades Workers	1833.5	138.9	2078.7	1582.9	2429.8	1898.2	1833.5	138.9
Glaziers	516.8	132.0	595.1	470.4	1041.7	1143.6	516.8	132.0
Plasterers	1241.5	69.9	1394.7	1050.1	1567.2	1147.7	1241.5	69.9
Roof Tilers	302.4	16.5	338.9	253.8	382.1	279.5	302.4	16.5
Wall and Floor Tilers	690.8	43.0	781.5	602.5	879.1	661.1	690.8	43.0
Plumbers	3412.1	338.2	3935.8	3123.4	4585.0	3728.9	3412.1	338.2
Electricians	6402.6	2601.0	8402.1	8091.1	11021.0	11844.5	6402.6	2601.0
Air-conditioning and Refrigeration Mechanics	770.4	251.0	985.1	943.6	1461.8	1655.8	770.4	251.0
Electrical Distribution Trades Workers	1729.2	1883.9	2998.4	3819.6	3230.5	4252.2	1729.2	1883.9
Electronics Trades Workers	712.7	467.4	1048.3	1196.8	1848.5	2502.4	712.7	467.4

Table B.2 Gross green skills and green employment increase (continued)

	Gross (green skills or supporting green skills)						Green employment increase compared to 2010 (excludes displaced skills, e.g. in black coal stations)	
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Telecommunications Trades Workers	495.7	260.7	712.8	754.3	1062.8	1322.2	495.7	260.7
Bakers and Pastry cooks	130.4	138.9	230.7	331.8	347.3	531.4	130.4	138.9
Butchers and Smallgoods Makers	95.9	75.9	145.7	175.0	275.1	387.7	95.9	75.9
Chefs	253.6	221.6	450.7	563.0	763.9	1103.2	253.6	221.6
Cooks	227.5	209.7	421.6	574.3	677.6	1020.9	227.5	209.7
Animal Attendants and Trainers	66.8	97.2	172.9	371.7	214.8	459.0	66.8	97.2
Shearers	201.7	393.2	643.9	1651.7	672.3	1773.0	201.7	393.2
Veterinary Nurses	2.3	1.9	4.5	6.5	6.6	10.1	2.3	1.9
Florists	19.6	15.9	31.2	42.8	58.6	88.1	19.6	15.9
Gardeners	1322.1	566.1	2237.9	2544.7	2952.3	3724.4	1322.1	566.1
Greenkeepers	72.3	59.2	155.1	207.0	219.3	332.5	72.3	59.2
Nurserypersons	104.6	135.8	238.3	488.5	323.1	647.1	104.6	135.8
Hairdressers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Print Finishers and Screen Printers	60.3	49.0	99.9	119.4	186.4	268.5	60.3	49.0
Graphic Pre-press Trades Workers	73.3	63.5	130.0	161.8	233.8	342.4	73.3	63.5
Printers	212.1	181.3	356.7	434.1	654.5	949.3	212.1	181.3
Canvas and Leather Goods Makers	67.6	56.0	101.8	123.5	219.3	317.1	67.6	56.0
Clothing Trades Workers	84.4	70.6	135.8	173.5	254.4	370.8	84.4	70.6
Upholsterers	201.4	161.9	244.9	209.0	854.0	1203.8	201.4	161.9
Cabinetmakers	831.8	420.1	995.1	811.9	2558.2	3326.7	831.8	420.1
Wood Machinists and Other Wood Trades Workers	224.7	135.0	280.8	263.4	738.4	1004.2	224.7	135.0
Boat Builders and Shipwrights	25.0	15.0	34.9	35.1	72.7	96.5	25.0	15.0
Chemical, Gas, Petroleum and Power Generation Plant Operators	918.1	1022.5	1588.4	2062.9	1999.0	2770.8	918.1	1022.5
Gallery, Library and Museum Technicians	24.5	22.4	69.6	71.8	87.2	135.2	24.5	22.4
Jewellers	43.7	26.7	61.3	67.5	115.2	154.8	43.7	26.7
Performing Arts Technicians	115.4	85.4	197.4	230.0	353.0	490.9	115.4	85.4
Signwriters	138.9	124.3	237.7	357.7	431.2	687.3	138.9	124.3
Other Miscellaneous Technicians and Trades Workers	363.8	273.3	580.0	811.0	903.6	1343.9	363.8	273.3
Ambulance Officers and Paramedics	3.9	3.7	8.0	10.5	12.8	20.0	3.9	3.7
Dental Hygienists, Technicians and Therapists	81.7	67.2	92.8	64.4	386.1	544.3	81.7	67.2
Diversional Therapists	1.5	1.3	5.1	4.8	6.1	9.4	1.5	1.3

Table B.2 Gross green skills and green employment increase (continued)

	Gross (green skills or supporting green skills)				Green employment increase compared to 2010 (excludes displaced skills, e.g. in black coal stations)			
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Enrolled and Mothercraft Nurses	17.0	13.8	41.7	41.1	69.1	90.2	17.0	13.8
Indigenous Health Workers	0.7	0.6	2.5	2.4	2.9	4.8	0.7	0.6
Massage Therapists	6.1	6.0	12.3	17.8	20.2	31.9	6.1	6.0
Welfare Support Workers	127.7	106.8	390.8	373.3	511.6	738.0	127.7	106.8
Child Carers	97.4	83.5	238.4	267.3	330.2	488.9	97.4	83.5
Education Aides	109.2	101.7	218.0	254.9	318.7	460.4	109.2	101.7
Aged and Disabled Carers	87.6	76.7	311.9	298.0	387.2	578.0	87.6	76.7
Dental Assistants	10.3	8.7	19.4	23.6	35.1	51.6	10.3	8.7
Nursing Support and Personal Care Workers	47.1	38.6	119.9	116.4	193.8	253.2	47.1	38.6
Special Care Workers	5.4	4.4	11.3	12.0	17.2	24.3	5.4	4.4
Bar Attendants and Baristas	331.3	291.2	584.1	734.3	985.3	1426.6	331.3	291.2
Cafe Workers	103.4	92.6	183.4	237.0	315.1	465.0	103.4	92.6
Gaming Workers	8.1	7.0	17.8	19.7	26.9	39.9	8.1	7.0
Hotel Service Managers	35.1	29.7	64.0	75.9	108.5	152.3	35.1	29.7
Waiters	506.1	441.6	900.9	1127.0	1524.2	2202.0	506.1	441.6
Other Hospitality Workers	26.5	25.6	51.0	73.0	80.6	125.0	26.5	25.6
Defence Force Members - Other Ranks	3.7	2.4	5.8	6.1	11.2	15.6	3.7	2.4
Fire and Emergency Workers	67.8	73.2	138.7	223.0	194.9	329.9	67.8	73.2
Police	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Prison Officers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Security Officers and Guards	264.0	188.0	435.3	479.9	719.2	978.9	264.0	188.0
Beauty Therapists	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Driving Instructors	13.2	11.5	23.4	28.9	35.7	50.9	13.2	11.5
Funeral Workers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gallery, Museum and Tour Guides	63.9	58.2	120.2	161.5	196.7	299.1	63.9	58.2
Personal Care Consultants	5.5	4.5	9.4	12.2	17.3	25.6	5.5	4.5
Tourism and Travel Advisers	162.0	144.7	288.7	377.3	483.3	715.9	162.0	144.7
Travel Attendants	71.8	66.8	126.1	159.2	206.1	298.9	71.8	66.8
Other Personal Service Workers	25.5	19.1	44.6	57.2	69.6	100.3	25.5	19.1
Fitness Instructors	2.2	1.8	4.2	4.7	6.9	9.9	2.2	1.8
Outdoor Adventure Guides	3.6	3.2	6.9	8.4	10.8	15.8	3.6	3.2
Sports Coaches, Instructors and Officials	40.0	35.2	86.6	99.9	125.6	185.8	40.0	35.2
Sportspersons	13.4	12.2	39.6	45.1	48.3	78.2	13.4	12.2
Contract, Program and Project Administrators	1813.4	1463.3	3310.7	3902.2	4635.7	6505.4	1813.4	1463.3
Office Managers	1326.4	874.4	2096.7	2577.1	3499.7	4901.0	1326.4	874.4
Practice Managers	35.9	30.5	64.8	73.7	121.3	169.3	35.9	30.5

Table B.2 Gross green skills and green employment increase (continued)

	Gross (green skills or supporting green skills)				Green employment increase compared to 2010 (excludes displaced skills, e.g. in black coal stations)			
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Personal Assistants	874.4	707.8	1524.3	1815.9	2454.5	3467.7	874.4	707.8
Secretaries	1228.5	1228.5	1927.1	1927.1	3260.1	3260.1	1228.5	1228.5
General Clerks	1801.7	1334.2	3134.2	3798.0	4820.7	6853.3	1801.7	1334.2
Keyboard Operators	294.5	251.2	532.7	638.8	848.9	1203.8	294.5	251.2
Call or Contact Centre Workers	498.2	469.9	1019.4	1118.7	1483.0	1964.4	498.2	469.9
Inquiry Clerks	1101.9	1049.6	2107.8	2468.5	2884.1	4029.3	1101.9	1049.6
Receptionists	843.8	606.8	1366.2	1581.8	2458.6	3416.3	843.8	606.8
Accounting Clerks	1344.8	961.7	2119.8	2510.2	3617.8	5035.8	1344.8	961.7
Bookkeepers	969.3	591.7	1465.5	1801.4	2445.7	3399.8	969.3	591.7
Payroll Clerks	216.2	162.9	380.6	447.8	623.1	868.9	216.2	162.9
Bank Workers	921.1	903.1	1627.0	2187.4	2202.2	3198.7	921.1	903.1
Credit and Loans Officers (Aus) / Finance Clerks (NZ)	422.7	398.9	734.8	957.7	1040.8	1492.2	422.7	398.9
Insurance, Money Market and Statistical Clerks	187.2	164.7	381.5	448.8	552.2	799.4	187.2	164.7
Betting Clerks	5.5	4.3	9.8	11.4	15.9	21.9	5.5	4.3
Couriers and Postal Deliverers	492.3	423.5	844.4	1112.0	1377.9	2043.1	492.3	423.5
Filing and Registry Clerks	243.9	192.0	457.6	532.7	697.5	1001.4	243.9	192.0
Mail Sorters	199.2	172.6	352.1	426.7	593.2	854.5	199.2	172.6
Survey Interviewers	85.5	71.2	133.8	155.3	281.3	401.8	85.5	71.2
Switchboard Operators	83.8	66.3	152.0	167.7	240.7	325.6	83.8	66.3
Other Clerical and Office Support Workers	474.1	434.8	820.3	948.0	1361.4	1882.3	474.1	434.8
Purchasing and Supply Logistics Clerks	1508.3	1212.6	2273.7	2668.7	4550.6	6439.3	1508.3	1212.6
Transport and Despatch Clerks	536.4	443.7	848.6	1071.3	1573.8	2283.6	536.4	443.7
Conveyancers and Legal Executives	273.1	221.1	420.4	474.2	865.0	1220.8	273.1	221.1
Court and Legal Clerks	207.4	174.9	402.3	435.4	708.3	1039.9	207.4	174.9
Debt Collectors	219.5	193.9	448.3	482.8	688.3	926.3	219.5	193.9
Human Resource Clerks	124.0	116.1	247.0	305.1	355.4	512.4	124.0	116.1
Inspectors and Regulatory Officers	267.2	261.9	929.3	950.8	943.9	1552.9	267.2	261.9
Insurance Investigators, Loss Adjusters and Risk Surveyors	36.1	31.2	65.2	83.4	95.5	139.0	36.1	31.2
Library Assistants	30.9	26.3	89.4	90.8	107.0	166.7	30.9	26.3
Other Miscellaneous Clerical and Administrative Workers	204.4	174.5	356.3	437.6	608.4	876.8	204.4	174.5
Auctioneers, and Stock and Station Agents	61.8	57.4	105.6	159.0	181.2	286.1	61.8	57.4
Insurance Agents	55.4	49.3	99.5	131.0	151.4	221.1	55.4	49.3
Sales Representatives	2105.5	1600.0	3141.4	3650.7	6280.9	8811.8	2105.5	1600.0
Real Estate Sales Agents	1416.8	855.2	2150.7	2324.7	3460.3	4457.1	1416.8	855.2

Table B.2 Gross green skills and green employment increase (continued)

	Gross (green skills or supporting green skills)				Green employment increase compared to 2010 (excludes displaced skills, e.g. in black coal stations)			
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Sales Assistants (General)	2152.0	1575.9	3274.5	3806.1	6139.0	8547.8	2152.0	1575.9
ICT Sales Assistants	142.6	114.1	234.7	270.5	434.4	607.2	142.6	114.1
Motor Vehicle and Vehicle Parts Salespersons	309.1	251.1	454.7	549.2	994.3	1437.0	309.1	251.1
Pharmacy Sales Assistants	68.0	43.7	95.6	100.5	195.8	264.0	68.0	43.7
Retail Supervisors	103.7	77.6	154.9	181.0	311.7	439.3	103.7	77.6
Service Station Attendants	34.1	25.2	52.1	61.4	93.9	130.9	34.1	25.2
Street Vendors and Related Salespersons	79.5	70.1	132.6	166.2	223.0	317.0	79.5	70.1
Other Sales Assistants and Salespersons	119.9	93.5	188.0	228.7	348.6	496.0	119.9	93.5
Checkout Operators and Office Cashiers	288.1	204.8	454.0	497.0	836.0	1159.5	288.1	204.8
Models and Sales Demonstrators	122.1	103.1	201.6	238.5	389.4	550.3	122.1	103.1
Retail and Wool Buyers	37.2	33.5	62.8	87.3	112.4	170.1	37.2	33.5
Telemarketers	178.8	140.2	337.3	347.8	582.5	754.0	178.8	140.2
Ticket Salespersons	191.1	180.3	342.7	431.1	535.1	763.5	191.1	180.3
Visual Merchandisers	29.0	25.5	48.7	62.2	89.4	130.2	29.0	25.5
Other Sales Support Workers	28.6	23.4	43.6	50.1	93.8	133.1	28.6	23.4
Clay, Concrete, Glass and Stone Processing Machine Operators	267.0	83.9	332.7	305.9	513.2	578.1	267.0	83.9
Industrial Spray painters	603.9	397.1	746.3	661.9	2102.2	2860.6	603.9	397.1
Paper and Wood Processing Machine Operators	481.7	523.5	1015.2	2022.5	1342.6	2619.2	481.7	523.5
Photographic Developers and Printers	21.9	17.5	35.2	41.1	71.0	101.6	21.9	17.5
Plastics and Rubber Production Machine Operators	582.8	456.2	798.9	842.9	1990.9	2796.2	582.8	456.2
Sewing Machinists	304.1	239.1	419.3	439.3	1129.6	1609.2	304.1	239.1
Textile and Footwear Production Machine Operators	173.1	165.8	287.6	433.8	575.1	914.6	173.1	165.8
Other Machine Operators	400.7	283.3	561.2	611.7	1247.6	1732.5	400.7	283.3
Crane, Hoist and Lift Operators	336.3	160.2	440.5	433.8	745.6	911.7	336.3	160.2
Drillers, Miners and Shot Firers	890.9	775.4	1420.9	1720.5	1829.6	2389.9	890.9	775.4
Engineering Production Workers	1214.9	817.9	1481.2	1287.8	4349.7	5940.5	1214.9	817.9
Other Stationary Plant Operators	510.9	370.5	841.9	1157.5	1100.8	1603.7	510.9	370.5
Agricultural, Forestry and Horticultural Plant Operators	991.9	1846.3	3092.0	7787.0	3285.0	8462.7	991.9	1846.3

Table B.2 Gross green skills and green employment increase (continued)

	Gross (green skills or supporting green skills)				Green employment increase compared to 2010 (excludes displaced skills, e.g. in black coal stations)			
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Earthmoving Plant Operators	2196.9	724.2	3121.6	3867.2	3549.0	4482.9	2196.9	724.2
Forklift Drivers	1010.8	762.1	1481.5	1696.1	3195.4	4504.2	1010.8	762.1
Other Mobile Plant Operators	186.8	76.4	280.9	302.5	373.5	463.6	186.8	76.4
Automobile Drivers	332.7	281.9	561.9	786.2	897.2	1359.9	332.7	281.9
Bus and Coach Drivers	335.1	277.0	612.6	844.2	875.4	1349.0	335.1	277.0
Train and Tram Drivers	289.4	298.3	496.8	664.3	694.8	1003.4	289.4	298.3
Delivery Drivers	469.1	373.3	732.8	921.3	1348.2	1946.3	469.1	373.3
Truck Drivers	3095.3	2363.8	5247.7	7706.4	7502.6	11576.6	3095.3	2363.8
Storepersons	2014.4	1604.5	2965.9	3386.2	6424.3	9074.4	2014.4	1604.5
Car Detailers	234.8	209.7	402.2	545.4	674.4	1002.8	234.8	209.7
Commercial Cleaners	1716.7	1339.0	3871.3	3712.7	6739.5	8510.1	1716.7	1339.0
Domestic Cleaners	288.0	227.3	728.8	696.8	1224.1	1523.4	288.0	227.3
Housekeepers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Laundry Workers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Cleaners	230.6	178.2	519.7	530.1	856.1	1108.0	230.6	178.2
Building and Plumbing Labourers	1804.2	258.9	2173.9	1813.5	2653.4	2404.5	1804.2	258.9
Concreters	1365.4	127.4	1588.8	1269.4	1788.0	1424.5	1365.4	127.4
Fencers	462.4	85.1	570.8	556.5	691.7	704.8	462.4	85.1
Insulation and Home Improvement Installers	676.9	142.1	780.8	617.8	1243.0	1293.5	676.9	142.1
Paving and Surfacing Labourers	317.2	40.9	429.3	357.2	469.0	445.0	317.2	40.9
Railway Track Workers	160.3	96.3	222.1	234.2	368.0	466.0	160.3	96.3
Structural Steel Construction Workers	718.2	169.3	868.9	740.5	1163.8	1140.9	718.2	169.3
Other Construction and Mining Labourers	209.4	129.1	315.7	387.2	466.8	635.0	209.4	129.1
Food and Drink Factory Workers	323.5	410.3	650.9	1061.2	893.9	1490.1	323.5	410.3
Meat Boners and Slicers, and Slaughterers	99.5	94.4	174.2	232.4	273.1	397.8	99.5	94.4
Meat, Poultry and Seafood Process Workers	161.6	171.5	289.0	411.5	458.3	698.9	161.6	171.5
Packers	889.7	833.9	1583.5	2082.1	3000.5	4445.1	889.7	833.9
Product Assemblers	2285.8	1703.7	2735.2	2239.2	9251.7	12851.0	2285.8	1703.7
Metal Engineering Process Workers	901.0	608.6	1102.9	965.3	3243.1	4437.9	901.0	608.6
Plastics and Rubber Factory Workers	161.3	127.5	228.0	248.7	535.0	753.1	161.3	127.5
Product Quality Controllers	456.8	379.5	658.7	771.6	1664.8	2426.8	456.8	379.5
Timber and Wood Process Workers	301.1	223.5	530.6	899.4	708.7	1201.5	301.1	223.5
Other Factory Process Workers	471.4	286.7	652.6	687.5	1378.2	1860.9	471.4	286.7
Aquaculture Workers	5.2	4.8	9.5	13.9	14.8	23.1	5.2	4.8

Table B.2 Gross green skills and green employment increase (continued)

	Gross (green skills or supporting green skills)				Green employment increase compared to 2010 (excludes displaced skills, e.g. in black coal stations)			
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Crop Farm Workers	722.8	1247.3	2099.1	5049.0	2330.3	5649.5	722.8	1247.3
Forestry and Logging Workers	1232.3	2355.5	3906.5	9992.4	4149.7	10831.5	1232.3	2355.5
Garden and Nursery Labourers	654.7	698.6	1594.0	2646.3	2152.4	3705.1	654.7	698.6
Livestock Farm Workers	377.3	623.5	1025.6	2356.7	1160.6	2682.6	377.3	623.5
Mixed Crop and Livestock Farm Workers	275.4	540.0	883.5	2273.0	871.4	2361.5	275.4	540.0
Other Farm, Forestry and Garden Workers	360.4	505.8	1010.1	2014.7	1270.2	2531.1	360.4	505.8
Fast Food Cooks	143.1	126.3	250.2	315.3	424.4	615.6	143.1	126.3
Food Trades Assistants	16.7	15.2	28.1	37.0	47.7	70.0	16.7	15.2
Kitchenhands	400.3	351.1	723.5	895.1	1230.4	1773.7	400.3	351.1
Freight and Furniture Handlers	206.2	162.9	338.9	445.8	571.6	836.7	206.2	162.9
Shelf Fillers	139.5	93.5	199.0	219.4	402.2	551.5	139.5	93.5
Caretakers	46.8	33.4	90.2	102.7	136.3	187.0	46.8	33.4
Deck and Fishing Hands	61.3	49.7	103.5	128.4	158.4	222.9	61.3	49.7
Handypersons	699.3	216.7	992.4	939.7	1345.8	1485.1	699.3	216.7
Motor Vehicle Parts and Accessories Fitters	242.7	179.3	356.1	425.2	697.6	985.9	242.7	179.3
Printing Assistants and Table Workers	79.0	64.9	133.5	155.5	249.7	355.7	79.0	64.9
Recycling and Rubbish Collectors	25.2	25.0	78.9	92.9	87.2	145.8	25.2	25.0
Vending Machine Attendants	29.4	24.8	50.3	62.0	87.5	125.9	29.4	24.8
Other Miscellaneous Labourers	1179.7	775.9	1902.5	2151.8	2920.2	3913.6	1179.7	775.9
Total	**167809.2**	**126107.1**	**279646.6**	**369018.3**	**447915.4**	**655427.5**	**167809.2**	**126107.1**

Appendix C: Detailed tables – Weak action

Table C.1 Weak action: Real demand and demographic aggregates – average annual growth rate (per cent)	2010-2015	2015-2020	2020-2025	2025-2030	2010-2030
Household consumption	1.6	1.0	2.5	1.5	1.6
Household consumption excluding energy	1.5	1.0	2.6	1.6	1.7
Government consumption	4.2	7.3	2.9	4.3	4.7
Equipment investment	4.1	2.1	2.6	2.6	2.8
Construction investment	5.0	1.6	2.6	2.4	2.9
Exports of goods and services	3.2	3.5	3.8	4.0	3.6
Imports of goods and services	2.0	2.2	3.5	3.3	2.8
Gross domestic product	3.2	2.9	2.6	2.6	2.8
Capacity GDP	3.6	2.9	2.5	2.5	2.8
Total planned output	3.2	2.7	2.5	2.4	2.7
Population	1.6	1.5	1.5	1.4	1.5
Households	2.3	2.2	2.2	2.1	2.2
Per capita private consumption growth	0.0	-0.5	1.1	0.1	0.2

Table C.2 Weak action: Factor inputs and costs		2010-2015	2015-2020	2020-2025	2025-2030	2010-2030
Total hours	% change	0.9	0.9	0.5	0.6	0.7
Total hours per capita	% change	-0.7	-0.6	-1.0	-0.8	-0.8
Total employment	% change	1.2	1.2	0.8	0.9	1.0
Employment to population ratio less 2005 level	Average ratio for span years	-0.6	-1.2	-2.5	-3.8	-2.0
Total factor productivity	% change	0.6	0.4	0.8	0.8	0.6
Capital output ratio	Average ratio for span years	1.23	1.32	1.38	1.42	1.3
Real wage cost per hour	% change	0.3	0.1	1.2	1.6	0.8
Implicit consumption deflator	Average ratio for span years	4.1	4.1	2.8	2.3	3.3
90 day bill rate	Rate at end span year	6.8	7.0	6.6	5.7	6.5
Wages and salary share in GDP	% – average for span years	50.9	47.2	45.1	44.3	46.9

Table C.3 Weak action: Balance of payments						
		2010-2015	2015-2020	2020-2025	2025-2030	2010-2030
Nominal trade balance	% of GDP – span average	-2.3	-1.3	-0.7	0.0	-1.1
Income balance	% of GDP – span average	-4.8	-7.6	-8.6	-9.4	-7.6
Balance on current account	% of GDP	-7.1	-8.8	-9.4	-9.3	-8.7
Terms of trade	Span average	1.75	1.72	1.72	1.74	1.7
$A/$US	Span average	0.77	0.69	0.74	0.83	0.8
Total non-equity liabilities owed from ROW	$billion average for span years	534.1	661.0	711.5	746.7	663.3
Total non-equity liabilities owed to ROW	$billion average for span years	1471.8	2259.4	3035.2	3910.6	2669.2
Total net international debt	$billion average for span years	937.7	1598.4	2323.7	3163.9	2005.9
Net international debt – % of GDP	Average ratio for span years	58.8	72.2	79.3	84.5	73.7
Gross international debt – % of GDP	Average ratio for span years	92.3	102.1	103.6	104.4	100.6
Gross foreign obligations as per cent of finance sector assets	Average ratio for span years	28.6	27.3	25.6	24.7	26.5

Table C.4 Weak action: Household sector balance sheet						
		2010-2015	2015-2020	2020-2025	2025-2030	2010-2030
Household non-equity financial assets – ratio of gross disposable income	Average for span years	2.8	2.9	3.0	3.1	2.9
Household debt to gross disposable income ratio	Average for span years	2.0	2.0	2.0	2.0	2.0
Household gross saving – % of gross disposable income	Average for span years	5.6	12.7	10.0	12.1	10.1
Household debt service ratio – % of income	Average for span years	28.5	28.7	28.1	27.0	28.1
Total taxes	% of GDP	31.0	28.9	29.7	30.9	30.1

Table C.5 Weak action: Share in GDP of major sector (per cent)						
		2010-2015	2015-2020	2020-2025	2025-2030	2010-2030
Agriculture	Average for span years	2.6	2.3	2.3	2.2	2.4
Mining	Average for span years	4.8	5.3	6.1	7.3	5.9
Manufacturing	Average for span years	11.0	10.8	10.1	9.3	10.3
Tertiary	Average for span years	81.6	81.6	81.5	81.2	81.5
Total	**Average for span years**	100.0	100.0	100.0	100.0	100.0
Heavy Industry	Average for span years	1.8	1.8	1.8	1.7	1.8

Table C.6	Weak action: Manufacturing and mining – real indicators (average annual per cent rate of growth)					
		2010-2015	2015-2020	2020-2025	2025-2030	2010-2030
Manufacturing	Output	3.3	1.7	1.2	0.9	1.8
Manufacturing	Exports	3.1	1.8	1.2	0.7	1.7
Manufacturing	Imports	2.3	2.3	3.5	3.1	2.8
Manufacturing	Domestic demand	2.9	2.0	2.4	2.1	2.3
Manufacturing	Investment	5.1	2.7	2.5	2.2	3.1
Manufacturing	Output prices	0.3	0.2	0.3	0.3	0.3
Manufacturing	Hours worked	0.9	0.2	0.4	0.6	0.5
Manufacturing	Capital stock installed	4.7	4.2	3.1	2.6	3.6
Manufacturing	Factor input	3.1	2.7	2.1	1.8	2.4
Manufacturing	Factor productivity	1.1	1.1	1.0	1.0	1.0
Mining	Output	5.8	5.3	6.1	6.1	5.8
Mining	Capital stock	5.8	6.8	7.4	7.2	6.8

Table C.7	Weak action: Gross saving and investment by sector (per cent of GDP – average for span years)					
		2010-2015	2015-2020	2020-2025	2025-2030	2010-2030
Gross saving						
	Private non-financial companies	7.6	7.8	8.3	9.0	8.2
	Public non-financial companies	0.6	0.7	0.7	0.7	0.7
	Finance sector	4.3	5.9	6.6	6.8	5.9
	General Government	2.8	-5.2	-6.1	-8.7	-4.3
	Households	3.5	7.6	5.7	6.7	5.9
	Rest of world	7.1	8.8	9.4	9.3	8.7
	Total	**25.8**	**25.6**	**24.5**	**23.8**	**24.9**
Gross investment						
	Private non-financial companies	10.9	11.7	11.5	11.8	11.5
	Public non-financial companies	1.6	1.7	1.6	1.5	1.6
	Finance sector	0.7	0.7	0.5	0.5	0.6
	General Government	2.6	2.4	2.1	1.8	2.2
	Households	10.0	9.1	8.7	8.3	9.0
	Rest of world	0.0	0.0	0.0	0.0	0.0
	Total	**25.8**	**25.6**	**24.5**	**23.8**	**24.9**
Net lending						
	Private non-financial companies	-3.3	-4.0	-3.2	-2.7	-3.3
	Public non-financial companies	-1.0	-0.9	-0.9	-0.7	-0.9
	Finance sector	3.6	5.2	6.0	6.3	5.3
	General Government	0.1	-7.6	-8.2	-10.5	-6.5
	Households	-6.5	-1.5	-3.1	-1.7	-3.2
	Rest of World	7.1	8.8	9.4	9.3	8.7
	Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Table C.8 Weak action: CO_2 emissions						
		2006	2015	2020	2025	2030
Energy and fugitive emissions	Million tonnes	391	422	436	444	448
Other emissions	Million tonnes	175	161	148	139	131
Total emissions	Million tonnes	566	582	585	583	579
Total emissions	% of 1990 levels	104	107	107	107	106
Emission allocation	Million tonnes	566	500	411	335	274
Imported permits	Million tonnes	0	0	174	248	305
Domestic emission price	$2007	0.00	41	55	106	158
Value of accumulated import permits	$2007 million	0.00	0	50925	163638	383127
Total emissions per unit of GDP		1.0	0.8	0.7	0.6	0.5

Table C.9 Weak action: Change in sector CO_2 emissions from 2006 (direct emissions only)					
	2006	2015	2020	2025	2030
Agriculture and mining	0	8	19	35	53
Manufacturing	0	-9	-7	-8	-11
Electricity	0	15	17	15	16
Transport	0	2	2	1	-4
Other industries	0	0	0	0	-2
Households	0	14	14	11	4
Total energy, fugitive and industrial	0	30	45	52	57
Other emissions	0	-14	-27	-36	-44
Total energy, fugitive and industrial	0	16	18	16	13

Table C.10 Weak action: Key emission reduction indicators					
	2006	2015	2020	2025	2030
Per cent of electricity primary fuels from renewable sources (excluding household solar which is credited to household sector)	6.2	11.8	16.1	17.3	17.9
Per cent coal plants CCS	0	0.0	0.0	17.8	29.2
New biodiesel as per cent of petroleum sales	0	3.5	6.2	8.3	10.4
Electric cars as per cent of motor vehicle stock	0	6.8	14.0	20.6	25.1

Table C.11 Weak action: Accumulated investment in decarbonisation by sector ($2007 million)					
	2006	**2015**	**2020**	**2025**	**2030**
Expenditures on resources					
Agriculture and mining	0	2443	4526	7790	11516
Manufacturing	0	4169	7740	10341	12566
Electricity	0	52162	97157	131459	152443
Transport	0	17371	32901	45490	52438
Other industries	0	5929	10988	14673	17813
Households	0	21320	40671	50810	56848
Land management and administration	0	1191	5492	13438	24658
Total expenditures	0	104585	199474	274000	328282
Financing support					
Government subsidies to household sector	0	13624	23711	27841	29479
Government subsidies to household sector	0	4835	7880	9777	10923
Cumulative subsidy support ratio (excludes electricity and transport infrastructure)	0.0	52.7	45.5	38.8	32.7

Appendix D: Detailed tables – Intermediate

Table D.1 Intermediate: Real demand and demographic aggregates – average annual growth rate (per cent)										
						Difference from Weak action scenario (Intermediate less Weak action)				
	2010-2015	2015-2020	2020-2025	2025-2030	2010-2030	2010-2015	2015-2020	2020-2025	2025-2030	2010-2030
Household consumption	0.5	2.4	2.8	2.5	2.1	-1.0	1.4	0.3	1.0	0.4
Household consumption excluding energy	0.5	2.5	2.9	2.6	2.2	-1.0	1.5	0.3	1.1	0.5
Government consumption	4.9	6.6	3.1	4.9	4.9	0.8	-0.7	0.3	0.6	0.2
Equipment investment	4.6	2.0	3.1	2.4	3.0	0.5	-0.1	0.5	-0.2	0.2
Construction investment	6.8	0.5	3.5	1.6	3.1	1.8	-1.0	0.9	-0.8	0.2
Exports of goods and services	3.3	3.2	3.6	3.6	3.4	0.1	-0.3	-0.2	-0.4	-0.2
Imports of goods and services	2.0	2.6	3.8	3.7	3.0	0.0	0.4	0.3	0.4	0.3
Gross domestic product	3.1	3.2	2.9	2.9	3.1	-0.1	0.3	0.3	0.3	0.2
						0.0	0.0	0.0	0.0	0.0
Capacity GDP	3.6	3.1	2.9	2.7	3.1	0.0	0.2	0.4	0.3	0.2
Total planned output	3.2	3.0	2.8	2.6	2.9	0.1	0.3	0.4	0.2	0.2
Population	1.6	1.5	1.5	1.4	1.5	0.0	0.0	0.0	0.0	0.0
Households	2.3	2.2	2.2	2.1	2.2	0.0	0.0	0.0	0.0	0.0
Per capita private consumption growth	-1.1	0.9	1.4	1.1	0.6	-1.0	1.4	0.3	1.0	0.4

Table D.2 Intermediate: Factor inputs and costs

							Difference from Weak action scenario (Intermediate less Weak action)			
		2010-2015	2015-2020	2020-2025	2025-2030	2010-2030	2010-2015	2015-2020	2020-2025	2025-2030	2010-2030
Total hours	% change	1.0	1.0	0.8	0.8	0.9	0.0	0.1	0.3	0.2	0.2
Total hours per capita	% change	-0.6	-0.5	-0.7	-0.6	-0.6	0.0	0.1	0.3	0.2	0.2
Total employment	% change	1.3	1.3	1.0	1.1	1.2	0.0	0.1	0.3	0.2	0.2
Employment to population ratio less 2005 level	Average ratio for span years	-0.6	-1.1	-1.8	-2.6	-1.5	0.0	0.1	0.7	1.2	0.5
Total factor productivity	% change	0.5	0.4	0.9	0.8	0.7	-0.1	0.1	0.1	0.0	0.0
Capital output ratio	Average ratio for span years	1.25	1.36	1.41	1.45	1.4	0.0	0.0	0.0	0.0	0.0
Real wage cost per hour	% change	-0.2	0.6	1.5	2.0	1.0	-0.4	0.6	0.3	0.4	0.2
Implicit consumption deflator	Average ratio for span years	4.5	3.5	2.5	1.9	3.1	0.4	-0.6	-0.3	-0.4	-0.2
90 day bill rate	Rate at end span year	6.9	6.8	6.2	5.3	6.3	0.0	-0.1	-0.4	-0.4	-0.2
Wages and salary share in GDP	% – average for span years	50.9	47.4	45.1	44.5	47.0	0.0	0.2	0.1	0.2	0.1

Table D.3 Intermediate: Balance of payments

							Difference from Weak action scenario (Intermediate less Weak action)			
		2010-2015	2015-2020	2020-2025	2025-2030	2010-2030	2010-2015	2015-2020	2020-2025	2025-2030	2010-2030
Nominal trade balance	% of GDP – span average	-2.3	-1.7	-1.6	-1.5	-1.8	0.0	-0.4	-0.9	-1.5	-0.7
Income balance	% of GDP – span average	-4.9	-6.9	-7.3	-7.1	-6.6	-0.1	0.6	1.3	2.2	1.0
Balance on current account	% of GDP	-7.2	-8.7	-8.9	-8.7	-8.4	-0.1	0.2	0.4	0.7	0.3
Terms of trade	Span average	1.75	1.72	1.72	1.74	1.7	0.0	0.0	0.0	0.0	0.0
$A/$US	Span average	0.77	0.71	0.77	0.88	0.8	-0.002	0.013	0.024	0.046	0.020
Total non-equity liabilities owed from ROW	$billion average for span years	535.3	652.7	696.6	722.7	651.8	1.2	-8.2	-14.9	-24.0	-11.5
Total non-equity liabilities owed to ROW	$billion average for span years	1476.8	2234.5	2955.4	3732.1	2599.7	5.0	-24.9	-79.7	-178.5	-69.6
Total net international debt	$billion average for span years	941.5	1581.7	2258.8	3009.3	1947.8	3.8	-16.7	-64.8	-154.6	-58.1
Net international debt – % of GDP	Average ratio for span years	59.0	71.7	76.7	79.8	71.8	0.2	-0.5	-2.6	-4.6	-1.9
Gross international debt – % of GDP	Average ratio for span years	92.6	101.3	100.4	99.0	98.3	0.3	-0.8	-3.2	-5.4	-2.3
Gross foreign obligations as % of finance sector assets	Average ratio for span years	28.6	27.0	24.8	23.7	26.0	0.0	-0.3	-0.8	-1.1	-0.5

Table D.4 Intermediate: Household sector balance sheet

							Difference from Weak action scenario (Intermediate less Weak action)			
		2010-2015	2015-2020	2020-2025	2025-2030	2010-2030	2010-2015	2015-2020	2020-2025	2025-2030	2010-2030
Household non-equity financial assets – ratio of gross disposable income	Average for span years	2.8	2.9	3.0	3.0	2.9	0.0	0.0	0.0	-0.1	0.0
Household debt to gross disposable income ratio	Average for span years	2.1	2.0	1.9	1.9	2.0	0.0	0.0	-0.1	-0.1	0.0
Household gross saving – % of gross disposable income	Average for span years	6.8	14.4	10.9	13.3	11.4	1.2	1.8	0.9	1.2	1.3
Household debt service ratio – % of income	Average for span years	28.8	28.3	27.1	25.5	27.4	0.3	-0.4	-1.0	-1.5	-0.7
Total taxes – % of GDP	Average for span years	31.6	29.6	29.5	29.5	30.1	0.6	0.8	-0.2	-1.4	-0.1

Table D.5 Intermediate: Share in GDP of major sector (per cent)

							Difference from Weak action scenario (Intermediate less Weak action)			
		2010-2015	2015-2020	2020-2025	2025-2030	2010-2030	2010-2015	2015-2020	2020-2025	2025-2030	2010-2030
Agriculture	Average for span years	2.6	2.5	2.6	2.7	2.6	0.0	0.1	0.3	0.4	0.2
Mining	Average for span years	4.9	5.3	6.0	7.0	5.8	0.0	0.0	-0.1	-0.2	-0.1
Manufacturing	Average for span years	11.1	11.0	10.3	9.7	10.5	0.1	0.2	0.3	0.3	0.2
Tertiary	Average for span years	81.4	81.3	81.1	80.7	81.1	-0.1	-0.4	-0.5	-0.5	-0.4
Total	**Average for span years**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Table D.6 Intermediate: Manufacturing and mining – real indicators (average annual per cent rate of growth)

							Difference from Weak action scenario (Intermediate less Weak action)			
		2010-2015	2015-2020	2020-2025	2025-2030	2010-2030	2010-2015	2015-2020	2020-2025	2025-2030	2010-2030
Manufacturing	Output	3.4	2.2	1.8	1.3	2.2	0.1	0.4	0.5	0.4	0.4
Manufacturing	Exports	3.1	1.6	1.0	0.4	1.5	0.0	-0.2	-0.1	-0.4	-0.2
Manufacturing	Imports	2.3	2.7	3.8	3.5	3.1	0.0	0.4	0.3	0.4	0.3
Manufacturing	Domestic demand	2.9	2.5	2.9	2.6	2.7	0.1	0.5	0.5	0.5	0.4
Manufacturing	Investment	5.8	2.3	3.0	2.1	3.3	0.6	-0.3	0.5	-0.1	0.2
Manufacturing	Output prices	0.4	0.1	0.2	0.2	0.2	0.0	-0.1	-0.1	-0.1	-0.1
Manufacturing	Hours worked	0.8	0.5	0.8	1.0	0.8	-0.1	0.3	0.4	0.4	0.3
Manufacturing	Capital stock installed	5.0	4.3	3.3	2.8	3.9	0.3	0.1	0.2	0.2	0.2
Manufacturing	Factor input	3.2	3.0	2.4	2.1	2.7	0.1	0.3	0.3	0.4	0.3
Manufacturing	Factor productivity	1.1	1.1	1.1	1.0	1.1	0.0	0.0	0.0	0.0	0.0
Mining	Output	5.7	5.3	6.0	5.7	5.7	0.0	0.0	-0.1	-0.4	-0.1
Mining	Capital stock	5.9	6.8	7.3	6.7	6.7	0.1	0.0	-0.1	-0.4	-0.1

Table D.7 Intermediate: Gross saving and investment by sector (per cent of GDP – average for span years)										
						Difference from Weak action scenario (Intermediate less Weak action)				
	2010-2015	2015-2020	2020-2025	2025-2030	2010-2030	2010-2015	2015-2020	2020-2025	2025-2030	2010-2030
Gross saving										
Private non-financial companies	7.5	7.7	8.4	9.2	8.2	0.0	0.0	0.1	0.2	0.1
Public non-financial companies	0.6	0.7	0.8	0.8	0.7	0.0	0.0	0.1	0.1	0.0
Finance sector	4.5	5.6	5.7	5.4	5.3	0.2	-0.3	-0.8	-1.4	-0.6
General Government	3.0	-4.9	-4.9	-7.2	-3.5	0.2	0.3	1.3	1.5	0.8
Households	4.0	8.6	6.2	7.5	6.6	0.6	1.0	0.6	0.9	0.8
Rest of world	7.2	8.7	8.9	8.7	8.4	0.1	-0.2	-0.4	-0.7	-0.3
Total	**26.9**	**26.5**	**25.2**	**24.4**	**25.8**	**1.0**	**0.9**	**0.8**	**0.6**	**0.8**
Gross investment										
Private non-financial companies	11.2	11.9	11.5	11.6	11.5	0.3	0.1	0.0	-0.2	0.1
Public non-financial companies	1.6	1.6	1.6	1.5	1.6	0.0	0.0	0.0	0.0	0.0
Finance sector	0.7	0.6	0.5	0.5	0.6	0.0	0.0	0.0	0.0	0.0
General Government	3.2	2.8	2.3	2.0	2.6	0.6	0.4	0.2	0.2	0.4
Households	10.2	9.5	9.3	8.9	9.5	0.2	0.4	0.6	0.6	0.4
Rest of world	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**26.9**	**26.5**	**25.2**	**24.4**	**25.8**	**1.0**	**0.9**	**0.8**	**0.6**	**0.8**
Net lending										
Private non-financial companies	-3.7	-4.1	-3.1	-2.3	-3.3	-0.3	-0.1	0.1	0.4	0.0
Public non-financial companies	-1.0	-0.9	-0.8	-0.7	-0.8	0.0	0.0	0.1	0.1	0.0
Finance sector	3.8	4.9	5.2	4.9	4.7	0.2	-0.3	-0.9	-1.4	-0.6
General Government	-0.2	-7.7	-7.1	-9.2	-6.0	-0.4	-0.1	1.1	1.3	0.5
Households	-6.2	-0.9	-3.0	-1.4	-2.9	0.4	0.6	0.0	0.3	0.3
Rest of world	7.2	8.7	8.9	8.7	8.4	0.1	-0.2	-0.4	-0.7	-0.3
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Table D.8 Intermediate: CO_2 emissions

							Difference from Weak action scenario (Intermediate less Weak action)			
		2006	2015	2020	2025	2030	2006	2015	2020	2025	2030
Energy and fugitive emissions	Million tonnes	391	354	291	236	197	0.0	-68.0	-145.3	-207.7	-251.2
Other emissions	Million tonnes	175	147	119	99	76	0.0	-14.1	-29.1	-40.4	-55.7
Total emissions	Million tonnes	566	500	410	335	273	0.0	-82.2	-174.4	-248.1	-306.9
Total emissions	% of 1990 levels	104	92	75	61	50	0.0	-15.0	-31.9	-45.4	-56.2
Emission allocation	Million tonnes	566	500	411	335	274	0.0	0.0	0.0	0.0	0.0
Imported permits	Million tonnes	0	0	-1	0	-1	0.0	0.0	-174.4	-248.1	-306.9
Domestic emission price	$2007	0.00	54	86	106	156	0.0	13.4	31.5	-0.3	-2.2
Value of accumulated import permits	$2007 million	0.00	0	5784	13559	22228	0.0	0.0	-45140.8	-150078.7	-360899.6
Total emissions per unit of GDP	2006 = 1	1.0	0.7	0.5	0.3	0.2	0.0	-0.1	-0.2	-0.3	-0.3

Table D.9 Intermediate: Change in sector CO_2 emissions from 2006 (direct emissions only)

						Difference from Weak action scenario (Intermediate less Weak action)				
	2006	2015	2020	2025	2030	2006	2015	2020	2025	2030
Agriculture and mining	0	6	15	26	34	0.0	-1.9	-4.3	-8.2	-18.5
Manufacturing	0	-11	-13	-13	-18	0.0	-2.3	-6.1	-4.9	-7.0
Electricity	0	-36	-92	-146	-169	0.0	-51.3	-108.4	-160.2	-185.4
Transport	0	-4	-10	-15	-22	0.0	-6.1	-12.2	-15.3	-17.9
Other industries	0	-2	0	-1	-1	0.0	-1.7	0.2	-0.5	1.3
Households	0	9	0	-8	-19	0.0	-4.8	-14.6	-18.5	-23.8
Total energy, fugitive and industrial	0	-38	-100	-155	-195	0.0	-68.0	-145.3	-207.7	-251.2
Other emissions	0	-28	-56	-76	-99	0.0	-14.1	-29.1	-40.4	-55.7
Total energy, fugitive and industrial	0	-66	-156	-232	-294	0.0	-82.2	-174.4	-248.1	-306.9

Table D.10 Intermediate: Key emission reduction indicators

						Difference from Weak action scenario (Intermediate less Weak action)				
	2006	2015	2020	2025	2030	2006	2015	2020	2025	2030
Per cent of electricity primary fuels from renewable sources (excluding household solar which is credited to household sector)	6.2	15.9	34.0	37.4	46.7	0.0	15.9	34.0	37.4	46.7
Per cent coal plants CCS	0	0.0	0.1	60.8	100.0	0.0	0.0	0.1	43.0	70.8
New biodiesel as per cent of petroleum sales	0	7.3	15.0	21.5	31.4	0.0	3.9	8.7	13.2	20.9
Electric cars as per cent of motor vehicle stock	0	11.3	23.8	36.2	48.2	0.0	4.5	9.8	15.6	23.1

Table D.11 Intermediate: Accumulated investment in decarbonisation by sector ($2007 million)

						Difference from Weak action scenario (Intermediate less Weak action)				
	2006	2015	2020	2025	2030	2006	2015	2020	2025	2030
Expenditures on resources										
Agriculture and mining	0	4814	9414	16796	27842	0.0	2370.9	4887.3	9005.4	16325.9
Manufacturing	0	8233	16118	21980	28598	0.0	4064.5	8378.2	11639.9	16032.1
Electricity	0	99223	194402	268693	335603	0.0	47061.8	97245.2	137234.2	183160.1
Transport	0	34306	67852	96125	116800	0.0	16935.3	34951.3	50635.6	64361.4
Other industries	0	11688	22857	31163	40525	0.0	5758.0	11869.1	16489.8	22712.2
Households	0	41394	85246	105373	123784	0.0	20074.2	44575.6	54562.9	66936.0
Land management and administration	0	5844	32377	66688	118276	0.0	4652.6	26885.3	53249.5	93618.1
Total expenditures	**0**	**205503**	**428266**	**606817**	**791428**	**0.0**	**100917.5**	**228791.9**	**332817.3**	**463145.8**
Financial support										
Government subsidies to household sector	0	25712	47270	55623	60520	0.0	12087.5	23559.4	27781.5	31040.8
Government subsidies to household sector	0	8023	12302	15202	18116	0.0	3188.1	4421.9	5424.9	7193.6
Cumulative subsidy support ratio (excludes electricity and transport infrastructure)	0.0	46.9	35.9	29.3	23.2	0.0	-5.8	-9.6	-9.5	-9.5

Table D.12	The relationship between resource cost and welfare gain: Intermediate versus Weak action (cumulative change $2007m)				
	2006	**2015**	**2020**	**2025**	**2030**
Resource costs	0	100917	228792	332817	463146
Benefit offsets (negative indicates benefit)					
Household energy and transport cost consumption		-3557	-21291	-46132	-74162
Imports of oil products	0	-7975	-58832	-133464	-239502
Imports of permits	0	0	-33715.3	-112585	-273434
Other (price relativities, capital intensity)	0	13922.5	77139	28869.4	-124884
Welfare indicators					
Private household consumption expenditure (excluding energy/transport)	0	-92670.6	-160381	-24183	267350
Government consumption expenditure (excluding direct CO_2 abatement expenditures)	0	-10637.3	-31712.8	-45323	-18514
Total	**0**	**-103308**	**-192093**	**-69505**	**248836**

Appendix E: Detailed tables – Strong action

Table E.1 Strong action: Real demand and demographic aggregates – average annual growth rate (per cent)										
						Difference from Weak action scenario (Strong action less Weak action)				
	2010-2015	2015-2020	2020-2025	2025-2030	2010-2030	2010-2015	2015-2020	2020-2025	2025-2030	2010-2030
Household consumption	0.5	2.7	3.4	2.6	2.3	-1.0	1.7	0.9	1.1	0.7
Household consumption excluding energy	0.5	2.8	3.5	2.7	2.4	-1.0	1.8	0.9	1.1	0.7
Government consumption	4.9	6.6	3.3	5.0	5.0	0.7	-0.7	0.5	0.7	0.3
Equipment investment	4.9	2.5	3.0	2.3	3.2	0.8	0.4	0.4	-0.4	0.3
Construction investment	7.0	0.9	3.5	1.4	3.2	2.0	-0.6	0.9	-1.0	0.3
Exports of goods and services	3.2	3.2	3.8	3.5	3.4	0.0	-0.2	0.0	-0.5	-0.2
Imports of goods and services	1.9	2.7	4.0	3.6	3.0	-0.1	0.5	0.5	0.3	0.3
Gross domestic product	3.2	3.5	3.3	3.0	3.2					
						0.0	0.0	0.0	0.0	0.0
Capacity GDP	3.7	3.4	3.2	2.7	3.3	0.1	0.5	0.7	0.3	0.4
Total planned output	3.4	3.4	3.1	2.7	3.1	0.2	0.6	0.6	0.3	0.4
Population	1.6	1.5	1.5	1.4	1.5	0.0	0.0	0.0	0.0	0.0
Households	2.3	2.2	2.2	2.1	2.2	0.0	0.0	0.0	0.0	0.0
Per capita private consumption growth	-1.1	1.2	2.0	1.2	0.8	-1.0	1.7	0.9	1.1	0.7

Table E.2 Strong action: Factor inputs and costs											
							Difference from Weak action scenario (Strong action less Weak action)				
		2010-2015	2015-2020	2020-2025	2025-2030	2010-2030	2010-2015	2015-2020	2020-2025	2025-2030	2010-2030
Total hours	% change	1.0	1.2	1.0	0.9	1.0	0.1	0.3	0.5	0.3	0.3
Total hours per capita	% change	-0.6	-0.4	-0.5	-0.5	-0.5	0.1	0.3	0.5	0.3	0.3
Total employment	% change	1.3	1.5	1.3	1.1	1.3	0.1	0.3	0.5	0.3	0.3
Employment to population ratio less 2005 level	Average ratio for span years	-0.5	-0.8	-0.9	-1.5	-0.9	0.0	0.4	1.6	2.3	1.1
Total factor productivity	% change	0.6	0.6	0.9	0.8	0.7	0.0	0.2	0.1	-0.1	0.1
Capital output ratio	Average ratio for span years	1.25	1.35	1.40	1.43	1.4	0.0	0.0	0.0	0.0	0.0
Real wage cost per hour	% change	-0.2	0.8	1.8	1.9	1.1	-0.4	0.7	0.6	0.2	0.3
Implicit consumption deflator	Average ratio for span years	4.4	3.1	2.2	2.1	2.9	0.3	-1.0	-0.6	-0.2	-0.4
90 day bill rate	Rate at end span year	6.9	6.5	5.9	5.3	6.1	0.0	-0.5	-0.7	-0.4	-0.4
Wages and salary share in GDP	% – average for span years	50.9	47.4	45.3	44.7	47.1	0.0	0.2	0.2	0.4	0.2

Table E.3 Strong action: Balance of payments											
							Difference from Weak action scenario (Strong action less Weak action)				
		2010-2015	2015-2020	2020-2025	2025-2030	2010-2030	2010-2015	2015-2020	2020-2025	2025-2030	2010-2030
Nominal trade balance	% of GDP – span average	-2.3	-1.7	-1.6	-1.5	-1.8	0.0	-0.4	-0.9	-1.5	-0.7
Income balance	% of GDP – span average	-4.9	-6.9	-7.2	-7.1	-6.6	-0.1	0.7	1.4	2.2	1.0
Balance on current account	% of GDP	-7.2	-8.6	-8.8	-8.7	-8.3	-0.1	0.2	0.5	0.7	0.3
Terms of trade	Span average	1.75	1.72	1.72	1.74	1.7	0.0	0.0	0.0	0.0	0.0
$A/$US	Span average	0.77	0.72	0.79	0.89	0.8	0.0	0.0	0.0	0.1	0.0
Total non-equity liabilities owed from ROW	$billion average for span years	534.5	643.7	683.7	716.7	644.6	0.4	-17.3	-27.8	-30.1	-18.7
Total non-equity liabilities owed to ROW	$billion average for span years	1474.5	2199.9	2896.7	3699.9	2567.8	2.7	-59.5	-138.4	-210.7	-101.5
Total net international debt	$billion average for span years	940.0	1556.2	2213.0	2983.2	1923.1	2.3	-42.2	-110.6	-180.6	-82.8
Net international debt – % of GDP	Average ratio for span years	59.0	71.1	75.4	79.0	71.1	0.2	-1.1	-3.9	-5.5	-2.6
Gross international debt – % of GDP	Average ratio for span years	92.5	100.5	98.7	98.0	97.4	0.3	-1.6	-4.9	-6.4	-3.2
Gross foreign obligations as % of finance sector assets	Average ratio for span years	28.6	26.9	24.5	23.6	25.9	0.0	-0.5	-1.1	-1.1	-0.7

Table E.4 Strong action: Household sector balance sheet

							Difference from Weak action scenario (Strong action less Weak action)			
		2010-2015	2015-2020	2020-2025	2025-2030	2010-2030	2010-2015	2015-2020	2020-2025	2025-2030	2010-2030
Household non-equity financial assets – ratio of gross disposable income	Average for span years	2.8	2.9	3.0	3.0	2.9	0.0	0.0	-0.1	-0.1	0.0
Household debt to gross disposable income ratio	Average for span years	2.1	2.0	1.9	1.9	2.0	0.0	0.0	-0.1	-0.1	0.0
Household gross saving – % of gross disposable income	Average for span years	6.8	14.3	11.2	13.1	11.3	1.1	1.6	1.2	1.0	1.2
Household debt service ratio – % of income	Average for span years	28.8	28.2	26.7	25.4	27.3	0.3	-0.5	-1.4	-1.6	-0.8
Total taxes – % of GDP	Average for span years	31.7	29.7	29.4	29.3	30.0	0.7	0.9	-0.3	-1.6	-0.1

Table E.5 Strong action: Share in GDP of major sector (per cent)

							Difference from Weak action scenario (Strong action less Weak action)			
		2010-2015	2015-2020	2020-2025	2025-2030	2010-2030	2010-2015	2015-2020	2020-2025	2025-2030	2010-2030
Agriculture	Average for span years	2.6	2.5	2.5	2.7	2.6	0.0	0.1	0.3	0.4	0.2
Mining	Average for span years	4.8	5.2	5.9	6.7	5.7	0.0	0.0	-0.3	-0.5	-0.2
Manufacturing	Average for span years	11.1	11.2	10.8	10.1	10.8	0.1	0.5	0.7	0.8	0.5
Tertiary	Average for span years	81.4	81.1	80.8	80.5	81.0	-0.2	-0.6	-0.7	-0.7	-0.5
Total	**Average for span years**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Table E.6 Strong action: Manufacturing and mining – real indicators (average annual per cent rate of growth)											
							Difference from Weak action scenario (Strong action less Weak action)				
		2010-2015	2015-2020	2020-2025	2025-2030	2010-2030	2010-2015	2015-2020	2020-2025	2025-2030	2010-2030
Manufacturing	Output	3.7	2.9	2.3	1.4	2.6	0.4	1.1	1.1	0.5	0.8
Manufacturing	Exports	3.1	1.8	1.8	0.5	1.8	0.0	0.0	0.6	-0.2	0.1
Manufacturing	Imports	2.3	2.8	4.0	3.4	3.1	-0.1	0.5	0.5	0.3	0.3
Manufacturing	Domestic demand	3.1	2.9	3.2	2.5	2.9	0.2	0.9	0.8	0.4	0.6
Manufacturing	Investment	6.0	2.9	3.4	2.1	3.6	0.8	0.3	0.9	-0.1	0.5
Manufacturing	Output prices	0.3	0.1	0.1	0.2	0.2	0.0	-0.1	-0.2	-0.1	-0.1
Manufacturing	Hours worked	1.0	1.0	1.2	1.0	1.0	0.1	0.8	0.8	0.4	0.5
Manufacturing	Capital stock installed	5.0	4.5	3.8	3.0	4.1	0.4	0.4	0.6	0.4	0.4
Manufacturing	Factor input	3.3	3.2	2.8	2.3	2.9	0.2	0.5	0.7	0.6	0.5
Manufacturing	Factor productivity	1.1	1.1	1.1	1.1	1.1	0.0	0.0	0.1	0.1	0.0
Mining	Output	5.7	5.3	5.8	5.5	5.6	0.0	0.0	-0.3	-0.5	-0.2
Mining	Capital stock	5.9	6.7	7.1	6.4	6.5	0.1	-0.1	-0.3	-0.8	-0.3

Table E.7 Strong action: Gross saving and investment by sector (per cent of GDP – average for span years)										
						Difference from Weak action scenario (Strong action less Weak action)				
	2010-2015	2015-2020	2020-2025	2025-2030	2010-2030	2010-2015	2015-2020	2020-2025	2025-2030	2010-2030
Gross saving										
Private non-financial companies	7.5	7.8	8.4	9.1	8.2	0.0	0.1	0.1	0.1	0.1
Public non-financial companies	0.6	0.7	0.8	0.8	0.7	0.0	0.0	0.1	0.1	0.0
Finance sector	4.5	5.5	5.6	5.4	5.2	0.2	-0.4	-0.9	-1.3	-0.6
General Government	3.1	-4.4	-4.6	-7.2	-3.3	0.3	0.8	1.5	1.5	1.1
Households	4.0	8.5	6.4	7.5	6.6	0.5	0.9	0.8	0.8	0.7
Rest of world	7.2	8.6	8.8	8.7	8.3	0.1	-0.2	-0.5	-0.7	-0.3
Total	**27.0**	**26.7**	**25.5**	**24.3**	**25.9**	**1.1**	**1.2**	**1.1**	**0.5**	**1.0**
Gross investment										
Private non-financial companies	11.2	12.0	11.5	11.1	11.5	0.3	0.3	-0.1	-0.6	0.0
Public non-financial companies	1.6	1.7	1.8	1.8	1.7	0.0	0.0	0.2	0.3	0.1
Finance sector	0.7	0.6	0.6	0.5	0.6	0.0	0.0	0.0	0.1	0.0
General Government	3.2	2.9	2.3	2.0	2.6	0.6	0.5	0.2	0.2	0.4
Households	10.2	9.6	9.4	8.9	9.5	0.2	0.4	0.7	0.6	0.5
Rest of world	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	**27.0**	**26.7**	**25.5**	**24.3**	**25.9**	**1.1**	**1.2**	**1.1**	**0.5**	**1.0**
Net lending										
Private non-financial companies	-3.7	-4.2	-3.0	-2.0	-3.2	-0.4	-0.2	0.2	0.7	0.1
Public non-financial companies	-1.0	-0.9	-1.0	-0.9	-1.0	0.0	0.0	-0.1	-0.2	-0.1
Finance sector	3.8	4.8	5.1	4.9	4.6	0.2	-0.4	-1.0	-1.4	-0.6
General Government	-0.1	-7.2	-6.9	-9.2	-5.9	-0.3	0.4	1.3	1.3	0.7
Households	-6.2	-1.0	-3.0	-1.5	-2.9	0.3	0.5	0.1	0.2	0.3
Rest of world	7.2	8.6	8.8	8.7	8.3	0.1	-0.2	-0.5	-0.7	-0.3
Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

Table E.8 Strong action: CO_2 emissions

							Difference from Weak action scenario (Strong action less Weak action)				
		2006	2015	2020	2025	2030	2006	2015	2020	2025	2030
Energy and fugitive emissions	Million tonnes	391	354	292	237	198	0.0	-67.8	-144.4	-206.4	-250.0
Other emissions	Million tonnes	175	146	118	98	74	0.0	-14.4	-29.9	-41.7	-56.9
Total emissions	Million tonnes	566	500	410	335	273	0.0	-82.1	-174.3	-248.1	-306.9
Total emissions	% of 1990 levels	104	92	75	61	50	0.0	-15.0	-31.9	-45.4	-56.2
Emission allocation	Million tonnes	566	500	411	335	274	0.0	0.0	0.0	0.0	0.0
Imported permits	Million tonnes	0	0	-1	0	-1	0.0	0.0	-174.3	-248.1	-306.9
Domestic emission price	$2007	0.00	54	87	107	159	0.0	13.5	31.8	1.0	1.2
Value of accumulated import permits	$2007 million	0.00	0	5752	13540	22398	0.0	0.0	-45173.2	-150097.7	-360729.5
Total emissions per unit of GDP	2006 = 1	1.0	0.7	0.5	0.3	0.2	0.0	-0.1	-0.2	-0.3	-0.3

Table E.9 Strong action: Change in sector CO_2 emissions from 2006 (direct emissions only)

						Difference from Weak action scenario (Strong action less Weak action)				
	2006	2015	2020	2025	2030	2006	2015	2020	2025	2030
Agriculture and mining	0	6	15	26	33	0.0	-1.9	-4.4	-8.8	-19.9
Manufacturing	0	-10	-12	-11	-16	0.0	-1.8	-4.7	-3.2	-5.3
Electricity	0	-36	-92	-146	-169	0.0	-51.5	-109.0	-160.6	-185.7
Transport	0	-4	-10	-14	-21	0.0	-6.1	-12.0	-14.9	-17.2
Other industries	0	-2	0	-1	0	0.0	-1.7	0.2	-0.4	1.5
Households	0	9	-1	-7	-19	0.0	-4.8	-14.7	-18.4	-23.4
Total energy, fugitive and industrial	0	-38	-99	-154	-193	0.0	-67.8	-144.4	-206.4	-250.0
Other emissions	0	-29	-57	-77	-101	0.0	-14.4	-29.9	-41.7	-56.9
Total energy, fugitive and industrial	0	-66	-156	-232	-294	0.0	-82.1	-174.3	-248.1	-306.9

Table E.10 Strong action: Key emission reduction indicators

						Difference from Weak action scenario (Strong action less Weak action)				
	2006	2015	2020	2025	2030	2006	2015	2020	2025	2030
Per cent of electricity primary fuels from renewable sources (excluding household solar which is credited to household sector)	6.2	16.0	34.3	37.9	46.9	0.0	16.0	34.3	37.9	46.9
Per cent coal plants CCS	0	0.0	0.1	63.1	100.0	0.0	0.0	0.1	45.4	70.8
New biodiesel as per cent of petroleum sales	0	7.4	15.1	21.7	31.5	0.0	3.9	8.9	13.4	21.1
Electric cars as per cent of motor vehicle stock	0	11.4	24.0	36.6	48.5	0.0	4.6	10.0	16.0	23.4

Table E.11 Strong action: Accumulated investment in decarbonisation by sector ($2007 million)

						Difference from Weak action scenario (Strong action less Weak action)				
	2006	2015	2020	2025	2030	2006	2015	2020	2025	2030
Expenditures on resources										
Agriculture and mining	0	4855	9544	17108	28163	0.0	2412.2	5017.6	9317.6	16646.5
Manufacturing	0	8304	16341	22343	28965	0.0	4135.2	8601.6	12002.3	16399.7
Electricity	0	100042	197282	273582	340546	0.0	47880.4	100124.9	142123.7	188102.8
Transport	0	34600	68835	97750	118441	0.0	17229.9	35934.5	52260.6	66002.4
Other industries	0	11788	23174	31676	41046	0.0	5858.2	12185.7	17003.3	23232.8
Households	0	41703	86334	107057	125509	0.0	20382.8	45663.4	56247.3	68660.8
Land management and administration	0	5866	32651	67706	120315	0.0	4675.1	27159.8	54267.7	95657.0
Total expenditures	0	207159	434161	617222	802984	0.0	102573.7	234687.5	343222.4	474702.0
Financial support										
Government subsidies to household sector	0	25928	47716	56057	60853	0.0	12303.5	24005.4	28216.0	31373.8
Government subsidies to household sector	0	8082	12438	15411	18327	0.0	3247.0	4558.0	5634.4	7404.5
Cumulative subsidy support ratio (excludes electricity and transport infrastructure)	0.0	46.9	35.8	29.1	23.0	0.0	-5.8	-9.7	-9.7	-9.7

Table E.12	The relationship between resource cost and welfare gain: Strong action versus Weak action (cumulative change $2007m)				
	2006	**2015**	**2020**	**2025**	**2030**
Resource costs	0	102574	234688	343222	474702
Benefit offsets (negative indicates benefit)					
Household energy and transport cost consumption		-3607	-21565	-46169	-72237
Imports of oil products	0	-7981	-58660	-132030	-236807
Imports of permits	0	0	-32501	-109615	-268063
Other (price relativities, capital intensity)	0	0	0	0	0
Welfare indicators					
Private household consumption expenditure (excluding energy/transport)	0	-94168	-146059	133321	649401
Government consumption expenditure (excluding direct CO_2 abatement expenditures)	0	-12282	-41159	-49065	1450.3
Total	**0**	**-106450**	**-187218**	**84256**	**650852**

Appendix F: Detailed tables – Gross green skills

Table F.1 Gross green skills and green employment increase								
	Gross (green skills or supporting green skills)						Green employment increase compared to 2010 (excludes displaced skills, i.e. in black coal stations)	
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Chief Executives and Managing Directors	1193.3	879.9	1957.6	2438.6	3462.6	4963.9	1193.3	879.9
General Managers	818.6	632.6	1363.7	1705.4	2324.4	3334.2	818.6	632.6
Legislators	7.5	7.1	42.9	39.2	37.4	67.1	7.5	7.1
Aquaculture Farmers	15.5	16.3	30.2	48.2	45.9	76.2	15.5	16.3
Crop Farmers	1766.4	3249.4	5385.7	13466.1	5613.0	14456.6	1766.4	3249.4
Livestock Farmers	863.1	1269.2	2073.2	4326.5	2463.8	5140.7	863.1	1269.2
Mixed Crop and Livestock Farmers	3343.2	6607.9	10803.4	27915.9	10615.2	28940.3	3343.2	6607.9
Advertising, Public Relations and Sales Managers	2044.2	1640.7	3256.8	3889.9	6110.8	8635.8	2044.2	1640.7
Corporate Services Managers	466.7	346.6	806.1	1024.2	1302.3	1886.4	466.7	346.6
Finance Managers	923.2	745.8	1560.7	1930.4	2583.1	3690.9	923.2	745.8
Human Resource Managers	687.0	569.0	1246.3	1474.4	2010.8	2803.7	687.0	569.0
Policy and Planning Managers	173.9	178.2	487.0	571.1	558.6	906.8	173.9	178.2
Research and Development Managers	186.6	167.5	343.3	466.8	570.4	875.2	186.6	167.5
Construction Managers	2864.7	418.2	3428.4	2918.1	4119.7	3710.8	2864.7	418.2
Engineering Managers	696.1	563.9	1074.6	1302.2	1965.0	2784.4	696.1	563.9
Importers, Exporters and Wholesalers	343.9	280.5	519.5	640.7	1006.7	1443.9	343.9	280.5
Manufacturers	800.4	559.4	1057.3	1098.0	2678.5	3736.9	800.4	559.4
Production Managers	1864.0	1575.8	2881.4	3918.9	6028.9	9118.3	1864.0	1575.8
Supply and Distribution Managers	610.1	517.8	975.4	1246.9	1754.8	2550.0	610.1	517.8
Child Care Centre Managers	7.7	6.4	22.5	21.8	26.1	39.5	7.7	6.4
Health and Welfare Services Managers	21.3	16.8	54.8	55.6	74.8	108.3	21.3	16.8
School Principals	34.8	32.6	65.2	78.5	99.1	141.9	34.8	32.6
Other Education Managers	23.7	21.9	53.6	59.7	76.3	110.8	23.7	21.9
ICT Managers	510.9	460.2	925.4	1137.9	1460.8	2103.7	510.9	460.2
Commissioned Officers (Management)	7.7	6.2	13.7	16.3	21.8	31.1	7.7	6.2
Senior Non-commissioned Defence Force Members	0.4	0.4	0.9	1.1	1.4	2.0	0.4	0.4
Other Specialist Managers	927.2	842.6	1598.6	2038.5	2590.0	3769.3	927.2	842.6
Cafe and Restaurant Managers	248.5	212.3	435.0	533.2	747.1	1071.4	248.5	212.3
Caravan Park and Camping Ground Managers	31.8	34.1	65.9	110.0	96.6	166.3	31.8	34.1
Hotel and Motel Managers	119.2	101.1	206.8	254.5	350.2	501.0	119.2	101.1
Licensed Club Managers	31.8	26.9	55.0	67.8	93.9	134.8	31.8	26.9

Table F.1 Gross green skills and green employment increase (continued)

	Gross (green skills or supporting green skills)				Green employment increase compared to 2010 (excludes displaced skills, i.e. in black coal stations)			
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Other Accommodation and Hospitality Managers	51.9	40.9	89.5	108.2	146.7	206.5	51.9	40.9
Retail Managers	1077.7	837.2	1702.4	2142.4	3063.4	4409.1	1077.7	837.2
Amusement, Fitness and Sports Centre Managers	18.7	12.6	41.5	40.8	59.0	81.7	18.7	12.6
Call or Contact Centre and Customer Service Managers	590.6	468.9	986.3	1159.1	1663.7	2319.0	590.6	468.9
Conference and Event Organisers	149.4	122.3	341.5	337.1	576.6	746.4	149.4	122.3
Transport Services Managers	267.6	220.7	452.1	625.6	665.4	990.8	267.6	220.7
Other Hospitality, Retail and Service Managers	689.1	542.1	1214.3	1474.9	1792.9	2505.9	689.1	542.1
Actors, Dancers and Other Entertainers	25.3	20.9	46.4	55.5	81.2	115.0	25.3	20.9
Music Professionals	34.3	28.1	60.8	72.5	105.5	149.4	34.3	28.1
Photographers	34.4	27.5	57.0	67.9	106.3	152.4	34.4	27.5
Visual Arts and Crafts Professionals	92.4	46.9	133.6	143.2	228.2	299.5	92.4	46.9
Artistic Directors, and Media Producers and Presenters	117.3	100.5	203.9	253.6	389.3	567.3	117.3	100.5
Authors, and Book and Script Editors	32.1	27.1	61.2	73.1	104.9	150.5	32.1	27.1
Film, Television, Radio and Stage Directors	86.2	71.9	152.9	184.1	290.0	416.1	86.2	71.9
Journalists and Other Writers	235.3	196.0	423.3	497.3	742.8	1061.2	235.3	196.0
Accountants	3295.3	2734.5	5284.7	6259.3	9932.0	14100.9	3295.3	2734.5
Auditors, Company Secretaries and Corporate Treasurers	283.0	261.9	525.6	641.5	815.2	1193.4	283.0	261.9
Financial Brokers	239.3	232.2	433.2	592.0	605.9	904.6	239.3	232.2
Financial Dealers	269.2	258.1	519.0	676.5	695.9	1036.5	269.2	258.1
Financial Investment Advisers and Managers	411.8	368.2	743.7	943.0	1069.6	1535.0	411.8	368.2
Human Resource Professionals	877.4	748.9	2094.3	2079.0	3477.8	4451.7	877.4	748.9
ICT Trainers	28.1	23.2	50.3	56.5	87.3	121.2	28.1	23.2
Training and Development Professionals	293.1	269.5	557.1	647.4	864.2	1204.7	293.1	269.5
Actuaries, Mathematicians and Statisticians	63.7	58.3	120.6	153.5	200.0	298.7	63.7	58.3
Archivists, Curators and Records Managers	47.7	45.9	107.2	133.5	149.8	229.2	47.7	45.9
Economists	53.5	52.7	121.2	146.5	166.5	246.1	53.5	52.7
Intelligence and Policy Analysts	69.3	70.7	275.8	286.3	282.6	481.2	69.3	70.7

Table F.1 Gross green skills and green employment increase (continued)								
	Gross (green skills or supporting green skills)						Green employment increase compared to 2010 (excludes displaced skills, i.e. in black coal stations)	
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Land Economists and Valuers	306.1	135.9	447.8	472.2	619.4	755.7	306.1	135.9
Librarians	57.1	50.2	144.4	157.6	196.9	304.1	57.1	50.2
Management and Organisation Analysts	798.7	734.3	1614.5	1845.1	2579.5	3513.1	798.7	734.3
Other Information and Organisation Professionals	139.7	133.2	325.8	379.8	436.0	663.5	139.7	133.2
Advertising and Marketing Professionals	778.7	663.1	1303.4	1599.8	2440.3	3518.4	778.7	663.1
ICT Sales Professionals	160.4	125.5	249.2	286.9	494.8	694.8	160.4	125.5
Public Relations Professionals	216.5	199.4	469.4	552.4	715.1	1016.4	216.5	199.4
Technical Sales Representatives	516.8	432.0	766.8	916.3	1638.7	2349.7	516.8	432.0
Air Transport Professionals	120.0	148.3	265.4	500.8	367.7	692.6	120.0	148.3
Marine Transport Professionals	97.1	84.5	172.0	229.3	265.4	393.2	97.1	84.5
Architects and Landscape Architects	689.6	603.5	1248.0	2010.9	1958.2	3249.4	689.6	603.5
Surveyors and Spatial Scientists	370.9	359.1	732.0	1178.1	986.9	1671.5	370.9	359.1
Fashion, Industrial and Jewellery Designers	160.2	129.7	235.4	279.7	550.6	799.5	160.2	129.7
Graphic and Web Designers, and Illustrators	648.8	598.9	1165.7	1737.6	2031.8	3235.2	648.8	598.9
Interior Designers	217.6	166.3	364.4	543.6	598.4	939.3	217.6	166.3
Urban and Regional Planners	154.2	150.6	369.9	540.4	481.2	830.5	154.2	150.6
Chemical and Materials Engineers	105.0	91.1	165.9	218.4	332.6	495.9	105.0	91.1
Civil Engineering Professionals	1072.6	747.8	1823.0	2535.4	2681.8	4074.1	1072.6	747.8
Electrical Engineers	1229.8	1275.1	2096.7	2711.3	2686.5	3723.4	1229.8	1275.1
Electronics Engineers	170.2	137.1	243.4	279.2	601.4	868.5	170.2	137.1
Industrial, Mechanical and Production Engineers	1055.5	868.2	1493.5	1700.0	3706.0	5336.6	1055.5	868.2
Mining Engineers	178.4	170.7	311.4	445.0	455.4	691.3	178.4	170.7
Other Engineering Professionals	209.4	189.8	353.2	476.0	664.3	1002.0	209.4	189.8
Agricultural and Forestry Scientists	769.7	1397.2	2361.6	5821.4	2597.7	6494.5	769.7	1397.2
Chemists, and Food and Wine Scientists	173.5	169.4	301.7	437.2	552.2	863.5	173.5	169.4
Environmental Scientists	290.1	317.1	702.1	1018.1	932.7	1524.3	290.1	317.1
Geologists and Geophysicists	143.0	144.3	275.4	403.5	404.9	640.1	143.0	144.3
Life Scientists	116.5	125.5	252.7	424.6	378.2	666.8	116.5	125.5
Medical Laboratory Scientists	169.9	170.2	321.9	534.0	533.4	904.4	169.9	170.2

Table F.1 Gross green skills and green employment increase (continued)

	Gross (green skills or supporting green skills)				Green employment increase compared to 2010 (excludes displaced skills, i.e. in black coal stations)			
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Veterinarians	11.5	14.5	31.0	54.5	38.7	75.5	11.5	14.5
Other Natural and Physical Science Professionals	66.6	59.3	115.9	164.1	213.8	333.5	66.6	59.3
Early Childhood (Pre-primary School) Teachers	27.2	25.1	58.4	65.4	83.7	120.6	27.2	25.1
Primary School Teachers	258.3	243.7	478.5	586.6	737.2	1056.7	258.3	243.7
Middle School Teachers (Aus) / Intermediate School Teachers (NZ)	2.5	2.4	4.7	5.7	7.3	10.3	2.5	2.4
Secondary School Teachers	246.5	230.5	446.6	546.1	692.7	986.2	246.5	230.5
Special Education Teachers	30.0	27.8	56.9	68.2	87.1	124.1	30.0	27.8
University Lecturers and Tutors	84.5	79.5	150.4	188.8	238.4	341.9	84.5	79.5
Vocational Education Teachers (Aus) / Polytechnic Teachers (NZ)	178.7	171.7	336.4	424.6	513.6	733.4	178.7	171.7
Education Advisers and Reviewers	36.1	32.5	93.2	99.1	134.6	194.4	36.1	32.5
Private Tutors and Teachers	65.8	59.5	122.6	152.9	190.5	274.9	65.8	59.5
Teachers of English to Speakers of Other Languages	12.2	11.3	22.6	27.0	35.7	50.2	12.2	11.3
Dieticians	5.4	5.8	12.5	19.6	17.9	31.1	5.4	5.8
Medical Imaging Professionals	6.0	5.6	12.8	17.7	20.1	31.9	6.0	5.6
Occupational and Environmental Health Professionals	212.1	163.1	400.3	466.1	570.6	803.9	212.1	163.1
Optometrists and Orthotists	5.5	7.7	13.7	28.3	19.0	38.4	5.5	7.7
Pharmacists	46.7	36.6	76.2	97.4	143.7	212.2	46.7	36.6
Other Health Diagnostic and Promotion Professionals	12.0	10.4	24.9	27.2	45.5	68.3	12.0	10.4
Chiropractors and Osteopaths	1.4	1.3	2.7	3.7	4.7	7.3	1.4	1.3
Complementary Health Therapists	5.9	5.0	11.1	13.5	19.3	28.4	5.9	5.0
Dental Practitioners	5.7	5.0	10.5	13.5	19.3	29.2	5.7	5.0
Occupational Therapists	10.0	9.2	26.2	27.3	36.1	51.8	10.0	9.2
Physiotherapists	7.8	6.9	18.0	20.8	27.7	41.7	7.8	6.9
Podiatrists	0.9	0.8	1.7	2.3	2.8	4.5	0.9	0.8
Speech Professionals and Audiologists	5.8	5.2	14.0	15.3	21.9	34.1	5.8	5.2
Generalist Medical Practitioners	21.4	19.8	45.1	57.9	73.8	113.5	21.4	19.8
Anaesthetists	1.3	1.3	2.9	3.8	4.7	7.3	1.3	1.3

Table F.1 Gross green skills and green employment increase (continued)

	Gross (green skills or supporting green skills)						Green employment increase compared to 2010 (excludes displaced skills, i.e. in black coal stations)	
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Specialist Physicians	3.6	3.4	7.6	10.5	12.3	19.3	3.6	3.4
Psychiatrists	1.2	1.1	3.1	3.5	4.4	7.0	1.2	1.1
Surgeons	2.8	2.4	5.7	6.9	9.7	14.1	2.8	2.4
Other Medical Practitioners	6.5	5.7	12.8	15.7	22.7	33.4	6.5	5.7
Midwives	8.1	7.2	19.5	21.6	31.6	44.9	8.1	7.2
Nurse Educators and Researchers	9.0	8.8	18.3	26.9	29.4	47.3	9.0	8.8
Nurse Managers	10.2	9.2	24.6	27.4	36.6	52.6	10.2	9.2
Registered Nurses	157.7	137.6	405.4	413.1	642.9	883.3	157.7	137.6
ICT Business and Systems Analysts	306.1	288.9	556.8	669.4	845.1	1190.7	306.1	288.9
Multimedia Specialists and Web Developers	48.8	40.1	88.4	103.0	155.6	223.9	48.8	40.1
Software and Applications Programmers	790.3	703.4	1385.9	1696.7	2428.4	3516.4	790.3	703.4
Database and Systems Administrators, and ICT Security Specialists	405.6	376.4	740.8	918.8	1138.6	1644.2	405.6	376.4
Computer Network Professionals	288.9	247.7	490.6	591.7	847.7	1208.2	288.9	247.7
ICT Support and Test Engineers	123.2	108.4	212.0	251.0	358.4	508.0	123.2	108.4
Telecommunications Engineering Professionals	152.4	130.6	263.2	329.0	433.0	621.7	152.4	130.6
Barristers	134.7	110.8	214.8	237.2	446.1	637.5	134.7	110.8
Judicial and Other Legal Professionals	156.0	136.1	317.8	352.6	522.1	777.7	156.0	136.1
Solicitors	1074.9	893.3	1674.3	1898.3	3472.6	4942.2	1074.9	893.3
Counsellors	53.0	45.6	134.8	131.1	198.7	270.3	53.0	45.6
Ministers of Religion	36.9	32.8	63.8	78.8	110.8	159.0	36.9	32.8
Psychologists	31.8	28.2	90.5	91.3	129.4	183.9	31.8	28.2
Social Professionals	62.7	59.1	138.0	179.3	215.9	332.4	62.7	59.1
Social Workers	19.9	17.4	83.2	73.2	91.8	144.3	19.9	17.4
Welfare, Recreation and Community Arts Workers	41.4	35.8	160.1	142.6	174.8	274.7	41.4	35.8
Agricultural Technicians	71.7	98.4	182.1	368.1	230.8	477.3	71.7	98.4
Medical Technicians	53.9	49.7	93.1	130.1	185.1	287.3	53.9	49.7
Primary Products Inspectors	32.2	44.1	111.7	179.0	122.9	246.2	32.2	44.1
Science Technicians	409.0	494.3	871.2	1609.9	1283.4	2361.4	409.0	494.3
Architectural, Building and Surveying Technicians	1816.8	771.7	2576.6	2981.2	3547.8	4538.6	1816.8	771.7
Civil Engineering Draftspersons and Technicians	347.5	268.4	606.9	868.9	917.0	1427.6	347.5	268.4
Electrical Engineering Draftspersons and Technicians	857.0	831.5	1417.3	1767.5	1820.3	2446.1	857.0	831.5

Table F.1 Gross green skills and green employment increase (continued)

	Gross (green skills or supporting green skills)				Green employment increase compared to 2010 (excludes displaced skills, i.e. in black coal stations)			
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Electronic Engineering Draftspersons and Technicians	189.1	149.2	268.4	285.1	647.8	910.9	189.1	149.2
Mechanical Engineering Draftspersons and Technicians	261.1	221.1	392.7	492.1	869.7	1281.4	261.1	221.1
Safety Inspectors	187.1	145.5	327.0	383.6	447.5	616.7	187.1	145.5
Other Building and Engineering Technicians	431.2	370.2	677.2	833.9	1128.8	1583.1	431.2	370.2
ICT Support Technicians	483.6	431.9	890.9	1085.6	1423.4	2053.9	483.6	431.9
Telecommunications Technical Specialists	105.0	81.6	166.4	195.9	273.2	376.9	105.0	81.6
Automotive Electricians	192.1	154.2	297.8	384.0	540.8	785.0	192.1	154.2
Motor Mechanics	1827.6	1627.3	3066.1	4311.8	5173.4	7863.8	1827.6	1627.3
Metal Casting, Forging and Finishing Trades Workers	269.4	323.6	532.9	1025.5	994.4	1815.0	269.4	323.6
Sheetmetal Trades Workers	399.8	273.3	489.3	426.4	1435.8	1962.4	399.8	273.3
Structural Steel and Welding Trades Workers	3329.9	2153.1	4214.4	3991.7	11008.5	14994.8	3329.9	2153.1
Aircraft Maintenance Engineers	102.1	96.7	180.0	242.4	344.5	521.4	102.1	96.7
Metal Fitters and Machinists	3298.3	2646.3	4834.0	5672.7	10206.2	14489.9	3298.3	2646.3
Precision Metal Trades Workers	199.2	162.0	303.4	364.6	577.2	815.6	199.2	162.0
Toolmakers and Engineering Patternmakers	407.9	318.9	506.8	461.4	1641.4	2313.5	407.9	318.9
Panel beaters	361.5	328.8	619.9	898.7	946.0	1449.7	361.5	328.8
Vehicle Body Builders and Trimmers	329.4	276.3	403.6	353.9	1418.5	2013.0	329.4	276.3
Vehicle Painters	295.6	249.7	469.6	626.8	845.0	1248.7	295.6	249.7
Bricklayers and Stonemasons	1159.5	86.2	1315.9	1018.8	1516.6	1180.8	1159.5	86.2
Carpenters and Joiners	4061.1	434.5	4657.8	3593.6	5912.3	5106.2	4061.1	434.5
Floor Finishers	355.8	26.5	404.9	309.9	468.3	362.3	355.8	26.5
Painting Trades Workers	1833.5	138.9	2078.7	1582.9	2429.8	1898.2	1833.5	138.9
Glaziers	516.8	132.0	595.1	470.4	1041.7	1143.6	516.8	132.0
Plasterers	1241.5	69.9	1394.7	1050.1	1567.2	1147.7	1241.5	69.9
Roof Tilers	302.4	16.5	338.9	253.8	382.1	279.5	302.4	16.5
Wall and Floor Tilers	690.8	43.0	781.5	602.5	879.1	661.1	690.8	43.0
Plumbers	3412.1	338.2	3935.8	3123.4	4585.0	3728.9	3412.1	338.2
Electricians	6402.6	2601.0	8402.1	8091.1	11021.0	11844.5	6402.6	2601.0
Air-conditioning and Refrigeration Mechanics	770.4	251.0	985.1	943.6	1461.8	1655.8	770.4	251.0
Electrical Distribution Trades Workers	1729.2	1883.9	2998.4	3819.6	3230.5	4252.2	1729.2	1883.9
Electronics Trades Workers	712.7	467.4	1048.3	1196.8	1848.5	2502.4	712.7	467.4

Table F.1 Gross green skills and green employment increase (continued)								
	Gross (green skills or supporting green skills)						Green employment increase compared to 2010 (excludes displaced skills, i.e. in black coal stations)	
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Telecommunications Trades Workers	495.7	260.7	712.8	754.3	1062.8	1322.2	495.7	260.7
Bakers and Pastry cooks	130.4	138.9	230.7	331.8	347.3	531.4	130.4	138.9
Butchers and Smallgoods Makers	95.9	75.9	145.7	175.0	275.1	387.7	95.9	75.9
Chefs	253.6	221.6	450.7	563.0	763.9	1103.2	253.6	221.6
Cooks	227.5	209.7	421.6	574.3	677.6	1020.9	227.5	209.7
Animal Attendants and Trainers	66.8	97.2	172.9	371.7	214.8	459.0	66.8	97.2
Shearers	201.7	393.2	643.9	1651.7	672.3	1773.0	201.7	393.2
Veterinary Nurses	2.3	1.9	4.5	6.5	6.6	10.1	2.3	1.9
Florists	19.6	15.9	31.2	42.8	58.6	88.1	19.6	15.9
Gardeners	1322.1	566.1	2237.9	2544.7	2952.3	3724.4	1322.1	566.1
Greenkeepers	72.3	59.2	155.1	207.0	219.3	332.5	72.3	59.2
Nurserypersons	104.6	135.8	238.3	488.5	323.1	647.1	104.6	135.8
Hairdressers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Print Finishers and Screen Printers	60.3	49.0	99.9	119.4	186.4	268.5	60.3	49.0
Graphic Pre-press Trades Workers	73.3	63.5	130.0	161.8	233.8	342.4	73.3	63.5
Printers	212.1	181.3	356.7	434.1	654.5	949.3	212.1	181.3
Canvas and Leather Goods Makers	67.6	56.0	101.8	123.5	219.3	317.1	67.6	56.0
Clothing Trades Workers	84.4	70.6	135.8	173.5	254.4	370.8	84.4	70.6
Upholsterers	201.4	161.9	244.9	209.0	854.0	1203.8	201.4	161.9
Cabinetmakers	831.8	420.1	995.1	811.9	2558.2	3326.7	831.8	420.1
Wood Machinists and Other Wood Trades Workers	224.7	135.0	280.8	263.4	738.4	1004.2	224.7	135.0
Boat Builders and Shipwrights	25.0	15.0	34.9	35.1	72.7	96.5	25.0	15.0
Chemical, Gas, Petroleum and Power Generation Plant Operators	918.1	1022.5	1588.4	2062.9	1999.0	2770.8	918.1	1022.5
Gallery, Library and Museum Technicians	24.5	22.4	69.6	71.8	87.2	135.2	24.5	22.4
Jewellers	43.7	26.7	61.3	67.5	115.2	154.8	43.7	26.7
Performing Arts Technicians	115.4	85.4	197.4	230.0	353.0	490.9	115.4	85.4
Signwriters	138.9	124.3	237.7	357.7	431.2	687.3	138.9	124.3
Other Miscellaneous Technicians and Trades Workers	363.8	273.3	580.0	811.0	903.6	1343.9	363.8	273.3
Ambulance Officers and Paramedics	3.9	3.7	8.0	10.5	12.8	20.0	3.9	3.7
Dental Hygienists, Technicians and Therapists	81.7	67.2	92.8	64.4	386.1	544.3	81.7	67.2
Diversional Therapists	1.5	1.3	5.1	4.8	6.1	9.4	1.5	1.3

Table F.1 Gross green skills and green employment increase (continued)

	Gross (green skills or supporting green skills)				Green employment increase compared to 2010 (excludes displaced skills, i.e. in black coal stations)			
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Enrolled and Mothercraft Nurses	17.0	13.8	41.7	41.1	69.1	90.2	17.0	13.8
Indigenous Health Workers	0.7	0.6	2.5	2.4	2.9	4.8	0.7	0.6
Massage Therapists	6.1	6.0	12.3	17.8	20.2	31.9	6.1	6.0
Welfare Support Workers	127.7	106.8	390.8	373.3	511.6	738.0	127.7	106.8
Child Carers	97.4	83.5	238.4	267.3	330.2	488.9	97.4	83.5
Education Aides	109.2	101.7	218.0	254.9	318.7	460.4	109.2	101.7
Aged and Disabled Carers	87.6	76.7	311.9	298.0	387.2	578.0	87.6	76.7
Dental Assistants	10.3	8.7	19.4	23.6	35.1	51.6	10.3	8.7
Nursing Support and Personal Care Workers	47.1	38.6	119.9	116.4	193.8	253.2	47.1	38.6
Special Care Workers	5.4	4.4	11.3	12.0	17.2	24.3	5.4	4.4
Bar Attendants and Baristas	331.3	291.2	584.1	734.3	985.3	1426.6	331.3	291.2
Cafe Workers	103.4	92.6	183.4	237.0	315.1	465.0	103.4	92.6
Gaming Workers	8.1	7.0	17.8	19.7	26.9	39.9	8.1	7.0
Hotel Service Managers	35.1	29.7	64.0	75.9	108.5	152.3	35.1	29.7
Waiters	506.1	441.6	900.9	1127.0	1524.2	2202.0	506.1	441.6
Other Hospitality Workers	26.5	25.6	51.0	73.0	80.6	125.0	26.5	25.6
Defence Force Members - Other Ranks	3.7	2.4	5.8	6.1	11.2	15.6	3.7	2.4
Fire and Emergency Workers	67.8	73.2	138.7	223.0	194.9	329.9	67.8	73.2
Police	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Prison Officers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Security Officers and Guards	264.0	188.0	435.3	479.9	719.2	978.9	264.0	188.0
Beauty Therapists	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Driving Instructors	13.2	11.5	23.4	28.9	35.7	50.9	13.2	11.5
Funeral Workers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gallery, Museum and Tour Guides	63.9	58.2	120.2	161.5	196.7	299.1	63.9	58.2
Personal Care Consultants	5.5	4.5	9.4	12.2	17.3	25.6	5.5	4.5
Tourism and Travel Advisers	162.0	144.7	288.7	377.3	483.3	715.9	162.0	144.7
Travel Attendants	71.8	66.8	126.1	159.2	206.1	298.9	71.8	66.8
Other Personal Service Workers	25.5	19.1	44.6	57.2	69.6	100.3	25.5	19.1
Fitness Instructors	2.2	1.8	4.2	4.7	6.9	9.9	2.2	1.8
Outdoor Adventure Guides	3.6	3.2	6.9	8.4	10.8	15.8	3.6	3.2
Sports Coaches, Instructors and Officials	40.0	35.2	86.6	99.9	125.6	185.8	40.0	35.2
Sportspersons	13.4	12.2	39.6	45.1	48.3	78.2	13.4	12.2
Contract, Program and Project Administrators	1813.4	1463.3	3310.7	3902.2	4635.7	6505.4	1813.4	1463.3
Office Managers	1326.4	874.4	2096.7	2577.1	3499.7	4901.0	1326.4	874.4
Practice Managers	35.9	30.5	64.8	73.7	121.3	169.3	35.9	30.5

Table F.1 Gross green skills and green employment increase (continued)

	Gross (green skills or supporting green skills)						Green employment increase compared to 2010 (excludes displaced skills, i.e. in black coal stations)	
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Personal Assistants	874.4	707.8	1524.3	1815.9	2454.5	3467.7	874.4	707.8
Secretaries	1228.5	1228.5	1927.1	1927.1	3260.1	3260.1	1228.5	1228.5
General Clerks	1801.7	1334.2	3134.2	3798.0	4820.7	6853.3	1801.7	1334.2
Keyboard Operators	294.5	251.2	532.7	638.8	848.9	1203.8	294.5	251.2
Call or Contact Centre Workers	498.2	469.9	1019.4	1118.7	1483.0	1964.4	498.2	469.9
Inquiry Clerks	1101.9	1049.6	2107.8	2468.5	2884.1	4029.3	1101.9	1049.6
Receptionists	843.8	606.8	1366.2	1581.8	2458.6	3416.3	843.8	606.8
Accounting Clerks	1344.8	961.7	2119.8	2510.2	3617.8	5035.8	1344.8	961.7
Bookkeepers	969.3	591.7	1465.5	1801.4	2445.7	3399.8	969.3	591.7
Payroll Clerks	216.2	162.9	380.6	447.8	623.1	868.9	216.2	162.9
Bank Workers	921.1	903.1	1627.0	2187.4	2202.2	3198.7	921.1	903.1
Credit and Loans Officers (Aus) / Finance Clerks (NZ)	422.7	398.9	734.8	957.7	1040.8	1492.2	422.7	398.9
Insurance, Money Market and Statistical Clerks	187.2	164.7	381.5	448.8	552.2	799.4	187.2	164.7
Betting Clerks	5.5	4.3	9.8	11.4	15.9	21.9	5.5	4.3
Couriers and Postal Deliverers	492.3	423.5	844.4	1112.0	1377.9	2043.1	492.3	423.5
Filing and Registry Clerks	243.9	192.0	457.6	532.7	697.5	1001.4	243.9	192.0
Mail Sorters	199.2	172.6	352.1	426.7	593.2	854.5	199.2	172.6
Survey Interviewers	85.5	71.2	133.8	155.3	281.3	401.8	85.5	71.2
Switchboard Operators	83.8	66.3	152.0	167.7	240.7	325.6	83.8	66.3
Other Clerical and Office Support Workers	474.1	434.8	820.3	948.0	1361.4	1882.3	474.1	434.8
Purchasing and Supply Logistics Clerks	1508.3	1212.6	2273.7	2668.7	4550.6	6439.3	1508.3	1212.6
Transport and Despatch Clerks	536.4	443.7	848.6	1071.3	1573.8	2283.6	536.4	443.7
Conveyancers and Legal Executives	273.1	221.1	420.4	474.2	865.0	1220.8	273.1	221.1
Court and Legal Clerks	207.4	174.9	402.3	435.4	708.3	1039.9	207.4	174.9
Debt Collectors	219.5	193.9	448.3	482.8	688.3	926.3	219.5	193.9
Human Resource Clerks	124.0	116.1	247.0	305.1	355.4	512.4	124.0	116.1
Inspectors and Regulatory Officers	267.2	261.9	929.3	950.8	943.9	1552.9	267.2	261.9
Insurance Investigators, Loss Adjusters and Risk Surveyors	36.1	31.2	65.2	83.4	95.5	139.0	36.1	31.2
Library Assistants	30.9	26.3	89.4	90.8	107.0	166.7	30.9	26.3
Other Miscellaneous Clerical and Administrative Workers	204.4	174.5	356.3	437.6	608.4	876.8	204.4	174.5
Auctioneers, and Stock and Station Agents	61.8	57.4	105.6	159.0	181.2	286.1	61.8	57.4
Insurance Agents	55.4	49.3	99.5	131.0	151.4	221.1	55.4	49.3
Sales Representatives	2105.5	1600.0	3141.4	3650.7	6280.9	8811.8	2105.5	1600.0
Real Estate Sales Agents	1416.8	855.2	2150.7	2324.7	3460.3	4457.1	1416.8	855.2

Table F.1 Gross green skills and green employment increase (continued)

	Gross (green skills or supporting green skills)				Green employment increase compared to 2010 (excludes displaced skills, i.e. in black coal stations)			
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Sales Assistants (General)	2152.0	1575.9	3274.5	3806.1	6139.0	8547.8	2152.0	1575.9
ICT Sales Assistants	142.6	114.1	234.7	270.5	434.4	607.2	142.6	114.1
Motor Vehicle and Vehicle Parts Salespersons	309.1	251.1	454.7	549.2	994.3	1437.0	309.1	251.1
Pharmacy Sales Assistants	68.0	43.7	95.6	100.5	195.8	264.0	68.0	43.7
Retail Supervisors	103.7	77.6	154.9	181.0	311.7	439.3	103.7	77.6
Service Station Attendants	34.1	25.2	52.1	61.4	93.9	130.9	34.1	25.2
Street Vendors and Related Salespersons	79.5	70.1	132.6	166.2	223.0	317.0	79.5	70.1
Other Sales Assistants and Salespersons	119.9	93.5	188.0	228.7	348.6	496.0	119.9	93.5
Checkout Operators and Office Cashiers	288.1	204.8	454.0	497.0	836.0	1159.5	288.1	204.8
Models and Sales Demonstrators	122.1	103.1	201.6	238.5	389.4	550.3	122.1	103.1
Retail and Wool Buyers	37.2	33.5	62.8	87.3	112.4	170.1	37.2	33.5
Telemarketers	178.8	140.2	337.3	347.8	582.5	754.0	178.8	140.2
Ticket Salespersons	191.1	180.3	342.7	431.1	535.1	763.5	191.1	180.3
Visual Merchandisers	29.0	25.5	48.7	62.2	89.4	130.2	29.0	25.5
Other Sales Support Workers	28.6	23.4	43.6	50.1	93.8	133.1	28.6	23.4
Clay, Concrete, Glass and Stone Processing Machine Operators	267.0	83.9	332.7	305.9	513.2	578.1	267.0	83.9
Industrial Spray painters	603.9	397.1	746.3	661.9	2102.2	2860.6	603.9	397.1
Paper and Wood Processing Machine Operators	481.7	523.5	1015.2	2022.5	1342.6	2619.2	481.7	523.5
Photographic Developers and Printers	21.9	17.5	35.2	41.1	71.0	101.6	21.9	17.5
Plastics and Rubber Production Machine Operators	582.8	456.2	798.9	842.9	1990.9	2796.2	582.8	456.2
Sewing Machinists	304.1	239.1	419.3	439.3	1129.6	1609.2	304.1	239.1
Textile and Footwear Production Machine Operators	173.1	165.8	287.6	433.8	575.1	914.6	173.1	165.8
Other Machine Operators	400.7	283.3	561.2	611.7	1247.6	1732.5	400.7	283.3
Crane, Hoist and Lift Operators	336.3	160.2	440.5	433.8	745.6	911.7	336.3	160.2
Drillers, Miners and Shot Firers	890.9	775.4	1420.9	1720.5	1829.6	2389.9	890.9	775.4
Engineering Production Workers	1214.9	817.9	1481.2	1287.8	4349.7	5940.5	1214.9	817.9
Other Stationary Plant Operators	510.9	370.5	841.9	1157.5	1100.8	1603.7	510.9	370.5
Agricultural, Forestry and Horticultural Plant Operators	991.9	1846.3	3092.0	7787.0	3285.0	8462.7	991.9	1846.3

Table F.1 Gross green skills and green employment increase (continued)

	Gross (green skills or supporting green skills)				Green employment increase compared to 2010 (excludes displaced skills, i.e. in black coal stations)			
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Earthmoving Plant Operators	2196.9	724.2	3121.6	3867.2	3549.0	4482.9	2196.9	724.2
Forklift Drivers	1010.8	762.1	1481.5	1696.1	3195.4	4504.2	1010.8	762.1
Other Mobile Plant Operators	186.8	76.4	280.9	302.5	373.5	463.6	186.8	76.4
Automobile Drivers	332.7	281.9	561.9	786.2	897.2	1359.9	332.7	281.9
Bus and Coach Drivers	335.1	277.0	612.6	844.2	875.4	1349.0	335.1	277.0
Train and Tram Drivers	289.4	298.3	496.8	664.3	694.8	1003.4	289.4	298.3
Delivery Drivers	469.1	373.3	732.8	921.3	1348.2	1946.3	469.1	373.3
Truck Drivers	3095.3	2363.8	5247.7	7706.4	7502.6	11576.6	3095.3	2363.8
Storepersons	2014.4	1604.5	2965.9	3386.2	6424.3	9074.4	2014.4	1604.5
Car Detailers	234.8	209.7	402.2	545.4	674.4	1002.8	234.8	209.7
Commercial Cleaners	1716.7	1339.0	3871.3	3712.7	6739.5	8510.1	1716.7	1339.0
Domestic Cleaners	288.0	227.3	728.8	696.8	1224.1	1523.4	288.0	227.3
Housekeepers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Laundry Workers	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other Cleaners	230.6	178.2	519.7	530.1	856.1	1108.0	230.6	178.2
Building and Plumbing Labourers	1804.2	258.9	2173.9	1813.5	2653.4	2404.5	1804.2	258.9
Concreters	1365.4	127.4	1588.8	1269.4	1788.0	1424.5	1365.4	127.4
Fencers	462.4	85.1	570.8	556.5	691.7	704.8	462.4	85.1
Insulation and Home Improvement Installers	676.9	142.1	780.8	617.8	1243.0	1293.5	676.9	142.1
Paving and Surfacing Labourers	317.2	40.9	429.3	357.2	469.0	445.0	317.2	40.9
Railway Track Workers	160.3	96.3	222.1	234.2	368.0	466.0	160.3	96.3
Structural Steel Construction Workers	718.2	169.3	868.9	740.5	1163.8	1140.9	718.2	169.3
Other Construction and Mining Labourers	209.4	129.1	315.7	387.2	466.8	635.0	209.4	129.1
Food and Drink Factory Workers	323.5	410.3	650.9	1061.2	893.9	1490.1	323.5	410.3
Meat Boners and Slicers, and Slaughterers	99.5	94.4	174.2	232.4	273.1	397.8	99.5	94.4
Meat, Poultry and Seafood Process Workers	161.6	171.5	289.0	411.5	458.3	698.9	161.6	171.5
Packers	889.7	833.9	1583.5	2082.1	3000.5	4445.1	889.7	833.9
Product Assemblers	2285.8	1703.7	2735.2	2239.2	9251.7	12851.0	2285.8	1703.7
Metal Engineering Process Workers	901.0	608.6	1102.9	965.3	3243.1	4437.9	901.0	608.6
Plastics and Rubber Factory Workers	161.3	127.5	228.0	248.7	535.0	753.1	161.3	127.5
Product Quality Controllers	456.8	379.5	658.7	771.6	1664.8	2426.8	456.8	379.5
Timber and Wood Process Workers	301.1	223.5	530.6	899.4	708.7	1201.5	301.1	223.5
Other Factory Process Workers	471.4	286.7	652.6	687.5	1378.2	1860.9	471.4	286.7
Aquaculture Workers	5.2	4.8	9.5	13.9	14.8	23.1	5.2	4.8

Table F.1 Gross green skills and green employment increase (continued)

	Gross (green skills or supporting green skills)				Green employment increase compared to 2010 (excludes displaced skills, i.e. in black coal stations)			
	Weak action		Intermediate		Strong action		Strong action	
	2020	2030	2020	2030	2020	2030	2020	2030
Crop Farm Workers	722.8	1247.3	2099.1	5049.0	2330.3	5649.5	722.8	1247.3
Forestry and Logging Workers	1232.3	2355.5	3906.5	9992.4	4149.7	10831.5	1232.3	2355.5
Garden and Nursery Labourers	654.7	698.6	1594.0	2646.3	2152.4	3705.1	654.7	698.6
Livestock Farm Workers	377.3	623.5	1025.6	2356.7	1160.6	2682.6	377.3	623.5
Mixed Crop and Livestock Farm Workers	275.4	540.0	883.5	2273.0	871.4	2361.5	275.4	540.0
Other Farm, Forestry and Garden Workers	360.4	505.8	1010.1	2014.7	1270.2	2531.1	360.4	505.8
Fast Food Cooks	143.1	126.3	250.2	315.3	424.4	615.6	143.1	126.3
Food Trades Assistants	16.7	15.2	28.1	37.0	47.7	70.0	16.7	15.2
Kitchenhands	400.3	351.1	723.5	895.1	1230.4	1773.7	400.3	351.1
Freight and Furniture Handlers	206.2	162.9	338.9	445.8	571.6	836.7	206.2	162.9
Shelf Fillers	139.5	93.5	199.0	219.4	402.2	551.5	139.5	93.5
Caretakers	46.8	33.4	90.2	102.7	136.3	187.0	46.8	33.4
Deck and Fishing Hands	61.3	49.7	103.5	128.4	158.4	222.9	61.3	49.7
Handypersons	699.3	216.7	992.4	939.7	1345.8	1485.1	699.3	216.7
Motor Vehicle Parts and Accessories Fitters	242.7	179.3	356.1	425.2	697.6	985.9	242.7	179.3
Printing Assistants and Table Workers	79.0	64.9	133.5	155.5	249.7	355.7	79.0	64.9
Recycling and Rubbish Collectors	25.2	25.0	78.9	92.9	87.2	145.8	25.2	25.0
Vending Machine Attendants	29.4	24.8	50.3	62.0	87.5	125.9	29.4	24.8
Other Miscellaneous Labourers	1179.7	775.9	1902.5	2151.8	2920.2	3913.6	1179.7	775.9
Total	**167809.2**	**126107.1**	**279646.6**	**369018.3**	**447915.4**	**655427.5**	**167809.2**	**126107.1**

Appendix G: Detailed tables – Employment growth and change at the regional level by scenario

Table G.1 Employment growth and change at the regional level by scenario

	Industry employment			Resident employment			Increase in agri/mining employment from Weak action		Increase manufacturing employment from Weak action		Increase in construction employment from Weak action		Increase in service industry from Weak action		Total employment increase from Weak action	
	Weak action	Inter-mediate action	Strong action	Weak action	Inter-mediate action	Strong action	Inter-mediate action	Strong action	Inter-mediate action	Strong action	Inter-mediate action	Strong action	Inter-mediate action	Strong action	Inter-mediate action	Strong action
ACT	254371	260966	263867	237410	243542	246321	345	449	495	847	681	869	5073	7331	6594.781	9496.093
Adelaide Inner	349715	357697	360509	221985	227625	231659	222	276	691	1067	1175	1421	5895	8030	7981.813	10794.624
Adelaide North	249102	256358	270783	276873	284263	294958	303	519	1134	8803	1063	1714	4756	10644	7255.360	21680.438
Adelaide South	111055	115176	119338	210064	216641	223142	499	798	467	1770	784	1208	2371	4507	4120.727	8282.758
Melbourne Central	907397	927052	933679	420335	429029	435171	410	504	1403	2011	1856	2217	15986	21550	19654.874	26281.999
Melbourne East	322770	331167	340866	364985	375230	385749	156	247	1053	4653	580	857	6609	12339	8397.376	18095.877
Melbourne North	305166	314071	332017	370762	380793	394580	245	422	1358	10921	1421	2298	5882	13212	8905.655	26851.436
Melbourne North East	242992	250782	257065	410134	421898	433912	502	761	912	2571	973	1416	5403	9326	7790.828	14073.468
Melbourne Outer South East	223133	231189	238993	356318	367329	379819	564	904	933	3228	1013	1546	5546	10183	8055.345	15860.002
Melbourne South East	398841	408615	426694	309042	317429	328203	252	417	1504	10869	1101	1711	6917	14856	9774.468	27853.531
Melbourne West	354174	363909	381046	473878	484580	500179	327	554	1561	10325	1712	2696	6135	13296	9735.093	26871.593
NSW Central Coast	138300	141693	143015	175099	179459	181530	178	227	443	664	1107	1373	1666	2451	3392.874	4715.077
NSW Central West	118759	125290	129662	118525	125044	129424	2430	3721	494	974	1467	2274	2141	3935	6531.882	10903.866
NSW Far West	33713	35113	35541	32973	34562	35200	2752	3550	219	302	702	919	-2274	-2943	1399.566	1827.613
NSW Hunter	324558	335627	346866	328513	339696	350811	696	1113	1315	5132	3523	5350	5535	10712	11069.032	22307.376
NSW Illawarra	195242	201134	204384	220376	227052	230967	329	464	584	1125	1065	1445	3913	6108	5891.922	9141.734
NSW Mid North Coast	131090	135304	137453	133276	137593	139848	597	828	390	659	524	710	2704	4166	4214.203	6362.610
NSW North	70626	77979	83598	70125	77382	82919	4302	7190	526	1009	461	790	2065	3983	7353.101	12972.313
NSW Richmond Tweed	112771	116350	118033	117165	120955	122815	464	635	296	463	591	789	2228	3374	3579.015	5261.382
NSW Riverina	102666	108726	112965	98570	104402	108438	2440	3788	482	969	580	916	2558	4627	6060.617	10299.039
NSW Southern Tablelands	101522	106791	110246	116087	121699	125227	1248	1925	412	733	2272	3480	1337	2587	5268.992	8724.265
NT Darwin	127270	129983	130390	131972	134874	135443	141	157	267	333	282	310	2023	2320	2713.827	3119.969
NT Lingiari	42462	45434	47395	34760	37387	39112	1768	2755	232	404	954	1531	19	243	2972.618	4933.024
Perth Central	618882	633646	638853	386070	395996	401336	397	498	1358	1987	2733	3332	10277	14154	14764.437	19971.500
Perth Outer North	235655	242381	250143	368079	378006	386055	363	576	971	4089	933	1398	4459	8425	6726.126	14488.594
Perth Outer South	214189	221994	230177	325185	335663	343953	370	606	942	3708	2035	3141	4458	8533	7804.813	15988.282
QLD Cairns	130275	135784	138915	131778	137365	140558	1633	2346	451	752	1343	1945	2082	3597	5508.953	8639.953
QLD Darling Downs	135062	140603	144376	130268	135749	139496	2466	3621	508	1223	575	852	1992	3617	5540.828	9313.235
QLD Fitzroy	142707	148328	152781	140096	145603	149951	1226	1836	548	1651	1468	2207	2378	4379	5620.938	10073.469
QLD Mackay	121528	127156	131203	118212	123656	127572	2028	3049	479	1233	725	1106	2396	4288	5628.422	9675.820
QLD North	141013	150806	157912	143380	153218	160341	4574	7234	798	1516	980	1590	3442	6559	9793.407	16898.548
QLD Resource region	50653	53272	54881	44267	46629	48084	1254	1880	175	342	1301	1972	-110	34	2619.269	4228.108
QLD Wide Bay Burnett	136426	143666	148550	138094	145345	150237	2518	3860	583	1130	1196	1847	2943	5288	7239.922	12124.672
SA Mallee South East	50182	54904	58416	49102	53619	56988	2518	4177	329	607	693	1172	1181	2277	4721.417	8233.245
SA Mid North Riverland	59145	62726	65023	65230	68957	71678	2137	3298	295	514	730	1142	419	924	3581.339	5878.225

Table G.1 Employment growth and change at the regional level by scenario (continued)

	Industry employment			Resident employment			Increase in agri/mining employment from Weak action		Increase manufacturing employment from Weak action		Increase in construction employment from Weak action		Increase in service industry from Weak action		Total employment increase from Weak action	
	Weak action	Inter-mediate action	Strong action	Weak action	Inter-mediate action	Strong action	Inter-mediate action	Strong action	Inter-mediate action	Strong action	Inter-mediate action	Strong action	Inter-mediate action	Strong action	Inter-mediate action	Strong action
SA Spencer Gulf	51193	53797	55781	47040	49465	51314	887	1356	250	682	2291	3572	-824	-1023	2604.019	4587.519
SEQ Brisbane City	994837	1018865	1031078	717671	737334	748562	694	925	2478	4867	3348	4308	17508	26142	24027.499	36241.186
SEQ Brisbane South	218833	225490	232823	323247	332040	339373	316	505	858	3509	621	937	4863	9039	6657.516	13990.046
SEQ Gold Coast	342738	352012	357629	346757	356310	362534	304	429	1033	2328	1097	1479	6839	10655	9273.312	14890.656
SEQ Moreton Bay	151612	156600	160750	244759	251811	256803	334	513	586	1709	409	602	3659	6314	4988.328	9138.359
SEQ Sunshine Coast	197282	202531	205085	209367	215005	217861	521	695	555	1009	451	588	3721	5511	5248.328	7803.015
SEQ West Moreton	214258	220876	226694	291047	297553	302864	783	1191	837	2713	1031	1507	3968	7025	6618.484	12436.375
Sydney Central	1022588	1044883	1052133	458837	468880	473163	411	504	1628	2282	3119	3713	17137	23045	22294.500	29544.375
Sydney Eastern Beaches	108085	110951	112050	160535	164551	166151	55	73	231	327	241	303	2339	3262	2866.437	3965.187
Sydney Northern Beaches	121864	125276	127033	175654	180354	182617	158	215	319	536	304	402	2631	4016	3411.344	5168.790
Sydney Old West	130450	134358	136625	185003	189835	192353	74	108	417	728	324	443	3093	4897	3907.812	6175.390
Sydney Outer North	178382	184176	189666	261463	269574	275511	362	561	581	1972	328	491	4524	8260	5794.233	11284.015
Sydney Outer South West	235619	243247	253298	351019	359672	368949	349	584	1073	5237	708	1107	5498	10752	7628.608	17679.780
Sydney Outer West	297580	306678	317174	435296	446935	458245	396	640	1240	5256	1003	1525	6459	12174	9098.313	19594.344
Sydney Parramatta-Bankstown	444729	455895	464230	342841	352530	359540	197	289	1440	3925	1251	1719	8278	13568	11166.250	19501.531
Sydney South	157573	162533	165513	258849	266590	270909	92	136	482	907	753	1044	3632	5853	4959.454	7939.907
TAS Hobart-South	136412	141192	143765	136646	141451	144054	593	839	362	640	1473	2045	2352	3829	4780.687	7352.875
TAS North	72729	76643	79603	73398	77334	80309	969	1526	300	736	1401	2203	1243	2410	3913.945	6874.172
TAS North West	56885	60301	63251	56887	60282	63206	848	1377	292	884	1581	2569	696	1536	3416.254	6366.277
VIC Ballarat	92150	95913	99389	99667	103573	107348	768	1190	385	1404	974	1506	1635	3140	3763.250	7239.141
VIC Bendigo	132276	137217	141037	154899	160390	165089	1010	1513	469	1383	1051	1561	2411	4304	4941.625	8761.031
VIC Geelong	130987	130878	134325	135318	135963	139763	26	111	64	2952	121	465	-319	-190	-108.733	3338.056
VIC Gippsland	123414	129561	133607	128159	134426	138675	953	1485	461	867	3528	5370	1206	2472	6147.367	10193.140
VIC Mallee Wimmera	58948	64312	68304	58554	63772	67637	3053	5024	395	743	184	310	1731	3278	5363.766	9355.383
VIC North East	119602	124111	126609	125004	129778	132586	1018	1458	410	713	1175	1660	1906	3177	4509.101	7006.734
VIC West	87929	94053	98446	99241	105300	109995	2320	3719	466	894	2100	3405	1238	2499	6123.883	10517.031
WA Gascoyne Goldfields	72585	76302	78456	61346	64567	66443	1410	2080	301	504	2361	3542	-355	-255	3716.538	5871.116
WA Peel South West	154130	159962	163667	168091	174268	178284	879	1302	516	1141	2281	3293	2155	3800	5832.141	9536.298
WA Pilbara Kimberley	75511	78898	80915	57420	59984	61514	568	831	228	467	1994	2937	597	1169	3387.375	5404.218
WA Wheatbelt Great Southern	73226	79689	84410	74815	81077	85655	3677	6057	428	787	828	1388	1530	2952	6463.398	11184.367
Total	**13507815**	**13938874**	**14278979**	**13507815**	**13938874**	**14278979**	**66678**	**102422**	**43690**	**140684**	**78934**	**115532**	**5073**	**7331**	**6594.781**	**9496.093**