Low Carbon Growth Plan for Australia

Impact of the carbon price package

August 2011

Revised edition

The *Low Carbon Growth Plan for Australia,* released in 2010 by ClimateWorks Australia, quantifies the size and cost of a range of opportunities to reduce Australia's greenhouse emissions using existing technology. It found that Australia could reduce emissions by 25% below 2000 levels for a lower than expected cost. It also found that a range of barriers currently hinder the implementation of these opportunities.

The Australian Government's recently announced carbon price package - *Securing a Clean Energy Future* - aims to steer our economy towards a low emissions future. To achieve this, it will put a price on carbon pollution as well as support action through a range of complementary measures.

In the context of the *Low Carbon Growth Plan for Australia,* this report assesses:

- how the carbon price package will impact investor profitability
- how the carbon price package may reduce non-financial barriers
- the amount of emissions reduction potential that could be unlocked in Australia by the carbon price package
- what still remains to be done

KEY FINDINGS

The carbon price package has the potential to reduce Australia's domestic greenhouse gas emissions by 124 million tonnes per year - more than double Treasury's modelling of domestic abatement achievable through the carbon price alone.

This flows not just from the carbon price itself, but from the impact of the full suite of complementary measures outlined in the package. It is based on the current default settings for the carbon price (cap set for a 5% target).

If implemented optimally, the Federal Government's carbon price package could take Australia 76% of the way towards achieving its international commitment to reduce greenhouse gas emissions by 5% below 2000 levels by 2020 through domestic emissions reductions alone. A further 2.4 million tonnes can be achieved through soil carbon opportunities, which are not yet recognised internationally. This would enable Australia to reverse its growth in domestic emissions, almost reaching 2000 levels. These domestic abatement opportunities are in addition to internationally sourced abatement opportunities. This provides solid evidence for increasing Australia's 2020 pollution cap, to be considered by the independent Climate Change Authority.

The carbon price package achieves these results in two ways.

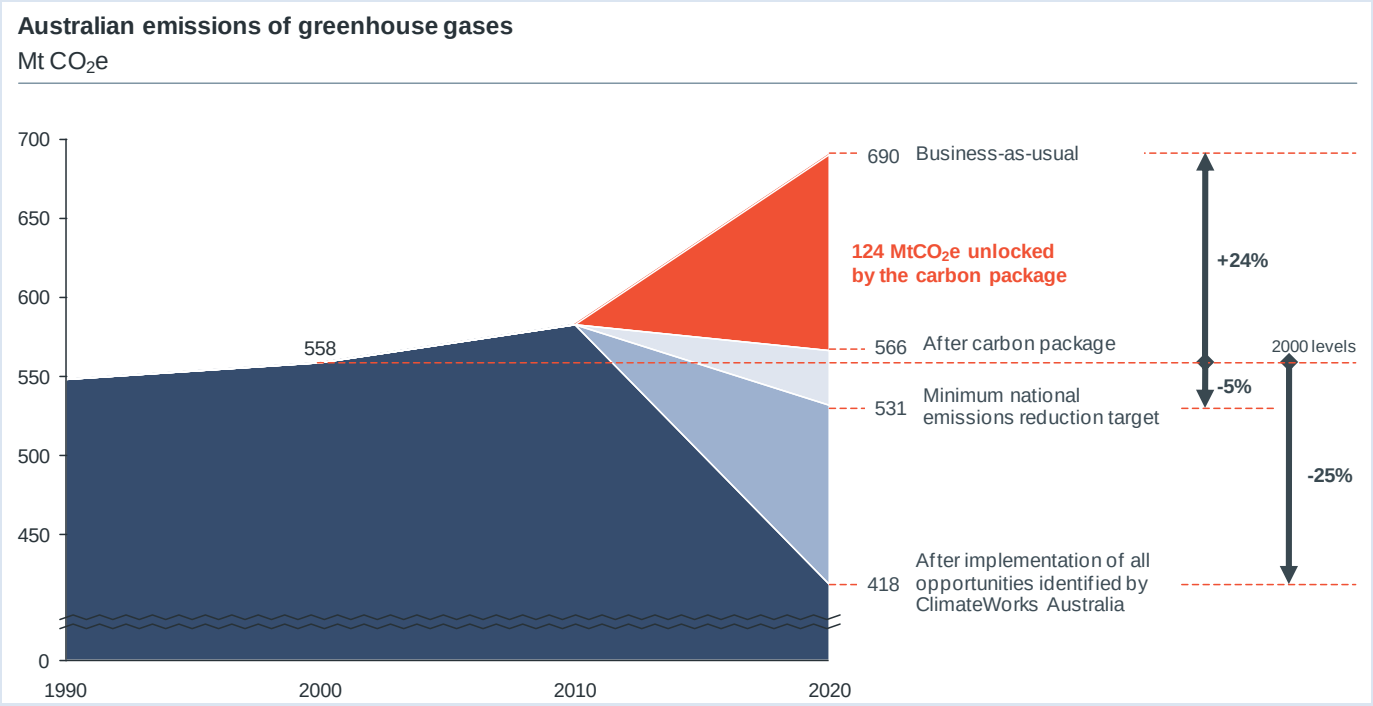
- *The carbon price improves the economic attractiveness of emissions reduction activities*
  A price on carbon pollution works to increase the priority of some emissions reduction activities, by making those opportunities profitable, by creating a signalling effect that steers investment to lower emissions technologies, and by creating new markets for aggregation of opportunities.

- *The complementary measures address other barriers that currently prevent action*
  Some non-price barriers to reducing our emissions are lowered or removed through a range of targeted complementary measures. These include financial support (such as grants, loans, equity investments or loan guarantees to overcome capital availability issues); dissemination of information and upskilling; and adjustments to rules and regulations.

The table below indicates the abatement potential associated with major programs in the carbon price package.

Key programs (acting with carbon price)	Associated abatement (MtCO2e)
Carbon Farming Initiative (Kyoto compliant)	39.1
Clean Energy Finance Corporation (CEFC)	12.1
National Energy Savings Initiative (NESI)	12.0
Payment for closure	11.9
Clean Technology Investment Program	6.5
Tax breaks for Green Buildings	5.9
Carbon Farming Initiative non-Kyoto Carbon Fund	2.4
Small Business Instant Asset Write-Off Threshold Change	1.9
Clean Technology - Food and foundries Investment Program	1.3
Productivity Commission review of fuel excise	1.4
Low Carbon Communities	1.1
Coal Mining Abatement Tech Support Package	0.8
Other programs	1.5
Total from complementary measures (with carbon price)	98
Emissions trading scheme (ETS) at default 5% target	Contributes to all above plus 26
Total potential to be achieved by carbon package	124

Exhibit 1 - Emissions reductions compared to business-as-usual



Note: 2.4 $MtCO_2e$ from non-Kyoto abatement opportunities could not be counted towards international commitments

Smart implementation is key to achieving this potential, and more can be done.

Achieving the emissions reduction potential of the carbon price package depends upon good program design and delivery. The complementary measures can more than double what the carbon price would do alone – thus making their implementation critical to overall success. In particular, allocation of grant funding must be prioritised on the basis of maximising abatement tonnes per dollar spent.

In addition, the governance measures in the carbon price package allow the ambition of the target to be increased on the basis of independent advice. ClimateWorks Australia's research shows that 25% reductions below 2000 levels is achievable in Australia.

To unlock the remaining opportunities to achieve a 25% reduction (272 $MtCO_2e$), it will be necessary to build upon the momentum that this carbon price package can create and extend its efforts through measures to deploy more low emissions power, more ambitious mandatory efficiency standards, and incentives to make it easier for the remaining profitable activities to be implemented.

This is all within our reach.

Throughout this report:

- *All emissions reduction cost curves are for 2020 and represent the opportunity that can be captured from 2012 to 2020*
- *All costs are calculated using the investor perspective (see the Low Carbon Growth Plan for Australia for methodology) and expressed in 2010 real dollars*
- *All carbon price values are shown in 2010 real dollars in order to be consistent with all cost curve data*
- *$MtCO_2e$ stands for million tonnes of carbon dioxide equivalent*
- *The report models the carbon price package with the default target of 5% reduction by 2020*

Australia could reduce its greenhouse gas emissions by 25% below 2000 levels using existing technologies available domestically.

In March 2010, ClimateWorks Australia published the *Low Carbon Growth Plan for Australia*. It found that by 2020 Australia could reduce its greenhouse gas emissions by 249 $MtCO_2e$ for a lower than expected cost. This represented 25% below 2000 levels. By 2011, the emissions reductions needed to meet a 25% reduction target had grown to 272 million tonnes - a result of faster than expected growth in Australia's emissions[1].

The *Low Carbon Growth Plan for Australia* identifies a range of solutions to reduce our national emissions from activities in energy efficiency, land and power (see Exhibit 3). All of these focus on current technology or best practice, and can therefore be achieved without relying on technological breakthrough, adjustments to our lifestyles, or changes to the business mix of our economy.

Exhibit 2 – Australia's emissions continue to rise under business-as-usual

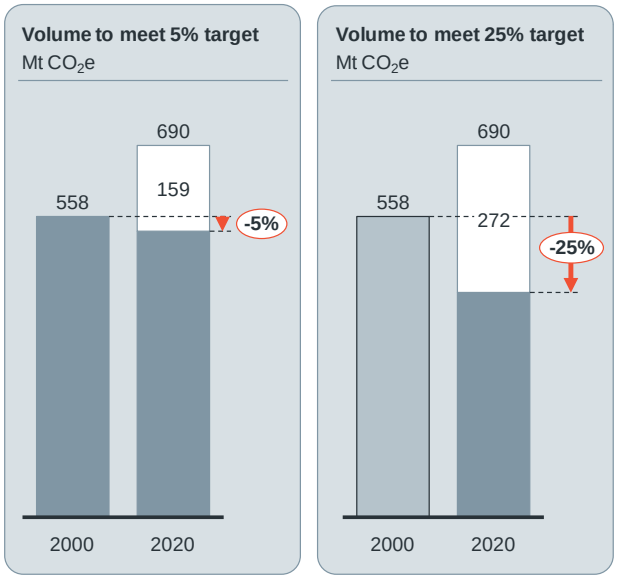
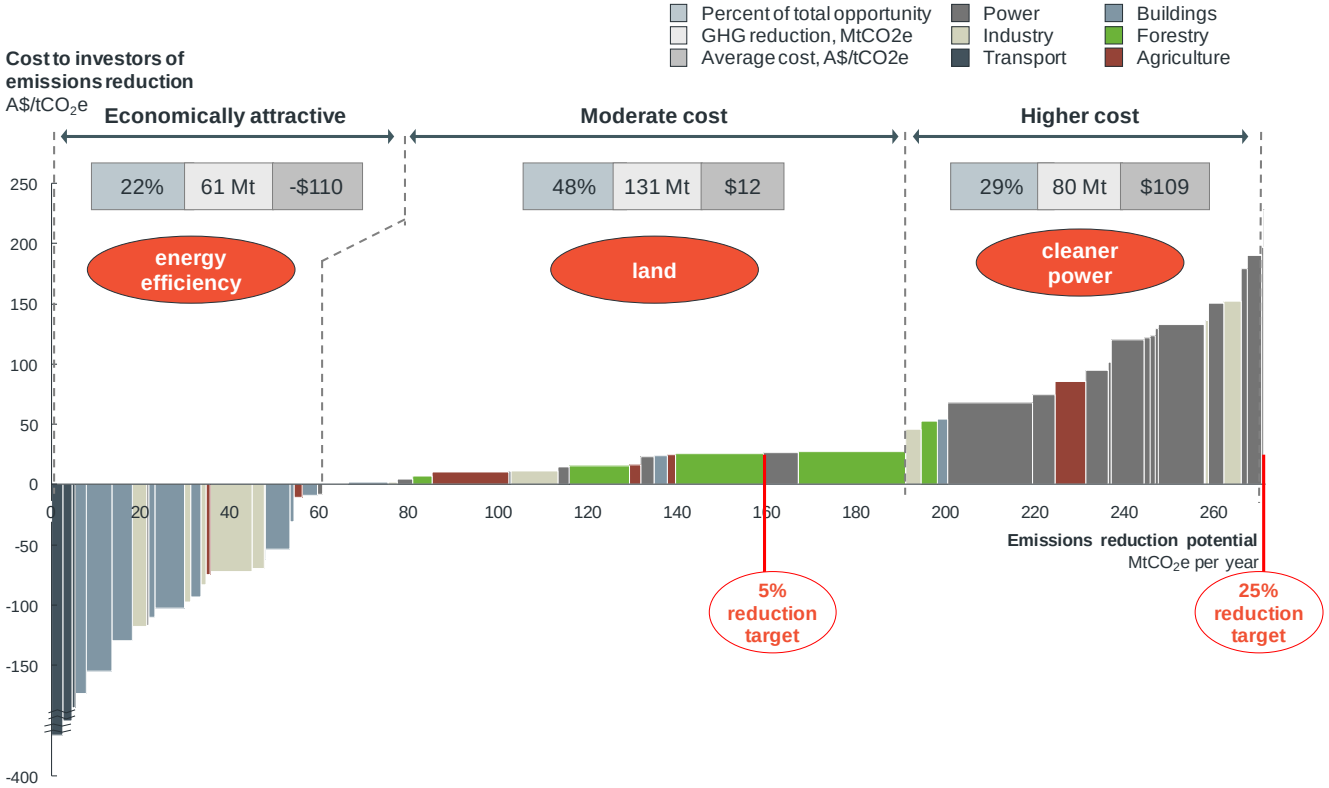


Exhibit 3 - 2020 greenhouse gas emissions reduction investor cost curve (from Jan 2012 on) for Australia[2]



Note: see back page for how to read an emissions reduction cost curve

[1] As outlined in the Department of Climate Change and Energy Efficiency's updated 2020 BAU estimates and discussed in ClimateWorks *2011 Update*

[2] Since the *Low Carbon Growth Plan for Australia* was released, this cost curve has been updated to reflect the larger abatement requirement (from 249 $MtCO_2e$ to 272 $MtCO_2e$). New opportunities have been added, energy prices have been updated, the power sector has been revised based on latest knowledge, the change in economic context has been accounted for, and the impact of delay from 2010 to 2012 has been factored in.

A range of barriers, however, are preventing action on opportunities available to reduce greenhouse gas emissions in Australia.

All opportunities to reduce greenhouse gas emissions identified in the *Low Carbon Growth Plan for Australia* are additional to those that are expected to occur under business-as-usual. It is therefore assumed that these opportunities will not be captured by 2020 without further action.

While the cost of implementing some opportunities is the primary barrier, others are already profitable, indicating that non-price barriers exist. For many opportunities a combination of price and non-price barriers are at play.

Barrier type	Example barriers
Investor profitability *Is the opportunity profitable?*	• Even factoring in any additional savings from efficiencies, there is still a net cost associated with capturing the opportunity
Capital constraints and investment priorities *How hard is it to access the capital needed?*	• Finite access to capital means emissions reduction projects are low priority • It is difficult to access loans for energy efficiency projects or projects with higher risk • The payback period on investment is too long to attract investment • The return on capital does not meet the internal hurdle rate
Information gaps and decision process *Is the opportunity poorly understood?*	• Access to information on emissions reduction opportunities is limited • There is a lack of awareness of the potential financial or productivity benefits • Emissions reduction projects are not core business and staff do not have the required skills • Scientific or technical uncertainty about an opportunity is preventing its uptake
Market structure/supply *Does the structure of the market prevent the opportunity from being captured?*	• Electricity pricing has been negotiated at non-market rates, reducing the attractiveness of energy efficiency projects • Split incentives exist that see someone other than the investor benefit from financial savings (e.g. owner/tenant, current/future) • Without aggregation, the project is too small for an individual business (high transaction costs, limited profitability) • It is difficult to access energy efficient equipment through existing supply channels • The market is too small or immature to guarantee reliability/quality of supply • There are not enough workers with the requisite skills to make large-scale deployment possible

The Australian Government's carbon price package, *Securing a clean energy future,* will attach a cost to the emission of carbon pollution as well as provide a range of other support mechanisms such as funding, information and governance or regulatory adjustments. Combined, these measures aim to encourage investment in technologies and solutions that will steer the Australian economy towards a lower emissions future. See page 16 for summary of the carbon price package. This report assesses the impact of the carbon price package on the opportunities identified in the *Low Carbon Growth Plan for Australia*.

In our analysis, we first assess how the carbon price package impacts the profitability of opportunities.

The carbon price package impacts the cost of emissions reductions opportunities for investors in three ways, as illustrated in Exhibit 5.

1. By putting a price on carbon

The introduction of the carbon price will change the economics of most opportunities:

- **For businesses that are included in the emissions trading scheme**, every tonne emitted will require a permit, whose value will be equal to the carbon price in the year in which it is sold. This will therefore reduce the relative cost of abating emissions by the same amount. These businesses include power generators and large energy intensive businesses.
- **For businesses that can provide offsets** (through the Carbon Farming Initiative), every tonne of offset can earn a certificate which can then be sold to emitters as equivalent to an emissions permit. Its value will therefore be equal to the carbon price in the year in which it is sold.
- **For other businesses and individuals**, the impact of the carbon price will be experienced mostly through an increase in electricity prices, passed on by electricity generators who need to buy permits for their emissions. This provides an incentive to invest in energy efficiency and cleaner technologies.

Step 1 in Exhibit 5 *opposite shows the impact of the 2020 carbon price alone on all opportunities. See page 14 for detailed assumptions on carbon and electricity prices.*

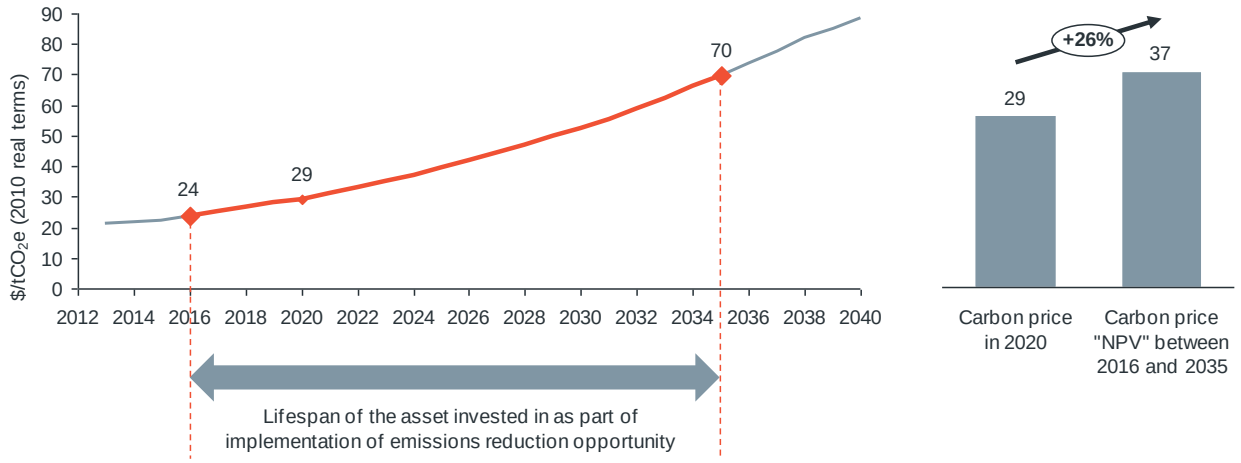
2. By creating a signalling effect for long-life assets

For operational activities (eg. Changing the utilisation of gas and coal power stations, implementing process improvements), the value of the carbon price at the present moment drives investment decisions. However, for asset-based activities (eg. building a new power station, investing in new energy efficient equipment, establishing a forest), investment decisions will be based on the expected value of the carbon price over the life of the asset.

We have modelled this effect by taking the Net Present Value (NPV) of the carbon price over the life of the asset involved in delivering each emissions reduction opportunity, and annualising it (both based on an investor cost of capital between 8% and 14%). Exhibit 4 below illustrates this for a 20-year life asset. In this case, taking into account the NPV of the carbon price increases the experienced carbon price in 2020 from \$29 to \$37/tCO_2e.

Step 2 in Exhibit 5 *shows the impact of adding the "NPV" consideration on all opportunities.*

Exhibit 4 – Calculation of the carbon price "NPV" for an emissions reduction opportunity related to a 20-year life asset



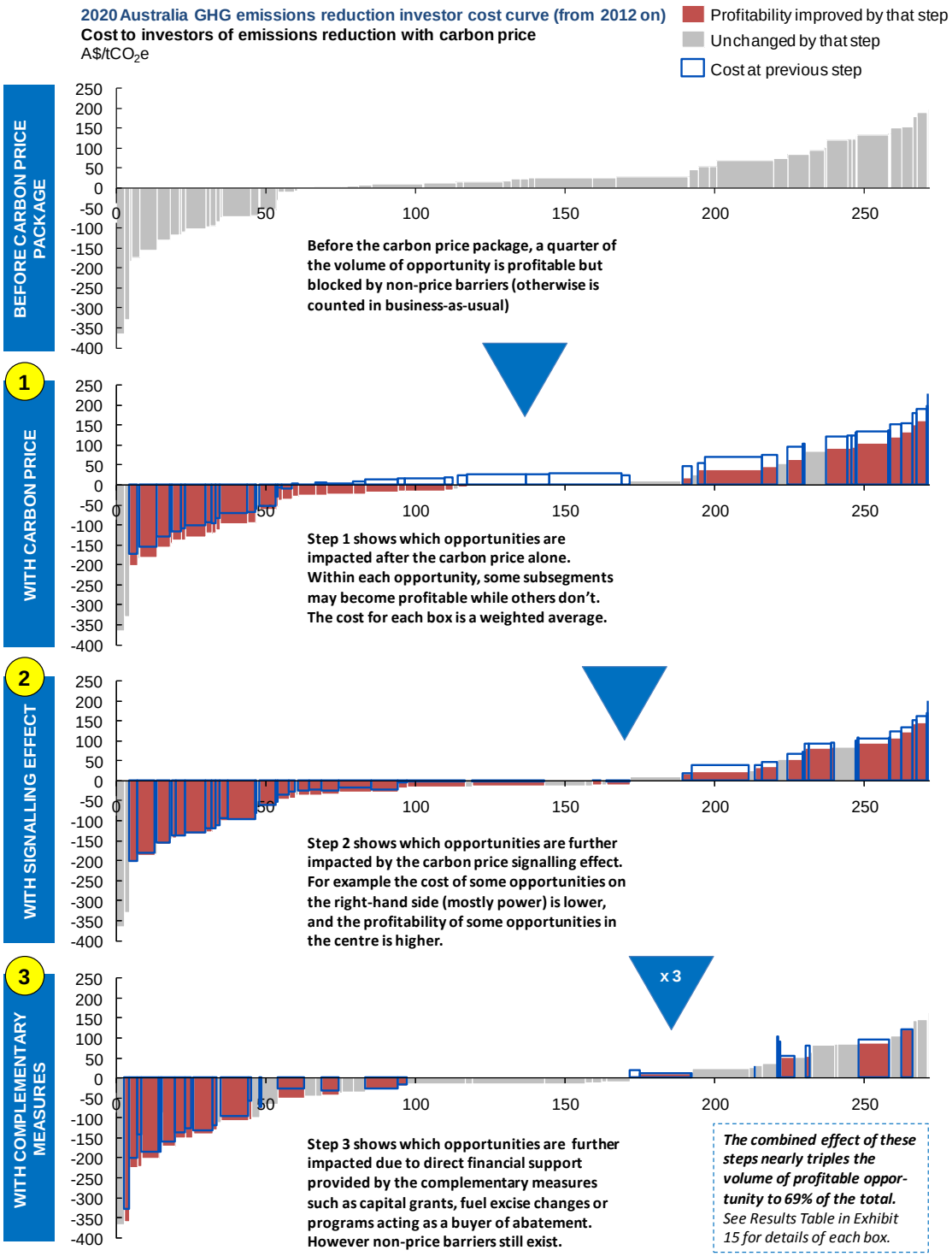
3. By additional complementary measures that provide financial support

In addition to the carbon price, many of the complementary measures also directly improve the cost of some emissions reduction opportunities through:

- **Grants**, which have the effect of decreasing the capital needed to implement an opportunity.
- **Financing assistance**, for example through low interest loans, equity or loan guarantees, which we have modelled as decreasing the cost of capital paid on the capital expenditures of those opportunities.

Step 3 in Exhibit 5 *shows the impact of the complementary measures on all opportunities.*

Exhibit 5 - How the carbon price package addresses profitability of emissions reduction opportunities



This shows the volume that would be profitable with the carbon price package; however most of this is still obstructed by a range of non-price barriers. We analyse the impact of the package on those barriers next.

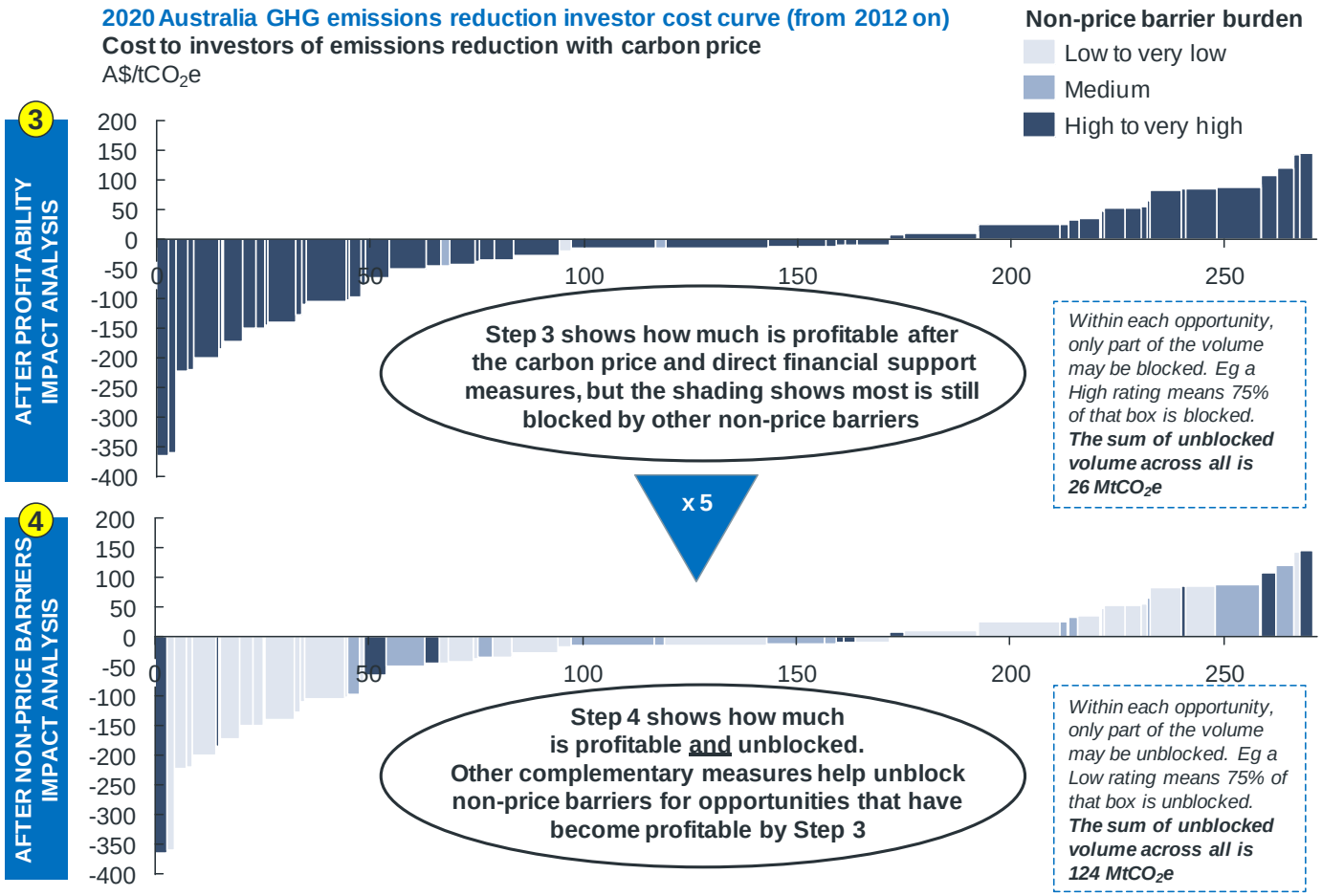
Second, we assess how the carbon price package alleviates the non-price barriers.

Non-price barriers include capital constraints, information gaps, and market structure and supply barriers. The carbon price will not only act on profitability, but also on those barriers: it will increase the interest of businesses in energy efficiency and emissions reduction investments by increasing their profitability, and by increasing management attention. Complementary measures will also alleviate non-price barriers through direct financial support, information and upskilling programs and changes in governance and regulation. See page 15 for details.

Exhibit 6 shows the alleviation of non-price barriers on the emissions reduction potential.

- Step 3 replicates the final step on Exhibit 5 (previous page), with each emissions opportunity shaded based on the non-price barrier burden it experiences (see next page for explanation of methodology).
- Step 4 shows the impact of alleviation of non-price barriers by the complementary measures.

Exhibit 6 - How the carbon price package addresses non-price barriers



The final result shows that the carbon price package can unlock 124 $MtCO_2e$ of domestic emissions reductions: 78% of the 5% target* (and 45% of the 25% target).

*This number reduces to 76% when considering only internationally recognised abatement activities

Our analysis looks at the impact of all the measures included in the carbon price package as announced by the government. Where details are not yet known, we have assumed a design that achieves optimal emissions reduction and barrier alleviation, for example:

- We have not attributed funds to opportunities which were locked by other barriers, and we have given priority to opportunities which offer the highest levels of abatement for each dollar spent in capital
- We have also taken a conservative approach regarding the take-up of government funding by either creating "buffers" – not all the money is allocated when supply may constrain the amount spent – or taking leverage ratios lower than those announced.

More detail on how we have modelled each program can be found in our methodology section on page 17.

For each opportunity, we assessed how the carbon price package will help alleviate each of the major non-price barriers. We analysed the impact both in terms of strength (how much does the measure alleviate the barrier) and coverage (how many businesses or individuals are affected by the measure).

The table below illustrates our methodology for Food, beverage and tobacco manufacturing energy efficiency.

First, we identified the major barriers locking the opportunity in the business-as-usual case for each sub-segment: process improvements versus equipment or infrastructure upgrades, SME versus large businesses, and energy intensive versus non-energy intensive businesses.

We then estimated the strength and coverage of major barriers for each segment (5 = very high and 1 = very low), and looked at how the carbon price package would impact those.

Non-price barriers before package	Strength	Coverage	Barrier burden	Overall burden
1. ***Low priority.*** *Energy efficiency above that achieved in business-as-usual has a low priority for business –very strong barrier for non-energy intensive businesses.*	5	3	3	5
2. ***Capital constraints.*** *It is difficult to access the capital necessary to invest in new energy efficient equipment –very strong barrier for equipment ugrade as low priority/insufficient returns as compared to other investments.*	5	4	4	
3. ***Operational risk.*** *The risk of operational disruption is too high due to lack of familiarity with new equipment –strong barrier for equipment ugrades.*	4	4	3	
4. ***Supply constraints.*** *Access to energy efficient equipment can be difficult (eg. limited supply, not offered by current supplier) –strong barrier for some equipment ugrades.*	4	3	2	
5. ***Limited understanding.*** *The potential energy savings are not clear due to lack of knowledge of current energy consumption –strong barrier for smaller businesses (large businesses can use energy service companies).*	4	3	2	
Non-price barriers after package				
1. ***Low priority.*** *The carbon price and associated energy price increase will help increase the business priority for the opportunities with the shortest payback.*	3	3	2	2
2. ***Capital constraints.*** *We assumed 27% of the opportunity will be eligible for the Clean Technology Investment Program and 35% for the Clean Technology –Food and foundries Investment Program (see page 17 for program design assumptions).*	5	2	2	
3. ***Operational risk.*** *The Clean Energy Skills Program will help improve knowledge of energy efficiency equipment and processes in most businesses (especially large).*	4	2	2	
4. ***Supply constraints.*** *The Clean Technology Focus for Supply Chains Program will help fill in the gaps in equipment supply.*	4	2	2	
5. ***Limited understanding.*** *The Energy Efficiency Information Grants program will help increase the understanding of potential savings amongst SMEs.*	2	3	2	

Of the full potential identified by ClimateWorks to achieve the 25% target in Australia…

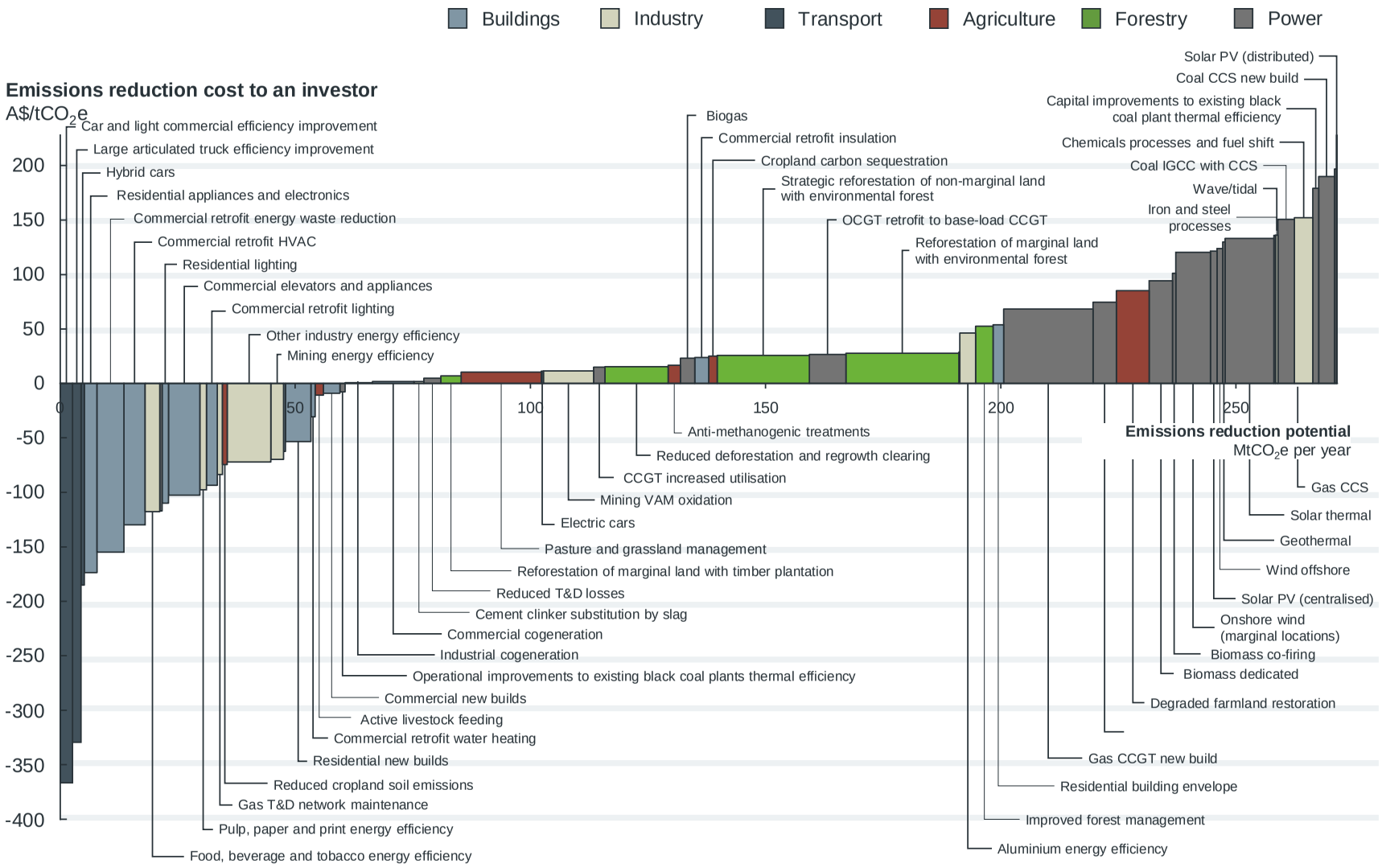


Exhibit 7 - Opportunities to reduce emissions in Australia in 2020 by 272 MtCO2e

… the carbon price package has potential to unlock 124 $MtCO_2e$ of those opportunities.

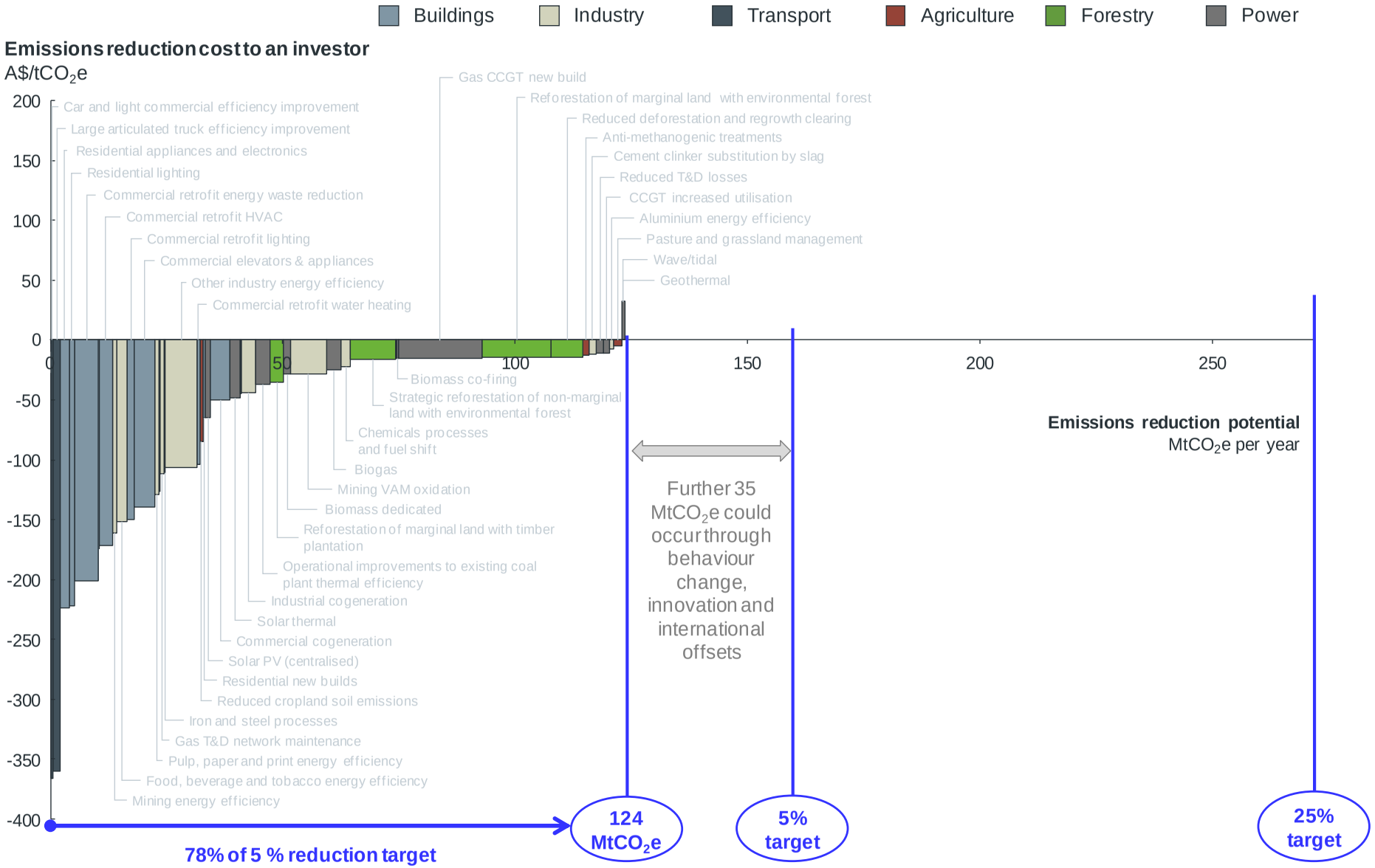


Exhibit 8 - Opportunities to reduce emissions in Australia in 2020 that can be unlocked by the carbon price package

Smart implementation is key to achieving this potential, and more can be done.

There are three major areas of focus to ensure optimum delivery of Australia's emissions reductions:

1. Get the implementation right

Good program design and delivery are critical to ensuring the complementary measures in the carbon price package deliver their full potential for emissions reduction. It is essential that lessons are learned from previous efforts and input is sought from stakeholders to ensure programs best meet their needs in overcoming barriers.

Unlocking capital for projects can be achieved through loan guarantees, low interest loans or innovative recoupment structures. And targeted programs to ensure the right information reaches the right people to encourage emissions reduction activities is also crucial to capturing the remainder of these opportunities.

2. Raise the emissions reduction target to 25%

The *Low Carbon Growth Plan for Australia* demonstrated that Australia can reduce its greenhouse gas emissions by 25% below 2000 levels by 2020 using technologies available in Australia. This would not require technological breakthroughs or changes to the business mix of our economy or to the lifestyles of Australians.

Many of these low cost emissions reduction opportunities are only available for a finite time. A failure to capture them by 2020 would result in a higher cost for the same outcome.

This provides solid evidence for increasing Australia's 2020 pollution cap, to be considered by the independent Climate Change Authority.

Why aim for more than 5%?

The United Nations Inter-governmental Panel on Climate Change recommends that industrialised nations achieve reductions in emissions of 25-40% by 2020 (compared to 1990 levels), to provide a 50% chance of limiting global warming to 2°C.

Australia currently has bipartisan political support for an emissions reduction target of between 5% below 2000 levels. The Government has a commitment to increase this target to 25% below 2000 levels if an ambitious global agreement is reached.

The *Critical Decade* report by Australia's Climate Commission concludes that "emissions must peak in the next few years and then strongly decline… unless effective action is taken, the global climate may be so irreversibly altered we will struggle to maintain our present way of life."

3. Unblock the barriers to the remaining opportunities

While the package has the potential to unblock 124 $MtCO_2e$ of emissions reductions, a further 148 $MtCO_2e$ of potential reductions remain blocked by barriers.

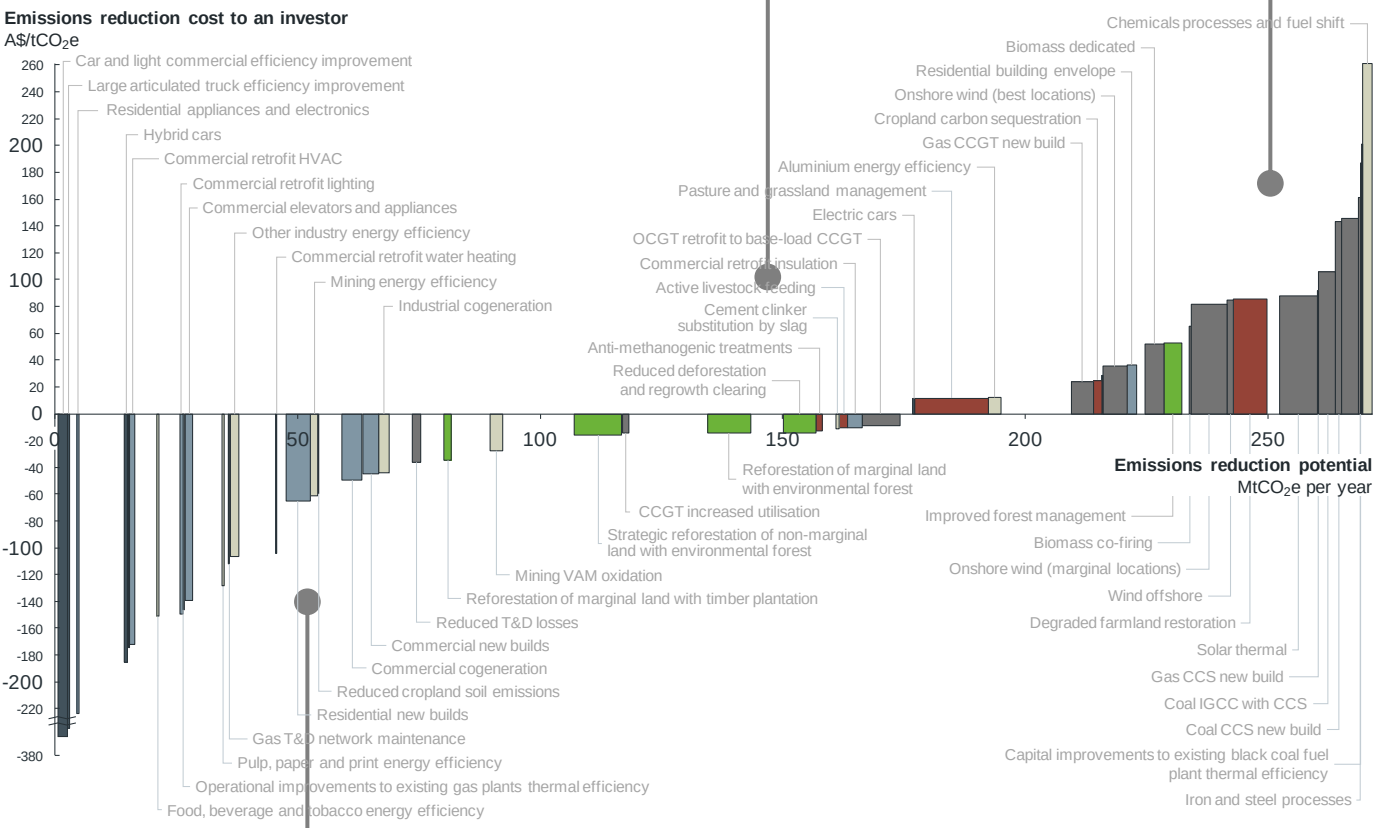
Unblocking these barriers will require targeted intervention by business and government. The *Low Carbon Growth Plan for Australia* suggests a range of mechanisms to overcome the remaining barriers faced by each sector. In particular, solutions that are missing from the carbon price package include:

- **More ambitious mandatory efficiency standards** for vehicles, buildings, appliances and equipment. These are simple and effective in ensuring emissions reductions through improved energy efficiency.
- **Emissions performance standards** for power generation and/or further measures to bring forward more zero- or low-emissions power generation.
- **Making it easier** for the remaining profitable activities to be implemented by those not currently reached by the carbon price package.

Exhibit 9 - Some opportunities will remain blocked by barriers without further intervention

Some higher cost opportunities, particularly in the Power sector, remain unprofitable with a carbon price consistent with the 5% target

Some land-based opportunities remain blocked due to the high degree of fragmentation, a lack of information about productivity co-benefits, cash constraints faced by individual landowners, and the ineligibility of non-Kyoto opportunities in the CFI program



Some energy efficiency opportunities that are already profitable will not be captured, due to constraints on capital, risk of operational disruption or lack of information about the value of energy efficiency

ASSUMPTIONS AND RESULTS

Impact of the carbon price package

This section of the report consists of two parts:

Assumptions regarding the modelling of the package

A. **Carbon and electricity price modelling**. What we have assumed regarding future carbon price values and impact on electricity prices (pass-through rate).

B. **Description of the carbon package**. A summary of the major aspects of the carbon price package, and especially of key complementary measures by type and by sector.

C. **Modelling assumptions for major programs**. What we have assumed regarding the design criteria for measures that were not detailed in the government announcement –leverage, interest rates, overall distribution of funds, etc. Detailed assumptions regarding the distribution of funds for the Clean Energy Finance Corporation (CEFC), the Clean Technology Investment Program (CTIP) and the Carbon Farming Initiative (CFI) non-Kyoto programs, assumptions regarding the distribution of abatement by opportunity for the National Energy Savings Initiative (NESI).

Results of the modelling

D. **Introduction to results table**. Methodology flow chart and step by step walk through of the analysis conducted for the Food, beverage and tobacco energy efficiency opportunity.

E. **Results table**. Table showing for each opportunity: the share of opportunity that is profitable before and after the carbon package, the barrier burden before and after the carbon package, the overall level of activity unlocked by the package, and the key drivers to the results.

A. Carbon and electricity price modelling

1. Carbon price

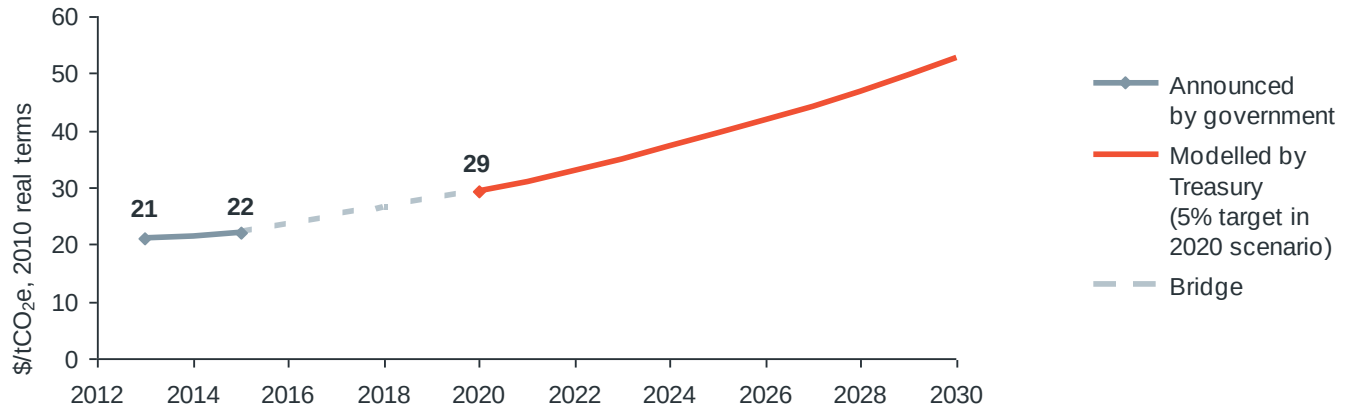
Our carbon price modelling relies on two sources:

- **The carbon price specified in the carbon price package** for the fixed price period (between 2012-2015).
- **The Treasury modelling**[3] of the expected carbon price in 2020 necessary to reach the 5% reduction target and its estimates of the future values of the carbon price from 2020 onwards.

Between 2015 and 2020, we have assumed a linear growth of the carbon price. When values were needed after the end of the government projections, we also assumed a continued linear growth. Exhibit 10 shows the carbon price values used between 2012 and 2030.

We have rebased carbon price values back to 2010 real dollars in order to be consistent with all cost curve data.

Exhibit 10 - Carbon price assumptions used in our modelling



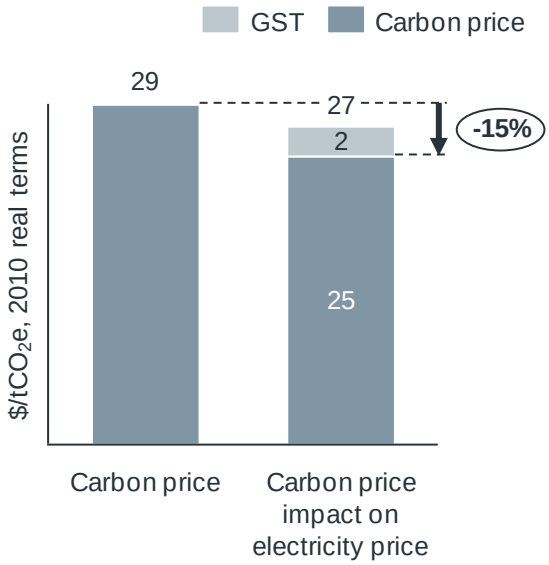
2. Electricity price

Our electricity price modelling is based on:

- **A business-as-usual electricity price** (before carbon package) based on projections from the Treasury modelling.
- **A pass-through rate** of 85%. We assume that 85% of the carbon price will be passed through to the electricity price. This corresponds to the pass-through rate assumed by the Treasury modelling.
- **A GST rate** of 10%. We assume that the GST will apply to the increased electricity price.

Exhibit 11 illustrates our modelling for the year 2020.

Exhibit 11 - Electricity price modelling, 2020



[3] Australian Treasury, *Strong growth, low pollution, modelling a carbon price* (2011)

B. The carbon price package includes a number of complementary measures that work with the carbon price to overcome key barriers

The table opposite summarises the major programs in the carbon price package. It sets these out against the three major areas of emissions reduction potential on one axis, and against the key classes of barriers discussed in this report.

Importantly, the package is more than simply a carbon price. Most opportunities face a range of barriers that a carbon price alone cannot overcome. The government's carbon price package contains multiple complementary measures to address these barriers:

1. ***A carbon price*** – can be an effective, market-based method to ensure that some opportunities that currently come at a net cost become profitable. In addition, as well as having a profitability impact, the carbon price acts by providing a signalling effect that raises the profile of activities that reduce exposure to a carbon price, even when they are not profitable in the short term.

2. ***Direct financial support*** – the package provides direct financial support to projects that will reduce greenhouse gas emissions. A range of funding programs will provide finance through grants, loans, equity investments or loan guarantees which will lower the upfront cost, reduce capital availability constraints and reduce the risk for other investors.

   e.g. the Clean Energy Finance Corporation will invest $10 billion to help finance renewable and low emissions power generation through loans, equity and loan guranantees; the Low Income Energy Efficiency Scheme will distribute $100 million in grants to support low income households to trial energy efficiency approaches.

3. ***Information and skills*** – the package provides additional support to facilitate the dissemination of information and development of skills or that can enable emissions reduction opportunities to be identified and captured. This helps to reduce transaction costs and enable increased aggregation of opportunities.

   e.g. the Energy Efficiency information grants program provides $40 million in grants to industry associations and NGOs to deliver information to small businesses and community groups about how to manage the impact of a carbon price; the Carbon Farming Futures program will deliver $429 million to help farmers and landholders benefit from the Carbon Farming Initiative, through research and conversion of that research into practical measures.

4. ***Governance and regulations*** – the carbon price package works to remove perverse incentives that encourage investment in less efficient technologies, and provide governance arrangement s that review the effectiveness of the carbon price package in meeting its aims and to ensure compliance.

   e.g. mandatory vehicle efficiency standards for cars and light commercial vehicles stimulates demand for vehicles that produce less emissions (although we note that the proposed standard for Australia is weak compared to Europe, US and China); long term framework for an emissions trading scheme is established including an independent Climate Change Authority to conduct public reviews and recommend future emissions caps.

Snapshot of how the carbon price package addresses the barriers faced by emissions reduction opportunities

	Energy efficiency	Land sector abatement	Cleaner power generation
Emissions trading scheme	✓ Fixed price for carbon permits for first 3 years, transitioning to emissions trading scheme with a cap at least consistent with Australia's unconditional emissions reduction target of 5% below 2000 levels by 2020 and ongoing scheme providing long-term price signal ✓ Ability to strengthen emissions reduction cap on advice from independent Climate Change Authority (CCA) after public review provides transparency and helps de-politicise process for setting future emissions trajectories ✓ Long-term target of 80% emissions reduction by 2050 to be legislated and must be taken into account by CCA provides clear signal for investments in long-life assets and new technologies		
Further price incentive	✓ National 'white certificate' scheme (NESI) proposed to oblige energy companies to undertake energy efficiency improvements for residential, commercial and industrial energy users ✓ Industry recipients of free permits can sell surplus permits back during fixed price period, incentivising emissions reductions	✓ Unlimited ability to use Kyoto-compliant CFI credits to offset emissions from July 2015, and up to 5% during fixed price; creates strong demand for CFI credits ✓ Govt to act as buyer for non-Kyoto CFI credits with $250m fund, helping develop the market for soil carbon abatement	✓ Electricity generators must obtain permits for all emissions, making lower-emissions generation relatively more financially attractive ✓ Payment to close up to 2000 MW of emissions-intensive power generation capacity by 2020
Capital constraints and investment priorities	✓ Grants for manufacturers to invest in energy efficient equipment and R&D in low emissions technology ✓ Grants for community facilities and low income households to undertake energy efficiency upgrades	✓ Grants for landholders to road test new ways to increase soil carbon and reduce emissions ✓ Purchase of conservation tillage equipment encouraged through refundable tax offset	✓ $10 billion Clean Energy Finance Corp to fund commercialisation and deployment of renewable and low emissions energy ✓ Clean Energy Investment Plans are required of coal-fired generators that receive transitional support
Information gaps and decision process	✓ ABS to improve collection of energy efficiency data ✓ Medium energy users can access EEO Program voluntarily which provides case studies and other information to encourage energy efficiency ✓ Funding for educational institutions and industry to develop materials to support tradespersons and professionals to deliver energy efficiency services and clean energy projects and products	✓ Funding for capacity-building via Landcare and extension and outreach officers ✓ Funding for research into carbon farming practices and to convert research into practical methodologies for the CFI ✓ Funding for regional Natural Resources Management organisations to develop plans that maximise benefits from carbon farming ✓ Funding to help Indigenous communities to develop carbon farming projects	✓ AEMO to create planning scenarios for moving towards 100% renewables in electricity grid ✓ Transmission and distribution network owners and electricity generators to be included in the Energy Efficiency Opportunities (EEO) Program
Market structure and supply	✓ Car and light commercial vehicle efficiency standards to be introduced by 2015	✓ Funding to develop national carbon farming accreditation ✓ Biodiversity Fund for optimisation of habitat and carbon outcomes and management of biodiverse carbon stores	✓ R&D support for renewables including new Australian Renewable Energy Agency to coordinate existing funding

C. Modelling assumptions for major programs

The tables below summarise the assumptions we used to model the impact of major programs in the carbon price package, and the abatement that can be delivered by them. Where details are not yet known, we have assumed a design that achieves optimal emissions reduction and barrier alleviation. See Exhibit 12 for more details.

Clean Energy Finance Corporation (CEFC)	Leverage (1:X)	Funds used (million $)	Funds unlocked (million $)	Abatement unlocked (MtCO2e)
Industrial cogeneration	2.0	853	2,558	2.4
Commercial cogeneration	2.0	1,647	4,942	4.3
Cogeneration total	***2.0***	***2,500***	***7,500***	***6.7***
Wave/tidal	0.0	16	16	0.0
Geothermal	0.0	530	530	0.6
Solar thermal	1.0	1,306	2,612	2.2
Solar PV (centralised)	1.0	660	1,319	1.2
Developing technologies total	***0.8***	***2,512***	***4,477***	***4.0***
Biomass dedicated	2.0	126	379	1.4
Support to proven technologies total	***2.0***	***126***	***379***	***1.4***
Total	**1.4**	**5,138**	**12,357**	**12.1**

National Energy Savings Initiative (NESI)	Abatement unlocked (MtCO2e)
Residential lighting	1.2
Residential electronics and appliances	1.8
Residential buildings total	***3.0***
Commercial retrofit energy waste reduction	5.1
Commercial elevators and appliances	0.6
Commercial retrofit lighting	0.4
Commercial buildings	***6.0***
Other industry energy efficiency	3.0
Industry	***3.0***
Total	**12.0**

Carbon Farming Initiative (CFI) non-Kyoto Carbon Fund	Unit price paid ($/tCO2e)	Total funds spent (million $)	Abatement unlocked (MtCO2e)
Reduced cropland soil emissions	10	36	0.6
Pasture and grassland management	20	214	1.8
Total	**16**	**250**	**2.4**

Clean Technology Program (CTIP), including all sub-programs	Funds used (million $)	Funds unlocked (million $)	Abatement unlocked (MtCO2e)
Food, beverage and tobacco energy efficiency	267	801	1.9
Other industry energy efficiency	242	727	2.9
Aluminium energy efficiency	215	630	0.9
Cogeneration	199	598	1.3
Pulp, paper and print energy efficiency	68	203	0.7
Chemicals processes	24	72	0.1
Total	**1,015**	**3,030**	**7.9**

Exhibit 12- Modelling of major programs included in the carbon price package

Key programs	Sectors	Funds	Target audience	Leverage (1)	Modelling assumptions based on package description	Major opportunities affected	Associated abatement (MtCO2e)
Emissions trading scheme (ETS)	All except Transport	Fixed carbon price between 2012 and 2015, starting at $23/tCO2e, and transferring to a floating price thereafter based on a default 5% emissions reduction target in 2020 (the target may be increased by Parliament on advice from independent Climate Change Authority). Enables some opportunities that currently come at a net cost to become profitable, improves the payback period of some opportunities that are already profitable and provides a long-term price signal. It is thus central to overcoming the barrier that causes decision makers to overlook the long run costs imposed by activities that produce emissions—or the benefits of reducing them. By increasing the cost of activities that produce greenhouse gas emissions, a carbon price amplifies the operational savings available from capturing opportunities to reduce those emissions.					Contributes to all below plus 26
Carbon Farming Initiative (Kyoto compliant)	Land use	Carbon certificate revenue	Farmers, forest growers and landholders	N/A	Carbon offsets through reforestation, savanna fire management and reductions in pollution from livestock and fertiliser. CFI credits can be used during the fixed price period for up to 5% of obligation, and banked for future use. Unlimited use of CFI credits past 2015.	Reduced deforestation, reforestation activities, anti-methanogenic treatments and biogass	39.1
Clean Energy Finance Corporation (CEFC)	Power, Industry, Commercial buildings	$10 billions in loans, equity, etc	Renewables generation and supply chain (minimum 50%), low emissions energy, energy efficiency	various	We assume it allocates: - $2.5 billion used to help finance cogeneration - $2.5 billion used to help finance projects in developing renewable technologies that could provide zero-emissions base-load generation - $5 billion used to help support renewables and clean energy in other ways: eg. help fund grid extensions, capital intensive technologies, loan guarantees for smaller companies. This may help support post-2020 abatement. All support is assumed to be at 4% interest rate.	- Industrial cogeneration (especially SMEs) and commercial cogeneration (leverage 1:2 to achieve 6.6 Mt) - Geothermal and wave/tidal (leverage 1:0 to achieve 0.6 Mt); solar PV and solar thermal in remote areas (leverage 1:1 to achieve 3.4 Mt) - Biomass dedicated plants (funding with leverage 1:2 to achieve 1.4 Mt); All renewables opportunities (help alleviate grid connection and access to capital barriers)	12.1
National Energy Savings Initiative (NESI)	Industry, Buildings	N/A	Mostly individuals and SMEs	N/A	Designed to achieve around 5% reduction in electricity and gas emissions by 2020 (based on PM task group analysis), focusing on least costly and capital intensive abatement opportunities.	Residential lighting, residential appliances and electronics, commercial energy waste reduction, commercial lighting, commercial appliances, other industry energy efficiency	12.0
Payment for closure	Power	Undisclosed	Coal generators	N/A	Payment for closure of ~2000 MW of emissions-intensive coal-fired generation (>1.2 tCO2e/MWh) capacity by 2020. Contingent upon: power system reliability; payment of workers' entitlements; and appropriate remediation of the site.	New gas CCGT builds (2000 MW)	11.9
Clean Technology Investment Program	Industry	$800 m in grants	Medium to large, energy intensive manufacturers	1:3 (1:2)	We assume it allocates funding for proven and profitable opportunities for which capital availability is a constraint.	Energy efficiency in pulp, paper and print, food, beverage and tobacco, aluminium (existing technologies), and other industries; cogeneration	6.5
Tax breaks for Green Buildings	Commercial buildings	$1 billion in tax rebates	Private commercial buildings	1:2	Energy efficiency retrofits of commercial buildings.	Replacement of water heaters, Heating Ventilation and Air Conditioning (HVAC) systems, lighting and appliances in private commercial buildings	5.9

(1) Where two values are listed, the first value represents the leverage as announced by the government, and the second value (in parenthesis) represents the value as used in the modelling. When the leverage is high, this represents a buffer in case the take-up rate is not as high as expected and the government needs to decrease the leverage to improve attractiveness to investors.

Key programs	Sectors	Funds	Target audience	Leverage (1)	Modelling assumptions based on package description	Major opportunities affected	Associated abatement (MtCO2e)
Carbon Farming Initiative non-Kyoto Carbon Fund	Land use	$250 m in carbon certificate revenue	Farmers, forest growers and landholders	N/A	Provide early demand for non-Kyoto activities such as soil carbon projects, taken up at the end of the fund by voluntary market. Credits will be bought by government via a least cost tendering process.	Reduced cropland soil emissions and pasture and grassland management.	2.4
Small Business Instant Asset Write-Off Threshold Change	Industry, Commercial buildings	$200 m in tax rebates	Industry ($70m) and Commercial buildings ($130m)	1:2	We assume it allocates funding for proven and profitable opportunities for which capital availability is a constraint.	Other industry energy efficiency, replacement of water heaters, Heating Ventilation and Air Conditioning (HVAC) systems and appliances in commercial buildings	1.9
Clean Technology Food & foundries Investment Program	Industry	$200 m in grants	Food manufacturers ($150m) and metal foundries ($50m)	1:3 (1:2)	Provides funding for proven and profitable opportunities for which capital availability is a constraint.	Energy efficiency in food, beverage and aluminium (existing technologies)	1.3
Productivity Commission review of fuel excise	Transport	N/A	All vehicles	N/A	Review of fuel excise arrangements, including examination of the merits of a regime based explicitly and precisely on the carbon and energy content of fuels.	Large articulated trucks efficiency improvements	1.4
Low Carbon Communities	Commercial buildings	$200 m in grants	Local council and community operated buildings	1:2	Energy efficiency upgrades of public buildings, facilities and lighting assumed to be allocated to the lowest capital opportunities.	Replacement of water heaters, Heating Ventilation and Air Conditioning (HVAC) systems, lighting and appliances in public commercial buildings	1.1
Coal Mining Abatement Tech Support Package	Industry	$70 m in grants	Coal mining with high level of fugitive emissions	1:3 (1:2)	Help the coal industry implement abatement of fugitive emissions in gassy coal mines.	Mining Ventilation Air Methane (VAM) oxidation	0.8
Mandatory vehicle fuel efficiency standards	Transport	N/A	Cars and light commercial vehicles	N/A	Mandatory CO2 emissions standards for all new light vehicles with a national target for average CO2 emissions per km driven	Cars and light commercial vehicles efficiency improvements	0.7
Clean Energy Investment Plans	Power	N/A	Coal generators	N/A	Generators receiving free permits (above 1.0 t/MWh) will be required to prepare and make publicly available their Clean Energy Investment Plans. These plans will identify proposals to reduce pollution from existing facilities and to invest in R&D and new low or zero-emissions capacity. Information on projects identified through EEO will also be included.	Operational improvements to existing black coal plant thermal efficiency, Biomass co-firing	0.3
Steel Transformation Plan	Industry	$300 m in grants	Steel manufacturers	1:0	Encourage investment and innovation in steel manufacturing to reduce emissions.	Iron and Steel processes (not all funds are used as it is assumed that will also serve other purposes)	0.3
Clean Technology Innovation Program	Industry	$200 m in grants	R&D, proof of concept and early stage commercialisation	1:1	Funding for R & D for renewable energy, low-pollution technology and energy efficiency	Aluminium energy efficiency ($15 m), Cement clinker substitution by slag	0.2

(1) Where two values are listed, the first value represents the leverage as announced by the government, and the second value (in parenthesis) represents the value as used in the modelling. When the leverage is high, this represents a buffer in case the take-up rate is not as high as expected and the government needs to decrease the leverage to improve attractiveness to investors.

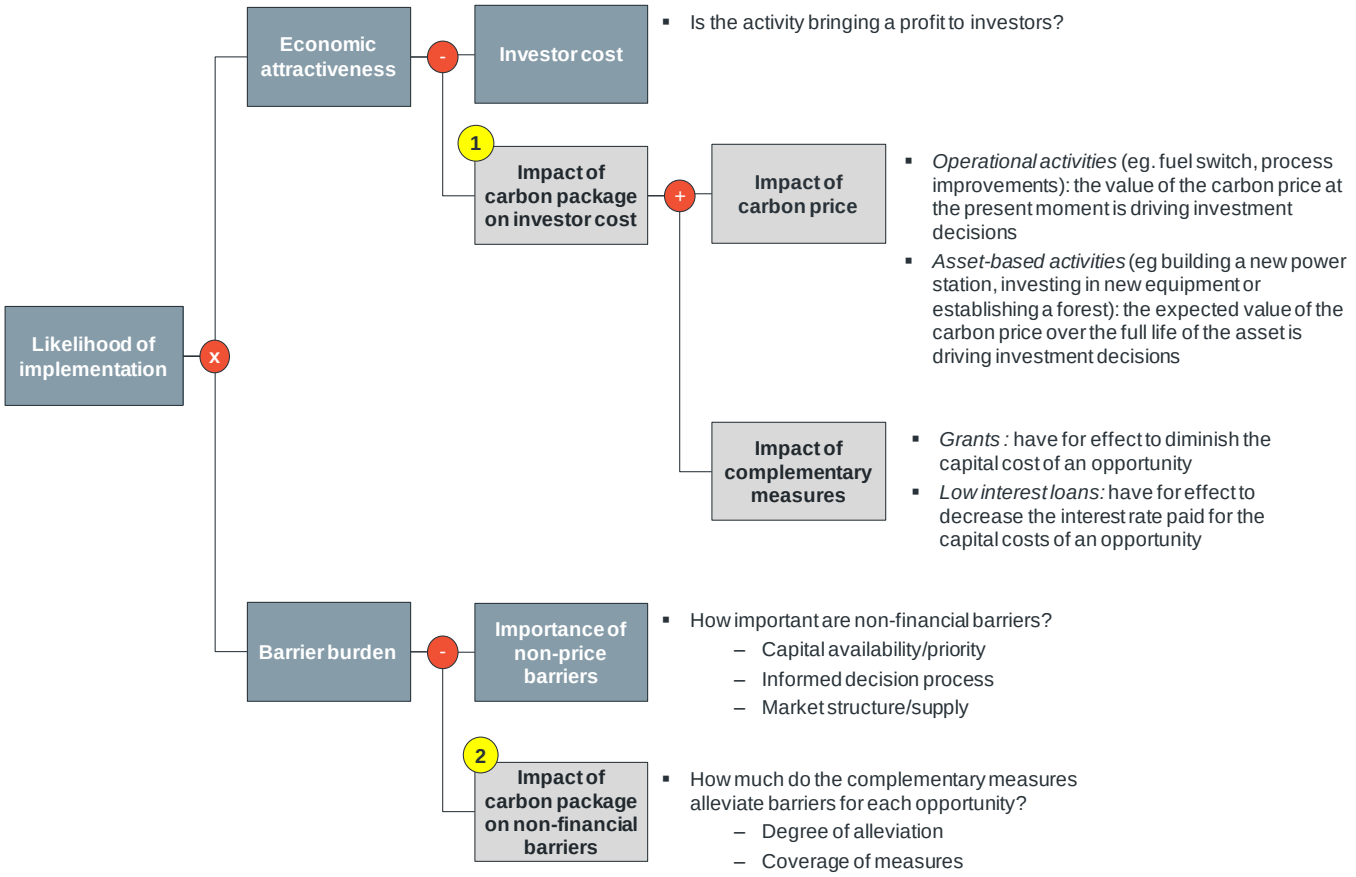
Key programs	Sectors	Funds	Target audience	Leverage (1)	Modelling assumptions based on package description	Major opportunities affected	Associated abatement (MtCO2e)
Low Income Energy Efficiency Program	Residential buildings	$100 m in grants	Low income households	1:0	Trial energy efficiency approaches in low income households.	Heating Ventilation and Air Conditioning (HVAC) systems	0.1
Household Energy and Financial Sustainability Scheme	Residential buildings	$30 m in grants	Low income households	1:0	Assist low-income households find more sustainable ways to manage their energy consumption.	Heating Ventilation and Air Conditioning (HVAC) systems	0.1
Energy efficiency information grants	Industry	$40 m in grants	Small Business & Community Groups	N/A	For industry associations & NGOs to establish relationships with SME and community organisations to deliver information about the implications of the carbon price and practical steps to manage its impact.	All energy efficiency opportunities -lowers information/transaction cost barriers for SMEs and individuals	-
Clean Energy Skills Program	Industry	$32 m in grants	All industrial players	N/A	Skills development for energy efficiency services, clean energy project and low pollution products.	All industrial opportunities -lowers barriers such as skills constraints and increased operational risks due to unfamiliarity with new equipment/ processes for industrial players	-
ARENA	Power	$3.2 billion in grants and loans	Renewables	various	Early stage grants and financing assistance to make renewables more cost competitive.	Pre-existing funding, not taken into account in the analysis	-
Carbon Farming Futures	Land use	$429 m	Farmers, forest growers and landholders	N/A	Aim to help farmers and landholders benefit from CFI by providing research, conversion of research to practical measures, action and extension.	All land use activities -lowers information and uncertainty barriers	-
Indigenous Carbon Farming Fund	Land use	$22 m	Indigenous land holders	N/A	Funding for specialists to work with Indigenous communities to develop projects. Development of low-cost estimation and reporting tools for abatement activities.	All land use activities -lowers information barrier for Indigenous communities	-
Carbon Farming Skills	Land use	$ 4 m	Support agencies ie carbon brokers	N/A	Accreditation of carbon brokers and aggregators and provision of workshops for extension officers, catchment authorities and rural service providers.	All land use activities -lowers information, uncertainty and fragmentation issues	-
Regional NRM Planning and Climate Change Fund	Land use	$44 m	Landholders	N/A	Help for NRM agencies to include carbon in their regional plans, to help identify the best locations for carbon sequestration, maximise benefits from carbon farming initiatives.	All land use activities -lowers information barriers	-
Biodiversity Fund	Land use	$946 m	Private and public land holders	N/A	Provides incentive to enhance environmental outcomes of carbon farming projects. Supports projects that establish, restore, protect or manage biodiverse carbon stores.	Assumed to not deliver abatement directly but enhance environmental outcomes of forestry and revegetation activities	-

(1) Where two values are listed, the first value represents the leverage as announced by the government, and the second value (in parenthesis) represents the value as used in the modelling. When the leverage is high, this represents a buffer in case the take-up rate is not as high as expected and the government needs to decrease the leverage to improve attractiveness to investors.

D. Introduction to results table

The results table on the following pages summarises the analysis conducted for each emissions reduction opportunity based on the two steps highlighted in the flow chart below.

Exhibit 13 - Methodology flow chart for results table



In addition, a third step is required for calculation purposes due to the integrated nature of power sector assumptions on the abatement potential of other opportunities. This step is explained below.

Power adjustment factor

All emissions reductions from power generation (demand reduction or shift to lower emission technologies) require a displacement of more emissions intensive generation.

The analysis of the power sector opportunities unlocked by the carbon package in this report is based on the likely market outcome when the carbon price is set to a 5% emissions reduction target. This varies from our modelling in the *Low Carbon Growth Plan for Australia,* where we assumed that a 25% emissions reduction target could be achieved, and that sufficient volume of power abatement would occur commensurate with the 25% target being delivered domestically. A different mix of displaced generation occurs in this report because the abatement target is lower (5%). The power adjustment factor reflects that every MW of electricity replaced achieves a different number of tonnes in abatement. The power displacement scenario modelled for this report varies depending on the type of opportunity: demand reduction, increased utilisation of existing CCGT gas plants, new power generation connected to the grid, and new power generation not connected to the grid.

Example: Food and beverage energy efficiency

Description of the opportunity: Achieve 13% savings in energy by improving control systems (automated or manual); reducing duplicated or oversized equipment; upgrading boilers and steam distribution systems; recovering waste heat to use in pre-heating; improving building utilities

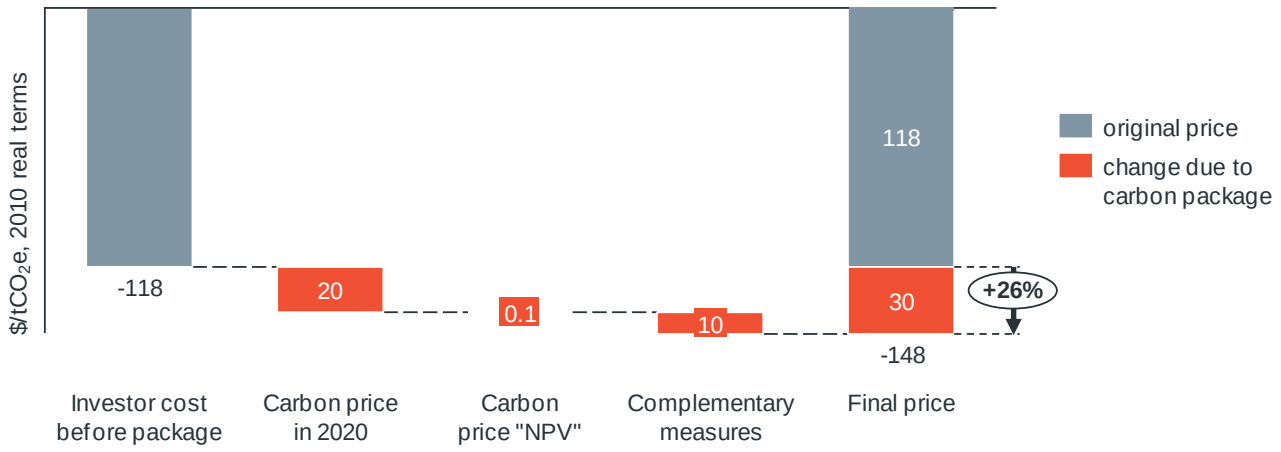
Opportunity	Abatement opportunity (MtCO2e)	1 Profitable abatement (%)		2 Non-price barrier burden (level)		Estimated abatement unlocked by package		
		Before package	After package	Before package	After package	% of activity	Power adjustment factor (1)	MtCO2e
Food, beverage and tobacco energy efficiency	3.1	100%	100%	5	2	81%	0.91	2.3

This opportunity has an investor cost of -$118/tCO$_2$e, which means it is already profitable – the energy savings are greater than the annualised upfront costs. However, it is blocked today by non-price barriers (barrier burden of 5 before package). The analysis for step 1 is illustrated below. The carbon price package makes it more profitable:

- **Carbon price**. 70% of the opportunity corresponds to reducing electricity use. This share of the opportunity will therefore be impacted by the expected increase in electricity price in 2020. The remaining 30% of the opportunity corresponds to reducing other fossil energy use (gas, coal or oil). We assume that only 10% of this opportunity will be relating to businesses covered by the emissions trading scheme (based on the fact that only 40% of businesses have more than 200 employees, not all businesses in this sector are energy intensive and emission intensive businesses tend to have implemented more energy efficiency opportunities in business-as-usual than non-energy intensive businesses). This means 3% only of the opportunity will be experiencing the carbon price directly (30% x 10%).
- **Carbon price signalling effect**. The weighted average lifespan of the equipment that is needed to unlock this opportunity is 10 years. We assume that on average the investments occuring between 2012 and 2020 happen in 2016, which means that the NPV calculations are made for the period from 2016 to 2025. Therefore, the signalling effect impact is very small, as 2020 is around the middle of the period.
- **Complementary measures**. Based on the allocation of program funding shown on page 17, 27% of the opportunity will be eligible for the Clean Technology Investment Program and 35% for the Clean Technology – Food and foundries Investment Program. This means 62% of the opportunity is eligible for a government grant which covers a third of the capital costs due to the 1:2 leverage requirement modelled (see program design assumptions in Exhibit 12). This significantly reduces the price of the opportunity, as around 20% of the total capital required (62% x 33%) is covered by the government.

Overall, the investor cost decreases by $30/tCO$_2$e, a 26% increase on the net savings offered by the opportunity.

Exhibit 14 - Impact of the carbon package on the investor cost in 2020



The barriers analysis conducted for step 2 of the methodology is detailed on page 8.

E. Results table. Exhibit 15 – Results table: Modelling of carbon price package impact on opportunities from the *Low Carbon Growth Plan for Australia*

Sector	Opportunity	Abatement (MtCO2e)	Profitable abatement (%)		Other barrier burden (level)		Estimated abatement unlocked by package			Comments
			Before package	After package	Before package	After package	% of activity	Power adjt factor	MtCO2e	
Commercial buildings	Commercial retrofit energy waste reduction	5.8	100%	100%	5	1	100%	0.88	5.1	Unlocked by NESI, considered to deliver 6 MtCO2e in the commercial sector by 2020, focusing on least capital intensive opportunities
	Commercial retrofit lighting	2.3	100%	100%	5	2	75%	0.87	1.5	~75% of capital needed for these opportunities is eligible for a new governmental program: NESI (20% of lighting and 10% of appliances); Low Carbon Communities ($200m); Tax breaks for Green buildings ($1b), or Small business instant asset write-off ($200m)
	Elevators and appliances	6.7	100%	100%	5	2	75%	0.87	4.4	
	Commercial retrofit HVAC	4.5	100%	100%	5	2	75%	0.88	3.0	
	Retrofit water heating	0.8	100%	100%	5	2	75%	0.89	0.6	
	Commercial cogeneration	8.8	0%	100%	5	3	53%	0.88	4.1	Partially unlocked by CEFC funding -we estimated that $2.5b would be used to support commercial and industrial cogeneration with a leverage of 1:2
	Commercial new builds	3.5	100%	100%	5	5	5%	0.88	0.2	Considered too capital intensive to be eligible for funding programs (focused on opportunities which can deliver most abatement); demand for green buildings will increase slightly due to higher mind share (energy price increase, expansion of energy efficiency in government buildings)
	Commercial retrofit insulation	2.9	0%	100%	5	5	0%	N/A	0.0	
Residential buildings	Residential lighting	1.4	100%	100%	5	1	100%	0.87	1.2	Unlocked by NESI, considered to deliver 3 MtCO2e in the residential sector by 2020, focusing on least capital intensive opportunities
	Residential appliances and electronics	2.7	100%	100%	5	2	83%	0.87	2.0	
	Residential HVAC	0.4	64%	100%	5	3	50%	0.90	0.2	Partially unlocked by: improved information (NESI, hotline); increased priority of electricity consumption in investment decision criteria; low income household programs ($130m of capital assumed used for HVAC primarily)
	Residential new builds to 7.2 stars	5.4	100%	100%	5	5	10%	0.96	0.5	
	Residential building envelope	2.3	0%	8%	5	3	8%	0.92	0.2	
Transport	Large articulated truck efficiency improvement	1.8	100%	100%	5	2	75%		1.4	We assume the Productivity Commission review of fuel excise will decrease the market distortions and increase profitability as well as business priority of efficiency improvements; smaller businesses will face higher transaction costs for investments such as optimisation software.
	Car and light commercial efficiency improvement	2.6	100%	100%	5	4	25%		0.7	Mandatory fuel efficiency standard will only deliver a small portion of the potential as they are not very ambitious.
	Bus and rigid truck efficiency improvement	0.2	2%	2%	5	5	0%		0.0	We assume there is no policy applicable to these opportunities.
	Car hybrids	0.6	97%	97%	5	5	0%		0.0	
	Electric cars	0.4	0%	0%	5	5	0%		0.0	

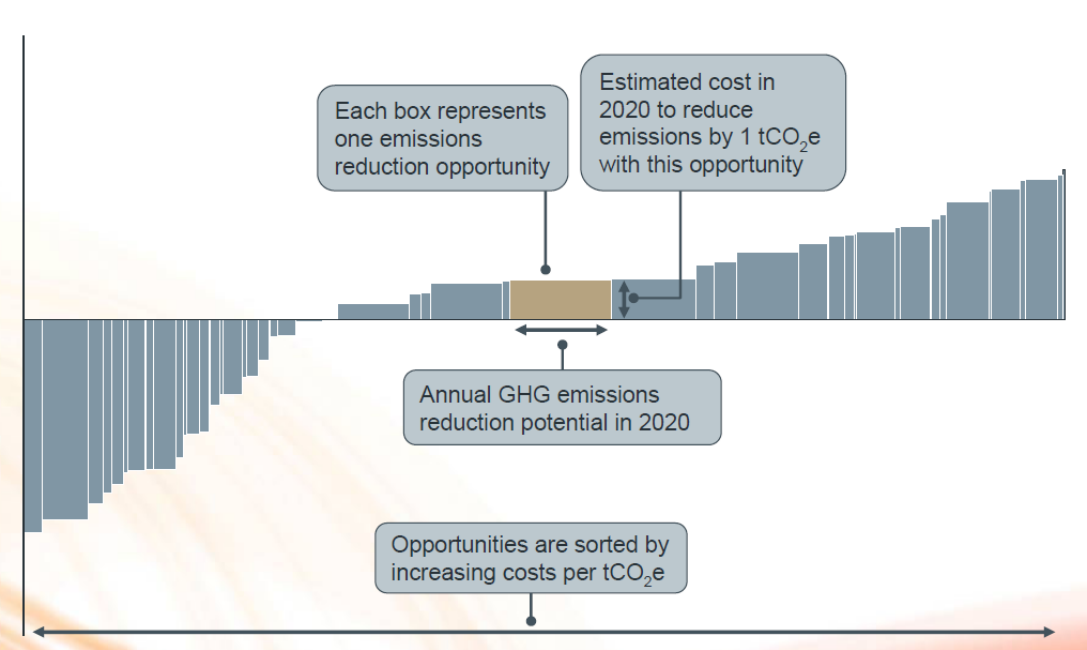
Industry	Other industry energy efficiency	9.3	98%	100%	5	2	81%	0.89	6.8	Carbon price will make opportunities more profitable and increase business priority, and government funding will help deliver capex (we assume Clean Technology Investment program will cover 31%, Small Business Instant Asset Write-Off 11% and NESI 36%); Energy efficiency information grants and Clean Energy Skills Program will help overcome information/unfamiliarity barriers; Clean Technology Focus for Supply Chains Program will help with the provision of equipment.
	Food, beverage and tobacco energy efficiency	3.1	100%	100%	5	2	81%	0.90	2.3	Carbon price will make opportunities more profitable and increase business priority, and government funding will help deliver capex (we assume Clean Technology Investment program will cover 27% and Clean Technology - Food and foundries Investment Program 35%); Energy efficiency information grants and Clean Energy Skills Program will help overcome information/unfamiliarity barriers; Clean Technology Focus for Supply Chains Program will help with the provision of equipment.
	Pulp, paper and print energy efficiency	1.4	100%	100%	5	2	79%		1.0	Carbon price will make opportunities more profitable and increase business priority, and government funding will help deliver capex (we assume Clean Technology Investment program will cover 54%); Energy efficiency information grants and Clean Energy Skills Program will help overcome information/unfamiliarity barriers; Clean Technology Focus for Supply Chains Program will help with the provision of equipment.
	Mining VAM oxidation	10.7	0%	100%	5	2	75%	0.97	7.8	Carbon price will make opportunity profitable and increase business priority; we assume government funding will help prove technology (Coal Mining Abatement Tech Support Package covers 7%) and Clean Energy Skills Program will help overcome skills limitations. This would result in implementation in 38% of gassy mines.
	Gas T&D network maintenance	1.1	96%	96%	5	2	75%		0.9	Carbon price on fugitive emissions will increase business priority, especially for direct methane leakage given higher carbon intensity.
	Cement clinker substitution by slag	2.1	0%	100%	3	2	75%		1.6	Carbon price will make opportunity profitable and increase business priority; we assume Clean technology innovation Program will help demonstrate quality of cement with higher share of substitute; quality concern barrier assumed to remain for some end-uses.
	Industrial cogeneration	5.8	75%	80%	5	2	63%	0.87	3.2	Partially unlocked by government funding programs: we assume Clean Technology Investment program will cover 22% and CEFC funding 41% (we estimated that $2.5b would be used to support commercial and industrial cogeneration with a leverage of 1:2, mostly focused on SME).
	Iron and steel processes	0.5	0%	51%	5	3	51%		0.3	For fuel shift (around 50% of opportunity), the carbon price and government funding will make opportunity more profitable and help deliver capex (Steel Transformation Plan). For process change, the opportunity remains too costly.
	Chemicals processes	3.9	3%	49%	5	3	49%		1.9	Carbon price will make Ethylene cracking and Decomposition of nitric acid become economically attractive and acquire a higher business priority; Clean Energy Skills Program will help overcome unfamiliarity barriers. Other opportunities remain too costly.
	Mining energy efficiency	2.7	100%	100%	5	3	38%	0.89	0.9	Carbon price will increase attractiveness and business priority for least capital intensive opportunities (operational and controls improvements, representing 43% of the total opportunity); Clean Energy Skills Program will help overcome unfamiliarity barriers
	Aluminium energy efficiency	3.4	0%	33%	5	4	27%	0.87	0.8	For improvements using existing technologies (29% of opportunity, the carbon price will make the opportunity profitable and we assume Clean Technology Investment program will help unlock around 75% of the capital. For improvements using new technologies, we assume the Clean technology innovation Program will co-fund pilot programs ($15m funding, leverage 1:1, covering 7% of opportunity).

Sector	Opportunity	Abatement (MtCO2e)	Profitable abatement (%)		Other barrier burden (level)		Estimated abatement unlocked by package			Comments
			Before package	After package	Before package	After package	% of activity	Power adjt factor	MtCO2e	
Agriculture	Reduced cropland soil emissions	0.9	100%	100%	5	2	75%		0.7	Non-Kyoto. This opportunity was already profitable before the carbon price and was originally faced with strong informational barriers. We assume that complementary measures (especially Carbon Farming Futures) and the additional revenue provided first through the CFI non-Kyoto Carbon Fund and subsequently by the voluntary market will alleviate those barriers for most farmers. A small proportion of this opportunity (0.1 Mt) relating to nutrient management is assumed to be Kyoto-compliant and eligible for CFI
	Pasture and grassland management	17.1	0%	**11%**	**4**	**2**	11%		1.8	Non-Kyoto. The driving informational barrier -uncertainty around an accounting system that measures soil carbon -will be mostly overcome by the Carbon Futures Farming Funding. We assume that the CFI non-Kyoto Carbon Fund will unlock 1.8 MtCO2e of the cheapest part of this opportunity during the fund application period, and that this will be maintained by demand for voluntary credits after the funding period ends (in line with Department of Climate Change and Energy Efficiency's estimated price of $5/tCO2e for voluntary carbon markets in 2020[4]). The remainder of this opportunity will not be taken up as it remains unprofitable.
	Anti-methanogenic treatments	2.6	0%	100%	4	3	50%		1.3	Kyoto. The use of anti-methanogenic treatments is not yet common practice amongst farmers and is difficult to undertake with cattle that are managed on large expanses of land. For this reason, we have modelled that only 50% of the opportunity gets unlocked despite becoming profitable.
	Cropland carbon sequestration	1.8	0%	0%	5	3	0%		0.0	Non-Kyoto. The uptake of this opportunity is reliant on overcoming informational barriers around new crop varieties and planting and then managing the new crop. Overcoming these barriers requires a higher level of support compared to other opportunities. Unlocked opportunity is modelled to be purchased through the $250 million CFI non-Kyoto carbon fund. There is still scope within the $250 million non-Kyoto carbon fund further abatement should these barriers be overcome.
	Active livestock feeding	1.8	100%	100%	5	5	0%		0.0	Assumed not covered by CFI. Further, there are no other programs that are seen to target this opportunity.
	Degraded farmland restoration	7.0	0%	0%	5	2	0%		0.0	Non-Kyoto. This opportunity is assumed to be too expensive to be unlocked by the CFI non-Kyoto carbon fund. Some informational barriers have been unblocked, however due to the high price it is unlikely that the government will purchase these credits as part of the $250 million non-Kyoto carbon fund.
Forestry	Reforestation of marginal land with timber plantation	4.3	0%	100%	4	2	69%		3.0	Kyoto. The introduction of a carbon price makes these opportunities profitable for land owners. Programs such as Carbon Farming Skills and Carbon Farming Futures will help overcome informational barriers. Capital constraints and fragmentation issues are assumed to be partially overcome by the formation of brokers who can aggregate opportunities. Models forests as a 30-year asset. Forests with high conservation value might be eligible for additional support from the Biodiversity fund.
	Reforestation of marginal land with environmental forest	24.0	0%	100%	4	2	63%		15.0	
	Reduced deforestation and regrowth clearing	13.4	0%	100%	5	3	50%		6.7	Kyoto. The introduction of a carbon price makes these opportunities profitable for land owners. We assume opportunity cost is still a barrier for half the land concerned. Forests with high conservation value might be eligible for additional support from the Biodiversity fund.
	Strategic reforestation of non-marginal land with environmental forest	19.6	0%	100%	4	3	50%		9.8	Kyoto. The introduction of a carbon price makes these opportunities profitable for land owners. Similar to other reforestation opportunities but higher opportunity cost barrier.
	Improved forest management	3.7	0%	0%	5	2	0%		0.0	Non-Kyoto. This opportunity is assumed to be too expensive to be unlocked by the CFI non-Kyoto carbon fund. Forests with high conservation value might be eligible for additional support from the Biodiversity fund.

[4] Department of Climate Change and Energy Efficiency, *Carbon Farming Initiative - Preliminary estimates of abatement Discussion Paper* (2011)

Power	Biogas	3.0	0%	100%	1	1	100%	1.04	3.2	The fact that biogas power generation will be eligible for carbon offsets through the CFI will make it very attractive to investors.
	Operational improvements to existing black coal plant thermal efficiency	1.1	100%	100%	5	1	100%	2.71	3.0	Average of 3% efficiency improvement found across all the black coal power generation remaining after demand reduction and switch to alternative generation technologies.
	Solar PV (centralised)	1.4	0%	100%	4	1	100%	0.86	1.2	Modelled as replacement of new oil/OCGT gas power plants in remote locations as Solar technologies then become competitive. We assume that the Clean Energy Finance Corporation will help finance these projects with a leverage of 1:1.
	Geothermal	0.5	0%	0%	5	1	100%	1.14	0.6	We assume that the Clean Energy Finance Corporation will finance pilots in developing renewable technologies that could provide zero-emissions base-load generation, at a leverage of 1:0.
	Wave/tidal	0.01	0%	0%	5	1	100%	1.14	0.01	
	Gas CCGT new build	19.0	0%	77%	4	2	77%	1.22	17.8	We assume that the 2000 MW of early retired brown coal generation (buy-out) will be replaced by 2000 MW of gas CCGT. We also assume that the 1450 MW of gas CCGT projects that are at advanced planning stage but are currently stalled by lack of regulatory certainty will be built once the carbon package is legislated.
	Reduced T&D losses	3.6	0%	100%	5	3	50%	0.93	1.7	We assume that the expansion of the Energy Efficiency Opportunities (EEO) program to transmission and distribution networks as well as the increased public scrutiny on network managers will unlock half of the opportunity identified.
	CCGT increased utilisation	2.4	0%	100%	3	3	50%	1.07	1.3	We assume that half of the existing CCGT gas plants will be competitive with some brown coal and black coal plants in terms of Short Run Marginal Cost (SRMC).
	Operational improvements to existing gas plant thermal efficiency	0.5	100%	100%	5	3	50%	1.00	0.2	We assume that half of the existing CCGT gas plants will be able to find attractive opportunities to increase efficiency through operational improvements.
	Solar thermal	10.4	0%	25%	5	3	25%	0.86	2.2	Modelled as replacement of new oil/OCGT gas power plants in remote locations as Solar technologies then become competitive. We assume that the Clean Energy Finance Corporation will help finance these projects with a leverage of 1:1.
	Biomass dedicated	5.0	0%	25%	4	2	25%	1.14	1.4	We have assumed that 25% of the biomass dedicated opportunity could be met by low cost sources of biomass (eg wood waste) and would therefore become attractive to investors with the introduction of a carbon price. We have also assumed that the CEFC would help alleviate the non-price barriers (eg. capital availability, costly grid connection).
	Biomass co-firing	0.7	0%	25%	4	3	25%	2.71	0.5	We have assumed that 25% of the biomass co-firing opportunity could be met by low cost sources of biomass (eg wood waste) and would therefore become attractive to investors.
	OCGT retrofit to base-load CCGT	7.8	0%	0%	4	2	0%	1.00	0.0	Not profitable for investors anymore after implementation of other levers (utilisation factor of OCGT plants goes down to 5% on average) and assumed not to be supported entirely by CEFC funding.
	Capital improvements to existing black coal plant thermal efficiency	1.3	0%	0%	5	2	0%	N/A	0.0	Not profitable for investors and assumed not to be supported entirely by CEFC funding.
	Capital improvements to existing gas plant thermal efficiency	0.4	0%	0%	5	4	0%	N/A	0.0	
	Coal CCS new build	3.3	0%	0%	5	4	0%	N/A	0.0	
	Coal IGCC with CCS	3.5	0%	0%	5	4	0%	N/A	0.0	
	Gas CCS new build	0.3	0%	0%	5	4	0%	N/A	0.0	
	Onshore wind (best locations)	4.9	0%	0%	4	2	0%	N/A	0.0	
	Onshore wind (marginal locations)	7.4	0%	0%	4	2	0%	N/A	0.0	
	Solar PV (distributed)	0.2	0%	0%	4	4	0%	N/A	0.0	
	Wind offshore	1.2	0%	0%	5	5	0%	N/A	0.0	
Total		272	24%	69%	5	3	46%		124	

How to read an emissions reduction cost curve



All costs include the typical private cost of capital for each sector (8-14%), energy taxes and retail margins and subsidies, in order to illustrate the direct cost faced to implement an opportunity. However, project transaction costs (e.g. admin/ management time or consultancy fees) have not been included, as these can vary significantly depending on how the opportunity is captured.

ClimateWorks AUSTRALIA

This report, as well as the *Low Carbon Growth Plan for Australia* and the *2011 Update report* can be accessed at www.climateworksaustralia.org

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