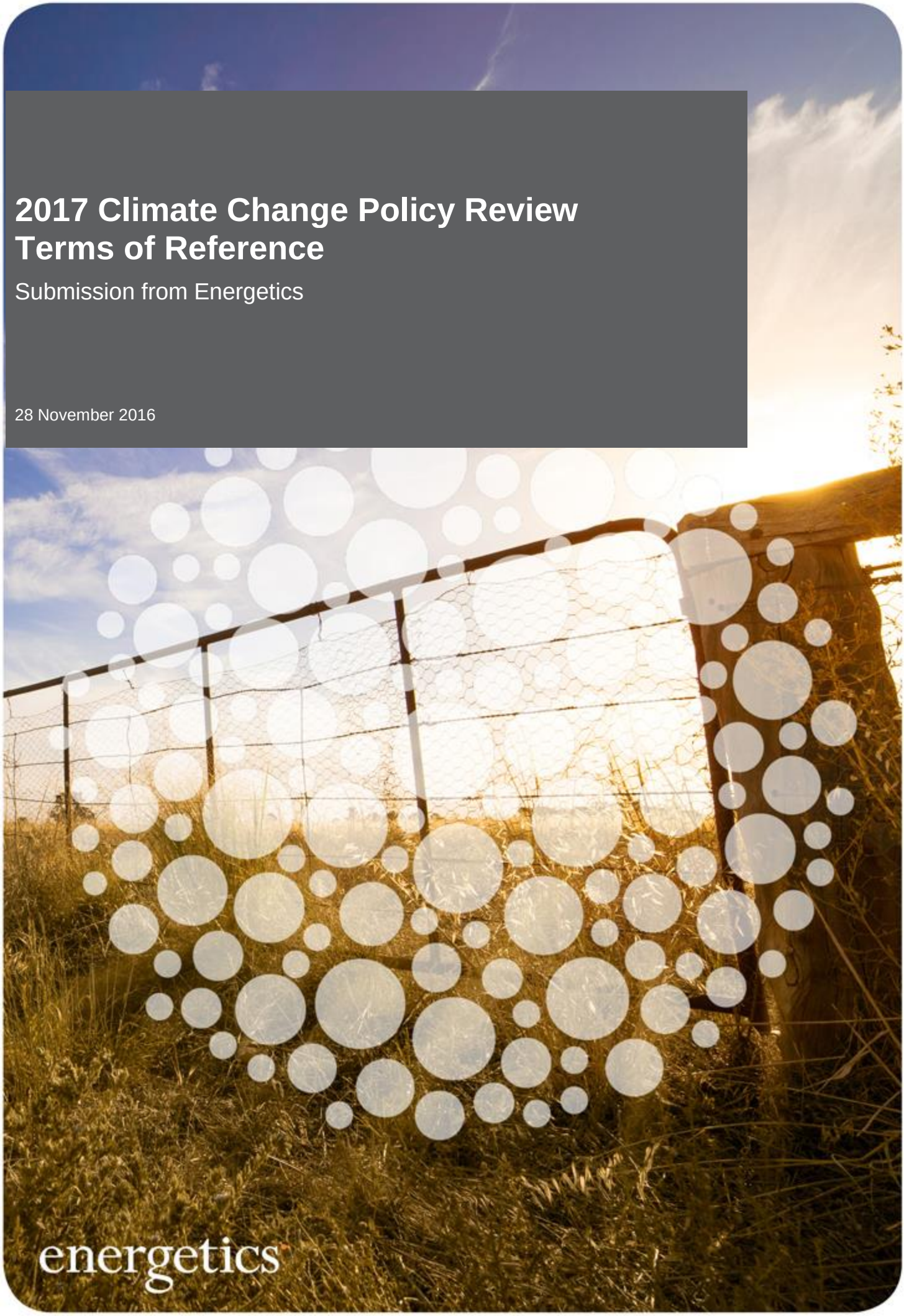
2017 Climate Change Policy Review Terms of Reference

Submission from Energetics

28 November 2016



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- Be leaders. Develop and implement strategy
- Be informed. Make data-driven decisions
- Be efficient. Drive business improvement and realise savings
- Buy better. Leverage energy supply and carbon markets

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Document Control

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Executive summary

As energy and carbon management advisers across all sectors of the Australian economy, Energetics has observed a number of consistent views from business leaders about the risks and opportunities associated with climate action and the need to meet our international obligations.

These are:

- Acceptance that there will be a future price on carbon. Many businesses have applied an internal carbon price to large, long term capital investment decisions for some years.
- Desire for policy stability.
- Interest in renewable energy, from procuring supply, investing in on-site generation and investigating energy storage options, through to participation in buying groups.
- Concerns for the outlook for energy costs and the reliability of supply.
- An understanding that coal fired generation must decrease; particularly where sourced from brown coal.
- Anticipation that the baselines under the Safeguard Mechanism will decline to drive deeper emissions reductions across the economy.

Energetics' submission to the terms of reference for the 2017 Climate Policy Review considers the convergence of a number of issues. We have examined the impact of climate policy on energy generation and security of supply; energy productivity and the rate of decarbonisation; and the opportunities for our land sector into the future as Australia participates in a growing international carbon offsets market. We also argue strongly in favour of bringing forward action on climate change as both a fiscally responsible approach and to reverse the current upward trend in national emissions.

Our recommendations:

- **The transformation of Australia's energy mix needs to be actively managed**
  Achieving the emissions reduction target of 28% relative to 2005 by 2030 will disrupt the electricity generation mix. Brown coal generated power will need to be substituted with either natural gas powered generation or additional renewable energy, or a combination of both.

  The two principal challenges associated with these substitution options are the current severe natural gas supply constraints in the south eastern states, and the inability of our transmission and distribution systems to reliably manage increasing intermittent supply from renewables.

- **Improving energy productivity is critical**
  Energetics' submission discusses the impact of different energy productivity targets in view of the anticipated growth in GDP through to 2030 of 54%. For example, our modelling shows that Australia can achieve the 28% emissions reduction target with the current national target of a 40% improvement in energy productivity, however it will result in a major disruption to the generation mix given the growing demand for energy in an expanding economy.

  As outlined the preceding point, the Review will need to consider the support needed to achieve a managed, smooth transition to an energy mix with a high level of renewables penetration.

- **Carbon credits: need to minimise costs locally and support the land sector to develop ACCUs for future sale into international carbon market**
  The price of ACCUs may approach $65 towards the end of the next decade, reflecting both domestic and international supply and demand for carbon credits. With such a high cost associated with emissions reductions, abatement activity should be brought forward to minimise the economic impact over the back half of the next decade.

  Conversely there is a significant economic opportunity associated with the generation of carbon credits. By 2030 Australia could sequester in the land sector some 2 billion tonnes of carbon in excess of its domestic requirements. The actual figure will depend upon the international demand for offsets and their traded price. Creation of offsets from the land sector could see a transfer of funds from Australian urban areas to regional areas, and generation of carbon offsets for export.

  The 2017 Review should therefore address international linkages and pathways for abatement in the land sector to generate wealth for the regional areas of Australia.

- **Emissions reduction measures should be brought forward**
  There is a clear and compelling case for bringing forward abatement measures. Firstly, as emissions are currently rising in the economy, this trend needs to be reversed. Secondly, Energetics' modelling demonstrates the economic value of early action: one tonne of abatement implemented before 2020 displaces over three tonnes of emissions reductions needed over 2020 to 2030.

  The Review is an opportunity to reassess program timelines, deployment costs and impacts in order to drive emissions reduction measures before 2020. To this end, Energetics has already conducted an analysis of abatement that could be brought forward. This work can be found in Table 1 of our report for the Department of the Environment (**click here**) which was released in May 2016. It is our intention to update this information as part of our submission to the 2017 Review.

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1. Considerations for the Terms of Reference

1.1. Background

The Australian Government has scheduled a review of domestic climate policy in 2017. As the Review will inform the evolution of Australia's climate policies over the next few years, a thorough examination is necessary to ensure the effectiveness, stability and predictability of the domestic policy framework over the long term.

The Australian business sector does not oppose action on climate change. The Joint Principles for Climate Policy issued by the Australian Climate Roundtable[1] clearly demonstrate the willingness of the business sector to act. The submission of the Business Council Australia (BCA) that supports the ratification of the Paris Agreement[2] provides a summary of the requirements of the Australian business sector with respect to climate policy and acknowledges the need for climate action. The BCA document stresses the need for a suite of climate change policies that are "capable of delivering Australia's emissions reduction targets, at lowest possible cost, while maintaining competitiveness and growing Australia's future economy" and which "provide[s] confidence that long-term investment decisions can be made and adequate returns earned".

Our clients in the business community also tell us that they seek clarity on likely changes to climate policies including tightening of existing policy settings. Above all else, the terms of reference for the 2017 Review must facilitate the development of policies that provide clarity for business and the level of predictability essential to stimulate investment in a low carbon future.

1.2. Uncertainty needs to be addressed

There is some uncertainty in the market as to how the current suite of policies will allow Australia to meet its international commitment.

Work released by the Department of the Environment and Energy (the Department) showed that Australia has the capacity to meet a 28% reduction target[3]. Further, the Department has indicated which current policies will drive the abatement needed to achieve the target[4]. Figure 1 shows the policies that will drive abatement. The key is the 300 Mt $CO_{2\text{-}e}$ of abatement that will be driven by the Emissions Reduction Fund (ERF) and Safeguard Mechanism post 2020. The anticipated cost of this abatement significantly exceeds the Government's proposed top-ups of the ERF, and the current settings for the safeguard mechanism will not fill the gap. Therefore, there is widespread recognition in the business community that policy settings, and the safeguard mechanism baselines, will need to tighten in the period to 2030.

[1] *http://www.australianclimateroundtable.org/wp-content/uploads/2015/06/Climate-roundtable-joint-principles-June-29-2015-final-embargoed.pdf*
[2] *http://www.bca.com.au/docs/d068c899-ef28-4ae6-bf15-279fc34f9eef/Submission_to_JSCOT_Inquiry_into_Paris_Agreement_FINAL_2016.pdf*
[3] *https://www.environment.gov.au/climate-change/publications/modelling-and-analysis-australias-abatement-opportunities*
[4] *https://www.dpmc.gov.au/resource-centre/domestic-policy/fact-sheet-australia%E2%80%99s-2030-climate-change-target*

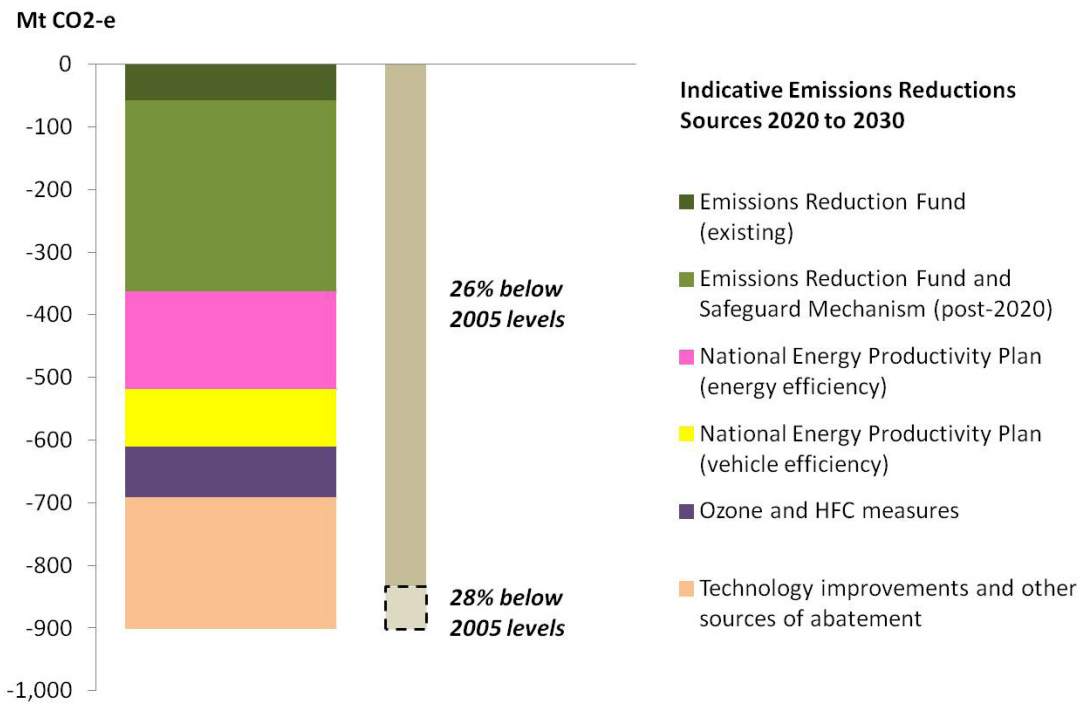

Figure 1: Meeting Australia's emissions reduction target (Source: Department of the Prime Minister and Cabinet)

Energetics believes that the target of a 26-28% reduction on 2005 levels by 2030 that was set by Australia in our commitment under the Paris Agreement is a floor, and that the review mechanisms included in the Paris Agreement will support a strengthening of this target.

In this document, we build on Energetics' understanding of national abatement opportunities and the sources of national emissions to develop recommendations for the terms of reference for the 2017 Review.

In developing these recommendations, Energetics has been guided by a number of key principles. The policy suite must:

- acknowledge that the **delivery of a reliable and secure energy supply** is a paramount role of government
- be capable of **delivering abatement that meets the current international target**, and be sufficiently adaptable **to drive measures in keeping with expected deeper targets**
- be broadly aligned with the positions of both major political parties so that **bipartisan agreement** is feasible.

1.3. Scope of this submission

We assume that the terms of reference for the 2017 Review will already cover a range of critical issues relating to existing climate policy that will address the key principles above. So we have not considered the following in any detail in this submission, other than to outline what we see as clear themes that must be covered in the Review:

Safeguard Mechanism

- Review the **role of the Safeguard Mechanism** in facilitating Australia meeting its emissions reduction objectives. This should account for any deepening of targets both before and after 2030.
- The process for **adjusting Safeguard Mechanism baselines** so that they align with the trajectory of emissions reduction required under Australia's emissions reduction commitments.
- Whether the threshold of coverage of the **Safeguard Mechanism should be expanded**

Emissions Reduction Fund

- Whether **funding for the ERF** should be expanded to ensure the continuity of the domestic carbon offset industry until the expected demand under the Safeguard Mechanism expands.

In the following sections of this document we outline four aspects of climate policy and energy generation that we consider should be areas of focus in the Review.

2. Energy productivity improvements and decarbonisation

To meet the 28% reduction in emissions, the **volume of coal fired generation must reduce, especially brown coal fired generation**.

Renewable generation or natural gas fired generation can increase to fill the gap, although the extent will depend on the change in electricity demand that is driven by **energy productivity improvements**. These changes to the generation mix have significant implications for energy supply security and emissions profiles in Australia.

Therefore, Energetics recommends that the Terms of Reference address **energy reliability and supply** as well as **climate policy**. The elements include:

- **Changing energy mix**: The climate objectives will see greater penetration of renewable energy into the generation mix, so should the current RET be abandoned in favour of other market mechanisms? Will intervention be required for closure of coal-fired generation? We anticipate the Review will consider a broad range of options to achieve climate objectives and energy supply reliability at the lowest cost to society.
- **Reliability of supply**: Should the intermittency of some forms of renewable generation be seen as imposing a cost on the whole network, and so should intermittent sources be required to internalise these costs? For instance, should there be a requirement for wind farms to meet a minimum ramp-down rate through say the use of battery storage?
- **Management of the energy networks**: The changes to the energy networks imposed by the national climate objectives will be significant and rapid. Are the existing governance arrangements and in particular the processes for rule-setting appropriate?
- **Natural gas supply**: The trade-off between additional intermittent generation in the NEM and additional natural gas fired generation is currently limited due to constraints on east coast gas supply. Should we either impose a domestic natural gas reservation policy or further exploit unconventional gas supplies?

Energetics has analysed the relationship between improvements in energy productivity and the generation mix required to achieve the national emissions abatement target (for more detail see Appendix 1). The analysis shows that increasing energy productivity is essential if the national emissions reduction target is to be achieved, and it offers a relatively low cost way of driving down energy demand. The following table summarises the key outcomes.

Table 1: Energy productivity and the mix of power generators

Scenario	Emissions reductions	Variable renewable energy penetration	Impact on the generation mix
'Business as usual' trajectory Scenarios with a 40% improvement in energy productivity relative to 2015 by 2030. A 40% increase in energy productivity leads to an increase in electricity demand of 9% (due to GDP growth of 54% over this time, relative to 2016).			

Result: National climate target missed. Demand for energy rises.			
• No coal phase-out • No targeted adjustments to mix of fossil-fuel generators	21%	21%	• The increase in utility scale renewable energy is driven by the current RET • The growth of cost effective solar PV sees gas generation reduced by 45% • This is not considered a realistic outcome due to the imminent closure of the Hazelwood power station. It also fails to meet the national climate objective.
• All brown coal fired generation is retired • This is replaced with a similar quantity of natural gas fired generation • Some black coal generation is retired	26%	21%	• Even if all brown coal fired power stations are retired and replaced by natural gas fired generation, the reduction in emissions still falls short of the national climate objective. • While electricity demand increases, black coal fired generation experiences an 11% fall due to the preference for renewable energy generation driven by the renewable energy target.
• Two brown coal fired power stations are retired • Demand is met by a similar quantity of gas generation. • In addition, the RET is increased to 56 TWh to force out additional black coal fired generation.	28%	29%	• This scenario meets the national emissions reduction target through the introduction of additional renewable energy. This in turn increases the penetration of renewable generation in the national electricity mix to 29%. • Regulators can therefore expect several states to have renewable energy penetrations that approach or exceed 40%.
Bridging to decarbonisation Scenarios with a 76% improvement in energy productivity relative to 2010 by 2030. A 76% increase in energy productivity holds electricity demand constant out to 2030. **Result: National climate target met. 2 degree target missed. Demand for energy constant.**			
• No coal phase-out • No targeted adjustments to mix of fossil-fuel generators	28%	23%	• Market forces see around 25% brown coal fired generation and around 50% of gas fired generation removed. • Black coal fired generation remains constant. • The rise in renewable energy

			generation through the current RET and the expansion of rooftop solar PV see a slight increase in the penetration of renewable generation.
Commitment to a low carbon future Scenarios with a 100% improvement in energy productivity relative to 2010 by 2030. A 100% increase in energy productivity will reduce electricity demand by 12%. **Result: Just short of 2 degree climate objective. Energy demand reduced.**			
• No targeted coal phase-out. • Market forces used to remove old generators.	36%	26%	• The rise in renewable generation due to the current RET plus the fall in demand squeezes out around 40% brown coal generation and around 50% of natural gas generation is removed. • Black coal generation falls by 20%. • The scenario significantly exceeds the current climate objective, and approaches but does not meet the emissions reductions required for the 2 degree world objective.
• The RET is expanded to pursue the 2 degree world objective • No targeted coal phase-out.	45%	42%	• Market forces see 75% of coal fired generation removed. • Gas expands by 30%. • 38 TWh of additional wind power is needed. • Renewable generation exceeds 40% across the whole electricity system which is higher than current penetration. This requires a re-evaluation of how networks are managed.
• Natural gas replaces coal for all baseload generation.	44%	26%	• Gas expands by 94% to meet demand.

2.1. Summary of insights

Energetics' analysis has demonstrated that the **intended 40% improvement** in Australia's energy productivity by 2030, delivered through the National Energy Productivity Plan, is inconsistent with the national climate change target. However, while modest, if this improvement in energy productivity is pursued (noting that it is not significantly different from business as usual), high impact changes to the national generation mix will be required if Australia is to achieve its 2030 emissions reduction objective. These changes were discussed in the previous section.

A doubling of energy (electricity) productivity will see Australia achieve its emissions reduction targets. However, the associated 12% reduction in electricity consumption places pressure on the generation mix. A significant portion of the existing fossil fuel fired generation fleet will be forced out of the market, which will result in a higher penetration of intermittent renewable generators.

The 100% increase in energy productivity allows the nation to achieve the deeper cuts in emissions required by the 2 degree world objective. Our modelling indicates that this will be accompanied with extensive displacement of coal fired generation, which could extend through to the complete elimination of coal fired generation. There is then a trade-off between the introduction of additional natural gas fired generation (leading to pressure on already constrained east coast gas supplies) or additional renewable generation (with the resultant increase in the penetration of intermittent renewable generation).

Energetics' modelling also suggests that a **76% improvement in energy productivity** will see the national emissions reduction target achieved without requiring specific disruptive measures to force changes to the generator mix. However, it will result in 25% of brown coal fired generation being retired, and 50% of the gas fired generation may also be forced out of the market. A 76% uplift in energy productivity is a significant increase over business as usual, and it is reasonable to expect that a range of policy interventions will be needed to achieve this.

We therefore recommend that the Terms of Reference address **policies to accelerate the increase in energy productivity**. In particular,

- **Lifting the energy productivity target**: Improvements in energy productivity result in both emissions reductions and cost savings. Our analysis shows that the current 40% target is barely above business as usual and is inadequate for meeting the current Nationally Determined Commitment (NDC).
- **Funding the National Energy Productivity Plan:** Any increase in energy productivity that is consistent with the emissions reduction target will be well beyond business as usual, and therefore policy interventions will be required to drive the necessary increase. The 2017 Review should discuss the potential policy interventions required to drive increases in energy policy and the level of funding necessary to implement these policies.

3. Maximising benefits to all Australians

The move to a carbon constrained world offers opportunities for Australia. Several studies have demonstrated how Australia can evolve to net zero emissions within a few decades[5], something that is important in the light of the potentially deep emissions cuts that will be required by the 2 degree world scenario.

This potential exists because of Australia's large land area relative to its population, which offers potential for sequestration of carbon in the land sector greater than what is needed for the 28% reduction target. This surplus can create carbon offsets for export. Energetics' analysis suggests than in excess of one billion tonnes of abatement could be exported, depending upon the international market for abatement (price and volume). It is essential therefore that carbon offsets issued by the Clean Energy Regulator comply with international standards.

We note as well that the sequestration that is available in the land-sector allows for the transfer of benefits from urban areas to rural and regional areas.

We recommend that the following be considered by the 2017 Review:

- **Alignment**: The Review should consider how methods available to generate ACCUs from the land-sector can be aligned with international standards, and how developments under the implementation of the Paris Agreement can enhance integration of markets and possible export market opportunities for ACCUs.
- **Land-sector (LULUCF) carbon credit creation**: Abatement though LULUCF activities appear to be relatively low cost, and work by the CSIRO and others has suggested that the volume of abatement is very high. Therefore the 2017 Review should assess the support needed for the creation of large volumes of ACCUs from LULUCF activities in the near term.
- **International linkages**: How can Australia's agricultural sector and land holders be given the opportunity to exploit a large amount of marginal land to sequester carbon and create quality credits?

[5] The Deep Decarbonization Pathways Project (DDPP) is a global collaboration of energy research teams charting practical pathways to deeply reducing greenhouse gas emissions in their own countries. The Australian contribution was developed by the ANU and ClimateWorks (***http://deepdecarbonization.org/wp-content/uploads/2015/09/AU_DDPP_Report_Final.pdf***).
Beyond Zero Emissions (***http://bze.org.au***) proposed a ten-year pathway to a zero carbon Australia.

4. Concluding comments

Australia's current NDC of a 28% reduction in emissions by 2030 is not in line with the 2 degree goal that is the centrepiece of the Paris Agreement. The five-yearly review process of the Paris Agreement is likely to see more challenging targets emerge in order for Australia to meet its commitments.

Our modelling described earlier tells us that in addition to seeking more ambitious energy productivity targets, achieving deeper cuts in emissions will require significant changes to the power generation fleet. For instance, a 45% reduction in emissions requires the complete removal of brown coal fired generation and its replacement with natural gas fired generation or a very much higher penetration of intermittent renewables in the national electricity mix. We have already noted that both of these options pose major challenges to Australia's energy supply systems.

Given that there is a reasonable expectation that the emissions reduction target will deepen over time, any policies developed now should be capable of delivering deeper cuts through changes in the settings of those policies. It will be unfortunate if a commitment to deeper cuts in emissions required the development of a new set of policies, which would create uncertainty and delays.

Further, our analysis shows that taking early action significantly reduces the magnitude of the future abatement task. This will be particularly valuable as the requirement for deeper cuts increases the size of the future abatement task.

We therefore suggest that the 2017 Review consider the following:

- **Flexibility**: Is the current policy suite, with associated policy settings sufficiently robust to deal with more stringent targets?
- **Early action**: What policy measures can be implemented immediately to drive abatement in the short term?

Appendix A - The relationship between carbon abatement and renewable energy penetration

Energetics has examined the options available to reduce national emissions and our insights from these studies inform our recommendations. Abatement comes from reducing energy consumption, decarbonising energy supply or various other measures which are dominated by the land sector – land use change and agriculture in particular.

This section looks at the relationship between carbon abatement and the makeup of the electricity generation fleet. We use a model of national emissions to examine how combinations of improvements in energy productivity ($GDP/unit of energy input), renewable energy penetration and the phasing out of fossil fuel generation can deliver the national emissions reduction target.

The key outcomes of the modelling are:

1) Achieving the emissions reduction target of 28% relative to 2010 by 2030 will disrupt the electricity generation mix either by forcing the substitution of (brown) coal by natural gas for power generation, by driving the introduction of additional renewable energy into the electricity markets or a combination of both. The former will place pressure on the supply of natural gas on the east coast of Australia and the latter will introduce network stability challenges.
2) Our modelling shows that Australia can achieve the 28% reduction target with a 40% improvement in energy productivity, however it will result in a major disruption to the generation mix as demand for energy grows in an expanding economy.

Australia's emissions and sources of potential abatement

Figure 22 below shows the sources of Australia's emissions. Two thirds of national emissions are due to the combustion of fuel, either to generate electricity, to generate heat or motive power, or for transportation.

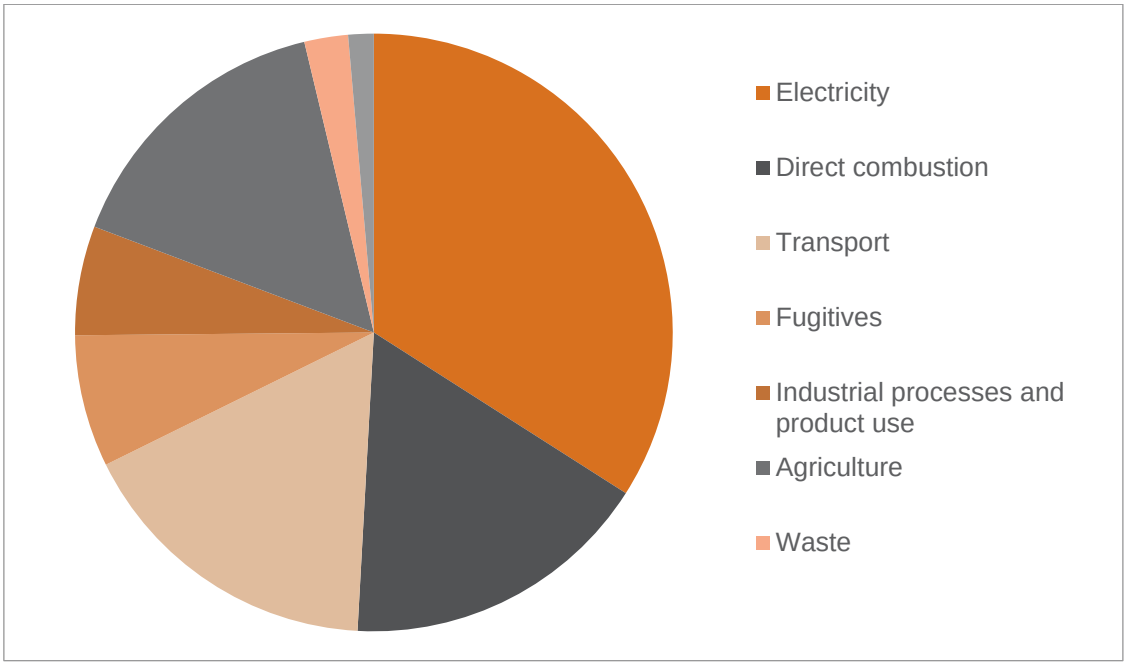

Figure 2: Australian greenhouse gas emissions (Mt CO2-e)

Agriculture is the largest of the non-energy related sources.

The ranking of the areas where the potential to reduce emissions is the largest also informs our analysis of abatement and electricity generation. Energetics' work for the Commonwealth[6] identified a range of opportunities to reduce national emissions. The following two figures characterise these emissions abatement opportunities according to the broad category of abatement and the sector.

[6] ***https://www.environment.gov.au/system/files/resources/b8540c8a-8a31-4aba-a8b5-63cc46466e33/files/modelling-and-analysis-australias-2030-abatement-opportunities.pdf***

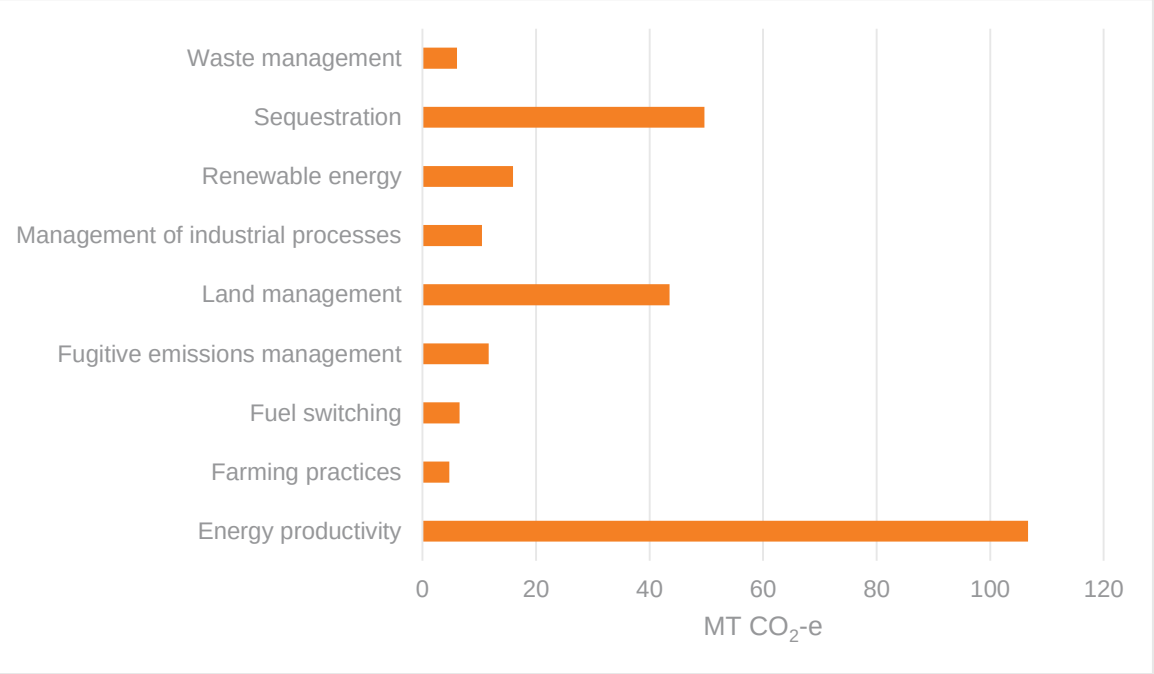

Figure 3: Abatement opportunities in 2030 by abatement type

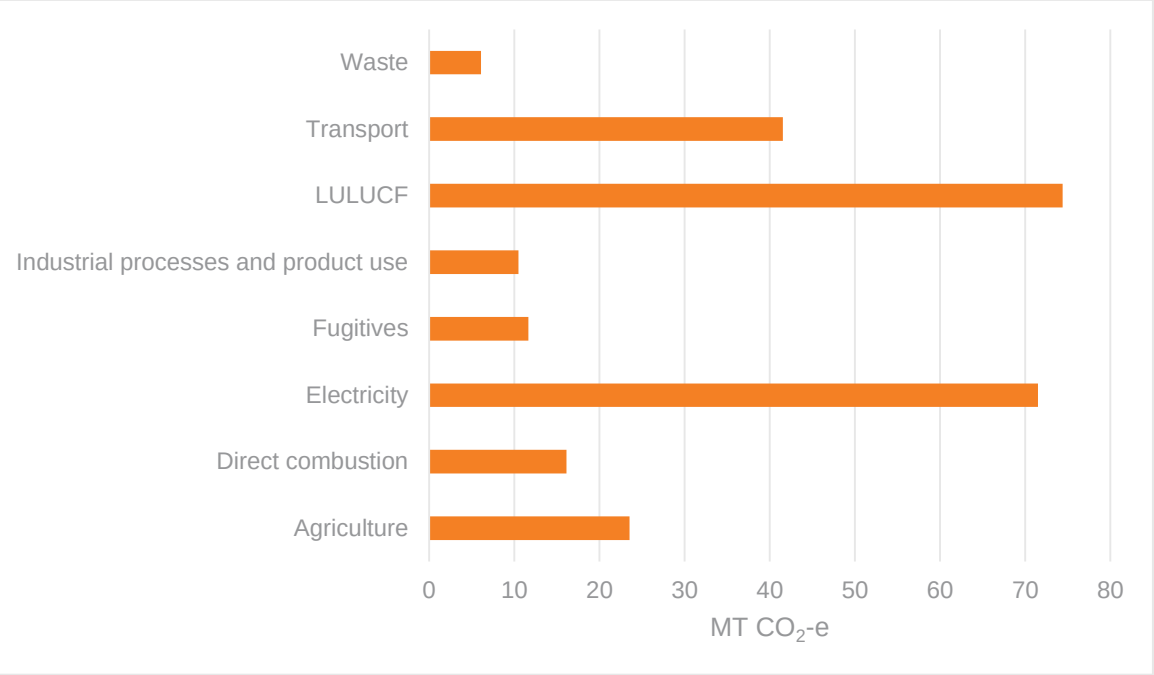

Figure 4: Abatement opportunities in 2030 by emissions source

Together, these two charts suggest that the major sources of abatement are associated with the more productive use of electricity, better land management and sequestration of emissions in the land sector. Savings will also emerge from the more productive use of fuel for stationary energy and for transport.

Our work for the Commonwealth considered measures that could emerge under the current suite of climate change policies. This meant that any expansion of renewable energy beyond that which will occur under the existing renewable energy target or will be business as usual after 2020, is not assessed.

The cost curve for abatement opportunities (Figure 5) shows that the bulk of the low cost opportunities involve improving energy productivity with many having a net positive financial benefit. Abatement involving forestry (re-afforestation, better management of forest land) and agriculture generally involve a modest cost, which is less than the cost of measures associated with changes to electricity generation. It is important to note that the indicated costs of abatement from changes to electricity generation are for measures that involve the displacement of operating generators with low emissions alternatives. The relative economics of new-build power stations are rather different, with new-build wind or solar power stations being comparable in cost to new-build coal fired power stations.

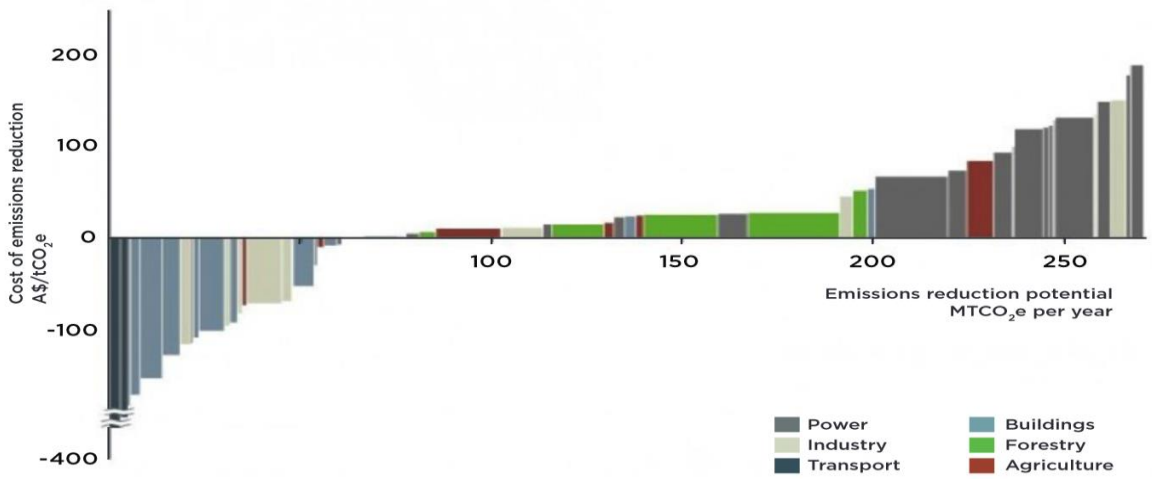

Figure 5: Cost curve for emissions abatement opportunities (Source: ClimateWorks)

The analysis presented in this section considers the impact of falling electricity demand on the penetration of renewable generation. The renewable energy target (RET) places a minimum on the volume of electricity from renewable sources. Further, under the RET's framework, small scale generation, most often rooftop solar PV, falls outside of the 33 TWh contribution of utility scale renewable energy. Therefore, investments in cost effective small scale generation (i.e. rooftop solar PV) will be additional to the 33 TWh of large scale renewable electricity.

The effect of declining electricity demand and expanding renewable electricity will be to squeeze out existing generators.

Modelling improvements in energy use

Our analysis models abatement due to measures aimed at reducing energy use by considering scenarios that improve national energy productivity (energy use per unit of GDP). The magnitude of effort required to improve energy productivity can be assessed by comparing an assumed improvement in national energy productivity with the business-as-usual trend in energy productivity and national targets. A summary is presented in Figure 66. It shows the recent trend in energy productivity against some targets.

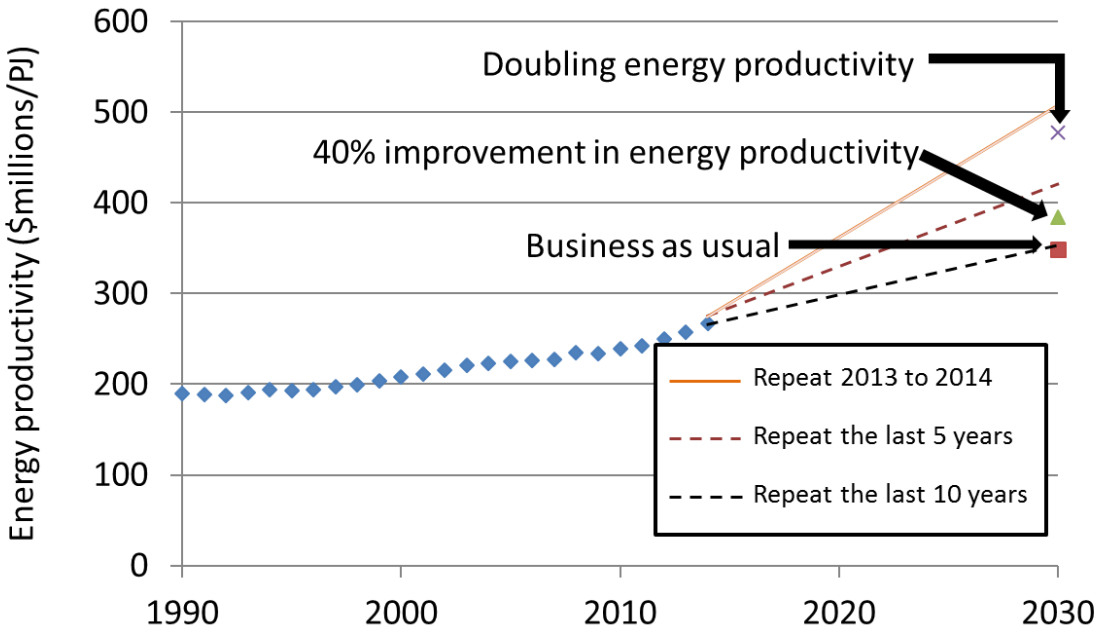

Figure 6: Trends in energy productivity

Two targets for the raising of national energy productivity have recently been proposed. The COAG Energy Council[7] has proposed an increase in energy productivity of 40% compared to the current figure. The Australian Alliance for Energy Productivity[8] has proposed a doubling of energy productivity compared to the value in 2010. The figure shows that the rate of improvement in energy productivity has been increasing over time. COAG's 40% target is similar to the 'business-as-usual' outcome, which is a projection of the trend observed over the past decade. The 100% increase in energy productivity will require a significant uplift on BAU.

In the period from 2015 and 2030, GDP is expected to rise by just over 50%[9] and so a 40% increase in energy productivity actually leads to a 20% increase in primary energy consumption compared to the 2005 figure. This outcome is incompatible with the national climate objective of a reduction in emissions of 28% compared to 2005.

In the period from 2010 and 2030, GDP is expected to rise by 80% and so the doubling of energy productivity will see a reduction in primary energy consumption of the order of 2% compared to the 2015 figure. This outcome is also incompatible with the greenhouse gas emissions reduction target. As reducing energy consumption was one of the prime sources of emissions abatement, the effect of increasing energy productivity by only 100% is to place more pressure on the other sources of abatement.

The remainder of this section will examine the potential contribution of other sources of abatement, focusing on the decarbonisation of electricity generation.

[7] ***https://scer.govspace.gov.au/files/2015/12/National-Energy-Productivity-Plan-release-version-FINAL.pdf***
[8] ***http://a2se.org.au/***
[9] ABS and Treasury forecasts

Sources of abatement other than changing the generation mix

Energetics' earlier studies into meeting the national emissions reduction task identified the following sources of abatement available in 2030:

Table 2: Non-energy based sources of abatement

Source	Abatement in 2030 Mt CO_2-e
Low emissions farming practices	5
Fugitive emissions management	12
Land management	44
Management of industrial processes	10
Sequestration	50
Waste management	6

These additional measures could provide up to 126 Mt CO_2-e of abatement in 2030. Our investigation did not find major abatement through the decarbonisation of stationary energy and transport. Electric vehicles make a minor contribution in 2030. However, this may need to be reassessed over time because EV technology is rapidly evolving.

Low emissions farming practices include changing soil management methods to reduce cropland soil emissions, sequestration of carbon in cropland soil and anti-methanogenic treatments to reduce enteric emissions of methane from livestock. Land management and sequestration cover activities associated with changes in land use, such as avoiding deforestation, as well as improving the retention of carbon in the biosphere, with, for example, better management of pasture soils to enhance carbon capture and retention.

The largest abatement activity associated with the management of industrial processes is the phase out of low ozone depleting substances that have a high global warming potential.

Forecasting emissions in 2030

This section describes the process that we followed to determine the emissions in 2030.

Emissions due to electricity

An improvement in energy productivity was selected, and was used to establish the level of electricity consumption in 2030. We adopted a scenario based approach rather than attempt to predict the improvement in energy productivity based on current and potential interventions. The trends in Figure 66 show that a 40% improvement in energy productivity compared to 2016 is broadly in line with BAU, while a 100% increase in energy productivity relative to 2010 is a significant rise compared to BAU. Our analysis considered these two scenarios.

We assumed that the change in electricity consumption was the same as the change in total energy consumption. Having assumed a change in energy productivity compared to a base year, we used the projected increase in GDP from the Australian Treasury to calculate the energy consumption in 2030. The contributions to energy consumption of electricity use, fuel for stationary energy (heating and motive power) and fuel for transport we assumed to vary in proportion to the change in total energy consumption.

We adjusted the generation mix to meet the calculated electricity consumption. A series of rules were applied to adjust the generation mix:

1) Certain aspects of the generator mix in 2030 were pre-set e.g. 33 TWh for wind and utility scale solar to reflect the current RET, 24.4 TWh of solar outside of the RET to reflect BAU uptake of behind the meter solar PV[10].
2) We established a broad scenario to define how the generator mix will change e.g. brown coal replaced by natural gas.
3) The fossil fuel generator mix was then adjusted so that the calculated electricity consumption was met.

The total emissions due to electricity generation were determined. This was derived from the published emissions intensity factors for the various generation sources.

Emissions due to other sources in the absence of abatement measures

Emissions due to energy use other than electricity were estimated by scaling the emissions in 2015 due to those sources in proportion to the change in total energy use. At this point, we assumed that no actions were taken to reduce the carbon intensity of fuels for stationary energy or transport. The greenhouse gas emissions due to the use of these fuels, therefore varies in proportion to the consumption of the fuels.

Emissions due to non-energy sources were assumed to change over time according to our model of emissions change with GDP. Energetics has developed a model of national greenhouse gas emissions that is based on the observed relationship between GDP growth and emissions growth. Our model forecasts that national emissions will rise from 560 Mt CO_2-e in 2015 to 640 Mt CO_2-e if business as usual is maintained. This is a 14% rise. We applied this 14% rise to all emissions sources excluding those associated with the use of energy.

Total emissions for Australia in 2030

We summed the emissions due to electricity generation and the emissions due to other sources and then applied the abatement available outside of the electricity sector determined in Table 2.

A worked example

This worked example considers a 40% energy productivity improvement relative to 2015 and the retirement of 50% of brown coal generation and its replacement with natural gas fired generation.

[10] The figure for solar PV uptake was sourced from AEMO's 2015 forecast of electricity demand. The AEMO figure was adjusted to account for states and territories outside of the NEM.

Emissions due to electricity

The assumed 40% rise means that energy productivity will increase from 274.6 $millions/PJ to 384.5 $millions/PJ. As the GDP is forecast to be $2,522,693 million in 2030, total energy consumption will be 6560 PJ, which is a 9.0% increase compared to 2015.

The national electricity consumption in 2015 was 256.1 TWh[11] and so applying the same 9.0% increase means that the electricity consumption in 2030 is estimated to be 279.3 TWh.

The generation mix in 2015 and 2030 is shown below.

Table 3: Generation mix in 2015 and 2030 (TWh)

Generation source	2015	2030	Comment
Black coal	114.7	102.0	Generation from black coal was adjusted so that the overall electricity demand of 279.3 TWh was met.
Brown coal	46.1	23.1	The 50% reduction was assumed in the modelled scenario
Natural Gas	49.0	72.0	Brown coal generation has fallen by 23 TWh and has been replaced by 23 TWh of natural gas generation.
Diesel	3.0	3.0	
Hydro	16.2	16.2	We assume no change in electricity sourced from hydro.
Wind	18.9	33.0	Wind generation rises in line with the existing RET
Bioenergy	2.0	4.0	A minor increase in bioenergy and geothermal electricity was allowed. We assumed this happens after 2020 so it does not impact the RET.
Solar	6.2	24.4	Solar PV increases (as per the AEMO forecast) outside of the large scale RET of 33 TWh
Geothermal	0.1	1.6	

We used to following emissions factors to calculate the total emissions due to electricity consumption from the 2030 generation mix. These emissions factors were derived from a regression analysis of the total emissions due to electricity use reported by BREE and the reported generation mix.

[11] Bureau of Resource and Energy Economics

Table 4: Emissions intensity of generation sources

Generator type	Unit of measure	Emissions factor (kT CO_2-e/unit)
Black coal	Kt	0.837
Brown coal	Kt	1.435
Natural Gas	TJ	0.564
Diesel	ML	0.974
Hydro	GWh	0
Wind	GWh	0
Bioenergy	GWh	0
Solar	GWh	0
Geothermal	GWh	0

The emissions due to electricity consumption in 2030 are estimated to be 168.0 Mt CO_2-e.

Emissions due to other sources in the absence of abatement measures

This has two components – the emissions due to energy other than electricity and emissions due to non-energy related activities. The former are assumed to rise in proportion to the change in total energy consumption i.e. they will both increase by 9% from 2015 to 2030.

Table 5: Other energy related emissions in 2030 (Mt CO_2-e)

Source	2015	2030
Direct combustion	94.4	103.0
Transport	92.7	101.1

Emissions due to non-energy related sources are assumed to rise in proportion to the BAU increase in national emissions. The latter is derived from our forecast of national emissions, which in turn comes from the relationship between national emissions and GDP. Energetics forecasts that in the absence of any abatement activities, emissions will rise from 560 Mt CO_2-e in 2015 to 640 Mt $CO_{2\text{-}e}$ in 2030.[12]

The non-energy related emissions are summarised in the following table.

Table 6: Non-energy related emissions in 2030 (Mt CO_2-e)

Source	2015	2030
Fugitive	37.9	43.3

[12] Note: These figures to not account for the updating to the entire emissions time series that was reported in mid-2016.

Agriculture	81.2	92.8
Industrial processes	31.9	36.5
Waste	12.7	14.5
LULUCF	23.1	26.4

Total emissions for Australia in 2030

Emissions total 585.6 Mt CO_2-e. Applying the abatement measures in Figures 3 and 4 reduces emissions to 458.6 Mt CO_2-e.

Emission abatement scenarios

Table 7 displays the results of a series of scenarios. The meanings of the columns are:

- The national emissions inventories are for 2030 in Mt CO_2-e. The first column has the emissions without the application of the non-energy related abatement opportunities. The second column shows the emissions after the application of the non-energy related measures.
- The reduction in emissions is relative to 2005.
- The final column shows the penetration of intermittent renewable generation (e.g. wind and solar PV) and covers the entire national electricity mix - not just the NEM. The figure in 2015 was 10%.

Two key issues emerge from the results in the table.

First, the 40% improvement in Australia's energy productivity by 2030 that the National Energy Productivity Plan is to deliver appears to be inconsistent with the national climate change target. In particular, this modest improvement in energy productivity (noting that it is not significantly different from business as usual) means that high impact changes to the national generation mix will be required if Australia is to achieve its emissions reduction objective. These changes could be:

- the displacement of all brown coal fired generation by natural gas fired generation which will place significant pressure on east coast gas supplies; or
- an additional 23 TWh of large scale renewable energy which will see the average intermittent renewable energy penetration in the electricity markets rise to 29%.

Secondly, a doubling of energy productivity (assuming it also sees a doubling of electricity productivity) will see Australia achieve its emissions reduction targets. However, the associated 12% reduction in electricity consumption places extreme pressure on the generation mix. A significant portion of the existing fossil fuel fired generation fleet will be forced out of the market, and there will be a resultant increase in the penetration of intermittent renewable generators.

The 100% increase in energy productivity allows the nation to achieve the deeper cuts in emissions required by the 2 degree world objective. Our modelling indicates that this will be accompanied with extensive displacement of coal fired generation (up to the complete elimination of coal fired generation). There is then a trade-off between the introduction of additional natural gas fired generation (with the resultant pressure on east coast gas supplies) or additional

renewable generations (with the resultant increase in the penetration of intermittent renewable generation).

Our modelling suggests that a 76% improvement in energy productivity will see the national emissions reduction target achieved without a significant disruption to the generator mix. But even this will see 25% of brown coal fired generation retired. Market forces may also force out 50% of the gas fired generation.

Table 7: Emissions reduction scenarios

Scenario	National emissions in 2030 (Mt CO2-e)		Emissions reduction	RE penetration	Comments
	Excluding non-energy abatement	Including non-energy abatement			
40% energy productivity improvement relative to 2015, no coal phase-out, no targeted adjustments to mix of fossil-fuel generators	609	482	21%	21%	Overall electricity demand increases by 9%. However, the increase in renewable energy driven by the RET and by cost effective solar PV sees natural gas generation reduced by 45%. The scenario falls well short of the national climate objective.
40% energy productivity improvement relative to 2015, 50% of the brown coal fired generation is retired and replaced with a similar quantity of natural gas fired generation. Some black coal is retired.	586	459	25%	21%	Overall electricity demand increases by 9%. Black coal fired generation experiences an 11% fall. The scenario falls just short of the national climate objective.
40% energy productivity improvement relative to 2015, all brown coal fired generation is retired and replaced with a similar quantity of natural gas fired generation. Some black coal is retired.	566	439	26%	21%	Overall electricity demand increases by 9%. Black coal fired generation experiences an 11% fall. The scenario just meets the national climate objective.
40% energy productivity improvement relative to 2015, 50% of the brown coal fired generation is retired and replaced with a similar quantity of natural gas fired generation. Some black coal is retired.	578	452	28%	29%	Overall electricity demand increases by 9%. Black coal fired generation experiences a 31% fall. The scenario just meets the national climate objective.

RET increased to 56 TWh. Black coal is allowed to fall to meet the overall demand.					
76% energy productivity improvement relative to 2010, no coal phase-out, no targeted adjustments to mix of fossil-fuel generators	567	440	28%	23%	Electricity demand remains constant to 2030. Market forces see around 25% brown coal generation and around 50% of natural gas generation removed. Black coal generation remains constant. The scenario meets the national climate objective.
100% energy productivity improvement relative to 2010, no targeted coal phase-out. BAU removal of old generators.	516	389	36%	26%	Overall electricity demand decreases by 12%. Market forces see around 40% brown coal generation and around 50% of natural gas generation removed. Black coal generation falls by 20%. The scenario significantly exceeds the current climate objective, and approaches but not meets the reduction required for the 2 degree world objective.
100% energy productivity improvement relative to 2010, expansion of the RET to chase the 2 degree world objective, no targeted coal phase-out.	473	340	45%	42%	Market forces see 75% of coal fired generation removed. Gas expands by 30%. 38 TWh of additional wind power is needed.
100% energy productivity improvement relative to 2010, complete phase-out of coal.	473	340	45%	28%	Gas expands by 88%, and an additional 6 TWh of wind is needed to meet demand.

Appendix B - The value of early action

The previous analysis of the relationship between carbon abatement and renewable energy penetration only focused on 2030 and did not consider the timing of abatement. In this section, we show with a simple example that early action significantly reduces the volume of abatement required to achieve the 2030 target.

Figure 7 shows the case of no early action. The GDP intensity trend is our forecast of emissions in the absence of any abatement such as activities supported by the Emissions Reduction Fund.

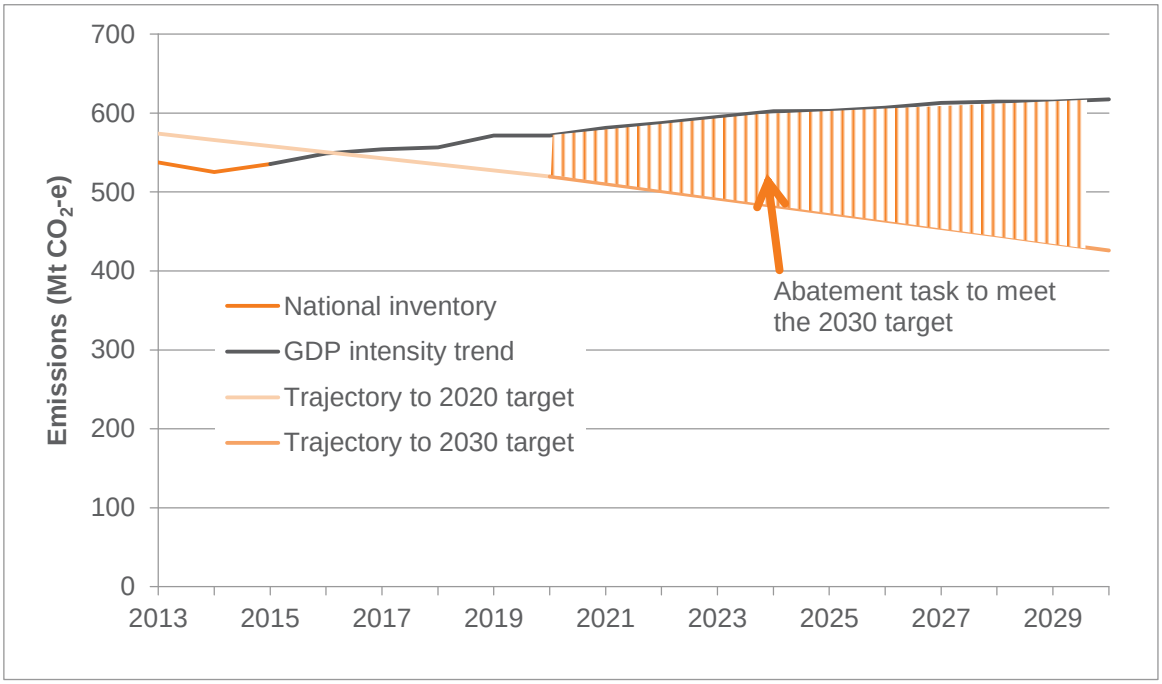

Figure 7: Abatement scenario 1 - no early action

The order of 1400 Mt CO_2-e of cumulative abatement is required to meet the 2030 target.

The next figure shows the impact of early action. In particular, it proposes taking action in the period to 2020 so that Australia's emissions match the trajectory to the 2020 target. We assume that the measures taken to reduce emissions up to 2020 have a lifetime of 10 years.

We find that measures that deliver a total of 129 Mt CO_2-e of cumulative abatement prior to 2020 mean that the cumulative abatement task for the period from 2020 to 2030 is 910 Mt CO_2-e.

Each tonne of abatement prior to 2020 removes 3.8 tonnes of emissions after 2020.

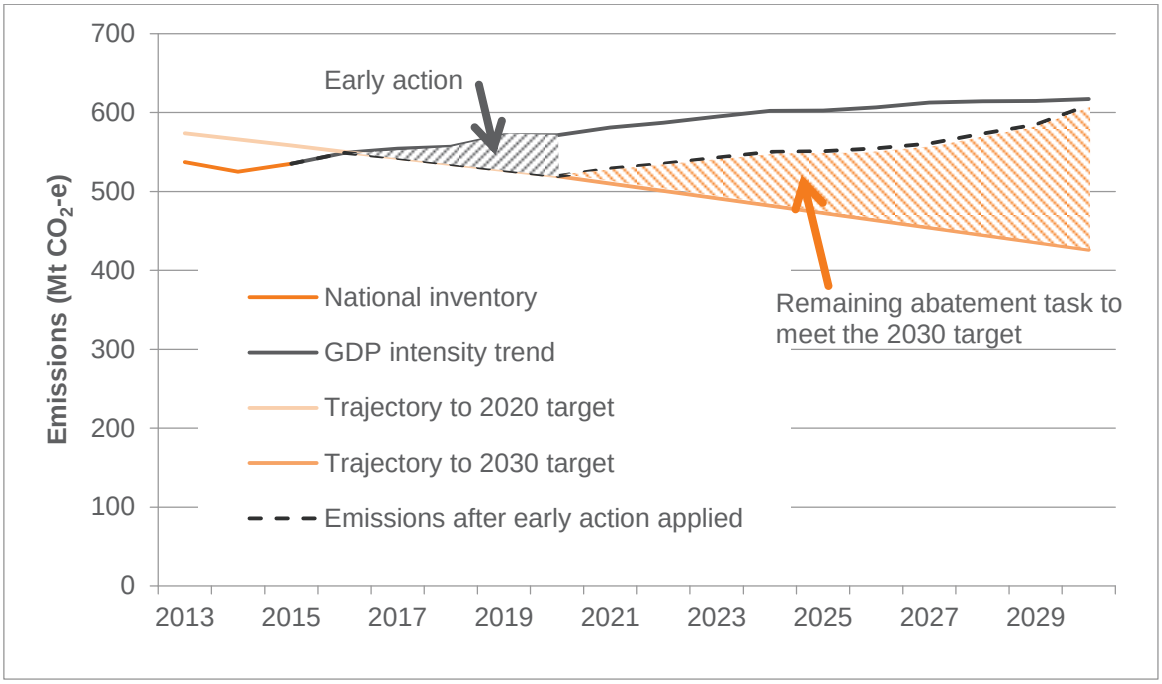

Figure 8: Abatement scenario 2 - early action

Appendix C - The market for natural gas on the east coast

AEMO reports annually on the adequacy of eastern and south-eastern Australian gas markets to supply maximum demand and annual consumption over a 20-year outlook period. The most recent report[13] noted that proved and probable gas reserves start to deplete from 2019, and that development will be required to ensure contingent and prospective resources and undeveloped reserves become commercially recoverable in the period from 2019 to 2035.

The figure shows the volume of supply projected to meet domestic and export LNG demand forecast. As proved and probable reserves are projected to decline from 2019, currently undeveloped gas reserves and contingent and prospective resources will be required to meet forecast demand. We note that the demand projections in the figure are unlikely to include a significant expansion of gas fired generation.

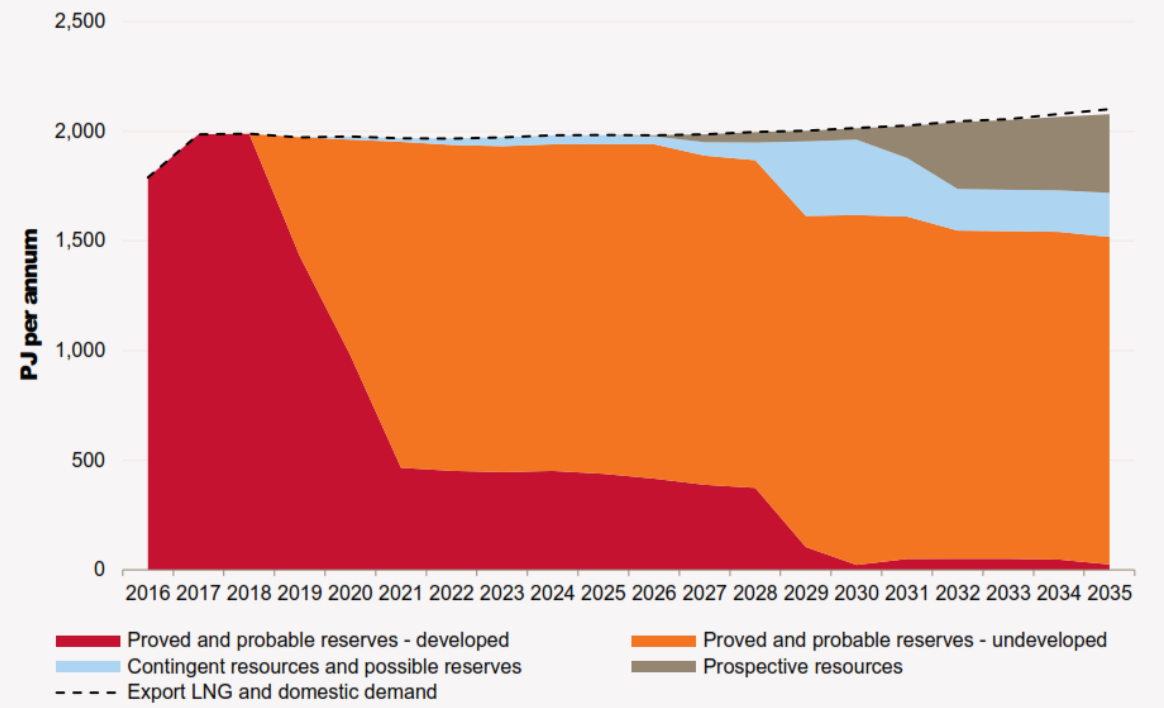

Figure 9: Eastern and south-eastern Australia gas markets, 2016−35 (Source: AEMO)

[13] "Gas Statement of Opportunities for eastern and south-eastern Australia", Australian Energy Market Operator, March 2016

Appendix D - Opportunities in the offset market

The market for carbon in Australia is currently subject to a significant degree of uncertainty. Linkage with international carbon markets is also unknown and the likely global price ranges for carbon offsets will be dependent on how the Paris Agreement, particularly Article 6 – which covers international trading – will progress over time. As a result of these uncertainties, we have considered the potential price range for carbon in Australia across five different scenarios. The scenarios considered are:

Scenario	Overview
Scenario 1	26-28% emissions reduction target, no international linkage
Scenario 2	26-28% emissions reduction target, limited international linkage (trade with major markets only)
Scenario 3	26-28% emissions reduction target, full international linkage for carbon offsets
Scenario 4	45% emissions reduction target, full international linkage for carbon offsets

The projected weighted average ACCU / carbon offset price for these scenarios between now and 2030 is outlined in the figure below.

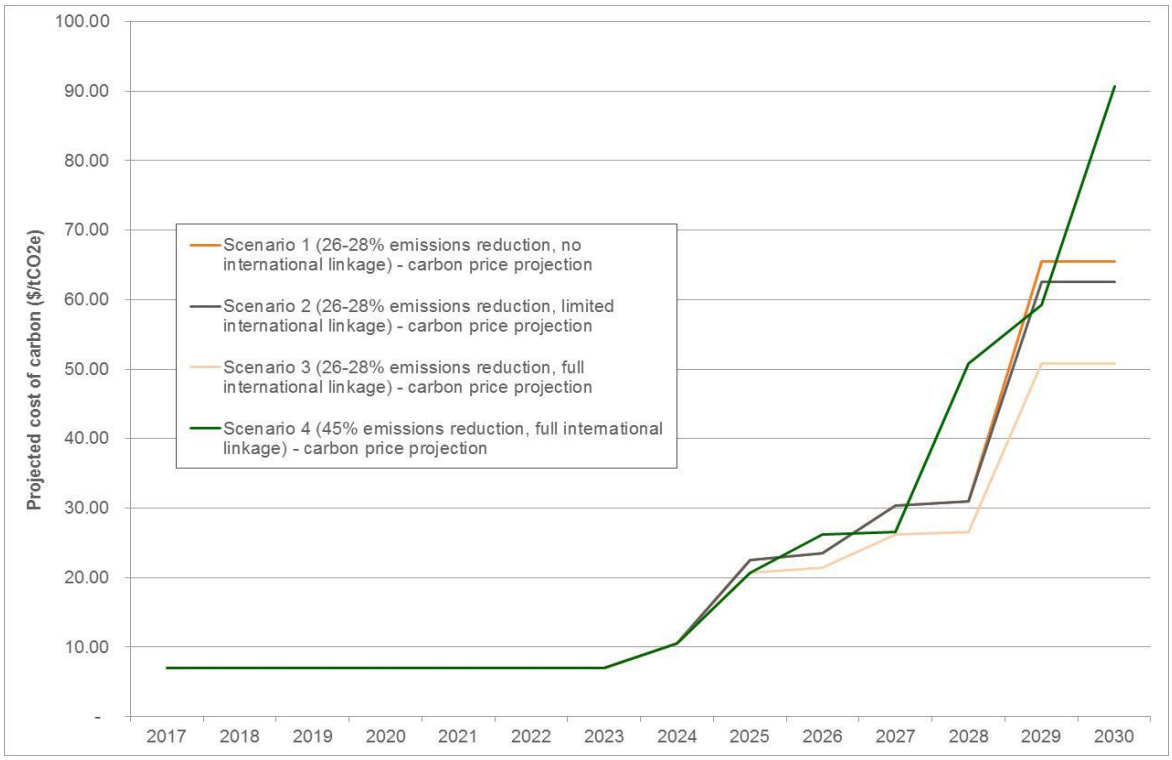

Figure 10: ACCU price curve projections 2017 - 2030

It is important to consider the forecast of the price for ACCUs in the context of the potential international market for carbon offsets. The future of existing mechanisms for generating

international carbon offsets established under the Kyoto Protocol (the Clean Development Mechanism) is unclear beyond 2020 when the Kyoto Protocol draws to a close. The Paris Agreement's Article 6 provides a framework for 'Internationally Transferred Mitigation Outcomes' which may develop into a new form of credit issuance protocol in the post-2020 period. However, there is uncertainty on the likely volume and price of international credits. There is an expectation that with the potential demise of the CDM, rise of the Chinese ETS (the world's largest market for permits) and potential demand for credits in the EU, that the price of internationally traded offsets may be much higher than is currently experienced.

The likely cost of permits in other markets is therefore a relevant consideration in the framing of Australia's policies.

Figure 111 shows a series for projections of the carbon permit price in 2025 in the three largest markets. These prices are broadly in-line with Energetics' forecast for ACCU prices.

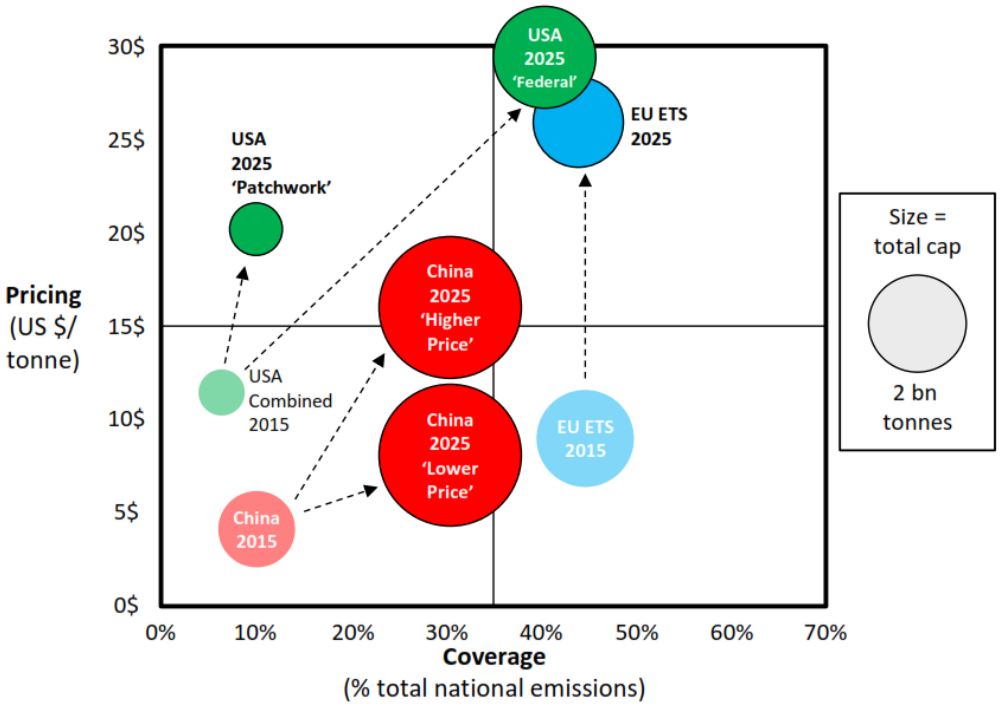

Figure 11: Price and coverage of carbon trading scheme scenarios in 2025[14]

Enerdata also looked at future prices for permits in Europe in the period to 2030[15], and they saw the EUA price reaching the order of €70 in 2030.

Australia becomes a potential exporter of offsets at these prices. The CSIRO's study into the potential for Australian land-sector carbon sequestration[16] found that the Australian land sector could sequester up to 3 billion tonnes of carbon by 2030. The next figure shows the results.

[14] Source: "Climate change policy outside the EU: the role of carbon pricing", James Rawlins, Energy Research Centre of the Netherlands, March 2016

[15] "The EU ETS under Phase IV: A quantitative assessment based on results from the POLES model", Enerdata, COP21 Side-event: Carbon prices - Perspectives for the Development of the EU Emissions Trading Scheme by 2030, December, 2015

The focus is the L1 scenario which carries with it a carbon price the order of $90/tonne in 2030[17], and is therefore aligned with the projections of the international carbon prices.

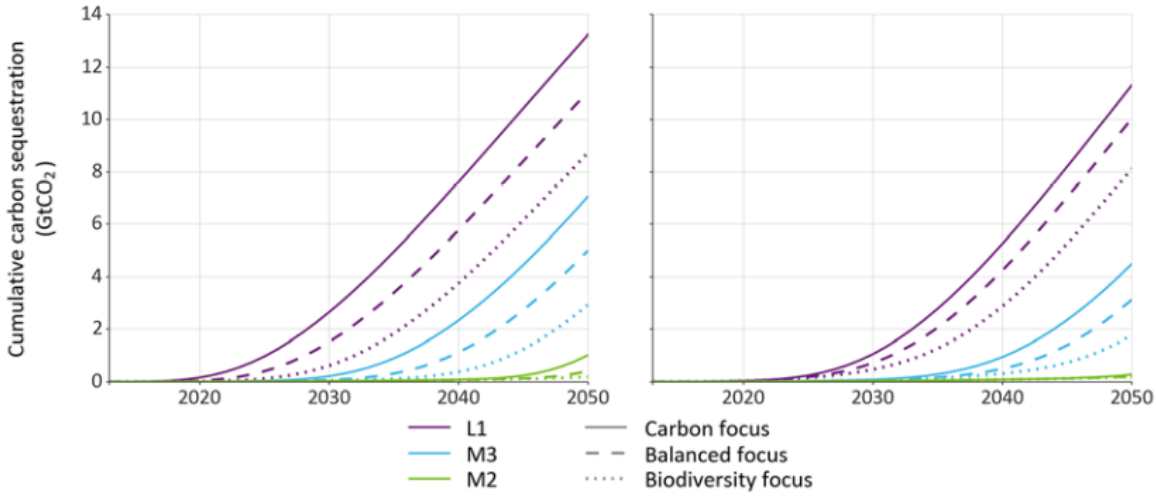

Figure 12: Cumulative supply of land carbon offsets for various global change scenarios[18]

Our own analysis of the national abatement task suggests that Australia will need to deploy the order of 900 million tonnes of cumulative abatement in the land sector in order to meet the national emissions reduction target. A comprehensive set of abatement measures required to meet the target of 28% is shown in Figures 3 and 4. The impact of these measures on national emissions from 2020 is shown in the next figure.

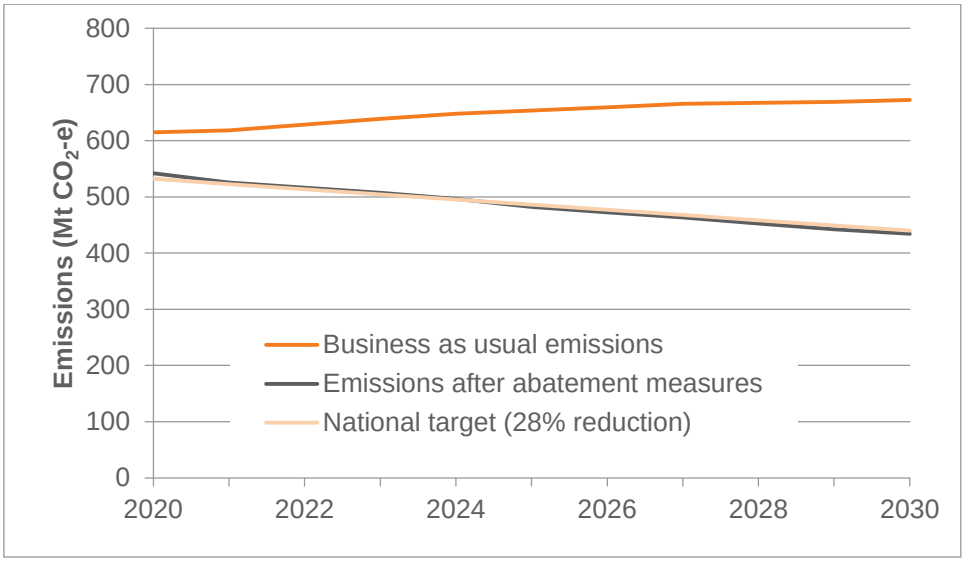

Figure 13: National emissions after abatement measures applied

[16] Bryan BA, Hatfield-Dodds S, Nolan M, McKellar L, Grundy MJ, McCallum R (2015) Potential for Australian land-sector carbon sequestration and implications for land use, food, water, and biodiversity: Report for the Australian National Outlook 2015. CSIRO, Australia
[17] Ib id. See Figure 2
[18] ib id. See Figure 7

These results suggest that by 2030 Australia could generate sequestration in the land sector of the order of 2 billion tonnes that is in excess of its domestic requirements. The actual figure will depend upon the international demand for offsets and the traded price for these offsets.

Table 8: Abatement measures required to meet the national emissions reduction target[19]

Measure	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
EP-Advanced energy efficient equipment	0.0	2.1	4.1	5.7	7.2	8.8	10.5	12.2	13.9	15.6	17.3	17.2	17.2	17.1	17.1	17.1
EP-Advanced industrial energy efficiency	0.0	1.9	3.8	5.6	7.3	9.0	10.9	12.8	14.7	16.6	18.5	19.3	20.1	20.8	21.5	22.3
EP-Smart buildings	0.0	0.0	0.0	0.0	0.0	0.0	1.1	2.2	3.2	4.0	5.0	6.0	6.9	7.9	9.0	10.0
EP-Low carbon transport	0.0	0.0	0.0	3.3	6.6	9.8	13.1	16.4	19.7	23.0	26.3	29.5	32.8	33.4	34.0	34.6
EP-Electric vehicles	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.3	0.4	0.4
EP-Solar PV (residential and commercial)	0.0	1.1	2.2	3.1	4.0	4.8	5.8	6.7	7.7	8.6	9.5	9.5	9.4	9.4	9.4	9.3
EP-Sustainable cities	0.0	0.0	0.0	0.0	0.0	0.0	1.3	2.6	3.9	5.3	6.9	8.4	9.9	11.3	12.4	13.5
GEN-Improve generator efficiency	0.0	1.1	2.2	3.3	4.3	5.4	6.5	7.6	8.8	10.1	11.5	12.1	12.6	13.1	13.4	13.7
Alternative Waste Treatment	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.2	1.8	2.4	3.0	3.5	4.1	4.7	5.3	5.9
Management of synthetic gases	0.0	0.0	0.0	0.0	6.5	6.8	7.1	7.4	7.8	8.1	8.5	8.9	9.3	9.7	9.8	9.9
Reductions to fugitive emissions	0.0	0.0	0.0	0.8	1.6	2.3	3.1	3.9	4.7	5.4	6.2	7.0	7.8	8.5	9.3	10.1
LAND-Advanced farming methods	0.0	0.0	0.7	1.5	2.2	3.0	3.7	4.4	5.2	5.9	6.6	7.4	8.1	8.9	9.6	10.3
LAND-Advanced forest management	0.0	0.0	1.6	3.1	4.7	6.2	7.8	9.3	10.9	12.4	14.0	15.5	17.1	18.6	20.2	21.8
LAND-Better management of pastures	0.0	0.0	1.3	2.6	3.9	5.2	6.5	7.8	9.1	10.4	11.7	13.0	14.3	15.6	16.9	18.2
LAND-Reduced deforestation	0.0	0.0	1.1	2.1	3.2	4.3	5.4	6.4	7.5	8.6	9.7	10.7	11.8	12.9	14.0	15.0
LAND-Reforestation	0.0	0.0	1.9	3.7	5.6	7.4	9.3	11.2	13.0	14.9	16.7	18.6	20.5	22.3	24.2	26.0

[19] Source: Energetics analysis – see ***https://www.environment.gov.au/system/files/resources/b8540c8a-8a31-4aba-a8b5-63cc46466e33/files/modelling-and-analysis-australias-2030-abatement-opportunities.pdf***

Energetics' awards

2016

Winner of Financial Review Client Choice Awards

- **Niche Firm Leader**

Finalist of Financial Review Client Choice Awards

- **Best Consulting Engineering Firm with Revenue <$50m**

2015

Winner

- **Australian Business Award for Service Excellence**
- **Australian Business Award for Marketing Excellence**

2014

Winner of BRW Client Choice Awards

- **Best Professional Services Firm (revenue < $50M)**
- **Best Consulting Engineering Firm (revenue < $50M)**
- **Best Value**

Finalist of BRW Client Choice Awards in 3 categories

- **Best Client Service**
- **Most Friendly**
- **Most Innovative**

2013

Finalist

- **BRW Client Choice Award for Best Client Relationship Management**
- **Leading in Sustainability Banksia Award**

2012

Winner

- **Australian Business Award for Recommended Employer**
- **Australian Business Award for Service Excellence**

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