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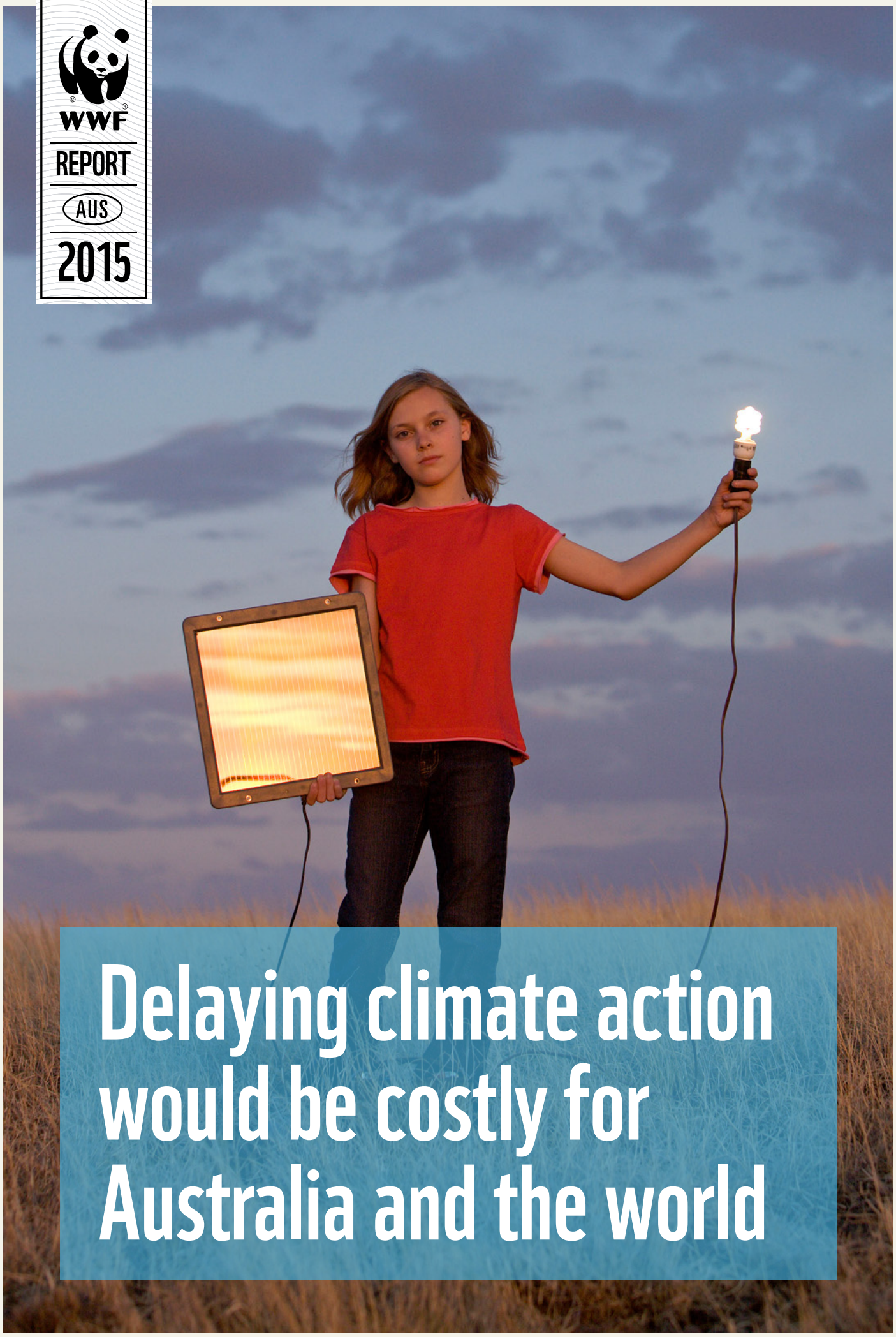

Delaying climate action would be costly for Australia and the world

This brief was prepared by the Centre for Climate Economics and Policy at the Crawford School of Public Policy, Australian National University. Authors: Luke Kemp and Frank Jotzo. The authors thank colleagues for expert review and suggestions.

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SUMMARY POINTS

Australia stands to gain from early and strong global climate action and needs to contribute its fair share.

- Australia is vulnerable to climate change and has more to gain from strong global action than most developed countries. All sides of politics agree that strong global climate action is in Australia's national interest.
- Other countries are acting and are making significant commitments for the post-2020 period.
- Australia's commitments and actions on climate change matter, and are noticed internationally.

The case for early and strong global climate change action is compelling scientifically and economically.

- This is reflected in broad international agreement on the 2°C goal, with calls for even lower temperature targets, such as 1.5°C.
- Successive economic analyses have provided a stronger case for more rapid decarbonisation of the world economy.
- This is as a result of more recent scientific analysis finding climate change impacts will be larger and occur earlier than previously estimated, changes in the valuation of future impacts and risks, and faster reductions in the costs of low carbon energy.

The global carbon budget is limited. If we do less today, then we must do more in the future.

- A 15 year delay would effectively push the 2°C target out of reach. A 1.5°C target would become unattainable with an even shorter delay.
- Any global carbon budget implies a carbon budget for each country.
- Every plausible carbon budget for Australia will involve deep reductions in emissions before 2030, even with relatively modest global climate action.
- The longer emissions increase or plateau, the steeper the required reductions – and the harder the task – later on.
- If Australia remained on a high emissions economy for an extended period of time, this would create very large adjustment pressures later.

Delayed action increases the risk of locking in more adverse climate impacts for Australia and other countries.

- Strong action now can achieve significant reductions using demonstrated technologies.
- Delaying action would require relying even more on untested technologies in the future, such as large scale deployment of bio-energy combined with carbon capture and storage (BECCS) in order to limit warming to 2°C. This adds avoidable risks and potential costs to achieve the same climate outcome as earlier stronger global action.

A coal train carries coal to the terminal in Gladstone, Queensland, Australia. Coal is transported hundreds of kilometres by rail from the coal mines of central Queensland to the Great Barrier Reef coast where it is loaded into ships for export. In the next few years there are plans to construct new railway lines to carry millions of tonnes of coal a year from new mega-mines over 300km inland in the Galilee Basin to the expanding port of Abbot Point beside the Reef World Heritage Area.

Delayed action by Australia risks higher economic costs and future adjustment pressures.

- Major studies on global and Australian climate action all suggest that the delay of mitigation leads to larger overall costs. Greater delay results in greater costs.
- In recent years, large amounts of high-carbon infrastructure have been added in Australia, despite a weaker outlook for global fossil fuel demand. Adding further carbon intensive infrastructure risks forced early retirement of carbon intensive assets retired before the end of their technical life span.
- Locking in high carbon energy infrastructure also poses risks for Australia's energy intensive export industries, which already compete with producers using low carbon energy.
- Going slow on emission reductions now means that more drastic action will need to be taken in future in order for Australia to achieve its carbon budget, at higher overall cost and with more intense adjustment pressures.

Most of Australia's fossil fuel reserves are unburnable given climate change constraints.

A large share of global fossil fuel resources cannot be used if the world is to limit global warming to 2°C.

- A large share of global fossil fuel resources cannot be used if the world is to limit global warming to 2°C. Over 90% of coal resources in Australia could be unburnable, even if CCS technology becomes available.
- Key importers of thermal coal are scaling back demand. China's domestic coal use is likely to be close to its peak or may already have peaked, and its import demand for coal is likely to fall.
- Global coal demand is projected to fall under strong global climate action, and some of Australia's mining and coal transport infrastructure may be left stranded. This poses particular risks for low-grade, high-cost coal.
- Australia may need to prematurely retire already existing coal mining infrastructure due to overinvestment during the mining boom. Any further expansion in coal infrastructure would run a significant risk of being unprofitable.

There are significant opportunities for Australia in a low carbon world.

- Australia's energy intensive industries will need to transition to low carbon models of production, and there is the chance to build new competitive advantages.
- Australia has extensive capabilities for large-scale renewable energy production at relatively low cost. This could underpin future energy intensive industries such as metals processing, if the world moves to a low carbon economy.
- Carbon forestry and agriculture has the potential to provide a significant new revenue stream for rural areas. It can also provide co-benefits such as biodiversity conservation and improved air and water qualities.
- Given the opportunities and risks for both delayed and avoided mitigation, early action on cutting emissions is clearly in Australia's national interest.

1. AUSTRALIA'S NATIONAL INTEREST: STRONG GLOBAL CLIMATE ACTION AND THE NEED TO ACT

A key consideration in setting emissions targets is the extent of emission reductions action in the short term compared to the longer term. If a 'budget' approach is taken to emission reductions, as underlies most recent analyses and as recommended by Australia's Climate Change Authority[1] and earlier analys is published by The Climate Institute[2] , then less action now implies the need for even stronger action later.

The dynamic aspects of climate change policy are complex and depend on as yet unknown future developments in emission reductions options. However, a clear picture that emerges from existing research suggests that delay in emission reductions would be costly for Australia, and that delay in global action risks missing the chance to limit warming to the agreed goal of 2°C or less.

This report summarises key findings from previous Australian and international studies and highlights findings that are relevant for Australia's decision about post-2020 emission reductions targets. It canvasses the economic case for Australia's interest in deep emissions cuts, reviews the results from studies about the effects of delayed climate change action, and summarizes existing knowledge on the dangers of locking-in to high-carbon structures as well as the opportunities for Australia in a low carbon world.

A companion report released in April 2015 investigated technical opportunities, and the economic costs and benefits from reducing Australia's emissions.[3]

Both reports are intended to inform the government process for deciding Australia's post-2020 greenhouse gas emissions target. All countries have been called on to submit an initial pledge for their 'intended nationally determined contributions' to future global climate action, ahead of the Paris UNFCCC Conference of the Parties (COP21).

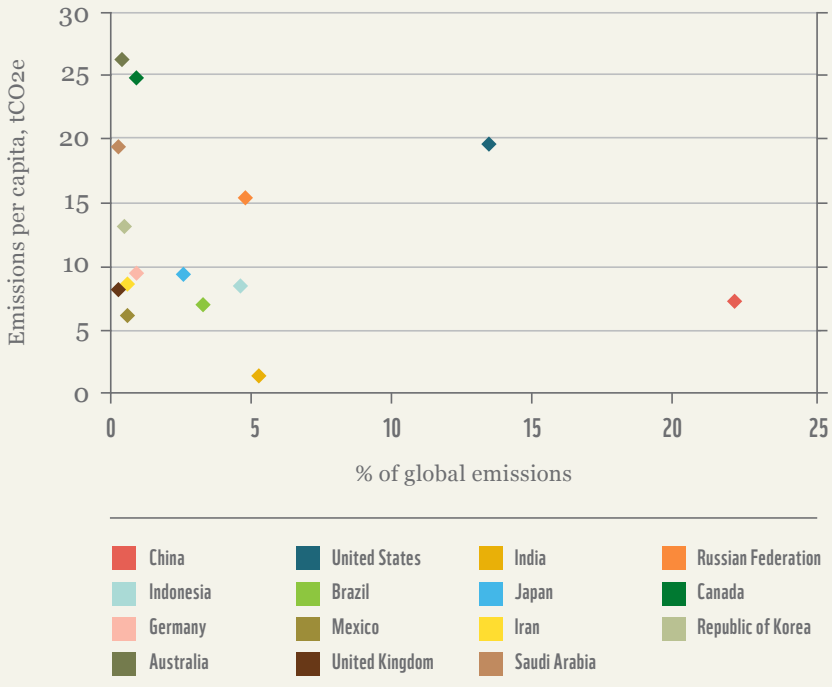
It has been well documented that Australia is one of the most vulnerable countries to climate change amongst developed economies.[4] Australia's interest is in strong global action. This has been noted in the government's issues paper on Australia's post 2020 target[5], and the federal government has voiced its strong support for the goal of limiting global warming to 2°C. All sides of politics agree that strong global climate action is in Australia's national interest.

Australia is prominent in the international climate change negotiations, as one of a small number of developed country players, a prominent middle-power, and as both a high-income and highly emissions intensive economy. Australia's total emissions account for around 1.3% of the global total, but this puts us in the top 15 countries – in a world where the USA, EU and China account for around half of global emissions (excluding land use change), and only Japan and the other major emerging economies (India, Russia, Brazil and Indonesia) account for more than 2% of global emissions.[6] As shown in Table 1 and Figure 1, **we are also the highest per capita emitter out of these top 15 countries. Australia's targets, both short and long-term, matter.**

Table 1: The top 15 global emitters, 2011 (adapted from CCA 2015).[7]

Rank	Country	% global emissions	Emissions per capita (tCO2c)
1	China	22.3	7.6
2	United States	13.4	19.7
3	India	5.1	1.9
4	Russian Federation	4.8	15.5
5	Indonesia	4.5	8.4
6	Brazil	3.1	7.2
7	Japan	2.5	9.2
8	Canada	1.8	24.7
9	Germany	1.8	9.9
10	Mexico	1.6	6.1
11	Iran	1.6	9.4
12	Republic of Korea	1.4	13.2
13	**Australia**	**1.3**	**26.6**
14	United Kingdom	1.2	8.5
15	Saudi Arabia	1.2	19.2

Figure 1: The 15 largest global emitters and their per-capita emissions in 2011. (Data from CCA 2015)[8]



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Rome, Italy, 21 September 2014. People's Climate March in Rome to protest climate change. Volunteers and activist ready to form a huge green hearth that will be photographed by a drone flying over the Colosseum.

The international community will pay close attention to Australia's post-2020 emissions targets. Other countries, including major powers and allies, have already asked questions about Australia's existing emissions target and domestic mitigation policies. This is evident by a number of critical questions posed to Australia this year under the climate negotiations by the likes of the US and China, as per excerpts in Box 1 below.

BOX 1: QUESTIONS POSED TO AUSTRALIA BY OTHER COUNTRIES IN THE CLIMATE NEGOTIATIONS[9]

'Australia further indicated that the 15% and 25% conditional targets are based on the level of international action, especially from advanced economies... This ambition level is far below the requirement that Australia set out for advanced economies. Please clarify the fairness of such requirements.' – ***China***

'Considering the low level of ambition presented until now, as well as the historical data, does Australia intend to change its unconditional target in order to increase its level of ambition?' – ***Brazil***

'What additional PaMs [Policies and Measures] are taken into consideration by the Party in light of longer term requirements to substantially lower per capita GHG emissions as recommended by science and thus contribute to the collective achievement of the 2 degree warming limit?' - ***Switzerland***

'Could Australia provide information on the anticipated mitigation potential of the emissions reduction fund to meet the two conditional more ambitious emission reduction targets?' - ***EU***

'Will the emissions reduction fund constitute the primary measure implemented to replace the emissions trading scheme, or are other significant policies and measures being contemplated?' – ***US***

Australia is also facing additional pressure to act strongly, given the announcement of emissions reductions targets by the EU and United States, and China's climate action. **China has adopted the 2020 target of reducing their emissions intensity by 40-45% on 2005 levels and pledged to peak their emissions by 2030. The EU has the long-term goal of reducing emissions by 80-95% on 1990 levels by 2050, and the 2030 target of -40%.**

The United States has enacted a number of domestic level measures such as the 2014 Clean Power Plan and the adoption of vehicle fuel efficiency standards. Underpinning their action is a recently announced pledge to reduce emissions by 26-28% on 2005 levels by 2025. This is accompanied by a longer term target of cutting emissions by 83% on 2005 levels by 2050.

Given this and the upcoming Paris climate summit, the timing of emissions cuts in Australia is crucial. Setting strong emissions reduction targets this year will have Australia join increasing global action and help create the necessary conditions for a strong international agreement. There are also other clear economic reasons for ambitious early action. As this brief will highlight, there are significant costs to delaying mitigation domestically and clear benefits in early action for Australia.

The analyses summarized in this report on the whole focus on the internationally accepted goal of limiting global warming to 2°C above pre-industrial levels. However it is also noted that many have argued that a 'safe' level of warming may only be 1.5°C,[10] and this is the preferred target for most vulnerable countries and groups such as the Alliance of Small Island States (AOSIS) and the Least Developed Countries (LDCs).

Man cycling through the polluted streets of Taiyuan, capital of China's coal province Shanxi. Shanxi province is the heartland of China's coal belt, known for high levels of pollution and a thriving coal industry with large legal mines and an undergrowth of smaller and illegal mines.

2. THE 'INVISIBLE CONSENSUS': STRONG CLIMATE ACTION IS ECONOMICALLY DESIRABLE

The consensus on the science of anthropogenic climate change is well known. Yet equally important points of consensus exist on the economics of climate change mitigation. There is a consensus among many economists, that is invisible to most, on the benefits of limiting warming to 2°C and that the necessary emissions reductions are compatible with strong economic growth and an improvement in standards of living worldwide.[11] Our previous policy brief highlights that this second point of consensus applies to both the world as a whole, and Australia specifically.[12]

The first point of the invisible consensus can be seen in the changing opinions of some key economists. Lord Nicholas Stern, author of the Stern Review, originally argued for stabilisation at a greenhouse gas level between 450-550 ppm, with some emphasis on 550ppm.[13] However since then Stern has strengthened his position. At the 2013 World Economic Forum Stern stated:

"Looking back, I underestimated the risks. The planet and the atmosphere seem to be absorbing less carbon than we expected, and emissions are rising pretty strongly. Some of the effects are coming through more quickly than we thought then... I would have been much more strong about the risks of a four- or five-degree rise."

Another striking example of re-evaluation of the economically optimal level of climate change action is Yale Economist William Nordhaus, who was originally critical of the Stern Review and argued that the world should allow for much higher temperature increases.[14] Since then, in light of new evidence, Nordhaus has found progressively lower 'optimal' levels of warming.[15] In his more recent work he finds that achieving the 2°C goal would bring net benefits to the world.[16] His re-evaluation brings him into relative agreement with Stern and Australia's Garnaut Climate Change Review, which argued for a 450 ppm or lower stabilisation (associated with 2°C expected warming).[17] [18] There is an increasingly clear trend of economists favouring strong and early mitigation in order to limit warming to 2°C or lower.[19] [20]

This echoes, and has been influenced by, new insights on the physical climate science, along with observed and projected climate change impacts.[21] The economics literature gives increasing attention to the risks of catastrophic climate change, and the full social and economic impacts of global warming of 4°C or more. **Even if the risk of catastrophic impacts are small, the insurance benefit of avoiding these risks may override other considerations in a correctly framed economic analysis,** and call for very strong action to cut emissions, or even the implementation of geo-engineering if mitigation efforts are too weak or climate change impacts too rapid.[22] [23] [24]

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An almost dried up farmer's watering hole on a farm near Shepperton, Victoria, Australia. Victoria and New South Wales have been gripped by the worst drought in living memory for the last 15 years. River levels have dropped, water holes have dried up and stocking rates on many farms have dropped as the land can no longer support as many animals.

3. KEEPING TO THE BUDGET: THE COSTS OF DELAY

Delaying action risks blowing our carbon budget

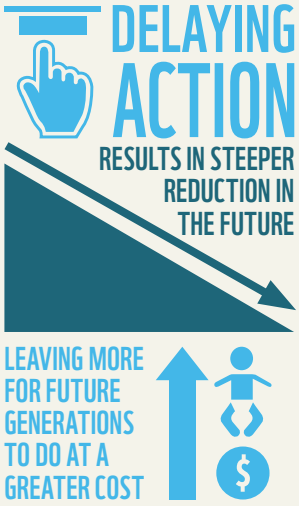
The ability to limit warming to 2°C or lower is highly contingent upon timing; the earlier the action the higher the world's chances of keeping to 2°C. **Recent modelling suggests that out of a range of factors such as the level of action, technology development and climate sensitivity, that the timing of emissions reduction cuts is the single most important element.**[25]

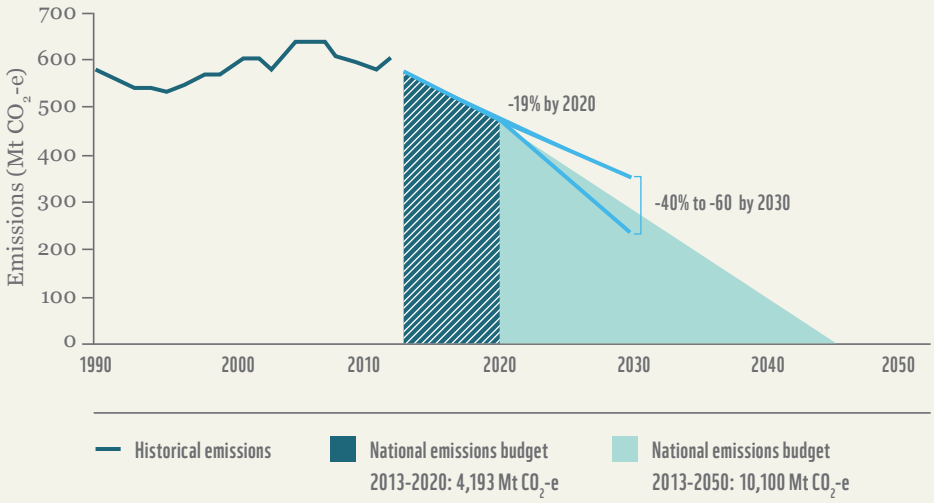
It has been well documented that delayed action significantly increases the chances of overshooting our carbon budget. One recent study found that while the 2°C target is still within reach with 'comprehensive' climate policies globally, the achievable temperature target rises by approximately 0.4°C with a 15 year delay in strong action, compared to current modest action.[26] The authors concluded that a 15 year delay would effectively push the 2°C target out of reach. A 1.5°C target would become unattainable with an even shorter delay.

The Intergovernmental Panel on Climate Change (IPCC) has noted that many models with annual 2030 emissions higher than 55 GtCO2-equivalent (a likely outcome given a delay to 2030) cannot produce scenarios that limit warming to 2°C with a chance of 'as likely as not' (33-66% probability).[27] Another modelling exercise found that delaying mitigation until 2030 resulted in 50% higher warming rates in the 2040s, creating adaptation challenges.[28]

Figure 2 shows an illustrative emissions budget for Australia, as recommended by Australia's Climate Change Authority.[29] A larger cut in emissions now means that a greater share of our carbon budget is left for later. If we use up more of the budget now, emission reductions in the future will have to be significantly steeper to reach the same cumulative target. This also has a dimension of intergenerational equity as the greater costs and burdens of steeper reductions will be on populations in future decades, when the effects of climate change are also likely to be felt more strongly than today.

Figure 2: A carbon budget for Australia (CCA 2014).





The closing window: delay restricts our options

But this is not just an issue of intergenerational equity. Many energy sector and industrial investments committed in the next few years will have a technical life to the middle of the century or beyond. Decisions that the Australian Government and investors make now will have long-term consequences for its emissions trajectory, and the cost of achieving emission reductions. Policy settings that are uncertain, or lack market credibility, risk higher energy costs and reduced security of supply, deter investment in low-carbon technologies and stock, and increase the cost of achieving emission reductions.[30]

Recent studies suggests that weak action between 2010-2030 would lead to the premature retirement of coal fired power stations and a reliance on untested or non-commercial technologies, in order to meet a 2°C goal.[31] [32]

The IPCC states with high confidence that delaying mitigation to 2030 will 'narrow the range of options consistent with maintaining temperature change below 2°C relative to pre-industrial levels'.[33]

Delayed action would also mean strong reliance on technologies that are currently not commercially available, such as the large-scale use of bioenergy and carbon capture and storage (BECCS).[34] In a BECCS system, energy is generated by burning specially grown biomass, grown to draw down carbon from the atmosphere, and the resultant carbon dioxide is captured and sequestered underground, leading to a net carbon negative system. A large number of modelling scenarios for the latest IPCC report suggests that in order to meet a 2°C target without immediate strong action is likely to require widespread adoption of BECCS later this century.[35]

However there are doubts about the economic, institutional and technical feasibility of large scale BECCS systems. It would be a very high-risk strategy to rely on the emergence of 'silver-bullet' technological solutions to the energy transition faced after 2030 under a delayed action scenario.[36]

A costly lock-in: delay results in greater costs

A large number of studies highlight that the cost of mitigation both globally and within Australia are modest, particularly when mitigation is started early.[37] [38] [39] Conversely, there are significant costs to delaying emission reductions. Existing models are conclusive that delay leads to higher overall macroeconomic costs of achieving a given global outcome.[40] [41] [42] This trend across studies is highlighted in Box II.

BOX II: WHAT THE MAJOR REPORTS SAY: THE ECONOMIC COSTS OF DELAY

'Delaying mitigation efforts beyond those in place today through 2030 is estimated to substantially increase the difficulty of the transition to low longer term emissions levels and narrow the range of options consistent with maintaining temperature change below 2°C relative to pre-industrial levels (high confidence).' - **IPCC AR5, 2014**[43]

'Delaying action is a false economy: for every $1 of investment in cleaner technology that is avoided in the power sector before 2020, an additional $4.30 would need to be spent after 2020 to compensate for the increased emissions.'[44] – **IEA, 2011**

'Early global action is cheaper than delayed action. Every year of delay adds to the eventual cost of action as it locks in more emission-intensive industry and infrastructure, and defers new investment in low-emission technology, industry and jobs. [...] For economies with high levels of carbon pollution per unit of output every year of deferring action on climate change will lead to higher long term costs'[45] – **Treasury, 2011**

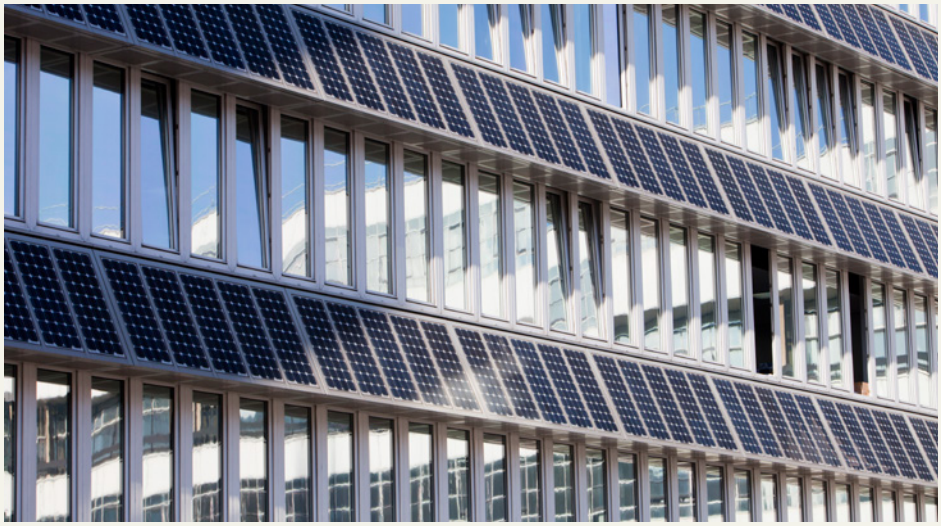
'Delaying mitigation action in the global economy will increase climate change risks, lock in more emission-intensive industry and infrastructure, and defer cost reductions in low-emission technologies. This will increase the cost of achieving environmental goals.'[46] – **Treasury, 2008**

'The longer emissions reductions are delayed, the faster the available global emissions budget will be used up, requiring greater efforts to reduce emissions in future and eventually ruling out the possibility of limiting warming to 2 degrees or less.'[47] – **Climate Change Authority, 2014**

'Changing paths later would also likely mean increased disruption to the economy, for example through the need for early retirement of industrial or electricity generation assets that are emissions intensive.'[48] - **Climate Works Australia and ANU, 2014**

'Australia can deliver significant reductions at an affordable cost. Furthermore, the longer we delay acting, the more expensive it becomes for business and for the wider Australian economy.'[49] – **Australian Business Roundtable on Climate Change, 2006**

The longer a country waits to introduce strong emission reductions the more disruptive and costly an eventual 'technological transition' to a low carbon economy is likely to be.[50] [51] [52] Delay also means missing out on investment in more energy efficient long-lived assets such as buildings.[53] This problem is known as 'carbon lock-in', which is the accumulation of carbon-intensive assets and investments, making future emissions cuts more expensive.[54] [55] The specific costs caused by delay across a number of recent studies are shown in Box III. The costs of delay based on a review of existing studies performed by the IPCC are depicted in Figure 3.



Solar panels on a building on the campus of Northumbira University, Newcastle upon Tyne, UK.

BOX III: ESTIMATES OF THE COSTS OF DELAY

Results from peer review literature:

- Modelling by IIASA[56] found that delaying global action by just five years would require double the marginal cost of abatement to give the same expected temperature outcome.
- The Potsdam Institute found that delaying global action until 2030 triples the cost of reducing emissions to 2050 in comparison to beginning action in 2015.[57]
- Other studies have found that delaying strong global action by 10-15 years results in economic costs that are double or more the impacts of earlier action.

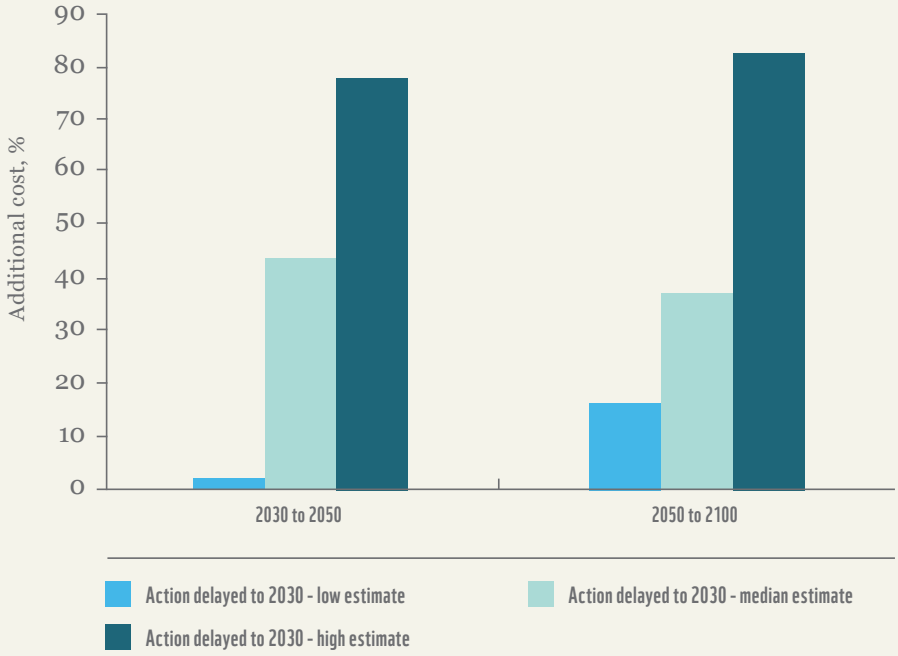
Estimates from the Australian Treasury:

- The Australian Treasury also found that delay results in higher cumulative costs.[58] Assuming a steady rise of marginal abatement costs over time, the modelling showed delaying global action results in higher starting costs and higher annual costs in future decades, which outweighs the savings in the early years of delay.

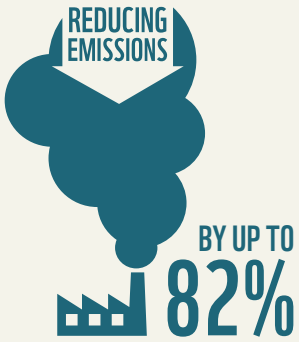
The conclusions of the IPCC:

- The IPCC in its recent 5th Assessment Report concluded that delay leads to higher long-term and transitional economic costs, an increased reliance on carbon dioxide removal technologies and more rapid low carbon technology deployment.[59] The IPCC finds that the increased long-term median economic costs of delaying mitigation until 2030 across a number of existing studies is 44% for the period 2030-2050 (with a range of 2-78%), and 37% for between 2050-2100 (with a range of 16-82%), for global emissions greater than 55 GtCO2-equivalent.[60]

Figure 3: Estimated cost increases due to delaying mitigation to 2030, relative to immediate action. (Adapted from IPCC AR5, WGIII).



A DELAY OF EMISSION REDUCTION BY 15 YEARS COULD DOUBLE OR TRIPLE THE COST OF MITIGATION.



BY UP TO 82%

THE IPCC SUGGESTS THAT THIS DELAY COULD INCREASE THE OVERALL COST OF REDUCING EMISSIONS BY UP TO 82%.

Most assessments of the risks to Australia of adopting 'weak targets' from an international perspective have been qualitative, due to both the very wide range of potential risk vectors, and difficulties in calibrating the magnitude of each risk. For example, perceptions that Australia is not pulling its weight could lead to other countries applying 'border tax adjustments', for example penalties on imports from Australia that seek to offset the perceived lack of abatement policies within Australia. Adverse impacts could also occur through capital markets, such as overseas banks and investors applying a higher risk premium to Australian fossil fuel intensive projects (increasing financing and capital costs). It is also possible that impacts could occur in other sectors due to shifts in international consumer sentiment and perceptions of Australia.

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4. A FOSSILIZED ECONOMY: THE RISKS OF LOCK-IN

If the world takes ambitious mitigation action, and Australia does not, there is the potential for significant losses in trade-exposed emissions intensive industries and the export of carbon intensive fuels.

Emissions intensive commodities

In a world that takes effective and economically efficient action to cut emissions, the production of energy intensive commodities will be concentrated in locations where energy comes from low- or zero-carbon sources. Production based on high-carbon fuels – such as aluminium smelting using coal-fired electricity – will not be viable in the long run. Australian producers of emissions intensive commodities already compete with industries elsewhere in the world that use cleaner transitional energy sources, including hydropower and gas.

Governments may seek to insulate domestic production for export from measures to cut emissions, however this would come at a high opportunity cost as it would require cutting emissions elsewhere at a higher cost.

Furthermore, countries may take trade measures against any exporter of emissions intensive goods, if such production is seen not to be subject to emissions constraints. As mentioned previously, carbon border tax adjustments – such as import tariffs linked to the amount of greenhouse gas emissions incurred in production – are one possible measure. Such measures have already been discussed by the EU and US.[61] Others could include preferential treatment of trade that has low levels of embodied carbon or carbon accounting requirements.

With this prospect, the prudent course of action is to transition industrial structures away from high emissions production. Delaying the transition risks greater adjustment pressures in the future, and is likely to result in additional economic costs over time.

Thermal Coal

The largest importer of Australian coal is China, and the IEA World Energy Outlook 2014 suggests that China's coal demand may peak and fall back shortly after 2030.[62] That is just for an existing policies scenario. The peak could occur much sooner, particularly if the world is to meet the 2°C target. There is already evidence to suggest that China's carbon emissions could peak by or during the 2020s, well ahead of China's pledge of a peak around 2030.[63] [64] [65]

Only if there were no additional policies implemented would global coal demand keep growing steadily in coming decades.

China's coal consumption is already plateauing and thermal coal use could potentially decrease over the coming years, in a drastic turnaround from the consistent high-growth trend over the first decade of the century.[66] [67] [68] Global coal prices have been falling and are currently less than half their peak levels over recent years.[69]

The potential impact of global climate change action on coal use is evident in the projections of the IEA World Energy Outlook 2014, as summarised in Box IV. Under a scenario of strong global action to meet a 2°C goal, global coal demand would peak within the next decade and decline steeply thereafter. In the IEA core scenario, the 'new policies' scenario, almost two-thirds of the projected increase in world coal demand occurs over the next ten years. Only if there were no additional policies

implemented would global coal demand keep growing steadily in coming decades. Decreasing demand will be partially driven by rising prices over time.

BOX IV: THE FUTURE OF COAL UNDER THE IEA WORLD ENERGY OUTLOOK 2014 SCENARIOS

Scenario	The future of thermal coal
Current Policies (no additional measures)	'World coal demand grows by 1.5% per year over 2012-2040, three times faster than the New Policies Scenario, with coal overtaking oil as the world's leading fuel by around 2025. With a share of 40%, a level similar to today, coal remains the leading source of global electricity generation in 2040.'[72]
New Policies Scenario (core scenario)	'In the New Policies Scenario, at 24% of the global energy mix in 2040, coal remains just ahead of natural gas and behind oil. Renewables (including hydro) overtake coal around 2035 as the leading source of electricity generation: coal's share shrinks from 41% today to 31%. Almost two-thirds of the projected increase in world coal demand occurs over the next ten years. Coal demand to 2040 is projected to decline in all major OECD regions, including the United States, where coal use for power plunges by more than a third between 2012-2040. China's coal demand also slows sharply, peaking around 2030.'[73]
450 (ambitious global action to stabilise at 450 ppm)	'Global coal demand is one-third lower in 2040 relative to 2012, returning to the level of use in the early 2000s. Demand peaks in the current decade and then falls rapidly..... The share of coal in the global fuel mix and in electricity generations declines to 12 and 27 percentage points over the projection period, reaching 17% and 13% by 2040.'[74]

Under strong global climate action and/or trade measures by major countries that preference lower carbon energy, Australian coal exports could compete in shrinking markets. A recent ranking of G20 countries placed Australia as third last on a low carbon competitiveness index.[70]

Furthermore, in a decarbonising world many major trading partners and emitters, such as China and India, are likely to preference their own domestic coal resources over imports.[71]

Lower global coal demand also means lower coal prices. For Australia this also means reduced royalty payments to state governments (as the owners of these resources), increasing the risk that further development of coal assets and infrastructure could result in overall economic and fiscal losses.

How the Australian coal industry fares in a scenario of increased global action and decreased coal demand is highly dependent on the deployment of carbon capture and storage (CCS). The Garnaut Review noted that there is little future for the export of Australian coal under a scenario of global climate action unless low carbon ways to use coal are developed and implemented.[75] As one recent study notes **'limiting global warming to 2°C will likely entail the complete phase-out of coal-based electricity generation without carbon capture and storage (CCS).'**[76]

Accordingly, further research and development of CCS technologies is an important near-term policy for coal exporters including Australia. However, CCS has not experienced the reductions in cost enjoyed by many renewable energy technologies over recent years.

Unburnable reserves

Limiting global temperature rise by 2°C entails keeping significant global and national reserves of fossil fuels in the ground. Analysis in a recent Nature paper demonstrates that 93% of coal reserves (known reserves that would be extracted under current economic conditions) within developed OECD Pacific countries – principally Australia – cannot be used.[77] The number rises to 95% if CCS is not deployed. Australia has a substantial amount of 'unburnable carbon' and will likely only be able to use approximately 5-7% of existing coal reserves. This means that the development of new coal reserves within Australia is likely incompatible with limiting global warming to 2°C.[78] The extent of Australian unburnable oil, gas and coal reserves is shown in Figure 4.

Given the extent of existing unburnable carbon, the Carbon Tracker program has stated that 'capital spent on finding and developing more reserves is largely wasted'.[79]

Over 90% of Australian coal reserves, over 50% of gas reserves and 40% of oil reserves are likely to be unburnable under a 2°C carbon budget.

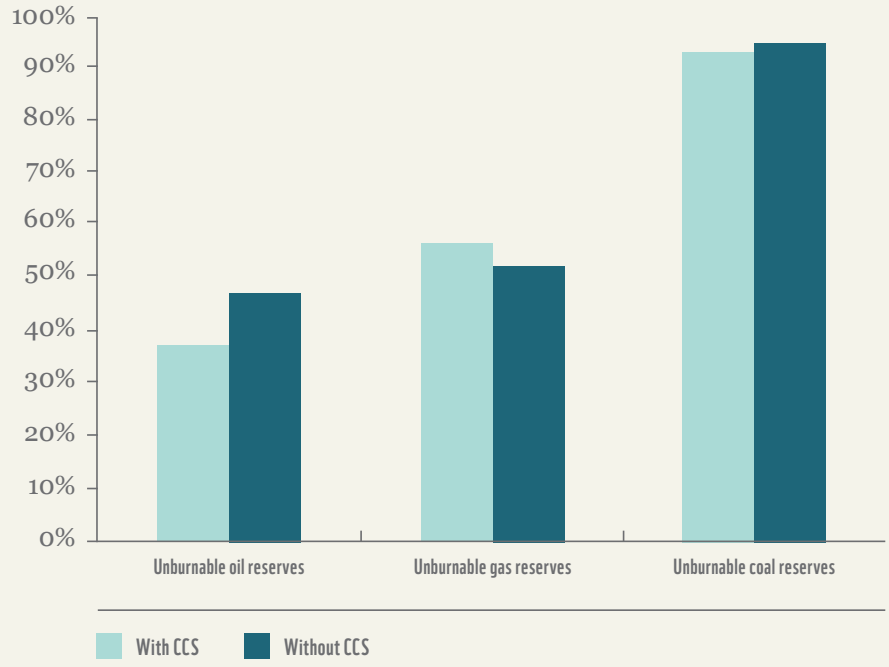

Figure 4: The extent of unburnable oil, gas and coal reserves under a 2°C carbon budget, share of total reserves for OECD Pacific countries (principally Australia).

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Many carbon intensive assets, including existing infrastructure and coal-based power plants, will face the prospect of being written down, devalued or turn into financial liabilities if the world undertakes ambitious action on climate change. **One study by the Potsdam Institute and others found that across a large number of models, if a 2°C stabilisation target is to be met 'huge quantities of installed coal capacity will need to be prematurely retired between 2030 and 2050. Such a vast global write-off of capital would be unprecedented in scale.'**[80]

A recent modelling exercise on delayed mitigation and stranded assets found that unambitious short-term global policy scenarios (with targets of 59–61 Gt CO2e) had triple the amount of stranded assets in comparison to scenarios with stringent near-term global action (targets of 51–53 Gt CO2e).[81]

This premature retirement of coal assets under a carbon budget would occur in Australia as well.[82] Australian economist Ross Garnaut judges that some premature retirement of thermal coal mining infrastructure is likely to already be required due to overinvestment during the mining boom.[83] [84] This wasted investment in coal mining capacity would be further compounded by increased global action on climate change.

Carbon lock-in even poses the risk of systemic financial crisis. An assessment by HSBC found that the market value of coal assets owned by major Australian mining groups could be reduced by almost half, if the world follows a 2°C carbon budget.[85] At present Australia may be susceptible to systemic financial risk from such asset write-downs.[86] This has led to the Climate Institute and the Carbon Tracker Initiative, amongst many others, to call for investors to reduce their exposure to potential stranded assets such as thermal coal investments.[87]

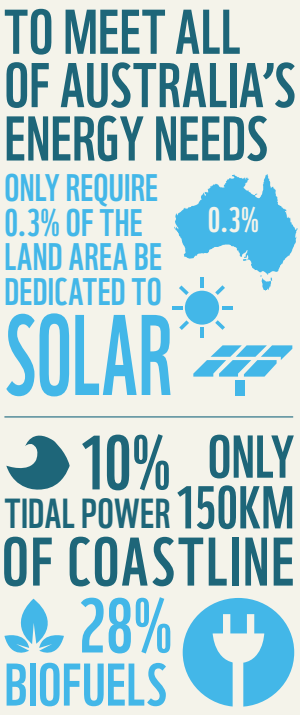
Strong and early emission reductions are the logical course of action to reduce the economic and financial risks posed by unburnable carbon and stranded assets in Australia. With the right approach these threats could be turned into opportunities.

5. OPPORTUNITIES IN A LOW CARBON WORLD

Australia's economy has good opportunities to prosper in a low carbon world economy, given its endowments and opportunities for zero emissions energy. There are a number of significant potential advantages for Australia in a low carbon world, including the revival of energy intensive manufacturing industries due to the low energy costs of a low carbon electricity system.[88] [89]

Low energy costs, in international comparative terms, under decarbonisation could increase Australia's competitiveness in areas such as metals processing.[90] As highlighted in Box V, areas of potential low carbon comparative advantage for Australia include zero on near zero carbon energy, including CCS and biosequestration over the longer term.

As noted in our previous brief,[91] Australia is the windiest and sunniest continent in the world and our potential for renewable energy generation far outstrips potential energy demand.[92] All of Australia's renewable energy options, except for hydropower, are underdeveloped and could make significant contributions to the future energy supply of Australia.[93]



One recent overview of renewable energy potential in Australia highlights that Australia has the highest average solar radiation per square meter of any continent and that to meet all of Australia's energy needs would only require 0.3% of the land area be dedicated to solar energy generation.[94] Tidal power generation from the ocean could provide roughly 10% of energy demand with the use of as little as 150km of Australian coastline.[95] Electricity storage using new technologies such as molten salt, compressed air or large scale batteries is becoming cost effective for covering peak demand. The Australian Capital Territory has announced a tender for the provision of 50 megawatts of solar power with storage.[96] Australia also has significant potential for geothermal power.

Australia's vast land mass and opportunities for changes in land use are another large advantage in a low carbon global economy. Research by the CSIRO has found that first and second generation biofuels from new and current systems in Australia could mitigate 5% of national emissions, while plant biomass could supply 28% of national electricity generation.[97] The use of biomass and biofuel production could strengthen the economic development of rural and regional areas in Australia, although this is dependent upon the policies used.[98] [99] Biofuels also have significant potential for particular sectors which rely upon fuel use, such as aviation, where significant progress towards biofuel use has already been made.[100] [101] Any policy mechanism promoting the use of biofuels and biomass however would need to be guided by strict environmental safeguards.

In the longer term Australia could become a low-carbon energy exporter to our region, as distinct from the current position as a high-carbon energy exporter. One prospect for this is if the production of liquid synthetic fuels through the use of solar power proves technologically and commercially fruitful.[102]

Use of carbon forestry and land sequestration and bioenergy could lead to an economic revitalisation of rural areas throughout Australia, as well as help to protect biodiversity and restore habitats and create improved soil and water quality.[103] [104]

Australia has strong research capabilities and has already made important contributions to renewable energy technology development.[105] [106] Solar energy is an area in which Australia can make important research contributions to, and typically benefits from commercialisation and technological progress made overseas.[107] Similarly, Australia has significant potential for CCS deployment creating a potential advantage in CCS development and research expertise.[108] [109] This could be of particular benefit in select industrial applications, and in decades to come if large-scale application of BECCS were to occur, as foreshadowed in IPCC scenarios of strong climate action.[110]

Many of these technologies today seem speculative. However, the speed of technological change and changes in commercial advantage in energy systems has been rapid. New forms of solar photovoltaic systems are already capable of being expanded to a multi-terawatt scale and the cost of implementation is decreasing drastically over time.[111] Cheap solar power, affordable large-scale electricity storage and high performance electric cars seemed futuristic a decade ago yet are a becoming a reality now. With intensifying efforts to develop the zero emissions technologies of the future, new opportunities will open up for Australia.

BOX V: WHAT THE MAJOR REPORTS SAY: AUSTRALIA'S OPPORTUNITIES IN A LOW CARBON WORLD

'Australia's strength in agricultural and biological research provides a clear comparative advantage for low emissions innovation in the land sectors… carbon capture and storage and biofuels and biosequestration, are areas in which Australia has a strong comparative advantage in research as well as a strong national interest in application.' – **The Garnaut Review Update, 2011.**[112]

'In a decarbonised world, Australia's abundant renewable energy resources as well as its geological storage potential could form the basis of a new comparative advantage in low carbon electricity generation, replacing the existing comparative advantage derived from fossil fuels. The realisation of this comparative advantage could eventually result in a revival of energy-intensive manufacturing industries such as aluminium smelting, and the potential to develop renewable energy carriers for export markets, such as biogas or hydrogen.' – **Climate Works Australia and the ANU, 2014.**[113]

'The restructuring of the economy to take advantage of new opportunities in a low carbon world accounts for the other one-third of the reduction in the economy's emission intensity.' - **Treasury 2011.**[114]

'Carbon pricing affects different parts of the mining sector differently…parts of the mining sector are less affected and some, such as iron ore mining, grow faster with a carbon price than without.' – **Treasury 2011.**[115]

'Australia's natural resource endowments provide an inexpensive and reliable supply of electricity. Access to low-cost energy provides a comparative advantage and contributes to the development of a range of energy-intensive manufacturing industries. Industries that benefit either directly (through their use of resources as material inputs) or indirectly (through their use of electricity) include mineral processing (iron and steel, non-ferrous metals), petroleum and chemicals, and wood and paper products.' – **Treasury 2008.**[116]

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