SOUTH AUSTRALIA'S **LOW CARBON ECONOMY EXPERTS PANEL**

Findings and recommendations

November 2015

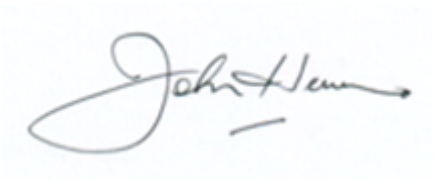
FOREWORD

South Australia is well-placed to capitalise on the opportunities of an early transition to a low-carbon economy.

In September 2015, the State Government requested our advice on:

- The objectives and targets for the South Australian Climate Change Strategy and legislation having regard to national and international developments
- The key strategies and actions that the South Australian Government should pursue in meeting those objectives, to maximise economic opportunities and ensure the South Australian economy is best placed to adjust to a carbon constrained future.

The following report was developed during a short and intensive period of review of South Australia's carbon emission reduction opportunities. As the report shows, there is plenty to be excited about.



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EXECUTIVE SUMMARY

The South Australian Government established South Australia's Low Carbon Economy Experts Panel (the Panel) to provide independent advice about climate change targets and objectives for the State to 2050. The Panel was also asked to provide advice about the key strategies and actions that should be pursued in order to: meet these objectives; maximise economic opportunities; and ensure the South Australian economy is best placed to adjust to a carbon constrained future.

As a result of its assessment, the Panel found that it is feasible for South Australia to achieve a target of net zero emissions by 2050 and that a commitment to this target will position South Australia well in a low carbon world. The South Australian Government should also strongly consider signing the 'Under 2' MOU and join the other sub-national governments making ambitious climate change commitments.

Global transition to a net zero emissions future

The Panel has made its assessment in the context that at an international level we are moving towards a low carbon world. Through the United Nations Framework Convention on Climate Change (UNFCCC) process the global community has committed to a maximum temperature rise of 2 degrees Celsius (2°C) above pre-industrial levels. The United Nations climate conference in December 2015 is expected to re-affirm and possibly strengthen this goal. Stabilisation of atmospheric greenhouse gas emissions at any level ultimately requires net zero greenhouse gas emissions, making the 'net zero' target the natural overall objective of climate change policy.

Other nations are taking action now. Leading into the climate conference in December, most have pledged to reduce emissions in the coming years and decades, which adds up to significant global action. Many sub-national governments are also making significant commitments to reduce emissions. Major global asset owners, including superannuation funds, sovereign wealth funds and insurance companies, are also recognising the opportunities from a low carbon economy, favouring investments in low carbon industries over fossil fuels and other carbon-exposed investments. Over 1,000 companies have made commitments through the UNFCCC to reduce emissions, improve energy efficiency and use renewable energy.

Net zero emissions economy for South Australia

The Panel has found that there are many benefits of a low carbon economy for South Australia. As well as contributing to the national and global decarbonisation effort and building resilience to climate change, a low carbon economy will provide significant economic, social and environment benefits for South Australia. These include more liveable cities, better energy productivity, improved land and biodiversity management and new industries and jobs. Crucially, moving early towards the low carbon industries of the future can also give the State a competitive advantage.

The report identifies some particular areas of opportunity. One example is the potential for South Australia to be a low carbon electricity powerhouse and a net exporter of renewable energy. Abundant renewable electricity combined with its rich resource base and existing manufacturing expertise mean that the State could be a natural base for energy intensive mining and manufacturing industries in a low carbon world. The closure of the power plant in Port Augusta and the coal mine in Leigh Creek, while challenging in the near term, actually gives the State an opportunity to transition more quickly to a greater share of renewable energy and greater national grid integration.

The Panel has also identified the State's strengths in education and the potential for these to be applied to developing the skills and workforce for a carbon-constrained future, not just for South Australia but for the world. There are significant market opportunities for energy storage solutions from South Australia's high penetration of solar energy, with the potential to attract and develop technology suppliers and expertise. For example, the significant reserves of high-quality graphite on the Eyre Peninsula, once processed, could assist with optimising energy storage in thermal and electric battery storage systems and provide job creation opportunities.

While there are significant wins from decarbonisation, there will also be challenges. However, by putting effective policies in place now, these can be transformed into opportunities. Assistance for workers to move from industries in decline and into new opportunities is critical, as is support for communities affected by rapid change. High penetration of renewable, distributed power will require investments in new forms of grid integration. South Australia can contribute to global technological progress on electricity systems by establishing itself as a first mover with a very high percentage of renewable generation. Local knowledge, gained from dealing with significant levels of renewable energy, can then be exported. Funding for investment in innovative plants and systems could be available from Australian Federal Government bodies and a variety of international industry and foundation sources, which can help leverage further private investment. Furthermore, there could be options for emissions trading that bring financial resources for South Australia.

Positioning South Australia to benefit from decarbonisation

The Panel has three overarching recommendations to position the State to benefit from decarbonisation, with a range of specific recommended actions listed at the end of the report.

RECOMMENDATION 1: SIGNAL the transition to a net zero emissions economy – set the goals and make them long and loud

Making a commitment now to be a net zero emissions State by 2050 defines the goal and pace of deep decarbonisation. Embedding the net zero emissions target in key policy instruments will be an important signal across government and to business and the community that provides policy certainty and harnesses innovation and investment. A net zero emissions target can be complemented by a target for zero carbon electricity supply, with South Australia as a net exporter of electricity to other States. South Australia should step up its leadership in climate change and encourage other governments at the State and Territory, national and international levels to commit and take ambitious action.

RECOMMENDATION 2: SUPPORT the community and industry in the transition to a net zero emissions economy

The South Australian Government has an important role to support industry and community in the transition to a net zero emissions economy. Proactive facilitation of opportunities and provision of transition support that enables further progress in low carbon innovation will be key. An improved understanding of cost effective abatement opportunities in each sector and the issues faced by industries and communities in the transition will be important. Industry and the community will need to be engaged in the move to a net zero emissions economy. A comprehensive engagement program should be developed as a basis for developing low carbon transition plans.

RECOMMENDATION 3: IMPLEMENT the transition – the South Australian Government should take action now to drive the transition to a zero emissions economy

There are immediate actions that the South Australian Government can take. They include: driving improved appliance and building standards; ensuring the necessary skills and knowledge are being developed in the State; more effectively utilising government procurement and approval processes; accessing a variety of different funding opportunities; and developing a thriving sequestration industry.

The Panel has focussed on setting out a longer-term strategy for decarbonisation through to 2050. In so doing it recognises the significant short-term political and commercial constraints under which the Government is operating, particularly those relating to economic transition and energy market issues. The Panel strongly recommends that these near-term issues be dealt with in a way that does not compromise the requirements of the long-term strategy. South Australia now has a unique opportunity to commit to ambitious action that will create the conditions for a prosperous, low carbon future.

1. INTRODUCTION

Terms of Reference

The South Australian Government has commissioned the Panel to provide advice in relation to:

1. The objectives and targets for the South Australian Climate Change Strategy and legislation having regard to national and international developments; and
2. The key strategies and actions that the South Australian Government should pursue in meeting these objectives, to maximise economic opportunities and ensure the South Australian economy is best placed to adjust to a carbon constrained future.

Under the Terms of Reference, the Panel is required to provide specific advice on: the matter of targets (including pathways to achieving targets); economic development opportunities and benefits from taking early action; measures to accelerate a reduction in emissions, increase the deployment of clean energy technologies and improve energy efficiency incentivised through government procurement and regulation; and how climate change should be taken into account when making infrastructure investment decisions. The Terms of Reference are attached (Attachment 1).

Methodology

In developing its report for the South Australian Government, the Panel has undertaken an initial high-level assessment of the achievability of net zero emissions for South Australia by 2050. Its assessment also draws on a high level abatement technical analysis for South Australia. The results of this analysis are attached (Attachment 2).

Further analysis will be required to better understand options and transformation pathways in each sector of South Australia's economy and to specify policies and measures that can facilitate the transition. The Panel also recommends an extensive process of engagement with industry and the community to improve understanding of opportunities in the low carbon economy and how to structure the transition.

In making this assessment, the Panel has been guided by the global *Deep Decarbonisation Pathways* project, which provides nationally grounded analysis on how countries can transition to a very low carbon economy. The project involves 16 countries and is convened under the auspices of the Sustainable Development Solutions Network, a global initiative for the United Nations. The Australian study[1] was led by ClimateWorks Australia and the Australian National University (ANU), with modelling by CSIRO and the Centre of Policy Studies. The study found that Australia could move to net zero emissions by 2050 while retaining economic prosperity. The four pillars for decarbonisation are energy efficiency, low carbon electricity, electrification and fuel switching and non-energy emission reductions.

> *Energy efficiency*: Greatly improved energy efficiency: in all energy end use sectors, including passenger and goods transport, improved vehicle technologies, smart urban design and optimised value chains; in residential and commercial buildings through improved end-use equipment, architectural design, building practices and construction materials; and in

[1] ClimateWorks Australia and ANU, *Pathways to Deep Decarbonisation in 2050*; Initial project report, available at http://climateworksaustralia.org/sites/default/files/documents/publications/climateworks_pdd2050_initialreport_20140923.pdf, published September 2014

industry through improved equipment, material efficiency and production processes, and re-use of waste heat.

Low carbon electricity: Decarbonisation of electricity generation through the replacement of existing fossil fuel based generation with renewable energy (eg hydro, wind, solar and geothermal), nuclear power and/or fossil fuels (coal, gas) with significant efficiency increases. In some other jurisdictions, carbon capture and storage (CCS) could also play an important role.

Electrification and fuel switching: Switching end use energy supplied from highly carbon-intensive fossil fuels in transportation, buildings and industry to lower carbon fuels, including low carbon electricity, other low carbon energy carriers synthesised from electricity generation (such as hydrogen), sustainable biomass or lower carbon fossil fuels.

Non-energy emissions: these emissions can be reduced through process improvements, material substitution, best practice farming and CCS for some process emissions. In addition, carbon can be stored in the soil and vegetation, in particular through reforestation, offsetting some of the emissions created by other sectors.[2]

These four pillars are also the basis for decarbonisation of South Australia's economy.

The CSIRO modelling used for the Australian *Deep Decarbonisation Pathways* report is the same as used for CSIRO's first ever Australian National Outlook, published on 5 November[3] and in the November 2015 issue of *Nature*[4].

2. GLOBAL TRANSITION TO A NET ZERO EMISSIONS FUTURE

The global move towards decarbonisation

As required under its Terms of Reference, the Panel has made its assessment within the context of international action. A key assumption is that there will be binding international policies to support the delivery of carbon pollution abatement to limit global warming to less than 2°C.

The global community has committed to a maximum temperature rise of 2°C above pre-industrial levels, through a decision made at the Conference of the Parties to the UNFCCC in Cancun in 2010. The United Nations climate conference in Paris in December 2015 is expected to re-affirm and possibly strengthen this goal. The Intergovernmental Panel on Climate Change (IPCC) has found that to achieve the 2°C goal, emissions from developed countries will need to fall to near zero during this century,[5] implying that developed countries will need to decarbonise earlier. Stabilisation of atmospheric greenhouse gas emissions at any level ultimately requires net zero greenhouse gas emissions, making the 'net zero' target the natural overall objective of climate change policy.

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[2] ClimateWorks Australia and ANU, 2014, *Pathways to Deep Decarbonisation in 2050*; Initial project report, available at http://climateworksaustralia.org/sites/default/files/documents/publications/climateworks_pdd2050_initialreport_20140923.pdf, published September

[3] See http://www.csiro.au/nationaloutlook/

[4] See http://www.nature.com/nature/journal/v527/n7576/full/nature16065.html

[5] Global Commission on the Economy and Climate, 2014, New Climate Economy, accessed at www.newclimateeconomyreport.report on 29/10/2015 p280

The commitment to a 2°C outcome has proved solid and is expected to guide global climate policy in the future. The concept of 'decarbonisation' of the world economy, and the opportunities that go with it, is now firmly entrenched in international thinking about climate change.

This goes hand in hand with a new concept of what decarbonisation means for economic progress. In the past, climate change mitigation action was typically seen as economically costly, and thus the objective was seen as minimising cost. The new thinking emphasises the potential for low carbon growth, increased investment and jobs, greater productivity, enhanced quality of life and thereby as an engine of future prosperity. This is evident, for example, in China's actions and goals to modernise its economy and provide the underpinning of future growth.[6]

The vehicle for nations to signpost their actions and ambitions under the United Nations framework are the so-called 'Intended Nationally Determined Contributions' (INDCs), which have voluntary emissions targets at their core. The Paris climate conference is expected to put in place a process of five-yearly reviews and ratcheting up of ambition of these emissions pledges.

The INDCs of 150 countries have been submitted to the United Nations. Australia's national target is a 26-28% reduction on 2005 levels by 2030. The United States has submitted an economy-wide emissions reduction target of 26-28% below 2005 levels by 2025. The European Union has committed to a target of 40% reduction in emissions below 1990 levels by 2030.

China has pledged to: reduce the greenhouse gas emissions intensity of its economy by 60-65% of 2005 levels by 2030; have greenhouse gas emissions peak by 2030, if not earlier; and to increase the share of non-fossil fuels in primary energy consumption to around 20% by 2030. India has pledged to reduce the greenhouse emissions intensity of its economy by 20-25% relative to 2005 levels, underpinned in part by very large investment in expanding renewable electricity generation.

The pledges of all countries' combined are assessed to be compatible with a trajectory towards a 2.7°C temperature rise.[7] This is very different from a likely rise of 4°C or more associated with a 'business as usual' scenario. The process of reviewing and increasing ambition over time can bring the global emissions trajectory towards 2°C.

At the sub-national level, significant commitments are being made to reduce emissions. To date, more than 50 sub-national governments have signed up to the 'Under 2' MOU. All have agreed to reduce their greenhouse gas emissions by between 80 to 95%, or limit emissions to two metric tons CO_2e per capita by 2050. It is estimated that 85 cities have committed to reducing their GHG emissions by 80-100%, or procuring 100% of their power from renewable sources[8].

Policy instruments and business leadership

Almost 40 countries and more than 20 sub-national governments already use carbon pricing mechanisms or are planning to implement them. These jurisdictions are responsible for more than 22% of global emissions.[9] Examples include China's emissions trading pilot schemes in seven cities and provinces, with plans to move to a national system in 2016, Mexico's voluntary carbon market,

[6] Teng, F. and Jotzo, F. (2014), 'Reaping the Economic Benefits of Decarbonization for China' China & World Economy 22(5): 37-54.
[7] UNFCCC, October 2015; *Synthesis report on the aggregate effect of the intended nationally determined contributions*.
[8] The Climate Group, September 2015; *Unlocking Ambition: Top Corporate and Sub-National Climate Commitments* p13
[9] The World Bank http://www.worldbank.org/en/programs/pricing-carbon accessed on 1/11/15

Chile's carbon tax that targets large thermal power plants, South Korea's emission trading scheme that covers 525 businesses from 23 sectors, the European Union's pioneering international carbon emissions trading scheme, and the emissions trading schemes in California and Quebec, which were formally linked in 2014.

The private sector has also realised that while climate change is one of the greatest risks to be faced, it does offer important economic opportunities. Companies and investors understand that creating a low carbon strategy is good for their bottom line. Forward thinking businesses and investors are already making commitments. Over 1,000 companies across 20 sectors have made commitments through the UNFCCC to reduce emissions, improve energy efficiency, use renewable energy and enact internal policies.

For example, Microsoft has adopted an internal carbon price, with the revenue being used to invest in energy efficiency, renewable energy and offset projects. Kellogg's has renewable energy and emission reduction targets that have resulted in carbon and deforestation reduction projects. Honda has a net zero emissions goal. Over 20 multinational companies, including BT, IKEA, Mars, Nestle, Unilever and Swiss Re have joined the RE100 initiative and have committed to going 100% renewable. Two of Australia's largest electricity companies, AGL and Origin, recently announced they are committing to the 'We Mean Business' climate change initiative (http://www.wemeanbusinesscoalition.org/). 'We Mean Business' is a coalition of organisations working with thousands of the world's businesses and investors including IKEA, Nike, Unilever, Nestlé, Goldman Sachs, Coca Cola and Westpac to address climate change. The major global asset owners – pension and superannuation funds, sovereign wealth funds, insurance companies and some university endowment funds – are also progressively recognising and responding to climate risk. In some cases, they are divesting from fossil fuels and other carbon/climate exposed investments, otherwise hedging their exposures, or investing in low carbon industries.

National context

As the largest per capita emitter in the Organisation of Economic Cooperation and Development (OECD), and with excellent opportunities to improve its emissions performance, Australia is widely expected to put forward and implement ambitious emissions targets. The national Climate Change Authority recommended stronger targets than the 26-28 % reduction on 2005 levels by 2030 submitted in Australia's INDC, and there is significant room to increase ambition. The likelihood of a strengthening of the national target has already been flagged by the Federal Government.

Political uncertainty over climate change policy has stood in the way of effective and efficient action to reduce emissions in Australia. This has included a protracted process to design a carbon price or emissions trading scheme, the implementation and then subsequent repeal of the Carbon Pricing Mechanism, the review and reduction of the national Renewable Energy Target, as well as inaction on a number of areas for potential emissions savings. The ongoing policy uncertainty has been a brake on investment in Australia's energy and industrial sectors.

There remain doubts regarding the Emissions Reductions Fund established to replace the Carbon Pricing Mechanism, including its fiscal sustainability and the effectiveness of the so-called Safeguard Mechanism (emissions baselines). National emissions have not declined since the repeal of the national Carbon Pricing Mechanism in 2014 and emissions within the National Electricity Market (NEM) have increased by 6.4MT CO_2e to June 2015.[10]

[10] Pitt & Sherry CEDEX Electricity Update July 2015

In this situation there is an opportunity for South Australia to take a real leadership role among Australia's States and Territories and set a signal for national policy by setting a long-term net zero emissions target and establishing a process to map out and support the transition to a low carbon State economy.

The Panel's long term recommendation is supported by recommendations for shorter-term activities that will position South Australia well, even in an uncertain federal policy environment.

3. A NET ZERO EMISSIONS ECONOMY FOR SOUTH AUSTRALIA

There are many potential benefits for South Australia from a decarbonised economy. In making this assessment, the Panel has referred to the extensive work by the Global Commission on the Economy and Climate and in particular its flagship project, the *New Carbon Economy*[11].

Benefits of a decarbonised economy

Decarbonisation would facilitate a shift to more compact, connected and coordinated urban development. Cost-effective investments in smarter transport systems would improve connectivity, reduce reliance on private vehicles, improve traffic congestion, reduce accidents and improve air quality. Public services would be delivered more cheaply and efficiently in a decarbonised, more compact urban form that utilises integrated energy, waste and water systems, energy efficient street lighting technology and smart grids. More compact urban growth can also provide significant financial savings for government from reduced capital requirements for infrastructure and other significant economic, social and environmental costs resulting from unconstrained urban expansion.

More compact cities can also be more economically dynamic, with a correlation between geographic density and productivity. The clustering together of individuals and firms in more connected, compact urban areas facilitates productivity increases and economic growth. Denser cities provide more vibrant markets and an environment that encourages innovation in ideas, technologies and processes. This in turn helps to attract talent and capital for investment in smarter infrastructure and technology and widens the skilled labour pool.

Decarbonised, more compact cities also have many social benefits. They are more liveable, with improved air quality and green spaces. They provide greater opportunities for social inclusion, with functionally and socially mixed neighbourhoods and walkable local urban environments. Low income households benefit from reduced transport and energy costs and enhanced access to jobs.

A decarbonised energy system, particular electricity generation, will have many benefits. Use of renewable energy provides the opportunity to diversify and expand domestic energy production, with energy security, investment and employment benefits. It would also reduce pollution from the combustion, mining, transport and processing of fossil fuels for energy use. With the exception of geothermal and large hydropower, renewable energy provides flexibility as new capacity can be built quickly and at a wide range of scales. Innovation in the development of new energy systems, including electric and heat battery storage, has the potential to create new clean technologies that could be cheaper in the future than those currently based on fossil fuels. New business models, financing mechanisms, regulatory approaches and market designs that are more responsive to issues associated with the deployment of renewable energy, will potentially facilitate faster roll out and

[11] Global Commission on the Economy and Climate, 2014, New Climate Economy, accessed at www.newclimateeconomyreport.report on 29/10/2015

reduced costs. Decentralised renewable energy solutions would also increasingly be used, often at a small scale and for specific needs.

Decarbonisation would also encourage greater efficiency in energy use in industry, buildings and transport. While investments in technology are required, the resultant savings from the measures generally outweigh the costs, making a significant contribution to productivity, employment and economic growth. Decarbonisation has huge potential to cut and manage energy demand, reducing the need for expensive infrastructure, energy imports and balance of payment pressures.

A net zero emissions outcome would likely involve changes on the land, with expanded forestry plantations for carbon sequestration, and changes in agricultural practices. Implemented well, this could result in productivity improvements that will increase food production, raise farmers' incomes and strengthen resilience to climate change.

Innovation is critical to decarbonisation and is the fundamental driver of long-term sustainable economic growth. Innovation can drive incremental improvement as well as dramatic disruption of existing industries. Knowledge generated by clean technology research and development will have spill over benefits. A recent analysis of patent data across countries in the OECD has shown that new patents associated with clean-tech research and development are much more likely to be used by other fields than are new patents associated with research and development in fossil fuel-based technologies[12].

Investment costs

The transition to a low carbon economy is characterised by large investments up front. Low carbon assets and infrastructure have significantly lower operating expenses than the high carbon options. There will also be savings in relation to future infrastructure investment in power plants, exploration and transport of fossil fuels and electricity transmission as a result of greater energy efficiency. Global savings from reduced infrastructure costs in more compact decarbonised cities, including road, telecommunications, water and waste treatment, have been estimated to be worth up to US$3.4 trillion by 2030.[13.]

Net economic costs arise only to the extent that existing high carbon assets are retired early, or that new low carbon investments are more expensive over their lifetime than the higher-emissions alternatives. The latter is less and less the case as the clean technologies of the future are becoming more established and costs are falling rapidly; for example, the costs of solar photovoltaic plants this year have already fallen to levels far below what was projected for the 2020s just five years ago.

Assuming a minimum cost for new renewables exceeding those of existing generation, any remaining cost increase needs to be compared to the reduction in the long-term climate risks, which is the ultimate objective of climate change policy. This is in addition to the immediate benefits of cleaner, more modern options in energy, industry, commodities production, transport, housing and agriculture.

A low carbon transition for South Australia

A decarbonised economy can help South Australia during its period of economic transition as it requires an emphasis on IT, innovation, research and development, technology transfer,

[12] Global Commission on the Economy and Climate, 2014, New Climate Economy, accessed at www.newclimateeconomyreport.report on 29/10/2015, p253
[13] Ibid p211

entrepreneurial development and the creation and retention of a highly skilled workforce. The development of these skills and characteristics would help to create a more flexible and responsive economy for the future in South Australia. Decarbonisation will also drive important reforms in a range of areas, including competition and product market policy, trade and investment policy, labour market policy and human capital and education policy, which will support the conditions for growth. This would position South Australia well to deal with the transformation of the world economy that is likely over the coming decades as well.

A decarbonised economy will drive demand for new industries that can replace some of South Australia's declining industries. The industries that will flourish in a decarbonised economy provide products, services and processes that can optimise operational performance and productivity, reduce the necessity for natural resource exploitation and cut or eliminate emissions and wastes. These might include industries with a focus on renewable energy development, water technologies, desalination, waste management and recycling, green building design and construction, energy efficiency, biomaterials, energy storage, vehicle technologies, environmental services, biofuels and carbon[14]. Innovation and technological progress in decarbonisation will drive the development of new industries that are difficult to predict now.

While there are significant gains to be made from the transition to a decarbonised economy, there will also be some challenges. However, by putting effective policies in place, these challenges can be transformed into opportunities. A particular issue relevant to South Australia during its current period of economic transition is the loss of jobs in some high carbon industries. While there will be new jobs and larger markets for many businesses in a decarbonised economy, some job losses will be inevitable. Effective management of this transition will be critical, such as providing support to displaced workers, affected regions and communities and low income households. This can include assisting workers to move from declining industries to expanding sectors, from low-tech firms to high tech industries, and between varying job types. Reskilling and training can increase the responsiveness of the workforce to change and boost the employment skills and training sector.

The job losses being experienced now in South Australia as a result of closing of coal fired plants and coal mining activities are difficult for the State. The fact that this is happening now, however, means that the transition to a low carbon economy can come sooner and with lower opportunity costs. A well planned transition for workers to move from fossil fuel electricity generation to a renewable electricity generation system will leave South Australia well positioned in the global carbon constrained future.

Another particular issue affecting South Australia that can be transformed into an opportunity is the integration of variable renewable energy into the electricity grid. Active planning, coordination and management of this integration will be required, resulting in some additional costs. If this transition is handled well, it can stimulate more innovation and opportunity. Learning from this process will contribute to the global technological progress, help drive down future costs and create local knowledge and capacity that can be exported. Financial assistance can also be sought from bodies such as the Australian Renewable Energy Agency (ARENA) and the Clean Energy Finance Corporation (CEFC) to improve management of the grid. This could be in the form of public private partnerships to stimulate innovation from the private sector, with the additional comfort of government support.

[14] O'Brien, J (2011), *Clean Technology Investments; Short and Long Term Trends*, The European Financial Review

Despite the challenges in the short term, South Australia's transition to a decarbonised economy now will position the State to prosper in a carbon constrained global economy and will mean that investors, firms and household will be better placed to plan, adapt to, evolve with, embrace and manage change, to reallocate resources more efficiently, and to foster growth opportunities more generally. They will have the flexibility to tap new markets and adopt new innovations. Resisting change will leave the State less resilient and more vulnerable to shocks.

4. TOWARDS NET ZERO EMISSIONS – THE TASK FOR SOUTH AUSTRALIA

4.1. South Australia's current emissions

The Panel has taken into consideration South Australia's current greenhouse gas inventory and recent trends in its assessment of abatement potential to 2050.

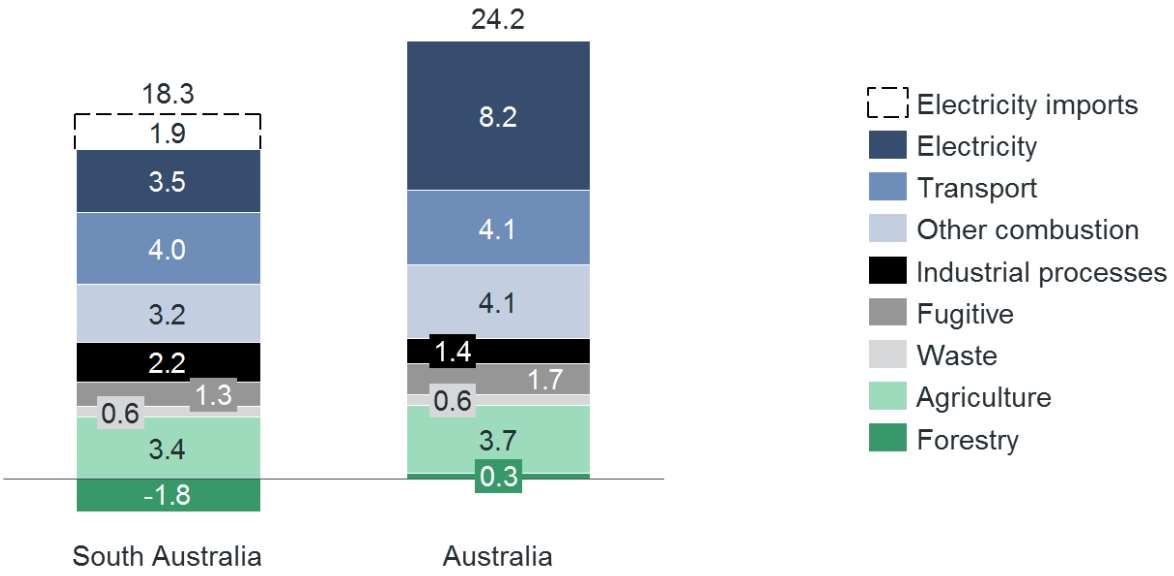
Net emissions peaked in the State during 2005-06 at 35 Mt of CO_2e, or approximately 8% above 1990 levels. South Australia's net greenhouse gas emissions have been reducing since and the latest estimate indicates that between 1989-90 and 2012-13 emissions decreased by 9%. During this time South Australia's Gross State Product (GSP) grew 60% from $55.2 billion to $94 billion, demonstrating that economic growth can be decoupled from growth in greenhouse gas emissions.

Figure 1: South Australia's greenhouse gas emissions trends 1989-90 to 2012-13, Mt CO_2e

Source: Department of the Environment 2015

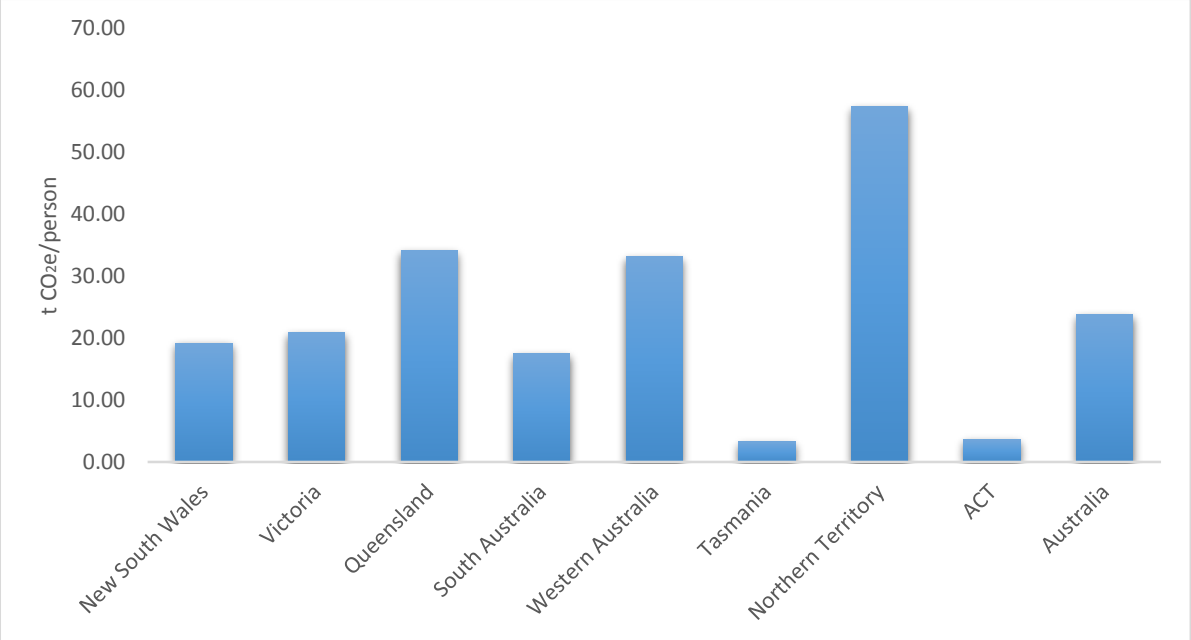
South Australia's per capita emissions are significantly lower than the average Australian per capita emissions. South Australia's per capita emissions are 18tCO2e, as compared with 24tCO_2e at the national level.

Figure 2: Emissions per capita by source in 2012-13, tCO2e



Source: ClimateWorks Australia 2015

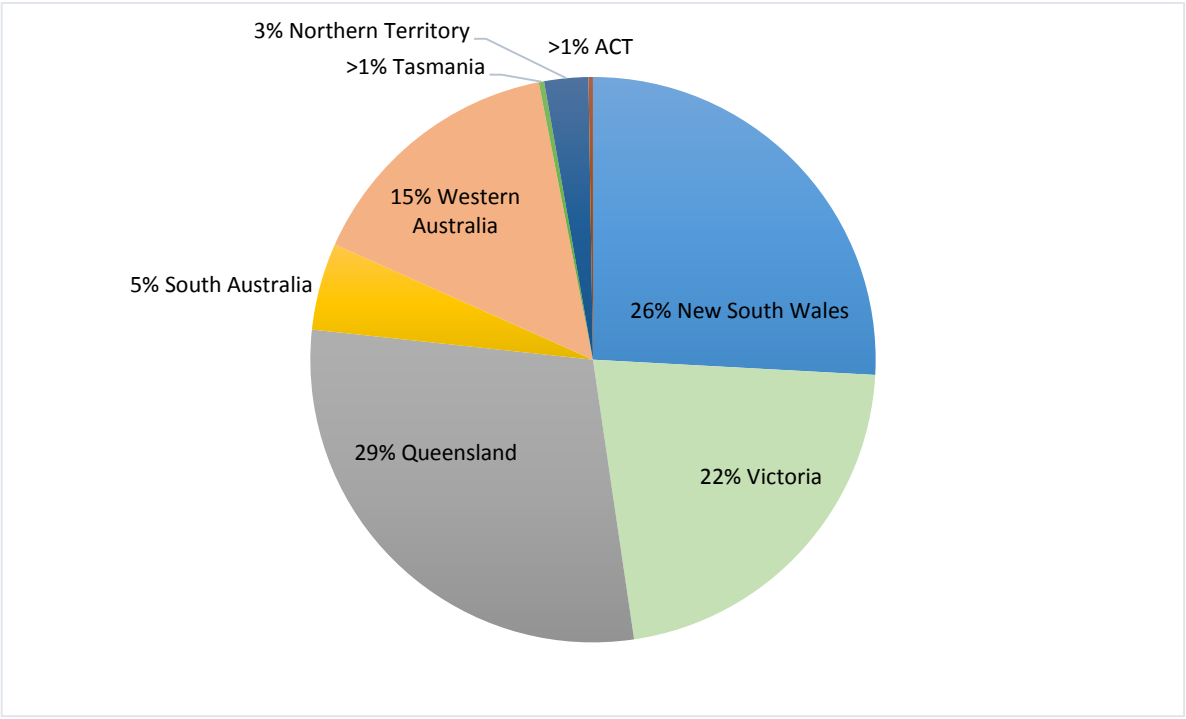
Figure 3: Australian per capita emissions, tCO_2e/person



Source: Department of Environment, State and Territory Inventories 2013; and ABS population data.

South Australia also has a small share of emissions relative to its size, with 5% of the nation's emissions and 7% of the population.

Figure 4: State and Territory greenhouse gas emissions 2013

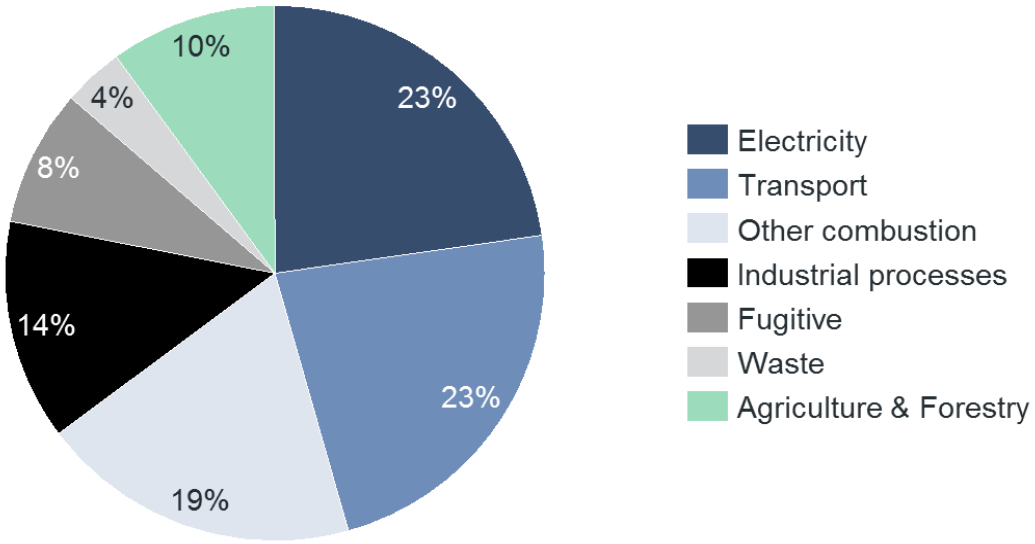


Source: Department of Environment, State and Territory Inventories 2013

The main sources of emissions in South Australia are from electricity generation and transport, with non-energy emissions representing around 35% of the total.

*Figure 5: South Australia's greenhouse gas emissions by source in 2012-13, $MtCO_2e$**

100% = 27.6 $MtCO_2e$



**This does not include emissions from electricity imports*

Source: ClimateWorks Australia 2015

4.2. SA's emission trends

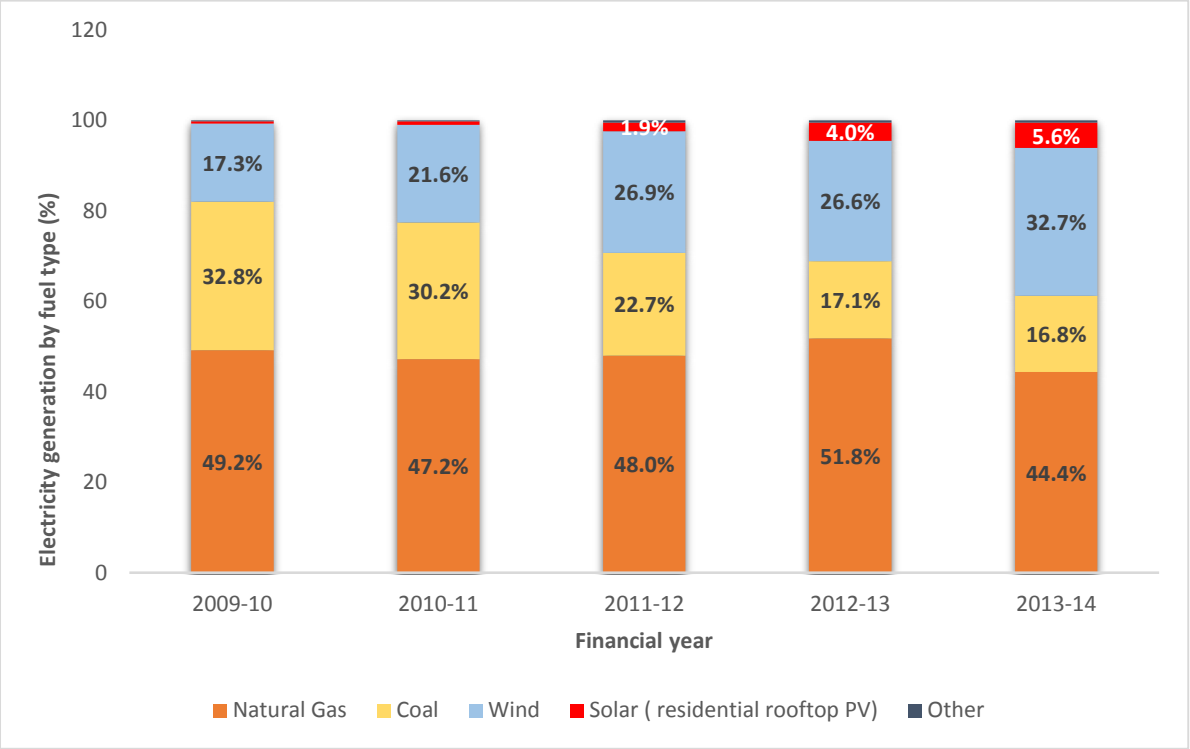
4.2.1. Electricity

Electricity production is a significant source of emissions in South Australia. However, with the State's significant penetration of wind and solar generation reducing the emissions intensity of generation and a declining demand, particularly at the household level, there has been an ongoing reduction in emissions from the State's electricity demand since 2006. This decline takes into account emissions from electricity imported from Victoria via the interconnector. Although there has been some increase in the amount of imported electricity in recent years, it is not sufficient to offset the decline of emissions from electricity generation within the State.[15.]

Imports are expected to remain high through the period following the closure of South Australia's coal fired power plants, but can reduce over time and subsequently reverse to net exports from South Australia to other States as renewable electricity generation increases in the State.

South Australia already has among the highest share of renewable electricity in any large grid system in the world. The share of renewable energy has been growing quickly, reflecting the very favourable conditions for wind and solar power in SA. Wind and solar power grew from near zero in 2003 to 1473 megawatts in wind and 663 megawatts in rooftop solar to date. In 2015, 41% of the State's electricity generation was from renewable sources.

Figure 6: South Australian electricity generation share by fuel type (2009-10 to 2013-14)



Source: AEMO 2015: South Australia Fuel and Technology report

[15] St Kitts and Associates, 2014 *Emission Reduction Fund: Preliminary Review of Opportunities for South Australia*, p8

4.2.2. Industry

South Australia's industrial sector comprises a small number of large businesses that can be divided generally into mining and manufacturing. With a significant transition occurring in the State's manufacturing sector and the changing global outlook for the mining sector, it is expected that the industrial sector will experience some volatility over the coming years. Fugitive emissions and electricity use have declined in this sector, but otherwise emissions have generally grown since 1990.[16.]

4.2.3. Commercial and residential buildings

Emissions from the combustion of fuel for electricity used in residential and commercial buildings have all decreased since 2007[17]due in part to a reduction in the emissions intensity of South Australia's electricity generation and a general reduction in energy demand.

4.2.4 Transport

The transport sector is dominated by road transport, with cars representing just under half of the sector total. Transport sector emissions have experienced strong growth over recent years, particularly for light commercial vehicles, heavy duty trucks and domestic aviation. Emissions from cars have remained relatively stable[18].

4.2.5. Land sector

Emissions from this sector are attributable to the agricultural sector and land use, land use change and forestry. The land sector is both an emissions source and an emissions sink. A significant percentage of land sector emissions are methane and the land sector is responsible for all nitrous oxide emissions.[19.] Land sector emissions have experienced some growth over recent years, particularly from nitrous oxide from soils. Afforestation and reforestation have provided a fairly constant emissions sink of around -6%.

With the pace of technological development, the historical trends in each of the sectors could change dramatically. The shift towards low carbon technology is already occurring and could be accelerated.

4.3. South Australia's current low emission policies and measures

The Panel notes the significant action that South Australia has taken to address climate change despite changes in the national climate change and economic policy environment. The State has made significant gains in the uptake of renewable energy and there is now a new target to generate 50% of the State's grid electricity from renewable energy. The State Government played an important role in stimulating the solar photovoltaic sector by introducing a premium feed in tariff mechanism. This has resulted in 1 in 4 households having solar photovoltaic systems in place.

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[16] Department of Environment, Water and Natural Resources, 2013 *2013 report on the operation of the Climate Change and Greenhouse Emissions Reduction Act*, p77

[17] Department of Environment, Water and Natural Resources, 2013 *2013 report on the operation of the Climate Change and Greenhouse Emissions Reduction Act* p75

[18] St Kitts and Associates, 2014 *Emission Reduction Fund: Preliminary Review of Opportunities for South Australia* p25

[19] St Kitts and Associates, 2014 *Emission Reduction Fund: Preliminary Review of Opportunities for South Australia p6*

The Panel also notes that a number of initiatives have been put in place to encourage energy efficiency and conservation in residential, commercial, transport and government sectors, including programs focussed on dwellings, such as water heater and air conditioner energy efficiency standards, as well as energy efficiency targets with energy retailers and energy advisory services.

The Panel also notes that the Government has recognised the importance of working with industry to stimulate low carbon investment and create economic opportunities. It has partnered with industry through the Tonsley redevelopment to encourage research and development in new technologies that will assist in taking action on climate change. It has also introduced legislation to introduce Building Upgrade Finance, a mechanism to help building owners access finance to improve the energy, water and environment efficiency of existing commercial buildings.

The Carbon Neutral Adelaide initiative, with a target of Adelaide as the world's first carbon neutral city has important connections with South Australia setting a target for net zero emissions. Adelaide reaching net zero emissions will be an important first step towards the net zero emission target for the whole State. The Carbon Neutral Adelaide initiative is intended to drive emissions reductions, increase the demand for renewable energy, build the State's green industries, increase resource efficiency, and facilitate the change to cleaner transport modes. These are all key elements of the State's transition to a low carbon economy.

The Panel also notes that the State Government has a process in place to assist the South Australian community to prepare for the impacts of climate change. While outside its Terms of Reference, the Panel recognises the importance of effective adaptation policies and that these should complement policies to reduce greenhouse gas emissions. It also recognises that there are economic development opportunities in preparing the South Australian community for the impacts of climate change.

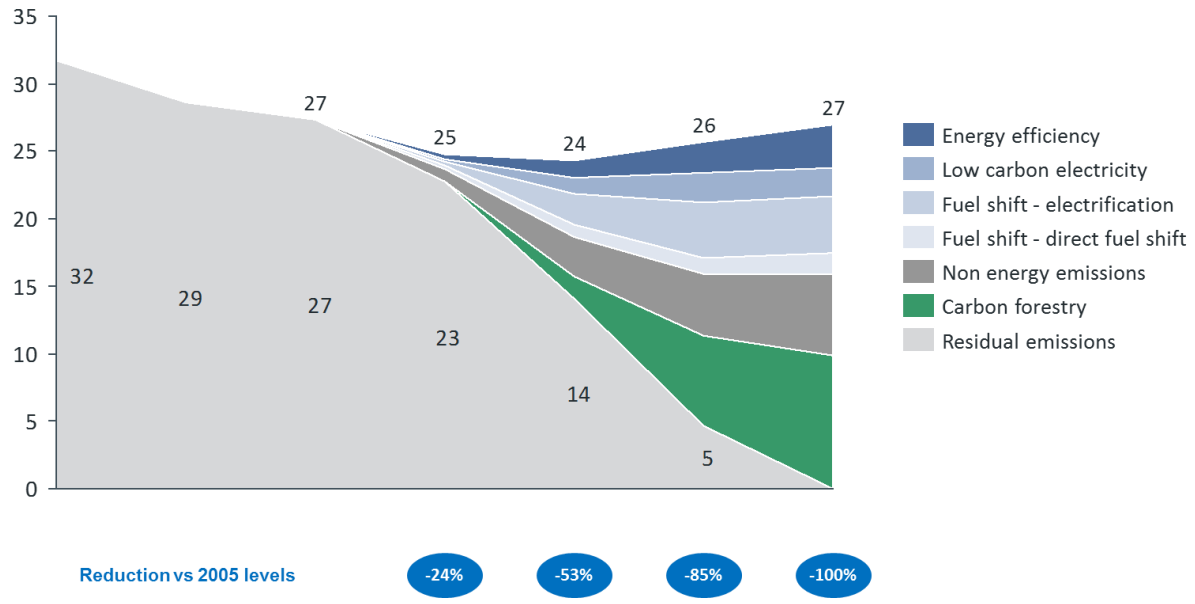
5. TOWARDS NET ZERO EMISSIONS – A DEEP DECARBONISATION PATHWAY FOR SOUTH AUSTRALIA

The Panel's assessment of the achievability of net zero emission utilising the *Deep Decarbonisation Pathways* approach and specific modelling for South Australia found that South Australia could achieve a 56% reduction in emissions by 2030 and net zero (100% reduction) by 2050 by utilising the deep decarbonisation pillars. It found that this could be achieved without using all of the State's renewables and carbon forestry potential. The largest opportunities to reduce emissions include:

- Decarbonising the State's electricity generation system and electrification
- Carbon forestry to offset residual emissions
- Reducing non-energy emissions in particular in the industrial sector.

An important finding for the Panel from the technical analysis is that the reference case indicates that without additional policy measures to drive decarbonisation, emissions in South Australia would be expected to remain stable.

Figure 7: South Australian emissions reduction opportunities, MtCO2e



Source: ClimateWorks Australia 2015

South Australia is already more advanced than Australia in its journey towards decarbonisation, with lower electricity emissions and already negative forestry emissions. South Australia is therefore extremely well placed to transition to the net zero emission economy.

The specific modelling of emissions reduction potential for South Australia was estimated at a high level based on existing analyses by ClimateWorks Australia, including the work that was undertaken as part of the *Deep Decarbonisation Pathways* project and the *Low Carbon Growth Plan for Australia*.[20] These research projects looked at the technical potential of abatement opportunities using technologies already known today and which are already cost effective. The analysis did not look at the potential impact of policies to quantify the potential, which means that cost estimates do not consider any transaction costs that the Government may incur. National findings were adapted to South Australia at a high level. A more detailed analysis would be required to understand the exact potential and costs for the State.

It should also be noted that, other than where stated, the technical analysis underpinning the Panel's analysis does not include emissions from imported electricity; in contrast, emissions from imported electricity are currently included in the State's greenhouse gas inventory.

Below is the assessment that the Panel undertook in relation to the abatement potential in each of the economic sectors utilising the deep decarbonisation pathways, with reference to the national *Deep Decarbonisation Pathways* project. The SA-specific analysis was based on South Australian results from the *Deep Decarbonisation Pathways* project and the following sources.

[20] ClimateWorks Australia, (2010), *Low Carbon Growth Plan for Australia* available at http://climateworksaustralia.org

Energy use emissions:

The emissions projections relating to the buildings and industry sectors were based on historical trends for growth and fuel mix, adjusted to reflect expected trends in economic growth by sector and recent improvements in energy efficiency. Heavy industry was modelled at an asset level and a literature review of existing industrial projects was undertaken. Projections relating to the transport sector were based on national modelling, adjusted based on historical trends.

Non-energy emissions

Projections relating to industry were based on national data and historical trends. Projections for agriculture were based on the national data and adjusted historical emissions trends. Emissions projections for forestry and waste were based on national data and the Emissions Reduction Fund registry.

The Panel recognises that to achieve the potential identified below, a range of policy measures will be needed to stimulate the market and accelerate uptake of the identified solutions. The 'Recommendations' section of this report includes some suggestions for this but the Panel notes that significant further detailed analysis of policy options and engagement with stakeholders is required.

5.1. Energy efficiency

Energy efficiency is recognised worldwide as one of the largest opportunities to abate greenhouse gas emissions from the energy sector in a cost-effective manner. The *Deep Decarbonisation Pathways* report recognises the significant opportunities for abatement in the buildings, industry and transport sectors.

Modelling undertaken for the Panel indicates that for South Australia there is up to 58MtCO_2e of abatement potential from energy efficiency initiatives over the period 2013-2050, representing around 12% of the total net zero emissions abatement task. This assumes continued growth in mining and continuation of manufacturing at relatively similar energy usage levels.

5.1.1 Buildings

Energy use is a significant component of emissions from the building sector nationally, with the vast majority of emissions from both the residential and commercial sectors coming from grid supplied electricity.[21] Energy efficiency will therefore play an important role in reducing emissions from this sector.

In the *Deep Decarbonisation Pathways* report, it was found that significant improvements could be made in relation to energy use in the building sector at a national level, with a 50% reduction in energy use in residential dwellings and a 50% reduction in the energy use per square metre in commercial buildings. This could be achieved generally in a cost-effective manner by constructing

[21] ClimateWorks Australia 2013, *Tracking Progress Towards a Low Carbon Economy; Buildings*, accessed on 6 November 2015
wwww.climateworks.com.au/sites/default/files/documents/publications/climateworks_tracking_progress_full_report_july 2013_1.pdf, p12

extremely efficient new buildings, replacing appliances and equipment with best practice models and improving the efficiency of equipment used to heat and cool.[22]

In the modelling undertaken for South Australia, significant abatement potential was identified for residential buildings, with energy efficiency combined with decarbonised electricity to bring emissions to near zero. Energy efficiency would contribute around 37% of the abatement potential in residential buildings. It contributes around 30% of abatement in commercial buildings, with low carbon electricity playing a larger role due to the high share of electricity in the energy mix today.

In total, energy efficiency from buildings could save around 20 $MtCO_2e$ of cumulative emissions from 2013 to 2050, which represents around 63% of the abatement potential in the buildings sector and around 4% of the total abatement potential identified to achieve net zero emissions in the State. Policy measures that could accelerate this transition are discussed in the 'Recommendations' section but could include thermal ratings standards and financial incentives to increase building thermal efficiency and convert to renewable energy supply. Building upgrade measures are generally cost-effective and provide long-term gains for emissions reduction.

5.1.2. Industry

In the *Deep Decarbonisation P*athways report, energy efficiency improvements in manufacturing are made through process improvements, equipment upgrades and the implementation of best practice technologies at the time of construction. Energy savings are estimated at approximately 1.2% per annum, with the exception of the iron, steel and aluminium manufacturing sector.

In the *Deep Decarbonisation Pathways* report, energy efficiency improvements in mining are made through operational improvements. However, these efficiency improvements are counterbalanced by a structural increase in energy intensity caused by additional energy being required for extraction due to lower levels of ore quality and increasingly difficult access to resources. As a result, modelling from the project indicates that mining energy intensity would double by 2050.

South Australia has a small number of high emitters in the manufacturing and mining sectors, with roughly two-thirds of the emissions attributed to manufacturing and one third to mining.[23]

Modelling undertaken for the Panel indicates that for South Australia there is up to 13$MtCO_2e$ of cumulative abatement potential to 2050 from energy efficiency initiatives in the industry sector in South Australia. This represents around 13% of the abatement potential in the industry sector and 3% of the total net zero emissions abatement task. It should be noted that mining energy intensity trends would be the same as past trends.

5.1.3. Transport

In the *Deep Decarbonisation Pathways* report, energy efficiency improvements in cars and light commercial vehicles are mainly achieved through the electrification of vehicles combined with fuel efficiency improvements and a continuation of the trend towards smaller vehicles. Energy efficiency

[22] *Pathways to Deep Decarbonisation in 2050*; Initial project report, available at http://climateworksaustralia.org/sites/default/files/documents/publications/climateworks_pdd2050_initialreport_20140923.pdf, published September 2014 p20

[23] St Kitts and Associates, 2015 *Emissions Reduction Fund: Preliminary Review of Opportunities for South Australia* p15

of aviation is improved through technological efficiency. In freight, trucks improve by 15% while rail and marine achieve an improvement of 17% and 22% respectively.

In line with national trends, emissions from the transport sector in South Australia have increased. The strongest growth in emissions has been from light commercial vehicles and heavy duty trucks and buses, while emissions from cars remained relatively stable. Aviation emissions also grew.[24]

Modelling undertaken for the Panel indicates that high emissions reductions can be achieved in South Australia in the transport sector with energy efficiency, in particular in relation to cars. It shows that for South Australia there is up to 25MtCO_2e of cumulative abatement potential to 2050 from energy efficiency initiatives in the transport sector. This represents around 25% of abatement potential in the transport sector and around 5% of the total abatement task.

5.2 Low carbon electricity

The *Deep Decarbonisation Pathways* report found that an important decarbonisation pathway to net zero emissions is the supply of low carbon electricity. The decarbonisation of the electricity sector also has important implications for the electrification and fuel switching decarbonisation pathway to be discussed below. The *Deep Decarbonisation Pathways* project proposes low carbon electricity from either 100% renewable energy or a mix of renewable energy and either carbon capture and storage or nuclear power. Three different scenarios were modelled for Australia, representing different combinations of renewable energy, carbon capture and storage (CCS) and nuclear power. The modelling found that low carbon electricity could be cost effective in 2050. The key difference between the different options was the choice of technology to deal with variability of renewable technologies. For the nuclear and CCS scenarios, back up for variability is met by those technologies combined with peaking gas, while in the 100% renewables scenario variability is dealt with through energy storage and non-variable renewables such as geothermal. In the high-level analysis for South Australia undertaken for the Panel, the CCS and nuclear scenarios were not considered, and all data was derived from the 100% renewable scenario.

Given South Australia's abundance of wind and high solar rating (DNI), South Australia has the capacity to move to 100% renewable energy more quickly than other States and has already made significant progress in decarbonising its electricity supply utilising these advantages. Establishing a secure, low carbon energy supply can position South Australia as an attractive location for future industries needing energy in carbon constrained world. This has been shown in other jurisdictions. For example, the Queensland Government capitalised on the abundance of coal in that State and built a major coal fired power station at Gladstone to provide cheap electricity. This was closely followed by the Gladstone aluminium production plant and then supporting industries. This created a major energy/commodities hub that has now expanded to include LNG production. If the SA government follows suit with the implementation of low cost renewable energy supply, industry will follow. "Build it and they will come"

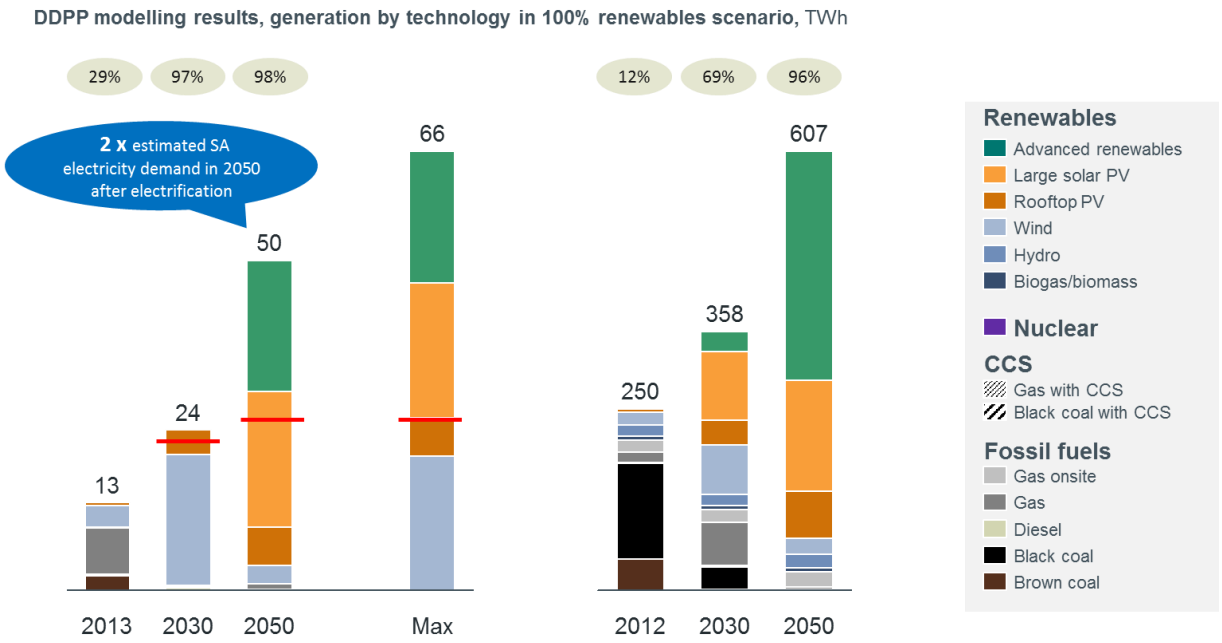
Through investments made in the last decade, SA has significant levels of renewable energy generation capacity, with 41% of energy generated in the State in 2014-15 coming from renewable sources. The State has the largest installed level of wind generation in Australia, with total registered capacity of wind farms reaching 1473 MW in 2015. Uptake of rooftop PV has also been high compared to other States, with an estimated 663 MW of rooftop PV capacity as at 30 June 2015. The growth in renewable energy generation is set to continue, with more projects under

[24] St Kitts and Associates, 2015 *Emissions Reduction Fund: Preliminary Review of Opportunities for South Australia* p7

construction and others in the pipeline, including 10 potential projects with a total capacity of 2313 MW. The State has sufficient renewable resources, including abundant solar, wind, oceanic, geothermal and bio-energy resources, to enable it to reach the 100% renewables mix. The costs of technologies required to assist with variability, including electric and heat battery storage, solar thermal technologies and geothermal, would need to be considered.

Modelling for the Panel indicates that around 47 $MtCO_2e$ of cumulative abatement potential exists to 2050, which is around 10% of the total net zero emissions abatement task. This 100% renewable scenario provides that no new capacity replaces retiring gas plants, which are phased out almost entirely by 2040, except for small amounts of peaking capacity. The modelling suggests that a range of renewable technologies could be economically viable in South Australia in a decarbonising world. In the indicative modelling undertaken here, it is assumed that there is large-scale solar PV and wind power and a substantial role for other renewable energy sources that are capable of providing baseload-type energy supply, including technologies such as solar thermal, geothermal and wave power, with additional generation from rooftop PV. Depending on the evolution of technologies and costs, the mix could differ substantially from present assumptions.

Figure 8: DDPP modelling results, generation by technology in 100% renewables scenario, TWh



Source: ClimateWorks Australia 2015

The national *Deep Decarbonisation Pathways* project identified some key approaches required to enable a high share of renewables in the electricity generation mix. These include:

- Trading between regions
- Use of flexible fossil fuel generation before the assets are retired
- Inclusion of more flexible and load-following renewable technologies
- Deployment of energy storage, in particular heat and electrical energy battery storage technology, which appears to be on a trajectory towards significant cost improvements
- Demand management could also help to manage intermittency, especially as the penetration of electric vehicle and other distributed electrical storage increases.

The modelling for the Panel did not include consideration of whether the nuclear and carbon capture and storage scenarios modelled at the national level are a cost-effective means to move to low carbon electricity for South Australia. The *Deep Decarbonisation Pathways* modelling found that nuclear power stations generally need to be of a certain size to be cost effective and thus precluded their consideration for use in smaller States such as South Australia. In addition, South Australia's capacity for cost-effective carbon capture and storage is unknown. There is only one small carbon capture project in South Australia – the recovery plant to be built and operated by Air Liquide at the AGL Torrens power station that will capture and purify up to 50,000 tonnes of carbon emissions from the power station each year.

5.3 Electrification and Fuel Switching

The third decarbonisation pathway has significant connections with the transition to low carbon electricity. As electricity generation moves increasingly to low carbon energy sources, it becomes the least emissions intensive energy source. Widespread electrification across the transport, buildings and industry sectors would then result in substantial decreases in emissions from these sectors. Fuel switching from fossil fuel to bioenergy and from coal to gas would drive further emissions reductions.

Modelling undertaken for the Panel indicates that for South Australia there is up to 121 $MtCO_2e$ of abatement potential from electrification and fuel switching over the period 2013-2050, which represents around 25% of the total net zero emissions abatement task.

5.3.1. Buildings

In the *Deep Decarbonisation Pathways* report, a switch to a decarbonised electricity supply for nearly all energy use results in near elimination of emissions from buildings by 2050, even with the increased number of households and the size and output of the commercial sector. This would involve the use of electricity for all heating, hot water and cooking equipment.

Modelling undertaken for the Panel indicates that for South Australia there is up to $12MtCO_2e$ of cumulative abatement potential to 2050 from similar electrification initiatives in the building sector. This represents around 38% of abatement potential in the buildings sector and around 3% of the total abatement task. As for the national case, energy efficiency and electrification and fuel switching result in the near elimination of emissions from buildings by 2050.

5.3.2. Industry

In the *Deep Decarbonisation Pathways* report there is a significant reduction in industrial energy emissions resulting from a shift from coal and oil use towards electricity, bioenergy and gas. Emissions reductions from this strategy are likely to result in an approximate 60% reduction in energy emissions. Iron and steel production would utilise Electric Arc Furnace technology. Further emissions reductions would result from a shift to electricity for heating processes, and most significantly a shift in mining from trucks to electricity-based technologies, such as conveyors for materials handling. Bioenergy is utilised for half of the remaining mining oil use, increasing bioenergy consumption nine-fold compared to 2012 levels, and 15% of remaining direct fuel use is shifted to biomass/biogas in manufacturing.

Modelling undertaken for the Panel indicated that for South Australia there is up to $33MtCO_2e$ of cumulative abatement potential to 2050 from similar electrification and fuel switching initiatives in the industry sector. This represents about 32% of abatement potential in the industry sector and around 7% of the total abatement task.

5.3.3. Transport

In the *Deep Decarbonisation Pathways* report, significant reductions in transport emissions are shown to be possible by replacing a substantial amount of liquid fuel with electricity and utilising biofuel for the remaining fuel as far as possible. The modelling demonstrates that the most significant levels of abatement could occur in the road transport sector. This would occur through cars and light commercial vehicles shifting from internal combustion engines to electric and hybrid drivetrains and some hydrogen fuel cell, as well as by reducing oil use for road freight by replacing it with LNG. More modest emission reductions were shown to be possible for the non-road transport sector, achieved from replacing around 15% of air travel with fast electric rail travel and biofuels replacing 50% of oil use in aviation. There is also some modest fuel switching by marine and rail sectors to gas and biofuels. It should be noted that the modelling predominantly utilised technological and fuel-related solutions to reducing emissions rather than attempting to predict abatement potential from modal shifting. More significant abatement levels could be achieved if these additional pathways were explored.

The Panel acknowledges the complexity involved in calculating the levels of abatement that can be achieved from utilising biofuels. These issues are addressed in the technical report to the *Deep Decarbonisation Pathways* project.

Modelling undertaken for the Panel indicates that for South Australia there are significant abatement opportunities from electrification in the transport sector with up to 59 $MtCO_2e$ of cumulative abatement potential to 2050. Fuel switching provides a further 17 $MtCO_2e$ of cumulative abatement potential. Together electrification and fuel switching represents around 75% of abatement potential in the sector and around 16% of the total abatement task.

5.3.4. Bioenergy feedstocks

In the Deep Decarbonisation Pathways report, bioenergy utilised for alternative fuels is exclusively sourced from second and third generation feed-stocks to supply key energy requirements.

A study was undertaken recently to map some of the available bio-energy resources in South Australia. This revealed that there are untapped existing and potential sources of biomass which would be suitable for providing the energy requirements for industry in South Australia. The study also included first generation feed-stocks, but generally involved the planting of species in areas not associated with high value food crops and where there is low rainfall and/or poor soil fertility.

5.4. Non energy emission reductions

The above three decarbonisation pathways make significant inroads into decarbonising and reducing energy related emissions. The *Deep Decarbonisation Pathways* report proposes reducing non-energy emissions to as great an extent as possible through process improvements and sequestering remaining emissions through either CCS or profitable carbon forestry.

Modelling undertaken for the Panel indicates that for South Australia there is up to 253$MtCO_2e$ of abatement potential from reducing fugitive emissions, process improvements, waste, land use change and sequestration through carbon forestry over the period 2013-2050, which represents around 53% of the total net zero emissions abatement task.

5.4.1. Industry

The *Deep Decarbonisation Pathways* report provides that process and fugitive emissions from the industry sector would be reduced via various process improvements, including the partial use of bio-

coke in iron and steel production, the use of clinker substitute in cement production, increased combustion/catalysation of gases with high global warming potential, and carbon capture and storage. Fugitive emissions intensity would be reduced by at least 50%, mostly through methane flaring/oxidation and carbon capture and storage.

Modelling undertaken for the Panel indicates that there is significant potential for abatement of industrial process emissions in South Australia, particularly in the iron and steel and cement sectors. It indicates that there are emission reductions available of up to 44MtCO_2e to 2050. It is estimated that there is further abatement potential from capturing fugitive emissions of around 13 MtCO_2e. Together this represents around 56% of abatement potential in the industry sector and around 12% of the total abatement task.

5.4.2. Agriculture

In the *Deep Decarbonisation Pathways* report, emissions from agricultural production are reduced through the use of best practice farming techniques. A significant source of methane emissions is beef production and the project found that emissions would be reduced by improved practices as well as a future global slowdown in beef demand. However, the project found that overall demand for Australian agricultural production will see agricultural emissions grow by 20% to 2050.

Modelling undertaken for the Panel indicates that there is limited abatement potential from agriculture in South Australia, with only around 19 MtCO_2e of cumulative abatement potential to 2050, representing around 4% of total abatement potential. Projections for South Australia based on the National Greenhouse Gas Inventory indicate moderate decreases in livestock emissions and moderate increases in other agricultural emissions.

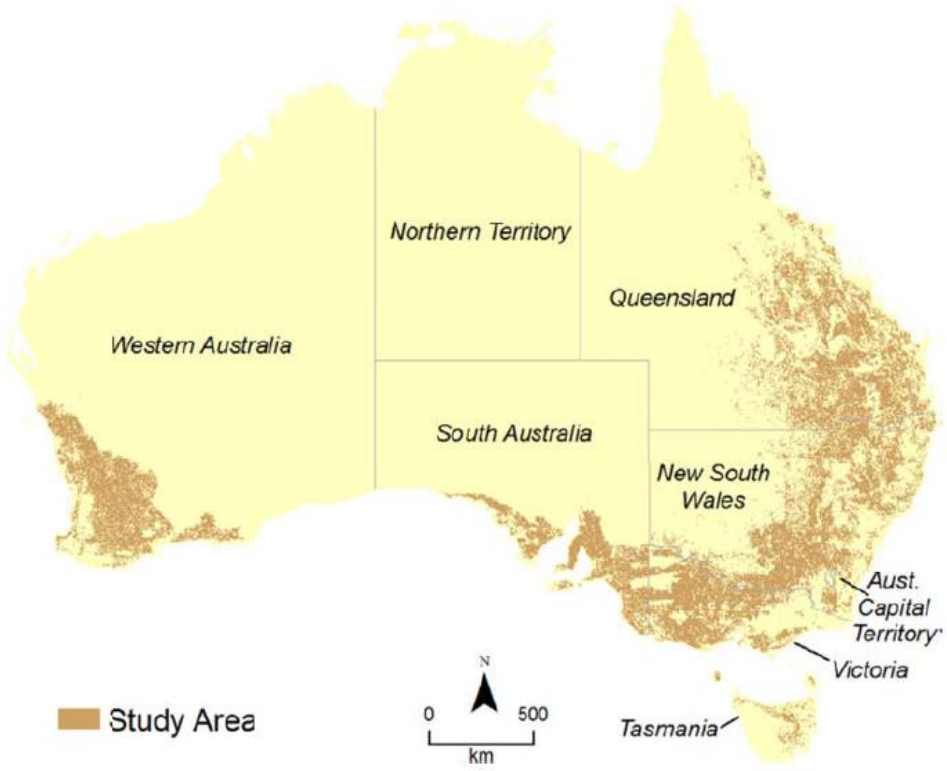
5.4.3. Carbon Forestry

In the *Deep Decarbonisation Pathways* report, Australia is found to have significant potential to offset emissions via forestry bio-sequestration. A number of different scenarios were modelled to compensate for all residual emissions, including scenarios that consider land use, water availability and biodiversity priorities.

Modelling undertaken for the Panel indicates that using only 37% of the total carbon forestry potential available in the State could offset all residual emissions in South Australia by 2050. The modelling suggests there is around 139MtCO_2e of potential cumulative abatement from carbon forestry, which is about 29% of the total abatement task.

However, there are some limitation associated with these results. The potential could be underestimated as the model only includes a small part of South Australia's land. It should also be noted that carbon forestry is not a long-term solution, as more and more trees need to be planted to keep stable levels of abatement. It can, however, be a useful transition strategy to help achieve net zero emissions before technologies exist to completely decarbonise industry, transport and agriculture.

Figure 9: Study area for LUTO model: The Australian intensive use zone



Source: ClimateWorks 2015

Modelling undertaken for the Panel indicates that there is a further 38MtCO_2e of potential cumulative abatement to 2050 from land use change and waste measures.

5.5. Costs

Estimates of the economic costs of a transition to low emissions systems on the basis of standard economic models are usually hampered by the fact that: models represent existing structures and policy settings as optimal; the benefits for economic growth from new investment opportunities and the creation of new industries are often not properly represented; and the costs of future, low-carbon technologies are almost always overstated. Furthermore, the non-economic benefits from decarbonisation are usually ignored, for example the advantages of a cleaner local environment and greater amenity from modern transport systems and improved buildings.

Nevertheless, it is worth modelling economic costs as accurately as possible within these constraints. In the time available to the Panel for this report, a dedicated analysis of costs of a net zero emissions trajectory for SA could not be prepared. However, cost modelling was undertaken for the national *Deep Decarbonisation Pathways* study. Given the broad similarity in emissions reductions trajectory between SA and nationally, it is reasonable to infer that the broad magnitudes of economic impacts would also be roughly similar.

The economic modelling for Australia's deep decarbonisation study projected national GDP growth at 2.4% per year on average to 2050 – 0.19% per year lower than under a hypothetical baseline of no action to reduce emissions. This means that Australia would achieve the same level of (greatly increased) GDP in the year 2053 with net zero emissions, rather than in 2050 with a very high emissions level. GNI per person would be reduced by only 0.12% per year.

Comparison with earlier modelling of emissions reduction scenarios by the Australian Treasury shows that the costs of full decarbonisation as modelled in 2014 are about the same as the costs of partial emissions reductions modelled in 2008 and 2011. For example, the most ambitious 2011 Treasury scenario had domestic emissions reduced by 42% and emissions net of international trading reduced by 80% (using international emissions units to cover the difference), at an economic cost closely similar to that in the national *Deep Decarbonisation Pathways* study, with 100% net reduction in domestic emissions.

The reason for the implicit revision in cost estimates is twofold. Firstly, technological and commercial progress with low emissions technologies has been much better, and future prospects are better than expected several years ago. The present and expected future cost of renewable energy is much lower, for example.

Secondly, the *Deep Decarbonisation Pathways* project explored a wider range of emissions reductions options than the Treasury modelling (and indeed the majority of mainstream economic modelling exercises), in particular in industry, buildings and the land sector. A closer look at the options usually reveals more and cheaper opportunities. This has also consistently been the experience with the implementation of emissions reductions policies in Australia and overseas.[25]

In addition, as has been emphasised throughout this report, there are significant potential opportunities from the transition to a low carbon economy, which means that new industries are likely to be created. Advances over the next 35 years are also likely to drive down the costs of low carbon technology.

Figure 10: Economic cost estimates for Australia's national Deep Decarbonisation study, compared to earlier Treasury modelling [26]

	Annual average growth		Annual average growth relative to reference case		Economic parameters at 2050, compared to reference case			Emissions level relative to reference, 2050		Emissions reductions from 2000 to 2050	
	GDP	GNI per person	GDP	GNI per person	GDP	GNI per person	PFC	Domestic emission	Net emissions	Domestic emssions	Net emissions*
DDPP scenario	2.4%	1.1%	-0.19%	-0.12%	-6.6%	-4.6%	-4.9%	-100%	-100%	-100%	-100%
2011 Treasury "high price" scenario	2.5%	1.0%	-0.21%	-0.19%	-4.7%	-7.1%	-8.3%	-66%		-42%	-80%
2008 Treasury "Garnaut 25" scenario	2.2%	1.1%	-0.14%	-0.17%	-5.8%	-6.7%	-6.5%	-83%		-69%	-90%

[25] Jotzo and Kemp, April 2015, *Australia can cut emissions deeply and the cost is low*, report for WWF Australia.
[26] *Pathways to Deep Decarbonisation in 2050*; Initial project report, available at http://climateworksaustralia.org/sites/default/files/documents/publications/climateworks_pdd2050_initialreport_20140923.pdf, published September 201, page 14.

6. RECOMMENDATIONS

The Panel finds that moving early will provide the best opportunities for South Australia to capture the opportunities and make the preparations for the transition to a net zero emission economy. As it is important to begin the process now, there are a series of steps that should be taken in the short to medium term. The Panel undertook an indicative high-level assessment of abatement opportunities for South Australia, and more detailed work will be required in relation to each of the State's economic sectors, on policy options and on measures to assist the transition. The Panel has three key overarching recommendations and a number of suggested actions to assist in the implementation of the recommendations.

RECOMMENDATION 1: SIGNAL the transition to a net zero emissions economy – set the goals and make them long and loud

The South Australian Government should provide a clear consistent signal about the transition to a net zero emissions economy. A clear commitment to net zero emissions by 2050 and any associated interim targets should be articulated in key public statements and policy documents. This will signal the Government's commitment and leadership for South Australia, as well as among Australia's States and Territories, nationally and internationally. Some suggested key actions that could support the implementation of this recommendation include the following:

Action 1.1. Become a signatory to the 'Under 2' MOU

By signing the 'Under 2' MOU, South Australia would be part of the growing group of sub-national governments making ambitious commitments that contribute to the global task to limit global warming to 2°C. Making a commitment to net zero emissions as part of an international partnership may also serve to increase the level of ambition at the international level.

Action 1.2. Articulate the target for net zero emissions by 2050 in key policy documents, including the climate change legislation

Given the volatility of the national climate change policy landscape, it is important that a clear and consistent signal is provided to the South Australian community and business about the transition to a net zero emissions economy. A clear commitment to net zero emissions by 2050 and any associated interim targets should be articulated in key policy documents.

Action 1.3. Build broad-based support for the achievement of the net zero emissions target with a view to a bipartisan position

To provide the policy certainty required to encourage and attract private sector investment, the commitment to net zero emissions needs to be an enduring one, with significant broad-based support. Engagement with all sides of politics would also assist. There are international examples of the benefits of such an approach, such as the tri-partisan climate change agreement in the United Kingdom.

Action 1.4 Step up South Australia's climate change leadership among the States and Territories, nationally and internationally

Working with other States and Territories in relation to policy issues in particular can play an important role in accelerating action in some key sectors, particularly energy efficiency and effective integration of renewable energy generation in the national electricity grid. Continued advocacy to

the Federal Government is required for the establishment of robust, long-term targets that are defensible in international fora and the introduction of efficient, robust policy instruments, including a carbon pricing mechanism within Australia, with international linkages to trading schemes in other countries.

Action 1.5. Investigate options for South Australia to implement a State-based emissions trading scheme, linked to the Californian emissions trading scheme

The different possible actions to move towards decarbonisation identified in this initial report by the Panel can be achieved using a variety of different policy measures, some at the State level and others at the Federal level. The work of the Panel did not extend to a detailed examination of policy options, which should be done on the basis of more detailed analysis and stakeholder consultation.

However, the Panel has identified one particular potential opportunity for South Australia in taking leadership among the States on climate change policy. The opportunity to reduce South Australia's emissions profile quickly, coupled with the State's internationally visible leadership position, could make it possible and profitable to implement a State-based emissions trading scheme (ETS) linked to California's ETS. California has the world's most well established sub-national ETS and is thought to be actively interested in linking its scheme to other sub-national schemes. A link with South Australia could be politically and economically attractive to California, and provide significant benefits for South Australia. This could also lead to technology sharing for major emissions reduction programs and new investor relationships.

Significant further analysis would be necessary. Initial views by the Panel are that a South Australian ETS could be implemented using the rules established for the Carbon Pricing Mechanism, and potentially administered by Australia's Clean Energy Regulator. Industry assistance measures could be informed by the provisions under the previous federal legislation. Revenue received by the South Australian Government could be used to support the low carbon transition and for the overall benefit of the South Australian Budget.

The relative emissions trajectories and emissions reduction opportunities suggest that the flow of emissions permit trading would be from South Australia to California, with net revenue flowing to South Australia. By linking to the Californian ETS, South Australia would have the same emissions price as prevails in California. The Californian price has been relatively stable.

Establishing a South Australian ETS with a California linkage would provide clarity and predictability for South Australia's industry, put South Australia in a clear leadership position among Australia's States and Territories, and send a powerful signal internationally.

RECOMMENDATION 2: SUPPORT the community and industry in the transition to a net zero emissions economy

The South Australian Government has an important role to support industry and community in the transition to a low carbon economy. The Panel's assessment of abatement opportunities for the State is a high-level indicative assessment only. It is important that the South Australian Government develops a much more detailed understanding of cost-effective abatement opportunities in each sector, including transition issues. The Panel has already identified a number of transition issues in some sectors and has included suggested actions to address them.

The South Australian community, including industry, will also need to be engaged in the move to a net zero emissions economy. An engagement program should be developed that clearly articulates the need for South Australia to remain within its emissions budget and reach net zero emissions by 2050. The engagement program should be forward-looking and focused on identifying opportunities and transition pathways for industry, business and the broader community.

Suggested actions to implement this recommendation include:

Action 2.1 Develop a comprehensive net zero emissions engagement program that involves working with key sectors to commission detailed studies of abatement potential and the development of net zero emission plans

As well as engaging the South Australian community, including industry, in the move to a low carbon economy, it is also important that key stakeholders, including the South Australian Government, have a detailed understanding of cost-effective abatement opportunities in each sector, and of how the economic and social transitions can be managed. This will assist with the development of detailed policy measures to drive emission reductions, provide a better understanding of appropriate technologies for the conditions in South Australia and give information about future infrastructure requirements.

An engagement program should be developed that clearly articulates the need for South Australia to reach net zero emissions by 2050. This should involve stakeholders from key sectors working together on detailed studies of abatement potential and the development of net zero emission plans, including pathways for transition for industries and communities. Consideration could be given to the use of compacts between the Government and key stakeholders, utilising the sector agreements provisions under the State's climate change legislation. In particular, there should be a focus on engagement with the State's largest energy using companies and greenhouse gas emitters.

Action 2.2. Develop a low carbon economy transition program comprising skills development initiatives and support and structural adjustment funding to prepare workers to move from traditional industries to new low emissions industries

South Australia should be proactive in determining the future skills that will be required in a low carbon economy. Appropriate skills and knowledge should be integrated into the curriculum in schools, universities and TAFE colleges. The Government should also work with these institutions to develop a strategy for being a leader internationally in the delivery of skills and training. Support, structural adjustment and appropriate training will be required for workers moving from traditional industries to low carbon industries. South Australia's strengths in education and training can be well utilised in helping to prepare the workforce of the future.

Action 2.3. Seek funding from ARENA and CEFC for assistance to help resolve electricity transmission grid stability, infrastructure funding, regulatory and energy market issues associated with a high penetration of renewable energy

South Australia's electricity generation sector will have an important role to play in decarbonising the economy. The State's significant penetration of renewable energy provides some early mover advantages and sets it up well to be a future net exporter of renewable energy. The closure of South Australia's coal-generated electricity facilities, while highly challenging in the short term, provides an opportunity for early transition to a cleaner electricity generation mix and for accelerated interstate grid connectivity. South Australia's experiences also provide valuable learning opportunities for the rest of the country in relation to dealing with current grid stability, infrastructure, regulatory and

energy market issues that are occurring due to the high proportion of intermittent renewable energy and the retirement of some fossil-fuel-powered stations. ARENA and the CEFC have funding available to assist in with the resolution of some of these issues. Collaborative opportunities with other governments could also be explored.

Action 2.4 Increase the focus on low emissions technology in the State's innovation agenda and include initiatives that bring together industry, universities and the public sector

Innovation and technology are critical for decarbonisation. The Government could build on the State's strengths in science and research and provide a stronger focus on decarbonisation in its innovation agenda in order to encourage the development of low carbon technology, products and services. New initiatives are also required to bring the private, public and research sectors together. This can include 'GovHack' style initiatives that make data available to innovators; for example, energy usage data and vehicle usage data, including parking and storage options.

South Australia should also aim to be an active participant in the emerging innovation agenda of the Federal Government.

Action 2.5. Encourage the development of community wind and solar projects

This would build on interest being expressed in some regional areas for local governments to work together on the development of community solar projects. There are many active organisations that promote economic and strategic growth in regional Australia and in local communities that would make ideal partners for initiatives led by the State Government.

RECOMMENDATION 3: IMPLEMENT the transition – the South Australia Government should take action now to drive the transition to a zero emissions economy

Whilst the transition to a net zero emissions economy is a long-term one, there are some key actions that the South Australian Government can take now to drive change, be a first mover and avoid costly lock-in of emissions intensive infrastructure. As well as suggesting some actions that the Government can take regarding its own decision-making processes, the Panel makes some initial suggestions for actions in each of the key economic sectors. A detailed assessment of abatement potential in each sector as proposed under Recommendation 2 would provide information to inform a broad range of policy measures that the South Australian Government can put in place to facilitate the transition to a low emissions economy.

Government decision making

Action 3.1. Introduce a requirement for the South Australian Government to consider the transition to a net zero emission economy when making major infrastructure, planning and policy decisions

The South Australian Government has an important role to play in assisting the transition to a net zero emission economy. As part of the Cabinet process, all major policy, infrastructure and planning decisions should be evaluated on whether they are net zero carbon ready.

Economic appraisals of policy and regulatory change, as well as major projects and government investments, should include evaluation of emissions at a shadow cost of carbon.

Electricity sector

Action 3.2. Set a goal of 100% renewable electricity

South Australia can greatly expand its renewable energy generation, to the point where on balance over the year all of the State's electricity comes from renewables and a significant amount is exported interstate. According to the Panel's preliminary analysis, this could occur relatively quickly. South Australia can therefore set an indicative goal of 100% renewable electricity with the timeframe to be decided. The timeframe will depend on expansion of interconnectors, costs of renewables and extent of support for renewable energy federally. The share of renewables in South Australia is expected to be double that in the National Electricity Market at any point in time up to 100%.

Action 3.3. Provide and facilitate support to accelerate the development of cost effective energy storage options for the State

Cost-effective energy storage is critical for South Australia to realise its renewable energy ambitions and deal with current grid stability issues. The development and manufacture of cost-effective storage technology could itself be a valuable new industry for the State and provide part of the needed technology solutions for full integration of a high share of intermittent renewable electricity generation.

Action 3.4 Investigate the potential for a more diverse portfolio of renewable energy technologies and systems in the State, including through State-based auctions for advanced renewable energy plants

Currently large-scale wind projects and rooftop PV are the predominant renewable energy technologies in South Australia. These technologies risk crowding out more nascent renewable energy technologies which could be important in dealing with grid stability issues. Options for government to contract for the construction of advanced renewables plants should be investigated following the ACT model of large-scale solar auctions with a contract for difference model. These would allow the South Australian Government to steer investment in desired directions and locations, while being assured that the costs are as low as possible for a given technology at a given time. This is not an attempt to 'pick winners' but rather to get advanced technologies deployed at the most competitive price while meeting South Australia's decarbonisation objectives.

Action 3.5. Facilitate renewable energy system integration within South Australia and advocate renewable energy integration nationally

A fully renewable energy supply will require changes in electricity supply infrastructure and in the regulatory frameworks governing electricity distribution and pricing. The South Australian government will need to facilitate the necessary change. To fully achieve the potential for South Australia to be a renewable energy powerhouse and net exporter of renewable energy, expansion of grids and interconnectors to enable energy sharing with other states is needed. The South Australian Government should advocate for such expansions, including resolution of cost, financing and regulatory issues. Expansion of interconnections with other states which also provide grid stability benefits in other states.

Industry sector

Action 3.6. Examine the feasibility of introducing a shadow carbon pricing and/or net zero emission pathway requirements for Government procurement and major project approval processes

Procurement and approvals processes are important, potentially low-cost policy levers that the South Australian Government can use to help drive the transition to a net zero emissions economy. Use of a shadow carbon price in government approval processes has been shown to drive low carbon decisions in the private sector in other jurisdictions. It will be important to consider the implication of any decision to move to an ETS as suggested in Action 1.5 above.

Action 3.7. Consider the imposition of a net zero emission requirement for all major projects in South Australia to drive an offsets industry

There are excellent opportunities for carbon forestry and the development of a profitable emissions offsets (land-based sequestration) industry in the State. As well as providing information and tools to land holders, policy measures can be put in place that will help drive the development of a profitable offsets industry. A requirement to cover emissions from new major projects with South Australian-based offsets could help develop land-based sequestration quickly. Cost and competitiveness aspects will need consideration. Similar to Action 3.6 above, it will be important to consider the implications of an ETS in relation to this suggested action.

Action 3.8 Work with industry on innovation and process emissions reduction programs

Due to the high percentage of non-energy emissions from this sector, the Government should work collaboratively with industry to encourage innovation and improvements in current processing technologies and industry practices.

Transport sector

Action 3.9 Promote the uptake of electric vehicles by providing information, financial incentives and appropriate public charging infrastructure

Increased uptake of electric vehicles, along with other measures may assist in attracting an electric vehicle manufacturer to South Australia as part of the transition from the traditional manufacturing sector. A range of policy measures could be used to encourage the uptake of electric vehicles. International best practice suggests a combination of consumer incentives, community awareness programs, high visibility provision of electric vehicles and infrastructure support for public charging point in desirable locations. Some measures can be designed to be budget neutral, such as vehicle registration prices linked to emissions levels. Electric buses are also now available in Australia and should be considered as part of public transport procurement decisions or as investment facilitation support to private bus fleet owners.

Action 3.10 Accelerate the transition of the South Australian Government's transport fleet, including its public transport fleet, to a zero emission fleet utilising more efficient vehicles, electrification and fuel switching

The South Australian Government can play an important role in decarbonising transport by taking action in relation to its own transport fleet. This could include favouring contractors that have a high percentage of electric vehicles in their fleet.

Buildings sector

Action 3.11. Work with other interested jurisdictions to drive evolution of the Building Code and appliance standards to improve the energy efficiency of buildings

The energy efficiency measures in Section J of the National Construction Code have not been updated since 2010, and the current version of the Code is in force until 2018. There is an opportunity for South Australia to work with other State and Federal members of the Australian Building Codes Board to develop an upgraded Section J to be included in the Code that will apply from 2019. Consideration could be given to combining thermal rating standards and financial incentives as a means to encourage an increase in building thermal efficiency. The efficiency of appliances can also play an important role in improving the energy efficiency of buildings. At the national level the imposition of the Greenhouse and Energy Minimum Standards (GEMS) process has been very effective in reducing energy consumption. However, the national process has been slow.

There are many exciting new technologies that can save energy in buildings and improve comfort. In addition, there may be potential for South Australia to develop new industries to deploy some of the new and emerging building technologies.

Action 3.12. Increase the energy efficiency of buildings in South Australia through state based variations to the Building Code, increasing energy efficiency requirements in the Planning Code and considering changes to stamp duties.

Increasing the stringency of building standards has been shown to have a significant impact on the energy efficiency of new buildings. While there are some benefits from national consistency, the national Building Code process has been extremely slow. There are benefits from South Australia introducing its own building variations and utilising the Planning Code being developed through the planning reform process as well as working with other States. Also South Australia can consider adjusting its stamp duty rates to be linked to emissions performance, which can help drive consumer interest and market demand. When the net zero emissions goal is the guide, it may be sensible to move much faster to universal uptake of building measures such as renewable energy systems in all new property developments, widespread off-peak energy storage and reticulated hot water and space heating and cooling, all of which are typically more efficient on large scale than multiple micro installations.

Action 3.13. Consider provisions to mandate Solar Photovoltaics on all new houses

The construction of new homes provides an opportunity to include infrastructure that will assist households to integrate with a low carbon energy system. Solar panels installed as part of the construction of new homes can reduce capital costs of solar PV for households.

Action 3.14. Implement best practice programs which will significantly improve the energy efficiency of appliances used in buildings

Investigations should be undertaken into appropriate best practice programs to be implemented in the State. Consideration could be given to implementing a program similar to Japan's Top Runner Program, which requires manufacturers to meet a standard based on the best performance of current technologies. Not only has this increased the energy efficiency of appliances, but it has also encouraged greater innovation and research and development.

Land sector

Action 3.15. Work closely with the forestry and agricultural industries and research institutions to develop practices and technologies that will assist with productivity and deliver abatement potential

Many of the opportunities for abatement in agriculture are consistent with best practice farming techniques. Active engagement with the agriculture sector is needed to encourage and maintain uptake of these practices, including through offset industries as per recommended Action 3.7. Further work is also required in this area to find new abatement potential, to identify geographical areas that would be physically suitable for carbon plantations and where environmental and social benefits can be achieved at the same time.

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SA LOW CARBON ECONOMY EXPERTS PANEL
TERMS OF REFERENCE

Background

It is preferable to have a consistent and coordinated national approach to climate change policy, interlocked with international agreements to foster effective emissions reduction efforts. However absence of strong national leadership should not hinder South Australia from capitalising on the opportunities of early transition to a low-carbon economy.

The South Australian Government is progressing a range of initiatives including development of a new Climate Change Strategy, Carbon Neutral Adelaide Green Zone action plan and a Low Carbon Investment Plan which are seeking to capture economic opportunities associated with responding to climate change.

Given changes in national climate change policy settings and the desire of the South Australian Government to develop strengthened mitigation strategies in the context of current national and international action, it is timely to seek a major independent review to inform the development of the South Australian climate change strategy.

Purpose

The SA Low Carbon Economy Experts Panel will conduct the South Australian Climate Change Review, focussing on key issues of importance to South Australia in relation to climate change.

Terms of Reference

The SA Low Carbon Economy Experts Panel will review and produce a written report containing recommendations and options to the Government in relation to:

1. The objectives and targets for the South Australian Climate Change Strategy and legislation having regard to national and international developments; and
2. The key strategies and actions that the South Australian Government should pursue in meeting these objectives and to maximise economic opportunities, and ensure the South Australian economy is best placed to adjust to a carbon constrained future.

The SA Low Carbon Economy Experts Panel should provide specific advice on the following matters;

- Advice to SA Government on targets, including those under the Climate Change and Greenhouse Emissions Reduction Act and relevant South Australian Government policy (including the 10 Economic Priorities).
    - This should encompass a review of existing emissions reduction and renewable energy targets, giving regard to emerging national targets and reviews undertaken by the Climate Change Authority. Consideration should also be given to the adoption of targets required for signatories to the under 2°MOU, including an 80% reduction on 1990 levels by 2050 and associated interim targets. The benefits and impacts of the different target options should be identified.

- Pathways to achieving the recommended targets, with a particular emphasis on those that would support employment opportunities and a transition of the workforce from carbon intensive industries into low-carbon industries.

- Economic development opportunities and benefits from taking early action on climate change.
- Measures to accelerate a reduction in greenhouse gas emissions, increase the deployment of clean energy technology and improve energy efficiency including through government procurement and regulation.

- How climate change should be taken into account when making infrastructure investment decisions in South Australia.

Experts Panel

Panel membership will be:

John Hewson

John Hewson is the former leader of the Liberal Party of Australia. John has had a distinguished business career both before and after his political career.

He has worked as an economist for the Australian Treasury (Census and Statistics), the Reserve Bank, the International Monetary Fund and also as an advisor to two successive Federal Treasurers and the Prime Minister. John was a Director of Macquarie Bank and a past Chairman of ABN AMRO in Australia.

His academic career included 11 years as a Professor of Economics, with four years as Head of the School of Economics at the University of New South Wales, and two years as Dean, Macquarie Graduate School of Management and Professor of Management at Macquarie University.

John has been director of many organisations and has guided many from early stage to maturity. John has been extensively involved in the climate debate in Australia and internationally.

He is the Chairman of the Asset Owners Disclosure Project.

John is Professor and Chair Tax and Transfer Policy Institute at the Crawford School of Public Policy at the Australian National University.

Frank Jotzo

Frank Jotzo is Associate Professor at the ANU Crawford School, Director of the School's Resources, Environment and Development (RE&D) program, Director of the Centre for Climate Economics and Policy, and an ANU Public Policy Fellow. Frank Jotzo's focus is on policy relevant research on the economics and policy of climate change, energy, and broader issues of environment and development. He is a frequent contributor to public policy debates, was advisor to Australia's Garnaut Climate Change Review, advisor to Indonesia's Ministry of Finance, consultant to international organisations and a Lead Author of the Fifth Assessment Report by the Intergovernmental Panel on Climate Change. He currently leads a collaborative research program on market mechanisms for China's climate and energy policy. He teaches the courses Domestic Climate Change Policy and

Economics (EMDV8081) and Issues in Development and Environment (EMDV8013), and co-convenes the Master of Climate Change degree.

Anna Skarbek

Anna has been Executive Director of ClimateWorks Australia since its inception in 2009, leading the organisation's work in analysing emissions reduction opportunities and partnering with business and government in unblocking barriers to their implementation.

Anna is a also director of the Clean Energy Finance Corporation, a trustee of the Sustainable Melbourne Fund, a member of the Australian Government's Energy White Paper Reference Panel and the Grattan Institute's Energy Program Reference Panel. She is a former director of the Carbon Market Institute and of the Linking Melbourne Authority. She was a member of the Australian Government's Land Sector Carbon and Biodiversity Board and NGO Roundtable on Climate Change.

Anna is an experienced investment banker, policy adviser and qualified lawyer. Before ClimateWorks she was working in London's carbon markets as Vice President of Advisory with Climate Change Capital, a specialist investment manager and advisor dedicated to raising and deploying capital for low carbon activities. Anna's prior career in Australia included senior policy adviser to the Victorian Deputy Premier, investment banker in Macquarie Bank's energy and utilities team, and solicitor with the national corporate law firm Mallesons Stephen Jaques. She also served on the board of The Big Issue and the board of Amnesty International Australia for six years in roles including National Treasurer and Victorian President.

She holds First Class Honours Degrees in Commerce and Law from Monash University and is a graduate member of the Australian Institute of Company Directors

Governance

The SA Low Carbon Economy Experts Panel will report to the Climate Change and Carbon Neutral Adelaide Cabinet Task Force.

The SA Low Carbon Economy Experts Panel should ensure that, in undertaking the review, it consults with:

- The Premier's Climate Change Council
- Other relevant business, environment and community groups and organisations.

The report from the Experts Panel will fulfil requirements for consultations with experts under the *Climate Change and Greenhouse Emissions Reductions Act 2007.*

Timing

The SA Low Carbon Economy Experts Panel should deliver their report by 31 October 2015.

ClimateWorks AUSTRALIA

SOUTH AUSTRALIA'S EMISSIONS AND ABATEMENT PROJECTIONS

TECHNICAL ANALYSIS PREPARED FOR SOUTH AUSTRALIA'S LOW CARBON ECONOMY EXPERTS PANEL

November 2015

CONTENTS

The project provides a quantitative analysis of the emissions reduction potential in South Australia

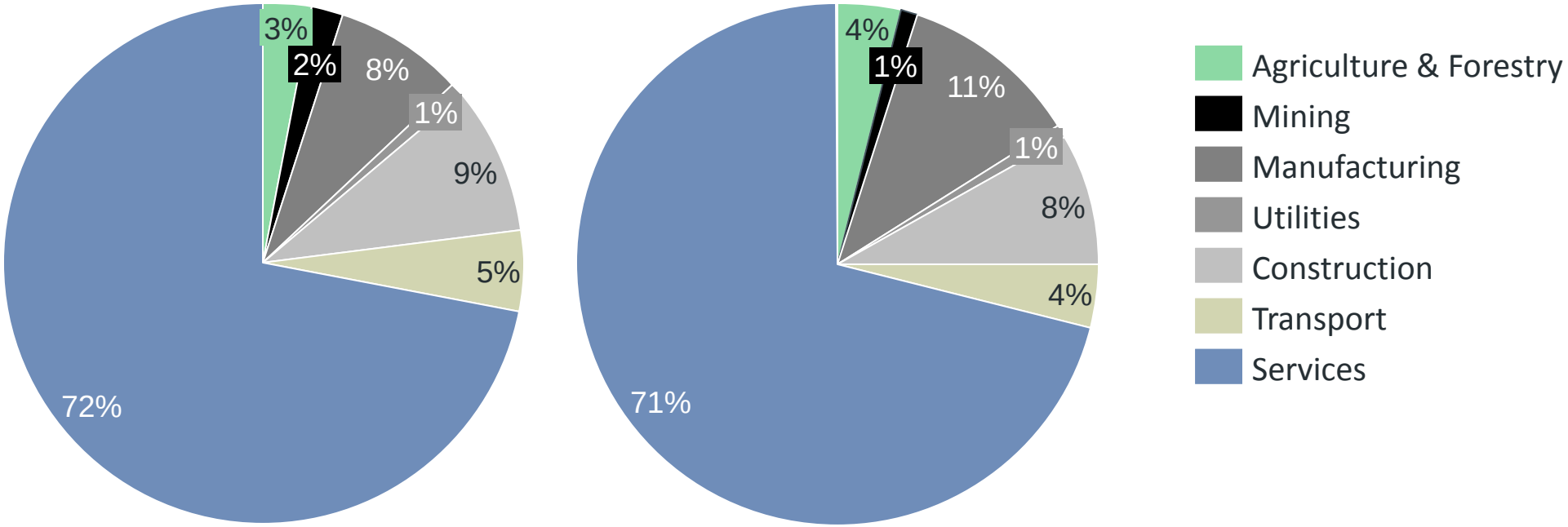
Scope of the analysis*

- Emissions projections for South Australia to 2050,
- Calculations of emissions reduction opportunities by sector and category,
- A short report in powerpoint format summarising key results and assumptions

Note: In all slides, 2013 refers to 2012-13
*Details of assumptions underpinning analysis can be made available

South Australia's economic structure is fairly similar to Australia

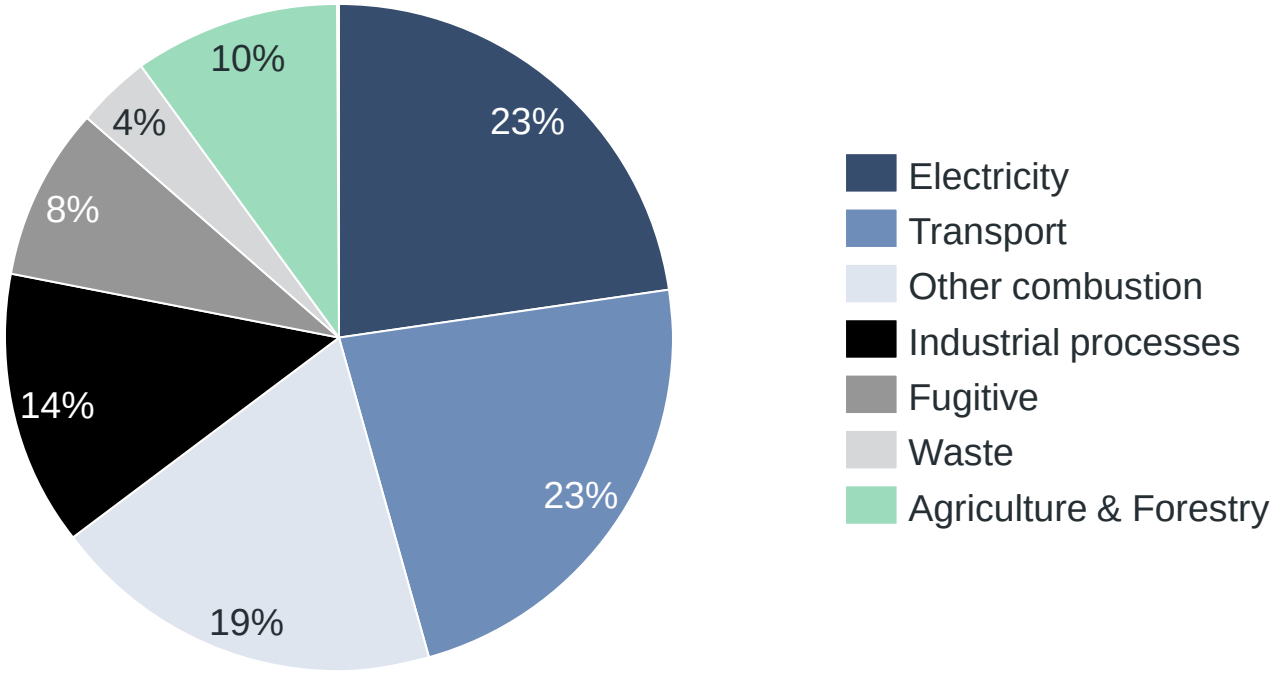
2011 employment breakdown in Australia (left) and in South Australia (right)



The main sources of emissions today are electricity generation and transport emissions, with non-energy emissions representing 35% of total

South Australia's emissions by source in 2012-13, MtCO2e

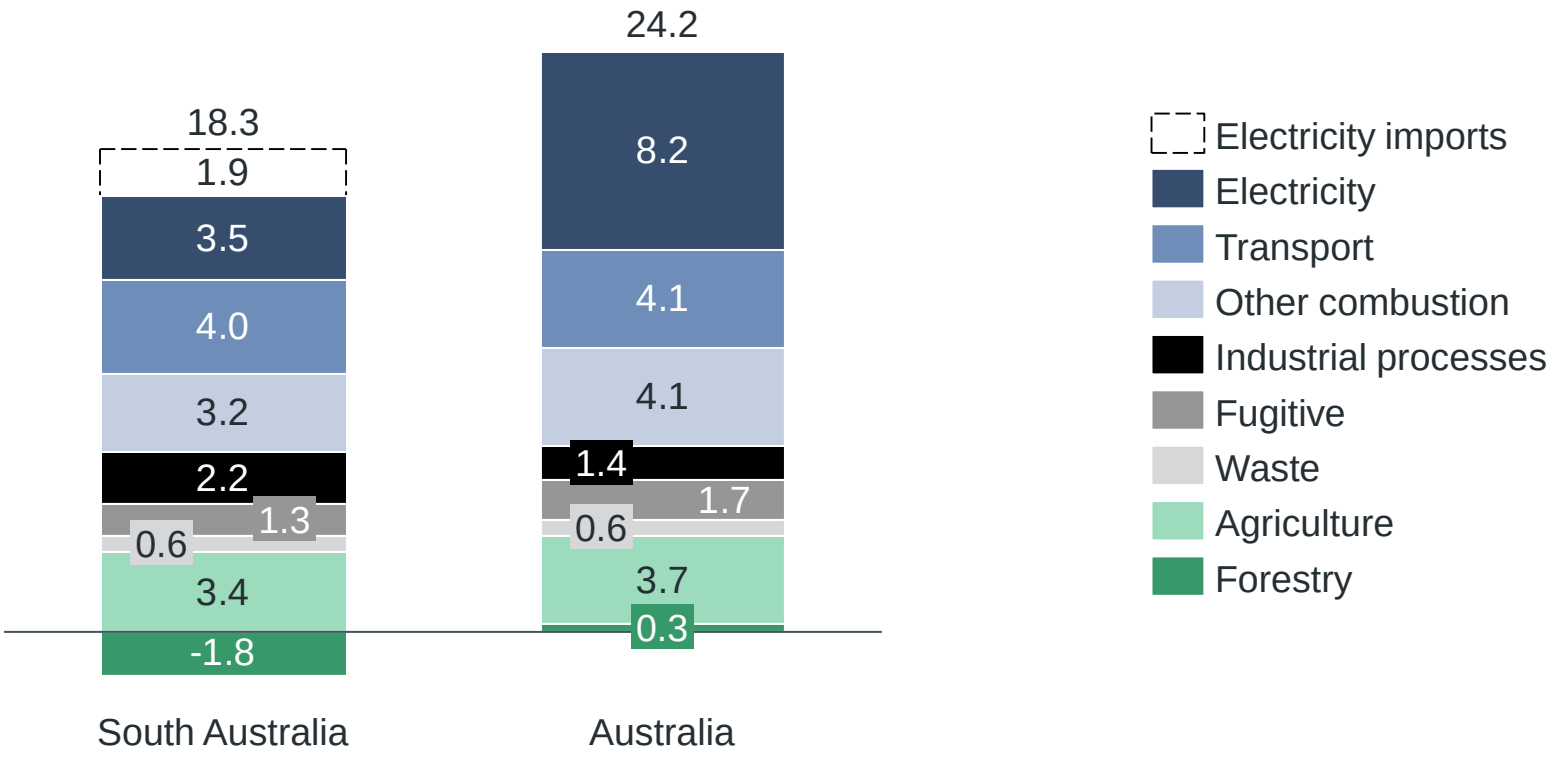
100% = 27.6 $MtCO_2e$



Note: this does not include emissions from electricity imports

South Australia has lower per capita emissions than Australia, thanks in particular to the electricity and forestry sectors

Emissions per capita by source in 2012-13, tCO2e/capita



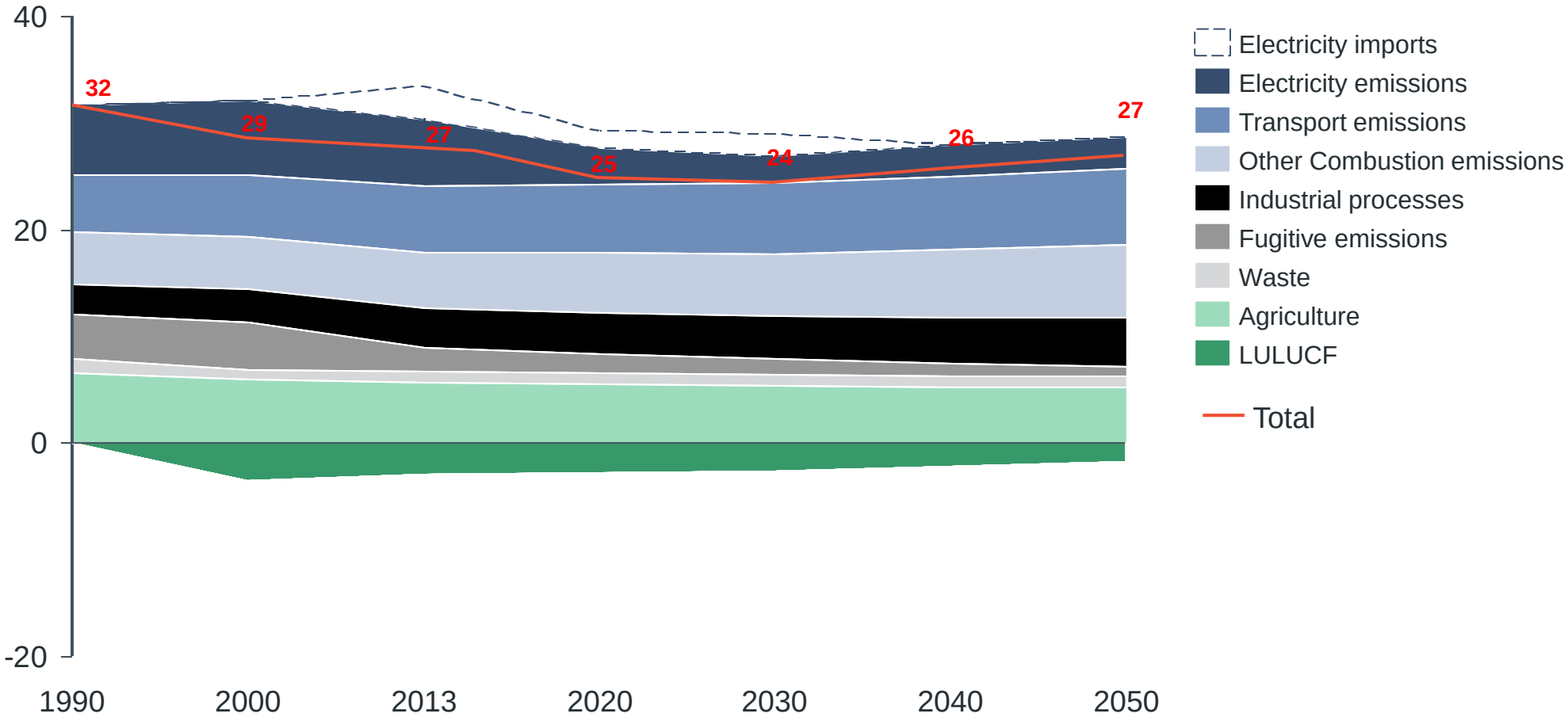
Key findings

- If no further action is taken, South Australia's emissions will stay about stable
- South Australia could achieve a **56% reduction in emissions by 2030 and net zero by 2050**, without using all its renewables and carbon forestry potential
- The **largest opportunities** to reduce emissions include:
  - ✓ Decarbonising the state's electricity generation & electrification (29% total potential)
  - ✓ Carbon forestry to offset residual emissions (29%)
  - ✓ Reducing non-energy emissions, in particular in the industrial sector (24%)
- **More potential exists** that could create economic opportunities for the state:
  - ✓ South Australia could become a net exporter of renewable electricity to other states
  - ✓ South Australia could also become an exporter of carbon offset from forestry plantations

CONTENTS

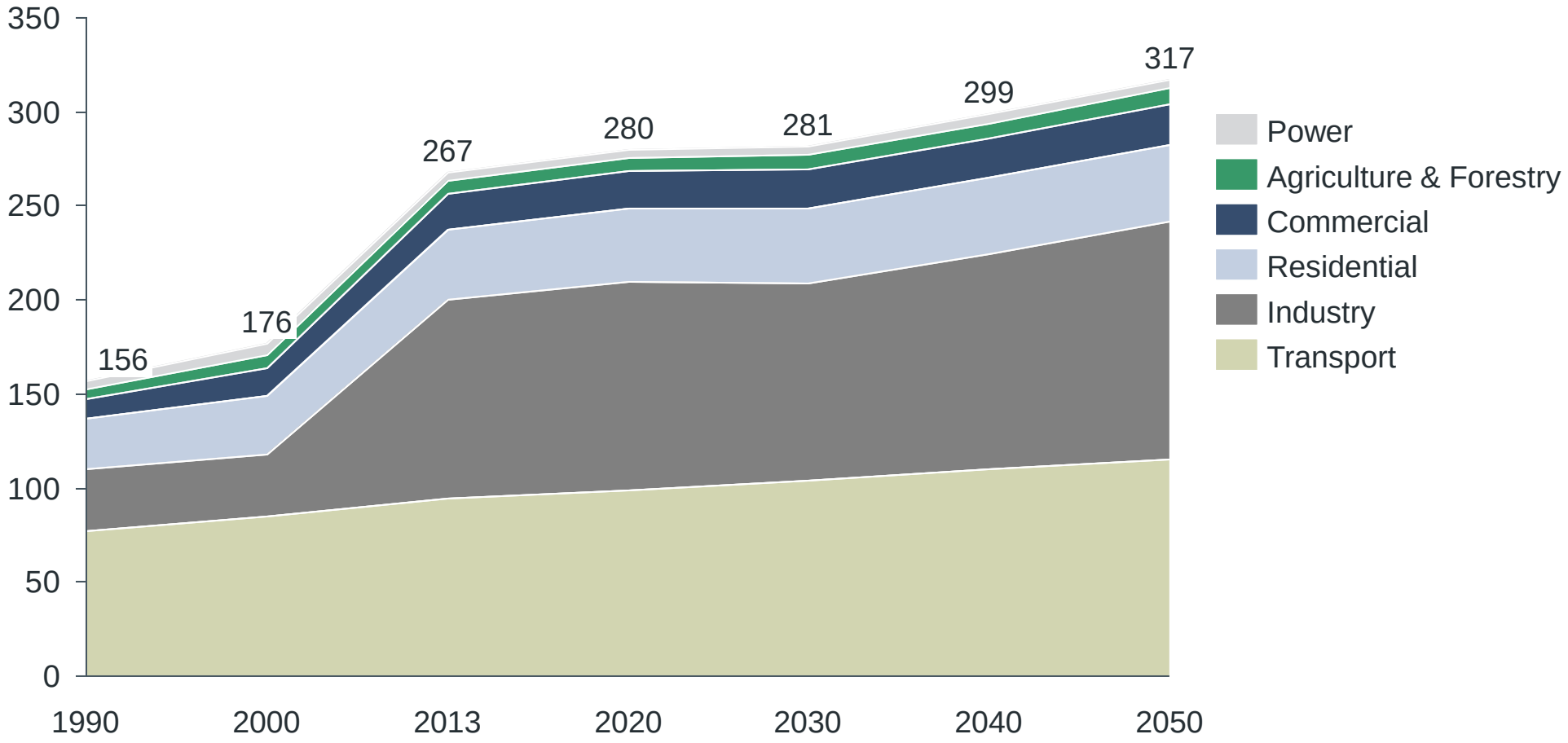
Reference case emissions are expected to stay relatively stable to 2050

South Australian emissions projections, reference case, MtCO2e



Reference case energy use increases to 2050 with mining growth offsetting expected manufacturing slow down

South Australian final energy use by sector, reference case, PJ



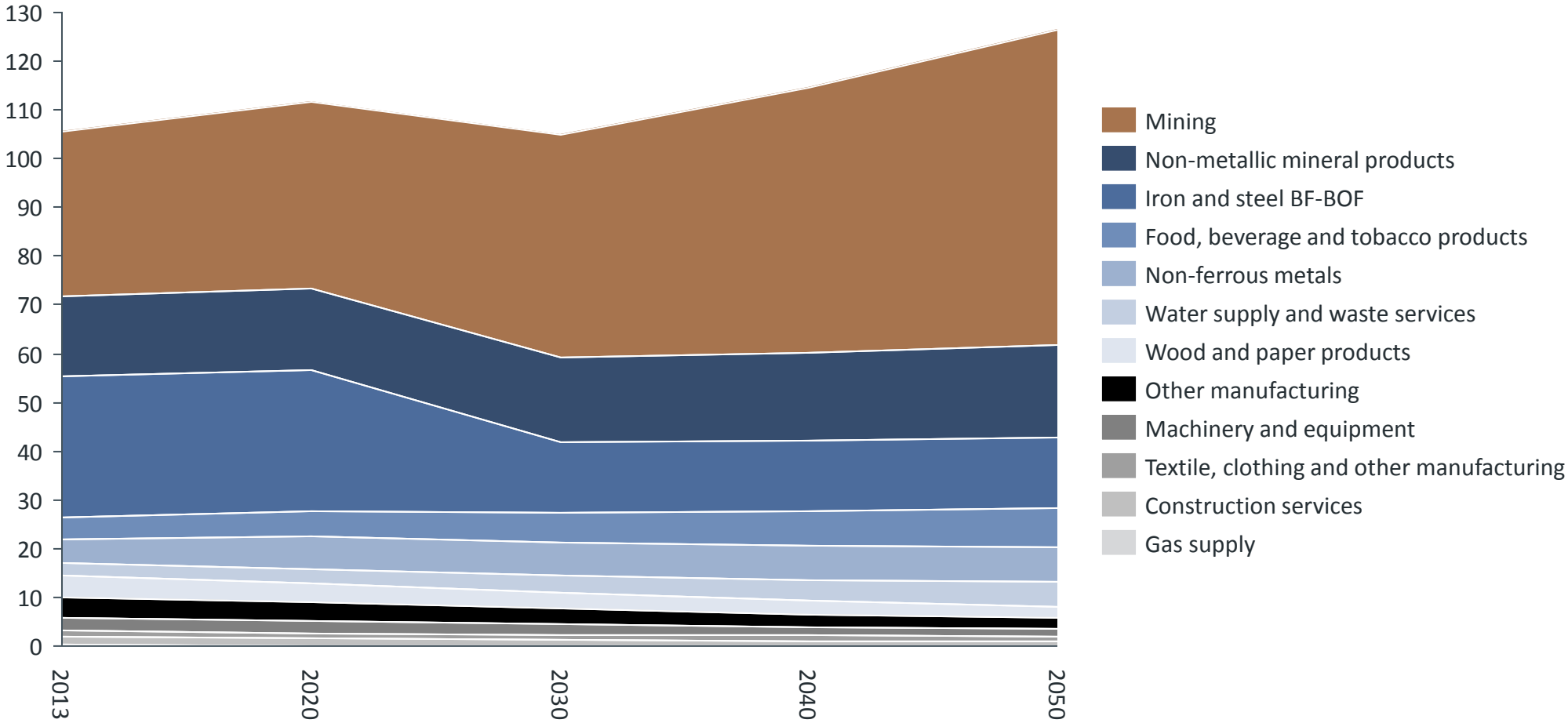
Reference case energy use increases to 2050 with mining growth offsetting expected manufacturing slow down

South Australian final energy use by sector, reference case, PJ

Sector	1990	2000	2013	2020	2030	2040	2050
Power	3.50	5.90	3.94	4.18	4.48	4.78	5.08
Agriculture & Forestry	5.70	6.70	7.09	7.34	7.70	8.09	8.49
Commercial	10.70	14.70	18.86	19.39	20.18	21.00	21.86
Residential	26.70	31.20	37.26	38.88	39.99	40.32	40.12
Industry	32.90	32.70	105.44	111.69	104.81	114.51	126.54
Transport	76.90	85.10	94.82	98.35	104.21	110.04	115.38
Total	156	176	267	280	281	299	317

By 2050, it is currently assumed that industrial energy use will grow slightly, mostly driven by mining activity

South Australian final energy use by industrial subsector, PJ



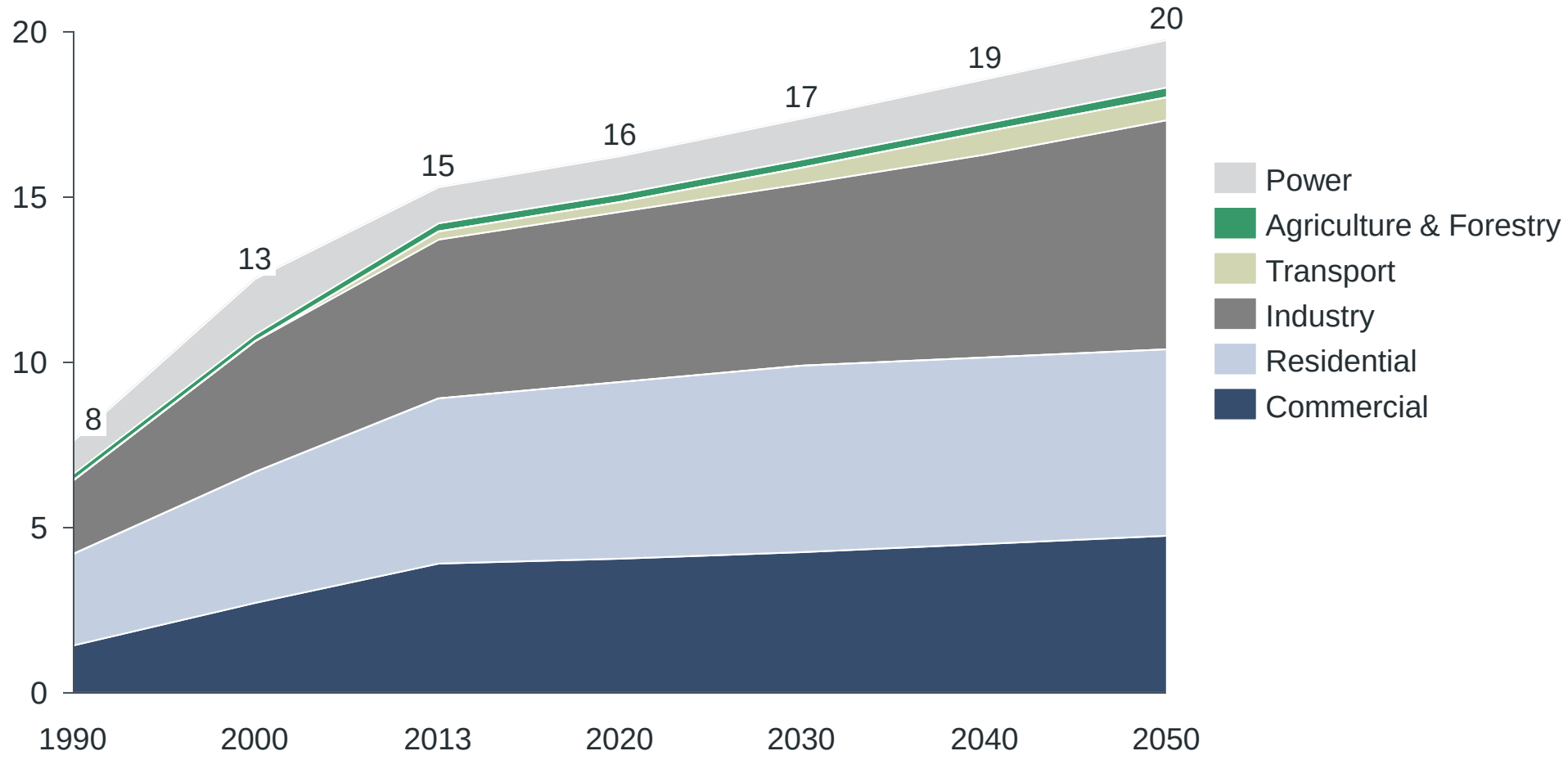
By 2050, it is currently assumed that industrial energy use will grow slightly, mostly driven by mining activity

South Australian final energy use by industrial subsector, PJ

Industrial subsector	2013	2020	2030	2040	2050
Mining	33.7	38.2	45.5	54.3	64.8
Non-metallic mineral products	16.4	16.8	17.5	18.2	18.9
Iron and steel BF-BOF	29.0	29.0	14.5	14.5	14.5
Food, beverage and tobacco products	4.6	5.1	6.0	7.0	8.2
Non-ferrous metals	4.8	6.9	6.9	6.9	6.9
Water supply and waste services	2.5	2.9	3.5	4.3	5.3
Wood and paper products	4.4	3.9	3.3	2.8	2.3
Other manufacturing	4.2	3.7	3.2	2.7	2.3
Machinery and equipment	2.8	2.5	2.1	1.8	1.5
Textile, clothing and other manufacturing	1.2	1.1	1.1	1.0	1.0
Construction services	1.6	1.4	1.2	1.0	0.9
Gas supply	0.3	0.2	0.1	0.0	0.0

Reference case electricity use increases across all sectors modelled

South Australian electricity demand, TWh



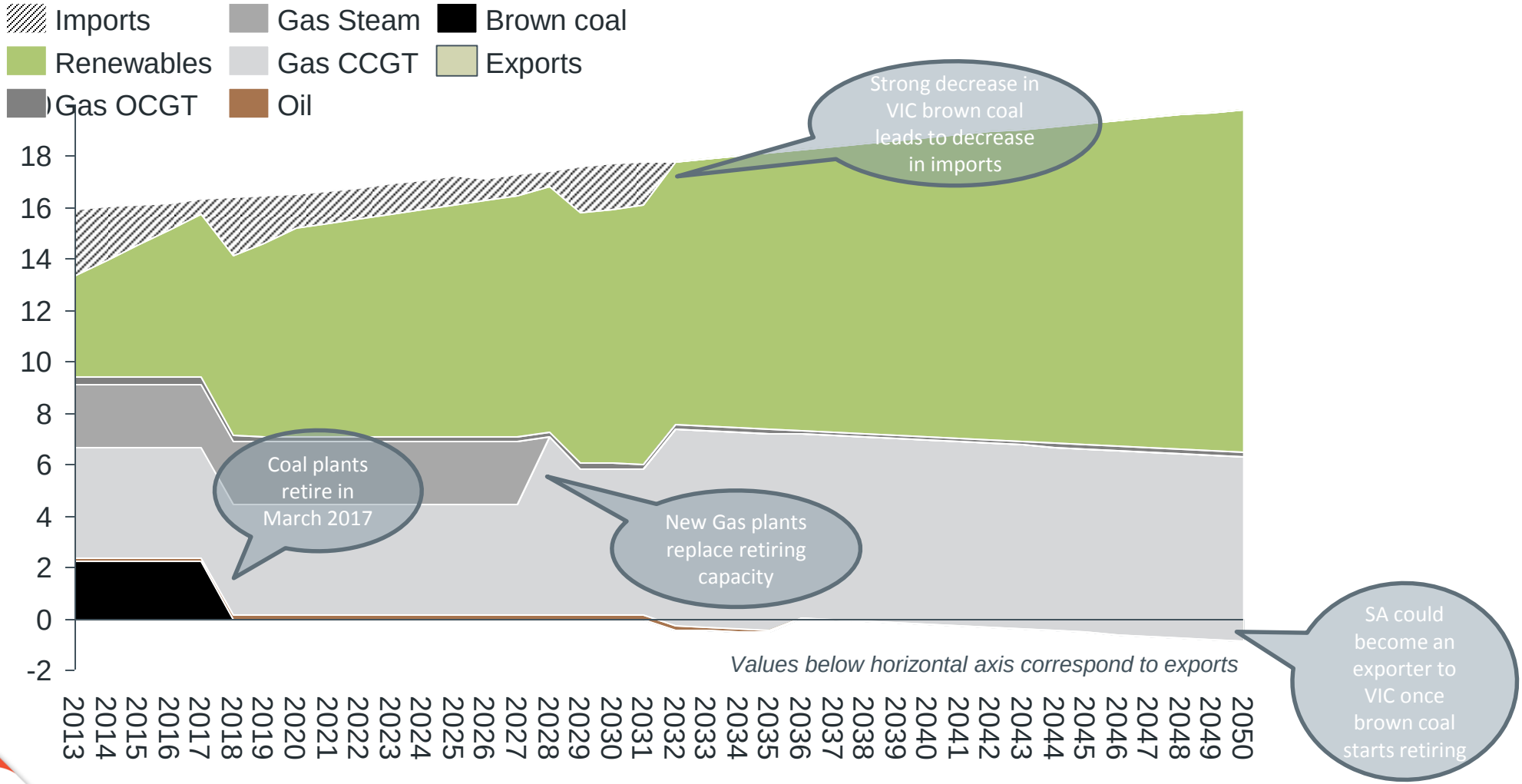
Reference case electricity use increases across all sectors modelled

South Australian electricity demand, TWh

Sector	1990	2000	2013	2020	2030	2040	2050
Power	1.0	1.6	1.1	1.2	1.2	1.3	1.4
Agriculture & Forestry	0.2	0.2	0.2	0.3	0.3	0.3	0.3
Transport	0.0	0.0	0.3	0.3	0.5	0.7	0.7
Industry	2.3	4.0	4.8	5.2	5.5	6.1	6.9
Residential	2.8	3.9	5.0	5.3	5.6	5.7	5.6
Commercial	1.4	2.7	3.9	4.0	4.3	4.5	4.7
Total	7.6	12.5	15.3	16.3	17.4	18.6	19.7

It is assumed that growth in electricity demand is met by renewables and new gas CCGT

South Australian electricity generation, reference case, TWh



It is assumed that growth in electricity demand is met by renewables and new gas CCGT

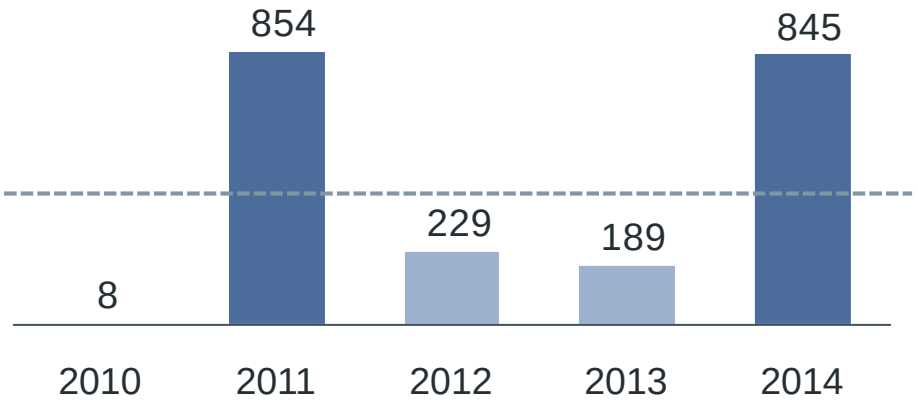
South Australian electricity generation, reference case, GWh

Fuel type	2013	2020	2030	2040	2050
Imports	2,527	1,301	1,751	-216	-848
Renewables	3,951	8,144	9,885	11,626	13,367
Gas CCGT	4,317	4,317	5,716	7,162	7,162
Gas Steam	2,427	2,427	0	0	0
Gas OCGT	317	218	208	162	162
Oil	141	141	141	0	0
Brown coal	2,238	0	0	0	0

It is assumed that renewables grow in line with recent trends

- New large scale renewable generation grows at 425GWh p.a. until 2020 (then stays stable)

Additional generation, GWh

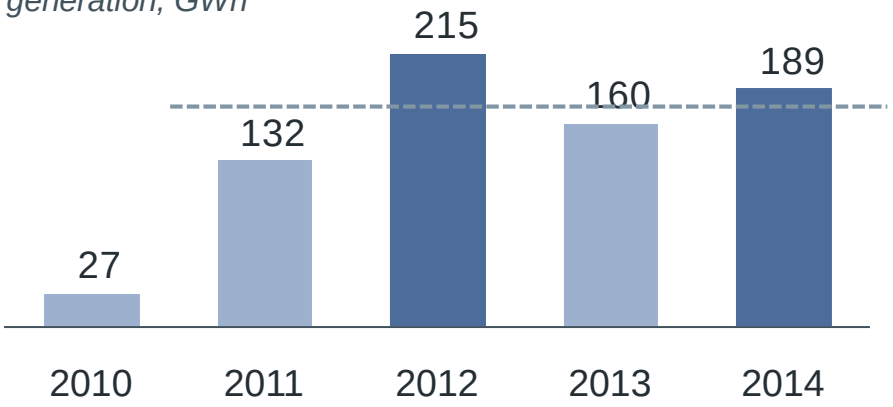


Average of 2010-2014
425 GWh

This leads to wind generation in 2020 in line with AEMO's estimates

- New solar PV generation grows at 174 GWh p.a. until 2050

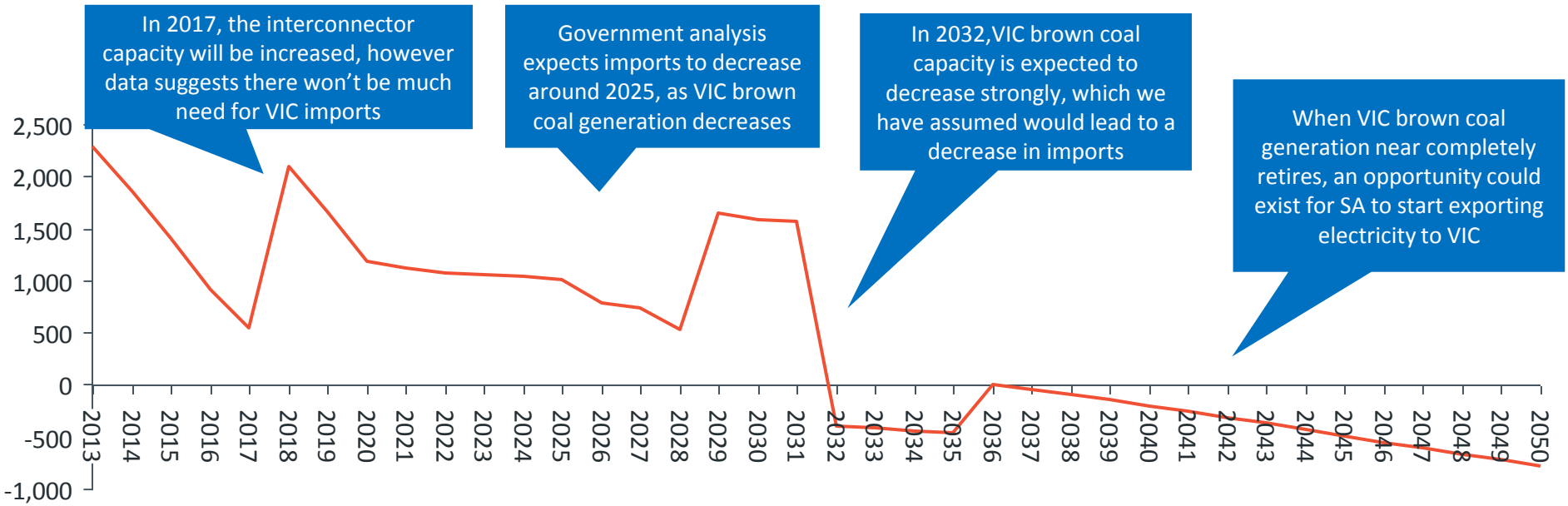
Additional generation, GWh



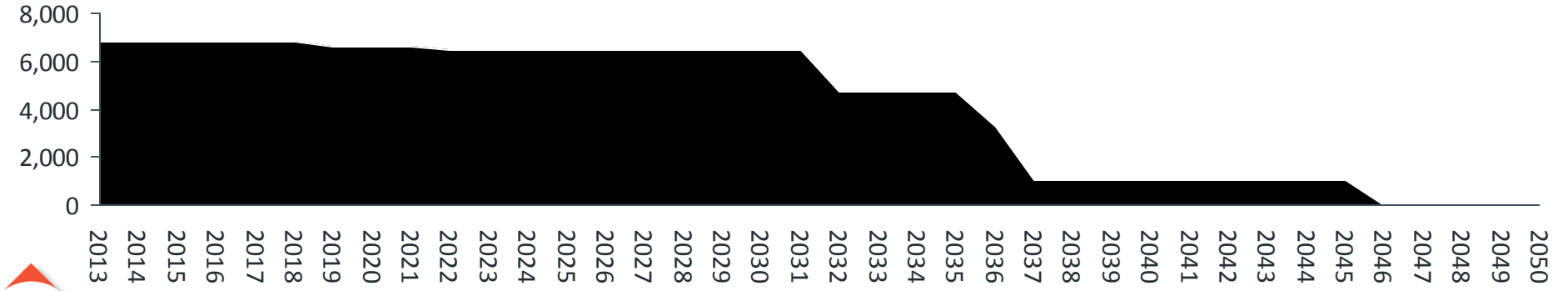
Average of 2011-2014
174 GWh

Imports: Use of the interconnector for imports peaks in 2031, until VIC brown coal generation starts reducing strongly

Imports from VIC, GWh, initial high level estimates



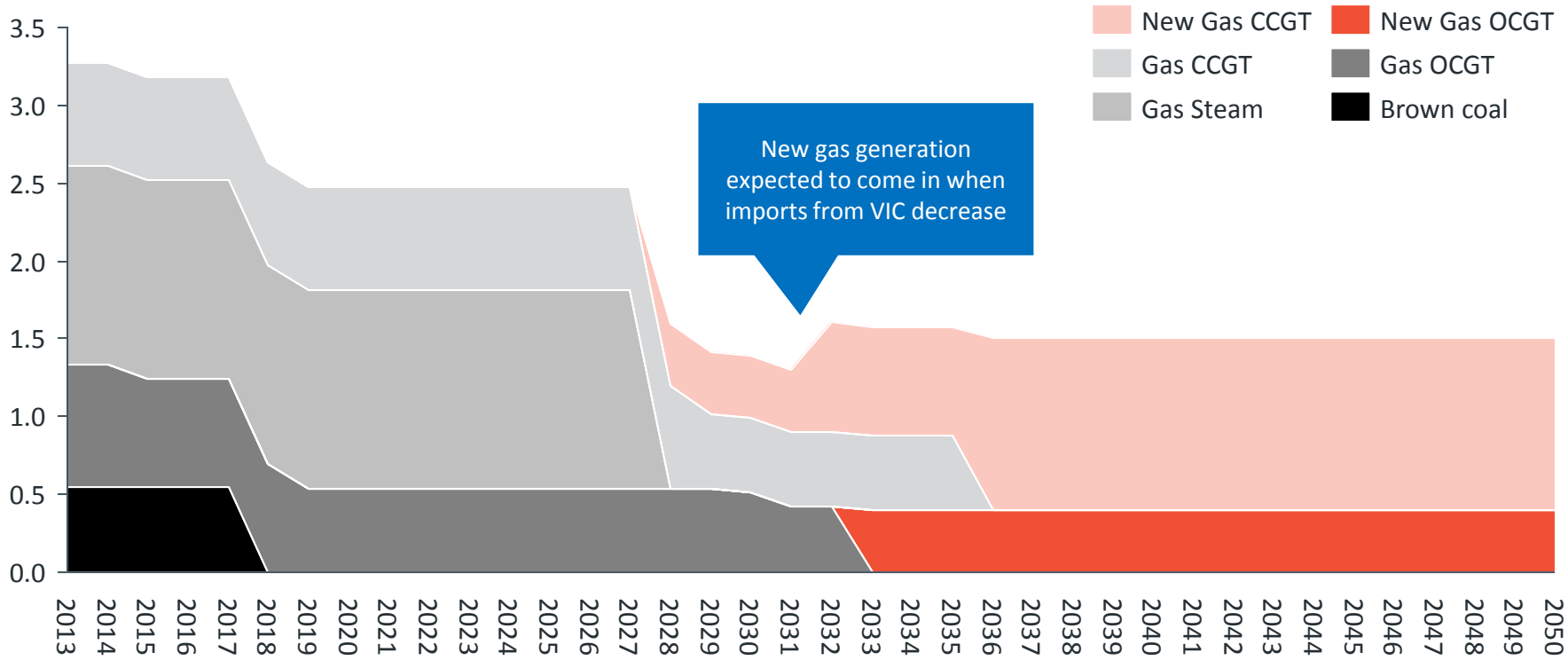
Retirement profile of existing generation assets in VIC, GW[1]



1. Age of Retirement from ACIL Allen review for CCA

Fossil fuels: it is assumed that new CCGT capacity would fill the gap between demand and supply from existing and expected generation

Retirement profile of existing generation assets in SA, GW[1], and high level estimates of new gas builds



- Additional 1,100 MW of CCGT capacity, staggered over 9 years to meet supply gap
- 400 MW of OCGT gas capacity added from 2028 to 2050 (as per AEMO forecasts)

1. Age of Retirement from ACIL Allen review for CCA

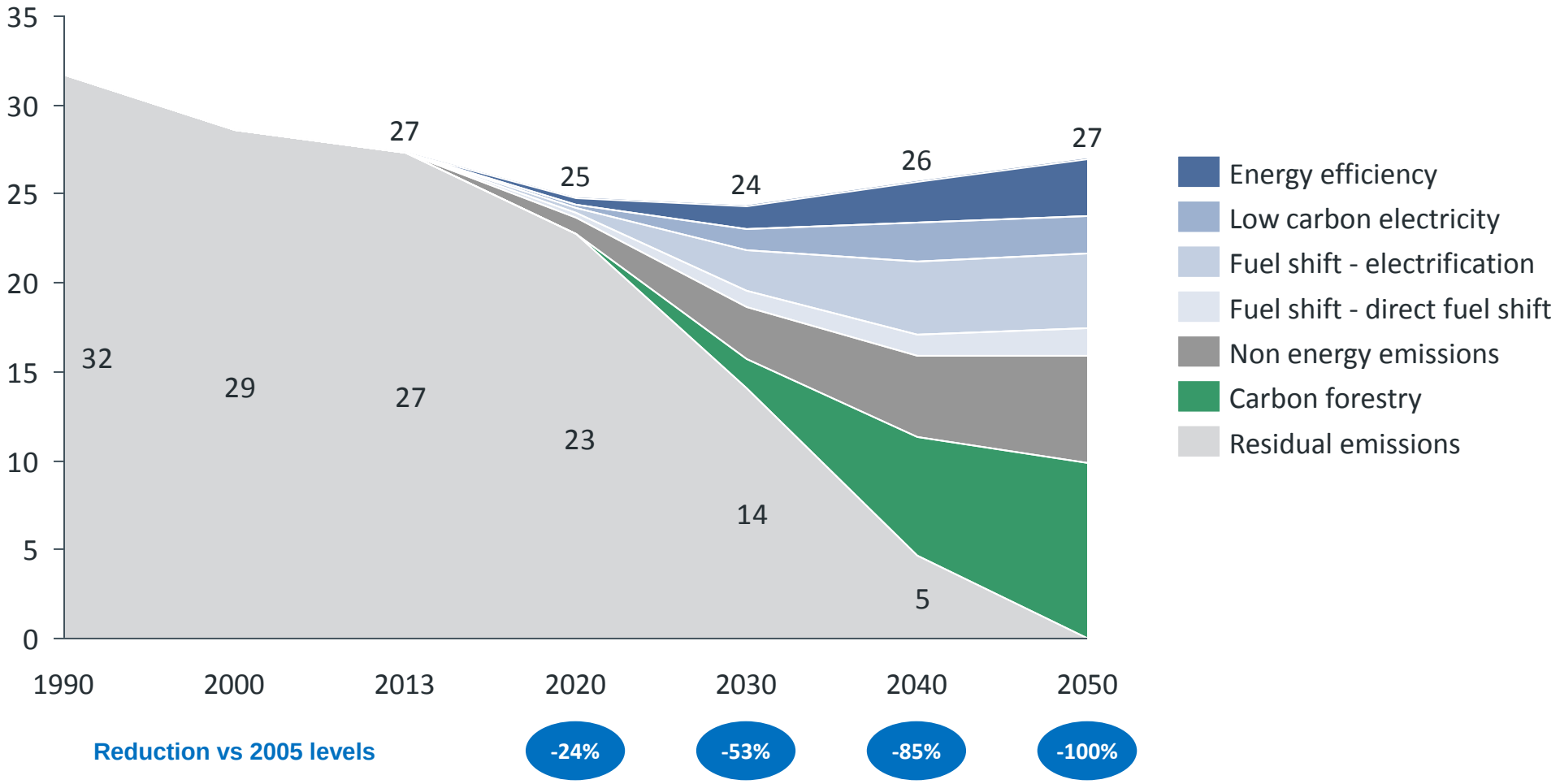
Energy use and non-energy emissions were estimated based on historical trends and government projections

	Sector	Key assumptions	Key sources
Energy emissions	Buildings & Industry	▪ Projections were based on historical trends for growth and fuel mix, adjusted to reflect expected trends in economic growth by sector and recent improvements in energy efficiency ▪ Heavy industry (Iron and Steel production, Non-ferrous metals) was modelled at an asset level and a literature review of existing industrial projects was conducted	▪ BREE energy statistics ▪ ABS population projections ▪ SA gov. economic forecast ▪ Public information on industrial assets & projects
	Transport	▪ Projections were based on the CSIRO modelling done for the CCA targets and progress review, and adjusted based on historical trends and DOE emissions projections where required ▪ In particular, road transport was assumed to grow in line with recent trends (0.1% p.a.), as this rate was much lower than national trends	▪ BREE energy statistics ▪ CSIRO modelling for CCA ▪ DOE emissions projections
Non-energy emissions	Industry	▪ Historical trends were assumed to continue for fugitive emissions ▪ For process emissions, we assumed continued intensity for iron and steel production, and used national trends from the DOE projections for other contributions (no data on breakdown)	▪ NGGI emissions statistics ▪ DOE emissions projections
	Agriculture	▪ Projections were based on the historical emissions trends, with moderate decreases expected in livestock emissions and moderate increases in other agricultural emissions	▪ NGGI emissions statistics
	Forestry	▪ Slight decrease in forestry emissions (negative) expected over time, as existing plantations are harvested, and currently limited reforestation projects are registered for the ERF	▪ NGGI emissions statistics ▪ DOE emissions projections ▪ ERF projects registry
	Waste	▪ Waste emissions modelled to stay about constant, with recent increases trends offset by ERF participation	▪ NGGI emissions statistics ▪ ERF projects registry

CONTENTS

South Australia can achieve net zero emissions by 2050 without using its full renewables and carbon forestry potential

South Australian emissions reduction opportunities, MtCO2e



South Australia can achieve net zero emissions by 2050 without using its full renewables and carbon forestry potential

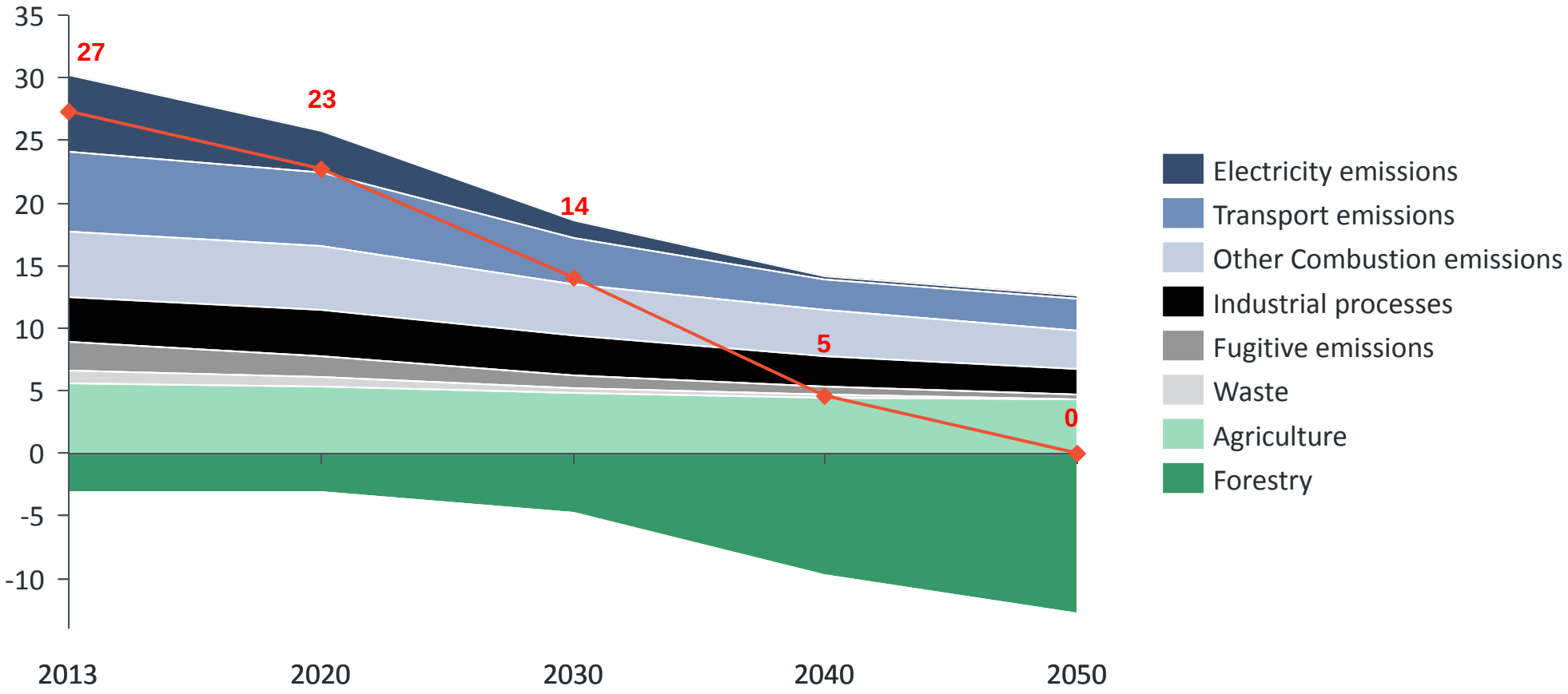
South Australian emissions reduction opportunities, MtCO2e

Emissions	1990	2000	2013	2020	2030	2040	2050
Energy efficiency			0.0	0.4	1.3	2.3	3.2
Low carbon electricity			0.0	0.1	1.1	2.2	2.0
Fuel shift - electrification			0.0	0.3	2.3	4.1	4.3
Fuel shift - direct fuel shift			0.0	0.3	0.9	1.2	1.5
Non energy emissions			0.0	0.9	2.9	4.6	6.0
Carbon forestry			0.0	0.0	1.7	6.7	9.9
Residual emissions	31.7	28.6	27.3	22.8	14.0	4.6	0.0

Emissions reduction	2020	2030	2040	2050
Reference case emissions, MtCO2e	24.8	24.4	25.7	26.9
Total abatement potential, MtCO2e	-2.0	-10.3	-21.1	-27.0
Residual emissions, MtCO2e	22.8	14.0	4.6	0.0
Reduction vs ref case	-8%	-42%	-82%	-100%
Reduction vs 2005 levels	-24%	-53%	-85%	-100%
Reduction vs 2000 levels	-20%	-51%	-84%	-100%
Reduction vs 1990 levels	-28%	-56%	-85%	-100%

Residual emissions are mostly made of agriculture, transport and industry emissions

South Australian residual emissions, decarbonised case, MtCO2e



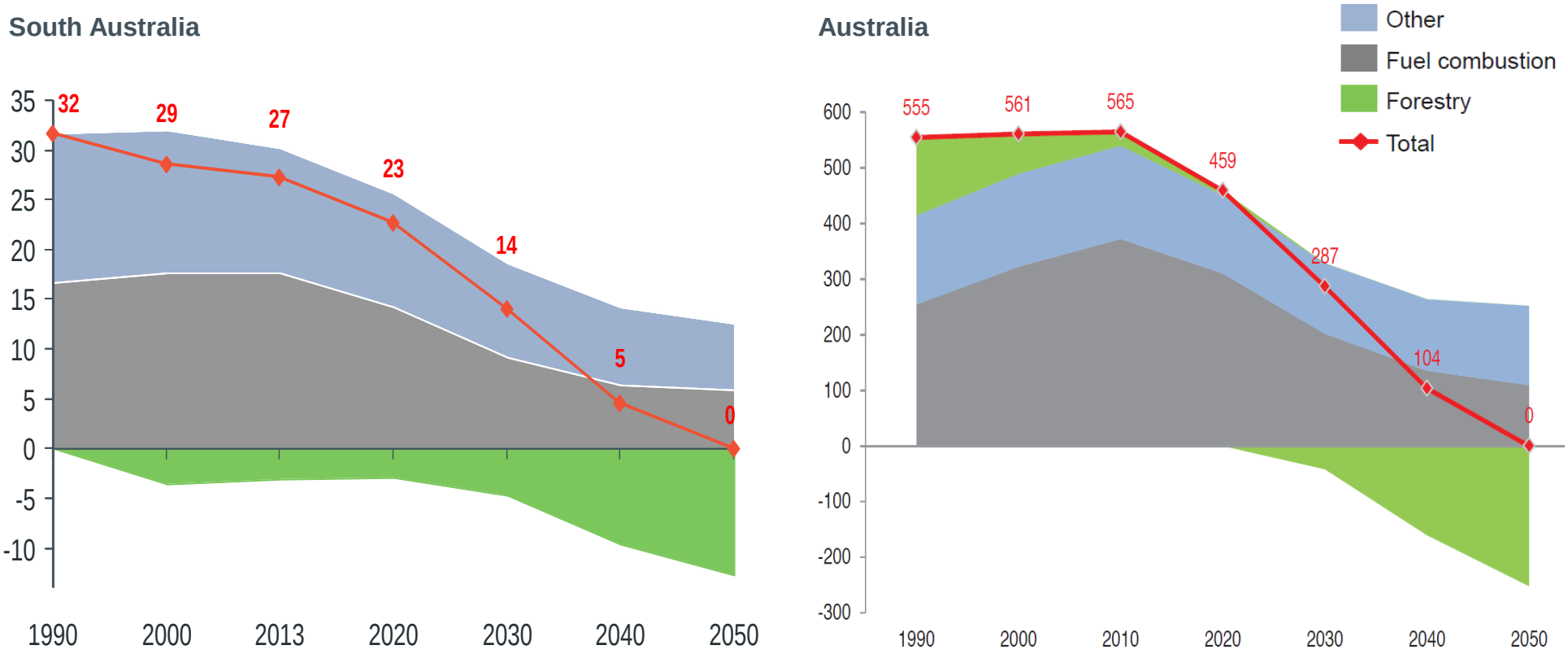
Residual emissions are mostly made of agriculture, transport and industry emissions

South Australian residual emissions, decarbonised case, MtCO2e

Emissions source	2013	2020	2030	2040	2050
Electricity emissions	6.2	3.3	1.4	0.3	0.3
Transport emissions	6.3	5.8	3.7	2.4	2.4
Other Combustion emissions	5.2	5.2	4.1	3.6	3.1
Industrial processes	3.7	3.6	3.1	2.5	2.0
Fugitive emissions	2.2	1.7	1.0	0.6	0.4
Waste	1.0	0.8	0.4	0.2	0.1
Agriculture	5.7	5.4	4.9	4.5	4.3
LULUCF	-3.0	-3.0	-4.7	-9.6	-12.7
Total	27.3	22.8	14.0	4.6	0.0

SA is more advanced than Australia in its journey towards decarbonisation, with lower electricity emissions and already negative forestry emissions

Greenhouse gas emissions trajectory, $MtCO_2e$, 1990-2050



SA is more advanced than Australia in its journey towards decarbonisation, with lower electricity emissions and already negative forestry emissions

Greenhouse gas emissions trajectory, $MtCO_2e$, 1990-2050

South Australia

Emissions	1990	2000	2013	2020	2030	2040	2050
Forestry	0.0	-3.5	-3.0	-3.0	-4.7	-9.6	-12.7
Other	14.9	14.4	12.6	11.5	9.4	7.9	6.8
Fuel combustion	16.7	17.7	17.7	14.3	9.3	6.4	5.9
Residual emissions	31.7	28.6	27.3	22.8	14.0	4.6	0.0

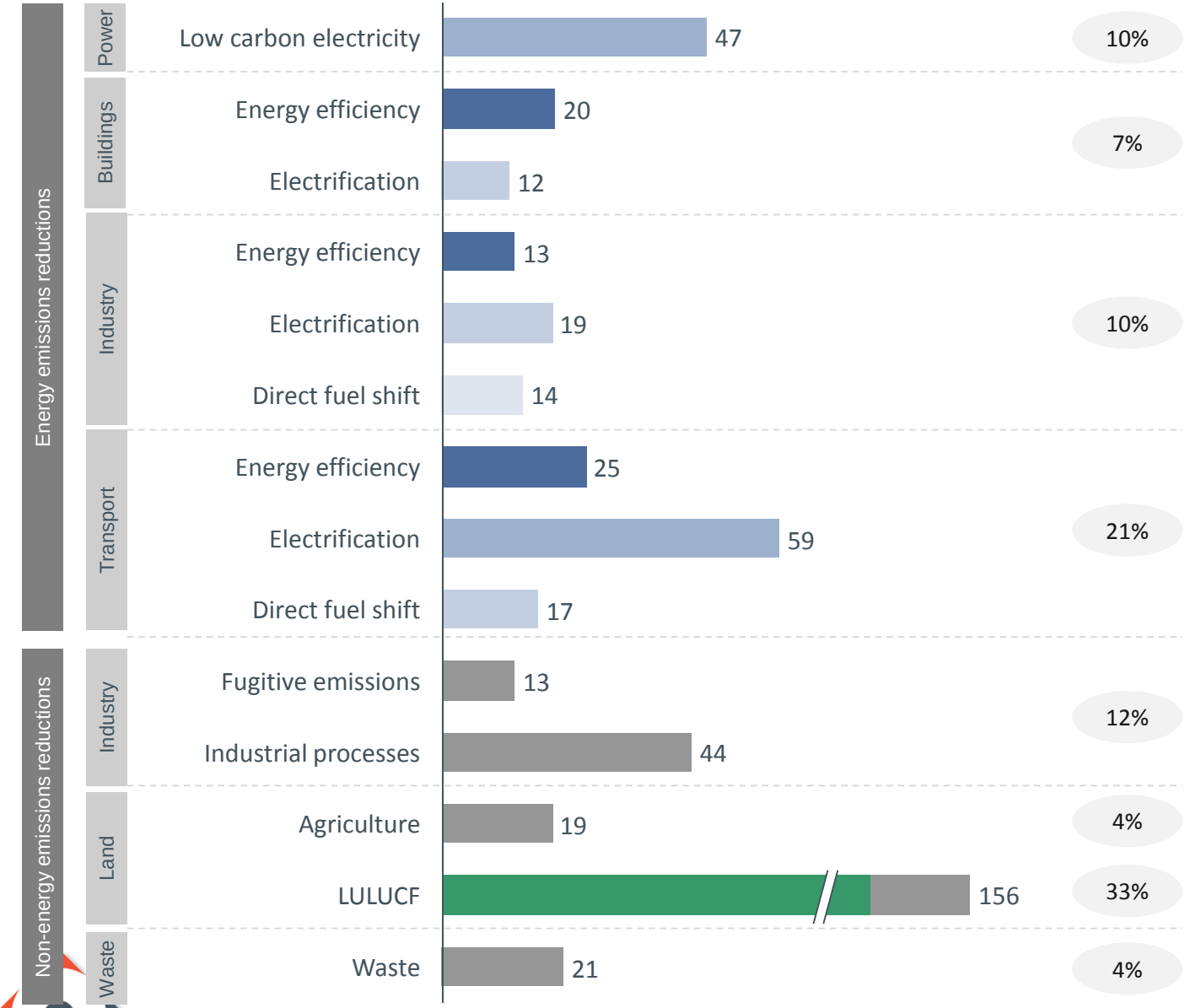
SA is more advanced than Australia in its journey towards decarbonisation, with lower electricity emissions and already negative forestry emissions

Including imports

Emissions reduction	2020	2030	2040	2050
Reference case emissions, MtCO2e	26.4	26.4	25.7	26.9
Total abatement potential, MtCO2e	-1.2	-12.4	-21.1	-27.0
Residual emissions, MtCO2e	25.2	14.0	4.6	0.0
Reduction vs ref case	-4%	-47%	-82%	-100%
Reduction vs 2005 levels	-25%	-58%	-86%	-100%
Reduction vs 2000 levels	-22%	-56%	-86%	-100%
Reduction vs 1990 levels	-28%	-60%	-87%	-100%

Note: No data on electricity imports pre-2005, assumes 1990 and 2000 import levels were equivalent to 2005 levels (around 2.6 TWh), assumes all imports are brown coal

The largest opportunities are in electricity, carbon forestry and transport



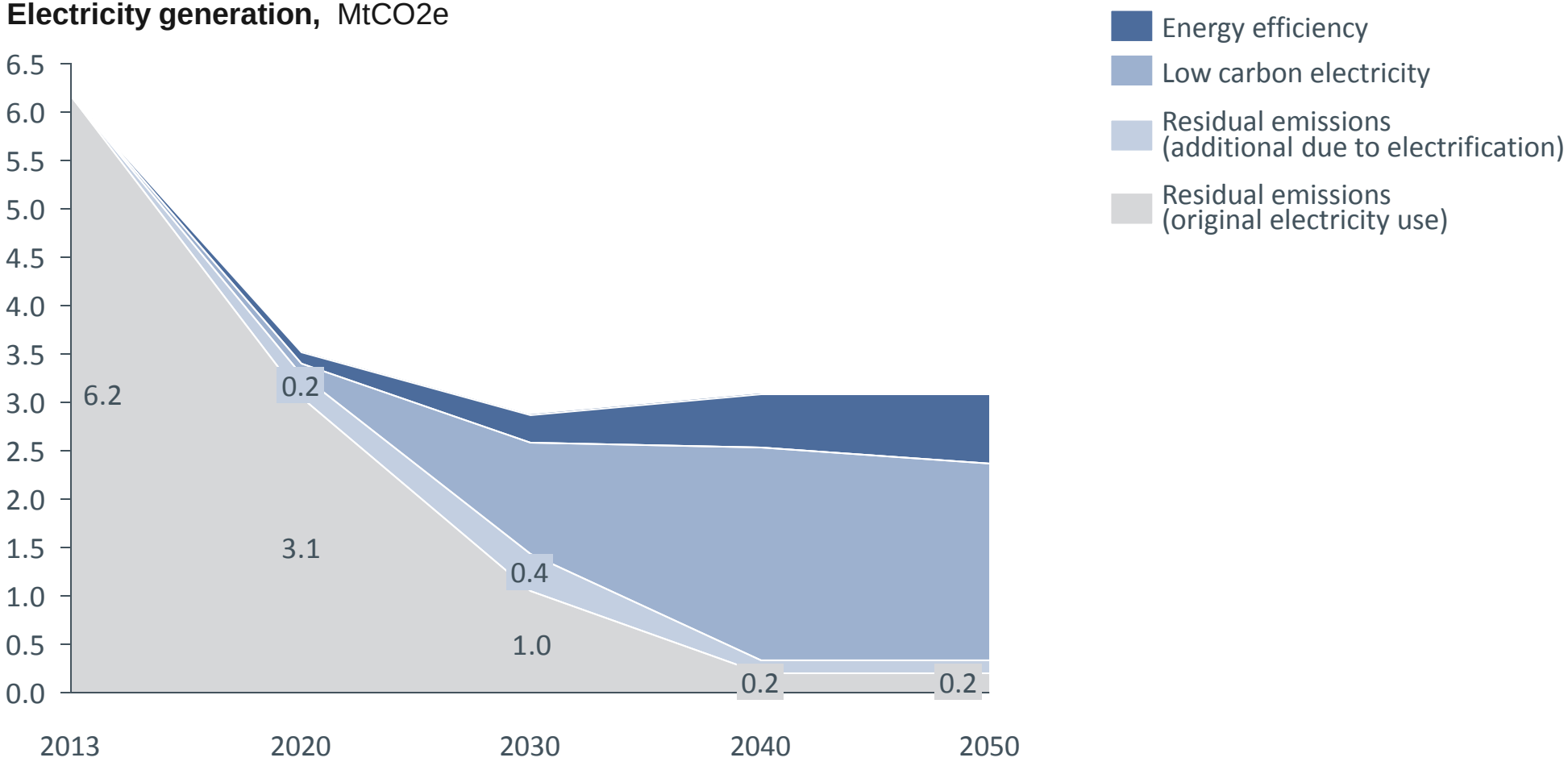
Total cumulative emissions reduction potential by sector 2013-2050, MtCO2e

Categories

Energy efficiency	12%
Low carbon electricity	10%
Electrification	19%
Direct fuel shift	7%
Non-energy	24%
Carbon forestry	29%

Electricity in South Australia can be nearly completely decarbonised, with the reference case expected to achieve significant reductions already

South Australian emissions reduction opportunities, Electricity generation, MtCO2e



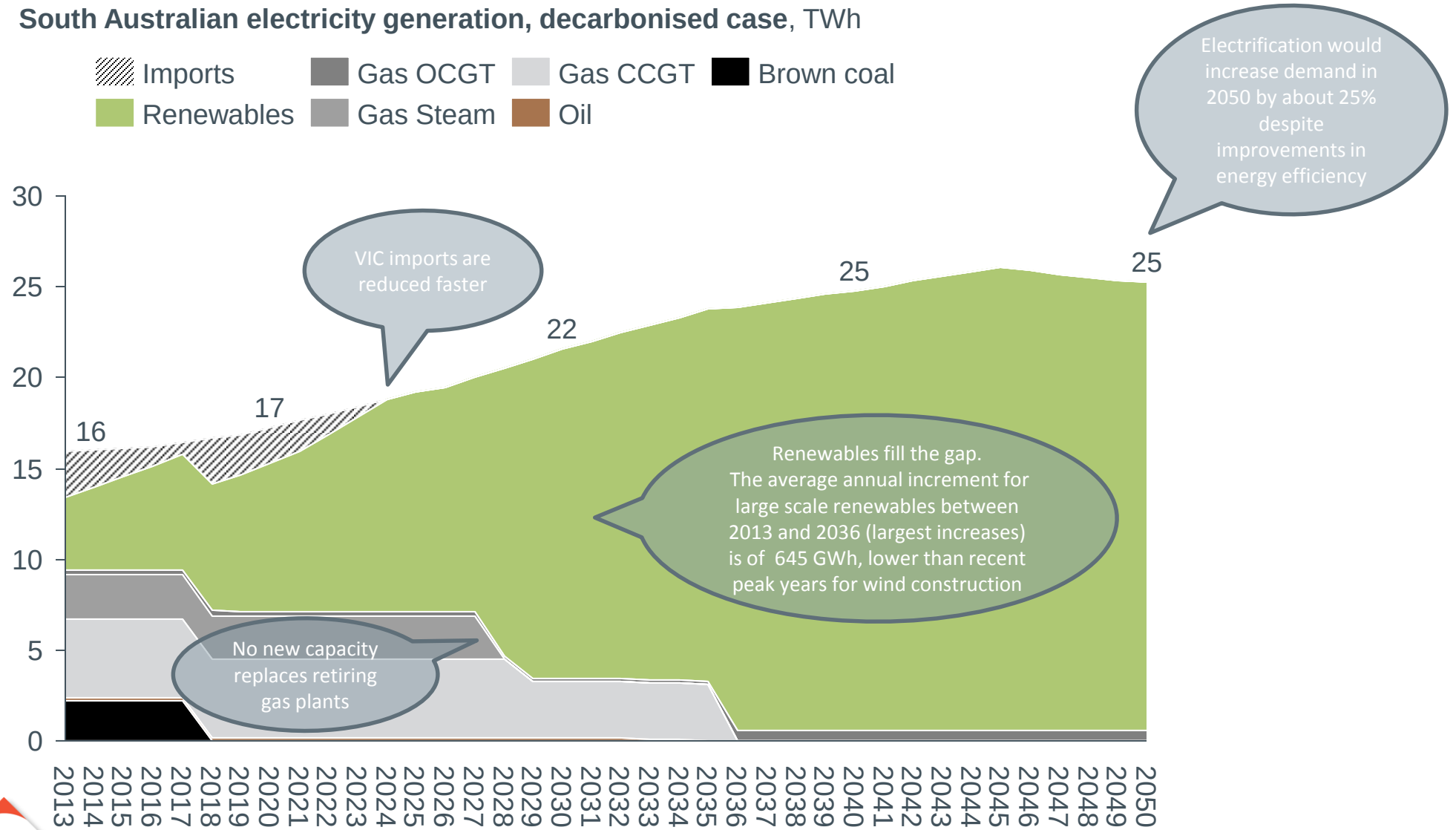
Electricity in South Australia can be nearly completely decarbonised, with the reference case expected to achieve significant reductions already

South Australian emissions reduction opportunities, Electricity generation, MtCO2e

Emissions	2013	2020	2030	2040	2050
Energy efficiency	0.0	0.1	0.3	0.5	0.7
Low carbon electricity	0.0	0.1	1.1	2.2	2.0
Residual emissions (additional from electrification)	0.0	0.2	0.4	0.1	0.1
Residual emissions (original electricity use)	6.2	3.1	1.0	0.2	0.2

South Australia could generate enough renewables to meet all its demand or even start exporting

South Australian electricity generation, decarbonised case, TWh



South Australia could generate enough renewables to meet all its demand or even start exporting

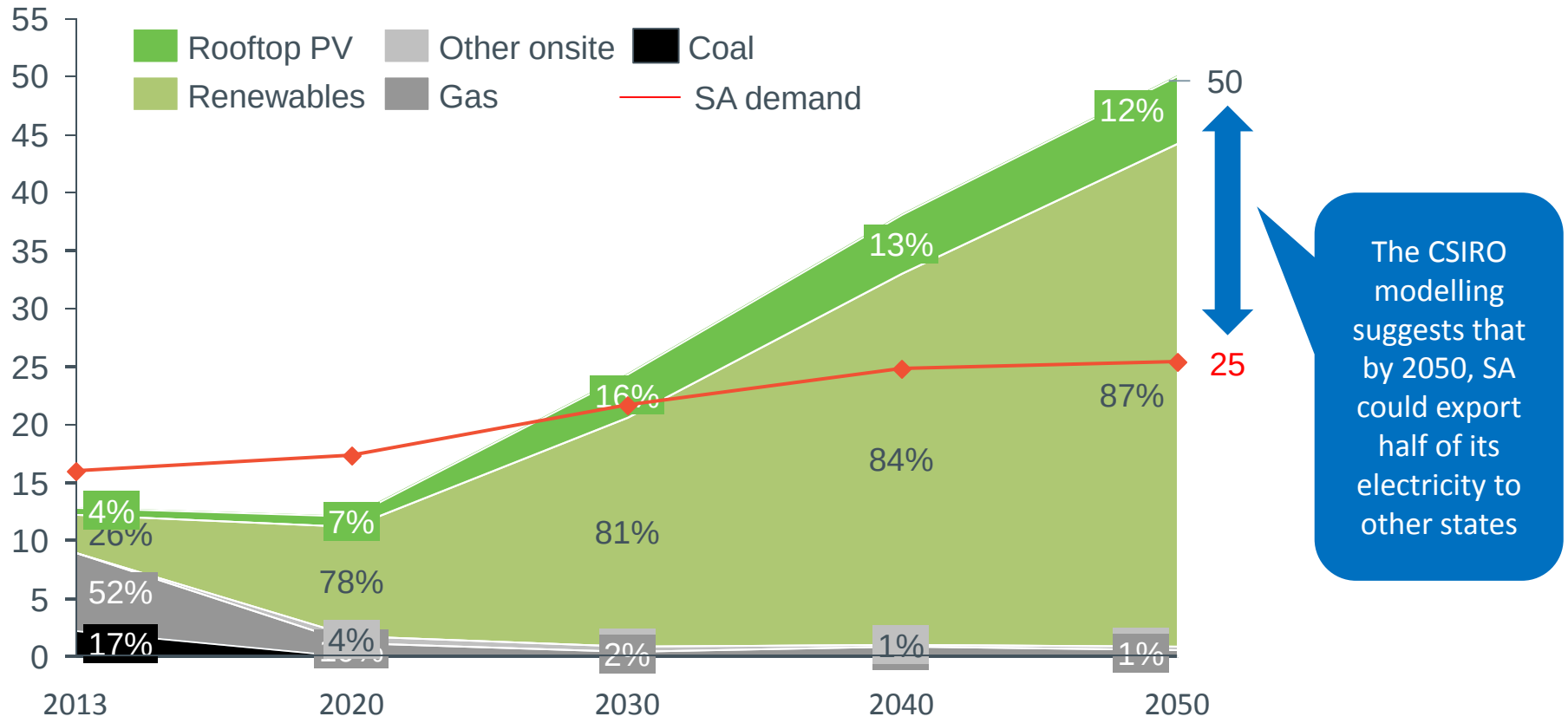
South Australian electricity generation, decarbonised case, GWh

Fuel type	2013	2020	2030	2040	2050
Imports	2,299	1,801	0	0	0
Renewables	3,951	8,144	18,111	24,255	24,721
Gas OCGT	317	218	208	539	539
Gas Steam	2,427	2,427	0	0	0
Gas CCGT	4,317	4,317	3,112	0	0
Oil	141	141	141	0	0
Brown coal	2,238	0	0	0	0
Total	15,689	17,047	21,572	24,794	25,261

As a comparison, the DDPP expects that SA will have more renewables than other states, with intermittency managed at the national level

NOT FOR CIRCULATION
SHARED IN CONFIDENCE

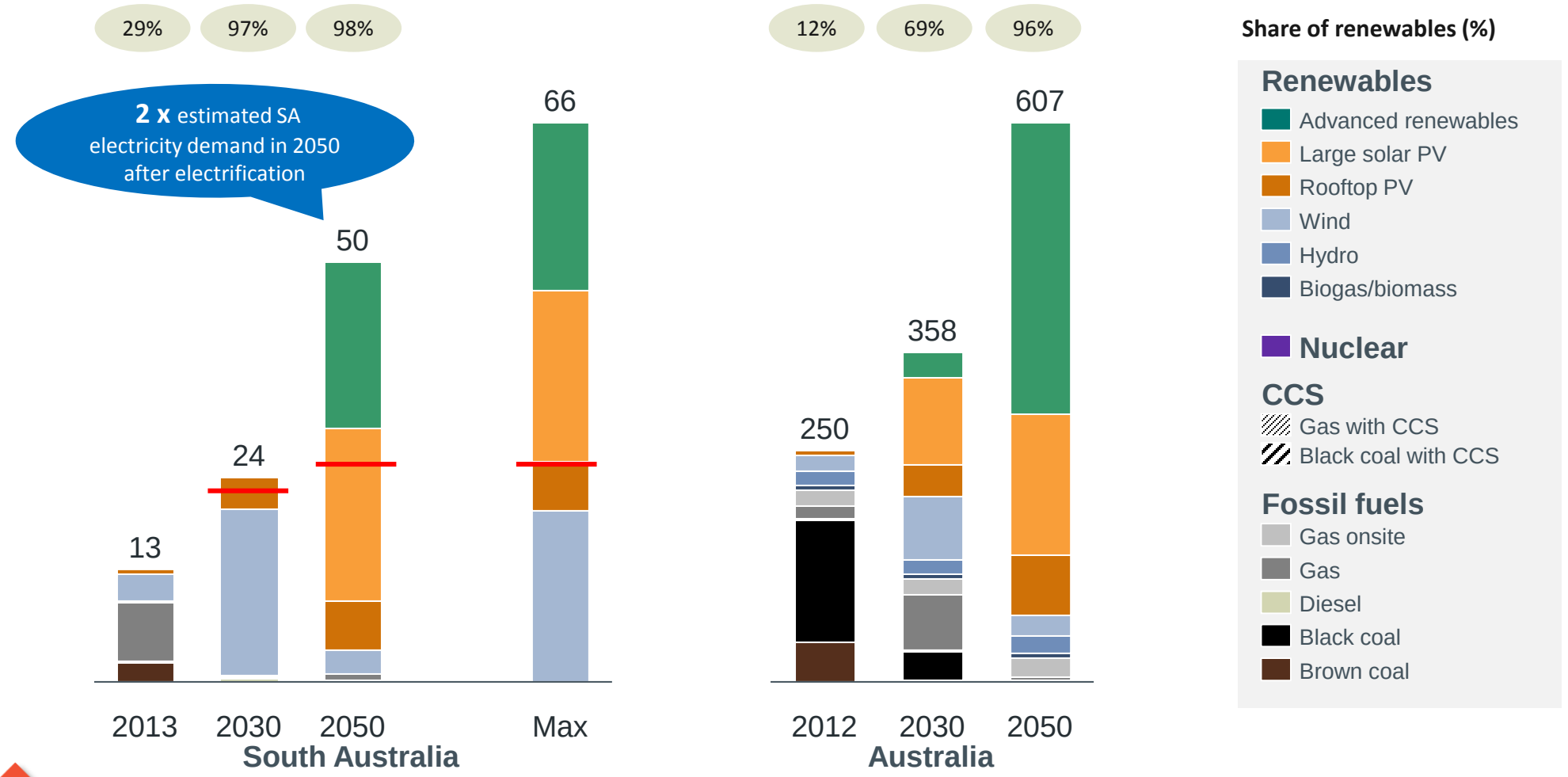
South Australian electricity generation, DDPP 100% renewables, TWh



The CSIRO modelling suggests that by 2050, SA could export half of its electricity to other states

The CSIRO modelling suggests that a range of renewable technologies could be economically viable in South Australia in a decarbonising world

DDPP modelling results, generation by technology in 100% renewables scenario, TWh



Note: We only include results for the 100% renewables scenario as the CSIRO model didn't identify economic potential for CCS and nuclear in SA.

The CSIRO modelling suggests that a range of renewable technologies could be economically viable in South Australia in a decarbonising world

DDPP modelling results, SA generation by technology in 100% renewables scenario, TWh

Technology	2013	2030	2050	max
Hot fractured rocks	0.0	0.0	6.8	6.8
Wave	0.0	0.0	13.0	13.0
Solar thermal with storage	0.0	0.0	0.0	0.0
Solar thermal	0.0	0.0	0.0	0.0
Large solar PV	0.0	0.0	20.4	20.4
Rooftop PV	0.6	3.8	5.8	5.8
Wind	3.3	19.6	2.9	20.2
Hydro	0.0	0.0	0.0	0.0
Biogas/biomass	0.1	0.0	0.0	0.1
Nuclear	0.0	0.0	0.0	
Gas with CCS	0.0	0.0	0.0	
Gas onsite		0.3	0.0	
Gas	7.1	0.2	0.7	
Diesel	0.1	0.3	0.2	
Black coal with CCS	0.0	0.0	0.0	
Black coal		0.0	0.0	
Brown coal	2.2	0.0	0.0	

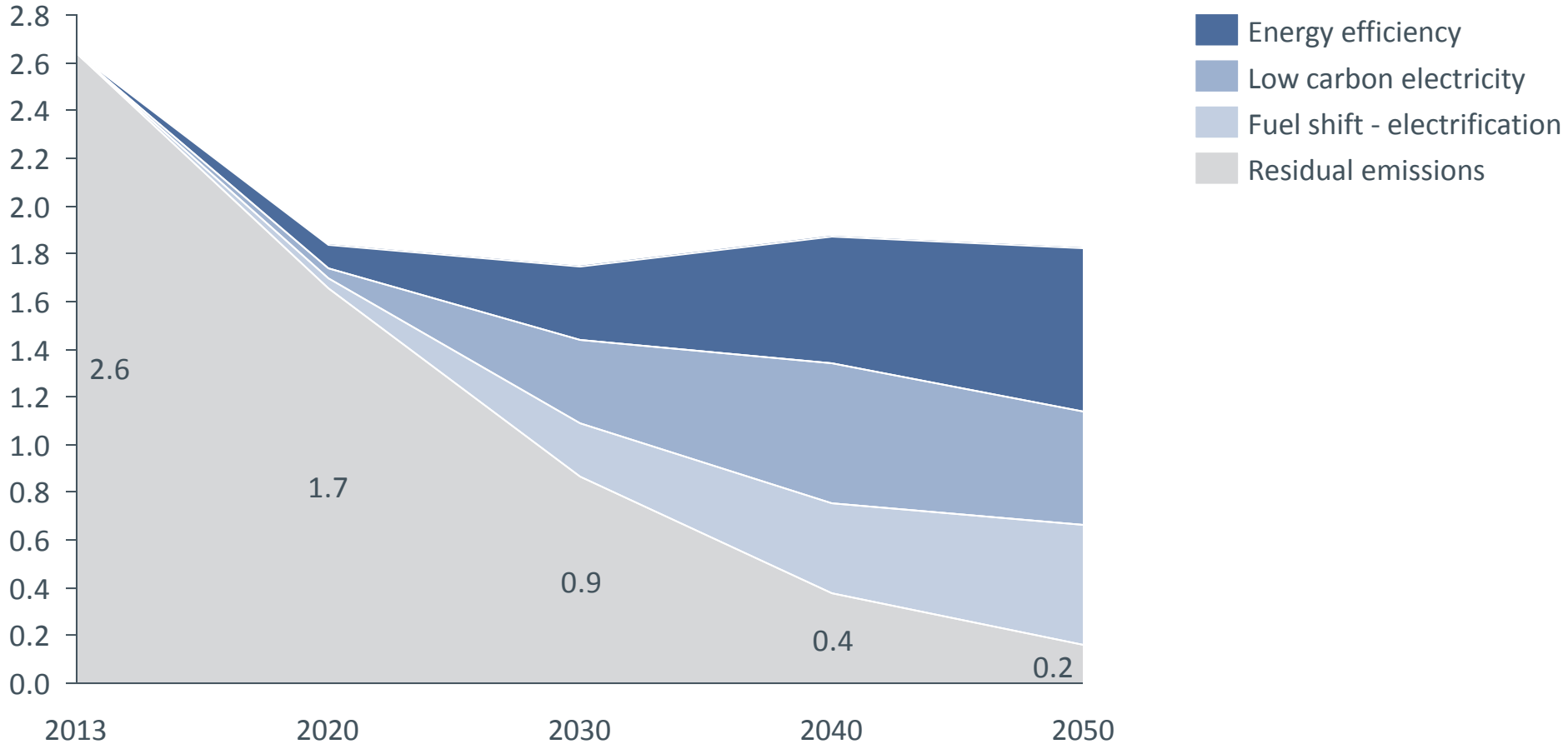
High shares of renewables are enabled by a mix of approaches

Key approaches used to enable high shares of renewables in electricity generation:

- Trading between regions
- Use of flexible fossil fuel generation before assets are retired
- Inclusion of more flexible and load-following renewable technologies, such as wave and enhanced geothermal, hydro and solar thermal with or without thermal storage
- Deployment of electrical storage, in particular battery storage technology appears to be on a trajectory towards significant cost improvements (conservative assumptions were taken for the modelling, with halving of battery costs between 2013 and 2020)
- Demand management could also help to manage intermittency, especially as the penetration of electric vehicles and other distributed electrical storage increases

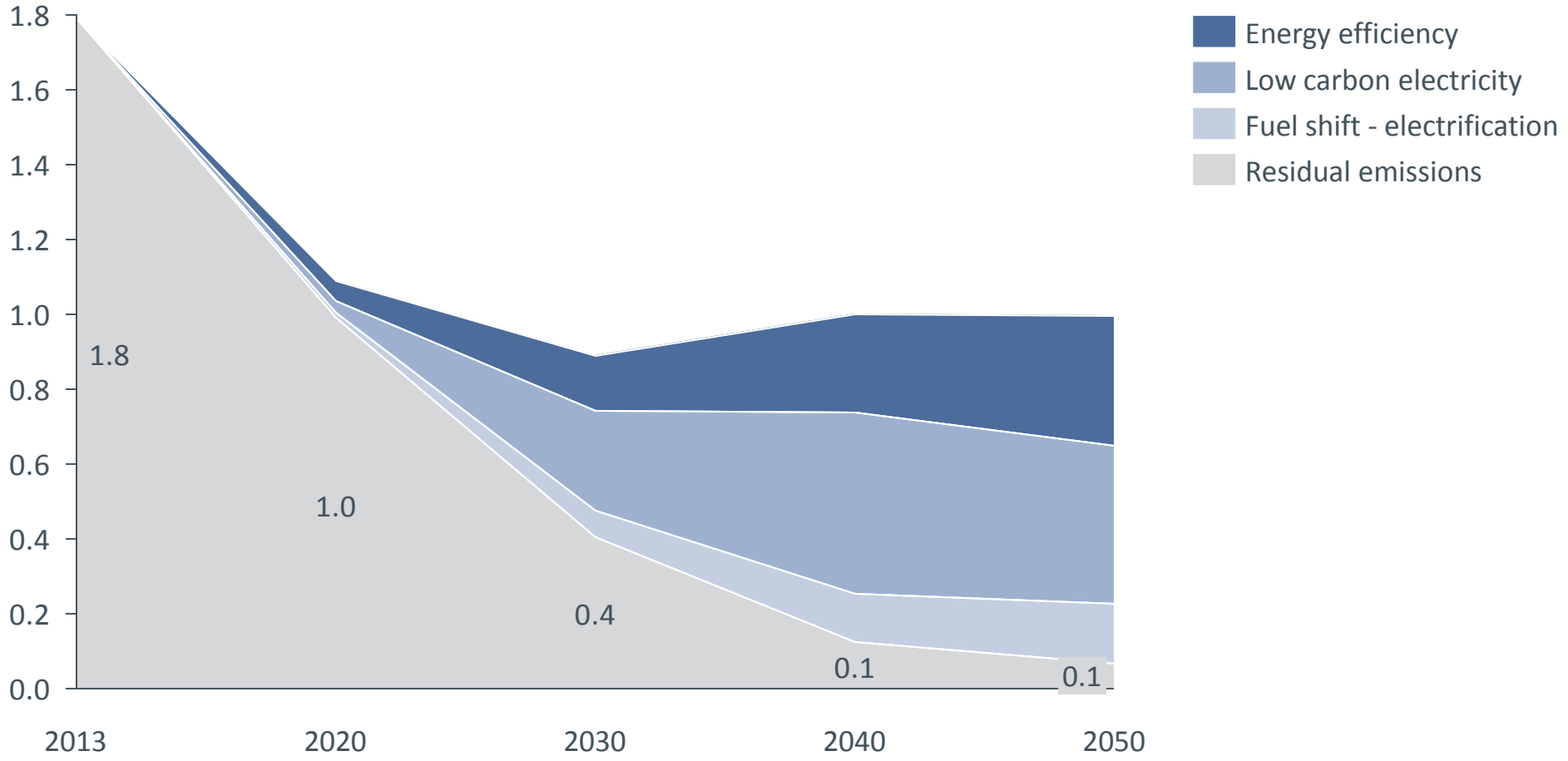
In the residential sector, energy efficiency combined with decarbonised electricity can bring emissions to near zero

South Australian emissions reduction opportunities, Residential buildings, MtCO2e



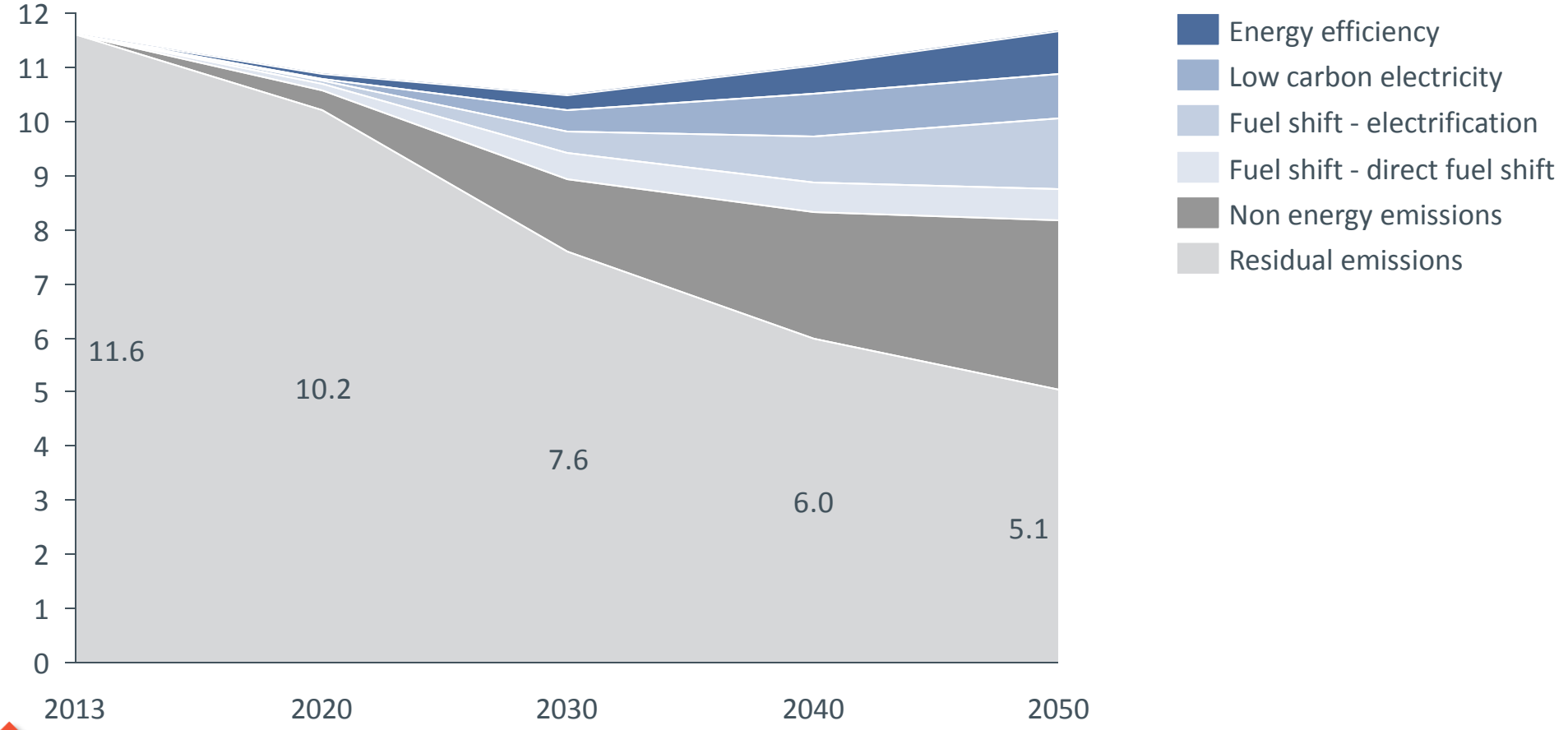
In the commercial sector, low carbon electricity plays a key role due to the high share of electricity in the energy mix today

South Australian emissions reduction opportunities, Commercial buildings, MtCO2e



Industry emissions require a combination of decarbonisation approaches, with reduction of non-energy emissions in Iron and Steel, Cement and refrigerant gases offering particularly large opportunities

South Australian emissions reduction opportunities, Industry, MtCO2e

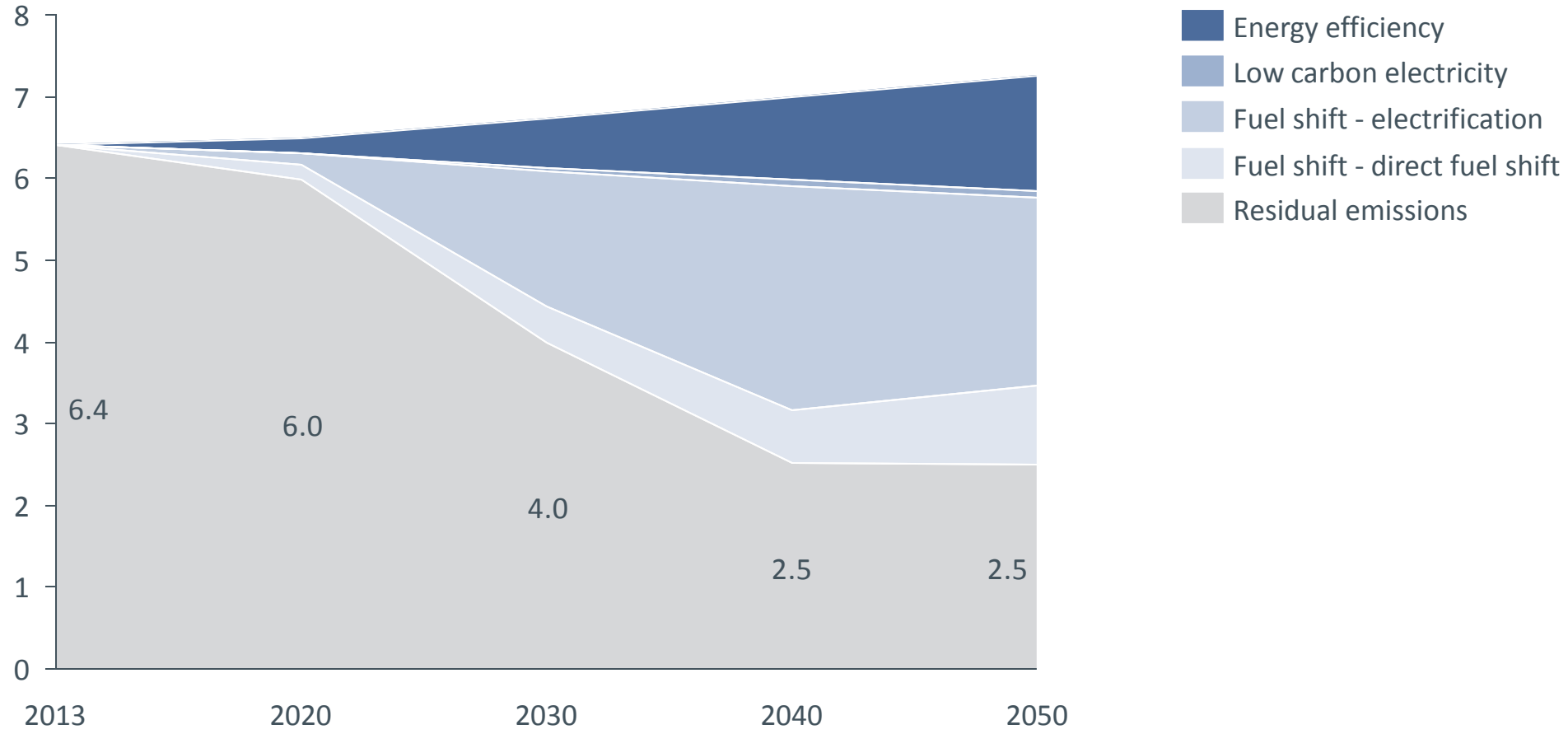


Data

Residential					
Emissions	**2013**	**2020**	**2030**	**2040**	**2050**
Energy efficiency	0.0	0.1	0.3	0.5	0.7
Low carbon electricity	0.0	0.0	0.3	0.6	0.5
Fuel shift - electrification	0.0	0.0	0.2	0.4	0.5
Residual emissions	2.6	1.7	0.9	0.4	0.2
Commercial					
Emissions	**2013**	**2020**	**2030**	**2040**	**2050**
Energy efficiency	0.0	0.1	0.1	0.3	0.3
Low carbon electricity	0.0	0.0	0.3	0.5	0.4
Fuel shift - electrification	0.0	0.0	0.1	0.1	0.2
Residual emissions	1.8	1.0	0.4	0.1	0.1
Industry					
Emissions	**2013**	**2020**	**2030**	**2040**	**2050**
Energy efficiency	0.0	0.1	0.3	0.5	0.8
Low carbon electricity	0.0	0.0	0.4	0.8	0.8
Fuel shift - electrification	0.0	0.1	0.4	0.9	1.3
Fuel shift - direct fuel shift	0.0	0.1	0.5	0.5	0.6
Non energy emissions	0.0	0.4	1.3	2.3	3.1
Residual emissions	11.6	10.2	7.6	6.0	5.1

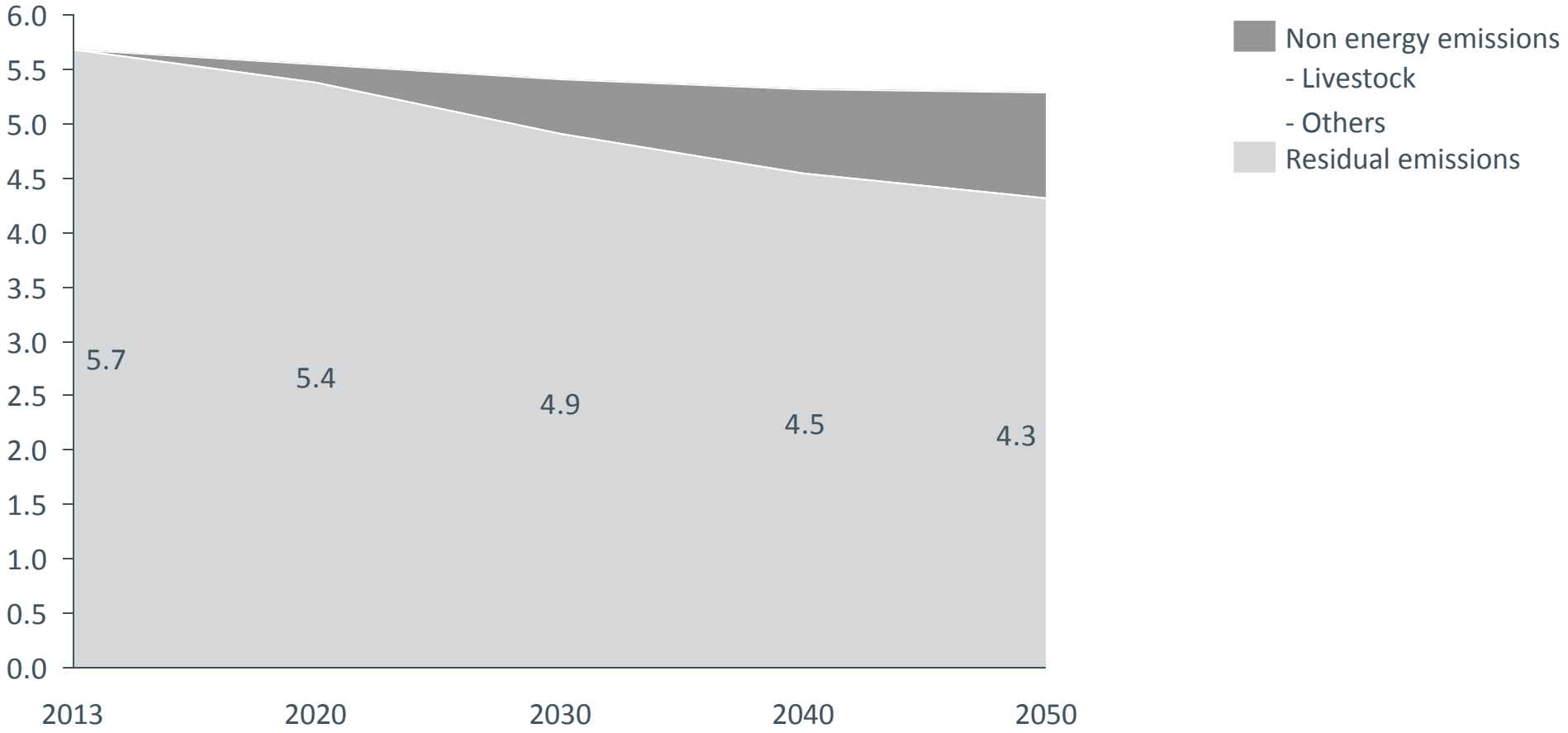
High emissions reductions can be achieved in transport, in particular for cars with energy efficiency and electrification

South Australian emissions reduction opportunities, Transport, MtCO2e



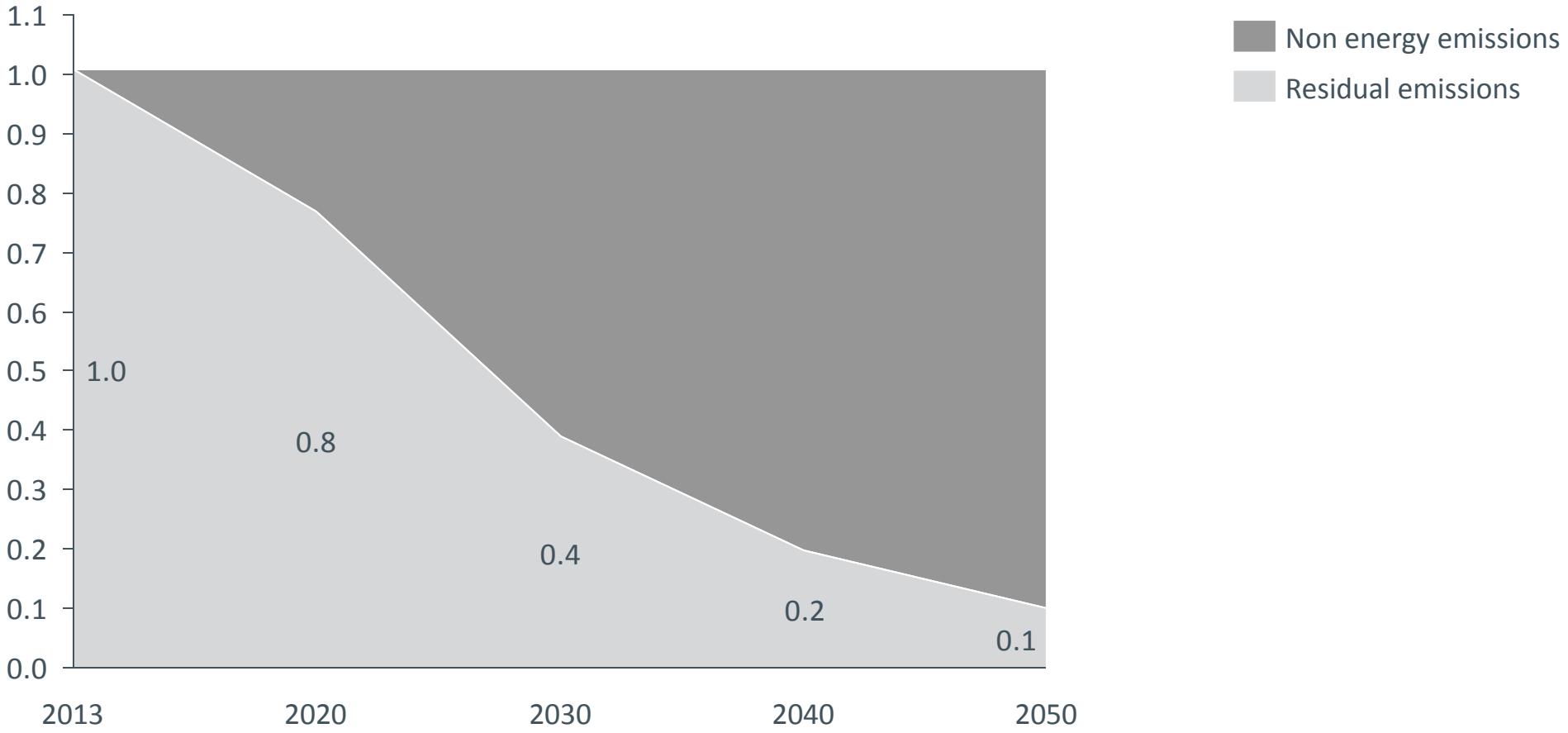
Only limited abatement potential exists in the agriculture sector

South Australian emissions reduction opportunities, Agriculture, MtCO2e



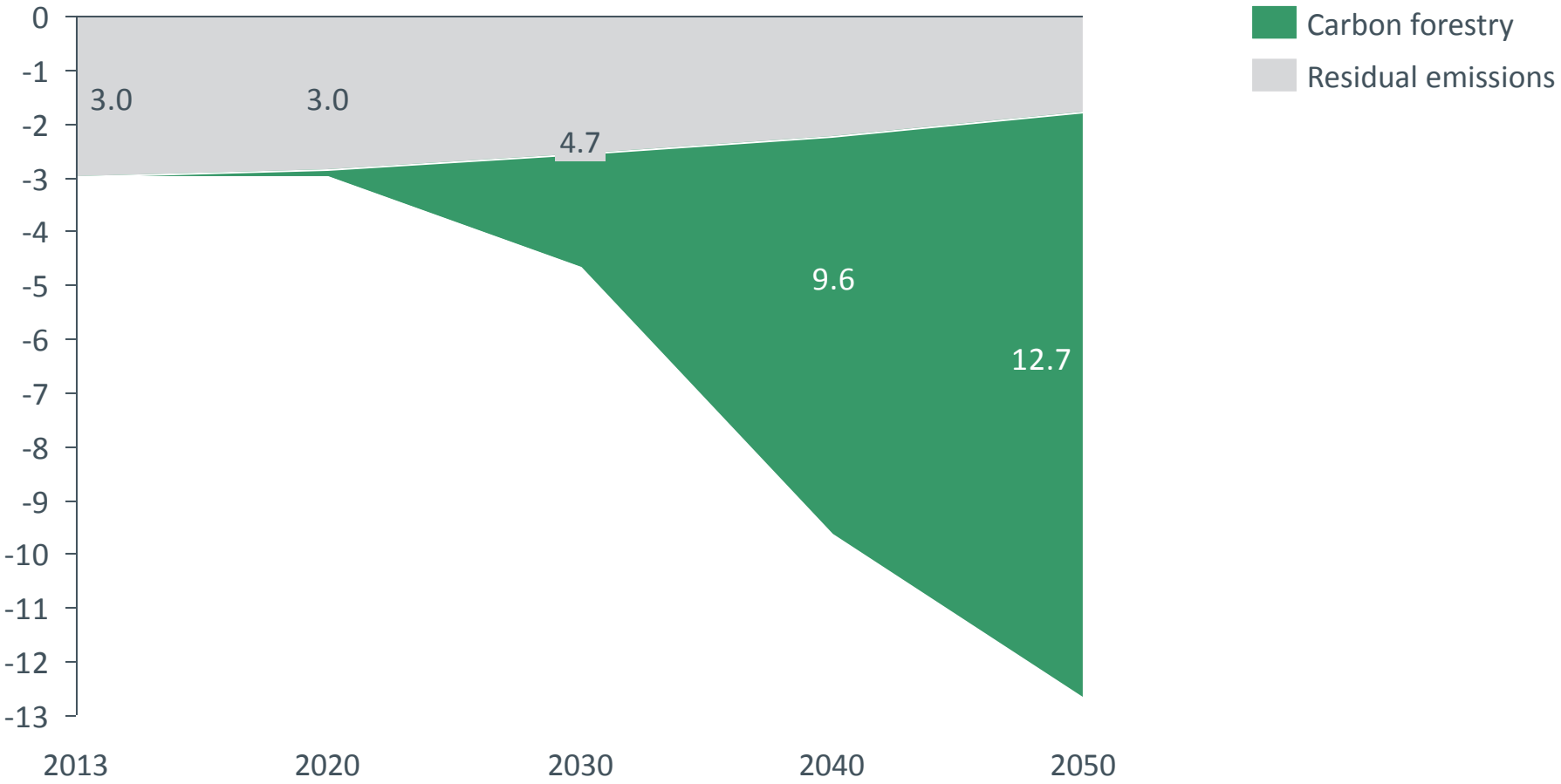
Waste emissions could be nearly eradicated through capture and combustion of landfill methane

South Australian emissions reduction opportunities, Waste, MtCO2e



Using 37% of the total carbon forestry potential available in the state could offset all residual emissions in South Australia by 2050

South Australian emissions reduction opportunities, Forestry, MtCO2e

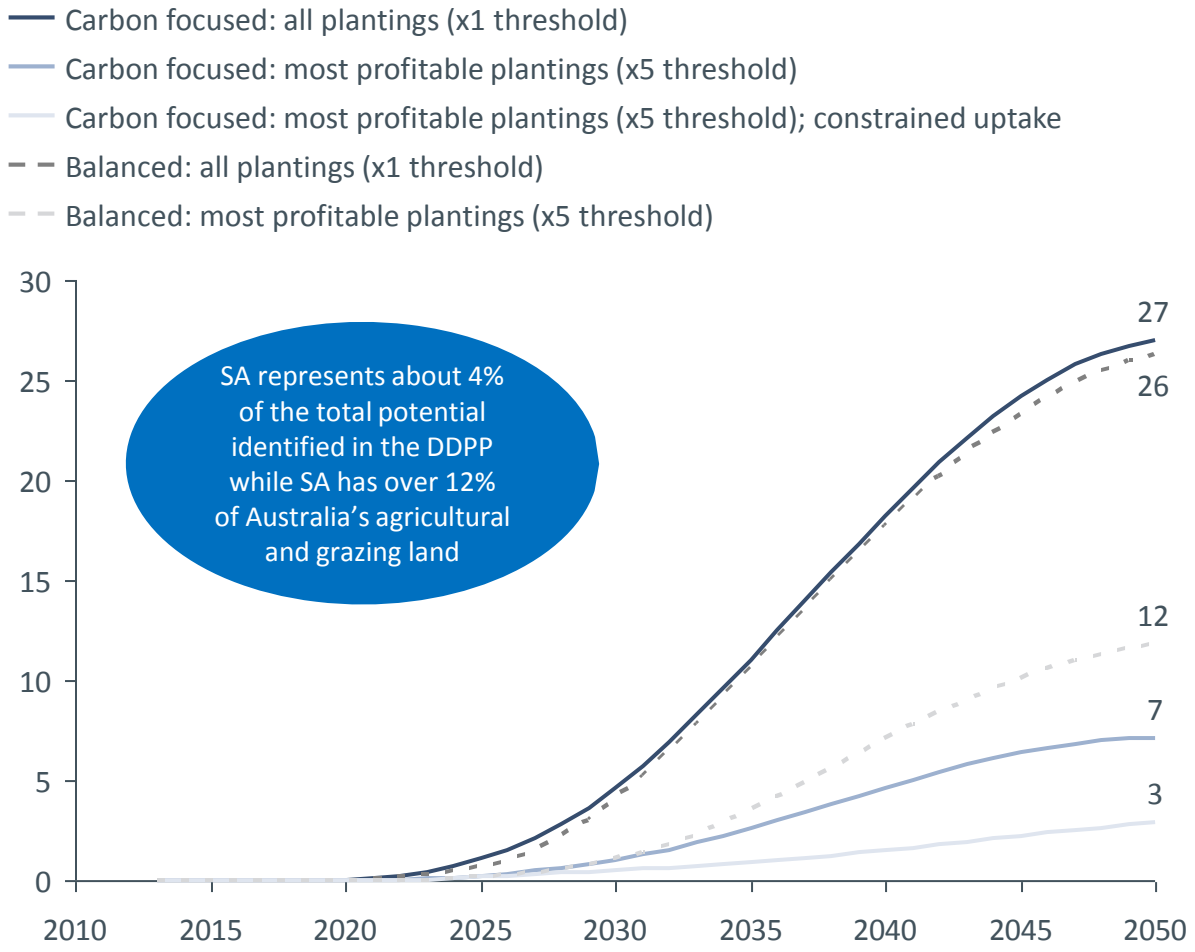


Data

Transport					
Emissions	**2013**	**2020**	**2030**	**2040**	**2050**
Energy efficiency	0.0	0.2	0.6	1.0	1.4
Low carbon electricity	0.0	0.0	0.0	0.1	0.1
Fuel shift - electrification	0.0	0.2	1.6	2.7	2.3
Fuel shift - direct fuel shift	0.0	0.2	0.4	0.6	1.0
Residual emissions	6.4	6.0	4.0	2.5	2.5
Agriculture					
Emissions	**2013**	**2020**	**2030**	**2040**	**2050**
Non energy emissions	0.0	0.2	0.5	0.8	1.0
Residual emissions	5.7	5.4	4.9	4.5	4.3
Waste					
Emissions	**2013**	**2020**	**2030**	**2040**	**2050**
Non energy emissions	0.0	0.2	0.6	0.8	0.9
Residual emissions	1.0	0.8	0.4	0.2	0.1
Forestry					
Emissions	**2013**	**2020**	**2030**	**2040**	**2050**
Carbon forestry	0.0	0.1	2.1	7.4	10.9
Residual emissions	-3.0	-3.0	-4.7	-9.6	-12.7

The CSIRO modelling suggests that there is about 27 MtCO2e of carbon forestry potential in 2050 under carbon incentives

Carbon abatement potential under various scenarios considered, MtCO2e



Explanation of scenarios

- Carbon focused: incentives provided on volume of carbon sequestered
- Balanced: provides stronger incentives for mixed species plantings yielding both carbon and biodiversity benefits
- X1 threshold: land where carbon forestry offers economic returns higher than current use
- X5 threshold: land where carbon forestry offers economic returns at least 5 times higher than current use
- Constrained uptake: max planting rate of about 0.725 Mha/year across Australia

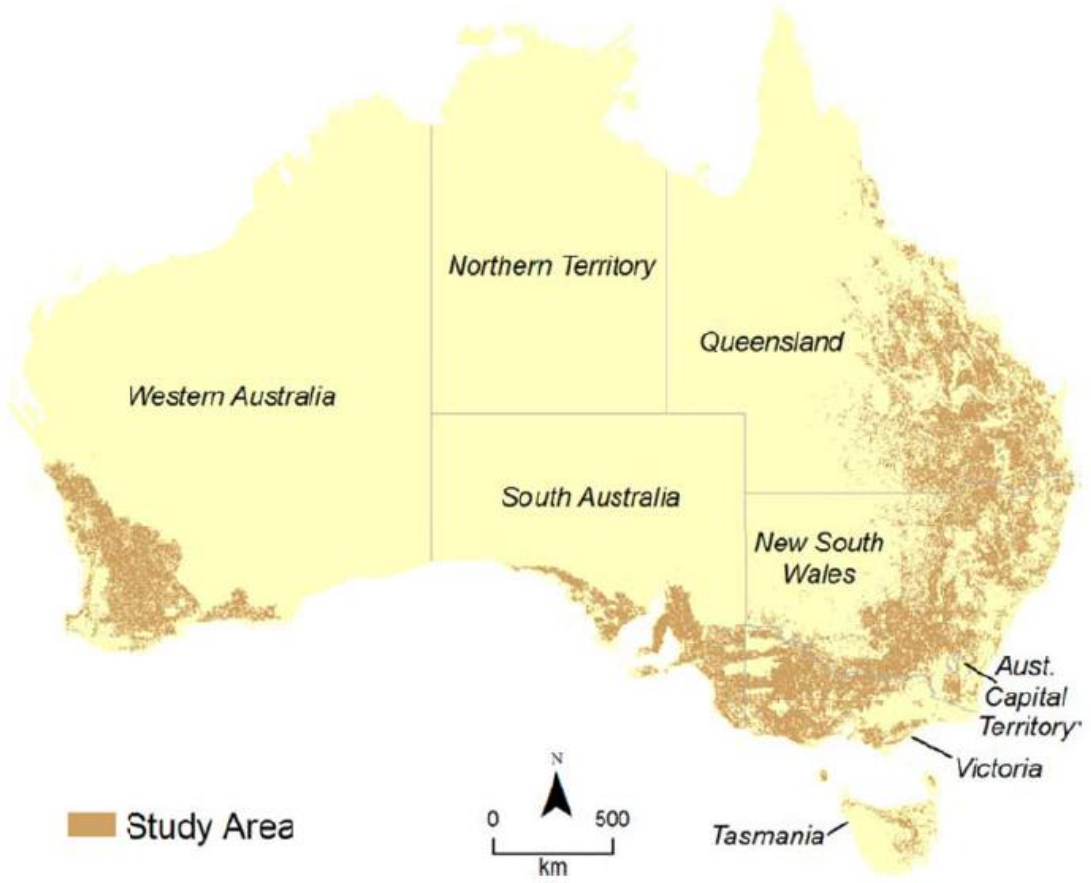
The CSIRO modelling suggests that there is about 27 MtCO2e of carbon forestry potential in 2050 under carbon incentives

Carbon abatement potential under various scenarios considered, MtCO2e

Scenario	2013	2020	2030	2040	2050
Carbon focused: all plantings (x1 threshold) - total	0	0.0	4.6	18.2	27.0
Carbon focused: most profitable plantings (x5 threshold) - total	0	0.0	1.0	4.6	7.1
Carbon focused: most profitable plantings (x5 threshold); constrained uptake - total	0	0.0	0.5	1.5	2.9
Balanced: all plantings (x1 threshold) - total	0	0.0	4.1	17.7	26.3
Balanced: most profitable plantings (x5 threshold) - total	0	0.0	1.1	7.1	11.8

Some limitations are associated with those results

Study area for LUTO model – the Australian intensive use zone



- The **potential could be underestimated** given the coverage of the LUTO model, which only includes a small part of South Australia's land
- It is important to remember that **carbon forestry is not a long term solution** as more and more trees need to be planted to keep stable levels of abatement
- Carbon forestry can be a **useful transition strategy** to help achieve net zero emissions before technologies exist to completely decarbonise industry, transport and agriculture

The emissions reduction potential was estimated at a high level based on existing analyses by ClimateWorks Australia

- The emissions reduction potential was estimated using **previous analysis by ClimateWorks**, in particular:
  - ✓ Deep Decarbonisation Pathways Project (2014)
  - ✓ Low Carbon Growth Plan (2010, 2011)
- These research projects looked at the **technical potential** of abatement opportunities, using:
  - ✓ Technologies already known today – no technology breakthrough was assumed
  - ✓ Technologies which are relatively cost effective – an economic analysis was conducted in particular in the transport, power and land sectors
- The analysis **did not look at the potential impact of policies** to quantify the potential – this means cost estimates do not include an transaction costs that may be incurred by the government
- National findings were **adapted to South Australia at a high level**, and more detailed analysis would be required to understand the exact potential and costs in the state (in particular for regionally-specific opportunities such as carbon forestry, bioenergy and HVAC/insulation)
- The state modelling also only looked at the **potential for the state** and didn't consider opportunities for SA to contribute to decarbonisation in other states (eg. Exports of renewable energy or carbon forestry offsets)

An order of merit has been applied to calculate the emissions reduction from various opportunities

- Step 1: Energy efficiency
  - Energy savings x Reference case emissions intensity of energy
- Step 2: Low carbon electricity
  - Electricity consumption after energy efficiency x reduction in emissions intensity of electricity
- Step 3: Electrification
  - Direct fuel savings x Reference emissions intensity of energy – Electricity use increase x Decarbonised electricity emissions intensity
- Step 4: Other fuel shift
  - Direct fuel use after energy efficiency and electrification x reduction in emissions intensity of direct fuel

CONTENTS

Key findings

- If no further action is taken, South Australia's emissions will stay about stable
- South Australia could achieve a **56% reduction in emissions by 2030 and net zero by 2050**, without using all its renewables and carbon forestry potential
- The **largest opportunities** to reduce emissions include:
  - ✓ Decarbonising the state's electricity generation & electrification (29% total potential)
  - ✓ Carbon forestry to offset residual emissions (29%)
  - ✓ Reducing non-energy emissions, in particular in the industrial sector (24%)
- **More potential exists** that could create economic opportunities for the state:
  - ✓ South Australia could become a net exporter of renewable electricity to other states
  - ✓ South Australia could also become an exporter of carbon offset from forestry plantations