SOUTH AUSTRALIA

Government of South Australia
Department for Energy and Mining

South Australia's Green Paper on the energy transition

Discussing opportunities and challenges as South Australia transitions to a net-zero emissions future.

Minister's Foreword

The Malinauskas Government has embarked on a consultative process to co-design a comprehensive energy transition policy for the next three decades. Through early and meaningful engagement, this government wants to agree on a vision for South Australia's economic transformation by 2050.

To be successful, this policy requires broad agreement on what we want to achieve as a state, and acceptance of what we can do together, to reach our shared objective.

South Australia has declared a Climate Emergency and set itself the bold emissions reduction ambition of net-zero emissions by 2050. A genuinely considered response to this climate emergency and the emissions reduction goal needs to be meticulously planned, yet flexible enough to adapt to changing circumstances.

Two decades ago, when South Australia set out to become a leader in the global energy transformation, I can't imagine we were thinking that by 2023, we'd already be generating around 70 per cent of our state's energy needs through renewable sources.

More than two-thirds of the way toward our target of 100 per cent is an appropriate time to tease out some of the thorny issues still to be addressed, propose some options for further progress, and try to anticipate what lies ahead for our state.

The responses we receive through this Green Paper will feed into a comprehensive, whole-of-government, long-term Energy Transition White Paper that will be the foundation economic document for the remainder of the first half of the 21st Century.

There are undoubtedly short-term energy issues to be resolved in 2023 but this co-designed policy aims to look beyond the horizon to plan for the next steps.

South Australia has already attracted billions of dollars of investment and plenty of first-hand experience. The reward for the efforts we have already made for clearing the obstacles ahead, must be a much cleaner, more prosperous future.

Foremost, any Energy Transition Policy must deliver reasonable energy prices to South Australian consumers, large and small. Our plan will ensure achieving net-zero emissions supports the economic ambitions of our state.

The energy transition also needs to contemplate a virtuous cycle of low-cost energy value-adding to locally sourced minerals that become components of wind turbines, electric vehicles and other products vital to a net-zero emissions world.

As a first step in the process of co-design, I hosted the inaugural Energy Transition Roundtable in November 2022. Bringing together a diverse group of stakeholders, I challenged them to "be part of a bold ambition for our state and to help make a difference".

In reading this document, I hope you too can join us to help guide the state's energy transition, and, in considering the many questions it poses, I would like South Australians to think ahead to what a prosperous, sustainable net-zero emissions future can look like for this state.

Hon Tom Koutsantonis MP

Minister for Infrastructure and Transport
Minister for Energy and Mining

Setting directions

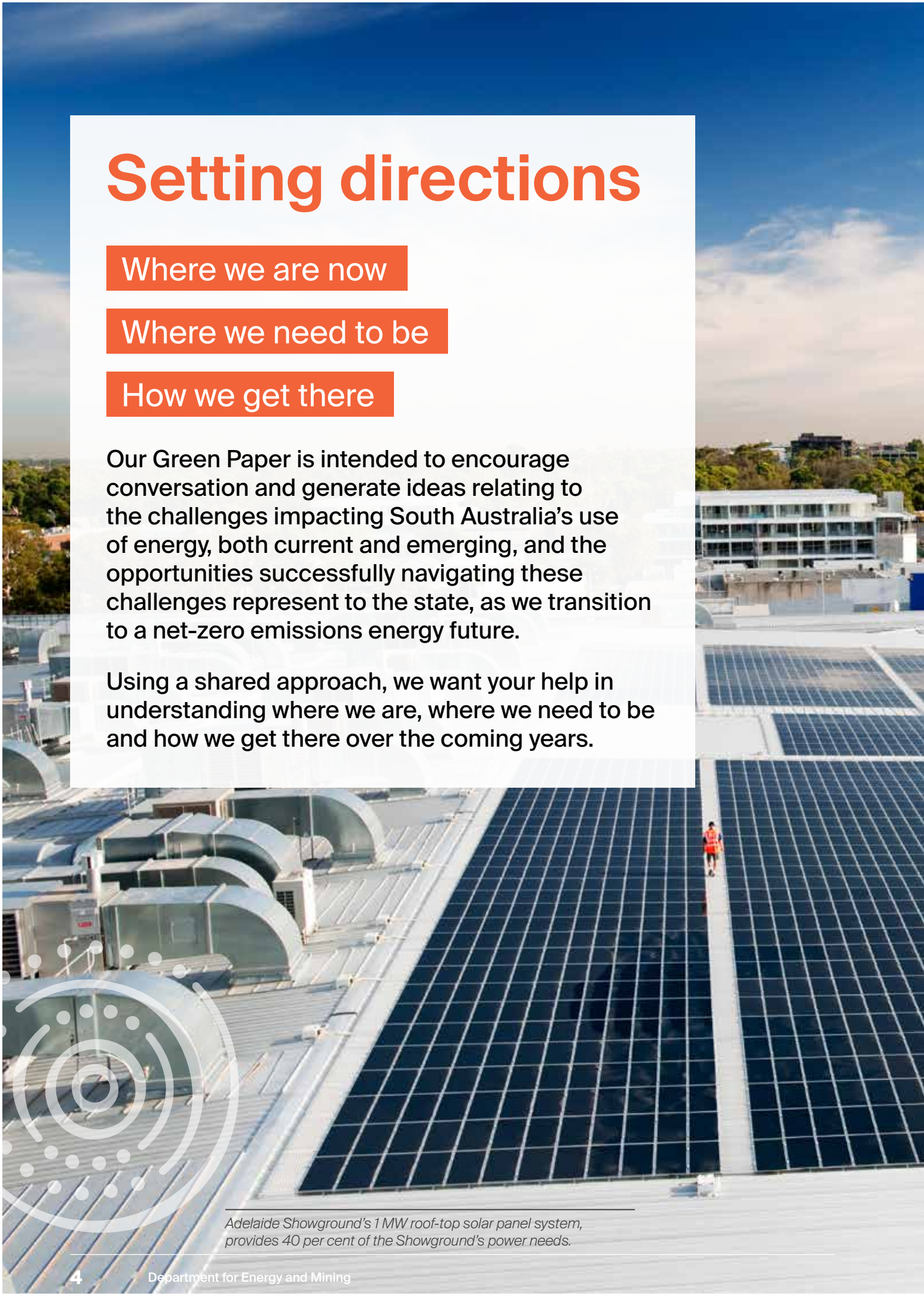
Where we are now

Where we need to be

How we get there

Our Green Paper is intended to encourage conversation and generate ideas relating to the challenges impacting South Australia's use of energy, both current and emerging, and the opportunities successfully navigating these challenges represent to the state, as we transition to a net-zero emissions energy future.

Using a shared approach, we want your help in understanding where we are, where we need to be and how we get there over the coming years.



Adelaide Showground's 1 MW roof-top solar panel system, provides 40 per cent of the Showground's power needs.

Contents

Why is a Green Paper on South Australia's energy transition required?

A transformation of the energy sector offers opportunities for sustainable economic development, social inclusion, ongoing engagement, energy security, improved health, job creation, and other benefits for society.

For almost two decades, South Australia has been at the forefront of the energy transformation process as it transitions to a net-zero emissions future[1].

As the first state to legislate targets to reduce gas through the introduction of the *Climate Change and Greenhouse Emissions Reduction Act 2007*, the Government of South Australia has remained committed to reducing energy costs, improving energy reliability and reducing emissions.

Our state is making good progress towards our emissions reduction goals. In the 2020 financial year, South Australia emitted 25.4 million tonnes of carbon dioxide equivalent ($MtCO_2$-e), a 31 per cent reduction in greenhouse gas emissions compared with the 2005 financial year[2].

With new technologies such as rooftop solar photovoltaic (PV) systems, batteries, electric vehicles (EVs), smart meters and smart appliances continuing to be developed and installed on an ever-increasing basis in the state, our electricity grid is changing from the traditional one-way system delivering electricity to homes and businesses, to a modern two-way system where people can now consume, generate, export and trade energy.

In South Australia, rooftop solar PV, our largest generator, has the capability to provide more than one gigawatt of energy under the right conditions. The Australian Energy Market Operator (AEMO) stated[3] that, in 2021-22, annual rooftop solar PV generation was estimated at 2,269 gigawatt hours (GWh), or 17 per cent of total annual underlying consumption[4]. In the coming years, this number will continue increasing as more and more South Australians take up this economically advantageous technology.

But our electricity grid was not designed to make the best use of these new and emerging technologies, and is now experiencing many new challenges, including frequency and voltage fluctuations, and minimum operational demand and system strength concerns.

1 On 31 May 2022, South Australia's Parliament committed to transforming the economy to zero-net emissions because of the climate emergency.

2 Department of Climate Change, Energy, the Environment and Water, State and territory greenhouse gas inventories: 2020 emissions State and territory greenhouse gas inventories: 2020 emissions - DCCEEW.

3 Australian Energy Market Operator, South Australian Electricity Report, November 2022, South Australian Advisory Functions.

4 Underlying consumption means all the electricity used by consumers, which can be sourced from the grid but also, increasingly, from other sources including consumers' distributed PV and battery storage.

In recent years, external pressures, such as (but not limited to) the COVID-19 Pandemic and more recently, the war in Ukraine, have accelerated the global energy transition. Countries around the world are continuing to recover from a myriad of challenges, from ongoing disrupted supply chains to labour shortages in critical sectors, as well as the increasing impact of inflation and broader cost of living pressures.

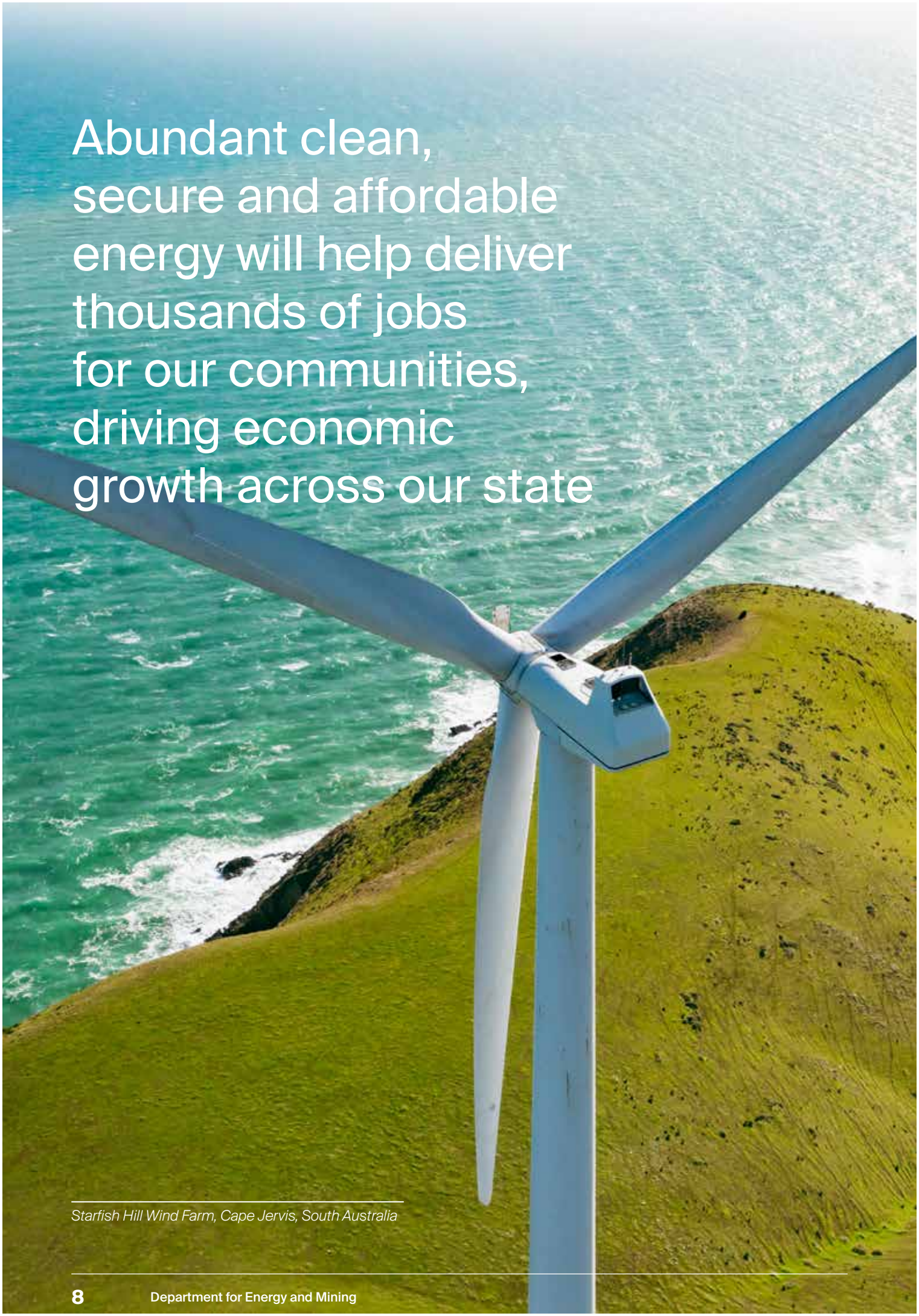
Communities are also becoming increasingly dependent on the energy system, as the digital economy rapidly expands and becomes intrinsically linked with the electricity grid. Not only should the power system be physically secure, but digitally secure too. Protecting Australia's energy sector from cyber threats is of critical importance in supporting economic stability and national security, both now and into the future.

As our energy system continues to change, there are challenges as well as opportunities that need to be identified and explored, to determine their relative impact on South Australian energy consumers, both small and large, as well as the state's economy more broadly.

Work done to date, both in South Australia and beyond, provides an invaluable first step in further policy development, informing the development of this Green Paper. Together with submissions provided by interested stakeholders, this work will inform the basis of a White Paper to be developed by the Government of South Australia in 2023.

The outcomes of this discussion will set in motion the works of tomorrow.

We all have a part to play in our transition to a net-zero emissions future



Abundant clean, secure and affordable energy will help deliver thousands of jobs for our communities, driving economic growth across our state

Starfish Hill Wind Farm, Cape Jervis, South Australia

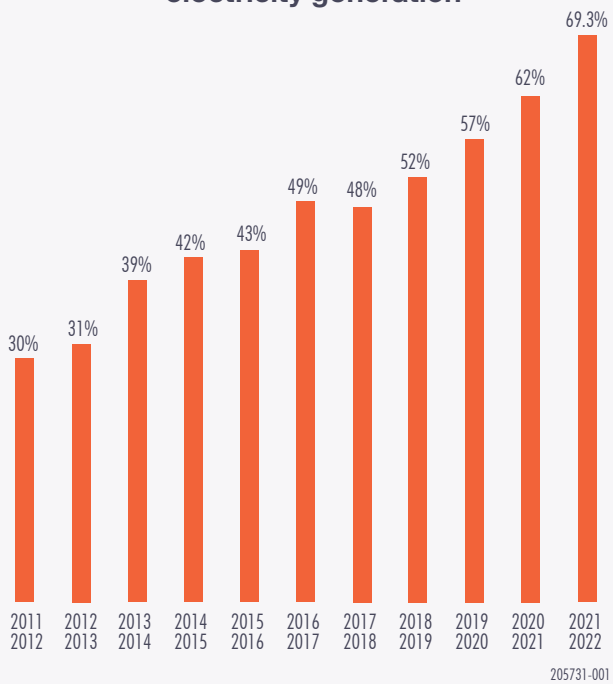
1 Introduction

South Australia is at the forefront of the global energy transition, having transformed its energy system from one where all electricity was generated from fossil fuels to now being recognised as an international renewable powerhouse, all in under two decades.

Renewable electricity generation in South Australia has continued its upward trend since 2000-01. For the fourth consecutive year, South Australia's renewable energy production was greater than 50 per cent in 2021-22. South Australia has received global recognition for its transition to renewable energy, with almost 70 per cent of the electricity currently generated in our state coming from renewable sources[5] (Fig. 1).

5 Australian Energy Market Operator, South Australian Electricity Report, November 2022, AEMO | South Australian Advisory Functions.

Figure 1 **Proportion of renewable electricity generation**



In 2021-22, renewable energy met around 69.3 per cent of South Australia's total electricity consumption, an increase of 7.5 percentage points in renewable energy consumption from the 2020-21 result of 61.8 per cent.

Abundant clean, secure and affordable energy will help deliver thousands of jobs for our communities, driving economic growth across our state, particularly at the epicentre of the transformation economy, the Upper Spencer Gulf. By becoming a major renewable energy and hydrogen export hub, this region is set to capitalise on multiple benefits ranging from new employment and industry opportunities through to community and lifestyle-building.

South Australia's leadership in transitioning its energy system, abundant natural resources, skilled workforce and research sector provides a strong base from which to transform the economy and achieve the twin goals of reducing state greenhouse gas emissions by more than 50 per cent below 2005 levels by 2030 and achieving net-zero emissions by 2050.

South Australia shares this goal with all other Australian states and territories committing to net-zero emissions by 2050. In September 2022, the Australian Government introduced the *Climate Change Bill 2022*[6], which enshrined Australia's commitment to reduce greenhouse gas emissions by 43 per cent below 2005 levels by 2030 and net-zero emissions by 2050.

6 Australian Government, Climate Change (Consequential Amendments) Bill 2022, September 2022.

These initiatives will help us address climate change, protect the environment and support jobs and growth.

On 31 May 2022, the Government of South Australia was the first state parliament in Australia to declare a Climate Emergency, reaffirming the urgent need to decarbonise South Australia and continue our upward trajectory of renewable sources of energy. This important declaration again confirmed South Australia's role as a leader in responding to climate change.

A broad range of actions to address this challenge are currently underway in South Australia, including (but not limited to):

- plans to create clean and sustainable energy with a grid-scale hydrogen plant in South Australia
- gigawatts of electrolyser projects being proposed or underway in the state (including the 1.25 megawatt (MW) electrolyser at the Tonsley Innovation District and the Eyre Peninsula Gateway Project at Cultana, which will provide a facility integrating more than 75 MW in water electrolysis)
- the export of hydrogen and other products both nationally and internationally (via hubs at Port Bonython and Cape Hardy).

These initiatives will help us address climate change, protect the environment and support jobs and growth.

More action will be required to tackle these challenges. By opening the discussion and using a shared approach through this work, we are seeking your help in determining where we are currently, where we need to be in order to achieve our goals and objectives, and how we will get there in the coming years.

ROLE OF THE GOVERNMENT OF SOUTH AUSTRALIA

The Government of South Australia is committed to reducing energy costs, improving energy reliability and security, and reducing emissions from power generation.

As the world looks to decarbonise, South Australia is making a once-in-a-generation investment in green hydrogen to accelerate a new economy. While the Hydrogen Jobs Plan represents one action the Government of South Australia is taking, other key initiatives are also underway, including the state government's actions on climate change[7] and the development of a Hydrogen and Renewable Energy Act.

These build on other transformative innovations already introduced by the Government of South Australia, such as the world's first big battery, the Hornsdale Power Reserve in the state's Mid-North, and our partnership with Adelaide City Council to make Adelaide the world's first Carbon Neutral City.

7 Department for Environment and Water, Government action on climate change, Department for Environment and Water - Government action on climate..

ROLE OF THE DEPARTMENT FOR ENERGY AND MINING

South Australia's Department for Energy and Mining (DEM) leads the state's transformation economy, overseeing the responsible mining and production of the minerals, metals and fuels needed to safely and sustainably generate the energy and low carbon products of the future.

Energy and Mining is a diverse and significant sector in the South Australian economy. It contributed $10.2 billion or 8.7 per cent to the state's economic output and employed almost 52,000 people across South Australia in 2020-21[8]. The sector encompasses energy generation, storage, distribution and retail services, extractive materials, oil and gas, value-adding processing and products from resources, equipment, technology and services, and direct construction of new projects.

In 2020-21, the sector also contributed $383 million in royalties[9] and $5.9 billion in exports or around 40 per cent of South Australia's total goods exports[10].

DEM is also one of the very few government departments globally to recognise the link between mining and renewable energy. This link is critical to the world's net-zero emissions future. The department's position is built on abundant natural assets, a culture of innovation, a strong position in export income, global leadership in adopting renewable energy and a commitment to creating a modern energy system.

Through this work, DEM will play a key role in capturing information valuable to the sector and its companies. The department will also work with key stakeholders and business leaders to bring new ideas to the table, building on the state's existing strengths while creating new ones.

8 Energy and Mining Satellite Account Economic Indicators 2020/21, BDO EconSearch.

9 DEM Annual Report 2021-22.

10 DEM estimate based on Australian Bureau of Statistics International Trade in Goods and Services, Australia and DEM Resources Production Statistics.

ABORIGINAL RIGHTS AND INTERESTS

Informed, early and ongoing participation of Aboriginal people is essential to achieving South Australia's energy transition and net-zero emissions future target.

This transition must deliver Aboriginal empowerment and greater self-determination, in line with the Government of South Australia's commitment to restart treaty negotiations and implement a state-based Voice to Parliament.

The Government of South Australia is committed to engaging and working with Native Title groups and traditional owners to respect their rights and interests and ensuring informed and active participation in our state's energy transition.

NATIONAL ENERGY CRISIS COMMITTEE OF CABINET AND NATIONAL ENERGY CRISIS TASKFORCE

The Commonwealth Budget delivered on the 25 October 2022, forecast electricity prices to increase in the National Electricity Market (NEM) by 20 per cent by the end of 2023 and a further 30 per cent next financial year, with the estimate later increased to 36 per cent to give a potential cumulative increase of 56 per cent. In addition, Federal Treasury expects retail gas prices to increase by 20 per cent in 2023 and a further 20 per cent in 2023-24.

To reduce the impact of rising energy prices on South Australians, the Government of South Australia has established a National Energy Crisis Committee of Cabinet, which is being supported by a National Energy Crisis Taskforce, chaired by the Minister for Energy and Mining and DEM.

To inform the National Energy Crisis Committee of Cabinet and the National Energy Crisis Taskforce's deliberations, the Minister for Energy and Mining has tasked the Essential Services Commission of South Australia (ESCOSA) with conducting an Inquiry[11]. The Terms of Reference require ESCOSA to conduct an Inquiry into evidence of, or the potential for, a party (retailer, generator, trading entity or relevant other party) in the electricity industry and/or gas industry to earn or have earned sustained super profits to the financial detriment of South Australian energy consumers.

ENERGY TRANSITION ROUNDTABLE

In order to provide feedback and guidance on South Australia's energy transition to a net-zero emissions future, the Minister for Energy and Mining has formed an Energy Transition Roundtable.

The Energy Transition Roundtable comprises representatives acting on behalf of South Australian consumers (such as residential, small to medium enterprises (SMEs) and commercial and industrial (C&I) customers, energy industry participants, investors, producers, market bodies, peak bodies and research institutes. The Energy Transition Roundtable's make up reflects the impact the energy transition to a net-zero emissions future will have on stakeholders, the variety of touch points, and that a single solution is unlikely to be suitable.

The first Roundtable meeting was held in Adelaide on 21 November 2022, with over 100 industry, consumer and government stakeholders attending. Providing views, feedback and other information on the opportunities and barriers the energy transition is likely to encounter, this Green Paper includes the input gathered at this session.

The Energy Transition Roundtable will continue to inform the Government of South Australia's actions through future sessions, to build on existing strengths and opportunities embedding the state's competitive advantage as we transition to a net-zero emissions future.

11 Essential Services Commission of South Australia, Inquiry into retail energy prices, ESCOSA - Inquiry into retail energy prices.

2 South Australia's energy transition

Our energy sector is changing. South Australia's growing renewable electricity sector and developing hydrogen industry will support climate smart jobs and growth, and will provide the cornerstone for a net-zero emissions economic transition.

South Australia has world-class renewable energy resources, including abundant wind resources and outstanding solar capacity that is generated, bought, sold and transported in the NEM.

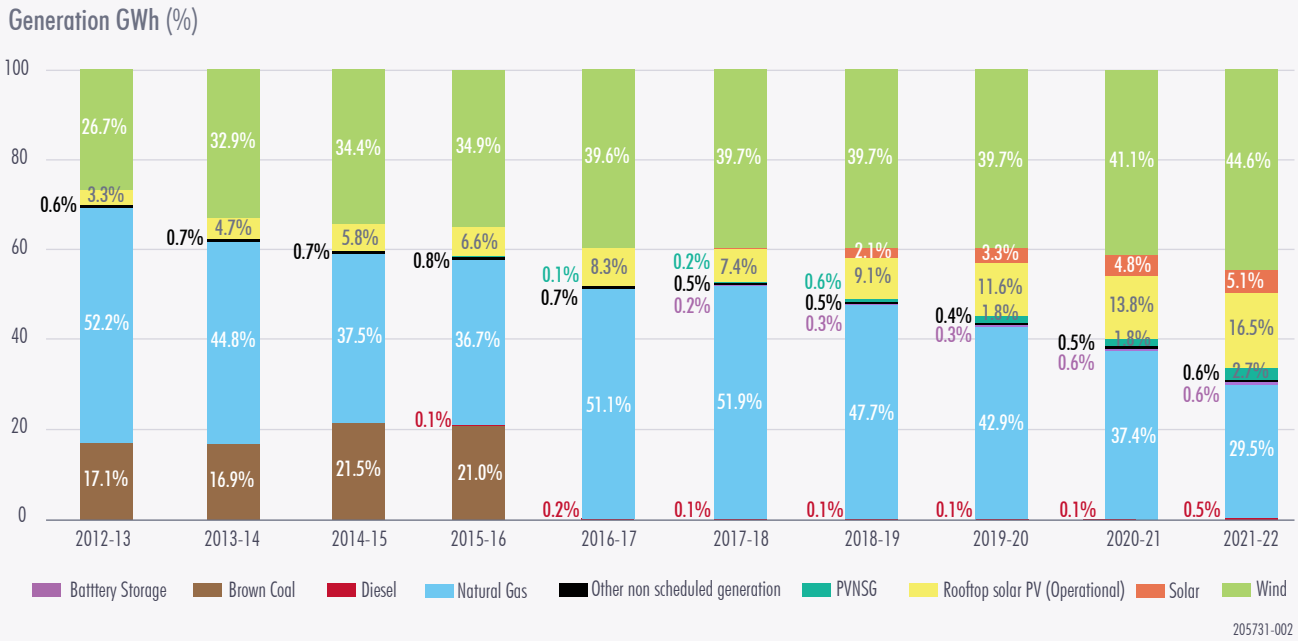
As a result of government policies and initiatives, South Australia is at the forefront of renewable energy innovation, with the state's forecast variable renewable energy generation projected to reach 85 per cent by 2025[12].

12 Australian Energy Market Operator, South Australian Advisory Functions.

Over the last 20 years, South Australia's energy generation has changed dramatically – from generation comprised predominantly of non-renewables, to a system of largely renewable generation, as Fig. 2 shows[13].

13 Australian Energy Market Operator, South Australian Advisory Functions.

Figure 2 **Generation type and generation GWh, 2012-13 to 2021-22**



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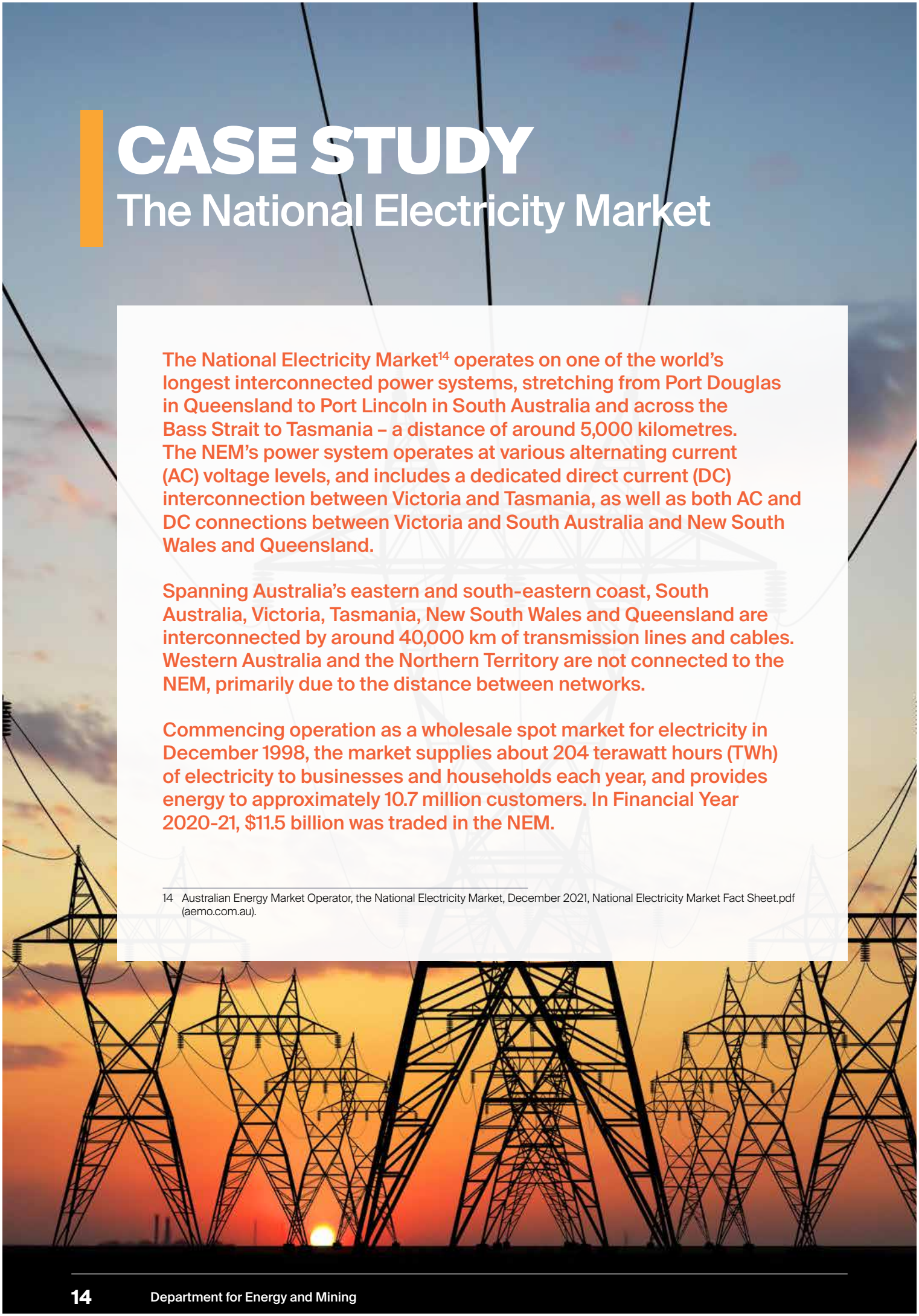


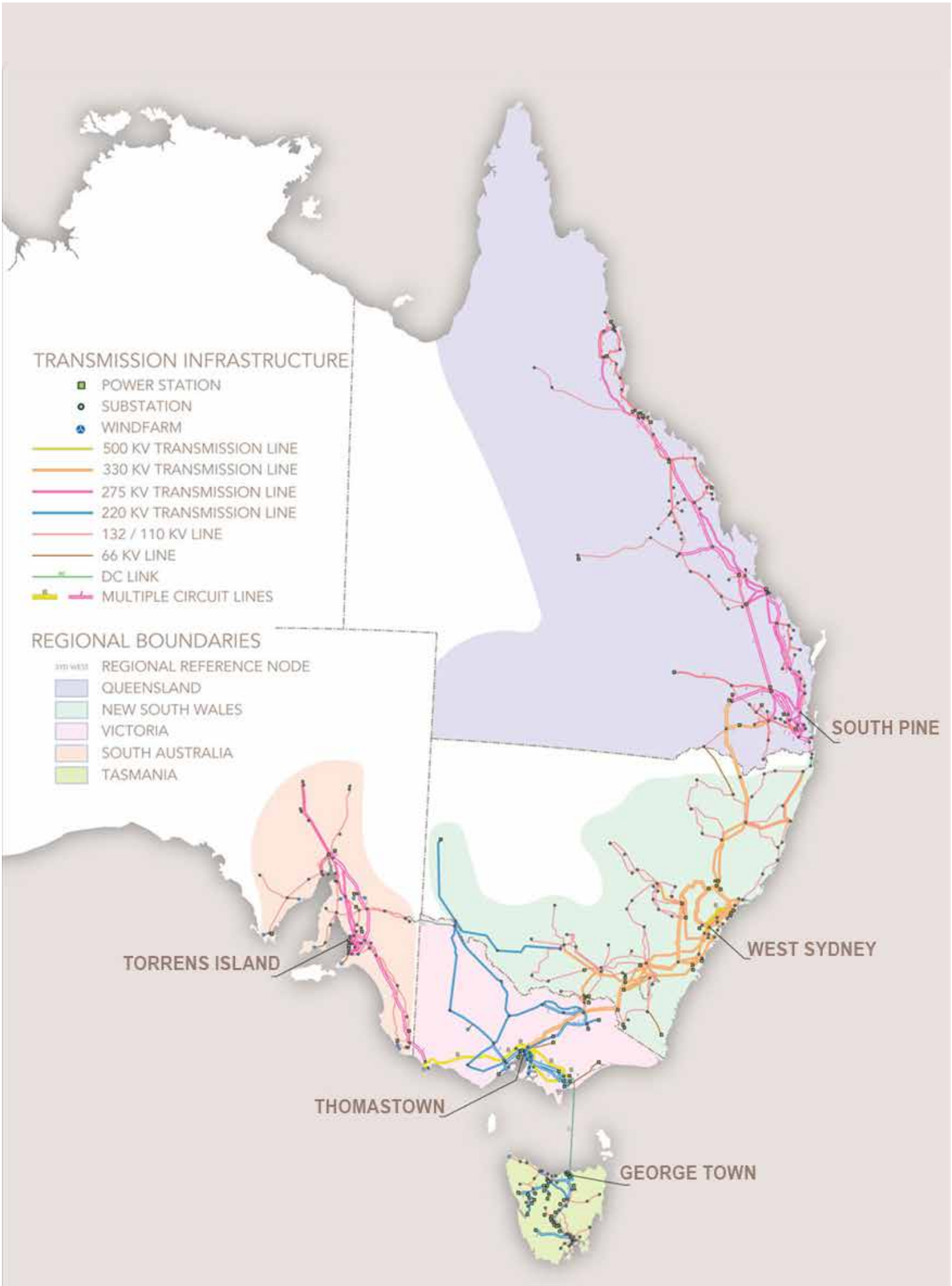
CASE STUDY
The National Electricity Market

The National Electricity Market[14] operates on one of the world's longest interconnected power systems, stretching from Port Douglas in Queensland to Port Lincoln in South Australia and across the Bass Strait to Tasmania – a distance of around 5,000 kilometres. The NEM's power system operates at various alternating current (AC) voltage levels, and includes a dedicated direct current (DC) interconnection between Victoria and Tasmania, as well as both AC and DC connections between Victoria and South Australia and New South Wales and Queensland.

Spanning Australia's eastern and south-eastern coast, South Australia, Victoria, Tasmania, New South Wales and Queensland are interconnected by around 40,000 km of transmission lines and cables. Western Australia and the Northern Territory are not connected to the NEM, primarily due to the distance between networks.

Commencing operation as a wholesale spot market for electricity in December 1998, the market supplies about 204 terawatt hours (TWh) of electricity to businesses and households each year, and provides energy to approximately 10.7 million customers. In Financial Year 2020-21, $11.5 billion was traded in the NEM.

14 Australian Energy Market Operator, the National Electricity Market, December 2021, National Electricity Market Fact Sheet.pdf (aemo.com.au).


TRANSMISSION INFRASTRUCTURE
POWER STATION
SUBSTATION
WINDFARM
500 KV TRANSMISSION LINE
330 KV TRANSMISSION LINE
275 KV TRANSMISSION LINE
220 KV TRANSMISSION LINE
132 / 110 KV LINE
66 KV LINE
DC LINK
MULTIPLE CIRCUIT LINES
REGIONAL BOUNDARIES
REGIONAL REFERENCE NODE
QUEENSLAND
NEW SOUTH WALES
VICTORIA
SOUTH AUSTRALIA
TASMANIA
SOUTH PINE
WEST SYDNEY
TORRENS ISLAND
THOMASTOWN
GEORGE TOWN

In 2001, over 99 per cent of South Australia's generation mix was delivered by fossil fuels, principally coal and natural gas. Historically, up to 35 per cent of South Australia's electricity was produced by the Northern and Playford B coal-fired power stations, but with the increase in renewable generation, this declined to around 15 per cent of the state's energy mix.

In June 2015, Alinta Energy announced the Northern and Playford B power stations and the Leigh Creek Mine closures – as their operations became increasingly uneconomic[15].

Final generation from the Northern Power Station occurred on 9 May 2016.

At the same time, a number of gas-fired power stations announced the temporary closure of some capacity, while also reducing the amount of electricity they provided to the grid during periods of low prices.

As conventional synchronous generators reduced their generation in the NEM, many of the system services provided as a by-product of energy production were also reduced. In particular: inertia, voltage control, and system strength. This resulted in increased risks to system security as the system's ability to ride through and manage challenges was reduced[16].

Changing weather patterns, including more severe weather events, also impacted South Australia's energy systems.

In September 2016, a severe supercell thunderstorm moved through the state, producing high speed tornadoes, severely damaging three significant transmission lines. The rapid sequence of faults led to nine wind farms across South Australia activating protection features, significantly reducing their output, and in turn, greatly increasing flows on the Heywood interconnector with Victoria which had a nominal capacity of 650 MW.

This continued until automatic protection features operated to prevent further damage to equipment.

The loss of 890 MW of supply from the Heywood interconnector caused the frequency across the system to drop faster than the underfrequency load shedding (UFLS) scheme could act, resulting in a system black event.

The Australian Energy Regulator (AER) took action in the Federal Court against the owners of the windfarms. The owners agreed to pay fines and made undertakings related to the settings on their equipment, but the AER did not press allegations that the windfarms were a contributing cause of the black event.

The installation of four synchronous condensers in the state by ElectraNet from October 2021, in order to achieve minimum levels of system strength and inertia on an ongoing basis, are a further critical measure in response to the event. A synchronous condenser operates in a similar way to a large conventional generator, by being electrically synchronised to the network.

15 This was a commercial choice by the private operators, not a decision made by the Government of South Australia.

16 Australian Energy Market Operator, South Australian Electricity Report, April 2020, Renewable Integration Study: Stage 1 Report, AEMO | Renewable Integration Study (RIS).

As a large spinning mass, it acts to stabilise the frequency and voltage on the power system, particularly following a fault on the network. Synchronous condensers are an important source of system strength and, depending on the specification, can provide other services, such as inertia.

The Government of South Australia continues to work collaboratively with industry and other key stakeholders to understand the flow-on impacts to South Australia's power system as existing generation assets continue to exit the market. The most recent example being the announcement in November 2022 that Torrens Island 'B' Power Station will close in 2026[17].

17 AGL, Torrens Island 'B' Power Station to close in 2026, 24 November 2022, Torrens Island 'B' Power Station to close in 2026 (agl.com.au).

A synchronous condenser installed by ElectraNet

Following the statewide blackout in 2016, significant changes were made to the regulatory framework designed to better manage system security in South Australia, including:

IMPROVED TECHNICAL STANDARDS FOR GENERATION

IMPROVED OPERATING PROCEDURES BY AEMO TO MANAGE FREQUENCY AND SYSTEM STRENGTH

RULES TO PROVIDE MINIMUM SYSTEM STRENGTH AND INERTIA, INCLUDING 'DO NO HARM' PROVISIONS FOR CONNECTING GENERATORS

RULES TO ESTABLISH A 'PROTECTED EVENT' FRAMEWORK TO MANAGE NON-CREDIBLE CONTINGENCIES

IMPROVED EMERGENCY CONTROL SCHEMES, INCLUDING AN OVER FREQUENCY GENERATION SHEDDING SCHEME.

THE EVOLUTION OF ENERGY TECHNOLOGY

The emergence of a decentralised power system

While a significant amount of work has been done to improve system security associated with grid scale renewable energy, the fast uptake of distributed energy resources (DER) (particularly rooftop solar PV systems) in South Australia has created a range of new emerging system security issues.

DER technologies are playing a central role in transforming our power system, as this small-scale method of power generation or storage is rapidly becoming a major source of our energy. According to the Australian Energy Market Commission's (AEMC's) guide, Opening up Renewable Energy for Everyone, the Australian Renewable Energy Agency (ARENA) is quoted with saying that over 40 per cent of energy customers will use DER by 2027. By 2050, that figure will grow to more than 60 per cent[18].

Ensuring that DER is integrated effectively and efficiently into our energy system is vital to supporting our transition to a net-zero emissions future, including improving our understanding of the ways in which inverter-based technology (that DER and other energy storage technologies use) are affecting South Australia's DC system and AC system, and whether further changes are required.

The International Energy Agency (IEA) notes[19] that many of the challenges presented by DER are because its generation is largely invisible to – and cannot be controlled by – grid operators, making it difficult to integrate them into overall grid operation.

For South Australia, these challenges have arrived earlier than in many other Australian jurisdictions. In May 2020[20], AEMO published a technical report highlighting that, to the Market Operator's knowledge, South Australia was the first gigawatt scale power system in the world to approach zero operational demand due to a high proportion of its demand being met by DER.

AEMO layed out several challenges arising from the increasing and unmanaged supply of electricity to the grid from rooftop solar PV. Following this advice, the Government of South Australia introduced a number of new technical standards and requirements for smaller generating systems[21], such as rooftop solar PV, that came into effect on 28 September 2020.

While these technical standards and requirements provided a mechanism for managing emerging system security issues under certain scenarios, further work is required to continue to leverage these technologies for the benefit of all South Australians.

The Government of South Australia remains committed to supporting the uptake of DER and acknowledges that the complexities of the energy transition should not compromise the sustainable growth of DER by energy customers, which is a main driver of South Australia's net-zero emissions by 2050.

The biggest savings to households have always been from using their own solar power rather than drawing energy from the grid.

In recent years, households have been able to further lower their bills, or even earn money, by exporting as much as possible during the day, offsetting the cost of evening electricity usage.

18 Australian Energy Market Commission, Opening up renewable energy for everyone.

19 International Energy Agency, Distributed energy resources for net-zero: An asset or a hassle to the electricity grid? Distributed energy resources for net-zero: An asset or a hassle to the electricity grid? – Analysis - IEA

20 Australian Energy Market Operator, Minimum operational demand thresholds in South Australia Technical Report, May 2020.

21 Department for Energy and Mining, Regulatory changes for smarter homes Regulatory changes for smarter homes | Energy & Mining (energymining.sa.gov.au).

As part of the energy transition, a new conversation will likely be required, encouraging households to take even greater advantage of their rooftop solar to offset their energy use, by shifting as much energy use as possible to better align with daytime solar production.

Retailers now offer time-of-use tariffs – typically charging more in the morning and evening but less in the middle of the day and late at night. Many household appliances such as dishwashers and washing machines can be programmed for a delayed start – providing savings to households by aligning energy use to the cheaper periods of the day.

Household batteries are also becoming a more economic proposition for some households as they allow storage of excess solar produced during the day for use in the evening.

The electrolysers that form part of the Government of South Australia's Hydrogen Jobs Plan are being used for exactly this purpose, to soak up excess renewable energy and create green hydrogen. This will fuel a 200 MW generator able to provide firming for intermittent renewable energy, adding to grid security.

WHAT ARE YOUR THOUGHTS?

- What do you want from South Australia's energy transition?
- What are the opportunities that you predict a successful energy transition offers to South Australia?
- What are the barriers that you foresee will be encountered as part of South Australia's energy transition?
- What are the key risks (short, medium and long-term) you consider the Government of South Australia should be mindful of and how can these be addressed as part of this work? To what extent are such risks quantifiable and is there any supporting evidence?
- What technologies do you believe the Government of South Australia should explore further, in partnership with industry, as part of the energy transition, that may not already be part of the state's energy system? Provide any supporting evidence, data or modelling on the potential viability of such technologies (noting whether such information can be published).
- Do you consider the Government of South Australia should explore a DC-only system as part of the energy transition future?


Using a shared approach, we want your help in determining where we are, where we need to be and how we will get there over the coming years

3 Opportunities and challenges for South Australia's energy transition

South Australia's uptake of renewable energy has been significant, and the Government of South Australia is focused on ensuring the next phase of the energy transition is orderly, delivers social and economic benefits to South Australians and maximises our potential as a world-leading renewable energy economy.

This Green Paper identifies a number of challenges impacting South Australia's use of energy, both current and emerging, and the opportunities that successfully navigating these challenges may represent for the state, as we transition to a net-zero emissions future.

Port Augusta Renewable Energy Park, a hybrid wind and solar plant with 317 MW capacity near Port Augusta

3.1. THE ENERGY NEEDS OF SOUTH AUSTRALIA

Considering South Australia's energy future first requires an understanding of what energy we currently use, how and where we use it, and how it has changed over time.

What was once a traditional power system supplied primarily from thermal generation across South Australia, is transforming into a two-way, smart system that is being further improved (and challenged) by continuous technological advancement and innovation.

This section provides information on the state's energy use, the targets and goals the Government of South Australia has already committed to and what industry bodies are forecasting for how our energy needs could change in the future[22].

Considering all forms of energy, South Australia makes up around five per cent of Australia's total usage[23], a share which has fallen from over seven per cent in the early 1990s[24]. In 2020-21, South Australia used 311.2 petajoules (PJ)[25] of energy, consisting of 145.5 PJ of oil, 92.5 PJ of gas, 44.2 PJ of renewables, 25.1 PJ of coal and 3.8 PJ of other energy sources. As shown in Fig. 3, energy consumption in South Australia has broadly fallen since 2006-07[26].

Another way to consider South Australia's energy consumption is through our energy intensity[27]. As also shown in Fig. 4, South Australia's energy intensity has steadily fallen over time[28]. This reflects both a shift in the composition of the South Australian economy from energy intensive manufacturing to less energy intensive services, as well as improved energy efficiency and increased use of energy saving technology by households and businesses.

Figure 3 **South Australia's annual energy use**

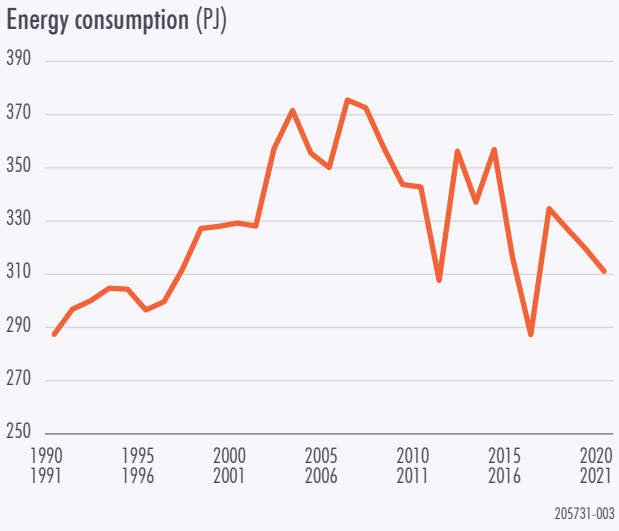
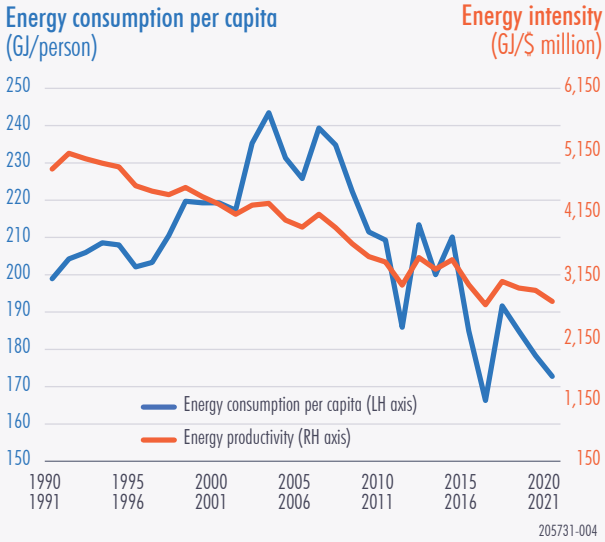


Figure 4 **South Australia's efficiency of energy use**



22 The information and figures in this section use 2020-21 statistics – reflecting the time in which the Green Paper was developed by DEM.

23 Total energy reflects the energy used by our homes, businesses, and industry and in turn, is influenced by our population size and the relative mix and energy intensity of our residential, commercial and industrial activity.

24 Australian Energy Statistics 2022, Table B, five-year average, Australian Energy Update 2022 | energy.gov.au

25 This section uses both petajoules (PJ) and gigajoules (GJ) throughout. The joule is a standard unit of energy and enables the energy content across all fuels to be more easily compared. One joule (J) is the equivalent of one watt of power radiated or dissipated for one second. One PJ is equal to 1,000,000 gigajoules (GJ). One GJ is equal to 1,000,000,000 joules (J). One petajoule, or 278 gigawatt hours, is the heat energy content of about 43,000 tonnes of black coal or 29 million litres of petrol.

26 Australian Energy Statistics 2022, Australian Energy Update 2022, energy.gov.au

27 The relationship between energy use and economic output can be described in terms of the energy intensity of the South Australian economy. Energy intensity measures the amount of energy used to produce a unit of economic output (energy consumption/GDP).

28 Australian Energy Statistics 2022.

South Australia's energy intensity of 2708 GJ/$million is currently below the national average of 2880 GJ/$million. As shown in Fig. 5[29], the energy intensity of South Australia is below that of the mining dependent jurisdictions of the Northern Territory, Queensland and Western Australia but just above the energy intensity of the services dominated economies of New South Wales and Victoria.

Compared to the national average, South Australia consumes far less coal[30], but more gas, oil and renewables as a share of total primary energy consumption[31] as shown at Fig. 6[32]. This difference mainly reflects South Australia's higher renewables penetration, with oil consumption largely reflective of the state's use in refined products (e.g. petrol and diesel) in the transport sector. Coal is primarily used in South Australia for iron and steel production.

Figure 5 **Energy intensity, by jurisdiction**

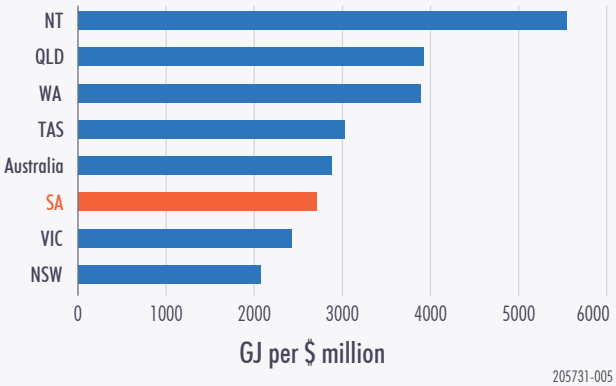
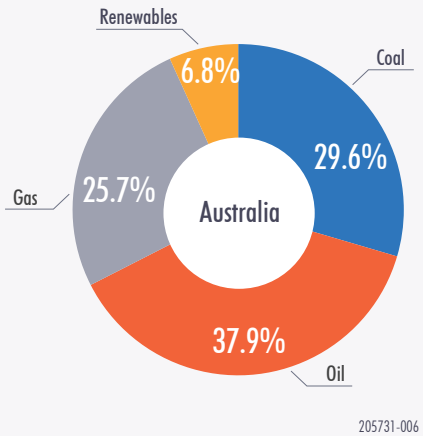
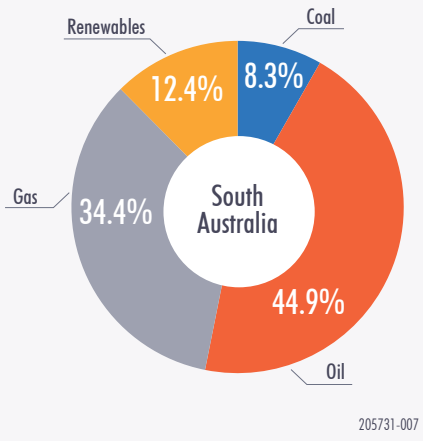


Figure 6 **Total energy consumption, by fuel**





Across industry sectors, South Australia consumes less net energy through mining and electricity generation as a share of total energy consumption, reflecting South Australia's high uptake of renewables compared with the national average. The state's share of energy use in the manufacturing, agriculture, residential, commercial and service sectors is above the national average, partly reflecting the relative size of these sectors in South Australia[33] (Fig. 7).

29 Australian Energy Statistics 2022

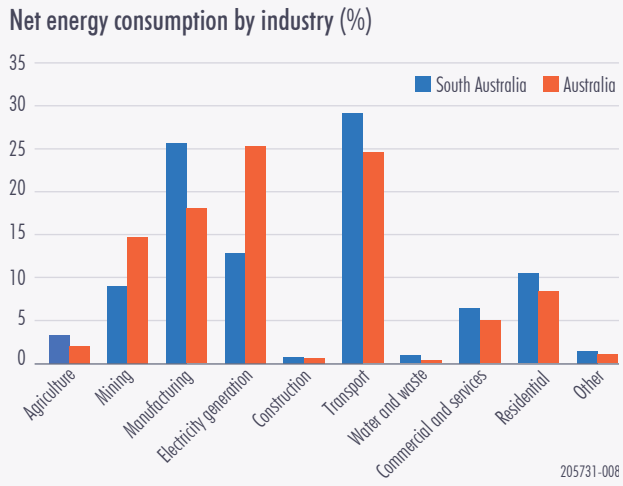
30 Coal is used in South Australia in a number of processes, including iron and steel production and in other industrial manufacturing processes.

31 Total net energy consumption is the total quantity (in energy units) of primary and derived fuels consumed less the quantity of derived fuels produced.

32 Australian Energy Statistics 2022, Table C, Australian Energy Update 2022 | energy.gov.au

33 Australian Energy Statistics 2022, Table E, Australian Energy Update 2022 | energy.gov.au

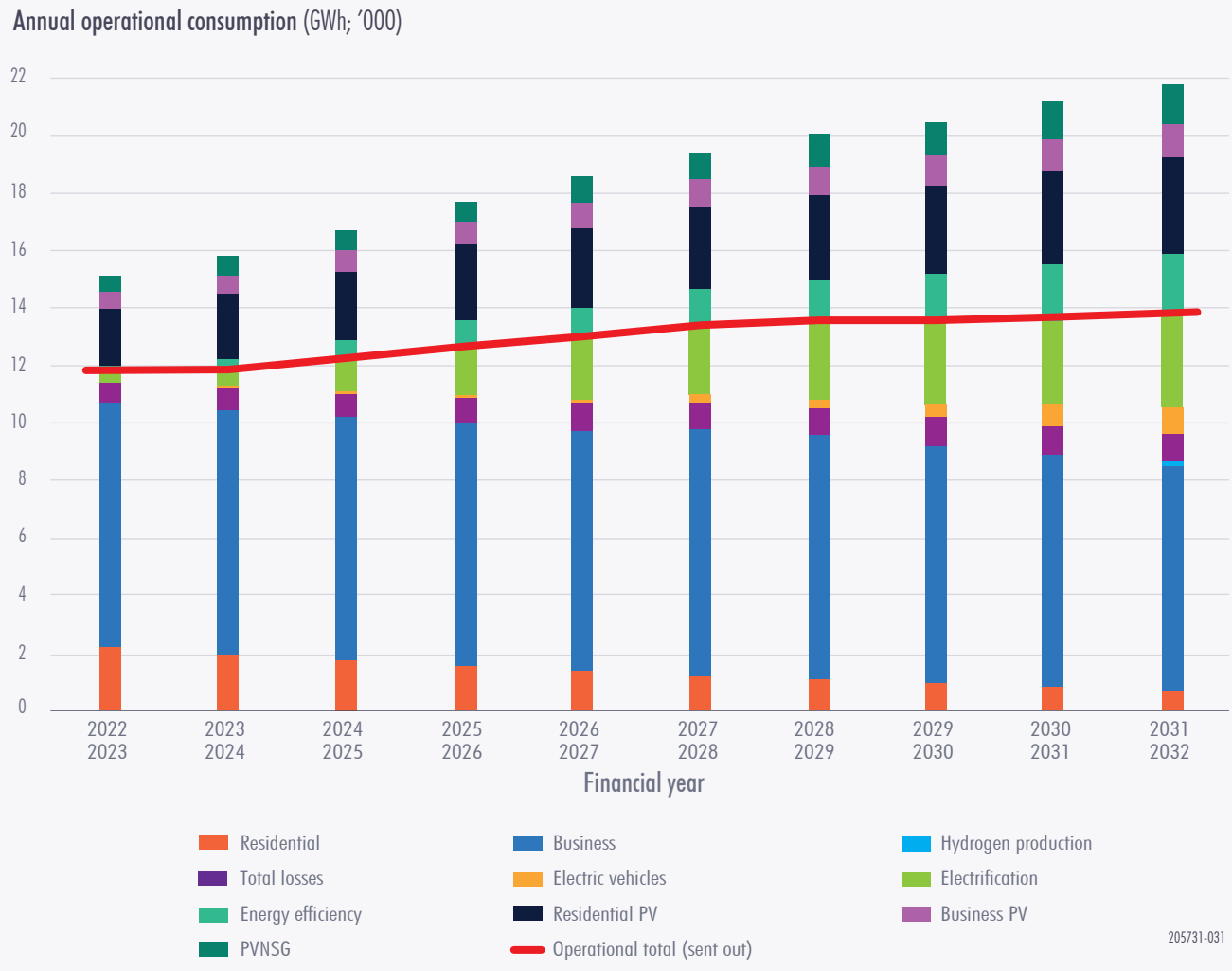
Figure 7 **Net energy consumption by industry**



According to AEMO, South Australia's operational demand on the grid in South Australia is growing far more slowly than total consumption. The business sector, including commercial and industrial customers, accounts for the largest share of demand. AEMO expects the electrification of households and industry as well as the expected uptake of electric vehicles to increase demand this decade (Fig. 8)[34].

34 Australian Energy Market Operator, South Australian Electricity Report, November 2022, South Australian Advisory Functions AEMO | South Australian Advisory Functions

Figure 8 **Forecast annual operational consumption (sent-out) with components (Central scenario), 2022-23 to 2031-32**



On average, each South Australian consumes around 179 GJ of energy, well below the national average of 240 GJ per capita. As shown in Fig. 4, per capita energy consumption in South Australia has fallen steadily since 2003-04.

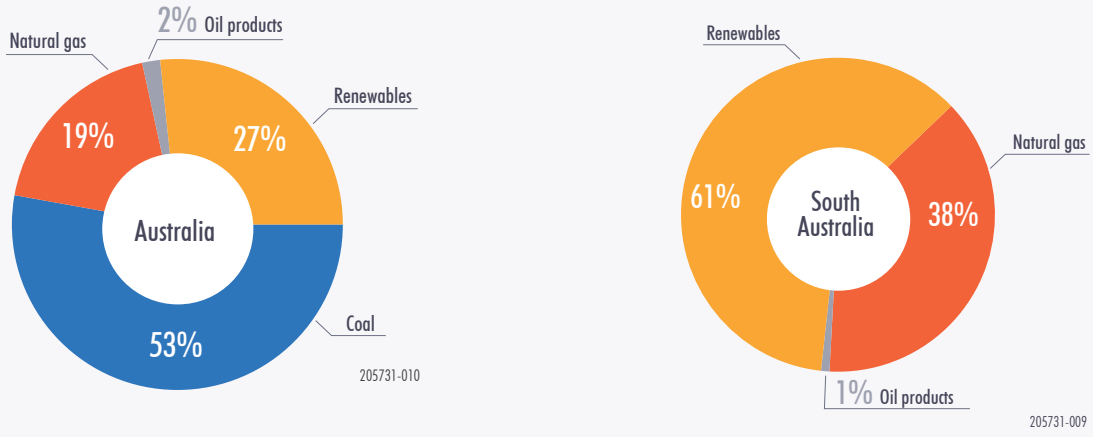
As shown in Fig. 9, South Australia generated almost all of its electricity using natural gas (38 per cent of total) and renewables (61 per cent) in 2020-21. This contrasts to Australia overall, where 53 per cent of electricity was generated from coal and only 27 per cent originates from renewable sources[35].

As noted earlier, the proportion of electricity generated by renewables increased to nearly 70 per cent in 2021-22.

Commercially, generated electricity is sold through the NEM (managed by AEMO) to electricity retailers, who on sell it to households and businesses. Most of this electricity is consumed in South Australia, but some is exported and used in other states and territories via interconnectors.

35 Australian Energy Statistics 2022, Table O, Australian Energy Update 2022 | energy.gov.au

Figure 9 **Electricity generation, by fuel type, 2020-21**



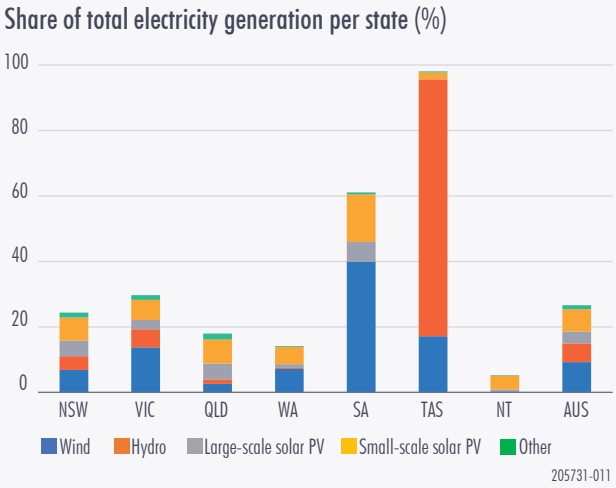
Bungala Solar Power Project is a solar power farm in Emeroo and Wami Kata near Port Augusta in South Australia.

South Australia generates more of its electricity from renewable sources than any other mainland state (Fig. 10)[36].

Compared to all other states and territories, South Australia generates more of its energy from wind (40 per cent), small-scale solar PV (14 per cent) and large-scale solar PV (six per cent).

In 2021, South Australia met 100 per cent of its operational demand from renewable resources for periods on 180 days.

Figure 10 **Renewable electricity generation, by fuel type and jurisdiction**



Our possible energy future

AEMO's role is to plan the future transmission network, including through the development of a NEM-wide integrated grid plan that informs future investment decisions.

As part of this role, in 2018, AEMO published the inaugural biennial Integrated System Plan (ISP). The ISP is a comprehensive, systems-engineering assessment with a goal to identify the lowest cost combination of investments and decisions over the next 20 years to support Australia's energy transition to a low-emissions future.

Four scenarios were developed as part of the most recent 2022 ISP to represent particular future pathways of renewables take-up, technology change, and emissions reduction ambition:

SLOW CHANGE

Challenging economic environment

PROGRESSIVE CHANGE

Pursuing an economy-wide net-zero emissions 2050 target progressively, ratcheting up emissions reduction goals over time

STEP CHANGE

Rapid consumer-led transformation of the energy sector and co-ordinated economy-wide action

HYDROGEN SUPERPOWER

Strong global action and significant technological breakthroughs

36 Australian Energy Statistics 2022, Australian Energy Update 2022, energy.gov.au

Of the four scenarios, Step Change was considered by AEMO and stakeholders to be the most likely scenario. This scenario delivers a fast-paced transition from fossil fuels to renewable energy in the NEM, requiring utility-scale generation and storage capacity to grow to 173 GW and deliver 320 TWh per year to customers by 2050, compared to today, where NEM installed capacity of nearly 60 GW delivers approximately 180 TWh of electricity to industry and homes per year.

For South Australia, the Step Change scenario describes an energy future where our energy needs are largely supplied by wind, utility-scale solar and distributed solar PV. Distributed energy resources, comprising virtual power plants, as well household and community batteries, are also expected to increasingly contribute (Fig.11 and Fig. 12)[37].

Peaking gas and diesel capacity is projected to decline from around 1.5 GW currently to under 0.5 GW by 2050. Total generation and storage capacity is expected to more than triple from just over 9 GW to around 30 GW by 2050.

37 Australian Energy Market Operator, 2022 Integrated System Plan (ISP), AEMO | 2022 Integrated System Plan (ISP)

Figure 11 **South Australia's capacity by year, ISP projections, Step Change scenario**

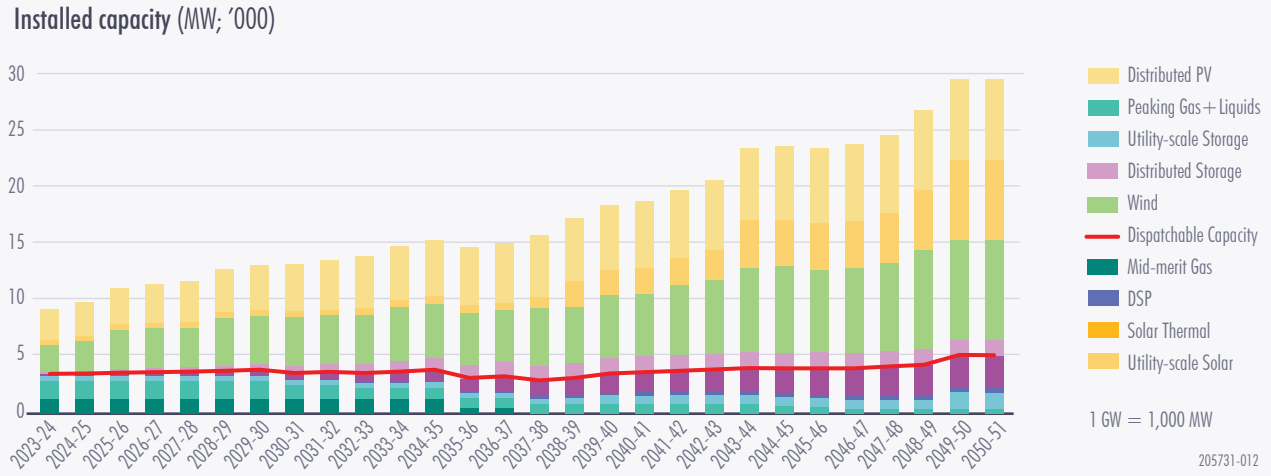
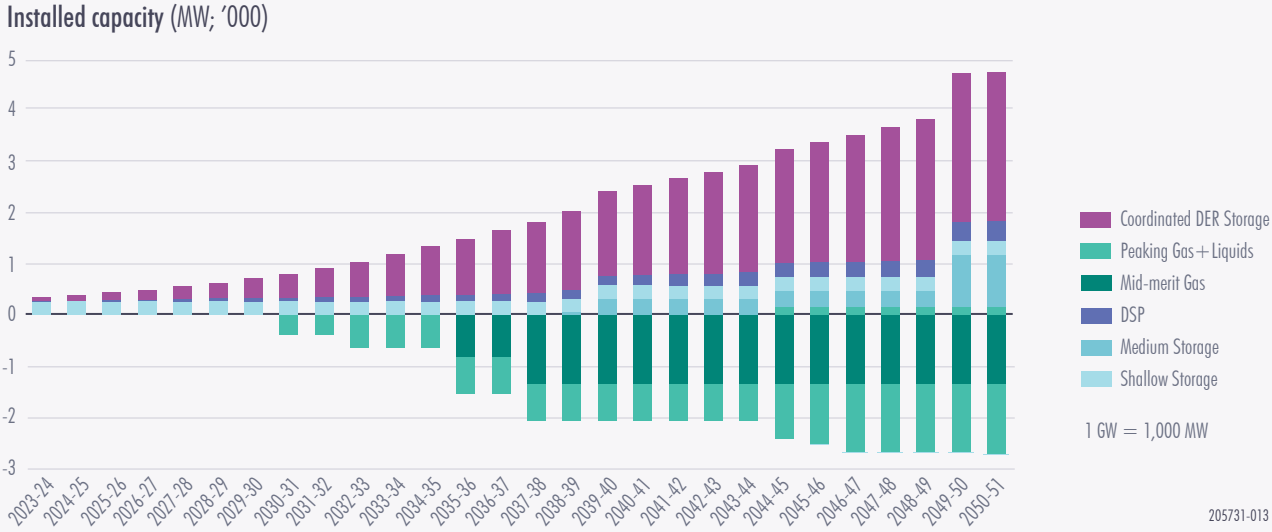


Figure 12 **South Australia's dispatchable capacity additions and retirements, ISP projections, Step Change scenario**



Dispatchable capacity is expected to increase by 50 per cent to around 5 GW by 2050.

Notwithstanding the Step Change scenario being considered as the most likely NEM-wide scenario, the Hydrogen Superpower scenario more closely aligns with the Government of South Australia's aspirations for the role of hydrogen in the future energy system – harnessing South Australia's wind, sun, land, infrastructure and skills to be a world-class renewable hydrogen supplier.

It is expected that the generation, storage, and dispatchable capacity requirements under this scenario would be many times higher than those suggested by AEMO for the Step Change scenario.

In South Australia, by 2050, the Hydrogen Superpower scenario leads to over three times more utility-scale storage capacity (5 GW), over six times more wind capacity (55 GW), and over seven times more utility-scale solar capacity (63 GW) (Fig. 13 and Fig. 14)[38]. This is broadly consistent with the Government of South Australia's understanding of current privately proposed projects.

Under the Hydrogen Superpower scenario, hydrogen turbines, peaking gas and medium storage (of four to 12 hours duration) play a more prominent role in providing dispatchable capacity. Under this scenario, dispatchable capacity is over three times higher, at over 18 GW, compared to the Step Change scenario.

38 Australian Energy Market Operator, 2022 Integrated System Plan (ISP), AEMO | 2022 Integrated System Plan (ISP)

Figure 13 **South Australia's Capacity by year, ISP projections, Hydrogen Superpower scenario**

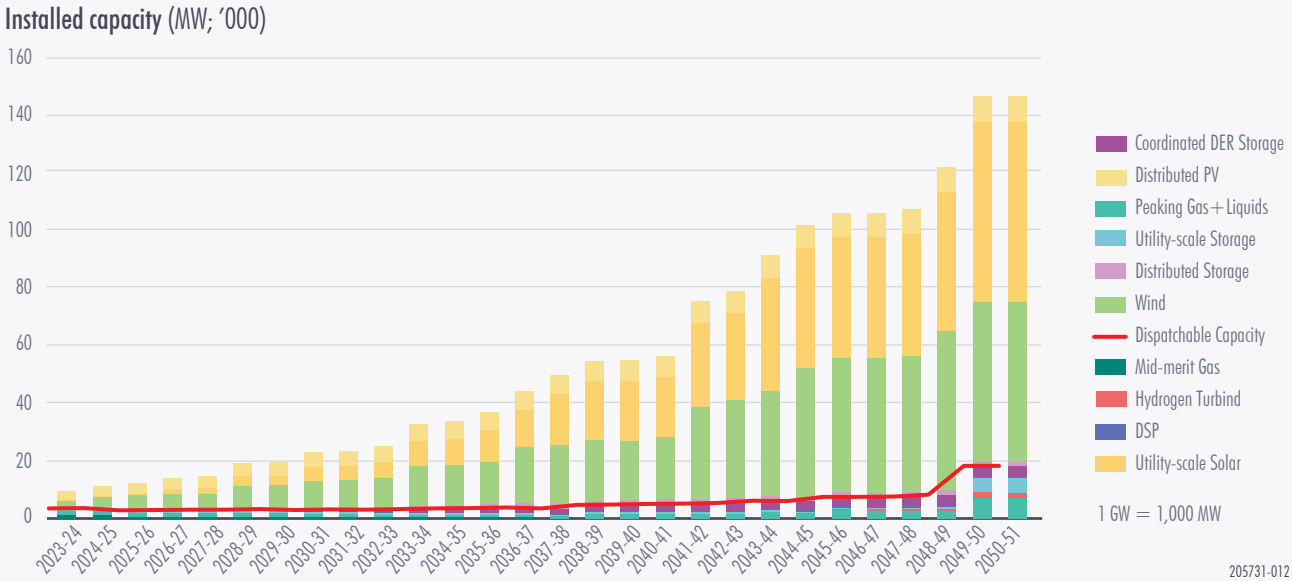
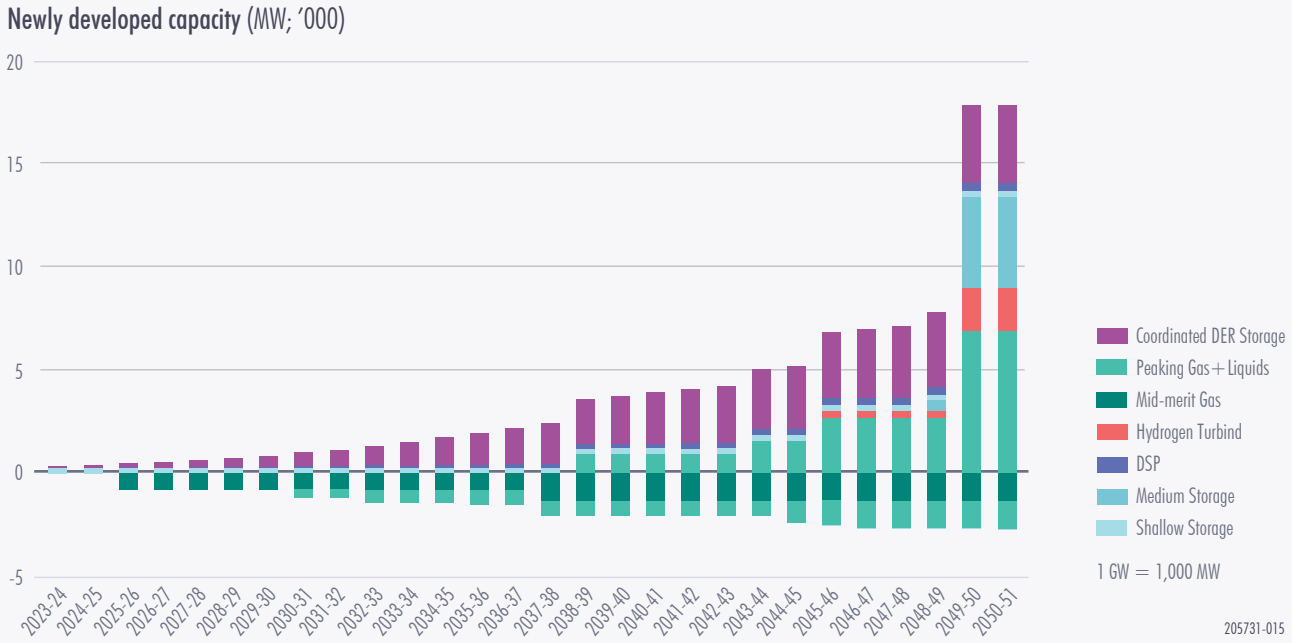


Figure 14 **South Australia's dispatchable capacity additions and retirements, ISP projections, Hydrogen Superpower scenario**



Working towards a net-zero emissions future

As we work towards a net-zero emissions future, we recognise that the energy needs of South Australians across the state will continue to evolve and likely vary, between metropolitan and regional and remote areas.

CASE STUDY
Remote Area Energy Supply

A safe, reliable and cost-effective electricity supply is available to homes and businesses in remote South Australian towns through the Remote Area Energy Supply (RAES) scheme. The scheme provides electricity to around 3,400 customers across 25 remote townships and Aboriginal communities.

The Government of South Australia owns or operates the electricity infrastructure supplying ten remote towns across the far north, west and east of the state and 15 Aboriginal Communities within the Anangu Pitjantjatjara Yankunytjatjara (APY) Lands, as well as Yalata and Oak Valley.

APY Lands communities in northern South Australia are set to receive improved electricity reliability and reduced operating costs after the Government of South Australia committed to upgrade the Central Power House (CPH) in remote Umuwa.

During the 2019-20 financial year, the CPH at Umuwa consumed around 2.8 million litres of diesel fuel to supply 11 GWh of electricity to APY customers on this network.

This dependence on fossil fuels to generate electricity at Umuwa sees the Government of South Australia spend about $3.6 million in diesel fuel and associated transport costs, which results in about 7,600 tonnes of CO_2 released into the atmosphere annually.

When completed, the upgraded CPH will have around 3 MW of solar PV panels and 1.1 MWh of battery storage capacity. It will be capable of delivering up to 4.4 GWh of clean, renewable electricity to local communities each year and reduce reliance on diesel by as much as 1 million litres per annum, almost halving fossil fuel use.

Central Power House, Umuwa, courtesy of APY

South Australia's emissions goals, closely align with other Australian states and territories, as well as the Australian Government, which are committed to net-zero emissions by 2050.

In the most recent National Greenhouse Gas Inventory Quarterly Update[39], the Australian Government reporting electricity generation was the largest source of emissions in the national inventory, accounting for 32.4 per cent of emissions in the year to June 2022. In the same update, the Australian Government noted that over the year to June 2022, ongoing substitution of renewable energy for fossil fuel power sources outweighed a short-term increase in emissions in the June 2022 quarter, with emissions from electricity decreasing by 3.7 per cent.

South Australia is ahead of the nation in the energy transition. In the Department for Environment and Water's (DEW's) Report on the operation of the Climate Change and Greenhouse Emissions Reduction Act 2007 (South Australia)[40], transport accounts for the biggest proportion of emissions in the state, at 28 per cent, followed by agriculture at 24 per cent, with energy industries, including generation, at 19 per cent.

Globally, the International Energy Agency (IEA) has reported[41] that the number of countries pledging to achieve net-zero emissions has grown rapidly over the last year, and now covers around 70 per cent of global emissions of CO_2. However, the IEA also states that most pledges made by countries are not yet underpinned by near-term policies and measures and that, even if successfully fulfilled, the pledges to date would still leave around 22 billion tonnes of CO_2 emissions worldwide in 2050. A continuation of that trend would be consistent with a temperature rise in 2100 of around 2.1 °C.

We welcome your thoughts on AEMO's 2022 ISP (and any other assumptions made by industry), and how we can strive to become a Hydrogen Superpower that will enable South Australia to seize this emerging global market opportunity.

Equally, we are keen to hear your views on the constraints that may exist in achieving this, considering technology, workforce, or other key issues that affect you.

39 Department of Climate Change, Energy, the Environment and Water, National Greenhouse Gas Inventory Quarterly Update: June 2022 National Greenhouse Gas Inventory Quarterly Update: June 2022 - DCCEEW

40 Department for Environment and Water, Climate change and greenhouse emissions reduction reports, Report on the operation of the Climate Change and Greenhouse Emissions Reduction Act 2007 (South Australia), 2021

41 International Energy Agency (IEA), Net-zero by 2050: A Roadmap for the Global Energy Sector, October 2021, Net-zero by 2050 – Analysis-IEA

WHAT ARE YOUR THOUGHTS?

- What energy needs will shape South Australia's energy systems in the future?
- What needs to be done to prepare South Australia's energy system for external shocks such as recent global events impacting the price and supply of coal and natural gas?
- How has technology changed lifestyle and related energy use?
- How have social and personal priorities influenced our energy system?
- How can the Government of South Australia and industry maximise the opportunities presented in documents such as AEMO's 2022 ISP?
- Do you consider the Step Change scenario described by AEMO in its Integrated System Plan to be the most likely scenario in South Australia?
- If the Government of South Australia were to establish an Energy Transition Taskforce responsible for managing the transition to a net-zero emissions future, what should be its scope, terms of reference and which key matters should it consider?
- If the Government of South Australia were to develop an Energy Transition Roadmap, what should be its scope, deliverables, timing and other key matters it should consider?
- If the Government of South Australia were to develop an Energy Transition Emissions Reduction Strategy, what should the Government consider in terms of its scope, the sectors it should cover as well as key milestones and timing?
- If the Government of South Australia were to develop an Energy Transition Entry and Exit Strategy, what would such a Strategy cover in terms of scope, timing and key deliverables?

3.2. THE CURRENT AND FUTURE ROLE OF ROOFTOP SOLAR PV

Rooftop solar PV converts energy from the sun into electricity that is used by the consumer at that premise, lowering the amount of electricity drawn from the grid or other sources. Electricity generated but not immediately self-consumed is then either exported to the main distribution network (managed by SA Power Networks (SAPN)) or stored in localised energy storage (for example lithium-ion batteries) where it exists on the premise.

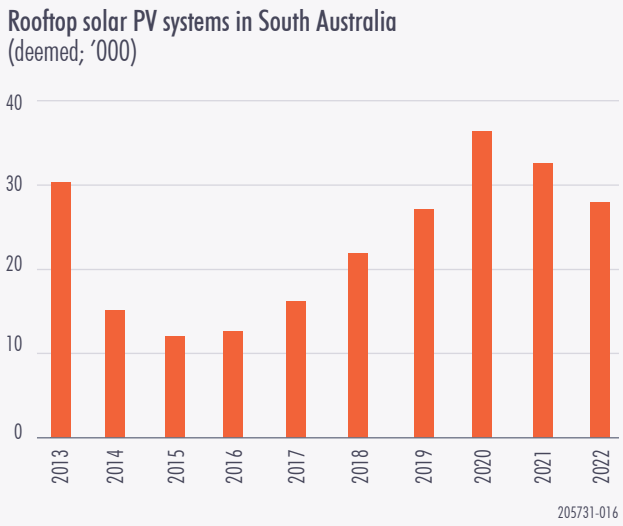
South Australia has one of the best climates and some of the best conditions for solar energy in the world, reflected in the rate at which homes and businesses have adopted rooftop solar PV for their energy needs.

For over 20 years, South Australians have installed rooftop solar PV in increasing numbers, and it is now the state's largest generator of electricity when aggregated. In fact, South Australia has one of the highest per capita levels of rooftop solar PV anywhere in the world. Rooftop solar PV accounted for almost 14 per cent of all electricity generation in the state in 2020-21[42].

According to AEMO, since 2018, South Australia has installed more than 200 MW of rooftop solar PV each year, the largest amount installed in 2020, with just under 400 MW across the state.

The Clean Energy Regulator (CER)[43] states that, in 2001, South Australia had 41 rooftop solar PV systems in the state. Fast forward to 2022 and South Australia now has more than 357,000 rooftop solar systems of up to 100 kW installed across the state, with a combined capacity of over 2,700 MW. These figures exclude the growing number of rooftop solar PV systems of more than 100 kW in size – in some cases multiple megawatts – increasingly being installed at larger businesses and sites across the state (Fig. 15)[44].

Figure 15 **Uptake of rooftop solar PV systems in South Australia**



42 Australian Energy Market Operator, South Australian Electricity Report October 2021, 2021-south-australian-electricity-report.pdf (aemo.com.au)

43 Clean Energy Regulator, Postcode data for small-scale installations, small generation unit – solar (deemed), South Australia, Postcode data for small-scale installations (cleanenergyregulator.gov.au)

44 Clean Energy Regulator, Postcode data for small-scale installations, small generation unit – solar (deemed), South Australia, Postcode data for small-scale installations (cleanenergyregulator.gov.au)

As the market has evolved over the last 20 years, rooftop solar PV systems have in general:

- decreased in cost
- increased in average system size per installation
- become more prevalent at businesses and other commercial premises
- supported and sustained renewable energy businesses and related workforces in South Australia
- become more affordable for homeowners to purchase larger systems that cover a higher proportion of their energy consumption
- become more efficient and 'smart' (such as being able to reduce their output either automatically or from a remote signal to support the power systems when required).

Financial returns and lower energy bills are the most common incentives for customers installing rooftop solar PV, with many people benefitting from energy bill reductions of hundreds or even thousands of dollars every year. These financial benefits are typically achieved by a combination of avoided grid electricity usage costs and payments for each kilowatt-hour (kWh) of excess electricity exported to the grid.

Payment for solar energy exported to the grid is referred to as a feed-in tariff (FiT). In South Australia, there are two types of FiT a customer may receive[45]:

1. The retailer FiT, available to anyone with an eligible solar PV system, is a variable payment amount offered by retailers. It can change regularly due to influences including the wholesale price of electricity and market competition. Each retailer sets its own FiT.
2. The distributor FiT (also known as the solar feed-in scheme) is fixed at 44 cents per kWh and available only to eligible solar PV systems connected to the grid prior to 30 September 2011. The distributor FiT is due to end on 30 June 2028. As of October 2022, there were over 87,000 South Australian customers receiving it. A condition on the distributor FiT is that the householder forfeits their benefit if their system is upgraded or altered.

   A "step-down" distributor FiT of 16 cents per kwh hour, offered to householders whose solar systems were installed between October 2011 and September 2013, expired in 2016.

   Customers receiving the distributor FiT may also be paid a retailer FiT.

With more than one in three households with rooftop solar PV systems in South Australia (and increasing), the amount customers are paid for their excess solar generation has been decreasing year on year as the market value of this energy decreases in line with typical supply and demand balances.

This is reflected in the ESCOSA latest Energy Retail Price Offers Comparison Report (2021-22)[46], which highlights large decreases in FiTs over the last three years.

The influence of rooftop solar PV on South Australia's grid electricity usage can be seen in what many refer to as the 'duck curve' diagram. The curve shows how the state's use of grid electricity changes over a day, in line with the generation pattern of solar panels.

The duck curve is characterised by a peak in grid electricity use in the morning, as customers are waking up and getting ready for their day, a dip in the middle of the day, when rooftop solar PV systems (generally) hit their maximum output and reduce demand from the grid, and a large peak in the evening as people get home and solar power output is simultaneously decreasing as the sun sets.

45 Government of South Australia, Solar feed-in payments SA.GOV.AU - Solar feed-in payments (www.sa.gov.au)

46 Essential Services Commission of South Australia, Energy Retail Offer Prices, ESCOSA - Energy retail offer prices

The changing shape of the South Australian duck curve in line with increasing uptake of rooftop solar PV by homes and businesses can be seen in Fig. 16[47], which shows average operational demand across several years. The figure shows how the increasing number of rooftop solar PV systems over this period has materially changed the profile of our energy demand, with less and less use of grid electricity in the middle of the day.

The 'duck curve' reaches its extremes when South Australia experiences a mild, sunny day (often in Spring or Autumn), where residential energy use is low, and a large amount of electricity is generated by rooftop solar PV.

As Fig. 17 from AEMO[48] shows, on 16 October 2022, South Australia's combined output of rooftop solar PV and other non-scheduled generation[49] exceeded demand – resulting in negative electricity demand and record low minimum operational demand of 100 MW.

These minimum demand days are becoming increasingly common, and while they are of benefit by increasing our use of renewable energy and lowering the bills of those with solar, they also create many challenges to ensure the power system remains stable in the absence of the important voltage, frequency, and inertia services typically provided by traditional thermal generation.

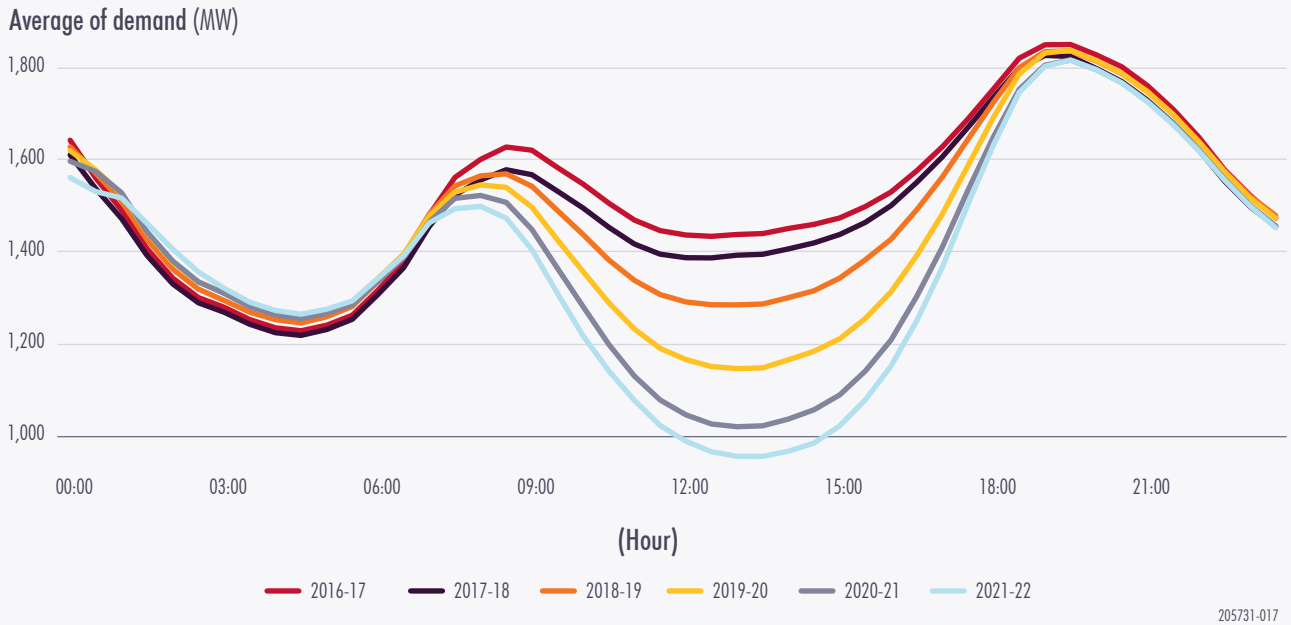
As there is lower demand, fewer large thermal generators are required to operate. However, these generators provide critical services to our power system, stabilising electrical frequency on the grid, helping the power system to ride through disturbances (such as transmission line outages) and responding rapidly to sudden changes in demand and supply. Without a minimum level of thermal generation, our power system becomes vulnerable to widespread outages.

47 AEMO's Power BI Dashboard, SAER Historical Generation - Power BI

48 Australian Energy Market Operator, New Minimum Operational Demand Recorded, 17 October 2022

49 Non-scheduled generation (generally) have an aggregate capacity of between 5-30MW and do not participate in AEMO's centralised dispatch process. AEMO forecasts non-scheduled generation to determine what remaining demand needs to be met by scheduled and semi-scheduled generation.

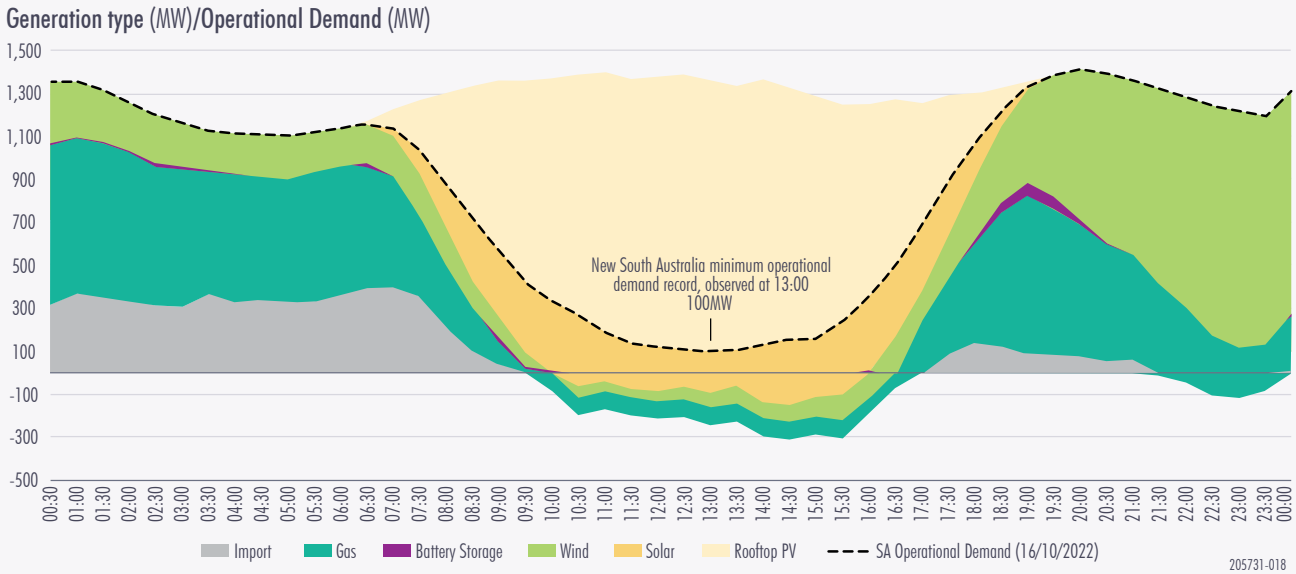
Figure 16 **Average daily operational demand in South Australia (MW)**



South Australia is actively dealing with these issues, with energy policy continually evolving to integrate increasing renewable generation into our power system while managing these emerging challenges. In 2020, South Australia, introduced a number of measures and other technical requirements to manage risks during certain scenarios of minimum demand. These measures saw the introduction of:

- Voltage ride-through standards for generating systems connected via an inverter
  - a new technical standard for systems to reduce impacts during disturbances.
- Remote disconnection and reconnection requirements
  - a new technical standard requiring that systems are capable of being remotely disconnected and reconnected by an agent registered with the Technical Regulator.
- Dynamic export limit requirements
  - from July 2023, new technical standards require that all new systems be capable of receiving updates to their export limits, referred to as dynamic export control. Currently, systems are set with a static export limit - typically 5kW per phase - which can be supported by the distribution network even at times of very high exports. As more systems are connected and the distribution network capacity to accept exports is filled, this static limit is set to be lowered to 1.5kW. A dynamic export limit allows for exports to be reduced at times where this could otherwise cause issues in the distribution network but permits much higher export limits outside of those times - up to 10kW per phase most of the time.
- Smart meter minimum technical standards
  - a new technical standard for smart meters with separate measurement and management of generation and controlled load.
- Tariffs to incentivise energy use in low demand periods
  - a new requirement that retailers offer plans rewarding customers for shifting electricity use to support the grid.

Figure 17 **South Australia Operational Demand and Generation Mix on Sunday 16 October 2022**



South Australia is not alone in experiencing these challenges with other jurisdictions beginning to encounter similar issues as their rooftop solar PV installations continue to increase.

Western Australia implemented Emergency Solar Management[50] in February 2022 to ensure new and upgraded solar and battery installations can be remotely turned down or switched off in emergency situations. Queensland also introduced a similar emergency backstop mechanism[51] for all new and replacement rooftop solar PV and battery systems of 10 kilovolt amperes (kVA) and over in 6 February 2023.

While the new technical standards and requirements over the last few years have provided mechanisms for managing emerging system security issues under certain conditions, further work is required to leverage these technologies for the benefit of all South Australians.

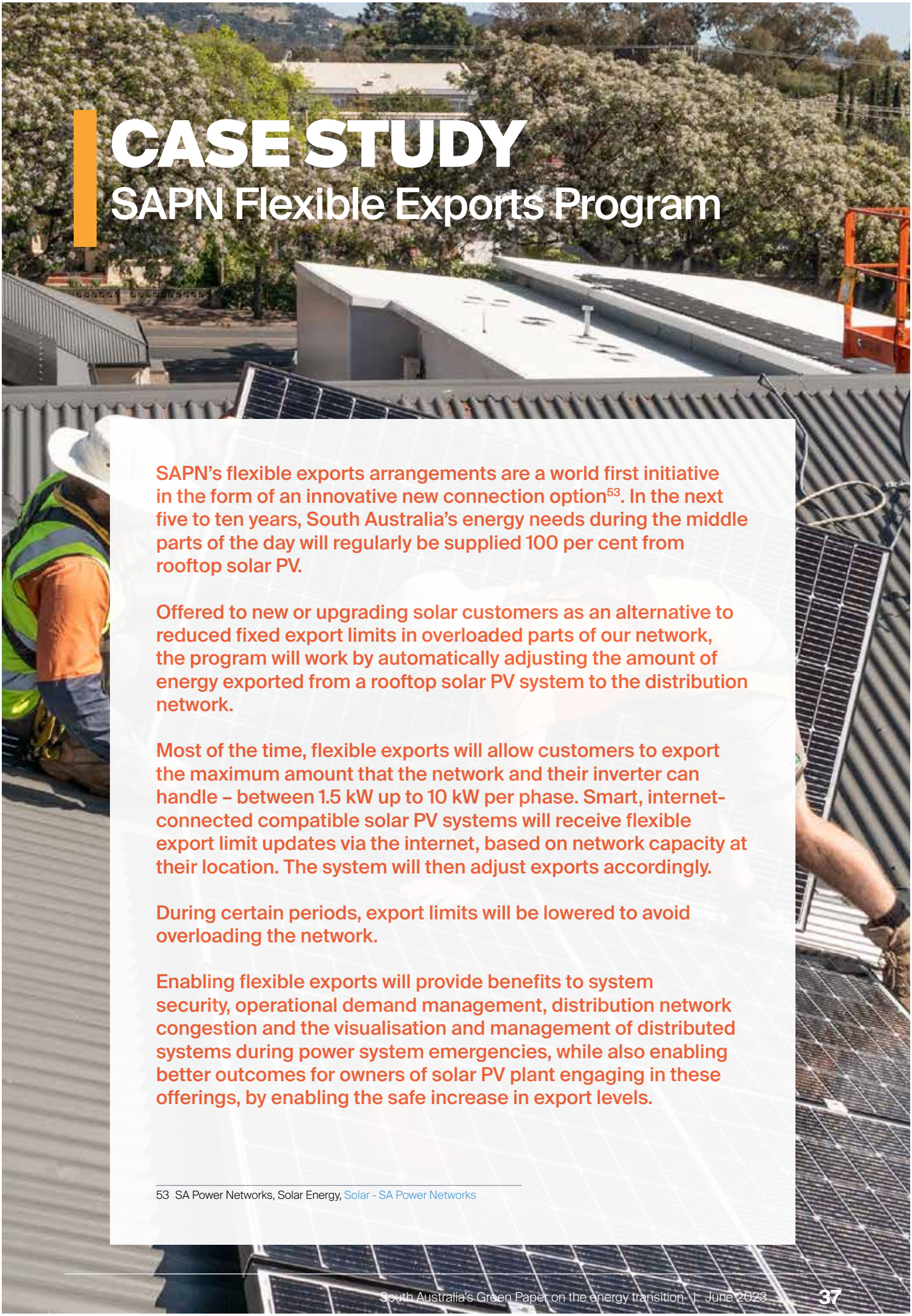
This work is already underway, with both government and industry enacting initiatives covered in other sections of this Green Paper, including the government's Hydrogen Jobs Plan and the introduction of flexible exports[52] by SAPN.

50 Government of Western Australia, Emergency Solar Management Emergency Solar Management (www.wa.gov.au)

51 Queensland Government, Emergency backstop mechanism Emergency backstop mechanism | Department of Energy and Public Works (epw.qld.gov.au)

52 SA Power Networks refer to dynamic exports as flexible exports.

South Australia has one of the best climates and some of the best conditions for solar energy in the world, reflected in the rate at which homes and businesses have adopted rooftop solar for their energy needs.



CASE STUDY
SAPN Flexible Exports Program

SAPN's flexible exports arrangements are a world first initiative in the form of an innovative new connection option[53]. In the next five to ten years, South Australia's energy needs during the middle parts of the day will regularly be supplied 100 per cent from rooftop solar PV.

Offered to new or upgrading solar customers as an alternative to reduced fixed export limits in overloaded parts of our network, the program will work by automatically adjusting the amount of energy exported from a rooftop solar PV system to the distribution network.

Most of the time, flexible exports will allow customers to export the maximum amount that the network and their inverter can handle – between 1.5 kW up to 10 kW per phase. Smart, internet-connected compatible solar PV systems will receive flexible export limit updates via the internet, based on network capacity at their location. The system will then adjust exports accordingly.

During certain periods, export limits will be lowered to avoid overloading the network.

Enabling flexible exports will provide benefits to system security, operational demand management, distribution network congestion and the visualisation and management of distributed systems during power system emergencies, while also enabling better outcomes for owners of solar PV plant engaging in these offerings, by enabling the safe increase in export levels.

53 SA Power Networks, Solar Energy, Solar - SA Power Networks

WHAT ARE YOUR THOUGHTS?

- What role should rooftop solar PV play in the future of South Australia's grid?
- How can access to rooftop solar PV and/or its benefits be made more equitable across energy users?
- How should the Government of South Australia ensure rooftop solar PV delivers the greatest value to consumers while maintaining a secure and reliable network?
- What, if any, changes are required to the ways in which premises are wired in South Australia?
- What reforms would help address the equity issue affecting renters and people in premises unsuited to solar PV systems?

The Government of South Australia recognises technology like rooftop solar PV systems presents many benefits and opportunities for our energy system, and will continue to play a significant role in our future. To cater for the increasing generation capacity from rooftop PV systems being installed in South Australia, our electricity system must continue to adapt, with customer behaviour evolving to utilise this resource in the most optimal way.

Renters and non-solar premises are missing out on the benefits of solar and bearing more of the cost-burden of the shared network. This lack of equity is a concern for the Government of South Australia.

The Government of South Australia is also mindful of the barriers in the housing rental market. Many community housing providers are engaged in programs to provide rooftop solar PV for their clients. However, many private landlords are reluctant to invest in solar systems and most renters lack the capital and the rationale to invest in a system with a payback of several years. In addition, many South Australians live in homes which are unsuitable for solar, such as apartments and properties in deep shade.

3.3. THE CURRENT AND FUTURE ROLE OF ENERGY STORAGE

The range of methods and technologies to store energy fall under four systems; electrochemical, mechanical, chemical and thermal[54].

Coupling energy storage with renewable energy provides stability services and emergency back-up power if a shortfall in energy is predicted. This helps overcome intermittent power generation (i.e. solar power is only generated when the sun shines) and can provide energy when it is needed.

As noted in section 3.1, in AEMO's 2022 ISP, the Market Operator has predicted that approximately 46 GW / 640 GWh of dispatchable storage capacity, 7 GW of existing dispatchable hydro and 10 GW of gas-fired generation is needed by 2050 to efficiently operate and firm[55] variable renewable energy (at utility scale) (VRE).

South Australia has played a pioneering role in demonstrating the critical value of storage in a modern energy system. South Australia has transformed its energy system from one per cent to just under 70 per cent renewable energy in just under two decades. More than 40 per cent of homes in South Australia have rooftop solar PV systems installed, one of the highest uptakes of residential batteries in the world. This has presented both an opportunity and a need for the evolution of Australia's energy market and technological innovation to manage the challenges associated with bi-directional flow on Australia's electricity grid.

South Australia is home to the world's original biggest battery – the 150 MW / 193.5 MWh Hornsdale Power Reserve. Built in 2017 and expanded in 2019, this battery provides essential grid-support services that have enabled increasing amounts of low-cost renewable energy to flow into the grid and, in 2022, became the first big battery in the world to deliver grid-scale synthetic inertia – a grid stability service that previously could only be provided by coal or gas-fired generators.

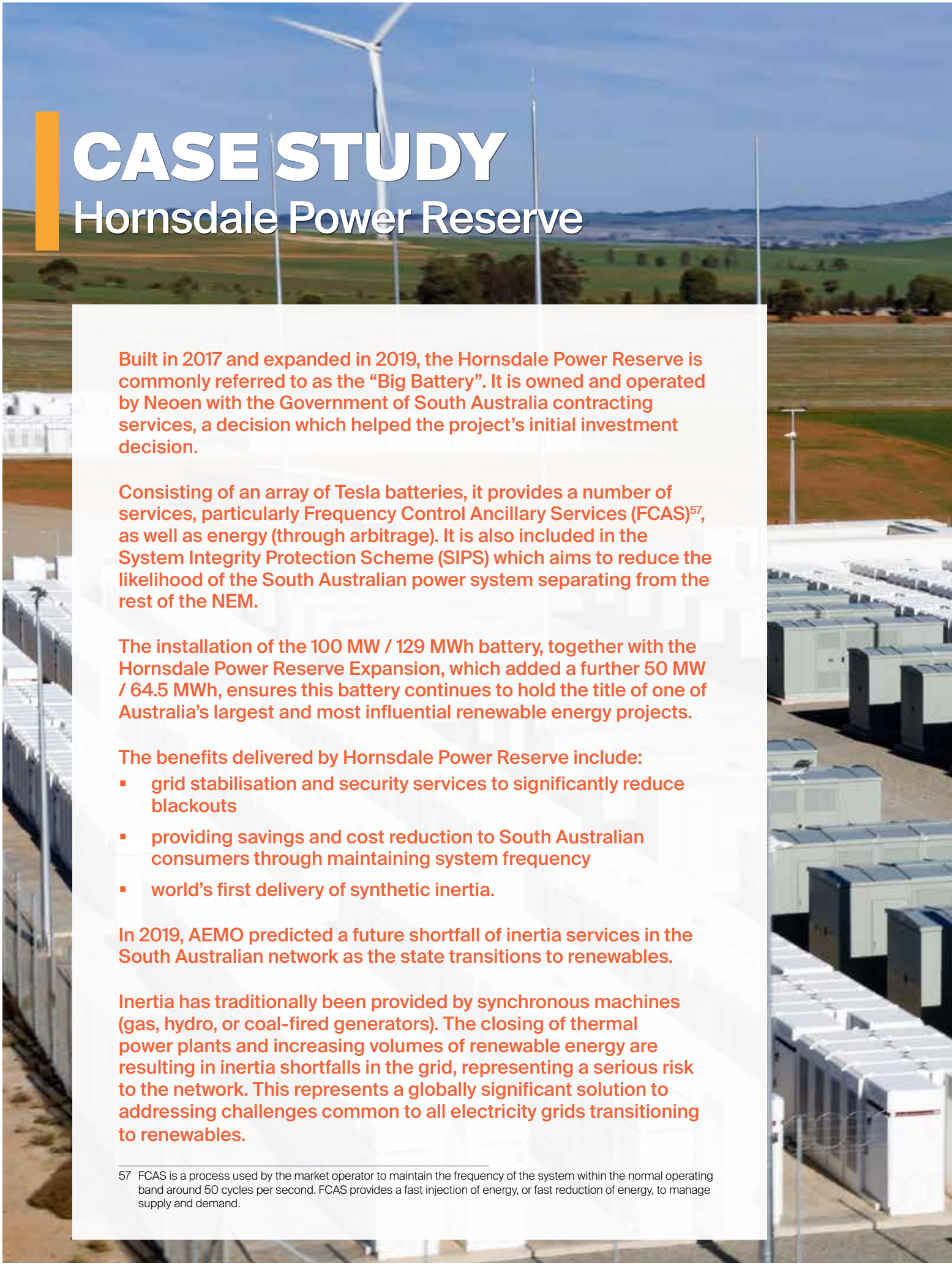
Independent analysis has shown that in its first two years of operation alone, Hornsdale Power Reserve saved South Australian consumers over $150 million[56]. Other grid-scale batteries also operate at Dalrymple, Lake Bonney, Lincoln Gap and the Adelaide Desalination Plant.

A number of other battery projects are also in development and/or have been proposed in South Australia. AGL's 250 MW / 250 MWh battery at Torrens Island is stated to be operational by mid-2023. Neoen is developing a 200 MW / 400 MWh battery with grid-forming inverter technology at Blyth, expected to be 200 MW / 400 MWh, and offering grid-forming capacity. Risen plans to build a 200 MW / 400 MWh grid-forming battery, located at Bungama near Port Pirie. Grid-scale batteries are also proposed for other battery projects include Iberdrola's Port Augusta Renewable Energy Park, Neoen's Goyder Renewables Zone and ZEN Energy's Solar River near Robertstown.

54 Commonwealth Scientific and Industrial Research Organisation (CSIRO), Renewable Energy Storage Roadmap, March 2023

55 Firming refers to the process of maintaining the output of intermittent power sources for a period of time.

56 Hornsdale Power Reserve, Strengthening the South Australian Electricity Grid, Aurecon Report(s), Learn | Hornsdale Power Reserve



CASE STUDY
Hornsdale Power Reserve

Built in 2017 and expanded in 2019, the Hornsdale Power Reserve is commonly referred to as the "Big Battery". It is owned and operated by Neoen with the Government of South Australia contracting services, a decision which helped the project's initial investment decision.

Consisting of an array of Tesla batteries, it provides a number of services, particularly Frequency Control Ancillary Services (FCAS)[57], as well as energy (through arbitrage). It is also included in the System Integrity Protection Scheme (SIPS) which aims to reduce the likelihood of the South Australian power system separating from the rest of the NEM.

The installation of the 100 MW / 129 MWh battery, together with the Hornsdale Power Reserve Expansion, which added a further 50 MW / 64.5 MWh, ensures this battery continues to hold the title of one of Australia's largest and most influential renewable energy projects.

The benefits delivered by Hornsdale Power Reserve include:

- grid stabilisation and security services to significantly reduce blackouts
- providing savings and cost reduction to South Australian consumers through maintaining system frequency
- world's first delivery of synthetic inertia.

In 2019, AEMO predicted a future shortfall of inertia services in the South Australian network as the state transitions to renewables.

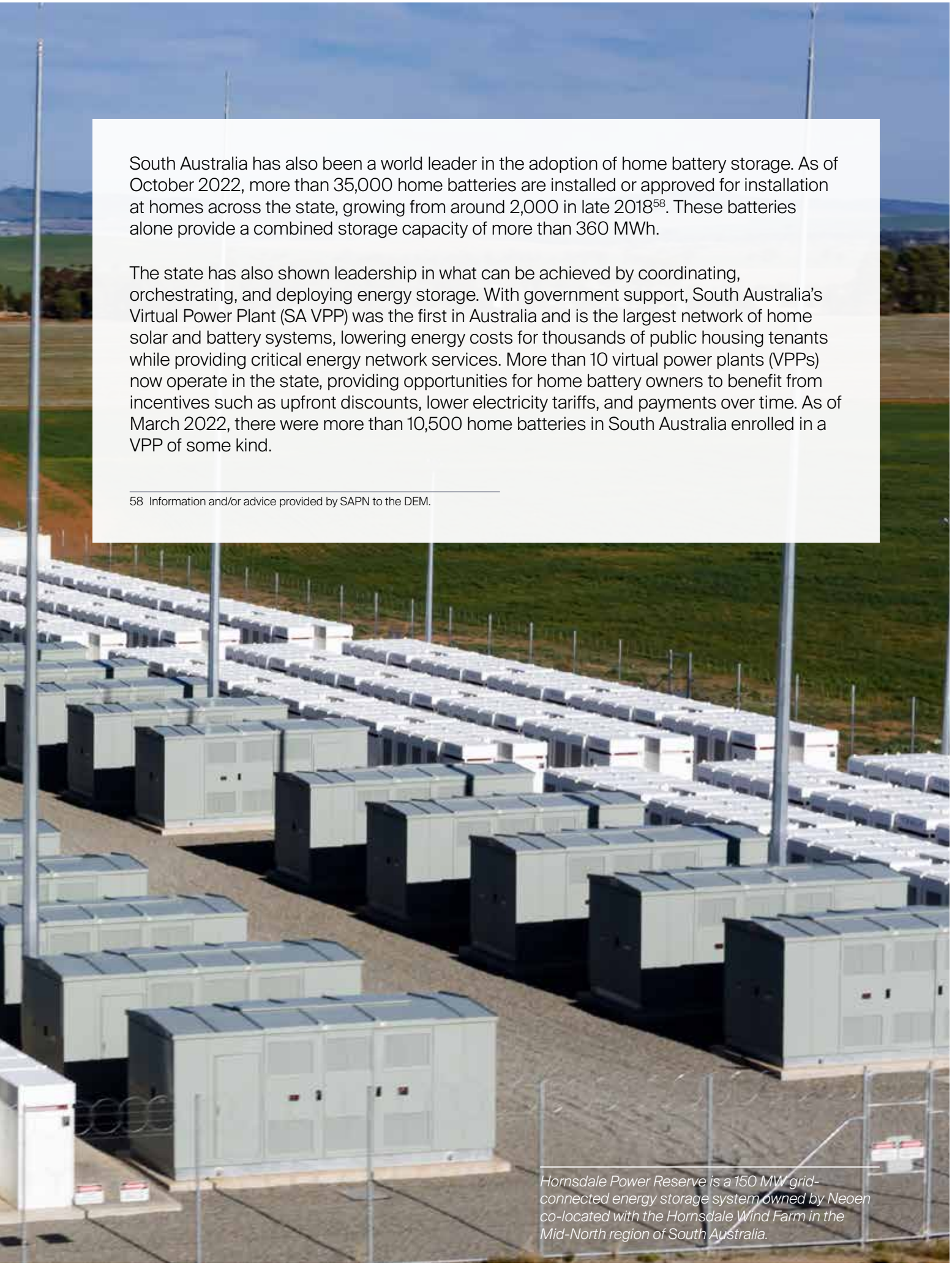
Inertia has traditionally been provided by synchronous machines (gas, hydro, or coal-fired generators). The closing of thermal power plants and increasing volumes of renewable energy are resulting in inertia shortfalls in the grid, representing a serious risk to the network. This represents a globally significant solution to addressing challenges common to all electricity grids transitioning to renewables.

57 FCAS is a process used by the market operator to maintain the frequency of the system within the normal operating band around 50 cycles per second. FCAS provides a fast injection of energy, or fast reduction of energy, to manage supply and demand.

South Australia has also been a world leader in the adoption of home battery storage. As of October 2022, more than 35,000 home batteries are installed or approved for installation at homes across the state, growing from around 2,000 in late 2018[58]. These batteries alone provide a combined storage capacity of more than 360 MWh.

The state has also shown leadership in what can be achieved by coordinating, orchestrating, and deploying energy storage. With government support, South Australia's Virtual Power Plant (SA VPP) was the first in Australia and is the largest network of home solar and battery systems, lowering energy costs for thousands of public housing tenants while providing critical energy network services. More than 10 virtual power plants (VPPs) now operate in the state, providing opportunities for home battery owners to benefit from incentives such as upfront discounts, lower electricity tariffs, and payments over time. As of March 2022, there were more than 10,500 home batteries in South Australia enrolled in a VPP of some kind.

58 Information and/or advice provided by SAPN to the DEM.



Hornsdale Power Reserve is a 150 MW grid-connected energy storage system owned by Neoen co-located with the Hornsdale Wind Farm in the Mid-North region of South Australia.

CASE STUDY

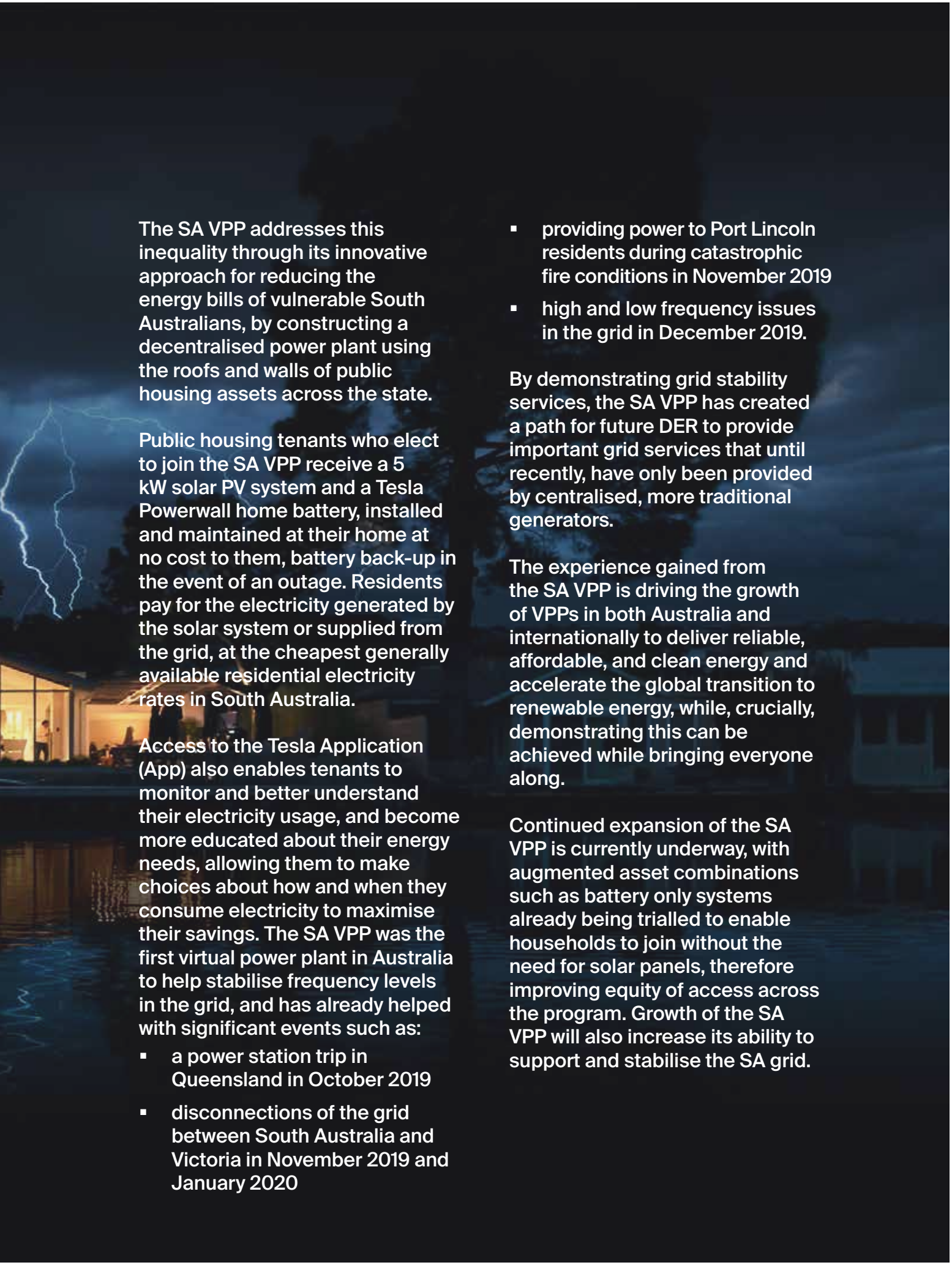
South Australia's Virtual Power Plant

South Australia's Virtual Power Plant (SA VPP) is the first and the largest network of home solar and battery systems in Australia, lowering energy costs for thousands of public housing tenants while providing critical energy network services.

SA VPP has developed innovative approaches to:

- significantly reduce energy bills for vulnerable and low-income South Australians
- improve electricity market competition through downward pressure on wholesale electricity prices for all South Australians
- provide more access to renewable energy for more people
- provide new commercial models for financing renewable energy assets
- provide system security services to the state's electricity distribution network (23 MW registered storage with AEMO)
- drive regulatory reform that accelerates Australia's energy market transition
- fast-track South Australia's energy transformation.

Despite the high rates of solar adoption in the state, many lower income and vulnerable South Australians are still "locked out" of realising the savings and energy autonomy benefits now synonymous with renewable energy technologies. In most cases, this is due to high upfront capital costs or lack of property ownership.



The SA VPP addresses this inequality through its innovative approach for reducing the energy bills of vulnerable South Australians, by constructing a decentralised power plant using the roofs and walls of public housing assets across the state.

Public housing tenants who elect to join the SA VPP receive a 5 kW solar PV system and a Tesla Powerwall home battery, installed and maintained at their home at no cost to them, battery back-up in the event of an outage. Residents pay for the electricity generated by the solar system or supplied from the grid, at the cheapest generally available residential electricity rates in South Australia.

Access to the Tesla Application (App) also enables tenants to monitor and better understand their electricity usage, and become more educated about their energy needs, allowing them to make choices about how and when they consume electricity to maximise their savings. The SA VPP was the first virtual power plant in Australia to help stabilise frequency levels in the grid, and has already helped with significant events such as:

- a power station trip in Queensland in October 2019
- disconnections of the grid between South Australia and Victoria in November 2019 and January 2020
- providing power to Port Lincoln residents during catastrophic fire conditions in November 2019
- high and low frequency issues in the grid in December 2019.

By demonstrating grid stability services, the SA VPP has created a path for future DER to provide important grid services that until recently, have only been provided by centralised, more traditional generators.

The experience gained from the SA VPP is driving the growth of VPPs in both Australia and internationally to deliver reliable, affordable, and clean energy and accelerate the global transition to renewable energy, while, crucially, demonstrating this can be achieved while bringing everyone along.

Continued expansion of the SA VPP is currently underway, with augmented asset combinations such as battery only systems already being trialled to enable households to join without the need for solar panels, therefore improving equity of access across the program. Growth of the SA VPP will also increase its ability to support and stabilise the SA grid.

WHAT ARE YOUR THOUGHTS?

- What role should energy storage play in the future of South Australia's grid?
- What energy storage is needed to deliver a modern energy system that operates reliably and affordably? For example, grid-scale, distribution level, and/or household energy storage?
- What types of energy storage should the Government of South Australia explore further in partnership with industry and consumers?
- How can the Government of South Australia ensure energy storage delivers the greatest value to consumers?
- What role can community renewable energy systems play in the future energy system and what role does government have in facilitating these?
- What is required to ensure consumers are central to the deployment and operation of energy storage and that the benefits are shared equitably?
- What reforms are needed to ensure storage has both sufficient capacity and depth, to meet the requirements of South Australia's future grid?

Other jurisdictions have recognised the critical role energy storage will play in the future, with grid-scale batteries, pumped hydro energy storage (PHES) and programs to support household storage becoming common across the country. A growing, emerging trend is community energy storage, with community batteries already deployed in a number of areas. In 2022, the Australian Government announced the $200 million Community Batteries for Household Solar program for the installation of 400 community batteries across the country.

A number of other technologies are being considered for energy storage in South Australia. For example, pumped hydro proposals include the Baroota reservoir, Goat Hill, Cultana and the Middleback Ranges. The Sundrop Farm near Port Augusta runs on concentrated solar thermal power (CSP). CSP will also be deployed by Vast Solar north of Port Augusta, at a site adjacent to 1414 Degrees. An advanced Compressed Air Energy Storage (CAES) System was also considered for the former Angas Zinc Mine at Strathalbyn.

South Australia is strongly positioned as a leader in the renewable energy transition – providing a clear pathway towards 100 per cent renewables both for the state, and for Australia.

3.4. THE CURRENT AND FUTURE ROLE OF HYDROGEN GAS

With almost 70 per cent of South Australia's energy already coming from renewable sources, hydrogen will complement the state's generation and further support South Australia in achieving its twin goals of reducing state greenhouse gas emissions by more than 50 per cent below 2005 levels by 2030 and achieving net-zero emissions by 2050.

When hydrogen is made using renewable electricity, the result is a carbon-free fuel. It is versatile and, when produced at scale, can significantly reduce emissions across the power, transport, and industrial sectors. A report[59] series released by the International Renewable Energy Agency (IRENA) sees hydrogen trade significantly contributing to a more diversified and resilient energy system, with hydrogen covering 12 per cent of global energy demand and cutting 10 per cent of CO_2 emissions by 2050.

The next phase of large-scale renewable energy development in South Australia is being driven by global demand for green hydrogen. Green hydrogen is rapidly emerging as a pivotal green energy source capable of meeting local and international energy demand.

South Australia is in a strong position to capitalise on this demand. Our state's variable energy resources – sun and wind – are among the best in the world, combined with significant land resources.[60]

The state is now seeing enormous interest from project backers in setting up renewable energy projects on government-owned pastoral lands and state waters in South Australia, areas of the state that are yet to host large scale renewable energy developments. DEM estimates the value of non-publicly announced projects at early design phase, including gigawatt-scale wind and solar projects proposed for the state's pastoral lands and state waters, could be even higher than the ~$20 billion currently in the investment pipeline (Fig. 18).

59 International Renewable Energy Agency, World Energy Transitions Outlook 2022: 1.5'c Pathway IRENA_World_Energy_Transitions_Outlook_2022.pdf

60 International Renewable Energy Agency, World Energy Transitions Outlook 2022: 1.5'c Pathway IRENA_World_Energy_Transitions_Outlook_2022.pdf

Iberdrola's 20 MW electrolyser at Puertollano (Spain).

South Australia's renewable energy projects pipeline

It is estimated there is nearly 100GW of economically developable wind and solar resources in South Australia with ~$20 billion and 15 GW of generation in the investment pipeline already.

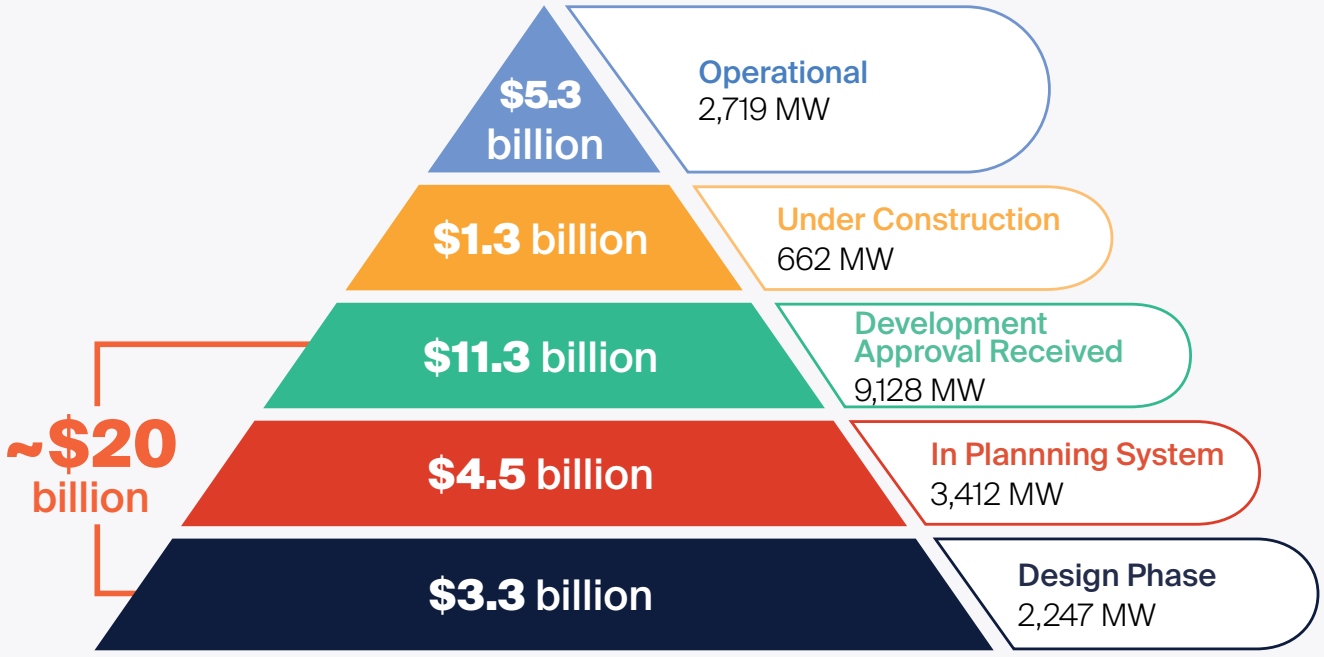


Figure 18[61] Estimates based on publicly available information, correct as of September 2022, from the following sources.

61 AEMO, Generation information;
GenCost: annual electricity cost estimates for Australia - CSIRO

Pastoral lands and state waters are also co-owned by Native Title groups, and any development will impact on Aboriginal peoples' interests, activities, and cultural and spiritual connections to the land. There is potential for new and significant economic opportunities for Aboriginal people – when development is done in the right way - including project ownership, direct employment, business development and procurement.

Large-scale projects hosted in regional and remote communities should deliver benefits to these communities. This may be through economic development opportunities, while the renewable energy supplies could potentially play a role in delivering clean, reliable and cheaper energy supplies to communities that are off-grid or at the end of the NEM infrastructure.

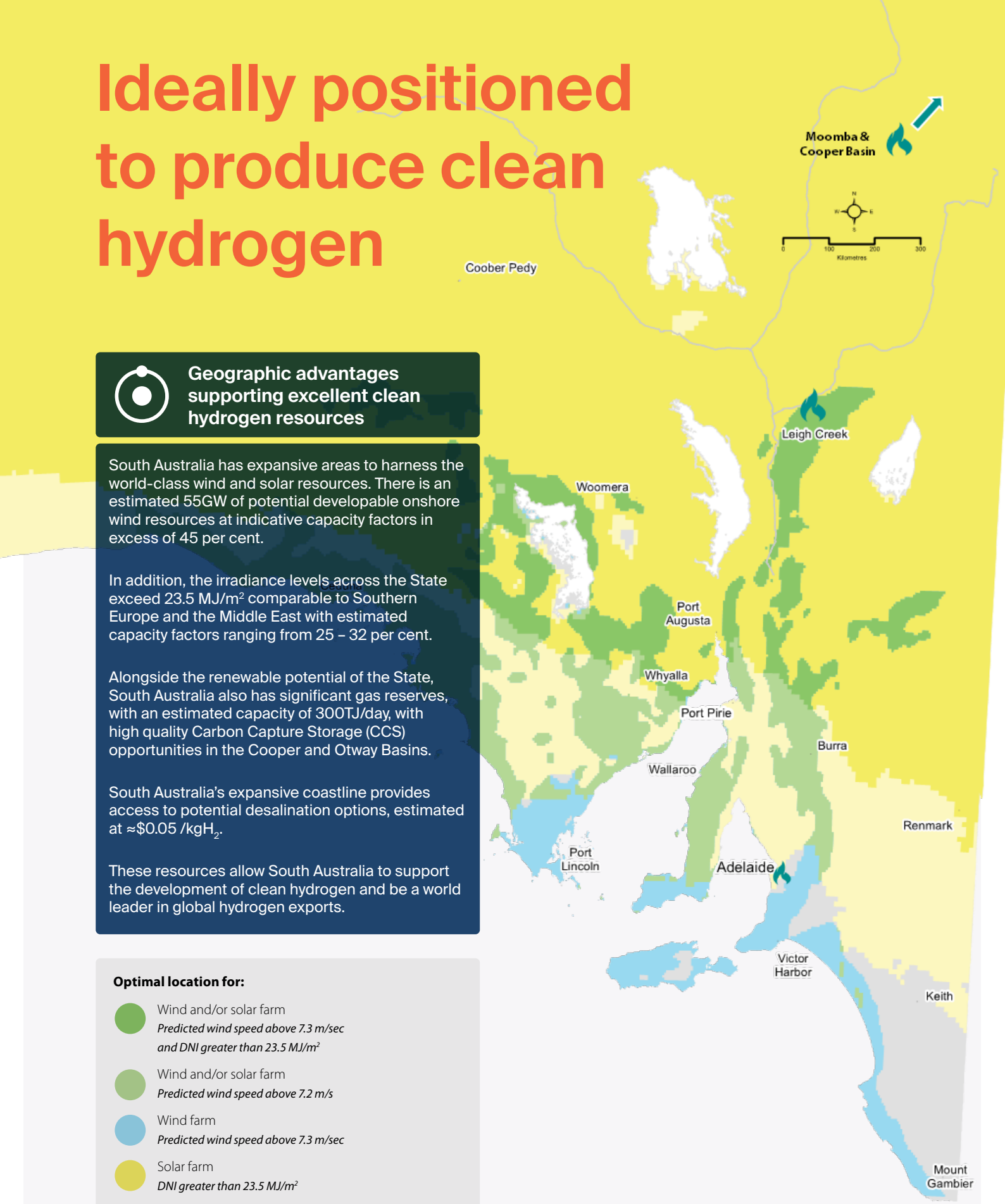
South Australia's world class renewable energy resources give the state a natural competitive edge in the race to supply clean, green, renewable hydrogen. Figure 19[62] highlights the combination of wind and solar that is estimated by the Hydrogen Export Modelling Tool[63] to allow hydrogen electrolyser usage to run on renewable energy in excess of 70 per cent of the year in South Australia.

62 South Australia A global force in hydrogen, October 2020, south-australia-hydrogen-export-prospectus.pdf (energymining.sa.gov.au)

63 Department for Energy and Mining, Hydrogen Modelling Tool, Hydrogen Export Modelling Tool

Undertaking ground access clearances for geological mapping on De Rose Hill Station. L-R: Peter de Rose, Rex Tjami, David Pearson (traditional owners) and Rian Dutch (Geological Survey of South Australia). (Photo 415963)

Ideally positioned to produce clean hydrogen



Geographic advantages supporting excellent clean hydrogen resources

South Australia has expansive areas to harness the world-class wind and solar resources. There is an estimated 55GW of potential developable onshore wind resources at indicative capacity factors in excess of 45 per cent.

In addition, the irradiance levels across the State exceed 23.5 MJ/m² comparable to Southern Europe and the Middle East with estimated capacity factors ranging from 25 – 32 per cent.

Alongside the renewable potential of the State, South Australia also has significant gas reserves, with an estimated capacity of 300TJ/day, with high quality Carbon Capture Storage (CCS) opportunities in the Cooper and Otway Basins.

South Australia's expansive coastline provides access to potential desalination options, estimated at ≈$0.05 /kg$H_2$.

These resources allow South Australia to support the development of clean hydrogen and be a world leader in global hydrogen exports.

Optimal location for:

- Wind and/or solar farm
  Predicted wind speed above 7.3 m/sec and DNI greater than 23.5 MJ/m²
- Wind and/or solar farm
  Predicted wind speed above 7.2 m/s
- Wind farm
  Predicted wind speed above 7.3 m/sec
- Solar farm
  DNI greater than 23.5 MJ/m²
- Solar farm
  DNI greater than 20.5 MJ/m²
- Blue hydrogen production
  Available gas/coal reserves

Figure 19

The Government of South Australia is investing $750 million to accelerate new hydrogen projects, shipping infrastructure and modelling tools for investors and developers to take advantage of our natural resources. Underpinning this work is the Government of South Australia's Hydrogen Jobs Plan ('Plan').

The Plan will deliver significant benefits for South Australia, including:

- creating jobs for South Australians
- enhancing South Australia's grid security by providing a source of new dispatchable power generation
- 'proving' hydrogen production and generation technology at scale
- helping to unlock a pipeline of renewable energy developments and associated manufacturing opportunities
- supporting South Australia's continued clean energy transition and decarbonisation

The Office of Hydrogen Power South Australia, established in 2022, oversees the design and delivery of the Hydrogen Jobs Plan, the Port Bonython Hydrogen Hub and industry development to accelerate South Australia's hydrogen economy.

The Hydrogen Jobs Plan targets the construction of:

- 250 MWe of electrolysers
- 200 MW of power generation
- hydrogen storage.

The $593 million hydrogen facility is expected to be operational by the end of 2025.

The hydrogen facility, once built, will operate electrolysers during the middle of the day, providing additional grid stability by 'soaking up' the state's abundant renewable energy generated from large-scale wind and solar farms.

The additional demand on the electricity network will minimise the need for household rooftop PV to be switched off by energy providers during periods of excess renewable energy production.

Whilst the Plan represents a large investment in hydrogen over the coming years, this will complement existing projects already underway in South Australia, such as:

- Hydrogen Park SA (HyP SA) at the Tonsley Innovation District
- the Port Bonython Export Hub
- the Whyalla Steelworks transition to green hydrogen for steelmaking
- the Green Hydrogen Port Pirie (H2P2) project being assessed by Trafigura with Nyrstar polymetallic smelter
- Cape Hardy Green Hydrogen Hub
- Bolivar demonstration electrolyser for grid stabilisation and small batch export.

CASE STUDY
Hydrogen Park SA Project

The facility at the Tonsley Innovation District is an Australian-first project, and one of only a few in the world, to supply renewable gas blend to homes connected to an existing gas network.

The facility currently supplies almost 3,000 homes and businesses in the Adelaide suburb of Mitchell Park with a blended gas made of five per cent renewable hydrogen, created on-site.

Currently Australia's largest renewable hydrogen facility at 1.25 MW

Located at the Tonsley Innovation District, HyP SA's 1.25 MW Siemens Proton Exchange Membrane (PEM) electrolyser is an Australian first project that produces renewable hydrogen gas.

DEM and the Port of Rotterdam, Europe's largest port and majority owned by the Netherlands Government, undertook a hydrogen export pre-feasibility study in 2021. The study indicated that exports of green hydrogen to Rotterdam from Port Bonython are likely to be globally competitive, with shipping accounting for six to seven per cent of the delivered cost.

Existing onshore hydrocarbon reserves in the South Australian Cooper and Otway basins have the potential to produce significant quantities of low carbon hydrogen from natural gas reformation combined with Carbon Capture and Storage (CCS) – also known as blue hydrogen. Blue hydrogen is a potential route for large scale hydrogen production for domestic use or export that is cost competitive using currently available technologies.

South Australia is committed to supporting investment in new hydrogen projects, as hydrogen will allow us to rethink how we generate and store energy, heat our homes, fuel transport, and decarbonise heavy industries such as mining, cement and steel production.

While this emerging sector will lead to further sustainable economic development, the Government of South Australia also recognises that further work is required to ensure our hydrogen and renewable energy generation sectors deliver outcomes that balance the interests of multiple stakeholders and building long-term wealth. The Government of South Australia's proposed Hydrogen and Renewable Energy Act[64] will establish a 'one window to Government' regulatory framework that provides benefits to all South Australians and businesses, so the state remains a competitive place to invest.

64 Department for Energy and Mining, Hydrogen and Renewable Energy Act, Hydrogen and Renewable Energy Act | Energy & Mining (energymining.sa.gov.au)

DEM is consulting on the development of a Hydrogen and Renewable Energy Act to:

- maximise the benefits for all South Australians and the environment, while ensuring environmental, economic, public safety and social impacts associated with such developments are effectively addressed in line with environment, social and governance requirements
- work with proponents that seek to deliver multiple and sequential land use outcomes (including coexistence with Native Title, primary industries, mining, and petroleum)
- expedite the development of the state's hydrogen sector and support delivery of the Hydrogen Jobs Plan
- deliver investment certainty and security and unlock the pipeline of renewable energy projects
- facilitate competitive tendering processes on pastoral land and state waters
- deliver community and environmental benefits through projects, in line with leading environmental, social and governance requirements
- facilitate regulatory process certainty.

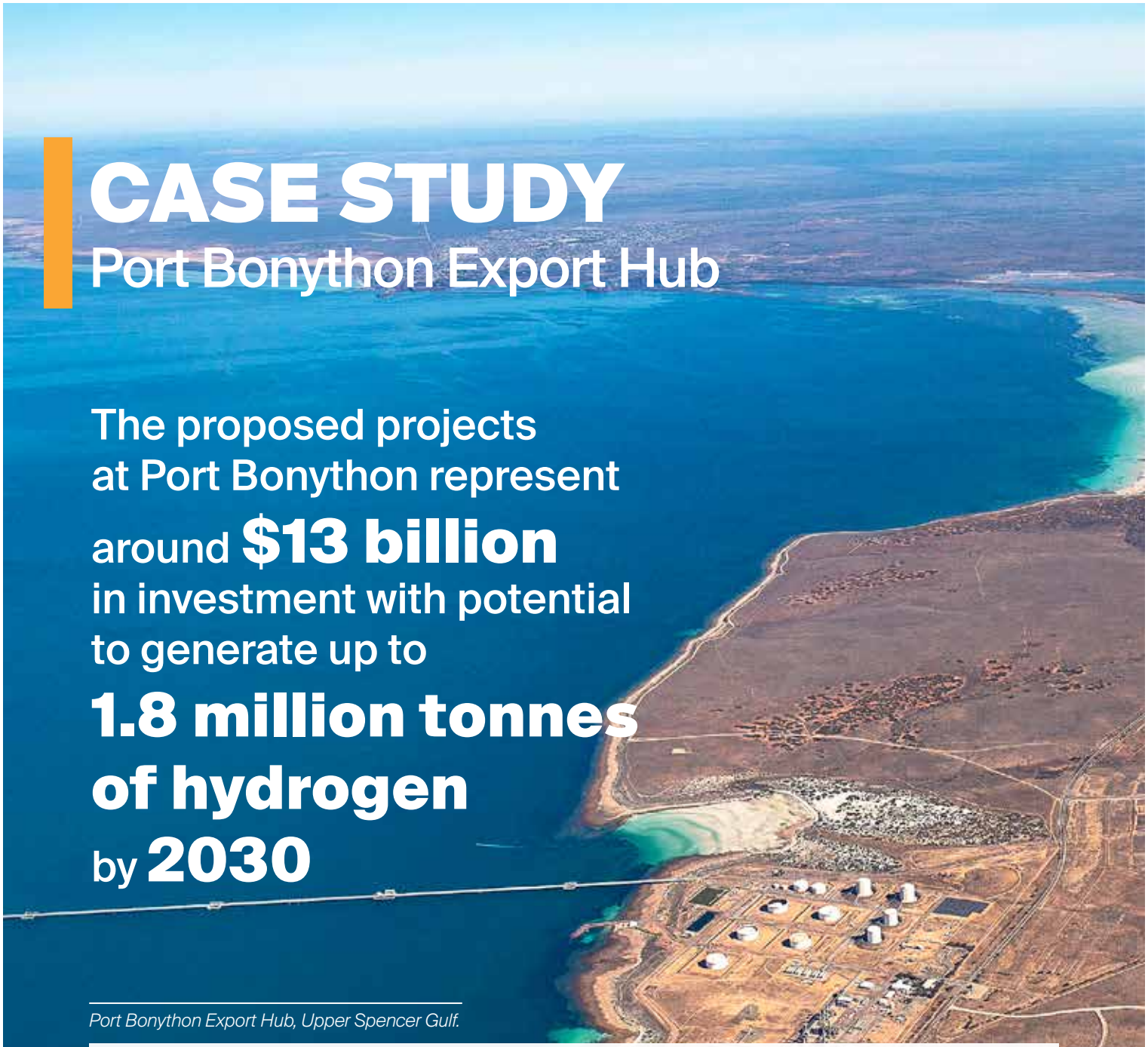
While this Green Paper acknowledges the development of this new Act, there is a separate consultation process on this matter.
Further information can be found on yourSAy.

WHAT ARE YOUR THOUGHTS?

- What is the best use of hydrogen in South Australia?
- How does hydrogen support the energy sector best in the future?
- What are the barriers to developing a hydrogen industry at scale in South Australia?

CASE STUDY
Port Bonython Export Hub

The proposed projects at Port Bonython represent around **$13 billion** in investment with potential to generate up to **1.8 million tonnes of hydrogen** by **2030**



Port Bonython Export Hub, Upper Spencer Gulf.

Port Bonython is well positioned to become South Australia's first large-scale export terminal for green and blue hydrogen.

Located 16 km from Whyalla in the Upper Spencer Gulf, Port Bonython has an existing deep-water liquid hydrocarbon export terminal, 1,700 hectares of developable land, world-class wind and solar resources and gas reserves located nearby.

The state government allocated $37 million from the 2020-21 State Budget to upgrade the Port Bonython jetty.

Together, state and federal governments have committed $100 million, and industry a further $40 million, to developing common user infrastructure, such as upgrades to the port, last mile pipelines, storage and access roads.

3.5. THE CURRENT AND FUTURE ROLE OF NATURAL GAS

South Australia's oil and gas industry has played a significant role for the state for over 150 years, with the first oil exploration in South Australia taking place in 1866 at Alfred Flat near Salt Creek, north of the Otway Basin.

It has contributed greatly to the economic prosperity and quality of life in our state, with the state's vast gas resources providing safe, secure and reliable energy supply to both South Australia and the broader NEM for many years.

Over the years, South Australia's oil and gas industry has adapted and evolved in line with resource needs. The Government of South Australia remains committed to carefully managing these assets, and their use, in partnership with industry – whether onshore or offshore, and in conventional or non-conventional reservoirs, to maximise community benefit.

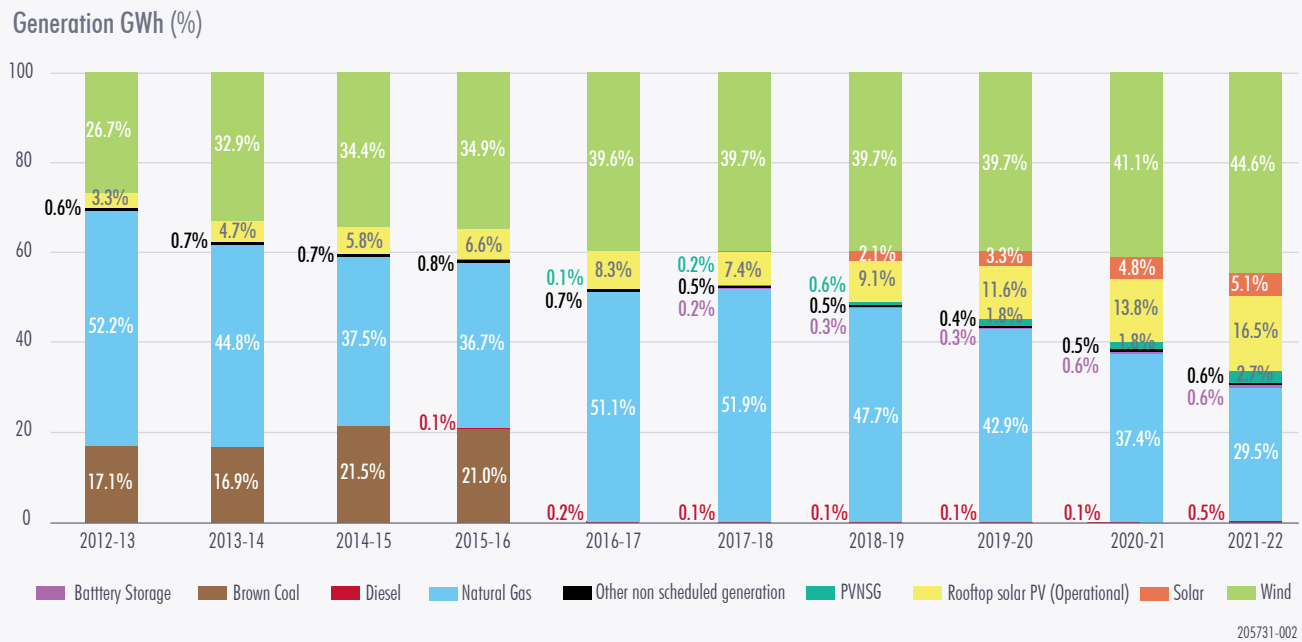
Today, gas assets in South Australia include gas-fired power stations, such as the Torrens Island 'B' Power Station, Barker Inlet Power Station, Pelican Point Power Station, Quarantine Power Station, and Hallett Power Station, to transmission pipelines, such as the Moomba to Adelaide Pipeline System (MAPS) and the South East Australia Gas Pipeline System (SEA Gas). In addition, storage such as the Moomba Gas Storage Facility, provides a critical energy storage function for the state.

In 2021-22, South Australia's gas production from Moomba (80 petajoules (PJ)) exceeded the state's demand for gas (72 PJ). As Fig. 20 shows[65], natural gas has played a critical role in our energy mix for a number of years, particularly since coal generation exited the market in 2016, forming part of the state's existing energy mix as dispatchable generation that can ramp up quickly as required.

While its role has decreased over the years, gas generation continues to provide a range of benefits to the state, including energy security during the evenings when renewable generation traditionally reduces.

65 Australian Energy Market Operator, South Australian Advisory Functions

Figure 20 **Generation type and generation GWh, 2012-13 to 2021-22**



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Natural gas is of particular importance during periods of time known as “dunkelflaute” (‘dark doldrums’ or ‘dark lull’), when there is minimal or no sunshine and wind for extended periods of time, usually during winter. This is an emerging challenge in power systems across the world comprised of large amounts of renewable generation, which need to be managed appropriately in the future.

As we transition to a net-zero emissions future, the oil and gas industry will continue to play a critical role for South Australia – particularly in the short-to-medium term. This transition has already begun, through investment in CCS technologies, and through a mixture of renewable technologies to support critical business functions[66] to reach net-zero emissions targets.

CCS gives South Australia the opportunity to create a new industrial ‘hub’ for competitive abatement of emissions – especially in sectors with difficult to abate process emissions such as cement, steel and iron manufacturing, natural gas processing, and biofuel production. CCS can also enable new technologies such as low carbon hydrogen production from natural gas, enhanced oil recovery, and direct air capture and storage (DACS).

South Australia has numerous proven storage reservoirs suitable for safe and low-cost CCS, particularly in the depleted fields of the Cooper and Otway basins, which have held oil and gas for 85 million years. In the long term, CCS in the Cooper Basin could store 20 million tonnes a year from other industrial emitters, accepting deliveries for more than 50 years.

Analysis from the Intergovernmental Panel on Climate Change[67] and International Energy Agency[68] consistently shows CCS is an essential part of the lowest cost path towards meeting global climate targets.

CCS is also a proven technology, with almost 30 commercial large-scale CCS projects in operation globally. These facilities successfully capture and store more than 40 million tonnes of CO_2 annually.

The Government of South Australia is keen to explore options in relation to liquefied natural gas (LNG) and other biogas resources, which will also play a critical role in the coming years, as the state continues its transition to a net-zero emissions future.

One such LNG project in South Australia is the Outer Harbor LNG Project, which received construction approval from the Government of South Australia in December 2021 and plans to be commissioned in 2024. While the import, storage and re-gas for LNG in South Australia is an emerging opportunity for the state, and builds on our existing industry, the Government of South Australia also recognises the emergence of other gases, such as hydrogen and biogas, that will also play a critical role in the future.

In relation to bioenergy, which includes biogas and biofuels, since 2015 (and with the release of the Bioenergy Roadmap for South Australia Report[69] and associated advocacy and industry development activities), DEM has:

- run several regional industry forums relating to biogases and/or bioenergy
- funded a $175,000 grant program for feasibility of bioenergy projects

66 An example of this is Santos, who announced in December 2018 that they would convert beam pumps on oil wells to solar and batteries at 56 sites (following a grant from the Australian Renewable Energy Agency (ARENA)), Conversion of Remote Crude Oil Beam Pumps to Solar & Battery - Australian Renewable Energy Agency (ARENA).

67 Intergovernmental Panel on Climate Change IPCC – Intergovernmental Panel on Climate Change

68 International Energy Agency IEA – International Energy Agency

69 Department for Energy and Mining, Bioenergy Roadmap, Bioenergy Roadmap | Energy & Mining (energymining.sa.gov.au)

- collaborated nationally through a jointly funded biomass mapping project (the Australian Biomass for Bioenergy Assessment (ABBA)) in partnership with ARENA, state governments and universities
- worked closely with industry, fellow South Australian government agencies, and other state and commonwealth government agencies, to provide industry development opportunities across the state.

Based on the biomass mapping data derived through the ABBA project, South Australia's biomethane potential is estimated at over 30 PJ per annum which equates to around 50 per cent of South Australia's domestic gas demand. This is a significant amount of green gas that can come online in a short timeframe.

Other benefits include provision of circular economy advantages such as reducing waste to landfill and high value by-products from the generation process (such as biochar and digestate).

Natural hydrogen found in underground formations may also have a place in our hydrogen industry and is why the Government of South Australia is continuing to lead nationally in enabling exploration licences for natural hydrogen. As an example, Gold Hydrogen propose to explore, appraise and develop natural hydrogen in the state[70].

While it is very early days globally for this potential natural resource (with only one producing natural hydrogen field in Mali), South Australia is leading the nation by enabling companies to explore for natural hydrogen via Petroleum Exploration Licences issued under the Petroleum and *Geothermal Energy Act 2000*.

70 Department for Energy and Mining, Gold Hydrogen natural hydrogen exploration, Gold Hydrogen natural hydrogen exploration | Energy & Mining (energymining.sa.gov.au)

WHAT ARE YOUR THOUGHTS?

- How does natural gas best support South Australia during the energy transition?
- What sectors will continue to use oil and natural gas in the long-term?
- What other gases should be explored further by the Government of South Australia and industry?
- How can the Government of South Australia further support other gas opportunities in the state?

Iberdrola's 20 MW electrolyser at Puertollano (Spain).

CASE STUDY

Cooper Basin Carbon Storage Project

The Cooper Basin Joint Venture CCS project will be operated by Santos. Currently under construction, the first injection is expected to commence in 2024.

Santos' exploration and production acreage is centred around Moomba, approximately 800 km north-east of Adelaide. The Moomba facility processes oil and natural gas from surrounding fields, made up of more than 1,000 producing wells. The oil and gas is piped to Moomba to be refined and distributed via pipelines to markets in South Australia, New South Wales, Queensland, and other domestic and international markets.

The project, which received a final investment decision from Santos and joint venture partners Beach Energy in 2019, will initially capture CO_2 emissions from the Moomba Gas Plant where existing equipment will separate CO_2 from sales gas. The captured CO_2 will be dehydrated, compressed, and then transmitted via pipelines to suitable locations, then injected into target geological formations deep underground. The CO_2 may be stored in hydrocarbon bearing formations, deep saline geological formations or other geological targets and may occur following utilisation of the CO_2.

The Moomba CCS project will permanently store 1.7 million tonnes per year of CO_2 into the depleted oil and gas fields of the Cooper Basin, representing a cut of more than seven per cent to South Australia's emissions. The project has the potential to expand to 20 million tonnes per year by storing CO_2 from other industrial sources outside of Moomba.

CCS in the Cooper Basin will create hundreds of jobs during the construction phase and importantly, will extend the life of more than 1,000 existing jobs in the Basin.

3.6. MINING, MANUFACTURING AND RECYCLING

The Australian Government reports that advanced manufacturing accounts for around half of Australia's $100 billion plus annual manufacturing output and is one of the fastest growing export sectors[71]. Through the Australian Government's A Future Made in Australia agenda, up to $15 billion of capital will be provided in the future to invest in job-creating projects through loans, equity and guarantees in resources, agriculture, transport, medical science, defence capability, enabling capabilities, and renewables and low emissions technologies.

Like the Australian Government, the Government of South Australia is putting in place a number of initiatives to support manufacturing in the state, such as the establishment of the South Australian Manufacturing Innovation Grant Program. This program, which provides $10 million over four years, will help to boost the manufacturing industry as the state continues to move past the impacts of the COVID-19 Pandemic.

The Government of South Australia has also established an attractive environment for manufacturing and innovation to thrive through precincts such as Lot Fourteen and the Tonsley Innovation District.

For South Australia, manufacturing is a vital driver of employment, due to its strong links to mining, agriculture and other essential services. By building on our state's low-cost renewable energy, a competitive advantage is created to attract clean energy intensive industries such as metal and mineral processing, and clean energy manufacturing.

In the Australian Bureau of Statistics (ABS) Australian Industry estimates for 2020-21[72], sales and services income for the manufacturing sector in South Australia was over $23 billion.

Figure 21 **Minerals used in electric cars compared to conventional cars**

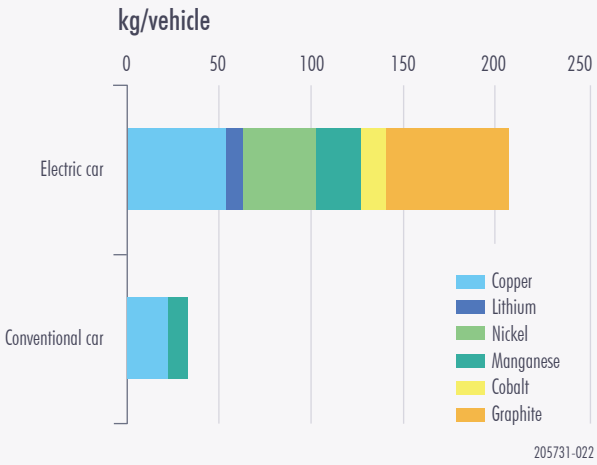
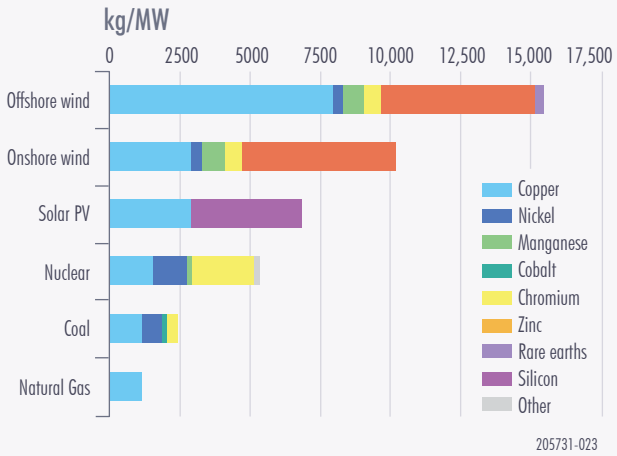


Figure 22 **Minerals used in clean energy technologies compared to other power generation sources**



71 Australian Government, Australian Trade and Investment Commission, Manufacturing, Manufacturing - Austrade's industry capability information - Austrade

72 Australian Bureau of Statistics, Australian Industry, 2020-21, Table 2: Manufacturing industry by States and territories by ANZSIC subdivision Australian Industry, 2020-21 financial year | Australian Bureau of Statistics (abs.gov.au)

A number of industries make up South Australia's manufacturing sector, from food production, to textile, leather, clothing and footwear manufacturing, through to primary metal and metal product manufacturing.

For the energy sector, minerals are an essential component in many of today's rapidly growing clean energy technologies, from wind turbines to batteries, and will play a growing role in the future, as Fig. 21 and Fig. 22 show[73].

Demand for these minerals, such as lithium, cobalt and graphite, will grow quickly, as the global energy transition gathers pace. This demand will create significant opportunities for Australia and South Australia in particular, thanks to the state's critical mineral reserves and reputation as a trusted and reliable supplier.

DEM reported[74] that mineral and resource production over the last 12 months (to June 2022) had a total resource value of $8.54 billion, comprised of metallic minerals, energy, petroleum production, gem and semi-precious stones, opal production, industrial minerals and construction minerals.

73 International Energy Agency, The Role of critical Minerals in Clean Energy Transitions, 2021, License: CC BY 4.0, https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions

74 South Australian mineral resource production statistics for the six month ended 30 June 2022 (pir.sa.gov.au)

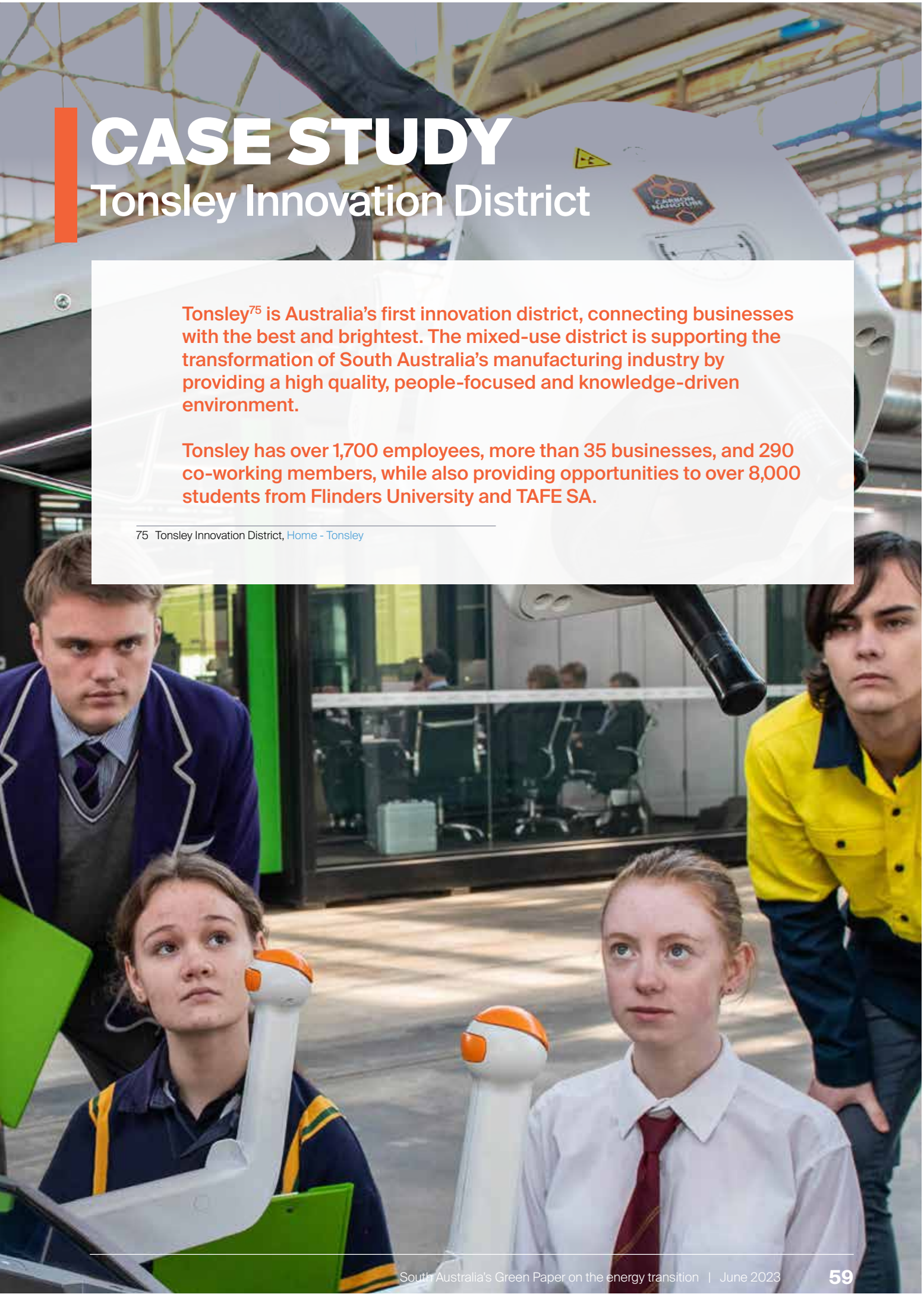
Students at Tonsley Innovation District is a living lesson in the importance of STEM for future careers.

CASE STUDY
Tonsley Innovation District

Tonsley[75] is Australia's first innovation district, connecting businesses with the best and brightest. The mixed-use district is supporting the transformation of South Australia's manufacturing industry by providing a high quality, people-focused and knowledge-driven environment.

Tonsley has over 1,700 employees, more than 35 businesses, and 290 co-working members, while also providing opportunities to over 8,000 students from Flinders University and TAFE SA.

75 Tonsley Innovation District, Home - Tonsley



CASE STUDY

South Australia's mining sector, and critical minerals in the state

South Australia possesses a wealth of minerals vested in the people of South Australia through the Crown

The state is a globally important producer of copper, uranium and zircon, and is stepping up production of iron ore. South Australia also produces gold, zinc, lead, silver, industrial minerals (including salt, silica sand and gypsum) and extractive materials (including dimension stone and opal).

The state has emerging opportunities to develop resources of critical minerals, rare earth elements, cobalt, magnesite, graphite, and the potential to process minerals. A number of these minerals are also critical minerals, and are essential for the energy, transport, aerospace, defence, medical, automotive and telecommunications sectors.

In the 2022 Critical Minerals Strategy prepared by the Australian Government, two new minerals were added to Australia's critical minerals list – high-purity alumina and silicon, both of which occur in South Australia (Fig. 23)[76].

76 Department of Industry, Science and Resources, Critical Minerals Strategy 2022, Critical Minerals Strategy 2022 | Department of Industry, Science and Resources

Production Engineer, Jeanette Taylor underground at Southern Mine Area, Olympic Dam. Courtesy of BHP.

South Australian Resources Information Gateway (SARIG) extract of kaolin and silica, June 2022

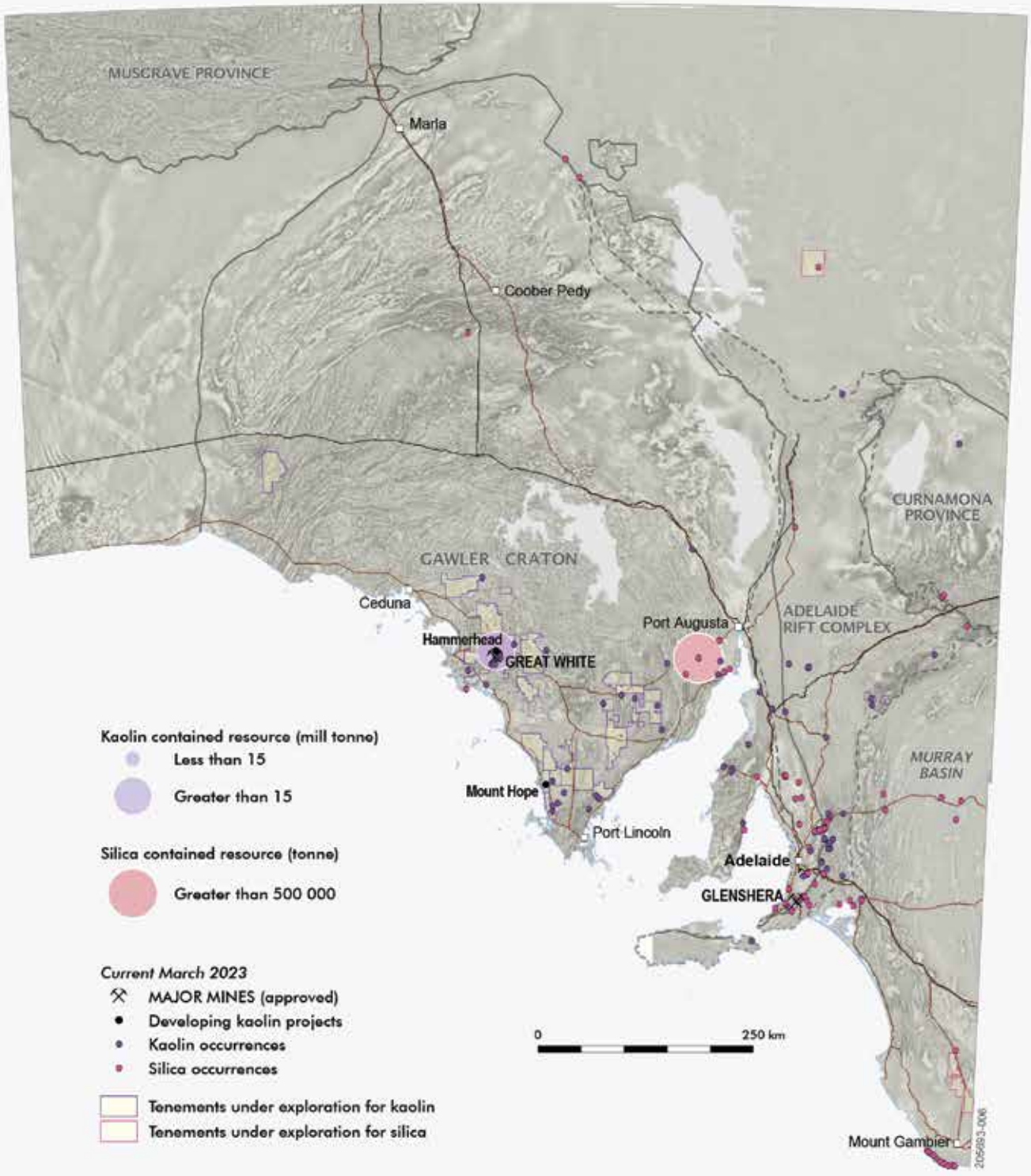


Figure 23

DEM regulates and administers these minerals through the *Mining Act 1971*. Regulation includes the prospecting, exploration and mining of minerals, and can include the production and processing of those minerals into a commercially viable product.

The department's role is to responsibly unlock the value and opportunities offered by the state's mineral resources in a way that:

- minimises harm to the environment and the public
- ensures all South Australians benefit from mineral extraction through reinvesting royalties into state infrastructure, jobs, regional business growth and other functions
- supports consistent, secure outcomes for mining companies.

As low-emission manufacturing grows, opportunities to be had in South Australia will leverage the state's abundant renewable energy.

The production processes of making steel and aluminium, copper and cement contribute to more than 15 per cent of total global emissions. Major producers around the world are investing significant capital in research and development to create green products (like green cement and green steel), using hydrogen and carbon reduction and/or capture and storage technologies.

The Government of South Australia is continuing to liaise and work with the Australian Government and GFG Alliance on its site-wide program to improve the performance of the Whyalla Steelworks through increased efficiency and value realisation, transforming its South Australian mining and steelworks operations into a state-of-the-art green steel manufacturing and product export facility.

The Government of South Australia is an active member of the Heavy Industry Low Carbon Transition Cooperative Research Centre, facilitating the decarbonisation of the iron/steel, cement/lime and aluminium industries.

With goals of reducing state greenhouse gas emissions by more than 50 per cent below 2005 levels by 2030, and achieving net-zero emissions by 2050, major contributions will come from low-emission manufacturing and mining, renewable electricity and hydrogen, and transport.

Research by the Government of South Australia[77] in 2020 found emissions from South Australian manufacturing and mining were still high and have not fallen since 2009. As a result, these industries have good prospects to expand and benefit from progressing towards net-zero emissions over the next decade.

In order to facilitate the clean energy transition required in South Australia, supply chains must be secure and resilient to disruption in the coming years. The IEA reported the critical importance of secure, resilient and sustainable clean energy chains for the future, and that disruptions to these supply chains will bring new energy system challenges to be managed accordingly.

In addition to supply chain matters, we must also consider sustainable practices, and end-of-life strategies in the context of the energy sector. Already, South Australia is a world leader in waste management, recycling and resource recovery with more than 80 per cent of the state's waste diverted from landfill. The Government of South Australia's commitment to the circular economy, through the work done by Green Industries SA (GISA), will increase economic growth for the state by reducing waste and pollution, improving

77 Department for Environment and Water, South Australia's Climate Change Challenge and Opportunity, September 2020

business practices and efficiencies, and building South Australia's competitive edge and resilience.

GISA states[78] that compared to a 'business as usual' scenario, a more circular economy could deliver significant job creation (an additional 25,700 full time equivalent jobs) and greenhouse gas reduction benefits for South Australia (by 27 per cent or 7.7 million tonnes of CO_2 equivalent).

To keep products, components and materials at their maximum utility and value this means:

- designing – or importing – 'smart' products that last longer and can be reused many times
- sharing things more and making repair the norm
- recycling materials effectively and converting some waste materials into biofuels
- displacing fossil fuels and derived products with bio-based materials
- entrepreneurs and innovation in reverse logistics, services, digital technologies will be needed to facilitate these changes.

78 Green Industries SA, Circular Economy Benefits, Economic Benefits of a Circular Economy for South Australia (greenindustries.sa.gov.au)

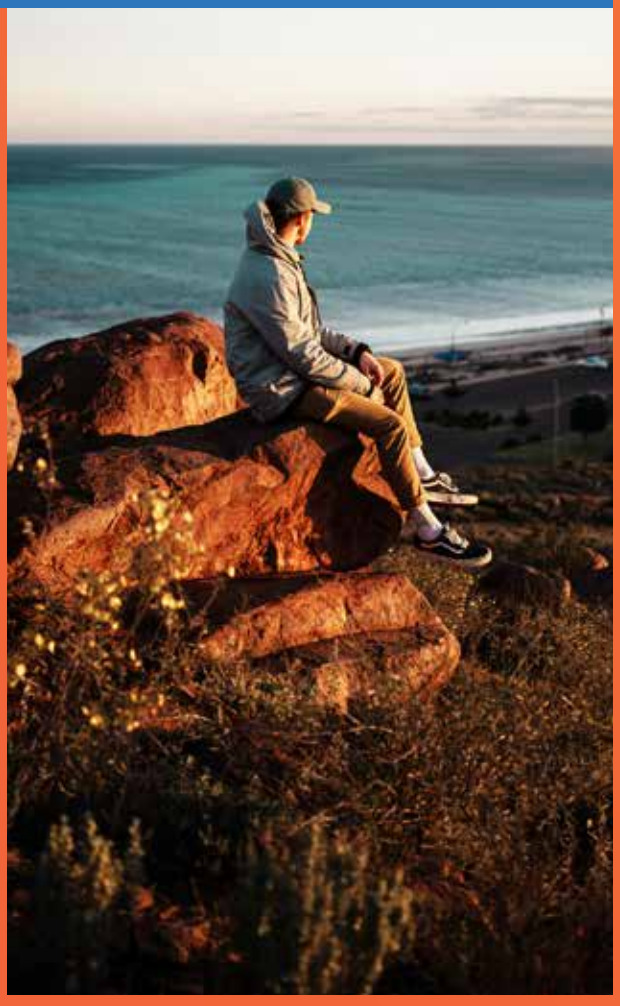
WHAT ARE YOUR THOUGHTS?

- What are the future training needs to develop a green economy in South Australia?
- What are the supply chain opportunities and risks that need to be considered and addressed as part of the energy transition?
- What are the key energy sector investment opportunities that will add value and help to diversify the South Australian economy?
- If the government were to develop a Green Manufacturing Strategy, what should be considered in terms of its scope, timing and key deliverables?
- How can the Government of South Australia best leverage opportunities presented by the energy transition to incentivise investment in the manufacturing and mining sectors in the state?
- Should the government consider the development of an Energy Transition Recycling Strategy to leverage the benefits of a circular economy, and if so, what would be the Strategy's key features?
- What do you think are the community, social, environmental and/or governance-related challenges these sectors and regions will face through the energy transition?
- What export opportunities exist and how can South Australia escalate these?
- Do you think the Government of South Australia should develop an Energy Transition Investment Framework to assist in the delivery of its 2030 and 2050 targets, and if so, what would such a framework look like?
- Should consideration be given to developing a Green Mining and Processing Strategy, and if so, what should such a strategy seek to achieve?

CASE STUDY

South Australia's steel industry and Whyalla Steelworks

In August 2022, GFG Alliance announced it had successfully produced high quality magnetite pellets from local magnetite, a critical milestone to produce green steel.



In 2015, the Steel Task Force was established to support Whyalla's mining, steel making and manufacturing operations.

South Australia is leading the future of steelmaking in Australia by working with GFG Alliance, owner of the Whyalla Steelworks, to create a globally competitive and sustainable industry. The South Australian steelworks is the only manufacturer of long products used for rail and other large scale projects.

In May 2021, GFG Alliance announced a plan to become carbon neutral by 2030 (CN30) and systematically transform the Whyalla Steelworks into a carbon neutral and competitive steel business. Part of GFG Alliance's vision is to establish a modern GreenSteel manufacturing facility in Whyalla, to capture the growing demand for environmentally sustainable steel.

In August 2022, GFG Alliance announced it had successfully produced high quality magnetite pellets from local magnetite, a critical milestone to produce green steel. Magnetite is a type of iron ore particularly suited to direct reduction using hydrogen, avoiding the traditional method of producing steel in a blast furnace using coking coal.

In December 2022, GFG Alliance outlined plans to boost magnetite production in South Australia to 30 million tonnes a year from today's 2.5 million tonnes, with the aim of reaching five million tonnes a year by 2026 and 30 million tonnes by 2030. This would require the GFG Alliance to quadruple the company's workforce and to make a significant investment in the Whyalla mining and steelworks assets.

Since acquisition in 2017, the GFG Alliance has stabilised the Whyalla Steelworks, investing over $600 million in recent years to improve productivity, with plans to implement a range of projects to continue improving its performance. The GFG Alliance's future plans include replacing the Whyalla Steelworks blast furnace with a Direct Reduction Iron (DRI) plant that will use hydrogen to produce green Hot Briquetted Iron (HBI) and an Electric Arc Furnace (EAF) that will use recycled steel, HBI and renewable energy to produce green steel in South Australia.

The Port of Whyalla, a uniquely positioned strategic asset, is also owned by the GFG Alliance. Investment has increased the port's capacity and availability to customers, opening both import and export pathways to international markets and generating new growth opportunities for businesses within the Upper Spencer Gulf region.

The Government of South Australia has made a $50 million grant commitment to assist GFG Alliance's steelworks' transformation to Green Steel and has extended the environmental authorisation provided to operate the Whyalla Steelworks to 2025. This provides the regulatory certainty required to continue to invest in the future of the South Australian operations.

The **Whyalla Steelworks** directly and indirectly **employs around 3,500 South Australians** and supports local businesses.

Keeping the Whyalla Steelworks operational, together with GFG's mining expansion and green steel plans, will ensure the Whyalla Community and Upper Spencer Gulf region thrive for many decades to come.

3.7. THE BUILT ENVIRONMENT

The built environment represents a significant opportunity to reduce the state's carbon emissions more broadly, and support the ongoing transition to a net-zero emissions future.

The United Nations Environment Programme (UNEP) and Global Alliance for Buildings and Construction (GlobalABC) have both reported[79] that the global building sector accounts for 38 per cent of all energy-related CO_2 emissions when adding building construction industry emissions, and that direct building CO_2 emissions need to halve by 2030. This is to ensure nations remain on track to deliver net-zero emissions carbon building stock by 2050.

For Australia, in November 2021, the Clean Energy Finance Corporation (CEFC) reported[80] that the economic value of the construction materials' sector is approximately $65 billion. With demand for low embodied carbon solutions expected to rise significantly, it is estimated it could result in a billion-dollar low carbon solutions market in the coming years.

A number of initiatives are already underway, targeting residential and commercial premises.

Residential premises

Nationally, residential buildings are responsible for around 24 per cent of overall electricity use and 12 per cent of total carbon emissions. Over nine million Australian homes were built before energy building standards came into effect, resulting in overall poor energy performance, including greater heating and cooling loads. This is reflected in higher household energy costs, lower householder comfort and health outcomes and higher emissions.

The resulting growth in household dependence on air conditioning is the major contributor to peak electricity demand and a key driver for investment in generation and network capacity.

The Government of South Australia is working with the Australian Government, as well as other state and territory governments, to implement the Trajectory for Low Energy Buildings (the Trajectory). This national plan, agreed by all Commonwealth, state and territory energy ministers in 2019, aims to achieve net-zero emissions commercial and residential buildings in Australia. It is a key initiative to address Australia's 40 per cent energy productivity improvement target by 2030 under the National Energy Productivity Plan (NEPP).

When implemented nationally, the Trajectory's key measures are designed to:

- improve the energy efficiency of new and existing homes
- improve home energy ratings and disclosure
- support householders to make informed choices about their energy use and appliance purchases.

A decision by Building Ministers in August 2022[81] introduced the first step change in energy performance rating of homes since a 6-star rating was introduced nationally in 2010. The new National Construction Code (NCC) requires all new Australian houses and apartments to meet a minimum energy efficiency rating of 7-stars under the Nationwide House Energy Rating Scheme (NatHERS). Equivalent increases exist for other NCC compliance pathways: the Deemed-to-Satisfy elemental provisions and the Reference Building Verification Method. South Australia will adopt these provisions on 1 October 2024.

Previously, NatHERS was used to assess only the orientation, design and materials used in the building shell, providing a star rating out of 10 based on how much heating and cooling

79 United Nations Environment Program and Global Alliance for Buildings and Construction, 2021 Global Status Report for Buildings and Construction GABC_Buildings-GSR-2021_BOOK.pdf (globalabc.org)

80 Clean Energy Finance Corporation, Australian buildings and infrastructure: Opportunities for cutting embodied carbon, Industry Report, australian-buildings-and-infrastructure-opportunities-for-cutting-embodied-carbon.pdf (cefc.com.au)

81 Australian Government, Department of Industry, Science and Resources, NCC 2022, industry.gov.au/news/building-ministers-meeting-communique-august-2022

was required to keep the home comfortable. With the introduction of 7-star into the NCC 2022, NatHERS has been expanded to assess and rate energy use for the whole home including the major appliances (heating and cooling systems, hot water heaters, lighting, pool pumps and spas) and solar panels and batteries.

This 'Whole of Home' assessment gives a second performance rating out of 100, offsetting energy used for heating and cooling, and appliances, against energy generated from solar panels. The Whole of Home rating scale ranges from 1 to 100, where 100 is a net-zero emissions value home. Ratings above 100 are possible where the home generates more energy than it uses.

By moving to 7-star with Whole of Home assessment, the NCC 2022 has enabled designers and builders to deliver both a Code compliant high performing 7-star thermal shell and fixed appliance rating, but also a net-zero emissions-ready home, should appropriate generation and storage be integrated at some point in the lifecycle of the home.

The Commonwealth Scientific and Industrial Research Organisation (CSIRO)'s Australian Housing Data Portal[82] is a national compilation of home construction information, including NatHERS energy rating data (with the potential to track and inform trends in residential energy performance). The portal currently shows South Australia to be under-represented in terms of NatHERS Certificates versus ABS Building Approvals.

Through the work of the National Energy Efficient Buildings Project (NEEBP)[83] conducted on behalf of the Commonwealth, states and Territories between 2012 and 2020, South Australia has made a considerable contribution to understanding barriers to the uptake of, compliance with, and capacity to deliver 6-star energy efficient homes. Extensive consultation over the course of several projects has uncovered significant discrepancies between the energy rating of the home when designed and approved and the same home "as built".

The NEEBP identified[84] that this discrepancy could be linked to a combination of inadequate industry knowledge and skills, the absence of inspections and quality safeguards, as well as off-plan (and unassessed) material substitutions and design changes initiated by both homeowners and builders that reduced the thermal performance and energy rating of the completed home.

Nationally, a number of pilots[85] were conducted with local governments to identify and prioritise the key areas of discrepancy and to trial a compliance checklist and Electronic Passport system. These would assist with quality control during the building cycle, provide "as built" verification for regulators on completion as well as be a permanent record of energy features and compliance for the owner. This work also surveyed industry to identify gaps in knowledge and skills needed to enable construction of both Code compliant and high performing thermally efficient homes.

South Australia was invited to take a lead role in both industry compliance and supply chain development, and since 2016, has received NEPP funding to develop and deliver instructional workshops, courses and on-line training. This has been done in collaboration with industry groups including Master Builders Association, Housing Industry Association, Adelaide Sustainable Building Network, Australian Institute of Building Surveyors, local government, TAFE and several construction training organisations and peak member groups such as The Insulation Council of Australia and New Zealand (ICANZ), Air Tightness Testing and Measurement Association (ATTMA) and Australian Glass and Window Association (AG&WA).

82 CSIRO Australian Housing Data Portal, Monthly NatHERS Certificates vs. ABS Building Approvals, NatHERS Certificates vs ABS Building Approvals - Australian Housing Data (csiro.au)

83 National Energy Efficient Buildings Project, National Energy Efficiency Building Project | Energy & Mining (energymining.sa.gov.au)

84 National Energy Efficient Buildings Project, Final Report, November 20214, Microsoft Word - HB13477H002 Final Report 31P Rev 01 (energymining.sa.gov.au)

85 New Home Energy Efficiency Compliance Inspections, National Energy Efficient Buildings Project – Phase 2, December 2015, NEEBP-phase-2-project-1-compliance-inspections-final-report.pdf (energymining.sa.gov.au)

CASE STUDY

South Australia's delivery of supply chain development and Industry capacity building initiatives

South Australia has been a leading government agency in residential energy efficiency for over a decade through the National Energy Efficient Building Project and leading residential built energy measures in the National Energy Productivity Plan. Since 2016, we have worked with industry developing skills training to support the national transition to net-zero emissions homes.

Through collaboration with the Commonwealth Trajectory for Low Energy Buildings and peak construction industry agencies, we have developed a suite of Continuing Professional Development (CPD) point-earning courses and Just-In-Time instructional videos hosted nationally on websites accessed by builders, designers and regulators.

In 2023, South Australia launched an on-line, on-demand Learning Hub for Energy Efficient Construction linking to free government and industry resources, case studies and nationally curated CPD options. The site showcases our own nationally respected Net-Zero Homes Skills Training course covering design and build of high performing, efficient 7-star-plus homes, integrating fixed appliances, rooftop solar PV and storage to achieve true net-zero.

Building energy efficiency training at Adelaide Sustainable Building Network seminar

Going forward, new residential buildings that adopt these enhanced energy efficiency standards will benefit from lower energy use, lower energy bills, and greater comfort for South Australian homes, with the benefits accrued over the life of the building.

At a broader level, these changes will reduce peak load demand on South Australia's network, and support the state's ongoing transition to a net-zero emissions future.

South Australian consumers require comprehensive information to assist them in selecting home designs, specifications, energy ratings, quality assurance, and skilled builders to deliver energy efficient, high performing homes that will:

- reduce energy consumption
- contribute to energy security and affordability
- reduce carbon emissions
- disclose their home's energy rating to the market
- improve people's comfort and health
- reduce wastage for the wider economy
- assist in lowering peak demand.

The value of utilising the NatHERS energy rating tool during the design phase for every home, the Whole of Home assessment to enable net-zero emissions-ready status with the incorporation of technology and generation, and inclusion in the Australian Housing Data Portal, must be communicated and incentivised throughout the building cycle. This should extend from homeowners, designers and builders to council approval staff and regulators.

Building regulators, including local council building inspectors, require training and resources to integrate "as built" energy compliance and quality inspections into the routine on-site progress and final completion documentation, and to deliver the Consumer Guarantee that the South Australian Code compliance has been met.

Continuing South Australia's nationally collaborative work in supply chain development will support specific designer, assessor, builder and trade-targeted skill development in:

- residential energy efficient and net-zero emissions design, material specification and appliance and technology selection, (including rooftop solar PV, battery storage and integration of EV charging facilities)
- the critical importance of skilled, quality assured personnel and the routine use of diagnostic technologies such as thermal infra-red cameras and air leakage testing to measure house energy performance
- design and implementation of informed and strategic, high impact energy efficiency retrofit and renovation activities to existing homes to improve thermal performance and resident's energy budget, comfort and health outcomes.
- support the national roll out of Mandatory Disclosure of residential energy performance at point of sale and/or rent, and progress the implementation of Minimum Energy Efficiency Rental Standards.

Commercial premises

Like the residential sector, there are also significant benefits to improving commercial building stock, such as offices, retail, and warehouses. The commercial building sector is responsible for around 25 per cent of overall electricity use and 10 per cent of total carbon emissions in Australia.

In 2016, the Australian Sustainable Built Environment Council (ASBEC) produced the *Low Carbon, High Performance* Report[86]. This report estimated the percentage of opportunities for cost effective upgrades to save energy in existing commercial buildings. It reported that, between 2005 and 2015, energy performance improvements led to commercial buildings savings of over 186 Mt CO_2-e of energy consumption emissions and over $28 billion (gross) in avoided energy bills.

Commercial building owners and tenants, therefore, have realised that energy efficiency is a cost-effective way to:

- lower energy bills
- reduce operating costs
- reduce carbon emissions
- increase property value
- attract higher rental returns.

In Australia, energy efficiency requirements for commercial buildings are prescribed in the Building Code of Australia (BCA) (which is part of the NCC).

Similar to what has occurred in the 2022 NCC for residential buildings (and the adoption of a minimum of 7-stars), the Trajectory (and its Addendum) proposes commercial building energy efficiency provisions are updated in NCC 2025, extending minimum thermal comfort requirements to all buildings, and planning for the future climate. This work will commence in coming years.

The Australian Government's Commercial Building Disclosure (CBD) Program requires most sellers and lessors of commercial office space of 1,000 square metres or more to disclose the building's energy efficiency using a National Australian Built Environment Rating System (NABERS) Energy rating.

NABERS provides a rating from one to six stars to help building owners understand their building's performance versus other similar buildings, providing a benchmark for progress. Since 1998, NABERS Energy ratings in Australia have saved an estimated $1 billion in energy costs and reduced greenhouse gas emissions in the commercial building sector by more than seven million tonnes[87]. In addition to office buildings, a NABERS rating can be obtained for apartment buildings, data centres, shopping centres, warehouses and hotels. A pathway to demonstrate compliance exists within the NCC for the following NABERS Energy building commitment agreement:

- Class 5 (Office Spaces): minimum NABERS Energy 5.5 star commitment agreement
- Class 2 (Apartment Buildings): minimum NABERS Energy 4 star commitment agreement
- Class 3 (Hotels): minimum NABERS Energy 4 star commitment agreement
- Class 6 (Shopping Centres): minimum NABERS Energy 4.5 star commitment agreement.

The NABERS commitment agreement is a contract signed by a building owner to design, build, and commission a building to achieve a specific NABERS energy rating.

South Australia is making progress with reducing emissions in the built environment, with more still required to achieve our goals of reducing state greenhouse gas emissions by more than 50 per cent below 2005 levels by 2030, and achieving net-zero emissions by 2050.

86 Australian Sustainable Built Environment Council, Low Carbon, High Performance Report, May 2016, 'Low Carbon, High Performance' Report - Australian Sustainable Built Environment Council (ASBEC)

87 NABERS Energy efficiency in commercial buildings report May 2022

Products

While the built environment represents one element, the Government of South Australia is also cognisant of the role that products and appliances play within the built environment.

In Australia, a number of products, such as air conditioners, refrigerators and freezers, televisions and hot water heaters, are regulated for energy efficiency standards under the *Greenhouse and Energy Minimum Standards (GEMS) Act 2012* ('GEMS Act'). These products are regulated so customers can choose more efficient models, households and businesses can consume less energy, save money on their energy bills, and help to reduce greenhouse gas emissions.

The GEMS Act has set a national framework for product energy efficiency in Australia. A report[88] found that, between 2000 and 2014, the Equipment Energy Efficiency (E3) Program, underpinned by the GEMS Act, reduced Australia's greenhouse gas emissions by between 23 and 35 million tonnes. The report also stated that GEMS regulations saved the average Australian household between $140 and $220 on their electricity bill (about 10 per cent to 15 per cent of the average annual bill) (at the time).

The Government of South Australia also recognises the important role energy productivity will play in the future. The Retailer Energy Productivity Scheme (REPS) is a Government of South Australia energy productivity scheme providing incentives for South Australian households and businesses to save energy.

The scheme obliges retailers to deliver services that support households and businesses in reducing their energy costs, while maximising the benefits to South Australia's power system by delivering a smarter, more affordable, reliable and sustainable energy future.

The scheme commenced on 1 January 2021 and is a 10-year scheme comprised of two, five-year stages (2021 to 2025 and 2026 to 2030). Each year, the Minister for Energy and Mining sets an energy productivity target (EPT) that retailers operating in South Australia are obliged to meet. The annual EPT for 2021 to 2025 was set in 2020 and published in the Government Gazette.

Obliged retailers are assigned an individual EPT (and any sub-targets that are also applicable) to meet under the REPS, which can be achieved by delivering eligible energy productivity activities to homes and businesses.

ESCOSA, the administrator of the scheme, reported in the scheme's first year, the EPT of 2,500,000 normalised gigajoules for 2021 was met by retailers[89].

South Australia is aligned to a number of national arrangements. It has a number of unique, state specific requirements that have been in place for some time, such as South Australia's water heater requirements. Since 2008, the state has had energy efficiency requirements for installing new, or replacement, of water heaters in residential premises. For most homes, this means:

- a low emission water heater, such as a high efficiency gas, solar or electric heat pump system
- water efficient shower heads or flow restrictors.

However, the Government of South Australia recognises these unique requirements were introduced at a time when certain products weren't as efficient as they are today, and that they may no longer be required moving forward.

88 Australian Government, The Independent Review of the GEMS Act 2012 Final Report, June 2019, Report: Independent Review of the GEMS Act - Final Report | Energy Rating

89 Essential Services Commission of South Australia, REPS Annual Report ESCOSA - Annual report

WHAT ARE YOUR THOUGHTS?

- What is the best way of developing energy efficient rental accommodation?
- How will technology play a role in improving energy efficiency in buildings and infrastructure?
- How can the benefits of energy efficiency be shared equitably?
- How can lower income households be supported to enable them to meet the capital costs of investing in more efficient appliances?
- What, if any, reforms should be made to encourage households to retrofit older, less energy-efficient homes?

3.8. DECARBONISING TRANSPORT

Our transport sector plays a critical role in supporting South Australia's economy, facilitating the efficient trade and movement of products, as well as enhancing the mobility of people across the state.

Currently, the transport sector includes emissions from the direct combustion of fuels in transportation by road, rail, domestic aviation and domestic shipping. The main fuels used for transport are fossil-fuel derived automotive gasoline (petrol), diesel oil, liquefied petroleum gas (LPG) and aviation turbine fuel. Battery electric vehicle (BEV) uptake is beginning to disrupt the sector by providing a zero emission[90] tailpipe option across the passenger, light and heavy commercial vehicles market segments.

Decarbonisation via the electrification of transport also presents opportunities to contribute to energy security plus enhanced public health and improved local amenity by reducing noise and air pollution.

In 2021, a report[91] by the Australian Road Research Board (ARRB) for the Government of South Australia found that transport was the state's largest emitting sector, contributing 29 per cent of South Australia's net greenhouse gas emissions. 87 per cent of the state's transport emissions were generated by road transport, 26 per cent of which were attributed to heavy vehicles.

The most recent State and Territory Greenhouse Gas Inventory (2019-2020) shows that transport accounted for 24.8 per cent of South Australia's emissions. As Fig. 24[92] shows, South Australia's 2020 transport emissions were comparable to March 2012, at around 6,303 CO_2-e.

South Australia's high level of renewables in electricity generation has led to that sector

90 True emissions will be influenced by the makeup of power generation of the state or territory grid at the time of charging and the presence or absence of rooftop solar PV.

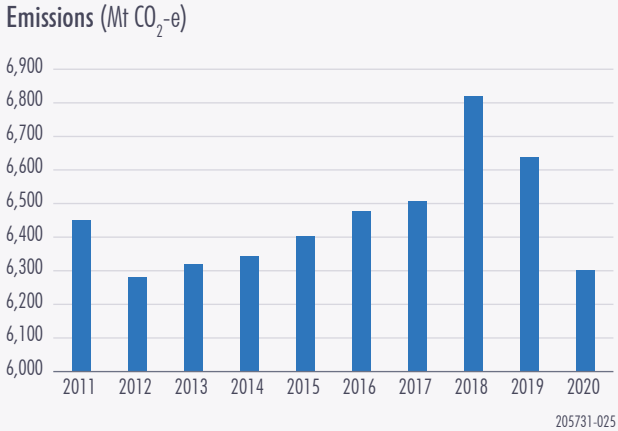
91 Smart charging trials | Energy & Mining (energymining.sa.gov.au)

92 Department of Climate Change, Energy, the Environment and Water, State and Territory Greenhouse Gas Inventories: 2020 emissions, State and territory greenhouse gas inventories: 2020 emissions - DCCEEW

accounting for only 17 per cent of the state's emissions – making South Australia the only mainland state where transport is the leading contributor to emissions rather than electricity generation.

Decarbonising our transport fleet is a vital part of the overall transition from carbon-emitting technologies to a greener, cleaner future that aligns with the Parliament of South Australia's declaration of a Climate Emergency. This will provide a number of benefits, from transport efficiency and productivity improvements, to reduced pollution across the state. In doing so, the state will progress its commitments, as a signatory to the COP-26 Declaration on Accelerating the Transition to 100 per cent Zero Emissions Cars and Vans agreement, to work towards all sales of new cars and vans being zero emission globally by 2040, and by no later than 2035 in leading markets.

Figure 24 **South Australian transport emissions trends, by year, 2011 to 2020**



To facilitate this transition, the Government of South Australia is supporting a range of initiatives to support the uptake of low and zero emission vehicles and fuels, including:

- passing the *Motor Vehicles (Electric Vehicle Levy) Amendment Repeal Bill 2022* into Parliament repealing the previous government's electric vehicle levy, which was due to come into effect in 2027 and charge EV drivers for every kilometre they travel
- providing up to 7,000 EV purchase subsidies of $3,000 and a three-year registration fee exemption
- securing private investment in South Australia's first statewide EV charging network, with an almost $12.35 million grant awarded to the RAA
- delivering a $3.2 million investment in EV Smart Charging Trials, at sites including Pasadena Shopping Centre, Victor Harbor Beachfront Holiday Park and Flinders University
- EV Fleet Pledge, which aims to foster a business network of like-minded organisations who share a commitment to transform their fleets to EVs, as cost effective and fit for purpose models become available
- seeking to implement the Australian Government's Driving the Nation fund which commits $39.3 million, matched by the NRMA, to fill gaps in Australia's national EV charging network to link Adelaide to Perth, Darwin and Broken Hill.
- supporting the Australian Government's development of fuel efficiency standards and National EV Strategy.

CASE STUDY

South Australia's electric vehicle charging network grant

The Government of South Australia awarded a $12.35 million grant to the RAA to construct and operate Australia's first statewide Electric Vehicle (EV) charging network, as a key initiative of South Australia's electric vehicle transformation.

The network will be comprised of over 530 chargers across 140 electric vehicle charging stations in over 50 rural, regional and metropolitan service locations.

The site locations are aligned with main roads and regional thoroughfares throughout South Australia, with regional towns hosting sites to help motorists overcome range anxiety and encourage visits within those regions.

The RAA is a member-owned motoring organisations and, with over 120 years' experience, is anticipated to be well placed to deliver the statewide EV charging network.

The RAA commenced construction in late 2022 and expect completion of the charging network will be finalised by early 2024.

Barriers to EV uptake have been driving range anxiety, availability of public charging infrastructure and the supply and choice of affordable vehicle models. Range anxiety and availability of public charging infrastructure will be mitigated with the rollout of charging networks by the RAA, NRMA and other EV charge point operators. To improve the supply and choice of affordable models, DEM's submission to the National EV Strategy consultation paper supported development of national vehicle fuel efficiency standards.

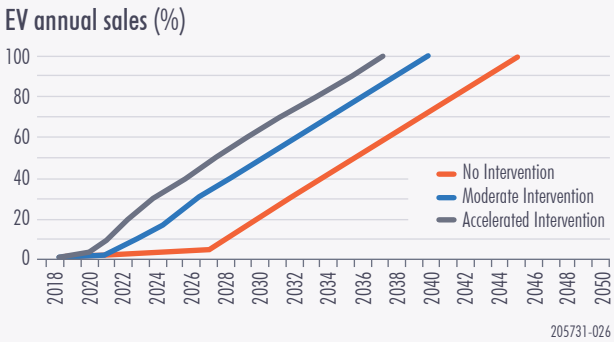
Decarbonisation of public transport is recognised as a sector government can influence. A study jointly commissioned by the Department for Infrastructure and Transport (DIT) and DEM investigated the feasibility of transitioning the bus fleet to 100 per cent zero emissions by no later than 2050. It found BEV buses can meet the vast majority of daily operations at present, while hydrogen Fuel Cell Electric Buses (FCEB) are not cost competitive at present. FCEBs may become cost competitive in time for post 2030 deployment.[93] The Minister for Infrastructure and Transport announced on 19 September 2022 that South Australia would not purchase diesel-only buses from that time.

In 2021, global plug-in battery EV sales reached over 6.1 million, and sales are estimated to grow to over 10.5 million in 2022. While EV uptake in Australia is currently lower than in other parts of the world, the number of EVs is expected to grow as cheaper models arrive and more charging infrastructure comes online.

Battery EV drive trains are forecast to become entrenched globally as the economically dominant drive train technology, above hydrogen fuel cell (hydrogen) EVs, for passenger, light commercial vehicles, and metropolitan buses. Increasing the supply of affordable battery EV models in Australia is an essential step to accelerate uptake by average and lower income households.

In 2020, Energeia provided modelling for DEM on EV uptake scenarios for South Australia[94]. These figures were based on a 2018 Clean Energy Finance Corporation (CEFC) report[95]. As Fig. 25 shows[96], forecast PEV sales (both BEVs and Plug-in Hybrid Electric Vehicles (PHEVs)) under their *Moderate Intervention* scenario are forecast to reach 4,694 in 2022, 16,109 in 2025 and 40,386 vehicles per annum by 2030, increasing to 117,409 annual new vehicle sales by 2040. This potentially represents 49 per cent of car sales (in 2030) and 100 per cent of car sales (in 2040). Out to 2040, consideration is required to plan for the smooth integration of EV charging into South Australia's renewable energy electricity grid.

Figure 25 **Annual plug-in Electric Vehicle sales in Australia**



93 Evenergi (November 2021), Electric Bus Integration Study: Government of South Australia

94 Energeia 2020, Benefits of Electric Vehicles for South Australian Consumers

95 Clean Energy Finance Corporation 2018, Australian Electric Vehicle Market Study, Australian Electric Vehicle Market Study - Clean Energy Finance Corporation (cefc.com.au)

96 Energeia May 2018 report, australian-ev-market-study-full-report-jun2018.pdf (cefc.com.au)

Like other DER, EVs represent an opportunity and a challenge to the power system that must be managed accordingly. As a pooled resource, EVs could offer a wide range of valuable grid services, such as voltage regulation, without compromising the performance of the vehicle. Coupled with innovative tariffs that encourage charging during specific periods of the day, EVs could become a valuable asset for distribution network service providers (DNSPs) across Australia, especially when utilised with smart charging.

Smart charging in homes and workplaces can be coordinated to align electricity consumption with periods of high renewable energy generation and/or low grid demand. This will encourage deferral of all non-essential charging during periods of high electricity grid demand. Supporting efficient use of existing electricity infrastructure is expected to reduce electricity costs for all consumers. The Smart Charging Trials will demonstrate the benefits of both smart charging and electric vehicle ownership.

It is expected 80 per cent of charging will occur at home due to convenience and cost. Home charging will be adequate for most Australian freestanding homes, however, further consideration is needed for apartment charging. Changes to the NCC, when adopted in South Australia, will require new buildings to incorporate provisions for EV charging[97].

Focusing on investments to address barriers to low emission vehicle uptake, the Australian Government has provided $500 million to help reduce transport emissions via the Driving the Nation Fund[98].

Light vehicles are just one considered action. The Australian Government, via ARENA, is addressing barriers to the roll out of new transport technologies (such as BEV, hydrogen and biofuels) for freight and heavy vehicles. The heavy vehicle industry and state governments have begun deploying these technologies:

- Janus Electric, Qube and OZ Minerals have partnered to run a 12-month pilot project investigating the feasibility of long-distance BEV heavy vehicle testing using battery swap technologies in South Australia
- NSW and Victoria announced a total of $20 million in funding for grants for at least four hydrogen refuelling stations between Melbourne and Sydney and at least 25 hydrogen-powered trucks along the Hume Highway
- biodiesel resources have been produced commercially in the past however external factors saw them become financially unviable (i.e. the falling price of mineral diesel in around 2015-16) and cease production. There is renewed interest in biodiesel with the ongoing high price of mineral diesel.

Regarding the freight and heavy vehicle sectors, in 2021, research by the ARRB for the South Australian Department for Environment and Water (DEW) found that heavy reliance on oil-based fuels provides a significant potential to de-carbonise the heavy road fleet by switching parts or all of the fleet to low or zero emissions vehicles. The key opportunities identified include:

- fleet modernisation to harness the latest vehicle technologies and designs including improved engine/transmission efficiency and aerodynamics.

The Department for Climate Change, Energy, Environment and Water (DCCEEW) (formerly the Department for Environment and Energy) and the Australian Alliance for Energy Productivity A2E) has forecast that heavy transport emissions will continue to rise out to 2030 (Fig. 26)[99]. Combating transport

97 Section J9D4, Australian Building Codes Board 2022, National Construction Code 2022: Volume 1.

98 P28, The Commonwealth of Australia, Budget 2022-23: Building a better future (October 2022) https://budget.gov.au/2022-23-october/content/overview/download/budget_overview.pdf

99 Department of the Environment and Energy, Australia's emissions

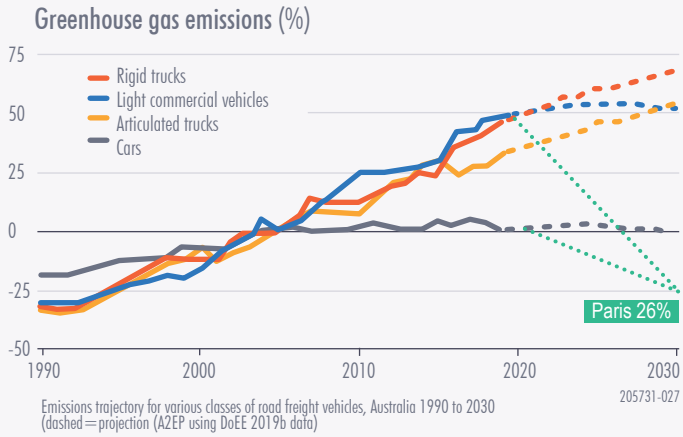
emissions becomes even more critical in order to achieve at least a 50 per cent reduction in the state's greenhouse gas emissions by 2030.

It is globally recognised that following the maturation of renewable energy generation, transport is the next sector to decarbonise, as the technology costs to mitigate emissions are declining. A 100 per cent renewable energy grid will assist in transitioning to zero emissions transport, in contrast with other state and territory grids in Australia and beyond, which have a high dependency on coal-sourced energy.

More recently, the Australian Government has issued a National Electric Vehicle Strategy (NEVS) consultation paper[100], to help shape a truly national approach to ensure Australians can access the best transport technologies, while helping the country to meet its emissions reduction targets. The proposed NEVS will provide social, economic, business, health and environmental benefits, while also ensuring an orderly transition to transport electrification.

Leadership on decarbonising the transport sector is essential. South Australia's policies will work together with those of other governments to ensure the roll out of EV charging, and refuelling infrastructure, is aligned and accessible for energy needs.

Figure 26 **Actual and projected growth in transport emissions 1990 – 2030, indexed against 2005**



Emissions trajectory for various classes of road freight vehicles, Australia 1990 to 2030 (dashed = projection (A2EP using DoEE 2019b data)

projections 2019 (December 2019) and the Australian Alliance for Energy Productivity (A2EP), Roadmap to accelerate energy productivity in freight transport by 2030

100 Department of Industry, Science and Resources, National Electric Vehicle Strategy: Consultation Paper Consultation hub | National Electric Vehicle Strategy: consultation paper - Department of Industry, Science, Energy and Resources

WHAT ARE YOUR THOUGHTS?

- How will battery electric and fuel cell EVs impact energy infrastructure in the future?
- What role should government play in the transport sector to minimise unwanted transitional impacts?
- How important is the choice of fuel and security of supply as the transport sector transitions to new fuel sources?
- What are the barriers to electrification of offroad vehicles in other market segments such as the mining and agriculture sectors?
- What role do e-fuels or synthetic fuels play in the transport sector?

3.9. EDUCATION AND WORKFORCE

The state's ability to reduce greenhouse gas emissions by more than 50 per cent below 2005 levels by 2030, and to achieve net-zero emissions by 2050, depends on our ability to transform not only the technology used but also our underlying behaviours. To do this, we require an understanding of the complex social and economic structures that underpin energy.

The complexity and dynamic nature of energy issues has seen our understanding evolve over time. Concerns regarding energy prices, the reliability and security of the network, renewable generation versus non-renewable generation and more recently, the role of zero and low emissions transport versus traditional transport, are just a few issues that are often discussed, and at times, misunderstood.

This confusion may have negative flow-on effects if not addressed or resolved as part of the energy transition. This section provides information on some of the key aspects the Government of South Australia is keen to explore further with stakeholders on this matter.

Energy literacy

As South Australian consumers and industry members continue to install technologies like DER in greater numbers, their interest and thirst for knowledge of the energy sector are also likely to grow – expressed through seeking more information on how to take control of their energy use and reduce their energy bills. This is often an indication of a consumer transitioning from a passive user of energy to an active user of energy – and also provides the Government of South Australia with an indication of a consumer's energy literacy.

In 2019, National Energy Resources Australia (NERA), the Australian Government's Industry Growth Centre for the energy resources sector, released a report[101] that highlighted some of the challenges associated with energy literacy, and the importance of developing a deeper knowledge and awareness of energy for Australia's continued prosperity. NERA defined an energy literate person as "someone with the appropriate level of knowledge which empowers them to make informed rational energy decisions and actions which have a positive outcome for the individual, and ultimately, society at large"[102].

In South Australia, a number of organisations assist customers in improving their energy literacy. For over 40 years, the Government of South Australia has offered various iterations of what is now called the Energy Advisory Service. This initiative provides free, independent information on a range of energy topics, including ways to save energy at home, relevant technologies such as solar and batteries, and assisting customers to understand their energy bills. A wide range of energy education and advisory materials is available via a comprehensive website, a small call centre, and printed materials made available via a large distribution network known as the Energy Partners Program[103] (EPP). The program also offers free training to staff and volunteers to help organisations support their clients.

The Government of South Australia funds several programs in support of the community service sector. One example is the ConnectEd[104] household utility literacy program delivered across South Australia by partners UnitingCare Wesley Bowden, Uniting Communities, and Uniting Country SA, with funding from South Australia's Department of Human Services (DHS). ConnectEd provides energy training for community sector workers and volunteers, information and education sessions for members of the public, one-on-one assistance in energy hardship, and on occasion, home visits from energy advisors to conduct energy assessments and deliver tailored energy advice.

101 National Energy Resources Australia, Building Australia's Energy Literacy, May 2019, National action needed to improve community energy literacy, according to new report: NERA National Energy Resources Australia

102 National Energy Resources Australia, Building Australia's Energy Literacy, May 2019, National action needed to improve community energy literacy, according to new report: NERA National Energy Resources Australia

103 Government of South Australia, Free training and education

104 ConnectEd, https://connected.org.au/

The Energy and Water Ombudsman of South Australia (EWOSA) provides a free, independent, accessible and fair service to help consumers who are in dispute with their provider. EWOSA's valuable service includes giving factual information on matters such as how bills are calculated and consumers' rights.

The Government of South Australia recognises, that in the coming years, customer interest in the energy sector will continue to increase, for a myriad of reasons, from rising energy prices, increasing customer interest in rooftop solar PV systems, increasing household energy consumption due to the proliferation of air conditioning and other lifestyle electronic devices in modern homes, to an increasing understanding in the community of the need to live sustainably.

Recent energy price rises are of particular concern to the Government of South Australia, which recognises the impacts this has had on South Australian residential and business customers. Energy poverty and customer hardship are growing issues exacerbated by the COVID-19 pandemic, in addition to the increasing cost of living pressures being felt, in South Australia, and across the world.

CASE STUDY

Government of South Australia's Energy Advisory Service

The Energy Advisory Service provides free, independent information on a range of energy topics, including:

- **saving energy at home**
- **understanding your energy bills and meters**
- **how to calculate appliance running costs**
- **links to services that can help you if you have trouble paying bills**
- **general information about energy efficient home design and renewable energy technology, like solar photovoltaic systems and battery storage.**

This service has operated (in various guises) since 1 June 1981, and originally operated as the Energy Innovation Centre.

Demand for energy information and advice in the community has continued to expand, and the Energy Advisory Service has evolved to meet these challenges.

This service can be contacted Monday to Friday, between 9:00 am and 5:00 pm.
Phone: 8204 1888 or 1800 671 907 (free call from fixed lines)
Email: energyadvice@sa.gov.au

Qualifications and training

The Government of South Australia recognises the workforce of the future must be suitably trained and qualified as part of the energy transition.

A balance must be struck between the existing workforce needs of the energy, mining and resource sectors, recognising the critical role these sectors will continue to play as part of the transition to a net-zero emissions future.

Skills and innovation, connecting industry with opportunities to innovate, and developing workforce capabilities through both the Industry Skills Council and the Resources and Engineering Skills Alliance (RESA) are core focus areas.

Since the publication of the most recent strategy, a new key focus area of hydrogen has been announced by the Government of South Australia through the Hydrogen Jobs Plan.

The maturation of South Australia's hydrogen industry will create hundreds of jobs in the construction stages and new ongoing operational roles, particularly in the regional areas between the Yorke and Eyre Peninsula. Creating and supporting a workforce to fulfil these jobs will require a range of skills and workforce development activities.

The South Australian Department for Industry, Innovation and Science (DIIS) is responsible for supporting sustainable economic growth by assisting South Australian industries and businesses to succeed in a local and global environment.

The DIIS strategic directions include the following objectives:

- developing a high performing research and innovation system
- supporting the growth of innovative and competitive industries and businesses
- improving the state's manufacturing capability and capacity
- helping businesses get the skilled workforce they need.

In addition to work being done at the state level, the Australian Government has highlighted renewable energy and related job creation as important focus areas for the Commonwealth through Powering Australia.

With specific regard to skills and workforce development, the Powering Australia program has proposed investment of $96 million to support 10,000 New Energy Apprenticeships, and $9.6 million in a New Energy Skills Program[105].

Ensuring South Australia is well positioned to secure an appropriate percentage of funding is of key interest to the Government of South Australia. The Minister for Energy and Mining has stated South Australia should aim to secure more than its per capita share of Commonwealth investment, with a potential target of 10 per cent.

Achieving an appropriate share of Australian Government funding for South Australia will require the right combination of networking, advocacy, and industry knowledge.

Workforce requirements

A suitably skilled workforce is critical to the growth of the energy, mining, resources and clean energy sectors, as well as the broader South Australian economy.

Workforce and skills' shortages present an imminent economy-wide challenge made more acute by the evolving skill requirements of the sector, competition for skilled labour between sectors and the states and territories, and the continuing impact of the COVID-19 Pandemic.

DEM's strategic priorities identify that:

- South Australia's energy and mining sector transformation requires an accelerating growth of skills and knowledge with a focus on meeting the needs of future industries

105 Department of Climate Change, Energy, the Environment and Water, Powering Australia, Powering Australia | energy.gov.au

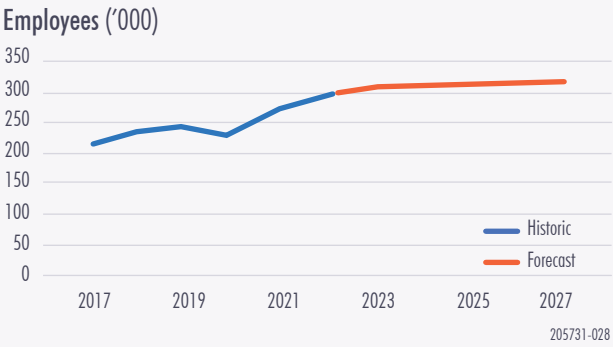
- a range of collaborative programs and partnerships with resource sector skill experts are required to grow the workforce for the future in order to increase productivity and leverage economic opportunities
- tailored education, training and employment pathways are needed to increase Aboriginal employment participation
- targeted skilling is needed to generate the responsive workforce required to continue driving innovation, research and commercialisation.

The effects of the COVID-19 Pandemic (in particular) continue to be felt by Organisation for Economic Co-operation and Development (OECD) economies, where millions of students have been unable to attend school or university, and people have been unable to go to work (across a multitude of sectors), resulting in an exceptionally stark drop in employment activity and unprecedented job losses.

The OECD reported[106] that COVID-19 exposed many inadequacies and inequities in collective education systems – from access to the broadband and computers needed for online education, and the supportive environments needed to focus on learning, to the misalignment between resources and needs.

A report[107] from the Australian Resources and Energy Employer Association (AREEA) highlighted that the resources and energy industry (as at quarter two, 2022) employs 295,200 people – with the industry (nationally) growing by nearly 20,000 workers in the last quarter alone. Over the next five years and as Fig. 27 shows, AREEA forecasts the resources and energy workforce will grow to over 300,000 workers.

Figure 27 **Resources and energy direct workforce (2017-2027) National**



For the clean energy industry, the IEA[108] estimates around 30 million new skilled clean energy jobs will be required worldwide by 2030 under a pathway to net-zero emissions by 2050. Similarly, in AEMO's 2022 ISP, Australian skilled labour demand is expected to double to 25,000 large scale renewable energy jobs in the next five years alone.

Similarly, the Clean Energy Council (CEC) found similar numbers in their "Skilling the Energy Transition" report[109], noting the sector currently employs around 30,000 people across large-scale renewable energy construction, operation and maintenance and small-scale rooftop solar PV design and installation. The CEC noted that if all of the associated renewable energy generation projects proceed in Australia, an additional 50,000 jobs will be created. However, the CEC highlights that the sector is heavily reliant on technical skills, which are in both high demand and in short supply.

For South Australia, an additional 25,000 to 30,000 jobs above business-as-usual growth is estimated for the state by 2030 under a strongly growing South Australian resources sector.

106 Organisation for Economic Co-operation and Development, The impact of COVID-19 on education, 2020, the-impact-of-covid-19-on-education-insights-education-at-a-glance-2020.pdf (oecd.org)

107 Australian Resources and Energy Employer Association, Resources and Energy Workforce Forecast 2022 – 2027, July 2022.

108 International Energy Agency, net-Zero by 2050, A Roadmap for the Global Energy Sector, net-zero by 2050 – Analysis - IEA

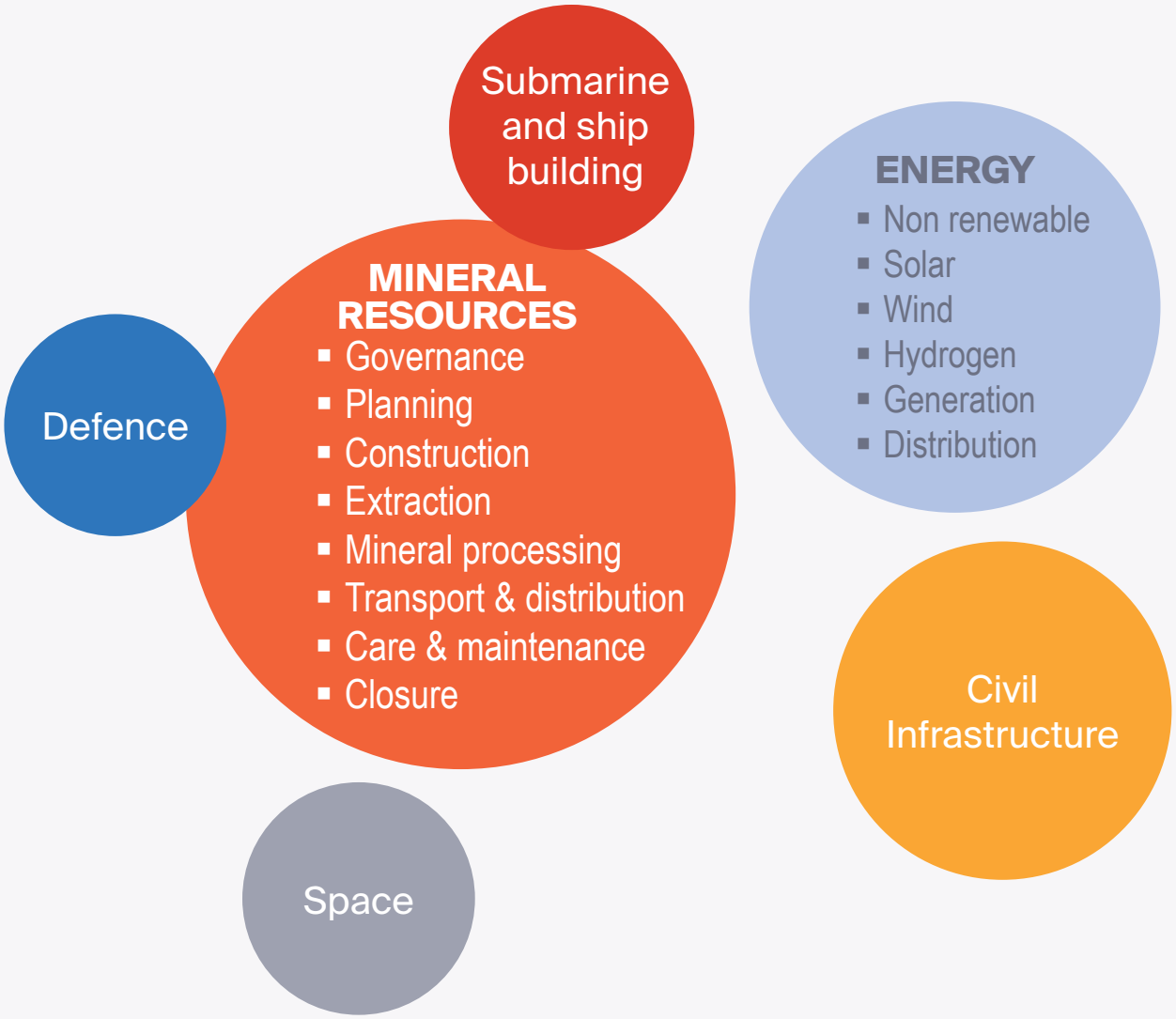
109 Clean Energy Council, Skilling the Energy Transition, CEC_Skilling-the-Energy-Transition-2022.pdf (cleanenergycouncil.org.au)

RESA has received funding from DEM to increase the availability and productivity of the workforce, including the position of learning and development and training projects, and will be the primary skills and workforce development advisory body for the mining and energy industry sectors. This will provide (amongst other things) state representation in national forums on workforce-related matters.

One of the workforce challenges for the resources and energy sectors in South Australia is the demand for similar occupational classifications from other, complementary, as well as competing, existing and emerging industries such as submarines and ship building, defence, space and civil infrastructure. A pipeline for a skilled workforce needs to be a priority to realise the potential of South Australia's mineral resources, energy transformation and emerging industries.

Increases in the workforce can materialise in a number of ways, from reskilling and retraining arrangements, migration of skilled workers, to long-term investment in education and schooling. For example, the future workforce commencing work in 2030 is currently in high school. Education and workforce, therefore, are integral to the future success of the energy sector.

Figure 28 **Workforce challenges for the energy and resource sectors in South Australia**[110]



110 Resources and Engineering Skills Alliance, Discussion Paper: Resourcing the Minerals Sector, SA Workforce Priorities 2023

For the energy and mining sectors, it is critical that further challenges are navigated together – by using collective experience gained over the last few years to build resilience in the future, raise awareness of energy literacy more broadly, and build capacity in our education sector to ensure the expected increase in the workforce for the future is met.

RESA continues to focus on industry attraction and retention strategies, including:

- shortages in critical skills for growth occupations
- improving speed to market
- attraction
- retention
- diversity and inclusion.

There are a range of issues impacting the resources and energy skills pipeline in South Australia. These can be categorised into three main areas, and are not standalone issues:

- engagement – attracting the right people with the right skills
- pathways – access to pathways that will develop the capabilities required by industry
- enablers – the systemic mechanisms with capability and capacity to develop and implement skilling solutions.

Engagement issues will, in part, be addressed by delivering effective strategies to ensure pathways are available and enablers are working together to ensure they are supported.

Opportunities for Aboriginal people

Many of the activities and investment associated with the energy transition will occur in regional areas, including places with Native Title interests.

Projects will create significant opportunities both for the employment of Aboriginal people and for the contracting of commercial services by Aboriginal companies.

The Government of South Australia is committed to genuine consultation and engagement with Aboriginal people to ensure opportunities are realised and supports are available.

Job and skills hub concept for the Upper Spencer Gulf

There is an opportunity to establish an Upper Spencer Gulf skills solution to support mining, energy and other industries in the state's critical economic growth region.

Industry drivers for a skilled workforce in the region include:

- the highest employment activity in the mining and energy sector on record
- ongoing operations and maintenance of mining and mineral processing operations
- mining operations ramping up at OZ Minerals Prominent Hill, Boss Energy and Rex Minerals
- the Hydrogen Jobs Plan project in Whyalla
- other civil and infrastructure projects.

Current industry forecasts indicate 9,000 new jobs are expected to be generated over the next few years in the Upper Spencer Gulf region.

At the same time, a number of training and education initiatives are in progress that could be framed in ways that would provide a regional skills solution, including:

- a technical college to be established in Upper Spencer Gulf (The 2022-23 State Budget allocated $208.8 million including $33 million operating costs for five technical colleges, one of which will be located in the Upper Spencer Gulf.)
- a TAFE SA review, with an opportunity to reposition TAFE and shape how it services the region
- 10,000 fee-free training places allocated for TAFE SA
- South Australia Skills Plan, redefining priorities for the state including industry driven solutions, place-based funding models and regional access to training, industry and skills labs
- skilled migration policy reform
- interest from Spencer Cities, Regional Development Australia (RDA) and industry in establishing a sustainable, demand driven training centre for the region – building on existing capability with agility to respond to emerging skill needs.

WHAT ARE YOUR THOUGHTS?

- Which areas need training and industry development to keep up with demand?
- Growth of new technologies in a modernising energy system presents an opportunity but also a risk of increasing the divide – how do we best support vulnerable members of the community to keep up with developments?
- Which areas of future growth will need a focus on increased education and consumer protections?
- What can the Government of South Australia do to improve energy literacy in regional and remote towns and communities in South Australia?
- How will regions attract and retain skilled workers to support the development, maintenance and operation of energy infrastructure?
- What other elements will support the attraction and retention of skilled workers in South Australia?
- How can the Government of South Australia ensure Aboriginal people are respected, consulted and are able to realise the opportunities?
- What measures are needed to ensure gender balance in job creation at all levels?
- Should the Government of South Australia continue to develop a targeted Energy Transition Workforce Strategy to identify and address workforce issues specific to the energy sector, or should its scope be broader?

3.10. HEALTH AND EQUITY

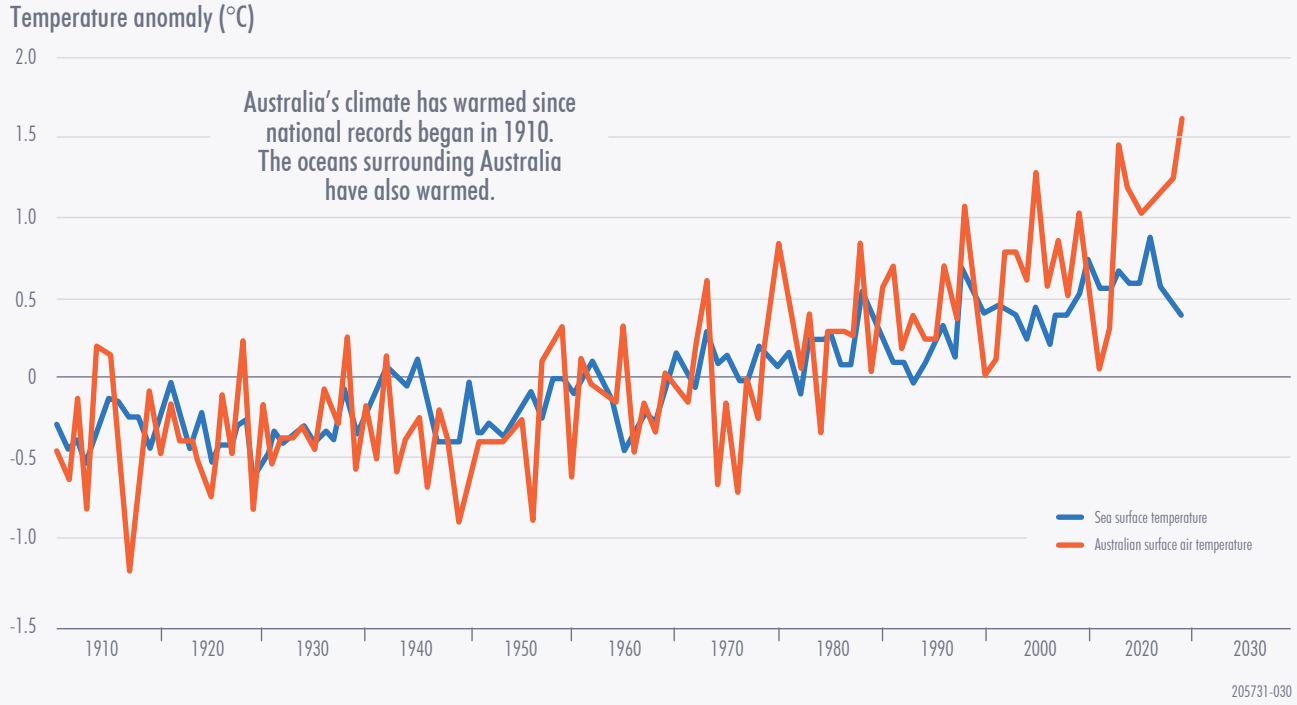
The climate of South Australia, and the world, is changing. Long referred to as the driest state, in the driest inhabited continent, South Australia's temperatures have been increasing, the rate of rainfall has been decreasing, and climate-sensitive air quality issues are emerging.

South Australia has been experiencing longer, hotter, and more frequent heatwaves, an increase in dangerous fire weather, as well as an increase in the intensity of heavy rain events, and rising sea levels along our coast.

The CSIRO reports[111] that Australia has warmed an average of 1.44 ± 0.24 °C since national records began in 1910, leading to an increase in the frequency of extreme heat events (Fig 29).

111 Commonwealth Scientific and Industrial Research Organisation (CSIRO), State of the Climate State of the Climate - CSIRO

Figure 29 **Australia's climate from 1910 onwards**



In recent years, South Australia has experienced a number of extremes, with Adelaide experiencing its hottest day on record on 24 January 2019, with the Bureau of Meteorology (BoM) reporting[112] that Kent Town and Parafield Airport recorded 47.7 °C, and West Terrace / Ngayirdapira recording 46.6 °C.

Between 2019 and 2020, South Australia experienced some of the most severe bushfires of recent years[113], from the 2019 major fire at Cudlee Creek in the Adelaide Hills that burned 23,000 hectares (ha), destroyed over 400 buildings, and resulted in the loss of life, to the Kangaroo Island bushfires of 2019-20, that burned 211,500 ha, destroyed hundreds of buildings, and resulted in the loss of life.

Most recently, the impacts of the River Murray floods were felt by South Australians located along the river, including through the disconnection of their electricity supply. The Government of South Australia provided grants and other forms of relief to support affected members of the community.

Health-related matters

Climate change has both direct and indirect impacts on health and wellbeing, through climate-related extreme events/disasters, and a range of environmental exposures. These include repeated or prolonged exposure to heat and heatwaves, bushfires and smoke, droughts and floods, and the changing risk of infectious diseases. Individual and population vulnerability to these exposures and events depends on many factors, including location, existing health conditions, and socio-economic status, with certain regions, such as remote and/or Indigenous communities in Australia, disproportionally affected by the negative health consequences of climate change[114].

With the state experiencing longer, hotter and more frequent heatwaves, South Australians are at increased risk of heat-related illnesses, which can have serious impacts on vulnerable groups of our society.

Cold-related illness(es) are a challenge that must also be managed, whether a residential customer unable to heat their home during winter, or a unhealthy indoor living environments due to inefficient residential premises. This issue is compounded further by the average Australian home's[115] estimated heating and cooling accounting for 40 per cent of energy use. With rising energy prices forecast by the Australian Government, this issue will be compounded further.

While health professionals play a key role in protecting vulnerable people from the potential severe health effects of increasing temperatures, and climate-related disasters and events, such as heat waves, the Government of South Australia recognises that more must be done to build resilience, adaptive capacity and reduce vulnerability, thereby helping the community adapt to the impacts of climate change.

The National Health and Medical Research Council (NHMRC) is increasing climate and health research capacity and capability through the Special Initiative in Human Health and Environmental Change[116]. Awarded $10 million over five years in November 2021, this initiative is designed to provide a catalytic stimulus to improve Australia's current capability and capacity in human health and environmental change research, by supporting a single, multidisciplinary, nationally focused, collaborative network of researchers across Australia. The work of this network will help to strengthen the Australian health system's resilience, preparedness and responsiveness to changing environmental conditions and extreme weather events.

112 Bureau of Meteorology, Greater Adelaide in 2019: drier than average Adelaide in 2019 (bom.gov.au)

113 National Emergency Management Agency, Australian Institute for Disaster Resilience, South Australia, November 2019 – February 2020, Bushfires – Black Summer Black Summer bushfires, SA, 2019-20 (aidr.org.au)

114 Beggs PJ, Zhang Y, McGushin A, et al. The 2022 report of the MJA-Lancet Countdown on health and climate change: Australia unprepared and paying the price. Med J Aust. 2022 Nov 7,217(9):439-458. doi: 10.5694/mja2.51742

115 Government of South Australia, Home energy use, SA.GOV.AU - Home energy use (www.sa.gov.au)

116 National Health and Medical Research, NHMRC Special Initiative in Human Health and Environmental Change, Special Initiative in Human Health and Environmental Change

In the latest State of the Environment report, the Australian Government stated[117] that the increasing storms, fires, flood, dust and rising temperatures are impacting human health and wellbeing as well as damaging homes, infrastructure and biodiversity in and around our cities. The 2019-20 bushfire alone, were estimated to have resulted in 417 deaths, 3,251 hospital admissions for cardiovascular and respiratory problems, and 1,305 asthma presentations at emergency departments. This translated to a combined health cost of $1.95 billion in economic terms. The annual Medical Journal of Australia-Lancet *Countdown on Health and Climate Change Report* found that in the year 2020 a total of 52,033 people in Australia were forcibly displaced by climate related disasters, including 47,529 for bushfires, 4201 for floods, 223 for storms, 52 for coastal erosion and 28 for landslides[118]. With the frequency and intensity of climate related disasters set to increase, so too will the impact on health and the economy.

Another study[119] found that, in Australia, at least 473 heat-related deaths were reported to the coroner in Australia in the 18 years from July 2000 to June 2018. 354 occurred during heatwave conditions and, of these, 244 occurred within or near buildings. The same study stated that, in terms of fatalities, South-eastern Australia – especially, in more recent years, Victoria and South Australia – were most at risk from heatwaves, with the risk extending to more remote areas as well as urban locations. This threat was likely to increase with the combination of an ageing population, increasing urbanisation and the expectation of longer and more frequent and intense heatwaves under changed climatic conditions.

Pollution from internal combustion engine (ICE) vehicles, including particulates, has been linked to ill-health, particularly respiratory problems. EVs will reduce these effects considerably. EVs, which run quietly, will also help greatly enhance the amenity of city and suburban living. It is important the government implements strategies to ensure people are not left behind due to affordability, including offering sustainable mass transport options, and monitoring for perverse incentives that could lead to greater marginalisation of vulnerable people. In addition, use of domestic wood heaters also contributes to concentrations of airborne particulate matter, that leads to harmful levels of air pollution[120]. Transitioning residential energy use, particularly for heating and cooling, to sustainable green energy would both reduce the health impacts, as well as energy bills, particularly if that transition includes rooftop solar PV.

Equity-related matters

Buildings need to be able to protect all members of the community from climate change-related health impacts, including minimising inland islands where buildings are too hot during summer and too cold in winter. Ensuring equity across energy affordability, reliability, access to renewable energy technologies and building standards, as some examples, will be critical in delivering equity and supporting health outcomes. Equity is a critical issue for lower income households, particularly those who also live in rental housing – who are unable to access technology and are faced with high energy bills within a constrained income stream.

117 Department of Climate Change, Energy, the Environment and Water, State of the Environment Report, 2021, State of the Environment report - DCCEEW

118 Beggs PJ, Zhang Y, McGushin A, et al. The 2022 report of the MJA-Lancet Countdown on health and climate change: Australia unprepared and paying the price. Med J Aust. 2022 Nov 7,217(9):439-458. doi: 10.5694/mja2.51742

119 International Journal of Disaster Risk Reduction, January 2022, Heatwave fatalities in Australia, 2001–2018: An analysis of coronial records - ScienceDirect

120 Beggs PJ, Zhang Y. The 2020 special report of the MJA-Lancet Countdown on health and climate change: lessons learnt from Australia's "Black Summer" (summary). Med J Aust. 2020 Dec 14,213(11):490-492.e1. doi: 10.5694/ mja2.50869

Although the state leads the nation in the amount of rooftop solar PV uptake, many South Australians have been unable to access energy efficiency technology, such as solar PV generation and home battery systems, due to living in rental properties, apartments or properties unsuitable for the installation of solar PV generation and home battery systems. This has resulted in their exclusion from the benefits of lower bills and energy independence. Additionally, many tenants are living under rental stress.

Tenants are a unique cohort of households. They are disadvantaged as the incentives to invest in renewable energy are very different between them and their landlords. Tenants are responsible for paying energy bills and are therefore incentivised to pursue opportunities to lower energy costs. However, they often do not have the tenure to justify even short-term investments. Landlords, however, may not be inclined to pay for the installation of a solar PV and battery system where the benefits of that system largely accrue to the tenant. This is known as a 'split incentive' and is the key barrier to the uptake of energy efficiency measures in private rental properties.

The split incentive means that many South Australians, particularly those on low or fixed incomes and younger people, have little opportunity to control their electricity bills using energy efficiency technology. This means their options are more likely to include reducing power usage by turning off air-conditioning or heating in their homes – or foregoing other essential items, including food (almost 10 per cent of South Australian households report food insecurity). This is particularly problematic for low-income South Australians who are most at risk of illness or death during heatwaves.

WHAT ARE YOUR THOUGHTS?

- How will reduced emissions from transport and the energy sector impact the health of South Australians?
- How can the transport and energy sector utilise a co-benefits approach: reducing emissions whilst improving the environment through biodiversity, greening and liveability?
- How will climate change impact liveability and what can be done to reduce these impacts?
- How will climate change, particularly rising temperatures, impact workforce capacity and recreation, particularly those undertaking work outside or wanting to exercise or play sport outside, and what can be done to reduce these impacts?
- How can the Government of South Australia develop and maintain engagement with South Australian communities, particularly with First Nations people and communities, (who are likely to be disproportionately impacted by climate change) on this topic? Should this include the development of an Energy Transition Engagement Strategy?
- How can the Government of South Australia support communities to transition to residential sustainable green energy to both reduce emissions and household living expenses, as well as improve health?
- What are the opportunities to develop industries in South Australia aligned with the energy transition that will increase equity, health, and wellbeing?

Climate change risks to South Australia, the citizens and businesses of this state, and Australia more broadly, have therefore never been clearer – with more urgent action required to ensure our society's prosperity, health, stability, and way of life.

As the impacts of rising heat, changing rainfall patterns and climate-sensitive air quality issues increase, so does the urgency to ensure equity while pursuing solutions. That is why the Government of South Australia was the first state parliament to declare a Climate Emergency on 31 May 2022, reaffirming the urgent need to decarbonise South Australia and continue our upward trajectory of renewable sources of energy and our ongoing leadership in responding to climate change.

The Government of South Australia recognises that climate change will impact all facets of our society, with the greatest impact felt by those least responsible for it and least able to afford mitigation measures.

Creating the energy future must be led by government in collaboration with industry and the community to provide solutions to address challenges together

Hornsdale Power Reserve, near Jamestown, South Australia.

4 Conclusion

The Government of South Australia recognises the state's transition to a net-zero emissions future must be carefully managed, to reduce energy costs, improve energy reliability, and reduce emissions.

This Green Paper has asked a range of questions, and the Government of South Australia is keen to know your thoughts on what needs to be done, in the medium to long-term, as the state transitions to a net-zero emissions future.

To express your views, go to: yourSAy
https://yoursay.sa.gov.au/energytransition or
Email: DEMenergytransition@sa.gov.au

4.1. HAVE YOUR SAY

DEM is seeking feedback on the questions covered in this paper. Visit yourSAy website to have your say.

South Australia's energy transition

QUESTIONS

- What do you want from South Australia's energy transition?
- What are the opportunities that you predict a successful energy transition offers to South Australia?
- What are the barriers that you foresee will be encountered as part of South Australia's energy transition?
- What are the key risks (short, medium and long-term) you consider the Government of South Australia should be mindful of and how can these be addressed as part of this work? To what extent are such risks quantifiable and is there any supporting evidence?
- What technologies do you think the Government of South Australia should explore further, in partnership with industry, as part of the energy transition, that may not already be part of the state's energy system? Provide any supporting evidence, data or modelling on the potential viability of such technologies (noting whether such information can be published).
- Do you consider the Government of South Australia should explore a DC-only system in the future as part of the energy transition?

The energy needs of South Australia

QUESTIONS

- What energy needs will shape South Australia's energy systems in the future?
- What needs to be done to prepare South Australia's energy system for external shocks such as recent global events impacting the price and supply of coal and natural gas?
- How has technology changed lifestyle and related energy use?
- How have social and personal priorities influenced our energy system?
- Do you consider the Step Change scenario described by AEMO in its Integrated System Plan to be the most likely scenario in South Australia?
- How can the Government of South Australia and industry maximise the opportunities presented in documents such as AEMO's 2022 ISP?
- If the Government of South Australia were to establish an Energy Transition Taskforce responsible for managing the transition to a net-zero emissions future, what should be its scope, terms of reference and which key matters should it consider?
- If the Government of South Australia were to develop an Energy Transition Roadmap, what should be its scope, deliverables, timing and other key matters it should consider?
- If the Government of South Australia were to develop an Energy Transition Emissions Reduction Strategy, what should the Government consider in terms of its scope, the sectors it should cover as well as key milestones and timing?
- If the Government of South Australia were to develop an Energy Transition Entry and Exit Strategy, what would such a Strategy cover in terms of scope, timing and key deliverables?

The current and future role of rooftop solar PV

QUESTIONS

- What role should rooftop solar PV play in the future of South Australia's grid?
- How can access to rooftop solar PV and/or its benefits be made more equitable across all energy users?
- How should the Government of South Australia ensure rooftop solar PV delivers the greatest value to consumers while maintaining a secure and reliable network?
- What, if any, changes are required to the ways in which premises are wired in South Australia?
- What reforms would help address the equity issue affecting renters and people in premises unsuited to solar PV systems?

The current and future role of energy storage

QUESTIONS

- What role should energy storage play in the future of South Australia's grid?
- What energy storage is needed to deliver a modern energy system that operates reliably and affordably? For example, grid-scale, distribution level, and/or household energy storage?
- What types of energy storage should the Government of South Australia explore further in partnership with industry and consumers?
- How can the Government of South Australia ensure energy storage delivers the greatest value to consumers?
- What role can community renewable energy systems play in the future energy system and what role does government have in facilitating these?
- What is required to ensure consumers are central to the deployment and operation of energy storage and that the benefits are shared equitably?
- What reforms are needed to ensure storage has both sufficient capacity and depth, to meet the requirements of South Australia's future grid?

The current and future role of hydrogen gas

QUESTIONS

- What is the best use of hydrogen in South Australia?
- How does hydrogen support the energy sector best in the future?
- What are the barriers to developing a hydrogen industry at scale in South Australia?

The current and future role of natural gas

QUESTIONS

- How does natural gas best support South Australia during the energy transition?
- What sectors will continue to use oil and natural gas in the long-term?
- What other gases should be explored further by the Government of South Australia and industry?
- How can the Government of South Australia further support other gas opportunities in the state?

Mining, manufacturing and recycling

QUESTIONS

- What are the future training needs to develop a green economy in South Australia?
- What are the supply chain opportunities and risks that need to be considered and addressed as part of the energy transition?
- What are the key energy sector investment opportunities that will add value and help to diversify the South Australian economy?
- If the government were to develop a Green Manufacturing Strategy, what should be considered in terms of its scope, timing and key deliverables?
- How can the Government of South Australia best leverage opportunities presented by the energy transition to incentivise investment in the manufacturing and mining sectors in the state?
- Should the government consider the development of an Energy Transition Recycling Strategy to leverage the benefits of a circular economy, and if so, what would be the Strategy's key features?
- What do you think are the community, social, environmental and/or governance-related challenges these sectors and regions will face through the energy transition?
- What export opportunities exist and how can South Australia escalate these?
- Do you think the Government of South Australia should develop an Energy Transition Investment Framework to assist in the delivery of its 2030 and 2050 targets, and if so, what would such a framework look like?
- Should consideration be given to the development of a Green Mining and Process Strategy, and if so, what should such a strategy seek to achieve?

The built environment

QUESTIONS

- What is the best way of developing energy efficient rental accommodation?
- How will technology play a role in improving energy efficiency in buildings and infrastructure?
- How can the benefits of energy efficiency be shared equitably?
- How can lower income households be supported to enable them to meet the capital costs of investing in more efficient appliances?
- What, if any, reforms should be made to encourage households to retrofit older, less energy-efficient homes?

Decarbonising transport

QUESTIONS

- How will battery electric and fuel cell EVs impact energy infrastructure in the future?
- What role does government play in the transport sector to minimise unwanted transitional impacts?
- How important is the choice of fuel and security of supply as the transport sector transitions to new fuel sources?
- What are the barriers to electrification of offroad vehicles in other market segments such as the mining and agriculture sectors?
- What role do e-fuels or synthetic fuels play in the transport sector?

Education and workforce

QUESTIONS

- Which areas need training and industry development to keep up with demand?
- Growth of new technologies in a modernising energy system presents an opportunity but also a risk of increasing the divide – how do we best support vulnerable members of the community to keep up with developments?
- Which areas of future growth will need a focus on increased education and consumer protections?
- What can the Government of South Australia do to improve energy literacy in regional and remote towns and communities in South Australia?
- How will regions attract and retain skilled workers to support the development, maintenance and operation of energy infrastructure?
- What other elements will support the attraction and retention of skilled workers in South Australia?
- How can the Government of South Australia ensure Aboriginal people are respected, consulted and are able to realise the opportunities?
- What measures are needed to ensure gender balance in job creation at all levels?
- Should the Government of South Australia continue to develop a targeted Energy Transition Workforce Strategy to identify and address workforce issues specific to the energy sector, or should its scope be broader?

Health and equity

QUESTIONS

- How will reduced emissions from transport and the energy sector impact the health of South Australians?
- How can the transport and energy sector utilise a co-benefits approach: reducing emissions whilst improving the environment through biodiversity, greening and liveability?
- How will climate change impact liveability and what can be done to reduce these impacts?
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- How can the Government of South Australia support communities to transition to residential sustainable green energy to both reduce emissions and household living expenses, as well as improve health?
- What are the opportunities to develop industries in South Australia aligned with the energy transition that will increase equity, health, and wellbeing?

LIST OF FIGURES

ABBREVIATION

ABBA	Australian Biomass for Bioenergy Assessment
ABS	Australian Bureau of Statistics
A2E	Australian Alliance for Energy Productivity
AC	Alternating current
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AG&WA	Australian Glass and Window Association
APY Lands	Anangu Pitjantjatjara Yankunytjatjara Lands
AREEA	Australian Resources and Energy Employer Association
ARENA	Australian Renewable Energy Authority
ARRB	Australian Road Research Board
ASBEC	Australian Sustainable Built Environment Council
ATTMA	Air Tightness Testing and Measurement Association
BCA	Building Code of Australia
BEV	Battery electric vehicle
BoM	Bureau of Meteorology
C&I	Commercial and industrial
CAES	Compressed Air Energy Storage
CBD	Commercial Building Disclosure
CCS	Carbon Capture and Storage
CEC	Clean Energy Council
CEFC	Clean Energy Finance Corporation
CER	Clean Energy Regulator
CN30	Carbon neutral by 2030
CO_2	Carbon dioxide
COP-26	26th United Nations Climate Change Conference of the Parties
CPD	Continuing Professional Development

CPH	Central Power House
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSP	Concentrated solar thermal power
DACS	Direct air capture and storage
DC	Direct current
DCCEEW	Department for Climate Change, Energy, Environment and Water
DEM	Department for Energy and Mining
DER	Distributed energy resources
DEW	Department for Environment and Water
DHS	Department of Human Services
DIIS	Department for Industry, Innovation and Science
DIT	Department for Infrastructure and Transport
DNSP	Distribution Network Service Provider
DRI	Direct Reduction Iron
DSP	Demand Side Participation
E3 Program	The Equipment Energy Efficiency Program
EAF	Electric Arc Furnace
EPP	Energy Partners Program
EPT	Energy productivity target
ESCOSA	Essential Services Commission of South Australia
EV	Electric Vehicle
EWOSA	Energy and Water Ombudsman of South Australia
FCAS	Frequency Control Ancillary Service
FCEB	Fuel Cell Electric Bus
FiT	Feed-in tariff
GEMS Act	Greenhouse and Energy Minimum Standards Act
GISA	Green Industries SA
GJ	Gigajoule

GlobalABC	Global Alliance for Buildings and Construction
GW	Gigawatt
GWh	Gigawatt hour
ha	Hectares
HBI	Hot Briquetted Iron
HyP SA	Hydrogen Park South Australia
ICANZ	The Insulation Council of Australia and New Zealand
ICE	International combustion engine
IEA	International Energy Agency
IRENA	International Renewable Energy Agency
ISP	Integrated System Plan
J	Joule
kWh	Kilowatt hour
LNG	Liquified natural gas
LPG	Liquefied petroleum gas
MAPS	Moomba to Adelaide Pipeline System
$MtCO_2$-e	Million tonnes of carbon dioxide equivalent
MW	Megawatt
NABERS	National Australian Built Environment Rating System
NatHERS	National House Energy Rating Scheme
NCC	National Construction Code
NEEBP	National Energy Efficient Buildings Project
NEM	National Electricity Market
NEPP	National Energy Productivity Plan
NERA	National Energy Resources Australia
NEVS	National electric vehicle strategy
NHMRC	National Health and Medical Research Council
OECD	Organisation for Economic Co-Operation and Development

OHPSA	Office of Hydrogen Power South Australia
PEM	Proton Exchange Membrane
PHES	Pumped hydro energy storage
PHEV	Plug-in hybrid electric vehicle
PJ	Petajoule
PV	Photovoltaic
PVNSG	PV Non-Scheduled Generator
RAES	Remote Area Energy Supply
RDA	Regional development Australia
REPS	Retailer Energy Productivity Scheme
RESA	Resources and Engineering Skills Alliance
RIS	Renewable Integration Study
SAPN	SA Power Networks
SARIG	South Australian Resources Information Gateway
SEA Gas	South Eastern Australia Gas Pipeline System
SIPS	System Integrity Protection Scheme
SME	Small to medium enterprise
ToR	Terms of Reference
TWh	Terawatt hour
UFLS	Underfrequency load shedding
UNEP	United Nations Environment Programme
VPP	Virtual Power Plant
VRE	Variable renewable energy

SOUTH AUSTRALIA

Government of South Australia
Department for Energy and Mining

ACKNOWLEDGEMENT OF COUNTRY

As guests here on Kaurna land, the Department for Energy and Mining (DEM) acknowledges everything this department does impacts on Aboriginal country, the sea, the sky, its people, and the spiritual and cultural connections which have existed since the first sunrise. Our responsibility is to share our collective knowledge, recognise a difficult history, respect the relationships made over time, and create a stronger future. We are ready to walk, learn and work together.

Central Power House, Umuwa, courtesy of APY

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South Australian Resources Information Gateway (SARIG)
map.sarig.sa.gov.au

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