Picture the Future: Australia

Energy

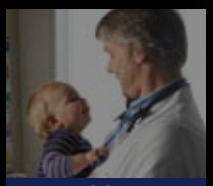
Innovation for generations.

SIEMENS

Water
Availability

Energy
Sustainability

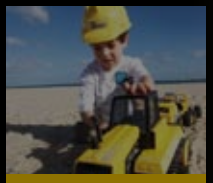
Environment
Preservation



Healthcare
Prevention

Productivity
Competitiveness

Mobility
Accessibility



Safety
Assurance

Security
Protection

Picture the fut

ure ...

... *where we provide sustainable energy to all Australians,*

where we export clean electricity to South East Asia,

where energy efficiency becomes a way of life, and,

where Australia's road transport fleet is fully electrified and powered by renewable energy.

2010 2011 2012 2013 2014 2015 2016 2017 2018

The future *starts now.*

Come and join us on a journey into the future of energy in Australia.

In this century, the global megatrends of climate change, demographic change, urbanisation and globalisation are creating our greatest challenges.

These four megatrends are changing our world.

As Charles Darwin said, "it's not the strongest but the one that's most responsive to change that will survive."

To create an Australia where energy is sustainable and reliable, we need to change our current ways.

Our future is our choice.

Opportunities for a bright and positive future.

Technology is providing us with new opportunities for a better future.

As the provider of technology-based solutions in eight of the most pressing areas of concern for Australia[1] – **water, energy, environment, healthcare, productivity, mobility, safety and security** – we at Siemens, have embarked on a unique research project to present our vision of the future from a technology perspective.

What challenges do we face now?

What solutions currently exist?

What kind of future could we create if we implemented these solutions today?

Picture the Future Australia: Energy

Combining our global expertise and local market knowledge, our research presents a new technology blueprint to tackle the challenges caused by the four global megatrends. This research is supported by our local presence in Australia and New Zealand of nearly 140 years. Our R&D investment of A$6.2 billion (2009) and 30,800 R&D employees in over 30 countries gives us access to a global network of expertise which enables us to deliver the latest in technology solutions.

What can Australians do to meet our greenhouse gas emissions target[2] when our population is growing and demanding more energy?

How can we become a net exporter of clean electricity?

In order to achieve these goals, we need to:

- transform our energy infrastructure and economy to one that is sustainable by adopting the latest technologies in energy generation, transmission and usage
- commit to ongoing development of new technologies to reduce our dependence on coal and oil
- focus on working together to achieve a sustainable energy supply for current and future generations

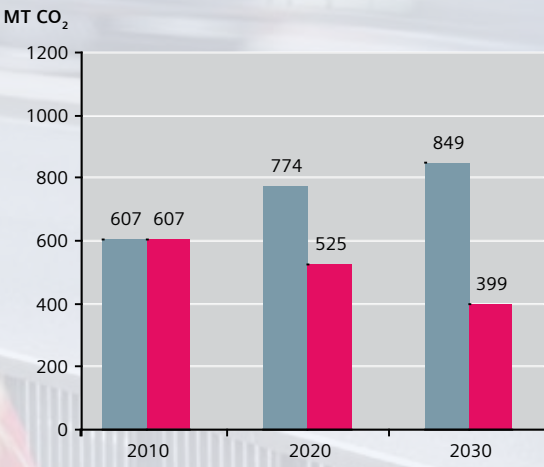
[1] CEDA, The Big Issues Survey Results 2008: Top 50, Melbourne 2008 [2] 221 megatonnes of CO_2 by 2050

Why do we have these energy challenges?

Australia is one of the highest per capita emitters of greenhouse gases in the industrialised world. As an energy wealthy country we have large reserves of coal, gas and uranium, along with huge potential in renewable energy sources such as the sun, wind, ocean and geothermal. However, we rely heavily on fossil fuels (coal, oil, gas) for power generation and transportation, as well as having an energy-intensive minerals and metals sector.

At the same time, our population is expected to grow by 75 percent from 2000 to 2050. In the past, there has been a direct link between population growth, energy usage and greenhouse gas emissions. Consequently, if population grows at this rate while energy sources and usage patterns remain unchanged, greenhouse gas emissions will increase in proportion with population growth.

Australian greenhouse gas emissions (business as usual) vs emissions targets (megatonne CO_2e)



Source: Commonwealth Government 2008 "Australia's Low Pollution Future"

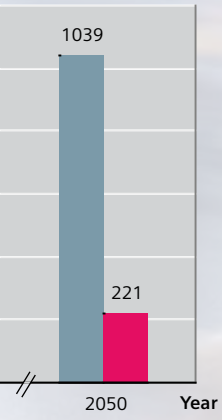
2015 2016 2017 2018 2019 2020 2021 2022 2023 20

Energy challenges

What are our energy challenges?

The Australian Government has committed to significant greenhouse gas emission reduction targets by 2050. If we continue to act as we do today, and our population grows as expected, our greenhouse gas emissions will reach nearly five times the targeted level by 2050.

The challenge for Australia will be to transition from an economy with high greenhouse gas intensity to one that is sustainable. This will enable us to achieve the target set for 2050.



"Business as usual" greenhouse gas emissions

Australian government target for emission reductions

24 2025 2026 20

CO_2e: Equivalent carbon dioxide describing how much global warming a given type and amount of greenhouse gas may cause, using the functionally equivalent concentration of carbon dioxide (CO_2) as the reference.

To achieve a sustainable energy future Australians have to:

- adopt energy-efficient technologies and an energy usage culture to match
- develop clean technologies to use our coal resources
- rapidly develop renewable energy sources such as wind, solar and geothermal
- adopt "smart grid" technologies such as smart meters
- convert our road transport fleet to electric vehicles, where the electricity comes from renewable sources

18 2019 2020 2021 2022 2023 2024 2025 2026 202

Achieving sustainable energy for future generations.

Although 2050 may seem distant, achieving Australia's ambitious greenhouse gas commitments must start today. Transitioning from an economy with high greenhouse gas intensity to one that is sustainable requires significant behavioural and technological changes across all levels of society.

How do we achieve sustainable energy for future generations?

The challenge of achieving increased energy output with less greenhouse gas emissions will require a radical conversion of Australia's energy infrastructure and economy over the coming decades. The adoption of current technology and the continuous development of emerging technologies must be combined to address Australia's energy challenge. This includes:

Efficient and low emission power generation

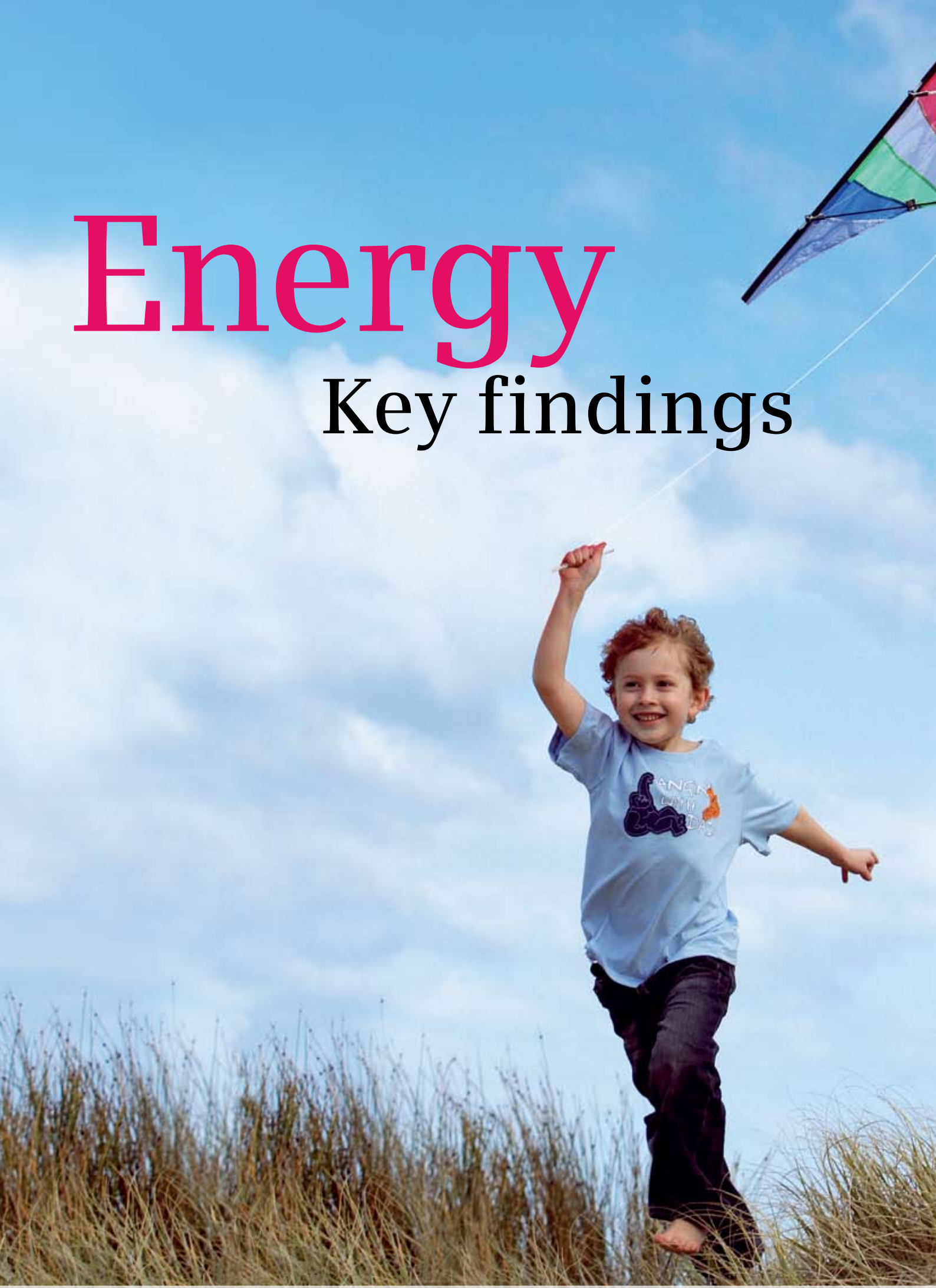
Renewables and large scale storage

Advance transmission and distribution

Energy-efficient transport

Energy

Key findings



1. Australia is an **energy wealthy country** and our high reliance on fossil fuels means that, per capita, we are among the highest emitters of greenhouse gases.

2. As a nation, we have committed to significant **reductions in greenhouse gas emissions** by 2050 to achieve a level of emissions that is ecologically sustainable.

3. While a 2050 target may seem distant, the **decisions and actions** that we make from now until 2030 will be critical to achieving the target and creating an economy based on sustainable energy.

4. Australia's **population will increase** by 75 percent from 2000 levels by 2050, while our target is to reduce greenhouse gas emissions by 60 percent. Therefore, if we are to meet our emission reduction target, we must significantly improve the efficiency of our energy use and change to sources of energy with a much lower greenhouse gas intensity.

5. Efficient **energy usage** in residential, commercial and industrial sectors is currently low relative to world standards because Australians have enjoyed some of the cheapest energy prices in the world, resulting in little drive towards energy efficiency.

6. Australia's ageing fleet of coal and gas fired **power plants** generate around 93 percent of our electricity, contributing significantly to greenhouse gas emissions. Replacement of the fleet with the latest technology and some fuel switching could reduce greenhouse gas emissions by 30 percent.

7. The construction of new, high-efficiency coal and gas-fired power plants, combined with **carbon capture** and storage technologies, will ensure greenhouse gas emissions are captured, providing a viable future for such plants.

8. **Renewable generation** technologies are currently dominated by hydro-electricity, providing around seven percent of electrical energy.

9. Growth in renewable energy will be achieved by a mix of **wind** and large-scale **solar** generation, with contributions from technologies such as **geothermal** and **ocean** power. For example, a 330 km x 330 km solar power plant in the Australian desert could produce enough energy to meet the world's demand during daylight hours.

10. Developing the **electricity transmission** networks of the eastern states and the separate Western Australian network, will be a key enabler for integrating power from remotely located wind, solar and geothermal plants into the electricity sector.

11. **Transportation** is currently petroleum based and results in around 15 percent of Australia's greenhouse gas emissions.

2021 2022

In 2010

Population: 22 million

Target Emissions: 602 Mt CO_2e

Greenhouse gas emissions (business as usual): 607 Mt CO_2e

The adoption of **energy efficiency** is still very slow. This is despite research showing that a 30 percent improvement in residential and commercial buildings, as well as in industry, is possible by adopting existing technologies such as energy-efficient lighting, smart-building heating and cooling, and efficient industrial processes.

Approximately 83 percent of Australia's electricity is generated from coal, and ten percent from natural gas, leading to a highly greenhouse gas intensive electricity sector. Replacing the current ageing fleet of **power plants** with current technology and some change in fuel mix could reduce greenhouse gas emissions by up to 30 percent.

Renewable generation provides approximately seven percent of electrical energy. This is mainly from hydro power, although wind generation is beginning to grow.

Electricity transmission networks currently connect large cities with coal-fired generators. Connection of new large-scale, remote solar and wind generators will require significant extensions of transmission systems. Applying the latest technology for long distance transmission (high-voltage direct current) would result in a reduction of losses by around 50 percent.

Road transport is based on internal combustion engine vehicles. Hybrid vehicles are still a niche technology. Australians drive approximately 200 billion kilometres per year, reflecting the size of the continent, our continued affection for the motor car and cities that are poorly served by public transport.

In 2020

Population: 25 million

Target Emissions: 525 Mt CO_2e

Greenhouse gas emissions (business as usual): 774 Mt CO_2e

All new buildings are 6-star rated for **energy efficiency** and have the ability to monitor and control power usage through smart metering. The buildings have high-efficiency lighting and solar power generation. Energy intensive industrial processes have been optimised, providing efficiency improvements of around 20 percent relative to 2010 levels.

All new coal-fired **power generation** plants are constructed with carbon capture and storage technology which captures the carbon dioxide (one type of greenhouse gas) emitted in the generation process.

Australia reaches a significant milestone – we have achieved our 20 percent **renewable electricity** generation target due to a mix of hydro, wind and solar technology. The challenge now is to develop technology that can store the intermittent solar and wind energy for use when there is a lack of sunshine and wind.

The initial phase of a more efficient long distance **transmission** network (high-voltage direct current technology) is put into place. Smart grid systems, which control energy consumption, begin to match the intermittent nature of renewable energy with demand.

In **road transport**, hybrid vehicles now account for over 20 percent of new passenger vehicle sales. While still a niche technology, electric/hydrogen vehicles are beginning to have an influence on society, because they are enabled by our increasing renewable electricity generation.

Picture the future

In 2030

Population: 28 million

Target Emissions: 400 Mt CO_2e

Greenhouse gas emissions (business as usual): 849 Mt CO_2e

Significant improvements in **energy efficiency** have been achieved due to innovative low energy processes being adopted by industry. All buildings are converted to high efficiency standards and smart meters are now helping to optimise energy use.

Renewable generation is growing strongly, currently producing 40 percent of the country's electricity, and is expected to produce 90 percent of electricity in the next two decades. Large-scale storage of renewable energy is enabling the growth of renewable generation, mainly dominated by solar. Nearly all homes have solar panels installed.

Half of all coal-fired power **generation plants** have carbon capture and storage technology, which captures the carbon dioxide emitted in the generation process. Over the next two decades all coal-fired power plants will be fitted with this technology.

A **national power grid** is being constructed to connect Western Australia's energy grid to the Eastern states. High voltage direct current transmission interconnectors are gradually replacing traditional alternating current lines. This will eventually link the grid to large-scale solar and geothermal power stations in central Australia, delivering renewable energy to all states. This grid will then be developed to transmit clean electricity, from renewable generation, by an undersea link to Indonesia and South East Asia.

Australia is working towards achieving a **road transport fleet** that is virtually greenhouse gas free. Around 20 percent of vehicles are electric or hydrogen-based, fuelled by electricity generated from renewable sources. Over the next two decades, virtually all land vehicles will be electric or hydrogen. A high speed rail network between all major cities is in construction, providing efficient transport between major cities.

of energy

CO_2e: Equivalent carbon dioxide describing how much global warming a given type and amount of greenhouse gas may cause, using the functionally equivalent concentration of carbon dioxide (CO_2) as the reference.


Renewables & Electricity Transmission
Picture the Fut
SIEMENS
All Electric Transport
ENERGY


Energy Saving
SIEMENS
Fridge
Off 11.00 Hrs
Send to Grid
SIEMENS
SIEMENS
Renewables &
Clean Energy
2030

Energy facts

How much does it cost?

Historically, energy prices in Australia have been very low. Electricity at the household typically costs around 12 cents per kilowatt hour (kWh), whereas in Europe the equivalent cost is around 33 cents per kWhr. A typical household uses around 6,500 kWh per year, with an electricity bill of around $800. The equivalent European household uses half the electricity but still pays nearly one and a half times as much.

Typically, petrol costs twice as much in Europe as it does in Australia. However, Europeans live in much more compact cities and commute by public transport, small efficient motor vehicles, or other means, so transport-based greenhouse emissions are significantly less than in Australia.

How can I reduce my greenhouse gas impact?

A typical house consumes around 6,500 kWh per year. In Australia this is equivalent to around 6.5 tonnes of greenhouse gas each year. A typical Australian car driving 20,000 kilometres per year will produce around 4.4 tonnes of greenhouse gas. By focusing on energy efficiency in the home and by using efficient motor cars, Australians can have a significant impact on greenhouse gas emissions.

How can you replace greenhouse intensive energy with renewable energy?

Currently 93 percent of electricity comes from greenhouse gas producing sources. Most current vehicles use petrol or gas for energy which also contribute to this. By progressively supplementing and replacing our coal and gas-fired power plants with renewable electricity generation and large scale energy storage, Australians can significantly reduce our greenhouse footprint. Once we have an electricity sector which is based on renewable energy sources, the adoption of electric vehicles for road transport means that it becomes greenhouse gas free.

How can we *reduce energy* consumption?

Energy efficiency is the fastest and cheapest way to reduce greenhouse emissions. In many cases, energy efficiency actually saves money.

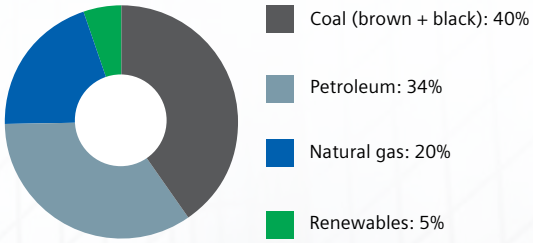
Here are some examples of energy efficiency measures that can be implemented now:

- Replacing incandescent globes with energy efficient lamps could save approximately five percent of electricity generated and the equivalent in greenhouse gases.
- In Australia, approximately 300,000 electric motors consume 65 percent of industrial energy. Optimising these motors could reduce greenhouse gas emissions by approximately five million tonnes per annum.
- The choice of motor vehicle can have a significant impact on fuel consumption, and therefore on greenhouse gas emissions. Currently the most efficient vehicles are small hybrid or diesel. In the future, however, electric vehicles powered by renewable electricity will become the norm.

Why are Australia's greenhouse gas emissions so high?

- **Coal is the predominant fuel for power generation.**
- **Most of Australia's transportation is based on fossil fuels. The predominant fuels are oil-based products.**

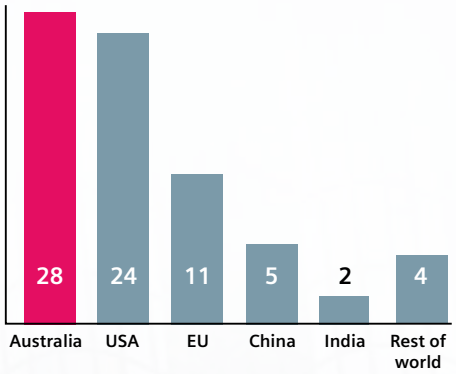
Primary energy sources used in Australia



Source: ABARE

How do Australia's greenhouse gas emissions compare globally?

Per capita greenhouse gas emissions (tonnes per annum)



Source: Carbon Planet

Australia is one of the highest per capita emitters of greenhouse gases in the industrialised world due to our heavy reliance on fossil fuels and an energy-intensive minerals and metals sector.

2034 2035 2036 2037 2038 2039 2040 2041 20

Can old buildings be just as energy efficient as new ones?

A positive future for energy in Australia is now in your hands.

As a technology-based solutions provider, Siemens can support you with the latest innovations in technology to help achieve Australia's goals for energy.

We are committed to research and development to find solutions for a world with sustainable energy. We will continually share our knowledge to empower you to make the right decisions.

What is left now is for you to take the next step. If we want a future of sustainable, clean and reliable energy, we need to start working together today.

As Australians, it's time for us to take action in response to the challenges caused by the four global megatrends – climate change, demographic change, urbanisation and globalisation. Now is the time to explore all the opportunities presented through current and emerging technologies to create a better world for future generations.

Together, we can picture the future of sustainable energy.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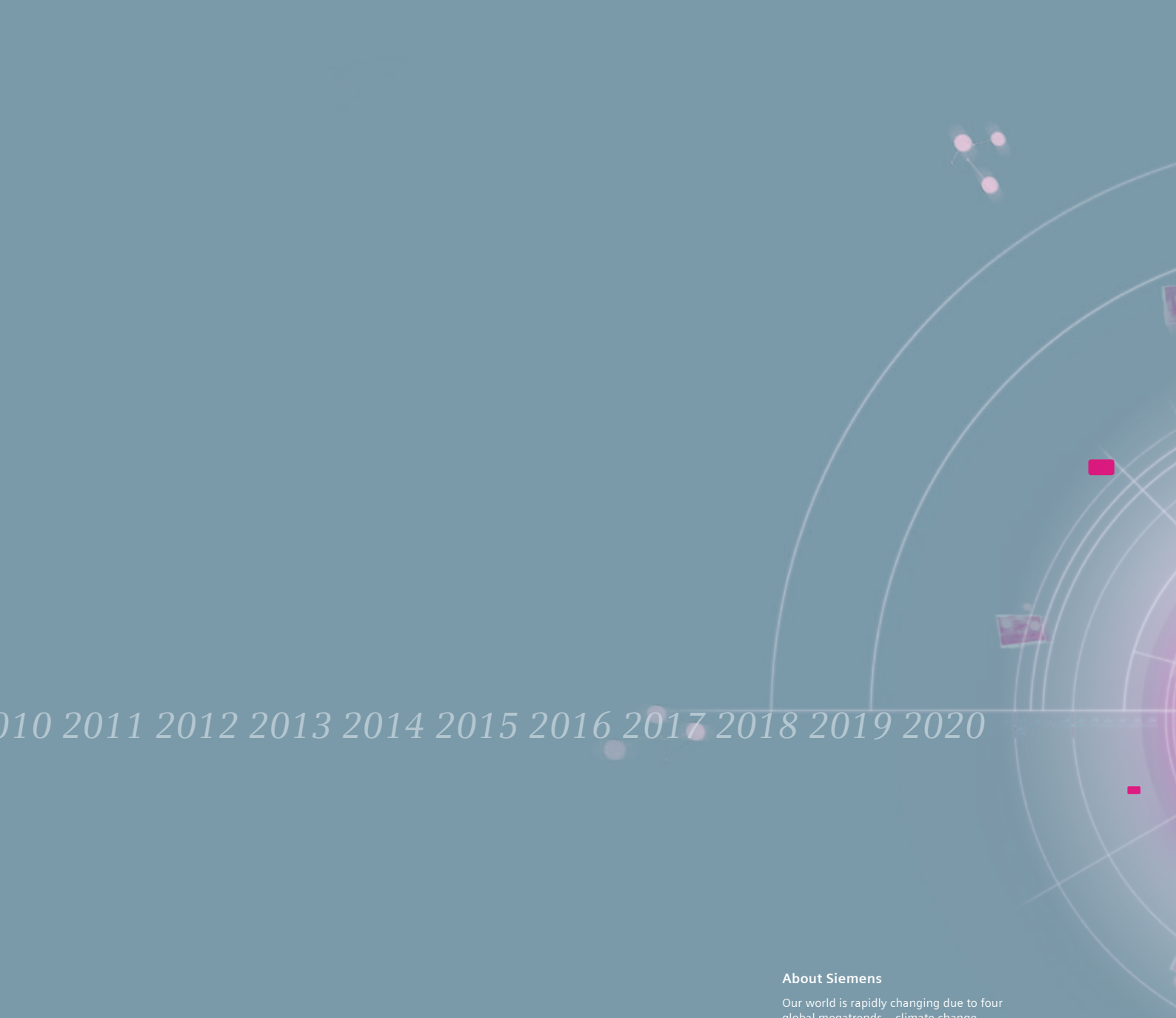
Picture
the Future
Energy



About Siemens

Our world is rapidly changing due to four global megatrends – climate change, urbanisation, globalisation and demographic change. The pressures brought on by these four global megatrends can affect businesses and individuals significantly. Siemens has a portfolio of technology-based solutions to help tackle such challenges. Through our innovative offerings, we can help you find solutions in the areas of water, energy, environment, healthcare, productivity, mobility, safety and security.

Siemens Ltd.
www.siemens.com.au

Head Office Australia
885 Mountain Highway
Bayswater VIC 3153
ABN: 98 004 347 880

Telephone 137 222
Facsimile 1300 360 222

Version 2

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The information in this document contains general descriptions of the technical options available, which do not always have to be present in individual cases. The required features should therefore be specified in each individual case at the time of closing the contract.

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