LOW CARBON LIVING CRC

Guide to Low Carbon Households

Acknowledgements

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Guide to Low Carbon Households

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Glossary

ABS
Australian Bureau of Statistics.

Active cooling / active heating
The use of energy consuming devices such as air conditioners, fans, radiators, gas fires and slow combustion stoves to heat and cool the home.

AIRAH
The Australian Institute of Refrigeration, Air conditioning and Heating.

Appliances
Household devices that use energy. These include fridges, freezers, washing machines, dishwashers, stoves, irons, kettles and fixed devices such as hot water systems.

Base-load (power)
The minimum power drawn by a home in a given period. This is generally during the early hours of the morning when people are asleep and only essential appliances, such refrigerators and security systems, are drawing power.

Behaviour
The way in which householders manage their home and operate their appliances.

Climate zone
A region or zone that has a unique climate, for example, cooling climate (North Queensland) or heating climate (Tasmania).

Controlled-load
See off-peak load.

Electrical energy
A form of energy that involves the flow of electric current to heat an element, drive a pump or produce indoor light. See Energy and kilo-Watt hour.

Energy
The ability to do work or apply a force to an object.

Energy efficiency
Minimising electrical or gas energy use and wastage by employing low consumption devices, improving building design and modifying behaviour.

Feed-in tariff
The tariff paid (c/kWh) to an electricity consumer for the surplus energy generated by a solar PV system dispatched to the grid.

Grid
The electrical system of large interconnected power generators that supply consumers via interconnectors.

Heat pump water heater
An electric water heating system that extracts heat from the air to heat water.

Home energy
Metered mains electricity or gas, or containerised liquids and gases.

Household
The residents of a home. These may be a person living alone, a couple, a family, or a group of adults in a share house.

Householder
Owner or renter of a home. There may be multiple householders in a household.

Hydronic heating (and cooling)
An electric heat pump system that circulates heated (or chilled) water to heat (or cool) a room or space.

Import / export meter
An electricity meter required for a grid connected solar PV system, which provides separate displays of total energy consumed from the grid (imported) and energy supplied to the grid (exported).

kilo-Watt (kW)
The units of power. For example, a 3kW air conditioner draws power at rate of 3kW.

kilo-Watt hour (kWh)
The units of electrical energy. For example, a 1 kW pump used for 3 hours uses 3kWh.

Mega Joule (MJ)
The units of energy from burning gas or other fuels.

NEM
National Electricity Market.
The market in which generators and retailers trade electricity and which interconnects Qld, NSW, ACT, Tas and SA. WA and the NT are not connected to the NEM.

Off-peak or Controlled-load
Electricity supplied to specific appliances, such as electric hot water systems or underfloor heating, and which are often separately metered. A controlled-load tariff is generally a lower rate as these appliances operate during off-peak hours.

Passive heating and cooling
Building design features such as correct orientation, eaves, double glazing, insulation, colour, thermal mass and air flow that optimise solar heating and natural cooling.

Payback period
The time an investment will take to pay itself off, in lower charges or accrued savings.

Peak latent cooling load
The maximum thermal power (kW) to reduce humidity.

Peak sensible cooling load
The maximum thermal power (kW) to reduce temperature.

Power
The rate at which energy is consumed. See kilo-Watt.

Renew
Trading name of the Alternative Technology Association. Community organisation that promotes sustainable living.

Renewable energy
An infinite (renewable) source of energy such as wind or solar that produces no greenhouse gas emissions.

Single-phase
The power supply in most Australian homes. A two wire Alternating Current (AC) power circuit.

Smart meter
An energy meter that performs various functions in addition to those of an import/export meter. These include time interval metering and wireless communication.

Solar PV system
A power generating system that converts sunlight into electricity using photovoltaic (PV) principles. Not to be confused with a solar water heating system.

Solar water heating
A water heating system that uses solar thermal collectors to heat water from the sun, which is then stored in a tank. Not to be confused with a solar PV system.

Split system (air conditioner)
A refrigerative air conditioner that has two parts. The indoor unit contains the evaporator component, while the outdoor unit contains the compressor and condenser.

Supply charge
The charge per day for connection to the electricity or gas grid.

Tariff
The pricing structure offered by energy retailers.

Thermal imaging
The use of special imaging equipment to detect the heat produced by people or things.

Three-phase
Three-phase power refers to three live (or active) wires in a power circuit that permits three times the amount of power. The phases are red, white and blue. Single-phase appliances run off one of the phases. Any large, three-phase appliances connect into all three phases.

Time-of-use tariff
An energy charge that bills you for energy used during certain times, for example between 4pm and 9pm on weekdays.

Emissions and the built environment

Buildings, in all their forms, have a huge impact on the environment. Globally, the United Nations Environment Program estimates they are responsible for **30–40%** of all primary energy used.

In Australia, buildings are responsible for one quarter of all greenhouse gas emissions.

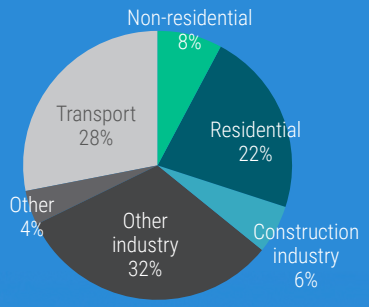
This presents a **significant challenge** as well as a **valuable opportunity** for the built environment sector to contribute to emissions abatement and mitigation.

In 2016, the Australian Government ratified the **Paris Agreement** within the United Nations Framework Convention on Climate Change, pledging to work alongside other developed nations to achieve net zero emissions by 2050 and a 26–28% reduction in emissions relative to 2005 levels by 2030.

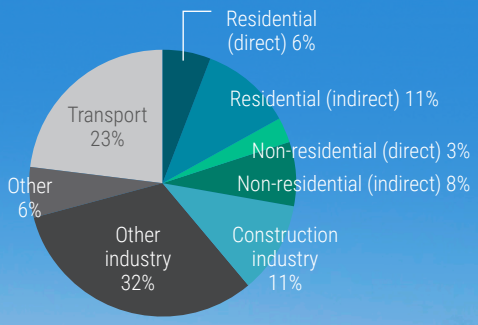
It is clear that if Australia is to achieve these targets, curbing emissions from **the built environment will play a central role**. And with more than 75% of the world's population predicted to be living in cities by 2050, the decisions and actions taken now will have effects decades into the future.

Global share of buildings and construction final energy and emissions, 2017

Energy



Emissions



Source: Derived from IEA (2018a), *World Energy Statistics and Balances 2018*, and *IEA Energy Technology Perspectives* buildings model

About the CRCLCL

The **Cooperative Research Centre for Low Carbon Living** (CRCLCL) is a national research and innovation hub for the built environment. It aims to influence policies and practices to reduce carbon emissions, improve energy efficiency and realise other co-benefits while driving competitive advantage for Australian industry. It has undertaken more than 100 research projects with industry and government partners and supported almost 100 PhD and Masters students.

Supported by the Australian Government and almost 40 industry and government participants, it links leading Australian researchers to organisations across all sectors involved in the built environment. When it ceases operations in mid-2019, the CRCLCL will leave a legacy of research outputs, policy and practice innovation, and enhanced national capacity. This Guide and others in the Low Carbon Guides series form part of that legacy.

A guide for every situation

Each Low Carbon Guide summarises best practice in various phases of the building lifecycle—construction, retrofit, operation—for a range of building types in the residential and commercial sectors and at the level of precincts. The series includes:

Guide to Low Carbon Residential Buildings – New Build
Options for homeowners, builders and designers during the planning and construction of new homes.

Guide to Low Carbon Residential Buildings – Retrofit
Retrofit solutions for existing homes, tailored for homeowners and their contractors.

Guide to Low Carbon Households
Advice to homeowners and renters on operating households using low carbon living approaches.

Guide to Low Carbon Commercial Buildings – New Build
The design and construction of low carbon commercial buildings.

Guide to Low Carbon Commercial Buildings – Retrofit
Methods for retrofitting commercial buildings to improve performance while reducing energy and carbon use.

Guide to Low Carbon Precincts
Frameworks and options to assist councils and developers with strategic planning decisions when implementing low-carbon neighbourhoods.

Further Guides cover Landscape, Urban Cooling, Value-chain and other topics.

For further information go to: builtbetter.org/lowcarbonguides

Introduction

This guide aims to help the occupants of a home reduce the amount of energy they use and, in doing so, help curb carbon emissions and save on utility bills.

Occupants, or householders, may be owners or renters and there may be multiple householders within one dwelling. This document recognises the needs and capacities of these different householder groups and, where appropriate, also addresses the needs of households in different climate zones.

The guide is a companion to the **Guide to Low Carbon Residential Buildings – Retrofit**, which offers advice on upgrades and adaptations to a home to improve its comfort and reduce energy bills and carbon emissions.

While the two guides cover similar ground, the tips here are targeted at ways to reduce the amount of electricity and gas used for cooking, heating, cooling, lighting and entertainment—the activities that account for the bulk of energy use in the home. For retrofit options beyond home energy use, please refer to the companion document.

Other concerns that fall outside the remit of this document include carbon reductions and energy savings related to fuels that power machinery such as cars and lawn mowers, general household water usage, and the generation, separation and management of household waste.

Similarly, this guide does not address energy and carbon savings related to major structural renovations or new constructions. These are dealt with in the **Guide to Low Carbon Residential Buildings – New Build**.

To reduce energy use in the home requires householders to change behaviours and make adaptations. The extent they can do this depends on whether they own or rent their home. Generally speaking, owners have more freedom to make choices about energy-saving options. Even so, if the home is a property or an apartment under Community or Strata Title, improvements may require prior approval from a management group made up of other owners.

Renters are constrained in the extent to which they can modify their home, but they may still be able to negotiate improvements with their landlord or property manager. This requires building a case to justify the changes, including identifying any cost to the landlord, savings in energy achieved, improvement to property value, enhanced appeal to future tenants, and improved rental value.

How to use this guide

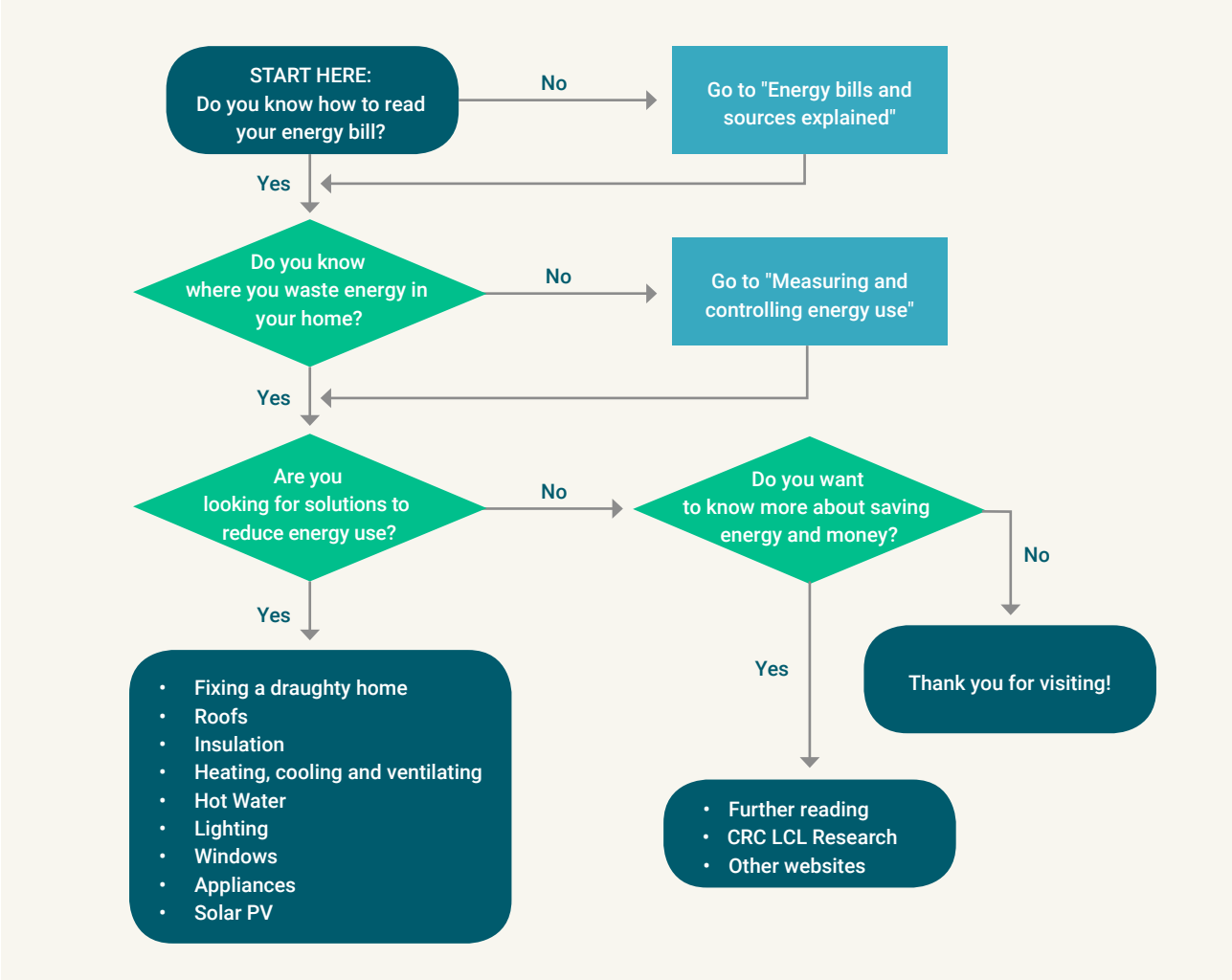
Congratulations on taking the first step towards curbing your household energy use. Before reading further, scan the flow chart below to determine what information is most relevant to you.

You may already know where in your home you want to save energy and can skip to that section. Each section features a table of suggested actions. Those listed on the left-hand side of the table are the simplest to implement while those on the right are more difficult. Don't be put off by the not-so-easy options; they may be the most beneficial.

Links and suggestions for further reading are also included. While much of the information in this guide is aimed at home owners, many of the tips also apply to renters. This information is tagged **If you are a renter:**

Finally, if you see words or terms you don't understand, check the Glossary on pages i and ii.

More information
For further advice on how to reduce household energy go to the Australian Government website: yourhome.gov.au

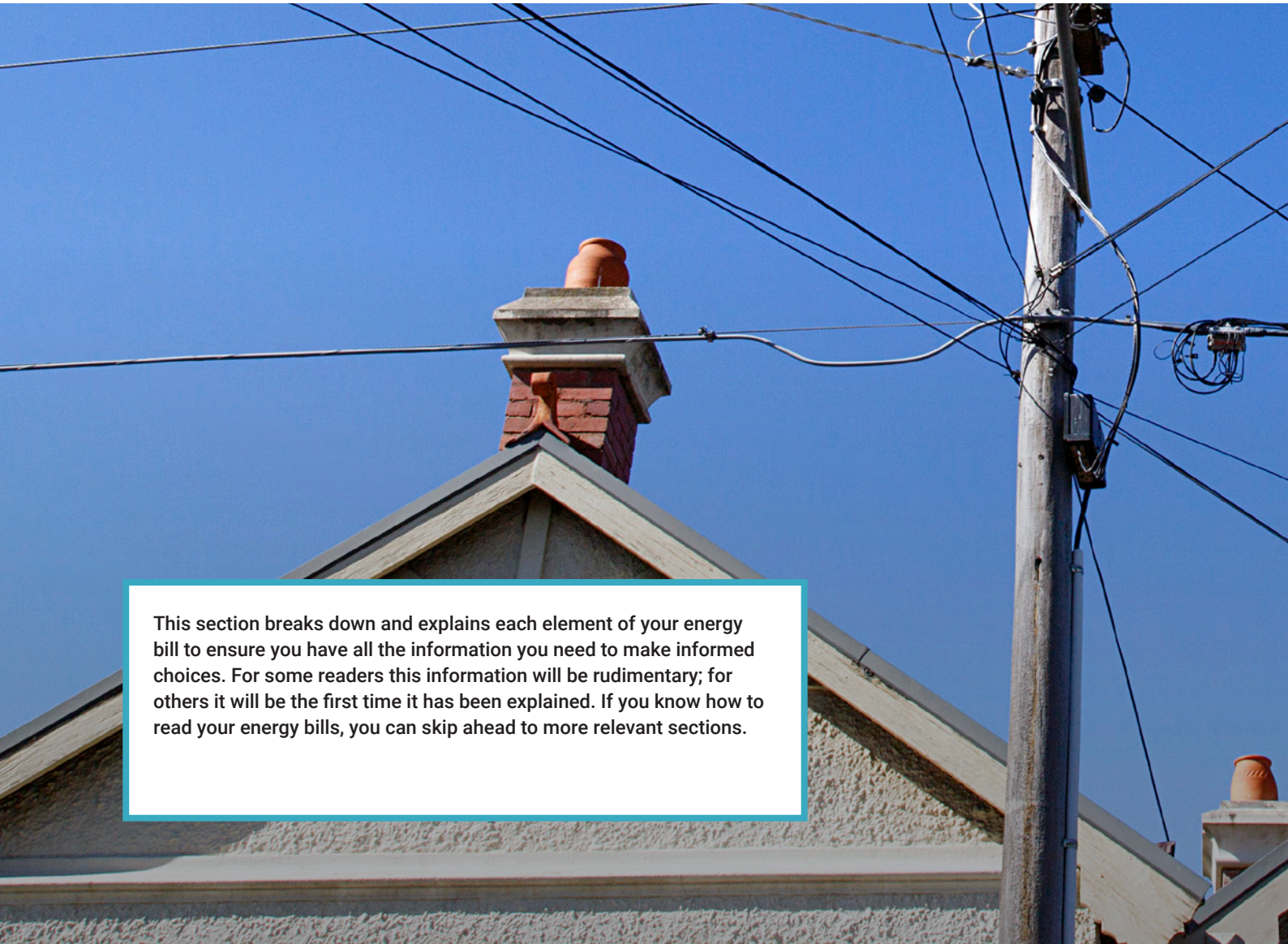


SECTION

01

Energy bills and sources explained

A typical energy bill contains a lot of information. Since many energy retailers offer their customers discounts for promptly paying bills via direct debit, it is understandable if consumers rarely check their bills for accuracy or register how much energy they are using.



This section breaks down and explains each element of your energy bill to ensure you have all the information you need to make informed choices. For some readers this information will be rudimentary; for others it will be the first time it has been explained. If you know how to read your energy bills, you can skip ahead to more relevant sections.

Reading your electricity bill

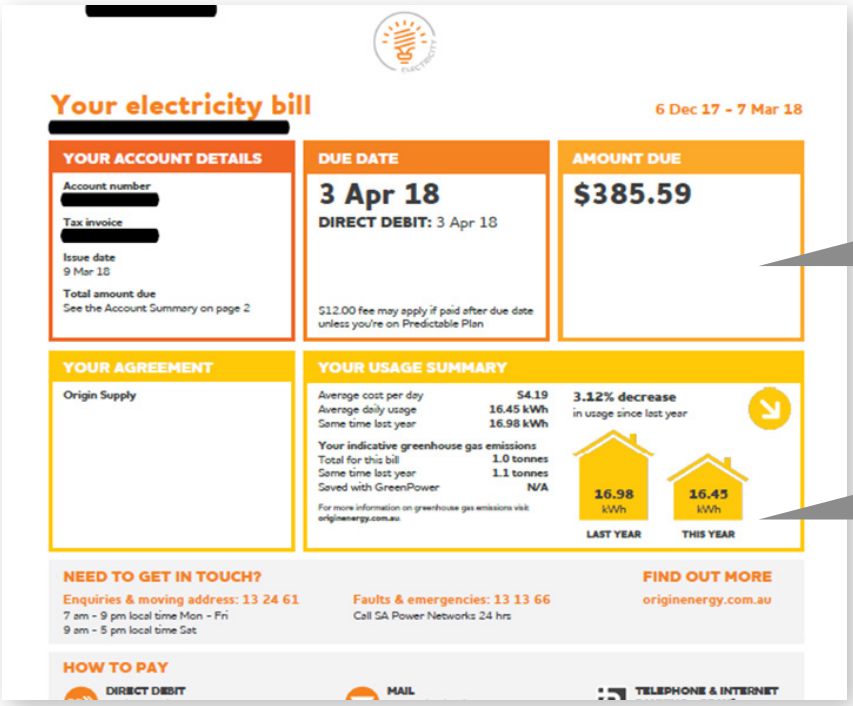
Below is an example of a typical electricity bill for a three-bedroom house in South Australia that is home to three adults. From the electricity supplier's point of view, the most important information—the amount you owe and the date it must be paid—is found at the top of the bill. However, for our purposes, what comes next is more illuminating.

In essence, an electricity bill comprises three main elements. These are used to calculate the amount you owe. The elements are:

- how much energy you used over the stated period (this is read from your home energy meter)
- the cost of that energy, plus any other fees
- what, if any, credits you are owed.

How much energy you used (i.e. imported from the grid) over the billing period will be registered near the top of the bill. There will be a summary of your total electricity usage, written in kilo-Watt hours (kWh) and an estimation of your average daily usage. Many electricity retailers will also indicate the greenhouse gas emissions this usage represents. Subsequent sections of the bill break this information down into even more detail.

To determine the cost of the energy used, the bill will state when your home meter was read and over what time period. If your home has a dual meter installed, there will be a breakdown of energy that was purchased on **peak rates** versus energy purchased on cheaper **off-peak** or **controlled-load** rates. Each will be listed under a different meter number. Not all homes have multiple meters, in which case there will be a single meter reading and all energy used will be charged at a single rate.

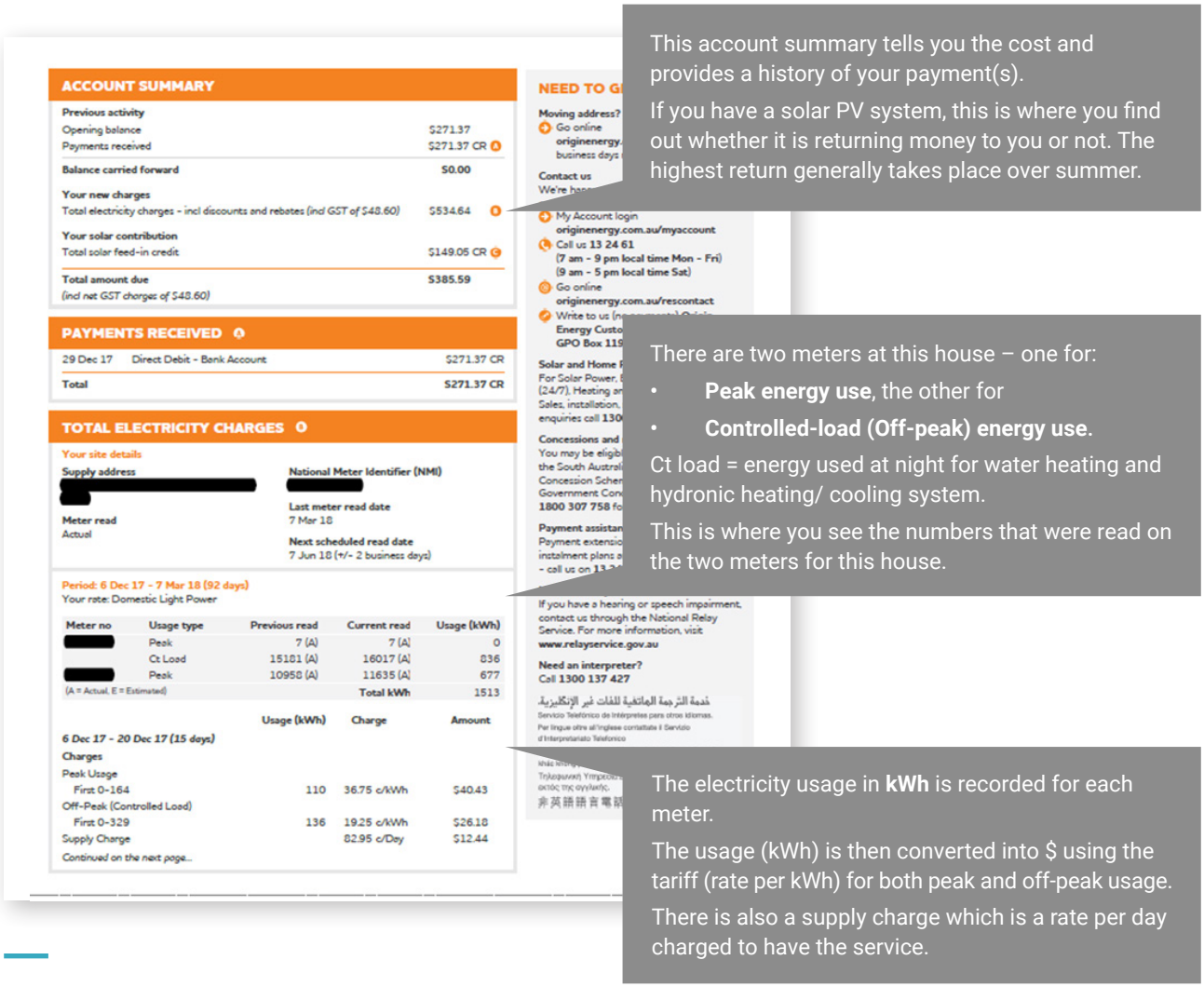


This is the overall bill cost, after the feed-in credit is applied.

Average daily usage in kWh (total before feed-in).

Comparison to previous year.

Page 1 of a typical electricity bill.
Source: CM Hamilton



Page 2 of the electricity bill. Source: CM Hamilton

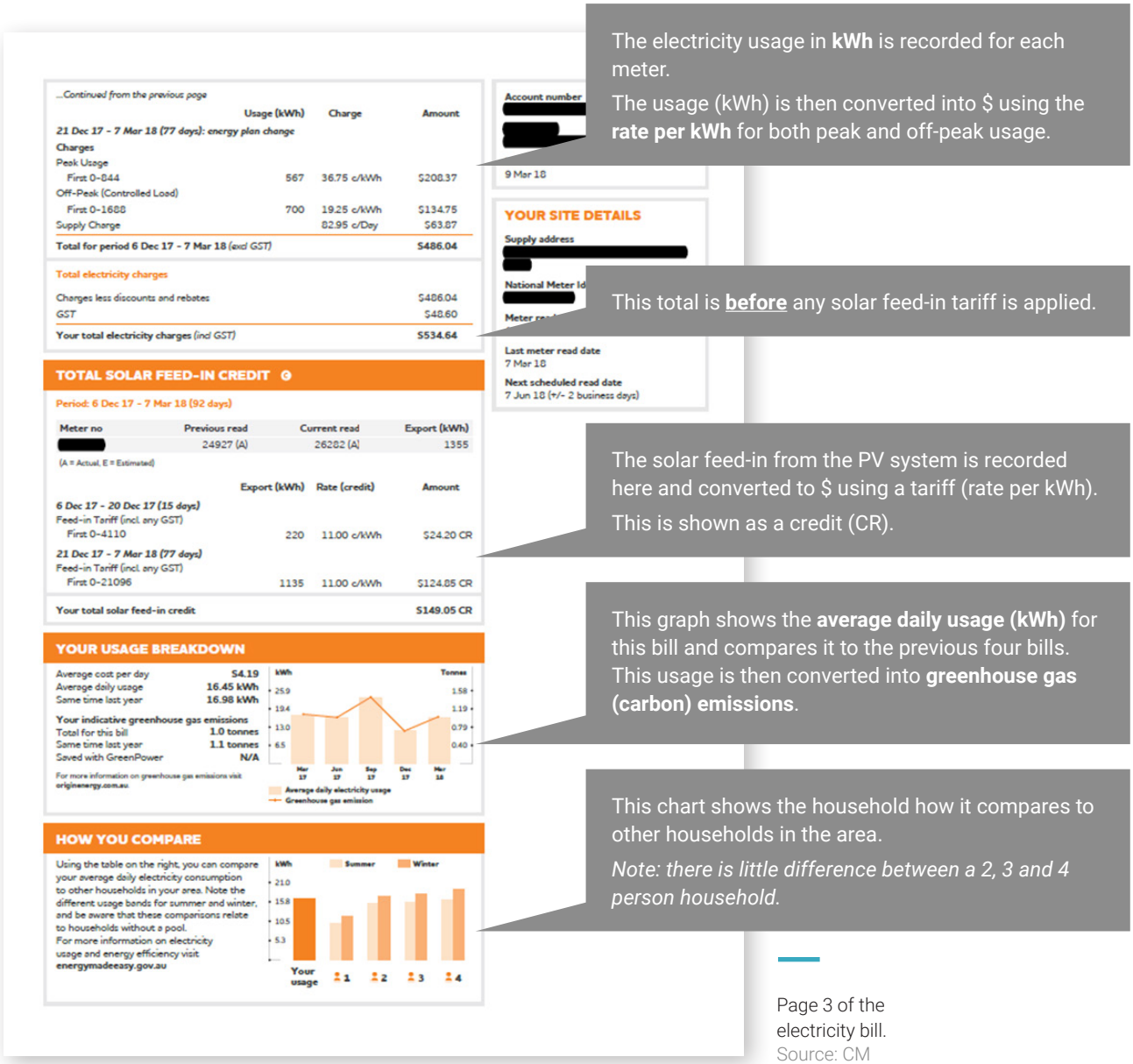
In our South Australian example, the home's hot water system and in-floor heating and cooling systems are operating on a controlled-load meter which is a **'time-of-use'** meter. Electricity was only provided through this meter during off-peak times when prices were cheaper. This off-peak tariff may be called different things in different states. Sometimes controlled-loads will be referred to as **dedicated circuits**.

The bill also shows a **daily supply charge**. This is a standard service fee (usually between 80 and 90 cents per day) that is calculated independent of your energy usage.

Often bills will also include credits or discounts owed to the user. If your home has a rooftop solar PV system, your bill will list how much money the system returned to you as a **solar feed-in credit**. This will happen only if your PV system generated more energy than your house used and that energy was exported to the grid. This energy will be converted to a dollar amount (which you agreed to in your contract) and will be subtracted from the amount you owe.

Many customers with rooftop solar PV mistakenly look to their electricity bill for information about the amount of energy their PV system generates. This is a common error. Your standard home electricity meter (and therefore your bill) will not show this amount.

To measure your solar energy generation and usage you will need to install a separate solar PV monitoring system. Examples are shown in Section 2.



Page 3 of the electricity bill. Source: CM Hamilton

Increasingly, retailers are offering customers information to help them compare their energy usage over time and against other households. Your bill may compare your current energy usage with the same period a year earlier, and with similar-sized households in the area. In our example, the household used 3% less energy compared to a year earlier, a usage that was typical of other nearby two- or three-person homes.

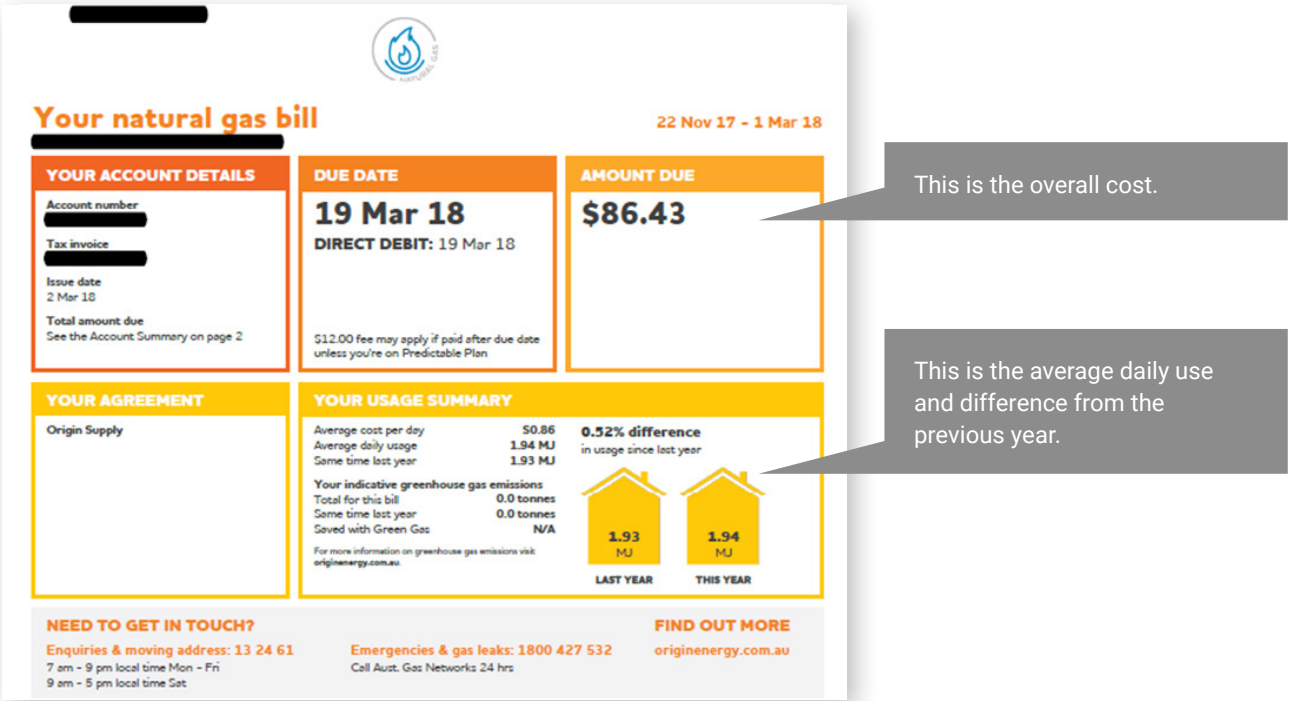
Reading your gas bill

Below is a gas bill from the same South Australian household. Gas bills are more straightforward than electricity bills because there is no need to account for variable peak and off-peak rates or solar PV system inputs. (The household in our example uses gas only for its cook-top in the kitchen).

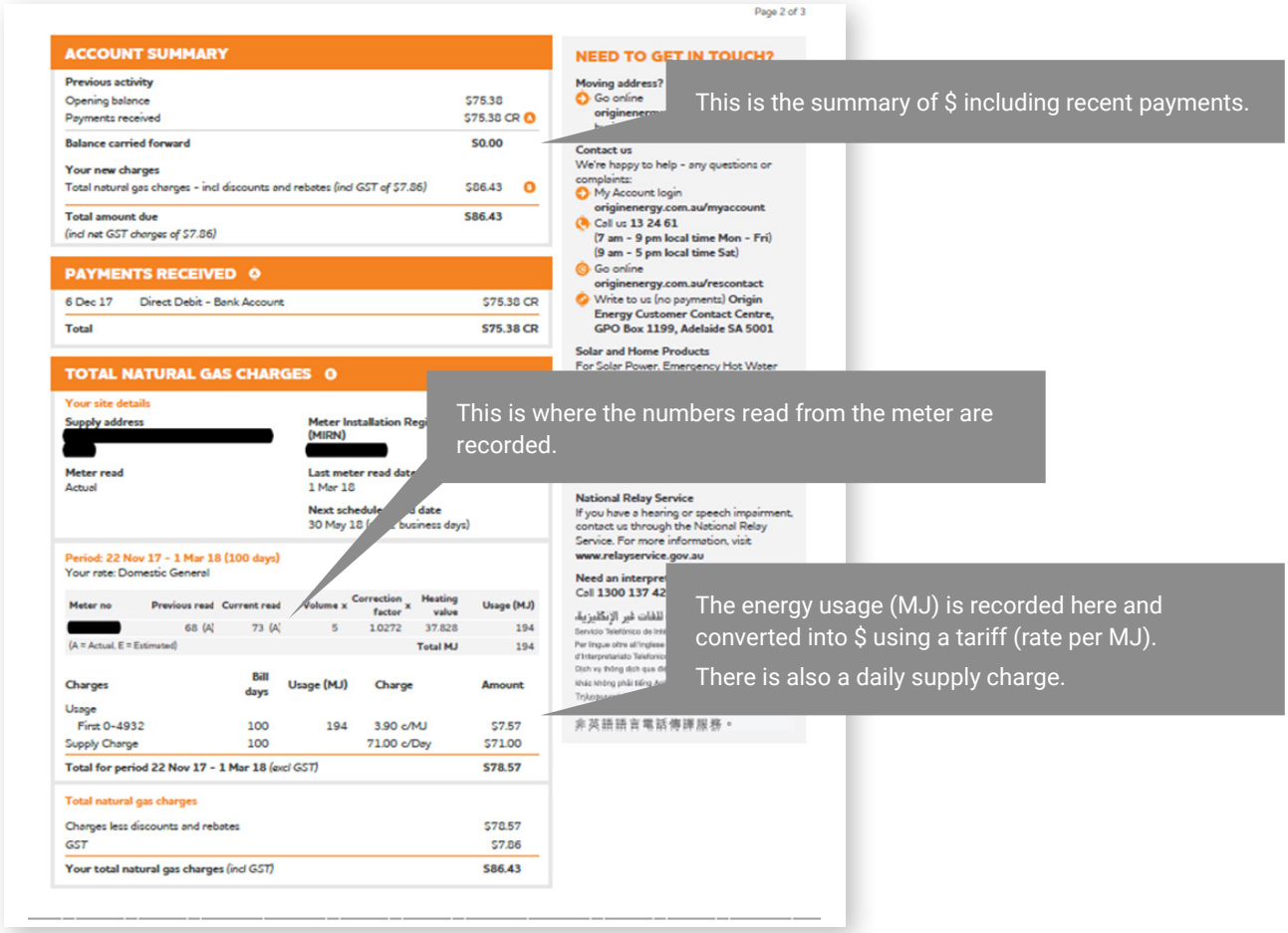
Gas usage is recorded in Mega Joules (MJ) which **is not the same** as kWh (i.e. how electricity usage is measured). This lack of equivalence makes it difficult to compare gas and electricity use. To make a comparison, kWh need to be converted to MJ or vice versa.

1kWh = 3.6MJ

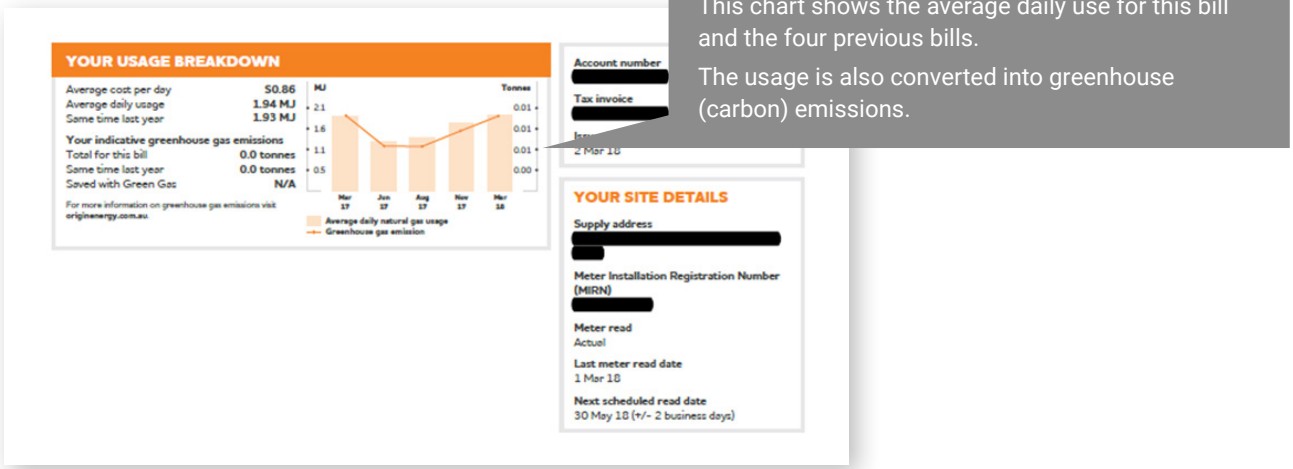
The bill will record your daily and total gas usage for the period. Note that while the household's gas usage is compared to the same period the previous year, there is no comparison with other households in the area.



Page 1 of a typical gas bill. Source: CM Hamilton



Page 2 of the gas bill.
Source: CM Hamilton



Page 3 of the gas bill.
Source: CM Hamilton

More information about your bill

The Australian Government website energymadeeasy.gov.au outlines what information retailers should provide on your electricity and gas bills. If you need more help to understand your energy bill contact your energy retailer or click on the relevant link below.

State/Territory	Website
Australian Capital Territory (ACT)	actsmart.act.gov.au
New South Wales (NSW)	environment.nsw.gov.au
Northern Territory (NT)	powerwater.com.au
Queensland (QLD)	qld.gov.au and for regional customers energymadeeasy.gov.au
South Australia (SA)	sa.gov.au
Tasmania (TAS)	auroraenergy.com.au and momentumenergy.com.au
Victoria (VIC)	sustainability.vic.gov.au
Western Australia (WA)	synergy.net.au

Bill concessions – are you eligible?

The Australian Government website yourenergysavings.gov.au can help you search for rebates and incentive programs. A summary of concessional rebates available in each state/territory is shown in the table below. If you are entitled to a concession, contact your retailer.

State/Territory	Concessional rebate information as at 31 July 2018
Australian Capital Territory (ACT)	actsmart.act.gov.au • Energy concession • Emergency relief voucher
New South Wales (NSW)	energy.nsw.gov.au • Low income household rebate • Life support rebate • Medical energy rebate • Family energy rebate • NSW gas rebate • Energy accounts payment assistance scheme
Northern Territory (NT)	powerwater.com.au • Pensioner and carer concessions
Queensland (QLD)	qld.gov.au and for regional customers energymadeeasy.gov.au • Energy rebate • Medical cooling and heating electricity concession scheme • Electricity life support • Home emergency assistance scheme
South Australia (SA)	sa.gov.au • Energy bill concession • Emergency financial assistance • Medical heating and cooling concession
Tasmania (TAS)	auroraenergy.com.au and momentumenergy.com.au • Annual electricity concession • Life support concession • Medical cooling concession
Victoria (VIC)	sustainability.vic.gov.au • Life support concession • Medical cooling concession • Service to property charge concession • Controlled load electricity concession • Annual electricity concession • Excess energy concession • Transfer fee waiver concession • Utility relief grant scheme (URGS) • Winter gas concession
Western Australia (WA)	erawa.com.au and synergy.net.au • Energy assistance payment • Hardship utilities grant scheme • Dependent child rebate • Account establishment fee rebate • Air conditioning rebate • Life support equipment electricity subsidy • Thermoregulatory dysfunction energy subsidy

The cost of energy

The average cost of powering a household has increased over time. While the cost of electricity and gas varies for each state and territory, and often between energy retailers, it is worthwhile adding up your weekly electricity and gas usage costs and comparing them to the average across Australia, shown in Figure 1.1.

Generally, households with more people use more electricity, resulting in larger bills – see Figure 1.2. However, the difference in cost is not directly related to the number of people in a household; a home with one occupant often uses *more energy per person* than multiple person homes. This is because:

- Energy is used for space heating and cooling, and quantities required do not change much if one person lives in a home or many.
- There is a daily energy supply charge which is standard for a home regardless of the number of occupants. For most metropolitan homes this is about 85c/day for electricity ($340/year), and 70c/day for gas ($280/year).

Choosing a retailer

Most states have multiple energy retailers who compete for customers. Consumers in locations connected to the National Electricity Market (NEM)—every state and territory except WA and NT—have the most choice. The factors to consider when selecting a retailer and contract include:

- the length of the contract, which may be up to two years
- any associated fees
- what discounts are included
- other deals or incentives.

Note: some offers will depend on where you live, and whether you have a smart meter or solar PV system installed.

The following Australian Government websites offer advice on how to select a retailer:

- energymadeeasy.gov.au
- energy.gov.au

Individual states and territories also offer information about choosing a retailer. See table on next page.

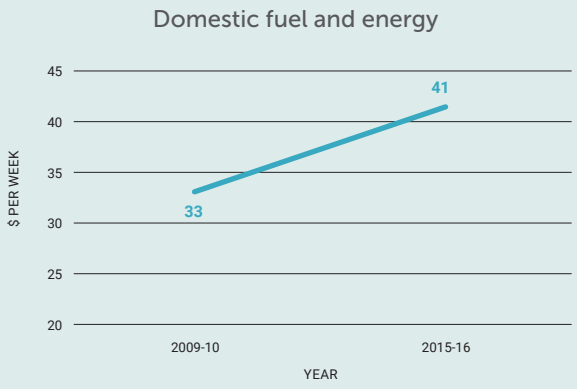


Figure 1.1 Average weekly cost per Australian household for domestic fuel and power.
Source: Adapted from ABS 2017

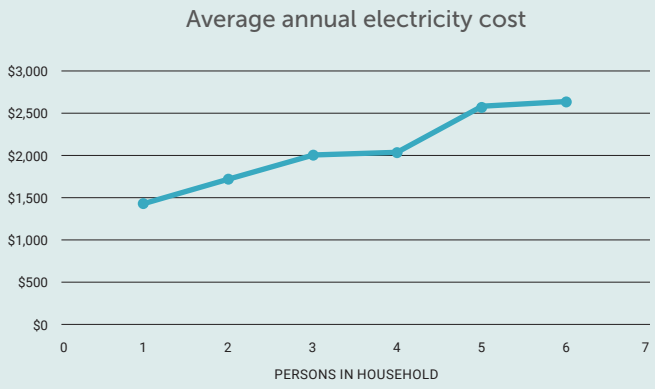


Figure 1.2 Average annual electricity cost per household size. Source: Adapted from Canstar Blue electricity customer satisfaction survey, January 2018

State/Territory	**Websites listing energy retailers** (as of 10 August 2018)
Australian Capital Territory (ACT)	actewagl.com.au
New South Wales (NSW)	energy.nsw.gov.au
Northern Territory (NT)	utilicom.nt.gov.au and powerwater.com.au
Queensland (QLD)	qld.gov.au/electricity and qld.gov.au/gas
South Australia (SA)	sa.gov.au
Tasmania (TAS)	tasnetworks.com.au
Victoria (VIC)	ewov.com.au
Western Australia (WA)	treasury.wa.gov.au and erawa.com.au

Can a landlord sell me energy?

Generally speaking, each household is responsible for purchasing its own energy through individual contracts with retailers. However, you may find you are buying energy from your building owner or landlord if you live in:

- some apartment complexes
- a retirement village
- a caravan park.

You should be aware of your rights regarding access to energy and whether you can choose your own retailer. For more information, see energymadeeasy.gov.au.

Renewable sources of energy

There are many ways to obtain energy from a renewable source. These include through green power plans offered by energy retailers, by acquiring rooftop solar PV and batteries or becoming part of a virtual power plant (VPP), or through installing a home energy management system that allows you to store and use renewable energy on-site rather than dispatch it to the grid.

Green power

Most energy retailers offer a 'green power' scheme which sources energy from wind farms, solar arrays or hydro-electric schemes. 'Green gas' products are also available where carbon emissions are offset by the retailer. You should be aware that green power products are often charged at higher rates and usually don't save you money. They do, however, reduce (or completely offset) the carbon emissions of your energy use. It pays to shop around and compare offers.

Rooftop solar PV

Most home owners have the option of installing a rooftop solar PV system to generate power locally. The number of solar PV systems installed on Australian roofs has grown rapidly in recent years; by mid-2018, one in five dwellings had a small-scale renewable energy system installed. (This includes solar PV, solar water heating and air sourced heat pump water heating systems). The average size of Australian domestic PV systems has also increased, from about 2kW in 2010 to about 6kW in 2018.[1]

If you are a renter:

Installing a solar PV system is generally not an option because you do not own the home. However, opportunities are available for renters to benefit from solar schemes.

- Landlord/tenant partnerships and interest-free loans allow renters to negotiate with landlords about solar PV – see energymatters.com.au
- Tenants can collectivise to purchase or lease solar panels and draw energy from within a centralised solar array, known as a solar garden. The Australian Renewable Energy Agency (ARENA) is providing $550k funding to explore five pilot locations in Blacktown, Shoalhaven and Byron Bay (NSW); Swan Hill (VIC); and Townsville (QLD) – see arena.gov.au
- Other options for renters are canvased in *Renew* magazine.

[1] See Peacock 2018 and http://pv-map.apvi.org.au/analyses.

If you decide to install rooftop solar PV, shop around and seek a reputable supplier. Online services can give you multiple quotes at no extra cost. Important things to consider include:

- Roof space—is there enough roof area on your home to accommodate solar panels?
- Which direction does the roof face? North and northwest are best.
- How much shade falls on the roof? Output is affected if the PV panels are shaded for long periods.
- Is the investment worth it? What is the pay-back period? PV panels generally have a guaranteed lifespan of 25 years, although the system inverter will need replacing sooner.

Batteries and virtual power plants

Adding **batteries** to a solar PV system creates a way to store surplus energy for later use. With their cost continuing to fall by 15% per year, batteries will be an essential component of most future renewable energy systems. They also play a major role in making current systems more affordable. By connecting to the grid, they allow energy to be drawn and stored during off-peak times, when wholesale prices are lower.

For more information on the pros and cons of batteries, see the Guide to Residential Buildings – Retrofit or solarquotes.com.au.

A virtual power plant (VPP) is the name for a system that combines battery storage with multiple sources of energy such as wind and solar. In a suburban setting, this is generally neighbourhoods that have banded together to generate energy from multiple solar PV systems and store it in batteries. Surplus energy is centrally controlled to meet the demands of individual members and the grid. State governments are joining with utilities to explore VPPs in their jurisdictions and some are offering generous rebates or subsidies for installation of home battery systems that are VPP ready. If you are approached to participate in a VPP scheme, do some homework and ask questions about the costs and benefits, including how long it will take to pay back the investment in the batteries and the PV system. You should also know if your home has a single or three-phase connection to the grid. If you have a three-phase grid connection, your battery system should be capable of off-setting grid electricity consumption on all three phases.

Home energy management system

A home energy management system (HEMS) makes decisions about when excess energy generated through your solar PV system is stored in a battery, used on site, or exported to the grid. The decisions are based on the price of the storage, the feed-in tariff, and the cost of electricity being drawn from the grid. Some HEMS devices use excess solar PV energy to heat water stored in water heaters. These devices measure the solar output and the home's power demand to decide the best and most cost-efficient time to heat water.

Actions to better understand your energy sources and bills

Simple actions	→		Harder/more costly actions
Set aside time to examine your energy bills. Do you understand what all the information means?	Consult online information including Government websites that explain energy bills, contracts and how to choose a retailer.	Phone your energy retailer and ask them to explain their billing.	Engage an energy consultant to develop an individualised energy plan.
Make time to canvass all available energy options including renewable energy sources, VPPs, HEMS and green power.			

Can I go off-grid?

Very few people would choose to completely disconnect from the electricity grid unless they have an alternative source of energy that is very reliable, such as a stand-alone conventional or renewable energy system. Some people believe that having a solar PV system and a battery allows them to disconnect, but there are important points to consider before taking this step:

- Disconnecting requires a much larger solar PV and battery system than most people anticipate.
- The cost of such a system is generally upwards of $50,000[2].
- Once disconnected, there is no way of profiting from your PV system by selling excess electricity generation back to the grid.

Disconnecting from gas mains is more straightforward and with rising gas prices more people are contemplating consolidating their energy sources (i.e. going completely electric) or generating their own energy on-site. The best time to consider reducing gas usage is when you need to replace cooking or heating appliances.

[2] See Ren et al. 2017

SECTION

02

Measuring and controlling energy use

Once you understand how your energy is sourced, and how much it costs, the next step is to reduce the amount of energy you use. This requires a broad understanding of how your household operates.

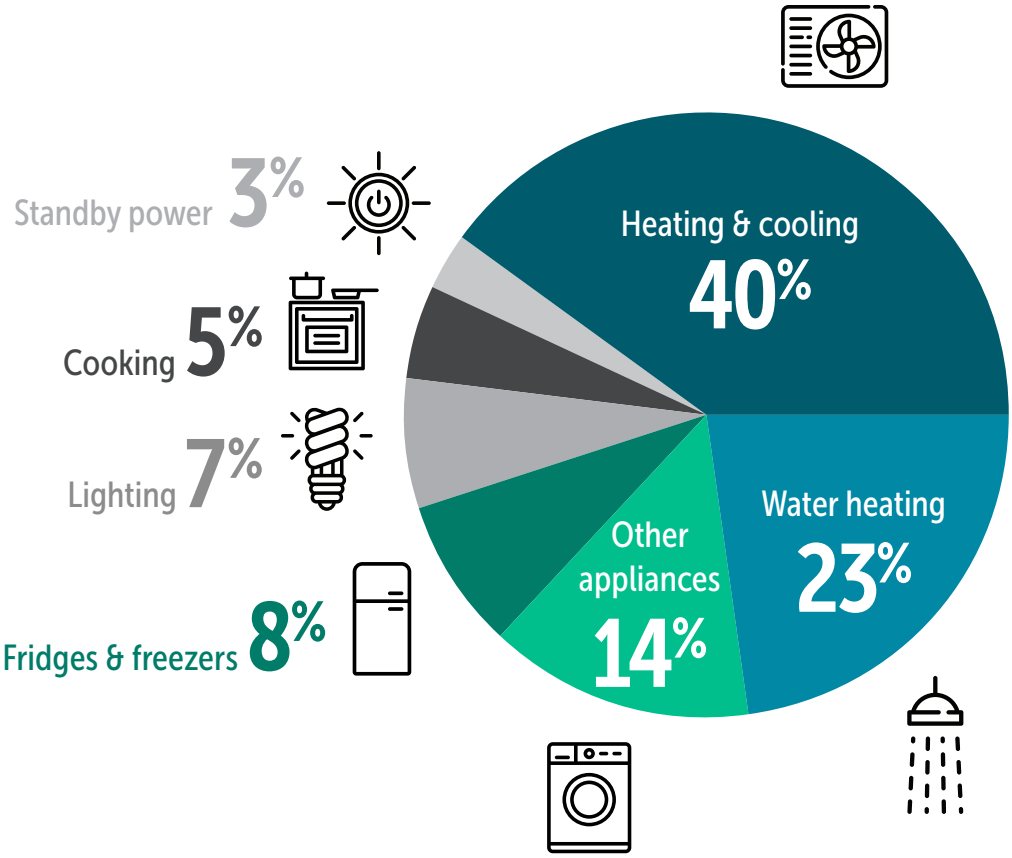


Figure 2.1
The energy use of a typical Australian household.
Source: SA Government 2017

Each household should take the time to understand its own patterns of energy usage and not assume it conforms to the average. Remember, **it is not buildings that use energy, but the people inside them**.

Heating and cooling systems along with water heating account for almost two-thirds of energy used in a typical Australian home. Determining the energy usage of other individual appliances is more problematic. Your electricity or gas bill will only reveal this information if, for example, you have just one gas appliance (i.e. a gas cooktop), or you have a single appliance such as under-floor heating on a controlled tariff electricity meter.

Reading your energy meter

Understanding the information on your home's energy meter will provide a good overview of how much energy is being used and when. Most retailers provide a guide to reading meters and this may be different in each state. See the table below.

When to read your meter

Meters should be read regularly, for example at the beginning of each month, to understand how much energy is being used in the home and when energy use fluctuates. Holidays away from home are the ideal time to check how much energy your home uses just to maintain minimum operations. By reading your meter

State/Territory	Websites offering information about reading a meter
Australian Capital Territory (ACT)	actewagl.com.au
New South Wales (NSW)	energysaver.nsw.gov.au and electricityandgas.com.au
Northern Territory (NT)	powerwater.com.au
Queensland (QLD)	ewoq.com.au
South Australia (SA)	sa.gov.au
Tasmania (TAS)	tasnetworks.com.au
Victoria (VIC)	ewov.com.au
Western Australia (WA)	erawa.com.au

(as of 10 August 2018)

when you leave for your holiday and again on your return you will discover:

- Your home's basic demand for energy before adding your normal daily usage.
- Normal daily energy and power demands.
- How much energy your house sitters used while you were away!

Energy and power usage of appliances

It is important to distinguish between energy and power. **Energy** is the total amount used over a specified time and is measured by kilo-Watt hours (kWh). **Power** is the rate of energy use per unit time and is measured by watt (W) or kilo-Watt (kW). For example, using a 2kW electric kettle for 15 minutes (one quarter of an hour), results in energy use of 0.5kWh.

The best way to determine the power usage of individual appliances is through a **home energy audit kit** or home energy action kit that can be borrowed from most local government libraries. The kit assists you to develop a plan to make improvements to save energy, water and, ultimately, money.

A typical audit kit includes:

- **Power meter** – to measure the rate of energy consumption and running costs of appliances. The meter can be plugged into a standard 10A power point/outlet socket.
- **Liquid-in-glass thermometer** – to measure fridge, freezer and hot water temperatures.
- **Infrared thermometer** – to measure temperatures of walls and ceilings.
- **Compass** – to identify the orientation of the home and passive solar heating and shading opportunities.
- **Stopwatch** – to measure shower and tap flow rates.
- **Instructions** – on using the equipment and worksheets to calculate your home energy efficiency.

When using an audit kit, test the power draw of each appliance in various operating modes, including standby. Once the power use of an appliance is known, you can estimate how much it costs to run. You can also use the kits in department stores to compare new appliances such as refrigerators.

Figure 2.2 A power meter measuring the standby power drawn by a smart power board (0.8W) and a smart kettle (2.39kW). Source: DM Whaley

Smart home technology

A **smart meter** (also known as an advanced meter or 'Type 4' meter) digitally tallies the energy used by your home and sends this information to the retailer. An example of a smart meter is shown in Figure 2.4. By using a feedback display or a notification from the retailer, smart meters allow households to manage their use of energy to coincide with local generation from their PV system. With rooftop solar PV becoming more popular, owners are installing smart meters and retailers are offering more time-of-use tariffs. In some locations, such as Victoria, smart meters have become mandatory, while in others they are being routinely installed in new premises and as replacement meters. Other smart home technologies include:

- smart systems for air conditioners, lights and light switches that can be controlled with smartphones or voice-activation.
- smart plugs that allow individual appliances to be controlled via a smartphone.
- thermostats that adjust temperature dynamically.

Seek advice from your energy retailer or supplier of smart technology about the suitability of your current system and what can be installed on your network.

Visual in-home displays

Another benefit of a smart meter is that it allows consumers to track their home's grid energy use and solar PV generation, and displays the information on a smartphone app. These types of systems can give you real-time information about the price impact of using particular appliances at certain times.

Time-of-use tariffs

Off-peak meters have been used for many years to manage the demand on the grid of electric hot water systems and some heating and cooling systems. However, with the installation of smart meters, households can also:

- Reduce energy costs by adopting a time-of-use tariff that encourages energy use during cheaper low-demand times including shoulder periods (7am to 2pm/8pm to 10pm); off-peak periods (10pm to 7am); and high PV generation or low wholesale generation periods.
- Receive reductions in cost of energy for off-peak water heating, which is managed through a **controlled-load (Ct)** meter.

Actions to better understand your energy use

Simple actions	→		Harder/more costly actions
Review energy bills for differences over time.	Read meters before and after time spent away from home.	If you have a smart meter, install and use a smartphone app that monitors your energy use and solar PV generation.	Install a home monitoring system that measures multiple appliances and indoor and outdoor temperatures.
Read meters regularly, e.g. first day of the month.	Measure energy use of appliances using a home energy audit kit.		

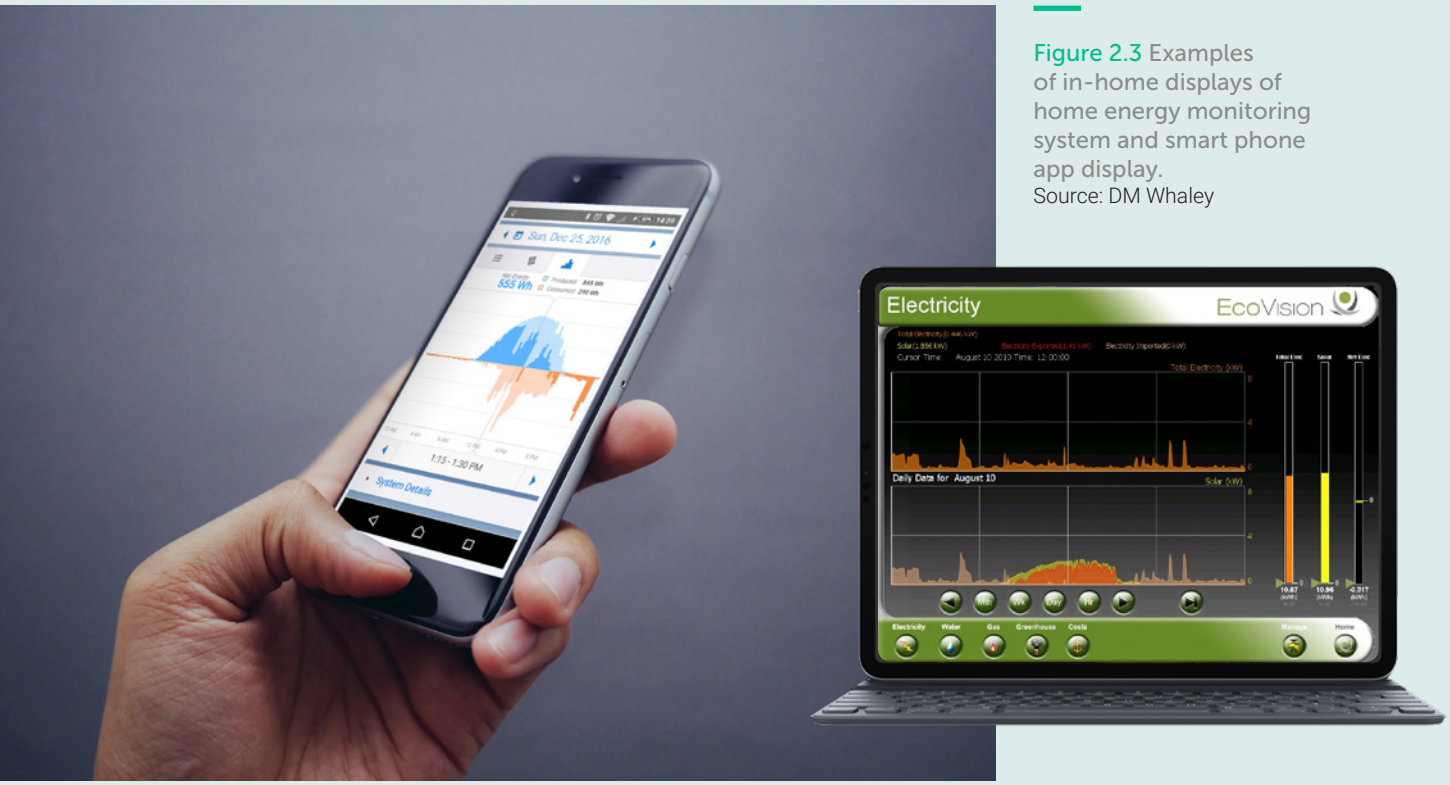


Figure 2.3 Examples of in-home displays of home energy monitoring system and smart phone app display.
Source: DM Whaley

Figure 2.4 An old meter (left) and a new, smart meter (right).
Source: energymatters.com.au

SECTION

03

Managing the home to reduce energy use

Understanding how your home functions—and introducing a few simple changes—can achieve dramatic results without the need for major investments.

Think of your house as a box, where the inside—the part where you live and sleep—is kept comfortable regardless of the outdoor climate. Heating and cooling are needed in most homes, but the extent varies depending on where you live. For example, homes in north Queensland may require only cooling and no heating, while in Tasmania the reverse is true.

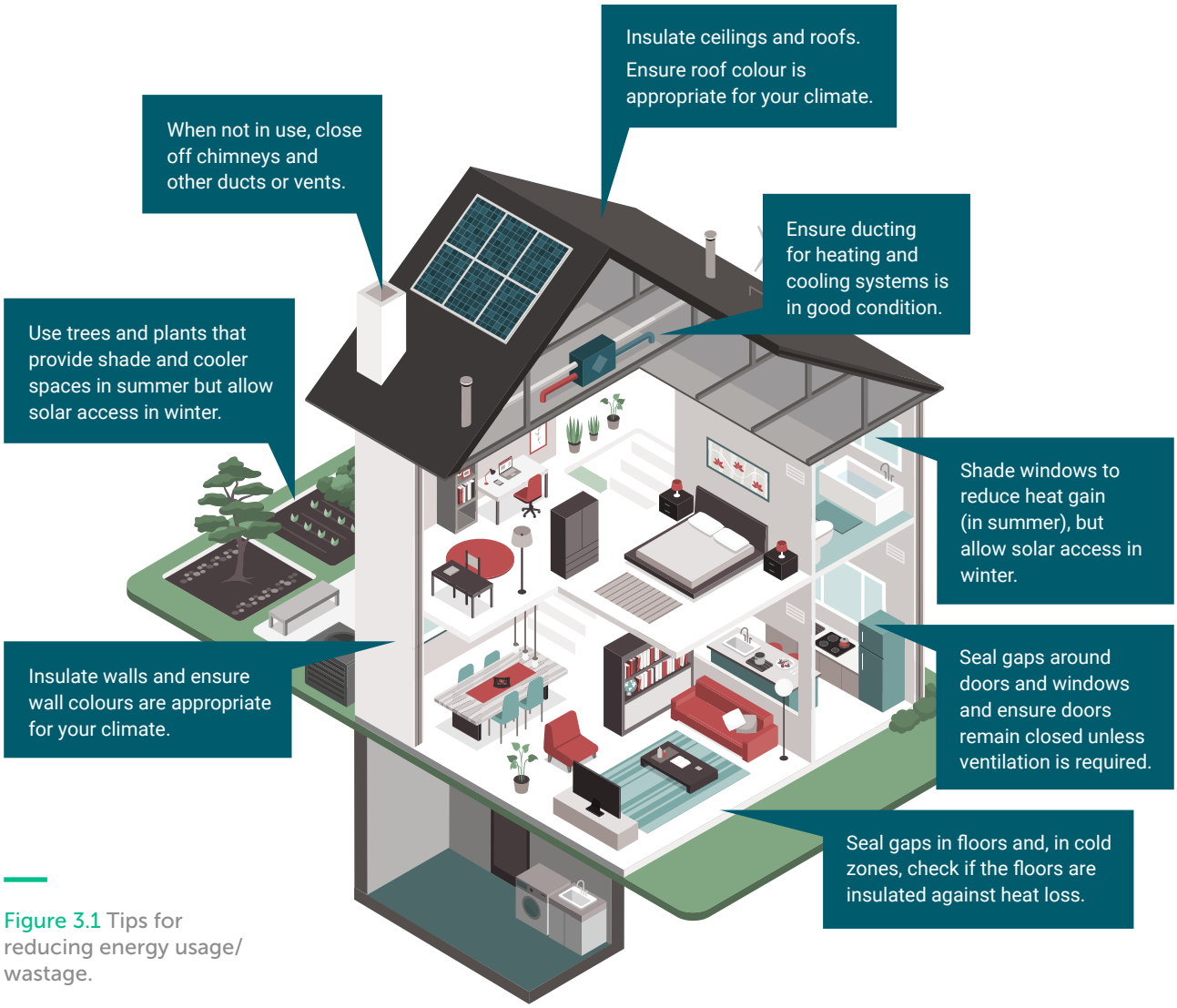


Figure 3.1 Tips for reducing energy usage/ wastage.

Detached or semi-detached houses

Many relatively small changes and upgrades can impact on a freestanding or semi-detached home's energy requirements. The most beneficial include:

- ceiling, roof and wall insulation
- improved airtightness
- upgraded window fittings and coverings
- upgraded lighting
- appropriate seasonal shading for external walls and windows.

Apartments

Apartments come in all shapes and sizes and build qualities. Their shared internal walls, floors and ceilings limit their exposure to the external environment and help maintain a more stable internal temperature compared to detached houses. Common areas such as lifts and stairwells, halls and paths also have an impact on energy usage. Options to reduce energy use in apartments are similar to those for detached houses:

- ensure windows, doors and other vents are airtight
- use appropriate curtains and blinds
- upgrade heating and cooling systems
- upgrade appliances
- upgrade lighting
- manage use of hot water.

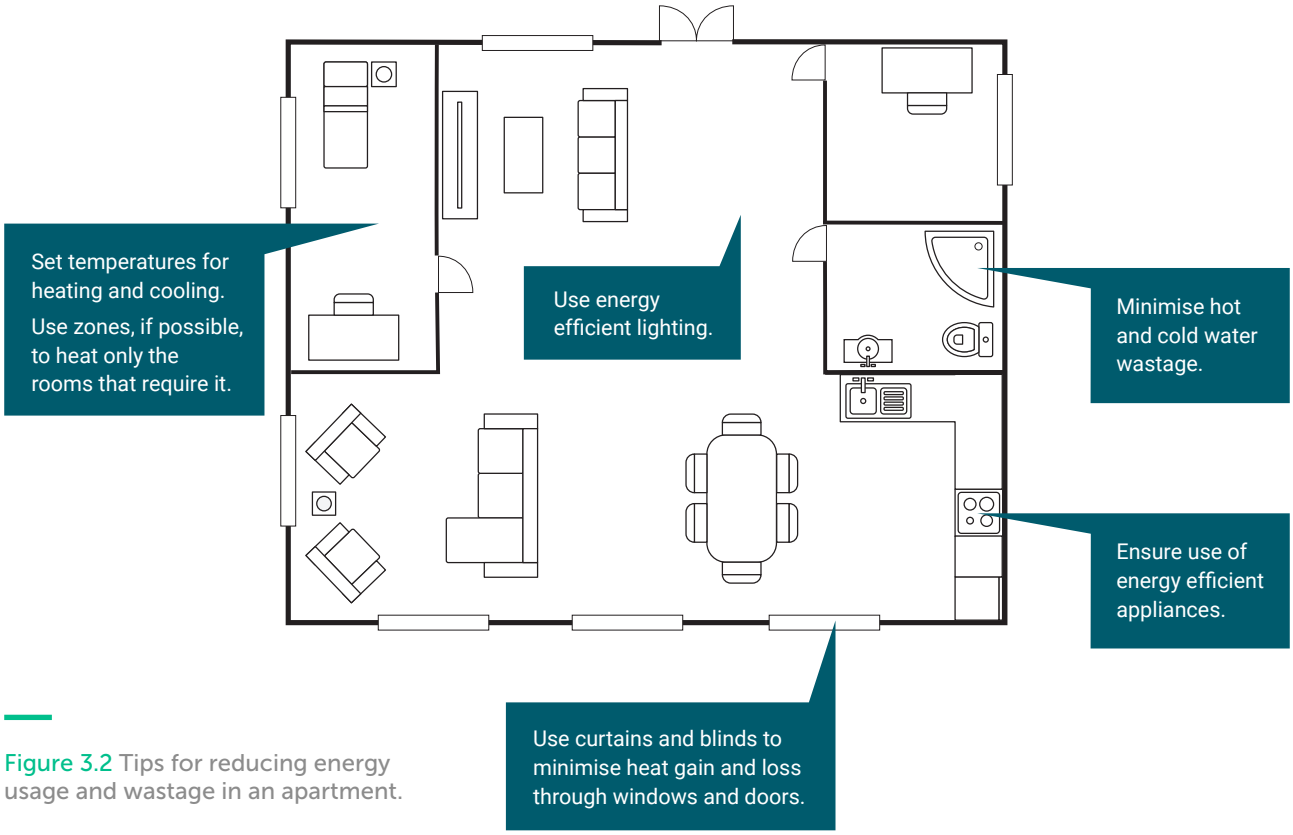


Figure 3.2 Tips for reducing energy usage and wastage in an apartment.

Windows

Windows are a major cause of heat gain and loss. Up to 40% of a home's heating energy in winter can leak out through windows or skylights. In many houses and apartments, window glass is thin and single-glazed and most window frames are aluminium or wooden and have gaps that facilitate air leakage. Tips for improving the energy efficiency of windows include:

- Allow sunshine through north-facing windows in winter. This can reduce heating requirements.
- Protect windows from direct sun in summer, reducing the need for air conditioning.
- Install roller blinds and heavy curtains, which provide more efficient insulation than vertical or venetian blinds.
- Seal windows with weather seals and gap fillers available from most hardware stores.

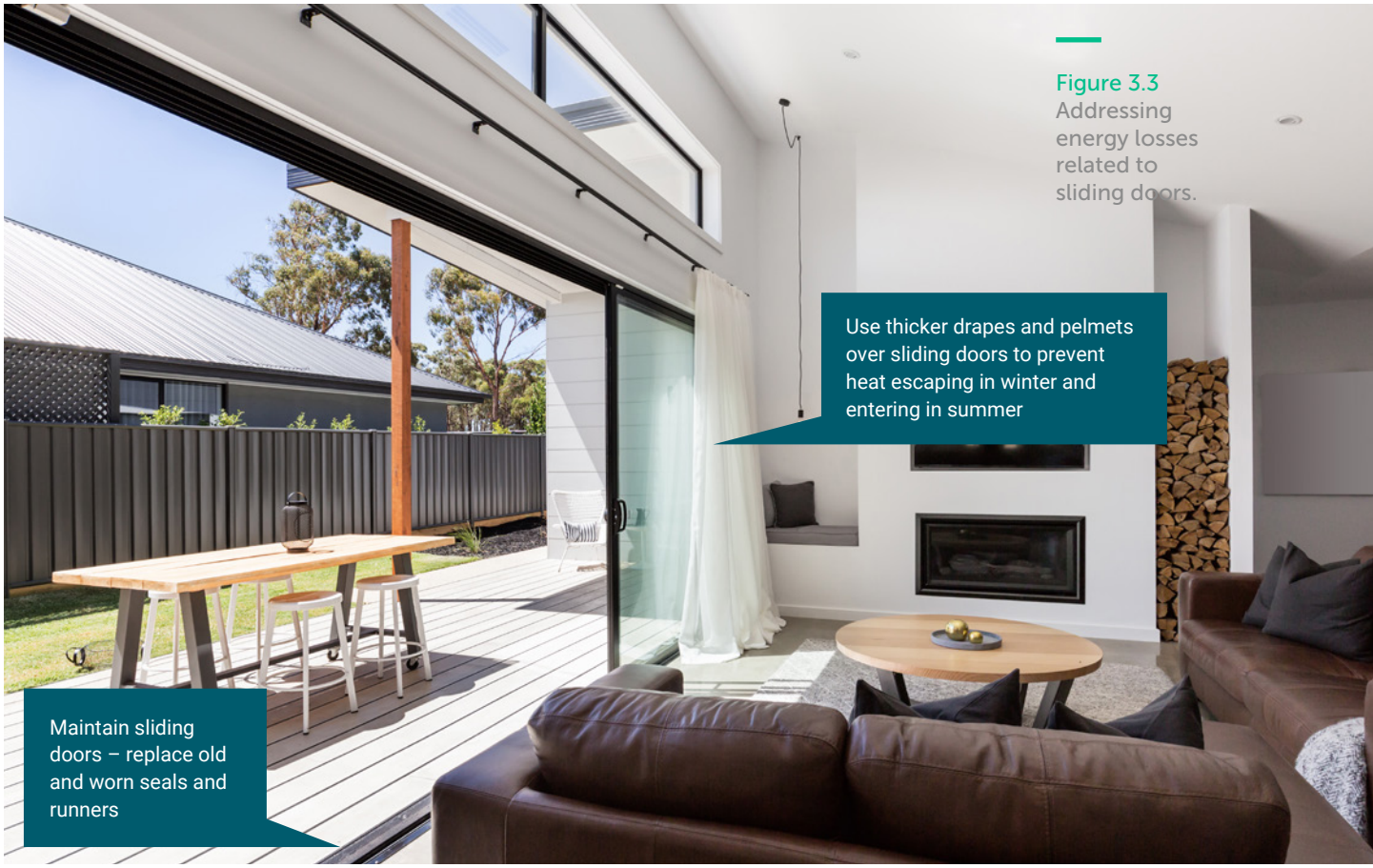


Figure 3.3
Addressing energy losses related to sliding doors.

External and sliding doors

Poorly fitted external doors can add up to 25% to heating and cooling bills[3]. To determine if this could be an issue in your home:

- Spend time adjacent to closed doors to feel for draughts.
- Listen for rattling doors when windy.
- Look for light around door frames; if there's light there's air leakage.
- Use the smoke from joss sticks or a candle to observe draughts.
- Ask your local council for assistance.

If you are a renter:

- Ask your landlord about providing or fitting weather seals on external doors and windows.
- Request appropriate window curtains and blinds, and/or magnetised glazing to reduce heat gain and loss.
- Use a door-snake or even rolled-up towels to plug gaps under doors. These are also useful for internal doors to block draughts between rooms.

Once you know where the draught-causing gaps are, seal them using self-adhesive foam strips on the inside of the door frame and weather strips attached at the base of the door. Both products are available at most hardware stores and can be installed by anyone with basic DIY skills.

Other air leakage

Gaps in other areas of your home also allow air to enter or escape. This is known as **air leakage**. In some extreme cases, air leakage can make it nearly impossible to successfully heat a home[4]. Common sources of air leakage include:

- downlights
- ceiling fan penetrations
- exhaust fans
- ducted air conditioners
- open wall vents
- gaps under skirting boards/above cornices
- chimneys.

[3] See http://yourenergysavings.gov.au/energy/heating-cooling/windows-doors-skylights
[4] See Marsh 2011.

Sealing gaps will greatly reduce heating and cooling costs. Other benefits include[5]:

- a reduction in the longer-term relative risk of mortality and sickness.
- an increase in amenity from less external noise.
- enhanced protection from damage caused by humidity entering the home.
- more effective mechanical ventilation strategies to reduce accumulation of internal moisture.
- less penetration of water in walls.
- avoiding the spread of fire.

Note: if you have an open wood fire or a gas space heater some ventilation is required to effectively remove smoke and to exhaust dangerous carbon monoxide. If you seal all the gaps around windows and doors you may need to open a door or window slightly for safe ventilation[6].

More information
For DIY videos that include how to seal air leakages, go to actsmart.act.gov.au

Improve airtightness to reduce heating and cooling loads

Airtightness is assessed by measuring air changes per hour in a room or building at a pressure difference of 50 Pascals (ACH@50Pa). In Australia, very airtight buildings have an ACH50 of under 7 and very leaky buildings an ACH50 of 15 or more. The goal for most buildings is between 1.5 and 7 ACH50.

Even when a very leaky home (35) is sealed only to a 'fair' level (10):

- **Peak heating load** is reduced by 21–32% in capital cities
- **Peak sensible cooling load** is reduced by 7–22%
- **Peak latent cooling load** is reduced by 1–43%.

Peak latent cooling load reduction (due to air sealing) is largely due to the prevention of infiltration of humid air and has the largest effect in warmer tropical climates.

Source: AIRAH 2016

[5] See AIRAH 2016.
[6] sa.gov.au

Figure 3.4 To reduce air leakage, fit external doors and windows with weather strips (left) and self-adhesive foam (right).

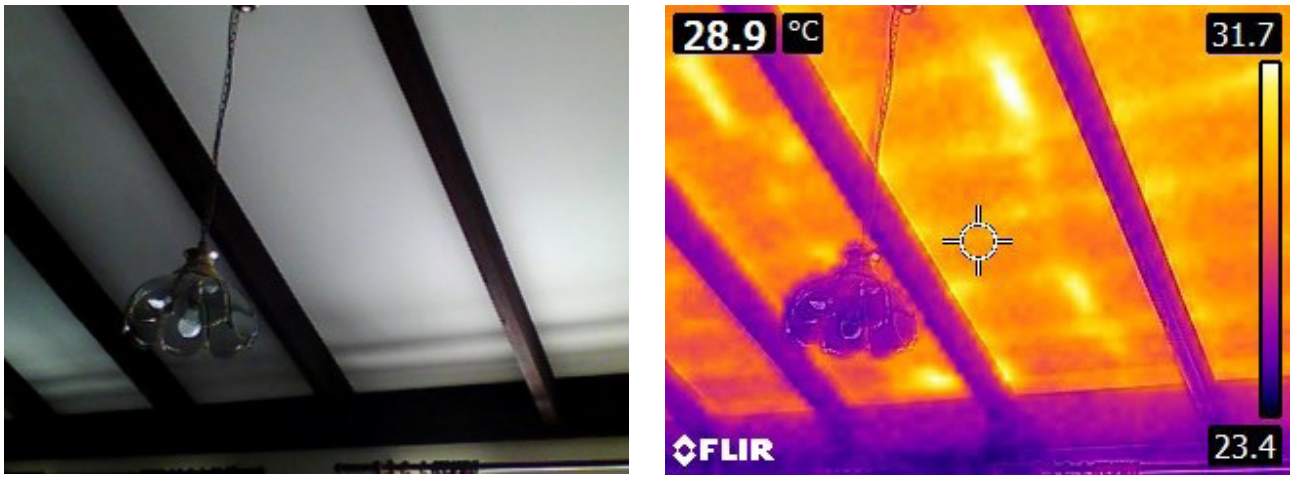


Figure 3.5 How a thermal camera captures lack of insulation and heat gain in a roof line.
Source: DM Whaley

Blower door testing

A home's airtightness can be determined through a **blower door test** organised by a contractor who will temporarily pressurise the house by fitting a fan to an external door. The contractor observes air pressure at different fan speeds and records an airtightness rating. The higher the number, the leakier the home. A mist generator shows air movement to pinpoint the exact source of any leaks.

Orientation

The orientation of your dwelling (whether it faces north, south, east or west) affects a range of variables that influence how easy it is to cool and heat your home. These variables include:

- sunshine available for passive heating
- natural lighting
- energy that can be generated by rooftop solar (PV) panels
- the ability to cross ventilate a dwelling to reduce heat build-up.

If you need to cool your house after a hot day, cooler air can be encouraged to move through rooms from external windows and doors. Ideally, air should enter from south-facing openings and exit through northerly openings. If you have an upstairs level, remember that heat naturally rises so open an upstairs window to allow hot air to escape.

Home energy health check

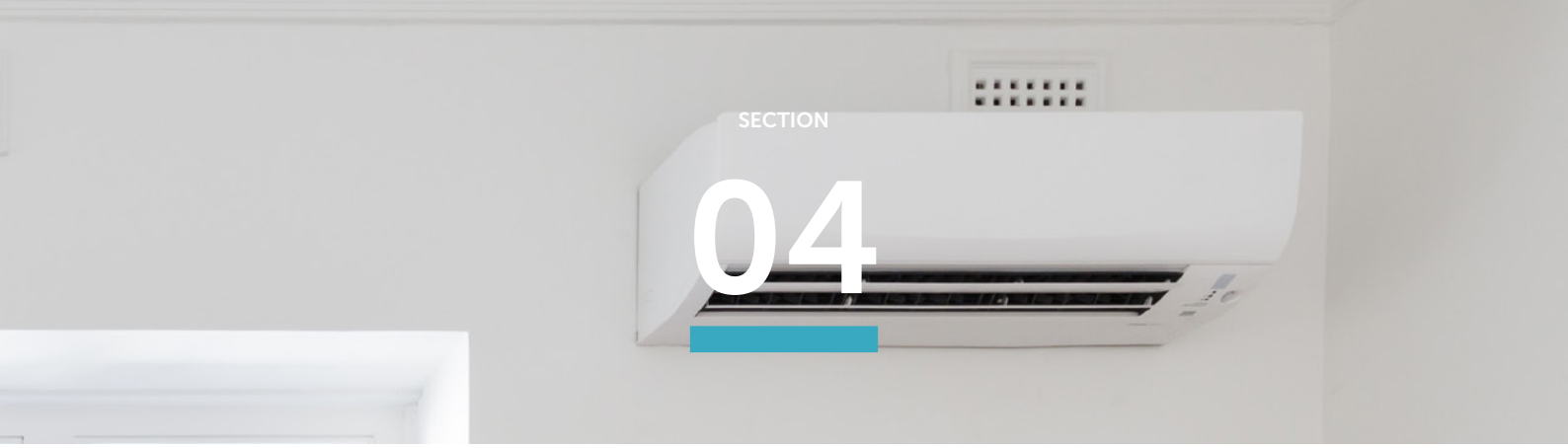
Engaging a sustainability expert to undertake an energy assessment on your home is a wise step if you can't do the inspections yourself. Some state government agencies or energy retailers provide free energy assessments. The assessment will involve an inspection of **water efficiency**, and **energy use**, including, heating and cooling, lighting, refrigeration, cooking, and entertainment systems. The assessor may look at your previous energy bills. Information is entered into an assessment tool to give you a tailored report for your home.

A thermal imaging assessment of your home can also identify areas where gaps such as inadequate insulation are contributing to heat loss or heat gain. Thermal imaging is also sometimes used during blower door tests to pinpoint leakages and therefore heat gains and losses.

More information about home assessments is available at yourenergysavings.gov.au

Actions to improve airtightness

Simple actions		→	Harder/more costly actions
Identify draught-causing gaps using a wet finger, smoke from candles or incense.	Seal gaps around doors by applying weather stripping.	Seal gaps around windows, vents and architraves, using flexible silicone and caulking gun.	Conduct blower door test. If results are greater than 10 air changes at ACH@50Pa then identify areas requiring air sealing.
Close chimney flaps.	If your chimney has no flaps, block with expandable material such as cushion or batt insulation.		



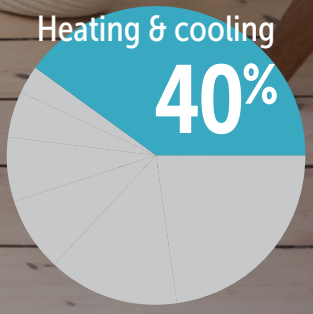
SECTION

04

Heating, cooling and ventilation

In most parts of Australia, some form of heating or cooling is essential to ensure comfortable indoor living conditions. With more homes featuring large floor areas and open plan living, air conditioning is becoming increasingly common.

Heating and cooling accounts for around 40% of a typical household's total energy consumption. Understanding how your heating and cooling system is performing is an important first step in determining what you can do to reduce energy use.



Climate zones

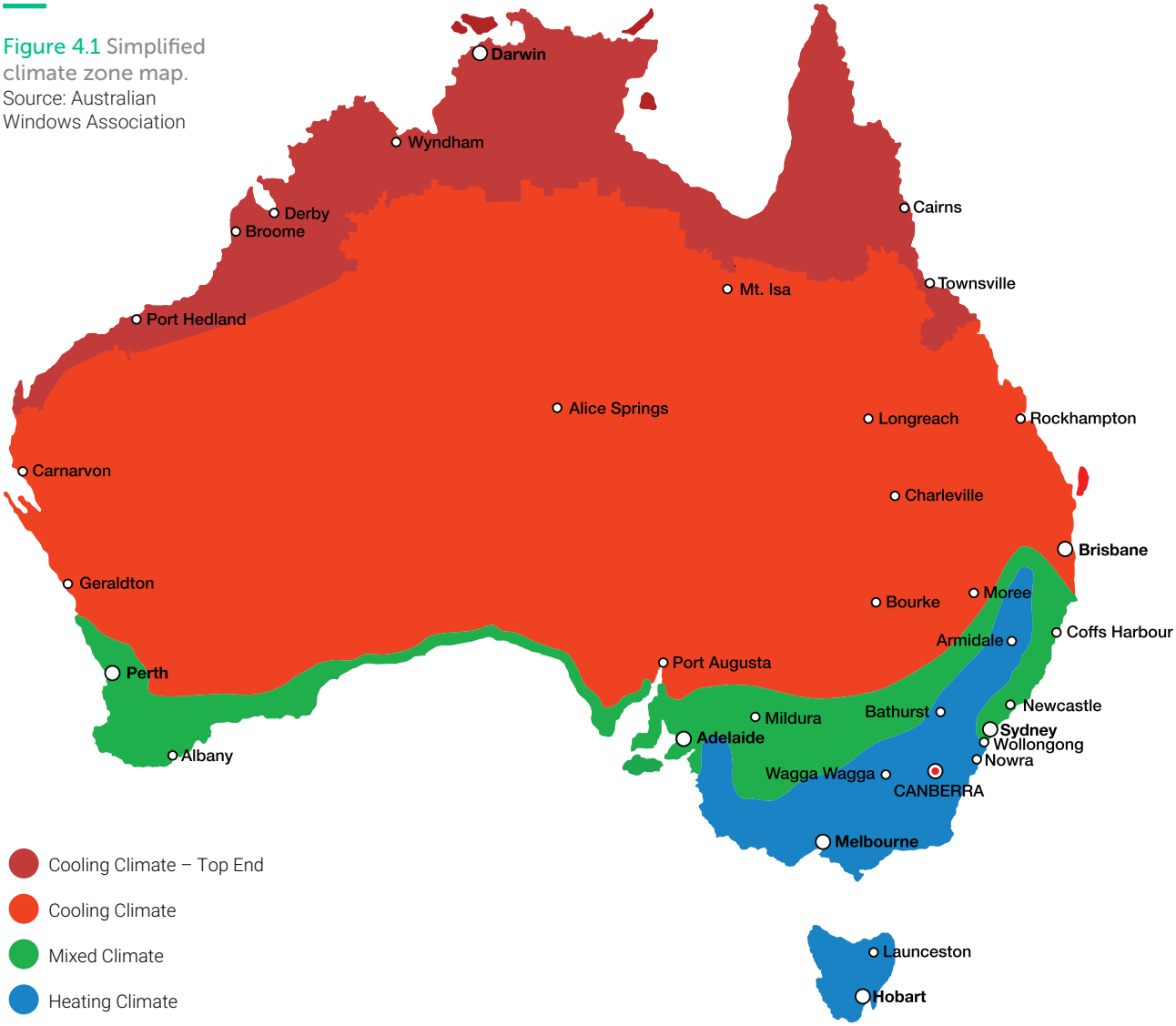


Figure 4.1 Simplified climate zone map. Source: Australian Windows Association

Heating

In cooler climates, heating is necessary for a home to be comfortable in winter and at night.

To reduce the amount of heating energy required and save money on utility bills, it is important to allow as much sun radiation as possible to enter the home through glazed windows and doors, and to reduce heat loss through those same openings and through poorly insulated walls or ceilings.

Passive heating

Passive heating uses winter sun to heat the air inside a home and to warm materials such as stone, bricks or concrete (**thermal mass**). In the same way that a battery stores energy for later use, heat stored in thermal mass can be stored and used to radiate through the home when it is most needed—at night. Allowing winter sunshine inside the home also provides welcome natural light.

Fuel burning or active heating systems

If you choose a fuel-burning or **active heating system** such as a wood fire or gas or electric heaters you should consider the volume (cubic metres) of air to be heated. Some heating systems are more efficient than others in larger rooms. You can measure a room volume in cubic metres by multiplying its floor area (metres squared) by its ceiling height (metres).

If you are heating a leaky or draughty home or room, your volume may be many times the calculated amount. Keep in mind that hot air rises, so it may not be necessary to heat an upstairs room.

Technology has vastly improved over time and **reverse-cycle air conditioners** (systems that heat as well as cool) have become much more energy efficient, to the extent they may now be the most cost-effective system to install. If you have an older system, ensure you use the lowest heat setting possible while still maintaining comfort—running costs can be reduced by up to 10% for each 1°C reduction in set temperature.

As seasons change, check your **air conditioning louvres**. They should be directing heat downwards to the floor in winter, and cool air horizontally in summer. When installing, ensure louvres are pointed away from uninsulated walls and windows.

Ceiling fans in winter

Most people are familiar with using **ceiling fans** in summer; but they can also be used to good effect in winter. The rotation of the blades on many fans can be reversed in winter to push warm air collected at the ceiling out towards the walls and down into the inhabited portion of the room. However, it is best to experiment to see if this works in your home—many fans are manufactured with speeds that are too fast for winter conditions, resulting in unwanted room cooling.

Actions to minimise the need for heating energy in winter

Simple actions →			Harder/more costly actions
Keep curtains open during the day to allow winter sun to enter and heat living spaces.	Ensure external shade devices are raised to allow winter sun into rooms and adjust if necessary.		
Close curtains and blinds to stop heat escaping at night or in rooms where there is no solar gain during the day.	Install pelmets over windows to prevent convection currents and reduce heat loss through single-glazed windows.		Replace vertical blinds with heavy curtains or roller blinds that extend beyond the window frame.
Use a door snake to reduce heat loss under doors.	Seal gaps around windows and doors.	Patch cracks in walls or vents.	
Heat the person, not the space. Have a warm drink, dress for winter even when inside.	Only turn on heating in zones where it's needed.		
Set heating thermostat as low as possible to no more than 21°C and raise only if needed.	Implement a heat transfer system, which can be as simple as a pedestal fan, that takes heat from upstairs spaces and pushes it into other rooms.	Change to a more efficient heating system or fuel.	
	Seek advice about how to inspect, operate, and service heating system.	Turn off pilot lights on gas heaters at the end of the heating season.	
	Experiment with the winter mode on ceiling fans to direct heat out to the walls and downwards.	Heat rises so direct heating ducts to the floor to increase the area heated. Close or cover cooling ducts when not in use.	

Cooling and ventilation

In Australia, most houses require cooling during warmer months at some stage. There are many strategies that can help cool a home before resorting to air conditioning.

These include taking advantage of natural breezes and external shading, and increasing ventilation and air movement through the home.

Passive or natural cooling

Natural methods of cooling rely on external shading or drawing in cool air from the nearby environment. Wide roof eaves and verandas protect windows from the hot summer sun and, in the tropics, breezeways and enclosed verandas provide natural cooling through shade. Air flow is important. This includes directing air across water or shaded gardens before it enters the home to provide a cooling effect and expelling warm air from inside the home.

Ceiling and pedestal fans

Ceiling or pedestal fans circulate air and can help delay the need to turn on an air conditioner. They are particularly useful in bedrooms at night. Fans are much cheaper to run than air conditioning; their power consumption on a low setting is around 20 Watts compared to a small air conditioner which typically consumes 1,000 Watts. Ducted systems use between 2,000 and 4,000W (2-4kW).

Ceiling fans need to be fitted by a licensed electrician, which increases their upfront cost. However, free standing or pedestal fans require no installation, can be positioned wherever needed and packed away when not in use. They can be used independently of an air conditioner to draw in cooler air from an open window or in conjunction to extend reach into adjacent areas. Match the fan quality to the size of the area that needs to be cooled and experiment with fan speed and position to optimise the amount of cooling for the least amount of energy.

Active cooling

Active cooling, or air conditioning, is becoming increasingly common in Australian households. The main cooling systems operate through either refrigeration or evaporation, and have different characteristics. **Refrigeration** results in cool dry air and requires

windows and doors to be closed. **Evaporation** uses water to cool air directly and results in a moist, cool airflow. Evaporative systems need an outlet for warm air to leave the space being cooled and are **NOT suitable for humid and tropical climates**. Evaporative systems generally provide cooling at reduced energy consumption. Replacing an old refrigeration system with a modern six-star evaporative system can cut cooling energy use by half.

Regardless of the system, you should aim for a set temperature between 23° and 27°C. Experiment with the settings—the higher the temperature that can be tolerated, the lower the energy bill.

Reducing air leakage

Improving a home's airtightness is one of the quickest and most beneficial actions to reduce the amount of heating and cooling energy required, see Section 3. Older homes are likely to need more heating and cooling than a newly built home, as housing construction and performance standards were only introduced across Australia in 2003/4. For more information on housing standards, refer to the nationwide house energy rating scheme NatHERS nathers.gov.au

Upgrading your air conditioner

Air conditioner technology has improved considerably in recent years and installing an upgraded heating and cooling system could save you a lot of energy and money. When upgrading, it is essential to do research on which models are the most energy efficient. Look for the appliance energy rating labels; these give you information about energy performance, including capacity output, required input power and efficiency.

- The higher the star rating, the more energy efficient the appliance
- Reverse cycle air conditioners have two ratings; one for heating and one for cooling. A good rating for heating may be more than offset by a poor one for cooling and vice versa, so examine both.

Reduce air leakage and save

A blower door test performed on an old and leaky house in Adelaide returned an air leakage rating of about 20 ACH@50Pa. Gaps were identified in walls, window frames and door frames.

Filling the gaps took about an hour and cost $200 for materials. Once the gaps were filled, the house was retested and the air leakage was assessed to be about 10ACH@50Pa, a 50% improvement.

The work was estimated to have reduced heating and cooling energy requirements by between 10 and 20%. Just as important, it improved comfort levels for the residents by increasing airtightness and reducing draughts.

Appliance energy (and water) ratings labels are discussed in Section 6. More information can be found at energyrating.gov.au

Is upgrading your air conditioner worth it?

Can replacing an old two-star reverse-cycle air conditioner with a new six-star* system *really* save you energy and money? The short answer is yes, and it's probably a lot more than you think. But it depends on a few variables:

- the purchase cost of the new system
- your climate zone and whether you need heating, cooling, or both
- the efficiencies of the new system and how often it is used
- the age, build quality and thermal rating** of your home
- the cost of electricity.

The figures listed below are based on anticipated heating/cooling requirements over a typical year for a 30-year-old house located in either Darwin, Brisbane, Perth or Hobart. To make the comparison fair, the home is the same size*** and has the same thermal performance**,*** rating in each city.

To see how much you could save each year by upgrading to a six-star system, locate your current unit of electricity cost on your electricity bill and consult the table below. If, for example, you live in Darwin and are paying 35c/kWh for electricity, the six-star air conditioner would save you $1,403 a year in running costs, when compared to the two-star option. The same house in Hobart would save $1,074.

Even after accounting for the upfront costs of purchase and installation and the payback period, the six-star air conditioner is a worthwhile investment.

Electricity tariff (c/kWh)	20	25	30	35	40	45	50
$ saved							
Darwin	$802.00	$1,002.51	$1,203.01	$1,403.51	$1,604.01	$1,804.51	$2,005.01
Brisbane	$172.04	$215.04	$258.05	$301.06	$344.07	$387.08	$430.09
Perth	$310.05	$387.56	$465.07	$542.58	$620.09	$697.60	$775.11
Hobart	$613.95	$767.43	$920.92	$1,074.41	$1,227.89	$1,381.38	$1,534.87

Source: DM Whaley

* The air conditioner star ratings of 2 or 6, apply for both cooling and heating modes.
** For more information visit the nationwide house energy rating scheme website nathers.gov.au
*** House has a floor area of 196m^2, and is equivalent to two stars, in each climate zone.

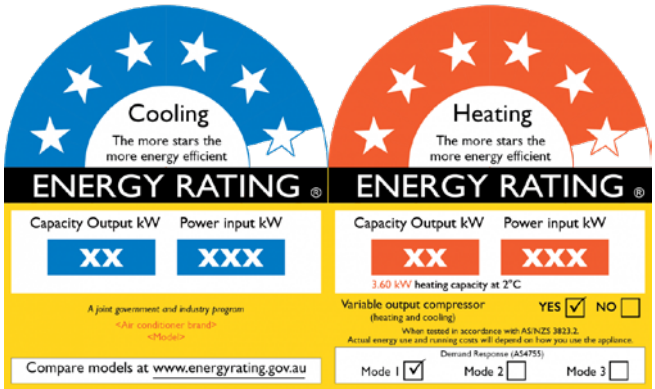


Figure 4.2 An appliance label for an air conditioner, showing cooling and heating ratings.
Source: energyrating.gov.au

Actions to minimise the need for cooling energy in summer

Simple actions →			Harder/more costly actions
Close curtains and blinds to stop heat entering the home during the day.	Lower shades on external windows to block the sun. If windows face east, shade in the morning; north, shade all day; and west, shade in the afternoon and evening.		
Use pedestal and ceiling fans instead of air conditioners, particularly at night.	Try fans for 5-10 minutes before turning on the AC. Sometimes the movement of air is enough.		
Cool one space at a time rather than the whole home–cool living areas during the day and bedrooms at night. Use zones if you have a ducted system.	Ensure heating ducts are covered or closed during summer to reduce air leakage.	Inspect ductwork to ensure cooled air is not leaking into roof space; replace ductwork as required.	Regularly service air conditioner units, ducting and pumps to ensure they are operating efficiently.
Use a door snake to reduce loss of cooled air from a room (applies only to split system or refrigerated unit, not evaporative unit).	Direct cool air from evaporative units into adjacent rooms.	Plant gardens on the south side of a home where AC units or vents are located to draw in cooler air.	
Wait until outdoor temperature is lower than indoor temperature to open doors and windows.	Set temperature on thermostat to no less than 23°C–higher if possible–and only reduce if needed.		

SECTION

05

Water heating

The energy necessary to heat household water can be significant and result in high carbon emissions and cost if not sustainably sourced and monitored.

Water heating is the second largest user of energy in a home, estimated at around 23%. You can reduce this amount by changing behaviours, minimising waste and upgrading to a more efficient system.

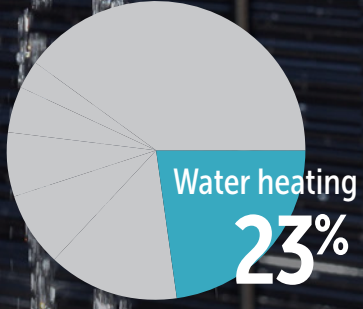


Figure 5.1 Common hot water systems in Australia.
Source: DM Whaley

What type of water heater do I have?

You can save energy and carbon emissions related to heating water, but first you need to know what type of water heater you have:

- Is it a gas system? If yes, is it instantaneous or does it store heated water in a tank?
- Is it an electric system? If yes, is it a heat pump or a traditional storage system?
- Do you have a solar water heater with thermal collectors on the roof? These collectors generate heat from the sun (not electricity as in solar PV panels). Solar water heaters have a storage tank located on the roof or on the ground and may be boosted by an electric element or a gas burner.
- If you are unsure what system you have, the most common electric, gas and solar water heater types are shown in Figure 5.1 above.

If you are a renter:

- Remember that you are paying the gas or electricity bill, not the landlord. Promptly report any hot water leaks to your landlord or property manager. Leaks mean heating energy is being wasted. In many states, tenants are also required to pay for any excess water used.
- If you cannot find or determine the type of water heater you have, ask your property manager or landlord.

The benefits of a temperature control pad for instantaneous hot water

Without a temperature control pad your instantaneous hot water system will likely heat water to 48°C, which will need to be lowered for use to around 42°C by adding cold water. The hotter temperature provides no benefit but accounts for an increased gas usage of about 35%. To learn how much you could save each year by setting the temperature to 42°C, locate your gas energy usage charge on your gas bill and match it to the column below.

Rate (c/MJ)	3.0	4.0	5.0	6.0	7.0	8.0
Annual cost saving	$28.21	$37.62	$ 47.02	$56.43	$65.83	$75.24

Source: DM Whaley

Gas systems

Gas systems have storage tanks or are tankless as is the case in instantaneous (continuous flow) units. Gas booster systems are also sometimes attached to solar water systems. Things to remember about gas systems include:

- The size of the storage tank will determine the amount of gas needed to heat it.
- Instantaneous water heaters are more energy efficient than storage systems because there is no heat lost from the tank.
- Tank size should be suitable for your family's needs. The system efficiency of an under-utilised gas storage water heater is only 20%[7].
- Turn off the gas pilot light when you leave the home for extended periods, but remember to light it again on your return. Be patient, it may take a few hours for water to reheat.
- The storage tank needs to hold water at 60°C or more to ensure pathogens such as *Legionella* do not grow in the system. This is not required for instantaneous water heaters.
- Check that the thermostatic mixing valve does not exceed 50°C (these can be set between 35-50°C).

In instantaneous systems:

- Water temperature is set by a control pad at the site of use. Ideal temperatures are 42°C for shower or bath and 50°C for the kitchen.
- Only the hot water tap is used.
- You cannot change the temperature while the unit is heating water.
- If there is no control pad to pre-set the temperature, water will be heated to 48°C and cold water will be needed to bring the temperature down to a comfortable level in the bathroom.
- Instantaneous gas systems automatically start the burner when hot water is flowing. Gas is consumed each time the burner starts, so avoid turning on the tap in short bursts..
- If using a front-loading washing machine that fills up gradually, it is more energy efficient to turn off your instantaneous water heater via the heat pad and let the washing machine heat its own water using electricity.
- Fill a sink with water to wash and rinse dishes rather than continuously stopping and starting the flow of hot water.

Electric storage systems

Electric storage hot water systems use significant amounts of energy each day. To reduce the demand on the electricity grid at certain times of the day, electric systems can be connected to a controlled tariff meter to heat water only in off-peak times. This reduces the cost of energy per kWh used.

- Small electric storage systems of 25L to 50L capacity are rated 9.5-10kW. Hence if heating water for a total of one hour per day, they can use up to 10 kWh each day.
- To minimise daily heat loss, the size of the storage tank should be appropriate to the household demand. Large electric storage tanks and their

[7] See Whaley et al. 2014
[8] Your Home see http://www.yourhome.gov.au/

fittings can waste up to 1,000kWh each year (equal to 2.74 kWh per day)[8]. Note that a large tank of 300L is permitted to have a daily heat loss of up to 2.38kWh/day, to meet Australian and New Zealand Standards[9].

If you use a controlled tariff for heating water, negotiate an afternoon boost, instead of only heating water overnight. This may be useful for families with young children that bathe in the evening or households that have a large daily hot water load.

Electric heat pump system

Electric heat pump systems use air to heat water and as such are recognised by the Clean Energy Regulator as small-scale renewable energy installations and treated in the same way as solar hot water systems. The drawback of these systems is that they are often more expensive to buy and install and usually must be located outside to allow for adequate ventilation. An efficient family-sized heat pump unit with storage capacity of around 300L uses an average of 3kWh per day compared to 9-11kWh per day for an electric storage tank.

Solar or hybrid systems

By their nature, **solar hot water systems** are the most energy efficient. There are three main types – flat plate collectors, evacuated tube collectors and heat pump systems.

Solar water heaters deliver extremely hot water, particularly in summer. A thermostatic mixing valve is required to reduce the temperature of water when it reaches bathrooms to a maximum of 50°C. As such, cold water is still required. In cooler climates, evacuated tube collectors are more efficient than flat-plate collectors with both systems usually requiring (gas or electric) boosters in winter.

If your house uses unfiltered rainwater, many installers recommend adding a filter to remove contaminants. Contaminants can stop or damage the pumps delivering water to the solar heater. Check that pumps are running and delivering water to the rooftop collectors. A blocked or damaged system will use extra electricity or gas to heat water via boosters.

[9] AS/NZS 4692.1:2005 (R2016)

Choosing a hot water system

Type	Annual Running Cost 1 to 2 people, 77 L/day	Comments
Electric storage	$357	5 kWh/day on controlled tariff of 19c/kWh
Solar Hot Water (Sunny)	$98 to $125	75% of hot water heated by the sun
Solar Hot Water (Cloudy)	$173	50% of hot water heated by the sun
Gas storage	$300	
Gas instantaneous	$215	
Heat Pump	$208 for three adults, 310 L tank	3 kWh/day on controlled tariff of 19c/kWh

Sources: canstarblue.com.au; CM Hamilton.

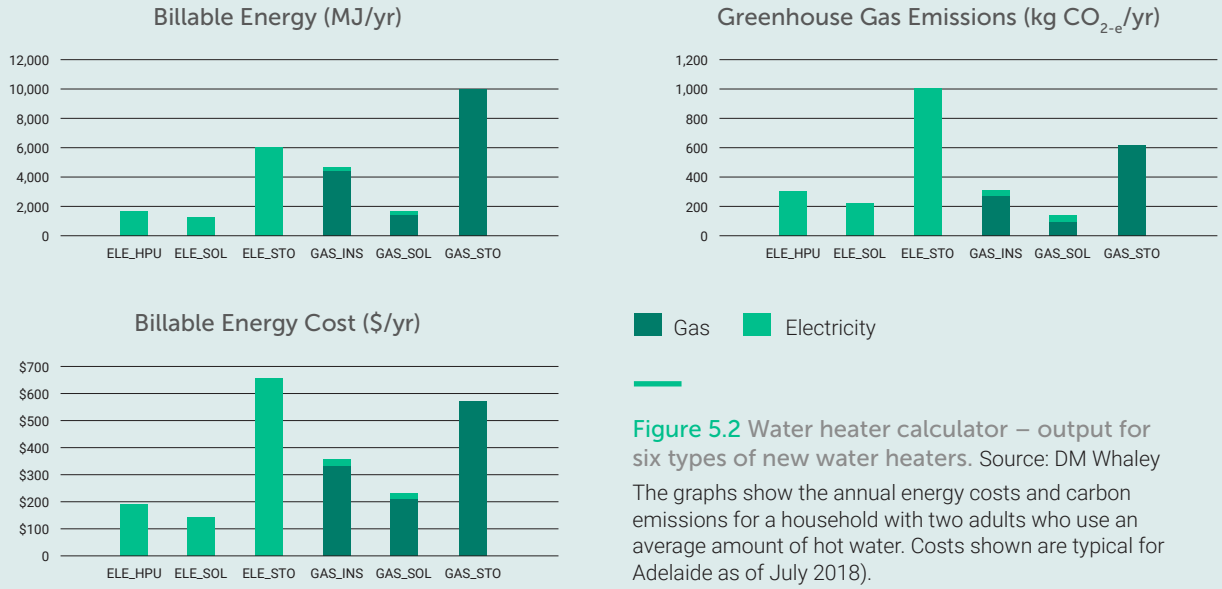


Figure 5.2 Water heater calculator – output for six types of new water heaters. Source: DM Whaley

The graphs show the annual energy costs and carbon emissions for a household with two adults who use an average amount of hot water. Costs shown are typical for Adelaide as of July 2018).

Replacing a hot water system

When an old hot water system stops working most people rush to replace it without doing any research to determine which system is most appropriate and cost efficient. New water heaters for use in domestic dwellings are subject to strict guidelines imposed by state governments, and need to be installed by a qualified tradesperson. New hot water systems that have a storage tank or solar collector must:

- Hold water at 60°C or more to ensure pathogens are not able to grow in the system.
- Have a thermostatic mixing valve (a safety device that limits the indoor water temperature to 35-50°C in the bathroom).

Online tools and websites can help you decide which type of water heater to purchase. The example here uses a tool developed by the University of South Australia for the SA state government[10]. This website shows a comparison of the billable energy, costs and carbon emissions for six types of water heaters.

The systems examined include:

- Three electric: heat pump (ELE-HPU), solar (ELE-SOL), storage (ELE-STO), and
- Three gas: instantaneous (GAS-INS), solar (GAS-SOL), and storage (GAS-STO).

[10] See sa.gov.au

Actions to reduce the energy used to heat household water

Simple actions →			Harder/more costly actions
Inspect hot water system for leaks.	Fix dripping taps.	Fix any leaks in the hot water storage tank.	
Take shorter showers (four minutes is recommended).	Shower rather than bathe.		Install a low-flow shower head and low-flow water taps.
If you wash dishes by hand, wash only once a day.	Plug sink and fill with the amount of hot water required rather than letting taps run.	Use a dishwasher, (but only when it is full).	
Turn off water taps, especially hot water, when brushing teeth.	Use residual heat in pipes for warm water.	Heat small amount of water in microwave or use stored boiled water from thermos.	
When using a kettle, heat only the amount of water needed.	Fill the kettle with water from the tap, not from a refrigerated tap or the fridge.	Invest in a kettle with temperature settings, or one that heats up water for a selected number of cups.	
Check the temperature of the hot water and ensure it is no greater than 60°C at the storage tank and 50°C in a bathroom.	Use holiday mode or turn off gas pilot light while away.	Ensure the electric storage hot water system operates on a controlled tariff meter. (This may not be suitable if you have a large hot water demand.)	
If using an instantaneous hot water unit, make sure the temperature is appropriate: 38–44°C for bathing, 50°C for washing dishes.	Insulate all hot water pipes with foam tubing (lagging) to prevent heat loss.	Install a temperature control pad on your instantaneous unit.	If using a front-loading washing machine, turn off the instantaneous unit from the temperature control pad. (Turn back on when you need hot water.)
Insulate pipes on solar hot water system from storage tank to solar collector with foam tubing (lagging) to prevent heat loss.	Regularly check the solar controller to ensure the system is not reporting issues.	Have a licensed plumber maintain the system and check wiring on the roof.	If you have solar heating, monitor energy used by your water heater to see if the sun is providing adequate heating.

SECTION

06

Appliances

Knowing how much power your appliances draw and understanding efficiency labels can help save a surprising amount of energy in an average home.

Home appliances account for around 30% of energy consumption in an average Australian household. When it comes to running appliances, there is little difference between home owners and renters; however, owners have more control over the installation of fixed appliances like stoves and cooktops.

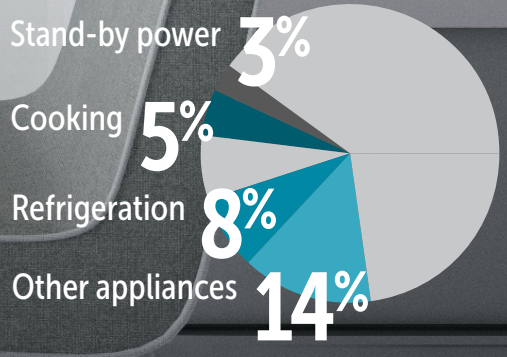


Figure 6.1 Energy and water efficiency labels.
Source: energyrating.gov.au / waterrating.gov.au

Energy and water efficiency labels

When buying new appliances, make sure you understand their energy and water rating labels. The higher the star rating, the more efficient the appliance. Many highly efficient appliances may cost more to buy upfront, but they save you money in running costs. Surveys show that ratings are increasingly dictating choices. Energy labels are considered by about 50% of customers when buying new appliances, while water efficiency ratings are considered by 39%.

For more information about appliance ratings and labels visit the Australian Government website energyrating.gov.au, or download the Energy Rating Calculator App.

Should you invest in an energy-efficient fridge?

You have shopped around and found two new models that look suitable to replace your aging refrigerator. One is rated at two stars for energy efficiency, while the other is rated five stars but costs an extra $250. Which one is the most cost-effective to buy?

- Using 2018 electricity prices in Adelaide, the savings on running costs associated with the more expensive fridge is $60 a year.
- This means the five-star fridge has a payback period of 4.2 years. That is, after 4.2 years its additional purchase cost will have been paid back by the annual energy savings it delivers. Since most fridges are made to last much longer than four years, if you can afford the extra outlay at the time of purchase it makes sense to buy the more expensive energy-efficient fridge.

Source: DM Whaley

How to conduct a home appliance audit

You've decided to conduct a power audit of your appliances and have borrowed an audit kit from your local library. The first step is to record how much power each appliance draws by using the kit's power meter. See Measuring and Controlling your energy use.

To carry out a comprehensive audit you need to:

- include as many of the home's appliances as possible
- include every instance of the same appliance
- be realistic about the length of time each appliance runs each day (or each week, month or year).

Remember, some appliances draw large amounts of **power**, but operate for only short periods of time, which result in a small amount of **energy** used (i.e. the kettle). Others draw small amounts of **power**, but run for long periods of time, resulting in a large amount of **energy** used (i.e. the refrigerator).

The example appliance audit below calculates power and energy used in a household over a 24-hour period. It shows that appliances used 7,000 Wh (or 7 kWh) over that period.

Appliance	Number	Power (W)	Time used (h)	Energy (Wh)
Refrigerator	1	100	24.0	2,400
Heater	1	1300	2.0	2,600
Kettle	1	2300	0.05	115
LED lights	7	15	3.0	315
TV	1	150	3.0	450
Computer	1	240	2.5	600
Washing Machine	1	520	1.0	520
			Total	**7,000**

Source: DM Whaley

Actions to buy the most energy efficient appliances

Simple actions	→		Harder/more costly actions
Seek recommendations from family and friends about energy and water efficient appliances.	Download the **Energy Rating Calculator App**.	When buying new appliances, select the ones with more stars on their water and energy efficiency labels.	Calculate the payback period, i.e. how long it will take for energy savings to pay off the extra cost of an energy efficient appliance.

Standby power

Even when they are standing idle, most electrical appliances will continue to draw power if they are switched on at the wall. Standby loads account for about 3% of the typical Australian household's energy use. Australian standards regulating standby power have been tightened considerably in recent years so it may be worthwhile to update old appliances with newer models.

Entertainment appliances are often the worst standby offenders. More of these devices are appearing in modern homes and are being left 'on' at the power point when not in use. Of Australian household in 2014[11]:

- 98% had at least one TV, 55% had two or more
- 72% had a DVD/Blu-ray player
- 53% had a stereo system
- 44% had a set top (digital) box
- 33% had a mains-powered gaming console
- 22% had a surround sound system.

Depending on the age of the appliance, the amount of standby power they use may be significant. The simplest way to eliminate this wasted power is to turn off appliances at the power point when they are not in use. Another option is to invest in a smart power board that will do this automatically. A smart power board kills power to an appliance once it detects that it is not being used. Smart power boards are particularly useful for TV and entertainment units, desktop personal computers, hard drives, screens and speakers. Many smart power boards also feature an energy meter that tells you the energy consumption of the devices plugged into it. Most offer surge protection, overload, spike and noise filtering.

Do not connect your modem (including an NBN modem) to a smart power board as this will disconnect you from your home internet when you turn your computer off. Similarly, some modern inkjet printers should always remain powered on, as each time these are switched off and on again, they clean their print heads (which consumes costly ink). You may save on standby power, but pay more in ink.

If you are a renter:

- You have little choice about existing fitted appliances; however, long-term renters may be able to influence decisions about which new appliances to fit.
- You do have a say about which discretionary appliances you bring with you to the property, such as refrigerators, freezers, TVs, stereos, washing machines and dryers. It pays to make energy efficient choices and to be familiar with appliance ratings and labelling.

[11] See ABS 2014

Energy and cost savings using a smart power board

Your personal computer system is normally plugged in and operating in standby mode for up to 22 hours a day. The computer (1.1W), LCD screen (0.7W), external hard drive (2.2W), and speakers (8.1W) could potentially be using 12.1W in standby power each hour, or 266Wh per day. The use of a smart power board costing $49 (and drawing its own standby power of 0.8W) would save 11.3W of standby power an hour or 248.6Wh per day, which is equal to 90.7kWh of energy a year. This translates to an annual saving of up to $45 a year. (See table below.) To calculate how much you could save using a smart power board match your electricity rate (c/kWh) from your electricity bill to the table below.

Electricity tariff (c/kWh)	20	25	30	35	40	45	50
Energy cost saving (per year)	$18.15	$22.68	$27.22	$31.76	$36.30	$40.83	$45.37
Payback period (years)	2.70	2.16	1.80	1.54	1.35	1.20	1.08

Source: DM Whaley

How much are you paying for standby power?

You have many new* appliances that are permanently switched on at the wall. Excluding the fridge/freezer and security system, which must remain on at all times, all other appliances** are wasting energy by drawing standby power. The following chart shows the amount of standby power (W) used by appliances.

Appliance	Standby Power (W)	Appliance	Standby Power (W)	Appliance	Standby Power (W)
Amplifier 1	0.7	Kettle	0.3	Printer	1.3
Amplifier 2	6.5	LCD screen	0.7	Rain water tank pump	1.2
Coffee machine	0.2	Microwave	1.6	Toaster	0.4
Desktop computer	1.1	Milk frother	0.7	TV	0.2
Dishwasher	0.4	Panel lift door	2.2	Washing machine	0.2
Electric toothbrush	1.2	PC speakers	8.1	Water heater pad	9.7
External HDD	2.2	PlayStation 3	0.4	Total	39.3

* New appliances are more tightly regulated than older appliances and therefore draw smaller amounts of standby power.
** Ducted and split-system air conditioners also draw standby power, but these are difficult to measure. Turning the circuit breaker on and off regularly can be inconvenient.

In the above example, the total standby energy used over one year is 344.2kWh. That is a lot of wasted energy. To calculate how much standby power your household is using, find your electricity tariff on your bill and match it to the table below.

Electricity tariff (c/kWh)	20	25	30	35	40	45	50
Standby energy cost (per year)	$68.85	$86.07	$103.28	$120.49	$137.71	$154.92	$172.13

Source: DM Whaley

Actions to save standby energy

Simple actions		→	Harder/more costly actions
Turn appliances off at the outlet/wall socket when not in use.	Use a home energy audit kit to check how much power your appliances use in standby mode.	Purchase smart power boards that automatically cuts power to appliances when they are not in use.	Using the information from the energy audit, do a payback assessment and replace inefficient appliances with more efficient models.

Cooking and dishwashing

Kitchen appliances consume a significant amount of energy and can cost you an unnecessary amount of money. Cooking via ovens and stovetops alone accounts for 5% of an average household's energy use.

Modern fan-forced electric **ovens** draw 1.2–3.6kW when the heating element is on, depending on the size. Oven-related tips to save energy include:

- Minimise pre-heating time and use an oven only when necessary.
- Unless the food manufacturer specifically cautions otherwise, defrost frozen food at room temperature prior to putting it in the oven.
- At purchase time, consider buying an oven with triple or quadruple-glazed glass doors to minimise heat loss.
- Buy ovens with thick insulation to minimise heat loss from the sides and rear.

Stovetops also use significant energy.

- Two or more items heating simultaneously can draw 2.4–4.8 kW, similar to an air conditioner.
- Electric and ceramic stovetops are more energy efficient than gas; however, gas provides the best heat control.
- Induction is the most energy efficient technology, but special pots and pans are required.

Dishwashers consume a large amount of energy. In 2014, 55% of Australian households had a dishwasher[12].

- Select your dishwasher according to energy and water consumption rating labels.
- Use Eco mode to save 15-30% energy. This mode heats water to a lower temperature but for longer, and promotes air drying of dishes.
- Only use the dishwasher when it is full.
- Ensure it is turned off at the power point when not in use to reduce standby power.
- If you have rooftop solar PV, operate the dishwasher only during daylight hours to take advantage of free solar electricity.

[12] See ABS 2014

Refrigeration

Refrigerators and freezers typically account for 8% of a household's energy consumption. Surveys show that a third of households have a separate freezer[13]. A fridge/freezer will work harder and consume more energy if it is working in a warm or hot environment, or if it is overloaded, so try to keep the fridge less than 80% full, locate it in a cool environment (not in a hot garage) and ensure there is adequate air ventilation. Upgrading old fridges and freezers with new, energy efficient models can save money in the long run. Most states have energy efficiency schemes designed to assist energy vulnerable households purchase new appliances like fridges. Energy retailers are also required to assist customers to identify improvements that reduce energy consumption.

Unplug your second fridge and save

Many households own a second fridge that runs all year long, yet are used only to keep drinks and other items cold for special occasions. A typical second fridge consumes 1,670kWh of energy per year. By switching it off, you could save as much as $835 per year. To calculate how much your household could save, match your electricity rate (c/kWh) from your electricity bill to the table below.

Electricity tariff (c/kWh)	20	25	30	35	40	45	50
Cost saving (per year)	$334.00	$417.50	$501.00	$584.50	$668.00	$751.50	$835.00

Source: CM Hamilton, DM Whaley

[12] See ABS 2014

Actions to reduce energy use in the kitchen

Simple actions	→		Harder/more costly actions
Buy energy efficient appliances. Check energy labels.	Cook with the microwave rather than the stove or oven—a microwave uses less power and time (and hence energy).	For small food items, cook with a small portable oven instead of the regular oven.	
Use lids on pots to speed up cooking times.	Reduce heat settings to the lowest that still allows the food to simmer or boil. Water boils at 100°C regardless of how much extra heat you provide.	If using gas, use the correct size burner to provide the required heat to the pot or pan.	
Boil the minimum amount of water in a kettle to make a cup of tea or coffee.	Make a large pot of coffee or tea at the beginning of the day and store in a thermos for later use. Reheat in the microwave as needed.	Turn off benchtop appliances when not in use to minimise standby power.	
Only use the dishwasher when it is full.	If you need to rinse off plates before putting them into the dishwasher, use cold or warm water in a small bowl.	Use the energy-saving (Eco mode) setting on the dishwasher and let dishes air-dry.	If you have a solar PV system, use energy intensive appliances such as the oven and dishwasher during daylight hours.
Keep fridge door seals clean and in working order.	Set your fridge at 3°C or 4°C and your freezer at -15°C to -18°C.		
Manually check your fridge and freezer temperatures using a thermometer.	Check energy use of fridges and freezers using a home energy audit kit.	Check seals and replace if worn. Recheck their efficiency.	Regularly clean the dust off the coils of an old fridge to improve the effectiveness of the heat exchange process.
Do not overload your fridge	Keep fridge and freezer ventilated, allow room for air to circulate around all external surfaces.		
Turn off your second fridge. There is no benefit to keeping items cool when they are not required.	Ensure the fridge and freezer are in a cool location, not in a sunny spot or in a hot garage.	Check energy ratings when selecting a new fridge or freezer.	Check the payback period of a new fridge or freezer—it is usually worthwhile to spend more upfront for an energy-efficient model.

Washing, drying and ironing

Almost all Australian households have a washing machine and 55% have a clothes dryer[14]. Simple measures such as always washing with cold water and avoiding the clothes dryer will save you in energy costs. Instead of using the dryer, establish an undercover clothes line to hang washing during inclement weather and set up a portable clothes rack to take advantage of direct sunshine. If you have a rooftop solar PV system, do your washing, drying and ironing during daylight hours when the sun is shining to minimise the amount of power you draw from the grid. Some households, especially those living in apartments, prefer to use a laundromat. Keep in mind a laundromat is a business and will charge inflated rates for energy and water use.

[14] See ABS 2014

Actions to reduce energy use in the laundry

Simple actions		→	Harder/more costly actions
Wash with cold water. Check the temperature settings for each load of washing particularly if you regularly change the program.	Wash with a full load to minimise water and energy use.	Disconnect the hot water hose or turn off the hot water tap. Modern washing machines can efficiently heat their own water to 30 or 40°C.	When buying new washers and dryers, select models with low energy and water use.
Avoid using clothes dryers. Dry clothes on a clothesline or on portable racks.	Dry clothes on an electric-heated clothes rack.	Install washing lines in an undercover area, such as a garage or on a veranda.	Install a condenser dryer with a heat pump/ exchange system. Though more expensive to buy, they consume considerably less energy than a conventional clothes dryer.
To minimise the need for ironing, shake clothes when wet and hang directly on hangers.	Switch off power to washing machine and dryer when not in use to reduce standby energy.		

Information technology and home office

A 2014 survey[15] showed that almost all Australian households (83%) have an internet connection.
In addition:

- 70% had at least one smartphone, 47% had more than one
- 51% owned a tablet
- 44% had a desktop computer
- 69% had a laptop computer, 10% had three or more
- 66% had a printer, scanner or fax machine.

All **portable devices** have batteries that require regular charging from mains power. Fully charge your device to 100% of battery capacity and engage power saving settings to maintain battery health and minimise the need for top-up charging.

If you have a rooftop solar PV system, charge your devices during the day rather than at night.

[15] ABS Quickstats from 2016 Census

Actions to save energy used by mobile devices and the home office

Simple actions	→		Harder/more costly actions
Turn off devices when not in use.	Check that you are using power-saving settings appropriately.	Check energy use of portable devices using a home energy audit kit.	Check energy use of home office equipment using a home energy audit kit.
	Purchase and use a smart power board to reduce standby power consumption.	Install a timer switch for equipment that is only required to operate at particular times.	If you have a rooftop solar PV system, try to use office equipment during the day.

Charge devices during sunlight hours and save

If you have rooftop solar PV, charging your devices during the day can save both energy and money. A typical household has at least four portable devices that require charging every day. The table below lists the power needed to charge each device, together with the individual and total energy used per year.

Device	Daily Energy to charge (Wh)	Annual Energy to charge (kWh/yr)
Smartphone 1	11.10	4.05
Smartphone 2	11.10	4.05
Tablet	60.00	21.90
Laptop	70.00	25.55
	Total	55.55

Charging information from canstarblue.com.au

To calculate how much you could save each year by charging your mobile devices using solar PV energy, find your import and export (feed-in) tariffs on your electricity bill.

Match your import tariff along the top of the table, and your export tariff down the left column of the table. For example, if you import (buy) energy at a rate of 40c/kWh and export (sell) this at 10c/kWh, you would save $16.67/year.

	Import tariff (c/kWh)						
Export (feed-in) tariff (c/kWh)	20	25	30	35	40	45	50
6	$7.78	$10.56	$13.33	$16.11	$18.89	$21.67	$24.44
8	$6.67	$9.44	$12.22	$15.00	$17.78	$20.55	$23.33
10	$5.56	$8.33	$11.11	$13.89	$16.67	$19.44	$22.22
12	$4.44	$7.22	$10.00	$12.78	$15.55	$18.33	$21.11
14	$3.33	$6.11	$8.89	$11.67	$14.44	$17.22	$20.00
16	$2.22	$5.00	$7.78	$10.56	$13.33	$16.11	$18.89
18	$1.11	$3.89	$6.67	$9.44	$12.22	$15.00	$17.78
20	$-	$2.78	$5.56	$8.33	$11.11	$13.89	$16.67

Source: DM Whaley

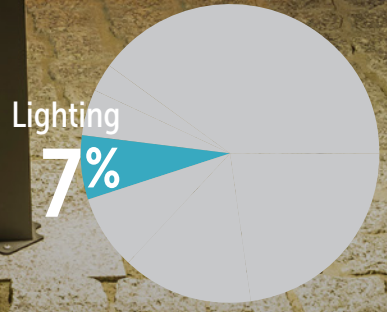
SECTION

07

Lighting

Lighting, both indoors and outdoors, is an essential element in any household and easily overlooked as a source of energy use and carbon emissions.

Lighting comprises 7% of a typical Australian household's energy consumption which is greater than the energy used for cooking (5%). It is also one of the easiest and cost-effective modifications to achieve significant energy savings.



Natural light

Sunlight is freely available, so make as much use of it as you can. **Natural light** can save you energy, make your home more comfortable and even improve your mood. The amount of natural light coming into a dwelling depends on dwelling design, orientation, window size and placement, and how much shading the house receives.

The sun's position varies throughout the year and will be higher in the sky in summer than in winter.
To make the most of natural light during the day:

- locate living rooms and work spaces on the northern side of a home, or in rooms with north facing windows and/or glass doors
- paint your internal walls a lighter colour
- place mirrors in locations to reflect more daylight into dark spaces
- consider installing a skylight.

Remember however, that along with direct sunlight comes heat; even double-glazing does not stop heat entering a window or sliding doors which is something to keep in mind in summer months.

Indoor lighting

Upgrading your interior lighting is one of the easiest and most cost-effective energy saving options. Incandescent light globes are the least energy-efficient form of indoor lighting and should be replaced with LED lights as soon as possible. LEDs have higher efficiencies and lower energy consumption than any other lighting type.They also have significantly greater lifespan, estimated at up to 50,000 hours.

Lighting technologies and their running costs

The following table shows the running costs of different types of lights. It assumes each light is operated for three hours per day and for 350 days per year. First, identify the lights you have and then match them with your tariff rate from your electricity bill. For example, if your retailer charges you 35c/kWh for electricity and you run a 75W incandescent globe, you would expect this to cost you $28.44 per year.

	Electricity tariff (c/kWh)						
Lighting Technology	20	25	30	35	40	45	50
Compact fluorescent lamp (15 Watts)	$3.13	$3.91	$4.69	$5.47	$6.25	$7.03	$7.81
LED downlight (15 Watt lamp and transformer)	$3.13	$3.91	$4.69	$5.47	$6.25	$7.03	$7.81
Fluorescent tube (18 Watts)	$3.75	$4.69	$5.63	$6.56	$7.50	$8.44	$9.38
Compact fluorescent lamp (20 Watts)	$4.38	$5.47	$6.56	$7.66	$8.75	$9.84	$10.94
Fluorescent tube (36 Watts)	$8.13	$10.16	$12.19	$14.22	$16.25	$18.28	$20.31
12 Volt halogen downlight (50 Watts)	$14.38	$17.97	$21.56	$25.16	$28.75	$32.34	$35.94
Incandescent globe (75 Watts)	$16.25	$20.31	$24.38	$28.44	$32.50	$36.56	$40.63
Incandescent globe (100 Watts)	$21.88	$27.34	$32.81	$38.28	$43.75	$49.22	$54.69

Source: environment.nsw.gov.au, DM Whaley

Table 7.1 The lifespan of various types of lights

Alternative lighting	Estimated lifespan
Halogen (general lighting service)	2,000 hours
CFL	8,000 to 15,000 hours
LED	15,000 to 50,000 hours

Source: Dee 2017

Table 7.2 The brightness of different types of lights

Lumens (Brightness)	Incandescent Globe	CFL	LED
250	25 Watt	4-6 Watt	3-4 Watt
400	40 Watt	7-9 Watt	5-8 Watt
600	60 Watt	11-14 Watt	8-12 Watt
800	75 Watt	15-23 Watt	11-17 Watt
1,050	100 Watt	19-23 Watt	15-23 Watt

Source: energyrating.gov.au

By late 2020, minimum standards for LED light bulbs will be in place to mirror standards in Europe. For more information refer to energyrating.gov.au.

Adjusting brightness

A light's brightness can be adjusted to match the space and also save on energy. A kitchen will generally need brighter light than a loungeroom, dining room or bedroom. Modern LEDs can be fitted with dimmer switches that do not impact on the life of the globes. Consult a licensed electrician for more information.

Energy efficient LED lights are the equal of incandescent globes in terms of brightness; however, the positioning of LED lights is important. More LED downlights may be required in a room compared to pendant lights, which hang lower and closer to the area being lit. Light fittings affect any globe's ability to illuminate a space. If there are gaps around the fixture, this may also affect a room's air leakage. Fittings should include a reflector to direct light down into the room and prevent light wastage into ceiling spaces.

Replacing incandescent and halogens with LEDs

Australian governments have committed to phase out inefficient incandescent and halogen light bulbs in favour of LEDs and eligible households can get assistance to make the change. Consult your energy retailer for more information about energy efficiency assistance schemes, or refer to your state/territory government website for a list of energy specialists.

Update to LED lights and save

A typical family living in a townhouse paid $969 for electricity in 2017/18. They acted to save energy and electricity costs by replacing halogen globes. The cost savings over a 10-year period (through savings in energy and replacement costs), are shown below:

Actions	Cost savings
Replace seven standard halogen light bulbs with LEDs. • Cost: $29 extra for light bulbs.	The family saves: • $43 / year on their electricity bill. • $464 over 10 years.
Replace 11 halogen light bulbs. • Cost: $45 extra for light bulbs.	The family saves: • $61 / year on their electricity bill. • $658 over 10 years.

Source: Australian Government

Sensor and automatic lighting control

Sensors fitted to existing lighting circuits can detect when a room or space is occupied and switch lights on and off as required. They can be adjusted for surrounding conditions and different ranges of movement or programmed to activate at certain times. They are especially useful for outdoor lighting, in garages, hallways, corridors and stairwells, and in publicly accessed areas of multi-unit housing. Some indoor sensor lights can be installed by householders but most require a licensed electrician. Sensor lights will consume standby power when not operating, although the rate is quite low.

External and security lighting

Outside lights are becoming popular to show off a home's exterior at night and for reasons of security. These sensor lights can be either grid or solar powered:

- Grid-powered lights and switches must be installed by a licensed electrician.
- Solar lights are less costly, are available at most hardware stores and can be installed by householders.
- Outdoor security lights can be operated using timer switches, daylight controls and motion sensors.
- If plugged in to a power point, check the power drawn by each light when on and when in standby mode.
- Choose the most efficient lighting product that meets your lighting needs. If mains-powered, this is LED.

Actions to save lighting energy

Simple actions		→	Harder/more costly actions
Switch off lights when leaving a room.	Replace incandescent globes with LEDs.	Replace Halogen downlights with LEDs.	Limit the use of energy guzzling heat lamps in bathrooms.
Open blinds and curtains in living areas during the day to take advantage of natural lighting.	Raise or remove shade devices in winter to allow more natural light inside.	Place mirrors in strategic locations to reflect more light into rooms.	Paint walls a light colour.
Plant a deciduous vine over your pergola to provide shade in summer and allow more light inside in winter.		Use solar powered garden and external security lighting.	

Further reading

We hope the advice in this Guide helps to reduce your household energy use (and carbon emissions) and saves you money on utility bills. If you found the Guide useful, please share it with your friends and family.

If you are seeking more information, browse the further reading suggestion below. If you plan to embark on your own research, be aware that some information online may be produced by non-experts or by suppliers with vested interests.

Good luck!

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yourenergysavings.gov.au

renew.org.au

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