CHAPTER 9

SERVICES, LIGHTING AND APPLIANCES

This chapter offers guidance on choosing home heating, cooling, water heating and lighting systems, and other major appliances.

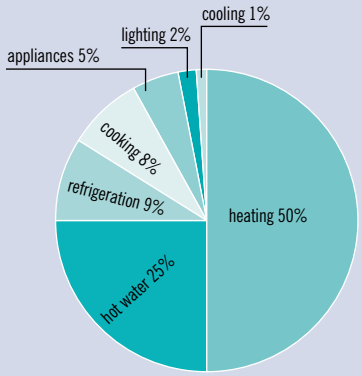


Figure 9.1: Energy use by Victorian households

Appliance considerations

In addition to building an energy smart home, it is vital to install energy efficient services, lighting and appliances to maximise energy savings. Once house designs are finalised, consideration of appliances must begin, as their selection may be limited by structural, economic and aesthetic considerations.

GENERAL SELECTION PRINCIPLES

- Ensure that the capacity of services and appliances will meet anticipated household needs.
- Wherever possible, select the most energy efficient services and appliances. Gas space heaters, ducted heaters and hot water services, air conditioners, refrigerators, freezers and whitegoods all carry Energy Rating labels, which enable their level of energy efficiency to be compared.
- When choosing between alternative models, consider both the initial cost and the ongoing running costs over the life of the appliance.
- Consider the greenhouse impact of alternative fuel sources. Using gas-fuelled or solar-boosted appliances will generally result in lower greenhouse gas emissions.
- Select services or appliances which have flexibility of control, a range of settings or preferably thermostatic control. This enables the most energy efficient setting for the task to be selected, i.e. a variety of hotplate sizes on cookers, thermostatic control on heating and cooling systems, timers and economy settings.
- Consider the optimum location of services at design stage, i.e. position hot water systems centrally to areas of use, locate space heaters in central positions in rooms, locate central heating systems as near as practical to main living areas.
- Energy efficiency also depends on you. By setting appropriate thermostat temperatures, turning off appliances and lighting when not in use, washing in cold water and other similar such actions, energy and financial savings will be maximised.

How the right selection can save energy

Victorian homes use energy for a large variety of appliances and services. However, the largest components of energy use in a typical home are heating (50%), hot water (25%), refrigeration (9%) and cooking (8%) (see figure 9.1). Ensuring these types of appliances are as energy efficient as possible, and are used in an efficient manner, will significantly reduce energy use and costs.

Choosing the energy source

There is a choice of fuels for most services and some appliances. Care should be taken to find the most economical fuel for particular uses.

KEY CONSIDERATIONS ARE

- Economy of operation. This does not just depend on the fuel used, but also on the tariff available. For instance, off-peak electric hot water systems are around three times cheaper to run than peak rate electric systems, such as under sink or continuous flow units.
- Availability of natural gas. Some regions in Victoria are restricted to the use of more expensive LPG (also known as bottled gas).
- Scope for utilising solar or other forms of renewable energy. For instance, solar hot water systems have much lower running costs than conventional gas or electric systems. However, their purchase price is much higher. Payback periods will vary depending on household size and the amount of hot water used.
- Construction restrictions. These may influence the choice of appliances or fuels, for example, the need for flues to gas appliances may be difficult in apartments.
- Greenhouse impact. Fuels used to produce energy give off greenhouse gases (predominantly carbon dioxide). Figure 9.2 shows the relative carbon dioxide emissions of various fuels in Victoria.

For one gigajoule of energy used an amount of carbon dioxide emissions in kilograms is produced (kg/GJ).

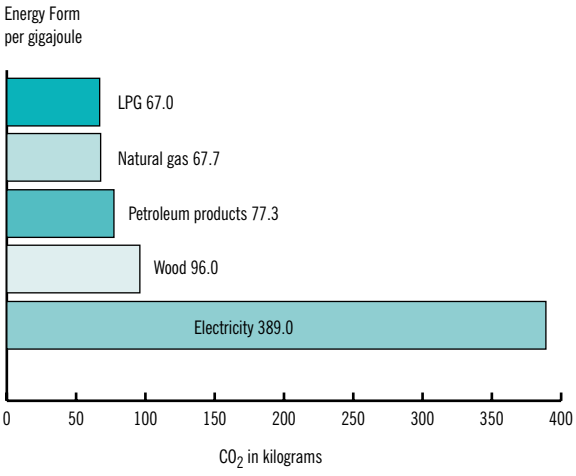


Figure 9.2: Carbon dioxide emissions of Victorian fuel types

It should be noted that Victoria's electricity supply, being predominantly brown coal based, results in considerably higher greenhouse gas emissions than electricity produced in other states from black coal or hydro-electric generation.

The amount of greenhouse gases released depends on both the fuel used and the appliance efficiency. Figure 9.3 compares the relative amounts of carbon dioxide (CO_2), which is the predominant greenhouse gas released by various fuels used to heat water and homes, when each supplies the same amount of heat.

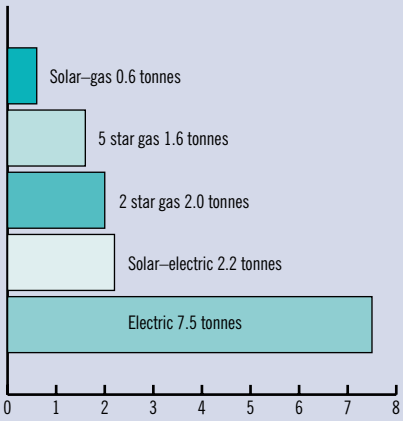
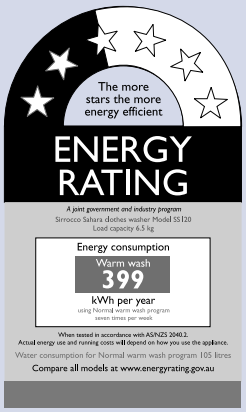


Figure 9.3: Carbon dioxide emissions for water heating fuels (tonnes CO_2 /annum)



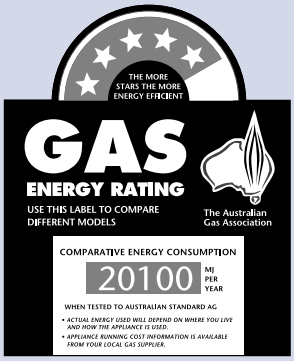


Figure 9.4: Gas and electric Energy Rating labels

Figure 9.5: Galaxy label

Look for the Energy Rating label

Most major household services and appliances now carry Energy Rating labels. These include gas space heaters, gas ducted heating furnaces, gas hot water systems, room air conditioners, refrigerators, freezers, washing machines, clothes dryers and dishwashers.

The stars on the Energy Rating label indicate the relative energy efficiency of the model. The more stars (maximum six), the more energy efficient the appliance.

The Energy Rating label also shows an energy consumption figure in a red coloured box. This indicates how much gas or electricity the appliance will use over a period of time (usually 12 months) when tested to an Australian Standard. It enables the running costs of different models to be compared. Of course, actual running costs will vary with patterns of use and energy tariffs.

An improvement of only 1 star can mean significant savings of around 10%. Even if a higher star rated appliance costs more to purchase, the running cost savings will make up the difference in only a few years.

When selecting an appliance, you should choose the type and size which suits your needs, and then compare the star rating of a range of suitable models.

Also ask for Galaxy Energy Award winning appliances. Galaxy Energy Awards are given to the most energy efficient appliances on the market each year.

Appliance energy consumption is conventionally expressed in units of kilowatt hours (kWh) for electricity or megajoules (MJ) for gas appliances. Check with your electricity and gas supplier, on what they charge for each kilowatt hour or megajoule an appliance consumes.

Home heating

A house designed on energy smart principles will need as little as 50% of the heating energy of a conventional home. Further savings can be achieved by installing an energy efficient heating system.

An effective heating system will meet household requirements efficiently and economically, respond quickly to changing outdoor conditions, use the least amount of energy and minimise the production of greenhouse gases. There are four decisions you will need to make to select an appropriate system.

DECISION 1: RADIANT OR CONVECTIVE HEAT

Heaters can produce two forms of heat—radiant and convective (or a combination of the two). The correct choice depends on the type of rooms to be heated and any special requirements or personal preferences.

Radiant heat

Radiant heat is emitted from hot surfaces, e.g. the glowing panel of a gas heater, the surface of a heated concrete slab, a bar radiator or open fire. Radiant heat directly warms people and objects in the room, rather than warming the air.

Radiant heaters are most appropriate if your rooms have large open spaces or high ceilings, or are particularly draughty, such as bathrooms.

Convective heat

Convective heat is heat which is transferred from one place to another using moving air. Convection heaters work by filling a room with warm air. Fan heaters and ducted heaters are examples of convection heaters.

Convection heaters are most appropriate for insulated, well-sealed rooms with average ceiling heights. They should be avoided in draughty rooms, rooms with high ceilings or areas with open stairwells.

DECISION 2: SPACE OR CENTRAL HEATING

Space heaters are designed to heat a room or area rather than a whole home. Central heating is used to provide whole-home heating.

It is vital to establish which areas of the home you need to heat, how large these are, and how long you need to heat them for.

Creating zones in your home can allow you to heat each zone individually, giving you flexibility—the key to energy efficiency.

Heating individual rooms with efficient space heaters, or installing a zoned central heating system, is preferable to whole-house central heating which heats all rooms regardless of whether they are in use or not.

Work through the table below to identify the best heating option for your home.

Table 9.1: Heater selection guide

AREA TO BE HEATED	HEATER
Only living zones (including kitchen, family room, lounge, etc.)	Use one or more high efficiency space heaters
Living areas for long periods, sleeping areas for short periods	Use high efficiency space heaters for living zones and electric 'spot' heaters for sleeping areas; or a high efficiency zoned central heating system
Living and sleeping areas for long periods at different times	Use a high efficiency zoned central heating system
Living and sleeping areas for long periods at the same time	Use a high efficiency zoned central heating system
Bathrooms/ensuites	Use radiant heaters, e.g. electric strip heaters, infra-red lamps

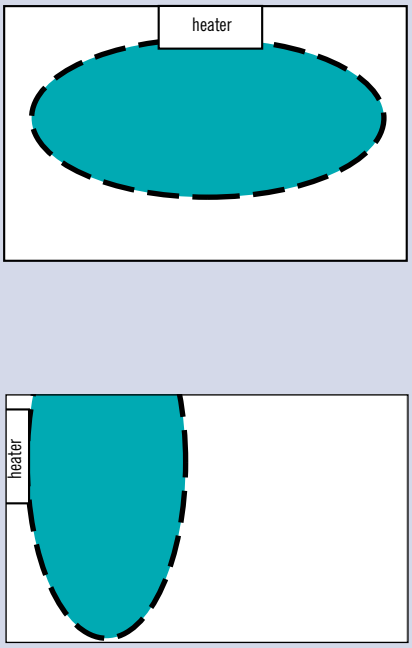


Figure 9.6: Positioning the heater

Space heating

A central location for a space heater is desirable so that it can distribute heat evenly around the room (see figure 9.6). Where possible, heaters or heating outlets should be placed close to windows to counteract cold draughts. Try not to have a heater opposite a window—this situation can create uncomfortable draughts across a room.

Central heating systems

For central heating systems, the furnace, boiler or air conditioning condenser unit should be close to the living areas to minimise heat losses in ducts or pipes. All ducting and piping should be well-insulated to reduce heat losses. Ducting should be insulated to a level of at least R0.9 for heating systems, and R1.5 for systems with heating and cooling. Dampers can be installed in the ducting to allow for energy efficient zoning. Supply air vents should be adjustable and closeable. Return air vents are best located at floor level, in a central area or within a main heating zone. Refrigerative piping should be covered with at least 10 mm thick Armaflex or similar insulation.

To maintain comfortable conditions, thermostats should be located in the main living area, at a height of about 1 m, rather than in a hallway or stairwell. Keep them away from draughts, external windows and sources of heat such as heating outlets or cooking equipment.

DECISION 3: SIZING THE HEATING SYSTEM

Heaters are generally sized according to the amount of heat needed to maintain a comfortable indoor temperature on a typical cold mid-winter night.

The size of a heating system should be based on calculations which take into account the areas of wall, floor and ceiling, construction materials, window sizes and their internal and external coverings, insulation levels, and ventilation rates. Prior to purchasing a heater, it is vital to have an installer carry out a heat load calculation.

If a heat load calculation is not carried out, there is the risk that the system could be undersized or oversized and its performance is likely to be unsatisfactory. An energy efficient home will not require a larger, more expensive heating or cooling system than a conventional home. In fact, the system required should be cheaper to run.

As a guide, table 9.2 gives estimates of heat requirements for each m^2 of floor area for homes of varying energy efficiency levels.

Table 9.2: Estimated heating requirements

TYPE OF DWELLING	HEAT OUTPUT REQUIRED (WATTS/M^2)*
Uninsulated	130
Insulated ceiling	100
Insulated ceilings and walls	80
Energy efficient design	60

* These estimates are based on 2.4 m ceiling height. Figures will be greater for electric storage heaters, and for rooms with ceilings greater than 2.4 m high.

DECISION 4: RUNNING COSTS

Indicative costs of different types of heaters are provided in figure 9.7. These costs are approximate and are intended for comparative purposes only. Actual running costs vary depending on such factors as the size of the area being heated, the capacity of the heater, and the hours of operation.

The following figures are based on providing heating for a home in southern Victoria built post 1990. Heating for eight hours a day to 21°C is assumed, except where indicated. Adjust the figures for each of the following:

- for an older home, increase space heating costs by 25% and central heating costs by 45%
- for an energy smart home, reduce costs by 30%
- for every 1°C increase in operating temperature, increase costs by 15%; for heating running 24 hours a day, double these costs (except for in-slab heating).

Figures based on:

- NatHERS THERMAL SIMULATION PROGRAM for a typical new home with R2.5 ceiling insulation and R1.0 wall insulation in Melbourne.
- 24 hours heating to 18°C for in-slab heating; 8 hours heating to 21°C for all others.
- Tariffs used—GD 15.0 c/kWh, Y6 5.0 c/kWh, Y8 6.0 c/kWh, natural gas 0.96 c/MJ, LPG 70.0 c/lt, wood $175/tonne. Supply charges not included.
- Costs for reverse-cycle air conditioners based on average GD electricity tariff. Selected retailers offer cheaper tariffs to customers using efficient reverse-cycle air conditioning systems.
- Includes energy costs of fans and pilot lights where used.

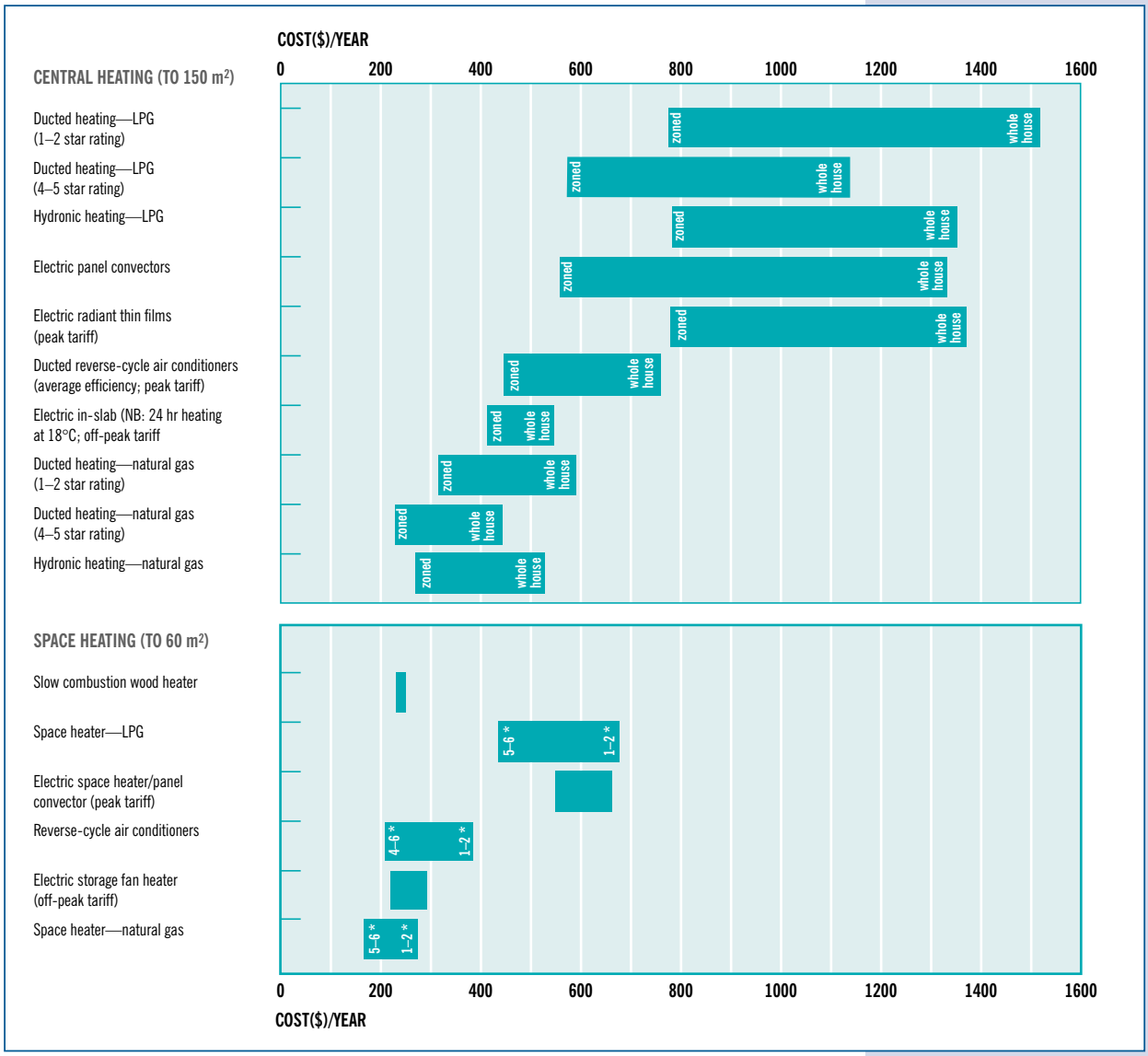


Figure 9.7: Comparative running costs for heating fuels (2002)

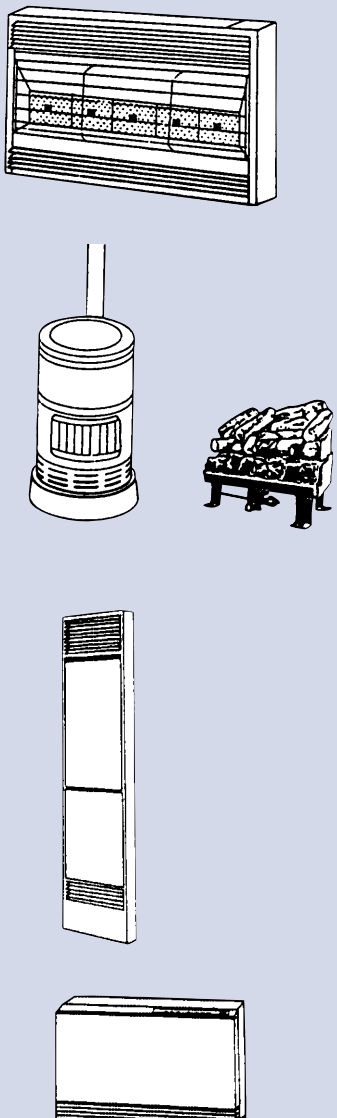


Figure 9.8: Gas space heaters

Types of heating systems

SPACE HEATERS

Gas space heaters

- Include wall furnaces, radiant/convective console units, convective console units and gas log fires.
- Run on natural gas or, where this is not available, LPG.
- Models can be flued or unflued (unflued models cannot be run on natural gas in Victoria).
- Can be installed on internal walls (need vertical flue) or external walls (need vertical or horizontal flue).
- Rated for energy efficiency with an Energy Rating label.
- Some wall furnaces have a rear register to heat an adjoining room.
- Heat areas from 30–100 m^2.
- Purchase cost: range from $1000–$2500 (unflued models start at around $600).

Checklist for greatest efficiency

☐ High star rating (at least 4 stars)

☐ Heat outlet at floor level

☐ Electronic ignition (avoid standing pilot lights)

☐ Power (or balanced) flue

☐ Thermostatic control

☐ Programmable timer

Off-peak electric storage heaters

- Three different types include storage radiators, storage fan heaters and combi banks.
- All produce both radiant and convective heat.
- Store off-peak electricity overnight as heat in storage bricks—this becomes available for use during the day.
- Combi heaters and storage fan heaters provide comfort conditions for living areas and can heat up to 60 m^2.
- Storage radiators are not fan assisted, and they heat up to 50 m^2. They provide 24 hour background heating at 14–18°C, and are suitable for areas such as bedrooms, studies, and hallways.
- Must be hard wired on a separate electrical circuit.
- Purchase cost: prices start at around $500.

Checklist for greatest efficiency

☐ Remote thermostat

☐ Charge controller

☐ Fan control

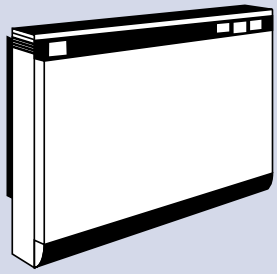


Figure 9.9: Storage fan heater

Reverse-cycle air conditioners

- Provide convective heating and cooling.
- Can be installed as a window-wall mounted single unit, or as a split system with the one motor outside and single console unit, or up to four console units (multi-split), mounted inside the home.
- Performance of some models suffers if external temperatures drop below about 5°C—check with the supplier for a guarantee of performance.
- Carry Energy Rating labels (all single-phase domestic systems).
- Heat up to 70 m^2.
- Purchase cost: around $800–$2000 for window wall units, and $1500–$5000 for split and multi-split systems.

Checklist for greatest efficiency

☐ High star rating (at least 4 stars)

☐ Remote thermostat

☐ Programmable timer

☐ Sleep mode

☐ Auto adjusting louvres

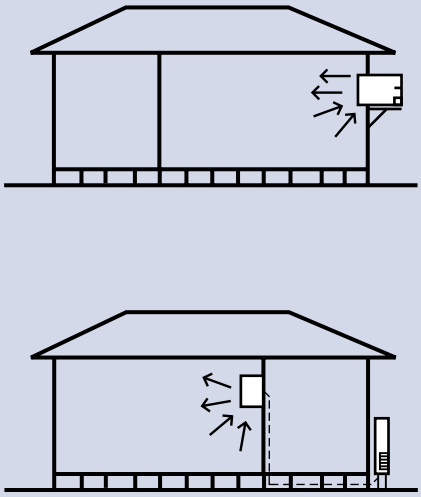


Figure 9.10: Reverse-cycle air conditioner

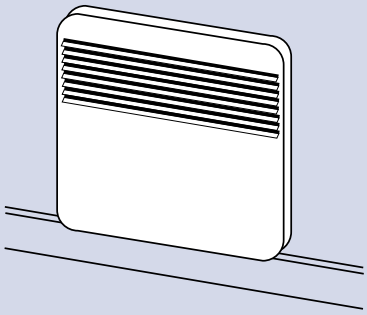


Figure 9.11: Electric panel convector

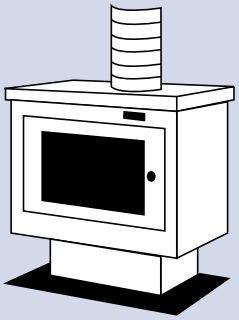


Figure 9.12: Slow combustion wood heater

Electric space heaters and panel convectors

- Convective and/or radiant heaters using peak rate electricity.
- Can be very expensive to run, generally suitable for heating small living areas.
- Can heat areas up to 35 m^2.
- Purchase cost: start at around $300 and they are cheap to install.

Checklist for greatest efficiency

☐ AAA rated or remote thermostat

☐ Programmable timer

Solid fuel heaters

- Produce radiant heat and convective heat (proportions of each depend on the model type).
- Include open fireplaces, fireplace inserts, pot belly stoves and high-efficiency slow combustion heaters.
- Slow combustion heaters are by far the most efficient, and can heat large, open areas (some large heaters can have water jackets installed to heat water). The other types are not suitable for use as the home's main heating source.
- The compliance plate will state the level of efficiency of slow combustion models.
- Convection models with a fan can heat areas up to 200 m^2.
- Require a flue.
- Purchase cost: start at around $800.

Checklist for greatest efficiency

☐ Check compliance plate for its level of energy efficiency (at least 60%) and heat output

☐ Air intake controls, baffles, secondary combustion chambers

☐ Good quality wood supply (e.g. seasoned redgum or box)

CENTRAL HEATING SYSTEMS

Regardless of the central heating system installed, it is important to ensure it is zoned. This allows different areas of the home to be heated independently as required, rather than having to heat the whole building all the time. Ideally, informal living areas should be separately zoned from formal living areas and bedrooms. All forms of central heating are able to be zoned, although not all brands of gas ducted heating and reverse cycle air conditioning allow this to occur.

Gas ducted heating

- Air is heated by a central furnace and distributed through ducts running under the floor or above the ceiling, and through registers into each room.
- Furnaces may be located in the roof space, under the floor or externally.
- Furnaces carry Energy Rating labels.
- Can heat areas of less than 90 m^2 to over 300 m^2.
- Purchase cost: start at around $2000.

Checklist for greatest efficiency

☐ Highest star rating (minimum of at least 4 stars)

☐ Zoning option

☐ Ducting insulated to at least R0.9 (and R1.5 if add-on cooling is included)

☐ Return air vent located at floor level (never in the ceiling)

☐ Thermostat located in the main living area, away from draughts

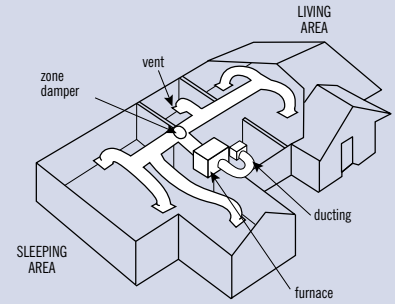


Figure 9.13: Gas ducted heating system

Ducted reverse cycle air conditioning

- Refrigerant becomes hot when it is compressed by an external compressor unit and pumped through to a heat exchange coil. Air is heated when blown through the coil. It is then distributed into each room through ducts running above the ceiling or sometimes under the floor.
- Also provides cooling.
- Can heat areas of less than 90 m^2 to over 300 m^2.
- Purchase cost: start at around $5000.

Checklist for greatest efficiency

☐ Zoning option

☐ Ducting insulated to at least R1.5

☐ Return air vent located at floor level (never in the ceiling)

☐ Thermostat located in the main living area, away from draughts

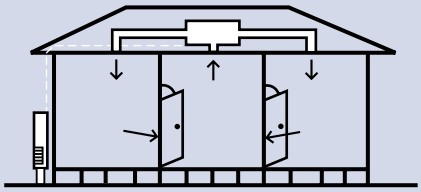


Figure 9.14: Ducted reverse cycle air conditioning

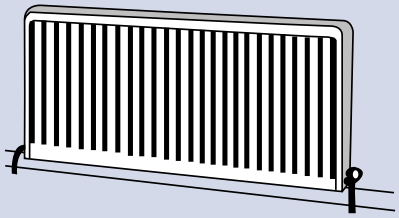


Figure 9.15: Hydronic heating

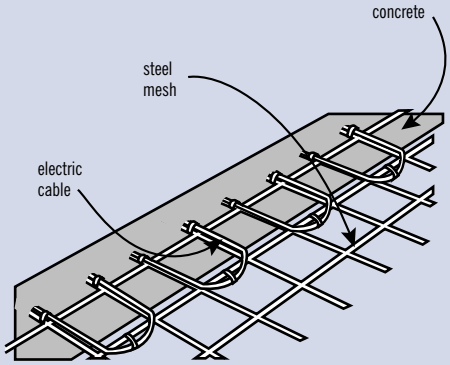


Figure 9.16: In slab heating

Hydronic heating

- Water is heated by a central boiler fuelled by natural gas or LPG (sometimes by off-peak electricity or solid fuel) and pumped through to panel radiators which heat rooms by radiation and natural convection.
- Each panel has its own control valve to provide independent room control.
- Can be used to heat areas from a single room to an entire home.
- Purchase cost: start at around $6000.

Checklist for greatest efficiency

☐ Low water content boiler

☐ Quick response panels (the most common is pressed steel)

☐ Well-insulated pipes (use Armaflex or similar)

☐ Independent controls for each panel

In-slab heating

- The home's concrete slab floor is heated using off-peak electric cables or hot water pipes embedded in the slab.
- Pipes or cables must be in place before the slab is poured, so usually suitable for new homes or extensions only.
- Slow response time (up to eight hours) to changes in settings means system should be set and left on for 24 hour heating.
- Should be kept at around 18°C for maximum economy.
- Purchase cost: start at around $2500.

Checklist for greatest efficiency

☐ Zoning for informal and formal living areas, bedrooms and utility areas

☐ Slab edge insulation

Home cooling

In most Victorian locations, an energy efficient home should need little or no additional cooling. By installing the appropriate insulation in ceilings and walls, shading to north, east and west windows and adjacent paved areas, good cross-flow ventilation and draught proofing will minimise cooling requirements. Also, the use of heavyweight building materials will also reduce the need for cooling, as it absorbs incoming solar radiation which would otherwise heat the air.

Regardless of the need, many homeowners decide to install a cooling system. If this is done, it is vital that the most energy efficient form of cooling appropriate to the home is used. This minimises both installation and operating costs.

TYPES OF COOLING SYSTEMS

In order of increasing energy consumption, the types of cooling systems available are:

- natural ventilation (i.e. opening doors and windows when the air outside is cooler than inside).
- fans.
- evaporative coolers.
- refrigerative air conditioners.

Selection is usually made on the basis of local summer climate, purchase and running costs, and practicalities of installation.

Fans

Fans are an energy efficient option for summer cooling, as they are inexpensive to purchase and operate, yet can still provide adequate levels of comfort. They do not reduce temperature or humidity, but produce a cooling effect by moving air over the skin. This increases heat loss from the body by convection and evaporation, lowering the perceived air temperature by 2–3°C.

Portable fans are most appropriate for personal cooling, whereas ceiling fans can provide whole room cooling.

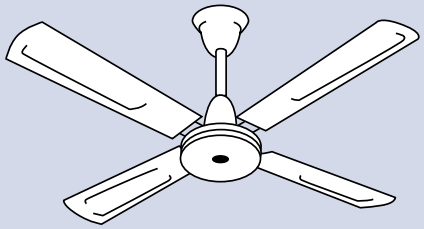
Portable fans

- Purchase cost: up to $100.
- Running cost: less than 1¢ per hour.

Checklist for greatest efficiency

☐ Oscillating feature

☐ Variable speed control



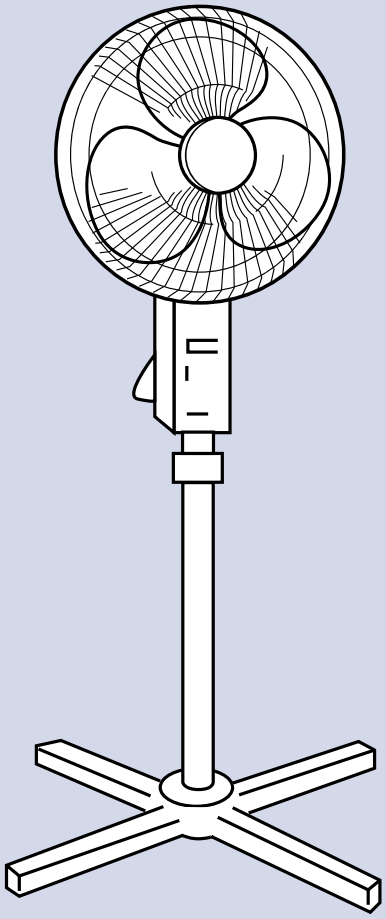


Figure 9.17: Ceiling fan and portable fan

Ceiling fans

- Will provide whole room cooling.
- Light can be included.
- Number of blades has no effect on cooling capacity.
- Curved blades produce more air movement than flat blades.
- Purchase cost: $70–$200.
- Running cost: 1¢ per hour.

Checklist for greatest efficiency

☐ Reversing function for winter use, to reduce down draught effect

☐ Variable speed control

EVAPORATIVE COOLERS

Evaporative coolers work by drawing warm outside air into the unit through a series of water moistened filter pads. This air is humidified and cooled, then blown into the home to replace warm inside air. Windows and/or doors must remain open while the system is operating, to exhaust moist air.

Evaporative coolers work best when humidity levels are low. The temperature of warm dry air is reduced by adding moisture to it. Hot, humid air cannot be cooled to the same extent. On days of high humidity, evaporative coolers provide a breeze-like effect.

Purchase and running costs are much lower than those for refrigerative air conditioning.

Portable evaporative units

- Suitable for small rooms, up to 25 m^2.
- Best positioned near an open window or external door, with another opening on the opposite side of the room.
- Purchase cost: $200–$400.
- Running cost: 1–3¢ per hour.

Checklist for greatest efficiency

☐ Water level gauge

☐ Variable fan speed

☐ Directional louvres

Ducted whole home evaporative systems

- Generally installed on the roof and ducted through the ceiling.
- Cool an entire home through ducting cool air to each room.
- Must have some doors or window open.
- Cannot use existing heating ductwork.
- Use up to 25 litres of water per hour.
- Purchase cost: $2000–$3000.
- Running cost: 8–12¢ per hour.

Checklist for greatest efficiency

☐ Site the unit on the side of the home which receives the prevailing hot winds

☐ Ducting insulated to at least R0.6

☐ Fit registers with dampers or vent covers to reduce winter heat loss

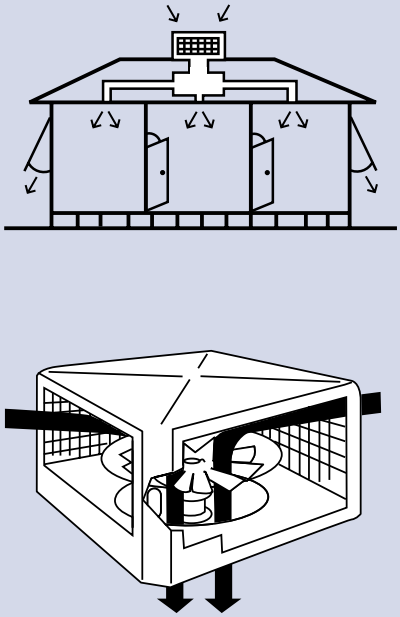


Figure 9.18: Evaporative coolers

REFRIGERATIVE AIR CONDITIONING

Refrigerative air conditioners (or heat pumps) cool homes by absorbing heat from the room air and transferring it outside. At the same time, the air is dehumidified. Unlike evaporative coolers, they work effectively in any climate. However, they are the most expensive type of cooling system to purchase and operate. Windows and doors need to remain closed when using air conditioners. All single-phase domestic units carry an Energy Rating label, with 1–6 stars. The more stars, the more efficient the unit. As well as cooling, reverse cycle air conditioners can provide cost-effective heating.

Portable units

- Separate internal and external unit connected by a flexible hose through an open window or door.
- Designed to provide cooling to smaller rooms, up to 20 m^2.
- Purchase cost: $800–$3000.
- Running cost: 6–8¢ per hour.

Checklist for greatest efficiency

☐ High star rating

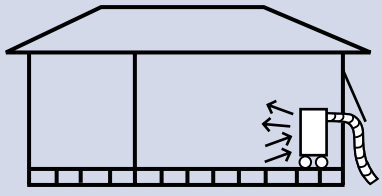


Figure 9.19: Portable air conditioner

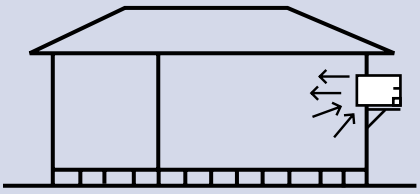


Figure 9.20: Window/wall air conditioners

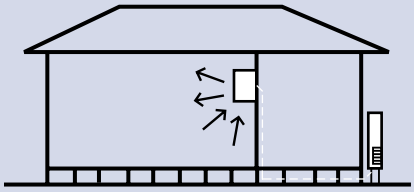


Figure 9.21: Split air conditioner

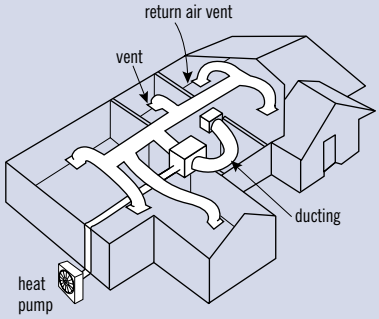


Figure 9.22: Ducted reverse-cycle air conditioning

Window/wall and split systems

- Room air conditioners, suitable for single rooms up to 60 m^2.
- Window/wall units have all components in the same 'box'.
- Split systems have separate indoor consoles and outdoor compressors, and are much quieter to operate. The indoor unit can be up to 15 m away from the outdoor unit.
- Split systems can have wall, floor or ceiling-mounted consoles.
- Purchase cost: $500–$5000.
- running cost: 20–30¢ per hour.

Checklist for greatest efficiency

☐ High star rating

☐ Reverse-cycle option

☐ Programmable thermostats

☐ Sleep or economy modes

Multi-split systems

- Split systems in which up to five internal consoles can be operated from the one external unit.
- Split systems can have wall, floor or ceiling-mounted consoles.
- Can be suitable for providing cooling to different parts of the home.
- Consoles may be able to be run independently or simultaneously, depending on system configuration.

Checklist for greatest efficiency

☐ High star rating

☐ Reverse-cycle option

☐ Programmable thermostats

☐ Sleep or economy modes

Ducted systems

- Designed to air condition an entire home.
- Generally placed in the ceiling, but floor systems can also be as effective.
- Can generally be run through existing ducted heating ductwork, provided it is of at least 200 mm diameter (standard heating ducting is 150 mm diameter).
- Not rated for energy efficiency.
- Purchase cost: $5000 plus.
- Running cost: 40–60¢ per hour.

Checklist for greatest efficiency

☐ Zoned system, with living and sleeping areas separately controlled

☐ Compressor protected from direct sun, and located on shady side of building

☐ Ducting insulated to R1.5

☐ Registers fitted with dampers to reduce winter heat loss (in cooling only systems)

Water heating

The annual cost of water heating for a four-person family, based on an average use of 220 litres of hot water a day, could be reduced from around $700 for an uneconomical instantaneous peak rate electric system to a low $70 for a gas-boosted solar hot water system.

About a quarter of the energy used by Victorian households is for water heating. Most of this water is used in the bathroom (40–60%) followed by the laundry (30–40%) and kitchen (10–20%). There is scope for substantial savings by choosing an appropriate energy efficient hot water service, and installing energy efficient washing machines and dishwashers, together with low flow showerheads or flow restrictors.

STORAGE AND CONTINUOUS FLOW SYSTEMS

The two main types of hot water systems are storage and continuous flow. Both types are suitable for most households, if sized correctly.

Storage systems

Storage systems hold hot water in an insulated tank ready for use throughout the day. They are available in either mains pressure or constant pressure. They can be fuelled using natural gas, electricity, LPG, solid fuels, with or without solar. The most economical types of storage systems are natural gas and off-peak electric.

Mains pressure systems provide hot water at a similar pressure and flow rate as cold water. This allows more than one outlet to be used without affecting supply pressure. Mains pressure units are normally located at ground level, either internally or externally.

Constant pressure systems deliver hot water at a lower pressure than mains pressure systems. They are usually located in the roof space of a home, and the pressure depends on the vertical height between the tank and point of use. The main advantages of constant pressure are that systems are much cheaper to purchase and have much longer life expectancies than mains pressure systems. These systems are also known as gravity feed or low-pressure systems. Problems may be experienced with inadequate pressure, although appropriate plumbing can assist in reducing these.

Continuous flow

Continuous flow ('instantaneous') systems have no storage capacity and heat water upon demand. They cannot 'run out' of hot water like storage systems. Depending on their capacity, units are able to provide sufficient hot water to run from one to three or more outlets simultaneously. It is vital that they are correctly-sized according to the number of hot water outlets in the home.

The most economical fuel for continuous flow systems is natural gas. They can also use LPG or peak rate electricity, however running costs will be considerably higher using these fuels.

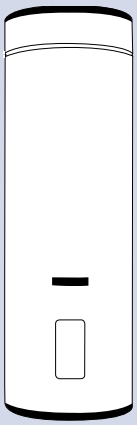


Figure 9.23: Mains pressure storage water heater

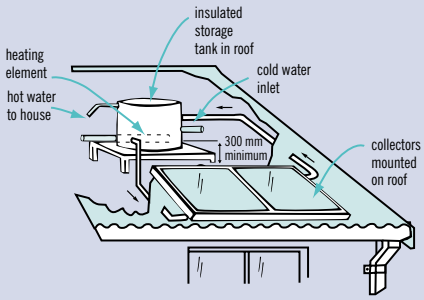


Figure 9.24: Constant pressure storage water heater

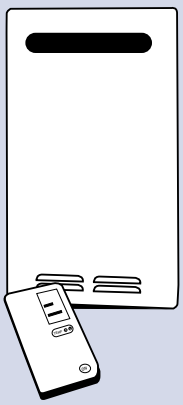


Figure 9.25: Continuous flow water heater

FUEL TYPES

The most common fuels for hot water systems are natural gas and off-peak electricity (storage units only). For similarly sized households, systems using either fuel cost approximately the same to buy and run.

Natural gas

- Available 24 hours a day at a set rate.
- Have quick recovery times and smaller storage tanks.
- Can be used in storage and continuous flow systems.
- All natural gas systems are rated for their energy efficiency with Energy Rating labels—the more stars, the more energy efficient.
- Internal and external models are available.
- LPG is used in areas where natural gas is not available. Running costs for LPG systems are 50–100% higher than natural gas.

Off-peak electricity

- Heats water overnight (generally between 1 am–7 am or 11 pm–7 am) to provide adequate hot water for daily usage.
- Requires larger storage capacity than gas units to serve the same size household.
- Only available for storage systems of 160 litres or greater capacity—not available in continuous flow systems.
- Internal and external models are available.
- Your electricity supplier can inform you as to what tariff to choose. The six hour tariff (1 am–7 am) is generally cheaper than the eight hour tariff (11 pm–7 am).

Solar energy

- Can supply 60–70% of hot water needs free in Victoria (60–65% in Melbourne).
- Usually the cheapest system to run, but relatively high purchase costs makes a payback period of around ten years.
- All systems have supplementary boosting to provide hot water during periods of low sunshine. Off-peak electricity, gas or solid fuel boosting is available.
- Generally located on the roof, with the storage tank directly connected to solar collectors. However, the tank can be located at ground level in some systems.
- Mains and constant pressure systems are available.

Peak rate electricity

- Can be used for continuous flow units and storage heaters of less than 160 litres capacity.
- Can be very expensive to run, and should be avoided where other options are possible.

Solid fuel (wood, briquettes, coal, etc.)

- Costs can vary greatly.
- Can be used alone or in conjunction with off-peak electricity and/or solar constant pressure storage units.
- Unless specifically designed, cannot be used with mains pressure systems.

Heat pumps

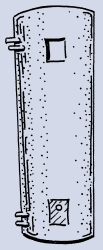
- A high-efficiency method of water heating, using around 65% less electricity than conventional water heaters.
- Heat is extracted from the atmosphere using a refrigerant gas, and used to heat water in a storage tank.
- Low running costs, similar to natural gas or off-peak electric systems.
- Have high purchase costs.

SELECTING A HOT WATER SYSTEM

Hot water systems must be sized to meet your household's hot water requirements. This is typically reflected by the number of people in the household. The following tables can be used as a guide to sizing a hot water system, however, consult your supplier for specific recommendations.

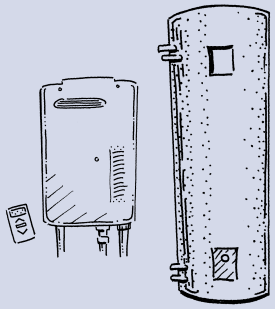
Note: high water usage households (e.g. those with spas or dishwashers) should select the next largest system size in the range. A dishwasher with a hot water connection should be counted as an extra person.

Table 9.3: Typical sizes for hot water systems



Electric storage hot water services

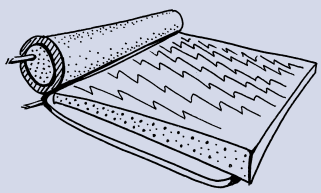
OFF PEAK		PEAK RATE	
Number of persons served	Capacity (litres)	Number of persons served	Capacity (litres)
1–3	160	1	25
2–4	250	1–3	50
3–6	315	2–4	80
5–8	400	3–5	125



Natural gas and LPG water heaters

STORAGE		CONTINUOUS FLOW	
Number of persons served	Capacity (litres)	Number of outlets served at one time*	Flow rate (litres per minute)
1–3	90	1	16
2–4	130	2	20
3–5	170	2–3	24
4–6	200	3+	32
5–9	260		

* Continuous flow systems are sized according to the required flow rate. A guide is often the number of bathrooms in the home. As always, consult the suppliers or manufacturers for specific sizing guidelines for their products.



Solar water heaters

NUMBER OF PERSONS SERVED	HOT WATER DELIVERY (LITRES PER DAY)	APPROXIMATE SIZE OF TANK (LITRES)	COLLECTOR (m^2)
1–2	120	180	2
3–4	200	300	4
5–6	300	440	6

RUNNING COSTS

Table 9.4: Typical running costs of hot water systems

FUEL	APPLIANCE	WATER	INSTALLATION	PURCHASE COST*	ANNUAL ENERGY COST (four person family)
					$100 $200 $300 $400 $500 $600 $700 $800 $900 $1000
ELECTRICITY	Off-peak (Y6) storage	Mains	Internal and external at ground level	$800–$1500	
	Off-peak (Y6) storage	Constant	In roof space	$600–$1200	
	Peak rate (GD) storage	Mains	Internal at floor level (typically in a cupboard)	$500–$800	
	Peak rate (GD) continuous flow	Reduced	Internal and external at ground level	$500–$1100	
	Heat pump (GD)	Mains	Internal and external at ground level	$2500–$3500	
NATURAL GAS	**STORAGE**				
	5 star efficiency	Mains	Internal and external at ground level	$800–$1200	
	2 star efficiency	Mains	Internal and external at ground level	$700–$1000	
	CONTINUOUS FLOW				
	5 star efficiency	Reduced	Internal and external, wall mounted	$800–$2100	
	2 star efficiency	Reduced	Internal and external, wall mounted	$600–$800	
LPG* **	**STORAGE**				
	5 star efficiency	Mains	Internal and external at ground level	$800–$1200	
	2 star efficiency	Mains	Internal and external at ground level	$700–$1000	
	CONTINUOUS FLOW				
	5 star efficiency	Reduced	Internal and external, wall mounted	$800–$2100	
	2 star efficiency	Reduced	Internal and external, wall mounted	$600–$800	
SOLAR ^	Solar/off-peak electric storage	Constant	Tank in roof space	$2500–$4500	
	Solar/off-peak electric storage	Mains	External tank at ground level or on roof	$2500–$4500	
	Solar/gas storage (5 star efficiency)	Mains	External tank at ground level or on roof	$3000–$5000	NG LPG

* Excludes installation costs.

** Cost range is based on using 180–260 litres/day. 180 litres/day is assumed for energy conscious users, 260 litres/day for high volume water users. Includes 7% pipe losses. Annual supply charges are not included. Costs are provided as a guide to running costs only. Actual costs will vary with usage, size of family and personal preferences.

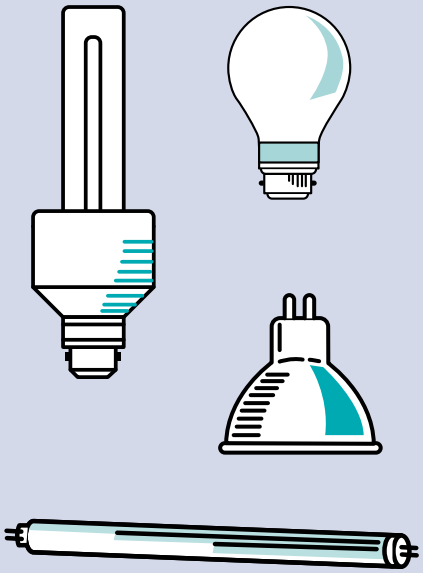
*** Does not include cost of delivery and rental on gas bottles. LPG cost at 70¢ litre. LPG prices can fluctuate widely and vary geographically.

^ Cost range for solar hot water systems is based on 65% solar contribution.

NG Natural Gas

LPG Liquid Petroleum Gas

Source: Figures are based on information provided by gas supply retailers, the Australian Gas Association, electricity retailers and relevant manufacturers.



Lighting

The key to lighting is getting the most energy efficient lamp in the right place and the best fitting to suit different lighting requirements. Different types of lighting can be used to provide general or task lighting. Savings of up to 50% can be made on lighting bills with an energy efficient system.

CHOOSING LAMPS

There are three main types of lamps—incandescent, quartz halogen and fluorescent. These lights are suitable for different rooms in the home.

Incandescent lamps

- The most commonly-used type of lighting.
- Inexpensive to buy, but with highest running costs.
- Last around 1000 hours.
- Recommended for lighting bedrooms, hallways, bathrooms and similar where light is frequently switched on and off or required for short periods.
- Can be dimmed.

Quartz halogen lamps

- Around twice as efficient as incandescent lamps.
- More expensive to buy.
- Last up to 2000 hours.
- Recommended for task lighting (e.g. over a kitchen benchtop), or for highlighting features.
- Not recommended for general lighting, which would demand extra light fittings, increasing running costs.

Fluorescent lamps

- Most energy efficient form of lighting.
- Last up to 8000 hours.
- Should be used for general illumination of living areas, kitchens, family, rumpus rooms and similar areas used for long periods.
- Available in straight or circular tubes.
- Also suitable for outdoor lighting.

Compact fluorescent lamps are designed for general lighting to replace conventional incandescent globes. They can provide the same lighting output, whilst using only around 20% of the power, and last up to eight times longer.

CHOOSING FITTINGS

Light fittings are not merely cosmetic. Maximum energy efficiency and light output depends not only on the choice of lamp but also on the fitting. The output of a 75 watt lamp with a good luminaire can be superior to that of a 150 watt lamp.

In general, pendant fittings should be used for general illumination. Avoid dark-coloured or heavily tinted fittings, or fittings with multiple globes which require more energy to produce similar light outputs. Downlights (recessed lights) can be useful for highlighting features, such as a picture, but are a poor source of general illumination.

A common design concern in new homes is the overuse of recessed quartz halogen (also known as low voltage) downlights. These lamps should not be used as the main source of general illumination in a home. They are more expensive to buy and run, require overlighting of rooms to produce light of acceptable quality, and need to maintain clearances away from insulation to prevent overheating. Consider the use of spot or track lighting instead of recessed lights.

DESIGNING HOUSEHOLD LIGHTING

Maximise the use of daylight

- Paint walls and ceilings in light colours.
- Maximise window sizes.
- Where natural light is restricted, use light-coloured courtyard walls to reflect light or use high-level clerestory windows or roof glazing.

Maximise the effectiveness of lighting

- Select luminaires which maximise light output for general lighting.
- Use downlights and uplights with opaque shades for accent lighting.
- Minimise high-contrast pockets that can cause glare.
- Keep fittings clean—dirty fittings can reduce output by up to 50%.

Provide separate switches

- Ensure lights can be separately controlled for maximum flexibility and economy.
- Consider two-way switches for rooms with more than one entry/exit point.

Match lighting to needs

- Use targeted or task lighting for concentrated tasks, e.g. study or kitchen.
- Use general lighting in rooms used for general activities, e.g. family room.
- Where lights need to be left on for more than 45 minutes, fluorescent lights are the most energy efficient.
- Where lights are on for less than 45 minutes, or are switched on and off frequently, use incandescent globes.

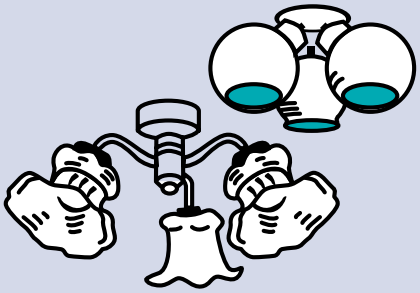


Figure 9.26: Multiple light fittings

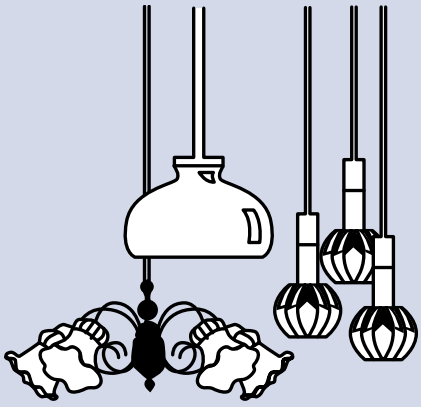


Figure 9.27: Pendant lights

LIGHTING FOR DIFFERENT AREAS

Some lighting recommendations for different areas are outlined in table 9.5. The selection of lighting depends on the type of activity taking place in the area, the length of time that the light is likely to be left on, and the likely on/off frequency.

Table 9.5: Lighting recommendations for different areas and activities

AREA	LIGHTING	LAMP TYPES	LUMINAIRE TYPE
KITCHEN	▸ high-level general lighting ▸ targeted task lighting	▸ fluorescent ▸ fluorescent or quartz halogen ▸ direct (downlights/ tracklights)	▸ diffused/direct (ceiling mounted, pendant or downlights)
LIVING, DINING FAMILY ROOM	▸ low-level background lighting ▸ general lighting ▸ targeted task lighting	▸ compact fluorescent ▸ compact fluorescent ▸ compact fluorescent or quartz halogen	▸ diffused/indirect (uplights, wall mounted diffusers) ▸ diffused/direct (ceiling mounted, pendant or downlights) ▸ direct (spotlights, downlights, portable lamps)
BEDROOMS AND STUDIES	▸ general lighting ▸ targeted task lighting	for general or targeted: ▸ incandescent for short periods; fluorescent for long periods	▸ diffused (ceiling mounted or pendant) ▸ direct (adjustable wall mounted or portable reading lights)
LAUNDRY, BATHROOM AND TOILET	▸ general lighting ▸ targeted task lighting	for general or targeted: ▸ incandescent for short periods; fluorescent for long periods	▸ diffused ▸ direct (mirror lighting)
HALLWAY AND ENTRY	▸ low level background lighting	▸ fluorescent for long periods; incandescent for short periods or use with motion sensors	▸ diffused (wall, ceiling mounted, pendant)

Table 9.5 continued

AREA	LIGHTING	LAMP TYPES	LUMINAIRE TYPE
OUTDOOR LIGHTING	▸ low level background lighting	▸ solar, incandescent for occasional lighting of large areas, or fluorescent for long periods	▸ diffused/direct (wall mounted, post mounted)
SECURITY LIGHTING	▸ high-level lighting ▸ general lighting	▸ High Intensity Discharge (HID) or fluorescent ▸ incandescent or quartz halogen used with motion sensors	For high-level and general lighting: ▸ Direct (wall mounted, post mounted)
GARAGES AND WORKSHOPS	▸ general lighting ▸ targeted lighting long periods; incandescent for short periods	for general or targeted: ▸ fluorescent for mounted	▸ diffused ▸ direct (wall or portable)

LIFETIME LAMP COSTS

The lifetime costs of various lamps are compared in figure 9.28. The factors which determine the cost of lighting are:

- purchase cost—lamps, luminaires, dimmers, ballasts;
- replacement costs and lamp life;
- power costs; and
- number of operating hours per day.

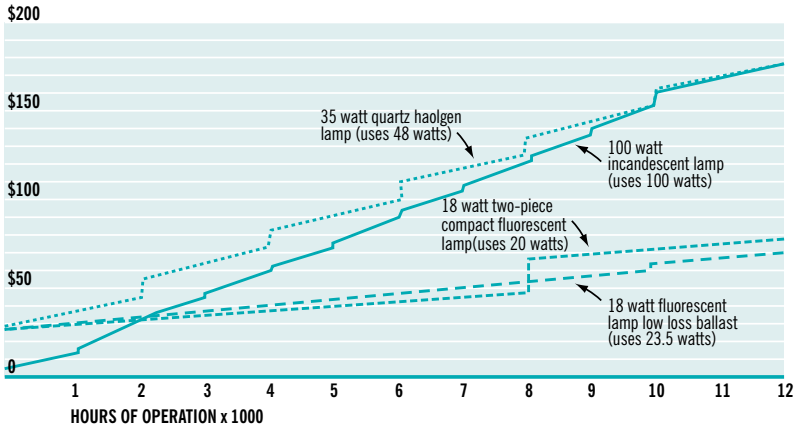


Figure 9.28: Comparative lifetime costs of lamps
Source: State Electricity Commission of Victoria, September 1993

Appliances

Appliances account for 25% of the total energy consumption of Victorian households. Of this, 9% is used for refrigeration. Selection of efficient appliances and responsible user behaviour can save 30–50% on the appliance component of the electricity bill.

Energy Rating labels are found on all new refrigerators, freezers, clothes washers, clothes dryers and dishwashers. These labels use stars to show the energy efficiency of an appliance. The more stars, the more energy efficient the appliance, the lower its running costs, and the lower its greenhouse gas emissions. Even a 1 star improvement can reduce running costs by around 10%.

When selecting an appliance, you should first of all work out what size or capacity you need, together with any specific features you require. Retailers or manufacturers can assist with this. Once the correct size has been found, look for the most energy efficient model to suit your needs.

The following checklists will help to find the most suitable and energy efficient appliances for your needs.

REFRIGERATORS AND FREEZERS

Look for the most appropriate size for your storage requirements.

Tips for use

- Locate away from heat or direct sunlight (being next to an oven or sunny window can increase energy consumption substantially).
- Keep the refrigerator section at 4°C, with the freezer at -18 to -20°C. For every one degree lower, energy usage rises by around 5%.
- Regularly check that door seals fit properly. (Try closing a door on a piece of paper. If you can pull the paper free, the seal is not working effectively.) Condensation around the door seals indicates a severe problem.
- Leave at least a 5 cm gap between the rear of your fridge and the wall to allow adequate ventilation for heat dispersal.
- Regularly dust the coils at the rear of your fridge.
- Help prevent frost build-up by covering liquids and regularly defrosting your freezer (except frost free models).

DISHWASHERS

Look for:

- economy cycle for lightly soiled dishes;
- a range of program settings which give flexibility for further savings on energy and water; and
- dual hot and cold water connection.

Tips for use

- Cold water connection uses the least energy, as the dishwasher only heats water for certain wash cycles (generally hot water is only required on the wash cycle). However because peak rate electricity is used to heat the cold water this usually costs slightly more to run.
- A hot water connection is usually cheaper to run, provided you use water heated by off-peak electricity, gas or solar hot water system. However this uses more energy using hot water on all the washing cycles.

WASHING MACHINES

Look for:

- a front loading machine—these use less water and energy, and are gentler on clothes, than top-loaders;
- a range of cycles to suit different fabrics; and
- variable temperature settings to suit different degrees of soiling and load sizes.

Tips for use

- Use cold water wherever possible, with an appropriate cold water detergent.
- Use your washing machine only when it is full.
- Avoid overloading or using excessive detergent.
- Use the 'suds save' option to re-use your washing water.
- Connect a self-heating washing machine and a clothes dryer to separate electrical circuits to prevent overloading. If this is not possible, do not use them simultaneously.

CLOTHES DRYERS

Look for:

- a range of fabric or temperature settings to match the type of load with the drying needed;
- autosensing models which automatically switch off when clothes are dry; and
- external venting or condensing models to shorten drying time.

Tips for use

- Use the dryer only when full.
- Don't overload—this increases drying time.
- Ensure clothes are spin-dried before loading.
- Clean the lint filter before each load—this will reduce drying time. Uncleaned lint filters can also be a potential fire hazard.
- Try not to mix heavy and lightweight clothing together.
- Use the dryer on high setting for optimum drying efficiency.
- If it's fine outside—use your clothes line!

COOKING APPLIANCES

Energy ratings have not yet been developed for cooking appliances. On the whole, smaller appliances are more efficient than larger ones. That is, if the same item can be cooked in a smaller appliance it is likely to be more economical to do so.

Cooktops

- A variety of burner or hotplate sizes assist efficiency.
- Gas burner efficiencies vary according to the setting and flame control adjustments made by users.
- Electric hotplates are generally slower to respond than gas burners, and cost about twice as much to run. A variety of types are available, including halogen and radiant coils (thin coil and mono coil) which may be concealed by a ceramic finish, with some loss of efficiency.

Gas and electric ovens

- Although gas is cheaper than electricity, gas ovens and electric ovens have comparable running costs (gas ovens are less efficient due to venting).
- A fan-forced oven can result in considerable savings, as the better heat distribution enables larger batches of food to be cooked, operating at lower temperatures with shorter cooking times.

Microwave ovens

- The most energy efficient form of cooking, with quick cooking times and low running costs.