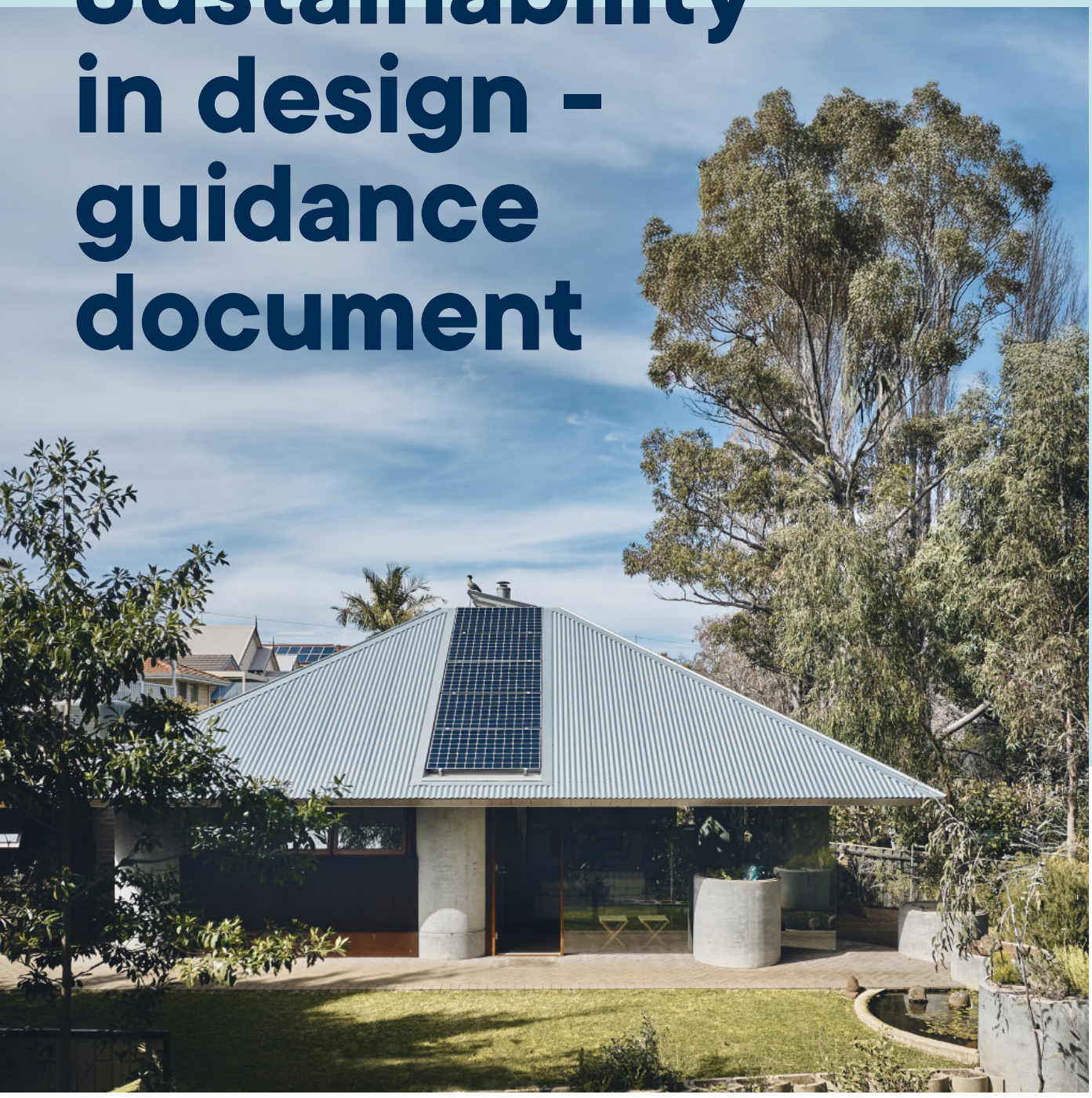
City of
Bayswater

Sustainability in design - guidance document



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CITY OF BAYSWATER
The Garden City - Quality Lifestyle

Contents

Introduction

Research has shown there is a growing interest in the idea of a sustainable home, not only for environmental reasons, but also for creating a cost-efficient comfortable environment in the home that does not heavily rely on energy and water use.

The purpose of the Sustainable in Design Guidelines ("Design Guidelines") is to provide sustainable design options for building new homes, renovating homes, and more generally building and renovating non-residential buildings.

Chapter 1 highlights the importance of site planning and preparation, with a focus on landscape and tree retention, and site orientation. Site orientation explores the best positioning of the home or building to maximise sunlight access (winter warming) and shade (summer cooling). This chapter also details how to maximise views of vegetation (biophilic design).

Chapter 2 explains passive design. It looks at the overall building design and how to rely on natural sources of cooling and warming the home, saving on long term energy costs. This includes ceiling fans, shading, cross ventilation, thermal mass, insulation, ventilation, and airtightness.

Chapter 3 looks at how to design an efficient electric home through the use of solar, solar battery storage and electric vehicles**.**

Chapter 4 details sustainable building material options including cool roofs and fences, and discusses the influence building material choice has on air quality and thermal performance.

Chapter 5 provides water sensitive urban design principles including grey water reuse, rain garden design, and rainwater tank information.

Chapter 6 highlights the role that landscaping plays for improved sustainability, through improved thermal performance (shading for cooling or direct sun for warming), and creating spaces to enjoy outside of the home.

Chapter 7 looks at various performance tools used in industry including NatHERS, Housing Industry Association's (HIA) Greensmart Protocol and Life cycle assessments.

This information also helps guide property owners and designers in applying the provisions of the City's Sustainable in Design Local Planning Policy.

Chapter 1: Site planning and preparation

Taking time to choose the right block and working through design options can improve the overall quality of a build, provide financial cost savings along with environmental benefits and personal satisfaction.

Landscape and tree retention

Consider existing trees and other vegetation that can be retained to provide natural shade and cooling to the home during the summer months, saving of electricity costs.

Where an existing healthy tree is located on site, speak to your local arborist to see if you can design your home around this tree.

Trees that are able to grow taller than 3 metres high, can take up to 10 years to grow to full maturity. Some trees such as Tuarts can take 15 years. This can be a long wait for a new tree to grow to its full maturity to give the full pleasure of its presence with shade, cooler environment, bird habitat and more.

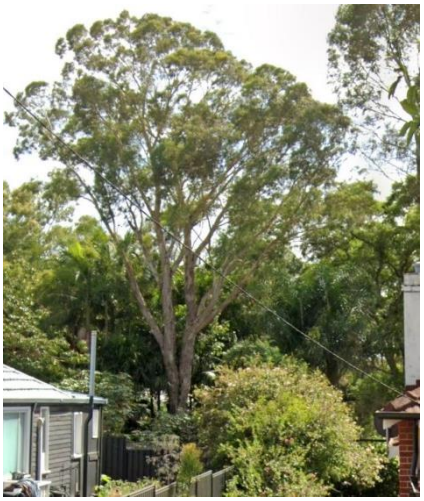


Figure 1 Trees on private land

Size

Bigger isn't always better. Sustainable homes are generally smaller in size. Larger homes require more heating, air conditioning and lighting and also take up valuable garden space.

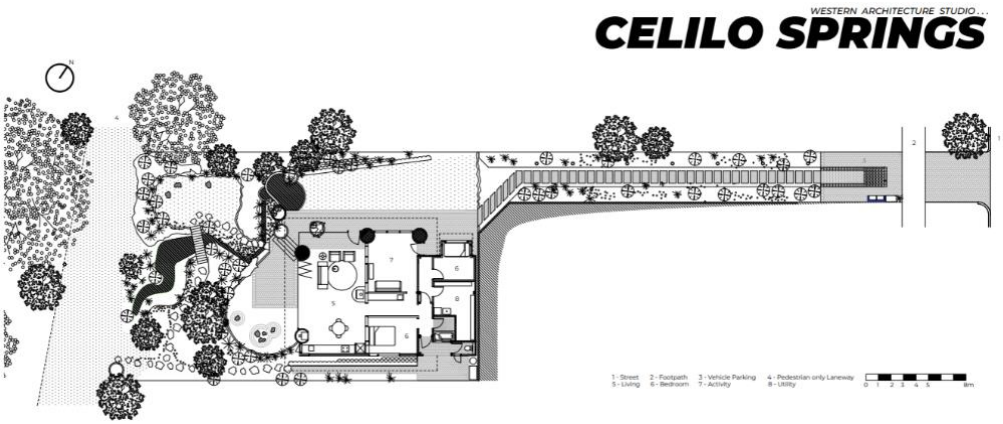


Figure 2 Celilo Springs landscaping and floor plan

Site Orientation

For a Perth climate the aim is to balance winter sun and summer shade. North orientation windows to living spaces is desirable to allow full sun access in winter. In these climates you can easily shade northern façades in summer with simple horizontal devices such as eaves.

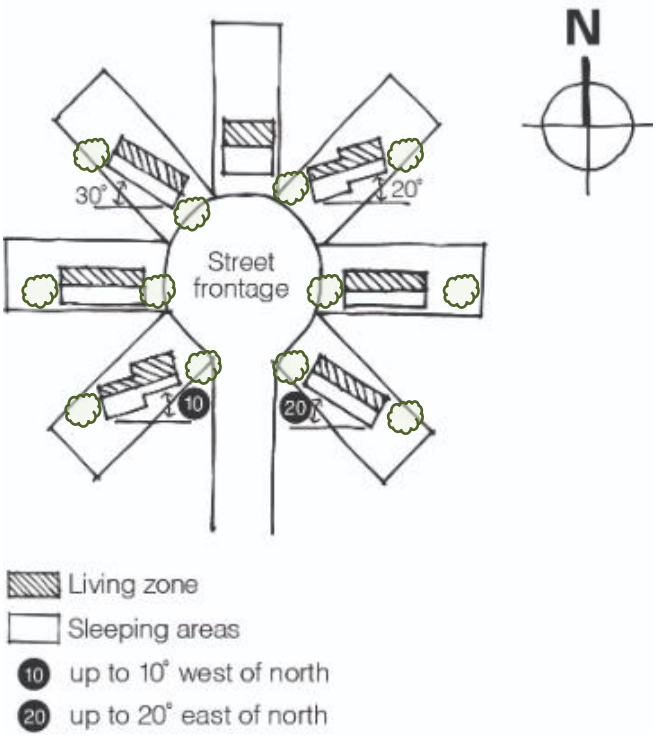


Figure 3 Optimal living space locations depending on lot orientation Source

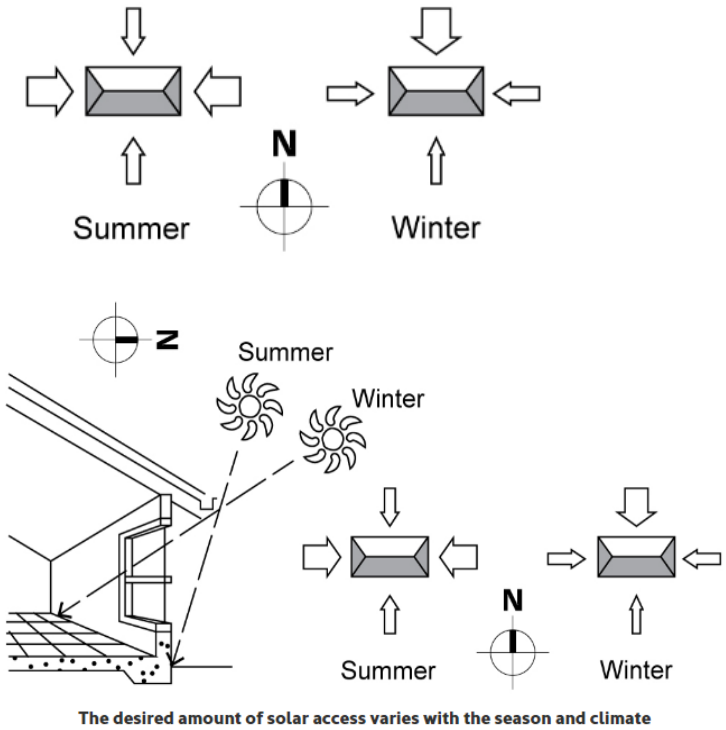


Figure 4 Above images demonstrating sun accessing the building during summer and winter months

Universal access design

The Livable Housing Design Guidelines (Livable Housing Australia) provides a practical, common sense guide to designing for livability for all life stages. It's makes smart sense to commit to livability features when a home is first designed and built rather than wait for an unplanned need to arise.

These features work for young families with kids, pregnant mums and people with injuries, as well as seniors, Australians with disability and their families.

Biophilic Design

The relative abundance of greenery visible from the home or in the neighbourhood is associated with improved feelings of happiness and reduced stress.[i]

Biophilic design aims to bring nature into urban areas and views of nature from the home. It puts nature at the core of design and planning, not as an afterthought.

The below development uses biophilic design principles:

Figure 5 Rear lot development (7 star energy rating) Celilo Springs - Mt Lawley

The below image shows the negative impact infill development has when there is no consideration of biophilic principles and demonstrates the extent of garden clearing including loss of tree canopy:

Figure 6 Land clearing and loss of vegetation

Biophilic Orientation

Where available, houses are to be orientated toward areas of natural vegetation, including water bodies, parks and reserves (public open space). A large window or sliding door to a bedroom or living space of a house facing a public open space, balanced with privacy to these spaces, will provide an optimal outlook improving enjoyment within the home. The image below demonstrates this with modified boundary fence to include portions that are visually open allowing views of the public open space (parkland).

Figure 7 Window positioning and visually permeable fencing to gain views of parkland

Where the public open space is not viewable from the house another option is strategically locating green plantings around the garden that are visible from bedrooms and living spaces of the home. Image below shows native shrubbery planted in the garden visible from the kitchen, dining and lounge room.

Figure 8 Views from living space to native garden Celilo Springs - Mt Lawley

Passive Design

Design for low cost comfort in the home

Approximately 40% of household energy is used for heating and cooling. This could be reduced to almost zero through design for climate. Perth is in a warm temperate zone, for which building design requires a balance between reducing cooling needs in summer and reducing heating needs in winter.

Passive cooling (during warmer months)

With passive cooling, building envelopes (the building components including walls, windows, doors, roof etc) are designed to minimise daytime heat gain, maximise night-time heat loss, and encourage cool breeze access when available.

Passive cooling includes reducing heat gain through whole of building design including:

- Earth-coupled concrete slabs-in-ground (at a depth of 3 metres transferring cool earth temperature via the slab to the house).
- Shading high thermal mass in living areas during the day in summer, and limit thermal mass in upstairs sleeping areas.
- Consistent layer of roof insulation provided with minimal gaps.
- Appropriate insulation for roofs, walls and floors.
- Exhaust fans/range hoods ducted directly out through the roof, rather than venting into the roof cavity, avoiding heat and moisture buildup.
- Providing airtightness.
- Shading of east and west facing glazing.
- Window treatments such as block out blinds or curtains and shutters.
- Increasing heat loss through optimising on cool breezes with narrow or open-plan layouts, openable windows, cross ventilation, and unrestricted breeze paths (refer to below image).
- Evaporation can also help to cool the air, and fans provide reliable air movement to cool people and supplement breezes during still periods.
- Providing gardens and green plants, and minimising hard surfaces outside the home.

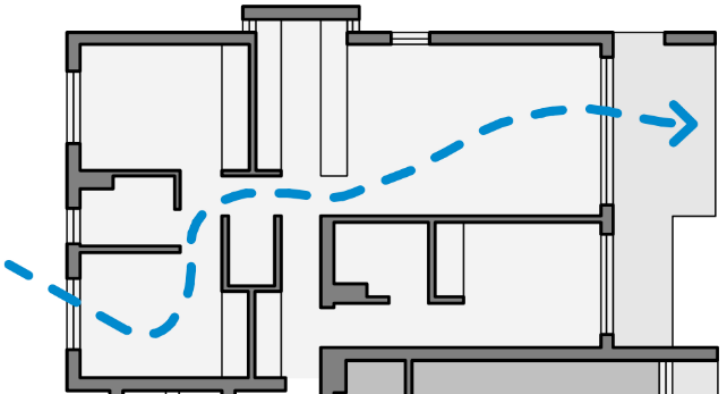


Figure 9 Natural cross ventilation Source.

Ceiling fans

Fans provide reliable air movement to cool people and supplement breezes during still periods. In a lightweight building in a warm temperate climate like Perth, the use of ceiling fans in bedrooms and all living areas (including kitchens and undercover outdoor areas) increasing comfort and significantly reduces cooling energy use. Fans use when coupled with air conditioners use overall 75% less energy use. This is because fans are more effective at moving air over people, increasing evaporation of perspiration, and keeping the air cool over people.

Figure 10 Passive designed home Source

Fans should be located centrally in each 'use area' of a room and positioned over the places where people spend the most time. Large areas, such as a large, combined lounge and dining area, may need 2 fans. In bedrooms, locate the fan close to the centre of the bed.

Passive heating (during cooler months)

Passive heating includes letting the sun in to the building through window orientation, frames and glazing type, storing the sun's heat through high thermal mass materials (this heat is released at night when the building starts to cool down), good heat distribution through air movement (ceiling fans), reducing heat loss (drought sealing and insulation), and ensuring that cold air does not enter (drought sealing).

The design of a pergola on a northern facing window or door can be designed with widths and spacings to allow for northern openings to be shaded from the summer sun, and in winter allow for the low angled sun to penetrate the windows warming exposed high thermal mass flooring (concreate slab) inside to the home. This has been achieved in an extension to a 1950's home in Bayswater (image right source).

Figure 11 Pergola design to allow winter sun into living room Source

Thermal mass

In simple terms, thermal mass is the ability of a material to absorb, store and release heat.

Materials such as concrete, bricks and tiles absorb and store heat. They are therefore said to have high thermal mass. Materials such as timber and cloth do not absorb and store heat and are said to have low thermal mass.

When used appropriately, the savings in heating and cooling energy from the thermal mass can outweigh the cost of its embodied energy over the lifetime of the building. In winter, thermal mass (such as exposed concrete flooring) can absorb heat during the day from direct sunlight. It then re-radiates this warmth back into the home throughout the night. In summer, make sure to shade high thermal mass from direct sun. If the sun is blocked from reaching the mass, the mass will instead absorb warmth from inside the home, helping to regulate inside temperatures.

Some options for exterior design of the building are:

- Reverse brick veneer on east and west facing walls, and upper floors (timber external walls, brick internal walls).
- Double brick cavity on northern and southern walls.
- Large windows on the north that are shaded in summer, fully exposed to winter sun.
- Be mindful on double glazing on northern windows, this can actually restrict winter sun access, reducing free winter warming from the sun.

Insultation

Insulation is a material that resists or blocks the flow of heat energy. Insulation is used to stop heat inside the home from escaping in winter, and to stop cool air inside the home from escaping in summer.

Installing roof and ceiling insulation can save up to 45% (or more) on heating and cooling costs, and insulating your walls can typically save around 15% on heating and cooling costs. The higher the R-Value, the more effective the material is at preventing heat transfer.

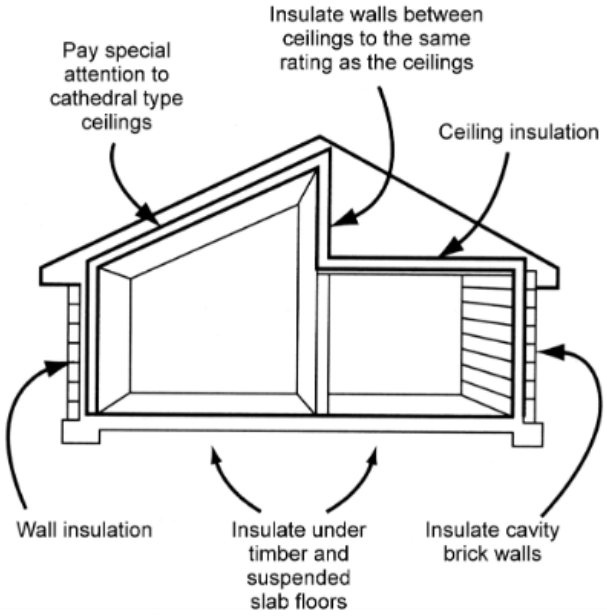


Figure 12 Principles of good insulation

Ventilation and airtightness

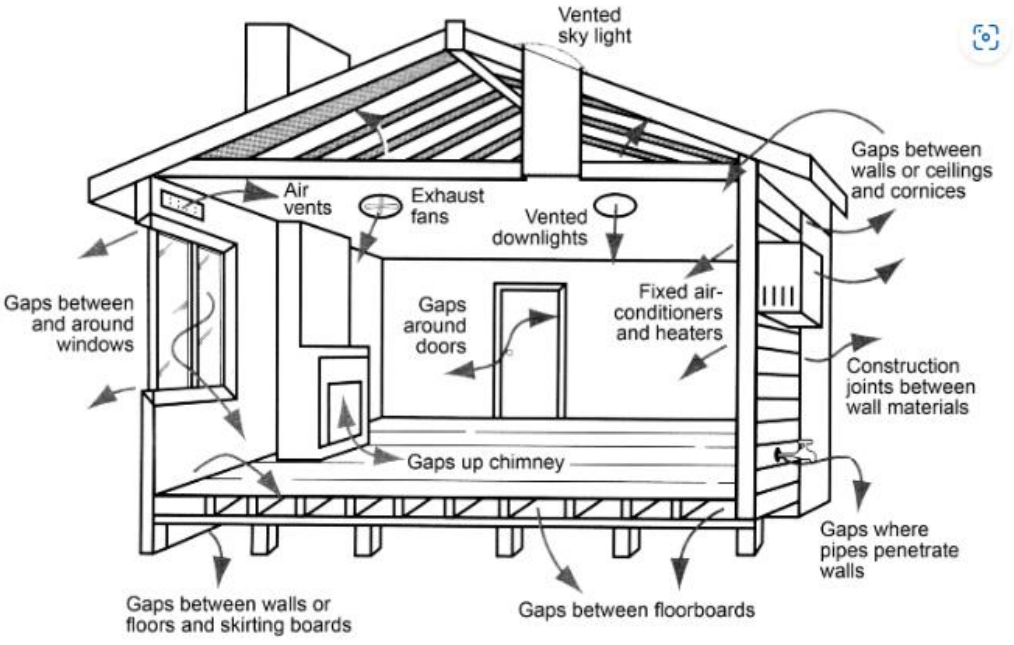
Ventilation is the introduction of outdoor air into the home. Good ventilation of a building is essential for human health. Good airtightness (that is, reducing or eliminating air leaks) leads to improved thermal comfort and energy efficiency – air leaks can cause up to 15−25% of winter heat loss in buildings (CSIRO 2015). Ventilation and airtightness should be used in combination to only allow air in/out as desired rather than uncontrolled.

Sealing a building is one of the simplest ways to increase comfort while reducing your energy costs. A well sealed home needs to have good ventilation to ensure indoor air quality and avoid buildup of air pollutants.

Windows and doors that have been designed to encourage ventilation and cool breezes when open are beneficial. But should be adequately sealed, restricting cold draughts in winter and hot draughts in summer.

Areas to provide adequate sealing include:

- Doors and windows.
- Vents, skylights and exhaust fans.
- Around ceiling insulation and around ceiling penetrations (for example, downlights, pipes and cables).
- Around wall penetrations (for example, pipes, conduits, power outlets, switches, air-conditioners and heaters).
- Between building envelope junctions (for example, floor−wall or wall−ceiling)
- Around floorboards.



Source: Sustainable Energy Authority Victoria

Figure 13 Common air leakage points.

Chapter 3: Efficient electric homes

Solar panels

Solar power is now the cheapest source of electricity available. A solar PV system is a popular way to embrace renewable energy. It is important to have the right size to suit the current and future energy needs of the home. The size of a system needed largely depends on current and future electricity use, dwelling orientation, and layout of the roof. Recommended sizes on the next page.

A big incentive with solar PV systems, apart from collecting energy from a renewable energy, is most solar system sizes will pay off within 3 – 6 years if all or most electricity usage come from the solar PV system.[ii].

Figure 14 Solar panels at Celio Springs

Solar panel battery storage

Another option to ensuring the maximum usage of solar is installing a solar battery storage system. This allows the energy captured during the day from the sun to be stored and used after sunset. It also comes in handy during a power outage, particularly on those 35 degrees and higher days. Source: Synergy-solar-battery. For solar battery safety information refer here.

Electric vehicle charging points

In 2023, there were approximately 130,000 electric vehicles on Australian roads[iii].

With the shift in vehicle ownership to electric vehicles, **it is recommended a minimum one general power outlet/wall socket provided per parking bay**, with one of the bays being installed with a 7kW electric vehicle charger for new developments.iv

For existing homes, trickle charging through a normal power outlet may suffice or there may be a need to upgrade to a larger 30amp outlet.

PlugShare is an app and website that shows all available EV charging locations.

Source: YouHome

Figure 15 EV charging point

The below table provides a guide to energy usage and solar system size:

Solar panel location	Peak energy demand of house
North-facing roof space	This is the optimal solar panel location to get maximum exposure to sunlight. It is ideal if you use the most energy from mid-morning to the afternoon (which might suit stay-at-home parents, retirees or those working from home).
West-facing roof space	This is the second optimal location. It works well if the afternoon is the peak energy usage time (everyone is home from work and school, the TV is on, as well as the computer and the air conditioner), the best orientation for your home could be west. Important to note that the most expensive tariffs (billing costs) are between 3-9pm.
East-facing roof space	Good for if the morning is the busiest time of the day (for example, you're getting the kids ready for school, doing the washing and ironing, running a dishwasher load).
Whole roof	If your energy usage is spread evenly throughout the day, purchasing a solar PV system size of between 5-6.6kW could give you the ability to spread your panels across your roof.

Solar system size calculator

The Department of Climate Change, Energy, the Environment and Water provides advice on Solar for households.

A Solar PV system with the following minimum size inverters is recommended:

- 3kW for dwellings with 2 or less bedrooms; or
- 5kW for dwellings with 3 or more bedrooms[v].

Solar battery storage of a minimum is recommended:

- 4kWh for each dwelling with 2 or less bedrooms; or
- 6kWh for each dwelling with 3 or more bedrooms.

Solar power is now the cheapest source of electricity available. The Australian Government is a partner of the SunSPOT project. The SunSPOT solar and battery calculator estimates system size and cost, the savings to be made, and likely time it might take to payback the upfront costs.

Calculate solar panel size here: Solar and battery calculator | Solar Savings | SunSPOT, Australia

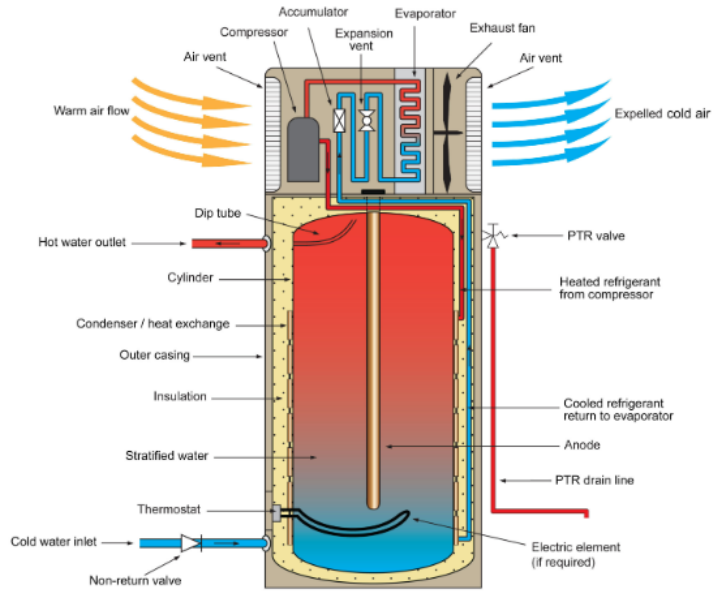
Other electric efficient options:

Solar hot water systems with a minimum 300L and a minimum 2 panels of solar collector area is a recommended size for a residential home.

Depending on the climate, a solar hot water system can provide up to 90% of your hot water. Solar hot water systems do cost more to buy and install than conventional hot water systems but save on energy, and reduce bills and greenhouse gas emissions. Most solar hot water systems use solar collectors or panels to absorb energy from the sun. Water is heated by the sun as it passes through the collectors. It then flows into an insulated storage tank for later use.

A heat pump hot water system is another option. Heat pumps use electricity to move heat from one place to another instead of generating heat directly. Energy use for heat pump hot water systems is much less than for electric systems that directly heat the water. Heat pump water heaters cost more to buy than hot water systems that directly heat the water, but save on energy and can reduce energy bills and greenhouse gas emissions.

Evacuated tube solar collectors consist of a series of transparent outer glass tubes that allow light rays to pass through with minimal reflection. The curved surface of the tubes allows the sun's rays to strike perpendicular to the water pipes for a greater part of the day. Each tube contains an inner water pipe coated with a layer that absorbs the sun's rays. Water runs through the pipe and is thus heated. A vacuum between the outer tube and the water pipe acts as insulation, reducing heat loss.



Integrated heat pump water heater with a wrap-around condenser and heat exchanger

Source: Department of Resources, Energy and Tourism

Figure 16 Heat pump water heater

Chapter 4: Sustainable building materials

Cool roofs

Cool roofs reduce the amount of solar (heat) being absorbed through the roof and transferring into the building. A cool roof is a roof or roof coating with maximum solar absorbance rating of 0.45. Cool roofs generally equate to lighter coloured roofs and certain materials are generally cooler than others. Many roof materials in any colour can be treated with a reflective coating, giving them a lower solar absorbance rating than the standard version of that material.

Solar absorbance is measured in a range between 0 and 1 and typically ranges from about 0.1 for fresh snow (which has a low level of solar absorbance) to 0.96 for charcoal (which has a high level of solar absorbance).

Cool fences

Cool fences, similar to cool roofs, reduce the amount of solar (heat) being absorbed along fence lines and radiating to outdoor living areas, driveways, gardens, and the home. A cool fence is a fence or fence coating with maximum solar absorbance rating of 0.45.

Many existing steel fences can be painted to a lighter colour to reduce the temperatures around the fence.

Other

Other alternative treatments may be cosidered appropraite provided it can be demonstrated the treatments will achieve a maximum solar absorbance rating of 0.45.

If you have an existing **tile / terracotta roofs** this roof can be painted in the following colours to achieve a ‘cool roof’ rating:

- Ghost-white (0.37)
- Alabaster (0.271)
- Aspen (0.441)
- Vanilla (0.442)

Steel Roofs and Fences: Colour & solar absorbance rating
Dover white 0.28
Surfmist 0.33
Classic cream 0.33
Southerly classic 0.40
Paperbark 0.43
Evening haze 0.43
Shale grey 0.44

Table 1 Solar absorbance ratings.

Sustainable building materials

All developments are encouraged to reuse materials and incorporate locally sourced recycled materials either within the building or within landscaping.

Reuse of materials includes reusing demolition building materials and landscaping from the existing site, or renovating an existing house, rather than demolishing the old and building from scratch.

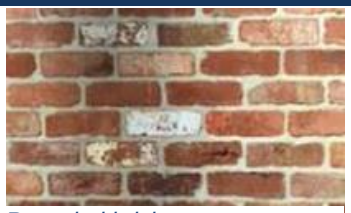
Recycled materials are non-hazardous resources that are left over or have reached the end of their useful life and are capable of being reused within building or landscape design. These materials may be in whole a recycled material or a material containing recycled content.

The following information has been sourced from Your Home and the Commonwealth of Australia Construction and Demolition Waste Guide - Recycling and Re-use Across the Supply Chain.

Materials that can be reused include:

- Concrete and bricks.
- Aluminium window frames and perforated metal railings.
- Timber. There are many options for re-use of timber including flooring, staircases, wall cladding or decorative beams.
- Plastic pipes.
- Glass may be cut and reused or recycled as aggregate for concrete. Glass can be also reused in insulation.
- Carpet can be recycled as a weed barrier or a covering and food for worm farms.
- Vegetation that is not able to be retained in its existing location can be replanted elsewhere within the lot.
- Rocks, soil and sand can be reused throughout the landscape design.

Recycled Materials



Recycled brick

Replanted grass trees from urban clearing Source.

Recycled timber (Wandoo) flooring from Subiaco Markets Celilo Springs

Recycled timber stair case Source

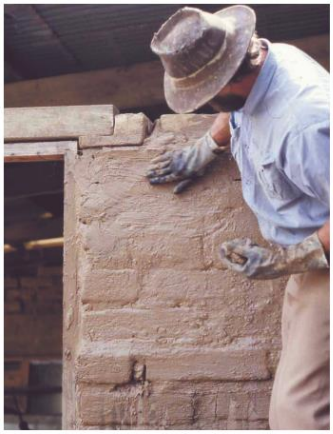
Recycled jarrah timber window frames

Alternative / Sustainable Building Materials:

Your Home is a great resource for information on recycled materials and sustainable building material options and practices

- **Mud bricks** are one of the oldest building materials in the world. Mud bricks usually only require earth and the energy of the sun, so have very low embodied energy and environmental impact. Materials for making mud bricks are readily available in most areas, and in some cases may be sourced directly from the building site. Mud brick provides high levels of thermal mass, but low insulation.

Figure 17 Mudbricks ready for air drying. Source



Applying a mud slurry finish

Photo: Paul Downton

- **Rammed earth walls** are constructed by ramming a mixture of gravel, sand, silt and a small amount of clay into place between flat panels called formwork. These wall systems have high thermal mass and low to medium embodied energy, depending on cement content (if used). Insulation can be difficult to add unless lined externally or with insulation integrated within the rammed earth itself. The process has average to high site impact, depending on the footing system, but has minimal manufacturing impact and transport energy. Rammed earth homes are very durable but require periodic reapplication of external waterproofing.

Figure 18 Rammed earth

- Hemp masonry - Hemp masonry is made of the woody part of the stem of a hemp plant, combined with lime binder, water, and sometimes sand. Hemp masonry has good thermal performance, and is a breathable material that reduces condensation and improves internal air quality. It has low environmental impact; it is a renewable material, and hemp crops generally have low water and fertiliser needs. They also absorb carbon during the growing process

Figure 19 Off-form finish hempcrete. Source

Figure 20 Off-form hemp masonry with sealer. Source

- Straw bale - Straw bales are among the most cost-effective thermal insulation available. Straw bales are usually attached to a frame and laid like giant bricks. Bales are compressed to minimise settlement and movement. The bales themselves have very low thermal mass, but the render usually provides reasonable thermal mass. Once rendered, straw bales have very low fire and pest risk. Even if a fire does reach the bale itself, the compression of the bale minimises oxygen availability and thus fire risk.

Figure 21 Straw bale construction.

Chapter 5: Water sensitive urban design

Grey water reuse

The highest water consumption for residential homes is usually in the gardens. Installing an approved grey-water reuse system that collects grey water from the home and re-directs it to the garden is an effective way to reduce demand on limited fresh (potable) water, irrigate the garden during drought or water restrictions, and save on water bills.

Greywater is wastewater from washing machines, laundry tubs, showers, hand basins and baths, that can be used to water the garden.

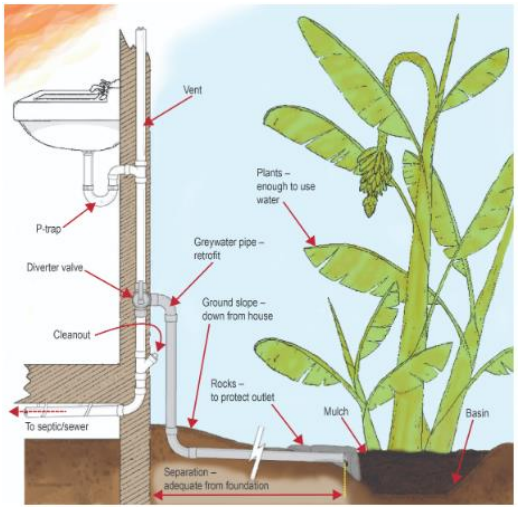


Figure 21 Simple greywater subsurface reuse

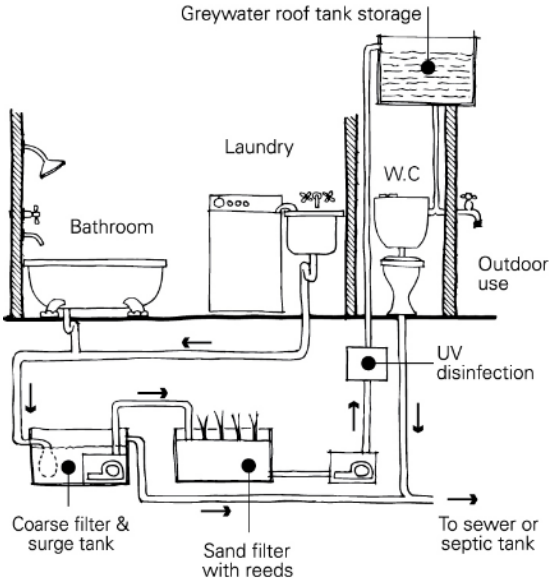


Figure 22 Diagram of a wastewater reuse system

Greywater does not include wastewater from a kitchen, dishwashers, toilet, urinal or bidet (water from these sources are known as blackwater).

Each wastewater type is treated differently and can be used in various ways. Greywater is ideal for garden watering, with the appropriate precautions, such as using low- or no-sodium and phosphorus washing and cleaning products and applying the watering system below the surface. Appropriately treated greywater can also be reused indoors for toilet flushing and clothes washing, both significant water consumers.

The Code of Practice for the Reuse of Greywater in Western Australia specifies a minimum application area to ensure the greywater is adequately dispersed across the garden area. The area is based on the occupancy rate, expected greywater volume and soil type permeability.

Greywater irrigation systems also require adequate setbacks from lot boundaries (0.5m-1.5m or greater when located adjacent to retaining walls, bores, wetlands, public drinking water and other structures).

A wastewater reuse system using the water not only for outdoor garden use, also for toilet use. The image right details this system.

Speak to the City's Health team for more information on grey water reuse (08) 9272 0622.

Rain gardens

Rain gardens are gardens of native shrubs, perennials, and flowers planted in a small depression, which is formed on a natural slope. It is designed to temporarily hold and soak in rain water runoff that flows from roofs, driveways, patios or lawns (image below right Source – Melbourne Water).

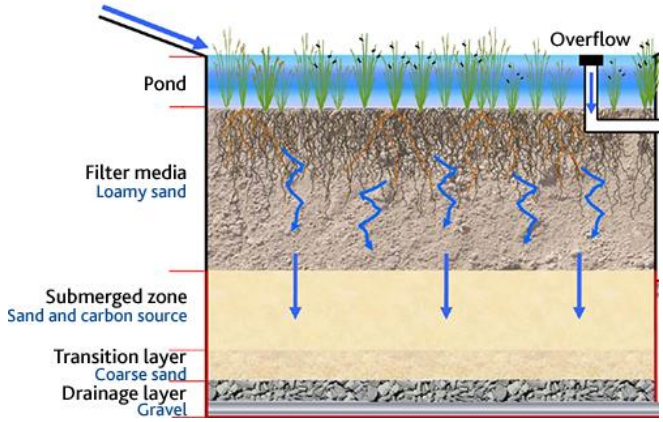


Figure 23 Rain Garden cross section

Raingardens, also known as biofilters, bioretention systems, and biofiltration systems, are a type of site level garden designed as a stormwater management practice to capture stormwater to reduce stormwater pollution and erosion. Roof runoff and runoff from non-permeable surfaces can be redirected to rainwater gardens for water capturing and biofiltration.

Raingardens are beneficial to sloping areas, or for developments and non-pervious surfaces that generate large quanitiy of stormwater runoff.

[vi]**As a minimum it is recommended that each building shall be provided with a rain garden with an area no less than 2% of the roof cover. For example, a dwelling with 100m^2 of roof cover will require a rain garden of at least 2m^2.**

How to Build Your Own Rain Garden

Katanning Landcare provides a useful *How to Build Your Own Rain Garden guide is* available here.

Step 1 - Dig a trench or bed ideally about 50 cm deep. If the soil is sandy a layer of clay gravel can be placed in the bottom to slow infiltration.

Step 2 - Place a layer of rocks, blue metal or washed gravel in the bed. The depth depends on the depth of your bed. The spaces between the rocks is your water storage.

Step 3 - Next place coarse grained sandy soil mixed with a small amount of pine bark or wood chip material over the rock layer.

Step 4 - Plant your choice of plants then cover the surface with blue metal, small stones, or washed gravel to act as mulch and protect the bed from erosion until the plants grow. The depth of your bed will control the selection of plants. A very shallow bed is best planted with sedges or reeds.

Step 5 - The edges of the bed can be planted with any vegetation. Deeper rain gardens, especially those in public areas, can incorporate larger species particularly Melaleucas which tolerate periodic inundation.

The City of Gosnells provides a number of stormwater specifications, including specifications for rain garden design (es-23_rain_garden_design.pdf (gosnells.wa.gov.au).

Rainwater tanks

Harvesting rainwater for use in households can reduce water bills in urban areas. Rainwater can be used indoors, to supply toilets and washing machines and used for garden watering.

Rainwater tanks vary in size with sizes 3,000L ranging up to 51,000L.

The size of a rainwater tank can vary depending on the roof catchment area and house usage. The Water Corporation have stated that in the South West and Great Southern regions that generally have higher rainfall than the Perth metropolitan area, a 125m2 roof area can collect up to 51,000L of water annually, supplying part of household's non-drinking water needs.

Smart Approved WaterMark recommends a tank that holds a minimum of 4 weeks' supply. For example, if it's likely you'll use 1,000L of rainwater each week in the garden, toilet and laundry combined, then consider a 4,000L tank. (Water Corporation).

Installing a rainwater tank does have upfront costs, and if a pump is part of the system there are ongoing electricity costs maintenance for the homeowner. The different components of a rainwater harvesting system are illustrated in the diagram to the left.

Figure 24 Slimline water tank

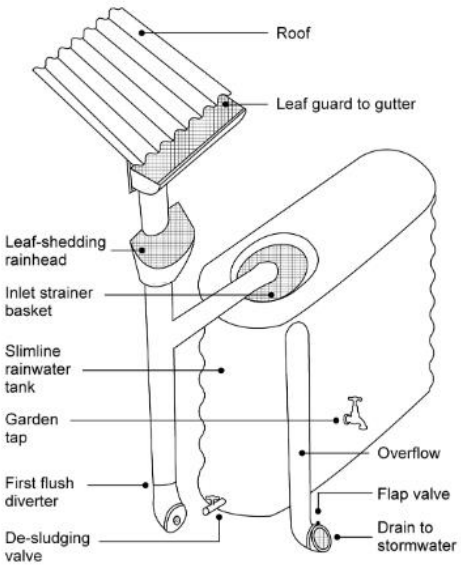


Figure 25 Components of rainwater harvesting system

Figure 26 Example of rainwater harvesting system at Enviro House

Chapter 6: Landscaping

Landscaping requirements

It is recommended that **a minimum 15% of a lot is to be soft landscaped, with a minimum soil depth of 300mm.** This does not include removable planter boxes/pots, artificial turf, green walls and porous paving areas. The image to the right demonstrates minimum soil depth below soft landscaping.

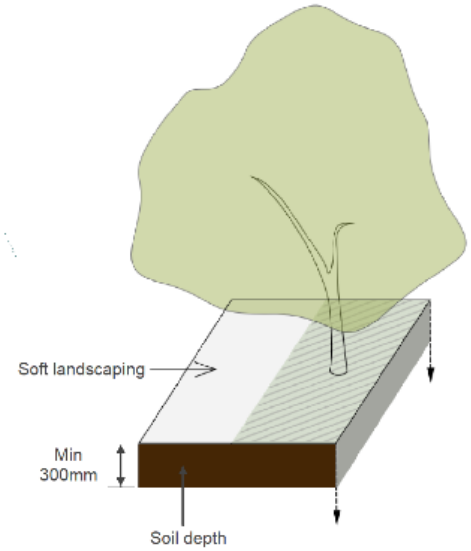


Figure 27 Minimum Soil Depth Source.

Using drip irrigation to soft landscaping areas will save on water usage in the long term. Landscaping areas are recommended to comprise local native and drought resistant species with a minimum of 2 plants per square meter. This will reduce reliance on water and fertilisers, and achieve sufficient coverage. Below lists City documents to assist in landscaping design:

- Local Native Plants Guide
- Tree Planting Guidelines
- Suggested Tree Species for Private Property
- Landscaping Guidelines

Alternative landscaping design outcomes may include green driveways, green roofs, and green walls.

Green driveways are driveways that are partially or completely covered with vegetation, with a stabilising base beneath. Examples of green driveways include permeable paving systems such as open cell pavers, with a stabilising base below, that allow for soft landscaping to grow and water to drain through the pavers to the water table below.

A green roof is a roof of a building that is partially or completely covered with vegetation and a growing medium, planted over a waterproofing membrane with inbuilt drainage and irrigation. Container gardens on roofs, where plants are maintained in pots, are not considered to be green roofs.

Green wall is a vertical structure that has plants attached to it, which may be free-standing or part of a building that is partially or completely covered with vegetation. The greenery is often planted in a growth medium on the surface or structure of the wall, consisting of soil, stone, or water with a built in irrigation system. It is important to consider orientation where a north or eastern facing wall may be the most successful depending on species selection and irrigation.[vii]

Chapter 7: Measuring performance

NatHERS

NatHERS rating is the star rating provided under the Nationwide House Energy Rating Scheme which measures a home's energy efficiency. The higher the star rating, the less energy (ongoing costs) needed to heat and cool the home to keep it comfortable. Achieving a minimum 7 NatHERS star rating (or other comparable star rating measurement tool accredited by the NCC / BCA) will deliver a significant improvement in thermal comfort for occupants and ongoing operating cost savings of the home.

The additional cost of constructing a single storey home to a 7 Star standard in Perth is likely to range from $1,750 for brick cavity to $2,500 for timber frame[viii] (2022 figures). Engaging a NatHERS accredited energy assessor in the early design stages can save thousands in construction costs by helping to avoid late stage design and material changes.

Check out YourHome for free home designs achieving a minimum thermal performance rating of 7 stars under the Nationwide House Energy Rating Scheme (NatHERS) and Whole of Home (WoH) performance rating of 60 out of 100.

Lifecycle assessment

A Lifecycle assessment (LCA) is a voluntary tool that measures the environmental performance of a building over its lifetime. Using a LCA is one of the easiest and simplest ways you can reduce your carbon footprint. They can help design a warm, dry, healthy and efficient home, reduce your environmental impact, save money on energy bills, and increase your home's resale value.

An eTool is available for a DIY option to undertaking an LCA: https://rapidlca.app/

Greensmart Protocol

GreenSmart is an industry-driven program that aims to encourage a mainstream application of the benefits of environmentally responsible housing and is registered by the Housing Industry Association (HIA).

GreenSmart is a voluntary initiative that focuses on educating builders, designers, product manufacturers and consumers. It provides appropriate market recognition for environmental endeavours in the residential construction industry.

This protocol focuses on energy management, water management, material selection, indoor air quality management, universal design, site management, and resource-efficient practice.

Source: Josh Byrne[ix] & HIA GreenSmart Guidelines

The GreenSmart assessment information booklet is available here.

Chapter 8: Examples throughout Western Australia

OneOneFive Hamilton Hill

Location: Boorlo Country
Hamilton Hill, WA

This project redeveloped an old high school and neighbouring lands (11.9 hectares) as a residential estate. OneOneFive Hamilton Hill is a local example in Western Australia for being recognised as a sustainable project by the national EnviroDevelopment initiative (DevelopmentWA).

OneOneFive Hamilton Hill reused demolition waste from an old high school in a residential development. Recycled materials in this project include:

- Salvaged timber in landscaping features such as shade structures and seating.
- 40,000 clay bricks and roof tiles reused as aggregates under the drainage infrastructure.
- Old bricks in brick walls and a toilet block.
- Crushed brick, tiles and concrete in the road sub-base.
- 2,425 cubic metres of recycled concrete in retaining walls.
- 400 tonnes of other recycled products in various constructions including temporary access roads.

1950's Weatherboard Extension

Location: Boorlo Country. Bayswater, WA

Single house extension featuring northernly orientated extension facing the large garden filled with native plants and veggies, allowing ample northern light into the living areas.

The lounge room has extensive glazing shaded by a timber pergola. The timber beams that make up this pergola are sized and spaced to ensure maximum winter sun penetration and no summer sun penetration to the internal areas.

Louvred windows are in every room and positioned to capture south-westerly breezes to cool the home on summer afternoons in combination with ceiling fans to avoid the need for air-conditioning at night.

The floor slab is exposed concrete, allowing it to act as a thermal mass, releasing its stored heat at night. Bulk insulation is in all external and internal walls and ceiling spaces.

Celilo Springs - Mt Lawley

Location: Boorlo Country
Mt Lawley, WA

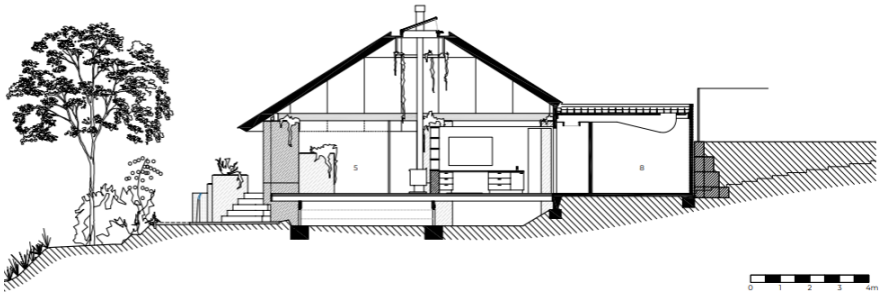
Celilo Springs is a rear lot single house development achieving a 7 star energy rating. This home is an energy positive house with a relatively small footprint and a raft of passive and active sustainability initiatives. It has a garden with near 200 species of endemic plants and is a positive contribution to its neighbourhood.

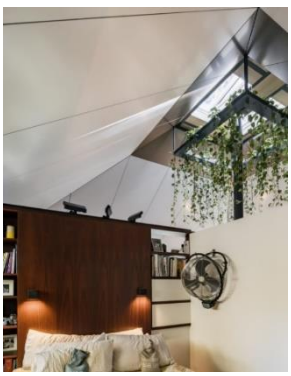
Celio Springs approach to sustainability is not a collection of independent technology systems, but an integrated approach where the whole house works together.

- Passive ventilation – combined living spaces (including main bedroom) allows for cross-ventilation. Combined with stack ventilation to draw air up through the apex of the building and exhausts through roof vents.
- Displacement cooling – cutting edge indirect-evaporative cooling system.
- Indirect evaporative cooler.
- Infrared Heating – Combined living spaces are all heated with a centrally located wood heated (wood off cuts sourced locally) Lightweight roof structure doesn't absorb heat, and infra-red reflective materials such as aluminium composite ceiling panels and low-e/infra-red reflective glass.

This home also features:

- Smart home features.
- Recycled and reused joinery, aggregate and floorboards
- Hot water heap pump
- Solar PV system 3.0
- Rain water storage
- Biophilic design principles





Blinco Street Ecohome

Location: Boorlo Country
Fremantle, WA

In 2018, the Blinco Street Ecohome was acknowledged as a finalist in the energy efficiency category of the Master Builder Housing Excellence Awards, with an 8.5 Star energy rating.

This Ecohome features:

- 2 water tanks, with an 8.500L above ground rain water storage.
- Recycled bricks, recycled jarrah decking and frame, internal recycled brick wall, 'green' concrete with minimal aggregate and lots of fly ash.
- All electric home with 3.5kW PV system.
- Passive solar designed home.
- Ceiling fans.

Hami Hill Sustainable Home

Location: Boorlo Country
Hamilton Hill WA

Iconic eco retrofit project and a 'Wastewise' success story. The total estimate cost of sustainable features $60,000 at time of installation with an estimate annual savings $3000.

This 4 bedroom 2 bathroom home renovation features:

- Draught proofing
- Smart home features
- Natural Shading from tree canopy
- Use of earth wool for ceiling and ceiling fans
- Recycled materials including aggregate, bricks and timber.
- Solar PV grid connect
- The garden features bee keeping, chickens, composting, drip irrigation, edible graden, green walls, permaculture, native and water wise plants.

Nightingale Apartments – Fremantle

Location: Boorlo Country
Fremantle, WA

Nightingale Fremantle apartments are fossil fuel-free and achieve an average 9.2 stars NatHERS rating.

Nightingale features:

- 20W photovoltaic array
- Low embodied energy materials
- Dual aspect passive cooling
- Embedded electricity network (100% GreenPower)
- Rainwater collected for common area use and garden beds
- Energy efficient heat pump hot water system
- Outdoor kitchen
- Shared rooftop laundry and veggie patches

Other examples across WA:

Gallery of Jimmy's House / MJA Studio - 5 (archdaily.com)

Witchcliffe Ecovillage • Vision Of Sustainability

Home – Josh's House

Sustainable Design Checklist		
Theme	**Options**	**Check**
Tree retention	Retain trees located on the east, south and west of the lot. If tree located to the north is deciduous, consider retaining.	☐
Orientation	Living areas with openings to face north.	☐
	High thermal mass on north facing walls and floors that gain sun access from northern winter sun warming the home.	☐
	All east and west elevations provided with shading to block summer sun, whilst allowing winter sun access.	☐
	Low thermal mass on east and west facing walls and floors. If high thermal mass provided, consider pergolas, awnings, wider eaves or other shading devices to block out the summer sun.	☐
Biophilic design	A living room, kitchen, or bedroom opening with views of green gardens and/or parklands.	☐
Universal access	Consider adopting Livable Housing Design Guidelines.	☐
Passive design	Centrally locate ceiling fans to living rooms and bedrooms.	☐
	Design for natural cross ventilation	☐
	Provide consistent layer of insulation to the roof.	☐
	Ensure all openings are drought sealed.	☐
	If considering double glazing to east and west facing windows. Northern windows should have glazing that allows for the winter sun to access the home providing light access and warmth.	☐
Solar efficiency	Solar PV system with the following minimum size inverters: • 3kW for dwellings with 2 or less bedrooms; or • 5kW for dwellings with 3 or more bedrooms.	☐
	Solar battery storage of a minimum: • 4kWh for each dwelling with 2 or less bedrooms; or • 6kWh for each dwelling with 3 or more bedrooms.	☐
	At least one car parking bay provided with a minimum 7kW electric vehicle charger.	☐
	A minimum 300L: • Solar hot water system with a minimum 2 panels of solar collector area; or • Heat pump hot water system.	☐

	Roof colour to have a solar absorptance value of not more than 0.45.	☐
	Fence colour to have a solar absorptance value of not more than 0.45.	☐
Sustainable building materials	Consider reusing materials from the original building, or using available recycled materials.	☐
Water efficiency	Rain water tank of minimum 3,000L capacity that is plumbed in to a toilet and/or laundry.	☐
	A minimum 3,000L capacity grey water reuse system1 that collects grey water from the laundry and bathroom and redirects it for garden irrigation.	☐
	Provide a rain garden with an area no less than 2% of the roof cover. For example, a dwelling with 100m2 of roof cover will require a rain garden of at least 2m2.	☐
Vegetation	Provide a minimum 15% of a lot is to be soft landscaped, with a minimum soil depth of 300mm. Drip irrigation to soft landscaping areas will save on water usage in the long term. Landscaping areas to comprise local native and drought resistant species with a minimum of 2 plants per square meter.	☐
	Provide 1 tree per 350sqm with an adequate tree growth zone area (Trees of Private Property and Street Verges Policy).	☐
Energy Efficient Design	Achieve a minimum 7 star standard of the Nationwide House Energy Rating Scheme (NatHERS) star rating.	☐
	Consider undertaking a life cycle assessment https://rapidlca.app/ and a GreenSmart assessment	☐
Other considerations		
Air quality	• Low-VOC paints for walls • Livos oil to seal the green concrete fllos • In the home only use natural cleaning products, keeping a BPA-free environment indoors	☐

Document details

Responsible Division	Office of the CEO
Responsible Business Unit	Property and Economic Development
Responsible Officer	Strategic Planning Officer
Affected Business Units	Property and Economic Development Statutory Planning and Compliance Parks and Environment
Strategic link	Goal E1 and Goal L4
Date prepared	December 2024
Next review due	November 2025

References

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[iv] DPLH Position Statement: Electric Vehicle Charging Infrastructure March 2024
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[ix] The Sustainable House Handbook. Josh Byrne. 2020