Building Design for Sustainable Living

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https://www.ierek.com

What is the importance of this article?

Climate change is the variation in the state of the climate, directly or indirectly due to human activities that alter the composition of the atmosphere. It is caused mainly by global warming and results in the melting of the polar ice caps, rising sea level and extreme weather conditions, among many other negative effects.
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What is the renewable energy?

Renewable energy is produced from natural processes and sources that are continually regenerating and replenishing. These sources include wind, sunlight, water, geothermal heat, tides and different kinds of biomass. This type of energy is inexhaustible and constantly renewing https://www.activesustainability.com

Why use renewable energy?

In the fight against climate change, the use of renewable energy is particularly relevant. Renewable energies are obtained from inexhaustible natural sources and generate clean electricity without contributing to climate change. The different natural sources for generating clean energy include wind, sunlight, water, geothermal heat, tides, and various forms of biomass, all of which are inexhaustible and in constant renewal.

- Wind power is one of the most widespread renewable energies today. It harnesses the wind to produce electricity.
- Photovoltaic solar energy directly transforms solar radiation into electricity thanks to the solar panels integrated by photovoltaic cells.
- Solar thermal power, also called concentrated solar power, concentrates solar radiation with mirrors to heat a fluid that produces steam to generate electricity.
- In the case of hydropower, the force of moving water is used to produce -and sometimes to store- clean electricity.
- Biomass uses organic matter as an energy source. This matter may be natural, residual or from energy crops.

Main benefits of renewable energies are:

- Environmental benefits: Renewable energies are clean sources that have a much smaller environmental impact than conventional energies.
- Long-lasting energy: Renewable energies are inexhaustible since they are constantly being replenished. In contrast with other types of conventional energies, which are finite and, therefore, can be depleted (e.g. oil and coal), renewable energies are our permanent ally.

- They create jobs and improve the economy: Most investments in renewable energies are spent on materials and the workforce to build and maintain facilities at a local level. This creates local jobs and grows the country's economy.
- Energy security: Renewable energies reduce a country's energy dependence, enhancing its self-sufficiency and sustaining major investments that would otherwise be used to pay for imports of non-renewable energy from other countries https://www.activesustainability.com/climate-change/

What is sustainability?

Sustainable development is able to satisfy today's needs without endangering the capacity of future generations. It comprises three basic elements that must complement one another: environmental, economic and social sustainability.https://www.activesustainability.com/climate-change/

Sustainable life

The way we adapt to the standards of a globalized world, the challenges we face in the immediate future, and new trends in services, products and technologies, all form an important part of sustainable development. https://www.activesustainability.com/climate-change/

What is the relationship between environment and architecture?

The environment includes all living and inert beings on the planet or a specific region. It also includes all the interactions between them and the factors that influence their survival and development, and the evolution of species. These factors can be natural - such as sunlight, temperature, water or nutrients in the earth - or caused by humans You can't build or design a good building without understanding their relationship with the natural systems and the surrounding environment. Architects need to make buildings that are friendly to the environment and more green which can be adaptable to the surroundings, in other words, they need to create buildings that are energy efficient, like green buildings or sustainable buildings which are designed to reduce the overall impact of the built environment on human health and nature.

So, they need to take into consideration:

- Efficiently using energy, water, and other resources
- Protecting residents' health and improving people's productivity
- Reducing waste, pollution, and environmental degradation

Green buildings (green architecture) are a trend these days for their positive effect on the environment because they take landscaping into account. Green buildings are also managed in the construction process to make sure that any waterways remain unpolluted with construction by-products.

Green buildings also have benefits that you'll find are luxury, like better indoor air quality. Many studies have found that they also lend themselves to a better work environment. These benefits which include the use of natural daylight, big windows, and good indoor air circulation, dramatically increase productivity and as residential buildings, they have substantial effects on their residents, as well.

Finally, the relationship between architecture and environment is very strong and can't be denied, as we look to have a sustainable and healthy environment we have to take good care of the buildings that are built in it and also to have sustainable buildings we have to take into consideration the environment surrounds it and its impacts.
https://www.ierek.com

What is sustainable housing?

Sustainable housing considers the design, construction and operation of your house over its lifetime, in three contexts:

- environmental sustainability, which considers things like water, energy, emissions, waste, vegetation, pollutants and contamination
- economic sustainability, which considers things like cost and materials for construction, utilities, property charges, maintenance, upgrades and major replacements, and resale value
- social sustainability, which considers things like aesthetics, safety, security, accessibility, functionality, future modifications and liveability for future generations.

How to make your house sustainable?

Consider the climate

When planning your home, think about the climate conditions in the area where you're building. Climate responsive design for new homes can cater for present and future predicted weather patterns like temperature, heat waves and rainfall variability. It can also minimise the impact from the urban heat island effect, where there is a high number of hardened surfaces and little vegetation in the neighbouring area.

Maximise sustainability opportunities

Many features within a house can provide the opportunity to address more than one form of sustainability. For example, a well-designed bathroom with a stepless shower, non-slip finishes, handrails and water efficient fixtures can provide.

- environmental benefits (e.g. using less of a valuable resource and creating less wastewater)
- economic benefits (e.g. reduced hot and cold water running costs)
- social benefits (e.g. safe accessibility for people of different ages and abilities).

Making changes to your existing home

Climate-responsive design can also be applied when retrofitting existing homes. For example, you can minimise the need to use air conditioning in summer by using passive features such as:

- using lighter colours on your home's external surfaces
- adding shade via wide eaves and window awnings
- promoting ventilation through the house - adding insulation in the roof.

Taking steps like this can also minimise energy costs and improve your comfort level
https://www.qld.gov.au/housing/building-home/sustainable-housing

What is passive energy?

'Passive design' is design that takes advantage of the climate to maintain a comfortable temperature range in the home. Passive design reduces or eliminates the need for auxiliary heating or cooling, which accounts for about 40% (or much more in some climates) of energy use in the average Australian home.

The importance of passive design cannot be overstated. Paying attention to the principles of good passive design suitable for your climate effectively 'locks in' thermal comfort, low heating and cooling bills, and reduced greenhouse gas emissions for the life span of your home.

Passive design utilises natural sources of heating and cooling, such as the sun and cooling breezes. It is achieved by appropriately orientating your building on its site and carefully designing the building envelope (roof, walls, windows and floors of a home). Well-designed building envelopes minimise unwanted heat gain and loss.

The most economical time to achieve good passive design in a home is when initially designing and building it. However, substantial renovations to an existing home can also offer a cost effective opportunity to upgrade thermal comfort, even small upgrades can deliver significant improvements. If you're buying a new home or apartment, assess its prospects for thermal comfort and/or ability to be cost effectively upgraded to reflect good passive design principles in its climate.

For best results, 'passive' homes need 'active' users — people with a basic understanding of how the home works with the daily and seasonal climate, such as when to open or close windows, and how to operate adjustable shading.

A number of different and interrelated strategies contribute to good passive design. Passive design strategies vary with climate. The best mix of passive design strategies also varies depending on the particular attributes of your site. Choose a designer who is experienced in passive design for your climate and consider engaging a thermal performance expert to model different design options using thermal performance software.
Good passive design is critical to achieving a lifetime of thermal comfort, low energy bills and low greenhouse gas emissions.

How to Design for Climate?

Good passive design ensures that the occupants remain thermally comfortable with minimal auxiliary heating or cooling in the climate where they are built. Each of the eight main climate zones in Australia has its own climatic characteristics that determine the most appropriate design objectives and design responses. Identifying your own

climate zone and gaining an understanding of the principles of thermal comfort helps you make informed design choices for your home. The Nationwide House Energy Rating Scheme (NatHERS), with its star classifications, is an additional and useful resource.

Orientation
Orientation refers to the way you place your home on its site to take advantage of climatic features such as sun and cooling breezes. For example, in all but tropical climates living areas would ideally face north, or as close to north as possible, allowing maximum exposure to the sun, and easy shading of walls and windows in summer. Good orientation reduces the need for auxiliary heating and cooling and improves solar access to panels for solar photovoltaics and hot water. Your home is thus more comfortable to live in and cheaper to run. It takes account of summer and winter variations in the sun's path as well as the direction and type of winds.

Shading
Shading of your house and outdoor spaces reduces the impact of summer temperatures, improves comfort and saves energy. Direct sun can generate the same heat as a single bar radiator over each square metre of a surface. Effective shading — which can include eaves, window awnings, shutters, pergolas and plantings — can block up to 90% of this heat. Shading of glass to reduce unwanted heat gain is critical, as unprotected glass is often the greatest source of heat gain in a house. However, poorly designed fixed shading can block winter sun. By calculating sun angles for your location, and considering climate and house orientation, you can use shading to maximise thermal comfort.

Passive solar heating
Passive solar heating is the least expensive way to heat your home. Put simply, design for passive solar heating keeps out summer sun and lets in winter sun while ensuring that the building envelope keeps that heat inside in winter and allows any built up heat to escape in summer. Orientation, thermal mass, sealing and other elements all contribute to the design of a house that benefits from passive solar heating.

Passive cooling
Passive cooling is the least expensive way to cool your home. To be effective, passive cooling techniques need to cool both the house and the people in it — with elements such as air movement, evaporative cooling and thermal mass. Passive cooling design techniques can be applied to new homes as well as renovations, across a range of different climate zones. All Australian regions except those above the tropic of Capricorn require some form of passive heating in winter.

Sealing your home
Air leakage accounts for 15–25% of winter heat loss in buildings and can contribute to significant loss of 'coolth (opposite of warmth)' in climates where air conditioners are used. Sealing your home against air leaks is one of the simplest upgrades you can undertake to increase your comfort while reducing energy bills and greenhouse gas emissions. The more extreme your climate, the more beneficial sealing is, with the exception of naturally ventilated homes in the tropics. As sealing your home and increasing insulation levels can also create condensation and indoor air quality problems, this article explains how condensation works, which climates present the greatest condensation risk and how you can limit its impact.

Insulation
Insulation acts as a barrier to heat flow and is essential for keeping your home warm in winter and cool in summer. It can also help with weatherproofing and soundproofing. A well-insulated and well-designed home provides year-round comfort, cutting cooling and heating bills by up to half and reducing greenhouse gas emissions. Climatic conditions determine the appropriate level of insulation as well as the most appropriate type to choose — bulk, reflective or composite. The most economical time to install insulation is during construction.

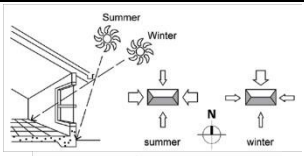
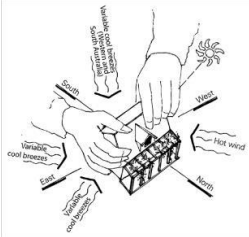
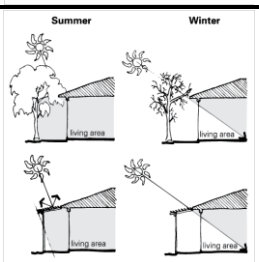
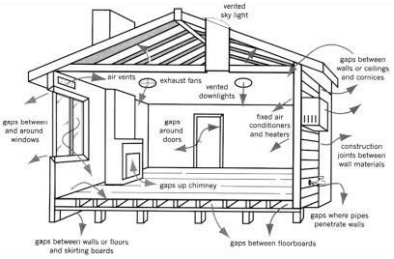
Thermal mass
Thermal mass is the ability of a material to absorb and store heat energy. A lot of heat energy is needed to change the temperature of high density materials such as concrete, bricks and tiles: these materials have high heat storage capacity and are therefore said to have high thermal mass. Lightweight materials such as timber have low thermal mass

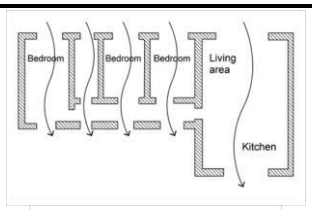
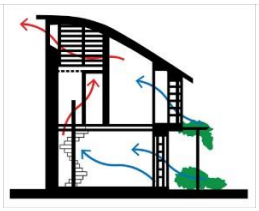
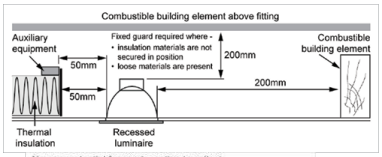
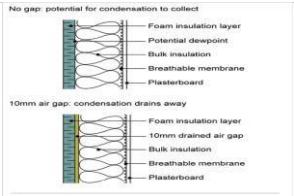
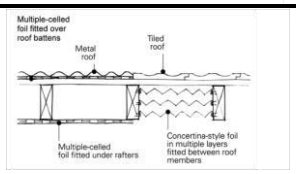
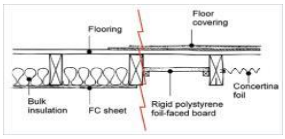
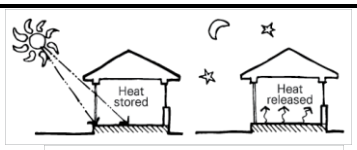
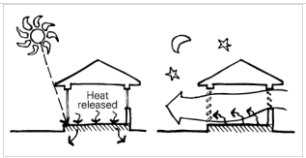
Use of materials with high thermal mass throughout your home can save significantly on heating and cooling bills, but thermal mass must be used appropriately. Poor use can exacerbate the worst extremes of the climate, radiating heat on a hot summer night or absorbing all the heat you produce on a winter night. Good use of thermal mass moderates' indoor temperatures by averaging day−night temperature extremes. To be effective, thermal mass must

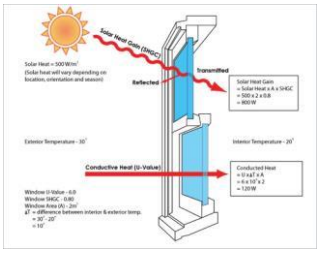
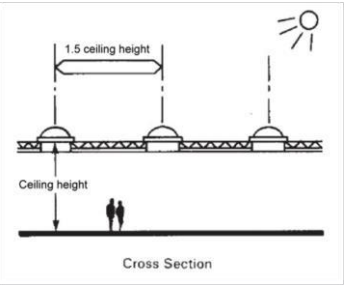
be integrated with good passive design techniques appropriate for the climate. Although this is most easily done during construction or renovation, in many circumstances thermal mass can also be retrofitted.

Glazing
Glazed windows and doors bring in light and fresh air and offer views that connect interior living spaces with the outdoors. However, they can be a major source of unwanted heat gain in summer and heat loss in winter. Up to 40% of a home's heating energy can be lost and up to 87% of its heat gained through glazing. These thermal performance problems can be largely overcome by selecting the right glazing systems for your orientation and climate, and considering the size and location of window openings in your design. Refer to the Window Energy Rating Scheme (WERS), which rates the energy and energy-related performance of different window products.

Skylights
Skylights can make a major contribution to energy efficiency and comfort. They are an excellent source of natural light, perhaps admitting more than three times as much light as a vertical window of the same size, and can improve natural ventilation. However, they can be a major source of unwanted heat gain in summer and heat loss in winter. Factors to be considered when selecting from the many skylight options available include sizing and spacing (to control glare and heat gain), energy efficiency and appropriateness for climate**.** (https://www.yourhome.gov.au/passive-design)

Passive designing	Guidelines	
Orientation	**Choosing the best orientation** temperature ranges, both seasonal and diurnal (day–night) humidity ranges direction of cooling breezes, hot winds, cold winds, wet winds seasonal characteristics, including extremes impact of local geographic features on climatic conditions (see Choosing a site) impact of adjacent buildings and existing landscape.	 
Shading	**General guidelines for all climate** Calculating sun angles Fixed shading Louvres Fixed shading for east and west Adjustable shading Using plants for shading	
Passive solar heating	**Passive solar heating requires careful application of the following passive design principles** northerly orientation of daytime living areas passive shading of glass and selection of appropriate glazing appropriate areas of glass on northern façades thermal mass for storing heat insulation and draught sealing floor plan design to address heating needs including zoning climate appropriate glazing solutions	

Passive cooling	**The efficiency of the building envelope can be maximised in a number of ways to minimise heat gain:** shading windows, walls and roofs from direct solar radiation using lighter coloured roofs to reflect heat using insulation and buffer zones to minimise conducted and radiated heat gains making selective or limited use of thermal mass to avoid storing daytime heat gains Air movement, Cool night air Convective air movement Solar chimneys, Evaporative cooling, Earth coupling	 
Sealing your home	**Air typically leaks through:** unsealed or poorly sealed doors and windows the poor design or omission of airlocks unsealed vents, skylights and exhaust fans gaps in or around ceiling insulation and around ceiling penetrations (e.g. downlights, pipes and cables) gaps around wall penetrations (e.g. pipes, conduits, power outlets, switches, air conditioners and heaters) gaps between envelope element junctions (e.g. floor−wall or wall−ceiling) poorly fitted or shrunken floorboards.	 
Insulation	**Adding insulation to existing buildings** **Walls (Bulk insulation, Reflective insulation)** Cavity brick walls Brick veneer, reverse brick veneer and timber framed walls Ceilings and roofs Floors Air leakage	 
Thermal mass	**Thermal mass properties** High density Good thermal conductivity Appropriate thermal lag **Where to locate thermal mass** Heating Heating and cooling Cooling	 

Glazing	**The impact of glazing on the thermal performance of a building is complex. Consider:** climatic conditions in your location — temperature, humidity, sunshine and wind building design — the orientation, form and layout of the building materials — the amount of mass and insulation the size and location of windows and shading thermal properties of glazing systems.	
Skylights	**Skylight types** Roof windows roof lights Tubular skylights **Effective delivery of daylight depends on the following factors:** sun's altitude and azimuth relative occurrence of overcast versus sunny weather season levels of air pollution and haze roof aspect shading from trees.	

Gathered by Author from (https://www.yourhome.gov.au/passive-design)

The best case study for understanding sustainable architecture

Council House 2 (CH2) was Australia's first building to be awarded a six-star green star design rating. Since its completion in 2006, CH2 has changed the landscape of its local area and inspired developers and designers across Australia and the world. CH2 is located at 240 Little Collins Street, Melbourne. The building has generated substantial interest, with many people keen to see for themselves how its features appear and work. (https://www.melbourne.vic.gov.au/building-anddevelopment/sustainable-building/council-house-2/conserving-energy-water/pages/windows.aspx)

(https://www.melbourne.vic.gov.au/building-and-development/sustainable-building/council-house-2/conserving-energy-water/pages/windows.aspx)

-**The water conservation** design strategy for CH2 has established a water consumption total of less than 31 litres per day per person.

Water management measures implemented by CH2 fall into four categories:

- water efficiency
- water recycling by sewer mining

- water reuse – rainwater harvesting and fire sprinkler test water
- innovative water saving techniques.

CH2 has the following features:

- 'AAAA' fittings and fixtures throughout the building
- taps and showerheads of low water flow rate – approximately 2.5 litres per minute and nine litres per minute
- water flow to all hand basin taps controlled by electronic sensors
- four litre / three litre dual flush toilets and two litre flush urinals.
-

-Energy generation

CH2 generates its own energy using a micro-turbine and solar panels to provide electricity, hot water and cooling.

-Heating system

Additional heating is provided by hot water through an underfloor hydronic system located around the perimeter windows. Given that air supplied to CH2's office spaces is already heated to about 20°C, when heat is required, it is designed to be supplied at the points where heat loss is concentrated – the windows.

Hot water pipes are located in the underfloor space along the north and south walls, while beneath each window in the floor is a timber grille supplying radiant heat from the hydronic system. There are also small wall-mounted radiators along the south wall to assist with heat to areas restricted by full-height partitions.

The heat from the grilles, forms a warm air barrier around the perimeters, which rises into the space naturally using buoyancy, not fans.

-Cooling system

Even in Melbourne's winter, office buildings require cooling. Heat is generated from two main sources:

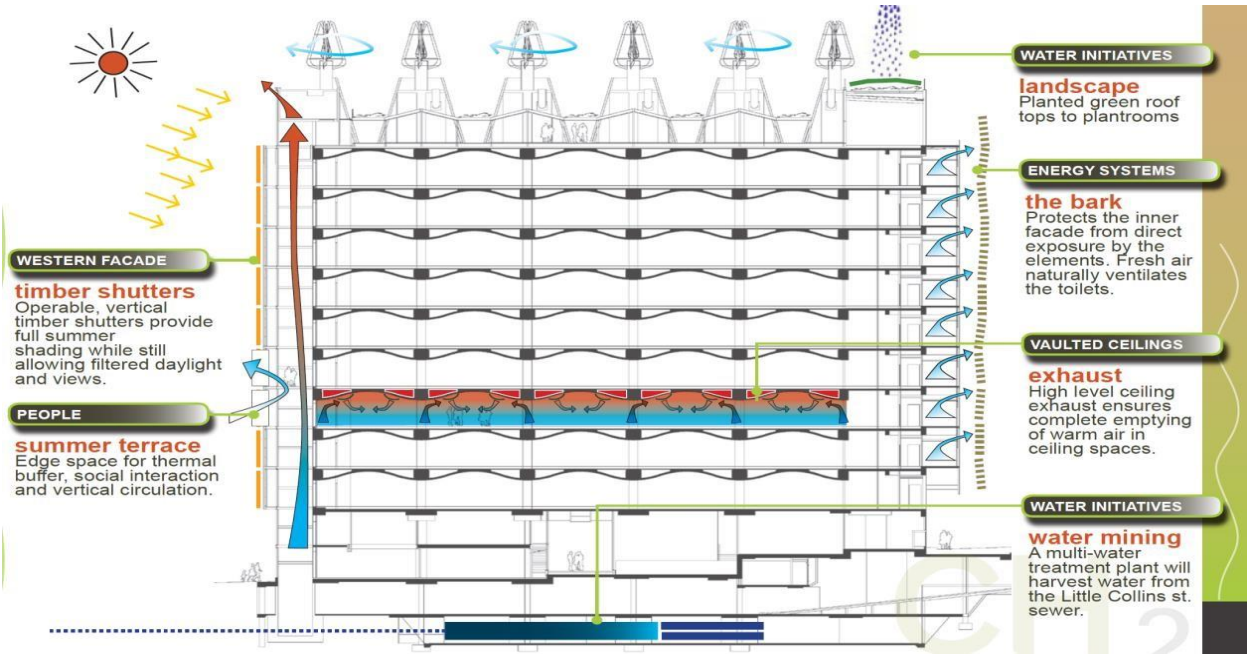
- heat load from people, lighting, computers and other equipment
- heat gain or loss at windows or through the fabric of the building.

Conventional air-conditioned buildings deal with this heat load by re-chilling recirculated air. In CH2 the air is refreshed twice an hour, removing around 40 per cent of the heat load from the building. The remaining 60 per cent of the heat load is stored during the day and removed at night.

The thermal mass of the exposed concrete ceilings absorbs the heat from the rising air during the day. The heat is later removed at night via a 'night purge'.

During the day, the chilled water circulating in the chilled ceiling panels absorbs heat and transports it to storage tanks in the basement. At night the heat is removed through evaporative cooling by cooling towers on the roof.

On particularly hot days, the cooling towers may be used, but this is kept to a minimum for energy efficiency.



(https://www.melbourne.vic.gov.au/building-and-development/sustainable-building/council-house-2/conserving-energy-water/pages/windows.aspx)

-Windows

CH2's windows have a number of features that assist in the heating and cooling processes in the building, control glare, and enhance use of natural light.

The following features are designed to provide a barrier to heat gain into the building in the summer and heat loss from the building in winter:

- double-glazing
- timber window frames, which are a low conductor of heat when compared with aluminium, reducing the 'heat bridge' effect
- external sunshade from balconies (from the floor above) and from fabric shades above doors to each balcony
- chilled beams over the window cooling the air and creating a protective curtain of falling cold air across the window when heat gain is an issue
- underfloor hydronic heating grilles, located adjacent to the window, providing a protective curtain of rising warm air when heat loss is an issue.