The Green Swing small-scale development features small building footprints for its two townhouses and two apartments, and large communal outdoor spaces. Two couples took the initiative to promote sustainable urban living on a site just 5km from the Perth CBD.

The dwellings’ impressive energy and lifecycle assessment results include a 10 star energy rating for one of the two-storey townhouses.

The owners have also rejuvenated the adjacent vacant land with a community garden.

### Site, location and climate

The 837m² site in the Perth suburb of Lathlain met the developers' needs for reduced car use. The site is within walking distance of the city, and shops, restaurants and entertainment. It is well serviced by public transport.
Case studies
Perth, Western Australia

being just 400m from a train station, and is on a bike path to the city.

The neighbouring vacant land, containing a stormwater drainage pit, was a key factor in deciding to buy the property. The developers requested and received council permission to build a community garden and revegetate the site for use by residents and the neighbourhood.

Solar access is best at the rear of the long and narrow site. Orientation is good, being 35° off north, yet consideration was needed to get the best orientation for multiple properties. A goal of 60% outdoor space in the development also presented a challenge when fitting several buildings on the narrow block.

The local climate is hot and dry in summer, but benefits from a cooling southerly sea breeze, the ‘Fremantle Doctor,’ on most afternoons. Winter is relatively mild with an average daily temperature of 18°C but temperatures can drop to below 10°C at night.

The development includes two townhouses and two apartments surrounded by edible and waterwise gardens.

Design brief

The developers’ clear goal was to create a sustainable urban environment. They wanted a showcase for increased density housing that set new precedents for townhouses and apartments close to the city. The development needed to incorporate at least three dwellings including one for each party (a couple and a family of five.)

The three very important elements in the design brief were to create a design that encouraged a sustainable community, have a small footprint for the dwellings and limit car impact. All are related to an overarching goal to maximise shared outdoor space.

The owners wanted zero emission homes, or at least very low energy use, meaning careful consideration of passive design principles to allow natural heating and cooling as well as solar access for renewable energy systems. (see Carbon zero, carbon positive)

Design response

The design presented two townhouses and two apartments surrounded by edible and waterwise gardens.

Increasing the number of dwellings from three to four met the developers’ goals for a community feel. The intended third townhouse became two apartments, one downstairs and one upstairs.

Three main building materials were chosen for their thermal efficiency and insulating properties. One townhouse is reverse brick veneer and the other straw bale combined with reverse brick veneer; the two apartments are insulated double brick. The reverse brick veneer and double brick are high in thermal mass, helping achieve passive design and energy efficiency goals.

Straw bale was specified for one townhouse because it is a renewable building material and provides a high level of insulation.
Each building occupies a small footprint of around 60–75m². However, building on two levels has opened up available floor space in each townhouse to 120–150m². The floor space in each apartment is around 60–65m² with a 45m² loft expanding the space in one. The small floor areas reduce building waste and help achieve a goal of 60% outdoor space.

To keep the dwellings small, the size needed for each room has been carefully considered. The children’s bedroom in the reverse brick veneer townhouse can be converted to two bedrooms in the future. Lofts create more storage or living space in otherwise unused ceiling and roof areas. Usual indoor activities, such as watching movies, can happen outside in the shared communal space.

Car parking to the front of the property makes a short driveway possible and ensures more open space elsewhere; it also allows all living areas to face the northern rear of the block. The development benefits from a shared undercover area, outdoor kitchen and communal gardens where a driveway might have been.

The design encourages residents to see each other, creating a stronger community. The dwellings cannot be accessed from within the garage; residents must walk outside the garage and use the front door. The entrances to all three buildings face a communal courtyard.

The dwellings require no mechanical heating and cooling due to their energy efficient design. This is achieved with concrete slabs-on-ground combined with thermal mass in walls, high levels of insulation and double glazing, and windows to the south-west for cooling sea breezes and natural ventilation. A common bike storage area on the western wall of the strawbale dwelling doubles as extra protection from the hot summer sun. Breezes from the surrounding garden help cool the homes.

The buildings are designed and orientated for renewable energy systems so that zero greenhouse gas emission goals can be met. The homes are orientated 15°C off north and the pitch of the roofs are maximised for solar photovoltaic panels.

The design was revised to ensure the homes met low greenhouse gas emission goals. Elements such as window size, differences in orientation and wall type were improved to increase the home energy rating. The strawbale dwelling has a 9 star rating, the reverse brick veneer a 10 star rating and the double brick apartments rate 9 and 8 stars.

Insulation

The strawbale walls have an estimated insulation benefit between R5.5 and R8.5. Other walls and ceilings in the strawbale townhouse are insulated with a local product made from up to 85% recycled materials including plastic bottles. The upstairs and downstairs ceilings have high-rating R4 insulation for maximum effect; the reverse brick veneer walls are insulated with R2.5 batts.

The reverse brick veneer townhouse has R2 wool insulation between the wall framing and in the upstairs ceiling. The external cladding is 75mm R2.5 polystyrene, giving the wall an estimated R-value of 4.5. The downstairs ceiling is designed without insulation to enable a thermal connection between the downstairs bedrooms and upstairs living area. (see Insulation)

Double glazing

Double glazed windows with FSC-certified hardwood frames are installed throughout. The windows are imported from the Netherlands (see Glazing). Louvred awnings on the northern façade shade the windows.

The floors are poured from concrete made from recycled aggregate and fly ash.
Case studies
Perth, Western Australia

Recycled materials
Most of what would normally go to landfill has been recycled or reused. The gable ends of a loft have been insulated with insulation offcuts. The clients asked the builder to use chipped bricks ordinarily thrown out. Waste minimisation has been a success due to negotiation between the clients and the various tradespeople.

Materials from a demolished house in Perth were used extensively, including recycled jarrah timber for the solar and louvred awnings. The loft in the reverse brick veneer dwelling is made from recycled floorboards and the flooring is made from granite bench top remnants. (see Waste minimisation)

Straw bale
Straw bale was specified for one townhouse because it is a renewable building material with a high level of insulation. The east and west walls are constructed from around 250 straw bales and have a clay and lime render which provides some thermal mass. (see Straw bale)

The north and south walls are reverse brick veneer, providing additional thermal mass to help with passive heating and cooling. The stud-framed walls upstairs are filled with loose straw and also rendered, limiting the use of plasterboard.

Reverse brick veneer
The other townhouse is reverse brick veneer, selected for its high thermal mass and insulation. The wall structure includes an internal wall made from new face bricks with a structural, insulated timber frame and is clad with an external rendered polystyrene layer, making it thermally tight. (see Brickwork and blockwork)

Low embodied energy
Several measures implemented from a life cycle analysis help to reduce embodied energy. The slabs are poured from a more environmentally sustainable concrete made with recycled aggregate and fly ash. Some dwellings have a lightweight timber structure. Some face brick is used instead of a rendered and painted finish. (see Embodied energy)

Solar hot water
All dwellings have flat plate solar hot water systems. The systems in the apartments have a tank capacity of 180L making them efficient at heating water for a smaller household. The townhouse tanks have a 300L capacity. (see Hot water service)

Solar photovoltaic systems
Each apartment has a 1.5kW solar photovoltaic system on the shared roof, the strawbale townhouse a 3kW system and the reverse brick veneer townhouse a 2.7kW system. The 3kW system has strong returns with bills showing that it covers more than the household’s electricity usage.

Energy efficient appliances
The dwellings have electric induction stoves, considered efficient because they only heat what they come in contact with. The owners prefer induction cooking to gas cooking because gas is non-renewable, and gas fumes can have a negative impact on indoor air quality, particularly in small, well-insulated homes.

Rainwater
Each townhouse has a 4500L metal rainwater tank; the apartments share a 4000L poly tank. Rainwater is plumbed to the entire strawbale townhouse while the other dwellings have rainwater plumbed to the toilet and washing machine.
The developers wanted all outdoor areas, except the private courtyards, to be commonly owned, but planning policies stated that each grouped dwelling needed an exclusive use area of $200\text{m}^2$. The developers had to produce a map showing this was achievable but never used it for strata titling purposes: it could be used for future strata arrangements.

Plans to place dwelling entrances away from the street and garages close to the street — important design features for car access and community — did not fit with planning regulations. Placing windows on the roadside, introducing eaves and gables, and facing the garages inward, softened the garages.

The WA Department of Health granted its first ever exemption under conditions from standard health guidelines that prohibit shared rainwater tanks and the dispersal of greywater over common areas. The owners pursued this exemption so that other developments could have shared water saving systems.

The Green Swing is a success because the developers persisted with negotiations on these policies and regulations. They set new sustainable design and building standards in the area. The development is a constant work in progress for residents, particularly revegetating and rejuvenating the adjacent land for community use. Future plans include another development in the same street.

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**Greywater**

All dwellings are greywater ready with dual plumbing to enable wastewater to be reused. Currently, the costs of a filtration system and government regulations mean only one property can disperse greywater over the common gardens.

**Evaluation**

The developers negotiated resolutions to several planning issues and other regulations so they could implement important sustainability features.

The proposed mixed development exceeded minimum site requirements for the space allocated to each home, so the size and layout of the dwellings had to be adjusted.