Affordability

Housing affordability is a growing issue in most Australian cities and, until recently, the additional cost of sustainable improvements was seen by some as a barrier to their inclusion in our homes. However, well-designed, climate appropriate sustainable improvements make a home more affordable over its life span.

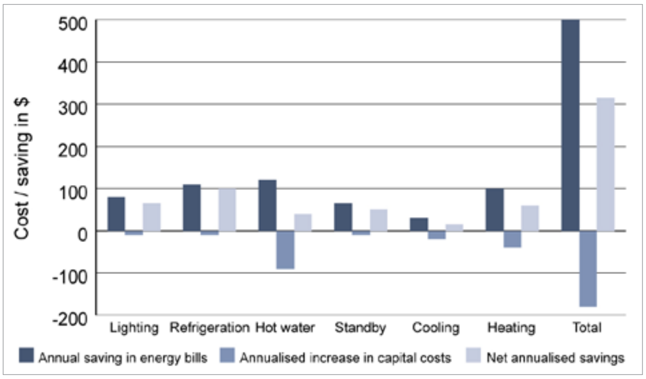
Affordable housing is any type of housing that is rented or purchased at a cost within the financial capacity of a household (generally less than 30% of gross household income). These costs include rent or mortgage payments, rates, property taxes, insurance, repairs and maintenance that are the responsibility of the resident (Gabriel et al. 2005). Although excluded from some studies, utility payments for energy and water are a critical affordability consideration.

Some sustainable features that add to the initial capital cost of a home are cost positive from day one when savings from reduced energy bills offset additional mortgage payments. Other energy and water saving features with higher initial cost deliver significant returns within the life span of the home or appliance.

Affordability of features that improve sustainable performance should therefore be considered across the life span of the home. This life cycle costing (LCC) typically focuses only on economic cost, though increased comfort, health and amenity are clearly significant benefits from sustainable improvements (*see 'Life cycle costing' below*).

Most energy and water saving improvements increase affordability over the life span of the home.

The following graph and the next table show capital costs and consequent savings of simple energy saving improvements for an existing home, even before recent energy price rises (ACF et al. 2008). Net annualised savings over the life of the improvement indicate the most cost effective savings.



Source: ACF et al. 2008

Approximate annual cost savings with energy saving improvements.

An efficient hot water service, which shows the highest initial cost in this study, delivered the biggest annual savings.

Although the initial cost of all these improvements was significant, annual net savings exceeded $300 and payback periods for some items were three to four years (ACF et al. 2008).

Energy poverty is already a considerable issue in Australia and many other developed countries. A household spending 10% or more of total income on energy requirements, or unable to consume energy required to meet basic living requirements due to financial constraints, is considered to be energy poor (Moore et al. 2010).

Environment Victoria estimated that retrofitting 1 million low income Victorian homes with a variety of basic energy and water-saving measures (depending on need) could reduce greenhouse gas emissions by more than 3 million tonnes and save 32.5 billion litres of water each year (Noble and Martinelli 2009).

Initial cost of energy saving improvements

Retrofit activity	Cost ($)	Proportion of dwellings requiring measure (%)
Audit	200	100
Upgrade household with compact fluorescent lamps	70	20
Weather sealing	420	75
Ceiling insulation	1,153	40
Hot water: electric to solar	3,500	30
Hot water: electric to heat pump	4,000	10
High efficiency showerhead	95	50
Dual flush toilet	750	20
Tap flow controllers	40	90
Fridge upgrade	950	15
Average cost per dwelling	$2,800	

Source: ACF et al. 2008

An average investment of $2,800 per household could reduce energy and water bills by up to $600 per year. This clearly presents both a responsibility and an opportunity to investors and landlords that will be rewarded at point of lease or sale.

Affordability considerations

Increasing house size is a substantial contributor to housing unaffordability in Australia. House size affects initial purchase cost, materials consumption and ongoing heating, cooling and maintenance costs, and environmental impact.

The number of people in each Australian household is shrinking but house size is growing — we are building much larger houses than we need.

The number of people per Australian household is shrinking but house size is growing.

Initial costs such as land and house purchase prices, finance costs, stamp duties, legal fees and inspection reports determine what you can afford in your budget. House and land prices are highly variable depending on location, type of house or unit, land and house size, market demand and market appeal.

Limited land supply and speculative investment practices (particularly during high demand periods) have a direct impact on property price increases that then become permanent (Horne et al. 2010a).

The table shows that initial costs relating to sustainable features may be affected by a number of factors.

Factors affecting initial sustainability costs

Increase of initial costs	Decrease of initial costs
• Insulation, advanced glazing, solar hot water service, water tanks, environmentally preferred materials, advanced technologies, etc • Premiums charged by builders and tradespeople unfamiliar with sustainable features • Initial low demand for 'new' or specialty products • Carbon price of energy-intensive materials	• Smaller, smarter floor plans reduce construction and purchase prices • Thermal efficiency requires smaller, simpler heating and cooling systems • Water efficiency reduces hot water service size • Innovative lighting design requires fewer light fittings • Economies of scale for sustainable technologies • Reduced urban sprawl lowers energy, water and road infrastructure costs • Lower overheads (energy and water), 'green' discount loans and rebates improving repayment capacity

Adapted from Horne et al. 2011

Smaller, smarter floor plans are arguably the most effective way to reduce initial and ongoing costs and increase housing affordability.

Smaller, smarter floor plans are arguably the most effective way to reduce initial and ongoing costs.

Ongoing costs affect affordability for householders (owners and tenants) living in and operating the home. These costs are driven primarily by transport and energy costs, interest rates, insurance costs, maintenance and repair costs, council rates, and waste disposal and water charges.

Factors affecting ongoing sustainability costs

Increase of ongoing costs	Decrease of ongoing costs
• Marginally higher maintenance for solar hot water service, rainwater tanks etc. • Water pump operating costs • Some environmentally preferred finishes require more frequent re-application	• Need to own fewer cars and drive less when living nearer to amenities • Lower energy and fuel bills • Reduced carbon cost premiums • Improved indoor air quality reduces health costs and sick days — especially for children • Improved thermal comfort increases enjoyment of home lifestyle • Accessible design accommodates all life stages including temporary disability and ageing • Lower maintenance costs for durable, sustainable materials and finishes

Adapted from Horne et al. 2011

With the exception of efficient user behaviour, sustainability improvements are among the few housing features capable of reducing operating costs. This highlights the importance of long-term thinking when considering affordability.

Think about affordability in the long term.

Life cycle costing

LCC facilitates analysis of the real cost comparison of purchasing or building and living in a home over its life span. In its simplest form, LCC uses the formula:

$$\text{LLC} = \frac{\text{initial cost + lifetime maintenance costs/savings + lifetime operating costs/savings}}{\text{useful life span (years)}}$$

When applied to the range of housing options or upgrade features being considered, this simple formula gives a useful indication of whole of life costs to inform decision making beyond the initial purchase price.

LCC helps answer these simple but important questions:

- What do I need now and how much will it cost or save me over the life of my home?
- What might I need to do in the future if I don't do it now and what will that cost me?
- Could I spend more of my initial budget on features that will save money as soon as I move in and add other features later that don't save money?

LCC examines only the cost to the purchaser or investor. It does not take into account advantages such as environmental benefits versus the cost of doing nothing (Garnaut 2008).

Neither does it factor in improved comfort, health and amenity during occupation of the home. Health care costs can be significant (including the need to take leave from work to care for sick family members) and comfort and amenity can reduce the pressures for more costly entertainment options. These factors should also be taken into account in LCC calculations.

Additional information is required to answer some of the more complex questions.

How long is the life span of my home? It depends on the quality and durability of the home, the likelihood of planning changes that might see it demolished and the length of time you plan to live in the home.

How do I evaluate future costs against current costs? In general terms, the cost of improving thermal performance during construction or renovation is much lower than doing it later. Efficient appliances last 10–15 years and it's most cost effective to upgrade them when they are purchased or replaced, rather than replace them for the sake of upgrading. The cost of on-site generation and energy management systems decreases each year while efficiency increases. These systems can be added cost effectively at a future date. Improved thermal performance is considerably more expensive after construction.

The next owner of your home is likely to value your sustainable improvements and be prepared to pay a premium for them.

Will my home be worth more when I sell it and by how much? While adding marginally to initial cost (2012 estimates are 0–10% of total cost depending on performance level and design innovation), growth in demand is seeing sustainability features increasingly reflected in property values.

Remember, you or someone else will be living in the home for its entire life and the next owner is likely to value your sustainable improvements and be prepared to pay a premium for them.

Recent cost–benefit research

RMIT research

Recent research by RMIT identified a lack of clear cost–benefit information available to consumers, practitioners and policy makers about low and zero emission housing. Their research focused on life cycle cost–benefit scenarios for a variety of energy efficiency standards for Victoria including various combinations of energy efficiency, appliance efficiency and renewable energy (Horne et al. 2011). Limited research findings for other states and climates are outlined below but no definitive cost–benefit studies are yet available.

Designers, consumers and builders should therefore cost a range of scenarios to determine the most cost effective housing solutions in their climate by varying the contribution of thermal performance, appliance efficiency, renewable energy and water efficiency.

Greenhouse gas emission reductions depend on several variables (listed in order of typical cost effectiveness) when included in new housing and major additions:

- efficient user behaviour
- reduced house size (see the section *Passive design*)
- solar hot water with efficient gas or heat-pump backup (see *Hot water service*)
- envelope efficiency (Nationwide House Energy Rating Scheme (NatHERS) rating; see *Passive solar heating; Passive cooling*)
- heating/cooling appliance size/capacity and efficiency (Minimum Energy Performance Standards (MEPS) star rating; see *Heating and cooling*)
- on-site (or community level) renewable energy generation (see *Renewable energy*)
- smart grid interactive demand management and on-site storage systems, appliances and plug-in hybrid electric vehicles (see *Home automation; Smart meters, in-home displays and smart appliances*).

The cost effectiveness of all but the first two factors varies with different house types and climates. For example, householders with limited or expensive thermal upgrade options may find that upgrading major appliances (heating, cooling and hot water service) and installing solar photovoltaics to be the most cost effective option for eliminating energy bills — particularly in more benign climates.

In more extreme climates, higher NatHERS ratings usually deliver the most cost effective outcomes. RMIT found that in Melbourne across a 50 year time-horizon, an 8 star NatHERS thermal performance with 3kW of solar photovoltaics and a solar hot water service provided cost-optimal outcomes for achieving a zero emission home (Moore et al. 2010).

In existing homes, thermal performance can and should always be improved to at least 5 stars NatHERS. Steps include adding insulation, shading and draught proofing, and zoning areas to be heated and cooled.

> *Improve thermal performance to at least 5 stars NatHERS by adding insulation, shading and draught proofing, and zoning areas to be heated and cooled.*

The table gives an overview of indicative heating and cooling energy use for homes with various NatHERS star ratings in a range of cities and climate zones, and highlights the current 6 star NatHERS standard mandated under the Building Code of Australia (BCA).

NatHERS star bands

The total heating and cooling load for each star band have been set for each climate zone taking into account the extremes of the local weather conditions. Each star band facilitates comparison of home energy use in a given climate zone and indicates differing energy requirements between climates zones to achieve similar thermal comfort levels.

Note: BASIX in NSW provides flexible compliance paths to reduce greenhouse gas emissions by 40%. NatHERS assessments are accepted as part of this flexible compliance protocol, but heating and cooling caps are not mandated.

The table demonstrates how similar NatHERS star ratings in different climates require substantially different amounts of heating and cooling energy to maintain equivalent thermal comfort. Take these variations into account when determining the most cost effective energy or carbon reduction solution for a given site and climate zone.

Cape Paterson Ecovillage

A study commissioned by Sustainability Victoria and the Cape Paterson Ecovillage (Szatow 2011) suggests that sustainable technology has reached a tipping point where the financial benefits of building and living in environmentally friendly homes now outweigh the initial costs over the lifespan of the home. The study concluded that:

- additional up-front investment in sustainable features could realise up to 10% after-tax returns per year over 20 years and allow faster mortgage repayment through energy and water savings

NatHERS star band criteria

Location*	Energy loads (MJ/m² conditioned floor/year)									
	1★	2★	3★	4★	5★	6★	7★	8★	9★	10★
Darwin	773	648	555	480	413	349	285	222	164	119
Broome	652	531	448	387	335	285	234	182	134	99
Cairns	302	253	214	242	207	128	105	84	64	48
Sydney E	230	148	98	68	50	39	30	22	13	6
Brisbane	203	139	97	71	55	43	34	25	17	10
Perth	387	251	167	118	89	70	52	34	17	4
Sydney W	450	298	203	146	112	87	66	44	23	7
Adelaide	480	325	227	165	125	96	70	46	22	3
Melbourne	559	384	271	198	149	114	83	54	25	2
Alice Springs	562	385	269	196	148	113	84	56	29	7
Hobart	723	498	354	262	202	155	113	71	31	0
Canberra	792	547	387	284	216	165	120	77	35	2
Thredbo	1238	888	655	499	387	298	216	136	61	1

*Indicative sample of cities and climate zones. For a complete listing, see Table 4 in NatHERS National Administrator (2011).

Rule of thumb allowances for preliminary budget planning

To increase the thermal performance of a typical $350,000 home beyond the current BCA mandatory 6 star performance standard, allow:

- 3–5% of budget per additional star (up to 8 star) in heating (cool) climates
- 1–5% of budget per additional star (up to 8 star) in temperate climates
- 1–7.5% of budget per additional star (up to 8 star) in cooling (tropical) climates

These ranges reflect the diversity of climate variations in each climate grouping — particularly in diurnal temperature ranges and solar or cool breeze access. Lower allowances reflect more benign climates or innovative thermal design. Upper allowances allow for extreme climates and challenging sites.

Allowances for individual items

- Solar hot water service: an additional $1,000–$3,000 less government rebates in your state/region to upgrade to solar over a typical gas or heat pump system.
- The highest MEPS efficiency heating and cooling systems (minimum COP (coefficient of performance) 4.0): an additional 2.5–5% per square metre of conditioned floor area. Save significantly on costs by minimising the floor area requiring conditioning through improved thermal performance — a 25% smaller conditioned area more than offsets the additional cost of a MEPS best practice heating and cooling system.
- Rooftop photovoltaics: $3,500–$5,000 per kW_{peak} less government rebates in your state/region.
- Rainwater harvesting system connected to toilets, laundry and garden: $5,000–$10,000 for tank, pump and plumber; an additional $3,000–$5,000 for underground tank
- Greywater diversion or recycling of shower and bath: from $3,500 for drainage separation and simple diversion system to garden to $10,000 for a system to treat and recycle for laundry and toilet flushing. Some state and local government regulations limit the use of greywater recycling or impose strict compliance and maintenance conditions making it among the least cost effective water saving options.

These allowances are indicative only and subject to change due to factors such as currency exchange rates, inflation, market forces and economies of scale, and local installation costs. Always check with local practitioners and suppliers for up-to-date costs.

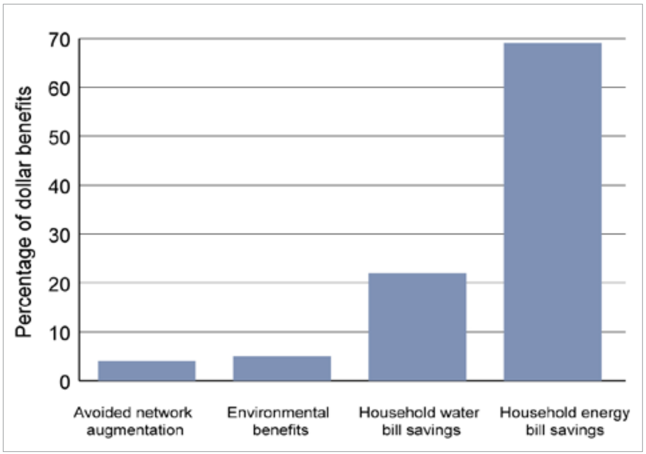
- a combination of high level thermal performance, efficient appliances, on-site power generation, electric vehicles, energy management systems and water efficiency could save residents more than $300,000 and eight years off a typical mortgage
- ongoing innovation in house design (smaller size and improved thermal performance) and construction methods will likely further reduce costs and improve returns.

The RMIT (Horne et al. 2011) and Cape Paterson Ecovillage (Szatow 2011) research projects both focus predominantly on Victorian conditions. However, many of the RMIT findings are currently being adapted to other climate zones throughout Australia.

Household benefits and costs under BASIX (NSW)

The NSW sustainability assessment tool BASIX facilitates flexible, performance based compliance using a user friendly online tool to calculate various combinations of the four main energy/carbon efficiency variables: thermal performance, appliance efficiency, carbon intensity of energy source and renewable energy contribution.

BASIX metrics are based on predicted greenhouse gas emission reductions relative to the state average per person (3,292kg of CO_2/person/year). The current benchmark is a 40% reduction. BASIX compliance also requires up to a 40% water reduction (varies with climate) from the state average of 90,340L/person/year.



Sources of dollar benefits to NSW.

Research by the NSW Government indicates that the cost for a new dwelling to comply with BASIX ranges from $1,114 for a Sydney high rise unit to $21,902 for a single detached house in the Southern Highlands with no gas. The compliance cost for an average Sydney western suburbs house was estimated at $6,417.

The total per dwelling benefits expected to accrue to households by 2050 is estimated at $3,273 for a Sydney high-rise unit to $14,661 for a large Sydney house relying on solar power to pass BASIX (Planning NSW 2009).

Queensland research

Townsville Enterprise cites research from 2010 that reported annual average electricity costs as:

- $1,643 in Queensland homes
- $873 in energy efficient Queensland homes.

It also reports on an Ergon Energy (2011) audit of 19 new homes in Townsville to examine potential energy savings from the following improvements:

- light coloured roof
- R3.5 ceiling insulation
- sarking (reflective foil insulation)
- ventilation in the roof space
- medium tinted glass.

The audit concluded that with those improvements:

- all 19 homes would improve their energy rating
- the average energy saving across the houses would be 21%
- the highest performing property would increase its BCA star rating from 6 to 8 and gain 37% of energy savings.

Cost–benefit of improved glazing

Research by Sustainable Windows Alliance into the cost–benefit of improved glazing in thermal performance upgrades for new housing reported findings from state capital cities.

Brisbane: use of appropriate windows and glazing in a 240m² home was estimated to save approximately 3,000MJ of mostly cooling energy per star, or $150–$250 and up to 0.35t of greenhouse gas emissions per year. Findings were based on:

- low solar heat gain coefficient ($SHGC_w$) glazing improving the rating by as much as 1 star
- low U-value glazing improving the rating by approximately 0.25 stars for each unit reduction in U-value (e.g. U4.5 to U3.5)
- ventilation improving the rating by up to 0.25 stars per additional 20% of openable area.

Each star corresponds to a reduction in heating/cooling requirements of 15–30% from the pre-improved level.

Sydney, Perth or Adelaide: use of appropriate glazing and window type to reduce heat flowing through windows (in and out) in a 240m² home was estimated to save approximately 3,000MJ of mostly cooling energy, worth about $250, and up to 0.4t of greenhouse gas emissions per star per year. Findings were based on:

- low U-value reducing conducted winter heat loss and summer gain
- mid-range $SHGC_w$ (varies according to orientation)
- season-specific passive or active shading
- window style with adequate openable area for ventilation.

Each star corresponds to a reduction in heating/cooling requirements of approximately 20–30% on the pre-improved level.

Melbourne/Hobart: use of appropriate glazing and window frames to exploit desirable solar heat gain for most of the year and reduce heat flowing through windows (in both directions) throughout the year was estimated to save approximately 10,000–15,000MJ of mostly heating energy per star worth around $300/year and 1.0t of greenhouse gas emissions. Findings were based on:

- lowest U-values (double glazing) reducing heat loss throughout most of the year
- marginally increased cooling requirements in periods of hot weather
- optimised $SHGC_w$ (clear) offering no improvement in stars (clear is baseline)
- season-specific physical shading of windows (e.g. eaves over north-facing windows)
- increased ventilation openings having little or no star impact (likely to change as climates warm).

Each star corresponds to a reduction in (mostly) heating energy requirements of approximately 20–30% on the pre-improved level.

Darwin: tropical housing was not modelled. Low U-value and $SHGC_w$ glazing reduces heat gain when windows are closed (e.g. when conditioning is operating) but cooling energy use depends largely on shading and breeze access and whether the home is designed to be free-running, conditioned or a combination of both.

A Darwin house would typically use up to eight times more energy to maintain thermal comfort than a Brisbane house with a similar star rating due to cooling requirements during the hot humid summer. A 9–10 star rated Darwin home would have similar cooling energy requirements to a 6 star Brisbane home but would be relatively expensive. (see *Passive cooling*; *Glazing*)

In all climates, the most affordable glazing solution in thermal performance terms is to reduce the total area of glass — particularly east and west facing.

In all climates, the most affordable way to improve the thermal performance of windows is to reduce the total area of glass.

Emerging economies of scale

Growing global demand for sustainable technologies is generating economies of scale that increase affordability. And in the relatively new field of sustainable building, research and innovation are rapidly developing new and more cost effective solutions.

Large housing developments can also deliver cost reductions through bulk purchasing and availability of trades who are skilled in sustainable construction (*see 'Cape Paterson Ecovillage' above*).

Prefabricated or transportable homes are emerging as promising alternatives to assist with housing affordability. Factory construction reduces costs through bulk buying, waste reduction and elimination of many site-related costs. A growing number of Australian companies offer attractive, flexible, factory built options that are manufactured to high construction standards from quality eco-materials and finishes.

Gateway Constructions in Far North Queensland makes modular, transportable and prefabricated homes that are environmentally sustainable and energy responsible

The company has achieved up to a 9 star energy rating in some of its products, and offers sustainability options such as:

- sustainable plantation timbers (60%) and recycled timbers (40%)
- recycled timber internal linings instead of plaster
- end of life planning for recycling building materials
- factory production to reduce environmental impact on site and minimise waste
- optimum site orientation for maximum energy efficiency
- water tanks for rainwater harvesting to potable standard
- solar hot water and heat pump systems
- integrated on-site power generation
- on-site waste treatment
- natural cooling and cross ventilation for air flow
- 3 star plus water efficient plumbing
- reflective roofing materials.

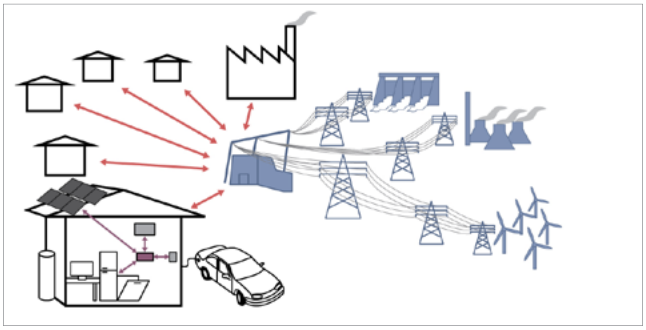
The homes are made with one to five bedrooms and being modular can be added to easily to meet the changing needs of families.

Future roles for energy management systems and smart grids

Read this section in conjunction with *Home automation* and *Smart meters, in-home displays and smart appliances*.

The Australian Government committed to the goal that, by 2020, the majority of Australian households, businesses and other organisations would have access to smart technology to better manage their energy use; the Victorian Government mandated that digital electricity meters (smart meters) be installed in all Victorian households and small businesses by the end of 2013. These programs have experienced delays, but smart grids and meters are likely to be available to most Australian homes in the medium term.

Time-of-use or smart metering varies electricity cost according to demand and allows consumers to see how much electricity they use, when they use it and how much it costs. Consumers can thus save money by using less power when electricity is most expensive and choose when to export any they generate or store on site to the grid at peak price.



Source: Forte 2011

Energy management systems can substantially reduce household electricity and transport costs.

These systems are rapidly developing to increase both efficiency and affordability and will likely offer a cost effective improvement option for all housing as smart metering and grids become available.

When combined with plug-in hybrid electric vehicles (PHEVs), energy management systems substantially reduce household electricity and transport costs, and maximise returns on any investment in on-site generation, storage and smart appliances while reducing peak demand.

Green Star — Communities

The Green Star — Communities rating tool is able to assess and certify the sustainability of community-level projects. As part of its best practice benchmarks, the tool requires a development to provide 'diverse and affordable living' through a diversity of dwellings, buildings and facilities that reflect the socioeconomic needs of the community and include access to local services including transport, food, health and conveniences.

The aim of the Green Star — Communities Econ-5 'Affordability' credit is to encourage and recognise projects that promote housing and living affordability. The affordability credit rewards the number of housing affordability strategies implemented in the project, from lot diversity to the promotion of affordable housing stock.

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