



Life Cycle Assessment

Example Detached Residence

Your Company

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Executive Summary

In order to quantify and improve the design of the Detached Residence a life cycle assessment (LCA) has been conducted. Three LCAs were conducted, each representing an alternative design:

- A business as usual or benchmark design, "Residential Dwelling Mix AU Res Ave 2013 Code Compl CZ 5 (10 dwellings)"
- Base case design, "Detached Residence Base Design"
- Improved design with modeled recommendations, "Detached Residence Improved Design"

Design life is a critical factor in LCAs of construction works. In this case, the estimated design life of the benchmark is 54 years and the maximum durability is 100 years. The estimated design life for the subject building "Detached Residence Base Design" is 55 years whilst the maximum durability is 175 years.

The Global Warming Potential impact associated with the base case design totalled 363,168 kgCO₂e

Taking into account the functional units of the building, this is equivalent to 2,620 kgCO₂e/year/Occupant. This represents a 37% saving compared to the benchmark.

Having quantified the impact associated with the base case design, this enabled a number of recommended design improvements to be identified. These are summarized below:

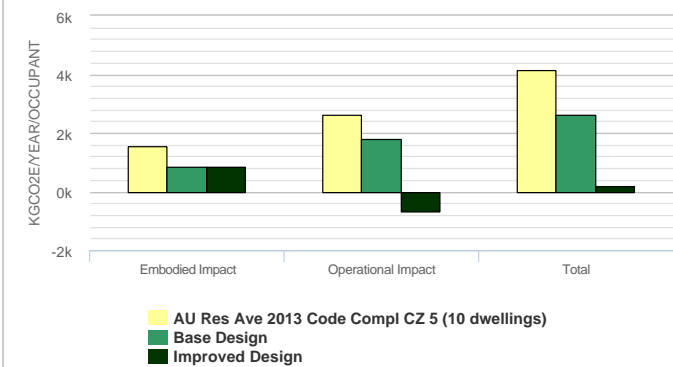
Recommendation	GWP (kgCO ₂ e/Occupant/year)			Saving Against Benchmark
	Initial	10 Year	Life time	
Concrete Replacement - 50% Fly-Ash Blend	-24.62	-24.62	-24.62	.59
Finishes - Reduce Floor Coverings	-14.79	-14.77	-54.63	1.32
Replacement - Aluminium Window Frames for Timber	-35.6	-35.92	-39.49	.95
Finishes - Plasterboard Alternatives	-9.15	-9.1	-17.36	.42
Replacement - Recycled Bricks	-27.17	-27.17	-27.17	.65
HWS - Heat recovery (shower & drain)	1.63	1	-.79	.02
High Efficiency Appliances	0	-8.03	-49.08	1.18
Energy monitoring - residential	.35	-9.86	-61.03	1.47
Refrigeration - Reduced fridge space	0	-2.92	-17.85	.43
Internal drying lines	.54	-1.44	-10.48	.25
Improved thermal performance	-11.61	-13.82	9.09	N/A
HWS - Solar Thermal Gas Boost	4.42	-25.91	-160.86	3.88
HVAC - Wood pellet heater	.84	-12.58	-79.05	1.91
Photovoltaics	51.68	-271.77	-1,851.02	44.61
Behavioural Change Programs	0	-10.39	-63.51	1.53
Total	-63.47	-467.29	-2,447.86	59.21

With recommendations a saving of 96% can be achieved.

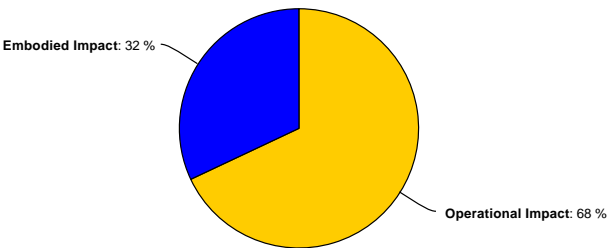
The following charts provide some further information regarding the comparative impacts of the three designs. A comparison has also been provided of the largest embodied and operational impacts. The detailed percentage split of impacts sources relating to the base case design have also been provided.

Total Life Cycle Global Warming Potential

Comparison of Global Warming Potential Profiles:

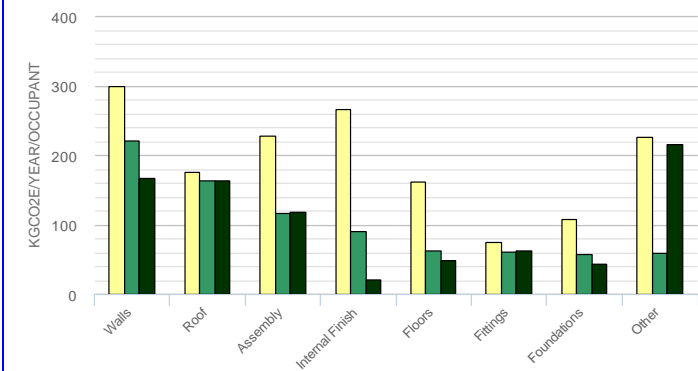


Total Global Warming Potential Profile for Base Design



Embodied Global Warming Potential

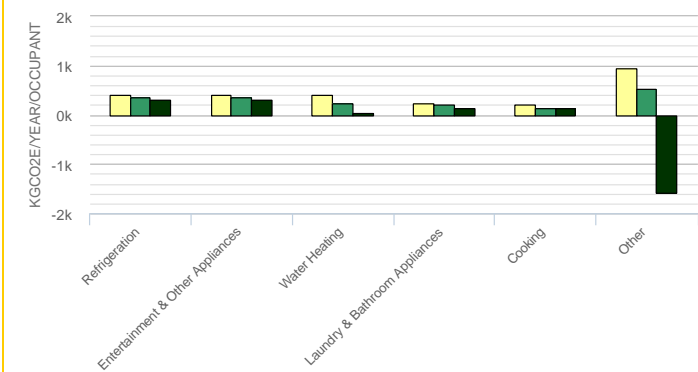
Comparison of Embodied Global Warming Potential:



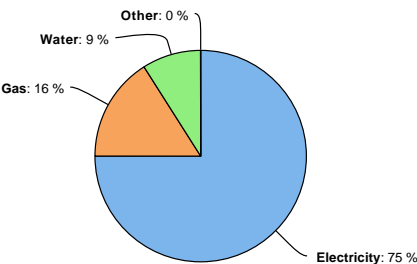
Embodied Global Warming Potential Profile for Base Design

Operational Global Warming Potential

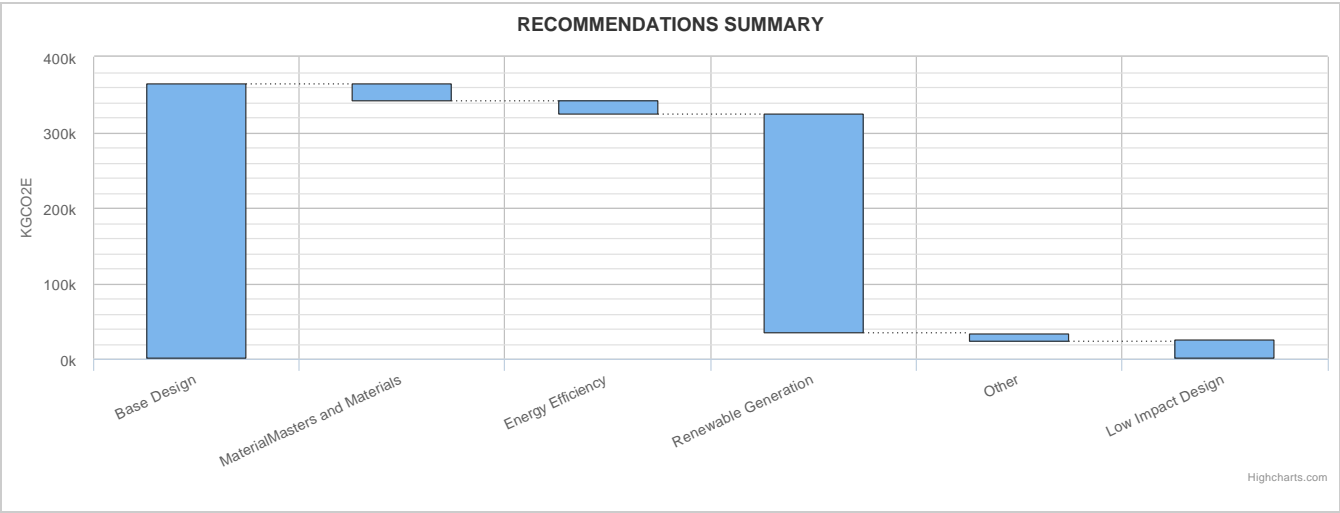
Comparison of Operational Global Warming Potential:



Operational Global Warming Potential Profile for Base Design



Recommendation Summary Global Warming Potential



Improvement Type	Savings (kgCO2e)
Base Design	363,168
MaterialMasters and Materials	-22,630
Energy Efficiency	-18,038
Renewable Generation	-289,804
Other	-8,802
Low Impact Design	23,894

Life Cycle Assessment Report Information

Introduction

Life Cycle Assessment (LCA) is a method used to determine the real cost and/or environmental impact of a product over its life. This LCA accounts for impacts and costs from cradle to grave (recycling environmental costs are not yet within the scope of eTool LCAs). In the case of construction works, the total life cycle energy consumption is made up of two elements:

- Embodied Impacts
- Operational Impacts

This life cycle assessment compares the life cycle impacts of design options to a chosen benchmark. Where recommendations are made, their purpose is to reduce the impacts of the design.

LCA Goals

The goals of this life cycle assessment are to:

- Quantify the environmental impacts of the clients design (normal eTool assessments pay particular attention to CO2 equivalent emissions, CO2e)
- Compare these impacts against a typical 'business as usual' benchmark
- Provide recommendations that will ideally reduce the total impacts of the construction works
- Conduct this in a cost effective, auditable and repeatable manner

A typical eTool assessment allows reporting of numerous impacts. This report only details the Global Warming Potential impacts of the design options. It is the goal of eTool to estimate impacts with enough accuracy to compare different design options. The aim is to be vaguely right not precisely wrong. Estimating impacts to high levels of confidence requires detailed resources. In the case of construction works, this will usually be overshadowed by the influence of occupant behavior on operational impacts, or the actual construction work life that will deviate significantly from that estimated in this assessment. The assessment does not attempt to predict the affects of future changes to:

- Grid Power Sources
- Inflation of construction materials (for maintenance), labour costs or energy costs

The assessment therefore represents a snapshot in time, all else being equal, of the building performance.

LCA Scope

A number of impact categories have been isolated for reporting. Furthermore, the extent to which these categories are measured are detailed in the scope. Both the system boundaries and specific detail of the scope are found below

System Boundaries

The system boundary of the assessment is detailed in Figure 1. The system boundary is quite broad for this LCA, however the omission of demolition and recycling impacts must be noted as this has potential to be significant in an unbounded LCA. The eTool database does however store an estimated percentage of recyclable materials used in the structure which can be reported on separately. Please contact us for more information.

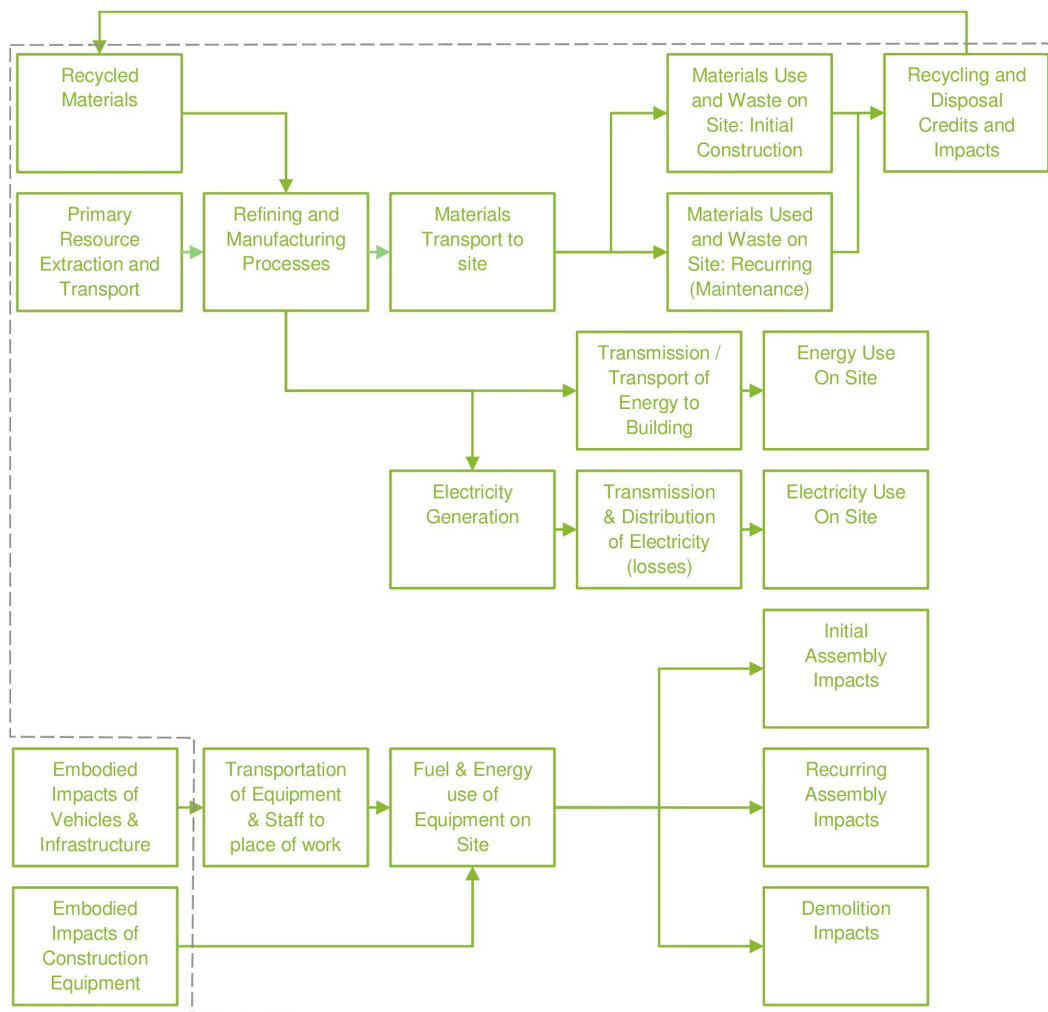


Figure 1: System Boundary of LCA

Specific Details of Scope

In relationship to the building envelope itself, the scope is further defined in Table 1. The impact categories are listed in the first column. The items falling in and out of scope are listed in detail. Factors that would greatly influence the total LCA GHG emissions of the designs include:

- Non permanent building fixtures such as furniture and appliances
- Operational Transportation (transportation of building occupants to and from the building to workplaces, recreational areas and retail outlets)
- Embodied carbon relating to building planning and sales

These factors listed are not considered significant to the conclusions of the LCA however please contact eTool if you would like to discuss how these impacts could be included in your assessment.

Category	In Scope		Out of Scope
Materials	<ul style="list-style-type: none"> Foundations <ul style="list-style-type: none"> Foundations and Footings Floors <ul style="list-style-type: none"> Slab or Posts Structure Insulation Walls <ul style="list-style-type: none"> Structure Doors Windows Insulation Roof <ul style="list-style-type: none"> Structure Covering Ceiling Gutters and Downpipes Eaves Insulation Internal Finish <ul style="list-style-type: none"> Paint Floor Coverings Cornices / Shadowlines Wall Coverings (eg plaster) Skirting Boards Wet area floors and walls 	<ul style="list-style-type: none"> External Finish <ul style="list-style-type: none"> Shades Security and Fly Screens Paint Wall coverings (eg renders) Services <ul style="list-style-type: none"> Power Plumbing Communications Sewerage Air-conditioning and Heating Lifts, elevators, access Fittings <ul style="list-style-type: none"> Showers and baths Lighting Toilets Shower Screens Door handles and hardware Taps Bathroom and Laundry Sinks 	<ul style="list-style-type: none"> Fittings <ul style="list-style-type: none"> Kitchens Fittings Cabinetry All furnishings and appliances Landscaping <ul style="list-style-type: none"> Paving Retaining Walls Gardening Other Landscaping
Assembly	<ul style="list-style-type: none"> Site Preparation and Earthmoving Assembly energy associated with all material categories listed "In Scope" above 		<ul style="list-style-type: none"> Assembly energy associated with all material categories listed "Out of Scope" above
Recurring	<ul style="list-style-type: none"> Replacement of Materials used in the categories listed "In Scope" above Maintenance of materials used in the categories listed "In Scope" above Recurring assembly impacts associated with maintaining and replacing building components in scope above. 		<ul style="list-style-type: none"> Any recurring impacts associated with out of scope materials or assembly.
Transport and Travel	<ul style="list-style-type: none"> Transport of Materials associated with all material categories listed "In Scope" above Transport of equipment and trade staff associated with all in scope assembly categories Transport associated with recurring impacts 		<ul style="list-style-type: none"> Travel of building occupants after construction Transport impacts associated with out of scope materials, assembly or recurring Embodied impacts of transport methods (eg trade staff vehicles)
Operational	<ul style="list-style-type: none"> Thermal Control Hot Water Refrigeration Lighting Cooking and other kitchen appliances Laundry appliances Entertainment and Communications Workshop and garage 	<ul style="list-style-type: none"> Swimming pool Domestic water supply Domestic water treatment Water pumps and bores Small scale energy generation Office / Work Stations Personnel or Service Lift / Elevator 	<ul style="list-style-type: none"> Operational Transport Energy

Table 1: Specific detail of scope in relation to the building envelope.

Data Sources and Assumptions

Embodied Impacts

The life cycle inventory data chosen for this assessment includes:

- The default cradle to factory gate embodied impacts of materials are derived from the Inventory of Carbon and Energy (Mammond). Alternative LCI sources can be chosen in eTool and may have been implemented in whole or part in this report.
- Environment Australia for freight transportation GHG coefficients (Atech Group for Environment Australia, 2001)
- National Greenhouse Accounts Factors for GHG coefficients for fossil fuel combustion (Department of Climate Change and Energy, 2011)

In selecting data sources for eTool software, efforts have been made to identify significant items and cross check these against second or third sources for consistency and relevance. For example, the embodied GHG coefficient for clay bricks was cross checked against the Think Brick Australia – LCA of Brick Products (Energetics, 2010) for geographical relevance to Australian based LCAs and found to be appropriate.

Operational Impacts

For residential buildings, operational energy demand was modeled using a range of data sources. Australian primary energy consumption (ABARE, 2009) was interpreted to establish the average energy demand in Australia. This data was then cross referenced against other international residential building energy statistics (D&R International LTD, 2009 and US Energy Information Administration, 2011). Once adjusted for climatic influence, the comparisons supported this method of estimating overall energy demand for average households. In the case of residential buildings, demand categories were then modelled using information from:

- Your Home Technical Manual (Department of Climate Change and Energy Efficiency, 2010)
- Baseline Energy Estimates 1990 – 2020 (Department of the Environment, Water, Heritage and the Arts, 2008)

- Energy use in Provision and Consumption of Urban Water in Australia and New Zealand (Kenway, et al., 2008)
- Nationwide House Energy Rating Scheme (NatHERS) starbands (www.nathers.gov.au) for average thermal performance

In the case of commercial buildings, operational energy demand was benchmarked using the following sources:

- Sustainability in the Commercial Property Sector (Department of Environment and Climate Change NSW)
- NABERS Office Reverse Calculator
- Actual commercial buildings energy consumption (both predictive and surveyed data)

Functional Units

In order to normalise assessments between building types the impacts were measured per Occupant. Furthermore, in order to normalise assessments between different building ages, the impacts were measured per year.

The Total Global Warming Potential for each of the designs assessed is outlined below:

- Base Design: 363,168 kgCO₂e
- AU Res Ave 2013 Code Compl CZ 5 (10 dwellings): 5,310,282 kgCO₂e
- Improved Design: 23,332 kgCO₂e

The design life of buildings has a very large effect on their comparable sustainability. Although difficult to predict, eTool uses a methodology aimed at producing fair and repeatable comparisons between building designs. Individual building life spans will deviate significantly from the design lives calculated using this methodology, however the aim is to predict the mean expected life of all buildings with similar characteristics and circumstances.

Although studies that quantify the actual life span of buildings are lacking, the reasons for demolition of buildings are quite well documented. Studies conducted in Australia (Kapambwe, Ximenes, F, Vinden, & Keenan, 2009) and the US (Athena Institute, 2004) indicate that less than 10% of buildings are demolished due to reaching the end of their structural service life. It is other factors that usually dictate service life, namely:

- Redevelopment for economic reasons (surrounding land has increased in value to the extent that it is more profitable to increase the density or use of the building)
- Redevelopment for aesthetic reasons (the building is no longer in fashion)
- Fire or other disaster

For this reason the following characteristics are also considered when estimating design life:

- Building density
- Density of the surrounding suburb
- Design quality

Best practice building design attempts to match the durability with the redevelopment potential of the building.

In this case, the estimated design life of the benchmark was 54 years whilst the maximum durability of the building is 100 years. The estimated design life for the subject building "Detached Residence Base Design" is 55 years whilst the maximum durability is 175 years.

The eTool estimated design lives often differ compared to industry perceptions of building life span. Architects in Australia for example expect detached residential buildings to last over 60 years (Kapambwe, Ximenes, F, Vinden, & Keenan, 2009).

Life Cycle Inventory

A summary of LCI outputs is found on the first page of this report. For further details on the life cycle inventory (both inputs and outputs) which are all stored in the eTool database please contact eTool.

eTool Design Recommendations

Concrete Replacement - 50% Fly-Ash Blend - Materials

Recommendation	GWP (kgCO ₂ e/Occupant/year)			Saving Against Benchmark
	Initial	10 Year	Life time	
Concrete Replacement - 50% Fly-Ash Blend	-24.62	-24.62	-24.62	.59

Fly-ash is a by-product of power generation in coal fired power stations and can be used to directly replace Portland cement in varying proportions up to 50%. Fly-ash is also cost competitive with standard cement depending on the application. Fly ash blend concretes can actually produce a stronger product but typically have longer curing times which can greatly impact multi-story developments. Curing agents are available to alleviate this but may have an impact on the cost.

Finishes - Reduce Floor Coverings - Materials

Recommendation	GWP (kgCO2e/Occupant/year)			Saving Against Benchmark
	Initial	10 Year	Life time	
Finishes - Reduce Floor Coverings	-14.79	-14.77	-54.63	1.32

Ceramic floor tiles have a large amount of embodied energy. Specifying polished concrete will have lower embodied impacts. Grind and polish concrete eliminates the use a polyurethane seal/coating and reduce maintenance associated with a grind and seal finish.

For this recommendation, all floor areas are ground and polished concrete.



(image source: <http://www.switcheroom.com>)

Replacement - Aluminium Window Frames for Timber - Materials

Recommendation	GWP (kgCO2e/Occupant/year)			Saving Against Benchmark
	Initial	10 Year	Life time	
Replacement - Aluminium Window Frames for Timber	-35.6	-35.92	-39.49	.95

Aluminium is a very carbon intensive material. Significant savings can be achieved by replacing aluminium windows with timber frame. A hybrid of aluminium coated timber frame is also available. Note that the saving detailed is embodied energy only, further savings are likely due to increased thermal performance of timber.



(Image source: <http://www.allkind.com.au>)

Finishes - Plasterboard Alternatives - Materials

Recommendation	GWP (kgCO ₂ e/Occupant/year)			Saving Against Benchmark
	Initial	10 Year	Life time	
Finishes - Plasterboard Alternatives	-9.15	-9.1	-17.36	.42

Due to the manufacturing process of plasterboard it has very high embodied energy. Although not currently mainstream, alternatives can be used in place by specifying a more sustainable products such as Knaufplasterboard and Modakboard.

In this recommendation we have assumed all walls are finished internally with feature face brick and no changes are made to the ceilings.

Replacement - Recycled Bricks - Materials

Recommendation	GWP (kgCO ₂ e/Occupant/year)			Saving Against Benchmark
	Initial	10 Year	Life time	
Replacement - Recycled Bricks	-27.17	-27.17	-27.17	.65

There is a large amount of masonry in the build. Using re-cycled clay bricks in all masonry walls will have significant impact on carbon savings. Although there is a lot of labour involved in sourcing and cleaning bricks, they can be cost competitive with new bricks. The aesthetic look of recycled brick is also very popular in architecturally designed buildings.

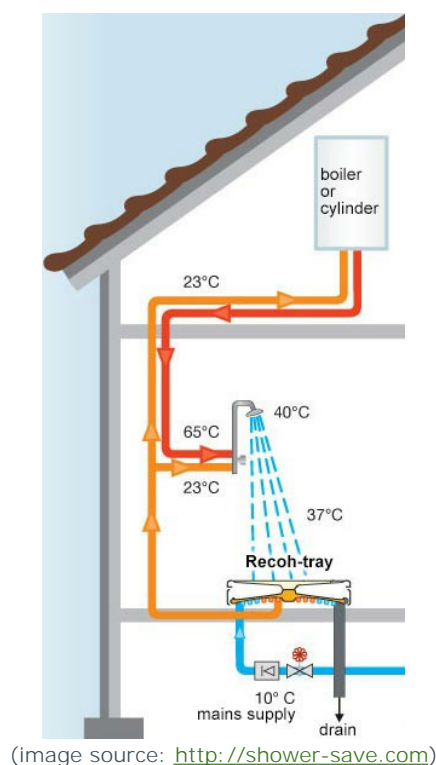


(Image source: Architizer.com)

HWS - Heat recovery (shower & drain) - Energy Efficiency

Recommendation	GWP (kgCO ₂ e/Occupant/year)			Saving Against Benchmark
	Initial	10 Year	Life time	
HWS - Heat recovery (shower & drain)	1.63	1	-.79	.02

An opportunity exists to warm the inlet temperature of the water by using a heat exchanger. Water exiting apartments in the shower drains will have a higher temperature than the normal inlet temperature of water coming into the building from the mains, particularly in winter. By passing the inlet water over the warmer outgoing water, the temperature can be increased. eTool have assumed a 7.5% reduction in energy demand of the hot water system based on a 20 degree inlet temperature (conservative assumption).



High Efficiency Appliances - Energy Efficiency

Recommendation	GWP (kgCO ₂ e/Occupant/year)			Saving Against Benchmark
	Initial	10 Year	Life time	
High Efficiency Appliances	0	-8.03	-49.08	1.18

Appliances account for a large percentage of the residential carbon emissions. High efficiency appliances (7 Star TV, 3 Star washing machine, 3 star dryer, 4 star dishwasher) help to reduce total energy consumption. In this recommendation, we assume that the builder will be providing the TV, washing machine, dryer & dish washer and that these will not be replaced with similar efficiency models after the warranty period - 2 years for TV, 10 years for washing machine, dish washer & dryer.

At eTool we're always cautious about recommending highly rated energy efficient fridges, as the embodied energy of the food is likely to be at least 10 times more than the energy consumed by the fridge. Sometimes a fridge which is actually less efficient and uses a bit more power can extend the life of food quite considerably making it the more sustainable option!

Energy monitoring - residential - Energy Efficiency

Recommendation	GWP (kgCO ₂ e/Occupant/year)			Saving Against Benchmark
	Initial	10 Year	Life time	
Energy monitoring - residential	.35	-9.86	-61.03	1.47

Energy monitoring allows occupants to understand what appliances and devices are demanding the most energy (electricity) and adjust behaviour accordingly. A 10% reduction in all electricity use is assumed. Studies show that energy monitoring can provide between a 5% and 30% saving in electricity. The savings are largely dependent on the sophistication of the interface and level of customer support available. More details at eTool online presentation http://www.youtube.com/watch?feature=player_embedded&v=CPrUHXWcOX8

\$250/unit capital cost (replaced every 10 years)



(Image source: www.efergy.com)

Refrigeration - Reduced fridge space - Energy Efficiency

Recommendation	GWP (kgCO ₂ e/Occupant/year)			Saving Against Benchmark
	Initial	10 Year	Life time	
Refrigeration - Reduced fridge space	0	-2.92	-17.85	.43

Restricting fridge space to one primary fridge or about 750 mm so no large models can be installed will have an estimated 20% energy saving. There are also likely to be indirect savings in that less food is wasted and residents will be encouraged to shop fresh and locally.

Some information on refrigeration applicable to this recommendation:

- eTool base case energy predictions are derived from top down allocation of energy use (not bottom up analysis as there are too many and not enough statistical data)
- Average occupancy of Australian dwellings is 2.37 persons per dwelling, for the base building this is adjusted up and down using regression analysis of ABS Census data with suburb density and number of bedrooms being the two most influential variables.
- It is assumed that in the base case model there is no specific restriction on primary refrigeration size unless the plans specify a reduced size.
- In detached dwellings it is assumed that
 - 55% of energy is used by primary refrigerator
 - 20% by secondary refrigerator
 - 25% by separate freezer
- An average Australian household has 1.25 fridges and 0.4 Freezers (Australian Residential Building Sector Greenhouse Gas Emissions 1990–2010, Greenhouse Office, 1999).
- It is assumed that the second fridge is less efficient than the first due to MEPS requirements which are increasing at a rate that would certainly offset any differences in size)
- For apartments, due to limited space and inability to house fridges on balconies, the allowance for separate freezers is removed unless the apartment is of unusually large size or the occupants have access to a fully enclosed private garage.

To estimate energy savings due to this recommendation:

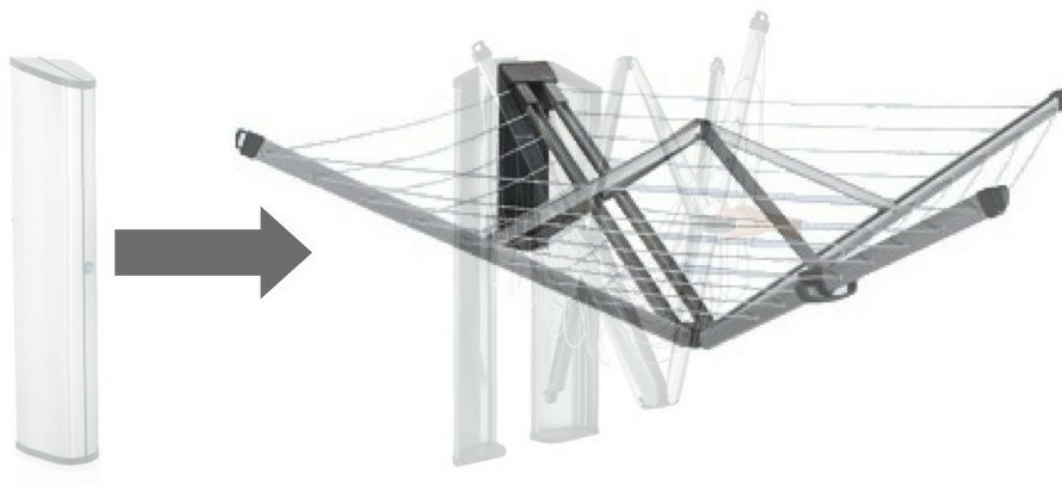
- The listed MEPS consumption figures for upright fridges less than 750mm gives an average consumption of 419kWh
- Listed MEPS consumption figures for side-by-side fridges between 750mm and 1000mm gives an average consumption of 695kWh which is a 66% increase in energy consumption.
- This is partly due to volume, but also largely effected by the prominence of ice and cold water dispenses in larger upright freezers that allow large heat transfer.
- In base case scenario it is assumed that uptake of side by side fridges with un-restricted cabinetry would be equal to that of current market share in Australia (17.5%)
- By reducing cabinetry size and removing the 17.5% of predicted side by side fridges installations, we see a overall average drop of 10.3% drop in energy demand for the primary refrigerator.

Internal drying lines - Energy Efficiency

Recommendation	GWP (kgCO ₂ e/Occupant/year)			Saving Against Benchmark
	Initial	10 Year	Life time	
Internal drying lines	.54	-1.44	-10.48	.25

Laundry energy demand can be reduced by installing indoor overhead clotheslines and reducing reliance on the drier. Installing an internal clothesline could reduce reliance on the drier by a predicted 25%. To qualify for this kind of reduction the drying space would need to take a full load of washing, approximately 10m of line length is required.

\$200/unit capital cost, replaced every 15 years.



(Image source: <http://www.brabantia.com/>)

Improved thermal performance - Energy Efficiency

Recommendation	GWP (kgCO ₂ e/Occupant/year)			Saving Against Benchmark
	Initial	10 Year	Life time	
Improved thermal performance	-11.61	-13.82	9.09	N/A

The current base design assumption is that the dwelling will achieve a 7.2 star NatHERS average. The carbon emissions associated with heating and cooling accounts for approximately less than 5% of the total life cycle carbon (and approximately 1% if recommended services are put in place to meet thermal requirements). The thermal performance assessor put forward recommendations that would lift the NatHERS rating to 8.4 stars. This was achieved through the following measures:

- Reverse brick veneer
- Superior glazing
- Double glazed windows (except bed 3, laundry and family NW elevation).

Capital costs associated with this recommendation as modelled should not be relied upon, they are very likely inaccurate.

HWS - Solar Thermal Gas Boost - Renewable Generation

Recommendation	GWP (kgCO ₂ e/Occupant/year)			Saving Against Benchmark
	Initial	10 Year	Life time	
HWS - Solar Thermal Gas Boost	4.42	-25.91	-160.86	3.88

Depending on the size of the system solar hot water can meet a significant proportion of the dwellings hot water requirements. In combination with instantaneous gas boost system, this reduces tank losses and the carbon intensity of the energy source. For more cool details about gas vs electricity visit: <http://etool.net.au/eblog/energy/are-you-using-gas-or-electricity-in-your-new-home/>

Solar thermal hot water can often be more effective use of roof space than solar PV (for more details see here <http://etool.net.au/wp-content/uploads/2013/06/Solar-PV-vs-Solar-Thermal.pdf>). More flexible vertical or horizontal mounting options are also available from evacuated tube type panels that can be angled towards the sun.

Typical roof area required for solar collectors:
2 collectors – 2.4 x 2m. Weight (full) 80 kg approx.

In this case we have modelled a standard detached dwelling size solar hot water system (approximately 4m² of collector area) and a tankless instantaneous gas booster.

HVAC - Wood pellet heater - Renewable Generation

Recommendation	GWP (kgCO ₂ e/Occupant/year)			Saving Against Benchmark
	Initial	10 Year	Life time	
HVAC - Wood pellet heater	.84	-12.58	-79.05	1.91

This recommendation will complement the installation of ceiling fans so that no installation of a reverse cycle heat pump will be required hence a savings of close to \$3000 in initial HVAC costs.

Pellet heaters are electronically sophisticated appliances that offer an environmentally friendly and low-cost heating option by using bio-mass fuel. Pellet boilers can be automatically fed and the wood fuel can be cost competitive with gas heaters.

No more than two pellet heaters for the living areas has been recommended for this project due to the open layout design of the Dining/Family/Kitchen. Higher heating energy efficiencies can be achieved if these areas can be closed off from the Activity & corridor/Theatre/Office with doors.

In modelling this recommendation it is assumed that by installing the pellet heater, 100% of cooling could also move to ceiling fans (80% assumed air source heat pump, 20% assumed ceiling fans currently). This reflects the predicted heating and cooling loads of the design based on NatHERS assessment results (heating loads are dominant).



(image source: <http://www.archiexpo.com>)

Photovoltaics - Renewable Generation

Recommendation	GWP (kgCO ₂ e/Occupant/year)			Saving Against Benchmark
	Initial	10 Year	Life time	
Photovoltaics	51.68	-271.77	-1,851.02	44.61

Using generated power on site results in much lower emissions associated with the dwelling compared to using the fossil fuel powered grid. Feeding out to the grid assumes a net environmental credit as the electricity will be consumed by a neighbouring consumer therefore reducing the demand on the grid. The embodied carbon of the solar system is included in the calculations.



(Image source: www.forceofthesun.com)

Behavioural Change Programs - Other

Recommendation	GWP (kgCO ₂ e/Occupant/year)			Saving Against Benchmark
	Initial	10 Year	Life time	
Behavioural Change Programs	0	-10.39	-63.51	1.53

Behavioural change programs can be extremely effective in encouraging residents to reduce their carbon emissions. A recent voluntary programme run by Living Smart as part of the Perth Solar Cities project used a number of "eco-coaches" to ring home-owners and renters at monthly intervals. The operatives successfully implemented the following:

- building effective relationships with households through coaching conversations

- facilitating self-directed conversations that provide households with the right information and advice at the right time
- setting simple and measurable targets for the household through the establishment of 'social contracts'

This voluntary programme had a 60% uptake by residents who achieved an average 8% reduction in electricity consumption with a maximum reduction of 33%. The scheme is likely to have wider social benefits than electricity savings alone and further emission reductions are also likely to occur through reduced car use, water consumption, waste reduction and sustainable food consumption. The cost of the scheme was approximately \$500/household (across 4000 Houses). Implementing such schemes across all developments will offer financial savings and it may be more viable to operate them in house. The schemes would be particularly useful in developments that have energy monitors to ensure that residents are getting the most out of the technology.

For modelling the result of this recommendation we have assumed a behavioural change program will result in a 5% decrease in energy demand for the life of the building. Although occupants may move on, it is expected they will take some of their learnings with them to other dwellings (and hence the saving will hopefully be realised elsewhere in the economy).

Sensitivity

Estimating impacts to high levels of confidence requires costly resources, and in the case of construction works, is very likely to be overshadowed by the influence of occupant behaviour on operational impacts, or the actual design life (both of which on a case by case basis will deviate significantly from the estimates in the LCA). eToolLCA software aims to be vaguely right not precisely wrong. The accuracy is sufficient to ensure that informed design decisions can be made by quantifying and comparing options. The conclusions drawn in this LCA are sensitive to the data sources and assumptions which should be understood carefully to ensure confidence in design decisions. Please contact eTool for clarification on the sensitivity of any conclusions drawn from this report.

List of Major References

- ABARE, Energy in Australia 2009, Australian Bureau of Agriculture and Resources Economics, Australian Government, 2009.
- Atech Group for Environment Australia, A National Approach to Waste Tyres, Australia Commonwealth Department of Environment, 2001.
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The LCA predictions of embodied and operational impacts (including costs) conducted in eTool software, by their very nature, cannot be exact. It is not possible to track all the impacts associated with a product or service back through history, let alone do this accurately. The software has been built and tested to enable informed decision making process when comparing design options. Generic cost and environmental impact coefficients do not necessarily correspond to those of individual brands of the same product or service due to differences within industries in the way these products and services are delivered. eTool PTY LTD cannot make assurances regarding the accuracy of these reports for the above reasons.