INDAR 9

9 STARS ENERGY RATED INSULATED CONCRETE THERMAL MASS HOUSE

Conserve Energy Live in Comfort

30 DOROTHY GREEN CRESCENT FRANKLIN ACT

This development is Australia's first 9 star energy rated insulated concrete thermal mass house. It utilises the thermal mass properties of concrete to absorb, store, and later release thermal energy to achieve significant energy savings whilst improving occupant comfort levels.

The owners have a strong interest and commitment to construction techniques that are not only energy efficient and sustainable, but are also cost effective. They have selected the latest products, systems and processes in building a house that minimises energy and water usage, provides long term economic benefits, and has a lower ecological footprint without compromising on lifestyle.

9 STARS ENERGY RATING

The house is highly energy efficient and has achieved 9 stars energy rating under the ACT house energy rating scheme. It has been assessed by ABSA to have a predicted annual energy load of 35 MJ/m2/yr. There is potential for the energy load to be lower than this figure given the addition of several innovative energy saving features such as:

- insulated concrete thermal mass walls;
- insulated concrete thermal mass ground slab with slab edge insulation;
- thermal break driveway and alfresco slabs, thermal break fasteners;
- air tight construction;
- and state of the art 5 Layer insulated curtains with radiant barrier.

BEYOND CARBON NEUTRAL

One of the main aims of the project was to design and build a house that is beyond carbon neutral in that it not only reduces energy consumption but also produces enough clean 'zero emission' renewable energy to supply all its operating needs.

If a building generates more renewable energy than it imports and is able to export that energy for others to use, it is considered to be a net energy generator, as opposed to an energy consumer. This can lead to it contributing to lower overall greenhouse gas emissions for energy if it is producing an excess of renewable or low emission energy, especially if it also utilises "green" energy sources where available for any imported energy.

This house is likely to have a net operational carbon footprint that is very close to or beyond carbon neutral1. This is because the house uses 100% Green Power, has expected production of 4.7 MWH of electricity annually from its solar PV installation along with 21.3 GJ of heat energy generated from its solar hydronic and hot water system, its 9 star energy rating and predicted low levels of energy use.

[1] Beyond Carbon Neutral is based on the projected annual green energy production data versus the projected annual energy consumption data. The most powerful data is the actual energy production and usage data once the house is lived in. For this reason the actual energy patterns of the house would be tracked over the next 24 months to compare the actual data to the projections to substantiate this claim.

PASSIVE AND ACTIVE SOLAR DESIGN

The house adopts a passive solar design in which the warmth from the sun is used as a natural source of free heating during winter. To achieve this, the living rooms have north facing windows which transfer winter solar energy when the sun sits low in the sky and exclude summer solar energy when the sun sits directly above the house.

Given that the plot is north facing, the lounge room has been placed in the front of the house, and the family room and rumpus have been arranged in an open plan setting with a shared raked roof that has north facing windows at the top.

To further harness the benefits of free solar energy the house also adopts an active solar design where in the free solar energy is absorbed by an active system consisting of a large 60 evacuated tubes roof solar hot water collector. The solar hot water is used to provide the hot water needs of the house and is further circulated into the under slab hydronic heating system which provides comfortable winter heating at a very low running cost.

INSULATED THERMAL MASS

The outside temperature of a house can fluctuate considerably during the course of a day. One way to avoid the corresponding fluctuations in the inside temperature is to use an insulated thermal mass in conjunction with the standard principles of passive solar design. Thermal mass is the ability of a material to absorb and store thermal energy. When combined with external insulation, the insulated thermal mass absorbs thermal energy when the surroundings are higher in temperature than the mass, and gives back when the surroundings are cooler.

In winter the insulated thermal mass is warmed during the day passively by the free solar energy from the sun. It can additionally be heated actively by the free solar energy collected by a roof top solar hydronic heating system. Thermal energy stored in the mass is then released back into the interior during the night to achieve comfortable living temperatures at a very low operating cost.

In summer the thermal mass needs to be shaded from the higher angle summer sun to prevent over-heating the structure. Then, the insulated thermal mass absorbs the heat from within the house, and in doing so, moderates the interior temperatures to within acceptable levels for human thermal comfort. The lower surface of the thermal mass also helps it to absorb radiant heat directly from the occupants.

INSULATED CONCRETE WALLS AND SLAB

To take full advantage of the passive solar design, insulated concrete thermal mass has been incorporated into the external walls and floor slab. After considerable research into the various building construction techniques and materials, insulated concrete was selected for its high thermal mass, unmatched strength and durability, good sound insulation, air and water tightness, and economical and fast construction.

The external walls of the house have been constructed using ECON WALL, which is a patent pending insulated concrete thermal mass wall system which places the insulation on the outside of the concrete walls. In doing so, the insides of the building are free of thermal insulation. This enables the concrete to absorb, store, and later release thermal energy to achieve significant energy savings whilst improving occupant comfort levels.

For this application ECON WALL utilizes a 135mm thick core of reinforced concrete combined with 100mm thick R 3.6 XPS outer insulation and 9mm thick inner cement lining to provide consistent energy savings during the life time of the building.

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In a passive solar design a considerable amount of thermal energy is absorbed by the slab. In this sense, the house has been constructed on an insulated concrete thermal mass slab consisting of 125mm thick reinforced concrete with 300mm thick R2.0 EPS under slab insulating waffle pods and 100mm thick R3.6 XPS outer slab edge insulation. These efforts ensure that the thermal energy absorbed by the slab is not lost from underneath it or from its sides.

ROOF

The roof of the house has been clad in the light colour of Colorbond Surfmist, which has a low solar absorbance and ensures that the roof is thermally efficient and does not absorb too much heat.

To complement the light colour, the roof also has a considerable amount of insulation. It has been lined with R1 insulation blankets with foil radiant barrier, the latter of which improves thermal comfort by reducing radiant heat transferring into the home from the ceiling. The roof voids have been insulated using R5 insulation batts and the underside of the ceiling have been insulated with 75mm thick R2.7 XPS all of which combined with the air cavities provide over R9 of insulation which significantly reduces the transfer of heat across the roof.

The roof and ceiling insulation does not have any penetrations or cavities. All lights and fans are surface mounted to ensure that the integrity of the insulation is maintained to prevent the heat loss across the ceiling.

THERMAL BREAKS

Thermal breaks have been incorporated around the entire building envelope to minimise the loss of energy due to thermal bridging. The alfresco slab, driveway slab and the paving around the house have all been provided with 100mm thick R3.6 XPS insulation thermal breaks to thermally isolate them from the main building envelope. The porch tiles have been provided with 20mm thick insulated XPS backer board which acts as a thermal break and minimizes the loss of energy from the porch slab. All window and doors have been provided with 25mm thick polymer thermal break sub frames to minimize the transfer of energy through these critical areas of the building envelope. Similarly, all external building elements such as pergolas, awnings, gates, down pipes, solar inverters and light fittings have all been connected to the house using thermal break fasteners from Germany.

WINDOW & DOOR FURNISHINGS

To further minimise the loss of energy across the windows and doors, the owners have installed state of the art five layer insulating curtains which have thinsulate insulation and a reflective radiant barrier. These curtains have been hung using the EVO covered pelmet system which stops the formation of convective currents which are the cause of major energy losses across windows and doors.

WINDOWS & DOORS

Windows and doors are often the weakest elements in the building envelope and can account for over 40% of the total heat gain or loss from the house. For this reason, the windows and doors of this house have been carefully chosen to maintain year round comfort by reducing the need for artificial heating and cooling and hence minimising energy consumption.

The entire house has been provided with high efficiency PVC windows with double glazed low e argon filled toughened glass units. The double glazed PVC windows have a U value of 1.73 to minimize the heat escaping from the house in winter and a SHOGC of 0.58 to reduce the amount of heat gain in summer.

Uncontrolled air leakage through the windows and doors is traditionally a major cause of energy loss in houses. To address this issue, all of the PVC windows and doors in this house have built in double compressive gaskets which ensure positive sealing with almost zero air infiltration.

GARAGE DOOR

The garage has been provided with a twin layer R 1.53 insulated garage door which helps to improve the overall energy efficiency of the house.

SKY LIGHTS

Highly energy efficient solatube sky lights with a U Value of 1.59 and SHOGC of 0.20 have been installed to bring natural light into the enclosed areas of the house.

SOLAR HOT WATER & HYDRONIC HEATING SYSTEM

The entire hot water and under slab hydronic heating needs of the house are sourced by a large 60 evacuated tubes solar hot water and hydronic heating system. This system has the potential of collecting 21.3 GJ per annum of free solar heat energy and has an 800 litre hot water heat exchanger. There is also a provision for a natural gas boost for overcast days.

SOLAR PV ELECTRICITY

The house has been equipped with a 3.04 kW solar PV System that is mounted on the back roof for on-site energy generation. Each solar panel contains photovoltaic (PV) cells which convert free solar energy into electricity. These PV cells produce direct current (DC) electricity which is then directed to an inverter that converts the low voltage DC to higher voltage alternating current (AC) power. This AC current then goes back into the grid via a smart meter which keeps a track on the electricity produced. Overall, the system has the potential to meet the entire electrical needs of the house.

ELECTRIC CAR

The house has been provided with a separate off peak meter along with a 15A single phase power point in the garage for charging an electric car at off peak electricity rates.

LIGHTING

Energy efficient lighting is part of the overall scheme of reducing electrical energy consumption while limiting the amount of heat generated by the lamps.

For this reason, the entire house has been fitted with LED lights, which are highly energy efficient and can last up to ten times longer than fluorescent lights. The modern pendants in the family room, rumpus and formal dining are lit using LED light bulbs. The other areas of the house are lit using ultra-thin LED panel lights rather than down lights to ensure that there are no ceiling penetrations. For a soft feel dispersed illumination, the internal lights have a colour temperature of 4500K. The external wall lights are also LED.

CEILING FANS

Every room of the house has a DC ceiling fan. Ceiling fans can provide summer comfort in most conditions and use significantly less energy than air conditioning. On top of this, DC ceiling fans consume 40% less electricity than AC fans. The fans chosen in the house can also be run in reverse, a feature which is useful in winters to push down warm air within a room.

APPLIANCES

Kitchen and other appliances can consume a considerable amount of power. All of the appliances in the house have been chosen very wisely and have the highest star energy and water ratings, which means that they consume less power and water than many of their rival products. The kitchen is equipped with the latest energy saving Miele appliances along with the latest energy saving fridge by Electrolux. The laundry has the latest water and energy saving washing machine and dryer by Electrolux. Finally, both televisions in the house use the latest energy saving LED LCD panel technologies by LG.

EXHAUST FANS

All the bathrooms have draft stoppa exhaust fans with built in self closing vents and are ducted out with self-closing wall vents. This ensures that there is minimum loss of energy through the exhaust system.

WATER SAVINGS

Using water efficiently not only reduces the water charges but also helps the environment by reducing the energy which is used for the processing and pumping of water. This house reduces the water consumption by using the following high water efficiency fixtures and appliances;

- 6 Stars WELS Rating 4 LPM Water Saving Mixers
- 4 Stars WELS Rating 7.5 LPM Kitchen Mixer
- 3 Stars WELS Rating 7.5 LPM Shower Heads
- 4 Stars WELS Rating 4.5/3 Litre Dual Flush Toilets
- 4.5 Stars WELS Rating Miele Dishwasher
- 5 Stars WELS Rating 57 Litre per wash Electrolux Washing Machine
- Gundfos Hot Water Re-circulator to save hot water wastage

RAIN WATER

Harvesting rainwater from the roof is essential for reducing water dependency from the mains. The house has an extra large 11,700 litre concrete rain water tank which is installed below the driveway with rain bank control. Water from this tank is plumbed to the laundry and is used for flushing the toilets, as well as for garden irrigation and growing of vegetables and herbs in the Vegepod.

GREY WATER SYSTEM

The house has an automatic water recycling system that takes the water from the showers, bath and washing machine, filters it and pumps onto the garden. The grey water system is self-cleaning with an automatic 24 hours flushing system.

IRRIGATION SYSTEMS

The garden is irrigated using two separate grey water and rain water irrigation systems for low cost irrigation.The first is a grey water irrigation system which provides sub soil irrigation using an automatic indexing k valve. The second is a rain water sprinkler irrigation system with an automatic programmable controller. Using recycled grey water as well as rain water in the garden ensures daily watering at no extra cost to maintain lush lawns, bushes and plants.

VEGE POD

The garden has a raised Vegepod with built in misting water irrigation system, water saving wicking system and a covered mesh canopy for growing healthy herbs and vegetables. The Vegepod is irrigated only with rain water from the automatic irrigation system.

HOME NETWORK

The house is digitally connected and is NBN ready with cat6 home network cabling reticulated to all rooms using a hub in the rumpus. There are also automated lighting and awning control systems which can be programmed and controlled remotely via mobile devices. In addition to this, there is a back to base security system.

VISION TO REALITY

We acknowledge with thanks the following partners who made the vision of the home into a reality.

- **ECON WALL System -** Conserve Energy Live in Comfort www.econwall.com
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- **Beyond Neutral -** Carbon Rating
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