Alternative Technology Association
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Building a Sustainable House from Scratch

This summary is based on notes taken at the meeting and should be used in conjunction with the presentation slides.

Sven is a Registered Building Practitioner and HIA Greensmart accredited, but emphasized that he is not the expert in everything and is always learning, He will draw on experience of people in the room. The aim tonight is to design a house from scratch. While we can't go into all the specifics, you should at least get an idea of design process and some of the main considerations.

Principles

A sustainable house is capable of being continued with minimal long-term effect on the environment. The most important aspect is passive design, but we'll also think about materials, insulation, orientation, thermal mass, water and energy use. The design must be responsive to the given climate, e.g. a building in Cairns will be different to one in Melbourne. Water is a big issue to target - we need to think about water tanks, planning and grey water regulations, WELS[1] ratings (beware the fine print on some imported appliances!).

Materials

You need to think about not only the embodied energy of building materials, but also their projected lifetime. A low embodied energy home built of timber may only last 100 years; one of concrete, aluminium and steel may well last 400 years. Chemicals and off-gassing of materials are an issue – the air inside a house may be six times more polluted than outside. Sven prefers low or non VOC[2] finishes (Volatile Organic Compounds).

Space heating and cooling

Heating and cooling are major contributors to household energy use. Environmentally sensitive systems such as hydronic in-slab technologies can work fantastically but tend to be expensive. Proprietary solar hydronic systems are available (e.g. Latento), but may need clarification on how well they work. Solar heating and heat pumps are other options. We are only touching on possibilities here; you need to follow up details. It all comes back to good passive design that will reduce the requirements dramatically. The basic philosophy is to *reduce, re-use and recycle.*

Designing the house from scratch

Sven then switched to a commercial 3D architectural program to create a house design based on input from the audience [Google Sketchup[3] is a useful free 3D modeling tool – PF]

Our first considerations are the client brief and climate needs. The suggested location is Daylesford. Large diurnal and seasonal temperature variations here mean the house will need good insulation. Sven suggested straw bale walls. A smaller house is better; we'll make it two bedrooms. To minimize heat loss in this climate we would keep surface area to volume ratio low. We can also use *thermal mass* to advantage - the ability of materials to store heat. Sven suggested an internal

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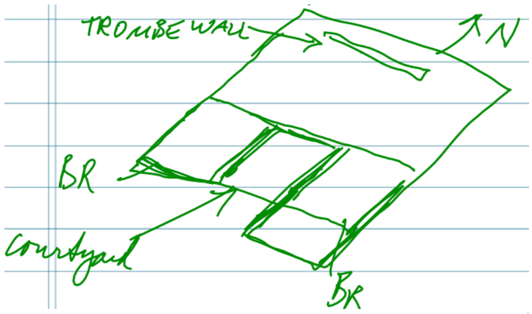
[1] Water Efficiency Labelling and Standards (WELS) Scheme http://www.waterrating.gov.au/

[2] VOC fact sheet http://www.environment.gov.au/atmosphere/airquality/publications/sok/vocs.html

[3] Google Sketchup http://sketchup.google.com/

rammed earth wall exposed to the north sun as a Trombe wall[4]. This technology has been around for a long time. Stored energy is released into the house as temperature drops at night.

Bedrooms are probably best on the South side (could also adopt them on the East or West sides – depends on the size of the block of land). Cross ventilation is important so you might put bi-fold doors in them. Alternatively you could sink the bedrooms under a full length living area but excavation might be a problem. Sven suggested a *passive cooling courtyard* in the South with ferns and shade to provide low-level moisture. High windows on N side would draw cool air in through the courtyard. [The sketches below hint at how the computer model progressively developed – PF]



Floor
A few options here, but let's use a concrete slab floor. As our house is on a slope, it might be good to dig into the side of the hill, but excavation is expensive so we try to avoid this. It also can't be 2m off the ground! Building regulations are important here. Termimesh[5] is highly regarded for protecting the slab from termites although nothing is better than providing visible access e.g. using a simple timber floor on stumps (and no plinth boards!) This would provide little thermal mass however. Proper consideration of the ground, slab structure and footings is critical to prevent cracking. Screw-in stumps might be great if you want to be able to relocate the house, but you'll need to find a builder familiar with technology in Daylesford. Getting the builder involved early will result in the most cost effective choices. Concrete or perhaps base metal footings could be used under the straw bales - seek ideas from local experts. Insulation under the slab is less important than around the edges.

Glazing
Try to use the climate to your advantage. Glazing on the northern wall is important. Double-glazing may lose a little solar input but the insulation benefits outweigh this (double that of plain glass). You can make up with additional insulation elsewhere. Thinking on windows is changing - you have to refer to data provided (e.g. from Pilkington). You could consider low-e glass, or toughened glass in bushfire areas, etc.

Thermal mass
Shading, verandahs, canvas blinds and deciduous plants are possibilities for building a buffer between the outside and internal living space. The 500mm straw bales provide excellent insulation and their mud coating provides additional thermal mass. This technology should be used more although it is currently not recognized in the building code. As we need storage we could place cupboards or wardrobes against external and/or internal walls as additional thermal and acoustic barriers. The concrete floor slab also provides a thermal mass - it needs to be worked out in combination with the Trombe wall. A solar study will show how the shadows fall - you need to consider how long it takes to get heat into and out of the building. Using water somehow could a possibility as it has twice the thermal mass of concrete!. These ideas are great but investigation of alternative technologies will eat into our $250k budget.

Roof
Lets have a cathedral ceiling with clearstory windows along the north wall and 900mm eaves. You wouldn't run glazing up to roof line as it will just lose heat as the sun won't hit the glass. The roof slope can be designed to accommodate windows and solar panels - a 37° slope for this latitude. Sven suggested having different roof sections sloping to the centre with solar panels installed on the side sloping North. The clearstory windows on south wall would give beautiful light, however will cost internal heat, also without eaves, the stray bale walls may be exposed to the elements. A two-section box gutter/roof running to E and W between the main roofs could be used to fill water

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[4] Trombe wall http://en.wikipedia.org/wiki/Trombe_wall

[5] Termimesh http://www.termimesh.com/

tanks on different sides of house – two tanks are an advantage in case one fails. Box gutters can be subject to flooding in increasingly heavy rain, but the arrangement proposed is 1500mm wide - accessible and easily maintained.

In practice you will need to marry different requirements, such as number of bedrooms and architectural style, with sound sustainable technologies. As this house is likely to be self sufficient, it will require an independent water supply with perhaps a minimum of 20kL storage and off-grid technologies. Waffle pod slab construction raises the possibility of in-slab water storage pods inserted between beams (New Water[6]). Such technologies may not be cost effective in a rural setting and are relatively new and unproven.

If the Trombe wall is too big, it'll keep sucking up the heat and end up heating the room at the wrong time. The thermal mass of the slab alone may be enough. Serious calculations looking at the room area, thermal mass and volume are required. Various calculators are available, but the Your Home Technical Manual[7] contains all the formulae you need. A ground source heat pump can exploit even a few degrees temperature difference to make it easier to heat in winter and cool in summer, but it will be expensive. Geopolymer concrete has environmental advantages, e.g. E-crete[8], but is a very new technology.

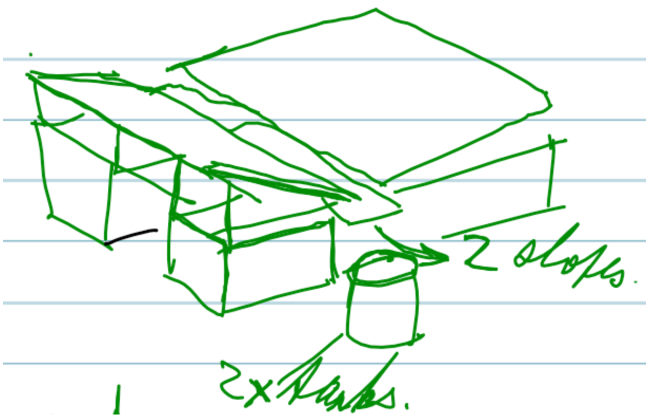
In considering the embodied energy of materials you really should look at cradle to cradle, rather than cradle to grave. Aluminium has high embodied energy but is durable and highly recyclable. The high heat conductivity of aluminium window frames can be reduced by breaking them with an insulating baffle. Timber, PVC and timber/aluminium composite frames are good alternative window systems.

The internal fit-out

Factors discussed included heat generated in the kitchen and ventilation around fridge. Sven suggested putting a drying cupboard beside the fridge. Fresh air vented to the pantry may keep it cool. One ATA member has used a high thermal mass "cool cupboard", which kept to 23° over the recent heat wave. Placing the bathroom near kitchen simplifies plumbing. Let's add a laundry on the S side of bathroom separated by a bi-fold door (i.e cupboard laundry). Glass bricks in the N side give privacy and better insulation than plain glass.

Cross-ventilation

The evaporative effect of moving air is an important principle in regards to passive cooling. Pockets of still air away from the ventilation path could be improved with ceiling fans. To encourage flow, use bigger apertures for the exit of air – like a funnel. Louvres and sliding doors are possibilities. Casement windows open wide and could be used up high. Ventilation and natural light in bedrooms are important. Perhaps make the double doors open onto the courtyard, rather than the exposed south side. Refer to the Bureau of Meteorology site for wind roses and climate data[9].



Heating requirements

Supplementary heating options include solar hydronics (expensive/to be proven), or a wood heater (should harvest own timber). A heater in the middle of the room would provide a room divider between living and dining areas. Dalesford is in climate zone 7 (Melbourne is 6) so we need to insulate well. The high ceiling in bedroom will be hard to heat so you could put in a suspended

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[6] New Water in-slab storage tanks http://www.spec-net.com.au/press/1108/new_261108.htm

[7] Your Home Technical Manual http://www.yourhome.gov.au/

[8] Zeobond E-Crete http://www.zeobond.com/

[9] BOM climate data online http://www.bom.gov.au/climate/averages/

ceiling. R3.5 insulation in the ceiling plus the straw bale walls will give a fantastic energy rating assessment if the home is small. The assessment is required by law. It will award a star rating and give you a theoretical heating and cooling energy value for the design. You should be able to achieve the minimum required 5 star energy rating easily with an R2.0 wall system, and an R4.0 roof system. A ‘system’ is the combined heat transfer resistance provided by the combined materials (insulation + air gap + materials).

Sven concluded by saying the exercise has been an introduction to sustainable design but would also give an insight into the life of the designer. It has shown how you have to balance client requirements and consider the pros and cons of all applicable building systems while offerings some suggestions for moving forward. Sven thanked everyone for their ideas and enthusiastic participation.

After a little tweaking by Sven, here’s the final external render of the “Melbourne ATA Design Group” house!

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