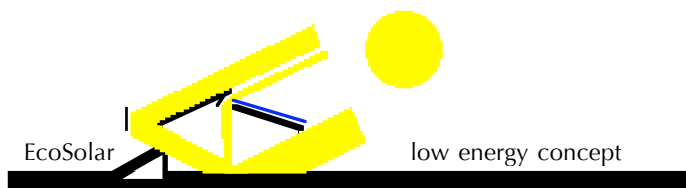


# Low energy affordable housing

The science is known, we have one of the world's best climates, we have the money - ***but why are we are not building for the 21st century?***

- why are we not*
- minimising the polluting effects of housing on global warming ?
  - using *natural*, renewable resources for heating and cooling ?
  - producing better oriented blocks of land for good solar houses ?
  - ensuring low running costs suitable for low income families ?
  - building smaller, more effective solar houses which are also bushfire and storm resistant with lower insurance premiums?
  - ensuring that interiors are more cheerful, and healthier ?
  - ensuring houses generate their own power and reduce pollution ?
  - powering the family car from the house ?
  - making houses more simple, sensible *and affordable* ?

*sustaining happier, healthier Australians*



A sequel to “Climate change needs housing change” written by **Derek F. Wrigley** OAM  
and complementary to the retrofitting bestseller “Making your home sustainable”

RRP : \$20

# Something is seriously wrong when science is telling us ...

*that* **our biosphere is in catastrophic decline**  
*and that* **we will have to change our ways**

Australia is the biggest polluter of greenhouse gases in the world *per capita*

with our *houses* contributing about 20% of our total emissions - *and growing*

Yet we design **and approve** of ineffective houses and siting that **rely** on polluting technologies to remain comfortable in winter and summer, ignoring the free natural resources that are so readily available in Australia

*can we continue....*

**to build houses which pollute so much  
because of outdated thinking ?**

**to build energy inefficient houses  
reliant on fossil fuelled energy for comfort ?**

**to satisfy our greed and irresponsibly pass the  
environmental costs on to our grandchildren ?**

The car industry did not heed the environmental warnings and made disastrous commercial judgments leading to government intervention at substantial cost in 2008.

*.....and the housing industry shows every sign of going in the same direction*

Consider these few examples of recent offerings to the unaware buying public

This is a slow and extremely expensive way of learning

*We must change direction - - -  
the consequences of not doing so  
are unthinkable*





No northern windows = no possibility of gaining winter heat and cheerfulness when heating fuels become too expensive. Dark coloured roofing = heat gain in summer  
 All upper windows face east and west with no sunshades = heating problems in summer  
 Hips and valleys = small, awkwardly shaped roof panels = no possibility of retrofitting photovoltaic array to generate an effective amount of electricity



Black roof = high heat gain in summer, adding about 7° to internal rooms  
 Air conditioner installed to remove heat from internal rooms = social stupidity = higher electricity bills  
 Initially a good roof for an effective photovoltaic array but spoiled by the air conditioner, vents and antenna = greater pollution  
 = more environmental degradation  
 = higher suburban temperatures  
 = higher water bills  
 = water wastage  
 = **poor value for the purchaser**

**Unthinking design now is contributing to an unthinkable future for our grandchildren**



Large northern and western windows = excessive heating problems  
 No effective sunshading and impossible to retrofit = high heat gain in summer = high heat loss in winter

**Why are these ineffective designs allowed to be built.....**

All built in 2007/8



**This is a typical narrow north facing frontage as described at A on pages 7 and 8**

Black roof = high heat gain in summer, adding about 7° to internal rooms and an air conditioner will become necessary (*extra cost*)  
 Small northern windows to street = long N-S house proportion = inadequate solar gain in winter = high heating fuel costs = greater environmental pollution and degradation = ineffective roof for adequate generation of photovoltaic electricity  
 Garage occupies the optimal solar position = a great waste of solar potential and boring street architecture  
 Tiled roofs like these may well become unsellable in future as the insurance companies decline to insure them when the increasing frequency and intensity of storms makes them so vulnerable to damage  
 The 360° guttering makes water harvesting more expensive - a simple gabled roof is more economical





When viewed in the light of our increasing environmental problems today's project houses will be seen as being of very poor value for money.

The quality of **workmanship** is usually excellent and probably deceives the buyers, but... the underlying problem lies upstream with the designers, the planners, the bean counters and the regulators - *- it is the quality and the consequences of their decision making which have to be perceived as ticking time bombs as they take many decades to become obvious - and by then, of course, it is far too late.*

***.....and to continue polluting our fragile world ?***

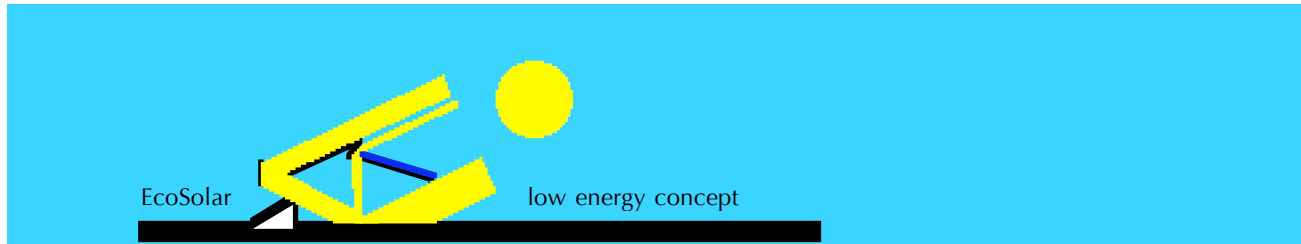
*consider -*

- \* today's houses have not been designed for *today's* climate, let alone tomorrow's, once global warming *really* takes effect
- \* they will certainly not be comfortable, or even livable, due to climate changes and *escalating prices* of fossil fuelled energies
- \* using fossil fuels for heating will become socially unacceptable simply because of pollution
- \* air conditioners will be eventually recognised as an outward sign of a badly designed and constructed house
- \* houses rely far too much on unsustainable, consumptive technologies - what happens when they can't be used?
- \* they have not made effective use of the free, natural resources available to every house
- \* subdivision practices are actually preventing good solar design because of inadequate proportions and orientation
- \* the designers of our suburbs are not aware of the implications of their decisions on the design of the eventual houses
- \* housing design is of poor value relative to the car industry which has researched efficient products (*but in the wrong direction*)
- \* houses are now unaffordable - partly because of anti-social thinking such as greed, complacency, apathy and ignorance
- \* houses with tiled roofs may well become uninsurable due to their susceptibility to increasing storm damage

***science eventually discovered that smoking was bad for our health and reduced our life expectancy and eventually the legislators did something about it....***

***For how long will governments and regulatory bodies continue to ignore the fact that the **design** of our suburban housing is bad for the health of our environment, reducing our planetary life expectancy ?***





## Fundamental physical problems

There are several areas in *southern* Australia which experience around six months of cool to cold weather in winter, and about two months of warm to hot weather in summer. Up to the end of the 20th century housing construction provided reasonable comfort during spring and autumn, but was often inadequate in winter and summer.

In the higher altitude regions, such as Canberra and the Blue Mountains, the extremes are more acute and the easy option has usually been to install heating and cooling equipment to provide comfort. Reverse cycle airconditioning and ducted gas heating have become commercially available - *but at a cost to the environment* - now revealing the consequences as global warming with its resultant climate changes.

This added equipment has been reliant on the convenient fossil fuels of oil, and natural gas, with coal being the main fuel for extremely useful electricity. The cost of these fuels is now rising and significant increases are forecast - most likely to the point of unaffordability for people on low incomes. Failing the rapid commercialisation and expansion of geothermal heating from the central areas of Australia we seem to have little option but to design smarter houses which make effective use of abundant solar radiation and other natural resources generally available to everybody - *all free*. Nuclear power cannot compete economically or in time, and there are great disadvantages with other types of fuels. What alternatives do we have?

**We need smarter houses to benefit effectively from our abundant solar energy**

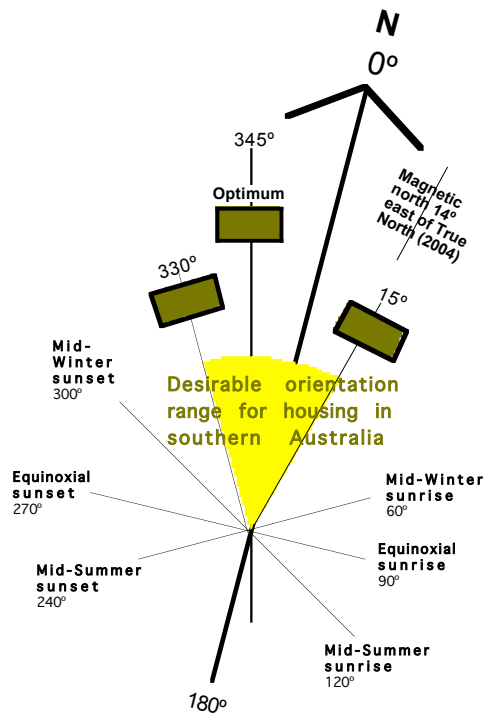
If we are to be ready for the future problems that global warming is already making evident, then we have little option but to quickly make up for having disregarded the benefits of solar energy for over 200 years.

Australia literally has more sunlight than it could ever need - about *1kW falls on every square metre of land* for several hours per day and the time is well overdue for all housing to make effective use of it.

**But smarter houses are useless unless the land on which they sit is equally smart - and it is not difficult**

*badly oriented blocks inevitably produce ineffective houses.....*

## The solar balancing act



### Smart blocks are essential to smart solar houses

Ideally, to achieve a *balanced* intake of solar radiation into northern rooms throughout the day it would be essential to orient the long elevation of a house toward north 0°.

However, there is growing opinion in the cooler regions such as Canberra in favour of orienting the long northerly elevation toward 345° to maximise the intake of the

late afternoon sun to counteract the increasing heat loss through windows from falling temperatures at that time.

A *second reason* - the southerly rooms in a 345° oriented house receive a very cheerful amount of **reflected** cool sunlight at breakfast time.

A *third reason* - these southerly rooms receive less penetration of the still hot late afternoon sun in summer and as they are often bedrooms they remain a little cooler in the late part of the day.

While northerly rooms will be most effective between 0° and 345° a wider orientation range allows reasonably effective solar planning.

A wider orientation range from about 15°E to 330°W may well suit early or late risers, but beyond these approximate limits the effectiveness of solar input into houses decreases, leading to greater reliance on expensive imported fuels for heating and cooling - **and greater environmental degradation.**

Unless geothermal heating becomes economically available in the near future to all Australians living in the cold winter areas of southern Australia, then we will have little option but to design our new housing along solar principles, placing decreasing reliance on fossil fuelled heating and cooling, both of which lead to .... **greater environmental degradation**

Author's interlude :

This booklet is rapidly changing its own direction into a design treatise which was not my intention.

I simply wished to draw attention to politicians, developers, designers and those who make money from putting up houses to take stock of where we are heading and realise that we could be providing much better value for buyers, better sales for the industry and certainly a better outcome for the environment - **if we have the will to change .**

Global warming is really offering this huge industry a wonderful opportunity - a *last chance* to change direction for the benefit of everybody in the community.

In describing the EcoSolar house I am not saying that it is the perfect answer - it is one possibility which illustrates our need to think differently, using free natural resources more wisely, making them perform multiple functions more effectively, using less energy, reducing pollution and enabling us to live at significantly less cost - it is really more of a conceptual system, capable of different structural interpretations.

However, in developing the concept of the EcoSolar house since 2003 I have had to realise that a solar house can not just be built on most of the usual blocks currently on offer, eg the recent release of the Bonner subdivision showed that about 89% of the blocks were unsuitable for solar housing - and 48% in the Forde subdivision. This is a loss situation for everybody and the environment - and should, and need not, continue.

**Quite clearly, subdivision practices for single houses will have to change if we are to benefit from solar energy.**

But that is not the only change - the following pages outline several other **pre-conditions** which urban planners and house designers should be considering **if our reliance on solar radiation is to be economically effective.**

# For any solar house to be effective, certain pre-conditions will have to be considered .....

*The ground rules are changing - global warming, economics, resource scarcities and increasing population densities .....*

*If we are to move forward with sustainable housing we cannot continue to think in the old ways.....*

## 1 **The proportions, sizes and orientation of the site must enable a solar effective house to be placed upon it**

When electricity and gas become too expensive to heat our houses (not too many years away) we will very quickly appreciate the enormous economic and personal value of solar warmth and cheerfulness - and it can easily be acquired in southern rooms as well as northern (see pages 15,16). Those who subdivide land into building blocks must ensure that every house can maximize its solar gain in winter. *(However, even though the subdivision guidelines in Canberra have been amended along these lines, about 89% of the new suburb of Bonner in N. Canberra will not enable solar houses to be effective).*

No longer can any size and any proportion be just a matter of X square metres. If houses are to rely on the sun for their heating then it is critical that the sun is allowed to penetrate the long side of the house - which must face within approx. 15° east to approx. 30° west of true north, to be really effective, with some variation for latitude. This enables late afternoon winter sun to have an extra hour's warming and it allows the early morning cool summer sun to give some psychological uplift through a southern window around breakfast time. It also allows the northern sunshading to be more effective in summer. These variations are shown in the alternative plan for the Forde subdivision on page 12.

## 2 **We have to take more notice of the sun's seasonally varying path across the sky and design houses to take better advantage**

While the hot summer sun is somewhat unfriendly it can be a wonderful friend in the cold months - but we have to understand its varying habits and learn to control them externally for our benefit. Builders rarely provide effective sun shading systems (if any at all - *why is this permitted?*) - leaving buyers unprotected and left to provide their own, often internal, retrofitted control measures which are not effective.

## 3 **Significant, evergreen trees in the wrong position can also prevent a solar house from functioning effectively**

Existing mature trees or even adolescent trees with growth to come have inherent environmental value and must be preserved if at all possible. However, if they are in such a position that will prevent a future house from being solar effective then there is a conflict of values. How do we resolve any difference in the value of a tree with the potential loss of valuable solar input into a house? Many subjective factors come into play here, but it should not be beyond human capacity to resolve them to the long term benefit to the planet.

## 4 **Neighbour's houses in close proximity can cause unreasonable overshadowing in winter**

Land economics are forcing higher densities, and when compounded by the increasing use of two storey houses is causing unreasonable overshadowing in the cooler months when solar gain is most needed. The rising costs of heating fuels is making this aspect more critical.

## 5 **We must learn to see the roof as being much more important than just an umbrella**

The roof is rapidly becoming our major solar receptor for the generation of all our free, non-polluting electricity, our free hot water, and our communications systems. It will soon become a source of free fuel for the family car. It is now possible for us to dispense with the waterproof roofing material altogether and replace it with commercially available, weathertight photovoltaic panels. This is already being done in Germany and in Sydney. However, the *form* of the roof - its simplicity, rectangularity, orientation, sizes, pitch and freedom from penetrating vents become much more critical if the applied technologies of photovoltaics and hot water panels are to be cost effective. ***We have now reached the stage when the form of the roof - as a solar receptor - must be planned right at the beginning of the design process, instead of just happening as a result of the planning of the useful spaces underneath. This is a necessary, major change in housing design, resulting from research into solar technology but if it is not done sensitively, with due regard to aesthetics, our suburban roofs will eventually look like junkyards - monuments to non-holistic thinking. It is already happening.***



## .....before it is designed and built

.....*must cause us to think more fundamentally - and adopt new criteria*

.....*which have caused the situation we are now trying to correct*

*with apologies to Einstein*

### 6 **Dark roof colours must be regarded as anti-environmental**

Increasing use of dark coloured photovoltaic panels will make the colour of the remaining roof even more critical if overheating of the interior is to be avoided. The increasing use of *dark coloured tiled roofs* in recent housing is to be deplored as it raises internal temperatures by up to 7°, stimulating the easy answer of the installation of air conditioners rather than improving the design quality of the house. *This approach is extremely disadvantageous to the environment and to suburban residents. In the Australian climate no roof should be darker than a very light grey (to be accurately described)*

### 7 **We must soon realise that the tiled roof as we know it has become obsolescent**

Climate changes will almost certainly show that the ubiquitous tiled roof is a wasteful, expensive and stultifying anachronism - totally unsuited to the more frequent, higher intensity storms predicted by CSIRO. Insurance companies may soon refuse to insure such expensive, damage prone types of roofing and the real estate agents will then find that they can't sell a tile roofed house. In addition, owners of a typical tile roofed house will find that they will be unable to retrofit an effective photovoltaic array to their roof consisting of ineffectively oriented, small roof panels of trapezoidal shapes with many hips and valleys unsuited to rectangular PV units. Smaller PV tiles are now becoming available which are also waterproof. This may be an answer if they are restrained.

### 8 **We have to be more realistic about the size of a house**

Our desires must be controlled to suit our real needs, rather than our supposed hedonistic wants. The MacMansion is now being recognised for what it is - a selfish and pretentious use of resources, both initial and ongoing. Continuing population growth must be seen as incompatible with finite resources.

### 9 **We have to recognise the practical advantages of houses produced as industrial units**

Houses built as single units, with on-site cutting and fitting must be recognised as wasteful of time, resources and unnecessarily expensive. This could be significantly reduced if houses were largely factory produced (as EcoSolar). Delays due to bad weather (and on-costs) could be drastically reduced.

### 10 **The house needs to be designed to enable a staged, practical minimum, capable of accepting 'plug-in' technologies later**

Staged construction could lower *initial* costs, but the design should be capable of accepting useful technologies, such as PVs and southern reflectors. Current housing designs give little or no design thought to the changing role of the roof form and its need to accept retrofitted technologies.

### 11 **Lending institutions must take a 'cradle to cradle', re-usable approach to mortgages**

Mortgages could be attached to the house rather than to the individual. This could have many advantages. There are signs that this is beginning to happen. (eg. Bendigo Bank, MECU...) but it needs to go further.

### 12 **House buyers' understanding and expectations must be more ecologically oriented**

This is a matter of public education, but there is a degree of urgency. Restraint has become socially acceptable in relation to smoking, seat belts, helmets etc. The emergence of self-help, grass roots community organisations (such as See-Change in the ACT), shows that this need has been recognised.

### 13 **Residents must learn to live in active harmony with the climate**

Low energy, self reliant, affordable housing implies a fundamental need for residents to respond to climatic variations by adjusting the natural systems of the house themselves, rather than relying on automatic or applied, consumptive technologies which often have deleterious environmental consequences.

A walk around any suburb will show that house owners do not understand how to use their windows effectively and manuals on "*How to run your home effectively*" should become mandatory with every solar house sale.

# Current subdivisions are not effectively taking the use of solar energy into consideration .....

*this is an economical alternative*

*this block is not adequately proportioned to enable an effective solar house design to be placed upon it*

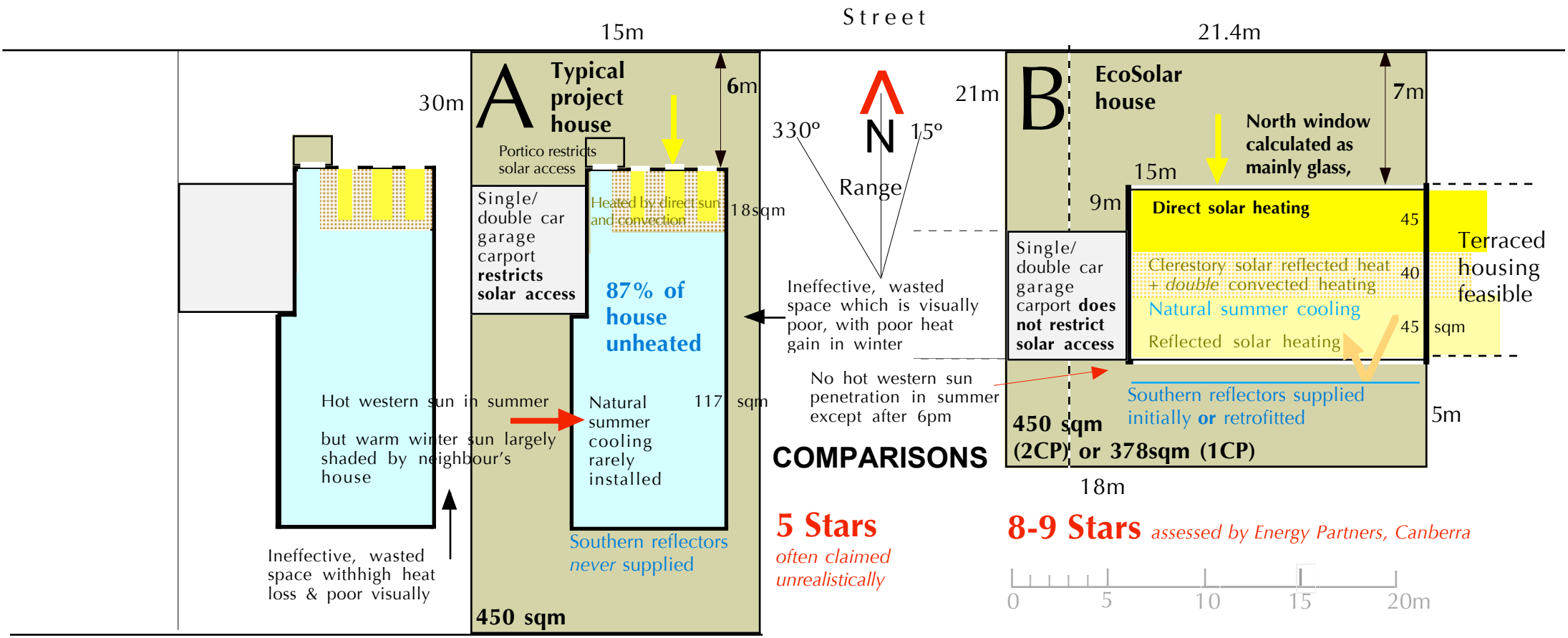
**A** Typical project house site is fairly typical of current thinking in subdivisional planning which **forces the house design to rely entirely on unsustainable heating methods** and will not allow an effective photovoltaic array to be retrofitted on the roof



**B** EcoSolar house  
the same block area with different proportions enables a house with the same floor area to be **8 times** more effectively heated by the sun and able to generate all its own non-polluting, *free* electricity.  
It also enables more effective use to be made of the surrounding garden.

compare the relative solar efficiencies of these two proportions >

# ..... and their comparative solar heating effectiveness



Both houses are 135sqm area  
 Both blocks are 450sqm area

**Total house area** 135sqm  
**Solar heated area** 5sqm  
**Convected heated area** 18sqm  
**Unheated area** 117sqm

**135sqm**  
**90sqm** (45N + 45 x 47%) = 66sqm effective  
**45sqm** (effective equivalent 85 because of double convection (45 N + (45 S + 40 x 47%)))  
**Negligible**

**Solar efficiency factor**  
 (naturally warmed area as % of total floor area)

**13%**  
 = 7.7 times less effective than >

**100%+** (Northern glass area could even be reduced - to be calculated)



# The EcoSolar low energy concept

- a rethink of housing design to counter global warming and climate changes

## Simpler design and technology can help us achieve a *more sustainable* direction

- 1 **The essence of the EcoSolar concept** is its simple, integrated structure and form, making it economical and self-reliant. It uses uncomplicated, reliable technology to achieve the fundamental aim of reducing initial and long term running costs, with minimum impact upon the environment, low energy use, and easy retrofitting capability with little waste, with renewed life after its period of first use.
- 2 **Its structural system** is desirably based on a prefabricated, externally insulated concrete panel system, preferably utilising low CO<sub>2</sub> TechEco cement or similar, to minimise its embodied energy and pollution content. This technique uses the mass qualities of concrete to good advantage and to erect the main structure on site in 2 or 3 days with significant cost savings. It has many advantages in saving time and money which could be used to better advantage in providing other energy saving techniques such as PVs, hot water systems, and on-site waste treatment systems. However, this does not preclude the integrated design principles being used with conventional construction techniques provided it is understood that there are likely to be consequential increases in cost and significant losses in effectiveness.
- 3 **It can start life as a basic functioning house** to be built at a reasonable initial cost with the knowledge *that designed provision has been made* for retrofitting added functions at a future date when other funds become available. *This is often not possible in current housing.*
- 4 **All solar radiant energy** can be absorbed through windows on the north *and on the south by the use of adjustable reflectors* as well as from the clerestory window which reflects sunlight into the internal kitchen. This not only provides free heat for the rooms but has a big psychologically cheering effect by *allowing sunshine to penetrate into every room*. The amount of radiant heat energy captured in this way will be almost **8 times** as much as is allowed to enter a traditional house in winter and will ensure adequate space heating on sunny winter days without the need for any fossil fuelled heating. *(See later analysis - p 10).*
- 5 **Its high internal mass structure is designed to absorb** most of this incoming radiant heat and store it for use in the evenings and the next 2 or 3 non-solar days with little or no topping up by artificial heating.
- 6 **All habitable rooms can now receive cheering sunshine** during all sunlight hours assisted by the use of a *world first* system of southern reflectors designed by the author. Southern rooms in this climatic zone are usually cold, cheerless and hence unused, but can now be transformed into cheerful, useful rooms (*owners of the five reflecting systems in Canberra report that they would willingly pay for the cheerfulness factor alone*). This virtually increases the size of the house to its full potential. *(see later note on Southern Reflectors - pages 21/22).*
- 7 **Windows on the north side** (with or without the optional conservatory - see pp15/16) are shaded by Coolaroo retractable sunshades permitting maximum sunlight entry in winter and effective exclusion in summer. This shading material cuts out 95% of the infrared heat and actually *increases the daylight intensity* in the house, ensuring no need for electric lights in the daytime - reducing running costs and pollution.
- 8 **The house collects and stores its rainwater** (relative to the house size) in a low-cost underground tank, saving space (*particularly on diminishing block sizes*). This system has been tested over the last 33 years and has proven cheap and reliable. With reasonable use the occupants could be almost self-reliant in potable water, depending on roof area, future rainfall and number of occupants.



9 **Integrated photovoltaic (PV) panels** on the northern roof slope could generate more than enough electricity for the household with some excess exported to the grid. With a Feed in Tariff based on gross generation, such as in the ACT, this would significantly reduce pollution and household running costs from one half to one sixth (see pp 31/32). Even if not built initially the PV system could be added later to suit future needs and finances. *Effective retrofitting possibility is rarely found in current housing with tiled roofs, which usually have small, fragmented roof panels, inappropriately shaped and often ineffectually oriented to the sun - a common design omission - (see Forde plan page 20).*

10 **The surplus heat under the PV panels** (*an inherent problem which can be turned to advantage by appropriate science*), can be collected under the roof decking into the roof plenum in winter and distributed by a solar energised fan to warm the house below. *(This is the only energy system which I have not tested in my five previous houses, but I have been encouraged by the confirming researches of Martin Belusko, Research Engineer in the Sustainable Energy Centre, Uni. of SA). There is a possibility that if the thermal efficiency of the house structure proves effective, this system of thermal roof collection may not be needed - making some cost saving. The potential is there if needed).*

11 **A total waste disposal system** (*such as Biolytix*) can treat and re-use all the grey and black waste effluents, distributing the clear effluent in the surrounding subsoil, requiring no connection to a sewer. This has a *significant* ecological benefit in helping to maintain the local water table level rather than transporting it away to a central treatment works at high cost. *(This could be a potentially huge saving in infrastructure costs in new developments, but largely dependent on local topography, soil structures and developmental density).*

12 **This house should not need air conditioning.** Natural ventilation, using the differential buoyancies of warm and cool air for *vertical* ventilation can be very effective. This is integral with the house construction through suitably placed vents, manually operated for simplicity and low cost which work in harmony with the insulated mass heat storage of the precast concrete structure. This lowers the capital cost, has **no running cost**, makes no noise and does not pollute the atmosphere, compared to the opposite effects of air conditioning, the cumulative effects of which create an expensive and socially detrimental vicious circle by way of 'heat islands' and increasing electricity blackouts. Taken holistically, it would be more beneficial to *not* fit an air conditioning system and use the money for buoyancy ventilation (*see p 16*).

13 **Naturally cooled air entry** through the cool air ducts buried in the east, south and west berms (*when available, due to planning*), further assists the complete achievement of cooling, vertical ventilation which exhausts accumulated warm air overnight through the clerestory windows in summer, *without any need for electro-mechanical assistance.*

14 **Protection against bushfires** is now of critical importance for many reasons and the EcoSolar house is designed to resist both immediate flame and embers and direct radiant heat. The high mass house structure (concrete floor, all walls and ceiling) provides a *safer haven* for the occupants and possessions during a bushfire, The roofing structure above the concrete ceiling contains no flammable timber which can burn in a bushfire (*traditional timber trusses are a major weakness as once the dry roof and ceiling structure is alight the house is virtually destroyed*). Over the northern windows one form of protection against radiant heat is to have a dual sunshade/heat screen which can be dropped down in an emergency to shield the upper part of the window. On the south side the vertical reflector also serves a dual role in reflecting some of the radiant heat from its reflective *outward* face, requiring no emergency action by the resident.

15 **The cool mass of under-slab tank water** can cool and humidify at very low cost the incoming air in summer (*not shown, but mentioned in note attached to tank - page 27*) as potential low energy evaporative fan cooling and humidifying - *this would be largely beneficial at times of continuing hot days (such as Jan/Feb 2009) and would use the solar PV generated electricity to optimum advantage - and no pollution*).

16 **Increasing intensity of storms is forecast by CSIRO** so the *steel* roof structure is rigidly connected to the concrete ceiling panels and will resist substantially more suction uplift. The Canberra fires in 2003 showed clearly that metal deck roofs stayed largely intact despite the fact the timber trusses and ceilings had completely burnt. *This integrated roof system should resist tensile stresses and significantly lower insurance premiums as traditional tiled roof structures are not designed for uplift forces. The time is not far off when insurance companies will probably decline to insure tiled roofs against storm damage. (This would be a step in the right direction as tiled roofs are often totally unsuited to receive photovoltaic arrays, often arising from badly oriented, narrow blocks).*

17 **Solar warmth and cheerfulness are also available in the central kitchen area** by way of low-cost, manually adjustable, light weight reflectors near the clerestory window which control the solar gain in conjunction with an insulating, translucent ceiling light over part of the area and are easily adjusted in summer to prevent the ingress of heat. They are optional extras, not primarily essential to the functional house.<sup>18</sup> **At the end of its useful life in its first location**, the structure can be easily dismantled (*not wastefully demolished*) and components can be re-used in other similar house forms - a significant contribution to re-usable componentry and *effective sustainability*.

18 **The appearance of the house is modestly conservative** in outward form, arising logically from its function without any unnecessary and expensive excrescences, giving a tangible expression to the buying public that a solar effective house need not look like an avant garde freak - a misconception which seems to worry some people.

19 **The simplicity of form contributes to easier construction**, much less cutting of materials on-site, consequently less wastage and handling, devoid of excessive energy using devices - all leading to lower initial and ongoing costs - *particularly suitable for low income families*.

20 **The northern conservatory**, shown on the drawings as a useful extension (*initially or in the future*) is *not an essential element* for the solar effectiveness of the house. It should be seen as a planned possibility to give extra living space, extra vegetable growing space (*useful for extending the growing period in a cold climate*), a source of heat collection and convective heating system, a CO<sub>2</sub> sink and a not so well known source of negative ionisation of the internal air which is beneficial to human health. Alternatively, simple pergola and cable structures of various sizes can be easily retrofitted to provide shade and coolth. Further controlled research is needed on the relative effectiveness of these techniques - one more instance of where research in the housing industry has been grossly lacking.

21 **A family electric car can now be recharged overnight**, compensated by an adequate daytime PV system. These cars are now becoming available and will become an integral part of the family energy system as fossil fuels become unaffordable. Alternatively, as an interim measure, while natural gas is still available at affordable cost it can be used to power a fuel cell in the family electric car and when that becomes too expensive the PV system could be used to produce hydrogen to replace the natural gas. A by-product of the fuel cell operation is pure water in small quantities which could well satisfy the potable water needs of a small family. Fuel cells are already a commercialised technology - it only requires the stimulus of a responsive housing industry to kick-start its widespread use and bring the cost down. Currently, all fuel cell units made in Melbourne by Ceramic Fuel Cells P/L are sold to European markets. The potential exists for such a change.

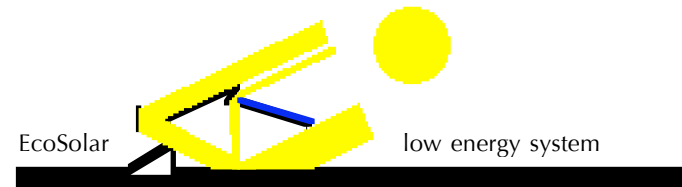
22 **The high mass structure also gives another possible advantage** to houses which are strangely being sited under flight path approaches to airports as is occurring in Queanbeyan, NSW. The concrete ceiling will certainly reduce airborne noise transmission through to the interior, but unless the windows are double glazed or at least 6mm thick they will form the weakest transmission path.

23 **Initial costs** of recent, similarly constructed precast houses have been a little higher than conventional, but this is to be expected in introducing new techniques into a traditional, conservative housing industry particularly on a one-off tendering basis. Quantity production will almost certainly reduce these costs to an acceptable level. **And if we consider all the features that are provided in current housing but NOT NEEDED the cost of an EcoSolar house is confidently expected to be only a little bit more than a 'normal' project house. When the low running costs are also taken into consideration (see table and graph pp31/32) it should well qualify as "an affordable house" - certainly very suitable for low-income families.**

***The calculations indicate that a saving in running costs of close to \$80,000 should be possible over 20 years.***

***even if the EcoSolar house is \$10,000 dearer to start with - which may not even be significant when added to a mortgage as the savings every year would more than cover the extra repayments.***

Note : Even if the figures are somewhat rubbery they show **orders of cost** which indicate good margins of successful possibility.



The **previous** pages give some indication that global warming and a simple change of heating fuels and construction techniques can have significant consequences on house design and on subdivision planning. The potential benefits to our way of life could certainly change our direction toward a higher degree of sustainability.

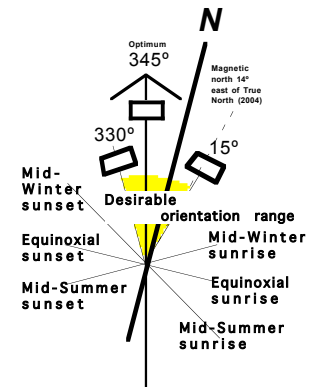
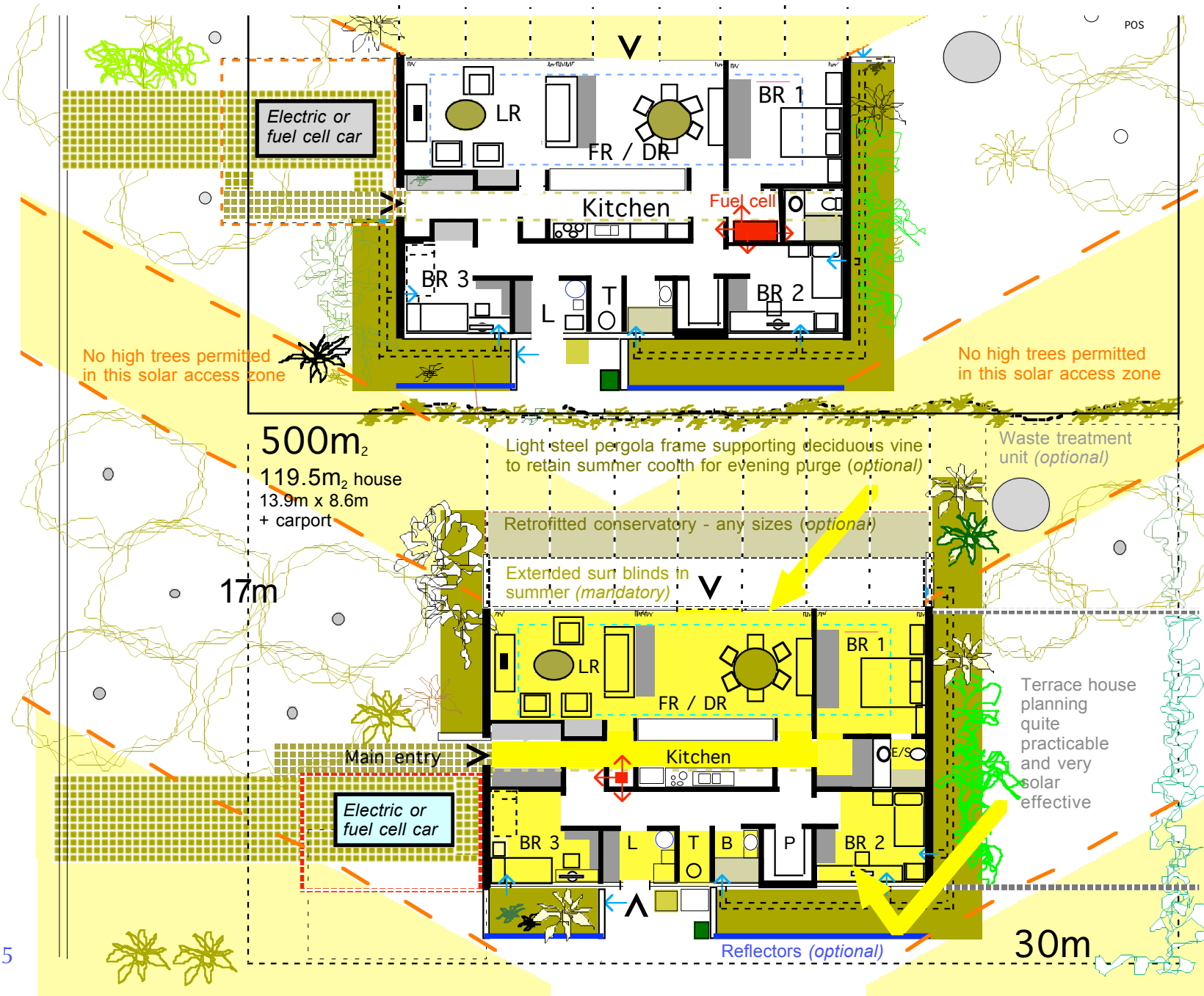
The EcoSolar integrated approach is a response to these external changes and should be seen as much of a system as it is a definitive design and that it can provide a planned 'starter' design at initial low cost, capable of accepting some of the more beneficial technologies as and when more personal funds become available

On the understanding that there can be no such thing as a completely 'sustainable house'- (it is really a contradiction in terms) - the EcoSolar house is perhaps best described as providing integrated low-energy functions equating to lower costs by way of:

- acceptable embodied energy,*
- low running costs*
- minimal pollution*
- reasonable initial cost*
- reasonable self-reliance*
- high degree of re-use of components*
- organised retrofits*
- lower family car fuel costs*

The **following** drawings and cost analyses show how a 3 bedroom version of the house works in the tighter planning we are coming to expect under today's economic circumstances. The system can adapt to all these variations.

# EcoSolar houses on minimal solar effective ~ east - west oriented blocks



**Range of effective orientations**

- Mulch or ground cover - no lawn (mandatory)
- Heat conserving berm (from water tank excavation)
- Sunlit internal areas most hours of the day
- Underslab water tank

Smaller houses and smaller blocks are possible if these solar design principles are maintained

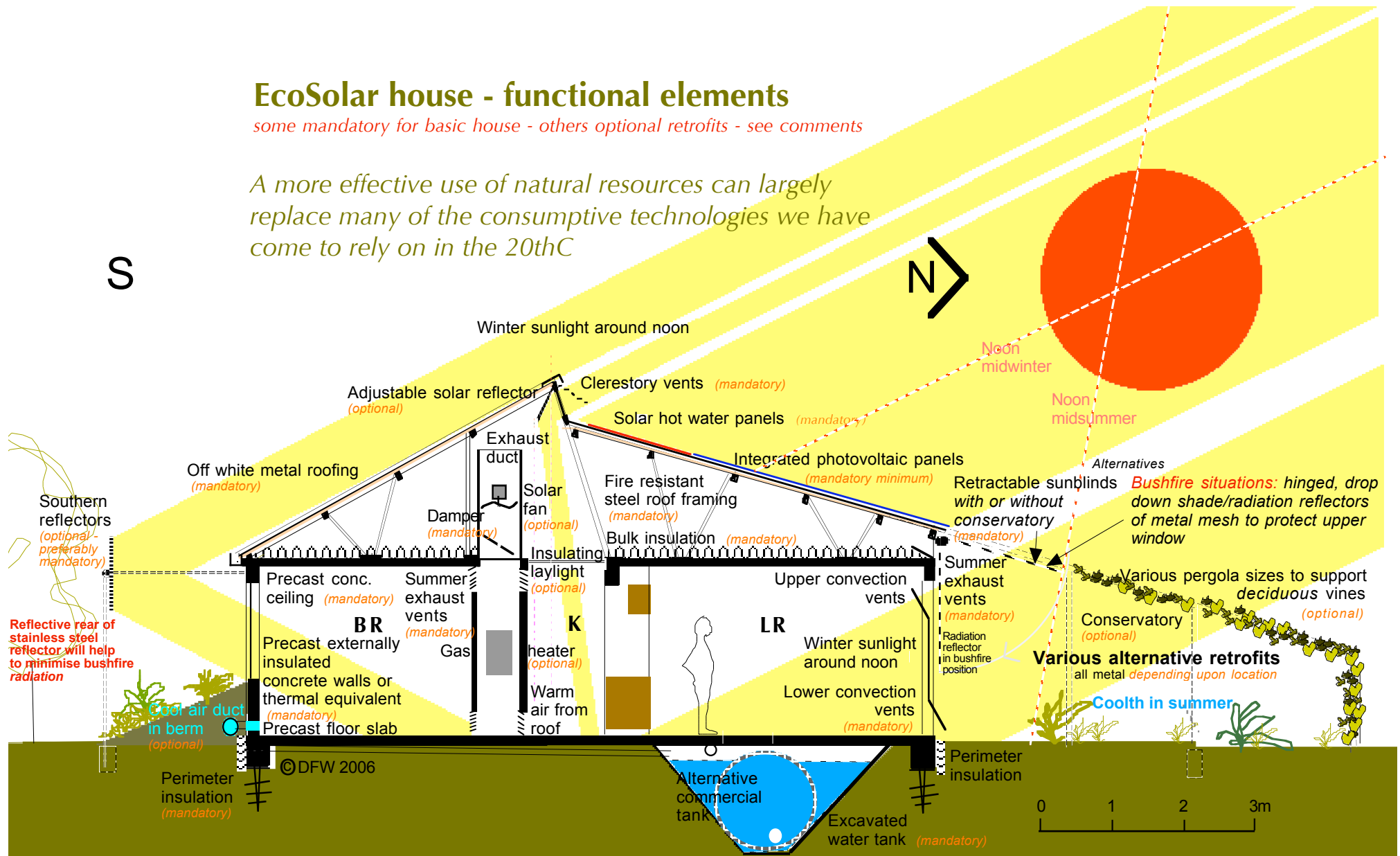




# EcoSolar house - functional elements

some mandatory for basic house - others optional retrofits - see comments

A more effective use of natural resources can largely replace many of the consumptive technologies we have come to rely on in the 20thC



Compare these advantages with current houses

## 88% winter solar effectiveness

Of all the solar energy being received by the EcoSolar house at noon in midwinter 88% is being effectively used to provide free warmth & psychological cheerfulness for the occupants. This contributes very effectively to better health and wellbeing (see medical research statistics).

## 100% summer solar exclusion

Once all shading devices have been adjusted correctly no unwanted hot summer radiant heat should penetrate the house, enabling the structure to keep the house cool through effective ventilation and use of structural mass.

## Optional items = low initial cost

Several items above are optional, enabling the initial purchase price of the house to be as low as possible (yet reasonably functional), in the knowledge that most of the items are designed to be easily added as retrofits when future money becomes more available. Bushfire options may prevail - depending on location and fire risk. See also p 27

## EcoSolar house - simple, low cost devices, assisted by subsequent retrofits can achieve .....

When first built and offered for sale to the market a house must be affordable, functional and have not only a low carbon footprint but *continue to function* with the lowest possible need for services based on fossil fuels.

To deserve the title of “sustainable” a holistic, ‘cradle to cradle’ evaluation of the performance of a house and its energy requirements must be taken. This is rarely, if ever, done, so the ‘sustainable’ house term must be used with caution.

Current housing is heavily reliant on coal to produce our electricity and on natural gas used for space heating and cooking.

Both of these are fossil fuels; are large polluters of our atmosphere and are steadily rising in price, even though still readily available.

**Current housing styles may soon be inadequate to meet reasonable future needs of their residents, and indeed the recent heat wave conditions of Jan/Feb 2009 have shown that *they are already inadequate for even today's conditions.***

New housing designs must,

- reduce their designed or inbuilt consumption of electricity and of natural gas (particularly while we continue to burn coal to produce electricity)
- integrate solar receptive devices to effectively generate sufficient green electricity for the use of the residents,
- harvest all rainfall for all domestic needs of the residents,
- be constructed to maximise solar gain to keep the residents warm in winter and minimise heat losses,
- be constructed to minimise solar heat gain in summer and avoid any reliance on cooling technology which requires the use of electricity, gas or water,
- be adequately effective at the point of first sale, but *designed* to accept at minimum cost and inconvenience new retrofitted items which later on become affordable by the residents.
- be constructed to minimise damage due to high winds, bushfires and, if possible, floods.

The following pages illustrate how the EcoSolar house meets these challenges in simple ways which not only keep the initial cost as low as possible, but significantly reduce the ongoing running costs. It is also demountable to encourage re-use.

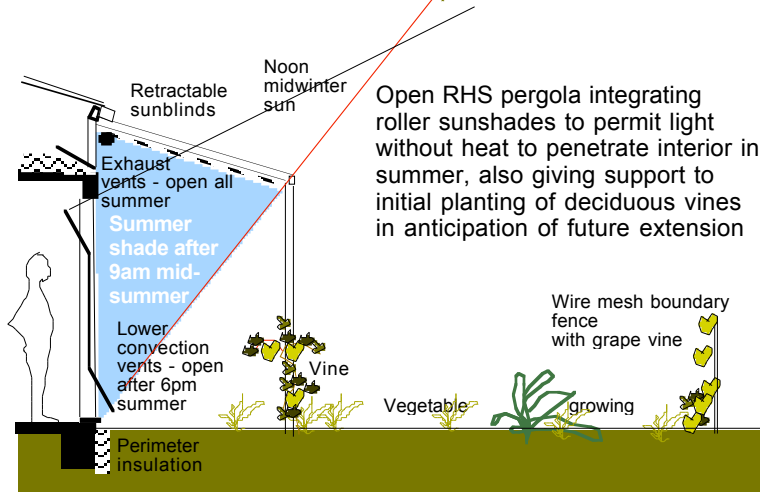
In this way the EcoSolar house should meet a growing social need for affordable housing and also provide a high degree of low energy consumption and self reliance probably never achieved before.

In one unique way - by integrating southern reflectors - this house can provide up to 7.7 times more free solar warmth (*compared to current typical houses - see p.10*) - and that most satisfying measure of *cheerfulness* which is a large, but unquantifiable, component of human wellbeing.

It is anticipated that EcoSolar residents will not only be more comfortable, but happier and healthier - a highly desirable outcome which has much wider community significance in relation to national behaviour.

..... can achieve comfort with low running costs in a cool temperate region

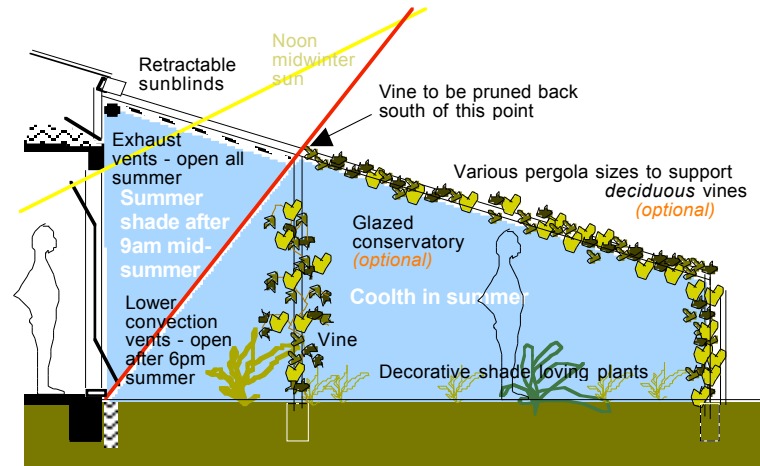
these are some examples of what can be achieved on the northern side of the EoSolar house



Simple, low cost shading can minimise solar gain through northern windows in **summer**

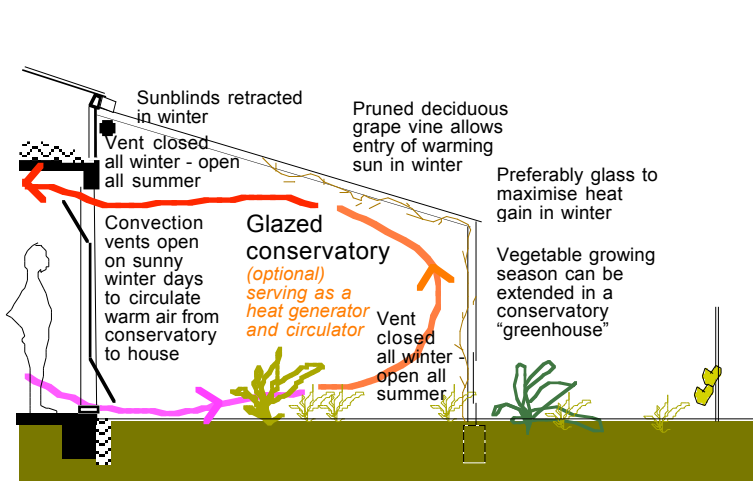


Subsequent retrofits when funds become available >



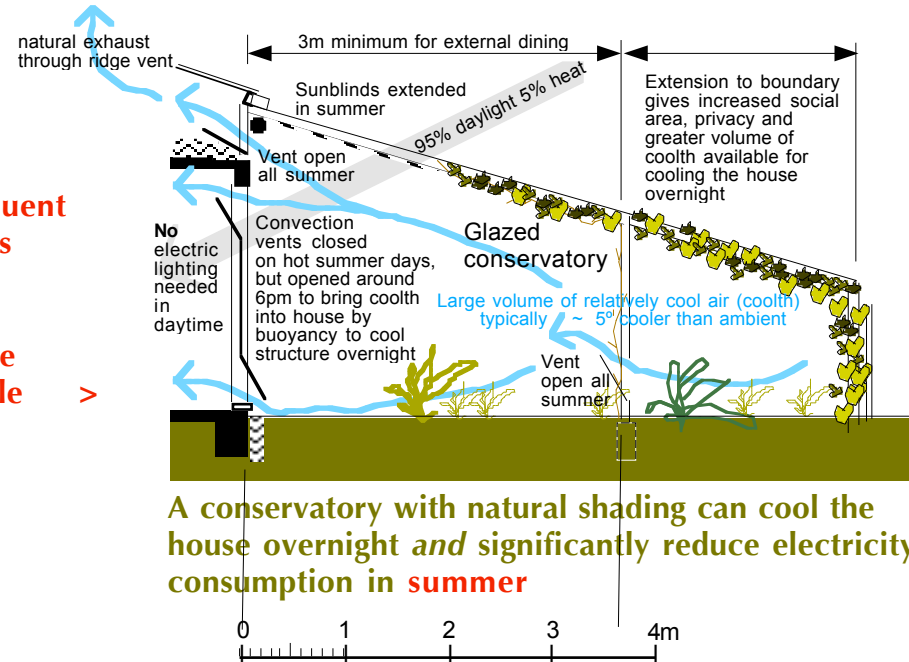
Symbiotic natural shading on the northern side also helps to keep the house cool in **summer**

air conditioning is completely unnecessary for heating or cooling



Alternatively, a northern conservatory can help to warm the house in **winter** by collecting and convecting free solar heat *without using any electricity*

Subsequent retrofits when funds become available >



A conservatory with natural shading can cool the house overnight *and significantly reduce electricity consumption in summer*

# The EcoSolar house also benefits subdivisional planning

it can achieve *higher density, without useless space between houses and with more effectively usable, personal space*

**and it enables every house to maximise solar gain** refer to plan B p10 and then compare these two plans

- to eliminate the problems of undesirable east and west solar gain
- to maximise the generation of electricity from the sun
- to reduce the length and cost of roadway access by about 42%
- to maximise separation of houses on north and south where aspect, prospect and solar access are more appreciated
- to reduce vehicular movement and pollution close to houses
- to increase the apparent visual space and privacy
- to eliminate the need for obstructive fencing by more effective landscaping
- to eliminate the appearance of 'overcrowding' by variable spacing
- to enable medium sized trees to be grown without creating solar shading problems
- to eliminate the need for expensive roads, kerbs and guttering by water sensitive planning
- to promote neighbourliness and community spirit



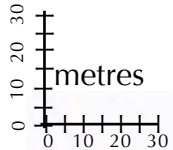


# As currently subdivided at Forde, ACT



**63**  
houses

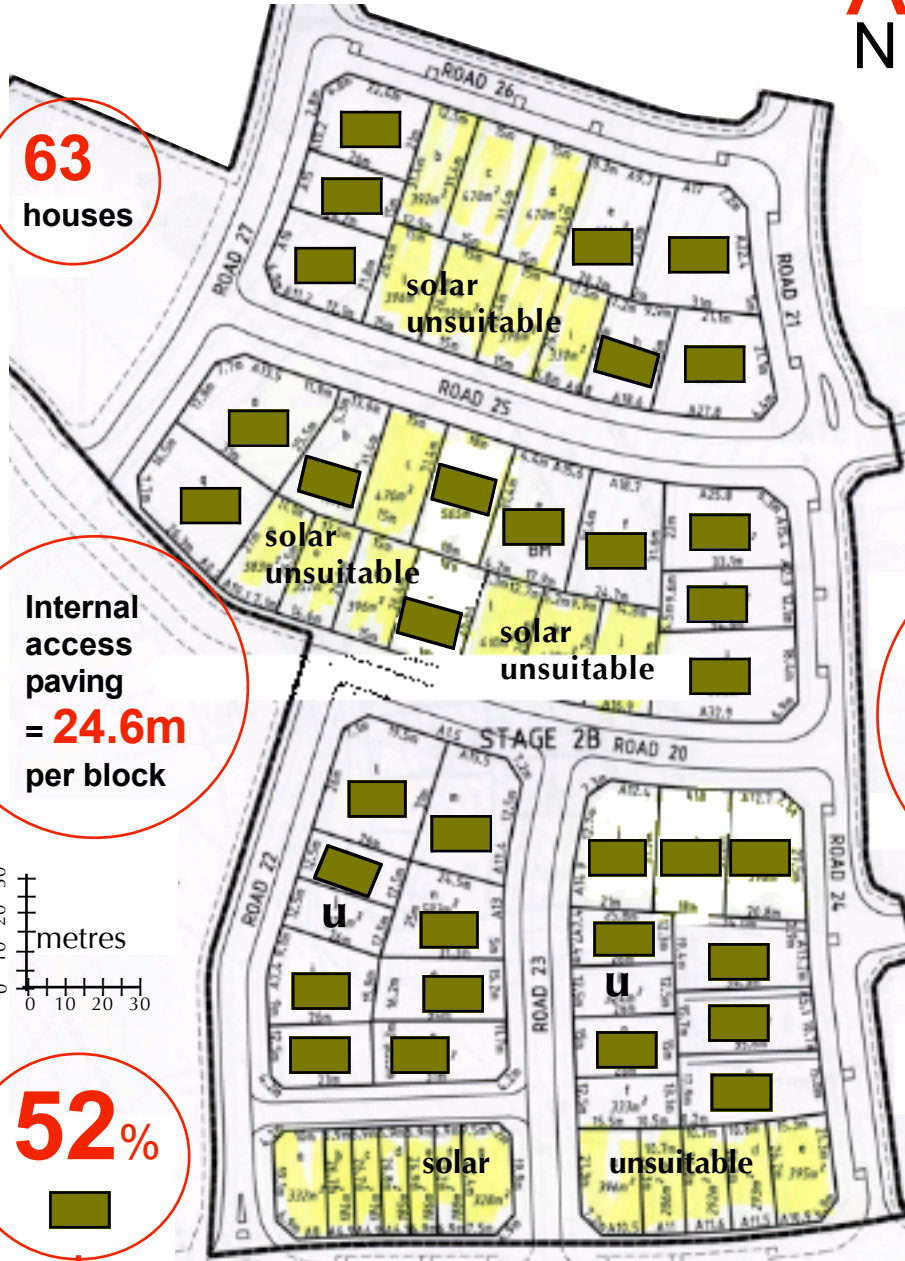
Internal  
access  
paving  
= **24.6m**  
per block



**52%**



percentage of houses which could be effectively warmed by the sun and generate all their own electricity

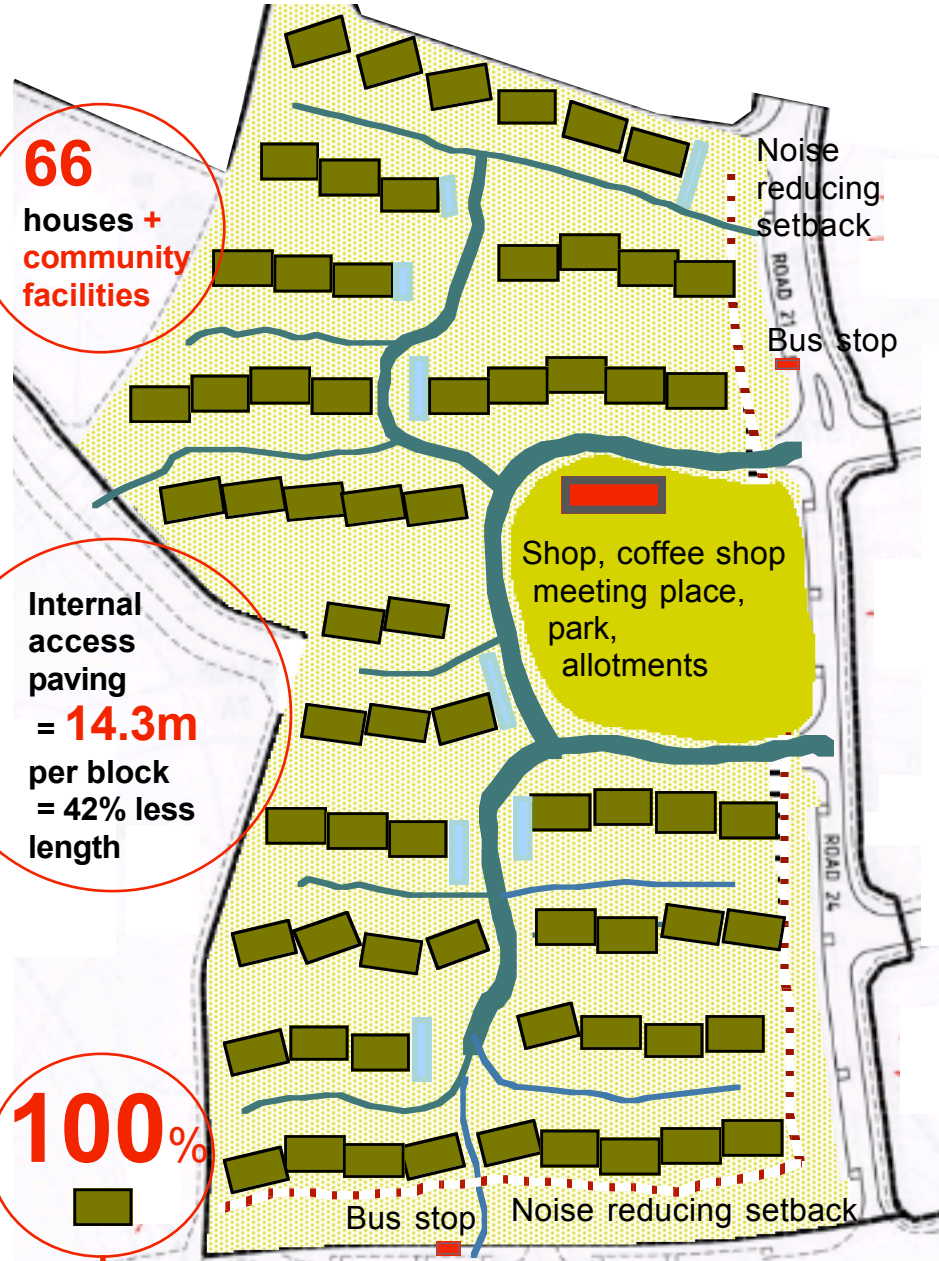


# As replanned with EcoSolar houses

**66**  
houses +  
community  
facilities

Internal  
access  
paving  
= **14.3m**  
per block  
= 42% less  
length

**100%**





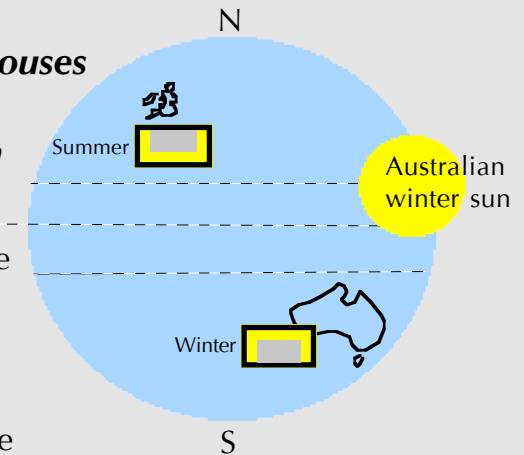
up to the  $>20^{\text{th}}$  C

*Ever since humans started to design houses it has been accepted that winter sun cannot shine through windows which face away from the Equator*

In Australia we never seem to have questioned the fact that south facing rooms in the cool temperate regions are always cold and cheerless in winter, *reducing their usefulness* for six months of the year.

We have always warmed these rooms by burning fossil fuels - a practice we now know is damaging our environment and threatening our existence on this planet.

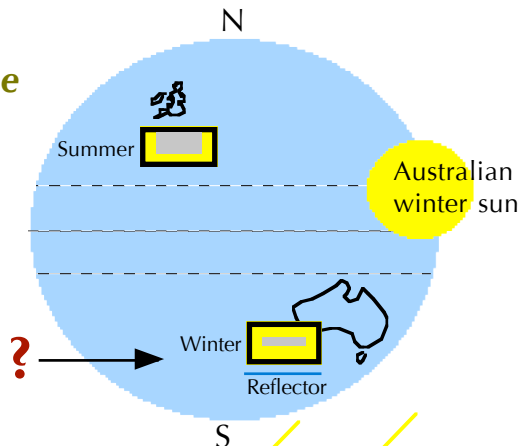
This is not only diminishing our non-renewable resources, but it is becoming increasingly expensive and families on low incomes may soon find it impossible to keep warm in winter.



## Southern reflectors

$21^{\text{st}}$  C  $>$

*(invented in Canberra) now enable the EcoSolar house to put sunlight into every southern window and - they can also be retrofitted to many existing houses - see photo below*



## Can we continue to ignore this free source of wellbeing ?

Reflectors of polished stainless steel have been researched and built in seven locations in Canberra. They are maintenance free, requiring little manual adjustment by the owners. They have raised the temperature of the rooms by  $8^{\circ}$  above normal, making the rooms sunny, warmer and more cheerful - *effectively increasing the useful space in the house.*

Recipients of this *free* warmth and cheerfulness have stated that they would willingly pay the same installation cost just to receive the cheering sunlight alone.

The reflection angle is just like 'normal' northern sun, with no glare.

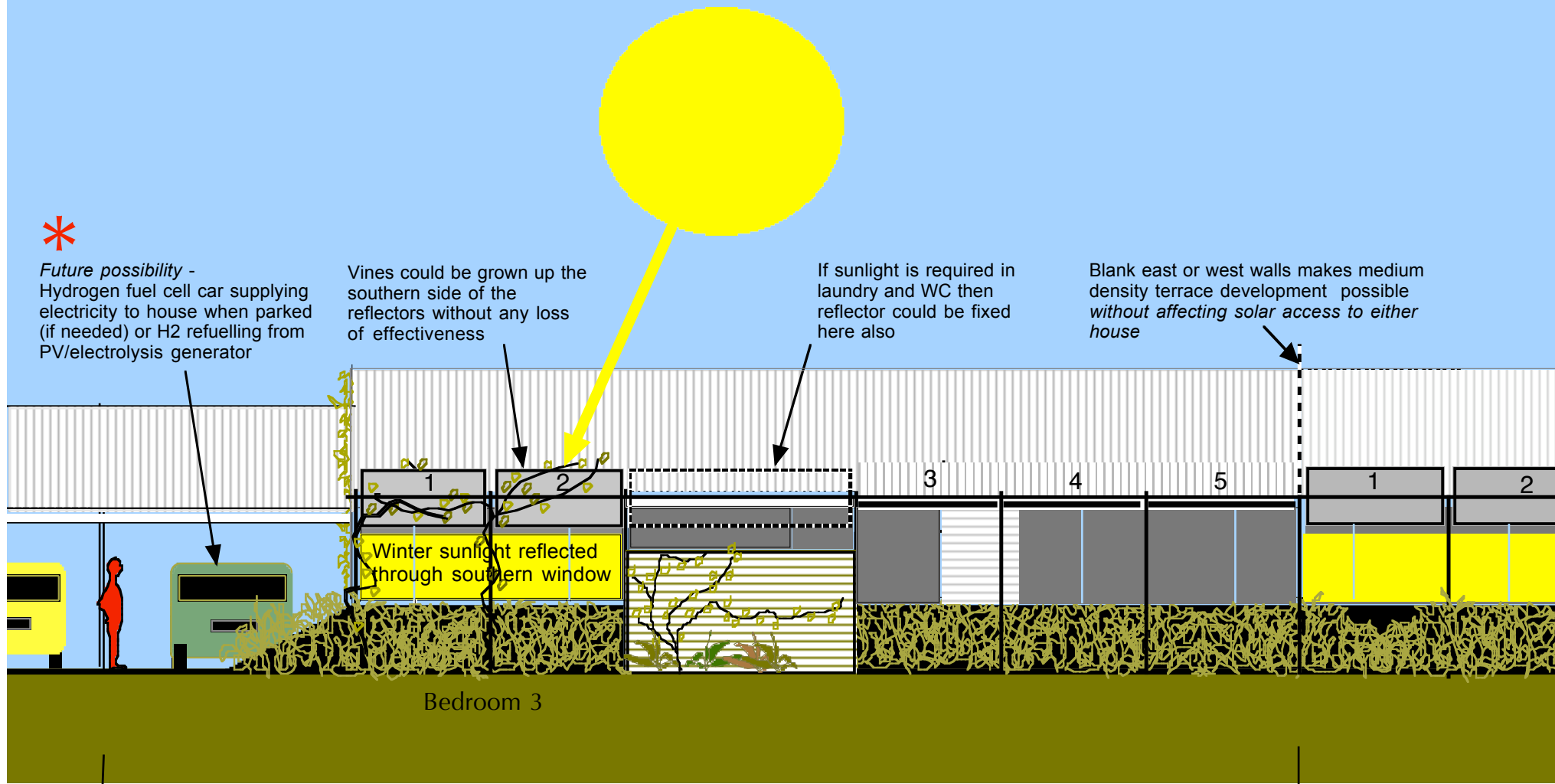
**A serendipitous feature of a reflector is its symbiotic relationship with the sun.**

Due to the lower angle of the sun in the cooler months the warming sunlight penetrates deeper into the southern rooms, but as the sun gets higher in the sky during the warmer months the penetrating sunlight gradually moves outside the window sill into the garden as the need diminishes. *It is thus self-correcting.*



A retrofitted southern reflector installed at the home of Professor Frank Fenner, AC, Canberra 2008

# Southern side of the EcoSolar house, showing the integrated southern reflectors



\*  
*Future possibility -*  
 Hydrogen fuel cell car supplying electricity to house when parked (if needed) or H2 refuelling from PV/electrolysis generator

Vines could be grown up the southern side of the reflectors without any loss of effectiveness

If sunlight is required in laundry and WC then reflector could be fixed here also

Blank east or west walls makes medium density terrace development possible *without affecting solar access to either house*

Winter sunlight reflected through southern window

Bedroom 3

## Southern elevation of one house

## Neighbour's house

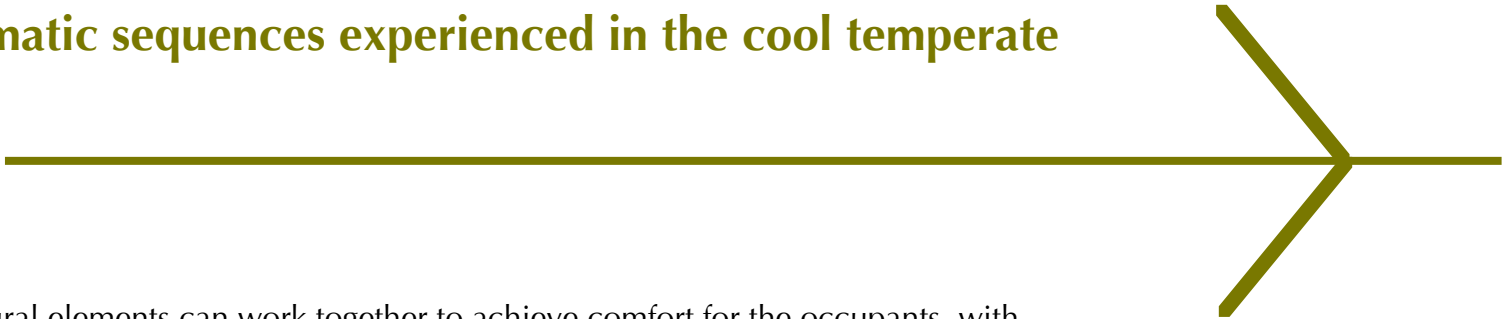
Adjoining terrace housing **will not affect solar access** effectiveness in either house

Reflectors will make these southern rooms ~8° warmer and cheerful in winter + more useful. *Panels 1, 2 are in winter position and show reflected sun entering BR3 at noon (yellow)*

Panels 3,4,5 are in summer position and act as sunshades to the window and bermed foliage planting, mainly in early morning and late afternoon - depending on latitude

Earth berms reduce heat losses and gains, re-use spoil from water tank, reducing costs of transportation and pollution

The following pages show how the EcoSolar house is likely to function through the various climatic sequences experienced in the cool temperate regions of Australia .....



...showing how the structural elements can work together to achieve comfort for the occupants, with the anticipated temperatures in various rooms - derived from experience and applied research.

The inherent thermal mass and insulating qualities of construction materials work in different ways at different times in response to the variations of a cool temperate climate with its *natural* useful resources - *sunlight, wind, rain, shade, buoyancy etc.* - *all free*. It is to our eternal shame that, in this wonderful Australian climate, housing has rarely been designed to take full advantage of nature's gifts - close to the best in the world.

By firstly using natural resources we can *then, if necessary*, apply smaller assistive technologies and imported energies - ***with significantly reduced capital and running costs compared to current housing examples.***

**Environmentally damaging air conditioning can certainly be eliminated in houses ...**

...and the need for *complete reliance* on lighting, heating and ventilation equipment and external public services, eg. water, sewerage and stormwater reduced or even eliminated by new products and better design - depending on local factors.

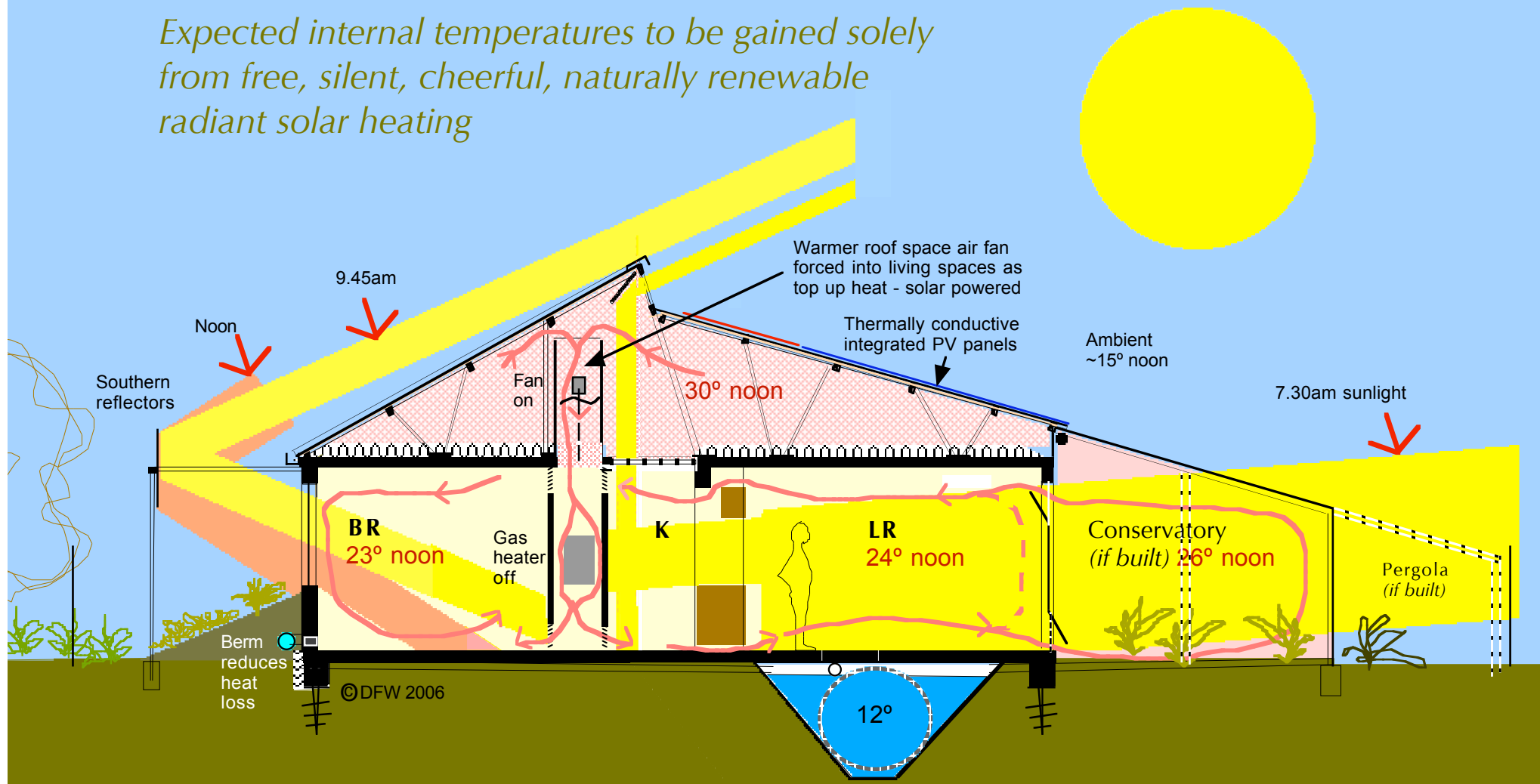
These *separate, natural resource* functions are known to work from empirical researches in previous houses, but what needs to be determined is how their functions can be practically *integrated*, simplified and costs reduced for commercial acceptance.

Only monitored building and testing under real living conditions can provide these answers.

***It is all possible now - with the know-how gained from the stimulus of global warming - it only needs encouraging with faith and funds.***

## EcoSolar house - sunny winter daytime

*Expected internal temperatures to be gained solely from free, silent, cheerful, naturally renewable radiant solar heating*



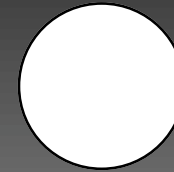
### Section through a 3 bedroom house

Showing direct radiant heating through northern *and* southern windows. If necessary this could be supplemented by indirect warm air heating collected in the roof space plenum, forced by a solar powered downdraft fan. Empirical results indicate that there would be no need for any artificial, supplementary heating in winter except during infrequent periods of extended cloudy days. *(In any case, the vertical duct also serves as a natural exhaust duct with or without reversed fan in summer - see page 21)*

These statements and expected temperatures are based on experience gained in similar conditions. The use of warm air from the roof space is regarded as supplemental only - if and when needed. Experience needs to be gained from a demonstration house under living conditions.

## EcoSolar house - winter evening

*Expected internal temperatures resulting from internal mass of structure - free, silent, and comfortable*



The moon will often be reflected in the southern reflectors which is quite an attractive feature, but not of much practical use !

Insulating vent closed

Ambient around freezing

Fan off

Damper closed

Vents closed

**BR**  
**19°**

Gas heater only when necessary

closed

**K**

**LR**  
**19°**

Vents closed

Vents closed all winter

Pergola  
**10°**

Conservatory  
*(if built)*

Pergola  
*(if built)*

Vents

open

Vents closed

©DFW 2006

**12°**

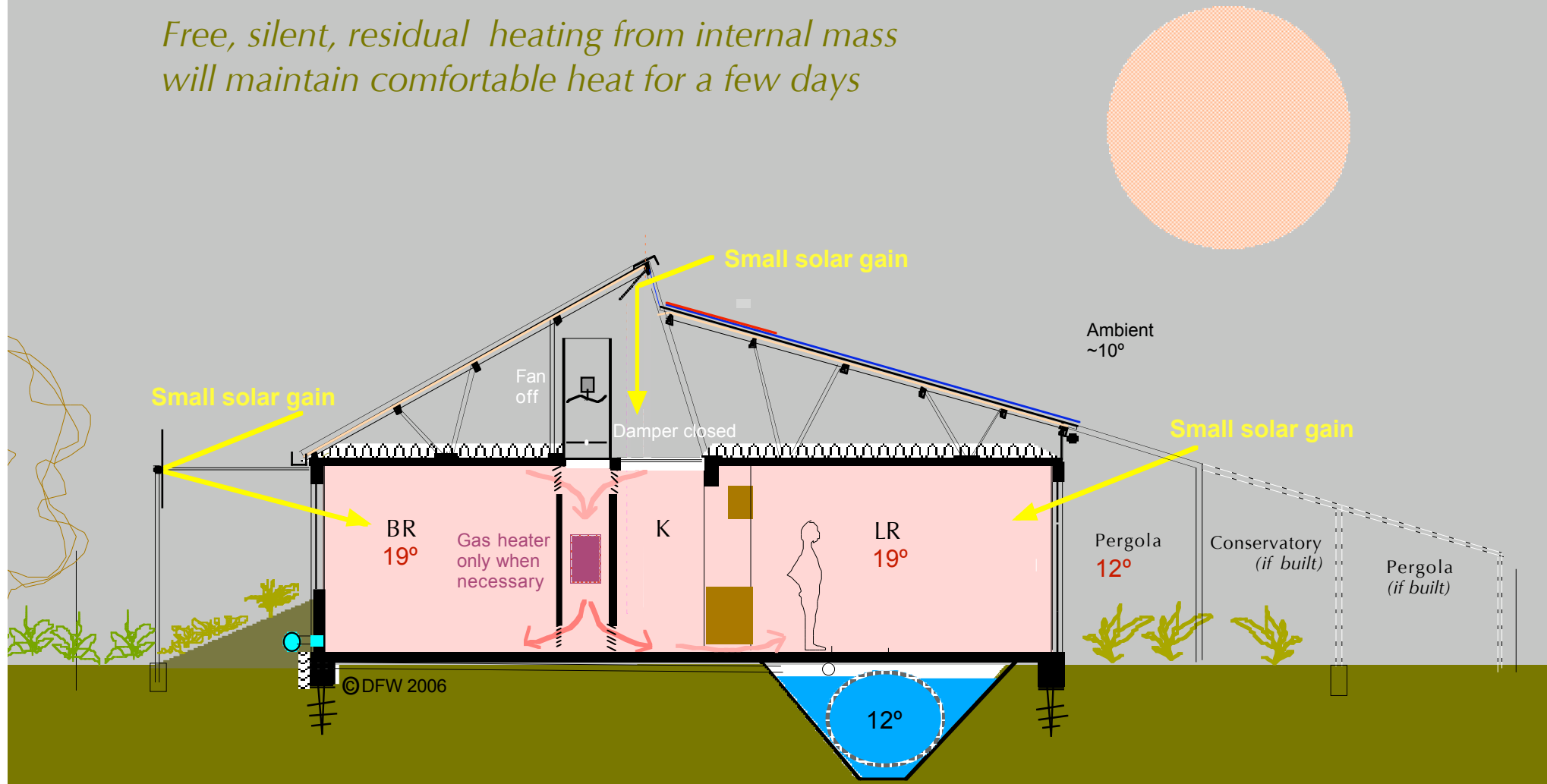
### Section through a 3 bedroom house

As all rooms would have received solar gain during the sunny daytime hours the concrete walls would have retained most of the heat and will now be radiating it back into the rooms fairly evenly. With the curtains, damper, and top vents closed the residual warmth will be contained. Top-up warmth from the natural gas heater would only be needed in colder weather or after a period of ~ 3 days of overcast weather.



## EcoSolar house - winter overcast days

*Free, silent, residual heating from internal mass will maintain comfortable heat for a few days*

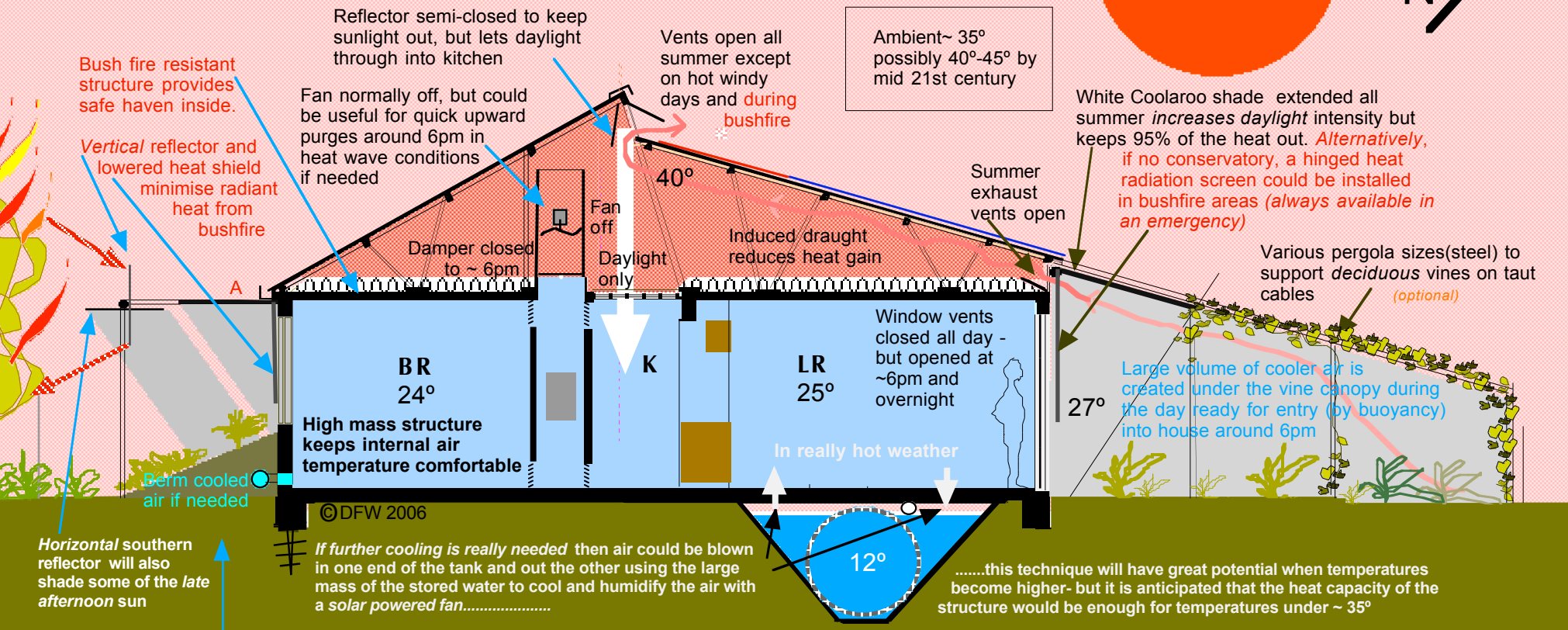


### Section through a 3 bedroom house

As all rooms would have received solar gain during the previous sunny days the concrete walls would have retained some of the heat and will now be radiating it back into the rooms fairly evenly. With the curtains, damper, and top vents closed the residual warmth will be contained in the habitable rooms. The top-up warmth from the natural gas heater would only be needed after two or three days of cold, cloudy weather.

## EcoSolar house - hot summer day

*Stored coolth in house structure, gained from overnight purging keeps the house cool for another hot day - eliminating any need for air conditioned cooling*



### Section through a 3 bedroom house

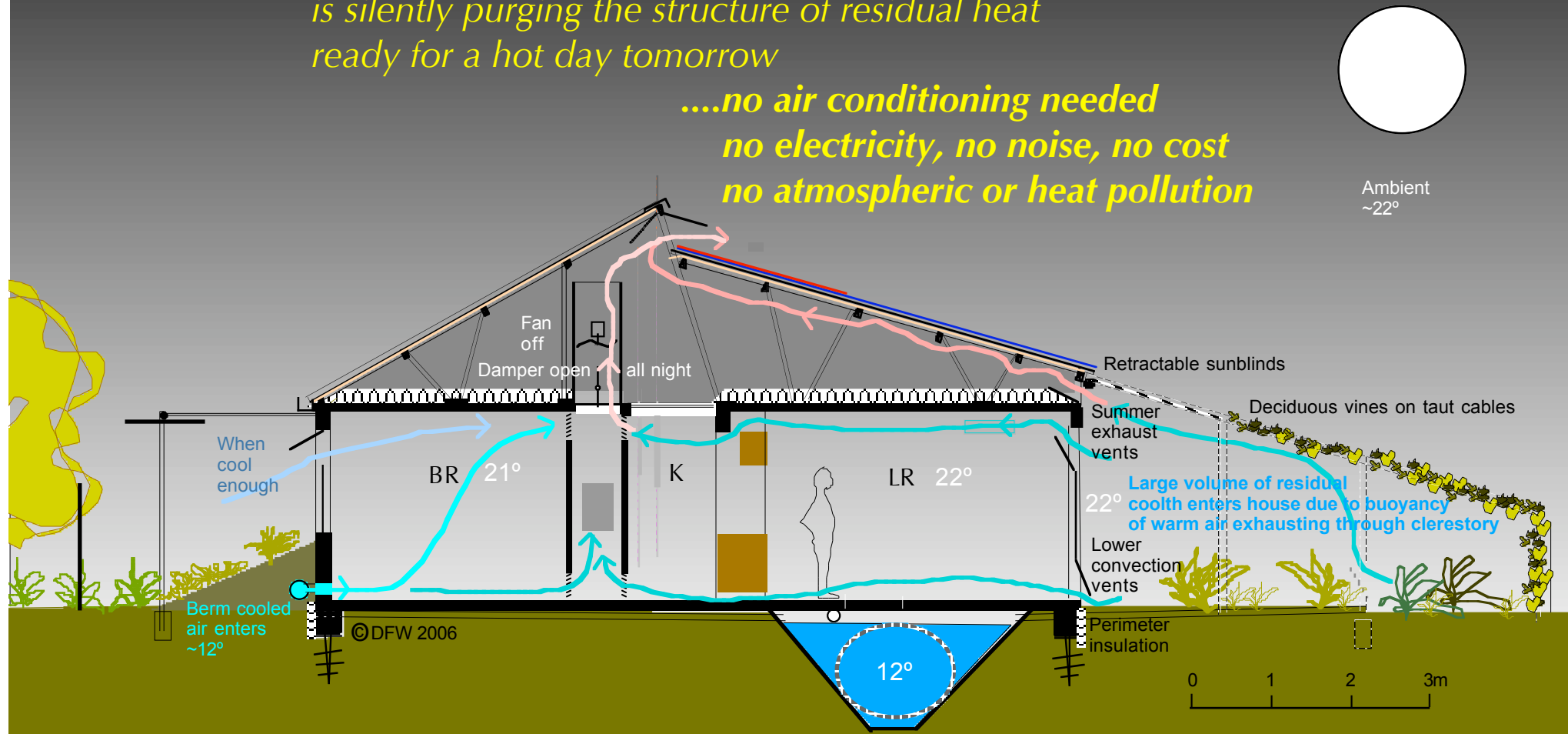
Due to the essential northern orientation of the house, the southern windows will receive some solar penetration after 3.30pm in midsummer which may be unwelcome. Temporary white Coolaroo shadecloth at A would prevent most of this. Alternatively, in a bushfire area, the use of hinged drop down metal Coolaroo screens with metal flywire would have the added function of reducing bushfire radiant heat about 30%.

As the whole house has been purged of any residual warm air during the cooler night, the high mass walls will have become cooler, creating a cool interior which will last for at least one day. All room vents will be closed during a hot day to maintain the coolth and only opened when the external air cools below internal temperature around 6pm.

## EcoSolar house - warm summer evening

*Free, naturally renewable vertical ventilation is silently purging the structure of residual heat ready for a hot day tomorrow*

*...no air conditioning needed  
no electricity, no noise, no cost  
no atmospheric or heat pollution*



### Section through a 3 bedroom house

When the external temperature falls below the internal temperature around 6pm all vents in the house should be opened to encourage vertical buoyancy cooling to take place, without any electricity being used. It will cool all internal surfaces in readiness for another hot day. All the vents should be closed as soon as the external temperature rises above internal. *This is not difficult - it only requires awareness of climatic variations to create comfort.*

If the external air temperature falls below the internal temperature then its greater density would encourage it to enter all house vents and effect greater cooling of the structure overnight.

## What does an EcoSolar house cost ?

A sustainable house - to paraphrase Einstein - *cannot be properly evaluated using the same criteria which have created the current problems.*

New thinking is now becoming evident, with new ideas and more appropriate criteria relevant to our today's problems, but it is becoming even harder to evaluate between the new (and unknown) and the old (and familiar).

Also, what relative values do we place on the *initial* cost and *running* costs - the latter can become very substantial over time with a new factor coming into play - the pollution dilemma, which our parents did not consider. New and cleaner energy sources will have to be found to replace the fossil fuels on which we have come to rely. So far as housing is concerned there is one simple answer - the use of natural resources, such as the sun, which have been largely ignored for over 200 years. The EcoSolar house uses these natural resources as much as possible and the results are quite surprising (see table and graph of running costs pp 31/32). These resources are free, very environmentally friendly and surprisingly reliable, having lasted for aeons.

The cost of any house is, at best, a slippery concept - it all depends on what you mean, what is really included and what is not - and above all - a better understanding of the running costs - often never considered. The concept of 'enoughness' in living also needs to be more understood among the community - *and acted upon*. These are the real factors which eventually lead to the ultimate decision on affordability.

The criteria by which an effective *sustainable* house can be assessed are laid out on pages 11-13 of this EcoSolar booklet, covering the factors appropriate to the design of the house itself and also to the way in which such a house can be effectively placed on a block of land (see pp 9/10).

EcoSolar criteria have also been listed on p 34 in an attempt to quantify its comparative, subjective values with the more usual project house offered for sale in our newer suburbs - it makes a revealing comparison and you are invited to make your own evaluation. Thorough analysis of what constitutes a sustainable house can be a detailed, somewhat daunting process if it is to be effective, involving many compromises and trade-offs. It cannot be fully explained in this booklet - and to be realistic, how many buyers will have the perseverance and the detailed knowledge to effectively evaluate a minimum of two houses - preferably more. To add to the difficulty, it is impossible to *quantify* many subjective values such as having cheerful winter sunlight in every room - a major factor when assessing comfort and wellbeing- ***and it is now possible for the first time ever to enjoy sunlight and warmth in southern rooms in the EcoSolar house - but how do we put a value on it ?***

A simple checklist to assist house buyers was also designed in 2008 by Wrigley and Sandeman and published by the ACT Minister for Planning. It is freely available online (4 pages) from ACTPLA or Nature and Society Forum (see *References, back cover*).

As this is written, the cost of a 3-bedroom EcoSolar house is not accurately known and in any case would have significant variation due to local factors, so *comparative* indicators can only be given as a guide to the functions we really should be considering as 'normal'. However, if one considers the ongoing, running costs as well as the initial cost, it will be seen that even though the EcoSolar might be a little more expensive initially the extra cost on the mortgage could be amortised in less than 3 years from the significant savings to be made from the running costs - particularly when it can be seen that ***the running costs of an EcoSolar house could be around 12.7 times less expensive***, saving up to around \$80,000 over 20 years.

A further guide to the tangible and intangible aspects of a house are also explored on pp.33/34.

*Global warming and the climate changes to come will unquestionably force us to reconsider our understanding of how we can be comfortable in a house. Today's "normal" house will be seen as "abnormal" with global warming in the coming years and that will equate to being "unsustainable".*

***Read on.....it gets very interesting....>***



## Analysis of construction cost of a 'starter' 3 BR EcoSolar house compared to a usual project house in a Canberra suburb

Comparison is very difficult because the EcoSolar house achieves its thermal and other advantages in different ways. This table attempts to cost those items which an EcoSolar house needs to function effectively and compare them to a project home which would include several items now seen to be unnecessary. All prices are guestimates but at least show *some order of comparison* even if not accurate - read in relation to Running costs p 31 and related graph p 32

Additional items in EcoSolar house not usually supplied in current houses	\$ +	Deduction of some items <i>not needed</i> in EcoSolar house but normally supplied in typical project house in 2008	\$ -
Under slab <b>water tank</b> system, plumbed into house with mains fail-safe connection. Incl. pump	5000	Simple <b>one car port</b> in lieu of two car garage (deduct)	3000
<b>Precast footings (screw anchors), walls, ceilings</b> <u>extra over</u> normal BV with good ext. insul. with fire resistant sheeting.	20,000	On-site <b>time saved</b> , fewer weather delays. Quicker delivery to point of sale (deduct)	10,000
<b>Steel roof framing</b> <u>extra over</u> timber trusses, incl. clerestory, operable vent remote opening. No reflector.	3000	Assume usual complex <b>tiled roof</b> costs same as simple <b>metal deck</b> roof as on EcoSolar	--
<b>Solar HW</b> system, <u>extra over</u> usual gas/elec. storage	2000	Smaller, simpler <b>house area</b> 135sqm(EcoS.) v.250sqm(project)(deduct)	30,000
Basic <b>PV</b> system, 1.5kW (based on standard type panels) (\$8000 <i>PVRP grant not deducted as possible doubt about its future availability</i> )	14,000	<b>Ducted gas heating</b> system not needed, <u>but add for</u> top-up heater fitted into ES duct,	15,000
<b>N pergola</b> with roller <b>sun blinds or hinged shade/radiant shields</b>	9,000	<b>A/C</b> system, cooling only	4000
<b>Vert. duct</b> with louvres, top-up gas heater, damper, solar fan etc	3000		
Footing perimeter <b>insulation</b>	2000		
<b>Berms</b> , free soil from excavation of water tank including cooling ducts and grilles, less no dumping or fees at tip	1,000	Saving on <b>elimination of transport</b> of tank spoil to tip ? Its value added as berms ?	500
<b>Double glazing</b> to N and S windows (essential?) Extra over single glazing. N glass may not need to be db.gl.if conservatory built.	5000	<b>Mesh fence</b> , undulating with vine plantings <u>saving over</u> solid steel Colorbond fence	2000
<b>Ceiling insulation</b> - R 4 probably adequate on top of 80mm concrete slab - same as "normal" project house	---		
<b>External top vents</b> to roof space, North side 4m long	300		
Desirable option : <b>Southern reflectors</b> to bedrooms	9,000		
<b>Biolytix</b> waste disposal system, in lieu of sewer (if possible).(\$15000) <i>BUT</i> - If sewer available but no connection <u>annual rates \$444 must be paid</u> . Assume \$1500 connection to sewer. Unless this charge is dropped Biolytix may well be seen as too expensive in serviced areas.	1500 <b>74,800</b> <del>66,000-</del> <b>8,800</b>	<b>Sewerage and stormwater</b> system as normal - no initial cost other than connection + \$444 annual rates (incl. on p 31). Stormwater - no initial cost (incl. in General Rates)	1500 <b>66,000</b>

**Note - the difference of about \$8,800 extra for the EcoSolar house could almost be eliminated if the \$8000 PVRP program continues.**

Even though possibly incomplete this analysis gives *some indication* that the cost of an *effective* EcoSolar house need not cost much more than an *ineffective* project house such as currently offered for sale. The graph (p32) shows clearly that with the *significantly* lower running costs *any* extra initial cost is easily recovered in a very few years. Compare also the intangible and the relative values (listed on pp 33 and 34).



# Comparative running costs of main energy services of a 'starter' EcoSolar house

assuming 4 reasonably 'green' people and a Feed in Tariff (FIT) similar to ACT

# Typical project house

assuming 4 typical non-environmentally aware people

Service	Expenditure / yr	Income		Service	Exp / yr	Income
<b>ELECTRICITY</b>						
<b>Consumption</b>				<b>Consumption</b>		<b>Generat'n</b>
365x7.53kWh/dx12.9c/kWh	= 355	Generation pa during FIT period (20 yrs)	1370	365x22kWh/dx12.9c/kWh	= 1036	Nil. PVs
Supply charge @ 47c/d	= 172	365x5hrsx1.5kWx12.9c/kWhx3.88FIT =		(incl. AC)		and solar
	527	<b>1370 - 580 = 790 CR</b>		Supply charge @ 47c/d	= 172	hot water
GST@10%	= 53	<b>Generation beyond FIT period</b>	353	GST@10%	= 1208	almost
	<b>580</b>	365x5hrsx1.5kWx12.9c/kWh =			= 121	never
		353 - 580 = 227 DB			<b>1329</b>	supplied.
<b>GAS</b>						
14 days heating@536MJ/d@1.69c/MJ	= 127	<b>Generation</b>	Free	100 days space heating		
(from ActewAGL)		Solar heating in all rooms, including		536MJ/d @ 1.69c/d	= 906	
365 days cooking@23MJ/d@1.69c/MJ	= 142	southern rooms		365 days cooking		
Solar hot water heater				23MJ/d @ 1.69c/d	= 142	
with natural gas boosting.	= 42			Hot water (storage heater)	= 168	
Supply charge @\$45/qtr	= 180			(web source)		
	491			Supply charge @\$45/qtr	= 180	
GST@10%	= 49				1396	
	<b>540</b>			GST @ 10%	= 140	
					<b>1536</b>	
<b>WATER</b>						
Usage of 250L/d (from records)=91kL/yr		<b>Harvested</b> rainwater stored in underslab	Free	350kL/pa (Actew) =0.967kL/d		Water
less 56kL/yr (tank) =35kL/yr from mains.		tank of 30kL capacity (variable - could		So:0.548kL/d/qtr@\$1.85/kL/d		tanks
35kL/yr = 96L/d (= under 548L/d tariff limit)		be larger). Roof supply 135sqm x		/qtrx91days x 4qtrs	= 369	rarely
@\$1.85/kL	= 65	550mm annual rainfall = 56kL/pa		0.967-0.548 = 0.419kLx\$3.7		supplied
Supply charge pa	= 85			/kL/d/qtr x 91days x 4qtrs	= 564	
No GST	<b>150</b>			Supply charge pa	= 85	
				No GST	<b>1018</b>	
<b>SEWERAGE</b>	<b>444</b>	....if owners want to do "the right thing"		Supply charge	<b>444</b>	
Supply charge applies whether used or not. This seems to be environmentally untenable.....		and install waste treatment systems then some incentive should be considered.				
Total services expenditure/yr =	<b>\$1714</b>	- compare this annual EcoSolar expenditure to the project house----->			<b>\$4327</b>	
Credit/yr during FIT first 20 yrs =	<b>1370</b>	= total \$344/yr for the 20yr FIT period .....				
Credit/yr from PV generation =	<b>353</b>	= total 1361/yr after the end of the FIT period ...				
<p><b>Conclusions : the EcoSolar is 12.6 times cheaper to live in every year during the 20 years of the Feed In Tariff program.</b></p> <p><b>After that time the ratio would be 3.2 if a 1.5kW PV array is in place (EcoSolar - full \$14,000 was included on p30 as future of PVRP is in some doubt).</b></p> <p><b>If no PV system the EcoSolar house running costs would be about three times cheaper (due to the non-availability of the FIT program) .</b></p> <p><i>Adjustments will have to be made in other states which have lower or no FIT programs in operation).</i></p>						

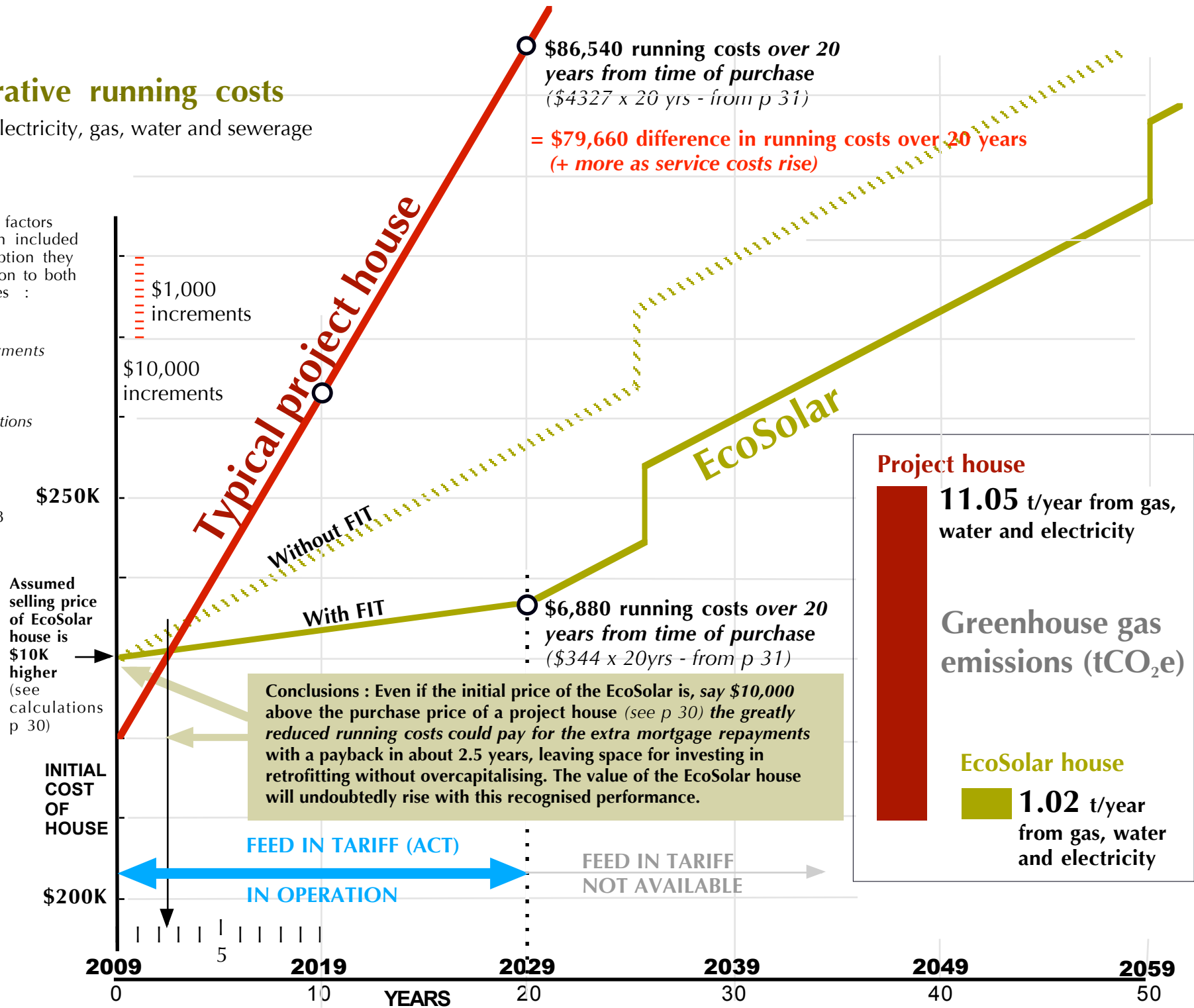
# Comparative running costs

including electricity, gas, water and sewerage

The following factors have not been included on the assumption they will be common to both types of houses :

- Maintenance
- Depreciation
- Mortgage payments
- General rates
- Inflation
- Telephone/communications

All these calculations have been based on 2008 figures for simplicity. There are strong indications that electricity, water and gas prices will rise significantly in coming years so graph lines will need adjusting upwards, favouring EcoSolar



## Intangibles / ephemerals / serendipities -

*the little subtleties that surprise and raise the spirit*

The cost of a house seems to be uppermost in people's minds whenever they are considering the purchase of a house.

The concept of affordability is critical these days, but, as when making other purchases it all comes down to the appraisal of value for money - what functional satisfaction or enjoyment are you getting for how many dollars.

To make things a little bit harder, many of the factors needing consideration are very subjective and unquantifiable but quite important for the enjoyment of life and our physical and mental wellbeing. Eg. how do you compare the value of sunlight at the breakfast table on a cold, sunny winter morning with the fact that the bedrooms, now used as studies by your growing children face south, never receive any sun at all, remaining cold and gloomy, discouraging any thought of study?

Are buyers even aware of all the nuances in a house which help them to *enjoy the experience of living* in it?

The psychology of living in houses is slowly becoming more appreciated - the rise of "feng shui" being just one outward expression of this interest - and we all know how the visual charm of romantic English cottages with thatched roofs can tug at the purse strings despite the uncomfortable fact that the loo is down at the bottom of the garden. All these factors need reconciling if a justifiable and sensible purchase is to be made. It is not easy, but this booklet will, I hope, awaken your interest in aspects other than money.

Essentially, this booklet is about obtaining real value for money, looking at needs rather than wants in an increasingly uncomfortable world, but this raises issues of what is happening to our environment which the average buyer and the real estate agent are not yet willing to discuss.

Consider this - having bought a new house, what are you going to do when you can't afford to pay the gas bills on which your comfort in your southern study relies? That decision is getting closer by the minute.

We have an environmental crisis on our hands which must be resolved. You, as a potential house buyer may feel that the crisis has nothing to do with you in the act of buying a house. However, if one house which is attracting your interest has many halogen downlights in the living room ceiling, or has two or three airconditioners needed to keep the house cool in summer, then your grandchildren may very well think you greedy or ignorant when blackouts become much more frequent in the near future.

**The design of our houses is now a major factor in reducing our emissions of greenhouse gases** but this requires buyers to understand what *really* represents value for money.

These factors might be seen as subjective, intangible and unquantifiable now, but as the life of the house you are considering will last well into this new century, they will become increasingly obvious and vital to your wellbeing.

We have absolutely no choice left to us but to think smarter, smaller and simpler - SSS - and nature has many of the answers if we are willing to learn. She has been around a very long time and has been highly successful - *we haven't and we are not* - we have yet to learn when enough is enough and need to understand the consequences of our decisions - of which buying a house is one.

# An attempt to compare the unquantifiable

## EcoSolar house

Functional effectiveness  
value 10 = best

## Project house

Cheerful winter sunlight in every habitable room during sunlit hours	9	2	Small amount of winter sunlight in living room, even less elsewhere
Effective solar warmth in winter in every room	9	2	Solar access usually far too small to be effective in heating house
Large mass = good nighttime winter heating	10	1	Small mass / small solar access = little stored heat
Vertical buoyant ventilation, no fans needed	10	1	Horizontal ventilation usually inadequate, fans needed = pollution
External walls, internal mass, external insulation	9	0	Usually brick veneer, ext. mass, int. insulation
Edge insulation to concrete slab reduces heat loss	8	1	Most unusual = excessive heat loss
Summer coolth without air conditioning	9	1	Ineffective mass:insulation ratio. Reliance on air conditioner essential
External adjustable sunshades optimise summer coolth and winter warmth, actually increase daylight intensity, eliminating need for electric light.	9	1	Ext. shades rarely supplied or are ineffective. Owners usually add canvas shades usually block daylight, increasing need for electric lighting
Good <i>daylight</i> throughout house	10	3	Southern rooms usually dark in winter, poor orientation
<i>Southern</i> rooms receive solar warmth and cheerfulness	9	0	Southern rooms cold and cheerless in winter; reflectors <i>never</i> supplied
Appropriate roof space for photovoltaic array	10	2	Tiled roofs rarely give adequate roof space for effective PV system
Collected winter heat below PV panels used to heat living spaces	8	0	PV system rarely, if ever, supplied
Solar hot water system supplied	9	2	Solar hot water systems rarely supplied
Internal coolth derived from light coloured roof. AC not needed	9	3	Most roofs dark tiled, increasing internal summer temperatures. AC essential
External berms with cooling ducts reduce heat losses/gains	8	0	Berms never supplied
Retrofitting of energy saving devices made easy by being 'designed in'	9	0	Retrofitting of energy saving measures never 'designed in'
Space for future heat generating conservatory allowed for	9	1	Conservatories rarely, if ever considered as functional heating units
Bush fire proof roof structure reduces/eliminates damage and total loss	9	0	Timber ceilings and roof structures guarantee severe loss from bush fires
High mass concrete structure forms safe haven for occupants in bush fire	8	5	Ext. brick walls give some protection against lateral fire entry (see above)
Large under slab water tank, significantly reduces reliance on mains	8	1	Smaller blocks make external tanks difficult to locate and ineffectual
Main structure completed in 2 days, saving on-site time (\$)	10	3	On-site traditional trades are slow, weather dependent and wasteful
Industrial techniques minimise waste and pollution by pre-planning	7	3	On-site conversion of materials is wasteful of time and resources
Side garage does not affect solar access (no E or W windows)	8	3	Garages often occupy best solar access locations - to no advantage
Proportions of block make solar effective house possible	9	1	Narrow northern frontage to street makes effective solar house impossible
EcoSolar house will be comfortable when gas/elect. becomes unaffordable	9	0	Ineffective solar access will make 'normal' houses unlivable when prices rise
The metal roof structure will withstand greater storm intensities	6	0	Tiled roofs will become uninsurable when higher intensity storms prevail
Social re-evaluation will make EcoSolar house extremely affordable	8	0	Social realisation of these poor values will de-value this type of house
Pollution from the EcoSolar house is 50% less	8	0	Continuation of this house type will increase global warming & its problems
With Biolytix (or sim.) system domestic waste water will be re-used on-site	8	4	No re-use of on-site waste water will increase mains water costs
PV system can help to reduce cost of charging family electriccar	9	0	PV system unlikely to be available due to ineffective roof form
Solar warmth and daylight in kitchen, reduces need for electric lighting	7	3	Sometimes skylights are provided to provide daylight
Under slab water tank is potentially a source of summer air cooling	5	0	Never supplied
Precast structure readily suitable for dismantling and re-use elsewhere	6	0	Demolition usual answer, with some ad hoc recycling of materials
Elimination of E and W windows enables improved urban planning	7	3	Windows on all sides restrict better urban planning
?	?	?	?

286 47

86% 14%

Why is it that the factors on this side are not regarded as 'normal'?

Relative order of effectiveness in providing human comfort and reducing its damaging effect upon the environment

Something is surely wrong when such functionally inadequate housing is seen as 'normal'

## Summary of the critical factors

### Benefits

The estimated **initial cost** of an EcoSolar house seems to be from **0 - 5%** above the cost of a 'normal' project house (p 30) which can be regarded as very reasonable, *without even considering the beneficial advantages of living in such a house.* .

**Initial costs could be reduced** even further by even small scale industrial production, coupled with more rational, aware planning of developments and rationalisation of servicing subdivided land. Consequently, current types of house construction will in future be seen as outmoded thinking, overpriced and out of touch with reality.

The **running costs** (as explained on pp 31/32) could be up to **12.6 times smaller** than current housing in Canberra, assuming the Feed In Tariff (FIT) system is in operation for the first 20 years, *making such houses extremely suitable for low-income families.* Post FIT, the running costs would reduce to around **3.2** times smaller with a modest PV array and about **3** times smaller without .

The **polluting effects on the environment could be about 11 times smaller** by the use of integrated, low-energy, more self reliant system design such as the EcoSolar (see bar graph p 31). Low running costs arising from environmentally friendly systems are largely responsible, together with a sensible degree of awareness on the part of the occupants - gradually becoming more common.

The 'starter' EcoSolar house would function quite well for young couples and a significant advantage to buyers in keeping initial costs low. They would know at the time of purchase that economic improvements could be made when future funds become available and that they were 'designed in' from the start to make retrofitting easy and as economical as possible.

### Society has retained some misconceptions from the past

Most of these 'urban beliefs' have arisen as a result of past bad practices and have become engrained in our collective consciousness.

*"That 'prefabs' are inherently ugly, small and old fashioned."* The appropriate appearance of the EcoSolar house should quickly dispell these prejudices which still persist from the post-war emergency housing in the 1950s. Retrofitted conservatories, pergolas with cooling vines and southern reflectors would eventually provide a softening variety in the landscape. Smaller houses will be perceived as necessary to keep costs affordable and comfortable and the current "McMansions" will be seen as gross, selfish and unsaleable as society becomes more acutely aware of the problems now arising from global warming.

*"That solar houses are goldfish bowls, they look 'different' and lack privacy"* Granted there is more glass than in a 'normal' house, but this is the main way in which solar access can be beneficially used. The use of pergolas, vines, landscaping can soften a house's appearance without interfering with solar access. Making blocks east-west gives high degrees of privacy, so the remedy lies largely with the subdividers.

*"They are all facing the same way"* Some angular variety is functionally acceptable and desirable to provide visual variety (p 6). If we are to make good use of solar energy we *have no choice* about restricting our dominant orientation toward north. In the future this will have become the logical norm if people want to stay warm in winter and enjoy internal coolth in the hot summers *without the serious environmental disadvantages resulting from airconditioning.*

We have to *show* that with better design we can allay most of these fears and this is why it is so important for us to build a demonstration house soon on a suitable block. We will then be able to monitor its performance so that we can learn and do even better.



## A penultimate word

Global warming is a wake-up call we cannot afford to ignore.

We have been designing houses for two centuries on an incorrect assumption that the sun is our enemy rather than our friend and *we must now find better ways*. Integrating the EcoSolar house system was one way of showing that more appropriate housing design is possible - and at lower ultimate cost.

There are serious inadequacies in a housing industry that has followed tradition without understanding the underlying fundamentals of building science and the climate that govern our methods. Global warming should now be making us think smarter; finding better ways of building houses for human beings to live in and enjoy the experience without the hidden consequences to the environment.

It is very troubling that society does not seem to know when enough is enough with an industry that bends over backwards to satisfy the many 'wants'. Money seems to be the dominant measure of all aspects of living. It is not, especially in evaluating housing.

One critical aspect of the solution is that nature can play an adequate and free role in keeping us comfortable in our houses and at the same time preserve itself - and us.

The EcoSolar house is not just a product - it is an integrated *system* from which all can benefit - developers, builders, real estate agents, and of course, the final owners - the reason for building.

The recent bushfires in Victoria in 2009 should, at long last, be teaching us some fundamental lessons and it is hoped that the integrated system in this booklet might offer some answers.

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Trevor Lee, Mark Snow and others from Energy Partners generously assessed the EcoSolar's EER and Steve Wootten and others from ANZSES have encouraged me to speak out.

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The Unsung Hero Award goes, I feel, to Mick Gentleman, previously MLA of the ACT Legislative Assembly, who was responsible for introducing the Feed In Tariff legislation into the ACT. Without his determination the figures in this book would be less effective. Sadly, his electorate did not recognise his efforts and he lost his seat in the 2008 election.

*I am most grateful to you all.*

Errors and omissions? - all mine and OTD.

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The EcoSolar

Low energy system

With increasing population the time is rapidly approaching when our finite resources will become too expensive to use or eventually become unavailable. Hopefully, we will realise before it is too late that solar energy is the only **free** source of energy, warmth *and cheerfulness* that is easily available.

### Why will the housing industry not learn to use this free resource to better advantage ?

*Everything* in the EcoSolar house is practicable *now* and a high degree of self-reliance is achievable with current technology - why must we wait until economics thinks it is what the market is looking for? Global warming will inevitably devalue the role of money in favour of an urgent need for human wellbeing.

The principles embodied in the **EcoSolar** integrated concept make it an **affordable house** when considered holistically over a reasonable lifetime.

Political courage can make this possible if *true needs* are recognised *before it is too late*.



The car industries did not heed the environmental warnings and made poor commercial judgments leading to government intervention

The housing industry is going in the same direction with little regard for the consequences its decisions will have on the environment.

***Will it too expect to be rescued in a similar way?***

**The last word** really goes to the Master Builders Association in Maryborough, Queensland who erected a large hoarding on the roadside, advertising its services to the public, saying *"wouldn't it be nice if somebody listened?"*

*Yes indeed, but get a move on.*