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Affordable eco-homes

Low income environmental solutions

Summary of key findings

This is an initial report from an academic research project looking at ways we can make eco-housing more affordable. Its key findings are that:

- We need both a technical assessment of materials and methods used, and a social assessment of people's choices and decisions in order to understand eco-housing.
- There is a diverse variety of eco-housing worldwide. The definition used in this report is that an eco-building minimises resource use (in construction and life-cycle) while also providing a comfortable environment in which to live. The USA has a long-standing and established eco-building culture, whereas eco-building has only existed in Thailand in the last decade.
- We already have the technical knowhow, and many working examples, to build resilient eco-houses in Britain. However, ecological building methods remain marginalised and often misunderstood.
- Eco-building will only be adopted if it offers what people demand from a house and that they can live how they want to within it.
- The success of eco-housing is only as great as the behaviour of the people who live in it. Construction and technology cannot compensate for excessive energy use.


A hybrid ecohouse at Lama Foundation, New Mexico

- There remains a perception that building an eco-house is more costly, whereas figures for the lifecycle costs of buildings have proved that in the long term they are actually cheaper. More investment may be required upfront but it pays off in costing less to run throughout its lifetime.
- Living sustainably has been associated with forgoing (doing without) many elements of contemporary life. However, a good eco-house is actually more comfortable.
- It is not technology, or even politics, which is holding us back in building more eco-houses, it is deep rooted cultural and social conventions in how we live and what we expect houses to do for us.
- Choices of building materials are made according to complex compromises between cost, local availability, skills and expertise required, suitability for climate, ecological properties, maintenance requirements and cultural attachments to certain forms. Thus eco-materials need to satisfy many criteria before they are adopted.
- Eco-building involves more than technical changes to construction; it involves cultural shifts in how we consider our houses and homes. There are dynamic relationships between physical structures and individual behavioural practices, culture, history and place.
- There are many simple ways to make eco-housing more affordable, including:
  - ✓ Reducing the size
  - ✓ Simple design and avoiding the use of unnecessary technology
  - ✓ Designing affordability in at the start
  - ✓ Designing in modular units so that a building can be extended at a later stage
  - ✓ Internal open plan design to enable maximum flexibility
  - ✓ Using the space between buildings
  - ✓ Building collectively
  - ✓ Sharing common facilities and infrastructure
  - ✓ Sharing the cost of the land
  - ✓ Avoiding the use of experts
  - ✓ Participating in the debate about new planning regulations to ensure that eco-building is permissible.
  - ✓ Careful choice of materials
  - ✓ Less durable houses
  - ✓ Using pre-fabricated elements or existing structures
  - ✓ Avoiding a purist approach
  - ✓ Ensuring design is aesthetically pleasing
  - ✓ Using hybrid combinations of materials
- Planning favours buildings which conform to existing styles and norms and building regulations need to be negotiated.
- Eco-building is gendered in that is it perceived to be a male domain where men are presumed to be better builders, more men than women actually build and women find their ideas and contributions to eco-building are often belittled. Socially constructed notions of gender have determined that strength is the most important attribute required for building, which is not true.
- The replication of eco-build techniques worldwide has less to do with whether the build actually worked or its cost, but is influenced by the less quantifiable factors of foreign importation of ideas, the appeal of the aesthetics, open discussion of failure, a critical mass of support, assertive pioneers, and people understanding how their existing houses work.
- Further research work is needed on how people understand their houses, how eco-build approaches are replicated, post-occupancy evaluations and the cultural dimensions of eco-building.

Aims of research

This report identifies the preliminary findings from a one year (March 2010 to March 2011) research project on low cost eco-housing. The aim of the project was to understand how to encourage more affordable eco-housing in Britain by learning from examples at home and overseas.

The aims of the research were to:

~ Identify successful examples of low cost eco-housing across a variety of different environments and contexts.

~ Understand how such developments have overcome any problems they faced (such as planning, local resistance, finance, or using non-conventional materials).

~ Identify common successful strategies in creating affordable eco-homes which could be adopted in Britain.

The main focus of this work thus far has been on new builds and on small scale projects. It includes retrofitting, community and individual builds, radical and more conventional approaches. However, it does not include large-scale commercial or state-led developments.

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an eco-building minimises resource use (in construction and life-cycle) while also providing a comfortable environment in which to live

Brighton Earthship, UK

Defining eco-building

Peninsula Park Commons, Oregon, USA

The broad definition used in this report is that an eco-building minimises resource use (in construction and life-cycle) while also providing a comfortable environment in which to live. In other words, a good eco-building balances our need for comfort with ecological impact. An extremely ecological house that provides no comfort does not satisfy our human need for a home.

This can be achieved in numerous ways and there is a breadth of approaches between buildings which use technology to reduce their environmental impact and those which rely upon natural materials and a low impact lifestyle. The more natural buildings can actually have a negative carbon footprint because materials like straw actually store CO_2. Eco-building thus requires careful consideration of location, materials, resource use, toxicity, durability, reclamation potential, biodiversity, aesthetics, relation to community, and the ongoing dynamic relationships between people and their homes.

What is affordable housing?

What is affordable greatly depends on average incomes and what people expect to have to spend on a house. According to government criteria, affordable housing is defined through a formula of local income levels and local house prices. Its basic premise is that it should be low enough for those on the lowest incomes to afford. Determining what is actually affordable, however, is very difficult. Currently many people are unable to afford to buy a house, and others secure 25 years of debt to buy one.

This research starts from the premise that even borrowing three times your annual income for a house is not low cost housing (instead there are examples of eco-houses built for just £3,000). 'Cheap' housing should also not mean low quality. However, people might be prepared to pay a little more for a house which costs less to run and is good quality—increasing purchase costs to save on life-cycle costs. As such we need to continue to critically question what 'affordable' should actually mean and examine ways to create better low cost homes.

What is wrong with current housing in Britain?

High environmental impact: Housing – both in construction and use – consumes significant amounts of energy and contributes at least 25% of all carbon emissions in Britain. Of residential CO_2 emissions in a house over 50% is used for space heating and 20% for water heating. Moreover, the construction industry is responsible for one-fifth of total UK waste. Despite lots of state-led environmental housing initiatives and legislation there has been a slow update of eco-building.

Our housing is very expensive: In January 2011 the average price of a house was £163,177 (Land Registry), but the median gross annual income in Britain was £25,900 (Office for National Statistics, April 2010). This means that on average a house costs more than six times a person's salary. Despite being average figures which hide the huge disparity in incomes and house values evident across Britain, our houses are still very expensive and many simply cannot afford a house. Even if they can they are saddled with debt for on 25 years average.

It is of poor quality and not energy efficient: As many as 20% of our existing houses are not thermally efficient in that they leak heat. As a result we use a lot of expensive energy trying to heat them and many people suffer from fuel poverty (when more than 10% of a person's income is spent on fuel to heat a house). Many of our houses are in poor condition with draughts, damp and are poorly insulated.

Our houses do not make use of 'free' energy: Few of our houses make use of simple passive solar design. Traditional terrace houses are often dark and only have small windows to the south.

Poor inflexible internal design: Our houses have historically been small, but they are also restrictive internally. Few are open plan and instead have layouts which no longer suit contemporary life. More than half a million people in Britain live in overcrowded conditions.

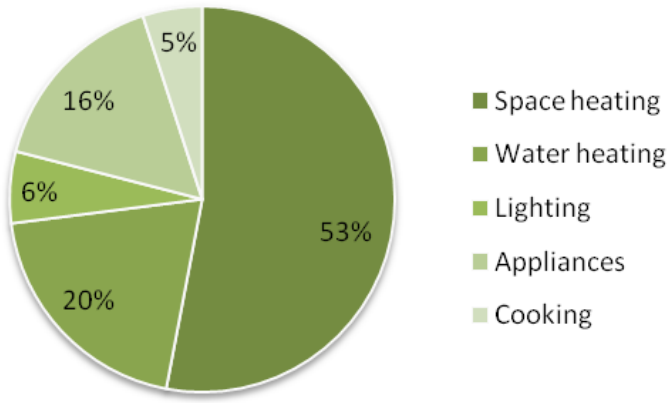
Limited possibilities for retrofitting: Although it would clearly be preferable to retrofit existing houses rather than build anew, our houses are difficult and expensive to retrofit, beyond simply adding more insulation. Full retrofitting has tended to cost 50% of the house value.

Increased pressure to provide more housing: Although our population is stable (in that it is not rapidly growing or declining) our household composition is changing and there is increased demand for more single occupancy dwellings.

Our houses are not built for climate change: The Met Office predict that temperatures will rise in Britain with increasing heatwaves and fewer frost days. At the same time we will have increased rainfall, more intensive rain showers, a rise in sea level, coastal surge events and more storms. In other words, we need to be prepared for flooding, storms and heat. If we don't, then not only will our houses suffer from damage but we will continue to increase our use of energy as more people need air conditioning to keep their houses cool – creating a vicious circle of increased emissions and then greater temperature rises.

Domestic carbon emissions 2005

(Department for Communities and Local Government, 2006)




Inside Earthship, Taos, USA

Housing contributes at least 25% of all carbon emissions in Britain. Of residential CO2 emissions in a house, over 50% is used for space heating

Why is this research necessary?

Good housing should be available to all: Eco-building is perceived as more costly than conventional building methods and thus is presumed to be a preserve of the wealthy. However, good housing is a basic fundamental need and has significant implications for health and well being. We need to understand why eco-building is perceived to cost more and how costs could be lowered.

Ecological building methods remain marginalised and often misunderstood: There is a need to understand what social, political and economic conditions encourage or hinder eco-building.

Perceived additional costs of eco-building: Ecological features are often only added to houses by contractors if costs can be recouped elsewhere in the build. Sometimes inclusion of eco-features are offset against quality elsewhere.

We need more eco-building: There is pressure from government to meet carbon reduction targets, but also from consumers concerned about rising energy prices. Building better houses is a good way to achieve this.

Economics will likely be the key driver to greater mainstream adoption of eco-housing and thus it is important to understand how we can make eco-houses cheaper and thus more desirable.

New houses are still being built: Although retrofitting is desirable, as long as we continue to build new houses we should ensure that they are eco-buildings.

More technology is not the answer: We already know the technical aspects of eco-building but not why it has not been better taken up.

"The construction industry needs radical change if we are to bring the cost of homes back to a level that ordinary people feel they can afford without being in debt all their lives" (Barbara Jones, the founder of amazonails, 2009, p.25).

Sabin Green, Portland, Oregon, USA

Method: Source of materials for this research

Kelly Hart, my guide around eco-houses at Crestone (USA), and builder Steve Kornher using his flying concrete method

Material was collected from March to October 2010. During these eight months 30 eco-homes were visited across five countries: Britain, Spain, Thailand, Argentina and the USA. The actual places are listed and mapped below and include a broad variety of environments and contexts:

- minority (for example, Lama Foundation) and majority world (Pun Pun),
- rural (Biotecture Earthships) and urban (Aldea Velatropa),
- individual dwellings (Casa Tierra) and communities (La ecoaldea del Minchal),
- small scale (Green Hills) and larger scale (Columbia Eco-village)
- Temperate, tropical, and semi-arid dry climates

These countries were chosen to provide a broad range of examples and in an attempt to look beyond the more familiar places renowned for eco-building in the search for innovative examples where cost might have been a key criteria.

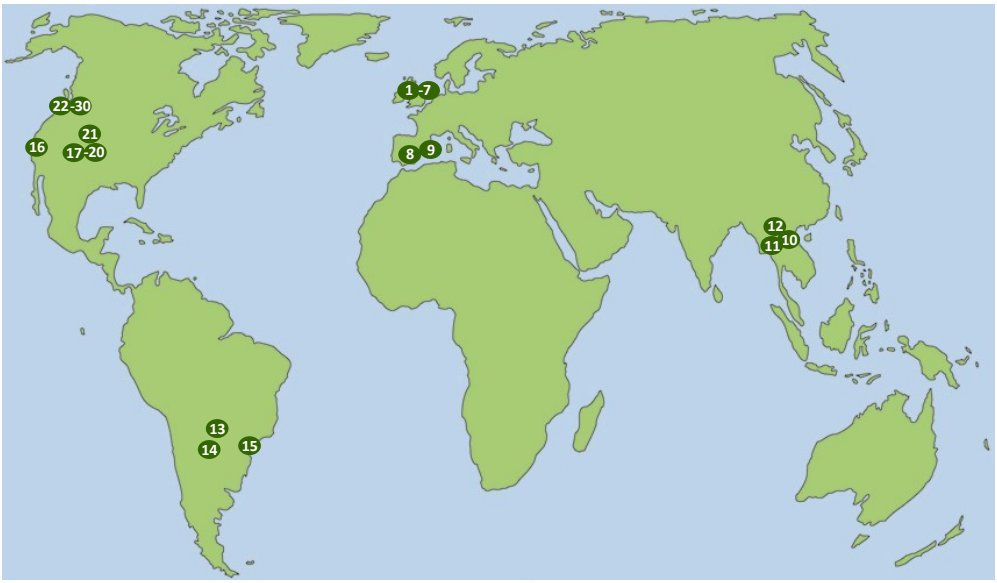
It was important to study eco-housing at this micro—scale in order to fully understand the complex choices people make about their homes, to test the reality of whether the houses actually work, and to appreciate the cultural, natural and political context in which they are built.

Wherever possible I stayed in the eco-homes themselves (on average three days, in some places a fortnight), spent time getting to know the residents and builders, and also experiencing how the houses functioned and were used.

In total I undertook 35 interviews with participants—many of them self-builders, residents and some building volunteers. Questions were asked about the materials and ecology of the buildings, their cost and how they were built, problems they encountered and how these were overcome, what the buildings were like to live in, and any response they had received from neighbours or the state. These interviews were then transcribed and analysed.

In addition extensive photographs were taken in each location, and secondary material such as reports and copies of costings were also collected. In some places I was able to participate by attending community meetings, volunteering in building, or attending a course in eco-building. Although I am neither an architect nor a builder I already had a basic knowledge of eco-building having built my own eco-house.

Thirty eco-homes were visited across five countries: Britain, Spain, Thailand, Argentina and the USA



Eco-homes visited

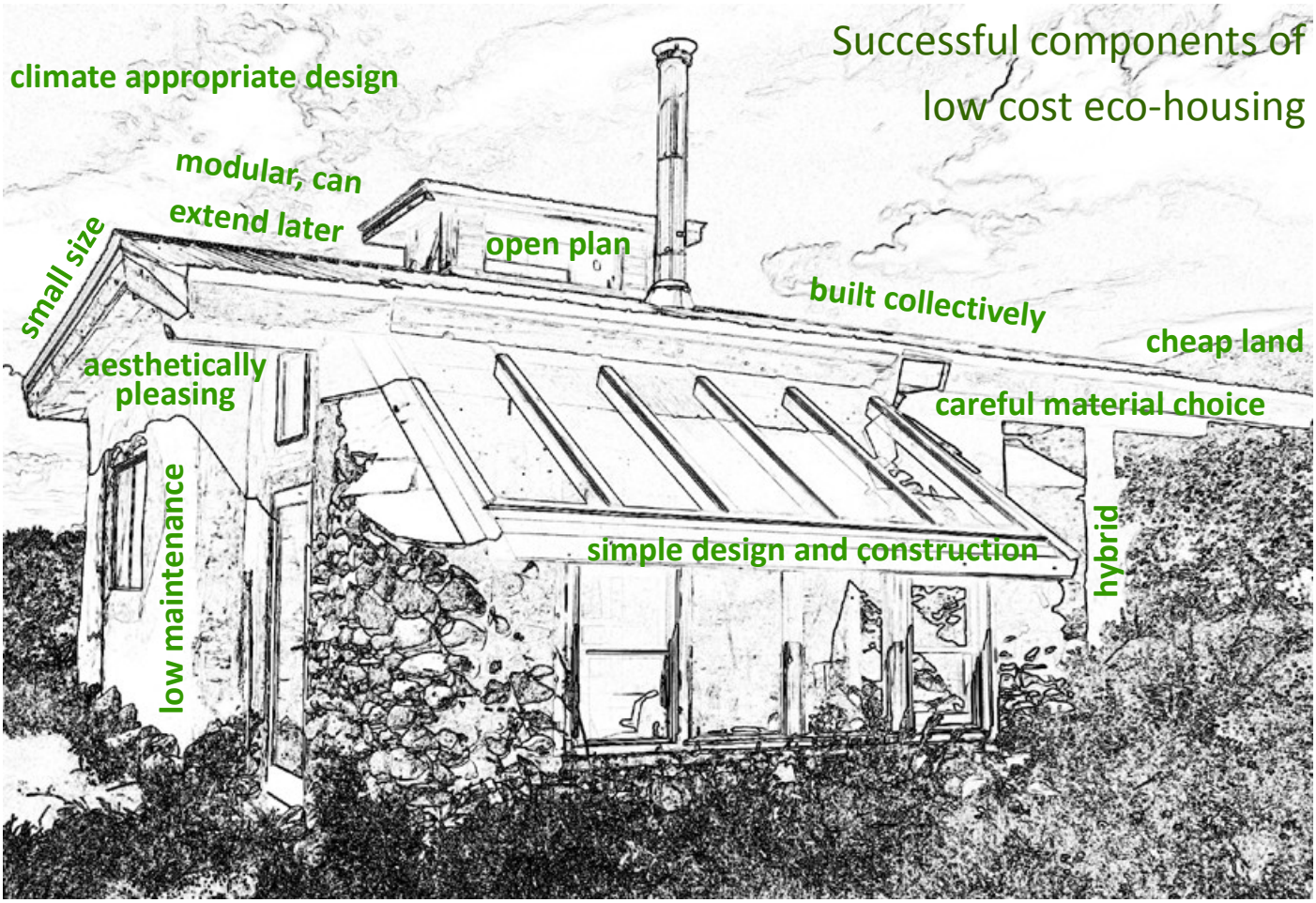
1. Straw bale council house, Lincolnshire, England
2. Lammas, Wales
3. Green Hills, Scotland
4. Newark Retrofit, Lincolnshire, England
5. Brighton Earthship, East Sussex, England
6. Tinkers Bubble, Somerset, England
7. Landmatters, Devon, England
8. La ecoaldea del Minchal, Motril, Spain
9. El valle de Sensaciones, Yator, Spain
10. Panya Project, Chiang Mai, Thailand
11. Pun Pun, Chiang Mai, Thailand
12. Amy's Earth House, Mae Hong Son, Thailand
13. Straw bale house, Yacanto, Cordoba, Argentina
14. Casa Tierra, San Luis, Argentina
15. Aldea Velatropa, Buenos Aires, Argentina
16. Los Angeles Eco Village, California, USA
17. Lama Foundation, New Mexico, USA
18. Thom Wheeler's, New Mexico, USA
19. Ampersand Learning Center, New Mexico, USA
20. Biotecture Earthships, New Mexico, USA
21. Crestone, Colorado, USA
22. Kailash Eco-village, Oregon, USA
23. Peninsula Park Commons, Oregon, USA
24. Dignity Village, Oregon, USA
25. ReBuild Center, Oregon, USA
26. Ruth's Garden Cottage, Oregon, USA
27. Sabin Green, Oregon, USA
28. People's Co-operative, Oregon, USA
29. City Repair Project, Oregon, USA
30. Columbia Eco-village, Oregon, USA

Key findings

1. How to build affordable eco-housing

More affordable eco-housing can be built by:

- Reducing the size; smaller houses are cheaper to build, cheaper to run and can sometimes avoid planning and building regulation stipulations.
- Simple design which is easy to maintain. Avoiding the use of unnecessary technology which is costly (to buy and repair) and instead making use of simple design features such as passive solar. This will reduce the lifecycle costs of a building.
- Employing accessible building methods which do not require specialist skills. Even in contract-builds this enables volunteer labour to be used.
- Designing affordability in at the start.
- Designing in modular units so that the house can be extended at a later stage.
- Internal open plan design to enable maximum flexibility.
- Using the space between buildings more; in some countries that is outdoor space, in others it is designating areas as communal and covering them. Often this involves (re)claiming 'public' areas like pavements for communal use like vegetable growing.
- Building collectively and thus reducing labour costs and time. This also enables skill sharing. Many low-cost eco-houses were built with volunteer labour—though this might be hard to scale-up. Building collectively has additional social benefits.
- This collective approach is best used to empower people to organise, participate, and decide what they want their housing to be.
- Sharing common infrastructure and facilities between neighbours. Exemplified by the co-housing model where residents retain individual privacy of space but share laundry, gardens, guest rooms, bike storage, and social spaces.
- Sharing the cost of the land and building in places where land is cheaper and less desirable.
- Avoiding the use of experts wherever possible. Whenever professionals were employed costs were significantly higher.
- Participating in the debate about new planning guidance to ensure that eco-building is made easily permissible.
- Ensuring that residents know how to live efficiently within the eco-house—minimising energy wastage and understanding the manual operation requirements.
- Careful choice of materials—balancing the need to reduce ecological impact with performance requirements, how forgiving the material is of mistakes, costs and availability.
- Less durable houses are cheaper to build and might be appropriate in some instances, but for many longevity and resilience is important in house design.
- Using pre-fabricated elements or existing structures as the basic structure and then adding additional natural materials to add insulation and adjust the aesthetics.
- Hybrid building approaches offer the flexibility to easily tailor a house to suit the climate without having to commit to just one build method. It enables the best aspects of different materials to be used for best effect.
- Avoiding a purist approach—eco-buildings can be a hybrid fusion of influences; not all aspects need to be ecological and they do not need to be perfect to work.
- Ensuring design is aesthetically pleasing—just because it is low cost does not mean it should be ugly or unappealing.
- Combining part-ownership with rental models.



Key findings cont.

2. A house is more than a shelter

In order to understand how we could encourage more low cost eco-housing we need first to know how people perceive a house. For many, a house is foremost about security, both the physical act of having somewhere safe to live and sleep, and financially as an investment. There is a deeply felt sense that our homes are our refuge. These values shape not just how households operate but how houses themselves are perceived.

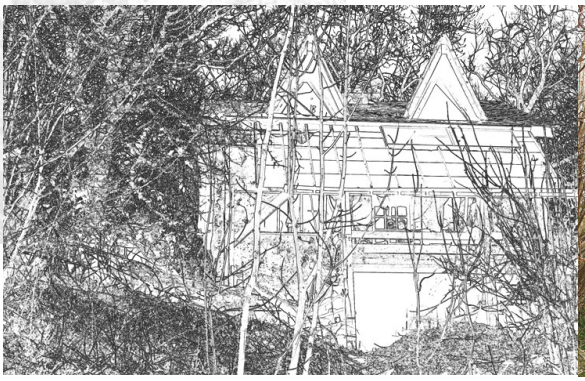
Eco-building will only be adopted if it offers what people demand from a house and that they can live how they want to within it. As such people want (eco-)houses to be:

- Aesthetically pleasing
- Comfortable and to offer convenient facilities (water, bathrooms, heat, refrigeration)
- Solid and long-lasting
- Cheap and easy to run and maintain
- Financially secure
- Spacious and flexible in function
- Private from others
- A place worthy of investing emotion, time and money

Eco-buildings can challenge these assumptions by often being smaller than conventional housing and requiring people to share space. They can be (but are often not) less robust than brick or concrete constructions or require more maintenance. They may also require more manual operation (such as wood stove heating or manual ventilation systems, rather than automated air-conditioning). Understanding what people want a house to do is key to encouraging eco-building. Moreover, understanding the diversity in what people consider 'normal' is an important part of this process.

Eco-houses need to be designed to meet needs but also to re-conceptualise what needs it is desirable to meet, and what needs are too environmentally costly. This involves challenging social conventions.

Eco-building will only be adopted if it offers what people demand from a house ... eco-building continues to be viewed as involving a loss of comfort



Green Hills, Scotland

3. Eco-housing should not require forgoing comfort

Living sustainably has been associated with forgoing (doing without) many elements of contemporary life; shifting to a simpler lifestyle, dispensing with (perceived) frivolous or environmentally damaging attachments to luxury or convenience.

Comfort, however, is central to many people's concepts of a home. People define comfort in many different and contrasting ways, but eco-building continues to be viewed as involving a loss of comfort.

The most successful examples of eco-housing negotiated the tensions between ecological impacts and the purpose and cost of comfort, privacy (which one interviewee suggests 'makes your own walls bigger'), size of dwelling, and time-saving electronic devices.

If people are asked to forgo too much, eco-housing will not appeal to the mainstream and it is particularly important that low cost eco-housing is not perceived to be too basic and somehow lacking the essentials of a home.

Living in an eco-house need not mean a spartan existence. A good eco-house is actually more comfortable—with more even internal temperatures through well balanced passive heating or plentiful hot water through solar thermal panels.

Eco-houses visited in Spain, Thailand and the USA had prioritised the importance of building good bathrooms with hot water—using solar or propane. This contrasted with examples in Britain where bathrooms were often the last to be built (and were often unfinished) and few communities had ready access to hot water. These different priorities are most likely cultural but they serve to reinforce the unhelpful perception that eco-houses are less comfortable to live in.

The women's shower block at Panya Project, Chiang Mai, Thailand

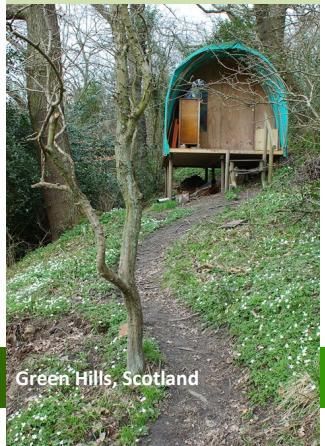
Case study: Green Hills, UK

Green Hills in Scotland is a small eco-community which makes its living from running a Community Supported Agriculture scheme where they sell weekly vegetable boxes of home-grown organic food. They have built an oak-framed straw-bale home in the woods and have recently started building an earth-sheltered house with earth-filled tyres as the back insulating wall. The straw bale cost £12,000 to build, though they do all the construction work themselves and use reclaimed materials wherever possible.

Kitchen at Green Hills

One night I had the privilege of sleeping in one of the bedrooms of the straw bale house and realised quite how warm and comfortable it was – even though we had not had the fire on for a few nights. Downstairs there is a large kitchen and dining area. There are also a few other structures on the land such as a yurt and a canvas-covered tunnel.

Green Hills is completely off-grid – generating all their electricity from photo voltaic panels and a small wind turbine. They use a compost toilet and collect rainwater.



Green Hills, Scotland

Case study: La Ecoaldea Del Minchal, Spain

Established in 2007, la ecoaldea del Minchal is creating an oasis of biodiversity and comfortable living. Every bit of land is being put to use to grow a huge variety of fruit trees – bananas, papaya, avocados and mangoes. At the bottom of the numerous olive trees Edgar has created circular plant beds in which grow lettuces and tomatoes. Brice has rows of beans, potatoes, broccoli, sprouts; the list goes on. Chickens are kept for their eggs, bee hives are in preparation, and a goat kid will eventually provide milk.


Zome at La ecoaldea del Minchal

The village is spread across a number of terraces cut into the hillside. As yet there is no communal space, though the individual plots are close enough for quick visits and sharing equipment, but far enough away to provide privacy, quiet, freedom and space for each other too. The village has an open and broad agenda – it does not have strict rules, it is about 'respecting themselves, others and nature'.

There are yurts on a couple of plots, a wooden timber frame house, and a house which is a wonderful mixture of wooden cabin, solid wall construction, traditional Spanish tile roof, eco-design and traditional Spanish appearance. The most magnificent house however is a zome. With eight straight walls, the ceiling and roof are constructed out of a spiral of diamond-shaped wooden sections which create a high airy ceiling. These are then covered in tiles of asphalt. There is something magical about the space a zome creates. The simplicity of the design means that no internal walls or poles are required to support the roof. Instead a wonderful curved ceiling, with the diamond shapes exposed, gives the feel of being somewhere magnificent – like a cathedral. It also helps the flow of air through the building and creates plenty of space for heat to rise to a fan in the roof. Inside a huge space is created – it feels a lot bigger than it looks from the outside or its actual dimensions (60 m2).

The village are also lucky in that there is tolerance in this area for a broad variety of buildings. Buildings without foundations, yurts, wooden cabins and caravans are currently ignored by the local Major.

Build costs are reduced by building collectively and using the 'free' labour of friends and family, relatively cheap land, living off-grid (no water, electricity or waste collection costs), reusing materials, few building regulation costs, and buying any new material they do need – like some wood – in large dimensions and cutting it up themselves. In addition, the houses they are building are a balance between being small-sized and yet acknowledging the importance of the sense of volume and aesthetics to a home in order to create 'a house with life'.

Living ethically and ecologically is as important here as the houses being ecological. Thus, in many ways, what constitutes a house or home is expanded to include ethical food production, water conservation, recycling water to grow bananas and sugar cane, micro-energy generation (via photovoltaic panels), and the treatment of faeces into compost. So when we consider an eco-house we have to start by expanding what we should include as necessary to a healthy functioning home, and la ecoaldea del Minchal serves as a great example in how this can be done.

"Buildings have the capacity to equalize people or segregate them"

(Lydia Doleman)

Barriers to low cost eco-housing

Barrier	Type of barrier
Resistance to greater up-front investment in housing in return for cheaper life-cycle costs	Financial
High cost of land available for building	Land ownership and planning
High cost of professionals and experts	Financial and regulatory
Lack of appropriately trained professionals	Education
Cost of adhering to planning and building regulations	Legislative
Perception that expensive technology is required to build an eco-house	Myth and education
Perceived need for privacy and opposition to sharing facilities	Social and cultural
Emphasis upon individual private construction and ownership	Social, cultural and financial
Lack of practical build skills and undervaluing of manual skills in building	Practical education
Competitive tendering process in construction which encourages poor quality building and prioritises profit	Financial


La ecoaldea del Minchal

4. Culture, history and place are important in contemporary eco-building

Eco-building involves more than technical changes to construction; it involves cultural shifts in how we consider our houses and homes. There are dynamic relationships between physical structures and individual behavioural practices, culture, history and place.

Valuing traditional styles: This involves ensuring that new house designs 'fit' with existing house structures, but also overcoming any stigma in using traditional methods. For example, although historically extensively used in western Argentina, clay adobe came to be perceived as only for those on low incomes and its replacement—bricks—as a sign of wealth and status. Contemporary eco-builders at Casa Tierra have worked with the local community to successfully revive an interest in traditional techniques. Likewise in north Thailand, where traditionally bamboo, grass or wood was used, there is an understanding that a house 'is where you need to nail it down and tie it up to make a house' (Oranratmanee, 2010), which is not considered possible with adobe, although Pun Pun are doing their best to convince people otherwise.

Bridging the old with the new: While valuing traditional styles it is also often necessary to challenge them and not become a hostage to tradition. Just because a practice has existed for decades does not make it the best choice. This process, however, has to be done carefully and often incrementally in order to gain acceptance in local communities. There is much to be learnt here from the ways in which new technologies are adopted by societies (see also Key finding 8 on page 12).

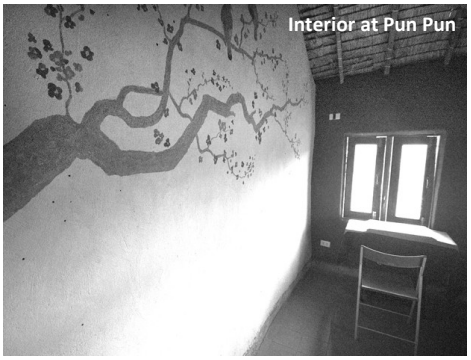
Climate appropriate building design is crucial for the success of an eco-house but relies on the builder having a detailed knowledge of the climate of a particular place. This is especially important when eco-houses are new to an area and it is tempting to import a design from elsewhere which might be unsuitable for the local climate.

Teaching through hands-on experience: Eco-housing can require social changes in how we live, which can be challenging to get people to understand. For example, understanding the subtle balance between the need for insulation and ventilation. We need insulation to reduce draughts and keep us warm but we need ventilation to keep us cool. This is best taught through hands-on experience. There are examples where houses were built without adequate ventilation.

By understanding the role that culture, history and place play in contemporary eco-building we can see that it is not (the lack of) technology, or even politics, which is holding us back in building more eco-houses—it is deep rooted cultural and social understandings of how we live and what we expect houses to do for us.

It is not technology which is holding us back in building more eco-houses, it is deep rooted cultural and social understandings of how we live and what we expect houses to do for us


Cafe at Pun Pun


Interior at Pun Pun

Case study: Pun Pun, Thailand

Pun Pun, Chiang Mai, is primarily a sustainable living centre concerned with seed saving and teaching the broad range of skills needed for sustainability, of which natural building is only part. This is motivated by a desire to be self-reliant, as many Thais once were, and thus provide the four basic needs of life – housing, medicine, clothes and food, for oneself.


House at Pun Pun

The construction at Pun Pun is big – both in the size of some of the buildings and in their number. There is a recently completed meeting hall which towers over the other buildings with its two storeys and a small third level. It is made from a combination of adobe and metal supporting beams with a concrete aggregate-fibre tiled roof. Elsewhere there is a cafe housed in the first adobe building on site which now has hot water heated by a solar cooker design adapted to heat water rather than food.

There are numerous other residential houses – all adobe of various forms and with different roofs – thatch or tile. Jon and Peggy's house is a majestic two-storey adobe double roundhouse which inside makes the most of its curved walls and views of the valley below.

This focus on adobe was triggered by Jon Jandai's visit to the earthern buildings of New Mexico. USA. The process of building has been experimental and has had to adapt to the tropical climate. After the first house on site was built, it was realised that larger roof overhangs were needed to protect the walls, and there is an ongoing fight to prevent the termites reaching the walls and wood. Thus all the walls begin on raised concrete. While it is acknowledged that a thatch roof of grasses is better suited to the climate – it enables good ventilation – and a concrete aggregate tiled roof is hotter, the tiles last considerably longer and have been used on the larger buildings where replacement every few years would be both costly and considerably time-consuming.

The shortage and high cost of teak wood, the traditional build material of the region, and the short lifespan of other natural materials often used for building here – bamboo and thatch – has left concrete and cement a clear favourite. Adobe is one of the few alternatives which can be freely, or at least cheaply, sourced locally, and learnt easily.

In addition to being a relatively easy technique to learn, Pun Pun deliberately focuses on working with groups who want to build together. They view building as a form of social change activism which can make communities more resilient and self-reliant, and ultimately more sustainable.

The defining lesson from Pun Pun is best encapsulated in their saying, 'whenever you are doing something, if it is hard, it is wrong'.

5. Building materials matter, but choices are complicated

Appropriate choice of materials is central to successful eco-building, but these choices are not always obvious or easy. Problems in choosing materials include:

- Some core building materials—like wood—might not be available locally and may be very expensive.
- New (or overseas) materials might be needed for structural strength or might be cheaper than local supplies.
- Reclaimed materials might not have good insulating properties (like the use of bricks made from plastic bags at Velatropa).
- Natural materials can require significant maintenance or not withstand the weather, thus increasing costs in time and regular replacement.
- Quality of natural materials might be unreliable and hard to determine if the builder is a novice.
- Standardised components are easier to use and replace.
- Cultural attachment to (or rejection of) particular materials.

Choices of material are also influenced by the skills available and level of expertise required. Some materials (like adobe and straw bale) are very forgiving of mistakes, others (like bamboo) are not. These factors are hard to quantify but for illustration (based on the places visited for this research) are estimated in the table below. It is clear why adobe and straw bale are popular, but also why they struggle to compete with concrete.

Overall, local materials are not always the best choice, as decisions need to be made taking into account a variety of requirements. What is clear is that natural materials often offer lower ecological impact and better thermal properties than more processed materials.


Los Angeles Eco-Village, USA

Estimation of expertise, precision, cost and time for different materials

Build method and material	Expertise necessary	Precision required	Ease of learning	Cost of materials	Time taken	Totals
Concrete	2	4	1	3	3	**13**
Adobe	2	1	1	2	8	**14**
Straw bale	5	3	2	2	3	**15**
Hybrid: straw and adobe	5	3	3	2	5	**18**
Rammed	6	3	3	3	6	**21**
Cob	5	2	2	2	10	**21**
Wood	7	8	5	8	5	**33**
Bamboo	8	9	7	6	3	**33**

Numbers out of 10, with 10 being the hardest/ most time-consuming and 1 the easiest/ quickest to do

"Affordable houses are now being built, to very high standards of thermal efficiency, without compromising on quality and while providing a beautiful, organic ambience to the house that increases well being"

(Barbara Jones, 2009)


Inside strawbale house, Crestone, USA


Carriage house, Crestone, USA


Adobe bricks at Pun Pun


House at Panya Project, Thailand

6. There is a need to negotiate planning and building regulations restrictions

Political context shapes what building types are permissible. Despite some successes in Britain, our planning system favours buildings which conform to existing styles and norms.

Planning does not simply ensure conformity of design but actively seeks to 'protect' land from development *per se*. It operates to confine house building to urban zones or places where there is existing construction. It operates under the premise that house building is by default damaging to the environment and that it is necessary to separate people from the land. Eco-housing seeks to reconnect people with their environment and to dramatically reduce the ecological impact of houses.

As such, special exception should be made for allowing eco-houses to be built on land not available to other forms of construction. There has been some success in allowing eco-building on farmland (for example, Lammas in Wales) but it is still seen as the exception, rather than best practice, or as an important way to enable low cost eco-housing.

In many countries building regulations do not exist but they can be a useful way to ensure that houses are safe. Unfortunately they are sometimes unable to account for innovative design and can enforce costly practices to ensure conformity. In the USA build codes enforce certain practices by being prescriptive in that you must do certain things. In Germany certain build types—like load-bearing strawbale— are not permitted at all. In Britain they are guidelines of what has to be achieved (such as U-values and fire resistance) but there is flexibility in how it is achieved. This is more tolerant of innovative eco-building.

However, those international places I visited without planning laws and building regulations produced successful and innovative eco-housing. The freedom to experiment was often necessary to prove new ideas work and we should consider following the USA in creating more experimental build zones. The New Mexico Sustainable Development Testing Site Act provides two acres for the trialling of new building methods. This site is deemed completely free of building regulations and planning restrictions. Such sites provide 'proof-of-concept' space which can also provide evidence for the necessary changes in building regulations and planning to enable innovative eco-building. In Britain such sites would enable more longevity and weather durability tests for novel eco-builds.

Planning and building regulations are important parameters for building, but can serve to hinder low cost eco-housing and are often used to restrict eco-housing even when they could be interpreted in more sympathetic ways. This potential flexibility in regulation and the use of land should only be for eco-building, not all development.

Appropriate choice of materials is central to successful eco-building, but these choices are not always obvious or easy

Eco-building is gendered in that is it perceived to be a male domain where men are presumed to be better builders, more men than women actually build and women find their ideas and contributions to eco-building are often belittled. Examples of women being leaders and full participants in build projects are rare (most were in the USA).

Reasons given for gender imbalance include that men are genetically stronger and that women lacked the scientific perspective necessary for building. In practice this has meant that:

- It was rarely acknowledged how much work women were doing on build sites.
- The assumptions about male skills and strengths which might not necessarily be true, are perpetuated.
- Female voices are excluded from design discussions and women's ideas about eco-building are often ignored, not acknowledged and not listened to.
- The history of women-led building (for example in Pueblos in New Mexico, USA) is often not acknowledged.

Delphine and a volunteer making a zome at La ecoaldea del Minchal, Spain

These views and exclusionary practices have important consequences. It means gender is an important marker of difference when it need not be so. There are many female eco-architects and some notable eco-builders. However, that there are not more means there is every possibility that we are excluding a wealth of knowledge and labour from eco-building. It also limits the possibility for more mainstream adoption of building.

Particular effort was put into overcoming these gender divisions in several places visited. In Argentina (perhaps ironically for a traditionally patriarchal society which still maintains much of its machismo) the Ruizes were first taught natural building by two women. They believe it is about both genders understanding and knowing their own bodies and its limitations. So building becomes about more than physical work than creative judgement, which both genders need to learn and practise. In the USA women-only build workshops are run.

Building has a lot to do with confidence and skill, but socially constructed notions of gender have determined that strength is the most important attribute required. Examining the gender divide in eco-building also raises questions about the relationship between bodies and building. The 'doing' and manual aspect of building is unfamiliar for many (not just women) and many interviewees commented on the need to relearn how to be practical and to understand the physical possibilities (and limitations) of their bodies.

Making glass bottles for Lammas

Case study: Casa Tierra, Argentina

Casa Tierra, just to the north of San Francisco del Monte de Oro, is the home of Nathalia and Diego Ruiz. It is an adobe house which curves towards the north with a living roof, a separate office and library building (Lak'a Uta, meaning earth house), and a separate wattle and daub bathroom block. The Lak'a Uta has no wood in its construction; instead it has a curved adobe roof designed by Jorge Belanko and the look of an old Moroccan building. These buildings are all incredibly aesthetically pleasing, with details of lizard designs on the wall, coloured bottles casting light inside and curved glass windows looking out on the countryside beyond. Inside, the curved spaces invite sitting and the fire place warms the room as well at the kettle. Despite not yet having a finished roof it already feels like a place to dwell peacefully.

They chose to build in clay because it was cheap, local, you can build curved walls, and it is easy (it forgives mistakes and can be easily maintained and repaired). Since building the living roof they have decided to avoid using wood as much as possible because it is very expensive and is not available locally. Similarly they rejected using straw because it is not easily available. If they chose to build adobe mainly because of cost, they have also sought to make their build affordable by using workshop participants as cheap labour: "Costs are a third materials, but two-thirds in labour" (Diego). So they have only spent AR$ 5,000 pesos (£800) on the build.

Casa Tierra, Argentina

Their house is not big because it is deliberately designed around function, not objects or action. Casa Tierra has been designed so that it is relatively easy to add rooms, which is what they have done as their family has expanded. Building has been a very collective process at Casa Tierra. Nathalia estimates that 150 people have helped build their home in some way. Nathalia and Diego learnt themselves through several workshops in Patagonia (southern Argentina) and chose adobe to build partly because it is easy to teach others; you do not need to be an expert.

Although their principle aim has simply been to provide a home for themselves, Nathalia and Diego have always sought to do this in a publically accessible way which might lead by example. They hope to make people aware that other solutions – to cold dark houses, or a dwindling supply of firewood – are available.

Refreshingly, gender has been acknowledged here as an important issue in eco-building; the Ruizes think it is important that women are specifically encouraged to realise the possibilities of building in a culture where it is considered strong and heavy work and thus a masculine activity.

The Ruizes purposefully chose to build with clay in San Francisco del Monte de Oro because of its tradition of clay building. Technically five blocks north of the town, their plot is considered *pampa* (countryside) and thus building regulations are unlikely ever to apply here. But regulations are being formulated for the town itself and they are keen to ensure that clay buildings are formally accepted, perhaps even advocated, within these new regulations.

8. Why some eco-build approaches are replicated and others are not

One of the purposes of travelling to see a variety of different eco-homes was to understand why some approaches to eco-building are easily replicated worldwide and others are ignored. The replication of eco-build techniques worldwide has less to do with whether the build actually worked or its cost, but is influenced by the less quantifiable factors , such as:

Foreigners: In Spain, Thailand and Argentina foreigners have often imported eco-build ideas. This is most effective when in collaboration with locals who are able to adjust the ideas for the appropriate climate and culture. In Thailand, foreign techniques are useful because they are respected culturally as a sign of development. In some instances it was clear that the lack of local involvement has resulted in miscomprehension, suspicion and a lack of further replication. It has also led to inappropriate use of materials.

Aesthetics are key to mainstream adoption of eco-building and yet eco-homes were often quirky in design, look and feel. We need to ensure that innovative building retains an aesthetic which 'fits' with other buildings regionally.

Talking about failure: There is a lack of open discussion about the failure of some eco-build attempts—whether that is poor choice of materials or innovative techniques which did not stand the test of time. As a result mistakes are repeated and builders demoralised. More open discussion about failure would facilitate the understanding that building is an ongoing and dynamic learning process and support those who make mistakes in continuing to build; as Greg (Panya Project) noted, 'people are afraid to make mistakes'.


Earthship, Taos, USA

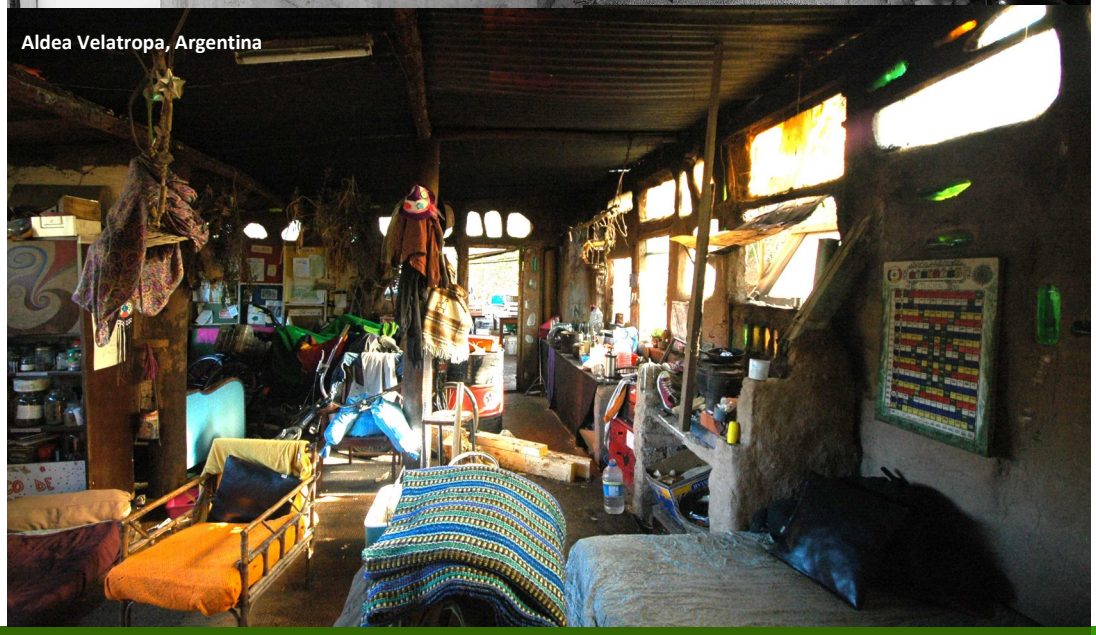
Pioneers are both inspiring and threatening and play a complex role in how eco-building ideas are spread. Their expertise can intimidate newcomers from trying their own ideas or they can be dogmatic in determining how things should be built. Yet without pioneers and risk-takers many innovative eco-houses would not exist.

Critical mass of support is crucial for encouraging people to build green and have the confidence to try it out—hence the clustering of eco-building in certain places. Where this critical mass has not been available builders have relied on international support and many commented they would not have succeeded had it not been for this support network.

Understanding how our houses work: For many the very concept of an eco-house is hard to comprehend because they do not know how their current house functions. Thus, for example, building large water storage tanks into a house design is not accepted as necessary if there is mains water. Our reliance on central systems counters people's ability to take ownership of the functions of their homes.

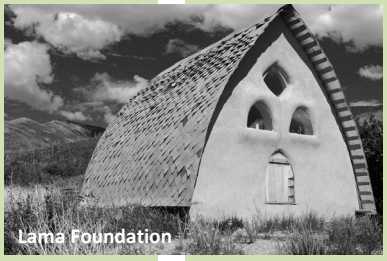
In Spain, Thailand and Argentina foreigners often imported eco-build ideas ... the lack of local involvement resulted in miscomprehension, suspicion and a lack of further replication


Ampersand Learning Center, USA


Aldea Velatropa, Argentina

Case study: Lama Foundation, USA

Clinging to the steep hillside of the Sangre de Cristo mountains north of Taos, New Mexico, the Lama Foundation has been building since 1968. Principally a spiritual centre, it has an eclectic mixture of eco-houses. These houses have changed quite radically over the years, not least because on 5th May 1996 a fire destroyed the majority of the site, leaving rather miraculously the central dome and the old wooden octagonal kitchen.


Lama Foundation

There is a log cabin, a straw-bale house, a new base for their cottage industry being made from straw-bale and adobe combined, some yurts for visitors, small vault homes, a hybrid house and many more. Over the years different visitors and residents have experimented with a variety of methods and styles – particularly hybrid approaches. This is when different methods such as straw-bale are used alongside adobe blocks or stone walls. Thus they make use of straw-bale in the north-facing walls (to keep the place warm) and adobe in a south-facing wall (because it allows a building to heat up more quickly than straw).

Use of adobe on site was originally inspired by the nearby Pueblo construction and many local Indigenous Americans came to the site in the early years to teach the newcomers how to build with earth. Many of the houses are also deliberately small, which are thus cheaper to build and easy to heat. The vaults are straw-bale with aluminium shingle roofs which hang over to the ground each side. Moreover under New Mexico building code very small buildings do not have to comply. The community setting encourages the building of small individual houses and the collective use of the large communal space. There are communal bathrooms, kitchen, library, music room, winter meeting room, and outdoor sheltered eating area. Building here is a collective process and part of a spiritual practice for many.

The main focus of the site is spirituality rather than eco-building so the co-ordination of building or the skills available is very much dependent on who happens to be around. This has created maintenance problems for the core full-time residents who are there all year because of the sheer number of buildings and the use of natural materials which require regular attention and patching. This tension between a lack of time and skills and the focus being primarily elsewhere has led to the use of concrete and stucco in recent buildings which is not very environmental. They have had at times to make compromises.

The whole community is off-grid, generating electricity through photovoltaic cells, using compost toilets, wood for heat, and water from an on-site spring (and some rainwater is collected). Water is heated in the main through a propane heater because solar capacity is limited.

There is undoubtedly something magical at the Lama Foundation, less in a spiritual sense for me personally, but something about its location and the freedom with which eco-building has been experimented. I left longing to stay and to move into my own little vault house on the mountain side.


Lama Foundation


Lama Foundation


Lama Foundation

We need both a technical assessment of materials and methods used, and a social assessment of people's choices and decisions

9. We need to research the technical alongside the social in eco-building

This research has identified the value of taking a micro-scale approach to understanding low cost eco-building. By taking the time to study individual homes and talk in-depth to builders and residents, the complexity of building eco-houses and the range of tensions and compromises negotiated become clear.

By taking this methodological approach it is evident that several factors must be included in research into eco-building:

- We need both a technical assessment of materials and methods used, and a social assessment of people's choices and decisions. Thus an interdisciplinary approach is necessary but is not always easy to achieve.
- The cultural context in which building occurs is important as this shapes many choices made as to materials, design and function. It also influences the potential for replication of eco-building. For example, in many cultures eco-building is perceived to take too long to satisfy the desire to build quickly.
- To know how people perceive how their current houses work and their functions, in order to comprehend how eco-building fits into existing notions of home.
- Usability tests as to whether claims made about performance of buildings are accurate. This can be done scientifically or through temporary occupation of the building.
- Multiple opinions on each build are necessary to confirm particular details and test claims made.
- Participation in the process of building offers a unique research opportunity to learn about issues which interviewees might not be able to articulate or reflect upon.

Successful examples of low cost eco-housing

Place	**Council house Waddington** **ENGLAND**
Location	Lincolnshire, UK
Made from	Straw bales and lime plaster
Extra detail	Built by North Kesteven District Council and amazonails as council houses – the first in Britain, 2 three bedroom homes
Contact info	http://www.n-kesteven.gov.uk/section.asp?catId=1521

Place	**Lammas** **WALES**
Location	Pembrokeshire, Wales, UK
Name of house	Jasmine and Simon's house
Made from	Earth sheltered roundhouse built using roundwood, earth and stone from the land, straw bales and reclaimed materials. Wood frame
How find	Glandwr village
Extra detail	New 9 family eco-community
Contact info	http://www.lammas.org.uk/

Place	**Green Hills** **SCOTLAND**
Location	Scotland, UK
Made from	Straw bale
Extra detail	A small eco-community building everything themselves with very little income
Contact info	http://naturalbuild.wordpress.com/2010/04/19/green-hills-scotland/

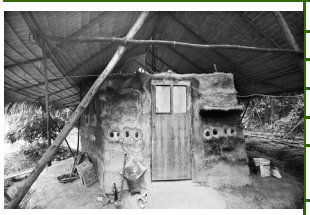
Place	**Brighton Earthship** **ENGLAND**
Location	Brighton, East Sussex, UK
Made from	Tyres and earth
How find	Stanmer Park, north Brighton
Extra detail	Built as a community centre and now runs training courses on how to build earthships
Contact info	http://www.lowcarbon.co.uk/earthship-brighton

Place	**Tinkers Bubble** **ENGLAND**
Location	Somerset, UK
Name of house	Charlotte's house
Made from	Straw bale, wood, mud, roundwood
How find	Little Norton, Stoke-sub-Hamdon, Somerset, TA14 6TE, UK
Extra detail	Long standing eco-community. Established in 1994
Contact info	http://naturalbuild.wordpress.com/2010/05/10/tinkers-bubble-somerset/, 01935 881975

Place	**Landmatters** **ENGLAND**
Location	Devon, UK
Name of house	Charlotte's Wooden Roundhouse
Made from	Wood
Extra detail	A permaculture intentional community
Contact info	http://www.landmatters.org.uk/

Place	**La ecoaldea del Minchal** **SPAIN**
Location	Molvizar, Andalucia, Spain
Name of house	Edgar and Mercedes' house
Made from	Wooden zome
How find	http://naturalbuild.wordpress.com/2010/06/18/how-to-find-la-ecoaldea-del-minchal-spain/
Extra detail	A new eco-community, this house built by Edgar and Brice
Contact info	http://naturalbuild.wordpress.com/2010/06/11/la-ecoaldea-del-minchal-andulacia-spain/ and http://laecoaldeadelminchal.webs.com/

Place	**El valle de Sensaciones** **SPAIN**
Location	Yátor in the Alpujarras, Spain
Name of house	Communal kitchen house
Made from	Adobe and handcrafted wooden windows and doors
How find	http://naturalbuild.wordpress.com/2010/06/23/how-to-find-el-valle-de-sensaciones-spain/
Extra detail	Built by Achim who owns and runs the project
Contact info	http://www.sensaciones.de/



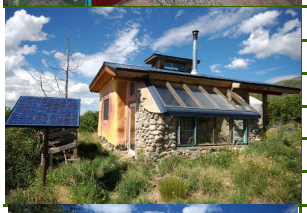
Place	**Panya Project** **THAILAND**
Location	Mae Taeng, Chiang Mai, northern Thailand
Name of house	Adobe house with grass roof
Made from	Grass, wood, and adobe
How find	http://naturalbuild.wordpress.com/2010/07/12/how-to-find-panya-project-and-pun-pun-thailand/
Extra detail	Established in 2004 it has become a site for experimentation and education in permaculture and natural building.
Contact info	http://www.panyaproject.org/

Place	**El Trébol del Monte** **ARGENTINA**
Location	Yacanto, Cordoba, Argentina
Made from	Straw bale and wooden beams
Extra detail	Built by Timothy Cullen as a single self-build project
Contact info	http://www.naturalhomes.org/straw-argentina-yacanto.htm

Place	**Fundacion Yanantin** **ARGENTINA**
Location	San Francisco del Monte de Oro, San Luis, Argentina
Name of house	Casa Tierra
Made from	Adobe
Extra detail	Built by Nathalia and Diego Ruiz
Contact info	http://www.casatierra.org.ar/

Place	**Los Angeles Eco Village** **USA**
Location	Los Angeles, California, USA
Made from	Eco-retrofit of existing brick apartment blocks
How find	117 Bimini Place, Los Angeles, CA 9004
Extra detail	Established in 1996 it is a long running and permanent fixture which not only houses thirty or so people but acts as a central hub for many green activities and campaigns in the city
Contact info	http://www.laecovillage.org/

Place	**Earthships Biotecture** **USA**
Location	Near Taos, New Mexico, USA
Made from	Car tyres and earth
Extra detail	Designed by Mike Reynolds
Contact info	http://earthship.com/



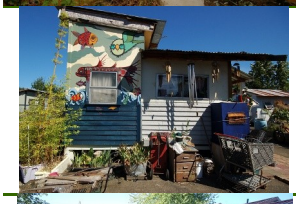
Place	**Lama Foundation** **USA**
Location	San Cristobal, New Mexico, USA
Name of house	The bluebird
Made from	Straw bale, some cob and some stonework, lime plaster
Extra detail	A spiritual intentional community with lots of different types of eco-housing
Contact info	http://lamafoundation.org/

Place	**Eco-buildings at Crestone** **USA**
Location	Crestone town, Colorado, USA
Name of house	Earthbag house built by Kelly Hart
Made from	Earthbags filled with volcanic ash
Contact info	http://www.greenhomebuilding.com/

Place	**Ampersand Learning Center** **USA**
Location	Near Cerrillos, New Mexico, USA
Made from	Straw, earthbags, and adobe
Extra detail	Built by Amanda and Andy Bramble
Contact info	http://www.ampersandproject.org/

Place	**Kailash Eco-village** **USA**
Location	SE Portland, Oregon, USA
Made from	Existing 1959 apartment building which has been eco-retrofitted
Extra detail	Owned and run by Maitri and Ole Ersson
Contact info	http://www.kailashecovillage.com/

Place	**Peninsula Park Commons** **USA**
Location	6325 N. Albina Ave, Portland, Oregon
Name of house	This is one of the newly built houses, next to the original retrofitted buildings
Made from	Wood, reslavaged windows, low energy use
Extra detail	Half retrofit of existing buildings, half new build, runs as co-housing
Contact info	http://www.penparkcommons.org/



Place	**Dignity Village** **USA**
Location	NE Portland, off NE Sunderland Avenue, Oregon, USA
Made from	All sorts of scrap reclaimed materials – wood, straw, adobe, metal
Extra detail	This site has been built and run by homeless people to give them free housing.
Contact info	http://www.dignityvillage.org/

Place	**Columbia Eco-village** **USA**
Location	4647 NE Killingsworth St, Portland, Oregon, USA
Made from	Eco-retrofit of existing apartment buildings
Extra detail	This is a new co-housing project
Contact info	http://columbiaecovillage.org/

Recommendations to encourage affordable eco-housing in Britain

1. Build more publically accessible examples of low cost eco-building. Although there are already many examples there is a need to publicise and document them better. Without access to examples it is hard for people to understand the value and benefits of eco-housing.
2. Adopt a myth busting approach to some of the perceived barriers to low cost eco-housing. Many myths contribute to a perceived lack of demand for eco-homes.
3. Enable more use of planning special exceptions for eco-building in areas where other building is not permitted. Create greater flexibility in building regulations for eco-building innovations.
4. Create experimental build zones whereby 'proof-of-concept' tests can be done outside of building regulations and planning.
5. Avoid reliance on technological solutions—they are costly and not as efficient as good basic design.
6. Always include neighbours and local community in any build; this helps with understanding and replication.
7. Provide more skills training and on-hands experience with different materials. This is especially necessary for practical build skills. Manual skills also need to be more clearly valued.
8. Teach ecological design to all architects and encourage collaboration between ecological architects and affordable housing programmes.
9. Encourage construction professionals to understand and value alternative methods, to be flexible in the way they interpret building regulations and to be less risk-adverse.
10. Offer more financial incentives to build eco-houses. Currently all incentives are targeted towards technology, not simple and good design. Likewise ensure guidance on good design is freely available.
11. Fund research into (long term) testing of alternative construction methods and materials, and conduct post-occupancy evaluation (particularly of energy consumption) across a diverse set of residents.
12. Encourage open accounting and partnership approaches in building rather than competitive tendering. The latter results in quickly built but poor quality housing.

University of Leicester

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All photographs were take by Jenny Pickerill

Useful organisations

amazonails
www.amazonails.org.org

Building Research Establishment (BRE)
www.bre.co.uk

Builders Without Borders
www.builderswithourborders.org

Centre for Alternative Technology
www.cat.org.uk

The Development Center for Appropriate Technology
www.dcat.net

Ecological Building Network
www.ecobuildnetwork.org

The Green Register
www.greenregister.org.uk

Global Ecovillage Network
http://gen.ecovillage.org

Habitat for Humanity
www.habitatforhumanity.org.uk

Natural Building Network
www.nbnetwork.org

Small House Society
www.resourcesforlife.com/small-house-society

The Sustainable Building Association
www.aecb.net

Women and Manual Trades (WAMT)
www.wamt.org

UK Green Building Council
www.ukgbc.org