David Thorpe is a founder/patron of the One Planet Council, a lecturer in One Planet Development at the University of Wales Trinity St David, a member of Calon Cymru Network, and the author of *Passive Solar Architecture Pocket Reference* (ISES/Routledge, 2017), *Solar Energy Pocket Reference* (ISES/Routledge, 2017), *Best Practices and Case Studies for Industrial Energy Efficiency Improvement* (with Oung, K. and Fawkes, S. UNIDO, 2016), *The One Planet Life* (Routledge, 2015), *Earthscan Expert Guide to Energy Management in Buildings* (Earthscan, 2013, *Earthscan Expert Guide to Energy Management in Industry* (Earthscan, 2013), *Earthscan Expert Guide to Solar Technology* (Earthscan, 2011) and *Earthscan Expert Guide to Sustainable Home Refurbishment* (Earthscan, 2010) amongst other titles.

***Each of the consultation questions is answered briefly, followed by further information in six appendices: 4 exceptional existing case studies, a proposal for a route to achieve 'one planet' towns and cities, and some evidence for a definition of 'zero carbon' buildings. References are either in footnotes or the above books.***

- **1. What role can housing can play in Wales' low carbon transition, including the potential positive impacts on greenhouse gas emissions?**
    1. The main challenge for housing is to improve the performance of existing housing. Housing is responsible for 27% of Wales' carbon emissions and houses last over 100 years.
    2. The total life cycle impact of the homes needs to be included in the assessment: design, materials sourcing, construction, in use phase, and deconstruction.

**2. The development and availability of technology needed for highly energy efficient housing;**

1. We already have the technology we need. There should not be an over-reliance on technology to achieve results. Instead results should be achieved by excellent design that is aimed at reducing overall life cycle impacts, which include embodied carbon.
2. Construction materials whether in retrofit or new build play an important part in carbon emissions. Some materials have far higher embodied carbon than others (see Appendix 6). Some materials have negative embodied carbon. These are cellulose products, which should therefore be favoured by Building Regulations (e.g. timber products, Warmcel cellulose insulation, straw bale, wool). These 'lock up' atmospheric carbon in buildings for the lifetime of the product, whereas plastic products (e.g. EPS, PIR, SIPs), being based on fossil fuels, have *caused* carbon emissions in their production cycle and are harder to dispose of end-of-life.
3. Cellulose products, being hygroscopic, also make for breathable buildings whereas plastic products do not. This has an implication for damp management.
4. Achieving Passivhaus Standard (or nearly passive house) has now about the same design and build cost as conventional build, and is a verifiable and absolute standard. It should therefore be mandated by Building Regulations. 'Almost Passivhaus' can sometimes be achieved at a much lower relative cost, without the use of mechanical ventilation with heat recovery.
5. Passivaus is not dependent on a building facing south, unlike passive solar design. But the Solcer House is dependent on being south facing for energy generation. I question the overall life cycle impact of this house and its replicability.
6. Affordability is a significant need in Welsh housing. The Solcer House is not cheap. But, for example, the Pentre Solar design (see Appendix 1) is affordable and made from cellulose and local materials (timber frame plus Warmcel). I favour this more low tech, affordable, near-Passivhaus approach.

7. It is not necessary for every building to generate electricity. In fact it is more cost-effective from the point of view of balance-of-system elements of an electricity supply system for generation to be done at local scale, using a multiplicity of renewable energy sources, including solar pv, solar thermal, wind, heat pumps.
8. We should not use biomass burning as this causes emissions of greenhouse gases and particulates with health impacts. Biomass should instead be sequestered (see point2.2.)
9. A building's form factor affects its energy performance (this is the ratio of exposed, heat-losing, surface area to volume). Therefore apartment blocks and terraces should be preferred over bungalows. Increasing housing density also saves energy and reduces the cost of service provision.

**3. What changes are needed to ensure that existing housing stock is as energy efficient as it can be?**

1. Retrofit strategies should take advantage of triggers - upon resale and when other work is being done there is an opportunity for a whole house retrofit to the best available standard at reasonable cost, approaching Passivhaus as far as practical.
2. Remembering it is generally cheaper to invest in energy efficiency than energy generation.
3. Retrofits should be mandatory at these points, supported by standards and enforcement.
4. A market needs to be created for investors in energy efficiency, as there is for energy generation plant. This is being supported by the Investor Confidence Project[1].
5. Councils have a role to play to encourage street-by-street retrofits.

**4. Whether it is possible and feasible to deliver low carbon, energy positive, affordable housing at scale in Wales and, if so, how this can be achieved**;

1. Land prices are a major factor in affordability. Planning system needs changing to prevent land banking and reduce land costs.
2. Smaller, social housing developers should be favoured by procurement strategies with a goal of ending the dominance or even presence in the marker of large commercial home builders focused mainly on profit.
3. This approach can be based on the German Baugruppen model. See attached case study.
4. If councils run competitions for developers where the criteria for success are social and environmental, and profits limited to 15%, as in the Baugruppen model, this creates a market for that type of developer. Many architects want to build this type of housing but do not get a chance as the present system does not favour their approach.
5. Charities, housing co-ops, community land trusts and other types of social enterprises should be put in charge of developing all new housing.

**5. What are the barriers to delivering transformative change in house building in Wales?**

1. The dominance of big developers - they should be helped to transform to 'one planet' developers by creating a new market which includes social and environmental criteria and curbs their profit. Social enterprise developers such as CLTs should be favoured.
2. The planning system - it should define the route to One Planet Wales.
3. We need a programme of training to upskill the workforce, including in procurement and planning.

**6. What is the role of Ofgem and the national grid in enabling grid evolution to accommodate new types of housing, and what are the challenges presented by decentralised energy supply?**

1. A decentralised supply needs to provide direct benefits for the local community.
2. Energy Service Companies should ideally follow a community interest company or mutual model (cf Dwr Cymru).

[1] http://europe.eeperformance.org/

3. Opportunities exist at neighbourhood scale for small energy service companies to provide local employment to provide operations and maintenance services for energy efficiency and energy generation.

**7. Whether Wales has the requisite skills to facilitate and enable change in the housing sector;**

1. It does not. Builders need to be accredited with the necessary skills to provide passive house level construction services, which hardly exist at present. Currently anyone can set themselves up as a builder and also offer retrofit services. This is not a situation that can guarantee reliable results. Accreditation and verification of performance are required.

**8. What changes are needed to Building Regulations in Wales to accelerate progress towards 'near zero' energy standards and beyond?**

1. Passivhaus Standard (or nearly passive house) should be mandated by Building Regulations.
2. Part L compliance needs to be enforced just as health and safety regulations are.
3. The use of cellulose-based products should be favoured by Building Regulations because these products (e.g. timber products, Warmcel cellulose insulation, straw bale, wool) lock up atmospheric carbon in buildings for the lifetime of the product, whereas plastic products (e.g. EPS, PIR, SIPs), being based on fossil fuels, have *caused* carbon emissions in their production.
4. There should not be an over-reliance on technology to achieve results. Instead results should be achieved by excellent design that is aimed at reducing overall life cycle impacts which include embodied carbon.
5. For rental properties the Minimum Energy Efficiency Standards (MEES) should aim to require a property to have an Energy Performance Certificate (EPC) of at least 'B' by 2025 in order to be rented as a residential property, or renewed to existing tenants. Properties below this rating should then be regarded as 'sub-standard' and non-compliance with the MEES could lead to civil penalties for landlords.

**9. How communities can be planned and shaped to be more energy efficient and low carbon (including examples of good practice in Wales and further afield).**

1. The location of the housing is important: housing located away from public transport, employment, and services such as schools, shops, community centres and entertainment will result in greater emissions from transport. New housing developments should promote a sense of place and community and be human scale. Planning policy should support this.
2. Towns and cities should be encouraged to declare intentions to, and set goals for, transforming into 'one planet' towns and cities. PPW signifies an intention for all development to reduce its ecological footprint. TAN6 allows for one planet development anywhere in towns, cities or edge of settlement, but no guidance currently exists for towns. Appendix 5 shows how this might work.
3. Ribbon development, where it exists, can be transformed into 'one planet' development by encouraging, with planning guidance based on TAN6, the use of the land directly behind the housing for more intensive land-based employment aimed at providing goods and services.

## Appendix 1 Case study: Pentre Solar, west Wales

**Useful lessons: Pentre Solar is a demonstration development of carbon-neutral, affordable homes built by local contractors from locally sourced cellulose-based materials which lock up carbon in the buildings.**

Dr Glen Peters, CEO of Western Solar, has an ambition for his company to supply thousands of homes and to work with housing associations and local authorities to provide social housing. Peters estimates the build cost at around £120 per square foot. This has led him to set a rental cost of the two-bedroom houses of £480 per month, a level in line with the local 106 planning condition of no more than 80% of local market rents. The three bedroomed houses are set at £620 per month. For the developer, this gives a 3.5-4% ROI.

*Right: Glen Peters standing outside one of the two-bedroomed semi-detached houses.*

*Above: The South-facing front of a three bedroomed house with plenty of glazing to capture the sun's heat. Inside it falls onto a black, melamine-covered concrete floor to absorb the heat.*

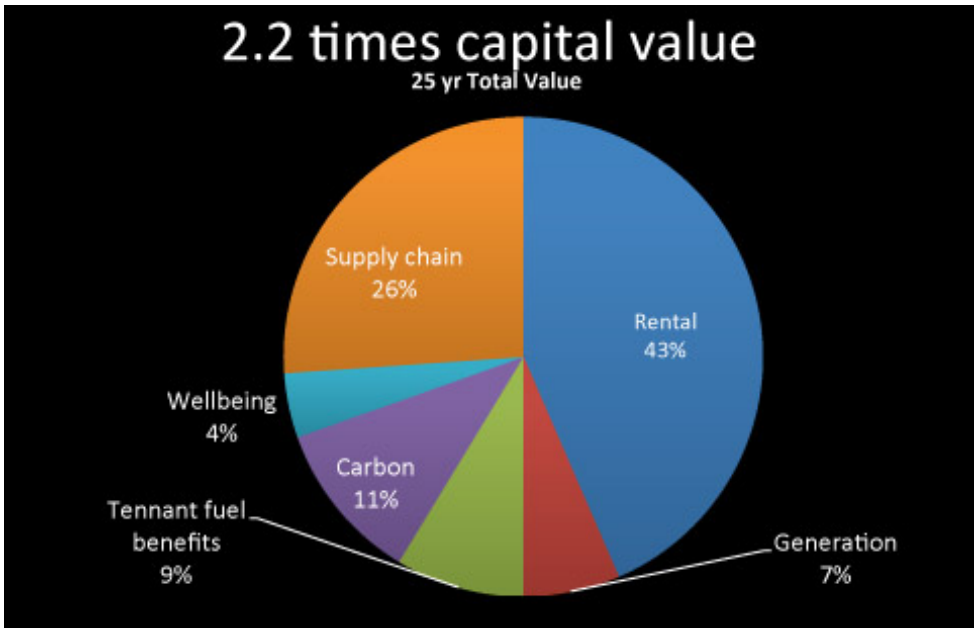
Left: *The North-facing rear of a three bedroomed house. The homes are clad in local larch. This is projected to last at least 25 years before it needs replacing. Much care in the detailing of the design should extend the cladding life well beyond this point.*

*Right: A pair of two-bedroomed semi-detached houses. All the homes have solar roofs.*

The first tenants moved into Pentre Solar, Glanrhyd, 3.5 miles from Cardigan, in July 2017.

## Local materials and labour

Costs have been kept low and as much as possible of the houses manufactured locally from local materials and labour. In total 80% of the building is manufactured locally out of local timber and 40% – the airtight frames – are manufactured in a nearby factory – a converted cowshed – to be assembled on site.  Peters reckons that this means that the multiplier effect of the benefit to the local community for every £1000 invested is £2200, a factor of 2.2.




The homes' design builds upon the developer's experience of a prototype house, Ty Solar (Ty is Welsh for House so the name means Solar House in English), in West Wales. Ty Solar was constructed in 2010 using the profit from Peters' solar farm, the first in Wales.  It cost about £75,000 and was built with a £47,000 grant from the Sustainable Development Fund.

The unit costs of the Glanrhyd houses, built on the site of a now-demolished garage, were higher mainly because of the land reclamation, provision of services and unusual weather related costs and complying with planning conditions  in an area of outstanding natural beauty.

The three-bed homes occupy 100 square metres, the two-bed ones slightly less, but still feel spacious.

The company is focussed on providing social housing as Peters believes there could be a reasonable business to create good quality affordable housing as none of the large developers seem to interested in doing so. Whilst it is economic and technically feasible to build these homes, politically Peters' route has not been easy. "Politicians have been unduly influenced by volume building companies, and while they love the houses it has been difficult to persuade local authorities and housing associations of the benefit of backing this design despite the fact that occupants have virtually zero energy bills. The Key Performance Indicators imposed on Housing Associations are unduly skewed towards capital costs rather than tenant and community welfare," he says.

## Zero energy bills

The timber frame houses are built according to passive house principles, although not validated as such because of the cost vs. benefit of doing so. Each monopitch roof sports 8kW of integrated photovoltaic panels. Over a year these generate surplus energy, providing an income from a feed-in

tariff as well as giving the occupants free electricity. Total energy demand is about 12% of a conventionally built home. Beneath the solar panels is a galvanised steel sheet that laps over the timber frame.

They sit on a concrete slab unlike from the prototype, which was constructed using the box beam method with a suspended timber floor. Peters says that concrete is more durable, with more thermal mass, although with a greater carbon footprint, and has a lower maintenance requirement.

The windows are double, not triple glazed to keep costs low as Peters believes that the incremental benefit of the extra pane of glazing is cancelled by the cost in the mild local climate. (This supposition is supported by a post-occupancy evaluation of the effectiveness of the Beddington Zero Energy Development in south London (BedZED).)

The insulation is all 27cm of recycled newsprint pumped into the cavity. This type of eco-insulation is in general the most economic and ecological. The paint is clay-based – breathable and with no off-gassing. Although more expensive per litre, it requires fewer coats on bare plaster.

The houses all come fitted out with the most efficient washing machine, condenser drier, kitchen, water-saving bathroom with occupancy sensors in areas such as toilets, Sky connection, Wi-Fi and an outside socket for charging an electric vehicle. There are LED lights throughout.

All of these relatively spacious homes are provided with the most energy-efficient appliances and attention to detail.

## Communal electric car

The occupants of the estate have been provided with a Nissan Leaf electric car to use collectively, charged by the solar panels on the roofs. The South-facing homes are generous in their space, their form determined by the maximum depth allowed by the passive heating.

## Energy storage

The rest of the heating is provided in a surprising manner, using the best of old technology with new: solar electricity and storage heaters. Storage heaters contain thermally massive blocks which are heated up by an element. They then release that heat gradually over many subsequent hours.

This form of energy storage was introduced to British homes in the 1960s and '70s on a special tariff called Economy 7. Since nuclear power stations could not be switched off unlike other forms of electricity generation, these tariffs allowed people to use nuclear electricity at night – at a lower rate when national demand was low – to charge the storage heaters.

The problem was that by the time the heat was needed, the following evening, they were often too cool and many people subsequently removed them and installed central heating instead. Here, the idea is to let the storage heaters be heated up during the day by the solar panels on the roof, meaning that they are able to provide adequate heating through the evening and night provided that there has been average sunshine (50% of a June summer day) during the day.

This may not be the case in the depths of winter and so the homes are also grid-connected. They export surplus energy when there is some – after the electric car and storage heaters have been topped up – and purchase it when not enough has been generated.

"Storage heaters are incredibly cheap," says Peters, "and a well proven technology. Whereas the storage we had to start with in the prototype house – lithium ion batteries – were designated a fire risk and we had them taken out. They are also much more expensive – a couple of hundred rather than thousands of pounds."

The prototype house has been monitored and has well exceeded the predicted generation capacity, providing twice the electricity used over the year.

## Appendix 2: The Baugruppen model of development

**<u>Useful lessons</u>: the involvement of residents in the design of their neighbourhood and housing, which fosters community cohesion; the zero profit housing model; support of local authorities; affordable housing; the use of non-financial criteria in selecting builders to work with.**

Baugruppen means “group build” in German. The model originated in Germany. In the last decade, Germany has seen over 1800 Baugruppen developments. With their increasing popularity, the city of Hamburg is now setting aside 25% of its land for Baugruppen developments. Other countries are fast copying this model because of its success in solving multiple social and housing problems.

# What is it?

A process that enables individuals to group together to become their own designer and developer. They deliver custom-built and individually designed homes and communities. The future residents design and develop the community, according to their long term needs, rather than investors doing it, who prioritise their own economic benefits. The process of working together in advance of construction helps to create a sense of community, as members collaborate on identifying their own needs and designing their homes and shared spaces.

# How does it work?

Baugruppen is a "zero profit" housing model that has the potential to deliver higher quality, more sustainable homes, designed for long-term needs rather than profit. Traditional developer building costs include:

- Land 15-20%
- Construction 45-50%
- Finance and Holding 8-10%
- Fees and Marketing 6-8%
- Developer Profit 15-20%

With Baugruppen there is no developer, so no marketing costs or developer profits. This allows for up to 30% savings. This makes it possible to develop higher quality accommodation with the same or a smaller budget. This was proven in a study of six self-build projects in southern England, which all resulted in significant financial benefits.

Local authorities can support individual baugruppen projects by offering access to cheap land, and this model can be applied anywhere, regardless of financial scope of a local authority. The latest research shows that if local governments want to solve their housing crises they must take a more proactive, participatory role and engage not just in house building, but community building.

<u>Three examples:</u>

# So.vie.so

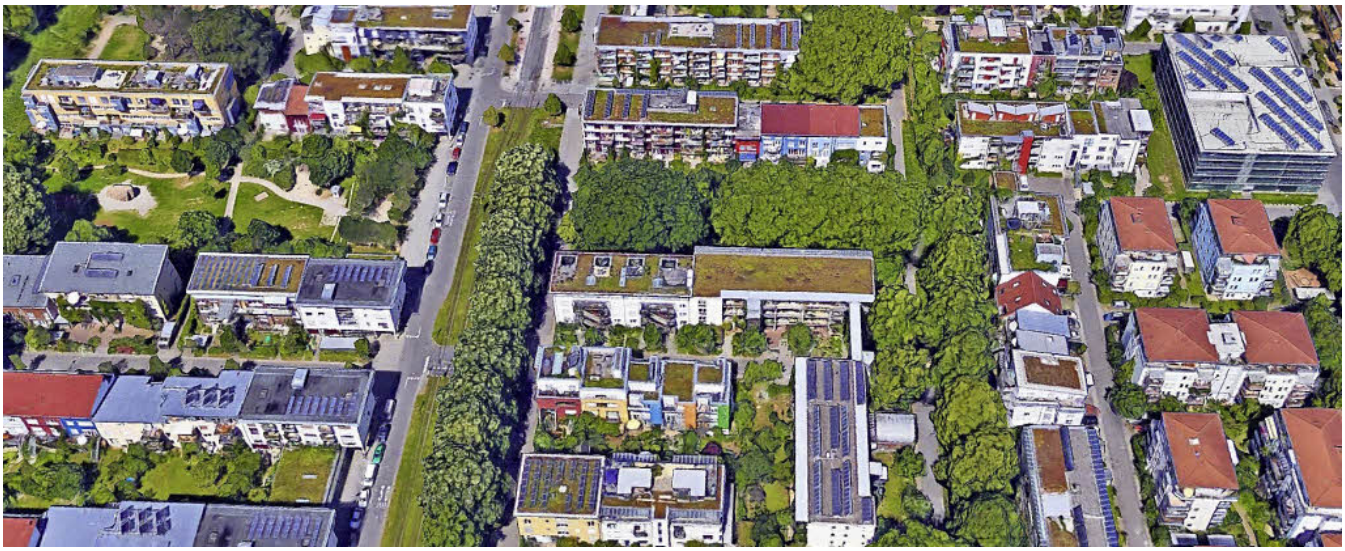
The So.vie.so development in Vienna consists of 111 subsidised rented apartments, communal facilities of different size, shared greenspace with neighbouring

housing schemes and spaces for small businesses, on former railway land.

A housing co-op was formed for the residents to support the planning process and on-going management. In pre-build stage residents collaborate on planning their communal spaces. Different task groups are formed. Over a year of planning the facilitators provided by the housing trust gradually move away, allowing the now-experienced group members to take over tasks such as maintaining the communication processes, organising and holding regular meetings to decide upon the allocation and use of funds or continuous activities.

Finance: To join a scheme there is an initial, one-off deposit which goes towards the land and construction costs, usually between 15,000 and 30,000 Euros for a medium sized to large flat. The higher the initial contribution, the lower the monthly rent. At the end of the tenancy, this deposit is paid back. Some co-op schemes offer buy-out options to tenants. High earners are discouraged, with a ceiling for tenant salaries. The rents are fixed for 10 years and existing rent contracts can be extended beyond then.

## Vauban



In the city of Freiburg, Germany, the city council made a conscience decision that developmental rights in the Vauban district (affordable and sustainable housing) would be preferentially given to baugruppen rather than developers. The city and working group felt that prioritizing affordability (through collaboratively-built projects), would make it attractive and feasible financially for families to live there.

Rather than bidding wars, lots were awarded to parties meeting sustainability criteria. These included: social diversity, most ecologically sound, etc. The city council provided facilitators to help a baugruppe procure legal and financial

representation for their project.  Verifiability of ecological criteria is achieved using the GEMIS model (Global Emissions Model for integrated Systems), a public domain life-cycle and material flow analysis model and database.

Population density: 5,300 inhabitants over 38 ha., but it has an open feel.

## Vienna Wild Garden Housing Project

Vienna Wild Garden Housing Project is for "people who want to shape their living and living situation" - single, family or senior. As is typical, future inhabitants get to know each other in the process of participatory planning to develop and design, together with a planning team, a cross-generational, mixed community.

Planning team consists of:

- single architecture (architecture)
- reality lab (building management)
- YEWO (landscape architecture)
- Schwarzatal (developer)

Included: A common garden, meadow and wild hedge.

Transport: Cars remain at the edge of the neighborhood and park in collective garages under the buildings, as in Vauban. Electric-car sharing, cycle parks and new public transport stations are provided.
Location: about 30 minutes from Vienna city centre.
Units: Approximately 1,100 altogether over 26.5 acres incl. 11.37 acres of green and open spaces. From two-family houses to multi-storey residential building, a neighborhood center, a natural kindergarten, Approximately 200 rented housing, a local supply, 80 owner-occupied apartments, 50 self-financed apartment buildings.

## Appendix 3. Case study: Heathcott Road Leicester

**<u>Useful lessons</u>: The importance of key driving individual(s), comprehensive community consultation; asset transfer from council; 100% affordable housing; training and the link to food production. It is managed by a charity, with aims including the relief of poverty, environment/conservation/heritage and economic/community development/employment. The leasing of land to a developer, Passivhaus Standard homes, and the rent income used to pay, *inter alia*, for an on-site development officer.**

**Size:** 68 Passivhaus Standard homes for affordable rent set about 20% less than the assessed local market value. These homes can be heated for as little as £13 per year. There are four one-bedroom flats and 23 two-bedroom, 20 three-bedroom and three four-bedroom houses. In June 2017 the first residents moved in.

Origin: This is the brainchild of Neil Hodgkin, Head of Development for the resource centre Saffron Lane Neighbourhood Council (SLNC). The area is one of the most deprived in Leicester. 10 years ago he had an idea for an urban community farm to grow vegetables for SLNC's day care service users. From this, Saffron Acres was born: allotments and a community garden which provide education and volunteering opportunities. Now, fruit grown on Saffron Acres is turned into jams and chutneys to be sold as part of a project providing skills training for local unemployed people and adults with learning difficulties.

Determined to rejuvenate the area, Neil identified housing as a key issue. SLNC embarked on a lengthy process of consultation with hundreds of local residents about the area's housing needs. It acquired 22 acres of former derelict allotment land as an asset transfer from Leicester City Council for £1

**Management**: SLNC oversaw the project. They leased the land to a developer: emh group, and engaged the architects: rg+p and builders: Westleigh Partnerships. The housing area is 13.3 acres. The cost: £9 million. It opened on 19 June 2017.

**Construction** took 70 weeks with 40 men on site every day, four of whom have been solely dedicated to achieving the Passivhaus credentials.

**Permaculture:** Next to the houses is a permaculture farm, intended to provide education on food growing, cooking and healthy eating, an allotment, beehives, a flower meadow, rejuvenation of field

ponds, reinstating of hedgerows and fruit tree planting. Residents are encouraged to work and grow their own fruit, vegetables and supplies on the farm. Existing community gardens are next door.

**Awards:** The project has already won the RICS East Midlands Awards and Project of the Year – Building Projects at the East Midlands Celebrating Construction Awards. July 2017 and a Best New Affordable Housing Scheme award at the Housing Excellence Awards on 1 June 2017

**Social dimension:** The income generated by the development pays for a full time debt and welfare support officer who is also onsite and plays a key role in advising and liaising with the community. Buoyed by the success of the development, Neil and SLNC plans a further £1.6m project to build 20 more housing units on the same site. The income from these will help to pay for a further two SLNC staff so they can do more work in the community.

Resident Claire (right) says that the fact that the Resource Centre is so firmly integrated with the development is a real benefit. “The Centre has lots of services we can use; we’ve been invited there for morning coffee and my next plan is to see more of what’s in the area and become part of the community. I can start working. I feel like I’ve really landed on my feet. Being here has changed our lives and opened up everything."

“This project shows that communities can plan, deliver and manage their own housing and address specific wider social needs,” said Neil. “Retaining money within the community to also directly deliver services within the community to help solve local social issues can offer longer-term solutions towards sustainable regeneration of neighbourhoods.”

## Appendix 4. Case study: The Cannery, Sacramento, USA

**<u>Useful lessons</u>: The inclusion in this project of a farm, agricultural training college, community-supported agriculture, some affordable housing, jobs, renewable energy, energy efficiency, and low-carbon transport, together with the support of the local council make it of interest. The financial approach is conventional (developer investment recouped from high value sales and retail outlet rent). There is an inclusive multigenerational approach to residential development.**

The Cannery, is on the site of a former tomato cannery (brownfield site) in Davis, on the outskirts of Sacramento near San Francisco. It is similar to a garden village.


**Size:** 583 residences, with an average density of 9.5 units per acre; with many sizes, types, densities and styles of housing including ownership and rental, detached and attached homes in low, medium and high densities ranging from three to thirty units per acre. A mix of land uses consisting of low, medium, and high density residential; a mixed-use business park; stormwater drainage retention; greenbelts, agricultural buffers, an urban farm, parks; and a neighborhood centre, on approximately 100.1 acres of land.

Together, these sites could accommodate employment opportunities for **approximately 600 to 850 jobs.**

The Cannery combines environmental engineering and landscape architecture elements into a neighbourhood plan. It contains five districts:

1. The Cannery Farm District
2. The Cannery Commerce District
3. The Urban Residential District
4. The Traditional Neighborhoods District
5. The Neighborhood Park District

**Greenspace:** A 7.42 acre urban farm is included as a community asset and as a transition between urban uses and adjacent agricultural land. This is part of 20.8 acres of open space consisting of the open space/bioswale, agricultural buffer on the north edge, agricultural buffer/urban farm on the east edge and greenbelts. It is an adaptive reuse and redevelopment of a former industrial site located within the city limits. In this picture, the area assigned to farmland is in the foreground.

**Owner and developer:** The New Home Company Inc. (fully commercial private company). New Home plans to deed the land to the City of Davis, which will then lease it to the Center for Land-Based Learning, which helps beginning farmers get their start.

**Services:** Water and sewer services are provided by the City of Davis. Planning the development was done in full cooperation with the planning department under normal processes, but was favoured by the council's policy approach. All the planning documents are here: http://cityofdavis.org/city-hall/community-development-and-sustainability/development-projects/the-cannery/environmental-review

**Financing:** the sale of market-price houses supplements the affordable housing. There are 110 affordable homes (16%) including 45 units suitable for rental to very-low, low- and moderate-income households.

**Energy:** Neighbourhood design includes street layouts, building orientation and landscaping to accommodate passive and active solar energy systems and to capture natural cooling and heating opportunities. Design treatments for passive solar are balanced with the neighborhood's overall

objective of reducing heating and cooling demands and providing solar-ready rooftops on south-facing roofs.

Energy efficiency measures increase building performance, livability and comfort well beyond the City's minimum requirement of the 2010 California Green Building Standards (Cal Green) Tier 1 requirement. Residential uses exceed California's 2008 Title 24 Energy Code by 40%, which is equivalent to 33% greater than 2010 Cal Green Tier II requirements. The mixed-use site will exceed California's 2008 Title 24 Energy Code by 15-20%.

All single family detached and attached homes will have a 1.5kW system installed at initial construction with the option to upgrade if desired, upgrading to 'net zero living'.

**Transport:** 9.9 miles of on-site bicycle and pedestrian improvements connected to existing cycle and pedestrian links into the city have been built. All places are no more than a ten-minute walk or a five-minute bicycle ride from one another. Every residence is within approximately 300 feet of a trail, park, greenbelt or open space area.

**Linked to:** the Center for Land-Based Learning (CLBL), which "cultivates opportunity for youth, for agriculture, for business, for the environment". This runs the California Farm Academy to help those wanting to break into a career in agriculture.

**Food supply:** a veggie box Community Supported Agriculture scheme. There are two farming businesses and three farmers at Cannery Farm. There's an agricultural college and a college where young people can study agriculture. Their mission is "to inspire, educate, and cultivate future generations of farmers, agricultural leaders and natural resource stewards". Food is also sold in a local market.

## Appendix 5: Towards One Planet Towns and Cities

**Here are suggestions for reaching Wales' target of One Planet Wales. For any development, existing or future, we must ask: What is the actual life cycle impact? Where does the food come from? Is the city really sustainable? Let alone regenerative? and How can we know? Here is a way to find out...**

# What is One Planet Development?

Through Technical Advice Note 6 and Planning Policy Wales (PPW) the Welsh Government sets out land use planning policies to support sustainable rural communities. Planning Policy Wales (2016) says:

> *4.5.11 "Closely aligned to the commitments to tackling climate change is the Welsh Government's approach to reducing the ecological footprint of Wales. Our Sustainable Development Scheme sets out an ambition for Wales to use its fair share of the Earth's resources, where,* ***within a generation, our ecological footprint is reduced to the global average availability of resources – 1.88 global hectares per person.*** *The current footprint shows that, if everyone on the Earth lived as we do, we would use 2.7 planets worth of resources. Reducing Wales' ecological footprint will require a large reduction in the total resources used to sustain our lifestyles****. The policy and guidance set out here in PPW will make an important contribution to reducing our footprint, whilst delivering sustainable development and tackling climate change."***

Section 4 of TAN 6 defines One Planet Developments as being exemplars of sustainable development:

> *4.15.2 One Planet Developments may take a number of forms. They can either be single homes, co-operative communities or larger settlements. They may be located within or adjacent to existing settlements, or be situated in the open countryside.*

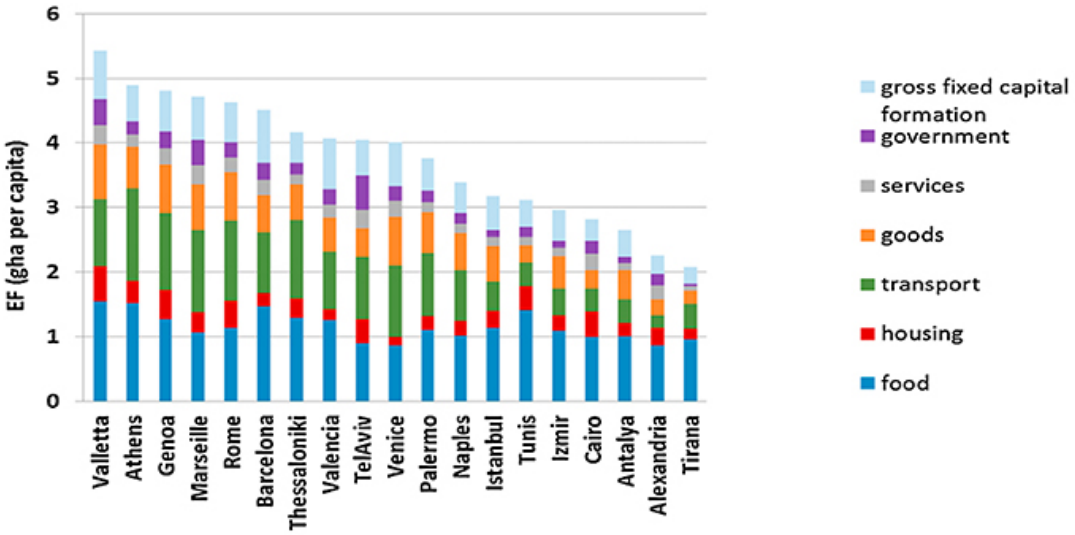
In other words, anywhere. However planning guidance exists only for OPD in the open countryside. It is therefore urgently necessary for planning guidance to be set for making both new and existing settlements satisfy, collectively, the criteria to be measurably 'one planet' within a generation.

Current criteria include:

1. An initial ecological footprint of 2.4 global hectares per person or less and clear potential to move towards 1.88 global hectare;
2. Buildings being zero carbon over their lifetime;
3. Carbon analysis;
4. Biodiversity and landscape improvement;
5. Community impact improvement;
6. Transport assessment and travel plan to minimise carbon impact of travel;
7. Sustainable water supply;
8. Zero waste (including biological waste - sewage treatment)
9. 100% renewable energy.
10. If located in the open countryside over a reasonable length of time (no more than 5 years), to provide for the minimum needs of the inhabitants in terms of income, food, energy and waste assimilation from land-based employment.

No criteria of this nature have yet been determined for urban or peri-urban developments but something comparable is anticipated at a collective community level.

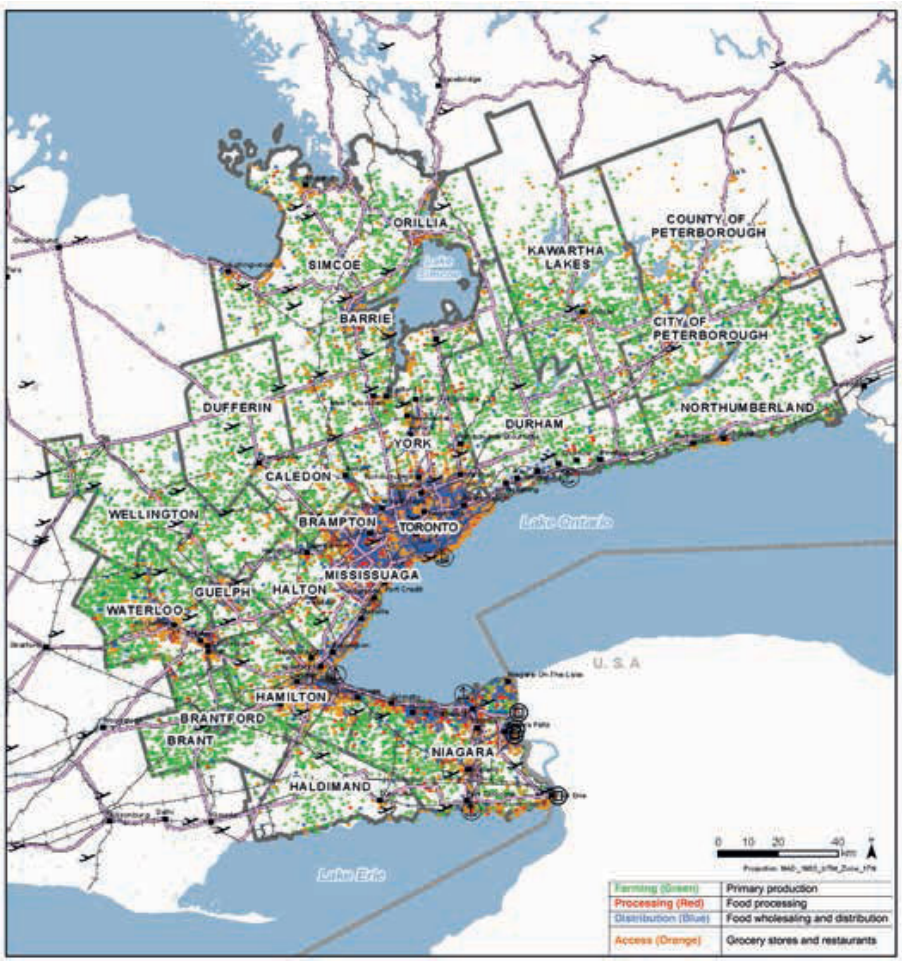
# The importance of food



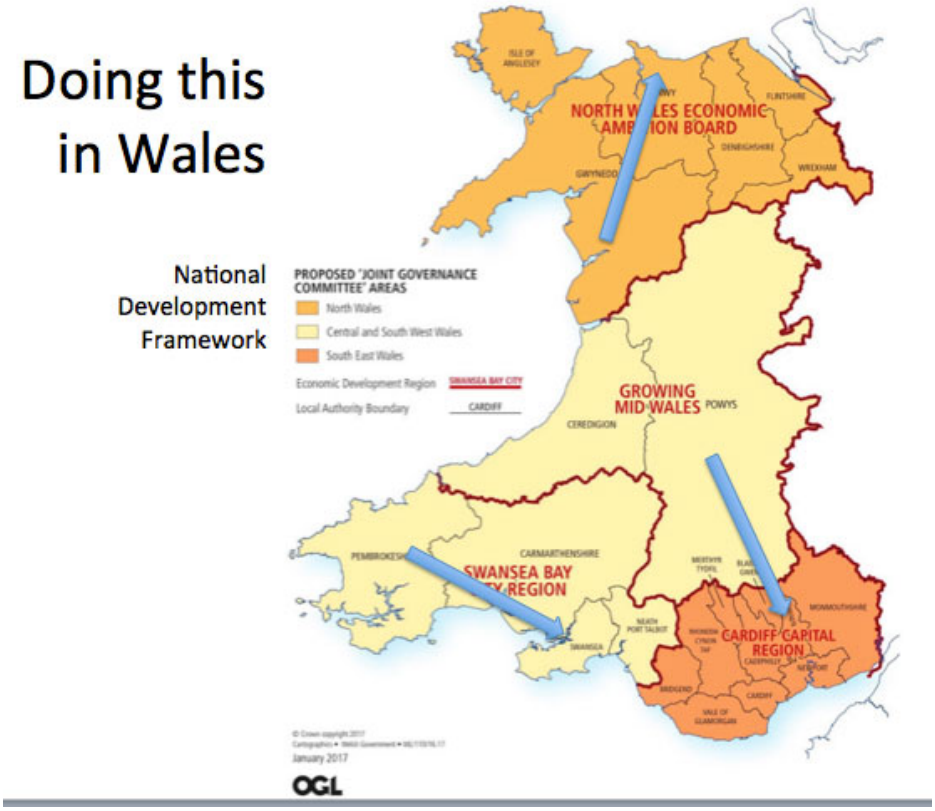

The above analysis of some Mediterranean cities shows that the hardest sector to reduce the ecological footprint of is food (the blue sector stays approximately the same height regardless of the height of the entire column). **But in Wales we have plenty of land.** And food connects all the Sustainable Development Goals that underpin the Wellbeing of Future Generations Act:


It follows that Welsh urban areas should ally themselves with defined hinterlands to develop procurement strategies that result in guaranteed markets for Welsh food and energy suppliers (and other goods and services) to minimise their ecological footprint, as they have in Canada's 'Golden Horseshoe'. This includes the Greater Toronto area. There, 7 municipalities in 2011 set a 10-year 'Golden Horseshoe Food and Farming Plan 2021' which aimed:

- to grow the food and farming cluster
- to link food, farming and health through consumer education
- to foster innovation to enhance competitiveness and sustainability
- to enable the cluster to be competitive and profitable by aligning policy tools, and
- to cultivate new approaches to supporting food and farming.




How can we do this in Wales?



We can begin by making the National Development Framework encourage this process, whereby each of the three largely rural areas of Wales are encouraged to supply their closest urban areas. A powerful message would be sent to the market by procurement strategies under the requirements of the WBFGA to spend public money sustainably that favour procurement from these areas by public bodies such as hospitals and schools. Procurement criteria could include organic production, renewable energy, low carbon transport, and the improvement of biodiversity, as with existing open countryside one planet planning criteria.

Pairing communities' schools and hospitals with local food supplies would have many spin-off benefits in health, awareness and rural regeneration.

## Towards one planet Wales

A suggestion: 'one planet' towns and cities can pave the way to One Planet Wales as a whole. Newtown, Powys, is one such town already beginning down this path.

Briefly, the six-step strategy from the present to a one planet future for a town or city would be:

1. Decide standards to use - e.g., ecological footprinting; ISO 37100:2016 (will contribute to UN Sustainable Development Goals through standardization ad is guided by ISO/TC 268); or GEMIS (Global Emissions Model for integrated Systems), a public domain life-cycle and material flow analysis model and database – used by Vauban;
2. Obtain buy-in and feedback at all levels through community participation;
3. Decide the objectives - for each topic: energy efficiency, energy supply, waste, biodiversity, health, transport, food, etc.;
4. Set the baseline – measure the current situation;
5. Set targets for each topic over realistic timescales and set in place ways to measure them
6. Ratchet down consumption over one or two generations via a series of ever-lowering milestone targets.

(This process could be managed by Public Service Boards, in some cases).

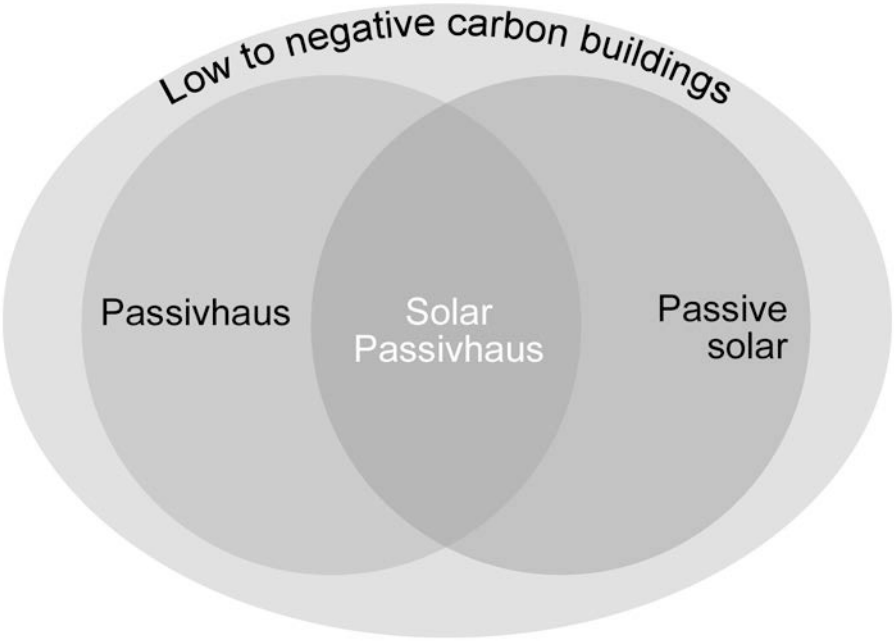
## Appendix 6: What is a zero carbon building?

Avoiding life-cycle emission of greenhouse gases in material sourcing, construction, in use and dismantling, by:

- Favouring local-ish, 'natural' and cellulose-based materials (which store atmospheric carbon);
- Capturing solar energy for lighting and heat, with shading to avoid overheating;
- making the structure airtight (no unwanted draughts);
- making the structure breathable (i.e. permeable to water vapour);
- making it durable, resilient, low-maintenance, fire- and weather-resistant;
- incorporating a large amount of insulation.

Passive solar and passive house overlap, but at extremes, depending on climate, can give rise to different building forms.

- The ideal form for a passive solar building in a temperate climate would be longer on the north-south-facing side than the east-west facing sides, with double or triple-glazed windows on the sun-facing side and very small or no windows on the opposite side.
- The ideal form for a passive house design would be a cube because it minimises the surface area to volume ratio, limiting heat loss.




# The Passivhaus Standard:

Energy performance targets and air changes per hour:

- Specific Heating Demand ≤ 15 kWh/$m^2$ per year
- Specific Cooling Demand ≤ 15 kWh/$m^2$ per year
- Specific Heating Load ≤ 10 W/$m^2$
- Specific Primary Energy Demand ≤ 120 kWh/$m^2$ per year
- Air Changes Per Hour ≤ 0.6 @ n50
- Some features of Passivhaus: continuous thermal envelope and airtightness layer; bringing in fresh air from outside via cooling or heating from a ground heat exchanger; mechanical ventilation with heat recovery.

# The Form Factor – keep it low to keep heat in

- The heat loss Form Factor (FF) measures the compactness of a building as a ratio of its external walls and roof area (not including the ground contact) to the floor area:
  Form Factor = Heat Loss Area / Treated Floor Area
- Can be between 0.5 and 5.
- A lower number indicates a more compact, efficient building.
- Aim to achieve 3 or less.

A low surface area to volume (S/V) ratio is better for a building that wishes to conserve energy for heating. This is the ratio between the external surface area and the internal volume. It is a measure of compactness:

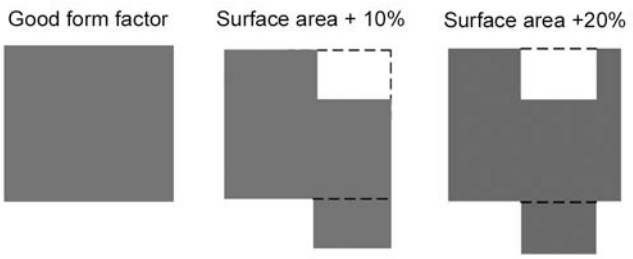
Compactness C = Volume / Surface Area

Size is also a factor: a small building with the same form as a larger one will have a higher S/V ratio.

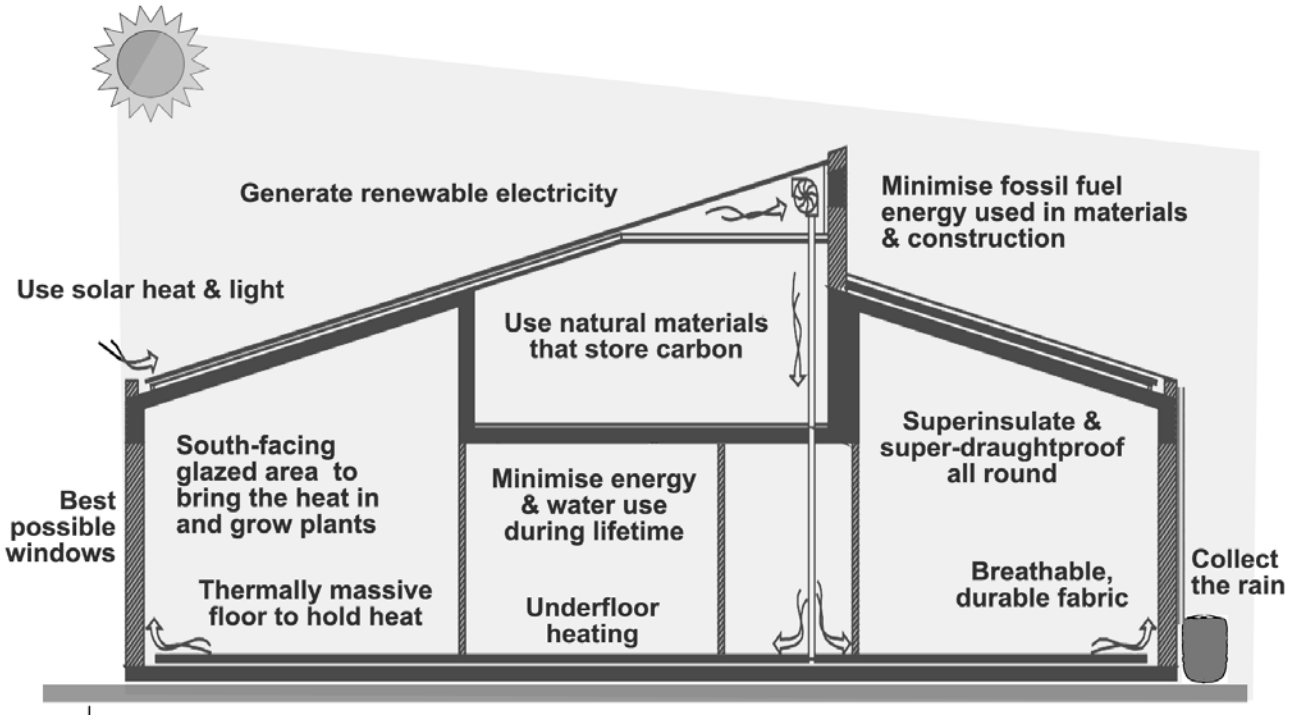
Types of home & form factors:

| | Type | Form Factor | Efficiency |
|---|---|---|---|
|  | End mid-floor apartment | 0.8 | Most efficient |
|  | Mid-terrace house | 1.7 | |
|  | Semi-detached house | 2.1 | |
|  | Detached house | 2.5 | |
|  | Bungalow | 3.0 | Least efficient |

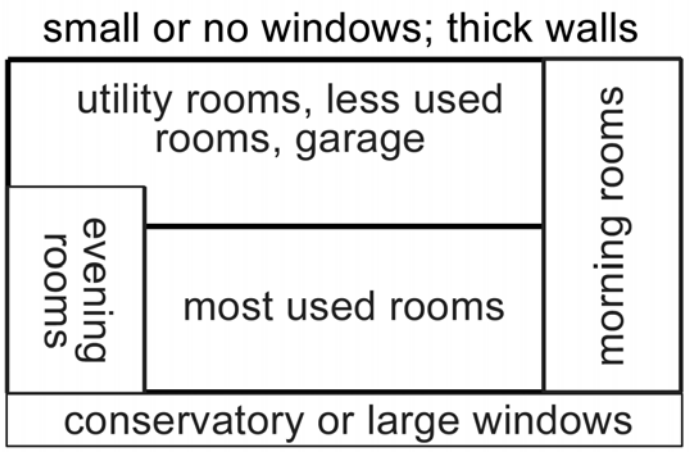
An increase in the Surface to Volume ratio of 10% (the building in the middle below) would require 20mm of insulation more than the good form on the left to achieve the same level of insulation. The one on the right (a 20% higher S/V ratio) would require an extra 40mm of insulation. Therefore compactness should be encouraged.



## Features of passive solar

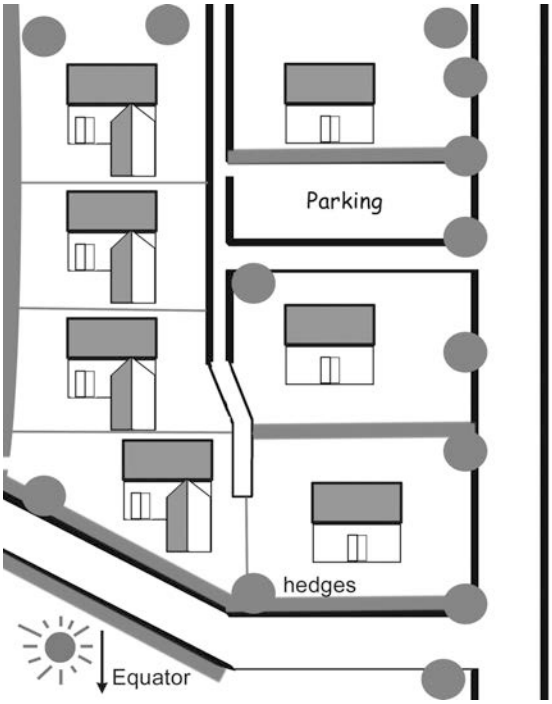



## Passive solar room and neighbourhood layout




Sample room layout above. South is at the bottom.

The diagram on the right shows a layout for houses so each house both has privacy and faces south.



# Embodied carbon of insulation

Cellulose materials have 'negative carbon' having absorbed it during growth, and so should be favoured over plastic ones:

| **Material** | **Embodied carbon (kgCO2e)** |
|---|---|
| Cork slab (300kg/m3) | -155 |
| Cork slab (160kg/m3) | -70 |
| Cork board | -65 |
| Woodwool board | -35 |
| Flax | -5 |
| Recycled loose cellulose | -1.9 |
| Glassfibre quilt | 3 |
| **Rockwool (30kg/m³)** | **7** |
| Glassfibre slab | 8 |
| Cork board | 9 |
| **Rockwool (60kg/m³)** | **13** |
| Expanded polystyrene | 15 |
| **Rockwool (100kg/m³)** | **20** |
| Cellular sheet glass | 28 |
| Foam glass (140kg/m³) | 30 |
| Foam glass (130kg/m³) | 31 |
| **Mineral wool (slabs)** | **38** |
| Expanded polyurethane | 160 |
| Unfaced polyurethane | 175 |

K-values of some insulation materials and depth needed to obtain U-value of 0.15W/m$^2$K (Passivhaus standard):

| **Material** | **k-value** | **Depth (mm)** |
|---|---|---|
| Foil-faced polyurethane with pentane up to 32kg/m$^3$ | 0.020 | 110 |
| Expanded Polystyrene (EPS) up to 30kg/m$^3$ | 0.030-0.045 | 145-250 |
| Glass wool [up to 48kg/m3] | 0.030-0.044 | 150-230 |
| Mineral wool [160kg/m$^3$] | 0.037-0.040 | 190-210 |
| Sheep's wool [25kg/m$^3$] | 0.034-0.054 | 170-330 |
| Cellulose fibre [dry blown 24kg/m$^3$] | 0.035-0.046 | 175-270 |
| Wood fibre batts or rolls | 0.039-0.061 | 195-350 |
| Hemp lime (monolithic) | 0.067 | 380 |
| Strawboard [420kg/m$^3$] | 0.081 | 450 |
| Straw bale (monolithic) | 0.047-0.063 | 310-360 |
| Hempcrete | 0.12-0.13 | 640 |

# Cellulose materials

'Natural', 'green', 'bio' or 'renewable' building materials are classed as 'cellulose-based'. They:

- lock up atmospheric carbon in the building;
- have varying degrees of insulation ability;
- are easy to work with;
- make structures that are breathable;
- Are biodegradable or easily recycled at the end of the building's life and may support local agroforestry.

**Wood** has a greater tensile strength relative to steel – two times on a strength-to-weight basis – and has a greater compressive resistance strength than concrete.

- Sustainably sourced timber must be specified.
- Products for structural use include glued laminated timber ('glulam') and Cross-Laminated Timber (CLT).

**Straw bale** is used as infill in timber frame structures and is rendered with hempcrete or lime. It has also been used structurally: the tallest frameless straw bale building is three storeys high. Typical properties:

- minimum recommended bale dry density: 110–130 kg/$m^3$
- thermal conductivity: 0.055–0.065 W/mK (density 110–130 kg/$m^3$)
- recommended initial moisture content: 10–16%
- recommended maximum in-service moisture content: normally not to exceed 20–25%.
- A 500mm thick structural straw wall with finishes has good insulation: a U-value of around 0.15 W/$m^2$K.

Wales has the potential to provide a good supply chain of many of these materials, including lime.