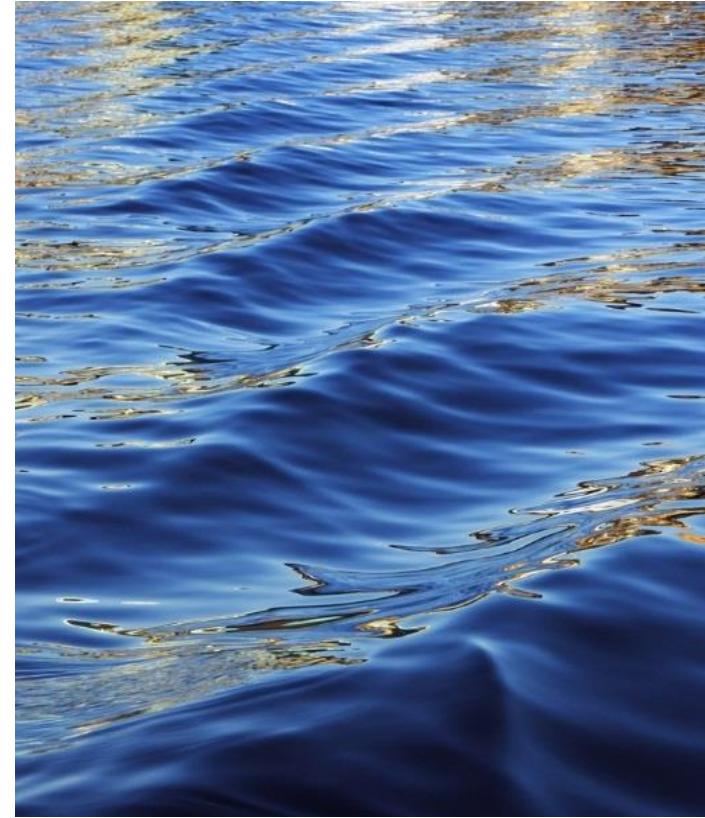




Sustainable construction

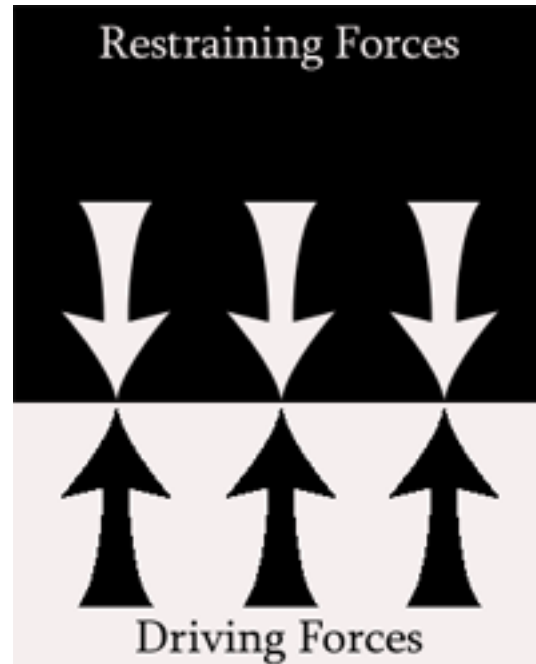
Ian brown



Session contents

1. Identify environmental planning and policy applicable to construction
2. Guidance to achieve policies
3. Key concepts in sustainable construction
4. Application case study examples

Driving Forces?



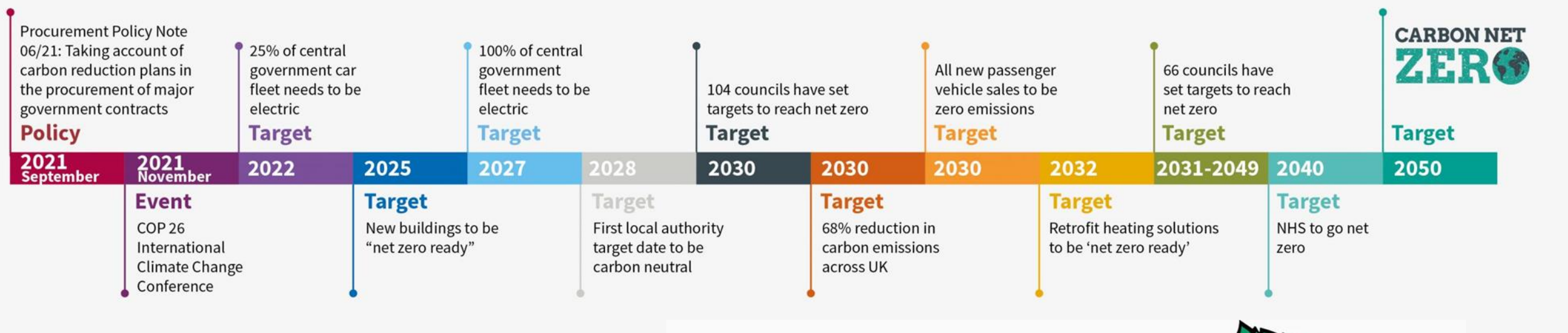
Identify environmental planning and policy

Spend 10 minutes:

Identify environmental planning and policy in the UK?

Extra points for specific Welsh policies?





Environment Act 2021

The Environmental Act was approved by Royal Assent on November 9th 2021 having taken since its birth in 2016 in the aftermath of the Brexit vote.

The Act lays down the foundations of environmental legal requirements post the UK's exit from the European Union and updates UK legislation to deliver the Government 25-year environment plan. The Act sets out through over 200 provisions, targets plans and policies for:



Improving the natural environment



Statements and reports about environmental protection



The establishment of an Office for Environmental Protection



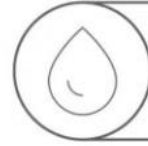
Enhanced waste and environmental efficiency



Air Quality



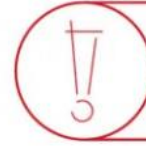
The recall of products that fail to meet environmental standards



Water (and the protection of water resources)



Nature and biodiversity, and conservation covenants



Regulation of chemicals

What's the problem?

Up front: The construction industry

Impacts associated with:

- Building materials
- Construction processes up to practical completion

Ongoing: Existing and operational

Impacts associated with:

- Heating, cooling and ventilating buildings
- Powering buildings
- Maintaining buildings
- Decommissioning or demolition of buildings

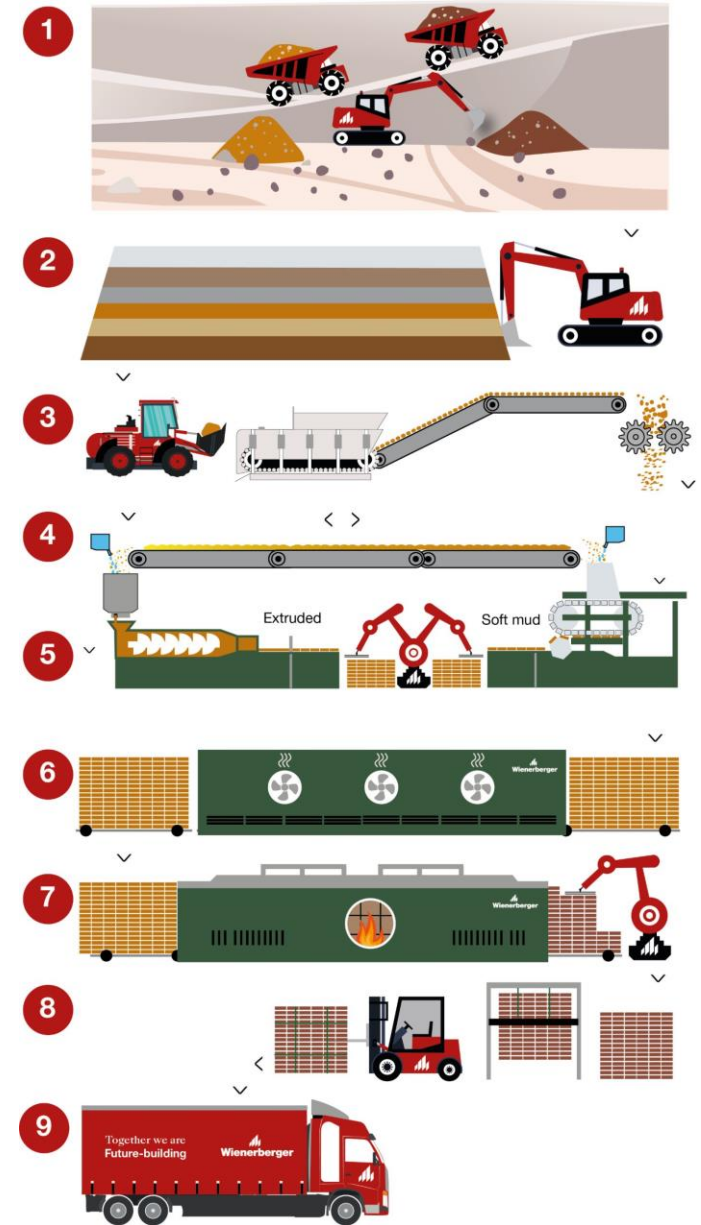
Up front

- Embodied carbon from the construction and refurbishment of buildings currently makes up 20% of UK built environment emissions
- Each year UK construction industry uses approx. 6 tonnes of building materials per head of population
- Construction Industry accounts for an estimated 30% of all waste generated in the UK



Up front: building materials

- Extraction
- Processing
- Transportation



£10 challenge : an addiction like no other

Find me **anything** in this room – within building or otherwise

That has not been: **extracted, processed or transported**

Using **petrochemical** sources

Winner gets the content of my wallet or £10!



Up front: construction phase

Installation / building with materials



Up front: construction phase

- Permeant change to landscape
- Noise, dust, light pollution
- Ground and water course pollution – chemical, silt etc



Ongoing

- From residential to commercial buildings, the UK's built environment is **responsible for 25% of the UK's greenhouse gas emissions**



House of Commons
Environmental Audit Committee

Building to net zero: costing carbon in construction

First Report of Session 2022–23

*Report, together with formal minutes relating
to the report*

*Ordered by the House of Commons
to be printed 11 May 2022*

Ongoing: Existing building stock

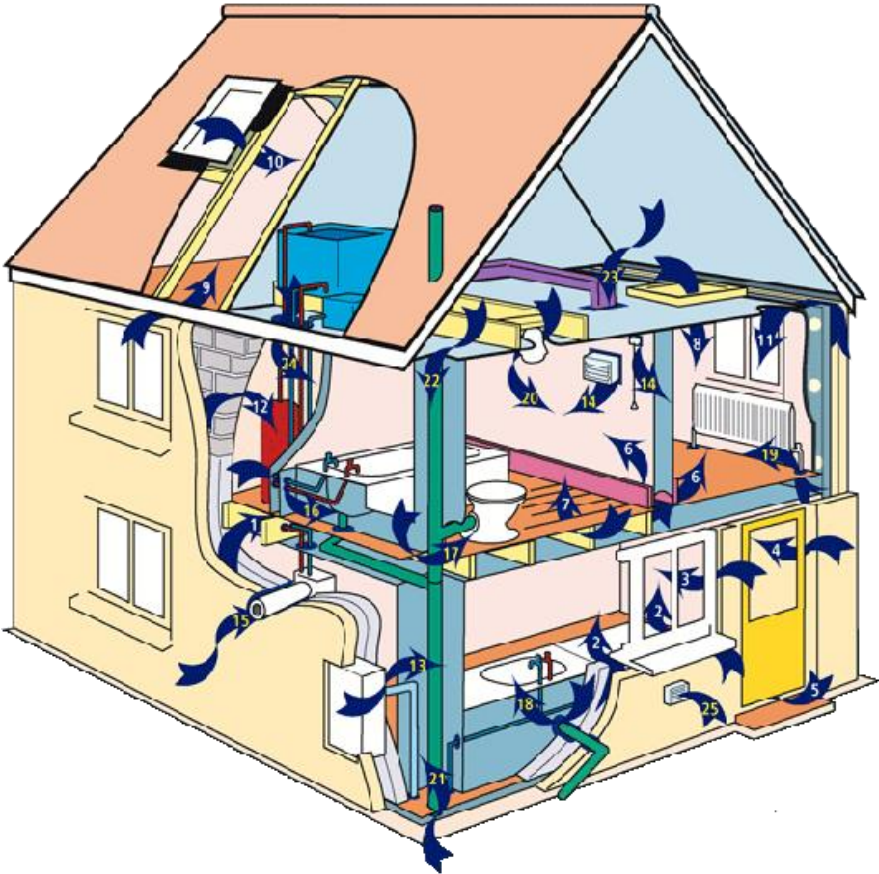


Table 2.4: Wall insulation, 2017 (thousands of dwellings / %)

	England	Scotland	Wales	Northern Ireland
Cavity insulated	11,157	1,363	636	570
Cavity uninsulated	5,242	457	298	66
All cavity walls	16,399	1,820	934	636
Solid with insulation	694	115	71	11
Solid uninsulated	6,301	529	307	107
All solid walls	6,996	644	378	118
Other	555	included above in solid walls	30	26
Cavity insulated	68%	75%	68%	90%
Cavity uninsulated	32%	25%	32%	10%
All cavity walls	100%	100%	100%	100%
Solid with insulation	10%	18%	19%	9%
Solis uninsulated	90%	82%	81%	91%
All solid walls	100%	100%	100%	100%

https://files.bregroup.com/bretrust/The-Housing-Stock-of-the-United-Kingdom_Report_BRE-Trust.pdf

Guidance: Help is on the way!

- Building regulations
- Future homes standards
- BREEAM
- UKGBC Net zero guidance document
- Passiv Haus (Passive house standards)
- AECB carbon lite standards

Building Regulations: June 2022 updates

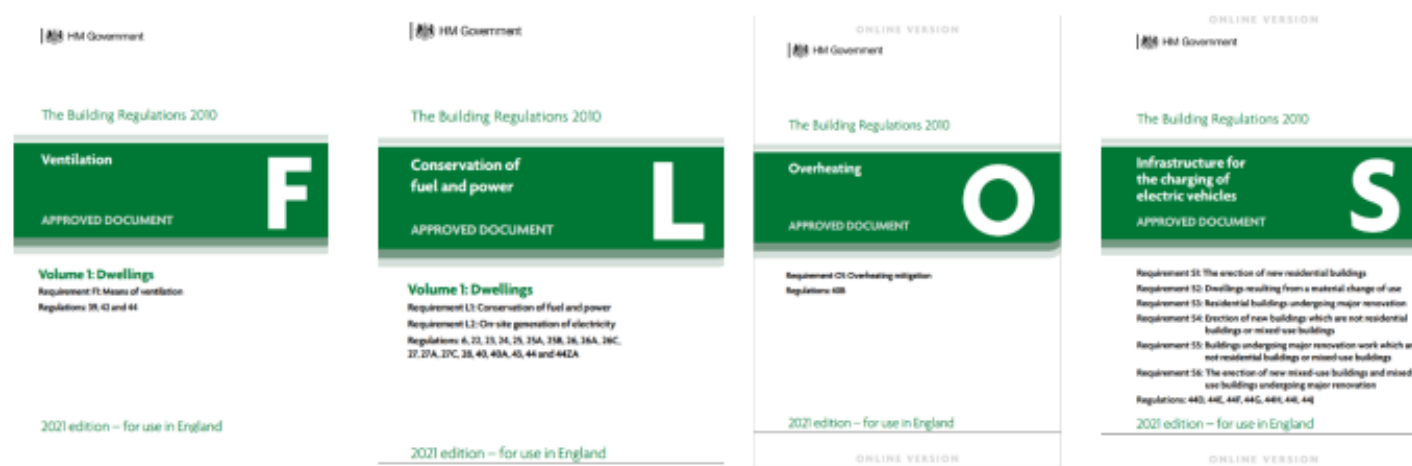
Key insights into Approved Documents:

F = Ventilation,

L = Energy efficiency,

O = Overheating,

S = Electrical vehicle charging points



Future Home standard

- Heating and powering buildings accounts for 25% of the UK's total energy usage, so our homes will play a vital role in the UK's efforts to reach net zero carbon emissions.
- In 2025, compliance with the Future Homes Standard (FHS) will become mandatory. Its aim is to ensure that new homes built from 2025 will produce 75-80% less carbon emissions than homes built under the current Building Regulations.





Offices



Retail



Industrial



Data centres



Other



Houses & apartments



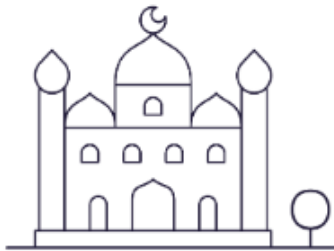
Education



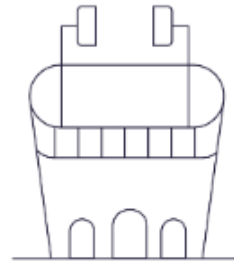
Transportation hub



**Hospitality &
residential institutions**



Community



Sports and leisure facilities



Government services



Healthcare

Reduce through design: BREEAM



A BREEAM assessment uses recognised measures of performance,

Set against established benchmarks, to evaluate a building's specification, design, construction and use.

New build Non-domestic or multi-dwelling buildings and Refurbishment & fit out domestic



Pollution



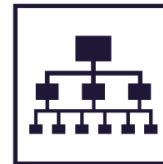
Materials



Waste



Innovation



Management



Water



Energy



Transport



Health & wellbeing



Resources



Resilience



Land use & ecology

Home Quality Mark

BREs HQM provides a comprehensive framework for creating homes that are not only environmentally friendly but also cost-effective and comfortable to live in.



<https://bregroup.com/products/home-quality-mark/>

UKGBC guidance document

Net Zero (zero carbon) buildings

Two main approaches:

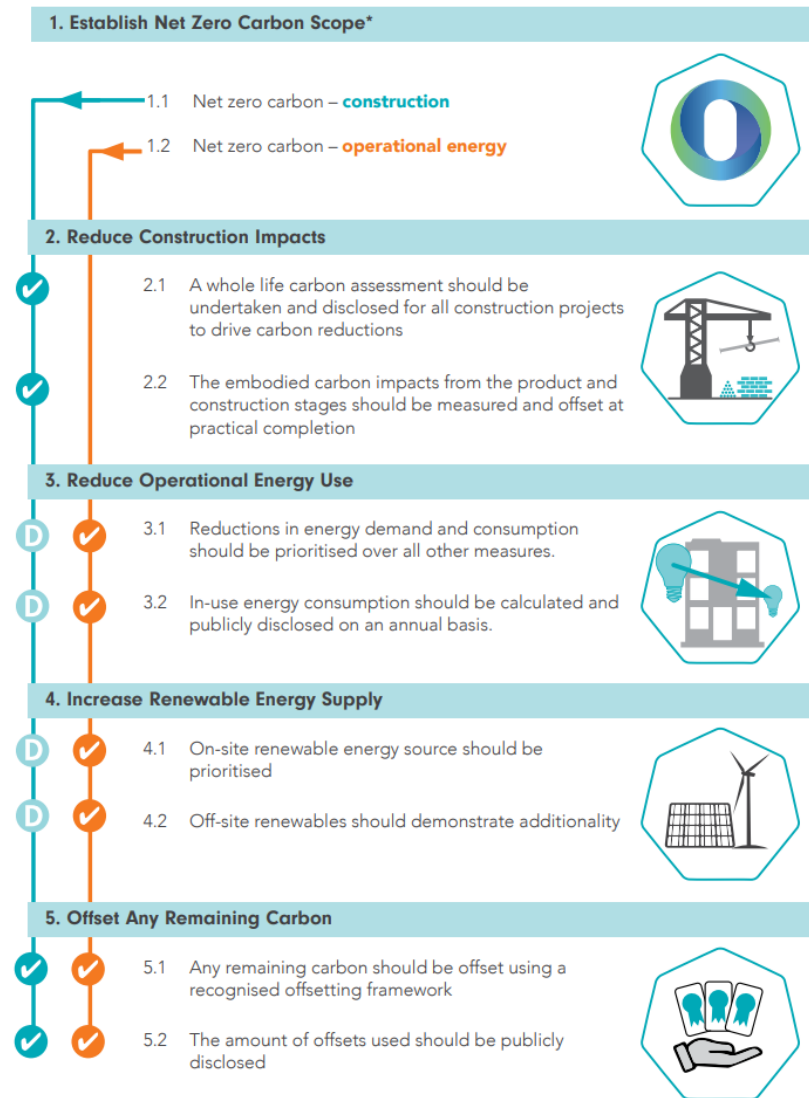
Net zero carbon – construction (1.1):

"When the amount of carbon emissions associated with a building's product and construction stages up to practical completion is zero or negative, through the use of offsets or the net export of on-site renewable energy."

Net zero carbon – operational energy (1.2):

"When the amount of carbon emissions associated with the building's operational energy on an annual basis is zero or negative. A net zero carbon building is highly energy efficient and powered from on-site and/or off-site renewable energy sources, with any remaining carbon balance offset."

Whole_life_carbon_assessment_PS_Sept23.pdf

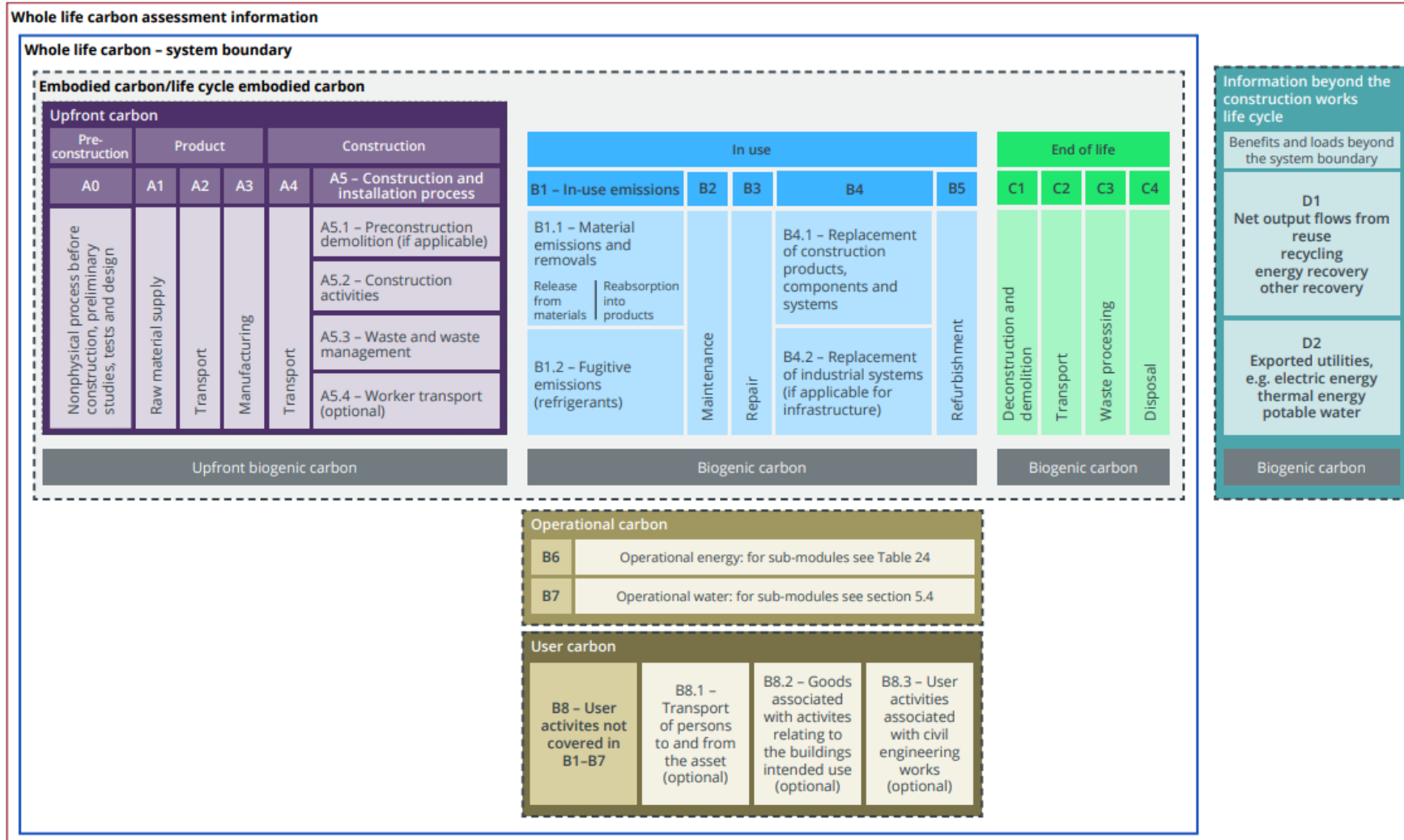


D New buildings and major refurbishments targeting net zero carbon for construction should be designed to achieve net zero carbon for operational energy by considering these principles.

* Please also note, a further scope for net zero whole life carbon (1.3) will be developed in the future.

Steps to Achieving Net Zero Carbon Buildings

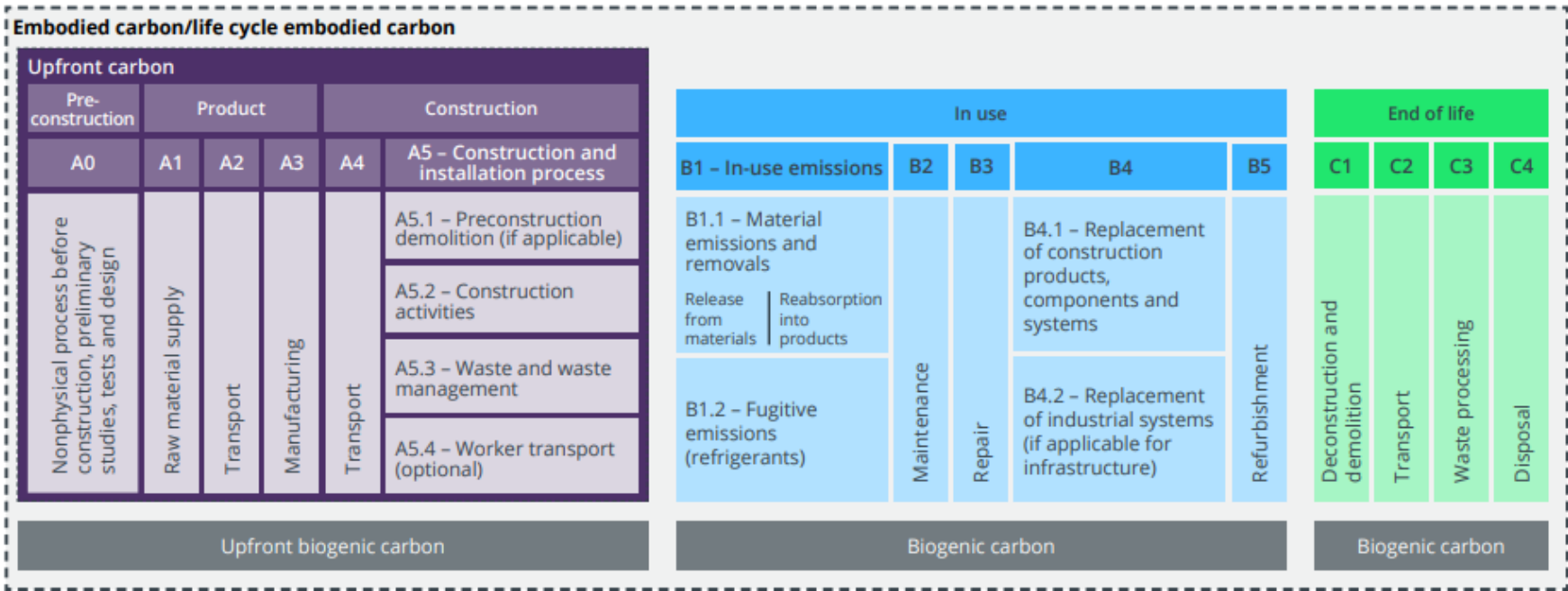
Whole life carbon assessment



Embodied Carbon

Embodied Carbon

The embodied carbon emissions of an asset are the total GHG emissions and removals associated with materials and construction processes, throughout the whole life cycle of an asset



Embodied Energy

Embodied energy

“the sum of the energy requirements associated, directly or indirectly, with the delivery of a good or service” (Cleveland & Morris, 2009)

The three most common options are:

- cradle-to-gate
- cradle-to-site
- cradle-to-grave
 - Initial embodied energy (C-2-S) + Recurring embodied energy + Demolition energy (not operational energy)

(Densley Tingley & Davinson, 2011)

Embodied Energy



Embodied Energy

https://www.greenspec.co.uk/building-design/embodied-energy/

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The Green Self Builder >

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home > green building design > embodied carbon & epds

Embodied Carbon & EPDs

Green Building Design

Why 'Green'?

Building Materials: Impacts Compared

Timber: Materials & Design

Earth & Clay: Materials & Design

Plaster: Render, Mortar & Boards

Complex Components: Materials & Design

Metals: Production & Environmental Impact

Concrete: Production, impact and design

Green Roofs & Planting

Toxic Chemistry: Chemicals in Construction

Building Physics

Passivhaus

Renewable Energy & Green Technology

Housing Refurbishment / Retrofit

Old Buildings

Building Dismantling: Re-use & Recycling

Embodied Carbon & EPDs

Glossary of Green building

Post Occupancy Evaluation (POE)

Water

Embodied Carbon & EPDs



LCA and EPD expert Jane Anderson of PE INTERNATIONAL introduces the concept of embodied carbon (aka embodied energy) - from the energy it takes to manufacture construction products.

Introduction

As regulation and voluntary measures such as BREEAM and the Code for Sustainable Homes have looked to reduce operational carbon, there has been an increasing focus on embodied carbon – the carbon which is associated with the materials in the building. Embodied carbon normally encompasses both CO2 and other greenhouse gases, and includes emissions from all the extraction, transport and manufacturing processes required before products are ready at the factory for delivery to the customer – such an assessment is known as “cradle to gate”. It can also cover transport to site (“cradle to site”), installation impacts (including the impact of dealing with construction waste) (“cradle through construction”), maintenance such as cleaning, repairs, replacement and refurbishment of products, and the impacts associated with the product’s end of life, such as demolition, recycling and disposal. If all the life cycle stages are included, then the assessment is known as “cradle to grave”, although this doesn’t mean that the assessment assumes products are landfilled. If products are normally recycled at end of life, then a “cradle to grave” assessment would account for this, but ensuring (in line with ISO 14044[1]) that the benefits of recycling for a material are not double counted for both the use of recycled content and its recycling at end of life.

Embodied carbon in the UK

The UK was one of the first countries to recognise the significance of the energy used to make construction

EMBODIED ENERGY		
MATERIAL	MJ/kg	MJ/m3
Aggregate	0.10	150
Straw bale	0.24	31
Soil-cement	0.42	819
Stone (local)	0.79	2030
Concrete block	0.94	2350
Concrete (30 Mpa)	1.3	3180
Concrete precast	2.0	2780
Lumber	2.5	1380
Brick	2.5	5170
Cellulose insulation	3.3	112
Gypsum wallboard	6.1	5890
Particle board	8.0	4400
Aluminum (recycled)	8.1	21870
Steel (recycled)	8.9	37210
Shingles (asphalt)	9.0	4930
Plywood	10.4	5720
Mineral wool insulation	14.6	139
Glass	15.9	37550
Fiberglass insulation	30.3	970
Steel	32.0	251200
Zinc	51.0	371280
Brass	62.0	519560
PVC	70.0	93620
Copper	70.6	631164
Paint	93.3	117500
Linoleum	116	150930
Polystyrene Insulation	117	3770
Carpet (synthetic)	148	84900
Aluminum	227	515700
NOTE: Embodied energy values based on several international sources - local values may vary.		

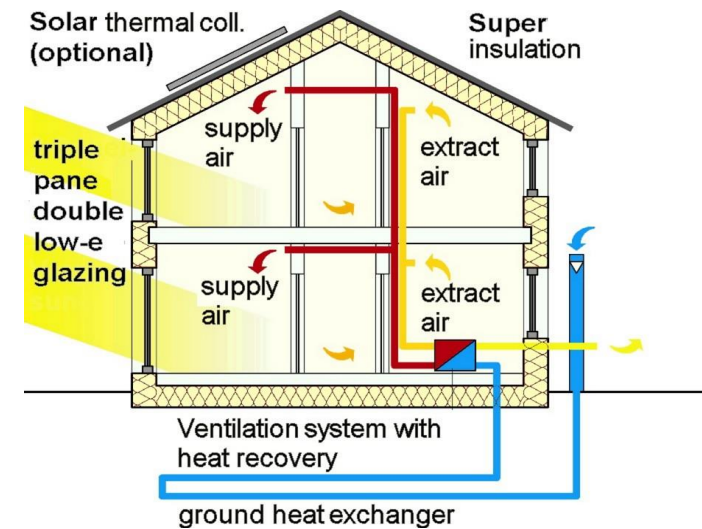
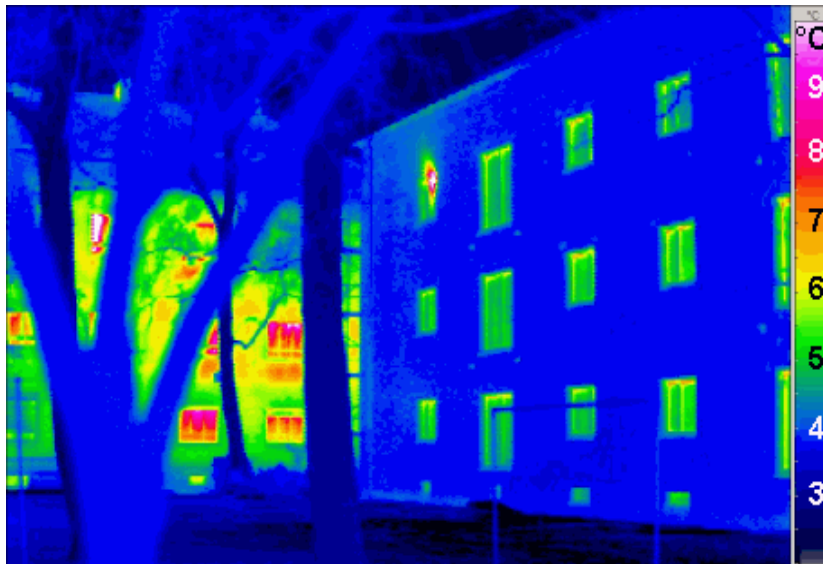
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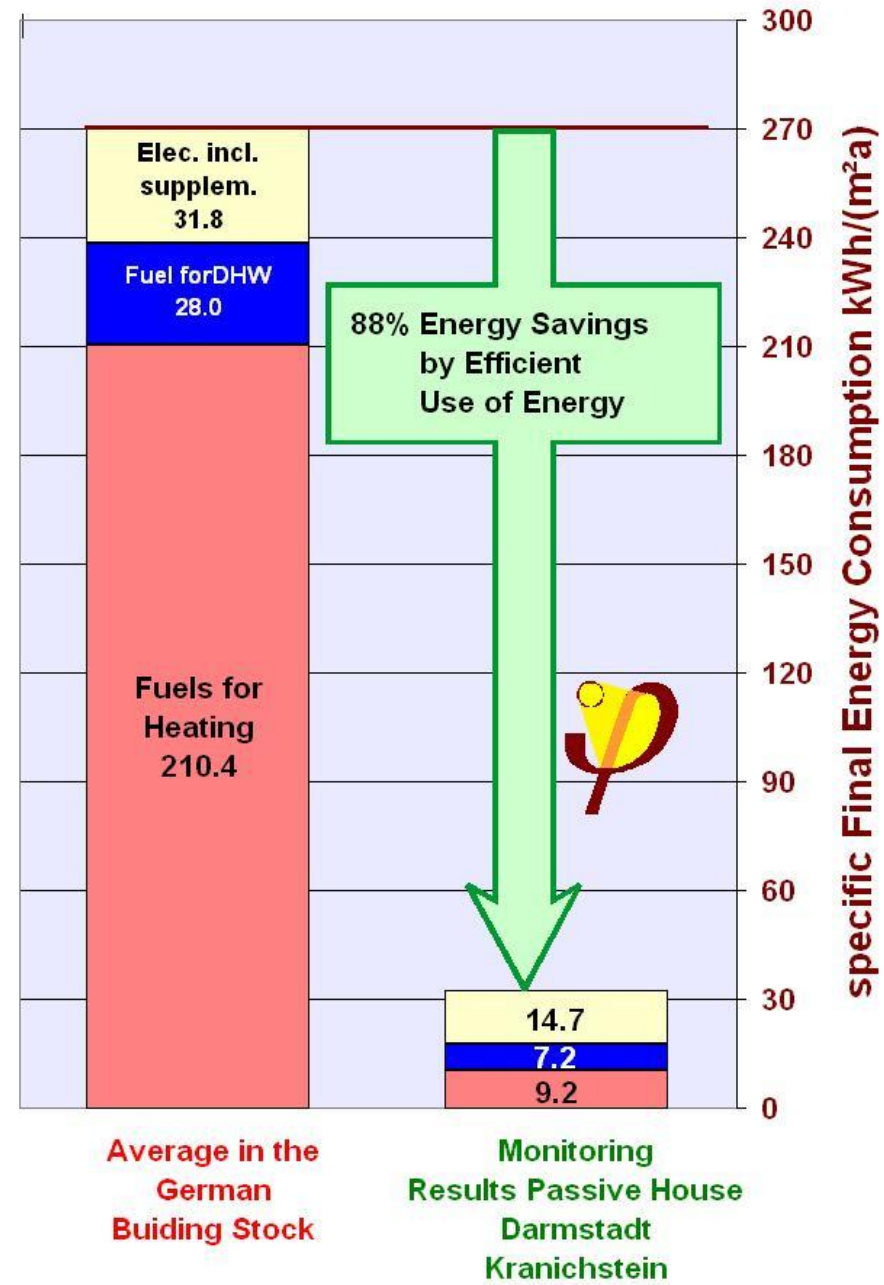
12/11/2024

Add a footer

Passiv Haus / Passive House

- A rigorous, voluntary, **standard for energy efficiency in buildings.**
- It results in ultra-low energy buildings that require little energy for space heating or cooling







Examples of Passiv Haus designs



Passiv Haus community - Germany

Passive House (Passiv Haus)



What is the Passive House Standard?



Passive House
Institute



IPHA



Passive House



<https://www.youtube.com/watch?v=hsDVIt7T7nU&list=PLs2Eor3shsLInWNafxbVEZCISFOT8PezE>

How to achieve the Passivhaus Standard in the UK?

To achieve the Passivhaus Standard in the UK typically involves:

accurate design
modelling using the
Passive House Planning
Package (PHPP)

very high levels of
insulation

extremely high
performance windows
with insulated frames

airtight building fabric

'thermal bridge free'
construction

a mechanical
ventilation system with
highly efficient heat
recovery



BUILDING PERFORMANCE

What Passivhaus achieves in terms of a building's energy demand, performance gap, comfort & quality.

- Low energy demand
- Reduces performance gap
- High levels of comfort
- Effective and healthy ventilation
- Higher performance building components
- Better site QA procedures resulting in better construction quality
- Lower risk of building fabric damage
- Resilient and future-proofed buildings



CLIMATE EMERGENCY

Decarbonisation is a critical part of our journey to net zero. Passivhaus enables the levels of demand reduction that we will need to achieve net zero.

- Lower carbon emissions
- Lowers peak demand
- Lowers the overall requirement for renewables
- More economical to save energy than to generate it
- Gives us the best chance of achieving net zero in buildings
- Enables decarbonisation without increasing fuel bills
- Robust in the face of short-term extremes and longer-term climate changes
- Ability to support demand response
- Lower cooling requirement in a future warmer climate



HEALTH & WELLBEING

Decarbonisation is a critical part of our journey to net zero. Passivhaus enables the levels of demand reduction that we will need to achieve net zero.

- Eliminates cold homes & associated health impacts
- Guarantees good levels of ventilation
- Reduces internal pollutants such as VOCs
- Deals with internal humidity - eliminates condensation and mould
- Improves quality of life for people with chronic illness or disabilities
- Protects against external air pollutants
- Reduces risk of airborne infection
- Reduces the impact of external noise
- Reduces risk of buildings becoming too hot in summer
- Improves health of people in schools & offices



PEOPLE PERFORMANCE

The improved living and working environments offered by Passivhaus can improve productivity, learning outcomes and reduce absenteeism.

- Reduced absenteeism
- Improved productivity
- Improved learning outcomes
- Attract and retain staff



FINANCIAL

Affordable to run, Passivhaus can also offer lower maintenance costs, reduce fuel poverty, and open access to green finance or better rates on mortgages.

- Lower energy bills
- Fewer & shorter rental void periods
- Reduces extent & depth of fuel poverty
- Higher capital value 5-7%
- Lower maintenance & management costs
- Access cheaper time of day tariffs
- Lower whole life costs
- Lower borrowing costs. Green mortgages
- Ability to access cheaper green finance
- Holds value in the event of future carbon or efficiency legislation
- Lower risk of defects litigation
- Lower risk of reputational damage due to quality issues



SOCIAL

Improved wellbeing and productivity reduce the load on health & social care and provides better life chances. These are potentially far-reaching benefits. Often difficult to quantify - they cannot be ignored.

- Improved health & wellbeing of communities
- Reduced demand on health and social services
- Improved learning outcomes for children
- Economic stimulus of construction
- Upskilling of the construction workforce
- Clear statement of intent for transition to a net zero economy
- Demonstrates compliance with social value policies & targets
- Aligns with several UN Sustainable Development Goals

AECB CarbonLite™

The AECB (Association for Environment Conscious Building) is a network of individuals and companies with a common aim of promoting sustainable building.

The AECB CarbonLite Building Standard is aimed at those wishing to create high-performance buildings using widely available technology.

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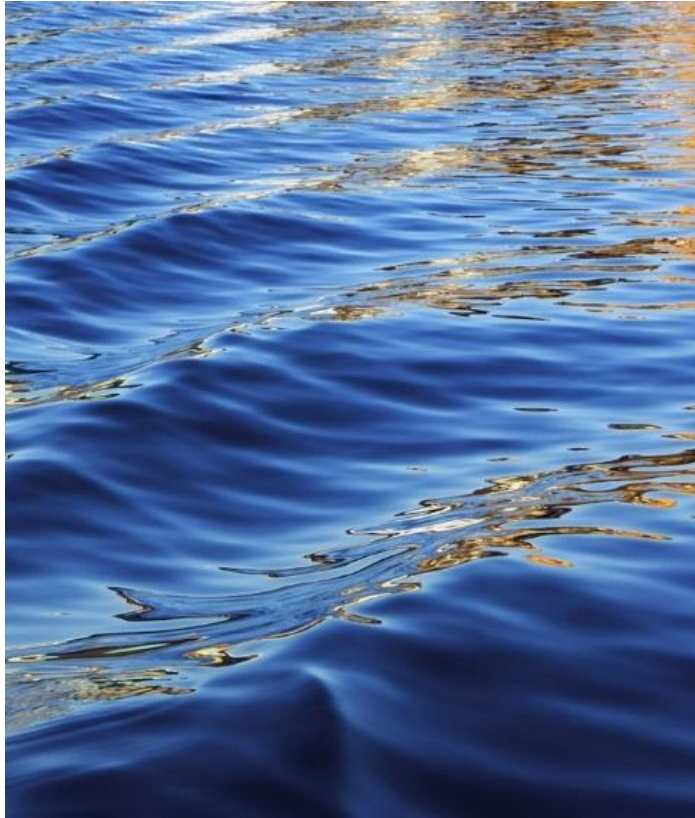


AECB CarbonLite™

AECB Standards certification criteria			
Criteria	Level 1	Level 2	Building Standard Level 3
	Retrofit Standard Level 1	Retrofit Standard Level 2	
Delivered space heating and cooling (kWh/m2/a)	report result	≤ 50 kWh/m2.a (≤ 100 kWh/m2.a with certifier-approved exemption)	≤ 40 kWh/m2.a
Primary Energy (PE, varies)	report result	report result	(varies) kWh/m2.a
Renewable (PER) (kWh/m2/anum)	report result	report result	≤ 75 kWh/m2.a
Ensure ventilation	Continuous MEV or MVHR must be installed : follow PAS 2035 Annex C or as required by Part F of the Building Regulations.		
Airtightness (q50)	≤5.0 m3/m2.h	≤2.0 m3/m2.h	≤ 1.5 m3/m2.h
Thermal Bridges	N/A. If some additional & significant fabric measures are being replaced or installed, certifiers will advise whether Level 2 requirements are applicable.	Assumed to be less than 0.01W/mk, else accounted for in PHPP or for L1 & L2 retrofit standards a default heat loss factor may be used.	Assumed to be less than 0.01W/mk, else accounted for in PHPP or for L1 & L2 retrofit standards a default heat loss factor may be used.
Surface Condensation (fRsi) assessed		fRsi not to exceed criteria in PHPP, or 0.75 (as Building Regulations/ PAS2035), or local standards - whichever is more onerous.	fRsi not to exceed criteria in PHPP, or 0.75 (as Building Regulations/ PAS2035), or local standards - whichever is more onerous.
Heating System	Change existing fossil fuel (or direct electric) heating system to a heat pump.	Existing heating systems may be retained, but a practical plan to allow for future low carbon heating supply must be in place.	Install a non fossil fuel system or connect to a low carbon district heating network.
Thermal Comfort	PHPP modelled overheating risk, <10% Acceptable (Guidance: <5% Good practice or <3% Best practice)		
Energy Model using PHPP, showing:			
	A. Pre-retrofit Baseline B. Level 1 achieved C. Retrofit scenario showing how Level 2 could be achieved (≤ 50 - 100 kWh/m2.a)	Level 2 achieved	Building Standard achieved
Where a heat pump is installed			
	For certification the following applies: Acceptable - Heating system is designed and installed for flow temp <50°C; Best Practice - heating system is designed and installed for flow temp <45°C		
	L1 - extensions If you are also building an extension as part of a Level 1 retrofit your AECB Approved Certifier will advise on an appropriate specification for this part of the project. Typically, this will involve building a new extension to levels of fabric performance expected from the AECB Building Standard, i.e., excellent U-values and airtightness for walls, floors, roofs, and windows.	L2 - extensions If you are also building an extension as part of a Level 2 retrofit your AECB Approved Certifier will advise on an appropriate specification for this part of the project – treating the new and retrofitted areas of the building as a single building and to comply with the overall energy performance criteria of the Level 2 Standard. Typically, this will involve building a new extension to levels of fabric performance expected from the AECB Building Standard, i.e., excellent U-values and airtightness for walls, floors, roofs, and windows.	



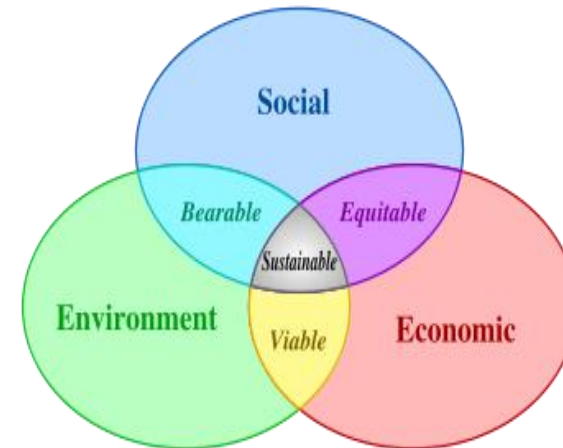
Key concepts



What is sustainability?

A sustainable development aims to balance:

- Social
- Environmental
- Economic factors



“development which meets the needs of the present without compromising the ability of the future generations to meet their own needs” Brundtland Commission (1992)

Design - What makes a good house?

This is an exercise for you to think about what elements go into **making a house / home** that you would like to live in.

Split into 3 or 4 groups and discuss what elements you think go into making a good house or building. You have 10 minutes. One person from each group will then present their recommendations.

Making a Good House

- Welcoming
- Healthy and happy
- Easy to navigate and accessible
- Private and safe
- Access to open space (garden)
- Aesthetically pleasing
- Adequate space for living and storage
- Life-long homes (adaptable to different ages / uses)
- Easy to control systems (heating, ventilation, cleaning etc.)
- Energy and water efficient
- Cheap to run and Low maintenance



Sustainable Design

- Environmentally friendly build and maintain
- Fit for purpose and durable
- Adaptable
- Future Proofed
- Healthy
- Recyclable
- Cheap to build and maintain



Sustainable building

Increasing efficiency of building in energy, water, and materials.

Reducing the building impacts on human health and the environment.

Considering the entire *life cycle* of the building.

Through better:

- Siting and design
- Construction
- Operation
- Maintenance
- Removal or refurbishment



Energy Efficiency

Energy efficiency

Insulation

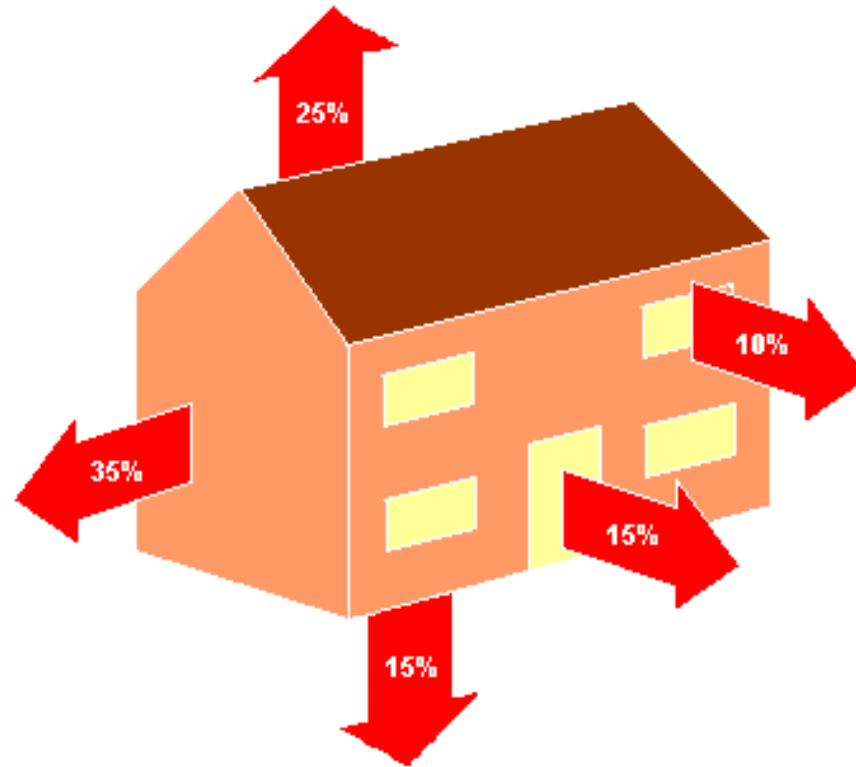
Thermal mass and passive solar gain

Thermal Bridging

Air tightness and ventilation

Energy Efficiency

- A typical house uses 100-150 kWh/m²/year from heating. Much of this is wasted through **air leaks** and **lack of insulation**.



Increasing Energy Efficiency

- Porch – to provide a 'heat-lock'.
- Large windows to the south (to allow for passive solar heating).
- Using certain rooms as thermal barriers to the northern aspect (garages, toilets, utility room).
- Good levels of natural light sources (sun pipes, large windows south facing.)
- Well insulated walls, **floors**, roofs, doors and windows.
- High levels of air tightness.



Insulation

Heat energy is lost through the elements of the building (walls, ceiling, floors, doors and windows) by conduction (the movement of heat through a solid).

Insulating the building envelope slows down the heat flow allowing greater retention of heat within the building.

It also helps create a more stable indoor temperature, preventing condensation and reducing over heating during summer.

Important considerations:

- Appropriate to structure
- Must be installed correctly



U-values

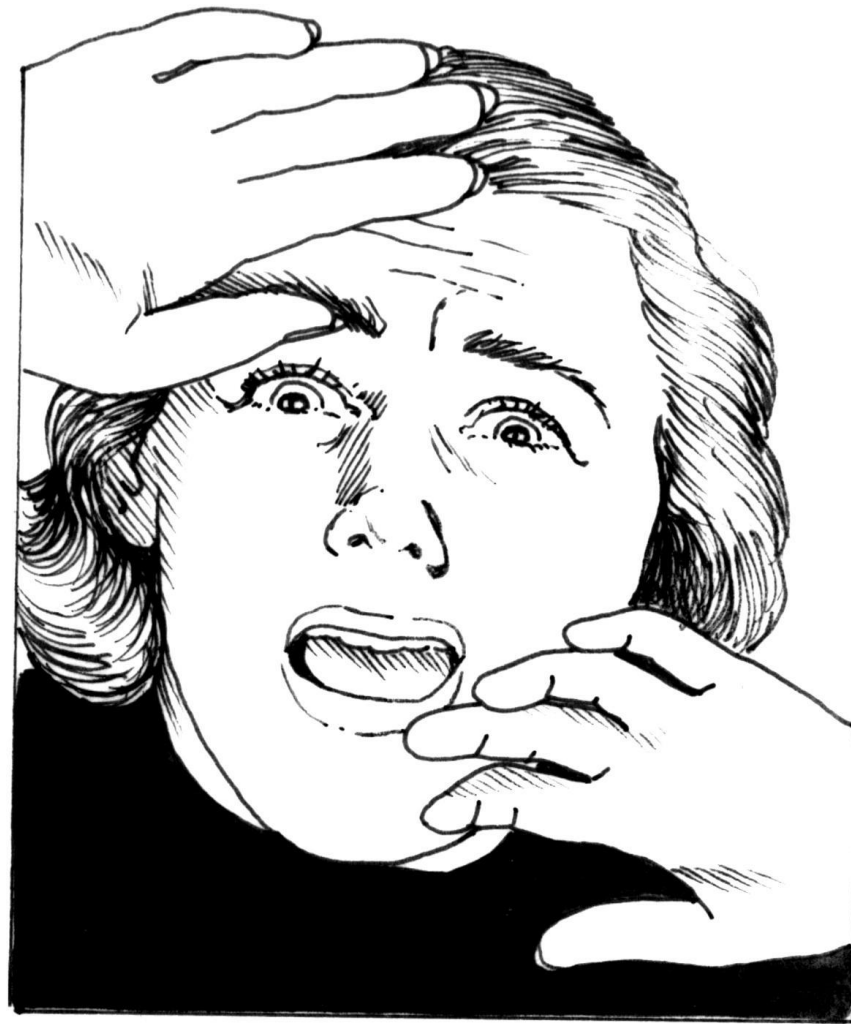
- **U-values, R-values and conductivities**

Best practice insulation specifications are generally expressed in terms of a U-value. This is the overall rate of energy transfer through 1m² of a particular building element when the air temperatures on either side differ by 1°C. It is measured in W/m²K.

For some refurbishment situations, it is more useful to quote thermal resistances, or R-values. Thermal resistance depends on thermal conductivity (λ) and thickness (d): $R = d / \lambda$ and is measured in m²K/W.

Thermal conductivities of insulating materials are published by manufacturers. The resistances of each component (as well as the resistances of cavities and surfaces) are used to calculate the overall thermal resistance or R-value for the structural element.

The U-value is the reciprocal of this figure.



Simply

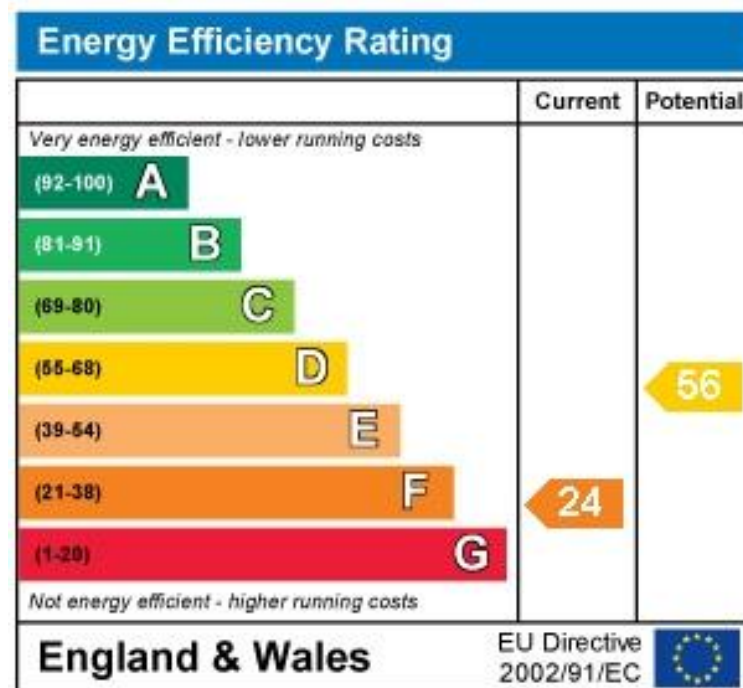
U values:

These are values of thermal performance for structural elements of a house.

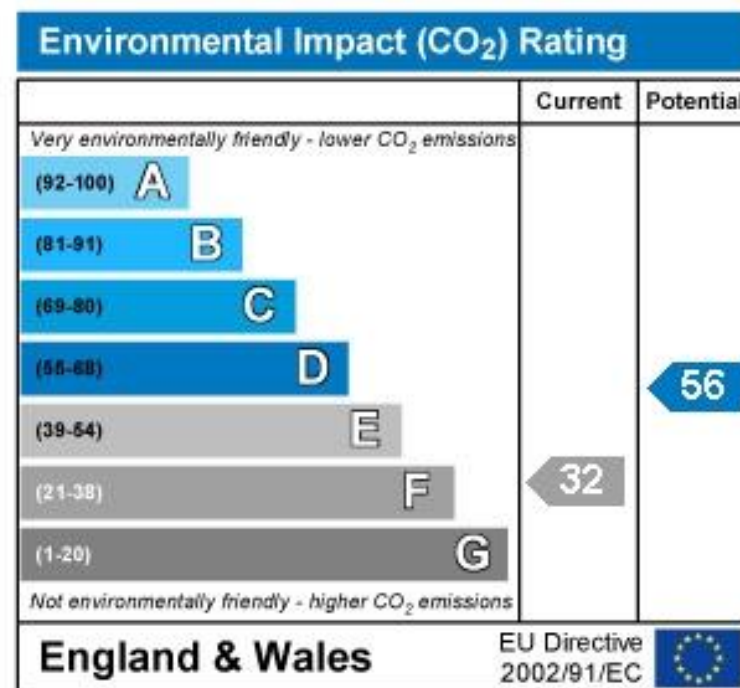
U values vary with the materials, specification, application and size.

The higher the U value the less well performing the structure, so a U value for a window of 1.1 is much better than that of one with 2.

This home's performance is rated in terms of the energy use per square metre of floor area, energy efficiency based on fuel costs and environmental impact based on carbon dioxide (CO₂) emissions.

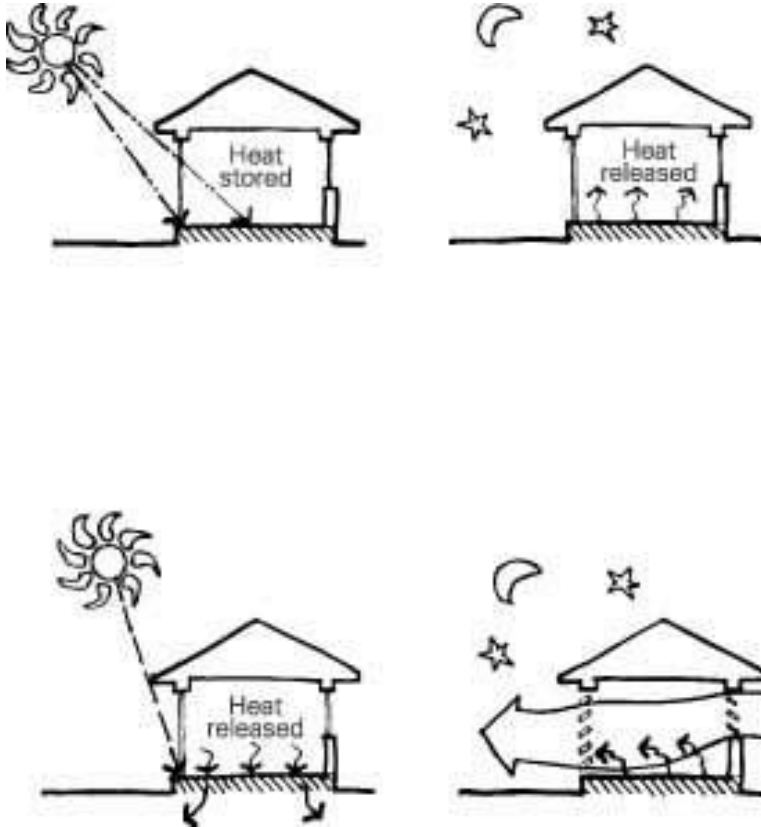


The energy efficiency rating is a measure of the overall efficiency of a home. The higher the rating the more energy efficient the home is and the lower the fuel bills will be.



The environmental impact rating is a measure of a home's impact on the environment in terms of carbon dioxide (CO₂) emissions. The higher the rating the less impact it has on the environment.

Thermal Mass and passive Solar Gain



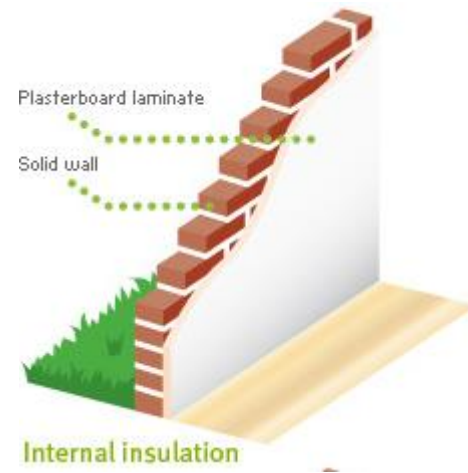
The **positioning** and **amount** of mass is essential to store enough solar energy in the winter and not too much in the summer to avoid overheating.

Passive Solar Gain

Overheating control

- Mainly passive measures like overhangs, shading devices (e.g. awnings) are used.
- In a Passive House these measures means less overheating than regular houses because the thermal insulation keeps the summer heat out.



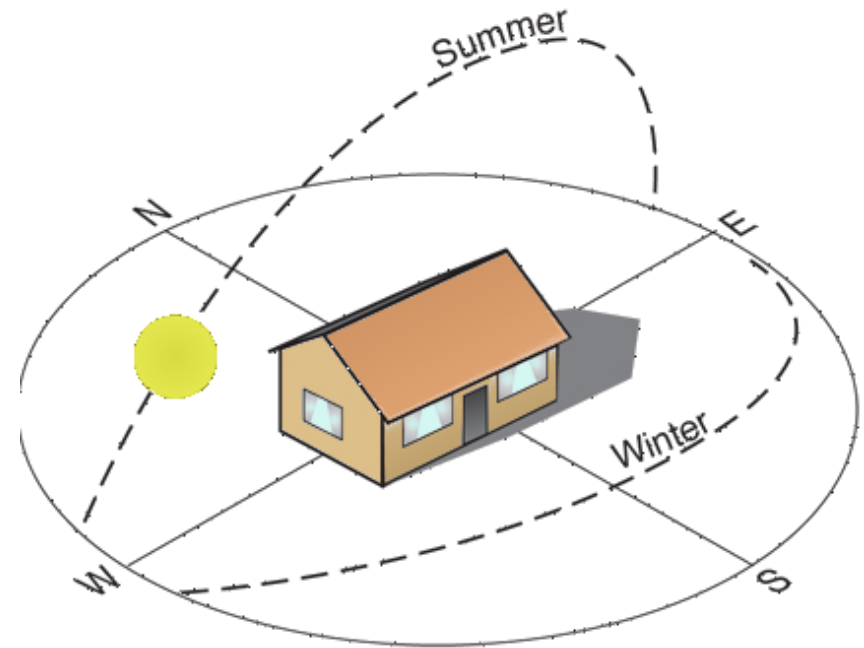


Design – Considering your location

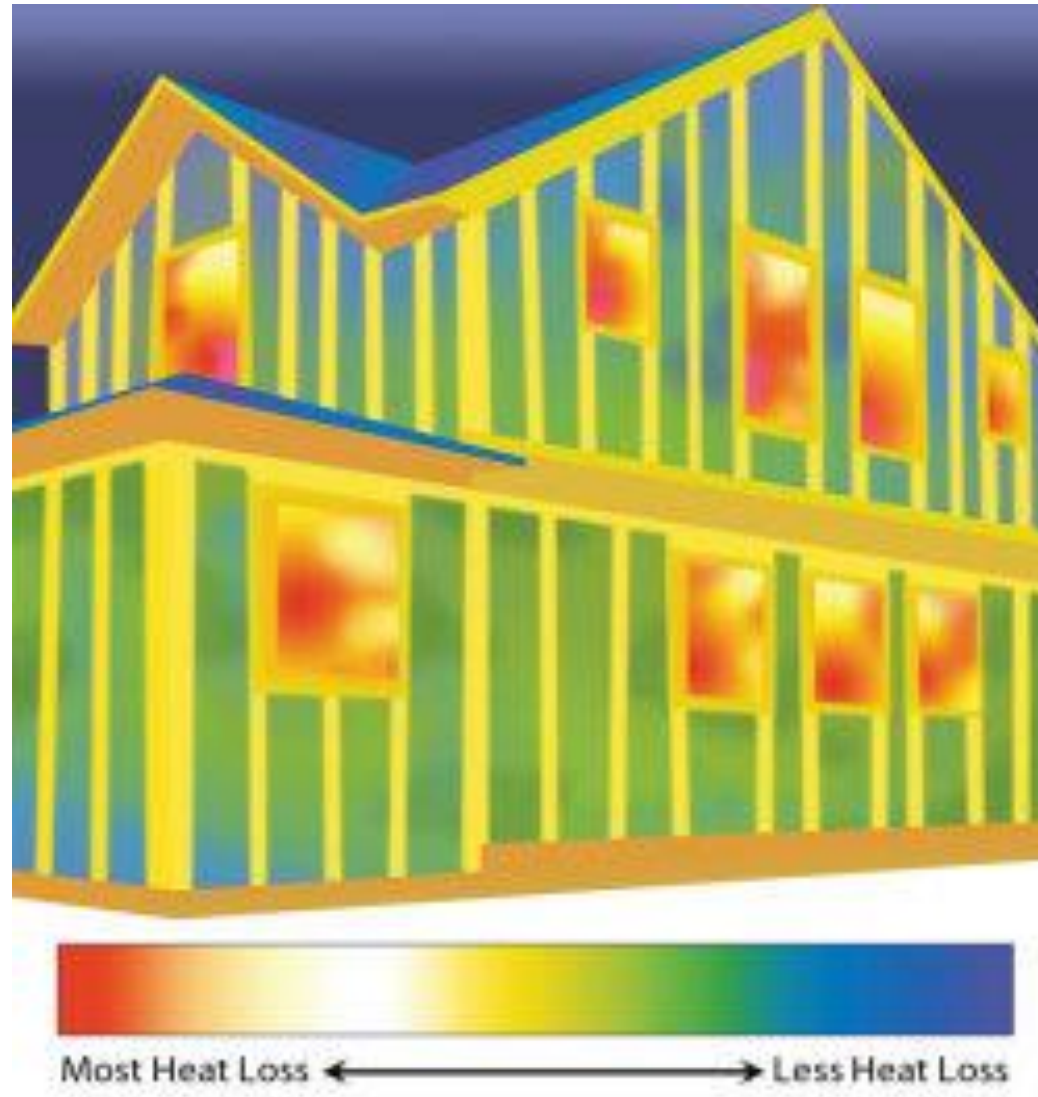
- Wind Directions
- Local materials available
- Local vernacular
- Environmental impact
- Rainwater run-off
- Orientation – for utilising solar energy.
- Service infrastructure – mains, water, sewage etc



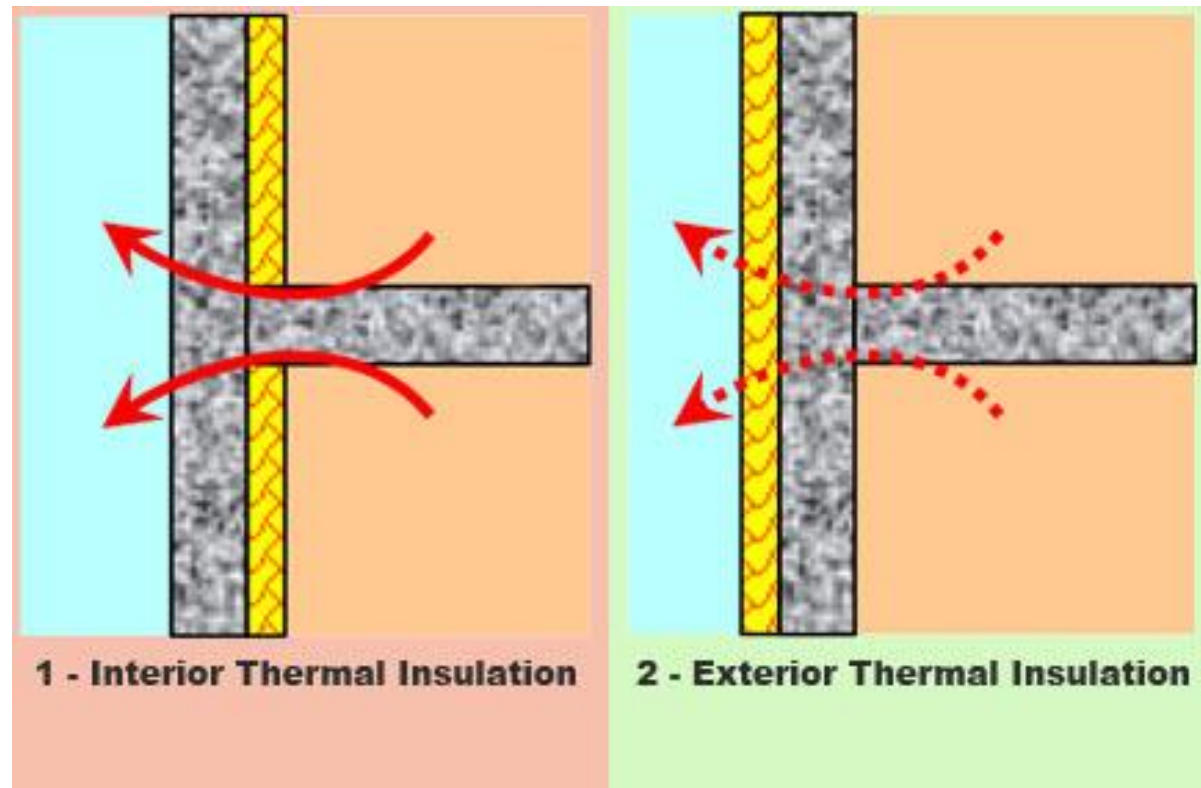
Location and orientation



Thermal bridging



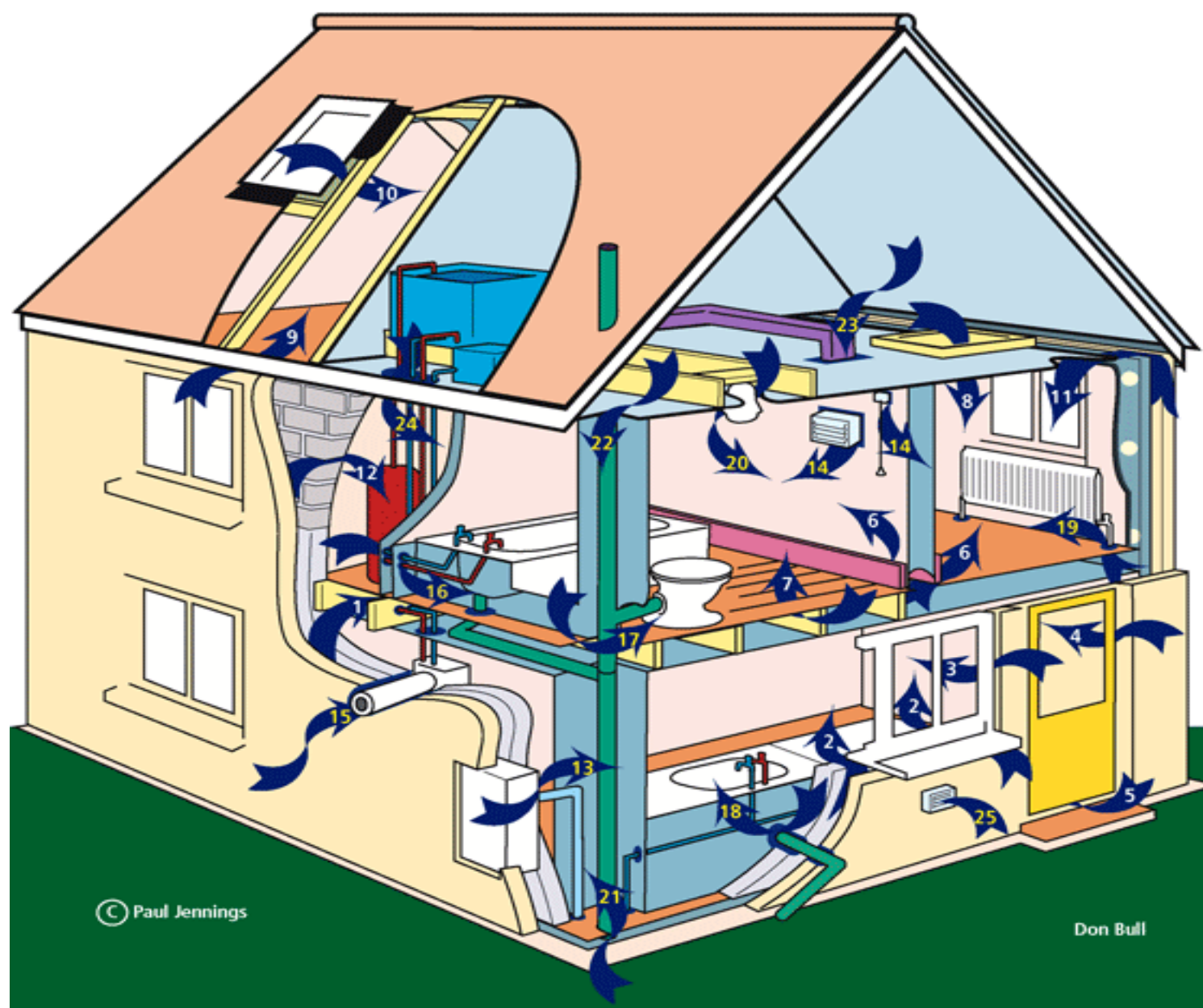
Thermal bridging



Air Tightness

Air Infiltration: Warm air leaking through holes and gaps in the building envelope (even very small gaps can have a significant effect).

- Air can escape through gaps at seams and interfaces where building elements meet.
- Sealing problem areas keeps warm air from leaking out from the building.
- Not to be confused with ventilation.



Common points of air leakage

Air Tightness

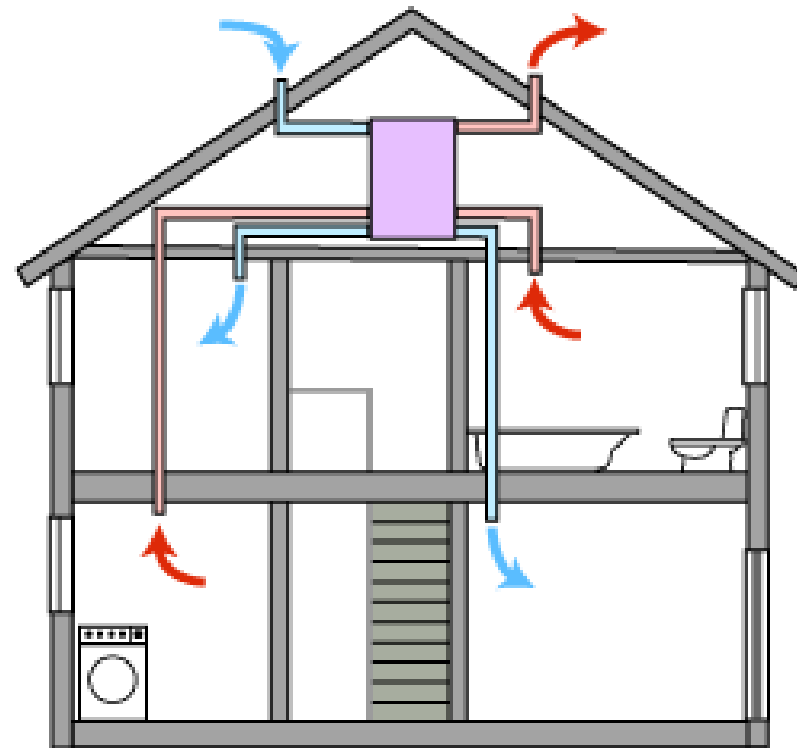
The current air tightness requirements are expressed in terms of air permeability, measured in cubic meters of air leakage per hour per square meter of envelope area at a reference pressure of 50 Pascals ($\text{m}^3/\text{h}.\text{m}^2$).

The maximum allowable air permeability for new buildings is $10 \text{ m}^3/\text{h}.\text{m}^2$ for new dwellings. This essentially means that when the test is completed, all of the air within the room can be replaced up to 10 times to meet the standard.

ARE YOU
ALL RIGHT?



Get airtight and then ventilate right



Ventilation standards

- Common practice ventilation rate is recommended for an entire dwelling of between 0.5 and 1.5 air changes per hour (ac/h)
- Passivehaus recommends 0.3 ac/h

Micro Generation

Micro Generation

Minimise demand and Increase efficiency by:

- Behaviour changes
- Retrofit devices
- Draft proofing and air tightness
- Replace inefficient devices
- Insulation where appropriate

These must all be done before considering generating your own energy!

Choosing a suitable renewable system

Things to consider:

- Your Property
- Location and orientation
- Existing systems: Heating and DHW
- Usage patterns and demands
- Design considerations for each system

Micro-Renewables

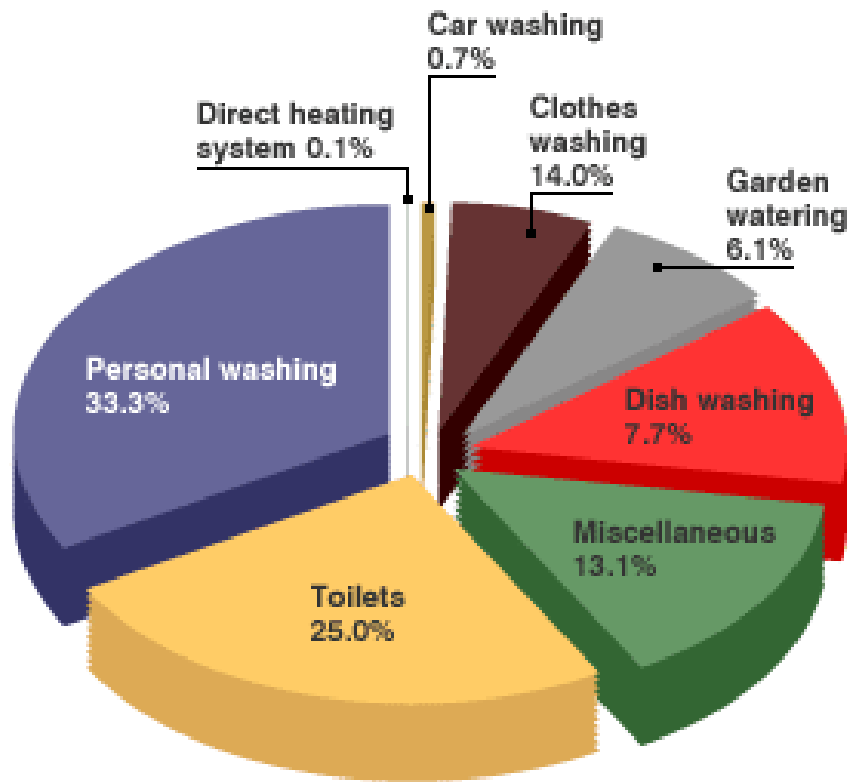
What are the main types of micro-renewables that are available?

- Solar thermal (water medium or air medium)
- Solar PV
- Wind turbines
- Micro-hydro
- Biomass
- Ground source / Air source heat pumps (require electricity, but high power co-efficiencies regain overall efficiency)
- Combined Heat and Power (require non-renewable fuels, but potentially more efficient)
- Fuel Cells (require fuel to be processed and this can require initial high energy input in order to create the hydrogen. Therefore hydrogen must be created by renewable energy sources to be 'green')

Water efficiency

Water Use

How a household uses water



SOURCE: Environment Agency

The Average house hold uses 100-200 Litres per person per day.

Water has a carbon footprint and a high embodied energy

The water industry consumes 8% of the UK total energy production for treatment and transportation (pumping).

Water Efficiency

First **Identify** water uses and potential reduction

Water reduction through **behaviour** changes

Water reduction through simple and cheap **retrofit devices**

Then:

1. Water Audit – Identify main use and efficiencies
2. Reduce main usage via
 - Water collection (Rainwater)
 - Water recycling (Grey water, Black water)
 - Water management and control systems
 - Low flow toilets, Compost toilets, Waterless urinals



Reuse and recycle

Water recycling – Grey water (water from baths, sinks)

- Used for toilets, gardens.
- Storage issue: Day storage flushing required if not used.
- Eco-play is the most common system in use.



Water recycling – Black water (water from toilets)

- Used to go back into toilets, but once treated could be used for anything.
- Expensive and questionable use of resources given that the sewerage system is a very efficient tool for this purpose. Unless off grid.



Rain Water Harvesting

Collected rainwater can be used for:

- Watering plants / washing bike
- Washing machines
- Toilets

With treatment can be used:

- Person washing (shower, bath etc.)
- Drinking
- All uses within the house!!

A second water circuit is required and also potential for need to pump water from a main collection tank to a header tank.



Rain Water Harvesting



Water: Run-off

Run-off can cause flash flooding.

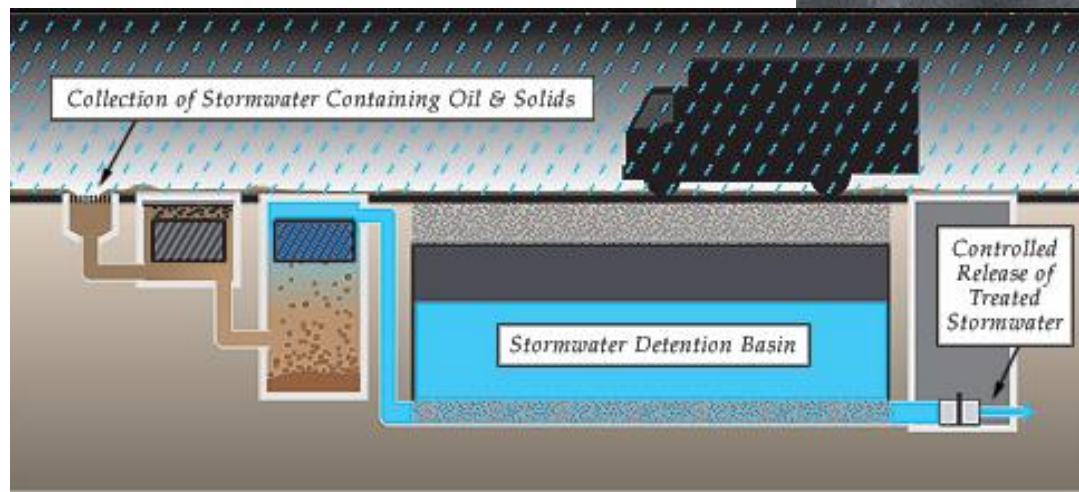
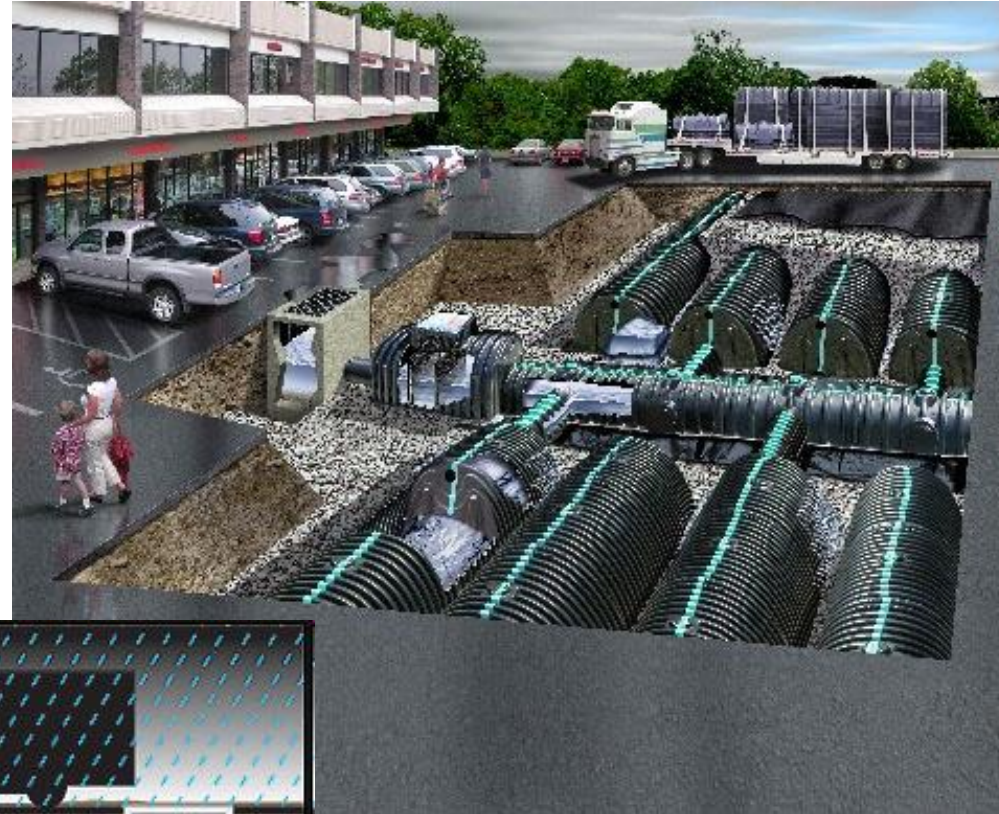
Using SUDS or Sustainable (Urban) Drainage Systems this can be achieved:

- Buffers (rainwater collection)
- Permeable surfaces
- Storm water detention/Retention (tank systems)
- Storm water infiltration (swales)
- Evapo-transpiration (green roofs)

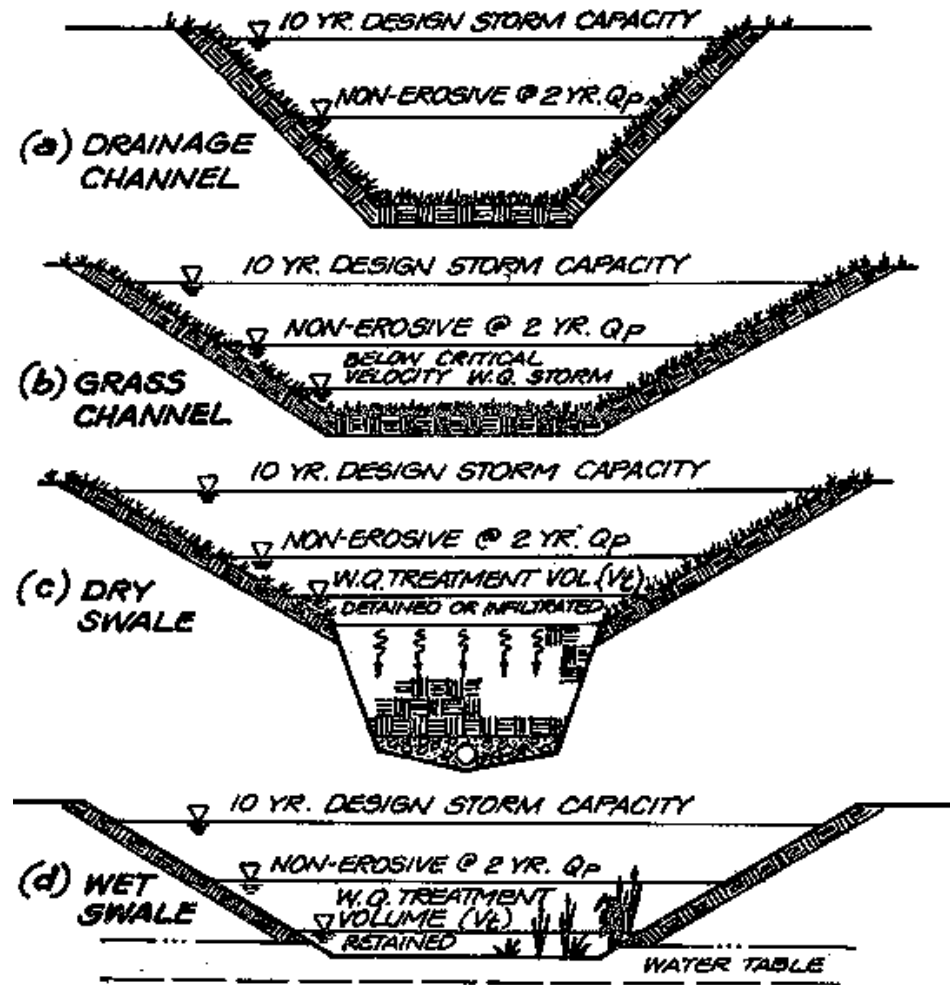
Permeable surfaces



Storm water detention/Retention



Storm water infiltration (swales)



Timbers West Swales 11/7/02

Green Roofs

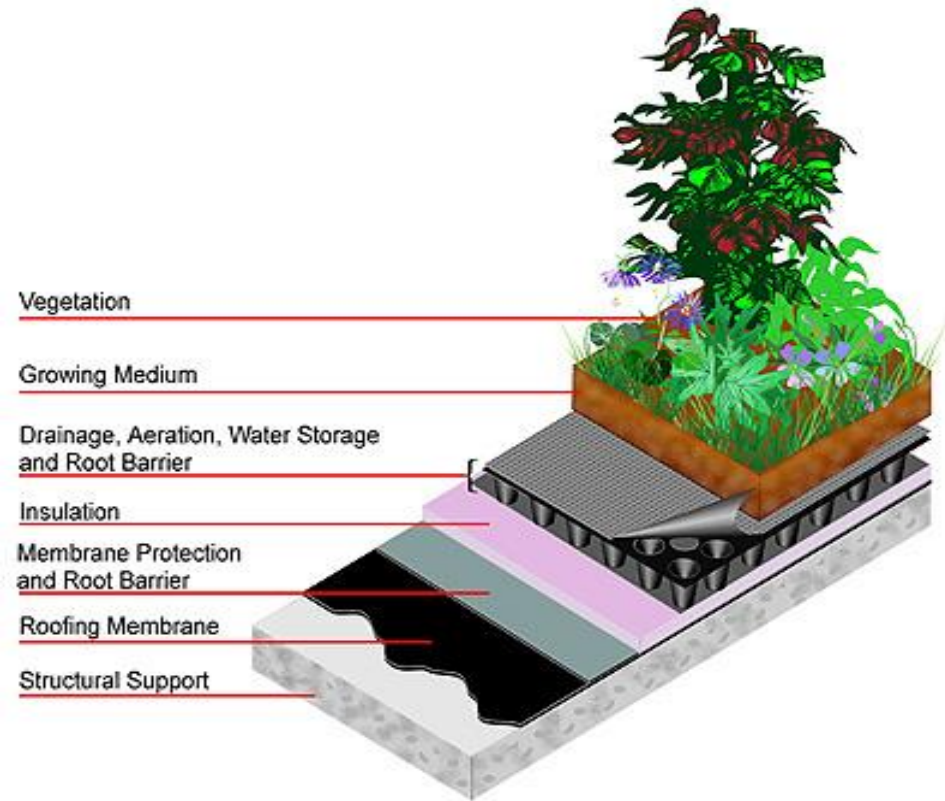
Two main types:

- Intensive

Traditional roof gardens, which require a reasonable depth of soil to grow large plants or conventional lawn. Labour-intensive, require irrigation, feeding and other maintenance. Could be herbs to small trees.

- Extensive

Virtually self sustaining, requiring minimum maintenance. Established on a very thin layer of soil. Typically sedum species and mosses.



Green Roof



ACROS Fukuoka building in Fukuoka City, Japan









Photo provided by:
Emilio Ancaya
Living Roofs, Inc.

Green Spaces

Green Space

Green space is important for a number of reasons:

- Cooling
- Sense of space
- Social space
- Security / Safety
- Slowing water run-off
- Ecology
- Food production
- Aesthetics

Imaginative models might be required:

- Green roofs, turf roofed car parks, roof terraces, controlled access parks, etc.



Green space: Internal



Materials

Materials

Issues to consider when choosing appropriate and compatible materials:

- Breathable structures
- Local vernacular
- Low environmental impact
- Use of building / occupancy levels
- Sound and heat insulation level required



Sustainable building Materials

What are the advantages of using sustainable building materials?

- Low Embodied energy
- Minimise waste
- Reclaimed materials
- Locally sourced
- Natural sources
- Materials from renewable sources
- Ethically sourced
- Durable
- Healthy to use and live with

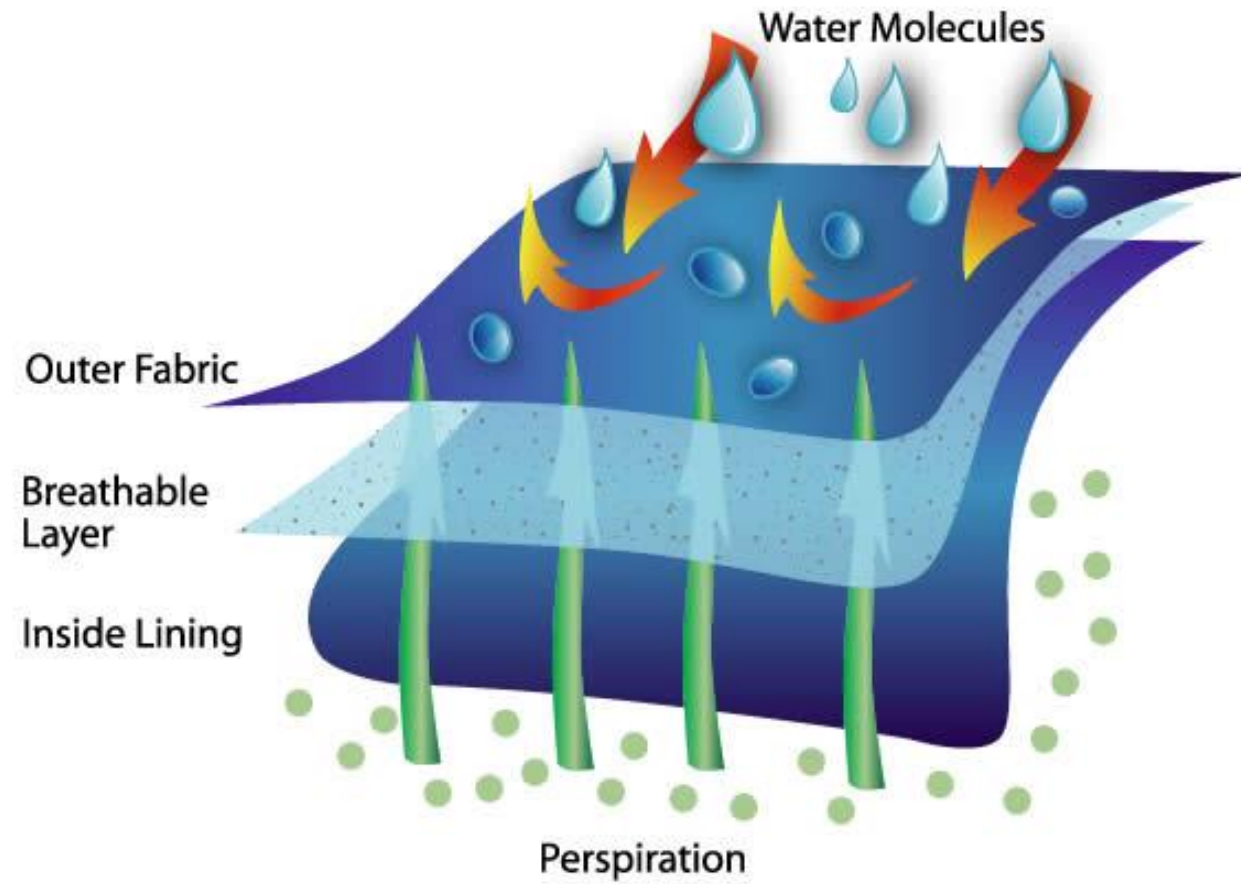
Breathability

Breathability is about the way water and water vapour moves in a building (nothing to do with pipes and plumbing!)

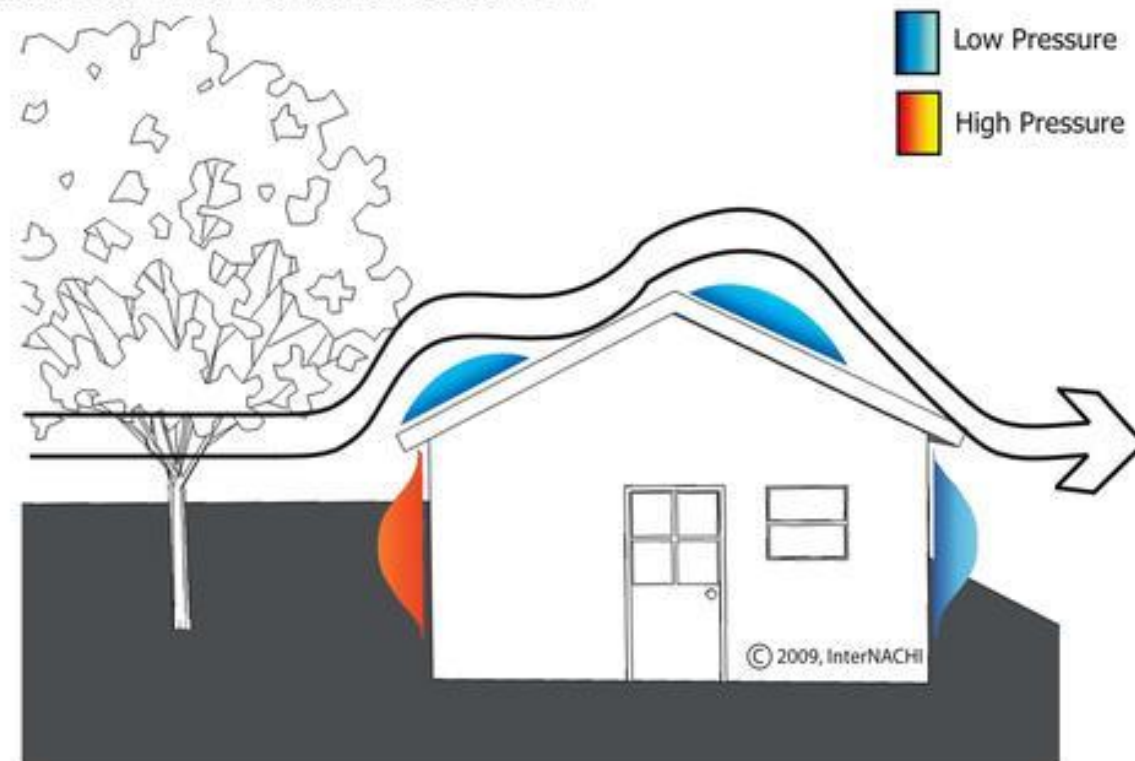
Materials and structures that allow water vapour to pass through them are called breathable or permeable.

Some materials are able to absorb and release water vapour easily, they are hygroscopic materials.

The Ultimate In Breathability



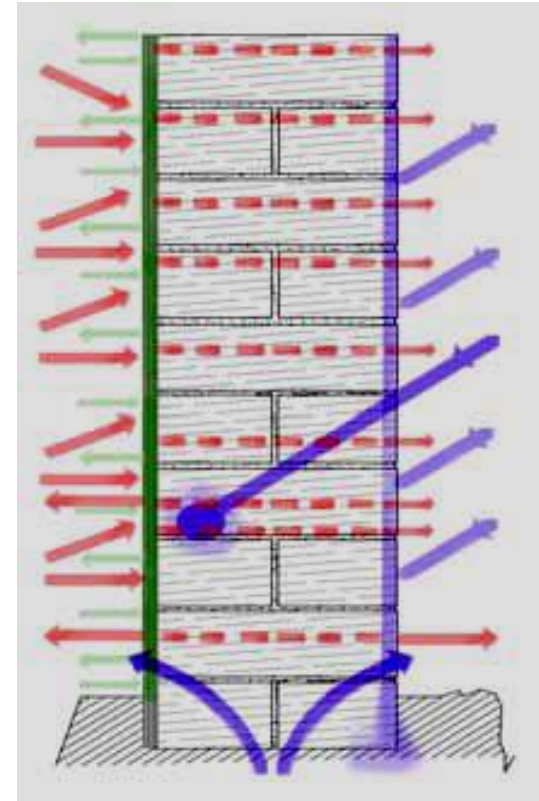
External Wind Pressure: Gable View



Breathability

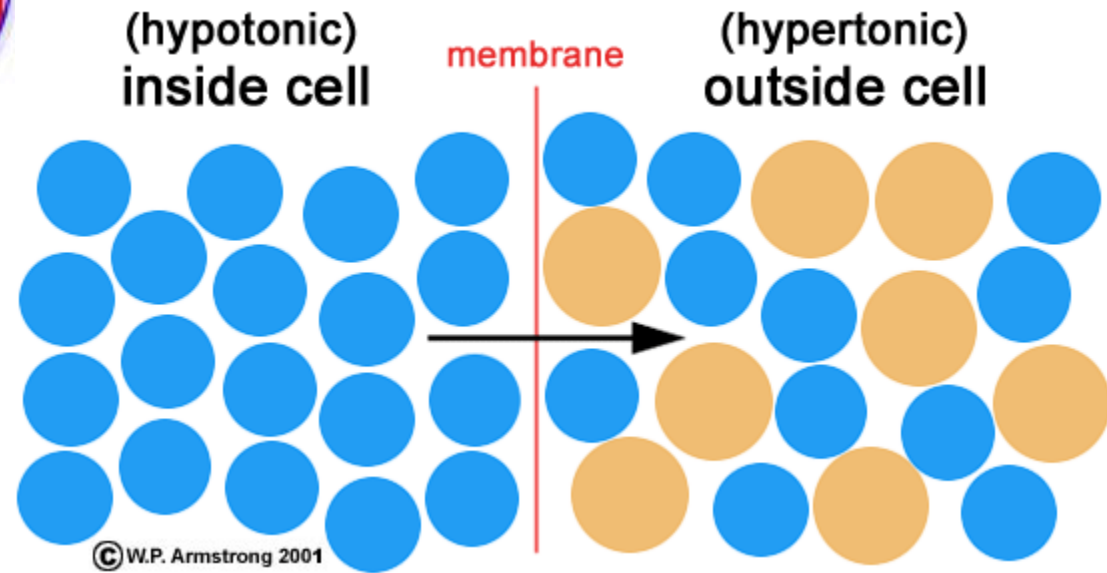
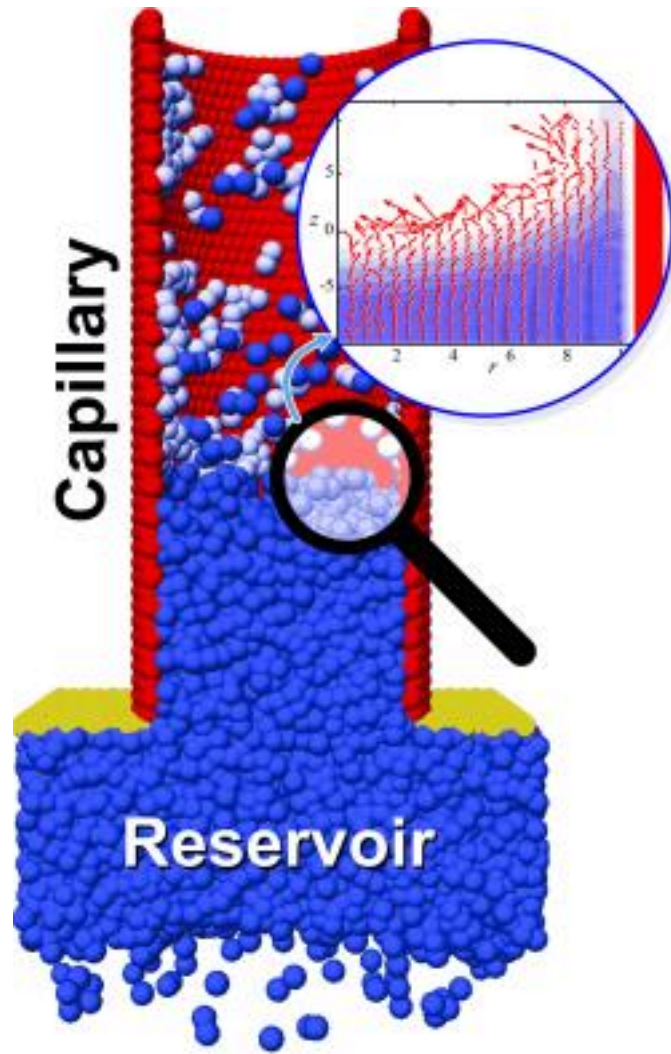
Water affects thermal performance of buildings and the health of the occupants.

Buildings made from 'breathable' materials regulate moisture and humidity levels. Keeping the building and it's occupants healthy.



Different materials also have different types of permeability.

Capillary
Osmotic



Natural versus conventional

Produced as a result of natural processes:

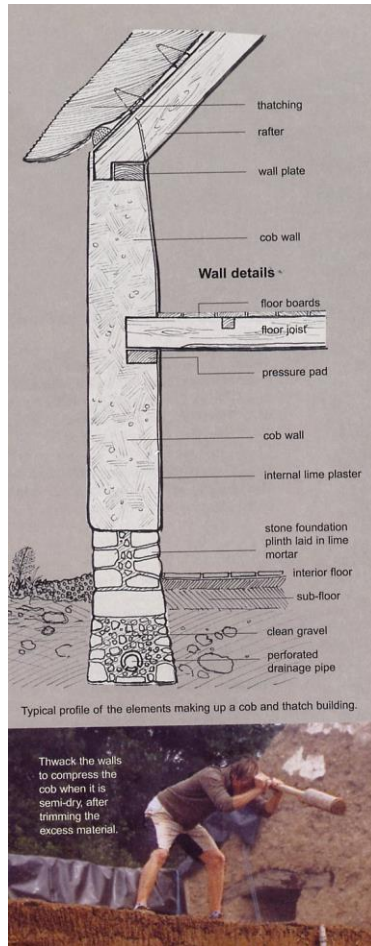
- Biodegradable
- Renewable
- Non-toxic
- Lock up CO2

Synthetic and Man-Made substances:

- Petrochemical derived
- Toxic and polluting
- Non-renewable
- Contribute to climate change

Un-fired clay brick / Human waste brick	Cement brick
Wooden windows and doors (double to triple)	uPVC windows and doors
Timber frame	Steel frame
Limecrete	Concrete
Natural insulations	Compound foam insulation

Natural Building



“A good hat and stout pair of wellies” is required for natural building structures



Durability of sustainable and natural materials

Cob Building



Hemp Building



Strawbale building



Earthship buildings



Building with lime

Beneficial properties

- Breathable
- Recyclable
- Allows recycling of bricks
- Lower carbon dioxide emissions
- Absorption of carbon dioxide in curing process



Issues

- Getting the right strength
- Getting the right mix
- Time required for curing
- Time of the year for use



Natural Insulation

- Cork
- Recycled cotton (jeans)
- Recycled paper
- Sheep's wool
- Hemp
- Flax

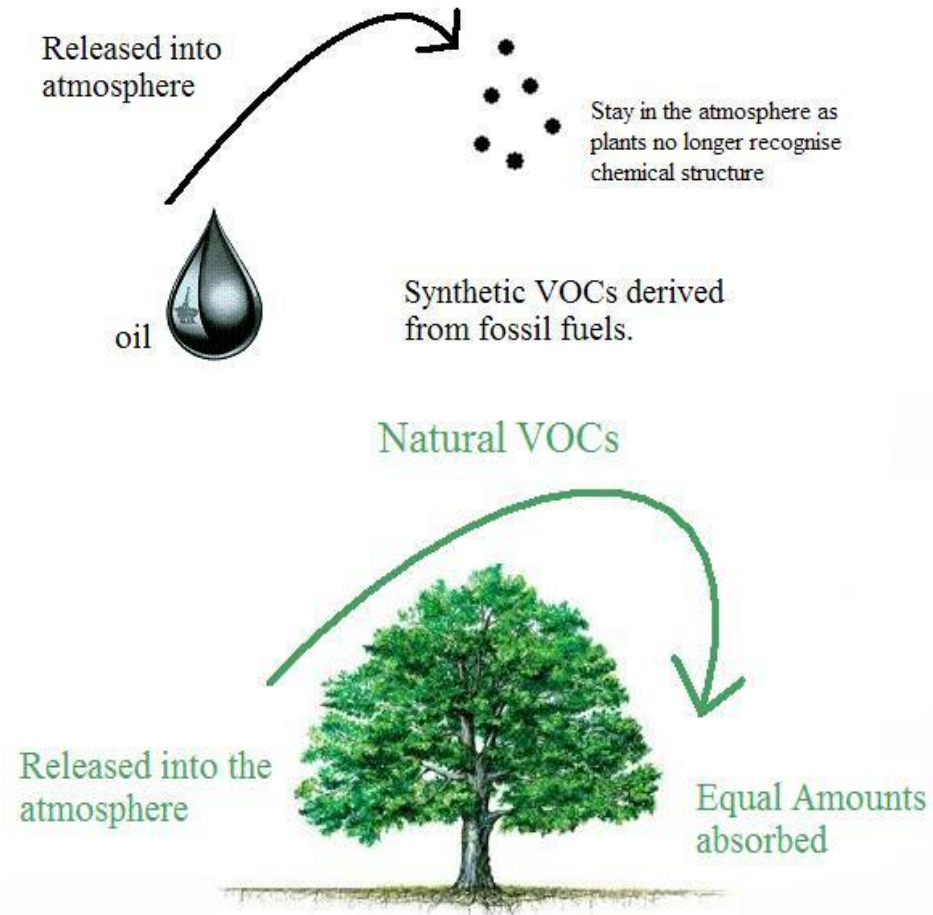


The advantages of natural fibres over conventional materials like PIR foam boards (Kingspan, Celotex etc.) is that they are:

- Breathable
- Non toxic
- Low embodied energy
- Healthy to use and live with



Natural paints and finishes

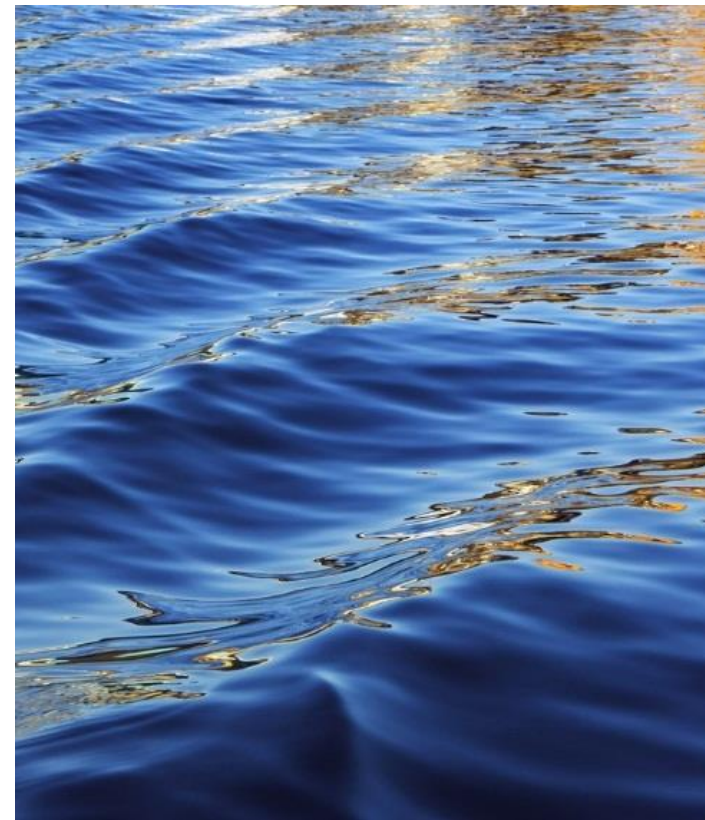


Refurbishment



Case study 1

Heat sources



Case study: boilers to Heat Pumps

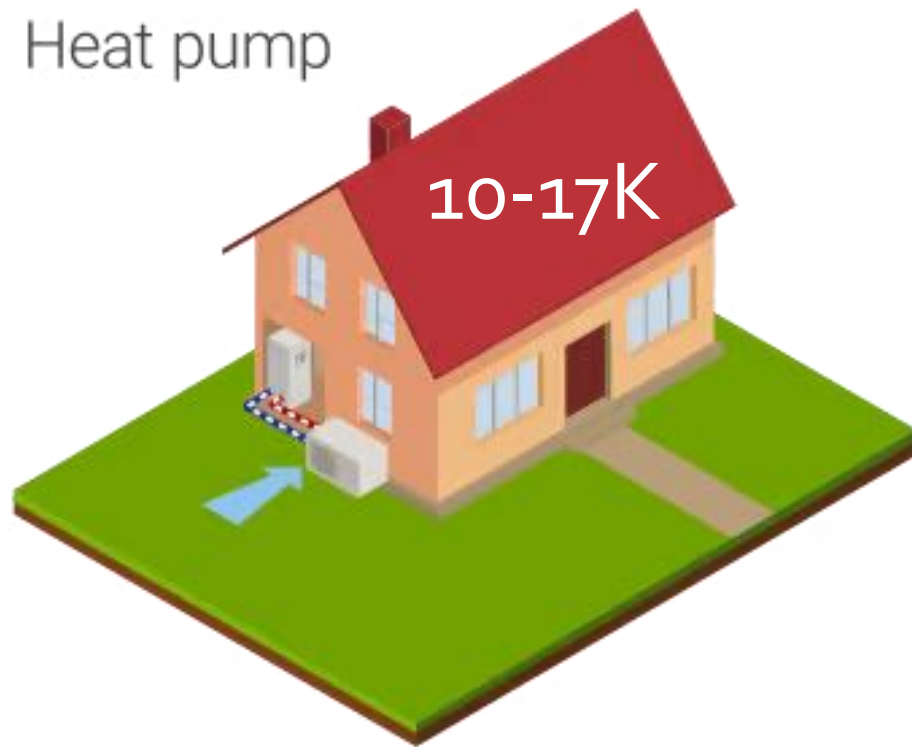
- The ban on new fossil fuel boilers for certain households will be delayed while cash grants for boiler upgrade schemes will increase by 50% to £7,500 for those who want to transition now.



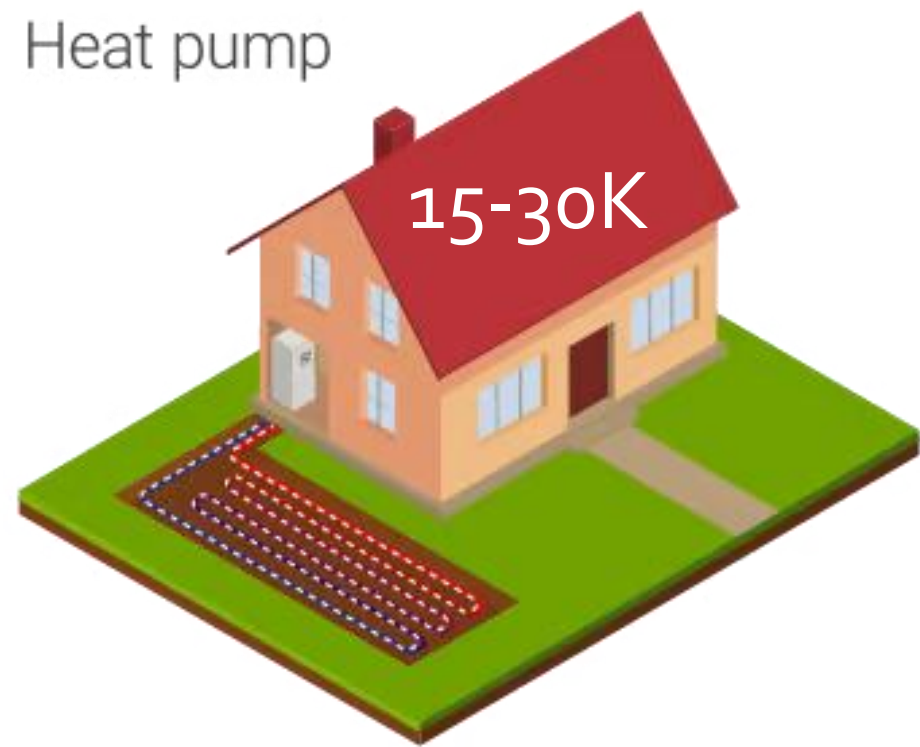
+£7,500



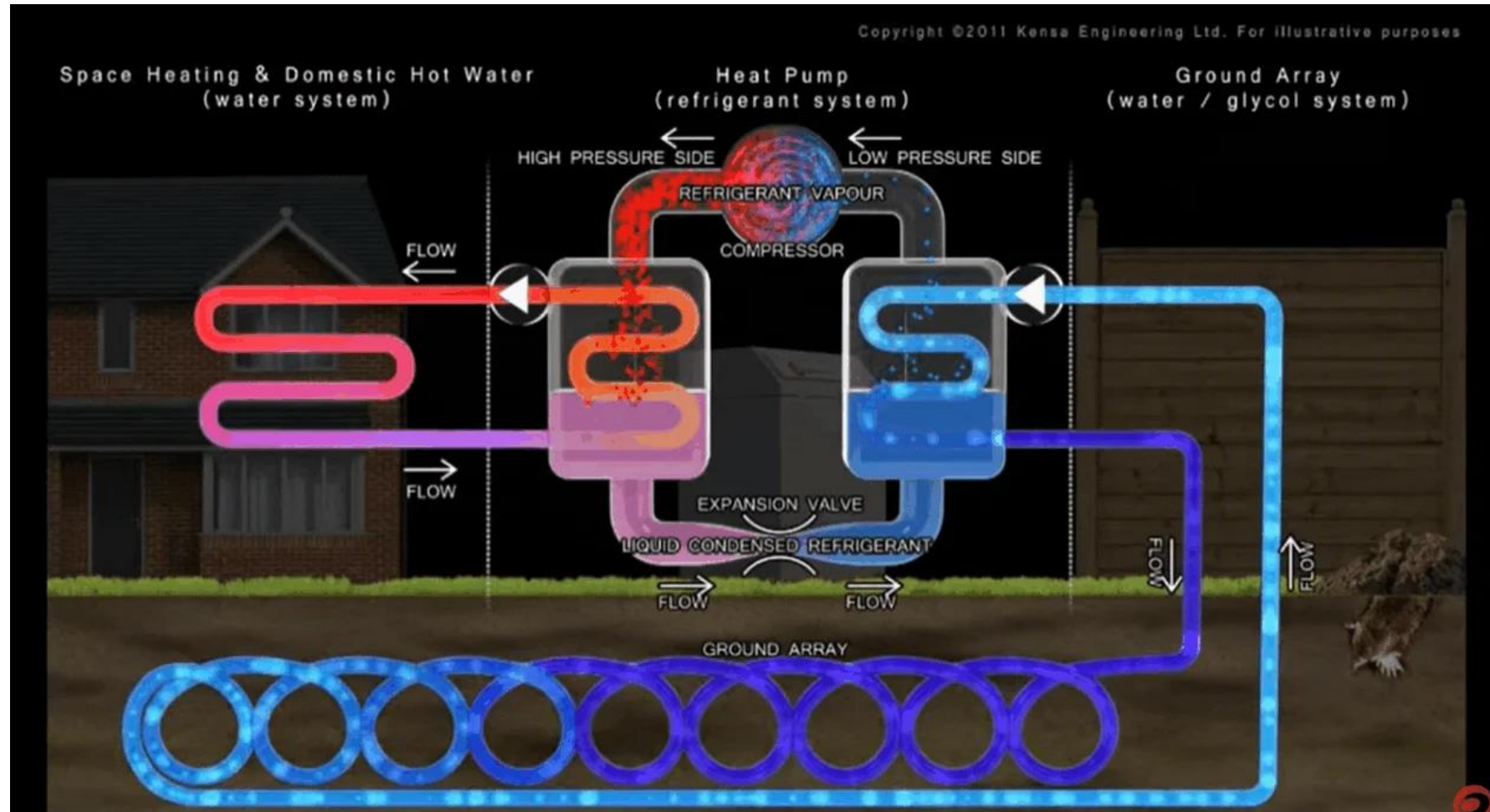
Air Source Heat pump



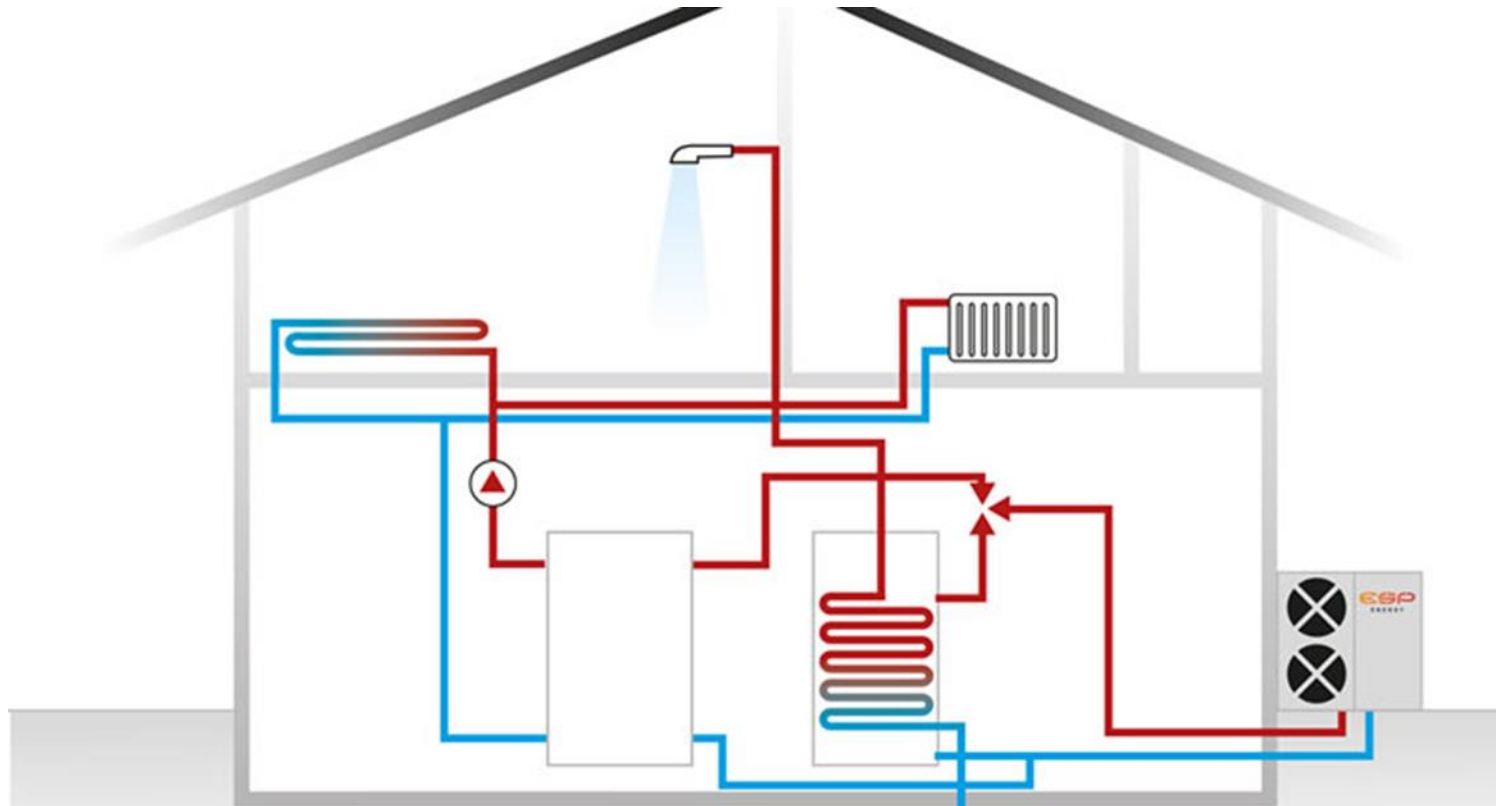
Ground Source Heat pump



Ground source heat pumps



Air source heat pumps



Issues



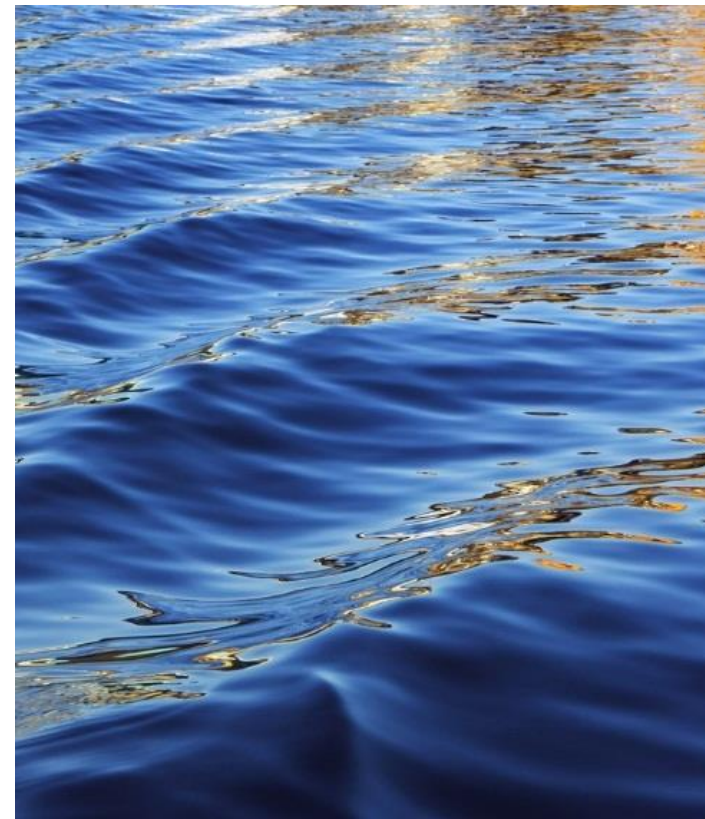
Issues

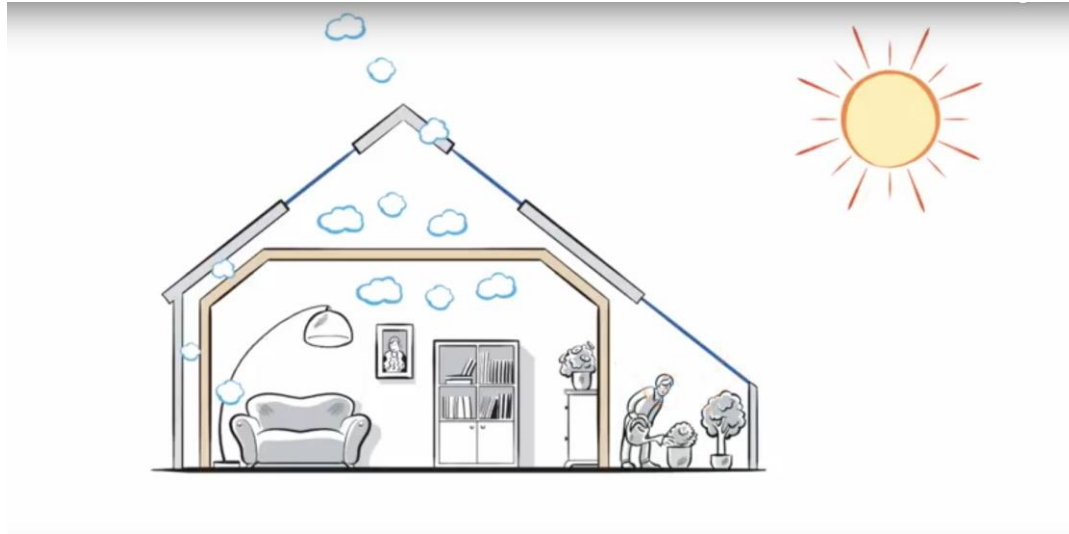




Case study 2

Bio solar house





Bio-Solar House

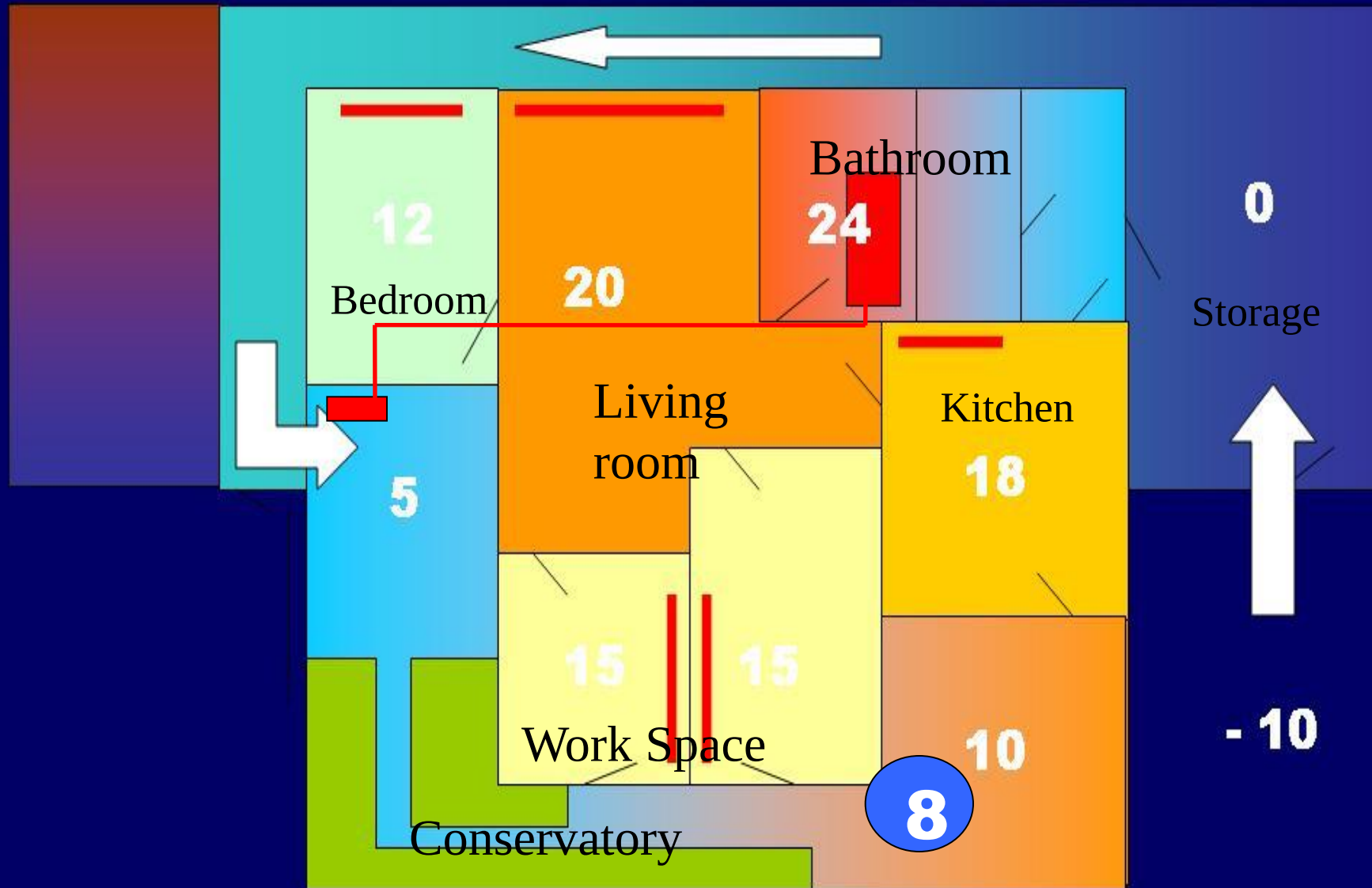








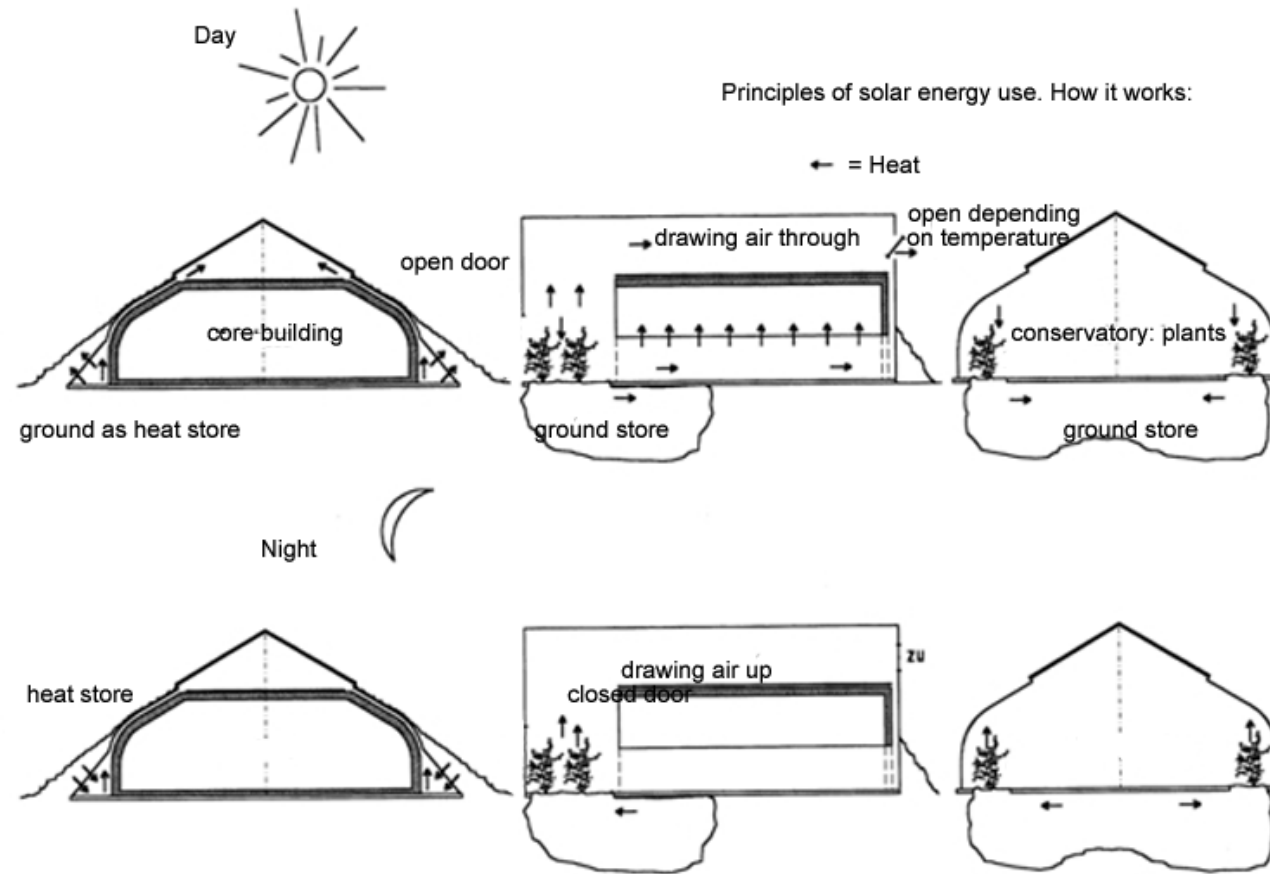




Zonierung Kälte/Wärme



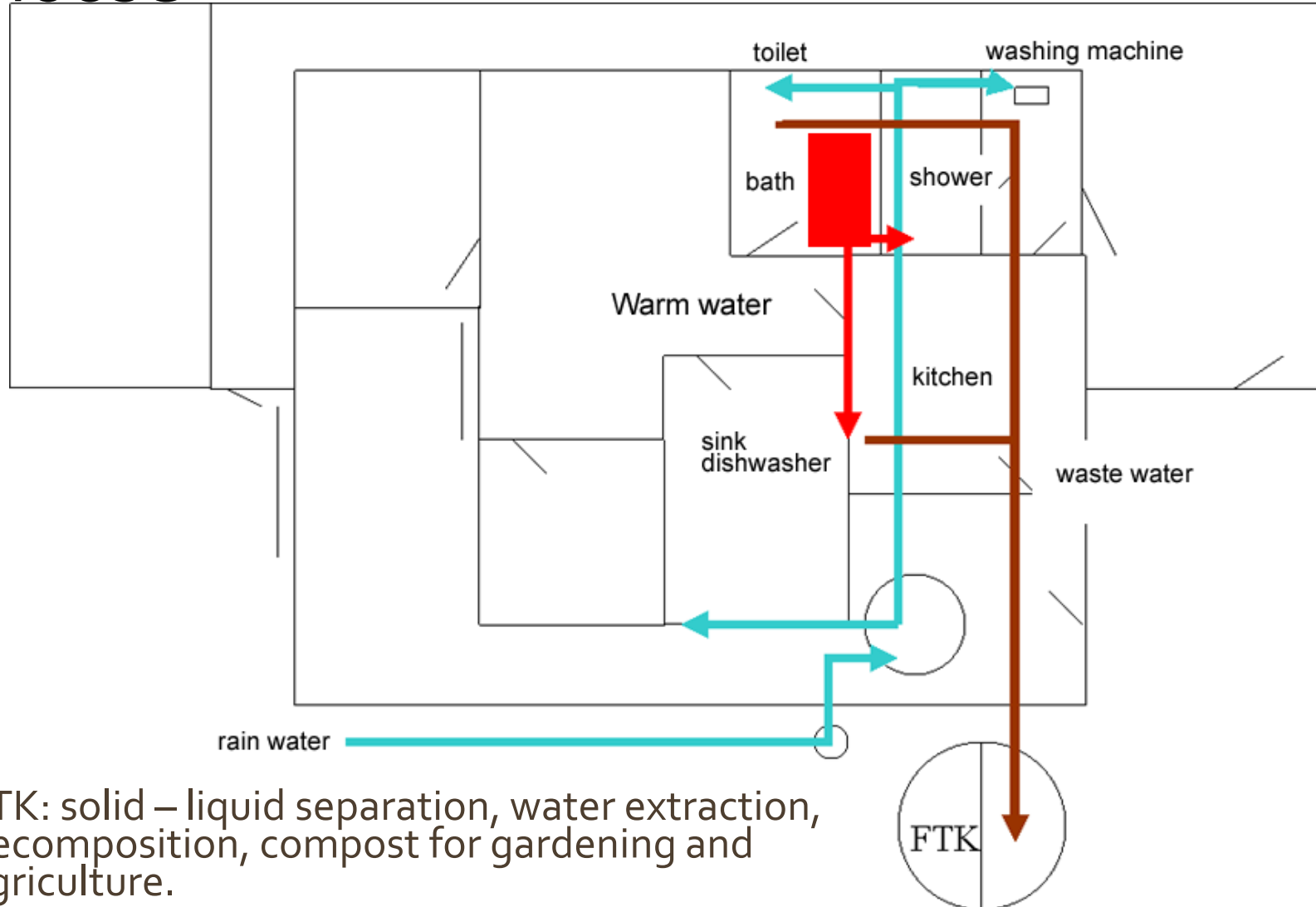
Bio-solar House







Rain water and water use in the bio-solar house



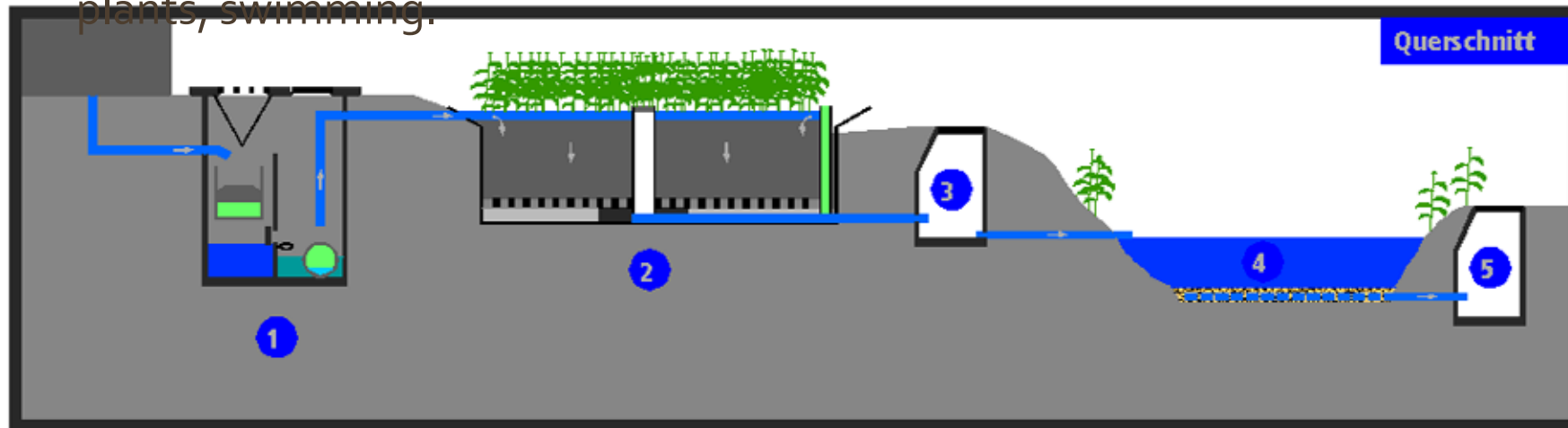
1. FTK. Sort at source: solid – liquid separation.

Composting water extraction, decomposition, compost for gardening and agriculture.

2. Biological filtration: Vertical filter, planted (reed bed).

3. Control chamber, for testing samples.

4. Natural pond; can be used as buffer, condensation, fire control, fish, water plants, swimming.













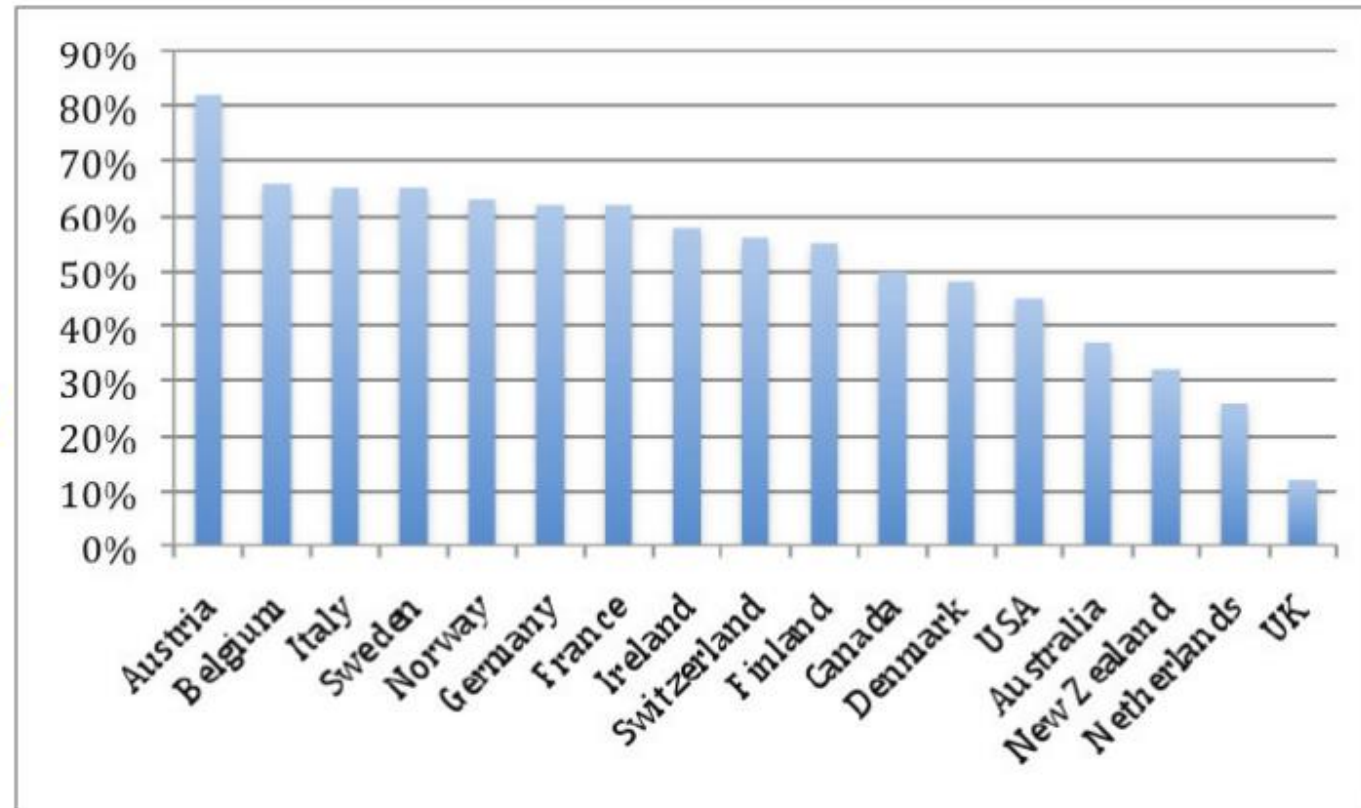
The End or is it?

Any questions



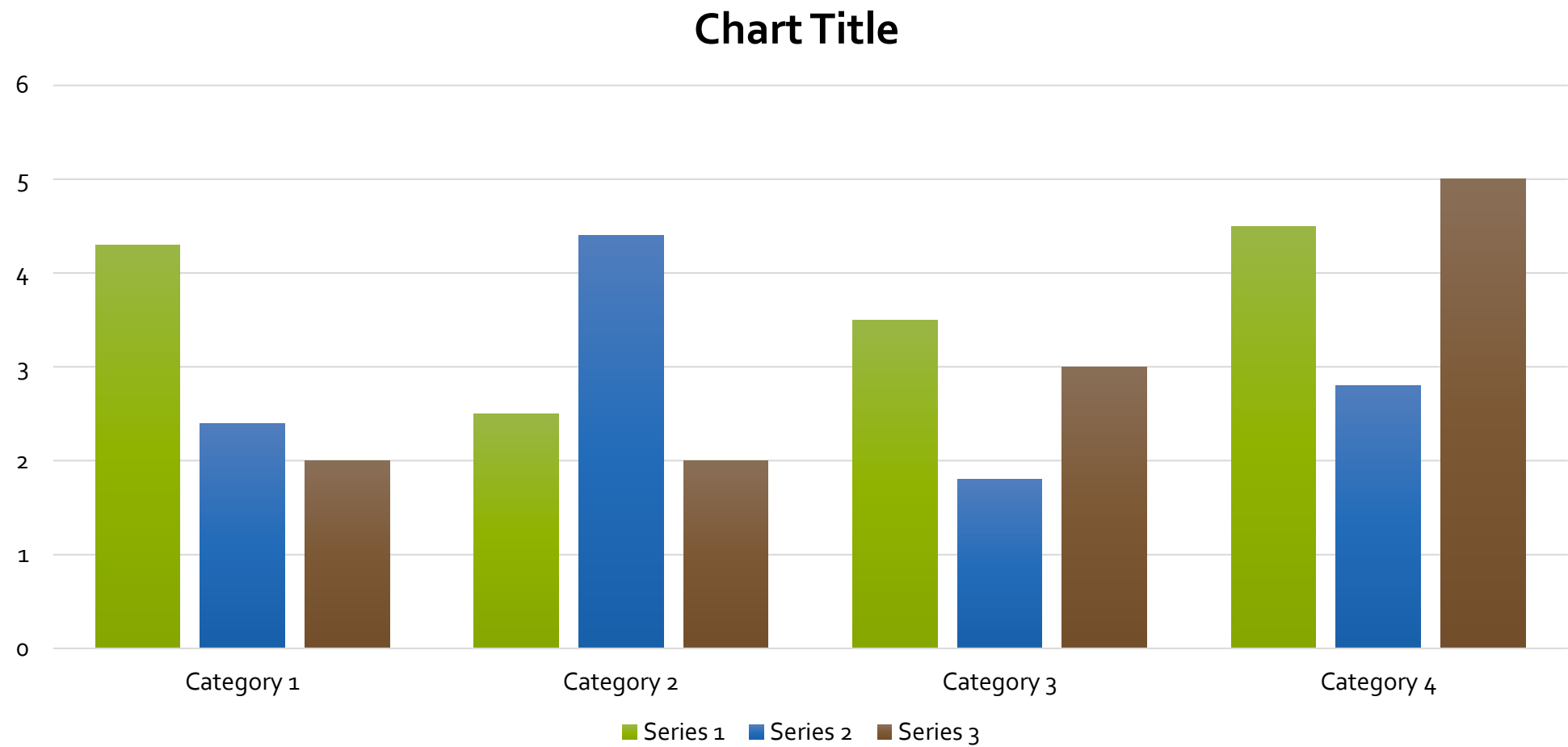






Percentage of new homes which are self-build homes in different countries (Data Source: 6).

Title and content layout with chart



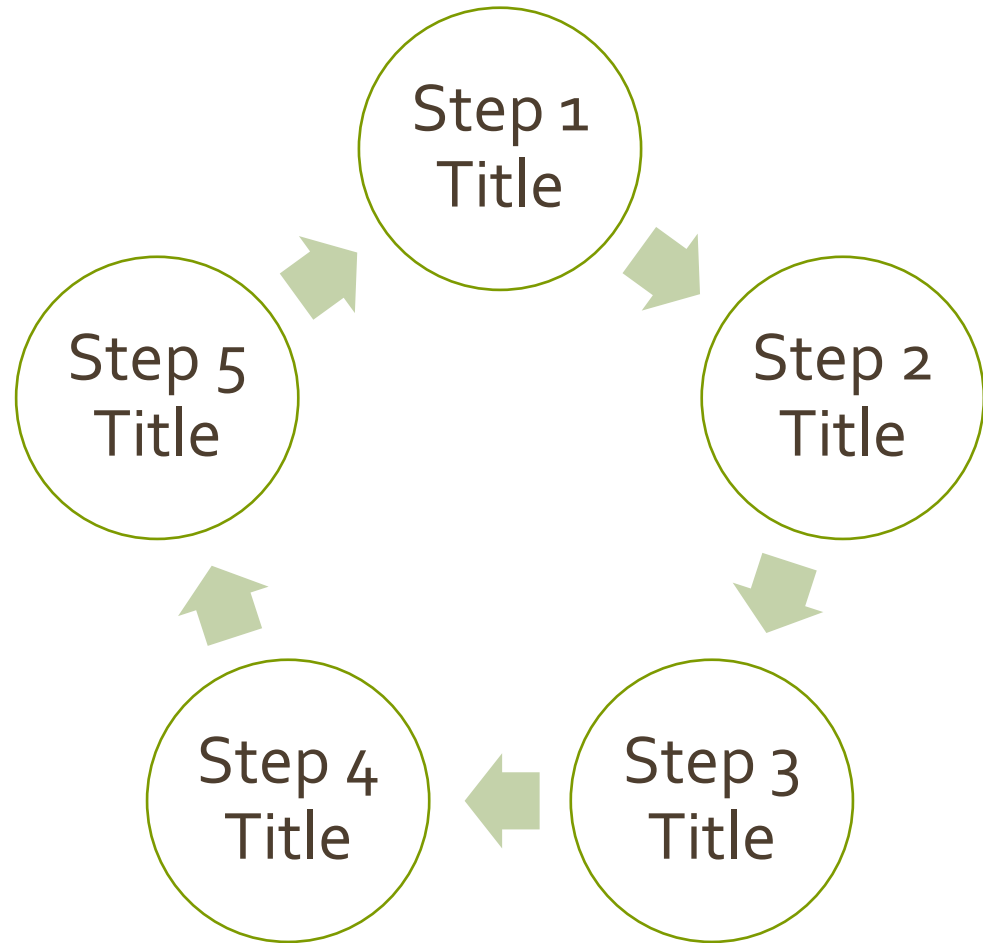
Two-content layout with table

- First bullet point here
- Second bullet point here
- Third bullet point here

Class	Group A	Group B
Class 1	82	95
Class 2	76	88
Class 3	84	90

Two-content layout with SmartArt

- First bullet point here
- Second bullet point here
- Third bullet point here



Add a slide title – 2

Add a slide title – 3



Add a slide title – 4

Add a slide title – 5