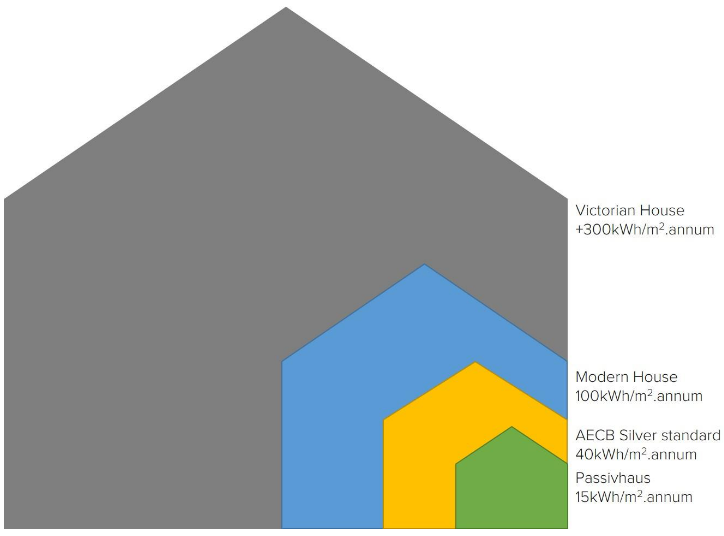
Introduction to Passivhaus:

Secrets to improving thermal comfort and energy efficiency

1 Comparison



The target of 15kWh/m².annum is the set limit where the heat losses are low enough so theoretically a traditional heating system is no longer required and the heating can be met through fresh ventilation air heating only. The Victorian house and Modern house heating demands are estimated.

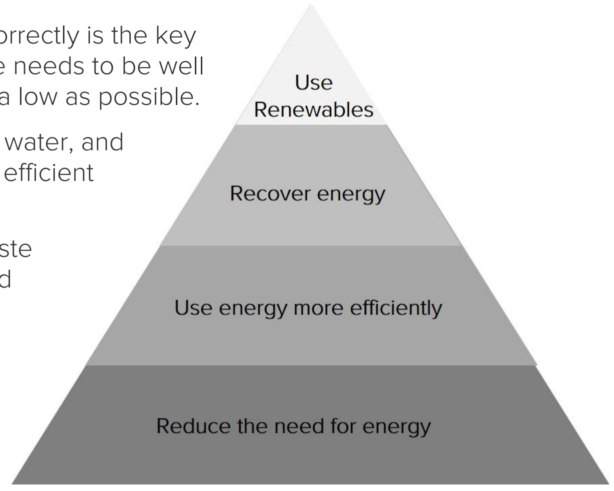
2 How to reduce the heating demand

Taking time to design the building fabric/envelope correctly is the key factor in reducing the need for energy. The envelope needs to be well insulated and air tight so that the heating demand is a low as possible.

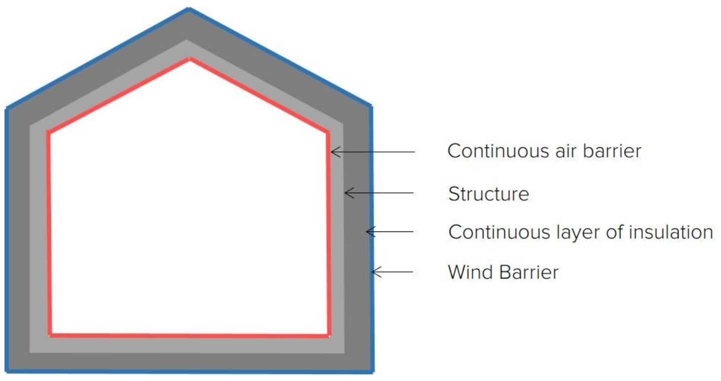
Some energy will be required e.g. for ventilation, hot water, and heating/cooling. Therefore making these systems as efficient as possible reduced the energy demand.

As using energy is inevitable, where possible the waste energy/heat can be recovered e.g. stale warm air and waste water from showers/baths.

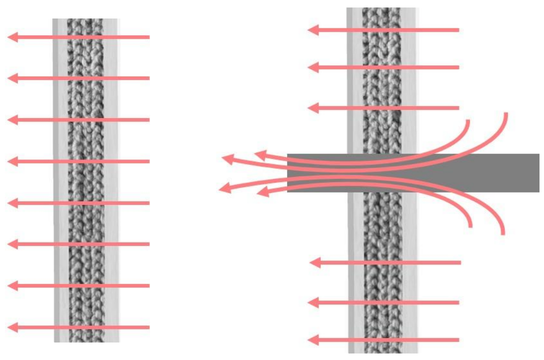
Finally once the energy use has been mitigated as much as possible, renewables or Low carbon technologies are then added. (Adding renewables isn't a Passivhaus requirement but could be required for building regulations).



3 Simplified Building Fabric strategy



4 U-values and Thermal Bridges



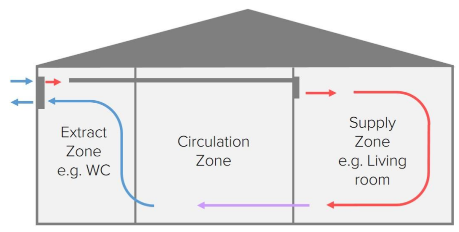
Walls, floors and roof surfaces all have an associated heat loss. A U-value measures how effective these surfaces are at insulating so a lower U-value the better the insulator. This is then used to calculate the heat loss per surface.

Thermal bridges are where there are discontinuities in the insulation which causes additional heat losses e.g. floor to wall junction and roof eaves junctions. These can be mitigated/reduced through careful design however, they all need to be accounted for- they are called Psi-values.

3D thermal bridges are called Chi values.

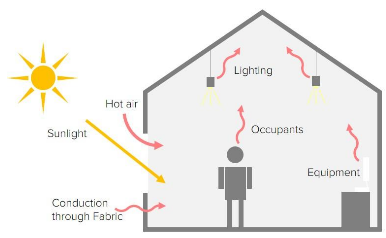
5 Ventilation

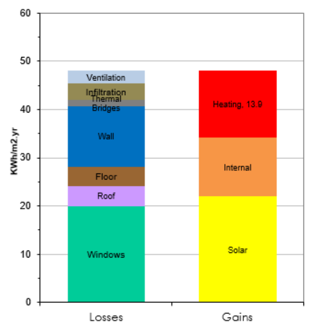
Fresh air is vital for good indoor air quality. By recovering the warm stale air this allows the fresh air to be pre-heated creating a thermally comfortable space with no drafts (MVHR).



6 Gains vs. Losses

The building's gains vs. losses are all calculated and the difference is the heating demand (max. 15kWh/m².year).

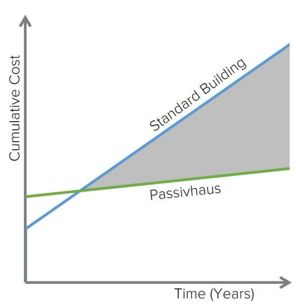




Gains include solar gains, people, lighting and equipment. Losses include wall/roof/floor surface losses, thermal bridge losses, infltration/ventialtion losses and window heat losses. Quantifying these variables gives an very good guide to how the building will perform when built.

7 Cost

Passivhaus can cost more than a standard build (not always) however, over the lifetime of the building the costs are significantly lower.



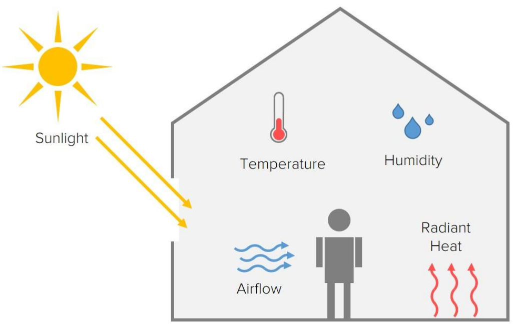
8 Air tightness

Per ~5m² of surface area- the average modern build allow gaps up to the equivalent area of around 5 x 20p. Passivhaus allows only 1 x 5p or 0.6ACH.

9 Thermal comfort

Buildings, especially homes, need to be comfortable.
- No drafts
- No condensation or mould
- No hot or cold radiant discomfort
- Warm surfaces
- Fresh air always (for good indoor air quality)
- Minimal summer overheating

This whole house approach ensures a healthy, comfortable environment with the added bonus of being energy efficient so energy bills are minimal so physiologically more comfortable as well. Although mechanical ventilation is used, windows can still be open although this isn't necessary for fresh air. There are limits on the noise levels of the mechanical ventilation units which surpass the normal standards to ensure that they are almost silent with very well filtered air.



Passivhaus has very strict criteria for ensuring that the building is thermally comfortable at all times. These reduce the risk of hypothermia whilst the energy efficiency helps mitigate fuel poverty.

10 Criteria

The requirements below are for a classic Passivhaus the Passivhaus Plus and Premium require additional renewables and retrofits/existing builds have different criteria.

When designing to Passivhaus the key considerations are having a compact form, optimising solar gains through glazing, excellent airtightness, thick and thermal bridge free insulation and mechanical ventilation with heat recovery (MVHR).

Comfort	
Ventilation	Mechanical ventilation with heat recovery (min 75% efficient) with strict low noise levels, fresh air and filters.
Air-tightness	0.6 ACH at 50pa
Surface Temperature	>17°C
Summer Overheating	Max 10% of hours over 25°C

Energy	
Heating	15kWh/m².year at 20°C or 10W/m²
Primary Energy	120kWh/m².year