Insulating a Home for Zero Carbon Design

Aims

- Keeping warm – insulation
- Methods for preventing heat escaping
- U Values
- PassivHaus Standards

Keeping Warm

- If we could prevent heat leaving a house, we would never need to put the heating on

Keeping Warm

- If we could prevent heat leaving a house, we would never need to put the heating on

Roof	
Walls	
Windows	
Draughts	
Floors	

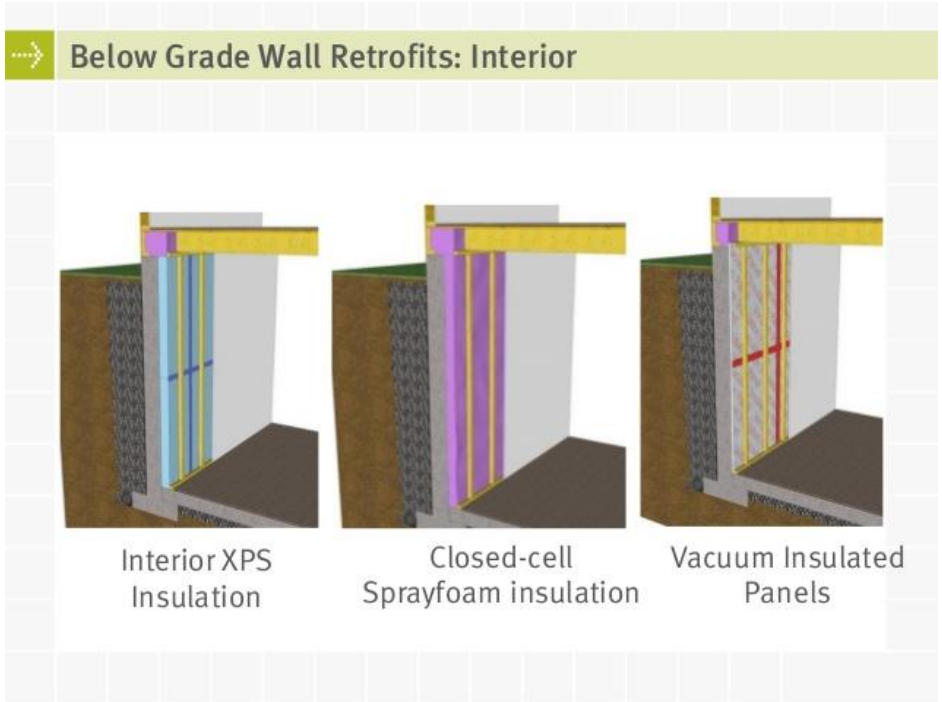
Keeping Warm

- If we could prevent heat leaving a house, we would never need to put the heating on

Roof	Loft insulation
Walls	Cavity wall insulation
Windows	Double glazing, curtains, blinds
Draughts	
Floors	Carpets, underfloor insulation

Roof

- Fibre glass / paper / recycled glass /
- 270 mm thick recommended
- Flat roofs



Walls

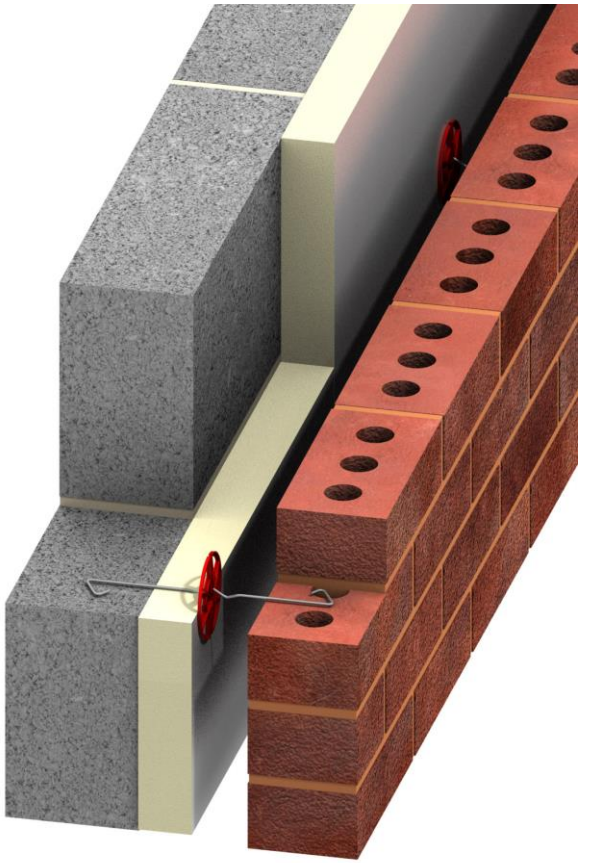
- Solid walls
  - Add a layer of insulation to the inside or the outside of the house

Walls

Prevents air circulating in the cavity and hot air escaping

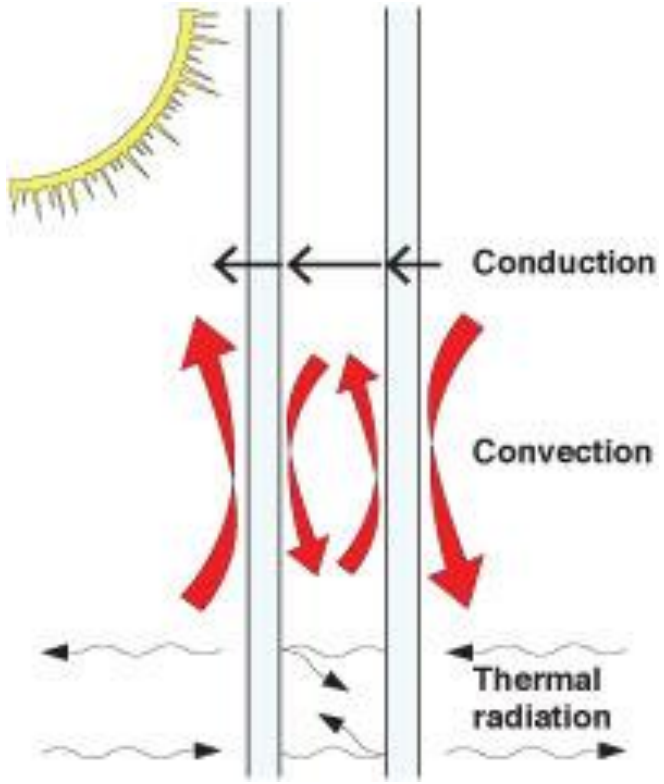
Insulation boards applied to all new houses

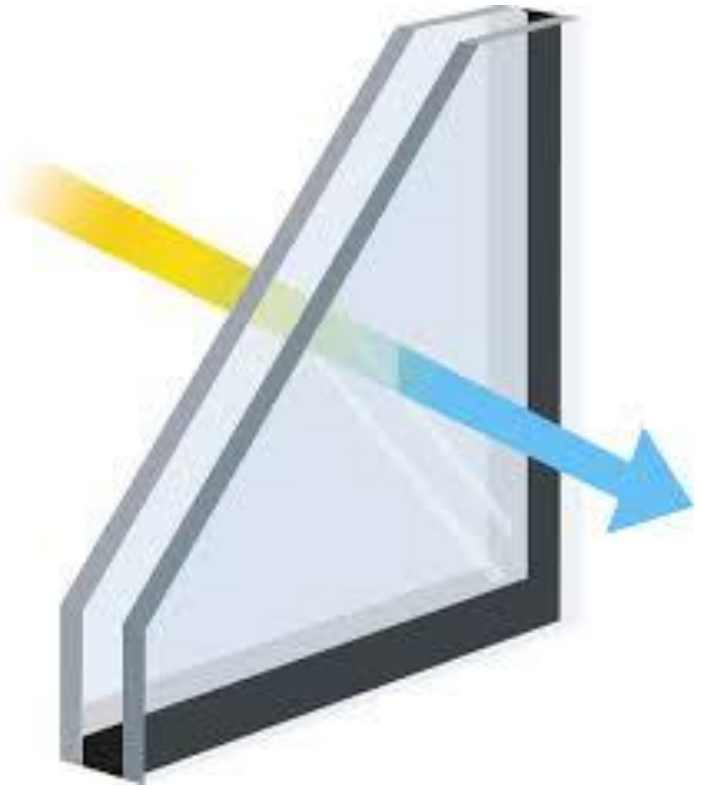
Older houses can have insulation injected into the cavity

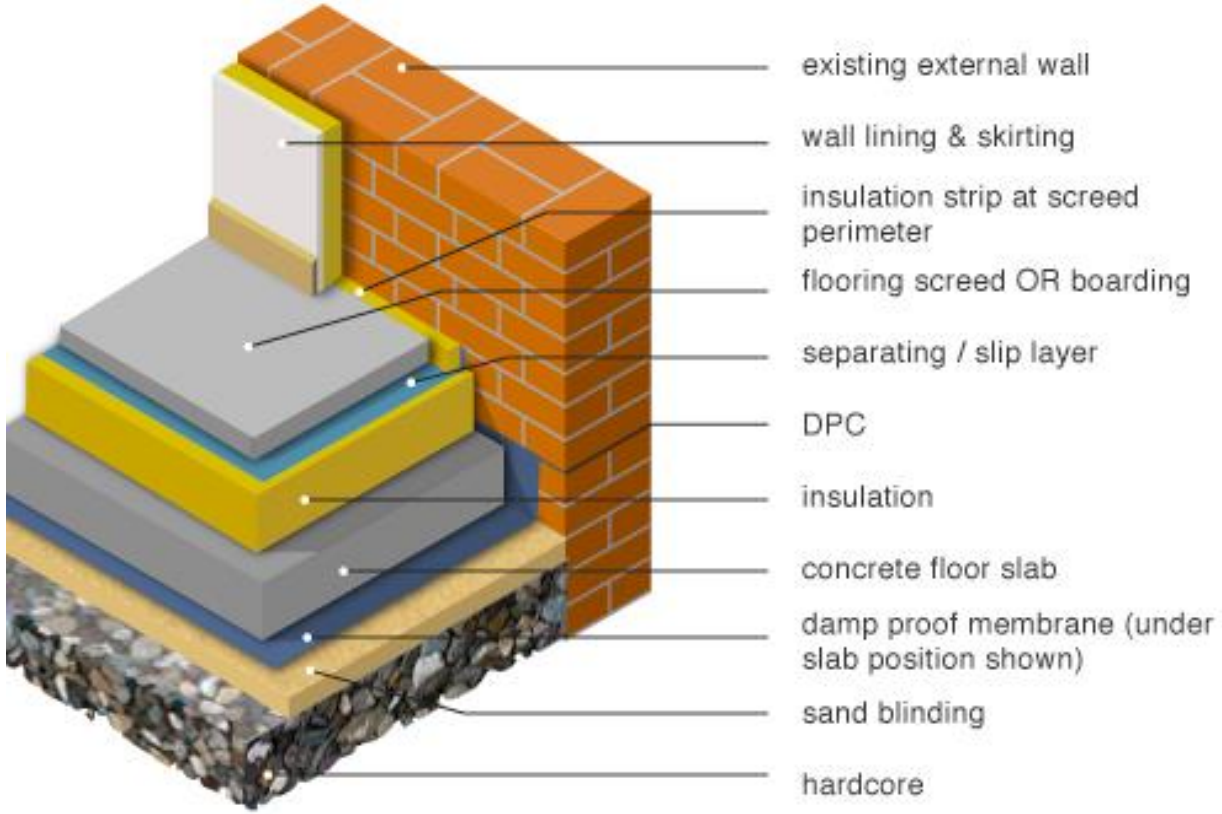


Windows

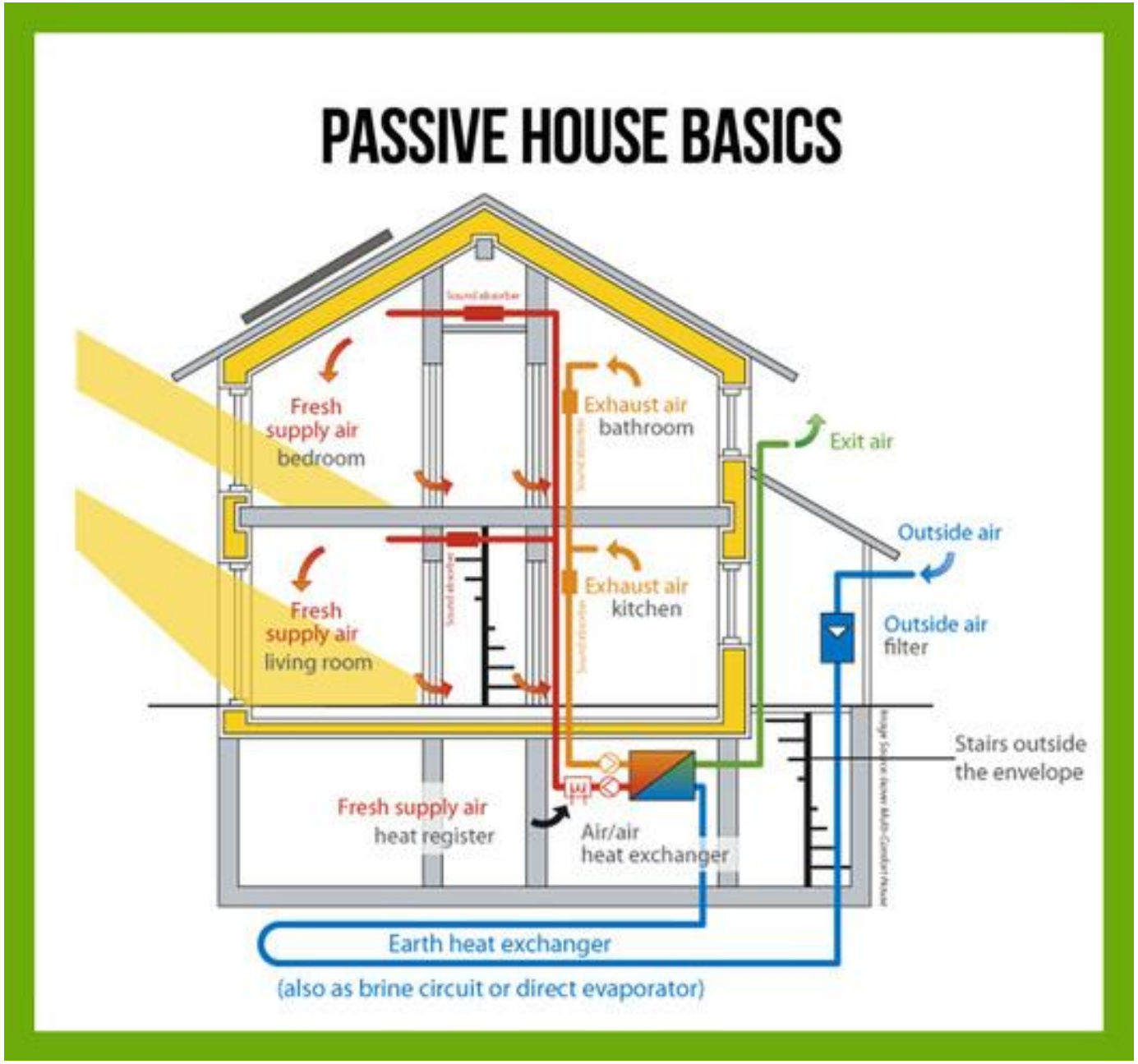
- Double glazing prevents heat leaving by conduction by creating a gap
- Filled with Argon






existing external wall
wall lining & skirting
insulation strip at screed perimeter
flooring screed OR boarding
separating / slip layer
DPC
insulation
concrete floor slab
damp proof membrane (under slab position shown)
sand blinding
hardcore

Floors



Passiv Haus

- If we could prevent heat leaving a house, we would never need to put the heating on

U values

- The amount of heat energy passing through a surface depends on
  - The temperature difference
  - the thickness of the material
  - the properties of the material

U value measured in W/m^2K

– the lower the value, the better the insulation

W = watts = energy transferred per second

m^2 = square meters = Area covered

K = kelvin, the temperature difference in Kelvin = the temp difference in degrees Celsius

The standard range for possible values includes :

- Cavity wall without insulation – 1.5
- Solid brick wall – 2.0
- Insulated roof – 0.2
- Insulated wall – 0.3
- Double glazing – 2.8
- Single glazing – 4.8
- Floor – 0.2

U values

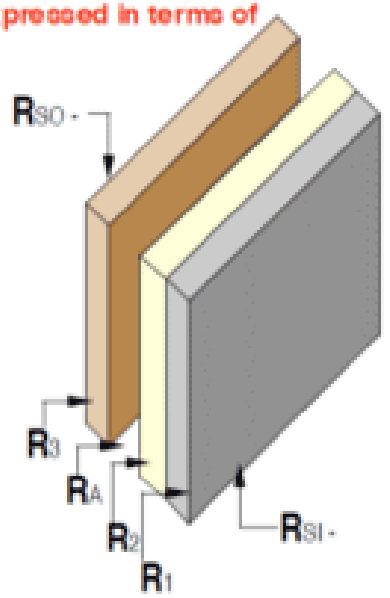
The inverse sum of all the resistances of each building material and surfaces

Why is a U value the reciprocal of the sum of all the resistances instead of the sum of all conductances?
Because - the interaction of the building element to outside environments is measured in terms of surface resistance, so for consistency, the behaviour of the built elements are also expressed in terms of resistances.

$$U = \frac{1}{R_{SI} + R_{SC} + R_A + R_1 + R_2 + R_4 + R_5}$$

R_{SI} - thermal resistance of internal surface
R_{SO} - thermal resistance of outside surface
R_A - thermal resistance of unvented air cavities
$R_{1\ etc.}$ - thermal resistances of building components

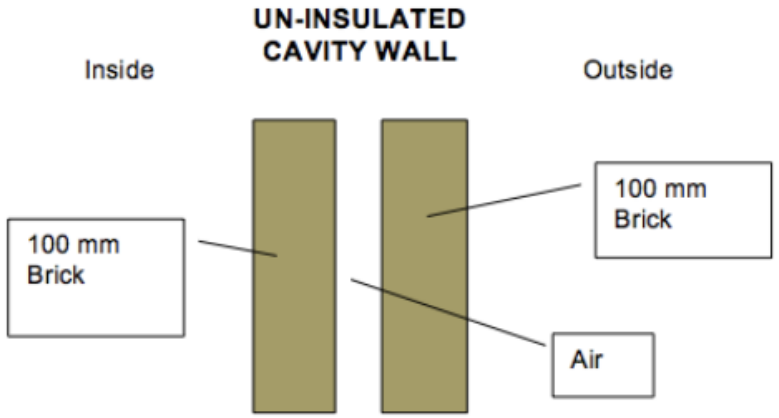
Units - W/m^2K



https://www.thegreenage.co.uk/what-are-u-values/

U values

A 1920s house has just brick and plaster. How much more efficient is it once the insulation is added?



Material	Thermal Resistance
external surface	0.06
Brick	0.080
air	0.17
insulation	
Block	1.020
plaster	0.120

U value of wall = 0.69 W/m²/K

U value = $1/\Sigma R$

sum up the thermal resistances of each layer, then reciprocate

U values

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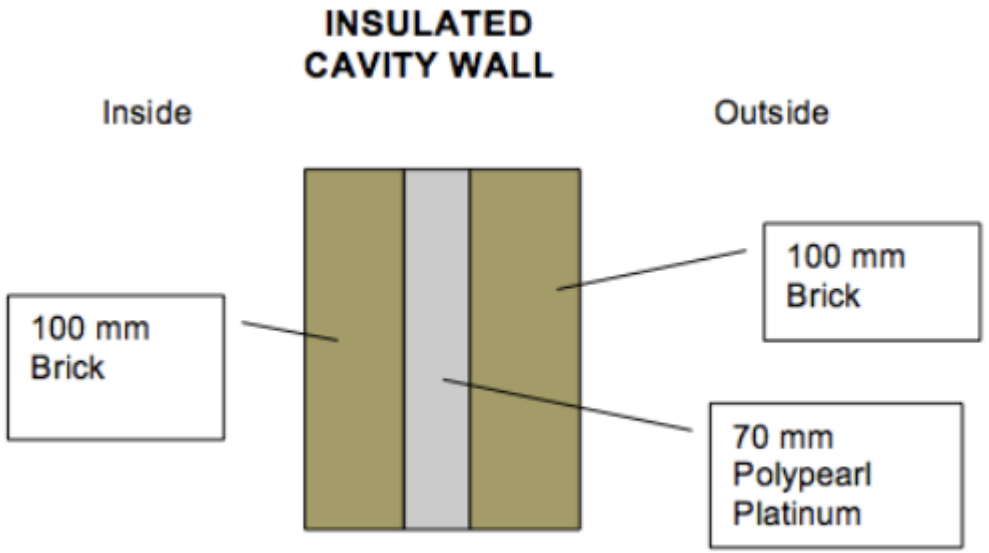

Material	Thermal Resistance
external surface	0.06
Brick	0.080
air	
insulation	2.120
Block	1.020
plaster	0.120

U value of wall = 0.29 W/m²/K

U values

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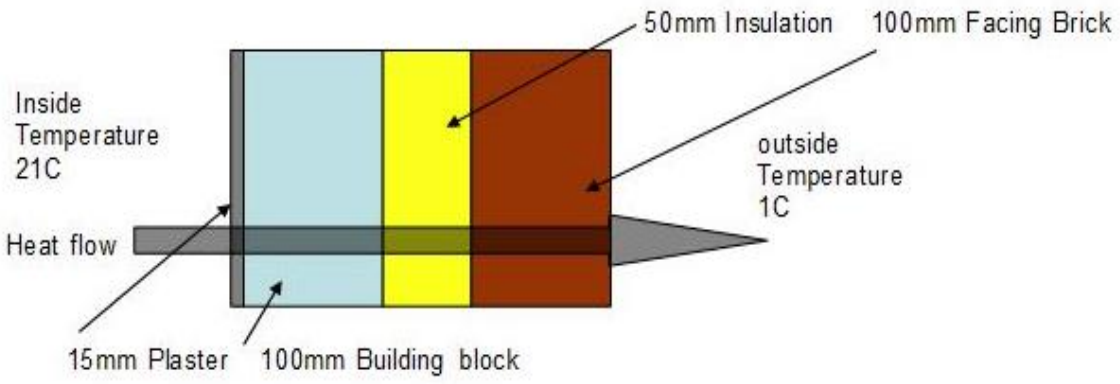


Energy lost through a 10 m^2 wall

= U x Area x Temp difference

= 0.29 x10 x 20

= 58 W

You need to do this for every outside surface of the house

Walls

Floor

Roof

Doors

Windows

U values

- Calculate the heat loss in a detached house with two walls of 6 m and two of 8 m wide, a 30° pitched roof and a wall height of 5 m. It has 8 windows, each 2 m^2 and 2 doors of 3 m^2
- The outside temperature is 10°C

Table 1 Worst acceptable fabric performance values	
External walls	0.21 W/m².K
Party walls	0.20 W/m².K
Floor	0.18 W/m².K
Roof	0.15 W/m².K
Windows, roof windows, glazed roof lights, curtain walling[2] and pedestrian doors	1.60 W/m².K

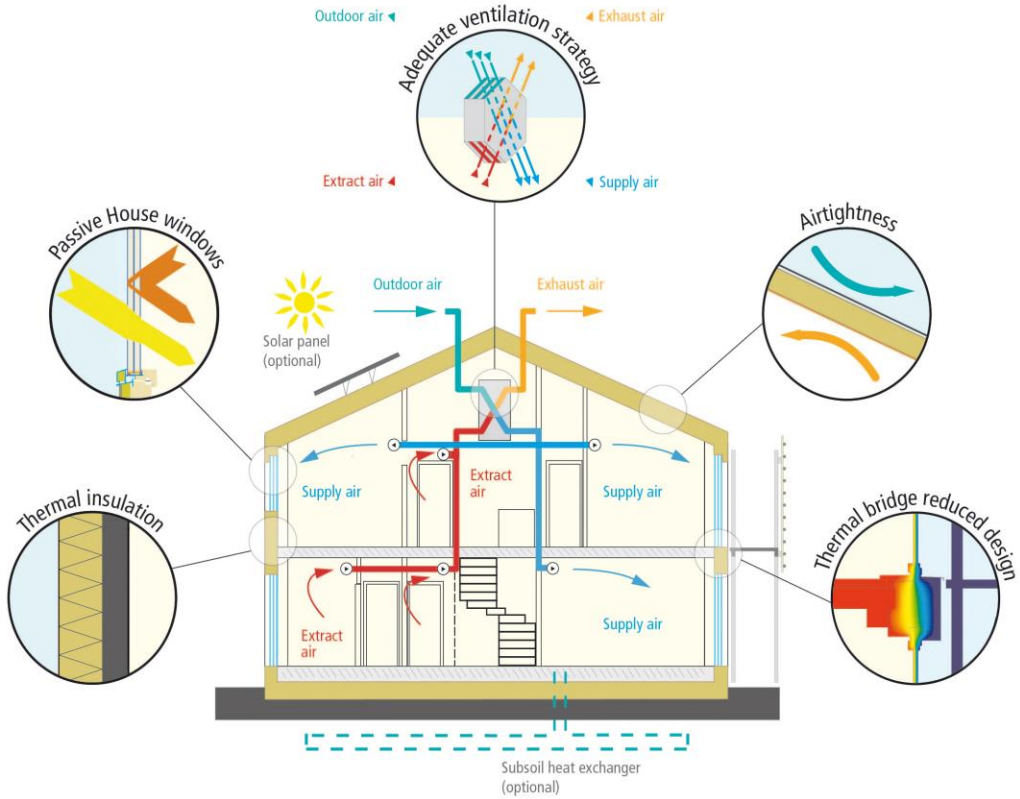
https://youtu.be/jok1QbzAvJo

Method

- Draw a table in excel
- List the external surfaces of your house
- List the U value of each surface
- Calculate the area of each surface
- Determine the temperature difference
- Calculate the heat loss in Watts

PassivHaus standards

- massive insulation (average depth 300mm), *wall U value <0.15, windows < 0.8*
- triple glazing with insulated frames
- 20 times more airtight than a standard build *(must score better than 0.6 air changes per hour)*
- mechanical ventilation with heat recovery >80%
- Uses 90% less energy to heat than an average home. Heating costs around £75 a year



15 kWh/m^2/y


Thank you
Any
Questions?