Passivhaus 101
GAINS

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Heat Balance

GAINS:

A ‘free’ gain that can contribute to the heat balance is via the sun.

Heat Balance

GAINS:

INTERNAL GAINS:

Internal Heat Gains = Length of heating period x Average Internal Heat Load x Treated Floor Area

$$Q_I = t_{HEAT} * q_i * A_{TFA}$$

t_{HEAT} = The number of days in year that require heating (Dublin = 205, Lisbon=107) ∗ **0.024 (hours)**

q_i = The typical average internal heat gains for the building type
(residential = 2.1
schools = 2.8
Assisted living = 4.1
Offices = 3.5)

Heat Balance
Example with our 5mx5mx5m cube

GAINS:

INTERNAL GAINS:

Internal Heat Gains = Length of heating period x Average Internal Heat Load x Treated Floor Area

$$Q_I = (205 \text{ days} \times 0.024) * 2.1 w/m2 * 25 m2$$
$$= 258.3 \text{ kWh/a}$$

t HEAT = The number of days in year that require heating (Dublin = 205, Lisbon=107) ***** **0.024 (hours)**

qi = The typical average internal heat gains for the building type
(residential = 2.1w/m2
schools = 2.8 w/m2
Assisted living = 4.1 w/m2
Offices = 3.5 w/m2)

Heat Balance

Now repeat for your project…

Remember we're only focussing on heat balance rather than heat load

Heat Balance – The final balance!

Steps:

1. Calculate the losses (transmission + ventilation)
2. Calculate the gains (solar + internal)
3. The Heat balance on heat space demand

= Losses minus Gains

Note this is for space heat demand, there's a similar calculation for heat load)

Heat Balance − The final balance!

Heat Balance =
Transmission Losses + Ventilation Losses − n x(Solar Heat Gains + Internal heat Gains)

(There's a 'Utilisation' Factor for 'Free' Heat that's also included in the Gains (n))

$$Q_H = (Q_T + Q_V) - n \times (Q_S + Q_I)$$

Heat Balance – The final balance!

Transmission Losses:

Are U from Galway?

Transmission Loss = Area x U value x Temperature Correction(f_T) x Heating Degree Hours (G_T)

For the 5mx5mx5m cube with 16m2 of windows:
Transmission loss = 1993.3 KWh/a

U value = 0.15 W/m2K for walls 0.8 W/m2K for windows
f_T for walls = 1
f_T for floors = 0.8
Heating Degree Hours = 62 (Temperature difference between inside & outside & depends on location):
Dublin = 60KWh/a
Birr = 67KWh/a – This effectively is the 'heating season' as 67kKh/a (67,000 degree hours per year)

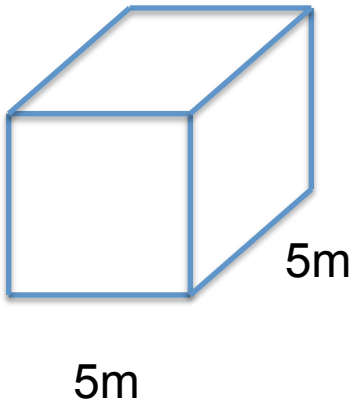
Heat Balance – The final balance!

Ventilation Losses:

Ventilation Loss= Ventilated Volume x Effective Air Change Rate x Heat Capacity of Air x Heating Degree Hours (G_T)

Ventilation Loss= V_V x 0.06 $_{h-1}$ x 0.33Wh/m3K x 60K (G_T)

$$Qv = V_v \times n_{equiv1} \times C_pP \times G_T$$



Ventilated Volume = 5m x 5m x 5m

= 125m^3

Ventilated Volume= 125m3 x 0.06 $_{h-1}$ x 0.33Wh/m3K x 60

= 148.5 KWh/a

Heat Balance – The final balance!

GAINS:

SOLAR GAINS:

Solar gains = Attenuating Factor For the glazing x Total solar energy Transmittance x Area of Window x Global Solar Radiation

$$Qs = r * g * Aw * G$$

Qs=solar gains
r = Attenuating factor for glazing comprising the frame to window ratio, how shaded/dirty the glass is and factoring in any radiation that is non-perpendicular to the glass
g=Total solar transmittance value of the glass (typically a value in the region 0.55-0.6 ie 55-60% of the energy is getting through the glass (ie the amount of solar gain delivered)
Aw=Area of the glazing
G=Global solar irradiation (this depends on location and orientation of window)

Heat Balance – The final balance!

GAINS:

SOLAR GAINS:

Solar gains = Attenuating Factor For the glazing x Total solar energy Transmittance x Area of Window x Global Solar Radiation

$Qs = 0.5 * 0.6 * 16m^2 * 391$ KWh(m2a)

$Qs =$ 1876.8 kWh/a

Qs=solar gains
r = 0.5
g=0.6
Aw=say 16m2
G=391 KWh(m2a) ((South facing in Dublin))

Heat Balance – The final balance!

GAINS:

SOLAR GAINS:

Solar gains = Attenuating Factor For the glazing x Total solar energy Transmittance x Area of Window x Global Solar Radiation

$Qs = 0.5 * 0.6 * 16m^2 * 391$ KWh(m2a)

Qs(south) = 1876.8kWh/a

Qs(north) = 403.2 kWh/a

Qs(east) = 1108.8 kWh/a

Qs(west) = 1147.2 kWh/a

TOTAL=4536 kWh/a

Heat Balance – The final balance!

Heat Balance =
Transmission Losses + Ventilation Losses – n x(Solar Heat Gains + Internal heat Gains)

(There's a 'Utilisation' Factor for 'Free' Heat that's also included in the Gains (n))

$$Q_H = (Q_T + Q_V) - n \times (Q_S + Q_I)$$

Q_H = (1993.3 KWh/a + 148.5 KWh/a)- 0.97 (97% safety factor) x (1876.8 kWh/a + 258.3 kWh/a)

Q_H = (2141.8 KWh/a)- 0.97 (97% safety factor) x (2135.1 kWh/a)

Q_H = (2141.8 KWh/a)- 2071.04 kWh/a

Q_H = 70.76 kWh/a

Heat Balance – The final balance!

Interesting Conclusions:

The **Passive House** criteria allow buildings is 15 kWh/(m²yr) heat demand (remember NOT LOAD!)

The 5mx5mx5m example FAILS

Passivhaus is easier with bigger buildings