The Alliance for Sustainable Building Products

The Importance and Influence of Thermal Mass on Thermal Comfort

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Rethinking IWI with Natural Fibre Insulation

NATURAL FIBRE INSULATION GROUP

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The Importance and Influence of Thermal Mass on Thermal Comfort

- **Aims -**
  - Explain, using data, how the thermal mass of insulation materials affects internal environment of internally insulated buildings.
  - Explain why high thermal mass is not always desirable.

What are Thermal Mass and Thermal Comfort?

- Thermal mass usually refers to the amount of heat a material stores.
- Materials with high thermal mass typically have higher density and higher specific heat capacity.
- Using commonly known properties like thermal conductivity, specific heat capacity and density we can calculate different properties of materials.
- Thermal comfort - keeping the internal environment at a steady temperature & minimising temperature fluctuations - not just warm.

Properties

- Thermal Diffusivity is a term used to describe how quickly heat moves through a material and is derived from the above three properties.
- Thermal Effusivity describes how quickly a material transfers heat to another.
- Combining these two terms with heat storage helps explain how materials affect heating requirement and comfort.

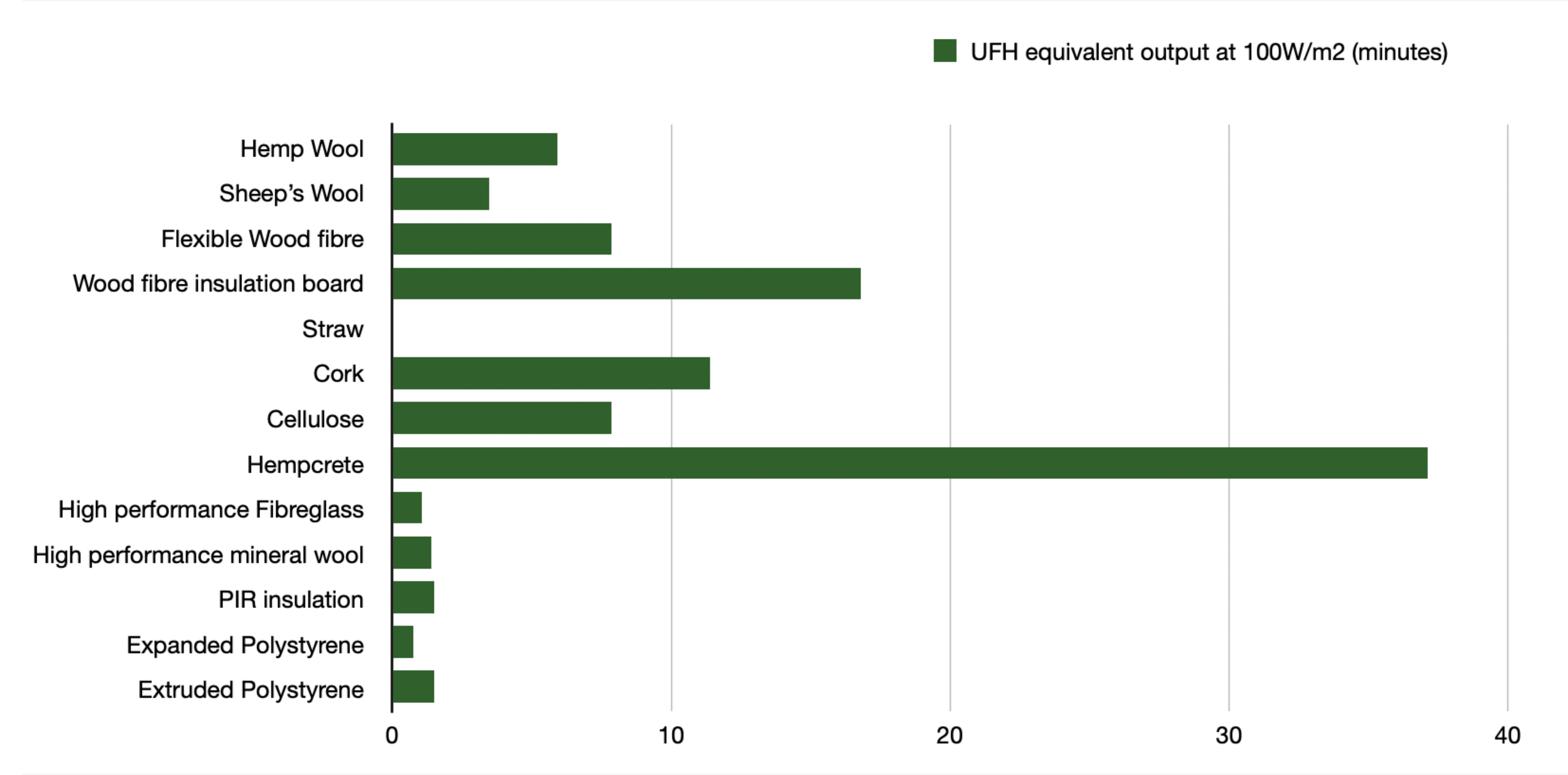
Product	Thermal conductivity W/mK	Density kg/m³	Specific heat capacity J/kgK
Hemp Wool	0.038	45	2100
Sheep's Wool	0.035	31	1800
Flexible Wood fibre	0.036	60	2100
Wood fibre insulation board	0.038	160	2100
Straw	0.060	120	2000
Cork	0.038	120	1900
Cellulose	0.038	60	2100
Hempcrete	0.068	270	1500
High performance Fibreglass	0.032	30	700
High performance mineral wool	0.035	33	840
PIR insulation	0.022	30	1500
Expanded Polystyrene	0.032	16	1130
Extruded Polystyrene	0.035	32	1130

Scenario

- Home for busy working-away occupants, only used infrequently and for short periods of time.

Product	Thermal conductivity W/mK	Density kg/m^3	Specific heat capacity J/kgK	Thickness for U-value <0.5 W/m^2k	Energy for 5C change (kJ/m^2)	UFH equivalent output at 100W/m^2
Hemp Wool	0.038	45	2100	75 mm	35.437	6 mins
Sheep's Wool	0.035	31	1800	75 mm	20.925	3.5 mins
Flexible Wood fibre	0.036	60	2100	75 mm	47.250	8 mins
Wood fibre insulation board	0.038	160	2100	60mm	100.80	17 mins
Straw	0.060	120	2000			
Cork	0.038	120	1900	60mm	68.40	11.5 mins
Cellulose	0.038	60	2100	75 mm	47.25	8 mins
Hempcrete	0.068	270	1500	110mm	222.75	37 mins
High performance Fibreglass	0.032	30	700	60mm	6.30	1 min
High performance mineral wool	0.035	33	840	60mm	8.32	1.4 mins
PIR insulation	0.022	30	1500	40mm	9.00	1.5 min
Expanded Polystyrene	0.032	16	1130	50mm	4.52	0.75 min
Extruded Polystyrene	0.035	32	1130	50mm	9.04	1.5 min

Heat absorption into insulation



Scenario One

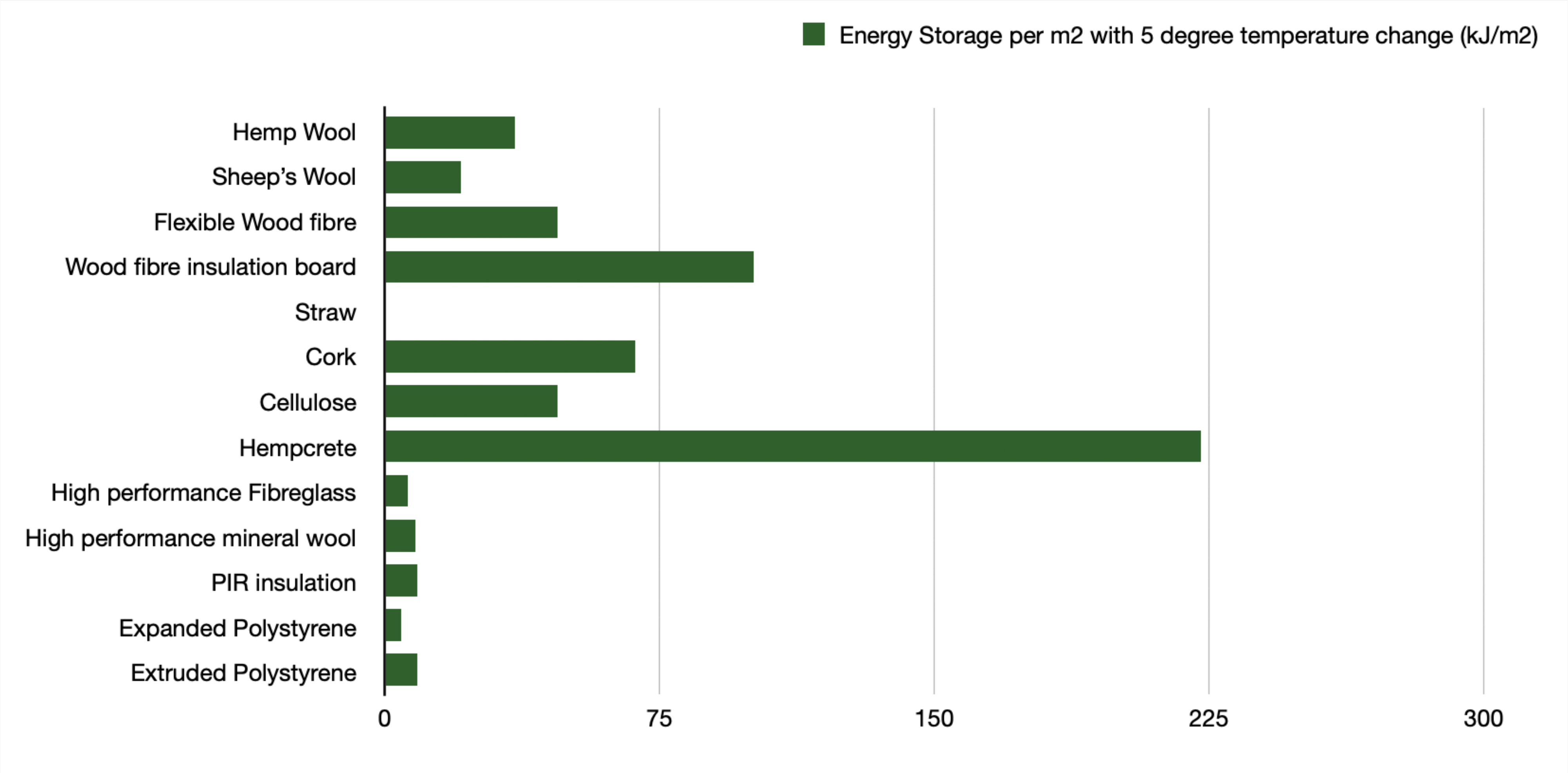
- Infrequent occupation, particularly in winter months, lends itself to a lighter weight, lower thermal mass insulation so that the interior heats up faster.
- Less heat would be required overall for this occupancy style with a low thermal mass building.

Scenario Two

- Internally insulated house with lots of glazing, particularly southerly, with large heat gains in Spring and Autumn.
- Occupants indoors almost every evening/morning, not necessarily all day.

Product	Thermal conductivity W/mK	Density kg/m³	Specific heat capacity J/kgK	Thickness for U-value <0.5 W/m²k	Energy Storage for 5C change (kJ/m²)	Thermal Effusivity (J/m²Ks^1/2)
Hemp Wool	0.038	45	2100	75 mm	35.437	59.92
Sheep's Wool	0.035	31	1800	75 mm	20.925	44.19
Flexible Wood fibre	0.036	60	2100	75 mm	47.250	67.35
Wood fibre insulation board	0.038	160	2100	60mm	100.80	113.00
Straw	0.060	120	2000			120.00
Cork	0.038	120	1900	60mm	68.40	93.08
Cellulose	0.038	60	2100	75 mm	47.25	69.20
Hempcrete	0.068	270	1500	110mm	222.75	165.95
High performance Fibreglass	0.032	30	700	60mm	6.30	25.92
High performance mineral wool	0.035	33	840	60mm	8.32	31.14
PIR insulation	0.022	30	1500	40mm	9.00	31.64
Expanded Polystyrene	0.032	16	1130	50mm	4.52	24.05
Extruded Polystyrene	0.035	32	1130	50mm	9.04	35.57

Heat transfer through insulation



Scenario Two

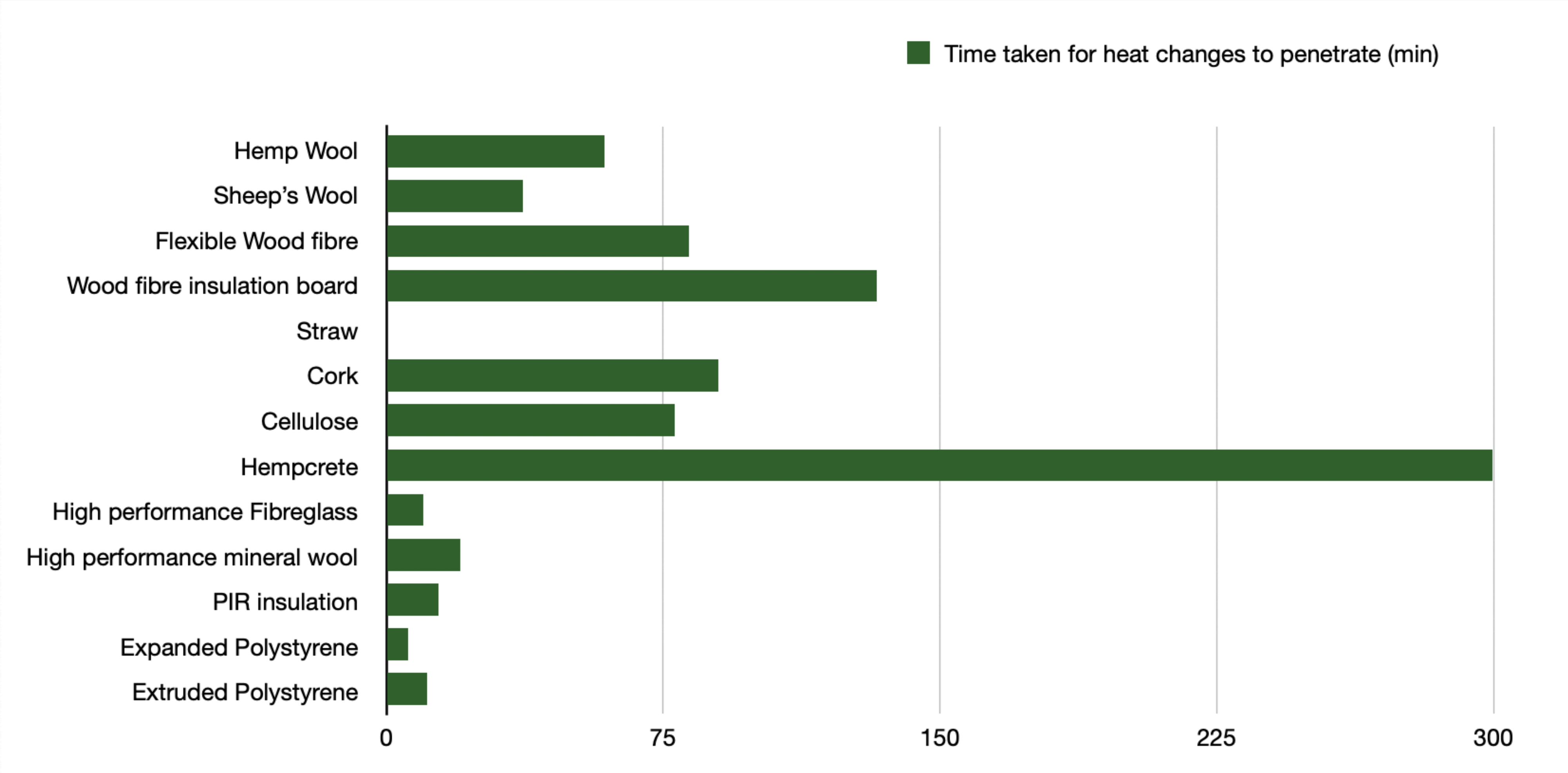
- More frequent occupation, particularly in Spring and Autumn, requires some attenuation of solar gains to prevent overheating.
- Heat gains through the day are absorbed by the internal linings of the walls (amongst other things) and buffer internal temperature gains.
- High thermal effusivity of materials ensures effective heat transfer back to the internal environment, reducing heating requirements.

Scenario

- Relatively thin, dark coloured masonry walling, facing south, with little or no overhang.
- Mid-summer hot day, peak external temps - 30C at 4pm.

Product	Thermal conductivity W/mK	Density kg/m³	Specific heat capacity J/kgK	Thickness for U-value <0.5 W/m²k	Thermal Diffusivity m²/s x 10^{-7}	Time taken for heat changes to penetrate
Hemp Wool	0.038	45	2100	75 mm	4.02	59 min
Sheep's Wool	0.035	31	1800	75 mm	6.27	37 min
Flexible Wood fibre	0.036	60	2100	75 mm	2.86	82 min
Wood fibre insulation board	0.038	160	2100	60mm	1.13	133 min
Straw	0.060	120	2000		2.50	
Cork	0.038	120	1900	60mm	1.67	90 min
Cellulose	0.038	60	2100	75 mm	3.02	78 min
Hempcrete	0.068	270	1500	110mm	1.68	300 min
High performance Fibreglass	0.032	30	700	60mm	15.23	10 min
High performance mineral wool	0.035	33	840	60mm	12.63	20 min
PIR insulation	0.022	30	1500	40mm	4.89	14 min
Expanded Polystyrene	0.032	16	1130	50mm	17.70	6 min
Extruded Polystyrene	0.035	32	1130	50mm	9.67	11 min

Heat transfer through insulation



Scenario Three

- High occupation, particularly during summer months, thermal mass and decrement delay help stabilise internal temperatures.
- Pushing internal peak heat to later in the day allows cool air to be drawn in from outside.
- Reduces reliance on the need for cooling

Thank you

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