Natural insulation and summer comfort

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BACKTOEARTH

Building Performance Specialists

Insulation

- It is the single most influential component of the building structure.

Affects thermal performance, comfort and therefore enjoyment and health.

Properties of insulation can be used to tailor internal environment

Eight roles of insulation

- The eight roles are:-
  Acoustic insulation
  Fire protection
  Health
  Comfort
  Buildability
  Durability
  Sustainability
  Thermal insulation

Comfort

- Buildings which stay at even temperatures, without significant heating or cooling create comfortable spaces.

Lightweight insulation gives low thermal conductivity - equilibrium state achieved quickly.

High density, high SHC wood fibre - equilibrium state reached very slowly.

Comfort

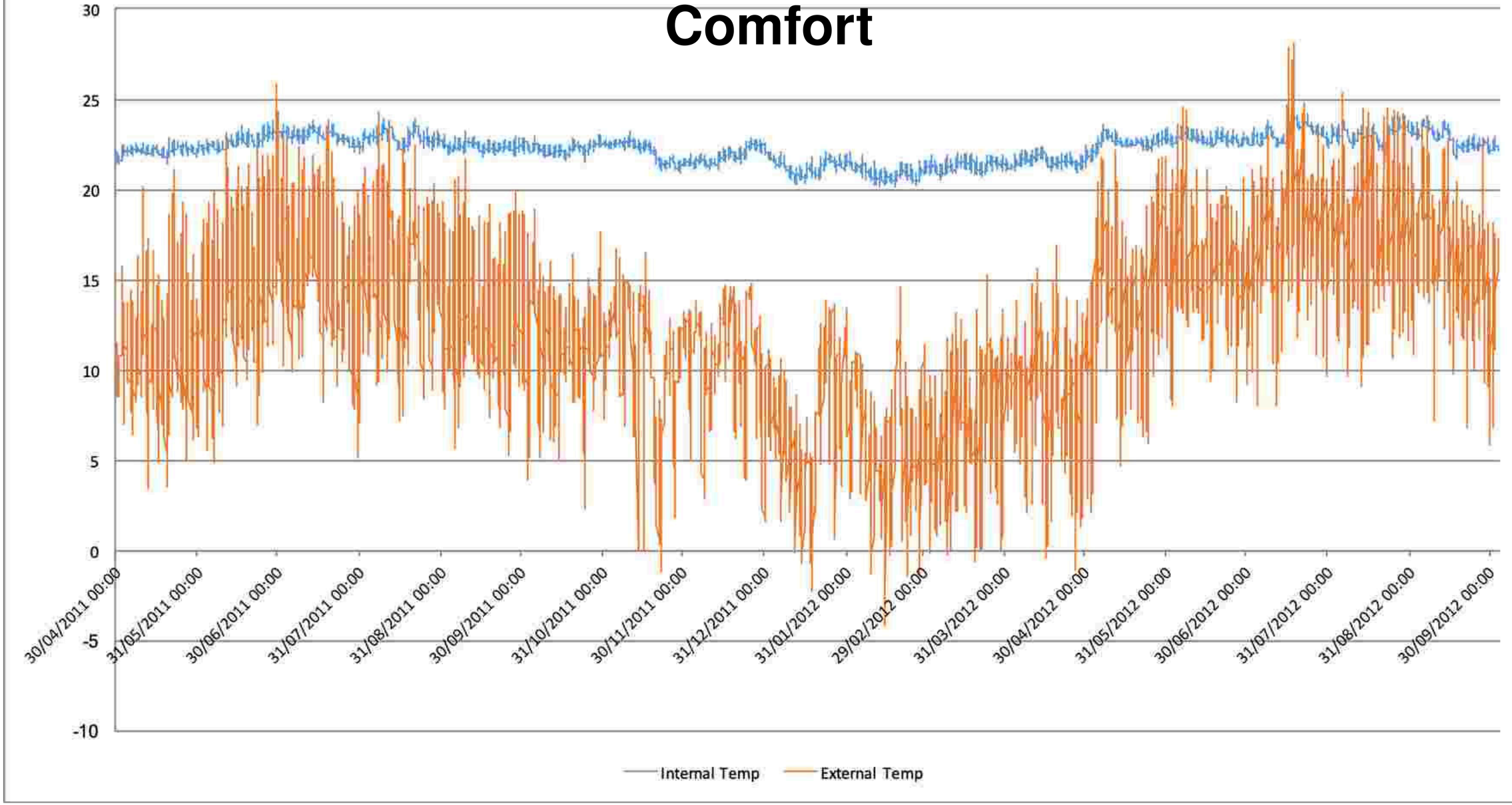
- Heat currently kills around 2000 people per year - rising to 7000 over next few decades.

Vital to create buildings that stay at stable temperatures easily.

Wood fibre/natural fibres have high decrement delay - helps to passively regulate internal environment.

Wood fibre/natural fibres are very complex - thermal performance is related to moisture.

Comfort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25
20
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-5
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31/08/2011 00:00
30/09/2011 00:00
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30/04/2012 00:00
31/05/2012 00:00
30/06/2012 00:00
31/07/2012 00:00
31/08/2012 00:00
30/09/2012 00:00
Internal Temp
External Temp

Buildability

- ‘Performance gap’ - term for difference between design and real performance - related to buildability.

Air gaps between insulation and other components reduce effectiveness of insulation - 3mm = +150%, 10mm = +400%.

Rigid boards are almost impossible to install in timber frames correctly - shrink due to off gassing.

Rigid boards in cavities are never in full contact with inner leaf.

Buildability

- ‘Performance gap’ - tends to be zero or negative for wood fibre - up to 75% better.

Construction detailing with wood fibre is simple - boards are T&G are compressible.

Format and structure of flexible batts mean that all voids are filled.

Combination boards for uneven surfaces.

Thermal performance

- Thermal conductivity and U-values are the main measure but ignore time taken for equilibrium state.

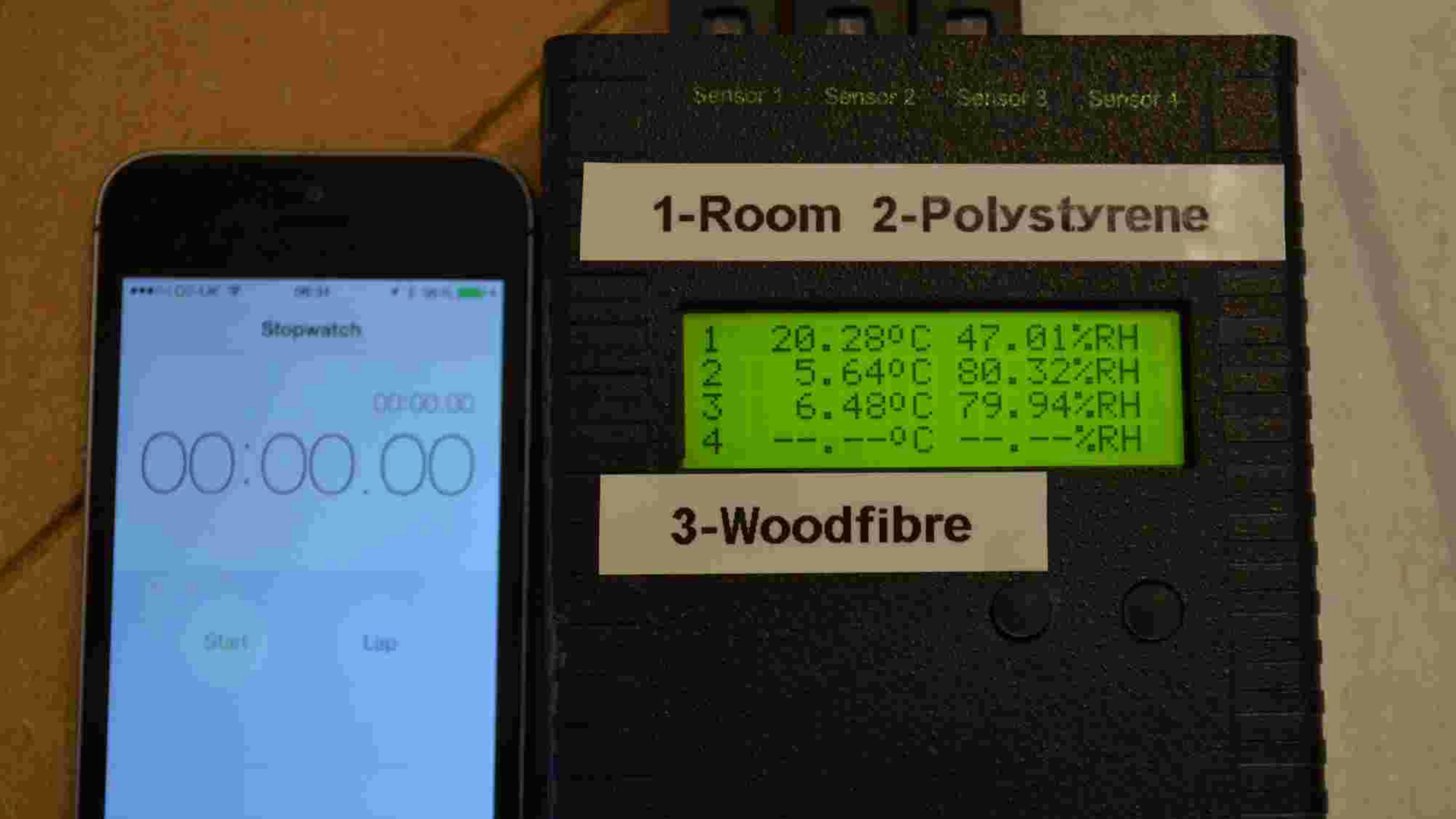
If long decrement delay less heat is transferred in a given time even though the thermal conductivity may be the same.

Thermal mass of insulation will also affect overall heating and cooling requirements due to heat storage.

Psi-Values very low for wood fibre systems, improving SAP scores.

Wood fibre insulation

Product	Thermal conductivity W/mK	Density kg/m^3	Specific heat capacity J/kgK	Thermal Diffusivity m^2/s x 10^{-7}	Decrement delay for roof - U-value 0.13 W/m^2K
Hemp Wool	0.038	45	2100	4.02	11.45 hrs
Sheep’s Wool	0.035	31	1800	6.27	7.90 hrs
Flexible Wood fibre	0.036	60	2100	2.86	15.7 hrs
Wood fibre sarking board	0.042	180	2100	1.11	15.7 hrs
Straw	0.060	120	2000	2.50	21.2 hrs
Cork	0.038	120	1900	1.67	
Cellulose	0.038	60	2100	2.86	13.50 hrs
Hempcrete	0.068	270	1500	1.68	
High performance Fibreglass	0.032	30	700	15.23	3.25 hrs
High performance mineral wool	0.035	33	840	12.63	4.28 hrs
PIR insulation	0.022	30	1500	4.89	6.30 hrs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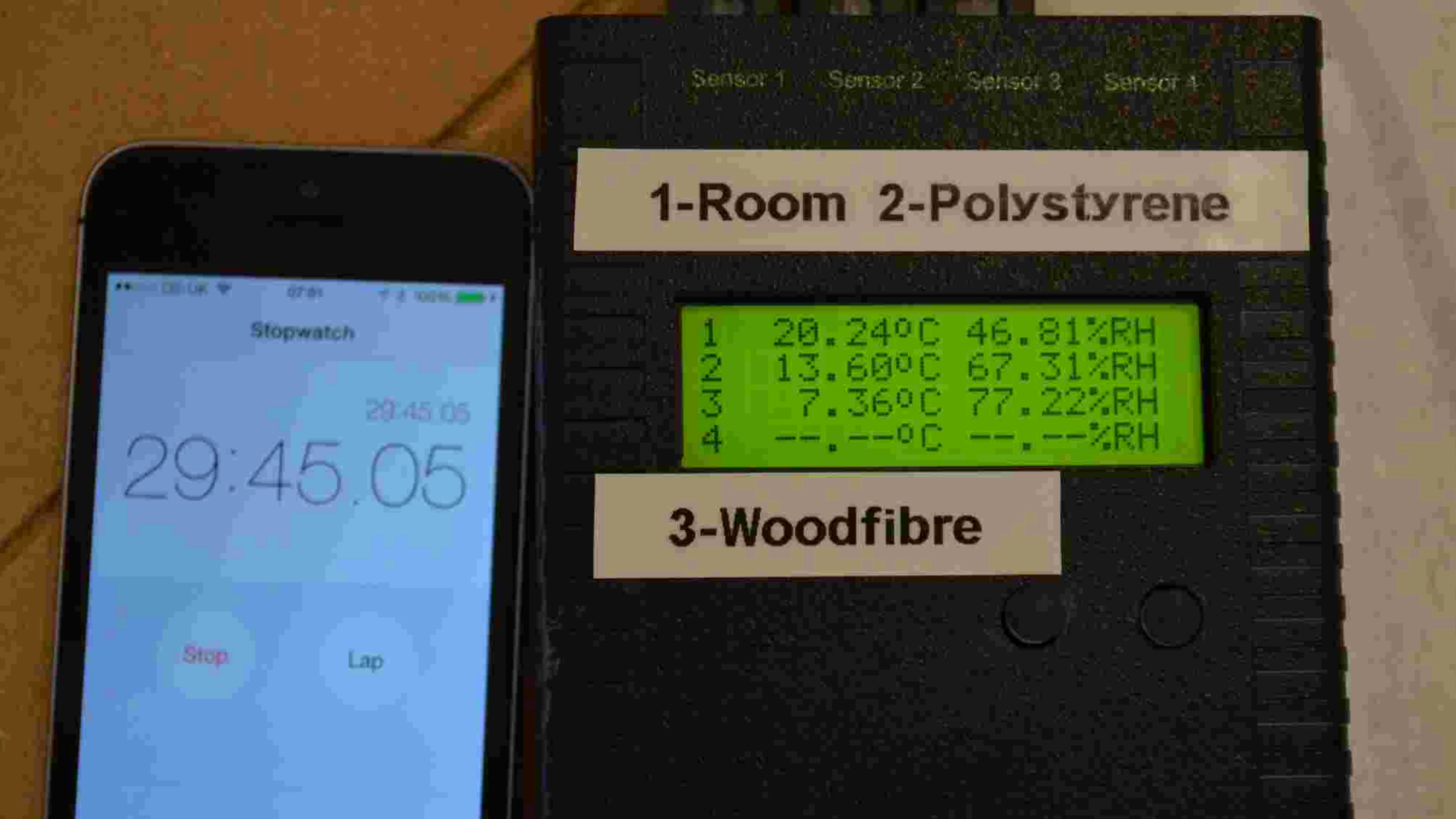
Sensor 2
Sensor 3
Sensor 4
1-Room 2-Polystyrene
1 20.28°C 47.01%RH
2 5.64°C 80.32%RH
3 6.48°C 79.94%RH
4 --.--°C --.--%RH
3-Woodfibre
Stopwatch
00:00.00
00:00.00
Start
Lap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Sensor 3
Sensor 4
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2 13.60°C 67.31%RH
3 7.36°C 77.22%RH
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3-Woodfibre
Stopwatch
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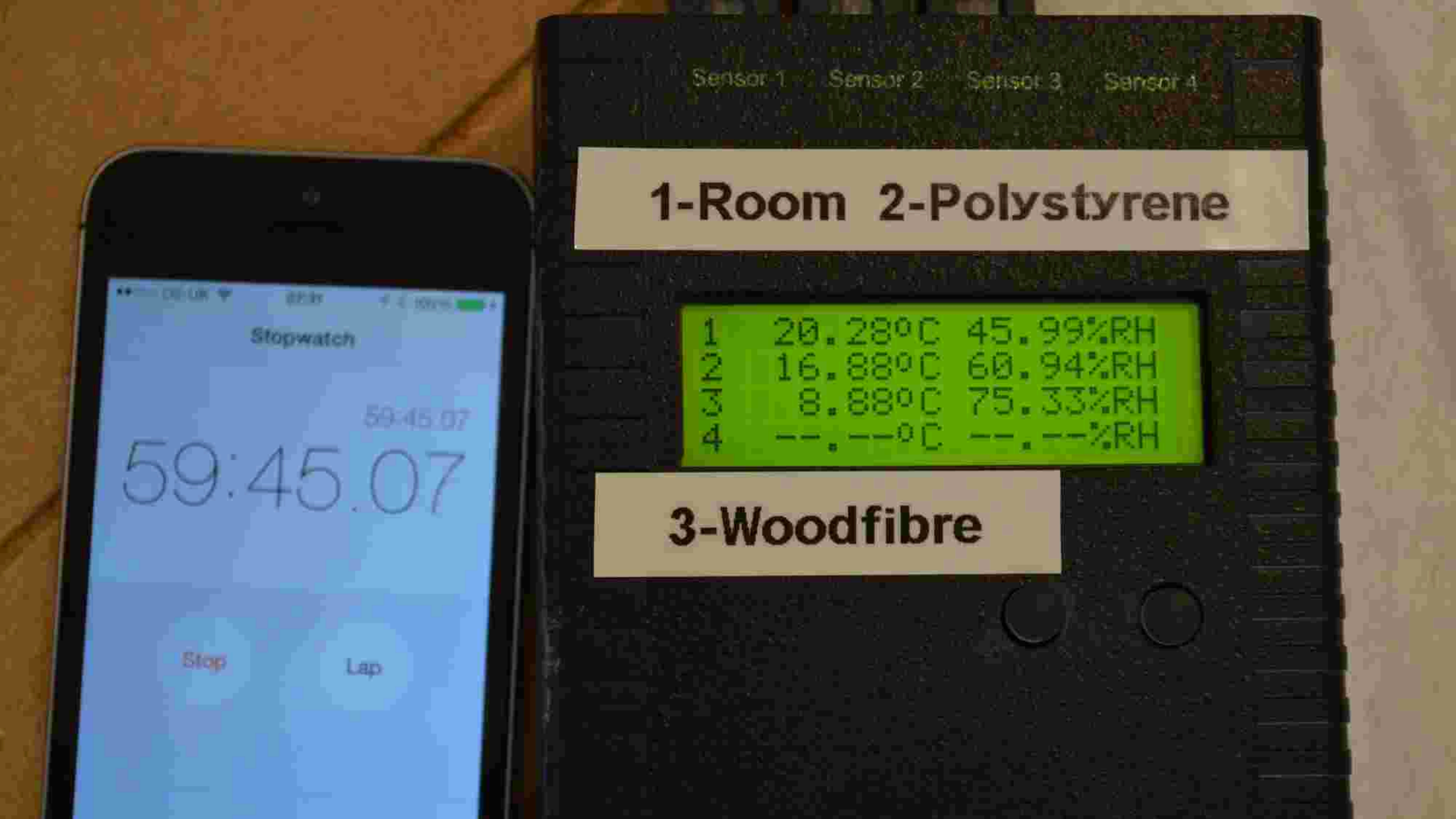
29:45.05
Stop
Lap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Sensor 2
Sensor 3
Sensor 4
1-Room 2-Polystyrene
1 20.28°C 45.99%RH
2 16.88°C 60.94%RH
3 8.88°C 75.33%RH
4 --.--°C --.--%RH
3-Woodfibre
Stopwatch
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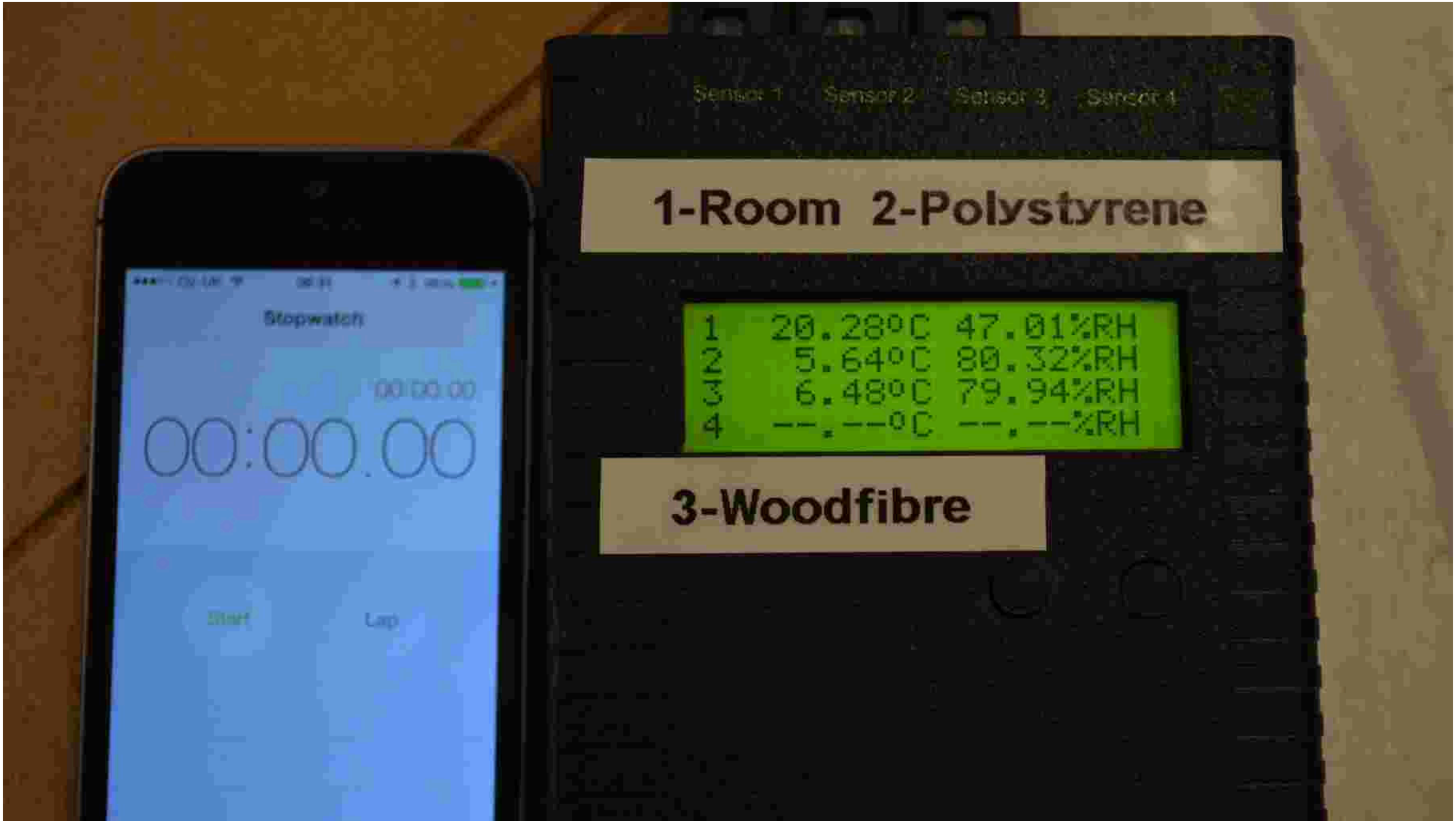
59:45.07
Stop
Lap


Sensor 1
Sensor 2
Sensor 3
Sensor 4
1-Room 2-Polystyrene
1 20.28°C 47.01%RH
2 5.64°C 80.32%RH
3 6.48°C 79.94%RH
4 --.--°C --.--%RH
3-Woodfibre
Stopwatch
00:00.00
00:00.00
Start
Lap

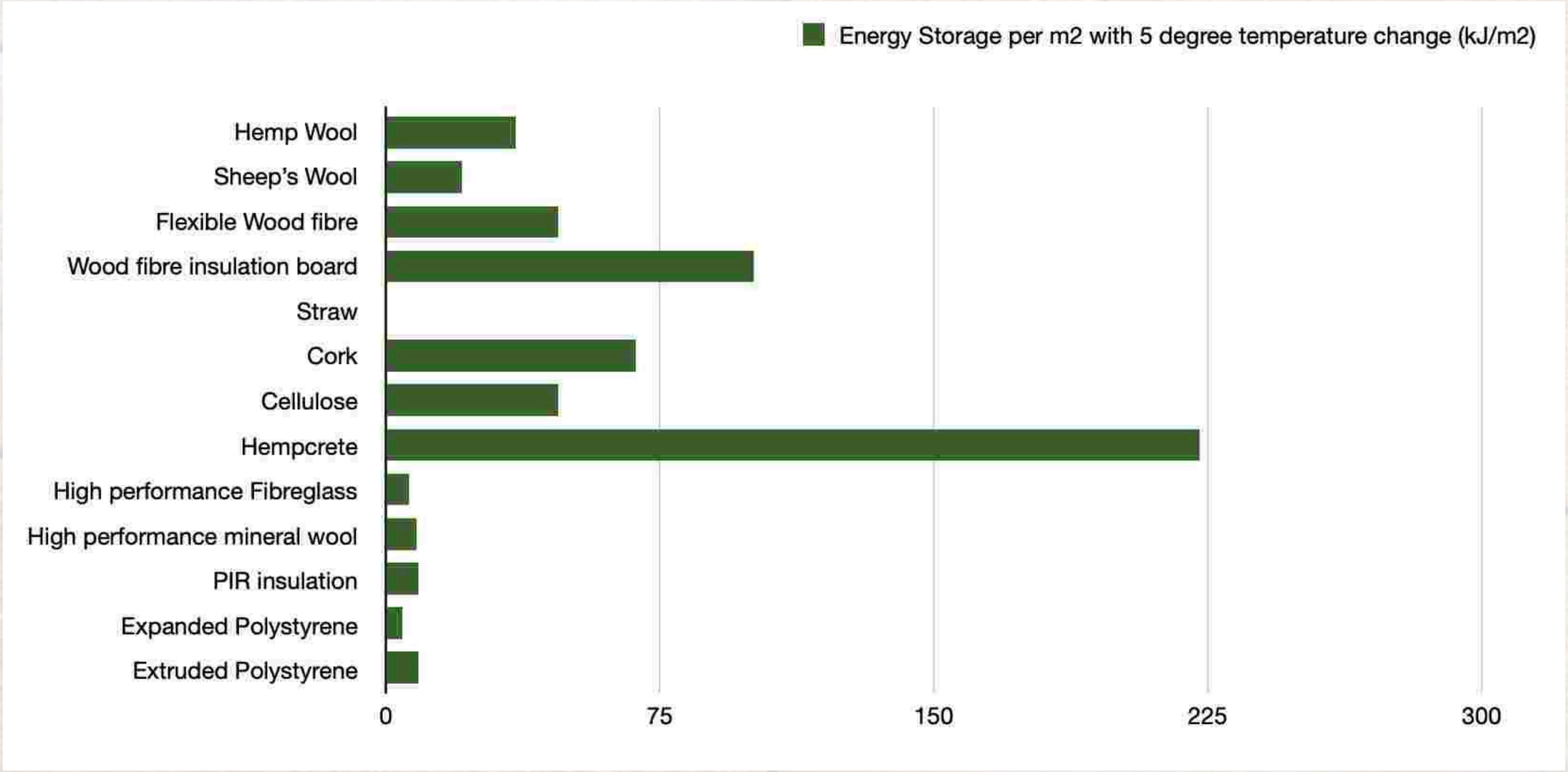
Scenario One

- 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/m^3	Specific heat capacity J/kgK	Thickness for U-value <0.5 W/m^2k	Energy Storage for 5C change (kJ/m^2)	Thermal Effusivity (J/m^2K$s^{1/2}$)
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

Energy storage within insulation



Scenario One

- 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 Two

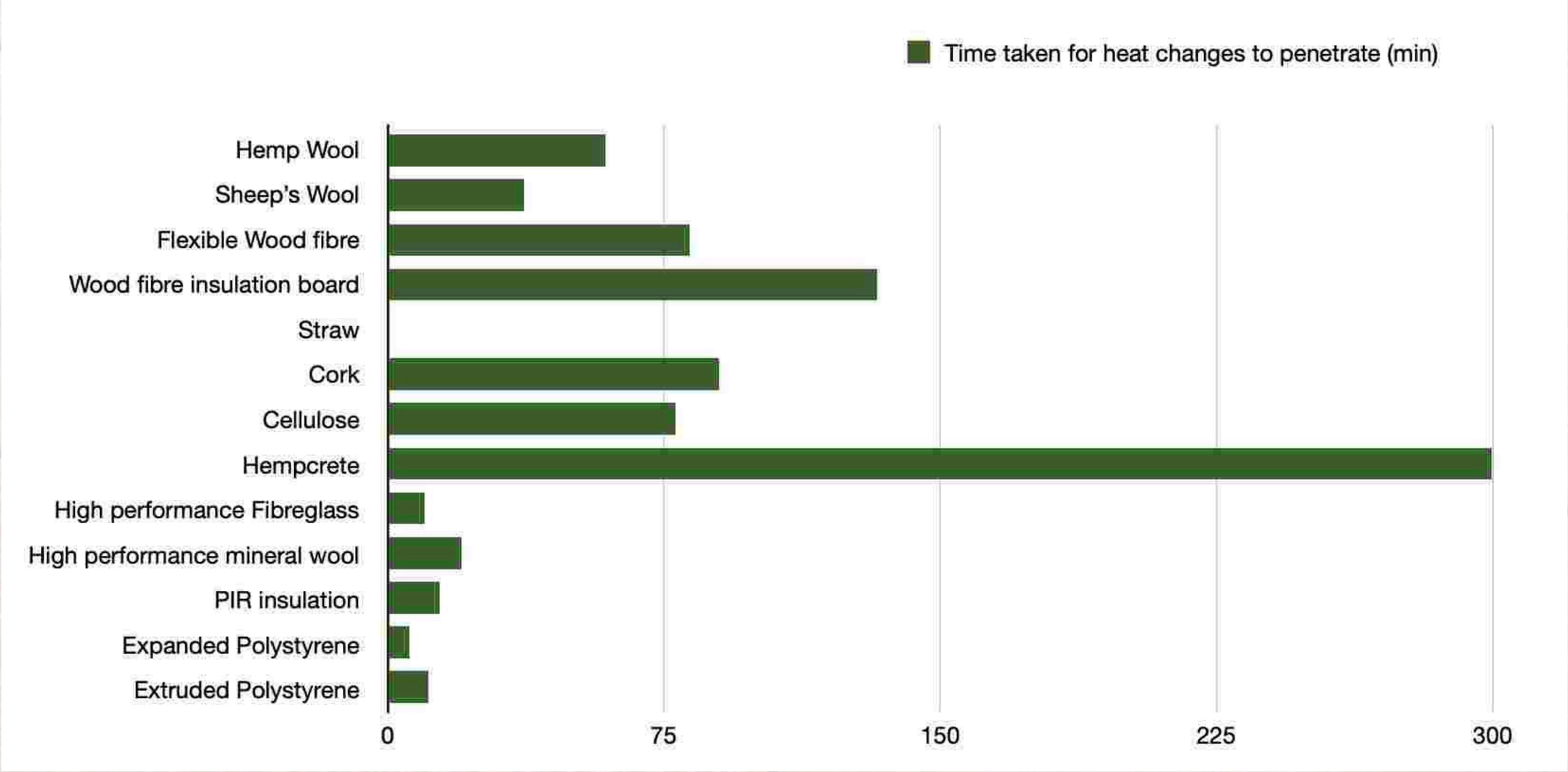
- Relatively thin, dark coloured masonry walling, facing south, with little or no overhang.

Mid-summer hot day, peak external temps - 30C at 4pm.

Internally insulated walls and roof to maintain appearance.

Product	Thermal conductivity W/mK	Density kg/m^3	Specific heat capacity J/kgK	Thickness for U-value <0.5 W/m^2k	Thermal Diffusivity $m^2/s \times 10^{-7}$	Time taken for heat changes to penetrate walls	Time taken for heat to penetrate roof - U-value 0.13 W/m^2K
Hemp Wool	0.038	45	2100	75 mm	4.02	59 min	11.45 hrs
Sheep's Wool	0.035	31	1800	75 mm	6.27	37 min	7.90 hrs
Flexible Wood fibre	0.036	60	2100	75 mm	2.86	82 min	15.7 hrs
Wood fibre insulation board	0.038	160	2100	60mm	1.13	133 min	15.7 hrs
Straw	0.060	120	2000		2.50		21.2 hrs
Cork	0.038	120	1900	60mm	1.67	90 min	
Cellulose	0.038	60	2100	75 mm	3.02	78 min	13.50 hrs
Hempcrete	0.068	270	1500	110mm	1.68	300 min	
High performance Fibreglass	0.032	30	700	60mm	15.23	10 min	3.25 hrs
High performance mineral wool	0.035	33	840	60mm	12.63	20 min	4.28 hrs
PIR insulation	0.022	30	1500	40mm	4.89	14 min	6.30 hrs
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



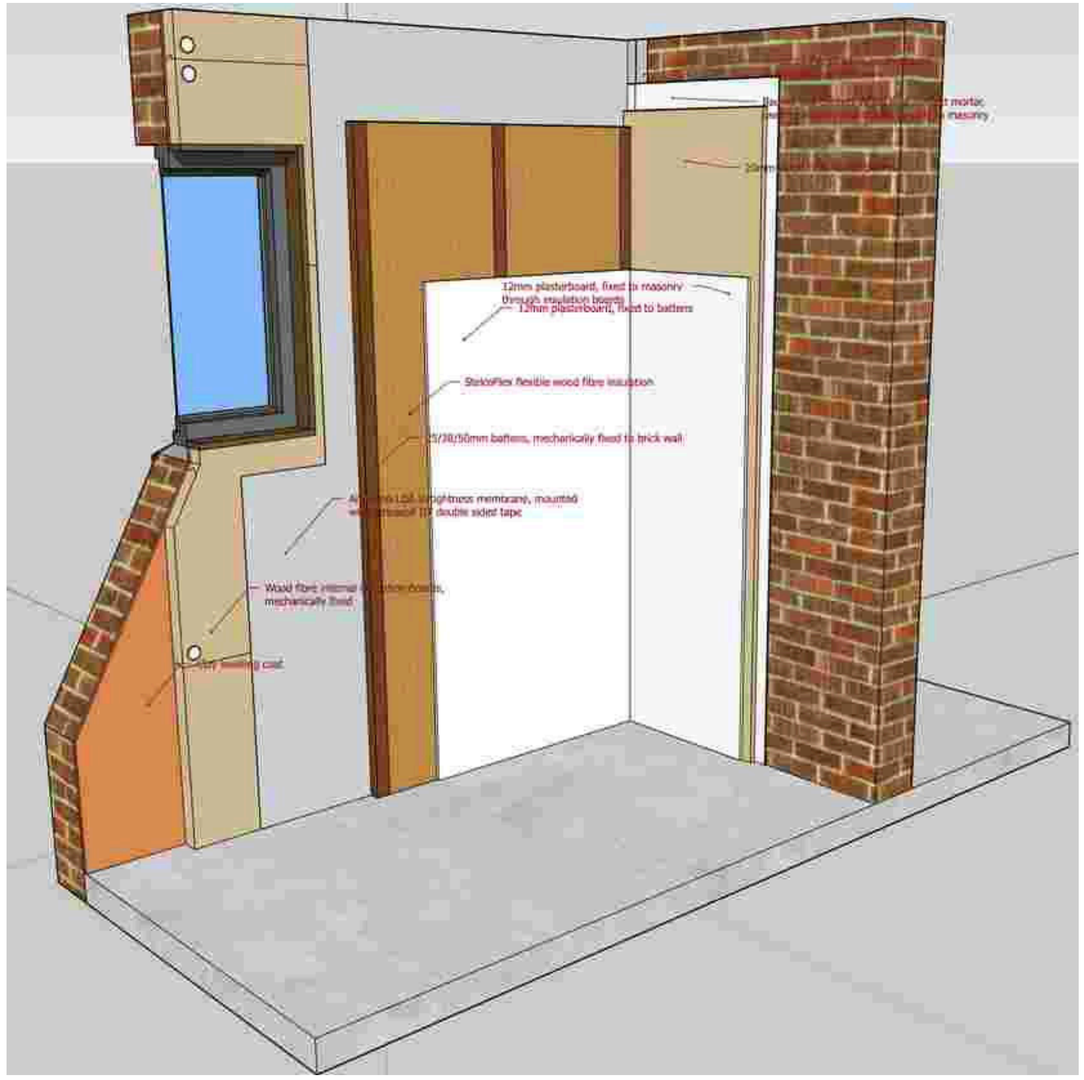
Scenario Two

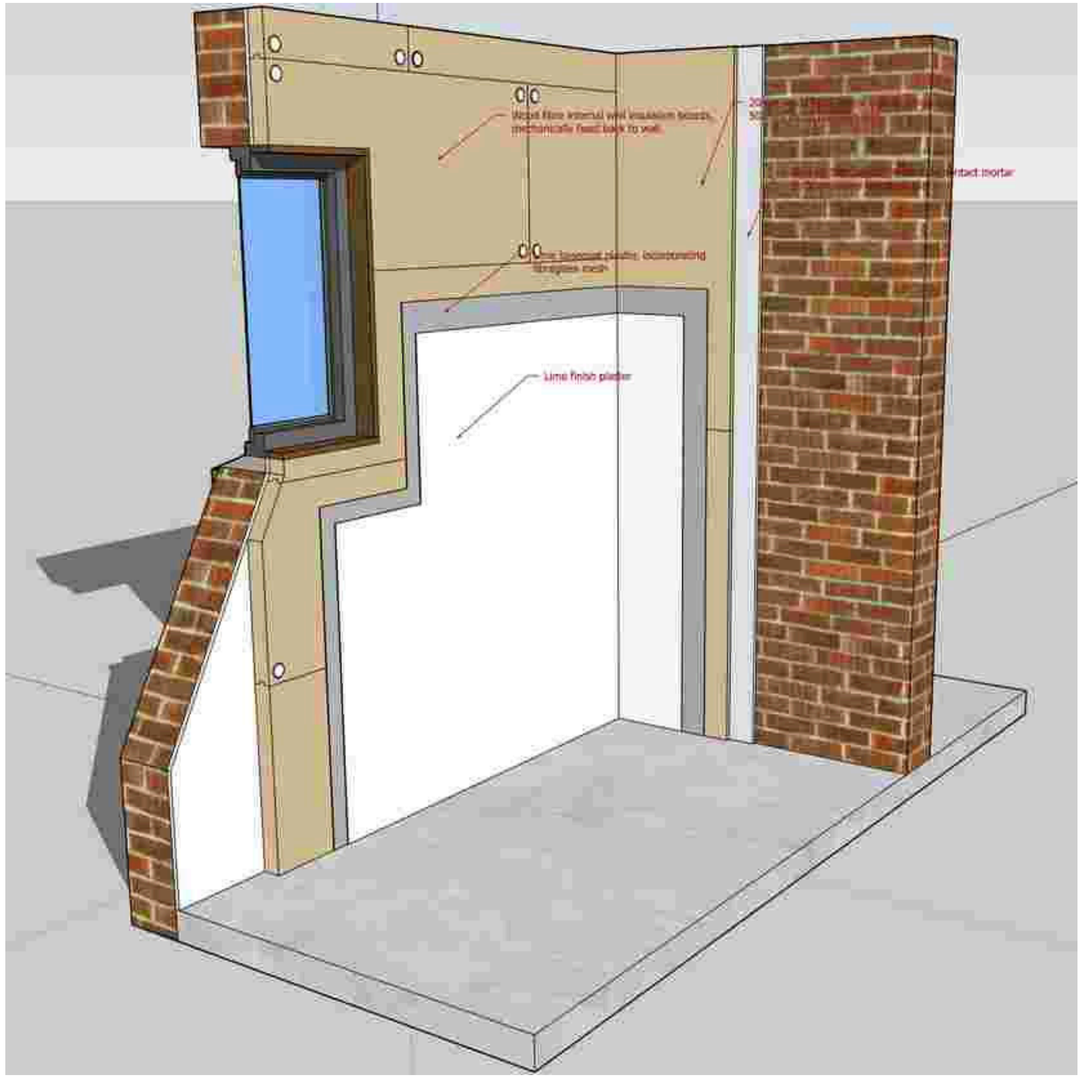
- High occupation, particularly during summer months, thermal mass and decrement delay help stabilise internal temperatures.

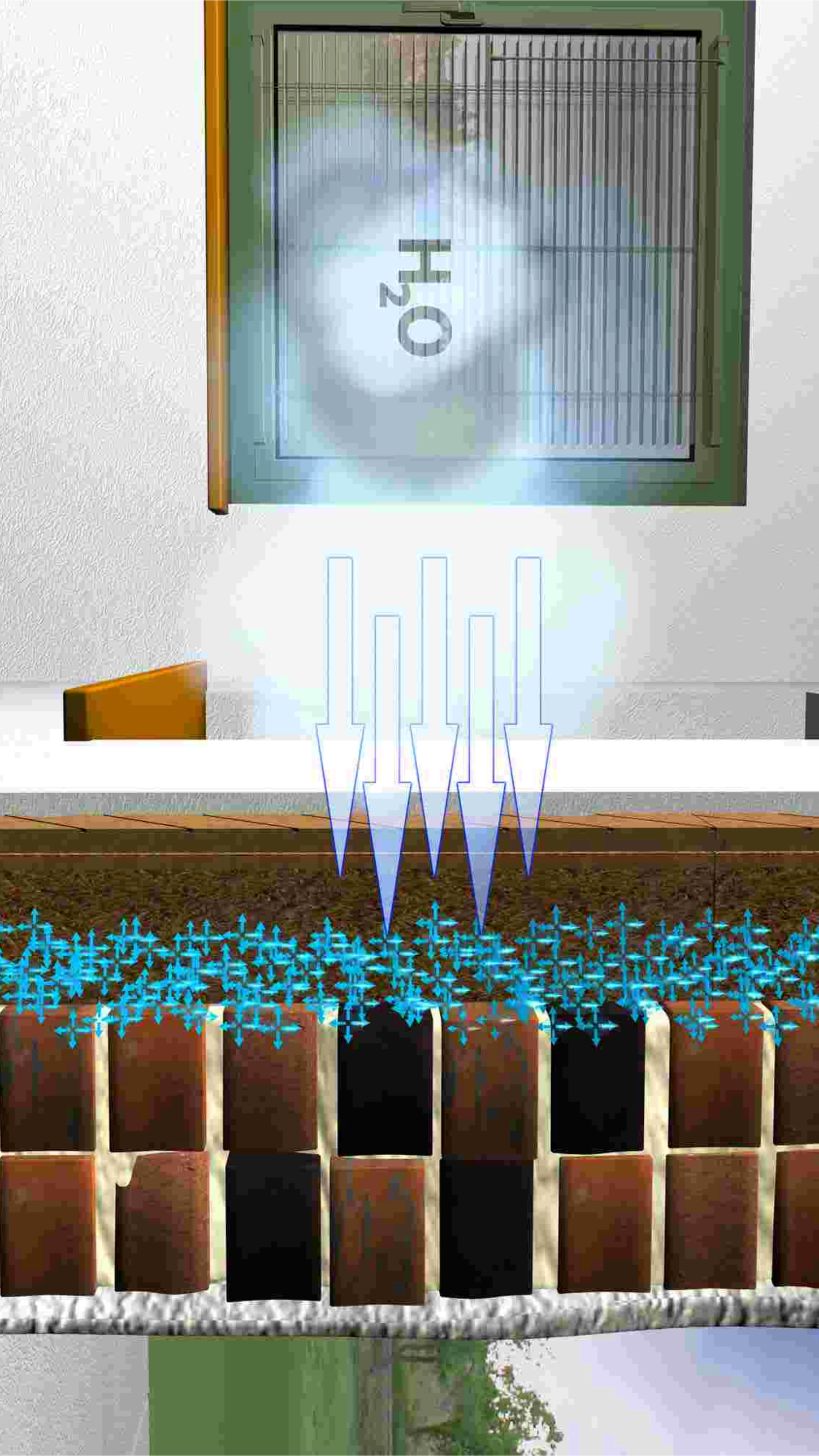
Pushing internal peak heat to later in the day allows cool air to be drawn in from outside.

Reduces reliance on the need for cooling

Internal Wall Insulation (IWI)






H2O

Any Questions?

ood fibre insulation, specifications installation guidance and free onli
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