NBT

Natural Building Technologies

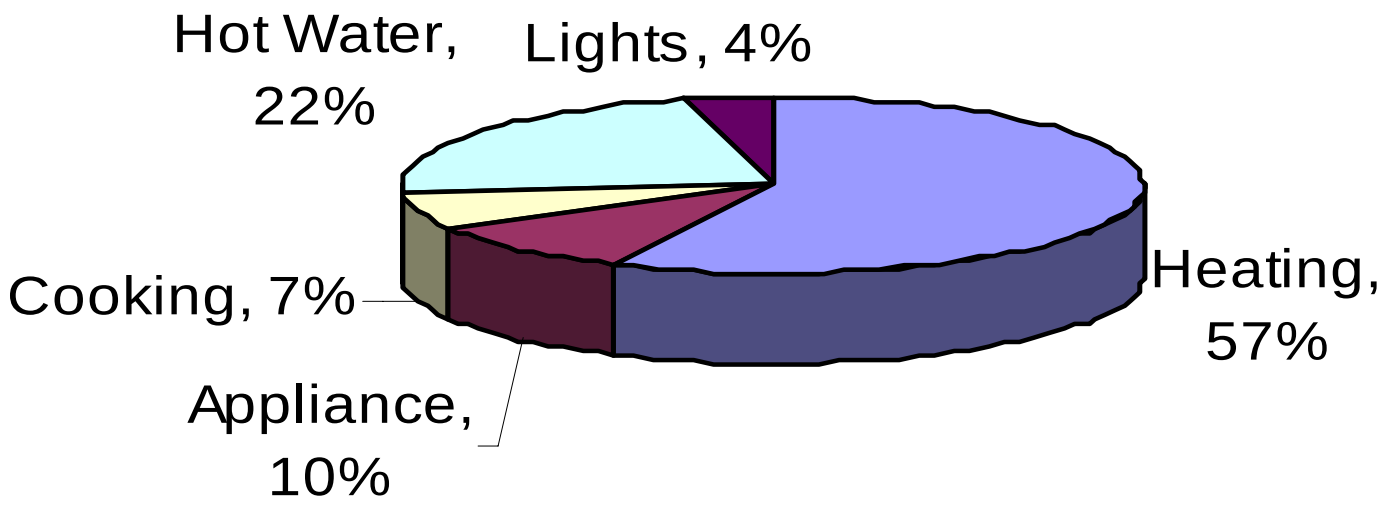
Breathability & Energy Efficiency

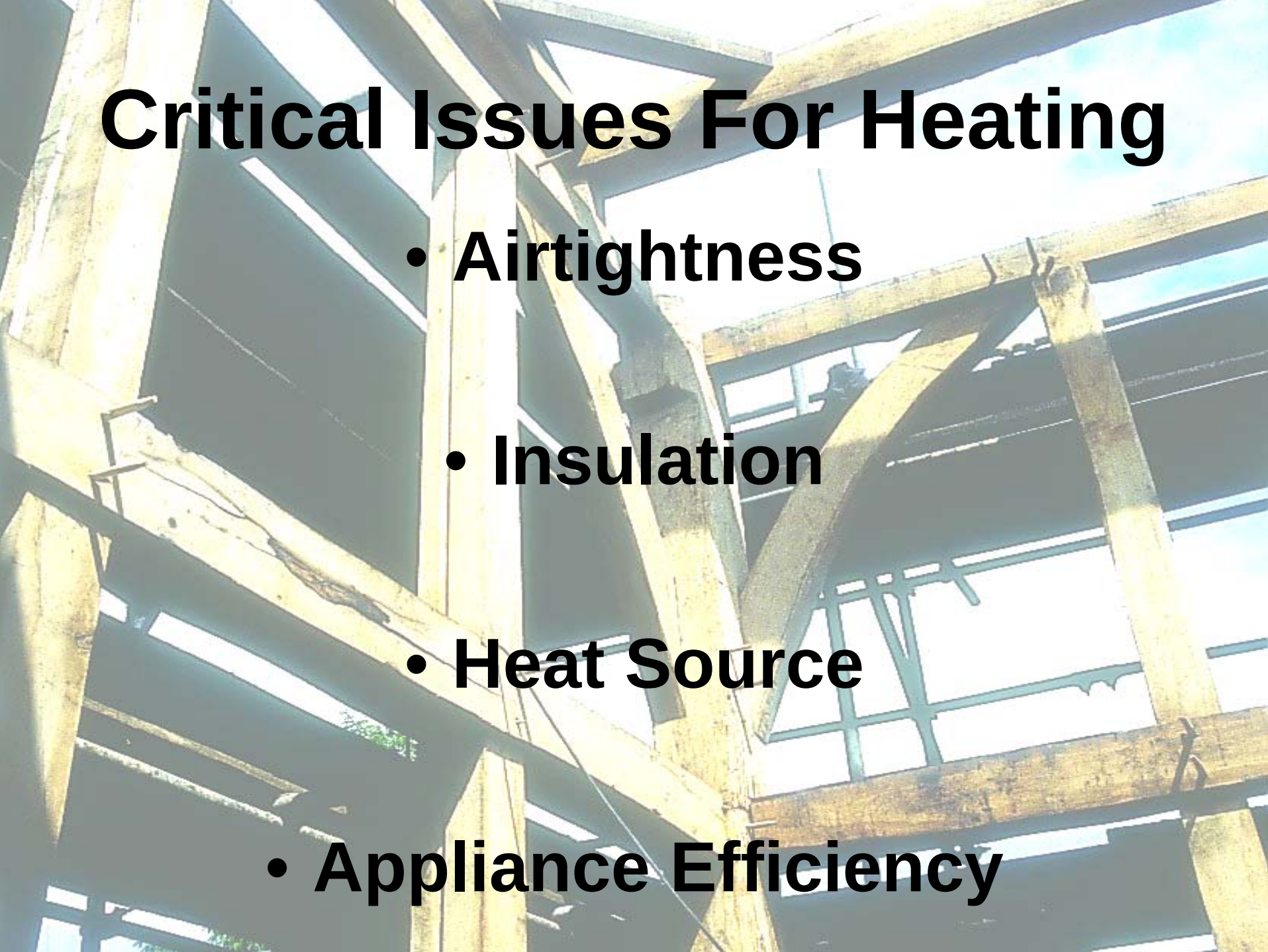
Real dangers & possible solutions

Why is energy efficiency important?

- Global Warming
- Resource Use
- Health/Comfort

Energy Efficiency and Buildings





Critical Issues For Heating

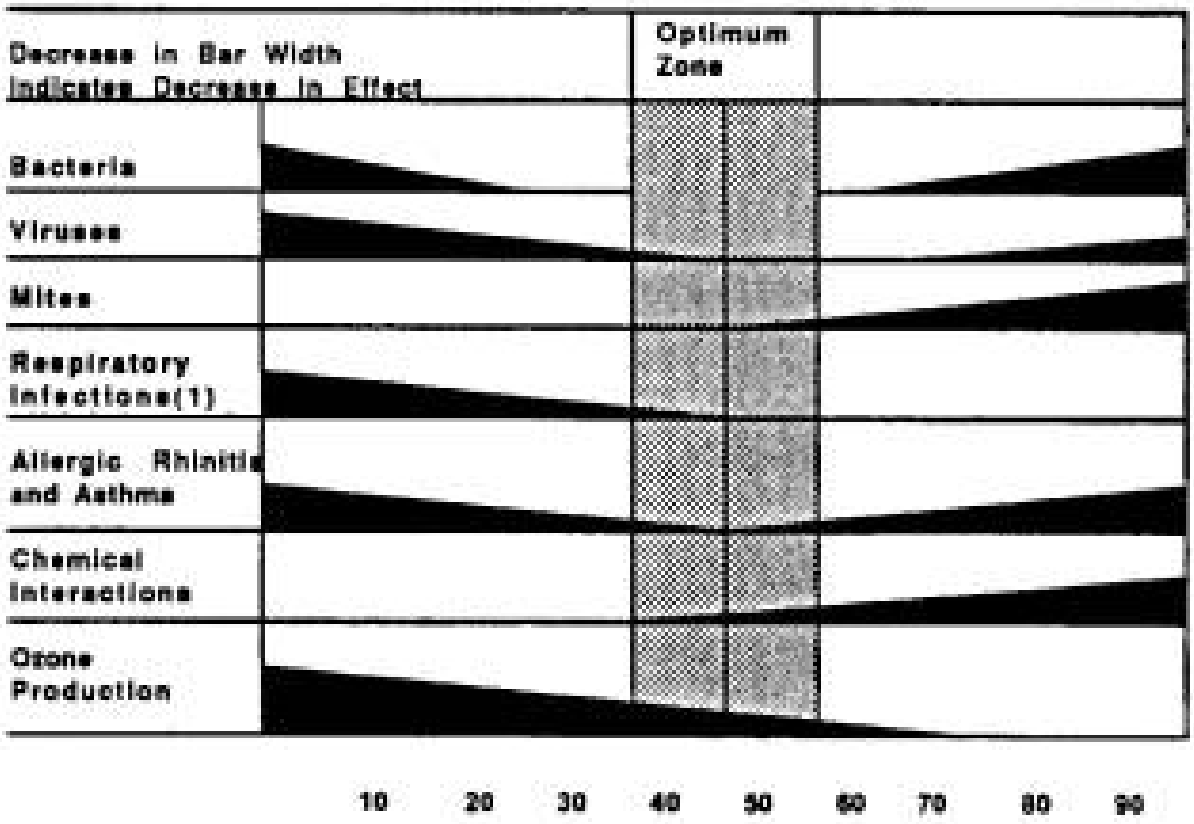
- Airtightness
- Insulation
- Heat Source
- Appliance Efficiency

The Story Of Professor Tristram & The Medieval Wall Paintings

Water & Buildings.

- Rain Penetration
- Interstitial Condition
- Inside Surface Condensation
- Indoor Air Quality

Building Health & Human Health



(1) INSUFFICIENT DATA ABOVE 50% R.H.
SOURCE: Sterling (1984) ASHRAE Transactions V.90, Part 2

Breathability

- **Vapour Permeability**
- **Hygroscopicity**
- **Capillarity**

Vapour Permeability Table A

Material	Range of resistivity r MNs/gm	Typical resistivity r MNs/gm	Thickness of the layer mm	Construction resistance (at typical resistivity) G MNs/g
Air	5	5	100	0.5
Foamed concrete	25-50	35	100	3.5
Bricks	25-70	50	100	5
Expanded polystyrene	100-750	150	100	15
Extruded polystyrene	600-1500	1000	100	100
Polyurethane foam	115-1000	300	100	30
Polyurethane foam with foil	c.10,000	10,000	100	1000
Polyisocyanate plastic insulation with foil	40,000 – 50,000	43,000	100	4300
Mineral wool, flax, sheepswool insulations	5-7	6	100	0.6
Woodfibre insulation boards,	25	25	100	2.5
Cellulose insulation (blown)	40-50	45	100	4.5
Spruce, pine, fir	45-1850	200	100	20
Oak, ash, beech	200-1850	400	100	40
Metals and metal cladding, some plastics and asphalts	250,000 - ∞	1,000,000	1	1000

Vapour Permeability Table B

Material	Range of resistivity r MNs/gm	Typical resistivity r MNs/gm	Thickness of the layer mm	Construction resistance (at typical resistivity) G MNs/g
Air	5	5	1000	5
Cement plaster	75 -200	100	20	2
Lime plaster	45-200	75	20	1.5
Clay plaster	30-50	40	20	0.8
Gypsum plaster	30-60	50	20	1
Emulsion paints for indoor use	1000-7500	1,500	100 µm	0.15
Emulsion paints for outdoor use	10,000-25,000	15,000	120 µm	1.8
Silicate paints	250-350	300	100 µm	0.03
5 coatings with pure limewash	250	250	100 µm	0.025
Solvent based glosses	15,000-25,000	20,000	120 µm	2.4
Alkyd varnishes	60,000-100,000	80,000	120 µm	9.6
Coatings, based on epoxy resins	175,000-250000	200,000	120 µm	24
Coatings, based on chlorinated rubber	350,000	350,000	120 µm	42

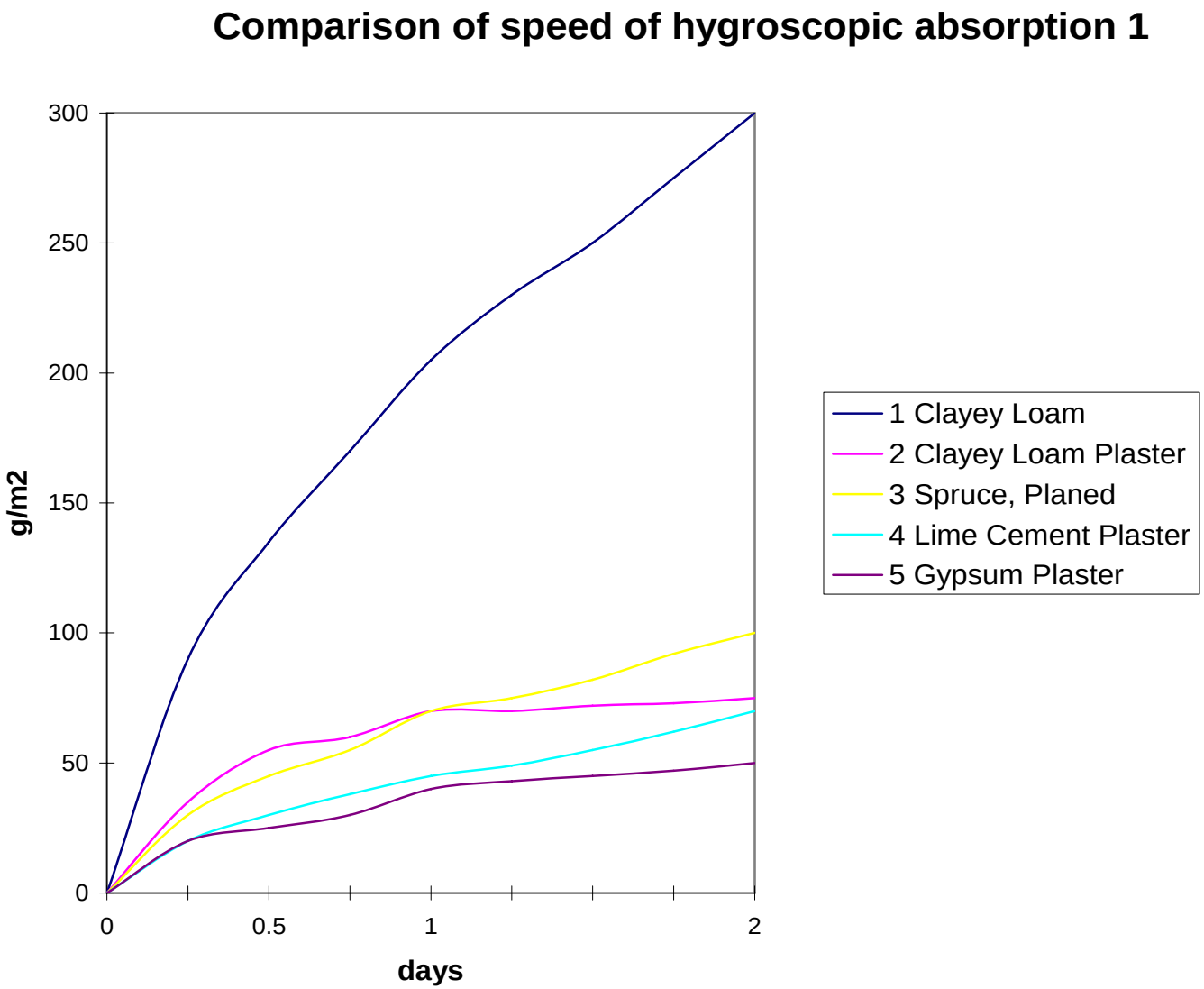
Hygroscopicity

- EMC
- Speed
- Mass

Equilibrium moisture content of timber at different RH and Temperature

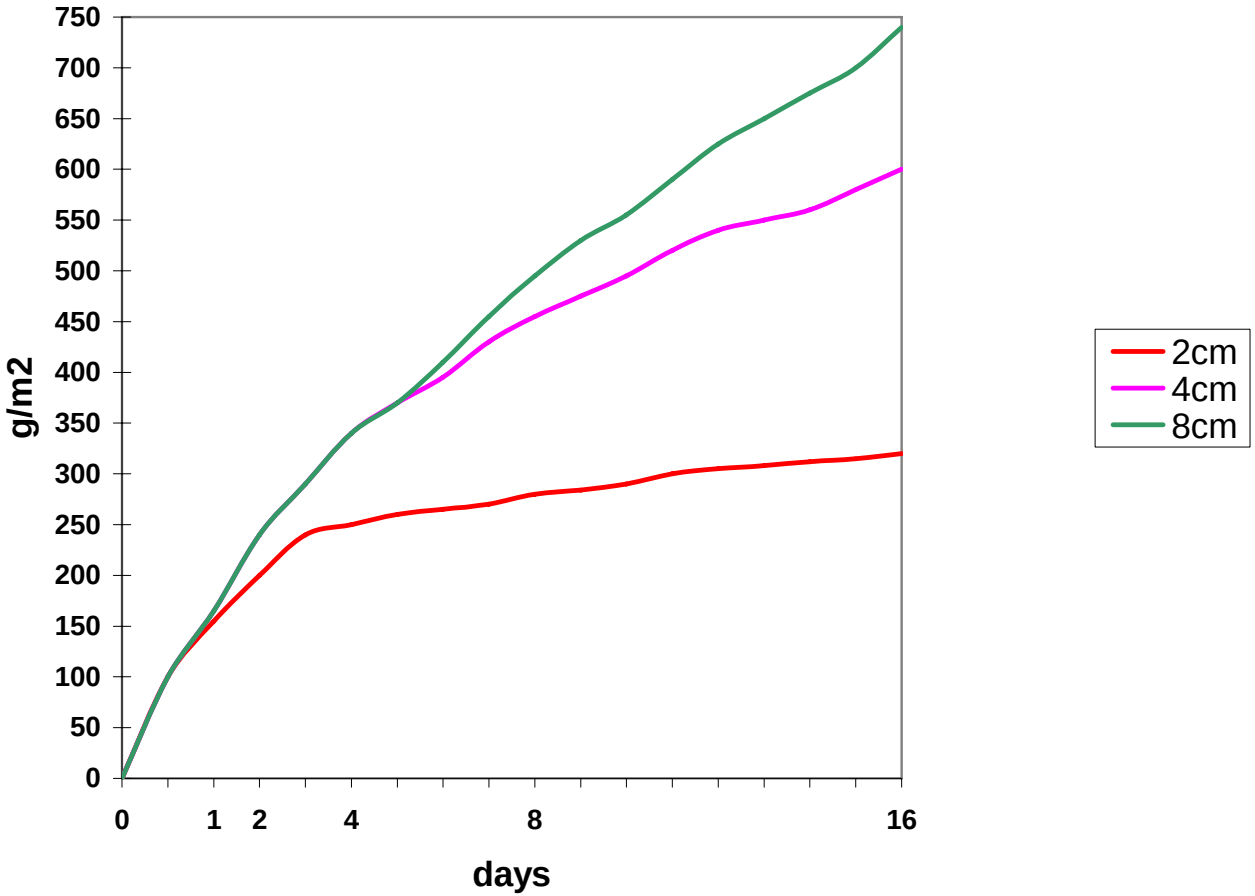
Relative Humidity	Ambient Temperature			
0%	**-1°C**	**10°C**	**21°C**	**32°C**
10%	2.6	2.6	2.5	2.3
20%	4.6	4.6	4.5	4.3
30%	6.3	6.3	6.2	5.9
40%	7.9	7.9	7.7	7.4
50%	9.5	9.5	9.2	8.9
60%	11.3	11.2	11.0	10.5
70%	13.5	13.4	13.1	12.6
80%	16.5	16.4	16.0	15.4
90%	21.0	20.9	20.5	19.8
98%	26.9	26.9	26.6	26.0

Comparison Of Hygroscopic Speed



Effect Of Thickness

Effect of the thickness of loam layers at a temp. of 21 deg C on their rate of absorption after a sudden rise in humidity from 50-80%

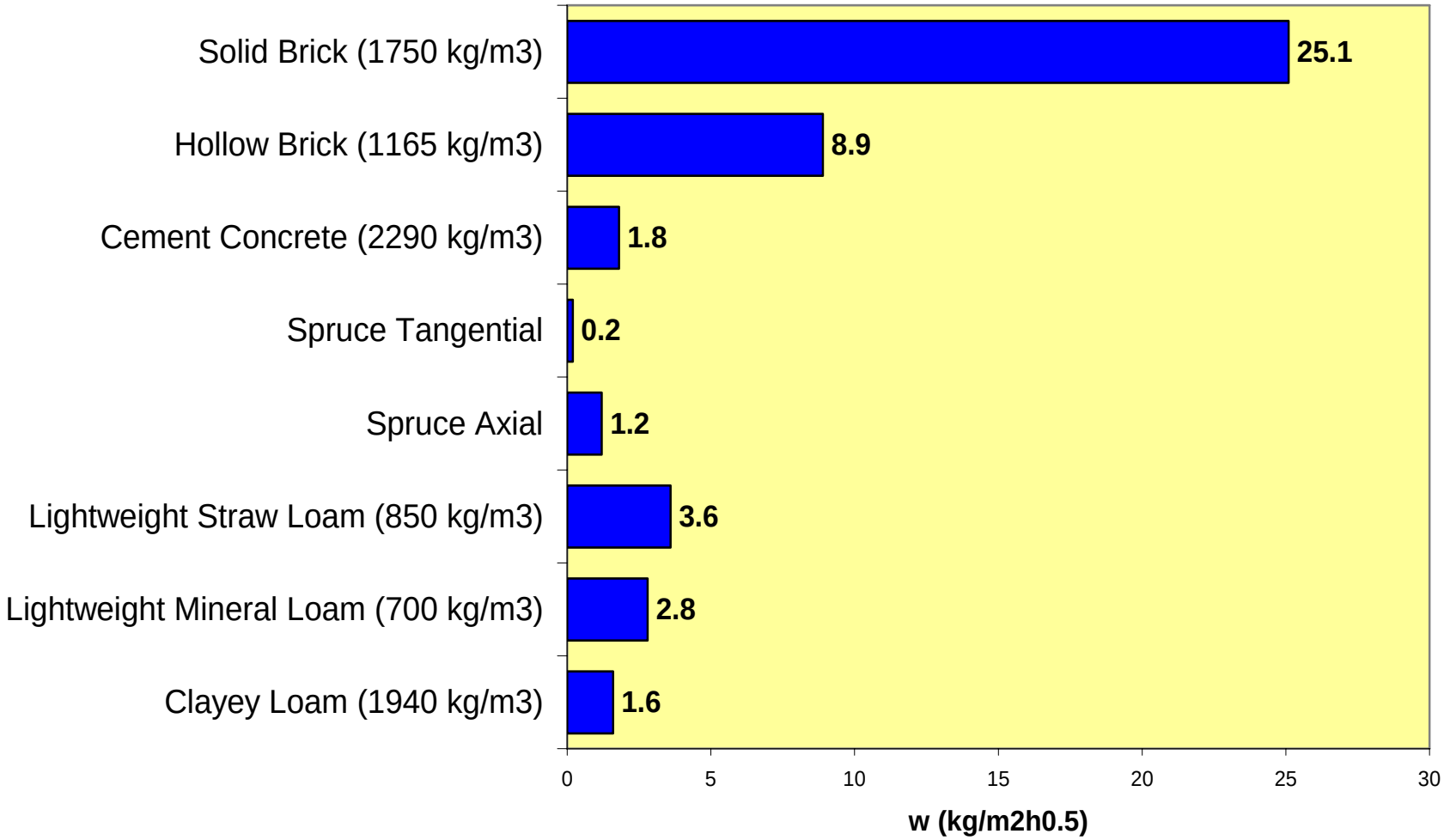


Hygroscopicity table

Material	Density Kg/m3	EMC at 50% RH (at 20º C)	EMC at 85% RH (at 20º C)	Hygroscopicity(increase in moisture/mass at 20º C from an RH of 50% to 85%)	Hygroscopic capacity Density x Increase Kg/m3	Speed of hygroscopic take up
Cement render	2000	0.5%	2.5%	2%	40	Slow
Lime render (hydraulic)	1600	1.25	3%	1.75%	28	Slow/medium?
Gypsum plaster	850	0.4%	1%	0.6%	5.1	Medium
Concrete	2000	0.5%?	2.5%?	2%?	40?	Slow
Aerated concrete	600	0.9%	2.5%	1.6%	9.6	Medium
Fired Clay Brick	1700	0.1	0.2	0.1%	1.7	Medium
Unfired Clay Brick	1700	4	7	3%	52	Very Fast
Spruce transverse	600	9	18	9%	54	Slow
Spruce end grain	600	9	18	9%	54	Fast
Plywood	500	9	18	9%	47	Very Slow
Mineral wool insulation	10	1.3	2.3	1%	0.1	Medium
All plastic insulations	15	0	0	0%	0	N/A
Woodfibre board insulation	200	8	17	9%	18	Fast
Cellulose insulation blown	45	8	17	9%	4	Fast
Flax/ hemp/ sheepswool insulation	25	8	17	9%	2.25	Fast
All paints	0.1 – 0.3	N/A	N/A	0%	0	N/A

Capillarity

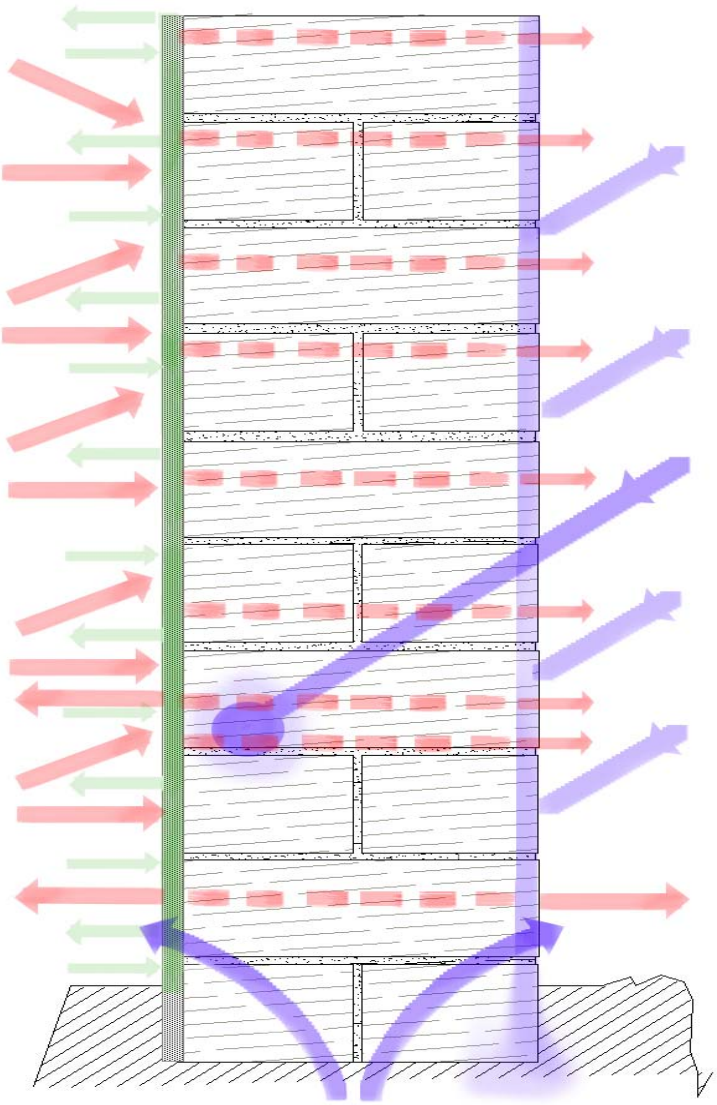
Water Absorption Coefficient "w" of Loams in Comparison With Common Building Materials



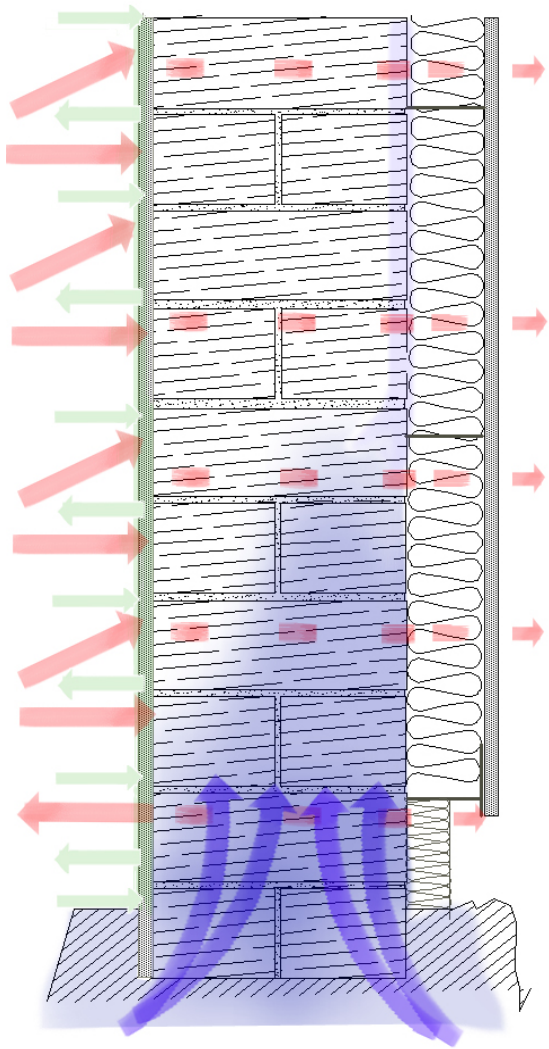
Breathability comparison of some common materials

Material	Vapour Permeability (r)	Hygroscopicity(increase in moisture/mass at 20º C from an RH of 50% to 85%)	Hygroscopic capacity Density x Increase Kg/m3	Speed of hygroscopic take up	Capillarity w $kg/m^2h^{0.5}$
Concrete	500	2%?	40?	Slow	1.8
Fired Clay Brick	50	0.1%	1.7	Medium	25.1
Unfired Clay Brick	40	3%	52	Very Fast	2
Mineral wool insulation	5	1%	0.1	Medium	0.1?
Expanded polystyrene insulation	150	0%	0	N/A	0.2?
Polyisocyanate Insulation	43,000	0%	0	N/A	0
Woodfibre insulation	25	9%	18	Fast	0.5 – 2
Cellulose insulation	25	9%	4	Fast	>10
Flax/ hemp/ sheepswool insulation	5	9%	2.25	Fast	1 - 2

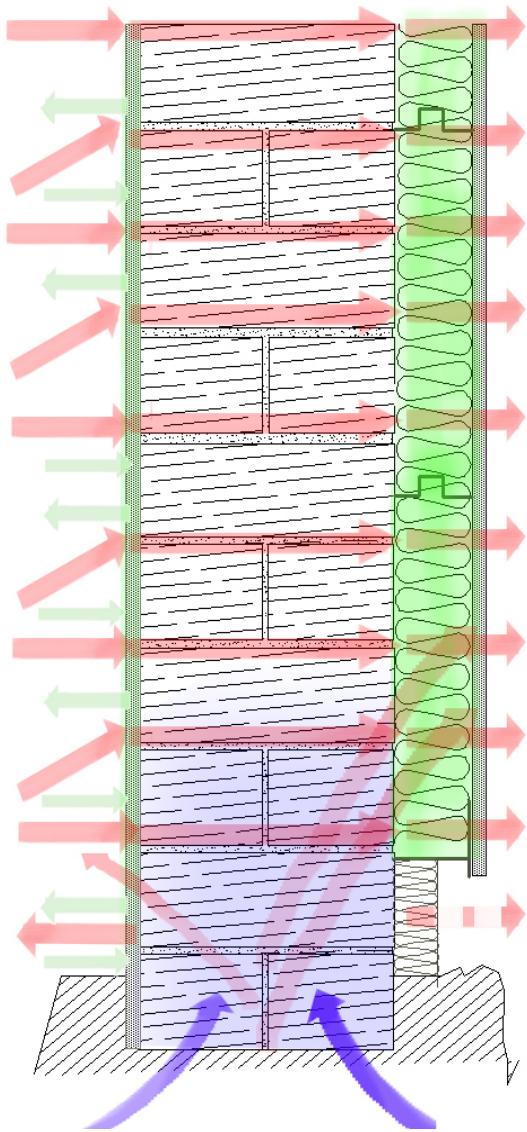
Victorian Solid 9” brick wall



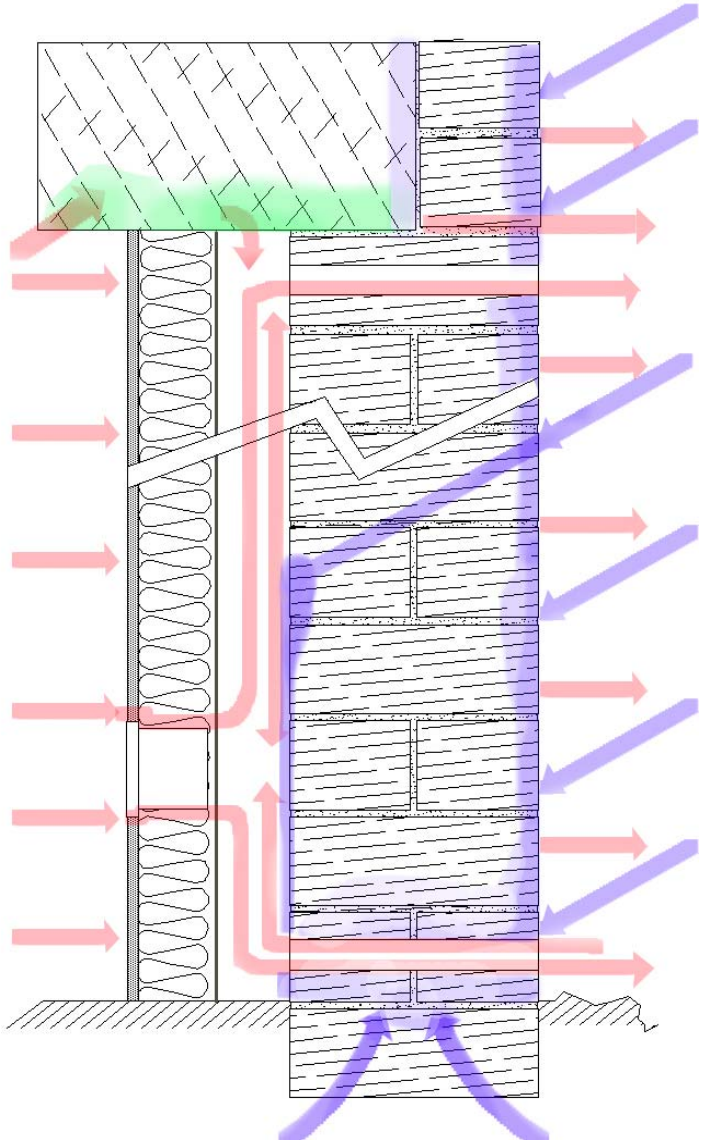
Polystyrene EWI System



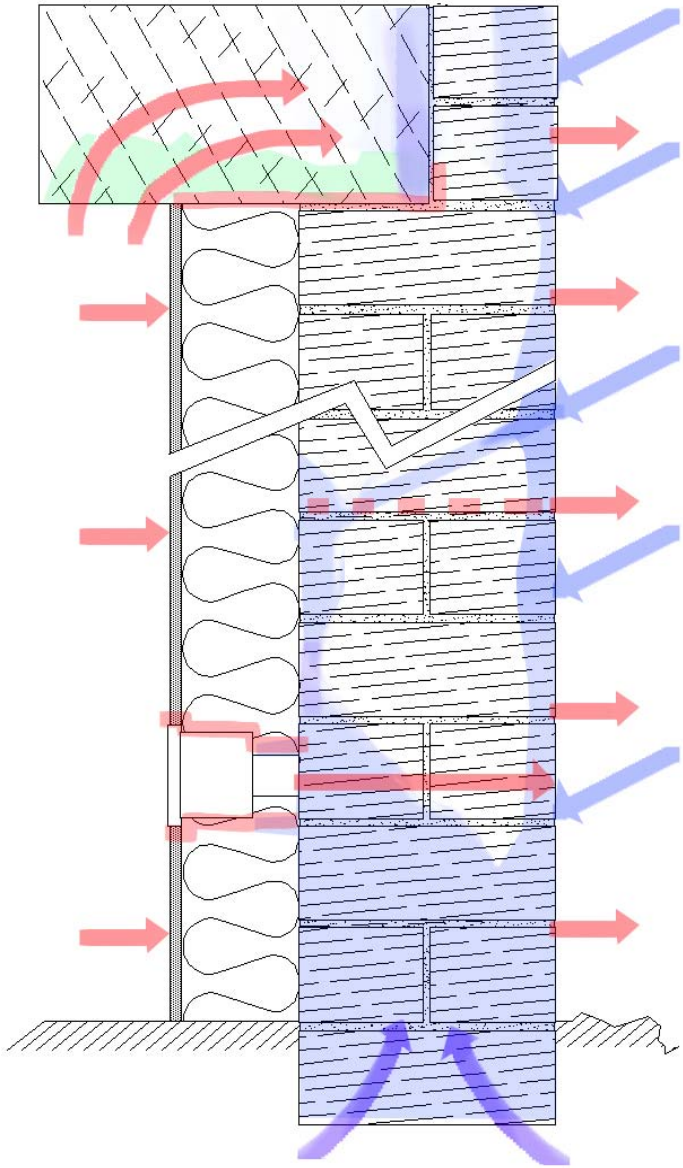
Woodfibre EWI System



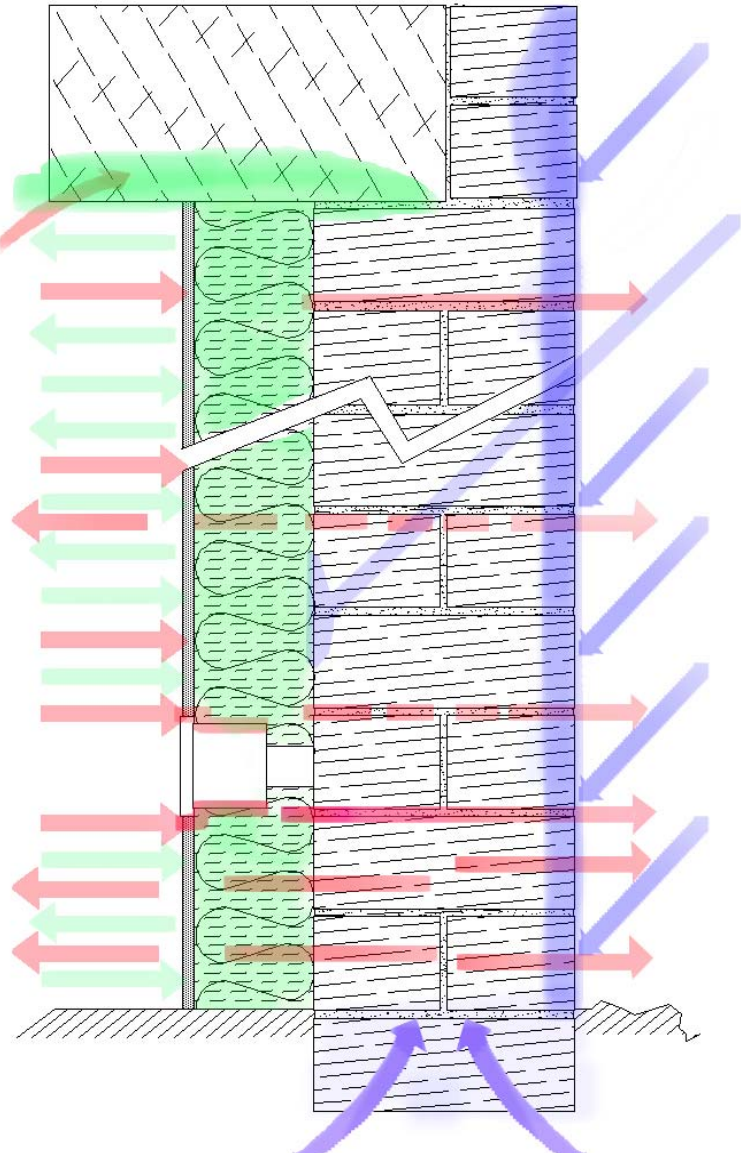
IWI – Dry lining with Vented cavity



IWI – Solid Plastic Insulation System



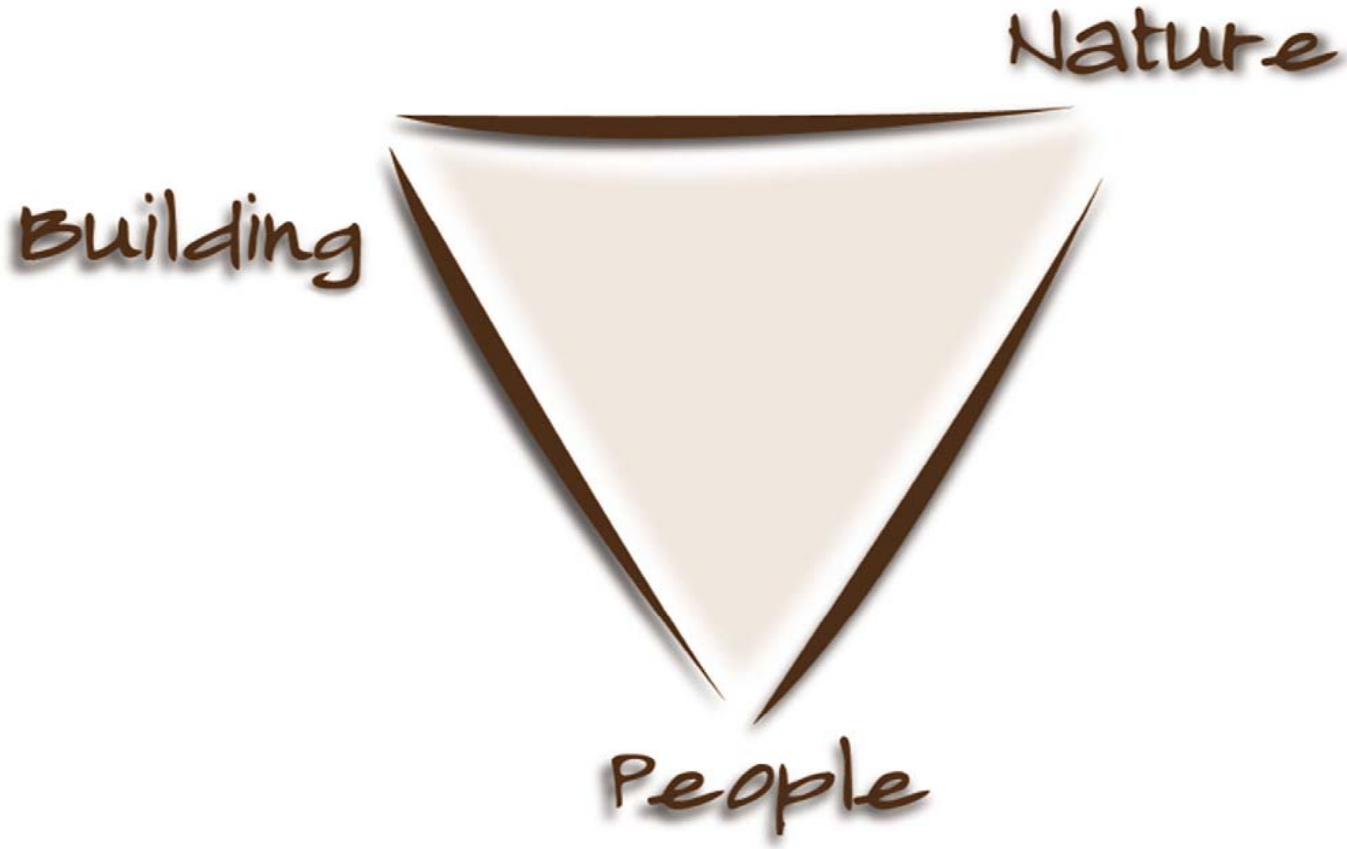
IWI – Solid Woodfibre Insulation System



Ventilation Compared With Hygroscopic Buffering

- Efficiency
- Application
- Durability
- Flexibility

The Potential Of “Exovation”



Natural Building Technologies

The Science of Nature

The Future of Construction

NBT

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