# Insulating Solid Walls & Managing Moisture

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# About Cornish Lime

## Care, repair & enhancing our built heritage.

- Over 25 years trading & experience
- In-house experts
- Off the shelf or custom and engineered solutions
- Suppling projects worldwide
- Consultancy and testing


Vernacular Buildings

Listed Buildings

Large Housing Developments

Global Heritage Sites

# Moisture in Construction

It has been estimated that 75% of building failure is due to water (new & old).

Water can effect a building in four areas –

1. Outer Envelope – Water Penetration
2. The Middle – Interstitial Condensation
3. Inner Envelope – Surface Condensation
4. Indoor Environment – Humidity & Air Quality

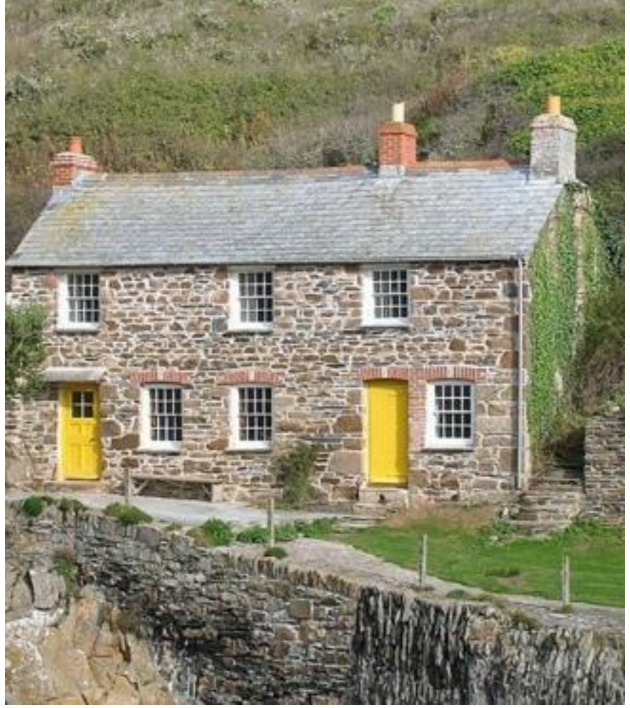
The two principal reasons for failure are Water Penetration and Interstitial Condensation.

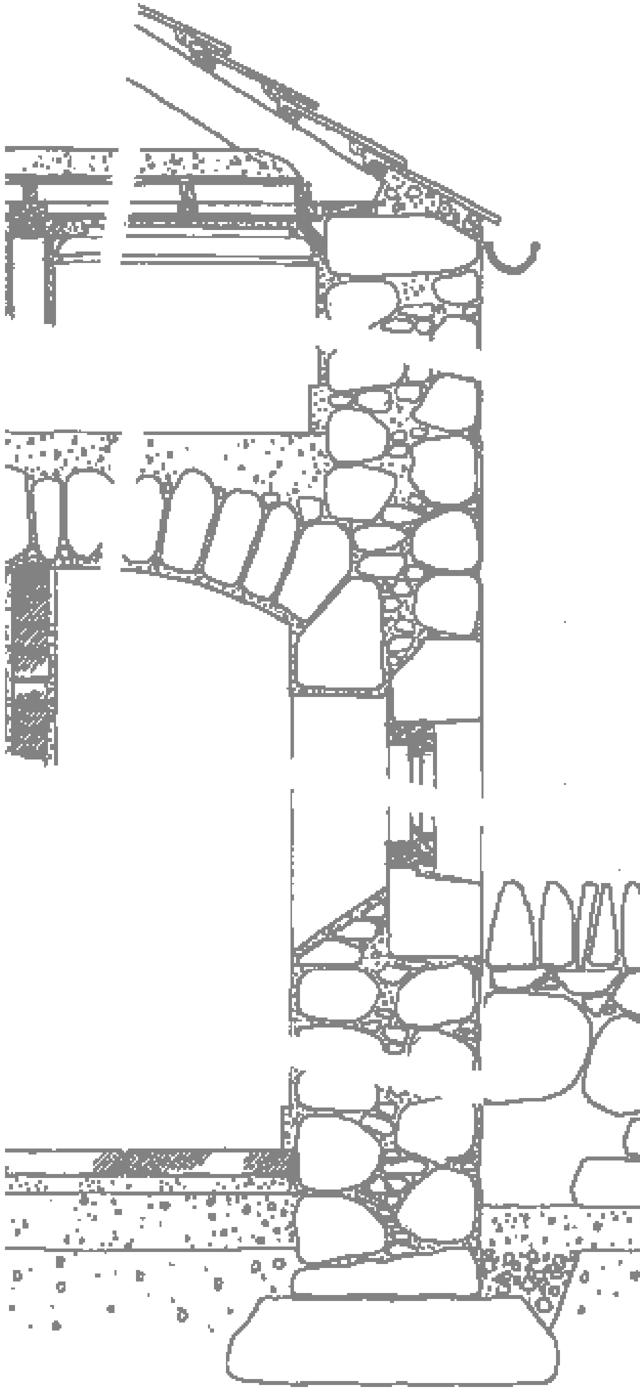
# Traditional Masonry – Solid Walls

Traditional construction is often referred to as **composite masonry**, where multiple units, such as brick and stone, are set with a mortar to create a wall.

This example illustrates two stone faces with a rubble core. The core of a composite wall would have been set with a mortar.

These walls would have been built using readily available materials from the local landscape.





# Traditional Mortars – Solid Walls

The mortar used for this type of construction would have comprised of earth and/or lime, depending on location and affordability.

The porous nature of the mortar allowed water (liquid and moisture) to ingress and egress through the masonry, creating a breathable construction.

The mortar was always softer than the host masonry, this allowed for both moisture movement and accommodated thermal movement within the structure.

# Traditional Construction

- 1 in 5 buildings of the UK stock is classified as historic construction (pre 1919, solid wall) (20%).
- 8 million buildings were built pre 1920.
- The vast majority of these buildings were constructed using lime and/or earth, making the building a vapour permeable construction.
- Walls were designed to a thickness that would keep the external elements away.
- As a general rule – the thicker the wall, the older the building.

# Building Physics and Breathability

There are 3 elements of moisture movement –

**Permeability** – the ability of a material to allow water vapour (gas) to pass through it.

**Capillarity** – the ability of a material to absorb and release water (liquid).

**Hygroscopicity** – the ability of a material to absorb and release water (vapour).

# Virtues of a Breathable Material

**High Permeability** – allows water vapour to transfer through a material, with low resistance.

**Low Capillarity** – will not take up large volumes of water as a liquid.

**Hygroscopicity** – depends on the materials use/location

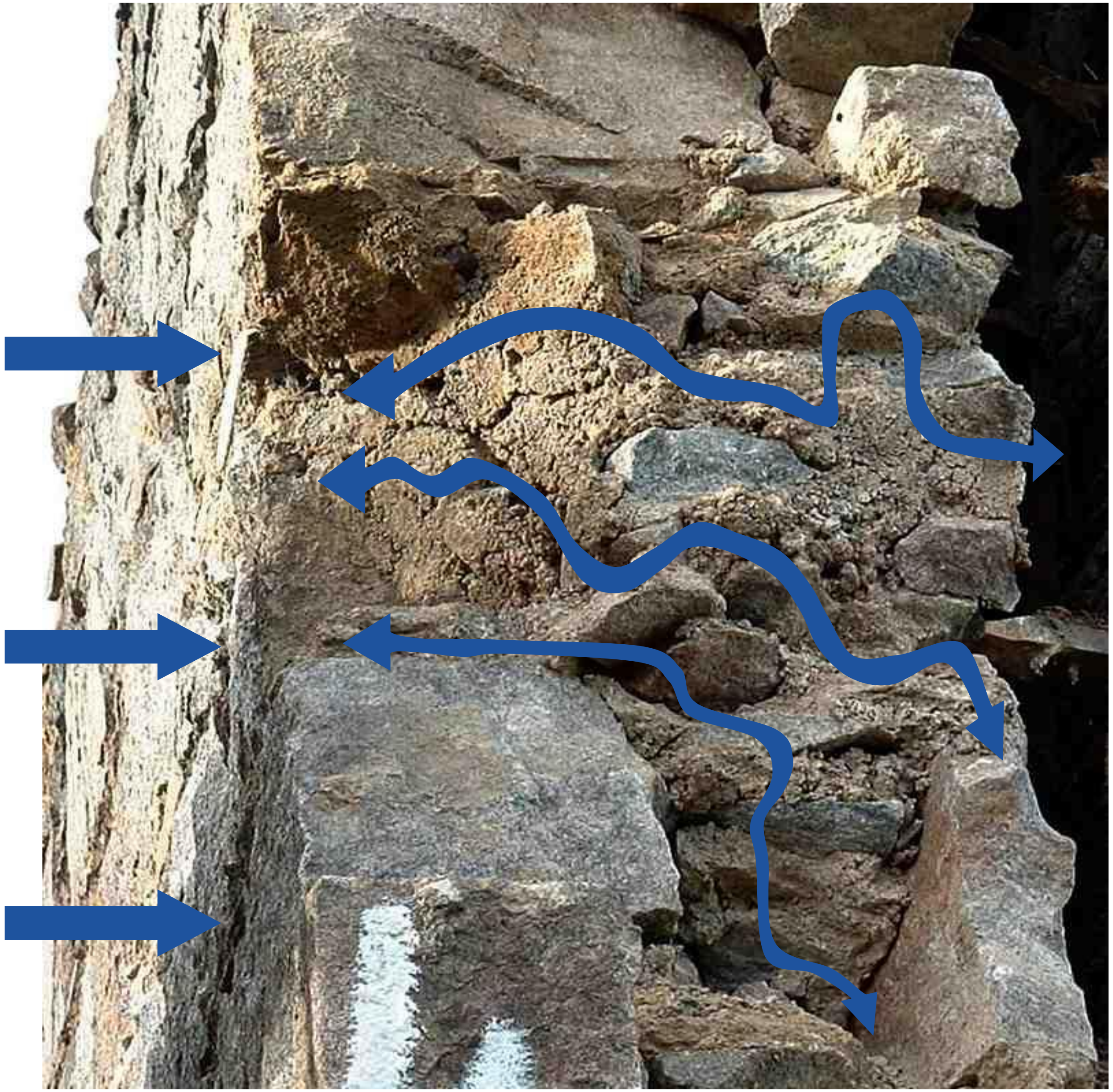
*In most cases only Permeability is accounted for.*

We need these 3 elements to work together to manage moisture.

**Water will take the path of least resistance, but it needs to be primed to take this path.**

# Moisture – The Engine of Decay

- There is no cavity, so water and moisture will always be present.
- Moisture movement will occur mainly through the mortar joints.
- The performance of the mortar is critical in relation to water and moisture ingress and egress.
- But so is any render or paint coating.
- Both ways – lack of moisture movement can cause issues as can  too much water and moisture ingress.



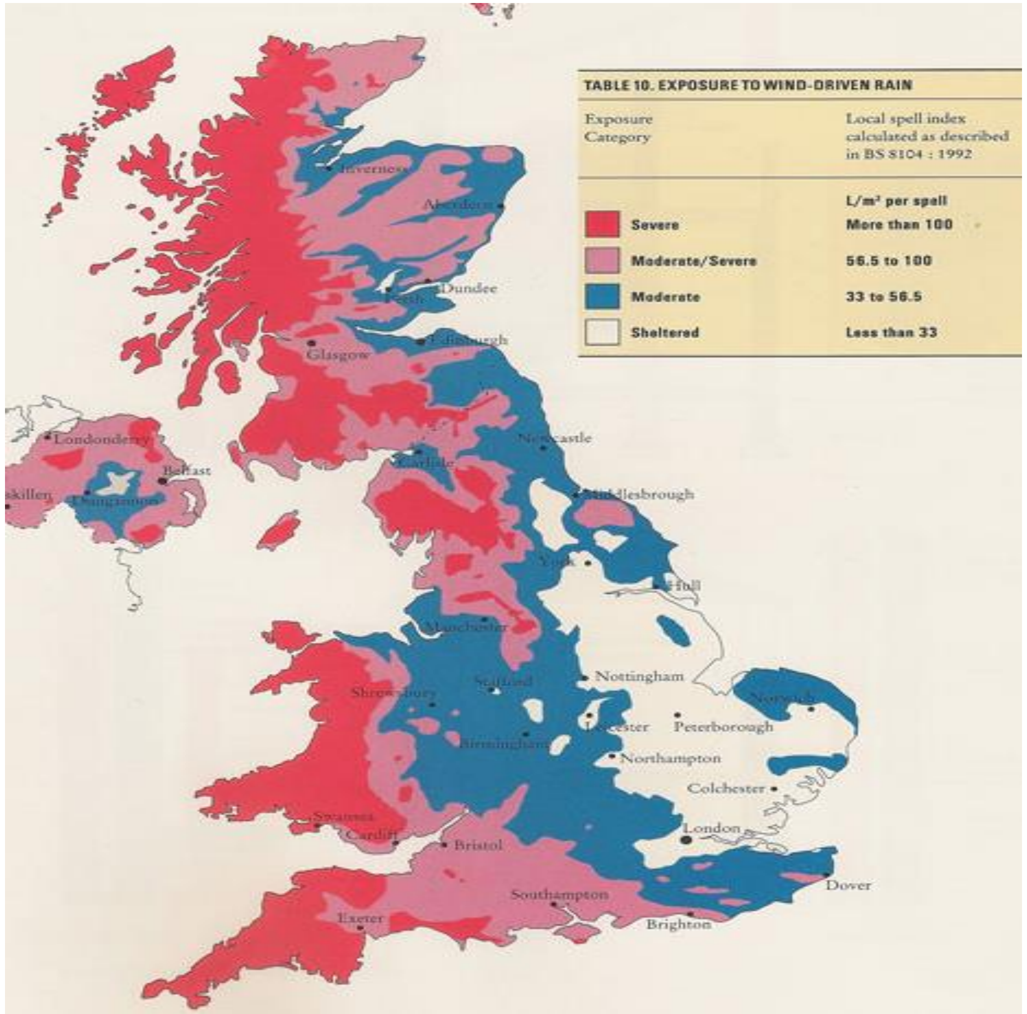
# Moisture in Traditional Construction

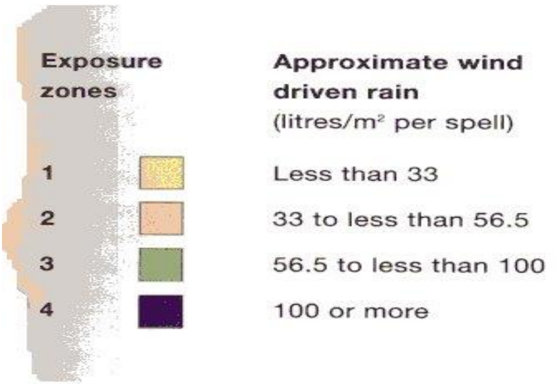
Under normal atmospheric conditions in Western Europe, external masonry walls have a moisture content ranging from 10 to 20%.

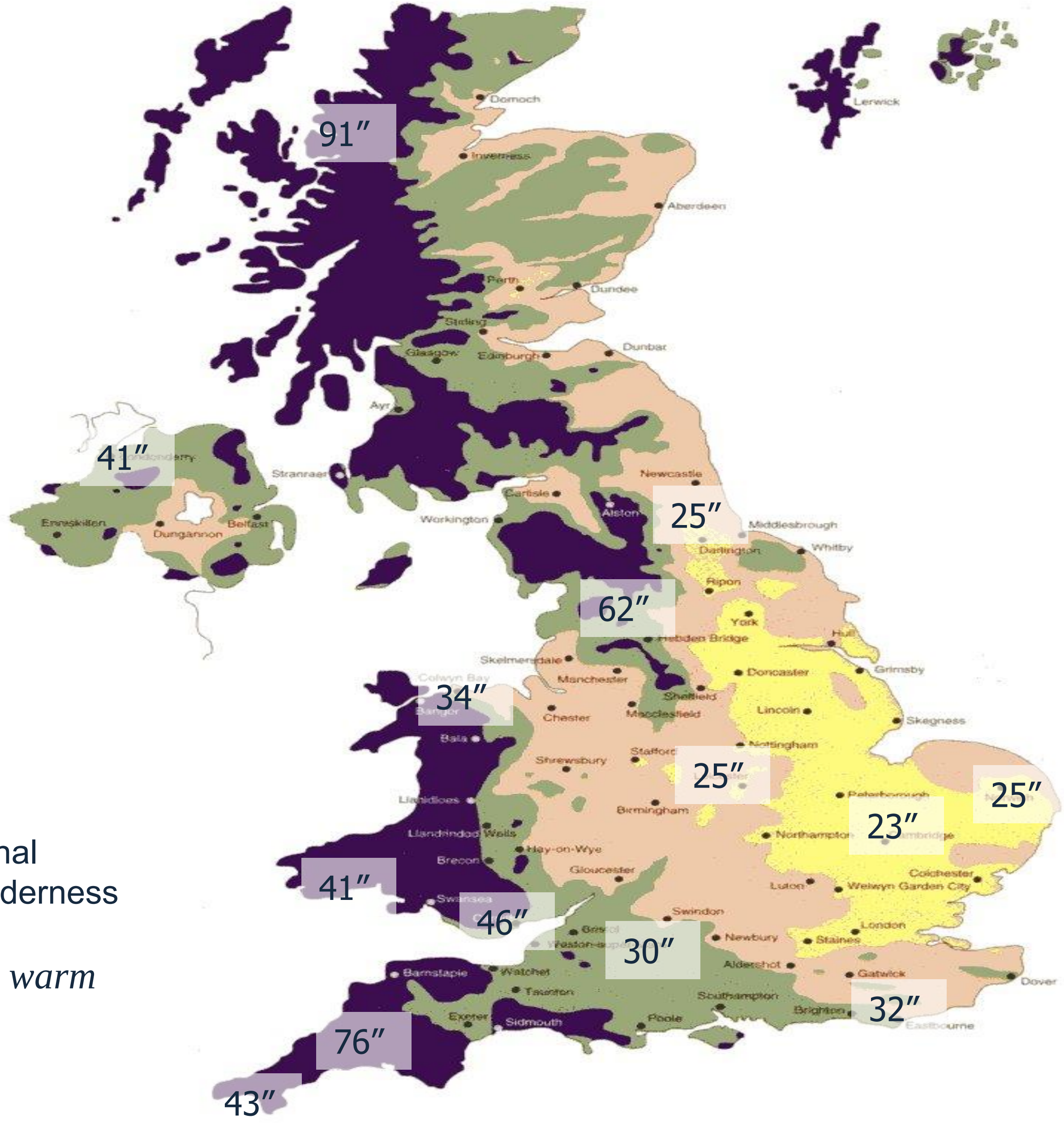
It is essential to allow the construction to breath and expel moisture to prevent its build up within the fabric through both the mortar and the paint.

# External Conditions

- BRE Rain Indices illustrates how the UK is subject to wind driven rains.
- The majority of SW England, Wales and Scotland is classed as severely exposed.
- Severely exposed = more than 100 litres of wind driven rain per m2, every rain spell.
- This is a huge volume of water that is subjected to the masonry.
- From 1961 to 2006, data shows significant increase in rainfall, some locations seeing anywhere from 50 to 200% increase.






## <u>**RAINFALL**  1981–2010 averages</u>

Penzance 43” Per annum 10” more than the National average. Dartmoor, southern England’s highest wilderness @ 76” nearly twice the rainfall of Penzance.

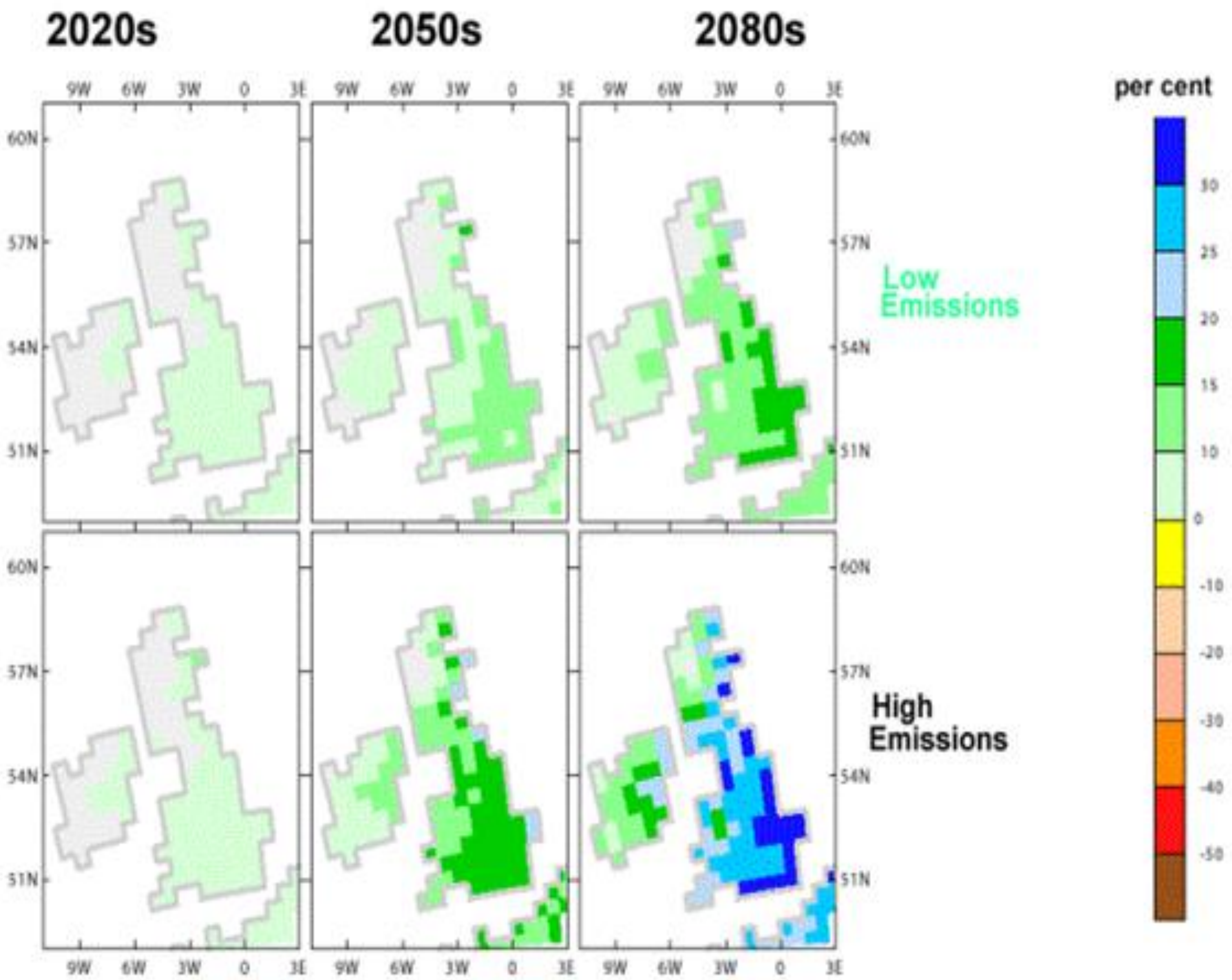
*You know its Summer up on the Moor, the rain is warm*

# WATER IS COMING

This graphic predicts the impact of climate change and increased winter rainfall in the UK.

Even with low emissions exposed locations are looking at a 15 to 20% increase within the next 50 years.
High emissions will see this increase up to 30%.

This is based on the mean or average – exposed conditions are likely to be higher.



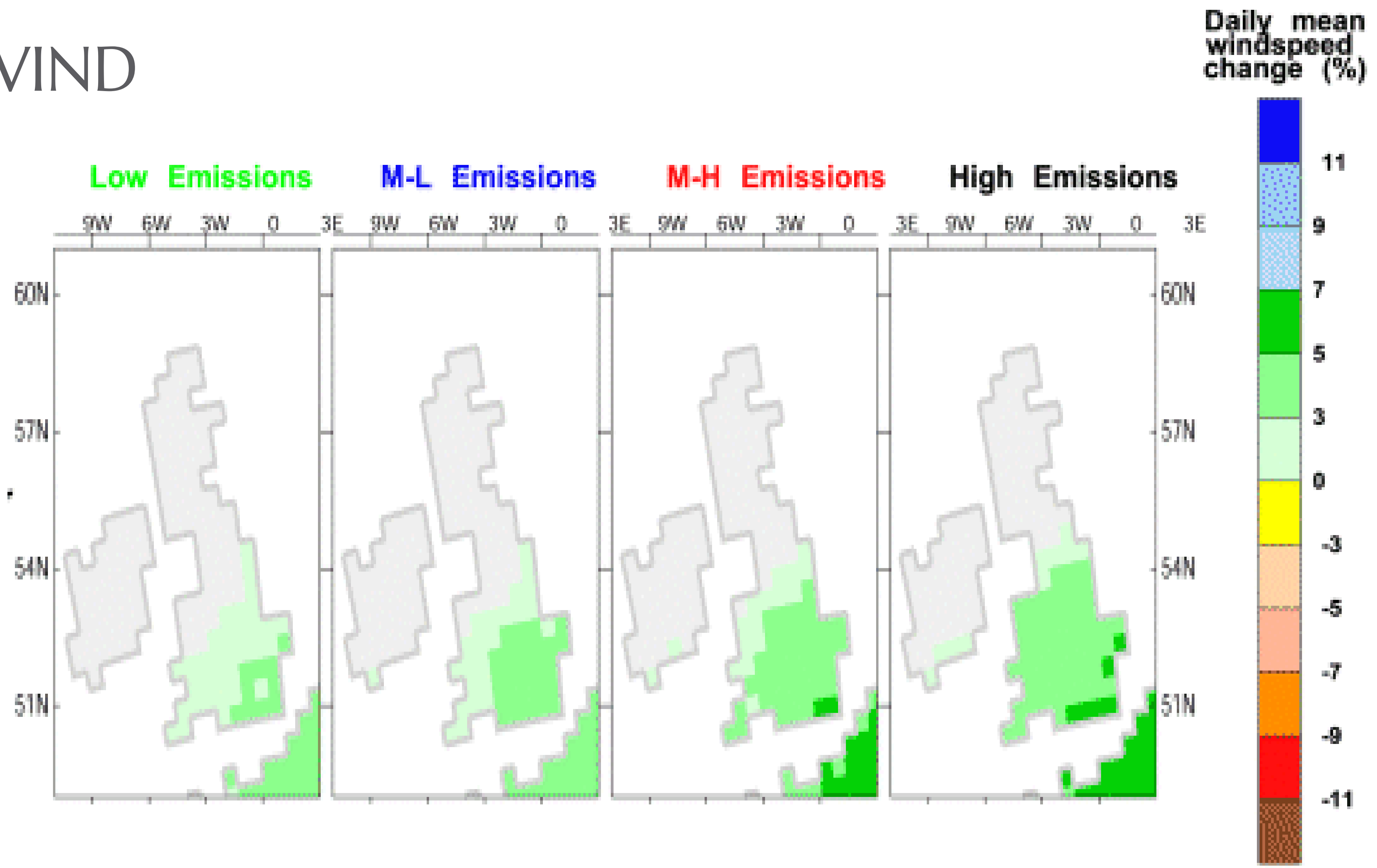
# AND SO IS THE WIND

Winter daily windspeed predictions 2050s.

Under low emissions we are looking at 3% increase.

Under high emissions we could be looking at 5%.

This is based on the mean or average – exposed conditions are likely to be higher.



# BRITISH STANDARD DEFINITIONS OF EXPOSURE *BS 5262:1991 CP for External renderings*

## SHELTERED

Areas of moderately low rainfall in which walls are protected from the weather by overhanging eaves and by the close proximity of buildings of similar or greater heights. Ground and first storeys in towns.

## MODERATE

Walls are partially protected from the weather by overhanging eaves and by other buildings of similar height in the neighbourhood. Applies to buildings in towns and suburban districts generally.

Render thickness not less than 16 mm built up in 2 coats

## SEVERE (roughly ¼ to 1/3 of the UK)

Exposure to the full force of the wind and the rain. Applies to buildings on hill sites and near the coast, and buildings projecting well above surrounding buildings in built up areas.

Render thickness not less than 20 mm built up in 3 coats

# Internal Conditions

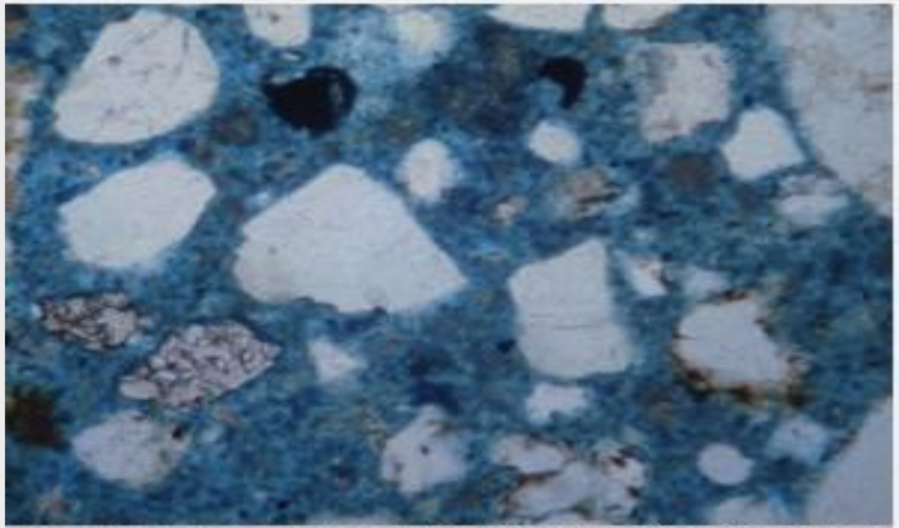
- The way we use the internal environment has significantly changed over the years.
- Historically, open fires, draughty windows and doors provided ventilation throughout the building.
- Advances in technology and energy has changed the way we heat and retain heat in buildings.
- We now generate considerably more moisture through the use of washing machines, tumble dryers, showers, kettles etc.
- With an increase in internal moisture, a move towards more sealed buildings and an increase in rainfall;

*The building fabric is critical in how moisture is managed.*

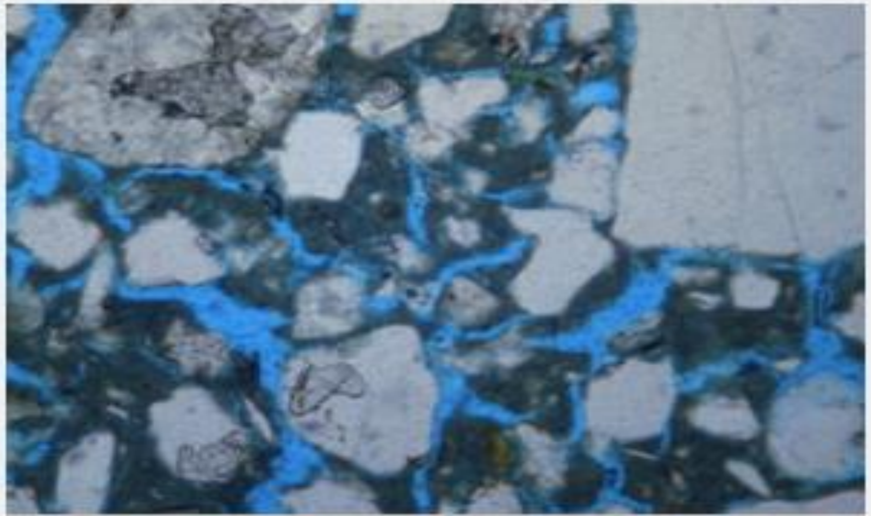
# Managing Moisture = Lime

The images show petrographic analysis of lime mortars.

The blue is an injected resin – notice the connected pore structure.



1 NATURAL HYDRAULIC LIME (3.5) TO 3 SHARP SAND



1 LIME PUTTY TO 3 PARTS OF SHARP SAND

# Why Modern Mortars Fail?

This image shows petrographic analysis of a cement mortar.

The blue is an injected resin – notice the decrease in the connected pore structure.

Stronger mortars are less permeable.

Hold moisture within the fabric.

Moisture will always take the path of least resistance.

As the stone is the weaker element it gradually erodes the stone.

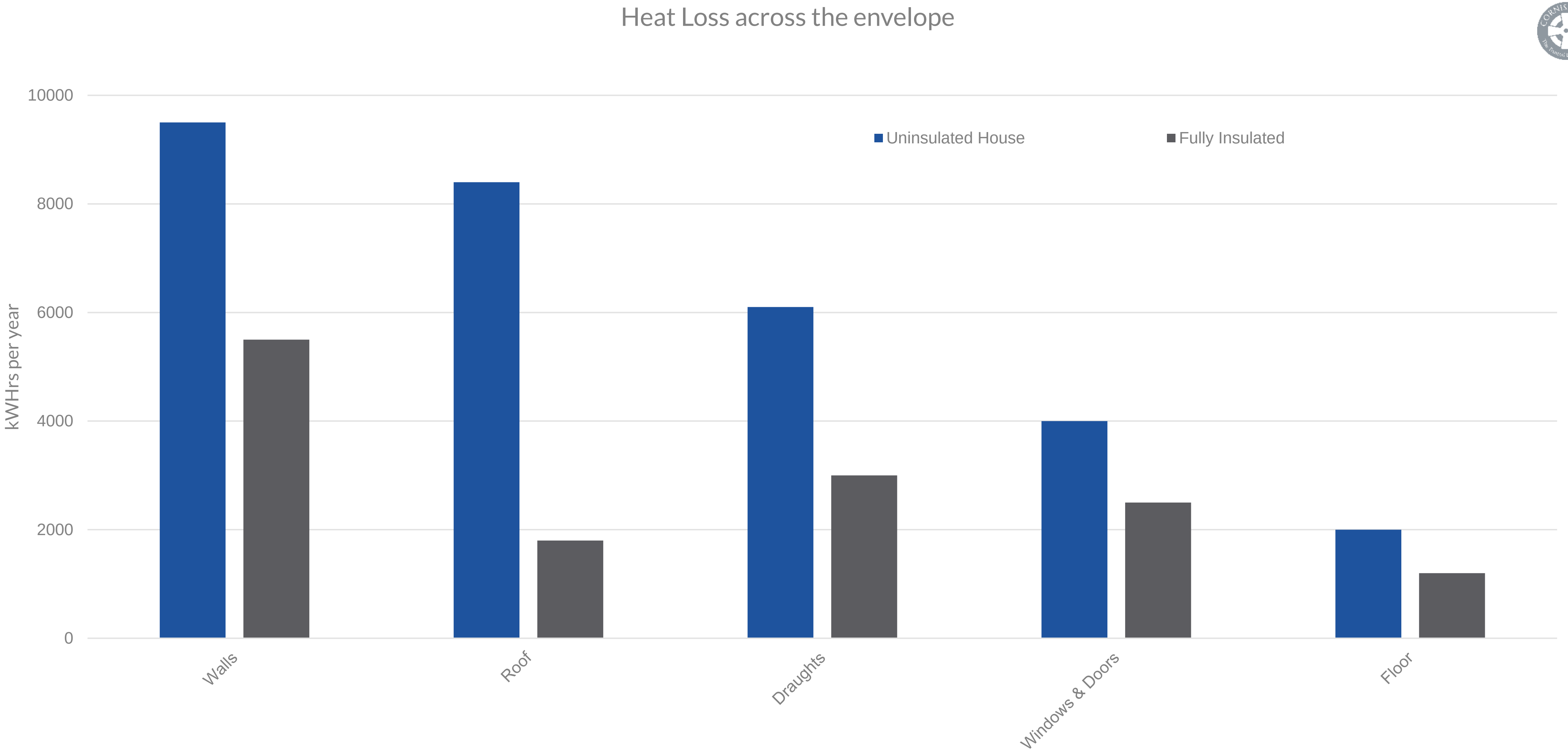
# Lime will fail too

- This image shows a putty render that was applied in October 2009.
- Colder conditions that winter prevented the mortar from forming an adequate set, leading to an expensive failure.
- Selection is critical, as lime putty (& hot mix) will only set through carbonation they have a window of use externally and are not suited for colder conditions.
- All limes need babysitting in their infancy.

Lime is not a panacea for damp and moisture damage, but it is the best available material for managing moisture.

# How can we insulate?

Insulation is the placing of a material between a building element and the environment to reduce heat loss.




Heat loss varies significantly for each building, as a rough rule of thumb in an uninsulated building 35% of heat loss is through walls, 25% through the roof and the remaining 40% through doors, windows, floors and draughts.

# Why do we Insulate?

There is currently and likely never will be legislation for owners to upgrade existing stock, unless certain work is being carried out.

This presentation focuses on our existing building stock – specifically older solid walls and why it is critical for any insulation measure to work in conjunction with moisture.

6 out of 10 insulate to improve the warmth & comfort.

2 out of 10 insulate to improve the value of the property.

2 out of 10 insulate to reduce heating bills and energy consumption.

# The Conventional Approach

Solid Wall Thermal Upgrade

- If concerned with moisture apply a tanking solution to the wall.
- Render the wall to flatten it and then apply PIR or EPS sheets.
- Or air gap, studwork, VCL and PIR, EPS or Mineral Wool insulation.
- Plasterboard
- Skim coat (gypsum plaster)

# Tanking? Cement?

- Tanking usually comes in the form of a chemical slurry.
- Solid walls are rarely flat so the tanking cannot be applied directly on the wall.
- The wall is usually rendered to flatten it off (cement based).
- Tanking and/or cement can hold moisture captive within the wall.
- Older walls are prone to thermal movement = cracking and water/moisture ingress.
- If tanking /cement isn’t in place, moisture can build up behind the insulation.



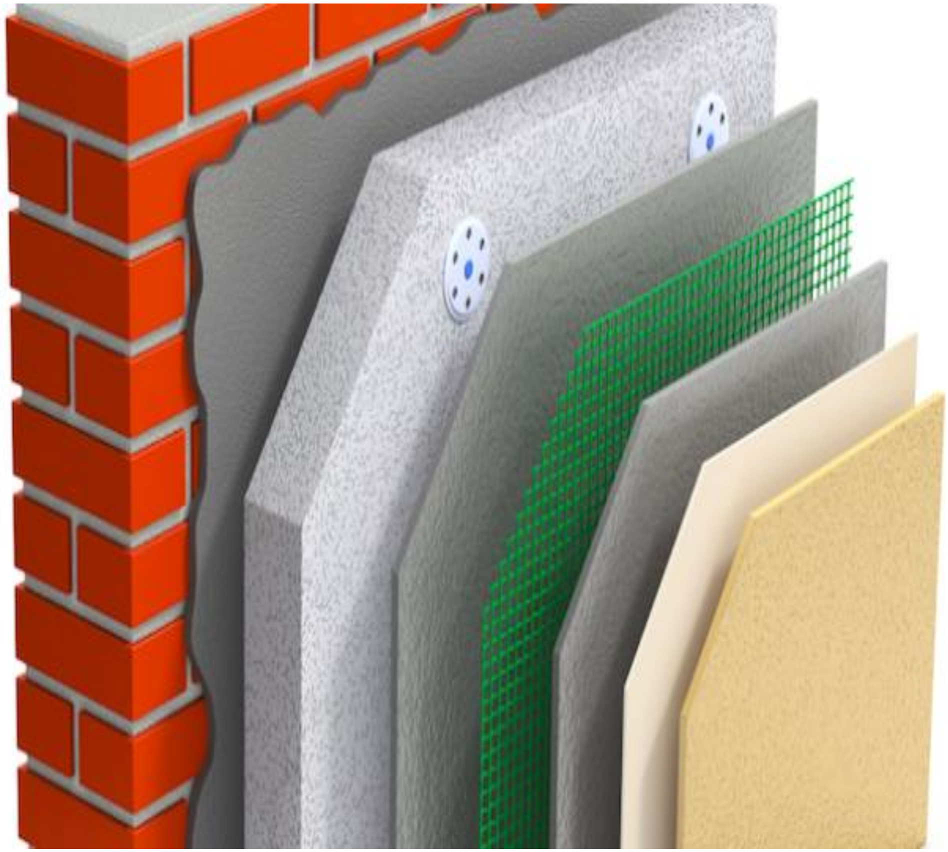

# The Insulation Layer

Polyisocyanurate or PIR

Expanded Polystyrene or EPS

An impervious system that offers superb insulating properties.

Does not allow anything to transfer through it – heat and moisture.



# Potential Internal Issues?

- Internal insulation prevents the escape of heat and in turn moisture.
- Increase in temperature = more water carried in the air, can lead to condensation.
- Excess condensation can lead to and increase mould and damage to surface finishes.
- Moisture within the wall hits the insulation and is held within the wall. A wet wall is a cold wall.
- Installing an air gap reduces internal space, moisture is still present but where does it go? (invisible damage).

# Potential External Issues?

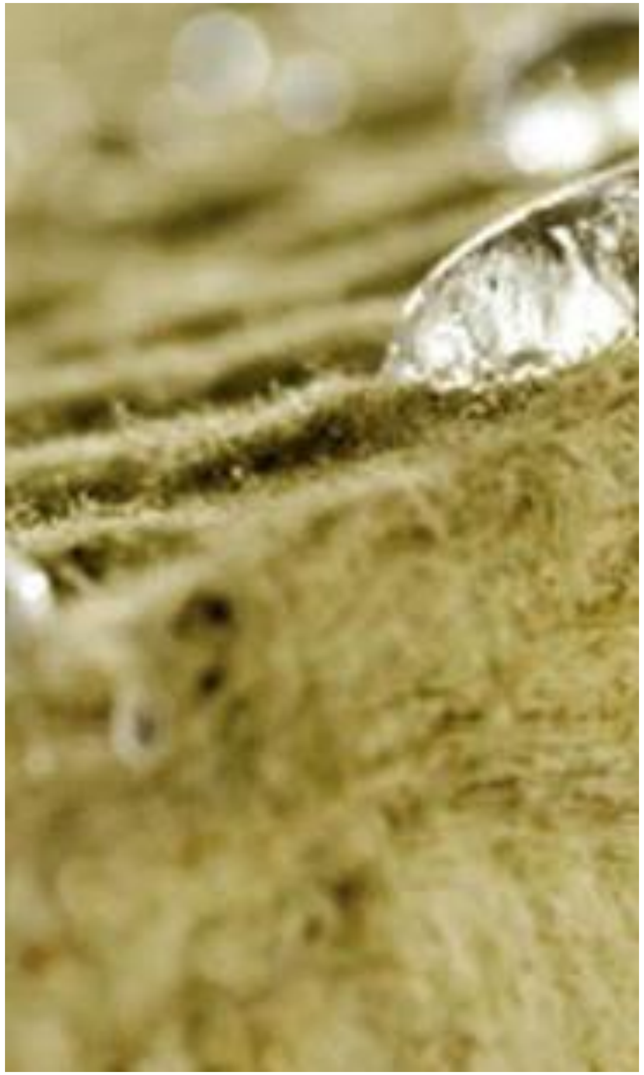
- External insulation requires sufficient overhang from the roof and readjustments for windows etc.
- Walls need to be flat to fix boards to, this usually involves inappropriate renders.
- Immediate loss of character.
- Change of dew point within the wall, can cause moisture to condense behind the insulation layer, moisture remains trapped.
- Multiple components (seals, tapes etc.) all need to work in conjunction and offer the same lifespan.
- A wet wall will require high energy consumption to dry, also where does the existing moisture go?

# The Insulation Layer

Mineral Wool

Sheep's Wool

Open Cell, technically will allow things to pass through.



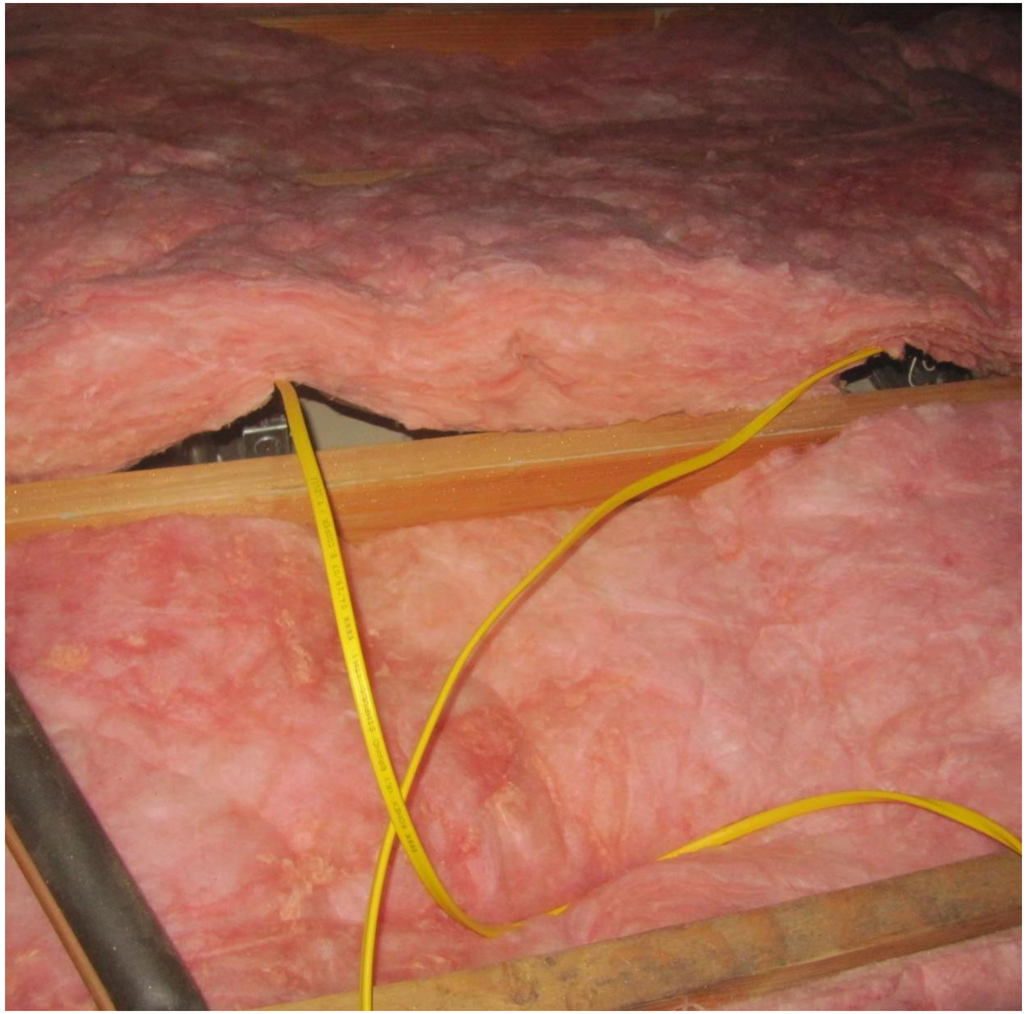
# Potential Issues?

- Mineral wool is itchy at best, there are concerns over respiratory systems.
- Technically it is vapour open (open cell), but it is not hygrothermal so will cannot regulate moisture and remains wet.
- Overtime this causes degradation and breakdown of the wool.
- VCLs are recommended, most wool is treated with hydrophobic coatings.
- Sheep's wool can be attacked by moths and insects, unless chemically treated*
- Sheep's wool can be quite expensive. Cheap wool is packed with polyester etc.

# Potential Issues?

- Slab form, cannot be fixed against the wall so a frame is required = immediate loss of space.
- Movement, sagging etc over time can create voids and gaps within the insulation.
- Fraunhofer Institute found that a 1mm gap can drop performance by a factor of 4.8. –

*A system designed to achieve a U Value of 0.3 can end up performing at 1.44*




Historic England Advice & Approach to Improving Efficiency
Reduce energy demand
Avoid wasted energy
Increase energy efficiency
Improve thermal efficiency where it can be accommodated
Improve controls
Use low carbon energy supplies
Avoid complication – Keep it simple

# Thermal Efficiency & Older Buildings

The Ministry of Justice researched the energy use of various buildings across its portfolio (of their 800 plus buildings, 20% are listed).

256 buildings were surveyed, with an age classifications of pre 1900, 1900 to 1930s, 1940 to 1960s, 1960s, 1970 to 1980s and 1990 to 2000s.

**The oldest buildings (pre 1900s) actually used the lowest energy per m2 and were the most energy efficient of all selected.**

**This is likely due to *high mass construction, natural lighting, natural ventilation, adaptable spaces and a lack of HVAC systems.***

# But we need the walls to reach a U Value of 0.3?

Section 1.7 states *the adoption of any particular energy efficiency measure should not involve unacceptable technical risk of, for instance, excessive condensation.*

Part L1B Building Regulations.

Section 3.8 states *there are 3 further classes of building where special considerations in making reasonable provision the conservation of fuel and power may apply;*

*(...)*

*Buildings of traditional construction with permeable fabric that both absorbs and readily allows for the evaporation of moisture.*

Section 3.9 of L1B states - *when undertaking work on or in connection with a building that within one of the classes listed above, the aim should be to improve energy efficiency as far as is reasonably practicable. The work should not prejudice the character of the host building or increase the risk of long term deterioration of the building fabric or fittings.*

Section 3.12 states – *Particular issues relating to work in historic buildings that warrant sympathetic treatment and where advice from others could therefore be beneficial include:*

*C) making provisions enabling the fabric of the historic building to 'breathe' to control moisture and potential long-term decay.*

These clauses need to be argued and unfortunately sometimes they are not accepted. Even though Historic England have produced guidance which states these clauses should be applied to most buildings built pre – 1920.

Historic England

# Energy Efficiency and Historic Buildings

## Application of Part L of the Building Regulations to Historic and Traditionally Constructed Buildings

"Ok, but there are breathable alternatives, so they are safe for conservation" –

Are they?

# Breathability

When it comes to managing moisture in a wall, people often look for a material which says its 'breathable'.

The term breathable is actually meaningless and has been hijacked.

Dictionary Definition – Breathable

1. Suitable or pleasant for breathing (it wont kill you).
2. Permitting air to pass through.

This is an extremely varied definition and wide scope for interpretation has led to confusion.

Breathable Nail Polish

Breathable Clothing


Breathable Paint?

“I can wrap my face in cling film, poke a pin hole where my mouth is and still breathe, I'm just not going to live for very long”

(A wise man – Unknown)

# Boards - Woodfibre & Cork

- Can be applied internally and externally.
- Very good K values – 0.04, this is close to some PIR systems with K values of 0.03.
- Relatively easy to install.

# Potential Issues?

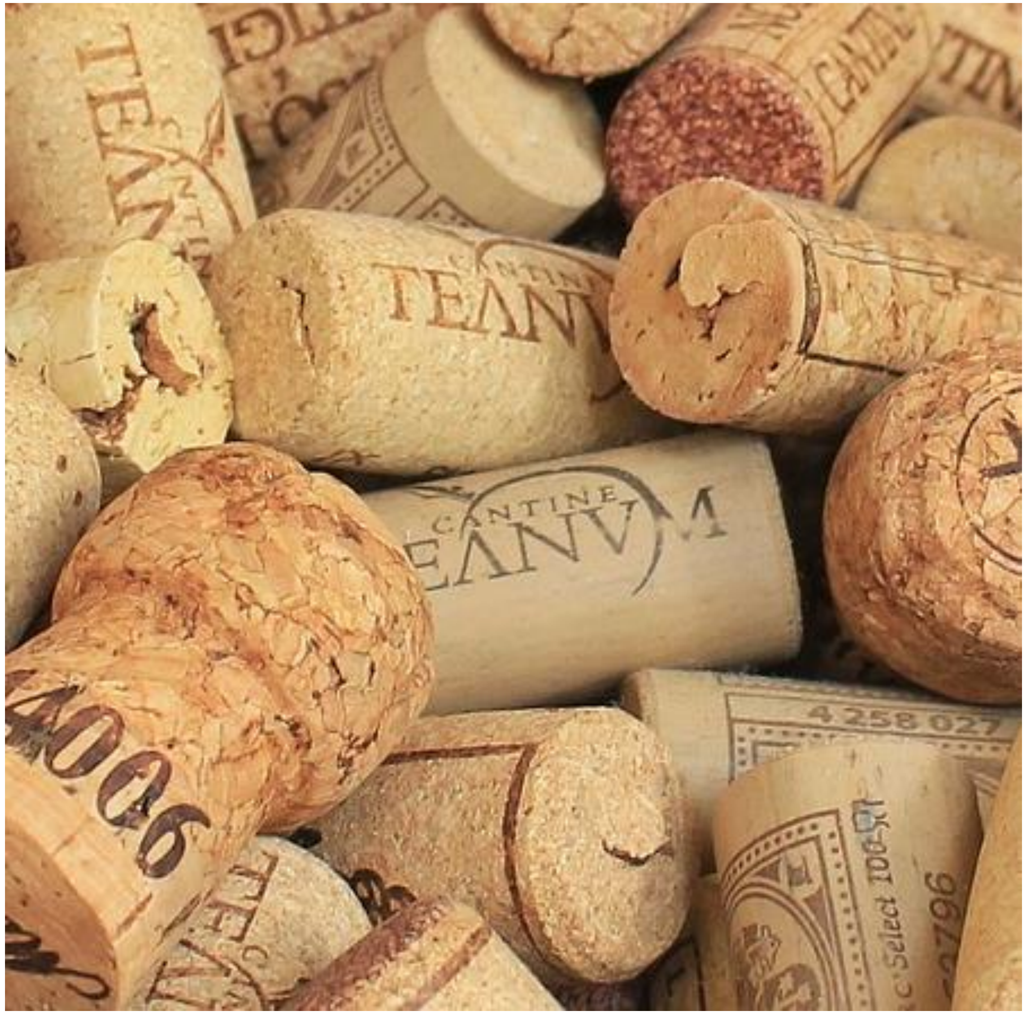
- The wall needs to be flat, if not there is the additional expense of rendering, combined with the expense of the board, specialist fixings, tapes, sealants and specific renders or plasters required.
- ROI becomes highly unlikely.
- External insulation requires sufficient overhang from the roof and readjustments for windows etc.
- Multiple components (seals, tapes etc.) all need to work in conjunction and offer the same lifespan.
- Much of the same issues which effect modern insulation boards.

# Potential Issues?

- **Organic content – wood can and will rot under moisture.**
- Lack of testing – there is not enough long term data available on various building types in the UK, long term performance and the impact on wind driven rain, interstitial condensation & dew point.
- They do not accommodate 20% + moisture content we often see higher moisture content than this  in solid walls.
- Board manufacturers do not advise going above 60 to 80mm internally due to the risk of interstitial condensation. *
- European data – Data from France suggests boards begin to fail in as little as 10 years and Europe's largest & leading lime manufacturer actively discourages using them.

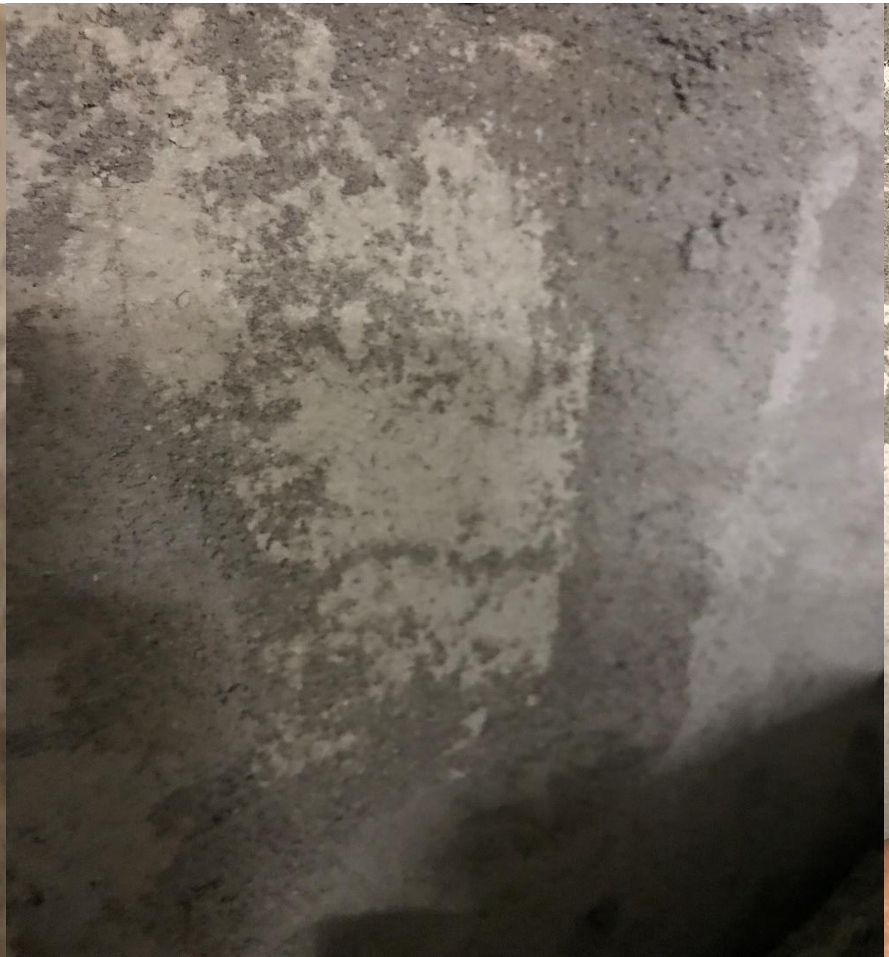
# Cork Render?

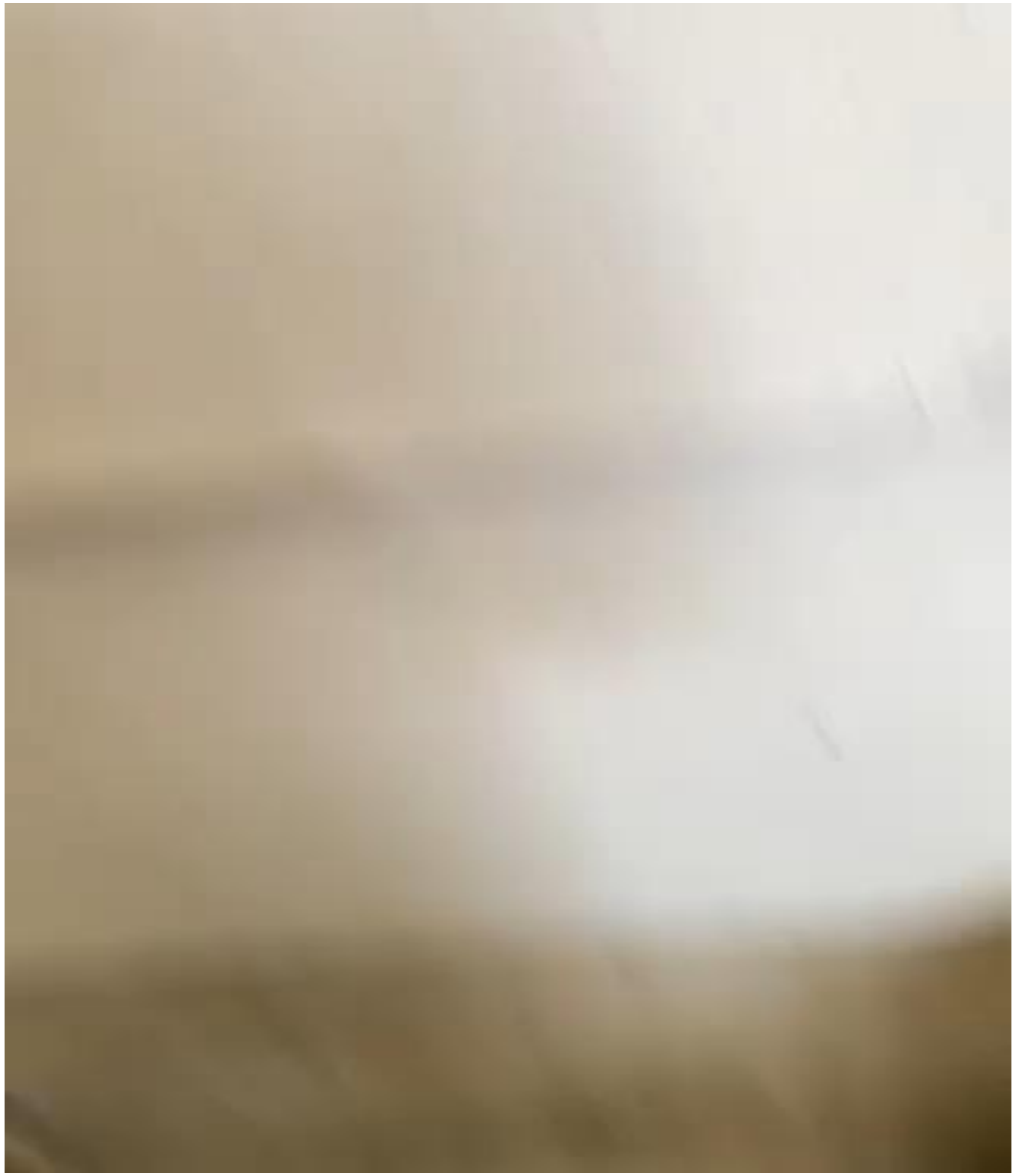
- Organic material – can and will rot
- Extremely low strength within the render, our tests have found the renders can be scraped back of the wall with light rubbing.
- Cork is burnt, otherwise it swells, burnt cork shrinks over time and pulls away from the binder matrix, which causes significant reduction on strength and little long term durability.
- Wild K Values – 1 cork render claims a K Value of 0.045, with a density of 250kg/m3, density of cork is 240kg/m3 and NHL5 is 500kg/m3, plus other mineral fillers – this is not realistic data.
- Other real life data shows a 20mm layer will improve U Value by 20%.
- Thermal performance is very misleading – test data shows the true K Value sitting somewhere between 0.15 and 0.2.



# Cork Render

Installed over 4 years ago

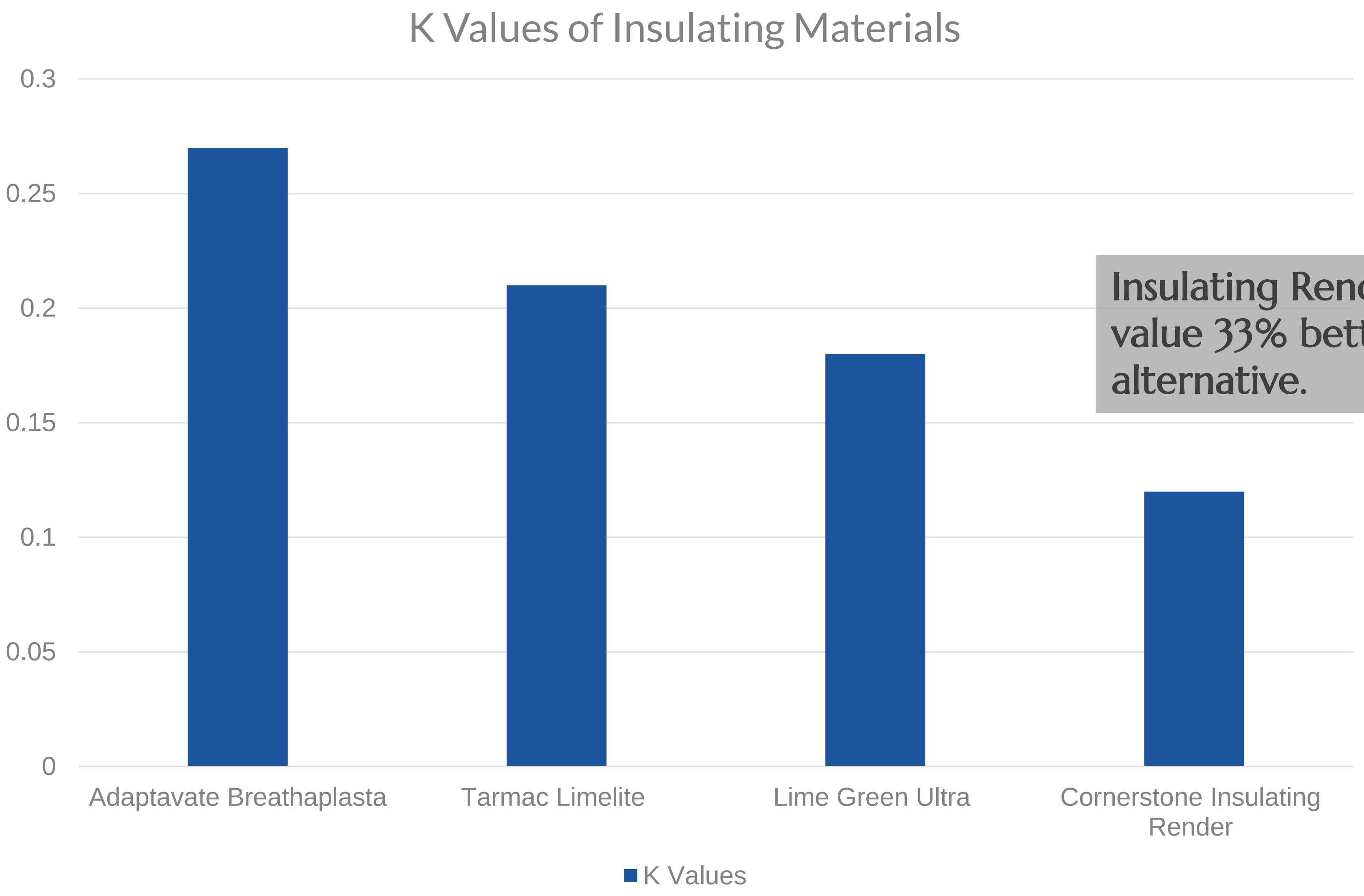



These systems are great for Eco construction & applications where the wall is dry and will remain dry, but in historic walls this is so often not the case.

We can improve the thermal performance of solid walls, but we need to compromise some insulation value for moisture regulation.

# Cornerstone Insulating Render

Specifically designed to offer an increased thermal performance without compromising moisture management.




Insulating Render offers a K value 33% better than closest alternative.

# NHL 2 &Aggregate

- The aggregate produces a void structure throughout the render, which improves insulation and will accommodate some salt deposits*.
- Insulating Render uses a unique recycled hardened aggregate,
- Which is non-porous so accelerates moisture movement through the render and helps reduce cold bridging and damp spots.
- The aggregate has a 3 dimensional structure, most alternatives use a 2 dimensional aggregate which results in decreased performance.
- NHL2 ensures maximum vapour permeability and allows it to be used on virtually any host substrate.
- Mineral – no organic content within the render, so no risk of the material breaking down or rotting.

# Quicker, Thicker, Faster

- Lightweight and contains fibres, allowing it to be applied up to 30mm per pass.
- 50mm within a day is achievable as a green on green application.
- 50mm with conventional lime render/plaster would take 4 to 5 coats and would require 20 to 35 days.
- 5% VAT under VAT guidance 708/6 – Energy-saving materials*.
- Significant labour and cost savings.

500m² project based on oil heating (medium cost).

Medium duty cycle

Wall starting U Value – 2.1

25mm Insulating Render – 1.47
30% improvement. 2,280kg $CO_2$ reduction

40mm Insulating Render – 1.25
40% improvement. 2,960kg $CO_2$ reduction

50mm Insulating Render – 1.13
46% improvement. 3,340kg $CO_2$ reduction

You can raise your temperature 2.5 degrees and still reduce energy bills.

## Building Parameters

| Substrate | Area of external envelope ($m^2$) | Room Temperature | Heating type | Months heated per year | Duty Cycle |
|---|---|---|---|---|---|
| As per SAP assessment | 500 | 18 | Oil Fired | 8 | Medium |
| **Preferred Room Temperature** | | **20.5** | | | |

## Uninsulated property under current conditions

### Thermal Comfort

| | | |
|---|---|---|
| **Room Temperature** | 18 | |
| **Sensation** | Uncomfortable, Cool | |
| **EN-15251 Category** | IV - not compliant | Where<br>Category I = Most Comfortable<br>Category IV = Uncomfortable |
| **% people satisfied** | 83% | 3 in 20 may find this too cold |

### Energy Consumption

| | | |
|---|---|---|
| **U Value ($W/m^2K$)** | 2.10 | Based on standardised SAP values for a solid wall |
| **Annual Energy Consumption (kWHrs)** | 56,100 | Based on heat loss through the walls |
| **Estimated Annual Heating Cost** | £4,200 | Based on average rates for oil fired central heating |
| **Annual Carbon emissions** | 13,740 | Kg CO2 produced per year |

### Insulated with temperature settings maintained

| | Room Temperature | Sensation | EN-15251 Category | % people satisfied | U Value ($W/m^2K$) | Annual change in emissions (Kg $CO_2$) | Annual Heating Cost Difference |
|---|---|---|---|---|---|---|---|
| Single Coat (25mm) | 18 | Uncomfortable, Cool | IV - not compliant | 83% | 1.47 | 2280Kg reduction | £700 saving |
| Single Coat (40mm) | 18 | Uncomfortable, Cool | IV - not compliant | 84% | 1.25 | 2960Kg reduction | £900 saving |
| Two Coats (50mm) | 18 | Uncomfortable, Cool | IV - not compliant | 84% | 1.13 | 3340Kg reduction | £1025 saving |

### Insulated at preferred temperature

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Single Coat (25mm) | 20.5 | Comfortable, Cool | II | 94% | 1.47 | 160Kg reduction | £50 saving |
| Single Coat (40mm) | 20.5 | Comfortable, Cool | II | 94% | 1.25 | 1160Kg reduction | £360 saving |
| Two Coats (50mm) | 20.5 | Comfortable, Cool | II | 94% | 1.13 | 1720Kg reduction | £530 saving |

| Insulating Render @ 25mm | | | | | |
|---|---|---|---|---|---|
| Product | Depth | Quantity | Volume | Cost Per | Total |
| Insulating Render | 25mm | 905 | 13.5 litre bags | £ 11.30 | £ 10,226.50 |
| CLM66 | 3mm | 125 | 25kg bags | £ 6.25 | £ 781.25 |
| | | | | **Total** | **£ 11,007.75** |

| Drymix (preblended NHL mortar) @ 25mm | | | | | |
|---|---|---|---|---|---|
| Product | Depth | Quantity | Volume | Cost Per | Total |
| Drymix CLD30 2:5 | 25mm | 925 | 25kg bags | £ 9.40 | £ 8,695.00 |
| CLM66 | 3mm | 125 | 25kg bags | £ 6.25 | £ 781.25 |
| | | | | **Total** | **£ 9,476.25** |

| CLM28 (premixed lime putty mortar) @ 25mm | | | | | |
|---|---|---|---|---|---|
| Product | Depth | Quantity | Volume | Cost Per | Total |
| CLM28 | 25mm | 25 | Tonne | £ 175.00 | £ 4,375.00 |
| CLM66 | 3mm | 125 | 25kg bags | £ 6.25 | £ 781.25 |
| | | | | **Total** | **£ 5,156.25** |

| CLM28 (premixed lime putty mortar) @ 25mm | | | | | |
|---|---|---|---|---|---|
| Product | Depth | Quantity | Volume | Cost Per | Total |
| CLM28 | 25mm | 1000 | 25kg bags | £ 5.75 | £ 5,750.00 |
| CLM66 | 3mm | 125 | 25kg bags | £ 6.25 | £ 781.25 |
| | | | | **Total** | **£ 6,531.25** |

| NHL3.5 Site Mix @ 25mm | | | | | |
|---|---|---|---|---|---|
| Product | Depth | Quantity | Volume | Cost Per | Total |
| CLS28 | 25mm | 19 | Tonne | £ 73.60 | £ 1,398.40 |
| NHL3.5 | 25mm | 152 | 25kg bags | £ 12.90 | £ 1,960.80 |
| CLM66 | 3mm | 125 | 25kg bags | £ 6.25 | £ 781.25 |
| | | | | **Total** | **£ 4,140.45** |

25mm ROI for materials

- Medium Cycle - 16 years
- High Cycle – 12 years

50mm ROI for materials

- Medium Cycle – 11 years
- High Cycle – 8 years

These ROIs are compared leaving the wall bare. The difference between 25mm and cheapest option (w/no ins.) = £6867.30, ROI suddenly becomes faster, around 6 years.

These figures don't include reduced labour times or any possible VAT reductions, so the ROI could be much faster and in some cases it can actually be cheaper to apply Insulating Render than standard lime renders.

# Insulating Render vs The Competition

Insulating Render cost per LTR = **£0.82**
Leading Competitor cost per LTR = £1.03

Insulating Render cost per m2 = **£20.50**
Leading Competitor cost per m2 = £25.75

Insulating Render K Value – **0.12**
Leading Competitor K Value – 0.18

**Insulating Render starts at a 20% lower cost,** but also offers **33% higher performance**, so for every 100 bags of I.R you would need 150 of the leading competition.

So when calculating using thermal comparison you would need 1114 bags, which pushes the cost to £17,267.00 (plus VAT).
= £34.53 per m2 or 40% more expensive.

| Insulating Render @ 25mm | | | | | |
|---|---|---|---|---|---|
| Product | Depth | Quantity | Volume | Cost Per | Total |
| Insulating Render | 25mm | 905 | 13.8 litre bags | £ 11.30 | £ 10,226.50 |
| | | | | **Total** | **£ 10,226.50** |

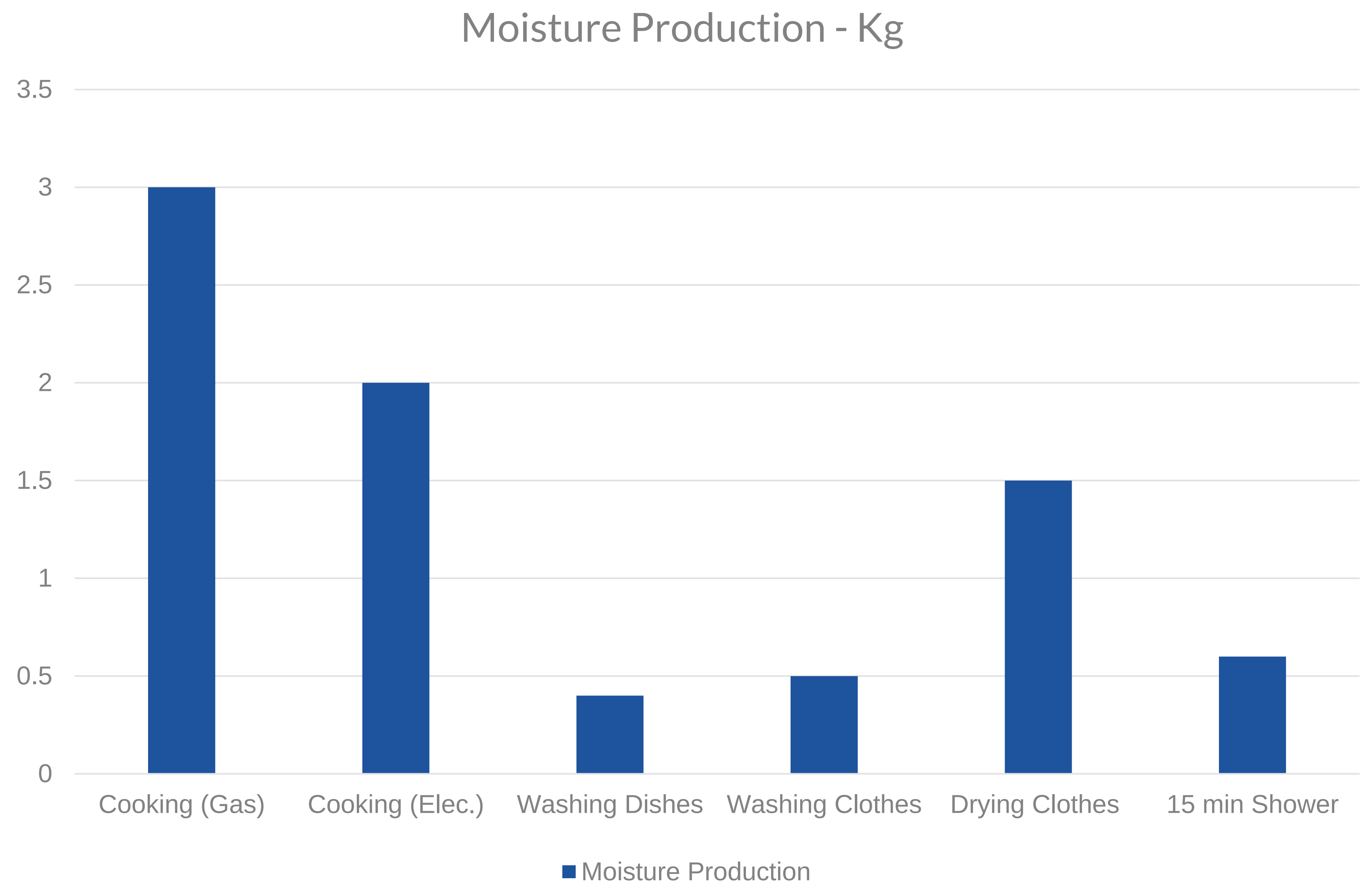
| Closest Competitor @ 25mm | | | | | |
|---|---|---|---|---|---|
| Product | Depth | Quantity | Volume | Cost Per | Total |
| L.G.U | 25mm | 835 | 15 litre bags | £ 15.50 | £ 12,942.50 |
| | | | | **Total** | **£ 12,942.50** |

# Relative Humidity RH %

- Relative Humidity is the percentage of moisture which the air can hold.
- For example if we are at 60% RH, the air could hold 40% more moisture.
- The ideal level of indoor humidity is between 40 to 60%, this figure is endorsed by CIBSE, BSRIA and BRE.

# On average 60% RH =
# 3 litres of water at 16C, or
# 4 litres of water at 20C

Over an average sized property – 3 bed.



Moisture Production - Kg
3.5
3
2.5
2
1.5
1
0.5
0
Cooking (Gas)
Cooking (Elec.)
Washing Dishes
Washing Clothes
Drying Clothes
15 min Shower
Moisture Production

# High RH & Human Health

- We spend up to 90% of our time indoors.
- High RH can cause the body to overheat, humidity impedes the body's ability to regulate temperature.
- This can increase sweating, respiration and alter blood circulation.
- Bacteria and viruses thrive and grow when RH is above 60%, increasing the risk of sickness, especially respiratory infections.
- Humid air causes the contaminates to stay airborne for longer.
- **Germs multiply and stick around for longer.**

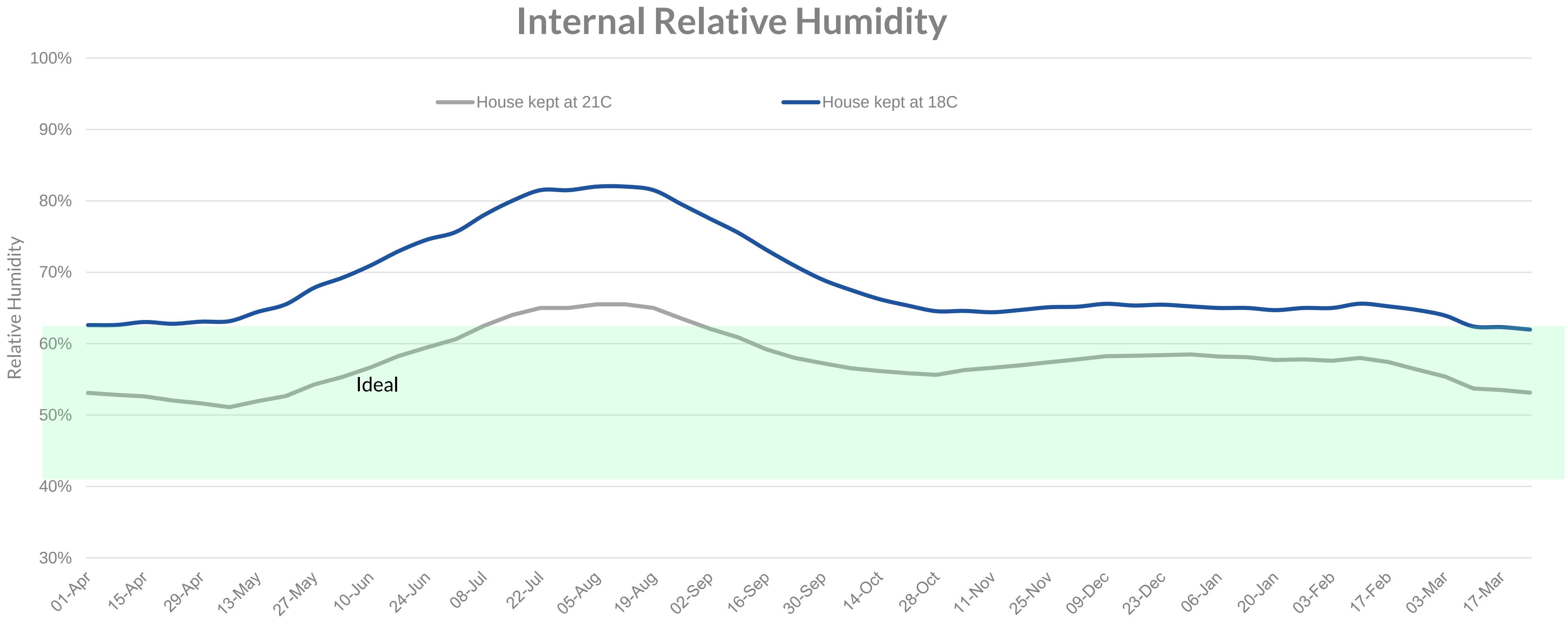
# High RH & Building Health

- Mould requires warm* temperatures, an organic food source (dust, grease, wood etc.) and moisture.
- Higher humidity = more moisture.
- Exposure to damp & mould can cause numerous health issues, from irritation through to infection, even in healthy people.
- Insects – some insects feed on mould and mildew, whereas others are just more comfortable in humid environments (dust mites, cockroaches, beetles).
- Moisture is the engine of decay, if the mould and insects don't effect furniture and surface finishes the moisture soon will – paint damage, peeling paper, decaying wood and plaster.

The World Health Organisation state that sealed or tight-dwellings, non-openable windows, increased temperature and higher dust levels are all related to a number of conditions:

Asthma, rhinitis, sinusitis, conjunctivitis, mental fatigue, headache, nausea, dizziness, sensation of dry mucous membranes, skin erythema, high frequency of airway infection and cough, hoarseness, wheezing, unspecified hypersensitivity – the list goes on.

Internal temperature plays a vital role.
Air from outside is cool and wet, with an average RH of 80 to 85%.
Air is brought in, heated and the RH drops.
For a well ventilated building, a higher internal temp = lower RH



# Ventilation

- As we know the actual amount of water the air can hold is minimal in comparison to what is produced within a building.
- Without adequate ventilation RH will remain high.
- Inadequate ventilation  contributes further to poor indoor air quality as contaminates from humans, pets and emissions stay within the internal environment.
- In a solid-walled building up to 0.8 ac/h may be required because of the extra moisture present.
- In a damp building the ventilation might need to be increased even further to maintain acceptable levels of RH.
- There are multiple ways to ventilate and you may need to consider more than one option.

# MVHRs

- Build. Regs calls for 10m3 per m2@50pa for new builds, which is 0.5 air changes per hour.
- 0.8 air changes per hour (solid walls) = 16m3 @ 50pa
- MVHRs require an air permeability of 5m3 per m2@pa or 0.25 air changes per hour to be effective.
- Above 5m3 and MVHR will have little to no effect.
- The chart shows that a building with 10m3 @ 50pa performed better with natural ventilation than MVHR.
- The MVHR actually caused a 6.2% increase in CO2 production and a 9.4% increase for energy use.
- Retrofitting is never easy.

Table 2. Impact of airtightness on modelled annual energy consumption and $CO_2$ emissions of the thermally upgraded E.ON 2016 house using an MVHR system specified to best practice standards.

| Study | Annual space heating energy ($kWh/m^2$) | Annual auxiliary energy ($kWh/m^2$) | Total building annual energy consumption ($kWh/m^2$) | % change (energy) | Total building annual emissions ($kg.CO_2/m^2$) | % change ($CO_2$) |
|---|---|---|---|---|---|---|
| 10 $m^3/m^2.h$ naturally ventilated | 65.7 | 9.6 | 126.9 | 0 | 44.6 | 0 |
| 10 $m^3/m^2.h$ with MVHR | 76.4 | 10.8 | 138.8 | +9.4% | 47.4 | +6.2% |
| 7 $m^3/m^2.h$ with MVHR | 66.3 | 10.8 | 128.8 | +1.5% | 45.4 | +1.7% |
| 5 $m^3/m^2.h$ with MVHR | 62.9 | 11.4 | 125.9 | -0.8% | 45.0 | +0.9% |
| 3 $m^3/m^2.h$ with MVHR | 56.5 | 11.4 | 119.5 | -5.9% | 43.8 | -2.0% |
| 1.05 $m^3/m^2.h$ with MVHR | 50.3 | 11.4 | 113.3 | -10.7% | 42.6 | -4.7% |
| 0.63 $m^3/m^2.h$ with MVHR | 49.0 | 11.4 | 112.0 | -11.7% | 42.3 | -5.3% |

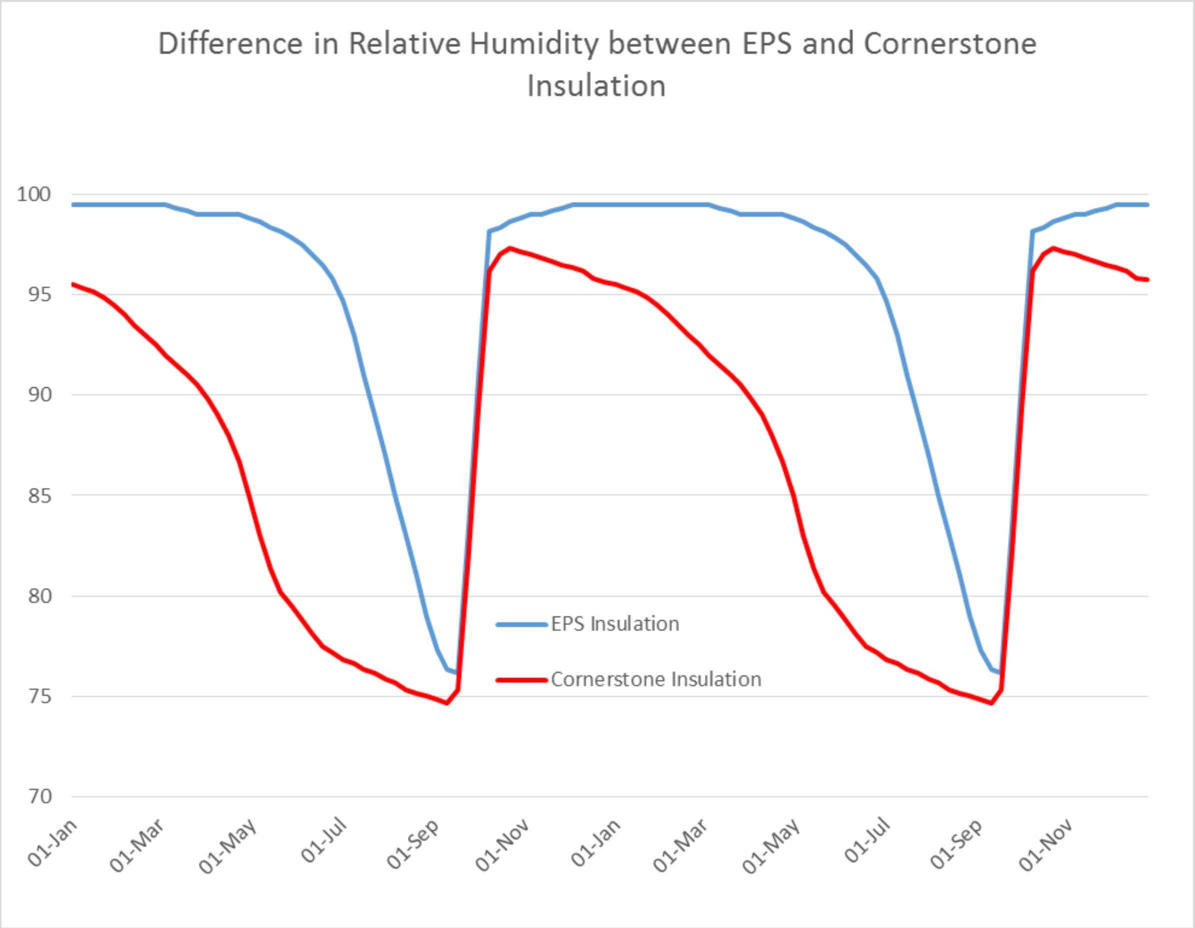
Ventilate, Ventilate, Ventilate.

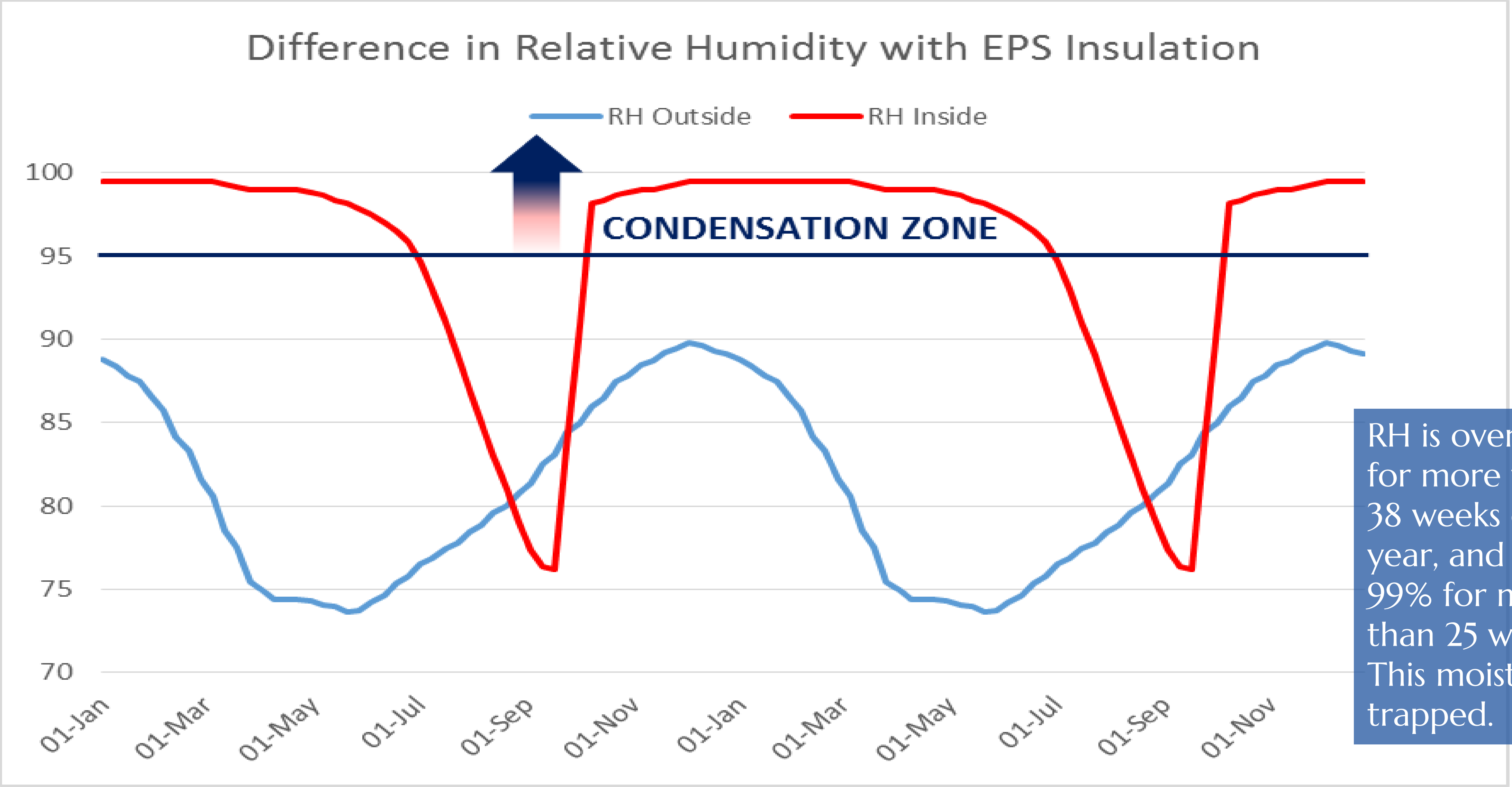
But the use of hygrothermal and vapour permeable materials can help naturally control RH and moisture levels.

Insulating Render will absorb & store excess moisture.

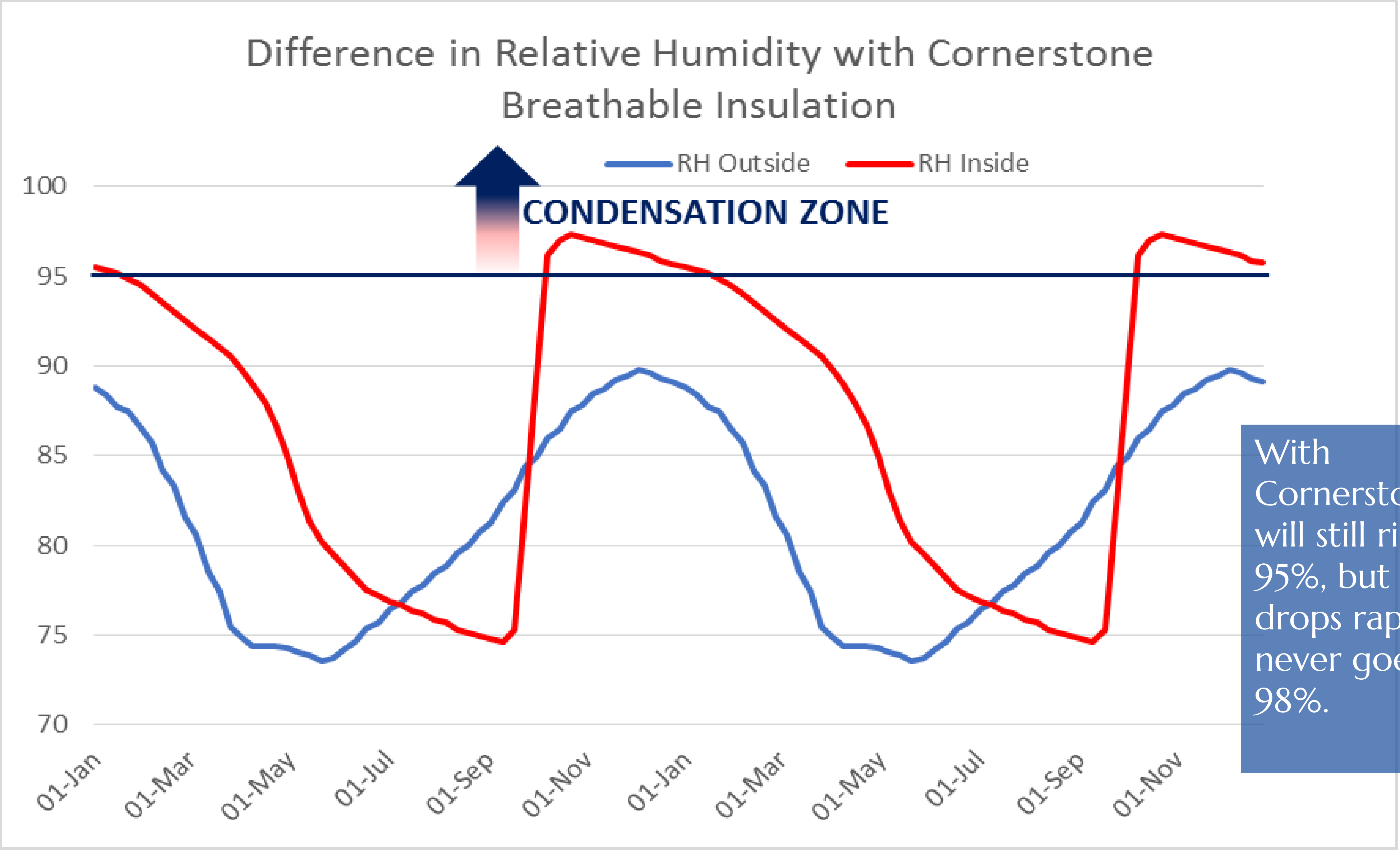
# Moisture Storage & Buffering

- The buffering effect of Insulating Render compared to a boarded system.
- Both products were at a depth to achieve the same R Value (apples to apples).
- In a building without adequate ventilation condensation starts to form at 95% RH
- the higher the RH the worse the condensation becomes.
- This can cause visible and  hidden damage.



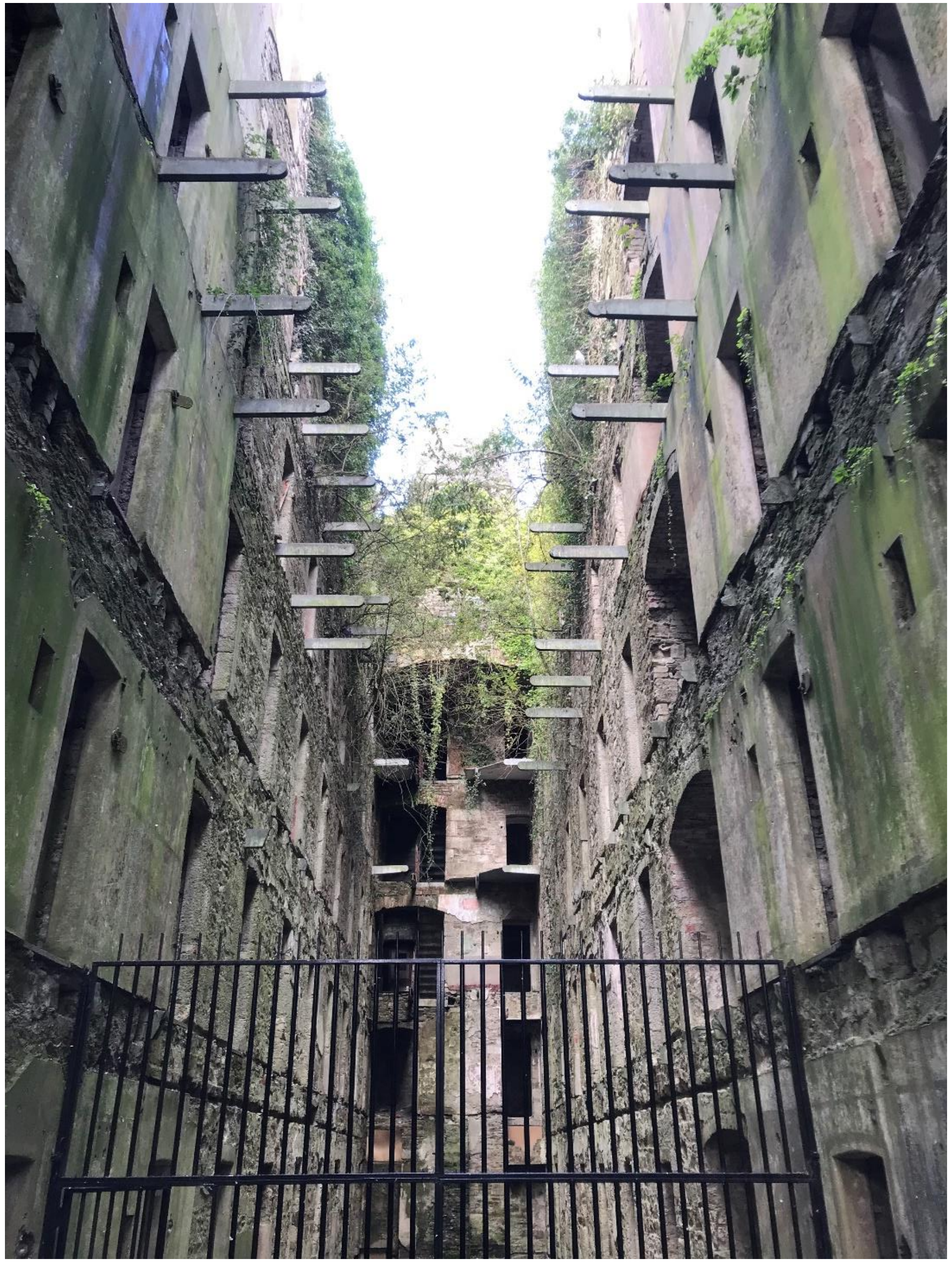



RH is over 95% for more than 38 weeks of the year, and over 99% for more than 25 weeks. This moisture is trapped.




With Cornerstone, RH will still rise above 95%, but then drops rapidly and never goes above 98%.

| | NHL3.5 @ 2:5 | Insulating Render |
|---|---|---|
| Water Absorption on 40x40x80mm bar | Saturated @ 46 minutes | Saturated @ 22 minutes |
| Water carrying capacity | 97Kg/m3 | 136Kg/m3 |
| Vapour Permeability | 0.63g/h.m^2.mmHg | 1.04g/h.m^2.mmHg |



Case Study - Conversion of a derelict listed Jail into a hotel.
**Cornerstone Insulating Render applied at 70mm to achieve a U Value of 0.7.**

Building in question had no roof for over 100 years, systems containing any organic material had been trialled and ruled out due to the vast moisture content held within the wall.
Insulating Render was first applied late Mid February, the above images were taken early March. The product acted as a poultice and was physically removing moisture from the walls.

With Covid restricting the work onsite. The main plastering commenced in July.

Early August, the walls are plastered and dry to touch with the project all but complete.

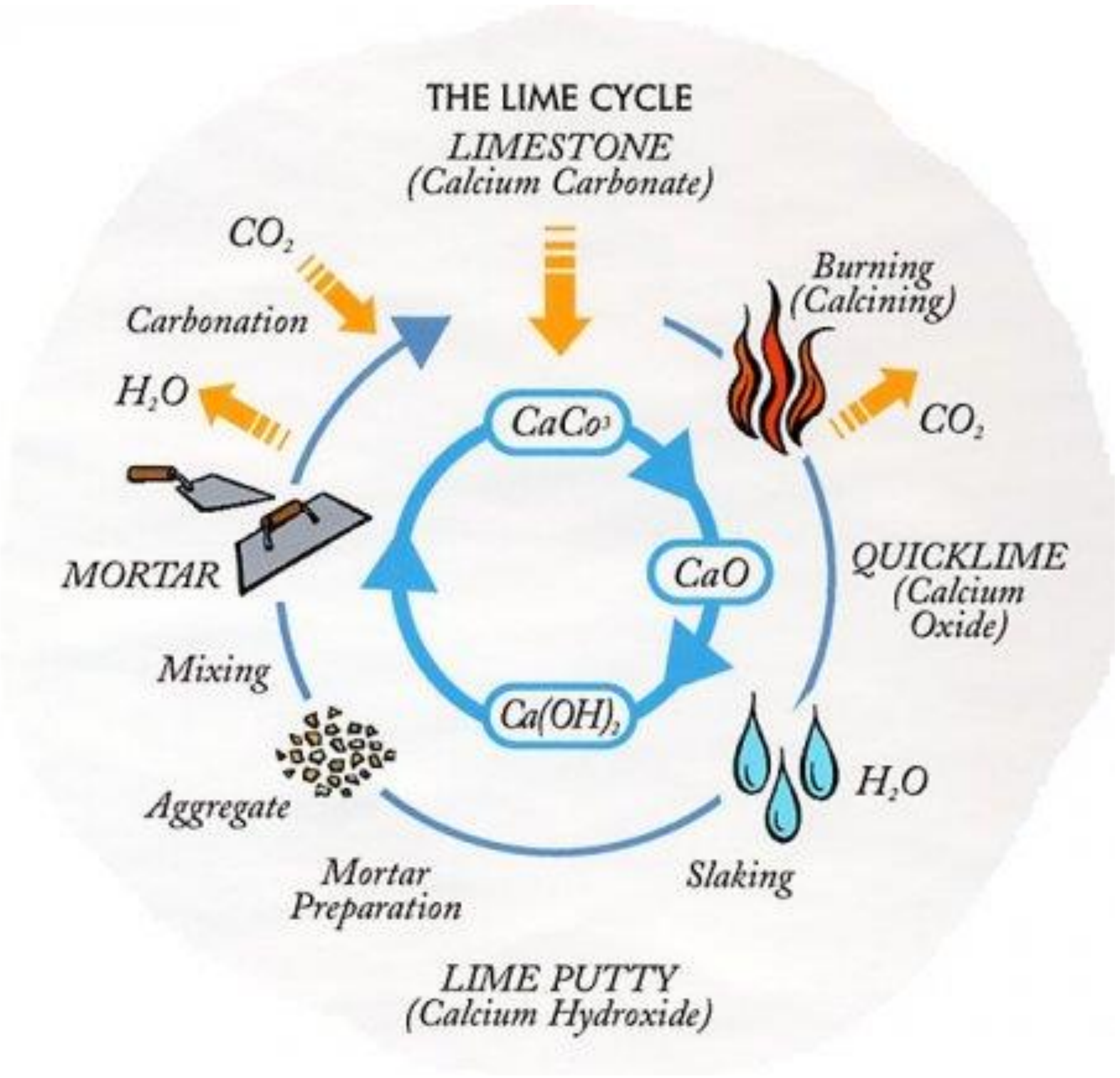
Insulting Render absorbs and disperses condensation over time, accommodating changes in RH.

Reducing the length of time and damage caused by condensation.

# CO2 Reabsorption

Calcium Hydroxide / Free Lime

It is the free lime which reabsorbs the CO2 to undertake carbonation.



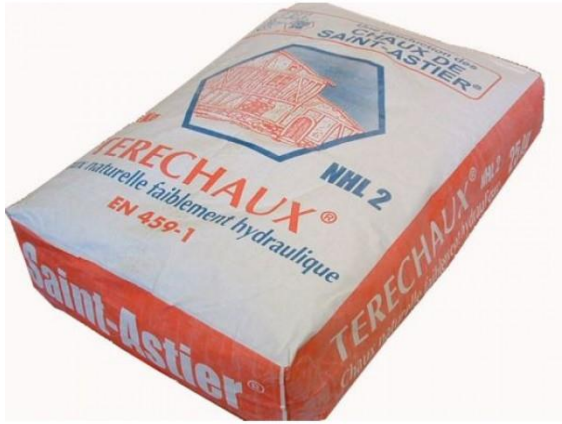
# Free Lime?

The amount of free lime determines the amount of CO2 with is reabsorbed.

The actual lime used will determine the amount of free lime present –

Lime Putty/ Quicklime – 99%

| | EN459 | Cornerstone Mortars |
|---|---|---|
| NHL 2 | 30% | 50% + |
| NHL3.5 | 9% | 24 – 26% |
| NHL5 | 3% | 15 – 20% |



# Cornerstone Insulating Render only uses NHL2

The NHL2 used contains around 55% free lime, significantly more than the amount required within the standard.

Based on the amount of NHL2 used within the product, each bag will reabsorb 2.16kg of $CO_2$.

24% of its weight is reabsorbed as $CO_2$.

For every 14 bags used, this is the equivalent of what a young tree will absorb in its first 3 years.

Based on LCA, lime mortars already have less than ½ the embodied carbon of equivalent cement renders. Insulating Render also contains recycled aggregate, so will be even lower.

Older buildings need compromise. We have to remember that they were not designed for todays use and lifestyle. As custodians of these buildings we must understand this.

So often we place unachievable demands on the building fabric which results in both short term and long term deterioration and damage.

Through careful management and material selection we can achieve a balance of conservation and improved thermal efficiency.

These buildings will never be ultra insulated sealed boxes, but they have stood and will stand for far longer than modern construction types.

*You could even say that our solid walled housing stock is the most eco friendly construction type we have today.*

# RECAP

- Understanding the nature of solid walls is vital.
- Moisture will always be present, we need to manage this and allow it to freely transfer/escape.
- Mortar/Render has to be weaker than the host masonry, the weaker the mortar the more vapour open.
- Lime is not a cure for damp, but it is the most appropriate material for managing moisture.
- Building Regulations do allow for vapour permeability over insulation*.
- Breathable is a meaningless term.
- Quite often systems seen or deemed suitable may not be.
- Insulation and 'breathing' performance can be achieved, but there has to be a compromise.
- Relative Humidity plays a huge role in condensation and moisture.
- Ventilation is key.
- The performance of insulation can be measured not just by £ but also by thermal comfort.
- Lime mortars offer more environmentally friendly alternative to modern materials.

# Any Questions?

# Thank You