Tree Cassyn

Damp. Timber. Moisture Investigations.

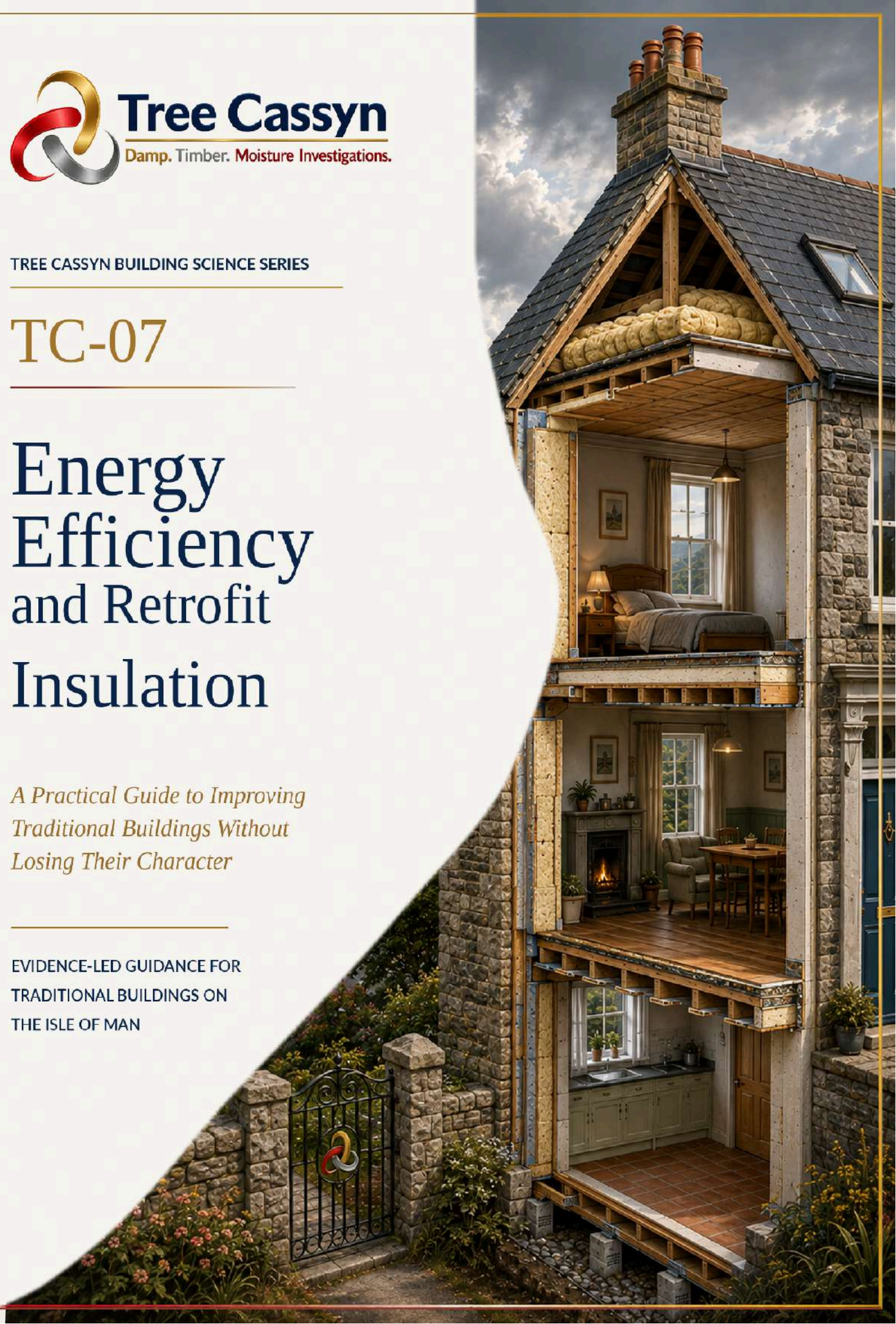
TREE CASSYN BUILDING SCIENCE SERIES

TC-07

Energy Efficiency and Retrofit Insulation

A Practical Guide to Improving Traditional Buildings Without Losing Their Character

EVIDENCE-LED GUIDANCE FOR TRADITIONAL BUILDINGS ON THE ISLE OF MAN



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Foreword

Why is Tree Cassyn writing about insulation?

At first glance, insulation can look like a different subject from dampness, timber defects and moisture movement. In reality, it changes all three. That is why Tree Cassyn is writing about it.

Insulation does more than slow heat loss. It changes the temperature profile through walls, roofs and floors. Put it in one place and existing fabric may become warmer; put it somewhere else and the same fabric may become colder. Drying routes can change. Air movement can reduce. The conditions in which condensation occurs can move too.

None of this means that insulation should be avoided. Improving the energy efficiency of our existing buildings can reduce energy consumption, improve comfort and contribute towards reducing carbon emissions. Those are worthwhile objectives.

But in a traditional building, one question is not enough: how much heat will this save? We also need to ask what else will change.

A wall has a history. It may contain moisture. It may be exposed to wind-driven rain. Its materials may depend upon evaporation and capillary movement to manage that moisture. It may contain embedded timber, irregular rubble, voids and materials whose properties differ considerably from those assumed by a simplified calculation.

Change one part of that system and the rest of the building may respond.

This guide approaches retrofit insulation from that perspective. We will explore U-values, insulation materials and energy savings, but we will also ask what happens to moisture, temperature, ventilation and drying when those interventions are made.

The intention is not to argue against retrofit, nor to promote one particular system. It is to encourage informed, proportionate decision-making.

The best retrofit is not necessarily the one that achieves the lowest possible U-value. It is the one that achieves the best whole-building balance of energy saved, comfort gained, cost, carbon reduction, durability and moisture safety.

1. Why Retrofit Is Different in an Existing Building

Why not simply add more insulation? It is a reasonable question. A building that loses less heat should require less energy to keep comfortable, reducing running costs, improving comfort and helping to reduce carbon emissions.

In a new building, those objectives can be designed together from the beginning. Insulation, airtightness, ventilation, heating, moisture control and weather protection can all be made to work as parts of the same system.

An existing building gives us a different problem. We are not designing a system from scratch. We are changing one that already exists.

A traditional house may have stood for well over a century. Its walls may be solid masonry, perhaps constructed from local stone and lime mortar with irregular rubble hearting. Its roof, floors, windows and internal finishes may have been altered many times. Some changes may have improved its performance; others may have unintentionally changed the way heat, air or moisture moves through the building.

Retrofit therefore begins with a different question. Rather than asking only, 'How much insulation can we add?', we should first ask, 'How does this building work now, and what will change if we intervene?'

Energy efficiency is more than insulation

It is tempting to treat energy efficiency as a simple fabric problem: if heat passes through a wall, add insulation until the calculated heat loss is sufficiently low. But the performance of an occupied building is influenced by much more than the U-value of its walls.

Air leakage, ventilation, heating controls, internal temperatures, moisture content, windows, roofs, floors, occupancy and the condition of the fabric all matter. A technically impressive wall specification cannot compensate for a leaking roof, persistently wet masonry, uncontrolled ventilation or a heating system that is poorly controlled.

Current historic-building guidance increasingly reflects this whole-building approach. Repair and maintenance, services, controls, ventilation and the condition of the existing fabric are considered alongside insulation rather than automatically placing maximum fabric insulation first.

The Isle of Man context

Improving the energy efficiency of existing homes is also an important part of Isle of Man Government policy. The Island has committed to achieving net-zero carbon emissions by 2050, and improving the performance of the existing housing stock forms part of that transition.

Importantly, the challenge is not simply to import generic retrofit solutions. Isle of Man Government's own Retrofit for the Future work has recognised that standard roof, floor and external or internal wall insulation solutions may not always be suitable for Manx stone cottages, Victorian housing and other parts of the Island's existing building stock, identifying potential consequences including condensation and loss of architectural character.

The objective of this guide is therefore not at odds with the Island's energy-efficiency ambitions. It is to explore how those ambitions can be achieved while respecting the construction, condition and moisture behaviour of the buildings we are trying to improve.

A different relationship with moisture

Traditional solid-wall construction also manages moisture differently from many modern wall systems. Moisture can enter from rain, the ground, the internal environment and normal occupation. Porous materials can absorb, redistribute, store and release that moisture as conditions change.



This does not mean that a traditional building should be damp. It means that its ability to dry is part of its successful performance.

Insulation can alter that balance. Internal wall insulation generally leaves the original masonry colder. External wall insulation generally keeps it warmer. New layers can change vapour resistance, capillary movement, air leakage and the routes by which a wall dries. Junctions around floors, roofs, windows and embedded timbers can behave differently after the work.

Related Building Science Guides

For a fuller explanation of how moisture moves through traditional building fabric, and how changes in temperature can affect condensation risk, see TC-01 - Understanding Moisture Movement in Traditional Buildings, TC-04 - Understanding Surface Condensation and Mould, and TC-05 - Understanding Interstitial Condensation.

These changes are not arguments against insulation. They are reasons to understand the complete construction before choosing it.

Policy, products and assumptions

Reducing domestic energy consumption and carbon emissions is a worthwhile policy objective. Manufacturers have also developed an increasingly sophisticated range of insulation systems capable of producing very substantial improvements in calculated thermal performance. Neither fact removes the need for scrutiny.

A calculated U-value depends upon inputs and assumptions. A manufacturer's declared performance applies under defined test conditions and at a stated thickness. A claim that a material is 'breathable' is only useful if we understand what property is being described. A predicted percentage saving depends upon assumptions about the building, climate, heating and occupants.

Ask what sits behind the number

Throughout this guide we will return to that principle. Is the figure measured or calculated? What construction was assumed? What thickness was tested? What happens at the junctions? What happens when the material becomes wet? What new maintenance obligations are created? And how much useful energy will the intervention actually save?

That is not an argument for doing less. It is an argument for doing the right work for the right reasons.

The objective: optimum, not simply maximum

The lowest achievable U-value may sometimes be appropriate, but it should not automatically become the objective.

An intervention that produces a large improvement in comfort and energy performance with manageable cost and moisture risk may represent a better solution than pursuing the final increment of theoretical performance at disproportionate cost, disruption or complexity.

Equally, caution about moisture should not become an excuse to leave an uncomfortable and unnecessarily inefficient building unimproved. Cold internal surfaces can themselves contribute to condensation and mould risk. Appropriate insulation can improve comfort, reduce heat loss and make a building easier to use successfully.

The objective is the best whole-building balance of kWh saved, comfort gained, cost, carbon reduction, durability and moisture safety. That balance is the starting point for everything that follows.

ILLUSTRATION 01

THE RETROFIT BALANCE

OPTIMUM, NOT MAXIMUM

The best retrofit is not the one that adds the most insulation. It is the one that achieves the best balance across all that matters.

Our objective is a home that is warmer, healthier, more efficient and more resilient – for less cost, lower carbon and greater peace of mind.

LOWER CARBON
Reduce operational carbon through lower energy use and choose low-carbon materials and methods where possible.

ENERGY SAVED
Reduce heat loss and energy demand to cut bills and improve efficiency.

DURABILITY & RESILIENCE
Protect the fabric from damage and decay so the building lasts, even as climate and conditions change.



COMFORT GAINED
Warmer in winter, cooler in summer, more even temperatures and fewer cold spots.

COST (WHOLE-LIFE)
Consider both the upfront cost and the long-term costs of running, maintaining and repairing.

MOISTURE SAFETY
Understand and respect how the building manages moisture so it stays dry and healthy in the long term.

HEALTH & WELLBEING
Improve air quality, reduce damp and mould risk, and create a healthier place to live.

THE GOAL
Not the lowest U-value.
Not the thickest insulation.
The best overall outcome for your building and your circumstances.

UNDERSTAND THE BUILDING
What is it made of? How does it manage moisture and heat?

+

ASSESS CONDITION & RISK
What are the issues? What could go wrong if we insulate?

+

CONSIDER OPTIONS
What are the realistic choices for this building?

+

PLAN & INSTALL CAREFULLY
Do the detail well. Use suitable materials. Avoid new defects.

+

VERIFY & LEARN
Check performance. Learn from results. Improve over time.

=

OPTIMUM OUTCOME
A home that performs well, stays dry, costs less to run and stands the test of time.

More insulation can help – but only when the building is understood, the risks are managed and the whole balance is right.

2. Before We Insulate - Understand the Building

Before we choose an insulation, there is a more basic question: what, exactly, are we insulating?

That sounds obvious. In practice, existing buildings frequently resist simple classification. Two houses that look almost identical from the road can conceal very different constructions. One property may contain solid masonry at the front, a later cavity-wall extension at the rear, a converted roof space, a replacement concrete floor and several generations of internal finishes.

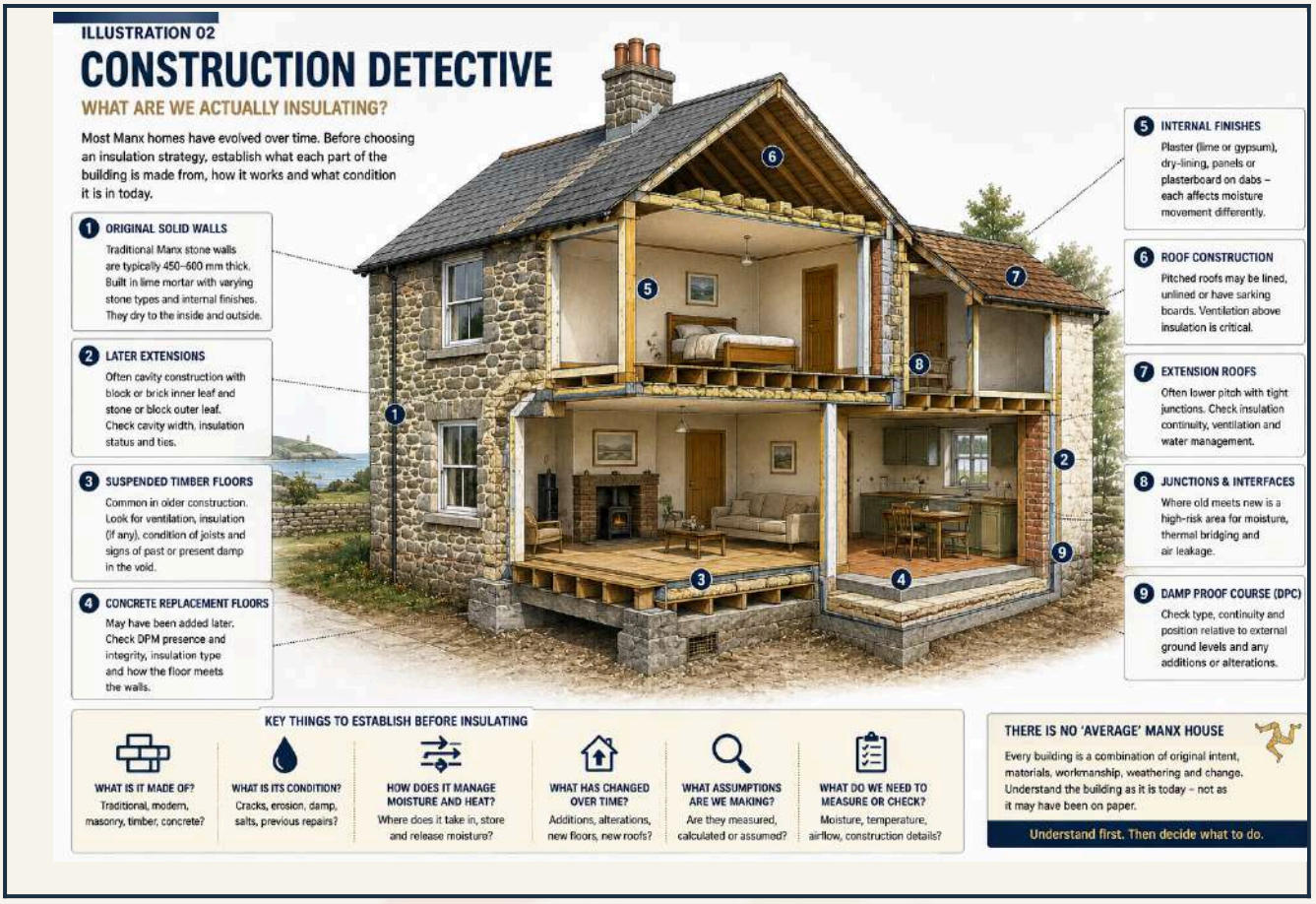
The appropriate retrofit solution may therefore vary not only from one building to another, but from one part of the same building to another.

What are we actually insulating?

The first task is to establish the construction as reliably as possible. Is the wall solid stone, solid brick, early cavity masonry, modern cavity construction or timber frame? How thick is it? What are the internal and external finishes? Has it already been insulated? Are there later linings or concealed voids?

In a Manx context, traditional masonry deserves particular care. A thick wall described simply as 'stone' may contain slate, sandstone, granite or other local material, together with lime mortar, rubble hearting, irregular voids and substantial variations in thickness. Later cement render, gypsum plaster or dry lining may have changed the behaviour of the original construction.

Roofs and floors deserve the same attention. A suspended timber floor behaves very differently from a later concrete replacement floor. A traditionally ventilated roof with insulation at ceiling level is different from a roof insulated between rafters, and different again from one retrospectively coated with spray foam.



Condition comes before calculation

Once the construction is understood, the next question is its condition.

Insulating a wall does not repair a leaking gutter. It does not cure defective pointing, cracked render, high external ground levels or rain penetration around a window. Nor should insulation be expected to solve an existing damp problem whose cause has not been established.

Moisture also matters thermally. Wet porous materials generally conduct heat more readily than the same materials when dry. A moisture-loaded wall may therefore perform differently from the wall assumed in a thermal calculation.

Current guidance for traditional buildings is clear that sources of excess moisture should be addressed before insulation is installed. Where masonry has remained wet for a prolonged period, drying can be slow.

Repairing the defect is not necessarily the same as drying the wall.

A gutter repaired today stops tomorrow's rainwater entering the wall. It does not instantly remove the moisture accumulated during the preceding months or years.

This becomes particularly important when an insulation system will cover the wall and change one or more of its drying routes.

A wall is not either 'dry' or 'wet'

Traditional masonry will normally contain some moisture. Porous materials interact continuously with their environment, absorbing and releasing moisture as temperature, humidity and weather conditions change.

The relevant distinction is therefore not between a perfectly dry wall and a wall containing any moisture at all. It is between a wall behaving within a normal, manageable moisture range and one carrying excess moisture because of a defect, exposure, inappropriate materials or another unresolved source.

That distinction also explains why a single handheld moisture-meter reading cannot, by itself, determine whether a thick masonry wall is ready to insulate. The pattern, source, depth and behaviour of moisture matter.

Look beyond the wall itself

Wall insulation interacts with adjoining parts of the building. Floor joists may be embedded in masonry. Roof timbers may bear into gables. Window reveals can become thermal bridges. External insulation changes details at eaves, sills, ground level and rainwater pipes. Internal insulation changes room dimensions, sockets, skirtings and junction temperatures.

Ventilation also forms part of the starting condition. A building that currently relies heavily on uncontrolled air leakage may behave very differently after draught-proofing and insulation. Improving airtightness can save energy, but the moisture generated by cooking, bathing, drying clothes and occupation still needs a deliberate route out.

For that reason, a useful pre-retrofit assessment is not simply an insulation survey. It is an assessment of the building as a system.

The starting questions

- What is the construction?
- What alterations have already been made?
- Is the building in good repair?
- Is there evidence of excess moisture, and has its source been established?
- How exposed is the building - particularly to wind-driven rain?
- How does the building currently ventilate?
- Where are the vulnerable junctions and embedded timbers?
- What problem are we actually trying to solve: high energy use, cold surfaces, discomfort, carbon reduction - or a combination of these?

Retrofit does not begin with the insulation. It begins with understanding what is being insulated.



3. Understanding the Numbers

Retrofit specifications can become a wall of letters and numbers remarkably quickly.

U-values. R-values. Lambda values. μ-values. Sd values. W/m²K. W/mK.

To someone simply trying to make their home warmer and more efficient, the terminology can make retrofit seem unnecessarily complicated.

The good news is that the ideas underneath them are much simpler than the notation suggests.

These numbers describe different properties, and they should not be confused with one another. Some tell us about heat. Others tell us about water vapour. Some describe an individual material. Others describe the performance of an entire wall, roof or floor.

Understanding those differences makes it much easier to interrogate an insulation proposal - and to understand what sits behind the numbers.

Thermal conductivity - λ

Usually written as the Greek letter lambda (λ), thermal conductivity describes how readily heat passes through a particular material.

It is normally expressed in:

W/mK - watts per metre kelvin

For insulation materials, a lower λ-value generally means that the material conducts heat less readily and is therefore a better thermal insulator for a given thickness.

For example, two insulation products might have different λ-values. If both are installed at exactly the same thickness, the product with the lower λ-value will normally provide the greater resistance to heat flow.

But λ describes the material.

It does not, on its own, tell us the thermal performance of the complete wall. That distinction is important.

R-value - resistance to heat flow

The R-value describes thermal resistance.

If λ tells us how readily a material conducts heat, R tells us how strongly a particular layer resists that heat flow. Here, higher is better. Thickness matters.

A thin layer of insulation and a thick layer of the same insulation have the same material λ-value, but the thicker layer has the greater R-value because heat has further to travel through it.

In simplified form:

R = thickness ÷ λ

So imagine an insulation with a λ-value of 0.040 W/mK.

At 50 mm thickness:

0.050 ÷ 0.040 = R 1.25 m²K/W

At 100 mm:

0.100 ÷ 0.040 = R 2.50 m²K/W



Same material. Same λ-value. Twice the thickness. Twice the thermal resistance.

This is why an insulation specification should never be judged by its λ-value alone. We also need to know how much of it is actually being installed.

U-value - performance of the complete element

The U-value is probably the number homeowners are most likely to encounter.

It describes the rate at which heat passes through a complete building element - for example a wall, roof, floor or window.

It is normally expressed in:

W/m²K - watts per square metre kelvin

This time, lower is better.

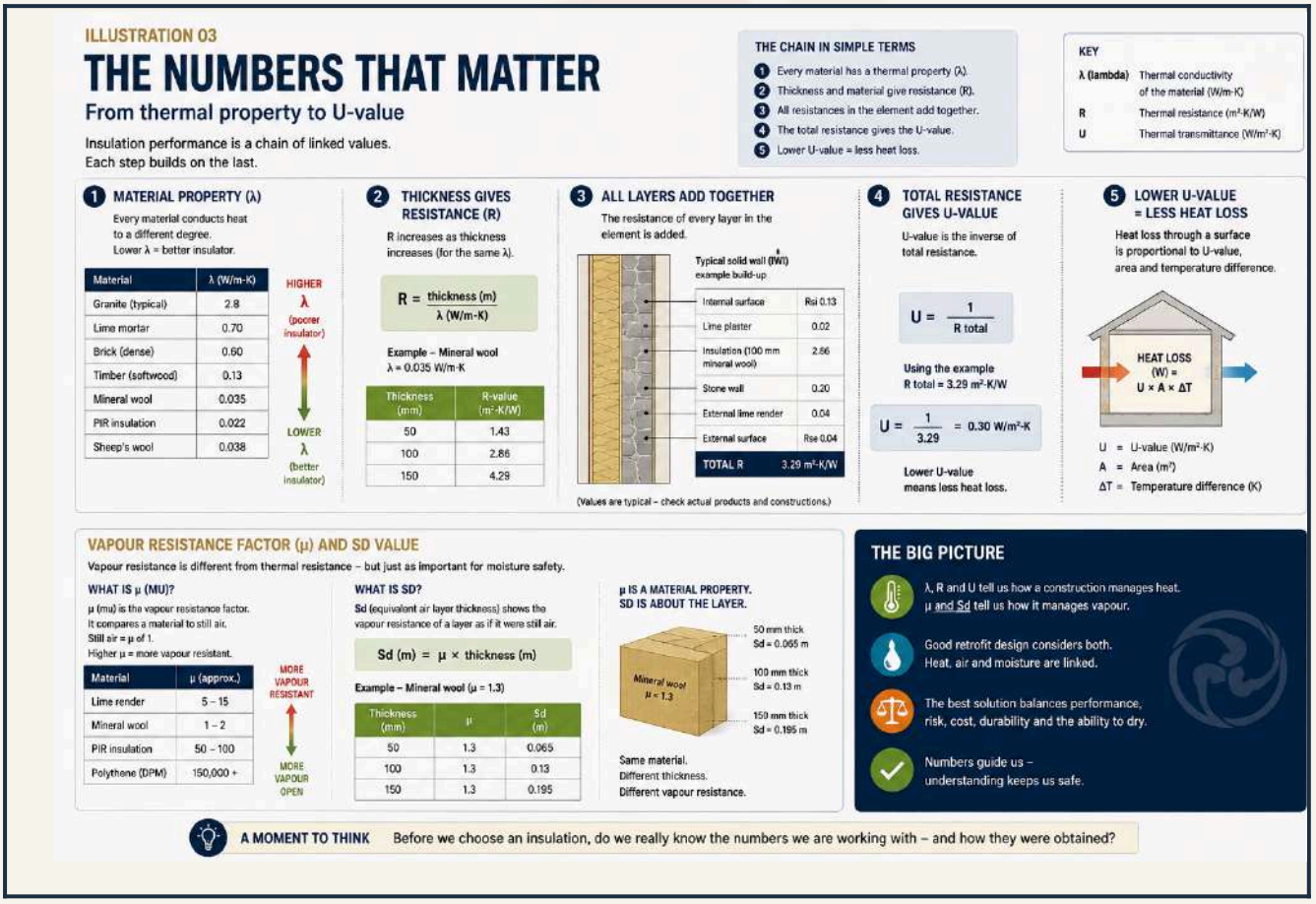
A wall with a U-value of 2.0 W/m²K loses heat more readily than one with a U-value of 0.5 W/m²K, assuming the same area and temperature difference. The important word, however, is complete.

A wall's U-value is not simply the λ-value of its insulation.

The calculation may include the external surface resistance, render, masonry, mortar, cavity, insulation, plaster and internal surface resistance. Each layer contributes something to the overall resistance to heat flow.

That makes the U-value extremely useful. But it also introduces something we will return to repeatedly:

A calculated U-value is only as representative of the real wall as the information used to calculate it.



A Manx wall is not a line in a calculator

Consider a 500 mm traditional Manx wall.

For the purposes of a thermal calculation it might have to be represented by a defined thickness of masonry with an assumed thermal conductivity.

But open the wall and reality may be rather different.

There may be Manx slate, sandstone or other stone. There may be large pieces of masonry and small pieces. Lime mortar. Rubble hearting. Voids. Variable density. Different proportions of mortar and stone. Thickness may vary considerably along the elevation. Moisture content can also affect thermal performance.

The calculation still has value. We need models in order to compare interventions and predict performance. But we should understand what the model represents.

The calculation is not the wall. It is a model of the wall.

That distinction becomes extremely important in the next chapter.

U-value and R-value - opposite directions, same story

One source of confusion is that the numbers move in opposite directions.

For R-value: higher = greater thermal resistance.

For U-value: lower = less heat transmission.

There is a mathematical relationship between them. In simplified terms, once the thermal resistances of the complete construction and its surfaces are combined:

U = 1 ÷ total R

You don't need to perform these calculations yourself to understand an insulation proposal.

R resists heat flow - higher is better.
U describes heat transmission - lower is better.

But U-value is not energy consumption

This distinction is fundamental.

Suppose someone tells you: “Adding this insulation will reduce the wall U-value from 1.5 to 0.3 W/m²K.”

That sounds impressive - and thermally, it is a substantial reduction in heat transmission through that element.

But it does not mean: “Your heating bill will fall by 80%.”

The wall is only one part of the building.

Actual energy consumption also depends upon wall area, roof and floor losses, windows and doors, air leakage, ventilation, internal temperature, external temperature, heating efficiency, occupancy and how the building is used.

So a U-value tells us something very useful. It tells us about heat transfer through a building element. It does not directly tell us how many pounds will disappear from the heating bill.

Later in this guide we will take the next step and translate changes in U-value into something much more tangible: kWh of heat.



Heat and moisture are described by different numbers

So far, all of our numbers have concerned heat.

But TC-07 is also interested in what happens to moisture when insulation is added.

That introduces another pair of values homeowners may encounter: μ and Sd. They describe something quite different.

μ - resistance to water-vapour diffusion

The Greek letter μ (mu) describes how resistant a material is to the diffusion of water vapour compared with still air. It is a dimensionless ratio.

A relatively low μ-value indicates that water vapour can diffuse through the material comparatively readily. A higher μ-value indicates greater resistance.

This is one of the properties hiding behind everyday descriptions such as “breathable” or “vapour-open.”

But μ alone still doesn't tell us the resistance of the layer actually installed. Once again: thickness matters.

Sd - what the installed layer means

Sd stands for equivalent air-layer thickness.

It combines the material's μ-value with its actual thickness:

Sd = μ × thickness in metres

The result is expressed in metres.

An Sd value of 0.1 m, for example, means that the layer provides approximately the same resistance to water-vapour diffusion as 0.1 metres of still air.

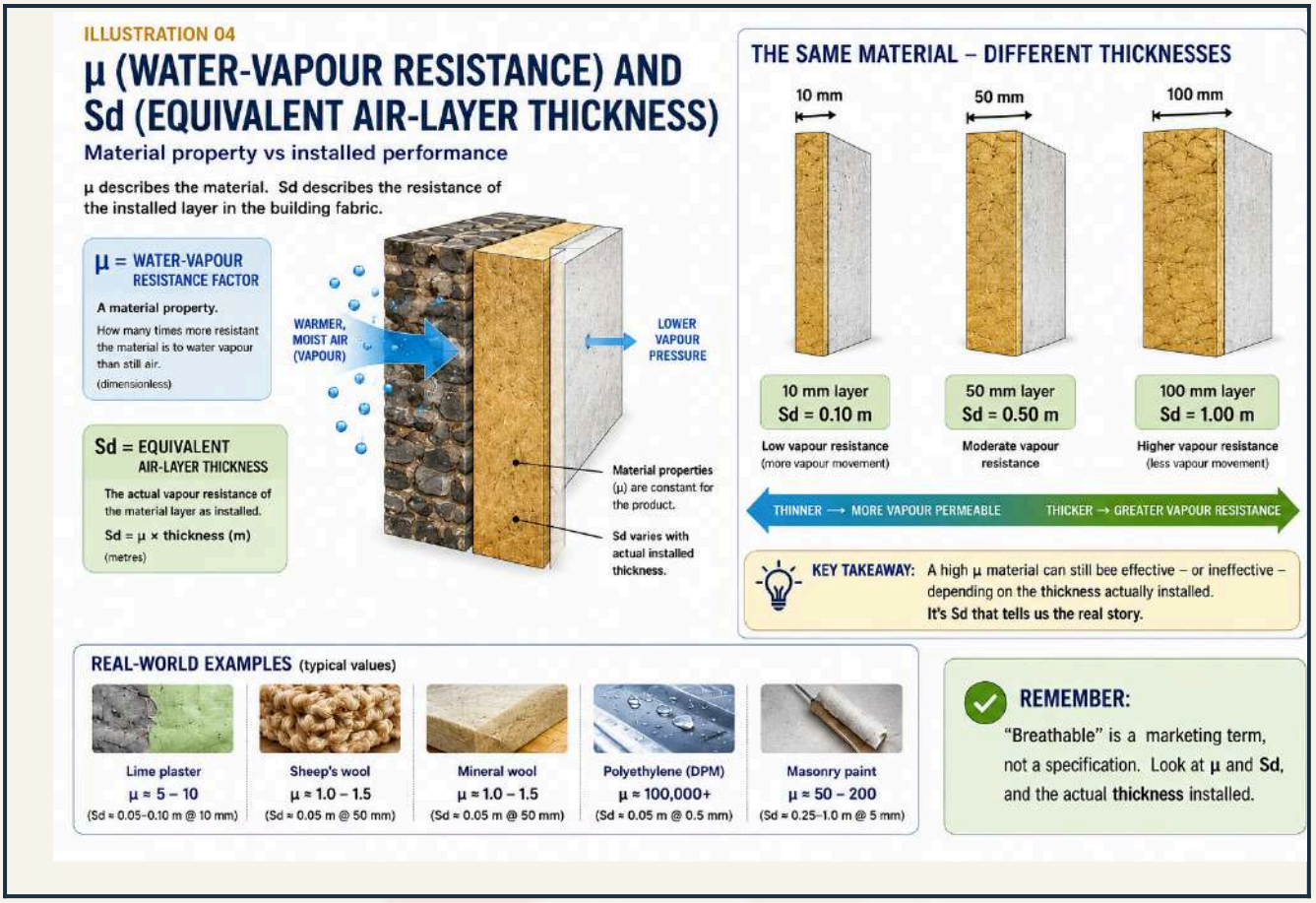
This gives us an important distinction:

μ describes the material.
Sd describes the vapour resistance of the constructed layer at a particular thickness.

That is why simply describing a product as “breathable” tells us surprisingly little.

A manufacturer might quote a favourable μ-value - but we should also ask: at what installed thickness? And therefore: what is the resulting Sd value?





Vapour-open does not mean moisture-proof

There is another important limitation.

μ and Sd concern water-vapour diffusion.

They do not, by themselves, describe liquid-water absorption, capillary transport, hygroscopic moisture storage, drying rate, resistance to wind-driven rain, or what happens if the material becomes saturated.

This distinction will become particularly important when we consider vapour-open internal insulation, external insulation and what flood research tells us about insulation materials becoming wet.

A product can therefore have a relatively low resistance to water-vapour diffusion while behaving very differently when exposed to liquid water.

That is why TC-07 will avoid using "breathable" as though it were a complete technical specification.

One product - several different questions

Imagine an insulation manufacturer states: λ = 0.038 W/mK.

That tells us something useful about thermal conductivity.

But it doesn't tell us:

- How thick will it be installed?
- What R-value will that thickness provide?

- What U-value will the complete wall achieve?
- What assumptions were made about the existing wall?
- What is its μ-value?
- What Sd will the installed layer have?
- How does it transport or absorb liquid moisture?
- What happens to its thermal conductivity when wet?
- How does the complete wall dry?

Those are not objections to the product. They are simply different questions.

And that leads us back to one of the central ideas of this guide:

Ask what sits behind the number

A λ-value can be perfectly accurate without telling us whether a product is appropriate for a particular wall.

A U-value calculation can be mathematically correct while relying upon assumptions that do not perfectly represent a heterogeneous traditional construction.

A low μ-value can genuinely demonstrate good vapour permeability without telling us how the material behaves when exposed to liquid water.

The numbers are useful. Understanding what each number actually measures makes them much more useful.

Measured, calculated and declared

There is one final distinction worth making before we leave the terminology.

A figure in an insulation specification may be:

Declared - a property stated for a manufactured product following a defined testing or assessment process.

Calculated - a result produced mathematically using assumed or measured properties of the materials and construction.

Measured in situ - performance observed from the building itself under suitable test conditions.

These are not interchangeable.

Manufactured insulation products can generally be characterised much more precisely than a 150-year-old random-rubble wall whose exact internal composition is unknown.

This doesn't make calculated values useless. Building design could scarcely function without calculation.

It simply means that we should understand the degree of certainty attached to the inputs.

And traditional buildings give us a particularly interesting example of why that matters.

SPAB's programme of in-situ U-value measurements found that the standard calculated approach underestimated the thermal performance of 77% of the traditional walls it sampled. In some examples, measured heat loss was substantially lower than the theoretical calculation predicted.

That does not mean that 77% of traditional walls don't need insulation.

Nor does it mean that U-value calculations are wrong. It means something much more interesting.

Sometimes the real building behaves differently from the simplified model used to describe it.

And that is where Chapter 4 begins: Traditional Walls - Are the Calculations Always Right?



4. Traditional Walls - Are the Calculations Always Right?

At this point, one distinction becomes crucial:

The calculation is not the wall. It is a model of the wall.

For modern construction, that representation can often be reasonably precise. We may know the exact thickness and declared thermal conductivity of each block, insulation board, plasterboard layer and cavity.

A traditional solid wall is rather less cooperative.

Its construction may never have been recorded. Its thickness may vary. The stone may be irregular. Different stones may have been used within the same elevation. The centre of the wall may contain rubble, lime mortar and voids in proportions that nobody can see without opening it.

And after a century or more of alterations and weathering, its moisture content and internal condition may be just as variable.

Yet to calculate a U-value, all of that complexity eventually has to become a series of numbers. That does not make the calculation wrong.

It means we need to understand the assumptions behind it.

What SPAB found

Research undertaken by the Society for the Protection of Ancient Buildings - SPAB - provides a particularly useful example.

As part of its energy-efficiency research, SPAB carried out in-situ U-value measurements on traditional walls and compared their measured performance with values derived using standard calculations.

In 77% of the walls tested, the standard calculation underestimated the wall's thermal performance - in other words, it predicted greater heat loss than was subsequently measured. In some cases, the difference was substantial.

That is an important finding, but also an easy one to misuse.

It does not demonstrate that all traditional walls perform better than calculated.

It does not mean that traditional walls are adequately insulated.

And it certainly does not mean that U-value calculations should be ignored.

SPAB's more useful conclusion is that default assumptions about traditional construction can sometimes produce pessimistic estimates of thermal performance, and that these estimates can influence decisions about how much intervention is considered necessary.

The lesson for TC-07 is therefore more measured:

Before deciding how much improvement a wall needs, it helps to understand how confidently we know where it is starting from.

The Manx random-rubble problem

This becomes particularly interesting on the Isle of Man.

Imagine a survey describes an external wall as:

Approximately 550 mm solid stone masonry.

That sounds reasonably specific. But what does stone masonry actually mean?



In one Manx property it might predominantly comprise slate. Elsewhere sandstone may dominate. Granite or other stone may be present. Different materials may appear within the same wall.

And the wall is unlikely to consist of neatly cut stone extending continuously from its internal face to its external face.

A traditional random-rubble wall might contain substantial facing stones, smaller packing stones, lime mortar, rubble hearting and irregular voids. The proportions may change throughout its thickness.

So, for a calculation, we might have to turn something like this:

slate + sandstone + lime mortar + rubble + air voids + variable moisture + irregular thickness

into:

550 mm stone wall

The simplification is necessary. But it is still a simplification.



Stone itself isn't one thermal material

Even the word stone hides considerable variation.

Different geological materials have different densities, pore structures and thermal conductivities. Their properties can also change with moisture content.

That makes the selection of a representative conductivity value important.

If the assumed conductivity is higher than that of the wall in reality, calculated heat loss will be pessimistic. If it is lower, the opposite may occur.

The same problem applies to mortar and the unknown composition of the wall's core.

This is one reason why a calculated U-value for an old heterogeneous wall should not necessarily be presented with the same implied precision as the declared thermal conductivity of a factory-produced insulation board.

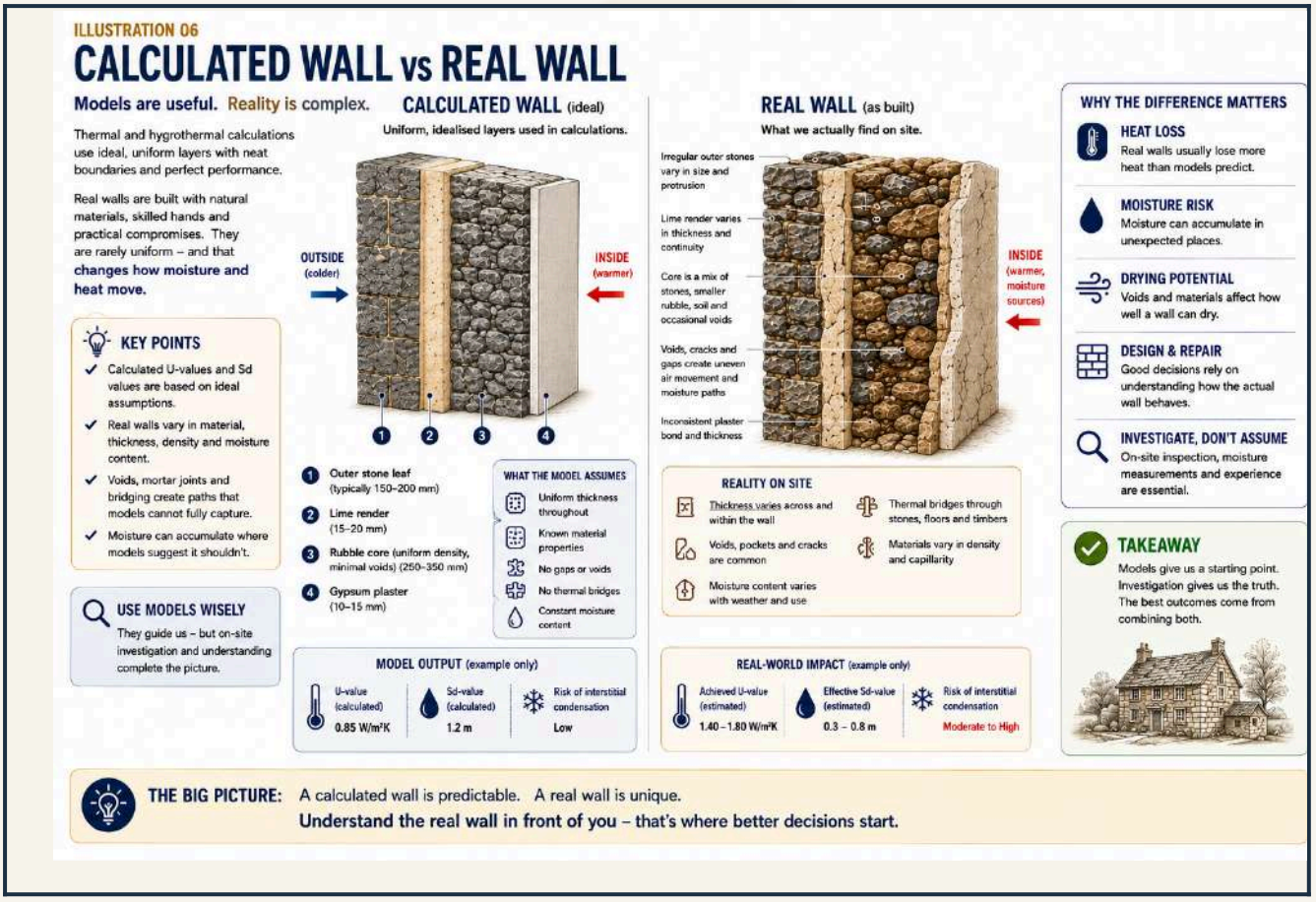
A result such as U = 1.73 W/m²K looks extraordinarily precise.

The arithmetic may indeed produce 1.73.

But if the underlying wall composition and material properties are estimates, the apparent precision of those two decimal places can disguise considerable uncertainty.

Precision in the answer does not remove uncertainty from the inputs.

That is another useful question to ask when looking at a retrofit calculation: How well do we actually know the existing wall?



Could we measure it instead?

Sometimes, yes.

In-situ U-value measurement uses heat-flow and temperature monitoring to estimate how much heat is actually passing through the building element.

This can provide valuable evidence about the real thermal performance of an existing wall. But measurement is not magic either.

Weather conditions, internal temperature stability, sensor location, duration of monitoring and the particular part of a heterogeneous wall being measured can all influence the result.

A heat-flow sensor attached to one small area of random-rubble masonry cannot reveal every variation across an entire house.

So measured performance should not simply replace calculated performance as another number to accept without question.

The two can instead provide different kinds of evidence.

Calculation asks: Given these assumptions, how should this construction perform?

Measurement asks: Under these conditions, how did this part of the actual construction perform?

Where the decision is significant enough, understanding both can be more useful than treating either as infallible.

Moisture changes the calculation too

There is another variable particularly relevant to Tree Cassyn. Moisture.

Water conducts heat considerably more effectively than air. As porous masonry becomes wetter, its thermal conductivity can increase.

That creates an important relationship between maintenance and energy efficiency.

A persistently rain-wetted wall is not simply a dampness problem. It may also be a thermal-performance problem.

Repairing defective gutters, addressing penetrating rain, maintaining appropriate pointing and finishes, and allowing masonry to dry can therefore contribute to the building's thermal behaviour before a single insulation board is installed.

This gives us another reason for the hierarchy introduced earlier: understand → repair → assess → then decide what intervention is justified.

It also raises an interesting possibility.

If a wall's U-value has been calculated using assumptions appropriate to dry masonry, but the wall in service is significantly moisture-loaded, its actual performance may be worse.

Conversely, if a calculation uses pessimistic generic conductivity assumptions for traditional masonry that is actually performing better, its true performance may be better. The answer is not automatically in one direction.

Understand the starting condition.

Thermal mass - a different property

Traditional stone walls have another characteristic that can easily become confused with insulation: thermal mass.

A thick masonry wall can absorb a considerable quantity of heat.

When the building is heated, energy is transferred not only to the air but into its fabric. Floors, internal partitions and particularly thick masonry walls gradually warm.

When the heating input reduces, some of that stored heat can subsequently be released back into the building. This is real and potentially useful.

But thermal mass is not the same thing as thermal resistance.

An uninsulated thick stone wall can have substantial thermal mass while still allowing considerably more heat to pass through it than a well-insulated modern wall. A useful analogy is a storage heater.



A storage heater can absorb a large amount of heat and release it slowly. That ability to store heat does not mean its casing is necessarily an exceptionally good insulator.

Likewise:

Insulation resists heat flow.
Thermal mass stores heat.

The "leap of faith"

This helps explain an experience familiar to many owners of traditional houses.

After a cold building has been left largely unheated, bringing it back to a comfortable temperature can require a surprising amount of energy.

The air warms relatively quickly. The building fabric does not.

Thick masonry walls, floors and internal fabric may remain cold for considerably longer, absorbing heat from the internal environment as they gradually warm.

It can feel as though the heating is disappearing into the building. In a sense, some of it is.

This is why continuously or thermostatically heating a traditional building can sometimes feel very different from repeatedly heating it from cold.

Once the internal fabric has reached a more stable temperature, the heating system is no longer repeatedly trying to raise the temperature of that same large thermal mass from a cold starting point.

There can also be a moisture benefit. Warmer internal surfaces generally reduce surface-relative humidity and increase the margin between surface temperature and dew point, reducing the likelihood of surface condensation where other conditions remain comparable. But we should be careful here.

A warm massive wall does not become an insulated wall.

Heat is still being lost through it. Maintaining a higher temperature also requires energy.

The storage-heater analogy therefore helps us understand how the building responds to heating, not prove that continuous heating is necessarily cheaper than insulation.

Could heating be the better intervention?

This leads to a much more interesting question than simply asking whether insulation works.

Imagine a traditional Manx house with sound roof and rainwater goods, appropriate lime-based finishes, no significant penetrating dampness, managed ground levels, good ventilation, a well-maintained solid wall and an efficient, thermostatically controlled heating system.

The wall may still have a relatively poor U-value compared with modern construction.

Could accepting some heat loss, while maintaining stable temperatures and allowing the original wall to continue managing moisture in the way it has historically done, sometimes represent a reasonable alternative to major IWI or EWI? Potentially.

But we cannot answer that from building physics alone.

We need to know how much energy the wall is actually losing.

We need to know how much insulation would save.

We need to know what that insulation would cost.



And we need to understand what else the intervention changes.

This is where the decision becomes one of proportionality rather than ideology.

The right answer might be substantial insulation. It might be modest insulation.

It might be insulating the roof and floor while leaving the walls largely alone.

Or it might be improving heating controls, airtightness and ventilation first, monitoring actual energy consumption, and reconsidering the wall later.

"The wall has a poor calculated U-value" is the beginning of the investigation, not necessarily the end of the decision.

How much improvement are we actually buying?

Suppose a retrofit proposal promises to reduce the U-value of a wall dramatically.

That tells us the intervention should reduce heat transmission through that wall.

But it still doesn't tell us whether the intervention represents good value. For that, we need to move beyond U-values.

We need to ask: How large is the wall? What temperature difference does it normally experience? For how many hours of the year? How efficient is the heating system? How much does the energy cost? How many kilowatt-hours might the intervention actually save?

And then:

Does the incremental energy saving achieved by insulating this particular wall justify the cost, disruption and building-physics consequences involved?

That question doesn't have a predetermined answer.

But it is a much better question than simply: How low can we make the U-value?

And that takes us naturally to Chapter 5: From U-value to kWh.

5. From U-value to kWh

A lower U-value tells us something important: less heat will pass through that building element.

But nobody buys a U-value. We buy energy.

So if an insulation proposal reduces a wall from, say, 1.5 W/m²K to 0.3 W/m²K, the more useful question is:

How many kilowatt-hours of heat might that actually save?

That is the point at which the calculation starts to become meaningful in the real world.

From a small number to actual heat loss

The basic relationship is surprisingly simple.

Heat loss through a building element depends principally upon its U-value, its area and the temperature difference across it.

$$\text{Heat loss (W)} = U \times A \times \Delta T$$

Imagine a house with 100 m² of exposed external wall. For simplicity, suppose its existing wall has a U-value of 1.5 W/m²K, the house is maintained at 20°C, and the outside temperature is 5°C.

The temperature difference is therefore 15°C.

$$1.5 \times 100 \times 15 = 2{,}250 \text{ W}$$

At that moment, approximately 2.25 kW of heat is passing through those walls.

If insulation reduced the wall U-value to 0.5 W/m²K:

$$0.5 \times 100 \times 15 = 750 \text{ W}$$

The difference is 1,500 W - or 1.5 kW.

Under those particular conditions, the insulation has reduced heat loss through the wall by approximately 1.5 kW.

But we still haven't calculated an energy saving. For that, we need time.

From kW to kWh

A kilowatt (kW) describes a rate of energy transfer. A kilowatt-hour (kWh) describes an amount of energy.

If we avoided 1.5 kW of heat loss continuously for one hour, we would save 1.5 kWh. For ten hours, 15 kWh. For 100 hours, 150 kWh.

This is why kWh is so useful when considering retrofit. It moves the discussion from an abstract improvement in U-value towards the amount of heat the intervention may prevent the building from losing over a heating season.

And ultimately, that is the energy we are paying to replace.

Real weather is not 5°C all winter

Our example contains an obvious simplification. The outside temperature does not remain at 5°C.

Some days will be considerably warmer. Some will be colder. Internal temperatures vary too. Solar gain, wind, occupancy and heating schedules all affect what happens in the real building.

Annual heat-loss estimates therefore normally use climate data and heating assumptions rather than pretending that one temperature difference exists throughout winter.



For the Isle of Man, local climate matters. A calculation based upon assumptions for a different part of Britain may still be useful, but the Island has its own maritime climate, exposure and heating conditions.

So an annual kWh figure should always prompt the same question we have already learned to ask:

What assumptions sit behind it?

The aim is not to distrust the calculation. It is to understand what the number represents.

A saving through one wall is not a saving through the whole house

If insulation reduces heat loss through the walls by 60%, that does not mean the building's total heating requirement falls by 60%.

Heat may also leave through the roof, floor, windows and doors, thermal bridges, air leakage and deliberate ventilation. Domestic hot water also consumes energy but has little to do with wall insulation.

So when a proposal says, “This measure could reduce heat loss through the wall by X%”, that statement can be perfectly reasonable. But it is very different from saying, “This will reduce your energy bill by X%.”

A percentage saving is only useful if we know what the percentage refers to.

From kWh to pounds

Once an estimated annual kWh saving has been established, it is tempting - and useful - to translate it into money.

At the time of writing, the standard Isle of Man domestic electricity unit rate is 29.5p/kWh. The standing charge is not part of this comparison because it remains payable while the property remains connected; insulation avoids units of energy, not the connection charge.

Suppose, purely for illustration, that a retrofit measure is predicted to avoid 3,000 kWh of purchased electricity each year.

3,000 kWh × £0.295 = approximately £885 per year

If the installed work cost £15,000, a very simple payback calculation would be approximately 17 years.

That is immediately more meaningful to many homeowners than being told only that the wall U-value will improve from one figure to another.

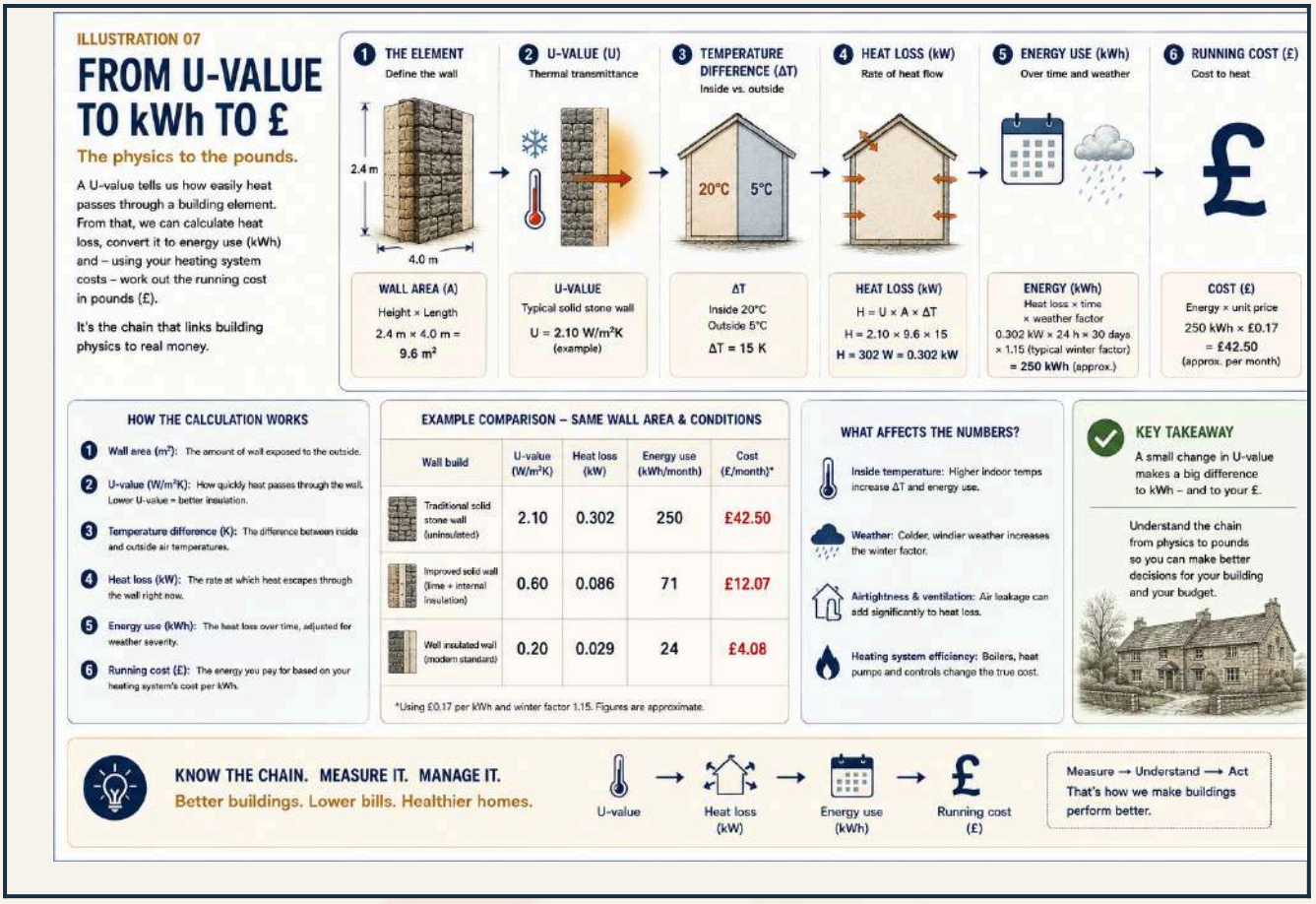
It also invites the same question people routinely ask when considering solar panels or other capital-intensive energy measures:

What will this cost, what is it expected to save, and how long will it take for those savings to recover the investment?

That is a perfectly reasonable question to ask of retrofit insulation too.

About the tariff example. The 29.5p/kWh figure is the Manx Utilities standard domestic unit rate effective from 1 April 2026. Other tariffs, fuels and heating systems will produce different £ values, and energy prices will change. The worked example is therefore illustrative, not a forecast for a particular property.





When does a calculated saving become a real saving?

There is an important assumption behind any estimate of annual financial savings from insulation.

For a fair before-and-after comparison, we need to imagine essentially the same building being used in the same way.

If the whole house is maintained at broadly comparable temperatures by thermostatic control, for comparable periods, with occupancy and ventilation otherwise broadly unchanged, reducing fabric heat loss should reduce the energy required to maintain those conditions. In that situation, converting predicted kWh savings into an approximate financial saving is reasonably intuitive.

But many traditional homes are not heated that way.

Rooms may be heated only when occupied. Heating may operate for a few hours in the morning and evening. Some rooms may rarely be heated. Occupants may turn the heating off once the air feels warm enough, particularly when energy cost is a concern.

In those circumstances, insulation can change behaviour as well as energy consumption.

Two ways of taking the benefit

A better-insulated room may reach a comfortable condition sooner and remain comfortable for longer. The occupants may therefore turn the heating off sooner. That may increase the financial savings.

Alternatively, because the room has become easier and more pleasant to heat, the occupants may maintain a higher temperature or heat it for longer. The financial savings may then be smaller than the theoretical prediction, while the improvement in comfort is greater.

Neither outcome means that the retrofit has failed. They are different ways of taking the benefit.

Modelled kWh saved, actual kWh saved, £ saved and comfort gained are related - but they are not the same thing.

Comfort, cost - and the building itself

The purpose of retrofit is ultimately to improve the building for the people who live in it. Comfort therefore matters.

But there is an important distinction between improving the comfort of the accommodation and improving the conditions experienced by the building fabric.

Insulation can make a room warmer, raise its internal surface temperatures and reduce the energy required to maintain a chosen indoor condition. Those are genuine benefits.

Yet the effect on the original construction depends upon where and how the insulation is installed. Internal wall insulation, for example, can make the room substantially more comfortable while leaving the masonry behind it colder. External wall insulation generally has the opposite thermal effect, keeping more of the original wall within the warmer part of the construction. Occupant behaviour adds another variable.

If an insulated room reaches a comfortable air temperature sooner, the occupants may switch the heating off sooner. In a lightweight modern room that may be largely an energy-use decision. In a traditional building with substantial thermal mass, the building fabric responds much more slowly than the air.

Short periods of heating can therefore produce comfortable air temperatures while thick masonry remains comparatively cold.

Where indoor moisture is present, colder surfaces can experience higher local relative humidity and a reduced margin to dew point. Repeated intermittent heating may therefore produce a very different moisture environment from one in which the building is maintained at more stable temperatures.

We are not simply heating the air. We are heating a building.

This does not mean that every traditional building must be heated continuously, or that stable heating automatically solves a moisture problem. It means that heating pattern, fabric temperature, ventilation and moisture generation are connected.

The question is therefore not simply what the insulation does to the room. We should also ask what the resulting heating pattern does to the building.

The first increments of insulation often do the most work

There is another characteristic of insulation that is easily overlooked: the returns diminish as more insulation is added.

Imagine again that our original wall has a U-value of 1.5 W/m²K. A first intervention might reduce it to 0.6 W/m²K. A thicker system might achieve 0.3 W/m²K. Still more insulation might reduce it to 0.2 W/m²K.

Each improvement is real. But the reductions in heat transmission become progressively smaller:

1.5 → 0.6 = improvement of 0.9 W/m²K

0.6 → 0.3 = further improvement of 0.3 W/m²K

0.3 → 0.2 = further improvement of 0.1 W/m²K



The relationship is not linear because insulation adds thermal resistance, while U-value is derived from the reciprocal of total resistance.

This means the early insulation can capture a large proportion of the available thermal improvement. Successive additions still save energy - but progressively less.

Twice as much insulation does not usually mean twice the energy saving.



The marginal pound

This is where financial comparison becomes particularly revealing.

Consider the following deliberately simplified illustration. The figures are not quotations or predictions for a real property; they simply demonstrate the principle.

Option	Wall U-value	Estimated annual saving	Illustrative installed cost
Existing wall	1.50	-	-
Moderate retrofit	0.60	2,500 kWh	£8,000
Greater retrofit	0.30	3,300 kWh	£12,000
Maximum approach	0.20	3,600 kWh	£16,000

In this illustration, the first £8,000 buys an estimated 2,500 kWh/year saving. The next £4,000 buys another 800 kWh/year. The final £4,000 buys only another 300 kWh/year.

At the current standard Manx domestic electricity unit rate, those final 300 kWh would be worth about £88.50 per year if they genuinely displaced electricity otherwise purchased at 29.5p/kWh.

Would an additional £4,000 be justified to achieve that final saving?

Perhaps not. But perhaps the additional thickness is required for regulatory reasons. Perhaps grant support changes the economics. Perhaps the marginal installation cost is much smaller in reality. Perhaps it solves an important thermal bridge. Perhaps future energy prices change the calculation.

Or perhaps the extra thickness creates more complicated junctions, greater loss of internal space, additional disruption or a less favourable moisture strategy. The point is not to prescribe the answer.

Calculate the marginal benefit, not merely the final U-value

Nor should the shortest payback automatically win

There is an important counterpoint. If we judge insulation only by simple financial payback, we risk reducing another complex building decision to a single number.

Insulation can improve radiant comfort, raise internal surface temperatures, reduce cold downdraughts and make previously uncomfortable rooms more usable. Warmer surfaces may also reduce surface-condensation risk where indoor moisture is appropriately managed. Carbon reduction may be an objective in its own right.

A homeowner may therefore reasonably accept a long financial payback because the lived benefit is substantial.

Equally, the intervention with the shortest theoretical payback may not be the best option if achieving that saving creates disproportionate moisture, durability or maintenance consequences for the original construction.

The objective should not automatically be the lowest achievable U-value.
Nor should it automatically be the shortest financial payback.

6. Internal Wall Insulation

Internal wall insulation - usually abbreviated to IWI - looks deceptively simple.

The external appearance of the building can remain largely unchanged. Insulation is installed on the inside face of the external walls. The internal surfaces become warmer, rooms become easier to heat, and heat loss through the walls can be substantially reduced.

Where external wall insulation would alter an important façade, IWI can look like the obvious solution. Sometimes it is.

But there is a catch. IWI creates one of the most important building-physics changes discussed in this guide.

It makes the room warmer by placing more of the original wall on the cold side of the insulation.

Understanding what that means is fundamental to designing IWI successfully.

What happens before insulation?

Consider an uninsulated solid stone wall during winter. The inside is warm. The outside is cold.

Somewhere between those two environments, temperature gradually falls through the thickness of the masonry.

The precise profile depends upon the construction, moisture content, internal and external temperatures, surface conditions and weather.

But importantly, heat from the room is reaching the masonry. The internal portion of the wall is therefore being warmed by the building.

That heat loss is exactly what insulation seeks to reduce.

What changes when IWI is added?

Now place an effective insulation layer against the internal face.

Heat finds it much more difficult to pass from the room into the masonry. That is the point.

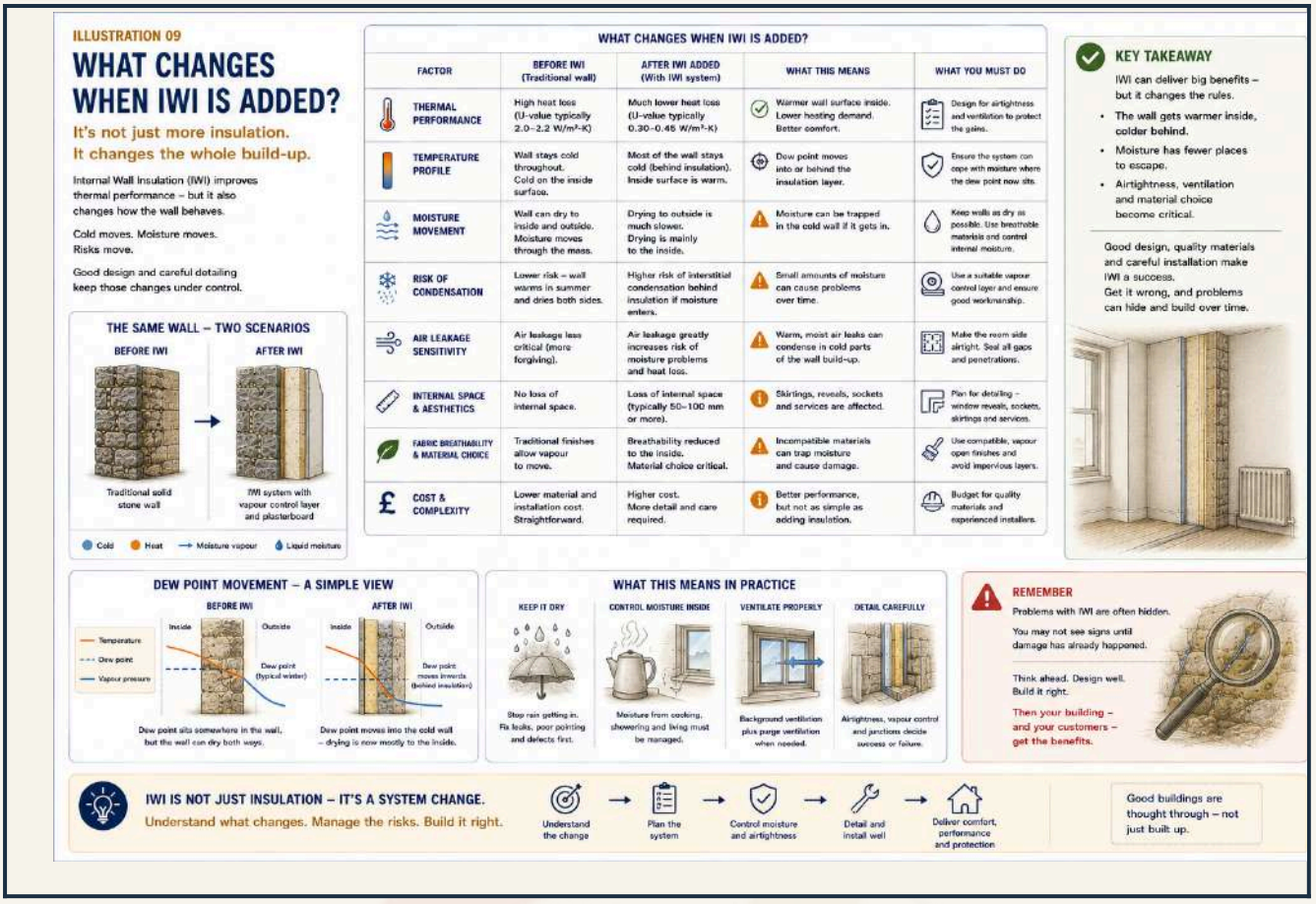
The internal face of the new insulation becomes warmer and the room requires less energy to maintain its temperature.

But because less heat is reaching the original wall, the masonry behind the insulation becomes colder. The temperature gradient has changed.

This is one of those occasions where the same physical process produces both the benefit and the risk.

IWI works because it thermally separates the room from the wall.
That also thermally separates the wall from the room.





What happens to the dew-point zone?

Readers of TC-05 - Understanding Interstitial Condensation will already be familiar with the relationship between temperature, water vapour and dew point.

Adding IWI changes the temperature profile through the wall.

The new internal lining is warmer. The original masonry behind it is colder.

Conditions at or close to the junction between insulation and masonry can therefore become much more demanding.

Warm internal air contains water vapour. If that moisture reaches sufficiently cold parts of the construction, relative humidity can rise substantially and condensation may become possible. That does not mean that IWI causes condensation.

It means that IWI changes where condensation risk may occur.

And because the critical area may now be concealed behind the finished internal surface, a problem can potentially develop without being immediately visible.

Current Historic England guidance specifically identifies the need to prevent vapour from warm internal air condensing on the cold side of IWI, against the original wall or within the insulation itself.

Vapour-open IWI - isn't that contradictory?

If water vapour reaching the colder masonry is potentially problematic, why would we deliberately install vapour-open insulation?

Why not simply install a vapour barrier and stop the moisture getting there?

The answer is that moisture in a traditional wall does not originate only from indoor water vapour.

A solid external wall may also encounter moisture from wind-driven rain, capillary absorption, ground moisture, construction moisture, leaks and defects, hygroscopic salts, and moisture already held within the masonry. But there is another important point.

A wall cannot dry without moisture moving through it.

Water vapour does not always travel from inside to outside.

Vapour diffusion is driven by differences in water-vapour pressure. Depending upon the temperature and moisture conditions inside and outside the building, the direction and strength of that vapour-pressure gradient can change.

During some conditions, the predominant vapour drive may be outward. At other times it may be weak, or potentially inward.

So moisture already held within a rain-wetted or otherwise damp wall may, when conditions favour it, migrate as vapour towards the warmer internal environment as part of the wall's drying process. That is particularly important when considering IWI.

A highly vapour-resistant internal system may reduce vapour diffusion from the room into the wall. But it may also impede vapour diffusion from the wall towards the room when conditions favour inward drying.

When considering insulation, restricting moisture movement may sound desirable. But some of that movement may be the very process by which moisture already within the wall is able to escape.

The objective is therefore not necessarily to stop moisture movement. It is to understand where moisture comes from, how it moves, where it might accumulate - and how the construction can dry.

How do we stop water vapour entering the wall?

is only half the question.

If moisture is already within the wall - or enters it later - where can it go?

Related Building Science Guides - For a fuller explanation of vapour pressure, moisture movement and interstitial condensation, see TC-01 - Understanding Moisture Movement in Traditional Buildings and TC-05 - Understanding Interstitial Condensation.

Vapour control is not the same as vapour closure

Modern IWI systems may incorporate an air and vapour control layer - AVCL.

Properly designed and installed, an AVCL can control air leakage into the construction and limit vapour diffusion. That can be entirely legitimate.

Indeed, air leakage through gaps can transport substantially more moisture into concealed cold areas than vapour diffusion through an intact material layer.

But an AVCL is not a magic membrane. Its performance depends upon continuity.

Junctions around floors, ceilings, windows, doors, electrical sockets, pipework, internal partitions, joists and fixings all have to be considered.

Historic England notes both the potential role of well-installed AVCLs and the practical vulnerability of membrane systems and their junctions.



So the debate should not be reduced to vapour barrier = bad, vapour open = good.

What moisture-control strategy is this particular system using?

Where is the wall expected to dry?

Vapour-open systems

Some IWI systems deliberately retain greater vapour permeability.

Examples can include wood-fibre systems, calcium-silicate systems, cork-based materials, lime-based insulating plasters and other capillary-active or vapour-permeable systems.

The precise properties vary considerably, so these labels should not themselves be treated as specifications.

Some systems are designed not merely to allow vapour diffusion, but also to redistribute moisture by capillary action and allow it subsequently to evaporate.

That is a more sophisticated idea than simply calling the material “breathable”.

It returns us to Chapter 3:

μ and Sd tell us about vapour diffusion. They do not tell us the whole story of moisture behaviour.

Historic England currently advises that insulation and finishes used internally should be compatible with the existing wall and should neither cause moisture accumulation nor unnecessarily hinder drying. It notes that permeable systems can reduce moisture accumulation risk, although the appropriate permeability remains building-specific.

And what about PIR-backed plasterboard?

This is particularly relevant because it is such an attractive renovation product.

A rigid insulation board bonded to plasterboard can provide high thermal resistance in relatively little thickness.

For a homeowner or contractor renovating a room, the appeal is obvious: insulation and internal lining arrive as one product; the build-up can be comparatively thin; installation is familiar; and excellent calculated U-values can be achieved without sacrificing as much internal floor area as some lower-conductivity alternatives might require. None of those advantages should be dismissed.

But on a traditional solid wall, the questions go beyond λ-value and thickness.

PIR itself is highly resistant to vapour compared with many traditional materials, and foil facings can be more resistant again. The completed system can therefore substantially change the inward drying potential of the wall.

There is also a second issue: how is the board attached?

The concealed void problem

Imagine PIR-backed plasterboard fixed to an irregular stone wall using adhesive dabs or another method that leaves intermittent voids behind the board. The finished room may look excellent.

But behind it we may have created a colder masonry surface, a concealed air space, possible pathways for warm humid room air, and local cold surfaces that can no longer be inspected.

If humid internal air reaches that concealed space through imperfect perimeter sealing, sockets, junctions or penetrations, the risk is not simply vapour diffusion through the board.

It becomes air movement carrying moisture behind the insulation. That distinction matters.



A vapour-resistant board does little to control moisture transported around its edges or through discontinuities.

The performance of an IWI system is determined by the complete installation, not merely by the insulation board.

Thermal bridges do not disappear

Insulating the broad face of a wall is relatively easy. The difficult parts are its edges.

At a window reveal, there may not be enough space for the full insulation thickness. At an intermediate timber floor, joists may disappear into the masonry. Internal partitions intersect external walls. Floors meet walls. Ceilings meet walls. Radiators, pipes, sockets and fitted furniture complicate the construction further.

If insulation stops abruptly at these locations, local temperatures can be much lower than on the newly insulated main wall.

The coldest surface in the room may simply have moved.

Historic England therefore emphasises thermal continuity around window and door reveals and wall/floor junctions as a central part of IWI design.

Insulation can remove one cold surface while making the remaining thermal bridges more important.

Embedded timbers deserve particular attention

Traditional buildings frequently contain timber joists, lintels, beams and other elements embedded within external masonry.

Before insulation, some heat from the room reaches the masonry surrounding those timbers. After IWI, those areas may become colder.

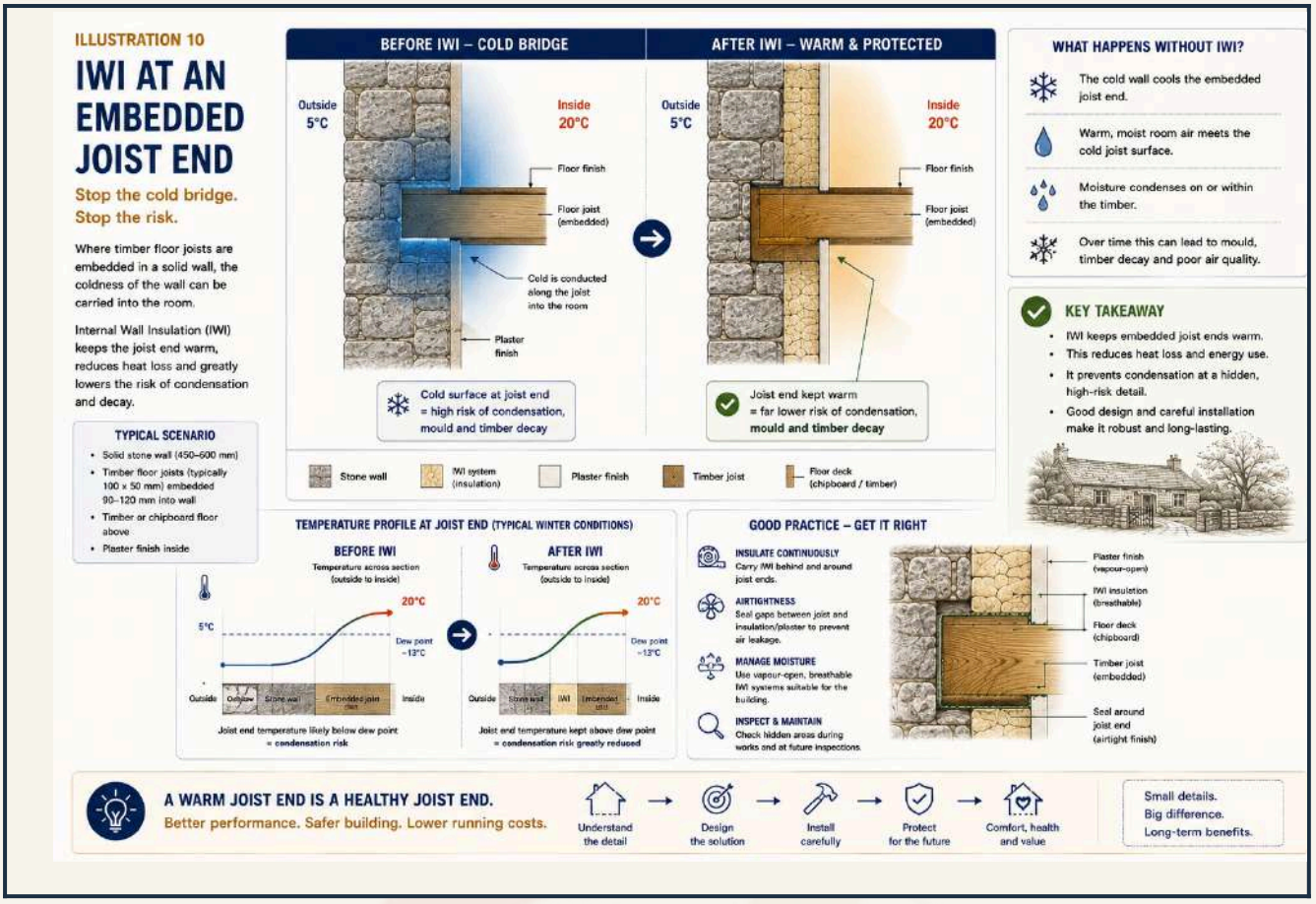
If the wall is also exposed to rain or otherwise moisture-loaded, the conditions surrounding embedded timber can therefore change.

This does not mean that IWI inevitably causes timber decay.

It means that timber moisture risk should form part of the design assessment, particularly where joist ends or other structural timbers disappear into exposed solid walls.

A beautifully insulated room is not a successful retrofit if concealed structural timber is subsequently maintained in conditions favourable to fungal decay.





Never insulate a wall because it is damp and cold

Insulation is not a treatment for a wet wall

If masonry is damp because of defective rainwater goods, failed pointing, inappropriate external coatings, leaking plumbing, high ground levels or another moisture source, that defect should be understood and addressed first.

Historic England's current guidance states that traditional walls should be in good repair and free from excess moisture before wall insulation is installed. It also notes that a wall which has remained wet for a long period may take years to dry fully. That has a particularly important implication for IWI.

Installing insulation does not reset the wall to a dry starting condition.

If a moisture-laden wall is covered internally, its future drying routes may be changed at precisely the moment when it most needs them.

So a pre-installation assessment should not merely ask: Is there visible damp?

It should ask: What is the condition of the wall, what moisture sources act upon it, and is it sufficiently dry and stable for the proposed system?

How much insulation?

This brings us directly back to Chapters 4 and 5.

If some insulation substantially improves comfort and reduces heat loss, does it necessarily follow that we should install enough to achieve the lowest technically possible U-value? Not necessarily.

Research cited in current Historic England guidance provides a particularly interesting example. DESNZ's DEEP case studies found that IWI increased moisture risk in the cases studied, even with relatively thin insulation. But the same research found that vapour-permeable systems presented lower moisture-accumulation risk, and that targeting a U-value of around 0.8 W/m²K rather than 0.3 W/m²K reduced interstitial-condensation risk while still achieving about two-thirds of the energy saving in the research scenarios.

That finding should not become a universal prescription for 0.8 W/m²K.

Different buildings, exposures, materials and systems require different solutions. But the principle is highly relevant to TC-07.

The final increment of thermal performance may not always justify the additional building-physics consequence required to achieve it.

Perhaps thinner can sometimes be smarter

This opens up an interesting middle ground.

The choice is not necessarily between no insulation and maximum insulation.

A more modest intervention might substantially raise internal surface temperatures and improve comfort while retaining more heat within the original masonry, using less internal space and potentially creating a less severe change to the wall's moisture regime. That does not make thin insulation automatically safer.

Even relatively modest IWI changes temperatures within the construction and requires proper moisture assessment and detailing.

But it reinforces the idea that retrofit should be optimised rather than maximised.

When a simple condensation check is not enough

Some insulation proposals can be assessed adequately using relatively simple calculation methods. But an exposed traditional wall may involve wind-driven rain, moisture storage, capillary transport, seasonal reversals in drying direction, variable material properties and embedded timbers. Those effects are not all represented by a simple steady-state condensation check.

For moisture-sensitive or otherwise uncertain constructions, a transient hygrothermal assessment may therefore be appropriate. BS EN 15026:2023 provides a framework for numerical simulation of heat and moisture transfer through building elements, while BS 5250:2021 adopts a broader whole-building approach to moisture-risk management.

Modelling is still only as useful as the construction, climate, material and occupancy information entered into it. It should inform judgement rather than replace it - but where the consequences of getting an IWI design wrong are significant, a more realistic moisture assessment may be considerably more useful than relying on a single dew-point calculation.

A Manx point worth knowing

Adding insulation to the inside of an existing external wall can bring the work within the Isle of Man Building Regulations framework because the external wall is a thermal element. This can include an insulated independent stud lining even where the work appears to be entirely internal. The applicable Building Control requirements should therefore be established before work begins. The extent of any required thermal upgrade depends on the nature and extent of the renovation and the tests of technical and functional feasibility and economic reasonableness.

A less aggressive option - insulating lime plasters

Internal wall insulation does not have to mean constructing a thick new lining in front of the existing wall.



Another recognised approach is insulating plaster, applied directly to the internal face of the masonry. These products are commonly lime based and may incorporate lightweight insulating constituents such as cork, hemp, perlite, aerated lime or silica-based compounds.

That places insulating lime plaster in an interesting position between ordinary internal plaster and more substantial IWI systems.

Its attraction is not necessarily that it achieves the lowest possible U-value.

It is that a comparatively modest thermal improvement may sometimes be achieved with a thinner, continuous layer that follows irregular masonry closely, improves internal surface temperature and airtightness, and can retain moisture-management characteristics that are compatible with traditional construction.

“Insulating lime plaster” describes a family of materials. It is not a thermal specification.

The word lime should not exempt a product from the same scrutiny applied elsewhere in this guide.

Different insulating plasters have different compositions, densities, thermal conductivities, vapour resistances, liquid-water behaviours and recommended application thicknesses.

So ask for the declared thermal conductivity - λ. Ask what thickness will actually be installed. From those two values, establish the thermal resistance the layer genuinely adds. Consider μ and the resulting Sd value. Understand how the product behaves when exposed to liquid moisture, what substrate it requires, how it dries, and what evidence supports its proposed use.

A material does not insulate because it is described as insulating. Its thermal conductivity and its installed thickness determine the thermal resistance it actually adds.

This is also where TC-07 deliberately avoids romanticising lime.

Lime is not being discussed here because traditional automatically means better, nor because modern insulation is automatically inappropriate.

A lime-based insulating plaster may be a very good solution for one wall and an inadequate or inappropriate solution for another.

Wet-applied systems containing natural fibres also deserve particular care where the substrate is damp or drying. Vapour openness alone does not resolve liquid-water loading, exposure or an existing moisture defect. The wall still needs to be understood first.

How far should we go?

Insulating plaster also helps expose a question that sits at the heart of this guide.

Suppose a thick high-performance IWI system produces a substantially lower calculated U-value than a thinner insulating plaster.

Thermally, the thicker system may be better. But that is not yet the whole decision.

How much additional energy does the extra improvement realistically save? How much more room area is lost? How much colder does the original masonry become? How much more difficult are window, floor and ceiling junctions? How much historic fabric is disturbed? How much does the intervention cost? And what additional moisture-management demands are introduced?

Research into IWI in traditional buildings supports the importance of this proportionality. More modest thermal targets can retain a substantial proportion of the achievable energy saving while reducing some of the hygrothermal risk associated with more aggressive insulation.



A lower final U-value is not automatically evidence of a better IWI design.

If a more modest intervention delivers much of the useful energy saving, raises internal surface temperature enough to improve comfort and condensation resilience, and imposes less change on the existing wall, it may represent the better whole-building outcome.

That does not make insulating lime plaster the answer.

It makes it one of the options worth properly evaluating.



What about party walls?

Party walls deserve separate consideration within an IWI strategy.

Unlike an external wall, a party wall commonly separates two occupied internal environments. Both sides can therefore influence its temperature and moisture behaviour.

The adjoining dwelling may be warmer or colder. It may be continuously or intermittently heated. Its occupants may generate substantially more or less water vapour. Ventilation arrangements may differ. And those conditions can change independently of anything happening within your own property.

A party wall can be exposed to two independently changing occupational moisture environments at the same time.

That matters not only when designing retrofit, but during later damp investigation. Conditions measured in one dwelling do not necessarily describe the environment acting on the other face of the shared masonry.

The conditions on the inaccessible side may therefore be a genuine unknown variable. There is also a more basic thermal question.

Where similarly heated accommodation exists on both sides, the temperature difference across a party wall may be relatively small and the potential energy saving from insulating it may therefore be very different from insulating an external wall.

If the adjoining property is vacant, substantially colder or intermittently heated, the calculation may change.

Party walls can also enter an external-wall IWI project indirectly. Insulation may need to return for a short distance along a party wall or other internal wall to reduce thermal bridging where it meets the newly insulated external wall.

Any such detail should also consider fire separation, acoustic performance, concealed chimneys or flues, historic moisture or salt problems, and the actual construction of the shared wall.

Neighbour communication

The Isle of Man does not have the same statutory Party Wall etc. Act procedure that applies in England and Wales. That should not be interpreted as meaning that work involving shared construction can have no legal or practical implications.

Ownership, title conditions, access, Building Control requirements and the precise nature of the work may still need consideration.

Quite apart from formal requirements, early communication with the adjoining owner is good practice where proposed work materially affects a shared wall.

Explaining what is proposed may reveal information that would otherwise be unavailable: a history of dampness, a concealed flue, previous alterations, or different conditions on the adjoining side.

Recording the pre-existing condition of the wall before work begins can also be sensible.

Shared does not automatically mean heat-losing - and heat-losing does not automatically mean worth insulating.

Do not assume the boundary of the property is also the boundary of the building science.



7. External Wall Insulation

External wall insulation - EWI - changes the same wall in almost the opposite way to IWI.

Instead of placing insulation between the room and the original wall, insulation is installed outside the masonry. That difference has profound consequences.

With IWI, the room becomes warmer while the original wall generally becomes colder.

With EWI, more of the original wall remains within the insulated envelope.

The masonry can therefore remain warmer. Its thermal mass remains more closely connected to the internal environment. Thermal bridges at intermediate floors and internal wall junctions can sometimes be treated more continuously. And the external insulation can provide another layer of protection between the original wall and the weather. Thermally, there is a great deal to like.

If IWI puts the traditional wall outside the thermal envelope, EWI can bring it inside.

That sounds attractive. But it is not the end of the story.

Because EWI also does something else:

It covers the outside face of the existing building.

For a traditional wall whose long-term survival depends partly upon managing, releasing and revealing moisture, that deserves careful thought.

Moving the temperature profile outwards

Consider again our uninsulated solid wall.

During winter, temperature falls progressively between the warm internal environment and the colder exterior.

With IWI, much of that temperature drop occurs before heat reaches the original masonry. With EWI, the opposite happens.

Heat from the building can continue to warm the masonry relatively easily, while the insulation resists its passage onwards to the external environment.

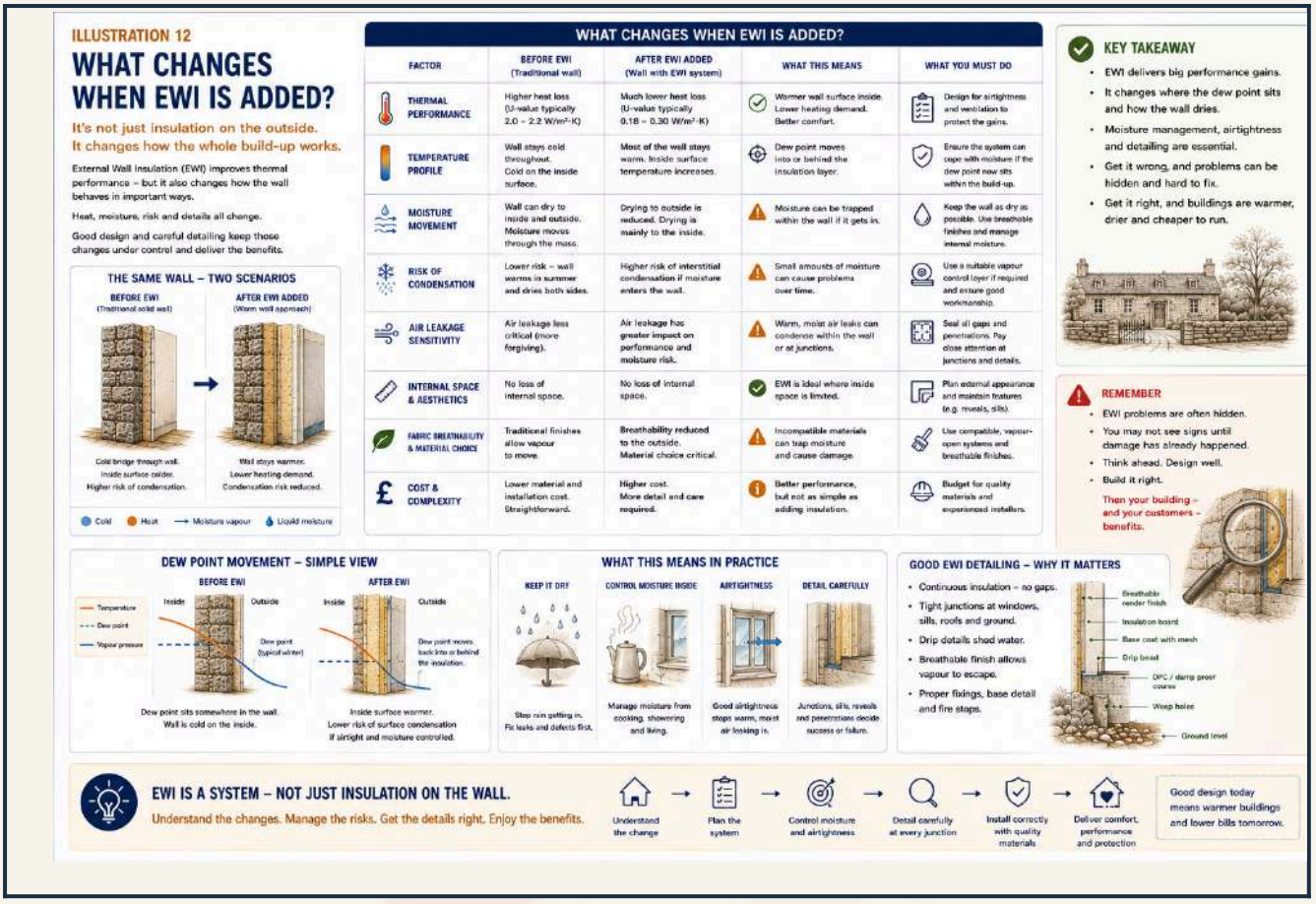
The substantial temperature drop therefore occurs principally within the external insulation layer.

In simple terms, EWI pushes the colder part of the construction outwards. This is one of its greatest building-physics advantages.

The masonry is warmer. Internal surface temperatures rise. Many structural junctions remain warmer. And the risk associated with very cold masonry behind an internal insulation layer can be reduced.

This is why EWI is often considered a technically attractive way of insulating solid masonry where the building's appearance and detailing allow it. Historic England describes it as a potentially robust option when carefully selected, detailed and installed.





Thermal mass remains useful

EWI also connects directly with the thermal-mass discussion in Chapter 4.

With the insulation outside the masonry, heat from the room can still enter the wall relatively readily.

The wall can warm and participate in the thermal behaviour of the internal environment.

Once warmed, that mass can help moderate changes in internal temperature.

Again, this does not make masonry itself an insulator.

But it means that EWI can combine greater thermal resistance outside with substantial thermal mass inside the insulated envelope.

For a thick traditional wall, that is an attractive combination.

Historic England similarly notes the potential for EWI on solid walls to retain beneficial hygrothermal buffering and help regulate internal temperatures.

So is EWI the obvious answer?

Not necessarily.

The thermal diagram tells us what happens to heat.

It doesn't tell us everything that happens to moisture.

And this is where TC-07 needs to return to the lesson from the previous chapter:



A wall cannot dry without moisture moving through it

A traditional external wall does not exist in laboratory conditions.

It gets wet. Rain strikes it. Wind drives rain against it. Gutters occasionally overflow. Sealants fail. Flashings age. Cracks develop. Ground conditions change. Pipes leak. Moisture may already be present within the wall before retrofit begins.

The question is therefore not simply whether EWI can prevent some future rain from reaching the masonry.

We must also ask:

What happens to moisture if it gets behind the system - or is already there when we install it?

A raincoat is only useful if the rain stays outside it

EWI is sometimes intuitively imagined as putting a protective coat around the building. That analogy has some merit.

A correctly designed external system can reduce direct weather exposure of the original wall. But buildings are more complicated than raincoats.

The new external surface contains junctions: windows, doors, eaves, verges, cills, pipes, cables, vents, meter boxes, balconies, canopies and ground-level interfaces.

Every penetration or termination has to manage water successfully.

If rain gets behind the insulation, the important question becomes whether the system can drain and dry.

A system that is excellent at preventing moisture movement through its broad surface may become much less forgiving if water enters through one defective junction and cannot readily escape.

This is why EWI design cannot be judged simply by looking at the insulation board.

The weather resistance of the whole system is only as good as its details.

What about “external ventilation”?

A traditional solid wall does not generally require ventilation across its external surface in the same sense that a roof void or suspended timber floor requires deliberate airflow.

What it does require is an appropriate ability to manage wetting and drying.

Those are related ideas, but they are not identical.

Wind passing over an exposed vapour-open wall assists evaporation from its surface. Sun and warmer weather do the same. Traditional lime renders and limewash can help manage rain while still permitting drying.

Once EWI is installed, that original external masonry surface is no longer directly exposed to those drying conditions. That is not automatically a problem.

Indeed, a correctly designed EWI system may substantially reduce how much rain reaches the masonry in the first place. But the wall's drying environment has changed.

Not “Have we stopped the wall being ventilated?” but “How have we changed its wetting and drying cycle?”

Historic England's current guidance takes essentially this approach: EWI materials and finishes should not cause moisture accumulation or hinder drying, and protection against rain should not be achieved by trapping liquid water or vapour within the wall.



Vapour-open EWI

For traditional masonry, vapour-permeable external insulation systems can offer an attractive strategy.

Depending upon the system, these may incorporate materials such as wood fibre, mineral insulation, cork, lime-based insulating render or other vapour-permeable products. Again, the material name is not enough.

We need the actual properties of the complete system: insulation, adhesive or fixing method, base coat, reinforcement, finish coat, and paint or decorative finish.

One highly vapour-resistant layer can substantially alter the behaviour of an otherwise permeable build-up.

And, as Chapter 3 established, vapour permeability is only one moisture property.

Capillary behaviour, liquid-water absorption, drainage and drying remain relevant too.

Historic England's current advice generally favours compatible permeable insulation and finishes for traditional construction and says modern closed-cell foam and other plastic-based insulation would ordinarily be incompatible in this application.

But what was behind it before we started?

Imagine a solid Manx wall that looks reasonably serviceable from inside. But within its thickness it contains elevated moisture.

Perhaps there has been years of wind-driven rain. Perhaps cement render has restricted drying. Perhaps a gutter leaked for months before being repaired. Perhaps there is a plumbing defect. Perhaps the wall has recently been repointed or rendered and contains construction moisture. Perhaps the moisture is simply the legacy of a defect that has now been corrected. Then EWI is installed.

The external conditions experienced by that wall change dramatically.

So before covering it, we should ask:

Do we know what condition the wall is actually in?

Historic England is explicit that existing walls should be in good repair and free from excess moisture before wall insulation is installed, and notes that a wall which has remained wet for a long time can take years to dry. That makes pre-installation moisture assessment highly relevant.

Not because every traditional wall must somehow be proved completely dry - moisture exists naturally within porous masonry.

But because there is an enormous difference between normal moisture equilibrium and a wall carrying excess moisture because something is wrong.

Covering the latter with insulation before understanding the cause is a very different proposition.

Making a wall harder to inspect does not make its defects disappear.

This is perhaps the aspect of EWI that concerns Tree Cassyn most from an investigative perspective.

Before retrofit, a crack may be visible. Failed pointing may be visible. A damp patch may correspond with an obvious external defect. Movement may reveal itself through masonry or render. Weathering patterns can provide clues.

The external surface tells us something about what the building is experiencing.

After EWI, much of that original surface is concealed.

That is not an argument against EWI. Many perfectly successful construction systems conceal the materials behind them.



But it increases the importance of getting the pre-installation diagnosis right.

The time to understand the wall is before we cover it.

Maintenance has not disappeared either

A newly rendered EWI façade can look almost maintenance-free.

It isn't. The system still depends upon successful weather detailing.

Sealants around openings age. Render can crack. Impact damage can occur. Flashings can fail. Cills and copings can become defective. Rainwater goods can leak. Biological growth may develop on some finishes. Services may subsequently be fixed through the system.

If water begins to enter behind EWI, identifying the route may be considerably more difficult than identifying a defect on an exposed masonry wall.

So the maintenance question changes from: How do I maintain my old wall? to: How do I maintain the new system that is now protecting my old wall?

That obligation lasts for as long as the insulation remains in place.

Details become architecture

EWI also changes the physical dimensions of a building.

A relatively thick layer is being added to its exterior. That sounds obvious, but the consequences multiply quickly.

Window openings become deeper. Cills may no longer project far enough. Roof overhangs may become inadequate. Verges need consideration. Downpipes move. External taps and services move. Vents need extending. Door thresholds change. Plinth details need redesigning. Roof-to-wall junctions may need modification.

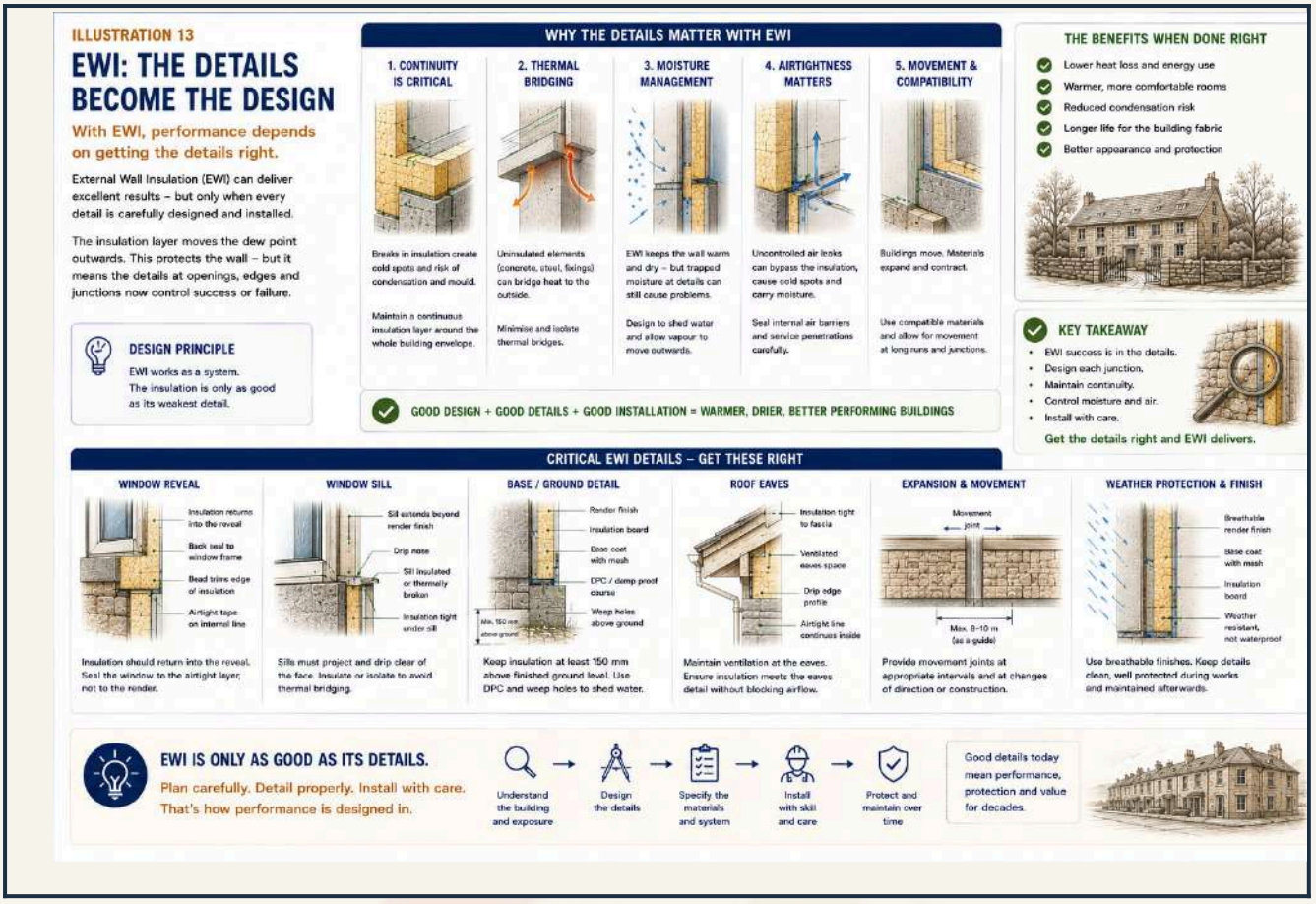
Historic England specifically highlights these physical adaptations and the need to preserve rain-shedding details when installing EWI. These are not cosmetic inconveniences.

A cill that no longer throws rain clear of the façade is a moisture detail. An inadequate eaves projection is a moisture detail.

A poorly terminated insulation system at ground level is a moisture detail.

The architectural detailing and the building physics become the same problem.





And what happens at the bottom?

The base of an EWI system deserves particular attention. Traditional solid walls often meet complicated ground conditions.

External paving may have been raised. Ground levels may differ around the building. A concrete floor may have replaced an earlier suspended floor. There may be no conventional damp-proof course. The wall may rely upon evaporation through its lower surfaces as part of its moisture balance.

So simply carrying an external insulation system down towards ground level without understanding that junction can alter both temperature and drying behaviour.

Splashback, capillary moisture, drainage and the durability of the insulation system itself all need consideration.

There is no universal detail that can be copied onto every traditional building.

The exposed Manx building

This issue has particular resonance on the Isle of Man.

The Island's maritime climate and frequent exposure to wind-driven rain mean that the external envelope of a building can experience demanding conditions.

A sheltered Douglas terrace and an exposed rural property overlooking the coast may both have solid masonry walls.

That does not mean their elevations experience the same moisture load.

Orientation matters. Exposure matters. Topography matters. Shelter matters. Condition matters. Detailing matters.

BS 8104:1992 provides a recognised technical framework for assessing the exposure of walls to wind-driven rain, including the influence of local climate and topography. It is not a substitute for site-specific inspection, but it reinforces why orientation and exposure should form part of the retrofit assessment rather than being treated as background information.

So an EWI system should not merely be specified for “a solid stone house.”

It is being specified for this solid stone house, on this site, facing this weather.

Current Historic England guidance similarly identifies exposure, construction, wall condition and context as factors in determining whether solid-wall insulation is suitable.

What happens if the building floods?

There is another consideration that may be easy to overlook.

Floodwater can introduce a very large moisture load into traditional masonry.

A conventional uninsulated permeable wall may be capable of drying after the event, albeit sometimes slowly. Insulation changes that recovery process.

Historic England's current flood guidance cautions against insulation in traditional buildings at flood risk unless the materials can be removed before flooding, because some insulation systems can substantially lengthen drying and may subsequently require replacement. For most homeowners this may never be relevant.

For a property in an identified flood-risk location, it deserves to form part of the retrofit decision before insulation is installed.

EWI and fire safety

External insulation also has a safety dimension quite separate from moisture.

The Grenfell Tower fire fundamentally changed the regulatory and professional scrutiny applied to external wall systems in the UK.

TC-07 does not need to become a fire-safety guide, and the requirements applying to a high-rise residential building are not directly transferable to a traditional Manx house.

But the broader lesson is relevant:

An external wall system is a system - not merely an insulation material.

Insulation, cavity barriers where applicable, fixings, render or cladding, membranes, openings and junctions all form part of its performance.

Fire classification and compliance should therefore be established for the proposed system and building, rather than inferred from an isolated product claim.

For Isle of Man work, the applicable Building Regulations and Building Control requirements should be confirmed for the particular project.

8. Cavity Wall Insulation - Filling a Space That Had a Purpose

So far, most of our attention has been on solid walls. A cavity wall asks a different question.

But many Isle of Man homes - including later extensions to older properties - are built with cavity walls. These behave differently.

A cavity wall was deliberately built with a separation between its outer and inner leaves. That gap is not simply unused space waiting for insulation. It has a job.

Before filling it, we need to understand what that job is.

What does a cavity actually do?

In a conventional masonry cavity wall, the outer leaf is the first line of defence against the weather.

But it is not necessarily expected to remain completely dry.

Under sufficiently severe exposure, particularly during wind-driven rain, moisture can penetrate through the outer masonry.

The cavity provides separation between that wetted outer leaf and the inner construction.

Water reaching the cavity side of the outer leaf can drain downwards, while the physical gap helps prevent moisture crossing directly to the inner leaf.

The cavity therefore contributes to both weather resistance and moisture separation.

This is fundamentally different from a traditional solid wall, where moisture may be absorbed into the masonry and subsequently redistributed and released as conditions change.

With a cavity wall, part of the moisture-management strategy is simply:

Keep the wet outer wall away from the dry inner wall.

Then why fill it?

Because an empty cavity can also represent an opportunity to reduce heat loss.

Retrospective cavity wall insulation - CWI - can often be installed with relatively little disruption.

Small holes are drilled through the external wall. Insulation is injected or blown into the cavity. The holes are made good.

No substantial internal floor area is lost. The external appearance changes very little. And the thermal performance of the wall can improve significantly.

Compared with major IWI or EWI, the proposition can look extremely attractive.

And in an appropriate building, properly assessed and correctly installed, it can be. The important words are: appropriate building.

Filling the separation

Once insulation occupies the cavity, the wall is no longer exactly the construction it was before. Material now exists between the two masonry leaves.

That does not automatically create a moisture bridge. Cavity insulation systems are specifically designed and tested for their intended application.

But it means that the performance of the wall now depends partly upon the behaviour of the insulation within a space that previously provided physical separation.



So we need to ask: What happens when the outer leaf gets wet?

How resistant is the insulation to liquid-water transfer? Can moisture drain? Does the insulation remain evenly distributed? Are there voids? Can it slump or settle? What happens around wall ties, mortar projections and debris?

And crucially: how exposed is the building to wind-driven rain?

The Isle of Man question

This last question is particularly difficult to ignore on the Isle of Man.

The Island is surrounded by sea. Its climate is maritime. Many buildings occupy exposed coastal, elevated or open locations.

Wind-driven rain is not an unusual design scenario confined to a handful of exceptional properties. For some Manx buildings it is simply part of normal weather exposure.

That does not allow us to conclude that retrospective cavity insulation is unsuitable everywhere on the Island.

But it does mean that exposure should be assessed rather than assumed.

A sheltered urban elevation may experience very different conditions from a west-facing wall on an exposed hillside.

A cavity-insulation proposal should therefore relate to:

this wall, on this elevation, on this building, in this location - not simply "this house has a cavity."

The question is not whether rain can reach the outer wall. We should assume that, in sufficiently severe conditions, it can.

The more useful question is: What prevents that moisture reaching the inside?

Before retrofit, one answer may be the cavity itself.

After retrofit, the answer depends upon the performance of the entire altered wall construction. That distinction matters.

The cavity may already contain bridges

Real cavity walls are rarely perfect laboratory specimens.

Mortar can fall onto wall ties during construction. Debris may collect at the base. Mortar projections can extend into the cavity. Wall ties themselves cross it. Window and door openings create complicated junctions. Later alterations may introduce further bridges. This matters before insulation is installed.

If the cavity already contains debris or local bridging, injected insulation may interact with those defects rather than somehow correcting them.

A pre-installation assessment should therefore establish more than simply the width of the cavity.

Where appropriate, borescope inspection can help determine what is actually inside it.

You cannot assess the suitability of a cavity properly if you do not know what condition the cavity is in.

Why can dampness appear in apparently random patches?

This is a pattern that can be particularly confusing to homeowners.

A wall may have been dry internally for years. Cavity insulation is installed. Later, apparently isolated areas of dampness develop internally.



They may not correspond neatly with ground level, plumbing or an obvious external defect.

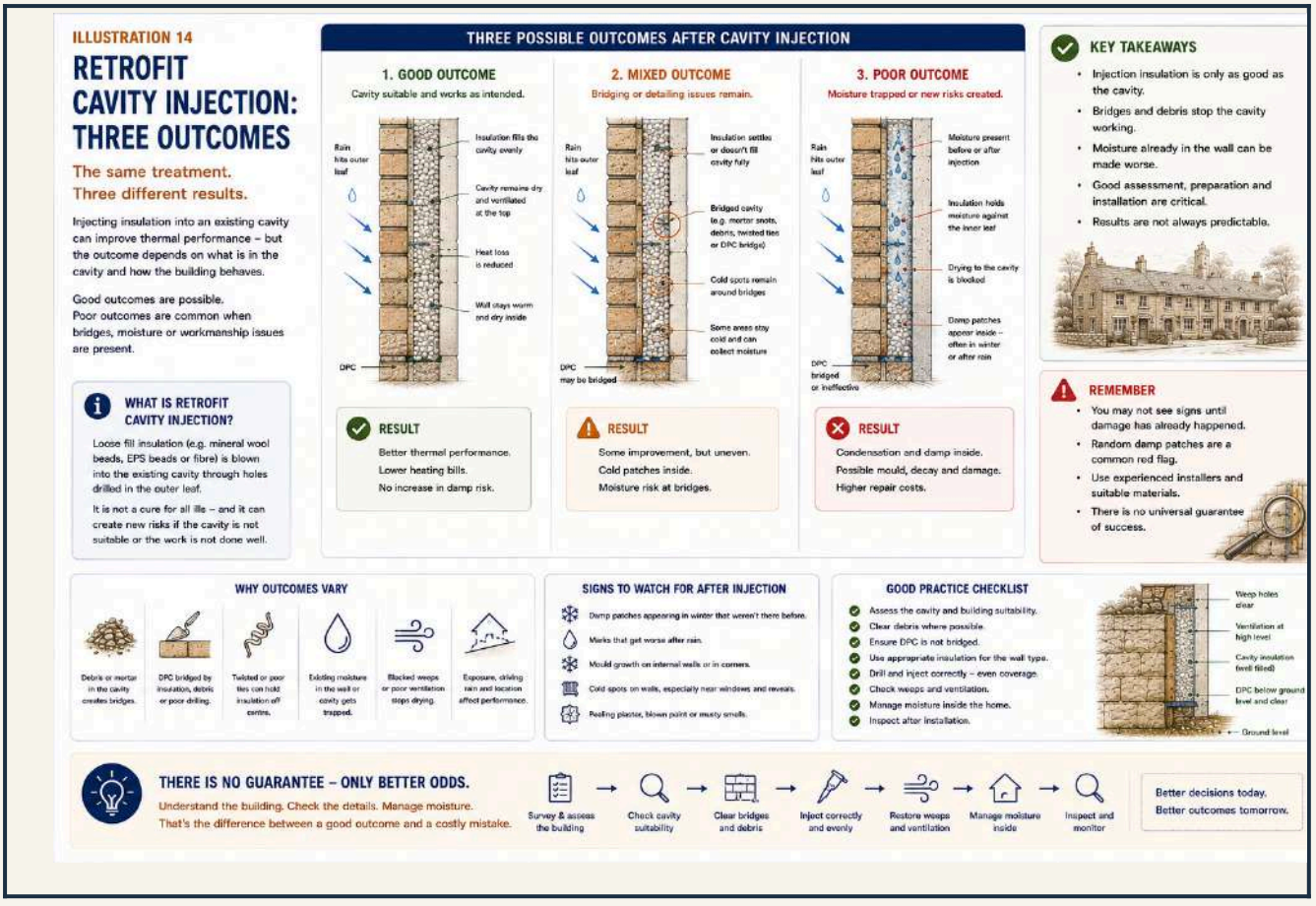
One possible mechanism is localised moisture transfer across the cavity.

If insulation becomes locally wet, is poorly distributed, interacts with existing debris or provides a route associated with another bridge, moisture behaviour can differ from one part of the wall to another.

The resulting internal pattern may therefore appear scattered rather than uniform.

That does not mean every random damp patch in an insulated cavity wall was caused by the insulation. The diagnosis still needs evidence.

But the presence, condition and distribution of retrospective cavity insulation become relevant parts of the investigation.



Installation quality matters

Injected insulation is largely concealed.

Once installed, the homeowner cannot simply look at the wall and see whether the cavity has been filled uniformly.

The success of the intervention therefore depends heavily upon the pre-installation survey, drilling pattern, installation method, suitability of the material, condition and width of the cavity, treatment of openings and junctions, and competence of the installer.

A perfectly suitable insulation material can still form part of an unsuccessful retrofit if the building was unsuitable or the installation defective.

Product performance and installed performance are not necessarily the same thing.



What about existing dampness?

Do not use insulation to conceal an unresolved moisture problem.

Before retrospective CWI is installed, defects that could introduce abnormal moisture into the wall should be identified and addressed.

That includes obvious issues such as defective gutters and downpipes, failed masonry or pointing, cracked render, poor window details and other sources of penetrating water.

The condition of the outer leaf matters because the insulation will subsequently sit immediately behind it.

understand → repair → assess → insulate

Building Control matters

There is also a regulatory point that homeowners - and purchasers - may not appreciate.

The Isle of Man Building Regulations expressly include the insertion of insulation material into a cavity wall within the definition of building work.

So retrospective cavity wall insulation should not be treated as an informal home improvement merely because most of the work disappears from view once completed.

The applicable Building Control process should be established before work begins.

That matters for the original homeowner. But it can become particularly important years later during a pre-purchase survey.

If retrospective cavity insulation is identified, sensible questions include: When was it installed? Who installed it? What system was used? Was the property assessed as suitable? What documentation or guarantee exists? Was the required Building Control process followed?

A small series of filled drill holes in an external wall can therefore tell a much bigger story.

And what if someone wants it removed?

Cavity insulation can sometimes be extracted.

That may be considered where the material has become wet, installation has been defective, significant bridging is suspected, or the building is otherwise considered unsuitable for the system.

But removal should not be regarded as simply returning the wall to its original condition.

Extraction involves intervention in the wall again. The reason for failure needs to be understood. The cavity may need inspection and cleaning. The condition of wall ties and masonry may require consideration. Any moisture-loaded fabric needs an opportunity to dry.

The regulatory position should again be checked with Building Control rather than assumed.

Removing an insulation system does not remove the need to diagnose why it became problematic.

A useful pre-purchase clue

For a purchaser, retrospective cavity insulation deserves neither automatic alarm nor automatic reassurance. Its presence is simply information.

It tells us that the thermal and moisture behaviour of the original wall has been altered.



The useful response is therefore investigative: What was installed? When? Why? Was the building suitable? What is the exposure? What condition is the outer wall in now? Is there any evidence of moisture transfer? And is there documentary evidence for the work?

This is exactly the kind of intervention that can disappear from view while remaining highly relevant to how the building behaves.

9. Insulation Beyond Walls - Roofs and Loft Spaces

Walls tend to dominate retrofit conversations. But they are only part of the heat-loss story.

But heat does not only leave a building through its walls.

For many houses, improving insulation at ceiling or roof level can be one of the simplest and most cost-effective ways of reducing heat loss. SPAB describes loft insulation above ceilings as frequently one of the easiest and most cost-effective energy-saving measures in an old building, while Historic England similarly identifies ceiling-level insulation as an intervention that can often be undertaken relatively cheaply and without substantial alteration to historic fabric.

That can make the loft an obvious place to start.

But here is the easily missed consequence:

If we keep more heat in the rooms below, less heat reaches the roof space above.

The insulation may be doing exactly what we want. But the environment on the other side of it has changed.

Where should the thermal envelope be?

Before choosing roof insulation, there is a deceptively simple question:

What part of the building are we actually trying to keep warm?

If the loft is an uninhabited roof void used only for storage, there is usually little reason to heat it.

The logical thermal boundary is therefore often the ceiling of the accommodation below.

Insulation can be laid between and above the ceiling joists, leaving the roof space outside the heated envelope. This is conventionally called a cold roof.

If the roof space contains habitable rooms, however, the thermal boundary may need to follow the roof slopes instead.

Insulation may then be installed above, between or below the rafters, or using a combination of these positions.

That sounds like a construction detail. In reality, it determines which parts of the building are warm, which are cold - and where moisture risks may develop.

Ceiling-level insulation

For a conventional unused loft, insulation at ceiling level has several attractions.

It concentrates the insulation close to the accommodation we actually want to heat. It can often be installed relatively easily. It usually remains accessible for inspection or alteration. The roof structure itself can remain visible. And high levels of roof-space ventilation can usually be retained.

But something important has happened. The loft has become colder.

A colder loft is often evidence that the insulation is working.

Before the insulation upgrade, some heat from the accommodation below escaped through the ceiling and warmed the roof void.

Increase the thermal resistance at ceiling level and less heat gets through.

The rooms below retain more heat. The loft above receives less. That changes the previous equilibrium.

And this is where a perfectly sensible energy-efficiency intervention can have an unintended moisture consequence.



Better insulation changes the equilibrium

A roof space that had existed for decades without obvious condensation may have been benefiting - unintentionally - from heat escaping from below.

Reduce that heat loss and surfaces within the loft can become colder.

The amount of water vapour that reaches the roof may not necessarily have increased. But its environment has changed.

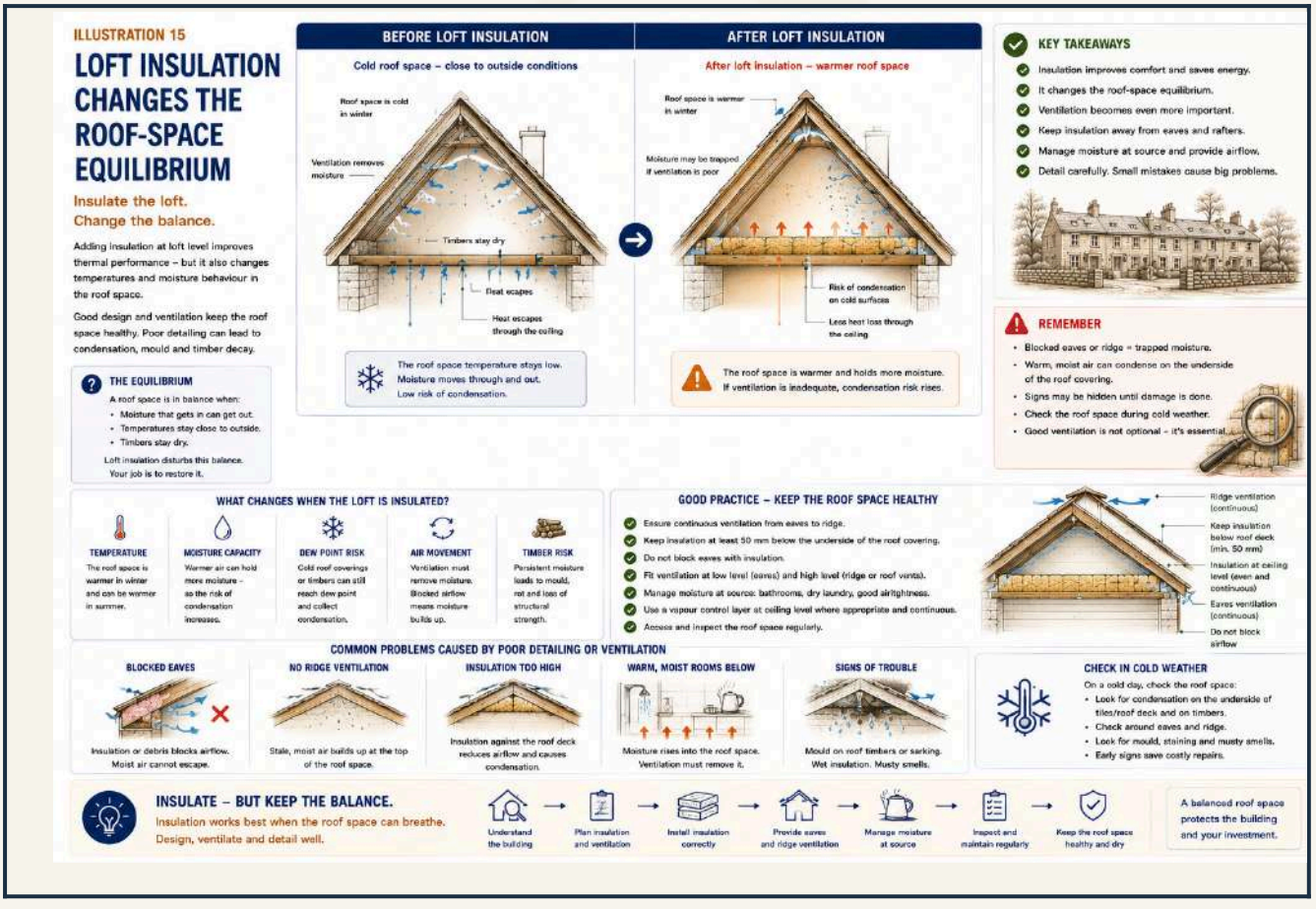
Moist air entering the loft can now encounter colder roofing underlays, slates, fixings and timbers.

As those surfaces become colder, the relative humidity of the air immediately around them rises. If a surface reaches dew-point temperature, condensation can occur.

Persistent moisture can then lead to secondary problems: mould growth, wet insulation, corrosion of metal fixings and, where timber remains sufficiently damp for sufficiently long, conditions capable of supporting fungal decay.

So the question is not simply: Does this loft have enough insulation?

Has moisture management been adapted to suit the colder environment that better insulation creates?



So just add more ventilation?

Not quite.

Ventilation is extremely important in many conventional cold roof constructions.

But simply saying “roofs need ventilation” misses half of the moisture story.

There are two things to consider:

How does moisture get into the roof space?

and How does moisture leave it?

Warm internal air can contain substantial quantities of water vapour.

Gaps around loft hatches, pipes, cables, recessed lights and other ceiling penetrations can allow warm moisture-laden air to move from the accommodation into the colder loft.

This is air leakage, rather than simply vapour diffusion through the ceiling materials.

The objective becomes:

Keep heat below the insulation.
Limit uncontrolled moisture-laden air leakage from below.
Provide the deliberate ventilation required above.

Those measures are complementary, not contradictory.

Don't block the very ventilation you now need

There is a particularly common practical mistake. More insulation is installed at ceiling level.

The new material is carried right into the eaves.

And in doing so, the installer obstructs the ventilation route into the roof space.

The insulation has therefore simultaneously made the loft colder and reduced its ability to remove moisture.

That is precisely the opposite of what we want.

Where the roof construction requires ventilation at the eaves, the ventilation pathway must remain effective after insulation is installed.

This is another example of why retrofit must consider the complete construction, rather than simply adding more insulation material.

What about “breathable” roofing membranes?

Modern vapour-permeable roofing underlays can change the ventilation strategy required by a roof.

But the word breathable should not be treated as permission to ignore ventilation altogether.

The performance depends upon the particular membrane, roof covering, construction, exposure and manufacturer's requirements.

Existing roofs also frequently contain older bituminous or other relatively vapour-resistant underlays.

So again:

Identify the construction before deciding what it needs.

The forgotten consequences: tanks and pipes

If the loft becomes colder after insulation is improved, everything within that loft experiences the colder conditions too.

That includes water tanks, pipework, ducts and other services. Their risk of freezing can therefore increase.



This may seem peripheral to a moisture guide. It isn't.

A frozen and subsequently burst pipe can introduce considerably more moisture into a building than the condensation problem we were trying to avoid.

What if the roof space is occupied?

The situation changes when rooms extend into the roof.

We can no longer simply insulate the horizontal ceiling beneath the entire roof void because part of the roof is now part of the accommodation.

The insulation may therefore need to follow the roof slopes.

That can mean insulation between rafters, below rafters, above rafters or in a designed combination.

Each arrangement changes the thermal and moisture behaviour of the roof differently.

Ventilation paths may need to be maintained. An air and vapour control strategy may be required. Rooflights, dormers, purlins and other junctions interrupt otherwise straightforward insulation layers.

And the available depth between rafters can tempt installers towards high-performance rigid boards fitted tightly into relatively shallow spaces.

“Just put PIR between the rafters”

PIR can provide comparatively substantial thermal resistance within a relatively small thickness.

That makes it attractive where rafter depth is limited.

Again, the material itself is not automatically the problem.

The questions are about the construction created around it.

Has the required ventilation path been maintained? How are gaps around irregular rafters treated? Where is the air-control layer? What is the vapour-control strategy? What happens at purlins? What happens at eaves? How does the roof connect with wall insulation? What happens around rooflights? Can the structural timber still be inspected? And what roofing underlay exists above?

A specification that consists simply of “100 mm PIR between rafters” does not answer those questions.

Spray foam insulation

Spray polyurethane foam - **SPF** - deserves separate consideration because it is increasingly encountered during inspections of existing roofs.

Applied directly to the underside of a roof, it can create a continuous insulation layer around irregular construction. That characteristic can look extremely attractive.

But retrospective spray foam is not simply another way of fitting insulation between rafters.

Guidance published by RICS and the PCA treats retrospective SPF as an intervention requiring careful assessment of the existing roof, moisture conditions, ventilation and the consequences for future inspection.

The PCA's inspection guidance reflects experience of roofs where sprayed foam has left timbers at increased risk of moisture damage. The presence of SPF is therefore something to assess, not a diagnosis in itself.

Open-cell and closed-cell foam

Not all spray foams behave identically.



Open-cell and closed-cell products differ in density, thermal properties, vapour resistance and other characteristics. That distinction matters.

But it should not distract us from the more fundamental question:

Is this particular product, installed in this particular roof build-up, appropriate?

Simply describing foam as open-cell, closed-cell, breathable or vapour-permeable does not establish that the completed roof construction is moisture-safe. Again, we need the system rather than the adjective.

What was the roof like before it was sprayed?

This may be the most important spray-foam question of all.

Was the roof watertight? Were the timbers dry? Was there existing decay? What underlay was present? How was the roof ventilated? Was ceiling-level insulation already installed? Was that insulation removed? How was condensation risk assessed?

RICS and PCA guidance both reinforce the importance of understanding the roof construction, its condition and moisture risks rather than judging the foam in isolation.

So, once again:

Insulation is not a repair for a defective roof.

A Manx point worth knowing

Retrospectively insulating a roof - including applying spray polyurethane foam at rafter level - can constitute renovation of a thermal element under the Isle of Man Building Regulations.

The fact that the insulation is installed entirely inside an existing roof space does not necessarily put the work outside Building Control.

This is particularly important where the thermal envelope is moved from ceiling level to roof level, because the intervention can fundamentally change the thermal and moisture behaviour of the roof.

The applicable Building Control requirements should therefore be established before work begins.

Where SPF is encountered during a pre-purchase survey, it can be appropriate to ask not only for the product specification, installation documentation, condensation-risk assessment and guarantee, but also for evidence of the relevant Building Control process.

The inspection problem

There is another issue of particular relevance during building surveys.

Spray foam can conceal the surfaces to which it has been applied.

Rafters may become partly obscured. Roofing underlay may disappear from view. The underside of slates or tiles may become inaccessible. Junctions may be hidden. Evidence of historic or ongoing water penetration may become more difficult to interpret.

And depending upon the installation, removing the foam to inspect what lies behind it may itself damage materials.

This does not prove that concealed timber is decayed.

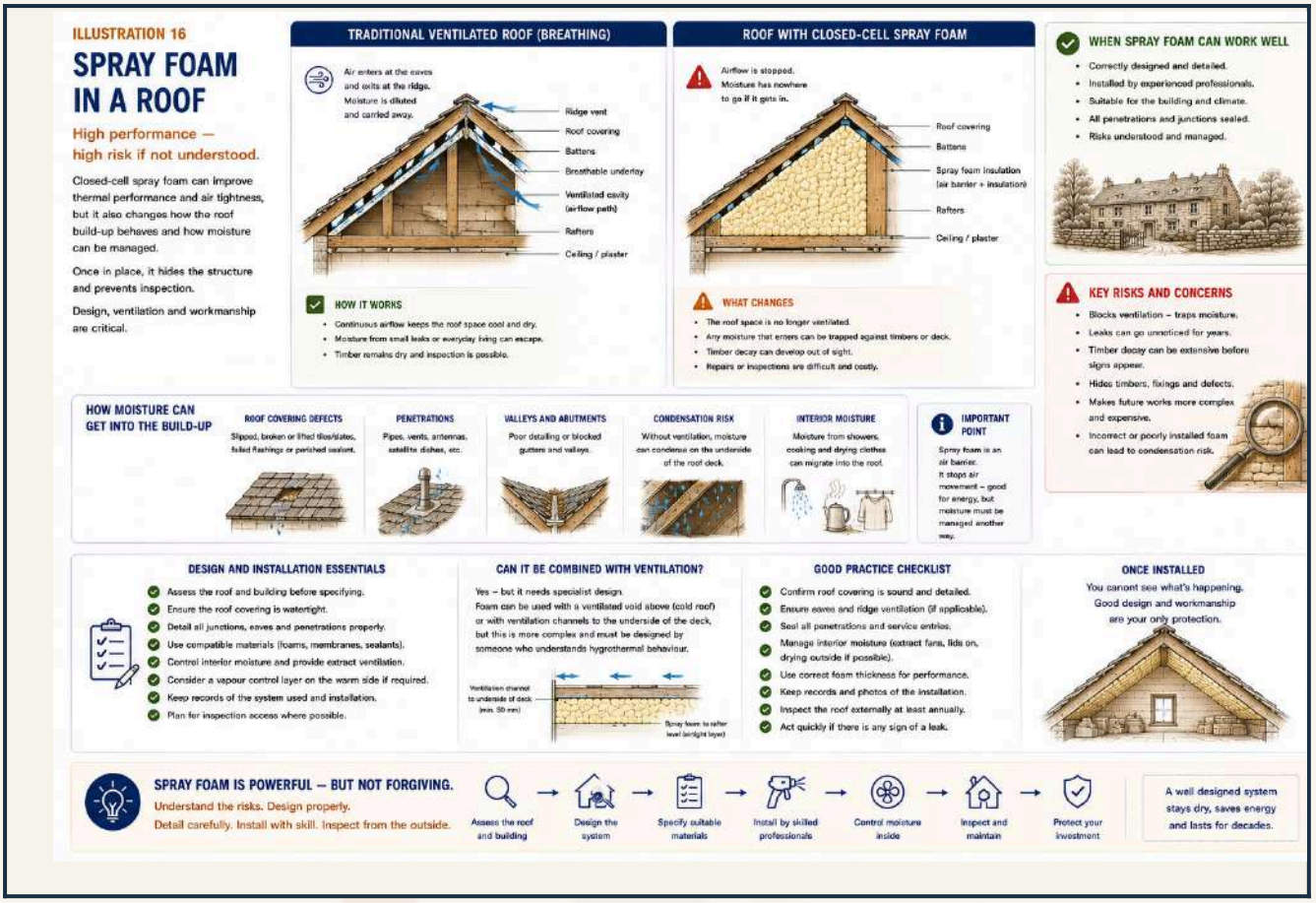
It means that inspection has been restricted. That distinction is essential.

Not being able to see a defect is not evidence that the defect does not exist.



Equally, not being able to inspect a timber properly is not evidence that the timber is defective.

It is an inspection limitation - and should be reported as one.



Spray foam and mortgages

Spray foam has also acquired a reputation for making properties "unmortgageable". That statement is too absolute.

Lenders have different policies, and surveyors and valuers must respond to the particular construction, documentation and lending instructions involved.

RICS and PCA guidance both recognise the practical difficulties that SPF can create for property assessment, lending and sale where the installation cannot be satisfactorily evidenced or the roof cannot be adequately inspected.

So the useful pre-purchase question is not: Does this house have spray foam - yes or no?

It is: What was installed, how was it designed, what lies behind it, what documentation exists, and can the roof structure be adequately assessed?

Removing spray foam

Removal is sometimes proposed as the automatic solution. Again, diagnosis should come first.

Why is it being removed? Because the installation is defective? Because moisture is present? Because the roof requires replacement? Because a lender requires further investigation? Because there is inadequate documentation? Or simply because someone has been told that all spray foam is bad?

Industry guidance also cautions against assuming that removal is automatically necessary in every case. Removal can itself be invasive.

So the sequence remains familiar:

understand → assess → decide → intervene

Flat roofs

Flat roofs deserve a brief mention because insulation changes their temperature and moisture profile too.

Many traditional buildings contain smaller flat-roof areas over extensions, dormers, porches or later additions.

The principles are familiar: Where is the insulation? Which parts of the construction become colder? Where is the vapour-control layer? How is moisture expected to dry? Are junctions thermally continuous?

The same building-science questions therefore apply even where the roof form is different.



10. Insulation Beyond Walls - Floors and Ground Conditions

Cold floors are persuasive. You can feel the problem through your feet.

That makes them an obvious target when a homeowner is trying to make an older building warmer.

But the surface that feels cold is not necessarily the place where the most useful energy saving lies.

Nor does it mean that every floor should be approached in the same way.

A suspended timber floor over a ventilated void behaves very differently from a traditional solid floor laid close to the ground.

And once again, the first question should not be:

What insulation should we put in?

It should be:

What floor do we actually have, and how is it currently managing heat and moisture?

Start by identifying the floor

Older buildings frequently contain more than one floor construction.

The front rooms may retain suspended timber floors. A rear extension may contain concrete. A hallway may have stone or tile. A former suspended floor may have been replaced with a modern concrete slab.

And successive alterations may mean that the floor visible today bears little resemblance to the original construction.

That matters because the appropriate retrofit strategy depends upon what lies beneath the finish.

Historic England distinguishes principally between suspended timber floors and solid floors, and stresses that the thermal and moisture consequences of insulating them are different.

So before discussing insulation thickness, U-values or products, we need to understand the construction.

Suspended timber floors

A traditional suspended timber ground floor is conceptually simple.

Floorboards are supported on timber joists. Those joists span over a void beneath the floor. Outside air enters that void through air bricks or other openings. The purpose of that ventilation is extremely important.

Ground beneath a building can continuously release moisture. Moisture may also enter through surrounding masonry.

The timber structure therefore exists relatively close to a potentially persistent source of moisture.

Ventilation helps remove that moisture and keeps the environment around the structural timber sufficiently dry.

The void beneath a suspended timber floor is not wasted space. It forms part of the floor's moisture-management system.

Why do suspended floors feel cold?

There are two separate effects that homeowners can easily experience as one problem.

The first is conductive heat loss through the floor construction. The second is air leakage.

Traditional floorboards commonly contain gaps. There may also be gaps around skirting boards, service penetrations and perimeter junctions.



Cold air moving through those openings can create noticeable draughts.

Suspended timber floors can therefore contribute to heat loss both through the floor construction and through uncontrolled air movement.

A draughty floor and a poorly insulated floor are related problems - but they are not exactly the same problem.

Sometimes the first thermal improvement is not more insulation. It is stopping unwanted air movement through the floor.

If cold air is visibly or perceptibly moving through gaps between boards, improving airtightness at floor level can improve comfort.

That may sometimes be achieved with considerably less disruption than lifting an entire historic floor and insulating beneath it.

Historic England recognises draught-proofing as an alternative where installing insulation would be difficult or potentially damaging to an existing floor.

This returns us to one of the recurring principles of TC-07:

Start with the problem you are actually trying to solve.

If the dominant complaint is draught rather than conductive heat loss, the most proportionate intervention may not be the most thermally ambitious one.

Insulating between the joists

Where insulation is justified, it can commonly be installed between the floor joists.

Various systems are possible. The insulation may be supported by membranes, netting, boards or other proprietary arrangements.

Different insulation materials bring different thermal, moisture, fire and installation characteristics.

But the critical point is what happens beneath the insulation. The ventilated void must continue to function.

So we arrive at a familiar retrofit principle:

Insulating the floor should not disable the mechanism that was keeping the floor structure dry.

Where does the timber sit after insulation?

This is worth thinking about carefully.

Before insulation, some heat from the accommodation passes through the floorboards and into the void below.

After insulation is installed between the joists, less heat reaches that void.

The accommodation becomes thermally better separated from the sub-floor space.

Which means, once again: the space on the other side of the insulation becomes colder. Does that sound familiar?

It is essentially the same principle we encountered in Chapter 9.

Better loft insulation makes the loft colder. Better suspended-floor insulation can make the sub-floor void colder.

And when a moisture-prone space becomes colder, its moisture conditions deserve renewed attention.



Insulation changes the environment on both sides of itself.

Another equilibrium has changed

The insulation has not created the ground moisture.

It has not created moisture within the surrounding masonry.

And it has not necessarily created the humidity within the void.

But by reducing heat flow from the accommodation above, it can change the temperature at which that existing moisture must be managed.

The response is therefore not: don't insulate suspended floors.

It is: don't insulate them without understanding the sub-floor environment.

That means checking air bricks. Checking cross-ventilation. Checking whether extensions or raised external ground levels have obstructed historic ventilation routes. Checking for plumbing leaks. Checking timber condition. Checking ground conditions.

And addressing existing moisture problems before concealing the structure behind insulation.



A particularly Manx consideration

Traditional Manx buildings frequently occupy sloping sites, particularly in certain parts of Douglas.

The external ground level at the rear of a building may be substantially higher than at the front.

Extensions, paths, concrete yards and later landscaping can further alter the original relationship between ground level and sub-floor ventilation.

A building may therefore have visible air bricks at the front while effective cross-ventilation to the rear is poor or absent. That matters before floor insulation is installed.

If the void is already marginally ventilated, making it colder without first understanding its moisture conditions could reduce its tolerance of moisture further.

So once again:

Inspect first. Insulate second.

Don't conceal a timber problem

There is another practical issue.

Floor insulation can make structural timbers more difficult to inspect.

Joists that were previously visible from a cellar or accessible void may become partly concealed. Insulation installed from above may hide the sides of joists. Membranes may obscure surfaces. That does not make floor insulation inappropriate.

But the timber should be assessed before it disappears from view.

Particular attention should be paid to joist ends where they enter external walls.

Those locations are already vulnerable because timber sits within potentially moisture-bearing masonry.

Changing the thermal conditions around that junction can make its behaviour even more important.

Do not insulate over evidence you have not investigated.

Solid floors are different

Now consider a traditional solid floor. There is no ventilated void beneath it.

The floor may consist of stone, tile, brick, earth, lime-based construction or some combination accumulated through the building's history.

Its relationship with the ground is therefore completely different. And the potential energy-saving case is different too.

Historic England makes an important observation: insulating an existing traditional solid floor can provide relatively modest energy savings compared with the cost and disruption involved. Part of the reason is that the ground beneath a building tends to remain at a comparatively stable temperature. This takes us directly back to Chapter 5.

How many kWh are we actually saving - and what must we change in the building to save them?

If an otherwise serviceable traditional floor has to be completely excavated and reconstructed simply to add insulation, that cost-benefit question becomes highly relevant.

When the floor already needs replacing

The calculation changes if the floor is already being removed.

Perhaps it has failed. Perhaps substantial renovation is unavoidable. Perhaps inappropriate previous work is being reversed.

In those circumstances, the marginal cost and disruption of incorporating a carefully designed insulated floor may be much easier to justify.



Historic England makes exactly this distinction: wholesale intervention solely for thermal improvement may offer poor cost-effectiveness, while an existing need to repair or replace a floor can create a sensible opportunity to improve its thermal performance at the same time.

This is another example of why retrofit decisions cannot sensibly be reduced to: existing U-value → target U-value.

The condition and future needs of the building matter too.

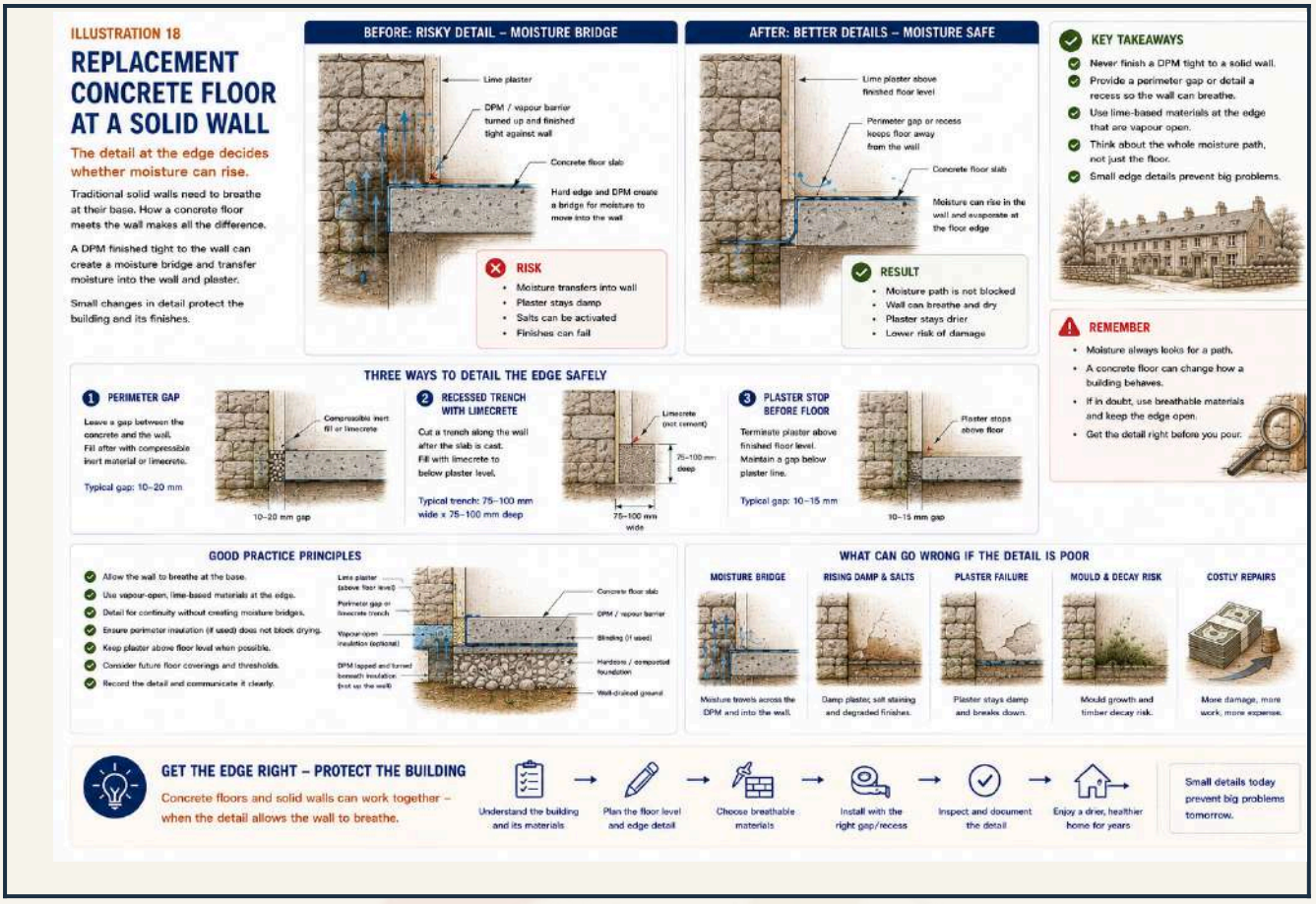
The concrete-floor problem

Many traditional buildings have had original floors removed and replaced with modern concrete slabs incorporating a damp-proof membrane (DPM). In an appropriate modern construction that is entirely normal. In an older building, however, the new floor can alter the moisture boundary conditions at the wall/floor junction and should therefore be considered as part of the whole construction.

It is often suggested that preventing evaporation through a formerly permeable floor will automatically divert ground moisture into the surrounding walls. That mechanism is physically plausible in some circumstances, and Historic England cautions that impermeable floor materials can exacerbate existing moisture problems in traditional construction. But it should not be treated as an inevitable consequence of installing a DPM or concrete floor.

The monitored Bath/Historic England rubble-wall study discussed in TC-06 is important counter-evidence. After a vapour-proof layer was installed over the historic floor, the adjacent wall did not show the predicted increase in moisture during the monitoring period. The study does not prove that moisture redistribution can never occur; it shows that the outcome depends on the actual wall, ground-water supply, drainage, floor build-up, interfaces and available drying routes.

So where low-level dampness exists beside a replacement floor, the useful question is not simply whether a DPM is present. It is whether the floor alteration has materially changed the moisture balance in this particular building, and what evidence supports that pathway. This links directly to TC-01 - Understanding Moisture Movement in Traditional Buildings and TC-06 - Rising Damp in Traditional Buildings.



Insulating a replacement solid floor

If a solid floor is genuinely being reconstructed, there are several possible approaches.

Modern insulated slab construction may be appropriate in some circumstances. Traditional or vapour-open floor systems may be appropriate in others.

Limecrete and foamed-glass systems are frequently discussed in traditional-building retrofit.

But once again, product labels should not replace design.

Recent Historic England guidance makes an especially useful distinction around foamed-glass aggregate: where liquid water is present, the same material cannot simply be assumed to perform simultaneously as both an effective capillary break and a dry thermal-insulation layer. Groundwater level and moisture conditions therefore matter to its design and thermal performance.

That is another excellent example of a TC-07 principle:

Ask what the material is being expected to do - and under what conditions its performance was measured.

“Breathable”, “insulating” and “capillary-breaking” are properties or functions. They are not substitutes for understanding the complete floor.

The wall/floor junction

Perhaps the most important detail in a traditional building is not the centre of the floor at all. It is the edge.



The point where the floor meets the external wall is where two constructions with potentially very different thermal and moisture behaviours intersect.

A floor may be thermally excellent in its centre. A wall may have been carefully considered.

But if the junction between them creates a moisture bridge, a thermal bridge, an impermeable barrier or a cold surface, the building may still develop a problem at precisely that location. This is why details matter.

Retrofit rarely fails in the middle of an idealised drawing. It often fails at the junctions.

Floors meeting walls. Walls meeting roofs. Insulation meeting windows. Membranes meeting timber. The edges are where theoretical systems encounter real buildings.

Floor insulation and flood risk

There is another consideration we should not ignore.

Some buildings are vulnerable to groundwater or other flooding.

In that situation, insulation should not be specified as though the floor will always remain dry.

Historic England's 2025 flood guidance advises against floor insulation for buildings at risk of groundwater flooding, noting that insulation materials lose thermal effectiveness when exposed to moisture.

That does not mean every property with theoretical flood exposure can never have an insulated floor.

It means that water exposure becomes a design condition.

What happens when the insulation gets wet? Can it dry? Can it be removed? Does it retain its properties? What happens to surrounding materials? How quickly can the building recover?

Those questions belong in the retrofit decision.

A Manx point worth knowing

Just as walls and roofs can constitute thermal elements under the Isle of Man Building Regulations, so can floors separating conditioned accommodation from the external environment or ground.

Substantial renovation or replacement of a floor, including thermal upgrading, may therefore engage Building Control requirements.

The applicable requirements should be established before work begins, particularly where an existing floor is being excavated or reconstructed.

And where a traditional building is concerned, compliance should not be interpreted simply as achieving a numerical thermal target without considering what the new floor construction will do to the surrounding fabric.

The wall and the floor must continue to work together.

What about underfloor heating?

There is one further attraction when a floor is already being reconstructed. Underfloor heating.

At first glance, it can seem particularly appropriate for a traditional building.

It distributes heat over a large area. It can operate at comparatively low water temperatures. It avoids large radiators. And rather than rapidly heating small areas of air, it can help create relatively even internal conditions.

That potentially fits rather well with something we discussed much earlier in TC-07: steady heating rather than intermittent heating. But again, the complete construction matters.



The floor build-up must be appropriate. Insulation beneath the heating system affects how much heat travels upwards rather than into the ground. Floor finishes affect heat transfer. Moisture conditions matter. And historic fabric may limit what can reasonably be altered.

So underfloor heating should not become the justification for unnecessarily excavating a serviceable traditional floor.

But where a floor genuinely requires reconstruction, it may form part of a carefully considered whole-building heating and insulation strategy.

11. The Whole Building - When Improvements Interact

By now, the pattern should be becoming clear.

A building does not experience retrofit one product at a time.

It experiences the combined consequences of everything we change to it.

Insulate the walls. Insulate the loft. Insulate the floor. Replace the windows. Seal the draughts. Improve airtightness. Change the heating system. Alter the ventilation.

Each measure may be perfectly reasonable when considered individually. But the building experiences them together.

Retrofit is therefore more than a collection of improvements. Taken together, those changes create a new building environment.

That is why the best-performing insulation product is not necessarily the same thing as the best-performing retrofit strategy.

A house is a system

Throughout TC-07 we have repeatedly changed one part of an imaginary building and watched something happen elsewhere. Insulate internally and the original masonry becomes colder.

Insulate externally and the masonry becomes warmer, but its external drying environment changes.

Fill a cavity and the physical separation between two masonry leaves changes.

Insulate the loft floor and the roof space becomes colder.

Insulate a suspended floor and the sub-floor void may become colder.

Improve airtightness and uncontrolled heat loss falls - but so does uncontrolled air exchange.

None of those observations means that the intervention is wrong.

They demonstrate something much more important:

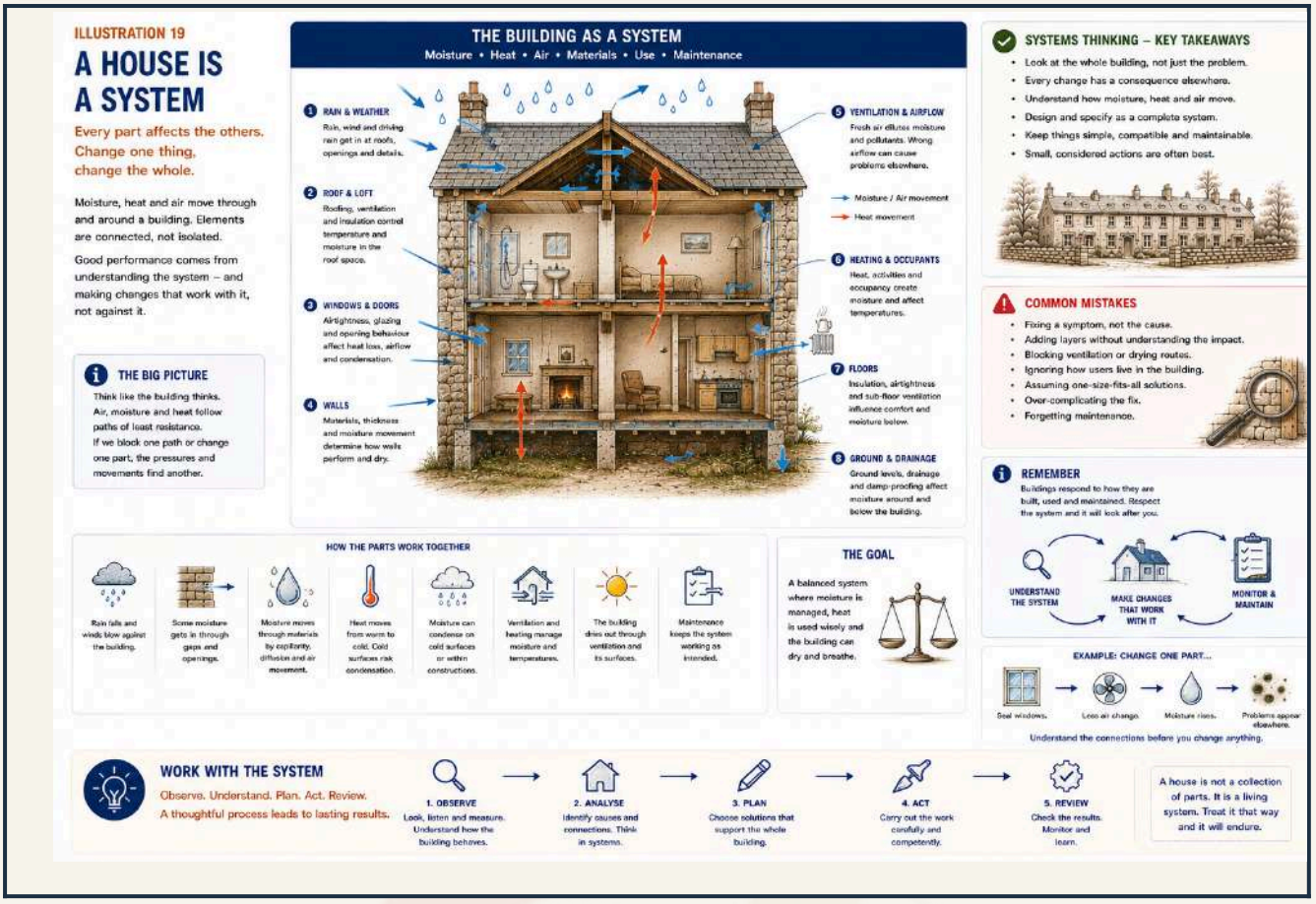
Buildings respond to relationships, not individual specifications.

Heat, air and moisture do not recognise the boundaries between different trades.

The roofer's work affects the insulation. The insulation affects temperatures. Temperatures affect relative humidity. Ventilation affects indoor moisture. Heating affects surface temperatures. External maintenance affects how much liquid water enters the fabric. And occupant behaviour affects almost everything.

Energy-efficiency measures can therefore alter the hygrothermal performance of traditional construction - the combined movement of heat, air and moisture - and poorly coordinated interventions can increase moisture accumulation, condensation and mould risk.





The comfortable room and the uncomfortable building

There is an important distinction here. Retrofit is usually experienced from the occupant's perspective.

Is the room warmer? Are the floors less cold? Have the draughts disappeared? Does the heating run for less time? Are the bills lower?

Those are entirely legitimate objectives. But the fabric experiences the same intervention differently.

The wall may now be colder behind insulation. The loft may now be colder above it. The sub-floor void may receive less heat. A previously ventilated junction may now be sealed. A timber joist end may sit within masonry whose temperature and drying behaviour have changed. A vapour-open surface may have been covered.

So it is possible to improve the comfort of the accommodation while making conditions somewhere within the building fabric less forgiving.

That does not mean comfort and building health are competing objectives. It means that successful retrofit must achieve both.

A warmer room is not, by itself, evidence of a successful retrofit.

The renovation trap

Imagine a traditional Manx house undergoing a comprehensive refurbishment. The intentions are excellent.

The owner wants a warm, comfortable and energy-efficient home.

So the contractor fits new double-glazed windows, seals obvious draughts, installs internal wall insulation, adds substantial loft insulation, replaces a suspended floor with an insulated concrete slab, fits powerful extraction, and installs a modern heating system.

Every individual item can be described as an improvement.

But compare the completed building with the one that existed before.

It may now be warmer, more airtight, less naturally ventilated, less vapour-open, thermally divided in different places, and dependent upon designed ventilation and heating in ways that the previous building was not. That is not necessarily a bad building.

But it is a different building. And it needs to be understood as one.

The more successfully we remove accidental heat loss and accidental ventilation, the more important deliberate environmental control becomes.

An old building may have been enormously draughty.

Those draughts wasted energy. They may also have provided considerable air change.

That does not mean we should preserve uncontrolled draughts as a ventilation strategy.

But if we seal them, we should recognise what has disappeared with them. The answer is not: keep the house draughty.

The answer is:

Replace uncontrolled ventilation with appropriate controlled ventilation.

Reducing uncontrolled air leakage can improve thermal comfort and reduce heat loss, but maximising airtightness without an adequate ventilation strategy can increase humidity, condensation risk and poor indoor air quality.

Airtightness is not ventilation

These two concepts are sometimes confused.

Airtightness concerns unwanted or uncontrolled movement of air through the building envelope.

Ventilation is the intentional replacement of indoor air with outdoor air to manage moisture, pollutants and indoor environmental conditions.

A building can therefore be draughty but inadequately ventilated in the places that matter, or very airtight but extremely well ventilated through a designed mechanical system. So TC-07 is not arguing against airtightness.

Reducing uncontrolled air leakage can be an important energy-saving measure.

The point is that:

As accidental ventilation is removed, intentional ventilation becomes more important.

That may involve appropriate background ventilation, effective local extraction, natural ventilation, mechanical systems or a designed combination appropriate to the building and its occupants. What matters is that it has been considered.

A safety point - combustion appliances

Where open-flued, solid-fuel or other combustion appliances are present, draught-proofing and airtightness measures also need to preserve the air supply required for safe combustion and effective flue operation. A leakage route that appears to be an energy defect may have been contributing air to an appliance, even if it was never intended to do so.



That does not mean retaining uncontrolled draughts. It means that changes to airtightness, ventilation and combustion appliances should be considered together, with the relevant Building Control requirements and competent appliance assessment established where necessary. Energy improvement must not compromise combustion safety.

Moisture production has not disappeared

There is another side to this equation.

Improving the building envelope does not stop people producing moisture.

We still cook, shower, dry clothes, breathe, clean and occupy the building.

So imagine that the moisture production remains broadly similar while the building becomes substantially more airtight.

The amount of water vapour entering the internal environment has not necessarily changed.

Its ability to leave may have. That can increase internal humidity.

And increased humidity changes the moisture load imposed upon every colder surface and construction within the building.

This takes us directly back to TC-04 - Understanding Surface Condensation and Mould and TC-05 - Understanding Interstitial Condensation.

Insulation and airtightness can change the temperatures. Occupation continues to supply the moisture. Ventilation determines how much of that moisture remains.

Those three things need to work together.

Heating belongs in the retrofit strategy

Heating can sometimes be treated as something separate from insulation. It isn't.

Insulation determines how readily heat leaves the building. Heating determines how heat is supplied. Thermal mass affects how the building responds. Ventilation removes both moisture and some heat. Occupants decide when the heating operates and what temperature feels comfortable. All of those variables interact.

This is why our earlier discussion of steady thermostatically controlled heating matters.

A traditional building that is allowed to become very cold and is then heated intensely for short periods experiences large swings in temperature.

The air may warm quickly. Thick masonry responds much more slowly.

That can leave relatively warm, moisture-laden internal air adjacent to colder fabric. TC-04 and TC-05 explain why that relationship matters.

A more stable heating regime may help maintain warmer fabric temperatures and reduce extreme fluctuations.

But the precise outcome depends upon the building, its heating system, insulation, ventilation, occupancy and weather.

So the lesson is not: traditional buildings must be heated continuously.

It is:

The heating strategy should be considered alongside the insulation strategy, not after it.



Do not forget summer performance

Most retrofit discussion naturally concentrates on keeping buildings warm in winter. But a whole-building strategy also needs to consider how the altered building will behave during warm weather. Insulation, airtightness, glazing, solar gain, shading, thermal mass and ventilation can all influence summertime comfort.

The Isle of Man is not exposed to identical overheating conditions everywhere, and risk will vary with orientation, glazing area, shelter, occupancy and the ability to purge heat through safe ventilation. The relevant question is therefore not whether insulation is inherently an overheating risk, but whether the complete retrofit remains comfortable and controllable across the seasons.

A successful winter energy strategy should not unintentionally create an avoidable summer problem.

The rebound effect

There is also a fascinating complication in our discussion about saving kWh.

Suppose retrofit reduces the theoretical amount of energy required to maintain a house at 20°C.

Does the household necessarily use all of that reduction to save energy?

Perhaps not.

Before retrofit, they may have tolerated 17°C because heating the building was expensive.

After retrofit, maintaining 20°C becomes affordable.

Some of the theoretical energy saving has therefore become additional comfort. This is often described as the rebound effect.

The related prebound effect can also matter: predicted pre-retrofit energy consumption may have been too high, meaning some of the theoretical saving was never realistically available in the first place. Neither effect means retrofit has failed.

If somebody previously lived in an uncomfortably cold house and can now afford to keep it warm, that is a meaningful benefit.

But it changes how we interpret predicted financial savings.

Not every saved kWh becomes a saved pound. Some may become comfort instead.

That is why actual household energy behaviour matters when evaluating retrofit.

One improvement can change the value of another

Whole-building thinking also affects the order in which work is undertaken.

Suppose we install a new heating system before reducing heat demand. The system may be sized for the old building. Then substantial insulation is installed. The heat demand falls. The heating system may now be oversized.

Or consider ventilation. A system designed around a very leaky building may behave differently after windows are replaced and draughts sealed.

Or consider wall insulation installed immediately before a leaking gutter is discovered. The sequence matters.

A sensible whole-building process therefore gathers information first, then assesses and plans, designs and specifies, installs, and finally evaluates and maintains.

It can also be phased over several years rather than undertaken as one enormous project. That is important.

Whole-building retrofit does not mean doing everything at once.

It means understanding how everything relates before deciding what to do, and in what order.



Maintenance before insulation

This may be the least glamorous energy-efficiency measure in the entire guide.

Fix the building.

Before insulating a wall, repair the leaking gutter above it.

Before insulating the roof, establish that the roof is watertight.

Before insulating a suspended floor, investigate the blocked air bricks.

Before covering external masonry with EWI, repair the defects and assess its moisture condition.

Before lining a damp wall internally, understand why it is damp.

Maintenance and repair should come before retrofit insulation. Why?

Because insulation does not cure building defects.

It can make some of them harder to see.

And in certain circumstances it can make their consequences more severe.

Repairing a defect may save less energy than insulation. But it may be what makes the insulation safe.

Measure what you can

Another recurring theme of TC-07 has been our reluctance to accept assumptions simply because they appear in a calculation. That applies at whole-building level too.

What energy does the house actually use? How is it heated? Which rooms are heated? To what temperature? When? What is the internal humidity? Where are the cold surfaces? What construction actually exists? What is the condition of the fabric? Where does the building experience severe weather exposure?

An accurate baseline should use actual rather than assumed information wherever practicable, particularly because generic predictive models can overestimate heat loss in traditional buildings.

That does not mean every homeowner needs a laboratory.

It means:

The better the evidence going into the decision, the less we need to rely upon assumptions coming out of it.

Don't solve the calculation instead of the building

This is perhaps one of the central warnings of TC-07.

A computer model may identify a U-value target.

A manufacturer may provide a product capable of achieving it.

A calculation may demonstrate compliance. All of those things have value.

But the building still exists in the real world.

Its wall may be 600 mm of irregular Manx rubble masonry. Its west elevation may experience severe wind-driven rain. Its floor may have been replaced with concrete. Its chimney may contain hygroscopic salts. Its rear ground level may be high. Its joist



ends may be embedded in masonry. Its occupants may dry washing indoors. Its heating may operate for two hours in the morning and four hours at night.

Those details do not invalidate calculation. They determine how useful the calculation is.

Do not solve the model and forget to solve the building.

The most ambitious intervention is not automatically the best one

There can be understandable pressure during retrofit to maximise improvement.

If 50 mm of insulation is good, perhaps 100 mm is better.

If a U-value of 0.6 is achievable, perhaps 0.3 must be preferable.

If some draught-proofing is useful, perhaps maximum airtightness is ideal.

But every additional intervention can carry cost, embodied carbon, disruption, loss of historic fabric, changes to moisture behaviour, maintenance requirements and potential unintended consequences.

Successful whole-building solutions should therefore be proportionate, effective and cost-efficient, rather than simply maximising thermal intervention.

That returns us to the proposition with which this guide began:

It should be the best whole-building balance of:

energy saved,
comfort gained,
financial cost,
carbon reduction,
durability,
and moisture safety.

Sometimes that may justify substantial insulation. Sometimes it may justify moderate insulation.

Sometimes another intervention may deliver greater benefit for lower risk.

And occasionally the correct decision may be: leave that element alone.

Whole-life carbon - not only operational energy

Reducing the energy used to operate a building can reduce operational carbon. But the materials and work used to achieve that reduction also have a carbon consequence. Insulation, fixings, membranes, finishes, scaffolding, transport, replacement cycles and eventual disposal all contribute to embodied carbon.

A proportionate retrofit appraisal should therefore consider whole-life carbon rather than assuming that the option with the lowest calculated U-value automatically produces the lowest overall carbon impact. Material quantity, durability, maintenance and service life can all affect that comparison.

The reverse caution matters too. Embodied carbon should not become a blanket argument against effective retrofit. A well-chosen intervention may repay its initial carbon investment through lower operational emissions. The useful question is the same one TC-07 asks elsewhere: what additional benefit are we buying, what does it cost - financially, physically and environmentally - and is that additional intervention justified for this building?



A staged retrofit can be a better retrofit

There is another advantage to resisting the urge to do everything immediately. We can learn.

Repair the building. Improve obvious draughts. Upgrade loft insulation. Improve heating control. Address ventilation. Then observe what happens.

How does energy use change? How does comfort change? How does internal humidity respond? Are previously cold surfaces now warmer? Does the building behave as expected?

Then consider the next stage.

A phased whole-building plan can accommodate budgets, coordinate work with maintenance and allow later phases to respond to the performance of earlier interventions.

That is not lack of ambition. It is evidence-led retrofit.

Intervene. Observe. Learn. Then decide what comes next.

The building after retrofit

One final point deserves more attention than it often receives.

The project does not finish when the contractor leaves.

Someone has to live in the building. They need to understand how it now works.

Perhaps background vents must remain open. Perhaps mechanical extraction needs to operate differently. Perhaps filters require cleaning. Perhaps a particular heating strategy is intended. Perhaps EWI needs periodic inspection. Perhaps roof ventilation must remain unobstructed. Perhaps humidity should be monitored during the first winter.

Use, evaluation and maintenance therefore form part of the retrofit process, not an optional afterthought.

This is particularly important when retrofit has made a building less forgiving of misuse.

A technically sophisticated retrofit that nobody understands how to operate is not a complete retrofit.

A Tree Cassyn way of looking at retrofit

Tree Cassyn investigates moisture.

That is why insulation belongs in this Building Science Series.

When insulation works well, it can reduce energy consumption, improve comfort, raise internal surface temperatures and contribute to better living conditions.

Those are real benefits. But insulation also changes temperatures.

Airtightness changes air movement. New materials change vapour and liquid-moisture pathways.

Heating changes fabric temperatures. Ventilation changes internal moisture loads.

And all of those effects meet inside the same building. So our interest is not in opposing insulation.

It is in asking:

What will this intervention change - not only where we intend it to act, but everywhere else that depends upon it?

That is the whole-building question.



12. Before You Insulate - A Practical Decision Framework

By this point, TC-07 has asked a lot of questions. That is deliberate.

Retrofit insulation is often presented as though the difficult decision is choosing the product. For a traditional building, that is usually one of the later questions.

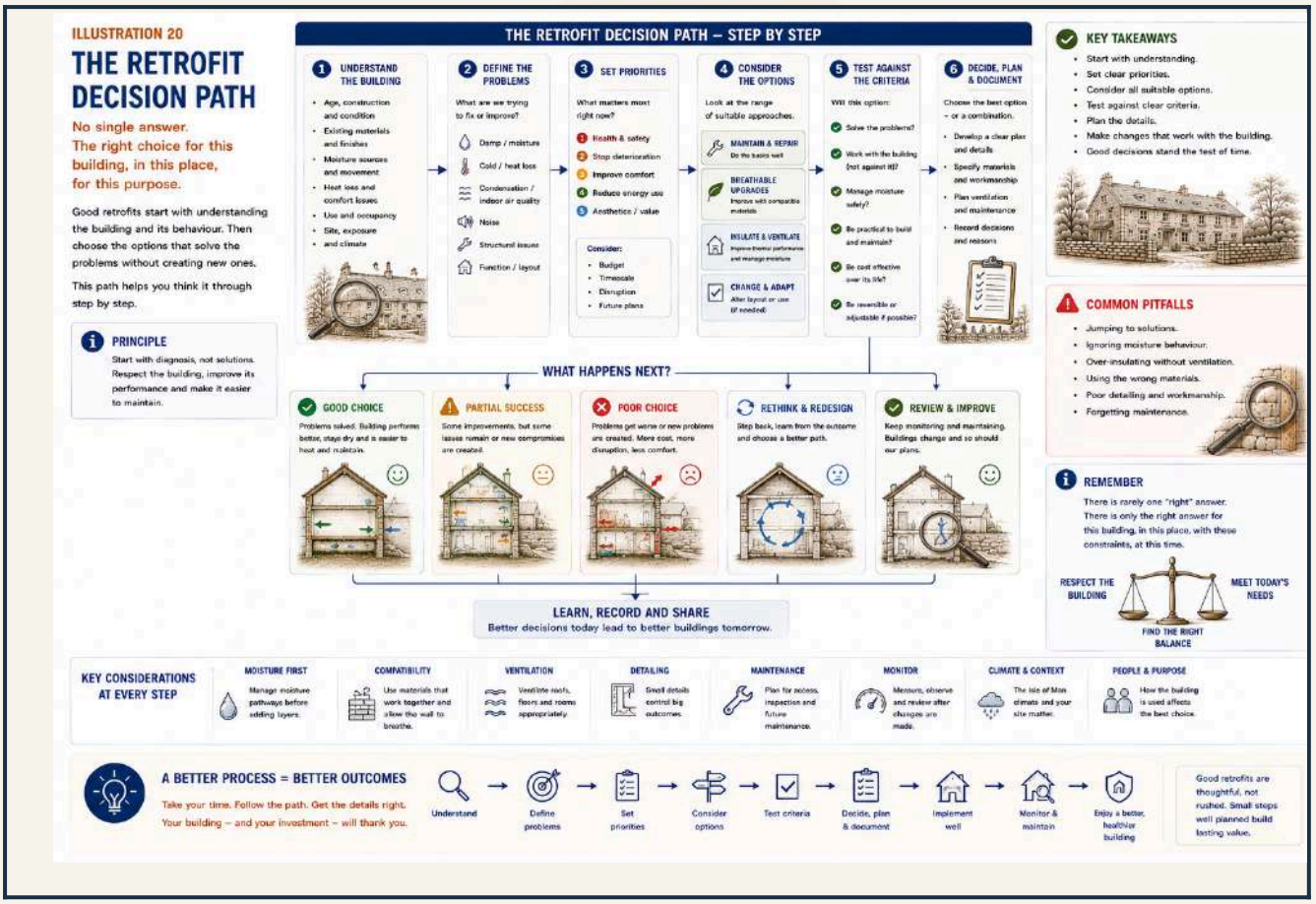
The more useful starting point is:

What are we trying to improve, what building are we changing, and what else might change when we do it?

This chapter brings those questions together.

It is not intended to produce the same answer for every building. Quite the opposite.

It is intended to help different buildings arrive at different, appropriate answers.



Step 1 - What are you actually trying to achieve?

Before discussing products, establish the objective.

Is the priority lower heating bills, greater comfort, lower carbon emissions, warmer internal surfaces, eliminating draughts, improving a particularly cold room, meeting Building Regulations as part of other work, making use of an opportunity created by renovation, or some combination of these?

Those objectives overlap, but they are not identical.

A measure that provides excellent comfort improvement may not provide the shortest financial payback.

A measure that produces a substantial calculated U-value improvement may involve considerable disruption.

A relatively modest intervention may save fewer theoretical kWh but offer a much better balance of cost, risk and benefit. So begin with the outcome.

Do not start with the insulation. Start with the reason for insulating.

Step 2 - Understand what you already have

Chapter 2 established why this matters.

What are the walls actually made from? How thick are they? Solid or cavity? Stone or brick? Random rubble or relatively uniform masonry? What internal and external finishes exist? What floors exist? How is the roof constructed? What insulation is already present? What alterations have been made previously? What party walls or other shared constructions form part of the building?

For a Manx building, apparently simple questions can still produce complicated answers.

A Victorian terrace may contain solid masonry at the front, a later cavity-wall extension at the rear, a suspended timber floor in one room, concrete in another, a traditional pitched roof over the main house and a modern flat roof over the extension.

There is no reason why all of those elements should receive the same retrofit treatment.

Step 3 - Understand the building's present moisture condition

The moisture assessment described earlier now becomes part of the retrofit decision.

Apply the relevant checks already discussed: wall moisture loading, weather-tightness, sub-floor conditions, embedded timber, ventilation and any unresolved source of abnormal wetting.

Do not make an existing moisture problem part of the new insulated construction.

Step 4 - Repair before you improve

If abnormal moisture is entering the building, deal with its cause before incorporating that fabric into a new insulated construction.

Repair the relevant defect and allow wet fabric to dry where necessary before the insulation decision proceeds.

This does not mean every traditional wall must reach some imaginary state of absolute dryness before retrofit. Traditional masonry normally contains and exchanges moisture.

The distinction is between normal moisture behaviour and an unresolved source of abnormal wetting. That distinction matters enormously.

Step 5 - Establish how the building is actually used

Two identical houses can behave very differently because two households can use them very differently.

How many people occupy the building? Which rooms are heated? For how long? To what temperature? Is heating thermostatically controlled? Is it intermittent? Are bedrooms deliberately kept cool? Where is washing dried? How effective is bathroom extraction? How effective is kitchen extraction? Are windows routinely opened? What internal humidity is typical? Are parts of the house unoccupied?

This information affects both energy consumption and moisture risk. It also affects predicted financial savings.



If only two rooms in a large house are currently heated, a calculation based upon maintaining the entire building at 20°C may produce a theoretically impressive energy saving that the household could never actually realise.

That is the performance gap between the model and the way the building is lived in.

Step 6 - Establish the real energy baseline

Before promising savings, find out what is currently being consumed.

Look at actual energy bills where possible. Separate space heating from other energy uses as far as practicable. Understand the heating system. Understand fuel type and current cost. Understand the heating pattern. And be careful with theoretical comparisons.

If a model says the building currently requires 20,000 kWh annually for heating but the household actually uses 10,000 kWh, we cannot simply claim that an intervention reducing modelled demand to 12,000 kWh will save the homeowner 8,000 kWh.

They never consumed those 8,000 kWh in the first place.

You cannot reliably calculate a saving from energy that was never being used.

Step 7 - Look for the easy gains

Now we can start considering intervention. But begin with the lower-risk opportunities.

Could loft insulation be improved? Could obvious draughts be reduced? Could heating controls be improved? Could pipework be insulated? Could an inefficient extraction arrangement be corrected? Could a poorly fitting loft hatch be improved? Could an existing insulation installation simply be repaired or completed properly? Could maintenance reduce heat loss or unwanted air movement?

The cheapest intervention is not automatically the best. But neither is the most technically sophisticated.

Step 8 - Identify the element you are proposing to change

Now focus on the wall, floor or roof concerned.

Apply the lessons from Chapters 3 and 4: what is its existing thermal performance, how certain are we, what does the proposed layer add, and which figures are measured, calculated or assumed?

Know what is measured. Know what is calculated. Know what is assumed.

Step 9 - Ask what becomes colder

This is one of the guide's recurring questions.

Insulation changes the temperature distribution through the construction.

So ask: What becomes colder after this insulation is installed?

The earlier chapters have shown how this can affect masonry behind IWI, roof voids, sub-floor spaces and localised junctions.

Then ask the next question: What moisture might reach that colder area?

Step 10 - Ask what becomes wetter - or dries more slowly

Not every moisture risk is condensation.

Could rain enter the construction? How exposed is the elevation? Could groundwater be involved? Does the wall contain residual construction moisture? Are hygroscopic salts present? Could plumbing leak? Could floodwater enter?

How does the construction currently dry? Will the proposed insulation alter that drying route?



The solid-wall chapters have already shown why this is especially important in traditional masonry.

If this construction becomes wet after retrofit, how does it become dry again?

Step 11 - Look at the junctions

Revisit the junctions identified in the earlier technical chapters, not only the convenient middle of the element.

Check where insulation stops, turns, meets another element or surrounds vulnerable fabric.

The centre of the insulation system may be the easiest part to design. The edges often determine whether it works.

Step 12 - Consider ventilation and airtightness together

Will the work reduce uncontrolled air leakage?

If so, that may be beneficial. But what happens to ventilation?

Apply the ventilation strategy developed earlier: how will moisture be removed, where will replacement air come from, and will roof or sub-floor ventilation be affected?

It is:

Controlled air movement appropriate to the building and its occupants.

Step 13 - Consider the heating strategy

How will the insulated building actually be heated?

Consider whether the existing system and heating pattern will remain appropriate, and whether occupants are likely to take the benefit as lower consumption, greater comfort, or both.

The answer influences both the financial calculation and the building's future moisture environment.

Heating, insulation and ventilation are not three separate projects. They create the internal environment together.

Step 14 - Interrogate the product

Only now are we ready to select and interrogate the product.

What is the declared thermal conductivity? At what thickness? What is the proposed installed thickness? What is the vapour-resistance factor? What is the resulting Sd value at the installed thickness? What happens when the material becomes wet? What evidence exists for the proposed substrate? What preparation is required? What are the exposure limitations? What maintenance is required? What fire-performance information applies? What independent testing exists? What assumptions underpin performance claims?

And perhaps most importantly:

Is the evidence describing the material - or the complete construction we are proposing to build?

Step 15 - Interrogate the installer

This deserves equal attention.

Who has assessed the building? Is the same company recommending, supplying and installing the product? What alternatives were considered? Why was this system chosen? What moisture assessment was undertaken? How were exposure conditions considered? How are junctions detailed? How will ventilation be maintained? What happens around embedded timbers? What Building Control process is proposed? What warranty applies? Who is responsible if the design proves unsuitable?



There is nothing inherently wrong with a manufacturer or installer assessing a property. But commercial interest should be recognised.

The question is not whether somebody wants to sell you insulation. The question is whether the evidence still supports their recommendation after you know that they do.

Step 16 - Check the regulatory position

Do this before installation, not afterwards.

Does the work engage the Isle of Man Building Regulations? Is Building Control approval required? Is Planning approval relevant? Is the property registered or otherwise protected? Are there boundary implications with EWI? Are there fire-safety requirements? Are ventilation requirements affected? Could airtightness changes affect combustion-air or flue requirements? What evidence of compliance will exist when the property is eventually sold?

As we have seen with IWI, EWI, cavity insulation, roofs and floors, insulation is not necessarily merely a decorative alteration undertaken inside someone's own home.

It can alter a thermal element of the building. That distinction matters.

Step 17 - Compare benefit with intervention

Now bring the information together.

What is the likely annual energy saving? What might that mean financially? How much comfort improvement is expected? What operational and whole-life carbon reduction is expected? Could summer overheating risk change? What does the intervention cost? How disruptive is it? How much existing fabric is altered? What maintenance will it require? What moisture risk is introduced? How reversible is it? What happens if the prediction proves wrong?

This is where a simple ranking can be enormously useful. Not: Which measure saves the most heat?

But: Which measure gives the best overall return for this building?

And “return” should be understood broadly.

Step 18 - Decide whether to proceed

There are several perfectly legitimate conclusions. Proceed as proposed. The evidence supports the intervention.

Proceed, but modify the design. Perhaps less insulation, a different material, improved detailing or additional ventilation produces a better balance.

Do something else first. Repair, ventilation, heating control or another lower-risk intervention may deserve priority.

Monitor before deciding. Perhaps one winter of temperature, humidity or energy-use information would materially improve the decision.

Do nothing to that element. This last answer deserves emphasis.

Sometimes repair, controls, ventilation or a lower-risk measure will offer the better result.

Choosing not to insulate something can be an evidence-led retrofit decision.

Step 19 - Record what was done

If the work proceeds, retain the evidence.



Drawings. Specifications. Product literature. Invoices. Photographs before, during and after installation. Building Control documentation. Planning documentation where relevant. Installer details. Warranties. Calculations. Moisture assessments. Commissioning information. Ventilation settings.

Those records may be extremely valuable later. Particularly when the building is sold.

A future surveyor looking at an insulated wall may not be able to see what lies behind it. A future owner should not have to guess.

Good retrofit leaves a record as well as an improved building.

Step 20 - Check whether it actually worked

Finally, return to the question with which we started. What were we trying to achieve?

Lower energy consumption? Check the consumption. Greater comfort? Ask whether the building actually feels more comfortable. Warmer surfaces? Measure them. Reduced condensation? Monitor humidity and affected surfaces. Lower carbon? Compare actual energy use. Better moisture performance? Inspect the building.

The retrofit calculation was a prediction. The building can provide the result.

The best evidence that a retrofit works is not that the calculation said it should. It is that the building subsequently demonstrates that it does.

The central decision

Different buildings can legitimately arrive at different answers.

So perhaps the final practical principle is this:

Good retrofit does not begin by deciding how to insulate a building.

It begins by understanding the building well enough to decide whether, where and how insulation will genuinely improve it.

13. After the Retrofit - Did It Actually Work?

The insulation is in. The scaffolding has come down.

The plaster has dried and the rooms have been redecorated.

The heating is back on. The project looks finished. But has the retrofit actually worked?

Throughout TC-07 we have repeatedly questioned predictions, assumptions and calculated performance.

So it would be inconsistent to accept the success of a completed retrofit simply because the specification was followed, the required thickness was installed, the calculated U-value was achieved, or the contractor has left the site. Those things tell us what was intended.

Now the building gets a vote. It can tell us what actually happened.

Retrofit should not end with installation. It should end with evidence that the building is behaving successfully afterwards.

Return to the original objective

Return to the objective established before the work.

Compare the intended outcome with what actually happened: energy use, cost, comfort, surface temperatures, condensation or mould, carbon performance and the condition of the building fabric.

The distinction between predicted and actual performance is fundamental. The retrofit specification provides the hypothesis.

The building provides the experiment.

Give the building time

Not everything can be judged immediately.

A newly completed retrofit may contain construction moisture. Wet-applied plaster systems need to dry. Weather changes. Occupancy changes. Heating patterns change with the seasons.

The moisture behaviour of a wall in August tells us relatively little about how that wall will behave during a wet Manx January.

Similarly, a roof void that appears completely satisfactory during summer may experience quite different conditions during the heating season.

So assessment should be proportionate, but it should also take place over a meaningful period.

For many moisture-related questions, the first winter after retrofit may be particularly informative.

That does not mean waiting for something to go wrong.

It means recognising that the building experiences conditions that no commissioning-day inspection can reproduce.

A retrofit has not really experienced the building until it has experienced the weather.

What should we monitor?

This need not mean turning every house into a research laboratory.

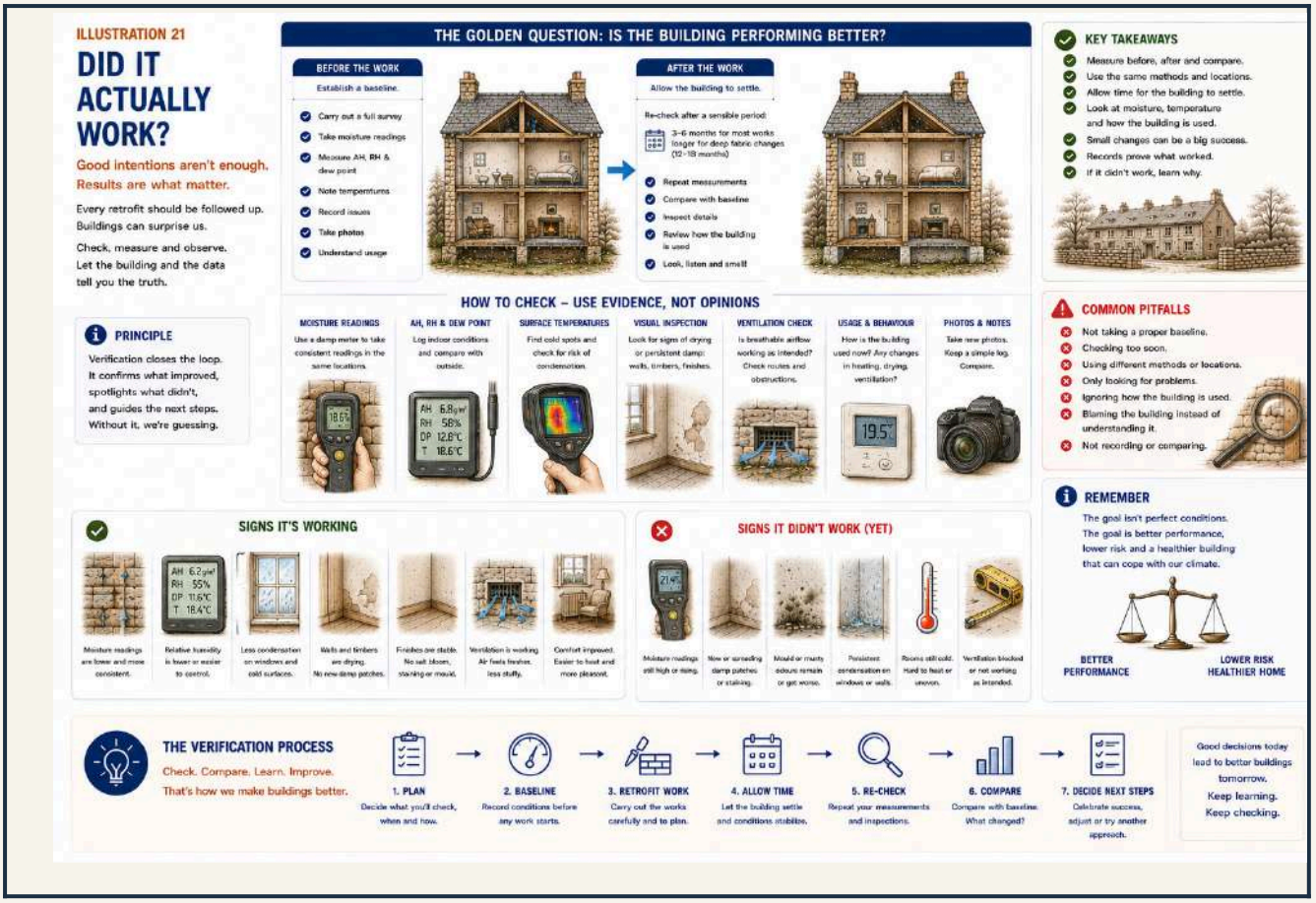
The level of monitoring should reflect the scale, complexity and risk of the intervention.



For a relatively straightforward project, useful evidence might include actual energy bills, meter readings, internal temperature, relative humidity, occupant comfort, visible condensation, mould growth, and periodic inspection of the altered fabric.

For a more substantial or technically sensitive retrofit, additional investigation might include surface-temperature monitoring, thermal imaging, fabric moisture assessment, air-permeability testing, CO_2 monitoring as an indicator of ventilation performance, in-situ U-value measurement, or longer-term environmental monitoring. The important point is proportionality.

Measure enough to answer the question.



Energy use: compare like with like

This is harder than simply comparing two annual bills.

Suppose the household used 12,000 kWh before retrofit and 10,000 kWh afterwards.

Has the retrofit saved 2,000 kWh? Possibly.

But what if the second winter was much milder? What if somebody began working from home? What if the thermostat was increased from 18°C to 20°C? What if a previously unheated bedroom became occupied? What if the household changed? What if electricity replaced some previously gas- or oil-supplied energy?

The numbers are still useful, but they need context.

This is the same discipline we have applied throughout TC-07:

Do not ask a number to tell you more than the evidence allows it to tell you.

And remember comfort taking

Remember that lower consumption is not the only possible benefit.

If occupants use some of the efficiency gain to heat the building more comfortably, the bill may fall less than predicted without the retrofit having failed.

A retrofit can succeed without every theoretical saved kWh appearing as a reduction on the energy bill.

Monitor the moisture environment too

For Tree Cassyn, this is perhaps the more interesting side of post-retrofit evaluation.

What happened to internal relative humidity? Are previously cold surfaces now warmer? Has surface condensation reduced? Has mould disappeared? Has it appeared somewhere new?

What happened in the loft? What happened beneath the suspended floor? Are previously dry timbers still dry?

Are there signs of moisture accumulating around window reveals, floor edges, joist ends or other junctions? Has an externally insulated wall remained weather-tight? Has moisture appeared at a location that was previously unproblematic?

These questions matter because insulation can improve one moisture condition while altering another.

For example, raising an internal wall surface temperature may substantially reduce surface-condensation risk. Excellent.

But if that improvement was achieved through IWI, the original masonry behind the insulation is now colder.

So success should be judged on both sides of the intervention.

The absence of condensation on the room surface is good evidence. It is not necessarily the complete moisture assessment.

Look at the places we worried about before installation

Good pre-retrofit documentation now becomes particularly valuable.

Revisit the junctions and vulnerable details identified during design.

If the design identified a particular junction as sensitive, inspect that junction. If a wall was unusually exposed to wind-driven rain, inspect it after severe weather. If a sub-floor void was already marginally ventilated, check its conditions after insulation makes it colder. If an IWI system surrounds embedded timber, that deserves particular attention.

We do not need to search randomly for failure.

We should revisit the places where building science told us failure would be most likely to appear.

Monitoring should follow the risk assessment.

What if something unexpected happens?

Suppose mould appears around one window reveal after IWI.

That does not automatically prove that the entire insulation strategy was wrong.

Perhaps the reveal was inadequately insulated. Perhaps air leakage exists at the junction. Perhaps internal humidity is unexpectedly high. Perhaps the extraction system is not operating correctly. Perhaps the window detail created a localised thermal bridge.

The response should therefore be familiar:



Investigate the mechanism before prescribing the remedy.

An unexpected result does not make defects desirable.

But it can provide new evidence about how the building behaves.

A building that behaves differently from the prediction is telling us that one or more of our assumptions were incomplete.

Perhaps the construction was different. Perhaps the moisture loading was greater. Perhaps the weather exposure was underestimated. Perhaps workmanship differed from the design. Perhaps occupant behaviour changed. Perhaps the model was wrong.

The sensible response is to learn from that evidence.

An unexpected result is not merely a retrofit problem. It is new evidence about how the building behaves.

Workmanship matters

There is another uncomfortable truth. A good design can be badly installed.

Insulation boards can contain gaps. Membranes can be punctured. Eaves ventilation can be blocked. Insulation can be compressed. Junction details can be omitted. Extract ducts can terminate incorrectly. Specified thicknesses may not be achieved. Materials can be substituted. Wet masonry can be covered prematurely.

So when actual performance differs substantially from the prediction, the question is not only: Was the design correct?

It is also: Was the design actually built?

This is another reason why photographs taken during installation can be so valuable.

Once the plasterboard goes on, much of the evidence disappears.

The handover matters

A technically successful retrofit can still perform badly if nobody explains how the completed building should be used.

A new ventilation system may have filters that require cleaning. Extract fans may have settings that should not be altered. Background ventilators may need to remain open. Heating controls may work differently. Roof or sub-floor ventilation routes must not subsequently be blocked. External insulation may require inspection and maintenance. New finishes may require compatible repair materials. The occupant should know these things.

If the successful performance of the retrofit depends upon something continuing to happen, somebody needs to know that.

Handover is part of the building science.

Maintain the retrofit

Insulation does not remove the need for building maintenance.

If anything, some retrofit systems make maintenance more important.

An EWI system depends upon the integrity of its external finish and junctions. A roof-insulation strategy may depend upon ventilation openings remaining clear. A suspended-floor system may depend upon air bricks remaining unobstructed. A mechanical ventilation system may depend upon clean filters and functioning fans. An IWI system may depend upon external masonry continuing to resist excessive rain penetration.

And every traditional building still depends upon the fundamentals: sound roofs, working gutters, appropriate external finishes, effective drainage, controlled moisture production, and sensible maintenance.



Retrofit does not replace maintenance. It becomes something else that needs maintaining.

Keep the records with the building

Chapter 12 recommended keeping drawings, specifications, photographs, calculations, product information, Building Control documentation and warranties. There is a reason.

Ten years later, somebody may investigate a damp patch on an insulated wall. Twenty years later, somebody may replace a window. Thirty years later, somebody may renovate the building again.

Knowing what is behind the visible surface could completely change the investigation.

So the retrofit record should ideally remain with the property, not disappear into the email account of the person who commissioned the work.

That is particularly important as buildings become more technically complex.

Closing Thoughts

Retrofitting insulation can be one of the most worthwhile changes we make to an existing building.

A warmer home can be more comfortable, less expensive to heat and less carbon-intensive to occupy. Better-insulated surfaces can reduce radiant discomfort and, in the right circumstances, improve resilience against surface condensation and mould. Those benefits are real.

TC-07 has not argued against insulation.

It has argued for something more demanding - and more useful:

Insulation that is appropriate to the building receiving it.

That distinction matters particularly in the Isle of Man.

Our building stock contains many different construction types, often combined within the same property. They do not all manage heat and moisture in the same way and should not automatically receive the same retrofit solution.

Energy efficiency matters

The need to reduce energy consumption and carbon emissions is legitimate.

So is the desire of a homeowner to make an expensive-to-heat building warmer and more comfortable.

Those objectives should not be diminished simply because a building is old.

Traditional buildings can and should benefit from thoughtful energy improvement.

But an admirable objective does not remove the need to interrogate the method used to achieve it.

Throughout this guide we have questioned calculated U-values, theoretical savings, manufacturer claims, material properties and assumptions about existing construction. That is not scepticism for its own sake.

It is the same evidence-led discipline we would apply to any other building problem.

A good objective does not make every intervention used to achieve it a good intervention.

The lowest U-value is not the destination

Perhaps the easiest mistake in retrofit is to allow a measurable target to become the objective. U-values are useful.

But a building is not a U-value.

A wall also has to manage rain, vapour, liquid moisture, salts, thermal movement and drying.

A floor may contain timber. A roof needs to manage ventilation. A junction may become a thermal bridge. A household produces moisture.

And a traditional building may already contain materials and alterations accumulated over more than a century.

The best solution therefore may not be the one that produces the most impressive number.

The objective should not automatically be the lowest achievable U-value.

The Tree Cassyn balance

It should be the best whole-building balance of:

energy saved,



comfort gained,

financial cost,

carbon reduction,

durability,

and moisture safety.

That is the central proposition of TC-07.

Learn from what has happened before

There is another reason for caution.

Many interventions now causing problems in traditional buildings were once undertaken with entirely good intentions.

Hard cement renders promised durable weather protection. Impermeable internal finishes appeared modern and convenient. Suspended timber floors were replaced with concrete. Ventilation openings were sealed to stop draughts. Chimneys were blocked. Cavities were filled. Roofs were sprayed with foam.

The people making those decisions were not necessarily careless.

They were often using the materials, knowledge and assumptions available to them at the time. Some interventions worked perfectly well.

Others changed the building in ways that were not fully appreciated until much later.

That history should make us neither nostalgic nor frightened of innovation. It should make us curious.

Before changing the way a building works, understand how it works now.

Sometimes less can achieve more

Proportionality matters.

The best retrofit is not necessarily the maximum intervention the building can accommodate. It may be the minimum intervention needed to achieve the desired result safely.

And sometimes the answer is not insulation

Choosing not to insulate something can be an evidence-led retrofit decision.

Buildings deserve individual answers

Perhaps that is ultimately what TC-07 is about.

Not insulation products. Not U-values. Not lime versus synthetic materials. Not internal versus external insulation.

It is about resisting the temptation to give complicated buildings simple answers.

A 600 mm random-rubble Manx wall facing the prevailing weather is not merely an entry in an energy model.

Neither is a Victorian brick terrace in Douglas. Neither is a cottage in Peel, a former mining house in Laxey, an inter-war cavity house or a converted traditional building containing several generations of alteration.

They have histories. They have materials. They have exposure. They have defects. They have occupants.

And they have existing ways of managing heat and moisture. Good retrofit begins by understanding those things.





One final thought

The buildings around us have already survived decades - and in many cases centuries - of Manx weather, changing occupants, changing heating systems, changing materials and changing ideas about how buildings should work.

We should absolutely improve them. We should make them warmer.

We should reduce unnecessary energy consumption. We should reduce carbon emissions.

We should make them comfortable places in which to live.

But we should do those things with enough understanding that the improvement we make today does not become the defect somebody investigates tomorrow.

Understand the building.
Understand the intervention.
Understand what will change.
Then insulate.

And after we do:

Keep listening to the building.

Glossary of Terms

This glossary explains the principal technical terms used in TC-07. Definitions are intended for practical building-science use within the context of this guide.

Absolute humidity (AH) - The mass of water vapour present in a given volume of air, commonly expressed in g/m³. Unlike relative humidity, it is a useful way of comparing the actual quantity of moisture in air at different temperatures.

Airtightness - The degree to which uncontrolled air leakage through the building envelope is limited. Improving airtightness can reduce heat loss, but it must be considered alongside deliberate ventilation.

Air permeability - A measure of how readily air passes through the building envelope under a pressure difference. It is commonly used when assessing airtightness.

Building Control - The regulatory process concerned with compliance with the Isle of Man Building Regulations. Retrofit insulation may engage Building Control requirements where work alters a thermal element or affects matters such as ventilation or fire safety.

Building fabric - The physical elements forming the building, including walls, floors, roofs, windows and doors, together with the materials and junctions that make them up.

Breathable - A commonly used descriptive or marketing term rather than a precise building-science property. It often implies vapour permeability, but moisture behaviour also involves liquid-water transport, capillarity, hygroscopicity, moisture storage and drying potential.

Capillary action / capillarity - The movement of liquid water through small pores within a material, including movement that can occur against gravity. It is distinct from water-vapour diffusion.

Carbon reduction - A reduction in greenhouse-gas emissions associated with a building or intervention. TC-07 distinguishes operational carbon associated with energy use from embodied carbon associated with materials and construction.

Cavity wall - A wall constructed with two separate leaves divided by a cavity. The cavity helps resist transfer of rainwater to the inner leaf and may also contain insulation.

Cavity-wall insulation (CWI) - Insulation installed within the cavity between the leaves of a cavity wall. Retrofit systems are commonly injected or blown into an existing cavity. Suitability depends upon construction, cavity condition, exposure and moisture risk.

Cold bridge / thermal bridge - A localised part of the building envelope through which heat flows more readily than through surrounding construction. Its internal surface may therefore be colder and more vulnerable to condensation or mould.

Condensation - The change of water vapour into liquid water when conditions cause air or a surface to reach saturation. In buildings, TC-07 distinguishes surface condensation from interstitial condensation.

Declared thermal conductivity - The thermal-conductivity value declared for an insulation material under specified test and assessment conditions. It should be considered together with actual installed thickness and the complete construction.

Dew point - The temperature at which air of a given moisture content becomes saturated and condensation can begin if further cooling occurs.

Drying potential - The capacity of a material or construction to release accumulated moisture over time. It depends upon the complete construction, environmental conditions and the available routes for moisture movement.

Embodied carbon - Greenhouse-gas emissions associated with producing, transporting, installing, maintaining and ultimately disposing of building materials and systems. It is distinct from emissions arising from energy used to operate the building.

Energy baseline - An assessment of the building's energy use before intervention, ideally informed by actual consumption, heating pattern, occupancy and relevant weather conditions rather than modelled assumptions alone.



Equivalent air-layer thickness (Sd-value) - A measure of the water-vapour resistance of a constructed material layer, expressed as the thickness in metres of an equivalent layer of still air. Sd = μ × material thickness in metres. Unlike μ, Sd therefore reflects the actual thickness installed.

External wall insulation (EWI) - An insulation system applied to the outside of an external wall, normally incorporating insulation, fixings and a protective finished surface. EWI changes the wall's temperature profile and external wetting and drying environment.

Fabric moisture - Moisture contained within the materials of the building itself, rather than water vapour present in the surrounding air.

Heat flow - The transfer of thermal energy from a warmer region towards a colder one. Insulation reduces the rate of heat flow; it does not stop heat transfer completely.

Hygroscopic - Describes a material capable of taking up and releasing water vapour from the surrounding air in response to changing humidity.

Hygrothermal - Relating to the combined behaviour and interaction of heat and moisture within a material, construction or building.

Injected cavity insulation - Retrofit cavity-wall insulation introduced through drilled holes into an existing cavity. Depending on the system, material may be blown, injected or foamed into place.

Insulating lime plaster - A family of lime-based plasters containing lightweight insulating constituents such as cork, hemp or mineral aggregates. Performance varies between products. The term itself does not define thermal conductivity, vapour resistance or suitable installed thickness.

Insulation continuity - The extent to which the insulation layer remains uninterrupted around the building envelope. Breaks or poorly detailed junctions can create thermal bridges.

Interstitial condensation - Condensation occurring within the layers or fabric of a building element rather than on its visible surface. It can arise where water vapour reaches sufficiently cold conditions within a wall, roof or floor.

Internal wall insulation (IWI) - Insulation applied to the room-facing side of an external wall. It can improve internal surface temperature and reduce heat loss, but generally leaves the original wall colder than before and can significantly alter moisture behaviour.

kWh (kilowatt-hour) - A unit of energy. One kilowatt-hour is the energy used by a 1 kW appliance operating for one hour. Household energy consumption and predicted retrofit savings are commonly expressed in kWh.

Lambda value (λ) / thermal conductivity - A material property describing how readily heat passes through a material, normally expressed in W/mK. A lower λ-value indicates lower heat conductivity. λ alone does not tell us how much insulation a layer provides: installed thickness also matters.

Liquid-water transport - Movement of water in liquid form through or across building materials, including absorption, capillary movement, gravity-driven flow and rain penetration. It is distinct from water-vapour diffusion.

Moisture buffering - The ability of materials to absorb and later release moisture in response to changes in surrounding conditions, moderating short-term humidity fluctuations.

Moisture content - The quantity of water contained within a material. The meaning and units depend upon the material and measurement method, so readings from different methods are not automatically interchangeable.

Moisture stress - A practical description used in the Tree Cassyn guides for the moisture loading imposed upon a building or part of a building by occupancy, weather, defects or environmental conditions.

MVHR (mechanical ventilation with heat recovery) - A mechanical ventilation system that extracts stale or moisture-laden air and supplies fresh air while transferring some heat between the outgoing and incoming air streams.



Operational carbon - Greenhouse-gas emissions associated with the energy used to operate a building, particularly heating, hot water, lighting and other services.

Performance gap - The difference between predicted or designed building performance and what is actually achieved in use. Causes can include assumptions, occupant behaviour, weather, workmanship, commissioning and differences between modelled and real construction.

Prebound effect - The tendency for some buildings or households to consume less energy before retrofit than theoretical models predict. This can mean that some modelled energy savings were never realistically available to be saved.

Relative humidity (RH) - The amount of water vapour in air expressed as a percentage of the maximum amount that air could hold at the same temperature. Because the capacity of air to contain water vapour changes with temperature, RH can change even when the actual amount of moisture remains the same.

Rebound effect - The tendency for part of an expected energy saving after efficiency improvement to be taken as additional comfort or increased use instead. For example, occupants may heat a previously cold home to a higher temperature after insulation.

Retrofit - Work undertaken to improve or alter an existing building after its original construction. In TC-07 the term is used principally for energy-efficiency and insulation measures.

R-value / thermal resistance - The resistance to heat flow provided by a particular layer, expressed in m^2K/W. For a uniform layer, R = thickness in metres ÷ thermal conductivity λ. Increasing thickness increases the thermal resistance provided by that layer.

Solid wall - A wall without a designed cavity separating inner and outer leaves. Traditional Manx examples include thick stone random-rubble construction and solid brick walls.

Spray polyurethane foam (SPF) - A foam insulation applied by spraying, commonly encountered on the underside of roof coverings or between roof timbers. Open-cell and closed-cell products behave differently. SPF can affect moisture behaviour and can restrict inspection of the roof structure.

Surface condensation - Condensation forming on a visible surface when that surface is sufficiently cold relative to the temperature and moisture content of the surrounding air.

Surface temperature - The temperature of the visible or accessible surface of a building element. It is important to comfort and to assessing surface-condensation and mould risk.

Thermal bridge - See Cold bridge / thermal bridge.

Thermal conductivity (λ-value) - See Lambda value (λ) / thermal conductivity.

Thermal element - A wall, floor or roof that separates a thermally conditioned part of a building from the outside, ground or another relevant space. Altering the thermal performance of such an element can engage Building Regulations requirements.

Thermal mass - The ability of building materials to absorb, store and later release heat. Heavy masonry generally has substantial thermal mass and may respond slowly to changes in air temperature.

Thermal resistance (R-value) - See R-value / thermal resistance.

U-value - A measure of the overall rate of heat transfer through a complete building element, expressed in W/m^2K. Lower values indicate lower heat transfer. U-values combine the thermal resistances of the layers and relevant surface resistances. In existing traditional construction, calculated values may depend heavily upon assumptions and should not automatically be treated as measured performance.

Vapour control layer (VCL) - A layer designed to limit the passage of water vapour into a construction. Its suitability, continuity and position depend upon the complete hygrothermal design; it should not be treated as an automatic requirement for every traditional-wall insulation system.



Vapour-open - Describes a material or construction offering relatively low resistance to water-vapour diffusion. Vapour openness can assist drying in appropriate constructions, but does not mean that a material is immune to moisture problems or necessarily manages liquid water appropriately.

Vapour pressure - The partial pressure exerted by water vapour within air. Differences in vapour pressure can drive water-vapour diffusion through materials.

Water-vapour diffusion - The movement of water vapour through materials in response to a vapour-pressure difference. It is only one mechanism of moisture movement within buildings.

Water-vapour resistance factor (μ-value) - A dimensionless material property comparing resistance to water-vapour diffusion with that of the same thickness of still air. μ describes the material; it does not by itself describe the vapour resistance of the installed layer.

Wind-driven rain - Rain carried against a building surface by wind. Exposure varies with orientation, shelter, topography and weather and is an important consideration when assessing wall insulation and moisture risk.

Whole-building approach - An approach that considers the building as an interacting system rather than treating individual energy measures in isolation. Construction, condition, exposure, moisture, heating, ventilation, occupancy, cost, carbon and maintenance are considered together.

Further Reading / Sources

TC-07 draws upon a broad evidence base spanning Manx legislation and policy, building-performance research, conservation guidance, retrofit research and professional guidance.

The sources below are selected because they materially informed the principles and technical discussion in this guide. They are not presented as a substitute for project-specific design, Building Control advice or professional assessment.

A note on jurisdiction - UK research and guidance is used extensively because the underlying building physics and much of the traditional building stock are directly relevant. However, UK legislation and Approved Documents do not automatically apply in the Isle of Man. Where regulatory requirements are discussed, the Manx legal and Building Control position should be checked separately.

Isle of Man - legislation, policy and local context

Building Regulations 2014 - Isle of Man Government / Manx Legislation

The principal Manx Building Regulations referenced when considering whether retrofit work alters thermal elements or engages requirements concerning energy efficiency, ventilation, fire safety and other regulated matters.

View source

Energy Efficiency Scheme - Isle of Man Government

Current Government information on domestic energy-efficiency support and the Island's policy objective of reducing household energy use and emissions.

View source

Energy Efficiency Scheme extended to help with energy costs - Isle of Man Government, 7 May 2026

Provides current policy context for household energy-efficiency measures and links those measures to the Island's net-zero commitments.

View source

Retrofit for the Future - Isle of Man Government

A particularly relevant Manx resource because it explicitly recognises that generic retrofit solutions may not suit Manx stone cottages, Victorian houses and other characteristic Island building types, and highlights condensation, character and detailing risks.

View source

Energy advice made simple - Isle of Man Government

Practical local energy-efficiency advice, including loft insulation and the importance of maintaining roof ventilation.

View source

British Standards and retrofit frameworks

BS 5250:2021 - Management of moisture in buildings. Code of practice

A current British Standard adopting an integrated whole-building approach to moisture-risk management. Particularly relevant to retrofit because its wall, floor and roof guidance addresses buildings undergoing energy-saving measures.

View source

BS 40104:2025 - Retrofit assessment for domestic dwellings. Code of practice

A whole-dwelling pre-retrofit assessment framework intended to ensure that proposed retrofit responds to the specific construction, context and use of the dwelling rather than relying upon generic assumptions.

View source



PAS 2035:2023 - Retrofitting dwellings for improved energy efficiency. Specification and guidance

An end-to-end retrofit framework covering assessment, option appraisal, design, installation, handover and evaluation. It is particularly relevant to TC-07's emphasis on whole-building planning and post-retrofit verification.

View source

BS 8104:1992 - Code of practice for assessing exposure of walls to wind-driven rain

Provides recognised methods for assessing wall exposure to wind-driven rain and identifies factors including local climate and topography. Particularly relevant to exposed Manx elevations and wall-insulation decisions.

View source

BS EN 15026:2023 - Hygrothermal performance of building components and building elements. Assessment of moisture transfer by numerical simulation

Sets out the basis for transient numerical simulation of heat and moisture transfer through building structures. Relevant where simplified steady-state condensation assessment does not adequately represent moisture storage, liquid transport, rain or drying behaviour.

View source

Historic England - whole-building retrofit guidance

Energy Efficiency and Retrofit in Historic Buildings - Historic England, updated 24 June 2026

The principal gateway to Historic England's current technical advice on energy efficiency, retrofit, climate resilience and traditional construction.

View source

Improving Energy Efficiency Through Mitigation - Historic England, updated 24 February 2026

Sets out a whole-building energy-efficiency hierarchy and cautions against assuming that a fabric-first approach is always the most technically sound or effective option for traditional buildings.

View source

Building Performance Factors - Historic England

Explains the interaction between external environment, building fabric, services and occupants - a useful foundation for TC-07's whole-building approach.

View source

Upgrading Thermal Elements: Installing Insulation - Historic England

Overview of the opportunities, limitations and technical risks associated with adding insulation to traditionally constructed buildings.

View source

Insulating Walls in Historic Buildings - Historic England, updated 7 July 2026

Detailed guidance on assessing wall condition, moisture, thermal behaviour and the suitability of solid-wall insulation. Particularly relevant to the principle that defects and excess moisture should be addressed before insulation is installed.

View source

Internal Wall Insulation - Historic England, published 29 October 2025

Detailed current guidance on IWI, including directly adhered systems, framed systems and insulating plasters; thermal continuity; moisture risk; junctions; and the effect of IWI on traditional fabric.

View source

Building Performance Evaluation for Energy Efficiency - Historic England

Supports the guide's emphasis on measured performance, proportional monitoring, post-occupancy evaluation and comparison between predicted and achieved results.

View source

Energy Performance Certificates - Historic England, updated 3 February 2026

Reviews limitations in standardised energy assessment of traditionally constructed buildings and the value of measured building data where default assumptions misrepresent actual performance.

View source

Adapting Historic Buildings for Energy and Carbon Efficiency - Advice Note 18 - Historic England, 2026

Current strategic guidance on improving energy and carbon performance while conserving historic fabric and significance.

View source

Whole-life carbon and overheating

Risks of Energy Efficiency Interventions in Buildings of Traditional Construction - Historic England, updated 22 May 2026

Current guidance on unintended consequences of retrofit, including moisture accumulation, overheating, indoor air quality and whole-life carbon. Supports TC-07's emphasis on whole-building risk rather than thermal performance in isolation.

View source

Overheating in Historic Buildings - Historic England, updated 7 July 2026

Current guidance on summertime overheating, thermal comfort and ventilation in historic buildings, using a whole-building approach and recognising the influence of construction, use, occupants and environmental context.

View source

Measuring Embodied Carbon of Different Retrofit Packages in Historic Buildings - Historic England Research Report 79/2025 - Ruth Saint and Jim Hart

Research quantifying embodied carbon across defined retrofit packages and traditional domestic archetypes, supporting consideration of material quantity, life cycle and whole-life carbon alongside operational energy reduction.

View source

Measured performance and hygrothermal research

Energy Efficiency and Historic Buildings: Assessing the Thermal and Hygrothermal Performance of Two Refurbished Dwellings - Historic England Research Report 11/2023 - Paul Baker and Iain McCaig

Long-term research into two traditionally constructed solid-wall dwellings following fabric upgrades. It includes in-situ U-values, airtightness, whole-building heat-loss testing and long-term monitoring of wall moisture behaviour, including comparison of vapour-open and vapour-closed IWI.

View source

The SPAB Building Performance Survey 2017 - SPAB / Historic England Research Report 89/2017 - Caroline Rye and Cameron Scott

Part of SPAB's long-running programme measuring fabric heat loss, air leakage, indoor air quality, wall moisture behaviour, comfort and fabric-risk conditions before and after energy-efficiency refurbishment.

View source

SPAB Completes Over Ten Years of Research into the Energy Efficiency of Old Buildings: A Précis - Society for the Protection of Ancient Buildings (SPAB)

A concise overview of SPAB's research programme, including in-situ U-value measurement and the finding that many traditional walls lose less heat than standard assumptions suggest, alongside caution over the type and quantity of insulation applied.

View source

Historic Building Energy Performance Potential: Demonstrator Project - Historic England Research Report 94/2025 - Chris Ricketts and Richard Jack

Compares default EPC assumptions with in-situ measurements across traditional buildings, including U-values, airtightness and whole-house heat loss. Particularly relevant to TC-07's distinction between measured, calculated and assumed performance.

View source

DEEP - Demonstration of Energy Efficiency Potential

DEEP Synthesis Report - UK Government / Department for Energy Security and Net Zero

Large retrofit research programme examining real-world performance of multiple energy-efficiency measures. The synthesis includes solid-wall insulation, measured heat-transfer changes, condensation risk, overheating, costs and the performance gap.

View source

DEEP Literature Review - UK Government

A broad evidence review covering loft, wall and floor insulation, windows, airtightness, whole-house retrofit, modelling and unintended consequences.

View source

DEEP Energy House - Fabric Performance Testing - UK Government

Controlled testing of retrofit measures including solid-wall insulation, whole-house heat-transfer coefficient testing and in-situ U-value measurement. Useful for understanding the difference between component and whole-building performance.

View source

Moisture, materials and responsible retrofit

Insulation Materials Selection for Traditional Buildings - Sustainable Traditional Buildings Alliance (STBA)

Technical guidance on moisture movement and material selection in traditional-building retrofit, including vapour, liquid-water and moisture-storage behaviour. Particularly relevant to TC-07's caution against treating 'breathability' as a complete specification.

View source

Sustainable Traditional Buildings Alliance - STBA

Further guidance, technical briefings and the Responsible Retrofit approach for traditional buildings.

View source

Spray polyurethane foam insulation

Spray Foam Insulation - Consumer Guide - Royal Institution of Chartered Surveyors (RICS)

Guidance on retrospective spray-foam roof insulation, including whole-building considerations, roof condition, condensation risk, ventilation, documentation, inspection and implications for future valuation or lending.

View source

How these sources have been used

TC-07 does not treat any single organisation as the authority for every retrofit decision.

Manx legislation and Government material provide the local regulatory and policy context. British Standards and PAS documents provide recognised technical frameworks for moisture management, exposure assessment, pre-retrofit assessment and hygrothermal analysis; they are used as technical references and do not displace the separate Manx regulatory position. Historic England and SPAB provide an extensive evidence base concerning traditional construction, measured thermal performance, whole-life carbon and moisture behaviour. DEEP contributes broader experimental and in-use retrofit evidence. STBA provides additional material-focused moisture and responsible-retrofit guidance. RICS guidance is used particularly where retrofit measures interact with surveying, inspection and property transactions.

Where evidence is derived from case studies or monitored buildings, TC-07 treats it as evidence of what can occur rather than proof that every superficially similar building will behave identically.

The purpose of further reading is not to replace judgement with more documents. It is to make the assumptions, evidence and uncertainties behind that judgement easier to interrogate.

ABOUT THE TREE CASSYN BUILDING SCIENCE SERIES

The Tree Cassyn Building Science Series provides practical, evidence-led guidance on the behaviour, maintenance and repair of traditional buildings on the Isle of Man.

Tree Cassyn is an independent Isle of Man firm specialising in damp, timber and moisture investigations, using a diagnostic, evidence-led approach informed by established professional guidance and relevant British Standards.

Each guide introduces one aspect of building performance in accessible terms, drawing upon the recurring construction details and moisture patterns encountered during Tree Cassyn investigations.

IMPORTANT NOTE

This publication provides general educational guidance. Traditional buildings vary considerably, and similar-looking symptoms may arise from different causes. Repairs should be based upon an investigation of the individual building rather than upon general descriptions alone.

TREE CASSYN

DAMP · TIMBER · MOISTURE INVESTIGATIONS

ISLE OF MAN

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