QUALITY BUILDING

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COMFORTABLE ✓ HEALTHY ✓ ENERGY EFFICIENT

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What do you need from your home?

You need a structure for you and your family to live in that is well-built and comfortable. It needs to help you stay healthy, by keeping out draughts, moisture and noise while bringing in lots of natural light and fresh air. You also need it to be affordable - so the costs to run and maintain your home don't break the bank every month.

"They've got insulation to die for!"

What does your house need from you to give you all of that?

Your home needs to be properly insulated, airtight and well ventilated. With those fundamentals covered, plus a few additional considerations, you and your family will be able to be healthy and comfortable in your home and save money on your energy bills as well.

As you read this book, you might be considering a new build or a renovation, or you may just want to learn more about quality buildings. This e-book will cover a variety of concepts and ideas that you can review and discuss with your designer and builder.

Contents

What is Quality Building?

Would you buy a car that had been cobbled together by a friend in a garage? Of course not! We love design and quality when it comes to our cars. We shop around for the best most modern design or the most fuel efficient car. We put our faith in certain brands because they have built a reputation of quality over the years

This quality is based on an integrated approach to design, materials, build quality, reliability and fuel efficiency. Yet a car only has a design life of 10 to 15 years.

Airtightness gasket

Why do we have a different attitude to quality when it comes to building or renovating our homes?

Our homes are structures that are supposed to last a hundred years and that we intend to pass on to our children. It is even more important that we demand quality from our designers and builders.

Quality results when everyone in the complicated process of building loves what they do, when they all share a common vision and have the skills and training to deliver it. However, it starts with you, the customer! Before you hire your architect and builder, ask them some questions.

Does the architect understand beautiful quality energy-efficient design? Are they prepared to slave over the design, through 10 different stages, crafting a beautiful and energy-efficient house, specifically for your needs, ensuring the perfect fit for your family, positioning the building on the site to capture the sun, creating a form that can minimise heat loss, sizing windows that will enhance your mood and feeling of wellbeing, considering views, daylight and visual delight while minimising impact on nature and the environment?

Can they test their design in simple excel-based software to prove to you that it will be energy efficient even before it is built? Will they lavish attention on the details, tweaking an eaves detail, honing a cill detail? Will they work on the tiny details that are needed to cut energy use to almost zero, ensuring there are no pathways for heat to leak out of your home? Have they upskilled to be able to deliver a near-zero-energy home required under new building regulations?

Does the contractor share this vision to take this honed and crafted design and turn it into the perfect realisation of quality? Does he understand why the designer slaved over that detail to eliminate heat loss? Does he work with his subcontractors as a team, or argue and recriminate?

Are the contractor and his operatives trained to deliver the build quality that matches the design? Will they take the same pride in crafting a beautiful and well-made building?

Will everyone on site work to deliver the same attention to detail? Will the plumber use the right drill bit to bore a perfectly sized hole for the pipe through the block work, lovingly sealing it again with a perfectly sized airtightness gasket? Or will he just bang a hole through with a lump hammer and squeeze a glob of TEK 7 in the gap?

Does the electrician understand why he must be careful not to damage the air tightness membrane? Do the insulation installers understand why they need to measure and measure again ensuring that the insulation is cut to the millimetre and fits perfectly between the joists with no gap? Will they work with the contractor to deliver this design? Is everyone on site aware of the latest building regulations?

Quality building is a team effort. The brick layer, the roofer, the plasterer, the electrician, the plumber, the architect, the foreman, all need to be united and trained in one common goal - Quality!

Only then can you get what you paid for - a comfortable, healthy and energy-efficient home.

We hope this book gives you some of the vocabulary and knowledge you need to start a conversation with your architect, builder and tradesmen about quality. It will also give you the tools you need to ensure that they have the training, experience and skills to deliver you the home that you deserve.

What Does Insulation Do?

Different materials have different abilities to conduct heat. Insulating materials work by having a low thermal conductivity. This means that they slow down heat moving through the material. The lower the conductivity of an insulation and the thicker the insulation, the slower the heat passes through. Some insulation materials perform better than others, so can achieve better performance with the same thickness. The thickness of a material combined with its conductivity is used to calculate its thermal resistance.

A wall is made up of a series of layers, for example a cavity wall might have internal plaster, a block wall, a layer of insulation, an air gap and finally a brick wall. Each of these layers has their own thermal resistance. All of these thermal resistances in the wall are combined to calculate the U-value.

The U-value is probably the term you will hear most when talking about the energy efficiency of buildings. The U-value is the measure of the rate of heat transfer through a building element, e.g. window, wall, roof or floor.

The lower the U-value, the lower the rate of heat transfer through that element. Therefore designers and builders are striving for lower U-values to improve the energy performance of a building. If the U-value is improved your costs will be reduced.

Continuous Insulation

In order to be effective, insulation needs to be continuous and wrap around the whole building without any breaks. You can see, in the illustration to the right, how the insulation forms a continuous line inside the house. While the illustration shows insulation installed internally, external wall insulation can also be installed.

This continuous thermal barrier will reduce the heat loss from the building as long as the insulation has a minimal amount of gaps. When insulation is maintained around the building, then heat loss is minimised.

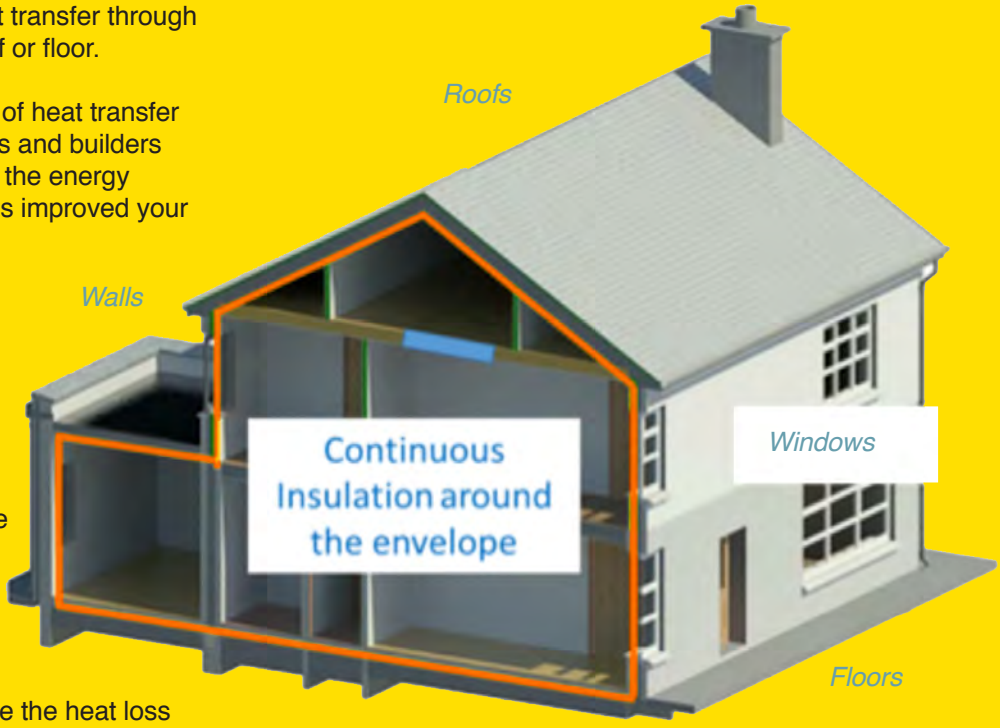
Think about how you wrap a jumper around you to keep warm, and any hole in your jumper will provide a draught which leads to discomfort and loss of heat. This also applies to a building.

So how do we achieve this continuous insulation?

There are 3 important points to remember when achieving continuous insulation

- Properties of Materials - choose adequate and correct insulation on all parts of the external building envelope
- Detailing - Eliminate thermal bridging
- Best Practice - Eliminate any gaps and holes in the insulation

Failure to achieve continuous insulation will give rise to heat loss and thermal bridging.



Continuous insulation shown by the orange line eliminates heat loss through the envelope

What is Thermal Bridging?

You might have heard about thermal bridging, perhaps mentioned by your builder or architect. But what exactly is it?

Thermal bridging occurs in building envelopes when gaps or breaks in the insulation envelope create pathways for heat to leak out of the building. It can be caused by poor workmanship where gaps are left between insulation bats.

It also happens when any material that easily conducts heat such as concrete or steel passes right through your insulation layer. It is like a leak in a bucket. Concrete window cills, lintels, thresholds, eaves details and rising walls are typical culprits.

This load bearing insulated foundation system helps eliminate thermal bridging from foundations.
Image courtesy Kore Systems

How is it avoided?

Architects and builders have to be clever to avoid thermal bridging and need to carefully design each detail using a combination of special products and ingenuity. They should be able to show you a blown-up detail drawing showing exactly how they propose to avoid a thermal bridge for each building junction. They can also use the Acceptable Details published by the Department of Environment but you need to be certain that these are followed exactly on site with no shortcuts.

For example, your rising wall from the foundation needs to have a thermal break built into it to avoid heat traveling down into the cold ground. Otherwise it is like your house is wearing no socks on a snowy day. This thermal break can be a special load-bearing material with insulating properties such as foamed concrete block like a concrete aero bar, or a special load bearing insulation that maintains the line of insulation at floor level. There are plenty of solutions but it needs careful thought by your builder.

The arrows in this photograph show where a thermal bridge has been formed by the chimney structure which passes right through the insulation layer.
Image courtesy of Gavin O'Shea

What does thermal bridging mean for heat loss and condensation?

On a cold day your valuable heat wants to be outside and will look for a way out. Any weak points such as poorly designed junctions or thermal bridges will act as one of these escape routes. Thermal bridging can be responsible for more than 15% of all heat lost through the thermal envelope.

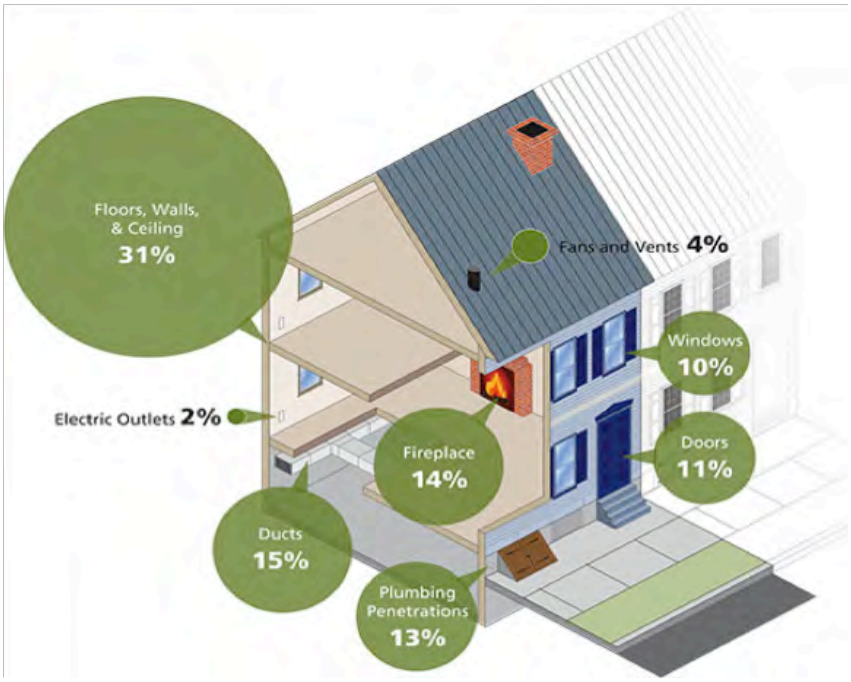
However that is not the worst. Thermal bridging means there are cold areas on the internal surfaces of your walls. As your precious heat queues up to leave through the thermal bridges, the water vapour from the moist internal air condenses onto these cold spots. This leads to mould growth and that is not a pretty sight!

Thermal bridging is a greater risk factor because of the levels of insulation now required under the current building regulations. Therefore your builder must take this issue much more seriously.

Thermal bridging leading to heat loss (the red parts of the image) can be seen in an infared photo

What is airtight construction?

The basic idea of an airtight building is that is has a continuous airtight envelope to control air leaking out of your home. This is especially important in cooler weather, as you don't want to lose the warm air that you have paid to heat!



Percentage of air leakage through a typical building

Why does Airtightness Matter?

An airtight building doesn't lose heat through gaps or allow incoming draughts. This means that your heating system will work more efficiently and you'll be more comfortable in your home. You'll also save money on your fuel bills.

How is Airtightness Achieved?

Airtightness means cutting out unwanted air leakage. While some leaks can be so slight as to be imperceptible, even slight draughts will increase heat loss and reduce comfort levels, sometimes dramatically. Airtightness requires attention to detail for new build situations. For retrofitting it is more challenging to achieve airtightness but it is possible through the application of particular approaches and systems.

What can your designer and builder do to achieve airtightness?

There are fundamental tasks your designer and builder should be doing to achieve air tightness. Beware of any builder who claims this doesn't matter – because it does!

Make sure your builder recognises that any worker who has a role in working on your building, i.e. bricklayers, carpenters, plasterers, plumbers, electricians, glaziers, painters and decorators, floor and carpet layers, and all other trades have a responsibility to ensure airtightness is not compromised.

Moisture in the Home

We produce a lot of moisture within the home from breathing, cooking, showers, baths and drying clothes. Unless your home is properly designed, there is a danger that this moisture can harm both your health and your home.

Surface condensation can be avoided by having good levels of insulation, avoiding thermal bridging and having a properly designed ventilation system. If the relative humidity levels in a home exceed 70% for prolonged periods, there is a high probability that the condensation occurring on cold surfaces will lead to mould growth. This can seriously affect the quality of the air for the occupants, and mould spores can have a detrimental effect on our respiratory systems.

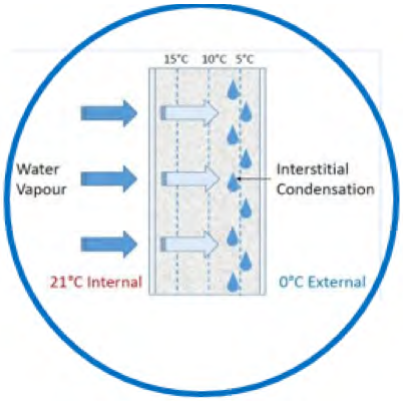
Make sure your building is designed right and built right for a healthy and comfortable home.

Surface condensation on windows due to heat loss through the windows and the incorrect levels of ventilation

Avoiding Interstitial Condensation

Interstitial condensation is when warm, moist air from inside the house penetrates inside a wall, roof or floor structure, reaches the dew point and condenses into liquid water. This is typically caused by poor installation of vapour barriers or failure to design in ventilation for timber structures which allows this moisture to dry out again.

A vapour barrier must be correctly installed when installing internal insulation. It must not be broken in any location and that includes plug sockets. Otherwise warm damp air bypasses the vapour barrier and condenses between the insulation and the cold wall.



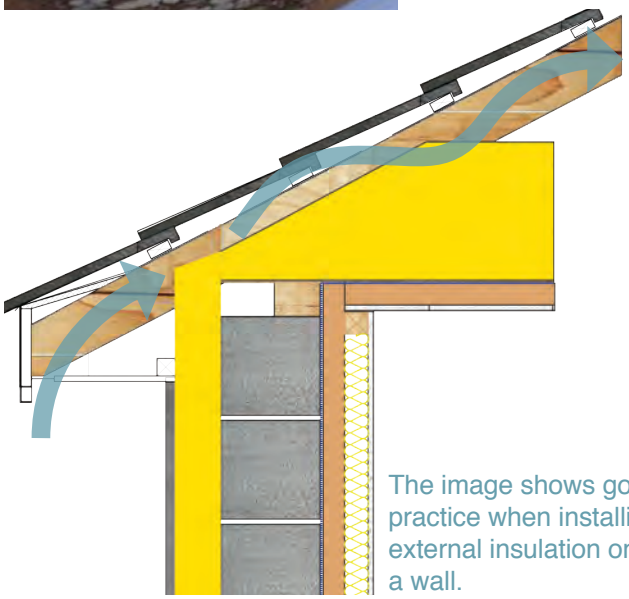
Interstitial Condensation through the wall of a house.

When moisture is trapped within the structure, it can cause reduced energy performance of the insulation, mould growth and even structural failure. This mould growth can have harmful consequences on the health of the occupants or other users of a building as the spores from the mould can get into the lungs and cause breathing and other difficulties.

Another typical example of where this can happen is when attics are converted. Often insulation is installed between the rafters, without ventilating between the roofing felt and the insulation. Even where a vapour barrier is installed, moist internal air can bypass the vapour barrier through weak points and get into the space between the rafters and condense onto the cold roofing felt under the slates. Without ventilation above the insulation to dry it out, moisture can build up over time making the insulation wet and ineffective. It causes mould and can eventually cause the rafters to rot. However you won't see anything until it's too late, maybe years after your builder has left.

Unfortunately this issue is not well understood by many builders so it is worth having a conversation particularly if you are insulating your attic. Make sure that they understand the principles of avoiding interstitial condensation. If you are seeking an SEAI grant for attic insulation, you are required to maintain or improve the ventilation levels within the roof structure. Many builders and insulation contractors think that this adds cost and is unnecessary. However they are wrong; it will be much more costly in the long run if you don't ventilate!

Showing interstitial condensation resulting with mould through the wall.



The image shows good practice when installing external insulation on a wall.

1. *The insulation (in yellow) in the attic must link up fully with the insulation on the external wall to avoid cold bridging.*
2. *The blue arrows indicate how the flow of ventilation is maintained from the eaves, up and over the insulation and into the attic ensuring that all the timbers, including that of the eaves and the rafters in the attic, are kept healthy and dry.*

Vapour Barrier applied carefully to underside of Rafters in attic to prevent moisture getting in. This also requires a ventilation space above the insulation to avoid interstitial condensation.
Image courtesy of Isover, Saint Gobain

Getting Ventilation Right

You have perhaps heard the saying **"Build tight, ventilate right".** This is critical; the more airtight your building the more important ventilation becomes. It is essential to provide the correct ventilation system to maintain a healthy indoor environment.

Options are available for both mechanical and natural ventilation systems, and your architect or builder should be able to explain the pros and cons of each in relation to your project.

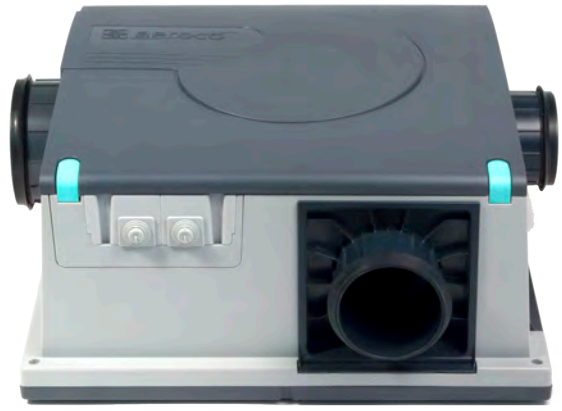
Ventilation is viewed by many as causing draughts and energy loss, but that is not true. Air infiltration from air leakage causes uncomfortable drafts. A correctly designed ventilation system is necessary to have a healthy, comfortable and energy-efficient home, but will not cause draughts.

Unfortunately, ventilation systems are often sealed up after installation by the occupants or left out altogether by the builders. This will eventually cause problems for the building and occupants.

Why Ventilate?

Ventilation is critical to provide you with a healthy and comfortable internal environment in your home. Ventilation is needed to remove unpleasant smells and odours and unhealthy toxins from paints, furniture, carpets and other products in your home. It is necessary to prevent the buildup of carbon dioxide. It is essential to prevent fatal consequences of buildup of carbon monoxide from combustion products. It removes excess moisture such as steam, especially from wet rooms, which prevents condensation and mould growth.

Ventilation systems should supply fresh air to the working, living and sleeping areas of buildings while removing stale air.



Components of a demand control ventilation system. A mechanical extract fan and wall vents react to humidity levels to increase the flow of fresh air to ensure good indoor air quality.
Images courtesy Aereco Ltd

How Windows Help Your House Stay Warm

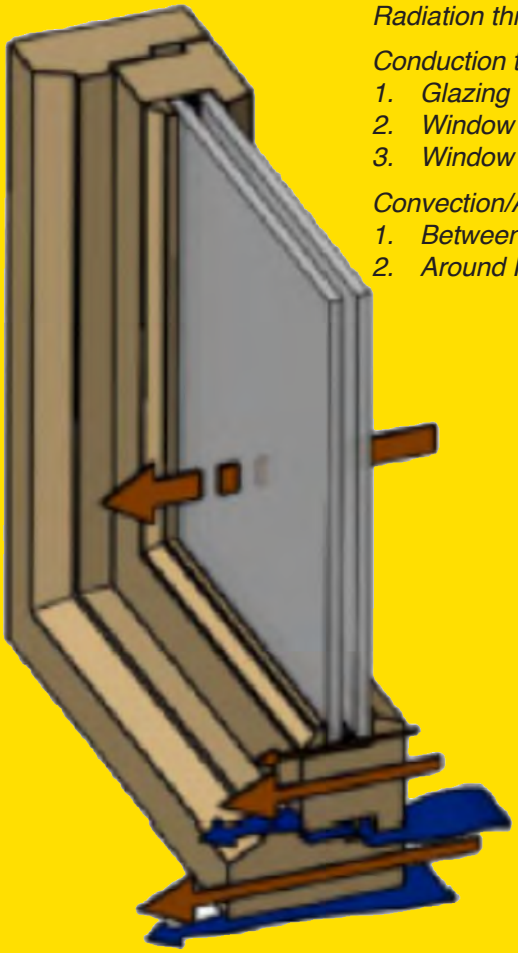
The size of your windows and where they are positioned in your house is a big contributor to the amount of heat that is gained from solar radiation. So designing the placement of the windows, buying the right type of windows and most importantly – making sure they are installed correctly! – are critical decisions when building or renovating your home.

Solar radiation enters through the glass part of the window before being absorbed by elements in the room such as the floors and walls, which in turn heat up. These elements will then give off heat which can be positive during winter.

To avoid overheating in the summer, shading along with specialised types of glazing can be used to control the rate and impact of solar gains, as well as helping to maintain the optimum amount of daylight for natural lighting. Different kinds of glazing can be used to draw the sun's heat into the interior, reject it, or allow interior heat to escape.

The number of panes of glass, internal coatings, colour tints, gaps and gasses between panes, all affect daylight and radiation transmittance. It is important to note that windows responsible for large solar gains (bringing in lots of heat) during the daytime and during summer may also be responsible for significant heat losses during night time and during winter, so thinking about window coverings is also important.

In Ireland, solar gain is optimised by positioning living area windows to face south, which maximises the potential heat gain where it can be most useful. Shading can then be used to block excess sun at warmer times and allow the sun's heat in at cooler times. To help you get the most benefit from your windows, your designer should work to maximise solar gain within your building in the winter to reduce space heating demand. However they also need to consider how to control solar gain in summer so that there is limited overheating. You may laugh at this but even in damp rainy Ireland, if your house is correctly built to current building standards it can overheat in the summer if there is excessive glazing facing south without summertime shading.



Radiation through glazing

Conduction through
1. *Glazing Spacer*
2. *Window Sash*
3. *Window Frame*

Convection/Air Leakages
1. *Between Sash & Frame*
2. *Around Frame*

Heat loss through a window

What You Need to Know about Building Regulations

You may have heard that the recent amendment to the Building Control (Amendment) regulations allows people building a single dwelling to opt out of the need for certification or inspection by a construction professional. However if you are considering this route you need to think about what you are getting into.

The current building regulations for energy efficiency – Technical Guidance Document Part L – are very onerous. In the space of five years, from 2006 to 2011, building regulations made a massive leap that requires a completely different approach to construction. New Irish houses, if built properly to comply with current regulations, would be amongst the best in Europe, but there's the rub...

Your builder used to be able to simply go down the builders' provider and ask how much insulation he needed in order to comply. Not anymore! It's a lot more complicated now, but for good reason. Even if you use the minimum insulation values for walls, floors, roof and windows as set out in the new building regulations (TGD Part L 2011), there is no guarantee the home will comply. For example you may have to increase the thickness of insulation still further if you have more windows than the regulations assume.

To prove compliance, builders and designers now have to use the software called DEAP (Dwelling Energy Assessment Procedure) which is used to generate BERs. This assesses whether you have the right mix of orientation, insulation, thermal bridge free construction, airtightness and heat recovery from ventilation to minimise overall heat loss. They also need to know about heating system efficiency, controls and renewable energy systems.

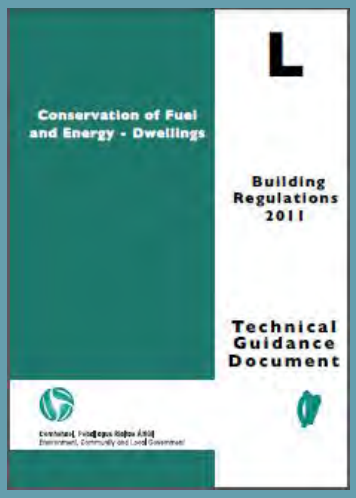
Put it simply, don't think you can hand over a basic set of planning permission drawings to a builder and expect to get a compliant home. Unless your builder is a dab hand at using specialist software, or has engaged in extensive retraining, your chances are next to ZERO.

Your builder will need a drawing for every junction of your home. He can forget about using any of the details he might have used five or ten years ago for window cills, lintels, foundations or eaves. Now all these junctions need to be carefully considered, designed and assessed to eliminate thermal bridging and, most importantly, condensation risk. The more insulation, the more care is needed to prevent moisture gravitating to weak points in your insulation. If your builder can do all that, he's a keeper!

Realistically, if you want a home that is compliant with building regulations you need the following:

- An upskilled professional: architect, engineer or surveyor who can calculate U-values; specify the insulation, heating and ventilations systems and prove compliance in the DEAP software
- Details of every wall, floor, roof and foundation junction in your home carefully assessed for airtightness, thermal bridging and condensation risk
- A builder who has upskilled in quality, energy-efficient construction and who knows how to implement these details on site
- An independent architect or other construction professional who can come on site at all the key stages of construction to check that all of these tiny details are built exactly in compliance with the drawings

Whilst you may save some money by skipping these steps you will probably lose far more on the resale value of your home and pay for it many times over in energy bills, not to mention putting your family's health at risk.



You can **DOWNLOAD** this document from the Department of Environment's website to have an idea of what is required to comply with building regulations for energy efficiency.

What is a Quality Home?

A Quality home is one that maximises our sense of wellbeing, has low running costs and is kind to our planet. Here are some of the issues under four key categories: Costs, Planet friendly, Wellbeing and Quality Assured.

Costs

- Very low running costs
- Flexible and adaptable design
- Low transport costs
- Low maintenance costs

Our Planet

- Very energy efficient with low carbon emissions
- Uses environmentally friendly materials
- Water efficient
- Efficient land use
- Reduces flood risk
- Improves local ecology

Wellbeing

- Excellent daylighting
- Good sound proofing
- Good indoor air quality
- Healthy materials
- Walkable distance to amenities
- Comfortable temperatures

Quality Assured

- Designed by highly skilled professionals
- Built by highly skilled Construction team
- Homes are tested for quality
- Developer provides aftercare

12 Tips for a Better Quality Renovation

01 Plan it right. Before you start, think about how each element - roof, walls, windows and floor - link up to create one cosy continuous unbroken warm coat for your house. How will the wall insulation connect seamlessly to the roof insulation? Remember if you went out on a cold day with a warm jacket but no trousers you wouldn't feel very comfortable either. (Not to mention the funny looks!)

02 Get your wall insulation right the first time. Don't skimp. You might want to consider external insulation rather than internal insulation. This means you don't need to redecorate internally and is also better at ensuring that there are no gaps in insulation where the internal walls meets the external wall.

03 When insulating your attic remember you need to maintain or improve the ventilation to your roof timbers. You don't want to be replacing your roof because of rot caused by moisture because of blocked ventilation.

04 The insulation in roof, walls and floors needs to connect. Even small gaps or spaces between insulation seriously affect its performance and you don't want to have wasted your money.

05 If you are insulating internally you need a properly designed vapour barrier inside the insulation to stop warm, moisture laden internal air infiltrating into the walls, condensing and causing mould inside your walls.

06 If replacing windows buy the best windows. Triple glazed windows are not much more expensive than double glazed. You will notice how much more comfortable it is to sit beside these as even in the coldest weather the inside surface of the glass stays warm.

07 Make sure that your windows are properly sealed to walls with proper airtightness tapes. Don't let the installer tell you that squirting foam between the window frame and the wall will make them airtight. It won't. Not much point putting in great windows if cold draughts are coming in all around the perimeter of the window.

08 If replacing windows at the same time as installing external wall insulation, make sure the windows are moved out to be in line with the insulation.

09 Consider increasing the level of daylight in your house. This will increase your sense of wellbeing. Roof lights are relatively easy to install and can make a great difference to your house.

10 If you've followed tips 1-8 your house is now nearly draught free, so you must be certain that you are getting adequate ventilation. Consider a proper ventilation system rather than those draughty hit-and-miss vents in your wall. A proper system will guarantee good indoor air quality, extracting excess humidity and keeping air fresh and dry, making sure that you don't get mould growth in the house that can affect your families' health.

11 Now that you have done all this work, you can now fit a new energy efficient boiler. This can be much smaller than you would have needed before you insulated and changed windows, as you now need a lot less heat output. Make sure that your plumber is sizing the boiler right, as an oversized boiler in an energy efficient house will operate inefficiently. Plumbers have a tendency to oversize so that they don't get called back.

12 If you don't want to plan this work on your own, or if you have questions about how to do it or what approach to take, you may want to consider getting independent professional advice, especially if you are undertaking major work.

Most importantly, your tradesmen must understand all of this too! Ask for examples of work, and make sure insulation contractors are on the SEAI installers list. Also check for evidence of upskilling in energy efficiency. Courses such as the Passive House tradesman training or completion of the European-funded QualiBuild Foundation Energy Skills training are examples.

Glossary of terms

Air Infiltration: The uncontrolled entry of fresh air into a building through air leakage paths, e.g. gaps at junctions between external building elements and around openings, unsealed penetrations of the building envelope..

Building Envelope: The building envelope is the line of separation between the inside and outside environments of a building.

Building Physics: The science of heat and moisture in buildings along with acoustical and light-related properties. Basic considerations include requirements for heating, sound, and lighting as well as comfort, air quality and general health of the internal environment.

Cost-optimal Level: The energy performance level which leads to the lowest cost during the estimated economic lifecycle.

Deep Retrofit: An investment in energy efficiency which saves 40% or more on energy bills. This typically involves a combination of two or more of the following: roof and wall insulation, renewable energy products, highly efficient heating system and heating controls.

Energy Audit: An assessment of the existing energy consumption of a building or service to identify and quantify cost-effective energy savings opportunities, and report the findings.

Energy Consumption: The amount of energy used excluding electrical generation and distribution losses.

Energy Performance Certificate: A certificate stating the energy performance of a building calculated using the national methodology as per European law. For domestic buildings, this is the Building Energy Rating (BER).

Energy Performance of a Building: The amount of energy measured or estimated to meet the different needs associated with the use of the building, which may include among other things: heating, cooling, hot water heating, insulation, ventilation and lighting, but also design and positioning in relation to climate and access to useful sunlight and influence of neighbouring structures, own-energy generation and other factors, including indoor climate, that influence the energy demand.

Nearly Zero Energy Building: A building that has very high energy performance, as determined in accordance with Annex I of the EPBD recast. The nearly zero or very low amount of energy required should be covered to a very significant extent by energy from renewable sources, including energy from renewable sources produced on-site or nearby [EPBD recast, 2010/31/EC].

Payback time/period: The length of time required to recover the cost of an investment.

Primary Energy: Energy from renewable and non-renewable sources which has not undergone any conversion or transformation process.

Renewable Energy Solutions: These are products that can produce energy from renewable sources such as sun, wind, water or air such as solar panels, wind turbines, wave turbines or heat pumps. Exclusively wood burning fires or boilers may also be considered ‘renewable’ as we can grow more trees.

Thermal Bridging: A fundamental of heat transfer that occurs in building envelopes when materials with high thermal conductivity (also called non-insulating material), such as steel, timber and concrete create pathways for heat loss that bypass thermal insulation.

Thermal Conductivity: The property of a material to conduct heat.

U-Value: U-value is the measure of the rate of heat loss through a material. It represents the amount of heat lost through one square meter of the material for every degree difference in temperature either side of the material. It is indicated in units of Watts per meter Squared per Degree Kelvin or W/m²K.

Ventilation: Ventilation is the controlled supply of outside fresh air to a building by natural and/or mechanical systems.