Multi-Comfort House

Renovation for comfortable living

Solutions for saving energy

ISOVER

Increased living comfort means a better quality of life

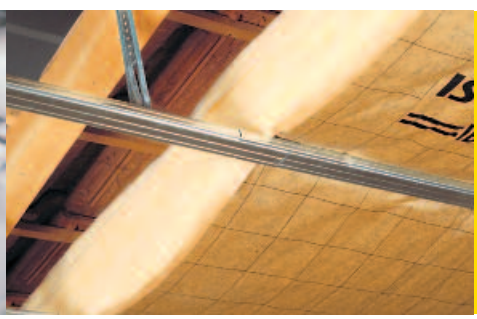
What do you need to make you feel truly at home in your own four walls? A comfortable indoor environment. We at ISOVER, the world's leading manufacturer of insulation materials, have recognized this and therefore offer products for thermal insulation, waterproofing, sound and fire protection which can be easily and securely installed to give you long-term protection, even in extreme weather conditions.

But how can you enjoy ideal indoor temperatures all year round and at the same time benefit from significant savings in energy bills? Our Renovation Guide provides you with useful information on thermal insulation and refurbishment. Simply consider your home, from roof to basement, and then use the ideas in this brochure to create the ideal level of comfort for your family's needs.

Start with an old barn – end up with a new lifestyle. Refurbishment to ISOVER Multi-Comfort House level.

Contents

Why make life difficult when it can be so easy? ISOVER not only offers you the products you need to renovate and modernize your home, but in this brochure we show you how to get the best results at the lowest cost for each stage of the work involved. Go ahead and discover the most efficient solutions for your home. Create exactly the level of comfort and indoor environment you want for you and your family.



Information – Planning – Realization: Effective insulation systems for your home.

Live life to the full in a Multi-Comfort House

When you are renovating your own home, you can make exactly the changes you want. ISOVER's perfectly matched systems and customized solutions help you achieve the comfort level of a passive house. And should your family situation change, you can even create additional, high quality living space, for example by converting the loft into a bedroom, study or children's room.

Increasing comfort standards increases the value and security of your home, in every way. The latest generation of high-performance insulation systems also sets new benchmarks for damproofing, sound insulation and fire prevention. You'll add value, and have a quieter and more relaxed atmosphere in your home.

Proper insulation makes all the difference

Modern comfort standards mean you are able to enjoy a constantly pleasant, uniform room temperature as well as fresh, draught-free air. In older buildings, however, it is harder to achieve these conditions, for the following reasons:

- Insufficient thermal insulation causes indoor floor and wall surfaces to feel cold, causing discomfort for occupants
- Leaks in the building envelope lead to permanent, uncontrollable draughts and significant heat losses.
- Windows and doors are poorly insulated and therefore leaky.

The ISOVER Multi-Comfort House ...

- *has been derived from the passive house concept and aims at bioclimatic design*
- *is sustainable and takes ecological, economic and social aspects into account*
- *offers maximum thermal comfort combined with high energy savings*
- *provides excellent acoustic and visual comfort, indoor air quality, fire protection and safety*
- *allows highly flexible design solutions – both indoors and outdoors*

and is a central element of the ISOVER strategy for sustainable building development.

Even if you are willing to put up with high energy consumption and hefty heating bills, you can never satisfactorily compensate for these structural defects. It's as simple as that: When living in a poorly insulated home, you pay a high price without any return on your investment in terms of living comfort. Moreover, the inefficient use of energy wastes resources and causes lasting harm to our environment.

Uncompromising comfort

A perfectly insulated building envelope, free of thermal bridges, keeps the warmth where it should be – inside your home. As a result, the surfaces of interior walls are maintained at very nearly room temperature, which not only creates a 'cosy' feeling, but prevents the detrimental effects of condensation. Don't compromise: make sure every part of your home, including windows and doors, is well insulated so that you can enjoy a constant temperature throughout your home.

Thermal renovation to low-energy house or even ISOVER Multi-Comfort House level drastically reduces the heating energy demand and saves cash for the truly enjoyable things in life. Once you have made the decision to renovate the existing building envelope, don't stop halfway, aim to substantially improve the overall energy performance of your home, to protect your family from ever-rising energy prices. Take the long-term view – short-term compromises will inevitably lead to significant additional expenditure.

The Energy Performance Certificate – making thermal performance transparent

Housing quality and property value – inseparably linked

In the foreseeable future, the energy efficiency of both residential and non-residential housing will be the pivotal factor in the real estate market. All buildings will require a so-called "Energy Performance Certificate", which vendors or landlords will soon be obliged to submit to potential buyers or tenants. Houses with low-level comfort and high operating costs will be easily recognizable by a rating in the "red" area, and will become unattractive and dramatically drop in value. It therefore pays to invest in existing buildings and get them "out of the red".

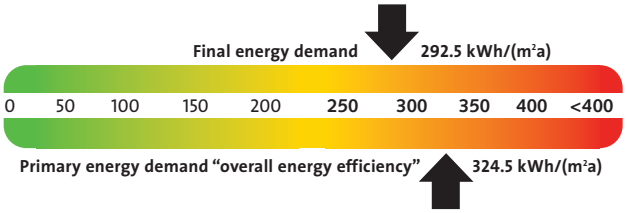
What exactly is an "Energy Performance Certificate"?

In the future, the energy efficiency of houses and flats will be rated, in the same way as household appliances. This rating is based on the type of construction, the architectural style, the building's use and its energy consumption at a defined level of operation. The energy certificate either indicates the calculated energy demand or the measured energy consumption of a building. In the near future, the certificate will also provide information on the building's carbon footprint (CO_2 emission) – like the registration certificate for vehicles. This will help raise our awareness that living, in the same way as car driving, has an impact on energy use and the environment.

Energy efficiency rating	Energy performance value
	Space heating requirement kWh/(m²a)
Low energy consumption	
A++	10
A+	< 15
A	< 25
B	< 50
C	< 100
D	< 150
E	< 200
F	< 250
High energy consumption	

Energy efficiency classes – a scale similar to that for the energy consumption of household appliances.

Future homeowners and tenants will keep a closer eye on energy performance indices since these have a decisive influence on the building's value and saleability. Houses will attract potential buyers if low energy costs can be certified. And if renovation work needs to be done, this should certainly include thermal refurbishment to increase the long-term value of the building.



Source: dena/BMVBS

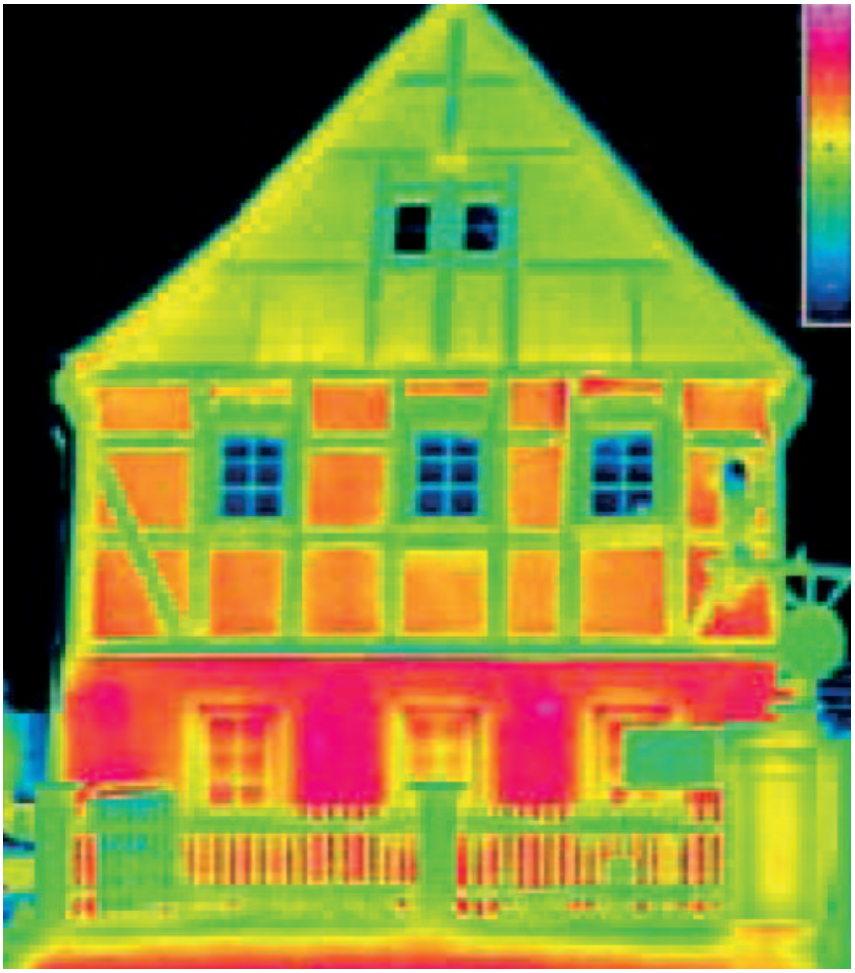
Climate and environment make growing demands on thermal insulation

It is a well-known fact that climates differ from region to region and that today, extremes of climate occur more frequently than just a few decades ago. Global warming is on the increase. But by protecting your roof, floors and walls with effective insulation, you can make your contribution to slowing down global warming and lowering carbon dioxide emissions. You can do your bit to ensure that future generations will find a world worth living in. Please remember: Energy efficiency is key to achieving the climate targets laid down in the Kyoto Protocol. Why not make a start by carrying out an energy-efficient refurbishment of your home?

Prepared for all eventualities – with efficient thermal insulation solutions.

First analyze, then renovate

When planning the low energy refurbishment of your house, the first step should be to insulate the exterior envelope so as to minimize heat loss. Only after the level of insulation achieved is acceptable, or better, should you look to further optimise energy efficiency and indoor environment by, for instance, installing an efficient ventilation system with heat recovery, combined with solar energy for water heating. But what exactly should your priorities be when carrying out a low-energy refurbishment of your house? These can best be determined via a thorough analysis performed by an expert.



The better the insulation, the higher the savings

Thermal insulation helps you to live more comfortably while at the same time cutting down on heating bills. Depending on which solutions you choose, you should be able to cut your energy usage by between 35% and 95%. The initial outlay for better thermal insulation will be quickly recouped, allowing you to reap lifelong benefits. And as the price of heating fuel is predicted to go even higher, your one-off investment in thermal renovation will pay back even faster every time energy costs rise in the future. Your savings will grow – year by year – while you reap the benefits in higher comfort levels.

A thermographic image shows the weak points in a building's insulation and helps you plan the necessary renovation steps. Red areas indicate very high heat losses.

It's your house – so go your own way

The steps you need to take to effectively reduce the heating energy demand of your house will only become clear following a thorough investigation of all of the existing construction elements. For your guidance, we have produced a table that focuses on three architectural periods and the most common building type of each: a classic old building (around 1900), a post-war building (around 1950) and a relatively recent building (around 1975) that is due for a first renovation The table below lists the thermal characteristics typical of each period.

Common building types and their typical insulation values.

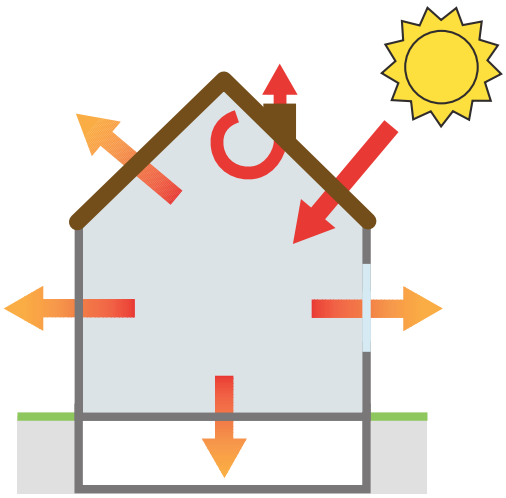
Building element	Built in 1900	Built in 1950	Built in 1975
Roof or top floor ceiling	Unheated attic, no insulation, U = 2.00 W/(m²K)	Unheated attic, 3 cm insulation, U = 0.90 W/(m²K)	Unheated attic, 5 cm insulation, U = 0.70 W/(m²K)
Exterior walls	40 cm natural stone U = 1.70 W/(m²K)	30 cm brickwork U = 1.10 W/(m²K)	30 cm lightweight brickwork U = 1.00 W/(m²K)
Basement ceiling	Wooden joists, no insulation, U = 1.00 W/(m²K)	Concrete, no insulation, U = 2.20 W/(m²K)	Concrete, 1.5 cm insulation from below, U = 1.00 W/(m²K)
Windows	Wooden frame, no gasket, single glazing, U = 5.00 W/(m²K)	Wooden frame, no gasket, single glazing, U = 5.00 W/(m²K)	PVC frame, with gasket, double glazing, U = 2.50 W/(m²K)
House doors	Wooden door, no gasket, 58 mm thick, U = 3.50 W/(m²K)	Wooden door, no gasket, 58 mm thick, U = 3.50 W/(m²K)	Wooden door, no gasket, 58 mm thick, U = 3.50 W/(m²K)
Ventilation	Window ventilation, joints, leaky building envelope	Window ventilation, joints, leaky building envelope	Window ventilation, reduced number of joints, leaky envelope
Airtightness	$n_{(50)}$ = 4.5 1/h	$n_{(50)}$ = 4.5 1/h	$n_{(50)}$ = 3.0 1/h
Space heating requirements (total energy demand)	Approx. 400 kWh/m²a	Approx. 300 kWh/m²a	Approx. 200 kWh/m²a

▶ *Please refer to the inside back cover for a glossary of all physical units and technical terms used.*

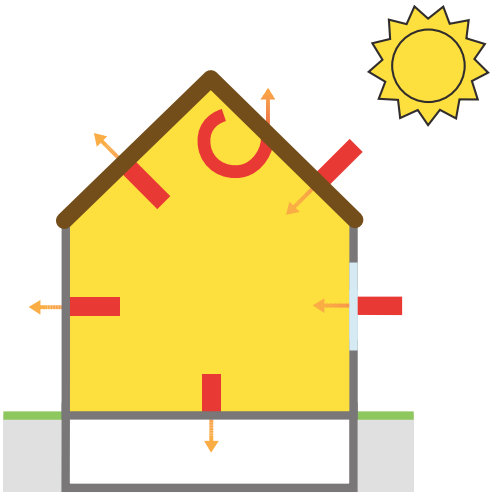
Trust your feelings

Even the greatest heat losses are normally invisible. But put your hand on the cool room-facing surface of a ceiling or external wall and you will immediately feel how much warmth is lost to the environment via the thermal envelope. Only by installing effective insulation can you put a stop to this constant and excessive loss of energy.

Keep the warmth where you need it most: inside your home.



Uninsulated



Insulated

What does a cold surface reveal?

Let's take a room which is regularly heated. If the wall or ceiling is cold to the touch, this is a clear indicator of significant thermal loss. As a result, more energy is needed to heat the room, and in most cases we don’t even suspect the true extent of this. Compared to an ISOVER Multi-Comfort House, a poorly insulated building can actually consume twenty times (!) the amount energy for heating.

Let's get down to the details:
Calculate the savings you can realize through thermal renovation.

Energy demand of typical single-family houses		Very poor insulation	Inadequate insulation	Low-energy house	Multi-Comfort House
Building element					
Roof or top floor ceiling	U-value in W/(m²K) λ-value in W/(mK) Insulation thickness	0.90 λ= 0.040 4 cm	0.25 λ= 0.040 / 0.035 16 cm / 14 cm	0.15 λ= 0.040 / 0.035 26 cm / 22 cm	0.10 λ= 0.040 / 0.035 38 cm / 34 cm
Exterior walls (25 cm, solidly built)	U-value in W/(m²K) λ-value in W/(mK) Insulation thickness	1.30 0 cm	0.40 λ= 0.040 / 0.035 6 cm / 5 cm	0.20 λ= 0.040 / 0.035 16 cm / 14 cm	0.11 λ= 0.040 / 0.035 32 cm / 28 cm
Foundation slab	U-value in W/(m²K) λ-value in W/(mK) Insulation thickness	1.0 0 cm	0.40 λ= 0.040 / 0.035 6 cm / 5 cm	0.30 λ= 0.040 / 0.035 10 cm / 8 cm	0,10 λ= 0.040 / 0.035 30 cm / 28 cm
Windows		5.00 W/(m²K) Single glazing	2.50 W/(m²K) Double glazing	1.20 W/(m²K) Double insulation glazing	0.80 W/(m²K) Triple insulation glazing, insulated frame
Ventilation		Window ventilation, joints, leaky building envelope	Window ventilation, reduced number of joints, leaky envelope	Controlled ventilation of the living space	Controlled ventilation of the living space with heat recovery
CO_2 emission **Heating energy consumption (heating oil per m² per year)**		**75 kg/m²a**  **30 litres**	**30 kg/m²a**  **15 litres**	**12 kg/m²a**  **4-5 litres**	**4.5 kg/m²a**  **1.5 litres**
Heating energy demand		300 kWh/m²a	150 kWh/m²a	50 kWh/m²a	≤ 15 kWh/m²a
Household electricity consumption		30 kWh/m²a	30 kWh/m²a	25 kWh/m²a	≤ 20 kWh/m²a
Energy consumption for domestic hot water		25 kWh/m²a	25 kWh/m²a	20 kWh/m²a	≤ 10 kWh/m²a
Electricity consumption for living space ventilation		–	–	5 kWh/m²a	≤ 5 kWh/m²a
Total energy demand		355 kWh/m²a Total waste of heating energy	205 kWh/m²a Very high heating costs	100 kWh/m²a Low heating costs	<= 50 kWh/m²a More energy consumed for hot water than for heating

▶ *Please refer to the inside back cover for a glossary of all physical units and technical terms used.*

Your Options

Old buildings transformed into Multi-Comfort Houses – The sky is the limit with ISOVER

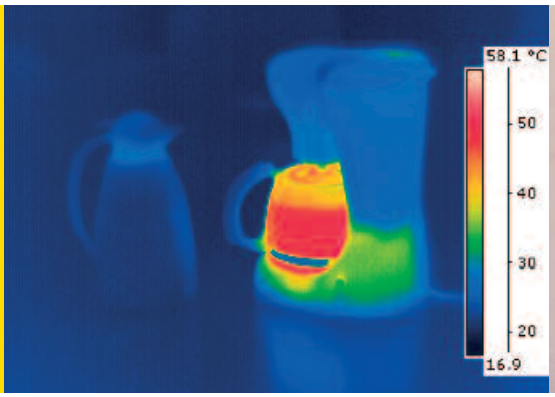
Welcome home:
Experience a new comfort of living

Whatever the weather outside: get cosy at home and feel more comfortable all year round. Renovate your home with products and energy-efficient solutions by ISOVER that are perfectly matched to give you exactly the level of comfort you desire. And what's more, you can rest assured your heating bill will be only a fraction of what it was. Excellence in comfort, cost efficiency and environmental protection – made so easy with the help of ISOVER.

Achieve long-term savings – but start today!

Once you've installed insulation the benefits will last a lifetime. The ISOVER thermal renovation solutions in this brochure will remain effective for as long as the building design stays unchanged. You can always rely on an excellent cost benefit ratio, and if you want to go further, the table opposite shows the kind of additional savings you can achieve by moving to higher insulation standards such as the "low-energy house" or the "ISOVER Multi-Comfort House". This table will help you to compare the annual and accumulated energy and heating cost savings directly with your current expenditure – and find your optimum solution.

Like a thermos flask, excellent thermal insulation keeps the warmth inside and minimizes the demand for heating energy.



ISOVER thermal renovation standards

		Low-energy house	Multi-Comfort House
Roof or top floor ceiling	U-value in W/(m²K) λ-value in W/(mK) Insulation thickness	U = 0.15 λ = 0.040 / 0.035 / 0.032 26 cm / 22 cm / 20 cm	U = 0.10 λ = 0.040 / 0.035 / 0.032 38 cm / 34 cm / 30 cm
Exterior walls	U-value in W/(m²K) λ-value in W/(mK) Insulation thickness	U = 0.20 λ = 0.040 / 0.035 / 0.032 16 cm / 14 cm / 13 cm	U = 0.11 λ = 0.040 / 0.035 / 0.032 30 cm / 28 cm / 26 cm
Basement ceiling	Insulation thickness λ-value in W/(mK) U-value in W/(m²K)	10 cm / 8 cm / 7 cm λ = 0.040 / 0.035 / 0.032 U = 0.30	30 cm / 28 cm / 26 cm λ = 0.040 / 0.035 / 0.032 U = 0.11
Windows		Plastic frames with 5 chambers, double gasket, double glazing U = 1.20 W/(m²K)	Insulated frame, triple gasket, triple glazing U = 0.80 W/(m²K)
House doors		Low-energy house doors U = 1.50 W/(m²K)	Passive house doors U = 0.80 W/(m²K)
Ventilation		Controlled ventilation of living space $n_{(50)}$ = 1.5 1/h	Controlled ventilation of living space, with heat exchanger $n_{(50)} \leq 0.6$ 1/h
Heating energy demand		~ 50 kWh/m²a	~ 15 kWh/m²a
Savings compared to poorly insulated house		67 %	90 %

▶ *Please refer to the inside back cover for a glossary of all physical units and technical terms used.*

Numerous recent studies have shown that low energy refurbishment of buildings produces huge savings, and can therefore be highly recommended as part of your later-years planning. Bearing in mind that energy costs almost doubled between 1998 and 2002 alone, we can expect the trend to be for ongoing higher energy prices, and even energy shortages, despite short term price reductions. It stands to reason therefore, that the decision to renovate will in the future be increasingly driven by economic motives.

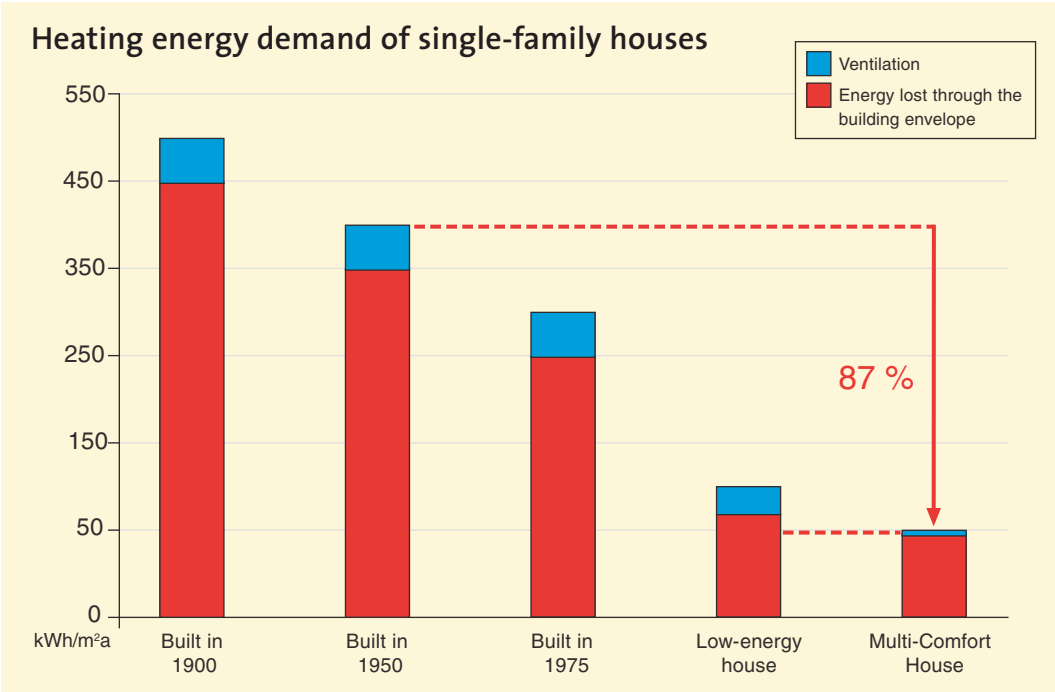
Experience has shown that the structural components of a building are only renovated every 20 to 50 years. With modernisation currently supported, in many areas, by government grants or tax reliefs, it is more advisable than ever to go straight to the best available level, and renovate your house to 'passive house' standards – 'while you're at it, do the job properly'. After all, leaving renovation of the building envelope for a later time will incur a second round of high, and unnecessary, additional costs for items like scaffolding, roof covering removal and replacement of interior linings.

How often do you order heating oil?

Your heating energy consumption is calculated using a formula based on heating energy demand per square metre of living space per year. This is a rather abstract figure, but you can get a better idea by basing it on something more easily measurable, such as the annual amount of heating oil consumed, or the number of heating oil deliveries per year. Whether this figure is high or low depends on the insulation quality of your house – it's as simple as that.

This is how a refurbished single-family house can save 19 truckloads of heating oil

Let's take a real example to better grasp the value of good thermal insulation. A single-family house, built in 1950, with a living space of approx. 100 m², underwent a low energy refurbishment in 2005 and consequently reached the insulation efficiency of a low-energy house. As a result, the demand for heating energy fell drastically – by 35,000 kWh or approx. 3,500 litres of heating oil per year. In other words: If, when the house was built, the owners had installed better quality insulation, they would by now have saved the equivalent of 19 truckloads of heating oil.



Energy savings realized thanks to thermal renovation.

▶ *Please refer to the inside back cover for a glossary of all physical units and technical terms used.*

Everything starts with meticulous planning

Every renovation project must be based on a coherent master plan. Start by assigning your house to one of the architectural periods listed below. The table shows average values for the different periods of construction, which may differ from region to region due to local building culture. However, it will give you a rough idea of current performance, which, in conjunction with a building energy performance certificate, or consultation with the relevant experts, will enable you to draw up a detailed and well-founded plan. Then refer to the tables and construction drawings later in the brochure to show which thermal improvements are technically feasible and likely to ensure a favourable cost-benefit ratio.

Optimal planning and coordination at every stage

In the ideal case, it is possible to plan and execute a full renovation in a single operation. But in many cases, especially where larger renovation projects are involved, they will often need to be scheduled over longer periods of time. In order to ensure that later steps can build on what has been done before and proceed without hitches and additional costs, it is vital to consider certain interdependencies. ISOVER has compiled a detailed list for you in the appendix.

Average values for different years of construction

Thermal insulation level U-value in W/(m²K)	Built in 1900	Built in 1950	Built in 1975	Low-energy house	Multi-Comfort house
Roof **Top floor ceiling** **Insulation thickness (cm)**	U = 2.60-1.10 U = 1.22-0.78 0	U = 1.41-1.11 U = 0.78 3	U = 1.11-0.77 U = 0.78-0.52 5	U = 0.15 U = 0.15 26	U = 0.11 U = 0.11 38
Exterior walls **Insulation thickness (cm)**	U = 2.48-0.86 0	U = 1.85-0.86 0	U = 1.30-0.52 3	U = 0.20 16	U = 0.11 30
Basement ceiling **Insulation thickness (cm)**	U = 1.37-0.73 0	U = 2.20-1.01 2	U = 1.20-0.85 2	U = 0.30 10	U = 0.11 30
Foundation slab **Insulation thickness (cm)**			U = 1.20-0.85 2	U = 0.30 10	U = 0.10 30
Windows / Doors	U = 5.20-2.57	U = 5.20-2.57	U = 4.30-2.57	U = 1.30-1.50	U = 0.80

▶ *Please refer to the inside back cover for a glossary of all physical units and technical terms used.*

Reduce heat loss – save ready cash

The biggest heat loss is caused by heat being transmitted through the exterior thermal envelope of the building, which is why the systematic insulation of the existing weak points should take priority over any other measures. The decisive factor is the so-called "U-value", indicating the rate of heat flow through a construction. Better (i.e. lower) U-values are achieved by using thicker insulation and/or products with better insulation properties. The lower the U-values of the structural elements, the more warmth stays exactly where you need it – inside your home.

Maximum performance even in tough conditions: insulation by ISOVER

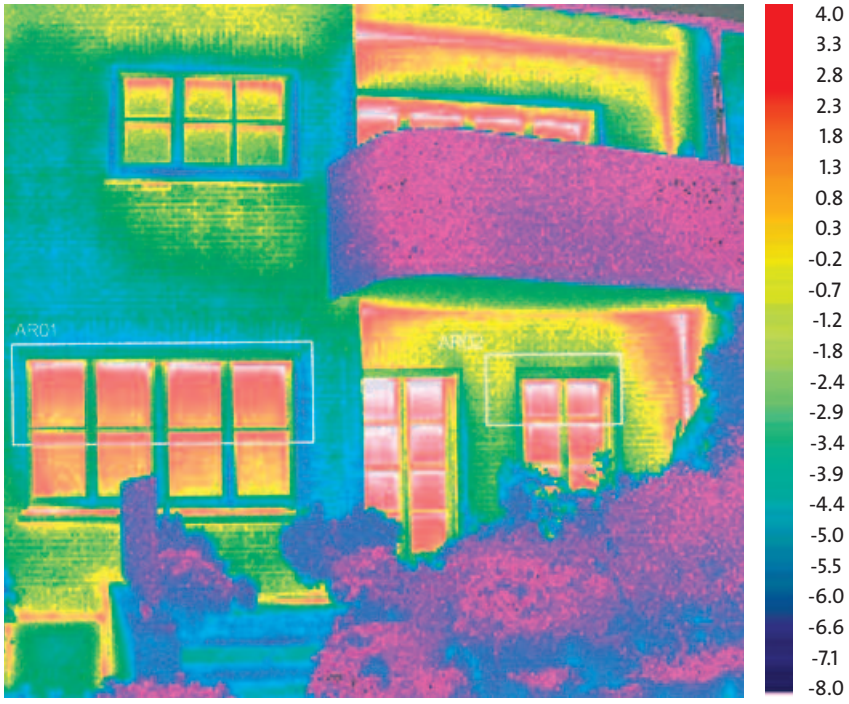
It goes without saying that insulation is particularly important where the thermal envelope is in direct contact with outside air. This is where dedicated ISOVER products really come into their own. To ensure superior performance for the building as a whole, you need high strength, high performance materials that will work in even the most demanding conditions. This is why insulation solutions by ISOVER help you to reduce heat transfer losses through your walls, roof and basement – in some cases by as much as 95 %.

Heat losses made visible

Every building component absorbs, transfers or emits thermal radiation. However, the intensity of this radiation varies considerably depending on the materials used. Thermographic imaging will show you the variation in heat loss using a colour scale (see example below). The most reliable way to reduce thermal radiation and curb your heat losses is to install proper insulation. With ISOVER you can be sure to get the right products and solutions for every area of application.

Useful contacts if you need thermographic images:

- *Energy information centres*
- *Architects*
- *Civil engineers*
- *The builders' guild*
- *Municipal utilities*
- *Power supply companies*



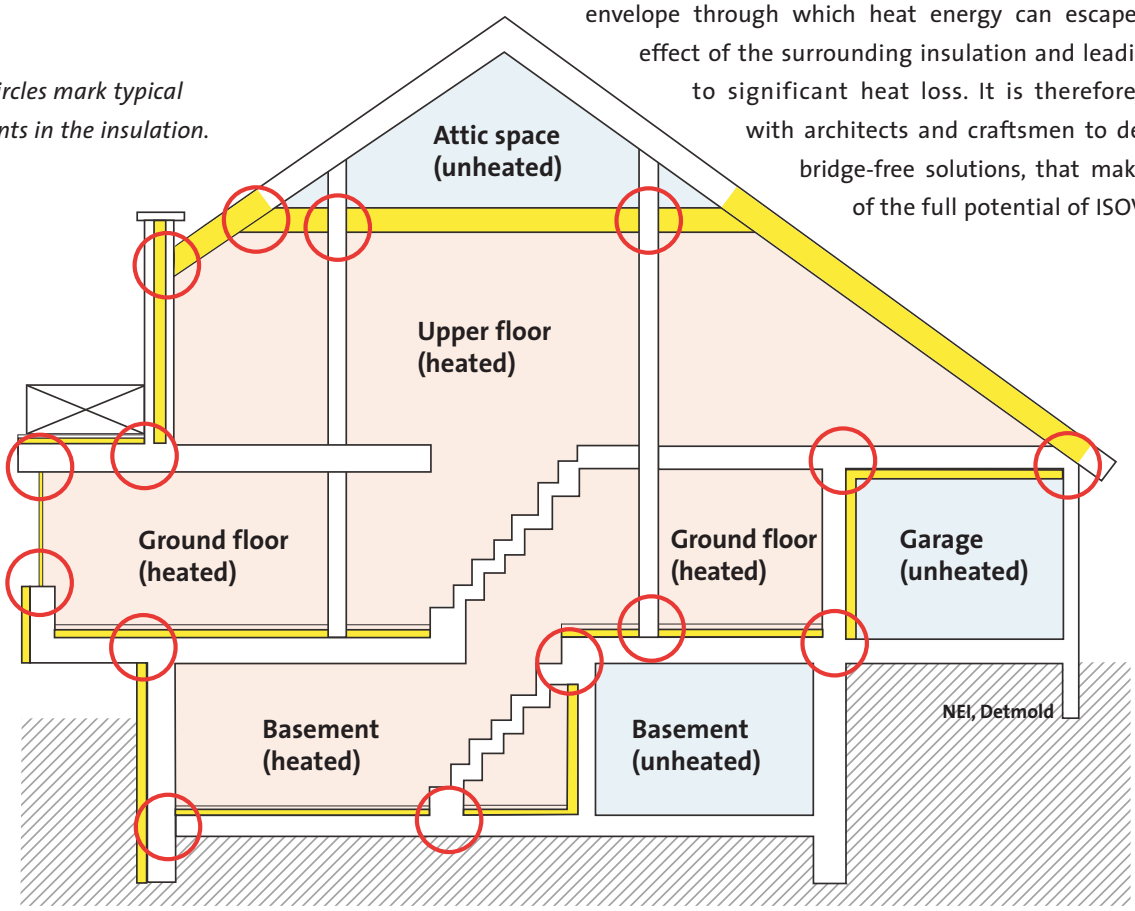
Thermographic imaging provides a coloured picture of the thermal energy radiated by an object. The red colour shows areas with very high heat losses.

A chain is only as strong as its weakest link

How to identify and eliminate thermal weak points

Heat is lost from buildings by three different routes – ventilation, transmission, and radiation. Ventilation heat loss occurs, for instance, through open windows and doors and, in an uncontrolled way, through small cracks and gaps in the building envelope. Heat will always flow from a warm area to a cooler area, and transmission heat loss therefore occurs because of the temperature differential between the inside and the outside of the building. This is affected by the quality of the thermal envelope the better the insulation, the lower the transmission heat loss. Heat is also radiated from the outside of the building into the cold external air, and is again affected by the quality of the thermal envelope.

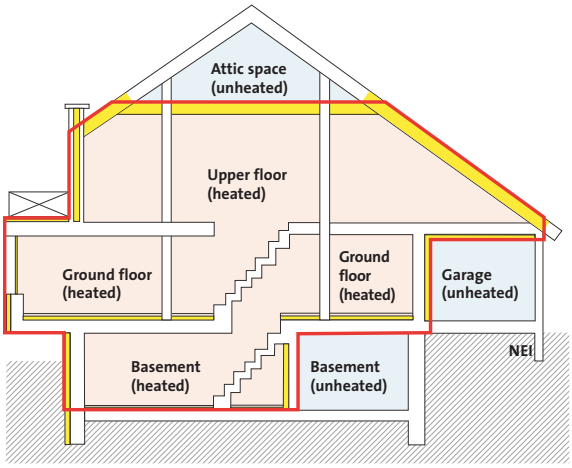
It is crucially important to have a design free of thermal bridges. These are weak points in the building envelope through which heat energy can escape, reducing the effect of the surrounding insulation and leading, potentially, to significant heat loss. It is therefore vital to work with architects and craftsmen to develop thermal bridge-free solutions, that make effective use of the full potential of ISOVER products.



The red circles mark typical weak points in the insulation.

What is the thermal envelope?

The thermal envelope separates the outside of your home from the inside, i.e. the permanently heated living space (above 19°C) from its "cold" surroundings: outside air, the ground, and any basement or loft space that is either unheated or only sporadically heated. The thermal envelope will often, therefore, run inside the building.



The red line indicates the thermal envelope.

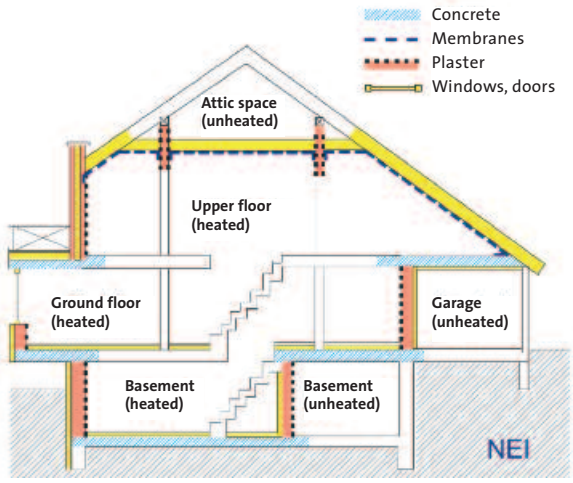
The most important thermal bridges at a glance

Thermal bridges lead to excessive loss of energy – for two main reasons. Firstly, highly conductive materials – such as metal, concrete or brick – may cause weak points in the insulation, and secondly, certain structural elements may actually increase the heat loss, projections, roof tips, pillars and building corners for instance can produce the so-called "cooling fin effect", which is due to an amplification of the surface area.

Thermal bridges are most frequently found around:

- *foundation slabs and basement ceilings*
- *stairs*
- *upper edges of walls (roof area)*
- *wall penetrations between heated and unheated areas*
- *balconies, landings and other cantilevered elements*
- *windows and roller shutter boxes*
- *rafters and support posts used in timber frame constructions*
- *anchoring elements etc.*

These thermal bridges must be taken into account when calculating the U-value of the affected building components. Apart from increased heat loss, thermal bridges may also cause structural damage. Special care must therefore be given to the detailed planning and execution of these critical building components.



Checking the airtightness

Enjoy fresh air – but don't sacrifice your thermal comfort

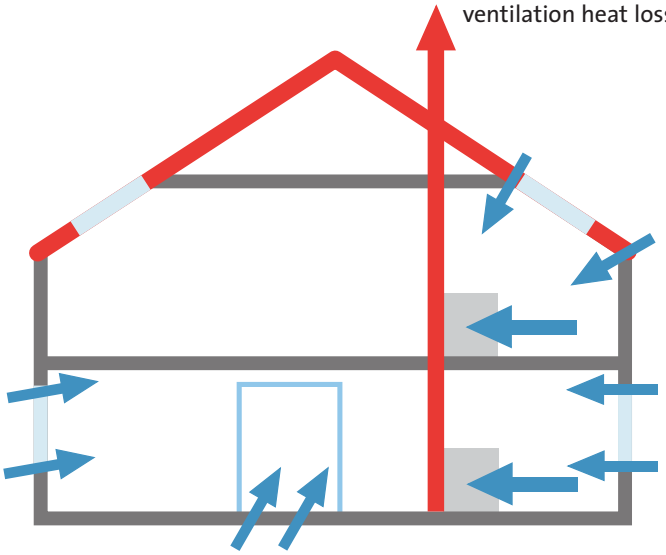
The movement of air between heated rooms and their cooler surroundings has a big effect on the amount of heat that is typically lost in older houses. Cracks and crevices in the brickwork, leaky chimneys and windows cause constant, uncontrollable draughts, resulting in high heat losses. Even an energy-conscious approach to ventilation has little effect.

Warm air: gone with the wind?

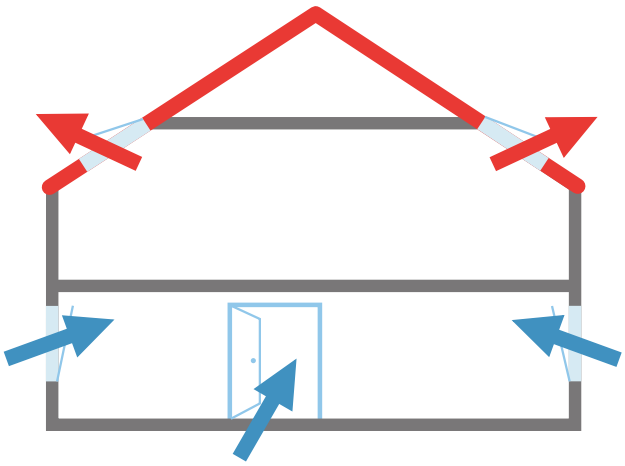
When ventilating rooms manually, there is a direct relationship between fresh air supplied and warm air lost. Even disciplined, regular "shock airing" has a big impact on indoor temperatures – and is often not feasible simply because the residents are away at work. But it is possible to have energy-efficient ventilation that is also resident-friendly. The best choice is a ventilation system with an integrated heat exchanger, controlled either automatically or via air humidity sensors. This not only ensures a constant supply of fresh air in your home, but also reduces ventilation heat loss by up to 85 %.

Don't let your warm air go up the chimney

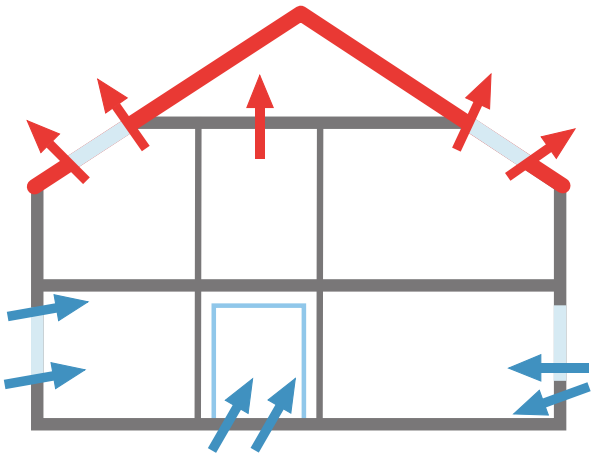
Old fireplaces and stoves draw the combustion air they need from the room while at the same time pulling in outside air through the chimney. As there is always danger of being poisoned by toxic gases, these old appliances need a steady stream of fresh air through leaks and penetrations in the thermal envelope. Since the incoming air is cold, additional heating will be needed to compensate: a textbook example of wasted energy. When thermally renovating your house to ISOVER Multi-Comfort House level, it is therefore advisable to install a fireplace with an integrated air supply hose. This operates independent of the room air, making it more energy-efficient – and healthier.



Required supply of air when operating old fireplaces and stoves.



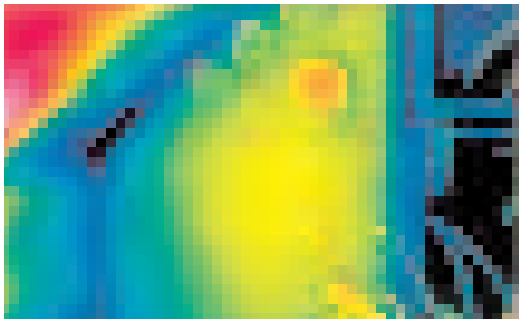
Airtight building: controlled ventilation via windows and doors.

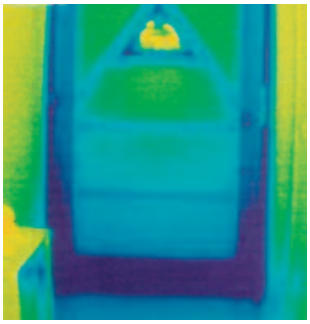


Leaky building: uncontrolled exchange of air through cracks and crevices.

ISOVER helps you stop draughts – easily and effectively

Storms, changes in barometric pressure and thermal effects can all cause cold air to penetrate through leaks in the thermal envelope. Even in heated rooms, this may cause large areas to become significantly cooler, especially at ground level. To tackle this problem effectively simply install airtight membranes and suitably coated ISOVER insulation materials. Stop the energy thieves and get rid of unwanted draughts once and for all – retake control of the fresh air and humidity levels in your home.





Whether visible or hidden: detect all leaks.

Many weak points, such as cracks, gaps or holes, are clear to see, but others may be more difficult to find. Once you feel a draught, however, the cause can often be located using, for instance, a moistened finger or some well-placed tea lights. In more difficult cases, the Blower Door Test can be combined with thermographic imaging to make diagnosis easier. Once the pressure difference between the inside and outside air reaches 50 Pa, any leaks will become immediately visible on the thermogram.

A practical guide: Analysis – Planning – Realisation

The renovation or refurbishment of a building is a large-scale project. To manage it effectively requires consistent, detailed planning. But what do you need to watch out for? Where should you set your priorities? Our indispensible guide will help you, as the building client, to prepare for your discussions with all of the other parties involved. Following the preliminary talks, you will then be able to discuss the planning details and required work steps with the respective experts, including energy advisers, architects, the builders' guild, craftsmen, municipal utilities and energy supply companies.

▶ *Please refer to pages 116-119 for printable checklists.*

1) Carry out the building analysis

Get someone to check the present insulation performance of your house for weak points and carefully record all results. Start with the roof area, including the roof covering, the trusses, all dormers, the gutters and the chimney. Include the top floor ceiling, the facade and the windows. Pay special attention to issues such rising damp and salt attack in these components, the condition of interior plasters and external renders, and any mould growth inside the rooms or the basement. If facade insulation already exists, make sure that it is in good condition and have its effectiveness checked.

With windows you should check carefully the quality of the glass and frame, their year of installation and the condition of any roller shutters and boxes. Inside your home, check in particular the thermal quality of the following areas: the floor above the basement and the foundation slab, the ceiling below the non-insulated attic and any ceiling/floor exposed to outside air.

2) Check the domestic service installations (HVAC)

After recording the present condition of the building as a whole, you should also examine the domestic service installations. This includes an expert check of the heating system, followed by a functional check of all indoor plumbing and electrical systems: cables, gas and water pipes, sewers, telephone and internet lines, security systems etc. A systematic record of the results and of the respective years of installation is vital.

3) Determine the future use

Lay down, as precisely as possible, what you require of your house in the future. Keeping these requirements in mind, check the current floor plan and – if this needs to be modified – check what effect this will have on the structural design and the thermal renovation. If, for instance, you are planning to convert a loft into fully developed living space, the construction of the insulated timber trusses may need to be adapted accordingly.

4) Work out concrete measures

First of all, decide on the quality of the thermal insulation you need for the roof, facade and basement. Next, schedule the required work steps. In particular, make sure that the thermal bridges and leaks detected by the building analysis are eliminated in the course of thermal renovation. Pay particular attention to windows – they not only require excellent insulation quality and expert installation, but if they are exposed to intense solar radiation on south facing walls, they may also require external shading. This brochure will provide you with a host of tried and trusted constructions to help you achieve a comfortable indoor climate.

5) Optimize the energy efficiency

Once the more important insulation measures have been taken care of, you can further optimize the energy efficiency of your house, using some of the following options. By installing a ventilation system with heat recovery, you can reduce your heating energy demand and at the same time further improve your indoor climate through continuous air exchange. And if you also want to minimize your dependence on external energy providers: why not consider locally available, renewable resources such as geothermal or solar energy? You just need to find out first about local grid connections. Another smart tip is to collect rainwater for domestic use: this cuts down on the consumption of precious drinking water.

Legal security and financial benefits

Before setting out on your renovation project, get answers to the following questions:

- *Is your house listed and therefore under a conversation order?*
- *Are the planned refurbishment measures subject to prior approval?*
- *Are state funds or grants available for the planned renovation works?*

Our Solutions

Maximum living comfort – from loft to basement

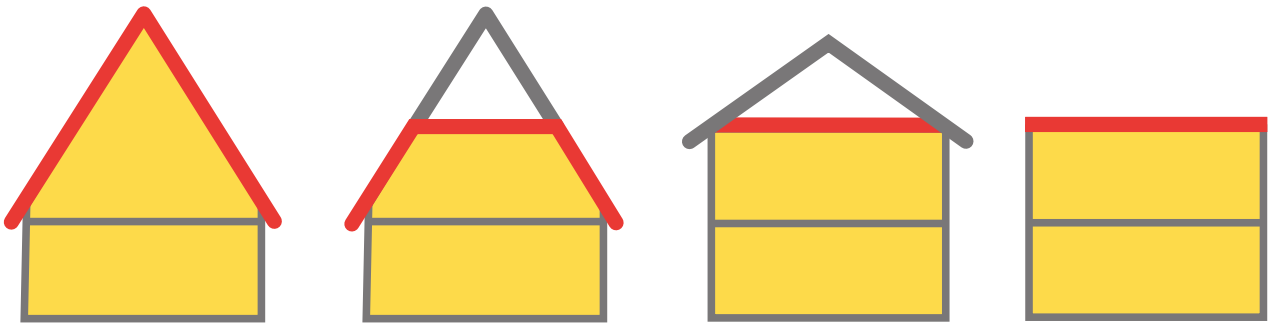
The roof: High-end insulation

In most cases, an extensive low energy renovation of a house starts with the effective insulation of the roof or top floor ceiling – the most cost-effective single way to minimize heat loss and make significant energy savings. Although this part of the house accounts for only 8 to 30 % of the thermal envelope, if it is poorly insulated it could easily account for up to 35 % of all heat lost. So, what's in it for you if you decide on insulation products made by ISOVER? There are a number of benefits, including fast and secure installation, even with flat or low-pitched roofs, plus a very favourable cost-benefit ratio.

Different roofs – one solution: ISOVER

ISOVER Insulation products not only provide effective protection against heat loss and solar heat gain, they also ensure long-term improvement in the roof construction and, when installed correctly, prevent structural damage. On the following pages, we have therefore included details of a range of solutions that have been developed to meet the low energy renovation requirements of different roof types. Before starting any work, however, you should always have the condition of your roof checked by an expert – ideally at the initial planning stage of the project.

Snow that has melted in uneven patches or smoke escaping during an airtightness test are strong indicators of a leaky and poorly insulated roof.



Steep roof

Steep roof and collar-beam ceiling

Top floor ceiling

Flat roof

Different roof shapes call for different solutions

As you will see from the above illustrations, depending on the construction of your house, it is either the external roof structure or the top floor ceiling that separates the permanently heated living space from an unheated space or from the outside air. The building components marked red in the sketches must therefore be equipped with good thermal insulation and an airtight barrier. But whether you are insulating a steep roof, flat roof or a top floor ceiling, in either timber or solid construction, the wide choice of solutions offered by ISOVER always ensures a successful result.

Flexible, fast and reliable: Loft conversions with ISOVER

There are a number of arguments in favour of a loft extension. On the one hand, the fast and inexpensive creation of additional living space, on the other, the unique atmosphere of rooms beneath the roof. ISOVER supplies a wide range of dedicated drywall construction solutions that not only ensure comfortable living conditions, but also high levels of thermal, acoustic and fire protection. Drywall elements minimize the ingress of moisture and their light weight means that the extra load can generally be carried by the existing construction, without additional strengthening. They also offer the added benefits of quick and easy construction and minimal drying out time.

Top-class thermal comfort for loft living

Even a hitherto uninhabited attic can be converted into a snug and beautiful living space in only a short time – thanks to a low energy retrofit with ISOVER. Even if your loft was converted some time ago, you can enhance its thermal and acoustic comfort by upgrading the insulation to current standards, at any time. And, depending on the existing design, you may be able to install insulation either internally or externally. On the following pages you will find some useful tips that will help you in achieving a reasonably priced conversion.

The right approach: Your path to fully developed roof space

It is advisable to work from the outside of the roof if:

- the roof covering and the flashing need to be replaced anyway,
- the insulation layers on the inside are still intact,
- the attic is already inhabited or in use,
- the attic ceiling is so low that sufficiently thick insulation cannot be installed.

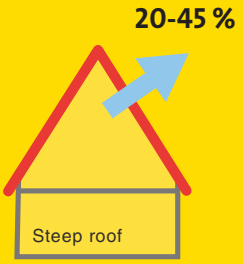
In these cases, use a reinforced thermal insulation – like the ISOVER VARIO system – which also ensures airtightness, and can be efficiently installed from the outside. This system is described in further detail on pages 34-35.

It is advisable to install the insulation from inside if:

- the roof covering and flashing are still intact,
- the attic was hitherto only used as a storeroom,
- the main objective is to create new living space.

Remember that the thickness of the insulation installed will affect the future ceiling height. If you want to reach the insulation level of an ISOVER Multi-Comfort House, it may be necessary to double up the rafters or joists.

Depending on the condition of the roof covering and structure, it may be sensible to use a combination of internal and external insulation. Before making a decision and starting the planning phase, however, make sure that you have the existing structure checked by building experts.



Insulate yourself from rising fuel bills

Rafters are normally between 10 and 20 cm deep, although this may differ dependant on region, climatic conditions and local building regulations. It may therefore be necessary to double the depth of the rafters if you want to achieve effective thermal insulation – a minimum 30 cm of insulation is required to achieve low-energy house standards, while to reach the excellent energy efficiency level of an ISOVER Multi-Comfort House, you will need at least 40 cm of insulation. With these kinds of insulation thicknesses, you can enjoy an ideal indoor climate while cutting down on your utility bills – with cost savings of up to 95 %!

Energy use and potential savings based on a steep roof with a roof area of 100 m²				**Low-energy house**			**ISOVER Multi-Comfort House**		
				Thermal conductivity W/(mK)			**Thermal conductivity W/(mK)**		
				0.032	**0.035**	**0.040**	**0.032**	**0.035**	**0.040**
Insulation thickness in cm	**0**	**5**	**10**	**28**	**30**	**33**	**38**	**40**	**43**
U-value in W/(m²K)	2.87	0.74	0.40	0.15			0.11		
Energy heating demand in kWh per year	24,108	6,216	3,360	1,260			924		
Heating energy demand in kWh over a period of 40 years	964,320	248,640	134,400	50,400			36,960		

The calculation is based on a moderate climate with 3500 Kd heating degree days and a construction with 10 % timber content

▶ *Please refer to the inside back cover for a glossary of all physical units and technical terms used.*

VARIO climate membrane – perfect moisture control down to the last detail

It's not surprising that uncontrolled ingress of moisture due to open joints or a missing vapour barrier can cause considerable damage to your roof structure. A timber frame construction, therefore, needs to be airtight – and this can only be ensured by a combination of good quality workmanship, and a high quality integrated system, such as the ISOVER VARIO system. You could say that VARIO is a form of "life insurance" for your property.

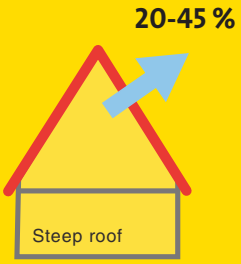
From inside the roof: the easy route to higher insulation comfort

A major advantage of renovating the roof from inside the building is that the work can be carried out independent of the weather – and often you can do it yourself. When planning to install higher thicknesses of insulation, it is often necessary to double up the rafters or joists. ISOVER clamping felts are then installed in the spaces between the rafters. For the best results, however, always install the maximum thickness of thermal insulation.

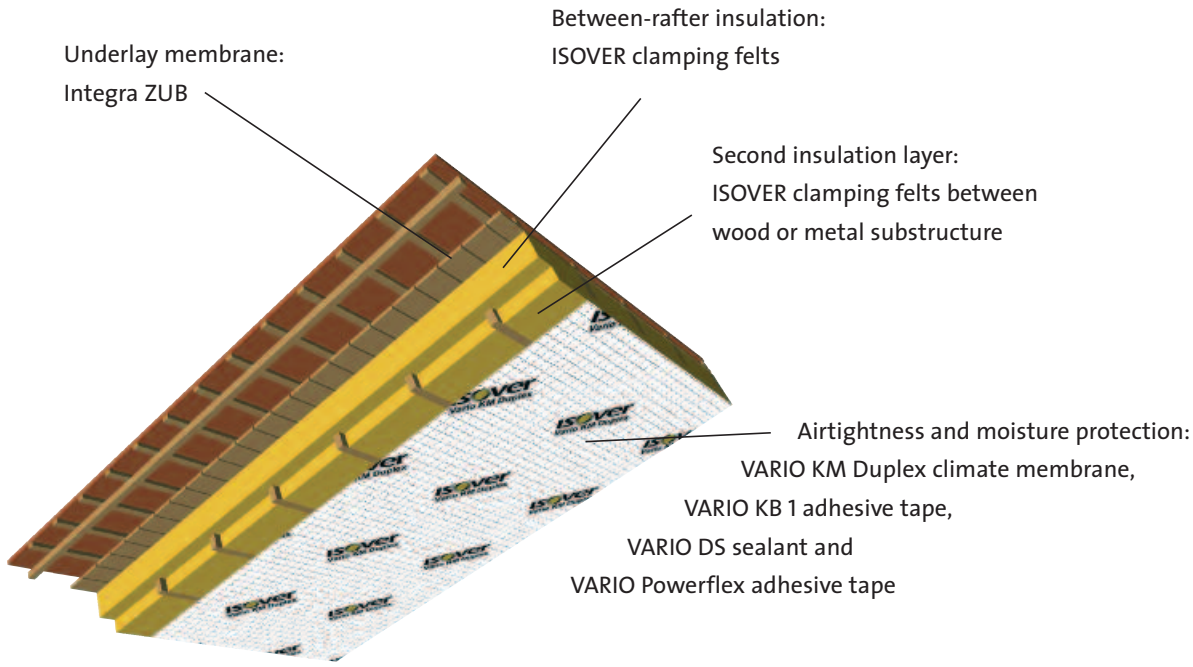
Reliable prevention of moisture damage

Living in the roof space in comfortable and energy efficient conditions means you must have a dry, airtight building envelope. And this is precisely where ISOVER's VARIO package sets new standards in air and moisture control with its perfectly matched range of bonding and sealing products. Thanks to the moisture-controlling effect of the VARIO KM and VARIO KM Duplex climate membranes, significantly less moisture penetrates the roof than is dried out over the year. During the cold season, the membrane prevents moisture from entering the roof, whilst in summer, it allows the roof to dry out and moisture to diffuse harmlessly into the building interior.

Installation tip:
Install the second layer of thermal insulation at right angles to the rafters to minimize the thermal bridge effect.



Schematic diagram of an air and wind tight roof structure meeting the performance level of an ISOVER Multi-Comfort House



VARIO, the multitasking membrane: the benefits at a glance

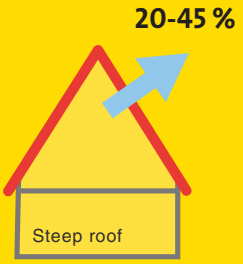
- Airtight and breathable
- Very high drying potential
- High security in the event of increased water loads
- Reliable protection against vapour convection and energy loss thanks to well-matched system components
- No need for chemical wood preservative treatments
- Aroma tightness protects from any toxic gases from old wood preservatives

VARIO – Perfect moisture control down to the last detail

Perfectly matched: the components of the VARIO system

Climate membranes	Properties	Applications
VARIO KM	• Vapour control climate membrane • Variable s_d-value from 0.2 m to 5.0 m	• For sealing the insulation layers installed on roofs and walls • Perfect moisture protection
VARIO KM Duplex	• Nylon-reinforced vapour control climate membrane • Variable s_d-value from 0.3 m to 5.0 m - Highly resistance to tearing - Easy to install thanks to line markings	
Adhesives and sealants	**Properties**	**Applications**
VARIO KB 1	Single-sided adhesive tape with high adhesion	Extra wide to ensure airtight seam sealing of the VARIO KM / VARIO KM Duplex climate membranes
VARIO KB 3	Single-sided, highly flexible adhesive tape	To ensure wind- and air-tight bonding of all penetrations and joints in VARIO KM / VARIO KM Duplex climate membranes
VARIO DS	Permanently elastic and self-adhesive sealant	For producing perfectly wind- and air-tight joints in VARIO KM / VARIO KM Duplex climate membranes
VARIO ProTape	Permanently elastic and self-adhesive sealant from the roll. 50 % faster than application by cartridge. Nonwater-soluble and stormproof up to 150 km/h wind speed.	
VARIO MultiTape	Flexible and ductile adhesive tape with high adhesion	For producing permanently airtight junctures between VARIO KM / VARIO KM Duplex climate membranes and Velux windows, pipes, roof penetrations and membrane overlaps
VARIO MultiTape SL	Flexible adhesive tape with a split liner	
Vario SilverFast	Waterproof and powerful adhesive tape with increased strength	Suitable for various bonding tasks both indoors and outdoors. Main application: bonding underlays, sarking and facade membranes.

▶ *Please refer to the inside back cover for a glossary of all physical units and technical terms used.*



Three simple steps to airtightness

After installing the second insulation layer staple the VARIO KM / VARIO KM Duplex climate membrane to the substructure. In case of metal structures, bond the membrane on top.

Install the membrane sheets with overlaps of approx. 10 cm. Tape over the seams with VARIO KB1 adhesive tape to ensure an airtight seal.

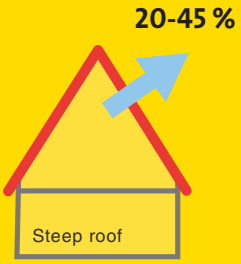
Seal any joints between the membrane and the building structure, e.g. gable, roof, walls or chimney, with VARIO DS sealant or VARIO ProTape. Produce permanently airtight joints around Velux windows, pipes, roof penetrations and the like with VARIO MultiTape or VARIO MultiTape SL.

Adding external insulation to enhance your comfort

When you need to strip and re-tile your old pitched roof, or even fit a completely new roof, you have the ideal opportunity to install low-cost, energy-saving thermal insulation. ISOVER's SANIDACH system has been developed precisely for this application.

SANIDACH – Perfectly suited for roof renovation from outside

The system is simple. Start by installing the patented VARIO KM or VARIO KM Duplex climate membrane between and above the rafters, from outside, to ensure both air tightness and moisture protection. Fit the matching clamping felts and cover with the Integra ZUB underlay, which also serves as a wind barrier, in order to complete the system. And because you are working from outside, you can continue to use the attic space, undisturbed, throughout the entire operation.



Installation procedure:

- Remove the roof covering, lathing, counterlathing and any underlay membrane and boarding, if it exists. Remove any screws and nails from below. Double up the roof timbers if you want to achieve a higher insulation thickness.
- Install the VARIO KM or VARIO KM Duplex climate membrane, without tension, on top of the internal lining and across the rafters. Where membranes join, overlap seams by approx. 10 cm and seal with VARIO adhesive tape. If the tips of screws or nails are visibly, install a protective layer (e.g. an ISOVER impact sound insulation board) underneath the VARIO KM membrane.
- Use the VARIO DS sealant to produce a rainproof seal between the membrane and adjoining elements like eaves, verge and chimney.
- Cut the ISOVER clamping felt to size (between-rafter width plus 1 cm) and position the cut felt between the rafters, from above, to produce tight joints. An insulation thickness of 40 cm will be needed to meet ISOVER Multi-Comfort House requirements.
- Install the remaining roof layers in accordance with the national building regulations. To prevent moisture damage, provide ventilation space below the roof skin, independent of the roof covering. Your carpenter or roofer will be able to advise you. Normally, the Integra ZUB underlay membrane is installed either directly on top of the insulation or on a solid timber board subroof.

Open to excellent ideas: Roof renovation from the inside out

Only by completely exposing the roof trusses do you create the ideal conditions for insulating your roof to the ISOVER Multi-Comfort House level. Once exposed, the existing rafters can be doubled in depth by adding additional timber either below or above. The cavity thus created is then insulated with ISOVER clamping felt over the entire roof area, to the full cavity depth and with tightly fitting joints. Here again, an insulation thickness of 40 cm will meet the ISOVER Multi-Comfort House standard and ensure maximum living comfort.

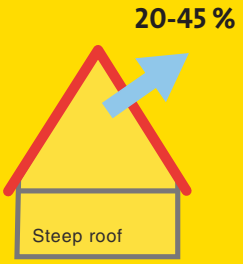
Indispensable: Reliable wind and air tightness

Fitting insulation between fully exposed roof trusses

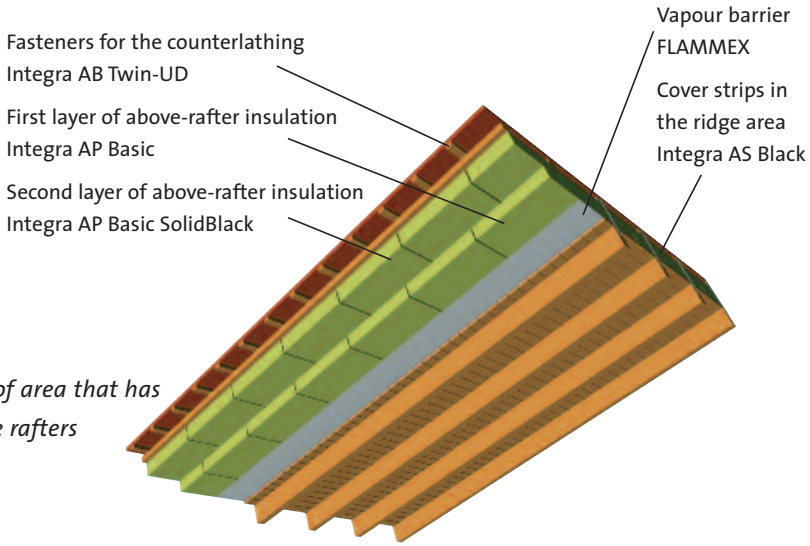
Since the insulation and other roof components are being newly installed, there is no need to compromise on quality or installation standards. In fact, with the roof timbers exposed on both sides, and no old existing layers of insulation to consider, access is far easier and the whole installation process is more straightforward than with single sided access. The key to success is a combination of VARIO KM or VARIO KM Duplex and Integra ZUB. When installed on the inside of the roof structure, the VARIO membrane prevents air and moisture ingress, whilst, on the external side, our CE-certified Integra ZUB ensures that the roof is both rainproof and windtight.

Above-rafter insulation: Gain space, save time

The advantage of using an above-rafter insulation system like Integra AP is that you can include the entire truss into your interior design plans. And during renovation it is possible to carry out several different jobs at the same time. Why? Because above-rafter mineral wool insulation slabs come complete with an integral breathable underlay membrane and overlapping adhesive tape edges to securely prevent leaks during installation. Moreover, Integra AP SolidBlack, which is generally used for the upper layer, has a laminated underlay with a surface that is both water-tight and skid-proof. What you get is a 3-in-1 product, combining insulation, underlay and adhesive tape that not only allows you to produce a thermal bridge-free insulation layer across the rafters, but also has



excellent fire and sound protection properties. The two-layered structure of Integra AP makes installation fast and easy. While the underside of the Integra AP insulation slab stays adaptable and flexible, the top is extremely hard, allowing it to be walked on – at any stage.



Schematic diagram of a pitched roof area that has been optimally insulated above the rafters

Integra AP: Installation in three steps

Step 1: Position ISOVER Integra AP SolidBlack on the roof area.
Step 2: Join the edges of the slabs together with the integrated, overlapping adhesive tape.
Step 3: Screw the load-distributing Integra AB Twin-UD fasteners into the rafters to secure the counterlathing.

A pivotal point: Insulation of the top floor ceiling

If the attic above is not used as living space, and is therefore unheated, the top floor ceiling forms the "thermal dividing line" between the heated and unheated spaces. It is absolutely essential therefore that the top floor ceiling is insulated, and an insulation thickness of 40 cm will ensure that you achieve the insulation level of an ISOVER Multi-Comfort House. The benefits to you will include a comfortable indoor climate in the rooms below, year-round round low energy consumption – and, of course, significant savings.

ISOVER glass wool flexibly adapts to every construction

Regardless of whether the top floor ceiling is timber or concrete, ISOVER insulation solutions, in combination with the VARIO system, will make make sure that you are well-prepared for all eventualities. Naturally, different solutions will be needed depending on whether the insulation is installed from above, below or both sides.

Energy use and potential savings based on a timber joist top floor ceiling with 100 m² floor space				**Low-energy house**			**ISOVER Multi-Comfort House**		
				Thermal conductivity W/(mK)			**Thermal conductivity W/(mK)**		
				0.032	**0.035**	**0.040**	**0.032**	**0.035**	**0.040**
Insulation thickness in cm	**0**	**5**	**10**	**28**	**30**	**33**	**38**	**40**	**43**
U-value in W/(m²K)	3.20	0.76	0.44	0.13			0.09		
Heating energy demand in kWh per year	26,880	6,384	3,696	1,260			924		
Heating energy demand in kWh over a period of 40 years	1,075,200	255,360	147,840	50,400			36,960		

The calculation is based on a moderate climate with 3500 Kd heating degree days and a construction with 10 % timber content

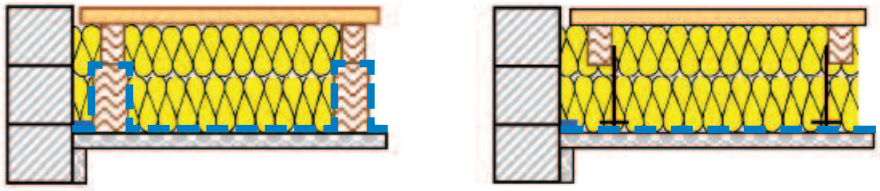
▶ *Please refer to the inside back cover for a glossary of all physical units and technical terms used.*

A cost-effective step that enhances your living comfort

Provided the attic is not used for living space, it is possible to install effective insulation on the top floor ceiling of your house at any time – even insulation that fulfils the requirements of an ISOVER Multi-Comfort House. This solution is especially economical as the total cost, including installation, will be recouped in lower energy bills within just one or two years.

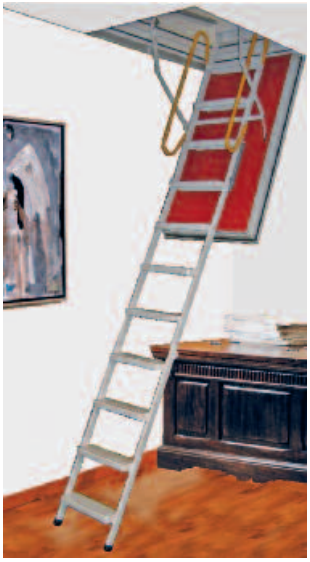
Doubling up for more living comfort

Insulation of the top floor ceiling will be especially cost-effective if the depth of the existing construction is doubled up. Depending on access, the additional depth can be added either above or below the existing joists. The VARIO KM or VARIO KM Duplex climate membrane has an important role to play in this construction, and can also be installed from either above or below, as the following illustrations show.



Doubling up the construction of the top floor ceiling

VARIO climate membrane



"Thermo Star", a Passive House certified attic access hatch with retractable ladder.

Source: company Steiner, Purgstall, Austria

Roof hatches – high heat loss in a confined space

Attic access hatches, used for instance with retractable roof ladders, must be installed by an expert. The hatch must be thermally insulated and the frame must always provide an airtight seal, or high energy losses and structural damage will be inevitable.

Lower weight – higher benefits

Thanks to its low weight, ISOVER glass wool has considerable benefits when used for insulating the intermediate ceiling. Unlike heavyweight building materials that make high demands on the load-bearing strength of the ceiling below, the uniquely lightweight ISOVER glass wool allows you much more freedom of planning and design.

Effective protection against chimney sooting

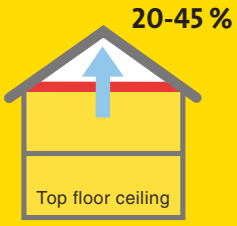
Sooting occurs when the water vapour in the flue gases caused by the burning of fossil fuels, such as coal or wood, condenses on the inner surface of the chimney. One reason for the sudden occurrence of sooting can be a change in flue gas temperature. In such a case, it is necessary to build in a steel or ceramic pipe. Additional insulation of the chimney wall will also reduce the thermal bridge effect of the chimney if the attic is unheated.

The solution: ISOVER SAW chimney insulation slabs

How can you avoid damage to your fireplace or chimney? Quite easily with purpose-made SAW stonewool insulation slabs developed by ISOVER. They are a sustainable way to prevent sooting and the gradual destruction of your chimney.

Installation procedure:

- Take the exact measurements, then cut the SAW insulation slabs to size with a knife or saw.
- Apply a mineral, non-flammable construction adhesive on the uncoated side of the slab. If the background is level, spread the adhesive over the entire slab surface. If the background is uneven, apply spots of adhesive. Position the insulation slab against the chimney and press home firmly.
- Protect the slab edges with commercially available angle or corner beads and apply a mineral plaster coat directly on top of the slabs. Embed a reinforcement fabric in the plaster when wet to avoid cracking.



ISOVER blowing wool for fast-track renovation

ISOVER blowing wool is high quality glass wool that has been specially manufactured for blowing into roof and wall cavities. On site, a purpose-built machine uses pneumatic air and vacuum technology to process the glass wool and blow it into the cavities via a hose. This ensures that the glass wool is applied uniformly throughout the construction that is being insulated. Using ISOVER blowing wool, uneven backgrounds and irregularly shaped spaces can be insulated without any problems.

Application by means of vacuum technology

Sucking and blowing the glass wool into the desired space helps to fill it with air and give it more body. In cavity walls the wool is injected through a regular pattern of holes drilled in one of the leaves. The special blowing machines are capable of injecting up to 6 m^2 of blowing wool per hour, at a height of up to 50 m, which is more than adequate for most normal height buildings.

ISOVER blowing wool – ideally suited for:

- *Roof cavities of low height*
- *Cavities in intermediate ceilings*
- *Cavities in double-leaf (cavity) walls*
- *Cavities in pitched roof areas*
- *Cavities in vaulted structures*
- *Cavities in old, suspended ceilings*

The advantages of using blowing wool

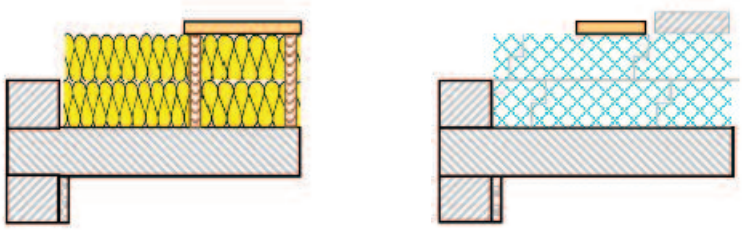
Existing wall and roof cavities can be difficult to access, so the ideal solution is to retro-fill with ISOVER blowing wool. Post construction thermal insulation with blowing wool, does not involve expensive and time structural measures. It will significantly reduce mould growth, condensation and other structurally damaging conditions, and can be installed quickly and cost-effectively, without any waste, offcuts or other material loss.

Solid soffits – lightweight thermal renovation

Often, solid concrete ceilings or brick ceilings topped with concrete form the upper limit of the thermal envelope. Good news: they are easy to insulate, simply by adding any thickness of thermal insulation directly on top. To be sure add at least two layers of insulation over the entire area, in order to reach the standard of an ISOVER Multi-Comfort House. Installation is not only easy and quick, it also noticeably lowers the amount of energy lost – and your heating bills.

Effective protection against moisture

Solid ceilings or floors are generally accepted as having a certain level of vapour-resistance and air tightness, however, to be on the safe side when building new, it is sensible to include an effective vapour resistant membrane. It should be applied over the whole area, with joints overlapped by at least 10 cm and sealed with adhesive tape, and all junctions with walls, structural brickwork and the like, properly sealed to maintain air tightness. Once the surface has been properly prepared, there is a whole choice of ISOVER solutions and materials – walkable or non-walkable that can be used alone or in combination.



We highly recommend "laying it on thick" when insulating the top floor ceiling. And no matter if you use ISOVER glass wool or expanded or extruded polystyrene (EPS or XPS): walkways facilitate the use and are suitable for sporadic foot traffic.

Realize high savings with ISOVER

Thanks to the technical ease of installation, there is very little that you need to budget for, other than material costs, when renovating or insulating the top floor ceiling. As a rule of thumb, the thicker the insulation, the better the cost-benefit ratio. A hitherto uninsulated concrete ceiling can therefore be quickly and inexpensively upgraded to reach the efficiency level of an ISOVER Multi-Comfort House. Who wouldn't want to make a saving of more than 95 % on the previous heating costs?

Examples for the insulation of solid ceilings

Energy use and potential savings based on a concrete top floor ceiling with 100 m² floor space				Low-energy house			ISOVER Multi-Comfort House		
				Thermal conductivity W/(mK)			Thermal conductivity W/(mK)		
				0.032	0.035	0.040	0.032	0.035	0.040
Insulation thickness in cm	**0**	**5**	**10**	**20**	**23**	**26**	**30**	**34**	**38**
U-value in W/(m²K)	3.50	0.65	0.36	0.15			0.10		
Heating energy demand in kWh per year	29,400	5,460	3,024	1,260			840		
Heating energy demand in kWh over a period of 40 years	1,176,000	218,400	120,960	50,400			33,600		

The calculation is based on a moderate climate with 3500 Kd heating degree days.

▶ *Please refer to the inside back cover for a glossary of all physical units and technical terms used.*

Insulation at its purest: Non-walkable insulation for solid ceilings

You need only standard insulation products if you are insulating an unused roof space at floor level – it's simple. High efficiency ISOVER thermal insulation felts are your best choice for the job, because they are low in cost, non-combustible and offer optimal insulation properties, combined with the extra benefits of compressed packing and ease of installation. Simply unroll the felt on the top floor ceiling, close any gaps – job done!

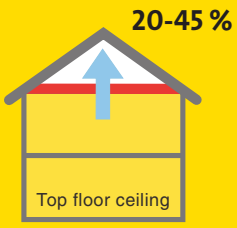
Get a secure return on investment through insulation

ISOVER thermal insulation felts help you achieve the highest possible insulation performance for only a small outlay in material and installation costs. That is why this type of thermal insulation pays for itself in only a short time and then goes on to provide you with lifelong savings in energy costs.

Easy installation but powerful performance

Thanks to their fibrous construction, ISOVER insulation felts offer seamless insulation when installed in two layers. But as they are not strong enough to take foot traffic, it is recommended that you install a walkway if you need access for maintenance work on the chimney, or if you are using areas of the roof space for storage.

Step 1: Cover the floor with a FLAMMEX vapour-resistant membrane, overlapping edges by 15 cm and sealing all joints with VARIO KB1 adhesive tape. At floor edges, extend the vapour retarder up the adjoining structure, then produce an airtight seal with VARIO DS sealant and a pressure lath. The vapour resistant membrane protects the construction against damage caused by condensation.



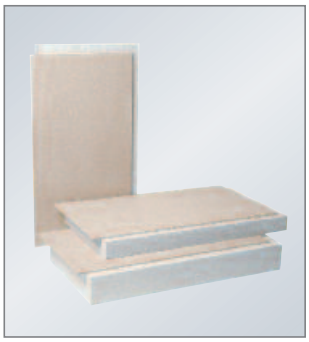
Step 2: Construct the attic walkway as a kind of "wooden box" or frame. Take two studs of a height to corresponding to the desired thickness of insulation and fasten to the floor with bolts and standard metal brackets.

Step 3: Cut the thermal insulation felt to the required width and fit inside the wooden frame. Fasten a layer of battens on top of the studs and, if required by local fire regulations, install a layer of fibrous plasterboard.

Step 4: Install a second layer of insulation felt on top of the first one with staggered joints. Also place felt around the wall plate to ensure the insulation is free of thermal bridges.

Solid ceilings: The advantages of a walkable attic

For all those with little time to spare but who want to walk around their insulted attic as quickly as possible, ISOVER insulation blocks are the perfect choice. These "heat blockers" not only offer highly efficient thermal insulation, but are also ready for foot traffic immediately after installation – thanks to a fibreboard facing.



Thermal insulation blocks: Rapid installation and sure-footed use

ISOVER's prefabricated attic insulation elements consist of glass wool or expanded polystyrene (EPS) with fibreboard bonded on top. The elements have a handy 110 x 60 cm or 100 x 50 cm format and an all-round shiplap edge between the insulation material and the fibreboard to facilitate installation and produce a homogeneous and level floor. As a result, the entire attic space can be used for storage purposes and occasional foot traffic. The insulation elements carry loads up to 150 kg/m² as well as offering excellent impact sound insulation.

Walkable attic insulation in only 3 steps

Step 1: *Level out uneven areas of the uninsulated ceiling with sand or another filler material.*
Step 2: *Cover the ceiling with a vapour-resisting membrane, such as FLAMMEX. Overlap adjacent edges by 15 cm and seal all joints with VARIO KB1 adhesive tape. At ceiling edges, extend the vapour resistant membrane up the adjoining structure and produce an airtight seal with VARIO DS sealant.*
Step 3: *Then, simply place the insulation blocks with staggered joints on top of the ceiling – job done!*

Ready for future loft conversion: the TEL raised floor system

If you, at this stage, just want to insulate the loft floor, but are considering using the space in the future as a walkable attic or even planning a complete loft conversion, the TEL raised floor is the best solution for you. Being an ideal subfloor construction, the TEL raised floor is not only dry, light weight and fast to install, it comes ready for covering with a variety of flooring materials – from carpet to parquet.

How to level out uneven ceilings without loose fill

The TEL raised floor system consists of "legs" or pedestals which support 32 mm thick solid wooden panels. Since these pedestals are available for floor heights of between 5 cm and 29 cm, they can easily be used to level out very uneven areas without need for a filler material. Afterwards, the cavity between the floor panel and the ceiling below is completely filled with ISOVER insulation slabs, thus allowing all service pipes and cables to conveniently disappear in the subfloor.

The cavity below the wooden floor panel hides away the insulation and all ductwork and cables.

Fast and easy installation – even if you Do It Yourself

Drive the TEL pedestals into the TEL raised floor panel. Place suitably sized ISOVER insulation slabs on top (format 120 cm x 60 cm). Slip sound absorber disks onto the pedestals and turn the complete panel over.

One turn of the screw from above is sufficient to level out any height differences.

Benefits of the TEL raised floor at a glance:

- *Low weight of only 22 kg/m²*
- *Can be covered with flooring after just one day*
- *Ductwork and cables can be routed through the cavity*
- *Level adjustment of the ceiling without need for a loose fill*
- *Installation heights of 5 to 29 cm*

The flat roof: Perfect insulation for "cold" and "warm" constructions

What distinguishes a "cold" flat roof from a "warm" flat roof? The sole difference is the relative position of the insulating layer, and the waterproof membrane. "Cold" or "warm" says nothing about the insulation effect of the construction.

Proper solutions for every roof: Insulation by ISOVER

Depending on the roof construction, the approach to renovation will be different. With "cold" roofs, there are two options: either open the roof and replace the interior insulation layers, or completely install the new insulation elements on top of the existing structure. With "warm" roofs, renovation is always done on the external face of the roof, without interfering with the load-bearing construction. In recent years, the so-called "duo roof" has come into existence which is actually a combination of a warm and an inverted roof. But whether "cold" or "warm", concrete or timber: ISOVER's comprehensive range of insulation products always offers you the right solution, making sure that you attain energy-efficient insulation that meets the standard of an ISOVER Multi-Comfort House.

Even flat roofs have a pitch

Even flat roofs need to have a slight pitch or slope so the rainwater can drain away. This slope is usually between 2 and 20 degrees, depending on the local regulations. With a slope of between 2 and 5 degrees, drainage may be impeded and water pools and collects in puddles. There is an even higher risk with roof slopes of less than 2 degrees.

"Cold" and "warm" roofs at a glance

Cold flat roof

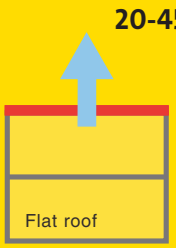
A "cold" flat roof is also referred to as a "ventilated" roof. First of all, a vapour-retarding layer is installed between the rafters or on top of a solid floor/ceiling. This is covered with thermal insulation and a ventilation layer on top. Above the rafters, wooden boarding is installed, covered with a waterproof membrane and the final roof finish.

Warm flat roof

With a so-called "warm" flat roof, the insulation layers are usually installed above the load-bearing ceiling or floor construction which may consist of concrete or wood. On top of the ceiling/floor, a waterproof membrane and a vapour barrier are installed. This is followed by continuous thermal insulation and a final layer of waterproof membrane or roofing felt.

Inverted roof

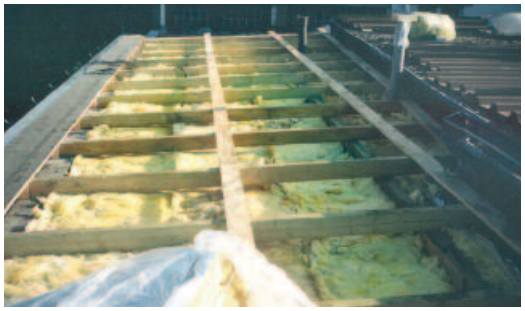
A special variant of the flat roof is the "inverted roof" where the thermal insulation and waterproofing roof layers have been arranged in reverse order. Since the insulation installed on top of the waterproofing layer is located in the wet area, it must only absorb a minimal amount of water. For this reason, insulation slabs made of extruded polystyrene foam (XPS) are primarily used for this purpose.



Thermal comfort and high-level savings

Regardless of the existing roof construction and the renovation approach taken, an insulation thickness of 30 cm is sufficient to bring your flat roof up to the standard of a low-energy house. Going one step further and installing 40 cm, however, will bring you greater benefits in every area: optimum indoor climate, extremely low energy consumption and higher cost savings. In other words, you will have reached the top level of an ISOVER Multi-Comfort House.

Renovation of a "warm" roof with expanded polystyrene boards



Renovation of a "cold" roof with additional insulation installed from above

Energy use and potential savings based on a "cold" flat roof with 100 m² floor space				**Low-energy house**			**ISOVER Multi-Comfort House**		
				Thermal conductivity W/(mK)			**Thermal conductivity W/(mK)**		
				0.032	**0.035**	**0.040**	**0.032**	**0.035**	**0.040**
Insulation thickness in cm	**0**	**5**	**10**	**28**	**30**	**33**	**38**	**40**	**43**
U-value in W/(m²K)	2.64	0.72	0.44	0.15			0.11		
Heating energy demand in kWh per year	22,176	6,048	3,969	1,260			924		
Heating energy demand in kWh over a period of 40 years	887,040	241,920	147,840	50,400			36,960		

The calculation is based on a moderate climate with 3500 Kd heating degree days.

▶ *Please refer to the inside back cover for a glossary of all physical units and technical terms used.*

Renovate "cold" flat roofs – enjoy new living comfort

The low energy refurbishment of a ventilated flat roof can also be achieved without disturbing the top floor ceiling. In this case, the new insulation elements can be completely installed from above, on top of the existing roof surface. The "cold" construction effectively becomes a "warm" one, in two respects – firstly because of the new roof structure and secondly, and much more importantly, because of the higher comfort levels achieved. There is no problem with space for high thickness insulation in this type of renovation, as the installation is carried out from existing roof level upwards – and because of the efficiency of ISOVER insulation, the effect on the proportions of the house will be minimal.

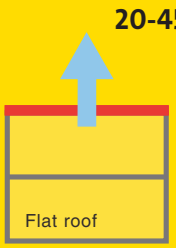
New tasks for old construction layers

Because of the position of the new insulation layer, the structure and operation of the roof construction will change. The old watertight surface is now located between the old and the new insulation layer and thus automatically has the effect of a vapour seal. The previous ventilation space needs to be closed and the new insulation layer sealed from above. Before undertaking this job therefore you should have the technical performance of the planned construction checked by an expert.

Renovation of a cold flat roof from above, including the waterproofing layer and the roof covering.

3 to 1: An insulation ratio that ensures perfect results

If you renovate the roof and do not remove the old waterproofing layer, there will now be a vapour-tight layer located below the new insulation layer. To prevent condensation forming in the old thermal insulation, the performance of the new insulation must be at least three times that of the old. In most cases, this requirement is met if the new insulation is three times as thick as the old insulation.



Thermal improvement – from the inside or from below

If renovation from the outside or from above is not possible, or not required, for instance because the waterproofing layer of the roof is still in a good shape, it is advisable to refurbish from the inside or from below. To achieve this a metal or timber frame sub-construction is built beneath the existing ceiling. The space between the framework and the original ceiling is then filled with suitably sized ISOVER clamping felt, and the whole area covered with a VARIO KM or VARIO KM Duplex membrane to provide an airtight seal. Saint-Gobain plasterboards are generally used to line the new ceiling. In multi-family houses, this method can be used to treat individual flats, with the advantage that it does not require the prior approval of all residents – and because of the relatively low cost it will generally not require a financing scheme.

Suitable even for individual rooms: insulation of the ceiling from inside. Highly important: airtight sealing of all joints with the VARIO system.

This is how "warm" flat roofs truly live up to their name

With so-called "warm" flat roofs, the existing insulation is entirely located on top of the load-bearing construction. Renovation is therefore exclusively done from outside. Before new thermal insulation can be installed, the old layers generally need to be removed, although in some cases they can be retained subject to a thorough analysis of their current condition. In most cases, however, an effective long-term solution can only be achieved by a complete replacement and renewal of all layers.

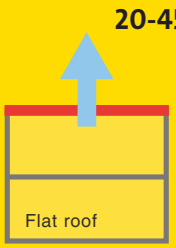
After the load-bearing construction has been exposed and checked, a vapour resistant layer must first be installed prior to fitting the insulation layer – ideally either ISOVER mineral wool or expanded polystyrene (EPS). Finally, the new waterproofing layer is installed.

Flat roof with ISOVER glass wool

Energy use and potential savings based on a "warm" flat roof with 100 m² floor space				**Low-energy house**			**ISOVER Multi-Comfort House**		
				Thermal conductivity W/(mK)			**Thermal conductivity W/(mK)**		
				0.032	**0.035**	**0.040**	**0.032**	**0.035**	**0.040**
Insulation thickness in cm	**0**	**5**	**10**	**23**	**26**	**29**	**30**	**34**	**38**
U-value in W/(m²K)	3.20	0.72	0.44	0.13			0.10		
Heating energy demand in kWh per year	26,880	6,048	3,696	1,092			840		
Heating energy demand in kWh over a period of 40 years	1,075,200	241,920	147,840	48,680			33,600		

The calculation is based on a moderate climate with 3500 Kd heating degree days.

▶ *Please refer to the inside back cover for a glossary of all physical units and technical terms used.*



The "duo roof" gives new life to your flat roof

In the past few years, the so-called "duo roof" has been developed especially for renovation purposes. Basically, it combines a warm roof with an inverted roof. The duo roof requires as a base an existing warm roof construction, with a well-preserved and fully functional waterproofing layer that needs to be checked before the renovation starts. A water-resistant insulation material, such as ISOVER XPS extruded polystyrene, is then laid on top. Thanks to the all-round shiplap edge of ISOVER XPS slabs, the thermal bridge effect of butt joints is minimized. Continuous construction sheeting and ballast layers are then installed over the insulation layer to prevent the lightweight boards from being lifted by wind suction. The final layer can then be either gravel fill, exposed aggregate concrete slabs or a plant substrate, if planning a green roof – the final choice depends on the intended use and desired look of the roof.

Green roofs are trendy and enhance the quality of life – not only of residential housing.

Roof vegetation: for aesthetic and ecological reasons

The thickness of the substrate layer and consequently the load to be carried by the entire roof construction, varies depending on the type and variety of vegetation. In practice, there are two basic types of roof vegetation – extensive roof vegetation that consists of a thin substrate layer only and largely sustains itself, and intensive roof vegetation, which can include big plants and even trees, and which requires special irrigation and care.

ISOVER products for roof insulation

VARIO KM Duplex

Reinforced climate membrane (vapour retarder) for waterproofing roofs and walls. Moisture-variable s_d-value of 0.3 m to 5 m. Equipped with a practical installation aid (line marking).

Length – Width	Packaging
40 m – 1.5 m	60 m²/roll

VARIO KM

Climate membrane (vapour retarder) for protecting roofs and walls from moisture damage. Moisture-variable s_d-value of 0.2 to 5 m.

Length – Width	Packaging
60 m – 2 m	120 m²/roll
30 m – 2 m	60 m²/roll
15 m – 2 m	30 m²/roll

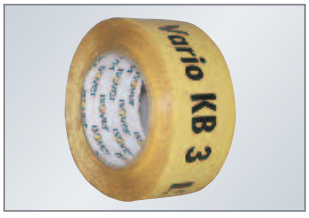
VARIO KB 1

Extra wide, single-sided adhesive tape for sealing joints in membranes to provide an airtight seal. Perfect for use with VARIO KM / KM Duplex climate membranes.

Length – Width	Packaging
20 m – 60 mm	12 rolls = 240 m
40 m – 60 mm	5 rolls = 200 m

VARIO KB 3

Single-sided, highly flexible adhesive tape to provide a wind- and air-tight seal at all joints and penetrations in VARIO KM / VARIO KM Duplex climate membranes.



Length – Width	Packaging
15 m – 60 mm	12 rolls = 180 m
25 m – 60 mm	10 rolls = 250 m

VARIO DB

Self-adhesive joint sealing tape from the roll that is used, together with clamping rails, for producing airtight joints between lightweight and solid constructions.

Length – Width	Packaging
8 m – 17 mm	6 rolls = 48 m

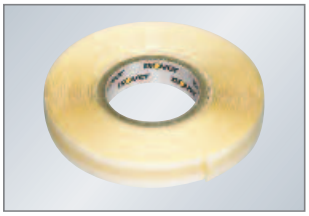
VARIO DS

Permanently elastic sealant in a handy cartridge or sausage. Used for producing airtight joints between VARIO KM / KM Duplex climate membranes and floors, ceilings and walls. Also used for fixing the overlapping seam areas.

Product	Volume	Packaging
Cartridge	310 ml	12 units
Sausage	600 ml	12 units

VARIO Pro Tape

Permanently elastic, self-adhesive sealant from the roll for producing airtight joints between VARIO KM / KM Duplex climate membranes and floors, ceilings and walls. Also used for fixing the overlapping seam areas.



Length – Width	Packaging
10 m – 25 mm	5 rolls = 50 m

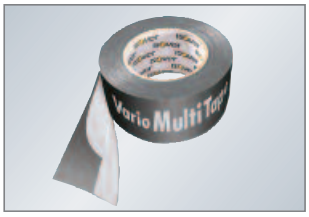
VARIO MultiTape

Single-sided, flexible and ductile adhesive tape with a high bonding strength for producing durable airtight seals between VARIO KM / VARIO KM Duplex climate membranes and Velux windows, pipes and roof penetrations. Also suitable for taping overlapping membrane seams (indoors and outdoors).

Length – Width	Packaging
25 m – 60 m	10 rolls = 250 m

VARIO MultiTape SL

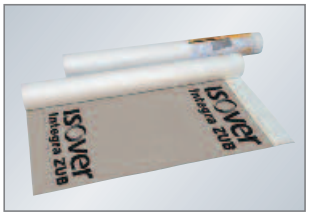
Single-sided, flexible adhesive tape with a split liner for producing durable airtight seals between VARIO KM / VARIO KM Duplex climate membranes and Velux windows, pipes and roof penetrations. Especially suited for use in corners and difficult-to-access areas, thanks to the split liner.



Length – Width	Packaging
25 m – 60 m	10 rolls = 250 m

ISOVER INTEGRA ZUB

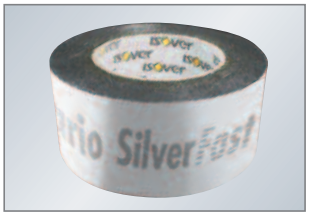
Robust and easy to install Polyolefin roofing underlay and sarking membrane, with integrated adhesive tape, used for steep roofs and timber frame constructions. Extremely breathable, rainproof and windtight.



Length – Width	Packaging
50 m – 1.5 m	75 m²/roll

VARIO SilverFast

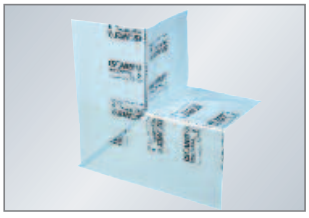
Single-sided adhesive tape used outdoors for producing durabe airtight bonds between the overlapping seams of underlay and sarking membranes as well as for sealing all junctures between the membranes and adjoining building components, e.g. Velux windows, pipes, etc. Also ideal for taping overlapping seams in VARIO climate membranes indoors and outdoors.



Length – Width	Packaging
25 m – 60 m	10 rolls = 250 m

VARIO TightTec

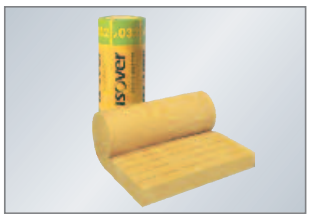
Facilitates the airtight sealing of junctions to exterior walls, windows, doors and inner corners. Easily foldable and adaptable to corners due to the line markings. Connections to the climate membrane must be taped over with VARIO Powerflex or VARIO MultiTape.



Product	Dimensions	Packaging
TightTec X	200 x 400 mm	60 pcs
TightTec X	120 x 400 mm	60 pcs
TightTec I	200 x 400 mm	60 pcs

ISOVER clamping felts of λ_d = 0.032 W/(mK)

- Used for loft conversions and timber construction as insulation between, above and under the rafters
- Ideal for insulating top floor ceilings
- Non-flammable (Euroclass A1)
- Easily cut to size thanks to a line marking

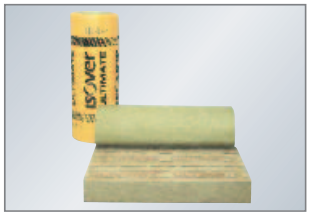


ISOVER clamping felts of λ_d = 0.035 W/(mK)

- Used for loft conversions and timber construction as insulation between, above and under the rafters
- Ideal for insulating top floor ceilings
- Non-flammable (Euroclass A1)
- Easily cut to size thanks to a line marking

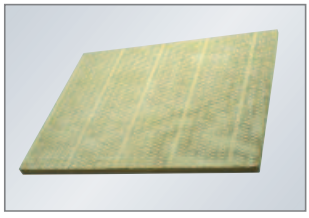
ULTIMATE fire protection clamping felt of λ_d = 0.035 W/(mK)

- The new generation of high-performance insulation materials
- Used for loft conversions and timber construction as insulation between, above and under the rafters
- Non-flammable (Euroclass A1)
- 30 minutes fire resistance without lining
- Easily cut to size thanks to a line marking



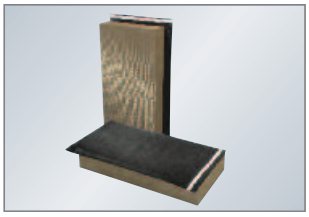
ISOVER SAW insulation board of λ_d = 0.035 W/(mK)

- Used for the external insulation of chimneys
- Non-flammable (Euroclass A1)



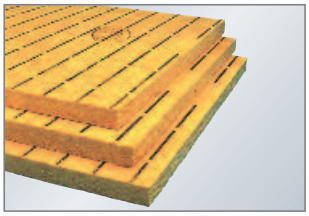
ISOVER Integra SolidBlack insulation slab of λ_d = 0.035 W/(mK)

- Used for robust, continuous insulation on top of roof boarding
- Integrated underlay membrane and adhesive tape facilitate installation



ISOVER LURO insulation slab of λ_d = 0.035 W/(mK)

- Used for robust, continuous insulation on top of roof boarding
- Non-flammable (Euroclass A2-s1, d0)

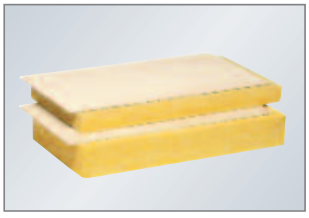


ISOVER blowing wool of λ_d = 0.040 W/(mK)

- Machine-applied insulation for difficult to access roof, wall and ceiling cavities
- Also suitable as non-walkable insulation for the attic floor
- Non-flammable (Euroclass A1)

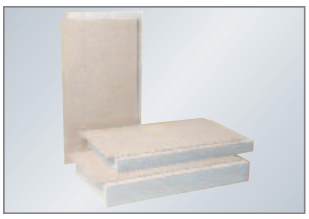
ISOVER insulation blocks of λ_d = 0.036 W/(mK)

- Composite element consisting of a non-flammable fibreboard and mineral wool.
- Used for thermal and acoustic insulation of top floor ceilings
- Load-bearing up to 150 kg/m^2



ISOVER insulation blocks of λ_d = 0.035 W/(mK)

- Composite element made of non-flammable fibreboard and expanded polystyrene (EPS).
- Used for thermal insulation of top floor ceilings
- Load-bearing up to 150 kg/m²

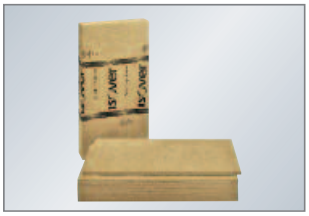


ISOVER TEL raised access floor system

- Dry and lightweight floor construction used for renovation and future loft conversion
- Variable height of 5-29 cm, optimally adaptable to all room conditions
- Levels out differences in height and uneven areas without problems
- System comprises wooden panels, pedestals with sound absorbers, flexible edge strips and ISOVER insulation slabs.

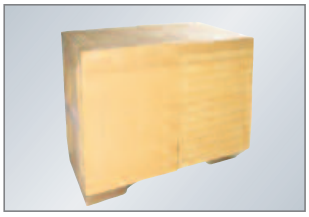
ISOVER stonewool slabs for dry screeds of λ_d = 0.035 W/(mK)

- Double-layered stonewool slabs with a highly pressure-resistant top layer
- For walkable thermal insulation of top floor ceilings under dry screed
- Dry screed can consist of fibreboard (thickness: 18 mm or two layers of 10 mm each) or chipboard (min. thickness: 19 mm).



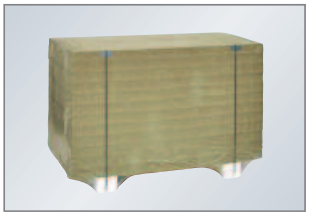
ISOVER glass wool slabs for flat roofs of λ_d = 0.037 W/(mK)

- For load-bearing insulation of warm or cold flat roofs, also used as bottom layer in duo roofs
- Suitable for wood, concrete and metal constructions
- Range of pre-shaped elements and sloping insulation boards facilitates installation
- Non-flammable (Euroclass A2-s1, d0)



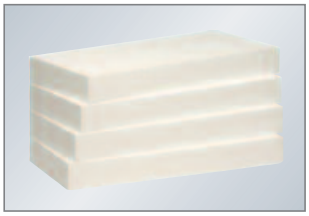
ISOVER stonewool insulation slabs for flat roofs of λ_d = 0.040 W/(mK) or 0.039 W/(mK)

- For highly load-bearing insulation of warm or cold flat roofs, also used as bottom layer in duo roofs
- Suitable for wood, concrete and metal constructions
- Range of pre-shaped elements and sloping insulation boards facilitates installation
- Non-flammable (Euroclass A1)



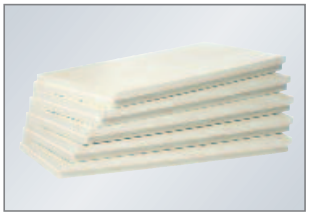
ISOVER EPS insulation slabs for flat roofs of λ_d = 0.035 W/(mK)

- Made of expanded polystyrene foam
- For highly load-bearing insulation of warm flat roofs and as bottom layer in duo roofs
- Range of preshaped elements and sloping insulation boards facilitates installation
- Fire behaviour: Euroclass E



ISOVER XPS insulation slabs for flat roofs

- Made of extruded polystyrene foam
- For highly load-bearing insulation of inverted roofs and as top layer in duo roofs
- λ_d = 0.033 to 0.039 W/(mK) (thickness related)
- Fire behaviour: Euroclass E



ISOVER products do not limit the creative freedom and aspirations of building owners and planners. Material structures and colours are variable and can be adapted to the individual style of the house.

The exterior walls: Your shield against cold, heat and rain

On a daily basis, the exterior walls of our homes have to stand up to high loads and stresses, as they provide us with a valuable shield against heat, cold and rain. Nearly half of a building's entire heat loss takes place through the exterior walls, and since they are the main "visual hallmark" of the house and its occupants, their optimization naturally takes high priority when undertaking renovation. Depending on the type of construction and the conditions on site, different solutions are possible, but before deciding on the precise measures to be taken, a thorough status analysis is essential. Whether you decide on interior or exterior insulation, whether you prefer a ventilated facade or a composite thermal insulation system, or whether you are planning to fill the cavity inside a two-leaf wall, however, ISOVER products will meet all of the your requirements for a low energy refurbishment.

Overview of typical wall constructions

The table below shows some of the most common wall structures and their respective insulation properties. The values will help you determine the current insulation standard of your home and define your future actions.

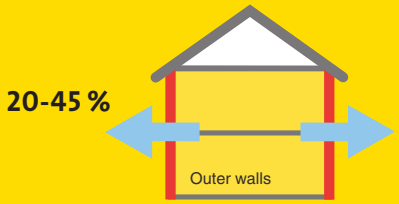
U-values of different wall constructions				Low-energy house			ISOVER Multi-comfort House		
				Thermal conductivity W/(mK)			Thermal conductivity W/(mK)		
				0.032	0.035	0.040	0.032	0.035	0.040
Insulation thickness in cm	**0**	**5**	**10**	**14**	**16**	**18**	**27**	**30**	**33**
Natural stones 40 cm	2.59	0.61	0.35	0.21			0.11		
Lime-sand bricks 30 cm	1.35	0.50	0.31	0.20			0.11		
Full bricks 30 cm (around 1900)	1.25	0.49	0.30	0.20			0.11		
Perforated bricks or light cement stones 30 cm (around 1950)	1.03	0.45	0.29	0.19			0.11		
Pumice stone or light perforated bricks 30 cm (around 1970)	0.76	0.39	0.26	0.18			0.10		
Double-leaf cavity walls 41.5 cm (around 1970)	0.66	0.36	0.25	0.17			0.10		
Timber-framed walls 15 cm (around 1970)	0.54	0.32	0.23	0.16			0.10		

The calculation is based on a moderate climate with 3500 Kd heating degree days.

Very high energy losses — *High energy losses*

Low-energy House — *Multi-Comfort House*

▶ *Please refer to the inside back cover for a glossary of all physical units and technical terms used.*



Indicators of insufficient insulation

The warning signs of poor thermal insulation are easy to spot. For example the facade where snow quickly melts either on or near the wall, the cool internal surfaces of walls, or the cold draughts that disturb the family's thermal comfort. In fact, a low temperature on room facing wall surfaces not only reduces thermal comfort, but means high heating costs and can bring with it structural risks. Humid air may form condensation on, on even within, the walls and, over time„ trigger mould growth and other common moisture-related damage.

Wall moisture: one problem, numerous causes

House building is a continuous battle against the damaging effects of water and moisture – both not only affect the comfort, useful life and appearance of the house, but also result in higher heating bills and may ultimately harm our health. Undesired moisture can originate from different sources: rising damp (due to missing or insufficient horizontal waterproofing), lateral moisture, seepage water, rainwater, water splashes, condensation or leaky sanitary facilities.

An efficient way to optimum living comfort: Insulation with ISOVER

If you want to achieve high levels of thermal insulation in the exterior walls, your primary consideration should be the performance of the insulation material you use. However, the opaque walls will also need to compensate for the heat lost through the transparent parts of the building, such as windows and doors, so when undertaking renovation, it makes sense to replace old windows and doors with new energy-saving alternatives. Depending on the energy performance of the existing wall construction (see table below), a 30 cm thick layer of ISOVER insulation should be sufficient to attain the level of a Multi-Comfort House. This guarantees a pleasant indoor climate and minimal heating costs all year round.

Energy use and potential savings based on an exterior solid brick wall, built around 1900, with 100 m² floor space				**Low-energy house**			**ISOVER Multi-comfort House**		
				Thermal conductivity W/(mK)			**Thermal conductivity W/(mK)**		
				0.032	**0.035**	**0.040**	**0.032**	**0.035**	**0.040**
Insulation thickness in cm	**0**	**5**	**10**	**14**	**16**	**18**	**27**	**30**	**33**
U-value in W/(m²K)	1.25	0.75	0.43	0.20			0.11		
Heating energy demand in kWh per year	10,500	6,300	3,612	1,680			942		
Heating energy demand in kWh over a period of 40 years	420,000	252,000	144,480	67,200			36,960		

The calculation is based on a moderate climate with 3500 Kd heating degree days.

▶ *Please refer to the inside back cover for a glossary of all physical units and technical terms used.*

Facade insulation from outside: Lots of space for lots of thermal comfort

It stands to reason that the thermal refurbishment of the exterior walls has enormous advantages: the entire building can be effectively "wrapped up" so that thermal bridges don't stand a chance. Whilst fitting insulation inside the building can often reduce your living space, there is usually no limits to extending outwards, so thicker layers of insulation can be used. The result: enhanced living comfort and your heat loss reduced by up to 95 %.

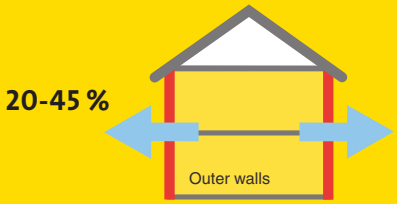
Systems for exterior wall insulation

In most cases, the exterior walls of a building can be refurbished by using some kind of composite thermal insulation or a ventilated facade. In the case of double-leaf cavity walls, however, cavity insulation can be used in combination with other systems.

• Composite thermal insulation systems

Following a thorough analysis of the external render and its load-bearing strength, the wall is directly covered with ISOVER mineral wool or expanded polystyrene (EPS) insulation slabs, secured by dowels if necessary. Window and door reveals must also be insulated to prevent thermal bridges. The whole surface is then covered with a reinforcement fabric embedded in an adhesive filler, before the final external render is applied for additional protection and to give the necessary aesthetic appearance.

If the windows and doors are not replaced, the reveals must also be insulated to avoid thermal bridges.



• Ventilated facades

Following a thorough analysis of the external render and its load-bearing strength, ISOVER mineral wool is clamped between the battens of a support lathing and secured by dowels if necessary. The facade cladding may consist of timber or wood-based materials, natural stone, artificial stone, fibrous cement, metal, plastic boards or other materials. To ensure ventilation of the facade, an air space of at least 3 cm must be provided, with openings to ensure that both fresh and exhaust air can circulate through the facade. This makes this system ideal for walls that are saturated with moisture. If speed is important, fast-track renovation is possible using large prefabricated, lightweight insulation panels that are mounted on timber frames and installed on site – just ask your carpenter for advice.

Watch out for thermal bridges

Great care must be taken to avoid thermal bridges. The insulation must cover all adjoining and non-insulated building components by a minimum of 50 cm. Pay particular attention to junctions between insulation and balconies or cellar walls, which are prone to thermal bridges.

Ventilated facade with untreated timber cladding – functional and attractive.

Insulation of double-leaf cavity walls

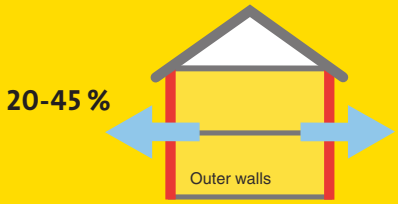
After a thorough analysis of the existing construction, the cavity between the two leaves of the wall can be completely filled by blowing insulation inside. Your choice of materials includes ISOVER blowing wool or ISOVER RigiBead® granulate made of expanded polystyrene foam (EPS). Since the cavity is generally no more than 6 cm wide, you should install additional interior or exterior insulation to ensure the desired level of comfort.

The energy efficiency of well-preserved clinker facades can be improved by cavity insulation.

Many facades – for example those made of clinker or travertine – have a high material value. It is therefore worth considering renovating the exterior walls from inside the house. Please refer to page 70 for further details.

Three steps towards a better insulation of double-leaf cavity walls:

- After inspecting the cavity, a regular pattern of small holes is drilled in the wall.
- The cavity is then completely filled by blowing insulation material.
- The drillholes are made good with matching mortar.



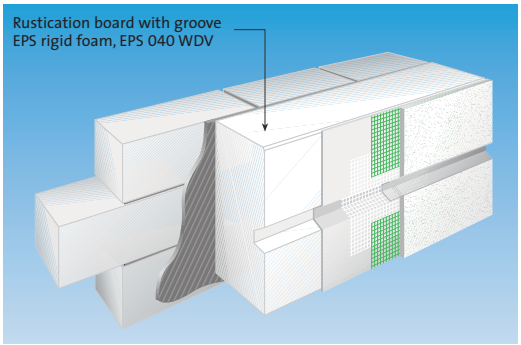
ISOVER rustication boards – Comfort behind a structured facade

The question is often asked whether an old, beautifully structured facade is compatible with state-of-the-art insulation. ISOVER has provided the solution with rusticated ISOVER facades. These innovative products not only offer significant energy savings thanks to a composite thermal insulation system, but they also visually upgrade and embellish thanks to a well defined facade surface – all achieved in just one operation.

New insulation – new look

Are you planning to upgrade your building facade to blend with the local architecture, or simply reinstate its original appearance? Whatever your plans, a rusticated facade using special ISOVER rustication boards provides the answer. You can choose from three different standard cross-sections that each give a natural stone appearance. Made by ISOVER from expanded polystyrene (EPS), the boards are precision grooved in the factory to give a regular structured appearance. They are installed using the same techniques as conventional composite thermal insulation systems.

System structure and facade cross-section



Three standard groove cross-sections lend an individual design to rusticated facades.

Insulate exterior walls from inside: an alternative worth exploring

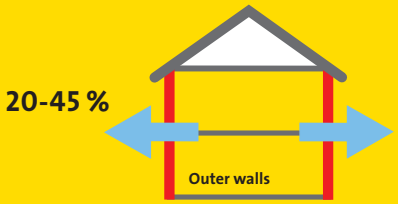
The advantage of insulating the room-facing side of exterior walls is that the complete renovation can take place in dry indoor conditions. If you wish, you can even do-it-yourself. This option is often chosen for multi-family houses and facades under monument protection.

Insulating from the inside will involve some reduction in your living space, but the high performance of ISOVER solutions will ensure that this is negligible – unlike the thermal effect, which will be considerable.

Effective airtightness

Airtightness of solid exterior walls is achieved by applying a plaster coat. Any weak points – such as joints around the windows, and penetrations for cable trays, ductwork etc. – need to be properly sealed before the interior insulation is installed.

The exterior walls of half-timbered houses present a special challenge with respect to air-tightness. We recommend covering the inner wall surface with a continuous wind protection membrane, such as ISOVER Integra ZUB before installing the insulation layers. In all cases, the procedure should be to firstly install the thermal insulation, cover with VARIO KM or VARIO KM Duplex, and finally fix the interior lining.



The OPTIMA system – or how to make lasting savings in energy bills

Choose the OPTIMA system for your renovation and you can be sure of a quick and efficient increase in your living comfort as well as considerably lower heating bills. OPTIMA is a drylining insulation system that saves time as there is no delay due to adhesive drying times. All cables and pipes can be conveniently accommodated and, more importantly, Optima will considerable improve airborne sound protection – reducing the levels of external noise in your home by as much as 50 %.

Higher living comfort – achieved in only four steps

1. Fix OPTIMA U 235 studs to the floor and ceiling and OPTIMA C 240 studs horizontally at mid-height on the wall.
2. Fix OPTIMA plastic spacers to mid height stud and fix ISOVER insulation slabs, skewering and fixing them using the plastic spacers. Fix C 240 studs vertically into floor and ceiling studs, over the insulation.
3. Completely cover the surface with a VARIO KM or VARIO KM Duplex membrane, securing overlaps with adhesive tape. Use VARIO sealant to give airtight seals with the adjoining wall, ceiling and floor.
4. Fix the desired lining board – Gyproc plasterboard or timber board – on top.

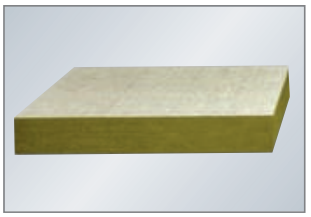
Get rid of thermal bridges – with ISOVER

The interfaces between intermediate ceilings or interior walls and the adjoining components are common areas for thermal bridges. It is essential to take the insulation of these flanking components into account when planning the job.

Insulation products for exterior walls

ISOVER stonewool slabs for use with composite thermal insulation systems

- For insulating exterior walls below an adhesive filler and plaster coat
- λ_d = 0.036 W/(mK) or 0.040 W/(mK)
- Breathable (i.e. open to diffusion)
- Excellent acoustic insulation
- Non-flammable (Euroclass A1)



ISOVER stonewool lamella mats for use with composite thermal insulation systems

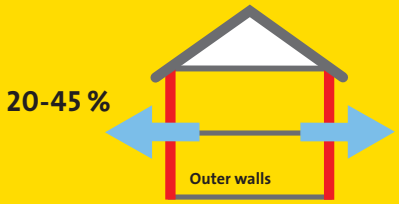
- For insulating exterior walls below an adhesive filler and plaster coat
- λ_d = 0.040 W/(mK)
- No need for dowelling on solid, load-bearing substrates and buildings up to 20 m height
- Breathable (i.e. open to diffusion)
- Non-flammable (Euroclass A1)

ISOVER glass wool slabs for use with composite thermal insulation systems

- For insulating exterior walls below an adhesive filler and plaster coat
- λ_d = 0.037 W/(mK)
- Breathable (i.e. open to diffusion)
- Excellent acoustic insulation
- Non-flammable (Euroclass A2-s1, d0)

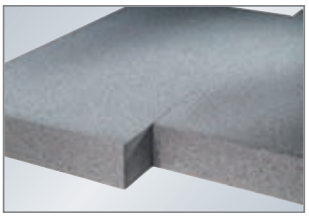
ISOVER EPS boards for use with composite thermal insulation systems and rusticated facades

- For insulating exterior walls below an adhesive filler and plaster coat
- λ_d = 0.035 W/(mK) or 0.040 W/(mK)
- Rustication boards – three different groove cross-sections for facade design
- Fire behaviour: Euroclass E



ISOVER EPS boards for use with composite thermal insulation systems

- For insulating exterior walls under adhesive filler and plaster coats
- λ_d = 0.032 W/(mK)
- Fire behaviour: Euroclass E

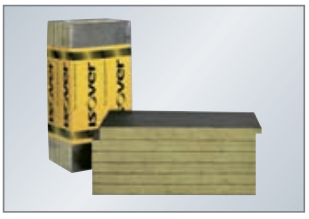


ISOVER stonewool insulation slabs for ventilated facades

- With or without a tissue facing
- λ_d = 0.035 W/(mK) or 0.040 W/(mK)
- Breathable (i.e. open to diffusion)
- Excellent acoustic insulation
- Non-flammable (Euroclass A1)

ISOVER glass wool insulation slabs for ventilated facades

- With or without a tissue facing
- λ_d = 0.030 W/(mK), 0.032 W/(mK) or 0.033 W/(mK)
- Breathable (i.e. open to diffusion)
- Excellent acoustic insulation
- Non-flammable (Euroclass A1 or A2)

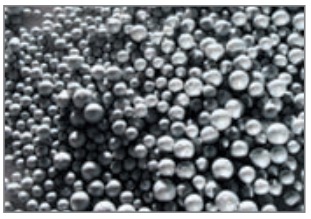


ISOVER glass wool rolls for ventilated facades

- With or without facing
- λ_d = 0.035 W/(mK) or 0.038 W/(mK)
- Breathable (i.e. open to diffusion)
- Excellent acoustic insulation
- Non-flammable (Euroclass A1 or A2)

ISOVER RigiBead® insulation beads of λ_d = 0.035 W/(mK)

- For machine-applied insulation in the cavities between double-leaf walls
- Fire behaviour: Euroclass E



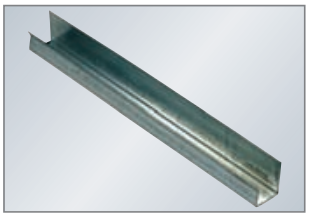
ISOVER blowing wool insulation of λ_d = 0.040 W/(mK)

- For machine-applied insulation of cavities in roof, wall and ceiling areas where access is difficult
- Non-flammable (Euroclass A1)

ISOVER OPTIMA System

OPTIMA U 235 floor and ceiling studs

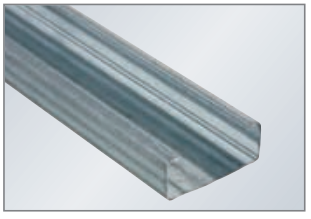
Metal floor and ceiling studs for fixing insulation boards and vertical C studs.



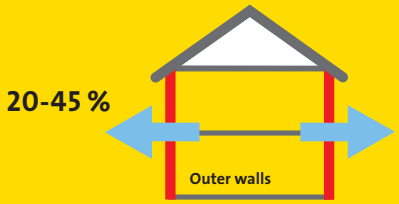
Article	Packaging
OPTIMA U 235 stud Length: 235 cm	Pallet of 12 bundles of 20 units = 564 m

OPTIMA C 240 studs

2.4 m long metal 'C' studs for fixing vertically between floor and ceiling studs to form the stud frame. Also used for mid height fixing to support OPTIMA spacers.

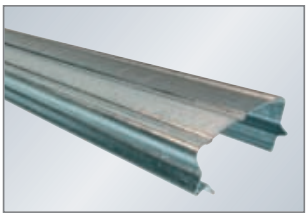


Article	Packaging
OPTIMA C 240 stud Length: 240 cm	Pallet of 40 bundles of 10 units = 960 m



OPTIMA 30 and OPTIMA 50 extension studs

Short metal studs for connecting or extending OPTIMA C 240 studs.



Article	Packaging
OPTIMA 30 extension stud Length: 30 cm	Pallet of 40 bundles of 10 units = 120 m
OPTIMA 50 extension stud Length: 50 cm	Pallet of 40 bundles of 10 units = 200 m

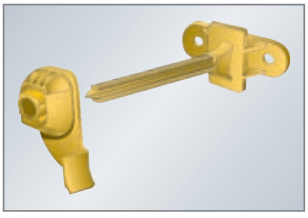
OPTIMA support pillars (spacers)

Plastic support pillars for securing insulation to metal 'C' studs. Plastic clamping key holds insulation securely in place.

Article	Packaging
OPTIMA support 75	50 units
OPTIMA support 100	50 units
OPTIMA support 115	50 units

OPTIMA support pillar Reno

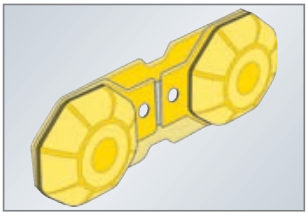
Plastic support pillar that can be fixed directly to the wall. Complete with plastic clamping key.



Article	Packaging
OPTIMA support Reno	40 units

OPTIMA connectors

Plastic connectors for joining OPTIMA C 240 metal studs.



Article	Packaging
OPTIMA connector	25 units

ISOVER VARIO System

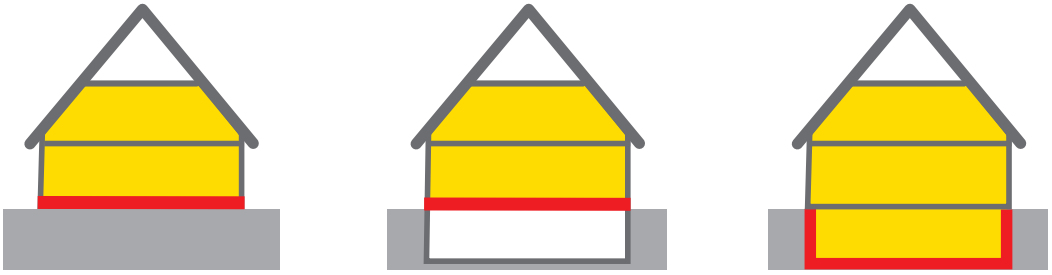
Please refer to pages 56/58 for details of system components.

The basement: Your foundation for thermal comfort

The basement components – walls, ceilings and foundation slab – form the lower boundary of the thermal envelope. If the rooms in the basement are lived in, or used – e.g. for fitness, parties or the accommodation of guests – their primary need is for high insulation levels to provide a comfortable living environment and protect the building fabric from damage. This, in turn, will increase the market value of the property.

Is the thermal envelope located inside or outside the basement?

Is the basement within the thermal envelope? As you will see from the illustrations below, this depends on how it is used. If the basement rooms are constantly heated and have a room temperature above 19°C, the boundary of the thermal envelope runs along the floors and walls of these rooms. If the basement is not used or heated, it is the ceiling of the basement that forms the thermal boundary. And if there is no basement at all, the foundation slab of the building constitutes the thermal boundary.

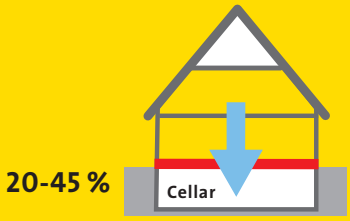


No cellar | Unheated cellar | Heated cellar

The area encompassed by the thermal envelope (red line) depends on how the basement is used.

Eliminate weak points in the cellar insulation

- *Exterior walls: insulation from inside or outside using perimeter insulation installed on the foundation and on the cellar wall.*
- *Interior walls: linings provide additional insulation.*
- *Floor and ceiling: insulation from above or from below.*
- *Heating system: insulation of the heating pipes (mostly in the cellar).*

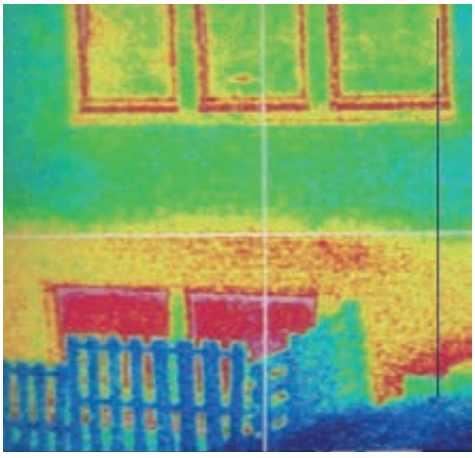


Save energy and avoid moisture – down in the cellar

In a heated cellar, the walls in contact with the ground need to be insulated just like the exterior walls of the house. This applies to the wall area above the so-called frost line, which is at a depth of around 1.5 m in Central Europe. Below this depth, the temperature differential between the walls and the outside soil is more or less the same as between the walls and the ambient outside air.

If the cellar is unheated, the ground floor of the house, which is also the roof of the cellar, forms the thermal boundary between the house and the earth below. In old houses, the walls and floors of cellars are often inadequately insulated against moisture, which may lead to mould growth and rot. Airing the cellar rooms is not the answer. In summer, humid air penetrates and condenses on the cold cellar walls, thus further increasing the humidity. And in winter people naturally avoid airing their cellars because of the cold outside air.

Prior to the planning phase, therefore, a thorough analysis should be carried out in order to determine the extent of the necessary renovation measures.



The high level of heat loss through the cellar walls and windows is clearly visible, as is the temperature difference compared to the upper part of the house.

How humid is the air?

The amount of water vapour in the air is dependent on the temperature. The higher the temperature, the more water vapour can be absorbed by the air. At a temperature of 30°C, up to 30 g per m^3 can be absorbed, whilst at 0°C this reduces less than 5 g/m^3, and at -10°C it is down to just 2 g/m^3 at most. In a 10 m^2 room with 2.5 m ceiling height and a temperature of +30°C, the air may contain as much as 750 g of water vapour.

Under tiles, laminate or parquet:
ISOVER products keep your feet warm.

Living comfortably, above the cold cellar

The ceiling above an unused and unheated cellar is an often not properly considered when undertaking the low energy refurbishment of a house. Yet It's not hard to understand that poor or even missing insulation in this part of the building will inevitably lead to a reduction in comfort levels and high energy losses. When your feet are in direct contact with a cold floor, your body loses around six times as much warmth as normal. So it's easy to see why it is vitally important to insulate the cellar ceiling.

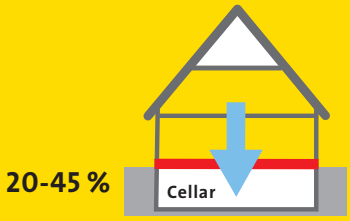
Cellar ceilings – with and without vapour barrier

Insulating a solid cellar ceiling from below is basically very similar to insulating a wall from outside. A vapour barrier is not required, and ISOVER insulation materials will ensure that the floor above the cellar, and therefore also your feet, are kept warm and dry. If, however, you decide to thermally renovate the solid cellar ceiling from above, i.e. from the warm side, you will need to install a climate membrane, such as ISOVER VARIO KM or VARIO KM Duplex, on the inner face to ensure an airtight seal. This will keep the insulation dry – and protect you from the cold. If the ground floor above the basement is of timber joist construction, you will also need to install one of the ISOVER climate membranes on the inner (warm) side of the floor.

Energy use and potential savings based on a cellar ceiling made of timber joists with 2 cm interior plaster and 100 m² ceiling space				**Low-energy house**			**ISOVER Multi-comfort House**		
				Thermal conductivity W/(mK)			**Thermal conductivity W/(mK)**		
	Built in 1900	**Built in 1950**	**Built in 1975**	**0.032**	**0.035**	**0.040**	**0.032**	**0.035**	**0.040**
Structure: 16 cm high timber joists with ...	air	cinder fill	3 cm insulation	**14 cm**	**16 cm**	**18 cm**	**22 cm**	**24 cm**	**27 cm**
U-value in W/(m²K)	1.14	0.78	0.59	0.23			0.16		
Heating energy demand in kWh per year	4,784	3,276	2,478	966			672		
Heating energy demand in kWh over a period of 40 years	191,352	131,040	98,952	50,568			30,912		

The calculation is based on a moderate climate with 3500 Kd heating degree days and a construction with 15% timber content. A degradation coefficient of 0.5 has been taken into account.

▶ *Please refer to the inside back cover for a glossary of all physical units and technical terms used.*



A perfect combination: timber ceilings and ISOVER

Since the joists are only 12 to 18 cm in depth, the load-bearing timber construction needs to be doubled up if you want to ensure optimum insulation results. As the floor clearance for doorways, fittings and other building elements at ground level is limited, it would be very costly in both time and labour to increase the floor level. In most cases, therefore, renovation is generally undertaken from the cellar side.

Install VARIO KM or VARIO KM Duplex on top of the ISOVER insulation, before covering it with your flooring of choice.

Before installing new insulation, the ceiling lining and any existing filling materials are completely removed. A sub-ceiling is then made in metal or timber frame and mounted below the existing ceiling, and the cavity between the two completely filled with ISOVER insulation. An insulation thickness of 24 cm thickness will be needed to guarantee that you reach the comfort level of an ISOVER Multi-Comfort House.

Provide an airtight seal – easy and fast

If you want to ensure that your timber joist cellar ceiling is airtight, install a VARIO KM or VARIO KM Duplex climate membrane on top of the insulation on the room-facing side. It is essential that seals in the VARIO membrane sheets are airtight. This is done with the help of two products: VARIO adhesive tape for securing the approx. 10 cm wide overlapping seam areas, and VARIO sealant, a flexible mastic that bonds the membrane edges to the adjoining parts of the building.

The advantage of blowing insulation: empty ceiling cavities can be completely filled while the lining remains almost intact.

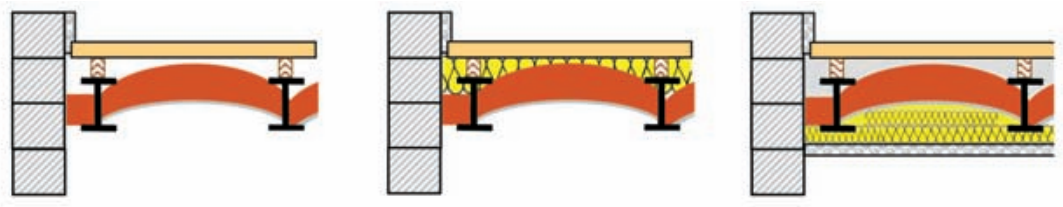
Vaulted ceilings and ISOVER go well together

In old cellars it is common to find a so-called "Kappendecke" or vaulted ceiling, made from vaulted brickwork supported by steel girders. Spacer slats are mounted on top to support the floor, leaving a cavity between the two elements of anything between 6 cm and more than 20 cm in height, depending on the vault.

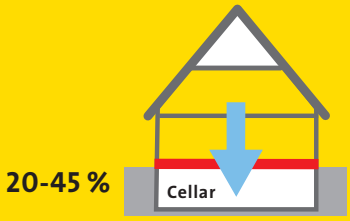
Make good use of old cavities – or create new ones

If the ceiling cavity is empty and the flooring needs to be replaced, thermal insulation is best installed from above. To do this, the old flooring is first removed and the enclosed ceiling space completely filled with ISOVER glass wool.

Constructions of this type are often filled with loose materials or cinders. In such cases, thermal insulation can be improved by mounting a timber or metal frame subconstruction below the vault and filling the resulting cavity with ISOVER glass wool. The new ceiling construction is then lined with plasterboard. As well as the two methods outlined above, it is also possible to use a non-destructive option – filling the existing ceiling cavity with blowing wool.



Possible options for renovating a vaulted ceiling



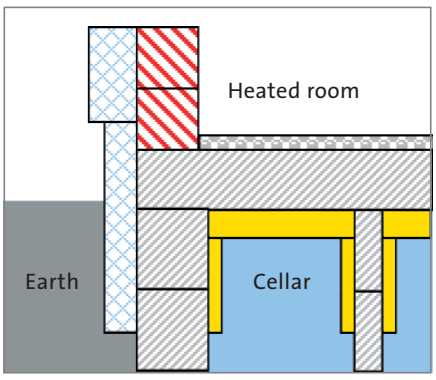
Simple but efficient: insulation of solid cellar ceilings

Solid cellar ceilings are usually made of concrete, brick or stone. More often than not, they are poorly insulated or, especially with older buildings, have no thermal insulation at all. Needless to say, this makes thermal upgrading a key issue, not only to address the problem of high heat loss, but to enhance comfort levels in the heated rooms. To achieve this, a timber or metal frame sub-construction is mounted underneath the ceiling, and the void created completely filled with ISOVER glass wool before applying a new ceiling lining.

Solid ceilings insulated from below – simple but efficient.

Avoid thermal bridging – and think "around the corner"

The renovation of a cellar ceiling can reduce the heat loss through that part of the building by up to 95 %. It is important beforehand to identify all areas where thermal bridges may occur and do everything possible to prevent them. Thermal bridging is caused when the insulated, and therefore warm, construction is in direct contact with cold cellar walls. To prevent the bridging, and resulting heat loss, the upper edges of the flanking walls need to be lined with minimum 50 cm wide, but preferably 100 cm wide, strips of thermal insulation no less than 4 cm thick.



Thermal bridge free insulation of the cellar ceiling: think "around the corner" and also insulate the flanking walls.

ISOVER solutions for the cellar ceiling – great variety, great effect

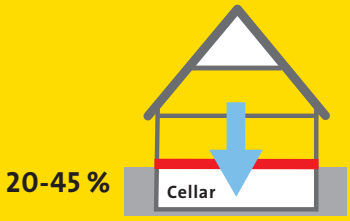
ISOVER insulation slabs allow flexibility in the way you achieve high levels of insulation for the cellar ceiling, when working from below. Thanks to a range of different materials, installation options and surface finishes, the insulation elements easily adapt to the different conditions on site. Take for example ISOVER mineral wool slabs. They can be fixed to the cellar ceiling by either bonding, dowelling or mounting in a metal framework, and thanks to their light coloured facing they will both brighten up and optically upgrade your cellar rooms.

Bonded, dowelled or mounted in a metal framework ISOVER offers a variety of solutions.

Whether storeroom, hobby room or garage – ISOVER optimally insulates and optically upgrades your basement.

Close the gaps and prevent airflows – with ISOVER

Concrete ceilings are airtight. But when drilling holes for routing cables or pipes, the penetrations must be properly sealed. No problem with a comprehensive range of purpose-made ISOVER products at your disposal.



ISOVER EPS: Ready-made insulation elements for the cellar ceiling

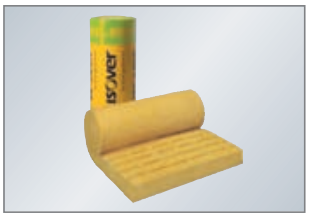
Designed specially for the insulation of cellar ceilings, the KDE insulation element, offers excellent technical properties and an impact-resistant, high-quality surface. It is based on an expanded polystyrene (EPS) board that comes factory laminated to 3 mm thick high-density fibreboard (HDF), finished on its exposed face with varnish. The handy elements are supplied with claw fasteners that are pressed into the insulation material and then dowelled into the ceiling. The minimal excess edge around the rigid EPS foam board is combined with tongue-and-groove connection around the perimeter, that determines the orientation and ensures that the elements fit together tightly to give continuous insulation with no fear of thermal bridges.

Aesthetic surface coupled with maximum efficiency – insulation elements by ISOVER.

ISOVER products for the insulation of basements

ISOVER clamping felts of λ_d = 0.032 W/(mK)

- For insulating cellar ceilings (solid and timber joist ceilings) from below
- Non-flammable (Euroclass A1)
- Can be easily cut to size thanks to a line marking.



ISOVER clamping felts of λ_d = 0.035 W/(mK)

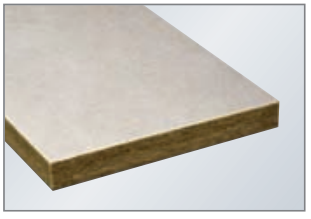
- For insulating cellar ceilings (solid and timber joist) from below
- Non-flammable (Euroclass A1)
- Can be easily cut to size thanks to a line marking.

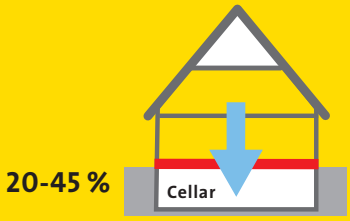
ISOVER glass wool slabs of λ_d = 0.030 W/(mK), 0.032 W/(mK) and 0.035 W/(mK)

- For insulating the cellar ceiling from below
- Non-flammable (Euroclass A1)

ISOVER stonewool slabs of λ_d = 0.035 W/(mK) and 0.040 W/(mK)

- For insulating the cellar ceiling from below
- Non-flammable (Euroclass A1)

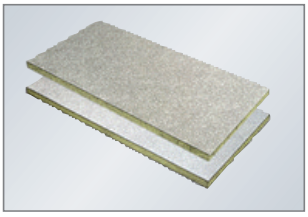




VARIO KM and VARIO KM Duplex climate membranes and their accessories are covered in detail on pages 56-58.

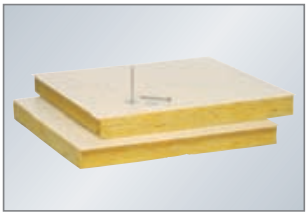
ISOVER stonewool slabs for insulating cellar ceilings

- For insulating cellar ceilings and garages
- Different surface structures
- Installation options: bonding, dowelling, mounting in metal framework
- λ_d = 0.040 W/(mK)
- Non-flammable (Euroclass A1)



ISOVER glass wool slabs for insulating cellar ceilings

- For insulating cellar ceilings and garages
- Different surface structures
- Installation options: dowelling, mounting in metal framework
- λ_d = 0.033 W/(mK)
- Non-flammable (Euroclass A2)



ISOVER EPS boards for insulating cellar ceilings

- For insulating cellar ceilings
- Installation: with metal rails and claw fasteners
- λ_d = 0.032 W/(mK)
- Fire behaviour: Euroclass E

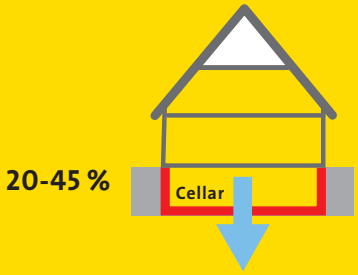
Excellent insulation – remember the outer walls of the cellar

Rooms in the basement that will be regularly used after refurbishment require high levels of thermal insulation and reliable protection from ground moisture and water seeping through the walls. This is why the walls should be professionally surveyed at the very outset of the project. Water can be present in the cellar as retained or capillary water and will even rise against the force of gravity. A permanently dry cellar can only be guaranteed if the necessary remedial measures are expertly planned and executed.

Successful insulation prevents water damage

If the outer walls of the cellar are damp or even leaking water, it is time to carry out large-scale exterior renovation of the cellar walls. The first step is to repair any defective moisture barrier or dampproofing. Thermal insulation, in the form of ISOVER expanded or extruded polystyrene (EPS or XPS) slabs, is then installed on the outer surface of the wall.

Correct renovation of a cellar wall from outside: expose the wall, install the drainage, apply the dampproofing and XPS-insulation layers and finally re-fill the excavation.



Even cellar walls are not totally protected from the cold

Although up to 80 % of the cellar walls are generally covered by the soil, and only 20 % therefore have contact with the external air, the same thermal requirements apply as for all other exterior walls. The frost line (or frost-free zone) starts underground at a depth of 1.5 m, below which constant summer and winter temperatures are maintained, which reduces the amount of heat loss through the cellar walls. It generally, therefore, requires only a 30 cm thickness of ISOVER glass wool insulation to achieve the thermal comfort level of a Multi-Comfort House.

Renovation on the inside: the easiest way to higher energy efficiency

Access to the outside of cellar walls is often difficult. Thermal renovation from inside, i.e. on the room-facing wall, is therefore the only viable option in most cases. The ideal solution in this case is the ISOVER OPTIMA system. Installation is quick and straightforward, and provided the correct insulation thickness is used, the rooms will remain warm in winter and pleasantly cool in summer. By including on top, VARIO KM or KM Duplex climate membranes in the construction you will also provide protection against the intrusion of moisture. Please refer to page 71 for details of the installation procedure.

OPTIMA combined with VARIO KM Duplex – an ideal solution for cellar walls.

Energy use and potential savings based on an outer cellar wall of 36 cm concrete, with a wall area of 100 m² and different insulation thicknesses			**Low-energy house**			**ISOVER Multi-Comfort House**		
			Thermal conductivity W/(mK)			**Thermal conductivity W/(mK)**		
	Built in 1900	**Built in 1975**	**0.032**	**0.035**	**0.040**	**0.032**	**0.035**	**0.040**
U-value in W/(m²K)	2.80	0.48	0.20			0.11		
Insulation thickness in cm	No insulation	6	14	16	18	27	30	33
Heating energy demand in kWh per year	23,520	4,032	1,680			924		
Heating energy demand in kWh over a period of 40 years	940,800	161,280	67,200			36,960		

The calculation is based on a moderate climate with 3500 Kd heating degree days.

▶ *Please refer to the inside back cover for a glossary of all physical units and technical terms used.*

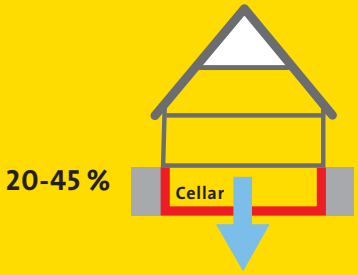
Thermal envelope inside the cellar? Proper protection of the inner walls is needed!

It may well be that the boundary of the thermal envelope runs through the cellar. In this case, the walls between heated and unheated areas – as well as the outer cellar walls themselves – must be properly insulated to prevent heat loss. This can be effectively achieved with ISOVER mineral wool slabs. They give you the choice of three installation options: either direct-fix to the wall: fixed in a timber or metal stud framework; or installed in ISOVER's high performance OPTIMA system. In each case, the insulation is then lined internally, usually with plasterboard.

When installing the thermal insulation on the warm room-facing side, it is also necessary to apply a VARIO KM or VARIO KM Duplex membrane over the insulation before the internal lining is fitted. This membrane is not needed when insulation is installed on the "cold" side.

When carrying out a cellar conversion, you may also want to include a toilet and shower room. ISOVER extruded polystyrene (XPS) boards are ideal for insulating wet rooms as they have a very high compression resistance and can be covered directly with tiles.

XPS boards are unaffected by water and therefore ideally suited for wet rooms. Additional benefit: they can be directly tiled over.



Cellar floors turned habitable with ISOVER insulation

Provided the existing cellar floor is already water- and vapour-tight, any additional thermal insulation can be installed directly on top. There are a number of different ISOVER systems designed for this purpose. Depending on the existing condition and future use of the room, the floor can either be covered with dry screed panels or with a wet screed to which the final floor covering is applied later. Whichever option you choose, an insulation thickness of 30 cm ensures that you reach the level of an ISOVER Multi-Comfort House.

But what if the cellar is heated and in use, but the cellar floor is not dampproof? In this case, expert analysis will generally recommend that the old floor be completely removed and replaced.

Energy use and potential savings based on a concrete foundation slab with 100 m² floor space			**Low-energy house**			**ISOVER Multi-Comfort House**		
			Thermal conductivity W/(mK)			**Thermal conductivity W/(mK)**		
	Built in 1900	**Built in 1975**	**0.032**	**0.035**	**0.040**	**0.032**	**0.035**	**0.040**
U-value in W/(m²K)	2.15	0.68	0.20			0.11		
Insulation thickness in cm	No insulation	4	14	16	18	27	30	33
Heating energy demand in kWh per year	9,030	2,867	840			462		
Heating energy demand in kWh over a period of 40 years	361,200	114,667	33,600			18,480		

The calculation is based on a moderate climate with 3500 Kd heating degree days.

▶ *Please refer to the inside back cover for a glossary of all physical units and technical terms used.*

Raised access floors: Top choice – not only when you need fast results

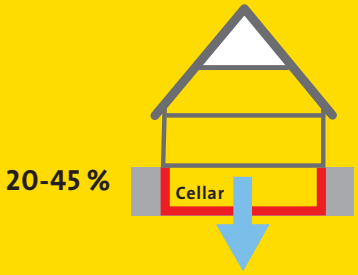
The TEL raised floor system is a dry and lightweight floor construction. Thanks to its adjustable height, it can be adapted to suit all floor conditions, while levelling out irregularities and differences in height. The "legs", or pedestals, are placed directly onto the load-bearing subfloor, even if the surface is uneven – all that's needed to level out any difference in height is a single turn of the screw, from above. The next day you can install the flooring – and the job's done!

How to install a raised access floor

Start by determining the direction of installation, then take the edge panels and cut off the tongue. Next, glue the flexible perimeter strips to the wall, along the floor edges. Drive the TEL pedestals into the predrilled holes of the panel and mount the ISOVER insulation slab on top of the panel. Then, slip the sound absorber disks onto the pedestal heads, turn the complete insulated panel over and install it on the floor. This is done by first adjusting the corner and then the middle pedestals using the special TEL screwdriver. Glue the tongue-and-groove joint and finally place the panels into position, with joints staggered. Pipes and cables can be conveniently hidden away under the TEL raised access floor.

Advantages of the TEL raised access floor:

- *Construction heights of 5 to 29 cm*
- *Installed on the subfloor without loose fill*
- *Pipes and cables can be simply hidden away*
- *Can be covered with flooring after just 1 day*
- *Low weight of only 22 kg/m²*
- *Load-bearing up to 500 kg/m² (5 kPa)*
- *Point loads up to 300 kg (3 kN)*



Dry screeds – the perfect basis for wooden floors

Wooden floors convey an aura of warmth and cosiness and are well suited for all types of room, from a living room or party room to your own private "fitness oasis". Regardless of its design, a high quality wooden floor, expertly fitted, will be hardwearing and will retain its good looks for decades to come.

Highly important: the vapour barrier

If the floor is located directly above the cold ground, it needs to be very well insulated. As well as thermal and acoustic insulation, effective dampproofing is a must. In this case 0.2 mm thick PE sheeting, such as ISOVER FLAMMEX, should be installed on top of the final thermal insulation layer. This is done immediately before installing, for example, tongue and groove boarding or chipboard floor covering. This sheeting acts like a vapour barrier and must always be installed on the warm side of the construction.

An energy-efficient solution: floating dry screed with a chipboard covering.

Whether tongue and groove boarding on timber battens or mosaic parquets on chipboard – together with ISOVER they will keep your feet warm.

ISOVER EPS and XPS – Floor insulation that meets every demand

ISOVER insulation boards made of expanded or extruded rigid polystyrene foam (EPS or XPS) are remarkably strong and robust. As these boards are also virtually immune to moisture, they are commonly used for insulating cellar floors and floors that are in direct contact with the ground – regardless of whether they are installed as part of a dry floor system or under a wet screed.

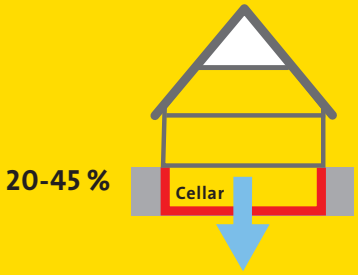
ISOVER expanded polystyrene insulation boards (EPS)

Extruded polystyrene (XPS) insulation boards: double-layered to ensure higher living comfort and lower energy costs.

Pinpoint and remedy weak spots

You will only be able to enjoy a healthy indoor climate and a cosy home if all of the components of the building are sufficiently dry. Besides increasing heating costs, building moisture can have other far-reaching consequences:

- *Moisture decreases the efficiency of the insulation materials in your home.*
- *Freezing water destroys materials and structures.*
- *Soluble salts may cause efflorescence.*
- *Moisture leads to rot, decay and corrosion.*
- *Moisture causes the growth of mould and fungi.*
- *Consequentially, the value of the property will decline.*



Lower energy costs – for HVAC systems too

HVAC systems, which include pipework for heating, ventilation, air-conditioning systems and the supply of cold and warm water, as well as technical equipment such as pumps and boilers, lose useful heat to their surroundings. When undertaking a low energy refurbishment of your home, take the opportunity to check these systems and associated equipment and improve their insulation. You will be surprised at just how much energy you can save.

Wrap up the pipes – ISOVER shows you how

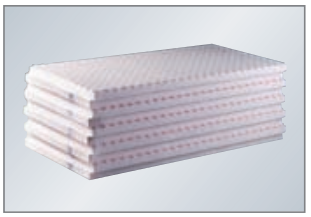
ISOVER offers you a range of different insulation systems designed to reduce heat loss through HVAC systems: mineral wool pipe lagging, with or without aluminium foil facing, as well as a choice of insulation slabs. Apart from cutting down on energy costs, this type of insulation offers an extra benefit: noise from, for instance, air-conditioning systems or sewer pipes is significantly reduced – so do your bit for a quiet life.

Apart from optimal thermal insulation, ISOVER pipe sections offer excellent fire, sound and environmental protection.

ISOVER products for insulating cellar walls and floors

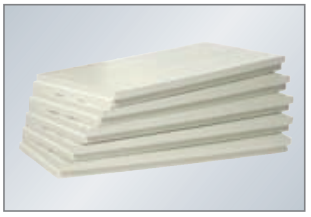
ISOVER EPS boards for insulating perimeter walls

- Compression-resistant, with an embossed surface
- λ_d = 0.035 W/(mK)
- Fire behaviour: Euroclass E



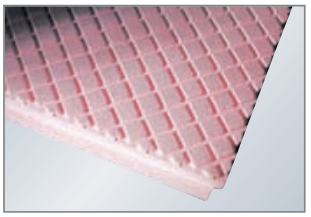
ISOVER XPS boards for insulating perimeter walls

- Highly compression-resistant, with an embossed surface
- Also suitable for insulating interior walls, especially in wet rooms. Can be directly covered with tiles.
- λ_d = 0.033 W/(mK) to 0.039 W/(mK) (depending on the thickness)
- Fire behaviour: Euroclass E



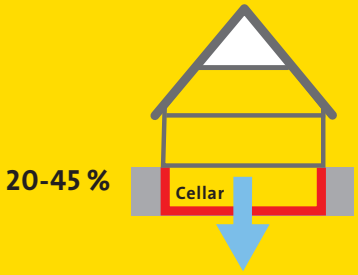
ISOVER EPS boards for insulating cellar walls

- Highly compression-resistant, with an embossed surface
- Ideal protection of vertical dampproofing, drainage and insulation layers
- Can be used down to a maximum depth of 6 m
- λ_d = 0.035 W/(mK)
- Fire behaviour: Euroclass E



ISOVER XPS boards for insulating cellar walls

- Highly compression-resistant
- Ideal protection of the vertical dampproofing and insulation layers
- λ_d = 0.033 W/(mK) to 0.039 W/(mK) (depending on the thickness)
- Fire behaviour: Euroclass E



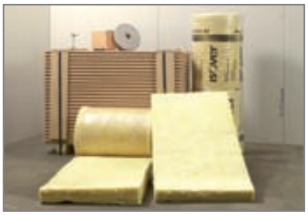
ISOVER OPTIMA and ISOVER VARIO system

- Insulation system for the inner face of cellar walls (dry wall construction)
- Fast installation thanks to matching components
- Durable thermal insulation and moisture protection

The system components are described on pages 74-75 (ISOVER OPTIMA) and 56-58 (ISOVER VARIO).

ISOVER TEL raised access floor system

- Dry and lightweight floor construction
- Due to the variable height of 5-29 cm, the construction can be optimally adapted to the room conditions.
- Levels out height differences and uneven surfaces
- The system consists of timber-based boards, pedestals with sound absorber disks, flexible edge strips and ISOVER insulation slabs.



ISOVER stonewool slabs for floor insulation

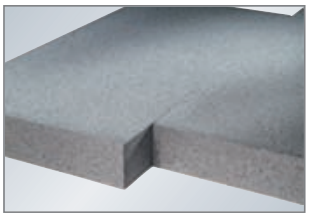
- For insulating floating dry screeds
- Stable and load-bearing
- λ_d = 0.040 W/(mK)
- Non-flammable (Euroclass A1)

ISOVER glass wool slabs for floor insulation

- For insulating floating dry screeds with timber-based board covering
- Stable and load-bearing
- λ_d = 0.033 W/(mK)
- Non-flammable (Euroclass A2-s1, d0)

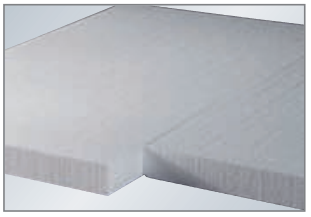
ISOVER EPS boards for floor insulation

- Ideally suited as insulation layer under wet and dry screeds
- Excellent thermal insulation
- λ_d = 0.031 W/(mK)
- Fire behaviour: Euroclass E



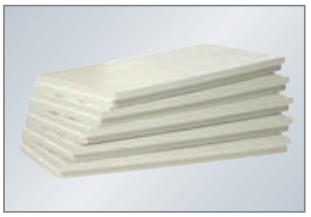
ISOVER EPS boards for floor insulation

- Ideally suited as insulation layer under wet and dry screeds
- λ_d = 0.035 W/(mK)
- Fire behaviour: Euroclass E



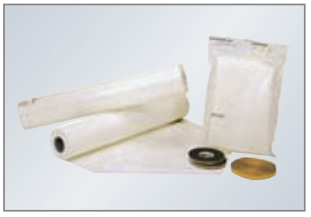
ISOVER XPS boards for floor insulation

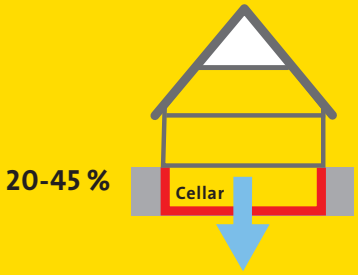
- Highly compression-resistant
- Ideally suited as insulation layer under wet and dry screeds
- λ_d = 0.033 W/(mK) to 0.039 W/(mK) (depending on the thickness)
- Fire behaviour: Euroclass E



ISOVER FLAMMEX vapour barrier membrane

- Extremely tear-proof PE sheeting of 0.18 mm thickness
- Ideally suited as separating layer and vapour barrier for wet and dry screeds
- High s_d-value (60 m)





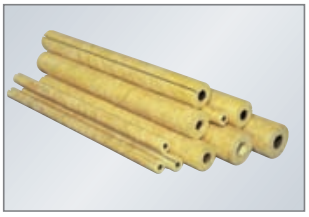
ISOVER products for insulating HVAC systems

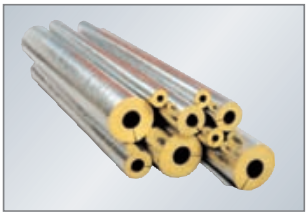
ISOVER ULTIMATE pipe sections, with / without aluminium foil facing

- For pipe insulation with precision fit
- λ_d = 0.035 W/(mK)
- Non-flammable (Euroclass A1) without aluminium foil facing
- Non-flammable (Euroclass A2) with aluminium foil facing

ISOVER glass wool pipe sections, with / without aluminium foil facing

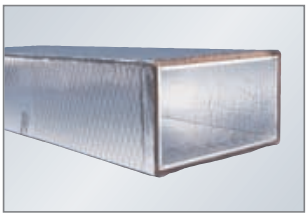
- For pipe insulation with precision fit
- λ_d = 0.035 W/(mK)
- Non-flammable (Euroclass A1) without aluminium foil facing
- Non-flammable (Euroclass A2) with aluminium foil facing





ISOVER CLIMAVER insulation system for ventilation ducts

- Lightweight and fast insulation of ventilation ducts
- λ_d = 0.035 W/(mK)
- Excellent thermal and acoustic insulation
- Non-flammable (Euroclass A2)



Acoustic comfort – an integral part of all ISOVER solutions

Whether at work or in your own home, more and more people are now complaining about the growing level of noise pollution. Many even suffer disturbed sleep. Sleep is crucial for regeneration of the mind and body and lack of it is known to bring about serious health problems. Noise not only includes the sound penetrating the building from outside. Noise is also generated inside the building – causing disturbance which is particularly important in multi-family houses. Recent studies in several European countries prove that, after road traffic, our own neighbours are the second largest source of noise nuisance.

When undertaking the refurbishment of a house or flat, this is also a good opportunity to reconsider the acoustic insulation requirements of single rooms and to plan appropriate solutions. With good planning and high quality workmanship, acoustic performance can be significantly enhanced with ISOVER insulation solutions. However, you need to differentiate between airborne sound and impact sound: the former is transmitted via the air through walls and ceilings, the latter through the floor or stair structures themselves.

The good news is that ISOVER solutions not only lower the energy consumption of your home but also the noise level – automatically.

ISOVER Acoustic Comfort Classes

Class	Music	Comfort	Enhanced	Standard
Airborne sound insulation between living units $D_{nT,w} + C$ (dB)	≥ 68 ($C_{50\text{-}3150}$)	≥ 63	≥ 58	≥ 53
Impact sound insulation between living units $L'_{nT,w} + C_I$ (dB)	≤ 40	≤ 40	≤ 45	≤ 50

Class	Music	Comfort	Enhanced	Standard
Airborne sound insulation of the components (excluding doors) within a living unit $D_{nT,w} + C$ (dB)	≥ 48	≥ 48	≥ 45	≥ 40
Impact sound insulation within a living unit $L'_{nT,w} + C_I$ (dB)	≤ 45	≤ 45	≤ 50	≤ 55

ISOVER acoustic classes ensure long-lasting, maximum comfort – even when changing the intended use of a room.

The noise factor

- *80 million EU citizens are exposed to harmful noise.*
- *Another 170 million live in acoustic grey zones that seriously affect their personal well-being.*
- *As a result of this negative health impact, the EU's GNP (gross national product) is reduced by up to 2 %, entailing annual follow-up costs of well over 12 billion euros.*

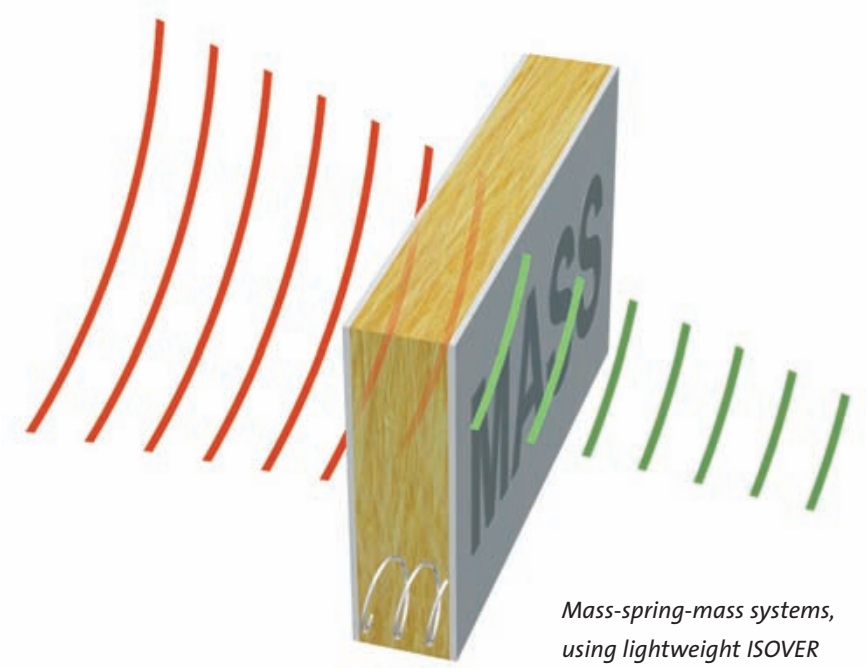
Sources: European Noise Policy. Strategy Paper of the CALMNetwork (DG Research of the European Commission – July 2002). European Union: Green Paper on Future Noise Policy (1996).

▶ *Please refer to the inside back cover for a glossary of all physical units and technical terms used.*

The insulation principle: Mass-spring-mass

Systems based on the 'mass-spring-mass' principle offer the most effective sound insulation. They are far superior to solid single-leaf constructions, whose acoustic performance is almost totally dependent on the mass of the element alone, and would require a disproportionately thick and heavy construction to achieve a comfortable level of sound insulation. In practical terms such an increase in wall thickness is virtually impossible as it would require stronger foundations, cut down on living space and entail longer construction and drying times.

In contrast, multiple-leaf mass-spring-mass systems filled with ISOVER mineral wool, add an extra 1 db of sound performance for every extra centimetre of insulation used. This makes mass-spring-mass systems superior in many ways, including their acoustic properties, their practicality of use and their cost effectiveness. A complex physical process with a clear, unbeatable effect: significant noise reduction.



Mass-spring-mass systems, using lightweight ISOVER glass wool as a "spring" material, apply the laws of acoustics and repeatedly "break up" the sound waves.

Where does indoor noise come from?

Noise originates from numerous sources:

- *external noise (mostly traffic)*
- *people talking and moving*
- *household appliances (washing machine, dishwasher)*
- *water supply and effluent drainage systems*
- *air-conditioning systems*
- *elevators*

Noise is transmitted via different paths:

- *directly through walls or ceilings*
- *indirectly via flanking (adjacent) components*
- *through ventilation shafts, chimneys and conduits*

A new room layout – fast and easy

A large-scale renovation project offers the ideal opportunity to design new room layouts. Naturally, our individual wishes and needs change over the life cycle, which is where lightweight partition walls, made of plasterboards and ISOVER insulation come into their own. They can be quickly installed and adapted as our needs change, making conversion and space separation easier, and providing excellent acoustic, fire and thermal insulation performance. All this is achieved without significant disruption, drying times or the need for additional structural strengthening. Even special features such as projecting box-type elements can be quite easily achieved with these systems, and the plumbing, wiring or lighting systems are easily accommodated inside the wall cavity. Since the wall surface is level and dry, it can be painted, wallpapered or even tiled without delay – according to your personal wishes.

"Class instead of mass"

Surprisingly, a lightweight stud wall with a mass per unit area of just 25 kg/m² has a weighted sound reduction index of about 50 dB – the same as a 250 kg/m² solid wall. However, to achieve this tenfold efficiency it is important that the cavity between the plasterboards is completely filled.

Compared to a conventional solid wall, a lightweight stud wall offers nothing but benefits: it saves time and money due to low material and transport costs, reduces the static load and prevents delays caused by long drying times.

It's all in the name: OPTIMA provides optimal sound insulation

The OPTIMA system not only boosts the energy efficiency of your home, it also improves the soundproofing and protects you from the noise produced by neighbours, music lovers, party fans or hobby craftsmen. Simply install ISOVER mineral wool with the black tissue facing. For more details on OPTIMA refer to page 71.

The OPTIMA system: simply better sound insulation for walls and ceilings.

Totally relaxed and soft-footed – thanks to impact sound insulation by ISOVER

Noise is stopped most effectively at its source. This is why the insulation of floors plays such an essential role in the acoustic refurbishment of your home. With ISOVER you can be sure to get optimum solutions that effectively prevent impact sound from footsteps from being transmitted through the surrounding walls and other flanking building components.

ISOVER impact sound insulation boards combine thermal and acoustic insulation.

From roof to cellar: acoustic insulation always included

The roof? The basement? The facade? No matter which components of your home you want to upgrade, ISOVER will always automatically include optimum sound insulation. Let's take, for instance, a pitched roof. After renovation with a double-leaf construction based on the mass-spring-mass principle, it reliably keeps the ambient noise outside. Whether you prefer between- or above-rafter insulation, resilient ISOVER mineral wool is guaranteed to "cushion" the noise. You can rest assured that the same ISOVER effect is achieved on the facade: noise is kept outside, warmth inside. This is why ISOVER facade insulation systems are ideal – even in areas suffering extremely high traffic noise levels.

Impact sound insulation below the ceiling

If it is not possible in an already inhabited building to improve the impact sound insulation at "source", it may help to mount a suspended ceiling from below. The new ceiling is suspended from special fastening elements to ensure an elastic construction. The resulting cavity is filled with ISOVER insulation. In this way, you can cut the perceived noise disturbance in half.

ISOVER products for acoustic insulation

ISOVER glass wool rolls for insulating partition walls and wall linings

- Quick installation thanks to roll widths of 40 cm, 60 cm or 62.5 cm to suit different stud centres
- Optimum acoustic insulation when completely filling the cavity, r ≥ 5 kPa·s/m²
- Considerable storage and transport benefits due to compressed rolls
- λ_d = 0.035 to 0.039 W/(mK)
- Non-flammable (Euroclass A1)

ISOVER glass wool boards for insulating partition walls and wall linings

- Optimum acoustic insulation when completely filling the cavity, r ≥ 5 kPa·s/m²
- λ_d = 0.035 to 0.039 W/(mK)
- Board width between 60 cm and 62.5 cm to suit different stud centres
- Non-flammable (Euroclass A1)

ISOVER stonewool boards for insulating partition walls and wall linings

- Optimum acoustic insulation when completely filling the cavity, r ≥ 5 kPa·s/m²
- λ_d = 0.040 W/(mK)
- Board width between 60 cm and 62.5 cm to suit different stud centres
- Non-flammable (Euroclass A1)

ISOVER glass wool boards for impact sound insulation

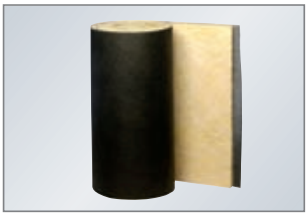
- Acoustic and thermal insulation under floating wet and dry screeds
- Optimum acoustic insulation thanks to high resilience
- Stable and load-bearing: from 2 kPa (200 kg/m³) to 10 kPa (1.000 kg/m³)
- λ_d = 0.033 to 0.035 W/(mK)
- Non-flammable (Euroclass A2-s1, d0)

ISOVER stonewool boards for impact sound insulation

- Acoustic and thermal insulation under floating wet and dry screeds
- Stable and load-bearing
- λ_d = 0.035 to 0.040 W/(mK)
- Non-flammable (Euroclass A1)

ISOVER glass wool rolls for acoustic insulation for use with the OPTIMA system

- Glass wool with a black tissue facing to ensure maximum soundproofing performance
- Very high sound absorption due to high porosity
- Ideally suited for use with the OPTIMA system
- λ_d = 0.038 W/(mK)
- Non-flammable (Euroclass A2-s1, d0)



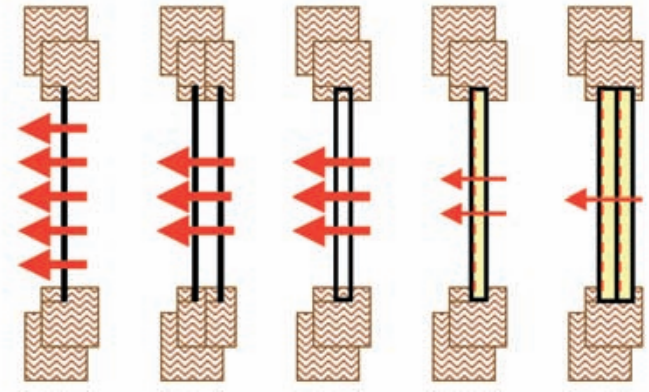
All components of the OPTIMA system are shown described on pages 74-75.

Windows and doors: Just closed or really tight?

Windows and doors may only constitute just a small part of the total thermal envelope, but they are, nevertheless, responsible for the majority of heat lost from the house. Why? Because door frames and window panes and frames are generally neither insulated nor properly sealed. The materials used in the past do not offer effective thermal insulation and actually promote the exchange of heat with the ambient air. A full renovation of your home therefore offers an ideal opportunity to check all windows and doors and replace them by new ones, if required.

Modern windows have multiple functions

Modern windows not only allow natural light into your home, they also provide a view of the outdoors and ensure ventilation. Over the course of time, however, windows have taken on additional functions, such as thermal insulation, sound reduction, solar control and protection of your privacy. State-of-the-art windows are even self-cleaning. Saint-Gobain Glass (SGG) is the world's leading developer of high-quality glass to satisfy all your needs. Thanks to a sophisticated production technology, windows equipped with Saint-Gobain glass not only keep the warmth inside, but at the same time allow sunlight to enter in a particularly pleasant way.



U- and g-values of window constructions from different architectural periods

U-value in W/(m²K)	5.7	3.0	3.0	0.9-1.5	0.5-0.9
g-value	0.80	0.64	0.50-0.64	0.50-0.64	0.40-0.60

The answer to all your needs: SGG CLIMATOP® MAX

Since energy prices are expected to rise in the mid- and long-term, the insulation of windows should not be left to chance. Highly energy-efficient SGG CLIMATOP® MAX glazing helps you attain Multi-Comfort House quality for your home, ensuring maximum comfort in winter and summer. The triple-glazed insulating glass with a krypton-filled cavity has a U-value of 0.5 W/(m²K) and will allow six times less energy to escape than conventional double glazing. On the other hand, SGG CLIMATOP® MAX still allows 60 % of the sun rays to enter the room – just as much as a conventional double-glazing.

CLIMATOP® MAX – optimum thermal insulation (U = 0.5 W/m²K) and maximum utilization of solar radiation in winter (g = 0.6)

Glass with a good "g-value" guarantees heat gains in winter

A crucial factor for the thermal optimization of windows is the difference between incoming and outgoing solar radiation. Glass with a high g-value allows the targeted and direct use of the sun's energy. When enlarging the window area of your home, therefore, you can combine two benefits: maximize the amount of natural light and achieve internal heat gains.

Proper sealing: The devil is in the detail

Individual weak points around doors and windows can adversely affect the heating efficiency of the entire house. Even small improvements, like the replacement of porous sealing tapes or uninsulated window panes, can make a big difference. However, in the case of more severe structural defects like a strongly heat-conducting window frame, it is necessary to replace the whole construction. Due to the great differences in the quality and design of door frames and leaves, window panes and frames, we recommend consulting an expert.

The calling card of your home: the house door

Over the years, the function of the house door has changed. No longer does it just give protection from unwanted visitors, it must now also meet the highest demands for thermal and acoustic protection – and provide an attractive focal point for your home.

VARIO FS2 provides a perfect, long-lasting seal between window and door frames and adjacent brickwork.

Balcony, loggia and terrace: seal the energy leaks

Love your balcony, loggia or terrace and use it as a kind of "green living room"? That's understandably, but you should keep in mind that, because of their open design, these parts of your home can badly affect the energy balance of your home. If there is no thermal separation between these open areas and the interior of the house, there will be an uncontrolled flow of warm air into the open. An energy assessment will, however, quickly reveal the weak spots in the insulation.

Renovated row of houses with self-supporting balconies (Ludwigshafen, Germany)
Source: Passivhaus Institut, Darmstadt

The balcony: systematic elimination of weak spots

In the process of thermal refurbishment, it is of crucial importance to also assess the condition of balconies. If these turn out to be thermal bridges, the whole construction should be separated – a solution which has proven its worth in practice. After insulating the exterior wall, a new thermally separated balcony can be fitted. Different solutions are possible. A new balcony can, for instance, be mounted on support pillars and anchored with fasteners to the building frame. Alternatively, it can be suspended with the help of lateral brackets without any pillars. Since this work is done from outside, the disturbance caused by construction noise and dirt will be minimal. Thanks to the new installation methods, it is also possible to front-mount a balcony where there has never been one, which not only enhances the quality of your living space, but also adds value to the building.

The loggia: a new part of the thermal envelope

The loggia is a popular architectural detail – for a good reason. The semi-protected additional living space, significantly increases the floor area and quality of your home. If, however, a building analysis reveals that the loggia ceiling is acting as a thermal bridge and causing considerable heat loss, or if the use of the loggia is not possible due to high dust and noise levels, full glazing is recommended. The benefits are obvious: the loggia is incorporated into the thermal envelope, heat losses are minimized and space is added to your home while dust and noise stay outside.

Before and after. Incorporation of the loggias into the building envelope.

Source: Arch. DI Erwin Kaltenegger, Passail, Austria

The terrace: converted into a conservatory

There are various possibilities for renovating a terrace. But converting your terrace into a conservatory can be an excellent solution as it offers you advantages in many respects. Any thermal bridges that did exis, and any weak spots in the insulation, will be eliminated. And unlike a terrace, you can enjoy your conservatory throughout the year, independent of the seasons.

Turning a terrace into a conservatory.

Source: Arch. Reinberg, Vienna, Austria

The icing on the cake: Controlled ventilation to complete your low energy refurbishment

A complete low energy refurbishment project includes a number of stages, but only when installing an expertly planned ventilation system will the living comfort and energy efficiency of your home be truly optimized. Such a ventilation system is indispensable if the facade and the windows have already been modernised. Unlike the unrenovated building, air exchange no longer takes place via leaks in the building envelope or through the chimney. Manual ventilation, by opening the windows, has proved to be an inefficient way of ensuring good air quality and removing moisture from the building, instead, a controlled ventilation system is needed to reliably and comfortably ensure indoor air hygiene. Such a system extracts the heat from the indoor air and thus makes a positive contribution to your energy balance. A built-in filter will also remove dust and pollen to make the incoming air more pleasant and healthy – and as long as the windows remain closed, acoustic comfort will be increased as external noise will be blocked out.

The ideal ventilation solution – as individual as your home

If you want to ensure optimum air-conditioning in your home, the ventilation system must be carefully planned, tailored to the internal environment and to the individual needs of the occupants, and carefully checked and adjusted by experts. In short, there is no such thing as a typical ventilation solution. Nevertheless, there are some standard solutions that can be used in certain house types. Single-family houses, for instance, are often equipped with standalone exhaust air units or single room ventilators with heat recovery, whilst for multi-family houses, the preferred solutions are generally central ventilation systems or single flat units with heat recovery.

3 good reasons for proper ventilation

- *Reduce or limit the CO_2 content of indoor air*
- *Control the relative air humidity*
- *Remove bad smells and air pollutants*

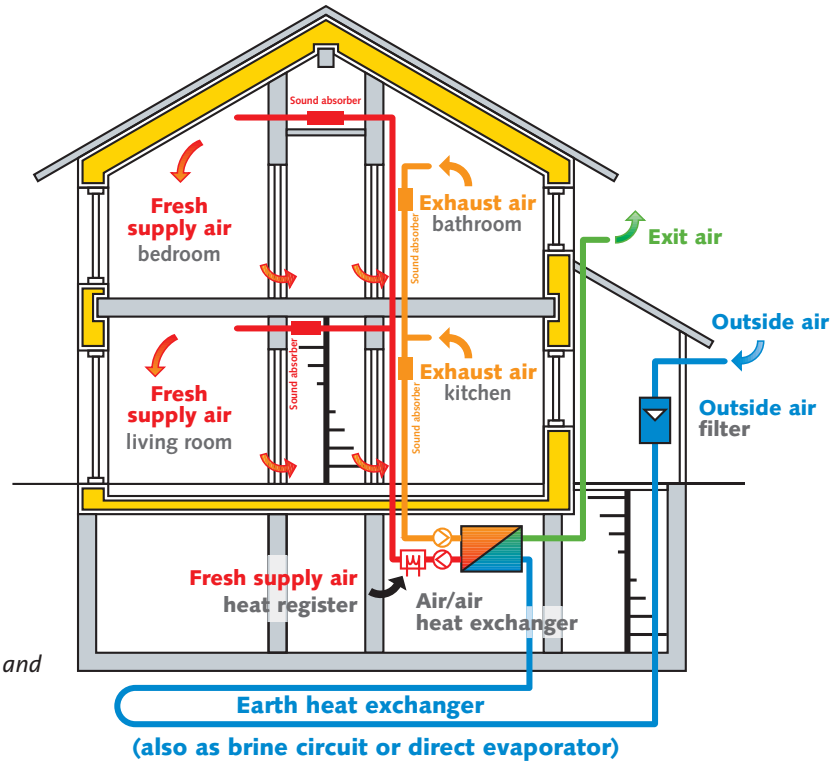
Manual or mechanical ventilation: energy efficiency is what matters most

It is difficult to accurately assess the quality of our indoor air, for example, when oxygen levels are low. To correct the situation our response is to let in more air by manually opening the windows – but we often delay in doing this, or leave the windows open too long, resulting in unnecessary heat loss. If we want to control the supply of fresh air correctly, we need the help of thermometers and hygrometers, which nowadays are often equipped with data memories or USB interfaces.

An easier and much more efficient way, however, is to install a controlled ventilation system. With the help of fans, specially designed air shafts automatically draw fresh outside air into rooms that have a high oxygen demand like bedrooms or living rooms. As part of the cycle, they remove the used air and smells from bathrooms, kitchens or similar rooms and release it to the outside. The result – A constant supply of fresh air, and reliable protection against moisture and mould growth.

Stale air goes out, thermal comfort stays in

To maximise thermal efficiency, the mechanical ventilation system should be coupled with a heat recovery unit. Depending on its efficiency, a heat exchanger recovers between 50 and 85 % of the heat from the waste air and recycles it back into the house by warming up the fresh incoming air. Compared to normal window ventilation, a heat exchanger will reduce heat loss by up to 85 % thus cutting down on your utility bill.



Schematic drawing of a controlled ventilation system using pre-heated air from a geothermal heat collector and waste heat recovery

Source: Passivhausinstitut, Darmstadt

Step-by-step to a better home

Guiding the path to increased living comfort

Good planning – excellent results

Before starting to renovate individual parts of your home, you should check which other measures have been planned or may become necessary in the coming years – either for this or for associated parts. You'll double the cost if your newly installed components need to be removed or assembled differently at a later time. If the required work cannot be carried out in one go, you can at least avoid unnecessary expense later by coordinating and properly scheduling the different stages. But bear in mind that a complete refurbishment always comes cheaper than the sum total of many individual activities. This stands to reason because certain work, such as erecting scaffolding, excavation work or installing a protective covering, will only need to be performed once.

Watch out for interdependencies, avoid double work

Roof:

When renovating the roof, you can "prepare the ground" for the planned thermal insulation of the facade. How? By increasing the roof overhangs so that they will also cover the later installed insulation layers and new facade.

Exterior walls:

If your facade is in need of repair or requires a new plaster or paint coat – it is advisable to bring forward the thermal insulation of the exterior wall, even if this has been planned for a later date. Otherwise, the facade renovation work will have to be repeated again when the wall is insulated.

Windows and doors:

If single windows are replaced ahead of a planned thermal upgrade of the facade, the new window frames should be aligned as accurately as possible with the existing frontage This avoids thermal bridges that may be caused later when the external insulation is installed.

When replacing doors or floor-to-ceiling windows on the ground floor of your home, you should also check whether the floor surface will need to be insulated or renovated later. In that case, windows and doors should be fitted in such a way that they can still be opened after the floor level has been increased by the insulation. Otherwise, the doors will need to be shortened.

When fitting new door frames on concrete balconies, it is advisable to install these approx. 10 cm higher. If the balcony acts as a thermal bridge, and needs to be insulated later, this will give enough clearance to allow doors to open when the new insulation layer has been installed.

Plumbing and wiring:

When undertaking the thermal renovation of walls or ceilings, make sure to check the present condition of all plumbing and wiring that is routed through them. You should not only replace pipes or cables that are already in a poor condition, if they do not seem fit to last for another 40 years or so, now is the time to replace them. 40 years is the average time before new repair work crops up, and It is much more cost-effective to replace them now than to have to cut up the newly installed thermal insulation when you do the job later. You should also seize the chance to install additional conduits for cable TV, telephone and the like, but make sure you make a detailed note of everything you do, so that any future repairs can be carried out quickly, without undue expense.

Get your priorities right: Weak points first

The more heating energy that is lost through an individual part of the thermal envelope, the more important it is for appropriate thermal insulation to be installed to that element. Please refer to the tables at the end of this brochure: they provide detailed information on the energy efficiency of typical constructions and advise you about possible savings. You will find that there are cases where thermal refurbishment not only makes sense or promises good results, but where it is absolutely imperative.

In urgent need of insulation: Components with high heat losses

- Top floor ceiling
- Roof components with an insulation layer under 3 cm
- Exterior walls made of solid brickwork or concrete that have neither internal nor external insulation
- Uninsulated partition walls (solid construction) between warm and cold cellar or attic rooms
- Window and door frames made of aluminium or steel without thermal insulation
- Single-glazed windows
- Sealing around doors and windows
- Uninsulated sections of the heating system, hot and cold water pipes

Everything under control: How to make things easier for yourself

Five useful tips to help you stay in control

The best preparations for a successful refurbishment project are a detailed status analysis and meticulous planning. The five most important steps are:

1. Carefully analyze the thermal and structural weak points of your house. If required, get expert advice and support.
2. Use the detailed information available on possible thermal refurbishment measures and calculate the respective cost-benefit ratio.
3. Decide which thermal level you want to achieve and for which parts of the house.
4. If planning a phased approach, watch out for technical interdependencies of single works.
5. Set up a well-defined time and task schedule.

Don't get stressed: Allow for delays

Neither the exact scope nor the complexity of a refurbishment project can be planned down to the very last detail. Especially when renovating older houses, the true state and condition of single building components or sections often only comes to light when the renovation is underway. Moreover, every schedule depends to some extent on external influences. Getting a building permit, for instance, may take longer than expected: the approval of loans can sometimes be delayed, and foul weather may slow down the work of tradesmen. The best solution is to plan generously and allow sufficient time for all work steps involved. This will help you stay on schedule – and keep your stress level down.

Think ahead: Documenting and filing assures long-term benefits

Keeping track of all actions will be of great help. Therefore make detailed notes of all measures to be taken, regularly check the progress and quality of all work done, and review your schedule if necessary.

Also, carefully file away all documents that contain constructional, financial and organizational information. Take pictures of details – however small or seemingly trifling – as they may later turn out to be of great significance, for example in the case of claims arising from faulty workmanship, or because tradesmen in future may require detailed knowledge of previous work done.

Checklists that facilitate the planning work

A large-scale refurbishment project not only takes the technical aspects of thermal and acoustic insulation into account. When enhancing living comfort, you may also wish to consider improving room layouts or enlarging the available living space. Last but not least, aesthetic aspects also need to be considered for all renovation activities. Since this cannot be done without meticulous planning, we have compiled checklists containing the most important points for you, to help when planning the work.

Prepare yourself as carefully as possible for the discussions with your architect, planner, contractor or other consultants. For this purpose, start with the "General considerations" checklist where you can lay down clearly your objectives and the future requirements of your refurbished home.

General considerations	Include in the plan		Details
Change the floor plan	yes	no	
Change the room layout	yes	no	
Change the room functions	yes	no	
Build an annex	yes	no	
Loft conversion	yes	no	
Intended use as workspace	yes	no	
Barrier-free (handicapped accessible)	yes	no	
Monument preservation orders (colour, design, townscape conservation)	yes	no	

Use the "Building fabric" checklist to document the overall condition of your house. Based on the time of construction and renovation, you can then assess its thermal quality. In addition, you can define the future insulation level of your house by entering the desired energy consumption in kWh/m² per year.

Building fabric	Please enter		Details
Year of construction			
Last renovation works (year and scope)			
Current energy consumption (kWh/m² per year)			
Desired energy consumption after renovation (kWh/m² per year)			
Condition of the basement	dry	damp	
Mould growth	yes	no	
Rising damp	yes	no	
Salt attack	yes	no	
Wall cracks	yes	no	
Ceiling cracks	yes	no	

The "Individual building components" checklist not only helps you prepare a detailed record of the current condition of your house and its technical facilities. The assessment – on a scale from "excellent" to "very poor" – also shows which priorities you need to set: the poorer the structural condition, the more urgent the renovation. Our tip: Put together detailed documentation, including photos and your own personal sketches, to fully prepare yourself for the discussions with experts.

Individual building components	Assessment			
	Very poor	Poor	Good	Excellent
External face of the roof				
Roof covering* (e.g. visible holes, breaks, cracks, corrosion)				
Gutters (e.g. slope, corrosion)				
Interfaces masonry/roof covering (signs of moisture and lifting)				
Dormers and gable roof walls (tightness)				
Velux windows (sealing)				
Flashings (corrosion)				
Chimney (e.g. connections, flashings, sooting)				
General condition of the roof (e.g. deformations)				
Internal face of the roof				
Condition of the truss				
Potential timber pest damage				
Leakiness (e.g. water stains on the ceiling)				
Chimney (e.g. cleanout doors, sooting)				
Attic installations (e.g. satellite dish, telephone line, ventilation)				
Condition, type and thickness of the existing insulation on the slanted areas and on the tie-beam ceiling				
Condition, type and thickness of the existing insulation on the top floor ceiling				
Exterior walls, windows, doors				
General condition of the paint coat				
General condition of the plaster coat				
General condition of the wall base				
Extent and location of cracks				
Signs of rising damp				
Condition, type and thickness of the existing exterior wall insulation				
Condition and type of windows, windowsills, fittings and roller shutter boxes				
Condition and type of exterior doors and terrace doors				
Condition of window and door junctions				

Individual building components	Assessment			
	Very poor	Poor	Good	Excellent
Ceilings above heated areas (top floor ceiling)				
Type of ceiling (solid or wood)				
Condition of thermal insulation				
Condition and type of impact sound insulation**				
Condition and type of flooring				
Ceilings above cold areas (cellar ceiling, floor slab above the ground, cantilevered floor)				
Type of ceiling/floor (solid or timber)				
Condition and type of thermal insulation				
Condition and type of impact sound insulation***				
Condition and type of flooring				
Interior ceilings (separating floors, mezzanine floors)				
Type of floor or ceiling (solid or timber)				
Extent and location of cracks				
Condition and type of impact sound insulation				
Condition and type of flooring				
Interior walls				
Condition and type of paint and plaster coats				
Extent and location of cracks				
Acoustic insulation				
Condition, type and arrangement of interior doors				
Balconies, loggias, terraces				
Condition and type of balcony or loggia slab (waterproofing, slope, insulation)				
Condition and type of terrace (waterproofing, slope, insulation)				
Installations (plumbing and wiring)				
Condition and type of hot and cold water pipes				
Condition and type of drain pipes and sewers				
Condition and type of electrical cables (electric circuits, power amplification), location and capacity of the electricity meter				
Earthing and lightning protection				
Heating system and hot water generation				
Condition, installation year and type of heating system and piping				
Condition, type and spatial arrangement of the radiators				
Condition, installation year and type of hot water generation system and piping				

* *In snowy regions, it is mandatory to install a tread-resistant roof sheathing to reinforce the roof construction when the attic is converted into living space (Bavaria, Austria, Northern Italy and Switzerland).*

** *Important in case the attic is converted and used as living space.*

*** *With semi-detached, terrace and multi-occupancy houses, impact sound insulation needs to be installed on floors above the cellar or the ground. This is also necessary because of the flanking sound transmission.*

Showing the way

Examples of inspirational building refurbishments

History and climate protection in constructive harmony

Refurbishing a centuries-old building is never easy. But this old tobacco barn, built around 1850, was a particular challenge. On the one hand, the building fabric was severely damaged, and on the other, there were stringent conditions for historic building preservation, as well as the ambitious town-planning requirements of the "energy-saving town" of Viernheim, that had to be fulfilled. The objective was to achieve a comfortable residential building with an energy demand as low as that of a passive house.

The starting point: not at all rosy

The outer natural stone wall, as well as the interior structure of the tobacco barn were badly affected by salt and damp after many years of agricultural use, and could have been preserved only at great expense. The roof structure had been damaged during the war and could not be restored – the replacement had to be as true to the original design as possible. Indoors, the rooms had to comply with town-planning requirements and could not be too high. The entire front courtyard had to be relaid and all sewage, gas and water pipes replaced, a new rainwater cistern provided and electricity and telephone lines newly installed. Connecting the barn to its neighbouring buildings required demanding structural solutions, and its location, in the inner city, meant that shading was a problem.

Agricultural tobacco barn before refurbishment.

The solution: innovative, individual, international

It goes without saying that this ambitious convertion of a dilapidated tobacco barn into a comfortable passive house, required a detailed survey and comprehensive planning before any work could start. Often it was only as a result of high quality workmanship and constant quality control that the desired results were achieved. Examples of the successful solutions used include: A raised floor system developed by ISOVER Austria was used in place of a screed. This was based on a 32 mm chipboard lining with 100 mm Kontur FSP 1-040 glass wool boards in the floor cavity. The dormer cladding was insulated internally using the ROSATWIST system from ISOVER France. To achieve maximum tightness for the interfaces between the wall construction and concrete members, joint sealing tubes developed by ISOVER Sweden were used. The Climatop V insulated triple glazing came from SAINT-GOBAIN GLASS in Aachen. And finally, the hygrothermal performance of the construction was successfully tested with the help of WUFI, a calculation program developed at the Fraunhofer Institute for Building Physics.

Reconstructed trussed gable. Stone slips were bonded on mineral wool infilling.

The new construction: concrete frame faced with natural stone masonry

The 200-year old natural stone walls of the tobacco barn were taken down and the stones carefully cleaned and stored, before reconstruction into a fully functioning passive house could begin. A solid ground floor slab was installed on ring footings and insulated with 160 mm of thermal insulation in two layers, to guarantee total freedom from thermal bridges. The new structural concrete frame was then built on the floor slab. The natural stone walls were rebuilt to allow enough space for the subsequent installation of internal insulation. This space was also essential as the high moisture and salt content of the natural stones meant they had to be completely isolated from the internal construction. Mineral wool was chosen as the insulation material, because it is not capillary active, and would provide the safest long term solution. Total insulation thickness was as high as 250 mm in places, dependant on the structural detailing.

To achieve a U-value of ≤ 0.09 W/(m²K), a combination of between- and above-rafter insulation was chosen. In some places, insulation in the barn roof is up to 440 mm thick.

New elements – Roof, window, conservatory

The roof was designed in consultation with the Monument Preservation Authority, with particular attention paid to the location, size and appearance of the dormer windows. Based on this, it was then possible to design the three floor levels, the window heights on the ground floor and the thermally separated conservatory facing the garden. In order to achieve the passive house standard, the main priority, after adequate, thermal bridge-free insulation, was airtight construction. After an initial check revealed an insufficient level of airtightness in parts of the roof, dormers and windows, improvements were made, which led to the required standards being achieved. Despite all of the challenges, this unique conversion was completed in around two and a half years.

VARIO KM used as vapour barrier and airtight layer. The electrical cables and wires are installed on the room facing side of the membrane which is then insulated with 60 mm glass wool.

Inside, the roof construction was insulated with 200 mm of ISOVER glass wool between the rafters and the ROSATWIST mounting system.

Photo: Dipl. Phys. Raimund Käser

The result: 212 m² of energy-efficient living

With a heating demand of 13.4 kWh per square metre, the residents of the former tobacco barn need not worry about rising energy costs and growing scarcity of resources: despite the spaciousness, the total cost of heating, hot water and cooking amounts to only 350 EUR a year. Totally in line with the principles of the Viernheim "energy-saving town", and in keeping with the Brundlandt Project objectives of CO_2-reduction and sustainable living.

Building owners/Building physics:
Stephanie and Raimund Käser, Viernheim
Architect: Dipl. Ing. Bernd Seiler, Seckenheim

Products used

- ISOVER glass wool for between-rafter insulation (Integra ZKF 1-035, 200 mm)
- ISOVER stone wool for above-rafter insulation (Integra Solid, 180 mm)
- ISOVER glass wool for facing constructions (Integra ZKF 1-035, 140-180 mm)
- ISOVER stone wool for half-timber constructions (Sillatherm VWL 1, 100 mm)
- ISOVER glass wool for partition walls (Akustik TP1 60 mm)
- ISOVER glass wool slabs for the raised floor system (Kontur FSP 1-040)
- ISOVER XPS boards for the insulation of foundations (Styrodur 3035 CS)
- ISOVER VARIO KM, VARIO KB1 and KB2 for providing airtightness
- ISOVER ROSATWIST system as a substructure for the ceiling insulation

Energy values

	U-value in W/(m²K)
Thermal insulation of glazing incl. frame	0.8
Wall areas	0.12-0.15
Barn roof (incl. timber parts)	0.09
Floor	0.14

Extraordinary savings in an ordinary single-family house

To illustrate in more detail the many different approaches to renovating an average single-family house, let's have a look at a typical building in the Dutch village of Bontebok.

Built around 1920 and designed to accommodate a single person, the two-storey house had no thermal insulation before its refurbishment in 2006. Extensive renovation was therefore required to fulfil two aims: provide enough space for a complete family and at the same time fulfil all thermal comfort demands.

The objective was achieved through a series of targeted measures: Not only was the living space considerably enlarged, but also the total energy consumption reduced to only a fraction of the former heating energy demand. Following renovation, the building now meets the low-energy house standard.

High-level comfort: fully developed living space directly underneath the rafters.

New possibilities and their systematic realization

For reasons of economy and sustainability, the new owners opted for extensive thermal renovation, thereby ensuring that they could enjoy the comfort of their new home for many years to come, without restrictions of any kind. Additionally, the project made use of leading-edge solutions, because the new owner was involved with the government on green issues, and was therefore familiar with the full potential of thermal renovation.

The yardstick for successful renovation? Your own needs and demands.

Most parts of the building did not only require thermal upgrading. For many years, the previous owner had neglected to carry out necessary maintenance work and as a result most of the house, including the thermal envelope, was in a very bad state. But this was a situation that could also be used to advantage. On the one hand, there was the general need to repair, move and rebuild several walls, and parts of the roof, in order to achieve the new family-friendly floor plan. On the other hand, there was an ideal opprortunity to combine this work with the replacement of all heating and hot water pipes and with the installation of a ventilation system. What made this renovation project so challenging was the new owners' wish to preserve the original character of the house, as it blended well with the architecture of the local area. Of special interest were the existing coloured leaded windows. Being the hallmark of the house, these had to be preserved but without sacrificing the insulation quality offered by modern windows.

Many challenges – but also many solutions: thanks to ISOVER

The aim was to preserve the outer appearance of the house as far as possible but also to maximise all cost savings. For this purpose, thermal insulation was only installed from inside the building. In order to achieve excellent thermal insulation standards without sacrificing inside space when insulating the exterior walls and rafters, ISOVER Systemroll was used. Due to its superior performance, this product is ideal for space-limited applications, and is also commonly used for insulating factory pre-fabricated narrow-wall structures.

The new, airtight window frames (Vrigo normplus by De Vries Gorredijk) feature double-layer insulating glass with excellent thermal properties. A specialist firm even managed to insert the original coloured leaded glass windows in-between the double glazing. The additional floor space required was achieved by converting the whole of the attic space into fully developed living space, which meant that there was no need to alter the exterior design of the house. Despite the extent of the renovation, the only visible change was the installation of solar panels on the rear of the roof to provide energy for the heat pump – otherwise the original visual character of the house has been flawlessly preserved.

Save energy, save natural resources

In the course of renovation, a new, energy-optimized NIBE 1220 heat pump was installed. This has a performance of 8.5 kW, is equipped with a main water heater of 200 litres capacity and is backed up by a 160-litre solar boiler, manufactured by ABB. The boiler is connected to a solar collector that was also newly installed on the roof.

In order to ensure effective energy production all year round, three approx. 100 m deep boreholes were drilled and integrated into the heat pump system. The resulting pipe system not only features high heating efficiency, but can also be used for cooling the house in summer. To reduce the heating energy demand, a low-temperature underfloor heating system was installed, combined on the upper floor with a dry screed. Also thanks to a heat recovery unit and Itho HRU Eco fan 3 ventilation system a constant healthy and pleasant indoor climate is assured – and fresh air constantly available, without the risk of associated heat loss.

Optimal values achieved for thermal insulation

Thanks to the excellent insulation, the U-values of the roof and exterior walls were reduced to 0.19 W/m²K after the renovation. Combined with the new, energy-optimized heating, hot water and ventilation systems, this has had a very noticeable effect on the building's energy consumption. As a result of renovation, the primary heating demand of the house has been reduced by 75 %, down to 50 kWh/m². After completion of all works, which took place over a period of only nine months, the building now fulfils – and in some areas even exceeds – the requirements of a low-energy house. Apart from significant energy savings and the careful use of resources, the most important thing that the house has given its new occupants, is a wonderfully satisfying feeling of having arrived "home".

Building owners: De Kock family
Architects: Jan Nieuwveld, Henk Seinen, Leeuwarden (NL)

Products used

- ISOVER glass wool for interior insulation (Systemroll 140 mm)
- ISOVER glass wool for roof insulation (Systemroll 180 mm)

Energy values

	U-value in W/(m²K)
Thermal insulation of glazing incl. frame	1.0-1.2
Walls	0.19
Roof	0.19
Floor	0.19

Steinbruchweg 36 Austria

Energy savings of
95%

Challenge

To expand this single-family home on the outskirts of Linz (Austria), the decision was made, for budgetary reasons, to renovate and add an additional storey, rather than to construct a new building. The main challenge was to bring the building's outer envelope up to passive house standard.

This was the first time in Austria that a renovation project had been completed to passive house standards, supporting international guidelines for climate protection.

Technical strategy

Timber frame construction was chosen in preference to solid construction, and careful attention paid to detailing and quality of workmanship in order to avoid thermal bridges. As a result, the heat would be evenly distributed and the level of comfort inside the building envelope substantially improved.

The installation of a controlled ventilation system now ensures a much better air quality. The final result has more than satisfied the initial energy objectives, with the total cost of energy and heating system maintenance combined, now less than just the maintenance costs prior to renovation.

Products used

- ISOVER glass wool for the insulation of roof, walls and floors (Uniroll Komfort 200 mm, two-layered)
- ISOVER VARIO KM, VARIO KB1 and KB2 for providing airtightness

Building type	Single family house
Facade / Construction	Timber framework construction
Total surface area	217 m²
Number of floors	2 floors + partial basement
Renovation time	9 months

Performance analysis	
Total consumption of the building	30.5 kWh/m²a
Total consumption on heating only	14.6 kWh/m²a
U-value of the windows	0.77 W/(m²K)
U-value of the roof	0.09 W/(m²K)
U-value of the ground floor	0.12 W/(m²K)
U-value of the walls	09.9-0.11 W/(m²K)
Airtightness	0.5

Höbelistrasse Switzerland

Challenge

For this 1985 house, the challenge was to extend the building by adding a separate living unit conforming to passive house standards. Due to the narrowness of the plot and local zoning laws, the only way to increase the living space was to add an additional floor above the existing structure. It was decided that this new addition should have a modern appearance, whilst respecting the original design of the building.

Technical strategy

It was jointly decided by the architects and owners that the additional storey should be constructed in timber frame to help with load distribution. Windows to the north-facing elevation were kept to a minimum, whilst on the south facade, large areas of glazing were installed to take maximum advantage of passive and active solar gains. For the same reason, solar panels and a heat pump were installed on the roof. Finally, energy losses were minimized by including high levels of insulation – between 340 and 400 mm thick, depending on the area and surface to be insulated.

Energy savings of

91%

Products used

- ISOVER glass wool for the insulation of roof, walls and floors (ISOCOMFORT 140 -200 mm, two-layered)
- ISOVER VARIO KM Duplex for providing airtightness

Building type	Multi-occupancy housing
Total surface area	341 m²
Number of floors	4
Year of construction	1985
Renovation time	6 months

Performance analysis	
Total consumption of the building	8.5 kWh/m²a
Total consumption on heating only	4.5 kWh/m²a
U-value of the windows	0.5 W/(m²K)
U-value of the roof	0.09 W/(m²K)
U-value of the walls	0.13-0.16 W/(m²K)

Dépot Cardinal Switzerland

Energy savings of
75%

Challenge

This project involved the renovation of a building with no insulation, situated in a downtown industrial zone by the side of a railway. In preserving its original construction, the challenge was to create new harmonised living and working spaces, with highly effective energy use and an improved interior environment.

Technical strategy

The space was expanded by the addition of a timber-frame structure. The roof, walls and floor were insulated to modern standards, and a winter garden area created to help with the building's energy balance. The additional floor space, along with the interior atrium and garden, now allows the occupants to increase or diminish their living space according to the season. Thanks to optimized thermal and acoustic insulation and a natural air circulation system, a comfortable interior climate has been created – both for living and working.

Products used

- ISOVER glass wool for the insulation of roof, walls and floors (ISOCOMFORT 120, 140 and 200 mm, PB F 160 mm and PB M 200 mm)
- ISOVER VARIO KM Duplex for providing airtightness

Building type	Before renovation: a warehouse After renovation: a mixed-use building, combining living space and offices (architect's office)
Total surface area	190 m^2
Number of floors	2
Year of construction	1960
Renovation time	16 months

Performance analysis	
Total consumption of the building	12.9 kWh/m^2a
Total consumption on heating only	10.3 kWh/m^2a
U-value of the windows	0.5 W/(m^2K)
U-value of the roof	0.1 W/(m^2K)
U-value of the walls	0.11-0.15 W/(m^2K)

Makartstrasse 30-40 Austria

Challenge

This 5-storey, multi-unit residential building was built in the late 1950s. As expected for a building of this age, a lot of problems were identified. In particular, Its low energy efficiency meant high heating costs. The challenge was to transform the building into a perfect example of passive house technology.

Prefabricated large-format elements were chosen for the renovation, which helped to considerably shorten the construction time. The aim was to assure the highest possible energy efficiency for the building envelope.

Technical strategy

The installation of a controlled ventilation system contributed to a clear improvement in interior air quality as well as providing better protection against exterior noise. The exterior architectural design, composed of solar panels in grey and red, gives the building a very modern appearance. Thanks to the high insulation levels throughout and the watertight design of the loggias, thermal bridges were completely eliminated.

Energy savings of

92%

Products used

- ISOVER glass wool for the prefabricated elements (Uniroll 160 mm)
- ISOVER glass wool for the basement ceiling (insulation board of 12 cm thickness)

Building type	Multi-occupancy housing
Facade / Construction	Solid construction with a timber framework
Total surface area	3106 m²
Number of floors	5 floors
Year of construction	1957/58
Renovation time	13 months

Performance analysis	
Total consumption of the building	14.4 kWh/m²a
U-value of the windows	0.86 W/(m²K)
U-value of the roof	0.094 W/(m²K)
U-value of the ground floor	0.24 W/(m²K)
U-value of the walls	0.082 W/(m²K)

Matznergasse 28 Austria

Energy savings of
76%

Challenge

This renovation project involved a building dating from 1912, situated near a park. While the building had been refurbished just after the Second World War, no further renovations had taken place until 2002. Despite its magnificent original facade, some flats were in a deplorable state, without running water or toilets. Poor internal living conditions had given the building a particularly bad reputation.

Technical strategy

Prior to renovation, several different types of heating system were in use in the building, including oil, coal and bottled gas. Because of the run-down condition of the roof and windows, and the flimsy construction of the existing doors, a considerable amount of the building's heat was being lost. Complete thermal insulation and a modern central heating system were installed. Terraces and balconies were incorporated on each floor, increasing the area of each apartment and enlarging the building's total living space from 1,143 m^2 to 1,795 m^2. Despite the enlargement, energy costs were significantly reduced, thanks in part to the installation of a passive solar heating system.

Products used

- ISOVER glass wool for insulating facing panels and partition walls (AKUSTO 75 mm and 100 mm)
- ISOVER ISOVER glass wool for roof insulation (Uniroll Komfort 200 mm, two-layered)
- ISOVER VARIO KM, VARIO KB1 and KB2 for providing airtightness

Building type	Multi-occupancy housing
Facade / Construction	Solid construction with a timber framework
Total surface area	1143 m^2 before renovation 1795 m^2 after renovation
Number of floors	7 floors
Year of construction	1912
Renovation time	16 months

Performance analysis	
Total consumption on heating only	35.43 kWh/m^2a
U-value of the windows	1-1.1 W/(m^2K)
U-value of the roof	0.13-0.18 W/(m^2K)
U-value of the ground floor	0.14 W/(m^2K)
U-value of the walls	0.46 W/(m^2K)

Multi-family house in Buxtehude Germany

Challenge

This project involved the complete renovation of a five-family building located in town, and finished within just four weeks. The renovation included the modification of the structure itself, the installation of technical equipment and systems, and the extension of the floor space, partly through the addition of a loft area. The living space was also extended by incorporating the balconies into the house.

Technical strategy

The interior refurbishment entailed, among other things, a top-to-bottom makeover of kitchens and bathrooms. A highly efficient heating system was installed, contributing to significant energy savings, as well as a modern ventilation system which improved the indoor climate. A heat pump and solar unit were installed for hot water and heating needs. All exterior parts of the house were rigorously insulated. The basement and the basement ceiling were rebuilt and equipped with state-of-the-art insulation.

Energy savings of

90%

Products used

- ISOVER glass wool for between- and under-rafter insulation (Integra ZKF 1-035, 180 mm and Integra UKF 1-035, 50 mm)
- ISOVER stonewool for insulating basement ceilings (TOPDEC DP 80 mm)
- ISOVER glass wool for insulating facing walls (Kontur KP 1-035, 80 mm)
- ISOVER VARIO KM, VARIO KB1, VARIO KB2 and VARIO DS for providing airtightness

Building type	Multi-occupancy housing
Total surface area	580 m² (474 m² living space)
Number of floors	3 floors
Renovation time	1 month

Performance analysis	
Total consumption of the building	45 kWh/m²a
Total consumption on heating only	8.5 kWh/m²a
U-value of the windows	1.1 W/(m²K)
U-value of the roof	0.17 W/(m²K)
U-value of the ground floor	0.26 W/(m²K)
U-value of the walls	0.27 W/(m²K)

Apartment building in Madrid Spain

Energy savings of
67%

Challenge

As often is the case, this renovation project had multiple goals: comfort enhancement, energy savings and modifications of the existing architecture. Specific goals included upgrading the building envelope (walls, windows and roof) and using every opportunity to improve the structure's thermo-acoustic performance. In addition, the improvements were intended to produce a harmonious balance between solar energy collection in winter and protection from excess heat in summer. Finally, access to the building was improved with the installation of an energy-efficient elevator and new stairwells.

Technical strategy

For budgetary reasons the decision was taken to preserve the building's original structure. From that point on, the building's orientation had to be taken into account at every stage, so as to make optimum use of solar energy.

The addition of terraces and balconies, not present in the original building, increased the availability of natural light, and a system of oriented mirrors, integrated into the balcony design, significantly improved light levels in the bedrooms.

Products used

- ISOVER glass wool for roof insulation (IBR 120 mm)
- ISOVER EPS expanded polystyrene slabs for facade insulation (ISOVER EPS type III 80 mm)

Building type	Multi-occupancy housing
Facade / Construction	Brick
Total surface area	2420 m²
Number of floors	5 floors
Number of units	28 apartments
Year of construction	1961
Renovation time	17 months

Performance analysis	
Total consumption of the building	20.36 kWh/m²a
U-value of the windows	2.6 W/(m²K)
U-value of the roof	0.3 W/(m²K)
U-value of the walls	0.30 W/(m²K)

Listed single-family house in Vienna Austria

Challenge

This single-family house is located in the protected historical area of Sievering, a suburb of Vienna. The street facing facade is a beautiful example of Art Nouveau from around 1900, and the Monument Preservation Office would not allow its architectural style to be modified in any way. The extensive renovation work involved changes to the whole building and the way it was used. The floor plan was changed, all installations replaced with new and the building extensively opened up towards the garden.

Technical strategy

Renovation of the garden elevation was a particular challenge, as the only access was through the building. It was however, completely rebuilt and insulated to passive house standard, whilst thermal insulation of the preserved front facade was carried out from the inside. Insulation was also applied to the sloping walls of the roof and to the basement ceiling. Special attention was paid to solving thermal bridging problems, and a low-temperature wall heating system was installed to keep the basement walls dry. The character of the old "box-type" windows was preserved; whilst the new garden-facing windows are in keeping with the passive house standard.

Energy savings of

75%

Products used

- ISOVER glass wool for insulating roofs and ceilings (Uniroll Komfort 200 mm and 160 mm)
- ISOVER glass wool for the second insulation layer above rafters (DUO Komfort 80 mm and 100 mm)
- ISOVER glass wool for insulating partition walls (AKUSTO 75 mm and 100 mm)
- ISOVER VARIO KM, VARIO KB1 and KB2 for providing airtightness

Building type	Single-family house
Total surface area	305 m²
Number of floors	2 floors
Year of construction	1900
Renovation time	12 months

Performance analysis	
Total consumption of the building	35 kWh/m²a
U-value of the windows	1.6-0.8 W/(m²K)
U-value of the roof	0.18-0.15 W/(m²K)
U-value of the walls	0.35-0.18 W/(m²K)
U-value of the basement floor	0.6 W/(m²K)

Thermal refurbishment definitely pays off

Scientific studies[1] over the last few years clearly show that thermal refurbishment is worthwhile regardless of the energy price scenario used. Energy prices almost doubled between 1998 and 2002, and despite a short respite, we are now faced with the fact that energy will not only become more expensive in the future, it will also become more scarce. The decision to invest in the thermal refurbishment of one's home will therefore increasingly become an economic necessity.

While you're at it, you may as well do it properly!

Once you have made the decision to renovate it makes sense to do the job properly, so renovating to passive house standards is the way to go. Normally, the structural parts of a building are only replaced or modernized every 20 to 50 years, so you should seize the opportunity, when carrying out maintenance or repair work, to improve the energy efficiency of your home. In many regions, home owners nowadays can claim subsidies and tax relief, to help with the cost of thermal refurbishment.

Experts advise that the first step in a refurbishment process should always be the complete or partial restoration of the thermal envelope. Only after completing this step, should you upgrade the heating and ventilation systems. Doing this in reverse order – i.e. heating first and thermal envelope second – will involve you fitting an oversized heating system, which will be economically and ecologically unsound in the long run. After all, would you install a new engine into the dilapidated chassis of your old car?

Compare the costs of maintenance and thermal refurbishment

The following table lists and compares the investment costs of different renovation measures with the unavoidable maintenance costs that would have been incurred anyway. The prices include the planning, purchase and installation as well as the ongoing operating costs of the system. The table considers only those renovation measures that can be expected to improve the building's energy efficiency. The figures are based on actual costs that were invoiced for real building activities in 2008. The data was sourced from the study: "Bewertung energetischer Anforderungen im Lichte steigender Energiepreise für die EnEV und die KfW-Förderung" (Assessment of energetic requirements in the light of rising energy prices of the EnEV and the KfW support) (BBR online publication 18/2008).

[1] BMVBS/BBR (publishers): "Bewertung energetischer Anforderungen im Lichte steigender Energiepreise für die EnEV und die KfW-Förderung", BBR online publication 18/2008.
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Institut für Wirtschaftswissenschaften, Universität Klagenfurt "Rentabilität der Wärmedämmung und des Kesseltausches eines durchschnittlichen österreichischen Musterhauses" (Institute of economics, university of Klagenfurt "profitability of the heat insulation and the kettle* exchange of an average Austrian showhouse"

Comparison of costs incurred for maintenance and thermal refurbishment at three energy efficiency levels (house in need of renovation, low-energy house and ISOVER Multi-Comfort House), based on a component surface of 100 m²

	Baseline scenario	Thermal refurbishment	
Heating energy demand in kWh/m²a	200	50	≤ 15
Heating energy savings in %		75	92.5
	Cost of maintenance work alone (house in need of renovation)	Cost of maintenance and insulation on low-energy house level	Cost of maintenance and insulation on Multi-Comfort House level
Non-walkable insulation installed on a top floor ceiling	–	1 900 €	2 200 €
Walkable insulation installed on a top floor ceiling	–	3 800 €	4 300 €
Roof renovation with above-rafter insulation combined with a new roof covering	New roof covering 7 000 €	12 500 €	13 600 €
Roof renovation with above- and between-rafter insulation combined with a new roof covering	New roof covering 7 000 €	12 600 €	13 600 €
Flat roof renovation combined with a new waterproofing layer	Waterproofing of the roof 5 000 €	11 000 €	11 900 €
Renovation of a solid exterior wall using composite thermal insulation, combined with a new plaster coat	New plaster coat 4 000 €	10 600 €	11 500 €
Renovation of a solid exterior wall with ventilated facade, combined with a new curtain wall	New facade 6 000 €	11 800 €	12 900 €
Renovation of a solid exterior wall with internal insulation, combined with new wallpaper*	New wallpaper 700 €	4 300 €	4 300 €
Renovation of a cellar ceiling from below in an unheated cellar*	–	5 100 €	5 100 €
Insulation of heating pipes in an unheated cellar (costs of 10 RM)	–	1 050 €	1 500 €

*Insulation of higher thickness would reduce the available space. For this reason, only the low-energy house level has been included in this table.

Refurbishment – what's in it for you?

The timing of your energy efficiency measures is very important. If a structural component is due for maintenance or replacement anyway, the additional investment will be quite low when compared with the unavoidable costs that you will incur in any case for transport, setting up the construction site, scaffold erection etc. It is the 'cost of energy saved' that is most important in a thermal refurbishment project. But how do you actually calculate a "kilowatt-hour saved"? By relating the additional annual costs incurred by the renovation measure to the actual energy savings achieved. The lower the value, the higher the profitability of the energy-saving renovation measure.

The following tables provide a detailed breakdown of costs (planning, materials and execution), and energy savings, based on a mean energy price of 6.8 cent/kWh. They are intended to help you assess the pros and cons of individual renovation activities. The prices are based on a mixed calculation, taken from several projects of different sizes, and will not reflect true costs in every case.

Insulation of the attic floor ceiling: the most efficient measure

If you want to save energy – always cover the pot when cooking. But how can this principle be applied to your home? Quite simply insulating the attic floor ceiling is the most effective energy efficiency measure you can take – and the one that pays you back most quickly. And on top of that, it is completely independent of other renovation and maintenance works. Even with a house on Multi-Comfort House level the "kilowatt-hour saved" is 87 % cheaper than the mean energy price.

Example 1: Non-walkable insulation installed on an attic floor ceiling

	Renovation	Renovation to low-energy house level	Renovation to Multi-Comfort House level
Heating energy demand in kWh/m²a	200	50	≤ 15
Heating energy savings in %		75	92.5
Insulation	None	Non-walkable insulation 28 cm λ = 0.040 W/(mK)	Non-walkable insulation 34 cm λ = 0.040 W/(mK)
U-value of the construction in W/(m²K)	U = 1.26	U = 0.13	U = 0.11
Total cost in €/m²	None [1]	19 €/m²	22 €/m²
Costs of saved energy in cent / kWh		0.8	0.9
Cost savings per year in €		980	1 244.5
Difference between energy costs and costs of saved energy	Energy price of 6.8 cent/kWh	6 cent/kWh	5.9 cent/kWh

Example 2: Walkable insulation installed on an attic floor ceiling

	Renovation	Renovation to low-energy house level	Renovation to Multi-Comfort House level
Heating energy demand in kWh/m²a	200	50	≤ 15
Heating energy savings in %		75	92.5
Insulation	None	Walkable insulation 28 cm λ = 0.040 W/(mK)	Walkable insulation 36 cm λ = 0.040 W/(mK)
U-value of the construction in W/(m²K)	U = 1.26	U = 0.13	U = 0.10
Total cost in €/m²	None[1]	38 €/m²	43 €/m²
Costs of saved energy in cent / kWh		1.6	1.7
Cost savings per year in €		940	1232.5
Difference between energy costs and costs of saved energy	Energy price of 6.8 cent/kWh	5.2 cent/kWh	5.1 cent/kWh

Renovation of the roof? Always include the insulation!

When you need a new roof covering, it is always adviseable to install above-rafter insulation or a combination of above- and between-rafter insulation. You will then be able to convert the attic, at a later date, into new and valuable living space that offers the thermal and acoustic comfort of a newly built house. If the waterproofing layer of a flat roof needs to be replaced, this is also a good opportunity to upgrade the insulation. This way you can realize annual heating energy savings of up to 90 %.

Example 3: Thermal renovation of a roof with above-rafter insulation combined with the necessary new roof covering

	Renovation	Renovation to low-energy house level	Renovation to Multi-Comfort House level
Heating energy demand in kWh/m²a	200	50	≤ 15
Heating energy savings in %		75	92.5
Insulation	None	Above-rafter insulation 22 cm λ = 0.040 W/(mK)	Above-rafter insulation 32 cm λ = 0.040 W/(mK)
U-value of the construction in W/(m²K)	U = 1.6	U = 0.17	U = 0.12
Total costs in €/m²	New roof covering 70 €/m²	Insulation and new roof covering 125 €/m²	Insulation and new roof covering 136 €/m²
Costs of saved energy in cent / kWh		1.8	2.1
Cost savings per year in €		915	1 226.5
Difference between energy costs and costs of saved energy	Energy price of 6.8 cent/kWh	5 cent/kWh	4.7 cent/kWh

Example 4: Thermal renovation of a roof with above- and between-rafter insulation combined with the necessary new roof covering

	Renovation	Renovation to low-energy house level	Renovation to Multi-Comfort House level
Heating energy demand in kWh/m²a	200	50	≤ 15
Heating energy savings in %		75	92.5
Insulation	None	Above- and between-rafter insulation 25 cm λ = 0.040 W/(mK)	Above- and between-rafter insulation 35 cm λ = 0.040 W/(mK)
U-value of the construction in W/(m²K)	U = 1.6	U = 0.17	U = 0.12
Total costs in €/m²	New roof covering 70 €/m²	Insulation and new roof covering 126 €/m²	Insulation and new roof covering 136 €/m²
Costs of saved energy in cent / kWh		1.8	2.1
Cost savings per year in €		915	1 226.5
Difference between energy costs and costs of saved energy	Energy price of 6.8 cent/kWh	5 cent/kWh	4.7 cent/kWh

Example 5: Thermal renovation of a flat roof combined with replacement of the waterproofing layer

	Renovation	Renovation to low-energy house level	Renovation to Multi-Comfort House level
Heating energy demand in kWh/m²a	200	50	≤ 15
Heating energy savings in %		75	92.5
Insulation	Little	Warm roof insulation 22 cm λ = 0.040 W/(mK)	Warm roof insulation 32 cm λ = 0.040 W/(mK)
U-value of the construction in W/(m²K)	U = 1.1	U = 0.16	U = 0.11
Total costs in €/m²	Replacement of the waterproofing layer 50 €/m²	Insulation and waterproofing 110 €/m²	Insulation and waterproofing 119 €/m²
Costs of saved energy in cent / kWh		3	3.3
Cost savings per year in €		870	1 208.5
Difference between energy costs and costs of saved energy	Energy price of 6.8 cent/kWh	3.8 cent/kWh	3.5 cent/kWh

New facade – but don't forget the insulation!

When renovating the facade, whether or not it needs a new plaster coat or new cladding to the ventilated construction, you have a unique opportunity to also carry out thermal refurbishment. The calculation of economic viability is almost always based on a period of 20 years, but with the typical life cycle of a new facade between 20 and 50 years, any maintenance or repair requirement provides an ideal, economic opportunity to also upgrade the insulation.

Refurbishing an exterior wall from the inside with higher thickness insulation will considerably reduce the available space, so we have only included an upgrade to low-energy house level. It stands to reason that internal insulation will invariably involve replacement of the old wallpaper.

Example 6: Thermal renovation of a solid exterior wall by installing a composite thermal insulation system combined with the required new plaster coat

	Renovation	Renovation to low-energy house level	Renovation to Multi-Comfort House level
Heating energy demand in kWh/m²a	200	50	≤ 15
Heating energy savings in %		75	92.5
Insulation	None	Composite thermal insulation system 22 cm λ = 0.040 W/(mK)	Composite thermal insulation system 32 cm λ = 0.040 W/(mK)
U-value of the construction in W/(m²K)	U = 1.4	U = 0.16	U = 0.11
Total costs in €/m²	New plaster coat 40 €/m²	Insulation and new plaster coat 106 €/m²	Insulation and new plaster coat 119 €/m²
Costs of saved energy in cent / kWh		2.5	2.7
Cost savings per year in €		890	1 217.5
Difference between energy costs and costs of saved energy	Energy price of 6.8 cent/kWh	4.3 cent/kWh	4.1 cent/kWh

Example 7: Thermal renovation of a solid exterior wall with ventilated facade combined with the required replacement of the curtain wall

	Renovation	Renovation to low-energy house level	Renovation to Multi-Comfort House level
Heating energy demand in kWh/m²a	200	50	≤ 15
Heating energy savings in %		75	92.5
Insulation	None	Ventilated facade 22 cm insulation λ = 0.043 W/(mK) incl. subconstruction	Ventilated facade 32 cm insulation λ = 0.043 W/(mK) incl. subconstruction
U-value of the construction in W/(m²K)	U = 1.4	U = 0.18	U = 0.12
Total costs in €/m²	Replacement of the cladding 60 €/m²	Insulation and replacement of the cladding 118 €/m²	Insulation and replacement of the cladding 129 €/m²
Costs of saved energy in cent / kWh		2.2	2.5
Cost savings per year in €		910	1 220.5
Difference between energy costs and costs of saved energy	Energy price of 6.8 cent/kWh	4.6 cent/kWh	4.3 cent/kWh

Example 8: Thermal renovation of a solid exterior wall with internal insulation combined with the required wallpaper replacement

	Renovation	Renovation to low-energy house level	Renovation to Multi-Comfort House level
Heating energy demand in kWh/m²a	200	50	≤ 15
Heating energy savings in %		75	92.5
Insulation	None	Internal insulation 10 cm incl. airtightness λ = 0.035 W/(mK)	Internal insulation 10 cm incl. airtightness λ = 0.035 W/(mK)
U-value of the construction in W/(m²K)	U = 1.4	U = 0.28	U = 0.28
Total costs in €/m²	Wallpaper replacement 7 €/m²	Insulation, airtightness and wallpaper replacement 43 €/m²	Insulation, airtightness and wallpaper replacement 43 €/m²
Costs of saved energy in cent / kWh		1.9	1.9
Cost savings per year in €		925	925
Difference between energy costs and costs of saved energy	Energy price of 6.8 cent/kWh	4.9 cent/kWh	4.9 cent/kWh

How to realize energy savings in the cellar

The good news is that the cellar ceiling, as well as the heating pipes in an unheated cellar, can be insulated at any time – this work is completely independent of other renovation and maintenance activities. True, the thickness of the insulation layer is generally limited by the room height of the cellar, but it is nevertheless quite easy to achieve the energy efficiency level of a low-energy house.

The rule of thumb for heating pipes is that the thickness of the pipe insulation should be 2 DN, i.e. twice the nominal diameter of the pipe (which is about the same as its internal diameter).

Example 9: Thermal renovation of a cellar ceiling from below in an unheated cellar

	Renovation	Renovation to low-energy house level	Renovation to Multi-Comfort House level
Heating energy demand in kWh/m²a	200	50	≤ 15
Heating energy savings in %		75	92.5
Insulation	None	Insulation from below 8 cm λ = 0.030 W/(mK)	Insulation from below 8 cm λ = 0.030 W/(mK)
U-value of the construction in W/(m²K)	U = 1.30	U = 0.29	U = 0.29
Total costs in €/m²	None	Insulation incl. plaster coat 51 €/m²	Insulation incl. plaster coat 51 €/m²
Costs of saved energy in cent / kWh		5.7	5.7
Cost savings per year in €		735	735
Difference between energy costs and costs of saved energy	Energy price of 6.8 cent/kWh	1.1 cent/kWh	1.1 cent/kWh

Example 10: Insulation of the heating pipes in an unheated cellar

	Renovation	Renovation to low-energy house level	Renovation to Multi-Comfort House level
Heating energy demand in kWh/m²a	200	50	≤ 15
Heating energy savings in %		75	92.5
Insulation	None	Pipe insulation 20 mm λ = 0.035 W/(mK)	Pipe insulation 40 mm λ = 0.035 W/(mK)
U-value of the construction in W/(m²K)	U = 0.73	U = 0.18	U = 0.14
Total costs in €/m²	None	Insulation 10.5 €/RM	Insulation 15 €/RM
Costs of saved energy in cent / kWh		1.2	1.6
Cost savings per year in €		960	1 234
Difference between energy costs and costs of saved energy	Energy price of 6.8 cent/kWh	5.6 cent/kWh	5.2 cent/kWh

Apart from purely economic criteria, there are also other criteria that need to be considered. There can be no doubt that enhanced living comfort, cosiness and pleasant indoor climate contribute to a higher quality of life – even though these improvements cannot be expressed in monetary terms. Regular home renovation also increases the market value of your house and keeps it "in good health". By increasing energy efficiency, you also increase saleability.

As an added bonus you can be safe in the knowledge that you are benefiting the environment: lowering CO_2 emissions thanks to lower energy consumption as well as helping security of energy supplies. In other words, thermal refurbishment pays for itself in many ways during the life cycle of a building.

Short glossary of insulation terminology

Energy performance indicator (kWh/m²•a)
The energy performance indicator is the most common reference value used to describe the thermal quality of the building envelope. It indicates how much energy per square metre a building uses over a year. This indicator can be easily converted into euros/m² if the price of one kilowatt-hour is known.

Space heating demand (kWh/m²)
The space heating demand is the amount of heating energy that must be supplied to air-conditioned rooms (heated or cooled) in order to maintain their predefined target temperature.

Final energy demand (kWh/m²)
This is the calculated amount of energy needed in average climatic conditions to cover space and water heating demand. It also includes the energy losses caused by the installation engineering. Besides the quality of the thermal envelope and the HVAC engineering, the actual amount of energy consumed also depends on the residents' living habits and the local climatic conditions.

Primary energy demand (kWh/m²)
Apart from the final energy demand for space and water heating, the primary energy demand also takes into account the losses that occur in the generation and transmission of the energy, right through to its distribution and storage inside the building.

U-value, thermal transmittance (W/m²K)
The U-value is a measure of the rate of heat loss through a building component. It is expressed as watts per square metre per degree Kelvin. It is influenced by the following factors: λ-value and thickness of the single layers of a building component. As a rule of thumb: The smaller the U-value, the lower the loss of heat and the better the thermal insulation.

λ-value, thermal conductivity (W/mK)
The λ-value indicates the amount of heat transmitted through a material, measured in watts per square metre of surface area for a temperature gradient of one Kelvin per metre thickness, expressed as W/mK. Thermal conductivity is an important criterion for assessing the quality of insulation materials. The lower the thermal conductivity of a building material, the better its thermal insulation properties.

R-value, thermal resistance (m²K/W)
The R-value is a measure of the thermal resistance of a particular thickness of material. It is measured in m²K/W and is equal to the thickness of the material (in metres) divided by its thermal conductivity. The higher the thermal resistance, the better the heat insulation of a construction element.

n_{50} value
This value is a measure of the quality of airtightness. It indicates how often the air volume inside a building is exchanged per hour when the enclosure is subjected to a 50-pascal pressure difference. The n_{50} value must not exceed 3.0 (1/h) for buildings without a ventilation system, a value of 1 (1/h) for buildings with a ventilation system installed and a value of 0.6 (1/h) for passive houses.

s_d-value (m)
The vapour diffusion-equivalent air layer thickness indicates the resistance that a building material offers to the penetration of moisture compared to air. The higher the s_d-value, the more vapour-tight the layer. Normally, building materials are expected to have a constant diffusion resistance. Exceptions are the climatic membranes VARIO KM and VARIO KM Duplex: they have a variable s_d-value that depends on the air humidity that each side of the membrane is exposed to. This allows the membranes to diffuse 25 times more moisture in summer than the structure absorbs during winter. As a result, the membranes offer high protection from structural damage.

$D_{n,T,w}$ airborne sound insulation (dB)
This value describes the resistance to airborne sound between rooms in a building. If sound is created in separating walls or flanking components, it will set off oscillations. This, in turn, causes the air of the adjoining room to oscillate, thus creating airborne sound. The higher this value, the higher the acoustic comfort.

$L_{n,T,w}$ impact sound insulation (dB)
This value describes the resistance to impact sound between rooms in a building. This sound is created by walking or similar stimulation of ceilings and stairs and is partly passed on as airborne sound in an underlying or adjacent room. The lower this value, the higher the acoustic comfort.

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