



Keep cool in hot countries – Save natural resources.

The ISOVER Multi-Comfort House.



Our comfort must be Nature's comfort.



Dear house owners, planners and architects, "My home is my castle" will be topped in the future by "My home is my ISOVER Multi-Comfort House". For this reason, we have created this brochure. The passive house concept already works successfully in cold countries, helping to reduce the heat demand. Adapted to hot countries, it can contribute to an excellent indoor climate while saving energy and money for cooling.

Of course, you will find here all the arguments in favour of building with the passive house standard: ecological, economical and quite comfortable reasons. But our brochure offers much more than just arguments. It can be a source of information and help you introduce the passive house concept in your country. And if you need further support: we will be glad to help you.

Good luck and have a good life!
Your Saint-Gobain ISOVER Team

The Kyoto Protocol is a climate protection initiative.

Everybody talks about more and more extreme weather events, but only few take action. With their signature under the Kyoto Protocol, more than 140 industrial nations have made a commitment to reducing their CO₂ emissions drastically. This means: top priority for using energy-saving technologies and thus top priority for saving our natural resources. Each and every one of us should contribute to more economical housekeeping by living comfortably and making most efficient use of energy.

Make your decision for the ISOVER Multi-Comfort House – Combine comfort & environmental protection under one roof.

Live comfortably. Make no sacrifices. But go easy on the environment all the same. A fantastic vision? The ISOVER Multi-Comfort House can make this vision come true. No matter what your dream house looks like: the passive house standard allows you to realize your home and build in pleasant comfort – quite simple, economical and energy-efficient. And it pays off – cash!

State-of-the-art knowledge for an excellent energy balance.

In the warm climates of Southern Europe, heating is less of a problem than in Central or Northern European climates. With minimal total energy consumption, buildings can be kept comfortable all year round. Both heating and cooling requirements need to be considered when defining insulation levels and glazing specifications in Southern Europe. Detailed planning and engineering as well as expert installation are essential for an excellent energy performance. This brochure is meant to help you achieve both comfort and energy efficiency in your home.

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*In hot countries thermal
insulation of walls and roofs
keeps the warmth outside.*



*For your cool dreams on
hot summer days.*



*ISOVER offers
technical support.*

The Comfort.

For a good life. For every one. For

Simply move in and feel at home.

Life in an ISOVER Multi-Comfort House doesn't need time for settling in. The simple reason is that you won't miss anything, except maybe a couple of annoyances. But honestly: who would seriously miss cold feet, draughty corners and musty or overheated rooms? In the passive house, everyone can enjoy their own patch of paradise.

No freezing and no sweating.

You will enjoy comfortable room temperatures between 20° and 26 °C. Scientifically, this has been proven to be the ideal range for relaxed living and efficient working. And, for the better part of the year, without any conventional cooling or heating. In very hot regions, it may be necessary to support the effect of passive cooling by efficient air conditioning.

Draw a deep breath – day and night.

Even allergy sufferers never run out of good air in an ISOVER Multi-Comfort House. Thanks to the Controlled Ventilation System which is part of a passive house's basic equipment. It works similarly to the human lung. A permanent flow of filtered fresh air constantly ensures best air quality, free of dust, pollen and aerosols, while at the same time removing stale air. And in the same breath, heat distribution and recovery take place. In summer,

Build with all comfort. And gain energy at the same time.

The most inexpensive energy is energy not consumed. It doesn't need to be generated, imported, or paid for. This is the basic concept of the passive house. Since a sufficient amount of warmth remains in the house in the cold season, there is normally no need for heat supply by traditional space heating. In hot periods, the perfect thermal insulation and the windows with outside shading keep most of the heat and solar radiation outside. The

cooling demand for a pleasant indoor temperature is reduced by up to 90 %. These energy and cost savings are all the more important in view of the steadily increasing world market prices for all kinds of energy. The ISOVER Multi-Comfort House makes you less dependent on energy prices. And thanks to its uncomplicated technical equipment, it requires very little maintenance.



ever.



the Comfort Ventilation System can also be used for cooling: it forces warm air out of the building and pulls in cool, fresh air. Unique advantage of the system: not only dust and insects are kept outside, but also street noise.

Built-in safety to ensure long life and value.

Thanks to its preferred humidity range of 30 to 70 %, the good air in the ISOVER Multi-Comfort House prevents the formation of mould and thus structural damage into the distant future. And this ensures the building's high resale value – just in case. Spanish regulations, for example, recommend a relative air humidity of 60 %.

The passive house standard gives you all the freedom you want.

A passive house does not define itself by outer appearance but by its inner values. Therefore any type and size of building can be realized. This is testified every year by a growing number of examples, including one-family houses and industrial estates, schools, churches and mountain shelters. Not only new buildings comply with this future-oriented building standard. There are even increasing numbers of old buildings whose refurbishment is based on passive house principles. The use of well-selected passive house components achieves ecologically and economically sensible results.



The Comfort.

Keep it cool.

While we try to keep the warmth inside in cold winter periods, the aim in hot summer periods is to keep the heat outside. Perfect thermal insulation works both ways and reduces heating and cooling energy demand to a minimum.

Snugly warm in winter, comfortably cool in summer.



Enjoy nice indoor temperatures even on hot summer days.

Compared to conventionally built houses, passive houses have a lower space heating demand by up to 90 %. In cold winters, a room of 30 m² can be heated with just 10 tea lights or three bulbs of 100 W to keep it snugly warm. On hot days, the same small amount of energy ensures a pleasantly cool temperature. The heat demand of passive houses is 15 kWh/m²a. In terms of fuel consumption, a passive house needs about 1.5 l heating oil or 1.5 m³ natural gas per square meter and year.



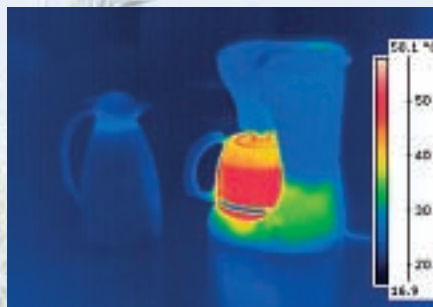
Insulation keeps cool in hot summers.

The motto for all rooms: Keep warm in winter and cool in summer.

Based on the thermos flask principle, the ISOVER Multi-Comfort House retains its comfortable indoor temperature in summer and winter. In winter, the interior of the building is well protected against loss of heat. In summer, the interior is kept pleasantly cool. Little energy is needed to provide additional cooling during long hot periods. The passive house really lives up to its name by making extensive use of

"passive" components. These include heat-insulating windows, controlled

ventilation with heat recovery and, above all, efficient thermal insulation.



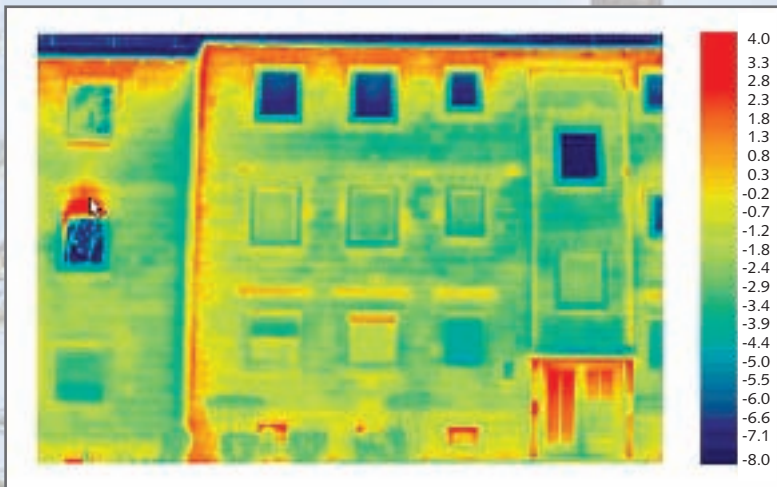
Modern comfort: saving energy instead of consuming more and more.

Every occupant is a heat source.

The internal heat gains – heat emitted by humans, animals and household appliances such as dishwashers and washing machines – are surprisingly important for covering the required heating energy. Everybody contributes by a calorific value of approx. 80 W to heating the interior. Considerable heat

gains are also realized through the sun-oriented windows. In winter, they allow higher amounts of solar energy to enter the house than lost to the outside. Together with the energy of the heat exchanger, this is normally sufficient to meet the demand. You can thus save the cost of installing and maintaining

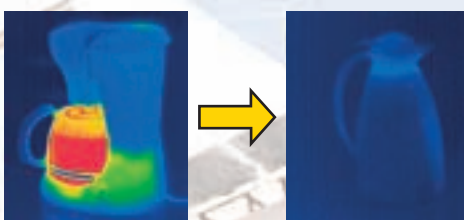
conventional heating and save a lot of money. In summer, internal heat gains can be reduced by using highly efficient household appliances. Furthermore, heat infiltrating from outside needs to be minimized by excellent thermal insulation and shaded windows.



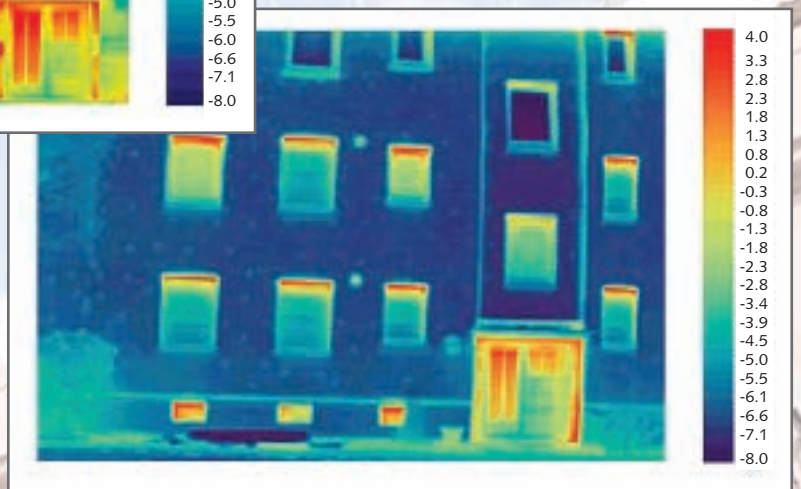
*Thermographic image – before refurbishment:
The entire house is a thermal bridge.*



*Multi-family house after energetic
refurbishment*



From active to passive!



*Thermographic image – after refurbishment: The external wall is
thermally insulated, but heat still leaks through windows and doors.*

Everything well-insulated and airtight.

From the roof down to the foundation slab: a jointlessly sealed building envelope ensures thermal and acoustic insulation. And the ventilation system – complete with heat recovery – takes care of fresh air supply and heat distribution. During a hot summer spell, the same components – supported by exterior window shades – reduce heat infiltration into the building.

Do we really need so much energy for comfort?

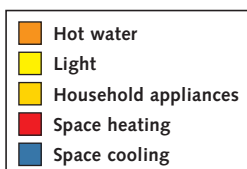
Passive houses without active heating and cooling?

Passive house design is a strategic approach in different locations and climates. Its objective is to minimize energy consumption for heating, ventilation, lighting and cooling. In Northern Europe, the demand for heating energy is still quite high. Naturally, it is lower in Southern Europe where the demand for mechanical cooling has been increasing rapidly. Recently, there is a growing interest in strategies to achieve passive house performance for both heating and cooling, i.e. to reduce total heating and cooling demand to less than 15 kWh/m²a according to the Passive House Planning Package (PHPP).

The designers of passive houses try to utilize ambient heat sources (e.g. the sun) and heat sinks (e.g. the night sky) for heating and cooling. Much of the early work in this field was done in the US in the 1970s and then further developed in Europe during the 1980s, funded by the European Commission. It is in this context that the passive house concept came into being.

Although Southern European homes still need to be heated in winter, there is a predominant need for cooling in summer. We at ISOVER have therefore recently adapted our Multi-Comfort House concept to warmer climates.

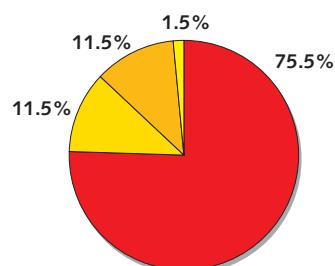
The mix of energy consumption has been calculated for a typical existing single-family house with an indoor temperature of 22 °C. The values can vary depending on the user habits and the selected indoor temperature.



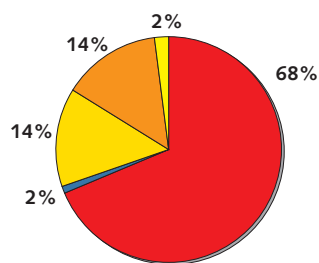
Space heating and cooling currently account for 70 % of our energy demand.

From all sectors of life, building and living is regarded to be most harmful to our climate. For instance, an approximate 3000 kg oil equivalents per capita still vanish into thin air every year for providing space heating, cooling and warm water (example: Western Europe). However, 90 % of this energy can be saved without extraordinary investment costs and even with state funding. Always comfortable in the ISOVER Multi-Comfort House.

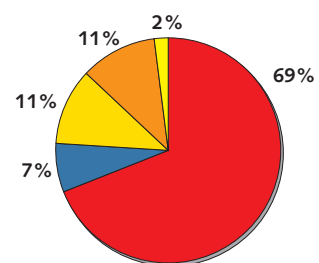
* Electricity, gas, oil, petrol etc. Source: VDEW, issued in 2002



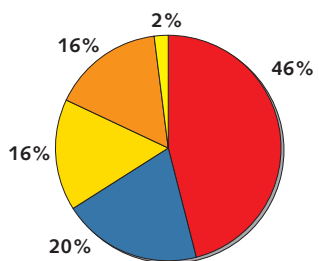
Characteristic energy mix* for residential buildings in Central Europe (Germany)



Characteristic energy mix for a conventional house in Porto



Characteristic energy mix for a conventional house in Madrid

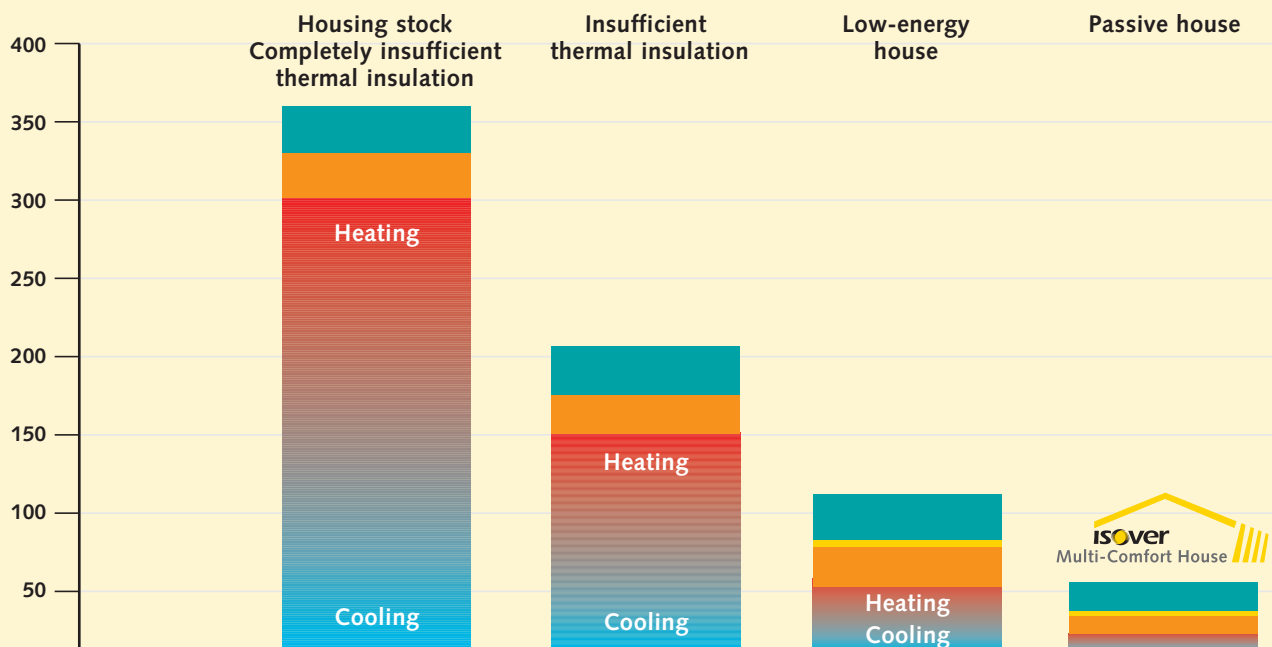


Characteristic energy mix for a conventional house in Sevilla

Energy demand in kWh per m² useful living space and year

- Household electricity
- Ventilation electricity
- Hot water
- Space heating
- Space cooling

Final energy demand in kWh/m²a



Heating and cooling energy demand of a typical single-family house	kWh/m²a 300-250	kWh/m²a 200-150	kWh/m²a 90-60	kWh/m²a ≤ 15
Heating	270-230	185-140	80-55	≤ 10
Cooling	30-20	15-10	10-5	≤ 5
BUILDING STANDARD	Completely insufficient thermal insulation Structurally questionable, cost of space conditioning no longer economical (typical of rural buildings, non-modernized old buildings).	Insufficient thermal insulation Thermal renovation is clearly worth the trouble (typical of residential houses built in the 50s to 70s of the last century).	Low-energy houses	Very low energy houses (passive houses need to meet this parameter as part of the requirement profile)
BUILDING ELEMENT	Typical U-values and insulation thicknesses			
External walls (massive wall of 25 cm) Insulation thickness	2.45 W/(m²K) 0 cm	1.0 W/(m²K) 2 cm	0.50 W/(m²K) 6 cm	0.20-0.45 W/(m²K) 20-10 cm
Roof Insulation thickness	1.38 W/(m²K) 0 cm	0.54 W/(m²K) 4 cm	0.28 W/(m²K) 10 cm	0.15-0.25 W/(m²K) 25-15 cm
Cellar ceiling Insulation thickness	1.66 W/(m²K) 0 cm	0.85 W/(m²K) 2 cm	0.57 W/(m²K) 4 cm	0.35 W/(m²K)* 8 cm
Windows	5.1 W/(m²K) Single glazing, thin wooden frame	5.1 W/(m²K) Single glazing, thin wooden frame	2.8 W/(m²K) Double glazing, standard frame	1.0-1.5 W/(m²K) Double low-e glazing, insulated frame, or triple glazing if necessary
Ventilation	Leaky joints	Window ventilation	Exhaust air unit	Comfort ventilation with heat recovery
CO ₂ emission	75 kg/m²a	30 kg/m²a	12 kg/m²a	4.5 kg/m²a
Energy consumption in liters heating oil per m² living space and year	30-25 liters	15-10 liters	5-4 liters	1.5 liters

* If the average temperature of the outside air is not below 15 °C, insulation to the ground is not so important.

Cooling and heating ener of 15 kWh/m²a:

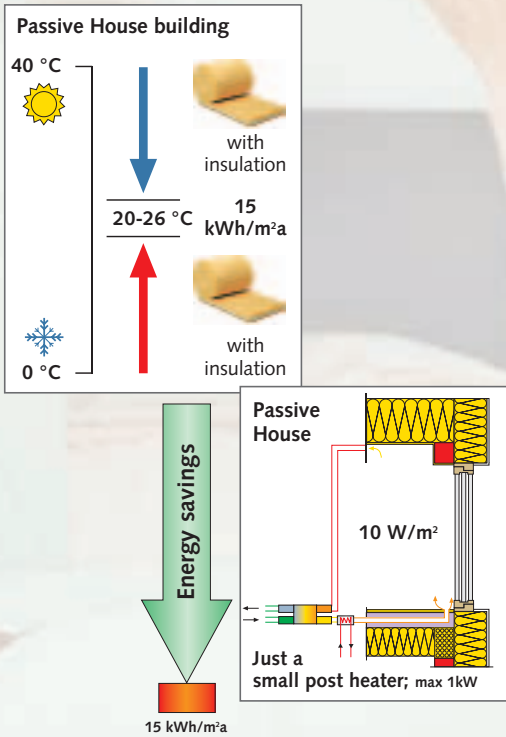
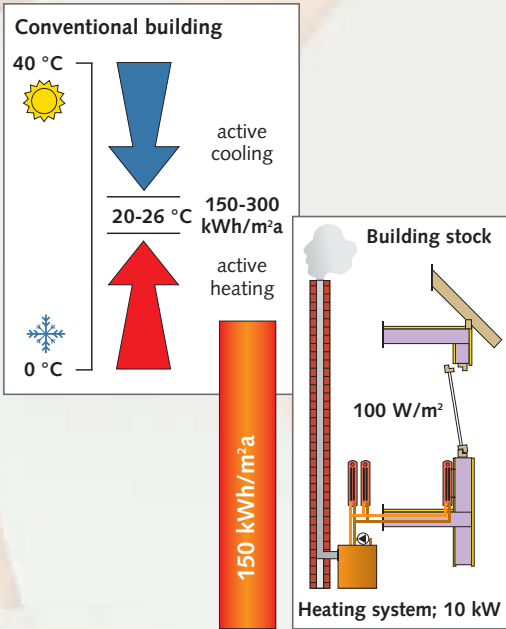
Building physics and design must be in perfect harmony.

Judging from outer appearance, an ISOVER Multi-Comfort House may look like a conventional building. But when it comes to interior design, meticulous planning is indispensable. This may be more demanding and cost-intensive – at least at the start. In the end, the new concept will help achieve the crucial energy balance: low energy losses on the one, adapted solar and internal energy gains on the other hand. The inhabitants benefit from low cooling and heating costs while enjoying a pleasantly stable indoor climate and the high, long-term living comfort of their homes.

Max. 10	W/m² *	Heating load calculated according to the Passive House Planning Package
Max. 7	W/m² **	Cooling load calculated according to the Passive House Planning Package
Max. 15	kWh/(m²a)	Specific heating energy demand
Max. 15	kWh/(m²a)	Specific cooling energy demand
40-60	kWh/(m²a)	Specific total*** final energy demand
100-120	kWh/(m²a)	Specific total*** primary energy demand
Reference area (m²) is the temperature-controlled useful living space.		
* If solar energy is used for hot water and space heating, the heat load can be even higher without negative effects on the environment. This allows more architectural freedom.		
** This is only a guidance value. In practice, the cooling load depends on the local climate and the solution chosen in a specific case.		
*** total = including all of the household's energy consumers (heating, cooling, hot water, ventilation, pumps, lighting, cooking and household appliances)		

One team. One plan. One house.

Careful planning is one thing, excellent workmanship another. Why? Because a passive house has only a limited "energy budget". Its positive energy performance must therefore be guaranteed for many decades. But in the long run, the quality of workmanship counts even more than the U-values calculated for the individual structural components. By the way: In an ISOVER Multi-Comfort House you'll rarely find structural damage caused by condensation and moisture.



Energy demand that's the benchmark.

Quality assurance right from the start.

When working with specialist companies, you can normally be sure that the predefined values are achieved. Nevertheless, it's highly advisable to incorporate quality assurance measures in the invitation to tender. These include above all:

- Energy demand calculation
- Measurement of airtightness (the so-called "Blower Door Test")

Meticulous planning facilitates the craftsmen's work.

The planning of passive houses is a highly demanding job that requires elaborate design, considering high efficiency standards and monitoring compliance with these standards. Thanks to detailed planning, the craftsman's job is relatively easy.

Point by point: Success factors for the passive house standard in warm climates.

Primary factors

- *Maximum thermal insulation, structural compactness, free of thermal bridges: Good insulation of roof and walls to achieve low U-values, but calculated individually and adapted to the needs of the local climate.*
- *The windows should have double glazing with Low-E coating, argon or krypton filling and insulated frames.*
Aim: a U-value of 1.0 to 1.5 W/(m²K), including the frame, and a g-value of 0.6 (total solar energy transmittance) for the glazing.
- *Airtightness of the building envelope: The result of the Blower Door Test must be < 1.0 air changes per hour.*
- *Heat recovery from the exhaust air: Via a counterflow heat exchanger, hot incoming air can be cooled down by the cool exhaust air and vice versa. The major part of the heat is fed back to where it came from. Heat recovery rate: above 80 %.*
- *Energy-saving household appliances: Fridge, oven, deep-freezer, lamps, washing machine etc. as efficient power savers are yet another useful element of the passive house concept. Low internal heat loads reduce the cooling demand in summer and help keep the building cool. In hot climates, solar hot water storage tanks should be placed outside the thermal envelope.*

Secondary factors

- *Conditioning of fresh air: Fresh air can be precooled in summer and preheated in winter via a geothermal heat exchanger (energy well).*
- *South orientation and little shading in winter: Passive use of solar energy saves heating energy.*
- *South orientation and shading of windows in summer: Window areas should be small enough to reduce solar heat loads in summer but big enough to provide natural lighting.*
- *Domestic hot water generation: The required energy can be produced by solar collectors (energy demand of the circulating pump 40/90 W/litre) or by air-to-water heat pumps (average coefficient of performance 3). In summer, the heat pump can also be used for energy-efficient cooling. Dishwashers and washing machines should be hot-water connected.*
- *Hot water from solar collectors can also be used for space heating for most of the year depending on the local climate.*

The multiple dimensions



Comfort comes first!

The ISOVER Multi-Comfort House concept stands for energy savings and environmental protection – and most important of all: the well-being of its inhabitants!

A passive house ensures all kinds of comfort. It offers a pleasantly stable indoor climate and excellent conditions for working and living – thanks to competent noise control, sound absorption and low-energy daylighting.

Neither cold feet nor sweaty hands – thermal comfort in passive houses.

Invigorating coolness in summer and comfortable warmth in winter. No problem for an ISOVER Multi-Comfort House. With only a few add-ons, you can maintain an almost perfect temperature, adapted to your individual needs.

Cooling in summer. Jointless insulation free of thermal bridges and airtight windows with outside shading are indispensable to keep the summer heat outside. Cooling can be achieved by making deliberate use of natural ventilation during day and night. A small adjustable cooling device ensures comfortable temperatures.

Heating in winter. On cold days, the controlled ventilation system with counter flow heat exchanger ensures that the used outgoing air warms up the fresh incoming air. Jointless insulation free of thermal bridges helps to keep the warmth inside and allows the inhabitants to make efficient use of internal heat gains.

A fire-safe home.

Always on the safe side: preventive fire protection is ensured with non-combustible mineral wool insulation made by ISOVER.

of comfort.

Enjoy the peace and quiet of your home – with acoustic comfort by ISOVER.

We are often disturbed by noise from the outside and from the inside. For this reason, the ISOVER Multi-Comfort House concept offers acoustic insulation that allows us to enjoy the peace and quiet of our homes. Whether we want to rest or do concentrated work – our noisy neighbour will not disturb us. This works, of course, both ways.

Good acoustics are particularly important in non-residential buildings.

In hospitals, quiet ensures the patients' speedy recovery. Offices need good sound insulation and room acoustics to produce efficient results. And in schools the progress of learning very much depends on good speech intelligibility. A short reverberation time in the classroom definitely improves the understanding between pupils and teachers.



Act environmentally friendly, live comfortably – and save money!

Upgrading your house to passive house level does not necessarily imply higher costs. But even higher costs of 5-10 % for passive houses (compared to standard houses) will be compensated by lower operating costs. The design of your home helps you save resources and contribute to comfortable living.

Dimensions of comfort:

- *Thermal comfort*
- *Acoustic comfort*
- *Healthy indoor air*
- *Safety from fire*
- *Lower energy bills – more money for enjoying life*
- *Use of local and renewable energy sources*
- *Independence from external energy suppliers*
- *Active environmental protection*
- *Higher property value*

Live comfortably – at low

**Air temperature 20-26 °C,
relative air humidity 30-70 %.**

In order to enjoy such agreeable living conditions, you have to dig deep into your pockets with conventionally built houses. Not with the ISOVER Multi-Comfort House where highest living comfort in all rooms helps you save a lot of cash because of low running and

maintenance costs. Although the construction of such a house incurs extra costs, the total financial burden will be significantly lower compared to a conventional new house – thanks to very low energy costs over the entire lifetime.

Burning sun on the outside, pleasant freshness inside.



Southern European homes often require little heating in winter. It's foremost cool comfort for hot summer days that needs to be assured. There are several possible approaches to cooling a house and providing pleasant freshness for its inhabitants.

**Adapting the cooling
concept to local climate.**

Even in one and the same country, we usually find different climatic regions. This makes it necessary to work out specific design solutions. There are precise calculation methods that consider all relevant input data such as outdoor temperature, heating degree days and solar radiation. Calculations can determine whether air-conditioning is required or not. Passive houses need additional active cooling only in very hot periods. Most of the time, passive cooling provided by efficient insulation, outside shading, airtightness and controlled ventilation is sufficient.

**Shading ensures comfort
and financial savings.**

As solar radiation is generally intense in Southern Europe, shading has a large impact on the indoor climate and thus on a building's energy design. There are many forms of shading which can be adapted to the region with its climatic particularities – from movable shadings to fixed constructions. They ensure cost-efficient, comfortable living.



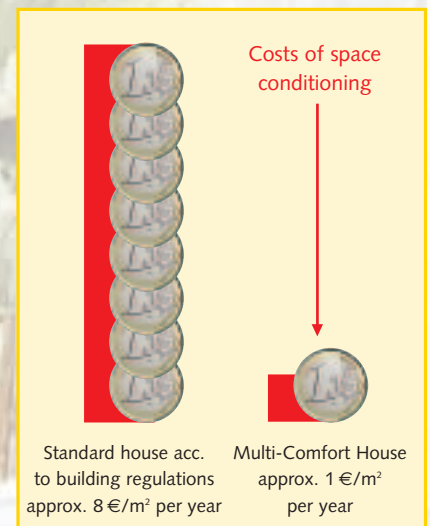
energy costs.

Improvement by 8:1 compared to building regulations. That's life in an ISOVER Multi-Comfort House.

Compared to the passive house, other building styles are more expensive. This includes not only conventionally built new houses, but also innovative types as the low-energy house. Whenever possible, choose the passive house standard right from the start. To be honest: how often do you build a house?

Cosiness comes cheap – but only in passive houses.

When living in a passive house, the building envelope – consisting of walls, floors, ceilings, roof and windows – ensures pleasant inner surface temperatures, even at extreme outdoor temperatures. The surface temperature of the building only differs by 0.5-1°C from the room air temperature. Passive house windows differ by only 2-3°C from the room air temperature. In houses that do not comply with the passive house standard, such a high degree of cosiness can only be achieved at considerably higher energy costs.



A profitable lifetime investment that pays off daily.

The former cost difference between Multi-Comfort Houses and conventionally built houses is diminishing. Today, passive houses are already built at prices typical of conventional construction. The reasons? Increasing demand, more experience in planning and building, and cheaper production of high-quality components. A look at total profitability will convince you. When including also the running costs, the ISOVER Multi-Comfort House shows itself at its best. Thanks to minimal annual heating and cooling costs of currently approx. 1 €/m², the possible extra costs pay off after only a few years.

In a standard house built according to the latest building regulations, energy costs of space conditioning account for roughly 10 % of the total net family income – compared to a mere 1 to 2 % in a passive house. Since energy prices will continue to rise over the next few years, their share of total costs will inevitably rise to 15 % and more in conventional homes. Consequence: even higher cost savings for passive house owners.

Point by point:

The ISOVER Multi-Comfort House scores many points in a cost/benefit analysis:

- *Energy-saving construction pays off from the very first day*
- *Safe investment into the future*
- *Added value every year through decreased operation costs*
- *Comfortable living in all seasons*
- *Longer useful life thanks to very high quality standard*
- *Valuable contribution to sustainable climate protection*

Peace and quiet don't co even in

Location is crucial.

How loud or quiet a building is depends first and foremost on the proper dimensioning of sound insulation with respect to the authoritative outdoor noise level. In the approach corridors of airports, along main roads and next to schools or swimming baths, a high level of external noise is inevitable. Here, more extensive soundproofing measures are necessary to ensure that the residents can live quietly. In these extreme conditions, the passive house shows itself off to best advantage: the windows need not be opened as fresh air is supplied via a ventilation system.



Meticulous planning.

If the building site is affected by excessive noise, the passive house can be located as far as possible away from the noise source. The windows of living and sleeping rooms should then be installed on the front facing away from the noise source. Depending on the dimensions of the house and its surrounding buildings, the sound level can be expected to be 5-10 dB lower. But since it is necessary to make passive use of solar radiation for heating, this might be feasible only to a limited extent.

Indoor and outdoor sound insulation.

Sound is a phenomenon that occurs both inside the building, caused by talking, walking, music, sanitary installations, and outside. It is therefore requisite to provide adequate sound insulation – from the roof all the way down to the cellar. When planning the building's facade, window areas play an important role: they determine the acoustic insulation of the external wall. As they are transparent, their sound absorption capacity is much

lower. To offset this shortcoming, the acoustic insulation of the lightproof components must be increased. Usually, a construction sound reduction index R'_{w} of approx. 53 dB is required by law. When designing quietness into the interior, structural engineers differ between airborne and structure-borne (resp. impact) sound. The sound reduction index indoors is determined by walls, doors and flanking components. In Europe, the recommended values are 40 to 48 dB. Impact sound insulation refers to the acoustic insulation of floors and stairs.

me easy – passive houses.

If possible, an impact sound insulation $L'_{nT,w} + C_{1,50-2500}$ of 40 dB should be achieved for neighbouring flats and of 45 dB within a flat or one-family house. The recommended value for comfortable airborne sound insulation between individual flats is in the range of 58 to 63 dB ($D'_{nT,w} + C$). On the whole, all building styles used in the construction of passive houses are able to ensure excellent acoustic quality.

technologies for designing perfect acoustic environments. The surface condition of ceilings and walls plays an essential role in this process. Soundproof wall and ceiling panels are able to reduce disturbing background noise. By absorbing sound, they prevent undesired reflections of sound. Thus, disturbing echoes and reverberant noise are suppressed and the background noise level is decreased. As a result, pupils can better hear and grasp what is being said: with less effort – also for the teaching

staff – better learning results are achieved. The same applies to offices, event locations and factory halls. By providing optimum acoustic conditions, it is possible to improve people's performance and well-being. We should take advantage of these positive effects: by making use of high-quality mineral fiberboards with fleece backing. They provide optimum sound absorption and excellent acoustic quality in all rooms.

Good acoustics, good marks.

Good acoustics also help in non-residential buildings such as offices, hospitals and schools. The things that children learn or don't learn at school often determine their future path of life. Since pupils spend most of their lesson time listening, good classroom acoustics are an important criterion. A low noise level and a short reverberation time in the classroom improve concentration, promote communication and make learning easier. Today, we have the necessary knowhow and



Live and let live in peace



Only "Enhanced" or even higher sound insulation is able to guarantee the residents' satisfaction. Hence, "Comfort Class" insulation should generally be installed. And, with musicians around, even a class higher.

Whether from inside or outside: noise is always disturbing.

Where more and more people live together on less and less space, noise becomes an increasingly disturbing factor. In their own four walls, residents often have to suffer from outdoor noise. As if that wasn't enough, indoor noise sources are also becoming increasingly important. Studies carried out in different European countries clearly show: the most important source of noise – besides road traffic – is your own neighbours! And it is the

European sound insulation regulations that must be blamed for this negative trend in the first place. Fact is that in virtually all European countries the legally required sound insulation is not sufficient to allow comfortable living.

Every human being has a need for quietness.

We need quiet phases in our daily lives like we need food and drink. They allow us to refuel body and soul. And they maintain our health. On the other hand, every human being does

also produce noise. By talking, walking, showering, cooking, playing, listening to music and other activities, we often cause a level of noise that is perceived as a nuisance by others. Of course, this affects first and foremost our neighbours. But also our own family members may feel disturbed.

The troublemakers: airborne sound and impact sound.

Surveys carried out among tenants have shown that the minimum sound insulation stipulated by the European

and quiet.

countries is sufficient only in rare living conditions. In particular the tenants of multi-family houses complain about noise nuisance caused by neighbours. But they also complain when they need to restrict their own activities to ensure their fellow tenants' peace and quiet. Based on these experiences, ISOVER has worked out recommendations and guide values which guarantee acoustic comfort even under unfavourable living conditions. In order to produce a quiet indoor climate, a distinction is made between airborne and structure-borne (resp. impact) sound. The quality of airborne sound insulation depends on walls and flanking components such as floors, doors etc. The level of impact sound is determined by floors



and stairs. In a nutshell: If you want to ensure a satisfactory level of acoustic quality, better go for the ISOVER Comfort Class right from the start.

Always favourable and worthwhile in new builds, costlier in old ones.

Provided good planning according to EN 12354 (valid in most European countries) and workmanship, a comfortable level of sound insulation can be achieved in new buildings at relatively low costs. You just need to budget for 2-3 % extra costs compared with "noisy" solutions. Often, the thermal insulation provided by the passive house standard at the same time ensures comfortable sound insulation. In these cases, next to no extra costs are incurred for either new or old buildings. Instead, the quality of living rises as does the value of the house. When letting or selling the house, a higher price can be achieved if the house is equipped with comfort class sound insulation. The acoustic comfort classes set up by ISOVER can serve as a valuation basis here.

To the point: The acoustic comfort classes of ISOVER.

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

Between living units

Class	Music	Comfort	Enhanced	Standard
Airborne sound insulation of partitions (without 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

Within living units

The Climate.

Passive houses in Mediterranean countries.



- Different climatic zones
- Influence of the Gulf Stream
- Sun radiation

Europe – a climatic rag

One continent – many climates – different building styles.

In European latitudes, all kinds of climates can be found. Even in one and the same country, no generalization can be made because of different landscapes. Take for instance the mountain regions of Italy. The climate there can change extremely within a few kilometres due to the different altitudes. The

climatic zones in Europe range from the Mediterranean in the South to the Arctic in the North. While there is still snow in Lapland, Sicily might already suffer from summer heat. And while it's raining again on the Shetland Islands, Andalusia is going through just another dry spell. Depending on local

weather conditions and building traditions, we find a great variety of architectural styles across Europe. The passive house concept allows us to preserve the style and charm of every region while significantly improving energy efficiency.

The maritime impact.

Both the Atlantic Ocean and the Mediterranean Sea have an enormous impact on the climate. They raise minimum temperatures and level out short-term fluctuations. On the coast, temperatures tend to be more stable than inland, but there is also more precipitation. On Western European coasts, there is no protection from the steady west wind blowing in clouds from the ocean. Inland, their passage is hindered by mountains or they simply disappear because of rain. In the Mediterranean area, summers tend to be arid and hot, winters cold and humid. It also doesn't

rain as often as in Western Europe, except for the winter time with the wind blowing from the Atlantic and bringing frequent rainfall. In countries with a continental climate, such as Romania and Russia, temperatures vary extremely and sometimes at short intervals.

The Gulf Stream – a natural heater for Western Europe.

Considering the northern latitudes, temperatures in Europe are relatively high. Just compare: Naples mean annual tem-

perature is 16 °C while that of New York is around 12 °C although on the same latitude. This fact can be explained by the impact of the Gulf Stream or North Atlantic Drift as its extension in Northern Europe is called. This second largest stream in the world, originating in the Gulf of Mexico and passing the coast of Western Europe, transports about 1.4 petawatts (10^{15} W) of heat, equivalent to 100 times the world energy demand. As it travels north, the water gets colder and colder. But its warmth is still sufficient to have a mellowing effect on the climate of Northwestern Europe.

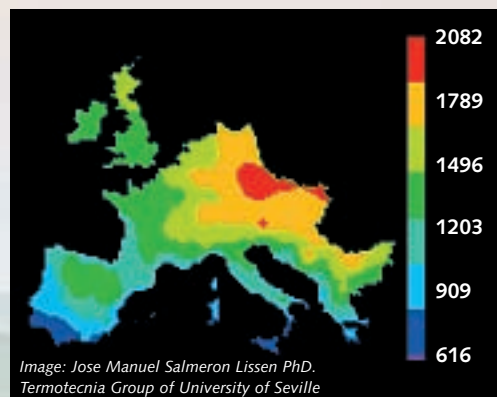
House building in every climate.

Efficient energy control in an ISOVER Multi-Comfort House can be adapted to every climate. Naturally, a passive house in Russia needs to fulfil other requirements than its South Italian counterpart. In cold continental climates, house builders and homeowners primarily agonize over the heating demand. But the passive house concept solves this problem. It offers a compact design together with a perfectly insulated and airtight building envelope. Active heating is thus reduced to a minimum. As it is generally hotter in the South, insulation must be good but not necessarily as thick as in the North. Also triple glazing is not required in most cases. Nevertheless, the house should be airtight and compact so as not to offer the sun large surfaces. Whether heating or cooling, the energy needed by a passive house can be reduced by proper design and passive components. The small rest can be covered by renewable energy sources. The ISOVER Multi-Comfort House offers its inhabitants a comfortable and healthy indoor climate **in every region** – low-cost and environmentally sustainable.

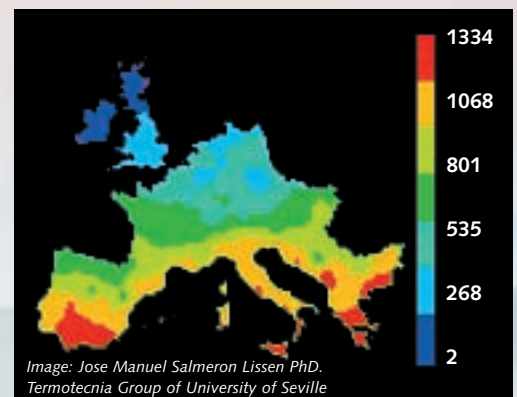
rug.

North and South – like day and night.

Basically, the European South is dominated by a hot, maritime climate, the North by a temperate to cold one. Even when neglecting the regional differences, passive houses differ a lot between Southern and Northern European countries. Up North, the heating demand is the most important concern for house builders. Down South, it's the need for cooling. There are also different landscapes with their prevailing natural energies that the houses need to be adapted to: windy, shady, close to a river or the sea. None of these factors are impedimental to passive house construction. But they need to be considered when designing an energy-efficient building.



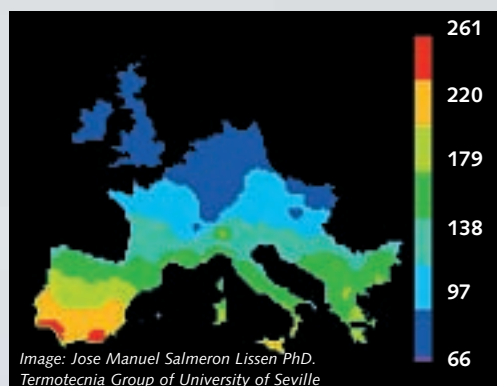
Winter degree days



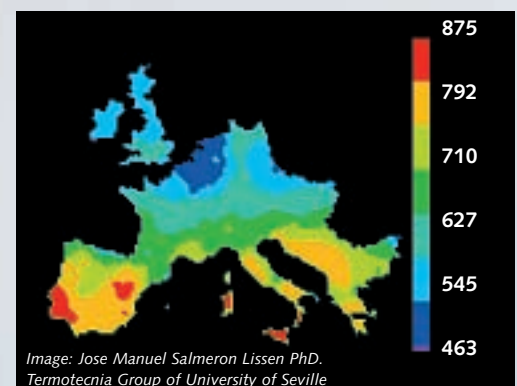
Summer degree days

Not to forget the sun.

It's not only air temperature that needs to be calculated when designing a house, but also solar radiation. Even if temperatures are fairly low, solar radiation is so high in some regions that houses can be easily heated without further energy. A desirable effect in some countries – too much of a good thing in others. Naturally, there is more solar radiation in Southern Europe than up in the North. That's why this aspect takes priority when designing coolness into Southern homes.



Solar radiation over horizontal surface
in winter (kW/m²)



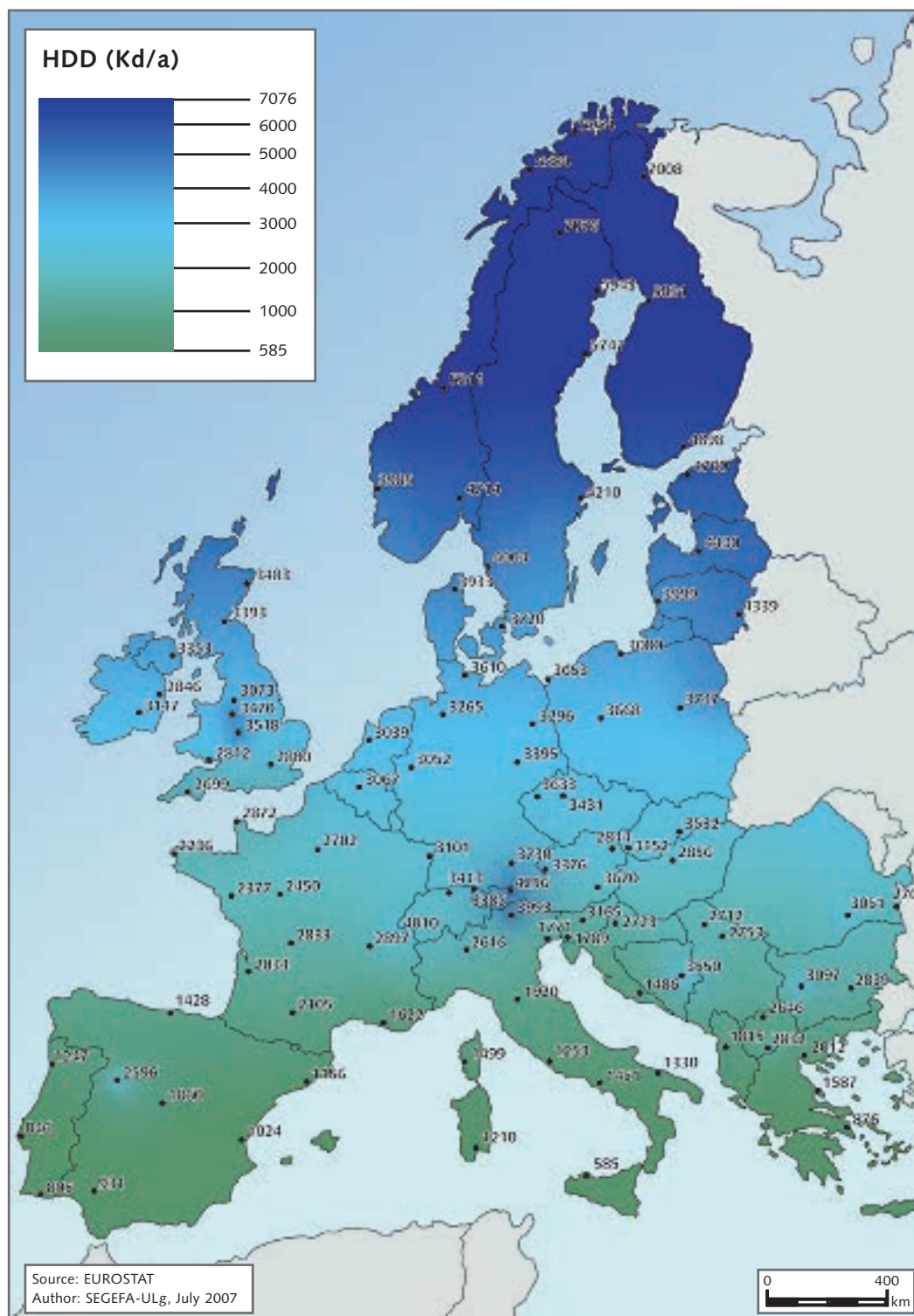
Solar radiation over horizontal surface
in summer (kW/m²)

Image: Jose Manuel Salmeron Lissen PhD. Termotecnia Group of University of Seville

The Climate.

European heating degree days

EUROSTAD method

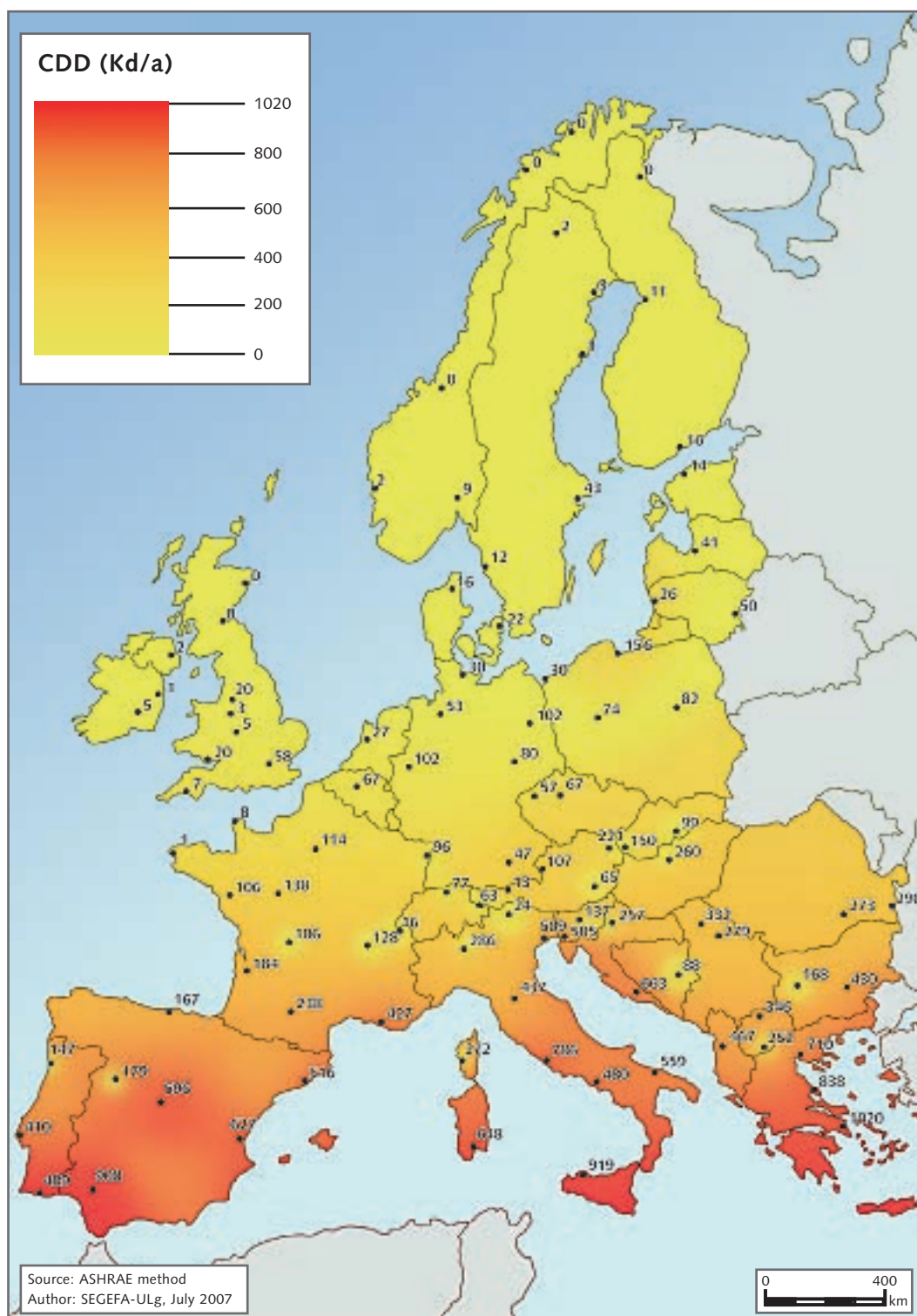


Due to the limited number of cities included in the map, regional details of heating degree days are not represented.

See also: "U-values for better energy performance of buildings", ECOFYS reports for EURIMA.

European cooling degree days

ASHRAE method

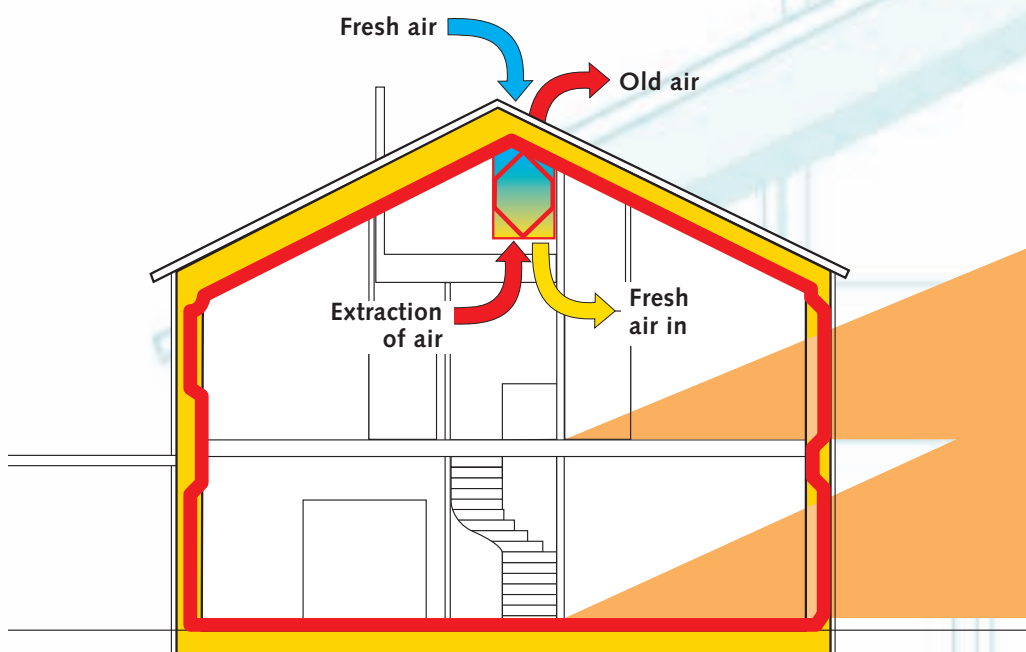


Due to the limited number of cities included in the map, regional details of cooling degree days are not represented.

See also: "U-values for better energy performance of buildings", ECOFYS reports for EURIMA.

Design principles.

Principles of a Passive House.



- Compact building design, favourable orientation
- Thermally insulated and airtight envelope
- Energy-efficient windows with outside shading
- Ventilation system with heat recovery
- Natural night ventilation

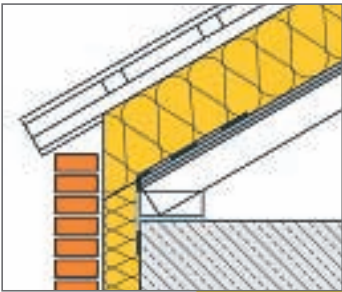
Design for Comfort.

Basic features of passive house construction in Mediterranean climates:

Good insulation and preferable orientation of the building:

All components of the exterior shell of the house are well insulated to achieve an average U-value of approx. 0.15-0.45 W/(m²K), depending on the local climate.

U-value 0.15-0.25 W/m²K



Airtightness of the building envelope

(Blower Door Test): Air change rate less than 1.0 per hour at a pressure difference of 50 Pa.



Airtightness

Southern orientation and shading:

Passive use of solar energy is one factor in passive house design. In summer, south-facing windows receive less solar radiation than those facing east or west. This is due to the fact that during summertime the midday sun is high in the sky whereas the morning and evening sun shines at a lower angle. Its rays can therefore penetrate deep into east- and west-facing windows, causing them to heat up.



U-value 1.0-1.5 W/m²K

Energy-efficient window glazing and frames:

The U-values of windows, depending on the local climate, should be between 1.0 to 1.5 W/(m²K) for the whole window (glazing and frames) with a solar heat-gain coefficient above 50 %.



Thermal bridge free construction: This is a precondition for passive houses and ensures that the building is not damaged by moisture condensation on the inner surface of the building envelope.

Largely reduced thermal bridges

Total heating and cooling demand:

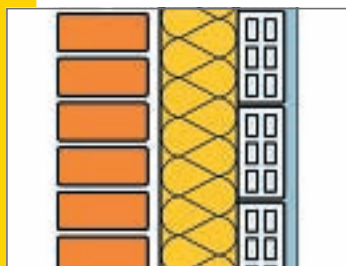
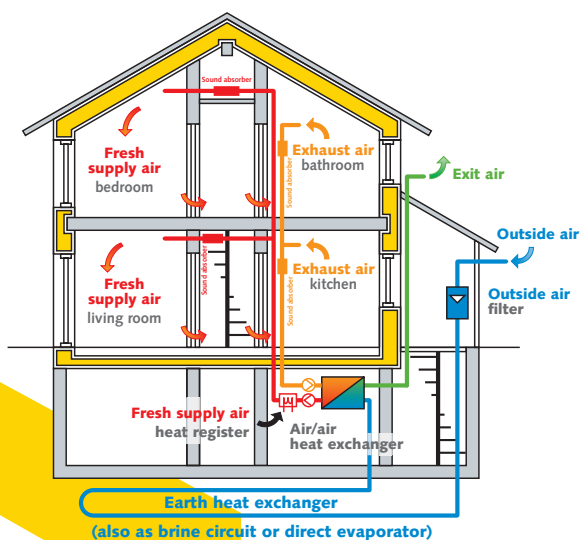
Max. 10	W/m² *	Heating load calculated according to the Passive House Planning Package
Max. 7	W/m² **	Cooling load calculated according to the Passive House Planning Package
Max. 15	kWh/(m²a)	Specific heating energy demand
Max. 15	kWh/(m²a)	Specific cooling energy demand
40-60	kWh/(m²a)	Specific total*** final energy demand
100-120	kWh/(m²a)	Specific total*** primary energy demand

Reference area (m²) is the temperature-controlled useful living space.

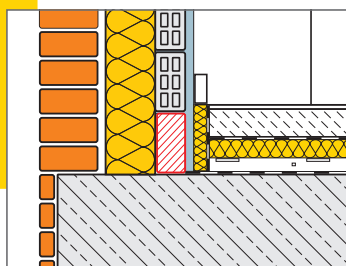
* If solar energy is used for hot water and space heating, the heat load can be even higher without negative effects on the environment. This allows more architectural freedom.

** This is only a guidance value. In practice, the cooling load depends on the local climate and the solution chosen in a specific case.

*** total = including all of the household's energy consumers (heating, cooling, hot water, ventilation, pumps, lighting, cooking and household appliances)



$U\text{-value } 0.20\text{-}0.45 \text{ W/m}^2\text{K}$



$U\text{-value } 0.35 \text{ W/m}^2\text{K}$

If the average temperature of the outside air is not below 15°C , an insulation to the ground is not so important.

Preheating and precooling of supplied air: Fresh air can be drawn into the house through underground ducts that exchange temperature with the soil. This preheats the air in winter and precools it in summer.

Efficient heat recovery from exhaust air using a counterflow heat exchanger: Most of the temperature or energy content in the exhaust air is transferred to the incoming fresh air and vice versa. Heat recovery rate: more than 80 %.

Warm water supply using regenerative energy sources: Solar collectors or heat pumps provide energy for domestic warm water. With some additional collectors it is possible to supply enough energy for a floor heating system.

How to define a "Passive House" in Mediterranean climates.

A passive house is a building in which a comfortable interior climate can be maintained without a dedicated heating system. The house is mostly heated by internal heat gains – hence "passive". The small heating demand that usually remains can be covered and distributed by the central ventilation system. The cooling is mostly achieved by natural night ventilation and in some climates for a certain period with a small air-conditioning system.

The precondition is an annual heating demand of less than $15 \text{ kWh}/(\text{m}^2\text{a})$ which must not be achieved at higher electricity costs. Where active cooling is unavoidable, the total cooling demand is also limited to $15 \text{ kWh}/(\text{m}^2\text{a})$. Furthermore, the combined primary energy consumption of a European passive house must not exceed $120 \text{ kWh}/(\text{m}^2\text{a})$ for heating, cooling, hot water and domestic appliances. A passive house is cost-effective when the combined investment and running costs do not exceed those of an average new home.

Point by point a profitable system.

- Heat-insulating roof structure
- Heat-insulating wall structures
- Heat-insulating floor structures (if necessary)
- No thermal bridges
- Airtight building envelope
- Double-glazed low-e windows
- Thermal-insulated window frames
- Outdoor shading for windows
- Central ventilation system
- Expert installation

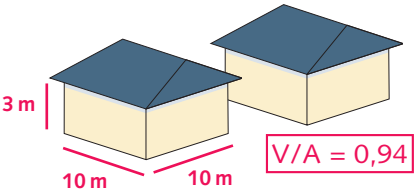
Compact design and orientation

Compact design is most favourable.

In order to keep the costs of building an ISOVER Multi-Comfort House as low as possible, we recommend choosing a simple, compact design. Every exposed

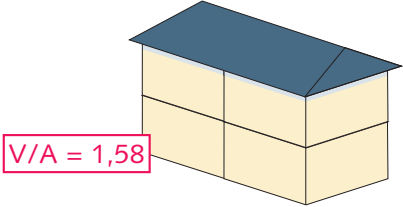
or projecting part of the building increases both energy demand and costs. As for the building's geometry, a favourable relation between envelope

and volume definitely helps. Less building envelope area reduces the energy loss and the cost of construction. Of course, this doesn't mean that your house should look like a cube. You are free to add attachments, but they have to be separately calculated and insulated. You don't need to restrain yourself just because you're building a passive house!



Detached houses are less compact.

2 x 100 m ²	
Treated floor area	200 m ²
Base slab	200 m ²
Roof	200 m ²
Outer wall	240 m ²
Envelope total	640 m ²



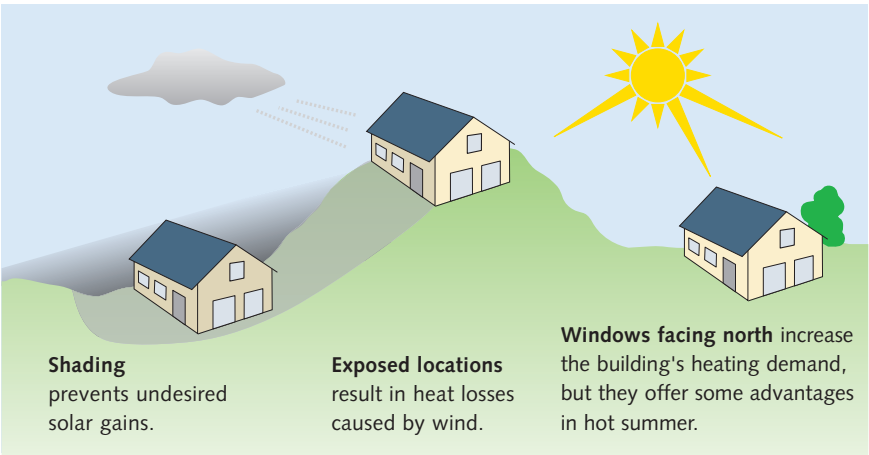
Attached houses have a better form factor.

4 x 100 m ²	
Treated floor area	400 m ²
Base slab	200 m ²
Roof	200 m ²
Outer wall	360 m ²
Envelope total	760 m ²

Recommendations: V/A (volume to surface area ratio) should be between 1-4; A/V (surface area to volume ratio) should be between 1-0.2.

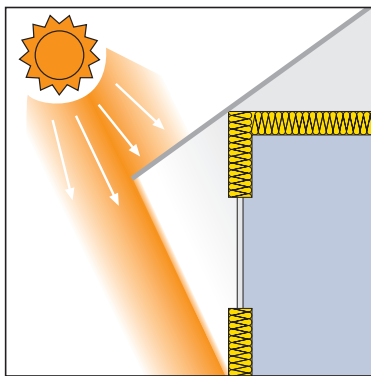
Plan with the sun.

Apart from shape, also location-related factors have an impact on the building's energy balance. If there's a choice, your ISOVER Multi-Comfort home should ideally face south. In cold regions, try to avoid the shade cast by mountains, trees or other buildings so that maximum solar gains can be achieved, especially in the cold winter months. Most of the windows should therefore face south. In hot countries, by contrast, you should benefit from any shade offered by trees or other buildings to keep unwanted direct sunshine out.

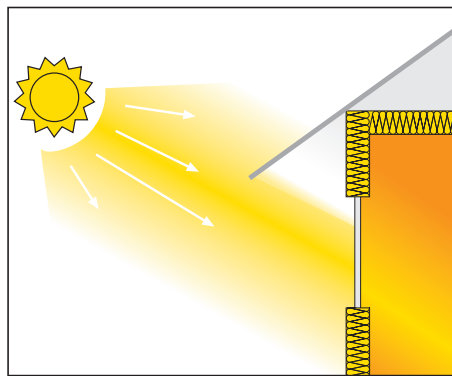


to the South.

Shading – the most natural way to cool.



Roof overhangs helps to keep the house cool in summer when the sun stands high.



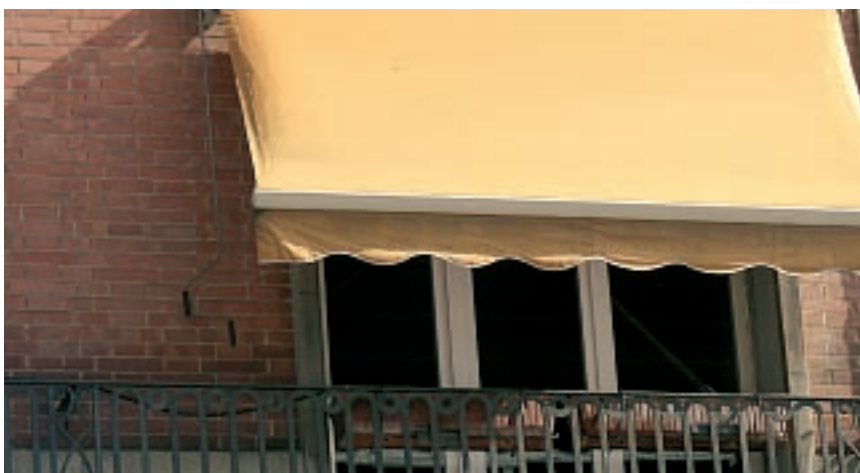
In winter when the sun stands low solar energy can enter the house.

Adequate and efficient – roof overhangs or balconies.

Wider roof overhangs or balconies above south-oriented windows keep the summer heat outside, but allow the low winter sun to enter the house in the cold season.

How to provide shade.

Shutters or Venetian blinds are the preferred method of shading rooms and controlling indoor climate in summer. The system can be opened in winter to take advantage of solar gains for heating. In addition, a variety of constructive shading devices can be fitted to suit the house owner's wishes. Trees in front of the windows or slight architectural modifications are measures to provide shading.



Arcades provide shades.

Another way to adapt the house to the climatic conditions is by architectural design. Arcades, for instance, are elegant transitions and provide shade.

Caressed and powered by

Free energy delivered to your home.

The sun's energy potential is virtually inexhaustible: it will be our most important energy supplier for the future. Day by day, the sun provides us with about eighty times the primary energy that is needed on earth. After deduction of the scattering loss to the atmosphere, an average of 1000 W per m² reach the earth's surface. This value is deemed to be the maximum possible irradiation on a cloudless day and at the same time serves as a base and reference value for all calculations.



Facade-integrated photovoltaic panels, Pettenbach, Upper Austria

Window, facade and roof as power plants of passive living.

The highest solar gains for a passive house can still be generated with roof-mounted solar collectors. But also photovoltaic facades and window surfaces can considerably contribute to the positive energy balance. Take for example passive house adequate Low-E double glazing. It allows solar radiation to enter the interior and take effect as passive heat gain in winter while at the same time limiting the heat loss.

The solar circuit in an ISOVER Multi-Comfort House starts on the roof. Solar collectors convert solar radiation into heat and transfer it to a carrier medium such as water, brine or air. Afterwards, the converted solar heat can be utilized for producing domestic hot water, but also for supporting the space heating.

Efficient all year round: the solar system.

A cost-optimized system can cover about 40-60 % of the entire low-temperature heat demand in an ISOVER Multi-Comfort House. What does that mean in terms of domestic hot water supply? In summer, more than 90 % of the required hot water can be produced with solar energy. In the winter months and transitional periods, the supplied energy is always sufficient to preheat the domestic water. When

To the point: Dimensioning of solar hot water systems.

Daily hot water demand (liters)	Storage capacity (liters)	Collector area*) Flat-plate collector SL (m²)	Collector area*) Flat-plate collector SS (m²)	Collector area*) Evacuated tube collector (m²)
100-200	300	6-8	5-6	4-5
200-300	500	8-11	6-8	5-6
300-500	800	12-15	9-12	7-8

*) Depending on deviation from south orientation, ideal roof pitch and climatic influences. SL: solar varnish coating, SS: selective absorber coating

the sun.



using modern appliances with warm water supply instead of conventional washing machines and dishwashers, the available solar energy can be exploited even more efficiently. When dimensioning your home's solar system, you should always proceed from an average water consumption of 50 litres (45°C) per person and day. The collector area required to cover this demand is normally between 1.2 m² and 1.5 m².

Following the principles of sustainable building, solar systems such as photovoltaic panels and solar panels should be included into passive houses. Photovoltaic panels can supply the electric energy that is needed for cooling air in hot summers. Solar panels also warm up swimming pools and

provide warm water for big central supply stations which can store temporary excess amounts of warm water. By choosing solar hot water systems take care of overheating resistance of all components. Warm water can also be produced by air-to-water heat pumps that also contributes to cooling of the flat in summertime. Cooling by warm water delivered from solar panels is technically feasible, but development of the necessary equipment is still at an early stage and not yet ready for production.

To the point:

Preconditions for a solar system to give its best.

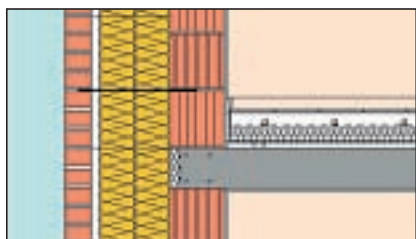
- *A good collector does not guarantee a good solar system.*
- *All system components must be of high quality and perfectly matched.*
- *The angle of inclination for collectors to produce maximum energy is 45° on an annual average.*
- *In summer (April to September), an angle of 25° is ideal. In winter, modules with an angle of up to 70° or 90° produce the highest yield.*
- *South orientation of the modules is always recommendable although deviations up to 20° do not significantly reduce the yield.*
- *If possible, the solar system should be free of shading.*



The most important: the envelope.

More than just a facade.

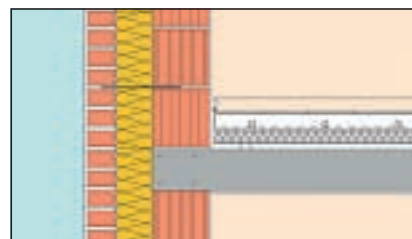
For economic reasons, the load-bearing masonry should be dimensioned to fulfil the necessary static requirements. But its thermal insulation should exceed the necessary minimum. Facades can be more than just the "visiting card" of your home. If properly insulated, they can save a lot of energy. On sun-oriented facades, photovoltaic elements can be installed – both as architectural elements and for supplying electrical energy.



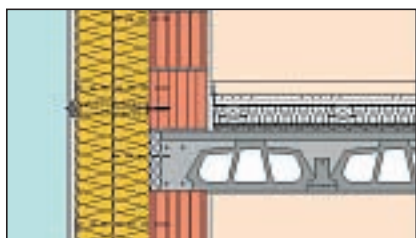
Double-leaf cavity wall with ventilation area

- **Cavity walls**

They assure good separation of the functions load bearing, thermal insulation and water protection. The use of hydrophobic core insulation made of glass wool provides durable, reliable as well as economical protection of the building.



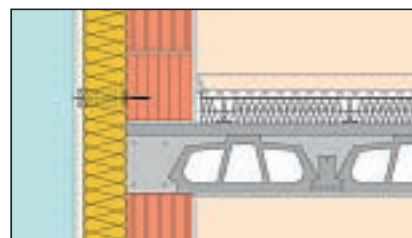
Double-leaf cavity wall non-ventilated



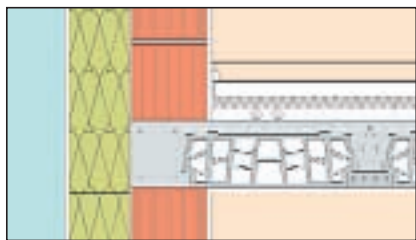
Ventilated outer wall with reinforced cement facade cladding

- **Ventilated facades**

Thanks to their high diffusibility, they support the rapid drying of damp walls.



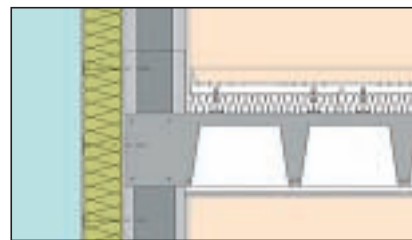
Ventilated outer wall with reinforced cement facade cladding



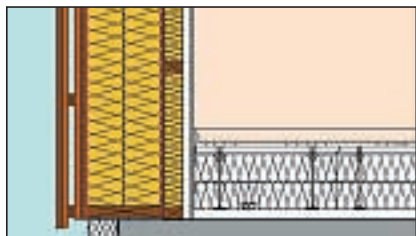
External thermal insulation compound system with ISOVER stone wool lamella facade boards

- **External thermal insulation composite systems (ETICS)**

The advantages of jointless facade insulation systems based on mineral wool boards are above all non-combustibility and sound protection.



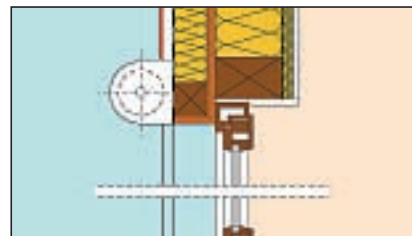
External thermal insulation compound system with ISOVER stone wool facade walls



Timber framework wall with timber I-section beams

- **Timber construction**

The great advantage of a timber construction is that a major part of the insulation can be fitted between the wooden frames and needs not be added from outside.



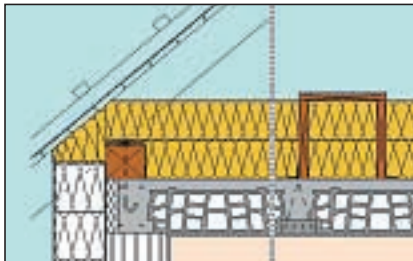
Timber framework wall with window and outside shading facility

mal insulation of

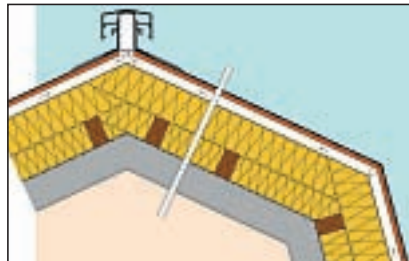


Each structural component has a crucial effect.

Whether roof, external wall or basement ceiling – thermal quality of the individual components always is the most sustainable way to avoid energy losses. All opaque elements of the building envelope should be adequately insulated. Depending on the climatic conditions, an average U-value of $0.20 \text{ W}/(\text{m}^2 \cdot \text{K})$ is normally required.



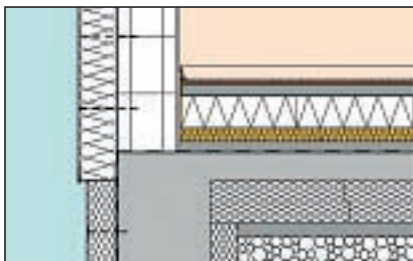
Insulation on top floor ceiling



Flat, "coffin-type" roof structure (sarking)



Collar beam insulation

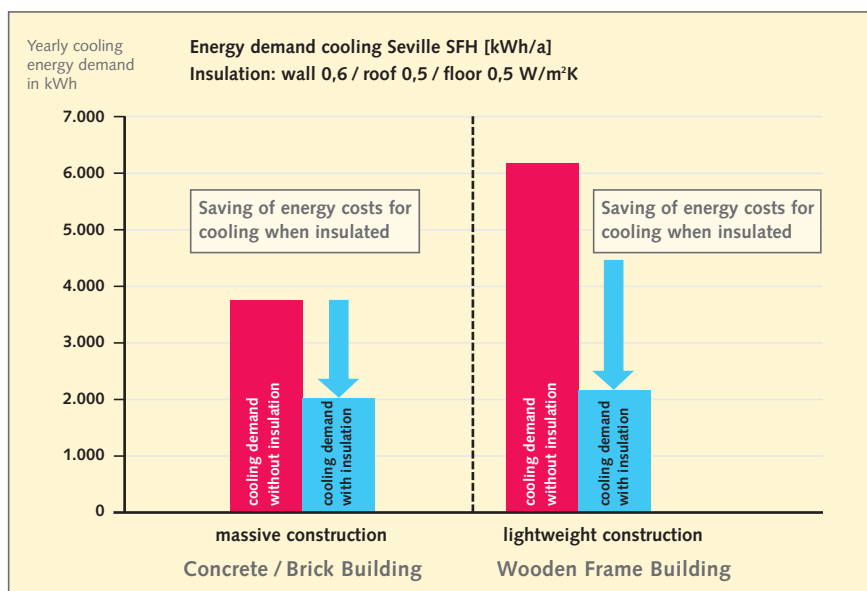


Slab-to-the ground insulation only in cold climates.

In warm locations with mean annual temperatures between 15 and 20°C , it doesn't make sense to insulate the floor slab or the ceiling to the basement. The moderate temperature of the ground can be used to cool the building during hot summer spells. The heat loss in winter is so small that it can be compensated by improved insulation of the above-ground components.

The Multi-Comfort House a gain for

Whether massive, wood or mixed construction – a passive house lends itself to any building style. Provided the individual components have been carefully installed without thermal bridges, a closed system results with attractive inner values. Thanks to high-quality insulation, the building envelope offers protection from cold, heat and noise. The residents enjoy greatest possible comfort – above all due to the small difference between indoor air and inner surface temperatures of the building envelope in both winter and summer months.



See also: "U-values for better energy performance of buildings", ECOFYS reports for EURIMA.

One-time perfect insulation – all-time pleasant temperature.

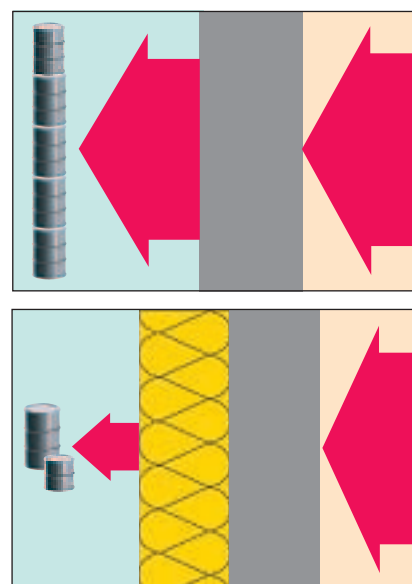
Insulation materials such as ISOVER mineral wool produce particularly good results. Just compare: To achieve the insulating effect of 1.5-2 cm insulation material, about 30 cm solid brick or 105 cm concrete would be required. Considering today's recommended insulation thickness of 10 cm or more, the impact on the statics of the building would be too high – let alone the costs.

Another important aspect is the excellent eco balance you can achieve with ISOVER mineral wool: less conditioning energy, lower CO₂ emissions and a longer service life. This ensures benefits – both for the individual and the community.

Good insulation helps you save a lot of money.

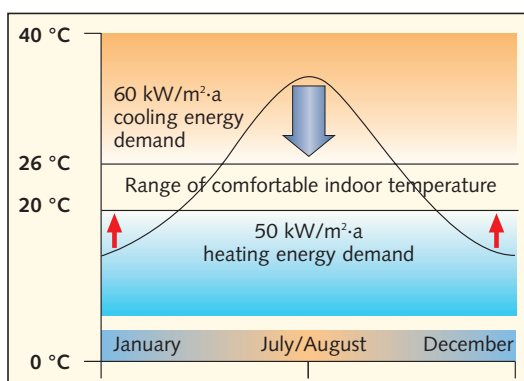
Thermal insulation keeps the heat outside and saves energy for cooling

The example of Seville shows: the better insulated the buildings, the higher the cooling energy savings. In a well-insulated building it makes nearly no difference for the amount of cooling energy needed whether it was built in massive or lightweight construction.

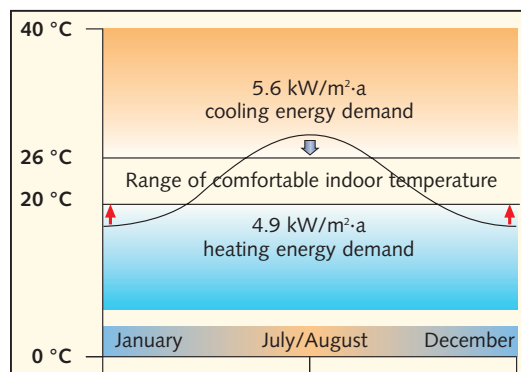


every building style.

Keep heat outside in summer and warmth inside in winter.



Example: Conventional house in Seville



Example: Passive house in Seville

Summer. With compact airtight constructions, outdoor shading and a ventilation system adapted to passive house standard, a pleasantly cool atmosphere can be enjoyed inside even at extremely high outdoor temperatures. To protect the residents from sweating in summer, preventive measures need to be taken:

- Provide shading for east-, south- and west-facing windows
- Construct roof overhangs or balconies to sunscreen south-facing windows
- Ensure efficient ventilation and just the necessary cooling

Winter. Only when high-quality insulation materials have been installed can the passive use of solar energy produce the desired effect: keep the solar gains inside the house. If the windows comply with the passive house standard, they can contribute to the positive eco balance: they give off more heat to the inside than to the outside during winter-time. Thanks to excellent glazing, appropriate window frames and thermal bridge free installation, solar gains in winter can largely compensate the transmission losses through the windows.

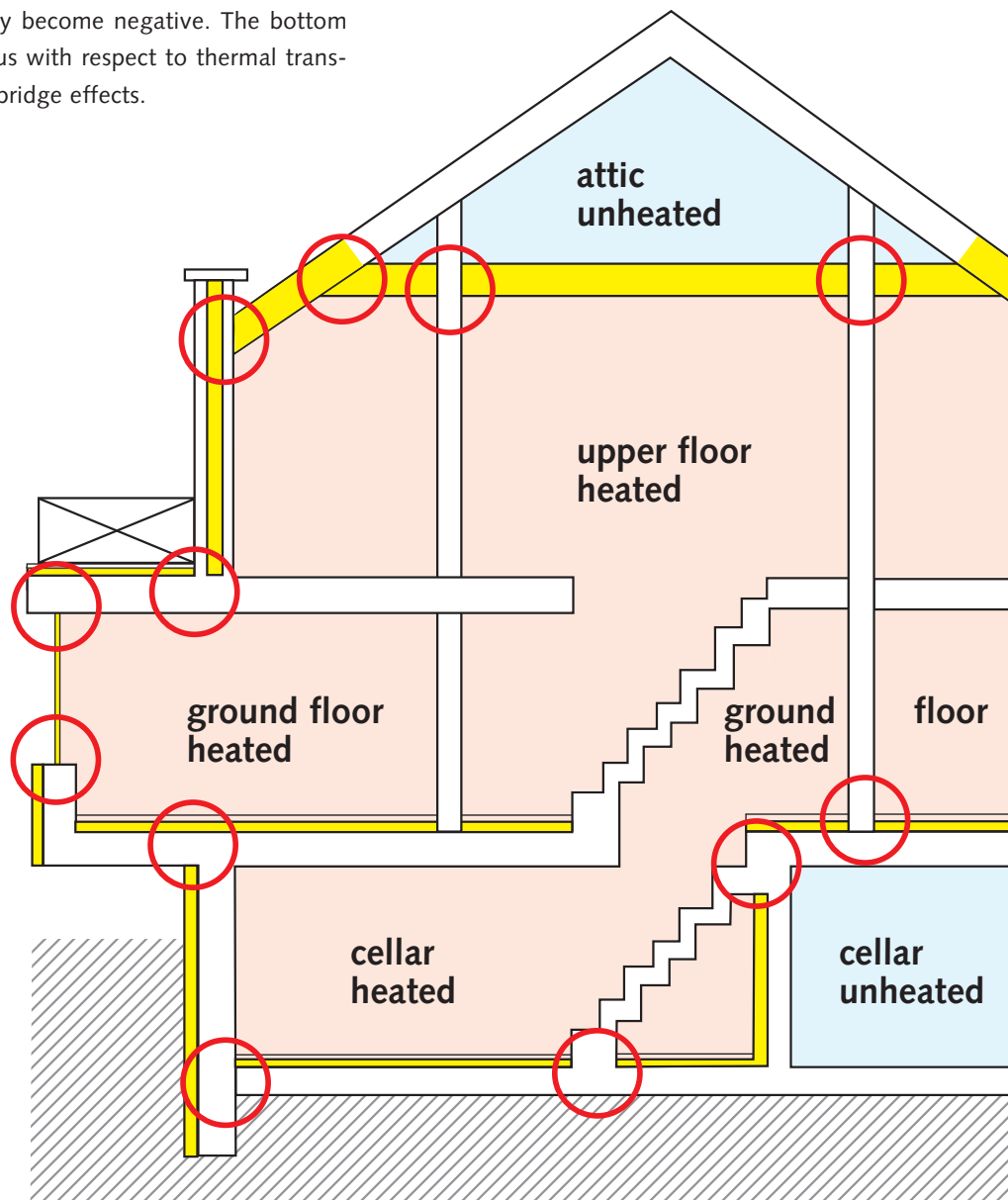
To the point.

The realization of ISOVER Multi-Comfort Houses in Mediterranean climates.

- *Appropriate thermal insulation:* average U-value of the envelope less than $0.2 \text{ W}/(\text{m}^2\text{K})$. Exceptions possible following detailed calculations. More insulation is required in more extreme (hot or cold) climates and for small, detached houses (lack of compactness).
- Avoid thermal bridges.
- Excellent airtightness proven by the Blower Door Test. Air change (n_{50}) at 50 Pa pressure difference less than 1.0 1/h acc. to EN 13829.
- Glazing with U-values from 1.0-1.5 $\text{W}/(\text{m}^2\text{K})$, combined with a total energy transmittance ($g \geq 0.5$ acc. to EN 410) so that net heat gains can also be achieved in winter.
- Windows with average area weighted U-value 1.0-1.5 $\text{W}/(\text{m}^2\text{K})$.
- Efficient ventilation (heat recovery at least 80 % acc. to Passive House Institute Certificate combined with low specific electricity consumption of the fans).
- In very hot regions, additional active cooling might be necessary to ensure pleasant indoor climates also during the hottest days.
- Very low heat losses in the generation and distribution of domestic hot water.
- Use energy-efficient household appliances.

Compensation effect of thermal bridges.

There is no doubt that thermal bridge effects must be avoided as much as possible. In this respect, passive houses also benefit from the high thermal efficiency of the building envelope with perfect insulation. Due to the building's external dimensions, linear heat transfer coefficients may become negative. The bottom line for the passive house: a mathematical bonus with respect to thermal transmission effects that compensate minor thermal bridge effects.

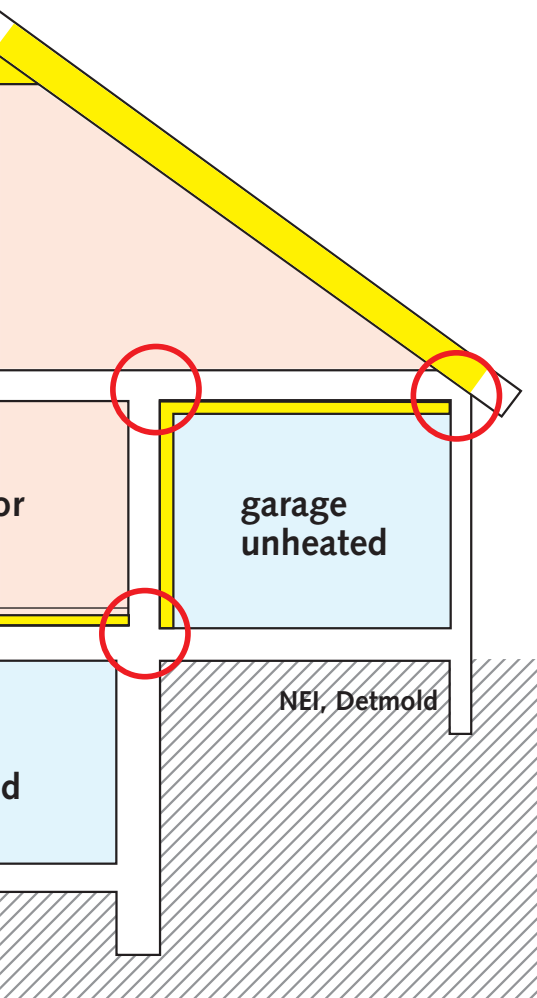


Source: *Niedrig-Energie-Institut (Low Energy Institute), Detmold, Germany*

geometrical

Critical points: interruptions of the insulated envelope.

A reliable method for detecting thermal bridges is to graphically capture the building. When studying floor plans, sectional drawings and detailed drawings, it becomes visible whether the exterior insulation shows any interruptions. First, mark the actual position of the installed insulation layers yellow. Afterwards, check in which places the yellow line running around the building is interrupted. These are the weak points where potential thermal bridges occur. Next, carefully consider if they are structurally avoidable. If not, find solutions so that they are minimized at least.



To the point: Geometrical and structural thermal bridges.

- Geometrical thermal bridges are negligible as long as the exterior insulation is sufficiently dimensioned and continuous.
- Structural thermal bridges must be avoided or at least be minimized.

This applies in particular to:

- Thermal bridges on floor slabs and cellar floors
- Thermal bridges on stairs
- Thermal bridges on the upper edges of walls in the roof area
- Thermal bridges on cold-warm wall breakthroughs
- Thermal bridges on balconies, landings, projecting building components

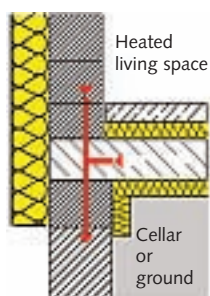
- Thermal bridges on windows and roller shutter boxes
- Thermal bridges that repeatedly occur within a building component (rafters, lathwork, anchoring elements etc.) must be considered with respect to the U-value of the building component concerned. These structural details are referred to as inhomogeneous building components. Apart from causing high thermal loss, they can also result in structural damage. However: inhomogeneities in a brick wall behind a continuous insulation layer (e.g. a ceiling support) can be neglected if the insulation has been sufficiently dimensioned.

Design Principles.

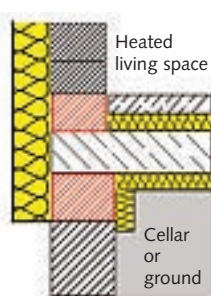
The comparison shows: There is always a good or even excellent solution to avoid thermal bridges.

Thermal bridges between cellar floors resp. base slabs with strip footing and external walls

With a single-leaf external wall and a cellar floor or sole plate insulated on its upper or under side

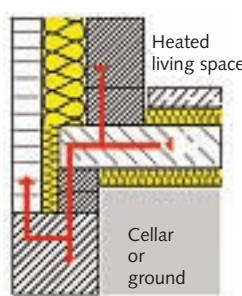


Insufficient if support of ceiling on cellar outer wall resp. strip footing and the support of warm internal wall ground floor has been installed without thermal separation using a material with $\lambda > \text{approx. } 0.12 \text{ W/mK}$.

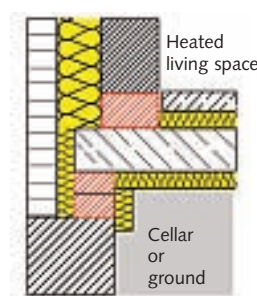


Good if both supports have been produced from a material with $\lambda < \text{approx. } 0.12 \text{ W/mK}$.

With an external cavity wall and a cellar floor or slab to the ground insulated both on its upper and under side

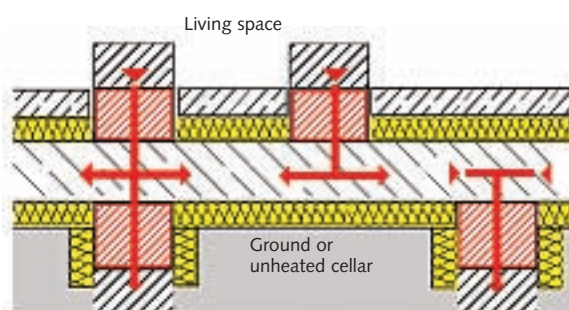
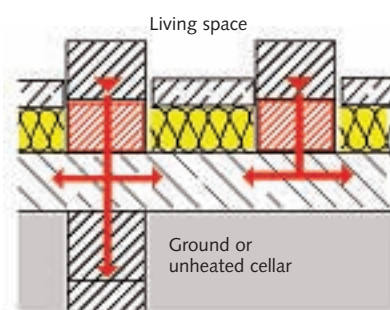


Insufficient if support of ceiling on cellar outer wall resp. strip footing and the support of warm internal wall ground floor has been installed without thermal separation using a material with $\lambda > \text{approx. } 0.12 \text{ W/mK}$.



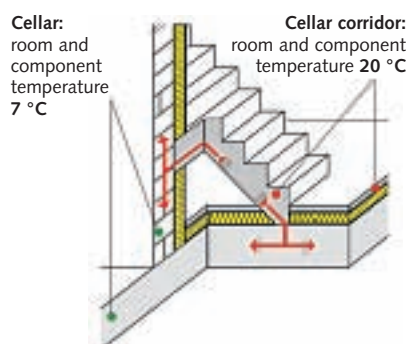
Good if both supports have been produced from a material with $\lambda < \text{approx. } 0.12 \text{ W/mK}$.

Thermal bridges between cellar floors or base slab and internal walls

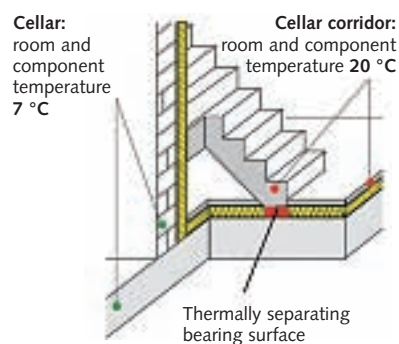


Here, the same applies as shown above for the external walls.

Thermal bridges between stair flights and thermally separating walls or base slab



Insufficient: Thermal bridges between the bearing surface of the "warm" stair flight and the "cold" base slab (cold because of its upper side insulation) and between the "warm" lateral flank of the stairs and the "cold" cellar wall (cold because of its room-facing insulation).

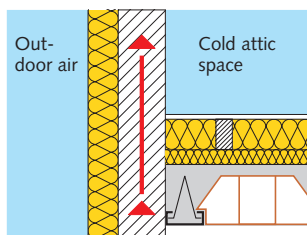


Good: Thermal separation between the bearing surface of the "warm" stair flight and the "cold" base slab by using a foundation stone of low thermal conductivity and by installing continuous insulation to ensure complete separation of the stair flight from the cellar wall.

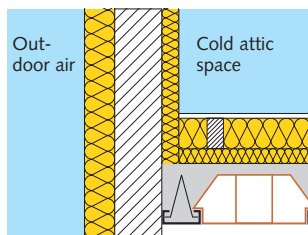
Source: Niedrig-Energie-Institut (Low Energy Institute), Detmold, Germany

Thermal bridges on vertical cold-warm wall breakthroughs

External walls

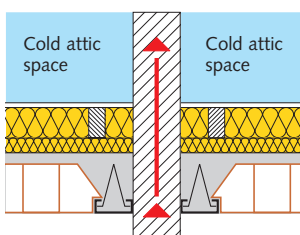


Insufficient: Thermal bridge caused by the external wall passing from a warm to a cold area with brickwork of $\lambda > 0.12 \text{ W/mK}$.

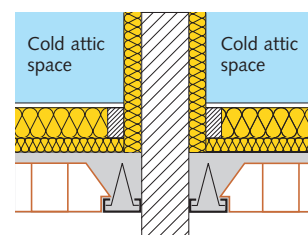


Good: Either interruption of a vertical wall with high thermal conductivity at the same height as the insulation level of the penetrating ceiling by installing a thermal separation layer using a material with $\lambda < 0.12 \text{ W/mK}$ (aerated concrete, foam glass, PUR etc.) or flank insulation to a height of approx. 60 cm on the inside of the external wall in the cock loft.

Internal walls

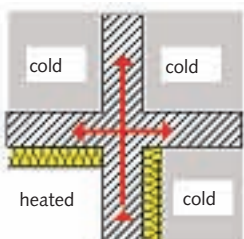


Insufficient: Thermal bridge caused by the external wall passing from a warm to a cold area for brickwork with $\lambda > 0.12 \text{ W/mK}$.

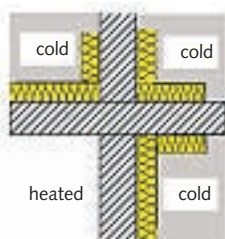


Good: Either interruption of a well heat-conducting vertical wall at the same height as the insulation level of the penetrating ceiling by installing a thermal separation layer using a material with $\lambda < 0.12 \text{ W/mK}$ (aerated concrete, foam glass, PUR etc.) or flank insulation to a height of approx. 60 cm on the inside of the external wall in the cock loft.

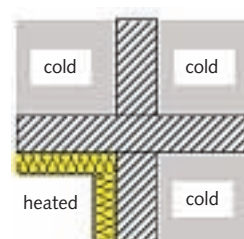
Thermal bridges on horizontal cold-warm wall breakthroughs



Unsatisfactory: The walls have been insulated partly on the warm and partly on the cold side. However, individual wall junctions pass right through.

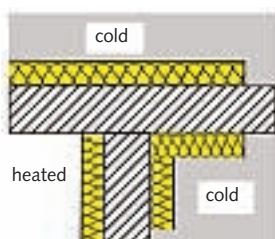


Satisfactory: All walls have been insulated on the cold side. Additionally, sufficient flank insulation has been installed on all wall junctions facing the cold side.

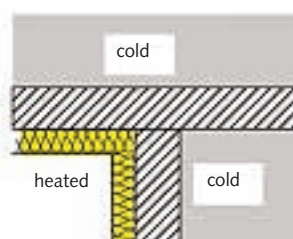


Excellent: The insulation layers interconnect without any interruption.

Thermal bridges on horizontal cold-warm wall junctions

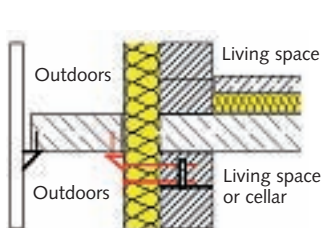


Satisfactory: Both walls have been insulated on different sides. In addition, sufficient flank insulation has been installed on the wall junction.

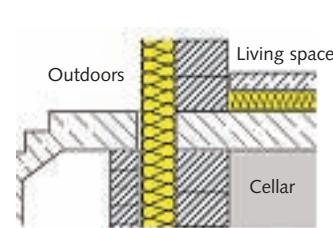


Excellent: Both walls have been insulated on the inside and the insulated areas directly adjoin each other.

Possible solutions to thermal bridging on balconies, landings and overhanging ceilings



Good: Only point support of balcony or landing slabs on small steel brackets and additional support by free-standing columns in front of the house. If the cross sections of the metal penetrating the thermal envelope are small, there will only be few thermal bridges.

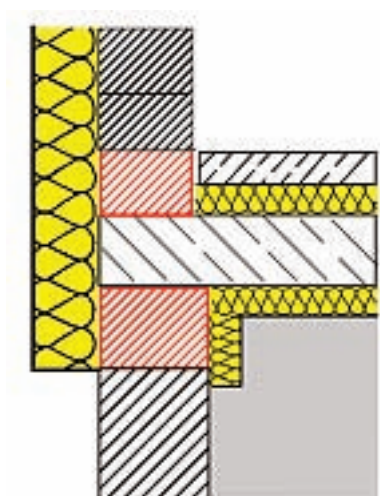


Excellent: Completely separated construction with a separate support of the landing (see picture) or of the balcony. This is a truly thermal bridge free solution.

The devil's in the detail: flaws in walls,

Junctions are the weakest spots.

Penetrations of the building envelope by utility pipes, windows and doors are unavoidable. For this reason, thermal bridges cannot be totally prevented. But it is indispensable to reduce these energy wasters to a minimum. For: The better the thermal insulation of the building, the stronger the impact of a structural weak point on the total energy loss.



For more security: decouple the foundation.

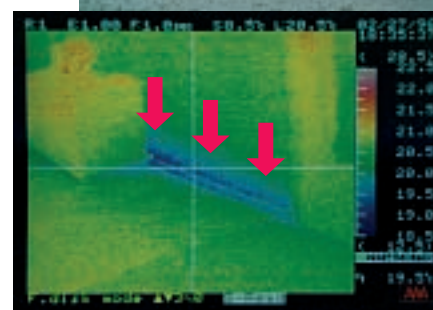
To prevent that heat is transmitted via the foundation or the wall, the foundation should be decoupled from the bottom slab. Even if the overlying insulation layer takes care of thermal insulation, greatest possible security can only be achieved by thermal separation.

Critical area: where the outer wall meets the cellar.

Especially with solidly built houses thermal energy must be prevented from escaping through the brickwork or into the ground via concrete elements of high thermal conductivity. Quite frequently, the cellar floor is insulated but the insulation layer interrupted in the area of the outer wall or of the foundations. This problem can be remedied by sufficient wall base insulation and should already be considered in the planning stage.

Likewise: partition wall meets insulated floor.

Where solid partition walls meet floors with room-side insulation, thermal separation by means of low heat-conducting building materials is necessary. The negative example on the right proves: seemingly, the job was executed with reasonable care and skill, but thermographic imaging clearly shows the thermal bridge. But the weak spot can be eliminated by additionally insulating the flanking building components.



*Typical weak spot because a well heat-conducting inner wall of the ground floor rises directly from the cellar floor.
(Source: Niedrig Energie Institut Germany)*

ceilings and basements.

Cavities, insulation gaps and joints.

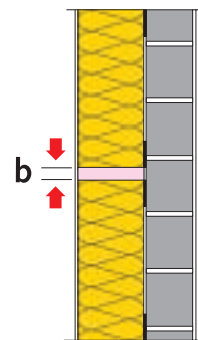
A closed, not too big cavity has only little energetic impact. By contrast, gaps and joints in the thermal insulation of a house cause considerable loss of cooling and heating.

No need to worry about closed cavities.

Closed cavities located in the insulation layer are always airtight although they are not insulated. With cavities below 5 mm width, this lack of insulation does not cause any problems. As long as the cavities are non-communicating, no remedial measures need to be taken. However, cavities above 5 mm width are critical. Their thermal bridge effect is so strong that they should be filled with mineral wool. But don't use mortar as this would even reinforce the negative effect. Avoid communicating cavities: they can render an insulating layer nearly ineffective.

Insulation gaps ruin the energy balance.

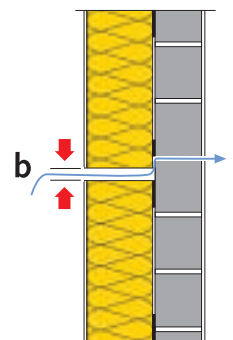
As gaps in the insulation are closed on only one side, they allow air flows on the other. This results in considerable loss of cooling and heating energy. A gap of 10 mm can thus reduce the insulating effect of a 300 mm composite thermal insulation system down to that of an insulation layer of just 90 mm thickness.



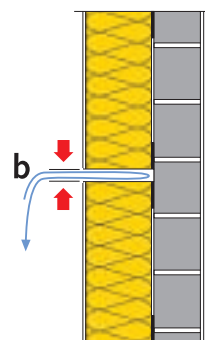
Cavities are airtight, but insulation is missing.

Joints are fatal.

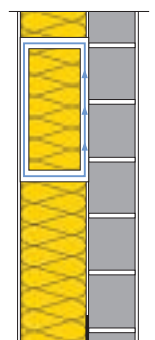
Joints which are open on both sides have only little flow resistance. In a system that is otherwise completely closed, the loss of cooling/heating energy multiplies many times over. It is therefore absolutely necessary to locate and completely eliminate them. Otherwise, the building will be draughty and prone to structural damage.



This joint is open on both sides and makes the house leaky.



Insulation gaps are open on one side.



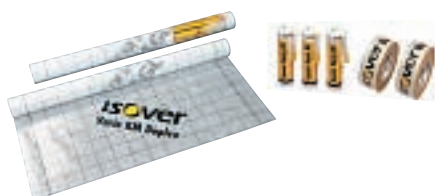
Communicating cavities considerably increase convection and can thus render the insulation nearly ineffective.

Airtightness in detail.

Dampproof and airtight down to the very last corner: ISOVER VARIO.

A system that adapts to all seasons.

Summer or winter – seasonal changes do not play a role for ISOVER VARIO. This innovative system for wood-frame constructions quite flexibly adapts to different climatic conditions. In winter, ISOVER VARIO blocks the moisture diffusing inwards. In summer, the membrane allows the moisture to escape from the structure to the inside. In this way, damp structural components can dry out more easily in summer months. Unavoidable with all lightweight constructions: the sore spots where membranes meet, joints form, pipes and other installations penetrate the building envelope. Every leak in the highly insulated areas will result in energy losses and substantial ingress of moisture. With very costly consequences. But all this can easily be prevented. With just a little effort – and the climatic membrane system ISOVER VARIO.



A perfect bond: climatic membrane, sealant and adhesive.

ISOVER VARIO system packages leave no gap or wish un(ful)filled. Besides high-performance protection against air and moisture, they offer good workability. Other benefits for the user include high quality, easy cutting to size and rapid bonding. This saves time, effort and money, and ensures long-term security. No matter whether you choose standard VARIO KM quality or premium VARIO KM Duplex with increased tear resistance.

To the point.

ISOVER VARIO KM

- Unique climatic membrane with variable resistance to diffusion
- Adapts to all seasons
- Vapour barrier function against ingress of moisture in roofs and walls
- Drying function that allows excess moisture to escape
- Proper installation ensures airtightness at passive house level
- Greatly improves the living comfort
- Rapid workability
- Variable sd-value of 0.2 to 5 m

ISOVER VARIO KM Duplex

- Further development of VARIO KM
- Extremely high tear resistance
- Improved protective function
- Practical line marking for easy cutting to size and fewer offcuts
- Easy installation without need for sagging
- Faster fixing thanks to a marked joint/overlap line
- Variable sd-value of 0.3 to 5 m

One example says more than 1000 words.

An important security factor is the quality of the bond. An airtight bond between two strips of a sealing membrane cannot be produced by riveting. The seam area must therefore be sealed with a suitable adhesive tape.

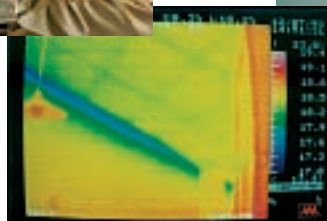


Carefully tape overlapping areas.

Source: Niedrig Energie Institut (Low-Energy Institute), Germany



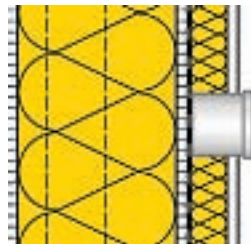
The lack of airtightness between ceiling and wall results in clearly visible heat losses.



Only knowledge of trouble sources can help avoid them.



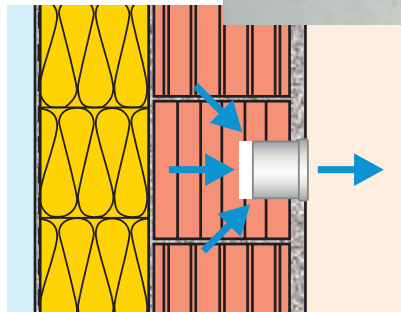
When penetrating the airtight layer, make sure to provide a leak-tight seal of the connections.



A sufficiently deep installation level helps prevent damage to the vapour barrier and airtight layer.

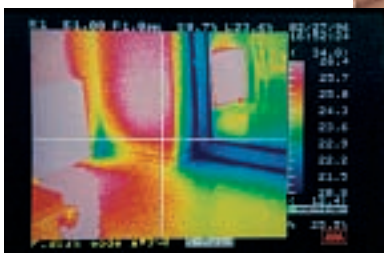


Sockets embedded deeply into a plaster bed prevent air flows in solidly built houses.



No matter whether solid or lightweight construction – wherever the airtight layer is penetrated by pipes, electric cables or sockets, thermal energy loss and water damage will result unless the penetrations have been expertly sealed.

Thermographic imaging is able to detect unwanted air flows caused by cellar doors and windows.

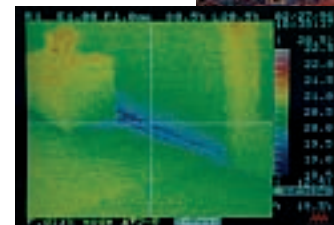


Source: Niedrig Energie Institut (Low-Energy Institute), Germany

To the point.

Typical leaks in the airtight barrier:

- Interface external wall and foundation slab
- Interconnection of the external walls, e.g. element butts and corner joints
- Interface external wall and mezzanine floor
- Interface external wall and roof wall
- Cables and pipes penetrating the airtight barrier
- Windows and doors interrupting the airtight barrier
- Sockets
- Unplastered masonry also behind wall-mounted fittings
- Poorly adjusted house doors and windows
- Service openings for roller blinds
- Damage to the airtight barrier during the construction phase



Untight mortar joints are responsible for leaks in the area where the floor meets the wall.

Keeps airtight, cool and w the building

Seamlessly tight and insulated.

What is the recommended design of a continuous building envelope? In regions with cold winters, the airtight layer – which at the same time serves as a vapour barrier – is always installed on the warm side of the insulation layer. Leaky spots in the building envelope such as joints have extremely unpleasant consequences:

- increased heat losses
- uncontrolled air exchange
- poor sound insulation
- danger of structural damage caused by condensate, mould or corrosion.

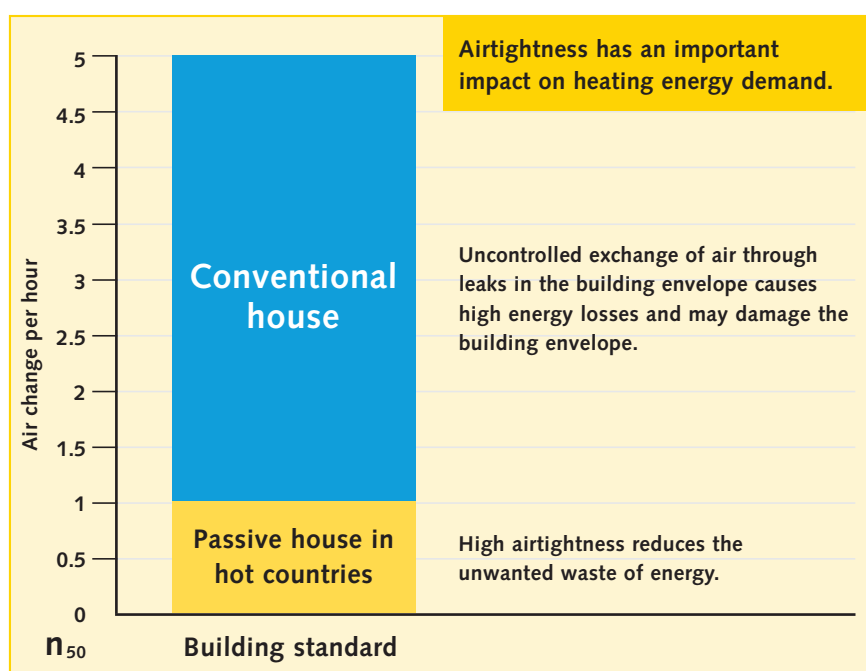
This is where the building styles differ.

Whether solid, lightweight or wood construction – the selected building style requires different concepts for the planning and execution of the airtight barrier. It is therefore imperative to work out a detailed overall concept of airtightness, including all connections between structural components, wall junctions and penetrations. For timber constructions, a separate installation layer on the room-facing side of the vapour barrier is recommended.

Good to know before starting work.

Nothing is more important for a passive house than the careful execution of its building envelope. For this reason, the selected materials must be installed under optimal conditions:

- Joints must only be sealed in dry weather.
- Substrate and joint flanks must be dry and free of dust.
- All junctions between adhesive tapes and porous materials must be pre-treated with a primer.
- Joint sealing tapes must also be able to prevent the ingress of moisture.
- Larger expansion joints can be sealed with VARIO KM FS (mineral wool joint tape).



The earlier the better: checking the airtightness.

The airtightness check is an essential constituent of the quality certificate for the ISOVER Multi-Comfort House. It is absolutely necessary to carry out this test before completion of the inner surface of the building envelope so that any faulty workmanship can be detected early enough and remedied at relatively low cost.

The Blower Door Test is used to detect leaks in the building envelope. The small-

arm: envelope.



er the measured value, the higher the airtightness. Passive houses in hot countries require a value ≤ 1.0 . This means: during the measurement, at most 100 % of the indoor air volume is allowed to escape through leaky spots within one hour. Experience has shown that values between 0.3 and 0.4 are attainable.

To the point.

These are the requirements to be met by the materials:

- Airtight surface materials, e.g. membranes, roofing felts, panels, plasters
- Carefully matched and compatible materials, especially sealing membranes and adhesives
- Moisture-, UV- and tear-resistant materials
- Vapour diffusion resistant materials (act as vapour barriers): in regions with cold winters, the airtight barrier is always installed on the warm side of the structure, i.e. facing the interior.

The ISOVER Multi-Comfort House leaves nothing to chance.

Only a controlled exchange of air makes sense. Otherwise, there will be temperature fluctuations, energy loss, draught, moisture, superheating and the like. The continuous airtight shell, which envelopes the passive house from its roof down to the cellar floor, protects it against these undesired effects and allows energy-efficient and comfortable living. No need to be afraid of suffocating: well-insulated walls do not breathe more or less than conventionally built walls. Moreover, the Comfort Ventilation System constantly supplies with fresh air of best quality. If you like, open the windows.

In summer, window ventilation is a suitable way to keep a well-insulated house cool.



The nose of a passive house: air duct for fresh air supply.

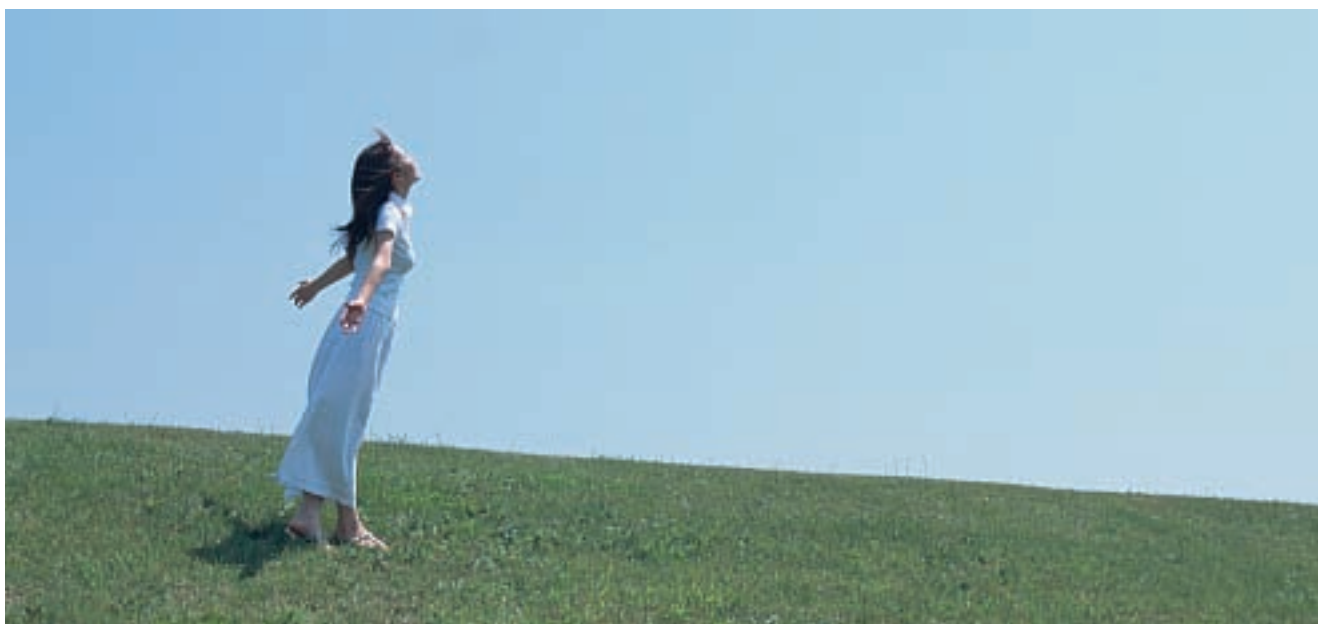
Breathing is done by the Comfort Ventilation System.

Controlled ventilation instead of an uncontrolled exchange of air. The Comfort Ventilation System caters to this need. Operated by solar energy and equipped with a heat pump and an air-to-air heat exchanger, it provides permanently fresh air in all rooms. At the same time, it controls the distribution and also recovery of coolness or heat in the whole house. And if you like, it cools you in summer with a lovely soft breeze.



Comfort Ventilation Systems with integrated heating and hot water supply are available today as compact units that hardly need more space than a fridge. (Ing. Lang Consulting)

Draught-free supply of



Healthy living – like in a health resort.

Improved indoor air quality.

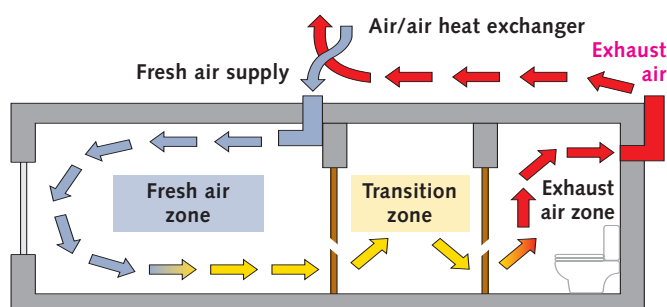
Air is one of our most vital commodities, but modern man increasingly consumes it behind closed doors. Usually, indoor air quality is worse than outside the door. Above all, it contains too much humidity and is contaminated by pollutants, smells and the like. Remedy: a steady exchange of air that fulfils the hygiene requirements for indoor air. Unfortunately, the air change rate cannot be dosed exactly by means of natural window ventilation. It strongly differs – depending on outdoor temperature, wind direction and individual airing habits. And just as bad: no possibility for heat or coolness recovery. Forced ventilation systems, by contrast, ensure a constant air change rate, recover the heat/coolness from the exhaust air and take care of its distribution.

The Comfort Ventilation System controls heating and ventilation in one breath.

The ISOVER Multi-Comfort House doesn't need a boiler room. A compact ventilation unit the size of a fridge is totally sufficient to supply all rooms with fresh air and cool or heat while at

the same time removing the consumed air. How does it work? The central unit comprises a heat exchanger, fans, filters, air cooler, air pre-heater and air humidifier or dryer. Stale air from kitchen, bathroom and WC is removed via the exhaust air system. Before being routed outdoors, the heat exchanger adapts the incoming fresh air to near room temperature. Today, heat recovery rates of up to 90 % are possible.

Simplified ventilation system



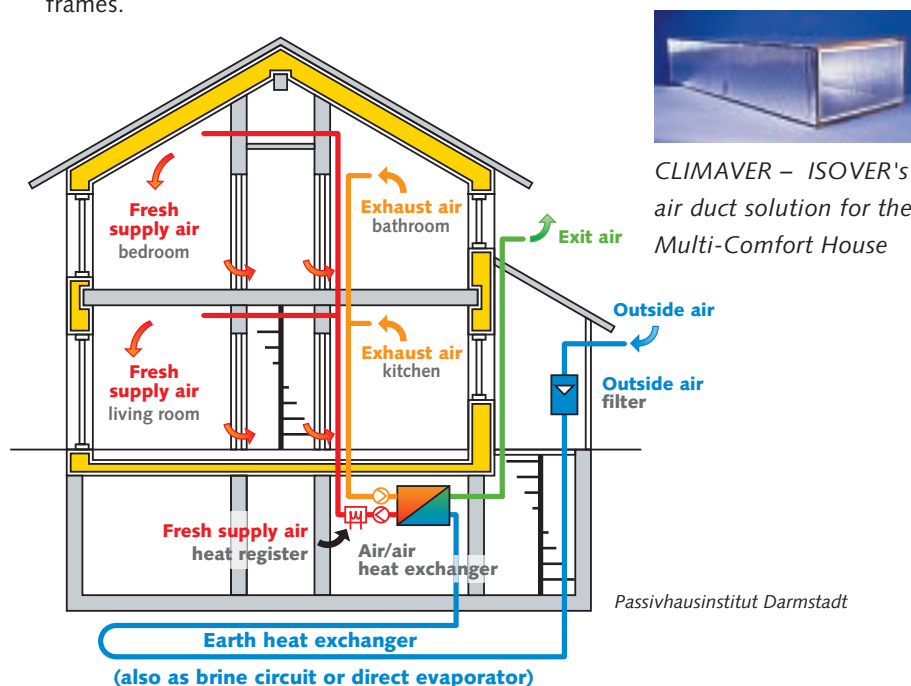
fresh air.

Features of a passive house conforming ventilation system.

As it requires only little space, the ventilation unit can be accommodated in a storeroom or even in a cabinet.

- Performance: At a maximum air change rate of about 0.4 per hour required for hygienic reasons, the ventilation system can contribute max. 1.5 kW energy to a residential building of 140 m² via the fresh air (when maintaining the max. supply air temperature of 51°C).
- Short wire lengths
- Duct dimensions – larger than 20 x 20 cm for main ducts, larger than 15 x 15 cm for branch ducts
- Acoustic insulation of the central unit. Install sound-absorbing ducts such as CLIMAVER. A noise level of 20-25 dB(A) should not be exceeded for living space.
- Easy maintenance, e.g. when changing filters and cleaning the unit
- The system can be easily adapted to your needs, e.g. switch off the incoming air fan when opening the windows, bypass for summer use.

If you want to ensure the permanent exchange of air and temperature even with closed doors, you should install long-range nozzles, preferably above the door frames.



Feel free to open the windows, whenever you want.

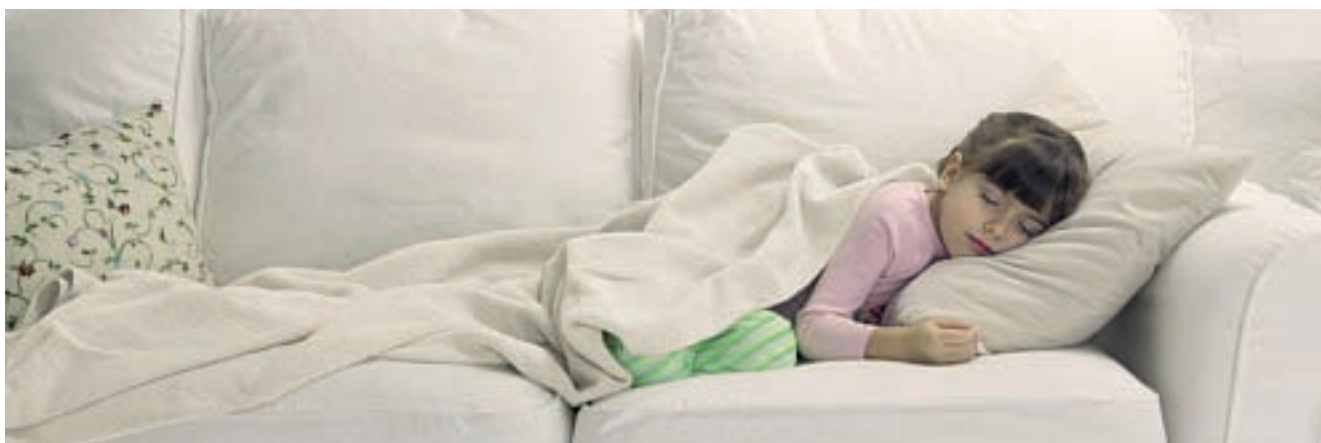
Of course, windows in a passive house can be opened just like in normal houses. Needless to say that also the temperatures will change as they do in normal houses. Leave the windows open in summer and the outside heat will enter. Open them in winter and the cold air will chill the room. The difference between an ordinary and an ISOVER Multi-Comfort House is the ventilation system. Once the windows are closed, it produces a pleasant, stable indoor climate by cooling down fresh incoming air and vice versa. A normal house, by contrast, needs active energy. This costs more money, pollutes our environment and never achieves the same comfortable effect.

To the point:

Comfortable advantages for man and building.

- Healthy fresh air – free of dirt, pollen, aerosols etc.
- Low air humidity helps prevent the intrusion of moisture, mould and structural damage
- No bad smells as the controlled air flow does not allow stale air to mix with fresh air
- No draughts
- No temperature fluctuations
- Window ventilation – if desired
- Highly efficient temperature recovery
- Low electricity consumption
- Easy maintenance
- Improved acoustic comfort

Air distribution via ducts: CLIMAVER, the



Sleep comfortably in your home.

Ventilation and air-conditioning for global comfort.

Air distribution in a house has the purpose of providing thermal comfort and ventilation to its inhabitants. But, of course, being comfortable means much more than feeling warm in winter and cool during summer days. We need to sleep in silence, without any disturbing noise. Acoustic comfort has also been duly considered in the Multi-Comfort House and is covered by a specially designed ventilation system.



Climaver, ISOVER's air duct solution for the Multi-Comfort House

CLIMAVER ducts, ISOVER solution for Multi-Comfort Houses, are made of glasswool boards which are cut and connected in order to obtain the required air duct network.

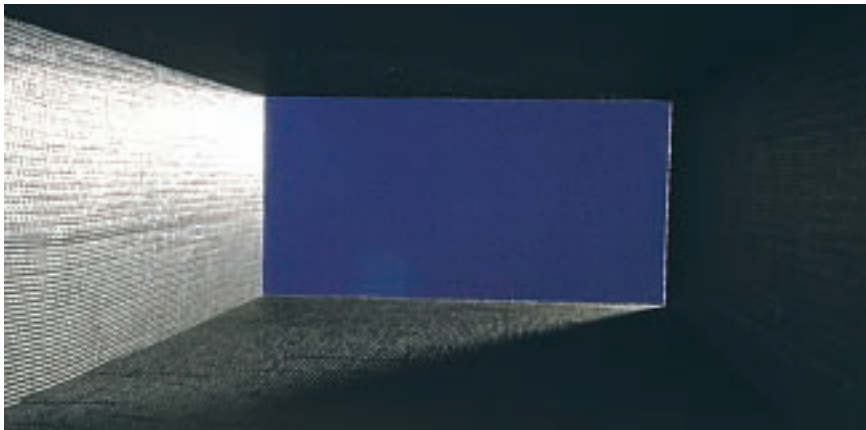
This system combines the properties and advantages of glasswool insulation with ease of installation:

- CLIMAVER ducts not only provide fresh air but also thermal protection and noise control. This is due to their high capacity of sound attenuation: they dampen sound that would otherwise be transmitted through the ventilation system. In addition, the thermal insulation with glasswool reduces thermal losses through the duct network.

- glasswool, reduces thermal losses through the ducts network.
- Thermal losses are reduced to a minimum. When considering energy losses in an air duct, you must balance two different effects: thermal loss because of insufficient insulation thickness and thermal loss due to air leakage. By combining these two elements, CLIMAVER ducts provide the best energy balance for an air system.
- The ductboards are faced on the inside so that the inner surfaces can be cleaned, thus ensuring good maintenance of the system.
- Since CLIMAVER products come pre-insulated, there is no need for further insulation. This reduces the number of working steps involved, saving both installation time and costs.

ISOVER solution.

CLIMAVER Neto, ISOVER's leading product for ensuring acoustic comfort.



When choosing the suitable CLIMAVER duct type from the range of available products, your choice depends on the desired property required for the application. However, the best option from the CLIMAVER range is, without doubt, CLIMAVER Neto as it ensures perfect acoustic comfort.

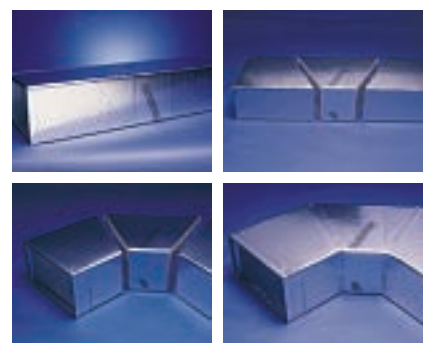
When circulating inside the duct, the air may cause turbulences and thus noise. This noise should be absorbed by the system. Otherwise, it will be audible through the grids and diffusion elements. The proper choice of an air duct equipped with an acoustic absorber –

such as CLIMAVER Neto – can significantly dampen this noise.

On the inside, CLIMAVER Neto is faced with a glass fabric that ensures maximum absorption of noise. Depending on duct size and air velocity, the duct can absorb more than 4 dB by linear meter. Moreover, the glass fabric allows internal cleaning of the duct and easy maintenance.

Excellent properties combined with ease of installation.

It's not always easy to combine good properties with ease of installation. But CLIMAVER systems are an exception from the rule. CLIMAVER ducts help you achieve noise control while at the same time realizing energy savings and thermal comfort. On top, their light weight makes them easy to install, with no need for additional insulation as they come pre-insulated. CLIMAVER ducts can be assembled on site: this not only saves energy, but also time.



CLIMAVER – advantages offered by a complete system:

- Energy savings
- Minimum air leakage
- Sound damping
- Fire safety
- Lightweight materials
- Easy assembly and handling

Spend the winter behind

Stable indoor climate due to double glazing.

With double glazing in hot regions, triple glazing in colder ones and thermally insulated frames, the passive house window is well able to resist heat and cold. And more than that. South-facing windows are harmless in summer if they are shaded. And in winter, they ensure solar gains that exceed the heat loss through the windows. Thanks to state-of-the-art glass quality, the temperatures measured on the inner surface of the panes are always close to inside air climate. The window temperature will never exceed 29°C in summer and never fall below 17°C in winter. Thus, a stable room temperature of 20-26°C can be assured all year round.

A gain for every room: properly positioned windows free of thermal bridges.

Under optimum installation conditions, passive house windows can contribute substantially to heating the building. Provided the following conditions are fulfilled:

- Windows size and orientation has to be optimised to have solar gains in winter, while avoiding overheating in summer
- Install the windows in the center of the insulated area.
- Cover the frame with an insulating wedge and install insulating layers below the windowsill.
- Provide an airtight seal of the perimeter joint between window frame and outer wall using environmentally friendly ISOVER VARIO FS1 or FS2 joint sealing strip and joint filler.

Good to know:

- 1.) In general, large-area window glazing with a small vent is more favourable in terms of energy and cost.
- 2.) To protect from overheating in summer, outside shading is essential – especially for east- and west-facing windows.



Passive house windows for Mediterranean climates	
Double low emissive glazing	approx. U_g 1.0-1.5 W/m²K
Triple glazing	approx. U_g 0.5-0.8 W/m²K
Insulated window frames	approx. U_f 0.7-1.8 W/m²K
Thermal insulation total window	approx. U_w 1.0-1.5 W/m²K
Total energy transmittance (g-value)	$g \geq 0.5$

In general, double low emissive glazing works in all Mediterranean climates. However, in a couple of colder regions, it may be an advantage to use windows with triple glazing.



Saint-Gobain glass CLIMATOP SOLAR consists of the extra-white Saint-Gobain float glass DIAMANT and the special Saint-Gobain glass coating PLANITHERM SOLAR. The triple glazing features excellent thermal insulation as well as a high g-value that normally can only be achieved with double glazing. This special relation of U_g - and g-value makes Saint-Gobain glass CLIMATOP SOLAR the perfect choice for energy-efficient buildings.

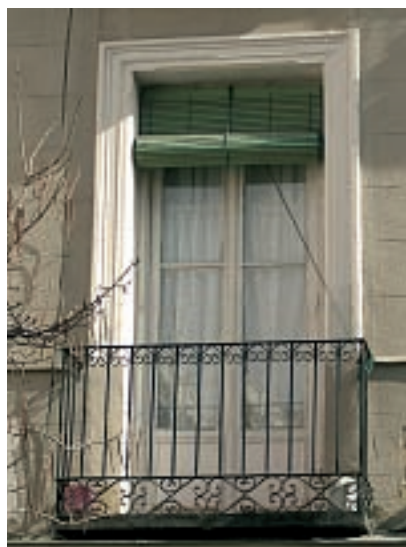
passive house windows.



VARIO FS1 and FS2 joint sealing strip

"Heat-free" in summer.

Especially on hot days, the ISOVER Multi-Comfort House remains pleasantly cool. This can be achieved by double or even triple thermal insulation glazing. It allows less sun heat to enter the house than with conventional windows. When the summer sun is high in the sky, structural sun protection is needed. A sufficiently dimensioned roof overhang, for example, can provide good shading from outside. For particularly exposed locations, additional temporary shading can be advisable. With east/west windows, temporary shading is a must.



The all-decisive U-value.

Modern double-glazed windows offer U-values in the range of 1.0 to 1.8 (W/m²K) while the frames reach less favourable values of 1.5 to 2.0 (W/m²K). U-values of 1.0-1.5 for the whole window might be sufficient for a passive house in Mediterranean climates. The requirements to be met by passive house windows in central European climates are much more rigorous: they need to achieve U-values of 0.7 to 0.8 (W/m²K). This heat transition coefficient applies to the whole window though – and this includes the frame.

So that everything runs

Point by point: The most important planning steps in hot countries.

1. Site plan

- Greatest possible freedom from shading in winter and structural shading in summer
- Compact building styles are preferable

2. Concept development

- Minimize shade in winter. This means: if possible build without parapets, projections, non-transparent balcony enclosures, divider walls etc.
- Choose a compact building structure. Use opportunities to combine buildings. Glazed areas should face south and cover up to 40 % of the wall area. Keep east/west/north windows small and only as big as required for optimum ventilation and sufficient incidence of light.
- Use a simple shell form, without unnecessary recesses.
- Concentrate the utility installation zones, e.g. bathrooms, above or adjacent to the kitchen.
- Leave space for the necessary ventilation ducts.
- Thermally separate the basement from the ground floor (including cellar staircase) – airtight and thermal bridge free.
- Get a first energy estimate, based on a calculation of the expected energy demands.
- Check the possibility for state subsidies.
- Work out a cost estimate.
- First exploratory talk with the building authority.
- Contract agreement with architects, including a precise description of services to be rendered.

3. Construction plan and building permit planning

- Select the building style – light or solid. Work out a design concept, floor plan, energy concept for ventilation, cooling, heating and hot water.
- Plan the insulating thickness of the building envelope and avoid thermal bridges.

- Consider the space required for utilities (cooling/heating, ventilation etc.).
- Floor plan: short pipe runs for hot/cold water and sewage.
- Short ventilation ducts: cold air ducts outside, warm ducts inside the insulated building envelope.
- Calculate the energy demand, e.g. with the Passive House Planning Package (PHPP) available from the Passivhaus Institut, Darmstadt.
- Negotiate the building project (pre-construction meetings).
- Apply for a housing subsidy.

4. Final planning of the building structure (detailed design drawings)

- Insulation of the building envelope: Depending on the local climate U-values of 0.15-0.45 are required for roofs and walls.
- Design thermal bridge free and airtight connection details.
- Windows should comply with passive house standard: optimize type of glazing, thermally insulated frames, glass area and sun protection.

5. Final planning of ventilation (detailed system drawings)

- General rule: hire a specialist planner.
- Ventilation ducts: short and sound-absorbing. Air flow velocities below 3 m/s.
- Include measuring and adjusting devices.
- Take sound insulation and fire protection measures into account.
- Air vents: avoid air current short-circuiting.
- Consider the air throws of the air vents.
- Provide for overflow openings.

smoothly.

- *Install a central ventilation unit, incl. a back-up unit (cooling devices and heater coils), in the temperature-controlled area of the building shell.*
- *Additional insulation of central and back-up unit may be necessary. Make sure to soundproof the devices. Thermal energy recovery rate should be above 80 %. Airtight construction with less than 3 % recirculated air. Current efficiency: max. 0.4 Wh energy required per m³ transported air.*
- *The ventilation system should be user-adjustable.*
- *Use cooker hoods with return air operation and grease filters made of metal.*
- *Optional: geothermal heat exchanger. Ensure airtightness. Observe the necessary clearance between cold parts of the piping and the cellar wall resp. water pipe. Provide a bypass for summer operation.*
- *Warm water pipes should be perfectly heat-insulated in order to avoid unwanted internal heat loads during the hot season.*

6. Final planning of the remaining utilities (detailed plumbing and electrical drawings)

- *Plumbing: Install short and well-insulated pipes for hot water in the building envelope. For cold water install short pipes insulated against condensation water.*
- *Use water-saving fittings and hot-water connections on washing machine and dishwasher. Short sewer pipes with only one downpipe.*
- *Sub-roof vents for line breathing (vent pipes).*
- *Plumbing and electrical installations: avoid penetration of the airtight building envelope – if not feasible, install adequate insulation.*
- *Use energy-saving household appliances.*

7. Call for tenders and awarding of contracts

- *Plan for quality assurance measures in the contracts.*
- *Set up a construction schedule.*

8. Assurance of quality by the construction supervision

- *Thermal bridge free construction: schedule on-site quality control inspections.*
- *Check of airtightness: all pipes and ducts must be properly sealed, plastered or taped. Electrical cables penetrating the building envelope must be sealed also between cable and conduit. Flush mounting of sockets in plaster and mortar.*
- *Check of thermal insulation for ventilation ducts and hot water pipes.*
- *Seal window connections with special adhesive tapes or plaster rail. Apply interior plaster from the rough floor up to the rough ceiling.*
- *n₅₀ airtightness test: Have a Blower Door Test done during the construction phase. Timing: when the airtight envelope is complete but still accessible. This means: before finishing the interior work, but after completion of the electricians' work (in concert with the other trades), incl. detection of all leaks.*
- *Ventilation system: ensure easy accessibility for filter changes. Adjust the air flows in normal operation mode by measuring and balancing the supply and exhaust air volumes. Balance the supply and exhaust air distribution. Measure the system's electrical power consumption.*
- *Quality control check of all cooling, heating, plumbing and electrical systems.*

9. Final inspection and auditing

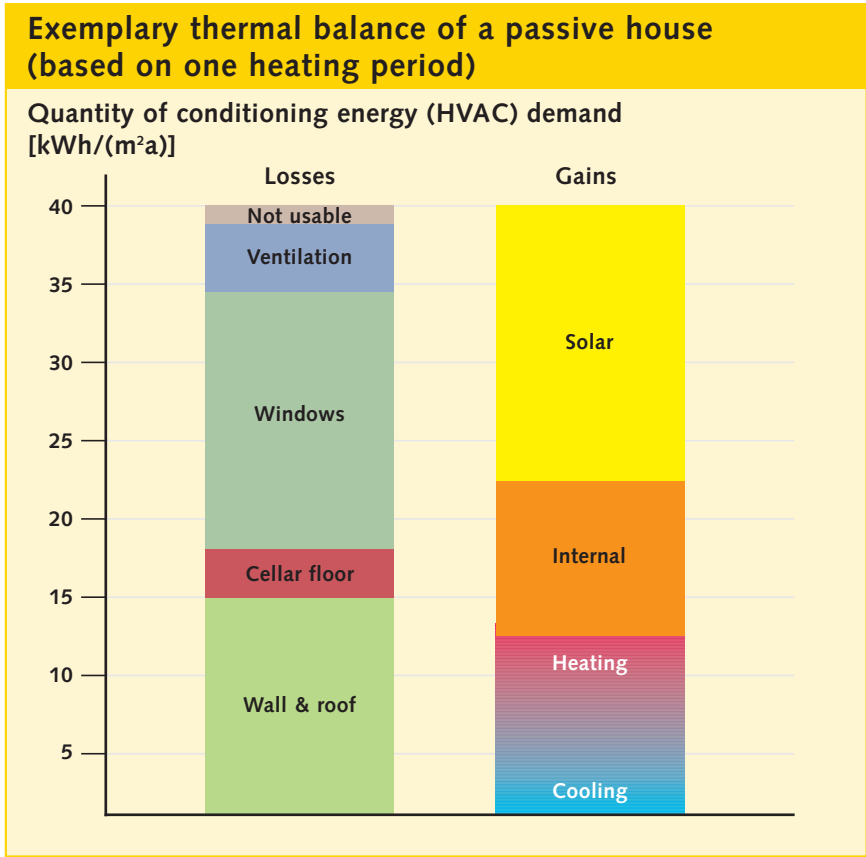
Energy efficiency is calculable.

Is it possible to design extremely energy-efficient houses with simple planning tools? In the 1990s, it was still widely believed that passive house planning could only be managed with the help of dynamic building simulation programs. These were based on hourly performance and took the different uses of the rooms into account. Meanwhile, it has shown that simplified calculation methods are sufficiently precise to dimension the conditioning system and predict the energy consumption of passive houses.

**Very helpful:
the Passive House
Planning Package (PHPP)**

Practical use of such an energy balancing procedure is made in the Passive House Planning Package (PHPP). This is a spreadsheet-based design tool that can be used to calculate the complete energy balance of a building. To do so, it is on the one hand necessary to determine the building's energy losses caused by transmission and ventilation.

On the other side of the balance, solar and internal energy gains need to be considered. These gains are not always achieved at times when they are needed, but this fact is accounted for by setting them off against the losses. The difference between losses and useful gains eventually results in the building's demand for cooling/heating energy that needs to be supplied additionally. In order to obtain correct results, it is of vital importance to distinguish between significant and insignificant factors and to choose the proper boundary conditions. This includes, for example, the heat gains from inhabitants and household appliances or the solar radiation inside a house. The PHPP contains standard values which have proved successful in comparison with field measurements. Apart from establishing the room temperature balance, the PHPP also deals with other issues that come up in the course of planning. These include temperature control via supply air, the energy demand for auxiliary power and household electricity, the energy needed for preparing domestic hot water and the indoor climate in summer.



The PHPP is available from the Passivhaus Institut in Darmstadt, Germany

(www.passiv.de)

Passive House Planning • ANNUAL SPACE HEATING REQUIREMENT

Climate: Interior Temperature: °C

Building: Building Type/Use:

Location: Treated Floor Area (TFA): m²

Spec. capacity: W/(m²K) (entry in the "Summer" sheet)

Building components	Temperature zone	Area m ²	U-value W/(m ² K)	Temp. factor f _t	G _i kWh/a	kWh/a
Exterior Wall – Ambient Air	A	194.3	0.345	1.00	50	3324
Exterior Wall – Ground	B			1.00		
Roof/Ceiling – Exterior Air	D	83.4	0.258	1.00	50	1065
Floor Slab	B	80.9	0.718	1.00	12	718
	A			1.00		
	A			1.00		
	X			0.75		
Windows	A	33.4	1.447	1.00	50	2395
Exterior Door	A			1.00		
Exterior Thermal Bridge (length/m)	A	116.9	-0.030	1.00	50	-173
Perimeter Thermal Bridge (length/m)	P			1.00		
Ground Thermal Bridges (length/m)	B	11.4	0.061	1.00	12	9

Transmission Heat Losses Q_T

Total **7339** kWh/a **47.0** kWh/(m²a)

	n _{L,system}	η*EWÜ	η _{WRG}	n _{L,rest}	n _{L,equiv. portion}
Effective air exchange exterior n _{Le}	0.300	*(1-0%)	0.82	0.019	0.074
Effective air exchange ground n _{La}	0.300	*(1-0%)	0.82	0.019	0.074

	V _L m ³	n _{L,equiv. portion} 1/h	C _{air} Wh/(m ³ K)	G _T kWh/a	kWh/a	kWh/(m ² a)
Ventilation Heat losses exterior Q _{L,a}	390	0.074	0.33	50	470	3.0
Ventilation Heat losses ground Q _{L,e}	390	0.000	0.33	12	0	0.0

Transmission Heat Losses Q_T

Total **470** kWh/a **3.0** kWh/(m²a)

	Q _T kWh/a	Q _L kWh/a	Reduction Factor Night/Weekend Saving	kWh/a	kWh/(m ² a)
Total Heat Losses Q _L	7339	470	1.0	7808	50.1

Orientation of the Area	Reduction Factor see Windows	g-Value (perp. radiation)	Area m ²	Global Radiation Heating Period kWh/(m ² a)	kWh/a
1. North	0.48	0.56	11.00	185	553
2. East	0.40	0.00	0.0	361	0
3. South	0.42	0.56	20.40	567	2727
4. West	0.40	0.56	2.00	370	168
5. Horizontal	0.40	0.00	0.00	585	0
6. Sum of opaque building parts					1200

Gross Solar Heat Gains Q_G

Total **4648** kWh/a **29.8** kWh/(m²a)

	kh/d	Heating Period d/a	Specific Power q _i W/m ²	A _{EB} m ²	kWh/a	kWh/(m ² a)
Internal Heat Sources Q _i	0.024	212	2.10	156.0	1667	10.7

Free heat Q _F	Q _G + Q _i	6315	40.5
Ratio free heat vs. losses	Q _F / Q _V	0.81	
Utilization of heat gains n _G		89%	

Heat Gains Q_G

η_G • Q_F = 5606 kWh/a 35.9 kWh/(m²a)

Annual Heat Requirement Q_H

Q_V - Q_G = 2202 kWh/a 14 kWh/(m²a)

Limit **15** kWh/(m²a) Requirement met? **YES**

Construction Examples.

Three different locations.



- Porto
- Madrid
- Seville

Passive House examples

Examples for Spain and Portugal

Up to now, only a few passive houses have been constructed in Southern Europe. For this reason, the examples below do not describe realized houses, but the results of simulations illustrating what a passive house in a warm climate might look like. The simulations were carried out with the help of the dynamic thermal building simulation program DYNBIL, developed by the Passive House Institute. Based on hourly data, the program calculates the thermal processes within a building. Comparisons with measurements taken in inhabited buildings have shown a very good accordance.

In order to illustrate different structural solutions that may result from varying conditions in the Mediterranean countries, three different locations will be compared. Below please find a brief description of each location. This will be followed by an overview of the common characteristics of the example buildings. Next, we will take a closer look at their adaptation to the respective climate and their resulting thermal behaviour. Finally, we will discuss different structural components and their influence on the thermal performance of the buildings.

Climate

Although all three cities are located on the Iberian Peninsula, they show considerable differences:

- At an altitude of more than 600 m, **Madrid** is located far away from the sea. Compared to other cities in the Mediterranean region, the climate is relatively continental – with high summer and low winter temperatures. In winter nights, temperatures frequently drop below 0 °C; precipitation and air humidity are comparatively low.
- **Seville** is one of the hottest cities in Europe. Every year, summer air temperatures exceed 40 °C. In winter, by contrast, there might even be night frost.
- The climate of **Porto** is influenced by its close proximity to the Atlantic Ocean. Therefore changes in temperature are much smaller than in the other two cities. Especially the summers tend to be cooler than in the more southern parts of the Iberian Peninsula. Night frost does not normally occur and summer temperatures seldom exceed 30 °C.

The climate data used in the simulations were measured at airports located in the vicinity of these cities. In the city centre, temperatures might be noticeably higher in summer, especially during the night.



Madrid



Seville



Porto

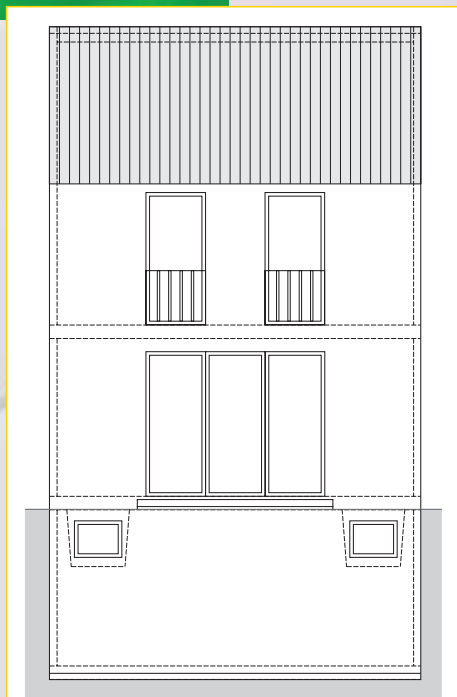
in hot countries.

Example buildings

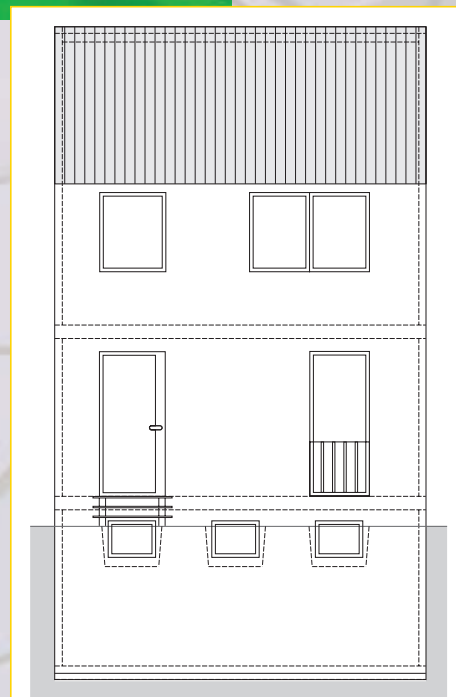
The simulations were based on the model of a two-storey end-of-terrace house with a cellar. The room layout is that of a typical terrace house, frequently used in low-cost housing construction all over Europe. The ground floor accommodates kitchen, dining room, living room and WC. The concrete core of the upper floor provides space for a bathroom and one or two further rooms facing south which are used as children's rooms in the example. The parents' bedroom is a slightly larger room facing north. The basement is exclusively used for storage. Access to the cellar is from outside. On the west side is the gable end wall of the row of houses whereas the east side adjoins the neighbouring house.

Model of a two-storey end-of-terrace house

View from the south



View from the north



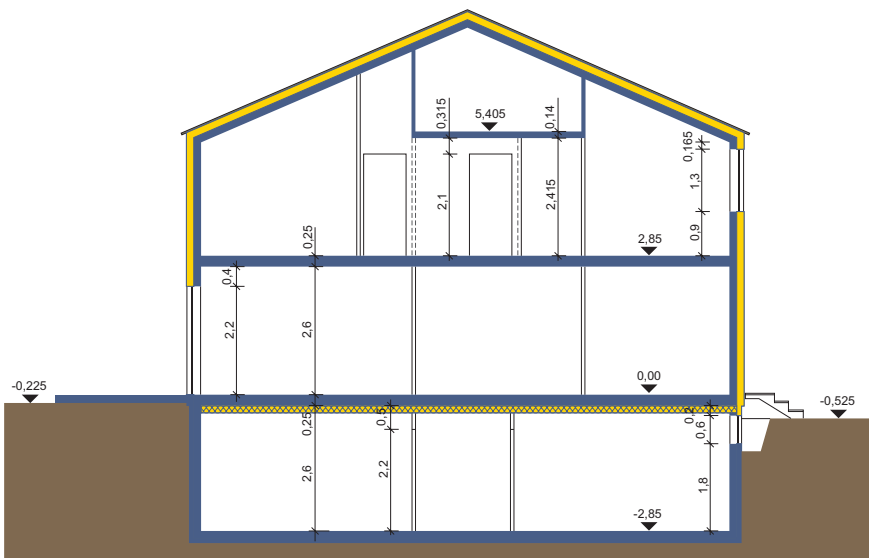
Construction Examples.

Model of a two-storey end-of-terrace house

Floor plans



Sectional view from the east



Structural components

The house features solid construction (11.5 cm vertically perforated bricks with intermediate ceilings made of reinforced concrete). The thermal insulation was installed on the external side (ETICS = external thermal insulation composite system). The exterior surfaces of the walls were plastered, the absorptivity of solar radiation is $\alpha = 0.6$.

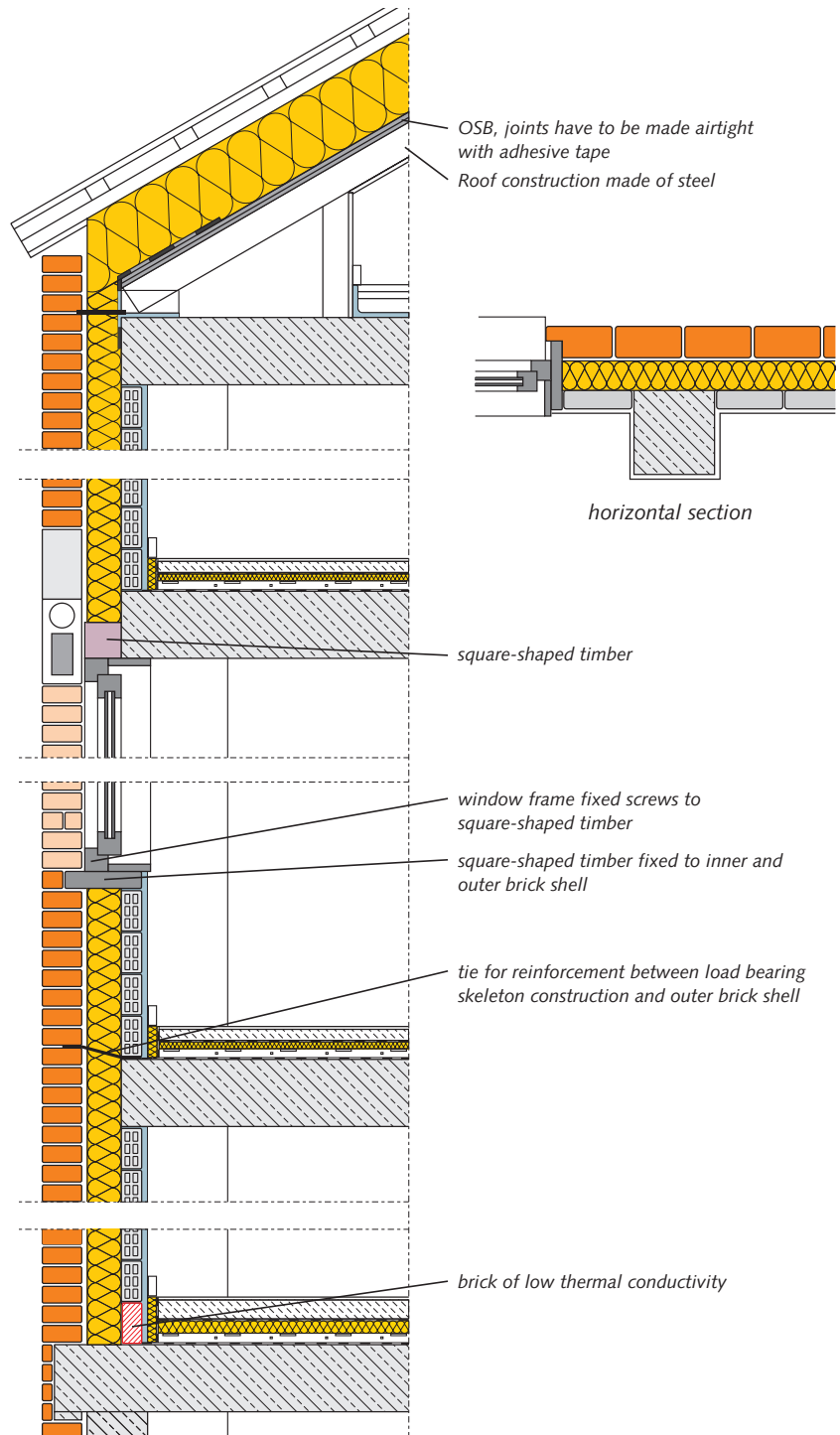
Thermal bridges could almost completely be avoided. The windows were integrated into the insulation in order to optimize the thermal insulation of the total window area.

Passive houses in hot countries can also be built in the tradition of cavity wall systems.

The windows feature double thermal insulation glazing with argon filling ($U = 1.2 \text{ W}/(\text{m}^2\text{K})$, $g = 0.6$). The window frames have a U-value of $1.6 \text{ W}/(\text{m}^2\text{K})$, corresponding to a wooden window frame of 68 mm thickness. Due to the cold winters, a thermally insulated window frame with a U-value of $0.75 \text{ W}/(\text{m}^2\text{K})$ was used in Madrid in order to ensure sufficiently high inner surface temperatures. Alternatively, triple glazing could be used in this location, but this would mean sacrificing solar heat gains.

In the area of the cellar ceiling, the building load must be distributed to the cellar walls. In a Central European climate, the thermal bridge effect caused at this point can be reduced by using aerated concrete blocks for insulation. In the Spanish housing examples, however, the brickwork is continued without interruption through the insulation of the cellar ceiling.

The roof is designed in conventional lightweight construction with rafters and roof tiling. The solar absorption of the tiles is 0.72. The example shows above-rafter thermal insulation, but the insulation can just as well be installed between the rafters.



Heating and ventilation: programme

Ventilation

As the bathrooms are located inside without windows, all houses were equipped with ventilation systems. These effect an air exchange rate of 0.35 per hour, related to the volume of the rooms. Part of them are pure exhaust air units, others are combined supply & exhaust air systems with additional heat recovery. In the latter case, the system is equipped with an automatically controlled summer bypass line. At room temperatures above 23 °C, this line bypasses the heat recovery system – provided the outdoor temperature is low enough.

In order to protect the building fabric and avoid draught, the building envelope is comparably airtight. The air exchange rate determined by the Blower Door Test is $n_{50} = 1.0 \text{ h}^{-1}$.

The interior doors leading from the staircase to the adjoining rooms are opened only occasionally. On average, these doors cause an air exchange of 50 m³/h.

Two alternatives are considered for thermal protection in summer. First, the air that is sucked into the building via the ventilation system can be pre-



cooled while at the same time dehumidifying it. Second, cooling can be exclusively achieved by passive means, i.e. the warm air is carried out of the building by increased ventilation.

It is assumed in both cases that, in summer, an additional removal of warm air is effected by window ventilation: if outdoor temperatures are not

too high, the residents will open their windows. The air exchange is merely caused by the difference between indoor and outdoor temperatures. A possible cross-ventilation by utilizing the "chimney effect" over several storeys or by making use of the wind is not taken into account. It is, however, available as an additional reserve.

the wellness for your home.

Heating and ventilation

As a rule, temperature calculation is based on the following resident behaviour: At operative room temperatures above 22 °C, residents tend to tilt their windows if the outdoor air temperature is below the indoor room temperature. At a 4 Kelvin temperature difference between indoor and outdoor air, an air exchange rate of approx. 0.80 h⁻¹ can thus be achieved.

In some cases, it is assumed that ventilation can also be effected by wide opening of the windows. The achievable air exchange is thus increased about tenfold. The air exchange rate is limited to a maximum value of 8 h⁻¹.

Every room can be heated individually. The heat is completely released by convection and adjusted in such a way that the operative temperature (mean value of air and radiation temperature in the room) just about meets the set point (here: 20 °C). If no active cooling is available in summer, the building is only kept cool by appropriate natural ventilation, i.e. opening the windows (see above). In the case of active cooling, the operative temperature in all rooms is adjusted to maximum 26 °C by the cooling device.

Internal heat gains

It is assumed that the energy efficiency of household appliances, lighting etc. is at an acceptable level. In winter, the internal heat gains calculated by the simulations amount to approx. 2.6 W/m². In summer, these gains are by 0.7 W/m² lower since at higher temperatures pot plants tend to evaporate more water.



Shading

The example building has an exact north-south orientation. When looking south, the next row of houses is located at a distance of 25 m. The house is equipped with traditional folding shutters that are closed at room temperatures above 23 to 25 °C. Modern roller blinds have the same thermal effect.

Beautiful cities – best exa

Example Porto



Due to the mild, oceanic climate of Porto, the energy demand for space conditioning is extremely low – even without ventilation heat recovery. To achieve this, a very good insulation of the roof and walls is required. Installation of an exhaust air system is recommended in order to ensure good indoor air quality. Heating can be provided by small radiators which may be placed on the interior walls of the most important rooms.

In the specific climate of Porto, the ambient summer temperatures hardly ever exceed 30 °C. This allows for a simple, purely passive cooling concept. Along with proper use of the exterior blinds, it is sufficient to tilt the windows whenever the indoor temperature approaches the upper comfort limit. In this case, the indoor temperature in the well-insulated building never exceeds 25 °C

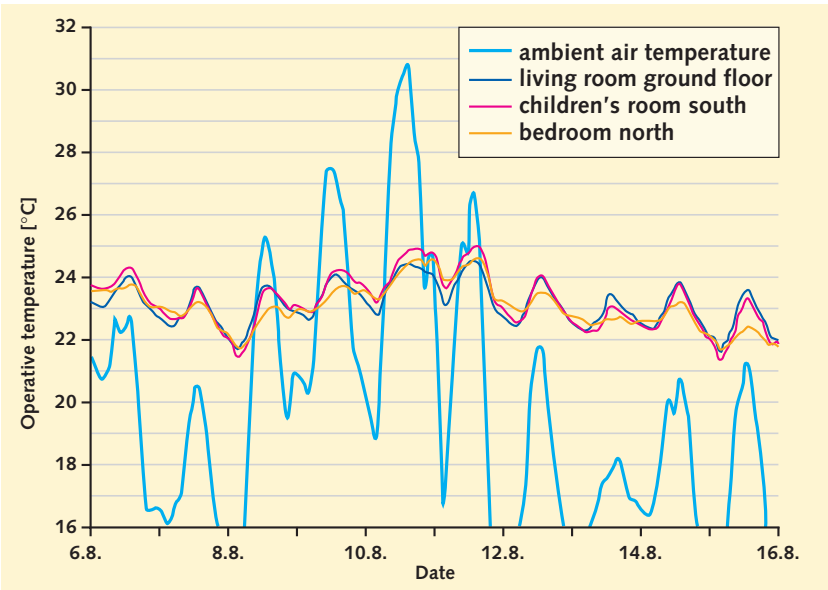
U-value wall [W/(m²K)]	0.20
U-value roof [W/(m²K)]	0.16
U-value basement ceiling [W/(m²K)]	0.43
U-value window double glazing [W/(m²K)]	1.20
U-value window frames [W/(m²K)]	1.60
Efficiency of heat recovery	0 % *

* The simulation for Porto shows that the passive house level can already be reached without heat recovery. By adding a ventilation system with heat recovery higher than 80 % the heating demand can be further reduced to 4.2 kWh/m²a. The average heating load will then be reduced to 4.5 W/m².

Useful heating demand (20 °C) [kWh/(m²a)]	12.8
Useful cooling demand (26 °C) [kWh/(m²a)]	0
Daily average heating load [W/m²]	9.0
Daily average sensible cooling load [W/m²]	0

One summer week in Porto.

Thanks to good insulation and natural night ventilation, the indoor temperature remains pleasantly stable. By contrast, the outdoor temperature fluctuates more strongly.



mples.

Example Seville



Excellent insulation of the roof reduces both the solar load in summer and the heat losses in winter. For the wall, less insulation is sufficient. Insulation between the building and the ground is not required. Since the ground temperature is close to 20 °C, only very small amounts of energy are lost to the ground in winter. On the other hand, the ground can store excess heat in summer.

In Seville, both heating and cooling are required to provide thermal comfort. When installing an air-to-water heat pump, the energy surplus during the cooling period can be used for producing domestic hot water. Both heating and cooling demand are very low.

Summer in Seville is among the greatest challenges for passive houses cooling in the Mediterranean area. Daytime maximum ambient temperatures regularly exceed 35 °C while nighttime temperatures may not drop significantly below 20 °C for up to 3 months. In addition, solar radiation is very intense. The dia-

U-value wall [W/(m²K)]	0.45
U-value roof [W/(m²K)]	0.20
U-value basement ceiling [W/(m²K)]	1.66
U-value window double glazing [W/(m²K)]	1.20
U-value window frames [W/(m²K)]	1.60
Efficiency of heat recovery	85 %

gram shows that a passive house in massive construction takes two days to heat up to the

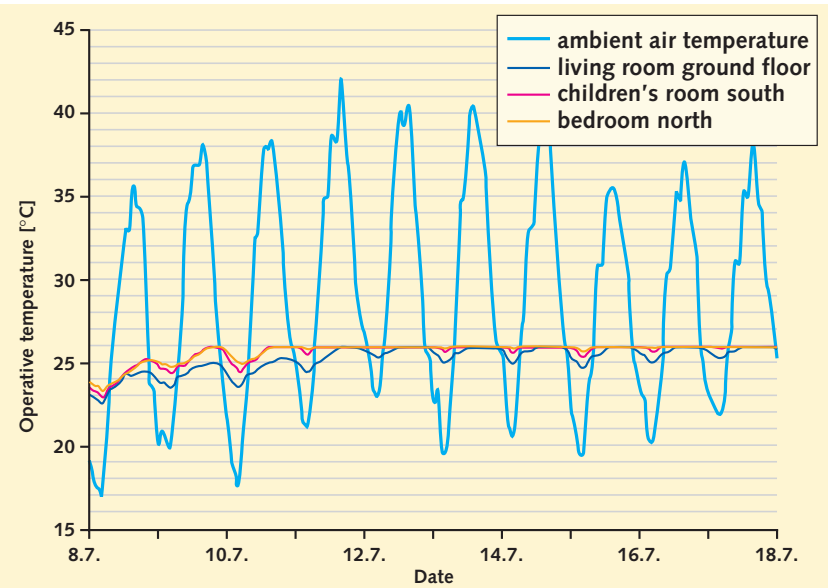
upper comfort limit during the beginning of a heat wave. Finally, the indoor climate needs to be controlled by active

Useful heating demand (20 °C) [kWh/(m²a)]	4.9
Useful cooling demand (26 °C) [kWh/(m²a)]	5.6
Daily average heating load [W/m²]	7.7
Daily average sensible cooling load [W/m²]	6.5

cooling. The comfortable indoor temperature of 26 °C can be maintained as shown in the diagram below.

One summer week in Seville.

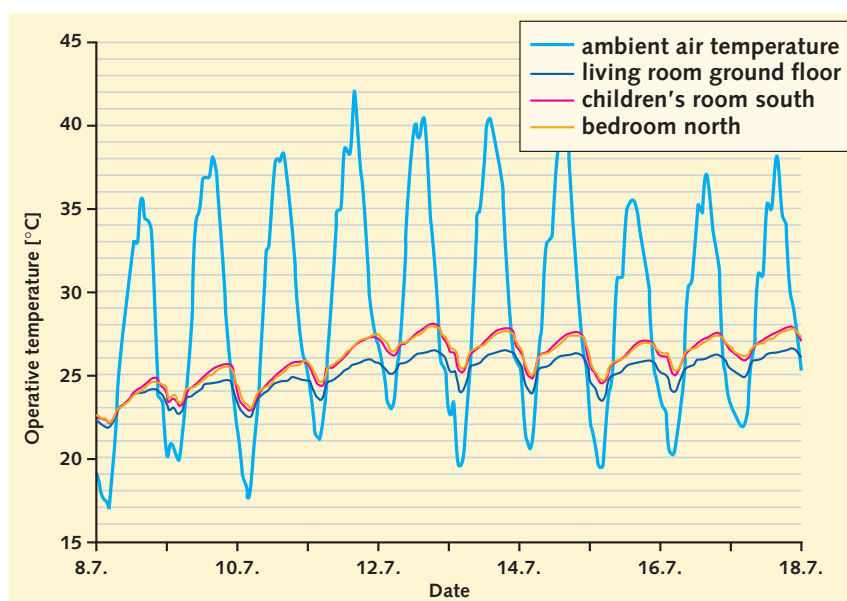
Night and day, outdoor air temperature remains above 20°C. Good thermal insulation, shading facilities for windows and active cooling are necessary to keep indoor temperatures on a comfortable level.



Construction Examples.

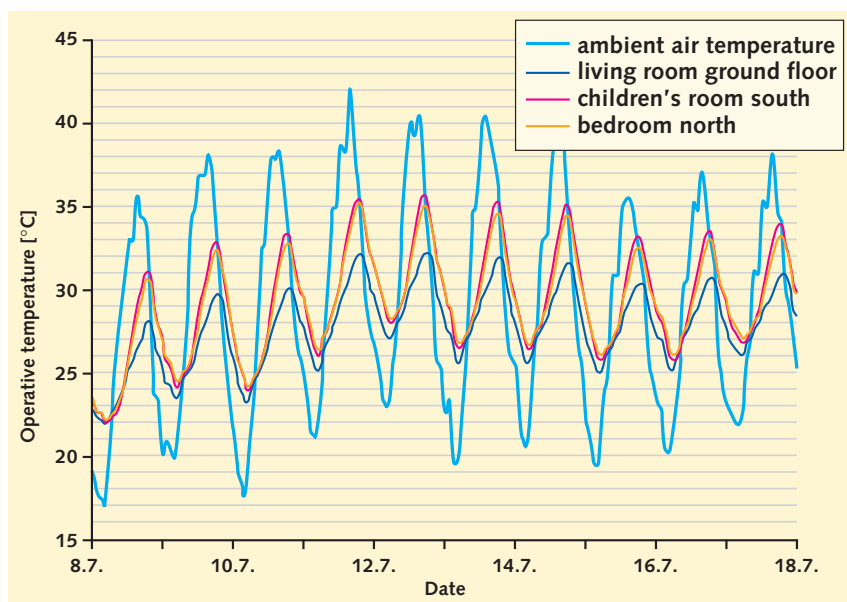
Example Seville

Without active cooling and only natural night ventilation the indoor temperature becomes too high during hot summer periods.



Example Seville

In buildings with only a little insulation the interior air temperature rises up to 37 °C in long hot periods.



Ensuring high thermal comfort in summer without active cooling is a very difficult task in this climate and would imply severe restrictions to the architectural design. The following diagram shows the indoor temperatures when no cooling system has been installed, but the windows are opened wide for night ventilation. Indoor temperatures rise to 28 °C in the period displayed, and reach 30 °C during the following weeks.

A comparable building with a standard thermal performance and a standard construction with less insulation consequently provides a considerably lower thermal comfort. In the following example, double-layered brick walls with a 6 cm cavity and a total U-value of 2.0 W/(m²K) are used, the roof is a lightweight construction with a U-value of 1.6 W/(m²K), and the double-glazed conventional windows are shaded with Persian shutters. There is no controlled ventilation. The interior ceilings are made of supporting concrete girders with hollow brick infill. Without active cooling, the daily temperature fluctuations are much more severe, and indoor temperatures rise to 37 °C in long hot periods.

Example Madrid



Due to the colder winters of the higher altitude and the continental climate of the Meseta Central, Madrid requires much better thermal insulation than Seville. Not only are the windows equipped with thermally insulating frames, but also a controlled ventilation system with heat recovery is installed. These measures are able to reduce the heat losses to a large extent, such that the insulation level is comparable to the Porto example. Space conditioning can be fully realised by heating or cooling the air supplied by the ventilation system.

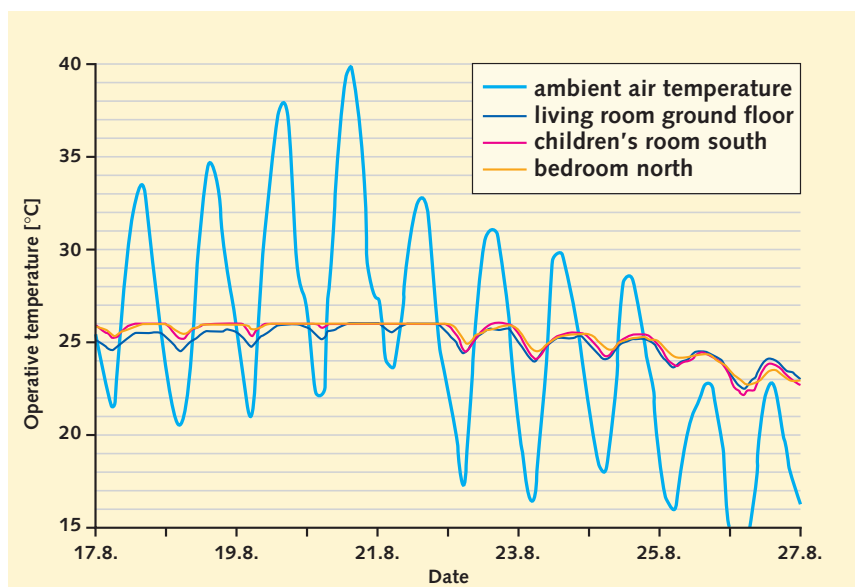
Summer temperatures rise to 40 °C and above and may continuously exceed 20 °C for several days. Due to this fact, a certain amount of active cooling is required. If the building were located in the city centre with its strong heat island effect instead of in the suburbs, nighttime temperatures would be higher by about 2°C or more. Consequently, the effectiveness of night ventilation would be further reduced.

U-value wall [W/(m²K)]	0.29
U-value roof [W/(m²K)]	0.13
U-value basement ceiling [W/(m²K)]	0.43
U-value window double glazing [W/(m²K)]	1.20
U-value window frames [W/(m²K)]	0.72
Efficiency of heat recovery	85 %

Useful heating demand (20 °C) [kWh/(m²a)]	11.6
Useful cooling demand (26 °C) [kWh/(m²a)]	0.49
Daily average heating load [W/m²]	9.7
Daily average sensible cooling load [W/m²]	3.4

Example Madrid

In summer months, a very small amount of active cooling is required to maintain comfortable indoor air temperatures.

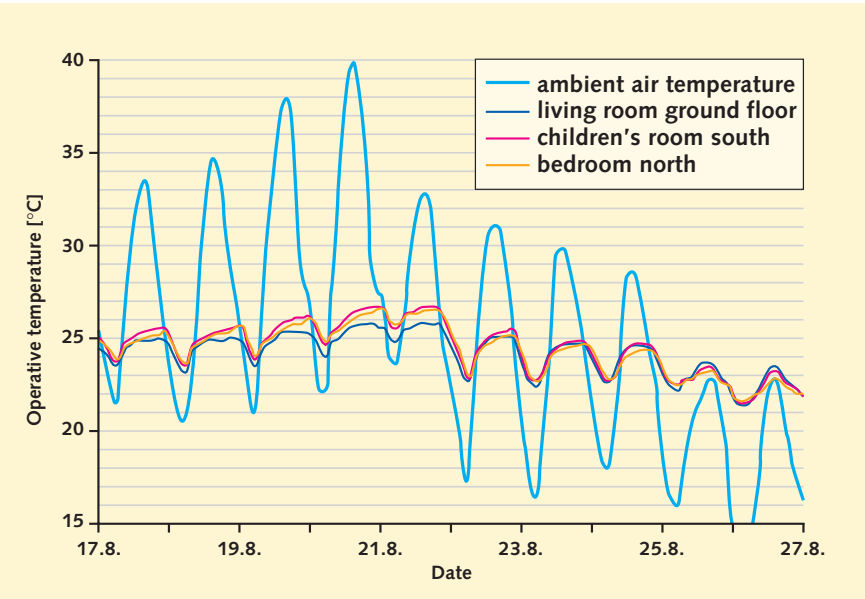


Construction Examples.

However, even without active cooling, the temperatures can be kept close to the comfort range in a passive house in Madrid. If the windows are opened wide whenever this provides some cooling, the peak indoor operative temperature can be kept below 27 °C. In this case, however, temperature fluctuations will be higher. Besides, the strategy requires more activity on the residents' part, acceptable safety and low exterior noise levels. For these reasons and also due to the heat island effect, such an approach will not work in the city centre of Madrid.

Example Madrid

Without active cooling, indoor temperatures in summer may become too high for real living comfort.



Influence of individual factors

What is the relative importance, in terms of overall efficiency, of the components that make up an ISOVER Multi-Comfort House? It is impossible to answer this question in a general manner. The answer very much depends on the climatic conditions and on the overall design of the building. Some components, which mainly affect summer performance, are considered in the next chapters.

Insulation of the building envelope

Insulating the building envelope (ground floor/ceiling of the basement, walls, windows, ceiling/roof) reduces heat losses during the heating period and the heat transfer into the building on hot summer days. Insulation therefore also reduces the number of days where conditioning of the ventilated air (active heating and cooling) is necessary.

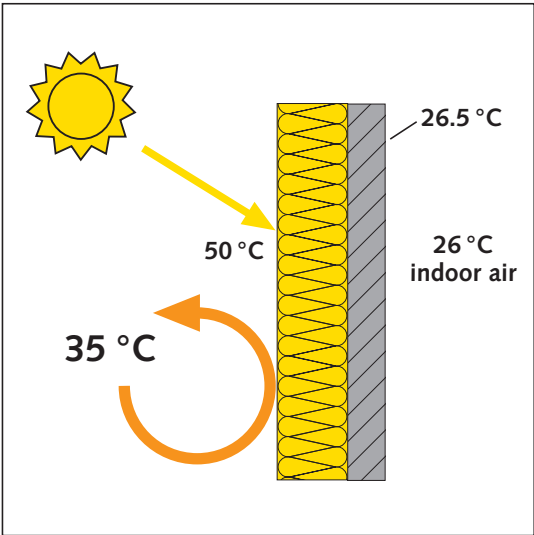
Savings by increasing the wall insulation from 50 to 150 mm			
	Porto	Seville	Madrid
Heating demand [kWh/(m²a)]	12.1	5.2	14.8
Daily heating load [W/m²]	5.1	5.6	5.8
Cooling demand [kWh/(m²a)]	-	1.7	0.6
Daily cooling load [W/m²]	-	2.7	2.4

However, heat removal through open windows is much more effective than through the walls, and opening a couple of windows will quickly reduce the

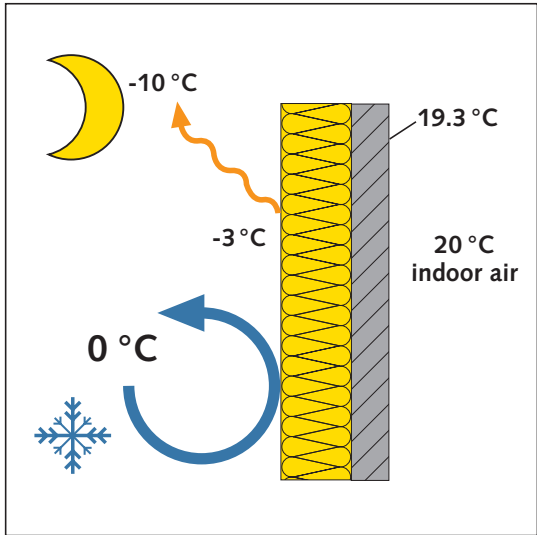
indoor temperature to the desired level in this weather situation. During periods when active cooling is required in a reasonably designed dwelling,

ambient temperatures are so high that insulation of the walls can definitely reduce the cooling demand.

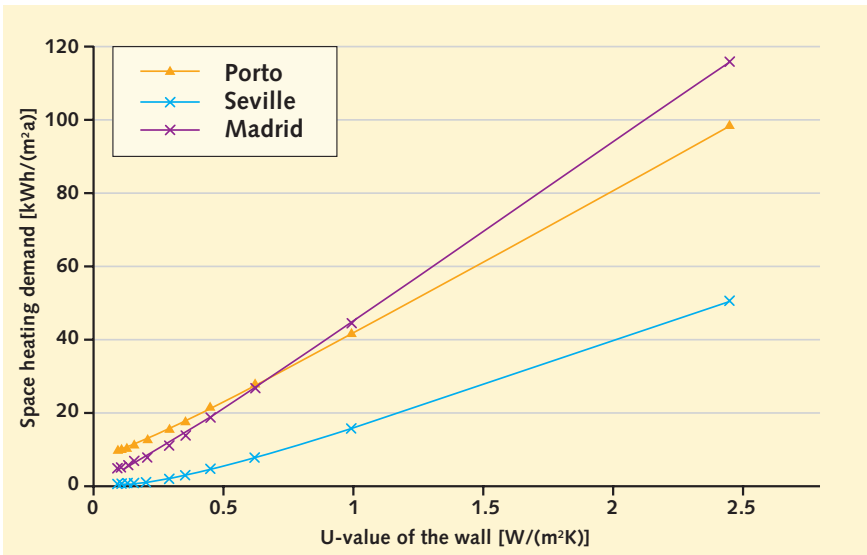
Bright summer day



Clear winter night



Under all climatic conditions insulation works most efficiently.



The graph shows the clear correlation: the lower the U-value, the lower the space heating demand.

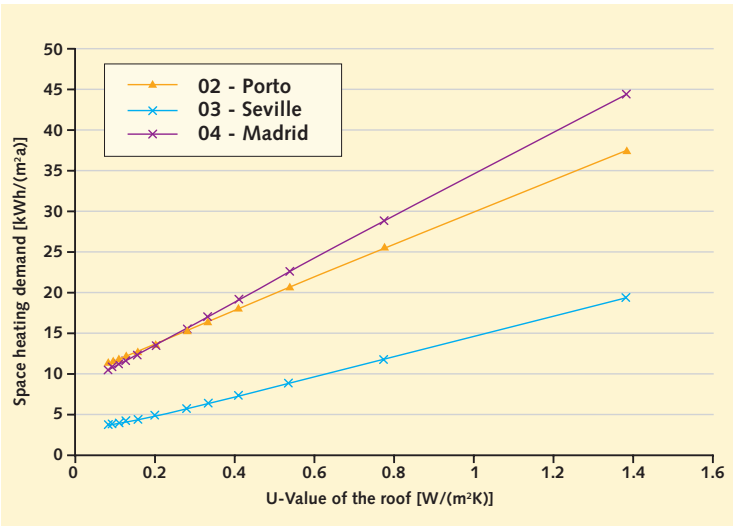
Different challenges, one

Insulation of the roof

Insulation of the roof is similar in effect to insulation of the walls, but it produces even better results – both in winter and summer. Typically, the roof is exposed to much stronger solar radiation than the walls on summer days. Similarly, in winter, a roof surface can radiate more heat into the cold night sky than a vertical wall surface.

Due to the higher solar radiation on the roof – although the example buildings have twice as much wall area as roof area, it is possible to achieve higher cooling energy savings from better roof insulation than from adding the same amount of insulation in the walls.

Savings by increasing the roof insulation from 50 to 150 mm			
	Porto	Seville	Madrid
Heating demand [kWh/(m²a)]	5.8	3.2	7.4
Daily heating load [W/m²]	2.6	2.5	2.8
Cooling demand [kWh/(m²a)]	-	2.0	1.0
Daily cooling load [W/m²]	-	2.0	1.5



Infiltration versus airtightness

An airtight building envelope eliminates the unwanted infiltration of cold or hot air by preventing draught and reducing energy demands. Airtightness is also essential for preventing structural damage and is a precondition for the operation of any mechanical ventilation. Assuming a building without any particular attention to airtightness, an improvement to passive house level would result in the following savings.

Savings by reducing n ₅₀ from 5.0/h to 1.0/h			
	Porto	Seville	Madrid
Heating demand [kWh/(m²a)]	12.0	7.0	15.0
Daily heating load [W/m²]	5.1	4.4	5.6
Cooling demand [kWh/(m²a)]	-	1.4	0.5
Daily cooling load [W/m²]	-	1.8	1.6

solution: insulation.

Ventilation heat recovery

Whenever active cooling or dehumidification is required, cooling the supply air is a reasonable solution. In this case a heat pump (electric cooling unit) has to be installed to cool the supply air. The following table illustrates the savings that can be achieved if the efficiency of heat recovery increases from 0 to 80 %.

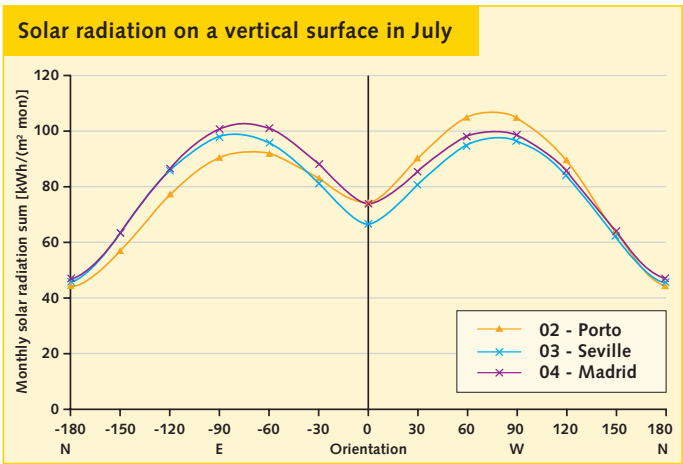
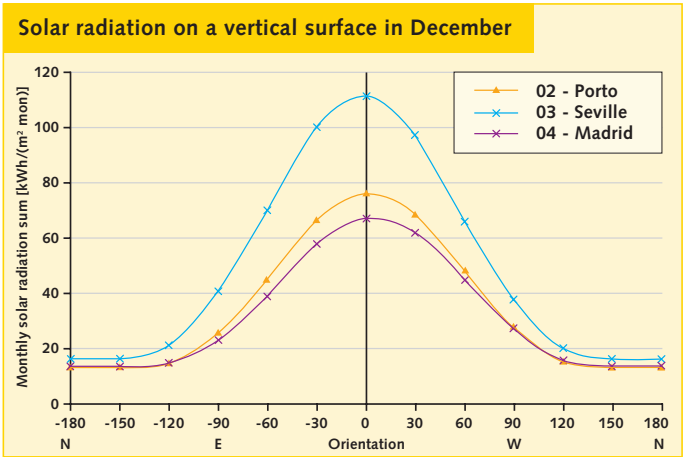
Savings by increasing heat recovery efficiency from 0 % to 80 %			
	Porto	Seville	Madrid
Heating demand [kWh/(m²a)]	8.6	6.4	14.1
Daily heating load [W/m²]	4.5	4.1	5.0
Cooling demand [kWh/(m²a)]	-	1.9	0.8
Daily cooling load [W/m²]	-	2.0	2.1

Orientation

In order to make use of passive solar energy, it is advisable to install the majority of windows on the south-facing facade. Other orientations will significantly increase the heating demand. South orientation also reduces the peak heating load of a Multi-Comfort House, because the coldest periods are usually sunny.

East or west orientations have negative impacts in summer, too. The south facade receives less solar radiation than the east and west facades during summer due to the high solar angle when the sun is in the south. Although the windows of the example passive houses have been equipped with efficient exterior shading devices, the simulation shows an increase in cooling demand and cooling load when the buildings no longer face south.

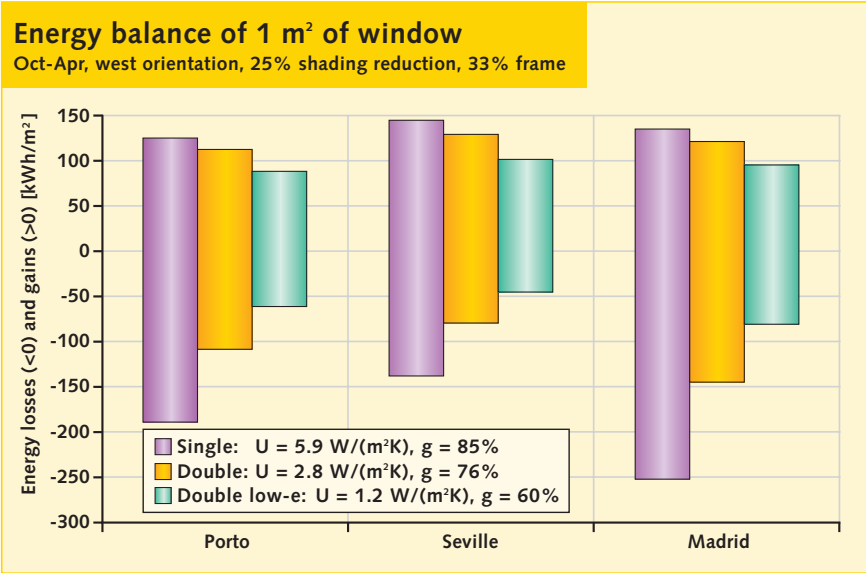
Savings by turning the main facade from west to south			
	Porto	Seville	Madrid
Heating demand [kWh/(m²a)]	6.6	6.7	6.6
Daily heating load [W/m²]	3.5	4.2	1.8
Cooling demand [kWh/(m²a)]	-	0.5	0.3
Daily cooling load [W/m²]	-	0.7	0.3



All single components are

Type of glazing

Glazings with a higher number of panes or with infrared-reflective coatings ("low-e") and noble gas fillings reduce the heat losses. However, these constructions also reduce solar heat gains: more panes absorb more solar radiation, and coated panes absorb more radiation than uncoated ones. The proper glazing type for minimizing the heating demand therefore depends on the location, the window orientation and the shading situation.



In summer, low-e double glazing is always advantageous: it not only reduces transmission heat loads from hot ambient air or hot exterior blinds, but also the solar heat loads.

In spite of the many influencing factors, it can generally be said that the use of double low-e glazing in most cases reduces the total energy demand. Otherwise, the increase is insignificant.

What is more important: Double low-e glazing, due to its lower U-value, provides higher surface temperatures in winter, thus improving thermal comfort. If no radiators are installed to compensate for cold downdraughts, standard double glazing is not sufficient to provide thermal comfort in the vast majority of Mediterranean climates.

Effects of replacing standard double glazing by low-e glazing*, south orientation (positive: savings, negative: additional consumption)			
	Porto	Seville	Madrid
Heating demand [kWh/(m²a)]	0.57	-0.23	1.15
Daily heating load [W/m²]	0.50	-0.16	1.07
Cooling demand [kWh/(m²a)]	-	0.14	0.22
Daily cooling load [W/m²]	-	1.16	0.94

Effects of replacing standard double glazing by low-e glazing*, north orientation (positive: savings, negative: additional consumption)			
	Porto	Seville	Madrid
Heating demand [kWh/(m²a)]	3.14	2.38	4.20
Daily heating load [W/m²]	1.51	1.44	1.66
Cooling demand [kWh/(m²a)]	-	0.24	0.09
Daily cooling load [W/m²]	-	0.88	0.37

*Only the glazing of the main facade has been changed, the latter facing south or north, respectively.

important.

Thermal mass

The availability of thermal mass is generally considered to be one of the most important features in solar architecture and passive cooling. In fact, in a poorly insulated building with purely passive cooling in Porto, the maximum indoor temperature is 33 °C in a very light-weight building (wooden construction with single cladding of walls, 22 mm chipboard ceilings without cement screed), whereas it is 27 °C in a very solid building (11.5 cm exterior masonry

walls, 16 cm interior concrete walls, 25 cm interior concrete ceilings). In a well-insulated ISOVER Multi-Comfort House, thermal mass still has its advantages, but it is not as important as in traditional buildings any more. The same change in thermal mass as described above reduces the maximum indoor temperature from 26.3 °C to 24.5 °C. However, the effectiveness of night ventilation depends on the avail-

ability of a certain amount of thermal mass. The table shows that the most significant reduction in the daily average cooling load is found in Madrid where the maximum cooling load occurs in a period where night ventilation can still be used to a large extent. This shows that the solid or massive structure can have some advantages.

Savings by increasing the thermal mass from light to solid construction*			
	Porto	Seville	Madrid
Heating demand [kWh/(m²a)]	2.6	2.8	2.4
Daily heating load [W/m²]	0.6	2.5	0.5
Cooling demand [kWh/(m²a)]	-	1.8	0.9
Daily cooling load [W/m²]	-	0.8	2.1

*41 MJ / K versus 168 MJ / K

Colours of exterior surfaces

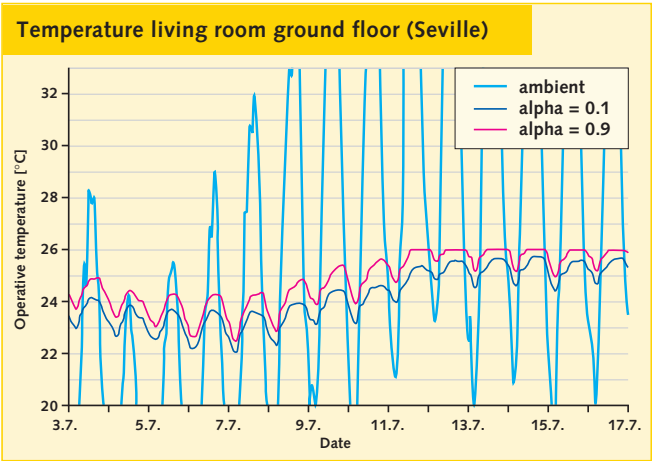
Dark surfaces absorb more solar radiation and become warmer in the sun than light-coloured surfaces. Dark surfaces therefore transfer additional heat to the interior of the building. This effect is probably best-known from comparing the interior temperature of white and

black cars that have been parked in the sun. White exterior surfaces are therefore a well-known feature of vernacular architecture in hot climates. Unfortunately, lighter colours also reduce

Effects of increasing the exterior surface absorption coefficient from 0.1, special white, to 0.9, nearly black (positive: savings, negative: additional consumption)			
	Porto	Seville	Madrid
Heating demand [kWh/(m²a)]	5.0	4.8	5.0
Daily heating load [W/m²]	1.5	2.3	0.5
Cooling demand [kWh/(m²a)]	-	-4.5	-0.9
Daily cooling load [W/m²]	-	-4.4	-3.7

of light colours differ between climates. In a hot climate such as Seville, any reduction in heating demand is compensated by an increase in cooling demand. In Porto, with its relatively cool summers, even very dark colours do not result in a need for active cooling; instead, they are able to reduce the heating demand.

The thermal effects of solar absorption on exterior surfaces are stronger in poorly insulated buildings. Freedom of design is therefore increased in a well-insulated ISOVER Multi-Comfort House.



Ground coupling

Insulation of the thermal envelope to the ground, in this case of the basement ceiling, will reduce the heat losses in winter. As the ground temperature is well below 25 °C in the Mediterranean area, it will also reduce heat losses during summertime, thus creating an increase in cooling demand. Building components adjacent to the ground or unheated base-

ment should be insulated if the annual average temperature is below approx. 15 °C. This is also important in order to prevent very low surface temperatures of the ground floor in wintertime. At higher temperatures, the savings in heating demand and the

Effects of increasing the basement ceiling insulation from 0 to 100 mm (positive: savings, negative: additional consumption)			
	Porto	Seville	Madrid
Heating demand [kWh/(m²a)]	10.1	2.5	10.2
Daily heating load [W/m²]	2.6	2.6	2.7
Cooling demand [kWh/(m²a)]	-	-2.0	-0.5
Daily cooling load [W/m²]	-	-1.9	-2.3

additional cooling demand are more or less balanced.

Movable shading

Exterior blinds like the traditional Persian shutters, roller blinds or Venetian blinds are an excellent possi-



bility to reduce undesired solar loads during hot periods without impeding the desired solar gains in winter. Without the exterior blinds that have been assumed in the calculation, the cooling demand of the Seville example will increase by a factor of nearly 3. The cooling load will also increase significantly – both in Seville and Madrid. In Porto, without a cooling system, the maximum temperature in summer will increase from 25 °C to 27 °C if no exterior blinds are available. Solar con-

Effects of removing the exterior blinds from the example buildings (positive: savings, negative: additional consumption)			
	Porto	Seville	Madrid
Heating demand [kWh/(m²a)]	0.1	0.0	0.0
Daily heating load [W/m²]	0.0	0.0	0.0
Cooling demand [kWh/(m²a)]	-	-6.9	-3.6
Daily cooling load [W/m²]	-	-3.4	-5.6

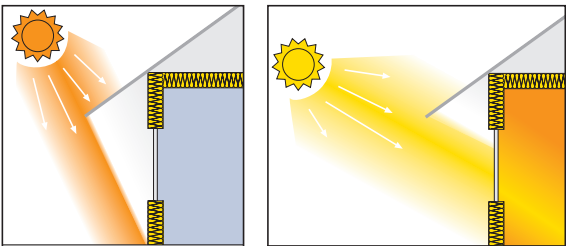
trol glass can help reduce solar gains, too. Compared to movable shading. However, it is disadvantageous as solar gains play an important role in the winter energy balance of Mediterranean houses. In many cases, the increase in heating demand will more than offset the reduction in cooling demand.

Fixed shading

The examples presented here are only slightly shaded by surrounding buildings, other obstacles or the buildings themselves. Most building sites do not benefit from an unobstructed view to the south so that most buildings cannot take full advantage of solar gains in winter. On the other hand, can the exterior blinds possibly be replaced by some fixed, exterior shading elements,

maybe in combination with solar control glass, to ensure thermal comfort in summer? The following table compares the reference buildings to a heavily shaded building with solar

control glass. Due to the important role of solar radiation in the winter energy balance, the heating demand increases dramatically in a heavily shaded environment. At the same time, fixed shading devices are not able to fully replace the



movable exterior shading of the windows, even if combined with solar control glass. Despite the fact that no direct solar radiation reaches the windows any more and that the roof overhang also protects the walls from the sun, the cooling demand is still higher than in the case with exterior blinds.

Effects of a heavily shaded location* + solar control glass, without exterior blinds, as compared to the reference case with nearly no shading* (positive: savings, negative: additional consumption)			
	Porto	Seville	Madrid
Heating demand [kWh/(m²a)]	-20.6	-14.8	-17.9
Daily heating load [W/m²]	-4.8	-6.3	-3.2
Cooling demand [kWh/(m²a)]	-	-1.3	-0.7
Daily cooling load [W/m²]	-	-0.3	-0.8

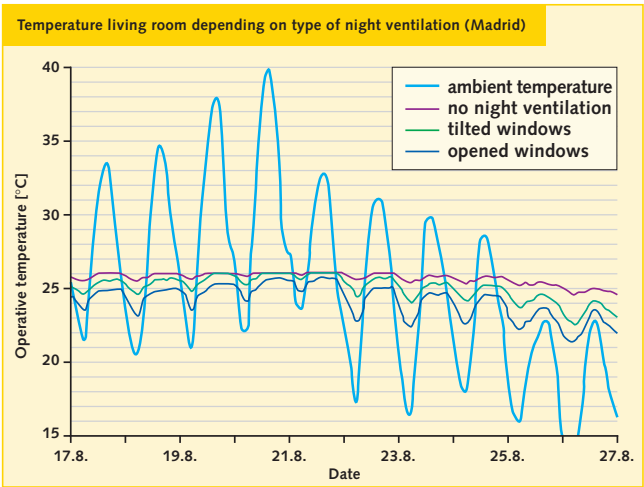
* Heavily shaded: 2 m roof overhang, 75° horizon angle. Nearly no shading: 20 cm roof overhang, 15° horizon angle. The solar control glass has a total solar transmittance of 30 %.

Night ventilation

Opening the windows during the night is important to release excess heat to the outside. Together with good insulation and appropriate solar control, this measure may be sufficient to keep a building comfortable during summer under many climatic conditions. Heating is virtually unaffected by night ventilation, but there is a significant

impact on the cooling demand. In the climate of Madrid, it is even possible to reduce the cooling demand to zero by night flushing with the windows wide open.

Cooling effect of fully opening the windows whenever useful (positive: savings, negative: additional consumption)			
	Porto	Seville	Madrid
Heating demand [kWh/(m²a)]	-0.26	-0.35	-0.35
Daily heating load [W/m²]	0.01	-0.09	0.00
Cooling demand [kWh/(m²a)]	-	3.51	1.13
Daily cooling load [W/m²]	-	1.46	2.98





The Ecological Impact.

Exemplary & sustainable.



- Isover – From nature, for nature
- Gypsum – Flexible and sustainable construction, Placo, Rigips, Gyproc
- Weber – Mineral-based thermal insulation composite systems

From nature – for nature.



Energy-efficient living.

Optimum thermal insulation produces the highest energy savings. But it must also meet the highest demands in terms of workability, quality and ecology. ISOVER has committed itself to fulfil all these criteria and develop the right products. ISOVER glass wool is primarily produced from waste glass. With a share of up to 80 %, this material now substitutes the main raw material quartz sand.

The production of ISOVER glass wool goes easy on our environment. The natural raw materials are extracted in small open-cast mines where the greening starts immediately after finishing the mining activities. Modern manufacturing methods assure that also the next production steps are environmentally sound.

On the safe side of insulation with mineral wool products by ISOVER.

When production is based on a natural raw material, the finished product will also qualify as natural and eco-friendly. Benefits of ISOVER glass wool that speak for themselves:

- safe application and use
- not carcinogenic and not a hazard to health in compliance with Directive 97/69/EC of the European Commission
- free of propellants and pesticides
- chemically neutral
- excellent heat, sound and fire protection
- especially economical in high insulation thicknesses
- non-combustible
- free of flame-retardant, ground water-polluting chemicals
- durable and rotproof
- capable of diffusion



Insulating with ISOVER.



ISOVER products – Exceptionally convenient handling.

ISOVER glass wool not only proves its worth in later energy savings, but as early as in the installation phase. Here, the material shows its strengths, also under economic aspects:

- up to 75 % storage and transport savings due to high compressibility
- easy workability
- dimensionally stable, high tensile strength
- no waste
- straight off the roll onto the wall
- versatile, reusable, recyclable
- easy disposal

From old bottles to welln

What the industry and households discard as useless waste glass is turned by ISOVER into a valuable raw material. ISOVER glass wool consists by about 80 % of recycled waste glass. The other ingredients such as quartz sand, soda ash and limestone are virtually inexhaustible resources. This does not only sound but definitely is ecologically sustainable in many ways. Just a few examples may illustrate the point.

Each built-in ton of glass wool insulation helps us save 6 tons of CO₂ every year.

The use of glass wool does not only help us meet the Kyoto target but also realize energy-efficient living all around the globe. Just consider: The production of 1 ton of glass wool releases about 0.8 tons of CO₂. The annual CO₂ saving that can be realized by building in glass wool amounts to as much as 6 tons. Assuming a useful life of 50 years, we can thus save up to 300 tons of CO₂. And this is 375 times as much as the CO₂ emission caused by production.



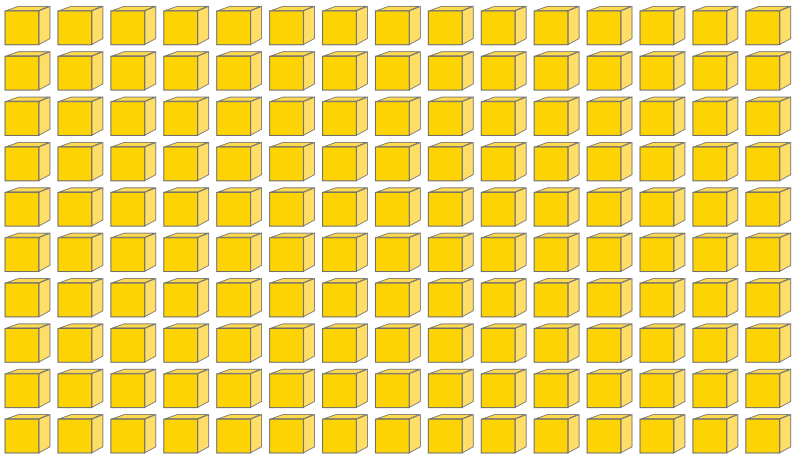
ISOVER turns 1 m³ raw material into 150 m³ glass wool.

This is sufficient to completely insulate a large one-family house from top to bottom in keeping with the passive house standard.

1 m³ raw material



150 m³ glass wool



ess climate with ISOVER glass wool.

Energy amortization

The production and transportation energy needed for glass wool already amortizes within a few days. The example below compares an upper floor slab made of reinforced concrete without thermal insulation with a reinforced concrete floor equipped with 35 cm (λ_D 0.04 W/mK) glass wool insulation (passive house level).

1 m³ upper floor slab		
Structure	Heat transfer coefficient	Energy loss per square meter and year
Reinforced concrete (20 cm) not insulated	U-value = 3.6 W/m²K	360 kWh
Reinforced concrete insulated with 35 cm glass wool	U-value = 0.1 W/m²K	10 kWh
Energy saving per m² and year (thanks to thermal insulation)		350 kWh

Compared to annual energy savings of 350 kWh/m², the energy needed for production, transportation and installation of the insulation material amounts to a mere 22 kWh. The energetic amortization time is less than 10 days.

Glass wool makes short work of application and amortization times.

When compressed into rolls, glass wool can be transported space-saving and quickly. With only little manual effort, it is installed directly from the roll onto the wall.

Glass wool offers further benefits as it is

- non-flammable
- not a hazard to health in compliance with Directive 97/69/EC
- free of propellants, pesticides, flame-retardant chemicals

Take responsibility: build safely with ISOVER.

Always on the safe side: preventive fire protection with non-flammable mineral wool insulation materials made by ISOVER – glass wool, stone wool and Ultimate. Optimum protection of roofs, walls and floors.

www.isover.com



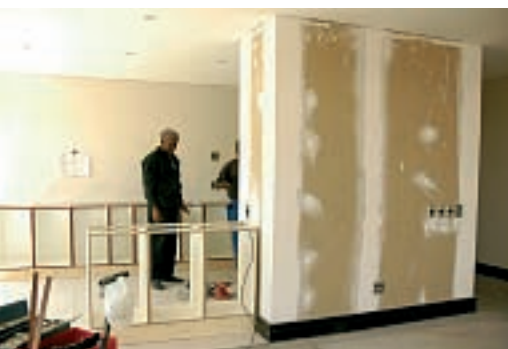
Flexible and at the same sustainable constructi

The future of construction is increasingly determined by people's changing life situations. From one day to the next, nuclear or extended families change into "patchwork families". Flatshares shrink into single households, grow newly, only to disintegrate again and so on. These developments call for flats that can be adapted to the ever-changing needs of their occupants – with minimum resources and costs and the lowest possible impact on our environment. In order to provide space for these constant changes, the required planning and construction processes must break with traditional patterns. Here a couple of model approaches:

- Urban as well as rural space programs, site development and traffic

areas, the increasingly dense infrastructure, the equipment of buildings adapt to the constantly changing forms of human coexistence.

- Structural masses are drastically reduced, thus generating material and energy savings – from the construction right up to the operation of a building.
- Operational costs of buildings are decreased by making use of passive and active energy systems.
- Structural components have multi-functional properties and are integrated into the overall insulation of the building.
- Sustainable housing construction balances the input side (resources, energy, materials, area etc.) against the output side (emissions, waste disposal).



Prepared for almost all eventualities with plasterboards by Saint-Gobain.

Where a solid shell is integral part of a building's structure, rooms can be designed with light and dry gypsum building elements in a particularly economical, flexible and environmentally compatible way. For example the

ISOVER Multi-Comfort House. Spot-precise and flexible – this is how the interior design can be realized. And should it later become necessary to adapt the interior to changing individual needs, this can be done fast and at

time on? No problem at all!



low cost. Renovation is, of course, possible any time. Saint-Gobain plasterboard systems are the ideal solution when children's rooms need to be built in or removed again, for shifting doors, removing partitions and for many other rearrangements of room layout. All this can be done fast, clean

and above all "dry" so that the residents can safely stay in their ISOVER Multi-Comfort House during the reconstruction work.

Light – strong – efficient.

When realizing building projects, Saint-Gobain system solutions based on gypsum turn out to be real lightweights. At a weight of only one fifth to one tenth of massive walls, living space can be generated in almost any building: without sacrificing living comfort or load-bearing strength. In any case, lightweight elements relieve



the building's static stress, triggering a chain reaction of advantages especially for multi-storey buildings. Material cost is reduced. Manufacturing and transport energy is saved. The slimmer construction generates up to 6 % extra space for living.



Gypsum-based innovative Best realized in the ISOV



Just like the ISOVER Multi-Comfort House, the gypsum-based system solutions offered by Saint-Gobain considerably contribute to reducing the consumption of resources and the emission of greenhouse gases. Thanks to their long service life, they save much more energy than needed for their production. And if finally the time for recycling should have come, the environmentally friendly plasterboards can even be returned to the production cycle or dumped in a non-polluting way.

Healthy living guaranteed by nature.

Being a natural building material, gypsum has proven its qualities for millennia now – far more than any other material: it controls the level of air humidity, is fireproof, provides a comfortable climate and is flexible in use. Worldwide, thousands of build-

ings and millions of people benefit from these natural properties. On the one hand, gypsum is a material that ensures fast, clean, space-saving and inexpensive construction. On the other hand, it provides high-quality living space with a dry, healthy climate – even for people suffering from allergies.

Combined quality and design.

When using gypsum products and systems, every flat and every office building can be made to look identical. But that's not how it needs to be. With plasterboard systems by Saint-Gobain it is so easy to be creative – without any



ifs or buts. For example, curved walls or single round arches can be realized with little effort and expense. Neither the completely cornerless flat nor stucco ceilings or avant-garde stairways need to remain unfulfillable dreams. And if you'd later like to create a walk-in wardrobe, this can be done fast and easily with Saint-Gobain plasterboards.

building concepts. ER Multi-Comfort House.



Based on a versatile raw material, Saint-Gobain provides manifold system solutions.

Regardless of the structural requirements, Saint-Gobain offers gypsum products and systems that satisfy the highest demands: solutions that enhance the acoustic and thermal comfort and at the same time reduce energy bills. Perfect for every ISOVER

Multi-Comfort House. Fit for the present and the future.

www.rigips.com
www.gyproc.com
www.placo.fr
www.placo.es
www.bpbitalia.it

To the point:

Gypsum and its traditional advantages.

- *Humidity control: If the room humidity is too high, gypsum stores excessive moisture in its pores and releases it again to dry room air.*
- *Fire protection: If the worst comes to the worst, the fire-resistant properties of gypsum take full effect. Its natural water content of about 20 % acts like built-in extinguishing water and helps prevent the worst.*
- *Audibly quiet: Even in a cramped space, products made of gypsum provide acoustic quality that massive walls can only achieve with much thicker walls.*
- *Aesthetic, flexible, economical: Gypsum offers a maximum of creative freedom, allowing clever and individual structural solutions. Already the ancient pyramid builders appreciated its special qualities. Any structural indoor change can be conveniently realized with plasterboards. Without drying times – and at a price that favourably compares both with respect to material and processing costs!*

Energetic, visual and fina mineral-based thermal



In order to achieve the passive house standard in hot countries, the outer wall must have a U-value between 0.20-0.45 W/m²K. Depending on the heat-insulating properties of the load-bearing outer walls and on the thermal conductivity of the insulation material used, it may be necessary to install an external thermal insulation system of up to 30 cm thickness. Modern external thermal insulation composite systems (ETICS) based on mineral raw materials combine best insulating properties with ease of handling.

Compared to conventional insulation systems, the additional expense pays off after only a few years, thus enabling house owners to save a lot of money in the long run and go easy on our environment.

Good for the outdoor and good for the indoor climate.

Especially the completely mineral-based insulation systems of Saint-Gobain Weber are ideally suited for

passive homes. This is due to their "natural" origin as well as their high-quality composition. All components of the external thermal insulation



ncial benefits: with insulation systems.

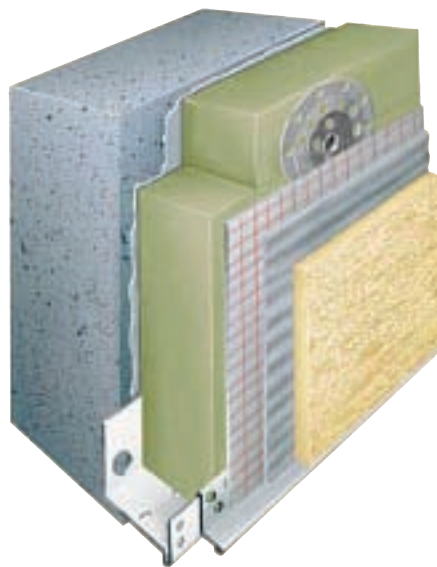
system such as adhesive and reinforcing mortar, insulation material and finishing render are exclusively made of naturally occurring mineral raw materials. Finishing mortars as for example the mineral scratch render contain above all silica sand, calcium hydrate, white cement and crushed Jurassic limestone.

This has numerous positive effects for passive homes and their residents. Best climate, for instance. Due to the natural, moisture-controlling properties, the masonry remains capable of diffusion despite the very high level of thermal insulation. As a result, the residents are able to enjoy a comfortable room climate while consuming only minimum amounts of energy. At the same time, they can rest assured of long-term protection against fungi and algae. An increase in value for the passive home. A higher quality of life for the residents.

Beautiful living with added safety.

No matter whether it's new buildings or old ones whose facades need to be refurbished to reach the passive house standard – the mineral-based thermal insulation composite systems of Saint-

Gobain Weber always show their multifarious advantages. Not only can excellent thermal insulation be realized but also best sound and effective fire protection – "all in one go" so to speak.



And there's the aesthetic appeal on top of it.

It is true that meanwhile numerous possibilities exist that allow an individual facade design. But it is also true that since the days of antiquity only mineral mortar has been able to stand the test of time – both technically and aesthetically. A fact which is also proved by the following comparison: While buildings with a non-mineral

facade need to be renovated after an average of 8 years, the renovation interval for facades with mineral wool insulation and mineral scratch render is 30 years and longer!

To the point:

These benefits can be expected of mineral-based thermal insulation composite systems from Saint-Gobain Weber.

- Perfect external and internal insulation
- Moisture control and capability of diffusion
- Maximum fire protection
- Optimum sound insulation
- Excellent resistance against the growth of fungi and algae
- Long service life
- Multitude of possible designs – even for old buildings
- Rapid and cost-saving workability

You want to learn more about the broad product range of Saint-Gobain Weber? For further information please refer to www.weberbuildingsolutions.com

The Service.

Well-founded & efficient.



- Addresses and contacts
- Selected literature

So just where can I find the ISOVER

Every year, thousands of people gain positive experience.

So far, more than 8,000 passive homes have been realized in Germany and well above 2,800 in Austria. All over Europe the number of new projects is constantly growing as well: there's no stopping the advance of energy-efficient construction. The future lies with the ISOVER Multi-Comfort House. In every location. For every purpose. And with best prospects – also for You!



Best addresses for best information.

In the meantime, a wide network of communication, information and further training on passive house construction has been established. Many initiatives support the idea of energy-efficient building and living. Experienced engineers, architects, manufacturers, applicators and research institutes as well as satisfied building project clients pass on their knowhow and experience.

www.ig-passivhaus.de
www.igpassivhaus.at
www.minergie.ch

Inform yourself on these websites about the advantages offered by passive houses, about quality criteria and available subsidies, about realized building projects and experiences made by the residents. Find suitable

partners for your own projects and exchange your views with architects, engineers, scientists and housebuilders. Benefit from the latest news and information made available to you by regular press releases, circular e-mails and forum contributions.

Multi-Comfort House?

**The higher the demand,
the better the solutions.**

Today, many passive house components are already part of the standard portfolio offered by the building industry and the trades. The passive house will soon become a reasonably priced standard solution.

Under www.isover.com ISOVER offers you many constructive solutions to the problems of thermal and acoustic insulation.



www.passiv.de

Consultancy and Passive House Certification. The top address for all those who want to make sure their project is properly planned with the help of the Passive House Planning Package (PHPP) and is certified to fully comply with the passive house standard.

www.ig-passivhaus.de

Information community for the passive house in Germany. Network for information, quality and further training.

www.passivhaus-info.de

Passive house service provider.

www.passivhaustagung.de

International Passive House Conference. Create a sustainable building culture based on the passive house concept.

www.passivhaus-institut.de

Welcome to the Passive House Institute. Research and development of high-efficiency energy systems.

www.passivhausprojekte.de

Realized passive house projects.

www.cepheus.de

Cost-efficient passive houses as European standards.

www.eversoftware.de

Energy Consultancy Center. Your partner for innovative energy consultancy.

www.blowerdoor.de

Systems for measuring airtightness.

www.optiwin.net

"Der Fensterpakt" – window systems for low-energy and passive houses.

www.passivhaus.de

Basic and comprehensive information on the passive house topic.

The Service.

www.nei-dt.de

Niedrig-Energie-Institut (Low-Energy Institute). Service provider for building consultancy and building research with the focus on energy-related construction issues.

www.sole-ewt.de

Brine geothermal heat exchanger for ventilation systems with highly efficient heat recovery.

www.passivehouse.org.nz

New Zealand Passive House.

www.igpassivhaus.ch

Information community for the passive house in Switzerland. Network for quality, information and further training.

www.pasivna-hisa.com

The first passive house in Slovenia.

www.minergie.ch

Minergie Switzerland. Higher quality of life, lower consumption of energy.

www.passiefhuis.nl

Passivhaus Holland. Passive House technology in the Netherlands.

www.passiefhuisplatform.be

Passive house projects in Belgium

www.pasivnidomy.cz

Passive House Center of the Czech Republic.

www.e-colab.org

Ecological Construction Laboratory.

www.passivhaus.org.uk

Passive House UK. Towards sustainable design.

www.europeanpassivehouses.org

Promotion of European passive houses.

www.energyagency.at

Austrian Energy Agency.

www.igpassivhaus.at

Information community for the passive house in Austria. Network for information, quality and further training.

www.oekobaucluster.at

Green building cluster of Lower Austria. The central hub for the topics energy efficiency, living comfort, indoor air quality and old building renewal.

www.nachhaltigkeit.at

The Austrian strategy for sustainable development.

www.dataholz.com

Collection of data sheets providing information on building materials, timber constructions and building element connections.

www.energieinstitut.at

Energy Institute of Vorarlberg / Austria. Consultancy, education and research for the rational use of energy and renewable energy carriers.

www.energytech.at

The platform for innovative technologies in the areas of renewable energy sources and energy efficiency.

www.klimabuendnis.at

Climate alliance Austria.

www.passivhaustagung.at

International Passive House Conference.

www.drexel-weiss.at

Energy-efficient domestic engineering. Thought leaders in the energy turnaround.

www.lamaisonpassive.fr

The French home page for passive houses.

www.passivehouse.us

Passive House Institute US | PHIUS. PHIUS is authorized by the Passive House Institute as the official certifier of Passive House standard in the US

Selected Literature.

Books and brochures

Gestaltungsgrundlagen

Passivhäuser

Dr. Wolfgang Feist

Building principles for houses where a special heating system is superfluous. A handbook for planners and architects.

Publishers: Das Beispiel GmbH

Luftdichte Projektierung von Passivhäusern

Passivhaus Institut / CEPHEUS

Planning principles and construction details for airtight connections with numerous pictures – example: passive house.

Grundlagen und Bau eines Passivhauses

Practice-oriented guide for developers and planners.

Publishers: Dieter Preziger, Ökobuch Verlag und Versand GmbH

Passivhäuser planen und bauen

Specialist book on basic principles, planning and construction details of passive houses.

Publishers: Carsten Grobe, Ökobuch Verlag und Versand GmbH

Niedrigenergie- und Passivhäuser

Published by Othmar Humm

The future-oriented technologies used in low-energy and passive house building styles, including realized building projects in solid and light-weight construction.

ISBN 3-992964-71-0

Das Passivhaus – Wohnen ohne Heizung

Anton Graf

Examples of passive houses from Germany, Austria and Switzerland.

Publishers: Georg D.W.

Callwey 2000

ISBN 3-76674-1372-8

Cepheus – Wohnkomfort ohne Heizung

Helmut Krapmeier, Eckhart Drössler

Documentation of 9 Cepheus building projects.

Publishers: Springer Wien –

New York

Das Passivhaus

Ing. Günter Lang, Mathias Lang

Basic planning, construction and calculation principles.

Publishers: Lang Consulting / Wien

Publikationen des Passivhaus-Instituts

Topic-related publications, conference proceedings, specialist journals and calculation software (PHPP Passive House Planning Package).

Supply source:

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www.passiv.de

This brochure is meant as a quick guide to help you find useful information on the passive house design. The information given in the brochure is based on the current state of our knowledge and experience and was carefully compiled. Should any incorrect information be provided, a deliberate or grossly negligent fault from our side can be excluded. Nevertheless, we do not accept any liability for the topicality, correctness and completeness of this information since unintentional faults cannot be excluded and continuous updates not ensured.

The brochure contains the Internet addresses of other companies and third parties. These have been included to help you get a complete overview of the spectrum of information and services available. As the contents of these websites do not necessarily reflect our views or position, we must therefore exclude any liability.



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www.isover.pt

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DK-6580 Vamdrup
www.isover.dk

Saint-Gobain Insulation
"Les Miroirs"
92096 La Défense Cedex
France
www.isover.com



Energy-efficient living.

By using the innovative ISOVER insulating materials you simply ensure a better climate: in our environment as well as in your home. You reduce the consumption of energy while at the same time increasing your well-being and comfort. Can there be a more convincing argument?

Build on ISOVER. Show responsibility for our environment and for yourself!