Implementing deep energy step-by-step retrofits

EuroPHit | Increasing the European potential

Implementing deep energy step-by-step retrofits

EuroPHit: Increasing the european potential

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Foreword

Pat Cox
Former President
European Parliament

This project is designed to raise consciousness, to inform and to stimulate a response by policy makers, financing bodies and product developers to promote an innovative ecosystem committed to deep energy retrofits of our inherited building stock.

Old and inefficient buildings have been identified as one of the biggest contributors to energy wastage in the EU. Improving energy efficiency is one of the pillars of the EU's policy response to addressing the challenges of climate change and the reduction of greenhouse gas emissions.

This easy to read brochure, which is EU funded, draws on the lessons of demonstration projects implementing deep energy retrofits in a step-by-step manner across 11 EU Member States. These have been developed to the EnerPHit Standard – the Passive House retrofit Standard. As regards retrofits the time now has come to shift a gear and to move from demonstration projects to mainstreaming.

The Passive House Standard is an evidence-led, scientifically robust, international low energy design methodology. Its worth has been proven in practice over the past quarter century. Those construction professionals from design through to delivery who advocate this standard are not simply expressing personal opinions but can point to the system's proven worth over time through careful scientific observation and abundant supporting evidence.

Passive buildings are near zero energy buildings and would over time make a significant contribution to reducing the EU's dependence on imported fossil fuels and to the achievement of its climate change targets and international commitments to lower greenhouse gas emissions. It is a standard supported by the UN Intergovernmental Panel on Climate Change (IPCC). At the level of individual projects the air tight thermally sealed insulation envelope of a passive retrofit ensures high levels of energy efficiency and optimises the thermal efficiency of natural light and heat which is the constant gift of the ambient environment. The counterpart of high energy efficiency is low fuel consumption for heating purposes. This too is a gift and one that keeps giving to the building's occupiers. A passive building is a more economic one to live and work in.

A low energy mechanical heat recovery system fitted with air filters ensures constant renewal of high quality airflow throughout the building. From a health point of view the quality of the circulating air and the ventilation system eliminates all internal dampness and ensures a healthier environment for anyone suffering from asthmatic conditions. A passive building is a healthier one to live and work in.

To achieve passive certification the building must pass an airtightness test conducted by a third party unconnected to the builder thus assuring externally validated quality control. A passive building is a quality assured one to live and work in.

Passive buildings offer a measurable and positive life cycle rate of return in terms of energy efficiency and health benefits. They are ideally suited to Europe's latitudes. They are a bridge to a more energy secure and less energy dependent future for the EU and its citizens. They represent an investment in self-reliance, privileging European human capital and know how over expensive and potentially vulnerable imported energy.

It is time now to raise our collective game, to get going and to develop the financial, production and professional ecosystems in sufficient depth and scale to rise to meet this challenge. This brochure is a contribution to that journey to a more resource efficient, climate adjusted and user-friendly construction philosophy and capacity.

Foreword

Europe is on the leading edge of the energy transformation towards renewables and efficiency. It has been realized, that this is one of the most important tasks in order to create a sustainable future.

The single most energy consuming service within the EU is thermal comfort control in buildings; the highest part of which is heating, accounting for at least 30% of the European energy demand. At the same time, the heating demand is also concentrated during the winter months - the time period where renewable energy is not abundant at all.

Dr. Wolfgang Feist
Director of the
Passive House Institute
Professor at Innsbruck
University

But there is good news: in the past 25 years significant progress has been made in the development of new buildings with very low heating demand. The Passive House Standard, first demonstrated on a large-scale in the European "CEPHEUS" project proved that a reduction to less than 15 kWh/(m^2a) is possible everywhere in Europe. Good experience with Passive House buildings was one reason for the European Commission to state the Nearly Zero Energy Building (NZEB) as the goal in the second decade of the 21st century. Heating demand in new buildings can be reduced by more than 80% compared to the existing average using the Passive House concept.

With this success for new buildings, there will be no problem with the additional energy demand of new construction - buildings with such an efficiency can easily be supplied with renewable energy.The real challenge now is the existing building stock - mainly built during times where energy seemed to be abundant and cheap and efficient components were not available on the market, these buildings consume between 150 and 250 kWh/(m^2a), about a factor 10 more than well-designed NZEBs.

Now there is more good news: existing buildings can be improved during a thorough retrofit process. All the measures, which have been proven successful in the construction of new NZEB's can also be applied for retrofits.

The only "problem" with that is that existing buildings have their own dynamics - these buildings are not static as many people think. Building components have to be retrofitted anyway from time to time. These events are the exact opportunities to not just replace an old component, but to improve their efficiency at the same time. If the improvement is not done at this time, it will be a lost opportunity. Therefore, it is really important to make the future-proof decisions at each of these refurbishment steps: "if you do it, do it right".

Acknowledging the fact that building components are refurbished according to their own dynamics and often at different times, EuroPHit demonstrated how even in such a situation a deep energy retrofit can be achieved. The key for this is the EnerPHit Standard: using Passive House components in each single step of the refurbishment chain will reduce the energy demand step-by-step. Using the PHPP as the planning tool, the overall goal is kept in sight. Well-planned deep energy retrofits, ensure cost-effectiveness, longevity and comfort.

The pilot projects within EuroPHit and showcased in this brochure, show that it is possible and desirable to undertake retrofit projects of all kinds. The concepts and examples developed within the framework of this project set a path for the European Union and its Member States to reduce energy consumption significantly in their existing building stock. This can only be achieved through smart policies, financing schemes that value and recognize the long-term potential, and forward-thinking product manufacturers. Examples at all levels are described here in this brochure with an eye towards the future, and sets the way forward for these institutions, individuals and relevant market players.

|1| + |2|

Deep energy retrofits: the European potential

EnerPHit Retrofit Plan and PHPP

Deep energy retrofits: the European potential

Buildings within the European Union are responsible for 40% of total energy consumption and 36% of CO_2 emissions. The European Commission has estimated that 75% of Europe's buildings are inefficient and it has pushed for energy efficiency to be prioritised by policy makers.

With more than 200 million buildings in need of energy retrofits, many will require deep retrofitting if the EU`s 2020 targets are to be fulfilled. The majority of the energy is used in heating and cooling. Deep renovation, improving the building envelope and applying Passive House technologies and concepts can save over 80 % of the energy requirement of those buildings.

The EU has introduced legislation to ensure that buildings consume less energy. A key part of this legislation is the Energy Performance of Buildings Directive first published in 2002, which required all EU countries to enhance their building regulations and to introduce energy certification schemes for buildings. At the same time, the refurbishment of the building stock provides an opportunity to create local jobs, stimulate the economy and generate savings.

While these figures show that the potential to reduce energy consumption through improving our building stock is huge, many barriers remain to turn these policy goals and recommended steps into real action.

Some of the barriers include, a lack of demonstration projects to such levels of deep energy improvement (achieving Passive House or EnerPHit Standards), lack of suitable products and professionals to meet the energy requirements, national and local policies which do not align with EU policy goals and lack of appropriate funding mechanisms, both from the private and public sectors. Other barriers include disturbance of inhabitants during the renovation process, motivation of building owners and an inability to perform deep retrofits to an entire building all at once, typically due to financial constraints.

The EuroPHit project and the accompanying capacity building activities undertaken throughout, looked to break down some of these barriers to provide a model to transform the existing building stock into one geared towards a sustainable energy future.

The project looked at implementing current know-how into pilot projects across the EU, including the development of a long-term retrofit planning tool and certification scheme, consulting and supporting industry to develop suitable products, and engaging with the financial industry to study existing best practices for investment and funding and potential future models.

To achieve EU policy goals, it is ideal for a building retrofit to be performed all at once. The reality for many building owners however, is that it is financially and logistically not feasible to complete an entire deep energy retrofit in one step. More common, are partial retrofit steps, completed on a building over time, also known as step-by-step retrofits. In fact, 80-90% of all retrofits undertaken are retrofit measures rather than complete one-time deep energy refurbishments. Specifically for this type of retrofit, an overall and well-thought out plan right from the beginning is therefore crucial to the final energy savings when all retrofit steps are complete. As the most viable strategy of a building retrofit is a step-by-step approach, the best technologies should be implemented every time when refurbishment activities are undertaken. For each building this requires a lifecycle concept and a long-term strategy. These long-term plans must be tailored to individual buildings and their specific requirements, so as not to jeopardize future steps or to ensure that they are adequate for other steps to be carried out in the future and avoid not being able to further improve, also known as the lock-in effect.

Taking into account that most retrofits are carried out in a step-by-step manner, it is important to understand the consequences of lock-in effects: retrofit processes started now with shallow measures cannot achieve a high level of energy efficiency in 20-30 years. The risk is that by 2050, the reduction of the energy demand of the building stock will

Figure 1 shows the heating demand per m² of a house comparing shallow and deep energy retrofit measures following various retrofit steps over years. In the end, the house with the shallow measures applied has a heating demand 3 times as high as that of the deep retrofit measures.

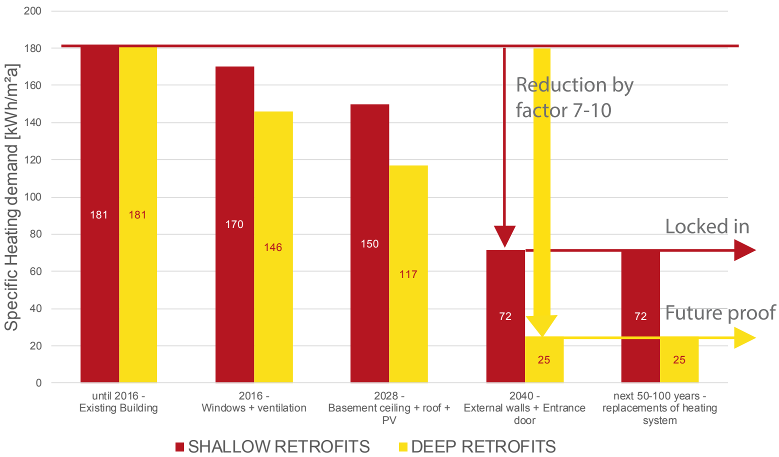


Figure 1:
Moderate or Deep Retrofits?
© Passive House Institute

only be 50-60%. As the life cycle of most building components, especially those of the building shell, last 40-60 years, no further improvements of this moderate efficiency would be expected in the next decades. It is thereby crucial to start with deep retrofit measures now in order achieve future-proof efficiency levels. Only by doing so will it be possible to make our building stock fit for a sustainable energy supply.

The EuroPHit project aimed to significantly increase the quality and energy efficiency of step-by-step retrofits throughout the EU by developing a comprehensive and integrated methodology, implementing uniform quality assurance of both design and construction, encouraging implementation by key actors and fostering knowledge dissemination through new and existing project networks.

The project worked with 14 partners in 11 EU-Member State countries over a period of 36 months. A minimum of 10 pilot projects were also agreed upon to test the overall refurbishment. Within the EuroPHit project, a selection of residential and non-residential buildings across Europe were selected to be retrofitted according to Passive House principles. There are currently a total of 20 pilot projects in 9 countries involved in the EuroPHit project. Of these, 11 have already completed first retrofit steps. Through the EuroPHit project a total of 40,000 m² of floor area are planned to be retrofitted with a budget of more than 26 Million € for the first steps.

This brochure is intended to bring the results and lessons learned of these activities to the foreground for relevant policy makers, financing institutions, product manufacturers and other stakeholders such as building owners and building associations.

Why efficency first?

The ability for the remaining energy demand to be covered by renewables will be limited if efficiency levels are not prioritized, specifically when greater demand for heating occurs over winter, when less renewable energy is generated and storage losses make it difficult to have a sufficient amount available.

EnerPHit Retrofit Plan and the Passive House Planning Package (PHPP)

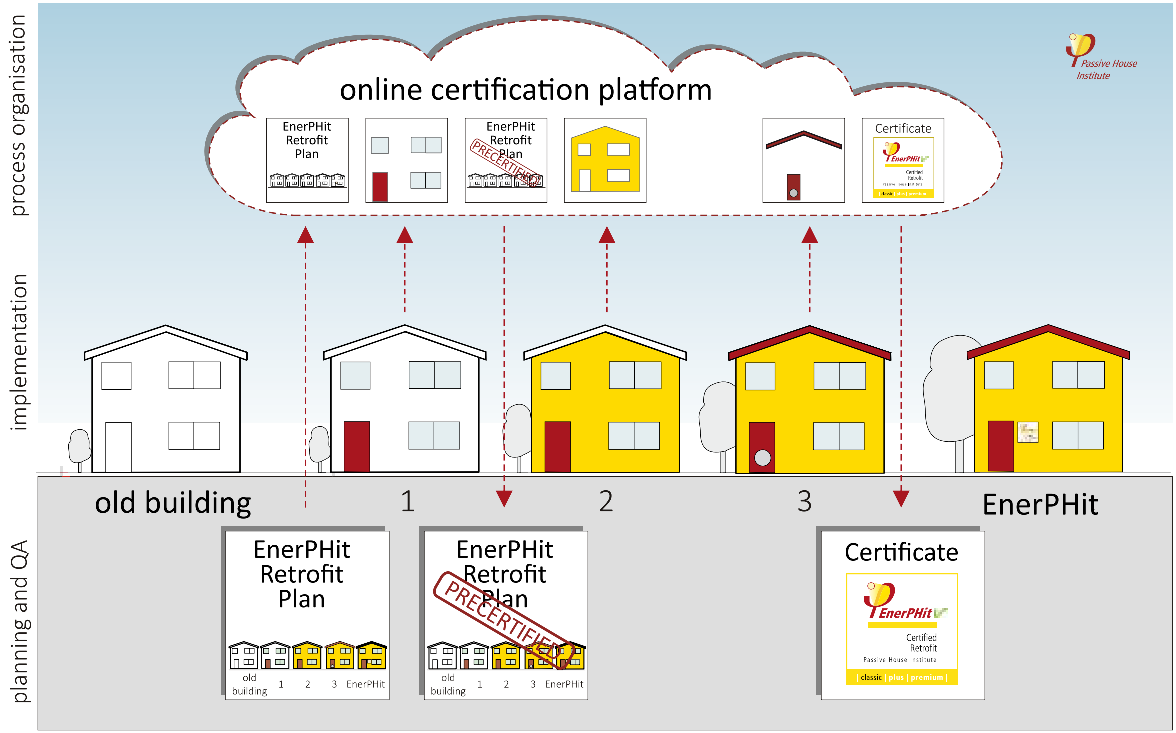
Figure 2:
Energy retrofits are usually carried out in several steps
© Passive House Institute

The challenge in step-by-step retrofits is to reach an optimal energy efficiency standard for the whole building after completion of all individual retrofit steps.

In order to reach this aim, all steps need to follow a common master plan. Such a plan should be devised before the first step is tackled. It includes information about order and quality of all energy retrofit measures as well as general definitions of the position of the airtightness layer and the thermal insulation layer in each part of the building envelope. If of two adjacent parts one is modernized some years before the other, a technical connection detail that works well during all phases should be developed. Other types of interdependencies between energy efficiency measures should also be considered carefully. An example of this is when installing new airtight windows, a heat recovery ventilation system is advisable to be safe from overly humid air and mould growth.

A well-thought-out master plan is not only indispensable for a good final result, it also helps keep the overall costs low. Costly alteration works because of a short-sighted earlier measure can be avoided and energy costs are gradually reduced to a minimum.

In EuroPHit a feasible approach for such a master plan has been developed:



the EnerPHit Retrofit Plan (ERP). The concept includes a template, a calculation tool, an online platform and an explanatory handbook amongst others. For energy consultants and architects the ERP is a great tool for efficient and well-structured planning of step-by-step retrofits. The building owner receives a copy of the ERP to keep for future reference.

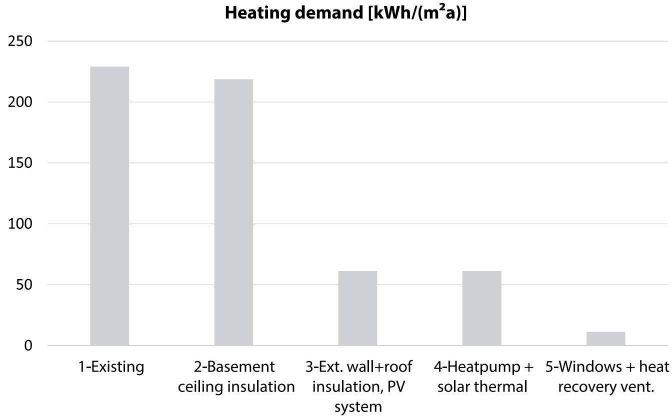
High-efficiency retrofits to the EnerPHit Standard differs from standard retrofits in a higher quality of design, workmanship, and construction

Figure 3:
Schematic representation of the EnerPHit certification process for step-by-step retrofits
© Passive House Institute

components. In order to ensure that the necessary quality is actually met, a third party check can be helpful. This is exactly what the Passive House Institute and its accredited certifiers offer with the EnerPHit precertification for step-by-step retrofits. Precertification includes a thorough check of the ERP as well as the detailed design documents for the first step. Once this first step is completed, a preliminary EnerPHit certificate can be issued. An online platform facilitates and structures the data exchange and communication between energy consultant and certifier. The precertification gives planners and building owners the certainty, that the desired energy standard will actually be achieved after the last step will have been completed. If a building is meant to achieve a specific target energy standard, an energy balance calculation tool is essential during the planning process. With such a tool, the

Figure 4:
Version 9 of the Passive House Planning Package includes new useful features for step-by-step retrofits
Photo: Loft building in Lüneburg © Cyrill Rückner | Oliver Rückner | Andreas Gäde

easiest and most cost-effective way to reach this standard can be found. The Passive House Planning Package (PHPP) is an easy-to-use tool for energetic planning of new buildings and retrofits. It has been continuously developed since the 1990s and is validated for high efficiency buildings as well as for evaluation of existing buildings with high energy consumption.



For the ERP, once the first bundle of energy efficiency measures has been carried out and has gone through quality assurance the precertificate is issued. Quality assurance can be continued for future steps. After the last step has been implemented and checked, the full certificate can be issued.

Figure 5:
Development of the heating demand per m² of an end-of-terrace house over several retrofit steps.
© Passive House Institute

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Practical implementation: projects + case studies

Home for the Elderly – Dún Laoghaire, Ireland

Lessons learned:
An airtightness test should be carried out at the design stage. This test involves a detailed examination of air leakages throughout the building and must be followed by recommendations on how to better eliminate existing leaks.

These recommendations need to take into account feasibility on site of different airtight taping options and craftsmen skills. As this building is to be externally insulated, the airtight layer can be on the outside of the existing fabric of the building, therefore on the warm side of the construction. This avoids the risk of condensation along the airtight layer (see schematic section below showing airtight journey from design stage to construction stage).

The existing floor slab is to be kept as it is - not insulated. The heat loss through the floor slab will be reduced by externally insulating the existing foundation vertically down to the top of the foundation. In order to assess energy balance calculations, it is important to know the dimensions and conditions of existing foundations, in particular how deep these go into the ground. This exercise must be carried out at the design stage to avoid miscalculations on thermal bridges and the PHPP results, generally.

Figure 6:
View of airtight layer being applied on new roof metal deck
© Mariana Moreira

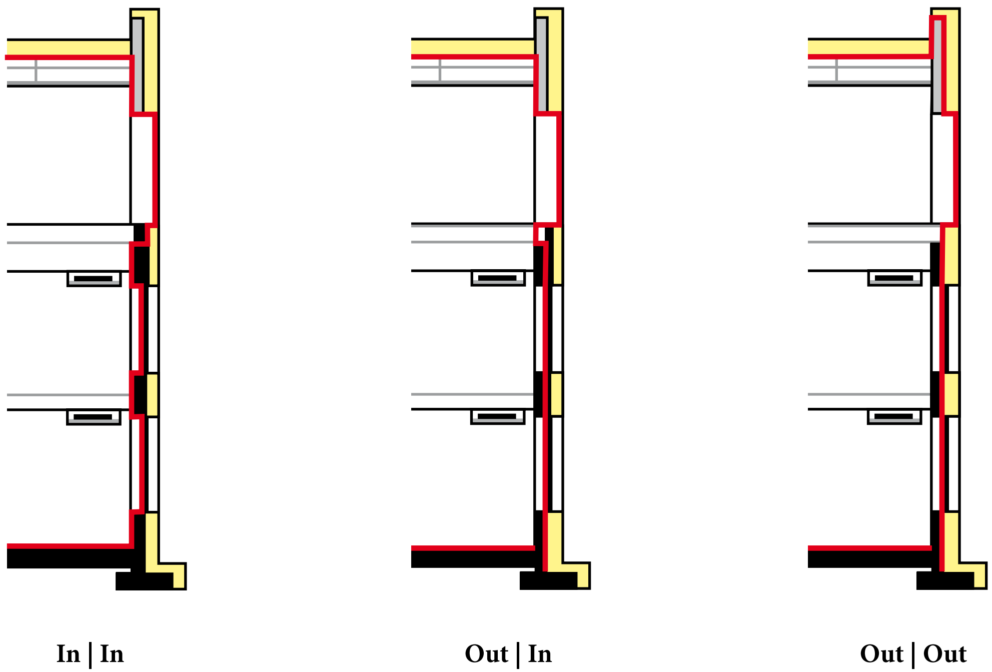
Figures 7-12:
existing view of front/Northwest façade; view of airtight layer being applied on new roof metal deck; external insulation on existing concrete panel; concrete panel view showing new window fitted and taped, HRV ducting taped and external insulation wrapping these around; current view of Northwest façade.
photos © Mariana Moreira

Design stage_airtight line_along inside face of the existing concrete structure. Internal render on the aerated block to be the airtight line on the second floor.

Construction stage_airtight line_ along outside face of the existing concrete structure. Internal render on the aerated block to be the airtight line on the second floor.

Agreed_airtight line_along outside face of the existing concrete structure. External render on the aerated block to be the airtight line on the second floor.

Figure 13: Airtight line stages
© Mariana Moreira



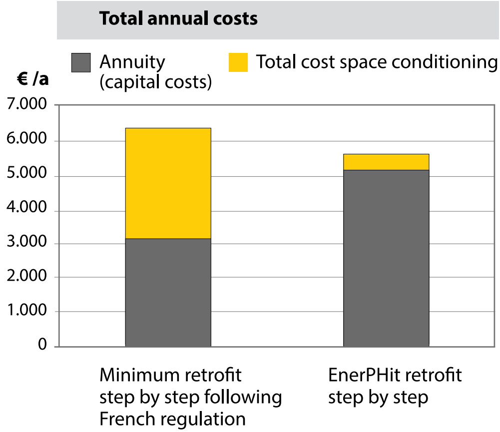
Bulgaria

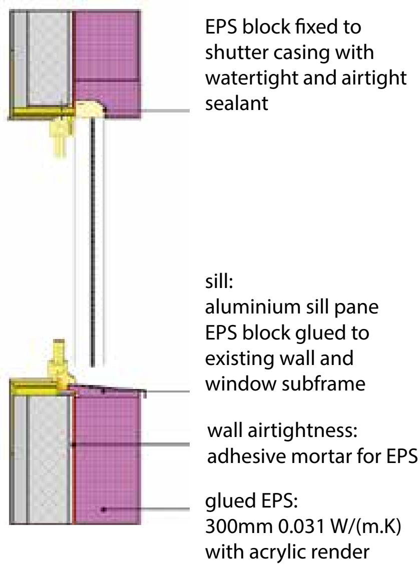
Subsidies for the renovation of heating systems and for replacing windows have been provided for the public sector in Bulgaria in the last few years. The school in Gabrovo is one of many buildings, in which these measures have already been implemented and are now pending complete renovation. However, the municipality of Gabrovo has the ambition to go beyond current regulations in order to achieve the EnerPHit standard.

Apart from the overall shortage in financing, the focus of granted money for the renovation to class C still represents a significant barrier for deep renovation. For higher levels of energy efficiency one should rely on their own resources. The limited grant financing from EU programmes will be supplemented and facilitated through the implementation of a step-by-step approach in the renovation process.

Municipalities face significant difficulties in preparing and carrying out public procurement procedures for both the design and the construction processes. Insufficient knowledge and experience hamper the introduction and application of higher criteria for the selection of designers and builders, as well as for the evaluation of outcomes. The evaluation of offers on the basis of the “lowest price” principle and the lack of similar examples in the country create additional obstacles.
In order to turn the renovation of “St. Kiril And Methodius” primary school into an inspiring example of deep step-by-step renovation, theoretical and practical training of the designers and craftsmen, as well as on-site consultancy services are required.

Figure 14 + 15:
St. Kiril And Methodius”,
Primary School, Gabrovo
© EnEffect


Total annual costs
Annuity
(capital costs)
Total cost space conditioning
€ /a
7.000
6.000
5.000
4.000
3.000
2.000
1.000
0
Minimum retrofit
step by step following
French regulation
EnerPHit retrofit
step by step


EPS block fixed to
shutter casing with
watertight and airtight
sealant
sill:
aluminium sill pane
EPS block glued to
existing wall and
window subframe
wall airtightness:
adhesive mortar for EPS
glued EPS:
300mm 0.031 W/(m.K)
with acrylic render

Pilot project retrofits in France

The step-by-step approach convinced a family in Tournon to start an ambitious retrofit without pausing their business or moving house while the work was being completed. The first step concerned insulation and airtightness in the basement, as it could only be done little by little during summer and autumn. The next step in their retrofit plan consisted of roof insulation from the outside, then the addition of a new ventilation system with heat recovery on the upper floor, and new windows with exterior insulation.

The single family house in St Cyr au Mont d'Or shows that retrofit to EnerPHit standard can be affordable, with a total budget for EnerPHit measures of 375 €/m² Treated Floor Area, excluding VAT. Three solutions have been successful in reducing the investment: reuse the existing air supply ducts in the new ventilation system with heat recovery; apply exterior insulation directly on the existing render without preliminary works, and choose perimeter insulation of the slab rather than the new insulation layer. Small to Medium Entreprises (SME) boost innovation in the growing market of step-by-step refurbishment. Tillieux Menuiseries developed a window kit called TipTep for step-by-step installation. The window frame integrates a layer of aerogel which enables simple connection to the existing or future insulation. The kit also supplies membrane, tapes and details for durable airtightness. This kit has been proposed for 24 semi-detached social housings in Auby. The social housing company SIA Habitat is interested in reproducing this solution on their large building stock.

Left page:
Figure 16 + 17:
Top photo
© Pollet Ingénierie
Bottom photo
© Tillieux Menuiseries

Figure 18 + 19:
chart: total annual costs
graphic: insulation
© La Maison Passive

Spain

Retrofit projects were not taken into account by the Spanish energy efficiency regulations until 2013 and to this day comfort and efficiency are not measured in compulsory technical inspections of existing buildings.

There are a large number of buildings in poor condition. More specifically, there are social dwellings where no retrofits have been made because of the owners' low purchasing power. Normally, most of these social houses are not rented but owned by their dwellers. In condominiums there are even more obstacles to perform community retrofits because every change or intervention has to be ratified by the majority of owners. In some cases, a single component in a flat has been replaced

by the owners at a certain point, coexisting with the original ones in other flats and making it more difficult to search for integral technical solutions for the whole building.
Nowadays there are several subsidies and funding systems available to promote partial retrofits such as windows, boiler changes and insulation improvement. However, neither a refurbishment plan nor building quality controls are taken into account. Moreover, since most of these retrofits or improvements are performed by small companies, qualified technicians are typically not involved.
In this context, the work within the European project EuroPHit have helped to highlight the challenges that lie ahead. Three different social housing examples, in which the first step towards the EnerPHit Standard has been carried out, are involved as case of study or observer projects. Each of them has been addressed from a different approach, allowing the exploration of three question and answer models.

– Centon House: Low budget detached house refurbishment in Santander in which part of the construction works will be undertaken by the owner (self-construction refurbishment). The building was in very poor condition, so first it was necessary to achieve basic living conditions. Due to financial issues the refurbishment is performed step-by-step. No external funding will be used.
– Treviana Social Housing: A single flat refurbishment in a social housing building in Madrid. The first step included minimal insulation of external walls to prevent moisture problems, window replacement, airtightness improvement and the installation of ventilation with heat recovery. No interventions have been made in the common areas since these have to be ratified by the neighbourhood association. In this case, the owners of a single dwelling made a first step to improve comfort and efficiency.

San Roque Social Housing in San Sebastian: The first step involves the refurbishment of the façade with exterior wall insulation and the installation of new windows. Difficulties may become apparent in this case when work on the apartments' interior needs to be done. The occupants will be living in the building while the construction work is carried out. The neighbourhood association needs to search for an alternative financial concept to undertake the investment.

Figure 20:
Building retrofit underway in Spain
© VAND arquitectura

Sweden

A typical 50's villa in Bagarmossen, Stockholm, came with the usual challenges to overcome when engaging in a deep retrofit. The project Svartbäcksvägen 11 was therefore a good example for finding out how to do things - and what not to do.

One of the main problems was that it is difficult to find Swedish craftsmen with the right skills for the materials which were used (e.g. Foamglas, Aluflex, Hasopor etc.). There are only a few companies with references and they are typically booked out or do not have time. The manufacturers often cannot provide concrete solutions to the renovation, because their materials are generally used for new construction. One example is the radon seal against the existing sole. "We want to find solutions which are both sustainable and health-friendly", says

1) Old floor slab dug out, pipes and ducts being laid
2) Floor being prepared for foamglas insulation
3) Foamglas being laid
1) View from South

Figure 21 - 24:
Photos of Svartbäcksvägen, Sweden © Ingo Theoboldt, IGPH

Andrea Mäkinen, “the work could have gone quicker if we had hired a project manager who has knowledge of sustainable environmentally-friendly, health-friendly materials and who has practical experience of working with them.” Another option would have been to hire a construction company which would be able to do all of the above, a one-stop-shop solution. Therefore, one of the main objectives of the EuroPHit project is to make up for this shortfall and train both craftsmen and designers.

A positive side worth mentioning is the fact that many are interested in the project both in terms of material selection, construction methods and energy efficiency. “We are very pleased with what we have done so far. The material feels solid, durable and healthy.”

UK

Compulsory energy efficiency measures when refurbishing existing buildings only became a requirement from 2006 onwards in the UK. Before this it was up to the building owner to consider energy efficiency as part of the plans.

Buildings account for nearly 40% of total energy consumption in the UK, placing significant importance in deep retrofitting if the EU's 2020 targets are to be fulfilled. The refurbishment of the building stock also provides an opportunity to create local jobs, stimulate the economy in addition to reducing the energy demand and greenhouse gas emissions. Step-by-step refurbishment – as proposed by the EuroPHit project – constitutes the most appropriate approach in most cases of energy efficient refurbishment, both from the building perspective and from the point of view of the building owners with limited resources.

The selected UK social housing example, Wilmcote House, will be the largest refurbishment project across the EU to target the first step towards achieving the EnerPHit Standard. Wilmcote House, built in the 1960s and owned by Portsmouth City Council, is a large residential building containing 100 three bedroom maisonettes above 7 ground floor one bedroom flats (and other ancillary accommodation) arranged in three towers linked with common stair cores. The structure is now in need of significant repairs due to weather related issues because of its close proximity to the coast and elevation. The choice to pursue a step-by-step approach to achieving the EnePHit standard allows for the provision of external wall and roof insulation and replacement glazing to be installed alongside the structural repairs and thus reducing overall costs.

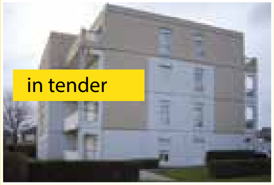
The main feature of the external wall insulation is the enclosure of the external balcony approach to the upper floor dwellings. In essence this has led to a designed 'exoskeleton' of steelwork being provided to encapsulate the entire building into which external wall insulation is provided in numerous layers to ensure that thermal bridging is kept to a minimum level. Work has now commenced to the first of the three towers, with a planned completion date of 2017.

The images below show the original state of the existing dwellings on one such balcony level, the steelwork installation process, and then an architectural rendered image of what the proposed finish will look like after the external walkways will become part of the internal environment within the insulated envelope.

Figure 25:
Wilmcote House - before
and after © ECD Architects

CS01 | Rochestown Home for Elderly in Dun Loaghaire

CS14 | Wilmcote Multifamily House in Portsmouth

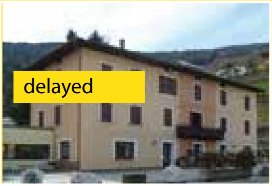


CS05 | Multifamily social housing in Courcelles-lès-Lens

CS10 | "St. Kiril and Methodius" Primary School, Gabrovo

CS06 | Social semi-detached houses in Auby

CS12 | Single family home, Stockholm



CS03 | Hotel-Restaurant Valcanover (cancelled)

CS11 | "Tsanko Dustabanov" Primary School, Gabrovo

CS13 | Tommerupvej 8B. Rehabilitation Workshop in Næstved

CS16 | Single family home Centón, Santander

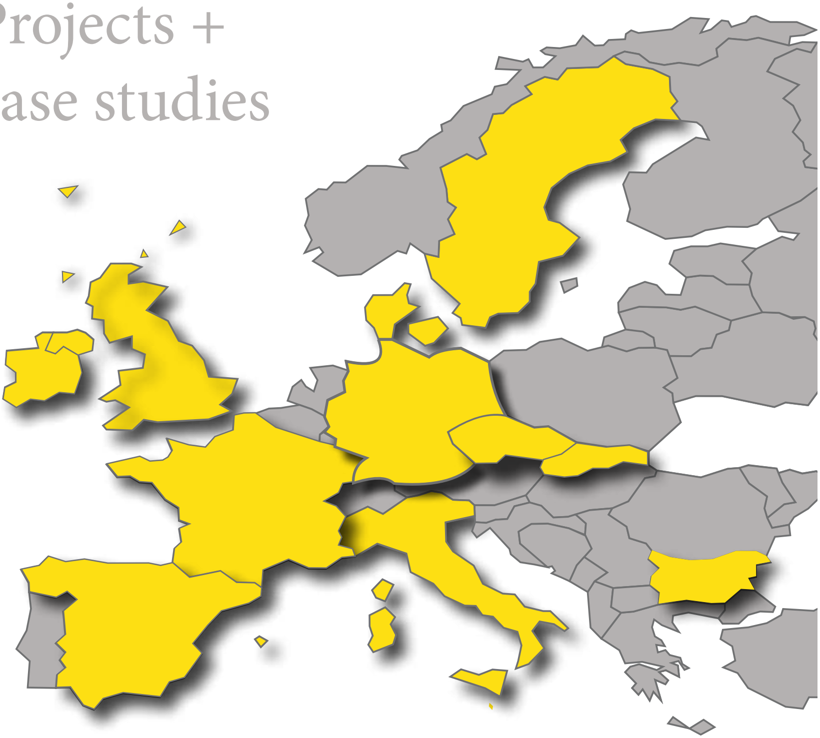
CS15 | Single family home, Tournon sur Rhône

At the heart of EuroPHit lie 20 pilot projects. Each of these are being retrofitted according to Passive House principles with the ultimate aim of achieving the EnerPHit Standard. These projects span most of Europe`s climate zones from Sweden to Spain and Britain to Bulgaria. They also represent a large number of building types including hotels, schools, a rehab centre, single family houses, an apartment block and an old age home.

Projects + case studies

OP24 | Church community centre in Pergine Valsugana

OP04 | Student house, Paris



OP20 | House in St Cyr au Mont d'Or

OP25 | Stjärnhus Stacken in Gothenburg

OP21 | Stella Maris, Family home in Wicklow Town

OP19 | Architecture Office Archipente

OP17 | Zellingen am Main

OP23 | Treviana Social Housing in Madrid

OP22 | Villa Nina, Bansko

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Product development

Figure 26: Cross Check for any building

Step-by-step	Façade	Roof	Windows/ Doors	Heating	Cooling	Ventilation	RES integration	Interior	1-step renovation
Façade	CHECK	Thermal bridges	Airtight connections, Thermal bridges	Façade integrated technologies	Shading optimalisation	Penetrations & Façade integrated technologies	Façade integrated technologies	Optimising building envelope	ALL
Roof		CHECK	Daylight optimization & Shading, Roof access	Roof integrated technologies	Penetrations & Roof integrated technologies	Penetrations & Roof integrated technologies	Roof integrated technologies	Optimising building envelope	ALL
Windows/ Doors			CHECK	Window & Façade integrated technologies	Night & Natural Ventilation	Window & Façade integrated technologies	Window & Façade integrated technologies	Daylight optimalisation & Shading	ALL
Heating				CHECK	Cooling/Heating synergies	Ventilation/ Heating synergies	RES strategies for Heating	Heating concepts	ALL
Cooling					CHECK	Ventilation/ Cooling synergies	RES strategies for Cooling	Cooling concepts	ALL
Ventilation						CHECK	RES s trategies for Cooling	Ventilation concepts	ALL
RES integration							CHECK	Energy storage & Conservation	ALL
New Interior								CHECK	ALL
1-step renovation									CHECK

Product development

Products developed specifically for step-by-step renovations can usually also be used for single-step renovations or new buildings as well. The main difference lies in the sequence they are applied to the building.

To be able to specify which products are crucial and what their characteristics should be, we have looked closer at the intersections of building structure and technologies and have identified synergies that might result in the creation of new products.

All products developed have to fulfill requirements recommended by the Passive House Institute.
We are looking at five areas of development in more detail:
– Windows & shading
– Ventilation
– Heating, cooling & hot water
– Insulation, thermal bridging & airtightness
– RES integration
Some of the new product ideas are valid for all building types and climates, others are very specific for certain types of buildings and/or climate conditions.

Most of the innovation is taking place at the intersection of the envelope with the building fabric, that is the façade and the roof. These are the areas that can be easily dealt with in a step-by-step approach.

An example of such an approach would be a ventilated façade integrated photovoltaic system. It would produce excess electricity as the whole façade would be covered with PV panels. Behind the panels the increased air temperature could be used to increase the efficiency of the ventilation, and if a small air to water heat pump would be included, also provide efficient heating in temperate climates.

“At the core of any product development is the search for new synergies by applying existing technologies.”

One objective of the EuroPHit project was to support industry in the development of suitable products for deep energy and step-by-step retrofits, not just in their conception but also in establishing criteria and in their actual production. Series of design briefs were created as part of this project, guiding manufactures on the various types of products required. The Passive House Institute and other EuroPHit partners consulted with industry to support the real development of product types which will better provide for the renovations required. In parallel, based on the recommendations and requirements elaborated during the project, the following component certification processes were or currently are being developed to ensure independent evaluation of product qualities and provide reliable calculation values for the planning of future retrofits:
Attic trap doors | Drain Water Heat Recovery | Decentralised ventilation units | Window installation criteria | Glazing criteria

Figure 27:
Machine application of insulating plaster. Wet-on-wet, thick-layer application
© Fixit AG

Examples and best practices

Attic staircase

The insulated attic staircase has been developed based on criteria defined by Passive House Institute. Together with a very well insulated attic floor, this cost effective step alone can save up to 30% of all heating costs.

Unfinished insulation edges

As it happens, the whole building cannot always be insulated at once. Sometimes one needs to finish the insulation at a corner or edge. Specially developed solutions can help solve these difficult details. For example, specially formed elements can be installed during insulation work on the roof making it easier to connect the façade insulation later on.

Aerogel insulating plaster

For historical buildings that can only be insulated with plaster, a product such as Fixit 222 Aerogel High Performance plaster for example can be used. With a thermal conductivity of just λD 0.028 W/mK and the possibility to be modeled into thick layers copying historic details, this plaster represents an important improvement that can be combined with interior insulation.

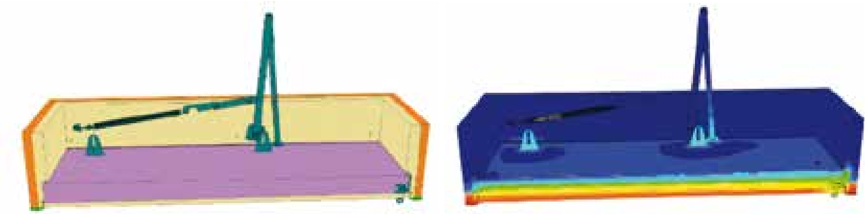


Figure 28:
Before and after insulation
© JOMA-Dämmstoffwerk GmbH

Figure 29:
The attic staircase
© Passive House Institute

Component Database:
database.passivehouse.com

Wall anchors for ventilated façade

This system from Rockwool enables the application of thick layers of insulation without creating thermal bridges. Such insulation solutions are an important contribution to step-by-step solutions, as they can achieve Passive House standard for parts of the building at a cost effective price.

Drain Water Heat Recovery (DWHR)

The basic concept of transferring heat from drain water back to the flow of fresh water during showers provides a good solution to reduce hot water demand and is a relatively simple solution that can be implemented during the remodeling of a bathroom. This provides the opportunity to increase the energy efficiency of the hot water system with any bathroom refurbishment.

Figure 30:
Installed drain water heat recovery pipe © Wagner Solar

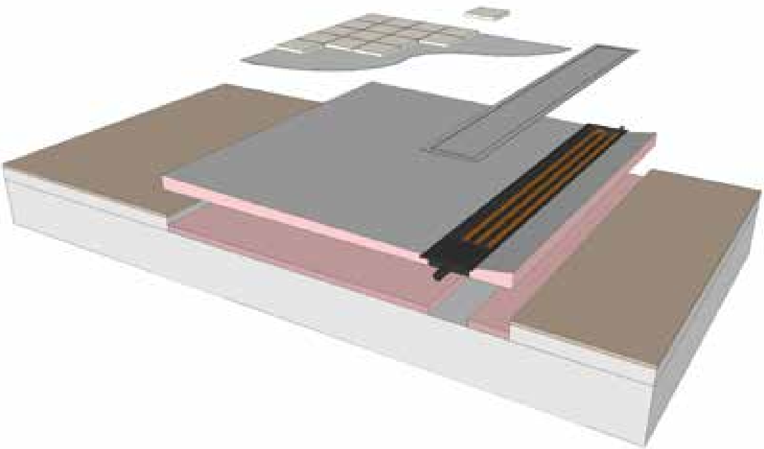


Figure 31:
Water drainage with heat recovery © Passive House Institute

Product demand and requirements

A future-proof product has to provide good value in terms of comfort and hygiene. It should save energy for the purpose of climate protection and it should also be reasonably priced. As an example windows will be discussed, demonstrating that all these factors fit together very well.

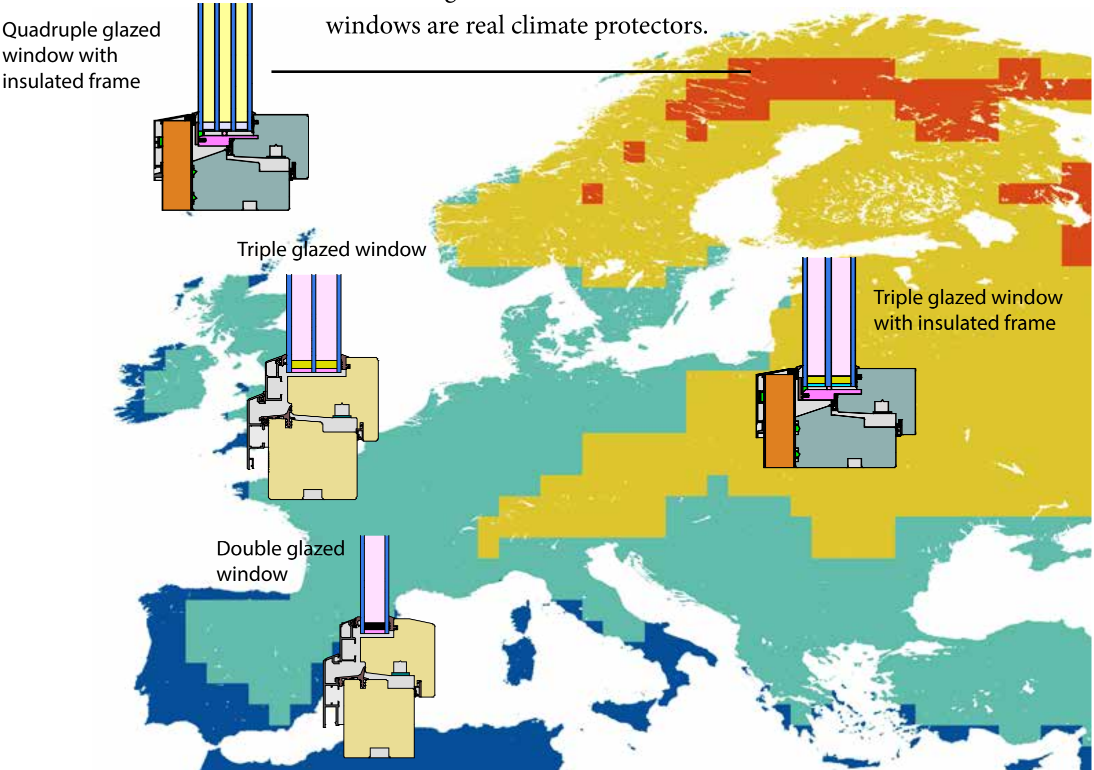
Comfort and hygiene

The U-value of a component is an indicator of the thermal performance of a component. The lower the U-value, the better the performance. The buildings envelope is a barrier between a possibly cold and uncomfortable climate outside, and cozy conditions inside the building. If the envelope has a poor thermal quality (a high U-value), the temperature of the inner surface is low and that leads to uncomfortable conditions inside the building. For most people, the conditions become unpleasant, when the difference between a cold surface and the average room temperature is higher than 4 Kelvin. By taking this temperature difference and the outside temperature into account, requirements for the U-values in different climates can be determined allowing suitable components to be selected. The following map of Europe shows which components are suitable in different places. Low temperatures on inner surfaces can lead to condensation and mold. Old windows can significantly increase the risk of mold and condensation build-up. By improving the thermal quality of windows, the risk of condensation and mold is reduced and in combination with a ventilation system it is eliminated.

Climate protection

With windows, the main issue relating to climate protection is to save energy on heating or cooling processes. In cooler climates, a window causes energy losses and also energy gains. Therefore, the energy balance of the window matters. In cool, temperate climate areas like Frankfurt, a window from the 1970s causes far more losses, than gains. To compensate for these losses, more than 3 kg CO_2 per square meter window is emitted every year by the heating system. For a single family dwelling, that might be more than 6000 kg over the lifespan of the windows. These emissions equate to driving approximatly 46,000km in an efficient diesel car. For modern, triple glazed windows with insulated frames, gains and losses can be more or less the same, so no additi-onal heating is needed and no CO_2 will be emitted. Because of that, windows are real climate protectors.

Figure 32 + 33: Windows for different climate zones © Passive House Institute



Economic issues

Climate protection, comfort and hygiene are important issues. But in many cases, economic considerations are dominant. Therefore, affordability is crucial for the implementation of energy efficient products. Together with the window manufacturer Pazen, Passive House Inatitute has carried out a study on German price levels in order to find out which windows are the most economically viable in different regions of Europe. All the different windows are manufactured by the same company, so the prices are comparable from window to window.

The results show that for an east-west oriented town house (shown in figure) the economically viable option has better qualities than the comfort criterion. Triple glazing is much more expensive in southern Europe than in Germany, which may lead to an increase in the amount of double glazed windows being used in southern Europe.

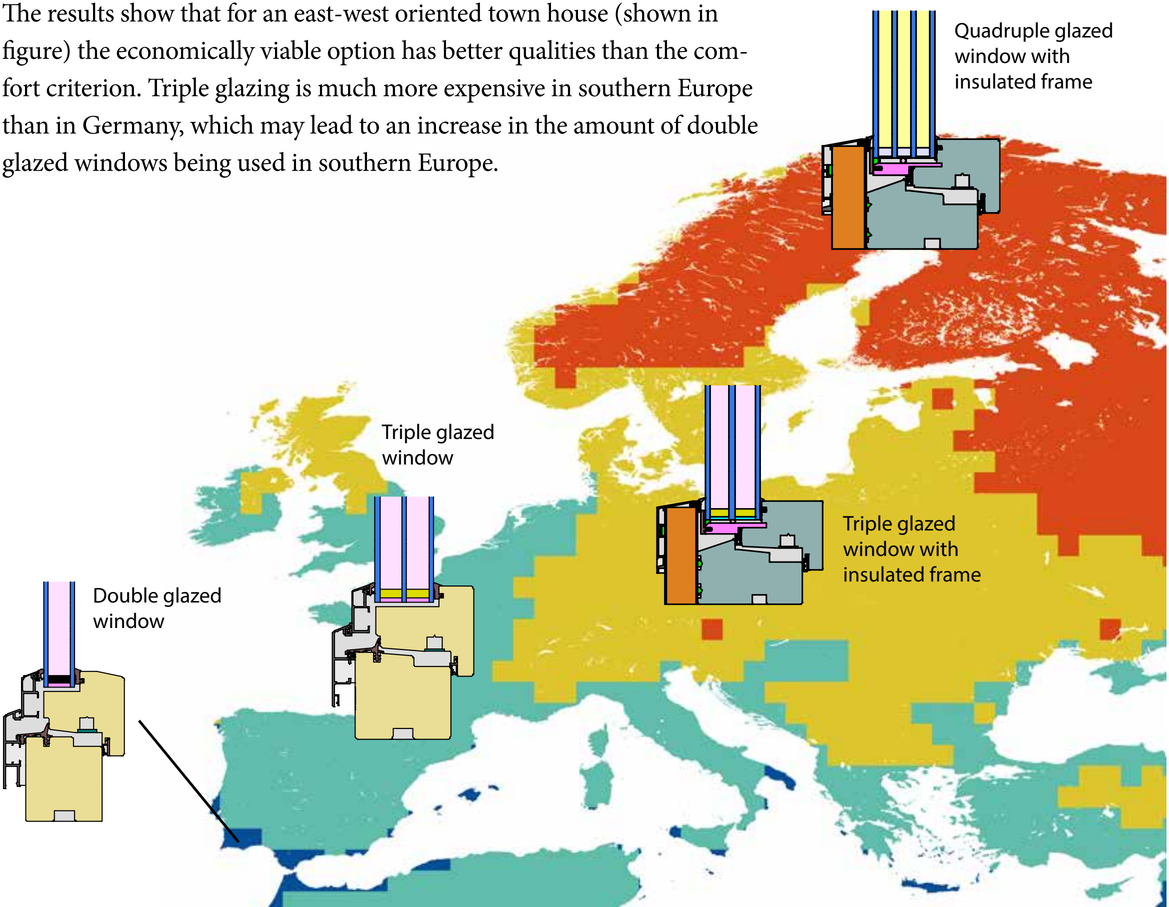


Figure 34:
Models of Passive House windows © Pro Passivhaus-fenster

Windows in step-by-step refurbishment

Regarding windows in façades, there are two principle possibilities for step-by-step refurbishment: First new window, second façade insulation; First façade insulation, second new window.

First step window, second step façade insulation

To find proper and practical solutions for this kind of renovation, Passive House Institute hosted the COMPONENT AWARD 2015, in which window producers made suggestions on how to solve the task. The winners of the award produced the following ideal solution: replace

the exterior plaster around the window with an insulated insulated plaster panel with an overlapping at the window opening. Install the new window directly on the outer edge of the wall against the plaster panel. This provides acceptable thermal bridges and interior surface temperatures as well as good weather protection. In step 2, the façade insulation should cover the complete plaster panel and the window frame to avoid thermal bridges. Regarding shading, the winners of the award decided that integrated shading is the most affordable solution.
The solution from smartwin (see figure) came closest to the ideal solution. The window has an inner double or triple pane and another single pane on the outside. The shading is installed in the emerging airgap in order for it to be weather protected as well as being easier and cheaper to implement.

First step façade insulation, second step new window
To improve the frame and to avoid thermal bridges, it is important to cover the reveal and the window frame (including the sash) with insulation. This can be done by a special insulation element. When the new window is applied, the reveal-insulation element can be removed and the new window can be installed directly at the edge of the wall with the frame covered by the insulation system (see figures).

1. Cover reveal and frame with insulation element
2. Add façade insulation and make the finishing
3. Remove the insulation element
4. Place the new window on the outer edge of the wall, covered by the façade insulation

Figure 35:
Window situation
© Passive House Institute

Ventilation for step-by-step refurbishment

General requirements for ventilation systems in step-by-step energy refurbishments: Ventilation systems with heat recovery are indispensable not only in Passive House new buildings but also in EnerPhit buildings. The only exceptions are in moderate climates where Passive Houses can even work with extract only systems.

In general, heat recovery not only signifcantly reduces the ventilation heat losses, it is also a very important comfort measure providing ventilation as well as comfortable air conditions. Certified Passive House ventilation is highly recommended for energy refurbishments for the following reasons:

– Quality assurance
– Reliable energy performance data for energy balance calculation of the building with PHPP

A step-by-step refurbishment requires components to be installed quickly and easily with minimum disturbance to the user. Components that don‘t take up much installation space are also required. Good ventilation concepts should not reduce the living area; instead, it is more beneficial to use installation places that are lost anyway for other purposes.

Requirements for Passive House ventilation:

- Heat recovery rate > 75%
- Electric power consumption < 0,45 Wh/m^3
- Acoustic:
  - Sound pressure level in living areas </= 25 dB(A)
  - Sound pressure level in functional areas </= 30 dB(A)
- Filter: Outdoor air filter minimum F7, extract air filter G4 recommended

Wanted: well integrated, easy to install and cost effective ventilation solutions

Looking at the European residential building stock, on average 50% of all apartments are located in multi-family residential buildings. Most of these are 3-4 room apartments. This is the target refurbishment group of residential buildings where, due to limited space conditions, there is a special interest on well integrated space saving ventilation solutions. A space saving solution for example, is the installation of ventilation devices in the ceiling. Some good concepts for ceiling installation are already available on the market. A rather new concept and a well integrated option is the installation of ventilation devices in the façade.

Figure 36 + 37:
left: © Vaventis BV
right: © Paul Wärmerück-gewinnung

Façade integration is a good option for step-by-step refurbishments as it only requires a small installation space and could simplify the integration of ventilation devices, especially if no device covering is needed.

For this reason, there is a lot of focus on the following characteristics:
- low sound emissions: making the devices suitable for installation in living areas
- Good design: no need for covering which provides a simplified installation

The first such devices are already available on the market.

Figure 38 + 39:
above: © Vaventis BV
right: © bluMartin GmbH

There is also a desire to integrate façade ventilation into non-residential buildings in order to reduce the required installation space. Michael Tribus, a Certified Passive House Designer, uses elements of curtain wall systems for the integration of a suitable ventilation device. The picture shows a decentralized ventilation system for one classroom integrated into an element of a curtain wall system.

Figure 40 + 41:
School in San Vito di Cadore, Italy
Michael Tribus Architecture ©
Guiseppe Ghedina

Figure 42 + 43:
left: RenoPipe system
© Helios Ventilatoren GmbH + Co KG
right: Wise apartment
© Swegon AB

Another issue is the **ducting system**: a complex air supply system is not only expensive but the installation is also inconvenient for residents (especially if the residents have to move out during the refurbishment works). Ducting solutions that are well designed and easy to install are the most practical in step-by-step refurbishments. In some cases where the design is attractive, an additional casing is not necessary, which also considerably reduces the require installation time. Some manufacturers already provide good solutions however, in the future this issue should be given more attention in order to increase availability and simplify the whole installation process.

The pictures show two duct solutions, which fit with the dry wall covering, due to the well designed duct system.

Ventilation concepts for refurbishments - suitable solutions for each floor plan

The typical cross ventilation concept is based on a double use of the airflow in the supply air rooms and later in the exhaust air rooms, which allows efficient use of the exchanged airflow.

An improvement of this concept is the extended cascade ventilation, where the living room or other rooms become part of the overflow area. This again minimizes the required air flow and reduces the amount of ducting. The possibilities of extended cascade ventilation depend a lot on the specific floor plan and can be easily checked with the ventilation tool “Luftführungskonzepte” from the University of Innsbruck (currently only available in German): http://www.phi-ibk.at/luftfuehrung/

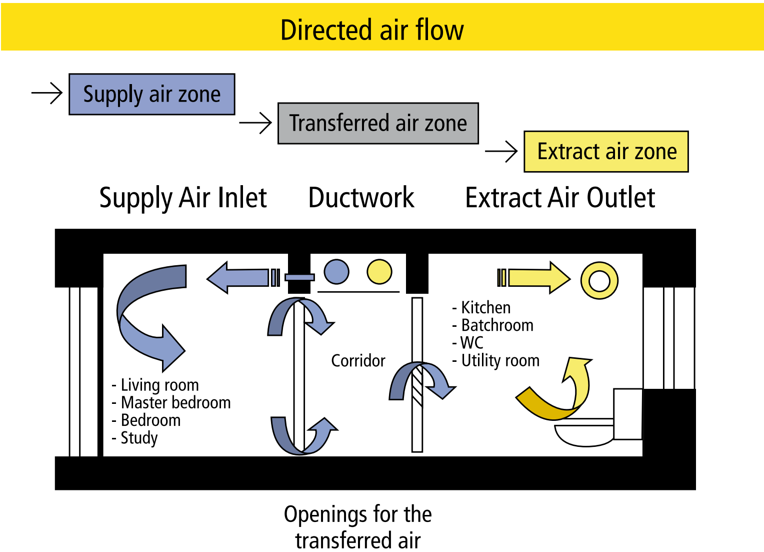


Figure 44:
Ventilation - directed air flow
© Drawing: Passivhaus Dienstleistung GmbH

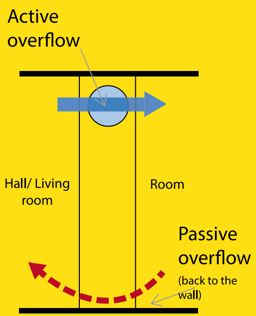


Figure 45 + 46:
Active overflow concept
© University of Innsbruck

Another promising concept especially for refurbishments is the **active overflow concept**, which can be used for example in dwellings with all rooms connected to one hall or one central living room. The corridor or common rooms become part of the air distribution system itself. Fresh air is supplied to the central room and is supplied to the connected rooms via active overflow ventilators. A very small duct system (extract air only) is required.

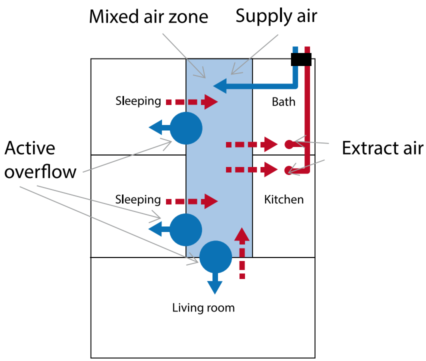
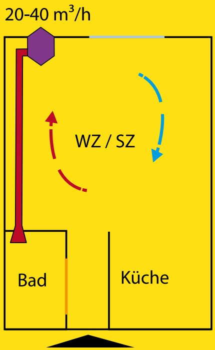


Figure 47:
Single room ventilation



Another ventilation concept that fits with an air distribution network is **single room ventilation**. The idea is to ventilate the installation room directly, without any duct connection. Several points need to be considered, such as the ventilation system to be installed in the extract air rooms (bathrooms or kitchen) and whether there will be additional heat recovery devices in these rooms or whether they will be extract only. No matter which system is chosen, it needs to be correctly considered using the PHPP calculations.
A variant of the single room ventilation concept are small devices with a second room connection that can still provide cascade ventilation e.g. for very small dwellings.

Building centralized ventilation solutions

For building centralized ventilation solutions, an important question is where to install the ventilation device. In existing buildings, there is often not enough room available for the installation of a centralized unit. A good alternative could be a roof top installation and some manufacturers already provide good outside installation solutions. A particular focus lies on good supply air flow and extract air flow ducting: well-designed options have very small duct sections outside the thermal envelope and good thermal insulation.

Another question, especially for centralized ventilation systems, is whether to install the central ducts. The old centralized shafts may be used for the insallation of ventilation ductwork.

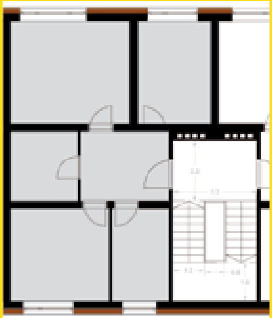


Figure 48:
Floor plan of the Component Award 2016
© Passive House Institute

Figure 49:
Roof-mounted ventilation unit
© Lüfta GmbH

Figure 50 + 51:
Atrea Duplex RS4 © Atrea

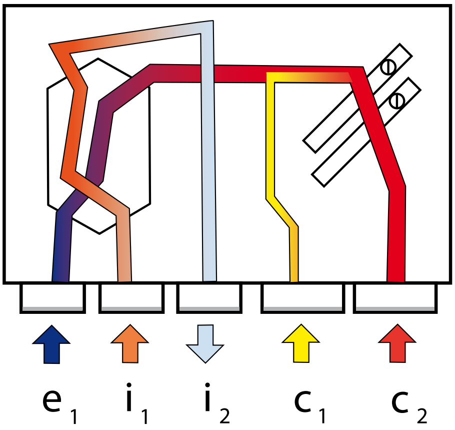
LEGEND

- **e_1** Fresh outdoor air inlet
- **c_2** Heating, cooling and outlet from the unit into usable space
- **c_1** Circulation air inlet from usable space into the unit
- **i_1** Exhaust air inlet from sanitary facilities into the unit
- **i_2** Exhaust air outlet from the unit

Figure 51:
Heating through ventilation
© Atrea s.r.o.

Ventilation heating even in refurbishments?
In some cases, it might be desirable to provide ventilated heating (or cooling depending on the climate). For example, if the previous heating system was based on old individual heaters, these should be replaced during the refurbishment.

The heating power provided by the outdoor air flow rate might not be sufficient for some EnerPHit buildings. One option is to increase the airflow rate for heating (or cooling) with additional recirculation air. Atrea have developed a device for this purpose, however air flow rates and device dimensions are rather high and would only be suitable for larger dwellings, multi-family residential buildings and non-residential buildings. Smaller sized devices may be available in the future.



Importance of airtightness concepts
High building efficiency and comfort by implementation of a mechanical ventilation system with heat recovery can only be guaranteed if the building is airtight. Otherwise, energy losses by infiltration and droughts will reduce the positive impact of the measure considerably. Therefore appropriate airtightness concepts specifically for retrofits are required.

External Air-tightening, Insulation and Finishing System (EAIFS)
One such solution is the application of an airtightness layer on the external surface of the existing wall, such as with an external air-tightening, insulation and finishing system (EAIFS). This is an ideal solution for retrofits so as to disturb the building inhabitants as little as possible and to reduce an extra step by integrating the airtightness concept into the wall insulation process.

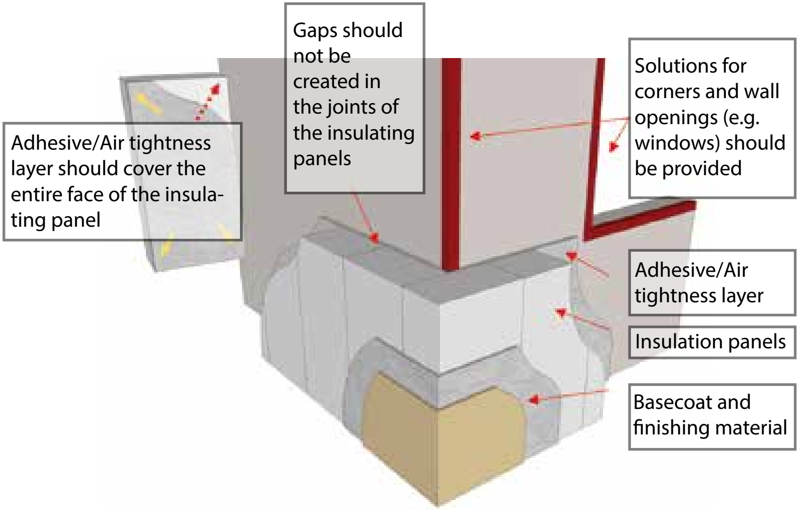


Figure 52:
Detail of the EAIFS
© Passive House Institute

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Financing solutions

What now? The way forward

Financing solutions

Building retrofits generate energy savings over the lifecycle of the investments, therefore long-term financing is needed. Getting financing right is the first step in the provision of the full solution

Financial institutions can help their clients access low-cost capital and grant funds provided by the EU or local government. Retrofit projects can also be promoted through grant funds.

In EuroPHit, financial guidelines were created to help financial institutions gain an understanding of the EU funding system and the design of special financial tools and financing programs. They also provide the necessary information for decision making within the hierarchy of banks throughout Europe and to implement promotional refinancing. There are a variety of financial models available for sustainable energy efficiency driven projects, including combined commercial market financing and various EU grant programs. Barriers however do exist in the financing of multi-annual investments, such as step-by-step retrofits.

The following provides guidance to commercial lending institutions on ways to address energy efficiency savings as part of assessing financial soundness of a project. Using the EuroPHit project as an example, the guidance illustrates developing a standardised technical criteria method for developing finance program for step-by-step energy efficiency refurbishments.

Existing barriers to financing of step-by-step retrofits
Various barriers are faced in sourcing financial investments for sustainable energy efficiency driven refurbishments of buildings. These hurdles include market barriers as well as market failures, legal barriers including cases of joint ownership of real estate.

From commercial financial institutions perspective, it has been identified that there is a general lack of:
- energy efficiency finance experience on existing buildings,
- dedicated time and resources to develop in-house capacity,
- lack of visibility and scale as it often represents a relatively small niche business for lenders;

In addition to the above, from a lending viewpoint some of the barriers are:
- High perceived end-user credit risks;
- Difficulties in creating creditworthy financing structures due to low collateral asset value of energy efficiency equipment itself, as the majority of investment costs is to do with high portions of engineering, development and installation costs.
- Cash flows from energy savings are not (yet) views as conventional revenues or guarantee of solvability in what is still an asset-based culture in financing discouraging commercial financial institutions entry into this market.
- Lack of reliable data on energy prices for long term forecasting which prevent the savings calculations for repayment of long term credits

Existing Best Practices
Many national and international financing support aims to developing the energy efficiency markets via grants schemes. However, most of the

projects must combine market-based instruments (loans and equity) with public instruments. This chapter presents the financial characteristics of an energy retrofit project and the financial schemes to assess its creditworthiness are highlighted.

The central interest of a lender is simply focused on the credit repayment ability of its borrower. In energy efficiency projects the repayment ability is strongly related to the amount of the investment, operating costs and future inflows generated by the energy savings. Therefore energy efficiency financing should include the following in the decision-making process:

- The base case values have to be well defined in terms of physical units (like KWh) as well as monetary units (€)
- Energy cost savings should be incorporated into lenders' analysis of free cash flow and ability of borrowers and end-users to meet debt service payments;
- Since there is normally no separate accounting methods for energy savings, their calculation must be defined : how they are measured and how price changes are treated.

Investments stand as upfront costs whereas energy savings constitute yearly inflows. Therefore it must be clarified that savings are reallocated to debt services. Or, considering the tenant-occupant dilemma, landlords should be able to benefit from energy savings generated by energy efficiency measures through financial inflows generated by higher rents. Energy efficiency related savings and investments required for routine maintenance should be separately assessed.

In addition to the above, lenders should also be considering the level of risk in terms of technical performance. Based on the risks identified, a sensitivity analysis will need to be carried out. For the same scenario the different energy efficiency assumptions should be evaluated one by one. Changing the energy efficiency requirements of a retrofit project influences the investments, the energy savings as well as the sensitivity related to energy prices. Scenarios including technical performance achievements should be taken into account.

Quality assurance and financing

Quality Assurance plays a lead role in the risk management of a performing energy efficiency project. Perceived performance gaps might complicate the evaluation of the creditworthiness of investments into energy efficiency in buildings. The EnerPHit Standard, however, serves as a key tool creating technical criteria for designing a financing program. By applying thorough planning and quality assurance, deep energy retrofits with Passive House components reach their expected level of energy efficiency. By offering a certification after completion of the retrofit process, the high standard of the retrofit process is confirmed by independent experts.

Energy efficiency investments are expected to be paid back through energy savings. Thus energy savings will help the building owner to pay back capital costs, guaranteeing the interest of the lender. Financing programs should therefore focus on cost-optimal measures.

The aim of the EnerPHit standard is to offer a guideline for cost-optimal components which can result in high energy savings. This will enable lenders to benchmark returns on investment and design financing programs reducing building energy consumption:

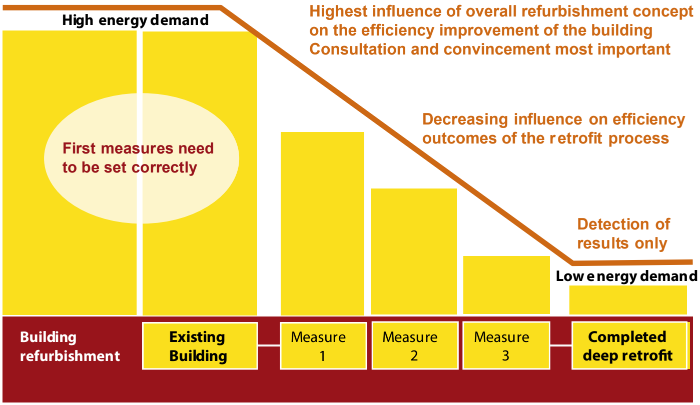
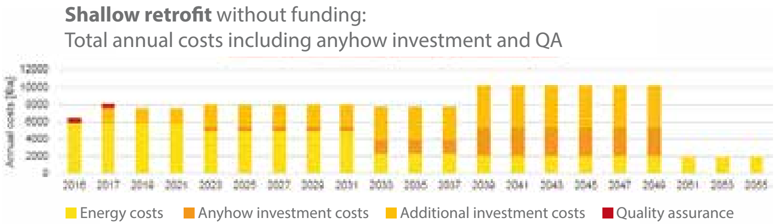


Figure 53:
Focus for step-by-step financing
© Passive House Institute



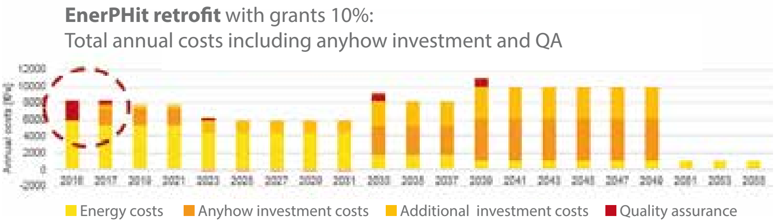


Figure 54 + 55
Shallow retrofit without funding
EnerPHit retrofits with grants
© Passive House Institute

– suitable for everyone;
– providing long-term financing approach.

Such a standard considerably simplifies the process of setting up rules and requirements for energy efficiency financing programs. In the case of a step-by-step retrofit, with the EnerPHit Standard, a repayment bonus financed from a grant could be used in addition with loans to reward the borrower when certain efficiency targets of the EnerPhit standard have been achieved.

Due to constraints of budgets, step-by-step retrofits are often carried out with single measures. As the investments of single measures are considerably lower than for complete retrofits, investments in quality assurance measures like initial consultancy and planning or airtightness tests often seem too high compared to the measures themselves and thereby should be promoted especially to encourage adequate planning and supervision of the retrofit process.

KfW Program 431 for example rewards the energy efficiency of a design, supervision and certification up to 50% of the technical expenses for experts, when a loan for certain efficiency level is eligible for funding. Quality assurance is thereby ensured from the start, when design and decisions have the biggest impact on the efficiency outcomes of the retrofit process which might last years until completion on a high efficiency level.

Public funding sources available across Europe
Governments can help to close the financing gaps, catalyse private investment and accelerate energy efficiency market uptake via financial interventions such as:

– Funding programs run by European Development Financial Institutions (e.g. European Investment Bank, European Bank for Reconstruction and Development, KfW Bankengruppe)
– Credit lines and guarantee schemes
– Grant programs
– Redemption grants
– EU funding sources (which are usually be provided in the framework of a national programme)
– National and regional schemes for individuals, social/municipal housing, residential and non-residential schemes

A large majority of energy efficiency technologies are commercially competitive, public financing should pave the way for private financing, rather than substitute it. Financial institutions (such as EIB, KfW, EBRD) have an important role to play in financing and leveraging money for energy efficiency projects. They can play a key role in guaranteeing funds on the financial market and make capital available to project leaders. As shown in Germany, KfW also uses state subsidies to improve financial conditions of funding programs and expand their volume. Dedicated credit lines or revolving funds may be appropriate tools when liquidity is scarce. Grants that are available to support the implementation of financing programs, can be used as:
– technical assistance to the borrowers (to pay for energy advisors);
– financing advice on retrofit concepts;
– repayment bonus to reward the achievement of certain energy efficiency targets set in primary energy (which should be confirmed by qualified energy advisors);
– reduce the interest rate and soften the loan conditions.

*) The current and previous evaluations and studies on the economic impacts are available at https://www.kfw.de/KfW-Konzern/KfW-Research/Economic-Research/Evaluationen/Energieeffizient-Bauen-und-Sanieren/ see Tabelle 2 on page 7 of the study

Public financing support should also enable the market investors to go for a more ambitious, more efficient long-term solution (”deep renovation”) with eventually higher investments in the beginning. Thus inciting the applicant to consider the ultimate goal of a refurbishment, even if done over steps.

In Germany, for example, the KfW handles the promotional programs on behalf of the Federal Government. The programs for energy-efficient construction and refurbishment receive favourable terms through German federal budget funds to provide financial incentives for more energy efficiency in the housing sector. Recent studies show that in Germany energetic refurbishment of buildings is a win-win situation for the home owners, the environment, the economy and the federal budget [*)].

The refurbishment of the building stock to high energy standards essentially contributes to the reduction of energy demand and the lowering of greenhouse gas emissions. For the tenants the energy-saving rehabilitation is cost-effective when incorporated as part of the rehabilitation cycle. The additional economic activity in the construction sector has a positive effect on employment, which especially benefits small and medium enterprises (SME). Within refurbishment projects the construction industry accounts for nearly three fourths of the direct employment effects. This also triggers indirect employment effects through the demand for inputs such as heating furnaces or insulation material in other industries. Investments in renovation are investments in today´s and future savings.

What now? The way forward

How to implement deep energy retrofitting into the current market

Deep energy retrofits are not only relevant for Europe for the huge potential savings - major investments into energy retrofits, backed by proper legislative and regulatory frameworks, will also spur local economies within the EU and increase energy security for its citizens.

In order to achieve these savings and benefits, through the results of the EuroPHit project, it has been made clear that thorough planning of the retrofit process is undertaken right at the beginning. This planning must involve a stringent method of quality assurance, such as building to the EnerPHit Standard and creating a long-term retrofit plan, to assure investors and secure financing. The involvement of experts in the field of deep energy retrofits and the creation of such planning are also then crucial to the process. Experts are required not just in the quality assurance planning and energy consulting but highly-skilled tradespeople are also required to perform such work. Therefore, capacity building for trades must also be supported by local governments and policies, not only creating more skills in the workforce and thereby stimulating job creation, but ensuring that this group of building professionals are equipped and capable.

The European Union‘s Energy Union also has important goals to save costs for grid investments and energy efficiency is recognized as the key to ensuring these costs are kept to a minimum. In fact, it has been shown that renovating the EU’s building stock to high levels of energy efficiency have the potential to save between 80 and 153 billion euro of investment costs into the power system. This is achieved through deep renovations and also has a significant effect on demand reduction and management of the grid due to expected lower energy consumption of buildings.

In order to reach Europe's 2020 energy efficiency targets of 20% compared to 1990 levels many billions of Euro will be invested into the building sector. In order to better guarantee these investments, high energy efficiency must be leveraged. The step-by-step retrofit projects which are started today, will be complete in a range of 20 to 30 years. If we are to reach EU goals set for 2050, **the time to start, through both policy and financial mechanisms, is now**. Retrofits started today outside of this framework will further lock-in the existing building stock to insufficient levels of energy efficiency. Moderate steps taken today will also not be adequate in order to realize these goals. In addition, the schemes that are now emerging from Europe are relevant the world over. With the EnerPHit criteria as the backbone, using climactically suitable Passive House components, deep energy retrofits to this Standard can be

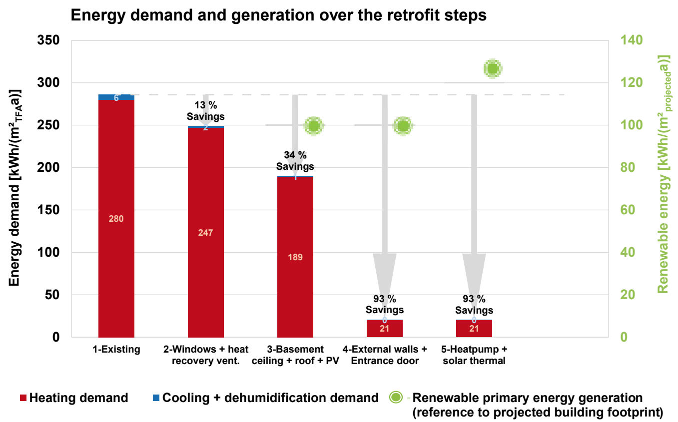


Figure 56:
Energy demand and generation over the retrofit steps
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completed internationally. This provides a worldwide quality assurance framework, by which relevant policies and programs can be designed and implemented taking local needs into account and further stimulating deep energy retrofits on a global scale.
The inclusion or planning for future implementation of renewable energy sources is also a large part of energy retrofitting, and one welcomed within the EnerPHit Standard. With reducing energy demand through efficiency measures as the priority, it can and should also be indicated if renewable energy sources are to be installed during one of the retrofit steps. The potential for inclusion of renewables is extremely significant. Of the total EuroPHit projects, a total PV implementation potential of almost 760 MWh/a has been calculated, which translates to almost 20 kWh/(m² floor area/a). Future implementation of renewable energy sources thereby would enable several of the pilot projects addressed in EuroPHit to be upgraded to the standards EnerPHit Plus or Premium after completion of the retrofit steps. These new classes of the EnerPHit Standard can be achieved depending upon the renewable primary energy (PER) demand and generation of renewable energy.

What is still needed?

Passive House is a building Standard that is truly energy efficient, comfortable, affordable and ecological at the same time. Passive House is not a brand name, but a construction concept that can be applied by anyone and that has stood the test of practice over the past 25 years. A cost-optimal retrofit using the Passive House principles, to the EnerPHit Standard, is one proven solution to the EU's issue of an inefficient building stock. Experience throughout the EuroPHit project, and in working with manufacturers and industry has already brought along important new products and models for deep energy retrofitting. Building envelope products, for example, are already one aspect of building components which have been well-developed and proven in practice. The industry has started to respond to the need for such products and it is now known how to do this correctly in practice.

Involvement and motivation from the industry is however still required. A step forward from product manufacturers is needed in order to meet the expected demand and market opportunity of deep energy and step-by-step retrofits. An example of this is higher efficiency systems for domestic hot water which are required. As the overall energy demand of buildings is reduced through improvements to the building envelope, the share of energy required for water heating grows – leaving an opportunity for further reductions and energy saving measures and an opportunity for this need to be met by new, innovative and cost-effective products in market. Not only from industry, but as explained in this brochure, the involvement of the development industry, local government and financing institutions is crucial to the success of such a visionary and long-term plan for the future of the EU's existing building stock.

The EU 2020-2030 targets for climate and energy are designed to work towards long-term and significant greenhouse gas reduction targets for 2050. As buildings are responsible for 40% of energy consumption and over a third of CO_2 emissions in the EU, strategies to implement policies and financing mechanisms that significantly reduce this consumption across the existing building stock are critical to achieving this goal.

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Further information

Further Information | EuroPHit and Passive House Resources

Passipedia
The ever-expanding knowledge database on energy efficient building and Passive House, comprising over two decades of research. Articles relating to step-by-step energy refurbishments and deep retrofits are also found here.
www.passipedia.org

EuroPHit Website
www.europhit.eu

Passive House Institute
An independent research institute that has played an especially crucial role in the development of the Passive House concepts – the only internationally recognized, performance-based energy standard in construction.
www.passivehouse.com

iPHA – the International Passive House Association
A global network for Passive House knowledge working to promote the Passive House Standard and connect international stakeholders.
www.passivehouse-international.org

Passive House Database
www.passivehouse-database.org

Component Award
www.passivehouse.com (awards)

Component Database
database.passivehouse.com

Supported by:

Partners:

www.passivehouse-international.org

www.zephir.ph

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www.eneffect.bg

www.askeen.it

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www.plataforma-pep.org

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