PROMOTION OF EUROPEAN PASSIVE HOUSES

www.europeanpassivehouses.org

Passive House Solutions

May 2006

Intelligent Energy Europe

The PEP-project is partially supported by the European Commission under the Intelligent Energy Europe Programme.
EIE/04/030/S07.39990

PEP

Promotion of European Passive Houses

www.europeanpassivehouses.org

Passive House Solutions

This report is the final version of Working paper 1.2, as described on page 16 of the contract documents (part II). The document encompasses deliverables 1.4 and 1.5 as listed on page 8 of the contract documents (part II).

Isolda Strom

Loes Joosten

Chiel Boonstra

DHV

Identifier: DHV_WP1.2

Date: 23-05-2005

Distribution: Public

Deliverables: 1.4, 1.5

Intelligent Energy Europe

The PEP-project is partially supported by the European Commission under the Intelligent Energy Europe Programme. EIE/04/030/S07.39990

Foreword

It is generally recognized that, within the housing sector in Europe, many building activities can be expected over the coming decades. The old building stock will need to be refurbished or, in many cases, even demolished and new buildings erected. The existing housing stock is responsible for a large share of our total energy consumption, and therefore many energy savings can be accomplished in these upcoming reconstruction activities. As previous demonstration projects (such as CEPHEUS) have demonstrated, the reduction of non-renewable energy demand by a factor 4 (compared to contemporary national standards) is not only possible but also realistic. The Passive House concept is a sound and relatively low-cost method to achieve these energy savings. To spread this knowledge throughout the professional building community, beyond the select group of specialists, PEP has set out to spread the experience gained throughout Europe on the Passive House concept.

The goal of this project is to disseminate the experiences with the Passive House concept that is gained internationally. The PEP project aims to provide guidance to all those involved in the building process.

The dissemination activities concentrate on:

- Documentation of specific practical solutions for Passive Houses in different regions and climates
- Preparing an information package (on CD-ROM) with practical information such as building product information, design guides, research results, calculation methods and quality assurance activities
- Documentation of the energy saving potential of the Passive House concept throughout Europe
- Preparing an (inter)national certification scheme for Passive House certification in relation to national Energy Performance certification schemes and the European Performance Building Directive (EPDB)
- Organisation of national and international workshops / conferences

This publication describes the specific practical solutions for Passive Houses in different regions and climates. The PEP-project team hopes you will find answers and inspiration to apply Passive House technologies in your project.

The PEP-project team

The PEP Consortium consists of the following beneficiaries:

Energy research Center of the Netherlands	ECN		The Netherlands	Coordinator
Arbeitsgeneinschaft ERNEUERBARE ENERGIE Institute for Sustainable Technologies	AEE INTEC		Austria	Associated beneficiary
Building Research Establishment	BRE		United Kingdom	Associated beneficiary
DHV Building and Industry	DHV		The Netherlands	Associated beneficiary
Ellehauge & Kildemoes	EK		Denmark	Associated beneficiary
National University of Ireland	NUID		Ireland	Associated beneficiary
Passiefhuis-Platform	PHP		Belgium	Associated beneficiary
proKlima	ProKlima		Germany	Participant
Passivhaus Institut	PHI		Germany	Subcontractor of proKlima
Stiftelsen for industriell og teknisk forschung ved Norges Tekniske Hogskole	SINTEF		Norway	Associated beneficiary
Technical research Centre of Finland	VTT		Finland	Associated beneficiary

Table of Contents

List of Figures

List of Tables

Acronyms and Abbreviations

CEPHEUS	Cost efficient Passive Houses as European standards
CHP	Combined Heat and Power
DH	District Heating
DHW	Domestic Hot Water
GIW	Garantie Instituut Woningbouw (guarantee institute housing construction)
Low-e	Low-emittance
PH	Passive house
SFP	Specific Fan Power
SME	Small medium enterprise
VOC	Volatile organic compound
VSE	Very small enterprise

Executive summary

In this working paper an overview is given of Passive House solutions. An inventory has been made of Passive House solutions for new build residences applied in each country. Based on this, the most common basic solutions have been identified and described in further detail, including the extent to which solutions are applied in common and best practice and expected barriers for the implementation in each country. An inventory per country is included in the appendix.

The analysis of Passive House solutions in partner countries shows high priority with regard to the performance of the thermal envelope, such as high insulation of walls, roofs, floors and windows/ doors, thermal bridge-free construction and air tightness. Due to the required air tightness, special attention must be paid to indoor air quality through proper ventilation. Finally, efficient ((semi-)solar) heating systems for combined space and DHW heating still require a significant amount of attention in most partner countries. Other basic Passive House solutions show a smaller discrepancy with common practice and fewer barriers have been encountered in partner countries.

In the next section, the general barriers in partner countries have been inventoried. For each type of barrier a suggested approach has been given. Most frequently encountered barriers in partner countries are: limited know-how; limited contractor skills; and acceptation of Passive Houses in the market. Based on the suggested approaches to overcoming barriers, this means that a great deal of attention must be paid to providing practical information and solutions to building professionals, providing practical training to installers and contractors and communication about the Passive House concept to the market.

1 Introduction

The general definition of the Passive House is a limited heating energy demand of around 15 kWh/m^2 treated floor area for heating and around 120 kWh$_{primary}$/m^2 treated floor area for space heating, domestic hot water (DHW) and all other electrical equipment combined.

To meet this criterion, the Passive House concept focuses first and foremost on reducing the energy demand of the building. Consequently attention is directed at high efficiency of energy use. The next priority lies with the use of passive (solar) techniques. After high efficiency has been obtained with all forms of energy use in the building, on-site renewable energy sources can be applied to meet the highly reduced demand of the residence.

Among project partners an inventory has been made of Passive House solutions and the extent to which they are applied in each country (please refer to the appendix for a complete overview). Practical solutions that result from this Passive House concept have been listed in Table 1. Where applicable, the Passive House standard value has been listed for the identified solution.

After collecting the technical solutions applied in Passive Houses in the partner countries, 3 categories of solutions have been distinguished: basic solutions, often applied optional solutions, and other optional solutions. Basic solutions have been applied in all Passive House examples, while optional solutions are not applied in all cases. The three categories of solutions and the corresponding value range are shown in Table 1.

Measure/ solution	*Passive House standard*
1. Super Insulation	
Insulation walls	U ≤ 0,15 W/(m^{2}K)
Insulation roof	U ≤ 0,15 W/(m2K)
Insulation floor	U ≤ 0,15 W/(m2K)
Window casing, doors	U ≤ 0,8 W/(m2K)
Window glazing	U ≤ 0,8 W/(m2K)
Thermal bridges	linear heat coeff ψ ≤ 0,01W/(mK)
Air tightness	n50 ≤ 0,6 h-1
Minimal Shape Factor (Area TFA/ Volume TV)	
2. Heat Recovery/ IAQ	
Ventilation counter flow air to air heat exchanger	heat recovery ηHR ≥ 75 %
Ventilation air sub-soil heat exchanger	air outlet after sub-soil heat exchanger above frost temperature
Ventilation ducts insulated	
Other heat recovery (e.g. ventilation & DHW return pipes)	
DHW heat recovery	
DHW pipes insulated	
Minimal space heating	postheater ventilation air/ low temperature heating
Efficient small capacity heating syst.	biomass, heat pump, gas, co-generation (e.g. district heating), etc.
Air Quality through ventilation rate	min. 0,4 ach^{-1} or 30 m^3/pers/h or national regulation if higher
3. Passive (Solar) Gain	
Window glazing	solar energy transmittance g ≥ 50 %
DHW (solar) heater	
Thermal mass within envelope	
Solar orientation	
Night-time shutters	
Shading factor [%] (East & West)	
4. Electric Efficiency	
Energy labeled household appliances [Labeling A - G]	Energy reduction 50% of common practice
Hot water connections washing machines/ dishwashers	
Compact Fluorescent lighting	
Regular maintenance ventilation filters	
Direct Current motor ventilation	
Efficient fans: SFP (Specific Fan Power)	≤ 0,45 W/(m3/h) (transported air)
5. On-site Renewables	
Wind turbine	
Photo Voltaics	
Solar thermal energy	
Biomass system	
Other	

(dark grey)	=basic measure/ solution
(light grey)	=often applied optional measure/solution
(white)	=other optional measure/ solution

Table 1 Passive House solutions/ measures

In the following sections each basic solution will be described, together with information regarding value range, the distance to target with respect to common practice in the partner countries, specific barriers or incentives encountered, and main proponent groups identified in partner countries. This will provide a broad international overview of the required solutions, the aspects that need attention, and approaches that can be employed to reach the Passive House standard in partner countries. More detailed information regarding the Passive House solutions applied in each country has been included in the appendix. General barriers encountered in partner countries are subsequently inventoried in chapter 3, along with a brief overview of possible approaches for each type of barrier encountered.

2 Basic Passive House solutions

2.1 Insulation (walls, roof, floors, windows & doors)

Description

The thermal envelope of a Passive House is the most prominent measure required to meet the Passive House criteria. Super insulation and maximal air tightness minimize the heat loss through the envelope. Insulation measures applied in some of the partner countries are shown on the following page.

Value Range

Existing passive houses in the partner countries show U-values ranging from 0.09 to 0.15 W/(m^2K).

Passive house solutions, with respect to thermal envelope, of several countries are shown in a matrix (next page). A lot of diversity can be seen in:

- Type of construction: wood or stone
- Thermal mass: high or low
- Type of finish: plaster or brick/ stone

This diversity indicates that within local constraints, such as building tradition, availability of components and regulation, solutions that comply with the Passive House standard are possible.

Figure 1 Thermal envelope details of Best Practice examples

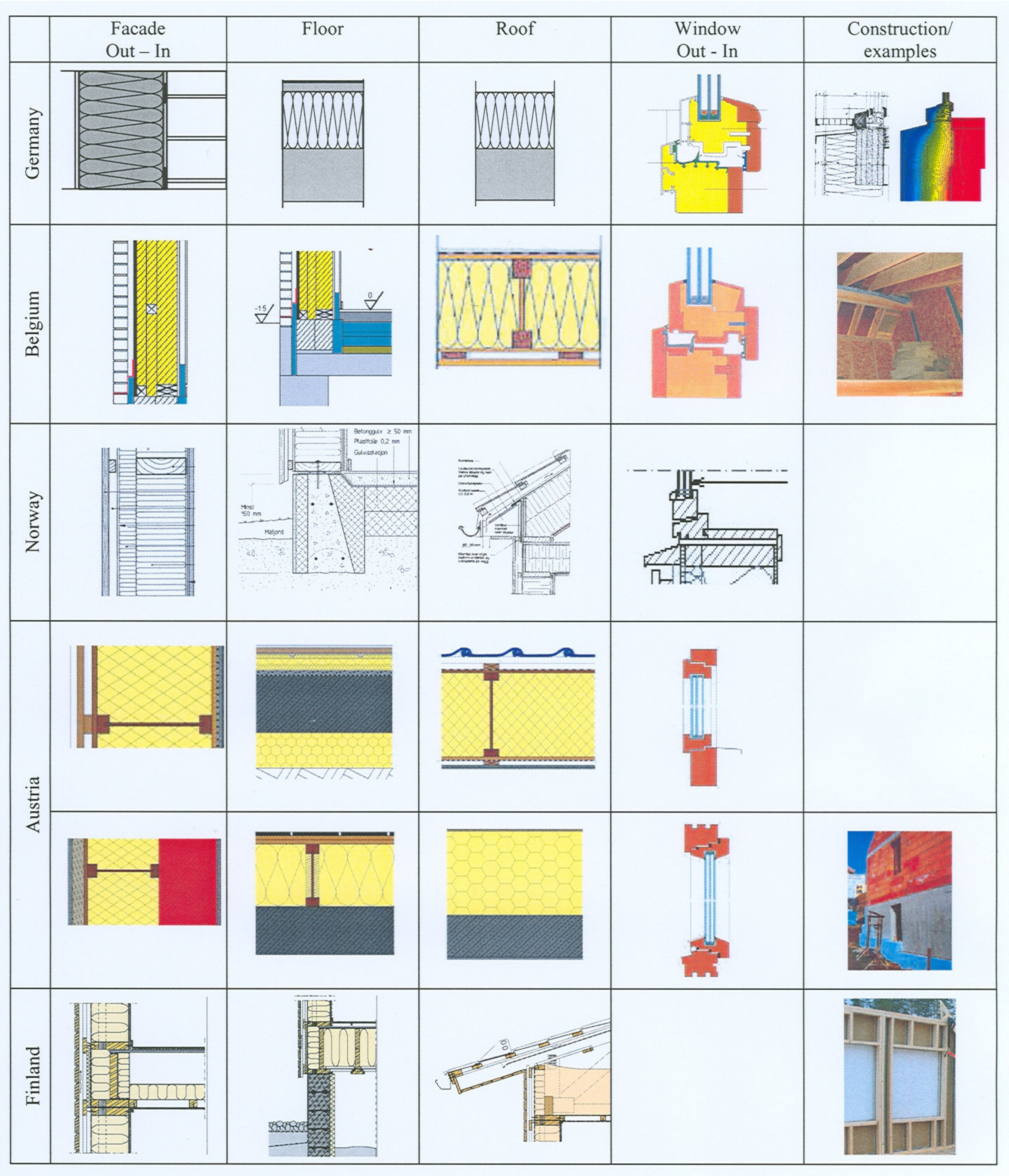


Figure 2 Thermal envelope details of Common Practice examples

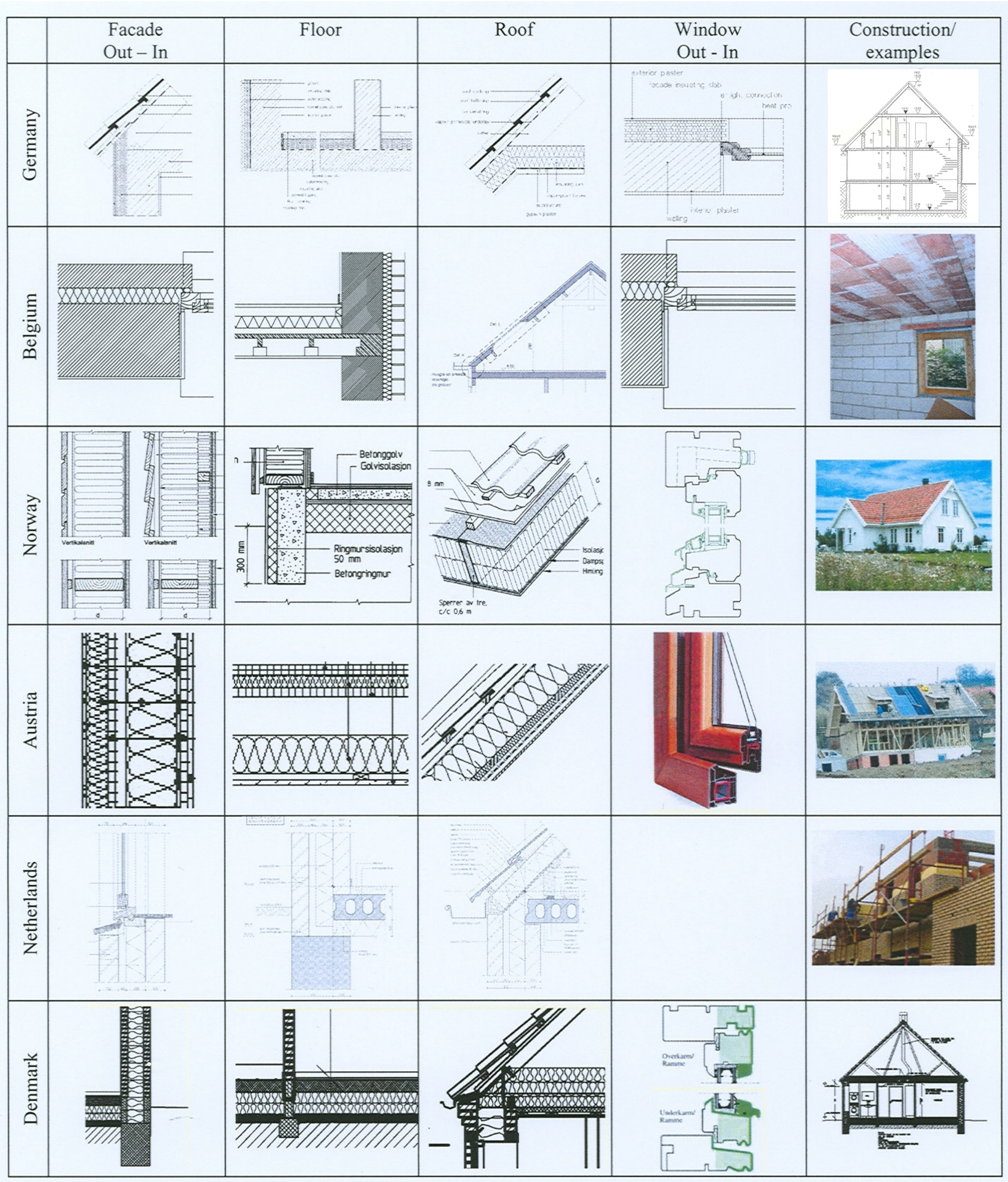
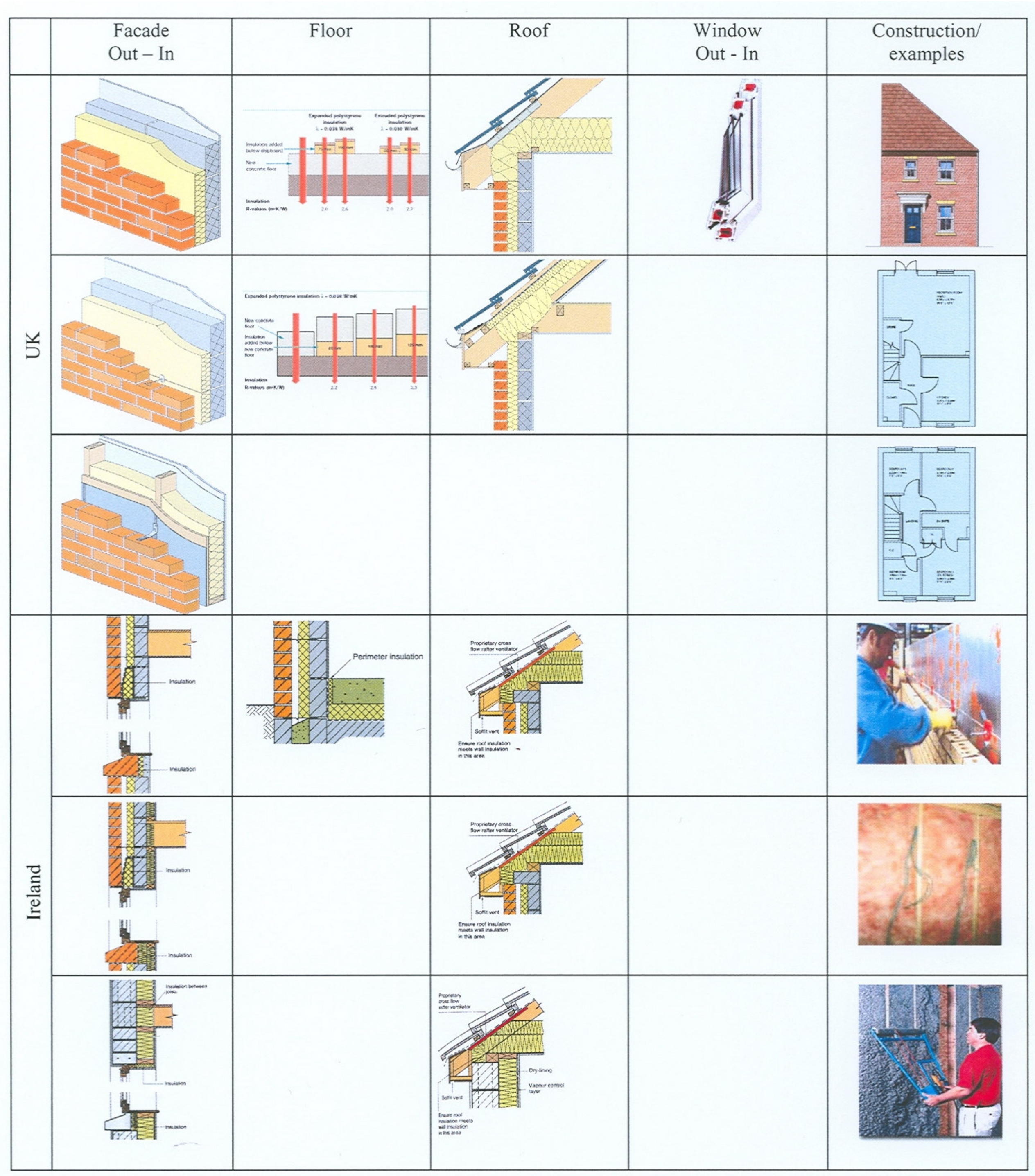


Figure 3 Thermal envelope details of Common Practice examples



Distance to target

Walls, roofs and floors

The thermal insulation applied in national common practice versus passive house construction is shown in Figure 4.

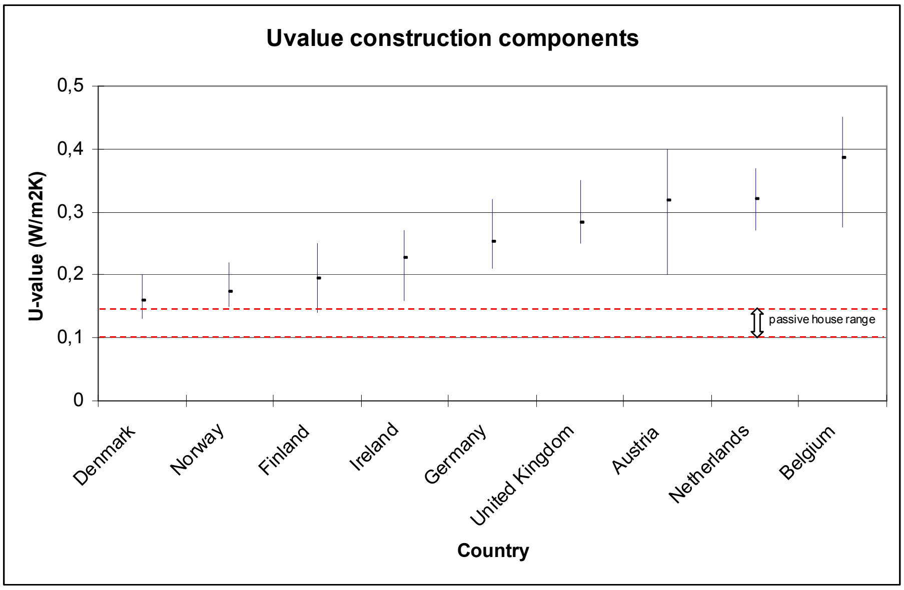


Figure 4 average U-values of construction components (wall, roof, floor) in European countries

Applied U-values in common practice for the partner countries range from 0.16 to 0.39 W/m^{2}K. Scandinavian countries show best thermal insulation in their construction and the performance of the thermal envelope comes close to passive house criteria. In other cases the thermal envelope performance is far from Passive House standards and a catch up with respect to thermal performance of the envelope is needed.

Windows and frames

Window frames with U-values lower than 0,8 W/(m^{2}K) (Figure 5) are not common practice in most countries. In the Netherlands for example, best practice in the building regulations is a U-value for window frames of 2,4 W/(m^{2}K). Triple glazing, as well, is not a common measure.

With regard to glazing and window frames, the performance of the common practice shows a fair distance to the Passive House standard of 0,8 W/(m^{2}K).

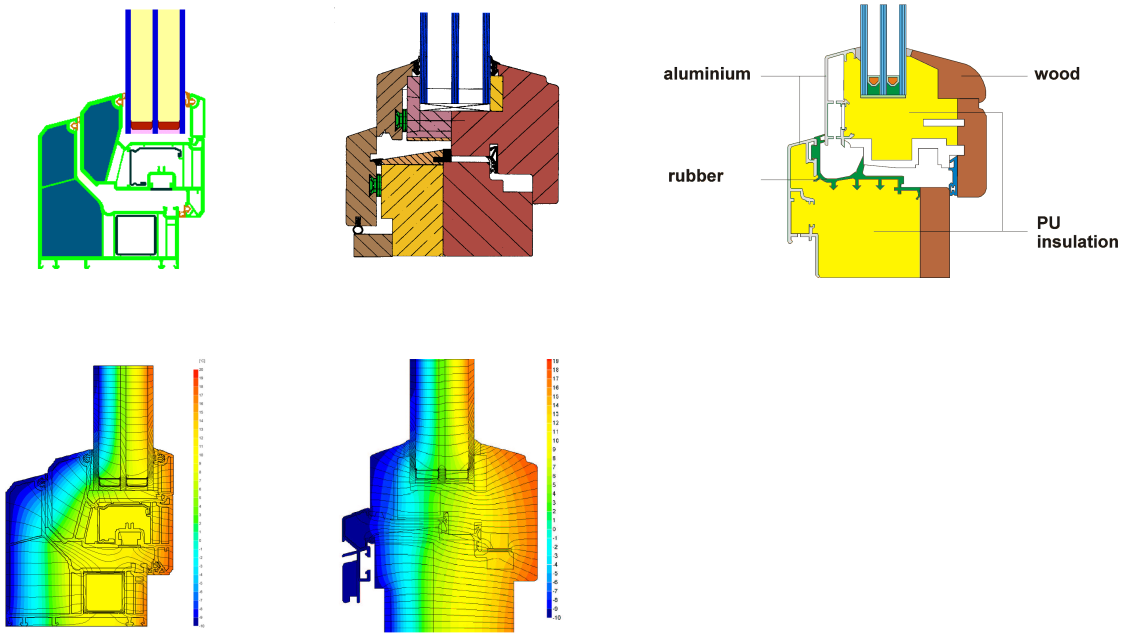


Figure 5:sample details of triple glazing in a window frame (U=0,8 W/(m2K))
Source: Passiv Haus Institut PHI, Passiefhuis-Platform vzw

Barriers / incentives

Barriers or incentives that have been identified with respect to insulation of the building envelope in partner countries are listed below.

Austria: An incentive is that good components are available for all envelope elements.

Belgium: Increasing the thickness of insulation in the brick cavity wall tradition is not feasible with the existing components. Slow penetration of appropriate window casings. Lack of air leakage standards for windows and doors.

Denmark: Lack of good window components. Tradition of a brick cavity wall, which the market prefers, forms a barrier for realization of the PH standard for U-value of exterior walls.

Ireland:

1. Private developer housing
2. Boom in construction industry
3. Little construction site inspection
4. Poor workmanship
5. Leaky construction
6. Lack of passive house components on the market.

Germany: The brick cavity wall tradition in North Germany forms a barrier for realization of the PH standard for U-value of exterior walls. An incentive is that good components are generally available.

Netherlands: Tradition of a brick cavity wall, which the market prefers, forms a barrier for realization of the PH standard for U-value of exterior walls.

Lack of appropriate window casing components on the market.

Norway: Lack of window casing components.

UK: In traditional wall types there is a lack of items such as wall ties and lintels to reach these higher performance levels with. For Structural Insulated Panels this is not a problem.

With respect to walls site practices and skill levels are an issue.

With respect to roofs adoption of new details by large housebuilders forms a barrier. However components are generally available.

Regarding floors carefully siting of insulation is required to avoid compression of the insulant.

With respect to doors there are problems with air leakage and thermal bridging.

The brick cavity wall building tradition poses challenges in several countries. To meet these challenges attention must be paid to good detailing, availability of appropriately dimensioned items (such as wall ties), and improvement of site practices will be necessary. If the market conditions allow, alternative wall-types could be developed.

The other barrier that is encountered in several countries is the lack of good window components. However, in other countries (such as Austria and Germany) these components are readily available. By temporarily importing these components, this barrier can be overcome. As demand increases it is expected that local availability will improve.

Proponent groups

Proponent groups that may play a significant role in the application of insulation of the building envelope according to Passive House standards are listed below.

Austria: Community of Insulation Industry Austria, Gemeinschaft Dämmstoff Industrie - www.gdi.at

list of producers according to the certified products of PHI - www.passiv.de

Belgium: The regional governments impose U-values to be reached. System builders, insulation manufacturers, window manufacturers. Building confederations like VCB, Bouwunie, CCW.

Germany: Gesamtverband Dämmstoffindustrie GDI, www.gdi-daemmstoffe.de

UK: Prefab producers, insulation manufacturers, ancillary manufacturers.

Glazing and door manufactures.

Netherlands: Insulation manufacturers, window/ door manufacturers (Glas Branche Organisatie: www.glasnet.nl)

Ireland: Insulation manufacturers.

Norway: Insulation manufacturers and window manufacturers

2.2 Thermal bridges

Description

A thermal bridge-free construction is a basic Passive House measure. Linear thermal conductivity should be lower than 0,01 W/(mK) for connections in the thermal envelope in reference to external dimensions. Attention must be paid to correct detailing and execution thereof, especially around connections with window- and doorframes, floors, and roofs.

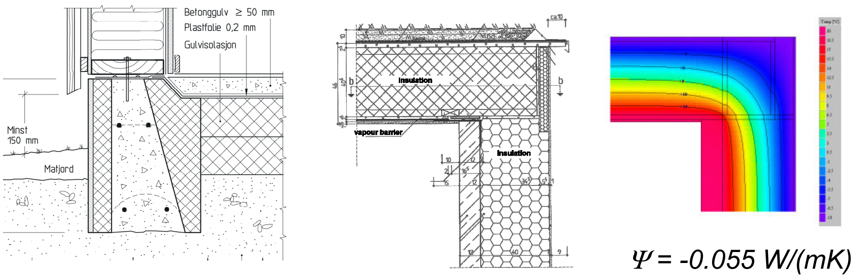


Figure 6 linear thermal conductivity Y ≤ 0,01 W/(mK), sources: SINTEF Byggforsk, PHI, ProKlima

Value range

Minimization of thermal bridges is necessary in different details (for examples, see Figure 6) in many different connections (see also Figure 1), dependant on the type of construction and elements applied. The values for Ψ encountered in the Passive House examples range from -0.03 to 0.01 W/(mK).

Distance to target

The Ψ-values for common practice in the partner countries range from 0,03 to 0,3 for different construction elements. Countries like Germany and Denmark show a narrower range and lie closer to the Passive House standard than countries like the Netherlands and the UK, which show a wider range. With respect to thermal bridges, much attention, in detailing as well as construction, is still needed to comply with the Passive House standard.

Barriers / incentives

Barriers or incentives that have been identified with respect to thermal bridge-free construction in partner countries are listed below.

Belgium: Lack of knowledge and skills on-site at the level of the (sub)contractor. Lack of good details for passive houses.

Denmark: Limited know-how.

Germany: Partly good Passive House details provided by manufacturers (e.g. Isorast, Marmorit), partly knowledge deficits among planners/architects, minimum standard for thermal bridges required by building regulation, www.baudetails.info shows details and psi-values for refurbishment of old buildings with Passive House components

Netherlands: Limited know-how and limited contractor skills and inspections, possibly prefabricated elements could form a solution.

Norway: Variable contractor skills form a barrier.

UK: Lack of solutions and guidance.

Ireland: Limited construction detailing know how, lack of construction skills and site inspections, poor workmanship.

In several countries information and education are needed to overcome limited skills and know-how with respect to thermal bridge-free construction. This could be done in the form of standard details and training material for contractors and inspectors.

Proponent groups

Proponent groups that may play a significant role in the realization of thermal bridge-free construction are listed below.

Belgium: Building teams for guarantee on a project basis (Architects, engineering offices, commissioning agents, constructors), details provided by (federations of) insulation manufacturers, system builders, trade unions

UK: Architects and developers.

Netherlands: Designers, prefab manufacturers, insulation manufacturers, builders.

Ireland: Architects, contractors, passive house components manufacturers.

2.3 *Air tightness*

Description

In the construction of Passive Houses a great deal of attention must be paid to air tightness of the building envelope, especially at connections between different elements, such as windows and doors. Through a blower-door-test (see Figure 7), the air leakage of a house at 50Pa can be measured. The Passive House standard is $n_{50} \leq 0,6\ h^{-1}$.

Figure 7 Blower-door-test Source: www.passivhaus.de

Value range

As with thermal bridge-free construction and good insulation, there are many different details possible to reach air tightness, dependant on the type of construction and elements applied. The value range for n_{50} encountered in Passive House examples in partner countries ranges from 0.2 to 0.61 h^{-1}. Here again, attention is needed to comply with the Passive House standard.

Distance to target

Air tightness (n_{50}) for common practice in partner countries lies around:

Austria: 1 h^{-1}

Belgium: 7.8 h^{-1} (recommended in national standard: 1-3 h^{-1})

Denmark: 2,3 h^{-1}

Germany: 1.5 to 3 h^{-1}

Netherlands: 2.32 h^{-1}

Norway: 2 h^{-1}

UK: 4 h^{-1}

Most country's common practice diverge considerably from the Passive House standard. As mentioned, this measure requires attention in detailing and execution.

Barriers / incentives

Barriers or incentives that have been identified with respect to airtight construction in partner countries are listed below.

Belgium: Limited know-how (contractor, architects)

Denmark: Limited know-how.

Germany: Increasing number of blower door tests in Germany (bonus in standard calculation method if a measurement is carried out)

Netherlands: Contractor skills and lack of on-site inspections form barriers to airtight construction.

Norway: Variable contractor skills form a barrier.

UK: On site build quality and failure to check for continuous airtight barrier on plans are major problems.

Ireland: Lack of builders skills, poor workmanship, lack of on site inspection, construction detailing know how. No air tightness measurement required by the building regulations.

As with thermal bridge-free construction, in several countries information and education are needed to overcome limited skills and know-how with respect to air tightness of the envelope. This is possible through standard details and training material for contractors and inspectors.

Proponent groups

Proponent groups that may play a significant role in the realization of airtight construction are listed below.

Austria: Institutions, which are providing air tightness measurements, (see also appendix).

Belgium: Companies providing air tightness measurements, contractors

UK: Builders/Architects

Ireland: Institutions providing air tightness measurements and tests.

2.4 Ventilation heat recovery

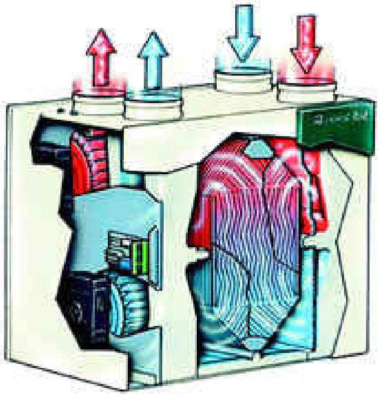


Figure 8 heat recovery unit, source: /www.energiebureaulimburg.nl

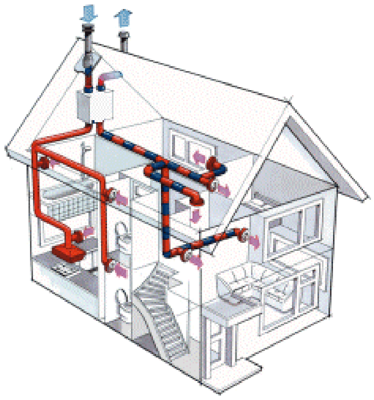


Figure 9 balanced ventilation, source:Informatiepunt Duurzaam Bouwen www.ipdubo.nl

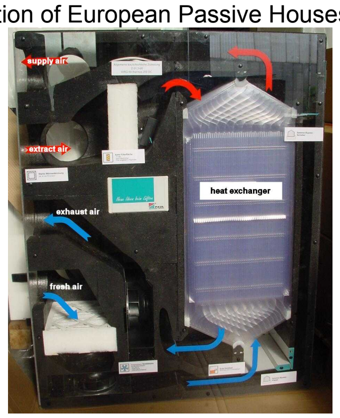


Figure 10 heat recovery unit, source: PHI

Description

Heat recovery in ventilation air can be applied with balanced ventilation, meaning mechanical supply as well as exhaust. This measure is essential to meet Passive House criteria. Main element of this heat recovering balanced ventilation system is a heat recovery unit. Obviously, aspects such as ductwork insulation are measures taken in Passive Houses to optimize the performance of the system.
Due to the low heat load requirement of a Passive House, the ventilation system can be utilized to heat the residence. Another possibility for heating a Passive House is to utilize low temperature heating (e.g. with few low temperature radiators) through a central heating system.

Value range

Heat recovery of ventilation air can only be applied in combination with mechanical ventilation. It is important that attention is paid to regular replacement of air-filters. Especially in countries where this system is relatively new, occupants may not be aware of this maintenance need and indoor air quality may suffer as a consequence. (Also, regular filter replacement improves ventilation fan efficiency.) In Passive Houses examples in the partner countries a ventilation air heat recovery of 75% - 90% was encountered.

Distance to target

In a few countries, e.g. Germany, heat recovery in ventilation air to minimize heat losses is hardly applied in common practice. However, in most countries this technique is available and has become a well-known measure. Common heat recovery rates vary between 65 and 90 percent. As illustrated below, the common practice in many countries already complies with the Passive House standard, and in the other cases the technology is available.

<u>Austria:</u> ≥ 75% heat recovery

<u>Belgium:</u> Ventilation of buildings only required from 2006 onwards (natural or (semi)mechanical), 90% heat recovery is available

Denmark: >65% heat recovery

Netherlands: Though existing houses have natural air supply and mechanical exhaust, current common practice is ventilation heat recovery of up to 95%.

Norway: None, though > 75% heat recovery is available

Germany: >75% heat recovery is available but the common practice is natural ventilation

UK: None, whilst it is common practice to naturally ventilate buildings, whole house mechanical ventilation systems with efficient (75% beyond)heat recovery systems are available

Ireland: None, most of new build dwellings have natural ventilation with mechanical extract in kitchens and bathrooms. High efficiency ventilation heat recovery systems are available from imports.

Barriers / incentives

Barriers or incentives that have been identified with respect to ventilation heat recovery in partner countries are listed below.

Austria: Good components are available.

Belgium: Good components are available. Lack of installers involved in using these components. Lack of project-based quality assurance (regulation of air flows, usually no handbook for the user, installation in dusty environments, no attention towards recommissioning, correct dimensioning of additional facilities like ground/air heat exchangers, post-heating)

UK: No barriers

Netherlands: An incentive for application of ventilation heat recovery in the Netherlands is the upcoming stricter energy performance regulation, which stimulate the application of balanced ventilation with heat recovery.
On the other hand, in the case of balanced ventilation there is a need for service contracts, ensuring regular replacement of air filters. Due to negative experiences with indoor air quality if regular maintenance does not occur, balanced ventilation may get a bad reputation.

Norway: The new building code will probably be an incentive

Ireland: High efficient mechanical ventilation systems are available from imports only. No incentives from building regulations. The common practice is natural ventilation with mechanical extract in kitchens and bathrooms.

Ventilation heat recovery does not pose any significant barriers for the development of Passive Houses in partner countries.

Proponent groups

Proponent groups that may play a significant role in the application of ventilation heat recovery are listed below.

Austria: List of producers according to the certified products of PHI - www.passiv.de.

Belgium: HVAC manufacturers/ installers and their branche organisations (ATIC, UBIC,..)

Netherlands: Heat recovery system producers (www.stichtinghrv.nl), mechanical ventilation producers and installers

UK: Mechanical ventilation manufacturers/ installers.

Norway: Suppliers of heat recovery units

Ireland: Heat recovery ventilation systems suppliers and installers.

2.5 Insulation of ventilation ducts and domestic hot water pipes

Description

To avoid heat loss, a Passive House requirement is to insulate the ventilation ducts and DHW-pipes.

Value range

Applying insulation of ducts and pipes is a measure that is readily available and applicable in all countries. The value range encountered in Passive House examples is from >6 cm - >10 cm for ductwork and around a factor 0.5 of the diameter of the pipe for insulation of DHW piping.

Figure 11 Insulation of ductwork, source: PHI

Distance to target

In about half of the partner countries some form of insulation is applied in common practice. In the other half it is merely best practice. For the Passive House standard these practices will need to be adjusted, however barriers for the application of insulation of pipes and ducts are very few.

Barriers / incentives

Barriers or incentives that have been identified with respect to insulation of ducts and pipe work in partner countries are listed below.

UK: No formal regulations in place and site practice can differ. With respect to insulation of piping, complete solutions are available.

It is evident that this Passive House standard does not cause any significant barriers. The application of this solution requires attention in execution, but no complex components or specialized skills.

Ireland: Common practice is insulation of boilers, all pipes and cylinder.

Proponent groups

Proponent groups that may play a significant role in the application of insulation of ducts and pipe work are listed below.

Belgium: Installers, manufacturers (education of installers), contractors

UK: Mechanical ventilation manufacturers / installers and heating installers.

Netherlands: Mechanical ventilation producers and installers

Ireland: Mechanical ventilation manufacturers / installers and heating installers.

2.6 Minimal space heating for comfortable indoor climate

Description

In order to reach a comfortable indoor climate in a Passive House, a limited capacity heater is needed to provide the small heating demand that remains. There are different methods in which to produce this heat, for example by post-heating ventilation air, or installing low temperature radiators. One thing that these systems have in common is the small capacity that is required. The advantage of post heating ventilation air is that no additional infrastructure is needed to transport the heat.

Value range

Solutions encountered in the Passive House examples are:

- **heat pump on geothermal heat** & **solar thermal collectors** supplying small central **low temperature floor heating**;
- small **biomass boiler** & **solar thermal collectors** supplying central **low temperature wall heating**;
- **solar-gas fired combination boiler** feeds hot water battery in the ventilation circuit, **heating ventilation air**;
- **district heating** (water) and **solar thermal collectors** supply heat to **ventilation air** & **radiator in bathroom**;

- electric **postheating** of **ventilation air;**
- **post-heating** by means of a **radiator in the bathroom**

Distance to target

The common practice for space heating in partner countries is listed below:

Austria: Wood pellets fired boiler with solar collectors for central low temperature wall- and floor heating.

Belgium: Condensing boiler (gas) for central heating with radiators and a thermostat for temperature control. Also fuel fired boilers.

Denmark: District heating, natural gas or oil boilers with water as heating fluid, supplying radiators and/or floor heating in the house with a thermostat for temperature control.

Germany: Condensing boiler for central heating with radiators and a thermostat for temperature control.

Netherlands: Gas heater HR (condensing boiler) for central heating with radiators and a thermostat for temperature control. Radiators are high temperature, low temperature radiators and floor/wall heating is applied sporadically.

Norway: Electric heating (hydro-electricity) with baseboard panels and a thermostat for temperature control.

UK: Gas condensing boiler.

Ireland: Oil fired boiler with water as heating fluid; thermostat control and radiator panels.

The two main overall differences identified between space heating in Passive House examples and national common practice are the heat source and the heat distribution in the residence. In the common practice the heat source is usually gas, while Passive Houses mostly use solar thermal heat in combination with another efficient heat source. With respect to heat distribution common practice usually shows central heating with radiators (generally high temperatures), while the Passive House examples demonstrate low temperature heating through ventilation air or radiators or floor/ wall heating.

Barriers / incentives

Barriers or incentives that have been identified with respect to minimal space heating solutions are listed below.

Austria: Good heat pump components are available, but it is still necessary to also fid/ develop appropriate concepts based on renewable energy for lowest energy demands (DHW and space heating for Passive Houses or lowest energy buildings). Alternatives to the heat pump (compact unit) need to be developed. Also, at the moment AEE INTEC is trying to work out the potential

and solutions for DH-concepts with solar and biomass in new settlement areas.
Austria is one of the world's leading countries in using solar thermal systems for DHW and for space heating. The quality of products is quite high but there is still a lack of high quality planning & installing large-scale systems. Plants for DHW in single-family houses are standard. Systems in a high quality, most of them realize as "plug-and-play" systems.

Belgium: Components are available (decentral needs market development). Clients have a fear that they will need extra heating and/or cooling or like to stick to a psychological fire-place.Installers stick to standards that require overdimensionning and provide for large power safety margins.

Germany: There are hardly any technical barriers in Germany.

Denmark: Duty of energy take within public district heating grid is in force, but may be abolished for low energy houses in new building regulations

Netherlands: The requirement for a certain level of heating capacity to comply with GIW guarantee (voluntary guarantee program, compliance with which increases market value of a house).

Norway: Barriers: Lack of affordable small bio-burners, low cost water based heating systems and heat pumps for DHW, only a few suppliers of solar collectors, and restrictive district heating legislation. Incentives: The upcoming energy labelling system.

UK: Skills of the workforce and cost of building to the standard.

Ireland: Solar thermal collectors for minimal space heating applications are expensive without funding. Heat pumps and low temperature under floor heating are becoming more widespread. Also, there is an Irish wood pallet burners manufacturer, and systems are becoming more available.

Proponent groups

Proponent groups that may play a significant role in minimal space heating are listed below.

Austria: List of producers according to the certified products of PHI - www.passiv.de.

Belgium: Media

Netherlands: System producers

UK: Manufacturers, installers

Ireland: Systems manufacturers and installers.

2.7 *Good indoor air quality through ventilation rate*

Description

Good indoor air quality is of vital importance to the occupants of a residence. Indoor air quality is influenced greatly by the amount of fresh air that enters the dwelling. This fresh air replaces stale air, which contains (biological) pollutants, excess moisture, and volatile organic compounds (VOCs), released from building materials, carpets, furniture and other household items as a result of aging, decomposition, or curing. Due to the extreme air tightness of passive houses, close attention must be paid to the ventilation rate that is reached inside the house.
Furthermore, attention must be paid to the noise-level produced by the installation system. Due to the high insulation levels of the building, the building is more prone to higher noise levels, which can cause annoyance for the occupant.

Figure 12 regular replacement of filters is important for IAQ, source: AEE Institut für Nachhaltige Technologien

Value range

The humidity of a climate can have an impact on the ventilation rate required to accomplish adequate indoor air quality. The Passive House standard for this measure is ≥ 0,4 ach^{-1} or 30 m^3/pers/h *or* the national requirement if it is higher. If this national requirement is much higher than the Passive House minimum, this will entail more heat loss for the Passive House in that country, which will need to be compensated in another way. In the Passive House examples inventoried, a value range of 0,22 – 0,69 ach^{-1} was encountered.

Distance to target

In all cases the minimum of 0,4 ach^{-1} is reached in common practice, as indicated below. In many countries the national regulations lie (slightly) higher than the Passive House minimum. The Netherlands have the highest requirement in place.

Austria: ≥ 0,4 ach^{-1} or 30 m^3/pers/h

Belgium: 30 m^3/pers/h ventilation rate per room

Denmark: ~ 0,5 ach^{-1}

Germany: ~ 0,5 ach^{-1}

Netherlands: ~ 0,9 ach^{-1}

Norway: ~ 0,5 ach^{-1}

UK: ~ 0,61 ach^{-1} (recommended in national document 0,5 – 1,0 ach^{-1})

Ireland: Recommended in building regulations:

- ventilation opening suitable for background ventilation having a total area not less than 6500mm^2, and

- ventilation opening suitable for rapid ventilation having a total area of at least 1/20th of the floor area of the room.

For mechanical ventilation: 30 Lit/s mechanical extract in kitchen and utility rooms; 15Lit/s in bathrooms for mechanical extract.

Barriers / incentives

Besides the fact that building regulations requirements need to be satisfied, no other barriers have been identified.

However, since Passive Houses have high air tightness, sufficient ventilation is more critical than in common practice, as the margin of error is smaller. Therefore sufficient attention must be paid to the actual realization in practice of the required ventilation rate.

Proponent groups

Proponent groups that may play a significant role in the air quality through ventilation rate are listed below.

Belgium: Installers, housing developers

Netherlands: Developers (www.neprom.nl), ventilation system manufacturers (www.stichtinghrv.nl), building inspectors, occupants

Norway: The association of ventilation systems engineers.

2.8 Window glazing and solar orientation

Description

By placing windows with a high solar energy transmittance (*and* a low e-value and U-value, as described earlier) in the residence and optimal orientation of the dwelling (windows towards the South), maximal advantage can be achieved from passive solar gains. (If applicable, well-dimensioned overhangs or awnings can be applied, to let the low winter sun enter the home, while in summer the window is shaded to avoid overheating.)

Generally besides a high solar energy transmittance, the windows usually have triple low-emittance glazing and well insulated frames, which let in more solar heat than is consequently lost again.

Value range

The value range encountered for solar energy transmittance of windows in the Passive House examples lies at 45% and higher.

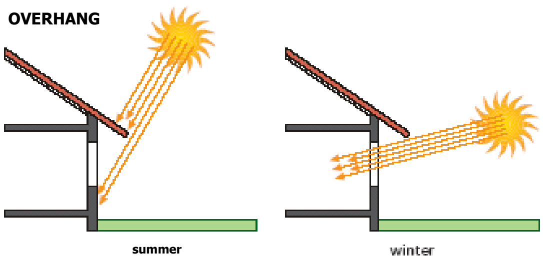


Figure 13 application of overhangs, source: Novem, 2000, "De zon in stedenbouw en architectuur"

Distance to target

The common practice values for solar energy transmittance are indicated below:

Austria: >50%

Belgium: 60-70%

Germany: 58%

Netherlands: 60-70%

Norway: 60-70%

UK: >50%

Ireland: >50%

The common practice values for U-values of glazing are indicated below:

Belgium:	1,6
Germany:	1,5
Netherlands:	1,2
Norway:	1,6
UK:	2
Ireland	2,2
Finland:	1,2

The Passive House standard with respect to solar energy transmittance is generally applied in the common practice. However, the low U-value and low-e (triple) glazing is not generally achieved in common practice and requires attention.

Barriers / incentives

With respect to solar energy transmittance value no barriers have been identified. However, in general it must be noted that careful choice in glazing type must be made in each individual situation.

Barriers or incentives that have been identified with respect to solar orientation and glazing are listed below.

Belgium: Constructors are not used to handle heavy triple glazing. This requires extra manpower or facilities for lifting. Glazing is often placed after placing the window frame in an opening in the construction.

UK: With respect to solar orientation local site factors can restrict orientation. The preferred South orientation is, however, recognized within building regulations.

Ireland: All triple glazed units have to be imported, as there is no manufacturer in Ireland.

The local site factors form restrictions within which solar orientation of the dwelling must be optimized. Attention must be paid to optimal solar orientation in each unique situation.

Proponent groups

Proponent groups that may play a significant role in the solar orientation and window glazing are listed below.

Belgium: Planners, architects, glazing manufacturers, window manufacturers

UK: Planners/ developers.

Netherlands: Architects, planners, glazing manufacturers (Glas Branche Organisatie: www.glasnet.nl).

Ireland: Planners, architects, developers.

2.9 Domestic hot water (solar) heating

Description

Not unlike any other type of residence, the Passive House requires a system that provides DHW. As with space heating, it is important that the system is (primary-) energy efficient and/ or has a small capacity that meets demand. Generally the DHW heating system in a Passive House is combined with the source for the space heating system. In all Passive House examples encountered, this system, though often supplied my multiple sources, in any case utilizes solar thermal collectors.

Value range

As mentioned, in Passive Houses the DHW heating system is generally combined with the space heating system. Solutions encountered in the Passive House examples are: **heat pump on geothermal heat** & **solar thermal collectors** (1-2 m^2 collector area/person) and/ or **gas heater**; small **biomass boiler** & **solar thermal collectors**; **solar-gas fired combination boiler**; DHW storage provided by **solar thermal collectors** and/ or **district heating**.

Distance to target

The common practice for DHW heating in partner countries is listed below:

Austria: Wood pellets fired boiler with solar collectors, combined with space heating.

Belgium: Combi-kettle gas, combined with space heating.

Denmark: District heating, natural gas or oil boiler supplies spiral in hot water tank, combined with space heating.

Germany: Condensing boiler (gas) with storage for DHW, combined with space heating.

Netherlands: Gas heater HR (condensing boiler) for instantaneous DHW, combined with space heating.

Norway: Electric heating (hydro-electricity) with storage for DHW, combined with space heating.

UK: Gas condensing boiler supplies hot water cylinder with 37,5 mm of spray foam insulation, and medium duty coil (typically 15-25 min. recovery period).

Ireland: Wood pellets fired boiler with solar collectors, combined with space heating (as used in the only one passive house example in Ireland at present).

Similar to the distance to target for space heating, the main overall difference identified between DHW heating in Passive House examples and national common practice is the heat source. In the common practice the heat source is usually gas, mostly with storage, while Passive Houses generally use solar thermal heat with storage in combination with another efficient heat source.

Barriers / incentives

Barriers or incentives that have been identified with respect to DHW (solar) heating in Passive Houses are listed below.

Austria: Good heat pump components are available, but it is still necessary to also fid/ develop appropriate concepts based on renewable energy for lowest energy demands (DHW and space heating for Passive Houses or lowest energy buildings). Alternatives to the heat pump (compact unit) need to be developed. Also, at the moment AEE INTEC is trying to work out the potential and solutions for DH-concepts with solar and biomass in new settlement areas.
Austria is one of the world's leading countries in using solar thermal systems for DHW and for space heating. The quality of products is quite high but there is still a lack of high quality planning & installing large-scale systems. Plants for DHW in single-family houses are standard. Systems in a high quality, most of them realize as "plug-and-play" systems.

Belgium: Belsolar certification for solar heating equipment. Hot water temperatures defined according to the avoidance of legionella. Lack of experience with heat recovery from waste water.

Germany: There are hardly any technical barriers in Germany.

Denmark: Duty of energy take within public district heating grid is in force, but may be abolished for low energy houses in new building regulations

Netherlands: Limited availability integrated (incl. passive) compact HR systems for DHW. Lack of small heat pumps.

Norway: Barriers: Lack of affordable small bio-burners, low cost water based heating systems and heat pumps for DHW, only a few suppliers of solar collectors, and restrictive district heating legislation. Incentives: The upcoming energy labelling system.

UK: Solar thermal collectors for DHW are not currently widespread, however very cost effective and available throughout the UK. 2006 building regulations is likely to drive uptake. Most European wide products are available.

Ireland: Wide range solar thermal domestic hot water systems are available. However, insufficient training and certification schemes for designers and installers.

Also, funding for DHW (solar thermal) systems unavailable.

Proponent groups

Proponent groups that may play a significant role in DHW (solar) heating in Passive Houses are listed below.

Austria: Austrian Association for promoting Solar thermal energy www.austriasolar.at

Belgium: Associations like Belsolar, ODE-Vlaanderen, IDEG

Netherlands: System producers

UK: Heat pump installers. Solar hot water installers, manufacturers. With respect to DH: Government, regional development agencies, large housing developers.

Ireland: Irish Solar Energy Association, Solar Energy Group, DIT, solar domestic hot water systems installers.

Norway: Manufacturers and suppliers of such systems.

2.10 Energy efficient appliances & lighting

Description

Regarding household appliances and lighting, the European Commission reports the following:

> *“The energy demand in* ***households accounts for 25% of the final energy needs*** *in the EU. Electricity used for* ***domestic appliances in households show the sharpest increase****. Higher standards of living and comfort, multiple purchases of electric appliances and the growing need for air-conditioning are main reasons for this trend to prevail. Energy consumption by consumer electronics and new media as Internet is also steadily growing.”*

Energy efficiency is a basic principle of the Passive House concept, but despite its importance, efficiency of household appliances is designated as an *optional* Passive House solution. As indicated above, household appliances account for a large portion of energy use. Applying energy efficiency requirements to household appliances will therefore have significant impact on energy use in a residence. However, household appliances are not necessarily considered part of a house, meaning control over the appliances used is not always with the designers/ builders of the house. Obviously this control varies per situation, type of appliance and local regulations. For example, in some countries certain residences are equipped with washer and full kitchen upon completion. In other situations no household appliances are included, and therefore there is no control over future appliances that are placed in the residence.

To influence efficiency of household appliances and lighting, the EU has responded with two complementary sets of legislation:

- **EU labelling schemes:** Seen that the market of household appliances such as washing machines, dishwasher, oven, air-conditioning systems etc. are highly visible to the consumer, the intention is to increase consumer's awareness on the real energy use of household appliances through a liable and clear labelling in their sales points.

  These labelling schemes are applicable to: Household electric refrigerators, freezers and their combination; Electric ovens; Air-conditioners; Lamps; Dishwashers; Combined washers-driers; Electric tumble driers; Washing machines; Household Appliances.

- **Minimum Efficiency Requirements:** Compulsory minimum efficiency requirements will encourage producers of household appliances to improve the product design in view to lower the energy consumption at their use.

  These efficiency requirements are applicable to: Fluorescent lighting; Household electric refrigerators, freezers and combinations; Hot-water boilers.

Value range

Generally, based on CEPHEUS findings, the Passive House standard regarding energy efficiency is an energy use reduction of 50% with respect to common practice. (This requirement partly coincides with the Passive House definition of a maximum total energy demand of around 42 kWh/m^2.) Values that have been encountered in Passive House and best practice examples are: recommendation to use A/ B rated appliances and energy savings lamps (Austria). A++ appliances and A rated lighting are available (UK).

Distance to target

The common practice values for energy efficiency of household appliances are indicated below:

Austria: Recommended: A/ B rated & energy savings lamps.

Belgium: No appliances are specified in common practice

Denmark: No appliances are specified in common practice.

Germany: No appliances are specified in common practice.

Netherlands: No appliances are specified in common practice.

Norway: EU labelling.

UK: Where specified A & B rated appliances now most common, approximately 30% low-e lighting is required by building regulators.

Ireland: A and B rated appliances are common.

Generally can be concluded that beyond EU legislation, not many energy efficiency requirements regarding household appliances have been established in the national common practices. This leaves plenty of room for improvement in the form of the energy use reduction of 50% with respect to common practice.

Barriers / incentives

Incentives that have been identified with respect to energy efficient household appliances and lighting are listed below.

UK: Worse than D-rated appliances generally not available anymore.

Norway: Incentives: The upcoming energy labelling system

In general an important barrier that is more or less applicable in all partner countries is the matter of control over appliances and lighting placed in the residence after completion. This has been described in greater detail in the previous section.

Proponent groups

Proponent groups that may play a significant role in energy efficient household appliances and lighting are listed below.

Belgium: building owners, Groen Licht Vlaanderen

UK: Specifiers/ house holders.

Netherlands: Manufacturers of electrical appliances & lighting, and occupants

Norway: Suppliers of household appliances

Ireland: House builders / owners.

2.11 Summary

The analysis of Passive House solutions in partner countries shows high priority with regard to the performance of the thermal envelope, such as high **insulation performance of walls, roofs, floors and windows/ doors, thermal bridge-free construction and air tightness**. Due to the required air tightness, special attention must be paid to **indoor air quality through proper ventilation**. Finally, **efficient ((semi-)solar) heating systems for combined (low temperature) space and DHW heating** still require a significant amount of attention in most partner countries. The other basic Passive House solutions show a smaller discrepancy with common practice and fewer barriers have been encountered in partner countries. In the next section, the general barriers in partner countries have been inventoried.

3 General national barriers for Passive House realization

In general three categories of barriers with respect to Passive House realization have been identified. For each type of barrier a suggested approach is given. In tackling the specific barriers it is important to involve proponent groups. These are the parties that may have a stake in the implementation of a specific Passive House solution. A selection of possible proponent groups for specific solutions has been listed in the previous chapter.

The barriers and suggested approaches are listed below.

Barrier	**Possible approach**
Technical/construction:	
- **A**vailability of components (A)	By temporarily importing components, this barrier can be overcome. As demand increases it is expected that local availability will improve. Another option would be to develop the component (together with proponent groups) for application in a specific project. Experience in other countries can be utilized.
- Limited **K**now-how (K)	Inform and educate e.g. through materials containing specific (local) solutions and workshops.
- **O**ccupant behaviour (O)	Inform and educate e.g. through an “Owner’s Manual” with specific instructions as well as underlying concepts and behavioural effects, or periodic feedback on building performance during occupancy.
- **C**onstruction skills (C)	Inform and educate e.g. through a practical manual with sufficient visuals illustrating the correct execution, as well as informing the relevance of the quality of work and its effect on performance. Another method of education could be by providing hands-on (certification) training of labour.
Market related:	
- **F**inancial (F)	Provide accurate information of actual costs and (financial) benefits (including possible subsidy schemes, etc.)
- **U**nknown concept (U)	Communicate and inform relevant parties (future occupants, developers, architects, etc.) regarding the Passive House concept and its benefits.
- Acceptation in **M**arket (M)	Communicate and inform relevant parties (future occupants, developers, architects, etc.) regarding the Passive House concept and its benefits. Provide an objective comparison with current practice.

Governmental

- **B**uilding regulations (B)	Involve regulators with Passive House developments. Communicate benefits regarding the Passive House concept (e.g. CO_2 reduction).

In the next section the barriers in each category inventoried in partner countries are listed.

3.1 Austria

Technical/ construction barriers:

Not many technical barriers are detected in Austria. Generally, good components are available. However, some technical barriers include:

- Energy concepts are not always fully thought through (which can for instance lead to problems with ventilation systems, such as un-insulated and un-cleanable ducts) (K) (C)
- Training of planners, builders and installers needs to be extended and improved. (K) (C)
- General conditions of the buildings must be improved (especially air tightness). (K) (C)
- Maintenance / quality assurance of the ventilation systems needs to be improved (e.g. regular maintenance of filters). (O) (K)
- Alternatives to the heat pump (compact unit) need to be developed. (A) (K)
- Good components are available, but it is still necessary to also find/ develop appropriate concepts based on renewable energy for lowest energy demands (DHW and space heating for Passive Houses or lowest energy buildings. (A) (K)

Market related barriers:

- There is still a lack of information within the different target groups (housing associations, producer of prefabricated houses, end user, etc). (U)

3.2 Belgium

Technical/construction barriers:

- Production/ construction: Many different types of construction methods exist in Belgium and they have to be adapted to the passive house concept. The main barrier is the brick cavity wall tradition. Constructors have to gain experience with new building systems. (K) (C)
- Calculation/ certification: Many houses are now being built without quality guarantee, which could lead to bad examples and counter-effects. (K) (C)

- Language barrier: Passive houses are mainly built in the Flemish Region because of available information in the Dutch language. (K)
- Educational: SME's and VSE's have little time to spare to innovate and require special attention and guidance in the development of innovations. (K)

Market related barriers:

- Financial: Building cost and other priorities in grant schemes: Passive houses still cost more and are not awarded with grants. (F)
- Awareness/ comfort: although the passive house concept has been introduced, efforts are still required to bring the concept to the main public (especially architects and people who want to build). (M)
- Due to availability of Passive House information mainly in the Dutch language, most Passive Houses are built in the Flemish Region (M)

3.3 Denmark

Technical/construction barriers:

- A Lack of good window components (A)
- Limited know-how of thermal bridges (K) (C)
- Limited know-how of air tightness (K) (C)
- There are no guidelines for best building practices for passive houses(K)
- Very limited know-how but growing interest in general among architects, costumers etc (U)

Market related barriers:

- Very limited know-how but growing interest in general among architects, costumers etc (U)
- Politicians are still ignorant about passive houses (U) (B)
- No official passive house programme with economical support (F)

Building regulations related barriers:

- Politicians are still ignorant about passive houses (U) (B)
- Duty of energy take within public district heating grid is in force, but may be abolished for low energy houses in new building regulations (B)
- New directive does not include passive houses (B)

3.4 Germany

Technical/construction barriers:

- Deficits in knowledge among architects, consultants, building contractors, sales staff: Life-long learning is not established in the building sector. Unemployment among architects is high and incomes are going down so that existing education offers are not affordable for an increasing group. (K)

Market related barriers:

- Passive houses are unknown: customers don't know the comfort of passive houses and take the technology to be complicated. (U) (M)
- Investment costs are decisive: CEPHEUS showed that passive houses can be offered at competitive prices on the market. Even though the sales price differs only marginally from that of "normal-energy house" that little price difference can be decisive. There is a trend to thriftiness and today's investment costs are the main criteria. (F)
- There are hardly any technical barriers in Germany. Components are available, however the brick cavity wall tradition in North Germany can be a barrier. (M)

3.5 Ireland

Technical/construction barriers:

- Triple glazed windows and other passive house components must be imported (A)
- Limited know-how amongst planners, architects, builders and installers. (K) (C)
- Limited knowledge on thermal bridges and air-tightness (K) (C)
- Cavity brick wall, concrete block wall and timber frame wall are most commonly used construction systems. They have to be adapted to the passive house concept or different building systems adopted.
- Builders skill levels
- On site build quality of continuous airtight barrier

Market related barriers:

- Lack of passive house information campaigns for future occupants, developers, planners, architects, builders. (U) (M)
- Lack of funding schemes. (F)

Building regulations related barriers:

- Existing standards. (B)
- Calculation methodologies and certification schemes. (K)

3.6 Netherlands

Technical/construction barriers:

- The main barrier is the brick cavity wall tradition. Lower U-values result in thicker walls. To avoid extreme thick walls other finishing materials and construction may be preferable. (K)
- Limited knowledge of thermal bridges and air tightness. (K) (C)
- Availability of appropriate window casing is a problem. (A)
- Ventilation: maintenance contract necessary for balanced ventilation systems, otherwise problems regarding indoor air quality and poor electrical performance of fans, as described earlier. (O)
- Lack of small heat pumps. (A) (K)

Market related barriers:

- The Dutch housing market can be characterized as a push-market. Real estate developers yearly develop many large housing projects. Often, municipalities play a big role in the targets that are set for developers. The occupants/sellers of houses buy what they can buy, without much interest and knowledge of (passive) houses. (U) (M)
- Another market-barrier is the brick cavity wall tradition. Besides the technical solutions needed to avoid thick walls, there is a market-related aspect to this barrier as well: the Dutch consumer is used to the brick cavity wall and associates this construction method with quality. (M)

Building regulations related barriers:

- Many houses nowadays are built according to the (voluntary) GIW-guarantee. This guarantee is only provided if the house has been built according to certain specifications. Due to the specification regarding heating capacity, the Passive House may not comply, which might weaken its position in the market, even though the quality could be comparable or higher than the homes that have been approved under the GIW-guarantee. (M) (B)

3.7 Norway

Technical/construction barriers:

- A Lack of good window components. (A)
- Lack of affordable small bio-burners, low cost water based heating systems and heat pumps for DHW. (A)
- Only a few suppliers of solar collectors. (A)

Other obstacles are:

- Lack of knowledge among planners. (K)
- A focus on investment cost, instead of quality of the end product (K)
- Variable contractor skills. (C)

Building regulations related barriers:

- District heating legislation (B)

3.8 United Kingdom

Technical/construction barriers:

- On site build quality and failure to check for continuous airtight barrier on plans are major problems. (C) (K)
- There is a lack of items such as wall ties and lintels to build traditional wall types to these higher performance levels. (A)
- Site practices and skill levels are also an issue. (C) (K)
- Filters of mechanical ventilation systems are mainly neglected by occupants, which can cause problems. (O)
- Adoption of new details is a barrier for large house builders. (C) (K)
- Calculation methodologies. (K)
- Availability if heating systems to meet lower heating demand. (A)

Market related barriers:

- Changing the traditional ‘cavity-wall’. (M)
- Consumer aspirations - they expect central heating and want fireplaces. (M)
- Previous voluntary certification schemes have failed. (U)

Building regulations related barriers:

- Existing standards. (B)

3.9 Passive House way forward

Key issues regarding the implementation of the Passive House concept in partner countries that have been raised by project partners are:

- Certification/ control of Passive Houses
- Feasibility of document retrieval for certification
- Strictness of values
    - Interpretation of round windows
    - Calculation of buffer zones
    - Mobile and/or transparent solar shading
    - Default reduction coefficients for uncertified technology
    - Shading coefficients for side buildings (future/ present)
- Cost effectiveness of the procedure

These are issues that will need to be addressed in an early stage of Passive House implementation in countries. Some items may be approached differently in each country, while others could be addressed multi-laterally within this project. In the following Work Packages these issues will be addressed in greater detail.

3.10 Conclusion

Most frequently encountered barriers in partner countries are: limited know-how; limited contractor skills; and acceptation of Passive Houses in the market. Based on the suggested approaches to overcoming barriers earlier in the chapter, this means that a great deal of attention must be paid to providing practical information and solutions to building professionals, providing practical information and training to installers and contractors and communication about the Passive House concept to the market.

Further reading: Links of interest

Belgium

General governmental portals considering energy efficiency
Flemish Region http://www.energiesparen.be
Walloon Region http://energie.wallonie.be
Brussels Capital Region http://www.ibgebim.be

Organisations sustainable building and energy
APERE www.apere.org
Centrum Duurzaam Bouwen www.cedubo.be
Groen Licht Vlaanderen www.groenlichtvlaanderen.be
Nature & Progrès www.natpro.be
Negawatt www.negawatt.be
ODE-Vlaanderen www.ode.be
Passiefhuis-Platform www.passiefhuisplatform.be
VIBE www.vibe.be

Builders/ manufacturers
Companies and institutes involved in passive houses:
see http://www.passiefhuisplatform.be/?col=/php_vzw/leden&lng=nl&doc=lijst

Related federations
Agoria www.agoria.be
ATIC www.atic.be
Bouwunie www.bouwunie.be
Confédération Construction Wallonne www.ccw.be
FEE www.feebel.be
UBIC www.ubic.be
Ventibel www.ventibel.be
Vlaamse Confederatie Bouw www.vcb.be

Background information Passive Houses
Mlecnik Erwin,: seminarie op Architecture & Energie 2050, 19 november 2005, Brussel
Cobbaert Bart, 'Airtightness in low energy buildings', AIVC conferentie 21-23 september 2005, Brussel, België
Mlecnik Erwin, 'The Success of the Passive House in Belgium', 8e Europäische Passivhaustagung EPHT 2004, 16-18 April 2004, Krems a.d. Donau, Oostenrijk (proc. 585-589)
Mlecnik Erwin, 'Passive House Platform: 1 year later', 1ste Benelux Passiefhuis-Symposium PHS 2003, 24 oktober 2003, Turnhout, België. (proc. 161-179)
Cobbaert Bart, 'Living Today: ontwerp en realisatie van luchtdichting / dichtheid', 1ste Benelux Passiefhuis-Symposium PHS 2003, 24 oktober 2003, Turnhout, België. (proc. 106-120)
Mlecnik Erwin, 'PHP: towards radical energy reduction in Flemish buildings', 7e Internationale Passivhaustagung, 21-22 februari 2003 Hamburg, Duitsland (proc. 271-274)

Germany

www.ig-passivhaus.de
www.passiv.de
www.passivhaustagung.de
www.proklima-hannover.de

Ireland

Organizations
Sustainable Energy Ireland http://www.sei.ie
Renewable Energy Information Office http://www.sei.ie/reio.htm

Solar Energy
Irish Solar Energy Association http://www.irishsolar.com
Includes full list of Solar installers and suppliers suplied in this website.
UCD Energy Research Group http://erg.ucd.ie
Solar Energy Group, DIT http://focas.dit.ie/groups/SolarEnergy/index.html

Bioenergy
Irish Bioenergy Association http://www.irbea.org/

WoodEnergy
Ireland's Natural and Renewable Energy Source www.woodenergy.ie
Both websites include complete lists of suppliers and installers of biomass related products.

Heat recovery Ventilation Suppliers

http://www.aerventgroup.com	http://www.aerventgroup.com
Air Purification Systems Ltd.	http://www.airpurification.ie
Atlantic Canada Home Ireland Ltd.	http://atlanticcanadahome.com
Mitsubishi Electric	http://www.MitsubishiElectric.ie
ProAir Systems	http://www.ProAir.ie
Radon Ireland Group	http://www.ProAir.ie
Low Energy Solutions Ltd.	http://www.conserve-energy.com

Insulation

Aerobord Ltd.	http://www.aerobord.ie/
Alan Beattie Manufacturers Agent	alanbeattie@eircon.net
Ecowise Insulation Ltd.	ecowise@eircom.net
Homatherm holzFlex 040	http://www.ecologicalbuildingsystems.com/
Kingspan Insulation Ltd.	http://www.insulation.kingspan.com
Sheep Wool Insulation Ltd.	http://www.sheepwoolinsulation.ie
U-Value Insulation	info@uvalue.biz
Western Insulation	colmglynn@eircom.net
Xtratherm Ltd.	http://www.xtratherm.com
Ochre Wool Teo	ochrewool@eircom.net

Air tightness Testing
Urban Institute Ireland www.urbaninstitute.net
UCD Energy Research Group http://erg.ucd.ie

Products
Proclima Airtight Solutions http://www.ecologicalbuildingsystems.com

Triple Glazing
Triple Glazing windows are usually imported from Central Europe, as there is no companies manufacturing triple glazing in Ireland.

Netherlands

Organisations sustainable building
Agentschap voor Duurzaamheid en Innovatie SenterNovem www.senternovem.nl
Nationaal Dubo Centrum http://www.dubo-centrum.nl/
Stichting Passief Bouwen.nl www.passiefbouwen.nl
Stichting Passiefhuis Holland www.passiefhuis.nl

Sustainable energy
Organisatie voor Duurzame Energie http://www.duurzameenergie.org

Builders/ manufacturers
Developers platform www.neprom.nl
Window/ door manufacturers: Glas Branche Organisatie www.glasnet.nl
Ventilation system manufacturers (www.stichtinghrv.nl)
Stichting WTA http://www.stichtingwta.nl/

Home owners: vereniging eigen huis http://www.eigenhuis.nl/VerenigingEigenHuis

Background information Passive Houses
Boer, B.J. de; Kaan, H.F.; Jong, M.J.M.; Koene, F.G.H.; Strootman, K.J. "De optimale PZE-woning: Literatuurstudie, Conceptontwikkeling & Voorlopig Ontwerp", ECN rapport ECN-C-03-002, Petten, 2003.
Boer, B.J. de; Kaan, H.F.; 'De optimale PZE-woning; Haalbaarheidsonderzoek naar de realisatie' ECN rapport ECN-CX-03-002, Petten, 2004.
Koene, F.G.H.; Jong, M.J.M.; Kaan, H.F. 'Verwarmingsconcepten PZE woning : weinig Joules met weinig installatie' ECN rapport ECN-00-097, Petten, 2001.

Norway

www.lavenergiboliger.no
www. sintef.no/lavenergiboliger

United Kingdom

General information on PassivHaus design in the UK
www.passivhaus.org.uk
(maintained and run by The Building Research Establishment)

Pressure testing
The Air Tightness and Testing Measurement Association
www.attma.org

Insulation
National Insulation Association (NIA)
Tel: 01525 383313
Web: www.insulationassociation.org.uk

Insulated Render and Cladding Association (INCA)
Tel: 01428 654 011
Web: www.inca-ltd.org.uk

Glazing
Glass and Glazing Federation
Tel: 0870 042 4255
Web: www.ggf.org.uk

Fenestration Self-Assessment Scheme
Tel: 0870 780 2028
Web: www.fensa.co.uk

British Fenestration Rating Council (BFRC)
Tel: 08700 278 494
Web: www.bfrc.org

Draught-proofing
National Insulation Association (NIA)
Tel: 01525 383313
Web: www.insulationassociation.org.uk

Draught Proofing Advisory Association Limited
Tel: 01428 654011
Web: www.dpaa-association.org.uk

Heating and hot water
HHIC (Heating and Hot water Information Council)
Tel: 0845 600 2200
Web: www.centralheating.co.uk

CORGI (Council of Registered Gas
Tel: 0870 401 2200
Web: www.corgi-gas-safety.com

OFTEC (Oil-Firing Technical Association)
Tel: 0845 6585080

Web: www.oftec.org

Heating Efficiency Testing and Advisory Service Ltd (HETAS Ltd)
Tel: 01242 673257
Web: www.hetas.co.uk

The Solid Fuel Association
Tel: 0845 601 4406
Web: www.solidfuel.co.uk

The British Electrotechnical and Allied Manufacturers' Association
Tel: 020 7793 3000
Web: www.beama.org.uk

References

Feist, W., Peper, S., Görg, M., CEPHEUS Projectinformation No. 38: Final Publical Report, Darmstadt July 2001.

Feist, W., Pfluger, R., Kaufmann, B., Schnieders, J., Kah, O., Passive House Planning Package 2004, Darmstadt 2004.

http://europa.eu.int/comm/energy/demand/legislation/domestic_en.htm

Novem, 2000, “De zon in stedenbouw en architectuur”

http://www.passiefhuisplatform.be

http://www.maisonpassive.be

http://www.passivehouse.be

Proceedings van het Benelux Passiefhuis-Symposium 2005, Aalst, België

La Maison Passive. Introduction pour les architectes et les futurs maîtres d’ouvrage. Ed. PHP & La Cambre Architecture, Berchem, 2005

Proceedings PHS 2004 2de Benelux Passiefhuis-Symposium, Gent, België, Ed. PHP, Berchem

PHPP 2003 Benelux – instrument voor de kwaliteitsbewaking van passiefhuizen, Ed. PHP, Berchem

Proceedings PHS 2003 1ste Benelux Passiefhuis-Symposium, Turnhout, België, Ed. PHP, Berchem

Cobbaert Bart, ‘Certificatiesysteem voor passiefhuizen’, Benelux Passiefhuis-Symposium 2005, 21 oktober, 2005, Aalst, België.

Mlecnik Erwin, ‘Passiefhuizen: energiebesparingspotentieel en klimaatkans voor de bouwsector’, Benelux Passiefhuis-Symposium 2005, 21 oktober, 2005, Aalst, België.

Mlecnik Erwin, ‘Developing an indigenous market for passive solar houses’, See the Light 2005, Galway, Ierland

Mlecnik Erwin, ‘Passive House Projects in Belgium’, 9de internationale Passivhaustagung 29-30 April, 2005, Ludwigshafen, Duitsland

Cobbaert Bart, ‘PHPP: instrument voor de kwaliteitsbewaking van passiefhuizen’, 2de Benelux Passiefhuis-Symposium PHS 2004, 22 oktober, 2004, Gent, België. (proc. 73-88)

Mlecnik Erwin, ‘Kwaliteitsbewaking van passiefhuizen en energiezuinige woningen’, 2de Benelux Passiefhuis-Symposium PHS 2004, 22 oktober, 2004, Gent, België. (proc. 133-147)

Mlecnik Erwin, ‘Stand van zaken passiefhuizen’, 2de Benelux Passiefhuis-Symposium PHS 2004, 22 oktober 2004, Gent, België. (proc. 2-14)

Mlecnik Erwin, ‘Demand and supply solutions for more passive buildings: implementation of PHP’, 21th conference on Passive and Low energy Architecture PLEA 2004, 19-22 September 2004, Eindhoven, Nederland

Appendix (separate documents)

Passive House Solutions Austria

Passive House Solutions Belgium

Passive House Solutions Denmark

Passive House Solutions Finland

Passive House Solutions Germany

Passive House Solutions Ireland

Passive House Solutions Netherlands

Passive House Solutions Norway

Passive House Solutions UK