European Embedding of Passive Houses

www.europeanpassivehouses.org

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Content

Summary

The passive house concept has become a European wide accepted solution to reach a significant energy demand reduction in the built environment. The European Commission has published the ambition to construct newly built houses in 2015 accordingly to the passive house standard. In most project participating countries this ambition is shared. With the support of the Intelligent Energy Europe program[1] this project "Promotion of European Passive Houses" (PEP-project) contributed to achieve this ambition to clear the first market barriers internationally to reach the status 'Business As Usual" for passive houses in 2015.

The PEP project aimed at the development of easy accessible web based documentation for stakeholders in the building process to solve national market introduction barriers regarding the passive house concept. The project also aimed at the distribution of this information via international and national workshops, seminars and conferences.

It can be concluded that the PEP-project has been successful. All participating countries made significant progress in the societal embedding process of passive houses and in most countries the passive house concept is on the brink of breaking through nationally. Further, the PEP-project contributed successfully in the internationalisation of the Internal Passive House Conference and fixed the definition of a passive house for three geographical European regions. Finally, the PEP website with its wealth of information was a powerful tool for promotion of passive houses in Europe.

In order to increase the implementation efficiency of the passive house concept it is recommended to develop additional information packages concerning passive house solutions for offices, schools and social homes (e.g. architectural examples, organisational issues); passive house renovations; financial schemes for passive houses; performance oriented quality approach for the design and construction process; industrial prefab construction of passive elements and practical training programs for craftsmen, to architects, engineers and developers. Further research is recommended to identify the relation between hygienics required of ventilation systems and comfort and health. Finally, it is recommended to start the implementation of the certification schemes for passive houses.

[1] http://ec.europa.eu/energy/intelligent/index_en.html

1 The PEP project

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. As previous demonstration projects (such as CEPHEUS project Number: BU/0127/97) 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 a relatively low cost method to achieve these energy savings.
The basic idea of a passive house is to minimise the heat demand for space heating so that the necessary heat can be supplied by additional heat to the ventilation air. Taking into account the outdoor temperature and as a consequence the temperature of the incoming ventilation air, the heat capacity of the air, and the maximum temperature to which the air can be heated to be comfortable, the maximum heat requirement was calculated to 15 kWh/m^2·year. An average energy reduction of 50% to 65% can be obtained per house compared to the business as usual [2]. Figure 1 illustrates the energy saving potential of a passive house compared to the average existing building stock and newly built houses per country.

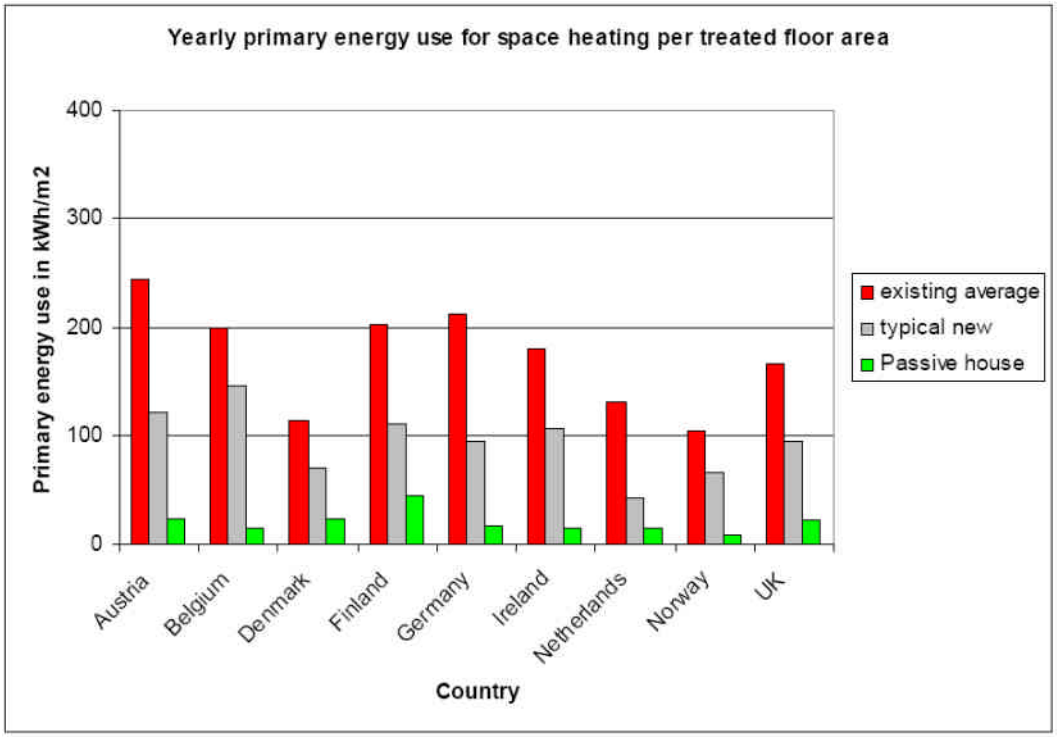


Figure 1 : Yearly primary space heating energy uses per dwelling, per existing, typical new and passive house[3]

On the PEP project website (www.europeanpassivehouses.org) more information can be downloaded about the definition of a passive houses, the energy savings potential of passive houses, the related CO_2 reduction potential per country, certification schemes and construction examples, solution for market barriers etc...

[2] http://erg.ucd.ie/pep/pdf/Passive_House_Sol_English.pdf
[3] PEP report "Energy saving potential", May 2006: http://erg.ucd.ie/pep/pdf/Energy_Saving_Potential_2.pdf

Most European countries have made large progress in reduction of energy consumption in the housing sector during the last two decades. However, much more can be achieved, as has convincingly been shown with building and renovating according to the passive house standard in Germany and Austria. Since many houses will be renovated and many houses will be newly erected in the near future the chance is offered to improve the energy efficiency in the housing stock substantially. In order to investigate how the experience and knowledge about passive houses can be used in this process, and how the principles of passive houses can be linked to the information and awareness strategies that are intended by the EU Directive EPBD, nine co-operating European countries (Ireland, UK, the Netherlands, Belgium, Norway, Denmark, Finland, Germany and Austria) started a project: Promotion of European Passive Houses (PEP). The project was financially supported by the EC, within the framework of the Intelligent Energy for Europe - programme. The project started in January 2005 and completed in January 2008.

The PEP project aimed at the development of easy accessible web based documentation for stakeholders in the building process to solve national market introduction barriers. The project also aimed at the distribution of this information via international and national workshops, seminars and conferences.

All general and country specific passive house information can be downloaded from the project website: www.europeanpassivehouses.org

This report will describe in brief the important results of the project and the effect of the project (inter)nationally.

Figure 2: Passive Houses in Kronsberg, Hannover, Germany [4]

[4] PEP project information No1 "Climate Neutral Passive House Estate in Hannover-Kronsberg: Construction and Measurement results", Passivhaus Institute, 2005

2 Embedding Passive Houses in Europe

In order to visualise the effect of the PEP-project a basic market penetration model, the well-known S-curve has been used. This chapter describes the status of market penetration of passive houses in the participating PEP countries at the beginning of the PEP-project.

2.1 Embedding a new concept

Potential innovations in the building process, such is the passive house concept, has to go through a societal embedding process before the concept is accepted as "business as usual". According to Rothmans the societal embedding process or diffusion process can be visualized as an S-curve with four phases: a pre-development phase, an introduction phase; an acceleration phase and a stabilisation phase (see figure 3).

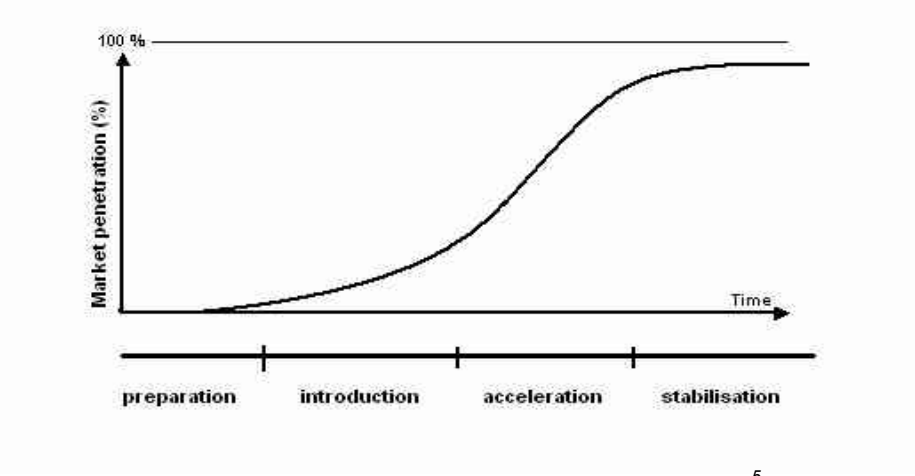


Figure 3: S-curve for embedding process of innovations [5]

During the pre-development phase, changes in the societal system are hardly recognizable. The emphasis in this phase is on small scale experiments in a secure environment (niche) and the development of a long term vision. This vision (in our case the vision of Prof. Wolfgang Feist) is the thread for future developments and is the basis for the requested corresponding behaviour and acting of actors involved. The long term vision has an evolving nature during the embedding process and can be changed by gained insight through experiments. In the introduction/take-off phase the passive house concept is introduced in several places, experiences are gained and actors are mobilized in a direction towards a mutual goal. The passive house concept has benefited in this sense by the International Passive House Conferences, which took place in one of the German speaking countries since 1992. The CEPHEUS project[6] results are a good example to indicate the market situation at the end of the introduction phase. After this introduction phase the passive house has the potential to grow further and initiate the first structural changes in the society in the acceleration phase. In this phase innovations developed in earlier phases find their way to other markets starting a new embedding process in that market. In the PEP-project it seemed that successful innovations (like triple glazing and air tightness solutions) developed for the newly built PH market are introduced a few years later in the refurbishment market. At the moment this happens in Germany and Austria. Finally, the embedding process will stabilize in the last phase. In this stabilization phase the passive house concept is fully socially accepted and became the new establishment for the building sector.

[5] Rothmans J. – Transitiemanagement – 2003, Koninklijke Van Gorcum BV, Postbus 43, 9400 AA Assen
[6] http://www.cepheus.de/eng/

Unfortunately, a societal embedding process does not follow a smooth systematic progress as visualized. The progress is influenced by market drivers and barriers of all sorts at different levels of the society[7] [8]. At the beginning of the PEP –project these drivers and barriers were identified on a national basis. Understanding the market barriers and the different embedding phases helped to focus the promotional activities in order to increase the success of the implementation of the Passive House concept[9] [10].

2.2 Passive House Market Penetration 2005

The first two phases of the embedding process are very important to create a foundation for the acceptation of the passive house concept. A crucial role in these phases is the realization of introduction projects initiated by entrepreneurs.
The pre-development phase for passive houses started in the seventies with several experimental low energy building initiatives in Denmark, the United States, Sweden, Canada and Germany. It took till 1990 that Germany started with the introduction phase by realising the first European passive house in Darmstadt. After the concept had been validated at Darmstadt, with space heating 90% less than required for a standard new building of the time, the 'Economical Passive Houses Working Group' was created in 1996. This group developed the Passive House Planning Package (PHPP)[11] as calculation tool for validating building design to the requirements of the passive house standard and initiated further product development of highly energy efficient windows and high efficiency heat recovery mechanical ventilation systems, also new products for achieving air-tightness, reducing thermal-bridging. Meanwhile further passive houses were built in Stuttgart (1993), Naumburg, Hesse, Wiesbaden, and Cologne (1997) [12].

With the start of the CEPHEUS projects countries like Sweden, France, Switzerland and Austria were able to use the experience gained in Germany for their start of the national introduction phase. At the end of this project (2001) these countries carried on through this introduction phase. The passive house realization in Germany and Austria continued as for France, Sweden and Switzerland the implementation stagnated. Figure 4 shows the position per country with respect to the embedding phase and the related market penetration of passive houses at the beginning of the PEP- project.

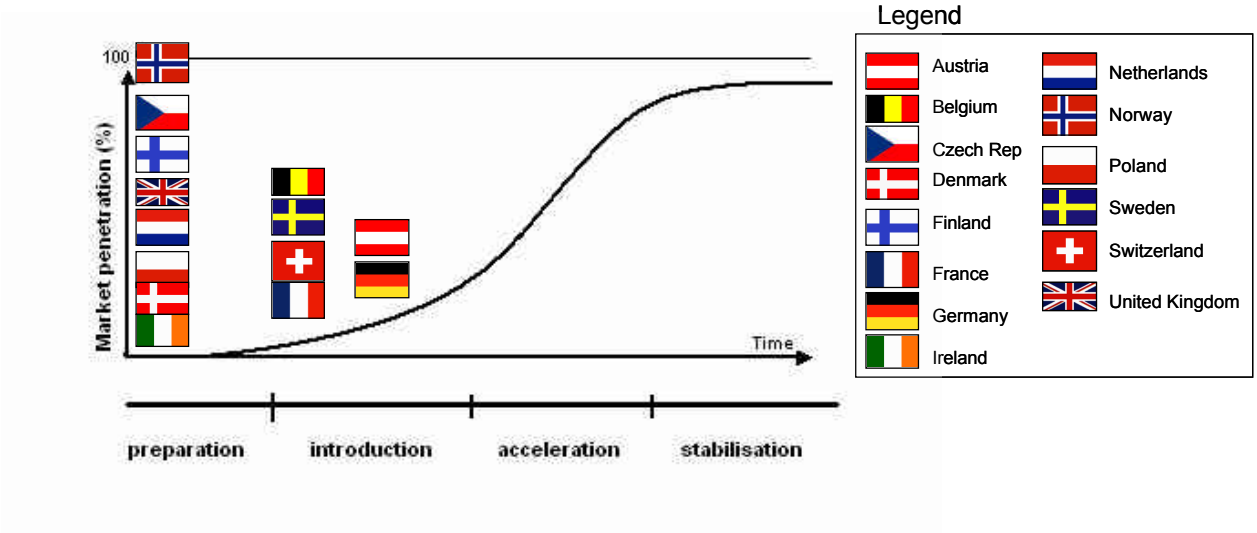


Figure 4: Market Penetration Passive Houses per country in 2005 in the newly building sector

7 Verbong, G., Mourik R, Raven R. - Towards integration of methodologies for assessing and promoting the societal embedding of energy innovations Paper for the ASRELEO Conference, Zürich 2006, October 5-6
8 Twuijver van T. "Woning als energieleverende systeem - analyse van de barrières en de kansen voor de grootschalige toepassing van energieleverende nieuwbouwwoningen"; ECN-report, Petten, September 2007.
9 PEP report "Passive House Solutions", May 2006. http://erg.ucd.ie/pep/pdf/Passive_House_Sol_English.pdf
10 PEP report "Energy saving potential", May 2006: http://erg.ucd.ie/pep/pdf/Energy_Saving_Potential_2.pdf
11 http://www.passivhaustagung.de/Passive_House_E/PHPP.html
12 Hermelink A. "Ultra Efficient refurbishment of panel flats-introducing the solanove project" ,june 2005, University of Kassel, Visegard

2.3 Market Barriers and Drivers

Though the physical principles of passive houses are valid in general, the elaboration for the respective countries is quite different. In the first place, the building tradition differs from country to country. In Germany, for instance, outer wall plastering is quite common, whilst in Belgium and in the Netherlands brick cavity walls are mostly applied, and Sweden and Finland have broad experience with wooden buildings. These three various construction methods ask for different constructional solutions. E.g. details of a passive house will even be different in Belgium compared to the Netherlands since constructors are familiar with local construction materials and detailed solutions. And even when this has technically been solved (which is the case in fact in this example), the solutions found in one country must be adapted to the specific building codes and standards of the other countries. In theory a construction method could be transferred from one country to the other, the practice will show however that this is not that simple. Figure 5 for instance shows the thermal insulation applied in national common practice versus passive house construction. It is clear, that in most of the countries the building practice must change, if the passive house standard has to be met.
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) 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.

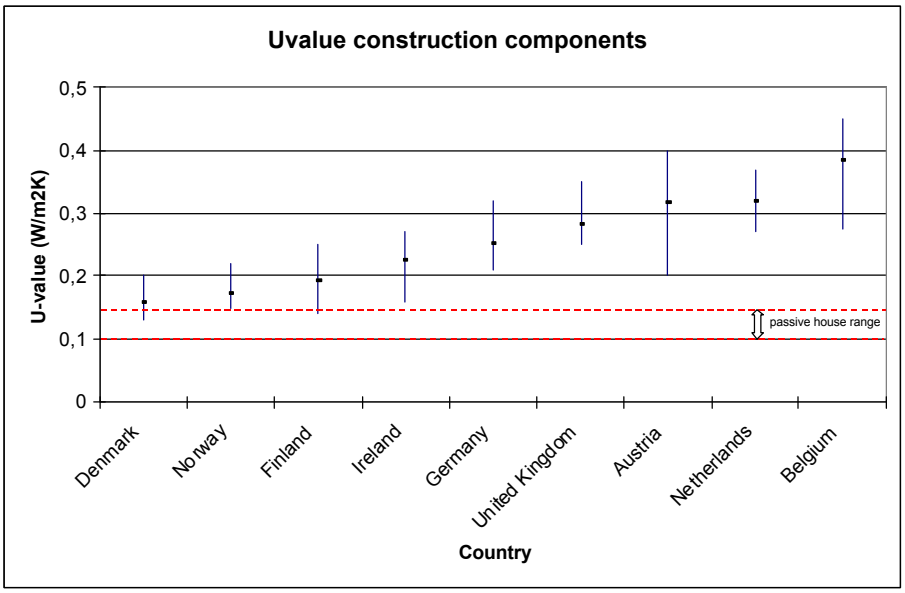


Figure 5: Average U-values of construction components (wall, roof, floor) in European countries[13]

Most frequently encountered barriers in partner countries were: limited know-how; limited contractor skills; and limited acceptation of passive houses in the market. To overcome these barriers, throughout the duration of the PEP project, a great deal of attention was 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 [14].

[13] PEP report "Passive House Solutions", May 2006. http://erg.ucd.ie/pep/pdf/Passive_House_Sol_English.pdf
[14] Kaan, H.F. Passivhaeuser Weltweit: Internationale Entwicklungen Presentation at the 10th International Passive House Conference, 19/20.05.2006 Hannover

3 Promotional Activities

The PEP-project developed information and knowledge by means of making national information packages focused on the specific needs of the country concerned, by means of doing suggestions for certification and accreditation of products, processes and people, and by means of workshops, translation of the design tool PHPP, articles, websites, national platforms and other forms of targeted dissemination.
This chapter describes the (inter)national promotional activities performed, their effect and the remaining challenges which need to be faced to achieve a large scale implementation.

3.1 Austria

Regarding the governmental sector in Austria two ministries support the implementation of passive houses. Since 1999 the Austrian Federal Ministry of Transport, Innovation and Technology promotes the development of innovative solutions for building components and systems for residential, office and other buildings based on low-energy and passive house standards within its research and development program “Haus der Zukunft” (Building of the future). Since 2005 the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management supports the dissemination and implementation of minimum criteria concerning the energy performance and the ecological quality of new built residential buildings within its Klima:aktiv Haus program. Depending on the level of the fulfilled criteria the accessed buildings are classified in Klima:aktiv houses and Klima:aktiv passive houses.

Within the industrial sector for more than 10 years the Austrian community of the insulation material industry (GDI- Gemeinschaft der Dämmstoffindustrie) campaigns for the passive house standard in Austrian housing grant schemes. On the other hand since 2001 the syndicate of passive houses in Austria (IG Passivhaus Österreich) is very active in dissemination of information and know-how by organizing networking events and by dealing with quality assurance systems.

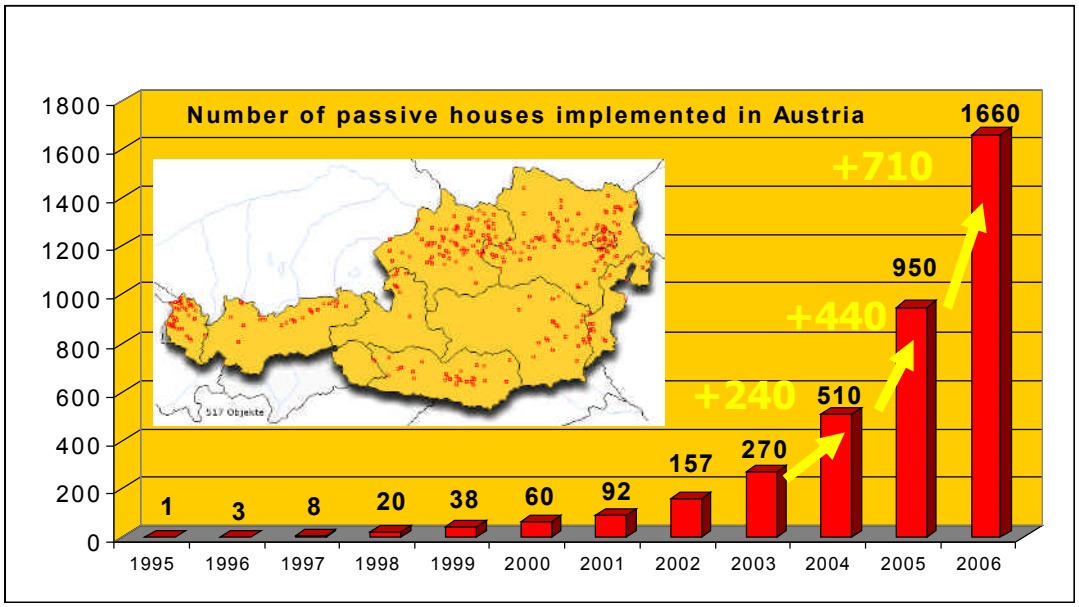
Except for the Klima:aktiv Haus program, the passive house actors do not have changed within the project duration, but they enforced and advanced their dissemination and development activities.

Barriers Solved
The syndicate of passive houses in Austria (IG Passivhaus Österreich) has listed at least 44 training workshops and dissemination events for energy consultants, architects, planners and building service engineers dealing with the passive house topic in the last four years. Significant for Austria of course is the consideration of the alpine climate, step-by-step the refurbishment with passive house components and to passive house standards gets more and more interesting for the target groups. Among the end-users a very attractive offer was established in the recent years. The so-called “test-living” in passive houses was promoted. Interested people can occupy a passive house for one week to experience living in a passive house. A very extensive database was established by the syndicate of passive houses (www.igpassivhaus.at); showing different designs of implemented passive houses in Austria in order to eliminate the prejudice, those passive houses are limited in their designs. Finally the lawmakers recognize the importance of energy efficient buildings and implemented the standard in Austrian housing grant schemes.

National Policy
In connection to the national policy the Program of the Austrian Government for the period between 2007 – 2010 is to be cited, where the Austrian government mentions and defines the passive house standard for the first time. The government determines the importance of thermal refurbishment of post war buildings, 50% of the new buildings should have low-energy standard according to the Klima:aktiv Haus program and preparatory works should be done to implement the passive house standard as a requirement for the receipt of housing grants.

The Austrian pioneer federal state is Vorarlberg, where the federal government constituted at the beginning of 2007, that for new buildings of public housing associations passive house standard is obligatory. In Austria nine different housing grant schemes exist. From 2005 to 2006 the passive house grant was increased by € 4.700 in average.
In Niederösterreich the incentive for a passive house is € 37.000 more for than for a low-energy house (with 50 kWh/m²·year). (Status: October 2007)

Number of Passive Houses Implemented
Figure 6 shows the number of implemented passive houses in Austria. 240 passive houses were erected in 2004, 440 in 2005, and 710 in 2006. Due to raising housing grants, growing level of awareness of the technology, training of experts and touchable lighthouse projects, this is development is clearly positive. It is obvious, that a big development potential is given in most building categories. Two family and terrace houses are disadvantaged because of their building geometries.



IG Passivhaus Österreich

Figure 6: Left: Number of Austrian passive houses implemented[15]

Market Potential
The expected development of the Austrian population allows drawing conclusions concerning the estimated demand of housing units to be built. Consequently the market potential of new passive houses is constantly given with more than 50.000 housing units per year, at the very latest in 2015, when the passive house standard will be obligatorily anchored in the housing grant schemes.

[15] Source: IG Passivhaus Österreich

It is common knowledge that buildings, which were constructed in the 60ies and 70ies, are most applicable for refurbishment to the passive house standard. The reasons for that are for example their compactness, their outer walls (mostly consisting of prefabricated constructions using concrete slabs), which can be insulated easily. Furthermore it is a fact, that because of their ages, they have to be renovated anyway. A very important development task is to find solutions for upgrading buildings with ventilation systems, to find place for conduits and shafts. In Austria one third of the residential building stock were built in this time period.

Certification of Passive Houses
The Austrian Institute of Construction (OIB) certifies passive houses using the Passive House Planning Package and/or the Austrian methodology. Within the Klima:aktiv Haus program criteria for so-called Klima:aktiv passive houses were defined. They must be heat –bridges-free and airtight, their heat energy demand and their total primary energy demand must be verified by the PHPP, they must be equipped with energy efficient ventilation systems with heat recovery and water saving fittings. Further the passive houses must not be constructed with HFCH or PVC containing building materials and they must fulfil requirements concerning summer suitability.

Acceptance PHPP in relation to national calculation method
There is one significant difference between the PHPP and the Austrian OIB methodology. The reference area in the PHPP is the heated occupied area whereas in the OIB guidelines the energy demand for heating refers to the heated gross building area. From this results the difference in the threshold value for the passive house standard of 5 kWh/m²·year. Very optimistic default values for internal heat gains and shading of the OIB methodology may be criticised. Finally the Austrian methodology has no representative validation results yet, as there are for the PHPP.

Change in awareness
Assessments show that private one-family-houses are responsible for 68% of the total energy consumption, which comes from urban sprawl and associated increase of traffic volume per household. In Austria 76% of the new buildings are one-family-houses. In order to work against this energetically unfavourable development, the passive house standard will be forced for multi-family-buildings in urban areas.
Some examples for new awareness and attitudes:

- In Vienna a competition for housing developers is in progress, where 1.700 housing units in 20 large volume passive houses will be built on 140.000 m². In Vienna the percentage of passive houses of new buildings will be increased from 3% in 2006 to 20% in 2008.
- In Innsbruck a housing company is implementing a settlement of passive-multi-family-buildings of 354 housing units.
- In Salzburg 300 housing units will be erected in passive-multi-family-buildings.
- In Linz 4 high-rise-residential-buildings in passive house standard will be implemented.

Especially for promotional reasons a competition occurred between operators of commercial buildings, for example between different chains of food market, about having the first / the most stores in passive house standard.

In Niederösterreich new built public buildings have to be passive houses. For this purpose obligatory “specifications for energy efficient public buildings” were introduced.

Information still required
As a result of these facts more information about passive house solutions for offices, schools and homes as well as for large volume residential buildings is needed. Further there is a need on information about refurbishment solutions. The hygienics of ventilation systems is questionable among potential end-users. At least the operation costs of a building should get a new weighting within the real estate assessment.

Future implementation path
Although the Austrian government does some careful steps in passive house direction, the most active groups are the syndicate of passive houses (IG Passivhaus Österreich) and the community of the insulation material industry (GDI) postulates more ambitious measures. They require passive house standard for all public buildings, for more-family-houses and for one-family houses step-by-step in the short term. In the long term they request from the government the creation of the necessary conditions for the refurbishment of after war buildings (including 718.000 one-family-houses) in order to save more than 70 % of their energy consumption. It is clear that those ongoing discussions are the result of the dissemination activities and knowledge development of the last four years.

Figure 7: Passive House Administration ChristophorusHaus in Stadl Paura, Austria

3.2 Belgium

In 2002 about 18 companies were involved in the establishment of the Belgian Passive House Platform (PHP). In 2004 three passive houses were realized in the Flanders Region. From a Flemish study it appeared that the existing insulation standards lacked efficient control, so quality assurance of passive houses was an issue from the beginning. EPBD regulations were being implemented, a Flemish calculation methodology was available and being implemented into software (freeware). In the Walloon and in the Brussels Region there were no experiences with passive houses until 2007. In 2004 mainly enthusiastic individuals were initiating passive house buildings, either as self built or as small companies. Nowadays, with the support of PHP, larger companies, building federations and local authorities are driving towards building passive house buildings. The marketing strategy and the success story of PHP were soon taken over by other actors: in the Netherlands the Stichting Passiefbouwen.nl was established, in the Walloon Region Plate-forme Maison Passive asbl, in France La Maison Passive France. A Czech guest student who stayed for a few weeks at PHP found enough inspiration to establish a similar platform in the Czech Republic.

Barriers Solved

With the PEP project, the foundations were set on a European level to define the passive house concept as a construction standard, to calculate energy saving potentials and to initiate the regional discussion about (certification of) passive houses. Basic knowledge about passive houses could be transferred from the more advanced German speaking countries towards Belgium. This resulted in the development of national brochures and manuals for architects and other target groups. Information specific to the Belgian building context is now available. The definition proposed in the PEP project is being accepted and is to more or less extent familiar to building practitioners. Now, there are a greater number of suppliers of building technologies and services suitable for passive houses, although the price of some components is still a market barrier. Also, new professions have appeared (e.g. companies specialized in insulation and air tightness services).

National policy

Since 1st January 2006, as part of the process of demonstrating compliance with required energy performance, assessment of the energy performance of design of new dwellings is mandatory in the Flemish Region (EPB start declaration). The current EPB does still not speak of passive houses, since the calculation procedures and the obligatory software was already under developed before the introduction of the passive house concept. A good coupling of the passive house concept with the EPB is still to be obtained and requires a substantial research effort. Also, the energy labelling system has not yet been implemented in Belgium. Best practice levels have been proposed as equivalent to the passive house requirements and the passive house is mentioned in official reports as a possible level for a future revision of building codes.

However, regional grants and federal tax reduction for passive houses were introduced. The Flemish government developed example buildings like the passive school De Zande in Beernem and the passive office building of the VMM in Leuven. Currently PHP and PMP are suggested as parties to control the grants and tax reductions, i.e. to control if the submitted projects really reach the passive house standard.

Recently the Flemish Minister for Housing decided to allocate € 500.000 for the construction of demonstration social housing in the passive house standard in 2008. Also the passive house concept was introduced into a large Flemish programme to build and renovate schools.

Figure 8: Passive House Symposium 2007 in Brussels

Number of passive houses implemented

A few trendsetters showed the good example and built further high quality Flemish passive houses, by now international example projects for the building sector and a show case for the potential of Belgian SME's. 8 habitats have received a voluntary passive house certificate, issued by PHP, as well as one office building and one school.

The PHP database currently contains 151 passive house projects under planning, construction or finished. This covers mostly only Flemish projects, providing that project participants have contacted PHP for consulting. In reality the number of passive houses might be double.

Market Potential

The biggest potential for the swift implementation of the passive house concept lies currently in the new built construction. In the wake of the construction of example projects, dozens of new passive houses are now under construction, including social housing, office buildings, schools and day care facilities. More than 50% of construction in Belgium is however renovation and finished examples are missing in this sector.

Certification of Passive Houses

For most buildings requiring a building permit, requirements are set for the energy performance and indoor climate (EPB requirements). The reporting of these requirements is undertaken by EPB reporters using required EPB software. (In the Brussels and Walloon Region similar energy performance laws are under construction). The EPB software will serve as a basis for the production of building energy certificates. Problems arising with the use of this software for the evaluation of passive houses have been reported to the Flemish Energy Agency.

Certification based on PHPP calculation is currently performed by PHP and PMP on a voluntary basis. The PHPP software serves as a basis. Federal tax reduction for passive houses refers to the necessity of demonstrating a certificate for passive houses.

Acceptance of the passive house definition
Up till now, the German passive house definition has been used in Belgium, with adjustments in the PHPP software to include regional climate files.
The passive house standard is now understood by the Regions as a long term goal to be set as a possible future performance requirement. For the moment the developed EPB software does not include the passive house criterion and does not include specific passive house technologies and criteria. Otherwise the definition has generally been taken up by the larger building industry and building clients. Very small enterprises and subcontractors are often still unaware of the exact definition and its implications. During the development of the federal research project Low Energy Housing Retrofit it was found that a too tight definition of the passive house standard will become a barrier for wide adoption in the renovation sector. On the other hand, for offices and schools, specific criteria for cooling energy demand and efficient (artificial and day) lighting are of interest.

Acceptance PHPP in relation to national calculation software
PHPP is used by passive house specialists and currently not accepted as an EPB calculation. Both calculations have to be performed. The EPB software will be the basis for the coming energy labelling method, although it has limitations in calculation of passive houses (ground heat exchanger not possible, heat load not calculated precisely, and punishment for necessary fictive cooling equipment,..).

Change in awareness
On a federal level the introduction of tax reductions for passive houses was discussed and established in 2007.
In the Walloon Region, under the auspices of PHP within PEP and the National Lottery, the passive house was first presented in 2005 in the French speaking parts of Belgium on three occasions/ conferences. Some attendants were convinced to build the first passive houses in the Walloon Region and enough interest was raised to establish a French speaking SME oriented consortium for the promotion of passive houses in the Walloon Region (PMP, Plate-forme Maison Passive asbl). This platform now works in close collaboration with the Walloon Region. Regarding the interest of regional industry, the Walloon Region announced grants for passive houses in 2007.

In the Brussels Region PHP was contacted by government officials in 2005 in the framework of PEP. After discussion ambitions were set high concerning the promotion of sustainable building and passive houses in the Brussels Region, resulting in several regional dissemination initiatives (Fête de l'Environnement, IceChallenge 2007, Passive House Happening 2007,..) and, in 2007, the introduction of grants for passive houses and the appointment of PHP and PMP as a facilitator for the realization of passive houses in the Brussels Region.

Due to PEP, PHP contributed in the Flemish transition management vision formation on closed energy loops and passive houses. A final outcome, entitled 'Flanders under construction', has recently been handed over to the Flemish Prime Minister.
On the level of communities and energy providers PEP provided the means to talk with local government officials. The cities of Bilzen and Turnhout and the distribution net manager eandis consequently decided to promote the passive house standard in their regions by providing extra financial means. Some other cities are looking for example projects.
The promotion of passive houses was however mainly driven by media attention.

Although there was a back-drop after the attention for the first demonstration projects in 2003, the passive house has regained full attention with the introduction of financial benefits and extra dissemination activities in 2007.

Information still required

Considering the general public, awareness should be increased on the benefits of living in a passive house (comfort and health). Technical information such as construction details for passive houses without thermal bridges should become available to all architects in 2008. Courses considering passive houses should be implemented for different target groups: architects, installers, contractors, consultants, general public.

Building a first passive house is time, labour and knowledge intense, for some contractors this poses a problem. In general the passive house standard requires a performance oriented quality approach in construction, which is generally missing in the Belgian building sector. Belgium does not have any good examples of energy performance contracting or total building commissioning in relation to energy performance requirements of passive buildings. The operation and energy costs of buildings should get a proper weighting with the real estate financial assessment.

More information is needed about passive house solutions for offices, schools and renovations, as well as for large volume buildings and cost efficient social housing. The installation and hygienics of ventilation systems can be questionable among potential end-users. User experiences should be demonstrated on a regional level. Since the passive house standard is often difficult to reach cost effectively for renovations, adapted definitions and technological solutions and ambitions are required. It can be investigated how prefabrication can lower the initial costs of passive houses.

Future implementation path

Although the government does some careful step in the passive house direction, the most active groups are industry driven (PHP and PMP). These provide the necessary information towards the building actors. However, the goals set in the transition management reference document ‘Flanders under construction’ require the implementation of an ambitious passive house impulse programme to reach the passive house standard as construction standard in 2015 for all new built construction.

Barriers that need to be solved on a short term are the definition of the passive house standard for office buildings, schools and renovations, since grants and tax reduction have been introduced. The example projects will have to show their energy efficiency, cost efficiency and will have to prove the expected comfort. Demonstration projects are urgently needed in the sector of social housing.

The development of the passive house standard from niche sector towards broad implementation will require the development of targeted education (at universities, high schools, and for different types of professionals) and a good coupling with EPBD development. Specific sector related innovation in regional companies has to be stimulated since the passive house market is now mainly being filled in with products and systems from abroad.

In the long term passive houses will need to be more cost and resource efficient and will have to take into account all issues of sustainable development (dismountable and flexible construction, lifelong building, adapted for elderly and handicapped people, local renewable materials, healthy buildings,..). Research is needed to raise the passive house concept outside the energy niche, and to educate, stimulate and obligate the building sector towards a quality oriented performance approach.

3.3 Denmark

In the beginning the most important initiators in the Danish building process were typical NGO's and energy consulting companies specialised within low energy houses. Several demonstration projects have been established within the last ten years but without reaching the passive house level. For the majority of the complete building sector including consulting companies the passive house concept has been quite unknown until the PEP project.
Nowadays the initiators behind the ongoing projects are mainly the Industry (especially Rockwool and Isover), energy consulting companies and idealistic persons building their own "dream house". For the coming future project developers could be an important player; several developers investigate potential building projects in passive house class.
Classic building companies are still hesitating. Anyhow the increasing energy prices combined with especially the large Isover project "Komforthusene" has forced them to analyse the potential (several classic building companies are involved in the Isover project).

National Policy
As a part of the new Danish building regulation from 2006, Denmark introduced two low energy classes, Class 2 (yearly space heat demand ≈ 40 kWh/m^2) and Class 1 (yearly space heat demand ≈ 28 kWh/m^2). From 2010 class 2 will be mandatory; from 2015 class 1 will be mandatory. We expect that the number of passive houses will accelerate slowly from about 2010 due to increased focus on low energy houses and the expected Danish passive house class which is planned for launching 2008. In 2015 we expect about 1-2 % of all new houses to match the passive house standard (1-2 % equals approximately 200-400 houses pr. year).

Barriers Solved
The promotion of the passive houses concept in Denmark focused on the PH concept potential, increasing knowledge and increasing the availability of PH components in the building chain by the development of a national PH website and promotion of the PEP website www.altompassivhuse.dk. Architects, installers and energy consultants were "educated" in workshops. The Danish website was found by industrial companies, contractors, project developers, housing associations and policy makers. During the PEP project the passive house concept reached a level of playing field.

Figure 9: Isover project "Komforthusene"[16]

[16] *www.komforthusene.dk*

Number of Passive Houses Implemented
Until now one passive house has been established. In 2008 approximately 10-20 houses are expected. The project “Komforthuse” initiated by Isover contains 10 single family houses. Houses will be ready Autumn 2008.

Certification of Passive Houses
Recently the Danish consulting company Passivhus.dk has been approved to certify passive houses according to guidelines from PHI. This will accelerate the real breakthrough of passive houses in Denmark.
Regarding products certification the Isover project “Komforthusene” has led to high focus on heat recovery efficiency of ventilation systems and the large difference between PHI test methods and Danish methods. Danish test institutes are putting more and more attention to the PHI certification in order to be able to offer testing.

Acceptance of PHPP in relation to national calculation software
PHPP is more and less only known among people dealing with passive houses. About 100 persons know PHPP. Among Danish passive house planners PHPP is accepted as being the “tool” for planning of passive houses. The Danish calculation tool Be06 has heavy limitations in calculation of passive houses (ground heat exchanger not possible, heat load cannot be calculated precisely etc.) but Be06-calculation has to be made for building approval. E&K has initiated a public financed project, where the purpose is to create a software tool able to convert PHPP-files to Be06-files. The software tool will motivate more people to use PHPP.

Change in awareness
The change in awareness has been remarkable in Denmark. From being a more or less unknown building concept many different actors now adopted the passive house concept.
The general interest for passive houses from normal people has been increasing a lot since the project has started. More than 293.000 people have visited the website www.altompassivhuse.dk, which has been created during the PEP-project (created March 2005) and which is one of the most popular sites about passive houses in Denmark. Several articles made by Ellehauge & Kildemoes and other actors have contributed to the increasing interest and discussion about passive houses. Producers of insulation material most clearly represented by Isover and Rockwool, now realise low energy / passive house demonstration projects which are strongly followed by the Danish building industry. Isover is creating the “Komforthus Projekt” with 10 passive houses in 2008 (www.komforthuse.dk). Rockwool has March 2008 launched a new WEB-portal about low energy / passive houses. In addition Rockwool is deeply involved the Denmark's first passive house apartment building in Kolding. Several kindergartens are planned to be built like the passive house concept.
Danish producers of building components especially windows/doors have realised that their standard “high energy performance products” do not match the requirements from passive houses. Several companies e.g. Vipo and Vrøgum (Danish window producers) have now established commercial cooperation with foreign producers in order to be able to deliver certified passive houses windows on the Danish market. A few Danish companies now claim that they produce passive house windows but windows have not yet been certified.

Two education seminars have been held as a part of the PEP-project. First seminar was in 2006 with about 80 participants. The seminar in 2007 had 136 participants including several key actors from the Danish building sector.

Figure 10: Passive House conference in Arhus, 2007 (Denmark)

Acceptance Passive House definition

The first two criteria PH definitions are accepted: The space heat demand of 15 kWh/m^2·year and the pressure test n< 0.6 h-1 is widely accepted (but also considered as extreme values). The final primary energy demand of < 120 kWh/m2 is less accepted/understood due to the use of German conversion factors and the "uncertainties" in calculation of energy demand from equipment as PC's, lamps etc. Most people find the Danish method - calculation of energy for technical equipment as pump, ventilation units etc. – more appropriate.

Information still required

In the new phase the focus of the promotional activities to implement PH in Denmark are the development of education programmes and specified technical guidelines. PHPP seminars and PHPP examples are highly needed. With respect to house design thermal bridge free constructions fitting to Danish building tradition and good HVAC designs are needed.
Another important aspect for a faster growth is financial support schemes for builders as in Austria. Additional Danish research programmes like the Austrian "Haus der Zukunft"[17] are required.

Future Implementation Path

The increased focus on passive houses has been stimulated during several articles. There has been a strong discussion about the reasons for the extremely slow development within passive house technology and how to change the situation. A remarkable change in national politics was announced by the Danish Enterprise and Construction Authority in the beginning of 2007.The Authority announced that a new passive house building class is planned for 2008. A working group with main building actors was established in the summer 2007.

[17] http://www.hausderzukunft.at/english.htm

3.4 Finland

At the start of the PEP project, in 2004 the term Passive House was already known in Finland, but there were no products on the market. The passive house concept was introduced with the national energy research programs in the early 1990's right after the first passive houses were build in Germany. Some single-family houses and a concept for a low energy office building demonstrated possibilities to reduce the heating energy demand close (25 – 35 kWh/m2) to the passive house level. However, the focus of the development was in the low-energy buildings and their structures and systems.

The construction boom in Finland has affected in the success of energy-efficient buildings. Energy-efficiency is still niche market, although the benefits were clear: Low or no extra cost of energy-efficiency, cost based payback: 0 - 6 years. The competition on housing market is based on price and image, and the industries' old practices and policies do not aim at changing the market situation. Although a demand for energy-efficiency exists, there is no supply - all sells in the current building boom. However, the attitudes are now changing.
The forerunners in the field of passive houses have been a SME construction company Rakennusliike Reponen Oy and thermal insulation manufacturer Paroc Oy Ab. Also, a special magazine for citizens interested construction and maintenance of buildings, TM Rakennusmaailma, has promoted the passive house principle. In 2004 passive houses were known as a topic, but there was only minor interest in developing the products. In 2005 one of the key players, Rakennusliike Reponen Oy, a SME construction company adopted the concept and started the development of the now awarded MERA concept. Several large producers are now working with the passive house development.

National policy
Finland's building energy use related legislation used to be one of the tightest in the world 20 years ago. Since then, only minor adjustments has been taking place. The present government aims at a new approach in 2010, as the building code requirements are to be renewed. The new code of 2010 aims at 30 – 40% reduction in energy demand of buildings compared to 2008 regulations.

Barriers Solved
Three kinds of barriers were identified at beginning of the project: technical, market dependent and institutional barriers. The main barriers solved during the project are user expectations (technical barrier), unclear benefits (market barrier), and attitudes towards passive houses and signal to change (institutional barriers). The passive house definition for the Nordic countries is now well known among building professionals.

Number of Passive Houses Implemented
Approximately 10 passive house construction projects have been started in 2007. One of them is an apartment housing project of 20 dwellings. The first passive house to be certified will be finished in summer of 2008.

Certification of Passive Houses
VTT is an accepted certification body, and VTT has developed a passive house certificate for whole building solutions.

Acceptance Passive House definition
During the development of the passive house information packages it was found out that too tight definition will become a barrier for wide adoption of the passive house concept in the Northern areas of Europe and present level of technology. Very thick insulation layers do require investment in product development of foundations (including the risk of frost damages), structural systems (including mechanical loads), connection details of building parts, and also architectural solutions for, e.g., positioning of a window into a wall with 45 – 60 cm of insulation. The Nordic definition of a passive house helped to overcome these barriers.

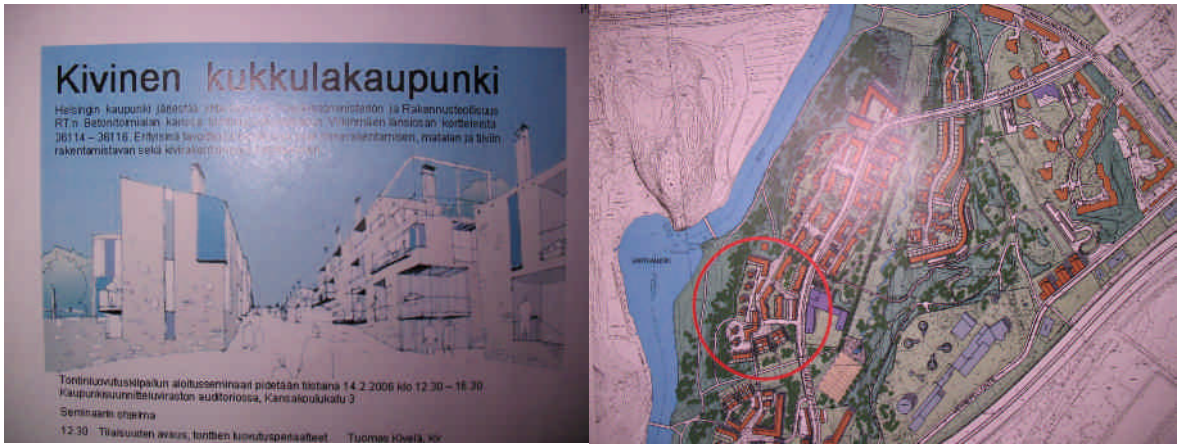


Figure 11: Passive House initiatives in Helsinki, Finland

Acceptance PHPP in relation to national calculation software
The Finnish building code (as of the beginning of 2008) requires an energy analysis with a building permission application. The tool for calculation of a building's energy demand is specified within the new building code. The calculation method is especially suitable for detached, semi-detached and row houses, but rather well performing for apartment houses as well. The tool is also rather practicable for early stage energy analysis. The PHPP tool has no relevant purpose in the process.

Change in awareness
Year 2006 seemed to be a turning point in public awareness in environmental issues. There has been a change on all levels in awareness in energy consumption and related emissions. The latest example is the yearly civil engineering award established by the Finnish Association Civil Engineers. The 2007 award was addressed to MERA low-energy housing project. The President of Finland, Ms. Tarja Halonen, selected the winning achievement.

The activities within energy issues are constantly increasing. Regional knowledge centers aim at environmental issues. Low-energy and passive housing are among the visions of these organizations.

VTT has been very active within the development of passive houses in Finland. Several companies have started design and construction within the field, and new enterprises concentrating only on construction of passive houses have been established. Passive house and passive house project have been featured in every main media channel in Finland during 2007.

Based on results of the PEP project several articles were also published in construction magazines on the energy saving potential from deployment of the passive houses. The basic Central European definition seemed to be a barrier earlier, but the adjustment to Nordic conditions opened the concept for the development leaders.

Information Still Required

The key problems in the present construction process are the architect's poor knowledge on energy related issues, and the chained process itself. Input into the beginning of the process is required. This also includes the use of energy calculation tools even in the draft design phase. The process should be able to allow feedback from different stakeholders.

Future Implementation Path

The market potential for passive houses increases. New build single-family and row houses is the predominant market. The estimate for 2010 is 500 – 1000 new dwelling units. On a short term, the most important steps in the implementation path are evoking investments into energy-efficient construction, break the industry's conception of perceiving passive houses as expensive, and improving the coordination of the process towards win-win situation between clients and producers by value added with high quality products, change from products to solutions, including services to solutions and building on user demands.

Figure 12: Brochure Finnish workshop on passive houses [18]

[18] Source: VTT

3.5 Germany

At the start of the PEP project, in 2005, passive houses were already introduced in the market. In 1999 the national 'Kreditanstalt für Wiederaufbau (KfW)' set up a programme which provided loans with low rate of interest for passive houses. During the period of the PEP project the market share of passive houses increased - but not as fast as in Austria. The number of passive houses which got a loan from KfW grew from 549 (market share appr. 0.2 %) in 2005 to 1246 (market share appr. 0.5 %) in 2006. The main difference between the German and the Austrian policy is that Austria visibly focuses on the passive house standard. In Germany not only passive houses achieve loans by KfW but also less efficient standards – and the interest rate advantage is very low. The accelerated market penetration is depending on local actors. Cities like Ulm, Freiburg, Frankfurt or Hannover with a passive house promoting policy have increased the degree of awareness for passive houses.
The PEP project participant proKlima, a founded climate protection fund by the city of Hanover and including suburbs and the Stadtwerke Hannover AG supports building structure improvements with the help of public support programs. Promoting passive houses is one of the five programs. The situation in the region of Hannover can be described as follows: After realizing the passive house estate Hannover-Kronsberg in 1999/2000 followed years of stagnation. The Kronsberg row houses were erected by a builder from Frankfurt and the local building companies showed not much interest in passive house projects.
The main argument was that there was no market for passive houses. Only a small number of architecture offices realized projects in that years, mainly for enthusiastic individuals. The customer interest increased with the rising energy prices and the focused promotion of passive houses within the PEP project. The open Passive House Days were very successful in demonstrating the advantages of passive houses. Parallel with the growing customer interest the first traditional local developers started passive house projects and were successful in selling them. Currently suppliers of prefabricated houses start integrating passive houses in their range of products.

National policy
The German government agreed on a national energy and climate programme which includes strengthening of building regulation concerning energy efficiency. The requirements will be strengthened by 30 % in 2008 and by another 30% in 2012. Occasions for retrofit building envelope or service systems will be imposed. The current resolutions will shorten the distance between building regulation and passive house standard.

Barriers Solved
In the region of Hannover the PEP project was very successful in stimulating customers' interest for passive houses. Events like the open passive house days, lectures for customers ('How works a passive house?') and passive house exhibitions (10th International Passive House Conference, Energiespartage 2007) attracted many visitors. A new website www.passivhaus-plattform.de provides detailed passive house information and publications of the PEP project.

Number of Passive Houses Implemented

Approximately 8.000 passive house dwellings have been built in Germany until now[19]. However, passive houses have still a very small market share of about 1 % in Germany. Regions with an active, passive house supporting policy achieve higher market shares.

In 2006 approximately 250.000 dwellings were erected in Germany. In relation to a number of 1.000 inhabitants this means 3 dwellings, the lowest rate in Western Europe. For comparison: Ireland had a new build activity of 21.3, the Netherlands 4.6 and UK 3.3. For 2007 and 2008 a new build activity of around 200.000 units is expected. The majority of existing 40 million units were erected before energetic requirements came into force. According to DIW Berlin more than 60 % of residential building activity is already generated in the existing building stock. It is expected that the retrofit market will become more important.

The proKlima area has already 95 dwellings completely refurbished with passive house components.

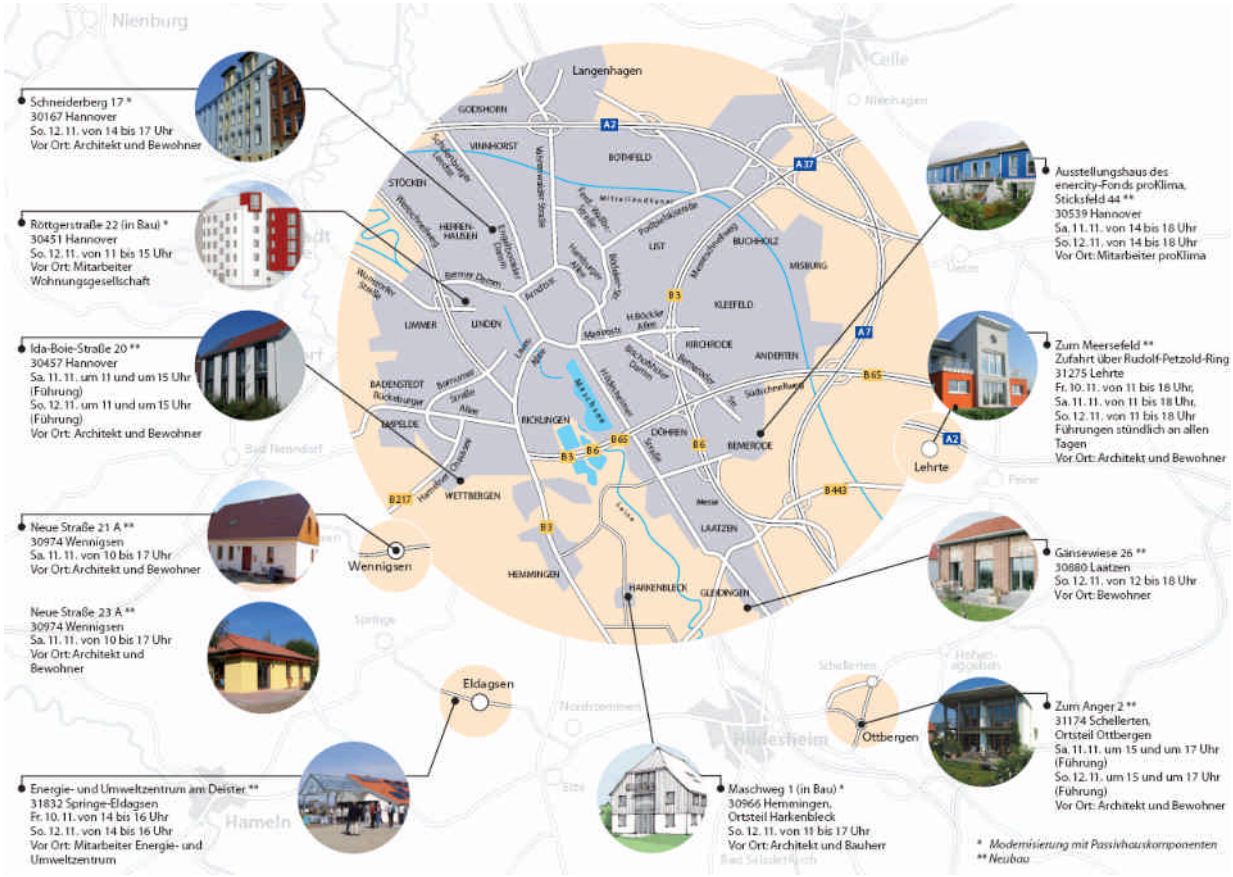


Figure 13: Passive houses in the region of Hannover, 2006 [20]

[19] Passive House Institute
[20] Presentation Anke Unverzagt, project meeting Dublin, .

Certification of Passive Houses
A certification system for passive houses and passive house suitable components was established in Germany in 1997 by the Passive House Institute Darmstadt. Certification of products facilitates finding and comparison regarding energetic qualities.

The certificate 'quality proofed passive house' confirms the 'as built' design of a building in accordance with the Passive House Planning Package. It will be assessed if the values for total energy demand, total primary energy and air tightness fulfil the passive house requirements. In future the certificate for passive house planners will make it easy to find a planner with substantiated knowledge regarding passive houses.

Acceptance of PHPP in relation to national Calculation Software
The calculation method as well as the limit values for passive houses according to Passive House Planning Package (PHPP) are validated and established in Germany. It was developed independently from German building legislation. The advantage is that calculation procedures and boundary conditions are not influenced by political considerations and special interests of stakeholders and fast integration of new research results is possible. Right these qualities are the reason that PHPP is a highly-estimated tool in Germany. Furthermore EnEV calculation procedure is included within PHPP to avoid extra work for planners.

Change in awareness
The awareness for the passive house concept has grown in Germany due to the promotional activities of the proKlima in the region of Hanover and the organisation of the international Passivhaus Tagungs by the Passivehaus Institute (see paragraph 4.1). The passive house concept is adopted in Germany.
The International Passive House Conference has established as a platform for international exchange concerning passive house development.

Information Still Required
Passive house demonstration examples and definitions for all kinds of non-residential buildings (supermarket, factory, museum etc) are needed. Refurbishments projects with passive house components should be evaluated especially concerning the influence of the existing heat distribution system. The evaluation should give recommendations how to deal with existing systems.

Future implementation path
In the short term the training/education of planners, building companies and developers should be improved. The number of experienced passive house planners is still too small. In 2007 the Passivhaus Institute started an examination for planners concerning passive houses. In case of passing the exam the planner gets the title 'certificated passive house planner'. In whole Germany training courses will be offered. ProKlima will focus on increasing the number of experienced planners in the region of Hannover.
In the long term (5 years) it is important that the passive house standard becomes the 'normal standard'. Existing DIN-standards (e.g. DIN EN 12831 for heat load calculations) form a barrier for passive house dissemination and should be updated as well as the current requirements for energy efficiency of buildings.

3.6 Ireland

At the start of the PEP project, in 2004 the term Passive House was largely unknown in Ireland. The passive house concept was first introduced to Ireland during the solar conference 'See the Light 2002' by the Sustainable Energy Ireland, SEI in 2002. The first Passive House dwelling in Ireland, 'Out of the Blue' by Tomas O'Leary and MosArt Architects, was under construction in 2004 (building completed in May 2005). This house is also the first in Ireland to receive the Quality Approved Passive House Certification by the Passivhaus Institute in Germany. From October 2005 the house has been a subject of a two-year energy monitoring programme by the UCD Energy Research Group, funded by the Sustainable Energy Ireland.

In 2004, there were other builders promoting passive house standard dwellings in Ireland. Those included the Scandinavian Homes Limited and Century Homes. The Scandinavian Homes company is an experienced manufacturer of low-energy timber-frame houses, offering an upgrade of a standard low-energy Scandinavian Homes Ltd. house to a passive house standard. Issues have been raised due to lack of air-tightness testing as part of the passive house requirements. Another well-known Irish timber-frame company, Century Homes, marketed the Formula One construction concept. The objective was to offer a construction system that has a low energy demand using indigenous solutions. Interestingly, the Formula One concept reach the 15 kWh/m^2 per year target but by preheating the ventilation air through an active solar air system, being able to relax certain requirements of the passive house standard in insulation level as well as trade-off some of the need for direct solar gains through glazing.

The property boom in Ireland continued in 2006 (showing signs of slow down in second part of 2007). Nearly 93,000 new built dwellings built in 2006 (population just over 4 million). Annual completions are 3.5 times what they were a decade ago, and the country has the highest per capita building rate in Europe. The problem arising from this is that buyers may prefer more sustainable / energy efficient homes but have to accept any dwelling if they want to get on the property ladder as soon as possible. However, the case is different in one-off houses, where the home buyer is demanding more sustainable and low-energy options, and it is the area for market penetration of passive house buildings in Ireland.

National policy
Most recent national policies have announced strengthening of building regulations concerning conservation of fuel and energy. For example, improved building regulations concerning energy efficiency regulations for new dwellings, coming into force in July 2008 will introduce 40% savings in energy and CO2 emissions compared to 2005 regulations. Further strengthening calling for 60% improvement is announced for 2010, clearly indicating the regulations moving towards low energy new dwellings achievable with the Passivhaus Standard.

Barriers Solved
Information specific has been provided to the Irish building methods and tradition. This includes: National Publication Ireland and Guidelines for the Design and Construction of Passive House Dwellings in Ireland. Definition of 'What is a passive house' is also being accepted and is to more or less extent familiar to building practitioners. Availability of building components for low energy buildings (i.e. materials for air-tightness; energy-efficient mechanical ventilation systems with heat recovery have become wider available in Ireland; triple glazed windows and energy efficient doors have also become available (although from imports only). There are several companies performing air-tightness testing.

Number of Passive Houses implemented

Approximately 30 passive house dwellings have been built in Ireland until now. The first passive house in Wicklow, remains the only building to receive a certification from the Passivhaus Institute in Germany. To the lack of more certified buildings contributes the fact that there is no official passive house certification body in Ireland. This is a barrier that needs to be addressed in future. New build dwellings is the predominant market, although the house retrofit market is emerging. It is expected that the new build market will still be predominant in near future, however moving in direction of non-domestic buildings as well as domestic. Refurbishment will follow.

Figure 14: First built and certified passive house in Ireland, Wicklow[21].

Certification of Passive Houses

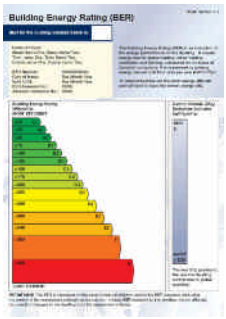
At present there is no national certification body established in Ireland. Any passive house building (including building components) certification must be done directly by Passivhaus Institute (or certifying body approved by). Information on certification is provided by SEI REIO, Sustainable Energy Ireland, Renewable Energy Information Office. The National Discussion included work done within the scope of the PEP project: PEP Workshop – Passive House Certification in Ireland held September 2006, (buildings and technologies). Future work to overcome this barrier should include: Discussion on Certification / link with BER Certification; Establishment of Certification body; Establishment of Building platform for Passive House in Ireland

Acceptance of the PH definition

There have been no problems in accepting the passive house definition as agreed amongst the PEP project partners. To this contributes the mild temperate climate in Ireland. Interest of building designers is at building envelope specification to respond to milder outdoor temperatures and good availability of solar radiation.

[21] www.mosart.ie

Acceptance PHPP in relation to national calculation software



The Irish official method for calculating and rating the energy performance of dwellings is DEAP, Dwellings Energy Assessment Procedure. Calculating a passive house dwelling in DEAP will result grade 'A2/A3 to B1'rating. Although the specific heat requirement calculated in DEAP is similar to PHPP calculation, discrepancies exist for calculating primary energy (no household appliances are part of DEAP calculation while calculated as part of the requirements in PHPP). There is also no indication on the BER label the house has achieved the passive house Standard. There is no official method of calculating energy and rating of non-domestic or refurbished buildings in Ireland at present.

Change in awareness

Since 2004 there has been a huge increase in awareness. The first built passive house in Ireland 'Out of the Blue', Wicklow by the MosArt Landscape-Architecture-Research Ltd, has intensely worked on promoting the passive house buildings. The house featured in at least 15 national newspapers / magazines; 4 television appearances; 8 live radio interviews live from the house; approximately 500 visitors to the house. Since 2004, there have been six conferences in which the passive house Standard was promoted to various stakeholders in the construction industry and home buyers onto which the National Publication for Ireland was promoted. Based on results of the PEP project several articles were also published in construction magazines on the energy saving potential from deployment of the Passivhaus Standard in Ireland and passive house barriers and solutions. The PEP website national section for Ireland host downloadable publications and conference announcements as well as list of passive house components suppliers.

Information still required

Awareness should be increased amongst the general public on the benefits of living in a passive house. Technical information such as construction details for minimizing thermal bridging should become available to building designers. Quality of building in Ireland is generally very poor (lack of effective Building Control). Building a passive house is time, labour and knowledge intense, that average builder does not (want to) have.

Future implementation path

Development of Financial support schemes with incentives to the builder and / or the building owner. Creating an Irish Passive House Platform could bring the various stakeholders in building industry to promote and influence the market. Building owners should be provided with information on the health, comfort and financial benefits of living in a passive house. Certification body for Ireland should be established.

3.7 The Netherlands

In The Netherlands passive house as phenomena was only known in limited circle of specialists. When the PEP project started only a few attempts to build a passive house have been done. At the same time ECN and DHV both initiators and partners in the PEP project, have contacted the later chair of the association Passiefbouwen.nl about the need to introduce passive housing in The Netherlands.
It was common sense that current insulation levels (around U = 0.3 W/m2K) should be considered maximal, whilst further energy-efficiency should be achieved through advanced energy supply systems. This is influenced by the common construction methods using cavity walls. Also the required energy calculation method for new construction (EPN) results in above findings. Organisations like housing associations, architects and project developers have been inspired by during the PEP-project.

National policy
The Dutch government sharpened the energy performance requirements (EPC) for newly built houses in January 2006 from 1.0 to 0.8. A passive house has an EPC of approximately 0.4.
According to the governmental policy program published in 2007, continuation of better energy performance is required. In 2016 the energy performance requirement for new constructions shall be at the level equivalent to the passive house standard. The ambition of the Dutch government is to construct energy neutral buildings in 2020.
On several levels in the market lobby takes place to promote energy reduction in the built environment. The government has established PEGO, the Platform Energy transition in the Built Environment (PEGO). The objective is to reduce the energy demand in the built environment with 30% within 30 years (2030). The participants in PEGO are different stakeholders in the building sector: amongst others project developers, research institutes (e.g. ECN), housing associations, the Ministry of Housing and the representative organisation of municipalities. PEGO have initiated several demonstration projects (~ 100 dwellings per project) with energy reduction targets of 30%, 50% and 80% lesser energy demand in comparison with buildings built as usual. The passive house concept is accepted in PEGO as a concept which must be demonstrated in the Netherlands on a large scale.
The research programme “Building Future”[22] cooperation between ECN and TNO has adopted the passive house concept as key solution to achieve an energy neutral built environment in 2050.

Barriers Solved
The passive houses concept was unknown before the project PEP started. Several projects were erected. However, this low energy houses never met the Passivhaus Institute requirements for a passive house. During the project, and due to the efforts of the Dutch project partners the awareness and initial knowledge has been widely spread. The passive house concept is today accepted as solid and feasible approach to achieve comfortable low energy buildings. The major barriers are the initial investment costs, which are initially higher than reported from experiences in Germany, due to the lack of components, and lack of practical experience.

Number of Passive Houses implemented
There are no certified passive house projects in the Netherlands. Three new passive houses in Roosendaal are currently under construction, a passive renovation scheme of 14 houses in a protected area in Rotterdam is scheduled for 2008.
A significant number of project initiatives, of up to 250 – 500 new passive houses is known to date, as well as a series of 200 passive renovation houses.

[22] www.buildingfuture.org

Most current initiatives focus on new construction, but the renovation market shows almost equal numbers of initiatives. The largest potential for passive house is in renovation, but the opportunity to adapt construction methods and insulation levels is relatively easier in new construction.

Figure 15: Passive houses under construction, Roosendaal, The Netherlands, 2008

Certification of Passive Houses

The association Passiefbouwen.nl is planning to issue a passive house certification procedure for passive house buildings. The initial stage is to certify the completed project, based on project documentation, a PHPP calculation, and on site blower door test results and infrared images. In future stages also other steps in passive house development process could be certified. It is anticipated that qualified independent assessors could fulfil the role, whereas the association Passiefbouwen.nl keeps oversight and supervises the process, and issues the certificates, called Passiefbouwenkeur. Investigations take place to position Passiefbouwenkeur, either independent, or in relation to existing or future certificates for buildings. The quality control process links into new procedures for independent quality control during construction.

Acceptance of the PH definition

In The Netherlands the German definition of passive house is accepted, in the first place with respect to the defined energy demand for space heating of less than 15 kWh/m^2·year. It is considered to include the requirement of a solar hot water system as part of the definition. Further discussion is necessary to define an objective, and reliable way to define and specify the 120 kWh primary energy/m^2·year for all energy uses, including appliances.

Acceptance PHPP in relation to national calculation software
The EPN calculation is required to get building permission. A PHPP calculation does not replace an EPN calculation, even though a passive house stays well within the energy requirements currently required. Therefore two calculations must be undertaken for a passive house project.

Change in awareness
Half way the PEP-project an inspiring document for principals called 'Passiefhuizen in Nederland' has been published using the PEP project result by a consortium consisting of Rockwool Benelux, BAM (large contractor); VDM (timber frame manufacturer and project developer), DHV (consulting engineers), SenterNovem (national energy agency) and Passiefbouwen.nl. This document was very well distributed in the Netherlands via workshops and attention in several popular magazines. The passive house concept today is widely known as energy concept, combining good comfort and low energy costs. In public private innovation programs, passive house is one of the main themes for building innovation. The association Passiefbouwen.nl grows steadily and plays an important role in dissemination the passive house concept. Private companies and the government participate in the scientific and advisory board of Passiefbouwen.nl. The largest Dutch contractor, BAM, has adopted the passive house concept for a number of project initiatives. Housing association Aramis in Roosendaal has chosen passive house as main concept for renovation and new construction in a post-war social housing area. Housing association De Woonplaats in Enschede develops passive house apartments. Similar initiatives for renovation and new building have been taken by De Goede Stede in Almere. Finally, local governments show interest in demanding passive house. The foundation for building research SBR is preparing courses "passive houses" for professionals in cooperation of Passiefbouwen.nl and Inholland, University of Applied Sciences.

Information still required
A successful realisation of a passive house can be used for further promotion of the passive house concept. With the experience of building the passive house more information can be developed on:
- Architectural design
    - Passive House conceptual design, and basic considerations for architects
    - Design and construction
    - Organisation of passive house design process
    - Information about construction details, thermal bridges and air tightness
- Organisation of construction process including quality control and tests.
- Education and training for construction workers

Further development is required of the passive house certificate "Passiefbouwenkeur" and financial schemes.

3.8 Norway

At the start of the PEP project, in 2004 the term “Passivhus” was known in Norway only by a few individuals. There were no builders promoting the passive house standard, but architects in particular began to gain interest in the concept, and some excursions were arranged to visit projects in Austria and Germany. The first house that claimed to have achieved the passive house standard was a single family dwelling that was completed in 2005 by Steinsvik Architects in Tromsø. Since then, several projects have been initiated aiming at the passive house standard.
In 2004 mainly enthusiastic individuals were initiating passive house buildings, either as self built or as small companies. Since then, larger property developers and local authorities are driving towards building passive house buildings. There is also greater number of suppliers of building technologies suitable for passive houses, although the choice and price of some components is still a market barrier. The government is also promoting passive houses through funding and subsidized loans via the Norwegian State Housing Bank (Husbanken) and the Norwegian state energy agency (Enova).

National policy
A new building code was implemented from January 2007 with a transition period of 2 years. The net heating energy requirement is around 57 kWh/m^2·year for detached houses and 37 kWh/m^2·year for apartment blocks. The passive houses standard is mentioned in official reports as a possible level for the next revision of the code (due in 5 years). The energy labelling system has not yet been implemented in Norway. The A/A+ level has been proposed as equivalent to the passive house requirements. The Norwegian State Housing Bank (Husbanken) has been a key actor in promoting low energy and passive houses during the last 5 years. They have arranged several seminars about passive houses around the country, and are one of the main contributors to the first Nordic Passive House Conference to be held in Trondheim, Norway in April 2008.
The Norwegian state energy agency (Enova) has also started to promote passive houses, and is one of the main contributors to the first Nordic Passive House Conference to be held in Trondheim, Norway in April 2008. The Norwegian Standardization Agency (Standards Norway), have started up a project to make a new Norwegian standard for passive and low energy houses. SINTEF is the main contributor to this work.

Barriers Solved
Through the PEP project period, information regarding how to build according to the passive house standard has become available to Norwegian building practitioners. Building components for low energy and passive buildings have become more easily accessible, i.e. solutions for air-tightness; energy-efficient mechanical ventilation systems with heat recovery; triple glazed windows with insulated frame and energy efficient doors. There are several companies performing air-tightness testing. And not least; several passive houses have been built, and many others are in the planning. The PEP-project has contributed significantly to this through information dissemination activities and exchange of knowledge.

Number of Passive Houses implemented
As of November 2007, 10 dwellings claiming the passive house standard have been completed, and 28 dwellings are being constructed. In addition, approximately 1000 dwellings are currently being planned around the country.
New build dwellings is the predominant market, although the house retrofit market is emerging.
It is expected that the new build market will still be predominant in near future, however moving in direction of non-domestic buildings as well as domestic. Refurbishment will follow.

Figure 16: Passive Houses under construction in Bergen, Norway

Certification of Passive Houses
At present there is no National certification body for passive houses in Norway. However, the Norwegian Standardization Agency (Standards Norway) have recently (Sept 2007) started up a project to make a national standard for certification of Passive and Low Energy Houses. SINTEF is a main contributor to this work.

Acceptance of the PH definition
Up till now, the German PH definition has been used in Norway, with some adjustments with respect to how to perform the calculations:

- The internal load of 2.1 W/m^2 has been adjusted to fit Norwegian standards.
- The primary energy requirement has not been used, since there is no national primary energy factors established.

Acceptance of PHPP in relation to national calculation software
PHPP is not widely used, but known by specialists on passive houses. As of October 2007, a new energy calculation standard have been launched in Norway (NS 3031), and several simulation and calculation software is being developed or adapted to this standard. This standard is also the basis for the building code and the coming energy labelling method, and will also probably be the basis for calculation of passive houses.

Change in awareness
Since 2004 there has been a significant increase in awareness about passive houses. In particular, the following examples demonstrate that the interest and knowledge about passive houses has grown during the last 3 years.

Several articles about passive houses have been published in the media. A Google search dating September 2007 using the Norwegian term Passivhus resulted in 14.200 hits for Norwegian language only. Even the Norwegian consumer agency now has information about passive houses on their web site www.forbrukerradet.no.
10 seminars with about 100 participants each have been arranged around the country. The attendees have included architects, consultants, developers and public agencies.
As a part of the PEP-project, a series of continuing education courses has been initiated at the Norwegian University of Science and Technology. Courses have been arranged in 2005 and 2006, and a new

course is planned in the beginning of 2007.
The 1st Nordic Passive House Conference is in the planning, and will be held in Trondheim, Norway in April 2-3, 2008.
Several components suited for passive houses have been developed: One window, systems and solutions for air tightness, low-cost water based heating system and ventilation systems with high thermal and electrical efficiency have been developed.

The PEP-project has played an important role in relation to the information dissemination activities, and indirectly also for the product development activities and construction projects.

Information still required
A standardization and certification scheme should be implemented.
A large scale education program should be implemented, ranging from craftsmen, to architects, engineers and developers.
A measurement and documentation program for the realized passive house projects should be carried out.
Awareness should be increased amongst the general public on the benefits of living in a passive house.

Future implementation path
On the short term:

- A certification and standardization scheme should be implemented.
- Measurement and documentation of realized projects.
- Further development of an education program

On the long term

- Implementation in the next revision of the building code
- Embedding of the passive houses in education programs of on several levels.
- R&D program for developing new components for very cold climates

Figure 17: Artist impression planned passive houses in Vendstøp, Norway [23]

[23] www.ddd.no

3.9 United Kingdom

At the start of the PEP project the concept of 'PassivHaus' was essentially unheard of in the UK. The commencement of the PEP project coincided with a national review of our building regulations. These new regulations highlighted for the first time the need to deal with the concepts of air tightness and thermal-bridging, with old regulations merely setting limits for the thermal performance individual elements and minimum heating system specifications. Building professionals had to consider the concepts of air tightness and thermal-bridging for the first time and whilst the term 'PassivHaus' was unknown the industry soon embraced the terminology to signify that a dwelling as having exceptional levels of thermal performance.
The initiators at the beginning of the project was BRE and the Energy Saving Trust – both of these organizations have significant influence in promotion higher standards of energy efficiency and have good marketing contacts.
Housing developers, especially those working in the social sector, are now actively pursuing PassivHaus standards as a result of the standard being referenced in the CSH.
Smaller architectural practices with affluent clients interested in self-build projects have also been a key source of local exemplar projects.

National policy
Whilst the PassivHaus standard has not been directly translated into national regulations (i.e. kWh/m2/yr) the standard is referenced within the Code for Sustainable Homes (CSH). The CSH is a new national standard for sustainable design and construction of new homes. Since April 2007 the developer of any new home in England can choose to be assessed against the Code. The Code measures the sustainability of a new home against categories of sustainable design, rating the 'whole home' as a complete package. The Code uses a 1 to 6 star rating system to communicate the overall sustainability performance of a new home. The Code sets minimum standards for energy and water use at each level and, within England, replaces the EcoHomes scheme, developed by the Building Research Establishment (BRE).
In addition to the above the CSH signifies the direction in which future buildings regulations will go – with the eventual aim that all new-housing in England will be zero carbon by 2016 (code level 6). Building regulations within England are also going to be reviewed in 2010 and 2013 prior to the delivery of zero carbon homes in 2016. It is envisaged that the bulk of new housing will need to achieve equivalent levels of energy efficiency as defined by the PassivHaus standards to achieve these targets.
As a part of achieving code level 6 in 2016 all dwelling will be required to achieve a 'Heat loss parameter' of 0.8 W/m^2K or less – which has been designed to reflect the German requirement of 15 $kWh/m^2 \cdot year$.

Barriers Solved
The major barrier which was initially perceived was a lack of components, and whilst this is still of importance it was realize early on this the project that the UK does indeed have access to the components necessary to construct PassivHaus dwellings.
The biggest success of the project has been the increased communication and amount for freely available information. In addition to this the PEP project has also assisted the UK in adapting the PassivHaus standard to the UK. There is still some ongoing argument over the terminology 'Passive House' or 'PassivHaus' and what this entails however the vast majority accept the German definition. Further the use of the 'PassivHaus Planning Package' in delivering the PEP project has also led to the discussion of future amendments to the UK's national energy calculation methodology to better model some of the low-energy features of these dwellings. The PEP project has allowed the UK to build up strong links with other EU organizations - many of which have provided information on products, detailing and advice on technical issues – this has been invaluable throughout the project and has helped to remove some of the 'myths' surrounding PassivHaus construction.

The development for a certification procedure for both whole dwellings and products has led to a better understanding of both national and EU legislation which may have hindered the progress of delivering PassivHaus in different countries.

Number of Passive Houses implemented

At present there are no 'certified' PassivHaus dwellings in the UK – however is it estimated that there are 10 to 100 projects currently in construction or planning which could fulfil the requirements. The main problem within the UK at present is achieving the quality of construction necessary to achieve PassivHaus levels of air tightness (which is 10x more demanding than the building regulation minimum requirements). Some developers whom have attempted to achieve the PassivHaus standard have also been put off by the currently high extra capital cost for the insulated triple glazed windows.

New build dwellings is the predominant market, although the house retrofit and also non-domestic markets are emerging. It is expected that the new build market will still be predominant in near future, however moving in direction of non-domestic buildings as well as domestic. Refurbishment will follow. In England the CSH will essentially require all new dwellings (circa. 230,000 per year) to be constructed to PassivHaus standards before 2016. In Wales the timescale is potentially shorter, as they have the aim of all new-build houses being zero carbon by 2011.

Figure 18: Demonstrations of Passive Houses at BRE premises (UK)

Certification of Passive Houses
Due to the adoption of the Code for Sustainable Homes in the UK the possibility of a standalone PassivHaus certification in the UK was not thought to be commercially viable. Discussion has therefore not been held between parties.
The challenge for the years ahead will be to take the lessons learnt from the PassivHaus Planning Package and update our national energy calculation methods to better reflect PassivHaus design and components – by doing this PassivHaus will automatically be given benefit within our building regulations, the Code for Sustainable Homes and on Energy Performance Certificates.
Until our national energy calculation methodology is updated the PassivHaus Planning Package remains the only way of verifying that a dwelling complies with the defined requirements.

Acceptance of the PH definition
The UK has adopted the German definition of 'PassivHaus' – also due to the nature of UK housing design a typical German specification is required (i.e. window U-values of 0.8 $W/m^2 \cdot K$) as most of the dwelling designs in the UK are not optimized (whether this is because of constraints in the local area or perhaps by client request for a specific design for example).

Acceptance PHPP in relation to national calculation software
PHPP will not be accepted as a national calculation methodology – at present two calculations must be undertaken.

Change in awareness
As a part of the PEP project BRE's involvement with the Code for Sustainable Homes has played a major role in promoting PassivHaus, but in addition to this the promotion of voluntary energy efficiency standards though the Energy Saving Trust (EST) and the Association of Environmentally Conscious Builders (AECB) has also increased uptake and assisted promotion as their voluntary standards are based around the PassivHaus concepts.
Whilst PassivHaus is not yet a mainstream building practice, the concepts are commonly discussed and referenced in building magazines and events as well.

Information still required
There remains an ongoing need for information in the UK, in particular:

- The concepts of air tightness are relatively well understood, however developers, architects and builders need more hands on experience to get these principles right.
- Translation of PassivHaus thermal bridging values to the UK standards.
- Information on design and commissioning of ventilation systems

BRE will continue to carry out promotional activities and provide free information where possible on PassivHaus once the PEP project is closed, however the main problem in the UK in delivering PassivHaus dwellings is the quality of training available to housing professionals and also the current arrangements for delivering houses (there are gaps in the supply chain and often it is not possible to work as a design team).

Future implementation path

- Update national energy calculation methodologies (due 2009)
- Greater number of local component suppliers (immediate)
- The production of cheaper PassivHaus windows (immediate)
- Creation of UK thermal bridging details for PassivHaus (2008)

3.11 Passive House Definition

The basic idea of a Passive House is to minimise the heat demand for space heating so that the necessary heat can be supplied by additional heat to the ventilation air. Taking into account the outdoor temperature and as a consequence the temperature of the incoming ventilation air, the heat capacity of the air, and the maximum temperature to which the air can be heated to be comfortable, the maximum heat requirement was calculated to 15 kWh/m^2·year. Experiences in Germany and Austria have convincingly shown that this can be reached in Central European climates. However, in Nordic climates this might be quite difficult, if not impossible. Northern Scandinavia copes with winter temperatures of minus 35 °C and lower. The Finnish and Norwegian partners in the PEP-project have shown that the criterion of 15 kWh/m^2·year is an unrealistic one for their countries. As a consequence, building Passive Houses is not an option for Northern Scandinavia and other countries with cold climates, unless Passive Houses should be defined more flexible. This does not mean that the result is worse than the Passive Houses in more moderate climates: the houses built according to such standard are in accordance with Passive House construction principles and very energy efficient.

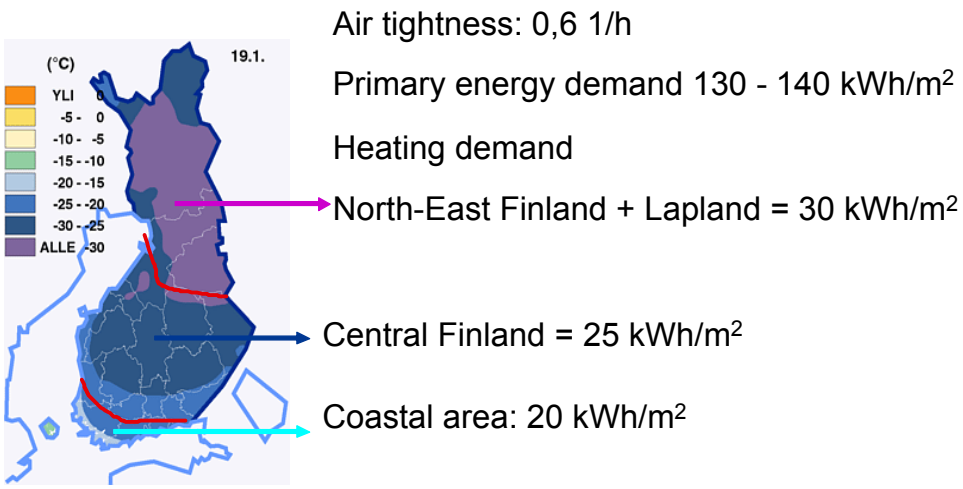


Figure 19: maximum heat requirement to meet PH definition in Finland [24]

After long discussions with the project partners, it was decided in the PEP-project to define Passive Houses as follows below, in a popular version (a) and in a more scientific version (b). Furthermore subject to discussion is the question, if only the ventilation air should supply the heat for space heating. The background of this criterion is that by doing so, a separate heating system can be avoided, thus saving costs that can be used for adding insulation, improving air tightness etc. However, in some countries, for instance in the Netherlands, houses have a (low temperature) water based space heating system which is combined with the domestic hot water supply, and which can be coupled to a solar collector. These systems are relatively cheap and supplying heat through ventilation air only will not have a significant cost reduction effect. The results of the discussion of this item in the PEP-project are also reflected in the definition of Passive Houses:

(a):"The term Passive House refers to a specific building standard for residential buildings with good comfort conditions during winter and summer, without traditional heating systems and without active cooling. Typically this includes very good insulation levels, very good air tightness of the building, whilst a good indoor air quality is guaranteed by a mechanical ventilation system with highly efficient heat recovery".

[24] Source: VTT

(b):"The term Passive House refers to a specific building standard for residential buildings with good comfort conditions during winter and summer, without traditional heating systems and without active cooling. Typically this includes very good insulation levels, very good air tightness of the building, whilst a good indoor air quality is guaranteed by a mechanical ventilation system with highly efficient heat recovery. Thereby the design heat load is limited to the load that can be transported by the minimum required ventilation air. However space heating does not have to be carried through the ventilation system. For 40° - 60° Northern latitudes, under conditions specified in the PHPP calculation model:
- the total energy demand for space heating and cooling is limited to 15 kWh/m^2·year treated floor area; the total primary energy use for all appliances, domestic hot water and space heating and cooling is limited to 120 kWh/m^2·year.
A Passive House has a high level of insulation with minimal thermal bridges, low infiltration and utilizes passive solar gains and heat recovery to accomplish these characteristics. Consequently renewable energy sources can be used to meet the resulting energy demand.

For 60° and higher latitudes, it is necessary to adjust the figures in order to be able to achieve an ambitious yet realistic solution. This can be done on a national basis. However, the specific heat loss for transmission, infiltration and ventilation (according to EN ISO 13 789) normalized for treated floor area should not exceed 0.5 kWh/m²·year."

For southern climates, where passive cooling is more dominant, a second addition to the definition should be made. However, in the PEP project this addition has not been discussed.[25]

Figure 20: Passive Houses in Belgium

[25] H.F. Kaan "Passive Houses worlde: international developments", passiefhuis-symposium 2006, Belgium

3.12 PEP Workshops

During the PEP- project several (inter)national workshops related to promote the passive houses took place. One of the targets of the PEP -project was to increase the number of non-German speaking visitors to the German International Passive House Conference with 10% in comparison with 2004. The PEP-project supported the IPHC's in Ludwigshafen 2005, Hannover 2006 and Bregenz 2007. During these years the amount of foreign visitors increased due to the promotional activities of the project partners on a national level. The IPHC established to be become an international platform for passive house professionals.

The visitors of the Passive House Conference 2007 in Bregenz came from 34 different countries: Austria (347), Germany (332), Switzerland (57), Ireland (42), Italy (37), Norway (27), Denmark (18), U.S. (16), Sweden (16), UK (14), France (12), Liechtenstein (12), Belgium (11), Netherlands (8), Czech Republic (8), Slovenia (7), Poland (7), Belarus (5), Slovakia (5), Luxembourg (5), Finland (3), Croatia (3), Lithuania (3), Hungary (2), South Korea (2), Canada (2), Ukraine (2), Serbia (2), Romania (2), Portugal (1), Latvia (1), Lebanon (1), Poland (1), Russia (1), Spain (1), Estland (1) and Japan (1).

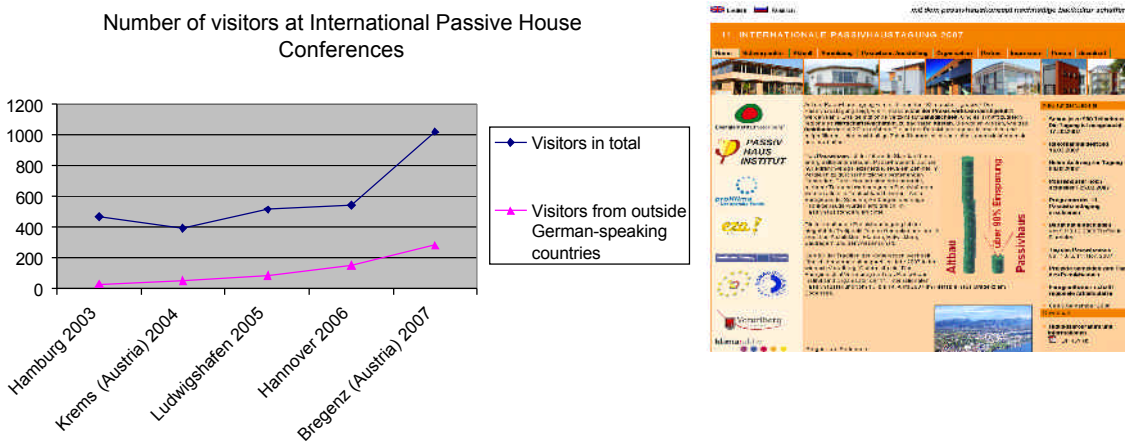


Figure 21: Number of visitors at International Passive House Conferences [26]

Figure 22 shows the number of stakeholders per country contacted directly via national workshops. The visitors of the IPHC are not taken into account in this graph. The total amount stakeholders reached is 10,680. The figure also shows an estimation of the type of stakeholders the PEP-project reached. The majority are building owners followed by architects and engineers. The amount of stakeholders reached in Belgium and Germany is higher in comparison to the other countries. These countries started the project with already established promotional platforms like the Passiefhuis platform, proKlima and the PassivHaus Institute. The workshops/conferences held in Belgium also were open for the consumers and private house owners during the weekends which were a great success. Austrian stakeholders went probably in 2007 to the IPHC in Bregenz which resulted in a lower attendance at the national workshops. The amount of visitors in Finland, Norway, Ireland, Denmark, United Kingdom and the Netherlands vary between 250 and 800 during the PEP-project. In Finland people visited the energy-efficient construction tours with large numbers. Norway concentrated on educational and seminars. In Ireland the passive house concept was introduced at low energy building conferences. Tours and disseminating via national low energy building conferences were successful in England. The Netherlands and Denmark held "stand alone" workshop only concentrating on the passive house concept and related calculation educational workshops.

[26] http://www.passivhaustagung.de/englisch/index.html

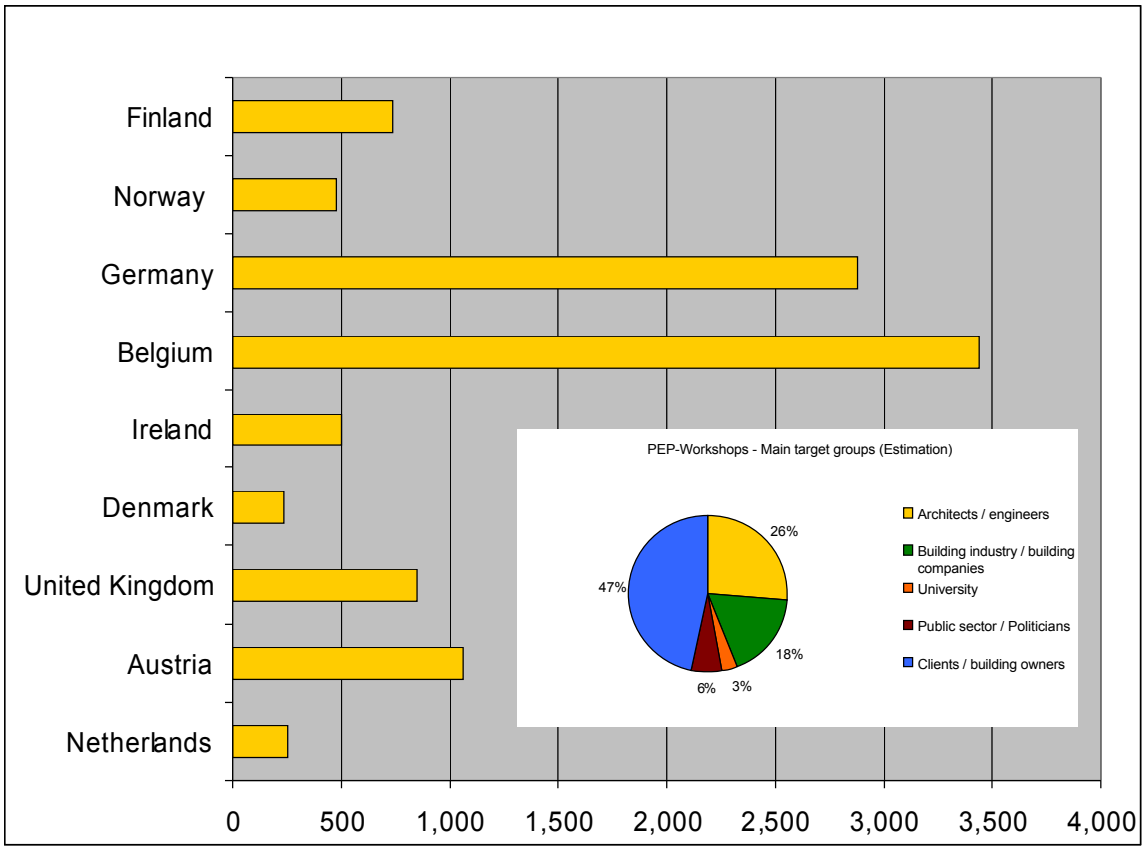


Figure 22: number of stakeholders per country contacted directly via workshops during the PEP project

3.13 The PEP website

The project website was an important dissemination tool to reach the target audience and accommodate technical and non-technical information relevant to passive houses. The website provides information regarding PEP project partners and observers, and provides easy accessible downloads of all project deliverables, research results, information package and relevant national links and contacts.

Since 25 January 2006 the website was great success with just over 2 million number of 'hits' and geographical spread covering all Europe and beyond. In terms of number of visitors from PEP partners countries, highest activity is from Belgium and the Netherlands followed by France, Ireland, United Kingdom and Denmark. Many visitors were also registered from outside Europe, such as from Japan, Australia, United States, Canada, New Zealand, Israel, Argentina, Indonesia, etc.

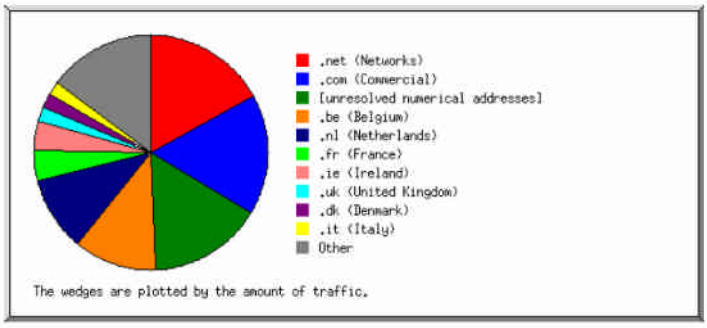


Figure 23: Indication of the (national) origin of website visitors

The PEP website with its wealth of information was used as powerful tool for promotion of passive houses in Europe. At the start of the project there were several barriers to promoting the passive house standard from Germany and Austria, where at the time most of the building examples, know-how, products and services already existed, to other parts of northern and western Europe. The definition of 'What is a Passive House?' which was developed within the scope of the PEP project is now available on the website, specified as popular and more scientific version.

Other barriers included insufficient information translated to national languages on the definition of a passive house, specification required to achieving the passive house standard, and passive house solutions adapted to national building methods and climate conditions. The PEP website contains various translated publications, links and information specifically targeted at overcoming these barriers. For example, translated National Publication and Information Packages are available as well as information on national events, workshops, conferences and list of national passive house websites and links of interest.

Another aspect and a barrier to widespread of building passive houses was a common approach to certification of buildings achieving the passive house standard and certification of components used in passive house design. The results of the PEP approach to certification of passive house buildings and components are now available on the website, including national translation of publications.

Technical barriers to building passive house buildings, is tackled in the Information Packages, with specific target groups (municipalities, architects, developers, energy designers, etc.). The information packages are being translated and adapted to national building conditions. In the case of Belgium, the Netherlands, Norway and Ireland Design Guidelines were being developed and are available from the website.

The new version of the PHPP, Passive House Planning Package (v 2007) for quality approval of passive houses was launched in July 2007. The work on internationalization of the calculation tool, especially the integration of additional climate data outside central Europe were made possible by the fact that the Passive house institute was a subcontractor of proKlima, Hanover Germany, in the PEP project. Information on available climate and sourcing of the PHPP software is now available from the website.

Figure 24: Multi family passive house, Linden, Hannover [27]

[27] http://www.passivhaus-plattform.de/Hohe-Strasse-Hannover.156.0.html

4 Conclusions

4.1 Passive House market penetration at the end of the project

At the beginning of the project in 2005 Norway, Finland, United Kingdom, Ireland, the Netherlands and Denmark were in the preparation phase with respect to the embedding process of passive houses. Belgium, German and Austria already were situated in the introduction phase. In addition, Germany and Austria had more passive houses realised and a larger establishment in comparison with Belgium.

During the PEP-project the countries in the preparation phase concentrated on experimenting with the first passive houses, the development of a long term national vision/policy and providing the stakeholders solutions for possible non-technical and technical market barriers.
Figure 25 shows the position per country with respect to the embedding phase and the related market penetration of Passive houses at the end of the PEP- project.

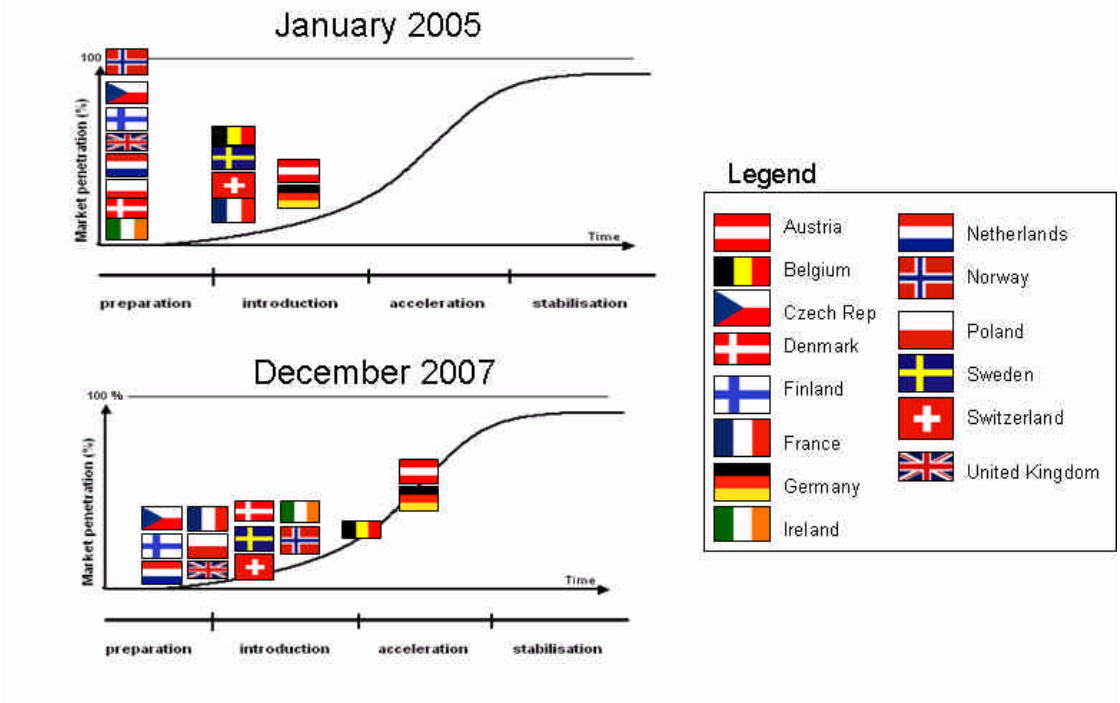


Figure 25: Market Penetration Passive Houses per country in December 2007 in the newly building sector

The Netherlands concentrated to create establishment. This resulted in the Netherlands in an acceptance of the passive house concept as a long term solution to reach an energy neutral built environment. However, within the project period a certified passive house was not erected. This is planned for 2008. The Netherlands are on the brink of entering the introduction phase. For the latter reason Finland balances on the edge of the introduction phase. Finland has made a progress by overcoming barriers like user expectations, unclear economical benefits and the attitudes towards passive houses.
The British government has the ambition to standardise zero carbon houses in 2016. The passive house concept is a key concept in achieving this goal. The United Kingdom focussed on dissemination of the solutions, the availability of PH components and physical demonstration of the passive house concept which finally resulted in three demonstration or passive house experiments. Irish individual entrepreneurship resulted in the first certified passive house and helped together with the available information to organise a bottom-up

approach to embed the passive houses in Ireland. In Denmark a bottom-up approach was also used: increasing the availability of PH components and educating installers and energy advisors. Additionally, industrial influences helped to promote the concept in Denmark and beyond. In Denmark one passive house has been built. The biggest step in the embedding process was taken by Norway. At the end of the project several passive houses were built, Norwegian building practitioners were trained and passive house are becoming well-known throughout the country. The promotional activities in Belgium concentrated on further promotion of the passive house concept. The passive house as a newly built house is accepted and proven passive house technologies find their way into the renovation market and other construction applications like schools and office buildings. Also financial schemes are clear. Belgium is on the brink to implement passive house on a larger scale. In Germany and Austria the passive house was embraced by politicians and further promotion via local and national conferences reached finally the housing owners. The experimental phase for the German and Austrian newly built market has been passed. The concept in this market is established and has past the first economical and societal market barriers.
Further proven technologies found their way towards the renovation market. Renovation projects take place on a large scale and the passive technologies are also accepted in these markets.

It can be concluded that the aim of the PEP-project to development and dissemination of easy accessible web based documentation for stakeholders in the building process to solve national market introduction barriers has been successful. All participating countries made significant progress in the embedding process and in most countries the passive house concept is on the brink of breaking through. Further, the PEP-project contributed successfully in the internationalisation of the Internal Passive House Conference. Last but not least, the PEP-project fixed the definition of a passive house for three geographical European regions:

- Nordic passive houses (> 60° northern latitudes)
- Central European passive Houses (40° - 60° northern latitude)
- Mediterranean passive houses (< 40° northern latitude)

4.2 Future challenges

Most information required to 'walk through' the first two phases of the embedding process of passive houses nationally has been developed within the PEP-project and is free available on the website. However, within the project new challenges were identified to increase the implementation efficiency of the passive house concept. Generally, the following challenges were identified to face in the coming future:

- Development of information packages concerning passive house solutions for offices, schools and social homes (e.g. architectural examples, organisational issues)
- Development of information packages concerning passive house renovations
- Development of financial schemes for passive houses
- Development of performance oriented quality approach for the design and construction process
- Implementation of the certification schemes for passive houses.
- Research of the relation between hygienics required of ventilation systems and comfort and health
- Development of industrial prefab construction of passive elements
- Synchronisation of national energy calculation methods, PHPP and the EPBD.
- Development of practical training programs for craftsmen, to architects, engineers and developers.

The passive houses concept has become a European wide accepted solution to reach a significant energy demand reduction in the built environment. The European Commission has published the ambition to construct newly built houses in 2015 accordingly the passive house standard. In most PEP participating countries this ambition is shared. The PEP-project with the support of the IEE-program contributed to achieve this ambition to clear the first market barriers internationally to reach the status ‘Business As Usual” for Passive Houses.