106: Certification of Passive Houses: a Western European Overview

Mlecnik, E. [1,2], Kaan, H. [3], Hodgson, G. [4]

Research Institute OTB, Delft University of Technology, the Netherlands[1]
E.Mlecnik@tudelft.nl
Passiefhuis-Platform vzw (PHP), Berchem, Belgium[2]
Energy research Centre of the Netherlands, Petten, the Netherlands[3]
BRE, Watford, United Kingdom[4]

Abstract

According to the popular definition, passive houses have to reach a target energy demand for heating less than 15 kWh per square meter and per year. This criterion is used as a basis for quality assurance procedures and certification of passive house projects.
This paper identifies the experiences in several western European countries concerning passive house certification, and hence the control of quality of the design process, the construction process, and the post construction inspection and testing of passive houses. Certification and quality assurance initiatives from Belgium, the Netherlands, France, the U.K. and Ireland are compared with preceding initiatives in Austria, Northern Italy, Switzerland and Germany.
It is recognized that with the current state of the emerging passive house market, passive house verification is necessary on a project level, but that it is still difficult to introduce certification of actors and processes in many countries. An open market and competition for certification services is proposed, as well as a good coupling with local energy legislation initiatives.

Keywords: passive house, passivhaus, certification, quality assurance, energy, comfort

1. Introduction

Promoting energy efficiency is a consequence of the Kyoto Protocol. The European building sector is responsible for about 40% of the total primary energy consumption. To reduce this share, the European Commission (EC) has introduced the Energy Performance of Buildings Directive, the EPBD (2002/91/EC). This framework has lead to energy performance certificate for buildings, in many countries to be introduced in 2007-2009. The EC has also highlighted that future adaptations of the EPBD may be extended to include 'low energy or Passive Houses' as a requirement.
According to the definition [1], passive houses have to reach a target energy demand for heating less than 15 kilowatthour per square meter net heated surface and per year (kWh/m^{2}a) and a total primary energy demand less than 120 kWh/m^{2}a. Some European countries and regions have introduced long term visions for the year 2015-2020 that include voluntary passive house certification or in certain circumstance a mandatory passive house standard. Often a verification of reaching the passive house standard is coupled with financial benefits.
Understanding the context of the western European situation is a prerequisite for making the right decisions considering strategy development for broad market implementation. This paper provides a PEST analysis: Political, Economical, Social and Technological factors influence the marketplace and therefore indirectly each building actor and building project. Further the competitive arena is analysed in different countries: suppliers, competitors, substitutes, customers, and so on, have a strong and most direct impact on a project development. SWOT analysis (Strengths, Weaknesses, Opportunities and Threats) is used to understand the advantages, opportunities, barriers and solutions of broad market introduction of passive house certification and to overcome threats.

2. Why certification of Passive Houses?

2.1 Political issues

The EPBD requires that an energy performance certificate should be available when selling or renting a house, and for display in public buildings. The existing passive house certificates and labels can be integrated in the political scope of the development of the EPBD.
Several countries show a political ambition level considering the improvement of energy efficiency in buildings. The EC has highlighted in its 'energy efficiency action plan' that future adaptations of the EPBD may be extended to include 'low energy or Passive Houses' as a requirement, setting a target date of 2015. For many countries the passive house level is seen as a long term political ambition level to reduce energy consumption in the building sector [2]. Many countries also have industry initiated target settings, supported by the government. E.g. in

France the 'Grenelle de l'environnement' specified targets for sustainable construction. In the United Kingdom there are compulsory standards, with the 'Code for sustainable Homes' setting the timeline for improvements in building regulations (by 2016 new dwellings will need to be zero carbon and will have to achieve a similar level of fabric performance as Passive House). In the Netherlands, a strengthening of the energy performance level of buildings is proposed to nearly passive by 2015 and the governmental programme 'More with Less' shows specific energy reduction targets for different types of buildings. In the Flanders Region specific passive house targets have been proposed by the transition arena 'sustainable living and building'. It remains to be seen if these political initiatives will reach their goals.

2.2 Economical issues

Many countries and regions have a range of financial stimuli for energy efficient investments in buildings, e.g. subsidies, tax reductions, attractive loans, etc. Typically for passive houses, a number of conditions have to be met to receive the benefits. This means that these conditions have to be verified by a non-involved independent expert.

2.3 Social issues

Under the influence of the media and information technology, consumers are becoming more aware of their options. Clients' wishes and rights are more often explicitly stated during the initial design phase. Consumers tend to value the energy and non-energy benefits of low energy and passive houses.

Consumer protection is an important issue for passive houses. In many schools in Western Europe designing passive houses is still not integrated in the education of architects. And building passive houses is no daily practice for many building contractors and installers. When a consumer wants to purchase a passive house, some form of quality assurance has to be provided. Certification of the project or product will offer more certainty for the consumer. Alternatively, or in addition, certification of the architect, the architect's office, the building contractor and the installer may help to make sure that the consumer gets the energy efficient and comfortable house which he/she had in mind: the passive house.

Performance based contracting is being initiated for passive houses and low energy buildings. The energy performance has to be calculated and the airtightness of the building envelope has to be tested in many countries. The client perceives the passive house certificate as a guarantee from the contractor, of energy saving and possibly also of good indoor comfort.

In addition to these aspects many home owners are not familiar with the types of technologies and controls commonly used in passive houses. Special care needs to be taken by the contractor to ensure that the services provided are correctly specified, installed and commissioned and that the occupier is provided sufficient information to ensure correct operation and occupant satisfaction. Some particular groups of individuals (e.g. elderly or infirm) may require a greater amount of pro-active engagement as to what features a 'passive house' has

2.4 Business issues

Financial benefits support market growth and seem to stimulate innovation by manufacturers of window frames, installations etc.

For companies to be recognized as market leaders (whether local, regional, national or international) the aim is to demonstrate that their product differs from that of their competitors. In many countries, passive house certification is viewed as a market mechanism whose main objective is to promote higher energy performance standards than the regulated ones.

Passive house technologies have been promoted with success by companies to build a serious and innovative image. Certificates of passive houses and passive house technologies provide credentials for companies.

For many companies a label or certificate is seen as an 'added value' for a realisation, a product or a system. As such passive house certificates already exist for individual projects (e.g. the quality assurance label in Belgium or the German passive house certificates). For passive house building systems and specific passive house technologies like triple glazing, high efficiency windows and doors, high efficiency heat recovery systems, and so on, certificates are provided in Germany by a list of experts. These certificates also specify comfort (e.g. also acoustical quality) and energy related parameters of the product or system and thus complement information from more standard types of certificates.

3. State of the Art

3.1 Germany

In Germany the passive house standard has seen a broad introduction in the mid nineties. Nowadays more than 6000 passive houses exist in Germany, also non residential buildings and renovations. In some cities like Frankfurt, Leipzig, Kreis Lippe, the passive house standard is required for the construction of buildings that belong to the municipality. Main economic driver for the construction of passive houses in Germany is the provision of a beneficial loan for the construction of low energy and passive houses by the German state bank KfW.

A certification system for passive houses and passive house suitable components was introduced in Germany in 1997 by the Passive House Institute Darmstadt.

The certificate 'quality proofed passive house' confirms the 'as built' design of a building in accordance with the Passive House Planning Package (PHPP [3], the excel software tool used for verification of the passive house standard). The limit values for passive houses according to PHPP are validated. It will be assessed if the values for total energy demand, total primary

energy and airtightness fulfil the passive house requirements.
PHPP 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. These qualities are the reason that PHPP is a highly-estimated tool in Germany. Furthermore the official
German building energy performance calculation procedure is included within PHPP to avoid extra work for planners. However, existing German norms (e.g. DIN EN 12831 for heat load calculations) are currently perceived as a barrier for certification.
The Passive House Institute Darmstadt and selected partners now also provide certificates to companies for passive house technologies (glazing, frames, heat recovery systems, building systems, etc.). Certification of products facilitates finding and comparison regarding energetic qualities.
In future the Passive House Institute also plans to certify building actors. A certificate for, and a listing of, passive house planners will make it easy to find a planner with substantiated knowledge regarding passive houses.

3.2 Belgium
In Belgium the passive house standard was introduced in 2002 by the non profit organisation Passiefhuis-Platform. First project certificates were delivered in 2005. Nowadays, the passive house standard is popular in the niche market of sustainable construction, covering different types of buildings and architecture. Special grants for passive house are given on a regional level and these are different in the Flemish, Walloon and Brussels Region. The cities of Turnhout, Bilzen and Mechelen also provide extra grants for passive houses. A federal tax reduction is offered for passive houses and a lowering of real estate tax is foreseen. [4-6]
For most buildings requiring a building permit, official EPBD requirements are set for the energy performance and indoor climate at the same time. These requirements are different in the Flemish, Walloon and Brussels Region. In the Flemish Region the standard is called EPB and the reporting of is undertaken by trained 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. A good coupling of the passive house concept with the EPB is still to be obtained and requires a substantial research effort. PHPP is used by passive house specialists and currently not accepted as an EPB calculation. Both calculations have to be performed.
Certification based on PHPP calculation is currently performed by Passiefhuis-Platform vzw and Plate-forme Maison Passive asbl on a voluntary basis. The PHPP software serves as a basis. Federal tax reduction for passive houses refers to the necessity of demonstrating a passive house quality assurance form, provided by independent experts. The quality assurance form is currently granted based on verification of PHPP calculations and results of a building pressurisation test to determine airtightness. In future, the quality assurance procedure will be extended to include summer comfort and air quality.

3.3 the Netherlands
In the Netherlands, the passive house concept is more and more accepted as solid and feasible approach to achieve comfortable low energy buildings. There are no certified passive house projects in the Netherlands. A significant number of project initiatives, of up to 250 – 500 new passive houses is known to date, about 50 percent also in renovation.
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.
However, the association involved is no accredited certification institute and choice of certification experts is currently not transparant. Investigations take place to position Passiefbouwenkeur, either independent, or in relation to existing or future certificates for buildings. The proposed quality control process is expected to include new procedures, also for quality control during construction.
The Dutch calculation method EPN (Energy Performance Standard, part of the Building Decree) is required to get building permit. Two calculations must be undertaken for a passive house project. A PHPP calculation does not replace an EPN calculation, even though a passive house stays well within the energy requirements currently required. [4-5]

3.4 United Kingdom
At the time of writing (June 2008) there are no dwellings which meet the passive house standard in the United Kingdom (there called PassivHaus), however there are a number of designs at the planning stage.
Many architects, clients, insurers, manufacturers, regulators and specifiers stated that third party certification and testing can be an accepted way of demonstrating conformance with standards and other requirements. As a result of this Building Research Establishment Ltd. (BRE) is currently authorised by the Passive House Institute Darmstadt to provide certificates for

dwellings meeting the passive house standard in the UK.
Attaining certification is subject to the same requirements as in Germany, however the air tightness requirement in the UK is set less severe, broadly equivalent at one volume air change rate per hour under 50 Pascal pressure, due to the milder climate. Airtightness testing and confirmation of correct commissioning of the mechanical ventilation unit is required. Consideration is currently being given to requiring the use of paints with less volatile organic compounds (VOC) for good indoor air quality.
Upon successful receipt of certification the owner can be entitled to reduced rated 'Green' mortgages which are starting to become available on the market.
U.K. building regulations require Standard Assessment Procedure (SAP) energy calculations to be undertaken to demonstrate compliance and obtain an Energy Performance Certificate. Thus, PHPP calculation can therefore only be used to verify that the house achieves the passive house standard. It is hoped that this need to undertake two calculations will be removed in the coming years.
The concepts of 'PassivHaus' design are also recognised as one route for achieving higher levels of the Code for Sustainable Homes and building regulations. [4-5]

3.5 Ireland
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 Passive House Institute Darmstadt in Germany. To the lack of more certified buildings contributes the fact that there is no official passive house certification body in Ireland.
The Irish official method for calculating and rating the energy performance of dwellings is called 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).
It is envisaged that creating an Irish Passive House Platform could bring the various stakeholders in building industry to promote and influence the market and that a certification body for Ireland should be established. [4-5]

3.6 France
The passive house concept was introduced in France in 2005 by different associations (La Maison Passive France, Minergie France, Plate-forme Maison Passive,..) and has received considerable attention in current legislation development.
In France the Réglementation Thermique 2005 defines the limits for primary energy demand for heating, cooling and production of hot water. Several labels are currently being used to improve energy performance. The French label Effinergie [7], the Swiss standard Minergie [8] and the German passive house standard are used and they all define criteria concerning passive construction. The label 'Bâtiment Basse Consommation' (BBC)-Effinergie, developed by the society Effinergie, has been accepted as the official promotion label for low energy buildings ('bâtiment basse consummation énergétique BBC 2005', decided 8 May 2007, published 15 may 2007). It is given to buildings consuming a limited amount of primary energy, taking into account the demand for heating, sanitary hot water, auxiliary systems for hot water and ventilation (pumps), lighting and cooling. The value can vary from 50 to 70 kWh/m^{2}a according to the climatic region (square meter gross floor area). Effinergie buildings also have to respect certain airtightness values, different for individual and collective housing. Certification is done by four official certification institutes, specialized in different subsectors and recognized by the state. Certification includes technical verification of the project before construction, on site control, detection of errors and delivery of the label. Effinergie buildings can get specific loans.
For passive houses also the Swiss Minergie-P and Minergie-ECO-P standards are used. Minergie-P fixes higher performance considering comfort, profitability and aesthetics. Energy consumption for heating, hot water, ventilation and cooling is limited to 30 kWh/m^{2}a (square meter gross floor area). Passive house certification is issued by the association Minergie Switzerland or Minergie France and additionally includes advice to the architect and the client and a thermal check.
For certification according to the German definition, the association La Maison Passive France is recognized by Passivhaus Institut Darmstadt.

3.7 Austria
In Austria the passive house standard is highly popular.
In connection to the national policy the Programme 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 so called 'klima:aktiv haus' programme and preparatory works are scheduled to implement the passive house standard as a requirement for the receipt of housing grants. [9-10]
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 2008 the city of Wels signed a declaration to build all future municipal buildings in the passive house standard.

In Austria nine different housing grant schemes exist, so verification can be different in different regions.
The certification of passive houses in Austria basically happens by means of the Passive House Planning Package and/or the Austrian methodology according the guideline no. 6 of the Austrian Institute of Construction (OIB), when it comes to housing grants. 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. Within the klima:aktiv haus programme 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 they must not be built of HFCH or PVC containing building materials and they must fulfil requirements concerning summer suitability.
Some differences occur between the Austrian OIB methodology and PHPP, especially concerning surface definition. Very optimistic default values for internal heat gains and shading of the OIB methodology have been criticised, while PHPP shows good validation.

3.8 Switzerland and Northern Italy

In Switzerland the passive house concept is promoted within a Swiss labelling initiative (Minergie) and also the German definition is promoted, e.g. by the Informationsgesellschaft Passivhaus Schweiz. In Switzerland the 'Minergie-P' (P for passive house) label also offers financial benefits.
In Northern Italy (South Tyrol) the certification programme KlimaHaus/CasaClima was introduced in 2002 [9-10]. It classifies buildings according to their annual space heat requirement (Gold: < 10 kWh/m^{2}a; A < 30 kWh/m^{2}a; B < 50 kWh/m^{2}a) and is based on a calculation code as well as on-site inspection (infrared thermography, airtightness verification). Passive houses are considered to be in the KlimaHaus Gold category. The calculation code is less detailed, so that this criterion does not correspond exactly to the requisites for a passive house according to Passive House Institute Darmstadt.

4. Passive House Certification: advantages, chances, barriers, solutions

4.1 Advantages and chances

Different European countries show a different embedding phase and related market penetration of passive houses and passive house certification. Some countries like the UK, Ireland and the Netherlands are still starting up initiatives, while others like Germany, Austria, Switzerland, Belgium, France and Luxemburg provide a framework for associated grants and/or tax reductions. In Western Europe the passive house standard is still a voluntary standard, while regions in Central Europe are already developing initiatives to include the passive house standard as a legal instrument and/or obligation for new constructions. Existing voluntary certification initiatives are different in different countries. Some harmonization between the different national initiatives might be interesting. Especially countries with no certification can already duplicate the most successful initiatives. Certification of passive houses usually includes an airtightness test, but also the functioning of technical systems and its effect on indoor climate can be considered.
Many countries consider or have developed financial aid for passive houses, as well as a performance oriented quality approach for the design and construction process of passive houses. Control of quality of the design process, the construction process and the post construction inspection and testing of passive houses is considered as essential. Some countries express the need to include comfort criteria (e.g. Belgium) or health criteria (e.g. UK, Austria), next to the energy performance criteria.
In some countries educational programmes were introduced, accompanying the certification systems. Remarkable is the limited passive house breakthrough in Luxembourg due to lack of education initiatives (although there are sufficient funding initiatives) [11], while experiences in Germany, Austria, Switzerland, Belgium and Italy illustrate that the passive house label has succeeded in getting through to the public due to provided passive house education initiatives. E.g. the KlimaHaus/CasaClima now registers now more than 500 planners as 'experts KlimaHaus/CasaClima' [10].
Larger shares of the annual new residential buildings were obtained when the label also includes low energy housing. E.g. KlimaHaus already achieved 20% in annual new residential buildings within 4 years, Minergie around 7%. A larger share of trained planners and companies contributes to a higher success.
Even if the certification was designed for single family houses, it is also used for large buildings, residential and non-residential and for renovations.

4.2 Barriers

For most countries passive house certification is limited to the verification of the 'as built' design in accordance with the PHPP by a competent and accredited institute or person and confirmation of the airtightness of the completed building by a practical test. Until now passive house certification according to the strict German definition, as applied in Germany, Belgium and the U.K., has not obtained a substantial market share, although many 'near' passive houses have been stimulated by the attention for passive houses.
New fields like non-residential buildings and renovations require more specific information for

certification. It is not clear if the strict definition can or should be maintained, especially since it is sometimes difficult to achieve for small houses or renovations. A fundamental passive house heat load requirement of 10 Watts per square meter remains fixed only if the designer wishes to heat the house using the fresh incoming air. Also, PHPP calculation procedures in themselves are often not sufficient to evaluate the design of, for example, office and school buildings.
EPBD calculation procedures are in many countries not adapted to specific passive house technologies. This means that in many countries for passive house projects both PHPP and EPBD calculations have to be performed. The cost of an extra certification next to the legal energy performance certificate is considered to be a bottleneck.
A good energy requirement does not necessarily bring thermal comfort and good indoor air. Especially summer comfort should be included in passive house certification as well as the proper working of balanced ventilation systems.

4.3 Solutions

If current regional EPBD initiatives are to be continued, then they should include the passive house definition. The introduction of the passive house standard as a building standard is only possible when passive house certification is also accepted as a legal instrument.
To improve the efficiency of some systems/ components to balance slightly lower efficiency of other components, a set of reference technologies can be defined which is showing a way to meet an overall passive house criterion.
A possible additional approach is also to set minimum qualities of passive house components. This has a direct effect on sectored market development of new technologies, systems and services.
Whereas a requirement based on PHPP calculation does not give any guarantee that attention will be paid to good construction, an explicit attention to building airtightness criteria has proven to be a very successful measure to stimulate education of contractors.
Further research is needed to include comfort and health aspects of passive houses in certification procedures and to couple this certification with other sustainability labels.

5. Conclusion

With the current state of the building market, passive house certification is necessary, but it still requires a lot of effort to introduce a certification approach for actors in many countries where passive houses still have a low market share. As good functioning passive houses are very sensitive to the quality of the building and installation designs, technical specifications and details, and to the quality of realisation, a certification could be considered as prerequisite, independent from the position of the passive house in the housing market.
Designs should be verified and their quality should be assured, especially because of the demonstration character of these buildings. In an emerging market existing voluntary labelling schemes can offer support. One might consider coupling this with labelling schemes for low energy buildings to reach a broader market share. An open market and competition for certification services is proposed, as well as a good coupling with local EPBD initiatives. The energy assessment methods upon which passive house certification methods are based, as well as their transparency, are key elements for the success of passive house certification.
An ideal European EPBD-linked calculation methodology and certificate format is highly unlikely to occur due to the fact that each EU nation has its own calculation methodology. However, lessons learnt on a national level from the monitoring of completed passive houses could be used to improve national calculation methodologies.
Although the passive house standard guarantees a low energy use for heating, certification initiatives in countries like the UK and Belgium show specific concern on how to guarantee a comfortable indoor climate of passive houses.

6. References

1. PEP (2008). Promotion of European Passive Houses, Intelligent Energy Europe SAVE project EIE/04/030/S07.39990, [Online], Available: http://www.europeanpassivehouses.org
2. Dyrbol, S., Thomsen, K. E., Wittchen, K. B. (2008). Member State approach towards strategy for passive/ very low energy buildings. In *Passivhus Norden 2008*. Trondheim, Norway, April 2-3: p. 234-239.
3. Passivhaus Institut Darmstadt (2007), PHPP 2007 (Passivhaus Projektierungs-Paket), software for the evaluation of passive houses, www.passiv.de.
4. Elswijk, M. et al. (2008). European Embedding of Passive Houses. IEE-SAVE project Promotion of European Passive Houses (PEP).
5. Beedel, C, Phillips, R., Hodgson, G. (2007). Final Report WP3.4 PassivHaus Certification, [Online], Available: [1] [3 May 2007].
6. Mlecnik, E. (2008). Marketing of Passive Houses: Experiences from the Low Countries. In *Passivhus Norden 2008*. Trondheim, Norway, April 2-3: p. 192-201.
7. Effinergie (2008) [Online]. Available: http://www.effinergie.org. Consulted: [22 May 2008].
8. Minergie (2008) [Online]. Available: http://www.minergie.com.
9. ALL (2006). Klimahaus Broschüre. Amt für Luft und Lärm der Autonomen Provinz Bozen, [Online], Available: http://www.klimahaus.info.
10. Troi, A., Sparber, W. (2007). Overview of realized passive houses in South Tyrol/ Italy and trends. EURAC Research, Bolzano, Italy.
11. Biver, J. (2006). Passive House Development in Luxemburg, presentation on *Passiefhuis-Happening 2006*, PHP, Belgium.