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*Advancing Project Management for the 21<sup>st</sup> Century  
"Concepts, Tools & Techniques for Managing Successful Projects"*

**29-31 May 2010  
Heraklion, Crete, Greece**

**Edited by  
John-Paris Pantouvakis**



**National Technical University of Athens  
Centre for Construction Innovation**



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## **Low Energy And Passive Housing Standards In Europe**

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### **Abstract**

Implementation of building energy ratio for new buildings resulted with a need to establish standards and certificates suitable for different building codes, geographical locations and building traditions of a specific nation or region. For Europe most highlighted energy rating indexes are "EPBD" ("Energy Performance of Building Directive"), with British version "BER" ("Building Energy Rating"), German "Energie-Pass" and Swiss "Minergie®", as well as for USA "LEED". Also well known are standards for extremely low energy buildings as "PassivHaus", "Minergie®P-Eco", "Zero Energy" and "klima:aktiv".

By the directive of the European Union all the buildings on the market that are being built, sold, or rented need to be certified. Gained certificate and annual energy consumption data could be presented to anyone interested, which will intensively affect the market.

This article is presenting different energy rating certificates with specific energy consumption data which enables the energy consumption comparison of different buildings. The article also presents the comparison of low energy building standards as: "PassivHaus", "Minergie®" and "LEED".

### **Keywords**

low energy housing, passive housing, standards, certificate, certificate comparison

### **1. Introduction**

Inducing the obligation of certifying the energy performance of the buildings resulted with establishing different standards and certificates which are customized according to different laws, geographic location, and building tradition of a specific region and a nation. Specially these certificates are worth mentioning: EPBD (Energy Performance of Buildings Directive), with it's versions like British BER (Building Energy Rating) and German Energie-Pass, but also American LEED, Swiss Minergie®, with their well known standards for very low energy buildings like PassivHaus, Minergie®P-Eco, Zero Energy and klima:aktiv.

By the directive from EU all the buildings that are built, sold or rented will be certified, and the data of annual energy consumption for heating will be provided or can be seen by all interested customers, which could have a major impact on the community and the market.

## 2. Comparison of needed conditions for very low energy consumption buildings in different EU countries

The assumptions and basics for energy consumption are different and therefore the comparison of required energy performance is not possible. For instance energy performance can be calculated by the area of heated floor, or by the populated area, or by the big floor area and these can vary 10 to 20%. Furthermore, which energy consumption processes are included in calculations of energy performance also makes a difference. Table 1. shows the limit consumption for several countries which have these regulations.

Country	Very low energy building limitations
<b>Austria</b>	Low energy buildings are usually those buildings with heating energy consumption below 60-40 kWh/m <sup>2</sup> of the total area (larger numbers for single family housing). Standard passive houses with 15kWh/m <sup>2</sup> are defined by the usable area in Styria and by heated area in Tirol.
<b>Denmark</b>	Temporary building regulative defines two different low energy consumption (LOC) classes. LOC class 1 and LOC class 2 are defined by the energy performance calculations which are 25 or 50% lower than the maximum obligatory for new buildings. Minimum energy consumption that is requested for new residential buildings is $70 + 2200/A$ kWh/m <sup>2</sup> annually (where A defines total heated floor area). For the other the minimum energy consumption request is $95 + 2200/A$ kWh/m <sup>2</sup> annually. Minimum energy consumption for the non residential buildings includes lighting.
<b>France</b>	Since May 8 <sup>th</sup> 2007. "Arrat� ministeriel" is defining requests for energy consumption of buildings. These regulations have five building types: HPE, HPE EnR, THPE, THPE EnR, BBC and "Low consumption building". BBC requests: New buildings: annual energy consumption for heating, cooking, airing, warm water and illumination have to be lower than 50 kWh/m <sup>2</sup> (40 – 60 kWh/m <sup>2</sup> depending on climate and height over the sea level). For other new buildings: annual energy consumption for heating, cooking, airing, warm water and illumination need to be at least 50% lower than the temporary building regulation proscribes.
<b>Germany</b>	Minimal energy consumption performance for a new residential building are defined and calculated by: $50,94 + 75,29 \cdot (A/V_e) + [2600 / (100 + A_n)]$ kWh/m <sup>2</sup> where A defines the outer area of insulation, V <sub>e</sub> is the volume surrounded by the insulation and A <sub>n</sub> defines the usable area. Public definitions which are meant for public support for low energy buildings are in suborder of state (Kreditanstalt f�r Wiederaufbau, Frankfurt (KfW)). These programs are mostly financed from public monetary funds. Temporary energy limit is 60% (KfW60) (request for primary energy is limited at 40 kWh/(m <sup>2</sup> a), but the insulation of the buildings are 45% better than EnE level). Besides that there is a financial aid program for "Passiv-Haus"

	buildings, which is defined by the Passiv-Haus-Institut as KfW40 with annual energy consumption lower than 15 kWh/m <sup>2</sup> .
<b>Swiss</b>	Some cantons include "Minergie®" as their regulations for new buildings: Minergie (38 kWh/m <sup>2</sup> ). Energy consumption includes heating, warm water and ventilation. Additional electricity consumers need to satisfy some criteria.
<b>United Kingdom</b>	Indices show that regulations are going to proscribe next: at 2010 level 3 (25% better than the contemporary regulations); 2013 level 6 (zero carbon for all the consumed energy – including the additional energy consumers)

**Table 1:** Low energy consumption building definitions

### **3. Comparison of different national standards for low energy buildings**

Several countries have developed standards and design processes in order to standardize, control and promote best low energy building practices. These three standards will be analyzed: German PassivHaus, Swiss Minergie® and American LEED.

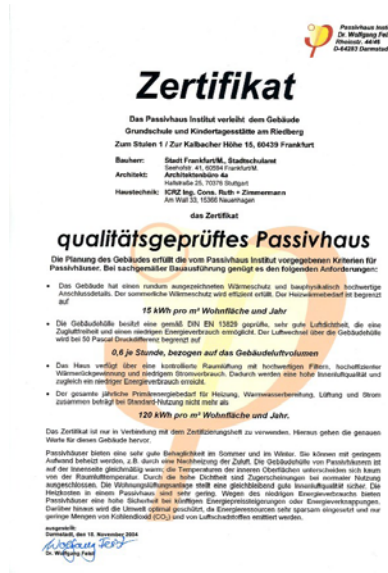
#### **3.1. PassivHaus**

Passive house institute (Passiv-Haus-Institut – PHI) in Darmstadt is intensively orientated towards studying energy characteristics of buildings. "PassivHaus" certificate means that the building complies with the requests for low energy building of PHI. Technical definition of that certificate is quite clear when speaking of climate for buildings between 40° and 60° northern geographical longitude. Or more precisely, a house can get a "PassivHaus" certificate if it complies with next criteria:

1. Comfortable inner climate can be preserved without using the central heating or cooling systems. Annual energy consumption for heating needs to be designed in that way that it doesn't rise above 15 kWh/m<sup>2</sup>.
2. The comfort criteria needs to be preserved in all rooms of the building as during the winter as during the summer. With those aims, certificate requests very precise levels of insulation for every construction element:
  - a. Lost heat ratio for all cross sections needs to be lower than 0,15 W/m<sup>2</sup>K
  - b. Every window and outer door needs to be with U-value lower than 0,8 W/m<sup>2</sup>K, as well as precisely defined window areas. The windows need to be at least with double isolation glass (triple isolation glass is recommended) with high thermal quality and good /BRTVLJENJE/
  - c. Air exchange per hour needs to be less than 0,6; Depending on the orientation and the building construction strong limitations are prescribed for each transparent element, regarding the orientation and a possibility to open. Ventilation openings are strictly controlled.
  - d. Ventilation and recuperator in passive houses are obligatory.

$$Q_{\text{sum}} = (Q_{\text{trans}} + Q_{\text{vent}}) - Q_{\text{gain}} < 15 \text{ kWh/m}^2 \text{ annually}$$

- Total primary energy consumption for all home appliances, sanitary water, heating and cooling of the area does not exceed 120 kWh/m<sup>2</sup>. This design is included in the project planning.



**Fig. 1:** PassivHaus certificate

After all works have been finalized each building is checked for the achieved properties especially all the seals are being checked. PassivHaus institute also certifies building elements as doors, windows, wall elements, etc. This process guaranties that after a new construction has been finished all the elements really comply with building requirements. Since the 80's, when the concept was founded, up to these days there are over 6000 projects finished in Germany, 1500 in Austria and about 300 in Benelux.

### 3.2. Minergie®



**Fig. 2:** Minergie® certificate

The Minergie certificate is temporarily available only in Swiss and Liechtenstein. Minergie certificate is conceptually very close to the PassivHaus. It defines very precise levels of energy consumption, and especially the Minergie-P® version. Minergie is a certificate that is appropriate for every type of buildings (residential buildings, hospitals, industrial buildings, etc.). There are two ways how to get a Minergie certificate. The first one is to use standard solutions that are usable only in single house projects. Those solutions cover three points:

1. Very precise insulation values for each construction element

Construction element	Values if in contact with outer climate or if berried less than 2m [W/m <sup>2</sup> K]	Values if in contact with non heated rooms or if berried more than 2m [W/m <sup>2</sup> K]
Roof, sealing	0,2	0,25
Wall		0,28
Floor		0,28
Heated floor		0,25
Windows	1,3	1,6
Doors	1,6	2,0

**Table 2:** Insulation standards requested for Minergie certificate

2. Choice between 5 technical solutions for heat production and distribution

Standard solution	1	2	3	4	5
System	Geothermal heat pump	Boiler heated by biomass + solar water heater	Automated heating system using biomass	Heating by waste	Air heat pump

**Table 3:** Available technical solutions for heating and warm water

Using all of these heating systems require double-flow heat exchanger with minimum 80% energy efficiency.

3. Additional costs for using Minergie standard solutions may not exceed 10% of conventional solution costs (15% by Minergie-P).

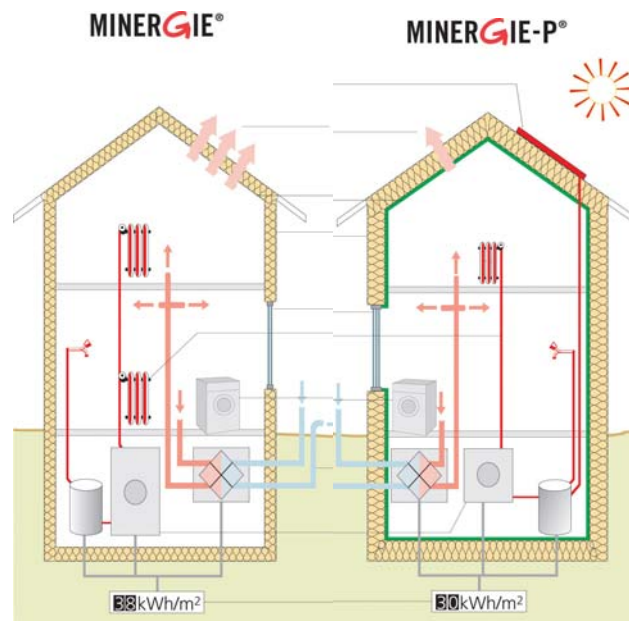
Second way of getting the Minergie certificate, which is also the only way for residential buildings, is by examining the buildings performance. Those performance tests are very detailed, and here are some specifications:

- Tests are different for private homes and for residential buildings
- Tests are different for new houses and for retrofitted houses
- Tests are customized to specific climate conditions (mostly height above sea level)



Building type	Residential buildings	Individual housing	Office buildings	Hospitals	Industrial buildings	Sport buildings
<b>Maximal values [kWh/m<sup>2</sup>/y]</b>	42	42	40	75	20	25

**Table 4:** Some of the requests for Minergie certificate



**Fig. 3:** Minergie and Minergie-P standard differences

[www.minergie.ch](http://www.minergie.ch) web page has announced that by the year 2007, 8200 buildings have received Minergie certificate. Minergie-P certificate, or better known as Minergie-Eco certificate is meant for buildings that use ecological building materials and processes.

### 3.3. LEED



**Fig. 4:** LEED standard certificate

LEED's (Leadership in Energy and Environmental Design) Green Building Rating System® is a voluntary national standard for high efficient building development. The system was developed by American Green Building Council, which has designed 7 different certificates. Certificates relate to the type of the building: LEED-H for houses, LEED-EB for existing buildings, etc. Certifying procedure is founded on a whole list of criteria, which by far exceeds the limits of using the energy. These certificates consider aspects such as energy transmission, visual design, use of local materials, etc. LEED uses Energy Star sign for request of energy consumption in a household. 15% decrease is proscribed in comparison with IECC (International Energy Conservation Code) form 2006. These regulations are delicately coordinated with the local climate and in accordance with that they define constructive elements and techniques.

In order to certify a building some basic rules are a must. A bonus is included for improved performance. Certificate is given in 4 different forms: certified, silver, gold and platinum. Although most of these building types have been constructed in Northern America, there are some in Europe as well.

Since LEED is including not only low energy consumption, but also the whole process of construction, activities, and the expected live cycle of the building LEED is a good example of a wider scope over civil engineering.

#### 4. Conclusion

Because the energy consumption limitations differ from place to place according to the climate and specific conditions and parameters, the simplest way to compare various energy icons is to compare the technical requests, and especially the requested insulation values. On the next picture there are several energy consumptions requests compared.

	Water heating	Other consumptions	Natural and local materials	Transportation	Inner air quality	Water	Education
<b>PassivHaus</b>	YES	NO	NO	NO	NO	NO	NO
<b>Minergie®</b>	YES	Minergie-P	Minergie-Eco	NO	NO	NO	NO
<b>LEED</b>	YES	YES	YES	YES	YES	YES	YES

**Table 5:** Comparison of observation areas for 3 standards

Most of the aspects in the Table 3 have energy values. Transportation is a good example: building a low energy home is useless if that requires increase in vehicle energy consumption. A certificate is available only by tests performed by the authorized institute, which can, but doesn't need to be, locally active. However, criteria and the evaluation of those low energy consumption buildings can serve as an inspiration and a guideline for every project.

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EN 15217:2007 – Energy performance of buildings – Methods for expressing energy performance and for energy certification of buildings

Internet:

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PassivHaus Standard: Passiv-Haus-Institut - <http://www.passiv.de>

Minergie® - <http://www.minergie.ch>

LEED standards - <http://www.usgbc.org/leed>

Klima:aktiv standards - <http://www.klima:aktiv.at>