A Classification of Passive House for Swedish Conditions

Åsa Wahlström and Svein Ruud, SP Technical Research Institute of Sweden
Martin Erlandsson and Jonas Norrman, IVL Swedish Environmental Research Institute
Eje Sandberg, ATON Teknikkonsult
Maria Wall, Lund University
Hans Eek, Passivhuscentrum Alingsås

1. Abstract

A requirement specification for residential passive houses for Swedish conditions has been developed. The classification sets requirements of supplied power for heating and recommendations of used energy for operational electricity, hot water and heating. This is first version of the definition and it might need a revision after more experiences are reached from built passive houses in Sweden.

2. Introduction

During the last years several good examples of buildings with very low energy use for operation has been realised but the technique has not become mainstream in the building industry. This might be due to that the building proprietor has difficulties to see the technical possibilities for very low energy using buildings and to set high requirements of low energy use when ordering the building from the constructor. In order to tackle these barriers and to speed up the process towards a sustainable built environment the Energy Agency in Sweden gave a mandate to FEBY (Forum for Energy Efficient Buildings) to establish a requirement specification for passive houses. This paper describes the results of the requirement specification settled for residencies.

The definition of Passive house has been developed by considering the corresponding definition in Germany but with adaption to Swedish climate conditions. In order to tackle the Swedish climate properly the requirement specification has two levels, -one for south Sweden and one for north Sweden. The development of the requirement specification is also considering the Building Regulations in Sweden and has therefore the same specifications for climate division of Sweden, specific area etc. Before settling the requirements the specification has been under consideration by national and international expertise within the field.

The aim with the requirement specification is to be used for communication on the building process and for marketing purposes on the Swedish market. It's a requirement specification that is freely to use but in order to avoid misunderstandings for export of Swedish constructions it is recommended to use the definition that is valid in the country considered.

The definition was settled in spring 2007 and thereafter it has been out under consideration by national and international expertise within the field. In autumn 2007 the referred version was corrected by the incoming comments and settled awaiting of experiences from built passive houses in Sweden.

3. Requirement specification of passive houses in Sweden

The requirements of passive house aim to minimize the need of supplied power for heating in buildings for requisite thermal comfort. Supplementary requirements of resource efficiency are set in order to limit the total use of "bought" energy (i.e. for operational electricity, hot water and heating). The requirements of indoor environment should be ambitious and cooling for comfort should not be needed.

Minimum requirements settled in the building regulations (BBR, 2006) are required besides the requirements that is mentioned in the requirement specification.

The requirements are set for A_{temp} that is the floor area in tempered rooms intended to be heated to more than 10°C limited by the inner side of the climate envelope (m^2) (i.e. as in BBR, 2006).

3.1 Requirements of power

Supplied power for the entire building for heating is calculated according to following conditions:

- a designed indoor temperature of 20^oC
- a designed outdoor temperature for winters (DUT) decided according to Swedish Standard SS 024310 (se Table 1 for DUT_{20} and a time constant of 300 hours).
- climatic zone south and north are the same as in BBR, 2006
- at calculations are a maximum value allowed of 4 W/m^2 from internal heat from domestic appliances and persons. Additional heat from the sun should not be included in the calculations.

Supplied power (P_{max}) has the following requirements:

- P_{max} = 10 W/m^2 in climatic zone south.
- P_{max} = 14 W/m^2 in climatic zone north.
- For detached houses with an area of less than 200 m^2 are the requirements, while considering the different climatic zones, according to: $P_{max200} = P_{max} + 2$ W/m^2

Note that it is not a requirement to use the supply air system as heat carrier. The requirements refer to the entire the building and not the separate residencies. Calculations of power need are based on calculated heat losses for the building envelope, ventilation and involuntary ventilation, while considering available surplus heat. Airing behaviour is assumed to give negligible losses at the designed outdoor temperature. Calculations of ventilation losses should consider system efficiency and defrosting.

Table 1: Designed outdoor temperature for winters (DUT) decided according to Swedish Standard SS 024310. This standard should be interpreted as at is accepted that the indoor temperature may be decreased with maximum 3 ^{o}C at extreme outdoor temperatures that appears only ones for 20 years.

City	$DUT_{20 \text{ at a time constant of 300 h}}$ ^{o}C	$T_{outdoor}$ January ^{o}C
Bromma	-10.5	-3.5
Uppsala	-12.8	-4.4
Linköping	-10	-2.9
Kalmar	-7	-1.7
Ronneby	-6.1	-1.5
Göteborg	-8.2	-1.4
Karlstad	-13.1	-4.3
Östersund	-18.2	-8.5
Luleå	-20.6	-10

3.2 Requirements of energy use

Use of energy for the entire building for operational electricity, hot water and heating (i.e. all energy use except for domestic electricity) is calculated according to following conditions:

- A designed indoor temperature of 20 ^{o}C.
- Energy calculations for the buildings should be made according to ISO 13790:2004.
- at calculations are a maximum value allowed of 4 W/m^2 from internal heat from domestic appliances and persons.

Use of energy (E_{max}) has the following recommendations:

- $E_{max} \leq 45$ kWh/m^2 in climatic zone south.
- $E_{max} \leq 55$ kWh/m^2 in climatic zone north.
- For detached houses with an area of less than 200 m^2 are the requirements, while considering the different climatic zones, according to: $E_{max200} = E_{max} + 10$ kWh/m^2

E_{max} is supplied energy by district heating, biofuels or electricity while fossil fuels are not alternatives for sustainability and are not allowed within the definition of passive house.

3.2.1 Energy use for yearly use of hot tap water (E_{vv})

A standardized use of hot water is assumed according to:

$$E_{vv} = V_{vv} \cdot 55/A_{temp} \, [kWh/m^2]$$

where the yearly use of hot water (V_{vv} [m^3]) are:

V_{vv} =12 m^3/appartment + 18 m^3/person for apartments and

V_{vv} =16 m^3/person for one-family houses and terrace houses.

The person based hot water volume may be reduced with 20% if energy efficient single level tap water devices are used.

The number of persons in each dwelling are assumed to be:
1 room and kitchen = 1 person/apartment
2 rooms and kitchen = 1.5 persons/apartment
3 rooms and kitchen = 2 persons/apartment
4 rooms and kitchen = 3 persons/apartment
5 rooms and kitchen = 3.5 persons/apartment
One-family houses and terrace houses less than 120 m^2 = 3 persons
One-family houses and terrace houses of more than 120 m^2 = 4 persons

Note that solar thermal systems are allowed to be placed anywhere of the property belonging to the building. Ii is allowed to use a distribution calculation if the property has several buildings that shares the same heating system. Domestic appliances with energy class A should be used. Use of domestic electricity should be limited in order to get a low energy use and to avoid over heating.

3.3 Requirements of the building

Air leakages through the building envelope shall be maximum 0,3 l/s m² at +/- 50 Pa, according to SS-EN 13829.

In order to be able to verify the buildings performance the energy use of operational energy and for heating shall be separately measured and entered each month. The used water volume for hot water shall be measured each month and the number of residents shall be entered.

The building shall have a window with an U-value of maximum 0.9 W/(m^2K), measured by accredited test laboratory according to SS-EN ISO 12567-1 for a representative window e.g. 12x12 m inclusive frame casement and glass. For additional sizes may calcaulations be made according to SS-EN ISO 10077-1. The buildings mean U-value for windows and glass partition shall be maximum 0.9 W/(m^2K).

3.4 Requirements of indoor environment

Sound from the ventilation system shall be at least sound class B in the bedroom according to SS 025267. The supply air temperature after the additional heating coil shall be maximum 52 ^oC.

4. Discussion

The definition was settled in 2007 and now needs to collect experiences from built passive houses in Sweden. The definition has requirements of supplied power for heating and recommendations of energy use. With more experiences from built and used passive houses in Sweden the recommendations of used energy should be sharpened with requirements. Further revisions might be needed in order include not only operational electricity connected to heating but also additional operational electricity. Also the definitions of designed outdoor winter temperature might to be improved.

5. Acknowledgement

The authors are grateful for financial support from the Swedish Energy Agency and Västra Götalandsregionen.

6. References

BBR, 2006, Building regulations of the National Board of Housing, Building and Planning, Boverkets byggregler, BFS BFS 1993:57 med ändringar till och med 2006:22.

Jonas Norrman, Martin Erlandsson, Eje Sandberg, Maria Wall, Hans Eek, Svein Ruud, Åsa Wahlström: “Kravspecifikation för passivhus i Sverige –Energieffektiva bostäder”, Energimyndighetens program för passivhus och lågenergihus, Version 2007:1, Forum För Energieffektiva Byggnader.