Active House Specification

– evaluation of comfort, energy and environment in buildings

The article outlines the specifications for designing an Active House, a building that combines energy efficiency with specific attention to user comfort, indoor climate and the environment. The scope of the specifications is residential buildings. The specification outlines the vision behind Active House, lays down the key principles that have influenced the evolution of the Active House concept and outlines the technical specifications of an Active House. This definition and description of an Active House is intended as a guideline at an international level, and can be used as a tool for designing nearly zero energy buildings. It seeks innovative technical approaches whilst introducing goals of architectural quality and environmental design – at the same time as providing energy efficiency.

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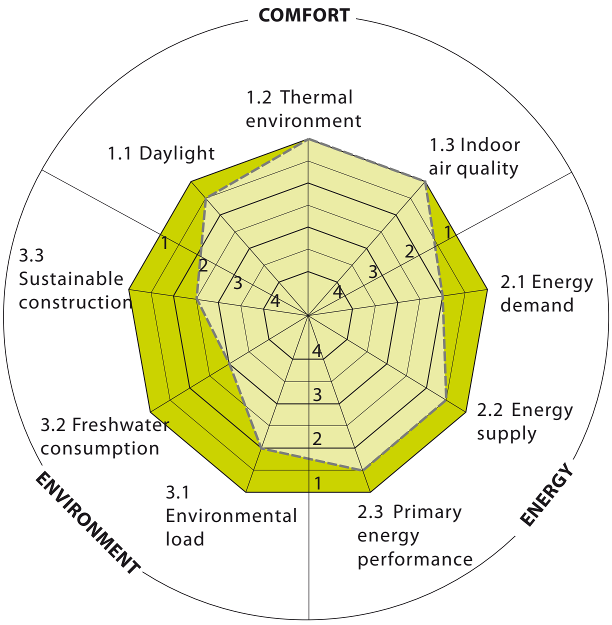

Figure 1 Active House Radar.

Active House Specifications

Members of the Active House Alliance and other experts have participated in the development of the Active House Specification. They have shared knowledge, experiences and feedback on their experience with development of energy efficient sustainable buildings, in order to develop this second edition. The new edition has been substantially improved, especially in terms of usability.

The specifications include the insight and knowledge needed to draw up the technical requirements and design concept for an Active House. The specifications include the important issues to consider when creating an Active House. These issues are often process oriented, some provide guidance on how to achieve the performance levels described in the technical specifications, and some describe the holistic approach of the design (biodiversity, local culture and location).

An Active House is finally evaluated on the integration the three main principles of Comfort, Energy and Environment. The performance can be described through the Active House Radar (**Figure 1**) showing the level of ambition of each of the three main Active House principles and their sub-parameters.

The integration of each parameter describes the level of ambition of how 'active' the building has become. For a building to be considered as an Active House, the level of ambition can be quantified into four levels where 1 is the highest level and 4 is the lowest. The ambitious requirement for Active House includes all nine parameters and recommends the best level for each of them. As long as the parameters are better than or equal to the lowest level of ambition, it is an Active House within the specific parameter.

Comfort

An Active House is a building that lets in an abundant amount of daylight and fresh air, thereby improving the quality of the indoor climate. Also the thermal indoor environment must be high quality.

As people spend 90% of their time indoors, the quality of the indoor climate has a considerable impact on their health and comfort. A good indoor climate is therefore a key quality of an Active House. Comfort must be an integrated part of the house design to ensure good daylight conditions, thermal environment and indoor air quality. To support this process, the parameters in the specifications must be considered.

Daylight

Adequate lighting and especially well-designed daylight penetration provide an array of health benefits to people in buildings. High levels of daylight and an optimal view out of the building positively influence people's mood and well-being. In an Active House it is thus important that the building allows for optimal daylight and attractive views to the outside.

Classification of daylight (classification is an average of the two requirements).

DAYLIGHT FACTOR: The amount of daylight in a room is evaluated through average daylight factor levels on a horizontal work plane:

1. DF > 5% on average
2. DF > 3% on average
3. DF > 2% on average
4. DF > 1% on average

Daylight factors are calculated using a Validated daylight simulation program.

DIRECT SUNLIGHT AVAILABILITY: For minimum one of the main habitable rooms, sunlight provision should be available between autumn and spring equinox:

1. At least 10% of probable sunlight hours
2. At least 7.5% of probable sunlight hours
3. At least 5% of probable sunlight hours
4. At least 2.5% of probable sunlight hours

The evaluation is made according to British Standard BS 8206-2:2008 "Lighting for buildings – Part 2: Code of practice for daylight".

Thermal environment

A pleasant thermal indoor environment is essential for a comfortable home. Adequate thermal comfort, both in summer and winter, enhaces the mood and increases the well-being. Active Houses should minimise overheating in summer and optimise indoor temperatures in winter without unnecessary energy use. Where possible, use simple, energy-efficient and easily maintained solutions.

Classification of thermal comfort (classification is an average of the two requirements).

THE MAXIMUM INDOOR TEMPERATURE limits apply in periods with an outside Trm of 12°C or more. For living rooms, kitchens, study rooms, bedrooms etc. in dwellings without mechanical air conditioning and with adequate opportunities for natural (cross or stack) ventilation, the maximum indoor operative temperatures are:

1. Ti,o < 0.33 x Trm + 20.8°C
2. Ti,o < 0.33 x Trm + 21.8°C
3. Ti,o < 0.33 x Trm + 22.8°C
4. Ti,o < 0.33 x Trm + 23.8°C

Trm is the Running Mean outdoor temperature as defined in Section 3.11 External temperature, running mean of EN 15251:2007'.

For living rooms etc. in residential buildings with air conditioning, the maximum operative temperatures are:

1. Ti,o < 25.5°C
2. Ti,o < 26°C
3. Ti,o < 27°C
4. Ti,o < 28°C

Reference: EN 15251:2007.

THE MINIMUM INDOOR TEMPERATURE limits apply in periods with an outside Trm of 12°C or less. For living rooms, kitchens, study rooms, bedrooms etc. in dwellings, the minimum operative temperatures are:

1. Ti,o > 21°C
2. Ti,o > 20°C
3. Ti,o > 19°C
4. Ti,o > 18°C

Indoor air quality

Active Houses should provide good air quality for the occupants while minimising energy use e.g. for ventilation. This means that natural ventilation should be used whenever possible, or hybrid systems (combination of natural and mechanical ventilation) as these systems provide the best energy performance. Active Houses should provide good indoor humidity levels for occupied spaces and set maximum requirements for indoor humidity. To avoid problems related to dampness and mould, it shall be guaranteed that there is sufficient exhaust ventilation in rooms with periodic high humidity loads (especially kitchens, bathrooms and toilets). The minimum exhaust air flow in these 'wet rooms' should be achievable as specified in national building codes or guidelines and the exhaust systems shall secure that the daily limit value for relative humidity in wet rooms such as bathrooms is below 80%.

Classification of indoor air quality

The fresh air supply shall be established according to the below limit values for indoor CO_2 concentration in living rooms, bedrooms, study rooms and other rooms with people as the dominant source and that are occupied for prolonged periods:

1. 500 ppm above outdoor CO_2 concentration
2. 750 ppm above outdoor CO_2 concentration
3. 1000 ppm above outdoor CO_2 concentration
4. 1200 ppm above outdoor CO_2 concentration

Energy

Globally, heating, cooling and electricity in buildings account for 40% of all energy consumption. Considering the total energy consumption throughout the whole lifecycle of a building, the energy performance and energy supply are important issues in the concern about climate changes, reliability of supply and reduced global energy consumption.

The design of an Active House has to be based on the Trias Energetica approach to sustainable design, focusing on the energy demand, integration of renewable energy and primary energy performance (**Figure 2**).

Energy demand

In an Active House the annual energy demand is minimized and the design phase must put focus on minimising the use of energy and heat loss from the building. This includes the transmission loss through constructions, thermal bridges etc. It is crucial to adopt a holistic approach to the use of energy. This means, for example, that an Active House should be optimised with maximum use of solutions that are not energy intensive. Such solutions could be solar gain, daylight, natural ventilation, ventilative cooling etc. This approach is also important in regards to the need for cooling of the building. Shading of exposed facades and windows shall be established either as permanent summer shading or dynamic shading, such as intelligent insulation of glazed facades.

Classification annual energy demand

An Active House is calculated by including all the energy demand for the building (including space and water heating, ventilation, air conditioning and cooling, technical installations and lighting).

1. ≤ 40 kWh/m²
2. ≤ 60 kWh/m²
3. ≤ 80 kWh/m²
4. ≤ 120 kWh/m²

The calculation methodology and definition of the heated floor area shall follow the national definition.

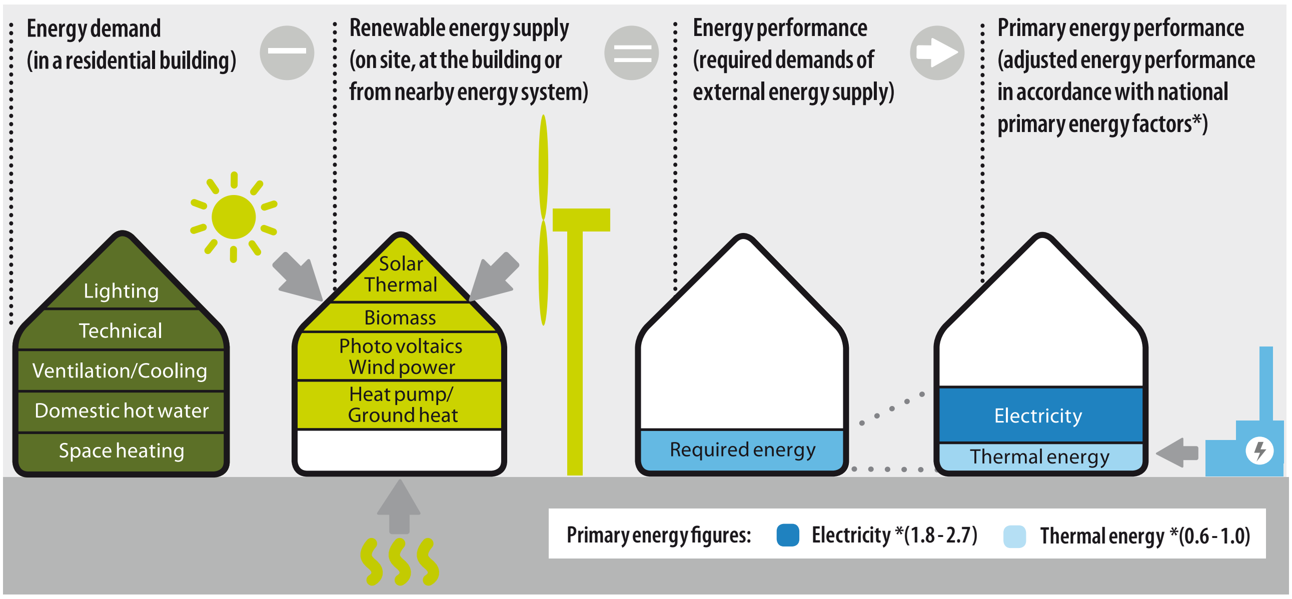

Figure 2. Energy principle for an Active House.

Energy supply

The goal is that the energy supply to an Active House shall be based on renewable and CO_2-neutral energy sources in accordance with the energy performance classification chosen. There are no specific requirements to where and how the renewable energy is produced. It can be on the building, the plot or the nearby system. It must, however, be documented that the energy comes from renewable energy in the energy system.

Classification of energy supply
The annual energy supply from renewable energy and CO_2-free energy sources shall be calculated and divided into the different sources (solar thermal, heat pumps, biomass, PV, wind etc). The energy produced on the building, on the plot or in a nearby system is:
1. 100% or more 2. ≥75% 3. ≥50% 4. ≥25%
The definition of renewable energy sources follows the EU Directive on the promotion of the use of energy from renewable sources (2009/28/EC of 23 April 2009).

Primary energy performance

The annual primary energy performance of an Active House shall be based on national figures on primary energy. The calculation shall include energy demand for the building as well as the energy supply from renewable energy.

Classification of annual primary energy performance
The primary energy performance is the "(energy used – renewable energy supply) multiplied with the national primary energy factors".
1. < 0 kWh/m² for the building 2. 0-15 kWh/m² for the building 3. 15-30 kWh/m² for the building 4. ≥ 30 kWh/ m² for the building
Calculation shall be based on the national calculation methodology and primary energy factors, as well as climate data.

Environment

Global environmental resources are under pressure from over-consumption and pollution. The pressure is felt at global, regional and a local level. When developing an Active House, it is important to ensure that such challenges are considered and that any harm to environment, soil, air and water are minimised

This is important in order to ensure a new generation of buildings and products that aim to have a positive impact on the environment. Consideration should be given in the design phase for how Active Houses use building materials and resources. It is also possible to consider the local building culture and behaviour in and around the local buildings as well as traditions, climate and ecology.

Environmental loads

The process of constructing a new building causes various emissions to air, soil and water, which have different impacts on the environment. When constructing an Active House and conducting a Life Cycle Assessment, it is important to know and consider the different impact categories of these emissions, which may have serious environmental effects. Active House sets requirement to evaluate 6 environmental loads, classified in the following table.

Classification of environmental loads (the classification is the average of all 6 criteria).
Building's primary energy consumption during entire life cycle 1. < -150 kWh/m² x a 2. < 15 kWh/m² x a 3. < 150 kWh/m² x a 4. < 200 kWh/m² x a
Global warming potential (GWP) during building's life cycle. 1. < -30 kg CO_2-eq./m² x a 2. < 10 kg CO_2-eq./m² x a 3. < 40 kg CO_2-eq./m² x a 4. < 50 kg CO_2-eq./m² x a
Ozone depletion potential (ODP) during building's life cycle. 1. < 2.25E-07 kg R_{11}-eq/m² x a 2. < 5.3E-07 kg R_{11}-eq/m² x a 3. < 3.7E-06 kg R_{11}-eq/m² x a 4. < 6.7E-06 kg R_{11}-eq/m² x a
Photochemical ozone creation potential (POCP) during building's life cycle. 1. < 0.0025 kg C_3H_4-eq./m² x a 2. < 0.0040 kg C_3H_4-eq./m² x a 3. < 0.0070 kg C_3H_4-eq./m² x a 4. < 0.0085 kg C_3H_4-eq./m² x a
Acidification potential (AP) during building's life cycle. 1. < 0.010 kg SO_2-eq./m² x a 2. < 0.075 kg SO_2-eq./m² x a 3. < 0.100 kg SO_2-eq./m² x a 4. < 0.125 kg SO_2-eq./m² x a
Eutrophication potential (EP) during building's life cycle. 1. < 0.0040 kg PO_4-eq./m² x a 2. < 0.0055 kg PO_4-eq./m² x a 3. < 0.0085 kg PO_4-eq./m² x a 4. < 0.0105 kg PO_4-eq./m² x a
When evaluating the above parameters the Life Cycle Assessment shall be made in accordance with the EN 15643 series on sustainable construction or with ISO 14040. In the above formular [a] is the number of years included in the estimated service life of the building.

Fresh water consumption

The depletion and scarcity of global freshwater resources are escalating and thus it is becoming increasingly important to consider water consumption – and treatment – during the life-time of a building. It is therefore also included in the Active House specifications. When freshwater is saved, it also results in wastewater savings as well. Freshwater consumption can be reduced by installation of water-saving faucets, use of grey or rain water for toilets and gardening, and the use of easy-to-clean surfaces.

Classification of fresh water consumption

MINIMISATION OF FRESHWATER CONSUMPTION DURING BUILDING'S USE:

Calculation is based on the national average water consumption per building per year

1. Improvement ≥ 50%
2. Improvement ≥ 30%
3. Improvement ≥ 20%
4. Improvement ≥ 10%

Percentages in the above is
"(National average – building consumption x 100) / National average"

Sustainable construction

When designing an Active House, it is important to assess the amount of recycled material and its sourcing. The recycled content in an Active House is evaluated by weight and the evaluation shall take into consideration 80% of the weight of the building. It includes pre-consumer, internal and post-consumer recycling. Responsible sourcing includes the requirement to use certified sourcing either directly, like PEFC and FSC for sourcing of wood, and a supplier certification EMS for other materials.

Classification of sustainable construction
(classification is an average of the two criteria).

RECYCLABLE CONTENT: By weight, the average of recycled content for all building materials (weighted by the proportion of the material in the building) should be:

1. ≥ 50%
2. ≥ 30%
3. ≥ 10%
4. ≥ 5%

80% of the weight of the building should be accounted for. (In the recycled content, we take into account internal, pre-consumer and postconsumer recycling).

RESPONSIBLE SOURCING: The requirement include the amount of wood certified as FSC or PEFC and the amount of other new materials supplier certified by EMS

1. 100% of the wood and 80% of the new material
2. 80% of the wood and 50% of the new material
3. 65% of the wood and 40% of the new material
4. 50% of the wood and 25% of the new material

Calculation tools

The specification can be downloaded for free from the active house homepage www.activehouse.info

The Active House alliance has developed a tool for calculation of the performance of an Active House and it is available for free for members of the alliance.

During CLIMA2013, the Active House Alliance will organize a workshop where the specification will be presented and discussed. The workshop is planned to be organized on Monday 17. June in meeting room 3. Participants at CLIMA2013 are welcomed for free. ■