Passive House Standard for India

What is the need for high energy efficiency for buildings?

As per the World Bank data, India is one of the largest greenhouse gas emitter in the world along with China, United States and European Union. As coal is still the major source of electricity in India as of 2020 as per IEA, the country needs to focus on energy transition to reduce its greenhouse gas emissions.

Domestic and commercial sector were responsible for 33% of the total electricity consumption in India in 2017-2018. India Cooling Action Plan (ICAP) mentions that with the increasing population purchasing power of people, it is now common to see air-conditioners installed in the buildings for better thermal comfort also in affordable housing. As the electricity demand is set to drastically increase, it becomes inevitable to focus on energy-efficiency of the buildings in order to counteract and mitigate rising energy consumption for cooling.

The Passive House (PH) standard is a design concept focussed on significantly reducing a building's need for cooling and heating. As the energy demand of the building is very low in a Passive House, it becomes easier to meet that demand locally using renewable energy resources. Low loads for heating and for cooling also means less stress on the electricity grids, thus, enabling a stable energy supply. When adopted on a large scale, Passive House can help to reduce the overall energy demand of the country and thus reduce overall GHG emissions.

What is a Passive House?

Passive House buildings allow for cooling-related energy savings of up to 80% and, for heating-related energy savings of up to 90%. The Passive House Standard offers a new level of quality pairing - a maximum level of comfort (20-25°C) and good indoor air quality both, during warm months and cold months while being cost-effective during their lifecycle.

Figure 1: Energy Plus Project Dubai / Wolf Haus / MBRSC Photo courtesy of Marco Filippi

There are built examples of Passive House buildings worldwide, with different typologies, shapes, materials, scales and functions. Whether it is an self sufficient house in Spain, an office in China, a refurbished garment factory in Sri Lanka or a high-rise student residency in New York city, you will find various inspiring examples on the Passive House Database.

What are the principles for high energy efficiency?

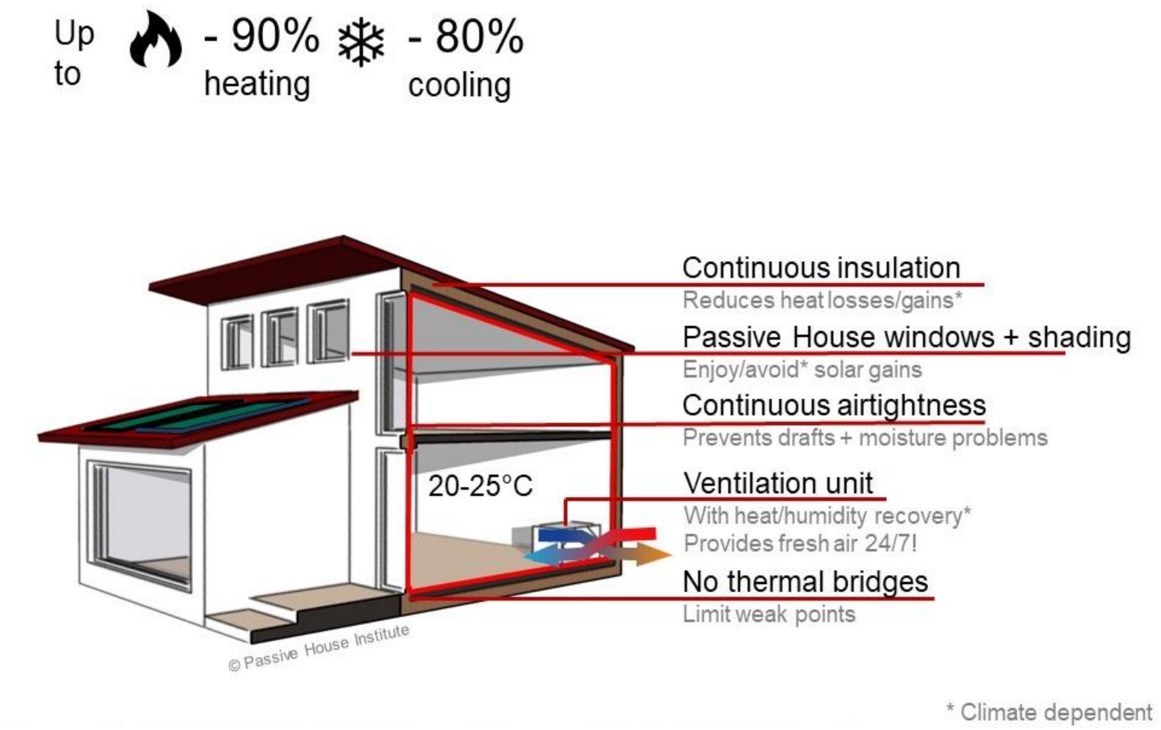

Figure 2: Passive House principles

Passive House (PH) standard revolves around 5 building physics principles for energy savings and to keep the building comfortable for its occupants all-round the year:

1. Continuous Insulation:
   A continuous layer of insulation slows down the heat transfer between two spaces with temperature difference, i.e., it will slow down the process of heat entering a cooled building when it is hot outside, and vice versa.

   There are many different types of insulation available in the market. Selection of the insulation mostly depends on its availability and the required characteristics like fire resistance, cost, compression resistance, moisture resistance, acoustic insulation, etc.

   The thickness of insulation needed to reach the high efficiency level of the Passive House standard depends on the climate and the compactness of the building. In hot climates cool colours on the roof can also be used in combination to reflect the solar radiation and reduce the solar heat load.

2. Thermal bridge-free design:

   Thermal bridges are the weak points in the thermal insulation of the building. Wherever the insulation is interrupted, heat flow becomes higher in that area leading to increased energy losses. In a conventional house, such weak points can be found at window, roof, slab and foundation connections, amongst others.

   Firstly, the designer should try to have a continuous layer of insulation and avoid any interruptions. If it is unavoidable, the material used for the penetration should have low thermal conductivity.

3. Passive House windows and shading:

   In the case of windows it is important to find the right balance of lighting, heat gains from solar radiation and heat transfer through the window itself, depending on the local climate. The heat transfer is driven mainly by the number of glass panes, the gas filling, specific coatings and insulated frames. Especially in hot climates, g-value of the glazing plays a major role in reducing the heat loads due to direct solar radiation. The lower the g-value, lesser is the direct solar radiation inside the building!

   Thermal bridges due to the glass edge are also considered at the time of selection of the windows, which can be limited by using plastic spacers instead of the usual aluminium spacer. It is also recommended to cover the frame with insulation to limit the installation thermal bridge.

   Shading is crucial in hot climates to limit the solar load. Exterior shading is more helpful than interior shading in regards to the solar load as in case of interior shading, the radiation has already entered the building. Fixed shading, movable shading or a combination has been used in various projects. Fixed shading has no human intervention whereas movable shading, when combined with a monitoring device can be used to optimize daylight and solar loads but is more expensive generally.

4. Continuous airtightness:

   Airtightness is required to prevent unwanted airflows and infiltration losses between the outside and inside of the building. The layer should be continuous and without any interruption. It is usually installed on the inside but in hot and humid climates, it can be more beneficial to install it outside to avoid any structural damages.

   To ensure the airtightness,

   1. Firstly, airtight surfaces are required
   2. then connections between those surfaces are to be sealed
   3. any penetrations due to e.g. cables or ventilation pipes are to be sealed

   In solid constructions, concrete is generally airtight, but masonry is not airtight by itself. An airtight and continuous inside cement or gypsum plaster can make the surface airtight. Once the airtightness layer is installed but still accessible, the airtightness must be checked using airtightness (blower door) test so that any leaks can be sealed.

5. Ventilation unit:

   Renewal of indoor air via ventilation is crucial for high air quality inside a building and thus for healthy conditions of the people inside. The current COVID-19 pandemic has highlighted the need for good ventilation as a health necessity.

   Relying solely on infiltration will not provide sufficient fresh air inside the building anyways so there are two options: natural ventilation (windows), mechanical ventilation or a combination of both. The selection of the ventilation approach depends mainly on the climate and on the air-quality outside. Practical experience has shown that relying solely on natural ventilation often does not lead to sufficient airflow needed for high indoor air quality (approx. 30 m^3/h per person).

   Mechanically controlled ventilation helps to ensure sufficient air supply. This can be an extract fan or a balanced supply/extract air handling unit. In more extreme climate conditions mechanical ventilation combined with a passive heat and/or humidity recovery core (climate dependent) pre-heats or pre-cools the air entering inside the building, which contributes to reducing the need for active heating and cooling. Considering the air-quality of most of the major cities in India, the possibility of filtering incoming air is an added health benefit of mechanical ventilation.

What energy standards are available for Passive House?

Passive House Institute (PHI) has developed energy standards depending upon the type of project:

- Passive House: High energy efficiency targets for new buildings
- EnerPHit: High efficiency targets for refurbishment projects
- Low Energy Building: Slightly less stringent efficiency targets for difficult cases.

For a fully sustainable energy supply structure both energy efficiency and renewable resources are essential. In order to encourage the uptake of renewables the Passive House standard as well as the EnerPHit standard are offered as three classes: Classic, Plus and Premium, which can be achieved depending on the use of renewable energy resources.

What are the criteria for PH standard?

Passive House standard has global performance goals which can be applied in all climate zones worldwide. They apply for residential buildings as well as for most non-residential building uses (e.g. office and educational buildings). Some of the main points are mentioned below (see building certification criteria):

- For Heating: globally fixed criteria, which can be met by either fulfilling the requirements for heating demand (15 kWh/(m²a) or load (10 W/m²).
- For cooling: the demand is a combination of sensible demand and latent demand which varies with the climate (15 kWh/(m²a) + dehumidification contribution). It is taken into account that in some climates, there is a long cooling period and an additional dehumidification demand.
- In case of buildings without active cooling it must be demonstrated that the frequency of overheating (temperatures above 25°C inside the building) is less than 10% hours per year.
- Airtightness: it is tested to determine the resistance of the building envelope against any leakages (n_{50}: 0.60 h-1)
- For primary energy: this limits the total energy demand of the building (including hot water, all equipment and appliances). The criteria varies depending on the class (classic, plus, premium).

Can Passive House be a net-zero energy building?

A renewable energy source is required to transform a building to a net-zero energy building. The higher the building's energy demand, the more renewable resources will be required to meet that demand. For many existing buildings in India, it is nearly impossible to meet the building demand completely by renewables – especially when also taking into account the energy storage that is needed to overcome supply gaps (which is often overlooked).

As an approach to net-zero, making the building more efficient first and then adding the renewables is known to be the most cost-efficient strategy. In a Passive House, the building energy demand is so low that it becomes much easier and feasible on a large scale to cover the rest of the demand.

PHI has introduced three classes to compliment the combination of renewable energy and energy-efficiency.

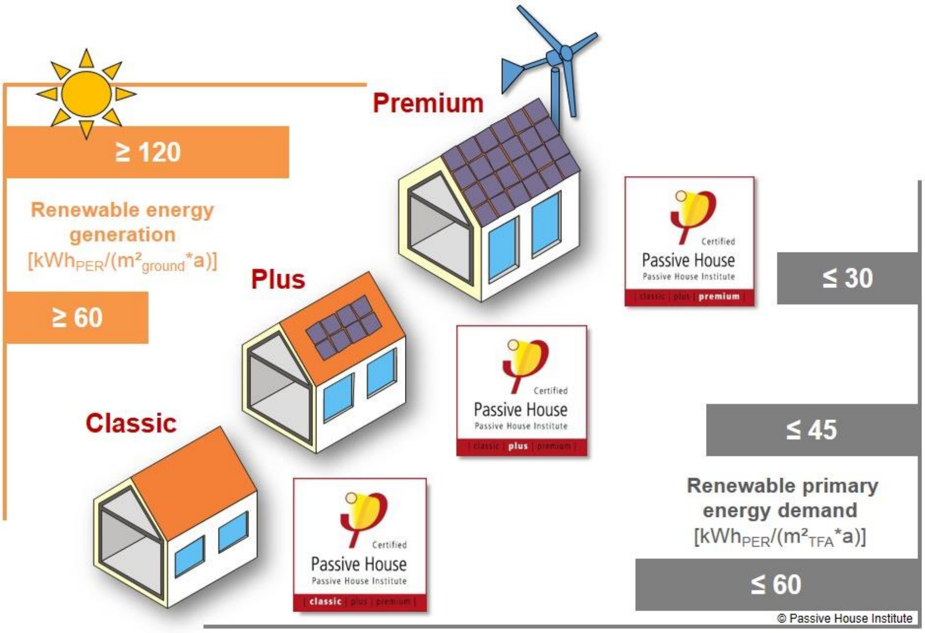

Figure 3: Passive House classes

Classic, Plus and Premium are the three classes which are dependent on the installed renewable energy source (related to the project footprint) and energy efficiency (related on the treated floor area).

The basic functionality of a Passive House remains unchanged in the three classes. Renewable primary energy (PER) is the unit of energy generated from renewable resources, e.g. electricity produced by a photovoltaic system / wind turbine or heat generated with a solar thermal system. PER-factors reflect the primary renewable resources needed to cover the final energy demand of a building, including distribution and storage losses. In the case of a PER-factor of 1.5, a surplus of 50% renewable primary energy is needed to be able to meet the final energy demand at the building. The higher the PER-factor, the higher the required resources and therefore the more important the implementation of efficiency measures in order to avoid compensation from non-renewable sources. Read more about PER here.

Crosswalks

In order to simplify certification processes and exploit synergies with additional sustainability aspects related to buildings, the Passive House Institute has partnered with institutions worldwide. Passive House energy performance requirements are recognised in other building standards, such as LEED certification, Green star certification, Homestar certification. The cross-walk with ILFI's net-zero building standard highlights how the high performance energy requirements of Passive House are a recommended pathway to reach net-zero.

What are the prerequisites for a successful Passive House Project?

- Technical Expertise: It is important to have an integrated and committed team of Passive House professionals at the early stage of a project. Most popular Passive House professional certifications include Passive House Designer/Consultant, Passive House Tradesperson, and Passive House Building Certifier etc.
- Appropriate design tools:

  - PHI has developed reliable design tools which can be used to easily calculate and optimize the building energy demand. Passive House Planning Package (PHPP), which is an Excel-based tool. PHPP has been and is continually being validated on the basis of monitoring data, dynamic simulations and new research findings.
  - DesignPH Plugin is available to provide a 3D model interface for entering building geometry into PHPP. The benefits of the tool are two-fold; firstly it will further simplify the process of entering data into PHPP and secondly, it will provide preliminary feedback on the performance of the design within SketchUp.
  - Bim2PH is a BIM Tool which aims to allow data entry in 3D BIM software and transfer information for the energy balance calculation and efficiency design into the Passive House Planning Package (PHPP). Based on the IFC format as data interchange format, a platform independent interface concept has been developed.
- Efficient components: PHI cooperates with the partners to develop the local market for better availability and cost of efficient components. This also compliments the “Aatma Nirbhar Bharat Abhiyan”. PHI also certifies the efficient components so that the stakeholders do not need to go through the verification of components for each project. Thanks to the Energy Conservation Building Code & Bureau of Energy Efficiency, India, the building energy efficiency market in India is growing rapidly but, there is still a lack of energy-efficient components in India. Once the components are manufactured locally, additional investment costs will progressively drop as it has already been witnessed in Europe and North America.

What is the current Situation of Passive House in India?

Passive House Institute (PHI) has been working to raise awareness about the PH concept in India through presentations at conferences and webinars.

In collaboration with GIZ India, Ashok B Lal Architects, LEAD Consultants and KPMG India, energy-efficient replicable designs for residential buildings are being developed in different climates of India, including selected prototypes to comply with the Passive House standard.

As an industry partner for Solar Decathlon India 2020, PHI is aiming to inspire the young minds for a sustainable future.

A research study for AluPlast India is available about savings by PVC windows compared to the single glazed aluminium windows in the climate of New Delhi, India. Dynamic building simulation for a reference Passive House and hygrothermal analysis of building components have been published for the location of Mumbai as part of the study “Passive Houses in tropical climates”.

PHI is continuously looking for local partners to pilot a Passive House project in India.

See also:

Passive House in Sri Lanka

Passive House in Dubai

Crosswalks with other energy standards

Tips and tricks for Passive House residents

Passipedia – An online knowledge resource tool

[Passive House Component Database]

[International Passive House Association]

[E-Learning Platform]

[Professional Training and Certifications]