Passive House to Improve the Environment

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Abstract

Buildings consume large amount of energy in order to achieve user's thermal comfort because building design doesn't take enough into account to the considerations of energy-saving, especially with regard to geometrical shape and orientation. The Passive House was originally developed in Germany and offers a realistic option for cost-efficient building that provides a high level of living comfort using very little energy for heating and cooling. It is necessary protect the environment and the best way is reducing the unnecessary consumption without decrease the quality of life. This makes the Passive House an attractive option. This paper evaluates the different elements of Passive House to reduce the energy consumption to protect the environment.

Keywords: Environment, Insulation, Orientation, Passive House

1. INTRODUCTION

The residential complexes take different patterns and their streets take different orientations without paying attention to the climatic factors, especially to the solar radiation. These situations would increase the energy consumption for heating and cooling in buildings affecting comfort and efficiency.
The solution is called Passive House that combines high-level comfort with very low energy consumption. They take into account elements as thermal windows, insulation, orientation or shape to keep the comfort of the user with the less consumption possible.

This kind of buildings is no different from conventional buildings, but the main difference is that uses less energy for heating. As can see on the image below German passive houses need no more than 15 kWh per year to heat a square meter. This means a saving of more than 75 % in relation to the average consumption in existing building. So each Passive House is an active contribution to climate protection.

	Heating demand		**Cooling Demand**	
	Standard [kWh/m2 yr]	***Passivhaus*** [kWh/m2 yr]	**Standard** [kWh/m2 yr]	***Passivhaus*** [kWh/m2 yr]
Germany	90	15	0	0
Italy	111	10.5	4.63	3
France	69.6	17.4	n/a	5
Spain	59	8.7	23.1	7.9
Portugal	73.5	5.8	32	3.7
UK	59	15	0	0

Fig. 1. Heating and cooling energy demand [1]

To explain with sufficient detail the main needs to be a Passive House, the information of this paper has been divided into separate points.

2. ORIENTATION

How the buildings are situated and how they are oriented provide important opportunities to reduce overall environmental impacts—including both direct and indirect impacts relating to energy consumption by the building[2].

Solar energy is friend and a foe of low-energy building design. The next figure illustrates the amount of daily solar energy availability relative to orientation for each month of the year at 40° latitude.

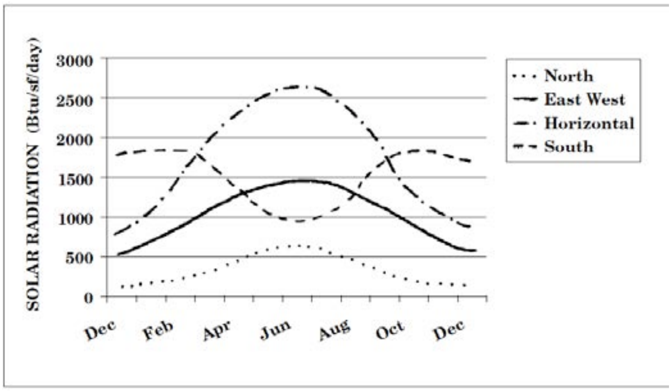

Fig. 3. Solar Radiation [3]

As can be seen on the image above, south-facing walls achieve a higher solar gain in the winter than in the summer. East and west vertical orientations and horizontal orientation (skylights), all result in more heat in the summer than winter. The optimal orientation depends of the application. Some examples of applications depending of the orientation of the house are:

- South-facing glass: Is recommended when we trying to use solar energy during the winter for passive solar heating. This kind of orientation is relative easy to shade with an overhang or awning during the summer to minimize solar heat gain.

- North-facing glass: This kind of buildings receives good daylight but relatively little direct insolation, so heat gain is less of a concern.

- East- and west-facing glazing: Is the most difficult to control (because of low sun angles) and the greatest contributors to unwanted heat gain.

Daylighting can be achieved with almost any orientation, but control of natural light is critical and will depend on the glazing area, the types of glazing used, daylighting design strategies, and other key issues.

3. SHAPES

The building's shape, spacing and configuration in its neighborhood affect both the solar and wind factors. They play a large role in determining the amount of solar radiation received by the building's surface and the airflow around it [4].

Furthermore, the building form can affect the thermal performance as it determines the size and the orientation of the exterior envelope exposed to the outdoor environment. Also, cost and aesthetics are affected by the building form. Selecting the optimum shape, orientation, and envelope configuration could reduce the energy consumption by about 40%. [5].

The following figure shows the energy consumption for different shape of buildings on heating and cooling:

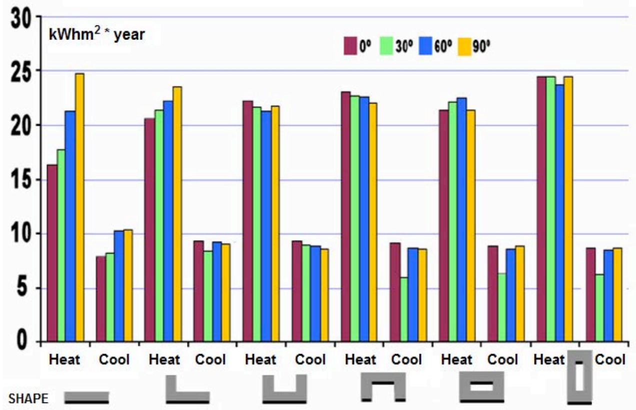

Fig. 2. Energy requirements in buildings by shape and orientation (similar envelope configuration, South top glazing) [6]

Consequently, the building's shape plays a large role in determining the amount of solar radiation received by the building’s surface and the airflow around it.

4. INSULATION

A key feature of a passive house is that they incorporate very high standards of insulation. This reduces the amount of heat lost through the building fabric.

The heat loss through an external wall, a floor to the basement or a slab on ground, a ceiling or a roof is characterized by the thermal heat loss coefficient or U-value. This value shows how much heat (in Watts) is lost per m^2 at a standard temperature difference of 1 degree Kelvin. The international unit of the U-value therefore is “$W/(m^2K)$”. To calculate the heat loss of a wall you multiply the U-value by the external wall area and the temperature difference.

The following chart presents the typical heat losses for different external walls based on a typical European single family house with an external wall area of 100 m². Winter temperatures of -12 °C outside and 21 °C at the inside are used as they are typical of Central Europe [7].

U-value (W/m^2K)	**heat loss load (W)**	**annual heat loss $kWh/(m^2a)$**
1	3300	78
0,8	2640	62
0,6	1980	47
0,4	1320	31
0,2	660	16
0,15	495	12
0,1	330	8

Table. 1. Typical heat losses for different external walls

5. WINDOWS

High-quality windows are essential components for Passive House. The stringent thermal protection requirement for the fitted window is determined by the demands for thermal comfort in living spaces. The window frame plays a particularly important role, because for typical windows sizes, the frame accounts for between 30 and 40 % of the total window area.

Heat losses from conventional window frame (U-value 1.5-2 W/m^2*K) are twice as great as the heat losses through an insulated frame with a U-value of 0.8 W/m^2*K.

Fig. 1 Difference on thermal comfort between standard house and passive house

Passive House Institute.

6. SHADING DEVICE

Shading is an essential parameter in all climates especially in Mediterranean climates to avoid overheating at midday on sunny days. The critical period for the Mediterranean summer season is the afternoon when the sun is still hot, yet low in the sky.

Shading must be provided to the west walls by trees, evergreen vegetation, trellises or overhanging roofs. It is advisable integrate the shading with insulation on west walls. Exterior shading devices should be provided on west windows with some air flow between the glass and the protection device, in order to maximize the benefit from internal shading systems.
The shadowed portion of the glazed area should be as large as possible in summer and as low as possible in winter.

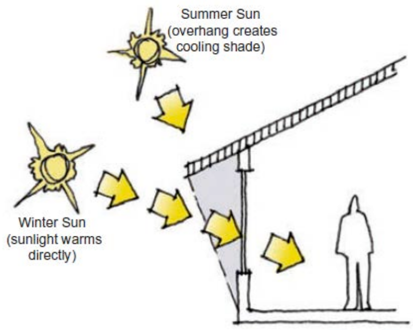

Fig. 4. Overhang [8]

7. LANDSCAPING

For the proximity of trees to buildings should take into account the growth rate, life span, and ultimate canopy shape. Planting's decision about trees requires a careful balance between the desirable qualities of shade with the loss of future solar access.

The evergreen trees may provide shade and block cold winter winds, but on the south side deciduous trees are preferred because they lose their leaves and admit more sun in winter. When existing tree plantings are too dense, selective thinning and lifting the canopy may improve air movement, enhance ground-level vistas, and allow remaining trees better growth potential. Special care should be used in construction near trees.

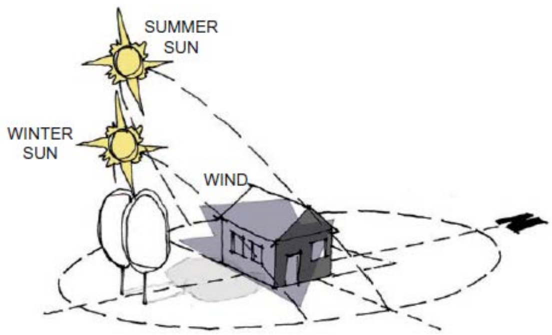

Fig. 2 -Landscaping [8]

8. INTERIOR LAYOUTS

A good interior layout will facilitate many of the passive strategies recommended in this paper. Following is shown the ideal location for the different rooms of the houses.

- Kitchens should ideally be located within the building in such a way as to avoid over-heating, either the kitchen itself or the rest of the building. One way to ensure this is to avoid placing kitchens on the western elevation. In most instances, this will cause overheating in the warm summer months, so an ideal location for a kitchen is on the eastern side of the building. This catches the morning sun but not the warmer, late afternoon sun.

- Rooms that are occupied predominantly in the evening should be located on the western side of the building, in order to take advantage of the evening sun.

- Frequently used rooms, should be located on the southern side where they can be warmed but sunlight throughout the day.

- Bedrooms generally require less heat. Decisions for the location of bedrooms can largely be based on aesthetics and occupant or designer preferences in addition to thermal comfort considerations.

The following image shows an example of good interior layout:

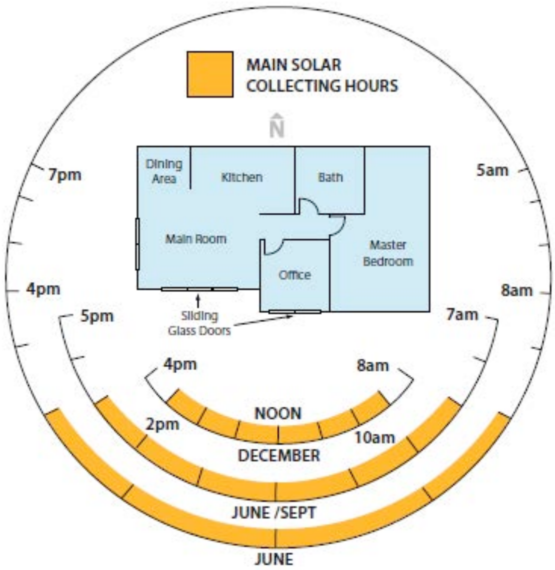

Fig. 5. Interior layout [8]

9. CONCLUSIONS

All elements of a building affect consumption, this paper has highlighted some advice order to influence designers to reduce energy consumption.

The following picture shows the main ideas of this study and how all the elements are related to energy consumption where the axes represent the compactness percent glass and the z axis represents the demand total energy for the three services: lighting, heating and cooling

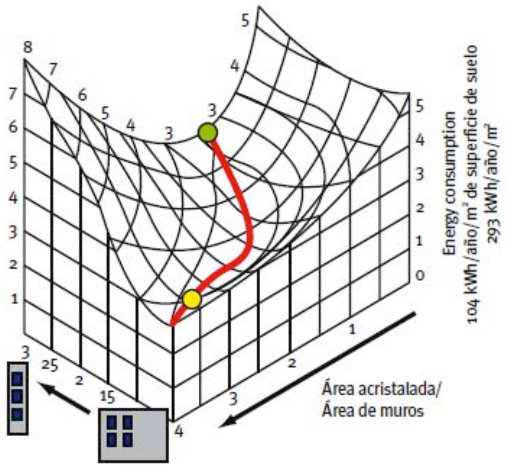

Fig 6. Energy consumption [9]

Anyway we think that it is necessary to introduce a new standard to improve the engagement of the builders with propose to reduce the effect in the environment.

10. References

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