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MANAGING ENERGY CONSUMPTION FOR A RENEWABLE TRIPLEX SYSTEM NECESSARY FOR A PASSIVE HABITAT

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ABSTRACT

Unprecedented development of industrial and domestic consumption of energy requires finding and putting into practice new sources of energy, such as: geothermal energy, wind energy, tidal energy, etc. If the house has an ecological and passive character that does not eliminate the noxes, the costs for achieving this increase with 28% over the costs of environmental house. Pollutants can be generated by the heating homes, producing electricity and the greening of wastewater and sewage.

Passive houses have high levels of insulation, passive heating and ventilation systems, photovoltaic panels (which generate electricity from the sun) and as much as possible natural light. These homes provide energy for heat and electricity from a plant that may use mixed wood waste. The houses are connected to national power network to prevent its own electric power fluctuations. A passive house preserves its energy very well, having a low thermal variation inside and an ecological house is environmentally friendly and noninvasive.

Keywords: renewable energy, ecological habitat, passive house

1. INTRODUCTION

Protection of the environment and sustainable development are two of high current affairs of the society. Technological development related to a new quality of life people is most in favor of protecting the environment and sustainable development.

It is also necessary to develop new energy technologies that relate unusual technical solutions for conversion, storage, transport and energy recovery.

From the economic point of view, even if the implementation of renewable energy and environmentally friendly sources [1] seems expensive at first sight, these types of alternative energy will prove durability and efficiency; the costs are being lowering in no more than 5-8 years.

Passive house, by its design, has the possibility to optimize energy consumption up to the level at which environment will not be infested with toxic fumes. Modern eco-homes are most often true works of art because of highlights of materials, textures, solutions chosen for covering and finishing techniques combined with modern construction materials and traditional techniques. The used construction materials are natural material thickness (materials which are not processed in factories and refineries) or simply processed in the workshops: wood, stone, earth, lime, sand, marble and glass, combined in the most spectacular ways.

Category of environmentally-friendly materials successfully applied in the process of building residential spaces may argue for natural stone used in the floor house for obtaining a thermal comfort. In this way, a rock of black bazalt or other dark color, as polished floor and built-in in a living, charges during the day with calorific energy and releases the stored heat at night.

For the construction of a house, systems for managing the energy may be used, such as solar panels and passive systems, capable of securing the heating requirements for the entire construction, while minimizing the fuel consumption.

Figure 1 shows the circulation of fresh air and viciated air in a passive house, provided with solar panels and heating with heat pumps.

Another technology, which may be possible to reduce long-term consumption, consists of the receptor system, storage and use of rain water in continuous mode in the household.

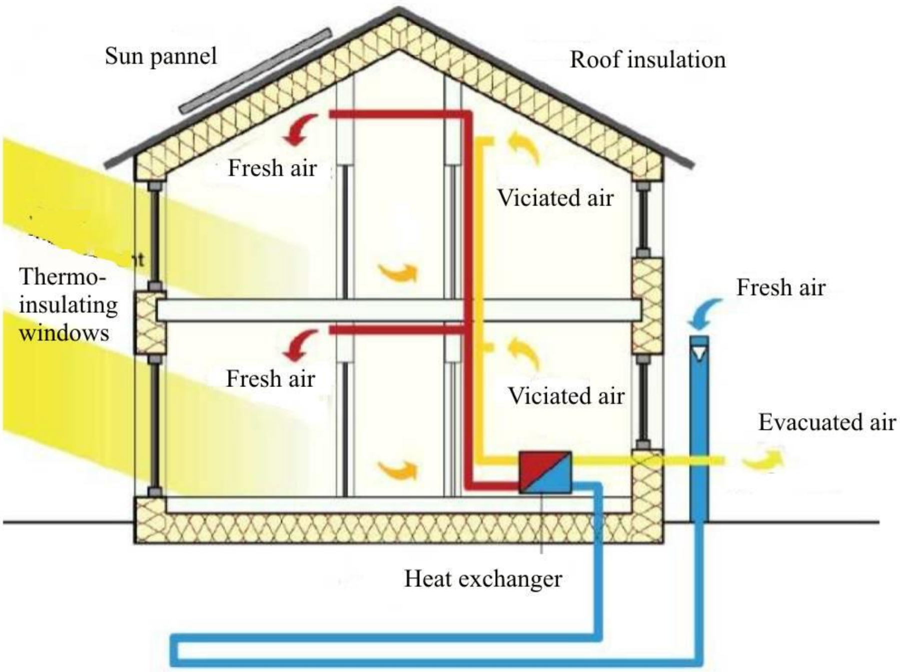


Fig. 1. Section throw a passive house [4]

There is a project, which provides for collecting pluviale water in a large middle tank within the house and the use of that pendulum heat shield in conjunction with a system of heat pumps, an ecological system, which involves reaching a layer of groundwater.

You can also remember Luxmate lighting system, which, by means of light sensors, determines the degree of lighting related to areas intended for offices, depending on the level of sunshine sensor, allowing for reducing your power consumption by artificial light, in buildings.

2. CALCULUS OF SPECIFIC CONSUMPTION FOR A PASSIVE HOUSE

2.1 COLD WATER CONSUMPTION

Passive houses are built to ensure a comfortable indoor climate in any season, without resorting to conventional heat sources. This type of housing reduces maintenance costs by up to 80% as compared to a house built in the usual way.

Building maintenance produces fewer greenhouse gases and, thus, it is environmentally friendly. In Europe, there are thousands of such buildings, especially in Austria and Germany. In Romania, there are only a few pilot projects of ecological houses made of earth, and the structure of resistance from fireproof wooden pillars.

Building energy consumption for heating must not exceed 15 kWh/m² per year, as compared to the energy requirements of 250-400 kWh/m² per year, for an average building.

Figure 2 presents a triplex system used for saving energy that has three components, such as: a wind system for producing electrical energy, solar panels for heating domestic hot water and a system for heating the passive house inside, with a heat pump.

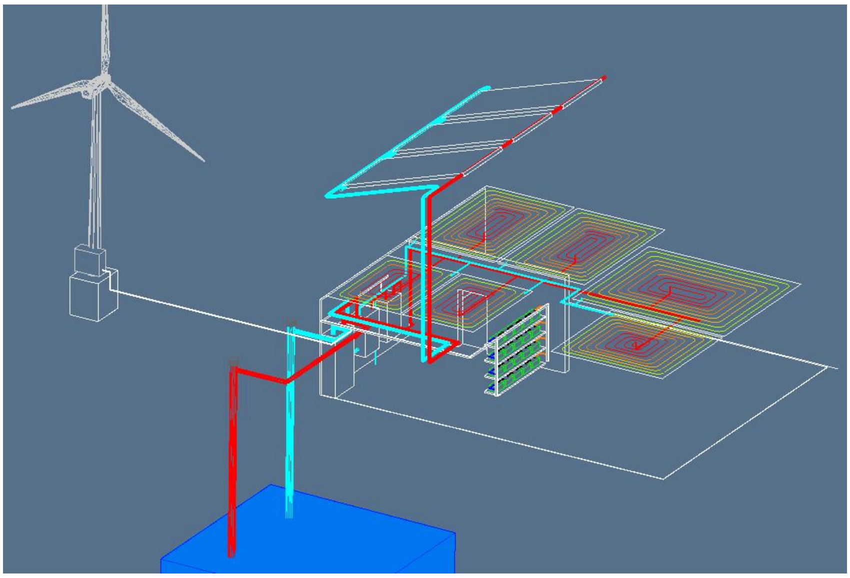


Fig. 2. Renewable triplex system for a passive house

Passive construction must have a solution of southern cover; it must have adequate inclination mounting solar panels and windows must be large and pointed also to the south. House must be equipped with three rows of glass included the windows. These windows are sized depending on the size and orientation of the building. Thus, they contribute up to 60% of the southern facade and 15% in the north. Triple windows with a heat exchanger wall will be oriented to the south, thus, the energy will be recovered at a rate of maximum 90 %.

2. PASSIVE HOUSE CONSUMPTIONS

The daily estimated water consumption for a person is about 50 l/day, at a temperature of 45^0 C. For everyday consumption of water, the calculus has been taken into account the provisions Romanian standards, with average values and maximum daily flow, estimated as follows [2]:

Average daily consumption (m^3/day):

$(Q_{av}) = (q_s \ x\ N)/10^3$

$(Q_{av}) = (4\ x\ 50)/10^3 = 0.2\ m^3/day$

Maximum daily consumption (Q_{max})

$Q_{max} = K_{day} \times Q_{av} = 1.2 \times 0.2 = 0.24\ m^3/day$

$K_{day} = 1.2$ (Roughness coefficient of daily consumption)

Maximum horary consumption ($Q_{horary\ maximum}$)

$Q_{horary\ maximum} = (1/24) \times K_0 \times Q_{max} = (1/24) \times 2.8 \times 0.24 = 0.028\ m^3/h$,

where $K_0 = 2.8$ (Roughness coefficient horary consumption).

2.1. THE CALCULATION OF THE HEAT REQUIREMENT FOR HEATING DOMESTIC HOT WATER

In order to size your installation, you will need to know the heat-flow the water will need to absorb to warm up. For this, we consider cold water temperature of $t_r = 15\ °C$. Domestic hot water will have a temperature of $t_c = 45\ °C$.

The installation will need to raise the temperature water with $\Delta T = 45 - 15 = 30 °C$.

To do this, you will need an amount of heat equal to [2]:

$$Q = m \times c_p \times \Delta T \tag{2.1}$$

where: m – the water mass that must heating daily, c_p – the specific heat of water at an average temperature $\frac{t_r + t_c}{2} = \frac{15+45}{2} = 30$ °C, that is $4180\ J/(kg \cdot grad)$.

Water mass flow is calculate with formulas (2.2), where the water density is $\rho = 1000\ kg/m^2$, at 30°C temperature. The volumic flow is 0.11 m^3/h or 0.00003 m^3/s.

$$m = \rho \cdot V \Rightarrow m = 1000 \cdot 0.00003 = 0.3 \frac{kg}{s}. \tag{2.2}$$

The amount of heat is:

$$Q_1 = 0.3 \cdot 4180 \cdot 30 = 37.62 \approx 38kJ \tag{2.3}$$

This heat is sufficient for warming up all the water that will be consumed in a day.

2.2. THE CALCULATION OF THE HEAT REQUIREMENT FOR HEATING IN THE FLOOR

Correct dimensioning of a heating system by floor must be respected:

- agent temperature heat shield on tour: 35-50 °C, depending on the outside temperature;

- interior temperature t_i: 20 °C - areas of accommodation, 24 °C - bath / shower.

- temperature at floor level t_{pmax}:

- living area: 29 °C - zone;

Perimeter: 35 °C ; bath / shower: 33 °C; specifical termal emission q_{max} [W/m^2]:

- living area 100 W/m^2;

- area perimeter 175 W/m^2;

- bath / shower 150 W/m^2; depending on specific thermal emission is calculated the demand for heat.

Taking into account the demand for heat dependent on the thermal insulation, the total heat demand is 44 kW.

The heat pump is rated for heating from 7.9 KW to 23 kW and in two steps, with outputs from 15.8 up to 46.0 kW. The type of pump is a water-water one as the heat source water is groundwater. The coefficient of performance of up to 4.9 ensures lower operating costs.

Solar energy entering through windows is stored inside the building due to battery materials, with strong inertia, used in building walls.

Thermal insulation is the key concept of the passive house. This should be applied to all tire performance and exterior of the building. The walls are insulated with either polystyrene or polyurethane foam or glass wool.

Insulator layer should measure 20 cm in the house, while the walls must be at least 30 cm. The floor and attic to be used polystyrene 40 cm.

Passive houses are heated through the floor. This is one of its peculiarities. In essence, the house is a thermal battery that absorbs heat during the day and releases the heat the inside, at night.

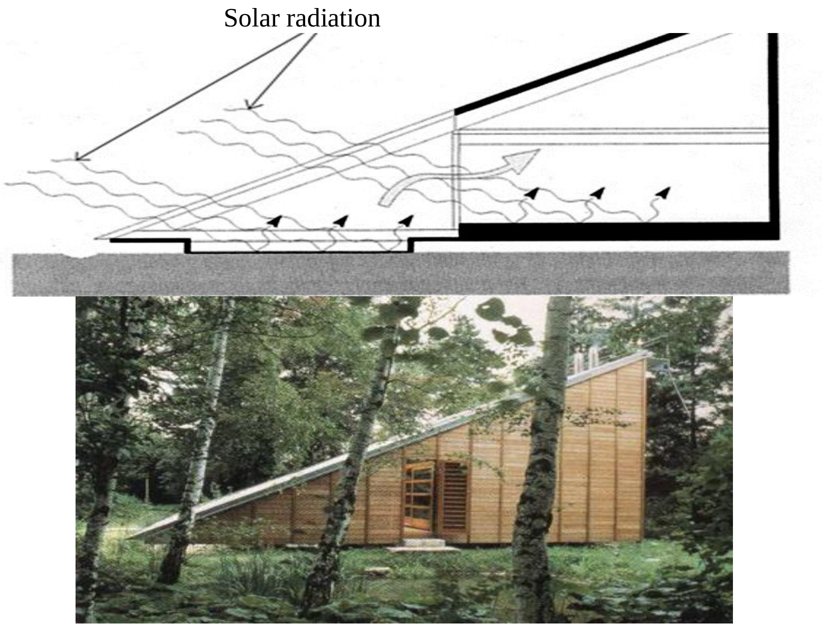


Fig. 3. Passive house at Regensburg (Thomas Herzog) [3].

Another feature is the concept of passive house building. This, also, contributes to heat exchange with the outside limit. Thus, the home maintains its temperature at a value of at least 16 °C to 18 °C, during winter. To avoid overheating the house in hot periods, it must be fitted with sunscreen, such as vegetable or blanket blinds. Moreover, if temperatures are extreme, indoor climate is adjusted with modern air conditioning systems, active or passive, such as heat pump or solar panels. However, it is important a good control of its functioning, as well as the air movement to and from greenhouse gases, because it could turn into an item with large heat loss during the night or in winter, or with a factor of overheating during the summer period.

By choosing the type of solar panel with a gross area of 2.15 m^2 and a net area of 2 m^2, the number of panels will result 4.68/2 =3, for this installation. To ensure the domestic electricity demand, a heat pump 1.25-3.7 kWh is necessary, and this is possible with the help of a wind generator of 5 kW.

5. WIND GENERATOR

It was chosen the generator Aeolian Airforce 4.1 5kW (Wind Energy Technology C. Ltd.); this model has an automatic adjustment of blade angles and a design of the blades to obtain maximum efficiency, has a compact size and lightweight [3].

The turbine has a wide range of useability of the wind speed, for starting, it needs a wind speed of 1.8 m/s, generates electrical energy from wind speed of 3 m/s and a low-noise of 50-60 dB, as well as the noise produced by a means of air conditioning.

Airforce 4.1 has the propeller diameter of 4.09 m. This means that the wind capture surface is of 13.14 m^2. To ensure a time range of 12 hours during the periods in which wind speed is not sufficient to supply electrical power to the heat pump, there are necessary 12 batteries that will provide a power of 2.1 kW/h.

The total power requirement is 2.1 x 12 = 25.2 kW.

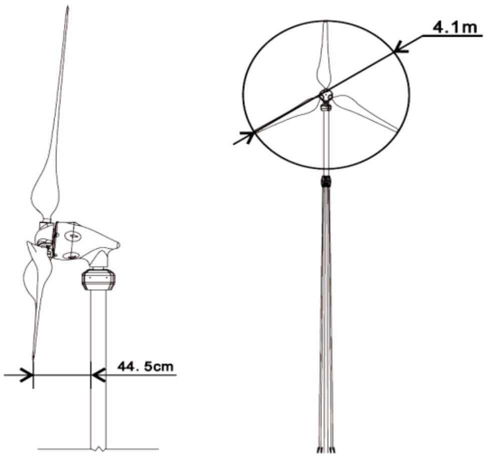
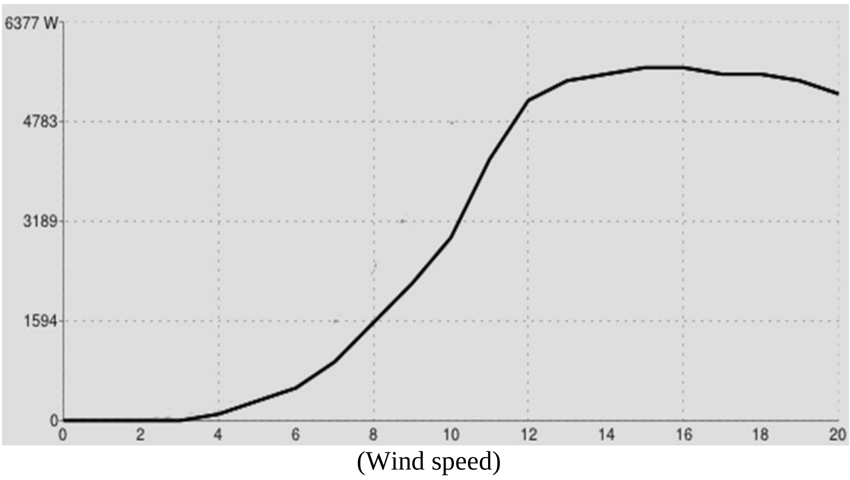


Fig. 4. Wind system Airforce 4.1 (source: www.encomgroup.com, 2012)[3]

The accumulators power will be used (Lithium ion battery), with a voltage of 24 V, a current with an intensity of 50 A and a power of 1.28 kWh, with 5 batteries in series of 4 rows in parallel.



(Wind speed)

Fig. 5. The amount of electrical power generated by Airforce 4.1 at different wind speed (source: www.bettergeneration.co.uk, 2012)[3]

6. USED CONSTRUCTION MATERIALS

The insulating panels are not expensive, using a binder cement and they have been delivered in the shape of plates, with a single layer or two layers.

Ecofibre finished plates are made of wood fibers and natural resins. Finished plates of ecofibre - plates of wood fibers for finishing the inside of the walls and ceilings for finishing the walls and give a good thermal insulation - the coefficient of heat transfer being 0,049 W/MK, as compared to mineral wool [4].

Light materials with their own - lytrosphers are objects created from microbeads autoiluminate, what light for 12 years. Self-lighthing materials do not require a source of energy, such as the sun or the electric current and can be added in the wall and floor paint [4]. These costs are lower and the intensity of the light is comparable to that of an incandescent bulb 20 W.

Maplex material is a derivative of wood, made from 100% cellulose, a compound malleable in continuous mode, also metal and can be very easy to cut, perforated, printed. These materials are manufactured under conditions which do not harm environment, ~~is~~ are fully biodegradable and has an area similar to that of a textile material which gives it an extremely pleasant appearance.

7. CONCLUSIONS

Passive houses have become more and more interesting, not because they are more cute, but because of energy-saving. The main characteristics of an eco-friendly dwelling are:

• bio-climate architecture that saves energy and shall be entitled to the maximum solar input;

• non-polluting and recyclable materials, for example: lime, wood, vaiuga, bricks insulating, hemp, foaming vegetable reagents, as well as cellulose, flax, cork, paints without chemical solvents.

These houses are based on two features of construction: the "green roof" and the "sandwich" walls. The "green roof" system is, as shown by the name, a roof with vegetation consisting of several layers, from the base to the outside: a hydroinsulating layer, covered by a layer for drainage, covered by a layer of earth plant and, in the end, the last layer, the vegetation itself. Roof retains water and has a high capacity of the water drain, both vertically and horizontally.

It is really important to understand the passive performance of systems by studying the physical elements of the building. The front panel geometry influences the air stream and, therefore, the temperatures at different heights of the space. Glazed surfaces and different shading devices give different physical properties. Interior and exterior elements may influence the type of air stream and its temperature in the space.

All these parameters determine the usefulness of double tapping or the front panel, a strategy which is required to be followed in order to achieve an environmental improvement and a reduction of used energy. Individual design and integrated design are the keys to high performance.

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