Smart Home in Passive and Active Ways

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Abstract

In the present paper, we summarize the realization of smart home in the passive and the active ways. Primarily, there is a route through solar energy utilization and the heat storage-heat equalization to the energy efficiency. In case of passive modes, we show the systems based on the high heat-capacitance and the phase transition. In case of active modes, we demonstrate the building integrated solar collector and the solar cell systems.

1 Introduction

Our global environmental problems traced back to energetic reasons in significant part [1]. The building industry and the building management are particularly large energy-consumer. Instead of fossil fuels using, as well as beside decrease of those using, the use of the renewable energy could improve more on the condition of our environment. Among these alternative energy sources, the solar energy is the most important energy source. The use of the solar energy is possible to use in multiple ways [1]. We reach energy efficiency by heat equalization also, which we accomplish by heat-storage structures. This solution is typically passive. The use of solar energy has active and passive way. In the present paper, we show these solutions.

2 Energy Efficiency in Passive Way

2.1 Heating-Storage-based Systems

The efficient method of passive heating is based on the green-house effect [1]. In this case, we solve the heating by the adequate shaping of the building and the using of special glazing [1]. If we wish to transport the warm air to inside of the building, the we could combine the green-house effect with air-collector [1]. The passive cooling already is not such clearly trivial. In this case, it is expedient to store the amount of the heat of the cooler term.

The earth house is the typical representative of the large heat-capacity systems. The construction to the soil or from the soil is the most acient building form of the mankind. There are three kinds of the earth architecture [2]. In the first case, we deepen space,

which is suitable for the stay, to the stable soil. Today, this solution is outdated and preferably specific for the historical periods. In the second case, we make a stable structure (e.g. wall) made from soil. The third one, where we make soil cover on support structure. The technologies matured during the centuries are preferred also by the ecological architecture [1]. In the vernacular architecture, there are many methods for the preparation of earth-wall construction [1,2]. Usually, these wall thickness are more than 50 cm. The earth-walling is excellent seasonal heat-equalizer [2]. Construction from soil has many advantages. One of them concerns to the energy balance of the building. The living space of the earth-house is warm in winter time and cool in the summer time. We can save energy because of heat-equalization. Other benefits are the cheap, local building material.

From architectural point of view, we distinguish thin and thick cover from earth. The thin earth-cover is thinner than half meter, while the thick cover exceeds the one meter earth thickness. The roof covered by plants is not a new invention. Especially, we can find examples in the folk architecture of North-Europe. The roof with plants is called as green-roof. The thin landcover more strongly exposed to the vicissitudes of the weather. This kind of green-roofs dry up easy, or soak through quickly. The most important element of the layer order is the device, which serves for the water retention and for the drain of the unnecessary water. There are further advantage of the green roofs, such as dust catching, water revulsive, humidification etc. [2]. The layer order of the thick earth-covering is fundamentally different from the thinner one. The thick cover does not require the insertion of the water retention and water revulsive structures, so its construction is simplier. Trees and shrubs can planted into the thick soil layer. Its heat equalization effect is large. However, in this case, it is necessary to calculate with the large weight of the soil layer [2].

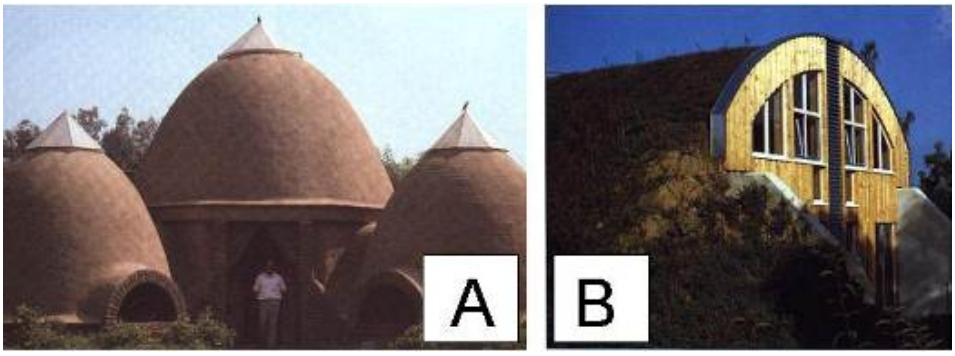

Fig. 1. Earth houses (A) House from earth (B) house covered by earth

2.2 Phase-Change-based Systems

The cooling of the building can be relized in passive way, i.e. without incorporation of equipment requiring a separate power [1]. Taking advantage of air circulation the hot air is transportable, which place is replaced by cooler air. The heat reduction property of the phase transition can be used for the room cooling, which effectivity can be increased by the previously mentioned ventilation. We can find solutions against overheating in the folk architecture [1]. The patented method of the passive cooling, operated by ventilation is the so called Trombe wall solution [1]. The heat storage large weight building structure can be realized with a conventional walling, but also can be realized by a water pool, where the water is not only the heat storage, but also as a refrigerant by vaporization [1,3]. Except water, the phase transition of other materials is used in the energy efficient architecture.

3. Energy Efficiency in Active Way

3.1 Cooling and Heating in Active Manner

The equipment of the active heating is the solar collector. By this device, hot water can be created or it can be operated as additional input energy source for heating [1]. But we can combine it by heat storage system too. In the warm period, we can heat the content of an insulated tank, where storage tank is filled by high specific heat material. In the cool weather, we use this previously stored amount of heat [3].

The active cooling can happen by heat pump compressor or by solid state device, which based on the thermoelectric-effect, the so-called Peltier-element [3]. Both of them requires electricity. The latter one is a semiconductor device and definitely requires direct current. Its operation is compatible with the solar cell usage. The solar cell cooling operation even more expedient, because the cooling is really need, when the solar radiation are intensive. Therfore the solar cell occupies center place in this field of the utilization of solar energy as well [3,4].

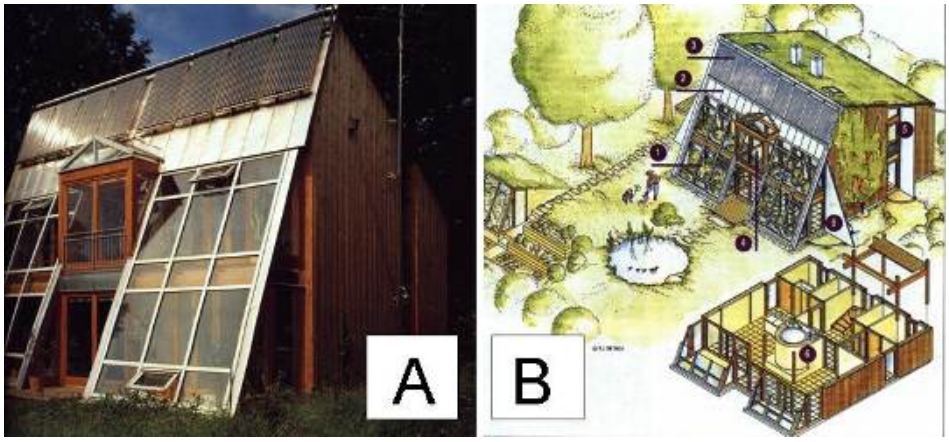

Fig. 2. Home with solar collector (A) view of the building, (B) insideand the work of the building

3.2 Building-integrated Electricty

In our country, not too many really competent solar cell literatures are available for the architects. Because of this, a relative information absence can be observed among the architect as regard to the solar cell applications [5,6]. The solar cells are very diverse types and made by a wide range of technologies [7]. Accordingly, its properties are strongly differ from each other as well. According to their properties, they are suitable for different architectural use [8,9]. The selection among different solar cell types for a given task is not only a technical, but also aesthetical question. The different solar cell constructions differ not only in technical parameters, but in their appearance as well. In order to discuss the different architectural application methods, we need to know the types of the solar cells. For architectural applications, fundamentally we use three different solar cell structures [5,7]. The first is made from crystalline and policrystalline module integrated matrix of semiconductor wafers. The second one is the so called thin film solar cell, produced homogenously on the substrate. Their materials can be $CuGeSe_2$, amorphous silicon etc. The third group is the cells with very high efficiency, which is performed by concentrator element. Typical materials of these are the GaAs and the related compound semiconductors.

The solar cell can be istalled on the roof or on the facade as well [5]. The solar cell installed to the flat roof is taken to the mounting rack. The installation to the flat roof not because of the weight of solar cell, but rather the area of the solar cell tables requires attention. Because of the sucking effect of the wind is necessary to charge the mounting rack. In case of high buildings, the fixing to the support structure are also considered.

The solar cell can be installed on the low angle of inclination roof as well. Primarily industrial and agricultural halls have this kind of roof. The coverage of these roofs happens by corrugated metal, plastic, or silicate boards. The wavy form gives the rigidity of these boards. We fix the rail system to the spine of the waves, where we install the solar cells. The conventional high-picked-roof requires particular discussion. The form, the type of the roof structure and the roofing material influences emphasisitically the appearance of the building. The solar cell installed to the high-picked-roof, fundamentally can occur in four different forms. The one of the most frequent case, where we install the solar cell modules located by fixing rail structure paralell to shells, a few centimeters from it [5]. In this case it is located on a special roof tile and connects the rail structure to the rafter. This solution gives a possibility to the placement of the solar cells, without the disruption of the scale cover. The next possibility is the solar cell installation to the plain of sale cover. This solution reminds for a window lying in the roof plain. The third solution is the application of solar cell sale cover. We apply the solar cell provided element with the same size and shape of the traditional roofing elements.

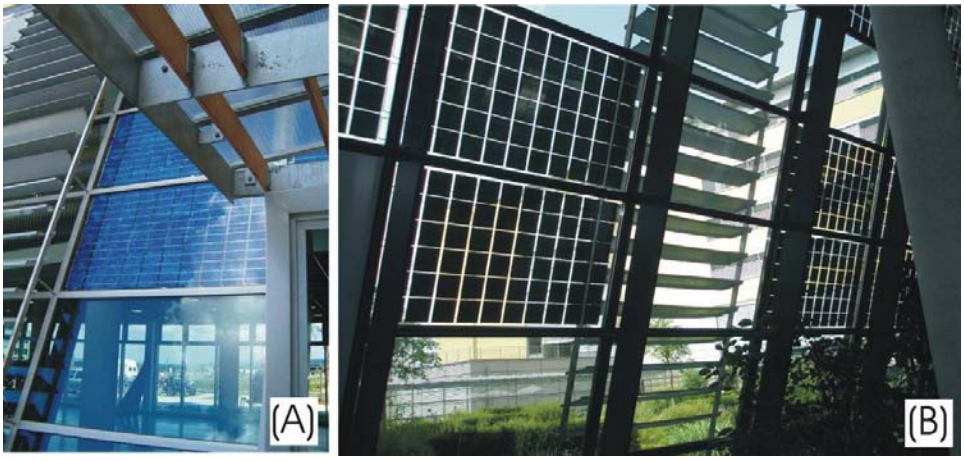

Fig. 3. Building integrated solar cells; view from (A) outside and (B) inside

The solar cell module can be mounted on the facade, too. It can be apply simply as glazing replacement as well. In this case, we use partially transparent modules. At curtain wall structures prefer to apply solar cell, in the front of parapet [5]. A facade element is a solar cell module, used as shadower. This is one of the most obvious application of the solar cell. Against the direct sun radiation, usually, they use shadow seeds. We can take solar cell to the place of shadow seeds. The solar cells fixed above

the window you should place, that the solar cell be incluned and a small air gap separate it from the wall [3,5,8]. This solution takes particulary efficient the air-circulation generated along the wall. The air circulation cools the solar cell.

4 Acknowledgements

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