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The Green Energy Building

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ABSTRACT

At the background of urbanization, energy consumption of buildings has been ranked among the one of the largest sector among the industry, building, irrigation and transportation. The energy conservation through energy efficiency in the building has acquired prime importance all over the world. Consequently, the renewable energy adopted in buildings has been quickly developed, which shifts 60% of total photovoltaic applications to the building sector, was enhanced. This paper explores feasibility of achieving net-zero energy goals in retrofitting commercial buildings. The objective was to investigate how to maximize energy savings and reach net zero energy goals by utilizing renewable energy sources for building's energy needs. The prior design before construction of solar passive building techniques adapted all over the world not only for passive heating/cooling but also for day lighting the building. The building has to include utility of integrated renewable systems for hot water heating, solar photovoltaic electrification, etc.

Keyword: ***Net-zero energy building, Photovoltaic (PV), Solar Thermal (ST), Renewable Energy.***

1. INTRODUCTION

The dwelling and habitat are invariably linked to making buildings as comfortable and convenient possible all over the world. In commercial buildings, high demand for energy used for lighting, heating, ventilation, and air conditioning leads to significant amount of carbon dioxide emissions. The present day buildings have become the third largest consumer of fossil energy after industry and agriculture, which is responsible for the increasing the carbon dioxide. Other sources claim, that in industrialized countries, energy usage in buildings is responsible for approximately 50% of carbon dioxide emissions. The energy conservation through energy efficiency in the building has acquired prime importance all over the world. In fact, the application of renewable energy in buildings focuses mostly on the PV, ST and GSHP, which takes advantage of thermal storage and temperature difference in the shallow soil and surface water.

New goals of renewable energy development are established by the government of India. The major point for energy efficiency in a building include first and foremost the nearly zero energy passive building design before actual construction, secondly the usage of low energy building materials during its construction, thirdly use of energy efficient equipment for low operational energy requirement and lastly integration of renewable energy technologies for various applications. There exists a tremendous potential to conserve energy in buildings. Energy conservation measures are developed for newly constructed buildings and for buildings under refurbishment. However, to achieve a significant reduction in energy consumption in the building apart from the standard energy-efficiency methods, proven renewable energy technologies should be implemented and integrated with the passive building. The renewable energy application has strongly regional characteristics, which mainly consist of three pivotal as follows: local resource endowment, building energy demand and the optimization of energy balance. Hence, sustainability assessment of buildings is becoming necessary for sustainable development especially in the building sector all over the world.

2. ENERGY CONSERVATION

There are ways to reduce the energy consumption of building which ultimately results in mitigating CO_2 emissions through energy conservation.

1. Building orientation for harnessing solar energy and Comfort passive building design.
2. Energy efficient domestic appliance
3. Building with renewable energy technologies.

2.1. Passive design strategies

Involvement of passive design strategies plays an important role in achieving energy savings in this commercial retrofit design. Passive design strategies improve energy consumption by designing the building form that responds to the environment, thus making it possible that to achieve high interior environmental quality and low-energy demand at the same time. Buildings with passive solar building designs naturally use the sun's energy for free of charge heating, cooling and day lighting. This reduces the need to consume energy from other sources and provides a comfortable environment inside.

Principle: In the passive solar design principle, it just the use of the building feature for mechanical cooling and heating and day time artificial lighting in order to reduce or even eliminate the need of energy. Special attention is given on the sun to minimize heating and cooling needs, with the knowledge of local climate, window technology and solar geometry. The basic natural processes that are used in passive solar energy are the thermal energy flows associated with radiation, conduction, and natural convection.

2.1.1 Passive solar heating

The passive solar heating system is design in such a way that the building materials capture the heat and released that heat when sun shine is not available.

There are two approaches to passive solar heating systems: Direct gain, indirect gain

2.1.1.1. Direct gain – The direct gain system will utilize 60– 75% of the sun's energy striking the windows. In this system, the actual living space is a solar collector, heat absorber and distribution system. South facing glass admits solar energy into the house where it strikes directly and indirectly thermal mass materials in the house such as masonry floors and walls as shown in Fig. 1.

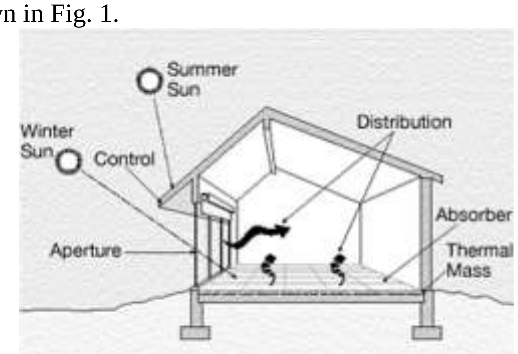

Fig-1 Direct gain

2.1.1.2 Indirect gain – The indirect gain system will utilize 30–45% of the sun's energy striking the glass adjoining the thermal Mass. In an indirect gain of solar passive heating system, thermal mass is located between the sun and the living space. The thermal mass absorbs the sunlight that strikes it and transfers it to the living space by conduction.

There are three types of indirect gain systems

1.Thermal storage wall systems (or Trombe wall).

2.Water wall.

3.Roof pond systems.

1.Trombe wall: Trombe wall absorbs and stores heat during the day. At night Trombe wall vents are closed and the storage wall radiates heat into the interior space as shown in Fig. 2.

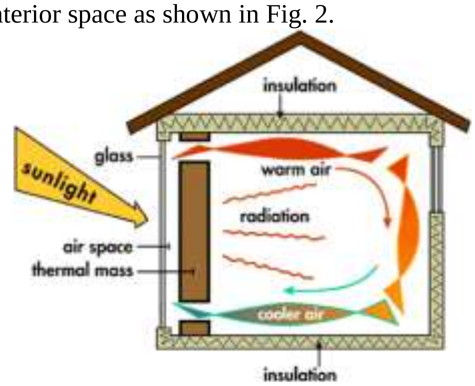

Fig-2 Trombe wall with air circulation open during day and closed in night.

2.Water wall: In water wall indirect solar passive heating system, the wall is composed of water stored in the transparent/opaque containers. During daytime water absorbs solar heat and radiates heat during night. The five basic elements of passive solar design are shown in Fig. 3.

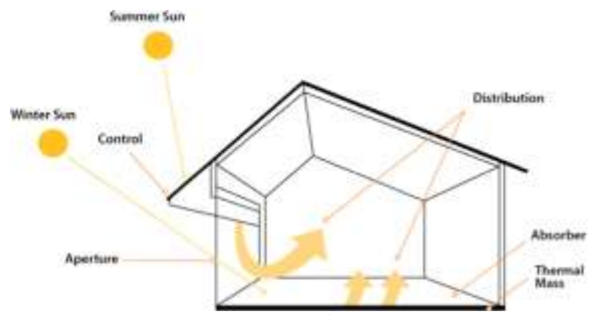

Fig-3 Passive solar design: control using overhang, location of aperture, thermal mass design and distribution of gain.

3.Roof pond systems: The thermal pond approach, which uses water encased in ultraviolet ray inhibiting plastic beds underlined with a dark color, that are placed on a roof. Hence, this system is known as roof pond solar passive heating/cooling system. Shown in fig. 4

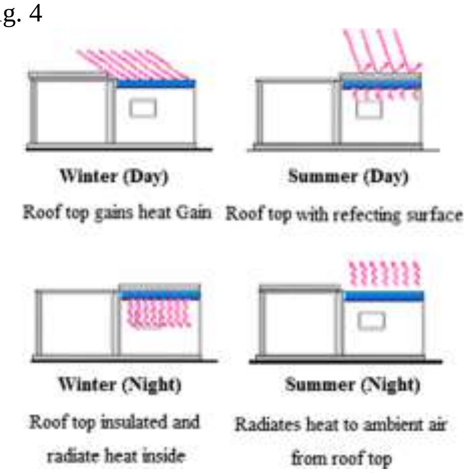

Fig-4 Roof pond stores heat daytime and radiates in nighttime for winter and reverse in summer.

2.1.2. Passive solar cooling

A combination of proper insulation, energy-efficient windows and doors, day lighting, shading, and ventilation will usually keep homes cool with a low amount of energy use. The approaches include use of operable windows, wing walls and thermal chimney.

(I) Ventilation and Operable Windows

- Place operable windows on the south exposure.
- Casement windows offer the best airflow. Awning (or hopper) windows should be fully opened or air will be directed to ceiling. Awning windows offer the best rain protection and perform better than double hung windows.
- If a room can have windows on only one side, use two widely spaced windows instead of one window.

(II) Wing Walls

Wing walls are vertical solid panels placed alongside windows perpendicular to the wall on the windward side of the house. Wing walls will accelerate the natural wind speed due to pressure differences created by the wing wall as shown in Fig-5.

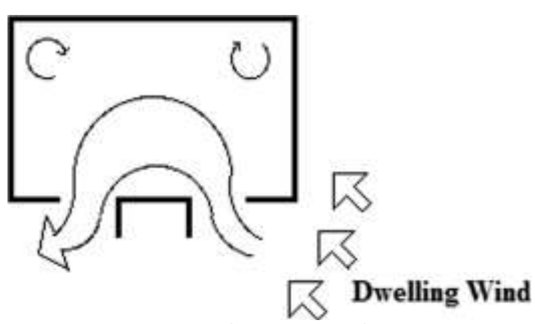

Fig-5 Top view of wing walls airflow pattern

(III) Thermal Chimney
A thermal chimney employs convective currents to draw air out of a building. By creating a warm or hot zone with an exterior exhaust outlet, air can be drawn into the house ventilating the structure.

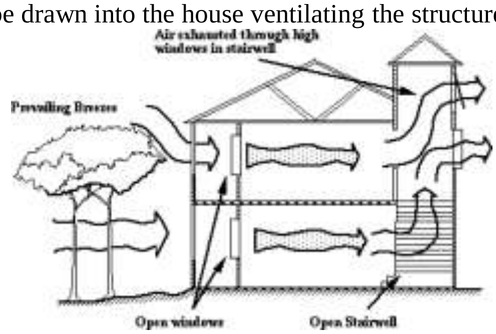

Fig-6 Thermal Chimney

3. SUITABILITY OF RENEWABLE ENERGY FOR BUILDINGS

Regarding the development of the renewable energy applied in buildings, no matter the PV, ST or the GSHP application, they depends mostly on regional conditions, so the supporting research of integration of comprehensive information are still in urgent need.

3.1. Application of PV

Taking the application of PV as an example, the commonly used indicators for evaluation of solar radiation condition are the peak sunshine duration hours (the hours converted from the total radiation quantity by radiation intensity of 1000W/m2) . However, because of the rough converted computation with the total radiation quantity, the potential prediction of solar power generation is usually overrated, by ignoring the filtration management of the low-effective or non-effective radiation ranges.
In other words, in the poorer radiation resource, the proportion of effective radiation occupies lower. The current key issues, including the substitution rates on fossil fuels, the conversion efficiency of energy and the economic evaluation, are quite worth studying. The photovoltaic application can achieve the better economic benefit and higher substitution rates for the large space buildings in city and facilities in agricultural projects in future. Some local guidelines or regulations are also brought out to strongly promote the photovoltaic applications installed in buildings with large roof areas.

3.2. Application of GSHP

Influenced by geological and climatic conditions, the systematic efficiency shows large differences when applied in the severe cold area and the hot-summer and warm-winter area. COPs in summer and winter are all relatively higher than those in cold area, hot summer and cold winter area The planning and designing of GSHP system should consider the local diversity, as well as the load characteristics related to the building types and local climatic conditions. The matching between building types and the different operation modes, which include continuous operation mode, intermittent operation mode and other operation modes based on the load intensity or seasons diversity, should also be taken into consideration to avoid hot stack resulting from the unbalance of heat. According to some verification testing and researches of GSHP systems, the energy consumption of transmission process is overlarge because of the partial load in most operating conditions. Due to the lack of optimization for the transmission systems, the situation can be even worse. In other words, the overall systematic energy efficiency is even lower than that of the traditional air conditioning systems. As one of the most typical operation problems of air conditioning systems, the phenomenon of large flow and little temperature difference should be paid more attention in GSHP systems.

Furthermore, authors find that the energy efficiency of numerous GSHP systems is reduced largely because of the overlarge transmission energy consumption. Consequently, the effective evaluation of energy efficiency and suitability for GSHP systems should be paid more attention.

3.3. Application of ST

The application of ST is closely related to the regional conditions. Based on the quantitative verification studies from recent ST projects (Fig. 6), the following problems should not be ignored.
a) Plenty of applications do not fit the local solar thermal conditions, leading to the unreasonable designs of auxiliary thermal sources. As a result, the environmental and economic efficiency cannot be realized as expected.

b) Efficiency of thermal collectors is largely affected by the local ambient temperature.
c) The demand of hot water is largely related to the local climate and the building types.
The surface cleaning of collectors depends on the local atmosphere environmental quality. Types of auxiliary thermal resources consist of electric heater, heat pumps, fuel gas heater, fuel oil heater and so on. Among all these, the electric auxiliary heater is more common, because of the low equipment price, convenient installation and operation. However, for projects in region with poor radiation conditions and low assurance rates, the auxiliary electric heaters are used frequently in most time of a year, which is, on the contrary, against the initial concept of environmental friendly and safety.

4.BENEFITS OF GREEN BUILDING

With new technologies constantly being developed to complement current practices in creating greener structures, the benefits of green building can range from environmental to economic to social. By adopting greener practices, we can take maximum advantage of environmental and economic performance. Green construction methods when integrated while design and construction provide most significant benefits. Benefits of green building include:

4.1 Environmental Benefits:

- Reduce wastage of water
- Conserve natural resources
- Improve air and water quality
- Protect biodiversity and ecosystems

4.2 Economic Benefits:

- Reduce operating costs
- Improve occupant productivity
- Create market for green product and services

4.3 Social Benefits:

- Improve quality of life
- Minimize strain on local infrastructure
- Improve occupant health and comfort

5.CONCLUSION

Modern day buildings are highly energy intensive with a significant consumption of energy right from the construction phase to the operation and maintenance stage, owing to global energy crisis suitable strategies needed to be developed to address energy conservation in buildings.

The utilizations of the solar PV, ST and GSHP are believed to be the most promising technologies in the future. It is also a big challenge for construction industry at the same time. Interdisciplinary cooperation between the architects and energy engineers could be the key driving force. Moreover, the exploding metering data sets should be integrated and managed to provide more technical support for urban energy planning, systematic optimization design and the efficient operation.

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