"With the increasing costs of imported energy, . . . utilization of both renewable and non-renewable energy sources has to be made."

Environmental Considerations in the Design of Energy Efficient Low-Cost Housing*

by:
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Buildings in general are said to be one of the largest consumers of energy. In several developing countries, buildings have been singled out as targets for energy conservation. In a study of electric consumption patterns in Singapore in 1978, it was found that 50 percent was consumed by industrial buildings, followed by commercial buildings (31.6 percent) and residential buildings with 17 percent.

Of the total amount of electricity consumed by residential buildings of 887 GWh, 55 percent was utilized to run the machines,and household appliances, 25 percent for refrigeration, 10 percent for air-conditioning and another 10 percent for lighting [1]. This situation in Singapore would be most typical for urban areas in Southeast Asia. However, it should be noted that access to energy in urban areas is easier as compared to the rural sectors of the economy and in economically deprived communities. The use of energy in all its manifest forms and utilitarian purposes becomes a larger issue whenever essential human functions are to be satisfied. How one would cook the family's food, provide comfort for building interiors, spend for lighting or even light a candle to revere one's deity are daily functions which can be expensive or cheap to undertake depending upon how one's shelter is designed.

The introduction of the energy parameter in the design of low-cost housing, although not new to the energy analyst, is a novel idea for residential developers. This apparent unawareness of builders and developers in the low-cost housing field may be due to the manner they view their responsibility. They look at it as merely the production end of the development framework for housing. On the other hand, housing estate managers look at low-cost housing as only building upkeep and building maintenance. Very few look at low-cost housing in a systemic manner where the structure is inherently energy efficient by the way the envelope is oriented, the way openings and shadings are optimized, or the way architectural spaces are planned for operational efficiency, habitable comfort and a peaceful setting for the family.

Areas of specific interest to the architect or engineer who designs an energy efficient low-cost house may cover the following:

1. Site considerations to be able to design in conformity with nature
2. Utilization of the most appropriate materials to maximize their useful properties

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3. Efficient production systems in order to develop high efficiencies in the use of labor, materials and equipment
4. Viable strategies for the demolition or the reuse of structures beyond their economic life
5. Creation of approaches in building operations particularly for indoor comfort, cooking facilities, daylighting, water systems and laundering
6. Anticipations and programs for building maintenance, component replacements and upkeep.

Lately, architects and builders have been teaming up with systems analysts, industrial designers and ergonomists in finding ways and means to reduce unnecessary expenses in human energy, besides all forms of process fuels and energy in the performance of daily activities of the home. New approaches in developing low-income housing with efficient energy utilization is thus in order. In most cases, a systems view of these two factors will lead to the considerations of the intended and unintended responses of the human body to enviromental conditions which may fall under any of the following[2] :

1. As an involuntary biologic response
2. As a psychic response
3. As a proxemic response through body protection
4. As a sheltering response by controlling the immediate environment
5. As a community building response in agreement with neighbors
6. As an institutional response through governmental regulations

In all of the above responses, the attainment of a neutral environment is the design objective. The underlying characteristic of a neutral environment in a home is when one enjoys comfort conditions in the performance of day-to-day activities. This is a house in the true sense of what sheltering means:

1. It protects one from the harsh elements of the environment.
2. It protects one from the bad elements of society even if it connotes only a psychologic dimension.
3. It is a thermally neutral environment, neither warm nor cool.
4. It is a visually neutral environment, neither dark nor very bright.
5. It is a habitable environment where its elements have a firm technical base and with interfaces with the psychological, social, physical and ergonomic factors.

With an understanding of these parameters, the targets that can be singled out in the design of an energy efficient low-cost housing can cover the following areas:

1. Building materials and components affordability
2. Building space affordability through incremental upgrading of quality and size
3. Utilization of fuels and energy in the house
4. Attainment of peace of mind and human comfort not only indoors, but also in the neighborhood
5. Drawing of water and the utilization of potable water
6. Elimination of wastes, either water-borne, air-borne or solids
7. Provision of adequate light
8. Provision of adequate ventilation
9. Manner of cooking and drying clothes and of ironing them
10. Handling of information, communication and other household activities using power
11. Maintenance and cleaning of the building fabric

UNDERLYING PRINCIPLES IN ENERGY UTILIZATION IN THE HOME

There are two underlying principles in energy utilization in the home. These stem from the understanding of the environment and one's role and opportunities in achieving a neutral environment. Specifically these are:

1. The house should first fully utilize natural on-site attributes to provide self-reliance in the use of energy as much as possible. Thereafter, add any other requisite systems by the active use of equipment and mechanical devices.

   Under this first principle, the knowledge of environmental factors such as solar temperature, solar radiation, air flow and its recurrence, air humidity and the predictability of typhoons is essential.
2. The housing envelope and components, particularly fenestrations and shading devices, as well as switching devices, should be so designed as to allow the occupant more leeway in adjusting the environmental conditions inside the building. Not only should the occupant be provided such opportunities,the controlling devices should also be so placed as to allow ease of handling and manipulation.

The effect of energy on the building envelope should be considered in bringing down the cost of construction. However, in designing most low-cost housing projects, this factor is often disregarded thus resulting in reliance on artificial and active measures in attaining a neutral environment. All throughout the development process only initial costs were given importance in considering affordability of low-cost housing. Unlike in the past when buildings relied heavily on the use of the sun for lighting purposes, or on the wind or massive construction to temper the hot periods of the day, now it is expected that these functions can be performed by using artificial or mechanical devices. However, these devices are not only expensive, they also require high energy consumption. And if a family can not afford them, their body functions and well-being are thus jeopardized.

The size and placement of windows are energy-related. Through empirical studies, the amount of sun and breeze admitted through the window can be regulated. The positioning of partitions and use of wall/roof insulation have impact on the energy needs of the house which is more often than not a cramped space.

Recognition of the importance of energy utilization in low-cost housing can commence from the design of the house to its production, operation and maintenance. If the trend in energy utilization in buildings shall be the gauge, it can be said that there is now a growing awareness of using local renewable energy sources as against imported non-renewable ones.

The best way to appreciate the meaning of renewable energy sources can be described in the following manner. Renewable energy sources are those that are available indefinitely but must be tapped with fixed regularity. For example, the amount of solar energy varies from day-to-day, but on the average, the sun continues to provide energy at a very steady state. A wood lot will provide a limited amount of wood fuel a year, but it will do so for years if properly harvested on a managed yield basis. A popular analogy for renewable energy sources is to compare its use with one who is receiving a fixed but steady salary without any increases. On the other hand, non-renewable energy sources are like savings accounts with no interests. Once spent, they are irredeemable just like fossil fuels.

Locally available energy sources are cheap and convenient to utilize up to a given point. As users of the energy increase, the ratio between fixed amounts of delivery to users also dwindles. Locally available quantitites thus become inadequate. At this point, the conveniences of an established distribution network and a precisely measured heat content, as that presently systematized in the distribution of electricity, gas, fuel oil and coal, should prove to be more attractive. With the

increasing costs of imported energy, the optimization of the utilization of both renewable and non-renewable energy sources has to be made. This goal should become the basis of whatever strategies policy makers and low-cost housing builders should choose to take.

Three attributes of low-cost housing design which adapt energy efficiency can take the following strategy [2]:

1. Homes have to be designed so that they can be weaned away from too much dependence on non-renewable energy. Architects and building developers both agree on the need to establish an energy budget in the production and operations of the house. This may be in the form of performance criteria or a regulation which shall specify the maximum allowable energy one can consume in a year. With the given energy budget, the designer can then combine his creativity to attain the target. This will allow the architect to choose a combination of materials and the type of envelope which will satisfy the criteria.
2. Houses have to be designed to maximize the use of available renewable energy sources which have to be equally shared and augmented by the available network of expensive non-renewable sources.
3. Housing for the low-income is getting to be smaller in area as a result of rising costs of materials processing, increases in labor costs and high delivery costs. Thus, it is necessary that a strategy of incremental house building and quality upgrading be adopted.

It is in this consideration where the concept of extending the service life of the components and building materials of a structure could be of use to maximize the economic life of the whole building.

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