INCORPORATING SMART TECHNOLOGIES FOR ENERGY SUFFICIENCY IN BUILT ENVIRONMENT OF DEVELOPING COUNTRIES: AN ARCHITECT'S PERSPECTIVE

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1 Introduction

This is a burning problem of present era. The present unplanned and uncontrolled growth of housing cares little about energy conservation aspects. Sometimes even providing minimum energy to all households is not becoming possible by the local authorities. Studies reveal that around 18% of total energy consumption of mankind is in housing sector. It is necessary to consider energy conservation techniques before, during and after construction; as energy can be saved considerably in each stage. Over 80% of the embodied energy in mass housing is the energy required to manufacture the materials. Most of this energy usage is for manufacturing only a small number of the (high-energy) materials used in construction of housing units, principally steel products, cement, concrete products, bricks and ceramic materials.

This embodied energy amounts to several times the annual energy consumption of that same housing in use. Energy is used wastefully in heat recovery processes, insulation techniques, and simple orientation concerns. Architectural lighting & space heating/ cooling are also two of the largest and most visible consumers of energy. A properly designed energy efficient housing will have a lower initial cost than one planned disregarding energy consequences. This cost advantage derives mainly from smaller building volume & lower energy demands. . The conventional centralized energy distribution network accounts for high transmission losses (ranging from 9 to 20% at times). In Indian context grid loss sometimes reach upto 35%. The energy consumption in residential structures accounts considerably high than other buildings, also it is a recurring ever cost increasing phenomena. It is very difficult to remain in the city and save energy beyond a certain limit without compromising the present day materialistic lifestyle by the city dweller households.

2 The Definition

But after all what are these intelligent buildings? The Intelligent or the "Smart" buildings are characterized by the following major properties :

1. Smart buildings should KNOW what is happening inside and outside the building fabric, by way of various sensors and microprocessors along with weather monitoring instruments and technologies.

2. Smart buildings should DECIDE the most convenient way of providing comfortable and productive environment, by the use of automated control systems and air handling units.

3. Smart buildings should CATER the exigencies of security and safety (from fire, weather hazards etc.), by simultaneous sensing, control, and monitoring of different factors.

4. Smart buildings should CALCULATE the minimum energy requirement levels and maintain the same with the help of dimmers or sometimes even by switching off the extra energy sources.

5. Smart buildings must RESPOND to occupants requests, with the provisions of different electronic and mechanical means.

3 Addition of Smart BMS

The field of Smart Buildings, Smart Homes and Building Management Systems (BMS) encompasses an enormous variety of technologies, suitable for domestic buildings, including energy management systems and building controls. The function of Building Management Systems is central to 'Smart Buildings' concepts; its purpose is to control, monitor and optimize building services, e.g., lighting; heating; security, CCTV and alarm systems; access control; audio-visual and entertainment systems; ventilation, filtration and climate control, etc.; even time & attendance control and reporting (notably staff movement and availability).

The potential within these concepts and the surrounding technology is vast, and our lives are changing from the effects of Smart Buildings developments on our living and working environments. The impact on facilities planning and facilities management is also potentially immense. Any facilities managers considering premises development or site relocation should also consider the opportunities presented by Smart Building technologies and concepts. Until recent years, energy efficiency has been a relatively low priority and low perceived opportunity to building owners and investors.

However, with the dramatic increase and awareness of energy use concerns, and the advances in cost-effective technologies, energy efficiency is fast becoming part of real estate management, facilities management and operations strategy. The concepts are also now making significant inroads into the domestic residential house building sectors. Since many of the problems of tall buildings can be solved by smart building features, it's high time BMS should be considered in design of tall buildings.

The addition of "intelligence" to the concept of mass housing in tall buildings is also necessary because this will further enhance their habitability by eliminating some of the major disadvantages and by incorporating comfortable living atmosphere [Sanyal, 1997].

4 Energy Conservation :

Smart buildings effectively use energy conservation methods and maintain the optimum energy usage level all the time. The energy production cost is higher in developing countries; the reduction of unnecessary wastage of household energy will be very advantageous in the long run. Reduction in energy consumption derives from strategies, in the form of intelligence, for manipulating the HVAC and electrical systems. These strategies are complex, because energy optimization schemes have an impact on many different functional aspects simultaneously; consequently, they can be effectively followed by smart system only. It has been already experienced that using energy management software that reacts to the electrical demand approaching a new monthly peak value can reduce electrical power costs, and then recommends shedding, of certain building electrical loads in accordance with a priority schedule. Smart buildings can offer the most comfortable and productive living environment. They can even change the inside environment as per changes of likings of occupants by voice actuation system (already in use in developed countries). Thus the psychological satisfaction of the habitants can be obtained to a greater extent by smart buildings.

A critical factor of smart is to develop an effective and flexible control for lighting systems. In mass housing units lighting represents a major portion of the energy costs. Traditionally, lighting controls are being enforced for: -

-Providing an effective/acceptable level of illumination,

-Reducing energy consumption in peak periods,

-Providing flexible scheduling & overriding capabilities,

-Saving of energy.

Studies reveal that out of 40% in buildings, around 18% of total energy consumption is in housing sector, where energy is used wastefully. Moreover, though people are aware of energy shortages as they are reminded by load shedding and power cuts time-to-time; still they have not yet developed a psychology to conserve energy whatever and whenever they can. As per UNCHS, approximately 60% of reduction in energy consumption is possible through employment of energy conscious design principles and it is the responsibility of architects/ designers to encourage such measures. The energy consumed by a housing unit depends upon the structure's energy needs and the efficiency with which those needs are satisfied. Energy conservation aims at both reducing basic demand by cutting a housing unit's appetite and improving the efficiency of energy supply system by eliminating wastage. Many of the dwellings are being designed to aggressive standards for illumination levels, which leads to over-illumination. Smart buildings can use dynamic area illumination techniques to effectively control and maintain optimum illumination.

An **Energy Management System** (EMS) is a system of computer-aided tools used by operators of electric utility grids to monitor, control, and optimize the performance of the generation and/or transmission system.

The computer technology is also referred to as SCADA/EMS or EMS/SCADA. In these respects, the terminology EMS then excludes the monitoring and control functions, but more specifically refers to the collective suite of power network applications and to the generation control and scheduling applications.

Manufacturers of EMS also commonly supply a corresponding dispatcher training simulator (DTS). This related technology makes use of components of SCADA and EMS as a training tool for control centre operators. It is also possible to acquire an independent DTS from a non-EMS source such as EPRI.

Energy management systems are also often commonly used by individual commercial entities to monitor, measure, and control their electrical building loads. Energy management systems can be used to centrally control devices like HVAC units and lighting systems across multiple locations, such as retail, grocery and restaurant sites. Energy management systems can also provide metering, sub metering, and monitoring functions that allow facility and building managers to gather data and insight that allows them to make more informed decisions about energy activities across their sites.

5 Other Energy conservation strategies:

The major actionable aspects to reduce energy consumption are:-

- Use energy management system to reduce the peak energy demands and cut on the energy wastage. Use energy efficient lighting fixtures, like L.E.D.

- Use passive architectural techniques like wind tunnel system, etc. to reduce air-conditioning load. Energy recovery wheels can also be used.

- Use of renewable sources of energy should be promoted. Solar energy can be tapped by adding solar panels to the external facades of tall housing or from Building Integrated Photo Voltaic. Energy can be also generated by using bio-mass technologies utilizing biological (kitchen/restaurant) wastes from tall buildings. Develop strategies to provide natural lighting. Studies have shown that it has a positive impact well being.

Further strategies can be:-

- Use of Task lighting reduces general overhead light levels.

- Use a properly sized and energy-efficient heat/cooling system in conjunction with thermally efficient walls, roofs and floors.

- Maximize light colours for roofing and wall finish materials; install high R-value wall and ceiling insulation; and use minimal glass on undesired sun exposures.

- Passive design strategies can dramatically affect energy performance. These measures include home shape and orientation, passive solar design, and the use of natural lighting. Over 80% of the embodied energy in housing is the energy required to manufacture the building materials. It has been established that most of this energy is used in only a small number of materials, principally, iron/steel products, cement/concrete products, bricks/ceramic materials. The embodied energy in a housing unit amounts to several times the annual energy consumption of that same housing in use [UNCHS, 1991b]. So, architects of super tall housing have the opportunity to make a major contribution to the reduction of total energy use in built environment through some of the strategies enlisted here:
- Maximum use of low energy materials.
- Selection of lower-energy structural systems.
- Selection of waste/recycled materials, or manufactured materials, which incorporate these.
- Use local materials, involving less transportation.
- Use more functional windows (designed as passive solar collectors). Optionally smart windows can be also used, which use anti reflection layers, low emission coatings and switch able films.
- During construction process, materials are combined in composite building components such as walls, floors and roofs. Based on the energy intensity of the materials and the quantities used, it is possible to calculate the energy insensitivity of various types of building materials and construction methods. It is notable that structures can vary up to 60% in **capital** energy requirement, as a result of architect's choice of materials [UNCHS, 1991a].

REFERENCE-

[1] Sanyal D. (1997). Development of Self Sufficient Housing using intelligent buildings in Indian context. New methods and technologies in Planning and construction of Intelligent Buildings II. *Proceedings of IB/IC Intelligent Buildings Congress*. Tel Aviv. pp88-97.

[2] UNCHS (Habitat) (1991a). *Energy efficiency in housing construction and domestic use in Developing countries.* Nairobi. (HS/218/91/E) pp8.

[3] UNCHS (Habitat) (1991b). *Energy for buildings*. Nairobi. (HS/250/91/E) pp88.

[4] Sanyal D. (2000). Exploration of architectural design aspects for intelligent self sufficient housing: a study. *Proceedings of World Conference on Green Design, World Congress on Environmental Design for the New Millennium*, Seoul. pp377.

[5] Sanyal D., Super tall buildings: exploring the architectural challenges, Journal of Ravishankar University, Vol.9, Raipur (1996) pp1-10.