CHAPTER VII

ENERGY SAVING

7.1. INTRODUCTION

This chapter intents to give some basic knowledge about the energy saving in buildings. One of the priorities in the modern world is related to this question due to environmental and economic reasons in first place.

The material in this chapter is extracted basically from [7] and [8] . The only intention here is to give the students a basic understanding of the energy efficiency problem. For a more complete study, please refer to the cited reference.

7.2. ENERGY USE OF A BUILDING

The geometry of a building affect its energy efficiency. For the same surface, geometrically different buildings permit different heat flow through their envelope. Some designers recommend a length to width ratio of 1.7 to 1 for Florida.

The used glass is another important factor. Minimizing glass areas, while maintaining design and ventilation requirements, can be energy efficient. Good design practice recommend no more than 10% of the wall areas of single-story houses should be allocated for windows and glass doors. For two-story houses this value is reduced to 6%. Walls in a building have a big influence in energy lost. This value can reach 15 to 20% of the total energy lost. The major factors affecting the energy performance of walls are: the surface area, the insulating characteristics, the infiltration and the thermal mass. For Florida it is recommended wall insulation with a value between R-11 and R-19. It is also important to seal the openings where wiring and piping run through floors and ceilings.

It is known that between 10 and 25% of the energy lost from a house is lost through the ceiling/roof system. In Florida ceiling insulation should have an "R" value 19 and 30.

In order to reduce the attic heat gain, a radiant heat barrier should be placed. There exist two options: to layer foil on top of insulation or to staple it to underside of roof sheathing. The attic ventilation reduces roof and ceiling temperatures, saving on cooling costs and lengthening the life of the roof. The amount of attic ventilation needed is determined by the size of the attic floor and the amount of moisture entering the attic. It is recommended 1 sq. ft. of attic vent for each 150 sq. ft. of insulated ceiling. Electrically powered roof ventilators are not recommended for houses, because can consume more electricity to operate than they save on air conditioning costs. Power vents can create negative pressures in the home which may cause that outside air be forced into the home, increasing the quantity of heat that the air conditioning system has to extract, and pulling pollutants into the home. It is recommended to staple radiant heat barriers directly to the underside of the roof sheathing during construction.

Doors can account for up to 10% of the energy lost from a house. Properly fitted solid wood doors or metal doors can be used. It is not recommended to use sliding glass doors because of air leaks around the edges.

The building orientation will affect the energy gained and lost through glass. For example, if sunlight strikes one 6 x 8 feet clear glass window on the west wall of a room, the cooling effect of more than one ton of air conditioning is required to remove the heat gained from this source alone.

Another factor is the cross ventilation. a house that provides cross ventilation during periods of mild weather can achieve considerable energy savings.

Air leakage, or infiltration, is a major problem for buildings. It can contribute to over 30% of cooling and heating costs. Additional effects are problems of comfort and moisture, pull pollutants into buildings and access for insects and rodents.

7.3. AIR CONDITIONING SYSTEM

One of the most important decisions when projecting the service systems in buildings is related to the type of heating and cooling system to install. The decision for an efficient system should be based on the size of the system for the specific heating and cooling load of the building; the selection and proper installation of controls; the correct design of the ductwork or piping; and the proper insulating and sealing all ductwork.

The heating and cooling load determines the equipment size. An oversized air conditioning system will operate for a short time and then cycle off. Short cycling limit the amount of time that the system is effectively removing moisture from the building. When installing a system smaller that needed, the design conditions are not met. The temperature may not reach the established on the set point temperature. A properly sized air conditioning system minimize the construction and energy costs and provide the expected comfort.

The cooling efficiency of a heat pump or an air conditioner is rated by the Seasonal Energy Efficiency Ratio (SEER), that measures the amount of cooling provided during the cooling season in relation to the amount of electricity used. Current national legislation mandates a minimum SEER 10.0 for most residential air conditioners. Modern air conditioning system can achieve a SEER of 15 or 16.

In order to increase the overall operating efficiency of an air conditioner, multi speed and variable speed compressors have been developed. Their cost is higher than standard units, but offer advantages as: saving more energy, working quieter and also they dehumidify better.

When dealing with the equipment maintenance, attention should be placed to the refrigerant charge. Improper refrigerant charging seriously degrades system performance. A refrigerant undercharge of 15% causes a 19.6% decrease in system efficiency.

The duct design and sealing is another very important aspect of an efficient air conditioning system. A proper duct size depends on the estimated heating and cooling load for each room in the building; the length, type and shape of the duct; and the operating characteristics of the air conditioning system.

Proper sealing and insulation of the ductwork in unconditioned areas require careful attention. Situations as disconnected components, seams in the air handling unit, plenums, and rectangular ductwork, lack of sealing in take offs, elbows, boots and other connections, must be carefully avoided.

7.4. APPLIANCES AND LIGHTING SYSTEM

Among the appliances, the water heater is the one that consumes more energy. It account for 16% to 20% of the total energy consumption in the home. Several measures that can be taken for more efficient use of the water heater are:

1) Lower the temperature setting on the water heater to 120º F

2) Insulate first four feet of all metal pipes extending out of the water heater

3) Insert a trap at the output of the hot water pipe

4) Minimize the piping runs to the bathroom and kitchen.

The refrigerator should be located in a cooler location. It should not receive direct sunlight or be positioned near heat- producing appliances. The operating temperature should be between 36° F and 38º F, and for the freezer between 0º F to 5° F.

The dishwashers should have light, medium, and heavy cycle options. The clothes washing machine should offer several wash and rinse cycles and several sizes of load. When selecting clothes dryer choose a model with energy- saving switch and that detect "dryness" and shut off automatically.

The interior lighting system should be based on the use of compact fluorescent light. When selecting the lamp attention should be given not only to the wattage but also to the quantity of Lumens (measure light output). Consider the high intensity discharge lamps for outdoor night illumination. Recessed units, when not properly installed may be sources of air leakage, which can greatly increase heating and cooling costs.

7.5. INTELLIGENT ENERGY MANAGEMENT SYSTEMS

The saving tendency has been in general focused to increase the equipment efficiency. Other approach has been the utilized by the electric companies, limiting the demand in the peak hours.

There exist another possibility. The use of computers and computerized networks to optimize the use of the electric energy in buildings. This possibility has not been fully utilized. It is assumed that the high cost of the computerized equipment and the scarcity of professional specialized in this field are enough elements to disuse a large scale application of these systems.

However, several companies in the US and abroad have developed equipment and software focused to this problem. As example can be cited Honeywell and Johson Controls.

Honeywell has developed what is known as Excel Building Supervisor, which requires minimal training before the customers are maximizing their building performance. This control system has the capacity for up to 128 physical input and output points, with an additional 255 pseudo points. Completely customized control sequences can be developed and are distributed in each controller, along with time schedules and energy management options such as night purge, optimum start/stop and occupancy scheduling. The system permit to organize from priority indexing of alarms to detailed occupancy scheduling. The system can be operated from the existing networks.

The use of this or similar systems lead to savings of to 15% of the total energy by acting on the necessary equipment according to the actual needs in the building without affecting the users comfort, and present an interesting option to be analyzed for installation in new or existing buildings.