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Energy Optimization of Buildings Using Sustainable Design

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ABSTRACT

Revision of manufacture and design patterns in various fields of human life, including industrial, construction, urban design, and so on is one of the solutions to sustainable development. The purpose of designing sustainable buildings is to reduce environmental damage and energy resources and nature which results in reducing non-renewable resources consumption, the development of the natural environment and eliminating or reducing the use of toxic or harmful chemicals to nature in building. In short, a sustainable building is a building has the least contradiction with its natural environment and in a wide range across the region and the world. Green design, a design based on environmental sensitivity, ecological design, natural design and so on are the titles' emerged as a result of revision in current construction patterns. In short, it's a design method that is based on rules derived from nature. This design method believes in viewpoint's reconcilement in energy, environment and Ecology (Ecology) field. For example, green design can be considered in a triangle which the energy, climate and ecology are the three vertices. Where the energy is the determining factor, designing would be different state and form than the ecology is the form factor. This is why a townhouse is different from a country house.
KEYWORDS: Energy, nature, sustainable design, Ecology, Building.

INTRODUCTION

Argument about the relationship between man and nature is a talk. For a long time thought that nature with its great purifying and controller force would control human aggression and scientific discoveries will offset possible progress losses, the world is uncontrollable and the population, deforestation and energy consumption would result in the risk of disrupting wonderful world rhythmic and order. Over the past 20 years, 120 million hectares are added to the world's deserts along with increasing the life luxury and excessive consumption and high demand for welfare, Especially in Western countries, which this amount exceeds the land cultivated every year in China and Nigeria. During the same period, more than 450 million farmers have lost their fertile agricultural earth and loom that is roughly equivalent to the entire earth is covered by agricultural land in India and France.

In the past 25 years, more than 2 million square kilometers of forest in the world that has disappeared which its area is over than an area of Iran.

1. ENERGY

Energy has special position and situation in human life and life of the future in general in all aspects depends on it. Supply, production and energy consumption methods at the same time is in such a way that even in the medium term, it is not possible to continue the current method. In particular, there is more concern about our country. To clarify the issue, just to mention some figures. For example, energy consumption growth rates in the world during the 1980 to 2006 was 1.98 percent in the world and 6.3 percent in Iran. In other words, over time, the growth rate of energy consumption in Iran is three times more than the global rate.

Awareness of energy resource limits and environmental issues (climate change, global warming and ozone layer tear and acid rain) in the world has now caused more attention to the subject of energy efficiency.

2. THE NEED FOR ENERGY EFFICIENCY IN BUILDINGS

According to statistics by the organization to optimize fuel consumption, average consumption in the buildings of Iran is about 310 kWh per year for per square meter. This amounts, to the same conditions in European countries is about 120 kWh for per square meter. So energy consumption of buildings in Iran is about 5.2 times more than

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European countries. Energy consumption, in cold climates of Iran, is about 542 kWh per square meter which this figure in the cold regions of Europe is 150 kWh per square meter. So energy consumption in the cold regions of Iran is about 4 times more than European countries. Figure (1-2) has compared an average allowed consumption of Iranian households to the Japanese, and Turkish.

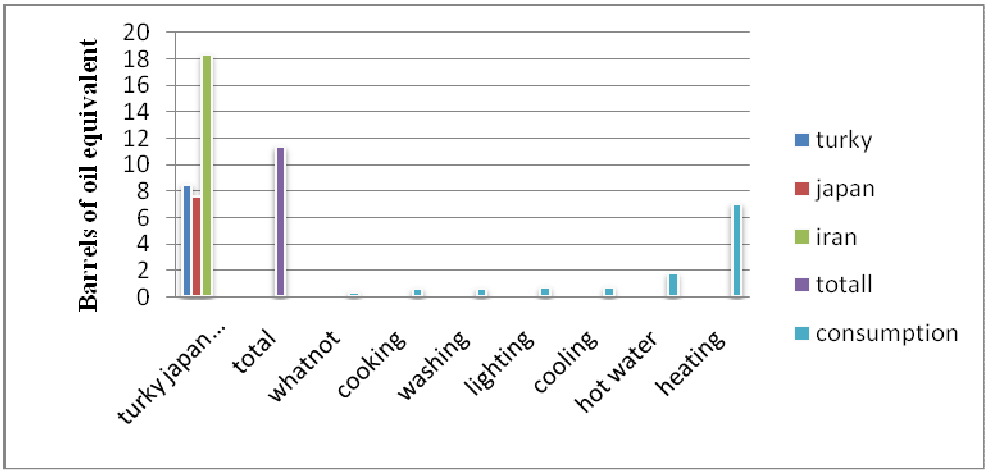


Chart (1) Compare the average household allowance. Source: energy efficiency, 2009, Page 43

Energy consumption intensity, as a measure and index to energy efficiency in different countries, in Iran is four times more than the global average in the amount of 907 tons of crude oil equivalent per million dollars in value (Figure 2-2). According to a survey conducted in our country, per capita consumption in Iran with a population of 75 million people is equal with a per capita energy consumption in China, with a population of over a billion people.

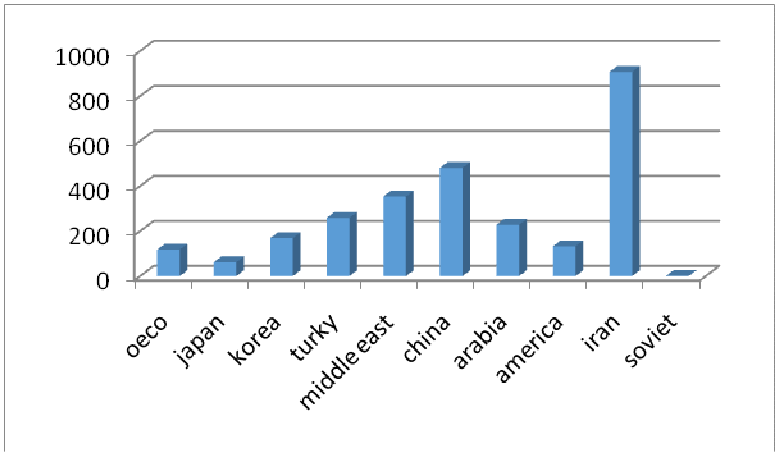


Chart (2) Compare the intensity of final energy consumption in different countries in 2007.
Source: energy efficiency, 2009, p.19.

The important point is that the intensity of the energy supply index which has a descending process or at least was constant in most countries, has faced an ascending trend (Figure (3-2). so by continuing the current trend of energy consumption in the country, by outlook in 2025, Iran will become an importer country from a country of net energy exporter and will lose comparative advantage revenues from energy exports (Source: fuel optimization, 2009, p. 6).

3. ENERGING SUSTAINABLE DESIGN

Sustainable design in architecture and urban planning is not as well as a new style like modernism or deconstruction; it is a way of design thinking based on harmony with nature. This way of thinking has existed for

centuries, for example, Eskimos have made their homes from local materials like the ice and snow in a way that (hemisphere) have the highest thermal efficiency to overcome the harsh Arctic climate As well as the orientation of the sun for light and heat utilization have been of attention years ago by the Greeks and the Egyptians and the Incas and many ancient civilizations. Our traditional method of architecture is also with examples formed on the environment and climate thinking and free from energy needs like Persian Gulf and Oman Sea coast cities orientation based on the direction of the sea breeze Or the use of ecological materials in different climates and eventually greater coordination of the structures with the environment, also taking advantage of introversion in the hot and dry and cold climate for the outdoor control and, ultimately, greater coordination structures with the environment and also Taking advantage of the deflector element in hot and dry climates, and hot and humid climate To achieve a clean and free- dust air flow that has been blowing in height And the use of small spaces with low height in cold climates or using drag and extroverted forms in temperate and humid climate in Iran or other more cases have proved this issue. But these methods have forgotten by emerging technology.

The views of organic architecture followers is somewhat closer to the principles of sustainable design among modern and contemporary architecture schools. Their beliefs Is interesting due to design according to the natural environment and its minimal interference in the environment.

4. PRINCIPLES OF A SUSTAINABLE DESIGN

Sustainable design is a thoughtful cooperation of architecture with mechanical engineering, electrical engineering and structures. Besides the usual design factors such as elegance, proportion and texture, shadow and light and the facilities that should be considered, the design should consider the long-term environmental, economic and humanitarian factors and follows the basic principles .

Sustainable design principles is classified into four general scale:

A: City
B: Region or area
C: Neighborhood
D: Building

5. TO ANALYZE THE PRINCIPLES OF SUSTAINABLE DESIGN IN BUILDINGS

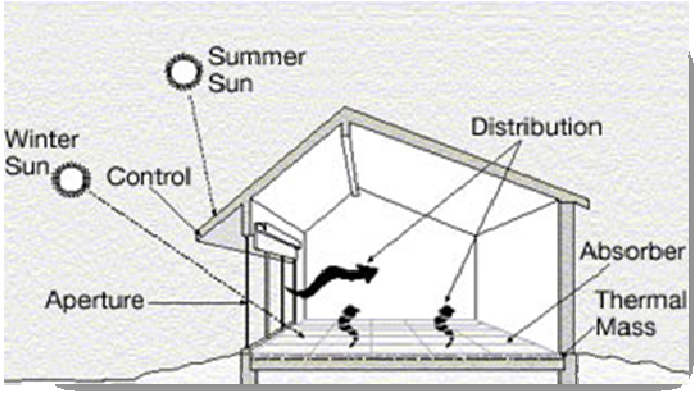
A) The use of active solar systems:

Active solar systems such as photovoltaic cells can be used in building design. The use of photovoltaic cells is very common for powering in a wide scale in the outer shell of the building and its surplus energy can be used for other uses.

B) The use of passive and inactive solar system:

Passive or inactive solar systems can be used to achieve the sustainable design. Buildings in passive solar systems are designed so that cooling, heating and lighting needs are provided in a natural and consistent with climate. They are called passive systems since it can minimized the need to operate heating and cooling equipment.

Socrates, 2400 years ago, found that: "Today, with homes in the south, the sun's rays in winter penetrate into the porch, but in the summer, the sun's path is exactly at the top of the head or on the roof, so that it shades. So the south should be larger and more elongated to get and receive winter sun and the north is made shorter to avoid winter winds.



Picture (1) passive solar thermal systems

Passive solar systems can be used easily in new and modern buildings and we will some examples.

1. The correct orientation of the building:

Establishment of building are also affected for heating and cooling loads in addition to the impact of energy consumption in building. In general, it is affective to settle the building widely to the north and south direction, significantly reducing the degree of insulation and useful ventilation. Further research revealed that the building ventilation load and energy consumption of the building to the east - west to south - north settlement will goes up again in the form of increasing the proportion of window to wall. Sometimes the building site location do not conform to the sun. In these cases, to improve the climate, it is possible to design some building components such as the ground or parking with the geographical location of the coordinated site and the plan in upper classes are in a form that windows are located in minimum insulation, north-south (in the tropics) direction. Otherwise if building plans are not designed to the proper sun orientation, the windows in the walls of the East – West should be reduced as far as possible.

2. The use of radiant heating systems:

The use of Radiant heating system is appropriate during winter with the correct orientation of the building in line with the sun and having a proper window to the south and reduce fuel consumption in winter and reduce the temperature of the building on sunny days. It is better for a building to settle in larger front in winter to collect heat from the sun. Studies have shown that optimal economic area and the building settlement in order to get the sun heat, is 5.1 to 6.1 with the ratios of north view areas to the east or west.

3. The use of materials with proper or suitable thermal mass (thermal capacity):

The use of thermal mass materials has an important role in traditional Iranian architecture. They applied the temperature difference between day and night for the benefit of heating and cooling the building by thicken walls and the use of materials with high thermal capacity, So that the heat of the day and cold at night would enter the interior during the day. Higher thermal mass of the walls and ceilings will increase the heat transfer between the interior and exterior.

4. The use of materials with appropriate heat and thermal resistance:

Material forming the outer shell of the building, should have the maximum heat resistance. Including light concrete (floor concrete, gas concrete, concrete without fine-grained).

5. To make thermal insulation of the outer shell in the building:

Thermal insulation causes a minimized heat exchange between inside and outside controlled space. We should use different types of insulation materials such as foam (polyurethane), Polystyrene), rock wool, glass wool, etc. for the thermal insulation of the outer shell of the building, including walls, ceilings and floors.

6. The use of materials of good quality and color for frontage:

Color and material of the outer surface is effective on the sun's acquired heat, Bright colors and reflective materials are preferred for warm climates and dark colors and absorbers are preferred for cold climates.

7. The use of recyclable materials:

The use of recyclable materials and the installation of materials so that they can be recycled.

8. To design windows properly

Windows are as one of the most influential factors in climate designing. Heat loss through windows is one of the most important factors influencing the thermal load in the building. A proper and good design of the window, resulting in reducing the energy consumption for cooling and improves the welfare of the residents. To analyze the effect of windows on energy consumption in the building s, we will consider two cases separately:

8.1. Increasing the layers of windowpane:

computational analysis revealed that double the efficiency of double glazed windows in the summer are less than single-glazed windows in terms of reducing energy consumption for air conditioning. Air conditioning in the summer through the outer shell is mainly due to the receipt of transferred solar heat that is why the resistance of double glazed window is only slightly more than a single glazed window. However, if double glazed windows are replaced with single windows in the winter, it has a significant impact on energy consumption. However, in the winter, due to the low thermal resistance of single-glazed windows, Heat loss through windows compromises large part of the total heat loss through the outer shell which in contrast, thermal resistance of the conductivity in double glazed windows is almost twice the thermal resistance of the conductivity of single glazed window.

8.2. Increasing the area of window to wall:

Window size, Due to the characteristics of solar thermal, must be determined by the direction of the wall So that to achieve the maximum energy efficiency balance between the maximum sun exposures in the winter, the minimum heat losses in winter and the minimum sun heat apperceive in the summer. Increase the area of the windows in winter will have little effect on energy consumption for heating because the heat loss would compensate through received solar heat. The most important factors about Windows includes: casement and sash, window size,

windows and a good type of windowpane. Sash and casement have a great impact on energy efficiency. The best type is wooden, aluminum and vinyl. Window size also has an influence on energy consumption, for example in areas where heating is significant, we should fully utilized the area of the window. Where cooling is significant, we should minimize cooling loads by creating mobile or fixed systems, awnings and shutters on the outside.

9. to Apply double glazed facade:

The use of double-glazed facade is to save and conserve energy consumption, and the holes in the façade will allow fresh air into the building and will provide the possibility of opening interior windows even for those which were in the top floor so to use natural ventilation. Another advantage of double glazes façade is using domestic air conditioning with air between two shell of façade and using dehumidifier system and heat collected between two walls as a heat source.

10. The use of double walls:

The use of advanced systems of double walls and fiberglass insulation for optimal use of sunlight (trump wall).

11. Decrease of the surface to volume ratio:

We should reduce exterior surface ratio to useful volume and the roof area ratio to useful surface of the building and also the ratios of openings in the outer shell of the building (windows and doors).

12. The air temperature control through tree planting:

Planting trees in the summer in the West and South West is practically useful to reduce heat entering the building.

13. The use of green roofs and green walls:

Green roofs, sustainable are healthy, sustainable and creates the view and are of the elements of sustainable design in modern design of ecological roofs. Green walls (vertical gardens), as well as an organism coating system having advantages such as green roofs in which different plant species grow on the surface of the building. These walls will avoid of the spread of dust in the air, and protect the building against ultraviolet radiation, rain and wind pressure.

Green roof is actually a kind of roof plants grow on its surface. Plant diversity in such a structure can be covered with artificial grass or garden which is covered with plants used in landscape design. Roof greening will cover the plants that have been carefully selected to resist against the harsh environment of the roof in terms of low / no water, climate factors, frostiness, sea breeze and drought. Plants are selected differently depending on weather and climate. Green roof or roof garden is the peak combination of performance with environment. Executive factors in such roofs are much different from conventional roofs, including insulation, thermal, waterproofing coatings, sand and also have materials and elements that can perform maintenance, moisture drainage and plant maintenance (according to Standard) in building.

14. The use of canopy:

The use of canopy, which will reduce the energy consume for cooling the building in summer is essential.

15. The use of natural light for lighting

The combination of interior spaces should be in a form, the space gain the highest and the most solar energy in terms of importance. Thus, this need can be met by putting the main spaces in south front such as living room in southeast and the kitchen in southwest direction. Northern front is for the spaces requires less light like garage and corridors and so on. If you do not take advantage of the light in south or due to inappropriate form of the building, roof window can also be used. Increasing natural light productivity and applying it inside the building by a proper design of the windows and locating the right places so that light penetrates deep into the interior space and there is no need to use artificial light during the day. The approximate area of the window to use the daylight, should be 5% of the total area of the floor.

(C) Other cases:

1. Possibility of natural ventilation in the building:

The use of natural air conditioning system, an average of 60 percent of the days of the year, can efficiently have a considerable role in ventilation of the interior space of the building.

2. Entrance filter design:

Entrance protection is important in terms of controlling heat loss and lots of energy is lost by opening and closing of the door. In a typical house, up to 10% of heat loss can be caused by transpierce of the cold weather and by the door opening and closing. Home entrance should be safe from winter winds by trees, wind break, or exposing in a cozy place.

3. The use of ecological materials:

The use of ecological materials results in the degradation of the environment and the building's coordination with external environment.

4. To prevent dissipation of energy in the building:

Infiltration of outside air into the building is a reason of heat loss in old buildings or new buildings, this happen when the warm air rises and cold air infiltrate through cracks in the building and increases fuel consumption in buildings by up to 25 times. It can be exacerbated by lanterns, high ceilings and open fireplaces chimneys and wind speed. Also, fans, air channels and air conditioning valves that are installed in some buildings, can cause the indoor air removal and replacement of the outside air.

Some of the ways to prevent air infiltration are:

• Sealant of doors and windows
• Install the spring on the door
• Fill holes and cracks
• block ceiling lanterns
• Install ventilator by automatic valve
• install valves or caps on chimneys
• Close roof's Channels
• Plant evergreen and tall plants around the building without creating shadows on it

CONCLUSION

Since a significant part of the energy consumption in our country is about the building, and residential buildings comprise 70% of buildings, energy optimization is of a high importance in this part and area. Nowadays non-compliance with the requirements of buildings administrative in terms of energy consumption, non-standard materials in accordance with climatic conditions in different regions of the country, leading to hig**h** energy consumption in the building in the country. Non-compliance with administrative standards has led to 21 percent energy loss through windows, 21 percent from the floor and 36 percent from the wall, so the development of regulations and technical standards is essential to save energy consumption in buildings. Given the high potential of this issue to fuel optimization, just with the correct implementation of section 19 and to prevent the loss of heating energy in buildings, it could be anticipated at least 6 billion$ in saving energy consumption and also reduce the cost of demolition. Thus by solutions such as roofs and green walls, and designing besides nature, we can help to sustainability and stability of both contemporary architecture and urban planning and development to ensure the protection of the environment and human life.

Green building, not only does not harm the environment, but positively contribute to the ecosystem and may even help to treat harmful effects of perspectives.

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