

Managing and Optimization of Energy Consumption and Offering Strategies to Materialize It

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Abstract

Undoubtedly, one of the most important challenges in this century in the world is energy crisis. On one hand, shortage of energy resources and its growing consumption and on the other hand, extreme usage of energy by different societies has endangered future life of human, polluted the environment and wasted national capitals. There are different methods to protect environment. The most common is saving that is not obtainable without correct management of energy as well as culture-making for correct using of energy. This paper tries to introduce useful and practical strategies to optimize energy consumption including Nanotechnology, natural gas energy consumption, floor heat systems in buildings, using natural light and Building Energy Management System (BEMS)

Keywords: Energy Management, Optimization, Consumption Standard, Smart Control.

Introduction

Human wish to reach perfection explains the theory of optimization. Human wants to depict and describe the best things and gain them.

The verb "optimize" that is stronger than the verb "improve" means achieving an optimized method. Therefore, the theory of optimization includes quantitative studies of optimizations and the ways to get to them. A thought, idea or plan that is raised by a scientist or engineer will improve during the process of optimization. None of human actions has a one hundred percentage return. So, optimized usage and prevention from wasting facilities are essential. This will become more important when the issue of energy is raised.

Nowadays, energy has been known as one of the most important factors for forming and developing industrial societies. So that country's access to various resources of energy represents their political and economic power. The high prices of energy and its huge costs in investment sector, on one hand, and rapid industrialization of societies and their increasing need for energy, on the other hand, have made countries adopt strategies called energy consumption optimization to prevent limitless consumption of energy, reduce production costs and increase public welfare.

Energy consumption optimization means choosing and adopting methods and policies for correct using of energy that is desirable from national economy point of view and guarantee energy stability. In this context, we determine the share of different forms of energy in energy basket of every society based on its long term facilities, the most effective way of using them that warrant the reduction of energy resources destruction as well as the reduction of negative effects of incorrect usage of energy on environment.

Constructing facilities for generating electricity and electricity networks needs huge costs. In addition to financial issues, constructing power plants also needs a lot of time. Also, sometimes current and fixed costs of power plants for a year exceed 20 percent of the initial investment. Therefore, reducing electricity consumption is highly effective in maintaining national products.

In addition to financial issues, there are also other factors that show the necessity of energy consumption optimization:

Population growth and the need for more energy
Energy resources limitation due to their unrenewability
The high increase in energy consumption due to incorrect pattern of energy consumption.
The lack of systems for recycling energy
The existence of old industries and factories
The dependence of national economy on oil revenues
The increase of greenhouse gases and acid rains

In order to optimize energy consumption, we must, at first, determine a set of consumption standards in different sectors based on the latest levels of technology and other factors affecting energy consumption. Then, they should be introduced to consumers and produces of different sectors in terms of feasible strategies. Hence, we can get energy consumption pattern to some extent close to the level of determined standards. In order to continue such a trend, we must use supporting polices and preventive-motivative tools.

Therefore, the following steps must be taken into account in every economic sector in order to save energy:

- Implementing saving plans and doing energy audit
- Writing standards and criteria for energy consumption
- Examining supporting policies like granting low-interest loans

In optimization, the initial condition was investigated by different methods and the collected data was used to improve a thought or method. Optimization is a mathematic tool that is used to find an answer to many questions concerning how to solve different problems. In this paper, due to the importance and necessity of energy consumption optimization, after the review of the related literature, we deal with optimization methods and use them in saving energy.

Review of the Related Literature

After the oil crisis in 1970s, different countries have tried to optimize energy consumption in order to be able to reduce energy costs and decrease the use of energy resources thereby protect the environment and continue their higher economy growth (Hap Basly & Ozalp 2003). Although developed countries have succeeded to pass the crises of 1970s using economic strategies and technology and reduce their energy consumption, the researches show that developing countries have not been successful in their economic and technological strategies owing to technology shortage and insufficiency of motivation of energy saving and access to inexpensive energy (Samti et al 2007).

So far, useful steps have been taken in Iran to optimize energy consumption. These steps include: writing standards and criteria for energy consumption, establishing and developing national laboratory of saving energy, Energy consumption and management in industries, energy audit in buildings, providing optimizing and advising softwares, educational activities and awareness. Despite of the taken steps, there is a wide variety of potentials for energy consumption optimization. If proper strategies are used, we obtain the following results: reducing energy demand, decreasing the growing rate of increasing power plants, improving production pattern, consuming and improving the use of the present system and releasing the capacities of more active presence in international market of energy.

In recent years, many researches have been done in order to optimize energy consumption in different strategies using optimization methods:

In 1940, a man called Sam Loet used floor heat systems to optimize energy consumption. Also in Iran, in cold and mountainous areas like Azarbayjan, this method has been used mostly in bathrooms. Mahmoodi and his colleagues (2009) have examined the role of nanotechnology for

providing suitable material for reducing energy consumption in different parts of building directly and indirectly. They analyzed the way nanotechnology is used in the following areas.

Optimizing energy consumption in buildings

Clearing the air of residential areas

Accessing to renewable materials that are durable and do not damage the environment.

Taghi Zadeh and his colleague (2010) investigated the role of energy management system in optimizing energy consumption in non metal industries. The results of this research show that energy management reduces energy consumption, production costs as well as pollutant gases.

Kardar Pour and his colleague (2013) carried out a research examining the energy waste in cement industries and the strategies to optimize energy consumption. They have proposed strategies to reduce energy waste regarding energy consumption optimization.

Describing Optimization Methods

The following methods can greatly affect effectiveness, saving and production of energy and reduce energy consumption: Nanotechnology, optimizing the energy obtained from natural gas, roof heat systems in buildings, using natural light, using Building Energy Management System software and using energy analysis softwares.

We describe them as follows.

Nanotechnology

Nanotechnology is the ability to produce materials, new tools and systems and control molecule and atomic level of them and use the properties that appear on their surface. Given to the extreme use of renewable energy and environmental energy, energy situation in the world is critical that paying attention to this issue is a solution for survival and maintenance of environment for future generations. Nanotechnology has changed other technologies and it has greatly affected the health and tranquility of people. Nowadays, different countries have used nanotechnology and combined it with other expertise. They have gained achievements including lower maintenance and production costs, low energy consumption and longer life.

Regarding the major changes in light technology (LED) in the next 10 years, we can produce a lot of semiconductors used in light diodes at nano scale. In USA, in buildings almost 20 percent of the generated electricity is used for lightening ordinary and florescent lamps. Based on the predictions, in the next 10 or 15 years, such developments can reduce over 10 percent of energy in the world that this in addition to saving energy can reduce carbone release in atmosphere. Inexpensive solar energy can easily be explored using nanotechnology. Imitating from nature, researchers seek to produce sustainable inexpensive solar energy. Nanotechnology researchers including Professor Nit Louis at California Technology Institution are examining nanomaterials. They imitate the lawn architecture and photos antis used in the materials to take and save solar energy. This scientist and his colleague have been able to enter little nanoparticles in every day products like house paint and ceiling poultry. They evolved solar energy production. Researchers believe that the amount of light coming from sun to earth is more than all the energy human uses for a year .

Nanotechnology Applications

One way of nanotechnology in green buildings is using nanomaterial by which we can prevent energy waste. A lot of architects have tried to use an insulation in buildings that is useful for wasting energy using solar energy and air and water treatment. Using walls with thin layers of carbon and titanium oxide. These covers are water-proof and resist against erosion. They are the healers of environment because they destroy the polluted air around the buildings and consume less energy for heating and cooling the buildings. These covers that have been designed using nano

clean the buildings and make people and environment healthy. These insulations are highly absorbent because they have nanoparticles that absorb light and produce electron.

Optimizing Energy Consumption of Natural Gas

The increase in natural gas consumption is worrying. Therefore, offering suitable strategies to reduce consumption is necessary. It is over three decades that the major countries of energy carriers are seriously seeking to reduce energy waste and optimize energy consumption. As a result, they have been able to considerably reduce the costs related to energy saving and stop the destruction of environment. The other outcomes of implementing policies of energy consumption include promoting production technology, reducing government costs related to fuel subsidies and the like. Residential areas consume one thirds of energy in the country. Given the amount of gas energy consumption in different parts of an apartment, the priority is given to examine and offer strategies to reduce gas consumption respectively from the wall of the building, the waste from heating system, hot water and cooking. Unluckily, a great amount of natural gas energy that is the main source of supplying energy for residential areas is wasted by heating systems. Heating systems waste is divided into two parts: 1- Energy waste from the equipment, heating system production, heat transit devices; 2- the waste from the wall of the building. Given the heating system and equipment, a limited amount of energy enters the apartment and a considerable amount of this is still wasted due to the inappropriateness of the wall.

Floor Heat System

Floor heat system is radiation transfer of heat. It plays an important role in the process of heating. It has many strengths in comparison with other heat systems regarding energy saving, energy consumption optimization and the welfare of the residents.

In recent years, floor heat system has become very common in Europe and USA because of its growing energy consumption optimization, equal distribution of heat in all parts of the house. It also does not have the problems that other methods have like darkening the wall and erosion of the pipes and so on. . Using floor heat system for heating the house has been done in different ways. Romans built canals under the floor and enter the hot air into it. Koreans transfer the smoke of burning under the floor before it passes the chimney.

Generally, there are three methods of floor heat system including heating with hot air, heating with electricity, and heating with hot water.

Hot air method is not that economic in residential areas since ho air can not trap much heat in itself and electrical method is only economic when the price of energy is low. In comparison with the said methods, hot water heating (hydrolic) is more economic and pleasant. This is why it is used in the world for many years.

The Advantages of Floor Heat System

Floor heat system is known as the most convenient and natural and healthiest method of heating. As people feel warm in a cold winter day by the radiation of sun, in this method, they receive heat by transferring radiation heat from the floor and certainly they feel more relaxed. In this heating system, the temperature of the hot water in the pipes of floor is between 30 and 60 Centigrade that in comparison with other methods that the temperature is between 54 and 71 Centigrade, 20 to 40 percent of the energy will be saved.

In buildings with tall ceiling, using floor heat system reduces energy consumption since in other methods hot water becomes light due to density and it goes toward the ceiling and the firs place that it makes warm is the ceiling.

Due to the high temperature in the ceiling, the amount of heat transfer to the ceiling is more than anywhere and this wastes a lot of energy. In floor heat method, first, the floor that is needed by

the people is warmed and the air reaches the ceiling with lower temperature that is one of the main advantages of the system.

The other advantage of floor heat system that has received a lot of attention today is the tranquility of the people so that the tranquility of the person is provided in the building without any limitations. Unlike the radiator system that makes the air of the house dry due to extreme heat, floor heat system keeps the humidity mild. Meanwhile, most people are not satisfied with the radiator and electrical heating systems because they make the walls and the environment dirty. Since in floor heat system, air flow comes slowly from the floor to the ceiling, therefore, the walls will remain clean.

One of the other ways of optimizing energy consumption in floor heat system is doing it with solar energy. In this method, the hot water needed for floor heat system is provided by solar energy instead of using fossil fuel, therefore, using a renewable source of energy, there would be considerable saving in energy consumption.

Optimizing Energy Consumption Using Natural Light

Lightening system consumes a considerable amount of electrical energy. With respect to energy consumption optimization, using natural light has a lot of advantages. Designing lightening system during day for using more natural light is in a way that reduces energy consumption. If suitable steps are taken to use natural light and the designing is based on lightening engineering principles, we can reduce energy consumption in some industries. In other words, using natural light instead of artificial one is a step toward optimizing energy consumption and reforming consumption pattern for providing lightening in building.

Moreover, given that building power plant needs huge amount of capital, investment in saving energy consumption is more economical than investment in building new power plans. On the other hand, regarding the release of environmental pollutants and greenhouse gases from power plants, with respect to supplying the required electrical energy and different environmental costs related to it, paying attention to electrical energy and its optimized consumption seems to be very important. The direct result of using natural light is reducing energy consumption and saving in the costs of lightening system.

Energy Optimization System (BEMS), Smart Control of Facilities

BEMS system is a central digital board that has replaced the common boards. It makes distributed controls possible using developed digital circuits. So that it covers all the lightnings of building, heating and cooling system, specific outlets. It is a smart system that considerably reduces energy consumption. The system is sensitive to destructive voltages, electrical shock and prevention from the leakage of electrical current. When the leakage of electrical current, gas current and water flow is identified, the orders are issued by telephone line and then order is issued to cut the water, electricity and gas current. In addition, the system has sophisticated alarm alert, fire alert and earthquake alert and it is equipped with voice telephone in a way that when needed, it announces the danger by telephone and voice warning. The system is able to connect all electrical equipment together, program them and transfer the relevant data to the outside. Even when you are not at home, you can issue the required orders.

Using Smart Management System in lightening Control Systems

If lightening control system is properly designed, it is able to save 30 to 50 percent energy. It is necessary to arrange the level of lightening based on natural levels of lightening or the presence of people or a combination of both of them. Sensors can switch off the lamps when there is no one at home. It is better to use natural light controls with low light rather than using on-off outlets. Not only do most kinds of controls provide a control based on the presence of people, but they also respond to the natural light of day and the presence of people by low light controls and ON or Off.

Comprehensive Energy Consumption Optimization Software in Residential Buildings

The considerable share and growing trend of energy consumption in residential sector from the total amount of the final energy consumption in the country and the important role heating and cooling systems and lightening make using experienced and effective methods of saving energy consumption in buildings inevitable. One of the methods of optimizing energy consumption and necessary instruments for examining energy consumption in buildings are applied programs called energy simulation software or building energy analysis.

The importance of such softwares with their features and abilities are explained as follows. The increasing growth of energy consumption on one hand and the importance of protecting and optimal exploitation of fossil fuels on the other hand have made programmers pay attention to new management methods of energy consumption and energy saving.

The research project titled "Designing and Providing Energy Consumption Software in built and unbuilt residential buildings in all parts of the country (Behsazan Software), with the goal of completing the previous activities, was begun in early 2001 and finished in late 2003 in order to provide a software for optimizing energy consumption in buildings regarding the climate of different parts of Iran the present materials in the country. The project was designed to provide a software for examining and optimizing energy consumption and analyzing energy saving in built and unbuilt residential buildings in different cities based on the properties of the building, climate of the place, performance of the equipment and the results of economic analysis that can minimize the amount and cost of energy consumption in buildings during exploitation based on choosing the best architectural plan, the most suitable materials, the most fuel-efficient heating and cooling systems and lightening systems and the most economic opportunities for saving energy.

The Advantages of Using the Optimization Software

Using energy analysis softwares in buildings has direct effects as follows:

- Saving in energy consumption (electricity and gas) in buildings
- Reducing the use of cooling equipment in buildings in hot seasons of year
- Reducing consumption in lightening system at early hours of night
- Reducing the release of pollutant gases in urban environment

Standard of Energy Consumption and Building National Regulation

One of the most important strategies to decline electrical energy consumption that have drawn the attention of many countries is writing the standard of energy consumption in buildings based on the architectural plan and the properties of materials used in the building. Article 19 of the national regulations of building in Iran includes issues that evaluate the quality of building architectural plan base on the potential to save energy.

One part of Behsazan software is the subsystem of calculating building national regulations that can determine source values for different cities, the said calculations in national regulations for values of building plan and compatibility or incompatibility of building plan. Since all the outer layers of building (walls, roof, floor, windows, doors and partitions) are defined in modeling part of the software so performing the calculations of national regulations will be made possible through asking about near buildings (their distance and height) and electrical equipment used in them for cooling and heating. For new buildings, the potential for saving energy in the building will be calculated based on the city and the area of the building and minimum coefficients for transferring the heat needed for the outer layers of building is offered to help building designers use materials that have the most amount of saving in building. Also, the permissible coefficients for transferring heat for different layers will be calculated for built or old buildings and then they are compared with

the coefficients for transferring heat to the outer layers of the present buildings in order to identify inappropriate layers and the general situation of the building in terms of energy consumption. Apart from showing the final results of calculations that are the coefficients for transferring heat in building plan, building national regulations system shows the values of coefficients for transferring heat to all outer layers of building for comparison with source values. This can help designers to reconsider the design of those outer layers in the modeling if heat coefficient transfer of every outer layer of building goes beyond the source limits and continue the reforms to achieve the acceptable results through changing the properties of that outer layer or those outer layers.

Regarding the high consumption of energy in residential and commercial sectors, particularly electricity consumption at early hours of night (peak hours) and summers (every year) and the compulsory enforcement of article 19 of building's national regulations, we can expect to remarkably save energy in cooling and heating systems, lightening and hot water using Behsazan software or similar softwares to design new buildings or giving opportunities to save energy in old buildings.

Strategies to Save Energy in Buildings

The followings are other strategies to save energy in buildings:

Adding insulation to the roof, floor or walls that are virtually feasible.

Using light color materials to reduce the heating load of sun radiation in buildings with good ventilation when repairing the roof

Ventilation of the spaces under the pipeline

Using reflector layer in windows to reduce coolness

Installing window shade or curtain in windows to reduce cooling and heating load

Installing UPVC instead of ordinary windows

Replacing door and window frameworks with suitable ones

Water tightness of the windows

Eliminating the extra middle distance among double entrance doors

Installing watertight tape around the doors and windows

Changing the broken windows

Keeping the doors of storages and garages as closed as possible

Conclusions

Nowadays, regarding the population growth and the decrease of energy resources, problems resulting from environment pollution and energy security, optimized use of energy is one of the most essential issues that both consumer countries and supplier countries are struggling with. So, energy consumption optimization is an evident issue. The shocking statistics suggest that energy consumption share in building sector in 2013 was about 40 percent of the total energy of the country that is virtually more than energy consumption in industry and agriculture. Energy consumption per capita in Iran is 5 times more than the world average and 13 times more than energy consumption per capita in China. Therefore, optimized heating systems in buildings and building complexes play an important role in controlling and optimizing energy consumption.

In Iran, Buildings are one of the most important consumers of energy. So, it is necessary and useful to offer suggestions to save and optimize energy consumptions. It may cause considerable energy saving (25 to 45 percent). Regarding that in designing most of present buildings, the criteria and standards for saving energy are not fully observed, some researches must be carried out considering the facilities to enforce economic parameters using present systems and methods in order to reduce energy consumption on one hand and offer economic justification for the proposed

activities on the other hand and the capital return is done within the shortest time. In order to achieve the goal of optimizing energy consumption of natural gas in residential areas, it is necessary to observe the correct pattern of consumption in high consumption places of building as the sensitive points.

The studies show that improving the efficiency of industrial processes, equipment yield, machines to convert energy and enforcing energy management programs are among the activities that are now being done in the world to make energy consumption logical. At the present time, it is clear that first, there is no serious motivation to improve energy consumption in the industry of the country, second, if there is a little motivation, there is enough and necessary awareness and recognition from energy audit. Third, there is no necessary knowledge and awareness on the methods and strategies of modifying consumption pattern and improving the process. In order to prevent unoptimized and limitless energy consumption, reduce production costs and increase public welfare, some policies called energy consumption optimization must be enforced. In order to optimize energy consumption, we must determine a set of consumption standards for different sectors based on the latest technologies and other factors affecting energy consumption and then offer them to producers and consumers of different sectors in terms of strategies that can be enforced. In Iran, due to low prices of energy including fossil energy and electrical energy, unfortunately, consumers and particularly managers of industries do not pay attention to decrease or improve energy consumption. It is clear that extreme usage of inexpensive energy cannot last forever. Even, using renewable energy has its own environmental problems. There always will be continuous pressure to reduce energy demand as well as protect natural resources in order to correctly use them. In Iran, energy consumption of many present industries is about three times more than the energy consumption of the three past decades and this means the impossibility of competition for Iranian products in world market. On the other hand, increasing energy prices like oil and gas prices in recent years, gradually the price of energy in Rial for produced goods has increased. Regarding the high rate of energy consumption in Iran compared to other countries, important steps must be taken to optimize energy consumption as soon as possible otherwise energy price in Rial will increase and therefore there will be no possibility for Iranian products to compete with foreign products. So, we must take important steps to optimize energy consumption in Iran as soon as possible.

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