

# The use of solar energy using nanotechnology to reduce energy consumption in biological buildings of Parand

Faezeh Asadpour<sup>1</sup> and Hosseinali Jamshidi<sup>2</sup>

<sup>1</sup> Master student of Architecture, Maziar Institute of Higher Education, Royan, Mazandaran, Iran,

<sup>2</sup> PhD of Architecture, Faculty member of Islamic Azad University, Savad kouh, Mazandaran, Iran.

Received: July 24, 2015

Accepted: September 31, 2015

## ABSTRACT

Solar energy is one of the free energy sources, clean and without environmental destructive effects. Due to the energy crisis in recent years as well as the reduction of pollution and energy saving, demand control and energy supply, replacing this renewable energy with fossil fuels is so important, however the simple use of new technologies such as nanotechnology in order to use solar energy in hot and dry areas of Iran, with respect to its climate potentials, as an useful healthy and safe resource for energy supply required for the biological buildings of Parand has been of the most practical and most affordable methods to use renewable energies in the world today, and this has led experts in the industry in Iran to be heavily are investing in this field. Thus in this paper, with documentary research and field survey, we have tried to conduct a detailed study on the biological buildings of Parand and adjust them with nanostructure technology in order to better attract solar energy, and it was concluded that according to the weather situation of Parand region and the solar radiation we can investigate for energy saving without environmental destructive effects in order to plan for a better future.

**KEYWORDS:** solar energy, nanotechnology, energy saving, new city of Parand.

## 1. INTRODUCTION

Today the optimal utilization of resources and potential powers of each country within the framework of the objectives of human environment has become as one of the main local, national and international concerns. This is more important in arid and semi-arid areas of the world and Iran especially outskirts of Tehran including new city of Parand, due to the vulnerability of biological vital and resources, fragile ecosystems of the region, climate pollution creation at the micro level, intensification of landslide hazards, noise pollution, underground water and solid wastes, increasing the burden of population and therefore increasing the pollution of area that are somehow as the factors of declining the quality of the natural environment in this city, since the pollution gradually will have irreversible effects not only on physical form of human communities, but also on its public behaviors and norms, the use of various technologies to create well-being, comfort and more savings on costs and reduce environmental pollutants is considered important, therefore, to understand and identify the enormous capabilities of these revolutionary technologies leads to organizing and developing many national programs in many countries of the world [1]. Because the main source of energy used in the country so far has been Fossil fuels, especially oil and gas resources, and the resources would stay for the next few years without an integrated planning, given to these important cases using solar energy is more increasingly evident than before. As the solar energy is basically consistent with the nature and has no pollution and it's also renewable so there is no end to it, however, nowadays, with the use of new technologies, including the newfound nanotechnology, the optimal use of this great and renewable energy could be provided [2].

Accordingly, in this study by identifying the present environmental problems in Parand and fast construction process and with appropriate use of solar energy in providing the energy needed for biological buildings of Parand using nanotechnology, it has been tried to increase its performance and efficiency, to reduce production costs and to facilitate the way for production process and its use, according to geographical and climate characteristics of warm and dry region of Parand and the potentials in it, in terms of receiving solar energy in order to optimize fuels consumption and reduce environmental pollutants, so that to provide the man with maximum comfort in his life and subsequently on a more general perspective, to increase the quality of the urban environment

## 2. Concepts and definitions

### 2.1. Solar energy

Solar energy in the core of the sun is in fact nuclear energy. In 25% of the inner layers of the sun, hydrogen is converted into helium at a speed of kg per second. The amount equals to the mass shipped on 10 million railroad cars. So there is no concern on the completion of the energy, because the sun has enough hydrogen and the trend will be continuing to 5 million years later. The energy production becomes double by the gravitational density and maintains the core of the sun at a temperature of about 16 million kelvins (29 million Fahrenheit degrees). At the beginning, the heat radiates from the core and then it is driven toward the sun's surface that remains at a temperature of 5800 Kelvin degrees. The first

\* **Corresponding Author:** Faezeh Asadpour, Master student of Architecture, Maziar Institute of Higher Education, Royan, Mazandaran, Iran, Email: [Asadpoor.faezeh@yahoo.com](mailto:Asadpoor.faezeh@yahoo.com)

transfer of energy from the sun's surface is the electromagnetic radiation. This heat transfer largely depends on the surface temperature of material and type of the energy [3].

## 2.2 . Nanotechnology

Nano is a Greek word that means small which is used to determine a billionth value or  $10^{-9}$  of a quantity. As an atom is almost 10 nm, the correction is applied to the general study of atomic and molecular particles [4].

Nanotechnology is the study of particles at the atomic scale to control them. The main objective of the majority of nanotechnology research is the formation of new compounds or the creation of changes to existing materials. Nanotechnology is used in electronics, biology, genetics, aviation and even in energy studies [4].

Nanoscience and nanotechnology is the ability to take control of matter on the nanometer scale (molecular) and exploitation of properties and phenomena of the material, the new tools and systems. This simple definition itself contains many meanings. For example, nanotechnology with its interdisciplinary nature, in the future will include all the modern technologies and rather than competing with existing technologies, it handles their growth and will integrate them as a "letter of science" [5].

## 3. The introduction of new town of Parand and its climatic and environmental potentials

### 3.1. The introduction of new town of Parand

New city of Parand that has been constructed to accommodate a part of overflowing population of the south-west of Tehran and the establishment of a number of transitional industries of Tehran in its industrial area consists of two industrial and residential areas. Of the main characteristics of this town are the proximity to the urban center of Robat-Karim and Imam Khomeini International Airport as well as the establishment in Tehran-Saveh highway. The city lands are widely extended in the southern highlands of Robat Karim and the north of Shoor (salty) seasonal river (Figure 1) [6].

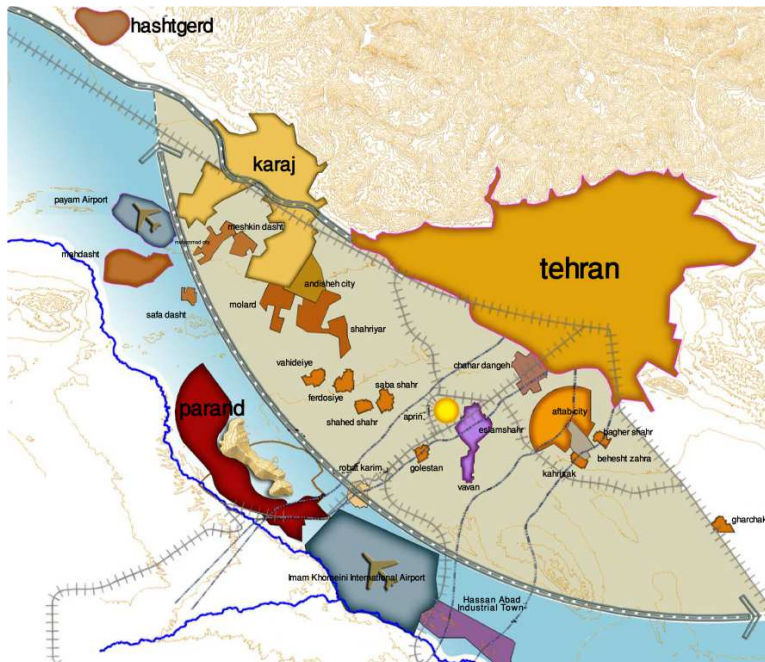


Fig. 1. Parand location to metropolitan Tehran

### 3.2. Geographical Location

The lands of new city of Parand are located in about 40 kilometers of southwest of Tehran. The lands are indeed the southernmost lands in Tehran's southern suburbs and the population centers and agricultural lands are deployed in the northern part of that, so that the city of Robat Karim, which is considered of the southernmost regions of Tehran is located at a distance of about 10 kilometers of northeast of the lands (Table 1).

In general, if Tehran is considered as a metropolitan core according to the map, and its southern suburbs including agricultural lands and rural population places and towns are considered as the shell of the core to a radius of about 35 km around Save the last point in the current situation will be Robat Karim area [6].

### 3.3 . Climatic conditions

Based on information and statistics of the weather station of Karaj phytology garden (as the closest weather stations in this area), the amount of annual precipitation in the region is 21.4 mm. The average maximum and minimum temperature in the region for July has been reported 35.9° C and -5.3° C, respectively. The average annual temperature is reported 15.6° C as well. Winds in this area, due to its geographical location and terrains is also a function of the general situation

of Tehran that the prevailing wind is "west winds". New city of Parand is located between two geographically different regions (high mountainous area of Alborz and its southern slopes foothills in the north, and the plains on the edge of the desert in the south and southeast). Being located between the two regions rises two slight and slow flows of air, one from the plains to the mountains (during the day) and the other is from the mountains to the plains during the night, that is generally considered as the desirable weather [6]. In this way and according to Table 1, the weather of Parand is influenced by hot and dry weather in central parts of Iran.

**Table 1.** Geographical location of the town and its surrounding

<b>Geographical Location of new town of Parand</b>	
<b>The geographical location of the town and its surrounding</b>	<b>Southwest of Tehran and the southern slopes of Takht Rostam in 1200 meters above sea level</b>
<b>Climate situation of the town</b>	Semi-arid desert
<b>Macro-regional land use</b>	Lacking of any agricultural activity or forest and grassland
<b>Restrictions on development</b>	Topographic and slope constraints in the north and parts of the city
	Shoor (salty) River and its floodplain in the south
	Climate
	Large fluctuations in temperature during the seasons of the year and increasing physical erosion
	Status of faults and earthquakes
<b>Development Facilities</b>	Location of all lands of Parand in the area with high risk on zoning done by the International Institute of Seismology and location of the lands of Parand in the area with high and so high risk according to the research center data
	water resources
	Lack of water resources
	Geographic
	The diversity of topographical characteristics
<b>Development Facilities</b>	appropriate slope to collect and direct surface water in the city
	Soil
	Flat and low slope lands in the north west for city development
	Lack of agriculture within the city range and lands development
	Climate
<b>Development Facilities</b>	Relatively good thermal bioclimatic domain
	Appropriate wind blow of Shariyar
	Hydrology and Geohydrology
	Shoor (salty) River with the possibility of beach building and beautification of the riverbank
	Water supply
	As steps by Tehran regional water company and of regional water resources

#### 4. Construction status of Parand

This way, the realities on the possibility of delay or non-realization of plans, despite significant progress in housing construction operations, strongly affect the demographic changes trend in the town, and accordingly the minimum and maximum population scenarios, including taking into account the acceleration of normal as well as the maximum possible acceleration in the process of realization of projects and development programs have been prepared, which, that unfortunately in order to achieve the predicted population horizon, one of the solutions of providing housing in line with the policies predicted is Mehr housing, that the notable point is that despite the fast housing construction of Parand, but the servicing systems have failed to be aligned with it and providing services and infrastructure facilities has become one of the major concerns in the development of this city (Figure 2). In general, it can be said urban equipment status in the current situation is not sufficient even for the population living in the city, because the urban equipment acts as nutritious veins and arteries in the city [6]. and in the case of lack of supplying and strengthening that as well as arbitrarily operations without appropriate management and monitoring will cause damage to the environment around. And even in construction technology of city buildings according to the government policies the only factor of accelerating the work is to deliver units as soon as possible to owners and settle them, and the aesthetics and biological factors are ignored, because the use of appropriate construction technologies given the existing potentials of Parand can be a solution to prevent and reduce the destructive effects of the environment (Fig. 3) [3].



**Fig. 2.** A view of the construction of Parand





**Fig. 3.** The use of new construction systems in new town of Parand

### **5. The necessity to use solar energies using nanotechnology in biological buildings of Parand**

Solar energy is one of the free energy sources, clean and has no environmental destructive effects. The energy crisis in recent years have prompted countries to differently deal with energy issues, and at the meantime fossil fuels replacement with renewable energies such as solar energy in order to reduce energy consumption and energy saving, control and demand and supply of energy and reduce emissions has faced with great welcome [2]. Therefore, in the case of biological buildings, the use of radiation and temperature criteria play more obvious role. Construction waste energy landscape in our country reflects the impact of models, which have different climate standards than the country, on buildings design and new architecture in cities of Iran. Given that solar energy plays a significant role in buildings architecture, the climate position to provide refined information on the sun radiation in the extent of the country and to estimate this information in the absence of direct measurements is empty in the set of investigations and offering climate-related thresholds can meet the needs of engineers in this field [7].

Cities that have a warm and dry climate and always face with extreme summer heat, severe winter weather, excessive dryness of air, hot dust in summer and cold winter winds throughout the year severe generally have rough and incompatible climate in desert areas. In the past, cities were formed organically by people. For this reason, to overcome the adverse climatic conditions, they built towns in the opposite direction of the prevailing inappropriate winds and to use favorable winds they built compact cities not to be against very hot winds in the summer and very cold winds in the winter, the passages were also located as very narrow routes and tracks through the residential tissues in the opposite direction of wind. Moreover, tortuous passages and covered paths led to create much difference between the sun and shadow temperature allowing pedestrians' traffic in the very hot summer. On the other hand, with the creation of gardens and farms around cities as a green belt, the sun's heat reflection of desert dry and scorching soil was prevented [8].

Thus, in the past, residents of towns in the hot and dry climate of Iran, using local materials of desert dry soil and overcoming the environmental conditions could provide favorable climatic conditions for themselves. But in the present era, using innovative technologies, the unfavorable climatic conditions governing these areas are used so that they have the lowest environmental risk and lead to economic savings as well. One of these technologies is the use of long sunlight in these areas to be a step towards reducing energy consumption [3].

In the hot and dry climate, which has severe storms with sand and excessive heat, especially in the summer, the use of technology in harmony with nature and environmental conditions becomes more necessary. For example, due to the intense radiation of sunlight in the summer and extreme cold in the winter, and installation direction of solar collectors on the south to southeast of the building in order to use the most energy in the summer is good. And also to prevent damage from strong winds and damage to installed panels, direction and slope of them should be taken into account according to the region climate and different wind direction in the winter [3].

### **6. Nanotechnology and its application in how to use solar energy to reduce energy consumption**

Low cost solar energy can be easily exploited with nanotechnology. Among these uses are the items as follows:

#### **6.1 . The role of nanostructures in polymer solar cells**

One type of photovoltaic cells is polymer solar cells. Because of the numerous potentials such as low weight, flexibility of low cost construction and the possibility to prepare in large scale should be taken into consideration. To increase the efficiency of photovoltaic cells new measures has taken. One of the measures is the use of nanostructures in solar cells architecture as an electrode or active ingredient. The nanostructures usage is much more effective due to the ratio of surface to high volume in increasing light absorption and carriers' transmission and ultimately the efficiency improvement [9].

Nano solar Company has developed quick and easy technology of printing solar cells using nanoparticles and quantum dots. Since these cells are easily printed on flexible metal foils to the desired sizes, they can be used by installing the necessary circuits on the roof of buildings to supply part of their energy (Figure 4) [10].

### 6.2 . Photovoltaic coating as building's roof

Titanium dioxide is a common material for photovoltaic coatings. It is a non-specific light diffuser and an ultraviolet light absorbent. The first feature makes titanium dioxide a very good material for white color and the second feature creates the feature of self-cleaning and protection against UV light.

Titanium dioxide is a compound semiconductor that exists in three chemical forms: Anatase, Rutile and Brookite. Only the first two types of this material are used in various applications. Although the band gap energy of Anatase is slightly larger than the band gap energy of Rutile, (3.2 eV to 3 eV) its photovoltaic activity is more. For this reason Anatase and Rutile are usually used as photocatalyst and white pigment, respectively. Photocatalytic activity of this material is based on the absorption of ultraviolet light in the range of higher than 3.2 eV that is equal to wavelengths less than 388 nm.

By absorbing ultraviolet light, electrons are transmitted to the conduction band, and as a result a hole is created in the valence layer. In non-photovoltaic materials, load carriers (electrons and holes) are once again together. But if the time of recombination is long enough, the electrons and holes can cause free radicals. As a result, the nanoparticles of titanium dioxide can be used for the production of flexible solar cells. Coating the surfaces such as roofs of buildings and glasses with the solar panels makes the possibility to produce electricity using the sunlight. Today prefabricated coatings could be purchased and installed on the roofs of buildings, which can be supplied in different types [10].



Fig. 4. the use of solar cells on the roofs of modern buildings

### 6.3. Nano glasses to reduce energy consumption

#### 6.3. 1. Low-emission nano glasses with coating

You can insulate glass windows using nano coatings and optimize heat exchange and give glass the so-called property of low emission. In this case, their role in reducing energy consumption would be undeniable (Figure 5).

Nano coating on the low-emission glasses allows the transmittance of light's visible spectrum, but it reflects and filters out thermal spectrum (infrared) and harmful radiation (UV). These glasses greatly reduce the heat transfer caused by the temperature difference that is a combination of conduction, displacement and radiation phenomena and they control radiative heat transfer (solar energy) as well.

According to these characteristics, the use of this type of glass has the benefits including thermal comfort in both the winter and summer, reduction of annual energy costs, prevention of harmful sun rays with proper lighting for the building and thereby reduction of the cost required for lighting [11].

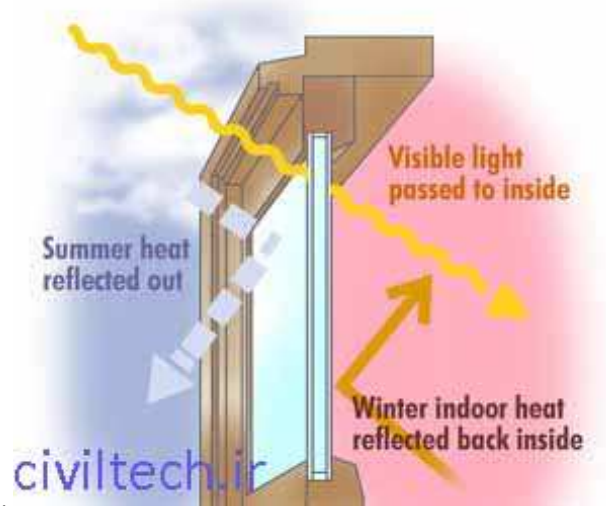


Fig. 5. energy management by low emission glasses

### 6.3.2. Smart windows (polyaniline nanowire arrays)

More recently, scientists were able to construct windows in which supercapacitors had been used. The supercapacitors are placed in the electronic windows, windows that are able to change color. When the sunlight is intense, the windows absorb light and store in them, when the windows' capacitance is completed, glasses are dark and limit the light transmission. This way the amount of light coming into the house and its temperature is controlled and on the other side, the energy stored in it can be used in electronic devices such as television screens. By consuming the energy stored in the smart window by other devices, capacitors are discharged and re-charged by absorbing sunlight.

These smart windows are made of polyaniline nanowire arrays that are deposited onto a transparent film, transparent films are themselves covered by conductive layers. The nanowires are coated by an electrolytic gel to be used as electrodes. Two electrodes are wrapped around each other as a sandwiched to provide a new structure (Fig. 6) [11].

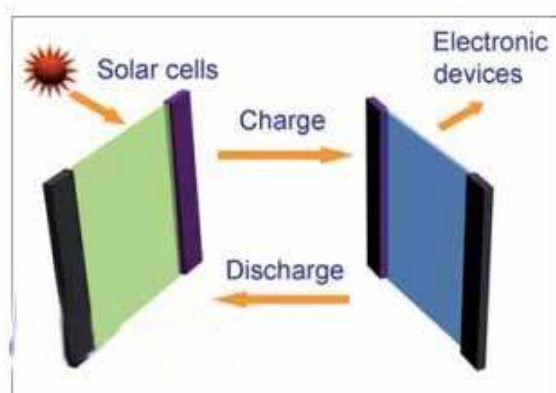


Fig. 6. glasses that convert sunlight into electricity and store in supercapacitors.

### 6.4. Changing color tiles to avoid energy waste

If until now you have walked on the roof of your house with bare feet in a sunny day, with burning your feet, you notice this phenomenon that dark surfaces absorb heat. In the wintertime, it can be good for us because it will reduce the cost of fuel. But making home warmer in the summer causes excessive use of cooling system and it's not pleasant. The reason that most people tend to have white roofs is that it's more appropriate in terms of energy optimization. The problem of energy loss is not a small problem that can be ignored.

So students of MIT have created tiles which change color based on temperature change, that is, when it's hot they become white and reflect much of the sun's heat and when it's cooling they become black and absorb heat. (Fig. 7) In the design an aqueous solution of a commercial polymer was used that is commonly applied in hair gels. The prototype for this solution was encapsulated between layers of glass and plastic and next samples between flexible plastic layers with a dark layer at the back of the case. When the temperature is lower than an extent (by changing the formulation, the temperature can be changed), the polymer remains as a solution and the black surface is visible through it, and it can better absorb the sunlight. But when the temperature rises, the polymer condenses and becomes droplets that due to the small size of the droplets they diffuse the light and create a white surface that reflect the sun's heat.

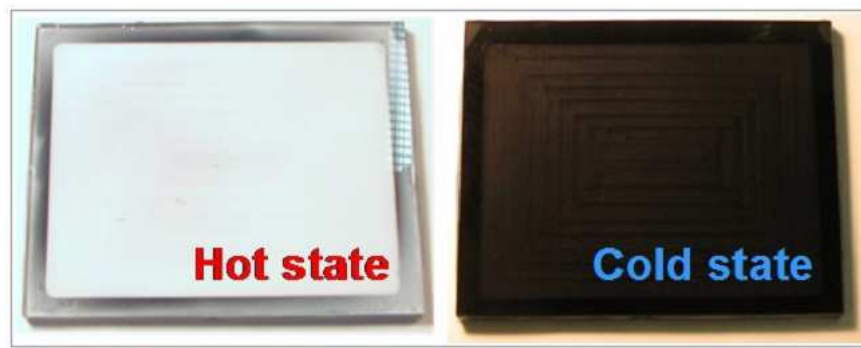


Fig. 7. Tiles coated with polymers whose color changed according to temperature.

### 6.5. Self-cleaning coatings

In the coatings the ultraviolet light is absorbed by titanium dioxide. The nanoparticles with absorbing ultraviolet light in the presence of water molecules can produce active oxygen components which have the ability to effectively remove bacterial films, decomposition of organic molecules and contaminants attached to the surface. By coating the walls, sidewalks and roofs of buildings with the particles, the desired effect of self-cleaning could also clean very sticky surfaces such as glass. However, this method is only suitable for outdoors applications (like the exteriors) (Figure 8) and the reason

is that the surfaces are more opposed to the sun's ultraviolet radiation. As noted the self-cleaning surfaces are activated under UV radiation and show the self-cleaning property.



**Fig. 8:** The Jubilee Church by Richard Meier-Rome: Use of titanium dioxide nanoparticles coating on its outer surface

### **6.6 Self-cleaning clay pieces**

Today, many manufacturers make clay roofing pieces that are self-cleaning. Using Photocatalyst nanoparticles, when these pieces are used on the roof the particles of dirt, grease, grime, algae and moss are removed from their surface with the help of the sunlight and they would be simply clean with the first rain.

## **7. Conclusions**

Solar energy is one of the free energy sources, clean and without environmental destructive effects. Due to the energy crisis in recent years as well as the reduction of pollution and energy saving, demand control and energy supply, replacing this renewable energy with fossil fuels is so important, due to the geography of Iran there is a possibility of maximum use of solar energy in different parts of the country during the year. While the hot and dry climate situation of Parand has paved the way for using the renewable solar energy and since this city is heavily exposed to environmental pollutants, the optimal use if the great and renewable energy could be provided in order to make possible the use of clean energy with proper application of newfound nanotechnology including polymer solar cells, photovoltaic coatings, nano glasses, nano change color tiles, self-cleaning coatings and self-cleaning clay pieces, in designing biological complexes of Parand, and to save energy without environmental destructive effects in order to plan for a better future, because the technology is mainly consistent with the nature and has no pollution and as it is renewable so there is no end to it.

## **REFERENCES**

- [1] Asadpour, F. Jamshidi, H. (2014), "Biological complexes, the needs and requirements of nanotechnology in new town of Parand", the First National Conference on the Development of Civil Engineering, Architecture, Electricity and Mechanic in Iran, 17 December, Gorgan, Iran.
- [2] Ramezannejad Kootenai, A. et al. (2012) "Solar energy and application of nanotechnology in solar energy", the First International Conference on Oil, Gas, Petrochemical and power plants, 20 June, Tehran, Iran.
- [3] Asadpour, F. Asadpour, A. (2014), "The use of solar baths in hot and dry climates of Iran for energy optimization, the National Conference on the Environment and Energy, 11 August, Shiraz, Iran.
- [4] Jamshidi, H. Asadpour, F. (2014), "The application of nanotechnology to reduce the environmental effects in new city of Parand", the First Conference on the Development of Civil Engineering, Architecture, Electricity and Mechanic in Iran, 17 December, Gorgan, Iran.
- [5] Najafi Moti'ei, M., Doroudi, Z. (2005), "The role of nanotechnology in energy optimization in buildings (nanotechnology in the construction industry)", the Fourth International Conference on Energy Conservation in Buildings.
- [6] The promotion scheme of the municipality rating of new city of Parand, Institute of Architectural Culture and Art of Iran, published by SID, (2013).
- [7] Hosseinian, GH. & Darkhal, Ali Asghar. (2003), "The climate investigation and the use of solar energy to reduce energy consumption in buildings", the Third Conference on Energy Optimization in Buildings, p. 3, Tehran, Journal of Nanotechnology
- [8] Khodabakhshi, Z. ( 2002), Evaluating the architecture of warm and dry, hot and humid area of Iran (due to the use of renewable energies), the Second International Conference on Energy Conservation in Buildings, Tehran, pp. 5 -7.
- [9] Ahmadi gorji,kh. Ahmadi,m. mir abbaszadeh,k. (2011), "The role of nanostructures in polymer solar cells",Tehran, Iran, 166 (5): 19-20
- [10] <http://edu.nano.ir>
- [11] <http://civiltech.ir>