

Solar Energy in Cities and the Emergence of Energy Parks

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ABSTRACT

Waste of energy is one of the world's most painful problems. Although some actions are being done in so called "developed" countries and the issue is familiar to academic world, still there is much to do to get public attention, specially in "developing" and "underdeveloped" countries. The use of new energies such as solar, wind, water, geothermal, biomass, geomagnetic and other alternative types is the best way to avoid environmental damages and to save the limited sources. In a sunny country like Iran solar energy is much more money saving. In addition to solar heat there is also a rich tradition of climate responsive design that has been developed in Iranian architecture through the ages. Public culture and information level is the most effective aspect in all energy matters and creating special places in order to show and propaganda all related to clear energy types, called Energy Park, can be helpful for most societies.

KEYWORDS: Environment, solar energy, solar cells, Iran climate zones, Energy Park.

1. INTRODUCTION

As it is apparent these days the industrial development and all that came after, has not just brought wealth and health for humankind. Some troubles, rose and grew gradually, until -according to many- converted to the main and most urgent problem against human society and planet Earth. The problems are mostly related to ecological unpleasant changes. Discovering that the classic energy sources are limited was the other main worry.

Moderately the "developed" countries started to operate differently and paid attention to the point, creating all called "Green". Although it's a long way until the damage will leave no trace, situation is even worse in "developing" and "underdeveloped" countries.

"Healthy city" is a practical concept in this struggle. Healthy city is a city in which everything is healthy, clear, natural and environmentally friendly. Energy is the basic theme in a "Healthy city". Non stopped use of fossil fuels damages the ecology system. unlimited gas pollutions cause greenhouse effect. Furthermore these kinds of energy are limited and nothing will be left for next generations, if we don't stop soon. So all energies used in a "Healthy city" should be renewable, clear and harmless.

2. Alternative energy

Energy is also one of the top items in sustainable development. In order to solve the difficulty we can control our energy usage. This means to save energy sources as much as possible for next generations.

We can also use renewable energy sources such as solar and wind energy. Solar collectors and invertors called solar systems convert the sun radiation to electricity and heat. This solar energy nowadays is available in many different and creative ways. The wind and water turbines and generators are the other familiar ways to use clear and unlimited energy sources.

Biomass is another energy source, which means to collect all of the city's wastewater and sewage in order to protect the ecology and recycle it. These biomasses are concerned as the forth energy source in the world. Biomass, a group of products made by photosynthesis, is convertible to electricity by some gas turbines.

Design buildings in a way responsive to climate or friendly to the nature and also using natural energies is the other way that is getting attention these days. This method was historically common for some populations, such as Iranians. Climate responsive design is sensible to sun and winds directions. Pays attention to geography and the season. Takes the advantage of local nature and avoids the disadvantages. Causes no damage to environment. Thus using proper materials, not destroying the natural sources and controlling the use of energy, when building and living in, are the matters to concentrate on.

Tidal power, geothermal energy, nuclear energy, hydrogen, geomagnetic field are some of the other alternative or so called "new" energies.

Besides all these, and alongside them, mentality and information are the most affecting and dominating aspects to pay attention to. [1]

3. Solar energy

Among the several types of alternative energies, solar energy is the most popular and easily available. Solar energy use has a special role in creating healthy city. Solar energy is both a clean and inexhaustible resource, and it can be used to

produce electricity wherever and whenever sunlight is available. In Iran there is 3000 hours of sunshine round the year and taking advantage of solar energy is considerably important and profitable. Converting sun's heat and light to electricity is the most common way and is increasingly being experienced in different creative ways. As a new energy tool which can effectively harness the amazing power of sunlight, solar cells have the potential to replace fossil fuels as our main means of power generation. Thus the photovoltaic convert systems are very useful and handy. These collectors can be used both synchronal and stand-alone.

3.1. Amorton

"Amorton" is an integrated type amorphous silicon solar cell with a new structural configuration. Virtually any-shaped custom-made product can be fabricated without difficulty. SANYO was one of the first companies to focus on amorphous silicon solar cells.

Amorton uses silane (SiH₄) as its source gas and is fabricated using a plasma CVD method. Three amorphous silicon layers, p-layer, i-layer, and n-layer, are formed consecutively on a glass substrate. This p-i-n junction corresponds to the p/n junction of a crystal silicon solar cell. In the process of this junction formation, a number of cells are connected in series on a substrate at one time. This allows any desired voltage to be obtained for a variety of equipment operation.

Of several technologies, amorphous silicon solar cells have many strengths that surpass those of the earlier crystalline silicon solar cells. In addition, they require little energy to manufacture and use less raw materials, and thus are truly environmentally friendly devices. This technology also allows larger area cells to be manufactured and can take advantage of the flexibility of thin film materials, and they have already been used in a wide range of applications. [2]

Thus the "amorton"s advantages are:

- High voltage
- Flexibility
- Large area
- Variety of support materials (ex. plastic for "Amorton" thin film)

[3]

As well the solar cells that in past were only suitable for buildings' roofs or open areas, by integration of these new technologies can be used on buildings' outer surfaces, glassy surfaces, roof tiles and roof slopes.

The "Amorton" cells have small microscopic holes made during the production process. The existence of these holes and being very thin make it possible to employ the cells as a transparent surface. In this way the surface provides both light and electricity. [4]

4. Solar Energy And Buildings

In spite of converting solar energy to other types of it in large scale for industrial or public purposes, still there's another more simple method. Make the most of sun radiation directly in ordinary building is even more widespread and simple but effective approach.

In order to reduce energy usage in ordinary building we can:

- Increase the materials thermal resistance (windows, walls, controlled air conditioning)
- Use thermal recycling tools (using the exiting air of conditioning system or exhaust and sewage)
- Use electrical or gas pumps
- Use solar energy

Basically there are two ways of doing the last called active and passive solar systems. [5]

Active solar systems are those which collect solar radiation and convert it in the form of heat to water, air, or some other fluid. The technology which is applied is fairly simple and there are many possible applications of it for low temperature systems heat uses. Still there's a second even more handy way called solar passive system.

In passive solar building design, windows, walls, and floors are made to collect, store, and distribute solar energy in the form of heat in the winter and reject solar heat in the summer.

This design shapes the building structure and architecture in order to use solar heat as much as possible. [6]

It is apparent that the main problem of designing to make most of sunlight would be the contextual characteristics. So one should study the climate, economy, culture and design standards of each context in order to select the best system.

4.1. Advantages of Passive Solar System

- Economy: It is money saving to build a passive solar system in compare with a traditional or active solar system. The active solar is much expensive because of the equipments and materials used and the traditional system is high-cost in energy consumed after habitation.
- Improvement of thermal conditions: When using a passive solar system, the inner air conditioning is happening automatically and in case of temperature changes in outer space the inner space adapts gradually.
- Simple guide: There are only some simple activities the consumers should do such as closing the curtains or other night isolation.
- Adaptability: It is possible to build this building in any geographic and cultural context. The climate, material, and techniques are the variables according to the local traditions.
- Aesthetics: This kind of building usually offers creative solutions and has attractive spaces on southern facade. So will help the environment to seem more pleasant. [3]

5. Energy Saving and Model Of Consumption

Energy consumption is still increasing day by day, due to industry and development, especially in “developing” and “underdeveloped” countries of the world. Insufficiency in construction and transfer in one hand, and extraction and conversion of the energy on the other hand, will make difficulties in developing programs of these countries.

The goals of economical and social development make us to work seriously on energy demand. To reach the target we should lead the consumers to energy saving and using a proper model of consumption. On sectors like industry and traffic we should make basic reformations. In order to recover and balance the country’s energy system we should balance the supply and demand and lead the consumer to efficient use by the mean of energy costs strategy. We should also study the technical and economical capability of energy saving in public, industrial, traffic and other sectors. Furthermore, as energy saving depends on increasing materials’ quality, having control systems and accurate tools in production and service processes and also production and maintenance of new industrial machines, we must also invest and work hard on these sides of the problem.

6. Climate Responsive Design in Iran

Apart from new energies, in a country with a long history and precious architecture culture, like Iran, there are superb traditions of climate responsive design. These techniques have been working properly for a long time, as late as the mimicking of the modern architecture works took the dominant role in most of Iranian cities.

Just as using the sun heat is, paying attention to wind direction and strength is so effectual in buildings’ design. It works both in single buildings and hole cities. [7]

Here we shortly introduce the main solutions, Iranian designers and architects found to face climate features. The topics have been formed honoring energy saving due to cultural and traditional background and are being presented in an up to date adopted complex. Being rrecommended for any contemporary building the points listed below are slowly getting attention back in latest energy oriented look to architecture in Iran.

6.1. Four climate regions

Climate features in any region depend on these items:

1. The geographical latitude
2. The distance from the sea
3. The hight from the sea level
4. The seasonal winds direction
5. The rainfall and humidity

According to these we can divide Iran to four main climate zones:

1. Caspian: Mild And Wet Climate
2. High And Mountains: Cold Climate
3. Oman Sea And Persian Gulf : Hot And Wet Climate
4. Central Desert: Hot And Dry Climate

We can gain appropriate living conditions in any of this zones according to points that came above. In all four climate regions of Iran, sun is the main source for heat in winter and in all four of them the building must face the sun. [8]

6.1.1. Caspian: Mild And Wet Climate

1. Sloped roof
2. Terrace all around the building
3. Directing building toward the summer favorable wind
4. Placing openings on the building’s both long sides
5. Designing narrow building (with little width) to take the advantage of drafts of summer wind
6. Placing the building on a pilot
7. Placing no underground for living purpose
8. Isolating the building’s outer surface

6.1.2. High And Mountains: Cold Climate

1. Making the southern surface of the building transparent
2. Using sun window, greenhouse and thermal wall on southern surface of the building
3. Protecting the building from winter cold winds
4. Earth sheltering some parts of northern, eastern and western surfaces
5. Using thermal mass such as masonry materials, rock pile or water in the building
6. Isolating the building’s walls and specially roof to avoid waste of energy
7. Using double glazed windows, thick curtains or dynamic isolation for night time
8. Reducing rooms height

6.1.3. Oman Sea And Persian Gulf : Hot And Wet Climate

1. Directing the main façade towards the sea or the summer favorable wind
2. Placing openings on the building’s both long sides
3. Making the building’s outer surfaces shaded by placing plants, sunshade or terraces all round

4. Placing the building on a pilot and designing narrow building (with little width)
5. Placing no underground for living purpose
6. Using materials with low thermal mass, such as wood
7. Isolating the building in order to avoid hit specially on the roof

6.1.4. Central Desert: Hot And Dry Climate

1. Directing the building towards summer favorable wind
2. Protecting the building from winter cold and summer dusty winds
3. Making the southern surface of the building transparent
4. Using sun window, greenhouse and thermal wall on the southern surface of the building
5. Using underground level, “badgir” (wind catcher) and “godal baghche” (courtyard lower than ground level)
6. Using thermal mass such as masonry materials, rock pile or water in the building
7. Earth sheltering some parts of the northern, eastern and western surfaces
8. Isolating the building’s walls and specially roof to avoid waste of energy

7. Solar Building

Solar building is the one getting the heat needed mostly from direct sunshine. This building should have some of these characteristics:

1. Getting heat from the southern façade or building’s roof
2. Saving heat in thermal mass such as masonry material, rock pile or water
3. Saving heat with thermal isolation on the outer surface, specially the roof
4. Being designed as a box with the longer side facing the sun
5. Receiving no shadows on the southern facade
6. Having the main rooms placed at the south and the less important of them at the north of the building
7. Getting sun heat by sun window, greenhouse or thermal wall
8. Getting sun heat by vertical windows at the south, on roof window or a pool on the roof
9. Having sunshine directly on thermal mass. (When using rock pile as thermal mass it is necessary to move the greenhouse heat to thermal mass in daytime.)
10. Using double glazed windows and night isolation for outer windows
11. Using the building form, needle leaf trees or windbreak to protect the building from the winter or dusty winds.
12. Using sunshade, drafts, evaporative cooling or wide leaf trees’ shade to make the building cool in summer.

8. DISCUSSION

The observation of energy matters has totally changed based on the sustainable development strategy. Human, being the main consumer of energy in the world will take the leading role affecting the limited energy sources. The most powerful aspect leading human to an accurate use of energy is the public knowledge and information level about the future of planet Earth. Therefore it is vital for any government to increase consumers’ knowledge. Besides the public media, which has the basic role in public awareness, it will be effective to have some guidance centers inside the cities to expand the consumers’ comprehension.

The idea mentioned above finally turned to a center in contemporary city, which acts as island and represents a proper energy consumption model. This model should be adopted by the city itself in future.

These complexes also provide the energy needed generally using wind turbines, water turbines or solar panels. The main goal is to make new technologies of energy aspect in reach, and act as a development and enlightenment unit. This unit presents new and creative solutions for energy problems. Increases the use of alternative or new energy types and recommends new technologies or tools.

The energy parks also:

- Study the renewable energies consumption in cities, in detail.
- Create a cooperating network of relevant organizations or institutions and the target groups
- Transfer the technologies between research centers
- Develop the related tourism
- Consult on energy system issues
- Hold professional courses in order to develop green commerce and industry
- Represent traditional and local techniques of each region in efficient energy use
- Propagate energy- efficient product inside the buildings and systems

As it’s apparent these centers are not made merely with professional education and commercial goals, but mostly designed as green areas for families having pleasure and fun. Therefore are called Energy Parks. The parks are mixture of activities such as being in nature, having fun and doing shopping.

As long as these centers are attended to produce their own energy, the service systems should be designed apart from the city’s energy system. It means that every single one of the energy system parts, from energy production, energy control to energy consumption must be designed according to the energy park model. Energy must be produced by solar panels, wind turbines, biomass systems that use the wastewater of the park. So the center will be functional and serving the public, and representing the energy systems at the same time.

Besides practical and simple exhibition of the solar, wind, water, geothermal and other alternative possible energy types or biomass systems for public perception, these centers can offer the traditional and local techniques and solutions in energy matters, as was said above. This can be greatly serious when talking about a country with a precious traditional culture in energy related aspects, like Iran. So climate responsive design of Iranian classic architecture is the best example of energy saving and environment friendly behaviour presentable in Iranian Energy Parks.

9. Conclusion

Energy consumption matters are one of the world's biggest contemporary problems. The topic is even hotter in "developing" countries. Although it seems that everything is clear and handy in academic world and there are many researchers working and much more researches on the matter, but what we see in fact specially in ordinary public is so limited.

Using alternative and so called "clear" energies, such as solar, wind, water, geothermal and other types is one of the possible ways to go. In a sunny country like Iran the use of solar is much more economic. Alongside of solar heat there is a rich tradition of climate responsive design that has been formed in Iranian architecture through the ages.

Most of the countries nowadays are working on public intellect around consumption matters. Informing and enlightening in this aspect, in wide scale and different ways needs a widespread and equipped place, where it may be possible to observe the complete processes from energy production to consumption, and what is called Energy Park.

Energy Park is a type of Science Park and is based on these aspects:

1. Creating a space for propaganda of efficient consumption models.
2. Creating a space where the environment friendly products are being shown and sold and the constructions are being presented.
3. Creating a space pleasant and attractive for the families to spend time in.

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