Opportunities and Obstacles in Utilizing the Renewable Electric Power Resources in Iran

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Abstract

Energy supply has currently become one of the most strategic and critical issues of human societies; as many political, economic and social challenges have been directly or indirectly related to the energy crisis over the past few decades. Given that the energy sector has the greatest impact on increasing carbon dioxide emissions, the need to develop renewable energy to reduce the risks of pollution and climate change is highly significant. In Iran, with more than 85000 MW of installed capacity of the electricity network, only about 859MW of electricity (about 1% of total capacity) is extracted from renewable resources. There are various obstacles to the development of renewable energies, which is generally dependent on the economic and technical conditions, and one of the most important challenges is the lack of social acceptance and lack of awareness of citizens and energy stakeholders. The most important benefits of renewable energies includes increasing energy security, reduced global warming, economic growth, job creation, increased per capita income, increased social justice and environmental protection. In this article, the opportunities and obstacles to the use of renewable electricity sources in Iran are described and with the help of Vensim software, the status of renewable energies until 1430 is simulated and predicted based on existing conditions and different scenarios. Suggestions for expanding the use of renewable energy have been mentioned eventually.

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1. Introduction

The macro plan of the Islamic Republic of Iran in the field of energy is the optimal use of fossil energy resources and improving the utilization of various renewable energy resources to meet the increasing of energy needs. Iran is one of the richest countries in the world in terms of various energy resources and in addition to the existence of large-scale resources of fossil and non-renewable fuels such as oil and gas, has great potential for renewable energy such as wind, solar, biomass and geothermal. According to statistics, the continuation of the current trend of energy consumption in the country will cause domestic consumption to exceed the total energy supply by 1405, and not only will it not be possible to export petroleum products, but we will become one of the importers of energy carriers [3]. According to SATBA (Renewable Energy and Energy Efficiency Organization)statistics, the total capacity of renewable energy throughout the country has reached 859 MW. Since the total capacity of power plants in the country is about 85000 MW, so renewable and clean power plants are about one percent of the total capacity of the country. Currently, solar power plants account for the largest share with 48% of the total capacity of renewable power plants, followed by wind power plants with a share of 36%, small hydropower plants with 13%, heat recovery and biomass power plants In total, about 3% are in the next categories [4].

2. Opportunities for the development of renewable energies

The most important opportunities for the development of renewable energies in the country are as follows [1]:

A) Energy security:

Statistics shows that oil, gas consumption is increasing, and consuming countries are increasingly dependent on oil markets, resulting in

the vulnerability of their economies to any disruption in oil imports. At the same time, the economic growth of developing countries is putting increasing pressure on the balance of oil world markets. Renewable energy will help countries importing and consuming fossil fuels (including Iran) to rely on domestic energy sources, thereby reducing their need for fossil fuels [5].

B) Climate change:

Iran is one of the victims of climate change in the world, the effects of climate change in our country have manifested themselves in the form of drought and water shortages and have raised concerns about destructive climate change. Greenhouse gases such as carbon dioxide and methane regularly condense in the thin layer of the Earth's atmosphere, and this density of gases raises the Earth's temperature day by day. Unfortunately, rising temperatures will have tragedy results [6].

C) Reliable energy resources:

Renewable energy resources, as local resources in supplying the energy needed by communities, are less affected by regional and international political, social and economic conditions. Therefore, paying attention to energy supply from these resources can help increasing the national security of countries. During of crisis and political conflict, major energy carriers such as fossil fuels are severely affected, and rising prices are affecting many communities around the world [7].

D) Diversification of the energy portfolio:

Among the duties of the Ministry of Energy and relevant organizations, including SATBA in development programs and the 20-year vision document of the country, is the diversification of the country's energy basket, because by diversifying the energy basket, It increases national security. Therefore, along with other energy resources such as nuclear and fossil energy, it is very important to develop the use of different types of renewable energy resources.

E) Reducing of environmental pollution:

Renewable energy resources generate a very small amount of environmental pollution compared to conventional fossil power plants. Also, in using this type of resources, there is often no waste material. The amount of production of environmental pollutions (including air, water and soil) for each kilowatt hour of fossil electricity are Co2 250 g,So2 0.7 g,Nox 2.2 g [8].

F) Economic growth and development:

The use of renewable energy as an endless resource, allows the use of local energy resources. Therefore, the countries that have these resources try to intern that in their energy basket in order to supply their energy consumption and make it possible to sell their other energies. Utilization of renewable energy resources leads to the development of less developed areas and leads to many economic and social effects. Generally, renewable energy contributes to the economy of each country because these energy resources are found in abundance in all countries [9].

G) Generating electricity at a stable price:

The use of renewable energy causes electricity to be produced at a stable price, because in conventional fossil fuel power plants, the cost of electricity generated is affected by the price of fuel used in the power plant, which has fluctuating prices in markets. Is the world during the designing of renewable power plants, before the construction , the necessary studies are done about the power supply of the power plant and the existence, amount and adequacy of the energy supply resource are ensured. Therefore, electricity generation in this type of power plants will not be affected by external factors and will have stable price.

H) Surplus value of fossil fuels:

In oil-rich countries similar to Iran, along with the development, exploration and production of oil and gas, the most focus should be on converting these energy resources into higher value-added products to earn more revenue and export them. It prevented the sale of raw materials and excessive domestic consumption for electricity generation or use in the transportation cycle and the building sector.

I) Job creation:

Renewable energy can create many job opportunities due to its novel and the possibility of rapid development and having a high market and demand. Also renewable energy resources are usually located in outmost and less developed areas, which are often affected by high unemployment. Therefore, by using renewable energy resources, suitable job opportunities can be created. Also, the number of jobs created per megawatt of electricity generated from renewable resources is almost three times the number of jobs created by conventional power plants, so with the development of renewable power plants, more jobs are created for a certain investment [11].

J) Simple operation:

Due to the less amount of equipment required in renewable electricity systems, mostly operation and maintenance of these systems in comparison with fossil and nuclear power plants, are simpler and need to look less care.

K) Income of local investors:

As regards the national support of most countries provide for private sector investment in the renewable energy, it brings a lot of income and financial benefits to investors, especially in less developed areas.

L) Lower production and operation costs:

Electricity generation from various fossil fuels, in addition to fuel and maintenance costs, are associated with significant hidden costs such as water consumption and the creation of a high pressure transmission network and etc. Considering these costs in the actual final cost of electricity generation, mostly renewable energy resources are in competition with fossil fuels to generate electricity.

The summary opportunities for development of renewable energy resources with the coefficients of each of them (which have been collected from various scientific sources) are in Table .1.

Table.1.
Opportunities to develop renewable electricity resources

No	*Opportunities*	*Factor*
1	Energy security	40
2	Weather changes	8
3	Reliable energy resources	5
4	Diversification of the country's energy portfolio	1
5	Reduce environmental pollution	17
6	Economic growth and development	44
7	Generate electricity by stable prices	12
8	Surplus value of fossil fuels	1.5
9	Employment	11
10	Simple operation	11
11	Lower production, operation and transfer costs	16
12	Local investors income	40
	total	***206.5***

3. Obstacles to the development of renewable energies

In many developing countries, including Iran, there is enormous potential for renewable energy resources such as wind, solar and biomass. However, there are obstacles that prevent them from growing and being used. Naturally, recognizing and collating these obstacles and barriers can lead to a wider use of this type of energy in developing countries. The main obstacles to the development of renewable energy are as follows:

A) Technical and technological obstacles:

Technical and technological obstacles can often be related to the geographical and climatic conditions of an area. This obstacle could be related to renewable energy equipment technology. On the other hand, the low quality of some of the renewable energy technologies that are being produced and sold in developing countries is an important obstacle. An example of this is solar home systems, which are often installed without a proper charge controller or battery. Globally, it is estimated that about twenty percent of all home-installed solar systems are no longer usable. One of most important technical factors is capacity factor (ratio of annual energy production divided to the maximum possible production of plant) of renewable power plants as in Table .2.

Table.2.
Capacity factor of fossil and renewable power plants.

Energy type	*Capacity coefficient*
Combined cycle, gas and steam power plant	91
Hydroelectric power plant	16
Solar power station (Photovoltaic)	20 to 22
Wave and tidal energy	25 to 30
Wind power plant	30 to 38
Geothermal power plant	80 to 90
Coal power plant	80 to 90
Nuclear power plant	96

B) Economic and financial obstacles:

Financial and economic obstacles are the most important deterrent to the spread of renewable energy in developing countries. Some renewables energy technologies are not competitive in terms of cost compared to conventional forms of energy. In many cases, conventional fossil fuel systems are privileged in terms of subsidies paid. Renewable energy systems, on the other hand, and their components are subject to customs duties, imports or other taxes. Second, the high initial cost of purchasing renewable energy systems is another obstacle. In most developing countries, only wealthy families can afford such systems. On a larger scale, governments, corporations, and related institutions have fewer tendencies to expand the use of renewable energy technology due to their relatively high cost.

C) Cognitive and social obstacles:

Cognitive factors of renewable energy technologies in developing countries can be considered as a deterrent. Incorrect prejudices about renewable energy can be encountered at all levels of society, in the families or the private sector, electricity companies and even the government. In general, there is little awareness of the benefits and characteristics of renewable energy. Many families do not think about renewable energy when planning their energy supply. Likewise, governments as well as international institutions continue to be accustomed to large-scale, centralized, and conventional fossil energy projects. Thus, in most developing countries, the experience of renewable energy projects is not very common, and therefore such projects contain high elements of risk and ambiguity.

D) Institutional and legal obstacles:

In developing countries, there is little direct government support for renewable energies, often due to a lack of financial resources. In many countries, electricity generation is still monopolized by the state, which means that it is not possible for an independent electricity producer to work in the field of renewable energy to enter the electricity market. In some non-developed countries, there are no regulations to connect renewable systems to electricity grids. In general, the position of renewable energy in national energy policies is often ambiguous, and the non-governmental sector is bounded from investing in renewable energy projects. The longsome process of obtaining a license to generate electricity for the private sector is also an important obstacle to the development of these energies.

E) Educational Obstacles:

Lack of specialized and trained manpower in organizations in charge, weakness in technology transfer in contracts with foreign companies, weakness in the development of higher education and academic disciplines related to renewable energy and lack of coherent training programs and professional technical courses in The field of renewable energy are the main reasons for the non-expansion of these energies [2].

The inhibitory coefficients and the complete list of obstacles to the development of renewable energies are as Table.3.

4. Research method and simulation results

In this paper, obstacles and opportunities for the development of renewable energy resources and their coefficients based on the library methods by using internal and external documents (articles, books, websites,…) are collected and identified and using modelling in Vensim software to The current situation is simulated and finally, by defining different scenarios and different growth rates, we predict the trend of renewable electricity development until 1430. The simulated model with Vensim software is generally drawn in Figure 1, which contains 12 opportunities and 20 obstacles to the development of renewable energy as input of the model and the outputs are shown as curves in the continuation of the research [12].

Table.3.
Obstacles of development of renewable resources

Obstacles ***(Ratio)***	***Description***
Educational 19.9	Lack of awareness activities Lack of promotional activities Lack of knowledge about protectionist laws Lack of general knowledge
Technical and technological 45	Localization of equipment with local capability Lack of planning Lack of field research Renewable energy sustainability problems Need for energy storage systems Lack of qualified experts
Legal and institutional 20.5	Lack of transparency in the relevant laws Lack of cooperation between executive bodies Lack of transparency of investor protection laws
Economic 67.4	High investment cost Targeting subsidies Lack of private sector investment More attention to the development of conventional power plants
Social and cognitive 42.2	Lack of social acceptance Lack of awareness of the benefits of renewable energy The problem of sustainability in socially renewable energy resources
Total	**195**

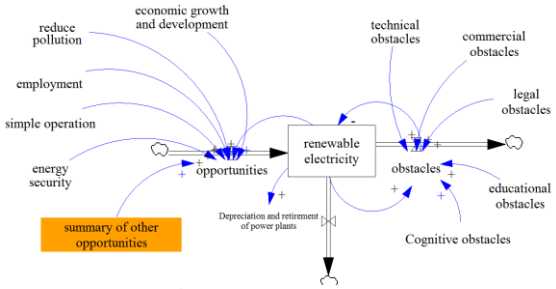

Fig. 1. Model of opportunities and obstacles in Vensim software.

A) Scenario 1 – Probable:

Taking into account all the existing obstacles and opportunities, the percentage increase in the annual capacity of renewable energy is about 11.5% and it is predicted that by 1430 the total capacity of renewable energy will reach 22503 MW according

to Figure No.2(without retirement). Similar to the country's fossil power plants, which have undergone major repairs and replacement of main and auxiliary parts of various systems and the useful life of the power plant is longer than initially predicted, so the idea of renewable power plants is not far from and this scenario is possible.

B) Scenario 2 – realistic:

If the current conditions of opportunities and obstacles are taken into account and considering the retirement of power plants after thirty years (average and approximate), the retirement curve and the output of the obtained model will be as figure3 and figure4 as follows. Finally, in 1430, the total capacity of renewable electricity gains 18987 MW.

C) Scenario 3 - Optimistic:

If the growth rate of renewable energy continues the same as the average growth rate of renewable energy in Iran in the last ten years which is equal to 19.8% ,the chart will be as Figure 4 .Finally at the end of 1430 the total renewable capacity will reach 193953 MW.

D) Scenario 4 - pessimistic:

considering the stability of the existing conditions and the existence of only obstacles and without using opportunities, in which case the simulation and analysis results are as shown in the chart below. Mathematical results indicate that after one year, all available facilities will be destroyed and all these centers will be closed.

The reason for the positives and negatives of the curve is the integral responses of the relation that the software takes from the equations. Existing power plants are depreciated over 30 years, and because no new capacity is added, we will not have any remaining renewable capacity in 1430.

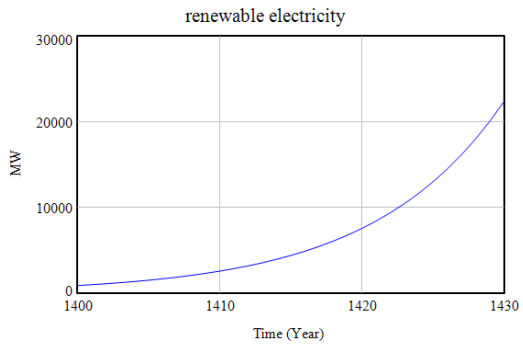

Fig. 2. Renewable electricity growth forecast in the first scenario.

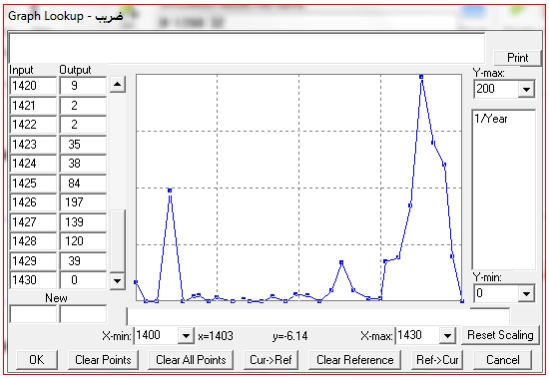

Fig. 3. Retirement curve of renewable power plants as input of Vensim software and using the Look Up command.

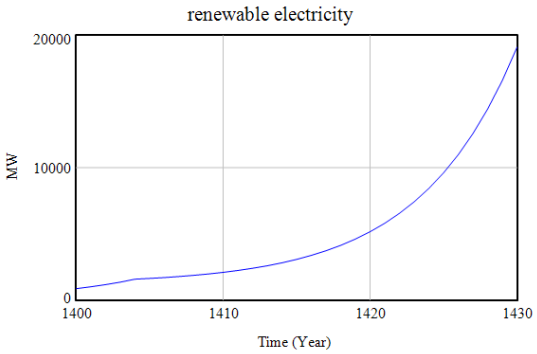

Fig. 4. Renewable growth forecast in the second scenario.

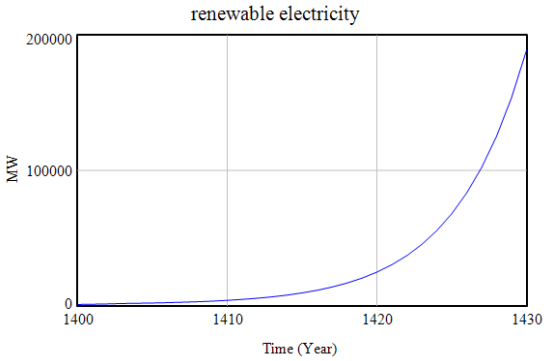

Fig. 5. Renewable growth forecast in the third scenario.

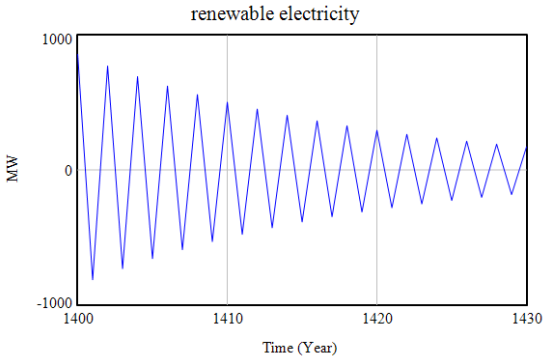

Fig. 6. Renewable growth forecast in the forth scenario.

5. Conclusions and suggestions

Specifically, on the subject of this paper , has not been a comprehensive and integrated study. Davood Manzoor and Lily Niakan (2012) in the article "Development of renewable energy in the country, obstacles and strategies" have given a general description of the obstacles and policies of renewable energy. Mohsen Mohammadi and Mohammad Sadegh Sabouri (2015) in the article "Study of obstacles to the use of renewable energy in Iran's agricultural sector" have examined the obstacles to the development of renewable energy.

According to the latest studies of SATBA Potential Resources Assessment Office, potential areas in the fields of renewable energy including solar, wind, geothermal, biomass and hydropower have been identified separately for 31 provinces of the country. Total theoretical potential in the field of solar energy has been identified Over 70,000 MW, wind energy more than 47,000 MW, biomass energy about 1000 MW, geothermal energy more than 1000 MW and small hydropower energy is estimated about 2500 MW. And there is a total of 121,500 MW potential for the construction of renewable power plants in the country [4].

Looking at Iran's performance in the field of renewable energy, shows that despite having good potential in the field of renewable energy, there is a poor performance in the field of development and exploitation of renewable energy. Compared to the average renewable electricity statistics in the world (Excluding hydropower), which is about 11.3 percent, has eleven times weaker performance, which requires effectively planning and action [10]. According to the statistics of the country's electricity network, the lowest growth rate of installed capacity of the electricity network is about 2.5%, which is assumed that if this rate continues in the recession until 1430, we will need 182750 MW network capacity. If we want to receive the roadmap drawn by global researchers, the growth rate of renewable energy should increase to 18.9%, which is very different from the current realistic rate in the second scenario of this study. In fact, with the current growth rate of renewable energy in 1430, we reach a capacity of 18987 MW, which covers only 10.4% of the global demand and the roadmap of researchers.

A summary of strategies and proposals for the development of renewable energy are as follows:

- Increasing awareness and promotion activities of electricity generation from renewable energies.
- Increasing public knowledge about the benefits of electricity generation from renewable energies.
- Increasing the level of localization of equipment with the local ability to generate electricity from renewable energies
- Increasing the number of field researches on electricity generation from renewable energies
- Reduce the problems of renewable energy sustainability from a technical view.
- Training of academic and industrial experts in the field of electricity generation from renewable energies.
- Increasing cooperation between executive bodies, for example payment regularly SATBA annual budget.
- Increasing transparency in laws to protect investors in the field of electricity generation from renewable energy.
- Increasing the support and level of assistance to the private sector in order to investing the field of electricity generation from renewable energies.
- Reducing the level of attention to the development of nuclear and fossil power plants.

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