Identification of the Situation of Renewable Energy Alternatives in the Criteria known by private sector investors (Case study: Iran)

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Abstract- Due to the diversified potentials of renewable energies in Iran, exploitation deployment of these resources as cleaner energies is one of the suggested strategies to minimize the fossil fuel usage and reduce the environmental footprints. In this relate in order to have the application of renewable energy economically, the government tries to diffuse these resources pervasively by private sectors supporting. As investment behaviour depends on the investment risk, investors have obscurities and concerns about entering and investing in this market in Iran. These concerns indicate a set of important investment indicators which are considerable from private sector viewpoint. This research based on previous investigations of the authors, discusses about selecting the optimal renewable sources for investment from private sector viewpoint in each identified investment indicators. The results clearly define the situation of each alternative in each index.

Keywords Renewable energy Alternative, private sector, investment criteria, quantitative research

1. Introduction

Although Iran is known as a wealthy country in terms of energy resources, the main conventions of these energies are hydrocarbon sources. According to the reports Iran is one of the most energy intensive countries of the world with per capita energy consumption 10 times that of European Union [1].

Further, it has an inefficient structure in energy systems with the energy intensity three times higher than global average and 2.5 times the Middle Eastern average [1]. Population and economic growth, cheap fuel prices (due to subsidies programs), poor resource management and etc. are as important reasons for rapidly growing energy consumption and high energy intensity in Iran.

Due to the rich and diversified potential of renewable energies (RE) in Iran, exploitation deployment of RE resources as cleaner energies has been one of the suggested strategies to minimize the fossil fuel usage and reduce the environmental footprints [2]. For example, because it is located in the sun-belt, two months solar radiation is equal to total ever-discovered reservoirs of fossil fuels in Iran [3].

Since RE provides a nearly unlimited supply of relatively clean and mostly local energy and considerable opportunities [4], participation of private sector in RE technology is an important development driver. For instance, while the share of private sector in generation of electricity is about 80% in the US, about 75% of sales to final customers are undertaken by private utilities in 2001[5].

Following the Iranian governmental policy towards privatization of governmental enterprises and replacing RE resources for fossil fuels, private sector supporting has been emphasized in exploration, production, exploitation, and transmission of new energy resources [6]. However, the statistics show only 38% goals of Iran's fourth national development plan in RE have been achieved [7]. On the

other hand, since almost all important national energy projects in Iran are given to the government owned company, the private sector doesn't have the competitive possibility to work or participate in this industry.

Although researchers consider to theses gaps from different viewpoints such as; lack of dynamic strategic management, non- optimal utilization of human resources and etc. [7, 8], our researches show that domestic and international investors still have obscurities and concerns to start their investment in this market [9]. Since investors are committing their assets for sometimes when investing, they need to think carefully about all aspects of investment decision [9]. This means there are important indexes an investor wants to consider to make a good and informed decision. In other word, as starting an investment is a delicate decision making, selecting the optimal RE resource is a multi-actors and sophisticated problem for private investors in which need to incorporate social, economic, technological, and environmental considerations.

While investors are currently uncertain about the future of this industry they like to be informed about different criteria (from marketing aspects to engineering and governmental policies) to prepare the scene for their participation and resolve their uncertainty in Iran [9].

For instance, as a research and based on identified criteria, the authors of this work have proposed the investment priority of RE resources to direct the investor's decisions [10].

Although these investigations demonstrate the capability and effectiveness of each RE resource in a multi-criteria decision making space among a pool of criteria, identifying the priorities of resources in each criteria have interesting results too[10]. In fact, it can show the potentials of renewable resources separately in each indicator to help the investors to find the answers of their questions.

This article with an innovative approach in the field of RE and based on the multi attribute decision making theory (MADM) is proposed to select the most appropriate RE resource for investment in each identified factor from investor viewpoint. The analysis has been done based on the analytic hierarchy process approach (AHP). The results and the approach of this research are valuable and applicable for decision-making or further investigations among different groups of investors, governmental policy makers, and researchers of other countries with the same conditions in the Middle East, Asia, Africa, and South America.

2. Literature Review

2.1. Reviewing renewable energy potentials in Iran

This section reviews the engineering and business perspectives of RE potentials in Iran briefly.

2.1.1. Solar energy

Iran is situated at 25˚ to 40˚ north latitude, in a region with one of highest receipt of world energy. The total absorption of solar radiation in Iran is estimated between 1800 and 2200 $kW.h.m^{-2}$ per year that is higher than global average [11]. Also the sunny days per year is 280 which is quite considerable [12]. This energy can be utilized by different systems in cleaner productions for various purposes that can be briefly sorted as follows [13]: 1. Utilization of solar thermal energy for domestic, industrial, and power plants, 2. Direct conversion of solar energy to the electricity by photovoltaic systems,

Solar thermal power plants can also be classified in three general groups: 1. Power plants with collectors of linear parabolic mirrors, 2. Power plants with central receivers installed on a tower in which sunlight is reflected by large mirrors called heliostat, 3. Power plants with reflectors of parabolic dishes

In addition to power plant-based functions of solar energy, off plant thermal functions would be considered as hot water supply by solar water heaters for washing and solar bath, heating-cooling and solar air conditioning, solar desalination, solar drier, solar ovens and solar furnace.

2.1.2. Hydro power

Rain and snowfall in mountains as well as water flow in steep slopes of rivers are prime energy resources for hydro power plants in Iran. Absence of fuel consumption and consequently fuel supply costs are the most beneficial use of hydropower plants. In addition, the average operational lifetime of these plants is relatively higher than thermal plants.

The potential of electricity generation by Hydro power in Iran is 50TWH [14]. There are numerous drainage basins in Iran among the most important ones: Karoon, Karkheh and Dez. Water resources control by construction of embankment dams is one of salient achievements in water management in Iran. There is a production capability of more than 30 GW of hydroelectricity in Iran [15]. By the end of 2007, total installed capacity of hydroelectric power plants was 7422.5 MW [12].

2.1.3. Wind energy

Nowadays, thousands of wind turbines are functioning in the world maintaining the production capacity of 73,904 MW, of which 65% is produced in EU [16]. Among all other energy production alternatives, wind electricity has the highest growth rate in 21^{th} century so that the wind power production in the world has quadrupled between 2000 and 2006. From geographical situation, Iran is located in the path of main air currents between Asia, Europe, Africa, Indian Ocean and Atlantic Ocean [15].

2.1.4. Geothermal energy

Geothermal energy may be exploited in two ways in Iran; power plant generation, and off-plant utilization. In general, geothermal power plants are classified in two important groups; geothermal power plant with two-phased fluid, and geothermal power plants with single-phased fluid.

Moreover, direct utilization or off-plant functions of geothermal energy in Iran can be applied in; warm water swimming pools, greenhouse applications, domestic heating, fish reproduction basins, snow melting and road defrosting, and heat pump.

In consideration of geothermal energy benefits and due to Iran is located on the global geothermal belt, the Ministry of Power and Nuclear Energy Organization of Iran have implemented rigorous study and research in this field as other RE applications[17].

2.1.5. Biomass

Biomass resources consist of; forests and forestry residues, agricultural products and residues, industrial waste and sewage, and solid waste, municipal waste and livestock waste. The first digester for methane generation in Iran was built in a village called Niazabad in 1976 [15].

The vastness of the country as well as quantitative and qualitative versatility of biomass resources offers a proper competence for electricity generation from biomass in Iran.

2.2. National policies toward diffusion and adoption of RE among private sector

The Iran's Ministry of Power as the main RE policy-maker has tried to encourage the participation of private sector by enacting the follows laws [9, 10]:

- Preparation of national RE atlas(potential areas of exploitation),
- Gradual elimination of public subsidies for electricity and energy from the beginning of 2011,
- Financial supports for private investment in RE providing by Ministry of power and the Environment Protection Organization,
- Guaranteed purchase of electricity exploited form RE from the private sector in long-term contracts, according to Governmental Financial Regulations Act.62,
- Supporting the private sector to export sustainable electrical energy to the neighbor countries,
- Incentives arising from pollutant emissions control and greenhouse gases control policies,
- Waiving the rent of lands used by the private sector to build RE power plants,
- Technological supports and flexible tax rules for importing RE equipment and technologies,

2.3. 2.3 Brief review of the prime criteria for private sector participation in RE investment in Iran [9]

To understand the different dimensions of decision making among private investors, the authors have investigated on the investor's criteria to investing in RE in Iran. Based on this comprehensive qualitative research seven criteria have been identified as prime indexes for participation in RE investments in Iran [9]. These criteria are classified in three main dimensions: politics and business, engineering, and the environment (Figure1). In following each of these factors are reviewed briefly.

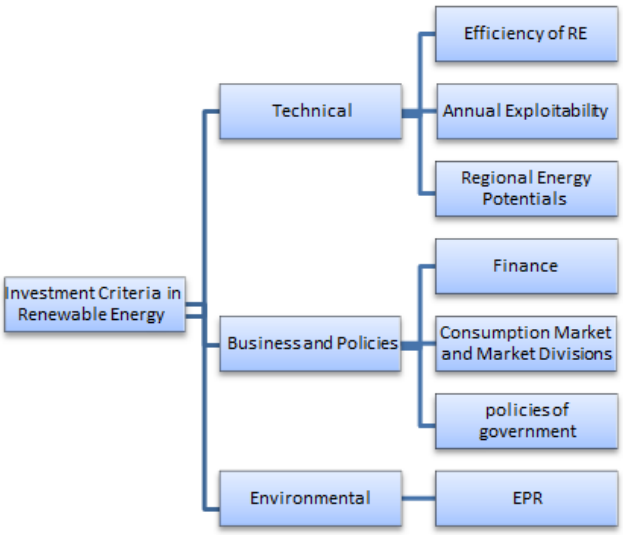

Fig. 1. Identified criteria for investment in RE from private sector point of view [9]

2.3.1. Efficiency of RE

Efficiency is defined as one of the two core bases of sustainable energy policies in addition to the usage of RE. Since efficiency would be an index for both creation of competitive advantage and increasing the customer's satisfaction, understanding the energy efficiency is important for investors [9]. The more efficiency in RE resources will lead to the further attention to the consumption behavior and, consequently, the more attraction in investment.

The researchers define the formula of output to input proportion for efficiency comparison of RE resources [9].

For instance, solar energy efficiency that is applied in electricity production using solar plates is defined as follows [22, 9]:

$$\text{Solar Efficiency} = \frac{\text{solar cell power out}}{\text{sunlight power in} \times \text{cell area}}$$

2.3.2. Annual Exploitability

One of the concerns of investors in a business is the period that a product or service can be efficiently used. Considering this index in energy production, the exploitability of a certain energy resource can be annually examined and compared [9]. For instance, in Yazd province the average availability of solar energy is about 317 days a year [23].This shows Yazd has a very good potential for investment in the solar energy thermal power plants and etc. Another example is the wind blow with the average pace of 26 km/hr in south east of Iran from the end of April until September that presents an adequate potential for the electricity production. But since this potential is not permanent in the rest of the year, the attraction for investment in this area substantially declines.

2.3.3. Regional energy potentials(geographical distribution)

From competitiveness viewpoint, resources are always considered as a constraint that may even endanger a business. Therefore, having more growth in the number of regions in which renewable energy can be utilized, there will be more attraction for investment. This assumption may be considered from different aspects among which the most important one is the potential of harvesting and distribution [9, 10].

2.3.4. Finance index

This factor is a financial measurement that indicates the importance of the required investment for each type of RE sources. This index is important for the investors and is considered as one of the restrictive factors in their activities in this industry [9]. Renewable energy technologies and related financial investment (project costs) will improve by time [24]. Therefore, renewable energy generation will be generally cheaper in time progress [25].

2.3.5. Consumption market and market divisions

The possibility of activity in the different markets using a defined investment has been identified as one of the interests of the investors based on this research. The end user markets are desirable since they provide more advantage compare to the medium markets for the suppliers [9].

2.3.6. Conformity with supportive policies of government

This factor is to identify the supportive governmental policies for investment on renewable energy generation, the point that the researchers of this paper found in all of their interviews with responders. On the other hands, the attention level of the government to the renewable energy projects is important in this indicator [9].

The Iranian governmental policy seems to incentivize the private sector to invest in this area (section 2.2).

2.3.7. Energy payback ratio (EPR)

This factor is identified as one of the important indexes for investor from customer's demands (market and consumer psychology), sustainability, and possible future rules. According to the reports, the electricity industry produces more than 37% of the world's carbon emissions that is predominant from burning fossil fuels [9].

3. Research Methodology

Due to practical nature of this research, the work is an applied research insight of result and a descriptive research from research purpose view point (figure2) [18].

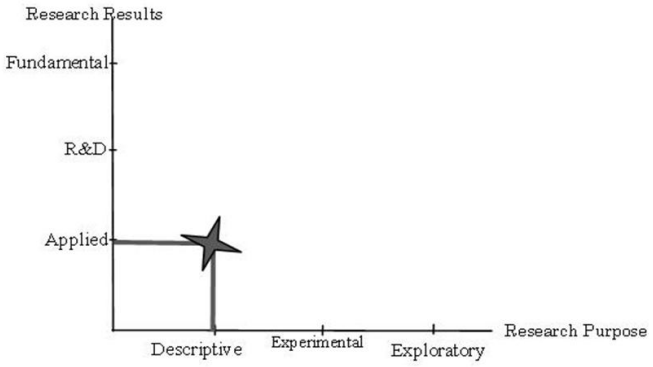

Fig. 2. Research method [18]

The main research question is; "Due to the identified criteria of RE's investment among private sector in Iran, which RE resources are in prior for investment in each criteria?" Therefore, identifying the best RE sources for private sector investment from five common RE sources (alternatives) in each seven criteria is the cardinal purpose of the article. To evaluate, compare and ranking of alternatives the analytic hierarchy process (AHP) is used as one of the best and valid methods of multi attribute decision making (MADM) [19].

3.1. Empirical survey and Data collection

A questionnaire consists of pairwise comparisons between five alternatives (RE sources) with respect the criteria has been designed. The phrasing of the questions was formulated carefully to reflect the scales intensity of relative importance suggested by Saaty (table1) [19]. Therefore, the validity of the questionnaires is confirmed by using standard tables [20].

Table 1. AHP scales intensity [19]

Intensity of Importance	Definition
1	Equal Importance
3	Moderate Importance
5	Strong Importance
7	Very Strong Importance
9	Absolute Importance
2,4,6,8	Intermediate Values

The responders of the questionnaire are energy and power experts, researchers, and professionals in the energy sector. They are working in the ministry of power and related departments in Iran's universities. The reason for this careful selection is related to high level of needed knowledge in the fields of energy and renewable sources that responders should have in order to compare pairwise resources in each criteria. This level of professional awareness is a point that an investor usually doesn't have about RE sources. Therefore, the reliability of the research is improved.

35 experts with the minimum master degree in energy, environment and related majors have been selected as the samples of research. In the questionnaire the researchers asked the respondents to compare the priority of each couple of RE sources in each seven criteria.

3.2. Data analysis

Expert Choice11 software has been used to analyze data based on AHP approach. AHP has feasible advantages. For instance, this method considers people more consistent when they do pair wise comparisons compared to when they just attempt to assign relative weights. Also both qualitative and quantitative information can also be compared using informed judgments to derive weights and priorities [26]. In Expert Choice a decision model typically consists of five steps: 1.structuring the decision model, 2.entering alternatives, 3.establishing priorities among elements of the hierarchy, 4.synthesizing, 4.conducting sensitivity analysis.

The inconsistency rates of responses for each pairwise comparison matrix have been checked by the software. This helps to ensure about the reliability of the research [20]. After calculating all priorities and inconsistency indices, the relative weight of each RE source for each criteria are determined (table 2).

Table 2. Weights of each RE resource in each index

	Efficiency index	Annual Exploitability index	Regional Potentials index	Finance index	Market Divisions index	Policies index	EPR index
Solar	0.18	0.25	0.32	0.25	0.36	0.33	0.18
Wind	0.22	0.13	0.17	0.19	0.20	0.27	0.22
Hydropower	0.26	0.17	0.13	0.18	0.11	0.18	0.26
Geothermal	0.21	0.32	0.18	0.15	0.18	0.09	0.21
Biomass	0.13	0.13	0.19	0.24	0.15	0.13	0.13

Figure 3 and 4 indicate the situation of each RE resource in compare with others in each criteria in two different charts. For example, from marketing, policies, finance, and regional potentials indexes the solar energy is the optimal RE source for investment in Iran. Also, hydropower is the best resource from EPR and efficiency indexes. Finally, the geothermal is the best renewable resource from Annual exploitability index.

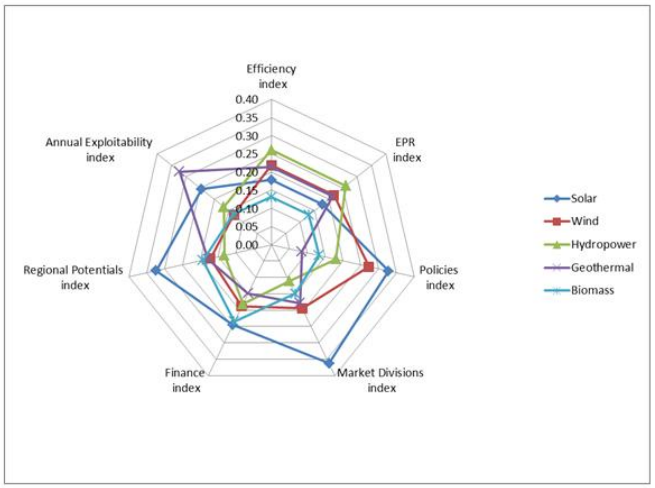

Fig. 3. Situation of each RE resource in compare with other alternatives in each criteria (radar chart)

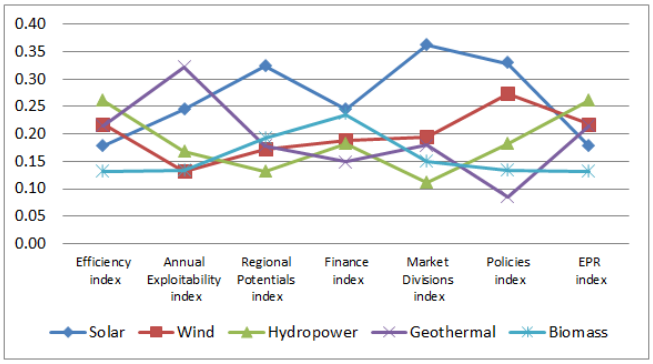

Fig. 4. Situation of each RE resource in compare with other alternatives in each criteria (line chart)

4. Conclusion

To reduce the effects of consuming the fossil fuels, renewable energies as the clean and sustainable sources need to be launched in the Middle East and Iran. For utilization of the alternatives potentials, participation of private sector is essential. While there are many talents and capacities of private sector companies in the energy engineering and services scopes in Iran, less than 5% of the investment and operation in energy industry is performed by private sector [21]. Since investors are committing their assets for sometimes when investing, there are different and important investment aspects that an investor wants to evaluate before making his/her decision.

In this paper and based on previous researches of authors, the situation and priority of each RE source in each criteria have been determined by using AHP approach from investors viewpoints.

In conclusion, the results of this article provide valuable research lines which can be implemented by different groups of audiences in the future. The first group is the investors who are interested to invest in RE sources and cleaner productions. This work can help them to make a good decision if they want to know; what is the best RE resource in each business, engineering or environmental index? The second group is governments. The results of this research not only can help them to comprehend the prime criteria and resources of private investors, but also they would enact more driver policies and encouragement packages based on the priorities of sources in each criteria. The third group includes the researchers of researches centers. Due to the investor's attitudes, which inferred from market demand, this study can work as a leverage for motivating the researchers to expand their researches areas to solve gaps and problems from engineering, cost-effective and etc. aspects. Finally, since almost all of the developing countries have the same investment problems, the results and the approach of this paper would be applicable in countries with same conditions in the Middle East, Asia, Africa, and South America.

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