

Private Sector Investment on Renewable Energy Utilization in Developing Countries

Alireza Aslani^{1,2,*}

¹Industrial Management Department, Faculty of Technology, University of Vaasa, P.O. Box 700 65101 Vaasa, Finland

²Invited Scholar in the Department of Mechanical and Aerospace Engineering, College of Engineering, University of Miami, Miami, FL 33146, USA

Abstract: Feasibility potentials in the Middle East and Iran offer many opportunities for private sector investment in renewable energy industry. However, due to the high primary investment costs in this technology, as well as dominate role of fossil fuels in the Middle East, promotion plans cannot be achieved without government incentives and supports. First, this article tries to answer to one of the main questions of private investors related to identification of the most important renewable source for investment in Iran. Then, to success implementation of investment and government plans, different polices and support schemes of the Nordic countries as successful countries in adoption of renewables are reviewed and discussed.

Keywords: Renewable Energy, Investment, Private Sector, Developing Countries, Nordic region.

1. INTRODUCTION

Today one of the important factors of world's energy production systems is security of energy supply. Energy security concerns along with consumption growth are rapidly rising in importance for both developed and developing countries. In response, electricity/heat generation from renewable energy resources (RER) is an option that contributes dependency reduction on imported energy and provides social and environmental benefits. As renewable energy (RE) utilization is usually developed in local areas, it brings social welfare and unemployment decrease in rural regions.

Despite progresses on RE utilization in the last decades, Middle Eastern countries have not been successful in diffusion and adaption of these technologies compered to developed countries. For instance, despite Iran is known as a rich country in terms of RERs, the main and dominant conventions of resources are hydrocarbon. According to EIA reports, carbon-based resources are supplying more than 97% of primary energy, in which the share of electricity generation is around 93% [1]. Indeed, electricity demand is growing between 7-10 percent annually in Iran, faster than the global average. The resultant, while the country is the third largest producer of natural gas in the world, it imported gas even for domestic usages in some years [2]. Therefore,

challenges exist for Iranian energy policy -makers in optimal utilization of hydrocarbon resources and diffusion of RER utilization [3].

Due to the rich and diversified potential of RE in Iran, development of RE utilization as cleaner energy resources is one of the suggested strategies to minimize the fossil fuel usage and reduce the environmental footprints [4]. However, most of the energy market in Iran is under dominance of government and private sector has not a clear role in RE utilization. The statistics show that only 38% of the goals of Iran's fourth national development plan in RE have been achieved in Iran [5].

This research reviews prioritization of RERs for investment in Iran. To provide a practical viewpoint, different policies and support schemes implemented in a successful case (Nordic region) are reviewed and discussed.

The article is organized as follows: Section 2 gives a brief review of RE potentials in Iran. Section 3 reviews current public policies toward diffusion of RE in Iran. Section 4 presents the prime criteria for private sector participation in RE investment. Section 5 prioritizes the main RE sources based on the identified criteria. Finally, section 6 discusses about a successful case in RE development. Different policies and support schemes are considered in two strategic and practical levels.

2. POTENTIALS OF RENEWABLES IN IRAN

As Iran is located on the world's Sun Belt, the total absorption of solar radiation is estimated between 1800

*Address correspondence to this author at the Industrial Management Department, Faculty of Technology, University of Vaasa, P.O. Box 700 65101 Vaasa, Finland; Tel/Fax: +358 44 255 0010; E-mail: alireza.aslani@uva.fi

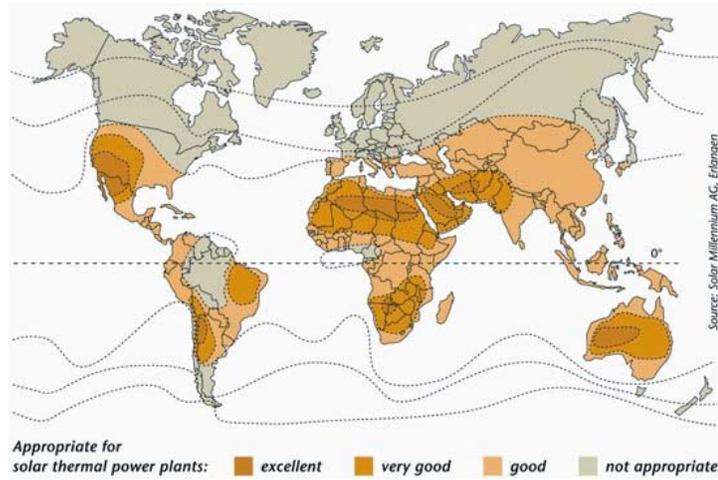


Figure 1: World sun rising [8].

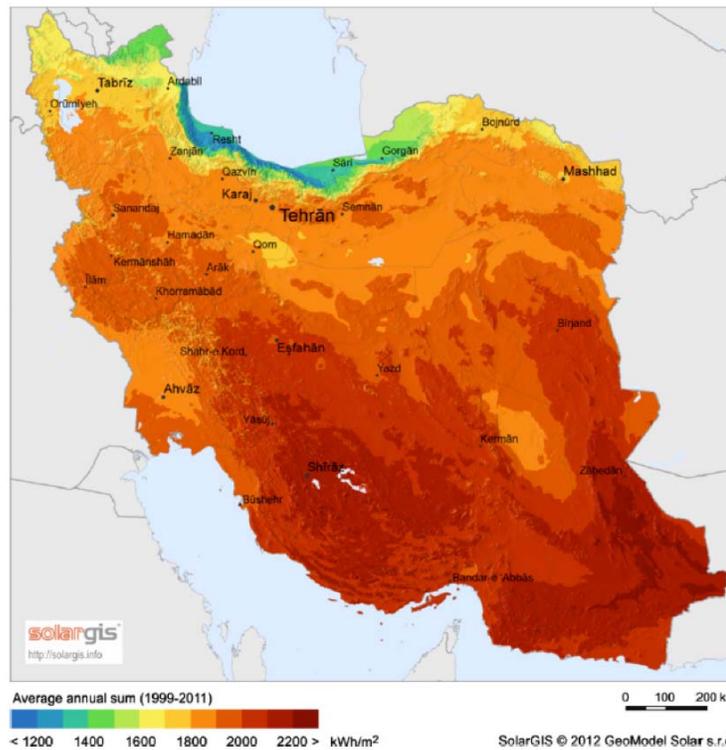


Figure 2: Iran solar energy map [9].

and 2200 kW.h.m⁻² per year (higher than global average) with 280 sunny days per year (Figures 1 and 2) [6, 7].

Table 1 shows the total electricity generation from solar power plants in Iran in the three selected years [10].

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. The potential of electricity generation by Hydropower in Iran is

around 50TWH (Figure 3) [11]. The production capability of hydroelectricity is more than 30 GW [12]. By the end of 2007, total installed capacity of hydroelectric power plants was 7422.5 MW in Iran [13].

There are 45 suitable sites for wind power utilization in Iran. The capacities are approximately expected 6500 MW, employing wind turbines of 60,000 MW nominal powers [10]. The estimated capacity factor of these wind parks is around 33%. Variation of wind speed potential in different sites is represented in Figure 4 [14].

Table 1: Electricity Generation from Solar Power Plants in Iran [10]

Year	30 kW photovoltaic (MWh)	Power plant (MWh)	Total (MWh)
2004	45	92.2	137.2
2006	42	37	79
2008	35	40	75
2010	32	35	67

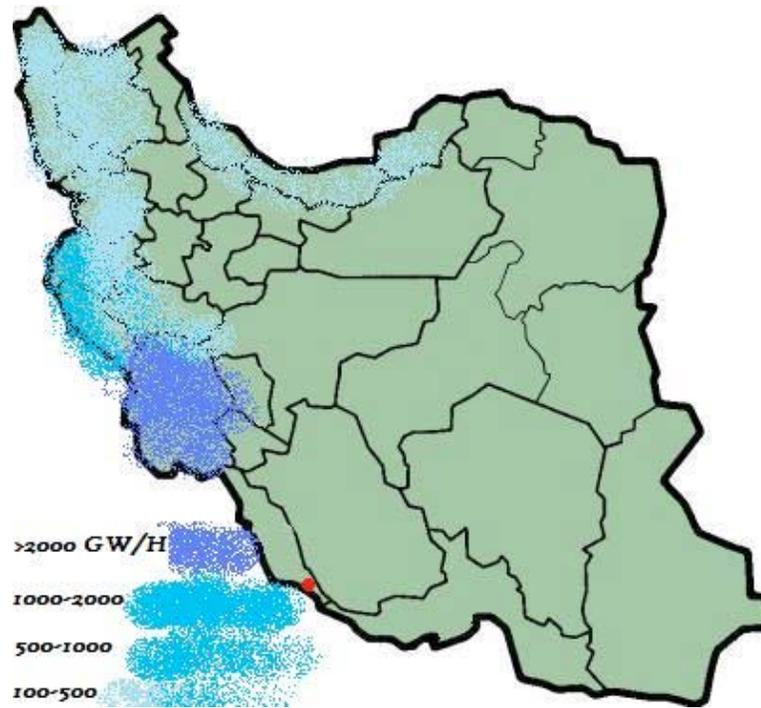


Figure 3: Iran hydropower energy map [7].



Figure 4: Variation of wind speed potential in different site in m/s [14].

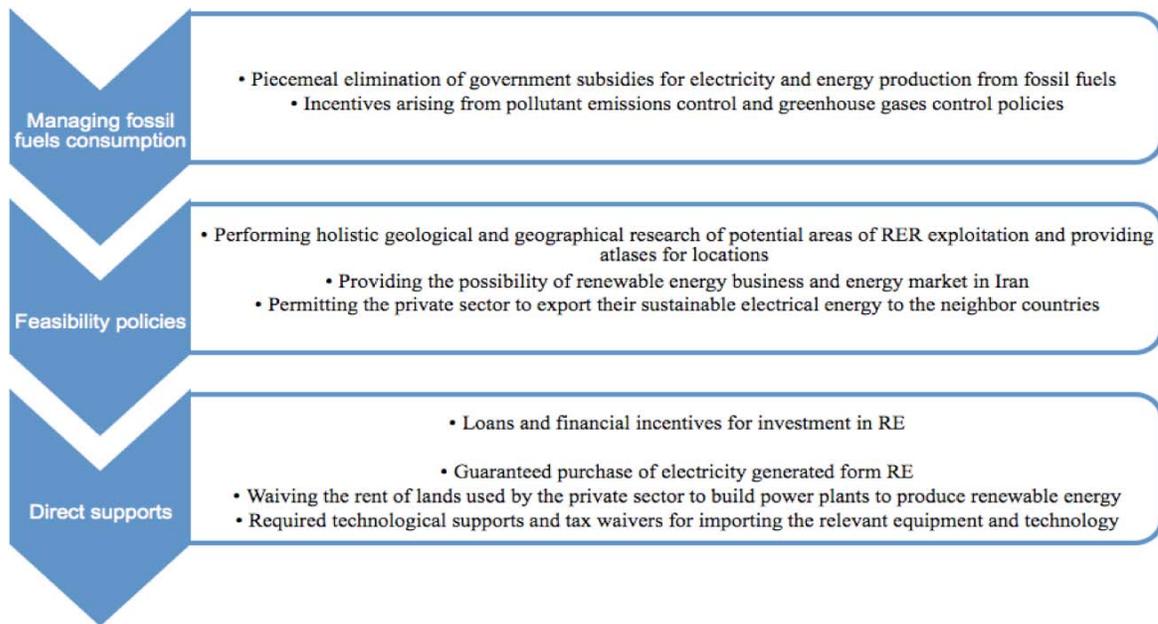


Figure 7: Government encouragement packages of RE development [17].

Ministry of Power is the responsible ministry for diffusion of RE development in Iran. It has tried to encourage the participation of private sector by providing different policies and regulations. Further, due to the situation of energy consumption in Iran and potentials of RERs, it has established an independent research and development organization called Renewable Energy Organization of Iran (SUNA) with the help of World Bank [16]. Figure 7 illustrates the important government policies related to diffusion of RE especially to encourage investments in Iran [17].

4. PRIME CRITERIA FOR PRIVATE SECTOR PARTICIPATION IN RENEWABLE ENERGY INVESTMENT

Studies show that there are important criteria for participation of private sector in RE utilization (Figure 8) [17]. The first and important factor is energy efficiency that is categorized in two different levels: efficiency in products and services, and efficiency in energy basis. More efficiency leads to the further attraction in consumption and consequently more attraction in investment.

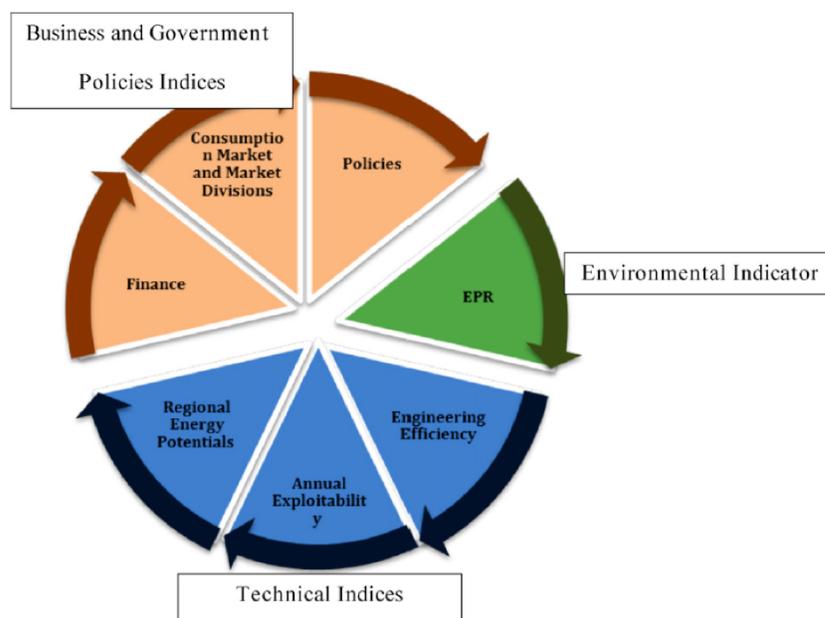


Figure 8: The identified criteria to participation of private sector [17].

Indeed, one of the concerns of investors in commerce of a business is the period that a product or service can be efficiently exploited [18]. Hence, investor's awareness about the accessibility and annual exploitability of RE is an important factor to evaluate the sub-indices such as investments return index, operation risk etc. On the other hand, energy resources are always considered as a constraint that may even endanger a business from competitiveness viewpoint. Therefore, the number of regions that RE sources can be utilized is more attraction for investment from investor's viewpoint (Figure 5). This assumption would be considered from different aspects that the most important one is distribution and harvesting potentials.

Since one of the main interests of investors is to minimize the costs of RE generation, introducing an index for indicating required investment of each type of RE is important for private sector. According to Sardianou, a large number of calculations are necessary for estimating an investment's profitability that investors would like to now before they decide to invest in energy industry [19]. Because RE technologies will improve with time, financial investment of RE (project costs) generally gets cheaper.

As end-user markets provide more advantage compare to mediator markets for suppliers, they are important interests of private sector [20]. The crucial issue in consumer market is advantage-cost of a product or service. To encourage an end user to purchase a new product, they should be satisfied with what they pay compare to what they obtain.

The supportive governmental policies for investing on RE is also another important factor. In other words, accredited degree of government to RE projects is important from investor viewpoint. The Iranian governmental policy seems to incentivize the private sector to invest in this area especially in some RE sources [24].

Finally, one of the main factors of RE investors for investment in energy sector is the environmental performance of RE that called Energy Payback Ratio (EPR) [21]. The factor is important from customer demands (market and consumer psychology), sustainability, and possible future rules.

5. PRIORITIZATION OF RENEWABLE ENERGY RESOURCES FOR INVESTMENT IN IRAN

Due to the important criteria of RE investment, the next step is identifying the most important criteria for investment. In other words, identification of the best RE sources from five common RE sources (alternatives) is the first aim. To analyze, evaluate, compare, and rank alternatives, the analytic hierarchy process (AHP) was used as one of the best and valid methods of multi attribute decision-making (MADM) [22]. 31 samples from 14 companies were randomly selected to compare and prioritize each couple of criteria, and criteria with each alternative. To analyze data, Expert Choice11 software was used. After calculating all priorities and inconsistency indices, the relative weight of each RE source for each criteria were determined. The result of RE sources in each criteria and overall result are shown in the Table 2. As table shows, solar energy is the best source for private sector investment in Iran. Wind energy is the second important source for investment in Iran.

6. LESSONS FROM A SUCCESSFUL CASE FOR DIFFUSION OF RENEWABLE ENERGY DEVELOPMENT IN IRAN

After identifying the priority of RERs for utilization in Iran, we study and compare a successful case in promotion and adoption of RE in order to be followed by Iran and other Middle Eastern countries. The Nordic countries including Finland, Sweden, Norway, Denmark, and Iceland are good examples for development of RE portfolios [23]. In 2011, the average utilization of RER for electricity generation in this region was 62.82% and Norway and Iceland are among top 10 renewable electricity producers with 96.6% and

Table 2: Ranks of each RE Source in each Criteria and Overall

	Overall	Efficiency	Exploitability	Regional	Finance	Market	Supports	EPR
Solar	1	4	2	1	1	1	1	4
Hydro power	3	1	3	5	4	5	3	1
Wind power	2	2	5	4	3	2	2	2
Geothermal	4	3	1	3	5	3	5	3
Biomass	5	5	4	2	2	4	4	5

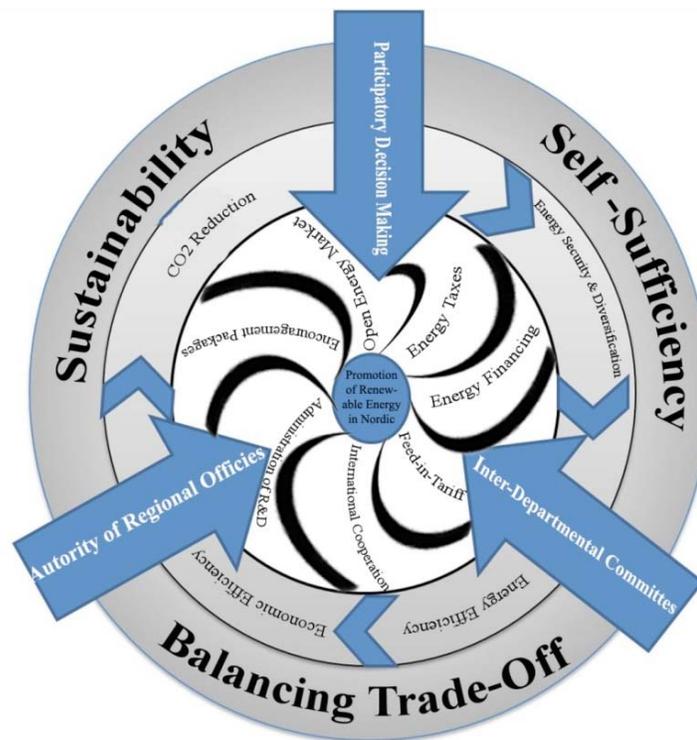


Figure 9: Layers of RE development in the Nordic countries and Finland [26].

100% of their electricity generation from RER in the world [23].

Our studies show that in terms of diversification policies and RE promotion, Nordic countries are one of the best case studies to be followed by other countries and regions. For instance, Finland and Sweden are two of the leading bioenergy-using countries in the world [28]. In addition, Norway with hydropower development, Denmark with high growth in wind power utilization, and Iceland as a successful country in geothermal utilization are very famous in RE studies.

To understand the success of Nordic countries, we have identified different layers of RE development in this region (Figure 9) [25]. These layers create a portfolio of political, technological, managerial, social, and cultural issues. Table 3 summarized each layer and their related supporting schemes that should be considered by policy makers in Iran to have a successful RE promotion programs [26].

On the other hand and beyond the strategic issues, development and performance of renewables are highly dependent to successful implementation of RE supply chain in the regional level [27]. In other words, different practical aspects of RE utilization should be considered in order to have a successful utilization of RER in Iran (Figure 10).

According to Figure 10, the practical issues of successful RE programs (RE supply chain) are characterized from two sides: domains and approaches. The domains cover the process of RE chain from resources to end-users for each source. They create opportunities for business activities and introduced in five main domains [27].

The approaches of RE supply chain show different aspects of RE supply chain process from engineering, social, and management science. They cover all necessary elements of supply chain management. The first approach, policies and strategies, takes into account the role of municipalities and government on diffusion of RE in the region. Creating a development road map for each domain of RE chain, as well as introducing supportive schemes (e.g., subsidies and taxes) are two subjects that are discussed in this approach. The approach "Technology" examines the ways to provide a successful use of RERs in the region. Evaluation and analysis of region's potentials in each domain from technological and infrastructure viewpoints are the focuses of this approach. "Networks and implementation" presents, analyzes, and designs high efficient performance of RE domains. Creating better value for customers and shareholders in each RE domains, quality of RE services, joint investments, and knowledge sharing with other regions are examples of this approach [26]. Finally,

Table 3: Different Layers of Strategic Analysis of Diffusion of Renewable Energy in the Nordic Countries [26]

Layer	Description	Sub-layer	Aim
Dimensions	To show the purposes of diffusion of RE utilization	Self-sufficiency	To reduce consumption of fossil fuels and increase the dependency of indigenous resources
		Balancing trade-off	To help to economic and technologic growth of the regions
		Sustainability	To reduce pollution and environmental impacts
Characters	To identify main stakeholders affect public policies and process of decision-making	Participatory decision-making	To have the supports of the community organizations and citizens
		Inter-departmental committees	To have a comprehensive and coordinative decision making
		Authority of regional offices	To increase the role of regional s (municipalities) in decision-making
Objectives	To show different perspectives of diffusion of RE	Energy security and diversification	To reduce the dependency to the external resources(energy imports)
		Energy efficiency	To produce specific amount of services using less energy
		Economic efficiency	Technical efficiency Allocative efficiency
		CO2 reduction	To minimize CO2 emissions from fossil fuel burning caused by human activities
Key schemes	To describe different policies or regulations related to diffusion of RERs utilization	Energy financing	To direct government investment on the RE technologies and efficiency solutions
		Energy taxes	To curb the growth of energy consumption
		Open energy market	To make RE utilization competitive
		Encouragement packages and green certificates	To improve the knowledge and awareness of the citizens about RERs
		Administration of research	To manage research and R&D funds
		International cooperation	To share and crate the knowledge
		Feed-in-tariff	To accelerate investment in RE utilization

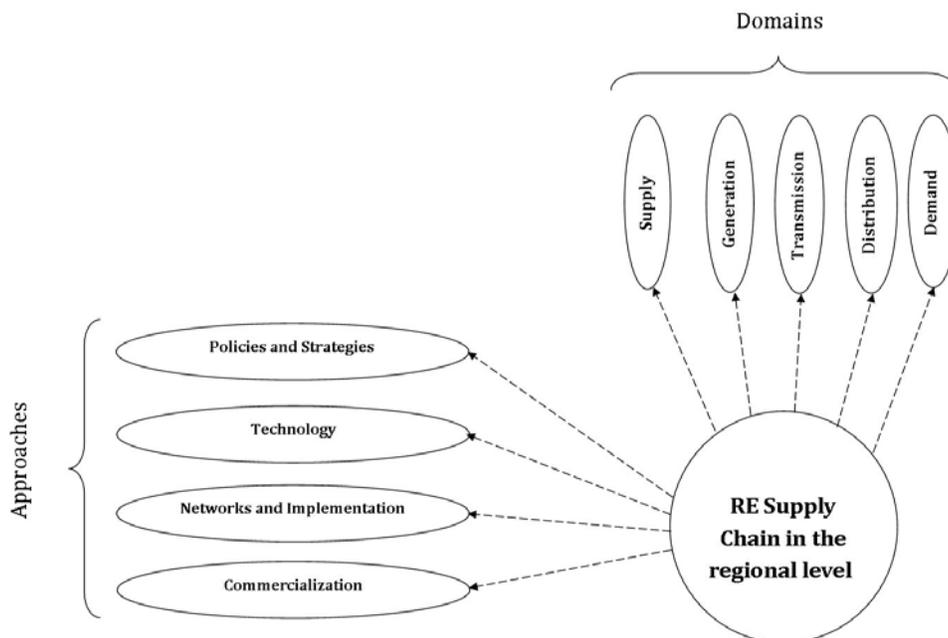


Figure 10: Framework of RE supply chain [27].

“commercialization” includes the economic and investment issues of RE development in the region. Studies show that RE market is complex. While Iran has not a free energy market, it should be encouraged like successful cases in the Nordic region. However, the government intervention or incentives should still support new technologies and businesses in this market.

7. DISCUSSION AND CONCLUSIONS

Increasing world demand for energy, fluctuating carbon based fuel prices, uncertain oil and gas supplies arising from geopolitical concerns, and global warming have caused developed and developing countries to have the secure and safe supply of energy by RE utilization. Despite high potential, promotion and adoption of renewable energy sources are very slow due to excessive concentration of fossil resources in the Middle East and Iran. To have a success utilization of RE, related industries need to be competitive and be subsequently non-government. Therefore, participation of private sector is the main driver engine of RE development in developing countries. On the other hand, as economics of renewables are not competitive because of installation costs per unit of energy, government supply and financing is essential, particularly for developing countries.

This article reviewed important RERs and prioritized them based on investor’s needs and concerns in Iran. Thereby, the solar energy was introduced as the best RE source for private investment and even in the Middle East. After solar, wind power and hydropower sources are in the second and third priorities for investment in Iran. To provide an action plan and executive road map, the strategic and practical factors and policies of a successful case were studied and compared.

As there are several options for renewable energy development in Iran and other developing countries such as generating energy in off-grid and rural power plants, cooking at scale with solar, powering mobile telephone masts by using solar energy, and converting different categories of waste to energy, the potential of each source and option can be discussed and studies for future researches.

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