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Evaluating the Role of Investment in Solar (Photovoltaic) Power Plant on Sustainable Development (Case Study: Boroujerd City)

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Abstract

In the present study, technical and economic evaluation of the role of investment in the construction of solar power plants (photovoltaics) on sustainable development of Boroujerd city was used using engineering economics method and economic analysis method and RETScreen software. The results show that the assumed photovoltaic power plant has an economic justification with an assumed megawatt period with a return on investment of 4.3 years, an internal rate of return of 28.1%, a net present value of 645.24 billion rials and a profit-to-cost ratio of 9.8. This power plant will produce 2197 MWh of electricity per year (about 0.39% of the total electricity required by the city) and 257 similar power plants are needed to provide the total electricity consumption of Boroujerd city. With the construction of this power plant, the annual emission of greenhouse gases equal to 365.2 barrels of crude oil has not been reduced. Also, this one-megawatt power plant saves 8.5 billion rials per year in fossil fuel, water and greenhouse gas emissions. This amount is equal to 11.7% of the initial construction costs of this power plant, which in addition to selling electricity generated, has positive social effects on society.

Keywords: Investment, Photovoltaic, Sustainable Development, Boroujerd City, RETScreen Software V:6.0.7.55 b31679.

1. INTRODUCTION

Today, sustainable development is one of the main goals of macro-policies in all countries. Sustainable development is a general concept related to various aspects of life as well as the relationship of these dimensions with the environment. One of the most important elements in sustainable development is energy resources [1].

Factors such as the share of the power plant sector in the emission of polluting gases, environmental costs due to the production of electricity based on fossil fuels and the depletion of these energy sources, lack of national electricity network in remote areas, high cost of transmission line Due to the long distance, increasing rate of electricity consumption and the large number of consumers far apart, Jadid has attracted attention to renewable energy sources such as solar energy and especially the photovoltaic system [2].

In recent years, the installed capacity of renewable power plants in the country has increased significantly. According to reports published by the Deputy Minister of Planning and Economy of the Ministry of Energy, the capacity of renewable power plants in 1397 (700 MW) compared to 1396 (562 MW), has increased by more than 24 percent. Of this amount, the capacity of photovoltaic power plants in 1397 (302.6 MW) compared to 1396 (187.4 MW), has increased by more than 61%, which has the highest capacity of renewable power plants Is. Also in 1397, electricity generated from renewable sources was 2924 million kWh. Therefore, due to the installation of renewable power plants instead of developing thermal power plants, the emission of 2018 thousand tons of greenhouse gases, consumption of 830 million cubic meters of natural gas and 643 million liters of water in the country has been avoided.

Boroujerd city with an area of 1710 square kilometers, has two central parts and Ashtrinan, two cities of Boroujerd and Ashtrinan and seven villages. According to the 2016 census, this city with a population of 337631 people and 99308 households is the second most populous city in Lorestan province after Khorramabad. The city of Boroujerd is located in the north of the fertile plain of Silakhor and the high peaks of Green from the Zagros Mountains range from northwest to southeast. Numerous permanent mirages that flow from the foothills of these mountains play a role in the region's economy and the development of Boroujerd city. Boroujerd city has had a special communication position since ancient times and today the location of this city on the Tehran-South highway is one of the factors of its economic prosperity.

The main purpose of this study is to evaluate the role of investment in these energies with emphasis on

solar energy (photovoltaic) on the sustainable development of the city. Considering the possibility of using this type of power plants in this region due to different weather conditions in different seasons is of great importance. Similar research in terms of realistic view and analysis from the perspective of sustainable development in this city has not been done so far. Also, in this research, RETScreen software has been used instead of other economic evaluation software, in a more accurate analysis of technical, geographical and climatic factors. Then, in the second part of the research, the theoretical foundations and background of the research are discussed.

2. MATERIAL AND METHOD

In this research, first, using technical and economic evaluation methods, assuming the real costs of the solar power plant (photovoltaic), the factors and cost-effective conditions of using this power plant in Boroujerd city will be investigated. For this purpose, project evaluation criteria including NPV, IRR and PP criteria are used.

2.1. Net Present Value (NPV)

The current net worth measure tries to find a balance between investment payments and investment income by considering the time adjustment of money. The assessment of this balance is in comparison with the standard interest rate set by the project management for the investment and use of funds. This interest is called the minimum interest receivable or the cost of capital. The present net value of a set of future cash flows can be calculated through Equation (1).

$$NPV = NCF_0 + \frac{NCF_1}{(1+i)} + \frac{NCF_2}{(1+i)^2} + \cdots + \frac{NCF_t}{(1+i)^t} \quad (1)$$

The NPV may be a negative, positive, or zero number. The higher the discount rate, the lower the value of future values in the present. Equation (2) shows the different states.

NPV <0 Non-economic projects (2)
NPV≥0 Economic project

2.2. Benefit-cost ratio

Benefit-cost ratio also shows the ratio of the total present value of project revenues to the total present value of costs, which is another expression of the net present value of projects.

2.3. Internal Rate Rate (IRR)

The internal rate of return criterion is a well-known of energy resources in the world are also included in this tool. As mentioned in the research methodology section, the economic criteria of net present value, net return on investment, internal rate of return and cost-criterion in the economic evaluation of projects. This criterion considers the condition for accepting the project as the IRR being greater than the cost of capital. IRR is the discount rate at which the net present value of the project is zero. If the NPV of a project is positive, the IRR of that project is higher than the rate of return used for the investment. In calculating the NPV, it is assumed that the discount rate is known and the project NPV is determined. In the IRR calculation, the project NPV is set to zero and the discount rate, which is the project IRR, is determined.

2.4. Payback Period

Using the criterion of net return on investment, the analyst seeks a period in which total annual income equals investment cost. PP is an approximate and simple way to deal with risk and is beneficial to projects that are more profitable in the early years. The smaller this index, the faster the offset of cash outflows by cash inflows, and therefore the more attractive the project is to invest. The net return on equity includes the period of net and normal return on equity. The concept of net return on equity is: the net cumulative cash flows of the project during operation and the net return on equity is that the time value of money is taken into account in the calculation of PP and the calculations are based on discounted data.

3. Results and Discussion

In order to evaluate the economic parameters of the solar power plant, RETScreen software version 6.0.7.55 b31679 was used. RETScreen Clean Energy Project Software is the premier software for clean energy decision making. This software has been made available to the public free of charge by the Government of Canada as part of the country's need to take an integrated approach to climate change and pollution reduction. RETScreen is recognized worldwide as a tool that enables the implementation of clean energy projects. This software significantly reduces the costs (financial and time) associated with identifying and evaluating potential energy projects. These costs, which are imposed in the pre-feasibility, feasibility, design and engineering stages, can be major barriers to the design of renewable energy technologies and energy efficiency. This product is the most comprehensive product of its kind and allows engineers, architects and financial designers to model and analyze any clean energy project. Technologies including RETScreen project models are all included in this software and have traditional and non-traditional sources of clean energy and conventional energy sources and technologies. Maps

benefit ratio were calculated to evaluate the solar power plant using RETScreen software. According to Table (3), the electricity generated by the photovoltaic power plant of one megawatt is 2197 megawatt hours per year,

which provides about 0.39% of electricity consumption in Boroujerd city per year. Revenue from the sale of electricity generated to the network is 13.99 billion rials per year. Also, in this power plant, the annual emission of greenhouse gases has been reduced, equivalent to 3654.2 barrels of unused crude oil. The internal rate of return (IRR) in this power plant was calculated to be 28.1%. The payback period, which is one of the important criteria in economic evaluation, is calculated to be 4.3 years. This criterion shows the return on investment made in 51 months after the commissioning of the photovoltaic power plant in Boroujerd city. The benefit to cost ratio is 9.8, which shows that the benefit of building this power plant is 9.8 times more than its cost. The net present value (NPV) of the plant is positive, indicating that each project is economical.

The main reason for the economic justification of the solar power plant in Boroujerd city is that the credits and green taxes, which are related to the order of non-emission and emission of greenhouse gases, were included in the model. Another reason is that the guaranteed purchase price of electricity from a solar power plant below 10 MW is 6730 Rials per kilowatt hour, while in a gas power plant it is 1196 Rials per kilowatt hour. The solar power plant does not cost fuel, but in a gas power plant, 800 rials must be paid per cubic meter of gas.

Reducing greenhouse gas emissions, saving fossil fuel and water consumption are among the most important criteria for sustainable development to evaluate the construction of renewable energy plants. According to the results of the economic evaluation of the solar power plant (photovoltaic) in the previous section, the amount of electricity generated by this power plant connected to the national electricity grid is 2197 MW per year. Now, according to the criteria calculated with the help of statistics and information published by the Ministry of Energy, the rate of reduction of pollutant emissions, fuel and water savings have been estimated.

According to Table (4), with the construction of a 1 MW power plant per year, 8.5 billion Rials will be saved in fossil fuel consumption, water and greenhouse gas emissions. With the approximate generalization of the 1 MW power plant to the power plants that provide the total consumption of Boroujerd city, the equivalent of 2195.65 billion Rials will be saved every year in the above cases. As previously mentioned, this power plant provides only 0.39% of electricity consumption in Boroujerd city. Therefore, with the development of renewable energy and especially the construction of solar power plants (photovoltaic), in addition to providing the required electricity, by saving the consumption of fossil fuels, water and non-emission of greenhouse gases, not only energy The needs of the present generation are met, but the needs of future generations are taken into account and the sustainable development of energy is justified.

4. Conclusions

According to the results of the present study, the government and the Ministry of Energy should support the potentials and solar capacities in this city by providing the necessary funds and facilities for the construction of solar power plants (photovoltaic) with a capacity of one megawatt. Also, by doing this, the consumption of fossil energy resources, water and greenhouse gas emissions will be saved and the interests of future generations will be realized in the preservation and sustainable development of energy in this city.

To complete and comprehensive the present study, it is suggested that a combination of renewable energies that have production potential in Boroujerd city be evaluated and modeled and an optimal combination of these types of energies be provided for the city. Also, by evaluating the social effects, the culture of development and use of these types of energies increases.

5. References

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