Economic possibility assessment of creating wind power stations at Soltanieh zone of Zanjan province

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Abstract

Due to increasingly expansion of energy consumption and also decreasing and tendency towards ending fossil energy reserves, the current energy cycle needs to use alternative energy specially wind energy, because it's considerably cheaper than other recycling sources. The present research investigates possibility of creating wind Power Station economically at Soltanieh zone of Zanajn province regarding economical perspectives. Cost of investment and other costs and also environmental effects, were assessed economically by considering annual obtained energy rate. Several scenarios were investigated; complete price of energy in every kW per hour at each scenario was calculated and compared with other sources of electricity energy generation especially fossil power stations. By considering obtained results, it's expected that creating wind power station at Soltanieh zone has yielded economical benefits.

Keywords: wind power station, discount rate, Soltanieh, investment return, balanced cost.

1. Introduction

Nowadays in the world, the impressive development of science and technology has led to comfort and welfare of human life. So, this development has created some new problems for humans including environmental contamination, extensive climatic changes on earth, and so on.

It's especially clear that oil and its derivatives are vital and national assets of our country, and in some cases non-optimal consumption of these products leads inevitable losses; therefore experts and researchers are looking for sources that gradually replace fossil fuels. Fossil fuels cause more environmental contamination; on one hand, by burning fossil materials, toxic gases enter into environment and lead to human respiratory problems; and on the other hand, concentration of these gases on the atmosphere prevent exit of heat from around the earth and increase weather temperature and cause intensive climatic changes on earth. This phenomenon is called greenhouse effect. If increasing weather temperature continues based on current trend, it will be almost impossible to return it to the previous condition. The best solution that most scientists suggested is to prevent growing trend of these harmful gases. Specialists believe that if we use clean energies such as wind, solar and geothermal energy, etc. rather than energies derived from fossil fuels, then environmental contamination and dangers related to it will be prevented. On the other hand, fossil fuels such as oil, gas and coal will finally end and through ending these fuels, human civilization depending directly on energy will lead to new and big challenges. This forces industrially developed countries use other available energies such as recycling energies. Before

using recycling energies, they should be studied and investigated more. Gradually, a set of recycling energy projects is carried out to supply the world's energy. Among recycling energies, wind energy has absorbed more attention due to its lower complete costs compared to other types of recycling energies. Wind energy, like other sources of recycling energy, is always sporadically available regarding expanded geographical outlooks. Wind energy has fluctuating and alternative nature and doesn't have constant movement. It's thousand of years that human uses little part of wind energy by windmill. This energy was extensively used before industrial revolution as a source of energy but at the period of industrial revolution, fossil fuels were replaced by wind energy due to cheapness and high safety. During this period, old wind turbines weren't more competitive with the market of oil and gas energies, so during years between 1973 and 1978, two big oil shocks influenced energy economy regression resulted from oil and gas. In this way, energy produced by wind turbines was improved regarding world rate of energy price. Also, researches at countries pioneered on this technology revealed that only one percent of total area of wind farms is occupied by these turbines. According to statistics, the production of every kW per hour electrical energy from wind can prevent spreading one kilogram CO compared to fossil fuels power stations. Generally, replacing wind electrical energy by electrical energy produced fossil fuel PowerStation that can prevent spreading greenhouse gases. As a result , according to statements above, wind energy is more affective at decreasing social costs is comparison to fossil fuel power stations that have negative external effects and the electricity obtained from wind can be used as a constant energy to develop economy society and culture.

2. Economical assessment

There are several methods and techniques to assess projects and plans based on engineering economic principles. [1,9] Current ways to assess economy include: calculating internal rate of return (IRR), net present value (NPV) and discounted complete cost (LEC or LCOE). In these methods, in addition to technical factors such as load factor, annually produced energy and power, and other factors including currency and foreign exchange costs of investment, maintenance and repair costs, degree of governmental protection, taxes and tax exempt, the value or price of scrapped power station after ending exploitation life time, discount rate, cost of electricity sale etc. are considered.

When assessing economy, instead of investigating profitability of plans or projects and investment return etc. irrespective of income generated of energy sale depending on policies of power ministry that can be varied annually, we can calculate updated and complete price and then compare them with complete price of fossil electricity that is available at energy balance sheet.

3. Economical relationships

To assess project and do economical comparison of wind power stations with other fossil power stations, we can use the method of cost equivalent or balanced cost equivalent (LCOE) that is the common method for determining electricity complete cost in Iran. According this method, complete cost of electricity generated for every kWh (kilo watt per hour) electricity of wind power station is computed and then compared with cost price of other methods of electricity generation. By this method, three type of investment, maintenance, and fuel cost are taken into consideration, but

fuel price at wind power station is zero. There are two important limitations when using this method and comparing it with other methods. The first limitation is that the comparison of different plans with LCOE method will be proper when all show similar procedures. Second, LOCOE method is suitable when the present plans are compatible with economical calculations. Cost equivalent method is stated as equation below: [2]

$$lec = \frac{\sum_{t=1}^{n} \frac{i_t + m_t + f_t}{(1+r)^2}}{\sum_{t=1}^{n} \frac{e_t}{(1+r)^t}} \quad (1)$$

Where in equation 1, LEC is average generated electricity price discounted at life-time of power station; expected investment cost at t year, expected maintenance cost at t year, fuel cost at t year that zone at wind power station, generated electricity at t year; r indicates discount rate and n shows life-time of power station.

Note: The cost of repair and maintenance for first two years is 2.17 percent of set and installment cost. Also cost of repair and maintenance for second eight years is 2.27 percent and for last ten year it is supposed to be 3.04 percent [3].

4. Description of Soltanieh wind power station

Based on detailed statistics of Iran electricity industry in 2013 (the last broadcast news at the time of writing thesis) [4], electricity consumption in Soltanieh in 2013 is 128831000 kWh, so nominal capacity of PowerStation is expected to be 45 MW. Overall features of Soltanieh wind power station are shown in table 1.

Table 1: Overall features of Soltanieh wind power station

type of turbine	Vestas v100-1.8Mw
Tubing power(kw)	1800
Amount of turbine	25
Power station power(kw)	45000
Capacity factor (load)	0/331
Annually generated energy of a turbine (kw)	5222836
Annually generated energy of power station	130570900
Power station life-time (year)	20
Rate of repair and exploitation cost during first two years	0/0217
Rate of repair and exploitation cost during second eight years	0/0227
Rate of repair and exploitation cost during third ten years	0/0304
Time of project creation (year)	2

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5. Description of scenarios

To do calculations, we should consider primary investing cost. Since this cost in several references has been considered to

have different values from 1200 to 2000

dollars per kW (kilo watt), the selection of a constant value for investment cost isn't absolutely documented and properly output. Therefore, contrary to common possibility assessments, this cost is considered as variable, so that by determining different scenarios, investment cost has been considered from 1200 to 2000 dollars per kW and for every scenario, separate cost price of electricity has been calculated.

Table 2: The results of first scenario

Unit cost of investment($/kw)	1200
Exchange rate of Dollar to Rial	28338
Discount rate	0/1
Overall investment cost($)	54000000
. Overall investment cost ratio (Rial)	1530252000000
Annually generated energy of power station	130570900
Power station life-time	20
Annual exploitation and repair cost during first two years. ($)	1171800
Annual exploitation and repair cost during second eight years($)	1225800
Annual exploitation and repair cost during third ten years($)	1641600
Annual average cost of repair and maintenance($)	1346400
Cost per KWh ($)	0/0588
Cost per KWh (Rial)	1666

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Table 3: The results of second scenario

Unit cost of investment($/kw)	1500
Exchange rate of Dollar to Rial	28338
Discount rate	0/1
Overall investment cost($)	67500000
. Overall investment cost ratio(Rial)	1912815000000
Annually generated energy of power station	130570900
Power station life-time	20
Annual exploitation and repair cost during first two years. ($)	1464750
Annual exploitation and repair cost during second eight years($)	1532250
Annual exploitation and repair cost during third ten years($)	2052000
Annual average cost of repair and maintenance($)	1683000
Cost per KWh ($)	0/0736
Cost per KWh (Rial)	2085

1-5 First scenario

At this scenario, we suppose that first investment cost is 1200$.

Table 2 indicates the results of economic analysis of scenario 1. Exchange rate of dollar to Rial is based on stated value of central bank on 23rd. April 2015 that is equal to 28338. [5]

2.5. Second scenario

At this scenario, we suppose primary investment cost to be 1500 dollars.

Table 3 shows the results of economic analysis of scenario 2

3.5- Third scenario

At this scenario, we suppose primary investment cost to be 1647 dollars that is

world's average cost. Table 4 shows the results of economic analysis of scenario3.

Table 4: The results of third scenario

Unit cost of investment($/kw)	1647
Exchange rate of Dollar to Rial	28338
Discount rate	0/1
Overall investment cost($)	74115000
. Overall investment cost ratio(Rial)	2100270870000
Annually generated energy of power station	130570900
Power station life-time	20
Annual exploitation and repair cost during first two years. ($)	1608295
Annual exploitation and repair cost during second eight years($)	1682410
Annual exploitation and repair cost during third ten years($)	2253096
Annual average cost of repair and maintenance($)	1847933
Cost perKWh ($)	0/0808
Cost per KWh (Rial)	2289

4.5. Forth scenario

At this scenario, we suppose primary investment cost to be 2000 dollars. Table 5 shows the results of economic analysis of scenario 4.

Also, the results and comparison of different scenarios with different costs of investment are shown in table 6.

6. Conclusion

According to results at section 4-2 and based on energy balance sheet of whole cities in

thesis, we compared cost price of electricity of fossil power station by considering environmental costs shown in graph 7

Table 5: The results of forth scenario

Unit cost of investment($/kw)	2000
Exchange rate of Dollar to Rial	28338
Discount rate	0/1
Overall investment cost($)	90000000
. Overall investment cost ratio(Rial)	2550420000000
Annually generated energy of power station	130570900
Power station life-time	20
Annual exploitation and repair cost during first two years. ($)	1953000
Annual exploitation and repair cost during second eight years($)	2043000
Annual exploitation and repair cost during third ten years($)	2736000
Annual average cost of repair and maintenance($)	2244000
Cost per KWh ($)	0/098
Cost per KWh (Rial)	2777

Table 6 The results and comparison of cost price of electricity with different costs of investment

Scenario	Investment cost (Dollar)	Cost per KWh (Rial)	Cost per KWh (Dollar)
1	1200	1666	0/0588
2	1500	2085	0/0736
3	1647	2289	0/0808
4	2000	2777	0/098

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2012[6] published at time of writing this As you see in fig.1., cost price of electricity at wind power station in first scenario is cheaper than cost price of electricity at fossil power stations by considering environmental costs.

Based on fig.1., we can easily conclude that wind power station can solely compete fossil fuel power stations through which environmental costs are taken into consideration.

According to results, economic analysis shows that by considering investigation of results of different scenarios at investment, when subside paid to power station votes and also environmental costs of fossil fuels are added to generated energy cost of fossil fuels and also government rendering facilities such as long-term loan, tax exemption, long-term warranted purchase, ... into consideration, creating wind power station by using our country reserves at most parts of country will be more economical and we encourage investors to invest on recycling energies specially wind energy. Based on results, it can be concluded that creating wind power station at Soltanieh zone is economically profitable.

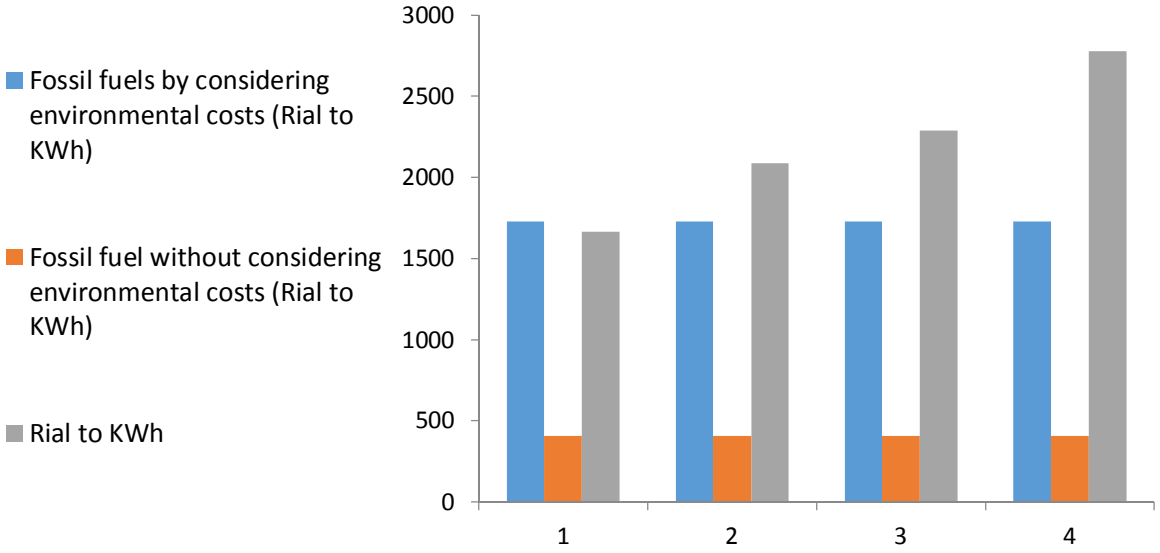

Fig.1. The comparison of cost price of electricity at wind power station with average cost price of fossil fuel power station

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