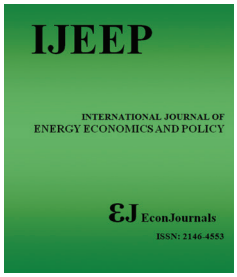

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Cost-Benefit Analysis of Renewable Power under Full Subsidy Targeting Law Enforcement Conditions in Iran

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ABSTRACT

Fossil energy extracted resources limitation, on the one hand and fossil energies induced environment pollution, on the other hand, have made renewable energies more attractive, especially for developing countries. Thus international programs and policies such as the UN programs have been considered in line with global sustainable development playing a special role for renewable energy resources. Although, in practice various factors in particular high initial cost and marginal price, not sufficient investment for localization and the associated technologies efficiency enhancement, taking external costs for granted in the economic equations and lack of supportive policies at local, regional and international levels have made renewable energies penetration and development very slow and limited. It is emphasized that rich fossil resources (standing 4th rank in oil reserves and 2nd in gas reserves) existence in Iran has been another giant obstacle for renewable energies development in Iran. Thus executing subsidy targeting policy and Article 44 of Iranian Constitutional law can be a great opportunity for renewable energies development in Iran. Through economically evaluating the renewable power and comparing it with fossil electricity under full subsidy targeting law enforcement conditions, renewable electricity marginal cost sensitivity analysis and various guaranteed renewable energies resources electricity purchase tariff proposal to the government, the researcher in this study hopes that the private sector investor's opportunity in this industry and subsequently, renewable electricity share increase in Iran energy basket will be provided.

Keywords: Cost-Benefit Analysis, Sensitivity Analysis, Renewable Power, Subsidy Targeting Law, COMFAR
JEL Classifications: C87, H23, Q27, Q42

1. INTRODUCTION

At the national level, at least 30 countries around the world already have shares of renewable energy above 20%. Some 120 countries have various types of policy targets for long-term shares of renewable energy, including a binding 20% target for the European Union by 2020. Some countries have long-term policy targets that will put them squarely in the "high renewable" domain by 2030 or 2050, such as Denmark (100%) and Germany (60%). Outside of Europe, a diverse group of at least 20 other countries target energy shares in the 2020-2030 time frame that range from 10% to 50%, including Algeria, China, Indonesia, Jamaica, Jordan, Madagascar, Mali, Mauritius, Samoa, Senegal, South Africa, Thailand, Turkey, Ukraine, and Vietnam (Martinot, 2013).

Several factors have made the penetration and development of renewable energies very slow and limited, especially initial cost, insufficient investment for localization and improvement of the corresponding technologies effectiveness, lack of accounting for foreign costs in economic equations, and lack of supportive policies worldwide, across region and across local places. Also, the existence of rich fossilized resources (forth rank of oil resources and second rank of gas resources) in Iran has become a larger obstacle for the development of renewable energies in this country. Thus the execution of targeted subsidy law (Available from: http://www.parliran.ir/index.aspx?siteid=1&pageid=3070) and the execution of the article 44 of the constitutional law (Available from: http://www.rc.majlis.ir/fa/content/iran_constitution) could be the most important opportunity for the development of renewable energies in Iran.

One of the important barriers to implement any such programs for enhancing the use of renewable energy is the limitation of financial resources and lack of government support, which is likely caused by weak economy and fundamental infrastructures deficiencies of countries, which will need to be addressed, first and foremost, by proper Governmental policies and deep support from the private investors (World Energy Council, 1986).

Along execution of the article 44 of the Iran constitutional law, the improvement of economic structure and the cooperation of the private sector for infrastructure activities is of important and effective actions. The requirement of actualization of this important task in power industry is a structure renewal for establishing competency healthy space, privatization and optimum allocating resources.

In Iran there have been also carried out the goal of establishing proper space for cooperation of private sector in power industry, several actions such as legal establishment, announcement of regulations and executioner trends. Although structure renewal and privatization of power industry are actualized when private sector – besides having satisfaction from obtained benefit – is sure from investment in this sector. In such a situation the execution of supportive tariff-making policy and guaranteed purchase of power by the government could be the most main and important tools for establishing confident conditions for investment and attraction of private sector investment. This policy is of the most main and the most important tools which are used for the development of this era.

It should be noted that the protective incentive policy, investment and guaranteed pricing of renewable energy sources are the most important tools in Iran for developing the fields, which policy has been used successfully in Turkey, Canada, Germany, Denmark, America, Spain, and is also used in the countries who intend to support investments in renewable energy sources. These policies and incentives also include the creation of a special for the Renewable Energy sector (DOE Report, 2009; Dabiri et al., 2013).

In this research the researcher have analyzed cost-benefit of the generation of renewable power and have compared it with the fossilized power in the condition of complete execution of targeted subsidy law having accounted for society cost of power generation, sensitivity analysis of finished cost of renewable power and suggestion of guaranteed purchase of power. The researcher hopes that the private sector investor be attracted to this industry and beside the renewable power is increased in the Iranian energy basket.

This research has been carried out by the consultative opinions of the experts of economic and strategic studies office of the Iranian organization of new energies and also experts of power industry, solar thermal power plant, water and wind power plant and steam power plant, small gas plant, large gas plant and combined cycle of fossilized technology.

2. MATERIALS AND METHODS

Cost-benefit analysis methods have been used to evaluate the data in this study. It is customary method in evaluating and measuring the Marginal Cost of production unit or cost of each energy production unit, which identifies the factors for incentives recommended for guaranteed electricity purchases and the equality of Cost-benefit ratio (B/C) for comparison purposes.

The Equivalent Uniform Annual Cost (EUAC) and in this case Levelized Cost of Energy (LCOE) is used. In this method all the Marginal Cost annually are measured with discounted rate (i=10) for the referenced year and then it is distributed during the project's lifetime.

$$B/C = EUAB/EUAC \quad (1)$$

If it is $B/C \geq 1$, it is justifiable for private sector investment, and

If $B/C < 1$, it is not justifiable for private sector investment.

In this method, LCOE is calculated as follows:

$$LCOE = AC + O\&M + P_{vf}/E_{out} \quad (2)$$

The variable terms for the above method of calculation are defined as follows:
AC: Annual cost of investment ($)
O&M: Annual cost of maintenance and operation ($)
P_{vf}: Annual cost of consumption fuel ($)
E_{out}: Total annual gross electrical energy produced by plant (kWh)
AC: Annual cost of investment

The annual cost of investment, is a uniform cost which has a constant value throughout the plant's life. To obtain cost of annual investment, at first the investment return coefficient CRF should be multiplied by the total cost of the primary investment:

$$AC = CRF \times C \quad (3)$$

C is the total primary investment amount for Engineering, Procurement and Construction (EPC), and

$CRF = i/1- (1+i)^n$, (n is the plant life time and i is the Discount rate) (4)

O&M: Maintenance and Operation
The cost of Maintenance and Operation is considered as a percentage of annual cost.
P_{vf}: Annual cost of fuel consumption

The amount of annual cost of fuel is calculated using the following formula:

$$P_{vf} = (W \times h/R_a \times NHv) \times P_g \quad (5)$$

W: The plant power (MW)
R_a: Plant efficiency
P_g: Base price of consumed fuel ($)
NHv: Heat value of Net fuel (MW)
H: Amount of work hours of plant unit in a year ($h = CR \times 8760$)
CR: Coefficient of accessibility
E_{out}: Annual gross value of plant production

The total annual gross energy production by plant (kWh):

$$E_{out} = W \times CR \times 8760 \quad (6)$$

In Iran, generally, financial resources and investment funds

required by the power industry are supplied by the internal resources of the industry, governmental complementary budgets, taking formal loans from the internal banking system, selling valuable papers inside the country, delivering loan and credit from multilateral and bilateral international agencies. In this survey having supportive approach, the investment conditions and financial supply have been considered with banking financial facilities stock equal to 85% and capital delivery stock equal to 15%. Considering the loan interest rate is the most important factor in financial decision-making activities, all the calculations, comparisons, and analyses have been carried out in loan different interests (7% interest from National Development Box of Iran and Finance, 12% and 17% interest from Governmental Banks in Iran and also 25% interest loan from private Banks) (Central Bank of the Islamic Republic of Iran, 2014). All of the indexes measured in the survey – NPB, DPB, IRRE, NPV, IRR – have been calculated having the goal of investigation of desired and attractive plans for the private sector investor with the least capital return rate IRRE=20% (Appendixes 1 and 2) (Table 1).

Evaluation calculations and economic comparisons of generated power cost price, suggested tariffs of guaranteed purchase of renewable and fossilized power in the conditions of exact execution of the law of subsidized targeting in 2015 are carried out considering external costs of fossilized power generation. Also, to recognize the most important factors affecting on the cost price of renewable power and the value of this effect, the sensitivity analysis of the cost price of the renewable power would be performed.

In this article, all the calculations are performed by the economic evaluation software of industrial projects COMFAR, which is a flexibility program for financial and economic evaluation of industrial capital projects in terms of the national and international standards.

3. THE CALCULATIONS AND ECONOMIC COMPARISON BETWEEN RENEWABLE POWER AND FOSSILIZED POWER

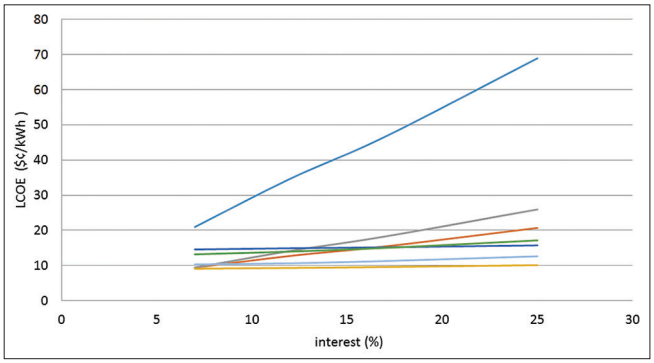
The existence of rich fossil resources is a great reason that shows that Iran is not developed in renewable energies. Thus it is necessary in the analysis and economic calculations related to the technologies of renewable power to carry out its analysis and comparison with fossilized power plants. In calculation of the cost price of the generated power from the fossilized power plants, the fuel price is the most important factor. Calculations have been carried out for several kinds of power plants assuming the fuel as natural gas. According to article 1 of the targeted subsidy law, the price of consuming natural gas of the power plants is equal to 75% from export natural gas mean price (Parliament of Islamic Republic of Iran). Meanwhile, the mean price of natural export gas price has been estimated in 2014, 30 ¢/m3. Also it is noted that the rate of dollar would be 24600 Rials/$ (Central Bank of the Islamic Republic of Iran, 2014).

To calculate the marginal cost or uniform expense of power generation in fossilized plants, the amount of social cost of power generation would also be considered. The same cost was calculated by the researcher based on energy balance sheet in 2011 (Ministry of Energy, 2013) for steam plant 0.93 ¢/kWh, gas plant 0.43 ¢/kWh, and combined cycle plant 0.25¢/kWh, respectively.

Having accounted for the above conditions, the calculations of the marginal costs of power generation, the tariffs of guaranteed purchase and Cost-benefit ratio - B/C of the power generated from the technology of renewable energy and the generated power from the technology of fossilized energy are represented as follows:

In the Figure 1 it is seen that in all of the loan interests, the gas small plant is the cheapest option and the cost price of the solar thermal plant is considerably the most expensive one. In the loan interest of 7% to 12% after solar thermal plant, the large gas plant is in the second rank. Also in the loan interests the increasing slope of

Figure 1: Levelized cost of energy versus interest rates with social cost/comparing



Interest (%)	Solar thermal	Small hydro	Wind	Small gas	Large gas	Steam	Combined cycle
7	20.96	9.40	9.42	9.09	14.56	13.18	10.32
12	34.64	12.73	14.13	9.30	14.89	13.95	10.64
17	46.63	15.43	18.26	9.57	15.18	15.00	11.28
25	68.90	20.69	25.94	10.10	15.73	17.14	12.62

Table 1: The manner of calculation of some of the Technical-Economical parameters

Tax	(Income−cost of exploration−capital amortization−loan interest)×tax coefficient
Annual net energy production	(Access coefficient×internal consumption −1)×nominal capacity×production coefficient×8760
Income	Tariff×annual net production energy
Annual amortization	Investment cost×plant life time/(depreciation coefficient-1)
Cash flow	Income − maintenance cost – loan origin rebate – loan interest
Total investment	Total primary cost+manufacturing period interest
LCOE	Investment annual cost+annual maintenance and operation costs+(total annual gross energy produced by plant/annual cost of fuel consumption)

LCOE: Levelized cost of energy

generated power cost is more than from technology of its fossilized analogs. Its main reason is the high required amount of cost for renewable technology, so that their loan stock is considerable and it is sensitive versus loan interest. The government could pay attention and support these options of small hydro and wind from the group of renewable and small gas plant from fossilized group.

In the Figure 2 it is observed that according to all of the amounts of loan interests, the tariffs of the guaranteed purchase of power generated is more expensive than fossilized technology. In this comparison the least tariff corresponds to gas small plants and the most tariffs corresponds to the solar thermal plants.

One of the benefit-giving evaluation indexes is Cost-benefit ratio - B/C. The higher is this ratio, the more is the amount of benefit-giving. Considering social cost in the cost price of generating power causes the ratio of revenue to fossilized power cost to decrease. It is evident from Figure 3 that generally the renewable power has the highest amount of benefit-giving compared with fossilized power. As it is seen from the calculations, in lower interests, for the investor of private sector the renewable power has the most absorption compared with the fossilized power. Therefore, the government should, to support the generation of power by renewable energies, provide and represent the facilities such as loan having low interest (loan with interest of 7% from the national box for development) and also provide the background for entrance of private investor in this field.

Considering Figure 1 the cost price of generated power by gas small plant versus three other fossilized is very low but, regarding Figure 3, since, versus other fossilized options the Cost-benefit ratio - B/C is low, this power plant has not any absorption for the private sector investor. But regarding that these plants can be used as combined cycle and CHP and their advantages such as performance increase and dissipated generation of this kind of power plants in generation and delivering power, and regarding low tariff of guaranteed purchase and also its low ascending slope, this kind of power plant could be an appropriate option for the government to support and absorb the investor of the private sector.

3.1. Calculation and Recommended Prices for Guaranteed Renewable Energy in Iran

In 2013, according to the instructions in paragraph (b) of Article 133, Iran's Fifth Five-Year Plan and the procedures for determining the power purchase rate of new and cleaner energy sources, the basic rate of purchase of electricity from the resource for contracts guaranteed for purchase for 5 years as follows: Guaranteed purchase rate of electricity from renewable energy sources is equal to:

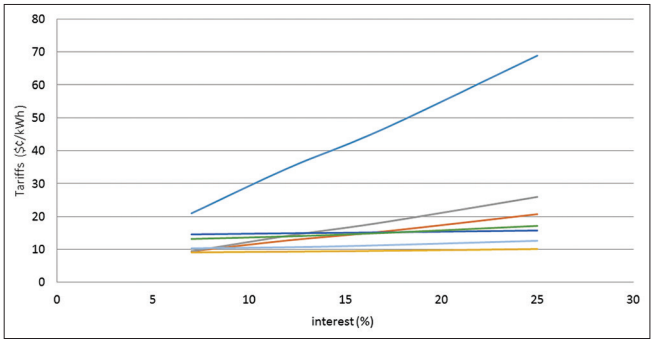
The average price of energy converted in to the electricity market per kWh

+Saving fuel values for liquid combined fuel per kWh

+Savings the values due to the lack of emissions - Social Cost per kWh

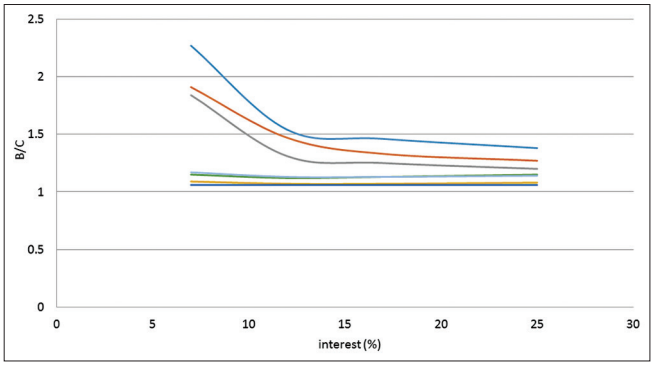
Base price was calculated for guaranteed purchase rate was determined and communicated for electricity from renewable energy sources at the rate of 17.77 ¢/kWh (Renewable Energy Organization of Iran, 2014).

Figure 2: Tariffs versus interest rates without social cost/comparing



Interest (%)	Solar thermal	Small hydro	Wind	Small gas	Large gas	Steam	Combined cycle
7	20.96	9.40	9.42	9.09	14.56	13.18	10.32
12	34.64	12.73	14.13	9.30	14.89	13.95	10.64
17	46.63	15.43	18.26	9.57	15.18	15.00	11.28
25	68.90	20.69	25.94	10.10	15.73	17.14	12.62

Figure 3: B/C Ratios versus interest rates with social cost/comparing



Interest (%)	Solar thermal	Small hydro	Wind	Small gas	Large gas	Steam	Combined cycle
7	2.27	1.91	1.84	1.09	1.06	1.15	1.17
12	1.54	1.47	1.31	1.07	1.06	1.12	1.13
17	1.46	1.33	1.25	1.07	1.06	1.13	1.13
25	1.38	1.27	1.20	1.08	1.06	1.15	1.14

Following three equations requires finding out the ratio B/C of the technologies:

1. Is the production of electricity through Wind power plant justified in Iran?
2. Is the production of electricity through Small Hydropower plant justified in Iran?
3. Is the production of electricity through solar thermal power plant justified in Iran?

It should be noted that the calculation of the electricity production from renewable sources is based on 7% interest loan to finance the foreign exchange reserves, to be considered by the private sector. Therefore, to examine the justification of the economic viability tariffs cost of LCOE by the resources, the loan interest

is set at 7%. With the tariff set by the government, it can be seen that, generating electricity through solar thermal power plant is not economically feasible, although it might be appropriate tariff for the two other options.

It's very important that consideration is given to setting different tariffs for guaranteed purchase of electricity based on the cost of producing electricity through investments in different technologies; hence, different tariffs for different technologies must be used. The same tariffs for different technologies impede balanced development to various renewable energy technologies, as the investors will favor the development of the technology that is more profitable.

Based on the opinion of the Economic and Strategic Studies Expert Advisory of the Renewable Energy Organization of Iran, the unit cost of electricity generated through renewable sources -LCOE in 2014, with goal of creating economic justifiability in order to encourage private sector investment in this section, different tariffs for different technologies is proposed and the B/C ratio of this resource has been calculated (Appendix 3) as Table 3:

As it can be seen, the proposed electricity tariff by three technologies will be economically feasible. It is hoped that the proposed tariff for Solar thermal power plants, which have a relatively high number, with the more power is considered in developing the proposed plant capacity and its future growth, it will result in reduced investment costs and lower energy prices in the future.

Wind power forecasts dependent on Iran's fifth economic and social development of wind power, the research-based purchase price is expected to be determined based on the high potential of Wind power in the value chain of technology and further supported by the Government for Wind power plants.

3.2. Renewable Electricity Cost Principle Sensitivity Analysis

The cost price of produced electricity (LCOE) through renewable energy resources is affected by many factors, known and unknown variables. Three main factors affecting it are "Discount Rate (i), Investment Cost for EPC and Net Production Factor."

Net production factor is the ratio of total energy produced by the plant during a specified period (generally a 1-year period) divided by the system peak load and the length of time in hours (generally 8760 h).

"Sensitivity analysis" has been used to determine the most important factors affecting the cost of electricity generated and the level of its impact. Sensitivity analysis repeats the calculations of a financial process by changing the main parameters and comparing the results from the primary data. If a small change in a parameter causes a considerable change in the results, it is said that the plan has high sensitivity with respect to that parameter and that is a sensitive parameter. To investigate the project sensitivity with respect to these changes, the Sensitivity Geometrical Graph methodology is used here (Oskounejad, 2008).

Figures 4-6 are the analyses of sensitivity of cost of the electricity produced through renewable energy resources, with respect to three main components of "discount rate, investment cost for EPC and net production factor," which has been calculated and presented as follows:

The following assumptions were used in analyzing Sensitivity Graphs of Figures 4-6:

- The cost/price of the production of renewable electricity - LCOE of the plants with respect to the component EPC has a direct relation and with respect to two other components (Discount Rate and Net production factor) has an indirect relation.
- The cost/price of the production of renewable electricity - LCOE with respect to component EPC, is most sensitive to solar thermal plant, water electricity plant, and wind plant, respectively (according to their EPC value).
- The cost/price of the production of renewable electricity - LCOE with respect to the component of Discount rate is most sensitive to solar thermal, wind, and small hydro respectively

Table 2: B/C ratio of renewable resources tariff in 2014

Power plant index	Wind	Small hydro	Solar thermal
LCOE (¢/kWh)	9.42	9.40	20.96
Tariff (¢/kWh)	17.77	17.77	17.77
B/C	1.80	2.03	0.91

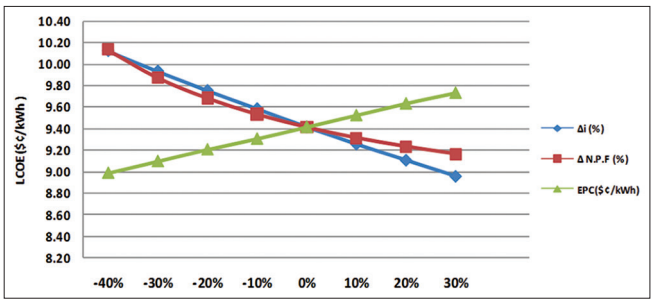
LCOE: Levelized Cost of Energy

Table 3: The researcher proposed tariff and the ratio B/C proposed tariff in 2014

Power plant index	Wind	Small hydro	Solar thermal
LCOE (¢/kWh)	9.42	9.40	20.96
Tariff (¢/kWh)	17.70	12.70	43.40
B/C	1.84	1.91	2.27

LCOE: Levelized Cost of Energy

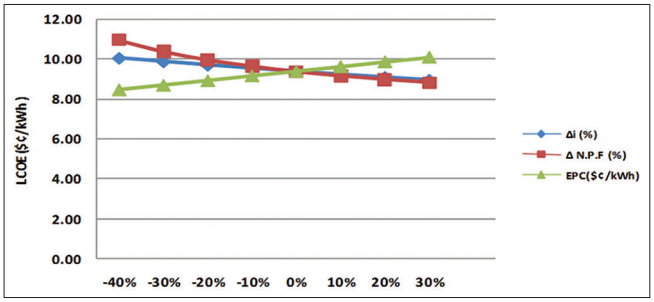
Figure 4: Sensitivity graph analyzing wind



Δi (%)	LCOE ($¢/kWh)	Δ N.P.C (%)	LCOE ($¢/kWh)	Δ EPC (%)	LCOE ($¢/kWh)
30	8.96	30	9.17	30	9.74
20	9.11	20	9.24	20	9.64
10	9.26	10	9.32	10	9.53
0%	9.42	0	9.42	0	9.42
−10	9.59	−10	9.54	−10	9.31
−20	9.76	−20	9.69	−20	9.21
−30	9.94	−30	9.88	−30	9.10
−40	10.13	−40	10.14	−40	8.99

*i=10%, Net Production Coefficient=30%, EPC=1600 $¢/kWh. EPC: Engineering, Procurement and Construction, LCOE: Levelized Cost of Energy

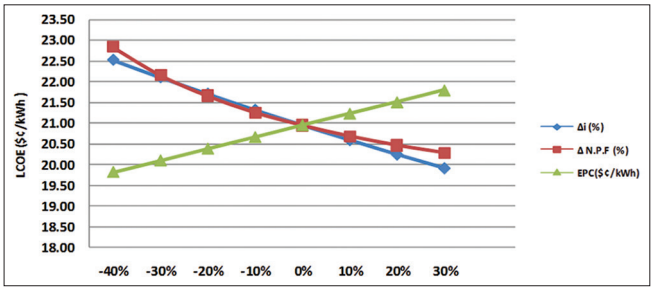
Figure 5: Sensitivity graph analyzing small hydro



Δi (%)	LCOE ($¢/kWh)	Δ N.P.C (%)	LCOE ($¢/kWh)	Δ EPC (%)	LCOE ($¢/kWh)
30	8.97	30	8.86	30	10.10
20	9.11	20	9.01	20	9.87
10	9.25	10	9.19	10	9.63
0	9.40	0	9.40	0	9.40
−10	9.56	−10	9.66	−10	9.17
−20	9.72	−20	9.98	−20	8.93
−30	9.89	−30	10.40	−30	8.70
−40	10.07	−40	10.96	−40	8.47

*i=10%. Net Production Coefficient=50%, EPC=2300 $¢/kWh. LCOE: Levelized Cost of Energy, EPC: Engineering, Procurement and Construction

Figure 6: Sensitivity graph analyzing solar thermal



Δi (%)	LCOE ($¢/kWh)	Δ N.P.C (%)	LCOE ($¢/kWh)	Δ EPC (%)	LCOE ($¢/kWh)
30	19.92	30	20.30	30	21.81
20	20.25	20	20.48	20	21.52
10	20.60	10	20.70	10	21.24
0	20.96	0	20.96	0	20.96
−10	21.33	−10	21.27	−10	20.67
−20	21.72	−20	21.67	−20	20.39
−30	22.12	−30	22.17	−30	20.10
−40	22.54	−40	22.85	−40	19.82

*i=10%, net production coefficient=50%, EPC=2300 $¢/kWh. LCOE: Levelized cost of energy, EPC: Engineering, procurement and construction

(according to their financial calculation).

- The cost/price of the production of renewable electricity - LCOE with respect to the component of the Net production factor, is most sensitive to solar thermal, small hydro and wind respectively.
- The cost/price of solar thermal plant with respect of three components varies based on the discount rate, Net production factor and EPC, respectively.
- The cost/price of small hydro power plant with respect to three components varies based on the Net production factor, EPC, and Discount rate, respectively.
- The cost/price of Wind Power plant with respect to three components varies based on the Discount rate, Net production factor, and EPC, respectively.

The main reason about high Sensitivity of cost/price of the electricity for Solar thermal plant with respect to the two components of Discount rate and EPC, compared to the two other options, is the amount of initial and long term financial investment over the life of the plant. Therefore, it is recommended that Solar thermal plant to be analyzed more thoroughly, so that by increasing the installation capacity of this kind of plant and the future growth of the related industry, the costs of its investment would be reduced over time and would be set forth as a candidate for cheap electricity in the future.

4. CONCLUSIONS AND SUGGESTIONS

Penetration and development of renewable energies have become very slow and limited because of various factors particularly high primary cost and cost price, lack of sufficient investment for localizing and performance improvement of corresponding technologies, lack of accounting for external costs in economic equations, lack of supportive policies worldwide, across region and local.

- Regarding that the most main factor in the cost price of fossilized power is the cost price of its fuel, so the execution of the law of subsidiary targeting and eliminating subsidy from fossilized energies would be caused the competency advantage of renewable power to increase versus fossilized power.
- In achieving steady development, considering external costs in economic transaction is a great task. Therefore, in the determination process of power purchase tariffs it is suggested to take into account the social cost in the cost price of fossilized power, however, it would cause the advantage promotion of the renewable power to increase versus fossilized power.
- Based on determined goals in the 20 years outlook document, 10% of the power required by the country should be supplied via renewable resources. Also, in the fifth plan of country development, it has been targeted to use renewable energies as much as 5000 MW (Available from: http://www.rc.majlis.ir/fa/law/show/790196; Parliament of Islamic Republic of Iran, 2014). These two documents could be a lever to support financial institutions in Iran. Since the amount of primary cost of investment in renewable power plants is high, development of this infrastructure industry is not possible but by supportive activities of the government. Thus the government can carry out the task through banks and the national development box and supply appropriate financial facilities for investing in this sector.
- As mentioned, identical tariff for different technologies of renewable power is an obstacle for balanced development of these technologies, since the private sector investor has the tendency to some technology that has less cost and more benefit. This in turn is an obstacle for other options to develop. Therefore, considering much difference between the primary cost and investment amount of different technologies of renewable power, the determination and approval of different tariffs for different technologies is a principle action for

balanced development of different technologies of renewable power.

- Therefore, the researcher having an approach of economic justifiability and encouraging private investor to invest in renewable power, has calculated and recommended different tariffs for different technologies of renewable power (according to Table 3) as: 20.96 ¢/kWh for solar thermal plant, 9.40 ¢/kWh for small water power plant and 9.42 ¢/kWh for wind plant.
- The high amount of the primary cost, high investment and financial flow of solar thermal power plant have caused this power plant to have high sensitivity in its cost price versus these two components of discount rate and EPC, comparing with the other two options of wind and small water plant. Therefore, it is predicted that using researcher's relatively high recommended tariff for solar thermal power plant, this plant may be accepted by the private sector. Also, by increasing the capacity of installation of this kind of power plant the investment costs of it would be decreased and in future it would be a candidate for the generation of cheap power.
- Regarding wind power plant, the researcher suggested the base price of power purchase, but it is expected that considering high potential of wind plant, recognizing its technology and its value chain in Iran, the technology of this plant will receive more support from the side of government.

The determination of time period of closing the contract and also applying the stepwise tariff in policy of guaranteed purchase are two other important subjects which are effective in renewable power development. The researcher intends to represent the results of his studies and calculations in another article.

REFRENCES

Central Bank of the Islamic Republic of Iran. (2014), Key Economic Indicators. Tehran: Public Relations Department. Available from: http://www.cbi.ir.

Dabiri, F., Zarei, A., Taghavi, L., Purhashemi, A. (2013), Development and Use of Renewable Energy Inefficiently in Iran and Selected Countries, 28th International Power System Conference, 4-6 November, Tehran, Iran.

DOE Report. (2009), A Comparative Study of OECD Country for Renewable Energy Technology. Available from: http://www.energy.gov/conferences/winter2002/gallery/jacobsson.

Martinot, E. (2013), Renewables Global Futures Report. Paris: REN21. p14.

Ministry of Energy. (2013), Energy Balance of Iran_ 2011. Tehran: Peyeke Noor. p554.

Oskounejad, M. (2008), Engineering Economy or Economic Evaluation of Industrial Projects. 30th ed. Tehran: AmirKabir University Publisher. p420.

Parliament of Islamic Republic of Iran/Research Center/Law. (2014). Available from: http://www.parliran.ir/index.aspx?siteid=1&pageid=3070.

Parliament of Islamic Republic of Iran/Research Center/Law. (2014). Available from: http://www.rc.majlis.ir/fa/law/show/790196.

Parliament of Islamic Republic of Iran/Research Center/Law. (2014). Available from: http://www.parliran.ir/?siteid=1&pageid=220.

Parliament of Islamic Republic of Iran/Research Center/Law/Constitutional Law, Article-44. (2014). Available from: http://www.rc.majlis.ir/fa/content/iran_constitution.

Renewable Energy Organization of Iran. (2014), Private Sectors Cooperation Office, Establishment of Non-governmental Renewable Energy Power Plants. Available from: http://www.privatesectors.suna.org.ir/fa/home.

World Energy Council. (1986), New Renewable Energy Sources. Tehran, Atlas: WEC, Energy Ministry of Iran, Kahrobaiyan. p15.

Appendix 1: Calculations of cost price of renewable electricity in investor's viewpoint in 2014

According to the data from the strategic and economic studies office of Renewable Energy Organization of Iran (SUNA) in 2014

Portion of financial bank facilities	85%
Portion of investor brought	15%
Rate of bank discount	10%
Rate of brought discount	10%

Some calculation consumptions	Wind	Solar thermal	Small hydro
Investment cost as EPC/¢$) kWh)	1600	4700	2300
Maintenance and operate cost/¢$) kWh)	0.8	1.3	%2
Coefficient of net production (%)	30	30	50
Plant life time (year)	20	30	10
Cost price components in private section viewpoint	Wind	Solar thermal	Small hydro
Fuel cost/¢$) kWh)	0.00	0.00	0.00
Maintenance and operate cost/¢$) kWh)	0.81	1.30	1.05
Constant brought cost/¢$) kWh)	1.07	2.85	1.28
The cost of facilities installments/¢$) kWh)	7.54	16.81	7.07
Social cost/¢$) kWh)	0.00	0.00	0.00
Cost price – before tax (LCOE)/¢$) kWh)	9.42	20.96	9.40
Minimum tariffs/¢$) kWh)	17.90	43.40	12.70
Cost price – after tax/¢$) kWh)	10.35	24.10	9.40

LCOE: Levelized cost of energy, EPC: Engineering, procurement and construction

Appendix 2: The Measurements related to renewable technologies - 2014

Solar thermal	Interest (%)	Loan payment period (years)	LCOE ($¢/kWh)	Tariff ($¢/kWh)	IRR (%)	IRRE (%)	NPB-total (years)	DPB-total (years)	NPB-equity (years)	DPB-equity (years)	Benefits-cost ratio
	7	8.5	20.96	43.40	11.98	22.30	9.16	18.37	11.08	13.20	2.27
	12	15	34.64	48.22	13.67	19.99	8.39	14.02	10.01	17.81	1.54
	17	15	46.63	61.14	17.71	19.99	6.96	9.78	16.36	18.15	1.46
	25	15	68.90	85.43	24.81	20.00	5.49	6.83	16.65	18.51	1.38
Small hydro	**Interest (%)**	**Loan payment period (years)**	**LCOE ($¢/kWh)**	**Tariff ($¢/kWh)**	**IRR (%)**	**IRRE (%)**	**NPB-total (years)**	**DPB-total (years)**	**NPB-equity (years)**	**DPB-equity (years)**	**Benefits-cost ratio**
	7	8.5	9.40	12.70	13.53	20.00	7.93	14.10	10.73	13.12	1.91
	12	15	12.73	14.16	15.84	20.00	7.04	10.74	6.85	16.15	1.47
	17	15	15.43	17.29	20.50	20.02	5.75	7.77	7.31	16.77	1.33
	25	15	20.69	23.15	29.18	20.02	4.39	5.36	8.49	17.48	1.27
Wind	**Interest (%)**	**Loan payment period (years)**	**LCOE ($¢/kWh)**	**Tariff ($¢/kWh)**	**IRR (%)**	**IRRE (%)**	**NPB-total (years)**	**DPB-total (years)**	**NPB-equity (years)**	**DPB-equity (years)**	**Benefits-cost ratio**
	7	8.5	9.42	17.90	12.91	20.02	7.84	13.57	10.61	12.65	1.84
	12	15	14.13	20.20	15.51	20.04	6.97	10.54	6.42	10.25	1.31
	17	15	18.26	25.10	20.52	20.00	5.69	7.66	6.69	11.26	1.25
	25	15	25.94	34.33	29.54	20.00	4.34	5.28	7.28	16.53	1.20

LCOE: Levelized cost of energy, EPC: Engineering, procurement and construction

Appendix 3: The measurement related to fossilized technologies - 2014

Under Full Subsidy Targeting Law Enforcement Conditions (the Natural Gas price # 30 $¢/m^3)

Small gas	Interest (%)	Loan payment period (years)	LCOE ($¢/kWh)	Tariff ($¢/kWh)	IRR (%)	IRRE (%)	NPB-total (years)	DPB-total (years)	NPB-equity (years)	DPB-equity (years)	Benefits-cost ratio	Benefits-cost ratio (E)
	7	8.5	8.31	9.15	17.07	27.86	6.72	9.79	5.64	7.94	1.10	1.09
	12	15	8.59	9.44	20.44	34.13	5.87	7.92	4.22	5.13	1.09	1.07
	17	15	8.85	9.70	24.66	34.08	5.09	6.47	4.24	5.17	1.09	1.07
	25	15	9.32	10.16	32.65	34.62	4.12	4.89	4.21	5.12	1.09	1.08
Large gas	**Interest (%)**	**Loan payment period (years)**	**LCOE ($¢/kWh)**	**Tariff ($¢/kWh)**	**IRR (%)**	**IRRE (%)**	**NPB-total (years)**	**DPB-total (years)**	**NPB-equity (years)**	**DPB-equity (years)**	**Benefits-cost ratio**	**Benefits-cost ratio (E)**
	7	8.5	11.13	11.98	19.02	32.80	6.65	8.63	4.82	5.83	1.07	1.06
	12	12	11.37	12.22	23.56	38.09	5.91	7.25	4.36	5.02	1.07	1.06
	17	12	11.60	12.45	27.49	38.13	5.41	6.43	4.36	5.03	1.07	1.06
	25	12	12.05	12.89	34.60	38.35	4.75	5.42	4.35	5.02	1.07	1.06
Steam	**Interest (%)**	**Loan payment period (years)**	**LCOE ($¢/kWh)**	**Tariff ($¢/kWh)**	**IRR (%)**	**IRRE (%)**	**NPB-total (years)**	**DPB-total (years)**	**NPB-equity (years)**	**DPB-equity (years)**	**Benefits-cost ratio**	**Benefits-cost ratio (E)**
	7	8.5	12.56	14.23	12.95	20.06	12.13	19.37	2.01	2.01	1.16	1.15
	12	15	13.51	15.18	16.71	836.48	10.52	14.03	2.01	2.01	1.14	1.12
	17	15	14.43	16.09	20.55	836.48	9.21	11.10	2.01	2.01	1.15	1.13
	25	15	16.30	17.96	30.78	836.48	7.84	8.71	2.01	2.01	1.17	1.15
Combined cycle	**Interest (%)**	**Loan payment period (years)**	**LCOE ($¢/kWh)**	**Tariff ($¢/kWh)**	**IRR (%)**	**IRRE (%)**	**NPB-total (years)**	**DPB-total (years)**	**NPB-equity (years)**	**DPB-equity (years)**	**Benefits-cost ratio**	**Benefits-cost ratio (E)**
	7	8.5	9.68	10.25	14.51	20.01	10.98	16.11	11.35	15.57	1.18	1.17
	12	15	10.33	10.88	16.48	20.08	10.21	13.84	9.31	13.36	1.14	1.13
	17	15	10.92	11.48	20.12	20.06	9.16	11.37	9.58	14.25	1.14	1.13
	25	15	12.12	12.67	27.12	20.92	7.92	9.03	9.68	14.61	1.15	1.14

LCOE: Levelized Cost of Energy, EPC: Engineering, Procurement and Construction