

Cost Benefit Analysis of Solar Power Electricity Consumption in Katugasthota Municipal Area

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Introduction

Solar powered systems are becoming more prevalent in many countries and it is one of the most important renewable energy sources that has been gaining increased attention in recent years (Khaligh, 2010). Solar energy is used worldwide and is increasingly popular for generating electricity or heating and desalinating water. Most countries have decided to aid consumers choosing to invest in solar in the hopes of supporting the “green” or sustainability movement. Solar energy is clean and free of emissions, which is beneficial for the environment, as it does not produce pollutants or by-products harmful to nature (Robert et al., 2010).

Sri Lanka should secure its energy future by focusing on the development and adoption of indigenous, renewable sources of energy to meet this growing demand and reduce the economic burden of imports. Accordingly, this study investigates the effectiveness of solar power electricity investment through a cost-benefit analysis and the calculation of two measurements of net present values (NPV) and internal rate of return (IRR) using data gathered from 100 households in the Katugasthota municipal area.

Objective

The main objective of this study is to investigate the effectiveness of solar power electricity investment through a cost-benefit analysis.

Methodology

In order to investigate the effectiveness of solar power electricity investment through a cost-benefit analysis we first obtained the electricity bill from

households before using solar power electricity. There are 11600 households in Katugasthota Municipal area and only 816 households are using solar panel to generate electricity for their consumption. Among them only 312 households are fully consuming solar power electricity. For this study we selected only 100 households among these 312 households which are only using solar power electricity.

Benefit and cost components were quantified from the economic perspectives. An economic sensitivity analysis was then followed with two measurements of net present values (NPV) and internal rate of return (IRR). The NPV was determined using the annual cash flows of the solar panels. The discount rates were determined by the most current rates in Sri Lanka. The average annual inflation rate was determined using the CPI index and estimates of what it will be for the next 20 years. The NPV was calculated taking into consideration inflation and the discount rates. The analysis was done for a certain time period that was based on the anticipated lifespan of the solar panels. Solar panels have at least a 20 year warranty. For the total cost it included instalment cost, operation cost and repair cost for 20 years. The NPV and IRR were calculated using the cumulative annual cash flows. If the NPV is positive, it is regarded as being a good investment. Another way to prove that the investment is a positive choice is if the IRR is at least greater than the discount rate. Lastly, the cost benefit analysis is done by adjusting costs and benefits. If benefits outweigh the costs, it is a worthwhile investment.

Results and Discussion

To begin the analysis, the monthly bills of the 100 households were totalled for getting the total cost of the sample. The monthly amounts were summed to determine the amount spent on electricity for one year as being Rs 5,857,296.00 (Table 1). The households' electricity bills not only included the amount of money spent on the energy, but also the amount of electricity used in kilowatt-hours (kWh). Each month was recorded to come up with a total yearly electricity usage of 199,032 kWh (Table 1).

Table 1: Electricity Consumption and Cost before using Solar Power

	Total kWh	Total cost (Rs)
Monthly	16,586	488,108
Annual	199,032	5,857,296

The average solar power system capacity is calculated using the sample data. According to the analysis, the average solar power system capacity was 0.98 kWh and the average production of solar power was 144.4 kWh per household per month. The results show that 1.0kWh system capacity is enough for one household and this implies that 100kWh solar power system capacity is needed for 100 households in the study area. The cost of 1kWh system capacity is Rs 250,000.00 and then the total cost for the 100kWh system capacity is approximately Rs 25,000,000.00 for the study area.

In order to perform the cost-benefit calculations, this study used financial information from the sample. The NPV and IRR were calculated using the cumulative cash flows for the 20 years. The inflation rate was determined using the electricity supply from the Ceylon Electricity Board Statistical Digest 2015. Referring to the Sri Lanka electricity price changes, household energy price inflation was 0.7%. This percentage value was used as the inflation rate in the analysis. Once the future avoided electricity costs are determined, taking into account the inflation rate, the annual cash flow is calculated for 20 years. The NPV of the annual cash flows is calculated each year by using 5%, 8% and 10% discount rates. Finally, the cumulative NPV is calculated.

Table 2: Calculated NPV and IRR at Three Discount Rates.

Discount Rate	NPV	IRR	Payback time period
5%	Rs. 55 097 919.62	23.921	5 years
8%	Rs. 35 868 094.38	22.341	6 years
10%	Rs. 27 583 793.80	21.978	6 years

Table 2 shows the calculated NPV and IRR values at 5%, 8% and 10% discount rates. Results show that highest net present value is Rs. 55 097 919.62 which is at 5% discount rate. This is followed by net present values of Rs. 35 868 094.38 and Rs. 27 583 793.80 at 8% and 10% discount rates respectively over a warranty period of 20 years. When the discount rate

increase from 5% to 8%, the NPV decreases by 65%; a further increase from 8% to 10%, causes the NPV to decrease again by 75%. The IRR values are 23.92%, 22.34% and 21.97% for these three discount rates respectively. IRR values are higher than all discount rates and they are above zero. If the discount rate increases, the IRR value decreases slightly. Accordingly, the highest NPV is at the 5% discount rate and the reason for that is, the low discount rate means that the NPV is affected more by the cash flows that occur further in the future.

Payback time period was calculated by using the cumulative net present value. When cumulative net present value began to get positive value that means the investment is beginning to generate positive cash flows and is no longer a burden to the households. At 5% discount rate the cumulative NPV began to show positive cash flows after 5 years. However, at the 8% and 10% discount rates the cumulative NPV began to show positive cash flows after 6 years. Accordingly, at 5% discount rate NPV value is higher and the payback time is less than other two discount rates.

The results of the cost-benefit analysis turned out to be positive over the time period of 20 years. The initial cost of installing the solar panels was only a small cost and eventually beneficial to the study area households. The NPV being a great deal larger than zero and the IRR being much larger than the discount rates indicate that the investment is financially favourable. Since the cost-benefit analysis proved financially favourable, installing solar panels would be a favourable investment for generating electricity in this area.

Conclusion

The purpose of this study was to determine whether applying solar energy system to the Katugasthota area households was going to prove cost-beneficial or detrimental. NPV and IRR are major indicators of whether or not an investment is beneficial. The NPV was calculated using the annual cash flows which took into account avoided electricity costs, the system cost, and any incentives. Unfortunately, in Sri Lanka the only incentive was to freely install the solar power and no transportation cost for the buyers. The results show the positive values of NPV and the internal rate of returns are greater than the discount rates. After 6 years, it began to make positive cash flows at the 8% and 10% discount rates while at 5% discount rate it takes

only 5 years. That means there is no burden to households of investing solar panel after 6 or 5 years at different discount rates. This analysis will help investors and policy makers to have a clearer idea about investing in solar panels. As homeowners are the investors, they can make a decision on whether it is effective to generate electricity from solar panels. This study shows that generating electricity by using solar panels is beneficial.

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