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Techno-Economic Analysis of Solar PV Based FM Radio Broadcasting Stations

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Abstract
Most of the FM radio broadcasting stations of Kathmandu valley depends on diesel generator during load shedding hours. Thus there is huge consumption of diesel which is one of the main contributors in trade deficits of Nepal. On the other hand, the FM radio of remote areas has to reduce their programs due to power shortages. People of remote areas where the radio is only means of information are deprived of the right to information. Two case studies are carried out in this research one is of Capital FM 92.4 Mhz located at Kathmandu and another is Radio Sindhu FM 105 Mhz located at Sindhupalchowk. For design of PV system PVSYST software has been used. Selection of charge controller, inverter and wire size is done by following the guidelines provided in "A Training Manual for Engineer on Solar PV System". Economic analysis of the PV system is done using two types of battery. From PVSYST software the required PV sizing for Capital FM is found to be 5.8 kWp and 3.8 kWp for Radio Sindhu FM . The total cost of installing solar photovoltaic system using ordinary lead acid and lithium ion battery at Capital FM is Rs. 17,41,425 and Rs. 36,16,305 respectively. Similarly the total cost of installing solar photovoltaic system using ordinary lead acid and lithium ion battery at Radio Sindhu FM is Rs. 11,14,295 and Rs. 23,12,135 respectively.

Keywords
PVSYST – Solar powered FM Radio – Lead Acid vs lithium ion battery

1. Introduction

There are 628 FM stations across country [1]. These FM stations operate on different megahertz with different powers from 88 MHz to 108 MHz. During July-August (wet season – adequate power supply), it was observed that the minimum amount of electrical power consumed from NEA by any one FM station was 500 units/month, as compared to 91 units per month during the March-April (dry season – peak load shedding period)[2]. This clearly shows that there is an about 80% decrease in power consumption during the peak load shedding period and it can very easily be assumed that this will have some significant impact on the operations of these FM radio stations. With the insufficiency of electric power generation in the country, load shedding has increased and had serious impacts on industry, development infrastructures, its effect on access to information dissemination sector is also an another important area seriously affected. Similarly all the areas within Nepal is not yet grid connected. Most affordable means of information and communication is FM stations that are widely spread around the country that are operated at local and regional levels. These FM broadcasting have not only given valuable information, entertainment and employment to many people but also secured and practice of right to information. But due the prevailing power shortages, FM stations are forced to cut their on-air time and hence decrease in number of programs that give valuable information to people in remote areas, decreases in economic activity of the station as number of advertisement decreased. Use of solar PV system will helps to address the power shortage problem and green house gases emission control.

2. Methodology

Capital FM of Kathmandu and Radio Sindhu FM of Sindhupalchowk is selected for case study. For Capital FM the power requirement during load shedding hour is considered and PV system is designed. For Radio Sindhu FM full solar PV system to power the station is designed. Price of the components is collected from local market and from different online sources for determining the total cost and per kWh cost of the system. Further economic analysis of the solar PV system using ordinary lead acid battery and lithium-ion battery is performed.

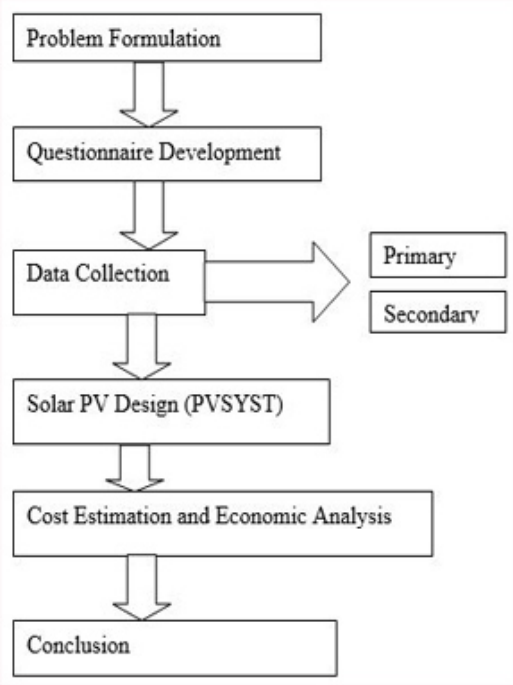

Figure 1: Flowchart of Research Methodology

3. Case I: Capital FM

We have designed the system considering the eight hours of load shedding (from nine am to one pm and from five pm to nine pm Sunday schedule of NEA effective from 2072-01-12).

When required energy data is given input in PVSYST software it calculates the required size of battery and panel size. Here suggested capacity of battery by PVSYST is 914 Ah. (Select 2V/900 Ah battery). Thus it requires 24 batteries in series to make it 48 system voltage. Similarly array size taken as 5.8 kWp. (Select 250 watt 48 volt solar module). It requires twenty three such modules in parallel. Charge Controller, Inverter and wire sizing is done by following the guidelines provided by "A Training Manual for Engineer on Solar PV System." Figure 2 shows the complete PV design.

Table 1: Energy Requirement at Capital FM During Load shedding

Name of Equipment	Qty. of Equipment	Power(W)	Operating hour(hr)	Energy Requirement (Whr)
From 9AM-1PM				
Computer	2	150	4	1200
Mixture	1	150	4	600
Microphone	1	5	4	20
Amplifier	2	60	4	480
Transmitter	1	500	4	2000
Printer	3	300	1.5	1350
Router	5	20	4	400
Sound Processor	1	20	4	80
Telephone Hybrid	1	20	4	80
From 5PM-9PM				
Computer	2	150	4	1200
Mixture	1	150	4	600
Microphone	1	5	4	20
Transmitter	1	500	4	2000
Router	5	20	4	400
Lights	5	15	4	300
Sound Processor	1	20	4	80
Total energy requirement				19810

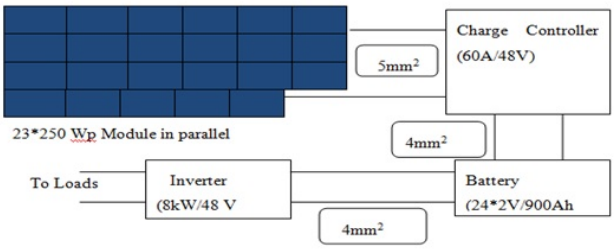

Figure 2: PV System Design for Capital FM

Economic Analysis

Price of different components are collected from local market and online sources to determine the total cost and per kWh cost of the solar PV system using PVSYST

software. Inflation rate of 8.5% [3] and interest rate of 4.5%, cash subsidy of Rs. 15,000 [4] and loan duration of 15 years is used.

Figure 3 shows that the total investment cost using ordinary lead acid battery is Rs.17,41,425 per kWh cost of PV based electricity is Rs. 50.40. Similarly price of lithium ion battery is entered in PVSYST software and the total investment cost is found to be Rs.36,16,305 and per kWh cost of PV based electricity is Rs. 83.50.

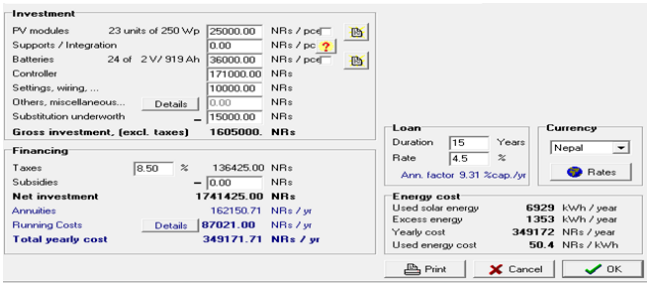

Figure 3: Economic Analysis Using Ordinary Lead Acid Battery

Running Cost Comparison

Figure 4 shows the comparative running cost comparison of using diesel and solar PV. The average annual cost of using diesel based generator is Rs. 5,27,795 (assume generator is used for eight hours). The total cost of installing solar PV system at Capital FM is Rs. 17,41,425 and its running cost (O and M) cost is taken 1% of the investment. Assuming that the diesel fuel price increases by 10% every year, the running cost of using generator is higher than solar PV system (using ordinary lead acid battery). Running cost of PV system is higher during battery replacement years only.

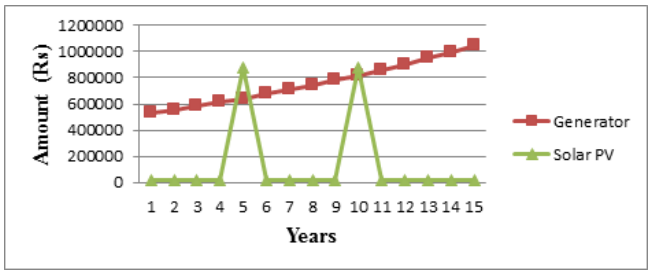

Figure 4: Running Cost Comparison

4. Case II: Radio Sindhu FM

When required energy data is given input in PVSYST software it calculates the required size of battery and panel size. Here suggested capacity of battery by PVSYST is 545 Ah. (select 2V/600 Ah battery). Thus it requires 24 batteries in series to make it 48 system voltage. Similarly array size taken as 3.8 kWp (select 250 watt 48 volt solar module). It requires twenty three such modules in parallel.

Table 2: Energy Requirement at Radio Sindhu FM During Load shedding

Name of Equipment	Qty. of Equipment	Power(W)	Operating Hour(hr)	Energy Requirement(w-hr)
Computer	1	150	18	2700
	3	150	8	3600
Mixture	1	100	18	1800
Amplifier/Speaker	1	50	18	900
Transmitter	1	100	18	1800
Telephone Hybrid	1	20	8	160
Printer	1	300	2	600
Router	1	5	18	90
Microphone	1	5	18	90
Lights	8	15	9	1080
Total				12820

Calculating like above the complete PV design for Radio Sindhu FM is shown in figure 5.

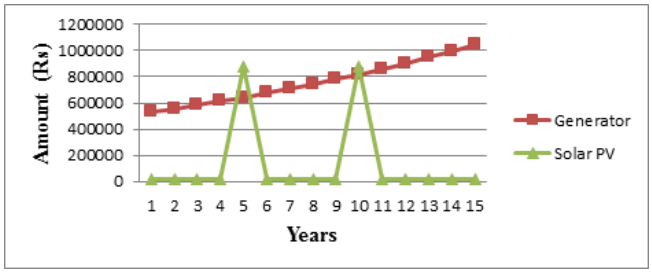

Figure 5: Solar PV System for Radio Sindhu FM

Economic Analysis

Figure 6 shows that the total investment cost using ordinary lead acid battery is Rs.11,14,295 per kWh cost of PV based electricity is Rs. 49.80. Similarly price of

lithium ion battery is entered in PVSYST software and the total investment cost is found to be Rs. 23,12,135 and per kWh cost of PV based electricity is Rs. 82.50.

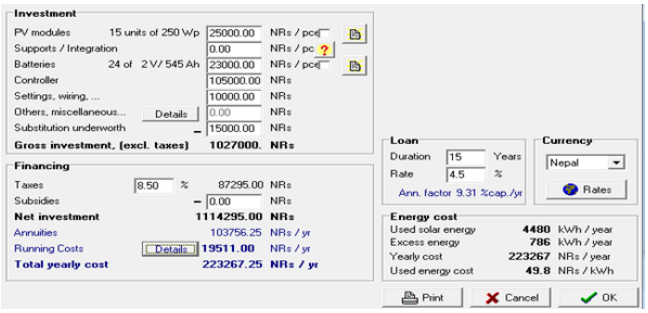

Figure 6: Economic Analysis Using Ordinary Lead Acid Battery

Running Cost Comparison

Figure 7 shows the comparative running cost comparison of using solar PV and grid electricity at Radio Sindhu FM. Annual grid electricity cost of Radio Sindhu FM is Rs. 90,000. The total cost of installing solar PV system at Capital FM is Rs. 11,14,295 and its running cost (O and M) cost is taken 1% of the investment. Assuming that the grid electricity prices increases by 10% every year, the running cost of using solar PV system (using ordinary lead acid battery) is less than that of grid electricity. Running cost of solar PV system is higher during battery replacement year only.

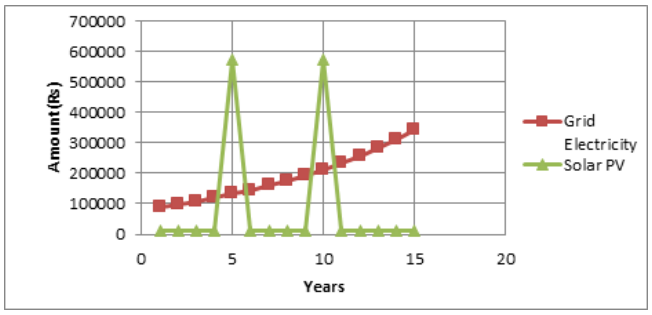

Figure 7: Running Cost Comparison 2

5. Battery Comparison

Table 3: Battery Comparision

	Ordinary Lead Acid	Li-ion
Weight of 1 kWh	25 Kg	6.7Kg
Energy Density(Wh/L)	60-110	250-676
Specific Energy(Wh/Kg)	33-42	100-265
Regular Maintenance	Yes*	No
Depth of Discharge	1000 Cycles@50%DoD	5000 Cycles@50% DoD
Temperature sensitivity	Degrades above 25°C	Degrades above 45°C

*VLRA do not require

6. Conclusion

From PVSYST software the required PV sizing for Capital FM is found to be 5.8 kWp and 3.8kWp for Radio Sindhu FM. The total cost of installing solar PV system using ordinary lead acid and lithium ion battery at Capital FM is Rs. 17,41,425 and Rs. 36,16,305 respectively. The per kWh cost of PV based electricity using ordinary lead acid is Rs. 50.40 and lithium ion battery is Rs. 83.50. Similarly the total cost of installing solar PV system using ordinary lead acid and lithium ion battery at Radio Sindhu FM is Rs. 11,14,295 and Rs. 23,12,135. Per kWh cost of using ordinary lead acid is Rs. 49.80, and lithium ion battery is Rs. 82.50. Annually 13,425 Kg of carbon emission can be reduced by use of solar PV system in Capital FM. Although the economic parameter shows that the lead acid battery is cheaper than lithium ion battery but lithium-ion battery have many advantages compared to lead acid as high energy density, high depth of discharge, low maintenance cost, higher temperature sensitivity and longer life cycles. These lithium ion battery provides longer power backups so that the FM radio station can transmit information for longer time and the people's rights to information is not affected. Replacing the existing diesel generator system can be done by solar PV system. On the other hand, FM radio who have to shut down the on air program due to power shortage can also install solar PV system for their continuous operation. Although the cost of the system is high but it will play important role in delivering the much needed information to public in sustainable way.

References

[1] Ministry of Information and Communication. Fm list in nepal. Technical report, Government of Nepal, 2015.

[2] Equal Access Nepal. Impact assessment of load shedding on media and access to information in nepal. Technical report, Equal Access Nepal, 2010.

[3] Nepal Rastra Bank. Monetory policy of nepal. Technical report, GoN, Kathmandu, 2015.

[4] AEPC. Urban solar subsidy. Technical report, GoN, 2015.