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Phase wise investment analysis of solar electricity generation units suitable for processing plants

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Abstract
In the present study excel based economic simulation tool was developed. Feasibility of solar electricity generation was computed using simulation tool considering phase wise installations with capacities ranging from 10 to 500 kW. Such an approach does not require huge investment rather plant can invest in solar systems in a phased manner. The analysis demonstrates promising results concerning the average production of electricity and year-wise savings over a 25-year period. The findings highlight the economics and benefits for installing rooftop units or smaller solar systems in a phased manner to gradually support the electrical load of various sections within the processing plant.

Keywords: Investment, economics, analysis, *solar* electricity, green energy, feasibility, roof-top units

Introduction
The food and pharmaceutical industries are expanding rapidly, and innovative technologies are being introduced every day to produce foods of higher quality. Common practice is to process equipment using conventional energy. The majority of the electricity we use today is generated by thermal power plants, which burn coal to create electricity. For the generation of 1 unit of energy, this process emits about 0.8 KG of CO_2, which has a significant negative impact on the environment (Rabaia *et al*., 2021) [8].

This carbon dioxide is a greenhouse gas and an air pollutant that hastens the process of global warming (Shahsavari & Akbari., 2018) [6]. To give our ecosystem a chance to heal itself is the major motivation behind each and every one of us switching to solar energy. Renewable energy also termed as "green energy", "clean energy" or "sustainable energy, solar energy represents largest source of renewable energy supply (Liu *et al*., 2022) [9].

Mini solar grid is an effort to improve the overall utilisation of solar energy for different industrial or non-industrial applications. Government initiatives, cost minimization and growing pressure to adopt green energy technologies have played a significant role in promoting companies to invest into solar energy (Prakashraja *et al*., 2022) [4]. Currently, almost all plant activities are run on grid power with diesel generators acting as a backup (Chouhan *et al*., 2013) [2]. The option for selling the surplus produced electricity to state electricity board or to any nearby industry has made the mini solar grid, an attractive business with a very good monetary return along with appreciations for reducing carbon emissions (Solanki *et al*., 2018) [7]. Effective solar irradiance reaching the earth's surface ranges from about 0.06kW/m^2 at the highest latitudes to 0.25kW/m^2 at low latitudes (Sahu *et al*., 2021) [12]. India is located in a country with plenty of sunshine. Regarding the situation in India, we receive 5 to 7 kWh/m^2 of solar energy for 300 to 330 days a year, which is enough to build 20 MW solar power plants per square kilo metre of land (BEE, 2010) [1].

There is tremendous potential of solar electricity generation in processing plants such as pharmaceutical, dairy and food processing plants, where the majority of daily activities heavily rely on grid power, supplemented by diesel generators as backup sources. One of the problems many firms have is requirement of huge investment. This study on phased wise approach for investment in solar electricity generation unit for processing unit can be a feasible solution. The objective of this study was to develop excel based economic simulation tool. The analysis of cost for installation of mini solar grid for capacity ranging from 10-500 KW has been made. The analysis also shows average production of electricity and the year wise saving of electricity in terms of cost. By harnessing solar energy, processing plants can reduce their reliance on conventional power sources and achieve sustainable and cost-effective operations.

2. Material & Methodology

The study focuses on the current energy practices in processing plants, where the majority of activities heavily rely on grid power, supplemented by diesel generators as backup sources. There is scope for phase wise installation of smaller solar units to support electrical load of different sections of the plant. Such an approach does not require huge investment rather plant can invest in solar generation systems in a phased manner. To assess the feasibility of solar electricity generation, an economic analysis was conducted, considering installations with capacities ranging from 10 to 500 kW. The research also determined the project viability conditions.

For the economic analysis of solar power grid a excel based simulation tool was developed. The calculations and cost estimation were based on the Solar Benchmark cost 2021-22 shown in table 1 (MNRE, 2021) [3]. The concept of net metering based solar electricity is shown depicted in fig 1. Subsidy has not been considered while making these calculations. Calculation has been made in view of, 270 operational working days in a year as per the weather of Karnal, Haryana, excluding the incapability due to fog formation in winter season and monsoon period. Charge of electricity considered as per the tariff charge of Uttar Haryana Bijli Vitran Nigam Limited (UHBVNL, 2021) [5]. Maintenance cost is taken as 7% of the cost of the electricity produced per year. Area Requirement was taken as 10 m^2/kW. Following calculations has been made for setting up grid of 10 -500 KW capacity:

- Cost for setting up solar electricity generation unit.
- Average production of electricity using solar unit.
- Cost of electricity saved per day by utilizing solar power.
- Annuing. al electricity cost sav
- Total saving of cost of electricity over its productive life (25 years)

3. Results and Discussion

In phase 1, a 10 kilo watt peak (kWp) mini solargrid will require only 100 m^2 with project cost of Rs. 4.50 lakhs. , it produces about 35 kWh a day and saves about Rs. 245 per day. Overall saving in electricity cost after deducting the maintenance cost for 25 years, it will be about 15.37 lakhs, which is approximately 3-4 times the project cost. At phase 6 level about 5000 m^2 area is required for setting up 500 kWp solar grid which can produce on an average 1750 kWh electricity per day, which is around Rs. 12,250 of saving in electricity bill a day. In a 25 year of its useful life it will save about Rs. 769 lakhs which is a very attractive investment for a project cost Rs. 200 lakhs.

Results manifest that the saving by developing the mini solar grid over the roof top or wherever the space is available, generates benefit of approximately 3-4 times of its project cost, even after deducting the maintenance cost (Table 2). The payback period of the project is also small. Solar energy technology has enormous potential in solving energy crisis difficulties in an era of rising businesses and their energy consumption. Solar energy as a renewable energy may play a critical part in ensuring a safe and secure energy future with diversity (Sodiqjon *et al*., 2022) [10]. The majority of processing activities, cold storage facilities for food and pharmaceutical products, and room conditioning for product packaging all rely on grid electricity to run (Almutairi *et al*., 2022) [11]. The portion load can be shared by developing solar-based systems to get around the peak load penalty issue.

Table 1: MNRE solar benchmark cost for grid connected rooftop solar power plant

Capacity	States other than Special Category (Rs./KWp)	Special Category States (Rs./KWp)
1 KWp	51,100	56,210
Above 1 KWp - 2 KWp	46,980	51,670
Above 2 KWp - 3 KWp	45,760	50,330
Above 3 KWp-10 KWp	44,640	49,100
Above 10 KWp - 100 KWp	41,640	45,800
Above 100 KWp - 500 KWp	39,080	42,980

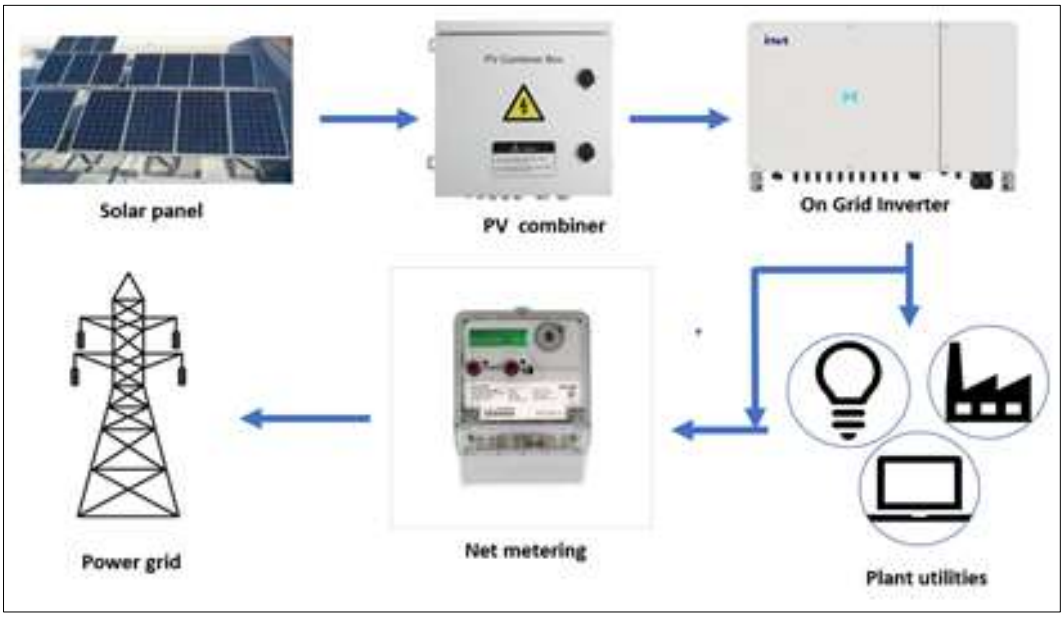

Fig 1: Concept of net metering based solar electricity generation system

Table 2: Cost analysis and saving detail of project

	Solar mini Grid capacity (kWp)					
	Phase 1	**Phase 2**	**Phase 3**	**Phase 4**	**Phase 5**	**Phase 6**
	10 kWp	**25 kWp**	**50 kWp**	**100 kWp**	**250 kWp**	**500 kWp**
Benchmark cost	45	42	42	42	40	40
Cost of project (Lakhs Rs.)	4.50	10.50	21	42	100	200
Area Requirement (m^2)	100	250	500	1,000	2,500	5,000
Avg. electricity production per hour (kWh)	7	18	35	70	175	350
Working hour (h)	5	5	5	5	5	5
Avg. production of electricity prod./ day (kWh)	35	90	175	350	875	1750
Cost of electric energy produced per day (Charge of electricity for industrial =6.95 ~ 7 Rs / kWh)	245	630	1225	2450	6125	12250
Cost of electricity produced (270 days) per year	66,150	1,70,100	3,30,750	6,61,500	16,53,750	33,07,500
Maintenance cost (7% p.a.)	4,631	11,907	23,153	46,305	1,15,763	2,31,525
Saving in electricity cost per year (270 days)	61,520	1,58,193	3,07,598	6,15,195	15,37,988	30,75,975
Total saving in 25 years (in Lakh Rs)	15.37	39.54	76.89	153.79	384.49	768.99

Conclusion

The results of the calculation shows that a very good amount in the plant utility cost i.e. electricity cost can be saved by developing roof top mini solar grid with space as small as 100 m^2. Other than the saving in electricity cost, when compared to conventional energy sources, solar energy has excellent environmental benefits because it produces no air pollution during power production, which lowers CO_2 emissions and other pollutants, slows the rise of the global temperature, and offers a practical blueprint for sustainable energy policies. Among other advantages, one is, Government also providing different subsidies for promoting and supporting the solar power generation, also the surplus electricity produced could be supplied to electrical grid by net metering it. The phase wise approach proposed in this study minimizes the need for substantial upfront investments, allowing the plant to invest in solar systems gradually. The results show promising returns and energy saving from such investment projects. By harnessing solar energy, processing plants can reduce their reliance on conventional power sources and achieve sustainable and cost-effective operations.

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References

1. BEE. A Report of BEE on Energy Conservation Achievements; Raichur, Bellary and Koppal district co-operative milk Producers Societies union limited, Bellary Dairy, Karnatak, BEE, 2010, 118.
2. Chauhan I, Patel S, Desai DD, Raol JB. Application of Solar energy for sustainable Dairy Development. European Journal of Sustainable Development. 2013;2(2):131-131.
3. MNRE. Solar Benchmark Cost. Ministry of New and Renewable Energy, Government of India, 2021. https://mnre.gov.in/img/documents/uploads/file_f-1629354435111.pdf
4. Prakashraja R, Sujatha G, Baskaran D, Perasiriyan V, Murali D. On grid solar powered milk processing: Development and cost analysis. Journal of Food Processing and Preservation, 2022, e17002.
5. UHBVNL. Schedule of Tariff -Uttar Haryana Bijli Vitran Nigam Limited; c2021. (https://uhbvn.org.in/staticContent/documents/Tariff.pdf)
6. Shahsavari A, Akbari M. Potential of solar energy in developing countries for reducing energy-related emissions. Renewable and Sustainable Energy Reviews. 2018;90:275-291.
7. Solanki A, Pal Y, Kumar R. Strengthening of Infrastructure in Dairy Industry through the Application of Solar Energy Technologies", International Journal of Scientific Research in Mechanical and Materials Engineering (IJSRMME), ISSN: 2018;2(1):01-04.
8. Rabaia MKH, Abdelkareem MA, Sayed ET, Elsaid K, Chae K-J, Wilberforce T, *et al*. Environmental impacts of solar energy systems: A review. Science of The Total Environment. 2021;754:141989. https://doi.org/10.1016/j.scitotenv.2020.141989
9. Liu G, Xu J, Chen T, Wang K. Progress in thermoplasmonics for solar energy applications. Physics Reports. 2022;981:1-50.
10. Sodiqjon K, Begyor S, Aleksandr K, Farrukh D, Mukhtasar M, Akbarjon A. Prospective aspects of using solar energy. Journal of new century innovations. 2022;18(1):142-148.
11. Almutairi K, Nazari MA, Salem M, Rashidi MM, Assad MEH, Padmanaban S. A review on applications of solar energy for preheating in power plants. Alexandria Engineering Journal. 2022;61(7):5283-5294.
12. Sahu GP, Singh P, Dwivedi P. Adoption of solar energy in India: A study through interpretive structural modelling. World Journal of Science, Technology and Sustainable Development. 2021;18(4):457-473.