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An Optimized System Configuration Design for Mini Solar Power Plants: A Conceptual Analysis

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ABSTRACT *Since the beginning of life on earth, the energy that was received by all living forms was radiated from the sun. The Sun is a reliable, non-polluting and inexhaustible source of energy. Photovoltaic is a way by which energy from the sun can be directly used for power generation. This method for electricity generation causes no environmental pollution, has no rotating or moving parts. Photovoltaic are also multi functional. It can generate and operate illuminations, pump water, operate any house hold equipments and appliances, can operate any electrical gadgets and communication equipment. The photovoltaic finds its wide application in village electrification in the developing countries and electricity production for the buildings, commercial areas and industrial sector in cities. In the cost optimization process, HOMER software selects one system configuration out of all configurations generated in the simulation process that satisfies all technical constraints and has the lowest life cycle cost.*

KEYWORDS : Optimization, simulation, cost of energy, net present cost.

I Introduction:

The radiant heat and light energy from the Sun is called as solar energy. This is the most readily and abundantly available source of energy. Since ancient times this energy has been harnessed by humans using a range of innovations and ever-evolving technologies. The earth receives more energy in just one hour from the sun than what is consumed in the whole world for one year. This energy comes from within the sun itself through process called nuclear fusion reaction. The practical sites analyzed for different Solar power locations as per there production ranges are:

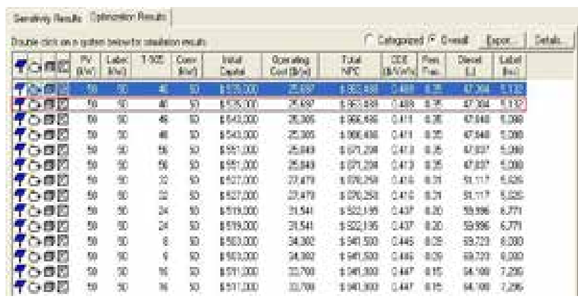
(a) **Tilonia Village Ajmer, Rajasthan 50KW Solar PV Power Plant:** During 2006-07, the Government of India notified .The Rural Electrification Policy, which lay down the broad framework for rural electrification programs in the country. The Rural Electrification Policy has laid down that in villages/ habitations where grid connectivity would not be feasible or not cost effective, off-grid solutions based on stand-alone systems may be taken up for supply of electricity. Solar stand alone is one such system. India receives solar energy equivalent to over 5,000 trillion KWh per year. The daily average solar energy incident varies from 4-7 KWh per square meter depending upon the location. The annual average global solar radiation on horizontal surface, incident over India is about 5.5 KWh per square meter per day. There are about 300 clear sunny days in most parts of the country. Tilonia Ajmer (Rajasthan) is ideally suited for exploiting the solar potential for electrification with the available technology. The approximated data collected is utilized for designing optimal configuration of plant is realized using software.

(b) **Lathi Village Pokaran, Jaisalmer 1 MW Solar PV Power Plant:** This plant is being installed by LANCO infratech Ltd.. Lanco solar has signed many power purchase agreement for higher capacity installations with other states of Rajasthan. The approximated data collected is utilized for designing optimal configuration of plant is realized using software.

(c) **Bap Village Phalodi, Jodhpur 5 MW Solar PV Power Plant:** The project activity consists of a 5MW solar plant at Bap Village of Phalodi Tehsil, Jodhpur District in Rajasthan. Annual power generation from the plant is expected to be 9,392 MWh/year. The electricity generated from project activity will be supplied to grid (Integrated Northern, Eastern, Western and North Eastern Grid).The purpose of the project activity is to generate electrical energy utilizing solar energy and export the generated electricity to the regional grid. In absence of the project activity equivalent amount of electricity would have otherwise been generated by existing and new power plants connected to the emission intensive electricity grid. Thus the project activity would result in avoidance of Greenhouse gas emissions and contributed to mitigation of global warming.

II Optimization & Analysis Results:

(A) Tilonia Village, Ajmer 50 KW Solar PV Power Plant: For Tilonia Village, various combinations have been obtained of solar system with SPV, Diesel, batteries and convertors from the HOMER Optimization simulation software. The best optimal system is shown in figure 1.1. results table.



PV (kW)	Label (kW)	T-105	Conv (kW)	Initial Capital	Operating Cost ($/yr)	Total NPC	COE ($/kWh)	Ren. Frac.	Diesel (L)	Label (hrs)
50	50	40	50	$535,000	25,697	$863,488	0.409	0.35	47,204	5,132
50	50	40	50	$535,000	25,697	$863,488	0.409	0.35	47,204	5,132
50	50	48	50	$543,000	25,305	$866,496	0.411	0.35	47,048	5,098
50	50	48	50	$543,000	25,305	$866,496	0.411	0.35	47,048	5,098
50	50	56	50	$551,000	25,849	$871,298	0.413	0.35	47,037	5,080
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50	50	32	50	$527,000	27,479	$878,250	0.416	0.31	51,117	5,626
50	50	32	50	$527,000	27,479	$878,250	0.416	0.31	51,117	5,626
50	50	24	50	$519,000	31,541	$922,195	0.437	0.20	59,996	6,771
50	50	24	50	$519,000	31,541	$922,195	0.437	0.20	59,996	6,771
50	50	8	50	$503,000	34,302	$941,500	0.446	0.25	69,723	8,000
50	50	8	50	$503,000	34,302	$941,500	0.446	0.25	69,723	8,000
50	50	16	50	$511,000	33,700	$941,300	0.447	0.15	64,100	7,296
50	50	16	50	$511,000	33,700	$941,300	0.447	0.15	64,100	7,296

Figure 1.1: Optimization Result Details

HOMER uses the total NPC as its main selection tool. All the possible solar system configurations are listed in ascending order of their total NPC in the figure shown above. Costs taken in optimization table are in Indian rupees and the technical and economical details of all the configurations of the solar systems from the optimization process are shown in detail in figure 1.1 where the best possible combination of SPV, DG, converter and batteries is highlighted in blue and the next best possible combination is marked with a red coloured box. As per the optimization results an optimal combination of renewable energy technology system components are a 50KW PV, 50KW generator, 40 Trojan T-105 Batteries, 50KW Inverter and a 50KW Rectifier with a dispatch strategy of cycle charging. The total NPC, Capital cost and cost of energy for such a solar system are Rs. 863,488, Rs. 535,000 and Rs. 0.409/KWh, respectively. This shows the cash flow summary based on the components selected in the system. The batteries have a low impact on the capital and O&M costs. PV and converter share the maximum portion of the capital investment. The replacement cost for generator and PV cell is higher. Replacements occur majorly in the 15th and 20th year of the system, mostly for changing batteries and replacing PV Panels. Other replacements and repair of electronics items is required time to time. All these cash flow calculations do not consider any discounts, government funding or subsidies.

(B) Lathi Village, Jaisalmer 1 MW Solar PV Power Plant: For Lathi village Jaisalmer, various combinations have been obtained of solar system with SPV, Diesel, batteries, Grid and convertors from the HOMER Optimization simulation software. The best optimal system is shown in figure 1.2.

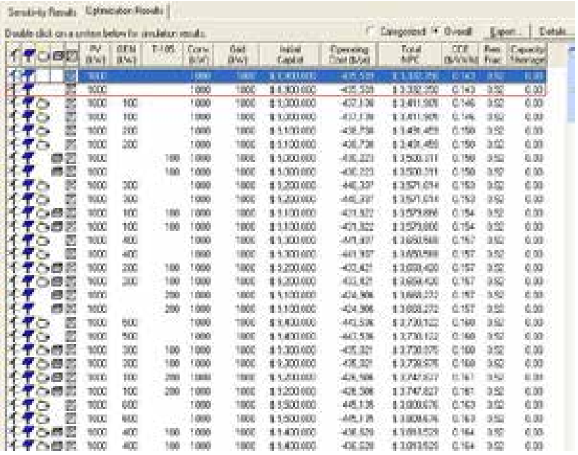

Figure 1.2 Optimization Results Details

HOMER uses the total NPC as its main selection tool. All the possible solar system configurations are listed in ascending order of their total NPC in the figure shown above. Costs taken in optimization table are in Indian rupees and the technical and economical details of all the configurations of the solar systems from the optimization process are shown in detail in figure 1.2, where the best possible combination of SPV, DG, grid, converter and batteries is highlighted in blue and the next best possible combination is marked with a red coloured box. As per the optimization results, an optimal combination of renewable energy technology system components are a 1000KW PV, 1000 KW, 1000KW Inverter and a 1000KW Rectifier. The total NPC, Capital cost and cost of energy for such a solar system are Rs.3,332,350, Rs.8,900,000 and Rs.0.143/KWh, respectively. PV and converter share the maximum portion of the capital investment. The replacement cost for PV cell and converter is higher. Replacements occur majorly in the 20th year of the system, mostly for changing batteries, maintaining generator and replacing PV panels. All these cash flow calculations do not consider any discounts, government funding or subsidies.

(C) Bap Village, Jodhpur 5 MW Solar PV Power Plant: For Bap village Jodhpur, various combinations have been obtained of solar system with SPV, diesel, batteries, grid and convertors from the HOMER Optimization simulation. The best optimal system is shown in figure 1.3.

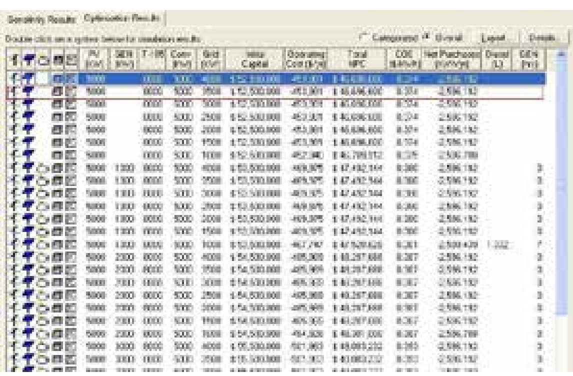

Figure 1.3: Optimization Result Details

HOMER uses the total NPC as its main selection tool. All the possible solar system configurations are listed in ascending order of their total NPC in the figure shown above. Costs taken in optimization table are in Indian rupees and the technical and economical details of all the configurations of the solar systems from the optimization process are shown in detail in figure 1.3, where the best possible combination of SPV, DG, grid, converter and batteries is highlighted in blue and the next best possible combination is marked with a red coloured box. As per the optimization results, an optimal combination of renewable energy technology system components are a 5000KW PV, 4000 KW Grid, 8000 Trojan T-105 Batteries, 5000KW Inverter and a 5000KW Rectifier with a dispatch strategy of cycle charging. The total NPC, Capital cost and cost of energy for such a solar system are Rs.46,696,600, Rs.52,500,000 and Rs.0.374/KWh, respectively .Figure 1.3 shows the cash flow summary based on the components selected in the system. PV, converter and batteries share the maximum portion of the capital investment. PV and batteries has maximum replacement cost. Replacements occur majorly in the 20th year of the system, mostly for changing batteries, replacing PV panels and electronic items. All these cash flow calculations do not consider any discounts, government funding or subsidies.

III Summary and conclusion:

Individual analysis of mini solar power plants is done using software and optimal cost system is designed for different specific location .For Off-Grid rural electrification, since the last decade with the help of renewable energy sources (RES) has become a cost-effective and convenient option for areas where grid connection is neither available nor feasible in the near future. The software has proved a valuable tool in this study especially because of its ability to simulate numerous components and load combinations. The graphs created by HOMER make the simulation's results clear and easy to understand. The various results obtained for different projects for designing an optimal system configuration are:

- Tilonia Village, Ajmer 50 KW Solar PV Power Plant:

As per the optimization results an optimal combination of renewable energy technology system components are a 50KW PV, 50KW generator, 40 Trojan T-105 Batteries, 50KW Inverter and a 50KW Rectifier with a dispatch strategy of cycle charging. The total NPC, Capital cost and cost of energy for such a solar system are Rs.863,488, Rs.535,000 and Rs.0.409/KWh, respectively.

- Lathi Village, Jaisalmer 1 MW Solar PV Power Plant:

As per the optimization results, an optimal combination of renewable energy technology system components are a 1000KW PV, 1000 KW, 1000KW Inverter and a 1000KW Rectifier. The total NPC, Capital cost and cost of energy for such a solar system are Rs.3,332,350, Rs.8,900,000 and Rs.0.143/KWh, respectively.

- Bap Village, Jodhpur 5 MW Solar PV Power Plant:

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REFERENCES

1. Kolhe, M., Kolhe, S., Joshi, J.C. (2002) 'Economic viability of stand-alone solar photovoltaic system in comparison with diesel-powered system for India', Energy Economics 24(2), pp. 155–65. | 2. Bates, J., Wilshaw, A. (1999) Stand-alone PV systems in developing countries, Technical report, The International Energy Agency (IEA), Photovoltaic Power Systems (PVPS) programme. | 3. Rana, S., Chandra, R., Singh, S.P., Sodha, M.S. (1998) 'Optimal mix of renewable energy resources to meet the electrical energy demand in villages of Madhya Pradesh', Energy Conversion and Management 39(3–4), pp. 203– 16. | 4. Nouni, M.R., Mullick, S.C., Kandpal, T.C. (2006) 'Photovoltaic projects for decentralized power supply in India: a financial evaluation' Energy Policy 34, pp. 3727–38. | 5. Koutroulis, E., Kolokotsa, D., Potirakis, A., Kalaitzakis, K. (2006) 'Methodology for optimal sizing of stand-alone photovoltaic/wind-generator systems using genetic algorithms', Solar Energy 80, pp. 1072-88. | 6. Rabah, K.V.O. (2005) 'Integrated solar energy systems for rural electrification in Kenya', Renewable Energy 30(1), pp. 23–42. | 7. Akella, A.K., Sharma, M.P., Saini, R.P. (2007) 'Optimum utilization of renewable energy sources in a remote area', Renew Sustain Energy Rev 11, pp. 894–908. | 8. Kaldellis, J.K., Zafirakis, D., Kaldelli, E.L., Kavadias, K. (2009) 'Cost benefit analysis of a photovoltaic-energy storage electrification solution for remote islands', Renewable Energy 34, pp. 1299–311. | 9. Moharil, R.M., Kulkarni, P.S. (2009) 'A case study of solar photovoltaic power system at Sagardeep Island, India', Renewable and Sustainable Energy Reviews 13(3), pp. 673-681.