Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 6 Special issue [1] 2017: 22-25

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.533
Universal Impact Factor 0.9804
NAAS Rating 4.95

FULL LENGTH ARTICLE **OPEN ACCESS**

Scheme of Grid-connected Solar Water Pumping System as a Source for Increasing Farmers Income

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ABSTRACT
The Scheme for Off Grid Solar Applications, implemented by the ministry, under which the installation of solar energy based pumps for drinking water and irrigation purposes is supported. Till now 1,16,509 number of solar pumps have been installed across various States/UTs. While implementing the scheme, it has been seen that only about 60% of the solar energy being produced is actually used for the pumping purpose. The rest of the energy could be utilized for injection into the Grid if such pumps are Grid connected. This will not only provide additional source of income to the farmers but also help DISCOMs to energizing agricultural feeder, reducing ATC losses, saving capital costs on new irrigation connections and meeting their RPO obligations. Further such Grid connected solar pumps would also incentivize farmers to pump water optimally, conserve ground water and help in energizing agricultural feeders and habitations.
Keywords:*Solar pumps, Irrigation, Farmer, Income*

Received 13.07.2017 Revised 02.08.2017 Accepted 19.08. 2017

INTRODUCTION

Currently, 30 million agricultural pumps are installed in India of which nearly 10 million pumps are diesel based and remaining are grid connected. However, due to unreliable grid supply and increasing diesel prices, solar water pumping system offers immense opportunities to replace conventional pumps.

At present, solar water pumping system market in India is subsidy driven. Non-subsidized pumps accounts for marginal share in the market. The Ministry of New and Renewable Energy (MNRE) is implementing solar pumping programme through States, National Bank for Agricultural and Rural Development (NABARD) and other Government institutions. High capital cost is the major hurdle in the growth of solar water pumping system market. Regardless of subsidies provided by the government, solar pumps are still unaffordable for small farmers due to their high upfront cost in comparison to diesel and electric pumps.

With this background, a programme may be developed to provide a reliable source of supply to agricultural pump sets which are currently being operated by diesel generators or through grid supply by way of solar mini grids. By developing such renewable energy based grids, farmers will be able to receive considerable revenue on monthly basis by selling the power to the grid for a period of 25 years. The benefits of the programme to the farmers includes social emancipation as well as contribution to the society by means of water conservation.

Solar Potential in India

India, with its large population and rapidly growing economy, needs access to clean, cheap and reliable sources of energy. India lies in the high solar insolation region, endowed with huge solar energy potential with most of the country having about 300 days of sunshine per year with annual mean daily global solar radiation in the range of 4 – 7 kWh/m^2/day. Solar power can also help meet energy requirements for both grid connected as well as off-grid applications such as solar powered agricultural pump sets.

Mini Grids

A 'Mini Grid' is defined as a system having a Renewable Energy (RE) based electricity generator (with capacity of 10 kW and above), and supplying electricity to a target set of consumers (residents for household usage, commercial, productive, industrial and institutional setups etc) through a distribution network. Mini grids generally operate in isolation to the electricity networks of the DISCOM grid (standalone), but can also interconnect with the grid to exchange power.

RE based Mini grids with its enormous potential are a promising solution to the access to energy challenge in the country. They offer the benefits of boosting local economy by meeting energy needs of residential and commercial activities thereby supporting enterprise development, generating employment opportunities, raising individual/ household incomes etc.

Large tube wells run by lrrigation Department, Govt. of Uttar Pradesh

In the State of Uttar Pradesh, there are 32,047 tube wells which are operated by irrigation department A potential to irrigate 28.52 lakh hectares has been created through these tube wells. Despite of much potential created, the total area irrigated by these tube wells is nearlytwo third of the created potential. This is because of various reasons like low voltage of grid in rural areas, overloading of transformers, non availability of grid power etc. Due to non meteredsupply and fixed charges @Rs. 2160/HP/month, the State Irrigation Department has to pay huge electricity bills to State Utilities. During 2014-15 alone, UP state Irrigation had paid Rs. 1100 Cr towards electricity bills. Under the proposed scheme such tube wells operated by State Government Departmcnt with higher capacity pumps can be powered with solar energy with lesser amount of subsidy (as compared to individual farmers) to reduce power bills. Whenever there is no requirement of irrigation, the power generated can be fed into grid at mutually agreed rates between utility and user department.

Proposed Scheme on Gridconnected Solar Pumps

In order to tap maximum power from existing solar panels it is proposed to grid connected solar pumps in the areas, where agriculture feeder was separated. in such areas solar pumps can be connected w the grid, to feed power generated from the panels when there is no requirement of water. A provision of higher capacity of solar panels (up to 3 times than required capacity to run solar pump) is proposed for generating extra income to the farmers, and DISCOMs will be able meet RPO ob1igatons of the respective States.

The proposed programme can be implemented under followíng conditions:

I. The areas where agriculture feeders were preferably separated.
II. Discomss / SNA/ State Government Department will be the implementing agency of the programme.
III. The pumps will be installed under net metering. Farmers are allowed to install solar panels upto 3 times of the required capacity or 10 kW (whichever is lower). The farmer will meet the generated energy for irrigation needs and excess available energy will be sold to Discom. In case of Govt. operated programme for large pumps the capacity will be limited 100 kW.
IV. Distribution companies have to purchase excess power @ Rs 2.00/kWh from the farmer through net metering.
V. CFA(Central Financial Assistance) for additional capacity of solar panels installed over and above the pump capacity will be as per norms of CFA finalised for Grid-connected Rooftop Programme (30% of the benchmark cost). States will be advised to contribute an equal amount i.e. 30% of the benchmark cost, to effect payback of the investment made by the farmer in seven years. In case of Govt. promoted programme for higher capacity pumps CFA will be restricted to 15% of benchmark cost
VI. DISCOMs will energise the feeder from 7.00 a.m. to 7.00 p.m. to feed the power into grid.

In the proposed programme, interested farmers will be given an energy efficient pump set of same rating as their existing pump set and solar modules to power the respective pump set, around three times the capacity of the pump set i.e. for ex. For a 5 HP pump set, 15 kW solar capacity will be installed in their agricultural land. Solar PV enabled agricultural pump sets can irrigate the farms during the day time and farmers would not have to depend upon the DISCOM for electricity supply. The excess energy generated by the system can be exported to the DISCOM's grid which will enable farmers to earn a substantial amount of revenue from the energy saved apart from reliable source of irrigation. Installation of grid connected Solar PV based Agricultural pump sets not only helps in replacement of expensive electricity from grid but also helps in reliable source of power to the farmers.

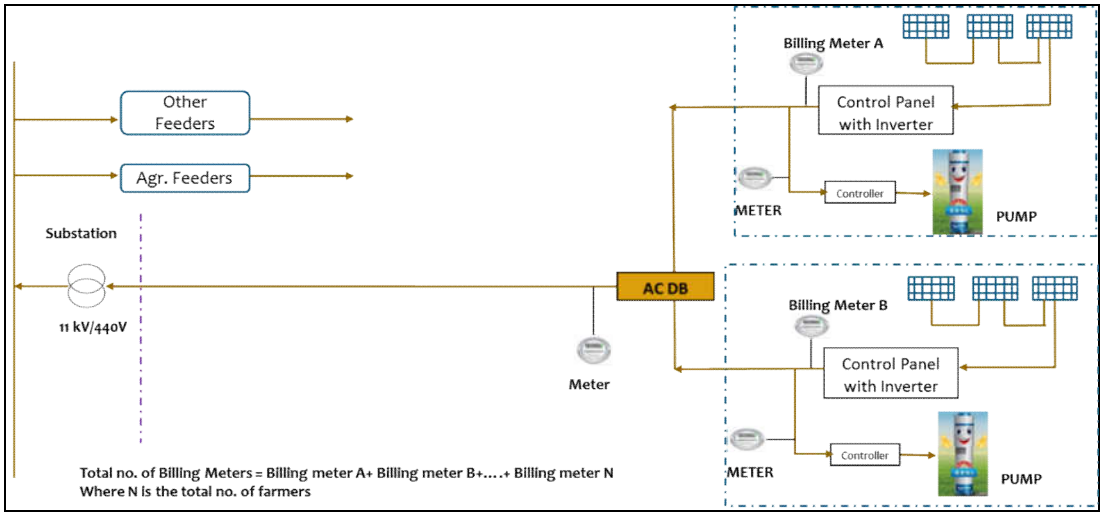

Figure 1: System Configuration of Proposed Solar PV based Mini Grid

System configuration for Grid-connected Solar Pumping System

Following are the key Components:

(a) Solar PV Array
(b) BoS including Inverters, control panels, structures meters etc,
(c) Water pump sets with Variable frequency drive(VFD) / Controller
(d) Real time monitoring system

Solar PV Array

Solar PV arrays are made up of solar PV modules which in turn are made up of numerous solar cells. The solar module, in general, are made up of a no. of multi crystalline silicon cells which convert sunlight into electricity.

Inverter

The Inverter converts the low voltage DC from solar PV modules to AC to operate the pumps.Solar power inverters comes with built in MPPT (Maximum Power Point Tracking) feature. Because the voltage generated by solar panel varies depending on the solar insolation, MPPT enables solar inverters to draw maximum power from the solar panels.

The solar inverter used for grid-connected solution may also include an anti-islanding functionality to prevent risks to grid in case there is power failure in the grid. For the proposed project, grid tie string inverters will be preferred.

Metering System

Grid connected systems allows any excess energy generated by the solar array to be exported to the utility grid. In proposed system utility requires the use of three meters—

- total energy generation by the system
- agricultural pump side meters the energy fed for pumping purpose
- net contribution to the grid (near the ACDB) after deducting the losses of energy For the proposed project, installation of smart energy meters for recording the total energy generation, consumption by pump sets, export and import of energy may be considered.

Electric Pumps with Controllers

Often when a single irrigation pump is required to operate over a range of flow rates and pressures, standard practice is to select the pump to meet the greatest output demand of both flow and pressure. For this reason, pumps are often oversized and they will be operating inefficiently over a range of duties. This common situation presents an opportunity to reduce energy requirements by using control methods such as a variable frequency drive (VFD), controllers etc.

Benefits to the farmer

Farmers participating in the scheme will be benefitted in the following ways:

a. Farmers receive reliable daytime power.
b. Farmers are incentivised to use less power for agriculture, thereby becomingefficient in terms of both energy as well as ground water usage.
c. Farmers have secondary source of income by selling surplus power to the DISCOMs.

Benefit to the DISCOMs

a. DISCOMssaves upfront capital expenditure of connecting each individual farmer to the grid at LT-1evel by providing only one HT-connection to the farmer cooperative.

b. DISCOM is also able to claim RPO on the solar power generated.

Benefit to the Government:

a. Fulfilment of RPO
b. Provide good quality day time power supply to farmers
c. Farmer gets an opportunity to earn additional income
d. Promote social welfare by encouraging agriculture sector
e. Encourages energy and water conservation
f. Step towards fulfilling Govt. commitment for doubling of farmer income by year 2022.

Economics:

Contribution from the Farmers

The proposed contribution from the farmer / beneficiary towards the programme is tabulated:

S No	Capacity of the Pump set	Contribution by the farmer / beneficiary (Rupees)
1	3 HP	40,000
2	5 HP	55,000
3	7.5 HP	75,000

For higher capacity pump sets, the contribution by each farmer may be higher than the values mentioned in the above table but limited to a maximum of up to 10% of the project cost.

Cost-Benefit Analysis:

Particulars	Details	Remarks
Total Generation	30,660 kWh	
Total consumption by pump sets	14,250 kWh	Paid @ Rs2/kWh Benchmark consumption =1900kWh/HP/Yr
Net Export	16,410 kWh	Paid @ Rs 2/kWh
Revenue to farmers	32,820 Rs+2850 Rs* +1200 Rs**	**Rs36,870/year** (Rs 32,820 from sale of energy &Rs 1200 by avoiding electricity bill being paid to DISCOMs)

If farmer saves 10% of Year marked quota i.e. 10% of 14250 = 1425 units
Total Incentive to farmer/Year =1425 2 Rs/kW/h ~ **2850Rs/Year**
** Approx. Yearly Electricity bill ~**1200 Rs**

As per above financial assumptions, minimum revenue to a farmer will be about Rs. 36,870/- per annum. The farmer will also save on the energy bill (approx. Rs. 1,200 per annum). The return to farmers can be increased to the farmers by exporting more energy to the DISCOMs grid by adopting better irrigation and cropping practices.

CONCLUSION

Grid connected Solar Pumping systemshas been recognized as suitable for grid isolated rural locations in poor countries where there are high levels of solar radiation. Solar photovoltaic water pumping systems can provide drinking water without the need for any kind of fuel or the extensive maintenance as required by diesel pumps. Grid connected solar pumping systemis more cost-competitive when usedto power a micro irrigation system as comparedto an overhead sprinkler system,and traditional flood irrigation system. Infuture, as prices of fossil fuels are will be increasing this will the best option as there will be additional earning by the farmer after meeting the pumping needs.

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CITATION OF THIS ARTICLE

Ch. Vidhyashree Venkatarao. Scheme of Grid-connected Solar Water Pumping System as a Source for Increasing Farmers Income. Bull. Env. Pharmacol. Life Sci., Vol 6 Special issue 1, 2017: 22-25