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SOLAR PETROL PUMP DESIGN & IMPLEMENTATION IN INDIA

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Abstract— **Petrol Pump Station is such a sector, which is heavily affected due to the significant gap between electricity demand and supply specially in that lagging areas of electricity. In this paper the complete preplanning for installation of a Solar petrol pump in India is presented. So a self-operated power generating system is applied for supplying the power to all essential systems, such as Fuel Filling Machine, Fire Fighting Equipment, computers, fan & many more internal wiring system range of any Petrol Station in order to avoid power cut, generator noise, environmental pollution and many more issues. Hence in order to achieve maximum power in effective manner a rooftop photovoltaic power station is used. This system uses one or more photovoltaic panels, installed on rooftop of petrol pump, to convert sunlight into electric power. The various components in a rooftop photovoltaic power station include photovoltaic modules, mounting systems, cables, solar inverters and other electrical accessories. So the complete design & Implementation idea of this combinational power system is discussed in this paper.**

Index Terms— maximum power point tracking (MPPT); cycloconverter; polyphase.

I. INTRODUCTION

Solar technology ensures uninterrupted availability of electric The eradication of fossil fuel resources in near future and the increase in percentage of carbon emission has focused the attention towards alternative energy sources to meet up the present day demands in an environmental friendly way. Solar energy being an inexhaustible, easily available and pollution free potential resource among all renewable energy options. In the present scenario; there is a need of uninterrupted supply of electricity; which cannot be met by alone solar photovoltaic (SPV) system due to periodical and seasonal variability in solar isolation and ambient temperature. Therefore in order to gratify the load needs the amalgamations of solar and conventional energy generation system are now being implemented as a Grid tied energy system.

Mostly, Diesel Generator (DG) set is used as power backup source in this sector which faces the less profit due to high running cost. By Switching to self operated solar generating power system with battery backup would free them from adverse effects of expensive diesel bills, load shedding and toxic fumes. However, higher initial investment on solar balance of systems (BOS) like battery, solar panels and associated electronics is not in favour for its wide adoption. There are very few areas in India where this concept is used. So it is very important to check the financial feasibility of it through proper estimating & costing calculation along with the comparative study with DG set system. Hence the complete economic analysis in terms of total cost of ownership, cumulative savings over years is presented along with the Indian scenario of government facilities, environment, Availability of Power supply and many more issues.

Solar technology ensures uninterrupted availability of electric power for its Petrol Stations at different areas where grid power supply interruption is too high so fulfilling this need of constant power supply without any interruptions.

II. MERIT OF SOLARSYSTEM

A Modular, Integrated and Smart System and Maintenance Free / No Moving Parts. Absolutely Green Technology with Zero Running Cost. DG running can be minimized to zero. Friendly for Lead Acid / VRLA Battery however best compatibility with Lithium-ion Battery (LiB) and LiB technology has long life and lasts for 4000 cycles with one charge/discharge cycle a day. It reduces carbon footprint and promotes green. Remote Operation/Monitoring Possible and High Efficiency with LiB technology. Payback period is just 3-4 years and it is easy to install due to Modular Design. High Power Conversion Efficiency and fully automated operations. Effective Power Management due to these life of solar plant is 25 years. System autonomy built to operate even during non-sunny days and min. 4 to 5 hours of power generation per day

III. SOLAR POWER SCENARIO IN INDIA

The electricity sector in India supplies the world's 6th largest energy consumer, accounting for 3.4% of global energy consumption by more than 17% of global population. The energy policy of India is predominantly controlled by the Government of India, Ministry of Power, Ministry of Coal and Ministry of New Renewable Energy and administered locally by Public Sector Undertakings (PSUs). About 70% of the electricity consumed in India is generated by thermal power plants, 21% by hydroelectric power plants and 4% by nuclear power plants.[1] More than 50% of India's commercial energy demand is met through the country's vast coal reserves. The country has also invested heavily in recent years in renewable energy utilization, especially wind energy. In 2010, India has installed wind generated electric capacity of 13,064 MW. Additionally, India has committed massive amount of funds for the construction of various nuclear reactors which would generate at least 30,000 MW. In July 2009, India unveiled a $19 billion plan to produce 20,000 MW of solar power by 2020. Due to the fast-paced growth of India's economy, the country's energy demand has grown an average of 3.6% per annum over the past 30 years. In December 2010, the installed power generation capacity of India stood at 165,000 MW and per capita energy consumption stood at 612 kWh. The country's annual energy production increased from about 190 billion kWh in 1986 to more than 680 billion kWh in 2006. The Indian government has set a modest target to add approximately 78,000 MW of installed generation capacity by 2012 which it is likely to miss. The total demand for electricity in India is expected to cross 950,000 MW by 2030. According to a research report published by Citigroup Global Markets, India is expected to add up to 113 GW of installed capacity by 2017. Further, renewable capacity might increase from 15.5 GW to 36.0 GW. In the private sector, major capacity additions are planned in Reliance Power (35 GW) and CESC (7 GW).

IV. DESIGN & COST ESTIMATION OF SOLAR PETROL PUMP

Rooftop photovoltaic power station is a system which uses one or more photovoltaic panels, installed on rooftops of residential or commercial buildings, to convert sunlight into electricity. The various components in a rooftop photovoltaic power station include photovoltaic modules, mounting systems, cables, solar inverters and other electrical accessories.
Estimating rooftop solar plant values in rooftops of any Petrol pump are impacted by the following:

1. Time of the year
2. Weather conditions
3. Shading from adjacent buildings
4. Shading from overhanging vegetation
5. Roof slope
6. Roof aspect
7. Shading from adjacent buildings and trees

So the proposed to set up of environmental friendly Solar Power plant at petrol stations is called Solar Petrol Pump. With this background two types of Solar PV Systems are proposed.

A. DESIGN OF SOLAR PETROL PUMP

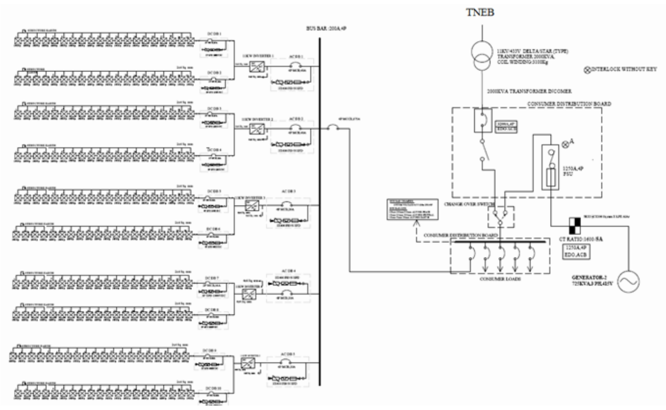

Figure1: Design of 50kw grid tie solar roof top power system for petrol pump

In general, A solar PV system can be designed through four steps:

a) Load estimation
b) Estimation of number of PV panels
c) Estimation of battery bank
d) Cost estimation of the system.
e) Base condition:2 CFLs(18 watts each),2 fans (60 watts each) for 6hrs a day.

• The total energy requirement of the system (total load) i.e Total connected load of PV panel system
= No. of units × rating of equipment = 2 × 18 + 2 × 60 = 156 watts

• Total watt-hours rating of the system = Total connected load (watts) × Operating hours
= 156 × 6 = 936 watt-hours

• Actual power output of a PV panel = Peak power rating × operating factor
= 40 × 0.75 = 30 watt

• The power used at the end use is less (due to lower combined efficiency of the system
= Actual power output of a panel × combined efficiency
= 30 × 0.81 = 24.3 watts (VA)
= 24.3 watts

• Energy produced by one 40 WP panel in a day = Actual power output × 8 hours/day (peak equivalent)
= 24.3 × 8 = 194.4 watts-hour

• Number of solar panels required to satisfy given estimated daily load :
= (Total watt-hour rating (daily load)/(Daily energy produced by a panel)
=936/194.4 = 4.81 = 5 (round figure)

B. ASSUMPTIONS FOR DESIGN:

• Inverter converts DC into AC power with efficiency of about 90%.

• Battery voltage used for operation = 12 volts

• The combined efficiency of inverter and battery will be calculated as:

Combined efficiency = inverter efficiency × battery efficiency = 0.9 × 0.9 = 0.81 = 81%

• Sunlight available in a day = 8 hours/day (equivalent of peak radiation.

• Operation of lights and fan = 6 hours/day of PV panels.

• PV panel power rating = 40 Wp (Wp, meaning, watt (peak), gives only peak power output of a PV panel)

• A factor called „ operating factor" is used to estimate the actual output from a PV module.
[The operating factor between 0.60 and 0.90 (implying the output power is 60 to 80% lower than rated output power) in normal operating conditions, depending on temperature, dust on module, etc.]

• Inverter size is to be calculated as:

a) Total connected load to PV panel system = 156 watts
b) Inverter is available with rating of 100, 200, 500 VA, etc.
c) Therefore, the choice of the inverter should be 200 VA.

C. COST ESTIMATION OF SOLAR PETROL PUMP

Option 1: 5.94 kWp Solar PV Power System for Outlets on Highways for powering,

1. Dispensing Pump (4 DUs – 2 of 1 HP & 2 of 0.75 HP) (3.5 HP motor). – 4
Hours/day on Solar
2. Fan (80 W) * 1 no – 10 hours/day
3. CFL (11W) * 6 nos. – 12 hours/day (for canopy)

Option 2: 3.3 kWp Solar PV Power System for Outlets in Rural area for powering,

1. Dispensing Pump (1 HP motor). – 4 hours/day on Solar
2. Dispensing Pump (0.75 HP motor). – 4 hours/day on Solar
3. Fan (80 W) 1 no – 10 hours/day
4. CFL (11W) 4 nos. – 12 hours/day

Apart from the above, it has also been proposed to have stand alone solar street lights varying from 6numbers in outlets in rural areas to 10 in other areas. Autonomy for the system shall be two days including one day of zero sunshine.

(a) Cost of arrays = No. of PV modules × Cost/Module
= 5 × 8000 (for a 40 Wp panel @ Rs.200/Wp) = Rs.40000
(b) Cost of batteries = No. of Batteries × Cost/Module
=1 × 7500= Rs.7500
(c) Cost of Inverter = No. of inverters × Cost/Inverter
= 1 × 5000 = Rs.5000

Total cost of system = A + B + C = 40000 + 7500 + 5000 = Rs.52500

[Additional cost of wiring may be taken as 5% of total system cost]

V. OLAR PUMP WORKINGMODEL

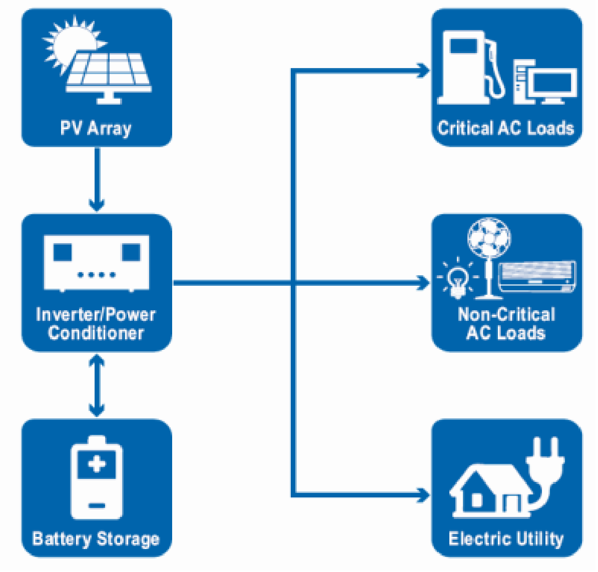

Figure 2 : Solar Pump working Model

VI. COMPARISON B/W GENERATOR & SOLAR P.V. SYSTEM

Comparision	Generator	Solar
Price (INR)	237250	549000
Yearly Maintenance (INR)	30000	N/A
Running Cost in INR (10Hrs Per day)	267250	N/A
Warrenty (in Years)	1	25
Co_2 emmision per year (in Kg)	11461	No Emission
Return on Investment	N/A	2-3 Year
Tax Benifits	N/A	80% of MRP

CONCLUSION

In this paper we present the comparative study of solar Petrol Pump and DG set operated Petrol Pump. And explain some design steps regarding installation of solar petrol pump in India. There are various merits of using solar petrol pump which are discussed in this paper. It is shown that though the initial investment of solar system is high, the total cost of ownership is much less than DG set if considered for period of 3 years or more with significant cumulative savings. Solar technology ensures uninterrupted availability of electric power for its Petrol Stations at different areas where grid power supply interruption is too high so fulfilling this need of constant power supply without any interruptions. With an objective to utilize non-conventional sources of energy it is strongly recommended to promote the research more and more in this field and installed the solar petrol pump in India.

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