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RURAL SOLAR ELECTRIFICATION AND DESIGNING SUITABLE INVERTER

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Abstract: More than half of the Indian population resides in villages where electricity through conventional grid extension has not reached yet. The reason behind this is that in the past the rural electrification was never considered a basic human need like water or food. But with the passage of time, it has been realized that the overall development of India as a nation may not be possible without paying attention to electrification of villages. An evaluation study was carried out by IEEEU.P. section SIGHT team a cross the three villages in Aligarh district (India) named Rasoolpur, Morthaland Baharabad. The study of these villages gave an overview of electricity problems in response to which the team has prepared a detailed analysis of the conditions, along with developing an inverter (340V variabledc input; 220Vacoutput) to meettherequirementsoftheareasthatcouldbeaffordedbypeopleofallsectionsofthesociety.
keywords: rural electrification, inverter, photovoltaic

I. INTRODUCTION

India is a vast country located in South east Asia, with an estimated population of about 1,210,193,422 as of 2011, that equivalents to about 17.5% of the total world population[1]. It is obvious that such big numbers pose a major and increasing stress on even simple day today needs and the gap between supply and demand is bound to widen, if the local requirements are not kept pace with. Further analysis of Indian population render sit sub-divided in to urban population and rural population. According to a World Bank survey of year 2011, rural population (% of total population) in India was last measured at 68.70% of total population of India in year 2011 [2]. Also, a study of the energy trends observes that the installed generating capacity of India was about 199,877MW till 31 Mar 2012. Going by all these facts, it is not hard to realize that the current installed capacity of India falls significantly short on the aim of providing a 24x7 supply of energy to every single house hold of India. Moreover, the condition of energy supply in rural regions of India is dismal, if a tall, with long hours of roasting and installation of inefficient equipment. The present rural scenario in India regarding energy demands thus calls for the use of alternative sources of energy, along with an idea that energy has to be generate data larger rate so as to meet the overall energy demands. One way is to make the villages exploit their own energy potentials and beself-sufficient towards petty energy needs. This buys the government ampletime to act on a proper electrification scheme while the village stake care of their demands by them selves. In an endeavor to take the idea forward, the IEEESIGHT A.M.U. Students' Branch surveyed 3 local villages within a span of 4 months for their ability to be harnessed for solar energy and to be developed an electrification scheme for, at the most basic level. The team took Up to a door to door campaigning program to ask the views of residents over the current energy supply and about their knowledge of energy generation from non-conventional energy sources. The surveys were conducted at:

1) Tajpur Rasoolpur
2) Morthal
3) Baharabad

The subject of the paper there by remains Baharabad which seemed to support the scheme better.

II. PROJECTOBJECTIVE

To equip village Baharabad with 24 Hour electricity and ensure the natives the use of a 20 watt CFL along with an 80 Watt ceiling fan throughout the day, by setting up solar PV systems a cross the village, transmitting DC power and installing affordable inverter sat each house.

VILLAGEBAHARABAD

The village is situated at a distance of about 30 kilometers from the main town of Aligarh. It was surveyed to seek appropriate places for installing the battery bank for the storage of energy from the solar panel. The span of village is roughly 700 meter in length and 500 meter in width. The edges of width span (500m) were chosen for placing the battery bank. The over all idea was to trap solar energy from solar array sand then store this energy in battery banks placed at the two corners of the village so as to form a portable local grid of energy. This energy was to be supplied in a fixed amount to every house hold through a feeding net work spread across the area, and then transformed to a usable 220 Vacby using a cost efficient inverter with an energy supply cap such that if a particular house hold tries to consume energy more than it is entitled to from that local grid, the circuit of the inverter breaks and automatically disconnects the local grid supply to that household.

III. STUDYAREA

Baharabad is small village located in Atrauli Tehsil of Aligarh district, Uttar Pradesh with total 577 families residing. The Baharabad village has population of 3233 of which 1719 are males while 1514 are females as per Population Census 2011. In Baharabad village population of children in the age group 0-6 years is 491 which makes up 15.19% of total population of village [3]. Average Sex Ratio of Baharabad village is 881 which is lower than Uttar

Pradesh state average of 912. Child Sex Ratio for the Baharabad as per censusis 964, higher than Uttar Pradesh average of 902. Baharabad village has higher literacy rate compared to Uttar Pradesh. In 2011, literacy rate of Baharabad village was 70.06 % compared to 67.68 % of Uttar Pradesh. In Baharabad Maleliteracy stands at 85.30% while female literacy rate was 52.47% [4]. As per constitution of India and Panchayati Raj Act, Baharabad village is administrated by Sarpanch (Head of Village) who is the elected representative of village. During the survey conducted by the team, it was observed that people used kerosene and wood stoves for lighting purposes and the consumption of kerosene varied from 6 to 8 liters per month per household. The access to electricity was one of the priorities and most of the households were interested to take the service connections. However, there is still along way to go on the part of government to ensure electricity to the village.

IV. SOLAR ELECTRIFICATION

The standard value of Solar constant averaged over the whole year across the world taking into account all the variations, is accepted as 1367 watt per square meter [5]. This enormous energy if harnessed, could serve mos to four basic energy needs rather satisfactorily. Generating solar power requires two things: flaw less management and sophisticated technology. With the acquired data and keeping in consideration the solar potential of the village, a model has been prepared by the team to facilitate electrification. The village is roughly a rectangle of 700mx500m dimensions. To make the distribution even and convenient, the proposed battery bank is to be divided equally and placed at the two opposite edges of shorter dimension, although not in alignment horizontally. The battery banks shall be connected with a 400 ADC feeder line that would eventually serve for distribution to peripherallines. Poles shall be erected uniformly with in the area. The 400 A lines hall supply to distributor lines of 50 A, running along the 500m side through the poles. The 50A lines would further feed the 10A lines which would eventually supply power to households. The assembly of 800 solar panels shall be connected as 32 parallel sets of 25 panels in series in each set, a panel to be installed at the terrace of each house.

A. Estimate cost for Solar Electrification at Baharabad

Rural electrification based on solar power often represents the most economical solution for settlements in sparsely populated rural areas. A centralized solar power plant supplies the village via a single or three phase mini-grid with electrical power.

For800housesasregistered:

Alternative 1:

A. Using 100 watt panels

100 watt panels are available at the rate of Rs.55/watt One 100 Watt panel is expected to deliver a current of 5Ampere.

Considering 1 panel per house, thus requiring 800 panels:

Total cost for panels=55x100x800 =Rs.44,00,000

800 panels are proposed to be arranged in 32 parallel sets of 25 panels in series in each set.

Each set of 25 panels will supply a current of 5 ampere

So 32 sets are expected to provide=5x32 =160ampere

Of this 160 ampere, 60 Ampere will be consumed to charge the battery bank while the rest 100 ampere will be available to the house holds for usage.

100 Ampere will therefore be distributed among 800 houses to be available at 400 V and be stepped down by the inverters to 220V.

So Power available for each home=(100/800)x400

=0.125x400

=50 watt

Alternative2:

B. Using 200 watt panels

200 watt panels are available at the rate of Rs.55/watt

One 200Watt panel is expected to deliver a current of 10 ampere Considering 1 panel per house, thus requiring 800 panels: Total cost for panels=55x200x800 =Rs.88,00,000

800 panels are proposed to be arranged in 32 parallel sets of 25 panels in series in each set. Each set of 25 panels will supply a current of 10ampere So 32 sets are expected to provide=10x32 =320Ampere Of this 320 ampere, 60 Ampere will be consumed to charge the battery bank while the rest 260 ampere will be available to the house holds forusage. 260 Ampere will there fore be distributed among 800 houses to be available at 400 V and be stepped down by the inverters to 220V. So Power available for each home=(260/800)x400 =0.325x400 =130watt

C. BATTERY BANK

For the purpose of storing the transformed energy through any of the proposed alternative, a battery bank is required to be created, preferably distributed equally at two peripheral ends of the village. Two appropriate sites have been selected by the team roughly 700 m apart. The battery bank would be divided into 2 sets of 32 batteries inseries, hence a total of 64 batteries. At a per unit rate of Rs.15,000, cost of 64 batteries = 64x15,000=Rs.9,60,000

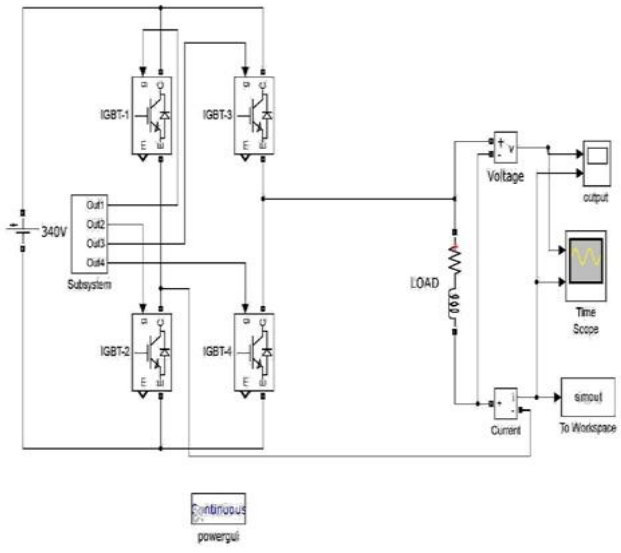

Fig1.MATLABsimulationofinverter

V. SOLAR INVERTER

The solar powered grid is comprehensive and effective enterprise that provide selectricity to more than 550 house holds. How ever though, the system remains in operable without the existence of a device that transforms the delivered dc power to ac. Moreover, the entire motive of the program stands at fault if the device ends up unaffordable for the locals. In designing such an inverter, the choice and sizing of the components, and the most adequate control and management strategy had to be obtained. The power inverter developed by the team in the context, Relates to the latest, low power micro inverter architectures that make the most sense in converting a photovoltaic (PV) panel's DC input voltage from 340-440V and produce an output voltage of 240V which again, is not constrained, and depends on the coding used to simulate inverter on MATLAB. Micro inverters are to be installed in each house and would typically handle 150W/house.

A. COMPONENTS

Inverter systems typically have two major components:

- A controller used to implement system management tasks and control algorithms. Two (ATMEGA16) microcontrollers have been used in the realization of the inverter.
- The second major component the DC-to-AC conversion circuit, converts DC power from the panels into AC power consistent with the voltage and power quality requirements of the utility grid. This conversion is accomplished by using a set of switching power devices such as metaloxide semiconductor field effect transistors (MOSFETs) or insulated gate Pulse width modulation (PWM) technology to control power switching components in the inverter circuit during DC-to-AC conversion.
- The inverter circuit also includes active high frequency filter (approximately 800Hz) to make the input voltage constant. Filtering circuit consists of measured inductor and capacitor.

	COMPONENT	RATING	QUANTITY
1)	MOSFET	600V,1A	4
2)	DCsource		1
3)	Capacitance	400V,1uF	
4)	MOSFET driver		4
5)	Resistance	1K	10
		0.1K	4
		22K	2
6)	PRESET	2K,1K	5,2

Table1.ComponentsoftheInverter

B. DELOPMENT AND COST ANALYSIS OF INVERTER

Each home would require to be installed with an inverter to allow the consumption of the harnessed energy. The inverter is in developmental stage and needs following components:

Resistances:1xRs.15=Rs.157805: 2xRs.5=Rs.10
7818: 3xRs.10 =Rs.30
7918: 3xRs.10 = Rs.30
Capacitor:
1xRs.50=Rs.50Inductor:2xRs.80=Rs.160MOSFET:
6xRs.10=Rs.60
MOSFET
driver:6xRs.45=Rs.270Microcontroller:2xRs.170=Rs240Additional:Rs.500
Total: Rs.1370
Totalcostfor800inverters=800xRs.1370
=Rs.1,096,000

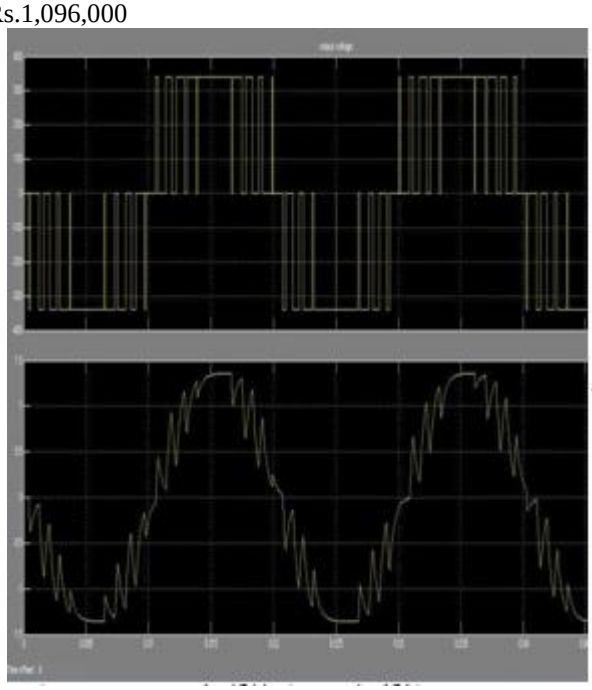

Fig.2 Output voltage wave forms of inverter

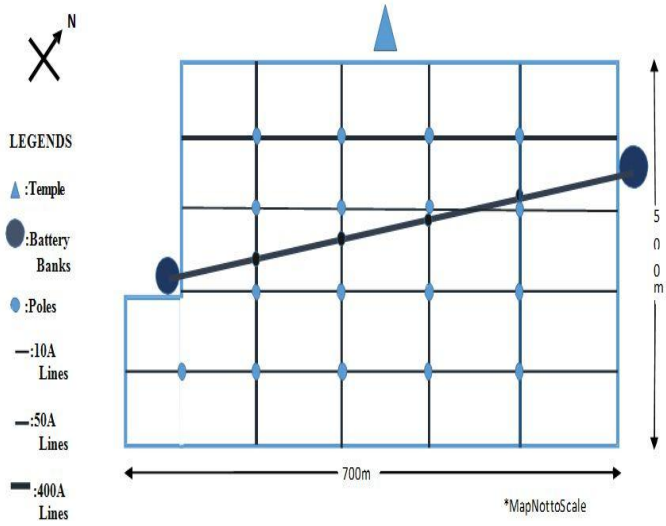

Fig.3 Power distribution scheme

VI. CONCLUSION

The greatest advantage of using solar energy is the self-sufficient nature of there source besides the fact that it boasts of an uninterrupted supply profile. The proposed project will provide the village with continuous electric power, and ensure the locals a better life in terms of their daily energy consumption needs. This is a single time investment and the system is easy to install and maintain. By going with implementation of solar panels, the consistency of power generation can be improved and if forwarded as an ideal energy resource model, it will mark an initiative incontext of Indian villages where ensuring a 24x7 electricity supply remains a challenge.

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