Solar Powered UPS

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ABSTRACT

This paper gives the innovative work of a solar powered UPS in Indian market to meet the other fuel source necessities of homes and little workplaces. It incorporates the plan, design, research methodology utilized and the discoveries of the market concentrate during the exploration. The plan of the solar UPS incorporates an exceptionally planned inverter circuit and a solar panel. The inverter circuit has been planned by the prerequisites and particulars of solar panel. Many example circuits have been concentrated to advance the current circuit. Assistance has also been taken from design engineers of existing UPSs in the market to see possible alternatives in case of any components’ failure or unavailability. The paper gives investigation of conceivable outcomes of plan and usefulness of a solar powered controlled UPS. It recommends that solar UPS can be a profoundly proficient and effective option in contrast to electrical UPSs on the lookout. There are two fundamental parts in the plan: An outdoor solar panel containing solar cells, which will change over sun based energy into electrical energy and inverter circuit that will change that energy into substituting current over to be utilized for home machines.

Keywords: Solar powered UPS; UPS design; Solar power India; Solar power domestic

INTRODUCTION

The world has seen a colossal improvement in Solar Panel innovation during ongoing years. Present day solar panels have demonstrated to be more productive and solid in outfitting solar energy and are accessible at generally lower costs. As the silicon lack vanished in last quarter of 2009 because of slim film producing, the cost of the solar panel dropped from ongoing degree of $3 - $4 per watt.

Solar technology has been capturing Indian market on large scale and deployed in high investment terrestrial projects since its commercial launch in 1950s. Rural offices, armed force lands, slope tops and in fact all the spots that don't have grid power accessible, utilize solar panel as elective fuel source. The purpose behind not conveying solar energy at homegrown level was a result of excessive costs of silicon solar cells, lower efficiencies and greater costs of charge controllers [1] and significant expense of upkeep free batteries. Using solar energy as an alternate energy source to replace grid power, an average household requirement of 150kWh/month will require an investment of US $11000 which is too high to be accepted by domestic users. Utilizing solar energy as a reinforcement arrangement costs US $2100 which is satisfactory by domestic clients considering the on-going energy emergency in the country.

I studied various options of deploying solar energy in India and making use of available resources most efficiently to develop a practical solution for domestic users in the country. Majority of the help got was from the test setup at an individual
lab with the large portion of the locally accessible and manufactured charge controller and inverter circuits, with the experience of calibrating and setting up electrical UPS systems and interviewing some power experts in the market for their knowledge and expertise to help getting to the most feasible solution. Additionally, the previous involvement with the field of designing equipment power-up and DC storage systems assisted with contemplating plausibility of solar power systems accessible on the lookout and their efficiencies. That included solar powered fueled base station system arrangements proposed by merchants including yet not restricted to Huawei, Ericsson Apex BP Solar and SunTech.

**ADVANTAGES OF SOLAR POWER**

Whenever utilized with right location and orientation, the effectiveness of solar panel to catch greatest daylight can be extremely high. The genuine excellence of solar powered fueled stock lies in its capacity to catch light energy and produce electrical energy, that can be utilized both as online fuel source (on-grid) if there should arise an occurrence of power failure and furthermore as autonomous/ alternate energy source (off-grid). Sun powered energy likewise increases the value of the end client's home. Solar power doesn't vacillate like fuel and can be used in far off and provincial territories where grid power can't be reached. Last yet not the least; solar innovation is useful for earth. Solar energy is renewable and practical for long haul. In the end, the speculation of end client gets repaid and the system gets productive inside couple of years. There is no contamination in air because of nitrogen oxide, carbon dioxide or some other toxins.

It is an unlimited source of power which is free, unlike deleterious fossil fuels which are expensive as well.

**SOLAR UPS SOLUTION**

India has been facing an unprecedented energy crisis since the last few years [2]. The issue turns out to be more serious during summers. Be that as it may, the winter of year of 2009 was the same as there was as yet a normal power outage of 3-4 hours per day. Those without generators and UPS confronted enormous issues in these outages. The costs of both kept on expanding because of a sharp expansion in their interest. The examination of the accessible choices alongside Solar UPS system is appeared in Table I:

| Domestic Technologies | Online | Input | Air/ Noise Pollution | Efficiency | Price | Production Cost | Life Cycle Phase | Warranty (Typical) |
|-----------------------|--------|-------|----------------------|------------|-------|----------------|------------------|-------------------|
| Petroleum Generator   | No     | Petrol/ Diesel/ Gas Fuel | Yes | 50-70% | 300 USD | 5-8kW/ Gallon | Maturity | 5 years |
| Electrical UPS        | Yes/No | Grid Electricity | No | 80-90% | 350 USD | Source cost | Unit | Maturity | 2 years |
| Solar UPS             | Yes/No | No Fuel | No | 80-90% | 4800 USD | Zero | Growing | 25 years |

As found in Table I, however beginning expense for oil and electrical UPS system are low, still both have their particular burdens. For instance, rising oil costs in India, domestic and business gas lack, commotion and air contamination brought about by generators, offline system (should be begun naturally or physically failure occurs) and relatively lower efficiencies are the issues addressed for Petroleum Generators Also, harm to costly battery banks in continuous electric failures (because of inadequate charging/releasing cycles) and rising costs
of grid electricity are a portion of the significant worries for the individuals utilizing or considering electrical UPS. Since the solar innovation has not been conveyed on domestic level and there is energy lack in the country, the market is deprived for a dependable domestic solar UPS arrangement that can go about as backup in the event of grid power failure. Indian climate is ideal for Solar UPS organization. The sun sparkles brilliant consistently. Worldwide solar radiation gauges have been made for most pieces of the world, and furthermore for significant urban communities of India which is fundamental for the ideal plan of solar energy change system [3]. We can utilize this endless asset and contribute towards meeting the shortage of electricity. One of the biggest advantages of being high solar content country is the use of CPV (Concentrated Photovoltaic) in India. CPV at large scale has just been conveyed and is assisting with accomplishing efficiencies of above 40%. Low concentration CPV is delivered from traditional silicon solar cell with no dynamic cooling system or sunlight based following necessities and consequently is generally less expensive.

**SYSTEM DESIGN**

The system contains two outside solar panel SunTech Power STP270-24/Vb1 (540Watt) which cost US $1440 [5]. Privately fabricated MPPT charge regulator (effectiveness 95%) and inverter (productivity 90%) are accessible well under US $300. US $200 is required to purchase two 12V and 150AH Lead-Acid Batteries. US $150 is needed for buying extra establishment parts and network wires, delivery and other overhead charges.

![Solar UPS Indoor Circuit](image)

**Fig. 1: Solar UPS Indoor Circuit [6]**
Figure 1 clarifies the availability subtleties for the indoor circuit. DC voltage created by Solar Panel is taken care of to the charge regulator which is put away in the fundamental battery or potentially extra batteries. Charge regulator characterizes upper and lower voltage cut-off focuses, charging current to battery bank and most extreme system effectiveness by changing voltage and current as per the accessible solar panel output. Variable resistors R1 and R2 are discretionary in the event of batteries with various AH appraisals and can be acclimated to control the charging current stream into every battery. Diodes D1 and D2 go about as short out from battery to inverter and consequently no current restricting happens on output to inverter. The two batteries are segregated from one another through Diodes D1, D2 and D4. It forestalls for the batteries from getting harmed if any one cell in a battery gets short. Reverse current stream to solar panel has been maintained a strategic distance from through Diodes D0 and D1. An extra diode can be embedded at contribution of charge regulator to dodge any opposite current stream from charge regulator towards solar panel in a sudden situation. Current restricting resistors disperse a great deal of warmth and should be put away from the batteries. Likewise, the system ought to have appropriate ventilation to abstain from warming and harm particularly during summers. An ATS power switch at the output of solar UPS can consequently change burden to UPS in the event of system disappointment.

RESULTS
The monthly mean sunshine hours in India vary between 8 hours/day (December) to 10 hours/day (April) with an exception to the monsoon season in months of July and August where this number might fall to as low as 4.7 hours/day [3].

| Month (2009) | Panel Output (W) | Optimum Operating Voltage (V) | Optimum Operating Current (A) | Type of Storage batteries | Battery Capacity (AH) | Mean sunshine hours/day | Power Stored/day (kWh) | Power Available/day (kWh) |
|-------------|------------------|-------------------------------|-------------------------------|---------------------------|-----------------------|------------------------|------------------------|--------------------------|
| January     | 540              | 35                            | 15.42                         | 24V (2*12V)               | 150                   | 7.7                    | 3                      | 2.7                      |
| February    | 540              | 35                            | 15.42                         | 24V (2*12V)               | 150                   | 8.7                    | 3.38                   | 3.05                     |
| March       | 540              | 35                            | 15.42                         | 24V (2*12V)               | 150                   | 8.89                   | 3.46                   | 3.12                     |
| April       | 540              | 35                            | 15.42                         | 24V (2*12V)               | 150                   | 9.95                   | 3.87                   | 3.49                     |
| May         | 540              | 35                            | 15.42                         | 24V (2*12V)               | 150                   | 9.06                   | 3.53                   | 3.17                     |
| June        | 540              | 35                            | 15.42                         | 24V (2*12V)               | 150                   | 8.41                   | 3.27                   | 2.95                     |
| July        | 540              | 35                            | 15.42                         | 24V (2*12V)               | 150                   | 7.07                   | 2.75                   | 2.48                     |
| August      | 540              | 35                            | 15.42                         | 24V (2*12V)               | 150                   | 4.77                   | 1.86                   | 1.67                     |
| September   | 540              | 35                            | 15.42                         | 24V (2*12V)               | 150                   | 7.12                   | 3                      | 2.71                     |
| October     | 540              | 35                            | 15.42                         | 24V (2*12V)               | 150                   | 8.69                   | 3.38                   | 3.05                     |
| November    | 540              | 35                            | 15.42                         | 24V (2*12V)               | 150                   | 8.89                   | 3.46                   | 3.12                     |
| December    | 540              | 35                            | 15.42                         | 24V (2*12V)               | 150                   | 7.96                   | 3.1                    | 2.79                     |

As demonstrated in Table 2, the outstanding situation is short daylight day in monsoon (August) where Power Available/day is 1.67kWh/day. Something else, the power accessible/day is equivalent to or more prominent than 2.48kWh/day which is adequate to take the heap of 800 Watt household for three hours outage for every day. In remarkable scenarios (e.g. weighty forecast and long
outages), when batteries are not completely chargeable by solar panel, double info charge regulator can be utilized to charge the batteries, which offers need to solar power when sun is shining and charges the batteries from grid power in case of solar power cut-off.

CONCLUSION AND FUTURE PROSPECTS

The future of solar technology is very bright in India, the reason being the abundance of solar energy in the country. The high level solar technologies including the CPV and CPVT are totally implied for nations high in solar energy. Besides, the declining costs of solar worldwide will additionally make the solar UPS a practical alternative for domestic purposes.

To accomplish the grid parity\(^4\), roughly 80 firms around the planet including top producers like Q-Cells, Sharp, Suntech, Kyocera, First Solar, Motech Solar, Topray Solar, Solar World, Sanyo and Yingli in Germany, Japan, China, USA and Taiwan have been pursuing to fabricate their cells at US$1/Watt. Different solar cell producing advances are as given beneath:

**First Solar’s CdS-CdTe Technology**

The lone organization that has figured out how to draw nearer to the grid parity is "First Solar" which has recently acquired mechanical advancement its item by building the solar cells on glass substrate with CdS-CdTe thin film technology and scaling up the light-catching area from the size of a postage stamp to almost the size of a traffic-sign. Here, the dynamic component is 1% of the thickness of regular silicon technology and creation of panel requires 150 minutes, the time needed in silicon equivalents is very nearly one tenth. These are the reasons that First Solar is being able to sell all the cells it is making and has increased the size of its production facilities resulting in production capacity of over 1 Gigawatt by end of 2009\(^7\). Fig. 2 shows CdTe-CdS based solar panel by First Solar.

![Fig. 2: Glass Substrate based First Solar’s CdTe-CdS Solar Panel](image-url)
The present CdTe modules produced by First Solar have 16% proficiency and 1.14$/Watt fabricating cost. It isn't barely enough for the First Solar to coordinate the grid generation costs as First Solar likewise needs to keep a monetary edge more than a few other PV producing organizations. Since 1950s, when it was industrially dispatched, customary silicon innovation has ruled the whole market it actually has some kick left. In short term analysis, conventional silicon manufacturers seem to be the main competitors of First Solar. Since since the innovation has developed, the proficiency doesn't appear to go much past the present figure of 16%, however with vanishing Silicon shortage, Cost/Watt figure will diminish and rivalry will increment, because of decreased material expenses. Likewise, the assembling hardware for traditional Silicon innovation is effectively accessible when contrasted with CdTe innovation, so boundary needed for passage for new producers is low.

CIGS Technology
Of the different thin film advances, CIGS (Copper Indium Gallium Selenide) has greatest proficiency in slight movies (up to 20%). Fabrication involves vacuum processes including co-evaporation and sputtering that makes it very expensive. Late advancements have been occurring at IBM and Nano solar to utilize non-vacuum techniques to bring down the expense. Until they prevail with regards to bringing down the expense, CIGS will stay out of rivalry notwithstanding of its high proficiency. [8]

Amorphous Silicon on Glass Technology
Amorphous silicon on glass innovation is another thin film innovation which an affects the solar market. It has effectiveness of around 7% and the innovation is unaffected by the silicon deficiency since assembling requires just little amount of Silicon. Likewise, since the assembling hardware is same like that of customary silicon innovation, it is all the more promptly accessible and thus gives a chance to new - producers with a lower boundary to entry. Despite the fact that the assembling time is quick, the expense per watt proportion is still somewhat high for this innovation.

Concentrated Photovoltaic
CPV-Concentrated photovoltaic innovation lessens in general system cost in terrestrial systems by saving the expense of enormous solar panel and utilizing focal points and mirrors rather to focus daylight on the solar cells. Accordingly, accomplishing just about 100 times concentrated light, expanding the productivity to practically 40%. Solar concentrators are normally mounted on solar trackers that shine the light on cells as the sun goes in the sky as demonstrated in Figure 4. Effectiveness of sun powered cells increments in concentrated daylight if the cell junction temperature is kept in charge utilizing heat sinks. The advantage of CPV comes from the lower cost of solar concentrator when contrasted with identical solar panel region. Cost of CPV system including collector and tracker is well under $3 USD. Not to fail to remember that this innovation must be conveyed in just 10-20% of the world, the spots which have bright climate; since diffuse light, which is made by cloudy conditions, can't be concentrated [9].
Multi-Junction Technology

Multi-intersection solar cell innovation is intended for non-concentrating aerospace applications, for example, space satellites. It includes testimony of numerous layers of Ge, Ga-As, and indium gallium phosphide (In-Ga-P) over little Germanium Substrates. The cells are roughly three times as efficient as CdTe cells. Multi-intersection cells are about multiple times as costly as silicon cells in light of generally more slow development rates needed in this procedure for statement over little Ge substrate [11]. Notwithstanding of every one of these disadvantages, multi-intersection cells actually got accomplishment in aerospace applications in which higher effectiveness and unwavering quality are required.

Nanotechnology

Nanotechnology is the technology of solar arrays of nano-antenna with high efficiency in capturing energy (up till 80%). Small metal spirals or squares are printed on polyethylene that acts as nano-antenna to capture infrared radiations. Cyrium Technologies Inc. has as of recently started fabricating high effectiveness and cost-effective QDEC (Quantum Dot Enhanced Cells) for terrestrial applications utilizing its restrictive nanotechnology [12].

Organic Solar Cells

Organic solar cell is another type of nanotechnology that is as yet under examination and testing, with cost and energy compensation time considerably less when contrasted with Silicon slight film innovation. Value decrease by multiple times to the current silicon based solar cells is normal because of this innovation [13]. A range of dyes have been developed in DSSC (Dye Sensitized Solar Cell). Naturally found organic compounds such as Chlorophyll, Hemoglobin etc. are utilized to get ready synthetic dyes. Green DSSC cells are produced using titanium dioxide which is a non-harmful, ample and renewable normal mineral and in this way are greater climate inviting when contrasted with Silicon based cells. Another favorable position of DSSC is that these cells perform well in diffused daylight, while the Silicon based cells work well just under direct light [14].

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