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Optimization of Electrical Energy through Prioritization of Loads in Solar based DC Standalone PV System

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ABSTRACT

The sun's energy will be one of the prime renewable energy source in future. There are two important types of solar based photovoltaic (PV) electric systems namely, standalone or grid based. Where there is no grid electricity, standalone PV systems become important. Moreover, DC standalone systems are most preferred now a days. Reason being it avoids conversion of DC into AC and undoubtedly DC loads are far more energy efficient & low power consumer than their AC counterparts. The standalone PV system converts solar energy to electrical energy through solar panels, charging the battery throughout the day to store the energy and run DC loads on stored energy in the battery at night. If all loads runs with battery energy at night it may happen that we may not be left with enough energy to run critical loads. Hence, an automated management system of energy is done for loads on priority basis.

Key Words: Solar PV, Microcontroller, DC Loads and Battery

RESEARCH METHODOLOGY

The standalone PV system is used in such a way to run DC loads on priority basis. The aim was to run DC loads entirely managed by solar electricity using a microcontroller. For this purpose, battery voltage is sensed the ADC associated with the microcontroller.

Microcontroller monitors battery's state of condition (SOC) and the energy to load is automatically cut-off which is having lower priority. The process continues for the other loads in order of priority till the load with most priority gets shut down before next day morning, till the energy is again available through solar panels.

Experimentation:
A planned energy analysis and sizing was done in detail for PV system and what loads need to be run on priority at night as per their significance & priority.

Requirements:
1. Solar Panel: Single Panel of 75W (12V/ 6.25A)
2. Charge Controller (12V/10A).
3. Storage: Lead Acid Battery (12V/7AH).
4. Intelligence: Raspberry pi -3 model B+(DEBIAN/LINUX OS)
5. Display – 7 inch interface to raspberry pi with virtual keyboard.
6. Buck converter 12 – 5V and 9A current
7. ADC 8951(8-bit , serial communication pins SDA and SCL)
8. Optocouplers 817
9. Driver Transistors 8040 – power transistors
10. 4 OR 8 Relays (12V, 2A)
11. Sensors: battery voltage divider circuit for SOC
12. 4-DC Loads (L1, L2, L3, L4) and L5, L6, L7, L8 (Further Enhancement)

The user can set the priority of loads. It depends on which 4-critical loads must be run instantaneously. This priority can be changed and decided by user instantaneously. It sets sequence of switching off and critical loads get switched off only at end.

An intelligence monitoring ADC 8951 reads the battery voltage level and a software written in python language loaded in Raspberry pi processes this data and it finally takes decision to which load is to be switched off depending on priority. If some loads get switched off earlier this saves precious energy for the higher priority critical loads.

Design
Sizing of PV System Includes

1. DC Load Estimation
2. Charge Controller Rating
3. Battery
4. Relay Ratings
5. Loads Priority

- DC load design

For our project we selected 4 LED lamps and were assigned priority 1-4 and sizing of various components in PV system done

SR. NO	Device	Priority	Power Rating	No.	Voltage	Current
L1	Led	2	9W	1	12V	0.75A
L2	Led	3	9W	1	12V	0.75A
L3	Led	1	9W	1	12V	0.75A
L4	Led	4	9W	1	12V	0.75A
	Total		36W			

- Charge controller rating

12V and 8.13 x 1.25 =10.16A ie we can use a 10A charge controller

- Battery rating

If all devices are run for maximum of 5hrs a day simultaneously we need an energy storage /battery of 36W x 5h = 180Wh

Taking 1 day autonomy and 80% efficiency of battery.

We have 180/0.8 X 12 V= 18.75Ah almost 20Ah battery. In project 7AH to show the demonstration.

Observations OR Results

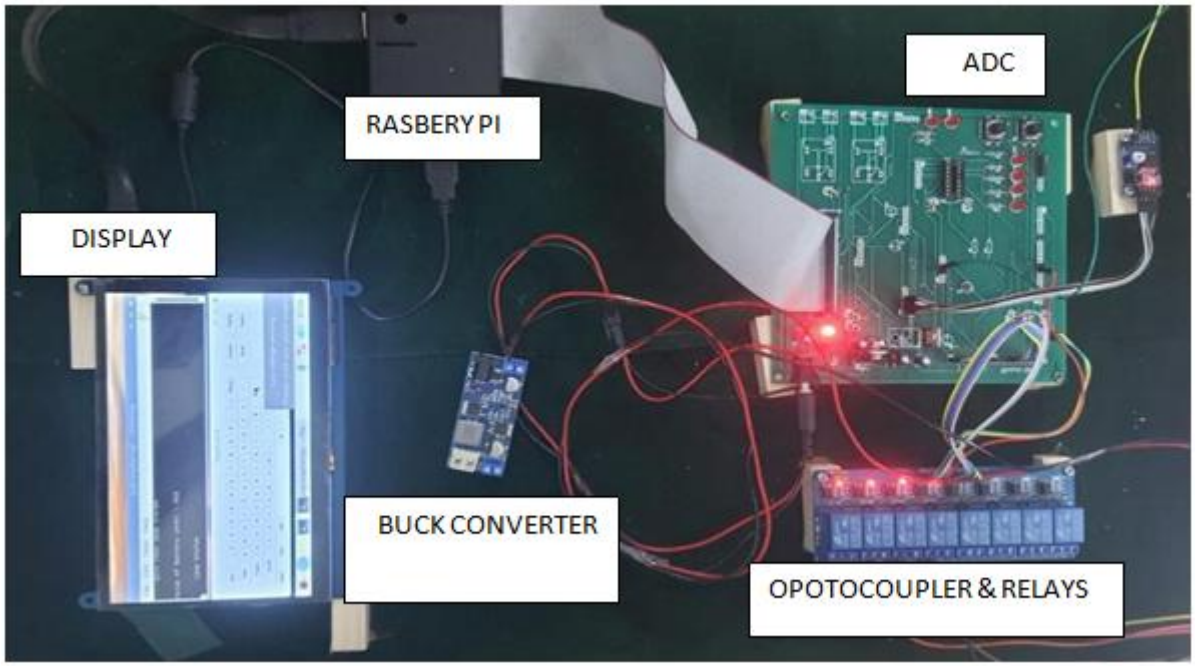
Fully charged Battery voltage =13.5V

SOC 60% of Battery voltage = 12.5 V

Hence difference = 1V divided in 4 levels so to switch off larger priority load in every one level.

Battery voltage	SOC of battery %	Level From ADC displayed on screen	Action by intelligence
>13.5 V	90 – 100	221 at 90 %	All loads on
13.25 -13 V	80 – 90	181 at 80 %	Priority 4 load is made off
13- 12.75 V	70 –80	121 at 70%	Priority 3 load is made off
12.75 – 12.5V	60 –70	66 at 60%	Priority 2 load is made off
< 12.5V	< 60	47 less than 60%	All loads off

Innovations:-
The introduction of Buck 12V to 5V with 9A current done between battery and raspberry pi along withdisplay. Hence whole intelligence running on battery side and loads were put on load section of charge controller. We wanted all things to run on dc solar energy. This means we did not use AC at all in project



Future scaling:
The project went through a lot of refinement and we came to know one can scale to 8 –loads easily. One can also put 8 different ADC so that more sensors included LDR and temperature sensor and one can control more number of loads.

CONCLUSIONS

The future is of solar smart city. In future the humankind will be depleted of fossil fuels and will be left with only solar, then one can use the concept of priority for important sectors of the city. For example if there is power used by industries, residential, railways and hospitals etc. Then based on the criticality of the areas an emergency sector has to be addressed immediately.

REFERENCES

[1]. Clean Electricity from Photovoltaics Archer, Mary D.; Hill, Robert.
[2]. Photovoltaics: Fundamentals, Technology and Practice Mertens, Konrad; Hanser, Karl Friedrich.
[3]. Photovoltaics System Design and Practice: System Design and Practice Haberlin, Heinrich.
[4]. Electricity from Sunlight: An Introduction to Photovoltaics Lynn, Paul A.
[5]. Solar Energy Engineering: Processes and Systems Kalogirou, Soteris
[6]. Solar Energy: Technologies & Project Delivery for Buildings Walker, Andy
[7]. Solar Cells and Their Applications Lewis M. Fraas and Larry D. Partain
[8]. Solar-electricity basics by Danchiras, new-soceity publishers