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Clean and Renewable Energy for Food Van

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***Abstract*— This paper deals with the detailed of a hybrid model of a solar and battery-inverter system, a high efficient hybrid model can be developed in which battery is used as storage system. In this thesis power delivered by the combine system component is shown and various conclusions are drawn. A comparative study of hybrid model of solar and battery-inverter system has been made. This paper describe of solar-battery-inverter hybrid system for supplying electricity to power grid. Work principle and specific working condition are presented in this paper. The proposed concept is a means to store the energy in batteries by solar energy or mains supply. With the recent excitement surrounding EVs, a surplus of post-consumer batteries and reject batteries is expected a few years down the road. The batteries would be utilized to store electricity during off-peak demand periods and redistribute to the grid during on-peak demand periods for grid stabilization. It works as an uninterruptible power source that is able to feed a certain minimum amount of power into the load under all conditions.**

***Index Terms*— Battery, Clean energy, Inverter, Solar**

I. INTRODUCTION

The energy is one of the most vital needs for human survival on earth. The world is currently dependent on fossil fuels for the automobiles. But the main problem of the fossil fuels is that they are not environment friendly and they are exhaustible. So it is necessary to change for the non-conventional sources of energy. In this paper an approach to the conversion of conventional car into solar powered electric car is discussed in detail.

The solar vehicle is a step in saving these non-renewable sources of energy. The basic principle of solar car is to use energy that is stored in a battery during and after charging it from a solar panel. The charged batteries are used to driven the motor which serves here as an engine and moves the vehicle in reverse or forward direction or this energy can be used as a power source for the electrical appliances of food van for cooking the food.

A food van is a vehicle equipped to cook and sell food. Some, including ice cream van, sell frozen or pre-packaged food; others have on-board kitchens and prepare food from scratch. Sandwiches, burgers, French fries, and other regional fast food fare are common. In recent years, associated with the pop-up restaurant phenomenon, food vans offering variety of specialties and ethnic menus have become particularly popular. Food vans, along with portable food kiosks and food carts, are on the front line of the street food industry that serves an estimated 2.5 billion people every day.

Food vans business is a very famous and a growing business in today’s time. With good food van business plan in India you can acquire good return on investment in very short interval of time. Almost every country over the world is following the trend of mobile food business. The famous restaurants around the world have started this mobile food business so that they can make their business grow in every part of the city.

Especially in the countries like the United States, China, Australia, England has a large number of food vans as compared to some other cities in the world. Now talking about India a clutch of entrepreneurs is doing a good business rustling up wholesome dishes in vehicles. They take their food on the street and attract people for the Indian cuisine and helping them turn their backs on the junk food.

II. DESCRIPTION OF THE HYBRID SYSTEM

In this section description of the different components such a solar, battery and Inverter cells and there various parameters are also given.

Solar energy:

Solar energy is the most readily available source of energy. It is free. It is also the most important of the non-conventional sources of energy because it is non-polluting. Fuel cells, magneto hydrodynamic systems, and devices based on thermoelectric, thermo ionic and solar-electric conversion are all potentially useful nonconventional electricity sources. Each of these sources has its advocates for further development, but none more so than solar energy which capitalizes, perhaps, on the deep-rooted associations between man and sun to foster an image of bountiful power from a non dependable, nonpolluting and benign source. The potential of a solar-electric conversion is immense and the current

Research seeking to realize it involves studies on bioconversion, the wind, photovoltaic, oceans currents, and photo electrochemical. list all these methods can be designed to yield the electricity as the end product, if so desired, It is only though the photovoltaic effect that sunlight can be converted directly into electricity. This feature of directness of conversion has been largely responsible for making photovoltaic such a popular mode of generation of electricity.

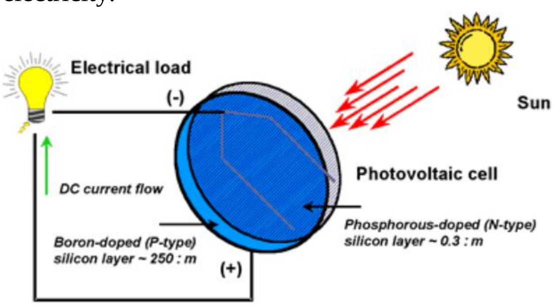


Fig – How Solar Cell Generates Electricity.

Earth surface receives 1.2x1017 W of power from sun. Energy supplied by the sun in one hour is almost equal to the amount energy required by the human population in one year most if the other source on renewable energy has their in sun. Renewable energy sources play an important role in electricity generation. Various renewable energy sources like wind, solar, geothermal, ocean thermal, and biomass can be used for generation of electricity and for meeting our daily energy needs. Energy from the sun is the best option for electricity generation as it is available everywhere. On an average the sunshine hour in India is about 6 hours annually also the sun shine shines in India for about 9 months in a year. Electricity from the sun can be generated through the solar photovoltaic modules (SPV). The SPV comes in various power output to meet the load requirement. Solar Energy is a good choice for electric power generation. The solar energy is directly converted into electrical energy by solar photovoltaic module. [1] [2]

This solar energy can be stored in the batteries and then can be used for running the electrical appliances in food van. We can install 4 solar panels of 115 Wp, 12 V capacity solar panel for Food van having roof size of 2.5 m x 1.5 m. Every panel can produce 9.5 A current. These solar panels will be in series so total system voltage will be 48 V and total system current will be 9.5 A. If we have 5 hours of full sunshine, we may get energy upto 47.5 Ah. If there is deficiency of electricity in remote places, we can use solar based van. We can also use combination of Solar and grid based charging.

Battery Inverter system:

A battery inverter system is the power source for the food van. To select the battery and inverter, we have to consider specific parameters.

A power inverter or inverter is an electronic device or circuitry that changes direct current (DC) to alternating current (AC).

The input voltage, output voltage, frequency and overall power handling depend on the design of the specific device or circuitry. The inverter does not produce any power; the power is provided by the DC source.

A typical power inverter device or circuit requires a relatively stable DC power source capable of supplying enough current for the intended power demands of the system. The input voltage depends on the design and purpose of the inverter. The inverter also converts alternating current (AC) to direct current (DC) while charging the batteries so no need of extra battery charge.

An electric battery is a device consisting of one or more electrochemical cells with external connections provided to power electrical devices. [2]

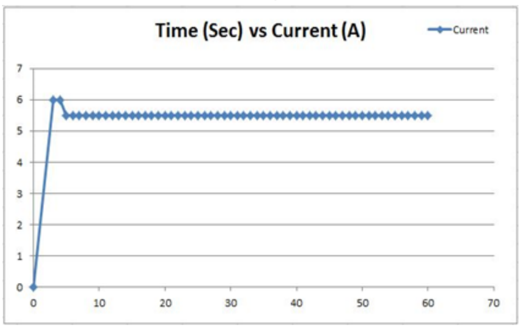
Steps in Inverter selection:

1. Determine Total Watts Required:

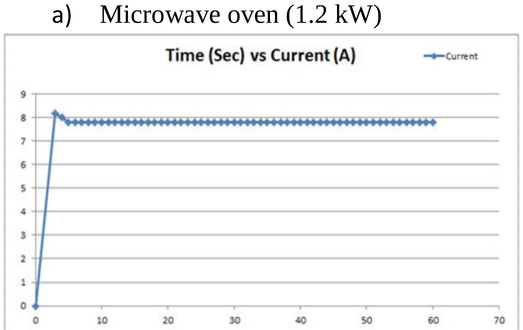
The wattage rating of your appliances is usually listed in the manual or on the product nameplate. If your appliance power is rated in amps, multiply that number times AC utility voltage, which is 230V in India, to determine watts.

While selection of the Inverter, we must check the starting current for appliances which have electric motors or heating elements in it. This starting current can be measured by the Tongue tester or Clamp meter. If Starting current is more than running

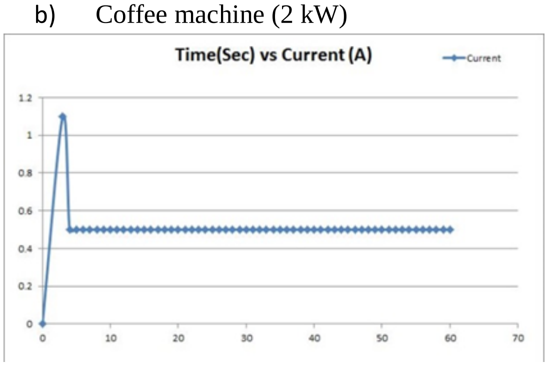
current, consider starting current for selection. Also consider the appliance which has highest power rating among all. Consider one case where there are three appliances Microwave oven (1200 W), Toaster (700 W) and Coffee machine (2000). Then for selection of Inverter, consider Coffee machine because it has highest power consumption. Now, because it has heating element in it we have to check its starting current. If starting current is 9 A, the power consumption in Watt = 230V x 9 A = 1840 W.
Tongue tester also known as Clamp meter is used to test the input current required for the appliances. We can see that the current curves are different for different appliances. For Microwave oven, Coffee machine and Mixer have more staring current than running current. Running current shows a straight line that shows that there is no variation in current when appliance is running.



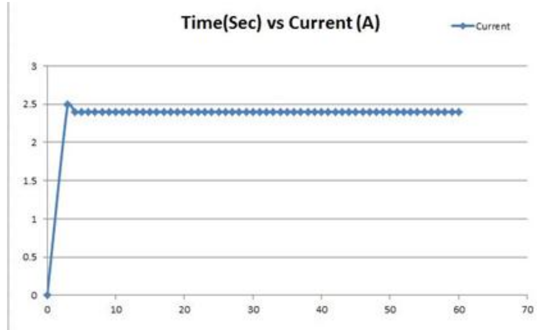
a) Microwave oven (1.2 kW)



b) Coffee machine (2 kW)



c) Mixer (550 W)



d) Toaster (750 W)

In case of small van, as all the appliances cannot run at a time, we can consider only one appliance which has highest power consumption while selecting the Inverter. In our case, we have coffee machine (2 kW) having highest power consumption.
From the experimental results, we can conclude that power consumption in case of coffee machine is maximum and starting current taken by it is 8.1 A. Also the voltage reading for AC was 228 V. Hence, highest power consumption will be 8.1 A x 228 V =1847 W.

2. Adjust for Maximum Efficiency

Your inverter will operate at higher efficiencies at about 88% - 94% of the nameplate rating, so divide the number you calculated in Step 1 by 0.90. This is the minimum number of watts that your inverter must support for continuous operation. Example: 1840 watts ÷ 0.90 = 2050 watts. (for 90% inverter efficiency.)

3. Power factor

In electrical engineering, the power factor of an AC electrical power system is defined as the ratio of the real power flowing to the load to the apparent power in the circuit, and is a . A power factor of less than one means that the voltage and current waveforms are not in phase, reducing the instantaneous product of the two waveforms (V x I). Real power is the capacity of the circuit for performing work in a particular time. Apparent power is the product of the current and voltage of the circuit. Due to energy stored in the load and returned to the source, or due to a non-linear load that distorts the wave shape of the current drawn from the source, the apparent power will be greater than the real power. For selection of Inverter we must consider this power factor. If we divide the power in KW by power factor, we get the KVA rating required for

Inverter. Generally power factor in India is considered as 0.8.

Hence, Inverter KVA rating required for above example = 2050/0.8 = 2560 VA. Hence required KVA rating of Inverter is 2.56 KVA. [5] [6]

Selection of Batteries

An inverter doesn't do anything unless you hook it up to a battery, which is sold separately. These aren't the kind of batteries you put in a flashlight. Instead, we're talking about 12-volt deep-cycle lead-acid batteries similar to the battery in your car. Deep-cycle means that they can be almost completely discharged without losing their ability to produce their specified output. Although they are similar to the battery in your car, the batteries that you use with an inverter are not quite the same. Instead, they are the kind of batteries that you might use in a golf cart, boat or Van.

All deep-cycle batteries are rechargeable, so it's not like buying batteries where you have to choose between disposable and rechargeable. The main decision you have to make is whether to get sealed or unsealed. Sealed batteries are often called maintenance-free because you don't have to periodically top them off with distilled water, which makes life much easier but they are costly.

A battery is a device that converts chemical energy into electrical energy and vice versa. This Summary provides an introduction to the terminology used to describe, classify, and compare batteries for hybrid, plug-in hybrid, and electric vehicles. It provides a basic background, defines the variables used to characterize battery operating conditions, and describes the manufacturer specifications used to characterize battery nominal and maximum characteristics.

Steps in battery selection:

1.Decide the number of batteries required based on the load.

The minimum voltage required for inverter must fulfill. If inverter has rating of 2.5 kVA/48V, then we have to arrange batteries in such a way that its total voltage must be 48 V. We can arrange four 12 V batteries in series. For this system we need inverter of 2.75 kVA and 48V DC input which can be fulfill by connecting 4 batteries in series.

2.*Calculate required energy (Ed) in VAh:*

It can be calculated by multiplying maximum power consumption with no of hours of backup for each appliance and add them.

Coffee machine: 2000 W, Let backup time 0.5 hr : 2000x0.5 hr=1000 VAh

Microwave oven: 1200 W, Let backup time 2 hr : 1200x2 hr=2400 VAh

Toaster: 750W, Let backup time 0.75 hr : 750x0.75 hr=560 VAh

Mixer: 550 W, Let backup time 1 hr : 550x1 hr=550 VAh

Total VAh = 4510 VAh.

3.*Decide these factors* : ka,kt,ke,kDOD

Battery ageing factor (ka) : Ageing factor captures the decrease in battery performance due to age. The performance of a lead-acid battery is relatively stable but drops markedly at latter stages of life. The "knee point" of its life vs performance curve is approximately when the battery can deliver 80% of its rated capacity. After this point, the battery has reached the end of its useful life and should be replaced. Therefore, to ensure that battery can meet capacity throughout its useful life, an ageing factor of 1.25 should be applied (i.e. 1 / 0.8).

Nominal battery voltage (Vdc) : It is the reported or reference voltage of the battery. For this application, we have considered 12 V batteries.

Temperature correction factor (kt): It is an allowance to capture the ambient installation temperature. The capacity for battery cells are typically quoted for a standard operating temperature of 25C and where this differs with the installation temperature, a correction factor must be applied. IEEE 485 gives guidance for vented lead-acid cells. Note that high temperatures lower battery life irrespective of capacity and the correction factor is for capacity sizing only, i.e. you cannot increase battery life by increasing capacity. For this application, temperature correction factor is selected from the IEEE 485 and for 40 C it is 0.89.

Maximum depth of discharge (kDOD) : The percentage of battery capacity that has been discharged expressed as a percentage of maximum capacity. A discharge to at least 80% DOD is referred to as a deep discharge.

System efficiency (ke) : System efficiency represents the amount of losses during the power transfer. Let system efficiency as 0.9.

4.Calculate the minimum battery capacity

Cmin=(Ed x ka x kt)/(Vdc x kDOD x ke)

Where, Cmin is the minimum battery capacity (Ah)

Ed = 4510 VAh, vDC= 48 V, ka= 1.25, kt = 0.89, kDOD = 0.8, ke=0.9

Cmin=(4510x 1.25 x 0.89)/(48 x 0.8 x 0.9) = 145.17 Ah

Now select the nearest available capacity (Ah) from battery standards. For above example, we can select 150 Ah batteries. [5] [7] [8] [9]

III.EXPERIMENTS ON SETUP

Actual experiments are carried out on the Appliances to find out actual back up from the battery system. For experiment, four 12 V, 150 AH batteries are used. As per requirement, Coffee machine is tested for 30 min, Microwave for 1 hr, Toaster for 75 min and Mixer for 1 hr.

While performing experiments open circuit voltage (O.C.V) and terminal voltage (T.V.) for battery, open circuit and terminal voltage for Inverter, Starting current and running current, also the time for each experiment is recorded.

Sr. No	Time (min)	DC O.C.V (V)	DC T.V. (V)	Starting current (A)	Running current (A)	AC Voltage (V)
a)Coffee Machine (2000 W)						
1	3 min	49.6	44.5	8.05	7.85	228
2	3 min	49.5	44.4	8.06	7.86	228
3	3 min	49.4	44.4	8.06	7.87	227
4	3 min	49.2	44.2	8.06	7.87	227
5	3 min	49.0	44.1	8.08	7.88	227
6	3 min	48.9	44.0	8.08	7.88	227
7	3 min	48.8	43.9	8.09	7.89	226
8	3 min	48.6	43.8	8.09	7.89	226
9	3 min	48.5	43.7	8.10	7.9	226
10	3 min	48.4	43.7	8.11	7.91	226
b) Microwave oven (1200 W)						
11	5 min	48.4	44.4	5.9	5.30	224
12	5 min	48.3	44.2	5.92	5.30	223
13	5 min	48.2	44.2	5.94	5.31	222
14	5 min	48.2	44.1	5.96	5.32	222
15	5 min	48.0	44.1	5.97	5.33	221
16	5 min	47.9	43.9	5.98	5.34	221
17	5 min	47.8	43.7	5.99	5.35	220
18	5 min	47.8	43.7	6	5.36	220
19	5 min	47.6	43.6	6.01	5.36	219
20	5 min	47.5	43.5	6.02	5.37	218
21	5 min	47.4	43.5	6.03	5.39	218
22	5 min	47.3	43.4	6.03	5.40	217
23	5 min	47.3	43.4	6.04	5.41	217
24	5 min	47.1	43.2	6.05	5.42	217
25	5 min	47.0	43.1	6.05	5.43	216
26	5 min	46.9	43.0	6.06	5.44	216
27	5 min	46.8	42.9	6.06	5.46	215
28	5 min	46.6	42.8	6.07	5.47	215
29	5 min	46.6	42.7	6.07	5.49	215
30	5 min	46.5	42.5	6.08	5.5	214
31	5 min	46.4	42.4	6.08	5.51	214
32	5 min	46.3	42.3	6.09	5.52	213
33	5	46.2	42.1	6.09	5.53	213

	min					
34	5 min	46.1	42.0	6.10	5.55	213
c) Toaster (750 W)						
35	3 min	46.1	44.8	2.38	2.13	213
36	3 min	46.0	44.6	2.39	2.14	212
37	3 min	45.8	44.5	2.41	2.14	211
38	3 min	45.6	44.3	2.42	2.15	210
39	3 min	45.4	44.2	2.44	2.15	209
40	3 min	45.2	44.0	2.45	2.15	208
41	3 min	45.1	43.8	2.47	2.16	207
42	3 min	45.0	43.7	2.48	2.17	207
43	3 min	44.8	43.6	2.49	2.17	206
44	3 min	44.5	43.6	2.51	2.18	205
45	3 min	44.4	43.5	2.52	2.19	205
46	3 min	44.3	43.5	2.53	2.2	205
47	3 min	44.2	43.4	2.55	2.21	204
48	3 min	44.1	43.3	2.58	2.21	204
49	3 min	43.9	43.2	2.60	2.22	204
d) Mixer (550 W)						
50	5 min	43.9	42.8	1.05	0.49	204
51	5 min	43.8	42.7	1.06	0.49	203
52	5 min	43.8	42.6	1.06	0.50	202
53	5 min	43.7	42.5	1.07	0.51	201
54	5 min	43.6	42.3	1.07	0.52	200
55	5 min	43.5	42.2	1.08	0.52	200
56	5 min	43.4	42.2	1.09	0.53	201
57	5 min	43.3	42.0	1.09	0.54	199
58	5 min	43.3	41.9	1.10	0.55	199
59	5 min	43.2	41.8	1.11	0.57	198
60	5 min	43.1	41.8	1.12	0.58	198

IV. RESULT AND DISCUSSION

1) The Open Circuit battery voltage started from 49.6 and it was continuously decreasing as experiments were performed. Similarly terminal voltage was decreasing based on the type of load applied on the Inverter. At 41.8 V battery voltages, the batteries are completely drained and we get alarming signal from the Inverter. From the readings it is concluded that the AC voltage is decreasing and to match the required power of the appliances, the current drawn is increasing. The Open circuit battery voltage against backup time is drawn in a graph.

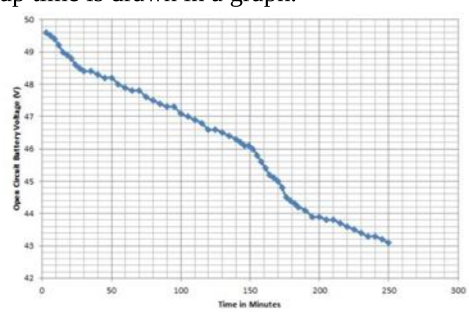


Fig. O.C.V vs Backup time.

From above graph it is observed that the battery voltage is reducing smoothly in the middle section and drastically at the end.

2) The current drawn from the batteries is increasing as the Battery voltage is decreasing to maintain the constant power input to the appliance.(Power = V x I)

3) Actual Backup time is matching with the design backup time with selected battery capacity.

4) If Solar panels are installed on the van, 47 Ah of energy will also additionally add to batteries in 5 hours. In remote areas where there is deficiency of electricity, it will be very useful to use this type of vehicle.

5) Electrical energy is clean energy and by using it as a power source, we can help to keep the environment clean.

V.CONCLUSION

Thus we can use Electrical energy as a alternate energy, which is cleaner than the conventional energy sources. Due to installation of the system on the vehicle, remote villages can also get benefit from this where there is deficiency of electricity. Installation of Solar panels can increase the backup time and the battery charging will also be independent on the power grid.

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