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RESEARCH ARTICLE

ESTIMATING TO OPTIMIZE THE POWER CONSUMPTION IN SVPB, NHCE CAMPUS

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ABSTRACT

Analyzing for the utilization of real power or useful power by the load at Sardhar Vallabhai Patel Block (SVPB). When load is energized either on alternating current (AC) or direct current (DC) supply, comparing loads real and imaginary power consumed when they are AC or DC load. The electrical characteristics of load are maintained constant for both supplies. For light load, its luminous is maintained at 2400 luminous seconded by fan's speed between 500 to 800 rpm. The total light and fan load at SVPB is tabulated. Theoretical calculations are made to calculate the active, reactive, apparent power and power factor in ac system without compensation and with compensation. Total Power in dc system is tabulated to compare the total real or useful power consumed in both systems for same load characteristics. The result shows that power consumed, when system operating with ac 1.4582 time for the same load characteristics over dc system. DC system consumes only 68.88% of ac power after power factor correction. The calculated results are verified over Matlab environment.

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INTRODUCTION

The relationship between voltage and current vectors is ac system depends on what the system is being loaded. When the systems load impedance (Z) is resistive, the vector relationship is in-phase i.e. the angle between voltage and current is zero. The power factor of such system is said to be unity power factor (Hristiyan Kanchev *et al*., 2011). Under such case the total power delivered to load, apparent power which is equal to active or useful power. Assuming the system load being inductive in nature, i.e. $Z= R + jX_L\ \Omega$. The relationship of voltage and current, taking voltage vector as reference at x-axis. The current will lag voltage by angle teta. For pure inductance the angle is 90 degrees. The total power her is vector summation of real and reactive power $S = P + jQ$. This can be depicted in power triangle. The useful power here is only active power, P. So the system has to supply the required reactive power from source side. Thus more current is drawn by the load to get the work done by the load (Seong-Chon Choi *et al*., 2014). This extra current can be shunned by achieving the power factor system near to unity. Thus by connecting capacitive bank, which has leading current, which pulls this lag current to near unity. Thus active power is equal to apparent power. In dc the relationship between voltage and current is in-phase or unity power factor. Thus total power P=V*I, which is useful power (Mohan Kolhe *et al*., 2013).

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The aim of this paper is to tabulate the total tube light and fan load in SVP block. Theoretically calculating the total power consumed by load, tabulating active, reactive and power factor of the system selected. For the ac system selected, the required reactive power is supplied from supply side. Due to which large current flows in the system. In-order to overcome this large current, the systems power factor is to be made near or to unity power factor. For the selected system, power factor correction is simulated over Matlab environment and the total power is made equal to active or useful power. For the selected system, its equivalent dc loads are selected, such that the load characteristics are same as in ac system (Nabina Pradhan and Nava Raj Karki, 2012). These dc loads, the power is generated through vacant roof top at SVP block. A 300W solar panel is selected its output voltage and current, 35.2V and 8.5A respectively. Total power required for dc system is calculated. The results are compared when the system behavior is resistive under ac and dc system.

Load data in SVPB

The block is built over *11200* sq feet. Elevation of ground, first, second and third floor. Fig.1 shows its elevation. Load data details in SVPB are shown in Table.1. Estimating the power enhancement in New Horizon Collage, selecting SVPB to tabulate the total light loads. The input power to campus is arriving at 11KV distribution line to college substation. From college substation the power is distributed to different blocks. SVPB is constructed, having elevation of 3 floors.

Fig.1. Elevation of SVP block

$(955.526 + 592.174\,i)/400$ ohms

$Z_{tube\ light} = 2.8105\angle 31.78$ ohms

Reactive Power drawn = 9.915 KVAR

Total power absorbed by tube light= Real + Reactive power is 18.823 KVA

Total fan load in SVPB is 246. The characteristic of fan is such that it rotates between 500 to 800 rpm. This characteristic is maintained same in both ac and dc system. Each fan in ac system is operated at operating voltage 230 volts. The name plate details of them are shown in Table.4.

Table 1. Load data details in SVPB

	Class room		Laboratory		Department		Total	
	Tube light	Fan	Tube light	Fan	Tube light	Fan	Tube light	Fan
Under ground	-	-	36	24	-	-	36	24
Ground floor	-	-	72	40	18	12	90	52
First floor	87	58	-	-	12	6	103	64
Second floor	42	28	36	24	20	10	104	62
Third floor	67	44	-	-	-	-	67	44

Tabulated data; for light load in class rooms and Labs. Here the total fluorescent lamp and Fans are noted as 400 and 246. Table 2. shows the total fixtures of fan and light load.

Table 2. Total light load data at SVPB

Total Fan and Tube Lights	
Fan	246
Tube Light	400

In this paper only light load data's are tabulated for evaluation. Theoretical calculations and simulink model on the measuring parameters are performed on the assumption that all load are switched on for a period of college working hours i.e. 8 hours daily.

AC Load Calculation

AC load without power factor correction

As per tabulated date in SVP block, there are 400 florescent lamps. The luminous of each tube light is 2400 luminous. The luminous is maintained same in both AC and dc system. Table 3. Shows details of one tube light used in SVPB.

Table 3. Name plate detail of tube light used in SVPB

Name plate detail of tube light used in SVPB			
Rated RMS Voltage	Rated RMS Current	Power	Impedance
230 V	0.2046A	40 W	955.526 + j592.174 Ω

Each tube light is rated at 40W; all bulbs are connected parallel to the applied voltage. The total power consumed by 400 bulbs is,

For 400 bulbs the active power is equal to

40W * 400 = 16KW- (1)

Total Current drawn

400×0.20446 - (2)

Total current drawn by fluorescent lamp is = 81.84A – (3)

Impedance for 400 lights connected in parallel is

Table 4. Name plate details, Fan in ac system

Name plate detail of fan used in SVPB			
Rated RMS Voltage	Rated RMS Current	Power	Impedance
230 V	0.3804A	70 W	483.76 + j362.69 Ω

Each fan is rated at 70W; all fan are connected parallel to the applied voltage. The total power consumed by 246 fan is,

For 246 fans the active power is equal to

70W * 246 = 17.22KW- (4)

Total Current drawn

246×0.3804 - (5)

Total current drawn by fan is = **93.587A** – (6)

Impedance for fan, 246 numbers connected in parallel is

$(483.76 + 362.69\,i)/246$ ohms

$Z_{Fan} = 2.457\angle 36.86$ ohms

Reactive Power drawn = 12.911 KVAR

Total power absorbed by tube light= Real + Reactive power is 21.525 KVA

Table.5. shows the operating voltage, current, real, reactive and total power for system being energized with ac supply.

Table 5. Calculated values for ac system

Operating Voltage	Total Current	Active Power	Reactive Power	Apparent Power
230V	175.42A	33.203KW	22.941KVAR	40.348KVA

The power factor for this system is calculated as

Power factor = KW/KVA
Power factor = 0.82291

The power companies would lay heavy fine to college for not maintaining power factor at 0.95. Thus, the system must be supplied with required reactive power near to load side and not from supply side (Chongru Liu *et al*., 2010). Thus power factor of the selected system can be improved by installing a capacitive bank near to load.

AC system with compensation

As discussed in above section, reactive power to be supplied from load side of the system and not from the supply side. The reactive power demand of the load needs to be supplied from load side through capacitive banks. The total KVAR required to achieve unity power factor is 22.9KVAR. Table.6. shows the total power consumed by load is same as active or useful power.

Table 6. Measured values with compensation

Operating Voltage rms	Total Current rms	Total Power
230V	144.419A	33.216KW

Power factor correction capacitor's capacitance calculation is given by:-

$C_{correction} = 1000 \times Q_{(kVAR)} / (2\pi f \times V^2)$

$C_{correction} =$ 1379.250586 micro Farad.

Thus the load at SVPB behaves as resistive load. The actual load characteristic is inductive, connecting capacitive bank near load side, the required reactive current is supplied and the real power alone flows through the line from source side. Thus the loss in line is reduced. Table 5 shows that the total current flowing in distribution line due to demand from load side is 175.42A without power factor correction. From Table.6 it can be seen that the total current flowing in the distribution line is 144.42A with power factor correction. The current flowing without compensation is 1.215 times the current flowing with power factor correction.

DC load calculation

The load characteristics of ac system are maintained same in dc system. Tube light in ac system having 2400 luminous and rpm of fan rage 500-800 is installed at SVPB. This characteristic is maintained same in dc system. The name plate details of the load in dc system are shown in Table.7.

Table 7. Details of dc load

Operating Voltage	Total Current	Active Power	Luminous	Resistance ohms
LED Tube Light				
24V	0.833A	20W	1300	24.8
DC Fan				
24V	1.166A	28W	500-800rpm	20.583

Thus to achieve same luminous as ac system, two led tube lights are used to make the ambient same. The total led tube lights and fan details estimated to install is shown in Table.8.

Table 8. Total load data estimated for dc system

Total Fan and LED Tube Lights in dc system	
Fan	246
Tube Light	800

Table.9. showing the total dc power required to experience the same ac ambient in SVPB.

Table 9. Total dc power consumed

Operating Voltage	Total Power consumed by load
24V	22.87KW

The power consumed in dc system is 68.87% of ac system. This analysis made as the load in conventional ac system is made to behave as pure resistive load with power factor correction.

Estimation of solar energy at SVPB

A 300W generating capacity solar panel is selected for analysis. This panel covers 3.26ft×6.5ft rectangular area. Generating power at 35.2V and 8.5A. The SVP block is covered over **11216 sq ft**. Here 20% of the built up area is considered for cleaning and maintenance purpose. Therefore 80% of the built up area is available to install solar cells for power generation.

Use full area = 0.8×11216 = 8973 sq.ft

The estimated power generation from 8972sq.ft is around *127KW*. Total solar energy that can be generated at SVPB considering solar isolation per day to remain constant, the efficiency of generation is not affected by dust and cloud blockage on panel. Isolation per day considered here is 8hours. Total solar energy estimated for generation in SVPB is *1.016MW*. The current requirement of load is near to 34KW, which is 3.346% of generation capacity of clean energy.

Matlab Model

The theoretical calculated values are simulated over Matlab environment for verifying and analysis. Fig.2. shows the matlab file without compensation. Fig, 2 – 12 shows matlab files simulated for justifying calculation.

RESULTS DISCUSSION

Here for ac system without compensation the apparent power or total power consumed in 40.348KVA and the total rms current consumed is 175.42A. The power factor is 0.8233. It is required to maintain with 0.95 as system power factor by industries; else a heavy fine will be leaved on industries for not maintaining. Thus the system should maintain .95 as its power factor. These calculated values are verified over matlab environment. It is seen that the useful power is 33.203KW. The total KVAR required for power factor correction is 23.48KVAR. The total power after compensation is equal to active power, i.e. 33KW. For the same load characteristics, the equivalent dc load is simulated for evaluating the calculations and comparing with ac system for analysis. The total power consumed by dc load is 22.87KW.

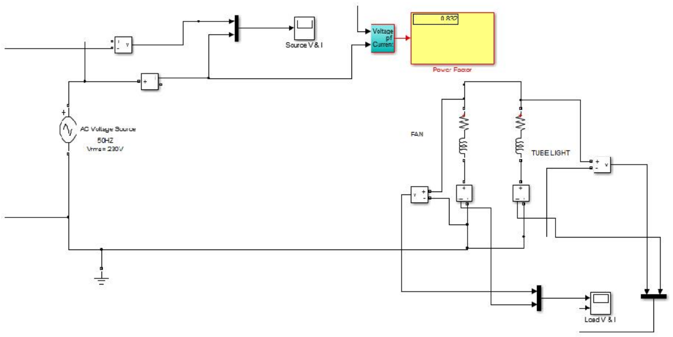

Fig.2. AC load without compensation

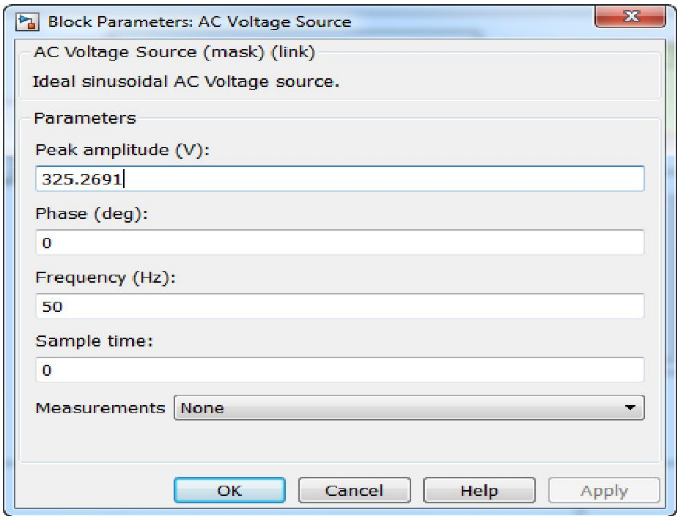

Fig.3. AC source details

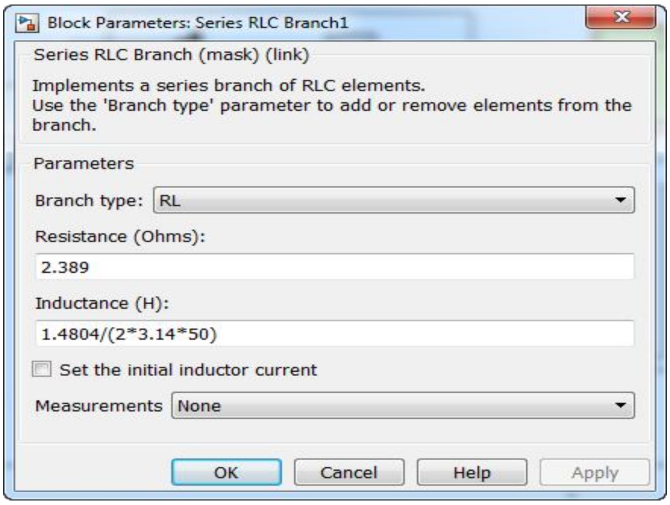

Fig.4. Load data for ac Tube Light

The system with dc supply requires 68.879% of power used in ac system after compensation. Ac system consumes 1.456 times dc power i.e. 45.7% more than dc system. Thus this paper suggest for utilization of dc system over current conventional ac system. With dc power the total power consumed can be reduced to 31.15%. Under three phase system the line current drawn is 100.8A which is 69.8% of 144.419A. Dc load is powered by vacant roof-top solar energy. Thus reducing our dependence on conventional electrical supply. by this we are reducing the carbon emission to nature.

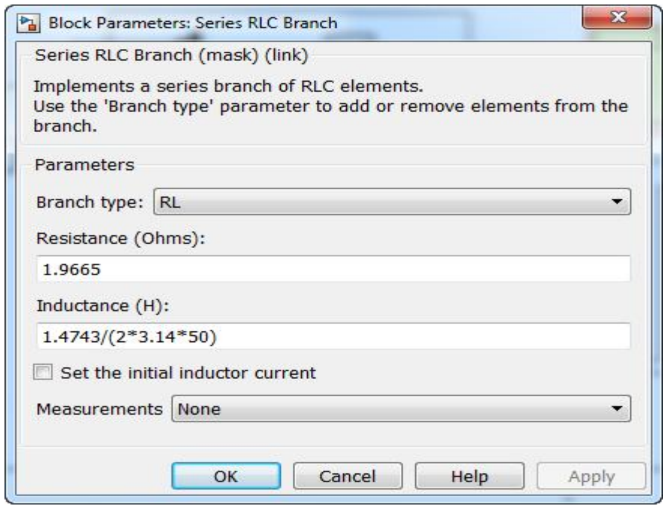

Fig.5. Load data for ac Fan

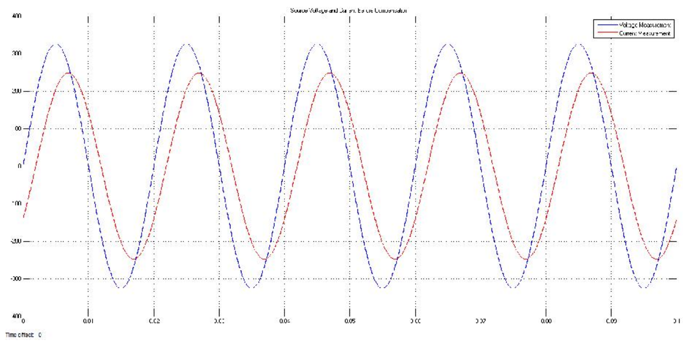

Fig.6. Source voltage and current without compensation

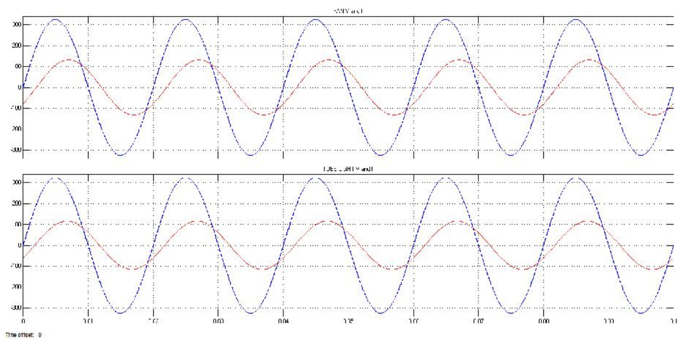

Fig.7. Fan and Tube light waveforms

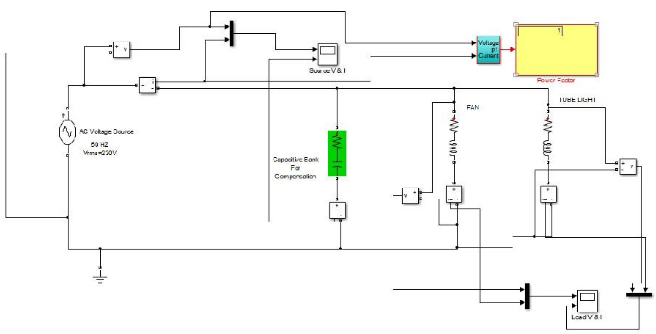

Fig.8. Matlab model for ac load with compensation

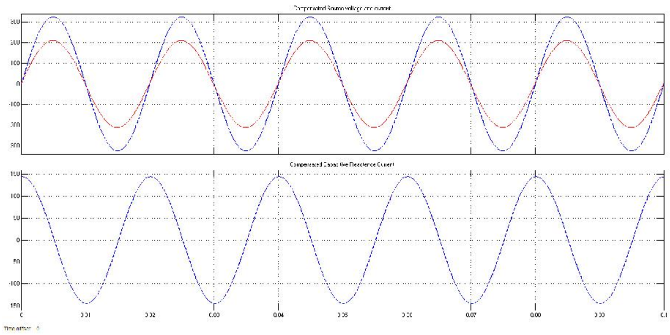

Fig.9. Source voltage and current with capacitive reactive current

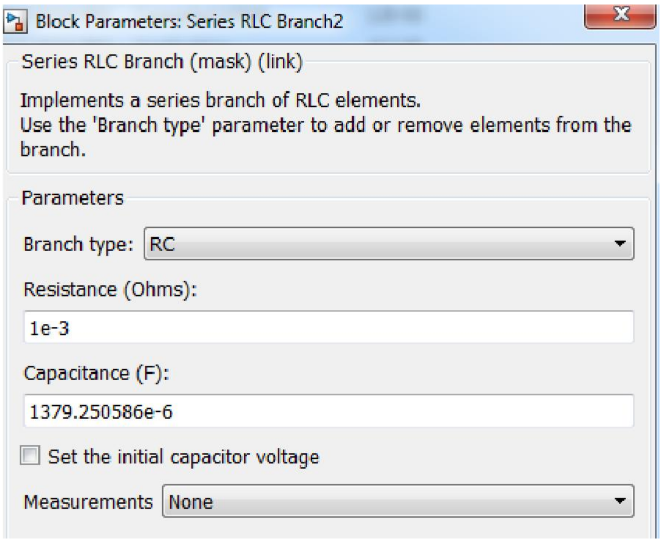

Fig.10.Power factor correction details

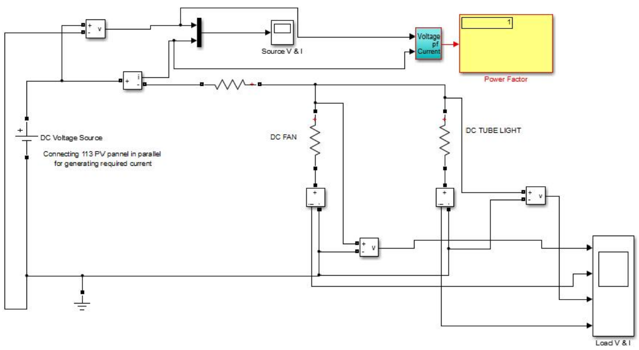

Fig.11. Matlab file for dc source

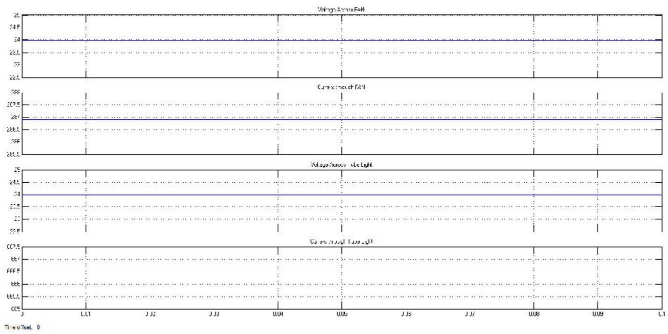

Fig.12. Load voltage and current waveforms for dc load

Conclusion

Analysis to estimate the total useful power consumed by ac and dc system for same load characteristic shows that system operating in dc consumes 31.15% less power in delivering same ambient as in ac system. The power demand is 33.203KW in ac system and assuming this to be the demand for one day.ie. all loads are switched on. The demand in dc is 22.78KW. The dc supply is generated through Solar roof-tops or clean energy at SVPB vacant roof top. The estimated capacity for generation here is *1.016MW.* The current requirement of load is near to 23KW, which is *2.264%* of generation capacity of clean energy. Thus this paper suggests the use of dc system for light loads.

Future Scope

The total current in dc system is around 953A. The size of conductor required to withstand this high current is more. The current drawn by the system depends directly on the applied voltage. Consider the operating voltage to be 230V same as ac system [6]. The current drawn for the same power is near to 100A. It can be seen that the current is reduced by 9.53 times. As the operating voltage is increased to 230V the current is 10.493% of 953A. The ratings of circuit breakers required, size of other equipments, replacement cost, steps to overcome the fault conditions, back up supply in dc system has to be considered for further analysis (Abul Masrur *et al.,* 1998). Thus, as in ac system 230volts is the standard operating voltage for single phase and 400V under three phase. A standard operating dc voltage should be commented.

REFERENCES

Abul Masrur, M., Daryl S. Sitar, and Sankaran, V.A. 1998. "Can an AC (Alternating Current) Electrical System Replace the Present DC System in the Automobile? An Investigative Feasibility Study—Part I: System Architecture"- IEEE Transactions on Vehicular Technology, Vol. 47, No. 3, August 1998

Chongru Liu, Jiang Zuo, Jia Wu and Dongxing Liu, 2010. "Observability analysis of AC-DC hybrid power system"- Power and Energy Society General Meeting, IEEE

Hristiyan Kanchev, Di Lu, Frederic Colas, Vladimir Lazarov, and Bruno Francois, 2011. "Energy Management and Operational Planning of a Microgrid With a PV-Based Active Generator for Smart Grid Applications", IEEE - IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS, VOL. 58, NO. 10, OCTOBER 2011

Mohan Kolhe, K. M., Iromi Udumbara Ranaweera, A. G. B. and Sisara Gunawardana, 2013. "Techno-Economic Optimum Sizing of Hybrid Renewable Energy System"- Industrial Electronics Society, IECON 2013 - 39th Annual Conference of the IEEE

Nabina Pradhan and Nava Raj Karki, 2012. "Probabilistic Reliability Evaluation of Off-grid Small Hybrid Solar PV-Wind Power System for the Rural Electrification in Nepal"- North American Power Symposium (NAPS), 2012

Roskhatijah Radzuan, Mohd Azril Ab Raop, Mohd Khairul Mohd Salleh, Mustafar Kamal Hamzah and Ruhaifi Abdullah Zawawi, 2012. "The Designs of Low Power AC-

DC Converter for Power Electronics System Applications"- 012 International Symposium on Computer Applications and Industrial Electronics (ISCAIE 2012), December 3-4, 2012, Kota Kinabalu Malaysia

Seong-Chon Choi, Min-ho Sin and Dong-Rak Kim, 2014. "Versatile Power Transfer Strategies of PV Battery Hybrid System for Residential Use with Energy Management System"- The 2014 International Power Electronics Conference

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