Linear Energy Efficient ROI model of an Urban Premise Using DSM Technique

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Abstract

Demand-side management(DSM) is used to describe the actions of a utility, beyond the customer's meter, with the objective of altering the end-use of electricity whether it be to increase demand, decrease it, shift it between high and low peak periods, or manage it when there are intermittent load demands - in the overall interests of reducing utility costs. In other words DSM is the implementation of those measures that help the customers to use electricity more efficiently and in doing so reduces the customer utility costs. DSM can be achieved through improving the efficiency of various end-uses through better housekeeping ,correcting energy leakages, system conversion losses, and using renewable energy(RE) systems. In the past few decades the renewable energy sources have received grater interest and considerable attention has been given to efficient energy conversion and utilization techniques. Due to seasonal & periodic variations a single renewable energy source cannot provide continuous supply. In this case the Hybrid system with combination of two or more Resources can provide a better efficiency with considerable optimal cost. Present paper discusses a case study of an Urban restaurant. As a first step ,walkthrough Energy Audit has been carried out and using Dialus package Uplamping technique has been proposed.In the next step ,HOMER 'NRELs simulation Tool has been used to model Hybrid RE system with diesel generator as the backup.

In the last step, based on the model developed in the HOMER, Return on investment(ROI) has been calculated with & without subsidy. The proposed ROI model has shown 20 % optimal contribution of Hybird RE for the problem considered in the present study.

Keywords: *Audit, Barchart, Dialux, HOMER,, Uplamping,*

1. Introduction

The primary objective of energy management is to maximize profits or minimizing the losses. This is achieved by conducting energy audit for the premises. The steps involved will be effective monitoring, reporting, and finding different strategies to save energy. Walkthrough audit is one of the preliminary audit which helps in understanding the type & power rating of the load, hourly usage of equipment & energy saving alternatives. In the restaurant, power load comprise of nearly 60% of the total load. So there is an significant scope of identifying the possible savings of energy ,these technique was discussed in report of Energy audit at KTDC Samudra[1].

The amount of energy used for lighting varies from 15 to 30% depending upon the type of industry. In case of restaurant it varies between 30% to 40 %. Uplamping technique was adopted to improve the illumination level & reducing the operating cost was discussed and

Dialux energy efficient simulation package was used to incorporate the uplamping technique [2].

There are many combination of different alternative energy sources & storage devices to build a Hybrid system have been discussed in different literature. Due to natural intermittent properties Standalone PV, Wind requires some energy storage device or some other generation sources to form Hybrid system .In India Biomass resources can be a more reliable among the renewable energy source as it can be generated from agricultural residue, animal dung, forest wastes, firewood etc., which is available in large quantities.

Rural based off grid electrification techno economic analysis of different combination of renewable energy models along with the existing diesel generators have been carried out with the HOMER software there are many software packages are available for the techno economic analysis of hybrid energy system for the isolated regions &[3]compares & concludes that HOMER is very user friendly, flexible, easy to model, analyze & optimize the micro power systems.

Techno economic survey in the remote village of Tamilnadu was carried out with an already exisisting biomass plant by integrating it with a PV& wind modules using HOMER [4].

In [5] Generator backup based Hybrid Systems was designed using HOMER and proved the fact that the system is feasibly, optimally sustainable alternative power supply for the Hilly areas.

In [6] PV-Wind-Diesel Hybrid system was also developed for the CDMA mobile base station at Bhopal and found out that system is Environment friendly & cost effective.

The Homer based papers mainly targeted at rural areas, the present paper attempts to provide Hybird RE based solution to an Urban Premise involving savings of Walkthrough Audit & uplamping techniques. The Paper also presents a linaerized ROI model for an Urban Premises.

2. Case Study

An Urban Restaurant was taken for the case study. The study was made as per flowchart shown in the Fig. 1. From the Walkthrough Audit conducted the loads are categorized & plotted as shown in the Fig.2.

In the Audit,it was observed that ,power loads such as freezers & centralized A.C comprising of

61% of the total load consumes monthly 12920kWh.Suggestions were made to switch off these loads during the winter season which accounts a savings of Rs 1.9Lakhs/year.

The Restaurant existing lighting system was studied in the Hall which comprises of CFL & Tube lights.. The lux distribution was measured using LuxMeter and found to be 63-75 Lux which is below the requirement of 100Lux .The existing arrangement of these lamps is shown Fig.3.

Based on equation (1) it is proposed to replace it by 24 , 14 W TL lamps with lux level of about 100 Lux .

n= Illuminance(lux)*length*breadth/ Flux per fitting*Utilization factor*Maintenance factor (1)

n= (150*30*20)/(3600*0.6*0.9)

= 48=24*2=6*4

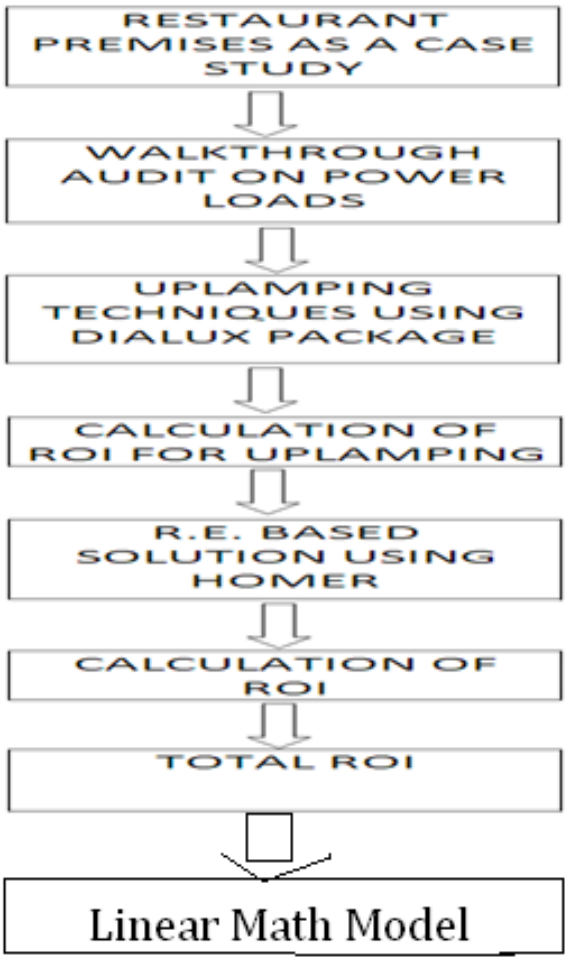

Fig. 1 Flow Chart of the Present Work

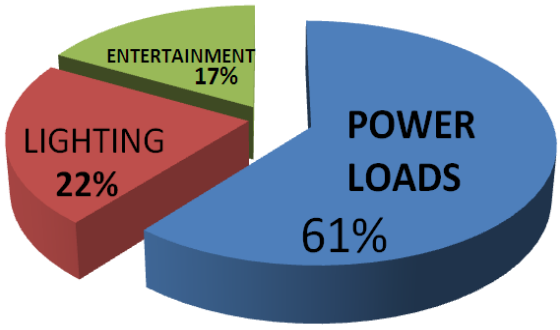

Fig. 2 Pie Chart of Hotel Load

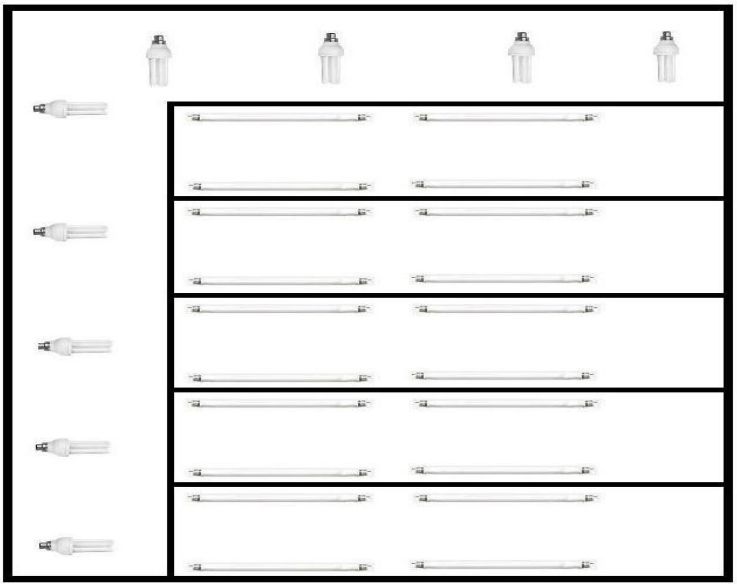

Fig. 3 Existing Lighting Arrangement of the Dining Hall of the Premises

The simulated images of The arrangement of the luminare, Fig 4, Room geometry along with fixtures Fig.5 & its lux distributions Fig.6 using Dialux.

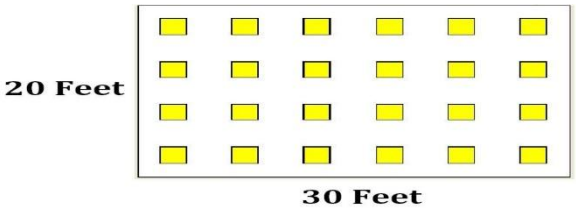

Fig.4 Arrangement of Proposed Luminare

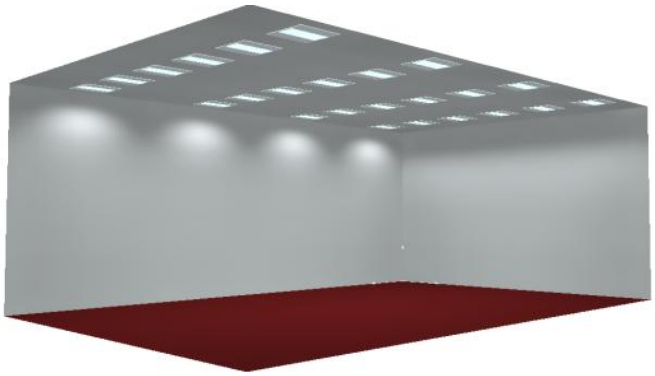

Fig.5 3D View of a Hall with T5 lamps using Dialux

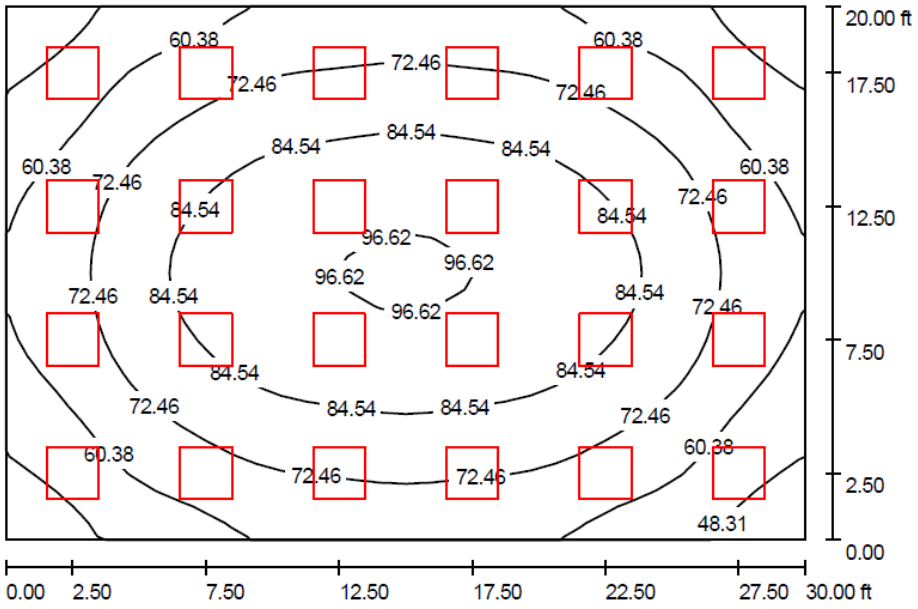

Fig.6 Proposed Lux Distribution of the Hall

Form the above we can observe that T5 lamps Uplamping technique has yielded the rise in illumination level with decrease in operating costs. Meanwhile Kitchen & storage areas 40 W tubes are replaced with 18W CFL. Uplamping ROI has been tabulated in the Table1.

Table 1: Estimated Uplamping ROI for the premises

Place	Existing Tubelights 20*40w/day	Monthly Consumption In Rs	Proposed T5 14 watts/usage/day	Lux level	Uplamping costs	Monthly savings in rs	ROI
HALL	20X40X10= 8KWHR	Rs 1440	24*14*10=3.36KWHR	75 to 96	24*500= Rs12,000	Rs 835	15Months
KITCHEN & STORAGE AREA	18X40X10= 7.2KWHR	RS1296	18WATS USAGE/DAY=18*18*10=3.24KWHR	---	200*18= RS 3600	RS 713	5 MONTHS

TOTAL UPLAMPING ROI

TOTA COST	TOTAL SAVINGS	ROI
RS 15600	RS 1548	10 MONTHS

The Hybrid RE system is developed for a Hotel for which load demand varies between 180kW to 210kW. It already has diesel generator capacity of 150 kW which has been included in RE model along with PV, wind & Biomass. Solar radiation is keyed in for the place of Bangalore along with latitude & longitude with the time zone. Data is collected from National Data Center Pune. It is fed as the HOMER soalr I/p data. The Wind data is collected from the Indian metrological department for the year 2010-2011.

Biomass resources are assumed to be available as 200kg/day to 300 kg /day.

The peak load demand varies between 150kW to 190kW.

It has a diesel generator capacity of 150kW. The capital cost is Rs 20,000

The capital cost of generating 1kW through Solar is estimated to be Rs.2 lakhs.

The capital cost of generating 1kW through Wind is estimated to be Rs.1.5 lakhs.

The capital cost of generating 1kW through Bio-Mass is estimated to be Rs.1.25Lakhs.

The input cost in each modules has to be done in Dollars, so we have taken 1$=Rs.45.

The cost of 1Litre Diesel is Rs.40.

In each case, diesel generator of 150kW is taken as prime backup, since the modules of Renewable Energy may not provide reliable source.

The inputs for the hotel load demand is taken from the maintenance department.

The Bio-Mass input is based on the Biowaste and Sludge that is generated from the hotel.

A converter of 100kW rating is used along with a battery of 100kW .

The capital cost of an converter for an 1kW is estimated to be Rs 5000.

The capital cost of the battery for an 1kw is Rs.3000

2. Simulation Model

The Proposed hybrid RE model in HOMER consisting of PV-Wind-Biomass & Diesel Generator is shown in Fig 7. Equipment & their ratings considered in the study are

PV Panel - 5kw. Wind turbine – 20kw.

Biomass generator-25Kw Diesel generator- 150kw

Battery-55 (460Ah) Converter-150Kw.

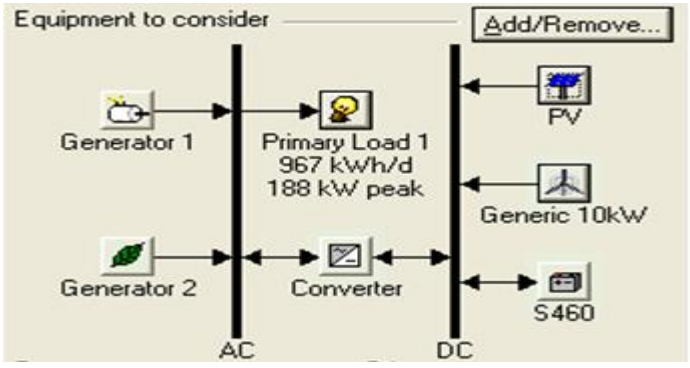

Fig.7 Proposed Hybrid RE Model in HOMER

The proposed Hybrid RE model in HOMER ratings /range of values for solar panel, Wind turbine & biomass unit are 2 to 6 kW, 20 to 30 kW & 15 to 25 kW respectively are used in the simulation. Optimum combinations obtained in the HOMER model are tabulated in Table 2.

Table2, Optimum combinations obtained in the HOMER model

PV (kW)	G10	dg (kW)	bio (kW)	S460	Conv. (kW)	Initial Capital	Operating Cost ($/yr)	Total NPC	COE ($/kWh)	Ren. Frac.	Capacity Shortage	Diesel (L)	Biomass (t)	dg (hrs)	bio (hrs)
6	5	150	15		150	$140,500	226,380	$3,034,399	0.673	0.27	0.00	174,702	114	7,016	2,549
6	5	150	15	4	150	$143,300	236,768	$3,169,956	0.703	0.27	0.00	188,711	114	6,723	2,508
4		150	20		150	$87,000	246,075	$3,232,663	0.718	0.08	0.00	192,980	114	7,593	1,761
6		150	15	4	150	$85,300	261,535	$3,428,591	0.761	0.09	0.00	190,787	114	7,528	2,159
4	5	150			150	$95,000	268,975	$3,533,398	0.784	0.18	0.00	215,352		8,607	
4		150			150	$37,000	276,291	$3,568,922	0.792	0.02	0.01	222,986		8,759	
4	5	150		4	150	$97,800	283,999	$3,728,255	0.827	0.18	0.00	212,775		8,496	
4		150		4	150	$39,800	294,500	$3,804,503	0.844	0.02	0.00	222,989		8,759	

From Table2 selecting the suitable combination of Solar, Wind, biomass units and Maximum Renewable fraction Utilization factor sensitivity analysis has been performed and the result is shown in Fig 8.

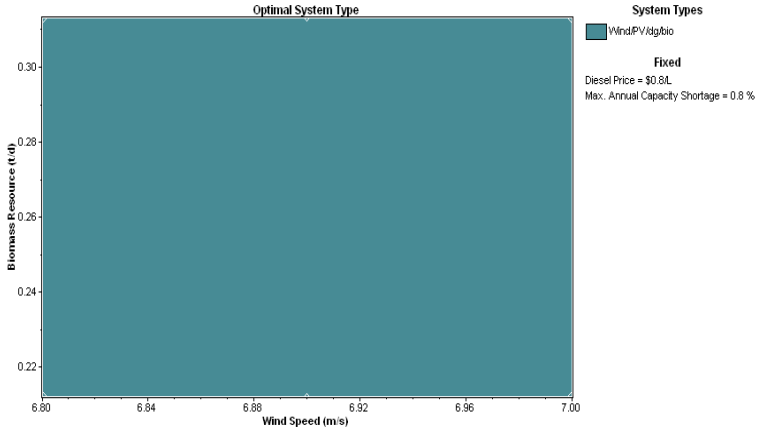

Fig.8 Sensitivity Analysis

From Fig.8 it is clear that for the wind speed ranging form 6 to 7 m/s & Biomass of 0.22 to 0.30 tonns/day combination of 6kWPV/50kWWind /15kWBio is Feasible. Further for more clarity Surface &line plots are drawn shown in Fig 9 & 10 respectively.

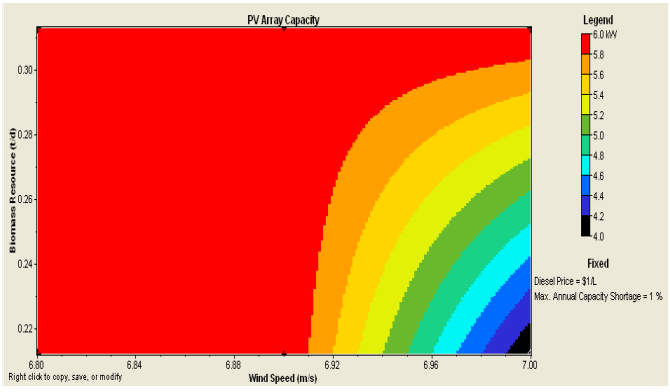

Fig.9 Surface Plot

From Fig .9 it suggests that as wind speed and biomass decreases use of solar capacity increases

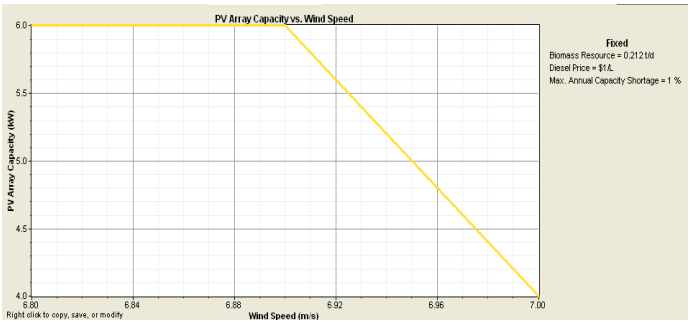

Fig. 10 Line Graph

Fig. 10 indicates PV array capacity decrease as wind speed increases . ROI without subsidy, with subsidy for proposed RE model is calculated and given in Table 3.

Table 3:ROI with Subsidy for the proposed RE model

Re model 5kw solar 30 kw wind 15 kw biomass (homer)	Total proposed watts/year operated by re component	Total savings/year	ROI
Rs 64 Lakhs	20kWhr*7*365=51100 kWhr	RS 3.06 LAKHS	21 YEARS
RS 52 LAKHS (SUBSIDY)			17YEARS

Final ROI of Hybrid RE model which comprises of without subsidy,with subsidy, Uplamping & walkthrough audit savings has been shown as a barchart in Fig.11.

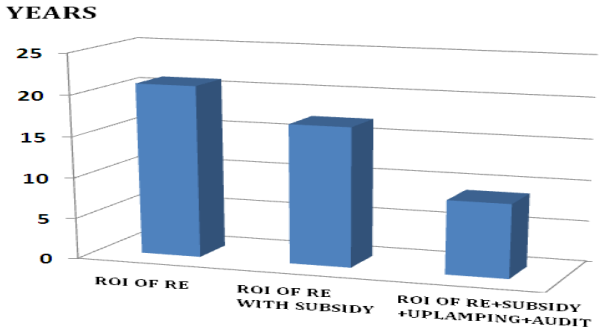

Fig.11 Barchart showing different ROIs

From the above Fig 11, ROI in the third case is only 9 years. The Hotel Load demand dips down to 10-20 % mainly during Night 11P.M -4 A.M which can be completely powered by RE based model whose efficiency is around 25 %. Incorporating all theses constraints it is

arrived as a Linear Mathematical Model given as equation (2). The main objective of the present study is to Minimize the equation (2) Subjected to two constraints for solar & uplamping.

Energy Efficient ROI Model OF an Urban Premise is

=∑capital Cost- Energy Saving cost

$$\sum_{i=1}^{365} [LfC + Kw\,C + Wu\,C + Bw\,C] - [Pi\,WmOh\,C + Lj\,Wn\,Ot\,C + 0.2\,Md\,Or\,C + Sc] \qquad (2)$$

Subject To constraints 0<Oh<8,0<Ot<10

Where Lf.C=Uplamping Capital Cost

Kw.C=PV Capital Cost,Wu.C=Wind Turbine capital cost,Bw.C=Biomass Capaital cost

Pi Wm Oh.C=Energy saved in Rs by switching off the power loads,

Lj Wn Ot C=ENrgy saved due to uplamping

0.2 Md.Or.C=Energy saved due to RE component

Sc=Scrap Cost(Neglected)

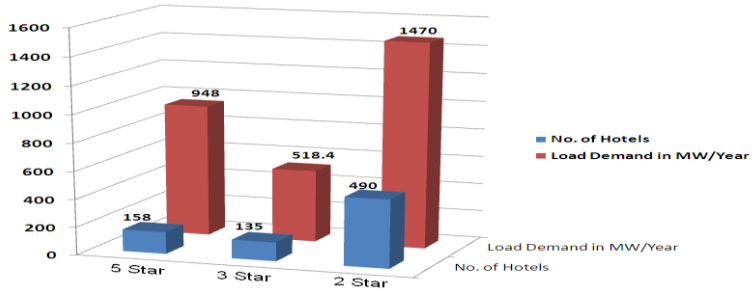

Fig.12 Bar chart showing yearly load demand of different Hotels

Figure 12 gives the information of different hotel segments & their Yearly load demand of Bangalore city. If it is supplemented at least by 25% with hybrid RE system then it can be a efficient ,reliable & cost effective model.

4. Conclusions

In the Present study a restaurant with diesel generator as the prime backup has been used to model a Hybrid RE system. During light load conditions it is not advisable to run Disiel generator set because of its higher cost and/or diesel consumptions/unit of generation. In the present study, Solar has been taken with the least kW and bio-mass with high capacity in order to balance for the cost & weather conditions.

In present scenario, India is facing a huge deficit of power, so renewable energy based generation for urban premises will be inevitable. The present work can be extended to the

grid with concept of sellback, ROI can be still decreased by supplying the excess electricity to the grid.

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References

[1] REC Kerala report on "Walkthrough Audit report " on Hotel Samudra.

[2] Mallya, "Improved illumination Level &Energy savings by up lamping technology in the office buildings."Spring conference by international Association of computer science And information technology 2009.

[3] Pavalos.S.Georgiolikas, "state of the art of the decision support system for the choice of renewable energy sources for energy supply in isolated regions" International journal of distributed energy sources 2006.

[4] S.Ashok and P.Balamurugan."Biomass Gasifier based Hybrid energy System for rural areas"IEEE Canada Electrical Power Conference, 2007

[5] E.Ferandez , "Sustainable Energy generation Using Hybrid Energy system for Remote rural Hilly Areas of India "International Journal of sustainable enegineering 2010

[6] R.K.Nema ,"Pv-solar/Wind Hybrid energy system for GSM/CDMA type Mobile base station " International Journal of energy & environment 2010.

[7] www.nrel.gov.

[8] www.homerenergy.com.

[9] www.dialux.de.com

[10] www.mnre.gov.in

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