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Study of Cost Analysis and Emission Analysis for Grid Connected PV Systems using RETSCREEN 4 Simulation Software

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Abstract: **The fast depletion of conventional sources is forcing to use renewable energy sources as replacement to meet the load power demand of any building, which is completely dependent on grids which are dependent on conventional sources for electricity generation and utilization. So, there is a need to reduce this dependency of loads on grids. For this we need to incorporate the grid technologies with CETS to reduce the energy cost of building and thereby reduce consumption of conventional sources. In this paper, analysis is done on combining the PV technology with grid technology for a hostel building of an engineering college in Gunupur, India. We have taken help of RETScreen 4 simulation software to find how much reduction of cost of energy consumption is possible by this combination. This study can help us to find ways for enhancing the life of conventional fuels in existence and know the reduction of greenhouseemissions. This report will consist of the cost analysis and emission analysis as per given by RETScreen 4 simulations which will give a complete idea of cost of establishing this combination and its global impact.**

Keywords—Cost analysis, emission analysis, RETSCREEN 4, simulation, weather condition, PV array.

I. INTRODUCTION

The total load of a building depends upon total number of electrical appliances which has been installed in the building. The load demand also varies throughout the day because we don't use all appliances all at once. This varying load is given the supply from the grids which are dependent on the conventional energy sources. So to reduce the consumption of the fossil fuels.

We need to incorporate the existing technology to the clean renewable energy technologies for reducing the overall electricity consumption cost and thereby the fossil fuel degradation. In this paper we have used the combination of the central grid and the PV technology for analysis by use of the simulation software RETSCREEN 4. The choice of the renewable energy is dependent on weather and climatic conditions in an area and their rate of change from time to time.

Grid connected PV systems is the most popular type of solar PV system for homes and businesses in the developed world. Connection to the local electricity network allows any excess power produced to be sold to the utility. Electricity is then imported from the network outside daylight hours. An inverter is used to convert the DC power produced by the system to AC power for running normal electrical equipment. In countries with a premium feed-in tariff, this is considerably higher than the usual tariff paid by the customer to the utility, so usually all electricity produced is fed into the public grid and sold to the utility. When a PV system is connected to the local electricity network, any excess power that is generated can be fed back into the electricity grid. Under a FiT regime, the owner of the PV system is paid according the law for the power generated by the local electricity provider. This type of PV system is referred to as being 'on-grid' [1].

In this paper analysis has been done to find the total cost associated and its impact on the environment due to reduction in greenhouse gases emission.

II METHOD OF COST ANALYSIS AND EMISSION ANALYSIS BY SIMULATION ON RETSCREEN 4

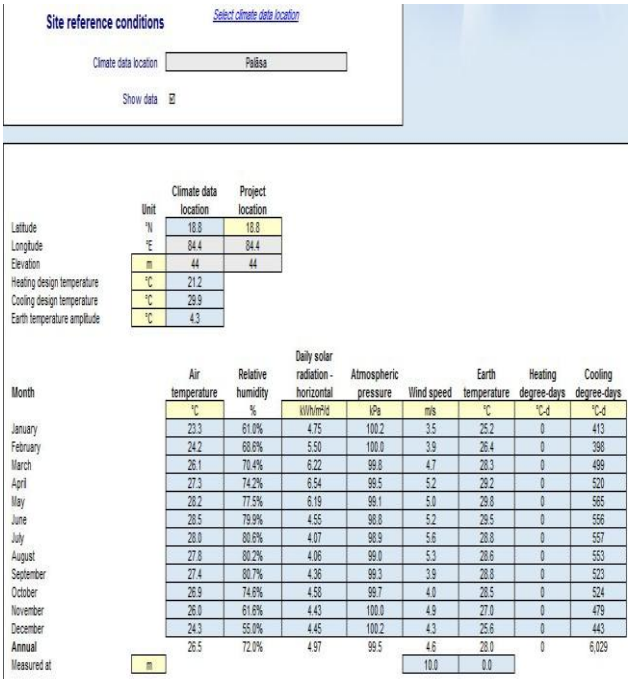
RETSCREEN is a clean energy awareness,decision-support and capacity building tool. The core of the tool consists of a standardized and integrated clean energy project analysis software that can be used world-wide to evaluate the energy production, life-cycle costs and greenhouse gas emission reductions for various types of energy efficient and renewable energy technologies (RETs). Each RETScreen energy technology model (e.g. Photovoltaic Project, etc.)is developed within an individual Microsoft® Excel spreadsheet "Workbook" file. The Workbook file is in-turn composed of a series of worksheets. These worksheets have a common look and follow a standard approach for all RETScreen models. In

addition to the software, the tool includes: product, weather and cost databases; an onlinemanual; a Website; an engineering textbook; project case studies; and a training course.

A. WEATHER ZONE TO BE SELECTED

We need to select weather zone of a place nearest to the place where the analysis is carried out. The RETSCREEN 4 software then gives the complete weather details of the place nearest to place of analysis. The software also gives data regarding the daily solar radiation(horizontal), heating and cooling days, wind speed, earth temperature etc. as is given in fig(1).

The data displayed is the data as per the data given by NASA.



Site reference conditions — Select climate data location

Climate data location: Palasa

Show data

	Unit	Climate data location	Project location
Latitude	°N	18.8	18.8
Longitude	°E	84.4	84.4
Elevation	m	44	44
Heating design temperature	°C	21.2	
Cooling design temperature	°C	29.9	
Earth temperature amplitude	°C	4.3	

Month	Air temperature	Relative humidity	Daily solar radiation - horizontal	Atmospheric pressure	Wind speed	Earth temperature	Heating degree-days	Cooling degree-days
	°C	%	kWh/m²/d	kPa	m/s	°C	°C-d	°C-d
January	23.3	61.0%	4.75	100.2	3.5	25.2	0	413
February	24.2	68.6%	5.50	100.0	3.9	26.4	0	398
March	26.1	70.4%	6.22	99.8	4.7	28.3	0	499
April	27.3	74.2%	6.54	99.5	5.2	29.2	0	520
May	28.2	77.5%	6.19	99.1	5.0	29.8	0	565
June	28.5	79.9%	4.55	98.8	5.2	29.5	0	556
July	28.0	80.6%	4.07	98.9	5.6	28.8	0	557
August	27.8	80.2%	4.06	99.0	5.3	28.6	0	553
September	27.4	80.7%	4.36	99.3	3.9	28.8	0	523
October	26.9	74.6%	4.58	99.7	4.0	28.5	0	524
November	26.0	61.6%	4.43	100.0	4.9	27.0	0	479
December	24.3	55.0%	4.45	100.2	4.3	25.6	0	443
Annual	26.5	72.0%	4.97	99.5	4.6	28.0	0	6,029
Measured at	m				10.0	0.0		

Fig(1): RETSCREEN 4 weather data

B. LOAD AND NETWORK ANALYSIS

Here the data regarding the average gross power load of the building is given by the user depending on the appliances used, season, weather conditions according to which the data is taken, number of people in the building, the appliances they are using etc. which is fed toRETSCREEN. The software also asks of how much load ratio of grid and the PV technology used is to be maintained. This will give us the proposed case load data characteristics. The charges per KW of energy as per the currency is also fed for cost analysis by the software.

Proposed case load characteristics	Power net average load kW
Month	
January	66
February	65
March	121
April	123
May	41
June	7
July	53
August	54
September	54
October	27
November	79
December	65
Peak load - annual	221

Fig(2): Proposed case load characteristics as per RETSCREEN 4 analysis

C. ENERGY MODEL

After the completion of data and networking model we need to fill the sheet for energy model. Here out of the two methods available we can choose any one method. Method 2 is more accurate and so asks for more data regarding the horizontal and azimuth solar panel inclinations. These data vary from place to place. Then we need to give data regarding the PV technology involved.

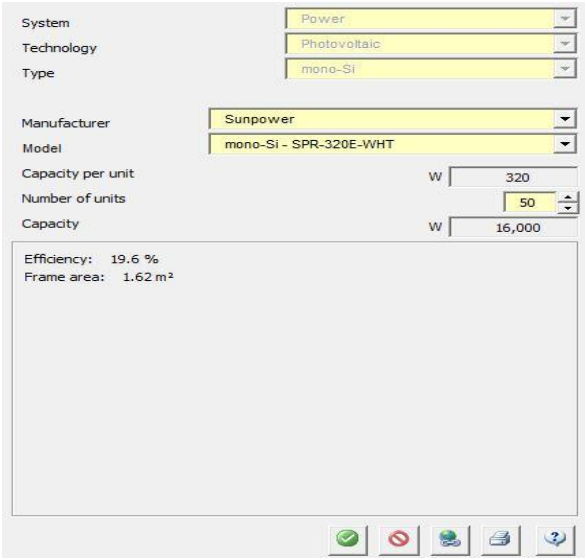
Sizing a photovoltaic system is an important task in the system's design. In the sizing process one has to take into account three basic factors:

i. The solar radiation of the site and generally the Metrological data

ii. The daily power consumption (Wh) and types of the electric loads, and

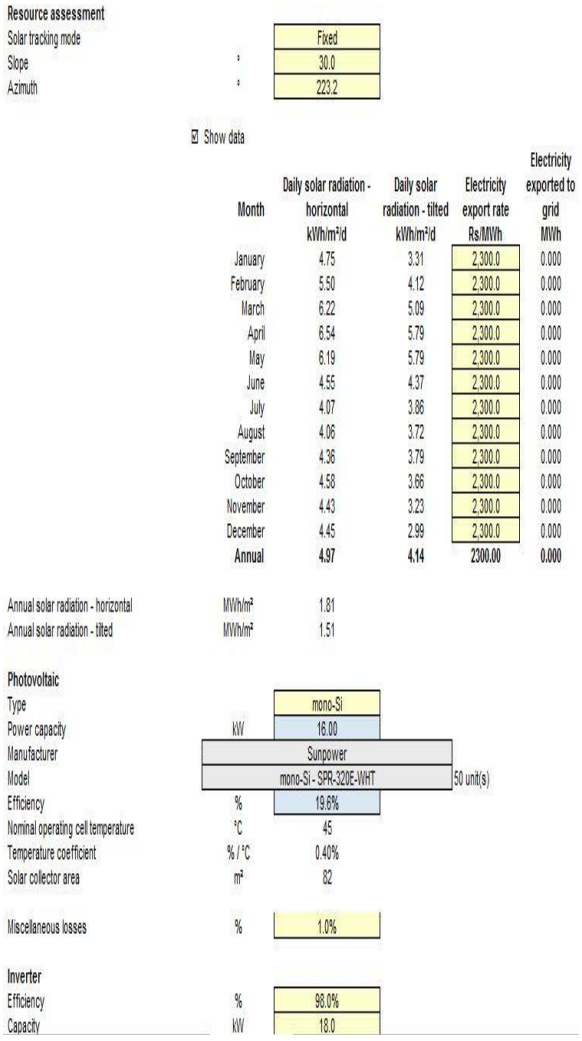
iii. The storage system to contribute to the system's energy independence for a certain period of time

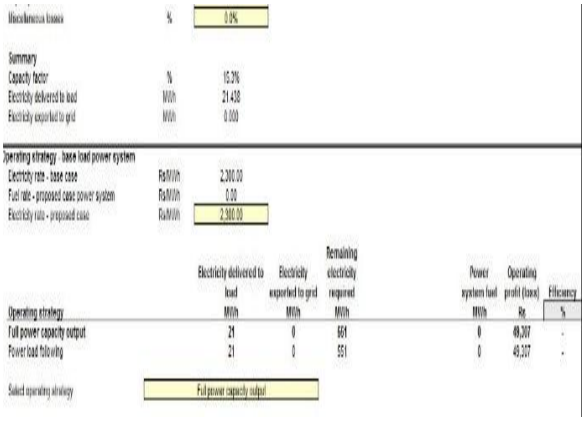
The PV generator is oversized it will have a big impact in the final cost and the price of the power produced and in the other hand, the PV-generator is undersized, problems might occur in meeting the power demand at any time .The amount of solar radiation at a site at any time, either it is expressed as solar intensity (W/m2) or solar radiation in MJ or Wh, is primarily required to provide answer to the amount of power produced by the PV generator. The amount of electrical energy produced by a PV-array depends primarily on the radiation at a given location and time[2]. The choice of the number of PV technology depends on user like in fig(3).



Fig(3): PV panel choice in RETSCREEN 4

After this the values of the other field as per convenience of the user is given that gives the following energy model in RETSCREEN 4 as is given in fig(4).

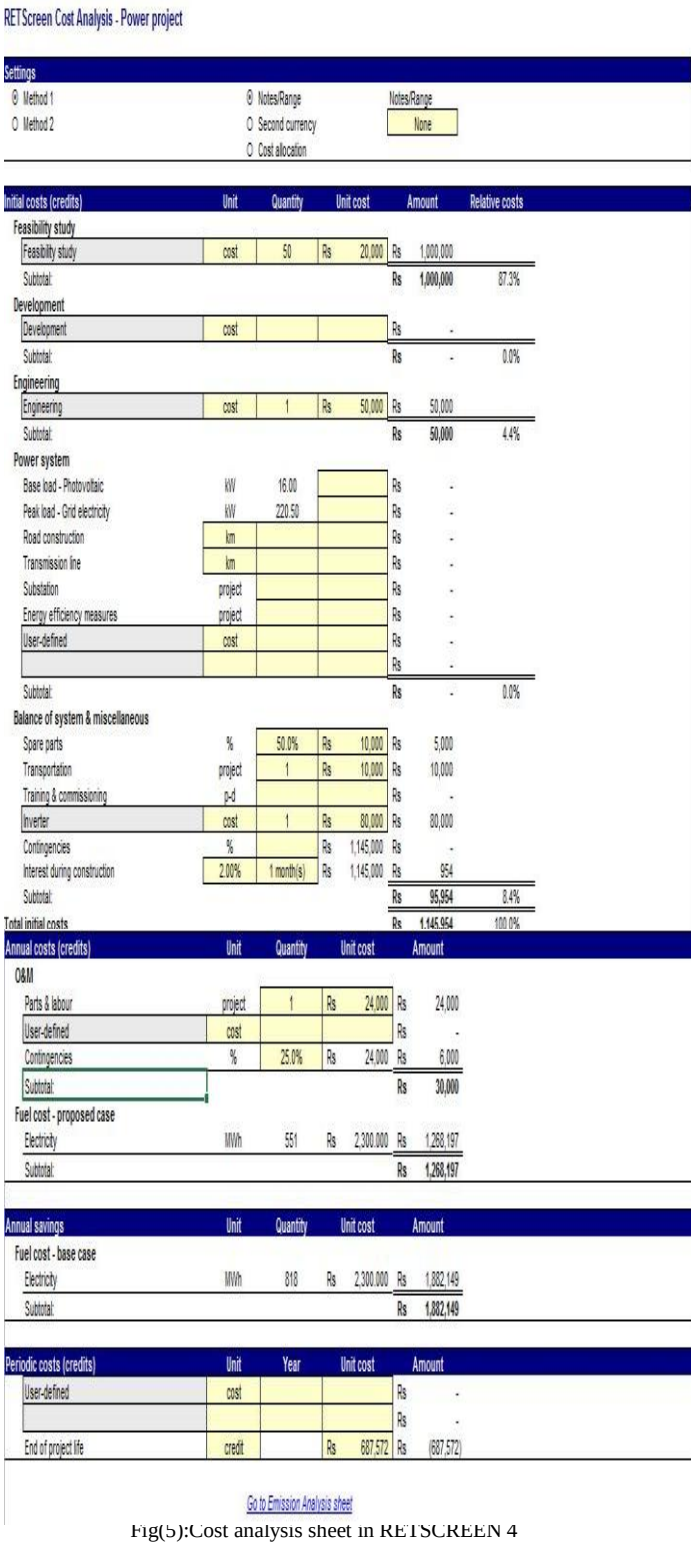




Fig(4): Energy model as in RETSCREEN 4

D.COST ANALYSIS

In this sheet we need to give all the details of the cost of various components required for the establishment of the combined system. In this worksheet, the user enters the initial, annual, and periodic costs for the proposed case system as well as credits for any base case costs that are avoided in the proposed case (alternatively, the user can enter the incremental costs directly). The user has the choice between performing a pre-feasibility or a feasibility study. For a "Pre-feasibility analysis," less detailed and less accurate information is typically required while for a "Feasibility analysis," more detailed and more accurate information is usually required. Since the calculations performed by the RETSCREEN Software for this step are straightforward and relatively simple (addition and multiplication), the information found in theonline manual for each input and output cell should be sufficient for a complete understanding of this worksheet [1]. This in return gives us details of annual savings and the annual andperiodic costs. It givesus option of entering all types of costs included in the making of the project. The details of the cost sheet analysis is given as in fig(5). The complete cost depends on the engineering costs, cost of the inverter and battery systems depending on their ranges and other labor and management costs.


RETScreen Cost Analysis - Power project

Settings

Method 1 / Method 2 — Notes/Range / Second currency / Cost allocation — Notes/Range: None

Initial costs (credits)	Unit	Quantity	Unit cost	Amount	Relative costs
Feasibility study					
Feasibility study	cost	50	Rs 20,000	Rs 1,000,000	
Subtotal:				Rs 1,000,000	87.3%
Development					
Development	cost			Rs -	
Subtotal:				Rs -	0.0%
Engineering					
Engineering	cost	1	Rs 50,000	Rs 50,000	
Subtotal:				Rs 50,000	4.4%
Power system					
Base load - Photovoltaic	kW	16.00		Rs -	
Peak load - Grid electricity	kW	220.50		Rs -	
Road construction	km			Rs -	
Transmission line	km			Rs -	
Substation	project			Rs -	
Energy efficiency measures	project			Rs -	
User-defined	cost			Rs -	
				Rs -	
Subtotal:				Rs -	0.0%
Balance of system & miscellaneous					
Spare parts	%	50.0%	Rs 10,000	Rs 5,000	
Transportation	project	1	Rs 10,000	Rs 10,000	
Training & commissioning	p-d			Rs -	
Inverter	cost	1	Rs 80,000	Rs 80,000	
Contingencies	%		Rs 1,145,000	Rs -	
Interest during construction	2.00%	1 month(s)	Rs 1,145,000	Rs 954	
Subtotal:				Rs 95,954	8.4%
Total initial costs				Rs 1,145,954	100.0%

Annual costs (credits)	Unit	Quantity	Unit cost	Amount
O&M				
Parts & labour	project	1	Rs 24,000	Rs 24,000
User-defined	cost			Rs -
Contingencies	%	25.0%	Rs 24,000	Rs 6,000
Subtotal:				Rs 30,000
Fuel cost - proposed case				
Electricity	MWh	551	Rs 2,300.000	Rs 1,268,197
Subtotal:				Rs 1,268,197

Annual savings	Unit	Quantity	Unit cost	Amount
Fuel cost - base case				
Electricity	MWh	818	Rs 2,300.000	Rs 1,882,149
Subtotal:				Rs 1,882,149

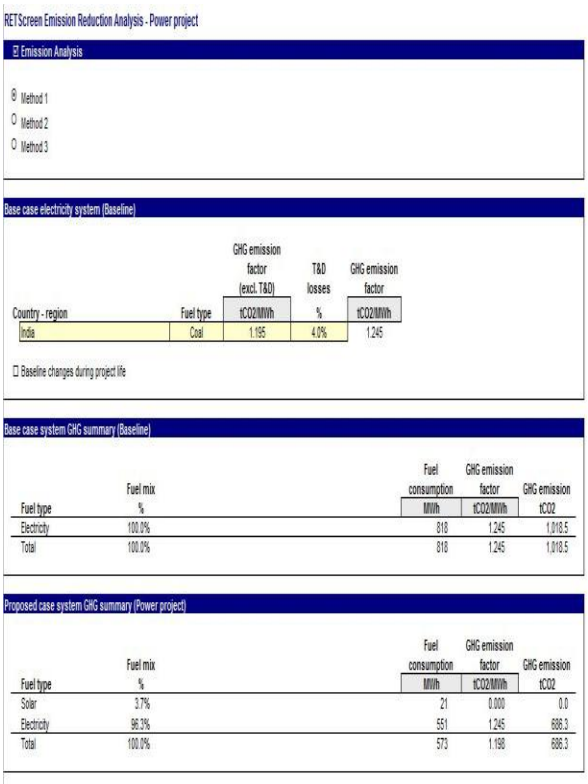
Periodic costs (credits)	Unit	Year	Unit cost	Amount
User-defined	cost			Rs -
				Rs -
End of project life	credit		Rs 687,572	Rs (687,572)

Go to Emission Analysis sheet

Fig(5):Cost analysis sheet in RETSCREEN 4

E.EMISSION ANALYSIS

This worksheet helps determine the annual reduction in the emission of greenhouse gases stemming from using the proposed technology in place of the base case technology. The user has the choice between performing a simplified, standard or custom analysis[1]. The analysis can be done by any of the three methods and according to it details are to be given. The transmission and distribution losses should be considered to be as low as possible as it will affect the total production and cost of the energy. The result is given in form of amount of the carbon dioxide emissions reduced which is shown in the form of either barrels of crude oil not consumed or other conservation equivalents as is given in the software. The data can vary as per the need. As for our analysis we are able to show that our data will reduce the amount of barrels of crude oil consumption by 772 gallons which is a promising data. The sheet for emission analysis is as given in fig(6).


RETScreen Emission Reduction Analysis - Power project

Emission Analysis

Method 1 / Method 2 / Method 3

Base case electricity system (Baseline)

Country - region	Fuel type	GHG emission factor (excl. T&D) tCO2/MWh	T&D losses %	GHG emission factor tCO2/MWh
India	Coal	1.195	4.0%	1.245

Baseline changes during project life

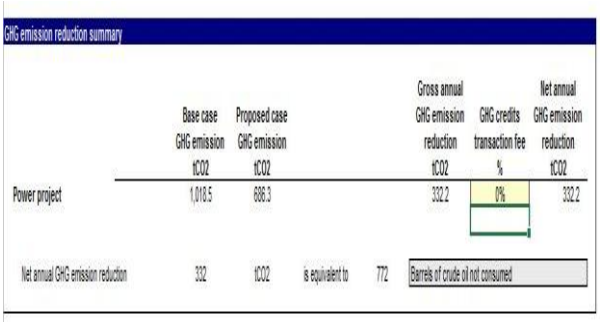
Base case system GHG summary (Baseline)

Fuel type	Fuel mix %	Fuel consumption MWh	GHG emission factor tCO2/MWh	GHG emission tCO2
Electricity	100.0%	818	1.245	1,018.5
Total	100.0%	818	1.245	1,018.5

Proposed case system GHG summary (Power project)

Fuel type	Fuel mix %	Fuel consumption MWh	GHG emission factor tCO2/MWh	GHG emission tCO2
Solar	3.7%	21	0.000	0.0
Electricity	96.3%	551	1.245	686.3
Total	100.0%	573	1.198	686.3

Fig (6):Emission analysis using RETSCREEN 4 (part 1)


GHG emission reduction summary

	Base case GHG emission tCO2	Proposed case GHG emission tCO2	Gross annual GHG emission reduction tCO2	GHG credits transaction fee %	Net annual GHG emission reduction tCO2
Power project	1,018.5	686.3	332.2	0%	332.2

Net annual GHG emission reduction 332 tCO2 is equivalent to 772 Barrels of crude oil not consumed

Fig(6):Emission analysis using RETSCREEN 4 (part 2)

III CONCLUSION

The results obtained by using RETSCREEN 4 software can be very realistic and gives very promising results for Hybrid systems. The main feature of this software is; it will integrate the local climatic conditions and hence planning of energy model is simpler [2]. The project can be further analyzed using the financial analysis and the risk analysis sheets. Thus we can plan for any combined technology using the RETSCREEN 4 software. It is a solution to any

engineer who wants to design a CET (Clean Energy Technology) connected grid technology. This project can be taken as a startup for converting an existing technology to CET in future without a sudden inflow of cash.

ACKNOWLEDGEMENT

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REFERENCES

[1] www.retscreen.net
[2] Design of Off-Grid Home with SOLAR-WIND-BIOMASS Energy; SmrutiRanjan Pradhan et al Int. Journal of Engineering Research and Applications; ISSN : 2248- 9622,Vol. 4, Issue1 (Version 2), January 2014, pp.76-81
[3] Biogas and biofuel production technologies Balancing Cost and performance in PV/Wind/Battery Hybrid Power System Ahmad Zahedi1, Akhtar Kalam2
[4] Energy and Comfort Management in Energy Efficient BuildingsUsing RETSCREEN Software-A Case Study Analysis; VijayaLalita. P et al Int. Journal of Engineering Research andApplications ;ISSN : 2248-9622, Vol. 3, Issue 6, Nov-Dec 2013,Pp.378-381