Performance calculation and probability Lifecycle price investigation of standalone photovoltaic power supply for a residential applications

R.Arulmurugan[1]
[1]Dept of EEE, Research Scholar, Anna University, Chennai, India
contact.[1]arul.lect@gmail.com,

Dr.N.Suthanthiravanitha[2]
[2]Prof and head, Dept of EEE,Knowledge Institute of Technology,Salem,India
contact. [2]varmans03@gmail.com

Abstract: *This paper offerings rigorous experimental outside performance of a 200 W_P standalone photovoltaic (PV) energy scheme in Salem, Tamil Nadu, India for clear weather data in month of 12th March 2014. The daily energy produced from the proposing standalone PV scheme was experimentally originating in the variety of 140–160 W h/day contingents on the usual sky circumstances. The number of times and everyday power produced corresponding to different weather state in March month were used to found yearly power creation from the proposing photovoltaic scheme. There are dissimilar load profiles with and without ground to air heat exchanger appropriate for varied periods like winter, rainy and summer. The hourly effectiveness of the standalone PV scheme components are found and offered in this paper. The lifespan price analysis for the proposing classic standalone photovoltaic scheme is conceded out to determine unit price of power. The effect of yearly degradation rate of photovoltaic scheme efficiency is also obtainable in this work. The extenuation of carbon dioxide release and production factor of the standalone PV scheme was also resolute and obtainable in this paper.*

Index terms:- *Solar Energy, Photovoltaic energy scheme, Lifecycle price estimation, performance evaluation*

1. INTRODUCTION

The PV structures with a suitable energy storing device have focused into one of the greatest favorable solutions for the crucial electrification difficult of several remote customers worldwide. In isolated areas, the grid extension lead is not feasible and costlier due to bodily barriers [1]. In detail, their application embraces a quite good-looking option from an economic point of observation, particularly for radiation in moderately huge solar possible areas [2], [3]. In recent years concerning the consumption of small photovoltaic producers to cover the power requirements of remote customers in the Middle East zones, or in some other zones offering alike solar possible characteristics [4]. The numerous applications of PV scheme for water pumping, BIPV and SAPV are used. This paper offerings a 200 W_P standalone PV scheme. There are two photovoltaic sub-modules which comprise of 36 cells photovoltaic modules manufactured by KCL Solar Pvt Ltd. The outside hourly performing parameters of the standalone PV scheme mechanisms are observed for different climate types in every month for Salem composite environment and obtainable in this paper [5]. The standalone photovoltaic scheme outside performance was observed for different weather situations in March month like hazy sky, clear sky, partially cloudy, foggy sky situations [6]. The numeral of days in March month consistent to different sky circumstances were got and utilized for finding monthly energy production of the proposing photovoltaic structure [7]. The effectiveness of standalone PV structure equipment’s was determined and obtainable in this work for classic vibrant sky conditions in March month. The particulars of investment price incurred for this standalone PV project is resolute and tabularized in this paper. The batteries wants to be exchanged at the interval of each six years was deliberated during lifespan price investigation with due deliberation towards annual conservation charge and salvage value of the standalone photovoltaic plant to regulate annualized lifespan charge. Based on the daily power creation (Watt hour per month) of the standalone PV structure consistent to different climate conditions in March month, the yearly power production (Watt hours per year) was resolute. The standalone PV scheme presentation was experimentally investigated for different climate conditions in March month at Salem composite weather. The numeral of days in every month consistent to different weather types is offered based on an annual hourly diffuse and global irradiation statistics of Salem position along with numeral of brightness hours got by Department of Indian Meteorological Center (IMD), Salem.

Fig.1.Experimetnal setup of PV array with direct load test scheme

The annualized lifespan charge of the standalone PV scheme and month energy creation were used to determine the unit price of power from the classic proposing scheme including of photovoltaic array having KCL Solar PV modules. The yearly degradation rate for photovoltaic scheme efficiency was determined 0.2% for the proposing setup. Therefore, the yearly power production of the standalone scheme reduces with lifetime linearly due to this degradation rate which is infrequently considered in the financial calculations in the current literature. Also, the result of yearly degradation rate on the unit charge of power from the standalone PV scheme is assessed and obtainable in this paper. The mitigation of carbon dioxide release from the proposing standalone PV scheme is obtainable in this paper. In adding, the paper assesses embodied energy of the standalone PV using, extenuation of carbon dioxide release and production factor and consistent possible to earn carbon credit in the emerging countries like India. There is necessity of load organization for the standalone photovoltaic schemes also investigated.

2. INDIVIDUAL PV STRUCTURE AT SALEM COMPOSITE CLIMATE

The classic 200 W_P individual PV energy scheme was installed and examined at the Salem location [11 39^0 N,: 78 12^0 E and an altitude of 270 m]. There are two photovoltaic sub-modules contain of 36 cells, these photovoltaic array are reserved at inclination angle is equal to latitude of zoon (Salem) as per yearly average supreme solar irradiation [8]. Based on weather situations of summer and winter sun system must be inclined at latitude -15° and latitude +15° correspondingly to gain supreme sun irradiation. The investment charge experienced in the proposing standalone photovoltaic scheme is specified in Table-I.

There are fewer important equipment’s for the standalone photovoltaic scheme such as two photovoltaic modules (KCL Solar make PV modules of 100W_P each), logic based smart charge regulator of 13A capacity, blocking diode to avoid battery current to drain through the PV panel cells at night, battery of capacity 12 V/80 Ah, DC power into AC power sine wave inverter of 200 VA size, balance of the scheme to support photovoltaic panel on steel bind structure made of L-shaped iron beams and ground, overload defense by miniature circuit breaker and electrical loads of the residential house (specified in Table-II). The photo setup of the standalone PV scheme is exposed in Fig.1.

The entire rated joined electrical load (Watts) of residential house is 240W (from Table 2). The regular energy reduction based on joined load and presumed numeral of hours of process is assessed as 600 Watt hours per day for summer periods as specified in Table-II. The numeral of hours of process of electrical loads in the proposing scheme differs contingent on the occupant’s necessities. Hence, the experimentations were approved out for the supposed load circumstances specified in Table-II. The classic electrical loads embraces fluorescent tubes, ceiling fans, TV and water pump as tabularized in

Table-II. The state of electrical load for the standalone photovoltaic scheme for is particular in Table-II. The electrical load must be accomplished as per the usual sky circumstances in the periods for effective operation of PV power. Likewise, it is needed to decrease night period electrical load to smallest so that it decreases the obligation of battery capacity which will decrease the standalone photovoltaic scheme price expressively [9], [10].

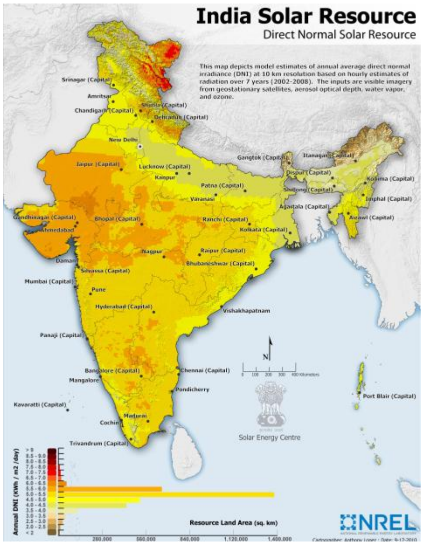

Fig.2. Numeral of sunlight hours on a best titled surface in India.

Table-I Investment price of Proposed Scheme

Name of the Equipment's	Numbers of Equip's	Cost of each equipment's in US $	Total Price in US $.
PV module 100 Wp	2	80	160
Charge regulator	1	32	32
80 Ah battery	1	72	72
DC to AC inverter	1	72	72
Frame and box	1	48	48
	Capital Investment in US $		384

The investigational setup of proposing 200 W_P SAPV power scheme is considered. The highest power values of two PV sub modules are 100W_P each for KCL Solar make photovoltaic module correspondingly. During daylight process, the electrical power produced is fed into the battery through charge regulator and the surplus energy is straight fed to the DC to AC converter (inverter) to supply AC energy to the electrical load. While during night period or little sunshine epochs, load is driven solely by battery power source. The blocking diode is utilized to avoid current drain from battery to the photovoltaic panel structure throughout night time.

3. EXPERIMENTAL CALCULATION

The numerical of sunlight hours in India changes from 4.5 hours to 6.5 hours per day from the illustrated Fig.2. The typical number of sunlight hours per daylight on the best tilted surface in an India is deliberated as 4.5 hours per day from the illustrate Fig.2. The best titled angle for photovoltaic panel for the specific zone is equal to latitude of that area [11]. The lowest number of sunlight hours per day for the Salem district can be obtained from the India map as shown the same figure [12]. The hourly measurements of different electrical limits observed during process of standalone PV scheme on classic clear days consistent to different weather situations in the months of March are specified in Tables-III. Basically, the conservation of the standalone photovoltaic power source scheme must be done on significance basis to evade poor executions and foremost failures. The photovoltaic array requisite frequent dust cleaning from their upper surface. Similarly, battery points necessity to be enclosed with petroleum jelly to evade their corroding. There is also obligation of preserving sufficient amount of distilled water inside the battery in every month. The investigational parameters are observed physically on hourly basis from 9 am to 6 pm on classic days consistent to different weather types in March month. The hourly standards of G and T at Salem locations shown in Fig.6 and Fig.5 were observed using portable digital clamp meter, have least count 0.01 with ±1% correctness. The PV module "T" for top surfaces were also observed with the help of digital ultraviolet laser thermometer, has least count 0.1 with correctness ±1%. The air "T" is observed using standardized mercury in glass thermometer with variety 0 to 100 ℃ and least count one ℃ with correctness ±10% of analysis (or ±0.1 °C). The outdoor diffuse and global solar irradiation on photovoltaic panel surface were observed using portable solari meter of smallest count 10 W/m^2 and correctness of ±2% of observed solar irradiation analysis.

Table-II Daily electrical demand conditions of March for standalone PV scheme

Name of appliance	Watt	Number	Total watt	Working hours (Hours/day)	Daily electrical load
Ceiling Fan	60	1	60	4	240
Tube light	40	2	80	2	160
CEL lamp	25	4	100	2	200
Total			240 W		600Wh/day

4. PROCEDURE TO ASSESS PERFORMANCE

The practice adopted for performance assessment of standalone photovoltaic scheme, its lifespan price analysis and extenuation of carbon dioxide releases are explained in the following sections:

4.1. Practice for performance assessment

The efficiency of dual photovoltaic panels, DC to DC and DC to AC converter and overall standalone photovoltaic scheme are resolute using subsequent formulae.

4.1.1 Power conversion of photovoltaic module

$$\text{Power in module} = [FF \times V_{oc} \times I_{sc}] \quad (1)$$

4.1.2 Conversion efficiency of single PV module

$$\eta_{module} = \left[\frac{FF \times V_{oc} \times I_{sc}}{G_T \times A}\right] \times 100 \quad (2)$$

4.1.3 Efficiency of DC to DC converter

$$\eta_{converter} = \left[\frac{\text{output power}}{\text{Input power}}\right] \times 100 \quad (3)$$

4.1.4 Complete transformation efficiency of the standalone photovoltaic scheme

$$\eta_{system} = [\eta_{module} \times \eta_{battery} \times \eta_{converter}] \times 100 \quad (4)$$

4.1.5. Numeral of days of autonomy of battery storage

The numeral of times, the specified electrical load can be functioned successfully with single battery backup control is called as numeral of autonomy times of battery storage for the specified load. The sizing of storage battery load standby is valuable for the standalone photovoltaic scheme during off-sunlight times due to cloud shelter and rain. Numeral of autonomy times is designed as follows for dissimilar functioning load situations. The working voltage of battery is observed as 12 V and battery storage capacity is 80 Ah.

$$\text{A battery storage capacity } (B_T) = 12\ (V) \times 80\ (Ah) = 960\ Wh \quad (5)$$

The everyday depth of release for battery must be 50 % for lengthier life. Though, the supreme permissible daily deepness of discharge was deliberated to be 70 % to evade battery disappointment due to everyday deep cycle depth of discharge in opposing weather situations. Therefore, the valuable battery storing capability (B) for design of autonomy days is measured as 672 kW hours by seeing 70 % complexity of discharge and 95 % battery release efficiency. Dissimilar regular electrical loads functioned by the standalone photovoltaic load is 600 watt hours per day [13].

$$\text{Number of days of autonomy} = \left(\frac{B\ (Wh)}{L(Wh)}\right) \quad (6)$$

Autonomy days of battery bank for 600Wh per day load

$$= \left(\frac{672}{600}\right) = 1.12 \text{ days}$$

Autonomy days of battery bank for 700Wh per day load

$$= \left(\frac{672}{700}\right) = 0.96 \cong 1$$

The autonomy existences of battery storage proposes that during March month (summer period) electrical demand of 600 Watt hour per day can be functioned for one successive day while in rise load request of 700watt hour per day can be functioned for same one successive day [14]. Therefore, the specified dissimilar load profiles for altered seasons can be functioned by the battery without power failure unless the opposing situation perseveres for numerous days in that month. The concert evaluation outcomes of the standalone photovoltaic scheme are specified in Table-III for the months of March using Eqs. (1)–(4).

Table-III Hourly executions of the standalone PV scheme on weather condition of March in Salem

Time in hours	Temp in ℃	Irradiance (W/m^2)	100 W_P PV module		200 W_P PV array		PV array generated Power in W	PV array efficiency in %
			V_{OC} (V)	I_{SC} (A)	V_{OC} (V)	I_{SC} (A)		
9 AM	27.1	396.583	18.8	2.611	18.8	5.223	69.72	34.86
10 AM	29.6	618.716	19.64	4.099	19.64	8.199	114.3	57.15
11 AM	31.2	819.915	20.39	5.454	20.39	10.91	157.9	78.95
12 PM	33	946.682	20.79	6.325	20.79	12.65	186.8	93.4
1 PM	33.9	975.757	20.85	6.534	20.85	13.07	193.5	96.75
2 PM	34.6	931.563	20.63	6.249	20.63	12.5	183.1	91.55
3 PM	35.3	803.633	20.08	5.4	20.08	10.8	154	77
4 PM	34.8	608.249	19.3	4.082	19.3	8.163	111.9	55.95
5 PM	33.8	382.627	18.37	2.561	18.37	5.123	66.83	33.415
6 PM	32.5	72.106	17.01	0.4811	17.01	0.9623	11.62	5.81

5. LIFESPANCE PRICE ANALYSIS FOR STANDALONE PV SCHEME

The lifespan price analysis was approved out for the proposing standalone photovoltaic energy scheme supposing useful life of 360 months for photovoltaic panel system and 60 months life for battery. The lifespan price analysis was approved out to approximation the price per unit of electricity produced using photovoltaic scheme. The size and price list of components are shown in Table-I. Let n is the life of the photovoltaic scheme (360 months) and 'I' is the interest rate. The aged batteries are substituted with new batteries with the refund of 7% on total price of battery in greatest of the countries like India. Supposing the battery replacement price remains constant throughout the life of photovoltaic scheme (i.e. 360 months) then the replacement price for the battery (CB) can be appraised using Eq. (7) as follows:

$$\text{Replacement cost of battery bank } (C_B) = 0.93 \times \text{Cost of battery bank} \quad (7)$$

$$\text{Replacement cost of battery bank } (C_B) = 0.93 \times 80\$ = 74.4\$$$

The current price of battery for forthcoming investments at each five years interval can be find as follows:

$$\text{Present battery bank cost } (P_B) = \left[\frac{C_B}{(1+i)^5}\right] + \left[\frac{C_B}{(1+i)^{10}}\right] + \left[\frac{C_B}{(1+i)^{15}}\right] + \left[\frac{C_B}{(1+i)^{20}}\right] + \left[\frac{C_B}{(1+i)^{25}}\right] \quad (8)$$

$$P_B = 74.4\ \$$$

The salvage value for building integrated PV scheme was considered to be zero in this lifespan price analysis. While the salvage value (S) of standalone scheme at the end of 360 months life was supposed equal to the current price of balance of scheme since the devaluation of balance of scheme was deliberated equivalent to the rate of growth in the value of mechanical steel per kg.

$$\text{Salvage value of Standalone PV after 30 years}(S) = \text{Present cost of balance of system} \quad (9)$$

Hence, current salvage value(P_S) of photovoltaic scheme can be resolute using Eq.(10) as follows:

$$\text{Present salvage value}(Ps) = \left[\frac{S}{(1+i)^{30}}\right] \quad (10)$$

$$Ps = 254/(1.04)^{30} = 78.31\$$$

Net current price of photovoltaic scheme (P_{Net}) is determined as addition of investment price (Pi), all other charge components converted into current charge and subtracted by present salvage value. The net current charge of photovoltaic scheme was resolute using Eq. (11) as follows:

$$P_{Net} = P_i + P_B + P_s \quad (11)$$

$$P_{Net} = 1270.11\$ - 78.31 + 214.58 = 1406.38\$$$

$$P_{Net} = 1778.15\$ - 78.31 + 214.58 = 1914.42\$$$

The constant annualized price of photovoltaic scheme system (C_A) over the 360 months lifetime is conveyed scientifically using Eq. (12) as follows:

$$C_A = P_{Net} * \left[\frac{(i*(1+i)^{30})}{((1+i)^{30}-1)}\right] \quad (12)$$

$$C_A = 1406.38 \times 0.05783 = 81.33$$

If M is the yearly maintenance charge as shown in Table-III then its value is generally measured as 10% of uniform annualized price (C_A). Therefore, the annualized lifespan price (ALCC) of photovoltaic scheme can be resolute from Eq. (13) as follows:

$$\text{Annualized life cycle}\frac{\text{cost(ALCC in US \$)}}{\text{year}} = 1.1 * C_A \quad (13)$$

U=1.1×2114.6=2326

The total yearly electrical energy units spent (E) by the stated electrical load is resolute using Eq. (14) as follows

E(Wh/year)=Daily electrical load(Wh/day)*Number of days of operation/year (14)

E=600*0.365=219

The price per unit of electricity produced (U) by photovoltaic scheme is resolute using Eq. (15) as follows:

$$U\left(\frac{US\$}{Wh}\right) = [(1.1 * C_A)/E] \quad (15)$$

U=(1.1×81.33)/219=0.407

12 % for BIPV system U=(0.8425)

The lifespan price analysis was approved out for dissimilar interest rate to approximation the price of electricity created by building integrated PV and standalone PV schemes with principal investment of US$ 9749 per W_P and US$ 6963 per W_P correspondingly as revealed in Fig.3. The appropriate yearly interest rates deliberated are in the choice of 4–16% and the causes for this are as follows: 4% is the funded interest rate usually offered by government parts in India to endorse the use of nonconventional energy appliance; 7–8 % is the interest rate generally offered by government banks; 10–12 % is the interest rate accessible by self-finance banking segments; 12–16% is the interest rate for some other private foundation.

6. EXTENUATION OF CARBON DIOXIDE EMISSIONS FROM PV SCHEME

The carbon credit potential of PV system was determined on the basis of total amount of CO_2 emissions mitigation from the system in its life time.

6.1. Mitigation of CO_2 emissions from PV system

Energy conversion through photovoltaic (PV) system is one of the more reliable and environmental friendly renewable energy technologies which have the potential to contribute significantly to the development of sustainable energy systems for power generation. It also plays an important role to mitigate CO_2 emissions. The numerical computation was carried out to estimate the amount of CO_2 emissions mitigated due to the existing SAPV power system. As discussed in the literature survey that average intensity of CO_2 emission from coal thermal power plant in India is 1.57 kg/kWh [15], [16]. The total mitigation of CO_2 emissions from the existing SAPV system for 30 years life can be calculated using Eq. (16) as follows:

$$CO_2 \text{ emission mitigated (kg/life)} = 1.57(\text{kg/Wh}) * E(\text{Wh/year}) * n(\text{year}) \quad (16)$$

In case of thermal power plants, out of the total amount of thermal input, 30–40 % output is in the form of electricity generated and rest about 60–70% part of the total input energy is dissipated into the environment in the form of heat energy which also accounts for global climate change. In addition to this large amount of heat dissipation, a substantial amount of CO_2 along with particulate matter is released into the environment every year. In contrast, a PV power system does not dissipate such enormous amount of heat energy into the surrounding environment and saves huge amount of CO_2 emissions. Hence, PV system is an environment friendly option for power generation and should be preferred where there is no electricity or extension of grid power is costlier option [17].

6.2. Carbon credit potential of PV system

The amount of carbon credit earned by PV system can be calculated from the following Eq. (17) as follows:

$$\text{Carbon credit earned} = \$33/\text{ton} * Co_2 \text{emission mitigated by PV system(tons/life)} \quad (17)$$

The factor considered in Eq. (17) is 33 US$/ton of CO2 mitigation represents the monetary value of one carbon credit for mitigation of 1 ton of CO_2 release [18].

6.3. Effect of carbon credit potential

The energy consumed by the load per year was determined as 3285 kWh/year and corresponding CO_2 emission mitigated was estimated as 5.151 tons/year from Eq. (16) for n equals to 1 year. The total CO_2 emission mitigated by existing PV system in 30 years life time was estimated using Eq. (16) as 154.53 tons. The carbon credit from the existing PV system was obtained using Eqs. (16) and (17) as US$ 5099.49. The carbon credit affects the unit cost of electricity produced from non-polluting PV power system. The Eq. (11) is modified to consider the effect of carbon credit which can be the future policy issue for promotion of renewable energy technologies for sustainable environment as follows:

$$P_{Net} = P_i + P_B - P_s - \text{Carbon credit for PV system} \quad (18)$$

Based on this modified Eq. (28), one can determine the unit cost of electricity consumed by the electrical load of the PV system using Eqs. (12)–(15). The unit cost of electricity without and with effect of carbon credit is shown graphically for both BIPV and SAPV systems in Fig.3.

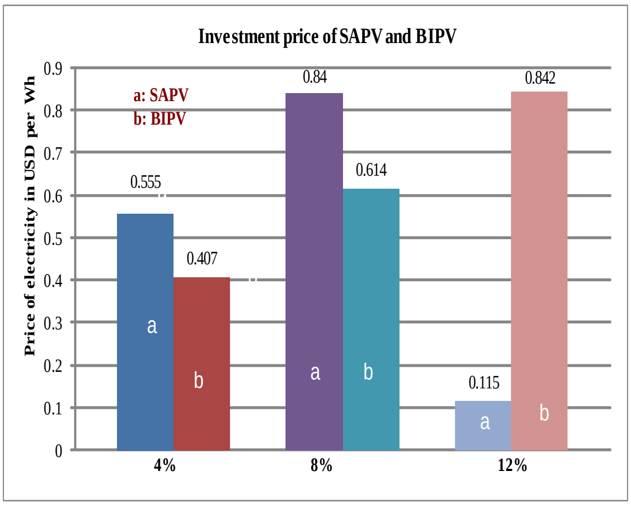

Fig.3.Unit cost of electricity for standalone PV system without carbon credit

7. SIMULATION AND EXPERIMENTAL RESULTS AND DISCUSSION

7.1 Simulation characteristics of 200W$_P$ PV array

The grouped modules of the panel simulation model are validated, and the results found from the complete model of the plant under dynamic conditions are discussed. The effects of radiation and temperature on the output of the grouped solar array were simulated. The voltage vs. current (V-I) and voltage vs. power (V-P) characteristics of the grouped solar array for radiation levels of 500, 750, 900 and 1000 W/m^2 and a constant cell temperature of 25 °C are shown in Fig.4(a). It can be seen the changes of radiation mainly affect the output current. Fig.4 (b) shows the V-I and V-P characteristics when the temperature was adjusted. The module was adjusted to operate with a radiation level of 1000 W/m^2. Operating temperatures were varied at 0 °C, 25 °C, 50 °C, and 75 °C. It can be witnessed that the operating temperature mainly affects the output voltage of photovoltaic module. In common, it was observed a decrease of voltage for high radiation because of the resulting higher temperature of the module. The effect of lowering the level of radiation mainly disturbs the current module and has only a slight influence on the voltage of the module. The effect is greater on the current of the module because it reductions linearly with the decrease of radiation while the voltage of the module only reductions logarithmically with decreasing radiation [19].

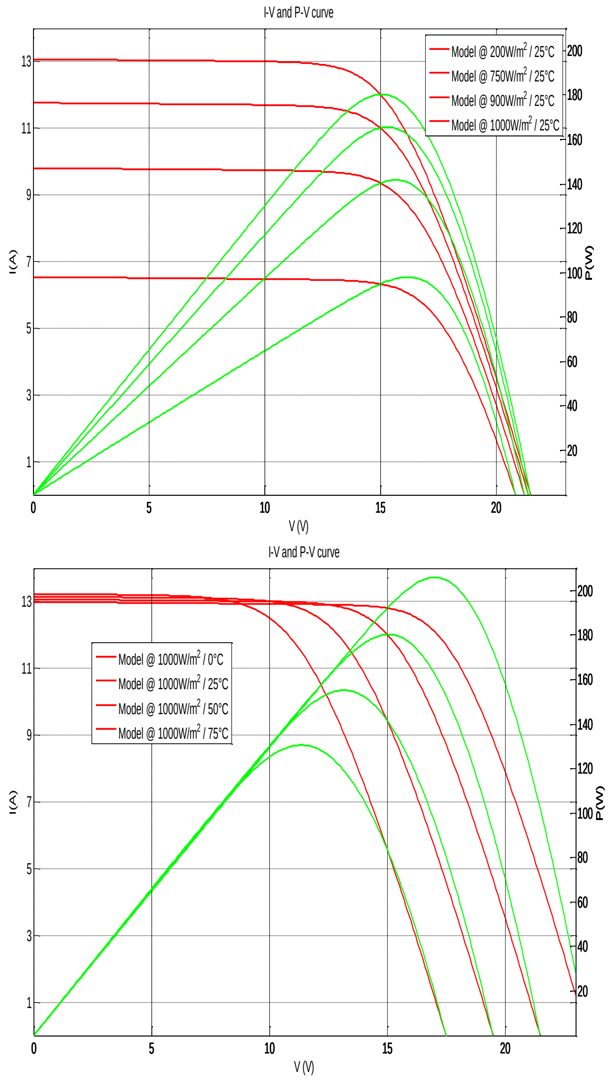

Fig.4.Curves I–V and P–V of the PV Array for (a) constant T and different G. (b) constant G and different T

7.2 Experimental analysis and results

The proposed experimental setup is revealed in Fig.1 and data were tested every hour during whole day of experimentation. Table-IV shows experimental data collected on a typical clear day of 12th March 2014 at Salem. The typical clear day hourly measurements of solar irradiance on panel, ambient air temperature, PV operating temperature, short circuit current, open circuit voltage for PV array were being observed during investigation with the help used for the design of numerous performance specifies of 200 Wp photovoltaic array.

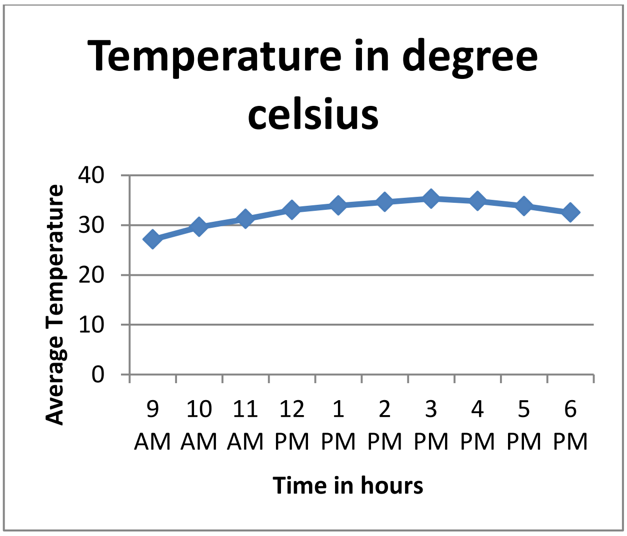

Fig.5. Hourly difference of solar ambient temperature on 12th March 2014

These investigational measurements of photovoltaic scheme parameters were designed graphically as revealed in Figs.5-9. Fig.5 displays the hourly changes of ambient T and working T for whole photovoltaic panel for a classic day of research at Salem. The PV panel contains four modules are located side by side. Supreme photovoltaic working T of photovoltaic panel was found 33°C at 12.00 afternoons when ambient T was observed 33.9 °C and solar irradiation was 975.75 W/m^2. The photovoltaic panel working T depends on ambient T and solar G on photovoltaic panel. Table-IV represents the value of observed equivalent hours of full sunlight (h_{EFS}) and photovoltaic working T (WT) of PV panel for a typical day. Great value of PV working temperature causes decrease in electrical efficiency of photovoltaic panel. Average hourly difference of solar radiation (G_{avg}) on specified photovoltaic panel located at Salem, Omalur for classic day is exposed in Fig.6. Now solar radiation on complete photovoltaic array at some specific time has been intended by taking normal of measured radiation on array and sub module at that similar period. Addition of area under the graph (Fig.6) stretches complete solar energy collected by the unit zone on similar day and this was utilized to analyze equivalent periods of full sunlight (h_{EFS}).

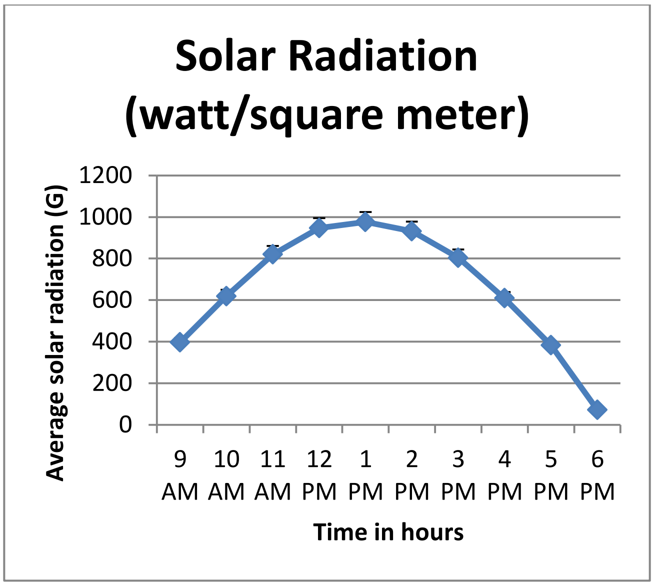

Fig.6. Hourly difference of solar radiation on 12th March 2014

Table-IV Observed values of standalone PV panel for a typical day in 12th March 2014

Size of PV panel	Equivalent hours of full sunlight in hours	PV working temperature (WT) in °C
PV array 200Wp	4.5	32.58

Fig.7 and Fig.8 demonstrations the hourly variant of open circuit voltage (V_{oc}) and short circuit current (I_{sc}) for PV array of the 200 Wp. The difference in the I_{sc} is credited to the difference in the solar G because short circuit current is directly proportional to inward light strength. The comparatively lesser variation in open circuit voltage during the day is mostly due to T variations and mist cover. By nonstop observing of short circuit current and open circuit voltage of an array, it is conceivable to directly notice any degradation in array and module performance and miscarriage can be readily sensed [8].

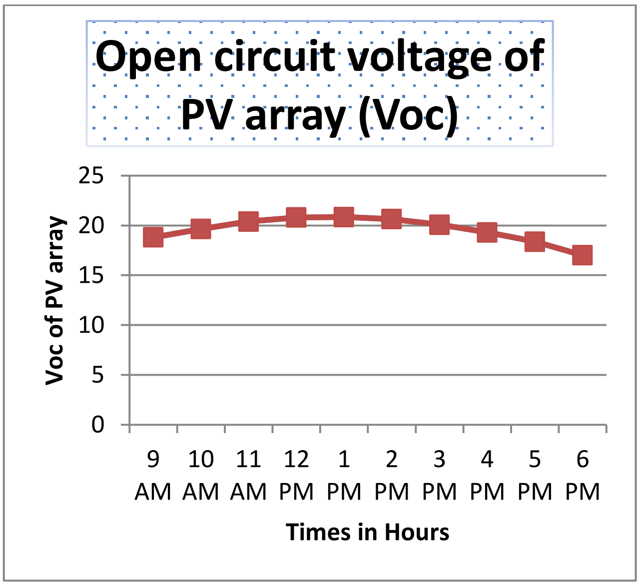

Fig.7. Hourly difference of open circuit voltage for PV array on 12th March 2014

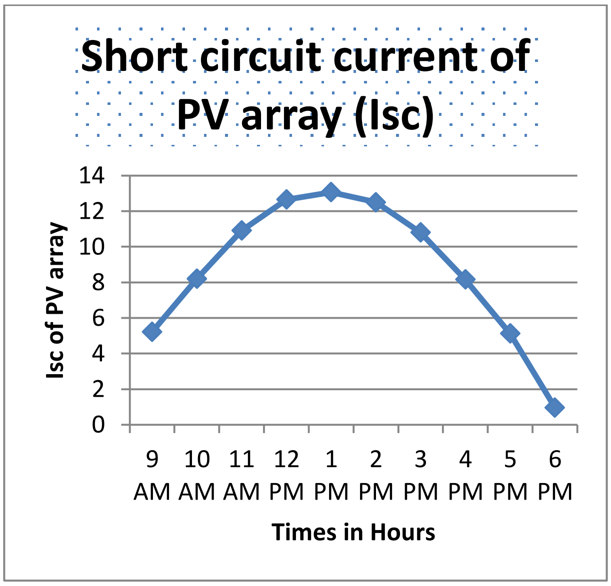

Fig.8. Hourly difference of short circuit current for PV array on 12th March 2014

Fig.9 displays the hourly variation of electrical power yield for PV array (200 Wp) and single PV module (100 Wp). Complete photovoltaic array output is the sum of the four sub modules production. From the test for a typical day supreme electrical power production of photovoltaic array (200 Wp) has been observed 193.5 W at 1:00 PM afternoon and electrical power yield of single PV module of 100 Wp has been gotten 96.75 W at 1:00 PM afternoon correspondingly. Total electrical energy production of array and single PV module were experimentally designed 1249.67 Wh/day and 624.82 Wh/day correspondingly. Electrical energy production of complete standalone photovoltaic array and module of 200 Wp and 100 Wp was calculated by using Eq.(1). These practically designed performance values previously including the consequence of photovoltaic working T during the day of research as hourly observed parameters of open circuit voltage and short circuit current are T dependent. For popularization in experimental controls fill factor (FF) has been expected of value 0.71 as gotten from rated values.

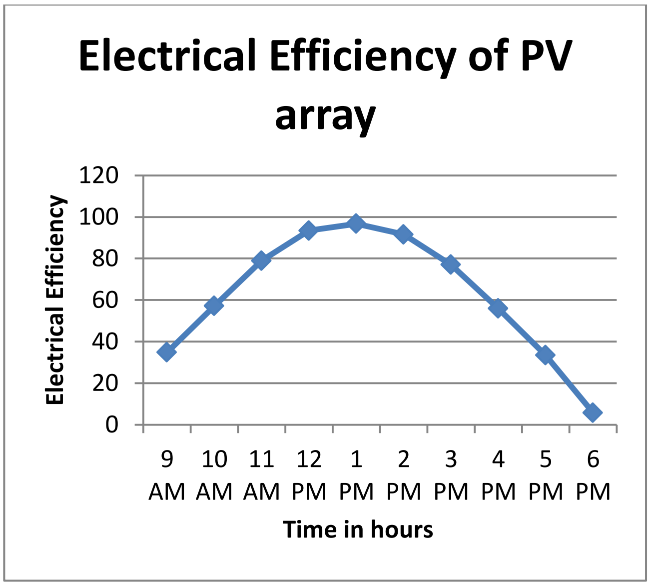

Fig.9. Hourly difference of electrical power production for PV array on 12th March 2014

8. CONCLUSION

This paper offerings basic approach for performance assessment, lifespan price analysis and extenuation of carbon release of 200 W_P standalone photovoltaic schemes for all over the domain, constructed on number of sunlight periods on the surface titled at angle equivalent to latitude of the site. The lifespan price examination was used to define unit cost of power (US$ per Wh) and investment price of photovoltaic scheme (US$ per Wp). The size of offering 200 W_P photovoltaic schemes was creating appropriate for the process of assumed load situations. Likewise, the lifespans price examination can be utilized for any photovoltaic scheme for approximation of unit cost of power with appropriate account to the marketplace value of photovoltaic scheme components. The consequence of carbon praise to decrease unit cost of power from standalone photovoltaic schemes was assessed and deliberated as one of the strategy matter for elevation of photovoltaic power schemes in distant zones. Over the past ten years, there is upsurge in the attention on nonconventional energy for the erected atmosphere. The emphasis is mostly on exploiting solar energy with talented developments in the addition of PV approach in buildings.

In conclusion, photovoltaic power schemes play a main role which has latent to change sunlight energy straight to electrical power at little working and maintenance prices and without sound and atmospheric pollution. Therefore, this energy scheme is ecological and supportable resolution for the close future of the every place.

ACKNOWLEDGMENT

The authors are thankful to the Government College of Engineering, Salem for providing PV panel to carry out research work sponsored by IIT Bombay.

References

[1] Arvind Chel, G.N.Tiwari, "A case study of a typical 2.32kWp stand-alone photovoltaic (SAPV) in composite climate of New Delhi (India)", Applied Energy 88, pp.1415-1426, 2011

[2] Arvind Chel, G.N.Tiwari, Avinash Chandra, "Simplified method of sizing and life cycle cost assessment of building integrated photovoltaic system",Energy and Building 41, pp.1172-1180,2009

[3] Rakhi Sharma, G.N.Tiwari, "Technical performance evaluation of stand-alone photovoltaic array for outdoor field conditions of New Delhi", Applied Energy, 92, pp. 644-652, 2012

[4] C. Armenta-Deu, "Prediction of battery behaviour in SAPV applications", Renewable Energy 28, pp.1671–1684, 2003

[5] Yoo Jae-Hyun, Gho Jeok-Seok, Choe Gyu-Ha, "Analysis and control of PWM converter with V–I output characteristics of solar cell",In: Proceeding of the IEEE international symposium on industrial electronics, vol. 2, pp. 1049– 54, 2001

[6] Heydenreich W, Muller B, Reise C, "Describing the world with three parameters: a new approach to PV module power modelling", In: Proceeding of the 23rd European photovoltaic solar energy conference, Valencia, Spain, pp. 2786–9, 2008.

[7] Luque A, Hegedus S., "Handbook of photovoltaic science and engineering", Berlin: John Wiley & Sons Ltd., pp. 87–111, 2002

[8] Deshmukh MK, Deshmukh SS,"Modelling of hybrid renewable energy systems", Renew Sustain Energy Rev 12, pp.235–49, 2008

[9] Chang Tian Pau., "Output energy of a photovoltaic module mounted on a single axis tracking system", Applied Energy 86, pp.2071–8, 2009

[10] Iskander Charles, Scerri Edward., "Performance and cost evaluation of a standalone photovoltaic system in Malta", Renew Energy 8, pp.437–40, 1996

[11] Kannan R, Leong KC, Osman R, Ho HK, Tso CP, "Life cycle assessment study of solar PV systems: an example of a 2.7 kWp distributed solar PV system in Singapore", Sol Energy 80, pp.555–63, 2006

[12] Mayar D, Heidenreich M., "Performance analysis of standalone PV systems from a rational use of energy point of view", French agency for environment and energy management, 2003.

[13] J.D. Mondol, Y.G. Yohanis, B. Norton, "Optimal sizing of array and inverter for grid connected photovoltaic systems", Solar Energy 80, pp.1517–1539, 2006

[14] García-Valverde R, Miguel C, Martínez-Béjar R, Urbina A, "Life cycle assessment study of a 4.2 kWp stand-alone photovoltaic system", Sol Energy 83, pp.1434–45, 2009

[15] M.M.H. Bhuiyan, M.A. Asgar, "Sizing of a stand-alone photovoltaic power system at Dhaka", Renewable Energy 28, pp.929–938, 2003

[16] Arulmurugan, R.,Suthanthira Vanitha, N., "Intelligent Fuzzy MPPT Controller using Analysis of DC to DC Novel Buck Converter for Photovoltaic Energy System Applications", In: Proceedings of the 2013 International Conference on Pattern Recognition, Informatics and Mobile Engineering, February 21-22, pp. 225-231

[17] Bhuiyan MMH, Ali Asgar M, Mazumdar RK, Hussain M, "Economic evaluation of standalone

residential photovoltaic power system in Bangladesh" ,Renew Energy 15, pp.403–10, 2000
[18] Chel, G.N. Tiwari, A. Chandra, "Sizing and cost estimation methodology for stand-alone residential PV power system", International Journal of Agile Systems and Management 4 (1/2), pp.21–40, 2009
[19] R.Arulmurugan and N.Suthanthiravanitha, "Improved Fractional Order VSS Inc-Cond MPPT Algorithm for Photovoltaic Scheme", International Journal of Photoenergy, vol. 2014, Article ID 128327, 10 pages, 2014. doi:10.1155/2014/128327.