Comparative Analysis In Overall Energy Generation With Anti Reflection Coating Using MWCNT, SiO2, TiO2 On PV System And Priority Based Energy Management System

1st K. Rakesh Tej Kumar   2nd M.Ramakrishna   3rd G. Durga Sukumar   4th K.Neelima

1st Department of Mechanical Engineering, Vignan's Foundation for Science Technology and Research, Guntur, Andhra Pradesh, India,

2nd Department of Mechanical Engineering, Vignan's Foundation for Science Technology and Research Guntur, Andhra Pradesh, India,

3rd Vignan Institute of Technology and Science, Hyderabad, Telangana, India,

4th Department of Electrical Engineering, VBIT, Ghatkesar, Hyderabad, India,

Abstract : In the present conditions there is a lot demand for the renewable energy and its Effective utilization. There are different techniques that are been implemented for better utilization of solar energy and efficient conversion of light energy to electrical energy and even still lot of research is going on in this area. The efficient results in terms of performance improvement and energy management can be obtained by handling the improvisation techniques for the light conversion rate and also implementing the intelligent priority based energy management controllers. With the combination of these both approaches in a Solar PV System on the panel side aswell as energy controlling side the overall performance is increased enormously. By the Anti reflection nano composite coating (ARNCC) on PV panel there is a power performance improvement of 36.45% and with the Priority based energy management controller there is a huge savings in energy by quick response time in terms of load shedding of unwanted power based on the schedule of the utilization of loads.

IndexTerms - ARNCC; MWCNT; Nano Composites; Energy Management Controller, Priority based Controller, TCP/IP.

I. INTRODUCTION

The sustainable energy sources are ideal with low ecological effect than the prevalent vitality source. The world depends on a number of wellsprings of vitality for strength age and daylight based totally usage. Presently a day the Non Renewable vitality is decreasing and giving a massive extension for the use of the sustainable strength supply betterly by means of receiving the innovation to it. The sustainable energy sources, for example, daylight primarily based and wind are handy brilliant in nature alternatively viably its more expensive when introducing and low in upkeep. Power age is a essential supply of air illness and the largest wellspring of a international temperature alteration emanation. The hobby for vitality is expanding step through step due to the fact of full-size industrialization all round the globe. Be that as it may, standard vitality sources are neglecting to meet with this overwhelming necessity in the strength division. So there is a squeezing want to quicken the improvement of cutting part easy vitality advances. The alternative is inexhaustible assets like solar based, wind, hydro, biomass, and so on[1].

The world will require drastically improved vitality provide in the following 25 years, specially neatly created power. Power request is expanding universal vitality utilize and is likely going to upward push 76% to 2030. The great enlarge in leveraging Micro grids has commenced successfully considering the fact that begin of 1998 [2]. The growing vogue of the use of consumer-accessible inexperienced strength technology, like solar energy, wind energy energy, geothermal energy etc.,[3] helps in minimizing the use of grid, power device or power grid and reducing the burden on the authorities via giving lower back the saved electricity to electricity board or central government.

The microgrid electricity machine or hybrid energy system are some examples that are related to the strength grid and renewable energies. A micro grid is a small-scale strength grid that can operate independently or in conjunction with the area's fundamental electrical grid. The Micro grid comprises a plurality of loads, a plurality of power sources, and a point of common coupling for selectively connecting the micro grid to the major grid, whereby the factor of frequent coupling, the power sources and the loads are interconnected[4].

An vital problem of these power structures is energy administration when there is want to connect or disconnect loads from the total energy demand when in islanded condition. The reason is to protect the generating sources when there is inadequate generation potential to meet the demand. This happens when the gadget is isolated from the grid, and load demand is a whole lot higher than the maximum power generated by using renewable power sources. Many of the applied sciences for Power management of load shading has been developed from time to time and can be understood from the prior work. But none of the prior artwork discloses and instruct an power administration gadget and approach that employs TCP/IP protocols for quick switching between off-grid and on-grid primarily based on precedence and shedding load at the stage of utilities based totally on prior defined precedence stage of utilities.

II. MULTIPLE APPROACHES TO IMPROVE PERFORMANCE

There are multiple approaches in improving the performance of the Solar PV System. Primarily to achieve this the focus should be kept not only on the PV Panel side but also on the Energy management side.

1. PV Panel:

As there is huge amount of Sunlight reaching the earth where the panels made of Silicon are known to be best absorbers of light but in the research it is found that 70% of light gets reflected when falls on the solar PV Panel and only 30% of light absorption happens. So to overcome this reflection, after doing a thorough research its been identified and implemented that Anti reflection nanocomposite coating should be applied on the PV panel to improve the anti reflection property of Silicon. This coating can be applied on any kind of panel like Mono-Si or Poly-Si[5].

2. Energy Management:

Based on the Conversion of Light energy to Electrical Energy, it would be more effective if there is a proper monitored way of Energy management techniques followed. In the past literature review there are different approaches which are been used to effectively manage the Energy with in a System of method like Industries, Organizations, Institutions, Hospitals etc., Based on our understanding the effectiveness matters a lot interms of shedding the load of unused devices and also with a Quick communication. The design built to control the loads by shedding the unused loads is through TCP/IP. This approach is unique and it is first of its kind in the entire world where we can control the loads with a priority based energy management controller which will do the load shedding when solar energy is less than the required load on priority basis and also the communication of controlling happens very fast through TCP/IP.

III. DESIGN APPROACH OF ANTI REFLECTION NANOCOMPOSITE COATING

1. How to put together the ARNCC:

An Experimental approach derives how to prepare the answer via mixing with an proportionate quantity of Al(O-i-Pr)3 which is a filler and TEOS which is coupling agent in Ethanol which acts like a Matrix, this will be the base materials which will give a higher glue and excessive optical residences like RI. This answer was once agitated in an ultrasonic cleaner for forty five minutes at 35 levels centigrade to split into tiny constituent parts. Once the composition is prepared the solution which is accomplished above is blended with composites like MWCNT, TiO2 and SiO2 which are floor fillers. The TiO2 has lot of refractive index and SiO2 has property of removal of water or accumulates the particles current on the panel. The entire solution have to be positioned in ideal stipulations for 1 hr and should be consistently and uniformly stirred work is referred.

The development of the Nano composite layer took place in three phases or stages.

Stage One: Preparation of the base solution and checking its adhesive property.

Stage Two: Addition of Aluminium iso propoxide to the base solution.

Stage Three: Applying the buffer layer on to the semiconductor wafer of the solar cell.

1.1. STAGE ONE: PREPARATION OF THE BASE SOLUTION

BASE:It is an adhesive solution used to transfer the Nano composites on to the semi conductor wafer.

In this process of making adhesive solution, the following solutions which possess adhesive nature were used:

TETRA ETHOXY SILANE ($C_8H_{20}O_4Si$)

TITANIUM (IV) ISO-PROPOXIDE ($C_{12}H_{28}O_4TI$)

The above solutions were added to 100ml of pure alcohol each to make the final buffer solution

PURE ALCOHOL (ETHANOL)

Properties of the Base Solution:

- It is viscous.

- It is adhesive

- It is volatile.

- The solution is capable of adsorbing the Nano composite in it without changing the actual properties of the material added to the base.

- After when coated on a flat surface, the buffer solution was able to dispose the foreign material and itself being dried up which resulted in the adhesion of the foreign material firmly on the flat surface.

1.1.1 Composition of Tetra Ethoxy Silane (0.1 Molar)

The molecular weight of the given compound was found to be 208.3 gram with purity of 98%.

Formulation 1: Finding weight of crude solution

WT = 1000*(98/100) *0.934

(where 0.934 is density of crude solution)

(where WT is the weight of crude solution)

WT = 915.32g

Formulation 2: Finding molarity of crude solution

M2 = (Weight of given solution / Molecular weight of solution)

$$= (915.37*1000)/(208.32*1000)$$

$$M2 = 4.3936 \ M$$

Formulation 3: Finding volume of crude solution from below Fig 1

M1V1 = M2V2

V2 = (0.1*100)/4.3936

V2 = 2.27 ml

Where,

M1 = molarity of stock solution

M2 = molarity of crude solution

V1 =100ml of alcohol

V2 = unknown volume of crude solution

Fig 1- 0.1 molar Titanium Iso Propoxide +Tetra Ethoxy Silane + Pure Alcohol

1.1.2 Composition of Titanium Isopropoxide (0.1 Molar)

The molecular weight of the given compound was found to be 284.23 gram with a purity of 98%.

Formulation 1: Finding weight of crude solution

WT = 1000*(98/100) * 0.955

(where 0.955 is density of crude solution)

(where WT is the weight of crude solution)

WT = 935.9g

Formulation 2: Finding molarity of crude solution

M2 = (Weight of given solution / Molecular weight of solution)

= (935.9*1000)/(284.23*1000)

M2 = 3.292 M

Formulation 3: Finding volume of crude solution

M1V1 = M2V2

V2 = (0.1*100)/3.292

V2 = 3.037 ml

Where,M1 = molarity of stock   solution

M2 = molarity of crude solution

V1 =100ml of alcohol

V2 = unknown volume of crude solution

 A.1.3 Sonication:

Sonication as shown in Fig 2 and Fig 3 can be used to speed dissolution, by breaking intermolecular interactions. It is especially useful when it is not possible to stir the sample, as with NMR tubes. It may also be used to provide the energy for certain chemical reactions to proceed. Sonication can be used to remove dissolved gases from liquids (degassing) by sonicating the liquid while it is under a vacuum. This is an alternative to the freeze-pump-thaw and sparging methods. It can be used for the production of nanoparticles, such as Nano emulsions, nanocrystals, liposome and wax emulsions, as well as for wastewater purification, degassing, extraction of seaweed polysaccharides and plant oil, extraction of anthocyanins and antioxidants, production of biofuels, crude oil desulphurization, cell disruption, polymer and epoxy processing, adhesive thinning, and many other processes. It is applied in pharmaceutical, cosmetic, water, food, ink, paint, coating, wood treatment, metalworking, nanocomposite, pesticide, fuel, wood product and many other industries.

Fig 2 – Soniction of the 0.1 Molar Solution

Fig 3 – Five layers coating of solution on Aluminum sheet to check the adhesive property of the base solution

1.2. STAGE TWO: Measurement of MWCNT, SiO2 and TiO2 to Be Added To the Base Solution.

Actual weight of base solution = W2 – W1 g

(W2 = Weight of the base solution with beaker)

(W1 = Weight of the beaker)

Actual weight of the solution = 227.24 – 90.85

W = 136.42g

 Addition of 1% MWCNT, SiO2 and TiO2 each separately to the Actual Weight of Base Solution.

Amount of MWCNT = (1/100) * 136.42

=1.3642g

Amount of SiO2 = (1/100) * 136.42

=1.3642g

Amount of TiO2 = (1/100) * 136.42

=1.3642g

1.2.1 Stirring the Prepared Solution by Using Magnetic Stirrer as shown in Fig 4:

Fig 4 – Buffer Solution on a Magnetic Stirrer

1.3 STAGE THREE: Comparison of potentials of coated and uncoated solar panels.
- Applying the prepared solution on solar panel uniformly.
- Placing the coated solar panel under the sodium vapour lamp for duration of 30 minutes.
- Comparing the voltage potentials, temperature of coated and uncoated solar panels with respect to time
- Voltage is measured using multimeter.
- Temperature is measured by using infrared thermometer.

1.3.1 Comparison of potentials of coated and uncoated solar panels as shown in Fig 5.

Fig 5 - Comparing Voltage Potentials of Coated and uncoated solar panels

IV. COMPARISON OF ANTI REFLECTION COATING USING MWCNT, SiO2, TiO2 ON PV SYSTEM WITH OTHER COATINGS

2. Other Coatings on PV Panel

2.1 Coating with Aluminium Iso Propoxide:
 The solution was prepared for 1% the actual weight of the base solution.
- Base solution is a mixture of TETRA ETHOXY SILANE ($C_8H_{20}O_4SI$) and TITANIUM (IV) ISO-PROPOXIDE ($C_{12}H_{28}O_4TI$) and pure alcohol.
- Chemicals:
- TETRA ETHOXY SILANE ($C_8H_{20}O_4SI$)
- TITANIUM (IV) ISO-PROPOXIDE ($C_{12}H_{28}O_4TI$)
- ALUMINIUM ISO PROPOXIDE
- Pure alcohol
    - molarity of TETRA ETHOXY SILANE was mixed with 100 ml of pure alcohol.
    - molarity of TITANIUM (IV) ISO-PROPOXIDE was mixed with 100 ml of pure alcohol.
- Later, 1% equivalent weight of ALUMINIUM ISO PROPOXIDE to that of the true weight of the 200 ml base was added to the solution.

2.2 Coating with Zinc Sulphide:
- The solution was prepared for 1% the actual weight of the base solution.
- Base solution is a mixture of TETRA ETHOXY SILANE ($C_8H_{20}O_4SI$) and TITANIUM (IV) ISO-PROPOXIDE ($C_{12}H_{28}O_4TI$) and pure alcohol.
- Chemicals:
- TETRA ETHOXY SILANE ($C_8H_{20}O_4SI$)
- TITANIUM (IV) ISO-PROPOXIDE ($C_{12}H_{28}O_4TI$)
- Zinc Sulphide
- Pure alcohol
    - molarity of TETRA ETHOXY SILANE was mixed with 100 ml of pure alcohol.
    - molarity of TITANIUM (IV) ISO-PROPOXIDE was mixed with 100 ml of pure alcohol.
- Later, 1% equivalent weight of Zinc Sulphide to that of the true weight of the 200 ml base was added to the solution.

2.3 Coating with Multi walled CNT:
- The solution was prepared for 1% the actual weight of the base solution.
- Base solution is a mixture of TETRA ETHOXY SILANE ($C_8H_{20}O_4SI$) and TITANIUM (IV) ISO-PROPOXIDE ($C_{12}H_{28}O_4TI$) and pure alcohol.
- Chemicals:
- TETRA ETHOXY SILANE ($C_8H_{20}O_4SI$)
- TITANIUM (IV) ISO-PROPOXIDE ($C_{12}H_{28}O_4TI$)
- Multi walled CNT
- Pure alcohol
    - molarity of TETRA ETHOXY SILANE was mixed with 50 ml of pure alcohol.
    - molarity of TITANIUM (IV) ISO-PROPOXIDE was mixed with 50 ml of pure alcohol.
- Later, 0.1% equivalent weight of Multi walled CNT to that of the true weight of the 100 ml base was added to the solution.

3. Results Comparison

3.1 Experimental Analysis

A thorough experimental study has been taken in comparison between different coatings on how much performance improvement every coating is giving in terms of mW.

Table 1: Comparison table of different coatings

| Resistance (ohms)	Power from uncoated cell (mW)	Aluminium iso propoxide (mW)	Zinc Sulphide (mW)	MWCNT (mW)	Power from MWCNT, SiO2, TiO2 coated cell (mW)
40	43.47	44.46	51.30	58.14	68.4
50	39.75	38.16	44.03	49.90	58.71
60	36	33.70	38.88	44.06	51.84
70	31.68	31.34	36.17	40.99	48.22
80	28.8	26.99	31.14	35.29	41.52
90	26.73	24.64	28.43	32.22	37.91
100	17.55	21.53	19.00	16.46	25.33
200	13.01	12.23	14.11	15.99	18.81
300	9.45	7.66	8.84	10.01	11.78
400	6.48	6.18	7.13	8.08	9.5
800	3.24	3.09	3.56	4.04	4.75
1000	2.43	2.47	2.85	3.23	3.8
2000	0.16	0.12	0.13	0.15	0.19

4. Analysis on Results Comparison

In the detailed comparison of all the above mentioned coatings, it is identified that the Anti reflection coating using MWCNT, SiO2, TiO2 is giving very good results when compared with other coating approaches. Its experimentally proved that the MWCNT, SiO2, TiO2 have given best performance.

Table 2: percentage of performance improvement with different coatings.

Power from uncoated cell (mW)	Aluminium iso propoxide (mW)	Zinc Sulphide (mW)	MWCNT (mW)	Power from MWCNT, SiO2, TiO2 coated cell (mW)
43.47	2.23%	15.26%	25.23%	36.45%

V. CHARACTERIZATION ANALYSIS

5. *Scanning Electron Microscopy (Sem) Photographs Of The Coating Mixtures:*
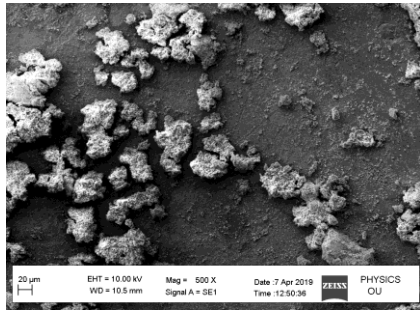
Fig 6:Image of Mixture -1 – SiO2+TiO2+MWCNT
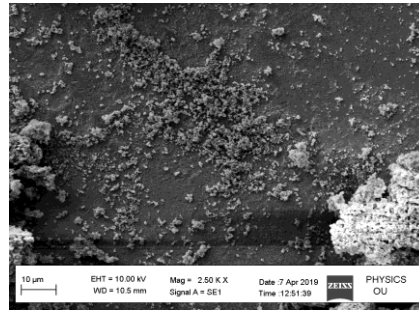
Fig 7: Image of Mixture -2 – SiO2+TiO2+MWCNT
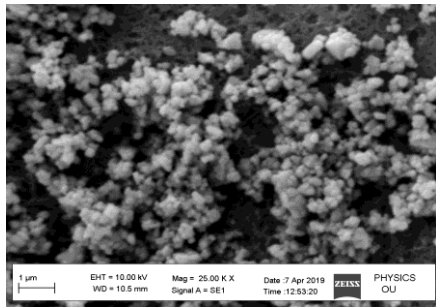
Fig 8:Image of Mixture -3 – SiO2+TiO2+MWCNT
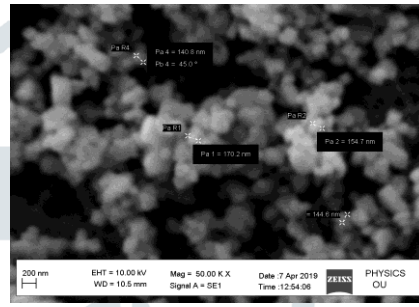
Fig 9: Image of Mixture -4 – SiO2+TiO2+MWCNT

VI. DESIGN OF PRIORITY BASED ENERGY MANAGEMENT IN AN EDUCATIONAL INSTITUTION

In order to acquire the above targets and/or functions, the activities such as teaching, lab works, and official works are being carried out in regular intervals, so a Systematic method is to be accompanied in a sequence[8]. Each work is based totally on the order of priority, which is to be already constant in the time schedule.

The shedding of loads is done in a prioritized manner for which the existing loads in the network like Reducible Loads and Deferrable Loads. The priority Levels of the devices like Projector, Fans, Lights, AC etc., can be fixed based on working Conditions or can be customized based on the need for each room like Calss room, Labs, Office, Seminar Hall etc.,

a. Rule to be Considered

In the design the optimization of load is managed based on weather condition aswell. For Further Optimizing the loads, the controlling of the Lights, Fans and Air Conditioners are completed with the aid of taking the climate condition into consideration. The real time climate record of that location is taken from a weather website.

b. Procedure of load shedding action in system:

At first the controller checks whether the system is in Islanded condition or not, if yes then the Main CB is opened. At that instance the power transferred, loading, Voltage and Frequency level are given to controller. Now calculate the generation available from local resources and balance it with present loading level, If generation is excess then corresponding excess power generation can be curtailed, in other case where generation is deficiency the system operates in the verge of stability, so to properly balance the generation-load scenario certain amount of load is to be shed.

Now this amount of load is to be shed in the network based on the priority of load that is already defined or that can be made to change at any point of time. The reducible power table is to be refreshed by the corresponding load according to the Usage so that the total power to be shed also varies such that the proper balance between existing

generation and loads can be maintained. This coupling can be effectively known from the spectrum of voltages and frequency measurements taken at different instance of operation. If it is not found suitable then there might be any misleading with the communication. This process is to be refreshed for every 8 to 10 minutes to calculate the amount of load to be shed. The entire sequence of procedure followed to accomplish the task of intelligent load. The flow chart for load shedding is given below. The below Fig. 1 represents the overall flow process and is self explanatory[6].
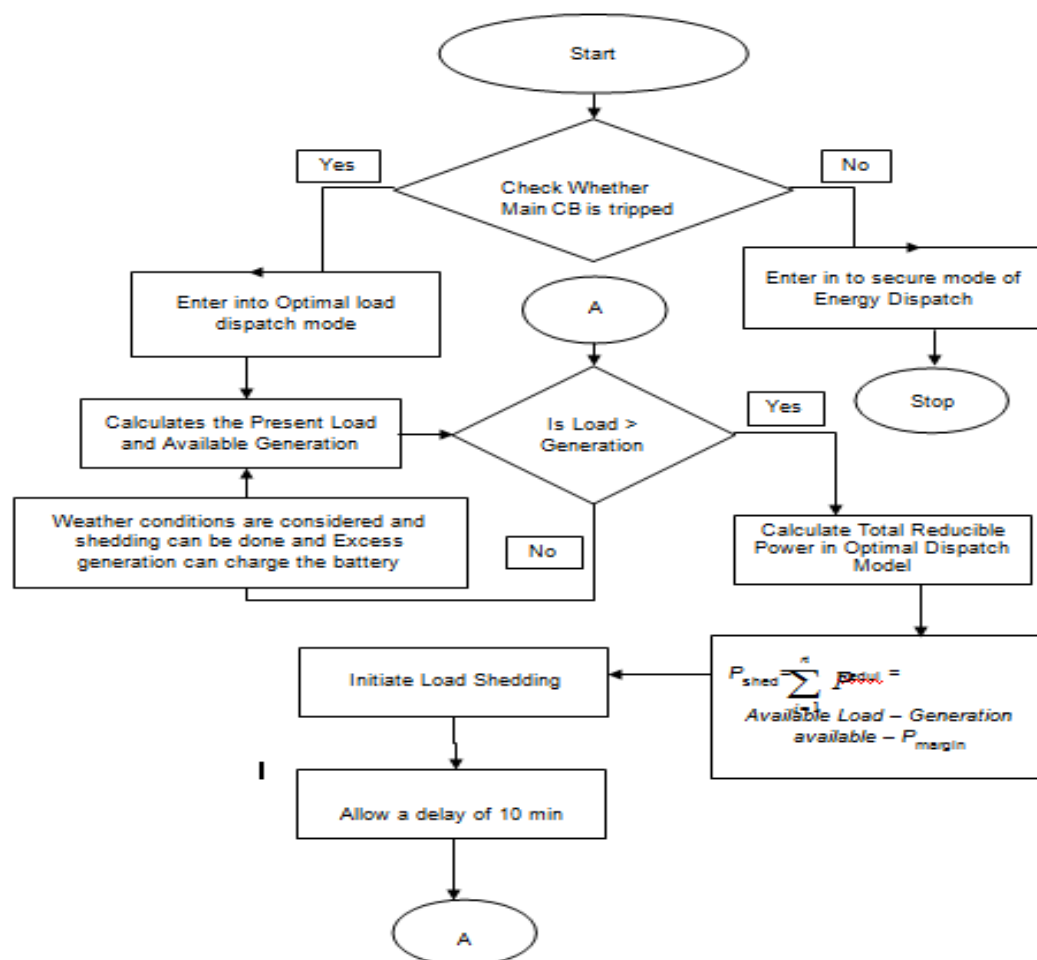

Fig. 10: shows a block diagram of the preferred operation of the overall load shedding control of the present invention.

VII. CONCLUSIONS

The overall performance of the Solar PV system is proved to increase in a enormous way. Major idea behind this research is to show on how the Solar PV system performance can be improved and also how the energy management can effectively happen so as to utilize the solar energy in an effective manner. The results of MWCNT, SiO2, TiO2 coated cells gives the best result of 36.45% improvement when compared to the other coated like Alluminium Isopropoxide, Zinc Sulphide, MWCNT and Uncoated panels. In addition to the above improvement there is a huge savings in energy by the intelligent Energy Management system and method which increases the power efficiency, has fast response time, and sheds the load according to the priority level set by user/manager. This Intelligent Energy Management system uses the TCP/IP protocols for fast switching. Power generated from local sources is efficiently distributed among the loads through a server in the form of request and response through TCP/IP, which helps to reduce the processing time and shedding time, so that the optimal level of load is shed in minimum time. This can be used to control priority based energy available for different needs in educational buildings, conference halls, hospitals, laboratories, industries, etc. Overall the work concludes to improve the performance of the Solar PV System with both ARNCC and Priority based energy management controllers.

VIII. ACKNOWLEDGMENT

IX. REFERENCES

[1] R. H. Lasseter et al., 1998. "Control of distributed resources," in Proc. Bulk Power System and Controls IV Conf., Santorini, Greece, pp. 323–330.

[2] R.Baños et al., 2011."Optimization methods applied to renewable and sustainable energy: A review" in Renewable and Sustainable Energy Reviews, pp. 1753-1766.

[3] Wayes Tushar et al., 2016. "Management of Renewable Energy for a Shared Facility Controller in Smart Grid" in IEEE Access, pp. 4269-4281.

[4] R. K. Rietz et al., 2008. " A Review of the Application of Analytic Hierarchy Process to the Planning and Operation of Electric Power Microgrids" in 2008 40th North American Power Symposium, pp. 1-6.

[5] M.Ramakrishna et al., 2018. "Antireflection nanocomposite coating on PV panel to improve power at maximum power point," in Taylor & Francis pp. 1-8.

[6] Gadwala.Durga Sukumar et al., 2018. " Intelligent Embedded Priority Based Energy Management System And Method ", Indian Patent, pp. 1-55.