ENERGY AUDIT – 2020

MES COLLEGE MARAMPALLY

Aluva, Ernakulam

Kerala

EXECUTED BY

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March 2020

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ACKNOWLEDGEMENTS

We express our sincere gratitude to the **MES College Marampally, Aluva**, for giving us an opportunity to carry out the project of Energy Audit. We are extremely thankful to all the staffs for their support to carry out the studies and for input data, and measurements related to the project of Energy audit. The environment audit conducted in the month of March 2020.

1. **Jb. M A Mohammed** Chairman, College Managing Committee
2. **Adv. A A Abul Hassan** Secretary, College Correspondent
3. Jb. V A Pareed Treasurer, College Managing Committee
4. Dr. A. Biju Principal
5. Dr. Manzur Ali P.P. Vice Principal & IQAC Co-ordinator
6. Shri K. P. Muhammed Shareef Junior Superintendent

Also congratulating our Energy audit team members for successfully completing the assignment in time and making their best efforts to add value.

ENERGY AUDIT TEAM

1. **Mr. Santhosh A**
   Registered Energy Auditor of Bureau of Energy Efficiency (BEE – Govt. of India)
   Accredited Energy Auditor No – AEA-0275

2. **Mr. Ashok KMP**
   Registered Energy Manager of Bureau of Energy Efficiency (BEE – Govt. of India)
   Energy Auditor No – EA 25612

3. **Mr. Jaideep P P,** M Tech, Energy Engineering.

Yours faithfully

Managing Director
Athul Energy Consultants Pvt Ltd

1. GENERAL DETAILS

The general details of the MES College are given below in table.

SL. NO	PARTICULARS	DETAILS
1	Name & Address of college	MES College Marampally, Aluva, Ernakulam Kerala 683107
2	Contact person	Bhavya Kamal K Menon Assistant Professor & Programme officer of EECC Department of Electronics, MES College Marampally.
3	Location: Latitude & Longitude	10.1066° N, 76.4115° E
4	No. of Teaching staff	136
5	No of technical staff	1
6	No. of Non-Teaching staff	60
7	No of students	Male =846 Female =1444
8	Building area	18885m^2
9	Land area	25 acres
10	Number of UG programs	17nos
11	Number of PG programs	09 nos
12	Number of departments	19nos
13	Hostel mates	150 nos
14	Average annual working days	263 days, (139 for odd and 124 for even semester)
15	DG Set	50 kVA (2 each)
16	Transformer	200 kVA (1 No)

Table 1: GENERAL DETAILS

2. ENERGY CONSUMPTION & COST ANALYSIS

The energy consumption and cost for the college campus premises are listed below- Monthly

Location	Units	Value	Average Cost
		Rs	**Rs**
College Buildings	kWh	112764	860916
College Hostel	kWh	37932	290532
LPG	Kg	1463	87780
Wood	Tons	17	34000
Diesel	Litres	500	25000
Total(Rs.)			1298228

Table 2: ENERGY CONSUMPTION & COST ANALYSIS

3. ENERGY SAVING PROPOSALS

The following table shows the energy saving proposals

Sl no	Particulars	Annual energy Savings (kWh)	Annual Financial Savings (Rs.)	Investment (Rs)	Simple payback Period (Months)
1	Replacement of ceiling fans with BLDC/BEE star rated fans	2500 and 1500	17875 and 10725	92000 and 68000	62 and 72
2	Replacement of existing Tube fitting with LED. T-12, CFL-23 and CFL -18	7200	51480	58000	14
3	Installation of 20kw solar on grid system	22000	157300	14,00,000	108

TABLE 3: ENERGY SAVING PROPOSALS

4. AUDIT SUMMARY - ACTIONS

The actionable summary of the audit report is given in the table below.

Sl No:	Particulars	Location	Action to be taken	Remarks
1	Replacement of ceiling fans with BLDC fans	Classrooms, Staff rooms	Change the existing old ceiling fans with BLDC fans	Energy consumption will come down
2	Replacement of old split AC with New 5 star rated ones	Computer Labs, Office Rooms	Change the old existing ACs with 5 star ACs.	Energy consumption will come down
3	Replacement of Fluorescent lights with LED	Class rooms, Staff rooms	Replace with LED lights.	Energy consumption will come down

TABLE 4: ENERGY AUDIT SUMMARY – ACTIONS

5. ENERGY AUDIT SUMMARY & RECOMMENDATIONS

The summary of the report with respect to each section is as follows.

1. **Electricity consumption analysis:**

- Presently 1 LT connection in the college premises. Which they are going to convert into HT connection
- College is benefitted with space in its roof top hence they can go for more solar installations in their facility and go for zero billing and claimed as solar powered college or Green college**.**
- **Air conditioners:** Replacement of old AC's with new energy efficient star rated AC's.
- **Light loads:** Majority of the lighting fixtures are fluorescent type (T12). By replacing these loads with LED light fittings will reduce the overall power consumption.
- **Ceiling fan loads:** Ceiling fans are installed in majority of the areas by replacing it with Brushless DC fans which consumes in the range of 25 to 30W at full speed, instead of 70W in normal fans, will reduce the power consumption considerably. Also while purchasing new fans priority should be given for BLDC.

ENERGY AUDIT

OBJECTIVES

An energy audit is a key to assessing the energy performance of facility and for developing an energy management program. The typical steps of an energy audit are:

- Preparation and planning
- Data collection and review
- Plant surveys and system measurements
- Observation and review of operating practices
- Data documentation and analysis
- Reporting of the results and recommendations

1.1. Definition of energy auditing

In the Indian Energy Conservation Act of 2001 **(BEE 2008)**, an energy audit is defined as:

"The verification, monitoring and analysis of the use of energy and submission of technical report containing recommendations for improving energy efficiency with cost-benefit analysis and an action plan to reduce energyconsumption."

1.2. Objectives of Energy Auditing

The objectives of an energy audit can vary from one plant to another. However, an energy audit is usually conducted to understand how energy issued within the plant and to find opportunities for improvement and energy saving. Sometimes, energy audits are conducted to evaluate the effectiveness of an energy efficiency project or program. In St. Aloysius college, as per the request, we have assessed the energy consumption and saving opportunities at present scenario.

Methodology for the study

The methodology adopted for energy audit starts from historical energy data analysis, power quality analysis, monitoring of operational practices, system evaluation, cost benefit analysis of the energy conservation opportunities, and prepare plan for implementation. The proposals given in the report includes economical energy efficiency measures to reduce facilities unnecessary energy consumption and cost. The energy conservation options, recommendations and cost benefit ratio, indicating payback period are included in this report.

Details Work

The Scope of Work includes:

1. Historical energy data analysis.
2. Electrical, Mechanical and Thermal energy analysis.
3. Power Quality Analysis.
4. Identification of Energy saving opportunities.
5. Cost Benefit Analysis.

ABOUT MES COLLEGE MARAMPALLY

M.E.S College -Marampally, situated in the KSRTC Route of Alva-Perumabavoor route., is the dream child of the MES Group of institutions in the field of Higher education. MES Group foreseen that this college requirement would cater to the educational needs of the suburban villages, in and around Aluva and Perumbavoor. M.E.S. College Marampally is a Government Aided college affiliated to Mahatma Gandhi University, Kottayam, established in the year 1995. The College has reaccredited by NAAC with A+ Grade (CGPA, 3.38) which is the first ever highest grade in the State as per the revised process of accreditation.

The Principal, the teaching staff, and the non-teaching staff work together as a well-knit team. The dedication, competence, and diligence of the staff have raised the reputation of the college within a short span of time. The college encourages many co-curricular activities, thus playing a major role in molding the personality and empowering the young ladies to rise to the challenges in their daily life. The main thrust is to make them respond creatively and positively to the various needs of the society and the community they live in. Thus, the NSS, NCC, Career Guidance, AIDS Awareness Cell, Reader's Club and Nature Club function effectively. Apart from these, various Enrichment Programs are being planned and conducted for the holistic development of the students.

The Campus, spread out in a hilly stretch surrounded by lush greenery, is a sure sight of delight for a lover of nature. The College is also in close vicinity to the river Periyar and very near to the city of Kochi and the International Airport, the satellite view of the college is shown in the following Figure 1. The academic building of the college is marked with the college name. The college ground is located west of this building. There is a plantation of banana plants south of the college ground. The College hostel building is located south of this plantation. Other main buildings are located south of the academic building.

The College offers Seventeen UG Programmes such as Computer Applications (BCA), B.Sc. Electronics, Business Administration (BBA), B.Com. (Model II), B.Com. (Taxation), B.Sc. Biotechnology, B.Sc. Microbiology, B.Sc. Physics (Model II) B.Sc. Mathematics (Model II), B.A. English, (Three Main) B.A. Arabic (Model II), B.Sc. Psychology, B. Voc. Logistics Management, B. Voc. Animation & Graphic Design, B. Voc. Software Development & System Administration, B. Voc. Fashion Designing & Management and B. Voc. Industrial Instrumentation & Automation and Nine Post Graduate programmes viz. M.Sc. Biotechnology, M.Sc. Electronics, M.Com. M.Sc. Microbiology, M.Sc. Biochemistry, M.A. English Language and literature, M.Sc. Computer Science, MHRM and M.Sc. Physics.


MES COLLEGE MARAMPALLY

ELECTRICITY CONSUMPTION ANALYSIS

1. ELECTRICITY BILLS ANALYSIS

The Electricity bills analysis of the college and other buildings are given below:

College Building -1

Base Line Data (Based on last Financial year 2019-20)		
1	Electricity provider	KSEBL
2	Tariff	LT-6A/Three
3	Consumer number	1155846010859
4	Connected Load (kW)	81.832 kW
5	Average monthly electricity consumption (kWh)	9397
6	Average Fixed charges	5330
7	Energy charge (Rs / kWh)	6.56
8	Fixed charge (Rs / kW)	65
9	Average monthly electricity cost (Rs)	71743

TABLE 5: EB BILLS – COLLEGE

College Hostel

Base Line Data (Based on last Financial year 2019-20)		
1	Electricity provider	KSEBL
2	Tariff	LT-6A/Three
3	Consumer number	1155841015860
4	Connected Load (kW)	15.898 kW
5	Average monthly electricity consumption (kWh)	3161
6	Average Fixed charges	971
7	Energy charge (Rs / kWh)	6.56
8	Fixed charge (Rs / kW)	65
9	Average monthly electricity cost (Rs)	24211

2. BILL ANALYSIS

The average monthly energy consumption details of the college are given below:

Month	Consumption	Energy Charge	Fixed Charge	Electricity Duty	Surcharge	Meter Rent	Total
Apr-19	7630	48132	4100	4813	0	50	57081
May-19	7380	46494	4100	4649	94	50	55279
June-19	10093	63586	4100	6359	65	50	74145
July-20	10810	69904	5330	6990	171	65	82056
Aug-20	5320	34580	5330	3458	0	65	43404
Sep-19	11320	73580	5330	7358	43	65	86347
Oct-19	9280	60320	5330	6032	86	65	71804
Nov-19	8940	58110	5330	5811	0	65	69287
Dec-19	10400	67600	5330	6760	0	65	79726
Jan-20	9460	61490	5330	6149	0	65	73005
Feb-20	12720	83401	5330	8340	0	65	97035

College Hostel

Month	Consumption	Energy Charge	Fixed Charge	Electricity Duty	Surcharge	Meter Rent	Total
Apr-19	540	10729	800	1073	0	50	12620
May-19	2099	13224	800	1322	15	50	15366
June-19	3225	20318	800	2032	46	50	23182
July-20	6200	40094	1040	4009	0	62.5	45167
Aug-20	3548	23063	1040	2306	9	65	26427
Sep-19	3126	20319	1040	2032	0	65	23418
Oct-19	3526	22985	1040	2298	0	65	26341
Nov-19	3187	20716	1040	2072	0	65	23845
Dec-19	2394	15561	1040	1556	0	65	18175
Jan-20	3331	21652	1040	2165	0	65	24875
Feb-20	3586	23512	1040	2351	0	65	26901

1. ENERGY CONSUMPTION ANALYSIS

The below figure shows the monthly consumption of college.

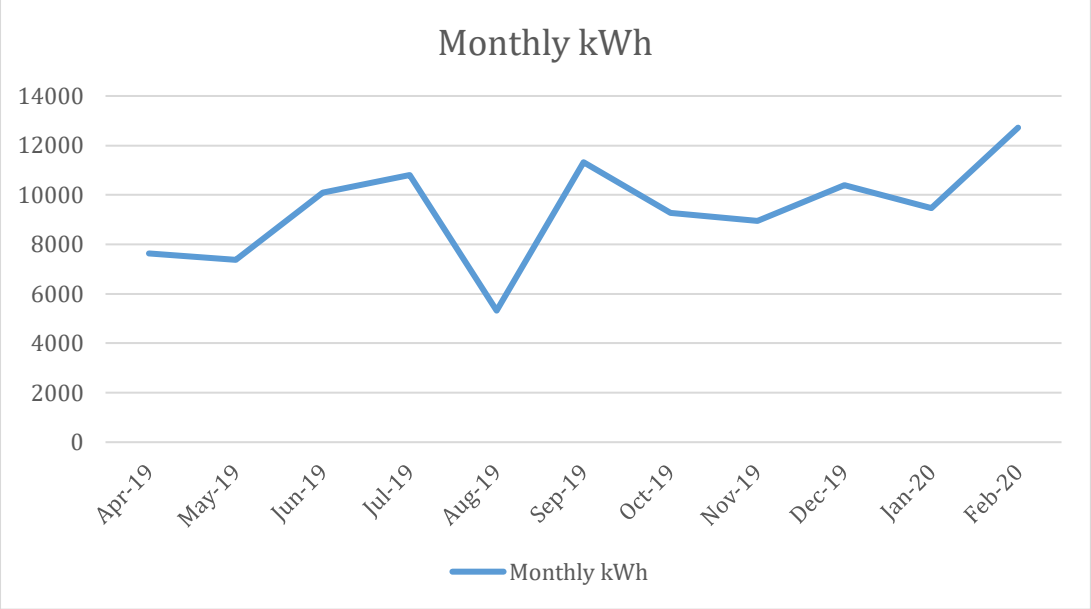


Figure 1: Monthly kWh variation

- In the last financial year, consumption is found to be higher in the month of Feb-20. And less in the month of August 2019.
- kWh consumption varies as per the seasonal variation.

2. TARIFF RATES ANALYSIS

The average monthly energy and demand charges for the past financial year is represented in Figure below.

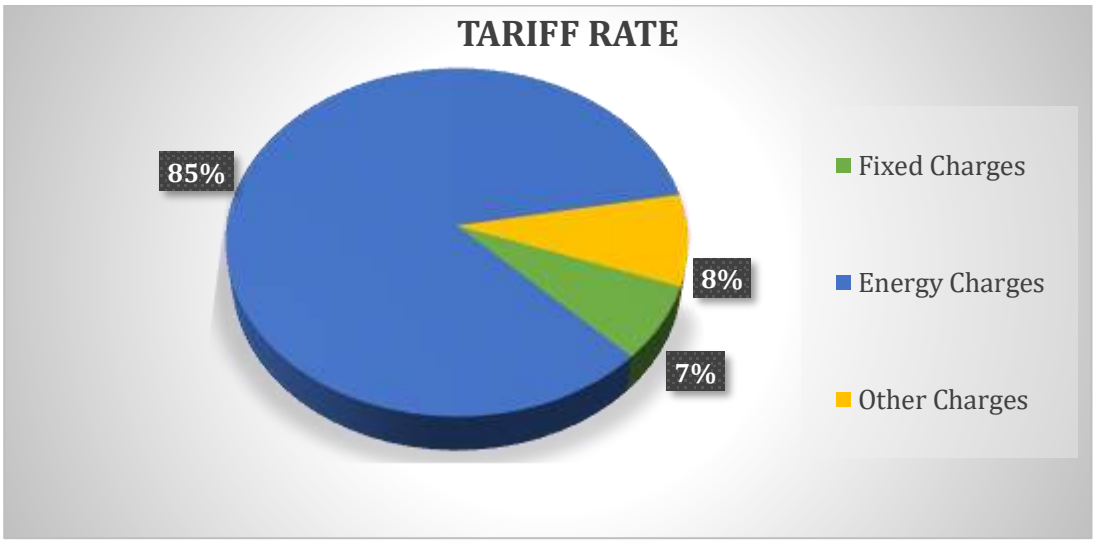


FIGURE 2: TARIFF RATE

Inference

i. Average demand charges for the past one year was Rs 4994/ per month and energy charges was Rs 60655/ per month.

ii. The energy charges came about 85% of the total bill.

1. ENERGY CONSUMPTION ANALYSIS

The below figure shows the monthly consumption of college.

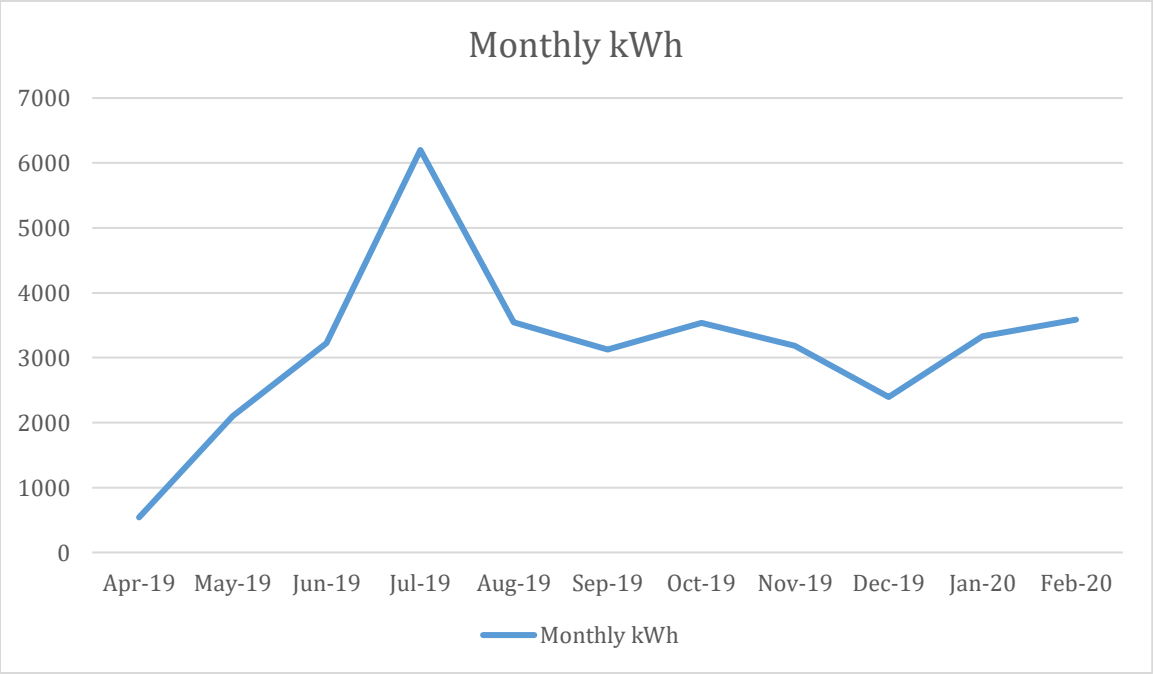


Figure 3: Monthly kWh variation

- In the last 6 months, consumption is found to be higher in the month of July-19. And less in the month of April 2019.
- kWh consumption varies as per the seasonal variation.

2. TARIFF RATES ANALYSIS

The average monthly energy and demand charges for the past financial year is represented in Figure below.

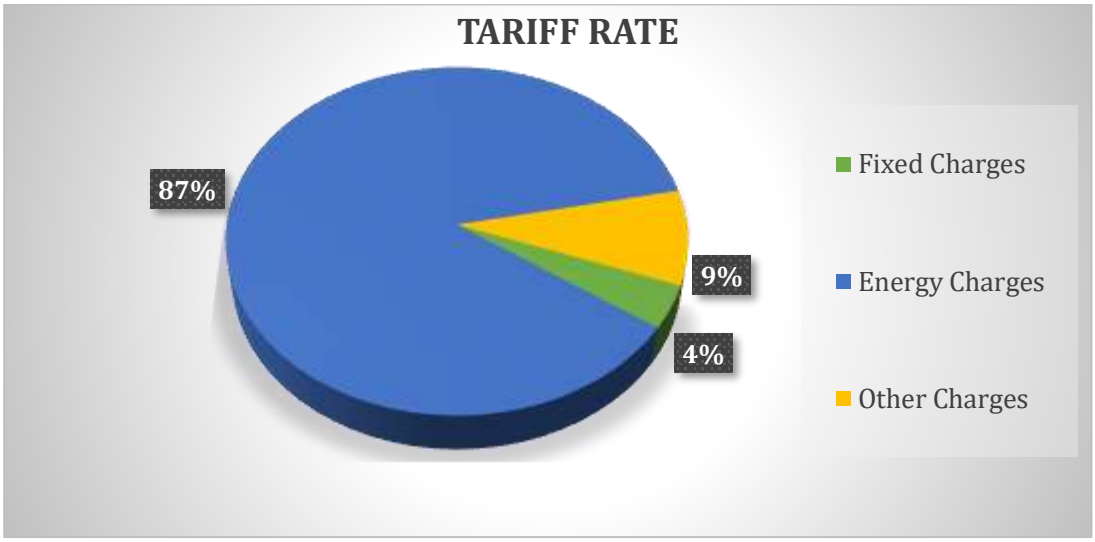


FIGURE 4: TARIFF RATE

Inference

iii. Average demand charges for the past one year was Rs 971/ per month and energy charges was Rs 21101/ per month.

iv. The energy charges came about 87% of the total bill.

1. CONNECTED ELECTRICAL LOAD

The connected load details of MES College -Marampallly are given below in the Table:

Sl.No:	Particulars	Power in kW
1	Lighting load	20.21
2	Ceiling Fan	13.86
3	UPS	20
4	Computer and Printer load	15.75
5	Air conditioner	6.3
6	Pumps	9.5
7	Miscellaneous	8.9
	Total	94.52

Table 6*: CONNECTED ELECTRICAL LOADS*

LIGHT AND FAN LOADS

The light and fan details in the college building are given below:

Particulars	Total Power	Quantity	Total Power
	Watts	Nos	kW
T8	40	180	**7.2**
T12	20	140	**2.8**
CFL	15	40	0.6
CFL	08	20	0.16
LED	8	90	0.72
LED	15	50	0.75
LED Tube	18	180	**3.24**
Ceiling fan	60	224	**13.44**
Metal Halide	150	06	**0.9**
Total			29.81

TABLE 7: LIGHT AND FAN LOAD

COMPUTER AND UPS LOAD

UPS Load

Sl. No:	Location	UPS		Battery		
		Rated kVA	**Make**	**Rating**	**Nos**	**Make**
1	Electrical Room	12.5	Igatech	12V, 60Ah	20	Exide
2	Electrical Room	2	Igatech	12V, 100Ah	6	Exide
3	Project Management Lab	10	Unitek	12V, 48Ah	20	Exide
4	Library	10	Igatech	12V, 60Ah	20	Exide
5	BCA Computer Lab	20	Igatech	12V, 100Ah	12	Exide
6	BCA Computer Lab	20	Igatech	12V, 100Ah	12	Exide
7	Instrumentation Lab	10	Igatech	12V, 100Ah	12	Exide

Computer loads

Particulars	**Rated Power**	**Quantity**	**Total Power**
Printer	**120**	53	5.83
Desk top Computers	**50**	315	15.75
Total			41.58

OTHER LOADS

In this section the canteen loads, small equipment's in labs etc. to be included and the details are given below:

Particulars	**Rated Power**	**Qty**	**Total Power**
	Watts	Nos	kW
Pump motor	**3000**	2	6
Bore well pump	**2500**	01	2.5
Submersible pump	**1000**	01	1
Mixer	**350**	1	0.35
Refrigerator	**250**	4	1
Water Steamer	**1000**	1	1
Water cooler	**300**	12	3.6
LED Projectors	**200**	15	3
Air conditioners	**2300**	20	46
Air conditioner	**2500**	01	2.5
Total			**66.95 kW**

Table 8: OTHER CONNECTED ELECTRICAL LOADS

LUX MEASUREMENTS

According to National Lighting code-2010 BIS to determine the overall energy efficiency of lighting system using measurements and methods, which is applicable to all commercial buildings. One of the methods is Illuminance method, which is the most practicable one. Details are given in the section. Lux levels of some areas are given in the Table 15. The lux levels mentioned as satisfactory need to be improved.

Sl. No.	AREA	Measured Lux	Required Lux	Remarks
1	Department of Bio science	140	150	Satisfactory
2	Bsc Bio technology	170	150	Good
3	Lab of BCA	130	150	Satisfactory
4	Office	180	150	Good
5	B com Ist	175	150	Good
6	Entrance	145	150	Good
7	Department of Electronics	145	150	Good
8	Chemistry 2nd	156	150	Good
9	Chemistry Lab	185	150	Good
10	Bio Technology lab	121	150	Satisfactory
11	Chemistry Department	140	150	Good
12	Principal office	135	150	Good
13	1st MSC Maths	145	150	Good
14	Department MSC Maths	160	150	Good
15	Physics lab	170	150	Good
16	Bsc Psychology	189	150	Good
17	1st BA English	160	150	Good
18	Electronic lab	170	150	Good
19	Physics computer lab	135	150	Satisfactory
20	English computer lab	180	150	Good
21	English Department	165	150	Good
22	Auditorium	175	150	Good

WOOD AND LPG

The LPG and wood is the main fuel in canteen and college hostel. The details of the LPG consumption in the last academic year is given in the Table 13. The college hostel consumed 28 cylinders of LPG in the last academic year.

Location	**Wood consumption**	**LPG consumption**
	TONS	**Kg**
Canteen	8	931
Hostel	09	532
TOTAL	17	**1463**

RENEWABLE ENERGY

MES Marampally college installed 10kWp on grid solar power plant on theire main building roof top of 30 numbers of 325Wp, Waree make mono crystalline panels. K star invertor is used. By using this solar power utilization approximately 12000 kWh electrical energy is aved per annual in electricity. 10% of KSEB power is reduced by using solar power plant

PV Details

Sl. No.	Particulars	Details
1	PV capacity	10 KWP
2	Wattage of module	325 wp
3	Module make	Waree
4	Module type	mono-crystaline silicon perc
5	Open circuit voltage	45.35 V
6	Short circuit current	9.55 A
7	Maximum peak Voltage	36.85 V
8	Maximum peak Current	8.82 A

Invertor Details

Sl. No.	Particulars	Details
1	Make	K Star
2	Model no	KSG-10K
3	Max PV array open voltage	1000 Vdc

4	Nominal Input Voltage	620 Vdc

STUDENTS ACTIVITIES

Solar lantern assembly

In association with Energy Conservation Society the prominent NGO working in the field of energy conservation over decades conducted solar lantern assembly workshop for students on 10-12-2019. In this energy conservation week programme nearly 40 students are attended the programme.

Energy Management Centre (EMC) visit

The members of Energy and Environmental Conservation Club visited Energy Management Centre (EMC) Thiruvananthapuram on 25 January 2020. EMC provided a training on the topic “Energy efficiency, conservation, management, tariff and auditing” in five interactive and demo sessions from 10am to 4pm. 43 club members along with 2 faculty members from Electronics and Physics departments attended the programme.

ANNEXURE-1

ENERGY SAVING PROPOSAL - 1

REPLACEMENT OF CEILING FANS IN THE OFFICE WITH ENERGY EFFICIENT BLDC FANS

Background

A BLDC fan takes in AC voltage and internally converts it into DC using SMPS. The main difference between BLDC and ordinary DC fans is the commutation method. A commutation is basically the technique of changing the direction of current in the motor for the rotational movement. In a BLDC motor, as there are no brushes, so the commutation is done by the driving algorithm in the Electronics. The main advantage is that over a period, due to mechanical contact in a brushed motor the commutators can undergo wear and tear, this thing is eliminated in BLDC Motor making the motor more rugged for long-term use. To explain, BLDC technology in simpler terms, BLDC uses a combination of Permanent Magnets and Electronics to achieve the kind of efficiency and performance, it delivers. A BLDC fan composes of 3 main components: - 1. Stator 2. Rotor 3. Electronics

Proposal

Replace the ceiling fans with BLDC in the as per preference of operating hours as office areas., staff rooms and in security cabin and in hostels the calculation for the savings is given in the table.

Particulars	Units	BLDC fan	With BEE star rated
Existing Ceiling Fans	Watts	60	60
Proposed BLDC Fans	Watts	35	45
Difference in Wattage	Watts	25	15
Avg No: of working hours/day	Hrs	10	10
No: of working days per year (Average)		250	250
No: of working hours per annum	Hrs	2500	2500
Number of Fans operating	Nos	40	40
Energy Saving per Annum	**kWh**	**2500**	**1500**
Cost per kWh	Rs	7.15	7.15
Annual Financial Savings	**Rs**	**17875**	**10725**
Cost of BLDC Fans	Rs	2500	1900
Salvage value of fan	Rs	200	200
Investment for Fans	Rs	92000	68000
Simple Payback period	Months	62	76

TABLE 9: EC PROPOSAL 1

ENERGY SAVING PROPOSAL – 2

REPLACEMENT OF FLUORESCENT TUBES WITH ENERGY EFFICIENT LED LIGHTS

At present LED lights are used in very few areas. Replacement of Fluorescent lights to be done in phase manner with LED lights.

Particulars		T-12	T-8	CFL
Existing Fluorescent lights	Watts	40	36	15
Proposed LED light	Watts	18	18	8
Difference in Wattage	Watts	22	18	7
Avg No: of working hours/day	Hrs	8	8	8
No: of working days per year (Average)	Nos	200	200	200
No: of working hours per annum	Hrs	1600	1600	1600
Number of Lights operating	Nos	100	120	20
Energy Saving per Annum	**kWh**	**3520**	**3456**	**224**
Cost per kWh (Average)	Rs	7.15	7.15	7.15
Annual Financial Savings	**Rs**	**25168**	**24710**	**1602**
Cost of LED light	Rs	250	250	150
Investment for LED lights	Rs	25000	30000	3000
Simple Payback period	Months	12	15	23

Summary

Annual Energy Savings	kWh	7200
Total Financial Savings	Rs	51480
Total investment	Rs	58000
Payback period	Months	14

TABLE 10: EC PROPOSAL 2

Reason for change in the lighting system

- Lighting quality can have a dramatic influence on the attitude and performance of working persons, if they have an environment that with proper uniform lighting.
- In addition to the lumens per watt which is a lighting quantity calculation lighting quality and life of lighting system is also to be considered.
- Lighting quality can be divided into Uniformity, Glare, Colour rendering Index, coordinated colour temperature.
- In case of consistency and in uniformity, the life time of LED is far better than CFL s and FTLs.
- Deterioration of lumens or lux level in FTLs and CFL are more as compared with LED which is consistent during in its life time.
- Considering VCP (Visual Comfort Probability) LED is better option than FTLs and CFL because the glare value is lesser.
- The LED are whitish in colour than FTLs which is giving a better feeling of brightness to the persons occupied or working
- CCT of LED is 5000k which is white as compared with lesser CCT for FTLS of 4500 k
- There is no mercury content in the LED as compared with CFL and FTL s hence it is environmentally supportive.
- The life cycle data of tube lights with LED is given in the table below.

Type of lamp	Typical life in Hours	Cost per lamp	No: of lamps required during LED lifetime (led 60,000 Hours)	Replacement cost per lamp	Approximate maintenance expense for replacement	Total cost per lamp
T12	5000	45	12	540	500	1040
T8	5000	45	12	540	500	1040
T5	5000	100	12	1200	500	1700
LED	60000	800	1	800	0	800

Table 11: Lifecycle data of light types

ENERGY SAVING PROPOSAL-3

INSTALLATION OF 20 kW SOLAR ON GRID SYSTEM

The Sun is an inexhaustible, reliable and non-polluting source of power. Since the inception of life on earth, the only energy that was available came from the sun. The time is now approaching when mankind will again depend upon the sun as dominant energy source. We are aware that fossil fuels are not going to last forever. A growing worldwide concern for conservation of energy has reignited our interest in ecologically sustainable materials, processes and sources of energy.

Of the numerous renewable sources of energy known to mankind, Solar Photo Voltaic or SPV is one that has the potential to supply power for our future needs. The advantages of solar power are:

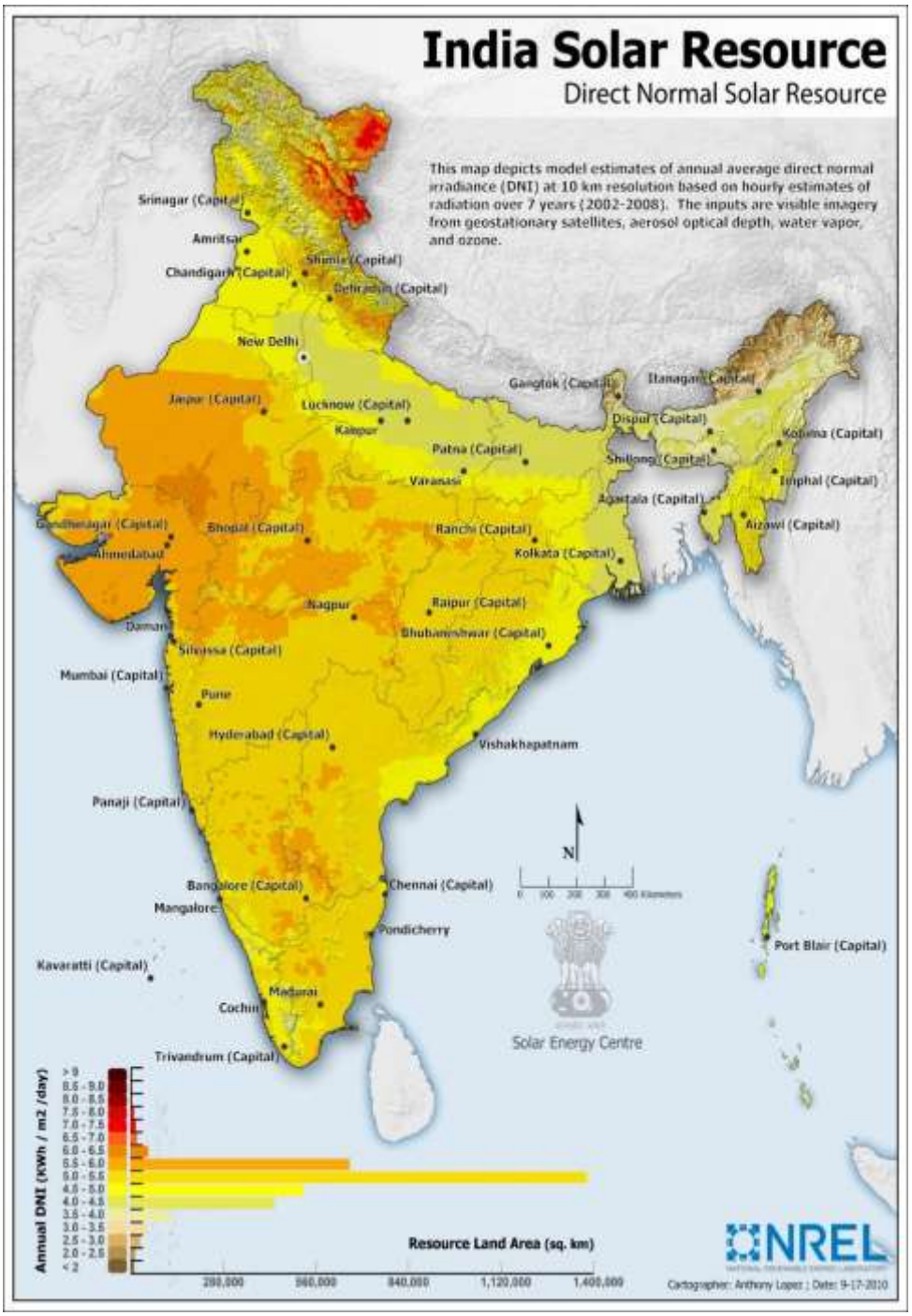
- The solar energy is more evenly distributed in the world than wind or biomass.
- It is well proven and demonstrated technology
- It promises to be most cost-effective renewable power at high volumes.

In addition, the solar photovoltaic technology offers following advantages:

- No recurring fuel cost
- Clean, silent and no moving parts
- Modular, Reliable with Low Maintenance
- Environmentally sound, does not contribute to greenhouse gas emission.
- Can be installed at the point of use and prevents transmission line losses.
- Solar panels have life in excess to 25 years and can withstand high winds, severe hail impact, high humility, ambient temperatures.

The solar energy potential in India is immense due to its convenient location near the Equator. India receives nearly 3000 hours of sunshine every year, which is equivalent to 5000 trillion kWh of energy.

The following image shows the solar generation potential of India.



LOCATION OF ST. ALOYSIUS COLLEGE

	Unit	Climate data location
Latitude	°N	9.36143
Longitude	°E	76.47597
Elevation	m	08
Average Relative humidity	%	72
Average Insolation	kWh/m²/d	5.1

Climate parameters of last 22 years average

Month	Air temperature (Average)	Relative humidity	Daily solar radiation horizontal	Atmospheric pressure	Wind speed	Earth temperature
	°C	%	kWh/m²/d	kPa	m/s	°C
January	24.9	55.5	5.49	96.6	4.23	26.3
February	25.8	56.2	6.07	96.6	3.54	28.4
March	26.9	59.5	6.52	96.5	3.94	30.5
April	26.4	71	6.39	96.4	4	29.8
May	25.8	77.2	5.6	96.3	4.71	28.5
June	24.6	83.9	3.75	96.2	7.04	25.9
July	24	85.1	3.55	96.3	6.84	24.8
August	23.8	84.8	4.07	96.4	6.56	24.8
September	23.9	82.4	4.93	96.4	4.83	25.5
October	24.4	78.6	4.74	96.5	3.59	25.8
November	24.9	65.6	5.01	96.6	3.96	25.9
December	24.9	56.6	5.27	96.7	5.01	25.8
Annual	**25**	**72**	**5.1**	**96.4**	**4.86**	**26.8**

Design Space Requirement for Panel Mounting:

A minimum shadow free space of 8 to 10m² is required for the solar panel mounting for the capacity of 1KW. The panel must be mounted facing south with appropriate inclination for obtaining maximum output from installation. Suitable structure according to wind speed and roof structure must be used without shading the panel surface.

Space availability in college at roof top: 200 m²

Approximate possible installation of solar power plant: 20 kW

Solar PV modules and Inverter:

Solar PV panels of 300 W or above must be selected for the rooftop installation above 10KW. The efficiency of individual panel must not be less than 15%. String inverter with MPPT charge controllers is more suitable for the solar power plant installation in roof top. Equipment and installation must be complied with CEA grid regulations-2013

SAMPLE SYSTEM ARCHITECTURE

Electrical

Component	Production (kWh/yr.)	Fraction %
PV array	28,000	100
Grid purchases	0	0
Approx. Total consumption	28,000	

As the present annual unit consumption through grid is only 22,000 units, by the installation of 20 kW system, the college can be entirely supplied from the solar power plant. Details of Solar PV system and its possible production rate is given below in table

Quantity	Units	Value
Rated capacity	kW	20
Mean output	kWh/d	80
Capacity factor	%	17.1
Total production	kWh/yr	28,000
Maximum output	kW	18
Present annual average consumption through grid	kWh	22,000
PV penetration	%	100

Summary:

Description	Value
Approximate unit savings per year (kWh)	22,000
Cost per unit of electricity (Rs)	7.15
Approximate annual financial savings (Rs)	157300
Approximate investment for installation of SPV system (Rs)	14,00,000.00
Payback period (years)	9

ANNEXURE-2

1. LED specification

The Department of Electronics and information technology issued "Electronics and information Technology goods order 2012" on 3rd October 2012 the following standards for LED lamps are covered.

1. IS 15885 (Part -2/section 13)
2. IS 16102 (Part-1): 2012

As per this order LED manufactures to get their product tested from BIS recognised labs.

Thus, the following electrical parameters and standards should ensure while purchasing LED in future based on the BIS standards. These are the minimum technical requirements for the acceptance of LED. Also, the LED test certificates as per the various standards mentioned below should be examined while purchasing.

Sl no	Parameters	Requirements	Applicable IS
1	Light source	SMD LED chip	LM 80/IS 16106
2	System Efficacy	>= 110 lumen /watt	IS 16106:2012
3	LED Driver Efficiency	Minimum 85%	
4	**Harmonics**	**Maximum 10%**	**IS 16102-2-2012**
5	**Power factor**	**Minimum 0.95**	**IS 16102-2**
6	Frequency	50 Hz ±3%	LM-79 report
7	Operating voltage	110V – 320V	LM 79 report
8	Surge voltage	>4 kV	LM 79 report
9	Ambient temp	-10 to 50 deg C	LM 79 report
10	Degree of protection	IP 66	IS 10322
11	CRI	Minimum 70	IS 16102 - 2

TABLE 12: LED SPECIFICATION

2. BLDC SPECIFICATION

Normal trend of one ceiling fan working hours with present cost while replacing with BLDC fan and the payback period is given in below table.

Number of working hours/day for a single ceiling fan	**Hours**	9	10	11	12	13	14	15	16	17	18	19	More than 20
Simple payback period after replacement with BLDC	**Years**	5	5	4	4	4	3	3	3	3	3	3	2

The BLDC fan test certificates as per the various standards mentioned below should be examined while purchasing.

Sl no	Parameters	Requirements	Applicable IS
1	Air delivery	215 CMM	IS 374 - 2019
2	Harmonics	Maximum 10%	IS 374 - 2019
3	Power factor	Minimum 0.95	IS 374 - 2019
4	Frequency	50 Hz ±3%	IS 374 - 2019
5	Insulation resistance	>2 MΩ	IS 374 - 2019
6	Speed	350 rpm	IS 374 - 2019
7	Maximum temperature rise	70 deg C	IS 374 - 2019
8	Degree of protection	IP 65	IS 10322

Table 13: BLDC specification

ABBREVIATIONS

APFC	:	Automatic Power Factor controller
AVG	:	Average
BDV	:	Breakdown voltage
BEE	:	Bureau of energy efficiency
CEA	:	Central electrical authority
CFL	:	Compact fluorescent lamp
CFM	:	Feet cube per minute
DB	:	Distribution Board
DG Set	:	Diesel Generator Set
EC	:	Energy Conservation
FD	:	Forced draft
HPSV	:	High-pressure sodium vapour
HT	:	High Tension
ID	:	Induced draft
IEC	:	International electro technical commission
IEEE	:	The Institute of electrical and electronics engineers
IS	:	Indian Standard
KG	:	Kilogram
KVA	:	Kilo Volt Ampere
KVAH	:	Kilo volt Ampere Hour
KVAR	:	Kilo volt-ampere
KW	:	Kilo Watts
KWH	:	Kilowatt-hour
LED	:	Light emitting diode
MAX	:	Maximum
MH	:	Metal halide
NEMA	:	National Electrical Manufacturers Association
OLTC	:	On load tap changer
ONAN	:	Oil natural air natural
PCC	:	Point of common coupling
PSI	:	Pound square inch
RMD	:	Registered Maximum demand
SEC	:	Specific electricity consumption
SFU	:	Switch Fuse Unit
SLD	:	Single Line Diagram
TDD	:	Total demand distortion
THD	:	Total harmonics distortion
TOE	:	Tonne of oil equivalent
UPS	:	Uninterruptible power supply
VFD	:	Variable frequency drive

INSTRUMENTS USED

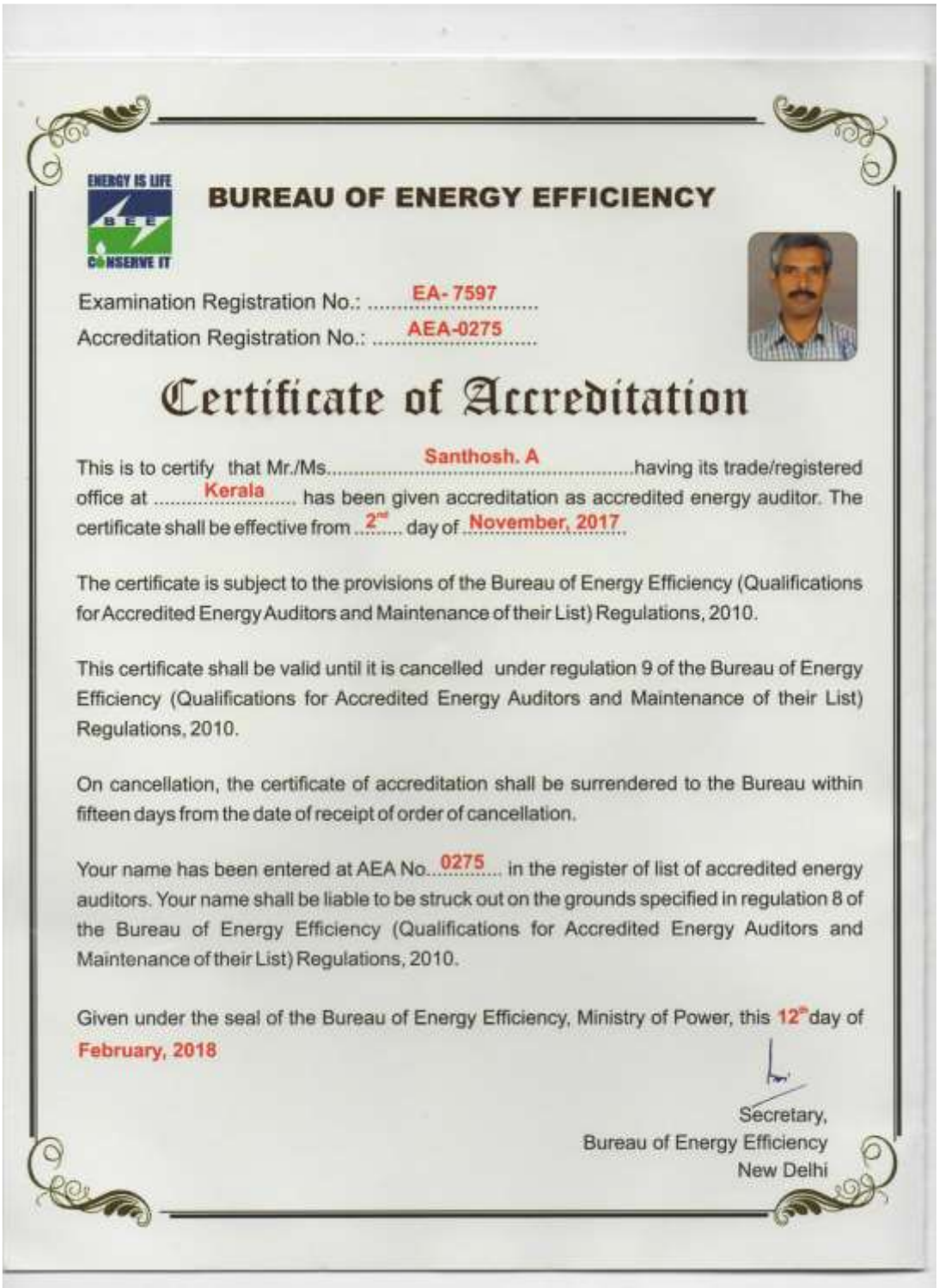
SL.NO	EQUIPMENT DESCRIPTION	MAKE & MODEL
1	Power energy & harmonic Analyser	Krykard ALM 35
2	Thermal Imager	FLIR E50

TABLE 14: INSTRUMENTS USED

REFERENCES

1. BEE energy audit books
2. CEA regulations of grid connectivity-2007
3. IEEE Std. 519-1992.
4. National lighting code – 2010

BEE CERTIFICATE



BUREAU OF ENERGY EFFICIENCY

Examination Registration No.: EA-7597

Accreditation Registration No.: AEA-0275

Certificate of Accreditation

This is to certify that Mr./Ms. Santhosh. A having its trade/registered office at Kerala has been given accreditation as accredited energy auditor. The certificate shall be effective from 2nd day of November, 2017

The certificate is subject to the provisions of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010.

This certificate shall be valid until it is cancelled under regulation 9 of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010.

On cancellation, the certificate of accreditation shall be surrendered to the Bureau within fifteen days from the date of receipt of order of cancellation.

Your name has been entered at AEA No. 0275 in the register of list of accredited energy auditors. Your name shall be liable to be struck out on the grounds specified in regulation 8 of the Bureau of Energy Efficiency (Qualifications for Accredited Energy Auditors and Maintenance of their List) Regulations, 2010.

Given under the seal of the Bureau of Energy Efficiency, Ministry of Power, this 12th day of February, 2018

Secretary,
Bureau of Energy Efficiency
New Delhi