ENERGY AUDIT – 2021

M. E. S COLLEGE ERUMELY

ERUMELY, KOTTAYAM

EXECUTED BY

ATHUL ENERGY CONSULTANTS PVT LTD
4th FLOOR, CAPITAL LEGEND BUILDING,
KORAPPATH LANE, ROUND NORTH, THRISSUR-680020
Ph: +91 7356111990-6 Web: www.athulenergy.com E-Mail: info@athulenergy.com

December 2021

BRIEF CONTENTS

PREFACE	5
ACKNOWLEDGEMENTS	6
EXECUTIVE SUMMARY	7
INTRODUCTION	9
ENERGY ANALYSIS	13
ENERGY CONSUMPTION ANALYSIS	13
ANNEXURE 1	19
ANNEXURE - 2	21
ANNEXURE-3	29

TABLE OF CONTENTS

PREFACE 5
ACKNOWLEDGEMENTS 6
EXECUTIVE SUMMARY 7
I. ENERGY SAVING PROPOSALS: 7
II. ENERGY AUDIT SUMMARY & RECOMMENDATIONS 7
III. AUDIT SUMMARY – ACTIONS 8
IV. ENERGY PERFORMANCE INDEX 8
INTRODUCTION 9
I. ENERGY AUDIT 9
II. M. E. S COLLEGE, ERUMELY 10
III. GENERAL DETAILS 11
IV. LOAD BALANCE- ELECTRICAL 12
V. BUILT UP AREA 12
ENERGY ANALYSIS 13
ENERGY CONSUMPTION ANALYSIS 13
I. DESCRIPTION OF ELECTRICITY BILL 13
II. DEMAND ANALYSIS 14
III. ELECTRICITY DEMAND IN VARIOUS TIME ZONES 15
IV. POWER FACTOR ANALYSIS IN KSEB BILL 16
V. TARIFF RATES ANALYSIS 17
VI. SPECIFIC ELECTRICITY CONSUMPTION (KWH/M2) 18
ANNEXURE 1 19
I. CONNECTED ELECTRICAL LOADS 19
ANNEXURE - 2 21
I. ENERGY SAVING PROPOSAL - 1 21
II. ENERGY SAVING PROPOSAL – 2 22
III. ENERGY SAVING PROPOSAL – 3 24
IV. ENERGY SAVING PROPOSAL – 4 25
ANNEXURE-3 29
I. ABBREVIATIONS 29
II. REFERENCES: 29
III. CERTIFICATES 30

LIST OF TABLES

TABLE 1: EXECUTIVE SUMMARY –ENERGY 7
TABLE 2: ENERGY AUDIT SUMMARY – ACTIONS 8
TABLE 3: ENERGY INDEX 8
TABLE 4: GENERAL DETAILS 11
TABLE 5: BUILDING AREA - DISTRIBUTION 12
TABLE 6: KSEB BILL ANALYSIS 13
TABLE 7: SPECIFIC ELECTRICITY CONSUMPTION 18
TABLE 8: LIGHT AND FAN LOADS 19
TABLE 9: UPS LOAD 19
TABLE 10: COMPUTER AND OTHER EQUIPMENTS 20
TABLE 11: AIR CONDITIONER LOADS 20
TABLE 12: EC PROPOSAL 1 21
TABLE 13: EC PROPOSAL 2 22
TABLE 14: LIFECYCLE DATA OF LIGHT TYPES 23
TABLE 15: EC PROPOSAL 3 24
TABLE 16: AVERAGE MONTHLY CLIMATE PARAMETERS 28
TABLE 17: EC PROPOSAL NO:4 28

LIST OF FIGURES

FIGURE 1: GOOGLE LAYOUT 10
FIGURE 2: LOAD BALANCE 12
FIGURE 3: DEMAND ANALYSIS 14
FIGURE 4: DEMAND IN VARIOUS TIME ZONE 15
FIGURE 5: POWER FACTOR ANALYSIS 16
FIGURE 6: TARIFF RATE ANALYSIS 17
FIGURE 7: SPECIFIC ELECTRICITY CONSUMPTION 18

PREFACE

Every institution should be imparting knowledge about the campus environment and its surroundings through activities that follows the principles of sustainability. An energy audit is essential first step to reduce energy cost and greenhouse emissions. Audit is defined as a systematic and implement examination of data statements, records, operations and performance of an enterprise for a purpose. Energy audits is a systematic study or survey to identify how energy being used in its own facility. And identifying the energy savings opportunities in the building Behavioral Change through the student education can provide greatest benefit at least cost. Even small savings in each house holds make dramatic change in the society and for nation. The idea of energy conservation and sustainability will be percolated to society through students will have long standing effect and successful too

This report is compiled by the BEE certified energy auditor along with the project engineers who are experienced in the field of energy, environment and management. The student volunteers made a mammoth contribution with data collection and preparing an initial skeleton for the report.

ACKNOWLEDGEMENTS

We express our sincere gratitude to M/s M. E. S College Erumely 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.

1	P. M Abdhul Salam	Chairman
2	Adv. Muhammed Najeeb	Secretary

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

GREEN AUDIT TEAM

1. **Mr. Santhosh A**
   Registered Energy Auditor of Bureau of Energy Efficiency (BEE – Govt. of India)Accredited Energy Auditor No – EA 7597

2. **Mr. Hari Krishnan K**
   Project Engineer

3. **Ms. Keerthana K**
   Project Engineer

ATHUL ENERGY CONSULTANTS PVT. LTD. THRISSUR 680 020

Yours faithfully

Managing Director
Athul Energy Consultants Pvt Ltd

EXECUTIVE SUMMARY

I. ENERGY SAVING PROPOSALS:

TABLE 1: EXECUTIVE SUMMARY –ENERGY

Sl. no	Energy conservation measures	Annual Energy Savings	Annual Financial Savings	Investment	Simple payback period
		kWh	Rs	Rs	Months
1	Power Factor Improvement		52380.25	20,000.00	5
2	Replacement of 40 T8 with LED Tube light	640	3878.40	12000	37
3	Replacement of 50 ceiling fan with BLDC	2500	15,150.00	175000	139
	Total	**3140**	**71408.65**	**207000**	
4	Installation of 20 kW Grid Tied Solar PV system	**25857**	148678	9,00,000	6.4 yrs

II. ENERGY AUDIT SUMMARY & RECOMMENDATIONS

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

1. **Baseline energy performance:**

Electricity consumption analysis

- **Demand analysis:** The demand analysis was done for the last 8 months. It is found that the recorded maximum demand was 27 kVA which is 41% of the contract demand. The percentage of maximum demand in the normal, Peak and off-peak period registered with respect to the contract demand (66 kVA) is 41%, 16.4%, and 11.3% respectively.
- **Power factor analysis:** The PF in the last 8 months was found to be low and penalties were levied. Rs 26,010 was paid as penalties for low PF during the last 8 months. Installing 20kVar inline capacitor would help to maintain the power factor close to unity.

2. **Equipment and utility description**

- **Ceiling fan loads:** Ceiling fans are installed in majority of the areas. By replacing it with Brushless DC fans which consumes about 25 to 30W at full speed, instead of 70W in normal fans, will reduce the power consumption considerably. While purchasing new fans priority should be given for BLDC. Detailed analysis given in the energy conservation measures section.
- **Light loads:** Replace the fluorescent light fitting with LED lights for low power consumption. Detailed analysis given in the energy conservation measures section.

III. AUDIT SUMMARY – ACTIONS

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

TABLE 2: ENERGY AUDIT SUMMARY – ACTIONS

Sl No:	Particulars	Location	Action to be taken	Remarks
1	Power factor improvement by installing capacitors	Main distribution panel	20Kvar capacitors to be installed	PF penalties would reduce
2	Energy efficiency – Replacement of ceiling fans with BLDC fans	Office, staff rooms, Classrooms	Change the existing old ceiling fans with BLDC fans	Power Consumption will get reduced
3	Energy efficiency – Replacement of fluorescent lights with LED lights	Office, staff rooms, Classrooms	Change the existing lights with LED lights	Power Consumption will get lowered

IV. ENERGY PERFORMANCE INDEX

EPI is based on the energy consumption during September 2020 to May 2021. The futuristic energy consumption after the implementation of energy saving proposals is given in the tables below.

TABLE 3: ENERGY INDEX

Parameters	Values
Present Annual electricity consumption(kWh/year)	29518
Present annual specific electricity consumption (kWh/m2)	3.64
Present CO_2 emission (Tons/year)	14.759
After Energy Saving Implementation	
Expecting annual electricity consumption (kWh/year)	26378
Expecting annual specific electricity consumption (kWh/m2)	3.25
Electricity and CO2 emission reduction %	10.64

INTRODUCTION

I. ENERGY AUDIT

An energy audit is a key to assessing the energy performance of an energy consuming 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

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 energy consumption."**

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 Mount Zion Institute of science and Technology as per the request from the institution, 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.

Scope of Work

The Scope of Work includes:

1. Historical energy data analysis.
2. Electrical, Mechanical and Thermal energy analysis.
3. Power Quality Analysis.

II. M. E. S COLLEGE, ERUMELY

M.E.S College, Erumely is the first unaided Arts and Science College affiliated to Mahatma Gandhi University, established in 1995. The college obtains minority status with effect from September 2012. The college situated on the side of Ernakulam- Pampa National Highway, 4Km away from Erumely. The serene atmosphere, sylvan surrounding and nourishing unpolluted air will ever provide quite a conducive environment for learning. The college belongs to a network of education institutes founded and operated by Muslim Educational Society. In founding the college, the founders had in their minds the glorious tasks of dispelling darkness and spreading the true wisdom all around irrespective of caste, creed, language and religion. The college had made every effort to be compassionate and sensitive to the marginalized and the people in need.

The College offers seven UG Programmes such as Computer Applications (BCA – model III), B.Sc. Electronics, Business Administration (BBA – Model III), B.Com. Computer Application (Model II), B.Com. Finance &Taxation (Model II), B.Com. Marketing (Model II) B.Com Office Management & Secretarial Practice (Model III) and eight Post Graduate programmes such as M.Sc. Computer Science, M.Sc. Electronics, M.Com Finance & Taxation, M.Com Marketing & International Business, M Com Management & Information Technology, Master of Social Work (M.S.W), M.A Economics, M.A. English Language and Literature.

Through the academic community consisting of faculty, staff and students the college create, integrate, and disseminate knowledge, and foster in the students critical thinking and other intellectual skills along with the attitudes and abilities that enable them to live as educated, tolerant, and empowered leaders disseminating values to the society.

FIGURE 1: GOOGLE LAYOUT

III. GENERAL DETAILS

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

TABLE 4: GENERAL DETAILS

Sl. No:	Particulars	Details
1	Name of the College	M. E. S College
2	Address	M. E. S College Erumely PO, Kottayam, Kerala 686509
3	Contact Person	
4	E-mail ID	principal@meserumelycollege.ac.in
5	Website Details	www.meserumelycollege.ac.in
6	Type of college	
7	Annual Working Days	210
8	No: of Shifts	9AM- 5PM
9	No: of students	1876
10	No: of teaching staff	78
11	No: of non-teaching staff	30
12	Total campus area	1876
13	Total built up area(M^2)	87294

IV. LOAD BALANCE- ELECTRICAL

Load balance among the connected loads is given in the figure below. The office equipment and the light – fan loads share 92% of the total connected load in the building.

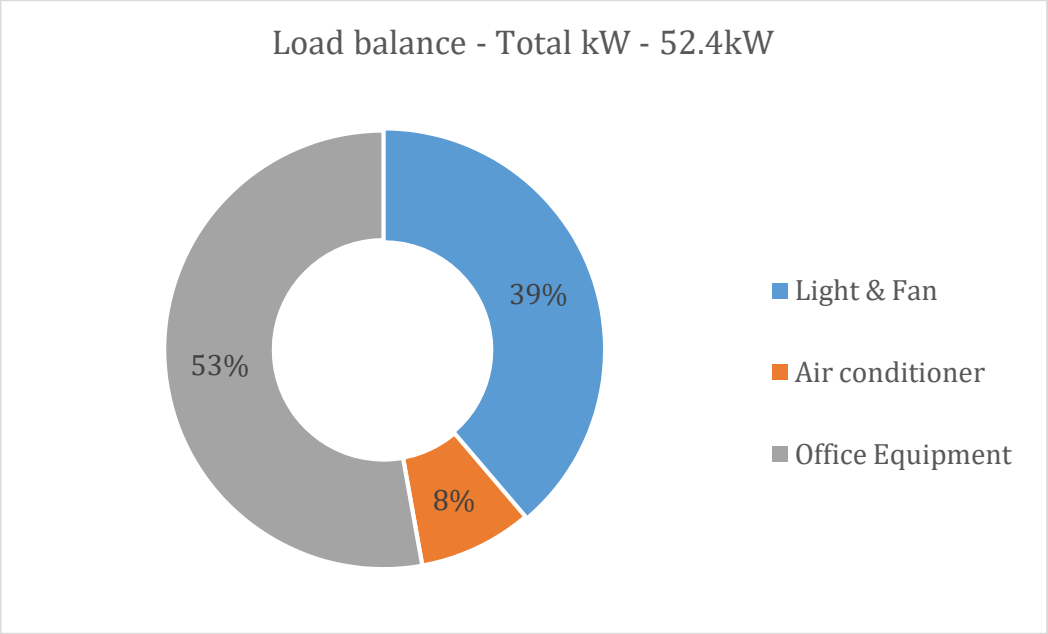


FIGURE 2: LOAD BALANCE

V. BUILT UP AREA

The collected details of the area distribution are given below

TABLE 5: BUILDING AREA - DISTRIBUTION

Sl. No:	Location	Area (sq. ft)
1	Administrative Block	16673.56
2	IT Block	14898.84
3	PG Block	13448.42
4	Golden Jubilee Block	10795.04
5	Amenity Block	3387.31
6	Seminar Hall	5476.56
7	Other Buildings	22614.72
Total		**87294.45**

ENERGY ANALYSIS

The different type's energy usage is given in this section. The major source of energy to the college is electricity. Other forms come in the form of LPG, petrol and diesel.

ENERGY CONSUMPTION ANALYSIS

The major source of electricity to the college is electrical connection from the KSEB. A diesel generator is provided in the college, but it is only used during the power failures.

I. DESCRIPTION OF ELECTRICITY BILL

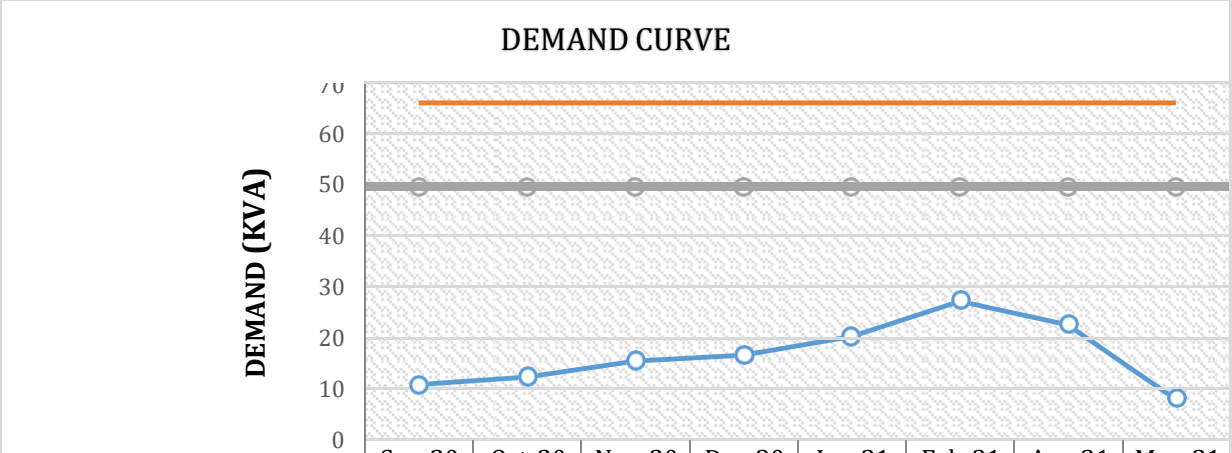
Base line data given below is based on the Electricity bill provided by the supplier of electricity to the College. Details obtained from the KSEB bill for the month of September 2020 to May 2021 is as follows in the Table.

TABLE 6: KSEB BILL ANALYSIS

Particulars	Details
Consumer No	1356370063201
Contract Demand	66 kVA
Connected Load	142.2
Tariff	HT 11B (General)
Recorded maximum demand (kVA)	27.16
Average monthly consumption (kWh)	2459.87
Average Demand charges (Rs)	22000
Average Energy charge (Rs)	15,412
Average PF	0.67

II. DEMAND ANALYSIS

This section analyses the trend for the maximum demand versus the Contract Demand (CD) over a 8-month period (Sep 2020 to May 2021).



	Sep-20	Oct-20	Nov-20	Dec-20	Jan-21	Feb-21	Apr-21	May-21
RECORDED MAXIMUM DEMAND	10.82	12.313	15.394	16.6	20.28	27.16	22.48	7.94
CONTRACT DEMAND	66	66	66	66	66	66	66	66
75% Contract demand	49.5	49.5	49.5	49.5	49.5	49.5	49.5	49.5

FIGURE 3: DEMAND ANALYSIS

Inference

i. Annual demand charges came as Rs. 2,64,000

ii. The recorded maximum demand came in the range of 12% to 41 % of the contract demand with an average of 25%.

III. ELECTRICITY DEMAND IN VARIOUS TIME ZONES

The variations of demands in the time zones are given below in figure.

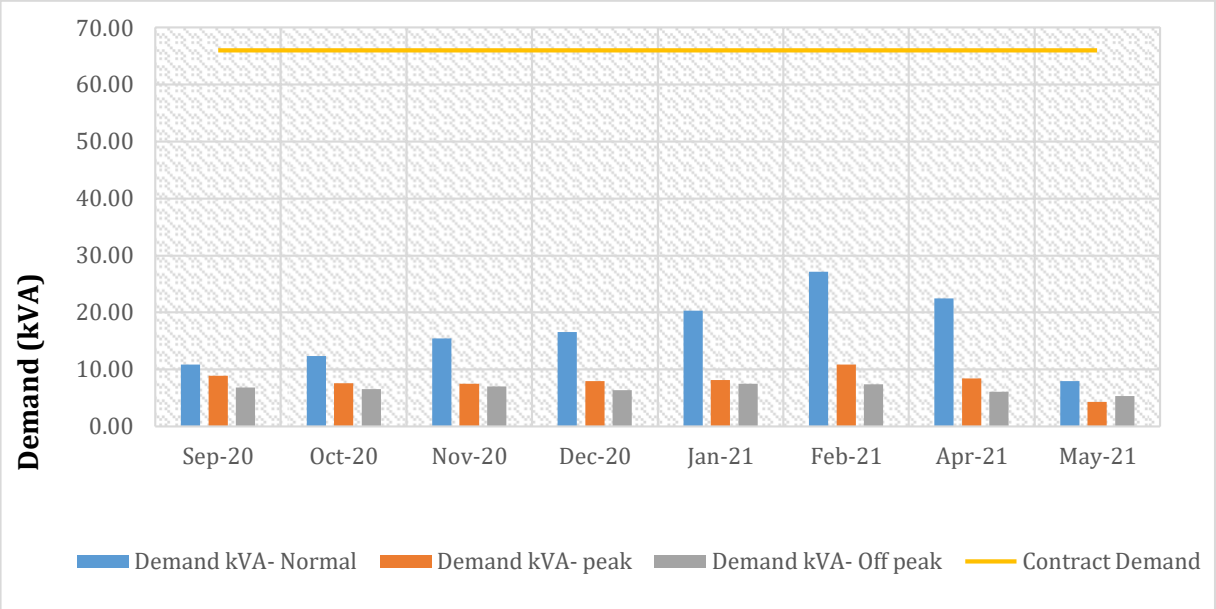


FIGURE 4: DEMAND IN VARIOUS TIME ZONE

Inference	i. The average maximum demand in the normal, Peak and off-peak period registered at college with respect to the contract demand is 25, 12, 10% respectively.

IV. POWER FACTOR ANALYSIS IN KSEB BILL

The Power factor is the ratio of Active power (kW) and apparent power (kVA).

$$PF = Active\ energykWh/Apparentenergy\ (kVAh)$$

The power factor variations in past one year is given below in figure.

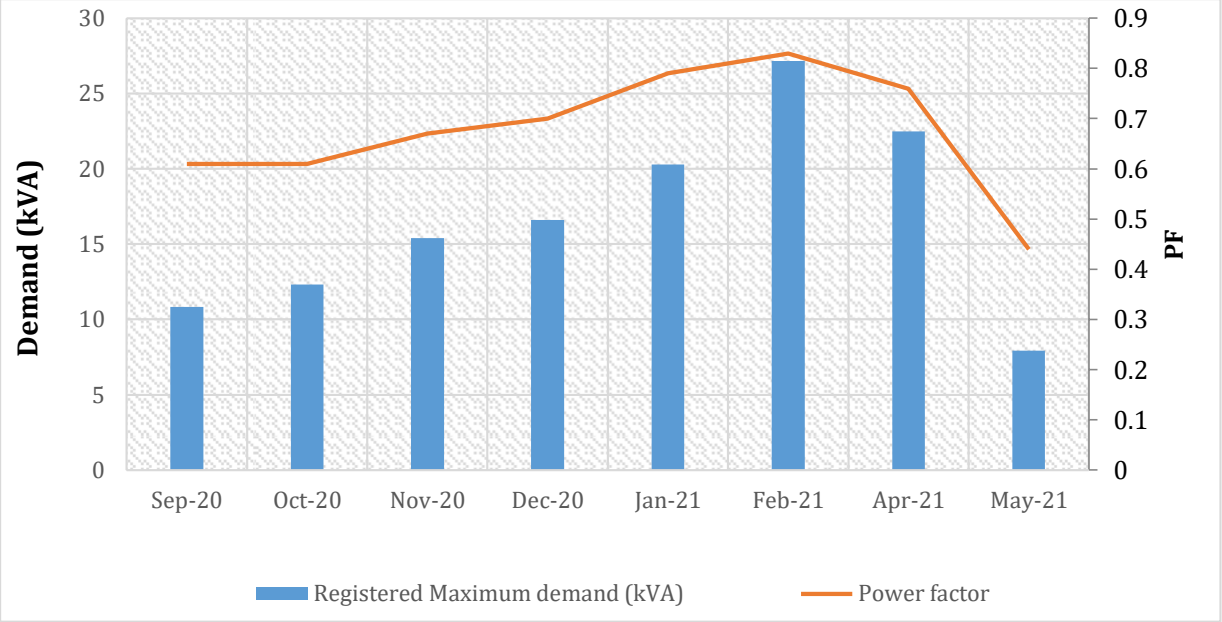


FIGURE 5: POWER FACTOR ANALYSIS

Inference	i. Average power factor during the past one year is found to be 0.67. ii. If the power factor is maintained close to unity, penalty incurred can be avoided.

V. TARIFF RATES ANALYSIS

The average monthly energy and demand charges for the period Sep 2020 to May 2021 is represented in Fig.

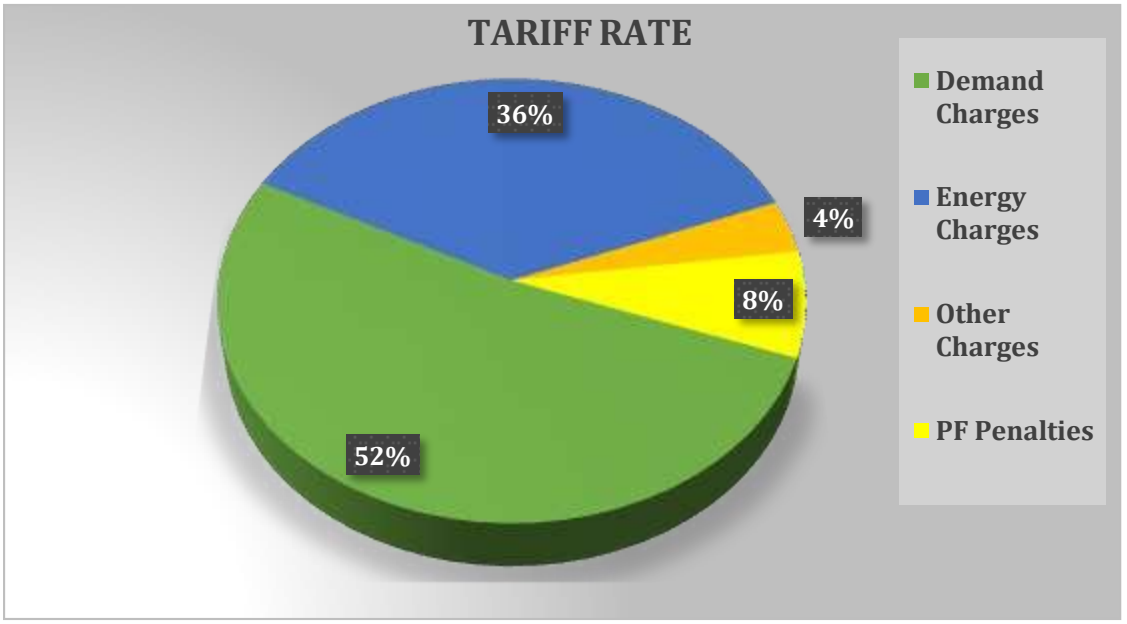


FIGURE 6: TARIFF RATE ANALYSIS

Inference	i.	Average demand charges for the past one year were Rs 22000/ per month and energy charges was Rs 15412/ per month.
	ii.	The energy charges come about 36% of the total bill.
	iii.	For last year the PF Penalties comes about Rs.26,010.

VI. SPECIFIC ELECTRICITY CONSUMPTION (KWH/M2)

The electricity consumption from the September 2020 to May 2021 has been taken for the benchmarking. Here the comparison is done with electricity consumption and the building area. The below table shows the specific electricity consumption of MES College.

TABLE 7: SPECIFIC ELECTRICITY CONSUMPTION

Month	Electricity Consumption	Building Area	SEC
	kWh	Sq. Metre	kWh/Sq.metre
Sep-20	1894	8109.91	0.23
Oct-20	1951	8109.91	0.24
Nov-20	2325	8109.91	0.29
Dec-20	2597	8109.91	0.32
Jan-21	3376	8109.91	0.42
Feb-21	3819	8109.91	0.47
Apr-21	2686	8109.91	0.33
May-21	1031	8109.91	0.13
Total	**2459.8**		**Avg =0.30**

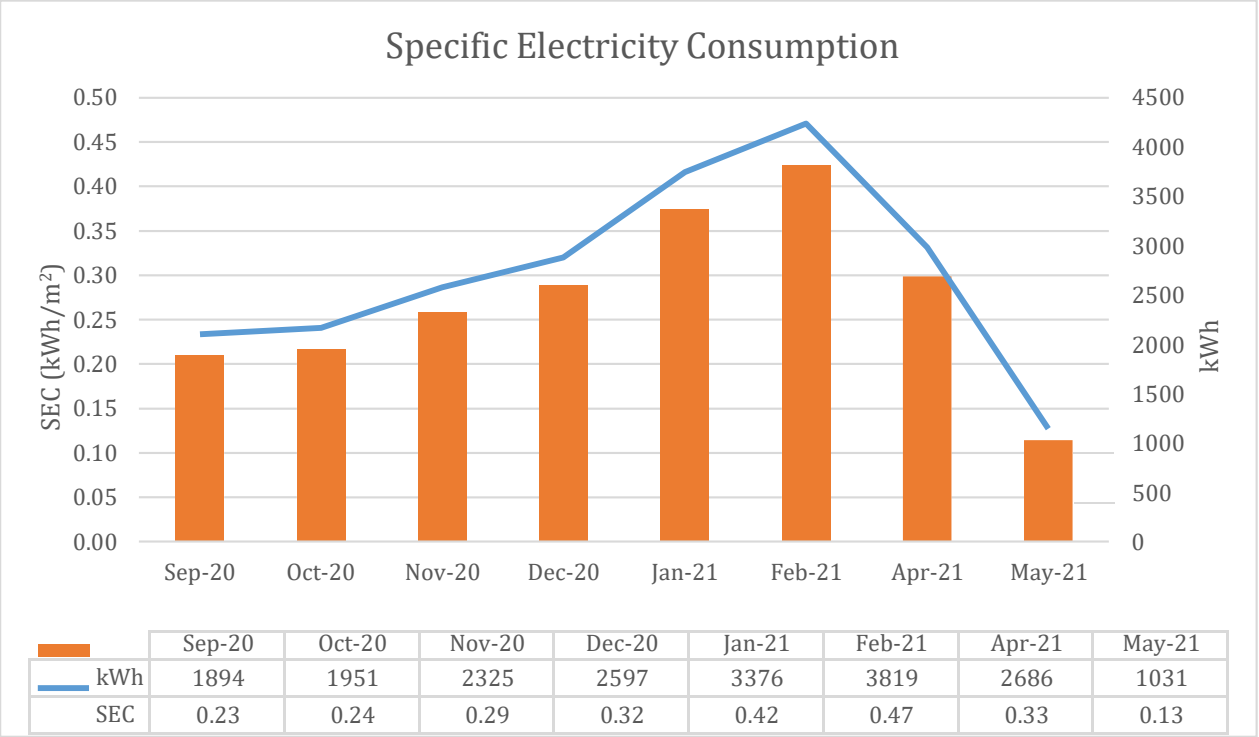


FIGURE 7: SPECIFIC ELECTRICITY CONSUMPTION

ANNEXURE 1

I. CONNECTED ELECTRICAL LOADS

1. LIGHT AND FAN LOADS

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

TABLE 8: LIGHT AND FAN LOADS

Location	T8	Led Tube Light	Ceiling Fan	Wall Fan	Pedestal Fan	Exhaust Fan
	36	**20**	**75**	**60**	**60**	**60**
Amenity centre	8	2	18			
Open Auditorium		16	5			
Ladies Hostel						
Seminar Hall	17		38			
PG Block	35		37			
Golden Jubilee Block		26	45			
IT Block			63		1	
Administrative block	24	35		2		2
Total (Nos)	**84**	**79**	**206**	**2**	**1**	**2**
Total (kW)	**3024**	**1580**	**15450**	**120**	**60**	**120**
Net Total (kW)	**20.354**					

2. UPS LOAD

TABLE 9: UPS LOAD

Rated kVA	Make	Battery	Capacity
15	Supra	Exide/Tubular/20	12/100
3	Supra	Exide/Tubular/4	12/100

3. COMPUTER AND OTHER EQUIPMENTS

TABLE 10: COMPUTER AND OTHER EQUIPMENTS

Location	PC	Printer	Printer	Projector	Xerox	TV	Tea maker	Fridge	Speaker
	120	**400**	**500**	**100**	**600**	**80**	**1000**	**250**	**50**
Seminar Hall				1					8
PG Block		2							
Golden Jubilee Block	15	3							
IT Block	124	2		2				1	
Administrative block	9	5	3		2	2	1	1	2
Total (Nos)	148	12	3	3	2	2	1	2	10
Total (kW)	17760	4800	1500	300	1200	160	1000	500	500
Net Total (kW)	**27.72**								

4. AIR CONDITIONER LOADS

TABLE 11: AIR CONDITIONER LOADS

Location	Capacity (Ton)	Rated Power(W)
Lab 2	1	1100
Server room	1	1100
Chairman room	1	1100
Principal Room	1	1100
Total(kW)	**4.4**	

ANNEXURE - 2

I. 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.

TABLE 12: EC PROPOSAL 1

Particulars	Units	BLDC fan
Existing Ceiling Fans	Watts	60
Proposed BLDC Fans	Watts	35
Difference in Wattage	Watts	25
Avg No: of working hours/day	Hrs.	8
No: of working days per year (Average)	Days	250
No: of working hours per annum	Hrs.	2000
Number of Fans operating	Nos	50
Energy Saving per Annum	kWh	2500
Cost per kWh	Rs	6.06
Annual Financial Savings	Rs	15150
Cost of BLDC Fans	Rs	3500
Investment for Fans	Rs	175000
Simple Payback period	Months	139

II. 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.

TABLE 13: EC PROPOSAL 2

Particulars	Units	T8
Existing Fluorescent lights	Watts	36
Proposed LED light	Watts	20
Difference in Wattage	Watts	16
Avg No: of working hours/day	Hrs	4
No: of working days per year (Average)	Nos	250
No: of working hours per annum	Hrs	1000
Number of Lights operating for change	Nos	40
Energy Saving per Annum	kWh	640
Cost per kWh (Average)	Rs	6.06
Annual Financial Savings	Rs	3878.4
Cost of LED light	Rs	300
Investment for LED lights	Rs	12000
Simple Payback period	Months	37

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, Color rendering Index, coordinated color 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 color 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.

TABLE 14: LIFECYCLE DATA OF LIGHT TYPES

Type of lamp	Typical life in Hours	Cost per lamp	No: of lamps required during LED lifetime (led 60,000 Hours)	Replacement cost perlamp	Approximate maintenance expense for replacement	Total cost perlamp
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

III. ENERGY SAVING PROPOSAL – 3

PF IMPROVEMENT IN ELECTRICAL SYSTEM

Background & Proposal

By referring the last year bills, it is clear that the power factor is in the lagging condition. As per the new KSEBL tariff structure, the consumer is not entitled to have incentives.

By providing a 20kVAr capacitor will maintain the PF in the lagging point near unity and will generate cost savings through incentives. The calculation for the saving is given in the table below.

TABLE 15: EC PROPOSAL 3

Particulars	Units	Values
Present PF		0.67
Proposed PF		0.99
Present average energy consumption/month	kWh	4,876.70
Present average energy charge/month	Rs	27,281.38
Incentives for improving the PF/month	Rs	4,365.02
Annual incentive	Rs	52,380.25
Investment @Rs.1000 per kVAr	Rs	20,000.00
Payback period	Months	5

IV. ENERGY SAVING PROPOSAL – 4

INSTALLATION OF SOLAR PV SYSTEM

The Sun is an inexhaustible, reliable and non-polluting source of power. Since theinception of life on earth, the only energy that was available came from the sun. The timeis 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 worldwideconcern 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 bio-mass.
- It is well proven and demonstrated technology
- It promises to be most cost-effective renewable power at high volumes.
- 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.

Solar Grid Tie mode system of 20 kW as rooftop, can be installed at the college without any modification in the electrical system as there is sufficient terrace area.

I. GEOGRAPHICAL SITE DESCRIPTION

Project site	-	MES College Erumeli
District head quarters	-	Kottyam
Nearest meteorological station	-	Trivandrum – ISHRAE
Software used for the solar radiation analysis	-	PVsyst 6.64

PVSYST V6.64

Definition of a geographical site

Geographical Site **Thiruvananthapuram** Country **India**

File Thiruvananthapuram of 00/00/00 00h00

Situation
Time defined as

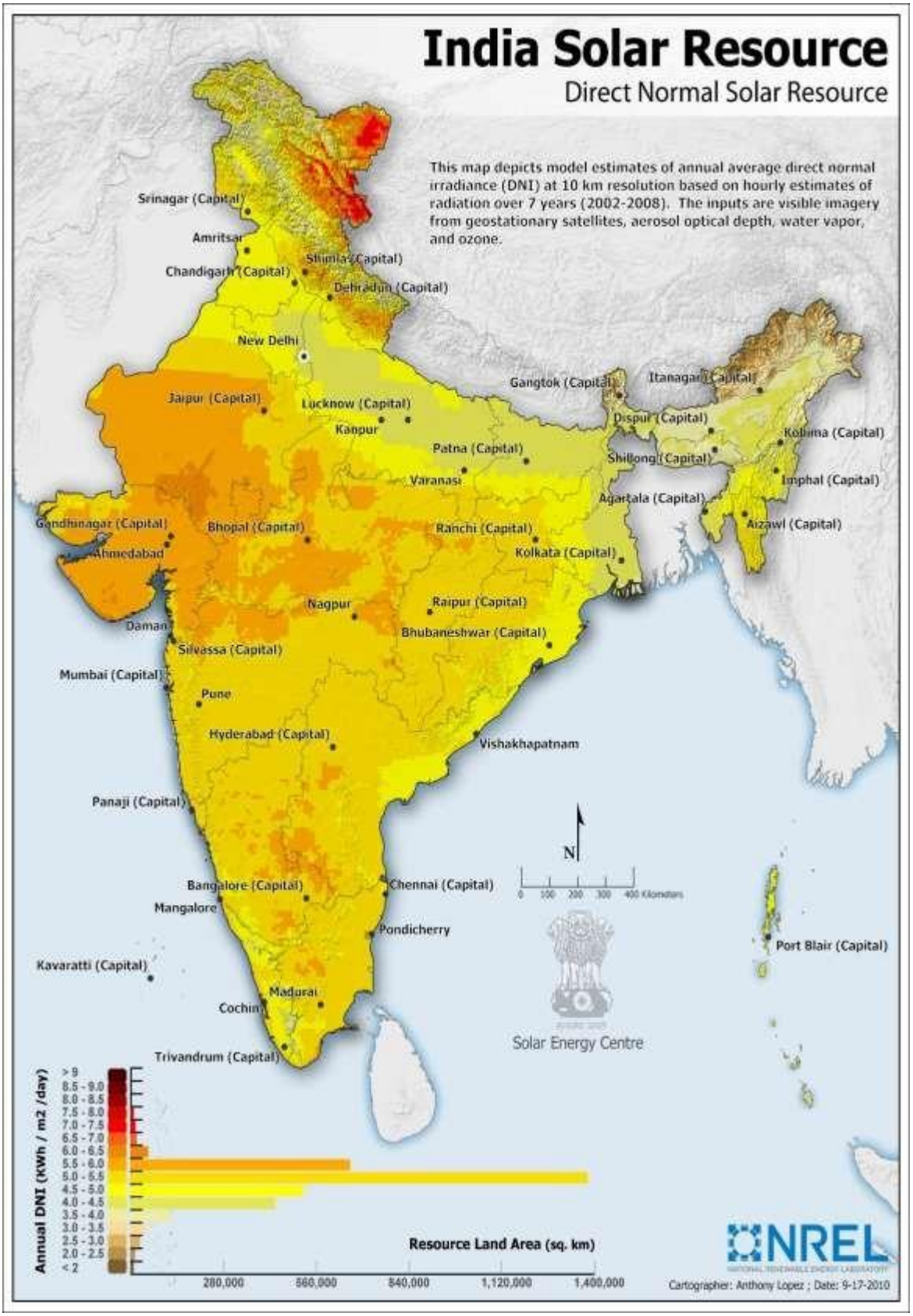
Latitude 8.48° N
Legal Time Time zone UT+5.5

Longitude 76.95° E
Altitude 13 m

Monthly Meteo Values

Source MeteoNorm 7.1 station

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year	
Hor. global	173.4	171.0	201.2	180.8	168.5	134.2	157.7	168.8	169.8	166.9	143.6	160.9	1996.8	kWh/m².mth
Hor. diffuse	60.2	63.8	75.5	80.4	87.6	86.8	88.9	88.7	76.4	75.7	76.9	64.6	925.5	kWh/m².mth
Extraterrestrial	282.1	273.9	319.7	314.9	320.2	304.2	315.5	321.0	310.0	307.7	277.9	274.5	3621.5	kWh/m².mth
Clearness Index	0.615	0.624	0.629	0.574	0.526	0.441	0.500	0.526	0.548	0.542	0.517	0.586	0.551	
Amb. temper.	27.2	27.8	28.7	28.3	28.6	26.7	26.7	26.8	26.6	26.9	26.5	27.1	27.3	°C
Wind velocity	0.8	0.9	1.1	1.1	1.5	1.7	2.1	2.1	1.7	1.0	0.6	0.7	1.3	m/s


India Solar Resource
Direct Normal Solar Resource
This map depicts model estimates of annual average direct normal irradiance (DNI) at 10 km resolution based on hourly estimates of radiation over 7 years (2002-2008). The inputs are visible imagery from geostationary satellites, aerosol optical depth, water vapor, and ozone.
Srinagar (Capital)
Amritsar
Shimla (Capital)
Chandigarh (Capital)
Dehradun (Capital)
New Delhi
Jaipur (Capital)
Lucknow (Capital)
Kanpur
Gangtok (Capital)
Itanagar (Capital)
Dispur (Capital)
Kohima (Capital)
Patna (Capital)
Shillong (Capital)
Varanasi
Imphal (Capital)
Agartala (Capital)
Aizawl (Capital)
Gandhinagar (Capital)
Bhopal (Capital)
Ranchi (Capital)
Ahmedabad
Kolkata (Capital)
Nagpur
Raipur (Capital)
Daman
Bhubaneshwar (Capital)
Silvassa (Capital)
Mumbai (Capital)
Pune
Hyderabad (Capital)
Vishakhapatnam
Panaji (Capital)
N
Bangalore (Capital)
Chennai (Capital)
Mangalore
Pondicherry
Port Blair (Capital)
Kavaratti (Capital)
Madurai
Cochin
Solar Energy Centre
Trivandrum (Capital)
Annual DNI (KWh / m2 /day)
> 9
8.5 - 9.0
8.0 - 8.5
7.5 - 8.0
7.0 - 7.5
6.5 - 7.0
6.0 - 6.5
5.5 - 6.0
5.0 - 5.5
4.5 - 5.0
4.0 - 4.5
3.5 - 4.0
3.0 - 3.5
2.5 - 3.0
2.0 - 2.5
< 2
Resource Land Area (sq. km)
280,000
560,000
840,000
1,120,000
1,400,000
NREL
Cartographer: Anthony Lopez ; Date: 9-17-2010

II.MONTHLY AVERAGE DAILY VALUES (AVERAGE, MAXIMUM, MINIMUM) OF CLIMATIC PARAMETERS FOR SITE

TABLE 16: AVERAGE MONTHLY CLIMATE PARAMETERS

Month	Air temperature - AVG	Relative humidity - AVG	Daily solar radiation horizontal	Atmospheric pressure	Wind speed	Earth temperature
	°C	%	kWh/m²/day	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	70.8	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**	**71.4**	**5.1**	**96.4**	**4.86**	**26.8**

III. GENERAL REQUIREMENT FOR ROOF TOP SOLAR PV PLANT INSTALLATION

Space Requirement for Panel Mounting:

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

Solar PV modules and Inverter:

Solar PV panels of 300W or above must be selected for the rooftop installation above 10KW. The efficiency of individual panel must not be less than 16%.

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.

TABLE 17: EC PROPOSAL NO:4

Particulars	Units	Values
Available insolation in the area - minimum	kWh/m²/day	5.1
Available rooftop area	m2	130
Approximate generation capability with respect to the area	kWh/day	663
Overall efficiency of the solar power plant- estimate	%	13
Approximate available units for utilization	kWh	86
Annual sunny days	Days	300
Approximate annual unit generation	kWh	25857
Annual cost savings @ Rs 5.75 Rs/unit	Rs	148678
Total expenses with GRID tie inverter - KSEB soura project (approx. size of the plant = kW)	Rs	9,00,000
Payback period	Years	6.4 Years

ANNEXURE-3

I. ABBREVIATIONS

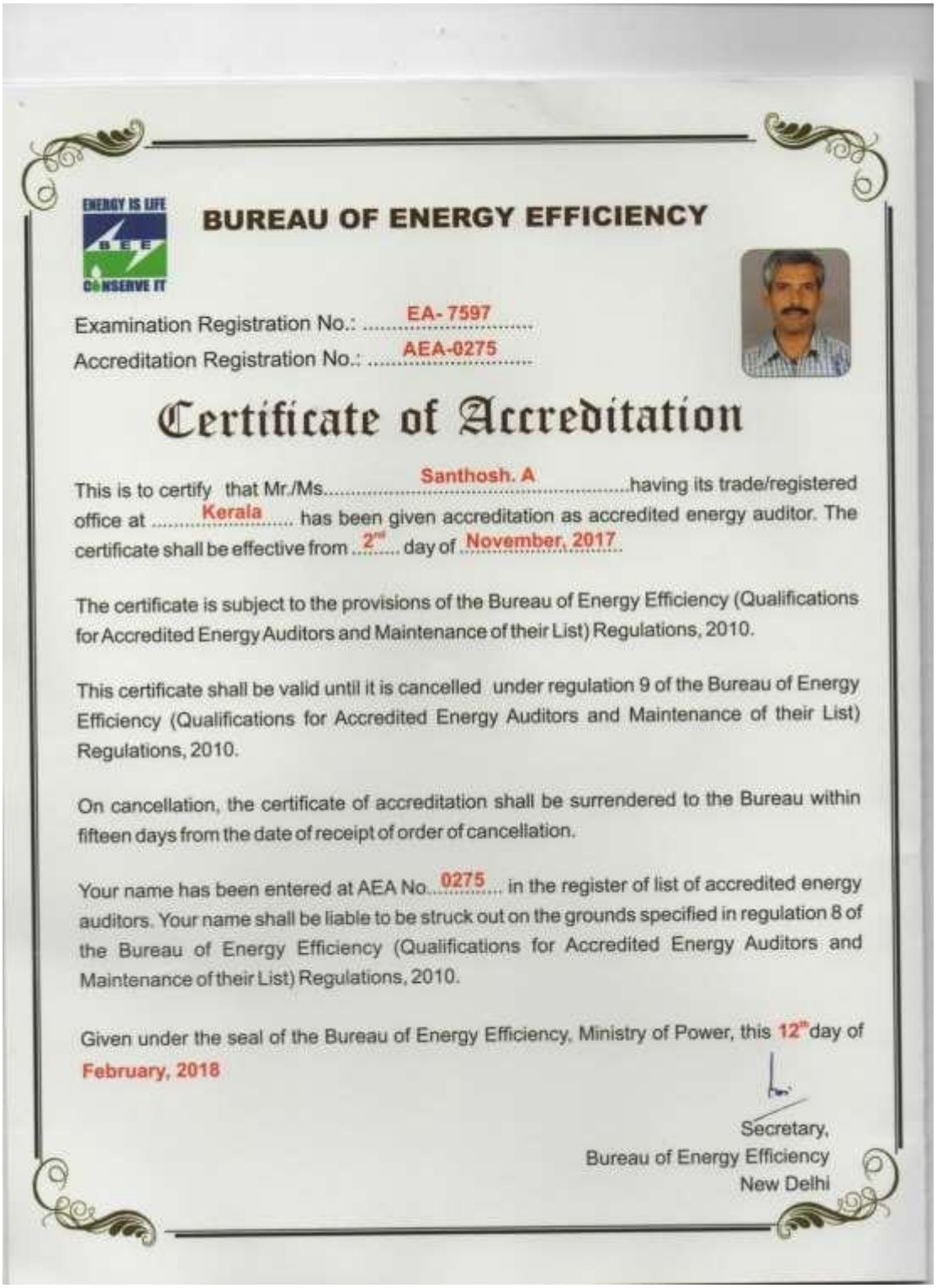
AVG	:	Average
BEE	:	Bureau of energy efficiency
CO2	:	Carbon dioxide
KSEB	:	Kerala State Electricity Board.
DB	:	Distribution Board
EC	:	Energy Conservation
IEEE	:	The Institute of electrical and electronics engineers
IS	:	Indian Standard
kL	:	kilo Liter
KVA	:	kilo Volt Ampere
kVAh	:	kilo volt Ampere Hour
kVAr	:	kilo volt ampere
kW	:	kilo Watts
kWh	:	kilo watt hour
LT	:	Low tension
MAX	:	Maximum
NSS	:	National Service Scheme
SLD	:	Single Line Diagram

II. REFERENCES:

- Handbook on energy audit and environment management by TERI.
- Bureau of Energy Efficiency (BEE) books for certification of Energy Auditors & Managers.

III. CERTIFICATES

I. BEE Accreditation 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