Energy Audit

(2021-22)

OF

Bhagat Phool Singh Mahila Vishwavidyalaya

Khanpur Kalan, Haryana

Conducted by

TMCC

Technical & Management Consultancy Center

Accredited Energy Audit Agency by the
Bureau of Energy Efficiency (BEE)
(Accreditation Number AEA- 0018)

SCO-89, First Floor, Swastik Vihar, MDC, Sector-5, Panchkula, Haryana
Contact Nos.: 94178 05135; 7009478849
Email: rakesh@tmccenergy.in
Website: tmccenergy.in

On Behalf of

HAREDA

Department of New & Renewable Energy, Govt. of Haryana

Akshay Urja Bhawan, Plot No-1, Sector 17,
Opposite Agarwal Bhavan, Panchkula, Haryana 134109

Acknowledgement

TMCC is grateful to the HAREDA, Department of New & Renewable Energy, Govt. of Haryana for their keen interest in energy solutions' portfolio of TMCC and giving us an opportunity to conduct an energy audit of Bhagat Phool Singh Mahila Vishwavidyalaya Khanpur Kalan, Sonipat, Haryana.

We are thankful to the Bhagat Phool Singh Mahila Vishwavidyalaya, Khanpur Kalan for showing keen interest and extending full co-operation to our team during the course of study, without which it would have been tough to strategize a realistic report.

We hope that the analysis providing in this report will be useful and worthy of discussions to take things forward to help the BPSMV management meet their aspirations of energy cost reduction. While we have made every attempt to adhere to high quality standards, in both data collection and analysis, as well as in presentation through the report, we would welcome suggestions so as to improve upon this report further.

(Rakesh Yecho)
BEE Accredited Energy Auditor
(AEA-0018)
Certified Energy Auditor cum Energy
Manager (EA-0592)

Contents

Tables

1 EXECUTIVE SUMMARY

With the advent of energy crisis and exponential hikes in the cost of different forms of energy, Energy Audit is manifesting its due importance in Industrial & Commercial Establishments.

It was with this objective that TMCC was entrusted by HAREDA, Department of New & Renewable Energy, Haryana, the energy audit of Bhagat Phool Singh Mahila Vishwavidyalaya, Khanpur Kalan, Sonipat, Haryana.

The study primarily covers the:

- Present energy scenario of the BPS building.
- Detailed analysis of the data obtained through onsite measurements using portable gadgets, discussions with concerned personnel etc.
- Recommendations for energy savings in all possible areas with cost benefit analysis.
- Technical specifications for any retrofit options and
- List of suppliers / manufacturers of energy efficient technologies.

Contact Details of Officials from BPSMV

Designation & Contact Details of Key Official from Bhagat Phool Singh Mahila Vishwavidyalaya, Khanpur Kalan, Haryana.	Registrar Bhagat Phool Singh Mahila Vishwavidyalaya, Khanpur Kalan, Haryana. Telephone: 01263-283007; 283530 Email: xenbpsmv@gmail.com Website: bpswomenuniversity.ac.in

Annual Energy Consumption Data & EPI

Particulars	Values
Power Supply from Grid	BPSMV has five grid connections Connection-1: 2107 kVA (for the main campus), Connection-2: 301 kW, Connection-3: 166 kW, Connection-4: 116 kW Connection-5: 64 kW Billing on connection-1 is done on kVAh basis. Billing on connection-2 to 5 is done on kWh basis.
Supply Voltage	11 kV
Units Billed (grid supply)	FY 2019-20 Connection-1 (main campus) = 28.56 lakh kWh FY 2020-21 Connection-1 (main campus) = 15.25 lakh kWh. The consumption has reduced due to the pandemic during FY 2020-21. Besides the above, there are four more connections in the campus, with an average power consumption as follows: Average monthly consumption based on data from Oct-20 to Sep-21 Connection-2: 3343 kVAh / 1916 kWh, Connection-3: 11318 kVAh / 8228 kWh, Connection-4: 7210 kVAh / 3652 kWh Connection-5: 55 kVAh / 10 kWh

Particulars	Values
Solar Power	
Installed capacity of Solar PV	The campus has a 1 MW solar power plant at the five locations. 11 kV main substation: 198 kWp B.Ed College substation: 435.6 kWp Mahila Polytechnic substation: 66 kWp Law college substation: 158.4 kWp Ayurveda New & Old Building: 145.2 kWp The power generation from Solar PV w.e.f. Apr-21 to Nov-21 was 9.52 lakh kWh.
Self-Generated Power through DG Sets	
Installed capacity: DG Sets (kVA)	2 Nos. of DG set-1 of 25 kVA rating 9 Nos. of DG set-2 of 62.5 kVA rating 2 Nos. of DG set-3 of 82.5 kVA rating 1 Nos. of DG set-4 of 100 kVA rating 3 Nos. of DG set-5 of 125 kVA rating 1 No. of DG set-6 of 128 kVA rating
Electricity generation through DG Sets	There is no energy meter installed on the DG sets, thus the annual kWh generation is not available. However based on the performance evaluation done on few DG sets, the specific power generation was around 3 kWh/ ltr, based on which the estimated power generation figures have been calculated: FY 2019-20: 1525 lts per annum (≅ 4575 kWh) FY 2020-21: 1423 lts per annum (≅ 4269 kWh)
HSD Bill	FY 2019-20: Rs 1.30 Lakhs per annum FY 2020-21: Rs 1.21 Lakhs per annum
Total Power Consumption	
Annual Electricity Consumption for main Campus (Grid Connection-1 + DG Sets)	FY 2019-20 Grid: 28.56 Lakh kWh per annum HSD: 0.045 Lakh kWh per annum **Total 28.60 Lakh kWh per annum**

Particulars	Values
	FY 2020-21 Grid: 15.25 Lakh kWh per annum HSD: 0.043 Lakh kWh per annum **Total 15.29 Lakh kWh per annum**
Energy Bill for main Campus (Grid Connection-1 + HSD in DG Sets)	FY 2019-20 Grid: Rs 237.8 Lakh per annum HSD: Rs 1.30 Lakh per annum **Total Rs 239.1 Lakh per annum** FY 2020-21 Grid: Rs 144.2 Lakh per annum HSD: Rs 1.21 Lakh per annum **Total Rs 145.4 Lakh per annum**
Built up area of the campus	Approx. 153797 sq mts Conditioned Area: 5500 sq mts Non air conditioned air: 148295 sq mts
EPI (Energy Performance Index)	FY 2019-20 519 kWh/m^2/yr based on conditioned area 18.5 kWh/m^2/yr based on built-up area FY 2020-21 277 kWh/m^2/yr based on conditioned area 9.9 kWh/m^2/yr based on built-up area

Annual Energy Consumption in TOE Terms

Source of Energy	Annual Consumption	Calorific Value	kCal/annum	TOE/annum
FY 2019-20				
Power Purchased from the grid	28.56 Lakh kWh	860 kCal/ kWh	2456160000	245.6
HSD for DG Sets	1525 Ltrs	9783 kCal/ltr	13921209	1.5
Total				**247.1**
FY 2020-21				
Power Purchased from the grid	15.25 Lakh kWh	860 kCal/ kWh	1311500000	131.2
HSD for DG Sets	1423 Ltrs	9783 kCal/ltr	13921209	1.4
Total				**132.6**

Cumulative Energy Saving Measures (EEM)
(Quantum, Monetary Benefit, Investment & Payback)

EEMs	Annual Energy Savings				Estimated Investment (Rs in Lakhs)	Simple Payback Period (Years)
	kVAh	kWh	toe	Rs in Lakhs		
EEM-1: Reduction of Contract Demand Limits				11.64	Nominal	Immediate
EEM-2: Improvement in the Operating Power Factor	25968			1.66	1.40	< 1
EEM-3: Replacement of old In-efficient Window AC/s with Five Star Rated A/Cs		62880	5.4	5.23	22	4.21
EEM-4: Replacement of conventional lights with LED Lights		47450	4.1	3.95	5.23	1.32

EEMs	Annual Energy Savings				Estimated Investment (Rs in Lakhs)	Simple Payback Period (Years)
	kVAh	kWh	toe	Rs in Lakhs		
EEM-5: Installation of astronomical timers on the Street Lights		5602	0.5	0.47	0.3	0.64
EEM-6: Replacement of Raw Water Pumps with Energy Efficient Pumps		8760	0.8	0.73	1	1.37
Total	**25968**	**124692**	**10.8**	**23.68**	**29.93**	**2-3**

Note:- There will be no TOE savings for reduction in kVAh consumption.

Energy Saving Potential

Percentage energy savings have been calculated based on the energy consumption during the FY 2019-20 as the power consumption during FY 2020-21 was less due to pandemic.

Particulars	In Monetary terms	In TOE Terms
Approx Purchased Power Bill on Connection-1 for the FY 2019-20	Rs 237.8 Lakhs/annum	245.6 TOE/annum
HSD for DG Sets	Rs 1.3 Lakhs/annum	1.5 TOE/annum
Total	***Rs 239.1 Lakhs/annum***	***247.1 TOE/annum***
Energy Savings Identified	Rs 23.68 Lakhs/annum	10.8 TOE/annum
Percentage Energy Saving Potential	**9.9%**	**4.3%**

2 INTRODUCTION

2.1 THE PROJECT

With the advent of energy crisis and exponential hikes in the cost of different forms of energy, Energy Audit is manifesting its due importance in industrial and commercial establishments. Energy Audit is the key to a systematic approach for decision-making in the area of energy management as it attempts to evaluate the energy usage pattern in an establishment. Also, it serves to identify all the energy streams in an establishment, so that potential areas wherein energy savings are practically feasible are identified.

It was with this objective that TMCC was entrusted by HAREDA, Department of New & Renewable Energy the energy audit of Bhagat Phool Singh Mahila Vishwavidyalaya, Khanpur Kalan, Haryana.

2.2 ABOUT BHAGAT PHOOL SINGH MAHILA VISHWAVIDYALAYA (BPSMV)

Bhagat Phool Singh Mahila Vishwavidyalaya is the 'dream come true' of Bhagat Phool Singh Ji, who established a Gurukul for girls at Khanpur Kalan in 1936. Even after the demise of Bhagat Phool Singh, his equally dynamic daughter Subhashini Ji not only took control of Gurukul but worked vigorously in expanding the Gurukul in terms of its various constituent institutions like BPS Memorial Girls' College (1967), BPS College of Education (1968), MSM Ayurvedic College (1973), BPS Mahila Polytechnic (1984), TIG Bhainswal Kalan(1999) and PSD Girls' Law College (2003).

The State Government took cognizance and upgraded the erstwhile Gurukul to the status of a University exclusively for women in August 2006 and christened it as Bhagat Phool Singh Mahila Vishwavidyalaya, which happens to be the first State Women University of North India. Since then BPSMV has undergone a complete transformation a 75 years old Gurukul started with only three girls has turned into a modern university with approximately 7000 girls on its rolls studying in various programmes.

BPSMV has the following block/buildings:

- Teaching Block-I
- Teaching Block-II
- Administration Block.
- New Guest House
- Old Guest House
- K.G.S.S School
- Campus School
- ITTR Collage
- IHL Collage
- LRC

- V.C. Residence
- Registrar Residence
- Hostel Chief Warden
- Central Library
- U.G.C
- Polytechnic Collage
- Law Collage
- BMS Medical Collage

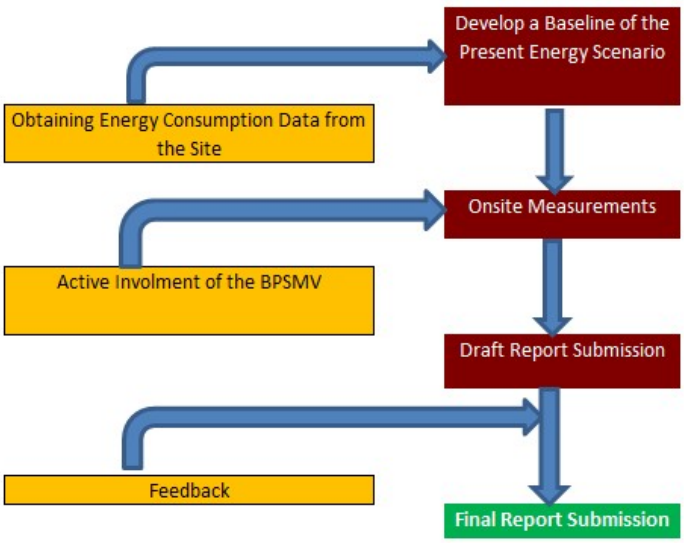
2.3 DELIVERABLES

- Present energy scenario of the Bhagat Phool Singh Mahila Vishwavidyalaya.
- Detailed analysis of the data obtained through onsite measurements using portable gadgets, discussions with concerned personnel etc.
- Recommendations for energy savings in all possible areas with cost benefit analysis.
- Technical specifications for any retrofit options and
- List of suppliers / manufacturers of energy efficient technologies.

2.4 METHODOLOGY

Methodology adopted for achieving the desired objectives viz: Assessment of the Current operational status and Energy savings include the following:

- Discussions with the concerned officials for identification of major **areas of focus** and other related systems.
- A team of engineers visited BPSMV and had discussions with the concerned officials/ supervisors to collect data/ information on the operations and energy distribution in the BPSMV. The data was analyzed to arrive at a **base line energy consumption pattern**.



- **Measurements and monitoring** with the help of appropriate instruments including continuous and/ or time-lapse recording, as appropriate and visual observations were made to identify the energy usage pattern and losses in the system.

- Computation and **in-depth analysis** of the collected data, including utilization of computerized analysis and other techniques as appropriate were done to draw inferences and to evolve suitable energy conservation plan/s for improvements/ reduction in specific energy consumption.
- Draft Report submission on the findings of the audit.
- Final report submission after incorporating the observations/ comments made by the BPSMV management.

2.5 Instrumentation Support Used

Table 1: Instrumentation Support Used

Name of the Instrument	Primary Measured Parameters
Electric Power Monitoring system for LT Supplies (3 phase 4 wire) & HT Supplies with Inbuilt memory for time lapse recording, programmable CT & PT Ratio for varied applications;	Electrical parameters like Voltage, Current, Frequency, Power, Harmonics etc.
Lux Meter	Lux Levels
Pitot Tube & Digital Pressure Meter	Pressure
Infra red Temperature Measuring Device/ Indicator,	Temperature
Ultrasonic Flow meter.	Water Flow

2.6 Operating Hours Considered for Calculation Purpose

Table 2: Operating hours considered for calculation purpose

Particulars	Hours/ annum
General Lighting (10 hrs./day, 365 days)	3650 hrs. per annum
Pumps (8 hrs./day, 265 days)	2920 hrs. per annum
AC's (10 hrs./day, 240 days for office blocks)	2400 hrs. per annum

2.7 ANNUAL ENERGY CONSUMPTION DATA

Table 3: Annual Energy Consumption Data

Particulars	Values
Power Supply from Grid	BPSMV has five grid connections Connection-1: 2107 kVA (for the main campus), Connection-2: 301 kW, Connection-3: 166 kW, Connection-4: 116 kW Connection-5: 64 kW Billing on connection-1 is done on kVAh basis. Billing on connection-2 to 5 is done on kWh basis.
Supply Voltage	11 kV
Units Billed (grid supply)	FY 2019-20 Connection-1 (main campus) = 28.56 lakh kWh FY 2020-21 Connection-1 (main campus) = 15.25 lakh kWh. The consumption has reduced due to the pandemic during FY 2020-21. Besides the above, there are four more connections in the campus, with an average power consumption as follows: Average monthly consumption based on data from Oct-20 to Sep-21 Connection-2: 3343 kVAh / 1916 kWh, Connection-3: 11318 kVAh / 8228 kWh, Connection-4: 7210 kVAh / 3652 kWh Connection-5: 55 kVAh / 10 kWh
Solar Power	
Installed capacity of Solar PV	The campus has a 1 MW solar power plant at the five locations. 11 kV main substation: 198 kWp B.Ed College substation: 435.6 kWp Mahila Polytechnic substation: 66 kWp Law college substation: 158.4 kWp Ayurveda New & Old Building: 145.2 kWp The power generation from Solar PV w.e.f. Apr-21 to Nov-21 was 9.52 lakh kWh.

Particulars	Values
Self-Generated Power through DG Sets	
Installed capacity: DG Sets (kVA)	2 Nos. of DG set-1 of 25 kVA rating 9 Nos. of DG set-2 of 62.5 kVA rating 2 Nos. of DG set-3 of 82.5 kVA rating 1 Nos. of DG set-4 of 100 kVA rating 3 Nos. of DG set-5 of 125 kVA rating 1 No. of DG set-6 of 128 kVA rating
Electricity generation through DG Sets	There is no energy meter installed on the DG sets, thus the annual kWh generation is not available. However based on the performance evaluation done on few DG sets, the specific power generation was around 3 kWh/ ltr, based on which the estimated power generation figures have been calculated: FY 2019-20: 1525 lts per annum (≅ 4575 kWh) FY 2020-21: 1423 lts per annum (≅ 4269 kWh)
HSD Bill	FY 2019-20: Rs 1.30 Lakhs per annum FY 2020-21: Rs 1.21 Lakhs per annum
Total Power Consumption	
Annual Electricity Consumption for main Campus (Grid Connection-1 + DG Sets)	FY 2019-20 Grid: 28.56 Lakh kWh per annum HSD: 0.045 Lakh kWh per annum **Total 28.60 Lakh kWh per annum** FY 2020-21 Grid: 15.25 Lakh kWh per annum HSD: 0.043 Lakh kWh per annum **Total 15.29 Lakh kWh per annum**

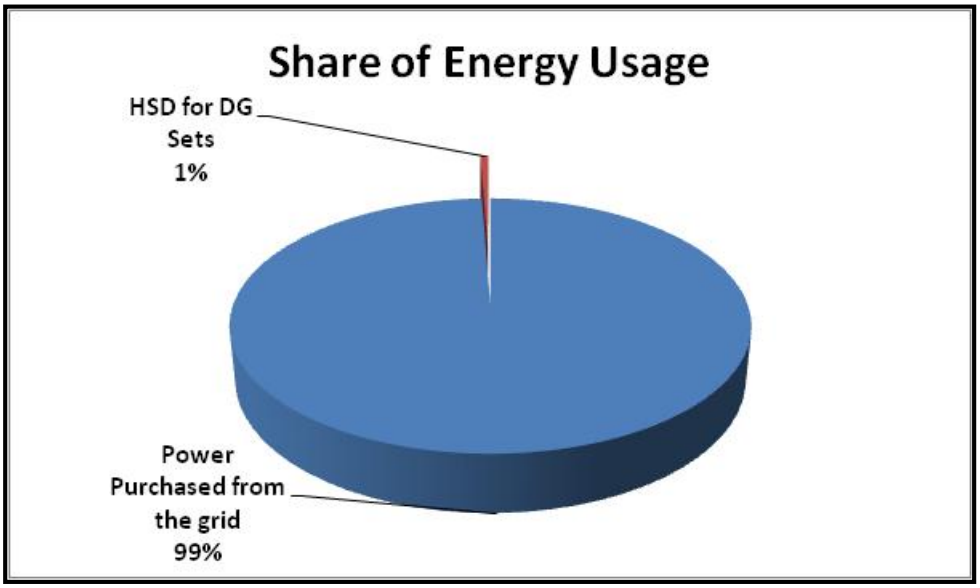
Particulars	Values
Energy Bill for main Campus (Grid Connection-1 + HSD in DG Sets)	FY 2019-20 Grid: Rs 237.8 Lakh per annum HSD: Rs 1.30 Lakh per annum **Total Rs 239.1 Lakh per annum** FY 2020-21 Grid: Rs 144.2 Lakh per annum HSD: Rs 1.21 Lakh per annum **Total Rs 145.4 Lakh per annum**
Built up area of the campus	Approx. 153797 sq mts Conditioned Area: 5500 sq mts Non air conditioned air: 148295 sq mts
EPI (Energy Performance Index)	FY 2019-20 519 kWh/m^2/yr based on conditioned area 18.5 kWh/m^2/yr based on built-up area FY 2020-21 277 kWh/m^2/yr based on conditioned area 9.9 kWh/m^2/yr based on built-up area

2.8 TOE CALCULATION

Table 4: Annual Energy Consumption in TOE Terms

Source of Energy	Annual Consumption	Calorific Value	kCal/annum	TOE/annum
FY 2019-20				
Power Purchased from the grid	28.56 Lakh kWh	860 kCal/ kWh	2456160000	245.6
HSD for DG Sets	1525 Ltrs	9783 kCal/ltr	13921209	1.5
Total				**247.1**

Source of Energy	Annual Consumption	Calorific Value	kCal/annum	TOE/annum
FY 2020-21				
Power Purchased from the grid	15.25 Lakh kWh	860 kCal/ kWh	1311500000	131.2
HSD for DG Sets	1423 Ltrs	9783 kCal/ltr	13921209	1.4
Total				**132.6**



3 POWER SUPPLY SYSTEM AND ENERGY CONSUMPTION PATTERN

3.1 POWER SUPPLY SYSTEM

The Power Supply to the BPSMV is sourced from:

- Grid - Uttar Haryana Bijli Vitran Nigam Limited at 11 kV (Five connections)

  Connection-1: 2107 kW (for the main campus),
  Connection-2: 301 kW,
  Connection-3: 166 kW,
  Connection-4: 116 kW
  Connection-5: 64 kW

- DG Sets – 2 Nos. of 25 kVA, 9 Nos. of 62.5 kVA, 2 Nos. of 82.5 kVA, 1 Nos. of 100 kVA, 3 Nos. of 125 kVA & 1Nos of 128 kVA.

The 11 kV input supply from the grid is stepped down to LT Voltage levels using ten transformers. Rated specifications of the transformers & DG Sets is given under Annexure-1 & 2.

3.2 MONTHLY POWER CONSUMPTION PATTERN

3.2.1 Power Purchased from Grid – Main Campus (Connection-1)

Table 5: Monthly Electricity Bill Analysis

Month	FY 2019-20		FY 2020-21	
	kWh Consumption	Amount (Rs)	kWh Consumption	Amount (Rs)
Apr	169488	1501810	76392	687528
May	240624	1992818	99984	1034455
Jun	308304	2261734	115992	1043928
Jul	191520	1664229	182904	1604883
Aug	270912	2454403	160848	1450594
Sep	286392	2315231	208200	1834737
Oct	357432	2836654	125472	1208943
Nov	223704	1877806	80448	896556
Dec	181224	1580439	108840	1088384

Month	FY 2019-20		FY 2020-21	
	kWh Consumption	Amount (Rs)	kWh Consumption	Amount (Rs)
Jan	226032	1891496	135000	1266260
Feb	241152	1995217	98400	1013282
Mar	159930	1414147	132288	1296576
Total	**2856714**	**23785984**	**1524768**	**14426126**

3.2.2 Tariff Structure of Grid Supply for Main Campus

Table 6: Tariff Structure for Commercial Grid Supply

Particulars	Connection-1	Connection-2 to 5
Fixed Demand Charges	Rs 160 per kVA	Rs 180 per kW
Basic Energy Charges	Rs 6.40 per kVAh	Rs 7.35 per kWh
Electricity Duty	Rs 0.10 per kWh	Rs 0.10 per kWh
FSA	Rs 0.37 per kWh	Rs 0.37 per kWh
Other Charges	Municipal Tax, etc	Municipal Tax, etc

3.2.3 Self Generated Power using DG Sets

There is no energy meter installed on the DG sets, thus the annual kWh generation is not available. However based on the performance evaluation done on few DG sets, the specific power generation was around 3 kWh/ ltr, based on which the estimated power generation figures have been calculated:

FY 2019-20: 1525 lts per annum (≅ 4575 kWh) amounting to Rs 1.30 Lakhs per annum

FY 2020-21: 1423 lts per annum (≅ 4269 kWh) amounting to Rs 1.21 Lakhs per annum

3.2.4 Overall Power Rate

Table 7: Overall Power Rate (Connection-1)

Particulars	FY 2019-20	FY 2020-21
Estimated Annual Consumption	28.56 Lakh kWh/annum	15.25 Lakh kWh/annum
Estimated Annual Bill	Rs 237.8 Lakhs/annum	Rs 144.26 Lakhs/annum
Overall weighted average Rate	Rs 8.32 per kWh	Rs 9.46 per kWh

Note:- For calculation of energy savings, we have considered the overall weighted average rate of Rs 8.32 per kWh as the power consumption during FY 2020-21 was less due to pandemic.

3.3 Energy Performance Index (EPI)

Energy performance index (EPI) is total energy consumed in a building over a year divided by total built up area in kWh/sq. m/year and is considered as the simplest and most relevant indicator for qualifying a building as energy efficient or not. To evaluate EPI, total carpet area of the building was measured and total energy consumption over the year. The details are as follows:

Approx. Built-up Area 153797 sq mts

- Conditioned Area: 5500 sq mts
- Non air conditioned air: 148295 sq mts

EPI for FY 2019-20

519 kWh/m^2/yr based on conditioned area
18.5 kWh/m^2/yr based on built-up area

EPI for FY 2020-21

277 kWh/m^2/yr based on conditioned area
9.9 kWh/m^2/yr based on built-up area

3.4 Transformer Loading

Measurement were made during the energy audit to measure the various electrical parameters on the transformers which were on load, summarized results are given hereunder:

3.4.1 Operating Parameters

Table 8: Summary of Operating Parameters on the Transformers

Particulars	UoM	Tr-1 (Guest House)	Tr-2 (Teaching Block-II)	Tr-6 (B.Ed Collage)	Tr-8 (Staff Quarter)	Tr-9 (Polytechnic)	Tr-10 (Law Collage)
Transformer Rating>>>	kVA	500	500	500	500	400	1500
Operating Voltage (Volts)	Phase "R"	412.4	412.5	430.8	406.7	409	423
	Phase "Y"	411.5	412.6	428.1	404.7	405.2	419.3
	Phase "B"	409.8	409.5	429.4	408.5	409.2	415

Particulars	UoM	Tr-1 (Guest House)	Tr-2 (Teaching Block-II)	Tr-6 (B.Ed Collage)	Tr-8 (Staff Quarter)	Tr-9 (Polytechnic)	Tr-10 (Law Collage)
Operating Current (Amps)	Phase "R"	0	40.9	319.3	27.3	14.1	227
	Phase "Y"	21.2	61.8	320.6	24.4	44.5	209.4
	Phase "B"	14.7	43.5	320.1	12.5	50.9	220
Operating Power Factor	Phase "R"	0	0.989	0.999	0.923	0.913	0.993
	Phase "Y"	0.969	0.987	0.999	0.979	0.987	0.993
	Phase "B"	0.965	0.993	0.999	0.702	0.981	0.987
Load (kW)		8.24	34.38	237.77	13.57	25.11	157.41
Load (kVA)		8.51	34.75	238.01	15.06	25.76	158.84

Note:- BPSMV has installed transformers near the load centers which is appreciated. This ensures very nominal distribution losses. For example in case of staff quarters / residences the average distance from the transformer to the residence is around 150 mtr. Considering an average load of 3 kW per residence, the LT line losses for a 6 Sq mm 3½ core Al cable having a resistance of 4.61 ohms per km works out to around 50 watt, which is very nominal.

3.5 RECOMMENDATIONS

3.5.1 EEM-1: Reduction of Contract Demand Limits

Connection-1 for main campus has a contract demand limit of 2107 kVA and BPSMV is paying fixed charges @ Rs 160 per kVA on the contract demand. The monthly charges amount to Rs 337120 per month. Based on the consumption pattern and measurements made during the audit, the actual maximum demand does not exceed 1000 to 1200 kVA at any point of time. Therefore it is suggested to reduce the contract demand limit from 2107 kVA to around 1500 kVA which will have a direct impact on the energy bills.

The resultant monetary benefits have been quantified herein:

Table 9: EEM-1: Energy Saving Investments & Payback Period

Particulars	Values
Contract Demand at present	2107 kVA
Fixed demand charges at present (@Rs 160 per kVA)	Rs 337120 per month
Suggested Contract Demand	1500 kVA
Fixed demand charges post reduction of contract demand (@Rs 160 per kVA)	Rs 240000 per month
Monetary Benefits	**Rs 11.64 Lakhs per annum** (Rs 0.97 Lakhs per month)
Estimated Investments	Nominal
Simple Payback Period	Immediate

3.5.2 EEM-2: Improvement in the Operating Power Factor

Since billing for connection-1 (main campus) is done on kVAh basis, power factor has a direct impact on the energy bills.

Based on the performance evaluation of the capacitor banks, it was found that several capacitor banks are delivering less than 70% of their rated capacity and these need replacement. The details of these capacitors is given below.

Particulars	Rated kVAr	kVAr Delivered	%age Delivery	Remarks
Transformer-1	5	1.76	35.1%	Need Replacement
	5	1.76	35.1%	Need Replacement
	10	1.98	19.8%	Need Replacement
	25	3.89	15.6%	Need Replacement
	25	6.03	24.1%	Need Replacement
	25	12.29	49.2%	Need Replacement
	25	18.7	74.8%	OK
Transformer-2	5	1.37	27.5%	Need Replacement
	5		0.0%	Not Working
	10	5.5	55.0%	Need Replacement
	25	6.11	24.4%	Need Replacement
	25	10	40.0%	Need Replacement
	25	10.61	42.4%	Need Replacement
	25	21.3	85.2%	OK

Particulars	Rated kVAr	kVAr Delivered	%age Delivery	Remarks
Transformer-3	5	2.67	53.4%	Need Replacement
	5	1.76	35.1%	Need Replacement
	10	1.37	13.7%	Need Replacement
	25	4.05	16.2%	Need Replacement
	25	3.89	15.6%	Need Replacement
	25		0.0%	Not Working
	25	2.29	9.2%	Need Replacement
Transformer-4	5	0.76	15.3%	Need Replacement
	5	2.59	51.8%	Need Replacement
	10	0.99	9.9%	Need Replacement
	25	5.04	20.2%	Need Replacement
	25	1.91	7.6%	Need Replacement
	25	5.11	20.5%	Need Replacement
	25	0.99	4.0%	Need Replacement
Transformer-5	5	1.37	27.5%	Need Replacement
	5	1.6	32.1%	Need Replacement
	10	2.21	22.1%	Need Replacement
	25	5.8	23.2%	Need Replacement
	25	3.31	13.2%	Need Replacement
	25	6.85	27.4%	Need Replacement
	25	8.85	35.4%	Need Replacement
Transformer 6	5	4.27	85.5%	OK
	5	4.2	84.0%	OK
	10	8.63	86.3%	OK
	25	21.3	85.2%	OK
	25	21.37	85.5%	OK
	25	21.3	85.2%	OK
	25	21.37	85.5%	OK
Transformer 7 (Stand By)	5	0	0.0%	Not in operation
	10	0	0.0%	Not in operation
	25	0	0.0%	Not in operation
	25	0	0.0%	Not in operation

Particulars	Rated kVAr	kVAr Delivered	%age Delivery	Remarks
Transformer 8	5	0	0.0%	Not in operation
	10	0	0.0%	Not in operation
	10	0	0.0%	Not in operation
	25	0	0.0%	Not in operation
	25	0	0.0%	Not in operation
	25	0	0.0%	Not in operation
	25	0	0.0%	Not in operation
Transformer 9	10	5.34	53.4%	Need Replacement
	10	2.6	26.0%	Need Replacement
	10	4.27	42.7%	Need Replacement
	10	4.12	41.2%	Need Replacement
	10	4.58	45.8%	Need Replacement
	10	4.27	42.7%	Need Replacement
	25	0.76	3.1%	Need Replacement
Transformer 10	5	1.53	30.5%	Need Replacement
	5	2.67	53.4%	Need Replacement
	10	0.76	7.6%	Need Replacement
	25	4.89	19.5%	Need Replacement
	25	6.95	27.8%	Need Replacement
	25	5.04	20.2%	Need Replacement
	25	0.76	3.1%	Need Replacement

Besides replacement of the above capacitors, further augmentation in the kVAr capacity may be required at various levels to improve the power factor to around unity.

Average overall system power factor at present based on the latest electricity bills for the month of Jul-21 to Sep-21 on Connection-1	0.964
Sanctioned Load	2107 kVA
Desired Power Factor	0.99
Additional kVAr requirement (based on 2107 kVA sanctioned load)	280 kVAr

Formula to Calculate the additional kVAr requirement

Additional kVAr Required = Power Drawn x [tan{$\cos^{-1}$(Old power factor)}-tan{$\cos^{-1}$(New power factor)}]

With the implementation of the above measures, the kVAh consumption would reduce, resulting in monetary benefits as follows:

Table 10: EEM-2: Energy Saving Investments & Payback Period

Present Scenario	Values
Average monthly kVAh Consumption (period Jul-21 to Sep-21)	83770 kVAh per month
Average monthly kWh Consumption (period Jul-21 to Sep-21)	80790 kWh per month
Average operating power factor based on above three months electricity bills	0.964
Scenario post improvement of power factor	
Average monthly kVAh Consumption at 0.99 power factor	81606 kVAh per month
Net reduction in the kVAh consumption with improvement in pf from 0.964 to 0.99	2164 kVAh per month (25968 kVAh per annum)
Net power rate (per kVAh) without fixed charges	Rs 6.40 per kVAh
Monetary Benefits	**Rs 1.66 Lakhs per annum**
Estimated Investments for additional capacitor banks of 280 kVAr to be installed	Rs 1.40 Lakhs
Simple Payback Period	< one year

4 STUDY OF AIRCONDITIONING SYSTEM

4.1 SYSTEMS INSTALLED

The location wise details of the ACs installed in given under Annexure-3. Summary of the same is given herein:

Table 11: Rated Specifications of Total Air Conditioning Systems Installed in all Block

Location	Window ACs		Split ACs		Cassette ACs
	1.0 Ton	1.5 Ton	1.5 Ton	2.0 Ton	3.0 Ton
Teaching Block – I		23	10	36	
Teaching Block – II		25		8	
Administration Block				46	3
New Guest House		5		16	
VC Residence				7	
Registrar Residence	1		4	1	
Hostel Chief Warden			1		
Central Library				15	
Old Guest House	1	6			
K.G.S.S School			1		
Campus School		4			
ITTR Collage			3	1	
IHL Collage		2	1	1	
LRC			1	21	
U.G.C		5	3	1	
Polytechnic Collage		16		1	
Law Collage		5	4	5	
BAMS Collage		5	2	2	
Other Labs & Dept.				31	
Dept. of Hotel Management				5	
Total	**2**	**96**	**30**	**197**	**3**

4.2 MEASUREMENTS MADE

The operating performance of few AC's was done on a sample basis, results have been tabulated herein:

Table 12: Operating Performance of Package ACs

Particulars	Package AC-1	Package AC-2
Rated Data		
Make	Blue Star	
Model	HNCS36YAFO	
Cooling Capacity (W.)	10000	
Heating Capacity (W)	12000	
Cooling Power Input (W)	3120	
Heating Power Input (W)	3320	
Location	Conference Hall (Academic Building)	
Numbers installed / Operational	3 (2)	
Operating Data		
Voltage (Volts)	438.9	437.8
Current (Amps)	3.88	3.87
Power Factor	0.963	0.947
Load (kW)	2.84	2.78
Tr Delivered	2.85	2.86
Specific Power Consumption	1.00	0.97
Remarks	Satisfactory	Satisfactory

Table 13: Operating Performance of Window / Split ACs

Type of AC	Split	Split	Split	Split	Split	Split	Split	Window	Split	Window
Rated Data										
Make	Whirlpool	Voltas	Voltas	Blue Star	Blue Star	Voltas	LG	LG	Hitachi	LG
Cooling Capacity	6400 W	6150 W	6450 W	5100 W	-	-	24000 Btu/Hr.	-	7030	-
Location	Mr. Lodhi Room (Technical Block-2)	Multipurpose Hall (Teaching Block-I)					Dr. Naresh Bhargaw Room	Room No. 119 (Technical Blick-1)	Room No. 104 (Technical Blick-1)	Room No. 201 (Technical Blick-1)
Operating Data										
Voltage (Volts)	234	231	231.3	233	232.9	230.1	230.5	232.1	231.4	230.8
Current (Amps)	12.69	13.99	10.49	12.19	10.70	10.52	11.51	10.50	12.31	9.70
Power Factor	0.64	0.65	0.68	0.69	0.71	0.69	0.72	0.71	0.73	0.71
Load (kW)	1.90	2.10	1.65	1.96	1.77	1.67	1.91	1.73	2.08	1.59
Tr Delivered	1.87	1.85	1.30	1.40	1.35	1.31	1.48	1.30	1.84	1.20
Specific Power Consumption	1.0	1.1	1.3	1.4	1.3	1.3	1.3	1.3	1.1	1.3
Remarks	Satisfactory	Satisfactory	Poor	Poor	Poor	Poor	Poor	Poor	Satisfactory	Poor

Average Specific Power Consumption of Poor performing ACs : 1.31 kW/TR
Average Specific Power Consumption of Satisfactorily operating ACs : 1.09 kW/TR

4.3 RECOMMENDATIONS

4.3.1 EEM-3: Replacement of old In-efficient Window AC/s with Five Star Rated A/Cs

Based on the performance assessment of the Window / Split ACs, it was observed that the average specific power consumption of the non star rated ACs was around 1.31 kW/TR which is quite high when compared to modern day 5 star rated / Inverter ACs. It is therefore suggested to replace the old non star rated ACs with new star rated energy efficient ACs. The list of ACs which require replacement have been given below:

Location	Make	Number of ACs considered for replacement		
		Window (1.5 TR)	Split (1.5 TR)	Split (2 TR)
Teaching Block – I				
Ground Floor				
D.S.W Room no.3	LG/Bluestar		1	2
Physical education Room no. 4	Blue Star	1		
Conference Hall Room No. 8	Voltas		4	
Hotel management Room No. 10	Voltas	1		
Multipurpose Hall Room No. 19	Voltas		4	5
Multipurpose Hall Room No. 19	Blue Star			2
History Department Room No. 23	LG		1	2
History Department Room No. 24	Blue Star			1
First Floor				
English Department Room No. 102	Voltas	2		
English Department Room No. 103	Videocon			1
English Department Room No. 109	Voltas	1		
Room no. 114	Voltas	1		
Public Relation officer Room no. 119	LG	1		
Second Floor				
Economics Room no. 201	Voltas	1		
Economics Room no. 223	Voltas	1		
Economics staff Room no. 205	Voltas	2		
Computer L.A.B Room no. 206	Voltas	1		
C.S.U.I.R. Room no. 208	LG	1		
C.S.U.I.R. Room no. 209	Blue Star			1
C.S.U.I.R. Room no. 210	Voltas	1		

Location	Make	Number of ACs considered for replacement		
		Window (1.5 TR)	Split (1.5 TR)	Split (2 TR)
C.S.U.I.R. Room no. 216 (Seminar Hall)	LG			2
Third Floor				
M.B.A Room no. 305 (Computer Lab)	Voltas	2		
M.B.A Room no. 306 (Hall)	Sharp	1		
M.B.A Room no. 308 (Staff Room)	Sharp	1		
M.B.A Room no. 309	Voltas / Bluestar	1		1
M.B.A Room no. 311	Voltas	1		
Management Room no. 317	Voltas	1		
Management Room no. 328	Sharp	1		
Commerce Room no. 331	Sharp	1		
Teaching Block – II				
Ground Floor				
C.S.E Room no.24 Chairperson of CSE / IT	Blue Star			1
C.S.E Conference Hall Room no.23	Blue Star			3
Library Room no. 20	Voltas	4		
First Floor				
Computer Center Room no. 121	Voltas	4		
Server Room no. 103	Voltas	2		
C.S.E/I.T Room no. 104 (D.B.M.S)	Voltas	3		
Programming L.A.B Room no.105	Voltas	4		
Operating System L.A.B Room no. 106	Voltas	3		
Second Floor				
ECE Room no.208 (Lab)	Voltas	4		
Third Floor				
Mathematic Room no. 324	LG	1		
Administration Block				
Ground Floor				
First Floor				
Room no. 14 (F.O)	Blue Star			1
Room no. 18 (Auditor)	Blue Star			1
Room no. 27	LG			1
Room no. 29	Voltas			1

Location	Make	Number of ACs considered for replacement		
		Window (1.5 TR)	Split (1.5 TR)	Split (2 TR)
Room no. 38	LG			1
Digital university Room no. 35	Voltas			1
Suresh Kr. Solanki (Assistant Registrar)	LG			1
New Guest House				
Ground Floor				
Visitors Room	LG			4
V.I.P. Suite	LG			2
Room No. 1	LG			1
Room No 2	LG			1
First Floor				
V.I. P Suite	Blue Star			1
V.I. P. Suite	LG			1
Room No. 3	LG			1
Room No. 4	LG			1
Room No. 5	LG			1
Room No. 6	Blue Star			1
Room No. 7	Blue Star			1
Second Floor				
V.I.P Suite	Blue Star			1
Room No. 8	Voltas	1		
Room No. 9	Voltas	1		
Room No. 10	Voltas	1		
Room No. 11	Voltas	1		
Room No. 12	Voltas	1		
VC Residence				
Ground Floor				
Office	Voltas			1
Room no. 1	Voltas			1
Room no. 2	Voltas			1
First Floor				
Room no. 3	LG			1
Room no. 4	Voltas			1

Location	Make	Number of ACs considered for replacement		
		Window (1.5 TR)	Split (1.5 TR)	Split (2 TR)
Registrar Residence				
Office	Voltas		1	
Drawing Room	Voltas		1	
Room no. 2	Voltas		1	
Room no. 3	Voltas		1	
Hostel Chief Warden				
Office	LG		1	
Central Library				
Central Library	Blue Star			15
Old Guest House				
Room no. 1	LG	1		
Room no. 2	LG	1		
Room no. 3	LG	1		
Room no. 4	LG	1		
Room no. 5	LG	1		
Room no. 6	Samsung	1		
K.G.S.S School				
Principal Office	Voltas		1	
Campus School				
Principal Office	Voltas	1		
	Voltas	2		
	Voltas	1		
ITTR College				
Principal Office	Voltas			1
Room no. 102	Voltas		1	
Room no. 103	Voltas		1	
Room no. 111	Voltas		1	
IHL College				
Principal Office	LG		1	
Room no.	LG	1		
Physics Lab	LG	1		

Location	Make	Number of ACs considered for replacement		
		Window (1.5 TR)	Split (1.5 TR)	Split (2 TR)
LRC				
Room	Blue Star		1	
Conference Room	Blue Star			1
Lib.	Blue Star			2
Lib. I	Blue Star			2
Lib. II	Blue Star			1
V. 2	Blue Star			1
A. 2	Blue Star			2
A. 3	Blue Star			2
V. 3	Blue Star			1
Polytechnic College				
Principle Office	LG			1
Computer Hall	LG	4		
Computer Hall Room no. 13	Voltas	2		
Computer Hall Room no. 14	LG	2		
Library Room no. 57	LG	4		
Faculty Room	Voltas	1		
Biology Lab Room no. 23	LG	1		
Computer Lab Room no. 45	Voltas	1		
Computer Lab Room no. 44	LG	1		
Law College				
Office Room No. 2	LG			2
Room no. 15	LG		1	
Conference Hall	LG	5		
Room no. 17	LG		1	
Video Conference Hall Room no. 14	LG		1	
Room no. 101	LG		1	
BAMS College				
Room No. 9 (Dr. M.K Gupta)	Voltas	1		
Room No. 12 (Pathology)	Samsung		1	
Principal office	LG		1	
Room No. 20	Voltas	1		
Labor Room No. 27	Voltas	1		

Location	Make	Number of ACs considered for replacement		
		Window (1.5 TR)	Split (1.5 TR)	Split (2 TR)
OT Room No. 38	Voltas	2		
Total number of ACs which require replacement		**91**	**27**	**80**
Replacement of all the ACs should be done in a phased manner or as a failure replacement policy. Under phase-1, it has been considered that 25% of the ACs may be replaced		30 ACs		20 ACs

Table 14: EEM-3: Energy Saving, Investments & Simple Payback Period

Particulars	Window / Split ACs (1.5 TR)	Split ACs (2 TR)
Average specific power consumption of the existing non star rated A/Cs	1.31 kW per TR	
Average specific power consumption of the new 5 star rated A/Cs	1.0 kW per TR	
Rated Cooling Capacity	1.5 TR	2 TR
Equivalent Power Saving	0.46 kW per AC	0.62 kW per AC
Number of A/Cs considered for replacement under phase-1	30 Nos	20 Nos
Total Power Saving	13.8 kW	12.4 kW
	26.2 kW	
Working Hours per annum (10 hrs/day x 240 days/annum)	2400 hrs/annum	
Annual Power Saving	62880 kWh/annum	
Weighted average Grid Power rate	Rs 8.32 per kWh	
Monetary Benefits	**Rs. 5.23 Lakhs/annum**	
Estimated Investment (for 30 AC's of 1.5 TR and 20 AC's of 2 TR)	Rs. 22 Lakhs	
Simple Payback period	4-5 Years	

5 LIGHTING

5.1 SYSTEMS INSTALLED

BPSMV has installed LED lights at most of the locations; however at few locations, conventional lights have been installed. Details of lights installed along with wattage, type etc is given hereunder:

Table 15: Details of lighting fixtures installed

Type of light	Watt per Light	Numbers of Lights Installed
LED Bulb	20 W	30
LED Bulb	40 W	10
LED Ceiling Light	36 W	254
LED Panel Light	30 W	22
LED Panel Light	36 W	60
LED Round Light	12 W	61
LED square light	12 W	51
LED Street Light fittings	45 W	176
LED Street Light fittings	90 W	52
LED Street Light fittings	150 W	47
LED Street Light fittings	200 W	36
LED Street Light fittings	60 W	54
LED Street Light fittings	30 W	20
LED Tube Light	18 W	2310
Light Fittings	2 x 14 W	144
Light Fittings	4 x 14 W	596
Tube Light	36 W	136
Tube Lights	1 x 28 W	833
Tube Lights	14 W	1024
Tube Lights	2 x 28 W	263

5.2 RECOMMENDATION

5.2.1 EEM-4: Replacement of conventional lights with LED Lights

BPSMV is already in the process of replacing conventional lights with LED lights and has installed LED lights at most of the locations; however at few locations, conventional lights has been installed. The conventional tube lights (TL) have low efficacy and can be replaced by the high efficacy LED lights for the same lumen output.

It is suggested that conventional Lights which are yet to be replaced may also be replaced with energy efficient LED lights of appropriate rating.

Table 16: EEM-4: Energy Saving, Investments & Simple Payback Period

Existing Scenario				Post Implementation scenario	
Type of Lights	**Wattage**	**Qty**	**Total Wattage**	**Wattage of Proposed LED Light**	**Total wattage of new LED Lights**
Tube Light	36	136	4896	20	2720
Tube Light	1x28	833	23324	1x20	16660
Tube Light	2x28	263	14728	2x20	10520
Total			**42948**		**29900**

Particulars	Values
Power Saving Potential	13 kW
Annual Operational hours	3650 hours
Overall Power Rate	Rs 8.32 per kWh
Energy Saving potential	47450 kWh per annum
Net Monetary Benefit	**Rs 3.95 Lakhs per annum**
Estimated Investment for 1495 nos of 20 W LED Tube Lights (@Rs 350 per LED light of 20 W)	Rs 5.23 Lakhs
Simple Payback Period	1-2 years

5.2.2 EEM-5: Installation of astronomical timers on the Street Lights

Astronomical timers can be used to automate the operation of street lights based on the time of sunrise and sunset. This is done by programming the coordinates and current time of the location which enables operation of the light without use of external sensors & manual intervention throughout the year. These are microprocessor-based device designed for operation in automatic control systems with reference to astronomical time (sunrise/sunset).

There is a program setting that ensures shutdown of the load within night time period (night break). The built-in power source (lithium-type battery) ensures keeping of operation state of the real-time clock and the device in case of power supply loss from the network.

Features of astronomical timer for street lighting:

- Digital time relay with astronomical program;
- Sealable front panel cover;
- Setting by means of four push-buttons;
- Automatic changeover to summer/winter time;
- Liquid crystal display (LCD);
- Working hours for days-off;
- Single channel;
- Double module mounted on 35 mm DIN-rail

Based on a conservative estimate, around 30 minutes of reduction in the operating time of the street lights per day can be achieved with the installable of the above astronomical timers.

Type of light	Watt per Light	Numbers of Lights Installed	Load (Wattage)
LED Street Light fittings	45 W	176	7920
LED Street Light fittings	90 W	52	4680
LED Street Light fittings	150 W	47	7050
LED Street Light fittings	200 W	36	7200
LED Street Light fittings	60 W	54	3240
LED Street Light fittings	30 W	20	600
Total			**30690**

Table 17: EEM-5: Energy Saving, Investments & Simple Payback Period

Particulars	Values
Connected load of street lights	30.7 kW
Estimated reduction in the operating time	30 minutes per day
Working days per annum	365 days
Energy Saving potential	5602 kWh per annum
Overall Power Rate	Rs 8.32 per kWh
Monetary Benefit	**Rs 0.47 Lakhs per annum**
Estimated Investment	Rs 0.30 Lakhs
Simple Payback Period	< 1 year

6 PUMPS

6.1 SYSTEMS INSTALLED

The campus has two raw water pumps & two filter pumps. The rated specifications of these pumps is given herein:

Table 18: Rated specifications of Pumps

Particulars	Raw Water Pumps	Filter Pumps
Number of pumps installed	2 nos	2 nos
Motor		
Make	Crompton Greaves	Crompton Greaves
Rating (kW)	15	37
Voltage (Volts)	415	415
Current (Amps)	27	66
Speed (rpm)	1460	1475
Frequency (Hz)	50	50
Phase	3	3
Pump		
Make	Mather + Platt Pumps Ltd.	Wilo/Mather + Platt
Type	576 LONO	100/127 BST TE
Head (MWC)	12	40
Flow (M^3/H)	228	228
Speed (rpm)	1460	1475

In addition to the above, two agricultural pumps are also installed, however the working of these pumps is limited to around ½ hour per day.

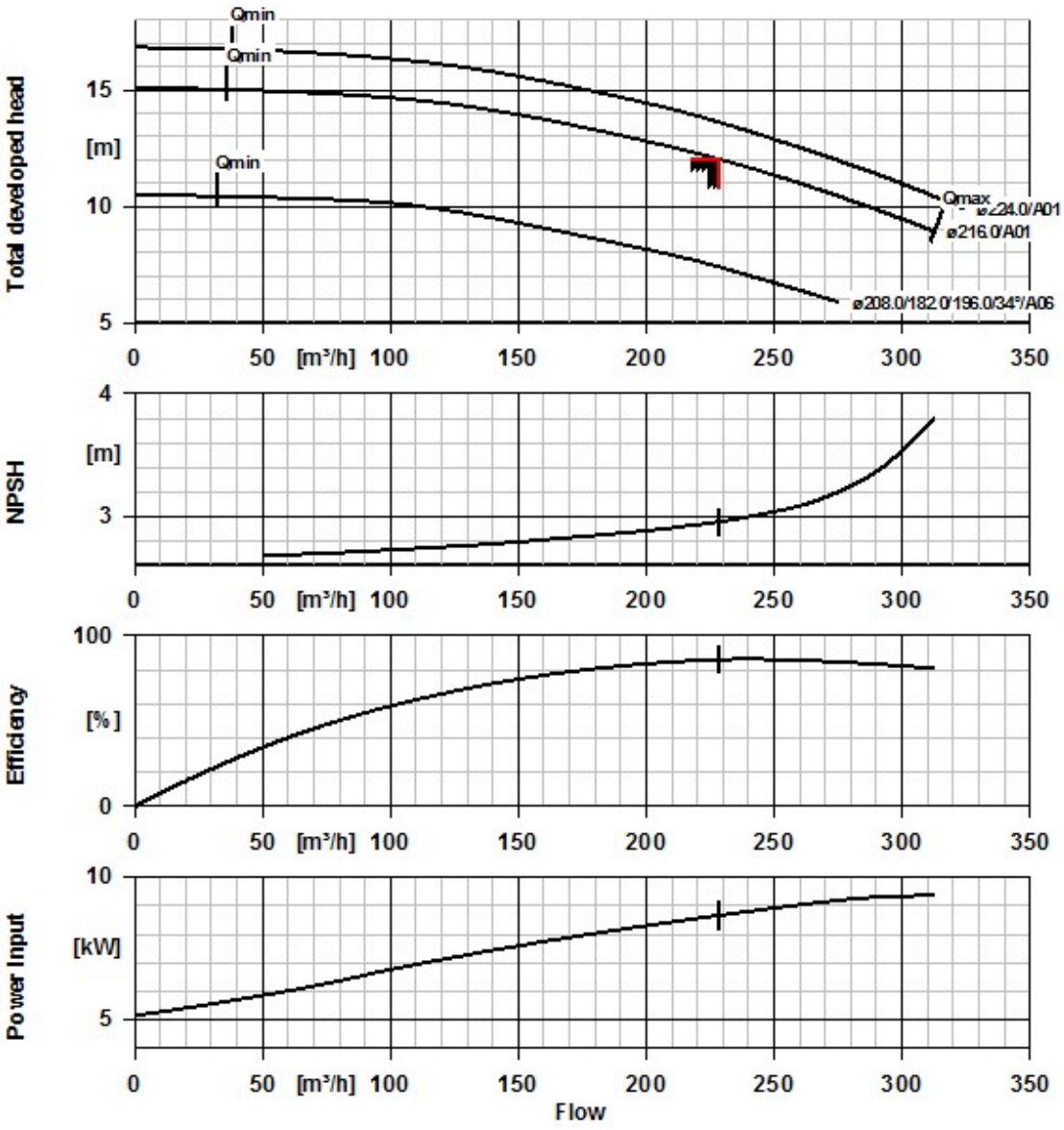
6.2 RECOMMENDATIONS

6.2.1 EEM-6: Replacement of Raw Water Pumps with Energy Efficient Pumps

The existing raw water pumps are quite old having a design efficiency of around 55% which is low when we compare it with modern day energy efficient pumps. It is suggested to replace the raw water pump motor set with new energy efficient pump motor set of the following specifications:

Rated Head: 12 mH
Rated Flow: 228 m^3/hr
Rated Pump Efficiency: 86%
Motor Rating:12.5 HP
Rated Motor Efficiency: 95%

Performance Curve of the proposed Pump



Speed	MassFlow	Flow rate	Discharge head	Discharge pressure	Efficiency	Q2Qop	Power	Power-MaxCurve	Min-FlowRate	Min. MassFlowRat	SoundPres Level
1457 rpm	63.14 kg/s	228.33 m³/h	12.03 m	1.17 bar.g	86.0 %	95.1 %	8.67 kW	9.37 kW	35.95 m³/h	9.94 kg/s	0 dBa

Table 19: EEM-6: Energy Saving, Investments & Simple Payback Period

Particulars	Values
Operating Voltage	403 Volts
Operating Current	20.1 Amps
Operating Power Factor	0.93
Operating Load	13 kW
Design Efficiency of the existing pump	55%
Operating Efficiency of new pump motor set (Design overall system Efficiency 81% considering p[ump efficiency at 86% & motor efficiency 95%)	72%
Estimated reduction in operating load	3 kW
Working hours per annum (8 hrs/day; 365 days)	2920 Hrs per annum
Energy Saving potential	8760 kWh per annum
Overall Power Rate	Rs 8.32 per kWh
Monetary Benefit	**Rs 0.73 Lakhs per annum**
Estimated Investment	Rs 1.0 Lakhs
Simple Payback Period	1-2 years

7 SUMMARY

7.1 IMPLEMENTATION PLAN

Implementation of the recommendations should be taken up in a phased manner. Recommendations, which involve least changes and lesser payback period, should be taken up under phase-1 of the implementation program. These would include the following:

- EEM-1: Reduction of Contract Demand Limits
- EEM-2: Improvement in the Operating Power Factor
- EEM-4: Replacement of conventional lights with LED Lights
- EEM-5: Installation of astronomical timers on the Street Lights
- EEM-6: Replacement of Raw Water Pumps with Energy Efficient Pumps

Under Phase-2, recommendations which involve higher investments and have longer payback period may be implemented. Here the sequence of implementation can be based on the investments. These would include:

- EEM-3: Replacement of old In-efficient Window AC/s with Five Star Rated A/Cs

7.2 CUMULATIVE ENERGY EFFICIENCY MEASURES

Table 20: Cumulative Energy Saving Measures, Investments & Payback Period

EEMs	Annual Energy Savings				Estimated Investment (Rs in Lakhs)	Simple Payback Period (Years)
	kVAh	kWh	toe	Rs in Lakhs		
EEM-1: Reduction of Contract Demand Limits				11.64	Nominal	Immediate
EEM-2: Improvement in the Operating Power Factor	25968			1.66	1.40	< 1
EEM-3: Replacement of old In-efficient Window AC/s with Five Star Rated A/Cs		62880	5.4	5.23	22	4.21

EEMs	Annual Energy Savings				Estimated Investment (Rs in Lakhs)	Simple Payback Period (Years)
	kVAh	kWh	toe	Rs in Lakhs		
EEM-4: Replacement of conventional lights with LED Lights		47450	4.1	3.95	5.23	1.32
EEM-5: Installation of astronomical timers on the Street Lights		5602	0.5	0.47	0.3	0.64
EEM-6: Replacement of Raw Water Pumps with Energy Efficient Pumps		8760	0.8	0.73	1	1.37
Total	**25968**	**124692**	**10.8**	**23.68**	**29.93**	**2-3**

Note:- There will be no TOE savings for reduction in kVAh consumption.

7.3 Energy Saving Potential

Percentage energy savings have been calculated based on the energy consumption during the FY 2019-20 as the power consumption during FY 2020-21 was less due to pandemic.

Table 21: Energy Saving Potential

Particulars	In Monetary terms	In TOE Terms
Approx Purchased Power Bill on Connection-1 for the FY 2019-20	Rs 237.8 Lakhs/annum	245.6 TOE/annum
HSD for DG Sets	Rs 1.3 Lakhs/annum	1.5 TOE/annum
Total	***Rs 239.1 Lakhs/annum***	***247.1 TOE/annum***
Energy Savings Identified	Rs 23.68 Lakhs/annum	10.8 TOE/annum
Percentage Energy Saving Potential	**9.9%**	**4.3%**

8 ANNEXURES

8.1 ANNEXURE-1: RATED SPECIFICATION OF TRANSFORMERS

Particulars	Transformers-1	Transformers-2	Transformers-3	Transformers-4	Transformers-5	Transformers-6 & 7	Transformers-8	Transformers-9	Transformers-10
Make	Kirloskar Power Equipments Ltd.	Kirloskar Power Equipments Ltd.	Kirloskar Power Equipments Ltd.	Kirloskar Power Equipments Ltd.	Kirloskar Power Equipments Ltd.	Kirloskar Power Equipments Ltd.	Kirloskar Power Equipments Ltd.	Kirloskar Power Equipments Ltd.	Kirloskar Power Equipments Ltd.
Rating	500 kVA	500 kVA	500 kVA	500 kVA	500 kVA	500 kVA	500 kVA	315 kVA	500 kVA
Voltage Ratio	11 kV /433 V	11 kV /433 V	11 kV /433 V	11 kV /433 V	11 kV /433 V	11 kV /433 V	11 kV /433 V	11 kV /433 V	11 kV /433 V
Current Ratio	26.20 Amps / 666.7Amps	26.20 Amps / 666.7Amps	26.20 Amps / 666.7Amps	26.20 Amps / 666.7Amps	26.20 Amps / 666.7Amps	26.20 Amps / 666.7Amps	26.20 Amps / 666.7Amps	16.50 Amps / 420 Amps	26.20 Amps / 666.7Amps
Frequency(Hz)	50	50	50	50	50	50	50	50	50
Phase	3	3	3	3	3	3	3	3	3
Impedance	4.91%	4.84%	4.92%	4.87%	4.76%	4.70%	4.68%	4.67%	4.77%
Cooling	ONAN	ONAN	ONAN	ONAN	ONAN	ONAN	ONAN	ONAN	ONAN

8.2 ANNEXURE-2: RATED SPECIFICATIONS OF THE DG SETS

Particulars	DG-1	DG-2	DG-3	DG-4	DG-5	DG-6	DG-7	DG-8	DG-9	DG-10
Location	Main Power House	Main Power House	Main Power House	Main Power House	Main Power House	Main Power House	Power House II	Power House II	Power House II	Power House II
Feeding Area	New Guest House	Hostel No-14	Hostel No-13	Hostel No-12	Teaching Block-1	Teaching Block-2	Admin Block	B.ED College	V.C residence	Campus school
Engine										
Make	Greaves cotton Ltd.	Greaves cotton Ltd.	Greaves cotton Ltd.	Greaves cotton Ltd.	Greaves cotton Ltd.	Greaves cotton Ltd.		Ashok Leyland	Greaves cotton Ltd.	Greaves cotton Ltd.
Engine No	3208041008421	3208041008423	3208041008424	3208041010451	3308041009272	3308041009271		CNHM120911	3108031009330	3208041008422
Model	4G11TG1K	4G11TG1K	4G11TG1K	4G11TG1K	4G11TAG3K	4G11TAG3K		AL4DT1G2	3G11NAG1K	4G11TG1K
Speed (RPM)	1500	1500	1500	1500	1500	1500		1500	1500	1500
Power (kW/HP)	61	61	61	61	114	114		CMO (915 A)	24	61
Alternator										
Make	Greaves cotton Ltd.	Greaves cotton Ltd.	Greaves cotton Ltd.	Greaves cotton Ltd.	Greaves cotton Ltd.	Greaves cotton Ltd.	Mahindra Powerol (Crompton Greaves Ltd.)	Green Power Generator Pvt. Ltd.	Greaves cotton Ltd.	Greaves cotton Ltd.
Rating (kVA)	62.5	62.5	62.5	62.5	125	125	125	82.5 Electrical kVA	25	62.5
Voltage (Volts)	415	415	415	415	415	415	415	415	415	415
Current (Amps)	87	87	87	87	174	174	174	114.6	35	87
Power Factor	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Frequency (Hz)	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz
Phase	Three	Three	Three	Three	Three	Three	Three	Three	Three	Three
Speed (RPM)	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500

Particulars	DG-11	DG-12	DG-13	DG-14	DG-15	DG-16	DG-17	DG-18
Location	Near Hostel (4,5,6)	Near Hostel (7,8,9) in front of Temple	Polytechnic College	Near Canteen	Main Gate	Near main Gate of Law College	BAMS College	BAMS College
Feeding Area	Degree College, Hostel No-(4,5,6), Central Library	High School, Hostel No-(7,8,9)	Hostel No-2 & 3 (Stand By)	Ravi Bhusan Lab	Street Light (Stand By)	Law College	BAMS College	Hostel No-1
Engine								
Make	Kirloskar Oil Engines Ltd.	Ashok Leyland	Ashok Leyland	Kirloskar Oil Engines Ltd.	Ashok Leyland	Escorts Limited	Greaves cotton Ltd.	Greaves cotton Ltd.
Engine No		A9NO1400	A9N00600				1308031607758	1308031612241
Model	4R1040TA	AL6DTIDG1	AL4CTIDG2	6RI080TA	AL485TAG3	G62.5	3G11TAG25	3G11TAG25
Speed (RPM)	1500	1500	1500	1500	1500	1500	1500	1500
Power (kW/HP)	77.3	94	59	115	20	65.5	59	59
Year	June/04	10/Dec/2015	20/Jun/2016	1/Jan/2007	1/Aug/2012	1/Sep/2019	4/Aug/2016	17/Dec/2016
Alternator								
Make	Kirloskar Oil Engines Ltd.	C & S Himoinsa (P) Ltd.	C & S Himoinsa (P) Ltd.	Kirloskar Oil Engines Ltd.	Kirloskar Electric		Crompton Greaves Ltd.	Crompton Greaves Ltd.
Rating (kVA)	82.5	100	62.5	128	25	62.5	62.5	62.5
Voltage (Volts)	415	415	415	415	415	415	415	415
Current (Amps)	114.8	139.6	86.9	173.9	34.8		87	87
Power Factor	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8
Frequency (Hz)	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz	50 Hz
Phase	Three	Three	Three	Three	Three	Three	Three	Three
Speed (RPM)	1500	1500	1500	1500	1500	1500	1500	1500

8.3 ANNEXURE-3: DETAILS OF ACS INSTALLED

Location	Name	Make	Window (1 TR)	Window (1.5 TR)	Split (1.5 TR)	Split (2 TR)	Cassette (3 TR)
Teaching Block – I							
Ground Floor							
D.S.W Room no.3	Pro. Mahesh Daddich	LG/Bluestar			1	2	
Physical education Room no. 4	Pro. Santosh Sharma	Blue Star		1			
Conference Hall Room No. 8	Gen. Branch	Voltas			4		
Hotel management Room No. 10	Pankaj Mishra	Voltas		1			
Room No. 16		Whirlpool				1	
Multipurpose Hall Room No19	Gen. Branch	Voltas			4	5	
Multipurpose Hall Room No19		Blue Star				2	
History Department Room No. 23	Pro. Sumitra Jatyan	LG			1	2	
History Department Room No. 24	- Do -	Blue Star				1	
First Floor							
English Department Room No. 102	Pro. Amrita Sharma	Voltas / Whirlpool		2		2	
English Department Room No. 103	-Do-	Videocon				1	
Room No. 104	Foreign Language	Hitachi				1	
English Department Room No. 109	Dr. Ravi Bhushan	Voltas		1			

Location	Name	Make	Window (1 TR)	Window (1.5 TR)	Split (1.5 TR)	Split (2 TR)	Cassette (3 TR)
Room No. 110	Foreign Language	Whirlpool				1	
Room no. 114	Dr. Ashok Verma	Voltas		1			
Public Relation officer Room no. 119	Dr. Himanshu Parmar	LG		1			
Room No.122	Library	Whirlpool				2	
Second Floor							
Economics Room no. 201		Voltas		1			
Room no. 204		Hitachi				2	
Economics Room no. 223	Dr. Surender Mor	Voltas		1			
Economics staff Room no. 205	-Do-	Voltas		2			
Computer L.A.B Room no. 206	-Do-	Voltas / Hitachi		1		1	
C.S.U.I.R. Room no. 208	Dr. Anshu Bhardwaj	LG		1			
C.S.U.I.R. Room no. 209	Dr. Manju Pawar	Blue Star				1	
C.S.U.I.R. Room no. 210	Dr. Gian Chand	Voltas		1			
Room No. 212	Staff Room	Hitachi				1	
C.S.U.I.R. Room no. 216 (Seminar Hall)	Dr. Anshu Bhardwaj	LG				2	
Room No. 217		Hitachi				1	
Room No. 222		Whirlpool				1	
Third Floor							
M.B.A Room no. 305 (Computer Lab)	Pro. Dr. Shweta Singh	Voltas		2			
M.B.A Room no. 306 (Hall)	Pro. Dr. Shweta Singh	Sharp / Hitachi		1		1	

Location	Name	Make	Window (1 TR)	Window (1.5 TR)	Split (1.5 TR)	Split (2 TR)	Cassette (3 TR)
M.B.A Room no. 308 (Staff Room)	Pro. Dr. Shweta Singh	Sharp		1			
M.B.A Room no. 309	Pro. Dr. Shweta Singh	Voltas / Bluestar		1		1	
M.B.A Room no. 311	Secretariat	Voltas		1			
M.B.A Room no. 312 (Conference Hall)		Whirlpool				2	
Commerce Room no. 315	Pro. Hawa Singh	Whirlpool				1	
Room no. 316		Hitachi				1	
Management Room no. 317	Dr. Ipshita Bansal	Voltas		1			
Room no. 325		Hitachi				1	
Management Room no. 328	Pro. Shweta Hooda Solanki	Sharp		1			
Commerce Room no. 331	Pro. Sanket Vij	Sharp		1			
Teaching Block – II							
Ground Floor							
XEN Office Room no. 5	Executive Engineer, Technical Advisor	Whirlpool				1	
Engineering Cell Office	SDE (C) , SDE (E), All Staff	Whirlpool				1	
C.S.E Room no.24 Chairperson of CSE / IT	Dr. Ajit Singh	Blue Star				1	
C.S.E Conference Hall Room no.23	- Do -	Blue Star				3	
Library Room no. 20	Librarian	Voltas		4			

Location	Name	Make	Window (1 TR)	Window (1.5 TR)	Split (1.5 TR)	Split (2 TR)	Cassette (3 TR)
First Floor							
Computer Center Room no. 121	Dr. Ajit Singh	Voltas		4			
Server Room no. 103	- Do -	Voltas		2			
C.S.E/I.T Room no. 104 (D.B.M.S)		Voltas		3			
Programming L.A.B Room no.105		Voltas		4			
Operating System L.A.B Room no. 106		Voltas		3			
Second Floor							
ECE Room no.208 (Lab)		Voltas		4			
Room no. 208	VLSI	Hitachi				1	
Third Floor							
Mathematic Room no. 324		LG		1			
Mathematic Room no. 328		Hitachi				1	
Administration Block							
Ground Floor							
V.C Office		Whirlpool				4	
P.S Office		Whirlpool				2	
P.A Office		Whirlpool				1	
Office		Whirlpool				1	
Conference Hall		Blue Star					3
Registrar Office		Whirlpool				2	
P.A Office		Whirlpool				1	

Location	Name	Make	Window (1 TR)	Window (1.5 TR)	Split (1.5 TR)	Split (2 TR)	Cassette (3 TR)
Officer		Whirlpool				1	
Room no. 1 (NAAC Cell)		Whirlpool				1	
Room no. 2		Whirlpool				1	
Room no. 3 (ENT Branch)		Whirlpool				1	
Room no. 4 (D.R)		Whirlpool				1	
Room no. 5 (A.R)		Whirlpool				1	
Room no. 7 (General Branch)		Whirlpool				1	
Room no. 8		Whirlpool				1	
Room no. 9 (ET Branch)		Whirlpool				2	
Room no. 11 (S.O)		Whirlpool				1	
First Floor							
Room no. 14 (F.O)		Blue Star				1	
Room no. 15 (Account – I)		Whirlpool				1	
Room no. 16 (Account – II)		Whirlpool				2	
Room no. 17 (RSA) Audit Branch		Whirlpool				1	
Room no. 18 (Auditor)		Blue Star				1	
Room no. 19 (D.D Audit)		Whirlpool				1	
Room no. 20 (A.R)		Whirlpool				1	
Room no. 23 (RTI Cell)		Whirlpool				1	
Room no. 24 (P&S)		Whirlpool				1	
Room no. 27		LG				1	
Room no. 28 (RUSA)		Whirlpool				1	
Room no. 29		Voltas				1	

Location	Name	Make	Window (1 TR)	Window (1.5 TR)	Split (1.5 TR)	Split (2 TR)	Cassette (3 TR)
Room no. 31 (Academic Branch)		Whirlpool				1	
Room no. 37 (EDP Cell)		Whirlpool				1	
Room no. 38		LG				1	
Controller Of Examinations		Whirlpool				1	
Secrecy Branch		Whirlpool				2	
Result		Whirlpool				1	
Digital university Room no. 35		Voltas				1	
Room no. 40 (Secrecy Branch)		Whirlpool				2	
Suresh Kr. Solanki (Assistant Registrar)		LG				1	
New Guest House							
Ground Floor							
Visitors Room		LG				4	
V.I.P. Suite		LG				2	
Room No. 1		LG				1	
Room No 2		LG				1	
First Floor							
V.I. P Suite		Blue Star				1	
V.I. P. Suite		LG				1	
Room No. 3		LG				1	
Room No. 4		LG				1	
Room No. 5		LG				1	
Room No. 6		Blue Star				1	

Location	Name	Make	Window (1 TR)	Window (1.5 TR)	Split (1.5 TR)	Split (2 TR)	Cassette (3 TR)
Room No. 7		Blue Star				1	
Second Floor							
V.I.P Suite		Blue Star				1	
Room No. 8		Voltas		1			
Room No. 9		Voltas		1			
Room No. 10		Voltas		1			
Room No. 11		Voltas		1			
Room No. 12		Voltas		1			
VC Residence							
Ground Floor							
Dining hall		Whirlpool				1	
Office		Voltas				1	
Room no. 1		Voltas				1	
Room no. 2		Voltas				1	
Drawing Room		Whirlpool				1	
First Floor							
Room no. 3		LG				1	
Room no. 4		Voltas				1	
Registrar Residence							
Dining Hall		LG	1				
Office		Voltas			1		
Drawing Room		Voltas			1		
Room no. 1		Whirlpool				1	
Room no. 2		Voltas			1		
Room no. 3		Voltas			1		

Location	Name	Make	Window (1 TR)	Window (1.5 TR)	Split (1.5 TR)	Split (2 TR)	Cassette (3 TR)
Hostel Chief Warden							
Office (Smt. Krishana Rathee)		LG			1		
Central Library							
Central Library		Blue Star			15		
Old Guest House							
Dining Hall		LG	1				
Room no. 1		LG		1			
Room no. 2		LG		1			
Room no. 3		LG		1			
Room no. 4		LG		1			
Room no. 5		LG		1			
Room no. 6		Samsung		1			
K.G.S.S School							
Principal Office		Voltas			1		
Campus School							
Principal Office		Voltas		1			
		Voltas		2			
		Voltas		1			
ITTR Collage							
Principal Office		Voltas				1	
Room no. 102		Voltas			1		
Room no. 103		Voltas			1		
Room no. 111		Voltas			1		
IHL Collage							
Principal Office		LG / Hitachi			1	1	

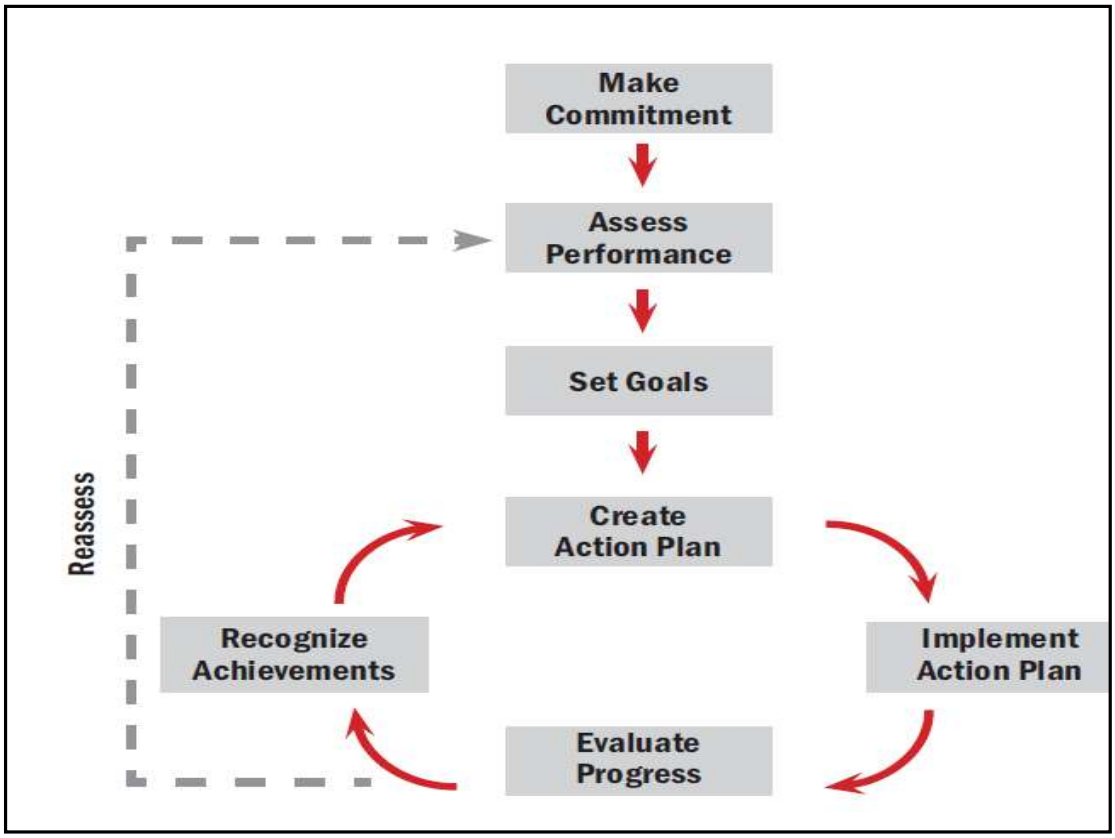
Location	Name	Make	Window (1 TR)	Window (1.5 TR)	Split (1.5 TR)	Split (2 TR)	Cassette (3 TR)
Room no.		LG		1			
Physics Lab		LG		1			
LRC							
Office LRC		Hitachi				1	
Room		Blue Star			1		
Head Office		Hitachi / Whirlpool				2	
Theatre		Hitachi / Whirlpool				2	
Conference Room		Blue Star / Hitachi				2	
Lib.		Blue Star				2	
Lib. I		Blue Star				2	
Lib. II		Blue Star / Hitachi				2	
V. 2		Blue Star / Hitachi				2	
A. 2		Blue Star				2	
A. 3		Blue Star				2	
V. 3		Blue Star / Hitachi				2	
U.G.C							
Office Room (Director)		Whirlpool				1	
Class Room		Whirlpool			2		
Library		Voltas			1		
Office		Voltas		1			
Ass. Professor		Whirlpool		1			
Computer lab		Whirlpool		3			
Polytechnic Collage							
Principle Office		LG				1	
Computer Hall		LG		4			
Computer Hall Room no. 13		Voltas		2			

Location	Name	Make	Window (1 TR)	Window (1.5 TR)	Split (1.5 TR)	Split (2 TR)	Cassette (3 TR)
Computer Hall Room no. 14		LG		2			
Library Room no. 57		LG		4			
Faculty Room		Voltas		1			
Biology Lab Room no. 23		LG		1			
Computer Lab Room no. 45		Voltas		1			
Computer Lab Room no. 44		LG		1			
Law College							
Office Room No. 2		LG				2	
Room no. 15		LG			1		
Conference Hall		LG		5			
Room no. 17		LG			1		
Video Conference Hall Room no. 14		LG			1		
Room no. 101		LG			1		
Computer Lab Ground Floor		Hitachi				1	
First Floor Library		Hitachi				2	
BAMS College							
Room No. 9 (Dr. M.K Gupta)		Voltas		1			
Room No. 12 (Pathology)		Samsung / Voltas			1	2	
Principal office		LG			1		
Room No. 20		Voltas		1			
Labor Room No. 27		Voltas		1			
OT Room No. 38		Voltas		2			
Total			**2**	**96**	**45**	**146**	**3**

8.4 ANNEXURE-4: ENERGY MONITORING AND ACCOUNTING

Present Energy Monitoring & Accounting System: There is a proper metering system for the purchased power. However, the data related to the power generated using DG sets is not being monitored on a monthly basis. There are no prescribed formats available to maintain such records. As a result of this, there is no periodic performance analysis of the energy consumption in the building.

Recommended Energy Monitoring & Accounting System



Energy Management should be seen as a continuous process. Strategies should be reviewed annually and revised as necessary. The key activities suggested have been outlined below:

- Clear **accountability for energy consumption** needs to be established, appropriate financial and staffing resources must be allocated and reporting procedures initiated. An energy management programme requires commitment from the whole organization in order to be successful.
- A **record of Energy consumption** both Electrical and Thermal must be kept and monitored on a regular basis. For this, sub meter on the DG set is required. This will enable an overview of energy use and its related costs, as well as facilitating the identification of savings that might otherwise not be detected. The system needs to record both historical and ongoing energy use, as well as cost information from

billing data, and capable of producing summary reports on a regular basis. This information will provide the means by which trends can be analyzed and reviewed for corrective measures.

- Some facts and figures related with energy may be displayed on boards or **posters in the premises**, to create awareness among the workmen and staff. A key ingredient to the success of an energy management program is maintaining a high level of awareness among staff. This can be achieved in a number of ways, including formal training, newsletters, posters and publications. It is important to communicate program plans and case studies that demonstrate savings, and to report results at least at 12-month intervals. As an incentive, new ideas and implementation of energy saving point must be recognized and awarded.
- The findings and **implementation status of Energy audit** should be reviewed periodically/annually for further action plan.

8.5 ANNEXURE-5: CHECKLIST FOR PREVENTIVE MAINTENANCE

➲ **Building Envelope**

Windows and Skylights

- Replace broken or cracked windowpanes
- Replace worn weather stripping and caulking
- Replace defective sealing gaskets and cam latches

Doors

- Replace worn weather stripping and caulking

Exterior Surfaces

- Replace worn weather stripping, caulking, and gaskets at exterior joints and at openings for electrical conduits, piping through-the-wall units, and outside air louvers

Stairwells and Shafts

- Replace worn seals and weather stripping in stairwells on penthouse machine-room doors, in elevator shafts in vertical service shafts and on basement and roof equipment room doors when they are connected by a vertical shaft that serves the building

➲ **Self-Contained Units (Such as Window and Through-The-Wall Units and Heat Pump**

- Clean evaporator and condenser coils
- Clean air intake louvers, filters, and controls
- Keep airflow from units unrestricted
- Replace worn caulking in openings between the units and windows or wall furnace

- Check the voltage to ensure that the unit is operating at full power
- Follow applicable maintenance guidelines for compressors, condensers and fans.

➲ **Motors, Fans, Pumps, Engines and Turbines**

Motors

- Check the alignment of the motor to the equipment it drives. Align and tighten as necessary
- Check for and repair loose connections and bad contacts regularly
- Determine the cause of excessive vibration and repair as necessary
- Clean motors regularly
- Lubricate the motor and drive bearings regularly
- Replace worn bearings
- Tighten belts and pulleys
- Check for overheating. If overheating is present, check for functional problems or inadequate ventilation and repair as necessary
- Balance three-phase power sources to motors
- Check for over voltage or low-voltage conditions and correct as necessary

Fans

- Check for excessive noise and vibration and correct as necessary
- Clean fan blades
- Inspect and lubricate bearings regularly
- Inspect drive belts for proper tension. Adjust or replace as necessary to ensure proper operation
- Keep inlet and discharge screens on fans free of dirt and debris

Pumps

- Check for packing wear and repack as necessary. Replace glandular packing with mechanical seals
- Inspect bearings and drive belts for wear and binding. Adjust, repair, or replace as necessary

Lighting

- Wipe lamps clean at regular intervals. Lamps that are exposed to substantial amounts of dirt, dust, grease, or other contaminants should be cleaned more frequently than lamps in a relatively clean atmosphere

- Maintain luminary efficiency by properly cleaning the reflecting surfaces and shielding media
- Replace lens shielding that has yellowed or become hazy with a clear acrylic lens with good non-yellowing properties. A clear glass lens can be considered if it is compatible with the luminary and does not present a safety hazard
- Clean ceilings, walls, and floors frequently to improve reflective qualities
- If day lighting contributes to lighting, wash windows frequently to maintain illumination levels
- Replace all lamps used for area illumination after they have been in service for a substantial portion (approximately 70 percent) of their rated life, instead of simply replacing lamps one at a time as they burn out.

8.6 ANNEXURE-6: ENERGY EFFICIENT EQUIPMENT SUPPLIERS

Product/ Equipment	Name	Website
Capacitors and APFC Panels	Standard Capacitors	www.standardcapacitors.com
Capacitors and APFC Panels	Ashish Consultant	www.ashishconsultant.com
Capacitors/ Switch Gears/ Reactors etc.	Shreem Electric Ltd	www.shreemelectric.com
Lighting Systems	Asian Electronics Ltd.	www.aelgroup.com
Lighting Systems	Philips India Ltd	www.india.philips.com
Lighting Systems	OSRAM India Ltd.	www.osram.in
Lighting Systems	Wipro Lighting	www.wiprolighting.com
Solar Products	Synergy Solar (P) ltd	www.synergysolar.net
Solar Products	Inter Solar Systems (P) Limited	www.intersolarsystems.com
Energy Efficient Pumps	Danfoss Industries Pvt. Ltd.	www.danfoss.com
Energy Efficient Pumps	Mather & Platt Pumps Ltd.	www.matherplatt.com
Energy Efficient Pumps	Xylem Water Solutions India Pvt. Ltd. (Distributor of Lowara, Italy)	www.lowara.com

Note: - The suppliers mentioned above are not the only ones or the best in the market. The management may contact other suppliers for competitive rates/ specifications.

8.7 ANNEXURE-7: LIST OF ABBREVIATIONS, UNITS & MEASURES AND CONVERSION FACTORS

List of Abbreviations		Units and Measures		Conversion Factors	
APFC	Automatic Power Factor Controller	°C	Degree Centigrade	1 kgoe	10000 kCal
CFL	Compact Fluorescent light	CFM	Cubic Feet per minute	1 kWh	860 kCal
DEA	Detailed Energy Audit	HP	Horsepower	HSD	9783 kCal/ Ltr (Density = 0.8263 Kg /Lit.)
DG	Diesel generator	Kg	Kilo Gram	1 TOE	10^7 kCal
DPR	Detailed Project Report	kW	Kilo Watt		
EE	Energy Efficiency	mmWC	Milli meter of water column		
EEM	Energy Efficiency Measure	MJ	Mega Joule		
EPI	Energy Performance Index	RPM	Revolutions per minute		
kWh	Kilo watt hour	T or MT	Tons		
LED	Light Emitting Diode	V	Volts		
SEGR	Specific Energy Generation Ratio	A	Amps		
SPV	Solar Photovoltaic				
SVL	Sodium Vapor Lamp				
TOD	Time of day				
VFD	Variable Frequency Drive				