Energy Audit

Of

Government Polytechnic Nanakpur

Conducted by

TMCC

Technical & Management Consultancy Center

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

Title

Report Title	=	Detailed Energy Audit
Client Name	=	Government Polytechnic Nanakpur District- Panchkula
Location of the Plant	=	Nanakpur District- Panchkula
Report Submission	=	January 2021
Name of The Accredited Energy Auditor	=	Rakesh Yecho Accreditation Number: AEA: 0018
	=	Pankaj Dhote Energy Audit Number :CEA :28926

Acknowledgement

TMCC is grateful to **Er. Suksham Goyal, Principal**, Government Polytechnic Nanakpur District- Panchkula for their keen interest in energy solutions' portfolio of TMCC and giving us an opportunity to conduct an energy audit of the Institute building.

We are thankful to the **Dr. Neeraj Kumar** Lecturer/ Government Polytechnic Nanakpur & also Certified Energy Manager, BEE**, Mr. Mandeep Singh** Electrical Instructor, and other staff of Government Polytechnic Nanakpur District- Panchkula 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 Institute meet the 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 your 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

Annexures

1. Energy Efficient Equipment Suppliers
2. Recommended Lux Levels
3. Energy Monitoring and Accounting
4. Checklist for Preventive Maintenance

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 Establishments.

It was with this objective that Technical & Management Consultancy Center (TMCC) was entrusted by Government Polytechnic Nanakpur District- Panchkula, the energy audit of the Institute.

The study primarily covers the I) Present energy scenario of the building, ii) Detailed analysis of the data obtained through field visits, trial measurements by portable gadgets, discussions with concerned personnel etc., iii) Recommendations for energy savings options in all possible areas with cost benefit analysis, iv) Technical specifications for any retrofit options and v) List of suppliers / manufacturers of energy efficient technologies

General Building Details & Energy Consumption

Sl. No.	**Item**		**Value**
1	Connected Load (kW)		70 KW
2	Installed capacity: DG Sets (kVA)		250 KVA x 01 Nos
3	Installed Solar Capacity		24 kWp
4	Annual Electricity Consumption, purchased from Utilities / Grid (kWh) - Last One year		32500 kWh
	Annual Electricity Consumption, through DG Sets (kWh) - Last One year		4338 kWh
4	Total Annual Electricity Consumption, Utilities/ Grid + DG Sets (kWh) - Last One year		32500 kWh (Grid Supply) 4338 kWh (DG Supply) Total: 36838 kWh per annum
	Annual Cost of Electricity, purchased from Utilities/ Grid (Rs.) - Last One year		Rs 368783
	Annual Fuel Cost of Electricity generated through DG Sets (Rs.) - Last One year		Rs 12000
5	Total Annual Electricity Cost, Utilities + DG Sets (Rs.)	368783+12000=380783	Rs 36838 (Grid Supply) Rs 12000 (HSD for (DG Supply) Total: Rs 380783 per annum
		Built Up Area	8206 m^2

Sl. No.	Item		Value
	Area of the building (exclude parking, lawn, roads, etc.)	Conditioned Area	462 m^2
6	Conditioned Area (as % of built-up area)		5.63 %
7	Working hours		General Lighting (5 hrs./day, 240 days a year) Compound Lighting (10 hrs./day, 365 days a year) Air Conditioning (5 hrs./day, 210 days a year)
8	Working days/week (e.g., 5/6/7 days per week)		05 days per week
9	Installed capacity of Air Conditioning System (TR)		Total no of AC Installed =05
10	Installed lighting load including Lights & Fans etc. (kW)		37.044 KW
11	HSD Consumption in DG Sets in the year		160 Ltr
12	Fuel (e.g., FO, LDO, LPG, NG) used for generating steam/water heating in the year (in appropriate units)		Nil

Total Energy Consumed in MTOE per annum

Source of Energy	Consumption	Calorific Value	Kcal	MTOE
Average Purchased Power per annum	32500 kWh/annum	860 Kcal/ KWH	27950000	2.795
HSD for DG Set	160 Ltr/annum	9783 Kcal/Ltr	1565280	0.156
Total				**2.951**

Cumulative Energy Saving Opportunities

Particulars	Annual Energy Savings			Estimated Investment (Rs in Lacs)	Simple Payback Period (months)
	kWh	toe	Rs in Lacs		
Improve Power Factor to optimize Electrical Bill	-	-	0.75	0.26	4-
Installation of Solar Photovoltaic System for the Administration Building	47040	4.05	5.29	19.25	44
Total	**47040**	**4.05**	**5.79**	**19.75**	**38**
Observation					
Replacement of 3 star rated / Split A/Cs with 5 Star Inverter Rated A/Cs on Failure Replacement Basis Replace Existing Ceiling Fans is low wattage Ceiling Fans on Failure Replacement Basis					

Energy Saving Potential

- Annual Purchased Power Bill = Rs 6.3 Lacs
- Energy Savings Identified = Rs 5.79 Lacs
- Percentage Energy Saving Potential = 91%

Note: Since Institute having substantial roof top area to Install Solar panel and due to that Institute will be able to achieve nearly net zero energy building.

CHAPTER 1.
INTRODUCTION

1.1. 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 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 Technical & Management Consultancy Center (TMCC) was entrusted by Government Polytechnic Nanakpur District- Panchkula, the energy audit of the Institute.

1.2. GENERAL DETAILS

Brief Description of assignment	:	Detailed Energy Audit of Utility Systems/Equipments
Name & Address of Company	:	Government Polytechnic Nanakpur District- Panchkula,
Contact	:	1. Er. Suksham Goyal, Sr. Lecturer & Officiating Principal, 2. Dr. Neeraj Kumar, Lecturer Certified Energy Manager-BEE Mobile No: 94162 86944
Annual Purchased Power Consumption (Period: Mar -20 to Dec-20)	:	32500 kWH (Rs 3.68 Lacs per annum)
Basic Purchased Power Rate	:	Rs 6.95 per kWh as on
Overall Purchased Power Rate including Fixed Demand and other Charges	:	Rs 11.34 per kWh (averaged out for the last one year)
Note: The Institute also has One DG Sets of 250 KVA each. The operation of the DG Sets is very limited. The annual HSD consumption in the DG Sets was around 160 Ltr during the last one year.		

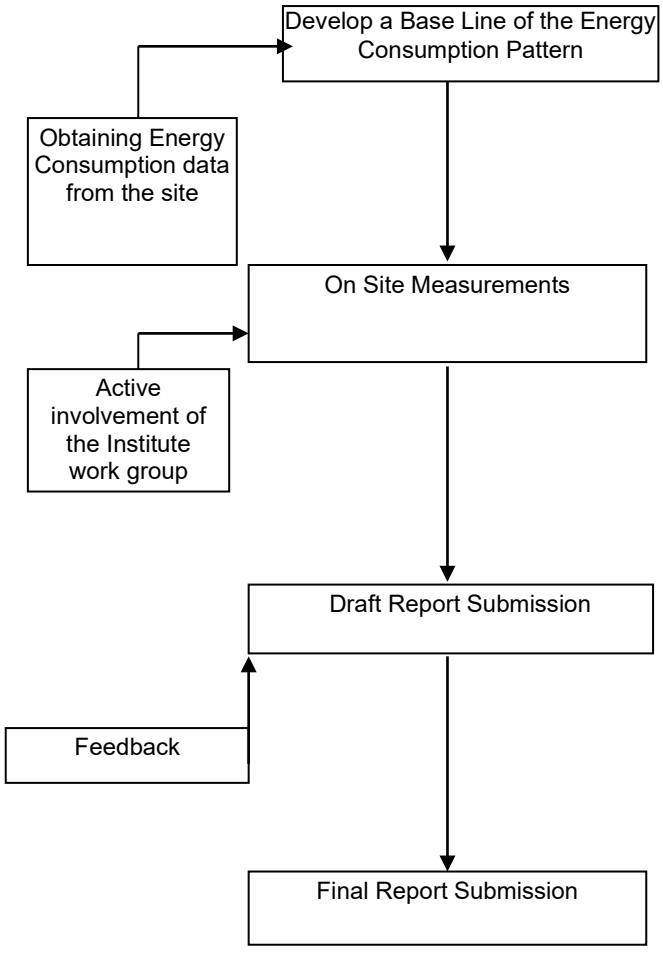
1.3. DELIVERABLES IN THE DETAIL PROJECT REPORT

- Methodology adopted for the study
- Present energy scenario of the building
- Detailed analysis of the data obtained through field visits, trial measurements by portable gadgets, discussions with concerned personnel etc
- Recommendations for energy savings options in all possible areas with cost benefit analysis.
- Technical specifications for any retrofit options
- List of suppliers / manufacturers of energy efficient technologies

1.4. METHODOLOGY

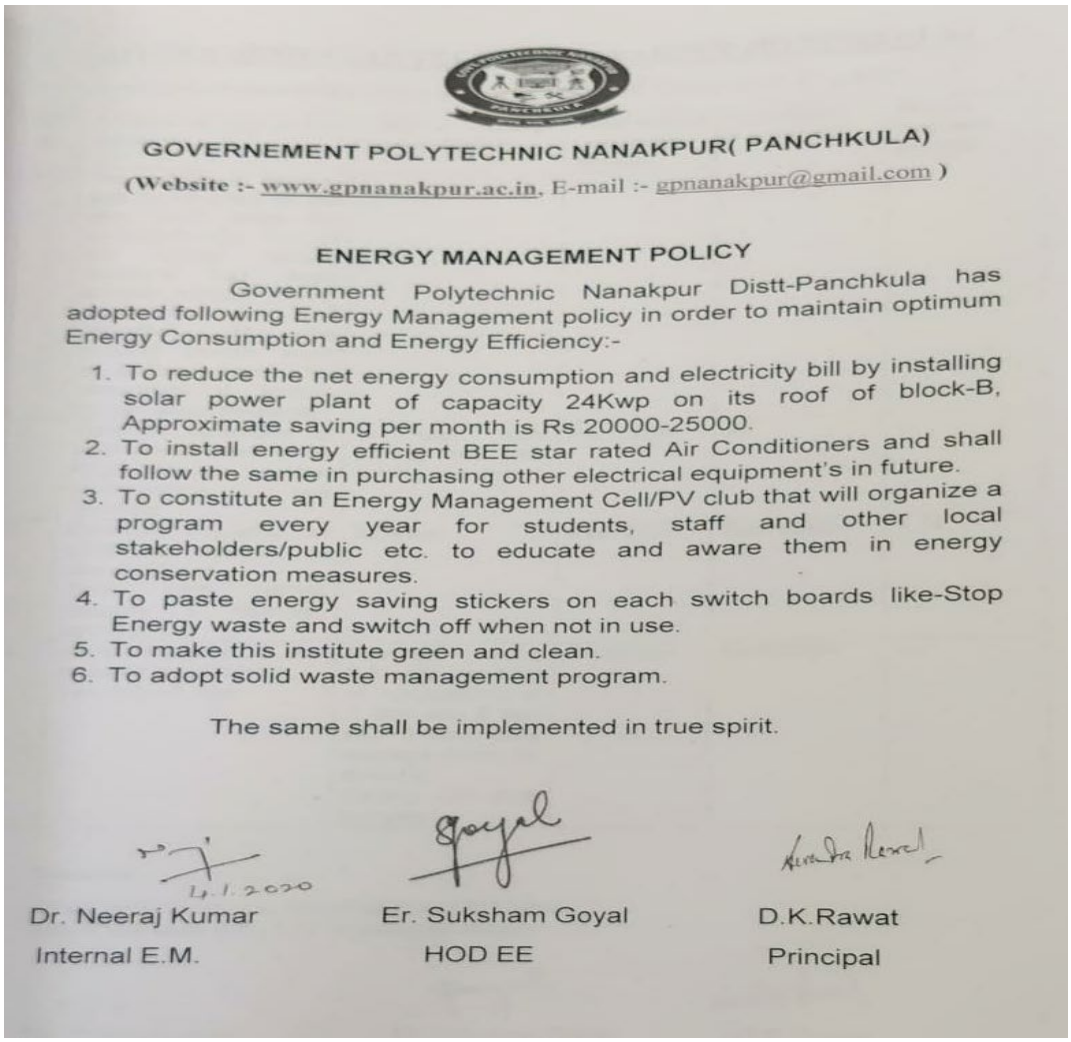
Methodology adopted for achieving the desired objectives viz: Assessment of the Current operational status and Energy savings include the following:

- Discussions with the concerned officials for identification of major **areas of focus** and other related systems.
- A team of engineers visited the Institute premises and had discussions with the concerned officials/ supervisors to collect data/ information on the operations and energy distribution in the building. 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 Institute.

1.5. ENERGY CONSERVATION POLICY



GOVERNEMENT POLYTECHNIC NANAKPUR(PANCHKULA)

(Website :- www.gpnanakpur.ac.in, E-mail :- gpnanakpur@gmail.com)

ENERGY MANAGEMENT POLICY

Government Polytechnic Nanakpur Distt-Panchkula has adopted following Energy Management policy in order to maintain optimum Energy Consumption and Energy Efficiency:-

1. To reduce the net energy consumption and electricity bill by installing solar power plant of capacity 24Kwp on its roof of block-B, Approximate saving per month is Rs 20000-25000.
2. To install energy efficient BEE star rated Air Conditioners and shall follow the same in purchasing other electrical equipment's in future.
3. To constitute an Energy Management Cell/PV club that will organize a program every year for students, staff and other local stakeholders/public etc. to educate and aware them in energy conservation measures.
4. To paste energy saving stickers on each switch boards like-Stop Energy waste and switch off when not in use.
5. To make this institute green and clean.
6. To adopt solid waste management program.

The same shall be implemented in true spirit.

14.1.2020

Dr. Neeraj Kumar
Internal E.M.

Er. Suksham Goyal
HOD EE

D.K.Rawat
Principal

1.6. INSTRUMENTATION SUPPORT USED

Name of the Instrument (Make/ Model)	Primary Measured Parameters	Measuring Range	Accuracy	Resolution
Load Manager with appropriate CT's and Voltage Probes for HT & LT measurements (Krykard/ALM 8 & ALM 30)	Active Power	0 – 9999 KW	± 1%	4 digits
	Reactive Power	0 – 9999 KVAR	± 1%	4 digits
	Power Factor	0.14 – 1	± 1.5%	0.001
Anemometer (Extech/ 45118)	Air Velocity	0.5 – 89 miles/hr	± 3%	3½ digit LCD with multi function indicators
Digital Pressure Meter (Comark, UK)	Pressure	0 – 350 mbar	± 0.2%	4 digits
Meter (TES 1332)	Lux	0 to 200000 lux	± 3%	3½ digit LCD
Surface Temperature Indicator with appropriate Probe (CHY 501 K)	Temperature	-50°C to 450°C	± 0.3%	0.5°C

1.7. OPERATING HOURS CONSIDERED FOR CALCULATION PURPOSE

Activity	Institute
General Lighting (5 hrs./day, 240 days a year)	1200 hrs. per annum
Compound Lighting (10 hrs./day, 365 days a year)	3650 hrs. per annum
Air Conditioning (5 hrs./day, 210 days a year)	1050 hrs. per annum

1.8. ENERGY PERFORMANCE INDEX (EPI)

Total Annual Electricity Consumption, Utilities/ Grid + DG Sets (kWh) - Last One year Jan -20 to Dec-20	32500 kWh (Grid Supply) 4338 kWh (DG Supply) Total: 36838 kWh per annum
Built Up Area	8206 m2
EPI	4.489 kWh/m2/year (for Total area only)
Air-Conditioned area (approx.)	462 m2
EPI	79.73 kWh/m2/year (for air-conditioned area only)

1.9. REPORTING REQUIREMENT (GENERAL DETAILS)

1.9.1. Contact Details of the Organization and the Contact Persons

Organization	
Name of the Organization	Government Polytechnic Nanakpur District- Panchkula
Postal Address	Nanakpur District- Panchkula
Contact Person	
Name & Designation	1. Er. Suksham Goyal, Sr. Lecturer & Officiating Principal, 2. Dr. Neeraj Kumar, Lecturer Certified Energy Manager-BEE Mobile No: 94162 86944

1.9.2. General Building Details & Energy Consumption

Sl. No.	Item	Value
1	Connected Load (kW)	70 KW
2	Installed capacity: DG Sets (kVA)	250 KVA x 01 Nos
3	Installed Solar Capacity	24 kWp
4	Annual Electricity Consumption, purchased from Utilities / Grid (kWh) - Last One year	32500 kWH

Sl. No.	Item		Value
	Annual Electricity Consumption, through DG Sets (kWh) - Last One year		4338 kWH
4	Total Annual Electricity Consumption, Utilities/ Grid + DG Sets (kWh) - Last One year		32500 kWh (Grid Supply) 4338 kWh (DG Supply) Total: 36838 kWh per annum
	Annual Cost of Electricity, purchased from Utilities/ Grid (Rs.) - Last One year		Rs 368783
	Annual Fuel Cost of Electricity generated through DG Sets (Rs.) - Last One year		Rs 12000
5	Total Annual Electricity Cost, Utilities + DG Sets (Rs.) Area of the building (exclude parking, lawn, roads, etc.)	368783+12000=380783	Rs 36838 (Grid Supply) Rs 12000 (HSD for (DG Supply) Total: Rs 380783 per annum
		Built Up Area	8206 m^2
		Conditioned Area	462 m^2
6	Conditioned Area (as % of built-up area)		5.63 %
7	Working hours		General Lighting (5 hrs./day, 240 days a year) Compound Lighting (10 hrs./day, 365 days a year) Air Conditioning (5 hrs./day, 210 days a year)
8	Working days/week (e.g., 5/6/7 days per week)		05 days per week
9	Installed capacity of Air Conditioning System (TR)		Total no of AC Installed =05

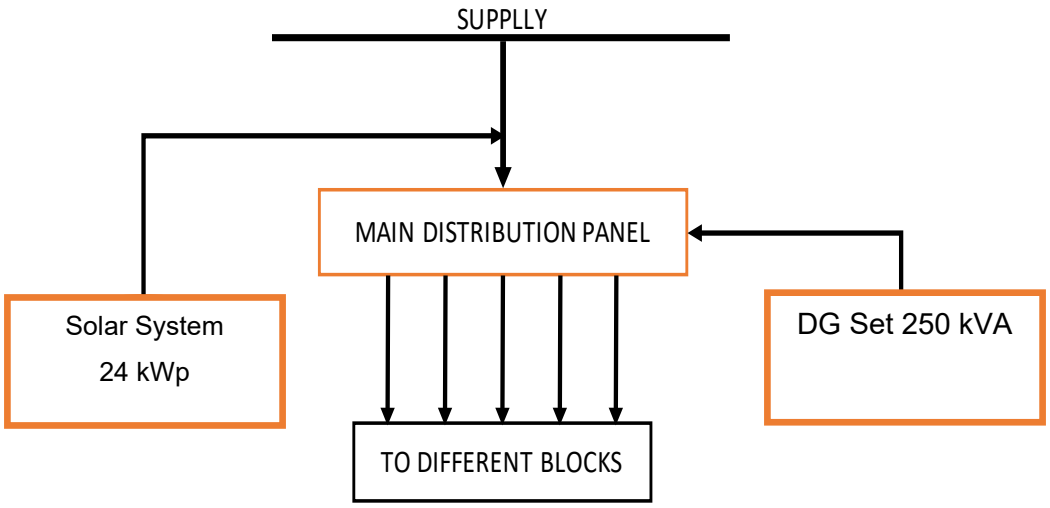
Sl. No.	Item	Value
10	Installed lighting load including Lights & Fans etc. (kW)	37.044 KW
11	HSD Consumption in DG Sets in the year	160 Ltr
12	Fuel (e.g., FO, LDO, LPG, NG) used for generating steam/water heating in the year (in appropriate units)	Nil

1.10. MTOE CALCULATION

Source of Energy	Consumption	Calorific Value	Kcal	MTOE
Average Purchased Power per annum	32500 kWh/annum	860 Kcal/ kWh	27950000	2.795
HSD for DG Set	160 Ltr/annum	9783 Kcal/Ltr	1565280	0.156
Total				**2.951**

CHAPTER 2.
POWER SUPPLY SYSTEM AND CONSUMPTION PATTERN

2.1. SINGLE LINE DIAGRAM



2.2. POWER SUPPLY SYSTEM

The Power Supply to the Institute is sourced from the Uttar Haryana Bijli Vitran Nigam Limited at 11 KV. The voltage is stepped down to 433 V using one transformer of 500 KVA.

Power is also generated in-house using DG Set of 250 KVA each.

Transformer Specifications

Particulars	Transformer
Make	NUCON SWITCHGEARS PVT LTD.
Rating	500 KVA

Particulars	Transformer
Voltage Ratio	11000/433
Current Ratio	26.24/666.28
Impedance	5 percent

DG Specifications

Particulars	DG No -1
Make	KIRLOSKAR OIL ENGINES LIMITED
Rating	250 KVA
Current	327 Amps
Voltage	415,3 PHASES
Speed	1500 R.P.M
Frequency	50 HZ
Year	2018

2.3. ELECTRICALS BILL ANALYSIS

Months	Contract Demand	MDI	kWhi	kVhi	net billed units	Power Factor	Fixed Charges in Rs	Energy Charges in Rs	Electricity Bill in Rs	Unit Rate in Rs
Mar-20	70	0	8900	9600	9000	0.927	23197	62550	91787	10.20
May-20	70	0	6300	6800	3399	0.926	23934	23630	50320	14.80
Jun-20	70	19	3200	3900	2900	0.821	10310	20155	32694	11.27
Jul-20	70	22	3300	3700	3000	0.892	12888	20850	35399	11.80
Aug-20	70	7	2792	2991	1691	0.933	14361	11753	27595	16.32
Sep-20	70	14	3508	10109	9109	0.347	8469	63308	74567	8.19
Oct-20	70	20	2800	6900	5900	0.406	12519	41005	55672	9.44
Nov-20	70	27	3500	200	2300	0.000	7364	0	368034	-
Dec-20	70	0	3100	100	0	0.000	16638	0	11943	-
Jan-21	70	0	100	100	0	0.000	11415	0	11798	-
			64800	**44400**			**141096**	**243250**	**759810**	**11.72**

2.4. TRANSFORMER LOADING

Rated Transformer Capacity: 500 KVA

Particulars	During Day Time (Normal Institute Hours till 2:30 PM)	Afternoon to Evening (2:30 PM to 7 PM)	During Night Time (7 PM onwards till 6 AM)
Voltage Variations	410 V to 420 V	414 V to 434 V	420 V to 446 V
Current Variations	30 to 37 Amps	25 to 28 Amps	14 to 19.90 Amps
Power Factor	0.969 to 0.986	0.825 to 0.977	0.757 to 0.976
Load Variations	20 KW to 26 KW 22 KVA to 28 KVA	15 KW to 21 KW 18 KVA to 22 KVA	8 KW to 15 KW 11 KVA to 16 KVA
Voltage Harmonics (V_{THD})	1% to 1.7%	0.7% to 2%	1.3% to 3.1%
Current Harmonics (A_{THD})	3.7% to 5.8%	4.5% to 13.3%	6.7% to 13.2%
Transformer Loading based on Max Load Observed (%)	**5%**	**4%**	**3%**
Operating Efficiency of the Transformer	≅ 98.3% to 98.5%	≅ 94.7% to 98%	≅ 93% to 97.5%

2.5. RECOMMENDATIONS

2.5.1. Improve Power Factor to optimize Electrical Bill

In detailed energy audit the electricity bills were analysed. The variation in power factor, active power consumption, energy charges throughout the year was studied. The scope to reduce demand charges was explored. The significant contributors in electricity bill are contract demand, Chargeable demand, energy charges and MDI (Maximum Demand Indicator) etc.

Contract Demand (CD) – This is the maximum value of Power being contracted between the industry and State electricity board (SEB).

Billable Demand Charges - is the minimum fixed kVA units for which industry have to pay charges.

Energy charges (variable charges) – This is amount paid for energy consumed by the industry.

Maximum Demand Indicator – this is the highest demand registered during a month/period. (It Might Be More or less then contract or billable demand kVA)

Existing Electricity Bill

During the audit, electricity bill is provided by Institute team. Following table shows electricity bill analysis and power factor.

	Contract Demand	MDI	kWhi	kVhi	net billed units	Power Factor	Fixed Charges in Rs	Energy Charges in Rs	Electricity Bill in Rs	Unit Rate in Rs
Mar-20	70	0	8900	9600	9000	0.927	23197	62550	91787	10.20
May-20	70	0	6300	6800	3399	0.926	23934	23630	50320	14.80
Jun-20	70	19	3200	3900	2900	0.821	10310	20155	32694	11.27
Jul-20	70	22	3300	3700	3000	0.892	12888	20850	35399	11.80
Aug-20	70	7	2792	2991	1691	0.933	14361	11753	27595	16.32
Sep-20	70	14	3508	10109	9109	0.347	8469	63308	74567	8.19
Oct-20	70	20	2800	6900	5900	0.406	12519	41005	55672	9.44
Nov-20	70	27	3500	200	2300	0.000	7364	0	368034	-
Dec-20	70	0	3100	100	0	0.000	16638	0	11943	-
Jan-21	70	0	100	100	0	0.000	11415	0	11798	-
										11.72

The Institute has a 70 KW connection and is being billed on kVAh basis. The present basic energy charges are Rs 6.95 per kWh and the fixed demand charges are Rs 160 per KW.

As per Haryana state electrical Tariff order Institute having Non-domestic Supply at 11 kV and details of Tariff below.

		benefits)		
2	**Non Domestic (including Independent Hoarding / Decorative Lightning / Decorative Lightning / Temporary Metered supply and others)**			
	Upto 5 kW (LT)	635/kWh	Nil	Rs. 235/kW
	Above 5 kW and Up to 20 kW	705/kWh	Nil	
	Above 20 kW and upto 50 KW (LT)	660/kVAh	160 / kW	Nil
	Existing consumers above 50 kW upto 70 kW (LT)	695/kVAh	160 / kW	Nil
	Consumers above 50 kW (HT) New	675/kVAh	160 / kW	

It is suggested that the Institute can improve the power factor and reduce KVAh billing. Once this is done, the basic energy charges would be Rs 6.95 per KVAh. Now if we consider last one year's data, the net monetary benefit would have been as follows:

Total kWh Consumption (Jan-20 to Dec-20)	32500 kWh
Basic Energy Charges as on date when billed on kVAh basis (@Rs 6.95 per kVAh)	Rs 2.25 Lacs per annum (32500 x 6.95 / 100000)
Measured power factor (power factor & KVAh consumption is not reflected in the electricity bills, however, during the site visits, the average system power factor was quite healthy but around 0.975)	0.750 As per Billing analysis
Equivalent kVAh Consumption (Jan-20 to Dec-20)	43333 KVAh (32500/0.750)
Difference in kVAh- kWh	(43333-32500) =10833
Corresponding basis Energy Charges when billed on kVAh basis (@Rs 6.95 per KVAh)	Rs 0.75 Lacs (10833*6.95 / 100000)
Net Monetary Benefit	**Rs 0.75 Lacs per Annum**

Note: To enhance the monetary benefits it is suggested to further improve the system power factor from the existing average of 0.75 to around 0.99 (lag) and this can be done by interchanging the small capacitors of 1,2,5,7.5,10,15 kVAr with existing big capacitors of 25 kVAr. This would ensure that the overall system power factor is maintained at around 0.99 (lag) and enable the Institute, achieve the above benefits on a consistent basis.

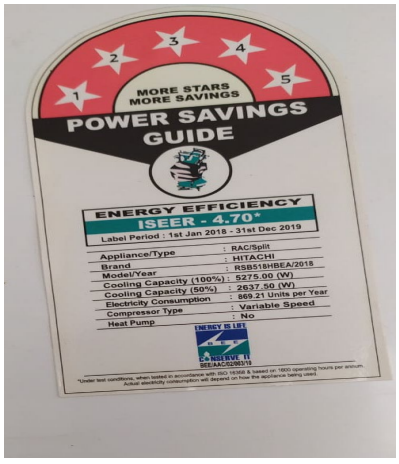
Estimated Investments for changing the Big 25 kVAr capacitor into small capacitor of 1,2,5,7.5,10,15 kVAr Range	Rs 0.26 Lac
Simple Payback Period	12 months

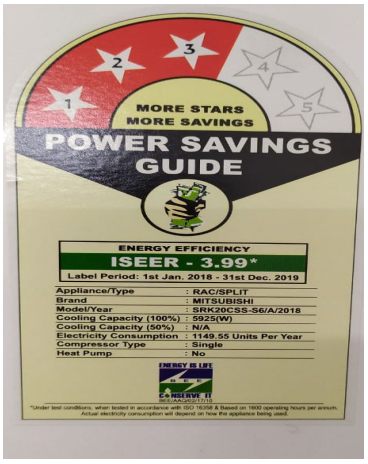
CHAPTER 3.
STUDY OF AIR CONDITIONING SYSTEMS

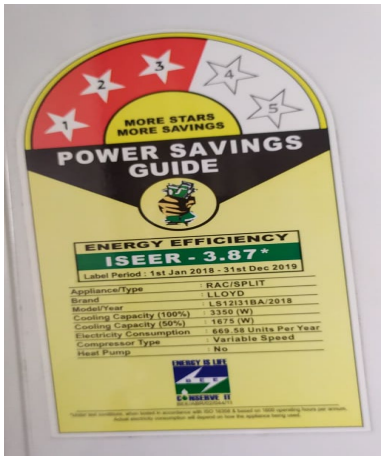
3.1. MEASUREMENTS MADE & ANALYSIS

Splits ACs of More than 1 TR are installed in the building. During the audit measurement were made to evaluate the performance of ACs on a sample basis, results are tabulated below: -

3.1.1. Air Conditioning installed at Institute







3.1.2. Split / A/Cs

Star	Tonnage in kW	Tonnage in TR	Compressor Type	ISEER	Annual Unit Consumption kWh
5	5275	1.7	VFD	4.70	869.21
3	5925	2.0	Single	3.99	1149
3	3350	1.1	VFD	3.87	669.58

The better the EER value, the lower will be the power consumption AC and hence lower will be impact on your pocket. So, if you see 5 STARs ACs, one having EER value of 4.70 and another 3-star having 3.87, then you should go for 5-star AC as its EER value is better.

Particulars	Tonnage	Split A/c	Make
TPO	2.0	1	Mitsubishi
Principal Office,	2.0	1	Mitsubishi
Computer Lab,	1.7	1	Hitachi
IT Lab,	1.7	1	Hitachi
Electrical Lab	1.1	1	Lloyd

3.2. RECOMMENDATIONS

3.2.1. Replacement of 3 star rated / Split A/Cs with 5 Star Inverter Rated A/Cs

During the site visits, the rated specific power consumption of the 3-star split A/Cs was observed and compare with existing 5 Star ACs. Thus, due to high SEC of 3-star rating ACs consuming higher power should be replaced with lower SEC 5-star Inverter rated energy efficient A/Cs.

Star	Tonnage in kW	Tonnage in TR	Compressor Type	ISEER	Annual Unit Consumption kWh	Units Per Hours	SEC kW/TR
5	5275	1.7	VFD	4.7	869.21	0.54	0.31
3	5925	2.0	Single	3.99	1149	0.72	0.37
3	3350	1.1	VFD	3.87	669.58	0.42	0.38

CHAPTER 4.
STUDY OF LIGHTING SYSTEMS

4.1.1. Systems Installed

Institute is established in 2018 and very energy efficient initiation has taken to installed LED lighting Lamps during the procurement time. Following are the details of building wise this

Lighting Details	Particulars Items	Number of items	Wattage
Block A	Street Light	12	150
Block A	Ground Floor Light	73	18
Block A	Ground Floor Gallery Light	7	18
Block A	First Floor Light	81	18
Block A	First Floor Gallery Light	14	18
Block A	Second Floor Light	76	18
Block A	Second Floor Gallery Light	11	18
Block B	Street Light	11	150
Block B	Ground Floor Light	97	18
Block B	Ground Floor Gallery Light	16	18
Block B	First Floor Light	106	18
Block B	First Floor Gallery Light	15	18
Block B	Second Floor Light	93	18
Block B	Second Floor Gallery Light	15	18
Block C	Workshop Street Light	9	150
Block C	Workshop-1 Light	24	18
Block C	Workshop-2 Light	35	50
Block C	Workshop Gallery Light	22	18

CHAPTER 5.
OTHER AREAS OF FOCUS

5.1. CELLING FANS

5.1.1. Replace Existing Ceiling Fans is low wattage Ceiling Fans on Failure Replacement Basis

The Institute building collectively have around 353 nos of Low wattage of 50-Watt ceiling fans installed for comfort air movement. Following table shows the details

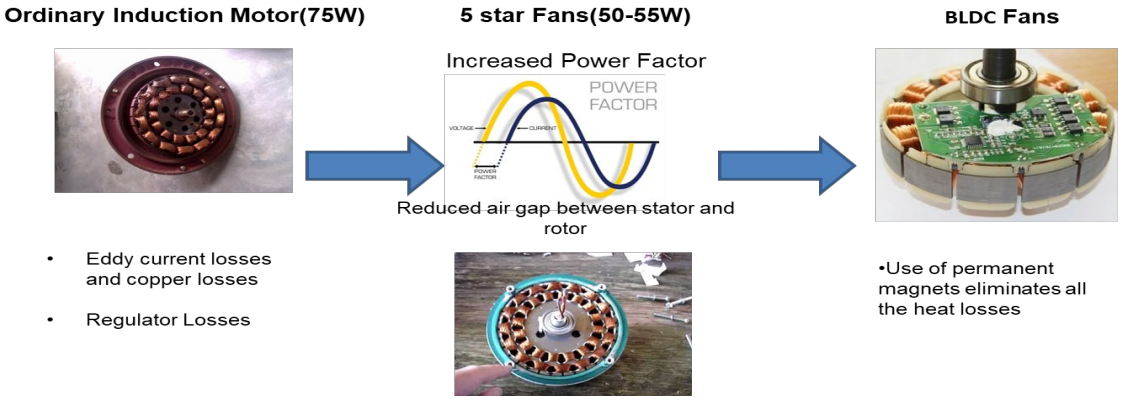
Fans Details	Particulars Items	Number of items	Wattage
Block A	Ground Floor Fans	42	50
Block A	First Floor Fans	44	50
Block A	Second Floor Fans	42	50
Block B	Ground Floor Fans	58	50
Block B	First Floor Fans	60	50
Block B	Second Floor Fans	52	50
Block C	Workshop-1 Fan	24	18
Block C	Workshop-2 Fan	24	18
Block C	Workshop Gallery Fan	6	50

With technological advancements, new energy efficient BLDC fans consumed much less power for the same air flow, besides offering allied benefits like lesser noise and enhanced life,

New Technology Energy Efficient BLDC Fans

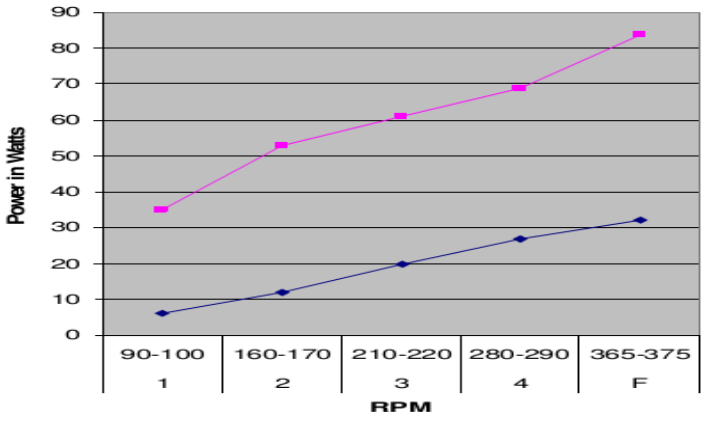
A brushless DC (BLDC) motor is a synchronous electric Motor powered by direct-current (DC) electricity and having an electronic commutation system, rather than mechanical commutator and brushes. In BLDC motors, current to torque and voltage to rpm are linear relationships. This linearity provides an excellent opportunity to use the BLDC motor in the conventional ceiling fans. This paper presents practical

implementation of such BLDC motor for ceiling fan application along with the actual power measurements in comparison with conventional ceiling fans. Complete electronics and the associated advantages and disadvantages of this BLDC ceiling fans are also presented.



Why BLDC Fans?

Today the typical ceiling fan is based on AC motors which are more power consuming. Along with this the typical AC motor-based fans have the rpm control through the capacitor or resistor-based regulators and is not efficient as there is loss in the regulator itself to some extent. In addition, the RPM control is by controlling the voltage and the voltage fluctuations of the mains make it very challenging to have constant RPM based on the AC mains supply. Further, existing AC motor solution, results in power factor (PF) degradation with no improvement for PF and there are other side effects like harmonics injection to the AC mains, etc.



The total amount of air flow or displacement is based on the blade size & rpm and does not change due to any other factor. The proposed solution is to keep the same air flow or displacement with less of energy usage along with improving the PF using the BLDC motor-based ceiling fans. Typical BLDC motor-based ceiling fan has much better efficiency and excellent constant RPM control as it operates out of fixed DC

voltage. The proposed BLDC motor and the control electronics operates out of 24V DC through an SMPS (switched mode power supply) having input AC which can vary from 90V to 270V. Following graph shows the comparison between BLDC and conventional ceiling fans

The power consumption is less than half at full speed and is about 20% at low speed for the BLDC motor compared to the conventional motor-based ceiling fan, as can be seen from the graph above. The Power Supply (PS) used is at 85% efficiency and the electronics circuit consumes less than 0.5 Watt. Generally, 210-220 RPM conventional fans are used which consumes almost 50-Watt power. From graph, as can be seen that same RPM BLDC motor consumes almost half power.

Rated specifications of various sizes is given below for ready reference:

	Gorilla 900 mm	Gorilla 1050 mm	Gorilla 1200 mm	Gorilla 1400 mm	Gorilla Premium Earth brown	Gorilla Premium Sand Grey
Power Consumption (Watts)	28	32	28	35	28	28
Air Delivery (CMM)	175	210	220	270	220	220
RPM	450	430	350	270	350	350
Service Value	7.1	6.6	7.8	7.7	7.8	7.8
Power Factor	0.98	0.98	0.98	0.99	0.98	0.98
Blade Span (mm/inch)	900/36	1050/42	1200/48	1400/56	1200/48	1200/48

We congratulate the Institute for such a good energy efficient step taken during establishment.

Further to BLDC Fans, Institute will go for failure replacement for replacing the existing fans with BLDC Energy efficient fans.

5.2. WATER PUMPING SYSTEMS

5.2.1. Water Pump for Institute Building

- Rated Make = KIRLOSKAR ELECTRIC CO. LTD
- Rated Power = 5.5 kW (7.37 H. P)
- Rated Head = 20 mtr.
- Rated Discharge =
- Efficiency = 87.7 %

- Measured Voltage = 415 VOLT
- Measured Current = 10.8 AMP.
- Power Factor = 0.8
- Power Drawn = 3.74 kW

5.3. DG SET

Two DG Sets of 250 KVA has been installed. Rated specifications of the DG Sets are given herein:

Particulars	DG No -1
Rated Make	KIRLOSKAR OIL ENGINES LIMITED
Rated Rating	250 KVA
Rated Current	327 Amps
Rated Voltage	415,3 PHASES
Rated Speed	1500 R.P.M
Rated Frequency	50 HZ
Year of Manufacturing	2018

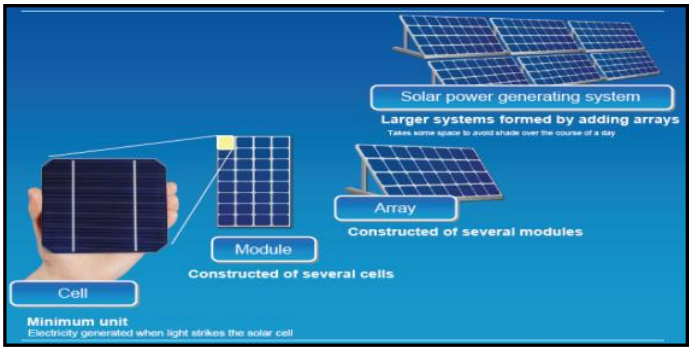
The performance of the DG Set was evaluated, results of which is given hereunder:

- Duration of the test = 1 Hour
- Power Generated = 25 kWH
- Power Factor = 0.84
- Average Load = 29.1 KVA
- HSD Consumed = 8.0 Ltr
- Specific Power Generation = 3.125 kWH per Ltr
- Percentage loading of the DG Set = 11.6%

5.4. INSTALLATION OF SOLAR PHOTOVOLTAIC SYSTEM FOR THE ADMINISTRATION & WORKSHOP BUILDING

The Institute building has substantial roof top area, which could also be utilized for the installation of a Solar Photovoltaic Plant.

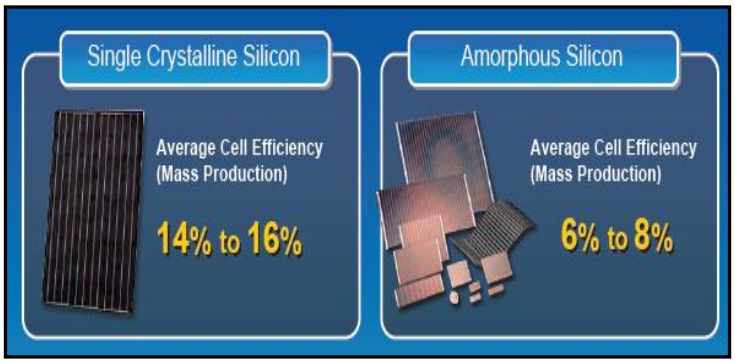
Solar Photovoltaic Technology converts the sunlight into DC electricity through solar cells. The generated electricity can be used directly during the day. **Batteries would not be required** as the utilization is only during the daytime. Some of the salient features are listed below:



- Provides uninterrupted & Stable DC / AC Power Supply to dedicated load
- No noise and Easy to install
- Simple to operate and Pollution free working
- Low maintenance cost with the generating panels having a long life
- Soft loan available

<u>Major Components & Cell Efficiency</u>

- PV Module
- MS Galvanized Mounting Structure
- Array / Sub-Main / Main Junction Box
- Power Conditioning Unit
- Cable and Hardware
- Earthing Kit



Area Requirements

Capacity	Estimated Number of modules Quantity (pcs)	Approx Weight (Kgs)	Approx Area (sq mt)
5 KW System	32	500	40.7
6.5 KW System	42	650	52.9
10 KW System	64	1000	81.5
30 KW System	192	3000	240
50 KW System	320	5000	400

Space Available for Solar Power Plant

Energy Savings & Payback period

• Rated capacity of the Solar PV System	=	35 KW
• Load Factor	=	80%
• Expect sunny days per annum	=	280
• Average working hrs per day	=	6 to 8 hrs per day (say 6 hrs/day)
• Expected power generation per annum	=	47040 kWh per annum
• Power Rate	=	Rs 11.25 per kWh

• **Energy Savings per annum**	=	**Rs 5.29 Lacs**
• Estimated Investments bench mark cost Rs 0.55 Lacs per KWp (without battery backup)	=	Rs 19.25 Lacs
• Simple Payback Period	=	44 months

• **Remarks**

The Payback Period for Solar PV is certainly on the higher side but this project could have a demonstrative effect for others to follow as it not only saves energy but is also environment friendly.

CHAPTER 6.
SUMMARY

6.1. IMPLEMENTATION PLAN

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

- Improve Power Factor to optimize Electrical Bill

Under Phase-2, recommendations which involve change of equipment / devices can be taken up. Here the sequence of implementation can be based on the payback period. These would include:

- Replacement of 3 star rated / Split A/Cs with 5 Star Inverter Rated A/Cs on Failure Replacement Basis
- Replace Existing Ceiling Fans is low wattage Ceiling Fans on Failure Replacement Basis
- Installation of Solar Photovoltaic System for the Administration & workshop Building

6.2. CUMULATIVE ENERGY SAVING OPPORTUNITIES

Particulars	Annual Energy Savings			Estimated Investment (Rs in Lacs)	Simple Payback Period (months)
	kWh	toe	Rs in Lacs		
Improve Power Factor to optimize Electrical Bill	-	-	0.75	0.26	4-
Installation of Solar Photovoltaic System for the Administration Building	47040	4.05	5.29	19.25	44
Total	**47040**	**4.05**	**5.79**	**19.75**	**38**
Observation					
Replacement of 3 star rated / Split A/Cs with 5 Star Inverter Rated A/Cs on Failure Replacement Basis Replace Existing Ceiling Fans is low wattage Ceiling Fans on Failure Replacement Basis					

6.3. ENERGY SAVING POTENTIAL

- Annual Purchased Power Bill = Rs 6.3 Lacs
- Energy Savings Identified = Rs 5.79 Lacs
- Percentage Energy Saving Potential = 91%

Note: Since Institute having substantial roof top area to Install Solar panel and due to that Institute will be able to achieve nearly net zero energy building.

Picture 1: Existing Solar System of 24 kWp installed at Roof Top of Institute Building

Picture 2: Plantation and Gardening of Institute premises for better environment and landscape


राजकीय बहुतकनीकी

Annexure-1

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.

Annexure-2

Recommended Lux Levels

- **Entrance**

Entrance halls, lobbies, waiting rooms	=	200
Enquiry Desks	=	500
Gate Houses	=	200

- **Circulation Areas**

Lifts	=	100
Corridors, passageways, stairs	=	100
Escalators, revelators	=	150

- **Staff Rooms**

Offices	=	300
Changing, locker and cleaners' room, Cloak rooms, lavatories	=	100
Rest Rooms	=	150

- **Staff Restaurants**

Canteens, Cafeterias, dining rooms, mess rooms	=	200

- **Communication**

Switch board rooms	=	300
Telephone, apparatus rooms	=	150
Telex room, post rooms	=	500
Reprographic room	=	300

- **Education**

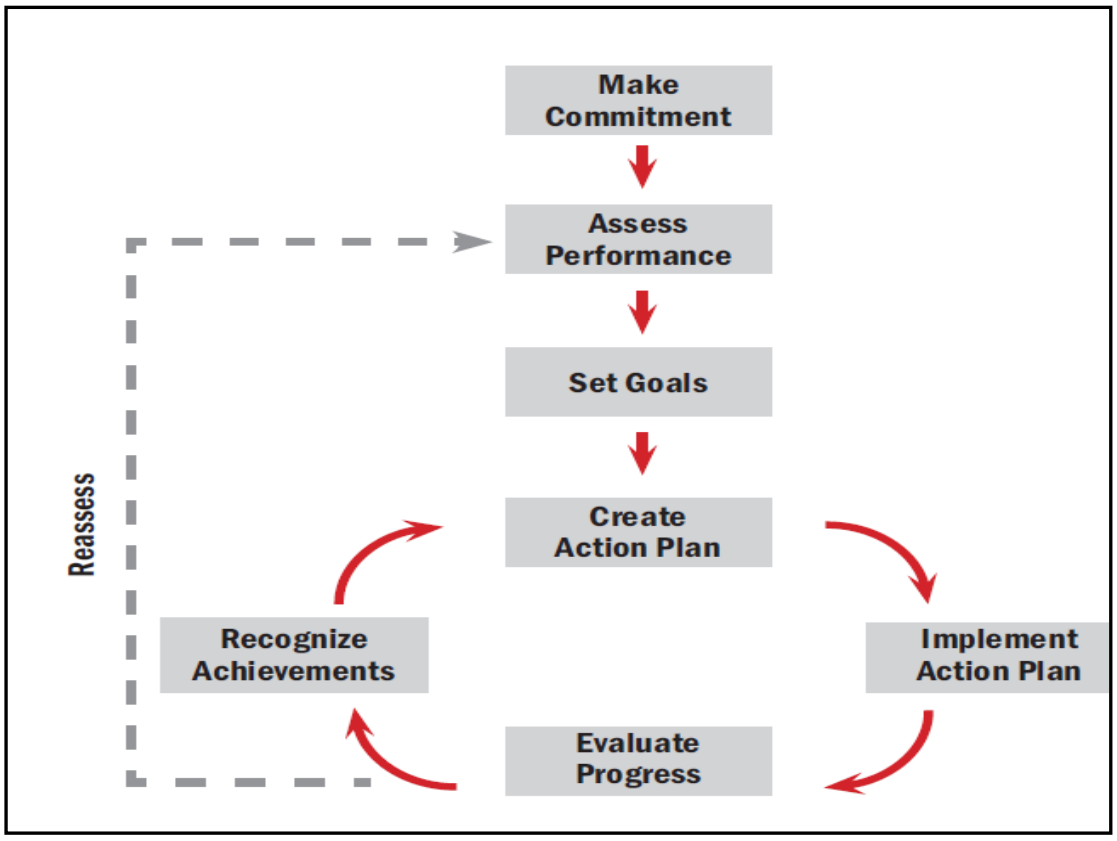
Assembly Halls	=	200-500 (average 300)
Teaching Places	=	200-500 (average 300)
Lecture Theatres	=	200-500 (average 300)
Seminar Rooms	=	300-750 (average 500)
Art Rooms	=	300-750 (average 500)
Needle Work Rooms	=	300-750 (average 500)
Laboratories	=	300-750 (average 500)
Libraries	=	200-500 (average 300)
Music Rooms	=	200-500 (average 300)
Sports Halls	=	200-500 (average 300)
Workshops	=	200-500 (average 300)

Annexure-3

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 audits** should be reviewed periodically/annually for further action plan.

Format for Maintaining a Monthly Record of the Purchased Power Consumption

Particulars	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Actual Demand (KVA)												
KWh Consumption												
KVAh Consumption												
Operating Power factor												
Fixed Demand Charges (Rs)												
Energy Charges (Rs)												
Penalty / Rebate, if any (Rs)												
Other Charges (Rs)												
Total Amount Payable (Rs)												

Format for Maintaining a Monthly Record of the Self Generated Power & HSD Consumption

Particulars	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Power Generated (KWh)												
HSD Consumed (Ltr)												
Lube Oil Consumption (Ltr)												
Total Running Hours												
Specific Power Generation (KWH/Ltr)												

Annexure-4

Checklist for Preventive Maintenance

➲ Building Envelope

Windows and Skylights

- Replace broken or cracked window panes
- 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.