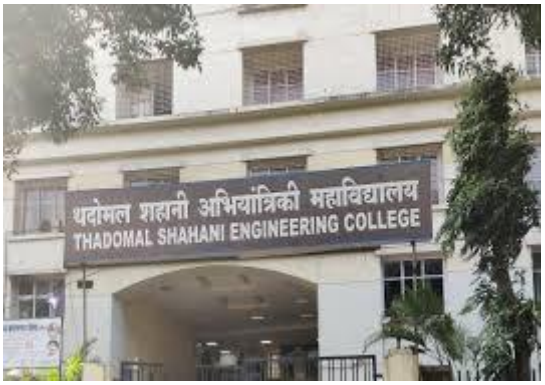
Energy Audit Report

of

THADOMAL SHAHANI ENGINEERING COLLEGE, BANDRA WEST, MUMBAI



Prepared

By

Dr. Santosh D Dalvi
BEE Certified Energy Auditor
Certification No: CEA- 12141

March 2021

Dr. G. T. Thampi
PRINCIPAL
Thadomal Shahani Engineering College
Bandra (W), Mumbai-400 050.

Lokmanya Tilak Jankalyan Shikshan Sansthaa's
LOKMANYA TILAK COLLEGE OF ENGINEERING
Approved by AICTE vide letter No. F-740-89-295 (E)/RC/94 Dt. 26-07-1994
Affiliated to University of Mumbai & Recognised by Govt. of Maharashtra

Shri. Satish Chaturvedi
Chairman

Dr. Vivek Sunnapwar
Principal

LTCE/Gen/2021/

Date: 18/03/2021

ENERGY AUDIT COMPLETION CERTIFICATE

This is to certify that Energy Audit has been carried out in the campus and buildings of Thadomal Shahani Engineering College, Bandra West , Mumbai as per the guidelines laid down in The Energy Conservation Act, 2001, in the month of March 2021.

Name of the Installation	Thadomal Shahani Engineering College, Bandra West, Mumbai-400050
Details of Facilities Audited	Laboratories, Classrooms, Library, Seminar halls of New and Old Building
Date of Energy Audit	15/03/2021
Name of Certified Energy Auditor	Dr. S D Dalvi
Certification Number	CEA- 12141
Validity of the Certificate	14/03/2022

Dr. S D Dalvi
Certified Energy Auditor

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Principal

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Executive Summary-Energy Audit

Energy Saving Potential

Sr No	Area & Proposed Action for Energy Efficiency Improvement	Savings Potential	Investment	Payback Period
		Rs/month	Rs	Months
1	Maintaining Power factor to unity and other incentives/discounts	14096	NIL	Immediate
2	Replacing magnetic ballast with electronic ballasts for tube lights and lamps	1581	81200	51
3	Improving & maintaining performance of air conditioners at optimal levels (Sampled)	362	Negligible	Immediate
4	Replacing tube lights (TL) by LED lamps	7714	133600	18
5	Replacing ordinary ceiling fans by energy efficient Fans	3683	985000	23

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Chapter-I

Introduction

1.1 Background of the study:

The fundamental purpose of the energy audit is not only to identify the potential saving areas but also to establish energy monitoring and control system to reap the gains on sustainable basis. It is with this purpose that Thadomal Shahani Engineering College (TSEC), Bandra (West), Mumbai, Maharashtra, assigned Dr. S D Dalvi, CEA-12141 Energy Auditor to carry out Energy Audit. It was really tough time to carry out study in Covid-19 Pandemic, But the TSEC management made it success.

This energy audit report presents the analysis of the data collected, observations made at the facility and is governed by the objectives, scope of work, methodology etc. discussed in the ensuing paragraphs.

Objective:

The basic objectives of the Energy Audit Study are to,

- Identify key result areas for energy saving along with their broad Cost Benefit Analysis.
- Suggest energy monitoring and control mechanism to realize the savings on the sustainable basis.

Methodology:

Prior to start of the Audit session, submitted a list of data required along with the execution plan.

Then deputed a team of Project Engineers for this task. The visit was undertaken in the First week of March 2021. The field training was given to the engineers

about data collection. The team was trained about operation and handling of the instruments used in the energy auditing, in Covid-19 Pandemic situation.

The prime objectives of these visits were:

- To hold discussions with Principal, to understand Energy consumption pattern, to get acquainted with the efforts already put in for energy conservation
- To collect historic data regarding energy consumption and maintenance practices.
- To undertake requisite field trials and to make observation.

Team:

The team members of the audit study.

1. Dr S D Dalvi, Certified Energy Auditor (CEA-12141)

2. Mr Swapnil D Mhatre, Project Engineer

3. Mr Shubham J Birambole, Project Engineer

4. Mr Nikhil C Varsolkar, Project Engineer

Instruments

The following instruments were utilized for measurement during the energy audit study.

1. Power meter
2. Hygro-temperature meter
3. Anemometers
4. AC power meter
5. Lux meter

Acknowledgment:

We wish to record our gratitude to the management of TSEC for awarding this assignment. We extend our thanks to the Principal, Dr. G T Thampi for initiating the work. We are also thankful to the maintenance team for extending all possible help and co-operation from their side.

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Chapter-II

Consumption Pattern

2.1 Brief Description & Consumption data:

Present Scenario:

- The average monthly consumption is around 9,061 kWh.
- The monthly maximum consumption in AY 2020-21 is observed as 25,617 kWh.
- The calculated cost of power is Rs 10.43/- per kWh in AY 20-21 for LT I (B) electricity meters.

As can be seen the major consumption is of

- Air conditioners
- Ceiling fans
- Computers
- Illumination

The other unaccounted consumptions are of elevators, centrifugal pumps,

printers, scanners, ups etc.

2.2 Electricity Bills:

The electricity is supplied through LT connection; TSEC has installed Seven LT I (B) electricity meters. TSEC has installed five LT II (C) electricity meters. This tariff category is applicable for electricity used at Low/Medium voltage in non-residential, non-industrial and/or commercial premises for commercial consumption meant for operating various appliances used for purposes such as

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lighting, heating, cooling, cooking, washing/cleaning, entertainment/ leisure and water pumping in.

The statistics of electricity consumption for month of February 2021is tabulated and shown in the graph.

The analysis of LT II (C) electricity meters is shown in table.

Category		LT II (C)				
Meter No		L1003438	L1003439	L1003440	L1004492	L1004495
MF		20	40	80	40	20
consumption	KWH	1111	131	1845	218	1728
Maximum Consumption	kWH	568	5470	6057	960	2799
Month and Year		Sep-20	Oct-20	Oct-20	Feb-21	Mar-21
Power factor		0.335	0.894	0.85	0.971	0.428
TOD 9-12 hrs charges	Rs	156.5	7	278	36.5	147
TOD 12-22 hrs charges	Rs	3	13	98	5	324
TOD 22-06 hrs charges	Rs	*3*	18	*135.75*	0	*293.25*
Prompt Payment Discount	Rs	0	0	0	0	0
Digital Payment Discount	Rs	0	0	0	0	0
Delayed Payment Charges	Rs	243.35	143.51	495.02	108.31	518.04
PF Panalty/Incentives	Rs	3639.08	93.74	1546.55	*71.59*	6762.22
Energy Charges	Rs	19467.74	11481.11	39601.45	8664.5	41443.31
Bill Amount	Rs	19711.15	11627.69	40100.73	8774.69	41962.66

The analysis of LT I (B) electricity meters are shown in table.

Category		LTI (B)						
Meter No		7735461	7735462	7780668	7602803	7882202	7541328	7881869
consumption	KWH	73	31	98	1339	139	1289	1059
Maximum Consumption	kWH	124	72	563	2239	1416	3218	2131
Month and Year		Feb-20	Jan-20	Jan-20	Feb-20	Feb-20	Jan-20	Jan-20
Prompt Payment Discount	Rs	0	0	0	0	10.47	0	0
Digital Payment	Rs	0	0	0	0	0	0	0

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Discount								
Delayed Payment Charges	Rs	na	na	Na	na	Na	na	na
PF Panalty/Incentives	Rs	Na	na	Na	na	Na	na	na
Energy Charges	Rs	888.12	332.65	700.62	13427.24	1663.61	12876.58	10995.97
Bill Amount	Rs	897.97	342.43	708.78	13521.97	1663.61	12882.35	11046.99

2.3 Energy Saving Analysis:

The observations are as below.

1. Power factor penalty of Rs. 11970 per month* is levied which can be saved and converted into incentives by maintaining power factor near to unity.
The improvement in power factor also reduces maximum demand and proportionally saves on demand charges. The power factor has been maintained at unity.
2. Delayed payment charges of Rs. 1508.23 per month* may be saved.
3. TOD charges of Rs. 1068 and incentives of Rs. 450 are levied in current month.
4. The prompt payment discount and digital payment discount are not observed in the electricity bills.

2.4 Important Information from Electricity Distributor:

The electricity distributor of TSEC is Adani Electricity Mumbai Limited. The tariff for LT I (B) meter is shown in the table.

Tariff w.e.f. 1 April, 2021 to 31 March, 2022 (LT I B)

Consumption Slab (kWh)	Fixed Charge / Demand Charge[$$]	Wheeling Charge (Rs/kWh)	Energy Charge (Rs/kWh)
0-100 units	75	1.46	3.05
100-300 units	115	1.46	5.00
301-500 units	115	1.46	6.65
Above 500 units	140	1.46	7.80

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The tariff for LT II (C) meter is shown in the table.

Tariff w.e.f. 1 April, 2021 to 31 March, 2022 (LT II C)

Consumption Slab (kWh)	Fixed Charge / Demand Charge	Wheeling Charge (Rs/kWh)	Energy Charge (Rs/kWh)
(A) 0-20 kW	Rs. 405 per month	1.46	5.65
(B) >20 kW and ≤ 50 kW	Rs. 335 per kVA month	1.46	6.05
(C) > 50 kW	Rs. 335 per kVA month	1.46	6.60
TOD Tariffs (in addition to above base Tariff)			
0600 to 0900 hours			0.00
0900 to 1200 hours			0.50
1200 to 1800 hours			0.00
1800 to 2200 hours			1.00
2200 to 0600 hours			-0.75

Power factor incentives

Whenever the average Power Factor is more than 0.95 (lag or lead) and upto 1, an incentive shall be given at the rate of the following percentages of the amount of the monthly electricity bill. The details are shown in the table.

Sl.	Range of Power Factor	Power Factor Level	Incentive
1	0.951 to 0.954	0.95	0.0%
2	0.955 to 0.964	0.96	0.5%
3	0.965 to 0.974	0.97	1.0%
4	0.975 to 0.984	0.98	1.5%
5	0.985 to 0.994	0.99	2.5%
6	0.995 to 1.000	1.00	3.5%

Power factor penalty

Whenever the average PF is less than 0.9 (lag or lead), penal charges shall be levied at the rate of the following percentages of the amount of the monthly electricity bill. The details are shown in the table.

Sl.	Range of Power Factor	Power Factor Level	Penalty
1	0.895 to 0.900	0.90	0.0%
2	0.885 to 0.894	0.89	1.0%
3	0.875 to 0.884	0.88	1.5%
4	0.865 to 0.874	0.87	2.0%
5	0.855 to 0.864	0.86	2.5%
6	0.845 to 0.854	0.85	3.0%
7	0.835 to 0.844	0.84	3.5%
8	0.825 to 0.834	0.83	4.0%
9	0.815 to 0.824	0.82	4.5%
10	0.805 to 0.814	0.81	5.0%
…	…	…	…

Chapter-III

Computers

3.1 Brief Description:

In new building there were 876 computers and in old building 65 computers counted as observed. There were printers and scanners in both the buidings.

General Suggestions:

1. An efficient power management system may be incorporated to

a. Switch off the display if not in use.

b. Put the computer in Sleep mode / switching off the machines, if not used for prolonged period.

2. Optimize brightness of the screen.

3. Discourage use of screen savers, which has similar power consumption

Chapter-IV

Air Conditioning System

4.1 Brief Description:

Air conditioning system is basically provided to maintain comfortable ambience inside the premises by maintaining the temperature (and relative humidity, at times) at appropriate levels. The performance of human being is optimal at the temperature of 24 ± 2 ^{o}C and at relative humidity (RH) of 60 ± 5%.

The warmer and humid air from the premises is drawn and fed to the Air Conditioning System by a circulating fan. This air is chilled in an evaporator by vaporizing the refrigerant and is distributed throughout the conditioned area. The refrigerant is pressurized by a compressor and subsequently s cooled and condensed by an air cooled condenser. The compressor and condenser are placed in an outdoor unit, located on the external side of the premise. While the circulating fan and evaporator is placed in an indoor unit located inside the premises.

4.2 Performance Evaluation:

The Air Conditioning effect (TR) and specific power consumption can be computed as under

AC Effect (TR) = Air flow rate x Specific gravity of air x (Enthalpy of supply air - Enthalpy of return air) / 3000

Specific Power (kWh/TR) = Power Consumption / AC Effect

The performance as well as chilling (or Air Conditioning) effect delivered by the air conditioner (represented as TR - Ton of Refrigeration) is computed by measuring

- Air Velocity along with the cross-sectional area of flow to determine flow rate and subsequently mass flow rate.
- Temperature and relative humidity of the air at the inlet of the evaporator coil to determine enthalpy of the air.
- Temperature and relative humidity of the air at the outlet of the evaporator coil to determine enthalpy of the air.
- Power drawn by the air conditioning unit

The chilling effect can be computed as under,

1. Flow Rate of Air (kg/hr)

= Average Air velocity (M/s) x Cross sectional area of the air flow (Sq M) X Specific gravity of air

2. Chilling or Air Conditioning Effect (TR)

= Air flow rate (kg/hr) x Enthalpy difference between the air at inlet and outlet of the evaporator coil (kJ/kg) / (4.18 x 3024)

3. Chilling or Air Conditioning Effect (kW)

= Air flow rate (kg/hr) x Enthalpy difference between the air at inlet and outlet of the evaporator coil (kJ/kg) / 3600

= 3.5112 x Chilling Effect (TR)

4. Specific Power Consumption (kWh/TR) =

Power consumption (kW) / Air Chilling Effect (TR)

Energy Efficiency Ratio - EER (W of cooling / W of input power)

= Power consumption (kW) / Air Chilling Effect (kW)

= 3.5112 / Specific Power consumption (kW/TR)

The data collected only at the sampled and accessible air conditioners, based on structural observations like filter condition, insulation damage etc. and analyzed is tabulated below.

Assuming,

daily operation hours= 5

No of functioning days per year= 200

No of functioning days per month= 22

Average cost of electricity = Rs. 5/kWh

Sr No	LOCATION	Make	TYPE OF A/C Split/window	CAPACITY	POWER	Average Velocity	FLOW
				TR	kW	MPS	M^3/hr
TSEC OLD BUILDING							
1	202	Voltas	Window	1.5	1.71	1.9	465.1
2	203	Blue star	Window	1.5	1.83	1.8	440.6
3	503	Voltas	Split	2	1.88	3.3	950.4
TSEC NEW BUILDING							
4	702	Voltas (2)	Split	2	1.88	1.6	460.8
5	704	Voltas	Split	2	2.85	2.8	806.4
6	802	Voltas	Split	2	2.89	2.6	748.8
7	804	Voltas (2)	Split	2	1.67	1.6	460.8

Sr No	AHU Inlet			AHU Outlet			AC Load	SPC	Savings	
	Temp	RH	Enthalpy	Temp	RH	Enthalpy				
	°C	%	KJ/Kg	°C	%	KJ/Kg	TR	kW/TR	kwh	Rs
TSEC OLD BUILDING										
1	30.5	70.5	80.72	20.6	72.6	50.65	1.34	1.27	0.4	366
2	29.4	72.2	80.7	20	78	49.04	1.34	1.37	0.8	830
3	28.7	80.5	80.16	24.9	77.7	64.24	1.45	1.29	0.5	469
TSEC NEW BUILDING										
4	29.2	69.3	74.67	27.2	68.4	78.96	1.50	1.25	0.3	267
5	26.4	75.3	75.48	18.2	70.9	48.41	2.10	1.36	0.8	798
6	26.5	75.4	75.48	18.2	70.9	48.4	1.95	1.48	1.4	1421
7	27	70.2	67.34	23.5	78.6	59.99	1.35	1.24	0.2	185

Opportunity for Conservation of energy:

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Performance improvement:

The specific power consumption of sampled air conditioning units is higher than the general norm of 1.2 KWH/TR or EER of around 3.0.

The saving potential works out to about 4-6% in the overall consumption of the air conditioners as can be seen from the table above.

The performance of air condition can deteriorate due to

- Lower suction pressure and consequently temperature due to constrains on the evaporator. Generally, 1 ^{o}C drop in condensing temperature increases the specific power consumption by 4 to 5%. The constraints on the evaporator include

o Clogging of the filters

o Choking of fins o Damages to the fins

o Deposition of dust on the external surface of the coil

o Scaling on the internal or external surface of the coil

o Depositions inside the coil o Inadequate surface areas due to improper design

- Higher discharge pressure and consequently temperature due to constrains on the condenser. Generally, 1 ^{o}C rise in condensing temperature increases the specific power consumption by 3 to 4%. The constraints on the condenser include

o Clogging of the fins o Damages to the fins

o Deposition of dust on the external surface of the coil

o Scaling on the internal or external surface of the coil

o Depositions inside the coil o Inadequate surface areas due to improper design

- Deteriorations in the fan (for the indoor as well outdoor unit) performance

o Damages to the fan blade o Deposition of dust on the fan surface o Damages to bearings, shaft, etc.

o Inadequate capacity due to improper design

- Improper location of the outdoor unit

o Direct exposure to sunlight o Inaccessible to maintenance / servicing o Restriction on cooling air circulation

- Improper quantity of refrigerant.
- Mechanical constrains on the refrigeration compressor

O Damages to bearings, shaft, etc.

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O Increases in internal clearances

o Drop in volumetric efficiency

The saving potential can be worked out based on specific power consumption of 1.2 kWh/TR (Energy Efficiency Ratio - EER of 2.93); as detailed above.

The expected saving is about 4.4 kWh, considering an operating period of 5 hours a day for 22 days per month.

The savings work out to Rs 4,336/- per year for sampled air conditioners.

There are no capital investment and the payback period shall be attractive.

Chapter-V

Illumination

5.1 Brief Description:

The detail list of light fitting is as under.

Most fittings in new buildings are fitted with electronic ballast and at very few locations magnetic ballast fittings are used.

The fittings in the old buildings are fitted with magnetic ballast, except few locations, are provided with electronic ballast.

SN	Location	(hrs/day and day/month) Opn		Length	Width	Height	Area	RI	Ballast Type	Type of Fitting			Intensity	Power Intensity		Desired Parameters		Installed Load Efficacy Ratio	Desired Parameters (ILER = 75%)		Energy Loss (-ve indicates gain due to solar)		Saving Potential Diversity Factor 75% & Power @ Rs. 5/kWh
				M	M	M	M2								Average	Actual	Desired		Power Intensity	Power			
										F	W	R	Watts	W/M2		Lux/W/M2			W/M2	W	W	%	kWh/M
	TSEC Old Building																						
1	Ground Floor	4	22	7	7	3.5	49	1.00	M	13	13	36	468	9.55	109	11.41	36	32%	4.04	197.8	270.2	58%	17.8
2	H-101	10	30	6.15	4.56	2.77	28.044	0.95	M	2	2	40	80	2.852660106	171.43	60.09	36	167%	6.35	178.1	-98.1	-123%	-22.1
3	101	4	22	9	7	3.5	63	1.13	M	5	3	36	108	1.71428	94.28	55.00	40	137%	3.14	198.0	-90.0	-83%	-5.9
4	102	4	22	9	7	3.5	63	1.13	M	5	4	36	144	2.28	130	57.02	40	143%	4.33	273.0	-129.0	-90%	-8.5
5	103	4	22	9	7	3.5	63	1.13	M	6	4	36	144	2.28	125.71	55.14	40	138%	4.19	264.0	-120.0	-83%	-7.9
6	104	4	22	8	6	3.5	48	0.98	M	6	5	36	180	3.75	132.85	35.43	36	98%	4.92	236.2	-56.2	-31%	-3.7
7	105	4	22	9	7	3.5	63	1.13	M	6	6	36	216	3.41	248.57	72.89	40	182%	8.29	522.0	-306.0	-142%	-20.2
8	106	4	22	8	7	3.5	56	1.07	M	6	6	36	216	3.85	87.14	22.63	40	57%	2.90	162.7	53.3	25%	3.5
9	107	4	22	8	6	3.5	48	0.98	M	5	5	36	180	3.75	109.28	29.14	36	81%	4.05	194.3	-14.3	-8%	-0.9
10	108	4	22	7	6	3.5	42	0.92	M	4	4	36	144	3.42	93.33	27.29	36	76%	3.46	145.2	-1.2	-1%	-0.1
11	109	4	22	7	6	3.5	42	0.92	M	4	4	36	144	3.42	126.67	37.04	36	103%	4.69	197.0	-53.0	-37%	-3.5
12	202	4	22	4	4	3.5	16	0.57	M	4	3	36	108	6.75	105.71	15.66	36	44%	3.92	62.6	45.4	42%	3.0
13	203	4	22	8	5	3.5	40	0.88	M	6	4	36	144	3.6	70	19.44	36	54%	2.59	103.7	40.3	28%	2.7

14	204	4	22	8	4	3.5	32	0.76	M	4	4	36	144	4.5	60	13.33	36	37%	2.22	71.1	72.9	51%	4.8
15	206	4	22	10	6	3.5	60	1.07	M	4	3	36	108	1.8	127.14	70.63	40	177%	4.24	254.3	-146.3	-135%	-9.7
16	207	4	22	10	6	3.5	60	1.07	M	5	4	36	144	2.4	107.14	44.64	40	112%	3.57	214.3	-70.3	-49%	-4.6
17	301	4	22	4	3.5	3.5	14	0.53	M	2	1	36	36	2.5	195.71	78.28	36	217%	7.25	101.5	-65.5	-182%	-4.3
18	302	4	22	3.5	4	3.5	14	0.53	M	2	2	36	72	5.14	94.28	18.34	36	51%	3.49	48.9	23.1	32%	1.5
19	304	4	22	10	6	3.5	60	1.07	M	6	6	36	216	3.6	11.42	3.17	40	8%	0.38	22.8	193.2	89%	12.7
20	305	4	22	10	4	3.5	40	0.82	M	6	6	36	216	5.4	277.14	51.32	36	143%	10.26	410.6	-194.6	-90%	-12.8
21	306	4	22	8	5	3.5	40	0.88	M	7	5	36	180	4.5	122.85	27.30	36	76%	4.55	182.0	-2.0	-1%	-0.1
22	307	4	22	8	5	3.5	40	0.88	M	5	3	36	108	2.7	134.28	49.73	36	138%	4.97	198.9	-90.9	-84%	-6.0
23	308	4	22	7	6	3.5	42	0.92	M	4	4	36	144	3.4	135.71	39.91	36	111%	5.03	211.1	-67.1	-47%	-4.4
24	401	4	22	5	3	3.5	15	0.54	M	3	3	36	108	7.2	225.71	31.35	36	87%	8.36	125.4	-17.4	-16%	-1.1
25	402	4	22	10	7	3.5	70	1.18	M	3	3	36	108	1.54	64.28	41.74	40	104%	2.14	150.0	-42.0	-39%	-2.8
26	408	4	22	7	6	3.5	42	0.92	M	4	4	36	144	3.42	172.85	50.54	36	140%	6.40	268.9	-124.9	-87%	-8.2
27	409	4	22	1.5	1.5	3.5	2.25	0.21	M	1	1	36	36	16	225	14.06	36	39%	8.33	18.8	17.3	48%	1.1
28	501	4	22	4	3.5	3.5	14	0.53	M	2	2	36	72	5.14	62.85	12.23	36	34%	2.33	32.6	39.4	55%	2.6
29	502	4	22	3.5	4	3.5	14	0.53	M	2	2	36	72	5.14	62.85	12.23	36	34%	2.33	32.6	39.4	55%	2.6
30	503	4	22	12	5	3.5	50	1.01	M	8	7	36	252	5.04	63.85	12.67	40	32%	2.13	106.4	145.6	58%	9.6
31	504	4	22	15	15	3.5	225	2.14	M	24	14	36	504	2.24	86.42	38.58	46	84%	2.50	563.6	-59.6	-12%	-3.9
32	505	4	22	12	5	3.5	60	1.01	M	6	6	36	216	3.6	202.85	56.35	40	141%	6.76	405.7	-189.7	-88%	-12.5

33	506	4	22	12	5	3.5	60	1.01	M	7	7	36	252	4.2	471.42	112.24	40	281%	15.71	942.8	-690.8	-274%	-45.6
34	507	4	22	7	6	3.5	42	0.92	M	4	4	36	144	3.42	407.14	119.05	36	331%	15.08	633.3	-489.3	-340%	-32.3
35	509	4	22	1.5	1.5	3.5	14	0.21	M	1	0	36	36	3.42	407.14	119.05	36	331%	15.08	211.1	-175.1	-486%	-11.6
36	601	4	22	3	3	3.5	9	0.43	M	2	2	36	-72	3.42	683.33	199.80	36	555%	25.31	227.8	-299.8	416%	-19.8
37	602	4	22	12	4.5	3.5	54	0.94	M	8	8	36	288	5.3	77.57	14.64	36	41%	2.87	155.1	132.9	46%	8.8
38	603	4	22	7	4	3.5	28	0.73	M	8	7	36	252	9	302.71	33.63	36	93%	11.21	313.9	-61.9	-25%	-4.1
39	604	4	22	7	8	3.5	56	1.07	M	12	12	36	432	7.7	252.85	32.84	40	82%	8.43	472.0	-40.0	-9%	-2.6
40	605	4	22	7.5	4.5	3.5	29	0.80	M	7	7	36	252	8.68	86.42	9.96	36	28%	3.20	92.8	159.2	63%	10.5
41	606	4	22	7.5	4.5	3.5	29	0.80	M	7	7	36	252	8.68	324.28	37.36	36	104%	12.01	348.3	-96.3	-38%	-6.4
42	608	4	22	4	5	3.5	20	0.63	M	6	6	36	216	10.8	174.28	16.14	36	45%	6.45	129.1	86.9	40%	5.7
	TSEC New Building																						
43	OFFICE	6	22	6	6	4.5	36	0.67	E	1	1	22	22	0.61	90	147.54	36	410%	3.33	120.0	-98.0	-445%	-9.7
44	TPO Room	4	22	6	6	4.5	36	0.67	M	3	3	22	66	0.54	140	259.26	36	720%	5.19	186.7	-120.7	-183%	-8.0
45	201	6	22	8	7	4.5	56	0.83	led	9	9	22	198	3.53	358	101.42	36	282%	13.26	742.5	-544.5	-275%	-53.9
46	202	6	22	8	7	4.5	56	0.83	E	12	7	36	252	4.5	306	68.00	36	189%	11.33	634.7	-382.7	-152%	-37.9
47	203	6	22	8	7	4.5	56	0.83	E	20	10	36	360	6.42	175	27.26	36	76%	6.48	363.0	-3.0	-1%	-0.3
48	301	6	22	8	7	4.5	56	0.83	E	9	9	36	324	5.78	125	21.63	36	60%	4.63	259.3	64.7	20%	6.4
49	302	6	22	8	7	4.5	56	0.83	E	8	8	22	176	3.14	115	36.62	36	102%	4.26	238.5	-62.5	-36%	-6.2
50	306	6	22	8	7	4.5	56	0.83	LED	9	9	22	198	3.53	117	33.14	36	92%	4.33	242.7	-44.7	-23%	-4.4

51	401	6	22	12	7	4.5	84	0.98	LED	44	44	22	968	11.52	255	22.14	36	61%	9.44	793.3	174.7	18%	17.3
52	403	6	22	8	7	4.5	56	0.83	E	9	9	36	324	5.78	170	29.41	36	82%	6.30	352.6	-28.6	-9%	-2.8
53	405	6	22	8	6	4.5	48	0.76	LED	8	8	22	176	3.66	175	47.81	36	133%	6.48	311.1	-135.1	-77%	-13.4
54	502	6	22	8	7	4.5	56	0.83	E	22	21	36	792	14.14	408	28.85	36	80%	15.11	846.2	-54.2	-7%	-5.4
55	503	6	22	8	7	4.5	56	0.83	E	16	8	36	288	5.14	173	33.66	36	93%	6.41	358.8	-70.8	-25%	-7.0
56	504	6	22	8	7	4.5	56	0.83	E	16	8	36	288	5.14	283	55.06	36	153%	10.48	587.0	-299.0	-104%	-29.6
57	505	6	22	8	7	4.5	56	0.83	CFL	14	7	36	252	4.5	254.28	56.51	36	157%	9.42	527.4	-275.4	-109%	-27.3
58	508	6	22	8	7	4.5	56	0.83	E	18	10	36	360	6.42	36.22	5.64	36	16%	1.34	75.1	284.9	79%	28.2
59	601	6	22	8	7	4.5	56	0.83	E	20	10	36	360	6.42	392.85	61.19	36	170%	14.55	814.8	-454.8	-126%	-45.0
60	602	6	22	8	7	4.5	56	0.83	E	24	12	36	432	7.71	257.14	33.35	36	93%	9.52	533.3	-101.3	-23%	-10.0
61	604	6	22	8	7	4.5	56	0.83	E	13	7	36	252	4.5		0.00	36	0%	0.00	0.0	252.0	100%	24.9
62	605	6	22	8	7	4.5	56	0.83	E	20	10	36	360	6.42	155.71	24.25	36	67%	5.77	323.0	37.0	10%	3.7
63	609	6	22	8	7	4.5	56	0.83	E	22	5	36	180	3.21	257.14	80.11	36	223%	9.52	533.3	-353.3	-196%	-35.0
64	704	6	22	15	12	4.5	180	1.48	E	48	24	36	864	4.8	557.14	116.07	43	270%	17.28	3109.6	-2245.6	-260%	-222.3
65	706	6	22	8	7	4.5	56	0.83	E	18	9	36	324	5.78	392.85	67.97	36	189%	14.55	814.8	-490.8	-151%	-48.6
66	801	6	22	8	6	4.5	48	0.76	E	14	7	36	252	5.25	151.57	28.87	36	80%	5.61	269.5	-17.5	-7%	-1.7
67	802	6	22	8	6	4.5	48	0.76	E	15	8	36	288	6	162.85	27.14	36	75%	6.03	289.5	-1.5	-1%	-0.1
68	803	6	22	10	7	4.5	70	0.92	E	36	18	36	348	4.97	457.14	91.98	36	255%	16.93	1185.2	-837.2	-241%	-82.9

69	805	6	22	10	7	4.5	70	0.92	E	24	12	36	432	6.17	242.85	39.36	36	109%	8.99	629.6	-197.6	-46%	-19.6
70	806	6	22	8	7	4.5	56	0.83	E	24	12	36	216	3.85	500	129.87	36	361%	18.52	1037.0	-821.0	-380%	-81.3
71	901	6	22	8	6	4.5	48	0.76	E	16	6	36	216	4.5	110.57	24.57	36	68%	4.10	196.6	19.4	9%	1.9
72	902	6	22	8	7	4.5	56	0.83	E	18	9	36	324	5.78	192.5	33.30	36	93%	7.13	399.3	-75.3	-23%	-7.5
73	906	6	22	8	8	4.5	64	0.89	E	13	4	36	144	2.25	105	46.67	36	130%	3.89	248.9	-104.9	-73%	-10.4
74	907	6	22	8	8	4.5	48	0.89	E	12	4	36	144	3	56.42	18.81	36	52%	2.09	100.3	43.7	30%	4.3
75	1002	6	22	8	5	4.5	40	0.68	E	18	9	36	324	8.1	96.67	11.93	36	33%	3.58	143.2	180.8	56%	17.9
76	1003	6	22	8	5	4.5	40	0.68	E	14	7	36	252	6.3	245	38.89	36	108%	9.07	363.0	-111.0	-44%	-11.0
77	1004	6	22	8	5	4.5	40	0.68	E	22	11	36	396	9.9	195	19.70	36	55%	7.22	288.9	107.1	27%	10.6
78	1005	6	22	8	8	4.5	64	0.89	E	16	8	36	288	4.5	147.5	32.78	36	91%	5.46	349.6	-61.6	-21%	-6.1
79	1006	6	22	8	5	4.5	40	0.68	E	20	10	36	360	9	140	15.56	36	43%	5.19	207.4	152.6	42%	15.1
80	1101	6	22	10	7	4.5	70	0.92	E	28	24	36	864	12.34	9.428	0.76	36	2%	0.35	24.4	839.6	97%	83.1
81	1102	6	22	1	7	4.5	70	0.19	E	13	12	36	432	6.17	102	16.53	36	46%	3.78	264.4	167.6	39%	16.6
82	1103	6	22	10	7	4.5	70	0.92	E	19	17	36	612	8.74	45.42	5.20	36	14%	1.68	117.8	494.2	81%	48.9
83	1104	6	22	10	7	4.5	70	0.92	E	19	16	36	576	8.22	158.42	19.27	36	54%	5.87	410.7	165.3	29%	16.4
84	1105	6	22	15	7	4.5	105	1.06	E	28	23	36	828	7.88	257.14	32.63	40	82%	8.57	900.0	-72.0	-9%	-7.1

Opportunity for Conservation of energy:

Electronic Ballast:

The conventional ballast may be replaced with electronic ballast. The magnetic ballast generally consumes 15 W of power; while the electronic ballast consumes just about 3 W and delivers 10% more light output. However, these ballasts are usually tuned to save about 15 W of power while providing slightly lower light output (about 5%).

Thus energy saving of over 30% can be realized by replacing conventional ballast by electronic ballast. The expected annual savings shall be around Rs 500/- per tube light; while the cost of installing a ballast shall be Rs 250/-

The saving potential can be computed as under.

Description	Unit	Value
Present Condition: Conventional Ballast		
Number of points	No	203
Rating of the point light	Watt	36
Rating of the switchgear	Watt	15
Power consumption of the lamp	Watt	51
Desirable Condition: Electronic Ballast		
Rating of the lamp	Watt	36
Rating of the switchgear	Watt	2
Power consumption of the lamp	Watt	32
Controllable Loss		
Loss	Watt	19
	%	37.3%
Saving Potential		
Cost of power	Rs/kWh	5
Operating period	Hr/Month	110
Diversity Factor	%	75%
Energy Saving	kWh/Month	424.27
	Rs/Month	1591

The magnetic ballast can be replaced by electronic ballast; saving around Rs 1591/- per month. The actual saving shall vary depending on the switching period of the luminaire.

The investment shall be Rs 81200/-; giving a payback period of 51 months.

LED Lamps:

A 15 W LED lamp can provide similar illumination level to that of 36 W TFL. It is thus possible to save about 21 W of power by replacing a 36 W TFL (with conventional ballast) with 15 W LED (with electronic starter). Thus energy saving of over 50% can be realized by replacing TFL with LED lamp.

The expected monthly savings shall be around Rs 2344.65/- for old building and Rs. 5370/- for new building.

The payback for the individual lamp shall be around 18 months.

Chapter-VI

Ceiling Fans

6.1 Brief Description:

Total 135 working ceiling fans are counted in the available locations of old building and total 259 working ceiling fans are counted in the available locations of new building. The average rating is around 60W for old fans in the old building. For comparison purpose 45W rating is considered for both old and new buildings.

6.2 Details:

The details are as below.

Sr No	Room No	Operation		Ceiling Fan Details			Energy Eff Fan	Savings per month		
				48'			28W@speed 5	@Rs 5/kWh		
		hr/d	d/m	Fitted	working	Rating	Rating	W	kWh	Rs
TSEC OLD BUILDING										
1	Ground	5	22	3	3	45	28	17	5.61	28.05
2	101	5	22	4	4	45	28	17	7.48	37.40
3	102	5	22	4	4	45	28	17	7.48	37.40
4	103	5	22	4	4	45	28	17	7.48	37.40
5	104	5	22	4	3	45	28	17	5.61	28.05
6	105	5	22	4	4	45	28	17	7.48	37.40
7	106	5	22	5	4	45	28	17	7.48	37.40
8	107	5	22	4	4	45	28	17	7.48	37.40
9	108	5	22	4	4	45	28	17	7.48	37.40
10	201	5	22	4	4	45	28	17	7.48	37.40
11	202	5	22	1	1	45	28	17	1.87	9.35
12	203	5	22	4	2	45	28	17	3.74	18.70
13	204	5	22	2	2	45	28	17	3.74	18.70
14	206	5	22	4	4	45	28	17	7.48	37.40
15	207	5	22	4	4	45	28	17	7.48	37.40
16	301	5	22	2	2	45	28	17	3.74	18.70
17	302	5	22	1	1	45	28	17	1.87	9.35
18	303	5	22	2	2	45	28	17	3.74	18.70
19	304	5	22	5	5	45	28	17	9.35	46.75
20	306	5	22	5	4	45	28	17	7.48	37.40

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21	307	5	22	3	3	45	28	17	5.61	28.05
22	308	5	22	4	4	45	28	17	7.48	37.40
23	401	5	22	3	3	45	28	17	5.61	28.05
24	402	5	22	3	3	45	28	17	5.61	28.05
25	408	5	22	4	4	45	28	17	7.48	37.40
26	409	5	22	1	1	45	28	17	1.87	9.35
27	501	5	22	3	3	45	28	17	5.61	28.05
28	502	5	22	1	1	45	28	17	1.87	9.35
29	503	5	22	5	5	45	28	17	9.35	46.75
30	504	5	22	4	4	45	28	17	7.48	37.40
31	505	5	22	5	5	45	28	17	9.35	46.75
32	506	5	22	4	4	45	28	17	7.48	37.40
33	507	5	22	5	4	45	28	17	7.48	37.40
34	509	5	22	4	1	45	28	17	1.87	9.35
35	601	5	22	1	1	45	28	17	1.87	9.35
36	602	5	22	6	6	45	28	17	11.22	56.10
37	603	5	22	4	4	45	28	17	7.48	37.40
38	604	5	22	4	1	45	28	17	1.87	9.35
39	605	5	22	5	5	45	28	17	9.35	46.75
40	606	5	22	4	4	45	28	17	7.48	37.40
41	608	5	22	4	4	45	28	17	7.48	37.40
TSEC NEW BUILDING										
42	101	5	22	2	2	45	28	17	3.74	18.70
43	102	5	22	1	1	45	28	17	1.87	9.35
44	103	5	22	4	4	45	28	17	7.48	37.40
45	office	5	22	2	2	45	28	17	3.74	18.70
46	201	5	22	5	5	45	28	17	9.35	46.75
47	202	5	22	1	1	45	28	17	1.87	9.35
48	203	5	22	6	6	45	28	17	11.22	56.10
49	204	5	22	2	2	45	28	17	3.74	18.70
50	206	5	22	1	1	45	28	17	1.87	9.35
51	301	5	22	5	6	45	28	17	11.22	56.10
52	302	5	22	6	6	45	28	17	11.22	56.10
53	306	5	22	7	7	45	28	17	13.09	65.45
54	403	5	22	4	4	45	28	17	7.48	37.40
55	405	5	22	1	1	45	28	17	1.87	9.35
56	502	5	22	6	6	45	28	17	11.22	56.10
57	503	5	22	7	6	45	28	17	11.22	56.10
58	504	5	22	7	7	45	28	17	13.09	65.45
59	505	5	22	4	4	45	28	17	7.48	37.40
60	508	5	22	4	4	45	28	17	7.48	37.40
61	601	5	22	5	5	45	28	17	9.35	46.75
62	602	5	22	8	8	45	28	17	14.96	74.80
63	604	5	22	7	6	45	28	17	11.22	56.10
64	605	5	22	7	2	45	28	17	3.74	18.70

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65	609	5	22	7	7	45	28	17	13.09	65.45
66	702	5	22	6	6	45	28	17	11.22	56.10
67	703	5	22	21	21	45	28	17	39.27	196.35
68	706	5	22	7	6	45	28	17	11.22	56.10
69	801	5	22	6	6	45	28	17	11.22	56.10
70	802	5	22	5	5	45	28	17	9.35	46.75
71	803	5	22	15	15	45	28	17	28.05	140.25
72	805	5	22	7	6	45	28	17	11.22	56.10
73	806	5	22	7	6	45	28	17	11.22	56.10
74	901	5	22	6	6	45	28	17	11.22	56.10
75	902	5	22	4	6	45	28	17	11.22	56.10
76	906	5	22	6	5	45	28	17	9.35	46.75
77	907	5	22	5	4	45	28	17	7.48	37.40
78	1002	5	22	5	5	45	28	17	9.35	46.75
79	1003	5	22	5	5	45	28	17	9.35	46.75
80	1004	5	22	6	5	45	28	17	9.35	46.75
81	1005	5	22	2	2	45	28	17	3.74	18.70
82	1006	5	22	3	3	45	28	17	5.61	28.05
83	1101	5	22	9	9	45	28	17	16.83	84.15
84	1102	5	22	6	5	45	28	17	9.35	46.75
85	1103	5	22	6	5	45	28	17	9.35	46.75
86	1104	5	22	9	9	45	28	17	16.83	84.15
87	1105	5	22	17	16	45	28	17	29.92	149.60

6.3 Economics:

Replacing old fans with new energy efficient fans can be considered. These fans save energy while delivering similar air flows.

The cost of replacement of 394 working ceiling fans (excluding non-working, wall and exhaust fans) shall be around Rs 9,85,000/- giving a payback period of around 22.28 years. It is calculated by considering 45W consumption on average operation basis.

The expected saving potential is around Rs 3683/- per month.

Thus, the investment is high and the payback period is not much attractive.

Chapter-VII

Miscellaneous Consumers

7.1 Brief Description:

The other consumers include elevators, street lighting, passage lighting, water pumps, fire pumps, machine tools in the work shop, xerox machines, printers and computers.

The consumption of above equipment was not possible due to unavoidable circumstances.

Chapter-VIII

Renewable Energy

8.1 Brief Description:

The institute should prefer the installation of solar system for both the old and new buildings.

It is possible to cut down the cost of electricity to great extent.

Also, solar water pumping must be considered which will save significant electricity as presently consumed by conventionally operated centrifugal pumps.