DETAILED PROJECT REPORT

ON

INVESTMENT GRADE ENERGY AUDIT

(Municipal Council Yamuna Nagar)

PREPARED FOR

ENERGY IS LIFE
BEE
CONSERVE IT

Bureau of Energy Efficiency

PREPARED BY

Pranat Engineers Pvt. Ltd.
28, Rishabh Vihar, Karkardooma,
DELHI-110092
Phones : 22372828, 22373565
Fax: 22375994 E-mail: enquiry@alienenergy.in

REVIEWED BY

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ABBREVIATIONS

BEE	: Bureau of Energy Efficiency
BEP	: Best Efficiency Point
CER	: Certified Emission Reports
DPR	: Detailed Project Report
DSM	: Demand Side Management
ECM	: Energy Conservation Measures
ESCO	: Energy Servicing Company
GHG	: Green House Gas
HVAC	: Heating Ventilation and Air Conditioning
IRR	: Internal Rate of Return
LD	: Liquidated Damage
LT	: Low Tension
M&V	: Measurement and Verification
MU	: Million Units
NGO	: Non Government Organization
PPP	: Public Private Partnership
R&M	: Repair & Maintenance
UNFCCC	: United Nations Framework Convention on Climate Change
YMC	: Yamuna Nagar Municipal Council
ULB	: Urban Local Body
ESCO	: Energy Service Company
ESP	: Energy saving project
SL	: Street Light

ACKNOWLEDGEMENT

We express our sincere gratitude to the Bureau of Energy Efficiency, Ministry of Power for giving the opportunity to be a part of this 'MuDSM Programme' and present the findings and recommendations. We thankfully acknowledge the support and guidance provided by all concerned officials during the conduct of this exercise.

Ministry of Power

- Shri Devendra Singh - Joint Secretary
- Ms. Rita Acharya - Director - EC

Bureau of Energy Efficiency

- Dr. Ajay Mathur - Director General
- Shri Saurabh Kumar - Secretary
- Shri Sandeep Garg - Energy Economist
- Shri Tarun Kumar - Project Engineer

We are also thankful to the Municipal Council, Yamuna Nagar for their positive support in undertaking this intricate task of system mapping and Investment Grade audit of two segments , viz . Municipal street lighting and municipal buildings (the other two segments of water treatment/pumping and sewage treatment/pumping are not there at municipal council, Yamuna Nagar). The field studies would not have been completed on time without their interaction and timely support. We are grateful for their co-operation during field studies and provision of data for the study.

Municipal Council, Yamuna Nagar

- Shri K.K. Jain - I/C Executive Officer
- Shri R.D.Diman - Municipal Engineer
- Shri Hari Krishan - Light Inspector

to express our appreciation for the support and inputs provided by M/s TUV SUD South Asia Pvt. Ltd. and their entire team.

M/s TUV SUD South Asia Pvt. Ltd.

- Shri Bratin Roy - General Manager, Environmental Engineering
- Shri Shatanshu Shekhar - Product Manager
- Shri Jayakrishnan Nair - Energy Auditor
- Shri Tejpal Gupta - Engineer

Last but not the least; we are thankful to all officers and employees of the Municipalities with whom we interacted during the field studies for their wholehearted support in undertaking measurements and eagerness to assess the system / equipment efficiencies and saving potential. The willingness of these key personnel to participate in the MuDSM programme and acknowledge the call for energy efficiency is more than half the issues resolved for a Municipal DSM effort.

For Pranat Engineers Pvt. Ltd.,

(Akash Jain)
Director

Executive Summary

1. Objective of MuDSM programme

The Mission of the MuDSM programme is to improve the overall energy efficiency of the ULBs thus leading to sustainable energy and cost reductions, in all the four energy consuming segments namely Water, Sewage, Street lighting, and Buildings. However, for Municipal Council, Yamuna Nagar only two segments, viz. street lighting and buildings are applicable.

The IGA is conducted with the following Objectives:

- Detailed study of the intended segment of Buildings and Streetlights including historical and present energy performance trends, and specific energy consumption.
- Creation of a database giving broad data on existing infrastructure and system maps of each of the segments in various ULBs
- Quantification of Energy Losses, and Energy Saving Potential.
- Creation of a database of Baseline Energy Measurements for reference during post-implementation measurements and verification.
- Presentation of Energy Efficiency Measures as Bankable Projects (which will be implemented through ESCO model in a later phase of the MuDSM project)

2. Brief Overview of the Segments

Street Lighting

Street lighting at Yamuna Nagar is controlled by its municipal council. However, it has given a contract for its maintenance and operation to outside contractor. The entire street lighting of the city is divided into four zones. There are 5 high masts in the city and each is having 6 fixtures. In each fixture, there are 2 lamps of 400 W HPSV. Besides these, there are several street light poles having 40 W FTL, 150 W & 400W HPSV lights. The total installed load on street lighting is around 435.06 KW and the burnt out percentage at the time conduct of IGA was 15.86 % which seems to be satisfactory in comparison of others and indicates street lighting maintenance is good. The operation of switching ON and OFF is manual and done by contractor.

Buildings

There is one building at Municipal Council. There is one single phase LT connection for all the five buildings. One 3 Phase LT connection is servicing for the building. The total installed load for building is 11.358 Kw and the total built up area of the building is 2200 sq.m. There is a double storied building. There is no air conditioner at any of the building and having one DG set.

3. Energy consumption patterns for the ULB

- Overall Annual Energy Consumption for ULB – 12,76,663 Units
- Segment wise Annual Energy Consumption for Yamuna Nagar Municipal council

S. No.	Sector	Annual Energy consumption (Lakh KWh)	Annual billing amount in (Lakh)	Annual Energy (%)
1	Street Lights	11.87	56.54	93%
2	Buildings	0.88	4.22	7%
Total		**12.76**	**60.76**	**100**

Table No. 1: Annual Energy consumption and Annual Billing amount

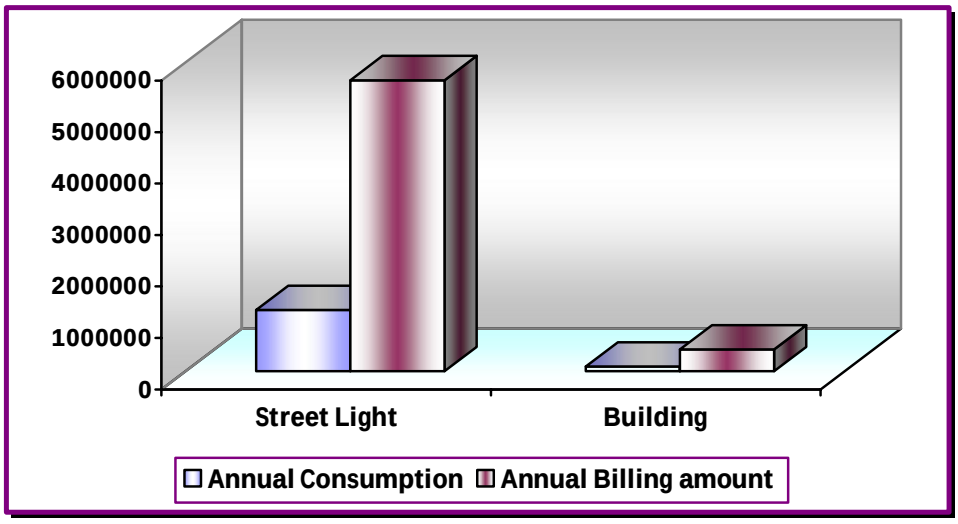


Figure No. 1: Representation of Annual Energy consumption and Billing amount

Pre ECM & Post ECM

S. No.	Sector	Annual Energy consumption (Lakh KWh)	Annual Energy consumption after implementation (Lakh KWh)	Annual Energy saving	Annual amount Saving (Lakh)
1	Street Lights	11.87	8.31	3.56	16.94
2	Buildings	0.88	0.86	0.02	0.094
Total		**12.75**	**9.17**	**3.58**	**17.03**

Table No. 2 - PRE ECM AND POST ECM segment wise detail

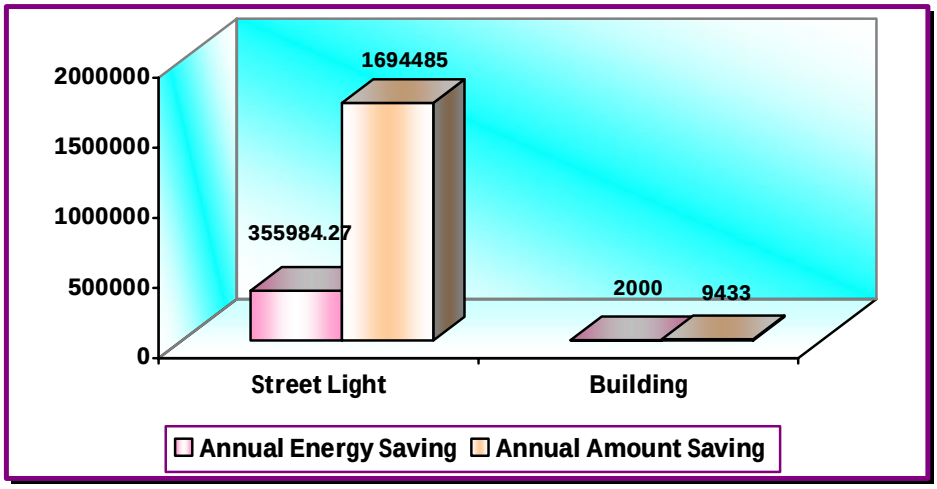


Figure No. 2- Representation of segment wise annual energy and amount saving

- Significant Energy Indices (Segment wise)
  - Per Capita kWh consumption for Street lighting – 6.26 Units
  - kWh / annum/Installed kW for Street lighting – 985.8 (Range 60.2 - 8922)
  - Average Street lighting Service levels (lux) for Major and Minor Streets – 5.07 (Range 0.68-28.21)
  - kWh / annum/ Lux for Street lighting – 2080(Range 44.61 - 21610)
  - Overall Energy Efficiency Index of Municipal Buildings (kWh / sq. mtr. / annum) - 9.573

4. Brief Segment wise Summary of Parameters studied

Street Lights

All electrical parameters like voltage, Power factor, Kw, KVA, current, KVAR and THD of voltage as well as current were measured at all switching points. The operating hours is also an important parameter impacting energy consumption of street lights but there is no record of operating hours. The average operating hours as informed by ULB officials for three different seasons have been considered as such. The lux levels, which indicate outputs of street lights, have also been measured. No static factors like weather or occupancy are applicable to street lights.

Buildings

The energy consumption of the buildings is very small and the metered energy data is the only way to assess annual energy consumption. Here also all electrical parameters like Voltage, Power factor, Kw, THD, current, KVA, KVAR etc were measured for both the electrical connections. As use of air conditioners is zero hence the weather effect is not so significant. Occupancy variation is also not significant. However, measurements of lux levels and power demand of major appliances were measured.

5. A. Brief Segment wise abstract on Energy Conservation Measures identified, Bundling of ECMs and Project Development

Sr. No.	ECM Description	Estimate of Energy Saving Potential		Estimate of Costs			Cost benefit Analysis		
		Annual Savings (kWh)	Rs. (In Lacs)	Investment (Rs. In Lacs)	Annual Repair & Maint. Costs (Rs. In Lacs)	Total Recurring Cost (Rs. In Lacs)	Simple Payback Period	IRR (%)	Notes on Feasibility
ECMs for BUILDINGS									
ECMs with Negligible Investment									
1	Replacement of Resistance type regulator	968	0.04	0.07	NIL	NIL	1.85	44.65	Feasible
ECMs with Medium Investment									
2	Replacement of T8 (40W) Lamps	1,014	0.04	0.11	0.005	0.005	2.95	31.72	Feasible
ECMs for Street Light									
ECMs with Negligible Investment									
3	Improvement in design of High mast	1,686	0.08	0.05	NIL	NIL	0.62	160.50	Feasible
ECMs with Medium Investment									
4	Replacement of 400W HPSV	31317	1.49	1.35	0.06	1.41	1.05	95.30	Feasible
ECMs with Major Investment									
5	Replacement of T12 (40W) Lamp	3,57,495	17.01	22.26	1.11	23.37	1.63	60.29	Feasible
6	Replacement of 150W HPSV	6,02,001	28.65	55.30	2.76	58.06	2.72	34.98	Feasible
7	Use of automation system	174556.14	8.30	16.50	1.25	NIL	2.34	41.45	Feasible

Table No. 3 - Brief Segment-wise Energy consumption

5. B. Brief Segment wise abstract on Energy Conservation Measures identified, Bundling of ECMs and Project Development for Option II on LED in Street Lighting*

Sr. No.	ECM Description	Estimate of Energy Saving Potential		Estimate of Costs			Cost benefit Analysis		
		Annual Savings (kWh)	Rs. (In Lacs)	Investment (Rs. In Lacs)	Annual Recurring and Repair & Maint. Costs (Rs. In Lacs)	Total Cost (Rs. In Lacs)	Simple Payback Period	IRR (%)	Notes on Feasibility
ECMs for Street Light									
ECMs with Major Investment									
1	Replace all the 4 feet T12 (40 W) lamps and fixtures with 16W LED Tube light	5,66,035	26.94	83.48	4.17	87.65	3.67	24.14	Feasible
2	Replace all the 150W HPSV lamps and fixtures with 60W LED street light	5,42,788	25.84	184.35	9.22	193.57	11.09	-1.84	Decision to be taken by ULB
3	Use of automation and voltage stabilizer with GSM based control system for street lighting	3,49,112	16.62	22.50	4.60	27.10	1.87	52.63	Feasible

Table No. 4- Brief summary of Energy consumption in SL through LED as Option-II

*** Note – As per instructions from BEE, one more option for street lighting has been worked out for LED lighting whose summary is mentioned above.**

6. Notes on Bundling of ECMs and Project Development

In financing individual ECM, the financial institution might not be interested as amount may not be substantial. Moreover, substantial amount will fetch better interest rates which are very important for low SPP and good IRR. Thus, it is necessary to bundle various ECMs for implementation due to (i) individual ECMs do not have enough volumes to attract ESCOs, (ii) financial institutions might not be interested due to low investment and (iii) Economical viability, ease of implementation, large no. of vendors involved and proper project management are other reasons for bundling the ECM together.

Looking to the above reasons, one comprehensive Energy Saving Project (ESP) has been developed for all ECMs of street lighting and building segments put together.

The major parameters of ESP as worked out are as under:

- **Estimated Investment –** Rs. 95.64 Lacs
- **Annual Energy Saving Potential –** 1169038 units
- **Annual Financial Saving Potential –** Rs.55.64 Lacs
- **Simple Pay Back Period –** 4 years
- **IRR for the Project –** 25.83 %
- **Estimate of CERs generated –** 1169.95 per annum

- **Feasibility of CDM –** Since the total volume of CERs generated is not enough and hence, it is not practically feasible to go for availing CDM benefits for Municipal Council Yamuna Nagar alone. It is proposed that either BEE should apply for this for all the municipalities put together or we as Pranat Engineers can take up this for the ULBs which we have audited for Phase-I,Phase-II and shall audit for Phase-III.
- **Projected IRR with CDM benefits (for CDM able projects) –** Though the ESP is CDM able but considering the above facts, it is not possible to project IRR with CDM benefits for Municipal Council of Yamuna Nagar alone.
- **Project Financing and Business Models –**

  The effective financing and business models create benefits and incentives for all stakeholders. Public residing in the ULB is benefitted by improved facilities for all the segments implemented under MuDSM programme. The ULB is directly benefited by savings in energy costs, other financial savings in terms of material and man power, ease of operations and proper monitoring & control. The ESCOs and technology vendors are benefited in the form of getting business, increase in their turnover and improved profitability. The nation is benefited through increased energy security, sustainable development and protecting the environment.

  Further details are mentioned at Chapter C of this DPR.

A. Introduction

It is not surprising that electricity consumption in municipal sector is increasing steadily over the last few years. Municipal corporation must not only consider financial & resource security benefit from DSM measures, but also need to recognize impact on environment created by burning of fossil fuels.

DSM measures have a key role in eliminating power shortage. There is need to address these issues on priority through integrated and comprehensive approach and by adopting latest techniques and technologies with active participation of all stakeholders.

Municipal bodies often lack sufficient institutional capacity to develop practical approach for maximizing efficiency, even after recognizing the potential benefits. Urban Local Bodies (ULBs) have to develop proper approach & proper model to identify energy efficiency projects & implementation strategy for the efficient energy management. The goal of energy management must be on provision of services like drinking water & street lights with the least cost and least environmental effect.

The major energy loads in a municipality are typically the water pumping systems, street lighting, sewage treatment and handling, and electricity distribution. Municipal buildings such as offices, hospitals, schools also contribute to the high municipal energy bills. Therefore, the following systems would be targeted during the municipal energy efficiency audit:

a. Municipal Buildings
b. Street Lighting

In order to take this concept forward and to measure the actual savings in power consumption, it is necessary to first establish a base line of energy consumption, which would act as a reference point.

Thus, as a first step it would be necessary to undertake the energy audit of the ULBs. The energy audit would involve studying configuration of the existing systems and its operations and the consumption and cost of electricity. Based on the energy audit, appropriate projects can be recommended that would lead to reduction in energy consumption. A cost benefit analysis would also be presented, which would enable the ULBs to decide whether or not to implement the recommended energy efficiency solution.

As the name implies, an Investment Grade Audit (IGA) is the process of conducting a detailed energy audit to quantify the savings potential, and translating the technical findings into financial terms, and present it as a bankable project capable of securing a loan. The report would contain comprehensive information related to energy use by the municipality and provide clarity on the baseline and assessment of savings once the project is implemented.

A.1 Objective

The basic objective of the project is to improve the overall energy efficiency of the ULBs which could lead to substantial savings in the electricity consumption, thereby resulting in cost reduction/savings for the ULBs.

The Mission of the MuDSM programme is to improve the overall energy efficiency of the ULBs thus leading to sustainable energy and cost reductions, in all the four energy consuming segments namely Water, Sewage, Street lighting, and Buildings.

This IGA is conducted with the following Objectives:

- Detailed study of the intended segments of Buildings and Streetlights including historical and present energy performance trends, and specific energy consumption (since Water Treatment / Pumping System, Sewage Treatment / Pumping System are not under the control of Municipal Council Yamuna Nagar).
- Creation of a database giving broad data on existing infrastructure and system maps of each of the segments in various ULBs
- Quantification of Energy Losses, and Energy Saving Potential.
- Creation of a database of Baseline Energy Measurements for reference during post-implementation measurements and verification.
- Presentation of Energy Efficiency Measures as Bankable Projects (which will be implemented through ESCO model in a later phase of the MuDSM project)

A.2 Scope of Work

In a broad view, the scope of work for Investment Grade Energy Audit includes, but is not limited to, the following:

A.2.1 Water Supply and Sewage Systems : Not applicable in case of Municipal council, Yamuna Nagar

A.2.2 Street Lighting

A. Data Collection & System Mapping

a) No. and rating of Feeders for Street lighting in the ULB

b) Total length and widths of street illuminated - feeder wise

c) Total No. and height of St. Light Poles - feeder wise

d) Total No. and type of fixtures - feeder wise

e) Control Mechanisms employed, and no. of working hours at different seasons in the year feeder wise.

B. Measurements & Analysis

a) General study of HT & LT electrical power distribution system and to carry out actual measurement of the electrical parameters like voltage, current, active / reactive power, power factor etc. using calibrated instruments and find out any energy conservation possibilities therein.

b) To review actual loading and load distribution on transformer and to assess possibilities of energy saving.

c) To review the voltage levels in street lighting systems, and suggest mechanisms for voltage optimization.

d) To review rating and location of capacitor and suggest power factor improvement scheme, if required and to carry out the harmonics analysis study and suggesting measures to mitigate it if required.

e) Feeder wise Monitoring & Measurement of Electrical Energy Consumption (KWH & KVAH).

f) Measurement of the lux level at different positions of the road. Along the pole, the lux level should be measured under light fittings, middle of the road and both edges of the road. Between two poles, the lux level should be measured towards verge, middle of the road and both edges of the road.

g) Providing a list of energy efficient street light manufacturers / suppliers.

h) Analysis of the reduction in Electrical Energy Consumption (KWH & KVAH) due to energy efficient lighting without compromising the present lux level based on technical parameters like power factor, lumen / watt, CIE Color Rendering Index, reduction of lux level with use, distance between two poles, angle of the fixture in which the light is to be mounted

i) Suggest retrofits where appropriate, with the best energy efficient lighting from among various options like LED, Metal halides, CFL, TL-5 etc.

A.2.3 Municipal Buildings

A. Data Collection & System Mapping

a) No. of Buildings owned by the municipality, or where the energy cost is borne by the municipality, including schools, hospitals etc.

b) No. of Municipal Buildings selected for the study and reasons for the selection (note: selection to be made on factors like Energy Consumption level, Purpose /Utility of Buildings, presence of energy consuming utilities like HVAC systems, Utilization etc.)

c) Total connected load of the individual Buildings

d) Electricity Consumption in the selected Buildings - Monthly Average KWh

e) Maximum Demand of the individual Buildings

f) Electricity bills for past 3 yrs. to be collected and studied / summarized for indicators like month wise Unit Consumption, Power Factor, Max Demand, Unit cost, Rebates and Penalties availed / levied for each billing period, as per local Tariff Rules of the State / Supply Utility. (Note: Electricity bills for the past 12 months required at a minimum)

g) Inventory including capacity ratings of all equipments like Transformers, Lighting Transformers, Water Storage and Pumping, HVAC system, DG Sets etc.

h) Electrical Single Line Diagram

i) Floor Mapping of buildings, with details of electrical fittings like lighting fixtures, location of ACs, Fan-Coil Units, AHUs etc.

j) Floor / Work Area wise inventory of lighting fixtures with details of type, wattage and Control Mechanism

k) Sketch / Line Diagram, and Design Details of Chillers, Chilled and Cooling Water Pumping Systems, Cooling Towers etc.

l) Condition of DG, its installed capacity, %loading, SEGR and status of maintenance practice.

B. Measurements & Analysis

A. ELECTRICAL & INSTRUMENTATION SYSTEM AND PLANT OPERATION

i) General study of HT & LT electrical power distribution system and to carry out actual measurement of the electrical parameters like voltage, current, active / reactive power, power factor etc. using calibrated instruments and find out any energy conservation possibilities therein.

ii) To review actual loading and load distribution on transformer and to assess possibilities of energy saving.

iii) To review rating and location of capacitor and suggest power factor improvement scheme, if required and to carry out the harmonics analysis study and suggesting measures to mitigate it if required.

iv) Load profile at LT mains should be prepared for at least 24 hours so that variation and problem of power quality can be addressed.

v) Study of electrical services to construct demand profile by measurement & analysis of daily load variations at mains of services

vi) To note and prepare a document showing various name plates and other important technical details and to collect missing information from manufacturer or to establish various technical parameters while measurement for various equipment like pump, motor, compressor etc is being done.

vii) Measurements of operating parameters for individual motors, and a simultaneous study of operating parameters of the driven equipment.

viii) Identifying improper facilities/ installations, and possibility of implementing best practices by the concerned department. Identifying the possibilities of energy saving by modification in plant machinery / equipment without deteriorating the plant results.

ix) Study and review the pattern of energy consumption of various water distribution stations, water treatment plants, drainage pumping stations, sewage treatment plants & other facilities and find out the areas of energy conservation possibilities.

x) Study and review the pattern of energy consumption of various equipments like air conditioning units, water heaters, various lighting luminaires, fans etc. and find out areas of energy conservation possibilities.

xi) Determination and Study of Specific Energy Consumption of major utilities like Air conditioning plants, Chillers, Air compressors, being used in the Treatment plants and Pumping Stations etc.

b) Sub-metering of major energy consuming systems and monitoring of system operating characteristics.

c) Study and review the pattern of energy consumption of various equipments like air conditioning units, water heaters, various lighting luminaries, fans etc. and find out areas of energy conservation possibilities.

d) Determination and Study of Specific Energy Consumption of major utilities like Air Conditioning Plants, Chillers, Air Compressors, being used in the Buildings.

e) Identifying opportunities to refine and/or expand the energy monitoring capability of Building Management System (BMS) where applicable.

f) Understanding the operating characteristics of all energy consuming systems, in the building, and also situations that cause load profile variations on both an annual and daily basis.

A.2.4 General

Having gone through various measurement and results and studying whole system in details, consultant has to suggest energy saving measures in following ways:

- Without investment measures
- Negligible investment measures.
- Investment measures

A.2.5 Baseline Measurements

Energy baseline parameters may include but is not limited to the following, as appropriate:

Any of the measurements and observations made during the IGA by the consultant may be identified as Energy Baseline parameters.

In general, baseline parameter measurements / observations should be logged over a sufficient and feasible duration during the IGA. (Eg. Simultaneous Power, Pressure and Flow measurements of Pumps to be logged for an hour at a minimum, Streetlight Feeder Power consumption Parameters like KWh, KVA, pf to be logged, for the entire operating hours for 1 day at a minimum).

Over and above the measurements and observations made, all efforts should be made to collect Historical data wherever available with MUNICIPALITY. These may include, but is not limited to:

Historical monthly Averages (eg. over the past 36 or 12 months, whichever is higher) for:

- Hours of Operation and Temperature settings etc. in each season, for Building systems \ equipment in like Air Conditioning Units etc.
- Hours of Operation in each season for Street Lighting

A.3 Overall Approach for DPR Preparation

The data including inventories of equipments in respect of both energy segments has been collected and variables affecting performance of the energy systems have been measured and analyzed for identification of ECMs. Energy Saving Projects (ESPs) have been developed by bundling ECMs after consultations with Technology vendors and prospective ESCOs.

The sequence of main activities in preparation of this DPR as carried out in the year 2009-10 is shown below:-

S. No.	Month/Activity	Oct	Nov	Dec	Jan	Feb
1	Visit to ULB					
2	Preparation of Schedule					
3	Data collection & system mapping					
4	Field measurement					
5	Analysis of data					
6	Identification of ECMs					
7	Documentation for data uploading & Uploading of Data					
8	Consultation with vendors					
9	Development of ESPs					
10	Preparation of Draft DPR					

Table No 5 :- Activity schedule for IGA of Yamuna Nagar

1) **Visit to ULB**

Visit made to ULB to start IGA activity. An opening meeting was held and MOM recorded.

2) **Preparation of schedule**

Schedule prepared in consultation with ULB person and mentioned in MOM of opening meeting.

3) **Data Collection and system mapping**

This included obtaining historic data's from ULB like name plate details of equipments, Electricity bills, Inventories records, Maintenance record etc. Field Measurement

4) **Field measurements** were made with the help of portable instruments and in association with ULB staff. This was not possible without the help of ULB staff. Data measured for both segments.

Street Light : -- All important parameters related to power quality and quantity as well as output lux value measured.

Building : -- A detailed survey of all utilities such as Llight fixture, Fan ,Cooler, Computer etc was carried out. Here also Power measurement as well as output data measured.

5) **Analysis Of Data's**

All measured data's were studied and an analysis carried out.

6) **Identification of ECMs**

Based on analysis of field measurement data and historic data as provided by ULB during data collection phase, identification of ECMs was done.

7) **Documentation for data uploading & uploading of Data's**

As per direction of BEE a detailed documentation work was carried out and the same was uploaded to BEE site.

8) **Consultation with Vendors**

This activity was done to know investment required for each ECM and to get specifications/technology details.

9) **Development of ESPs**

Based on above activities, one Energy Saving Project combining street light and building segments was developed . It was developed keeping in view of it's financial as well as technical viability.

10) **Preparation of Draft DPR**

It is basically summation of all above activities. A brief outline for preparation of M&V plan based on International Performance Measurement and Verification Protocol

(IPMVP) EVO 10000-1: 2009 published by Efficiency Valuation Organization (EVO) has also been included in the DPR. The best practices on energy management as relevant to the energy segments of the ULBs have also been included.

All the above activities were carried out by following team:

1. Shri R.K.Khilnani, BEE Certified Auditor and Team Leader
2. Shri Akash Jain, Director & Electrical Engineer
3. Shri Somesh Mittal, Electrical Engineer
4. Shri Brij Deo Prasad, Electrical Supervisor
5. Shri H.S.Negi, Electrical Supervisor

Sh. A.K.Jain, General Manager and BEE certified Energy Manager has helped in preparing the final DPR only

B.1 Water Treatment and Pumping Systems

This segment is not there within the purview of Municipal Council, Yamuna Nagar and hence not within the scope of work.

B.2 Sewage Water Treatment and Pumping Systems

This segment is not there within the purview of Municipal Council, Yamuna Nagar and hence not within the scope of work.

B.3 Municipal Street Lighting System

B.3.1 Overview & Analysis of Existing Systems

B.3.1.1 Switching Points / Wards / Zones

In all, there are 4 switching points' zones having 43 feeders. Most of the feeders are having single phase connection.

S. No.	Zone	Name of Feeder
1	Model Town	Shastrinagar
2	Model Town	Chhata Mandir
3	Model Town	Govind Puri Road
4	Model Town	Madhur Colony
5	Model Town	Civil Hospital
6	Model Town	Rampura
7	Model Town	Jindal power House
8	Model Town	Mena Bazar
9	Model Town	Workshop Road
10	Model Town	Tagore Garden Opp. Bus Stand
11	Model Town	Mela Singh Chowk
12	Model Town	Santpura Road
13	Model Town	Attack Society Small Model Town
14	Model Town	Bhatia Colony
15	Model Town	Kapurwiila Model Town
16	Model Town	Sharma Garden Mahindra Petrol Pump
17	Model Town	Ramnagar Near Kanya singh chowk
18	Model Town	Attack Society Govt. School
19	Model Town	Attack Society Prem Nagar
20	Model Town	Chhata Mandir road
21	Industrial Area	Dash Mash Colony
22	Industrial Area	Tanga Stand Near Agarsan Chowk
23	Industrial Area	Opp. Jindal House
24	Industrial Area	Chandpura
25	Industrial Area	Chandpura 66KVA
26	Industrial Area	ITI Chowk
27	Industrial Area	Bus Stand
28	Industrial Area	Bye Pass
29	Industrial Area	Key Iron Works
30	ITI	Sanjay Colony
31	ITI	Kansa pura Road
32	ITI	Dua Hospital
33	ITI	Kanhya Chowk

34	Sub.Divn. I	Gulab Nagar
35	Sub.Divn. I	Camp Colony
36	Sub.Divn. I	Veena Nagar
37	Sub.Divn. I	Old Hamida Colony
38	Sub.Divn. I	Anand Colony
39	Sub.Divn. I	Khajoori Road
40	Sub.Divn. I	Patel Nagar
41	Sub.Divn. I	Kunwara Chatt
42	Sub.Divn. I	VishwaKarma Chowk
43	Sub.Divn. I	Morni park

Table No. 6: Zone wise switching point detail

B.3.1.2 Street Lighting Inventory Survey

- Total No. of fixture in ULB: 4969

150W HPSV	400W HPSV	40 W TFL
1229	30	3710

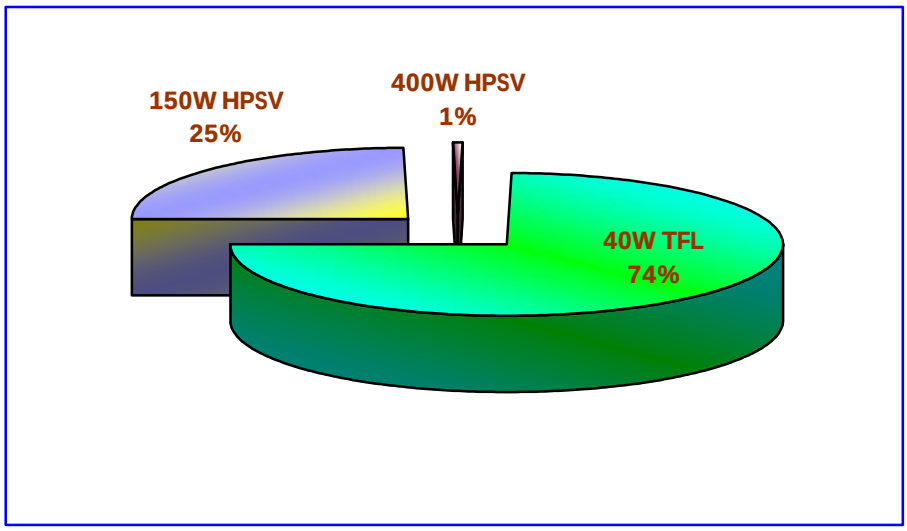


Figure 3: Percentage consumption of ULB as per inventory

- **Switching Point wise installed kW**

S. No.	Name of Feeder	Installed kW
1	Shastrinagar	12.978
2	Chhata Mandir	7.596
3	Govind Puri Road	13.212
4	Madhur Colony	12.24
5	Civil Hospital	14.382
6	Rampura	9.594

7	Jindal power House	9.54
8	Mena Bazar	4.824
9	Workshop Road	8.802
10	Tagore Garden Opp. Bus Stand	16.65
11	Mela Singh Chowk	5.976
12	Santpura Road	16.362
13	Attack Society Small Model Town	16.92
14	Bhatia Colony	13.932
15	Kapurwiila Model Town	16.704
16	Sharma Garden Mahindra Petrol Pump	8.604
17	Ramnagar Near Kanya singh chowk	8.496
18	Attack Society Govt. School	6.282
19	Attack Society Prem Nagar	27.396
20	Chhata Mandir road	7.002
21	Dash Mash Colony	12.366
22	Tanga Stand Near Agarsan Chowk	19.458
23	Opp. Jindal House	16.416
24	Chandpura	5.544
25	Chandpura 66KVA	0.36
26	ITI Chowk	6.3
27	Bus Stand	18.9
28	Bye Pass	17.226
29	Key Iron Works	0
30	Sanjay Colony	0
31	Kansa pura Road	4.32
32	Dua Hospital	2.088
33	Kanhya Chowk	3.762
34	Gulab Nagar	11.16
35	Camp Colony	12.294
36	Veena Nagar	12.06
37	Old Hamida Colony	11.718
38	Anand Colony	6.84
39	Khajoori Road	15.282
40	Patel Nagar	6.102
41	Kunwara Chatt	12.672
42	VishwaKarma Chowk	2.7
43	Morni park	0

Table No. 7: Switching point wise installed kW

Switching Point wise Fixture details and Installed kW can also be seen at ***Appendix B/3/1***

- **Fixture category wise installed kW -:**

S. No.	Existing Fitting	Installed Load (kW)	Percentage of Load
1	FTL40W	200.34	46%
2	HPSV 400W	13.20	3%
3	HPSV150W	221.22	51%
Total		434.76	100%

Table No. 8: Fixture category wise installed kW

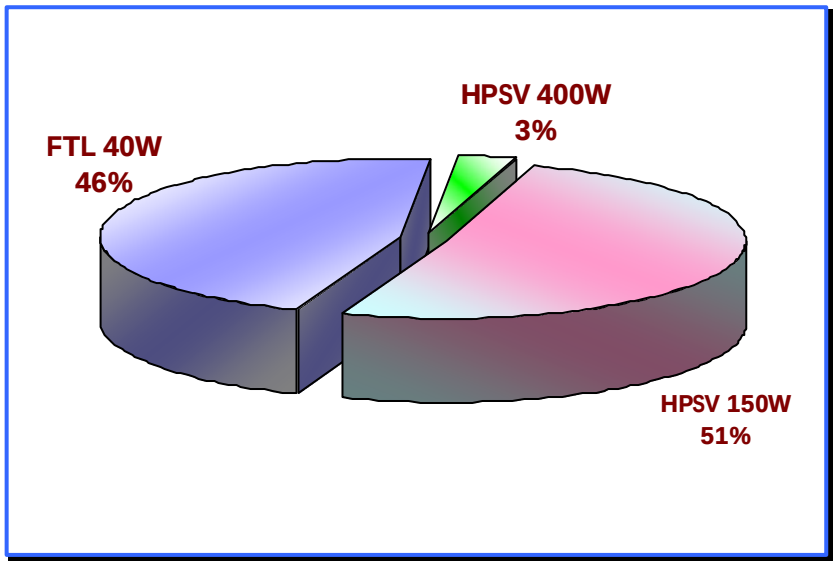


Figure No.4: Percentage fixture category wise installed kW

- **Reduction of Load after installation with energy efficient fittings**

S. No.	Existing Fitting	No. of Fixture	Installed Load (kW)	Proposed Fitting	Proposed Load (kW)
1	FTL40W	3710	200.34	28W-T5	111.3
2	HPSV 400W	30	13.20	3x36W CFL FLOOD Light	5.4
3	HPSV150W	1229	221.22	4x14W-T5	71.28
Total			**434.76**		**193.13**

Table No.9: Load Reduction Chart after implementation

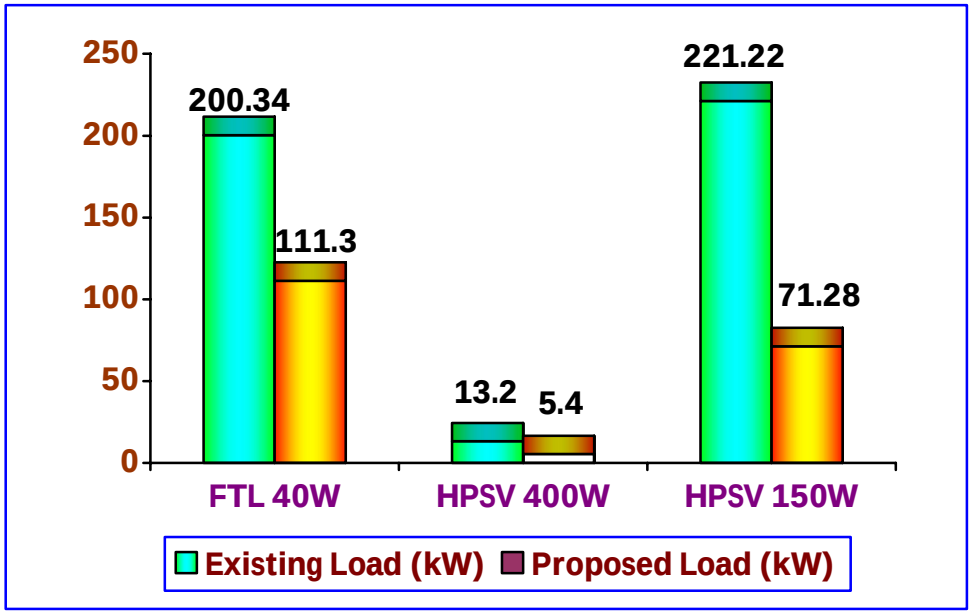


Figure No.5: Bar chart of Load Comparison Before and after implementation

- ***Appendix B/3/1*** Switching Point wise Fixture details and Installed kW

B.3.1.3 Maintenance and Replacement Trends: Records not readily available

B.3.2 Comments and Observations on Streetlight Design

- The street lights have been mounted on street light poles as well as on HT/LT electric line poles. At some places it was mounted on building structures as well. There is no standard practice for fixture fixing except few are where new fixture was installed.
- There is no uniformity of lighting. At some place it is highly scattered. Uniformity is observed at street lights which have been recently installed.
- Only few main roads are having poles at centre verge and rest all area whether it is main road or side road, all poles are at sides only.
- Pole span varies from 15 Mt to 45 Mt. But in average it is 30 Mt.
- Height of the pole in street light is 9 mt.

B.3.3 Baseline Period, Energy Consumption, and other Baseline Parameters

- Baseline Period considered during IGA studies: Mar.08-Jun.09
- Annual kWh consumption of Streetlight
  - Based on Measurements and extrapolation to the actual operating hrs: 7.59 Lakh KWh
  - Based on billing data: 11.87 Lakh KWh
    - Power tariff for the street light segment is Rs. 4.76/units
    - Annual kWh consumption season wise shown below

Type of Fitting	Installed Fixture	Total load (kW)	Working hours per day			Annual Energy consumption		
			Summer	Winter	Monsoon	Summer	Winter	Monsoon
FTL40W	3710	200.34	10	11	11	244.41	264.44	271.06
400W MH	30	13.2	10	11	11	16.10	17.42	17.85
HPSV150W	1229	221.22	10	11	11	269.88	292.01	299.31

Table No. 10 Annual kWH consumption Season wise

Note: *Assuming 122 days working of street light in summer season (i.e. March – June), 123 days working of street Light in Monsoon season (i.e. July – October) and 120 days working of Street Light in Winter season (i.e. November –* February)

B.3.4 Service Delivery Levels & Specific Energy Consumption

- Notes on methodology of data collection, measurements and study

  Field measurement was carried out by portable meters. It was connected and all necessary data related to power quality and quantity measurement was recorded. Recording time was between five minutes to half an hour depending upon requirement.

- Explanatory notes and analysis of service delivery levels, eg. Road Category wise Avg. Services Delivery levels (lux)

  There is lot of variation observed at some feeder or ward light density is too high where as at some place it is very low.

- Please refer to **Appendix B/1/2** Switching Point wise Illumination Measurement
- Also refer to **Appendix B/1/3** Switching Point wise Service Delivery Levels & SEC
- The Lux level and the Category of the road is defined under IS 1944. The detail is given below in the table:
- Per Capita kWh consumption for Street lighting – 6.26 Units
- kWh / annum/Installed kW for Street lighting – 985.8 (Range 60.2 - 8922)
- Average Street lighting Service levels (lux) for Major and Minor Streets – 5.07

  (Range 0.68 - 28.21)

- kWh / annum/ Lux for Street lighting – 2080 (Range 44.61 - 21610)

CLASSIFICATION OF LIGHTING INSTALLATION	TYPE OF ROAD	AVERAGE LEVEL OF ILLUMINATION ON ROAD SURFACE	RATIO MINIMUM/ AVERAGE ILLUMINATION	TRANSVERSE UNIFORMITY RATIO = (Min ILLUMINATION/ Max ILLUMINATION)	TYPE OF LUMINAIRE	
					Preferred	Permitted
(1)	(2)	(3)lux	(4)	(5)	(6)	(7)
Group A1	Important traffic routes carrying fast traffic	30	0.4	33	cut-off	semi -cut off
Group A2	Other main roads carrying mixed traffic , like main city streets , arterial roads ,throughways etc	15	0.4	33	cut-off	semi -cut off
Group B1	Secondary roads with considerable traffic like principle local traffic routes , shopping streets , etc	8	0.3	20	cut-off or semi cut off	not -cut off
Group B2	Secondary roads with light traffic	4	0.3	20	cut-off or semi cut off	not -cut off

Table No. 11: Road Category Illumination as per standard IS 1944

B.3.5 Energy Conservation Recommendations (ECRs) with cost benefit analysis

As per instructions received from BEE, one more option for using LED in street lighting has also been considered wherever feasible.

ECM No. 1/B-3 (Option-I):

A. Title Recommendation	:	Replace all single 40W FTL with 28W-T5 with electronic ballast
B. Description of Existing system	:	At many places single fitting of 40W FTL with electromagnetic ballast are in use. The average pole span is 30 mtrs. and pole height is 9.0 mtrs.
C. Recommendation	:	These should be replaced with 28W-T5 with electronic ballast.
D. Energy Saving Calculation		
Average power consumption of single 40W FTL with electromagnetic ballast	:	54 W
Average power consumption of single 28W-T5 fitting with electronic ballast	:	30 W
Average power saving after replacement of 28WT5	:	24 W
Average working hour per day	:	11 hrs.
Average No. of working days	:	365 days
Approximate No. of fixture	:	3710
E. Cost Benefit Calculation		
Annual Energy Saving potential	:	357495.60 units
Power tariff	:	Rs. 4.76 per unit
Annual Cost Saving	:	Rs. 1701679.06
Cost of Single fitting	:	Rs. 600 per fitting
Total investment cost	:	Rs. 2226000
Total R & M cost	:	Rs. 111300 (5% of Investment cost)
Total recurring cash flow	:	Rs. 222600 (10% of Investment Cost)
Annual Net Saving	:	Rs. 1367779.06
Simple Payback Period	:	1.63 years
Net NPV	:	Rs. 4912729
IRR %	:	60.29
Vendor Information	:	Please see annexure
Product Information	:	Please see annexure

Table No 12 A- Recommendation 1 for Street Light (Option – I)

ECM No. 1/B3 (Option - II)

A. Title Recommendation	:	Replace all single 40W FTL with 16 W LED tube light.
B. Description of Existing system	:	At many places single fitting of 40W FTL with electromagnetic ballast are in use. The average pole span is 30 mtrs. and pole height is 9.0 mtrs.
C. Recommendation	:	These should be replaced with 16 W LED tubular Street light
D. Energy Saving Calculation		
Average power consumption of 40 W FTL with electromagnetic ballast	:	54 W
Average power consumption of 16 W LED Street light	:	16 W
Average power saving after replacement with 16 W LED Street light	:	38 W
Average working hour per day	:	11 hrs.
Average No. of working days	:	365 days
Approximate no. of fixtures	:	3710
E. Cost Benefit Calculation		
Annual Energy Saving potential	:	5,66,035 units
Power tariff	:	Rs. 4.76 per unit
Annual Cost Saving	:	Rs.26,94,327/-
Cost of Single fitting of LED	:	Rs. 2,250/- per fitting
Total investment cost	:	Rs. 83,47,500/-
Total R & M cost on LED	:	Rs. 4,17,375 (5% of Investment cost)
Total recurring cost on LED	:	NIL
Annual Net Saving	:	Rs.22,76,952/-
Simple Payback Period	:	3.67 years
Net NPV	:	Rs. 40,33,738/-
IRR %	:	24.14%
Vendor Information	:	Please see annexure
Product Information	:	Please see annexure

Table No 12 B - Recommendation 1 for Street Light (option-II)

ECM No. 2/B3 (Option-I):

A. Title Recommendation	:	Replace all 150W HPSV Lamp with 4x14W-T5 with electronic ballast
B. Description of Existing system	:	At many places 150W HPSV with electromagnetic ballast are in use. The average pole span is 30 mtrs. and pole height is 9.0 mtrs.
C. Recommendation	:	These should be replaced with 4x14W-T5 with electronic ballast.
D. Energy Saving Calculation		
Average power consumption of 150W HPSV with electromagnetic ballast	:	180 W
Average power consumption of 4x14W-T5 with electronic ballast	:	58 W
Average power saving after replacement with 4x14W T5	:	122 W
Average working hour per day	:	11 hrs.
Average No. of working days	:	365 days
Approximate No. of fixture	:	1229
E. Cost Benefit Calculation		
Annual Energy Saving potential	:	602001.07 units
Power tariff	:	Rs. 4.76 per unit
Annual Cost Saving	:	Rs. 2865525.09
Cost of Single fitting	:	Rs. 4500 per fitting
Total investment cost	:	Rs. 5530500
Total R & M cost	:	Rs. 276525 (5% of Investment cost)
Total recurring cash flow	:	Rs. 553050 (10% of Investment Cost)
Annual Net Saving	:	Rs. 2035950.09
Simple Payback Period	:	2.72 years
Net NPV	:	Rs. 53,33,100
IRR %	:	34.98
Vendor Information	:	Please see annexure
Product Information	:	Please see annexure

Table No 13 A- Recommendation 2 for Street Light (Option – I)

ECM No. 2/B3 (Option - II)

A. Title Recommendation	:	Replace all 150W HPSV street light with 60 W LED Street light
B. Description of Existing system	:	At many places 150W HPSV with electromagnetic ballast are in use. The average pole span is 30 mtrs. and pole height is 9.0 mtrs.
C. Recommendation	:	These should be replaced with 60 W LED Street light
D. Energy Saving Calculation		
Average power consumption of 150W HPSV with electromagnetic ballast	:	180 W
Average power consumption of 60 W LED Street light	:	70 W
Average power saving after replacement with 60 W LED Street light	:	110 W
Average working hour per day	:	11 hrs.
Average No. of working days	:	365 days
Approximate No. of fixture	:	1229
E. Cost Benefit Calculation		
Annual Energy Saving potential	:	542788 units
Power tariff	:	Rs. 4.76 per unit
Annual Cost Saving	:	Rs. 25,83,671/-
Cost of Single fitting of LED	:	Rs. 15,000/- per fitting
Total investment cost	:	Rs. 1,84,35,000/-
Total R & M cost on LED	:	Rs. 9,21,750 (5% of Investment cost)
Total recurring cost on LED	:	NIL
Annual Net Saving	:	Rs. 16,61,921/-
Simple Payback Period	:	11.09 years
Net NPV	:	Rs. -80,75,693/-
IRR %	:	-1.84 %
Vendor Information	:	Please see annexure
Product Information	:	Please see annexure

Table No 13 B- Recommendation 2 for Street Light (Option- II)

ECM No. 3/B3:

A. Title of Recommendation	:	Replace all the 400W HPSV lamps and fixtures with 5x36W CFL fixtures
B. Description of Existing System and its operation	:	At many place 400W HPSV fixtures with choke consumption (40 W) are being used. The average pole span is 30 mtrs. and pole height is 9.0 mtrs.
C. Description of Proposed system and its operation	:	These should be replaced with 5x36W CFL flood light with electronic choke fixture.
D. Energy Saving Calculations		
Energy consumption of a normal 400W HPSV Lamp	=	440watts
Energy consumption of a 5x36W CFL fixture having electronic choke	=	180 watts
Energy saving per single Lamp replacement	=	260 watts
Approximate nos. of 400 W HPSV fixtures	=	30
Average use per day	=	11 hrs
Average use in days of the year	=	365 days of the year
E. Cost Benefits		
Annual Energy Saving Potential	=	260 X 30 X 11 X 365 / 1000 units
	=	31,317 units
Annual Cost Savings @ Rs. 4.76/- per unit	=	Rs. 1,49,068.92/-
Investment	@	Rs. 4,500/- per fitting
	=	Rs. 1,35,000 /- for all 30 fittings
Repair & Maintenance Cost	@	5% per annum of investment cost
	=	Rs. 6,750/- per annum
Other Intermittent or recurring Cash Flow	@	10% per annum on replacement
	=	Rs. 13,500/- for all 30 fittings
Net financial savings per annum	=	Rs. 1,28,818.92/-
Simple Payback period	=	1.04 years
IRR	=	95.30%
NPV	=	Rs. 5,29,335/-
Details of Technology / Specifications		Please see annexure
Equipment vendor		Please see annexure

Table No 14 - Recommendation 3 for Street Light

ECM No. 4/B-3:

A. Title of Recommendation	:	Improve designing of high masts
B. Description of Existing System and its operation	:	There are 5 high masts at Yamuna Nagar but most of them are poorly designed in following ways: (i) More directions have been covered than required (ii) street light poles are there where high mast light is reaching (iii) Angle of fittings is not okay (iv) somewhere there is more light than required
C. Description of Proposed system and its operation	:	Each high mast should be designed as per the need of its site. Accordingly, all the high masts will be modified to suit the actual needs.
D. Energy Saving Calculations		
Total no. of high mast at Yamuna Nagar	=	5
Average use per day	=	11 hrs
Average use in days of the year	=	365 days of the year
Total electricity consumption of 5 high masts having 6 lamps each of 250 W MH with improved choke as per ECM no. 3/B-3	= =	280X6X5X 11X365/1000 units 33,726 units
Estimated Saving due to modification of high masts	@	5 %
E. Cost Benefits		
Annual Energy Saving Potential	=	5 % of 33,726 units
	=	1,686 units
Annual Cost Savings @Rs 4.76/- unit	=	Rs. 8025.36/-
Investment on modification of high masts (one time only), mostly labour only	=	Rs. 5,000/- @ Rs. 1,000/- each high mast
Repair & Maintenance Cost	=	No extra cost due to modification
Other Intermittent or recurring Cash Flow	=	No extra cost due to modification
Net financial savings per annum	=	Rs. 8025.36/-
Simple Payback period	=	0.62 years
IRR	=	160.50%
NPV	=	Rs. 36,023/-
Details of Technology / Specifications		Please See Annexure
Equipment vendor		Please see Annexure

Table No 15 - Recommendation 4 for Street Light

ECM No. 5/B-3 (Option-I):

A. Title of Recommendation	:	Use of automation system for street lighting
B. Description of Existing System and its operation	:	Presently, all street lights are being switched ON & switched OFF manually.
C. Description of Proposed system and its operation	:	Automation will be done for entire street lighting. Timer based controls will be used for auto switching of street light. Also, there will be single/three phase energy meter, contactor, relays etc in the control panel. One control panel will be there for around 100 light poles/fittings.
D. Energy Saving Calculations		
Annual existing energy consumption for entire street light on the basis of fixture installation	= =	(54 x 3710 + 180 x 1229 + 440 x 30) X 11 X 365/1000 units 17,45,561.4 units
Estimated Saving after implementation of automation system	@ =	10 % of annual energy consumption 1,74,556.14 units
E. Cost Benefits		
Annual Energy Saving Potential	=	1,74,556.14 units
Annual Cost Savings @Rs 4.76/- unit	=	Rs. 8,30,887.22/-
Total load on street light after implementation all the recommendations mentioned in this DPR	= = =	187 kW
Total no. of panel required for entire street lighting	=	50 of 6 KVA (per 100 fixture single 6 kVA panel is required)
Cost of each panel	=	Rs. 25,000/- for 6 KVA Control panel
Total cost of all 50 panel	=	Rs. (50 x 25,000) Rs. 12,50,000/-
Cost for making proper distribution of load on street lighting and misc. works (one time cost only)	=	Rs. 1,50,000/-
Repair & Maintenance Cost	@ =	10 % on cost of panel Rs. 1,25,000/-
Net financial savings per annum	=	Rs. 7,05,887.22/-
Simple Payback period	=	2.33 years
IRR	=	41.41%
NPV	=	Rs. 20,87,875/-
Details of Technology / Specifications		Please see annexure
Equipment vendor		Please see annexure

Table No 16 A - Recommendation 5 for Street Light (Option- I)

ECM No. 5/B3 (Option - II)

A. Title of Recommendation	:	Use of automation and voltage stabilizer with GSM based control system for street lighting
B. Description of Existing System and its operation	:	Presently, entire street lights are being switched ON & switched OFF manually and there is no voltage stabilizer.
C. Description of Proposed system and its operation	:	Automation will be done for entire street lighting. Timer based controls along with voltage stabilizer will be used for auto switching of street light. Also, there will be single/three phase energy meter, contactor, relays, GSM based control etc in the control panel. One control panel will be there for around 100 light poles/fittings.
D. Energy Saving Calculations		
Annual existing energy consumption for entire street light on the basis of fixture installation	= =	(54 x 3710 + 180 x 1229 + 440 x 30) X 11 X 365/1000 units 17,45,561.4 units
Estimated Saving after implementation of automation system	@ =	20 % of annual energy consumption 3,49,112 units
E. Cost Benefits		
Annual Energy Saving Potential	=	3,49,112 units
Annual Cost Savings @Rs 4.76/- unit	=	Rs. 16,61,773
Total load on street light after implementation all the recommendations mentioned in this DPR	= = =	187 kW
Total no. of panel required for entire street lighting	=	50 of 6 KVA (per 100 fixture single 6kVA panel is required)
Cost of each panel	=	Rs. 42,000/- for 6 KVA Control panel
Total cost of all 50 panel	=	Rs. (50 x 42,000) Rs. 21,00,000/-
Cost for making proper distribution of load on street lighting and misc. works (one time cost only)	=	Rs. 1,50,000/-
Repair & Maintenance Cost	@ =	10 % on cost of panel Rs. 2,10,000/-
Annual GSM hiring charges for 50 control panels @Rs. 5,000/- point	=	Rs.2, 50,000/-
Net financial savings per annum	=	Rs. 12,01,773/-
Simple Payback period	=	1.87 years
IRR	=	52.63%
NPV	=	Rs. 40,53,826/-
Details of Technology / Specifications		Please see annexure
Equipment vendor		Please see annexure

Table No 16 B - Recommendation 5 for Street Light (option –II)

B.3.6 General Comments, Observations and Suggestions

Based on the observations made by the audit team as well as per the discussions held with municipal council staff, and some vendors during the course of conducting audit, following suggestions/comments/observations are made to improve the general working conditions street lighting at municipal council. Municipal Council management is advised to take a note of these for implementation to the extent possible:

1. A proper schedule should be maintained for the cleaning of light fittings to remove dirt and entrapped insects. This will improve the lux levels substantially.

B.4 Municipal Buildings

B.4.1 Overview & Analysis of Existing Buildings

There is only one building at Municipal Council, Yamuna Nagar. The building Municipal committee building is the only building from where all the activity of council is controlled by the officer. This is the only the building we have studied.

The details of these five buildings are as under:

S. No.	Building	Floors	Built up area m2	A/C Area (%)	Annual Working Hrs	Occupancy pattern	Type of ele. Connection
1	Municipal Committee	2	2200	0	240x8=1920	50	Three Phase LT

Table 17 : Details of building in Yamuna Nagar

There is five days a week working at Municipal Council Yamuna Nagar. There is one DG set of 15 Kva. No renewable energy is in use at any of the buildings at Municipal Council Yamuna Nagar.

For more details please refer **Appendix B/4/1.**

B.4.2 Building wise Inventory Survey of Energy Consuming Appliances

Details of existing inventories are given in Table -18 on the next page

Building Name & Location / Address:				Municipal Committee					
Sr. No.	Floor	Location / Room description	Appliance Category	Appliance	Capacity (Mention Value and Units eg. 2 TR for Window AC, Lit for Geysers etc.)	Wattage (W)	No. of Appliances	Working Hours	Installed Load (kW)
1	0	Executive Officer	Lighting	3X36 FTL	150	150	2	8	0.3
2	0	Executive Officer	Lighting	8W DL	8	8	4	8	0.032
3	0	Executive Officer	Lighting	23 W CFL	23	23	1	8	0.023
4	0	Executive Officer	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
5	0	Executive Officer	Fans/Exhaust Fans	Wall Fan	50	50	1	8	0.05
6	0	Executive Officer	Fans/Exhaust Fans	Exhaust Fan	50	50	1	8	0.05
7	0	Gallery	Lighting	28T5	30	30	1	8	0.03
8	0	Gallery	Fans/Exhaust Fans	Exhaust Fan	50	50	1	8	0.05
9	0	Bathroom	Lighting	28T5	30	30	1	8	0.03
10	0	Bathroom	Fans/Exhaust Fans	Exhaust Fan	50	50	1	8	0.05
11	0	Pardan Room	Lighting	3X36 FTL	150	150	2	8	0.3
12	0	Pardan Room	Lighting	8W DL	8	8	4	8	0.032
13	0	Pardan Room	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
14	0	Pardan Room	Fans/Exhaust Fans	Wall Fan	50	50	1	8	0.05
15	0	Pardan Room	Fans/Exhaust Fans	Exhaust Fan	50	50	1	8	0.05
16	0	Room No. 10	Lighting	28T5	30	30	2	8	0.06
17	0	Room No. 10	Lighting	23W CFL	23	23	1	8	0.023
18	0	Room No. 10	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
19	0	Room No. 10	Cooler	Cooler	130	130	1	8	0.13
20	0	Room No. 3	Lighting	28T5	30	30	1	8	0.03
21	0	Room No. 3	Lighting	23W CFL	23	23	1	8	0.023
22	0	Room No. 3	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
23	0	Room No. 3	Computer	Computer	220	220	1	8	0.22
24	0	Room No. 4	Lighting	28T5	30	30	1	8	0.03
25	0	Room No. 4	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
26	0	Room No.5	Lighting	28T5	30	30	1	8	0.03
27	0	Room No.5	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08

28	0	RoomNo. 6	Lighting	28T5	30	30	2	8	0.06
29	0	RoomNo. 6	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
30	0	RoomNo. 6	Other Appliances	Cooler	130	130	1	8	0.13
31	0	RoomNo. 6	Other Appliances	Computer	220	220	1	8	0.22
32	0	Room No.7(M.E.)	Lighting	28T5	30	30	2	8	0.06
33	0	Room No.7(M.E.)	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
34	0	Room No.7(M.E.)	Fans/Exhaust Fans	Wall Fan	50	50	1	8	0.05
35	0	Bathroom	Lighting	15W CFL	15	15	1	8	0.015
36	0	Bathroom	Fans/Exhaust Fans	Exhaust Fan	50	50	1	8	0.05
37	0	Computer Room	Lighting	28T5	30	30	2	8	0.06
38	0	Computer Room	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
39	0	Room No.8	Lighting	28T5	30	30	2	8	0.06
40	0	Room No.8	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
41	0	Room No.9	Lighting	28T5	30	30	1	8	0.03
42	0	Room No.9	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
43	0	Room No.11	Lighting	28T5	30	30	1	8	0.03
44	0	Room No.11	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
45	0	Room No.26	Lighting	28T5	30	30	5	8	0.15
46	0	Room No.26	Lighting	30WDL	45	45	3	8	0.135
47	0	Room No.26	Fans/Exhaust Fans	Ceiling Fan	80	80	7	8	0.56
48	1	Safai Bivhak	Lighting	28T5	30	30	3	8	0.09
49	1	Safai Bivhak	Lighting	30W CFL	30	30	1	8	0.03
50	1	Safai Bivhak	Fans/Exhaust Fans	Ceiling Fan	80	80	3	8	0.24
51	1	RoomNo.22	Lighting	28T5	30	30	2	8	0.06
52	1	RoomNo.22	Lighting	200W GLS	200	200	1	8	0.2
53	1	RoomNo.22	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
54	1	RoomNo. 23	Lighting	28T5	30	30	4	8	0.12
55	1	RoomNo. 23	Lighting	200W GLS	200	200	1	8	0.2
56	1	RoomNo. 23	Fans/Exhaust Fans	Ceiling Fan	80	80	3	8	0.24
57	1	RoomNo. 23	Fans/Exhaust Fans	Exhaust Fan	50	50	1	8	0.05
58	1	Document Room	Lighting	1X40	53	53	1	8	0.053
59	1	Document Room	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08

60	1	Document Room	Other Appliances	Computer	220	220	1	8	0.22
61	1	Tax Room	Lighting	28T5	30	30	1	8	0.03
62	1	Tax Room	Lighting	100W GLS	100	100	1	8	0.1
63	1	Tax Room	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
64	1	Committee Audit	Lighting	28T5	30	30	2	8	0.06
65	1	Committee Audit	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
66	1	Committee Audit	Fans/Exhaust Fans	Wall Fan	50	50	1	8	0.05
67	1	Committee Audit	Fans/Exhaust Fans	Exhaust Fan	50	50	1	8	0.05
68	1	Audit Officer	Lighting	28T5	30	30	2	8	0.06
69	1	Audit Officer	Lighting	20W CFL	20	20	1	8	0.02
70	1	Audit Officer	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
71	1	RoomNo.25	Lighting	28T5	30	30	2	8	0.06
72	1	RoomNo.25	Fans/Exhaust Fans	Ceiling Fan	80	80	2	8	0.16
73	1	Union Room	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
74	1	Union Room	Lighting	100W GLS	100	100	1	8	0.1
75	0	Visiting Room	Lighting	1X40	53	53	1	8	0.053
76	0	Visiting Room	Fans/Exhaust Fans	Ceiling Fan	80	80	2	8	0.16
77	1	JE Vaccination	Lighting	28T5	30	30	1	8	0.03
78	1	Store Room	Lighting	1X40	53	53	1	8	0.053
79	1	Store Room	Lighting	28T5	30	30	1	8	0.03
80	1	Store Room	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
81	1	Record Room	Lighting	28T5	30	30	1	8	0.03
82	1	Record Room	Lighting	20W CFL	20	20	1	8	0.02
83	1	Record Room	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
84	1	Side Room	Lighting	28T5	30	30	1	8	0.03
85	1	Side Room	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
86	1	Secretary	Lighting	28T5	30	30	3	8	0.09
87	1	Secretary	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
88	1	Secretary	Fans/Exhaust Fans	Wall Fan	50	50	1	8	0.05
89	1	Secretary	Fans/Exhaust Fans	Exhaust Fan	50	50	1	8	0.05
90	1	Secretary	Other Appliances	cooler	130	130	1	8	0.13
91	1	Bathroom	Lighting	100W GLS	100	100	1	8	0.1

92	1	Street Light Departure Room	Lighting	28T5	30	30	2	8	0.06
93	1	Street Light Departure Room	Lighting	2X40	106	106	1	8	0.106
94	1	Street Light Departure Room	Fans/Exhaust Fans	Ceiling Fan	80	80	2	8	0.16
95	1	Room No.15	Lighting	28T5	30	30	2	8	0.06
96	1	Room No.15	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
97	1	Gallery	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
98	1	Stairs	Lighting	28T5	30	30	1	8	0.03
99	0	Outdoor	Lighting	2X36	86	86	2	8	0.172
100	0	Outdoor	Lighting	150W sodium	200	200	1	8	0.2
101	0	Outdoor	Lighting	1X40	53	53	1	8	0.053
102	0	Outdoor	Lighting	100W GLS	100	100	2	8	0.2
103	0	Outdoor	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
104	0	Outdoor	Other Appliances	cooler	130	130	1	8	0.13
105	0	Outdoor	Other Appliances	freidge	165	365	1	8	0.365
106	0	Hall	Lighting	28T5	30	30	10	8	0.3
107	0	Hall	Fans/Exhaust Fans	Ceiling Fan	80	80	10	8	0.8
108	0	Entrance	Lighting	28T5	30	30	4	8	0.12
109	0	Entrance	Fans/Exhaust Fans	Ceiling Fan	80	80	1	8	0.08
110	0	Entrance	Other Appliances	water Cooler	300	300	1	8	0.3

Table 18: Building Inventory Details

B.4.3 Baseline Period, Energy Consumption, and status of other Baseline Parameters

- Specify the Baseline Period considered during IGA studies: (May '08 to Sep '09)
- Annual Energy Consumption of Municipal Building;

  Municipal committee building: 21,061 kWh (Annual avg. May 08 – Sept.09)

- **Details of energy usage:** (Ref: Appendix B/4/1)
  - Annual energy consumption (kWh/annum): 21,061KWh
  - Seasonal variation of Energy Consumption
  - Power tariff is Rs. 4.76/unit

❖ **Municipal Committee Building**

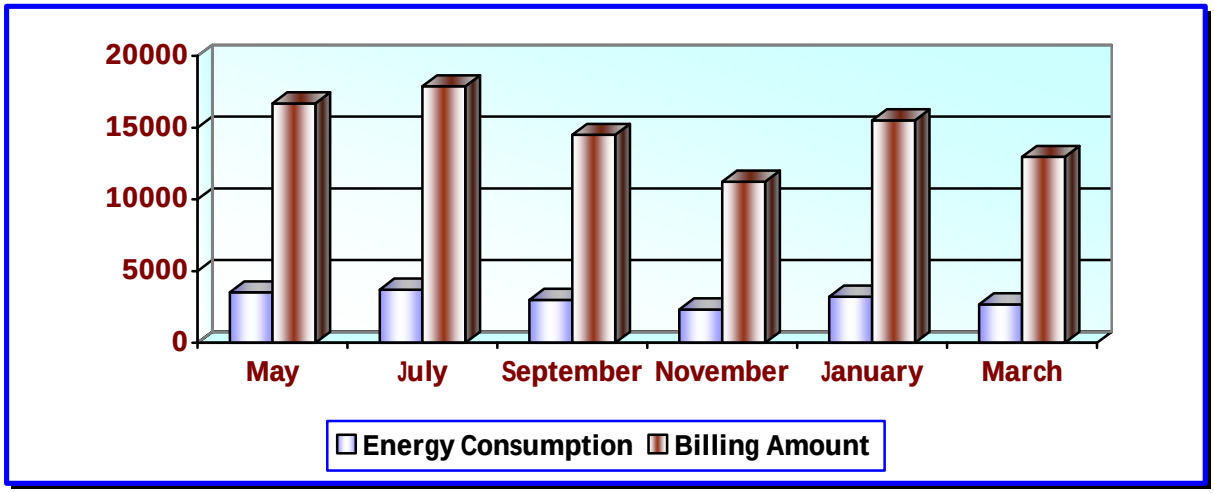


Figure No.6: Bar chart representation of annual billing of building

Figure no.7 – Power Manager in use at Municipal Council Yamuna Nagar

- **Demand scenario**: LT supplies for buildings up to 12 KW load have no demand surcharge.
- **Energy Performance Index :**

  ❖ **Main Office:** 9.573 KWh / M^2 / year

- **Service wise energy consumption for lighting, HVAC, and other major services:**

The service wise consumption of energy is shown in following graphics:-

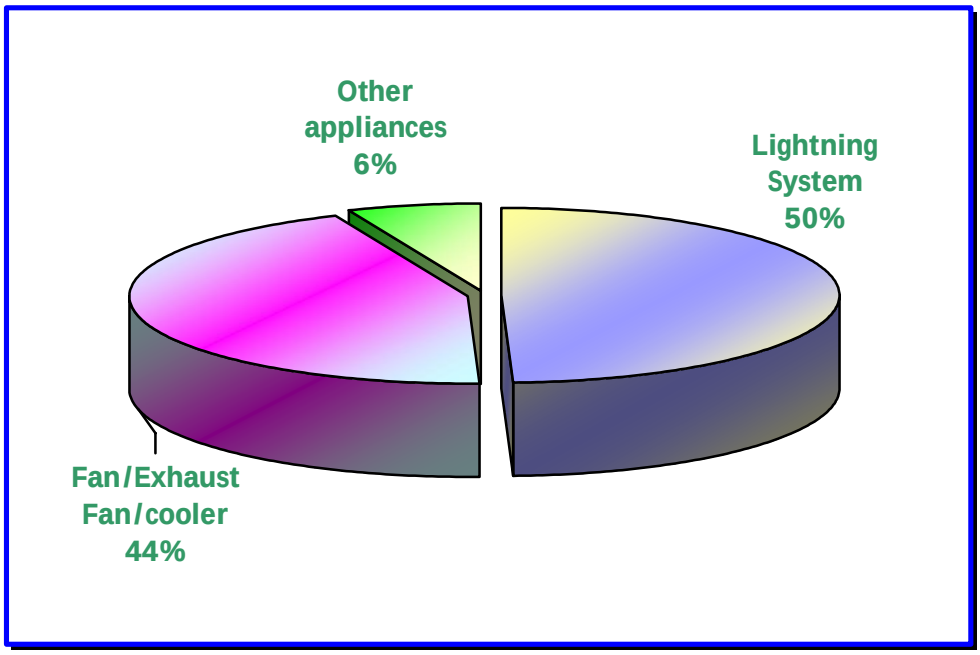


Figure No.8: Appliance Category wise consumption

B.4.4 Energy Conservation Recommendations (ECRs) with cost benefit analysis

Our audit has identified significant energy saving opportunities as illustrated in the table below. Following are the main energy conservation measures:-

ECM No. 6/B-4 :-

A. Title of Recommendation	:	Replacing resistance type conventional fan regulators with electronic regulators
B. Description of Existing System and its operation	:	At most of the ceiling fans installed at MCN conventional (resistance) type regulators have been used. Resistance type regulators are not energy efficient since rpm of fan is reduced by reducing voltage through resistances of varying length, which is an energy inefficient method to do so.
C. Description of Proposed system and its operation	:	Electronic regulators do not use the above principle for controlling rpm and thus are more energy efficient as compared to conventional regulators. The saving calculations are performed below.
D. Energy Saving Calculations		
Average run for each of the ceiling fan	=	8 hours / day
Average run days for each of the ceiling fan	=	180 days/year
Average power consumption of ceiling fan with conventional regulator assuming that it will run at rpm close to Step – 4	=	69 Watts
Average Power saving with use of electronic regulator at the above speed	=	20 % or 14 watts
Average Power saving with use of electronic regulator with speed at Step – 4 at those ceiling fans where there is no regulator as per the analysis	= =	81 – 55 watts 26 watts
No. of ceilings fans at municipal committee building with conventional regulators	=	48
E. Cost Benefits		
Annual Energy Saving Potential	= =	48X14X180X8/1000 units 968 Units
Annual Cost Savings @ Rs. 4.15/-unit	=	Rs. 4,017 /-
Investment	=	Rs. 7,200 /- @ Rs. 150/- per electronic regulator for

		48 regulators
Repair and Maintenance Costs	@	10% of investment Rs. 720/-
Other intermittent or recurring cash flows		NIL
Net annual saving	=	Rs. 3,297/-
Simple Payback period	=	2.18 years
IRR		44.65%
NPV		Rs.10,204/-
Details of Technology/ Specifications		Please see annexure
Equipment vendors		Please see annexure

Table No 19 - Recommendation no 6 for Building

ECM No. 7/B-4 :-

A. Title of Recommendation	:	Replace all the 4 feet T-8 (40W) & T-12 (36 W) lamps and fixtures with 4 ft T5 (28 W) lamp and fixtures.
B. Description of Existing System and its operation	:	At many places, 4 feet T-8 & T-12 with magnetic choke (14 W) are being used.
C. Description of Proposed system and its operation	:	These should be replaced with 4 feet T-5 tube fixture of 28 watt having electronic choke.
D. Energy Saving Calculations		
Average Energy consumption of a normal 4 feet T-8 & T-12 with magnetic choke	=	52 watts
Energy consumption of a 4 feet T-5 having electronic choke	=	28 watts
Energy saving per single tube replacement	=	24 watts
Approximate nos. of 4 feet T-8 &T-12 fixtures in use	=	22
Average use per day	=	8 hrs
No. of working days in a year	=	240 days
E. Cost Benefits		
Annual Energy Saving Potential	= =	24X22X240X8/1000 units 1,014 units
Annual Cost Savings @Rs. 4.15/- per unit	=	Rs 4,208/-
Investment	@	Rs. 500/- per fitting
	=	Rs. 11,000/- for 22 fittings

Repair and Maintenance Costs	@	5% of investment cost Rs. 550/-
Other intermittent or recurring cash flows	@	5% of investment Rs. 550/-
Net annual saving	=	Rs.3,108 /-
Simple Payback period	=	3.54 years
IRR	=	25.29%
NPV	=	Rs.5,858/-
Details of Technology / Equipment vendors		Please see annexure

Table No. 20:- Recommendation No. 7 for Building

B.4.5 General Comments, Observations and Suggestions

Based on the observations made by the audit team as well as per the discussions held with municipal council staff, and some vendors during the course of conducting audit, following suggestions/comments/observations are made to improve the general working conditions as well as comfort/maintenance/hygiene level at buildings of municipal council. Municipal Council management is advised to take a note of these for implementation to the extent possible:

1. Whenever any new/additional electrical load is to be added in the system, it should be checked whether the existing cable and switch gears can take the extra load.
2. A proper preventive maintenance schedule should be prepared for all the important equipments and the same should be adhered to.
3. Only electronic chokes should be bought in future.
4. A proper schedule should be maintained for the cleaning of light fittings to improve the lux levels.
5. Whenever new Tubular Florescent Lights, refrigerators, window/split air conditioners, water coolers, electric motors, pumps etc are to be purchased; then, only energy efficient appliances should be bought which have been given highest star (5 star) rating by the BEE to save energy.
6. Two 100 W filament lamps are in use at buildings of MCN and these are highly inefficient. These should be replaced with 23 W retrofit CFL. The cost of these CFLs is also very less and this can be done by the ULB from their own funds.

C. Project Financing and Business Models

C.1 Background

An Investment Grade Audit (IGA) is the process of conducting a detailed energy audit to quantify the savings potential, to translate the technical findings into financial terms, to present it as a bankable DPR capable of securing a loan, to develop the business models for financing the Mu DSM projects and to make M&V plans.

The effective financing and business models create benefits and incentives for all stakeholders. The ULB is directly benefited by savings in energy costs. The ESCOs and technology vendors are benefited in the form of business promotion. The nation is benefited through energy sustainability and the environmental concerns are also addressed.

As the individual ECMs do not have volume enough to attract ESCOs, the ECMs have to be bundled, keeping in mind the economical viability and portfolios generally dealt with by various vendors.

C.2 Notes on Bundling of ECMs and Project Development

As the works related to PF improvement capacitor banks are generally undertaken by pump vendors or contractors dealing with pumps, it is proposed to bundle ECMs for PFC capacitors with those for pumps. Similarly the ECMs for replacement of lights in buildings and automatic controllers of street lights shall be clubbed with the ECM for replacement of street lights as street light vendors and electrical contractors undertake such works.

Accordingly various ECMs described have been clubbed to result in to following energy saving projects (ESPs):-

S. No.	Project	Energy Savings (Lakh KWh)	Fin Savings (Lakh Rs)	Imp. Costs (Lakh Rs)	IRR %	SPP (Years)
1	ESP- Street Light & Building	10.69	44.23	97.55	30.29	4

C.3 Project Risk Assessment and Mitigation

Various risks in energy saving projects outlined below need to be deliberated upon before venturing in to ESPs.

Financial Risks

- **Interest Rates:** As the Govt. incentives for energy efficiency (EE) are likely to increase with time, finance for EE projects is likely to be available at the existing rates of interest. Thus it is not a major risk.
- **Energy Prices:** The change in energy prices can affect the financial savings. It can be addressed by freezing the existing prices or applying a suitable formula in all saving calculations.
- **Construction costs:** The construction costs include material and labour involved for the project. A steep rise in these costs may make the project unviable. The ULB may have to address this risk under contract provisions.
- **M&V costs:** These costs depend upon the rigour in M&V activities which need to be specified as per context and practical considerations like costs as percentage of annual savings.
- **Costs due to delay:** This can be addressed by inserting suitable clauses on compensation for the delay and also on escalation charges in the performance contract.
- **Costs due to changes:** A change in the installation by the users may affect the savings, though no major change is anticipated. A clause in the performance contract can address this issue.

Operational Risks

- **Operating Hours:** As a change in operating hours can affect the savings scenario, it is essential that any change in operating hours is avoided. This should be spelt out in the MV plan and contract documents.
- **Loads:** As the ESPs pertain to pumping and street lighting installations and not buildings, there is no situation where loads can be changed by users. Hence this risk is almost non-existent in respect of these projects.
- **Water Table:** The annual fall in water table level can affect the savings and needs to be documented in the performance contract and the M&V plan. However, practical considerations need to be kept in mind.
- **Water Levels:** As the changes in water levels in the sumps of sewage installations are likely to be similar during baseline and reporting periods, there is no significant effect and no major risk.
- **Weather:** As the ESPs pertain to pumps and street lights only and not buildings, the changes in weather/climate do not have any significant effect on savings over a long period.

- **User Participation:** As no participation of users is involved in these ESPs, this factor has no effect.
- **Resistance from Public:** As no ECM in the proposed ESPs has any adverse effect on the general public or a group of persons, no resistance to these ECMs is anticipated.

Performance Risks

- **Equipment performance:** The risk associated with equipment performance is invariably borne by the ESCO who gets an overriding power in the selection of equipments. The performance contract, therefore, needs to be drafted accordingly and should contain a clause for ensuring a minimum efficiency of equipments included in the scope and a clause to deal with a situation in which performance is below expectation.
- **Operation & Maintenance:** The responsibility for operating the equipments should be specified in the performance contract. This depends upon the type of equipment installed. The party operating the equipments shall be responsible for preventive maintenance also. However, the responsibility for repairs and maintenance is generally with the ESCO. Suitable clauses need to be incorporated in the performance contract.
- **Theft/Damage:** Such risks are generally borne by the ULB. Suitable clauses need to be put in the performance contract to cover all kinds of situations. Insurance covers can address this risk.

Project Risks

- **Contract Document Development:** The ESPs are to be implemented through ESCO route and the ULB has to take action for drafting of performance contract documents and for award of the contract to the ESCO who did the IGA or to some other ESCO. As this involves lot of decision making, support from BEE can be valuable input to reduce the ULB's risk.
- **Supervision of work:** The completion of the work in time and as per specifications requires that the quality and progress be monitored by project authorities of the ULB.

Contractual Risks

The contract clauses for damages for delay/failure can be invoked to address these risks.

M&V Risks

The M&V plan containing roles/responsibilities of the ULB and the ESCO should be incorporated in the contract.

C.4 Project Finance and Development of Business Model

Fixed fees based turnkey consultancy contracts and saving based performance contracts are two standard procedures for implementing ESPs. In fixed fees based turnkey consultancy contract the ULB arranges the project finance either from its own resources or from financial institutions and enters in to a contract with an energy consultant/ESCO for turnkey execution of the ESP including design, procurement and commissioning. Though the consultant gives no guarantee for energy savings and gets fixed fee irrespective of savings, he bears all technical and equipment performance risk.

In case of savings based performance contracts there are two models. In the first one, called the guaranteed savings, the finance is arranged by the ULB and certain minimum savings are guaranteed by the ESCO who makes up the shortfall if the savings are below the guaranteed savings. This is a preferred model as the cost of finance is low and the savings are guaranteed. In the second model, called the shared savings, the funds are arranged by the ESCO and the ULB shares the savings generated by the project. Thus the entire risk is with the ESCO but the costs of finance and the project are high. The ULB has to decide on the choice of business model to be followed in implementing the ESPs.

C.5 Project Cost Benefit Analysis

Any proposed Business model must have a sound Financial Model, designed to allow for sensitivity analysis of key project variables & assumptions. A detailed cost benefit analysis for each project proposal is already mentioned in Table no.

C.6 Monetary Savings / Benefits

Savings in energy costs resulting primarily from energy savings are the main monetary benefits to the ULB. Reduction in operating costs of street lights due to automatic controls is additional benefit. The reduction in repairs/maintenance expenses because of new pumps and street lights is also an additional benefit which has not been monetized.

C.7 A. Project Cash Flow and Financial Analysis

Since, identified ECMs in Street lighting and Building segments are similar in nature and hence bundling of ECMs as been done in order to develop projects with sufficient volume of savings to make the project viable and attractive, to all stakeholders including financers and ESCO players with sufficient technical expertise to undertake performance contracting and one Energy Saving Project (ESP) has been made as placed on next page:

- Assumptions for working out IRR:-

- The IRRs for various ECMs have been worked out for an estimated minimum life cycle of 10 years.
- The IRR for the project has also been worked out for a period of 10 years.
- The costs include all contingent costs.
- The annual savings are based on current energy prices.
- Annual maintenance costs and other cash outflow have been deducted from the annual savings to arrive at net savings and applied in cash flow analysis to arrive at NPV and IRR.
- Discount rate of 12% has been assumed for determining NPV.

Other details about the assumptions made are mentioned in the table as under:

Assumptions	Unit	Value
Tariff Cost		
Tariff	Rs/kWh	4.76
Tariff Escalation Rate per year	Rs/kWh	0.20
Capital Cost		
Excise Duty	%	6%
VAT	%	12.5%
Transportation Cost	%	5%
Erection Cost	%	5%
Interest & Debt		
Interest Rate	%	12%
Equity as a % of total costs	%	40%
Recurring Cost		
Corporate Tax	%	34%
Manpower Cost Escalation	%	5%
Repair & Maintenance Cost	%	10%
Repair & Maintenance Cost Escalation	%	3%
Depreciation Rate	%	30%
Calibration Cost of M&V Equipment	%	2%
Escalation in Calibration Cost of M&V Equipment	%	2%
ESCO Mode		
Investment made by ULB	%	0%
Investment made by ESCO	%	100%
Savings Shared by ESCO	%	80%
ULB Mode		
Investment made by ESCO	%	0%
Investment made by ULB	%	100%
Savings Shared by ULB	%	100%

Table -21: Assumptions for IRR calculation

Manpower, office and third party M&V Expenditure	No	Salary (Rs/month)	Annual Salary
Operator	1	10,000	120,000
Repair & Maintenance Technician	2	8,000	192,000
Office hiring	LS	5,000	60,000
Telephones, Mobiles, Stationary, Printing etc	LS	3,000	36,000
Local conveyance	LS	3,000	36,000
Third Party M&V Expenditure	LS	LS	60,000
Total	**3**		**504,000**

Table No.22: Estimated Expenditures for IRR calculation

ECM No.	Description	Annual Energy Potential in Units	Annual financial saving in Rs.	Investment cost in Rs.	Annual R&M cost in Rs.	Annual Recurring cost in Rs.	Net Saving in Rs.	Simply Payback period in years	NPV in Rs.	IRR (%)
ECM 1/B3	Replace all the 4 feet T12 (40 W) lamps and fixtures with 4 feet T5 (28 W) lamp and fixtures	357,495.60	1,701,679.06	2,226,000	111300	222600	1,367,779	1.63	4912729	60.29
ECM 2/B3	Replace all the 150W HPSV lamps and fixtures with 4X14w T5 (58 W) lamp and fixtures	602,001.07	2,865,525.09	5,530,500	276525	553050	2,035,950	2.72	5333100	34.98
ECM 3/B3	Replace all the 400W HPSV lamps and fixtures with 5x36W CFL flood Light	31317	149,068.92	135000	6750	13500	128,818	1.05	529335	95.30
ECM 4/B3	Improve designing of high masts	1,686.02	8,025.46	5,000.00	0	0	8,025.46	0.62	360.23	160.5
ECM 5/B3	Use Of Automation System	174556.14	830,887.23	1650000	125000	0	705,887	2.34	2087875	41.45
ECM 6/B4	Replacing resistance type conventional fan regulators with electronic regulators	967.95	4,607.44	7,200.00	720	0	3,887.44	1.85	10204	44.65
ECM 7/B4	Replace all the 4 feet T-8 (40W) & T-12 (36 W) lamps and fixtures with 4 ft T5 (28 W) lamp and fixtures	1,013.98	4,826.54	11,000.00	550	550	3,726.54	2.95	8976	31.72
TOTAL		**1,169,038**	**5,564,620**	**9,564,700**	**520,845**	**789,700**	**4,254,075**	**2.25**	**12,921,225**	**43.25**

Table 23: ESP detail of all the ECM of Yamuna Nagar

ESP for STREETLIGHT & BUILDING

Parameters	Unit	Value
No. of Equipment / Retrofit	No	9,564,700
No. of M&V Equipment	No	394,149
Parameters	**Unit**	**Value**
Bare cost of Equipment/Retrofit	Rs	7,275,023
Excise Duty	Rs	436,501
Vat	Rs	963,941
Transportation Cost	Rs	433,773
Erection Cost	Rs	455,462
Total Capital Cost	**Rs**	**9,564,700**
Parameters	**Unit**	**Value**
Bare cost of M&V Equipment	Rs	300,000
Excise Duty	Rs	18,000
Vat	Rs	39,750
Transportation Cost	Rs	17,888
Erection Cost	Rs	18,782
Total Capital Cost	**Rs**	**394,419**
Parameters	**Unit**	**Value**
Annual kWh Saving	kWh/annum	1,169,038

Table No. 24 Input Values of ESP of Yamuna Nagar

No. of years for debt	3
Total Investment Required (Lac Rs)	99.59
Total Equity (Lac Rs)	59.75
Total Debt (Lac Rs)	39.84

Particulars	Years										
	0	1	2	3	4	5	6	7	8	9	10
Capital Cost of Pumps (Lac Rs)	(95.65)	-	-	-	-	-	-	-	-	-	-
Capital Cost of M&V Equipments (Lac Rs)	(3.94)	-	-	-	-	-	-	-	-	-	-
Tariff, Rs/ Unit	4.76	4.96	5.16	5.36	5.56	5.76	5.96	6.16	6.36	6.56	6.76
Energy Saved (Lac kWh/annum)	-	11.69	11.69	11.69	11.69	11.69	11.69	11.69	11.69	11.69	11.69
Total Saving (Lac Rs)	-	57.98	60.32	62.66	65.00	67.34	69.67	72.01	74.35	76.69	79.03
Revenue (Share of ESCO in savings), in Lac Rs.	-	46.39	48.26	50.13	52.00	53.87	55.74	57.61	59.48	61.35	63.22
Manpower Cost (Lac Rs)	-	5.04	5.29	5.56	5.83	6.13	6.43	6.75	7.09	7.45	7.82
Repair & Maintenance Cost (Lac Rs)	-		9.96	10.26	10.57	10.88	11.21	11.55	11.89	12.25	12.62
Annual Calibration Cost of M&V Equipments (Lac Rs)	-		0.08	0.08	0.08	0.08	0.09	0.09	0.09		
Total Expenditure (Lac Rs)											
Interest on Debt (Lac Rs)											
Earning Before Tax (Lac Rs)											
Depreciation Cost (Lac Rs)											
Taxable Earning (Lac Rs)											
Tax (Lac Rs)											
Net Cash Flow (Lac Rs)			26.48	26.78	26.93	26.71	26.80	27.09	27.51	28.02	28.59
Cumulative Cash Flow (Lac Rs)	(99.59)	(65.30)	(38.82)	(12.04)	14.89	41.61	68.41	95.49	123.00	151.03	179.62
		1	2	3	4	5	6	7	8	9	10

Project IRR	**25.83%**
Payback in Years	**4**

Debt Calculations										
Particulars	**Years**									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Debt (Lac Rs)	39.84	39.84	19.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Repayments (Lac Rs)	0.00	19.92	19.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Closing Debt (Lac Rs)	39.84	19.92	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Average Debt (Lac Rs)	39.84	29.88	9.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interest Cost (Lac Rs)	4.78	3.59	1.20	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table No.25 : ESP for ESCO Mode

No. of years for debt	8
Total Investment Required (Lac Rs)	99.59
Total Equity (Lac Rs)	59.75
Total Debt (Lac Rs)	39.84

Particulars	**Years**										
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Capital Cost of Pumps (Lac Rs)	(95.65)										
Capital Cost of M&V Equipments (Lac Rs)											
Tariff, Rs/ Unit											
Energy Saved (Lac kWh/annum)											
Total Saving (Lac Rs)											
Revenue (Share of ESCO in savings), in Lac Rs.										76.69	79.03
Manpower Cost (Lac Rs)		5.04	5.29	5.56	5.83	6.13	6.43	6.75	7.09	7.45	7.82
Repair & Maintenance Cost (Lac Rs)			9.96	10.26	10.57	10.88	11.21	11.55	11.89	12.25	12.62
Annual Calibration Cost of M&V Equipments (Lac Rs)			0.08	0.08	0.08	0.08	0.09	0.09	0.09	0.09	0.09

Total Expenditure (Lac Rs)		(5.04)	(15.33)	(15.89)	(16.48)	(17.09)	(17.73)	(18.39)	(19.07)	(19.79)	(20.53)
Interest on Debt (Lac Rs)		(4.78)	(4.44)	(3.76)	(3.07)	(2.39)	(1.71)	(1.02)	(0.34)	-	-
Earning Before Tax (Lac Rs)		48.16	40.55	43.01	45.44	47.85	50.24	52.60	54.94	56.90	58.50
Depreciation Cost (Lac Rs)		29.88	20.91	14.64	10.25	7.17	5.02	3.52	2.46	1.72	1.21
Taxable Earning (Lac Rs)		18.29	19.64	28.37	35.20	40.68	45.22	49.09	52.48	55.18	57.29
Tax (Lac Rs)		-	-	-	-	-	-	-	-	-	-
Net Cash Flow (Lac Rs)	(99.59)	48.16	40.55	43.01	45.44	47.85	50.24	52.60	54.94	56.90	58.50
Cumulative Cash Flow (Lac Rs)	(99.59)	(51.43)	(10.87)	32.14	77.58	125.43	175.67	228.28	283.21	340.12	398.62
		1	2	3	4	5	6	7	8	9	10

Project IRR	**45.15%**
Payback in Years	**3**

Debt Calculations										
Particulars	**Years**									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Debt (Lac Rs)	39.84	39.84	34.15	28.45	22.76	17.07	11.38	5.69	0.00	0.00
Repayments (Lac Rs)	0.00	5.69	5.69	5.69	5.69	5.69	5.69	5.69	0.00	0.00
Closing Debt (Lac Rs)	39.84	34.15	28.45	22.76	17.07	11.38	5.69	0.00	0.00	0.00
Average Debt (Lac Rs)	39.84	36.99	31.30	25.61	19.92	14.23	8.54	2.85	0.00	0.00
Interest Cost (Lac Rs)	4.78	4.44	3.76	3.07	2.39	1.71	1.02	0.34	0.00	0.00

Table No. 26 : For ULB Mode

C.7 B. Project Cash Flow and Financial Analysis for Option II on LED for street Lighting

As per instructions received from BEE, one more option has been considered with use of LED in street lighting wherever feasible and accordingly, its casj flow and financial analysis are mentioned below:

Assumptions	Unit	Value
Tariff Cost		
Tariff	Rs/kWh	4.76
Tariff Escalation Rate per year	Rs/kWh	0.20
Capital Cost		
Excise Duty	%	4%
VAT	%	12.5%
Transportation Cost	%	2%
Erection Cost	%	1%
Interest & Debt		
Interest Rate	%	12%
Equity as a % of total costs	%	60%
Recurring Cost		
Corporate Tax	%	34%
Manpower Cost Escalation	%	5%
Repair & Maintenance Cost	%	5%
Repair & Maintenance Cost Escalation	%	3%
Depreciation Rate	%	30%
Calibration Cost of M&V Equipment	%	2%
Escalation in Calibration Cost of M&V Equipment	%	2%
ESCO Mode		
Investment made by ULB	%	0%
Investment made by ESCO	%	100%
Savings Shared by ESCO	%	95%
ULB Mode		
Investment made by ESCO	%	0%
Investment made by ULB	%	100%
Savings Shared by ULB	%	100%

Table no. 27- Assumption table of ESP of Yamuna Nagar (option-II)

Manpower, office and third party M&V Expenditure	No	Salary (Rs/month)	Annual Salary
Operator	1	10,000	1,20,000
Repair & Maintenance Technician	2	8,000	1,92,000
Office hiring	LS	5,000	60,000
Telephones, Mobiles, Stationary, Printing etc	LS	3,000	36,000
Local conveyance	LS	3,000	36,000
Third Party M&V Expenditure	LS	LS	60,000
Total	**3**		**5,04,000**

Table no. 28 - Estimated expenditures for IRR calculation (option-II)

Parameters	Unit	Value
No. of Equipment / Retrofit	No	2,90,32,500
No. of M&V Equipment	No	3,59,828
Parameters	**Unit**	**Value**
Bare cost of Equipment/Retrofit	Rs	2,42,05,338
Excise Duty	Rs	9,93,226
Vat	Rs	32,27,983
Transportation Cost	Rs	4,35,778
Erection Cost	Rs	2,94,876
Total Capital Cost	**Rs**	**2,90,32,500**
Parameters	**Unit**	**Value**
Bare cost of M&V Equipment	Rs	3,00,000
Excise Duty	Rs	12,000
Vat	Rs	39,000
Transportation Cost	Rs	5,265
Erection Cost	Rs	3,563
Total Capital Cost	**Rs**	**3,59,828**
Parameters	**Unit**	**Value**
Annual kWh Saving	kWh/annum	14,57,935

Table no. 29- Input values of ESP of Yamuna Nagar (option-II)

Table no. 30 – ESP details of all the ECMs for Option II on LED for street Lighting

ECM No.	Description	Annual Energy Saving Potential in Units	Annual financial saving in Rs.	Investment cost in Rs.	Annual R&M cost in Rs.	Annual Recurring cost in Rs.	Net Saving in Rs.	Simply Payback period in years	NPV in Rs.	IRR (%)
ECM 1/B3 (Option II)	Replace all the 4 feet T12 (40 W) lamps and fixtures with 16W LED Tube light	5,66,035	26,94,327	83,47,500	417375	0	22,76,952	3.67	4033738	24.14
ECM 2/B3 (Option II)	Replace all the 150W HPSV lamps and fixtures with 60W LED street light	5,42,788	25,83,671	1,84,35,000	921750	0	16,61,921	11.09	-8075693	-1.84
ECM 5/B3 (Option II)	Use of automation and voltage stabilizer with GSM based control system for street lighting	3,49,112	16,61,773	2250000	210000	250000	12,01,773	1.87	4053826	52.63
TOTAL		**14,57,935**	**69,39,771**	**2,90,32,500**	**15,49,125**	**2,50,000**	**51,40,646**			

Table no. 31 – ESCO mode

No. of years for debt	3
Total Investment Required (Lac Rs)	293.92
Total Equity (Lac Rs)	176.35
Total Debt (Lac Rs)	117.57

Particulars	Years										
	0	1	2	3	4	5	6	7	8	9	10
Capital Cost in SL (Lac Rs)	(290.32)	-	-	-	-	-	-	-	-	-	-
Capital Cost of M&V Equipments (Lac Rs)	(3.60)	-	-	-	-	-	-	-	-	-	-
Tariff, Rs/ Unit	4.76	4.96	5.16	5.36	5.56	5.76	5.96	6.16	6.36	6.56	6.76
Energy Saved (Lac kWh/annum)	-	14.58	14.58	14.58	14.58	14.58	14.58	14.58	14.58	14.58	14.58
Total Saving (Lac Rs)	-	72.31	75.23	78.15	81.06	83.98	86.89	89.81	92.72	95.64	98.56
Revenue (Share of ESCO in savings), in Lac Rs.	-										
Manpower Cost (Lac Rs)											
Repair & Maintenance Cost (Lac Rs)				15.14	15.59	16.06	16.54	17.04	17.55	18.07	18.62
Annual Calibration Cost of M&V Equipments (Lac Rs)			0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08
Total Expenditure (Lac Rs)		(5.04)	(20.06)	(20.77)	(21.50)	(22.26)	(23.05)	(23.87)	(24.72)	(25.60)	(26.52)
Interest on Debt (Lac Rs)		(14.11)	(10.58)	(3.53)							

Earnings Before Tax (Lac Rs)	-	49.55	40.83	49.94	55.51	57.52	59.50	61.45	63.37	65.26	67.11
Depreciation Cost (Lac Rs)	-	88.18	61.72	43.21	30.24	21.17	14.82	10.37	7.26	5.08	3.56
Taxable Earning (Lac Rs)	-	(38.63)	(20.90)	6.74	25.26	36.35	44.68	51.07	56.11	60.17	63.55
Tax (Lac Rs)	-	-	-	(2.29)	(8.59)	(12.35)	(15.19)	(17.36)	(19.07)	(20.45)	(21.60)
Net Cash Flow (Lac Rs)	(293.92)	49.55	40.83	47.65	46.92	45.16	44.31	44.09	44.30		
Cumulative Cash Flow (Lac Rs)							(19.50)	24.59	68.89	113.69	159.20
		1	2	3	4	5	6	7	8	9	10

Project IRR	**8.84%**
Payback in Years	**7**

Debt Calculations										
Particulars	**Years**									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Debt (Lac Rs)	117.57	117.57	58.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Repayments (Lac Rs)	0.00	58.78	58.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Closing Debt (Lac Rs)	117.57	58.78	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Average Debt (Lac Rs)	117.57	88.18	29.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interest Cost (Lac Rs)	14.11	10.58	3.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table no. 32 – ULB mode

No. of years for debt	8
Total Investment Required (Lac Rs)	293.92
Total Equity (Lac Rs)	176.35
Total Debt (Lac Rs)	117.57

Particulars	Years										
	0	1	2	3	4	5	6	7	8	9	10
Capital Cost of Pumps (Lac Rs)	(290.32)										
Capital Cost of M&V Equipments (Lac Rs)	(3.60)										
Tariff, Rs/ Unit	4.76	4.96	5.16	5.36	5.56	5.76	5.96	6.16	6.36	6.56	6.76
Energy Saved (Lac kWh/annum)		14.58	14.58	14.58	14.58	14.58	14.58	14.58	14.58	14.58	14.58
Total Saving (Lac Rs)		72.31	75.23	78.15	81.06	83.98	86.89	89.81	92.72	95.64	98.56
Revenue (Share of ESCO in savings), in Lac Rs.		72.31	75.23	78.15	81.06	83.98	86.89	89.81	92.72	95.64	98.56
Manpower Cost (Lac Rs)		5.04	5.29	5.56	5.83	6.13	6.43	6.75	7.09	7.45	7.82
Repair & Maintenance Cost (Lac Rs)			14.70	15.14	15.59	16.06	16.54	17.04	17.55	18.07	18.62
Annual Calibration Cost of M&V Equipments (Lac Rs)			0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.08
Total Expenditure (Lac Rs)		(5.04)	(20.06)	(20.77)	(21.50)	(22.26)	(23.05)	(23.87)	(24.72)	(25.60)	(26.52)
Interest on Debt (Lac Rs)		(14.11)	(13.10)	(11.09)	(9.07)	(7.05)	(5.04)	(3.02)	(1.01)	-	-

Earning Before Tax (Lac Rs)		53.17	42.07	46.29	50.49	54.66	58.80	62.92	67.00	70.04	72.04
Depreciation Cost (Lac Rs)		88.18	61.72	43.21	30.24	21.17	14.82	10.37	7.26	5.08	3.56
Taxable Earning (Lac Rs)		(35.01)	(19.66)	3.09	20.25	33.49	43.98	52.54	59.73	64.95	68.48
Tax (Lac Rs)		-	-	-	-	-	-	-	-	-	-
Net Cash Flow (Lac Rs)	(293.92)	53.17	42.07	46.29	50.49	54.66	58.80	62.92	67.00	70.04	72.04
Cumulative Cash Flow (Lac Rs)	(293.92)	(240.76)	(198.69)	(152.40)	(101.91)	(47.24)	11.56	74.47	141.47	211.51	283.54
		1	2	3	4	5	6	7	8	9	10

Project IRR	**13.27%**
Payback in Years	**6**

Debt Calculations										
Particulars	**Years**									
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Debt (Lac Rs)	117.57	117.57	100.77	83.98	67.18	50.39	33.59	16.80	0.00	0.00
Repayments (Lac Rs)	0.00	16.80	16.80	16.80	16.80	16.80	16.80	16.80	0.00	0.00
Closing Debt (Lac Rs)	117.57	100.77	83.98	67.18	50.39	33.59	16.80	0.00	0.00	0.00
Average Debt (Lac Rs)	117.57	109.17	92.38	75.58	58.78	41.99	25.19	8.40	0.00	0.00
Interest Cost (Lac Rs)	14.11	13.10	11.09	9.07	7.05	5.04	3.02	1.01	0.00	0.00

D. Measurement & Verification Protocol, Stakeholder Roles & Responsibilities

D.1 M & V Plan

An IPMVP compliant M&V plan for each of the ECMs is mentioned below. ECMs which are of similar nature have been clubbed together to avoid the repetition. All relevant topics including baseline energy, independent variables, interactive effects, static factors etc have been covered in each plan and cross references have been provided wherever required to give references.

All M&V plans mentioned on subsequent pages are IPMVP adherent since:

(i) The person responsible for approving the *M&V Plan* and for making sure that the *M&V Plan* is followed for the duration of the reporting period has been identified and he is Executive Officer of the ULB.

(ii) M&V Plans have been developed which:

- clearly state the version number of the IPMVP edition and Volume being followed,
- use terminology consistent with the definitions in the version of IPMVP cited,
- include all information mentioned in the M&V Plan,
- will be approved by all parties interested in adherence with IPMVP, and
- is consistent with the Principles of *M&V*

(iii) These will be followed during the contract period.

(iv) *M&V* reports will be prepared as per the requirement of IPMVP

ECM No. 1 to ECM No. 3 and ECM No. 7:- Replacement of energy inefficient lighting with energy efficient lighting.

Description	**ECM No.1/B-3** – Replace all the 4 feet T12 (40 W) lamps and fixtures with 4 foot T5 (28 W) lamp and fixtures **ECM No 2/B-3** – Replace all the 150W HPSV lamps and 125 W MV lamps with 4X14W T5 (60 W) lamp and fixtures **ECM No.3/B-3** – Replace all the 400 W HPSV lamps and fixtures with 5 x 36 W CFL lamp and fixtures **ECM no. 7/B-4** – Replace all the 4 feet T12 (40/36 W) lamps and fixtures with 4 ft T5 (28 W) lamp and fixtures
ECM Intent	These ECM aim to reduce energy consumption and thereby reducing energy costs by replacing lights with high efficacy lights.
Commissioning Procedure to verify successful implementation of ECM	Inspection and testing of installed light along with measurement of power and lux levels (9 point method for street lights and 12 point measurement for high masts where lux levels at three circles, viz. inner circle, middle circle and outer circle are taken by properly covering entire circular area covered by high mast at 90° apart).
Selected IPMVP Option (IPMVP Volume I EVO 10000-1:2009)	Retrofit Isolation: Key Parameter Measurement Option B of IPMVP Volume I (EVO 10000-1:2009) shall be used to determine savings from the engineering calculation of baseline and reporting period from short term or continuous measurement of key operating parameters and estimated values of other parameters. Here, routine and non-routine adjustments will be made as required. The parameters to be measured are power consumed by fixtures and operating hours. A suitable sampling based measurement method would be finalized prior to signing of performance contract.
Measurement Boundary	Key parameter (power) and operating hours are determined based on measurements in isolation for the retrofit, i.e. for the entire quantity of streetlights being replaced. Thus the measurement boundary encompasses the entire quantity of streetlights which are being replaced
Static Factor	There are two static factors: 1. No. of lamps for each type. It has agreed that it will be responsibility of ULB to inform ESCO about any increase or decrease in no. of lamps in any category and the date of such increase/decrease will be considered for calculating savings. 2. Availability of power for the entire street light duration. Since, it is neither in control of ULB nor in the control of ESCO and this will greatly affect the energy savings and thereby affect the viability of these ECMs. Hence, this shall be assumed that power is available throughout the street light operational hours even if it is not.
Interactive Effect	There is no interactive effect for these ECMs. Not even for ECM nos. 7 as there are no air conditioners in the buildings where energy efficient lights will be retrofitted and will generate less heat as compared with old lights.
Independent Variable	Voltage is independent variable as it affects the power consumption substantially. Thus, voltage will also be measured while measuring the power consumption in base line as well as reporting period.

Baseline: Period, Energy and Conditions	Period just before retrofitting the lights will be the baseline period and power consumption along with voltage will be measured on the required sample size.
Reporting Period	The reporting period for this ECM shall be equal to the payback period or performance contract period whichever is longer.
Basis for Adjustment	Voltage at the time of measuring power consumption will be taken into account for adjustment while taking power measurement for existing as well as retrofit light fitting. Any non-routine adjustment corresponding to change in the inventory of installed fixtures during the reporting period will also be made. The method of making the adjustments would be clearly defined and referenced in the performance contract. Similarly, the burnt out percentage will be found out as per agreed frequency in the reporting period and its annual average shall be considered while making energy saving calculations for each category of lamps.
Analysis Procedure	The saving analysis shall be based upon before and after installation energy measurement. The frequency for taking such measurements will be every quarter and the measurement noted will be applicable for next three months period. Operating hours will be the time set at timers each month for reporting period.
Energy Prices	The tariff schedule as applicable from time to time shall be applied for determining energy cost. The entire tariff schedule shall be applied rather than using marginal energy cost if it is found feasible to reduce contract demand after implementing these ECMs.
Budget	It would be Rs. 40,000/- for the entire contract period and has been included in the project implementation cost.
Resource Requirements	Calibrated instruments like Power Analyzer, lux meter along with qualified engineers and technicians.
Specifications of Metering & Monitoring Devices	Power Analyzer & Lux meter of reputed make having proper calibration certificates with 1% accuracy will be used.
Monitoring Responsibilities	This will be joint responsibility of ULB and ESCO for determining the savings from the measured data before and after implementation of ECM in the presence of third party representative.
Expected accuracy	All measuring instrument should be of accuracy class 1.0 or better. At least 90% accuracy is expected in the overall analysis
Reporting Formats	The format for reporting savings shall include all data including actual energy consumption, voltage, tariff schedules as per existing tariff, estimated operating hours and computed savings.
Quality assurance	Measurements will be taken jointly to have transparency in the system.

ECM No. 5 :- Use of Automation for street lighting

Description	Presently, all street lights are being switched ON & switched OFF manually.
ECM Intent	The ECM aims to reduce energy consumption and costs by installing control panels for automation of entire street lighting. These panels will have timer based controls so there will be auto switching for entire street light. Energy saving will come from reduction in operation hours as compared to manual operation.
Commissioning Procedure to verify successful implementation of ECM	Inspection and testing of installed panels to see that lighting gets switched ON & OFF automatically as per set time at timers.
Selected IPMVP Option (IPMVP Volume I EVO 10000-1:2009)	Retrofit Isolation: Key Parameter Measurement Option A of IPMVP Volume I (EVO 10000-1:2009) shall be used to determine savings from the engineering calculation of baseline and reporting period from short term or continuous measurement of key operating parameters and estimated values. Here, routine and non-routine adjustments will be made as required. Key parameters to be measured are power for base line period and operational hours for reporting period. The parameter to be estimated is operational hours for baseline period for each month of the complete baseline period of one year.
Measurement Boundary	Since key parameters are determined in isolation for the given control panel and entire lights and hence measurement boundary is the control panels being installed and entire lights whether they are retrofitted or not as power saving will be calculated for entire street lights .
Static Factor	There are two static factors: 1. No. of lamps for each type. It has agreed that it will be responsibility of ULB to inform ESCO about any increase or decrease in no. of lamps in any category and the date of such increase/decrease will be considered for calculating savings. 2. Availability of power for the entire street light duration. Since, it is neither in control of ULB nor in the control of ESCO and this will greatly affect the energy savings and thereby affect the viability of these ECMs. Hence, this shall be assumed that power is available throughout the street light operational hours even if it is not.
Interactive Effect	There is no interactive effect for this ECM.
Independent Variable	Voltage is independent variable as it affects the power consumption substantially. Thus, voltage will also be measured while measuring the power consumption in base line period.
Baseline: Period, Energy and Conditions	Operational hours for which lights remained ON just before retrofitting the lights will be measured and shall be considered for that month. Average time for which lights used to remain ON for remaining 11 months will be estimated after talking to operators and people living around street lighting.
Reporting Period	The reporting period for this ECM shall be equal to the payback period or performance contract period whichever is longer. Frequency of measurement will be once just before retrofitting the lights for base line period, every fortnight for finding out burnt out in reporting period.
Basis for Adjustment	Voltage prevailing during baseline period (just before retrofitting) will be measured and power consumption adjusted accordingly. Similarly, burnt out percentage for reporting period shall also be

	considered while calculating energy savings.
Analysis Procedure	The saving analysis shall be based on time period before and after installation of control panel. Engineering calculations will be done to calculate on total load on each control panel and thus can be done with the help of measurement taken for baseline measurements for first five ECM on retrofitting light fittings. The only parameter to be measured is operating hours and it would be taken as per the time set at the timers of each panel which is varied each month. The power measurement will be considered for the baseline period and the burn out will be considered prevailing for the reporting period for each category of lamps.
Energy Prices	The tariff schedule as applicable from time to time shall be applied for determining energy cost. The entire tariff schedule shall be applied rather than using marginal energy cost if it is found feasible to reduce contract demand after implementing these ECMs from 5 to 9.
Budget	It would be Rs. 25,000/- for the entire contract period and has been included in the project implementation cost.
Resource Requirements	Only qualified engineers will be required to see the performance of auto timers.
Specifications of Metering & Monitoring Devices	The timers installed at automation panels will be sealed and made tamper proof. The accuracy of these timers shall be +/- 5 minutes from the set time.
Monitoring Responsibilities	This will be joint responsibility of ULB and ESCO for determining the savings from the measured data before and after implementation of ECM in the presence of third party representative.
Expected accuracy	All measuring instrument should be of accuracy class 1.0 or better. At least 90% accuracy is expected in the overall analysis
Reporting Formats	The format for reporting savings shall include all data including actual energy consumption, voltage, tariff schedules as per existing tariff, estimated operating hours and computed savings.
Quality assurance	Measurements will be taken jointly to have transparency in the system.

ECM No. 4:- Improve designing of high masts

Description	There are 5 high masts at Yamuna Nagar but most of them are poorly designed as (i) More directions have been covered than required, (ii) street light poles are there where high mast light is reaching, (iii) Angle of fittings is not okay and (iv) somewhere there is more light than required.
ECM Intent	The ECM aims to reduce energy consumption and costs by designing each high mast as per the need of its site. Accordingly, all the high masts will be modified to suit the actual needs.
Commissioning Procedure to verify successful implementation of ECM	Inspection and testing of installed light fixtures
Selected IPMVP Option (IPMVP Volume I EVO 10000-1:2009)	Retrofit Isolation: Key Parameter Measurement Option A of IPMVP Volume I (EVO 10000-1:2009) shall be used to determine savings from the engineering calculation of baseline and reporting period from short term or continuous measurement of key operating parameters and estimated values. Here, routine and non-routine adjustments as required.
Measurement Boundary	Since key parameters are determined in isolation for the given equipment and for the given time and hence measurement boundary is not applicable.
Baseline: Period, Energy and Conditions	As there is no historic data hence baseline will be before and after installation energy measurement.
Reporting Period	The reporting period for this ECM shall be equal to the payback period.
Basis for Adjustment	As required.
Analysis Procedure	The saving analysis shall be based upon before and after installation energy measurement.
Energy Prices	The existing tariff schedule shall be made applicable for the reporting period.
Budget	Included in the project implementation cost.
Resource Requirements	Instruments like Energy meter, lux meter along with qualified engineers.
Specifications of Metering & Monitoring Devices	Energy meter & Lux meter of reputed make having proper calibration certificates
Monitoring Responsibilities	This will be joint responsibility of ULB and ESCO for determining the savings from the measured data before and after implementation of ECM in the presence of third party representative.
Expected accuracy	All measuring instrument should have class 1.0 accuracy. At least 90% accuracy is expected in the overall analysis
Reporting Formats	The format for reporting savings shall include all data including actual energy consumption, minimum billable consumption, tariff schedules as per existing tariff and computed savings.
Quality assurance	Only approved make/ISI marked products will be purchased and key quality parameters will be checked for a few samples before installation.

ECM No. 6:- Replacing resistance type conventional fan regulators with electronic regulators

Description	At most of the ceiling fans installed at MCS conventional (resistance) type regulators have been used. Resistance type regulators are not energy efficient since rpm of fan is reduced by reducing voltage through resistances of varying length, which is an energy inefficient method to do so.
ECM Intent	The ECM aims to reduce energy consumption and costs by installing electronic regulators. Electronic regulators do not use the above principle for controlling rpm and thus are more energy efficient as compared to conventional regulators.
Commissioning Procedure to verify successful implementation of ECM	Inspection and testing of installed electronic regulators
Selected IPMVP Option (IPMVP Volume I EVO 10000-1:2009)	Retrofit Isolation: Key Parameter Measurement Option A of IPMVP Volume I (EVO 10000-1:2009) shall be used to determine savings from the engineering calculation of baseline and reporting period from short term or continuous measurement of key operating parameters and estimated values. Here, routine and non-routine adjustments as required. Power consumption of individual fans would be measured being the key parameter. The operating hours will be estimated. The step at which fan is normally operated on yearly basis will also be estimated. An adequate sampling plan for measurement of wattage would be developed and agreed upon prior to signing of performance contract depending upon the confidence level and precision required.
Measurement Boundary	Since key parameters are determined in isolation for the given fan regulators and hence measurement boundary is the ceiling fan on which regulator is being replaced.
Static Factor	There are several static factors: 1. No. of fans having conventional regulators. It has agreed that it will be responsibility of ULB to inform ESCO about any increase or decrease in no. of fans with conventional regulators and the date of such increase/decrease will be considered for calculating savings. 2. Availability of power for the entire operational duration. Since, it is neither in control of ULB nor in the control of ESCO and this will greatly affect the energy savings and thereby affect the viability of this ECM. Hence, this shall be assumed that power is available throughout the operational hours even if it is not. 3. No. of working days in the whole year and no. of working hours for a working day. It has agreed that it will be responsibility of ULB to inform ESCO about any change in no. of working days in a year and no. of working hours per day and date of such a change will be considered for calculating savings.
Interactive Effect	There is no interactive effect for this ECM since there are no air conditioners in the buildings where these fan regulators are installed.
Independent Variable	Voltage is independent variable as it affects the power consumption substantially. However, since power will be measured just before and after retrofitting and will be completed within a very short span and therefore, it is assumed that voltage will be the same in baseline as well as reporting period. Similarly, frequency is another independent variable which will affect the rpm of fan and we are measuring power consumption in

	baseline and reporting conditions on the same rpm. However, since rpm will be measured just before and after retrofitting and will be completed within a very short span and therefore, here also it can be assumed that frequency will be the same while measuring rpm in baseline as well as reporting period.
Baseline: Period, Energy and Conditions	Baseline period will be just before implementation of ECM. Energy consumption and voltage will be measured just before the implementation of ECM as per agreed sampling plan and estimated operating hours.
Reporting Period	The reporting period for this ECM shall be equal to the payback period or contract period whichever is longer. Frequency of measurement will be yearly.
Basis for Adjustment	Voltage at the time of measuring power consumption will be taken into account for adjustment while taking power measurement for existing as well as retrofit electronic regulator.
Analysis Procedure	The speeds at all steps of a conventional regulator along with power measurements will taken using a distance (infra red based) tachometer. Now the conventional regulator will be replaced with stepless electronic regulator and power measurements will be taken on the fan speeds as noted during baseline tests. The difference between the two will be saving in power. The saving analysis shall be based upon before and after installation energy measurement. The frequency for taking such measurements will be annual and the measurement noted will be applicable for the complete year. Operating hours will be estimated after talking to staff working in those rooms and shall be assumed same for baseline as well as reporting period.
Energy Prices	The tariff schedule as applicable from time to time shall be applied for determining energy cost. The entire tariff schedule shall be applied rather than using marginal energy cost if it is found feasible to reduce contract demand after implementing various ECMs.
Budget	It would be Rs. 10,000/- for the entire contract period and has been included in the project implementation cost.
Resource Requirements	Calibrated instruments like Power analyzer, non-contact tachometer along with qualified engineers.
Specifications of Metering & Monitoring Devices	Power Analyzer and non-contact tachometer of reputed make having proper calibration certificates
Monitoring Responsibilities	This will be joint responsibility of ULB and ESCO for determining the savings from the measured data before and after implementation of ECM in the presence of third party representative.
Expected accuracy	All measuring instrument should have class 1.0 accuracy. At least 90% accuracy is expected in the overall analysis
Reporting Formats	The format for reporting savings including load, tariff schedules, fan speeds and inventory details applicable for few selected fans and computed savings for this ECM has been annexed in the DPR.
Quality assurance	Measurements will be taken jointly to have transparency in the system.

D.2 Savings Reporting Formats

The formats for saving reports are already covered in previous sections. It is, however, reiterated that all the relevant billed data (for taking latest tariff) along with observed and measured data, operating hours considered in the respective ECMs shall be included in the format which shall be prescribed in performance contract prior to implementation.

D.3 Responsibilities and Obligations of ESCO

Though the responsibilities for monitoring are covered in previous section, the detailed responsibilities of the ECSO shall depend upon the business model adopted by the municipality for implementing the ECMs. In case of performance contract based on shared saving model, the ESCO shall be responsible for financing, implementing, operating, maintaining, training, reporting and handing over the project on completion. In case of performance contract based on guaranteed savings model, the ESCO shall be responsible for implementing, operating, maintaining, training, reporting and handing over the project on completion. In case of fixed fee based turnkey consultancy contract also, the ESCO or the consultant shall be responsible for all these activities as prescribed in the contract.

D.4 Responsibilities and Obligations of ULBs

Providing administrative support and copies of utility bills and other relevant data is the main responsibility of the ULB. The contract would specify the ULB responsibilities in detail regarding administrative support and periodic payments.

D.5 Suggested Payment and Other Terms of Contract

In case of fixed fee based turnkey consultancy contract, a provision for advance payment as mobilization charges in the contract can result in reduced costs and fast execution. Payment for the work in progress can be made as per some yardstick agreed mutually. The payment terms should include payment within one week of submission of deliverables as specified in the contract. Similar provisions for payments can be made in case of guaranteed savings based performance contracts also. A time of one month for payment to be made by the ESCO to the municipality, if the savings are below the guaranteed savings, is considered workable. Payment of bonus payment to the ESCO, if the savings are more than the guaranteed savings, can be helpful in smooth implementation of the project.

In case of shared savings based performance contract, the suggested percentage of savings to be shared by ESCO is 70-80% which can be specified in the contract documents after consultative meetings.

State Govt. should give the Guarantee for timely release of payment to the ESCO on agreed rates.

E. ULB Energy Management Best Practices

Any successful energy management programme needs the total support of top management. Top management should give energy efficiency due importance along with their other organizational objectives. To establish energy management programme an organization should appoint Energy manager, form a dedicated energy cell and institute an energy policy. Thus top management shall make a commitment to allocate manpower and funds to achieve continuous improvement. The other important requirements are a well charted plan, an effective monitoring system and adequate technical ability for analyzing and implementing energy saving options.

E.1 Energy Policy

Energy policy provides the foundation for setting performance goals and integrating energy management into an organization's culture and operations. It formalizes top management support and articulates the organization's commitment to energy efficiency, for employees, the community and other stakeholders. An energy policy typically includes:

1. Declaration of top management's commitment to, and senior and middle management's involvement in, energy management.
2. Statement of policy
3. Statement of objectives, separated into short term and long term goals.

A sample Energy Policy suiting to energy scenario of Municipal Corporation YAMUNA NAGAR is placed on next page for Guidance to Energy Cell.

E.2 Duties Responsibilities and Obligations of Energy Cell

The tasks of energy cell are executing energy management activities across different parts of the organization and ensuring integration of best practices.

Decisions affecting energy use are made every day by employees at all levels in an ULB. Creating an energy cell helps to integrate energy management activities in an ULB. In addition to planning and implementing specific improvements, the energy cell measures and tracks energy performance and communicates with management, employees and other stakeholders. Energy cell can encourage communications and the sharing of ideas between various departments in an ULB. It can serve to obtain agreements on energy conservation projects, which affect more than one department. It can provide a stronger voice to the top management than a single energy manager normally could.

The frequency of team meetings depend on the importance of energy costs in the overall cost structure of the company and what projects are in progress at any time. Normally a monthly meeting is usual, so that monthly production and energy consumptions may be reviewed together by the cell. This review would include a comparison of actual performance against previously set targets and budget figures, as well as against previous months. Other items for

the agenda should be a review of the status of energy conservation investments in progress or planned.

The responsibilities, duties and obligations of energy cell can be summarized as below:

Responsibilities

- Prepare an annual activity plan and present to management concerning financially attractive investments to reduce energy costs
- Obtain management's consent about the mandate and task of the cell.
- Initiate activities to improve monitoring and process control to reduce energy costs.
- Prepare information material and conduct internal workshops about the topic for other staff.
- Establish a methodology how to accurately calculate the specific energy consumption of various services of the ULB.
- Develop and manage training programme for energy efficiency at operating levels.
- Co-ordinate nomination of management personnel to external programs.
- Co-ordinate implementation of energy audit/efficiency improvement projects through external agencies.
- Establish and/or participate in information exchange with other energy cells of the ULBs through top management.

Duties

- Report to BEE, state govt. and state level designated agency the information regard to the energy consumed and action taken on the recommendation of the accredited energy auditor, as per BEE Format whenever asked by them.
- Establish an improved data recording, collection and analysis system to keep track of energy consumption.
- Provide support to Accredited Energy Audit Firm, in case retained by the ULB, for the conduct of energy audit
- Prepare a scheme for efficient use of energy and its conservation and implement such scheme keeping in view of the economic stability of the investment.

Obligations

- Organize meetings as per agreed schedule.
- Keep track of energy consumption on monthly basis, compare with norms/targets and report to management in case of any abnormality.
- Coordinate with BEE, SDA and others on all energy related matters.

E.3 Best Practices Municipal Street Lighting Systems

- A schedule is prepared for cleaning of street lights and it is ensured that cleaning is carried out as per schedule. The cleaning of street lights improves the lux levels by removing the dirt from the lamp/reflector and insects trapped within the fittings are also removed.
- A complain register is maintained at the office where all the complaints regarding street light are maintained with a specific complaint number. The date, time and mode of receipt of complaint along with complainant details are recorded at the time of receiving the complaint. When this complaint is given to concerned person for attending it then the details of person and date & time are also noted. Ultimately when the complaint is attended then again the date and time are noted and thus closing of the complaint takes place. This register is monitored by the lighting in-charge/inspector every day to keep a track of things.

E.4 Best Practices Municipal Buildings

- Whenever any new/additional electrical load is to be added in the system, it is checked whether the existing cable and switch gears can take the extra load. Moreover, the present load on all the three phases is checked and balanced. Additional load is put on the phase least loaded in such a way that it does not lead to unbalancing.
- There is total ban on purchase of 40 W tube rod, resistance type ceiling fan regulator and filament lamps. In case, any one buys these items, then, the bill is not passed by the competent authority. In place of these, 36 W tube rods, electronic regulator and CFL are purchased.
- Whenever new Tubular Florescent Lights, refrigerators, window/split air conditioners, water coolers, electric motors, pumps etc are purchased; then, only energy efficient appliances are bought which have been given highest star (5 star) rating by the BEE to save energy.

MUNICIPAL CORPORATION, YAMUNA NAGAR

ENERGY POLICY

We, at Municipal Corporation YAMUNA NAGAR, are committed to optimally utilize various forms of energy in a cost effective manner to effect conservation of energy resources.

To accomplish this we will :

- Measure, Monitor and control the consumption of various forms of energy through an effective Energy Management System.
- Adopt appropriate energy conservation technologies.
- Use energy efficient appliances.
- Make energy conservation a mass movement with the involvement of all staff.
- Switch off lights/fans and all other appliances when not required.
- Reduce Energy Consumption in each segment by 5 % every year by 2011.

Date

Municipal Commissioner

F. Appendices

List of appendices has been put at page No. 6 of this DPR. Its soft copy has been kept in a separate file. Being bulky its hard copy has not been included in this DPR.

G. Annexures

List of Vendors

1. For Servo Voltage Stabilizer

Sl No	Name	Address
01	M/S Kakatia Energy System Ltd	3-6-272, NVK Towers Himayath Nagar Hyderabad -500029
02	M/S Alien Energy Pvt. Ltd	8/122, Karan Gali, Vishwas Nagar Delhi-110032 Mobile 09810250203 +91 11 2237 2828: 2237 3565
03	Conzerv System Pvt. Ltd. Del.sales@conzerv.com	87, First Floor, Ind Dev Colony Mehrauli Road, Gurgaon- 122 001 +91 124 4268965 : 4268899

2. For various luminaries, electronic chokes, electronic fan regulators etc.

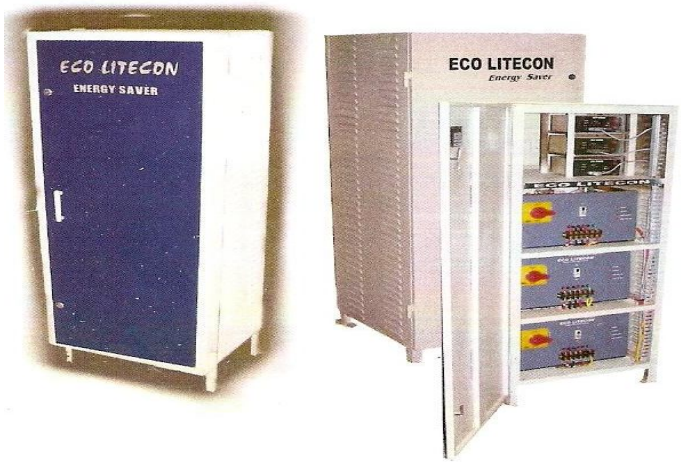
M/S Alien Energy Pvt. Ltd.,
8/122, Karan Gali, Vishwas Nagar
Delhi-110032
Mobile: 09810250203
011-2237 2828, 2237 3565

Technology/Technical Specifications

1. Servo Voltage Stabilizer

ECO LITECON ENERGY SAVER

The ECO LITECON Energy Saver is a micro controller based unit which is used to save energy in Out door lights and indoor lights of any type and wattage.
The ECO LITECON Energy Saver operates by putting the load connected to it, in one of the three modes viz. NORMAL Mode, EnergySAVE Mode and the DIM Mode. In the NORMAL Mode the unit supplies raw power to the load connected to it. In the EnergySave mode the unit supplies conditioned power to the load for maximum circuit efficiency and in the DIMming mode the lights are dimmed.
The load is put into the respective mode at a preset time maintained by an internal clock. The real time at which each of the mode is to be activated can be programmed independently into the ECO LITECON Energy Saver.Savings Potential:35-45%
Suitable for:Warehouses,Yards,streetlighting,facade lighting,etc



Technical Specifications

1. Protection : IP 65
2. Body : Metallic with Powder Coated paint
3. Rating : starts from 3 KVA to 9 KVA in single/double/three phase
4. Incoming Voltage : 150 to 270 Volts
5. Auto-tripping: The panel trips when incoming voltage is more or less than this range
6. Timer : Digital, micro-processor based with a least count of 1 minute

Offers from Vendors

1. Offer from M/S Alien Energy Pvt. Ltd. for Servo Voltage Stabilizer

Prices

   a. Rs. 25,000/- for 3 KVA single phase
   b. Rs. 42,000/- for 3 KVA two phase
   c. Rs. 7,000/-per KVA for each phase (For Example – A 3 KVA 3 Phase panel will cost Rs. 54,000/-)

   These prices are inclusive of all (even installation cost also).

2. Offer in the form of price list from M/S Alien Energy Pvt. Ltd. For lumenaires and other products is placed on next pages

ALIEN ENERGY PRIVATE LTD.
28, RISHABH VIHAR, KARKARDOOMA, DELHI 92
Tel : (91 11) 223/2828, 223/3565,
Telefax : +91-11-22327994
E-mail:enquiry@alienenergy.in
www.alienenergy.in
energy efficient solutions

PRICE LIST OF ALIEN ENERGY SAVING PRODUCTS

wef 1/2/2009

PRODUCT	MODEL NO	UNIT PRICE (in Rs.)
PAGE NO 4 : ENERGY SAVERS		
ENERGY SAVER FOR STREET LIGHTS	AESLS 7072	2800
ENERGY SAVER FOR STREET LIGHTS	AESLS 7073	3000
ENERGY SAVER FOR STREET LIGHTS	AELCTS 7026	3000
ENERGY SAVER FOR Acs	AETTS 7027AC	3500
ENERGY SAVER FOR WATER COOLERS	AETTS 7027WC	4000
ENERGY SAVER FOR Acs	AECTS 7030	2900
ENERGY SAVER DUAL Acs	AEACSHR 7038	3900
ENERGY SAVER DUAL Acs	AECTC	12800
PAGE NO 7 : LED PRODUCTS		
LED EMERGENCY LIGHTS		935
LED AVIATION LIGHTS	LOW INTENSITY	7000
LED AVIATION LIGHTS	MEDIUM INTENSITY	65000
LED HEAD LAMP		350
LED SIGNALING TORCH		1600
LED STEP LIGHT		1600
LED SQUARE DOWN LIGHT		1950
PAGE NO 8 : SOLAR PRODUCTS		
SOLAR TORCH	AE-S T-A	595
SOLAR TORCH	AE-S T-B	765
SOLAR TORCH	AE-S T-C	1700
SOLAR TORCH	AE-S T-D	8075
SOLAR GARDEN LIGHT	AE-SGL-04	4450
SOLAR GARDEN LIGHT	AE-SGL-08	7650
SOLAR GARDEN LIGHT	AE-SGL-12	8000
SOLAR LANTERN	AESL-CFL 7	5015
SOLAR LANTERN	AESL-CFL 5	2125
SOLAR LANTERN	AESL-LED 1	1870
SOLAR LANTERN	AESL-LED 3	2295
SOLAR HOME LIGHTING SYSTEM	AESHL-CFL	19550
SOLAR HOME LIGHTING SYSTEM	AESHL-CFLF 1	20060
SOLAR HOME LIGHTING SYSTEM	AESHL-CFLF 2	36040
SOLAR HOME LIGHTING SYSTEM	AESHL-LED 1	8075
SOLAR HOME LIGHTING SYSTEM	AESHL-LED 2	4675

NPV/IRR Calculation for ECM No. 1/B-3					
Year	Investment in Rs.	Energy saving in Rs.	Repair & Maint. Exp. In Rs.	Recurring Exp. On Replacement in Rs.	Net financial saving in Rs.
0	2,226,000.00				-2226000
1		1701679.06	111300	222600	1,367,779
2		1701679.06	111300	222600	1,367,779
3		1701679.06	111300	222600	1,367,779
4		1701679.06	111300	222600	1,367,779
5		1701679.06	111300	222600	1,367,779
6		1701679.06	111300	222600	1,367,779
7		1701679.06	111300	222600	1,367,779
8		1701679.06	111300	222600	1,367,779
9		1701679.06	111300	222600	1,367,779
10		1701679.06	111300	222600	1,367,779
				NPV	**4,912,729**
				IRR	**60.92%**

Table No.33A: NPV/IRR Table of ECM 1 (option-I)

NPV/IRR Calculation for ECM No. 1/B-3 (Option - II)					
Year	Investment in Rs.	Energy saving in Rs.	Repair & Maint. Exp. in Rs.	Recurring Exp. on Replacement of lamps in Rs.	Net financial saving in Rs.
0	83,47,500				-83,47,500
1		26,94,327.00	4,17,375.00	0.00	22,76,952
2		26,94,327.00	4,17,375.00	0.00	22,76,952
3		26,94,327.00	4,17,375.00	0.00	22,76,952
4		26,94,327.00	4,17,375.00	0.00	22,76,952
5		26,94,327.00	4,17,375.00	0.00	22,76,952
6		26,94,327.00	4,17,375.00	0.00	22,76,952
7		26,94,327.00	4,17,375.00	0.00	22,76,952
8		26,94,327.00	4,17,375.00	0.00	22,76,952
9		26,94,327.00	4,17,375.00	0.00	22,76,952
10		26,94,327.00	4,17,375.00	0.00	22,76,952
				NPV	40,33,738
				IRR	24.14%

Table No.33B: NPV/IRR Table of ECM 1(Option-II)

NPV/IRR Calculation for ECM No. 2/B-3					
Year	Investment in Rs.	Energy saving in Rs.	Repair & Maint. Exp. in Rs.	Recurring Exp. on Replacement in Rs.	Net financial saving in Rs.
0	5,530,500				-5,530,500
1		2,865,525.09	276,525.00	553,050.00	2,035,950
2		2,865,525.09	276,525.00	553,050.00	2,035,950
3		2,865,525.09	276,525.00	553,050.00	2,035,950
4		2,865,525.09	276,525.00	553,050.00	2,035,950
5		2,865,525.09	276,525.00	553,050.00	2,035,950
6		2,865,525.09	276,525.00	553,050.00	2,035,950
7		2,865,525.09	276,525.00	553,050.00	2,035,950
8		2,865,525.09	276,525.00	553,050.00	2,035,950
9		2,865,525.09	276,525.00	553,050.00	2,035,950
10		2,865,525.09	276,525.00	553,050.00	2,035,950
				NPV	**5,333,100**
				IRR	**34.98%**

Table No.34 A: NPV/IRR Table of ECM 2 (Option-I)

NPV/IRR Calculation for ECM No. 2/B-3 (Option - II)					
Year	Investment in Rs.	Energy saving in Rs.	Repair & Maint. Exp. in Rs.	Recurring Exp. on Replacement of lamps in Rs.	Net financial saving in Rs.
0	1,84,35,000				-1,84,35,000
1		25,83,671.00	9,21,750.00	0.00	16,61,921
2		25,83,671.00	9,21,750.00	0.00	16,61,921
3		25,83,671.00	9,21,750.00	0.00	16,61,921
4		25,83,671.00	9,21,750.00	0.00	16,61,921
5		25,83,671.00	9,21,750.00	0.00	16,61,921
6		25,83,671.00	9,21,750.00	0.00	16,61,921
7		25,83,671.00	9,21,750.00	0.00	16,61,921
8		25,83,671.00	9,21,750.00	0.00	16,61,921
9		25,83,671.00	9,21,750.00	0.00	16,61,921
10		25,83,671.00	9,21,750.00	0.00	16,61,921
				NPV	-80,75,693
				IRR	-1.84%

Table No. 34 B: NPV/IRR Table of ECM 2 (Option-II)

NPV/IRR Calculation for ECM No. 3/B-3					
Year	Investment in Rs.	Energy saving in Rs.	Repair & Maint. Exp. in Rs.	Recurring Exp. on Replacement in Rs.	Net financial saving in Rs.
0	135,000				-135,000
1		149,068.92	6,750.00	13,500.00	128,818.92
2		149,068.92	6,750.00	13,500.00	128,818.92
3		149,068.92	6,750.00	13,500.00	128,818.92
4		149,068.92	6,750.00	13,500.00	128,818.92
5		149,068.92	6,750.00	13,500.00	128,818.92
6		149,068.92	6,750.00	13,500.00	128,818.92
7		149,068.92	6,750.00	13,500.00	128,818.92
8		149,068.92	6,750.00	13,500.00	128,818.92
9		149,068.92	6,750.00	13,500.00	128,818.92
10		149,068.92	6,750.00	13,500.00	128,818.92
				NPV	**529,335.38**
				IRR	**95.30%**

Table No. 35: NPV/IRR Table of ECM 3

NPV/IRR Calculation for ECM No. 4/B-3					
Year	Investment in Rs.	Energy saving in Rs.	Repair & Maint. Exp. in Rs.	Recurring Exp. on Replacement in Rs.	Net financial saving in Rs.
0	5,000				-5,000
1		8025.46	0.00	0.00	8025.46
2		8025.46	0.00	0.00	8025.46
3		8025.46	0.00	0.00	8025.46
4		8025.46	0.00	0.00	8025.46
5		8025.46	0.00	0.00	8025.46
6		8025.46	0.00	0.00	8025.46
7		8025.46	0.00	0.00	8025.46
8		8025.46	0.00	0.00	8025.46
9		8025.46	0.00	0.00	8025.46
10		8025.46	0.00	0.00	8025.46
				NPV	**36,023**
				IRR	**160.50%**

Table No.36: NPV/IRR Table of ECM 4

NPV/IRR Calculation for ECM No. 5/B-3					
Year	Investment in Rs.	Energy saving in Rs.	Repair & Maint. Exp. in Rs.	Recurring Exp. on Replacement in Rs.	Net financial saving in Rs.
0	1,650,000				-1,650,000
1		830,887.23	125,000.00	0.00	705,887.23
2		830,887.23	125,000.00	0.00	705,887.23
3		830,887.23	125,000.00	0.00	705,887.23
4		830,887.23	125,000.00	0.00	705,887.23
5		830,887.23	125,000.00	0.00	705,887.23
6		830,887.23	125,000.00	0.00	705,887.23
7		830,887.23	125,000.00	0.00	705,887.23
8		830,887.23	125,000.00	0.00	705,887.23
9		830,887.23	125,000.00	0.00	705,887.23
10		830,887.23	125,000.00	0.00	705,887.23
				NPV	**2,087,875**
				IRR	**41.45%**

Table No.37 A: NPV/IRR Table of ECM 5 (option-I)

NPV/IRR Calculation for ECM No. 5/B-3 (Option - II)					
Year	Investment in Rs.	Energy saving in Rs.	Repair & Maint. Exp. in Rs.	Recurring Exp. on GSM	Net financial saving in Rs.
0	22,50,000				-22,50,000
1		16,61,773.00	2,10,000.00	2,50,000.00	12,01,773
2		16,61,773.00	2,10,000.00	2,50,000.00	12,01,773
3		16,61,773.00	2,10,000.00	2,50,000.00	12,01,773
4		16,61,773.00	2,10,000.00	2,50,000.00	12,01,773
5		16,61,773.00	2,10,000.00	2,50,000.00	12,01,773
6		16,61,773.00	2,10,000.00	2,50,000.00	12,01,773
7		16,61,773.00	2,10,000.00	2,50,000.00	12,01,773
8		16,61,773.00	2,10,000.00	2,50,000.00	12,01,773
9		16,61,773.00	2,10,000.00	2,50,000.00	12,01,773
10		16,61,773.00	2,10,000.00	2,50,000.00	12,01,773
				NPV	40,53,826
				IRR	52.63%

Table No.37B: NPV/IRR Table of ECM 5 (Option-II)

NPV/IRR Calculation for ECM No. 6/B-4					
Year	Investment in Rs.	Energy saving in Rs.	Repair & Maint. Exp. in Rs.	Recurring Exp. on Replacement in Rs.	Net financial saving in Rs.
0	7,200				-7,200
1		4,017.00	720.00	0.00	3,297.00
2		4,017.00	720.00	0.00	3,297.00
3		4,017.00	720.00	0.00	3,297.00
4		4,017.00	720.00	0.00	3,297.00
5		4,017.00	720.00	0.00	3,297.00
6		4,017.00	720.00	0.00	3,297.00
7		4,017.00	720.00	0.00	3,297.00
8		4,017.00	720.00	0.00	3,297.00
9		4,017.00	720.00	0.00	3,297.00
10		4,017.00	720.00	0.00	3,297.00
				NPV	**10,204**
				IRR	**44.65%**

Table No.38: NPV/IRR Table of ECM 6

NPV/IRR Calculation for ECM No. 7/B-4					
Year	Investment in Rs.	Energy saving in Rs.	Repair & Maint. Exp. in Rs.	Recurring Exp. on Replacement in Rs.	Net financial saving in Rs.
0	11,000.00				-11,000.00
1		4,826.00	550.00	550.00	3,726.00
2		4,826.00	550.00	550.00	3,726.00
3		4,826.00	550.00	550.00	3,726.00
4		4,826.00	550.00	550.00	3,726.00
5		4,826.00	550.00	550.00	3,726.00
6		4,826.00	550.00	550.00	3,726.00
7		4,826.00	550.00	550.00	3,726.00
8		4,826.00	550.00	550.00	3,726.00
9		4,826.00	550.00	550.00	3,726.00
10		4,826.00	550.00	550.00	3,726.00
				NPV	**8,976**
				IRR	**31.72%**

Table No.39: NPV/IRR Table of ECM 7

Income Tax Rules on Claiming Depreciation

[1][***NEW APPENDIX I***

[Effective from assessment year 2006-07 onwards]

[*See* rule 5]

TABLE OF RATES AT WHICH DEPRECIATION IS ADMISSIBLE

Block of assets	*Depreciation allowance as percentage of written down value*
1	**2**
PART A	
TANGIBLE ASSETS	
I. Building [*See* Notes 1 to 4 below this Table]	
(*1*) Buildings which are used mainly for residential purposes except hotels and boarding houses	5
(*2*) Buildings other than those used mainly for residential purposes and not covered by sub-items (1) above and (3) below	10
(*3*) Buildings acquired on or after the 1st day of September, 2002 for installing machinery and plant forming part of water supply project or water treatment system and which is put to use for the purpose of business of providing infrastructure facilities under clause (*i*) of sub-section (4) of section 80-IA	100
(*4*) Purely temporary erections such as wooden structures	100
II. Furniture and fittings	10
Furniture and fittings including electrical fittings [*See* Note 5 below this Table]	
III. Machinery and Plant	
(*1*) Machinery and plant other than those covered by sub-items (2), (3) and (8) below : 15	15
(*2*) Motor cars, other than those used in a business of running them on hire, acquired or put to use on or after the 1st day of April, 1990 15	15
(*3*) (*i*) Aeroplanes - Aeroengines	40
(*ii*) Motor buses, motor lorries and motor taxis used in a business of running them on hire	30
(*iii*) Commercial vehicle which is acquired by the assessee on or after the 1st day of October, 1998, but before the 1st day of April, 1999 and is put to use for any period before the 1st day of April, 1999 for the purposes of business or profession in	40

	accordance with the third proviso to clause (*ii*) of sub-section (1) of section 32 [*See* Note 6 below this Table]	
(*iv*)	New commercial vehicle which is acquired on or after the 1st day of October, 1998, but before the 1st day of April, 1999 in replacement of condemned vehicle of over 15 years of age and is put to use for any period before the 1st day of April, 1999 for the purposes of business or profession in accordance with the third proviso to clause (*ii*) of sub-section (1) of section 32 [*See* Note 6 below this Table]	60
(*v*)	New commercial vehicle which is acquired on or after the 1st day of April, 1999 but before the 1st day of April, 2000 in replacement of condemned vehicle of over 15 years of age and is put to use before the 1st day of April, 2000 for the purposes of business or profession in accordance with the second proviso to clause (*ii*) of sub-section (1) of section 32 [*See* Note 6 below this Table]	60
(*vi*)	New commercial vehicle which is acquired on or after the 1st day of April, 2001 but before the 1st day of April, 2002 and is put to use before the 1st day of April, 2002 for the purposes of business or profession [*See* Note 6 below this Table]	50
[1a]**[**(via)	*New commercial vehicle which is acquired on or after the 1st day of January, 2009 but before the* [1b]**[***1st day of October, 2009***]** *and is put to use before* [1b]**[***1st day of October, 2009***]** *for the purposes of business or profession [See paragraph 6 of the Notes below this Table]*	*50***]**
(*vii*)	Moulds used in rubber and plastic goods factories	30
(*viii*)	Air pollution control equipment, being—	
	(*a*) Electrostatic precipitation systems (*b*) Felt-filter systems (*c*) Dust collector systems (*d*) Scrubber-counter current/venturi/packed bed/cyclonic scrubbers (*e*) Ash handling system and evacuation system	100
(*ix*)	Water pollution control equipment, being—	
	(*a*) Mechanical screen systems (*b*) Aerated detritus chambers (including air compressor) (*c*) Mechanically skimmed oil and grease removal systems (*d*) Chemical feed systems and flash mixing equipment (*e*) Mechanical flocculators and mechanical reactors	100

	(*f*) Diffused air/mechanically aerated activated sludge systems (*g*) Aerated lagoon systems (*h*) Biofilters (*i*) Methane-recovery anaerobic digester systems (*j*) Air floatation systems (*k*) Air/steam stripping systems (*l*) Urea Hydrolysis systems (*m*) Marine outfall systems (*n*) Centrifuge for dewatering sludge (*o*) Rotating biological contractor or bio-disc (*p*) Ion exchange resin column (*q*) Activated carbon column	
(*x*)	(*a*) Solidwaste, control equipment being - caustic/lime/ chrome/mineral/cryolite recovery systems (*b*) Solidwaste recycling and resource recovery systems	100
(*xi*)	Machinery and plant, used in semi-conductor industry covering all Integrated Circuits (ICs) (excluding hybrid integrated circuits) ranging from Small Scale Integration (SSI) to Large Scale Integration/Very Large Scale Integration (LSI/VLSI) as also discrete semi-conductor devices such as diodes, transistors, thyristors, triacs, etc., other than those covered by entries (*viii*), (*ix*) and (*x*) of this sub-item and sub-item (8) below.	30
(*xia*)	Life saving medical equipment, being— (*a*) D.C. Defibrillators for internal use and pace makers (*b*) Haemodialysors (*c*) Heart lung machine (*d*) Cobalt Therapy Unit (*e*) Colour Doppler (*f*) SPECT Gamma Camera (*g*) Vascular Angiography System including Digital Subtraction Angiography	40

(*h*) Ventilator used with anaesthesia apparatus	
(*i*) Magnetic Resonance Imaging System	
(*j*) Surgical Laser	
(*k*) Ventilator other than those used with anaesthesia	
(*l*) Gamma knife	
(*m*) Bone Marrow Transplant Equipment including silastic long standing intravenous catheters for chemotherapy	
(*n*) Fibre optic endoscopes including, Paediatric resectoscope/audit resectoscope, Peritoneoscopes, Arthoscope, Microlaryngoscope, Fibreoptic Flexible Nasal Pharyngo Bronchoscope, Fibreoptic Flexible Laryngo Bronchoscope, Video Laryngo Bronchoscope and Video Oesophago Gastroscope, Stroboscope, Fibreoptic Flexible Oesophago Gastroscope	
(*o*) Laparoscope (single incision)	
(*4*) Containers made of glass or plastic used as re-fills	50
(*5*) Computers including computer software (*See* Note 7 below this Table)	60
(*6*) Machinery and plant, used in weaving, processing and garment sector of textile industry, which is purchased under TUFS on or after the 1st day of April, 2001 but before the 1st day of April, 2004 and is put to use before the 1st day of April, 2004 [*See* Note 8 below this Table]	50
(*7*) Machinery and plant, acquired and installed on or after the 1st day of September, 2002 in a water supply project or a water treatment system and which is put to use for the purpose of business of providing infrastructure facility under clause (*i*) of sub-section (4) of section 80-IA [*See* Notes 4 and 9 below this Table]	100
(*8*) (*i*) Wooden parts used in artificial silk manufacturing machinery	
(*ii*) Cinematograph films - bulbs of studio lights	
(*iii*) Match factories - Wooden match frames	100
(*iv*) Mines and quarries :	
(*a*) Tubs winding ropes, haulage ropes and sand stowing pipes	100

(*b*) Safety lamps	
(*v*) Salt works - Salt pans, reservoirs and condensers, etc., made of earthy, sandy or clayey material or any other similar material	
(*vi*) Flour mills - Rollers	
(*vii*) Iron and steel industry - Rolling mill rolls	80
(*viii*) Sugar works – Rollers	
(*ix*) Energy saving devices, being—	
A. Specialised boilers and furnaces :	
(*a*) Ignifluid/fluidized bed boilers	
(*b*) Flameless furnaces and continuous pusher type furnaces 80	
(*c*) Fluidized bed type heat treatment furnaces	80
(*d*) High efficiency boilers (thermal efficiency higher than 75 per cent in case of coal fired and 80 per cent in case of oil/gas fired boilers)	
B. Instrumentation and monitoring system for monitoring energy flows	
(*a*) Automatic electrical load monitoring systems	
(*b*) Digital heat loss meters	
(*c*) Micro-processor based control systems	
(*d*) Infra-red thermography	
(*e*) Meters for measuring heat losses, furnace oil flow, steam flow, electric energy and power factor meters	80
(*f*) Maximum demand indicator and clamp on power meters	
(*g*) Exhaust gases analyzer	
(*h*) Fuel oil pump test bench	
C. Waste heat recovery equipment:	
(*a*) Economisers and feed water heaters	
(*b*) Recuperators and air pre-heaters	80
(*c*) Heat pumps	

(*d*) Thermal energy wheel for high and low temperature waste heat recovery		
D. Co-generation systems:		
(*a*) Back pressure pass out, controlled extraction, extraction-*cum*-condensing turbines for co-generation along with pressure boilers		80
(*b*) Vapour absorption refrigeration systems		
(*c*) Organic rankine cycle power systems		
(*d*) Low inlet pressure small steam turbines		
E. Electrical equipment:		
(*a*) Shunt capacitors and synchronous condenser systems		
(*b*) Automatic power cut-off devices (relays) mounted on individual motors		
(*c*) Automatic voltage controller		
(*d*) Power factor controller for AC motors		
(*e*) Solid state devices for controlling motor speeds		
(*f*) Thermally energy-efficient stenters (which require 800 or less kilocalories of heat to evaporate one kilogram of water)		
(*g*) Series compensation equipment		
(*h*) Flexible AC Transmission (FACT) devices - Thyristor controlled series compensation equipment		80
(*i*) Time of Day (ToD) energy meters		
(*j*) Equipment to establish transmission highways for National Power Grid to facilitate transfer of surplus power of one region to the deficient region		
(*k*) Remote terminal units/intelligent electronic devices, computer hardware/software, router/bridges, other required equipment and associated communication systems for supervisory control and data acquisition systems, energy management systems and distribution management systems for		

power transmission systems	
(*l*) Special energy meters for Availability Based Tariff (ABT)	
F. Burners:	
(*a*) 0 to 10 per cent excess air burners	
(*b*) Emulsion burners	80
(*c*) Burners using air with high pre-heat temperature (above 300°C)	
G. Other equipment :	
(*a*) Wet air oxidation equipment for recovery of chemicals and heat	
(*b*) Mechanical vapour recompressors	
(*c*) Thin film evaporators	
(*d*) Automatic micro-processor based load demand controllers	80
(*e*) Coal based producer gas plants	
(*f*) Fluid drives and fluid couplings	
(*g*) Turbo charges/super-charges	
(*h*) Sealed radiation sources for radiation processing plants	
(*x*) Gas cylinders including valves and regulators	60
(*xi*) Glass manufacturing concerns - Direct fire glass melting furnaces	60
(*xii*) Mineral oil concerns:	
(*a*) Plant used in field operations (above ground) Returnable packages	
(*b*) Plant used in field operations (below ground), but not including kerbside pumps including underground tanks and fittings used in field operations (distribution) by mineral oil concerns	60
(*xiii*) Renewable energy devices being —	
(*a*) Flat plate solar collectors	
(*b*) Concentrating and pipe type solar collectors	
(*c*) Solar cookers	
(*d*) Solar water heaters and systems	80
(*e*) Air/gas/fluid heating systems	
(*f*) Solar crop driers and systems	

(*g*) Solar refrigeration, cold storages and air conditioning systems	
(*h*) Solar steels and desalination systems	
(*i*)Solar power generating systems	
(*j*) Solar pumps based on solar-thermal and solar-photovoltaic conversion	
(*k*) Solar-photovoltaic modules and panels for water pumping and other applications	
(*l*) Wind mills and any specially designed devices which run on wind mills	
(*m*) Any special devices including electric generators and pumps running on wind energy	
(*n*) Biogas-plant and biogas-engines	
(*o*) Electrically operated vehicles including battery powered or fuel-cell powered vehicles	
(*p*) Agricultural and municipal waste conversion devices producing energy	
(*q*) Equipment for utilising ocean waste and thermal energy	
(*r*) Machinery and plant used in the manufacture of any of the above sub-items	
(*9*) (*i*) Books owned by assessees carrying on a profession—	
(*a*) Books, being annual publications	100
(*b*) Books, other than those covered by entry (*a*) above	60
(*ii*) Books owned by assessees carrying on business in runninglending libraries	100
IV. Ships	
(*1*) Ocean-going ships including dredgers, tugs, barges, survey launches and other similar ships used mainly for dredging purposes and fishing vessels with wooden hull	20
(*2*) Vessels ordinarily operating on inland waters, not covered by sub-item	20
(*3*) Vessels ordinarily operating on inland waters being speed boats [*See* Note 10 below this Table]	20

PART B

Know-how, patents, copyrights, trademarks, licences, franchises or any other business or commercial rights of similar nature	25

Notes:

1. "Buildings" include roads, bridges, culverts, wells and tubewells.
2. A building shall be deemed to be a building used mainly for residential purposes, if the built up floor area thereof used for residential purposes is not less than sixty-six and two-third per cent of its total built-up floor area and shall include any such building in the factory premises.
3. In respect of any structure or work by way of renovation or improvement in or in relation to a building referred to in *Explanation 1* of clause (*ii*) of sub-section (1) of section 32, the percentage to be applied will be the percentage specified against sub-item (1) or (2) of item 1 as may be appropriate to the class of building in or in relation to which the renovation or improvement is effected. Where the structure is constructed or the work is done by way of extension of any such building, the percentage to be applied would be such percentage as would be appropriate, as if the structure or work constituted a separate building.
4. Water treatment system includes system for desalination, demineralisation and purification of water.
5. "Electrical fittings" include electrical wiring, switches, sockets, other fittings and fans, etc.
6. "Commercial vehicle" means "heavy goods vehicle", "heavy passenger motor vehicle", "light motor vehicle", "medium goods vehicle" and "medium passenger motor vehicle" but does not include "maxi-cab", "motor-cab", "tractor" and "road-roller". The expressions "heavy goods vehicle", "heavy passenger motor vehicle", "light motor vehicle", "medium goods vehicle", "medium passenger motor vehicle", "maxi-cab", "motor-cab", "tractor" and "road-roller" shall have the meanings respectively assigned to them in section 2 of the Motor Vehicles Act, 1988 (59 of 1988).[2]
7. "Computer software" means any computer program recorded on any disc, tape, perforated media or other information storage device.
8. "TUFS" means Technology Upgradation Fund Scheme announced by the Government of India in the form of a Resolution of the Ministry of Textiles *vide* No. 28/1/99-CTI of 31-3-1999.
9. Machinery and plant includes pipes needed for delivery from the source of supply of raw water to the plant and from the plant to the storage facility.
10. "Speed boat" means a motor boat driven by a high speed internal combustion engine capable of propelling the boat at a speed exceeding 24 kilometres per hour in still water and so designed that when running at a speed, it will plane, *i.e.,* its bow will rise from the water.]