# DETAIL PROJECT REPORT

# ON

# INVESTMENT GRADE ENERGY AUDIT

# (MUNICIPAL COUNCIL, BHIWANI)

PREPARED FOR

ENERGY IS LIFE
B E E
CONSERVE IT

## Bureau of Energy Efficiency


**PREPARED 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 |

# 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 'Mu DSM 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, Bhiwani 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, Bhiwani). 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, Bhiwani**

- Shri A. K. Jain - Executive Officer
- Shri Vivek Singh - Municipal Engineer
- Shri Anand Singh - Light Inspector

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

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**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, Bhiwani 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 Ph of the MuDSM project)

## 2. Brief Overview of the Segments

**Street Lighting**

Street lighting at Bhiwani is controlled by its municipal council. However, it has given a contract for its maintenance and operation. There are 10 high masts in the city and each is having 6-11 fixtures. In each fixture, there are 2 lamps of 400 W HPSV except one high mast which has 400 W MH lamps. Besides these, there are several street light poles having 40/20 W FTL, 250/150/70 W HPSV and 100 W GLS lights. The total installed load on street lighting is around 438.5 KW and the burnt out percentage at the time conduct of IGA was 20 % which is just satisfactory and should be improved. The operation of switching ON and OFF is manual and done by contractor.

**Buildings**

There is one building at Municipal Council, Bhiwani. There is one single phase LT connection for the entire buildings. The total installed load for building is around 3 kW and the total built up area of the building is 527.01 sq.m. This is a single storied building. There is no air conditioner at any of the room and one 3 KVA DG set is there. The building is hired one and soon they are going to have their own building which has been approved by Govt. of Haryana.

## 3. Energy consumption patterns for the ULB

- Overall Annual Energy Consumption for ULB – 9,27,810 Units
- Segment wise Annual Energy Consumption for Bhiwani Municipal council

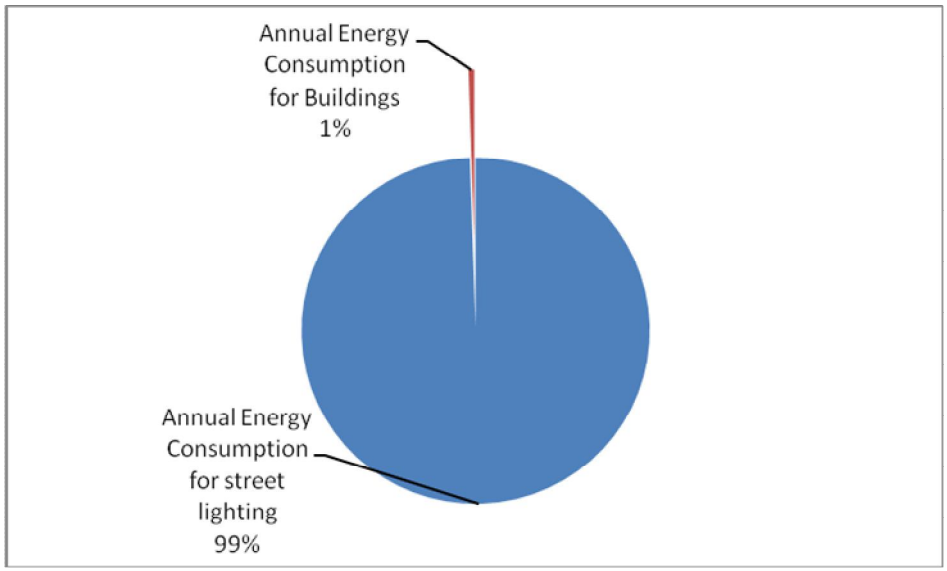


**Figure no. 1 - Segment wise Annual Energy Consumption for Bhiwani Municipal council**

- Significant Energy Indices (Segment wise)
  - Per Capita kWh consumption for Street lighting – 5.44 Units
  - kWh / Installed kW for Street lighting – 1381.79 Units
  - Average Street lighting Service levels (lux) for

    Major Streets – 0 to 60 (average around 20)

    Minor Streets - 0 to 30 (average around 10)

    kWh / Annum / lux for street light is coming around 1312.17
  - Overall Energy Efficiency Index of Municipal Building is

    9.5 kWh /sq. mtr. /annum

## 4. Brief Segment wise Summary of Parameters studied

**Water & Sewage Pumping –** Not applicable in case of Municipal Council, Bhiwani

### 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.

### Buildings

The energy consumption of the only building 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. Brief Segment wise abstract on Energy Conservation Measures identified, Bundling of ECMs and Project Development

| Sr. No. | ECM 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 Cost (Rs. In Lacs) | Simple Payback Period | IRR % | Notes on Feasibility |
| **ECMs for BUILDINGS** | | | | | | | | | | |
| **ECMs with Negligible Investment** | | | | | | | | | | |
| 1 | 11/B-4 | Replacing resistance type conventional fan regulators with electronic regulators | 242 | 0.01 | 0.018 | 0.0018 | 0.0198 | 2.18 | 44.64 | Feasible |
| 2 | 12/B-4 | Replace all the 4 feet T8 (36 W) lamps and fixtures with 4 foot T5 (28 W) lamp and fixtures. | 1,309 | 0.054 | 0.155 | 0.0155 | 0.1705 | 3.99 | 21.40 | Feasible |
| 3 | 13/B-4 | Installing changeover switch for DG set at right location | NIL | 0.06 | NIL | NIL | NIL | Immediate | NA | Feasible, Should be implemented by ULB |
| **ECMs for STREET LIGHTING (Option-I)** | | | | | | | | | | |
| **ECMs with Medium Investment** | | | | | | | | | | |
| 4 | 9/B-3 | Improvement of Designing of High masts | 12,507 | 0.519 | 0.10 | NIL | 0.10 | 0.19 | 519.04 | Feasible |
| 5 | 2/B-3 (Opt-I) | Replace all the 100 W GLS (filament) lamps with 23 W retrofit CFL lamp and fixtures | 60,594 | 2.51 | 1.12 | 0.168 | 1.288 | 0.48 | 209.3 | Feasible |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 6/B-3 (Opt-I) | Replace all the 70W HPSV lamps and fixtures with 1x36W CFL(36 W) lamp and fixtures | 18,212 | 0.756 | 2.10 | 0.315 | 2.415 | 4.76 | 16.39 | Feasible |
| 7 | 8/B-3 | Replace all the 400W MH lamps and fixtures with 320W MH lamp and fixtures | 7,950 | 0.33 | 0.55 | 0.0825 | 0.6325 | 2.22 | 43.79 | Feasible |
| 8 | 1/B-3 (Opt-I) | Replace all the 20 W FTL with 14 W T5 lamp and fixtures | 13,209 | 0.548 | 1.41 | 0.212 | 1.622 | 4.19 | 20.03 | Feasible |
| **ECMs with Major Investment** | | | | | | | | | | |
| 9 | 3/B-3 (Opt-I) | Replace all the 250 W HPSV lamps and fixtures with 4 X 24 W T5 lamp and fixtures | 1,31,519 | 5.458 | 8.26 | 1.24 | 9.50 | 1.95 | 50.20 | Feasible |
| 10 | 5/B-3 (Opt-I) | Replace all the 150W HPSV lamps and fixtures with 4X14W T5 (58 W) lamp and fixtures | 2,42,142 | 11.709 | 23.04 | 3.45 | 26.49 | 2.79 | 33.88 | Feasible |
| 11 | 7/B-3 | Replace all the 400W HPSV lamps and fixtures with 320W MH lamp and fixtures | 55,648 | 2.31 | 3.85 | 0.5775 | 4.4275 | 2.22 | 43.79 | Feasible |
| 12 | 10/B-3 (Opt-I) | Use of Automation for street lighting | 86,475 | 3.589 | 11.5 | 1.00 | 12.50 | 4.44 | 18.33 | Feasible |
| 13 | 4/B-3 (Opt-I) | Replace all the 4 feet T12 (40 W) lamps and fixtures with 4 feet T5 (28 W) lamp and fixtures | 3,03,630 | 12.6 | 34.66 | 5.13 | 39.79 | 4.68 | 16.86 | Feasible |
| **ECMs for STREET LIGHTING (Option-II)** | | | | | | | | | | |
| **ECMs with Medium Investment** | | | | | | | | | | |
| 14 | 1/B-3 (Opt-II) | Replace all the 20 W FTL with 8W LED | 19,814 | 0.82 | 3.76 | 0.18 | 3.94 | 5.93 | 10.84 | ULB may decide |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 2/B-3 (Opt-II) | Replace all the 100 W GLS (filament) lamps with 10W LED | 70,825 | 2.94 | 4.90 | 0.25 | 5.15 | 1.82 | 54.26 | Feasible |
| 16 | 6/B-3 (Opt-II) | Replace all the 70W HPSV lamps and fixtures with 30W LED | 18,212 | 0.76 | 7.56 | 0.38 | 7.94 | 20.01 | -10.96 | ULB may decide |
| **ECMs with Major Investment** | | | | | | | | | | |
| 17 | 3/B-3 (Opt-II) | Replace all the 250 W HPSV lamps and fixtures with 80W LED | 1,31,519 | 5.46 | 34.91 | 1.75 | 36.66 | 9.40 | 1.14 | ULB may decide |
| 18 | 4/B-3 (Opt-II) | Replace all the 4 feet T12 (40 W) lamps and fixtures with 16W LED | 4,80,748 | 19.95 | 70.90 | 3.54 | 74.44 | 4.32 | 19.12 | Feasible |
| 19 | 5/B-3 (Opt-II) | Replace all the 150W HPSV lamps and fixtures with 60W LED | 2,54,390 | 10.56 | 86.40 | 4.32 | 90.72 | 13.85 | -5.52 | ULB may decide |
| 20 | 10/B-3 (Opt-II) | Use of automation and voltage stabilizer with GSM based control system for street lighting | 1,72,950 | 7.18 | 26.70 | 4.52 | 31.22 | 10.05 | -0.09 | ULB may decide |

**NOTE – As per BEE's instructions, one more option (as Option-II) has been worked out exclusively for LED based street lighting.**

## 6. 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 is 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 (Option-I) as worked out are as under:

- Estimated Investment – Rs. 88.08 lakhs
- Annual Energy Saving Potential – 9,33,437 units
- Annual Financial Saving Potential – Rs. 40,39,764/-
- Net Pay Back Period – 6 years
- IRR for the Project –12.40 % considering ten years duration for the project
- Estimate of CERs generated – 933 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 Bhiwani 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 Bhiwani 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.

  As per BEE's instructions, one more ESP as been worked out as Option-II based on LED based street lighting exclusively.

  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. Water Treatment / Pumping
b. Sewage Treatment / Pumping
c. Municipal Buildings
d. 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 Bhiwani).
- 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 Ph 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, Bhiwani

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 luminaires, 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 (e.g. 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 carried out in 2009-10 in preparation of this DPR 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 1 :- Activity schedule for IGA of Bhiwani**

**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 Milan Goel, Electrical Engineer
4. Shri Brij Deo Prasad, Electrical Supervisor
5. Shri H.S.Negi, Electrical Supervisor

DPR is checked and finalized by : A.K. Jain, General Manager, BEE Certified Energy Manager

# B.1 Water Treatment and Pumping Systems

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

# B.2 Sewage Treatment and Pumping Systems

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

# B.3 Municipal Street Lighting System

## B.3.1 Overview & Analysis of Existing Systems

- Switching Points / Wards / Zones

  In all, there are 37 switching points having 59 feeders. Most of the feeders are single phase.

| Lamp Type | 250 W HPSV | 150 W HPSV | 400 W HPSV | 1X40W | 1X20W FTL | 70W HPSV | 100W GLS | 400W MH |
|---|---|---|---|---|---|---|---|---|
| No. of Fixtures | 179 | 576 | 154 | 3151 | 235 | 84 | 196 | 22 |

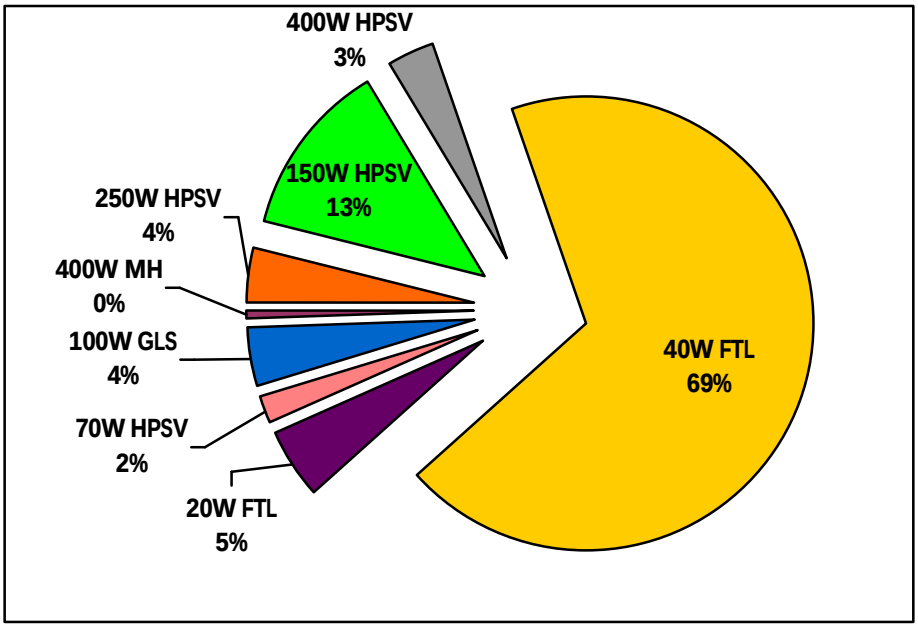


Figure -2 Percentage details of inventory

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

- Fixture category wise installed kW - The details of fixture category wise installed KW and pie chart are as under:

| Lamp Type | 250 W HPSV | 150 W HPSV | 400 W HPSV | 1X40W | 1X20W FTL | 70W HPSV | 100W GLS | 400W MH |
|---|---|---|---|---|---|---|---|---|
| Installed kW | 44.750 | 86.4 | 61.60 | 173.30 | 7.05 | 7.56 | 19.6 | 8.80 |

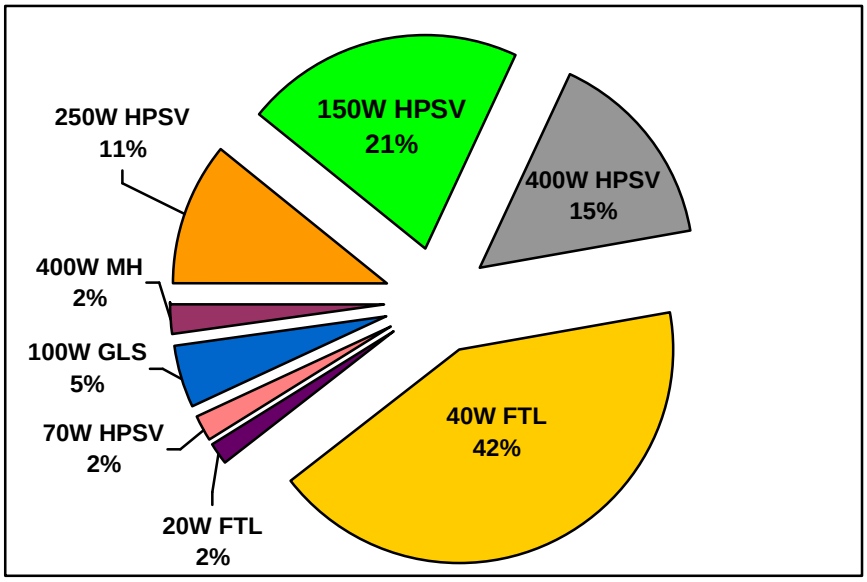


**Figure 3 – Percent Installed kW details**

- Maintenance and Replacement Trends

These data are not available with ULB since entire work of maintenance and replacement has been given on contract.

## 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 places 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 30 Mt to 50 Mt. But on an average, it is 40 Mt.

- Pole height is varying in the range of 6-12 mts. But most of the pole height is 9 mts. And overall avg. pole height is 9.06 mts. In case of high mast (10 Nos.) the pole height is 16-23 mts. But overall average is 17.1 mts.

## B.3.3 Baseline Period, Energy Consumption, and status of other Baseline Parameters

**Table no. 2 - Month-wise Electricity bills paid for the last five years in Rs.**

| S. No. | Month | 2004-05 | 2005-06 | 2006-07 | 2007-08 | 2008-09 |
|---|---|---|---|---|---|---|
| 1 | April | 236854 | 227051 | 234524 | 404106 | 441591 |
| 2 | May | 200290 | 200844 | 410119 | 369651 | 501252 |
| 3 | June | 203588 | 195319 | 234607 | 387713 | 1500436 |
| 4 | July | 284977 | 159288 | 227587 | 390787 | 52815 |
| 5 | August | 200269 | 166028 | 242122 | 391289 | 531998 |
| 6 | September | 204928 | 181372 | 254402 | 375401 | 620133 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 7 | October | 213321 | 216267 | 272154 | 583530 | 535345 |
| 8 | November | 243652 | 238160 | 313369 | 387305 | 525408 |
| 9 | December | 239675 | 219023 | 302143 | 395513 | 582552 |
| 10 | January | 265281 | 238983 | 336724 | 378155 | 598782 |
| 11 | February | 234918 | 249972 | 345948 | 393008 | 594224 |
| 12 | March | 277723 | 331764 | 379720 | 375473 | 436606 |
| | **TOTAL** | **2805476** | **2624071** | **3553419** | **4831931** | **6921142** |

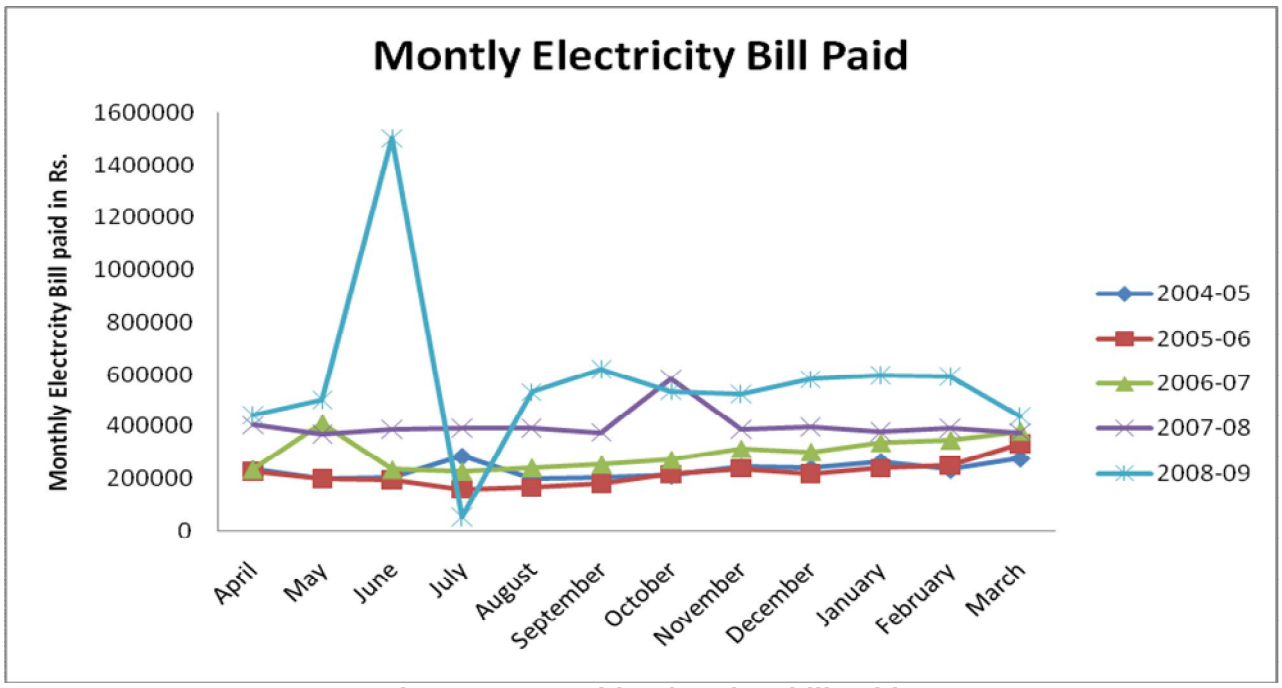


**Figure 4 – Monthly Electricty bill paid**

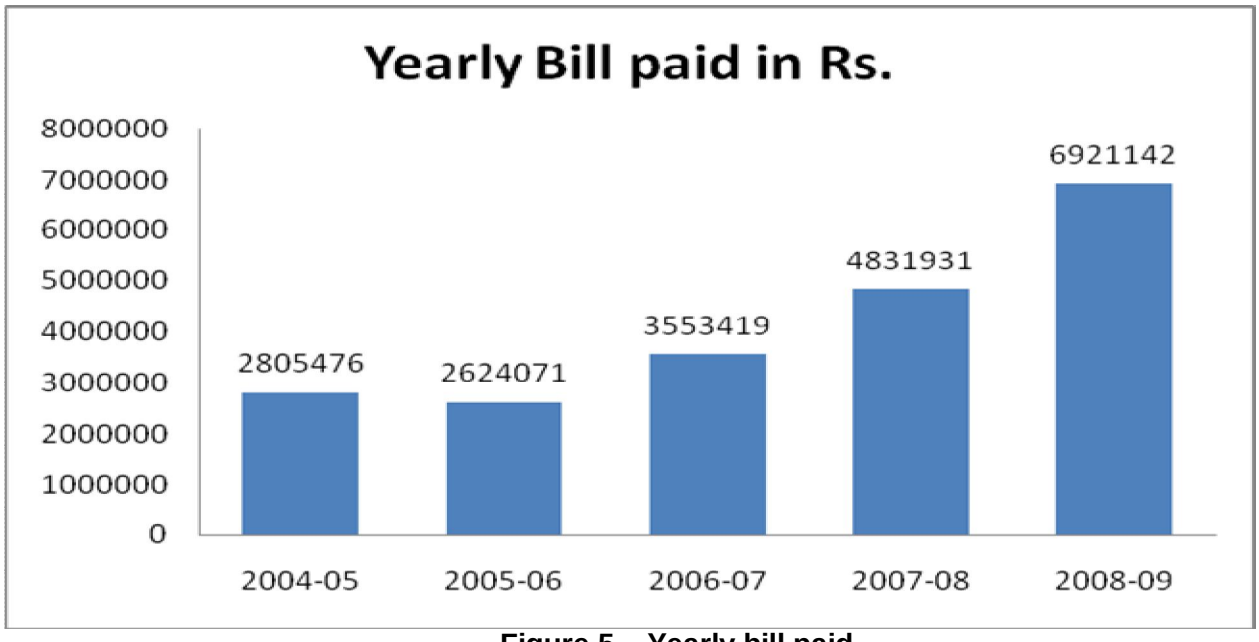


**Figure 5 – Yearly bill paid**

## B.3.4 Service Delivery Levels & Specific Energy Consumption

- 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.

- Notes on service delivery levels,

  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. There is not much data available from utility.

- Please refer to **Appendix B/1/2** for Switching Point wise Illumination Measurement
- Also refer to Appendix B/1/3 for Switching Point wise Service Delivery Levels & SEC
- Average lux level is around 13.52 and range is 1.31 – 93
- kWh / Annum / lux is quite variable i.e. 83 to 7892 and overall avg. is around 1312.17.
- kWh / Annum / kW $_{installed}$ figure is also quite variable i.e. 13.45 to 7020 but the overall average is coming around 1381.79.
- The road category and lux level is given in Appendix- B/3/3 of the DPR. The road wise classification and standards are given in mentioned table:

**TABLE - CLASSIFICATION OF LIGHTING INSTALLATION AND LEVELS OF ILLUMINATION**

| 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 |

## B.3.5 Energy Conservation Measures (ECMs) with cost benefit analysis

A total no. of 10 recommendations have been made in the subsequent pages on energy conservation in street lighting. A no. of ECMs are on replacement of conventional existing light fixtures with energy efficient lighting. While doing so, pole height and span will remain same.

It has also been recommended to replace SV lighting with some other energy efficient lighting. In doing so, there might be some drop in terms of lux levels but considering very poor Colour Rendering Index (CRI) for SV lighting, the illumination level will not fall below the existing illumination level with SV lamps.

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

| | | |
|---|---|---|
| **A. Title of Recommendation** | **:** | Replace all the 20 W FTL with 14 W T5 lamp and fixtures |
| **B. Description of Existing System and its operation** | **:** | At many places, 20 W FTL fixtures with choke consumption of 9 W are being used. The pole span is around 40mts. and pole height is around 9.0 mts. |
| **C. Description of Proposed system and its operation** | **:** | These should be replaced with T-5 fixture of 14 watt with electronic choke having 1 W consumption. |
| **D. Energy Saving Calculations** | | |
| Energy consumption of a normal 20 W FTL | **=** | 29 watts |
| Energy cons. of a 14 W T5 | **=** | 15 watts |
| Energy saving per single tube replacement | **=** | 14 watts |
| Approximate nos. of 20 W FTL fixtures | **=** | 235 |
| Average use per day | **=** | 11hrs |
| Average use in days/ year | **=** | 365 days of the year |
| **E. Cost Benefits** | | |
| Annual Energy Saving Potential | **=**<br>**=** | 235 X 14 X 11 X 365 /1000 units<br>13209 units |
| Annual Cost Savings @ Rs. 4.15/- per unit | **=** | Rs. 54,817/- |
| Investment | @ | Rs. 600/- per fitting |
| | **=** | Rs. 1,41,000/- for all 235 fittings |
| Repair & Maintenance Cost | @ | 5% of investment cost per annum |
| | **=** | Rs. 7,050/- per annum |
| Other Intermittent or recurring Cash Flow | @<br>**=** | 10% per annum on replacement<br>Rs. 14,100/- per annum |
| Net financial savings/annum | **=** | Rs. 33,667/- |
| Simple Payback period | **=** | 4.19 years |
| IRR | **=** | 20.03 % |
| NPV | **=** | Rs. 43,952/- |
| Details of Technology / Specifications | | Placed at page no. 78 |
| Equipment vendor | | Placed at page no. 77 |

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

| | | |
|---|---|---|
| **A. Title of Recommendation** | **:** | Replace all the 20 W FTL with 14 W 8W LED |
| **B. Description of Existing System and its operation** | **:** | At many places, 20 W FTL fixtures with choke consumption of 9 W are being used. The pole span is around 40mts. and pole height is around 9.0 mts. |
| **C. Description of Proposed system and its operation** | **:** | These should be replaced with 8W LED |
| **D. Energy Saving Calculations** | | |
| Energy consumption of a normal 20 W FTL | **=** | 29 watts |
| Energy cons. of a 8W LED | **=** | 8 watts |
| Energy saving per single tube replacement | **=** | 21 watts |
| Approximate nos. of 20 W FTL fixtures | **=** | 235 |
| Average use per day | **=** | 11hrs |
| Average use in days/ year | **=** | 365 days of the year |
| **E. Cost Benefits** | | |
| Annual Energy Saving Potential | **=**<br>**=** | 235 X 21 X 11 X 365 /1000 units<br>19,814 units |
| Annual Cost Savings @ Rs. 4.15/- per unit | **=** | Rs. 82,228/- |
| Investment | @ | Rs. 1600/- per fitting |
| | **=** | Rs. 3,76,000/- for all 235 fittings |
| Repair & Maintenance Cost | @ | 5% of investment cost per annum |
| | **=** | Rs. 18,800/- per annum |
| Other Intermittent or recurring Cash Flow | @<br>**=** | NIL |
| Net financial savings/annum | **=** | Rs. 63,428/- |
| Simple Payback period | **=** | 5.93 years |
| IRR | **=** | 10.84% |
| NPV | **=** | Rs. – 17,618/- |
| Details of Technology / Specifications | | Placed at page no. |
| Equipment vendor | | Placed at page no. |

**ECM No. 2/B-3 (Option-I):-**

| | | |
|---|---|---|
| **A. Title of Recommendation** | **:** | Replace all the 100 W GLS (filament) lamps with 23 W retrofit CFL lamp and fixtures |
| **B. Description of Existing System and its operation** | **:** | At many places, 100 W GLS fixtures are being used. The pole span is around 40 mts. and pole height is around 9.0 mts. |
| **C. Description of Proposed system and its operation** | **:** | These should be replaced with 23 W retrofit CFL |
| **D. Energy Saving Calculations** | | |
| Energy consumption of a normal 100 W GLS lamp | **=** | 100 watts |
| Energy consumption of a 23 W retrofit CFL | **=** | 23 watts |
| Energy saving per single lamp replacement | **=** | 77 watts |
| Approximate nos. of 100 W GLS lamps | **=** | 196 |
| Average use per day | **=** | 11 hrs |
| Average use in days/year | **=** | 365 days of the year |
| **E. Cost Benefits** | | |
| Annual Energy Saving Potential | **=**<br>**=** | 196 X 77 X 11 X 365 / 1000 units<br>60,594 units |
| Annual Cost Savings @ Rs. 4.15/- per unit | **=** | 2,51,466 Rs. |
| Investment | @ | Rs. 572/- per fitting |
| | **=** | Rs. 1,12,112/- for all 196 fittings |
| Repair & Maintenance Cost | @ | 5% of investment cost per annum |
| | **=** | Rs. 5,605.6/- per annum |
| Other Intermittent or recurring Cash Flow | @<br>**=** | 10% per annum on replacement<br>Rs.11,211/- per annum |
| Net financial savings/ annum | **=** | Rs.2,34,649.4/- |
| Simple Payback period | **=** | 0.48 years |
| IRR | **=** | 209.30% |
| NPV | **=** | Rs. 10,83,668/- |
| Details of Technology / Specifications | | Placed at page no. 78 |
| Equipment vendor | | Placed at page no. 77 |

**ECM No. 2/B-3 (Option-II):-**

| | | |
|---|---|---|
| **A. Title of Recommendation** | **:** | Replace all the 100 W GLS (filament) lamps with 10W LED |
| **B. Description of Existing System and its operation** | **:** | At many places, 100 W GLS fixtures are being used. The pole span is around 40 mts. and pole height is around 9.0 mts. |
| **C. Description of Proposed system and its operation** | **:** | These should be replaced with 10W LED |
| **D. Energy Saving Calculations** | | |
| Energy consumption of a normal 100 W GLS lamp | **=** | 100 watts |
| Energy consumption of a 10W LED | **=** | 10 watts |
| Energy saving per single lamp replacement | **=** | 90 watts |
| Approximate nos. of 100 W GLS lamps | **=** | 196 |
| Average use per day | **=** | 11 hrs |
| Average use in days/year | **=** | 365 days of the year |
| **E. Cost Benefits** | | |
| Annual Energy Saving Potential | **=**<br>**=** | 196 X 90 X 11 X 365 / 1000 units<br>70,825 units |
| Annual Cost Savings @ Rs. 4.15/- per unit | **=** | 2,93,924 Rs. |
| Investment | @ | Rs. 2,500/- per fitting |
| | **=** | Rs. 4,90,000/- for all 196 fittings |
| Repair & Maintenance Cost | @ | 5% of investment cost per annum |
| | **=** | Rs. 24,500/- per annum |
| Other Intermittent or recurring Cash Flow | **=** | NIL |
| Net financial savings/ annum | **=** | Rs.2,69,424/- |
| Simple Payback period | **=** | 1.82 years |
| IRR | **=** | 54.26% |
| NPV | **=** | Rs. 10,32,306/- |
| Details of Technology / Specifications | | Placed at page no. |
| Equipment vendor | | Placed at page no. |

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

| | | |
|---|---|---|
| **A. Title of Recommendation** | **:** | Replace all the 250 W HPSV lamps and fixtures with 4 X 24 W T5 lamp and fixtures |
| **B. Description of Existing System and its operation** | **:** | At many place, 250 W HPSV fixtures with choke consumption (33 W) are being used. The pole span is around 40mts. and pole height is around 9.0 mts. |
| **C. Description of Proposed system and its operation** | **:** | These should be replaced with 4 X 24 W fixture of 100 watt having electronic choke (4 W). |
| **D. Energy Saving Calculations** | | |
| Energy consumption of a normal 250 W HPSV | **=** | 283 watts |
| Energy consumption of a 4 X 24 W T5 | **=** | 100 watts |
| Energy saving per single Lamp replacement | **=** | 183 watts |
| Approximate nos. of 250 W HPSV fixtures | **=** | 179 |
| 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 | **=** | 179 X 183 X 11 X 365 / 1000 units |
| | **=** | 1,31,519.35 units |
| Annual Cost Savings @ Rs. 4.15/- per unit | **=** | Rs. 5,45,805/- |
| Investment | @ | Rs. 4,615/- per fitting |
| | **=** | Rs. 8,26,085/- for all 179 fittings |
| Repair & Maintenance Cost | @ | 5% of investment cost per annum |
| | **=** | Rs. 41,304.25/- per annum |
| Other Intermittent or recurring Cash Flow | @ | 10% per annum on replacement |
| | **=** | Rs. 82,608.50/- per annum |
| Net financial savings per annum | **=** | Rs. 4,21,892/- |
| Simple Payback period | **=** | 1.95 years |
| IRR | **=** | 50.20% |
| NPV | **=** | 13,90,804/- |
| Details of Technology / Specifications | | Placed at page no. 78 |
| Equipment vendor | | Placed at page no. 77 |

**ECM No. 3/B-3 (Option-II):-**

| | | |
|---|---|---|
| **A. Title of Recommendation** | **:** | Replace all the 250 W HPSV lamps and fixtures with 80W LED |
| **B. Description of Existing System and its operation** | **:** | At many place, 250 W HPSV fixtures with choke consumption (33 W) are being used. The pole span is around 40mts. and pole height is around 9.0 mts. |
| **C. Description of Proposed system and its operation** | **:** | These should be replaced with 80W LED |
| **D. Energy Saving Calculations** | | |
| Energy consumption of a normal 250 W HPSV | **=** | 283 watts |
| Energy consumption of a 80W LED | **=** | 100 watts |
| Energy saving per single Lamp replacement | **=** | 183 watts |
| Approximate nos. of 250 W HPSV fixtures | **=** | 179 |
| 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 | **=** | 179 X 183 X 11 X 365 / 1000 units |
| | **=** | 1,31,519 units |
| Annual Cost Savings @ Rs. 4.15/- per unit | **=** | Rs. 5,45,805/- |
| Investment | @ | Rs. 19,500/- per fitting |
| | **=** | Rs. 34,90,500/- for all 179 fittings |
| Repair & Maintenance Cost | @ | 5% of investment cost per annum |
| | **=** | Rs. 1,74,525/- per annum |
| Other Intermittent or recurring Cash Flow | @ | NIL |
| Net financial savings per annum | **=** | Rs. 3,71,280/- |
| Simple Payback period | **=** | 9.40 years |
| IRR | **=** | 1.14% |
| NPV | **=** | Rs. – 13,92,685/- |
| Details of Technology / Specifications | | Placed at page no. |
| Equipment vendor | | Placed at page no. |

**ECM No. 4/B-3 (Option-I):-**

| | | |
|---|---|---|
| **A. Title of Recommendation** | **:** | Replace all the 4 feet T12 (40 W) lamps and fixtures with 4 feet T5 (28 W) lamp and fixtures |
| **B. Description of Existing System and its operation** | **:** | At most of the places, 4 feet T12 with magnetic choke (14 W) are being used. The pole span is around 40 mts. and pole height is around 9.0 mts. |
| **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 (2 W). |
| **D. Energy Saving Calculations** | | |
| Energy consumption of a normal 4 feet T12 with magnetic choke | **=** | 54 watts |
| Energy consumption of a 4 feet T-5 having electronic choke | **=** | 30 watts |
| Energy saving per single tube replacement | **=** | 24 watts |
| Approximate nos. of 4 feet T12 fixtures | **=** | 3151 |
| 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 | **=** | 3151 X 24 X 11 X 365 / 1000 units |
| | **=** | 3,03,630.36 units |
| Annual Cost Savings @ Rs. 4.15/- per unit | **=** | Rs.12,60,066/- |
| Investment | @ | Rs. 1,100/- per fitting |
| | **=** | Rs. 34,66,100/- for all 3151 fittings |
| Repair & Maintenance Cost | @ | 5% per annum of investment cost |
| | **=** | Rs. 1,73,305/- per annum |
| Other Intermittent or recurring Cash Flow | @ | 10% per annum on replacement |
| | **=** | 3,46,610/- for all 3151 fittings |
| Net financial savings per annum | **=** | Rs. 7,40,150/- |
| Simple Payback period | **=** | 4.68 years |
| IRR | **=** | 16.86 % |
| NPV | **=** | Rs. 6,39,208/- |
| Details of Technology / Specifications | | Placed at page no. 78 |
| Equipment vendor | | Placed at page no. 77 |

**ECM No. 4/B-3 (Option-II):-**

| | | |
|---|---|---|
| **A. Title of Recommendation** | **:** | Replace all the 4 feet T12 (40 W) lamps and fixtures with 16W LED |
| **B. Description of Existing System and its operation** | **:** | At most of the places, 4 feet T12 with magnetic choke (14 W) are being used. The pole span is around 40 mts. and pole height is around 9.0 mts. |
| **C. Description of Proposed system and its operation** | **:** | These should be replaced with 16W LED |
| **D. Energy Saving Calculations** | | |
| Energy consumption of a normal 4 feet T12 with magnetic choke | **=** | 54 watts |
| Energy consumption of a 16W LED | **=** | 16 watts |
| Energy saving per single tube replacement | **=** | 38 watts |
| Approximate nos. of 4 feet T12 fixtures | **=** | 3151 |
| 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 | **=** | 3151 X 38 X 11 X 365 / 1000 units |
| | **=** | 4,80,748 units |
| Annual Cost Savings @ Rs. 4.15/- per unit | **=** | Rs.19,95,104/- |
| Investment | @ | Rs. 2,250/- per fitting |
| | **=** | Rs. 70,89,750/- for all 3151 fittings |
| Repair & Maintenance Cost | @ | 5% per annum of investment cost |
| | **=** | Rs. 3,54,488/- per annum |
| Other Intermittent or recurring Cash Flow | @ | NIL |
| Net financial savings per annum | **=** | Rs. 16,40,616/- |
| Simple Payback period | **=** | 4.32 years |
| IRR | **=** | 19.12% |
| NPV | **=** | Rs. 21,80,099/- |
| Details of Technology / Specifications | | Placed at page no. |
| Equipment vendor | | Placed at page no. |

## ECM No. 5/B3 (Option-I)

| | | |
|---|---|---|
| **A. Title of Recommendation** | **:** | Replace all the 150W HPSV lamps and fixtures with 4X14W T5 (58 W) lamp and fixtures |
| **B. Description of Existing System and its operation** | **:** | At many place 150 W HPSV fixtures with choke consumption (30 W) are being used. The pole height is mostly 9 m and span is varying between 30 to 50 m with average as 40 m. The lux level is varying between 5 to 10 lux using nine point method. |
| **C. Description of Proposed system and its operation** | **:** | These should be replaced with 4X14W T5 fixture of 58 watt having electronic choke (2 W). With the given pole height and span, the existing illumination level is expected to increase with this replacement considering the fact that SV lamps have a very low colour rendering index. |
| **D. Energy Saving Calculations** | | |
| Energy consumption of a normal 150W HPSV Lamp | **=** | 180 watts |
| Energy consumption of a 4x14W T5 having electronic choke | **=** | 58 watts |
| Energy saving per single Lamp replacement | **=** | 122 watts |
| Approximate nos. of 4x14W T5 fixtures | **=** | 576 |
| 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 | **=** | 576 X 122 X 11 X 365 / 1000 units |
| | **=** | 2,42,142 units |
| Annual Cost Savings @ Rs. 4.15/- per unit | **=** | Rs.11,70,890/- |
| Investment | @ | Rs. 4,000/- per fitting |
| | **=** | Rs. 23,04,000/- for all 576 fittings |
| Repair & Maintenance Cost | @ | 5% per annum of investment cost |
| | **=** | Rs. 1,15,200/- per annum |
| Other Intermittent or recurring Cash Flow | @ | 10% per annum on replacement |
| | **=** | 2,30,400/- for all 576 fittings |
| Net financial savings per annum | **=** | Rs. 8,25,289.63/- |

| | | |
|---|---|---|
| Simple Payback period | = | 2.79 years |
| IRR | = | 33.88 % |
| NPV | = | Rs. 21,06,313/- |
| Details of Technology / Specifications | | Placed at page no. 78 |
| Equipment vendor | | Placed at page no. 77 |

## ECM No. 5/B3 (Option-II)

| | | |
|---|---|---|
| **A. Title of Recommendation** | **:** | Replace all the 150W HPSV lamps and fixtures with 60W LED |
| **B. Description of Existing System and its operation** | **:** | At many place 150 W HPSV fixtures with choke consumption (30 W) are being used. The pole height is mostly 9 m and span is varying between 30 to 50 m with average as 40 m. |
| **C. Description of Proposed system and its operation** | **:** | These should be replaced with 60W LED |
| **D. Energy Saving Calculations** | | |
| Energy consumption of a normal 150W HPSV Lamp | **=** | 180 watts |
| Energy consumption of a 60W LED | **=** | 70 watts |
| Energy saving per single Lamp replacement | **=** | 110 watts |
| Approximate nos. of 150W lamps | **=** | 576 |
| 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 | **=** | 576 X 110 X 11 X 365 / 1000 units |
| | **=** | 2,54,390 units |
| Annual Cost Savings @ Rs. 4.15/- per unit | **=** | Rs.10,55,719/- |
| Investment | @ | Rs. 15,000/- per fitting |
| | **=** | Rs. 86,40,000/- for all 576 fittings |
| Repair & Maintenance Cost | @ | 5% per annum of investment cost |
| | **=** | Rs. 4,32,000/- per annum |
| Other Intermittent or recurring Cash Flow | @ | NIL |
| Net financial savings per annum | **=** | Rs. 6,23,719/- |
| Simple Payback period | **=** | 13.85 years |
| IRR | **=** | -5.52% |
| NPV | **=** | Rs. – 51,15,849/- |
| Details of Technology / Specifications | | Placed at page no. |
| Equipment vendor | | Placed at page no. |

## ECM No. 6/B3 (Option-I)

| | | |
|---|---|---|
| **A. Title of Recommendation** | **:** | Replace all the 70W HPSV lamps and fixtures with 1x36W CFL(36 W) lamp and fixtures |
| **B. Description of Existing System and its operation** | **:** | At many place 70 W HPSV fixtures with choke consumption (20 W) are being used. The pole span is around 40mts. and pole height is around 9.0 mts. |
| **C. Description of Proposed system and its operation** | **:** | These should be replaced with 1x36W CFL fixture of 38 watt having electronic choke (2 W). |
| **D. Energy Saving Calculations** | | |
| Energy consumption of a normal 70W HPSV Lamp | **=** | 90 watts |
| Energy consumption of a 1x36W CFL having electronic choke | **=** | 36 watts |
| Energy saving per single Lamp replacement | **=** | 54 watts |
| Approximate nos. of 1x36W CFL fixtures | **=** | 84 |
| 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 | **=** | 84 X 54 X 11 X 365 / 1000 units |
| | **=** | 18,212 units |
| Annual Cost Savings @ Rs. 4.15/- per unit | **=** | Rs.75,580/- |
| Investment | @ | Rs. 2,500/- per fitting |
| | **=** | Rs. 2,10,000/- for all 84 fittings |
| Repair & Maintenance Cost | @ | 5% per annum of investment cost |
| | **=** | Rs. 10,500/- per annum |
| Other Intermittent or recurring Cash Flow | @ | 10% per annum on replacement |
| | **=** | 21,000/- for all 84 fittings |
| Net financial savings per annum | **=** | Rs. 44,078/- |
| Simple Payback period | **=** | 4.76 years |
| IRR | **=** | 16.39% |
| NPV | **=** | Rs. 34,876/- |
| Details of Technology / Specifications | | Placed at page no. 78 |
| Equipment vendor | | Placed at page no. 77 |

## ECM No. 6/B3 (Option-II)

| | | |
|---|---|---|
| **A. Title of Recommendation** | **:** | Replace all the 70W HPSV lamps and fixtures with 30W LED |
| **B. Description of Existing System and its operation** | **:** | At many place 70 W HPSV fixtures with choke consumption (20 W) are being used. The pole span is around 40mts. and pole height is around 9.0 mts. |
| **C. Description of Proposed system and its operation** | **:** | These should be replaced with 30W LED |
| **D. Energy Saving Calculations** | | |
| Energy consumption of a normal 70W HPSV Lamp | **=** | 90 watts |
| Energy consumption of a 30W LED | **=** | 36 watts |
| Energy saving per single Lamp replacement | **=** | 54 watts |
| Approximate nos. of 70W HPSV lamps | **=** | 84 |
| 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 | **=** | 84 X 54 X 11 X 365 / 1000 units |
| | **=** | 18,212 units |
| Annual Cost Savings @ Rs. 4.15/- per unit | **=** | Rs.75,580/- |
| Investment | @ | Rs. 9,000/- per fitting |
| | **=** | Rs. 7,56,000/- for all 84 fittings |
| Repair & Maintenance Cost | @ | 5% per annum of investment cost |
| | **=** | Rs. 37,800/- per annum |
| Other Intermittent or recurring Cash Flow | @ | NIL |
| Net financial savings per annum | **=** | Rs. 37,780/- |
| Simple Payback period | **=** | 20.01 years |
| IRR | **=** | -10.96% |
| NPV | **=** | Rs. – 5,42,535/- |
| Details of Technology / Specifications | | Placed at page no. |
| Equipment vendor | | Placed at page no. |

**ECM No. 7/B3**

| | | |
|---|---|---|
| **A. Title of Recommendation** | **:** | Replace all the 400W HPSV lamps and fixtures with 320W MH lamp and fixtures |
| **B. Description of Existing System and its operation** | **:** | At many place 400W HPSV fixtures with choke consumption (40 W) are being used. The pole span is around 40mts. and pole height is around 9.0 mts. |
| **C. Description of Proposed system and its operation** | **:** | These should be replaced with 320W Metal Halide fixture of 350 watt having low power consumption choke (30W). |
| **D. Energy Saving Calculations** | | |
| Energy consumption of a normal 400W HPSV Lamp | **=** | 440watts |
| Energy consumption of a 250W MH having electronic choke | **=** | 350 watts |
| Energy saving per single Lamp replacement | **=** | 90 watts |
| Approximate nos. of 400W SV fixtures | **=** | 154 |
| 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 | **=** | 90 X 154 X 11 X 365 / 1000 units |
| | **=** | 55,648 units |
| Annual Cost Savings @ Rs. 4.15/- per unit | **=** | Rs. 2,30,939/- |
| Investment | @ | Rs. 2,500/- per fitting for replacing lamp, Choke and igniter as fixture will remain the same |
| | **=** | Rs. 3,85,000/- for all 154 fittings |
| Repair & Maintenance Cost | @ | 5% per annum of investment cost |
| | **=** | Rs. 19,250/- per annum |
| Other Intermittent or recurring Cash Flow | @ | 10% per annum on replacement |
| | **=** | 38,500/- for all 84 fittings |
| Net financial savings per annum | **=** | Rs. 1,73,189/- |
| Simple Payback period | **=** | 2.22 years |
| IRR | **=** | 43.79% |
| NPV | **=** | Rs. 5,29,961/- |
| Details of Technology / Spec. | **=** | Placed at page no. 78 |
| Equipment vendor | **=** | Placed at page no. 77 |

**ECM No. 8/B3**

| | | |
|---|---|---|
| **A. Title of Recommendation** | **:** | Replace all the 400W MH lamps and fixtures with 320W MH lamp and fixtures |
| **B. Description of Existing System and its operation** | **:** | At many place 400W MH fixtures with choke consumption (40 W) are being used. The pole span is around 40mts. and pole height is around 9.0 mts. |
| **C. Description of Proposed system and its operation** | **:** | These should be replaced with 320W Metal Halide fixture of 350watt having electronic choke. |
| **D. Energy Saving Calculations** | | |
| Energy consumption of a normal 400W MH Lamp | **=** | 440watts |
| Energy consumption of a 320W MH having electronic choke | **=** | 350 watts |
| Energy saving per single Lamp replacement | **=** | 90 watts |
| Approximate nos. of 320W MH fixtures | **=** | 22 |
| 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 | **=** | 90 X 22 X 11 X 365 / 1000 units |
| | **=** | 7,950 units |
| Annual Cost Savings @ Rs. 4.15/- per unit | **=** | Rs. 32,991/- |
| Investment | @ | Rs. 2,500/- per fitting for replacing lamp, Choke and igniter as fixture will remain the same |
| | **=** | Rs. 55,000/- for all 22 fittings |
| Repair & Maintenance Cost | @ | 5% per annum of investment cost |
| | **=** | Rs. 2,750/- per annum |
| Other Intermittent or recurring Cash Flow | @ | 10% per annum on replacement |
| | **=** | 5,500/- for all 22 fittings |
| Net financial savings per annum | **=** | Rs. 24,741/- |
| Simple Payback period | **=** | 2.22 years |
| IRR | **=** | 43.79% |
| NPV | **=** | Rs. 75,709/- |
| Details of Technology / Specif. | | Placed at page no. 78 |
| Equipment vendor | | Placed at page no. 77 |

**ECM No. 9/B-3**

| | | |
|---|---|---|
| **A. Title of Recommendation** | **:** | Improve designing of high masts |
| **B. Description of Existing System and its operation** | **:** | There are 10 high masts at Bhiwani but most of them are poorly designed in following ways:<br>(i) More directions have been covered than required<br>(ii) street light poles are there where high mast light is reaching<br>(iii) Angle of fittings is not okay<br>(iv) at few places there is more light than required |
| **C. Description of Proposed system and its operation** | **:** | Each high mast would be designed as per the need of every site. Accordingly, all the high masts will be modified to suit the actual needs. In case, lux level is more than required after making the angles of the fittings proper, then, wattage/number of lamps will be reduced to save energy. In case, street light poles are there where adequate high mast lighting is falling then the same would be removed. |
| **D. Energy Saving Calculations** | | |
| Total no. of high mast at Bhiwani | **=** | 10 |
| Average use per day | **=** | 11 hrs |
| Average use in days of the year | **=** | 365 days of the year |
| Total electricity consumption of 10 high masts having 156 lamps each of 400 W HPSV (to be replaced with 320 W MH as mentioned at ECM no.7/B-3) and 22 lamps with 400 W MH (to be replaced with 320 W MH as mentioned at ECM no. 8/B-3) | **=**<br>**=** | (156X350+22X350) X 11X365/1000 units<br>2,50,135 units |
| Estimated Saving due to modification of high masts | @ | 5 % of total electricity consumption |
| **E. Cost Benefits** | | |
| Annual Energy Saving Potential | **=** | 5 % of 2,50,135 units |
| | **=** | 12,507 units |
| Annual Cost Savings @Rs 4.15/- unit | **=** | Rs. 51,904/- |
| Investment on modification of high masts (one time only), | **=** | Rs. 10,000/- @ Rs. 1,000/- each high mast |

| | | |
|---|---|---|
| mostly labour only | | |
| 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. 51,904/- |
| Simple Payback period | = | 0.19 years |
| IRR | = | 519.04 % |
| NPV | = | Rs. 2,52,919/- |
| Details of Technology / Specifications | | Placed at page no. 78 |
| Equipment vendor | | Placed at page no. 77 |

**ECM No. 10/B-3 (Option-I)**

| | | |
|---|---|---|
| **A. Title of Recommendation** | **:** | Use of Automation 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 used for entire street lighting including high masts. Timer based controls will be used for auto switching for entire 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. In case. the high masts have independent switching and then, there will be one control panel for each high mast. |
| **D. Energy Saving Calculations** | | |
| Total no. of high mast at Bhiwani | = | 10 |
| Annual energy consumption for entire street light after implementing all the recommendations as mentioned in this DPR | =<br><br>=<br><br>= | (235X15+196X23+179X100+3151X30+576X58+84X36 +350X154+22X350)X11X365/1000 – 12,507 units<br>(3,525+4,508+17,900+94,530+33,408+3,024+ 53,900+7,700) X11X365/1000- 12,507 units<br>8,64,751 units |
| Estimated Saving due to installation of Automatic Control Panels | @<br>= | 10 % of annual energy consumption<br>86,475 units |
| **E. Cost Benefits** | | |
| Annual Energy Saving Potential | = | 86,475 units |
| Annual Cost Savings @Rs 4.15/- unit | = | Rs. 3,58,871/- |
| Total load on street light other than high masts after implementation all the recommendations mentioned in this DPR | = | 241 KVA at 0.85 power factor |
| Total no. of panels required for entire street lighting | = | 10 for high masts (one for each masts of 9 KVA capacity) and 30 for street lights @ 9 KVA per stabilizer (with little more for practical reasons) |
| Cost of each panel | = | Rs. 15,000/- for 3 KVA, Rs. 20,000 for 6 KVA and Rs. 25,000/- for 9 KVA Control panel |
| Total cost of all 40 panels | = | Rs. 40 X 25,000<br>Rs. 10,00,000/- |
| Cost for making proper distribution of load on street lighting and misc. | = | Rs. 1,50,000/- |

| | | |
|---|---|---|
| works (one time cost only) | | |
| Repair & Maintenance Cost | @<br>= | 5 % on cost of panels<br>Rs. 50,000 |
| Other Intermittent or recurring Cash Flow | @<br>= | 5% on cost of panels<br>Rs. 50,000/- |
| Net financial savings per annum | = | Rs. 2,58,871/- |
| Simple Payback period | = | 4.44 years |
| IRR | = | 18.33% |
| NPV | = | Rs. 2,79,178/- |
| Details of Technology / Specifications | | Placed at page no. 78 |
| Equipment vendor | | Placed at page no. 77 |

**ECM No. 10/B-3 (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** | | |
| Total no. of high mast at Bhiwani | = | 10 |
| Annual energy consumption for entire street light after implementing all the recommendations as mentioned in this DPR | =<br><br>=<br><br>= | (235X15+196X23+179X100+3151X30+576X58+84X36 +350X154+22X350)X11X365/1000 – 12,507 units<br>(3,525+4,508+17,900+94,530+33,408+3,024+ 53,900+7,700) X11X365/1000- 12,507 units<br>8,64,751 units |
| Estimated Saving due to installation of Automatic Control Panels | @<br>= | 20 % of annual energy consumption<br>1,72,950 units |
| **E. Cost Benefits** | | |
| Annual Energy Saving Potential | = | 1,72,950 units |
| Annual Cost Savings @Rs 4.15/- unit | = | Rs. 7,17,743/- |
| Total load on street light other than high masts after implementation all the recommendations mentioned in this DPR | = | 241 KVA at 0.85 power factor |
| Total no. of panels required for entire street lighting | = | 10 for high masts (one for each masts of 9 KVA capacity) and 30 for street lights @ 9 KVA per stabilizer (with little more for practical reasons) |
| Cost of each panel | = | Rs. 63,000/- for 9 KVA Control panel |
| Total cost of all 40 panels | = | Rs. 40 X 63,000<br>Rs. 25,20,000/- |
| 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 panels |

| | | |
|---|---|---|
| | = | Rs. 2,52,000/- |
| Annual GSM hiring charges for 40 control panels @Rs. 5,000/- point | = | Rs. 2,00,000/- |
| Net financial savings per annum | = | Rs. 2,65,743/- |
| Simple Payback period | = | 10.05 years |
| IRR | = | -0.09% |
| NPV | = | Rs. – 11,68,493/- |
| Details of Technology / Specifications | | Placed at page no. |
| Equipment vendor | | Placed at page no. |

## 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.
2. All Kundi connections should be replaced with proper switch gears.
3. Some of the street lights remain ON all the time. It is because the supply to street light has been taken from normal electricity supply conductor and not from street light conductor. This is gross wastage of energy and should be stopped immediately by making proper connection.

# B.4 Municipal Buildings

## B.4.1 Overview & Analysis of Existing Buildings

- There is only one building at Municipal Council, Bhiwani and it was studied.

  The details of this building are as under:

| S. No. | Building | Floors | Built up area (Sq.m.) | A/C Area (%) | Annual Working Hrs | Occupancy pattern | Type of elect. Connection |
|---|---|---|---|---|---|---|---|
| 1 | Municipal Office | 1 | 527.01 | 0 | 240x8=1920 | 8 | Single Ph LT |

**Table-3 Details of building at Bhiwani**

There is five days a week working at Municipal Council Bhiwani. There is one DG set having capacity of 3 KVA . No renewable energy is in use at any of the buildings at Municipal Council Bhiwani.

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

## B.4.2 Building- wise Inventory Survey of Energy Consuming Appliances

**Appendix B/4/2**

**Municipal Buildings – Inventory of Energy Consuming Appliances**

| **Building Name & Location / Address:** | **Municipal office, Near PWD Rest House** |
|---|---|

| Sr. No | Floor | Location / Room Description | Appliance Category | Appliance | Capacity | Wattage (W) | No. of Appliances | Working Hours | Installed Load (kW) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | Room, No.1 | Lighting | 1X36W | 50 | 50 | 2 | 8 | 0.1 |
| 2 | 0 | Room, No.1 | Other Appliances | Cooler | 130 | 130 | 1 | 8 | 0.13 |
| 3 | 0 | Room, No.1 | Fans | Ceiling Fan | 80 | 80 | 1 | 8 | 0.08 |
| 4 | 0 | Room, No.1 | Exhaust Fans | Exhaust | 50 | 50 | 1 | 8 | 0.05 |
| 5 | 0 | Govt. Auditor | Lighting | 1X36W | 50 | 50 | 2 | 8 | 0.1 |
| 6 | 0 | Govt. Auditor | Fans | Wall Fan | 50 | 50 | 1 | 8 | 0.05 |
| 7 | 0 | Room No.2 | Lighting | 1X36W | 50 | 50 | 2 | 8 | 0.1 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 8 | 0 | Room No.2 | Other Appliances | Cooler | 130 | 130 | 1 | 8 | 0.13 |
| 9 | 0 | Room No.2 | Fans | Ceiling Fan | 80 | 80 | 1 | 8 | 0.08 |
| 10 | 0 | Room No.3 | Lighting | 1X36W | 50 | 50 | 2 | 8 | 0.1 |
| 11 | 0 | Room No.3 | Fans | Ceiling Fan | 80 | 80 | 1 | 8 | 0.08 |
| 12 | 0 | Computer Room | Lighting | 15W CFL | 15 | 15 | 1 | 8 | 0.015 |
| 13 | 0 | Computer Room | Fans | Wall Fan | 50 | 50 | 1 | 8 | 0.05 |
| 14 | 0 | Computer Room | Other Appliances | Computer | 220 | 220 | 1 | 8 | 0.22 |
| 15 | 0 | Room No.3 Bathroom | Lighting | 100W GLS | 100 | 100 | 1 | 8 | 0.1 |
| 16 | 0 | Room No.4 | Lighting | 1X36W | 50 | 50 | 2 | 8 | 0.1 |
| 17 | 0 | Room No.4 | Fans | Ceiling Fan | 80 | 80 | 1 | 8 | 0.08 |
| 18 | 0 | Room No. 4 Bathroom | Lighting | 100W GLS | 100 | 100 | 1 | 8 | 0.1 |
| 19 | 0 | Room No.5 | Lighting | 1X36W | 50 | 50 | 1 | 8 | 0.05 |
| 20 | 0 | Room No.5 | Fans | Ceiling Fan | 80 | 80 | 1 | 8 | 0.08 |
| 21 | 0 | Room No.9 | Lighting | 1X36W | 50 | 50 | 2 | 8 | 0.1 |
| 22 | 0 | Room No.9 | Fans | Ceiling Fan | 80 | 80 | 3 | 8 | 0.24 |
| 23 | 0 | Room No.9 | Lighting | 100W GLS | 100 | 100 | 1 | 8 | 0.1 |
| 24 | 0 | Room No.10 | Lighting | 1X36W | 50 | 50 | 2 | 8 | 0.1 |
| 25 | 0 | Room No.6 | Lighting | 1X40 | 53 | 53 | 2 | 8 | 0.106 |
| 26 | 0 | Room No.6 | Lighting | 1X36W | 36 | 36 | 1 | 8 | 0.036 |
| 27 | 0 | Room No.6 | Fans | Ceiling Fan | 80 | 80 | 3 | 8 | 0.24 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 28 | 0 | Room No.6 | Lighting | 23W CFL | 23 | 23 | 1 | 8 | 0.023 |
| 29 | 0 | Room No.6 | Fans | Wall Fan | 50 | 50 | 1 | 8 | 0.05 |
| 30 | 0 | Room No.7 | Lighting | 1X36W | 50 | 50 | 2 | 8 | 0.1 |
| 31 | 0 | Room No.7 | Lighting | 20W CFL | 20 | 20 | 1 | 8 | 0.02 |
| 32 | 0 | Room No.7 | Other Appliances | Exhaust | 50 | 50 | 1 | 8 | 0.05 |
| 33 | 0 | Room No.7 | Fans | Wall Fan | 80 | 80 | 1 | 8 | 0.08 |
| 34 | 0 | Gallery | Lighting | 1X36W | 50 | 50 | 1 | 8 | 0.05 |
| 35 | 0 | Room No.8 | Lighting | 1X36W | 50 | 50 | 1 | 8 | 0.05 |
| 36 | 0 | Room No.8 | Fans | Ceiling Fan | 80 | 80 | 1 | 8 | 0.08 |
| 37 | 0 | Lobby | Lighting | 1X36W | 50 | 50 | 1 | 8 | 0.05 |
| 38 | 0 | Outdoor Lightning | Lighting | 2X36W | 100 | 100 | 2 | 8 | 0.2 |
| 39 | 0 | Outdoor Lightning | Lighting | 1X36W | 50 | 50 | 1 | 8 | 0.05 |
| 40 | 0 | Outdoor Lightning | Lighting | 250W Halogen | 280 | 280 | 1 | 8 | 0.28 |
| 41 | 0 | Other Appliances in Ground Floor | Other Appliances | Water Cooler | 130 | 130 | 1 | 8 | 0.13 |

**Table 4- Building-wise Inventory list**

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

There is not much data available for the past years and hence base line figures cannot be considered here.

- Overall Energy Efficiency Index of Municipal Building is 9.5 kWh /sq. mtr. /annum


**Figure no. 6 – Entrance to Municipal Council Bhiwani**


**Figure no.7 – Power Manager in use at Municipal Council Bhiwani**

## B.4.4 Energy Conservation Measures (ECMs) with cost benefit analysis

Our audit team has identified significant energy saving opportunities as illustrated in the table below.

**ECM No. 11/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 | =<br>= | 81 – 55 watts<br>26 watts |
| No. of ceilings fans at the only buildings with conventional chokes | = | 12 |
| E. Cost Benefits | | |
| Annual Energy Saving Potential | =<br>= | 12 X14X180X8/1000 units<br>242 Units |
| Annual Cost Savings @ Rs. 4.15/-unit | = | Rs. 1,004 /- |

| | | |
|---|---|---|
| Investment | = | Rs. 1,800 /- @ Rs. 150/- per electronic regulator for 12 regulators |
| Repair and Maintenance Costs | @<br>= | 10% of investment<br>Rs. 180/- |
| Other intermittent or recurring cash flows | | NIL |
| Net annual saving | = | Rs. 824/- |
| Simple Payback period | = | 2.18 years |
| IRR | = | 44.64% |
| NPV | = | Rs. 2,550/- |
| Details of Technology/ Specifications | | Placed at page no. 7 |
| Equipment vendors | | Placed at page no. 77 |

**ECM No. 12/B-4 :-**

| | | |
|---|---|---|
| A. Title of Recommendation | : | Replace all the 4 feet T8 (36 W) lamps and fixtures with 4 foot T5 (28 W) lamp and fixtures. |
| B. Description of Existing System and its operation | : | At many of the places, 4 feet T12 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 | | |
| Energy consumption of a normal 4 feet T12 with magnetic choke | = | 50 watts |
| Energy consumption of a 4 feet T-5 having electronic choke | = | 28 watts |
| Energy saving per single tube replacement | = | 22 watts |
| Approximate nos. of 4 feet T8 fixtures in use | = | 31 |
| Average use per day | = | 8 hrs |
| No. of working days in a year | = | 240 days |
| E. Cost Benefits | | |
| Annual Energy Saving Potential | =<br>= | 22X31X240X8/1000 units<br>1,309 units |
| Annual Cost Savings @Rs. 4.15/- per unit | = | Rs 5,432 /- |
| Investment | @ | Rs. 500/- per fitting |
| | = | Rs. 15,500 /- for 31 fittings |
| Repair and Maintenance Costs | @ | 5% of investment cost<br>Rs. 775/- |
| Other intermittent or recurring cash flows | @ | 5% of investment<br>Rs. 775/- |
| Net annual saving | = | Rs. 3,882/- |
| Simple Payback period | = | 3.99 years |
| IRR | = | 21.40% |
| NPV | = | Rs. 5,745/- |
| Details of Technology/ Specifications | | Placed at page no. 78 |
| Equipment vendors | | Placed at page no. 77 |

**ECM No. 13/B-4 :-**

| | | |
|---|---|---|
| A. Title of Recommendation | : | Installing changeover switch for DG set at right location |
| B. Description of Existing System and its operation | : | Presently, changeover switch for DG set has been placed before the electricity meter and therefore when DG set is run in case of power failure then also electricity meters runs and electricity bill increases. |
| C. Description of Proposed system and its operation | : | The Changeover switch should be located after electricity meter so that meter does not run when DG set is running. |
| D. Energy Saving Calculations | | |
| Diesel Consumption by DG set in the year 2008-09 | = | 582 litres |
| Energy produced by DG set in the year2008-09 @ 2.5 units/litre | = | 1,455 units |
| E. Cost Benefits | | |
| Annual Energy Saving Potential | = | NIL |
| Annual Cost Savings @Rs. 4.15/- per unit | = | Rs. 6,038/- |
| Investment | = | NIL, as ULB's own electricity can do it |
| Repair and Maintenance Costs | = | NIL |
| Other intermittent or recurring cash flows | = | NIL |
| Net annual saving | = | Rs. 6,038/- |
| Simple Payback period | = | Immediate |
| IRR | = | NA |
| NPV | = | NA |
| Details of Technology/ Specifications | | Not required |
| Equipment vendors | | Not required |

## 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. Three 100 W filament lamps are in use at the only building of MCB 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

In financing individual ECM as amount may not be substantial. Moreover, substantial amount will fetch better interest rates which is very important for low SPP and good IRR. 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 DPR capable of securing a loan. The term bankable DPR stands in the context of developing the business models to enable the financing of Mu DSM projects.

To sustainably realize MuDSM potential savings, it is essential to develop effective financing and business models to create benefits and incentives for all stakeholders

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.

It is necessary to bundle various ECMs for implementation due to following reasons:

(i) Individual ECMs do not have enough volumes to attract ESCOs.

(ii) Financial institutions might not be interested

(iii) Economical viability, ease of implementation, large no. of vendors involved and proper project management are other reasons for bundling the ECM together.

## C.2 Bundling of ECMs and Project Development

Since ECMs recommended for Street lighting and building segments are similar in nature and hence only one Energy Saving Project has been developed by covering all of them. This will make project implementation much easier and economical considering all the advantages as mentioned above.

## C.3 Project Risk Assessment and Mitigation

To develop an effective business model, it is necessary to identify the clear roles and responsibilities and the risks associated with the project development. This is useful to develop appropriate structure and plan for project financing and risk mitigation mechanism for ring fencing the risks of project investors.

Project risks can be categorized as project development risks, project competition risks, equipment / system operations and performance risks, financial; contractual, and political / regulatory risks as addressed below:

| Description of Risk Identified | Mitigation Strategies including Roles and Responsibilities |
|---|---|
| **Financial** | |
| **Interest Rates** Neither the ESCO nor the ULB has significant control over prevailing interest rates. Financing institutions (FIs) may have a partial control. During all phases of the project, interest rates will change with market conditions. Higher interest rates will increase project cost, financing / project term or both. The timing of the Contract / Delivery Order signing may impact the available interest rate and project cost. | The loan from FI can be taken on fixed rate of interest to avoid the risk. Since, such an interest rate will be considered by ESCO while finalizing the contract and hence, there is no risk involved. |
| **Energy Prices:** None of the stakeholders (ESCO / ULB / FI) has significant control over actual energy prices. For calculating savings the value of the saved energy may either be constant, change at a fixed inflation rate, or float with market conditions.<br>• If the value changes with the market, falling energy prices place the ESCO at risk of failing to meet cost savings guarantees.<br>• If energy prices rise, there is a small risk to the ULB that energy savings goals might not be met while the financial goals are.<br>• If the value of saved energy is fixed (either constant or escalated), the ULB risks making payments in excess of actual energy cost savings. | The change in energy prices can affect the financial savings. It can be addressed by either freezing the existing prices or by applying a suitable formula in all saving calculations. This should be clearly spelled out while finalizing the contract. |
| **Construction Costs:** the ESCO is responsible for determining construction costs and defining a budget. In a fixed – price design / build contract, the ULB assumes little responsibility for cost overruns. However, if construction estimates are significantly greater than originally assumed, the ESCO may find that the project or measure is no longer viable and drop it before Contract award. In any design / build contract, the ULB loses some design control. | The construction costs include material and labour involved for the project. A steep rise in these costs may make the project unviable. Normally, ESCO keeps some margins for such an increase but in case any increase beyond the expected levels, the ESCO has to bear this burden.<br>This is not a major risk since major amount of expenditure is incurred in the initial stages and will take place immediately after award of contract. |
| **M & V costs:** The ULB / FI assume the financial responsibility for M & V costs directly or through the ESCO. If the ULB wishes to reduce M & V cost, it may do so by accepting less rigorous M & V activities with more uncertainty in the savings estimates. | Review, Finalization, and Approval processes for the M&V Plan should consider the level of rigour in M&V vis-à-vis the impact on M&V costs. These costs depend upon the M&V activities which need to be specified as per context and some fixed cost can be considered on this account. |
| **Non-Energy Cost Savings:** The ULB and the ESCO may agree that the project will include | Recurring O&M must be based on actual |

| | |
|---|---|
| savings from recurring and / or one-time costs.<br>• This may include one time savings from avoided expenditures for projects that were appropriated but will no longer be necessary.<br>• Including one-time cost savings before the money has been appropriated entails some risk to the ULB.<br>• Recurring savings generally result from reduced O&M expenses or reduced water consumption. | spending reductions. |
| **Delays:** Any of the stakeholders (ULB / ESCO / FI) can cause delays.<br>• Failure to implement a viable project in a timely manner costs the ULB/FI in the form of lost savings and can add cost to the project (eg. Construction interest, re-mobilization). | This can be addressed by inserting suitable clauses on compensation for the delay and also on escalation charges in the performance contract. |
| **Major Changes in facility:** The ULB controls major changes in facility use, including closure. FI will have significant role in changes related to project funding | 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. |
| Payment risks to ESCO | ESCROW account will work as a payment security mechanism |
| **Operational** | |
| **Operating Hours:** The ULB generally has control over operating hours. Increases and decreases in operating hours can show up as increases or decreases in "savings" depending on the M&V method (e.g. Operating hours multiplied by improved efficiency of equipment v/s. whole-building / utility bill analysis). | As a change in operating hours can affect the savings scenario and therefore, consideration of operating hours should be avoided. This should be spelt out in the MV plan and contract documents |
| **Loads:** Equipment loads can change over time. The ULB generally has control over hours of operation, conditioned floor area, intensity of use (e.g. Changes in occupancy or level of automation).<br>• Changes in load can show up as increases or decreases in "savings" depending on the M & V method. | Any avoidable increase in load by ULB should be suitably compensated while calculating savings and this will become clear while implementing M&V plan. Otherwise also, in Option A its impact is very less. |
| Water table declines, rainfall, weather; all affecting water quantity pumped and head and hence energy consumption | |
| **Weather:** A number of energy efficiency measures are affected by weather. None or the stakeholders have control over the weather.<br>• Changes in weather can increase or decrease "savings" depending on the M&V method (eg. Equipment run hours multiplied by efficiency improvement vs. whole building / utility bill | This clause must be incorporated in contract so that this issue can be addressed. |

| | |
|---|---|
| analysis).<br>• If weather is "normalized", actual savings could be less than payments for a given year, but will average out over the long run. | |
| **User Participation:** Many energy conservation measures require user participation to generate savings (e.g. Control, settings).<br>• The savings can be variable and the ESCO may be unwilling to invest in these measures. | If performance is stipulated, document and review assumptions carefully and consider M&V to confirm the capacity to save (eg. Confirm that the controls are functioning properly) As no participation of users is involved in these ESPs, this factor has no effect. |
| Resistance from General Public / User groups within ULBs – a risk for all stakeholders since such resistance can defeat the | Create awareness about the MuDSM program, e.g. educate the general public regarding benefits of the energy efficient lighting project, like improved service levels, better Repair and Maintainance services etc.<br>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 associated with Equipment Performance:** Generally the ESCO has control over the selection of equipment and is responsible for its proper installation, commissioning, and performance. Generally the ESCO has responsibility to demonstrate that the new improvements meet expected performance levels including specified equipment capacity, standards of service, and efficiency. | Penalty clause will be included in case efficiency levels are below the minimum ones 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. |
| **Operations:** Responsibility for operations may rest with the ESCO for the entire performance contract period or a part thereof. Operations can impact performance. | Responsibility for operations, the implications of equipment control, how changes in operating procedures will be handled, and how proper operations will be assured will be clearly defined in the performance contract. |
| **Preventive Maintenance:** Responsibility for maintenance may rest with ESCO or ULB, and it can impact performance. | 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. |
| **Equipment Repair and Replacement:** Responsibility for repair and replacement of ESCO-installed equipment is negotiable; however it is | ULB will not get free repair and maintenance service by ESCO for the remaining period Such risks are generally borne by the ULB. |

| | |
|---|---|
| often tied to project performance. | Suitable clauses need to be put in the performance contract to cover all kinds of situations. Insurance covers can address this risk. |
| **Theft / Replacement of Energy Efficient retrofits** | 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. |
| **Project development risks** | 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. |
| **Project completion risks**<br>▪ On time<br>▪ According to specifications | Contractor or ESCO selected for the project will have capability to implement the project Turnkey contract with normal commercial protections will be used. Contract will include provisions with respect to installation schedule, complete equipment specifications, and commissioning and acceptance testing procedures The contract clauses for damages for delay/failure can be invoked to address these risks. |
| **Measurement & Verification risks** | Third Party monitoring and verification may be considered The M&V plan containing roles/responsibilities of the ULB and the ESCO should be incorporated in the contract. |
| **Contractual risks (parties fail to honor contractual commitments)** | Contract to be provided with appropriate commercial/ contractual provisions |
| **Regulatory risks** | Brain storming session to be organized with regulator and other stakeholders to identify key concerns and provide the information needed for an affirmative decision |
| **Political risks** | Project inaugurations through Local influential Politicians.<br>Senior cadre UDD bureaucrats to be involved in passing the message of MuDSM and energy efficiency to the ULB executives, and Energy Cell |
| **Bankruptcy of ESCO** | Since the payment to ESCO will be made from the savings and hence there should not be any problem even if ESCO goes bankrupt. Similarly, there is no problem for FI also because it does not give loan for 100 % amount and ESCO has to always give some margin. |
| **Refusal to pay by ESCO to FIs** | A suitable clause can be made in the agreement that a fixed amount/share will |

| | |
|---|---|
| | directly be sent to FI without routing the same through ESCO. Thus, the risk will not be there. |
| **Non-Payment / Delayed Payment by ULBs** | Since the saving amount will be realized by ULB in the form of reduced electricity bills and hence, it is very important that ULB pays to FI & ESCO in time. This becomes very important considering the relatively poor financial position of most of the ULBs. To mitigate the risk, State Govt. should give the guarantee through its Urban Development Department (UDD). |

**NOTE – Since it is of utmost concern for BEE that such contracts are successfully implemented and completed and thus, BEE can be made arbitrator to resolve all the disputes which can arise from to time. Being third party and without its direct involvement in the profit sharing, there is no doubt that BEE can take this responsibility very effectively. BEE should chair the regular meetings which will take place periodically to monitor and control of entire operations.**

## C.4 Development of Business Model

These are few standard procedures for implementing of ESPs.

a) Fixed fees based turnkey consultancy contracts :- 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.

b) Saving based performance contracts: - In case of savings based performance contracts there are two sub models.

**1. 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.

**2. 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.

- In this project following are stakeholders

I. BEE
II. ESCO
III. Municipality
IV. Financial Institution
V. Equipment Vendor

❖ Role & responsibility of different stakeholders

- **BEE**
  - The main and most important stakeholders in the entire chain, who will monitor and take active part in the process, It also provides a platform where all other stakeholders can resolve there issue related to implementation of projects.

- **ESCO**
  - It is an implementing partner, who will do the implementation part with the help of other stakeholders.
  - It will get finance from financial institution, equipment from equipment vendors and do the implementation part with the consent of municipality and BEE.
  - Loan repayment will be done either through ESCO or directly from municipality.

- **Municipality**
  - The ultimate beneficiary of entire chain who has to invest their willingness and provide playground for all players.
  - All implementation work will be carried out at this place and it will be beneficiary of implementation work.
  - Municipality will have to repay cost of implementation from the saving they achieve after implementation.

- **Financial Institution**
  - It has main role in the channel. Without its help any project will not see the light of day. Hence it becomes root of all projects.
  - It will finance the project through ESCO and get repayment of loan either directly from Municipality or through ESCO depending upon mutually agreed contract.
  - It can also finance directly to equipment vendor and get their repayment from municipality or ESCO.

- **Equipment vendors**

  They are the supplier of equipments and get payment either directly from financial institution or from ESCO.

## 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 project proposal is mentioned at Table no.

## C.6 Monetary Savings / Benefits

Monetary benefits to ULBs. Include the following

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 street lights retrofitting is also an additional benefit which is very difficult to quantify.

## C.7 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:-
    - o The IRRs for various ECMs have been worked out for an estimated minimum life cycle of 10 years.
    - o The IRR for the project has also been worked out for a period of 10 years.
    - o The costs include all contingent costs.
    - o The annual savings are based on current energy prices.
    - o 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.
    - o Discount rate of 12% has been assumed for determining NPV.

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

## Option-I:

| Assumptions | Unit | Value |
|---|---|---|
| **Tariff Cost** | | |
| Tariff | Rs/kWh | 4.15 |
| 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 no. 5 – Assumptions for working out IRR for Option-I**

| Manpower, office and third party M&V Expenditure | No | Salary (Rs/month) | Annual Salary |
|---|---|---|---|
| Project Engineer | 1 | 15,000 | 1,80,000 |
| Repair & Maintenance Technician | 2 | 7,500 | 1,80,000 |
| Office hiring | LS | 7,500 | 90,000 |
| Telephones, Mobiles, Stationary, Printing etc | LS | 5,000 | 60,000 |
| Local conveyance | LS | 6,000 | 72,000 |
| Third Party M&V Expenditure | LS | LS | 60,000 |
| **Total** | | | **6,42,000** |

**Table no. 6 – Estimated expenditure for working out IRR for Option-I**

| ECM No. | Description | Annual Energy Potential in Units | Annual financial saving in Rs. | Investment cost in Rs. | Annual R&M cost in Rs. | Annual recuring cost in Rs. | Net Saving in Rs. | Simply Payback period in years | NPV in Rs. | IRR (%) |
|---|---|---|---|---|---|---|---|---|---|---|
| ECM 1/B3 | Replacement of 20 W FTL with 14 W T5 lamp and fixtures | 13,209 | 54,817 | 1,41,000 | 7,050 | 14,100 | 33,667 | 4.19 | 43,952 | 20.03 |
| ECM 2/B3 | Replacement of 100 W GLS (filament) lamps with 23 W retrofit CFL lamp and fixtures | 60,594 | 2,51,466 | 1,12,112 | 5,606 | 11,211 | 2,34,649 | 0.48 | 10,83,668 | 209.30 |
| ECM 3/B3 | Replacement of 250 W HPSV lamps and fixtures with 4 X 24 W T5 lamp and fixtures | 1,31,519 | 5,45,805 | 8,26,085 | 41,304 | 82,609 | 4,21,892 | 1.95 | 13,90,804 | 50.20 |
| ECM 4/B3 | Replacement of 4 feet T12 (40 W) lamps and fixtures with 4 foot T5 (28 W) lamp and fixtures | 3,03,630 | 12,60,065 | 34,66,100 | 1,73,305 | 3,46,610 | 7,40,150 | 4.68 | 6,39,208 | 16.86 |
| ECM 5/B3 | Replacement of 150W HPSV lamps and fixtures with 4X14w T5 (58 W) lamp and fixtures | 2,42,142 | 11,70,890 | 23,04,000 | 1,15,200 | 2,30,400 | 8,25,290 | 2.79 | 21,06,313 | 33.88 |
| ECM 6/B3 | Replacement of 70W HPSV lamps and fixtures with 1x36W CFL(36 W) lamp and fixtures | 18,212 | 75,580 | 2,10,000 | 10,500 | 21,000 | 44,080 | 4.76 | 34,876 | 16.39 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ECM 7/B3 | Replacement of 400W HPSV lamps and fixtures with 320W MH(350 W) lamp and fixtures | 55,648 | 2,30,939 | 3,85,000 | 19,250 | 38,500 | 1,73,189 | 2.22 | 5,29,961 | 43.79 |
| ECM 8/B3 | Replacement of 400W MH lamps and fixtures with 320W MH (350 W) lamp and fixtures | 7,950 | 32,991 | 55,000 | 2,750 | 5,500 | 24,741 | 2.22 | 75,709 | 43.79 |
| ECM 9/B3 | Improve designing of high masts | 12,507 | 51,904 | 10,000 | 0 | 0 | 51,904 | 0.19 | 2,52,919 | 519.04 |
| ECM 10/B3 | Use of Automation for street lighting | 86,475 | 3,58,871 | 11,50,000 | 50,000 | 50,000 | 2,58,871 | 4.44 | 2,79,178 | 18.33 |
| ECM 11/B4 | Replacing resistance type conventional fan regulators with electronic regulators | 242 | 1,004 | 1,800 | 180 | 0 | 824 | 2.18 | 2,550 | 44.64 |
| ECM 12/B4 | Replacement of 4 feet T8 (36 W) lamps and fixtures with 4 foot T5 (28 W) lamp and fixtures | 1,309 | 5,432 | 15,500 | 775 | 775 | 3,882 | 3.99 | 5,745 | 21.40 |
| | **TOTAL** | **9,33,437** | **40,39,764** | **86,76,597** | **4,25,920** | **8,00,705** | **28,13,139** | **3.08** | **8,23,374** | **14.46** |

**Table 7 - Details of ECM in Energy Saving Project (Option-I) for Buildings & street Light**

The input values considered for the ESP are as under:

| Parameters | Unit | Value |
|---|---|---|
| No. of Equipment / Retrofit | No | 86,76,597 |
| No. of M&V Equipment | No | 1,31,473 |
| | | |
| | | |
| **Parameters** | **Unit** | **Value** |
| Bare cost of Equipment/Retrofit | Rs | 65,99,522 |
| Excise Duty | Rs | 3,95,971 |
| Vat | Rs | 8,74,437 |
| Transportation Cost | Rs | 3,93,496 |
| Erection Cost | Rs | 4,13,171 |
| **Total Capital Cost** | **Rs** | **86,76,597** |
| | | |
| **Parameters** | **Unit** | **Value** |
| Bare cost of M&V Equipment | Rs | 1,00,000 |
| Excise Duty | Rs | 6,000 |
| Vat | Rs | 13,250 |
| Transportation Cost | Rs | 5,963 |
| Erection Cost | Rs | 6,261 |
| **Total Capital Cost** | **Rs** | **1,31,473** |
| | | |
| **Parameters** | **Unit** | **Value** |
| Annual kWh Saving | kWh/annum | **9,33,437** |

**Table 8 – Input values considered for ESP (Option-I)**

# Table no. 9 - IRR Calculation for ESP (Option-I) under ESCO Mode

| | |
|---|---|
| No. of years for debt | 5 |
| Total Investment Required (Lac Rs) | 88.08 |
| Total Equity (Lac Rs) | 35.23 |
| Total Debt (Lac Rs) | 52.85 |

| Particulars | Years | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Capital Cost of Pumps (Lac Rs) | (86.77) | - | - | - | - | - | - | - | - | - | - |
| Capital Cost of M&V Equipments (Lac Rs) | (1.31) | - | - | - | - | - | - | - | - | - | - |
| | | | | | | | | | | | |
| Tariff, Rs/ Unit | 4.15 | 4.35 | 4.55 | 4.75 | 4.95 | 5.15 | 5.35 | 5.55 | 5.75 | 5.95 | 6.15 |
| Energy Saved (Lac kWh/annum) | - | 9.33 | 9.33 | 9.33 | 9.33 | 9.33 | 9.33 | 9.33 | 9.33 | 9.33 | 9.33 |
| Total Saving (Lac Rs) | - | 40.60 | 42.47 | 44.34 | 46.21 | 48.07 | 49.94 | 51.81 | 53.67 | 55.54 | 57.41 |
| Revenue (Share of ESCO in savings), in Lac Rs. | - | 32.48 | 33.98 | 35.47 | 36.96 | 38.46 | 39.95 | 41.44 | 42.94 | 44.43 | 45.93 |
| | | | | | | | | | | | |
| Manpower Cost (Lac Rs) | - | 6.42 | 6.74 | 7.08 | 7.43 | 7.80 | 8.19 | 8.60 | 9.03 | 9.49 | 9.96 |
| Repair & Maintenance Cost (Lac Rs) | - | | 8.81 | 9.07 | 9.34 | 9.62 | 9.91 | 10.21 | 10.52 | 10.83 | 11.16 |
| Annual Calibration Cost of M&V Equipments (Lac Rs) | - | | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| Total Expenditure (Lac Rs) | - | (6.42) | (15.58) | (16.18) | (16.80) | (17.46) | (18.14) | (18.84) | (19.58) | (20.35) | (21.15) |
| | | | | | | | | | | | |
| Interest on Debt (Lac Rs) | - | (6.34) | (5.55) | (3.96) | (2.38) | (0.79) | - | - | - | - | - |
| | | | | | | | | | | | |
| Earning Before Tax (Lac Rs) | - | 19.72 | 12.85 | 15.33 | 17.78 | 20.21 | 21.82 | 22.60 | 23.36 | 24.08 | 24.78 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Depreciation Cost (Lac Rs) | - | 26.42 | 18.50 | 12.95 | 9.06 | 6.34 | 4.44 | 3.11 | 2.18 | 1.52 | 1.07 |
| Taxable Earning (Lac Rs) | - | (6.70) | (5.64) | 2.38 | 8.72 | 13.86 | 17.37 | 19.49 | 21.18 | 22.56 | 23.71 |
| Tax (Lac Rs) | - | - | - | (0.81) | (2.96) | (4.71) | (5.91) | (6.63) | (7.20) | (7.67) | (8.06) |
| Net Cash Flow (Lac Rs) | (88.08) | 19.72 | 12.85 | 14.52 | 14.82 | 15.50 | 15.91 | 15.98 | 16.16 | 16.42 | 16.72 |
| Cumulative Cash Flow (Lac Rs) | (88.08) | (68.36) | (55.51) | (40.99) | (26.17) | (10.67) | 5.24 | 21.21 | 37.37 | 53.79 | 70.51 |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

| | |
|---|---|
| **Project IRR** | **12.40%** |
| **Payback in Years** | **6** |

| **Debt Calculations** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Particulars** | **Years** | | | | | | | | | |
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| Debt (Lac Rs) | 52.85 | 52.85 | 39.64 | 26.42 | 13.21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Repayments (Lac Rs) | 0.00 | 13.21 | 13.21 | 13.21 | 13.21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Closing Debt (Lac Rs) | 52.85 | 39.64 | 26.42 | 13.21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Average Debt (Lac Rs) | 52.85 | 46.24 | 33.03 | 19.82 | 6.61 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Interest Cost (Lac Rs) | 6.34 | 5.55 | 3.96 | 2.38 | 0.79 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

# Table no. 10 - IRR Calculation for ESP (Option-I) under ULB Mode

| | |
|---|---|
| No. of years for debt | 5 |
| Total Investment Required (Lac Rs) | 8.08 |
| Total Equity (Lac Rs) | 5.23 |
| Total Debt (Lac Rs) | 2.85 |

| Particulars | Years | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Capital Cost of Pumps (Lac Rs) | (86.77) | | | | | | | | | | |
| Capital Cost of M&V Equipments (Lac Rs) | (1.31) | | | | | | | | | | |
| | | | | | | | | | | | |
| Tariff, Rs/ Unit | 4.15 | 4.35 | 4.55 | 4.75 | 4.95 | 5.15 | 5.35 | 5.55 | 5.75 | 5.95 | 6.15 |
| Energy Saved (Lac kWh/annum) | | 9.33 | 9.33 | 9.33 | 9.33 | 9.33 | 9.33 | 9.33 | 9.33 | 9.33 | 9.33 |
| Total Saving (Lac Rs) | | 40.60 | 42.47 | 44.34 | 46.21 | 48.07 | 49.94 | 51.81 | 53.67 | 55.54 | 57.41 |
| Revenue (Share of ESCO in savings), in Lac Rs. | | 40.60 | 42.47 | 44.34 | 46.21 | 48.07 | 49.94 | 51.81 | 53.67 | 55.54 | 57.41 |
| | | | | | | | | | | | |
| Manpower Cost (Lac Rs) | | 6.42 | 6.74 | 7.08 | 7.43 | 7.80 | 8.19 | 8.60 | 9.03 | 9.49 | 9.96 |
| Repair & Maintenance Cost (Lac Rs) | | | 8.81 | 9.07 | 9.34 | 9.62 | 9.91 | 10.21 | 10.52 | 10.83 | 11.16 |
| Annual Calibration Cost of M&V Equipments (Lac Rs) | | | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| Total Expenditure (Lac Rs) | | (6.42) | (15.58) | (16.18) | (16.80) | (17.46) | (18.14) | (18.84) | (19.58) | (20.35) | (21.15) |
| | | | | | | | | | | | |
| Interest on Debt (Lac Rs) | | (6.34) | (5.55) | (3.96) | (2.38) | (0.79) | - | - | - | - | - |
| | | | | | | | | | | | |
| Earnings Before Tax (Lac Rs) | | 27.84 | 21.35 | 24.20 | 27.02 | 29.82 | 31.80 | 32.96 | 34.09 | 35.19 | 36.26 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Depreciation Cost (Lac Rs) | | 26.42 | 18.50 | 12.95 | 9.06 | 6.34 | 4.44 | 3.11 | 2.18 | 1.52 | 1.07 |
| Taxable Earning (Lac Rs) | | 1.42 | 2.85 | 11.25 | 17.96 | 23.48 | 27.36 | 29.85 | 31.92 | 33.67 | 35.19 |
| Tax (Lac Rs) | | - | - | - | - | - | - | - | - | - | - |
| Net Cash Flow (Lac Rs) | (88.08) | 27.84 | 21.35 | 24.20 | 27.02 | 29.82 | 31.80 | 32.96 | 34.09 | 35.19 | 36.26 |
| Cumulative Cash Flow (Lac Rs) | (88.08) | (60.24) | (38.89) | (14.69) | 12.33 | 42.15 | 73.96 | 106.92 | 141.01 | 176.20 | 212.46 |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

| | |
|---|---|
| **Project IRR** | **28.62%** |
| **Payback in Years** | **4** |

| **Debt Calculations** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Particulars** | **Years** | | | | | | | | | |
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| Debt (Lac Rs) | 52.85 | 52.85 | 39.64 | 26.42 | 13.21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Repayments (Lac Rs) | 0.00 | 13.21 | 13.21 | 13.21 | 13.21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Closing Debt (Lac Rs) | 52.85 | 39.64 | 26.42 | 13.21 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Average Debt (Lac Rs) | 52.85 | 46.24 | 33.03 | 19.82 | 6.61 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Interest Cost (Lac Rs) | 6.34 | 5.55 | 3.96 | 2.38 | 0.79 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

# Option-II

| Assumptions | Unit | Value |
|---|---|---|
| **Tariff Cost** | | |
| Tariff | Rs/kWh | 4.15 |
| 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 | % | 15% |
| 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. 11 – Assumptions for working out IRR for Option-II**

| Manpower, office and third party M&V Expenditure | No | Salary (Rs/month) | Annual Salary |
|---|---|---|---|
| Project Supervisor | 1 | 10,000 | 1,20,000 |
| Repair & Maintenance Technician | 2 | 6,000 | 1,44,000 |
| Office hiring | LS | 7,500 | 90,000 |
| Telephones, Mobiles, Stationary, Printing etc | LS | 4,000 | 48,000 |
| Local conveyance | LS | 4,000 | 48,000 |
| Third Party M&V Expenditure | LS | LS | 60,000 |
| **Total** | | | **5,10,000** |

**Table no. 12 – Estimated expenditure for working out IRR for Option-II**

| Parameters | Unit | Value |
|---|---|---|
| No. of Equipment / Retrofit | No | 2,35,12,250 |
| No. of M&V Equipment | No | 1,31,473 |
| | | |
| | | |
| **Parameters** | **Unit** | **Value** |
| Bare cost of Equipment/Retrofit | Rs | 1,78,83,693 |
| Excise Duty | Rs | 10,73,022 |
| Vat | Rs | 23,69,589 |
| Transportation Cost | Rs | 10,66,315 |
| Erection Cost | Rs | 11,19,631 |
| **Total Capital Cost** | **Rs** | **2,35,12,250** |
| | | |
| **Parameters** | **Unit** | **Value** |
| Bare cost of M&V Equipment | Rs | 1,00,000 |
| Excise Duty | Rs | 6,000 |
| Vat | Rs | 13,250 |
| Transportation Cost | Rs | 5,963 |
| Erection Cost | Rs | 6,261 |
| **Total Capital Cost** | **Rs** | **1,31,473** |
| | | |
| **Parameters** | **Unit** | **Value** |
| Annual kWh Saving | kWh/annum | 11,48,458 |

**Table 13 – Input values considered for ESP (Option-II)**

| 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 (Option-II) | Replacement of 20 W FTL with 8W LED | 19,814 | 82,228 | 3,76,000 | 18,800 | 0 | 63,428 | 5.93 | -17,618 | 10.84 |
| ECM 2/B3 (Option-II) | Replacement of 100 W GLS (filament) lamps with 10W LED | 70,825 | 2,93,924 | 4,90,000 | 24,500 | 0 | 2,69,424 | 1.82 | 10,32,306 | 54.26 |
| ECM 3/B3 (Option-II) | Replacement of 250 W HPSV lamps and fixtures with 80 W LED | 1,31,519 | 5,45,805 | 34,90,500 | 1,74,525 | 0 | 3,71,280 | 9.40 | -13,92,685 | 1.14 |
| ECM 4/B3 (Option-II) | Replacement of 4 feet T12 (40 W) lamps and fixtures with 16W LED | 4,80,748 | 19,95,104 | 70,89,750 | 3,54,488 | 0 | 16,40,617 | 4.32 | 21,80,099 | 19.12 |
| ECM 5/B3 (Option-II) | Replacement of 150W HPSV lamps and fixtures with 60W LED | 2,54,390 | 10,55,719 | 86,40,000 | 4,32,000 | 0 | 6,23,719 | 13.85 | -51,15,849 | -5.52 |
| ECM 6/B3 (Option-II) | Replacement of 70W HPSV lamps and fixtures with 30W LED | 18,212 | 75,580 | 7,56,000 | 37,800 | 0 | 37,780 | 20.01 | -5,42,535 | -10.96 |
| ECM 10/B3 (Option-II) | Use of automation and voltage stabilizer with GSM based control system for street lighting | 1,72,950 | 7,17,743 | 26,70,000 | 2,52,000 | 2,00,000 | 2,65,743 | 10.05 | -11,68,493 | -0.09 |
| | TOTAL | 11,48,458 | 47,66,102 | 2,35,12,250 | 12,94,113 | 2,00,000 | 32,71,990 | 7.19 | | |

**Table 14 - Details of ECM in Energy Saving Project (Option-II) for LED based street Light**

# Table no. 15 - IRR Calculation for ESP (Option-II) under ESCO Mode

| | |
|---|---|
| No. of years for debt | 5 |
| Total Investment Required (Lac Rs) | 236.44 |
| Total Equity (Lac Rs) | 94.57 |
| Total Debt (Lac Rs) | 141.86 |

| Particulars | Years | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Capital Cost of Pumps (Lac Rs) | (235.12) | - | - | - | - | - | - | - | - | - | - |
| Capital Cost of M&V Equipments (Lac Rs) | (1.31) | - | - | - | - | - | - | - | - | - | - |
| | | | | | | | | | | | |
| Tariff, Rs/ Unit | 4.15 | 4.35 | 4.55 | 4.75 | 4.95 | 5.15 | 5.35 | 5.55 | 5.75 | 5.95 | 6.15 |
| Energy Saved (Lac kWh/annum) | - | 11.48 | 11.48 | 11.48 | 11.48 | 11.48 | 11.48 | 11.48 | 11.48 | 11.48 | 11.48 |
| Total Saving (Lac Rs) | - | 49.96 | 52.25 | 54.55 | 56.85 | 59.15 | 61.44 | 63.74 | 66.04 | 68.33 | 70.63 |
| Revenue (Share of ESCO in savings), in Lac Rs. | - | 47.46 | 49.64 | 51.82 | 54.01 | 56.19 | 58.37 | 60.55 | 62.73 | 64.92 | 67.10 |
| | | | | | | | | | | | |
| Manpower Cost (Lac Rs) | - | 5.10 | 5.36 | 5.62 | 5.90 | 6.20 | 6.51 | 6.83 | 7.18 | 7.54 | 7.91 |
| Repair & Maintenance Cost (Lac Rs) | - | | 23.64 | 24.35 | 25.08 | 25.84 | 26.61 | 27.41 | 28.23 | 29.08 | 29.95 |
| Annual Calibration Cost of M&V Equipments (Lac Rs) | - | | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| Total Expenditure (Lac Rs) | - | (5.10) | (29.03) | (30.00) | (31.01) | (32.06) | (33.15) | (34.27) | (35.44) | (36.64) | (37.89) |
| | | | | | | | | | | | |
| Interest on Debt (Lac Rs) | - | (17.02) | (14.90) | (10.64) | (6.38) | (2.13) | - | - | - | - | - |
| | | | | | | | | | | | |
| Earning Before Tax (Lac Rs) | - | 25.34 | 5.72 | 11.18 | 16.61 | 22.00 | 25.22 | 26.28 | 27.30 | 28.27 | 29.20 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Depreciation Cost (Lac Rs) | - | 35.47 | 30.15 | 25.62 | 21.78 | 18.51 | 15.74 | 13.38 | 11.37 | 9.66 | 8.21 |
| Taxable Earning (Lac Rs) | - | (10.13) | (24.42) | (14.44) | (5.17) | 3.48 | 9.49 | 12.90 | 15.93 | 18.61 | 20.99 |
| Tax (Lac Rs) | - | - | - | - | - | (1.18) | (3.22) | (4.39) | (5.41) | (6.33) | (7.13) |
| Net Cash Flow (Lac Rs) | (236.44) | 25.34 | 5.72 | 11.18 | 16.61 | 20.81 | 22.00 | 21.89 | 21.88 | 21.95 | 22.07 |
| Cumulative Cash Flow (Lac Rs) | (236.44) | (211.10) | (205.38) | (194.20) | (177.59) | (156.78) | (134.78) | (112.89) | (91.00) | (69.05) | (46.98) |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

| | |
|---|---|
| **Project IRR** | **-3.59%** |
| **Payback in Years** | **11** |

| **Debt Calculations** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Particulars** | **Years** | | | | | | | | | |
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| Debt (Lac Rs) | 141.86 | 141.86 | 106.40 | 70.93 | 35.47 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Repayments (Lac Rs) | 0.00 | 35.47 | 35.47 | 35.47 | 35.47 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Closing Debt (Lac Rs) | 141.86 | 106.40 | 70.93 | 35.47 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Average Debt (Lac Rs) | 141.86 | 124.13 | 88.66 | 53.20 | 17.73 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Interest Cost (Lac Rs) | 17.02 | 14.90 | 10.64 | 6.38 | 2.13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

# Table no. 16 - IRR Calculation for ESP (Option-II) under ULB Mode

| | |
|---|---|
| No. of years for debt | 5 |
| Total Investment Required (Lac Rs) | 236.44 |
| Total Equity (Lac Rs) | 94.57 |
| Total Debt (Lac Rs) | 141.86 |

| Particulars | Years | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Capital Cost of Pumps (Lac Rs) | (235.12) | | | | | | | | | | |
| Capital Cost of M&V Equipments (Lac Rs) | (1.31) | | | | | | | | | | |
| | | | | | | | | | | | |
| Tariff, Rs/ Unit | 4.15 | 4.35 | 4.55 | 4.75 | 4.95 | 5.15 | 5.35 | 5.55 | 5.75 | 5.95 | 6.15 |
| Energy Saved (Lac kWh/annum) | | 11.48 | 11.48 | 11.48 | 11.48 | 11.48 | 11.48 | 11.48 | 11.48 | 11.48 | 11.48 |
| Total Saving (Lac Rs) | | 49.96 | 52.25 | 54.55 | 56.85 | 59.15 | 61.44 | 63.74 | 66.04 | 68.33 | 70.63 |
| Revenue (Share of ESCO in savings), in Lac Rs. | | 49.96 | 52.25 | 54.55 | 56.85 | 59.15 | 61.44 | 63.74 | 66.04 | 68.33 | 70.63 |
| | | | | | | | | | | | |
| Manpower Cost (Lac Rs) | | 5.10 | 5.36 | 5.62 | 5.90 | 6.20 | 6.51 | 6.83 | 7.18 | 7.54 | 7.91 |
| Repair & Maintenance Cost (Lac Rs) | | | 23.64 | 24.35 | 25.08 | 25.84 | 26.61 | 27.41 | 28.23 | 29.08 | 29.95 |
| Annual Calibration Cost of M&V Equipments (Lac Rs) | | | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 | 0.03 |
| Total Expenditure (Lac Rs) | | (5.10) | (29.03) | (30.00) | (31.01) | (32.06) | (33.15) | (34.27) | (35.44) | (36.64) | (37.89) |
| | | | | | | | | | | | |
| Interest on Debt (Lac Rs) | | (17.02) | (14.90) | (10.64) | (6.38) | (2.13) | - | - | - | - | - |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Earning Before Tax (Lac Rs) | | 27.83 | 8.33 | 13.91 | 19.45 | 24.95 | 28.29 | 29.47 | 30.60 | 31.69 | 32.74 |
| Depreciation Cost (Lac Rs) | | 35.47 | 30.15 | 25.62 | 21.78 | 18.51 | 15.74 | 13.38 | 11.37 | 9.66 | 8.21 |
| Taxable Earning (Lac Rs) | | (7.63) | (21.81) | (11.71) | (2.33) | 6.44 | 12.56 | 16.09 | 19.23 | 22.03 | 24.52 |
| Tax (Lac Rs) | | - | - | - | - | - | - | - | - | - | - |
| Net Cash Flow (Lac Rs) | (236.44) | 27.83 | 8.33 | 13.91 | 19.45 | 24.95 | 28.29 | 29.47 | 30.60 | 31.69 | 32.74 |
| Cumulative Cash Flow (Lac Rs) | (236.44) | (208.60) | (200.27) | (186.36) | (166.91) | (141.95) | (113.66) | (84.19) | (53.60) | (21.91) | 10.83 |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |

| | |
|---|---|
| **Project IRR** | **0.73%** |
| **Payback in Years** | **10** |

| **Debt Calculations** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Particulars** | **Years** | | | | | | | | | |
| | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** |
| Debt (Lac Rs) | 141.86 | 141.86 | 106.40 | 70.93 | 35.47 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Repayments (Lac Rs) | 0.00 | 35.47 | 35.47 | 35.47 | 35.47 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Closing Debt (Lac Rs) | 141.86 | 106.40 | 70.93 | 35.47 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Average Debt (Lac Rs) | 141.86 | 124.13 | 88.66 | 53.20 | 17.73 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Interest Cost (Lac Rs) | 17.02 | 14.90 | 10.64 | 6.38 | 2.13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

# D. Monitoring & 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. 8 and ECM No. 12:- Replacement of energy inefficient lighting with energy efficient lighting.**

| | |
|---|---|
| Description | **ECM No 1/B-3** - Replace all the 20 W FTL with 14 W T5 lamp and fixtures<br><br>**ECM No.2/B-3** - Replace all the 100 W GLS (filament) lamps with 23 W retrofit CFL lamp and fixtures<br><br>**ECM No.3/B-3** - Replace all the 250 W HPSV lamps and fixtures with 4 X 24 W T5 lamp and fixtures<br><br>**ECM No.4/B-3** Replace all the 4 feet T12 (40 W) lamps and fixtures with 4 feet T5 (28 W) lamp and fixtures<br><br>**ECM No. 5/B-3** - Replace all the 150 W HPSV lamps and fixtures with 4 X 14 W T5 lamp and fixtures<br><br>**ECM No 6/B-3** – Replace all the 70W HPSV lamps and fixtures with 1X36W CFL(36 W) lamp and fixtures<br><br>**ECM No. 7/B-3** Replace all the 400 W HPSV lamps and fixtures with 250W MH lamp and fixtures<br><br>**ECM No. 8/B-3** - Replace all the 400W MH lamps and fixtures with 320W MH lamp and fixtures<br><br>**ECM no. 12/B-4** - Replace all the 4 feet T8 (36 W) lamps and fixtures with 4 feet 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:<br>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.<br>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 no. 12 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 |

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| | 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. 9:- Improve designing of high masts

| | |
|---|---|
| Description | There are 10 high masts at Bhiwani but most of them are poorly designed as (i) More directions have been covered than required,<br>(ii) street light poles are there where high mast light is reaching,<br>(iii) Angle of fittings is not okay and<br>(iv) at some places 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 and measuring the lux levels & power consumption. |
| 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. Here, routine and non-routine adjustments will be made as required. The parameters to be measured are power consumed by all fixtures on the high mast before & after redesigning including modification and operating hours for the reporting period. There is no parameter to be assumed being option B. 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 10 nos. of high masts being redesigned. Thus the measurement boundary encompasses all the 10 high masts. |
| Static Factor | There are two static factors:<br>3. No. of high masts. It has agreed that it will be responsibility of ULB to inform ESCO about any increase or decrease in no. of high masts and the date of such increase/decrease will be considered for calculating savings.<br>4. 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. |
| 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 modifying the lights at high mast 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. |

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| 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 modified high masts Any non-routine adjustment corresponding to change in the inventory of high masts 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 in the lamps at high masts 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 all the 10 high masts. |
| Analysis Procedure | The saving analysis shall be based upon before and after modification 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 various ECMs on street lighting. |
| 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, measured operating hours and computed savings. |
| Quality assurance | Measurements will be taken jointly to have transparency in the system. |

## ECM No. 10 :- Use of Automation for street lighting

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| 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:<br>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.<br>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. |

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| 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 1 to 8. |
| 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.11 : Replacing resistance type conventional fan regulators with electronic regulators

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| 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:<br>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.<br>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.<br>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. |

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| | 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.<br>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 Council Bhiwani is placed at the end of this chapter 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

- **Best Practices in 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.
- **Best Practices in 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 Phs is checked and balanced. Additional load is put on the Ph 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 COUNCIL, BHIWANI

## ENERGY POLICY

We, at Municipal Council Bhiwani, 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

A. K. Jain
Executive Officer

# 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<br>Himayath Nagar Hyderabad -500029 |
| 02 | M/S Alien Energy Pvt. Ltd | 8/122, Karan Gali, Vishwas Nagar<br>Delhi-110032<br>Mobile 09810250203<br>+91 11 2237 2828: 2237 3565 |
| 03 | Conzerv System Pvt. Ltd.<br>Del.sales@conzerv.com | 87, First Floor, Ind Dev Colony<br>Mehrauli Road, Gurgaon- 122 001<br>+91 124 4268965 : 4268899 |

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

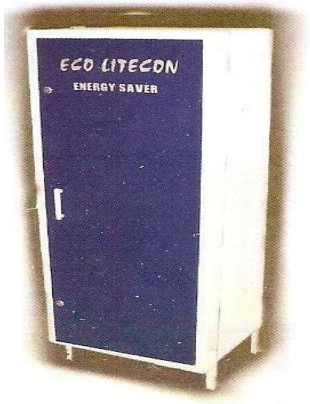
M/S Alien Energy Pvt. Ltd.,
8/122, Karan Gali, Vishwas Nagar
Delhi-110032
Mobile: 09810250203
011-2237 2828, 2237 3565

## 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

1. Rs. 25,000/- for 3 KVA single phase
2. Rs. 40,000/- for 3 KVA two phase
3. Rs. 6,000/-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 22372828, 22373565.
Telefax : 91 11 22375994
E-mail : corporate@alienenergy.in
www.alienenergy.in
energy efficient solutions



## PRICE LIST OF ALIEN ENERGY SAVING PRODUCTS

**wef 1/2/2009**

| PRODUCT | MODEL NO | SPECIFICATIONS | UNIT PRICE ( in Rs.) |
|---|---|---|---|
| **PAGE NO 1 : ENERGY SAVERS** | | | |
| ELECTRONIC BALLAST | AE 40 | SUITABLE FOR 1X36/40W FTL | 395 |
| LUMINARIE | AEBLR 8136 | 1X36W FTL BOX TYPE FITTING WITH ELECTRONIC BALLAST , POLYMER REFLECTOR AND HIGH LUMEN T/L | 850 |
| LUMINARIE | AEBLR 5028 | 1X 28W T-5 BATTERN WITH POLYMER REFLECTOR AND LAMP | 750 |
| LUMINARIE | AEBLR 5014 | 1X 14W T-5 BATTERN WITH POLYMER REFLECTOR AND LAMP | 650 |
| LUMINARIE | AEIL 13128 | 1X28W T-5 BATTERN WITH LAMP | 475 |
| LUMINARIE | AEIL 20254 | 2X 54W T-5 BOX TYPE FITTING WITH ELECTRONIC BALLAST , ALUMINIUM REFLECTOR AND LAMP | 2450 |
| OCCUPANCY SENSOR | AE - 05 | CAPACITY 6 AMPS | 6000 |
| STREETLIGHT SENSOR | AE - SLS | CAPACITY 6 AMPS | 2950 |
| **PAGE NO 2 : ENERGY SAVING HIGHBAY** | | | |
| LUMINARIE | AEIL 50050 | 1X50W MH LOWBAY LUMIANRIE COMPLETE WITH LAMP | 3100 |
| LUMINARIE | AEIL 50100 | 1X100W MH LOWBAY LUMIANRIE COMPLETE WITH LAMP | 3450 |
| LUMINARIE | AEIL 40150 | 1X150W MH HIGHBAY LUMIANRIE COMPLETE WITH LAMP | 3750 |
| LUMINARIE | AEIL 40200 | 1X200W MH HIGHBAY LUMIANRIE COMPLETE WITH LAMP | 3995 |
| LUMINARIE | AEIL 40320 | 1X320W MH HIGHBAY LUMIANRIE COMPLETE WITH LAMP | 4850 |
| LUMINARIE | AEIL 40414 | 4X14W T-5 HIGHBAY FITTING COMPLTE WITH ELECTRONIC BALLAST AND LAMP | 3350 |
| LUMINARIE | AEIL 40424 | 4X24W T-5 HIGHBAY FITTING COMPLTE WITH ELECTRONIC BALLAST AND LAMP | 3550 |
| LUMINARIE | AEIL 40336 | 3 X 36W CFL HIGHBAY FITTING COMPLTE WITH ELECTRONIC BALLAST AND LAMP | 3150 |
| LUMINARIE | AEIL 40724 | 7X24W T-5 HIGHBAY FITTING COMPLTE WITH ELECTRONIC BALLAST AND LAMP | 5120 |
| LUMINARIE | AEIL 40536 | 5X36W CFL HIGHBAY FITTING COMPLTE WITH ELECTRONIC BALLAST AND LAMP | 3960 |
| **PAGE NO 3 : ENERGY SAVING FLOODLIGHTS** | | | |
| LUMINARIE | AESL 60185 | 1X85W RETROFIT CFL FLOODLIGHT COMPLETE WITH LAMP | 1295 |
| LUMINARIE | AESL 60623 | 6 X23W RETROFIT CFL FLOODLIGHT COMPLETE WITH LAMP | 1700 |
| LUMINARIE | AESL 60285 | 2X85W RETROFIT CFL FLOODLIGHT COMPLETE WITH LAMP | 2350 |
| LUMINARIE | AESL 60485 | 4X85W RETROFIT CFL FLOODLIGHT COMPLETE WITH LAMP | 4200 |
| LUMINARIE | AESL 60424 | 4X24W T-5 FLOODLIGHT FITTING COMPLTE WITH ELECTRONIC BALLAST AND LAMP | 3550 |

ALIEN ENERGY PRIVATE LTD.
28, RISHABH VIHAR, KARKARDOOMA, DELHI 92
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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 |

| Table C-1A: NPV/IRR Calculation for ECM No. 1/B-3 (Option-I) | | | | | |
|---|---|---|---|---|---|
| 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 | 141000 | | | | -141000 |
| 1 | | 54817 | 7050 | 14100 | 33,667 |
| 2 | | 54817 | 7050 | 14100 | 33,667 |
| 3 | | 54817 | 7050 | 14100 | 33,667 |
| 4 | | 54817 | 7050 | 14100 | 33,667 |
| 5 | | 54817 | 7050 | 14100 | 33,667 |
| 6 | | 54817 | 7050 | 14100 | 33,667 |
| 7 | | 54817 | 7050 | 14100 | 33,667 |
| 8 | | 54817 | 7050 | 14100 | 33,667 |
| 9 | | 54817 | 7050 | 14100 | 33,667 |
| 10 | | 54817 | 7050 | 14100 | 33,667 |
| | | | | **NPV** | 43,952 |
| | | | | **IRR** | 20.03090% |

| Table C-1B: 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 in Rs. | Net financial saving in Rs. |
| 0 | 3,76,000 | | | | -3,76,000 |
| 1 | | 82,228 | 18,800 | 0 | 63,428 |
| 2 | | 82,228 | 18,800 | 0 | 63,428 |
| 3 | | 82,228 | 18,800 | 0 | 63,428 |
| 4 | | 82,228 | 18,800 | 0 | 63,428 |
| 5 | | 82,228 | 18,800 | 0 | 63,428 |
| 6 | | 82,228 | 18,800 | 0 | 63,428 |
| 7 | | 82,228 | 18,800 | 0 | 63,428 |
| 8 | | 82,228 | 18,800 | 0 | 63,428 |
| 9 | | 82,228 | 18,800 | 0 | 63,428 |
| 10 | | 82,228 | 18,800 | 0 | 63,428 |
| | | | | **NPV** | -17,618 |
| | | | | **IRR%** | 10.84 |

| Table C-2 A: NPV/IRR Calculation for ECM No. 2/B-3 (Option-I) | | | | | |
|---|---|---|---|---|---|
| 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 | 112,112 | | | | -112,112 |
| 1 | | 251,466.00 | 5,605.60 | 11,211.20 | 234,649 |
| 2 | | 251,466.00 | 5,605.60 | 11,211.20 | 234,649 |
| 3 | | 251,466.00 | 5,605.60 | 11,211.20 | 234,649 |
| 4 | | 251,466.00 | 5,605.60 | 11,211.20 | 234,649 |
| 5 | | 251,466.00 | 5,605.60 | 11,211.20 | 234,649 |
| 6 | | 251,466.00 | 5,605.60 | 11,211.20 | 234,649 |
| 7 | | 251,466.00 | 5,605.60 | 11,211.20 | 234,649 |
| 8 | | 251,466.00 | 5,605.60 | 11,211.20 | 234,649 |
| 9 | | 251,466.00 | 5,605.60 | 11,211.20 | 234,649 |
| 10 | | 251,466.00 | 5,605.60 | 11,211.20 | 234,649 |
| | | | | **NPV** | 1,083,668 |
| | | | | **IRR** | 209.30% |

| Table C-2B: 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 in Rs. | Net financial saving in Rs. |
| 0 | 4,90,000 | | | | -4,90,000 |
| 1 | | 2,93,924 | 24,500 | 0 | 2,69,424 |
| 2 | | 2,93,924 | 24,500 | 0 | 2,69,424 |
| 3 | | 2,93,924 | 24,500 | 0 | 2,69,424 |
| 4 | | 2,93,924 | 24,500 | 0 | 2,69,424 |
| 5 | | 2,93,924 | 24,500 | 0 | 2,69,424 |
| 6 | | 2,93,924 | 24,500 | 0 | 2,69,424 |
| 7 | | 2,93,924 | 24,500 | 0 | 2,69,424 |
| 8 | | 2,93,924 | 24,500 | 0 | 2,69,424 |
| 9 | | 2,93,924 | 24,500 | 0 | 2,69,424 |
| 10 | | 2,93,924 | 24,500 | 0 | 2,69,424 |
| | | | | **NPV** | 10,32,306 |
| | | | | **IRR%** | 54.26 |

| Table C-3 A: NPV/IRR Calculation for ECM No. 3/B-3 (Option-I) | | | | | |
|---|---|---|---|---|---|
| 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 | 826,085 | | | | -826,085 |
| 1 | | 545,805 | 41,304.25 | 82,608.50 | 421,892.25 |
| 2 | | 545,805 | 41,304.25 | 82,608.50 | 421,892.25 |
| 3 | | 545,805 | 41,304.25 | 82,608.50 | 421,892.25 |
| 4 | | 545,805 | 41,304.25 | 82,608.50 | 421,892.25 |
| 5 | | 545,805 | 41,304.25 | 82,608.50 | 421,892.25 |
| 6 | | 545,805 | 41,304.25 | 82,608.50 | 421,892.25 |
| 7 | | 545,805 | 41,304.25 | 82,608.50 | 421,892.25 |
| 8 | | 545,805 | 41,304.25 | 82,608.50 | 421,892.25 |
| 9 | | 545,805 | 41,304.25 | 82,608.50 | 421,892.25 |
| 10 | | 545,805 | 41,304.25 | 82,608.50 | 421,892.25 |
| | | | | **NPV** | 13,90,803.85 |
| | | | | **IRR** | 50.20% |

| Table C-3B: NPV/IRR Calculation for ECM No. 3/B-3 (Option-II) | | | | | |
|---|---|---|---|---|---|
| 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 | 34,90,500 | | | | -34,90,500 |
| 1 | | 5,45,805 | 1,74,525 | 0 | 3,71,280 |
| 2 | | 5,45,805 | 1,74,525 | 0 | 3,71,280 |
| 3 | | 5,45,805 | 1,74,525 | 0 | 3,71,280 |
| 4 | | 5,45,805 | 1,74,525 | 0 | 3,71,280 |
| 5 | | 5,45,805 | 1,74,525 | 0 | 3,71,280 |
| 6 | | 5,45,805 | 1,74,525 | 0 | 3,71,280 |
| 7 | | 5,45,805 | 1,74,525 | 0 | 3,71,280 |
| 8 | | 5,45,805 | 1,74,525 | 0 | 3,71,280 |
| 9 | | 5,45,805 | 1,74,525 | 0 | 3,71,280 |
| 10 | | 5,45,805 | 1,74,525 | 0 | 3,71,280 |
| | | | | **NPV** | -13,92,685 |
| | | | | **IRR%** | 1.14 |

| Table C-4 A: NPV/IRR Calculation for ECM No. 4/B-3 (Option-I) | | | | | |
|---|---|---|---|---|---|
| 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 | 3,466,100 | | | | -3,466,100 |
| 1 | | 1260065.00 | 173305.00 | 346610.00 | 740150.00 |
| 2 | | 1260065.00 | 173305.00 | 346610.00 | 740150.00 |
| 3 | | 1260065.00 | 173305.00 | 346610.00 | 740150.00 |
| 4 | | 1260065.00 | 173305.00 | 346610.00 | 740150.00 |
| 5 | | 1260065.00 | 173305.00 | 346610.00 | 740150.00 |
| 6 | | 1260065.00 | 173305.00 | 346610.00 | 740150.00 |
| 7 | | 1260065.00 | 173305.00 | 346610.00 | 740150.00 |
| 8 | | 1260065.00 | 173305.00 | 346610.00 | 740150.00 |
| 9 | | 1260065.00 | 173305.00 | 346610.00 | 740150.00 |
| 10 | | 1260065.00 | 173305.00 | 346610.00 | 740150.00 |
| | | | | **NPV** | 6,39,208/- |
| | | | | **IRR** | 16.86% |

| Table C-4B: NPV/IRR Calculation for ECM No. 4/B-3 (Option-II) | | | | | |
|---|---|---|---|---|---|
| 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 | 70,89,750 | | | | -70,89,750 |
| 1 | | 19,95,104 | 3,54,488 | 0 | 16,40,617 |
| 2 | | 19,95,104 | 3,54,488 | 0 | 16,40,617 |
| 3 | | 19,95,104 | 3,54,488 | 0 | 16,40,617 |
| 4 | | 19,95,104 | 3,54,488 | 0 | 16,40,617 |
| 5 | | 19,95,104 | 3,54,488 | 0 | 16,40,617 |
| 6 | | 19,95,104 | 3,54,488 | 0 | 16,40,617 |
| 7 | | 19,95,104 | 3,54,488 | 0 | 16,40,617 |
| 8 | | 19,95,104 | 3,54,488 | 0 | 16,40,617 |
| 9 | | 19,95,104 | 3,54,488 | 0 | 16,40,617 |
| 10 | | 19,95,104 | 3,54,488 | 0 | 16,40,617 |
| | | | | **NPV** | 21,80,099 |
| | | | | **IRR%** | 19.12 |

| Table C-5 A: NPV/IRR Calculation for ECM No. 5/B-3 (Option-I) | | | | | |
|---|---|---|---|---|---|
| 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 | 2,304,000 | | | | -2,304,000 |
| 1 | | 1,170,889.63 | 115,200.00 | 230,400.00 | 825,289.63 |
| 2 | | 1,170,889.63 | 115,200.00 | 230,400.00 | 825,289.63 |
| 3 | | 1,170,889.63 | 115,200.00 | 230,400.00 | 825,289.63 |
| 4 | | 1,170,889.63 | 115,200.00 | 230,400.00 | 825,289.63 |
| 5 | | 1,170,889.63 | 115,200.00 | 230,400.00 | 825,289.63 |
| 6 | | 1,170,889.63 | 115,200.00 | 230,400.00 | 825,289.63 |
| 7 | | 1,170,889.63 | 115,200.00 | 230,400.00 | 825,289.63 |
| 8 | | 1,170,889.63 | 115,200.00 | 230,400.00 | 825,289.63 |
| 9 | | 1,170,889.63 | 115,200.00 | 230,400.00 | 825,289.63 |
| 10 | | 1,170,889.63 | 115,200.00 | 230,400.00 | 825,289.63 |
| | | | | **NPV** | 21,06,313 |
| | | | | **IRR** | 33.88% |

| Table C-5B: 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 Replacement in Rs. | Net financial saving in Rs. |
| 0 | 86,40,000 | | | | -86,40,000 |
| 1 | | 10,55,719 | 4,32,000 | 0 | 6,23,719 |
| 2 | | 10,55,719 | 4,32,000 | 0 | 6,23,719 |
| 3 | | 10,55,719 | 4,32,000 | 0 | 6,23,719 |
| 4 | | 10,55,719 | 4,32,000 | 0 | 6,23,719 |
| 5 | | 10,55,719 | 4,32,000 | 0 | 6,23,719 |
| 6 | | 10,55,719 | 4,32,000 | 0 | 6,23,719 |
| 7 | | 10,55,719 | 4,32,000 | 0 | 6,23,719 |
| 8 | | 10,55,719 | 4,32,000 | 0 | 6,23,719 |
| 9 | | 10,55,719 | 4,32,000 | 0 | 6,23,719 |
| 10 | | 10,55,719 | 4,32,000 | 0 | 6,23,719 |
| | | | | **NPV** | -51,15,849 |
| | | | | **IRR%** | -5.52 |

| Table C-6 A: NPV/IRR Calculation for ECM No. 6/B-3 (Option-I) | | | | | |
|---|---|---|---|---|---|
| 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 | 2,10,000 | | | | -210,000 |
| 1 | | 75,579.96 | 10,500.00 | 21,000.00 | 44,079.96 |
| 2 | | 75,579.96 | 10,500.00 | 21,000.00 | 44,079.96 |
| 3 | | 75,579.96 | 10,500.00 | 21,000.00 | 44,079.96 |
| 4 | | 75,579.96 | 10,500.00 | 21,000.00 | 44,079.96 |
| 5 | | 75,579.96 | 10,500.00 | 21,000.00 | 44,079.96 |
| 6 | | 75,579.96 | 10,500.00 | 21,000.00 | 44,079.96 |
| 7 | | 75,579.96 | 10,500.00 | 21,000.00 | 44,079.96 |
| 8 | | 75,579.96 | 10,500.00 | 21,000.00 | 44,079.96 |
| 9 | | 75,579.96 | 10,500.00 | 21,000.00 | 44,079.96 |
| 10 | | 75,579.96 | 10,500.00 | 21,000.00 | 44,079.96 |
| | | | | **NPV** | 34,876 |
| | | | | **IRR** | 16.39% |

| Table C-6B: NPV/IRR Calculation for ECM No. 6/B-3 (Option-II) | | | | | |
|---|---|---|---|---|---|
| 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 | 26,70,000 | | | | -26,70,000 |
| 1 | | 7,17,743 | 2,52,000 | 2,00,000 | 2,65,743 |
| 2 | | 7,17,743 | 2,52,000 | 2,00,000 | 2,65,743 |
| 3 | | 7,17,743 | 2,52,000 | 2,00,000 | 2,65,743 |
| 4 | | 7,17,743 | 2,52,000 | 2,00,000 | 2,65,743 |
| 5 | | 7,17,743 | 2,52,000 | 2,00,000 | 2,65,743 |
| 6 | | 7,17,743 | 2,52,000 | 2,00,000 | 2,65,743 |
| 7 | | 7,17,743 | 2,52,000 | 2,00,000 | 2,65,743 |
| 8 | | 7,17,743 | 2,52,000 | 2,00,000 | 2,65,743 |
| 9 | | 7,17,743 | 2,52,000 | 2,00,000 | 2,65,743 |
| 10 | | 7,17,743 | 2,52,000 | 2,00,000 | 2,65,743 |
| | | | | **NPV** | -11,68,493 |
| | | | | **IRR%** | -0.09 |

| Table C-7 NPV/IRR Calculation for ECM No. 7/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 | 3,85,000.00 | | | | -3,85,000.00 |
| 1 | | 2,30,939.00 | 19,250.00 | 38,500.00 | 1,73,189.00 |
| 2 | | 2,30,939.00 | 19,250.00 | 38,500.00 | 1,73,189.00 |
| 3 | | 2,30,939.00 | 19,250.00 | 38,500.00 | 1,73,189.00 |
| 4 | | 2,30,939.00 | 19,250.00 | 38,500.00 | 1,73,189.00 |
| 5 | | 2,30,939.00 | 19,250.00 | 38,500.00 | 1,73,189.00 |
| 6 | | 2,30,939.00 | 19,250.00 | 38,500.00 | 1,73,189.00 |
| 7 | | 2,30,939.00 | 19,250.00 | 38,500.00 | 1,73,189.00 |
| 8 | | 2,30,939.00 | 19,250.00 | 38,500.00 | 1,73,189.00 |
| 9 | | 2,30,939.00 | 19,250.00 | 38,500.00 | 1,73,189.00 |
| 10 | | 2,30,939.00 | 19,250.00 | 38,500.00 | 1,73,189.00 |
| | | | | **NPV** | 5,29,961 |
| | | | | **IRR** | 43.79% |

| Table C-8 NPV/IRR Calculation for ECM No. 8/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 | 55,000 | | | | -55,000 |
| 1 | | 32,991.25 | 2,750.00 | 5,500.00 | 24,741.25 |
| 2 | | 32,991.25 | 2,750.00 | 5,500.00 | 24,741.25 |
| 3 | | 32,991.25 | 2,750.00 | 5,500.00 | 24,741.25 |
| 4 | | 32,991.25 | 2,750.00 | 5,500.00 | 24,741.25 |
| 5 | | 32,991.25 | 2,750.00 | 5,500.00 | 24,741.25 |
| 6 | | 32,991.25 | 2,750.00 | 5,500.00 | 24,741.25 |
| 7 | | 32,991.25 | 2,750.00 | 5,500.00 | 24,741.25 |
| 8 | | 32,991.25 | 2,750.00 | 5,500.00 | 24,741.25 |
| 9 | | 32,991.25 | 2,750.00 | 5,500.00 | 24,741.25 |
| 10 | | 32,991.25 | 2,750.00 | 5,500.00 | 24,741.25 |
| | | | | **NPV** | 75,709 |
| | | | | **IRR** | 43.79% |

| Table C-9 NPV/IRR Calculation for ECM No. 9/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 | 10,000 | | | | -10,000 |
| 1 | | 51,904 | 0 | 0 | 51,904 |
| 2 | | 51,904 | 0 | 0 | 51,904 |
| 3 | | 51,904 | 0 | 0 | 51,904 |
| 4 | | 51,904 | 0 | 0 | 51,904 |
| 5 | | 51,904 | 0 | 0 | 51,904 |
| 6 | | 51,904 | 0 | 0 | 51,904 |
| 7 | | 51,904 | 0 | 0 | 51,904 |
| 8 | | 51,904 | 0 | 0 | 51,904 |
| 9 | | 51,904 | 0 | 0 | 51,904 |
| 10 | | 51,904 | 0 | 0 | 51,904 |
| | | | | **NPV** | 2,52,919 |
| | | | | **IRR** | 519.04% |

| Table C-10 A: NPV/IRR Calculation for ECM No. 10/B-3 (Option-I) | | | | | |
|---|---|---|---|---|---|
| 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 | 11,50,000 | | | | -11,50,000 |
| 1 | | 3,58,871.00 | 50,000.00 | 50,000.00 | 2,58,871.00 |
| 2 | | 3,58,871.00 | 50,000.00 | 50,000.00 | 2,58,871.00 |
| 3 | | 3,58,871.00 | 50,000.00 | 50,000.00 | 2,58,871.00 |
| 4 | | 3,58,871.00 | 50,000.00 | 50,000.00 | 2,58,871.00 |
| 5 | | 3,58,871.00 | 50,000.00 | 50,000.00 | 2,58,871.00 |
| 6 | | 3,58,871.00 | 50,000.00 | 50,000.00 | 2,58,871.00 |
| 7 | | 3,58,871.00 | 50,000.00 | 50,000.00 | 2,58,871.00 |
| 8 | | 3,58,871.00 | 50,000.00 | 50,000.00 | 2,58,871.00 |
| 9 | | 3,58,871.00 | 50,000.00 | 50,000.00 | 2,58,871.00 |
| 10 | | 3,58,871.00 | 50,000.00 | 50,000.00 | 2,58,871.00 |
| | | | | **NPV** | 2,79,178 |
| | | | | **IRR** | 18.33% |

| Table C-10B: NPV/IRR Calculation for ECM No. 10/B-3 (Option-II) | | | | | |
|---|---|---|---|---|---|
| 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 | 3,76,000 | | | | -3,76,000 |
| 1 | | 82,228 | 18,800 | 0 | 63,428 |
| 2 | | 82,228 | 18,800 | 0 | 63,428 |
| 3 | | 82,228 | 18,800 | 0 | 63,428 |
| 4 | | 82,228 | 18,800 | 0 | 63,428 |
| 5 | | 82,228 | 18,800 | 0 | 63,428 |
| 6 | | 82,228 | 18,800 | 0 | 63,428 |
| 7 | | 82,228 | 18,800 | 0 | 63,428 |
| 8 | | 82,228 | 18,800 | 0 | 63,428 |
| 9 | | 82,228 | 18,800 | 0 | 63,428 |
| 10 | | 82,228 | 18,800 | 0 | 63,428 |
| | | | | **NPV** | -17,618 |
| | | | | **IRR** | 0.11 |

| Table C-11 NPV/IRR Calculation for ECM No. 11/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 | 1,800 | | | | -1,800 |
| 1 | | 1,004 | 180 | 0 | 824 |
| 2 | | 1,004 | 180 | 0 | 824 |
| 3 | | 1,004 | 180 | 0 | 824 |
| 4 | | 1,004 | 180 | 0 | 824 |
| 5 | | 1,004 | 180 | 0 | 824 |
| 6 | | 1,004 | 180 | 0 | 824 |
| 7 | | 1,004 | 180 | 0 | 824 |
| 8 | | 1,004 | 180 | 0 | 824 |
| 9 | | 1,004 | 180 | 0 | 824 |
| 10 | | 1,004 | 180 | 0 | 824 |
| | | | | **NPV** | 2,550 |
| | | | | **IRR** | 44.64% |

| Table C-12 NPV/IRR Calculation for ECM No. 12/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 | 15,500 | | | | -15,500 |
| 1 | | 5,432 | 775 | 775 | 3,882 |
| 2 | | 5,432 | 775 | 775 | 3,882 |
| 3 | | 5,432 | 775 | 775 | 3,882 |
| 4 | | 5,432 | 775 | 775 | 3,882 |
| 5 | | 5,432 | 775 | 775 | 3,882 |
| 6 | | 5,432 | 775 | 775 | 3,882 |
| 7 | | 5,432 | 775 | 775 | 3,882 |
| 8 | | 5,432 | 775 | 775 | 3,882 |
| 9 | | 5,432 | 775 | 775 | 3,882 |
| 10 | | 5,432 | 775 | 775 | 3,882 |
| | | | | **NPV** | 5,745 |
| | | | | **IRR** | 21.40% |

# 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, | 40 |

| | | |
|---|---|---|
| | 1999 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] | |
| (*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<br>(*b*) Felt-filter systems<br>(*c*) Dust collector systems<br>(*d*) Scrubber-counter current/venturi/packed bed/cyclonic scrubbers<br>(*e*) Ash handling system and evacuation system | 100 |
| (*ix*) | Water pollution control equipment, being— | |
| | (*a*) Mechanical screen systems<br>(*b*) Aerated detritus chambers (including air compressor)<br>(*c*) Mechanically skimmed oil and grease removal systems | 100 |

| | | |
|---|---|---|
| | (*d*) Chemical feed systems and flash mixing equipment<br>(*e*) Mechanical flocculators and mechanical reactors<br>(*f*) Diffused air/mechanically aerated activated sludge systems<br>(*g*) Aerated lagoon systems<br>(*h*) Biofilters<br>(*i*) Methane-recovery anaerobic digester systems<br>(*j*) Air floatation systems<br>(*k*) Air/steam stripping systems<br>(*l*) Urea Hydrolysis systems<br>(*m*) Marine outfall systems<br>(*n*) Centrifuge for dewatering sludge<br>(*o*) Rotating biological contractor or bio-disc<br>(*p*) Ion exchange resin column<br>(*q*) Activated carbon column | |
| (*x*) | (*a*) Solidwaste, control equipment being - caustic/lime/ chrome/mineral/cryolite recovery systems<br>(*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—<br>(*a*) D.C. Defibrillators for internal use and pace makers<br>(*b*) Haemodialysors<br>(*c*) Heart lung machine<br>(*d*) Cobalt Therapy Unit<br>(*e*) Colour Doppler<br>(*f*) SPECT Gamma Camera | 40 |

| | | |
|---|---|---|
| | (*g*) Vascular Angiography System including Digital Subtraction Angiography | |
| | (*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 | 100 |
| | (*ii*) Cinematograph films - bulbs of studio lights | |

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

| | |
|---|---|
| router/bridges, other required equipment and associated communication systems for supervisory control and data acquisition<br><br>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<br>(*b*) Emulsion burners<br>(*c*) Burners using air with high pre-heat temperature (above 300°C) | 80 |
| *G.* Other equipment : | |
| (*a*) Wet air oxidation equipment for recovery of chemicals and heat<br>(*b*) Mechanical vapour recompressors<br>(*c*) Thin film evaporators<br>(*d*) Automatic micro-processor based load demand controllers | 80 |
| (*e*) Coal based producer gas plants<br>(*f*) Fluid drives and fluid couplings<br>(*g*) Turbo charges/super-charges<br>(*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<br>(*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 | |
| | (*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 | 80 |
| | (*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 | 20 |

| | | |
|---|---|---|
| | purposes and fishing vessels with wooden hull | |
| (*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*

INTANGIBLE ASSETS

| | |
|---|---|
| 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.]