Infrastructure Development Department (IDD)

GOVERNMENT OF KARNATAKA

Directorate of Municipal Administration

Pre-Feasibility Report

Energy Efficiency Project

Energy Efficiency in Street Lighting through ESCO's at Hubli-Dharwad

June 2012

ICRA Management Consulting Services Limited

Contents

Exhibits

Abbreviations and Acronyms

AEL	Asian Electronic Limited
BEE	Bureau of Energy Efficiency
BIS	Bureau of Indian Standards
CDM	Clean Development Mechanism
CER	Certified Emission Reductions
DMA	Directorate of Municipal Administration
DPR	Detailed Project Report
ECA	Energy Conservation Act
EE	Energy Efficiency
EESL	Energy Efficiency Services Limited
ESCO	Energy Service Company
ESPC	Energy Saving Performance Contract
GHG	Green House Gases
Gok	Govt. of Karnataka
HESCOM	Hubli-Dharwad Electricity Supply Company Limited
HDMC	Hubli-Dharwad Municipal Corporation
IDD	Infrastructure Development Department
IGEA	Internal Grade Energy Audit
IMaCS	ICRA Management Consulting Services Limited
IRR	Internal Rate of Return
MHL	Mercury Halide Lamp
MIS	Management Information System
MUDSM	Municipal Demand Sid Management Programme
NMEEE	National Mission for Enhanced Energy Efficiency
NPV	Net Present Value
O & M	Operation and Maintenance
PPP	Public Private Partnership
SDA	State Designated Agencies
SEB	State Electricity Board
SVL	Sodium Vapour Lamp
TERI	The Environmental Research Institute
TOR	Terms of Reference
ULB	Urban Local Body

Executive Summary

The Government of Karnataka has identified Public Private Partnerships (PPPs) as one of the key elements of its infrastructure development strategy. GoK, through its Infrastructure Development Department (IDD) has initiated an exercise for Institutional strengthening and developing "Institutional Strengthening & Sector Specific Inventory for PPP Mainstreaming" across a number of departments and sectors. Under this initiative, the Department of Municipal Administration (DMA) has been identified as a nodal agency for urban infrastructure projects in Urban Local Bodies (ULBs) other than Bangalore Metropolitan Area.

In view of the above, GoK has appointed M/s ICRA Management Consulting Services Limited (IMaCS) as transaction advisors for Directorate of Municipal Administration. The objective of this report is to provide the assistance to develop pre-feasibility study.

Provision of street lighting for public safety is an important responsibility and function of ULBs in India. The Bureau of Energy Efficiency, based on Central Electricity Authority statistics, has estimated gross energy consumption for public lighting to be 6,131 million kWh in India for the year 2007-2008. Quite often, street lighting is poorly designed and inadequately maintained by ULBs, and uses obsolete lighting technology. Lighting can account for 10-38% of the total energy bill in typical cities worldwide (NYCGP 2009). Financial resources of ULBs in India are limited. Therefore, there is a need for energy efficient technologies in this sector. The Bureau of Energy Efficiency (BEE) was set up under the Energy Conservation Act, 2001 to promote energy efficiency. The various mandatory and voluntary provisions of the Act that have to be performed by BEE include measures to create awareness and disseminate information for efficient use of energy and its conservation, organize training of personnel and specialists, promote and facilitate implementation of pilot project and demonstration projects and use of energy efficient processes, equipments, devices and systems etc.

The increasing energy costs at municipal levels have created big concerns for urban local bodies and population residing in the cities. With increasing urban population, energy consumption and electricity tariff increase the concern is getting highlighted at individual levels. In twin cities of Hubli-Dharwad, whose present combined population is 9.4 Lakhs, Municipal Corporation has been providing street lighting services through HESCOM. In 2010-11, Electricity expenditure towards street lighting accounted for Rs. 828 Lakh out of Rs. 1032 Lakh (total expenditure under street lighting). Thus, Energy Efficiency in Street Lighting through ESCO's has been identified to save energy, costs and reduce carbon emissions in the atmosphere. This project would involve the scope for saving energy costs in street lighting in Hubli-Dharwad Municipal Corporation through ESCO's by use of energy efficient equipments.

The Present deliverable has been prepared as a Preliminary Feasibility Study with an objective to provide an insight of financial viability of the envisaged project – "Energy Efficiency in Street Lighting through ESCO's". The report also presents various project structuring options, applicable laws & acts with legal and regulatory framework which shall be considered while implementing the project through ESCO Mode. The report concludes with recommendations on the project structure and concession period considering the financial viability and nature of the project.

Technically, two options have been considered for developing project.

	Option 1	Option 2
Technical equipment	Replacement of conventional lamps with energy efficient lamps	Replacement of conventional lamps with energy efficient lamps and installation of automatic timers
Energy Saved	10190191 KWh	11841582 KWh
Energy Cost Saved	Rs. 427.99 Lakh	Rs. 497.34 Lakh
Reduction in CO2 Emission	12979.1 MT	15082. MT

Option 2 has been considered and taken up as it shows more savings, which is environmentally and financially sound. Results of financial analysis show that Post Tax IRR of the project is coming out to be 19.54 %.

The way ahead for the project has been analyzed and it is recommended that the key task for the HDMC is to select Transaction Advisor, which would develop Internal Grade Energy Audit Report (DPR) for the project which would allow development of realistic cost estimates. After this transaction advisor will facilitate selection of the ESCO.

1. Introduction

1.1 Project Background

The Government of Karnataka has identified Public Private Partnerships (PPPs) as one of the key elements of its infrastructure development strategy. To build capacity across various departments for conceptualizing, developing and implementing PPP projects, GoK, through its Infrastructure Development Department (IDD) has initiated an exercise for Institutional strengthening and developing sector level inventory for mainstreaming PPPs across a number of departments and sectors.

Under this initiative, the Department of Municipal Administration (DMA) has been identified as a nodal agency for urban infrastructure projects in Urban Local Bodies (ULBs) other than Bangalore Metropolitan Area. The exercise envisages creation of sector level inventory of PPP projects, conduct pre-feasibility studies for 5 projects (with potential for replication in rest of the state), maintenance of an MIS on PPP projects in the sector.

In view of the above, GoK has appointed Ms. ICRA Management Consulting Services Limited (IMaCS) as transaction advisors for Directorate of Municipal Administration. The objective of the assistance is to develop five types of projects in the urban sector.

The primary objective of this assignment is to prepare a Pre-feasibility study report for Energy Efficiency in street lighting through ESCO's on Public-Private Partnership (PPP) basis, which would include assessment of, prima facie, feasibility for development of such Project on PPP basis, recommendations, conditionalities & enablers for development of the Project on PPP basis, preliminary assessment of the project financials, cash flow and viability issues, exploring options of packaging with other allied commercial components to make the project viable for a PPP mode, identifying criteria for measuring and monitoring service quality to be provided by developers/ operators to be selected for the Project, recognition of infrastructure, financing & other requirements for establishing the Project and Plan of Action for initiating next steps of project development and bid process management of the Project.

Provision of street lighting for public safety is an important responsibility and function of ULBs in India. The Bureau of Energy Efficiency, based on Central Electricity Authority statistics, has estimated gross energy consumption for public lighting to be 6,131 million kWh in India for the year 2007-2008. Quite often, street lighting is poorly designed and inadequately maintained by ULBs, and uses obsolete lighting technology. This causes a great loss of energy and increased costs to ULBs. Lighting can account for 10-38% of the total energy bill in typical cities worldwide (NYCGP 2009). Financial resources of ULBs in India are limited. Therefore, there is a need for energy efficient technologies in this sector.

Energy efficient technologies and design can cut street lighting costs dramatically (often by 25-60%). These savings can eliminate or reduce the need for new generating plants and provide the capital for alternative energy solutions for populations in remote areas. These cost savings can also enable municipalities to expand street lighting to additional areas, increasing access to lighting in low-income and other underserved areas. A well-designed, energy-efficient street lighting system should permit users to travel at night with good visibility, in safety and comfort, while reducing energy use and costs and enhancing the appearance of the neighbourhood and city as a whole.

1.2 Project Idea

The Bureau of Energy Efficiency (BEE) was set up under the Energy Conservation Act, 2001 to promote energy efficiency. The various mandatory and voluntary provisions of the Act that have to be performed by BEE include measures to create awareness and disseminate information for efficient use of energy and its conservation, organize training of personnel and specialists, promote and facilitate implementation of pilot project and demonstration projects and use of energy efficient processes, equipments, devices and systems etc.

The increasing energy costs at municipal levels have created big concerns for urban local bodies and population residing in the cities. With increasing urban population, energy consumption and electricity tariff increase the concern is getting highlighted at individual levels. In this regard, meetings and discussions with Infrastructure development Department, Karnataka (IDD), Directorate of Municipal Administration, Karnataka (DMA) and Hubli-Dharwad Municipal Corporation in February and March 2012, the following PPP project was identified for further scrutiny and development as part of this initiative in Hubli-Dharwad Municipal Corporation. The project is:

Energy Efficiency in Street Lighting through ESCO's – This project would involve the scope for saving energy costs in street lighting in Hubli-Dharwad Municipal Corporation through ESCO's by use of energy efficient equipments.

In twin cities of Hubli-Dharwad, whose present combined population is 9.4 lakhs, Municipal Corporation has been providing street lighting services through HESCOM, which is a Government of Karnataka undertaking and is responsible for power distribution in Dharwad, Gadag, Bijapur, Bagalkot, Uttara Kannada, Haveri and Belgaum districts of Karnataka. In 2010-11, Hubli-Dharwad Municipal Corporation had spent Rs. 10.32 crore (accounting for 9% of the total revenue payments) towards street lighting from revenue account. Electricity expenditure towards street lighting alone accounted for Rs. 8.28 crore out of Rs. 10.32 crore in that year. Even 30% reduction in electricity expenditure could have saved around Rs. 2.5 crore for corporation. Should the energy efficiency project realised, this amount will have a great contribution towards scarce financial resources of the corporation. Moreover, corporation can earn some carbon credits through Clean Development Mechanism.

1.3 Scope of Work for Prefeasibility Study

The objective of the engagement for IMaCS is to support Directorate of Municipal Administration in developing the project listed above in Hubli-Dharwad Municipal Corporation. The scope of work for the study shall be to:

- Prepare Pre-Feasibility Report for the project identified which includes:
    a) **Sector Profiling and identifying needs and goals** - Identifying the need for energy efficiency in street lighting and its importance in developing countries. Also, understanding the effects and benefits of energy efficiency in street lighting and its success key factors through case studies. The goals that the corporation would achieve by undertaking such project have been identified. The goals could include energy bill reduction by optimizing energy use, improving delivery of services, reducing GHG emissions according to Energy Conservation Act 2001, undertaking rehabilitation of existing systems and so on. For example, the cost savings positively contributes to municipal finances, and installation of new energy efficient equipment improves delivery of services.

b) **Overview and profiling of Hubli-Dharwad Municipal Corporation** - Detailed profiling of HDMC and its infrastructure with respect to street lighting system, to understand the supply side for the project

c) **Technical analysis:** In the technical analysis, the technical assessment of the current situation and a proposal for changes has been incorporated. An evaluation of the accessibility to technology and its suitability for the identified problems has been made.

d) **Market assessment and economic analysis:** Market assessment has been done to evaluate the demand in order to estimate the project size and the capacity needed. In economic analysis, cost effectiveness of the project has been expressed and it includes all revenue and costs for the lifetime of the project, and accounts for time value of money.

e) **Financial analysis:** Preparation of preliminary financial model to explore the viability of the project on PPP mode in a sustainable manner has been done.

f) **Risk assessment:** Risk is a part of every project; therefore risk analysis helps in identifying the potential problems and estimates expenses to minimize the risks. There are some risks that can significantly affect the economic results of a project and these have been considered. Market fluctuations, such as demand or energy prices, dispersion of the economic assumptions initially made, technical problems and legislative changes are issues that can occur and thus have been addressed.

g) **Statutory and Legal Framework:** Understanding the statutory and legal framework which prevails in this project and identifying the policy issues which may slow down the process of implementation of the project on PPP mode has been covered in the study.

h) **Project Structuring:** Preliminary recommendations of possible Project Structure & Project Development Framework; which includes, structure of PPP, identification of components for PPP, Benefits, risks and mitigation etc.)

i) **Way forward**

- Prepare Procurement Plan for Selection of Transaction Advisors/ Technical Consultant for the project

a) Development of TOR for Transaction Advisor/ Technical Consultant

1.4 Approach and Methodology

The approach and methodology adopted in assessing the feasibility of the energy efficiency (EE) project in street lighting of Hubli-Dharwad Corporation is given below:

- **Situation Analysis and Review**

a) City Profiling: Understanding & Analysis of demographics, density distribution and overview of existing infrastructure and future growth pattern.

b) Existing Situation: Study of existing street lighting system, coverage areas, institutional arrangements, financial aspects, and review of on-going management plans within Hubli-Dharwad Municipal Corporation. Technical aspect would include analysis of lux level, loading pattern, energy savings by adopting different efficiency measures, etc.

- **Identification of Critical Issues**

a) Critical issues would be identified as a part of the project pre-feasibility which would be required to be addressed by the stakeholders prior to commencement of Project Development. Some of the critical factors are:

- Audit & Inventory of existing street lighting infrastructure
- Existing billing system, tariff in place, O&M cost
- Possibilities & limitation on Private sector participation in O&M

- **Preliminary Financial Viability Assessment**

As per the study requirements, IMaCS has carried out a Preliminary Financial Viability Assessment for the Project based on ball-park estimation of Capital costs, O&M costs, revenues and other key performance parameters. For this market data relating to cost of new fixtures, new technology, etc. has been considered based on secondary research. Financial data related to budget sheets has been collected from the Municipal Corporation to understand its financial health and its current expenses on street lighting system. Cost analysis has been performed for different options. After choosing the best option, financial analysis and project structuring has been finalized.

- **Project Implementation Structure**

An appropriate project implementation structure have been recommended for implementation of the project through ESCO's on the basis of the Preliminary Financial Viability Assessment, market and economic assessment, existing regulatory framework and risk assessment.

- **Project Development Framework & Way Forward**

The Pre-feasibility study report of the Project has included the suggested Project Development Framework and Way Forward for development of the Project.

1.5 Study of earlier reports

No studies related to energy efficiency in Hubli-Dharwad have been conducted till now and thus was not available for the reference. But various reports on EE projects in street lighting (IFC Energy Efficiency Manual, DPRs on Energy Audit, best practices etc. for other sites) have been reviewed before going for prefeasibility analysis.

The Manual for the Development of Municipal Energy Efficiency Projects, which was developed as part of the India ESCO/Municipal Energy Efficiency Linkages Program and was funded by the International Finance Corporation (IFC), serves as a practical tool for anyone interested in being a part in the development, financing and/or implementation of a municipal energy efficiency project using a performance contract. The primary audience for this manual consists of municipalities, ESCOs and other types of efficiency service providers, and financial institutions.

DPRs (of Meerut city, Guntur city and Varanasi city), prepared for Bureau of Energy Efficiency (BEE), on Investment Grade Energy Audits (IGA) have also been reviewed. These DPRs were prepared as a part of Municipal Demand Side Management (MuDSM) program. The Mission of the MuDSM program 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. The DPRs include detailed study of intended segment, creation of database, quantification of energy losses & energy savings, and presentation of EE project as bankable project.

Many States and Cities in India have come forward to implement energy efficiency project at municipal level to reduce energy consumption and costs and thus get benefits through savings from reduced budget costs and Clean Development Mechanism by reducing green house gas emissions in the atmosphere.

1.6 Report Structure

This document covers our Pre-Feasibility Report for the Energy Efficiency Project in Hubli-Dharwad Municipal Corporation, namely, Savings by means of Energy Efficiency in Street Lighting.

The report has been prepared based on information provided by Hubli-Dharwad Municipal Corporation and is organised along the following sections:

- Section 1 *"Introduction"* (this section) covers idea behind the project, scope of work and approach & methodology adopted for the study.
- Section 2 *"Sector Profile"* gives an overview of street lighting sector.
- Section 3 *"Project Brief"* covers description of the site with existing situation of street lighting system and secondary case studies.
- Section 4 *"Operating Framework"* covers the technical assessment, project structuring and risks involved in the project.
- Section 5 *"Project Financials"* covers the indicative financial estimations for the project
- Section 6 *"Statutory and Legal Framework"* covers the laws, acts, policies etc. which would be applicable for the project
- Section 7 *"Indicative Environmental & Social Impacts"* covers the possible impacts due to project implementation and mitigative measures to overcome them.
- Section 8 *"Way Ahead"* covers the project development Framework and Procurement Plan.

2. Sector profile

2.1 Sector overview

Public street lighting represents a significant load for India. It is the responsibility of the municipal Corporations and the state electricity boards (SEBs) to provide this service to the country. In several ULBs, the electricity required for this service is not metered, providing little incentive for system improvement. Lighting can account for 10–38% of the total energy bill in typical cities worldwide (NYCGP 2009). The Bureau of Energy Efficiency, based on Central Electricity Authority statistics, has estimated gross energy consumption for public lighting to be 6,131 million kWh in India for the years 2007-2008. With a demand of more than 1000 MW, public lighting represents approximately 1% of the total electricity consumed in India. Even if this represents a small percentage of the total consumption, it is an interesting segment due to its high potential for energy savings (average of 33% of the consumption).

Guidance for lighting of public streets, roads, and highways is provided in the Bureau Indian Standard (BIS, 1981). Since these guidelines are not enforced by any regulatory authority, it is common for municipalities to be unaware of the standards, and many fail to comply.

The most common reasons for inefficient street lighting systems in municipalities are:

- Selection of inefficient luminaires
- Poor design and installation
- Poor power quality
- Poor operation and maintenance practices

There is tremendous potential to improve lighting quality while reducing energy use, costs, and greenhouse gas emissions – through energy-efficient retrofits for street lighting and improved operation and maintenance (O&M) practices.

In the last few years, technological advancements in lighting have led to the development of energy-efficient lighting systems that consist of one or more components listed below:

- Low Cost Ballasts
- Constant wattage high intensity electronic ballasts
- Energy-efficient luminaires
- Better monitoring and control mechanisms

According to an NYSERDA (2002) report, effective energy-efficient street lighting design integrates efficient lamp technologies, optimum pole height and placement, efficient light distribution, and aesthetics while using the least energy and meeting requirements for visibility and appropriate light levels.

Street lighting components can be grouped based on their functions. They are generally described as the structural systems, electrical systems, and optical systems. Structural system includes poles and poles foundation. Electrical & optical system include fixtures such as luminaires, lamps, ballasts, meters, fuses, etc. All systems should be designed to minimize life-cycle cost, while meeting lighting requirements.

The most important element of the illumination system is the light source. It is the principal determinant of the visual quality, cost, and energy efficiency aspects of the illumination system.

The types of lamps commonly used for street lighting are listed below:

Exhibit 2-1 Lamp Technologies

Type of Lamp	Luminous Efficacy (lm/W)	Color Rendering Properties	Lamp life in hrs	Remarks
High Pressure Mercury Vapor (MV)	35-65 lm/W	Fair	10,000-15,000	High energy use, poor lamp life
Metal Halide (MH)	70-130 lm/W	Excellent	8,000-12,000	High luminous efficacy, poor lamp life
High Pressure Sodium Vapor (HPSV)	50-150 lm/W	Fair	15,000-24,000	Energy-efficient, poor color rendering
Low Pressure Sodium Vapor	100-190 lm/W	Very Poor	18,000-24,000	Energy-efficient, very poor color rendering
Low Pressure Mercury Fluorescent Tubular Lamp (T12 &T8)	30-90 lm/W	Good	5,000-10,000	Poor lamp life, medium energy use, only available in low wattages
Energy-efficient Fluorescent Tubular Lamp (T5)	100-120 lm/W	Very Good	15,000-20,000	Energy-efficient, long lamp life, only available in low wattages
Light Emitting Diode (LED)	70-160 lm/W	Good	40,000-90,000	High energy savings, low maintenance, long life, no mercury. High investment cost, nascent technology
Induction Lamps	85 to 150 lm/W	Good	60,000 – 1,00,000	High energy savings, low maintenance, long life, no mercury. Available in varied wattages

Exhibit 2-2 Cost Information– Various EE Street Lighting Technologies

Type of Lamp	Remarks	Installed Cost [Only Lamp + Luminaire]	Annual Energy Cost	Annual Operating Cost	Total Annualized Cost [Energy + Operating]
		Rs.	Rs.	Rs.	Rs.
High Pressure Mercury Vapor (MV)	High energy use, poor lamp life	465,800	805,920	43,625	849,545
Metal Halide (MH)	High luminous efficacy, poor lamp life	2,449,615	464,954	77,703	542,657
High Pressure Sodium Vapor (HPSV)	Energy-efficient, poor color rendering	1,750,286	345,394	10,512	355,906
Low Pressure Sodium Vapor	Energy-efficient, very poor color rendering	1,370,400	394,200	119,837	514,037
Low Pressure Mercury Fluorescent Tubular Lamp (T12 &T8)	Poor lamp life, medium energy use, only available in low wattages	390,857	550,629	36,041	586,670
Energy-efficient Fluorescent	High luminous efficacy, only available in low	510,000	474,500	105,120	579,620

Type of Lamp	Remarks	Installed Cost [Only Lamp + Luminaire]	Annual Energy Cost	Annual Operating Cost	Total Annualized Cost [Energy + Operating]
Tubular Lamp (T5)	wattages				
Light Emitting Diode (LED)	High energy savings, low maintenance, long life, no mercury. High investment cost, nascent technology	6,000,000	372,300	0 [incon-sequential]	372,300

Source: Industry data provided by Electric Lamp and Component Manufacturers' Association (ELCOMA) of India. Assuming 7.5 m. wide, dual carriageway type, 1 km long road.

Estimation of Energy Savings from EE Projects

In order to estimate the energy savings achieved by an EE project, electricity consumption pre and post project needs to be find out. Savings in energy would be calculated using following formula.

Electricity Saving = (Pre-implementation electricity use) – (Post-implementation electricity use) ± Adjustments

2.2 Regional profile

Main sources of energy in Karnataka state for electricity production include Coal – 35%, Gas – 2%, Diesel – 3%, Large Hydro – 38%, Renewable Energy Sources – 20% and Nuclear – 2% with total installed capacity of 9346 MW (March 2009). The electricity generation in the state had come down and the dependence on other states for meeting electricity requirements had increased from 2001-02. The Load Generation Balance Report (LGBR) prepared by CEA during June 2008, indicates that the actual requirement for 2008 was 40,320 MU, indicating an energy shortage of 2.7%. The peak requirement was 6,583 MW and the actual peak met was 5,567 MW, indicating peak shortage of 15.4%. It was also estimated that the deficits would increase in 2009.

2.3 Key Issues

The key issues which have been observed during the visits and consultations with the stakeholders are:

- The energy usage through street lights is very high due to lack of automatic timers, automation web system etc. Lack of such infrastructural components in the street lighting has led to wastage of energy.
- Excess use of energy is done to illuminate Hubli-Dharwad city in the night and cost is incurred by Hubli-Dharwad Municipal Corporation. Municipal Corporation had spent Rs. 10.32 crore (accounting for 9% of the total revenue payments) towards street lighting from revenue account. Electricity expenditure towards street lighting alone accounted for Rs. 8.28 crore out of Rs. 10.32 crore in that year.
- The SFC grants provided by the government are against the bills generated by HESCOM for the consumption of the electricity. After, the implementation of the project the cost incurred in energy consumption would reduce as the consumption would be less. During consultations it was found that the grants amount would also reduce accordingly and it will match with the new bills. This suggests that the saving done by the municipal corporation would not remain with them and thus it would be hard to implement this project from Municipal Corporation side. This needs to be discussed in detail and sought out before developing the project.

3. Project Brief

3.1 Project Objective

It is not surprising that electricity consumption in municipal sector is increasing steadily over the last few years. There is need to address the issues of high electricity consumption 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 basic objective of the project is to improve the energy efficiency of Hubli-Dharwad Municipal Corporation which could lead to substantial savings in the electricity consumption, thereby resulting in cost reduction/savings for the ULB. 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.

The objective is to reduce the electricity consumption in street lighting through demand side management measures which may include development and promotion of energy efficient technologies in lighting system, web-based monitoring system, peak-hour demand monitoring etc. 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 and then suggest solutions for reduction in energy consumption. This will lead to improvement in service delivery and reduction in green house gas emissions.

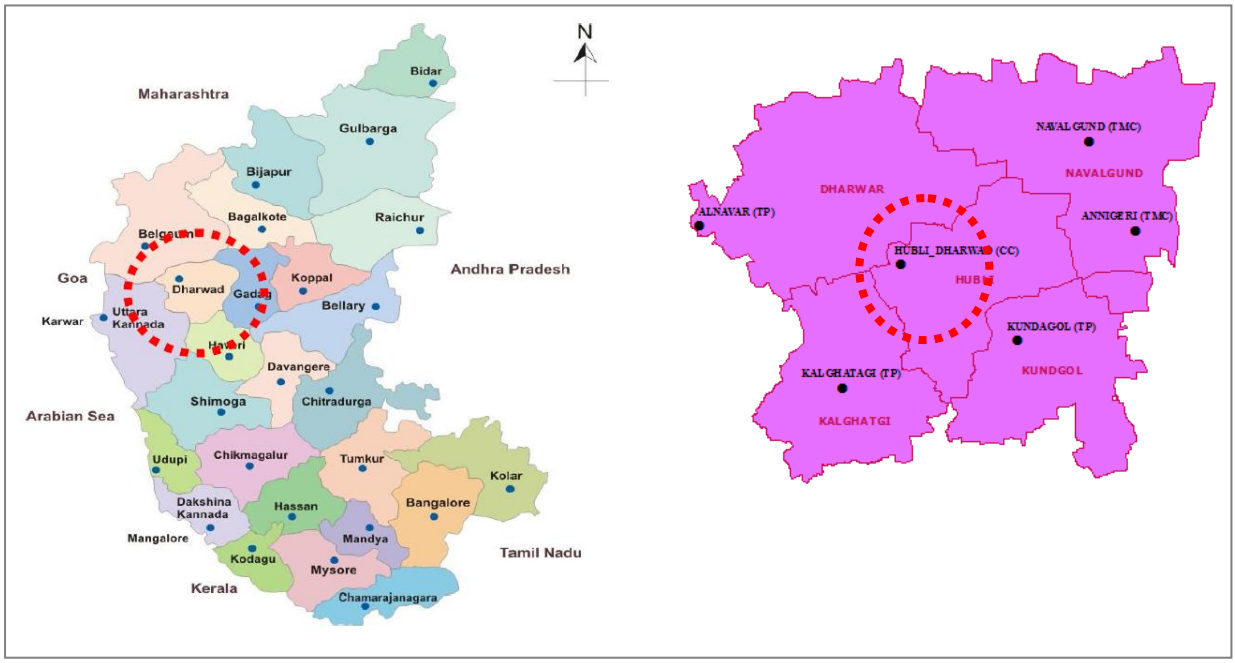
3.2 Description of the Site

Hubli-Dharwad is the second-largest conurbation in Karnataka after the State capital - Bangalore. Dharwad is a quiet, pleasant, and fast growing city in the northern part of Karnataka, which together with Hubli, 22 kilometres apart, forms a twin city, about 400 km from Bangalore.

While Dharwad is the administrative headquarters of Dharwad District and an important education centre, Hubli is primarily a commercial and industrial centre. It is believed that owing to this diversity and geographical proximity, the State government amalgamated the two cities. The Hubli Municipal Corporation (HDMC) was constituted in the year 1962 by combining the two cities. The twin cities have a population of nearly 9.4 Lakh (Census 2011) and it covers an area of 202.28 sq kms, with development concentrated in 72.78 sq kms including 45 revenue villages and large number of extensions spread in all the directions. The State Government promotes the industrialisation of the region leveraging its strategic location, good connectivity with metropolitan centres (like Mumbai, Pune and Bangalore), availability of water and forest resources, and labour.

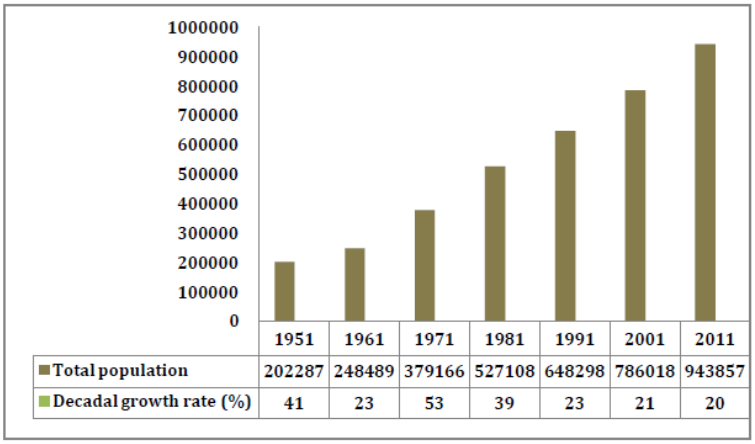
Located at about 480 km north of Bangalore and separated by a distance of 20 km, both the cities are connected to Pune and Bangalore by rail network; other rail links connect the city with Hotgi, holapur, Marmagoa and Bellary. The twin cities are also connected to Mumbai and Bangalore by Air.

Exhibit 3-1: Location map of Hubli-Dharwad City



The provisional reports of Census 2011 depicts that the total population of the City is 943857 of which male and female are 475,980 and 467,877 respectively. Population has increased from 2 lakhs to 9.4 lakhs in six decades.

Exhibit 3-2: Population Growth of Hubli-Dharwad Municipal Corporation



	1951	1961	1971	1981	1991	2001	2011
Total population	202287	248489	379166	527108	648298	786018	943857
Decadal growth rate (%)	41	23	53	39	23	21	20

Source: City Sanitation Plan, Hubli-Dharwad

The population growth in the post independence scenario is attributed to the importance given to these areas by Karnataka after the reorganization of states in 1956. A number of regional offices of the State Government for North Karnataka were located in Dharwad district. The population growth rates have been decreased over the decades due to lack of new economic activities and development as compared to other cities in Karnataka.

The population density has shown consistent growth during the past three decades in Hubli-Dharwad. The density has increased from 1837 persons/sq. km in 1971 to 3886 persons/sq. km in 2001 and then to 4666 persons/ sq. Km in 2011. While the city's overall density is quite low, the core inner areas and some older areas of the city are more densely populated than the fringe areas of the city.

3.3 Description of the Project

3.3.1 Existing Situation

Hubli-Dharwad has large 67 wards which have been divided for street lighting system into 12 zones by Municipal Corporation and into 6 zones by HESCOM (provider for electricity to Municipal Corporation). The town has total of 40278 street light fixtures and 1389 numbers of switching points, one at each metering point for the street lights which are handled manually. The street Lighting Fixtures comprises of 40W TLF, 250 W MHL/SVL, 400 W (MHL/ SVL) out of 79 high mast lamps and 1x28 W t-5 Fitting and 4x24 W T-5 Fittings as shown in Exhibit 3-3. Hubli-Dharwad has shown awareness in energy efficiency by putting energy efficient street lights at new areas which are equivalent to 5835 numbers. Effectively, at present Hubli-Dharwad have 34443 old conventional lamps on street light fixtures which consume high energy.

Exhibit 3-3 Composition of Street Lighting Fixture in Hubli-Dharwad

S.no.	Type of Street Light/ Fixtures	Numbers	Percentage
1	40 W TLF	22755	57%
2	250 W MHL/ SVL	10218	25%
3	400 W (MHL/ SVL) out of 79 High Masts	1470	4%
4	1 x 28 W T-5 Fittings	2470	6%
5	4 x 24 W T-5 Fittings	3365	8%
	Total	**40278**	**100%**

Source: Hubli-Dharwad Municipal Corporation

The total road length in the city is 1266 kms thus showing average distance of 31.5 meters between two street lights. This is very near to the UDPFI guidelines, but at some locations such as national highways, state highways, arterial and sub-arterial roads the two light fixtures are on one pole which could not be taken under the calculations. The average operating hrs is 10, 12 & 11 hrs per day for summer, winter & monsoon respectively based on discussion with technical personnel at Hubli-Dharwad Municipal Corporation. But in reality, the timing of running hrs of street lighting goes above than the prescribed timing. The electrical consumption in street lighting in the city was 16633572 KWH (16633 MWH) in 2011-12. On an average it comes out be 45571 KWH (45MWH) per day. The consumption of electricity has been shown HESCOM zone-wise in Exhibit 3-4. The connected load is equivalent to 5088 KW in Hubli-Dharwad.

Exhibit 3-4: Electricity Consumption and Connected load in the city

	Zone	Consumption (KWH in 2011-12)
Hubli	CSD-I	5325608
	CSD-II	3687594
	CSD-III	2441017
	Total	**11454219**
Dharwad	CSD-I	2887652
	CSD-II	2272463
	RSD	19238
	Total	**5179353**
Grand Total		**16633572**

Source: Hubli-Dharwad Municipal Corporation

In Existing Street Lighting system revenue income is through electricity grants from government and expenses include various heads. The cost is incurred in electricity bill, establishment cost, operation and maintenance and other office expenses. Hubli-Dharwad Municipal Corporation buys electricity from HESCOM.

Hubli-Dharwad Municipal Corporation handles the street lighting and pays for electricity bill to HESCOM, it works for asset management but it has outsourced the operation and maintenance of street lighting to private contractors. An agreement has been made on the quoted rates for annual maintenance of the type of street lights.

Exhibit 3-5 represents the share of expenses on street lighting and electricity bills being paid by Hubli-Dharwad Municipal Corporation with respect to total expenses. It has been observed that electricity bill shares a large proportion of 5 to 7% in the total expenses incurred by the corporation and it shares 60 to 80% of the payments done in street lighting.

Exhibit 3-5: Expenses on Street Lighting in last three years

Budget Heads	Actual	Actual	Revised
	2009-10	2010-11	2011-12
Total Revenue Receipts	11923.81	13418.52	15412.39
Total Revenue Payments	9355.14	11716.29	12606.77
Revenue Receipts - Street Lighting	**1559.59**	**2570.26**	**2258**
Revenue Payments - Street Lighting	**718.73**	**1032.37**	**1220.1**
Electrical Department Salary Expenses	49.61	44.68	90.67
Outsourced Street Light Expense	148.6	121.97	180.91
Energy Power Bill Expenses	494.31	827.93	760.36
Repairs and maintenance - Infrastructure Assets	20.61	25.71	30
Repairs and maintenance - Other Fixed Assets	2.42	1.31	3.95
Other Expenses	3.18	10.77	154.21
Payment Share			
Street Lighting Revenue Payment - % share wrt total	7.7	8.8	9.7
Electricity Bill of Street Lighting - % share wrt total	5.3	7.1	6.0
Electricity Bill of Street Lighting -% share wrt Revenue payment of street lighting	68.8	80.2	62.3

Source: Budget Documents, 2010-11, 2011-12 and 2012-13; HDMC

Municipal Corporation does not get any capital receipts for asset investment but it does capital payment for investing into erection of new poles and fixtures based on the requirements.

3.3.2 Suggested Framework: Components of the Project

The Energy Efficiency in Street Lighting Project through ESCOs in Hubli-Dharwad looks into the reduction of energy consumption at city-level which in due course will reduce the power cost. Few components of the project are:

- Investment in development of energy efficient fixtures to reduce the power consumption and reduce the municipal cost
- Installation of Automatic timers at switching points which will develop the efficient usage of electricity and makes ULB more sustainable

3.4 Best practices and case studies

3.4.1 Need for energy efficiency in municipal infrastructure

India's urban system is the second largest in the World with an urban population surging to 31.16% (Census of India, 2001) of the total population. According to the "Report on Seventh Electric Power Survey", Public Water Works in India consumes more than 12000 MUs and Public Lighting consumes 5000 MUs of electricity. Energy audits in India have determined that water supply and street lighting system takes away 50% to 60% of the operating expense in the budget, due to negligible awareness in the cities. By becoming energy efficient, each Urban Local Body (ULB) can reap energy savings of 25% to 40% at a minimum. This translates to at least 4000 MUs of energy savings that can avoid the need for an additional capacity of 600 MW. ULBs in India can realize tremendous benefits by adopting and executing Municipal Energy Efficiency Programs.

The overall objective of energy efficiency street lighting is GHG reduction with savings in municipal budget. The reasons for energy wastage and high GHG emissions is lack of design based approach in street lighting, use of lighting components from secondary market, inadequate metering and monitoring facilities, not aware of the guidelines on lamp/fitting selection and absence of control systems.

Street Lighting has a huge potential to save energy which can be done by various parameters such as; use of energy efficient lighting, design based approach, regulating power parameters to suit the actual requirements, providing guidelines on usage of quality material and controlling the burning hours of the lamps.

TERI (The Environmental Research Institute) conducted a study in 21 municipalities and found massive saving potentials. The municipalities encompassed states of Andhra Pradesh, Karnataka, Maharashtra and Delhi. The total population of these ULBs were 55.14 lakh and their energy cost was Rs. 5000 lakh (1400 lakh kWh). It was found that energy saving potential varies between 15 to 40%, thus saving total cost of Rs. 1050 lakh (220 lakh kWh), which saved Rs. 19/ person per annum. It has a potential to save GHG at 50,000MT per annum. Overall, this will be a big contribution towards sustainable development with improved quality of service and customer satisfaction, reduced impact on grid and reduced GHG emissions.

3.4.2 Case studies

1. **Performance Contracting for Street Lighting Energy Efficiency – Akola, Maharashtra**

Project Description and Design

In 2006, AMC called for competitive bids from eligible firms (Energy Service Companies or ESCOs) to implement a street lighting retrofit project within their service territory. Evaluation of bids resulted in the selection of Asia Electronics Limited (AEL), an ESCO that has been implementing a number of energy efficient street lighting projects in India. The arrangements included:

- AEL invested its own funds to replace the entire set of 11,518 street-lighting fittings (high-pressure sodium vapour lamps, mercury vapour lamps, and standard fluorescent tube lights) with energy-efficient, T5 fluorescent tube lamps. The retrofit began in April 2007 and was completed within three months.
- AEL and AMC staff monitored savings based on the metering of a 10% sample of lamps and used the data to estimate savings from all new lamps throughout the city.

- The M&V process is conducted each year in the first month of the financial year. As Per the contract between AEL and AMC, AMC shares 95% of savings with AEL and retains 5% in electricity bills. In addition to shared savings payments, AEL also receives a share in maintenance saving.
- The ESPC's duration is 6 years. Under the ESPC, AEL must replace any failed lamps and maintain a minimum lux level.

Costs and Benefits

Capital and Operations & Management (O&M) Costs: AMC incurred no capital investment outlays during implementation, maintaining a positive cash flow. AEL arranged for all investment needed to replace the street lights, which were estimated at about Rs. 57 lakh. AMC pays AEL a share of the energy savings seen from the new lamps, and also a share of savings realized from the maintenance program, amounting to Rs. 8.25 per lighting fixture per year. Annual O&M expenditures, which were paid to AEL by AMC separately, are Rs. 11 lakh.

Cost effectiveness: A project financial analysis shows a positive net present value (NPV) of Rs. 194 lakh, considering an initial investment of Rs. 500 per fitting and a discount rate of 10% applied to 6 years savings. The internal rate of return (IRR) for the project is 99%. Since AEL received 95% of the savings, it's NPV (Rs.180 Lakh) and IRR (94%) are also attractive.

Meeting project objectives: The project achieved the intended objectives of improving street lighting services while lowering energy costs. Prior to the ESPC, all existing light fittings were not functioning. With the retrofit project, the service level of street lighting was improved with fully functional lamps in place along city streets. In addition, AEL continues to ensure the installed T5 lamps are in use and is responsible for replacing failed lamps. Most importantly, AMC was able to reduce its electricity bills and improve service with no upfront investment or budgetary outlay.

Energy reduction benefits: It resulted in an annual savings of 21.3 Lakh kWh, representing a 55.7% savings compared to pre-project annual consumption of 38.2 Lakh kWh. The annual electricity bill savings were Rs. 64 Lakh/ year.

GHG emission reductions: Reductions of 1,830 MT of CO2 emissions per year, or a total of 10,980 MT of CO2 emissions over the 6 year contract period.

Lessons Learned

Leadership shown by AMC officials taking the initiative to implement the ESPC approach was an important factor in the project's success. City officials developed the project concept, prepared and issued the bidding documents, and selected AEL as the highest ranked firm.

The availability of locally manufactured energy efficient T5 fluorescent tube lamps and existence of local ESCOs were also factors in the project's success. AEL is a major manufacturer of T5 lamps and showed its capacity and interest in taking on projects on a performance contracting basis. Further, AEL's ability to serve as an ESCO that is, mobilize financing, provide turn-key services, and guarantee project performance also made the project succeed for all parties involved.

2. **Municipal Energy Efficiency Projects in Gujarat**

Project Description and Design

Gujarat Urban Development Company Ltd. (GUDC) on behalf of Govt. of Gujarat and IL&FS Ecosmart Ltd. has jointly taken initiative to improve the energy efficiency of 159 Urban Local Bodies

(ULBs) and 7 Municipal Corporations (MCs) in the State of Gujarat. The Street Lighting and Water & Sewage Pumping stations of the ULBs & MCs consume nearly 90% of their annual electricity bill.

In street lighting system, the suggested energy efficiency measures include replacement of old lights/lamps with energy efficient lamps; retrofitting such as installation of voltage controller, replacement of conventional choke to electronic chokes, alternate lamp lighting and angle of tilt and mounting height as per IS 1944. The project has faced few challenges which involved unavailability of historical data, Lack of metering/ sub metering and theft of energy during festive season or such kind of occasions which are hard to account and record.

The contract period is for 7 years with substantial completion period of EE measures is 6 months with the minimum saving of 30% for street lighting. It has been decided that ULBs will receive 25% sharing on guaranteed saving potential. The additional savings shall be shared at 50%-50%, if ESCO achieves savings more that that has been stated in performance contract after IGA. Performance security fee has been kept at 5% of guaranteed savings and for this an ESCROW account has been suggested to setup. Monitoring and Verification would be done by third party who would verify the saving potential guarantee by the ESCO. Frequency of M&V is 3 months for the first year and half-yearly thereafter. In the project, ESCO has been given the responsibility of maintaining the energy efficiency devices installed by them during the contract period and it has also got the responsibility to train the ULB personnel for operation and maintenance of the EE devices installed by them.

Potential Savings

Based on the baseline data of 2009 for 7 Municipal Corporation's and 159 ULBs, the energy bill for a year is Rs 285 crore and it has been estimated that the potential saving is equivalent to Rs. 85 crores which is 20-30% for the energy bill. It has a saving potential of 234 GWh through energy saving and it avoids 38 MW generation capacity in the state. The project has a CDM potential and it has been estimated that it will reduce 119 thousand tonnes of CO2 in the state and thus CDM Project is being implemented with assistance from BEE and Ernst & Young have been appointed as a CDM Consultant.

3. **Energy-efficient street lighting in Guntur, Andhra Pradesh**

The municipal corporation of Guntur was spending Rs1,072,074 (US$26,360.31) (based on the monthly average for electricity bills in 2002) for street lighting alone. A pilot demonstration project 'the Energy Efficient Street Lighting System' was initiated in March 2003. This involved using power saving instruments in four strategic locations, each device calibrated for that location's unique lighting load. The Servo Max Power (produced by Servomax India Limited) saver devices, installed at switch points, guarantees a 25% to 30% reduction in energy consumption. The devices in the four demonstration areas regulate voltage after peak hours and automatically reduce voltage during low traffic flow. The pilot project was supported by ICLEI under an agreement with Guntur Municipal Corporation (GMC), which agreed that once the results of the pilot project were substantiated GMC would implement its recommendations across the entire city in a phased approach through an Energy Services Company (ESCO). These devices resulted in an overall energy saving of 35%, saving 22,900 kWhs of electricity and reducing CO2 by 23 tonnes per year.

4. **Retrofitting streetlights for energy efficiency – Jabalpur, Madhya Pradesh**

ICLEI along with the Municipal Corporation of Jabalpur (MCJ) proposed an energy efficient street lighting pilot project to reduce the expenditure and improve the energy-efficiency in the existing system on finding that 20% of the energy bill is through street lights. The 'Retrofit Street Lighting Pilot Project' was launched in 2002. The project was located at two important locations in Jabalpur, namely

Nehru Garden, MCJ and Janki Nagar Residential Area, where 51 energy-saving retrofit tube lights were installed. The cost of the project was Rs.50,000 (US$1,208.75) 70% of which was shared by ICLEI, with the remaining 30% contributed by the project consultant, Asian Electronics Ltd.

The basic concept for the project is a retrofit of the conventional streetlight system with an energy-efficient tube light system. Jabalpur streets, walkways and parks are commonly lit with 40-W fluorescent tube lights with ballasts that consume an additional 10-13 W. To reduce energy consumption, 28-W retrofit tube lights have been introduced on the pilot project sites. The data gathered after six months of monitoring and observations suggests that the savings associated with the retrofit is Rs35/month/tube (US$0.85) according to 10-hour illumination/day and including maintenance and labour charges. This will also lead to an annual reduction of 7 tonnes of GHG emissions.

5. Summary of Energy Saving Streetlight Projects executed by AEL

Asian Electronics Ltd. is a company engaged in manufacturing of Energy Saving Products / system and implementation of Energy saving projects. AEL has formed a separate ESCO division to undertake energy saving project for buildings & street lighting.

Exhibit 3-6: Projects carried by AEL on EE for street Lighting

	Project	Status	Energy saving kwh/year	Energy saving (Rs. in lakh /year)	% Saving achieved	Energy saving systems offered
1.	Indore Municipal Corporation	Completed	8099813	247	36	New T8 based retrofit system & Energy Saver LMS panel
2.	Ujjain Municipal Corporation	Completed	2828096	86	38	New T8 based retrofit system & Energy Saver LMS panel
3.	Akola Municipal Corporation	Completed	1955330	59	58	New T-5 FTL Based Street light Fixtures as an alternative to HPSV / MV fixtures
4.	Latur Municipal Corporation	Completed	3376847	101	61	New T-5 FTL Based Street light Fixtures as an alternative to HPSV / MV fixtures
5.	Pune Municipal Corporation	Under implementation	9160000	275	55	New T-5 FTL Based Street light Fixtures as an alternative to HPSV / MV fixtures
6.	Amritsar Municipal Corporation PH. I	Completed	4880000	207	60	New T-5 FTL Based Street light Fixtures as an alternative to HPSV / MV fixtures
7.	Moga Municipal Corporation	Under implementation	1604902	68	-	New T-5 FTL Based Street light Fixtures as an alternative to HPSV / MV fixtures

	Project	Status	Energy saving kwh/year	Energy saving (Rs. in lakh /year)	% Saving achieved	Energy saving systems offered
8.	Ajmer Municipal Corporation & UIT Ajmer	Under implementation	4707985	181	-	New T5 FTL Based Street light Fixtures as an alternative to HPSV fixtures and GSM panels at switching points

Source: http://www.aelgroup.com/escoprojects.htm

3.4.3 Critical Success Factors

- Leadership shown by various urban local bodies' officials taking the initiative to implement energy efficiency approach was an important factor in the project's success. City officials participated in developing the project concept and selected the appropriate ESCO through proper bid process to make this initiative possible.
- The availability of locally manufactured energy efficient T5 fluorescent tube lamps and existence of local ESCOs were also factors in the project's success in few of the places.
- Few ESCO's are manufacturer of T5 lamps and showed there capacity and interest in taking on projects on a performance contracting basis. Further, their ability to serve as an ESCO that is, mobilize financing, provide turn-key services, and guarantee project performance also made the projects succeed for all parties involved.
- Achievement of potential savings in initial energy efficiency projects has put forward spill-over effect and thus helped in developing many projects across India.

4. Operating framework

4.1 Technical Assessment

The Energy Efficiency in Street Lighting can encompass various components to save energy and money of the urban local body. The report shows few technological options available for energy efficiency in street lighting and its benefits and finalizes one option based on cost-benefit analysis and advantages and disadvantages. The options consist of replacement of conventional lamps with energy efficient lamps or adding automatic timers at switching points with replacements of conventional lamps. Few more options such as dimming of lights at non-peak hours in the night and switching off of alternate lights have not been considered at this stage as these technologies require very detailed study and require very good supply side of electricity. The two options have been shown in Exhibit 4-1.

Exhibit 4-1: Various Options for Energy Efficiency in Street Lighting in Hubli-Dharwad

Option 1	Option 2
Replacement of conventional Lamps with Energy Efficient Lamps	Replacement of Conventional Lamps with energy Efficient Lamps and Automatic Timers at Switching Points

Option 1: Replacement of conventional lamps with energy efficient lamps

Existing Scenario

At present, the street lighting system in Hubli-Dharwad contains these fixtures:

- 22755 (40 W TLF)
- 10218 (250 W MHL/SVL)
- 1470 (400W MHL/SVL lamps)

Proposed Scenario

Based on secondary studies, it has been suggested to replace conventional lamps with energy efficient lamps:

- 40 W TLF with 28 W T-5 energy efficient Lamps
- 250 W MHL/SVL with 100 W Induction Lamps
- 400 W MHL/SVL with 150 W Induction Lamps

Benefits

On replacing all the conventional lamps with energy efficient lamps Hubli Dharwad Municipal Corporation saves 10190191 KWh of energy per year (10190 MWh/year). The cost saved by this process is equal to Rs. 427.99 Lakh/ annum at revised tariff which is equivalent to 56% of the total cost incurred by HDMC. This shows a very high saving in respect to both energy as well as cost. Through this, there is a reduction of 12979.1 of MT CO2 emissions. The detailed consumption and savings has been shown in Exhibit 4-2.

Exhibit 4-2: Energy and cost savings as per Option 1

Conventional Lamps			Replacements			Savings	
Type	Energy Consumed (KWh/day)	Energy Consumed (KWh/year)	Type	Energy Consumed (KWh/day)	Energy Consumed (KWh/year)	Energy Saved (KWh/ year)	Energy cost saved (Rs lakh/ year
40 W TLF	12015	4385344	28 W T-5	7509	2740840	1644504	69.07
250 W MHL/SVL	30347	11076823	100 W Induction Lamps	11802	4307653	6769170	284.31
400 W MHL/SVL	7406	2703139	150 W Induction Lamps	2539	926622	1776517	74.61
Total	**49768**	**18165306**		**21850**	**7975115**	**10190191**	**427.99**

Note: Energy Cost has been calculated on the basis of new tariffs; Rs. 4/ unit (HESCOM)

Advantages and Disadvantages

The advantages of 28 W T-5 tube lights is that it have normal 3 to 4 time higher life span (~5000 operating Hours) as compared to 40 W TLF. Much higher output in lumens value (104 lumens/ watt) against the conventional tube light. It can be replaced directly in existing fittings without any change in wiring or fittings. It has flicker free ignition and start, no humming noise and operating voltage range of 130V to 290V due to electronics ballast instead of electromagnetic ballast. MHL/SVL has been replaced by Induction Lamps as it has higher luminous efficacy as compared to conventional lamps. It has longer life (60000 to 100000 operating hours), fast warm-up/Re-strike, superior cold starting, improved colour uniformity.

Option 2: Replacement of Conventional Lamps with energy Efficient Lamps and Automatic Timers at Switching Points

Existing Scenario

At present, the street lighting system in Hubli-Dharwad contains:

- 22755 (40 W TLF), 10218 (250 W MHL/SVL) and 1470 (400W MHL/SVL lamps)
- 1389 switching points (manually operated)

Proposed Scenario

Based on secondary studies, it has been suggested to replace conventional lamps with energy efficient lamps as discussed in option 1 and to install automatic timers at switching points.

Benefits

On replacing all the conventional lamps with energy efficient lamps and installing automatic timers at switching points Hubli-Dharwad Municipal Corporation saves 11841582 KWh of energy per year (11841 MWh/year). The cost saved by this process is equal to Rs. 497.34 Lakh/ annum at revised tariff which is equivalent to 65% of the total cost incurred by HDMC. This shows a very high saving in respect to both energy as well as cost. Through this, there is a reduction of 15082 of MT CO2 emissions. The detailed consumption and savings has been shown in Exhibit 4-3.

Exhibit 4-3: Energy and cost savings as per Option 2

Type	Savings
Energy Saved by Replacement of Conventional Lamps with Energy Efficient Lights (KWh/ year)	10190191
Expected hours saved by automatic timers at switching points/ day	1
Expected hours saved by automatic timers at switching points/ year	365
Energy Saving through automatic timers (KWh/ year)	6323724
Total Energy Savings through option 2 (KWh/ year)	**11841582**
Total Energy Cost Savings (Rs. Lakh/ year)	**497.34**

Note: Energy Cost has been calculated on the basis of new tariffs; Rs. 4/ unit (HESCOM)

Advantages and Disadvantages

The advantages of replacement of various conventional lamps with energy efficient lamps have been discussed in earlier option. The benefit of automatic timer is that it reduces the energy consumption by not allowing lamp to remain lighted up even after natural light is there, which is generally observed in cities during early morning. There is a need to maintain timers regularly and also it needs to be checked for timings as per seasonal variation, so that it does not end up in wasting more energy.

Other Options

Although the use of dimming systems yields considerable energy savings and represents a financially justified investment, it should be used with caution. The use of dimming systems for street lighting is recommended when the supply voltage exceeds 220 V. This system is beneficial between late night and early morning hours when traffic density is significantly reduced. The use of dimming systems can result in issues such as color shift and poor lamp performance and if the supply voltage is less than 220 V after 10 pm then dimming method may not be suitable for energy efficiency in street lighting as it reduces lights life span, thus adding more cost for repairs.

The alternate lighting requires a detailed project report which identifies the actual distance between street light poles. Otherwise, if the distances are higher than prescribed norms for distance between street lights this system will lead to dark patches and insecure and unsafe environment.

4.1.1 Selection of option for the study

The most feasible option as per the advantages and disadvantages of various option and costs and benefits; Option 2 has been finalized which includes replacement of conventional lamps with energy efficient lamps and automatic timers at switching points.

CDM process can also become its part by floating CERs or carbon credits against carbon emission reduction in the atmosphere through energy efficiency technology after detailed study.

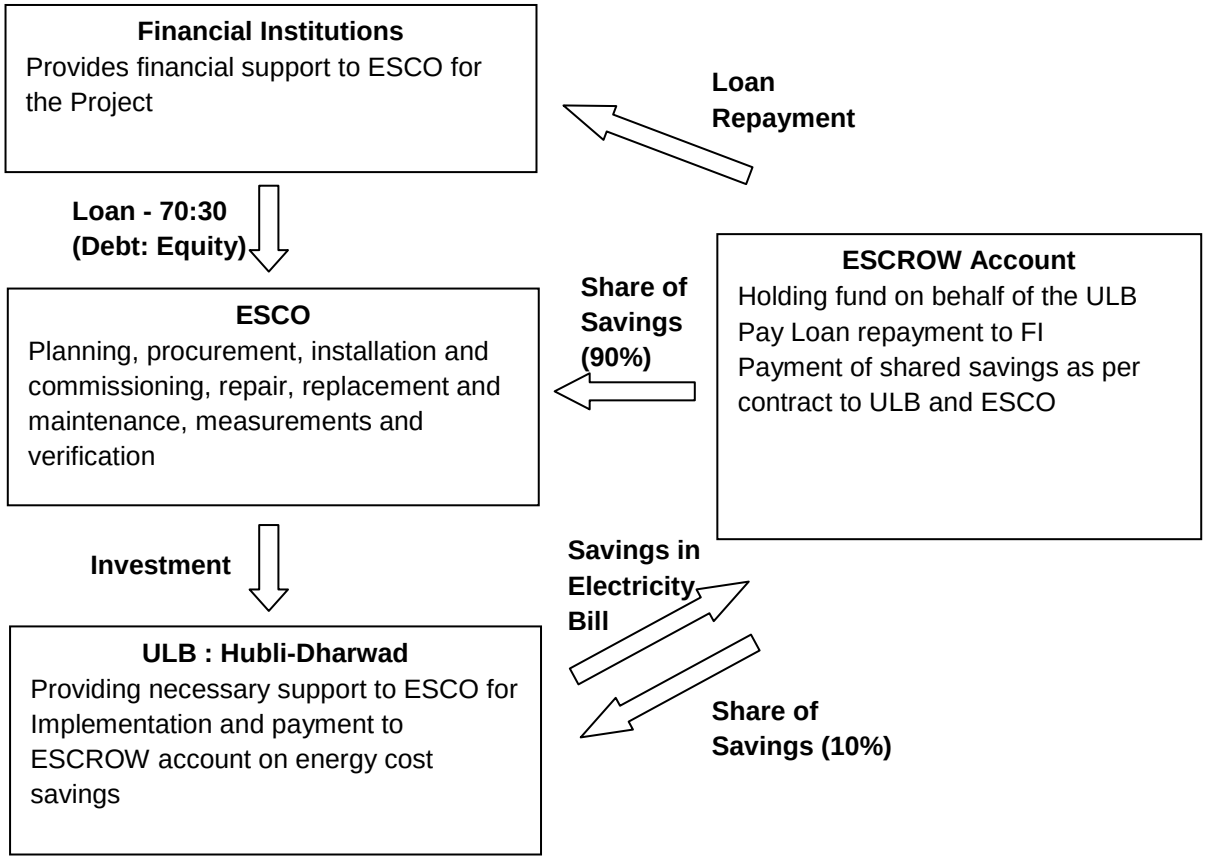
4.2 Business Model

ULB, ESCO and FI are stakeholders of the project. With the above-noted background in mind and after taken in to account the possible financing options, ESCO Mode business model have been developed.

Performance contract for ESCO has been considered for this project. ESCO with Third Party Financing at certain debt-equity ratio has been suggested. In this, the ESCO designs and implements

the project but does not finance it completely, although it arranges for or facilitate financing. The ESCO guarantees that the energy savings will be sufficient to cover debt service payments. It verifies energy savings and shares an agreed percentage of the actual energy savings over a fixed period with an ULB.

Exhibit 4-4: Business Model for ESCO



The specific terms and conditions of the proposed Project structure are detailed below:

1. Performance Contract between Hubli-Dharwad Municipal Corporation and ESCO would be for 10 years. It will include Design, Implementation, Finance, Operation, Maintenance and M & V. During this period, HDMC will allow an ESCO to use, replace, install, operate and maintain the existing street lighting system of HDMC.
2. Implementation period for replacement of fixtures and installation of automatic timers at switching points is 1 year for the project.
3. Financing of the project would be done at 70:30 debt-equity ratio. ESCO will arrange for finance by taking loan from a financial institution and put its equity at 30% of the project cost. The debt repayment with an interest would be paid back to financial institution within 5 years after implementation. The responsibility would be with an ESCO.
4. An ESCROW account would be developed to take account of all the savings and payments to ESCO and ULB and repayment on debt with interest to FI. It would be handled by the ULB.
5. The savings would be shared between ULB and ESCO where ULB would get 10% and ESCO would get 90% of the total saving. The repayment of debt and interest on debt would be paid fo FI from the share of an ESCO.

6. Measurements and Verification would be done either by the selected ESCO or by the third party as per the contract finalized between ESCO and HDMC.
7. The project can be taken under CDM mechanism also by generating CERs. This can be following "CDM project cycle". It can be finalized after detailed study and discussions between ESCO and HDMC.

4.2.1 Benefits of the proposed project structure

The proposed structure could potentially enable HDMC realise the following benefits:

1. HDMC would get an energy efficient street lighting system without any investments of its own.
2. HDMC will save 118.41 Lakh KWh energy per year through this project.
3. Energy cost savings of the project is Rs. 497.35 lakh in the first year with Rs. 49.73 Lakh revenue (saving) for HDMC. This saving increases over the year with escalations in the tariff rates.
4. The project results into the reduction of CO2 emission. Through this project would reduce 15082.5 MT of CO2 at production grid.
5. Citizens of Hubli-Dharwad will get improved service levels.

4.3 Risks & 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.

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

Risks	Description	Mitigation Measures
Financial		
Interest Rates	Both ESCO and ULB do not have significant control over prevailing interest rates. 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.	ESCO, ULB and FI can agree for a range of variation, Cost and saving calculation to be done with considering this risk factor.
Energy Prices	None of the stakeholders (ESCO / ULB / FI) has significant control over actual energy prices.	Due to shortage of power there is a potential of increasing the energy prize. The tariff has been revised this year in Karnataka. Energy cost has increased from Rs. 3.8. unit to Rs. 4/unit.
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	ESCO will demonstrate the minimum saving level periodically during the course of contract period. Savings to be monitored based on the actual consumption by installing calibrated

	with more uncertainty in the savings estimates.	energy meters at appropriate locations.
Payment Risks	Untimely payments to ESCO	Payment mechanism and deliverables to be well defined.
Delays	Both the ESCO and HDMC can cause delays. Failure to implement a viable project in a timely manner costs the HDMC and ESCO in the form of lost savings, and can add cost to the project.	To mitigate delays there is a need for regular monitoring over the implementation of the project
Operational		
Operating Hours and Loads	The ULB generally has control over operating hours. Increases and decreases in operating hours can show variations in "savings" depending on the M&V method. Equipment loads can change over time.	The baseline period should be carefully documented and agreed to, by all stakeholders.
Weather	A number of energy efficiency measures are affected by weather. None or the stakeholders have control over the weather.	Savings are calculated on annual basis so the annual variation in weather conditions is already taken into consideration. Baseline period need to be well defined.
Performance		
Risks associated with Equipment Performance	ESCO has control over the selection of equipment and is responsible for its proper installation, commissioning, and performance.	Minimum efficiency of new equipments will be included in the contract. ESCO will have to demonstrate the minimum efficiency level based on the accepted testing protocols. Penalty clause will be included in case efficiency levels are below the minimum ones
Operations	Responsibility for operations may rest with the ESCO for the entire performance contract period. Operations can impact performance.	Clarify responsibility for operations, the implications of equipment control, how changes in operating procedures will be handled, and how proper operations will be assured.
Equipment Repair and Replacement	Responsibility for repair and replacement of ESCO-installed equipment is negotiable; however it is often tied to project performance.	Minimum equipment life to be given by ESCO specifying warranties for all installed equipments. Potential impact on performance to be well addressed in case of equipment failure mentioning replacement responsibility
Theft /	It can increase the cost of the project	HDMC will not get free repair and

Replacement of Energy Efficient retrofits	and ESCO will have to suffer the loss if it becomes its responsibility.	maintenance service by ESCO for the remaining period
Political Risks	Change in law, expropriation, civil disturbance, non-default termination of contract.	These can be mitigated by effective legal documentation and insurance.
Force-Majeure Risk	Project is abandoned	Force majeure clauses in the contract agreement

Note: Based on the guidelines for ESCO by BEE

5. Project Financials

5.1 Concept and Methodology

A preliminary financial model has been prepared to assess the Estimated Project Cost, Estimated Revenues and the Project Returns. The Cost and Revenue assumptions were taken based on the estimates only to assess the feasibility of the project. However, it is recommended that the Project Financials may be firmed up only after preparation of the Internal Grade Audit Report for the project. The salient features of the preliminary financial model are highlighted in this section of the report.

The purpose of the Financial Analysis is to determine the financial viability of the investment in the project considering the cost of developing the project and the expected revenue stream through savings over a period of time. It also includes study of different scenarios from the ESCO's perspective.

5.2 Assumptions for Financial Analysis

5.2.1 Construction Period

It is assumed that replacement of conventional lamp with energy efficient lamps and installation of timers of the project will take 1 year.

5.2.2 Cost Assumptions

While calculating the project cost, the assumptions have been based on market feedback, other similar projects as well as IMaCS' own experience of advisory and project management consultancy.

Other assumptions which include Escalations in energy prices and other costs have been annexed in the report.

5.3 Cost Estimation

The estimated cost of the Project is Rs. 491.4 Lakh. The details of the Project Cost estimation are set out in Exhibit 5-1.

Exhibit 5-1 Cost Estimations

Cost Heads	Cost Estimates (Rs in Lakh)
Capital Cost of Replacements (Energy Efficient Fixtures)	308.4
Capital Cost of Automatic timers	158.3
Instalment cost incurred during replacement	24.6
Total Investment	**491.4**
Repair and Maintenance Cost	57.1 (will increase with escalation at 8% annually)
Measurement and Verification Cost	40.3 (will increase with escalation at 5% annually)
Man Power Expenses	43.9 (will increase with escalation at 1% annually)

5.4 Revenue Stream

The revenue to ESCO is dependent on the savings done by saving energy cost paid by HDMC every year. In the first year the total saving is equivalent to Rs. 497.3 Lakh. After sharing saving with HDMC and repayment of debt with its interest and other corporate taxes, the revenue of the ESCO after first year is Rs. 170.9 Lakh. The detailed financial model has been annexed.

5.5 Viability Assessment

The key financial indicators for the project are is shown in Exhibit 5-2 below.

Exhibit 5-2: Key Financial Indicator

Indicator	Value
Project IRR (Pre Tax)	35.59 %
Project IRR (After Tax)	19.54 %

From the above it can be seen that the Project IRR is greater than the common benchmark of 15%, where investors will most likely seek for such an investment. Thus the Project is viable on a standalone basis and any financial assistance would not be required towards the Project by Govt. to the ESCO. Also, the revenue through CERs has been not accounted which further increase the revenue stream and can increase the IRR for the project. This adds to the feasibility of the project.

5.6 Scenario Analysis

The following section presents the Scenario Analysis which provides the variation in the Project IRR in accordance with the variation in cost of the project as well as revenue from the project. The details of the same are as shown below in Exhibit 5-3.

Exhibit 5-3: Scenario Analysis

Variation in Project IRR		Revenue Variation				
		-20%	-10%	0%	10%	20%
Cost Variation	-20%	25.75%	27.82%	29.94%	32.12%	34.37%
	-10%	20.61%	22.48%	24.40%	26.36%	28.37%
	0%	16.05%	17.78%	19.54%	21.33%	23.16%
	10%	11.94%	13.55%	15.19%	16.85%	18.54%
	20%	8.15%	9.68%	11.23%	12.79%	14.38%

5.7 Conclusion

With the proposed structure, the project seems to be sustainable on a standalone basis without any financial support from Government.

6. Statutory & Legal Framework

Internationally, the emphasis on environmental problems such as biodiversity loss, land degradation and particularly the climate change have led to the emergence of important drivers of support for energy efficiency policies and programs.

In order to integrate energy efficiency in the development agenda, the Govt. of India has put in place an overarching legal, regulatory and policy framework to promote market based energy efficiency in the Indian economy.

6.1 Applicable laws

The Energy Conservation (EC) Act, 2001 came into force with effect from 1st March 2002. The Act empowers the Central Government and in some instances the State Government to take the following regulatory steps in various sectors to facilitate and enforce efficient use of energy and its conservation.

The Energy Conservation Act, 2001 (ECA) forms the core of the legal framework put in place by India to promote energy efficiency and conservation. Some important sections of ECA relevant to energy efficiency are:

- Section 3 – Bureau of Energy Efficiency-creation, administration
- Section 12 – Transfer of Assets and Liabilities of Energy Management Centre to BEE
- Section 13 – Powers and functions of the BEE
- Section 14 – Power of Central Government to Facilitate and Enforce Efficient use of Energy and its Conservation
- Section 15 -Power of State Government to Facilitate and Enforce Efficient use of Energy and its Conservation

6.2 Legal & Regulatory framework

Institutional arrangements have been created to implement the Act at central and state level. The Bureau of Energy Efficiency (BEE) is the nodal agency at the Central level and the State Designated Agencies (SDAs) work at the state level. These institutions are empowered with regulatory, promotional and enforcement roles under the Act.

Bureau of Energy Efficiency (BEE)

The mission of Bureau of Energy Efficiency (BEE) is to develop policy and strategies with a thrust on self-regulation and market principles, within the overall framework of the Energy Conservation Act (EC Act), 2001 with the primary objective of reducing energy intensity of the Indian economy. This will be achieved with active participation of all stakeholders, resulting in accelerated and sustained adoption of energy efficiency in all sectors. The setting up of Bureau of Energy Efficiency (BEE) provides a legal framework for energy efficiency initiatives in the country. The Act empowers the Central Government and in some instances the State Governments to:

- Notify energy intensive industries, other establishments, and commercial buildings as designated consumers.
- Establish and prescribe energy consumption norms and standards for designated consumers.

- Direct designated consumers to designate or appoint certified energy manager in charge of activities for efficient use of energy and its conservation.
- Get an energy audit conducted by an accredited energy auditor in the specified manner and intervals of time.
- Furnish information with regard to energy consumed and action taken on the recommendation of the accredited energy auditor to the designated agency.
- Comply with energy consumption norms and standards, and if not so, to prepare and implement schemes for efficient use of energy and its conservation.
- Prescribe energy conservation building codes for efficient use of energy and its conservation in commercial buildings State Governments to amend the energy conservation building codes to suit regional and local climatic conditions.
- Direct owners or occupiers of commercial buildings to comply with the provisions of energy conservation building codes.
- Direct mandatory display of label on notified equipment and appliances and specify energy consumption standards for notified equipment and appliance.
- Prohibit manufacture, sale, purchase and import of notified equipment and appliances not conforming to standards.

State Designated Agencies (SDA)

SDAs are statutory bodies set up under section 15 of the Energy Conservation Act (EC Act), 2001 at the state level to implement the Act. They are the nodal agencies at state level to coordinate with BEE to ensure implementation of the Act in the country. SDAs have an important role to play particularly to create public awareness and understanding about the values of energy conservation, enforcement of the Energy Conservation Act, 2001 at the grass root level, stimulating market transformation at the local level, collection, collation and analysis of data regarding energy use and dissemination of information to the masses regarding end use of efficient energy. They are the fulcrums for implementation of various initiatives at the central government level like publicity and awareness campaigns, directing Designated Consumers to get energy audit conducted by an accredited energy auditor, Investment Grade Energy Audit of Govt. Buildings and subsequent implementation through ESCO route, efficiency improvement in Municipal functions etc. In order to kick start the energy conservation activities at the state level with an emphasis on building institutional capacities of the SDAs, Ministry of Power had approved the scheme of Providing financial assistance to the State Designated Agencies for strengthening their institutional capacities and capabilities. During the 11th plan, the SDAs have undertaken various initiatives to promote the efficient use of energy and its conservation in the State. The Central Govt. supported SDAs in preparation of action plan, building institutional capacity of SDAs, to perform their regulatory, developmental and promotional functions in their respective states, by way of technical assistance, guidance and funding etc. Each SDA has been supported to develop a five year Energy Conservation Action Plan, customized to local needs aiming at and delivery of the EC act mandates.

Energy Efficiency Services Limited (EESL)

While BEE and SDAs provide the institutional, policy and regulatory framework, EESL has been set up to provide public sector leadership in the implementation of energy efficiency projects. EESL is expected to promote market access for energy efficiency, particularly in the public sector;

demonstration of effectiveness of ESCO delivery mechanism using the performance contract to leverage future cash flows; provide monitoring and verification leadership and also to encourage consultancy support in this sector. EESL fits well with the recently defined concept of 'Super ESCO' as it is sufficiently capitalized to undertake project implementation and to take financial risks.

EESL is also being entrusted with the role of being the implementation arm of the National Mission for Enhanced Energy Efficiency (NMEEE) and to unlock markets for energy efficiency in India.

7. Indicative environmental & social impacts

Energy Efficiency through street lighting is an initiative with certain objectives such as; reduction in electricity wastage, reduction in carbon dioxide emissions and reduction of expenses of urban local bodies on electricity bills. With all initiatives certain impacts are observed. The chapter detail outs the long-term and short-term environmental and social impacts with its mitigation measures.

7.1 Environmental Impacts

Energy Efficiency through street lighting is a step to make environment more clean and green and reduce the ill-effects of climate change. It has both positive and negative impacts on the environment which are:

- Reduction in Green House Gases – As the project reduces the consumption of energy for street lighting, the electricity required for municipal infrastructure reduces and thus the green house gas emission at generation point reduces.
- Handling / Storing used/damaged light bulbs (replaced or installed under the project as well as rejects) put out of use – If Environmentally deleterious materials generated by the replacement are not disposed off as per the guidelines then this effect the environment.
- Particulates in Air – This is possible if the fixtures and bulbs are broken on site such as breakage of lead or mercury lamps during replacement.
- Noise - Site work activities such as replacement of energy efficient lamps with old lamps create noises in the area and this can be disturbing for local residents.
- Vegetation ad Habitat Loss – During Installation, the existing plantation and landscaping can get affected.

7.2 Social Impacts

The Social Impacts due to energy efficiency in street lighting are:

- Efficient use of Electricity – The energy saved through street lighting can be supplied to un-electrified villages and other areas which lack electricity.
- Safety of Workers – Provision of personal protective equipment, traffic arrangements during installation of equipment, and emergency procedures in case of shocks, falls or other accidents.

7.3 Mitigation Measures

To mitigate the environmental and social impacts few steps become essential, so that the project does not face any problem during its implementation and it gets successful.

- Handling / Storing of used / damaged light bulbs - During installation of new energy saving streetlights, old streetlights are needed to be removed and stored in the corrugated box along with the lamps fitted into the old fittings in case of sodium vapour lamps. In case of replacement of old fluorescent tube light fittings, the lamps are required to be carefully removed first followed by the fitting. The lamps are needed to be kept in a separate box. A record sheet needs to be maintained while removing the old fittings mentioning the number of lamps removed. These old removed fittings & lamps would have to be transported daily to the place of storage (store depots / ward office stores) given by the Council. The old fittings would then be kept in a proper store room under lock & key. The units are not allowed to be used for re- installation. Any lamps broken

during the removal, transportation or storage of the old fittings need to be carefully collected and kept in a separate corrugated box for further disposal. The box is kept properly in the stores.

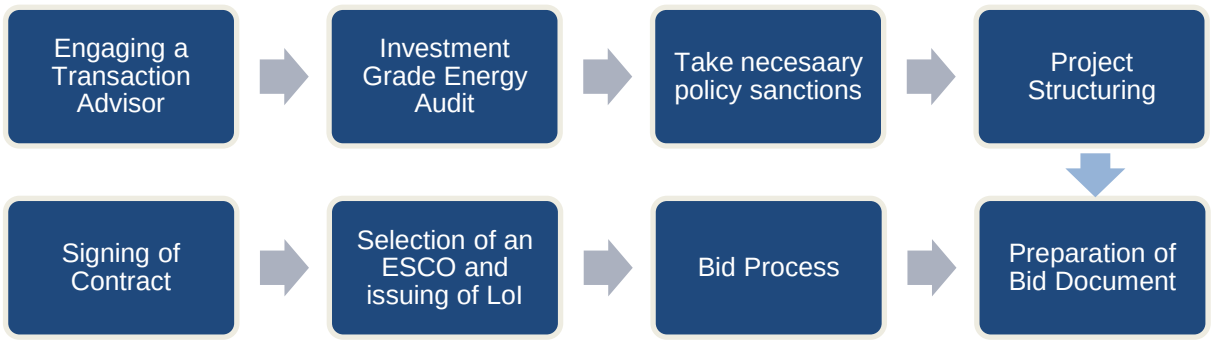
- Safety of Workers - The installation of the new fittings has to be done by workers as per the safety guidelines given in BEE. As per the guidelines, the installation needs to be done during the day-time with the entire power supply to the fittings shut OFF and by removing the fuse from the feeder points. Before the start of installation the concerned Council officials need to be informed about the exact location of the work, in order to avoid any accidental switching ON of the power by another maintenance team. While installation the workers have to be provided with helmet, rubber gloves, rubber shoes, insulated tools and safety belts. The workers have to be provided with proper extension type ladders for installation of streetlights above 7 meters. The ladders are provided with safety platforms covered from all sides for safety of the worker. At lower heights wooden ladder is used for removing the fittings for repairs. Proper medical kit is carried containing bandages & medicines. All the workers are covered under state insurance scheme. This gives them free medical treatment in case of any accident or illness in their dedicated hospitals. In case of any accident the workers should be given first aid at the nearest medical centre / hospital. Proper care is taken to divert the traffic while carrying on the installation. Sign boards indicating “Work in progress” are put on the road where necessary.
- Noise – To reduce noise effect site work activities are restricted to daytime operations. Attempts are also be made to limit unnecessary noises during the day so as to limit impact to the adjoining buildings containing offices, classroom, and residences. This is a short-term impact that will cease when the installation gets completed.
- Particulates in Air - Particulate emissions will be controlled by the off-site disposal of installation and removal debris. Burning of such materials will not be allowed on the site. Any lead, mercury and plastic containing materials will be removed by licensed abatement contractors using appropriate means to limit particulate emissions.
- Generated Wastes - Environmentally deleterious materials generated by the replacement activities, such as old or broken lamps will be stored separately & disposed in an appropriate, legal, and safe manner. In the event that hazardous wastes are generated during elimination, the contractor will properly dispose of them off site in accordance with appropriate disposal regulations
- Vegetation and Habitat Loss: Careful coordination will occur so as not to disturb any existing landscaping.

8. Way Ahead

8.1 Project Development Framework

Hubli-Dharwad Municipal Corporation needs to conduct detailed technical investigation and Investment Grade Energy Audit to determine the technical requirements and feasibility of the project in the form of Detailed Project Report (DPR). Upon preparation of the DPR, Hubli-Dharwad Municipal Corporation may then appoint a transaction advisor to carry out feasibility studies as well as to undertake bid process management.

Exhibit 8-1: Project Development Framework



8.2 Procurement Plan for further development

The first and foremost task for HDMC will be to appoint a transaction advisor which will be responsible for developing the project in the given time for its implementation.

Task for the Transaction advisor is to carry out Internal Grade Energy Audit on its own or through external sources. It needs to define structure of the project and finalize bid documents in discussion with HDMC. After that bidding process, selection of an ESCO and signing of contract will be completed within a month.

Activity/ Months	1	2	3	4	5	6	7	8
Appointment of Transaction Advisors (by HDMC)								
Preparation of IGEA (DPR)								
Project Structuring and Bid Documents preparation								
Bidding Process								
Selection of ESCO								
Signing of Contract								

8.3 Summary of Findings

The preliminary feasibility suggests that the project is achievable from a Technical, Strategic and Viability View Point, for a 10 year concession. However there are few issues on which the Detailed Feasibility Study shall focus on:

1. Exact estimation of Baseline consumption of energy
2. The accurate costs for fixtures and other equipments
3. Terms of Project Expansion with expansion of the town and requirement of new street lights at newly developed area.

Annexure 1: Assumptions & Financial Projections

Assumptions taken for Financial Projects

Assumptions	Unit	Value
Tariff Cost		
Tariff	Rs/kWh	4
Tariff Escalation Rate	Rs/kWh	0.2

Escalations		
Tax on Electricity Bill - %	%	5%
Manpower Cost Escalation	%	5%
Repair and Maintenance Cost Escalation	%	8%
Escalation in M&V Cost	%	1%
Contingency	%	5%

ESCO Mode		
Investment made by ULB	%	0%
Investment made by ESCO	%	30%
Savings Shared by ESCO	%	90%

Interest on Debt		
Interest Rate	%	12%
Repayment Period		5
Moratorium Years		1

Other Taxes		
Service tax on Invoice	%	10.3%
Factor for calculating service tax		1.103
Depreciation Rate	%	15%
Corporate Tax	%	34%

Cash Flow Projections

Technological Option Followed: Replacement of Fixtures and Installation of Automatic Timers

Total Investment		491.38
Debt	70%	343.97
Equity	30%	147.41

Cash Flow Projections (Figures in Rs. Lakh)

Year	1	2	3	4	5	6	7	8	9	10
Expenses/ Investment										
Capital Costs	466.74	-	-	-	-	-	-	-	-	-
Installation Costs	24.65	-	-	-	-	-	-	-	-	-
R & M Costs	-	57.07	61.63	66.56	71.89	77.64	83.85	90.56	97.80	105.63
M & V Costs	40.30	40.71	41.11	41.52	41.94	42.36	42.78	43.21	43.64	44.08
Man Power Costs	-	43.95	46.14	48.45	50.87	53.42	56.09	58.89	61.84	64.93
Contingency	24.57	-	-	-	-	-	-	-	-	-
Total Expenditure	**556.26**	**141.72**	**148.89**	**156.54**	**164.70**	**173.42**	**182.72**	**192.66**	**203.28**	**214.64**
Revenue										
Tariff (Rs/ unit)	4.00	4.00	4.20	4.40	4.60	4.80	5.00	5.20	5.40	5.60
Energy Saved (Lakhs KWH)		118.42	118.42	118.42	118.42	118.42	118.42	118.42	118.42	118.42
Electrical Cost Savings		**497.35**	**522.21**	**547.08**	**571.95**	**596.82**	**621.68**	**646.55**	**671.42**	**696.29**
Revenue through Savings		**497.35**	**522.21**	**547.08**	**571.95**	**596.82**	**621.68**	**646.55**	**671.42**	**696.29**
Total Revenue shared by ESCO		**447.61**	**469.99**	**492.37**	**514.75**	**537.13**	**559.51**	**581.90**	**604.28**	**626.66**
Revenue shared by ULB		**49.73**	**52.22**	**54.71**	**57.19**	**59.68**	**62.17**	**64.66**	**67.14**	**69.63**
Interest on Debt	41.28	41.28	34.78	27.50	19.35	10.22	-	-	-	-
Service Tax @ 10.3% of ESCO's invoice		41.80	43.89	45.98	48.07	50.16	52.25	54.34	56.43	58.52
Earnings Before Tax		222.82	242.43	262.35	282.63	303.34	324.54	334.89	344.56	353.50

Cash Flow Projections (Figures in Rs. Lakh)

Year	1	2	3	4	5	6	7	8	9	10
Depreciation Cost		70.01	59.51	50.58	43.00	36.55	31.06	26.40	22.44	19.08
Book Value of Assets	466.74	396.73	337.22	286.64	243.64	207.09	176.03	149.63	127.18	108.10
Taxable Earnings		**152.81**	**182.93**	**211.77**	**239.64**	**266.79**	**293.48**	**308.49**	**322.12**	**334.42**
Tax		**51.95**	**62.19**	**72.00**	**81.48**	**90.71**	**99.78**	**104.89**	**109.52**	**113.70**
Pre-Tax										
Net Cash Flow (Surplus/ Deficit)	**(597.53)**	**222.82**	**242.43**	**262.35**	**282.63**	**303.34**	**324.54**	**334.89**	**344.56**	**353.50**
Cumulative Cash Flow	(597.53)	(374.72)	(132.28)	130.07	412.70	716.04	1,040.58	1,375.48	1,720.04	2,073.54
After Tax										
Net Cash Flow (Surplus/ Deficit)	**(597.53)**	**170.86**	**180.24**	**190.35**	**201.15**	**212.63**	**224.76**	**230.01**	**235.04**	**239.80**
Cumulative Cash Flow	(597.53)	(426.67)	(246.43)	(56.08)	145.08	357.70	582.46	812.47	1,047.52	1,287.31

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For information about this report, please contact:

ICRA Management Consulting Services Ltd

Logix Park, First Floor
Tower A4 & A5, Sector - 16
Noida - 201 301
T: +(91 120) 4515800
F: +(91 120) 4515850