Detailed Project Report on ESCO project for Municipal Water Pumps replacement in Manipur State

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Submitted to:

United Nations Development Programme

UNDP

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Abbreviations

BEE	Bureau of Energy Efficiency
CAPEX	Capital Expenditure
DPR	Detailed Project Report
DSM	Demand Side Management
ECM	Energy Conservation Measures
EE	Energy Efficiency
EESL	Energy Efficiency Services Limited
ESCO	Energy Service Company
ESP	Energy Saving Proposal
ESPC	Energy savings performance contract
FI	Financial Institutions
GHG	Green House Gas
GWh	Giga Watt Hours
GoI	Government of India
IGEA	Investment Grade Energy Audit
IGEAR	Investment Grade Energy Audit Report
INR	Indian Rupees
IRR	Internal Rate of Return
HT	High Tension
kVA	Apparent Power
kW	Active Power
kWh	Kilo Watt Hours
LT	Low Tension
M&V	Monitoring and Verification
MLD	Million Litres per Day
NPV	Net Present Value
OPEX	Operating Expenditure
O&M	Operation & Maintenance
PHED	Public Health Engineering Department
PPP	Public Private Partnership
PMC	Project Management Consultancy
SAPCC	State Action Plan for Climate Change
ULB	Urban Local Body
W	Watt
WACC	Weighted Average Cost of Capital
WTP	Water Treatment Plant

Executive Summary

According to a recent Electric Power Survey, the Public Water Works in India consumes more than 12000 MUs and Public Lighting consumes 5000 MUs of electricity[1]. The experience of energy efficiency studies conducted at water utilities have shown that there is a substantial potential for energy conservation and achieving better energy efficiency levels in these installations without or with low / medium cost investments. Such initiatives will help water utilities, which are mostly under local bodies, to reduce their energy expenditure.

The Government of India has given high priority to curb the growing energy consumption and carbon footprints. The State Governments are taking necessary steps to adhere to the prioritize set. In this regards, the United Nations Development Program (UNDP) is supporting Jharkhand and Manipur States in implementation of their State Action Plan for Climate Change (SAPCC). The focus is specifically to support implementation of climate mitigation efforts focusing on renewable energy and energy efficiency. The focus on energy efficiency will lead to reduction on wasteful use of energy and developmentof clean energy projects with a thrust on private sector participation. The current project is targeting energy efficiency projects based on Public Private Partnership Models (PPP model) for Municipal water pumping systems of Imphal city of Manipur state. The current study is part of a series of Technical Assistance engagements supported by UNDP. One of the earlier engagements in this series is an engagement undertaken by another Consulting Firm to estimate the Marginal Abatement Cost Curve for interventions proposed under the Manipur SAPCC and basis that identify prioritized projects for further examination under our engagement. One of the identified projects includes energy efficiency improvement municipal water. The Table below provides the list of pumping systems covered under the proposed ESCO project.

Centre name	Pump Name	Existing Pump Rating	Design Flow Rate	Design Head	Design Efficiency	Actual Measured Efficiency
		kW	m3/hr	(M)	%	%
Porompat Water Supply	Turbine Pump	96	940	27	72%	46%
	Phase 2 Reservoir Pump 1	48	504	30	86%	35%
	Phase 1 Reservoir Pump 1	-	504	35	-	36%
	Maintenance Pump	37	403	26	78%	42%
	30 hp filtration tank Phase 1	17	432	12	83%	68%
	40 hp filtration tank Phase 2	21	432	15	84%	48%
Ningthem pukhri Water Supply	Mahabali P-1	37	227	40	79%	26%
	Thangpat Pump House P-1	45	306	30	83%	68%
	Ningthem pukhri-75 OH Pump	56	396	30	-	50%
	Ningthem pukhri-40 HP Supply pump	30	173	45	81%	22%
	Ningthem pukhri-75 HP supply pump	55	396	30	-	40%
Canchipur Water Supply	Kiyamgyi P-1	-	504	32	80%	27%
	Lilong P-1	-	504	32	80%	53%
	WTP-C1 areator pump	41	360	35	84%	24%
	WTP-C1 supply pump 1	48	360	42	85%	57%

[1] IFC, 2007

Centre name	Pump Name	Existing Pump Rating	Design Flow Rate	Design Head	Design Efficiency	Actual Measured Efficiency
		kW	m3/hr	(M)	%	%
	WTP-C1 supply pump 2	48	360	42	85%	56%
	WTP-C 2 areator pump	41	360	35	84%	50%
	WTP-C 2 supply pump	-	504	45	84%	56%

It is observed that existing municipal water pumps in Imphal city are operating at average efficiency of 45%. Hence, the PPP project targets to replace the existing pumps with energy efficient pumps of 80% efficiency.

Summary of energy conservation measures identified

S.No.	Energy performance improvement action (EPIA)	No. of replacement	Annual electricity savings	Annual energy savings	Monetary savings	Estimated investment	Simple payback period	Tons of CO_2
			kWh/y	MTOE	Rs Lakh/y	Rs Lakh	Months	tCO_2/y
1	Suction line modification	17	227894	19.6	11.4	11.6	12.2	218.8
2	Inefficient pump replacement with energy efficient pumps	15	873245	75.1	43.0	113.4	31.6	838.3
3	Energy efficient lighting system	53	6409	0.6	0.3	0.4	14.0	6.2
4 (a)	Option-1 : Contract demand reduction and APFC	8	-	-	76.0	23.5	3.7	-
4 (b)	Option-2 : Installation of meter for the electricity billing	6	-	-	19.1	7.8	4.9	-
Total		**99**	**1107548**	**95.2**	**149.8**	**156.6**	**12.5**	**1063.2**

Above listed four energy performance improvement actions can save annual energy consumption by 11,07,548 kWh. Implementing them would attract a one-time investment of Rs 156.60 lakh; it wouldlead to annual monetary savings of Rs 149.80 lakh.

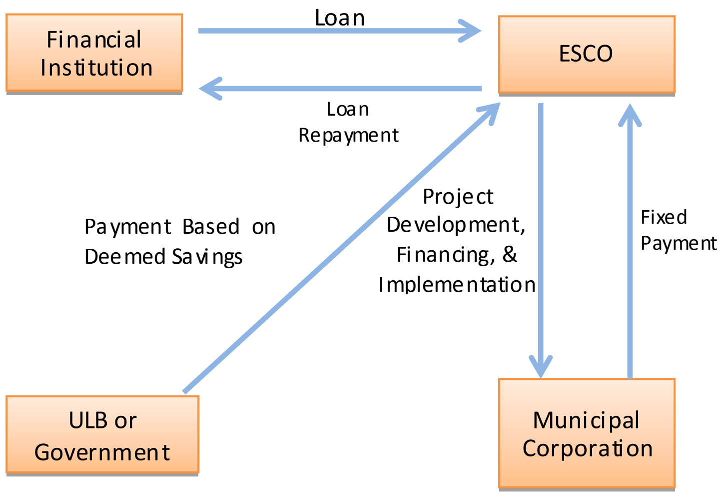
Development of a business model that is financially attractive to Municipal Corporation and ESCO is most crucial for successful implementation and operation of the project. In preparing the business case for ESCO and Municipal Corporation, we have bundled all the ECMs recommended in the energy saving proposals as one project on the basis of "Whole-pumping system approach[2]". Both Municipal Corporations do not have the financial strength and are not keen to implement the project from the internal sources of funding or debt financing. Hence the ESCO mode is considered for project implementation. The same was corroborated during discussions with Municipal Corporation.

ESCO financing may provide several advantages to the Municipal Corporation such as:

- Offering a complete one-stop-shop for project – technical risks as well as the financial risks suitably mitigated
- Transferring ownership of the equipment to the municipal corporation once the contract is fully paid out;
- Offering flexible models of payments to meet the needs of the project.

Proposal for implementation based on Annuity-Based Deemed Saving ESCO Model

We propose to implement the ESCO project based on Annuity-Based Deemed Saving Model. The tenure of ESCO project is seven years. The key features of the proposed ESCO project implementation are as follows:



- Energy Service Performance Contract (ESPC) would be executed between the ESCO and Municipal Corporation based on a fixed price for services to be provided
- Municipal Corporation/ State Government to make fixed yearly annuity payments to the ESCO against achievement of benchmark performance parameters defined in ESPC
- Financial agreement would be executed between the ESCO and FI for borrowing funds. Municipal Corporation or State Government will give guarantee to FI/ESCO for annuity payments as per the ESPC
- ESCO would make loan repayments from the money collected from Municipal Corporation
- The approach used to arrive at deemed savings is simple and based on non-complex targets
- This method involves multiplying the number of installed measures by an estimated (or deemed) savings per measure, which is derived, based on historical evaluations
- Deemed savings approach may be complemented by on-site inspections. Under this model, it can be ensured that the best available technology is retrofitted with an overall cost saving to the Municipal Corporation

[2] Whole-pumping system approach takes an integrative approach so that all elements of the pumping system help achieve an optimal energy performance.

- The model does not require periodically demonstration of energy cost saving

Conclusions

The cost benefits are calculated for the Municipal Corporation and the ESCO Company on adoption of whole-pumping system approach. The project is found to be financially viable on the basis of parameters such as Internal Rate of Return (IRR), Net Present Value (NPV) and payback period.

Benefits of seven years ESCO project to **Municipal Corporations** are as follows:

- Total outgo on account of annuity payment to ESCO: INR 39.9 million (NPV @14.3% is Rs. 24.3 million)
- Total benefits accrued on account of energy savings: INR 125.4 million (NPV @14.3% is Rs. 45.1 million)
- Equity IRR under annuity model for the project: 11.2%

Benefits of seven years ESCO project to the **ESCO Company** are as follows:

- Total expenditure (CAPEX and OPEX): INR 50.4 million (NPV @14.3% is Rs. 26.6 million)
- Total annuity: INR 39.9million (NPV @14.3% is Rs. 24.3 million)
- Total profit after tax to ESCO: INR 4.7 million (NPV of profit @ 14.3% is Rs. 2.8 million)
- Equity IRR under annuity model: 14.8%

Disclaimer

This is a suggested format for a Detailed Project Report on "Energy Efficiency for Municipal water pumps in Manipur State". The cost – benefit analysis and the financial analysis is based on the IGEAR data available.

The scope is defined considering that the Municipal infrastructure in both the cities selected is ageing and needs refurbishment and modernization. Thus, energy efficiency projects if clubbed with larger infrastructure projects incorporating renovation of electrical distribution network, piping network, smart metering and monitoring etc. will provide a long term benefits and will be cost effective solution.

1. Introduction

1.1. Context

According to a recent Electric Power Survey, the Public Water Works in India consumes more than 12000 MUs and Public Lighting consumes 5000 MUs of electricity[3]. The experience of energy efficiency studies conducted at water utilities have shown that there is a substantial potential for energy conservation and achieving better energy efficiency levels in these installations without or with low / medium cost investments. Such initiatives will help water utilities, which are mostly under local bodies, to reduce their energy expenditure. At the same time, there is also a need for creation of awareness among the operating staff ofwater utilities on energy issues, steps for evaluation of operating system from energyperformance view point, identification of energy efficiency opportunities and induction ofenergy management approaches for integrating better standards and practices in everyday operation of water utilities.

The Government of India has given high priority to curb the growing energy consumption and carbon foot prints. State governments are liable to take actions for GHG emission reduction, in this regards UNDP is supporting to Manipur state. Therefore, under the current project, there is a push for design and implementing energy efficiency projects based on Public Private Partnership Models (PPP model) for Municipal water pumping systems, street lighting and government buildings. It is envisaged that the following advantages will accrue to the State Government from this project:

- Reduction in carbon footprints ;
- Improved services to the people;
- Reduction in the energy cost, operation and maintenance costs
- Guarantee the energy cost reductions by private sector;

Eighty percent of the energy used in water treatment and distribution is used to pump water. EE in pumps may be achieved through a multipronged approach that involves the following:

- Reduction of overall demand and improvement in power factor
- Proper pump selection considering the head, flow and piping arrangements
- Use more efficient motors
- Proper maintenance of pump system
- Monitoring in conjunction with operations and maintenance
- Proper design and sizing of water suction and delivery pipes
- Adjustable speed drives to match speed to load requirement

Although many EE projects make economic and environmentalsense, municipalities have limited ability to finance and implement such projectsthemselves.

1.2. Objective

The overall objective of the assignment is to help in implementation of energy efficiency interventions and thereby achieve reduction in energy consumption in the municipal water pumps.

[3] IFC, 2007

1.3. Scope of Work

The present assignment aims to understand the technical and financial feasibility of implementing energy efficiency measures in the municipal pumps and to prepare detailed project report for the prioritised energy efficiency interventions. The scope of work of this engagement for DPR preparation for municipal pumps is mentioned below:

- To identify energy efficiency interventions and quantify the energy savings
- To prioritise energy efficiency interventions and undertake technical and financial analysis of prioritised interventions
- To identify appropriate business model and sources of project financing for implementation of prioritised interventions
- To suggest model Monitoring and Verification (M&V) protocol

The report contains an overview of existing conditions, recommendations regarding retrofits or replacement of equipment, financial analysis of the suggested changes, appropriate business models, and final recommendations.

1.4. Approach for DPR preparation

The DPR is prepared based on the available IGEARdata and technical assistance engagements supported by UNDP. The assumptions along with reasoning and sources are specified in Chapter 3. We have provided the scope of work for investment grade energy audit study in the Chapter 2. Overall approach for DPR Preparation involved following steps:

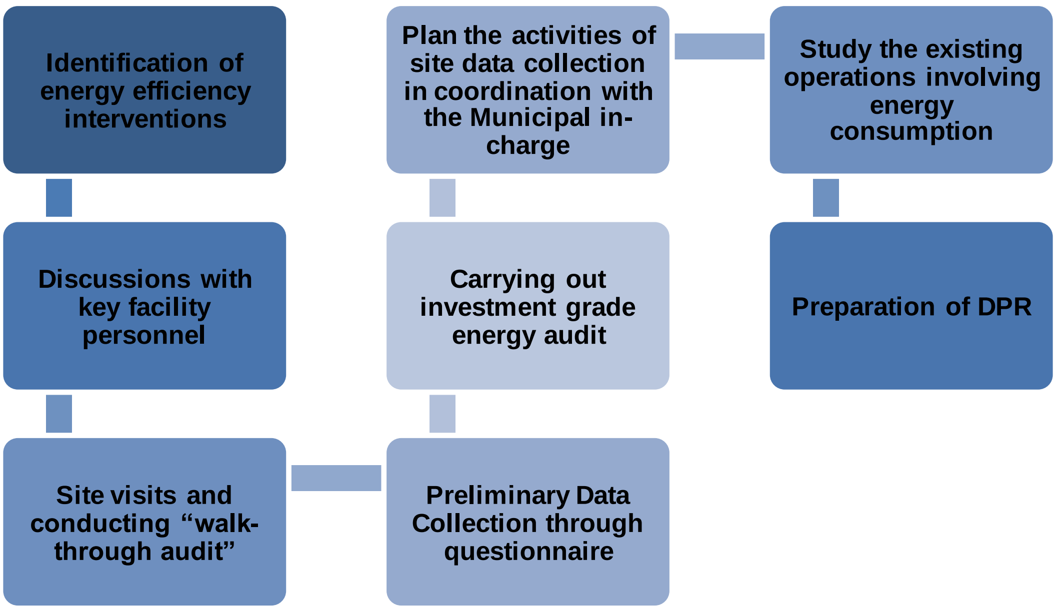


Figure 1 Approach for DPR preparation

2. Methodology for Investment Grade Energy Audit[4]

2.1. Objective

The primary objective of conducting Investment Grade Energy Audit (IGEA) is to improve overall system efficiency of the municipal water distributionwith identification of changes required in electrical and mechanical equipment to substantially reduce electricity consumption.

IGEA will help study historical as well as present energy performance trends, and specific energy consumption pattern of the municipal water pumps and water treatment plant as a whole. This process includes:

- Creation of a database giving broad data on existing infrastructure and system maps of each of the segments in municipal water pumping
- Creation of a database on baseline energy consumption and specific energy consumption
- Quantification of energy losses and energy saving potential
- Identifying Energy Conservation Measures (ECM)
- Presentation of Energy Efficiency Measures as Bankable Projects (to be implemented through selected business model in a later phase of the project)

2.2. Technical scope of work in IGEA

The Investment Grade Energy Audit (IGEA) will document existing field conditions of water pump-sets and water pumping infrastructure, recommend energy saving interventions, and present the technical description of the potential energy efficiency measures along with an assessment of the expected energy/demand and cost savings. The technical scope of work in this IGEA includes the following:

a) Energy audit of HT and LT connections of PHED/ULBs for raw water pumping, clean water pumping from treatment plants and booster pump distribution centres to determine baselines of electricity consumption and billing of existing water pumping system
b) Review of any existing metering and billing system and suggestions for a new or improved one.
c) Study existing water distribution network from the dedicated HT and LT pumps and map it to supply areas such as WTP/ wards (overhead, underground tanks) etc. Quantify respective water leakages from intake water pumping stations to the boundary of water treatment plant. Provide appropriate solutions along with costings for reduction in water leakages in upstream system (raw water pump to boundary of water treatment plant)
d) Performance analysis of existing pump sets installed at each HT and LT connections (including standby pump sets) individually as well as when they are running in parallel or series in the overall system and benchmarking performance of overall pumping system
e) Analyse the existing electrical supply network, transformers, control panels, distribution boards, electricity distribution system and water pumping facilities at each HT and LT connections and suggest appropriate modifications/changes required if any to achieve energy and demand savings.
f) Recommend replacement and retrofitting of identified inefficient system, and calculate projected benefits at each service connection and installations.
g) Provide break-up for yearly operation and maintenance cost accrued for each LT/HT connections. Suggest improvements to operation and maintenance practices.
h) Analyse financial details on the investment required, including materials, technical specifications and potential service providers, expected savings, and payback period

[4]This chapter suggests a standard IGEA methodology for EE in municipal pumping system. The same will need to be updated as on-going information improves.

considering the life cycle cost of the project. The cost considered should be substantiated with at least three vendor quotes

i) Develop list of the energy efficiency measures prioritized according to the highest rate of return on investment and organized into short, medium and long term categories (Payback periods for long term measures should be three years or less.)
j) Undertake risk analysis, technical & financial, including the mechanisms that need to be put in place to manage and control risks.
k) Suggest Monitoring and Verification (M & V) plan

2.3. Detailed description of the field data collection and electrical and mechanical measurements

i. Conduct extensive consultations with the ULBs to gather basic energy usage and other relevant data for water pumping and distribution readily available with them

ii. Undertake site visits for data collections should be undertaken to discuss and collect following data

a) Collect general information on water sources of each ULB
   - Location
   - List of intake raw water pumping stations
   - Water treatment plants (WTP)
b) Collect data related to numbers, including,electricity consumer numbers and capacities of pumping stations and water treatment plant (with LT/HT connections) in each ULB
c) Identify work initiated/completed and future plans designed under the ongoing ADB/JNNURM assignments and the pumps/motor, electrical distribution network modifications at each bulk pumping stations and WTP's in each city

Electricity related data collection:

- Prepare the list of connected load at each location with details of operating and standby equipment along with following information
- Electricity supply and distribution details
- Electricity bills of the individual pumping stations for the past 24 months
- Single line diagram, if readily available with ULB

Mechanical Data Collection:

- Pump and piping design details for all LT/HT pumps at intake source and pumps installed for clean water distribution from water treatment plants to various areas in the city
- Record of operation hours of the individual pumps on a daily basis for the past 24 months
- Quantity (in MLD) pumped in each month in last two years
- Operational details recorded in log sheet including flow, head, power and power related parameters (rated and actual efficiencies)
- Quantity of water pumped in MLD from each of the stations (intake well and WTP's) against the energy consumption on a daily basis for the past 24 months
- Identification of individual Pump-wise water supply to different locations (WTP/City areas)
- Maintenance expenses of the individual pumping stations for the past 12 months

d) Reservoir capacities and levels for the different seasons and their actual levels when the audit measurements are conducted
e) O&M expenses record for last 24 months (all the data on O&M, energy consumption, quantity of water distributed from WTP should correspond to the same months respectively)

iii. System mapping:

This includes visiting the site at each city and sketching the area map. If the piping and pumping network diagrams for these sites are available from the municipality, revalidate them against pipe sizes, number /types of valves, bends their locations and type of materials of pipes. Similarly sketch the electricity distribution network with details of feeders, transformer, distribution line sizes and panel details. Map the system in the following manner, including the distribution networks, pump design details, and suction discharge pipelines for the list of bulk water pumping stations/WTP/booster pumps provided city-wise:

a) Inventory of all the major equipment/motors and pumps. Numbering the pumps for system mapping
b) Layout of electrical supply and distribution network with detail specifications of electrical equipment's (transformers, control panels, capacitors, line sizes etc.)
c) Layout the systems including the intake arrangements, clarifiers, and filters, indicating their sizes, capacities, connected loads, etc.
d) Layout the pumping stations including the location of the pumps, their design details, suction and discharge pipe sizes, and routing
e) Sketch the water distribution system indicating pipe lines, pipe line sizes, branching points, approximate lengths, bends, and valves up to the end points, in case of direct pumping
f) Identify the locations for metering points that is best suited for measurement of the electrical and mechanical parameters in the system and make the proper provisions with prior approval from ULBs
g) Prepare data sheets to capture operational details of the system

Field measurement should include but not limited to the following:

Electrical & Mechanical measurements

a) Study and measure electricity supply and distribution system and provide recommendations for improvement
b) Instantaneous and continuous power measurements as applicable to capture the energy consumption patterns and variations in voltage supply
c) All Electrical parameters (including harmonics) measurement for all the pumps
d) Individual pump performance study (including standby pumps) and overall pumping system study with existing operation setup at all site location
e) Power, Flow and head measurements of individual pumps at various intervals. If the pumps are running at pre-specified times, at least four readings are to be taken at different time intervals
f) Power, Flow and head measurements of the entire system as a whole in normal operating conditions (parallel operation or series operation as the case may be) needs to be conducted. If the pumps are running continuously for twenty four hours, 15 minutes measurements with data logging should be conducted for 24 hours
g) Power, head and flow measurement are to be conducted simultaneously
h) Other measurements as needed to characterize the system
i) Use of theoretical way for flow and head measurements, if it is not measurable by calibrated ultrasonic flow and pressure meters

j) Water balance from source pumping station (raw water) to the end boundary for the clean water distribution pumps (HT and LT pumps up to the boundary of WTP only) installed after water treatment plants. Identification of loses due to leakage and piping system (frictional loses)

iv. Data Analysis

Conduct the following analysis to calculate the baseline of the entire project as well as for Individual projects making up the whole:

a) Historical data analysis to establish the power consumption trends against MLD of water pumped in last 24 months
b) Analyze design parameters and actual operational parameters with a view to identify problems
c) Evaluate the performance of the individual or combination of pumps operating in case of parallel operation, and the overall system as whole, including transformers/feeders etc.

v. Identify suitable pilot energy efficiency measures for subsequent implementation by ESCOs

Develop a list of potential priority projects for at least three pilot energy efficiency measures that may be implemented by municipal corporations immediately. Based on the energy audit and analysis, make a list of pilot projects with good potential for saving energy that includes the following information:

a) Configuration of the existing system
b) Configuration of the proposed system
c) Estimate of the guaranteed energy savings and other benefits
d) Estimate of the investment and its payback period
e) Retrofit requirements
f) Comments from facility personnel base

vi. Finalize pilot projects

a) Detailed Financial Analysis: Calculate the financial aspects of each individual project as well as that of the entire project, determining the costs on a net present value basis, marginal cost for each unit of savings at the time the audit is performed, the simple payback period from the savings, and return on investment. This should also include the costs for engineering, design, materials and operations.
b) Risk assessment and mitigation plan: The scope for the risk assessment and risk mitigation plan includes but is not limited to the following: Design and construction risks, Performance risk, financial, economic and regulatory risk, market risk, environmental risk, legal risk and force majeure. A Risk Matrix can be used for this task that lists the following variables in a table: Classification and reason for the risk, risk mitigation measure adopted, consequences for the lender and the investor and prioritisation of the risk.

vii. Establish the final baseline of the pilot projects and estimate the guaranteed savings from the pilot projects precisely

a) Develop a implementation plan for the pilot projects and a M&V framework
b) Develop technical specifications for recommended EE opportunities supported by vendor quotes
c) Provide audit support to ULB for implementation of pilot project.
d) Overall supervision and third party monitoring and verification of actual savings
e) Provide results of the project to ULB

2.4. Output and Deliverables

Table 1 Project output and deliverables

Sr. No.	Output	Estimated time for completion of work for each group	No. of copies
1.	Inception Report Collection of details and study as per the ToR	4 week	3 copies
2.	Submission of draft investment grade energy audit report as per the ToR	12 weeks from commencement	3 copies
3.	Submission of final report on investment grade Energy Audit	2 weeks after receipt of comments on draft report	3 copies
4.	Submission of Post implementation Monitoring and Verification report of Pilot Implementation as per the ToR	2 months after completion of Implementation Phase and commissioning of pilot project	3 copies

2.5. Expertise and Deliverables:

It is proposed that, the assignment will be undertaken by a Team Leader, with qualifications of Certified Energy Auditor. The team will consist of minimum three field level support staff and a water sector expert. The team should be able to demonstrate the following qualifications and experience as mentioned in the table Expertise and Deliverables:

Table 2 List of Expertise for required project

Position	Qualification & skills	Experience	Input Days
Team Leader	Graduate / Post graduate degree in Engineering	At least 10 years of experience on Energy Audit of Municipal water pumping. Should have experience of working with at least 3 ULBs on energy efficiency in water pumping	Full Time
Water sector expert	Graduate / Post graduate degree in Engineering	At least 7 years of experience of design and construction of water supply and distribution system	Full Time
Field staff (3)	Diploma / Degree in Engineering	At least 3 years' experience in Energy Audit of water pumping	Full Time

Note: All members of the team mentioned above should be available for the project in person for full time and should be involved in actual field measurements and field study. A time sheet for each member should be submitted to UNDP on monthly basis.

3. Manipur Municipal Water Pumping System

3.1. Overview and Analysis of Existing Structure

There are ten water supply facilities in the city with their rated capacity of 45.40 MLD (million liters per day) and responsibility of supplying water to entire city lies on the Public Health and Engineering Department of the State Government. The details on Imphal water supply scheme is provided in Table 3. Majority of the water treatment plants were constructed between the periods of 1965 to 1979[5].

Table 3 Imphal water supply schemes

Sl. No.	Scheme	Year of Commissioning	Installed Capacity (MGD)	Intake Source	Area Supplied
1	Kangchup	1965	3.20	Polok stream Kangchup	Lamsang, Sagolband, Keishampat, Thangmeiband, Uripok, Chingmeirong and Khwairamband Bazar
2	Singda	1990	4.00	Singda dam	-do-
3	Porompat	1977	0.50	Iril river at Top Khongnangkhong	Kongpal, Khurai, Lamlong, Telipatti, Hatta and Lairikyengbam Leikai
4	Chinga	1972	0.25	Imphal river at Singjamei	Singjamei, Yaiskul and Bamon Leikai
5	Canchipur	1973	0.50	Imphal river at Kiyamgei	Thongju, Langthabal, Kakwa and Heirangoithong
6	Koirengei	1979	0.50	Imphal river at Koirengei	Koirengei, Luwangsangbam, Khabam and Mantipukhri
7	Minuthong	Very Old	0.25	Imphal river at North A.O.C	D.M College Complex, Thangmeiband and part of Thangal Bazar
8	Sangaiprou	1989	0.10	Ground water (tube well)	Sangaiprou and Kwakeithel
9	Langol	1984	0.06	Ground water (tube well)	Langol Housing Complex
10	Potsangbam	1995	1.50	Ground water (tube well)	Mantipukhri and Chingmeirong

[5] Public Health Engineering Department, Government of Manipur

There is rapid and turbulent uncontrolled urban growth in Imphal city in last 15 years. Municipal infrastructure in the State of Manipur is ageing and needs to be expanded to meet the increasing urban demand. Thus, energy efficiency projects if clubbed with larger infrastructure projects incorporating renovation of electrical distribution network, piping network, smart metering and monitoring etc. will provide a long term benefits and will be cost effective solution. But Manipur state has limited financial resources for developing and implementing large infrastructure projects. Therefore, considering the above limitations, we have prepared the DPR focusing only on the retrofitting of existing end-use technologies with energy efficient technologies for the municipal water pumping system for the city of Imphal. The data for preparation of DPR is provided by UNDP. UNDP is planning to carryout actual field surveys/ measurements with detail energy audit study on the end-use equipment performance incorporating suggestions for existing infrastructure improvement and related costings. Thus, the numbers considered in this DPR are very preliminary and will change after detail energy audit study is undertaken.

Typically, raw water from river is pumped to water treatment plants and after removal of impurities, the clean water (drinking water) is suppliedto the entire city. The original designs of such system had limited consideration for energy consumption. At that time engineering design, process and capital cost considerations were given a higher priority.

Table 4 List of Municipal water pumps in various locations at Imphal

Centre name	Pump Name	Existing Pump Rating	Design Flow Rate	Design Head	Design Efficiency	Actual Measured Efficiency
		kW	m3/hr	(M)	%	%
Porompat Water Supply	Turbine Pump	96	940	27	72%	46%
	Phase 2 Reservoir Pump 1	48	504	30	86%	35%
	Phase 1 Reservoir Pump 1	48	504	35	-	36%
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	Ningthem pukhri-75 OH Pump	56	396	30	-	50%
	Ningthem pukhri-40 HP Supply pump	30	173	45	81%	22%
	Ningthem pukhri-75 HP supply pump	55	396	30	-	40%
Canchipur Water Supply	Kiyamgyi P-1	75	504	32	80%	27%
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	WTP-C 2 areator pump	41	360	35	84%	50%
	WTP-C 2 supply pump	-	504	45	84%	56%

The data on eighteen pumps has been collected from PHED for the water pumping stations in Imphal. The water pumps at three locations viz, Porompat Water Supply Station with capacity of 1.29 MLD, Ningthempukhri Water Supply Station with capacity of 4.45 MLD and Canchipur Water Supply Station with capacity of 11.35 MLD listed inTable 4.

Investment grade energy audit undertaken as part of UNDP's effort to support Manipur in implementation of the SAPCC have identified energy efficiency interventions for municipal water pumping as one of the prioritized projects.[6]

3.2. Examinations on Energy Bills

As per Joint Electricity Regulatory Commission for Manipur & Mizoram municipal water pumps is come under the consumer category of H.T. Category – 2: Public Water Works (HT- PWW)

Tariff structure which includes the following charges,

A. Demand Charge: Rs 100.00 per month per kVA of Billing Demand.

B. Energy charge per month:

I. **Metered Supply:** All units @ Rs 5.00 per kWh

II. **Un-metered Supply:** This shall be applicable to consumer without meter from initial connection and have not been covered under any of the metering schemes. The monthly energy consumption shall be computed as below:-

Energy Consumption = L x H X F x D

Where

L - Contracted load in kW or Billing Demand in kVA

H - Total number of hours in a month during which power is actually supplied to that consumer through that feeder / through that DT concerned

F - Load Factor shall be as stipulated for theft cases of the Joint Electricity Regulatory Commission for Manipur & Mizoram (Electricity Supply Code) Regulations, 2013. Load Factor for Public water supply is considered 50%

D - Demand factor which shall be taken as (1) 50 % in case of street lighting and (2) 45 % in case of other consumption.

C. Surcharge for late payment of bills: If payment is not received within due date surcharge @ 2% at simple interest on the outstanding principal amount for each 30 days successive period or part thereof will be charged, until the amount is paid in full.

D. Power Factor Incentive / Surcharge:

a) If the average monthly power factor of the consumer increases above 95%, he shall be paid an incentive at the following rate:	
For each one percent increase by which his average monthly power factor is above 95%, up to unity power factor	One percent (1%) of the total amount of the bill under the head 'energy charge'.
b) If the average monthly power factor of the consumer falls below 90%, he shall pay a surcharge in addition to his normal tariff, at the following rate:	
For each one percent by which his average monthly power factor falls below 90% up to 85%	One percent (1%) of the total amount of the bill under the head 'energy charge'.

[6] The same was corroborated during our stakeholder discussions

c) If average monthly power factor of the consumer falls below 85%, he shall pay a surcharge in addition to his normal tariff at the following rate:	
For each one percent by which his average monthly power factor falls below 85%	Two percent (2%) of the total amount of the bill under the head 'energy charge'.
d) If the average monthly power factor of the consumer falls below 70%, then the utility shall have the right to disconnect supply to consumer's installation after serving a notice of 15 days. Supply may be restored only after steps are taken to improve the power factor to the satisfaction of the Utility. This is, however, without prejudice to the levy of surcharge for low power factor in the event of supply not being disconnected.	

E. Suggestions for Savings with minimum investment:

Reducing Contract Demand: We identified following eightpumping stations have average contract demand of 260 kVA, by installing required APFC panel for improve average power factor of these pumping stations from 0.81 to 0.99 with minimal investment we can reduce the requiredaverage contract demand to 160 kVA. And therefore by reducing contract demand for eight locations we can save annual energy cost of INR 76 lakhs with one time investment of INR 24 lakhs.

Table 5 Contract demand reduction and APFC requirement

Centre name	Present demand	APFC Required	Suggested demand	Reduction in demand	Annual monetary savings	Investment on APFC	Simple Payback Period
	kVA	kVAr	kVA	kVA	Rs lakh/year	Rs lakh	year
Porompat Water Supply							
Porompat Main	400	145.6	250	150	10.54	7.60	0.7
Iril river intake	400	33.6	150	250	7.03	1.77	0.3
Ningthem pukhri Water Supply							
Mahabali intake	100	11.5	75	25	7.03	0.60	0.1
Thangpat	100	20.5	75	25	7.03	1.07	0.2
Ningthem pukhri	250	29.7	150	100	17.57	1.55	0.1
Canchipur Water Supply							
Kiyamgyi intake	200	31.2	100	100	8.89	1.62	0.2
Lilong intake	250	29.8	150	100	8.73	1.55	0.2
Canchipur	400	149.0	300	100	9.20	7.75	0.8
Total					**76.0**	**23.5**	**0.3**

❖ **Fixing Meter to Unmetered Locations:** From the electricity bills of listed water pumping stations we observed that 6 out of 8 pumping stations don't have energy meters as in Table 6 and as mentioned earlier that for unmetered pump stations Manipur electricity board considered fixed energy charge based on their contracted demand or billing demand even it consumes less energy. By fixing energy meter in all six locations we can save annual energy cost of INR 19 lakhs with one time investment of INR 8 lakhs.

Table 6 Monetary savings by installing energy meter

Centre name	Without Meter Energy		With Meter Energy		Monetary Savings		
	Annual consumption	Annual electricity cost	Annual consumption	Annual electricity cost	Annual electricity cost savings	Investment on Meter	Simple Payback Period
	kWh/y	Rs Lakh/y	kWh/y	Rs Lakh/y	Rs Lakh	Rs lakh	year
Ningthem pukhri Water Supply							
Mahabali intake	134749	6.7	131929	6.6	0.1	1.3	9.2
Thangpat	134749	6.7	219388	11.0	-4.2	1.3	-0.3
Ningthem pukhri	336872	16.8	129716	6.5	10.4	1.3	0.1
Canchipur Water Supply							
Kiyamgyi intake	254040	12.7	262940	13.1	-0.4	1.3	-2.9
Lilong intake	347925	17.4	334335	16.7	0.7	1.3	1.9
Canchipur	556680	27.8	305005	15.3	12.6	1.3	0.1
Total					**19.1**	**7.8**	**0.4**

❖ **Power Factor Incentive:** By fixing energy meters at pumping stations it is able to get power factor incentives as mentioned above if it maintains the power factor above 0.95

3.3. Evaluation of Energy Conservation Potential

In this study from the available data efficiency of present pump has been estimated using the formula,

Pump Efficiency = Hydraulic Power / Pump Shaft Power

$$= Q \times H \times P_W \times g / \eta_{motor} \times P$$

Where,

Q – Pump Discharge (m3/sec)
H – System total Head (m)
P_W – Liquid Density (kg/m3)
g – Acceleration due to gravity (m2/sec)
η_{motor}– Motor Efficiency
P – Driver Power Consumption

After calculating efficiency of selected pumps from the data, it is observed that most of existing municipal water pumps in Imphalis operating at average efficiency of 60%. In this case we recommend replacing the existing pumps with energy efficient pumps of 83% efficiency.

The pumping station-wise break-up for selection of pumps with estimated investment and energy efficiency potential is provided below.

I. Porompat Water Supply Scheme:

From the given list of 6 pumps which are currently under operational in Porompat water supply station, we have considered 5 pumps with higher capacity for replacement. Energy savings are calculated for replacement of 5 pumps as these all are operational and other 1 pump is considered to be on standby.

Table 7 Porompat Station Water Pumps Efficiency

Pump Name	Existing Pump Rating	EE Pump Efficiency	Proposed Pump Rating	Annual energy savings	Investment	Annual monetary savings	Simple Payback
	kW	%	kW	kWh/year	Rs lakh	Rs lakh/year	year
Porompat Water Supply							
Turbine Pump	96	82.0%	32	67765	9.6	3.4	2.8
Phase 2 Reservoir Pump 1	48	82.0%	18	59665	8.7	3.0	2.9
Phase 1 Reservoir Pump 1	48	82.0%	20	23020	8.7	1.2	7.6
Maintenance Pump	37	82.0%	18	47217	8.7	2.4	3.7
40 hp filtration tank Phase 2	21	84.0%	7	14792	9.4	0.7	12.7
Total				**212459**	**45**	**11**	**4.2**

The average efficiency of existing pumps is 46% and it is proposed to replace them by energy efficient pumps with efficiency of 82%. Replacement of these five pumps with energy efficient municipal pumps will cost around INR 45 lakhs as an initial investment and shall generate energy savings of 2,12,459kWh / annum leading to a monetary saving of energy cost around INR 11 lakhs.

II. Ningthempukhri Water Supply Scheme:

It is suggested to consider 5 pumps with higher capacity for replacement from Ningthempukhri Water Supply Station. Energy savings were calculated for replacement of 4 pumps as these are operational and other 1 pump is considered to be on standby.

Table 8 Ningthempukhri Water Pumps Efficiency

Pump Name	Existing Pump Rating	EE Pump Efficiency	Proposed Pump Rating	Annual energy savings	Investment	Annual monetary savings	Simple Payback
	kW	%	kW	kWh/year	Rs lakh	Rs lakh/year	year
Ningthem pukhri Water Supply							
Mahabali P-1	37	80.0%	6	81745	8.0	4.1	1.9
Ningthem pukhri-75 OH Pump	56	83.0%	23	21552	5.1	1.1	4.7
Ningthem pukhri-40 HP Supply pump	30	70.0%	10	30343	2.3	1.5	1.5

Pump Name	Existing Pump Rating	EE Pump Efficiency	Proposed Pump Rating	Annual energy savings	Investment	Annual monetary savings	Simple Payback
	kW	%	kW	kWh/year	Rs lakh	Rs lakh/year	year
Ningthem pukhri-75 HP supply pump	55	76.0%	17	26507	3.6	1.3	2.7
Total				**160147**	**19**	**8**	**2.4**

The average efficiency of existing pumps is 41% and it is proposed to replace them by energy efficient pumps with efficiency of 78%. Replacement of these four pumps with energy efficient municipal pumps will cost around INR 19 lakhs as an initial investment and shall generate energy savings of 1,60,147 kWh / annum leading to a monetary saving of energy cost around INR 8 lakhs.

III. Canchipur Water Supply Scheme:

From the available data of 7 pumps which are currently under operational in Canchipur Water Supply Scheme, we have considered 6 pumps with higher capacity for replacement. Energy savings were calculated for replacement of 6 pumps as these are operational and other 1 pump is considered to be on standby.

Table 9 Canchipur Water Pumps Efficiency

Pump Name	Existing Pump Rating	EE Pump Efficiency	Proposed Pump Rating	Annual energy savings	Investment	Annual monetary savings	Simple Payback
	kW	%	kW	kWh/year	Rs lakh	Rs lakh/year	year
Canchipur Water Supply							
Kiyamgyi P-1	75	82.0%	13	168996	8.7	8.4	1.0
Lilong P-1	75	80.0%	33	106708	9.5	5.3	1.8
WTP-C1 areator pump	41	84.0%	9	137238	6.7	6.9	1.0
WTP-C1 supply pump 1	48	78.0%	32	16674	6.7	0.8	8.0
WTP-C 2 areator pump	41	84.0%	9	38219	6.7	1.9	3.5
WTP-C 2 supply pump	-	82.0%	60	19439	11.0	1.0	11.3
Total				**487274**	**49**	**24**	**2.0**

The average efficiency of existing pumps is 46% and it is proposed to replace them by energy efficient pumps with efficiency of 82%. Replacement of these six pumps with energy efficient municipal pumps will cost around INR 49 lakhs as an initial investment and shall generate energy savings of 4,87,274 kWh / annum leading to a monetary saving of energy cost around INR 24 lakhs.

IV. Suction line Pipe Modifications:

It was observed that water velocity at suction side was very high as compared to standard less than 1.2m/s. So, pipe modification is also suggested.

Table 10 Suction pipe modification and monetary savings

Centre name	Exiting Suction Pipe Size	Water Velocity At Suction Side	New Suction Pipe Size	Water Velocity At Suction Side	Total Annual energy savings	Annual monetary savings	Investment on Pump	Simple Payback Period
	mm	m/s	mm	m/s	kWh/year	Rs lakh/year	Rs lakh	year
Porompat Water Supply								
Turbine Pump	300	1.8	350	1.2	15116	0.76	2.79	3.7
Phase 2 Reservoir Pump 1	200	2.4	300	1.2	13028	0.65	0.35	0.5
Phase 1 Reservoir Pump 1	200	3.3	350	1.2	13364	0.67	0.35	0.5
Maintenance Pump	250	1.6	300	1.2	10301	0.52	0.42	0.8
30 hp filtration tank Phase 1	250	1.6	300	1.2	2370	0.12	0.42	3.5
40 hp filtration tank Phase 2	250	1.7	300	1.2	3242	0.16	0.42	2.6
Ningthem pukhri Water Supply								
Mahabali P-1	169	2.1	167	1.2	19548	0.98	1.00	1.0
Thangpat Pump House P-1	226	2.5	229	1.2	13711	0.69	0.20	0.3
Ningthem pukhri-75 OH Pump	226	2.7	276	1.2	4921	0.25	0.24	1.0
Ningthem pukhri-40 HP Supply pump	169	2.3	211	1.2	8226	0.41	0.24	0.6
Ningthem pukhri-75 HP supply pump	226	1.7	204	1.2	6218	0.31	0.24	0.8
Canchipur Water Supply								
Kiyamgyi P-1	203	2.5	289	1.2	39196	1.96	1.03	0.5
Lilong P-1	203	2.8	291	1.2	27182	1.36	0.77	0.6
WTP-C1 areator pump	203	2.1	286	1.2	32864	1.64	0.77	0.5
WTP-C1 supply pump 1	203	2.5	284	1.2	4992	0.25	0.77	3.1
WTP-C 2 areator pump	203	2.3	287	1.2	8593	0.43	0.77	1.8
WTP-C 2 supply pump	254	2.4	348	1.2	5023	0.25	0.77	3.1
Total					**227894**	**11.4**	**11.6**	**1.0**

Replacement of these seventeen pumps suction line with required diameter which maintaining water velocity of 1.2 m/s will cost around INR 12 lakhs as an initial investment and shall generate energy savings of 2,27,894 kWh / annum leading to a monetary saving of energy cost around INR 11 lakhs.

V. Evaluation of lighting system

A lighting survey was carried out and in all pumping centres and replacement of existing conventional lighting system into LED lightings will cost around INR 0.37 lakhs as an initial investment and shall generate energy savings of 2108 kWh / annum leading to a monetary savings of energy cost around INR 0.32 lakhs.

Table 11 LED lightings and monetary savings

Existing Light Fixture	Proposed Light Fixture	Present Annual energy consumption	New Annual energy consumption	Annual monetary savings	Estimated Investment	Simple Payback Period
		kWh/year	kWh	Rs lakh/year	Rs lakh	year
Porompat Water Supply						
T-12	LED tube light	3203	1109	0.10	0.16	1.5
T-12	LED tube light	437	168	0.01	0.03	2.5
35W CFL	LED bulb	98	50	0.00	0.01	3.0
60W bulb	LED bulb	672	101	0.03	0.05	1.9
15W CFL	LED bulb	84	50	0.00	0.01	6.6
Ningthem pukhri Water Supply						
CFL	9W LED bulb	84	50	0.00	0.01	6.6
60 W Bulb	9 Watt LED bulb	168	25	0.01	0.01	0.8
200 W Bulb	18 Watt LED bulb	560	50	0.03	0.01	0.3
Canchipur Water Supply						
T-12	18 W LED tube light	582	202	0.02	0.03	1.5
T-8	18 W LED tube light	109	50	0.00	0.01	2.4
100 W bulb	9 W LED	2520	252	0.11	0.05	0.4
Total		**8518**	**2108**	**0.32**	**0.37**	**1.2**

3.4. Assumptions

The DPR is prepared considering the BOOT model for ESCO project implementation. We have made following assumptions for preparation of DPR and suggesting PPP model.

- Assumptions based on cost:
  1. The quotation for energy efficient pumps and capacitors for power factor improvement was taken from the manufacturer.
  2. Annual maintenance cost is assumed as 5% of total capital cost and it escalates 5% for every year. The maintenance cost escalation is assumed based on past experience.

3. Electricity tariff for each pumping station taken as Rs.5 per IGEAR andassumed escalation of 5% for every year.
4. Discount rate is considered as Weighted Average Cost of Capital (WACC) is 14.3%.

- Assumptions based on energy consumption and savings:
  1. Efficiency of existing pumps is assumed as per the data in Table 4.
  2. Average efficiency new EE pumping system is 82% and the same listed in **Error! Reference source not found.**, 8 and 9.
  3. Average efficiency of motor, which drives EE pumps considered as 93%.
  4. The specific speed of energy efficient pumps is 1500 rpm.
  5. Life of EE pumps is 15 years and ESCO contract period is 7 years. Hence, the operation and maintenance cost of pumps after the completion of ESCO project is considered as expenses by Municipal Corporation till 15th year.
  6. CO_2 factor for calculation of GHG abatement is 0.97 tCO2/MWh.

- Assumptions on financing:
  1. Life of EE pumps is 15 years and Life of ESCO contract period is 7 years.
  2. Interest rate for Long term Debt is 13.5%.
  3. Interest rate for Working Capital is 14.05%.
  4. Weighted Average Cost of Capital (WACC) is 14.3%
  5. The yearly depreciation is claimed for 7 years of project for calculation of ESCO project IRR.
  6. The corporate tax rate is considered as 33%.
  7. The project IRR calculation is post tax.
  8. The project return of 16% is considered as acceptable return for the ESCO. This assumption is based on our interaction with the ESCO companies and vendor manufacturers.

4. Financial analysis

4.1. Objective

Primary intent of carrying out detailed financial analysis is to determine project feasibility from the perspective of Municipality and ESCO and to recommend most suitable business model.

For the purpose of financial analysis, it has been assumed that all the ECMs recommended in the energy saving proposals will be implemented as one project on the basis of “whole pumping system approach[7]”. This approach has been considered as the project methodology under this approach is in sync with the objective of municipal officials to make the entire pumping system as efficient. Therefore, ESPs with high payback periods are also bundled; this will result in making the entire pumping system efficient.

There is an underlying assumption that energy consumption will remain constant throughout the project life. However, the energy consumption may increase due to the possibility that the use of water pumps would increase in future as demand increase.

The financial analysis covers crucial parameters for determining project feasibility, such as:

- Net present value (NPV):
  NPV is calculated for a project life of 15 years. For calculation of NPV, cash flows are discounted at the Weighted Average Cost of Capital (WACC). It has been assumed that WACC would remain same in both existing and proposed scenario.
- Payback period:
  Payback period is the length of time required for an investment to recover its initial outlay in terms of profits or savings. The calculation for the purpose of this project is on conservative basis as the increasing trend of savings has not been considered while calculating payback period. If the increasing trend is considered then the payback period would be shorter. This calculation does not affect NPV and IRR.
  It may be noted that it is assumed that the electricity consumption would be constant throughout the project life.
- Internal rate of return[8]:
  IRR is calculated for an estimated project life of 15 years.

4.2. Development of Business Model

Selection of an appropriate financing and business model is imperative to create adequate incentives for all stakeholders to invest and ensure sustainability of the interventions. Municipal Corporation would be directly benefited by savings in energy costs, other financial savings in terms of material and manpower, 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.

Development of a business model that is financially attractive to Municipal Corporation and ESCO is most crucial for successful implementation and operation of the project. The first step for selecting an appropriate business model is to analyse the financing options available to Municipal Corporation to finance the project, the details are provided below:

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[7] Whole-pumping system approach takes an integrative approach so that all elements of the pumping system help achieve an optimal energy performance.

[8] Internal rate of return (IRR) is a metric used in capital budgeting measuring the profitability of potential investments. Internal rate of return is a discount rate that makes the net present value (NPV) of all cash flows from a particular project equal to zero. A project is considered to be financially viable if IRR is more than WACC.

a) Internal funding:
The Municipal Corporation can use their internal funds such as O&M budgets and capital budgets for implementing the project. However, considering the budget constraints of Municipal Corporation, this option may not be feasible.

b) Debt financing:
The Municipal Corporation has an option to borrow from financial institutions, or utilize other debt instruments such as bonds. However, considering the financial situation of Municipal Corporation, it is very challenging for banks / financial institutions to provide loans or debt instruments to Municipal Corporation.

c) Energy service company:
The Energy Service Company (ESCO) brings the finance and implements the project based on agreed energy saving measures. Typically, ESCO expect the minimum returns of 16% from the project.

Internal funding or debt financing by Municipal Corporation is not considered for the project because of budget constraints and ESCO mode is considered for project implementation. The same has been corroborated during discussions with Municipal Corporation. The following section discusses benefits of ESCO mode and analyses possible business models available for implementation of identified ECMs.

I. ESCO Financing

ESCO financing may provide several advantages to the Municipal Corporation such as:

- Offering a complete one-stop-shop for project – technical risks as well as the financial risks
- Transferring ownership of the equipment to the client once the contract is fully paid out;
- Offering flexible models of payments to meet the needs of the project.

Due to above mentioned reasons; ESCO mode is preferred for Municipal Corporation. In ESCO approachAnnuity-Based Deemed Saving Model is considered for implementation:

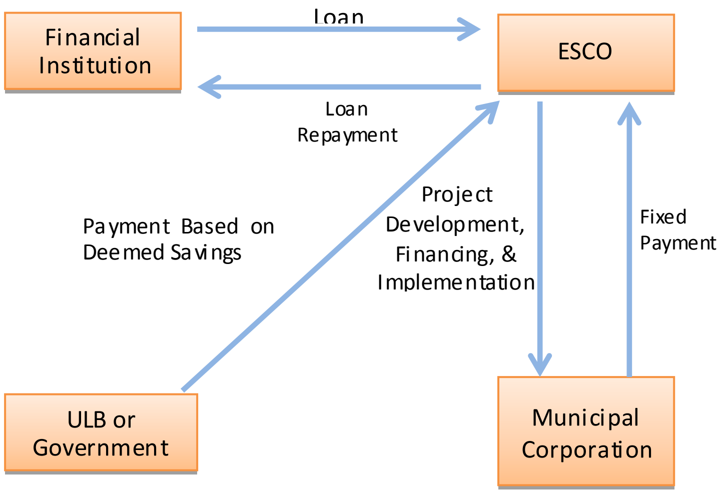

Figure 2 Schematic representation of Annuity based deemed energy saving model

- The tenure of the ESCO project is considered as seven years. Energy Service Performance Contract (ESPC) would be executed between the ESCO and Municipal Corporation based on a fixed price for services to be provided
- Municipal Corporation/ State Government may make fixed yearly annuity payments to ESCO against achievement of benchmark performance parameters defined in ESPC
- Financial agreement would be executed between the ESCO and FI for borrowing funds. Municipal Corporation or State Government will give guarantee to FI/ESCO for annuity payments as per the ESPC.
- ESCO would make loan repayments from the money collected from Municipal Corporation
- The approach used to arrive at deemed savings is simple and based on non-complex targets
- This method involves multiplying the number of installed measures by an estimated (or deemed) savings per measure, which is derived, based on historical evaluations
- Deemed savings approach may be complemented by on-site inspections. Under this model it can be ensured that the best available technology is retrofitted with an overall cost saving to the Municipal Corporation
- The model does not require periodically demonstration of energy cost saving

4.3. Project risk and mitigation

To develop an effective business model, it is necessary to identify the clear roles and responsibilities of stakeholders and the risks associated with the project development. Various risks in energy saving projects, outlined below, need to be deliberated upon before venturing in to ESPCs.

Table 12 Project risk and mitigation

Risks	Description	Mitigation Measures
Financial		
Interest Rates	Both ESCO and Municipal Corporation 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, Municipal Corporation 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 / Municipal Corporation / FI) has significant control over actual energy prices.	An annual escalation of 5% has been assumed for tariff in the financial analysis as a conservative measure.
M & V Costs	The ESCO / FI assume the financial responsibility for M & V costs directly or through the ESCO. If the Municipal Corporation wishes to reduce M & V cost, it may do so by accepting less rigorous M & V activities with more uncertainty in the savings estimates.	ESCO will demonstrate the minimum saving level during the start of contract period. Savings to be monitored based on the actual consumption by installing calibrated energy meters at appropriate locations on sample basis.
Payment Risks	Untimely payments to ESCO	Payment mechanism and deliverables to be well defined. Clauses related to payment security and minimum balance to be maintained in Escrow account to be clearly stated in the Contract.

Risks	Description	Mitigation Measures
Delays	Both the ESCO and Municipal Corporation can cause delays. Failure to implement a viable project in a timely manner costs the Municipal Corporation 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. Penalty clause to be added in the Contract to be paid by the party responsible for delays.
Operational		
Operating Hours and Loads	The Municipal Corporation generally has control over operating hours. Increase or decrease 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 equipment 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 often tied to project performance and annuity payment to ESCO.	Minimum equipment life to be given by ESCO specifying warranties for all installed equipment. Potential impact on performance to be well addressed in case of equipment failure mentioning replacement responsibility
Theft / Replacement of Energy Efficient retrofits	It can increase the cost of the project and ESCO will have to suffer the loss if it becomes its responsibility.	Municipal Corporation will not get free repair and maintenance service by ESCO for the remaining period
Others		

Risks	Description	Mitigation Measures
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*

4.4. Overall Financial Analysis

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.

This section covers financial analysis based on annuity model. Depending on the arrangement between the Municipal Corporation and ESCO, preferred business model may be adopted.

- Cost estimation

The overall investments proposal is prepared by combining allfour energy performance improvement actionsselected by UNDP summarizedTable 13. Total capital cost for all replacement is INR 156.60 lakhs and annual monetary savings of INR 150 lakhs.

Table 13 Capital cost of proposed equipments

S.No.	Energy performance improvement action (EPIA)	No. of replacement	Annual electricity savings	Annual energy savings	Monetary savings	Estimated investment	Simple payback period	Tons of CO_2
			kWh/y	MTOE	Rs Lakh/y	Rs Lakh	Months	tCO_2/y
1	Suction line modification	17	227894	19.6	11.4	11.6	12.2	218.8
2	Inefficient pump replacement with energy efficient pumps	15	873245	75.1	43.0	113.4	31.6	838.3
3	Energy efficient lighting system	53	6409	0.6	0.3	0.4	14.0	6.2
4 (a)	Option-1 : Contract demand reduction and APFC	8	-	-	76.0	23.5	3.7	-
4 (b)	Option-2 : Installation of meter for the electricity billing	6	-	-	19.1	7.8	4.9	-
Total		**99**	**1107548**	**95.2**	**149.8**	**156.6**	**12.5**	**1063.2**

4.5. Financial Model for implementation of ESCO project based on annuity model

Standard Assumptions		
O&M expenses	5.0%	of Capital Cost
Increase in O&M expenses	5.0%	per annum
Increase in Tariff Rate	5.0%	per annum
Average Tariff	5.0	INR/kWh
Capex Related - All Retrofitting's	156.62	Rs. Lakhs
Rate of Depreciation (WDV) _ IT	15%	
Amortization-No of years	7	
Corporate Tax rate	33.06%	
MAT Rate	18.50%	
Tax Holiday under sec 80 I A in years	0	

Operations and Maintenance cost	Years							
In Lakhs	0	1	2	3	4	5	6	7
O&M expenses		7.83	8.22	8.63	9.07	9.52	9.99	10.49
Total O&M cost		**7.83**	**8.22**	**8.63**	**9.07**	**9.52**	**9.99**	**10.49**

Capital Structure	% distribution
Debt	70.00%
Equity	30.00%
Total	**100.00%**

Rate of interest	**13.50%**
Tenure of debt	**7.00**

Capital expenditure	Years							
In Lakhs	0	1	2	3	4	5	6	7
Water Pumps	156.62	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	**156.62**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**

Debt from commercial lenders	109.63
Tenure of debt in years	7.00
Rate of interest-Commercial debt	13.50%

Debt schedule		1	2	3	4	5	6	7
Opening balance-Commercial debt		**109.63**	**93.97**	**78.31**	**62.65**	**46.99**	**31.32**	**15.66**
Principal repayment-Commercial Debt		15.66	15.66	15.66	15.66	15.66	15.66	15.66
Closing balance-Commercial Debt		**93.97**	**78.31**	**62.65**	**46.99**	**31.32**	**15.66**	**0.00**

Interest		**13.74**	**11.63**	**9.51**	**7.40**	**5.29**	**3.17**	**1.06**

Working Capital Requirement		1	2	3	4	5	6	7
Working Capital		**57.00**	**57.00**	**57.00**	**57.00**	**57.00**	**57.00**	**57.00**
Interest Rate (14.05% as per SBI advance rate)		0.14	0.14	0.14	0.14	0.14	0.14	0.14
Interest on Working Capital		**4.00**	**4.00**	**4.00**	**4.00**	**4.00**	**4.00**	**4.00**

Rs. Lakhs

Revenues	Years							
In Lakhs	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Annuity Payment		57.00	57.00	57.00	57.00	57.00	57.00	57.00
Total revenues		57.00	57.00	57.00	57.00	57.00	57.00	57.00

Rs. Lakhs

ESCO Revenues	Years							
In Lakhs	0	1	2	3	4	5	6	7
Income								
Annuity Payment		57.00	57.00	57.00	57.00	57.00	57.00	57.00
Total income	**-**	**57.00**	**57.00**	**57.00**	**57.00**	**57.00**	**57.00**	**57.00**
Expenses								
Water Pumps (Capex)	156.62	-	-	-	-	-	-	-
O&M Expenses		7.83	8.22	8.63	9.07	9.52	9.99	10.49
Amortization / Depreciation	-	22.37	22.37	22.37	22.37	22.37	22.37	22.37
Total outflows	**156.62**	**30.20**	**30.60**	**31.01**	**31.44**	**31.89**	**32.37**	**32.87**
PBIT	**(156.62)**	**26.80**	**26.40**	**25.99**	**25.56**	**25.11**	**24.63**	**24.13**
Interest on Debt		13.74	11.63	9.51	7.40	5.29	3.17	1.06
Interest on Working Capital		4.00	4.00	4.00	4.00	4.00	4.00	4.00
PBT	**(156.62)**	**9.05**	**10.77**	**12.47**	**14.16**	**15.82**	**17.46**	**19.07**
Tax		2.62	5.52	6.55	7.78	8.87	9.90	10.85
PAT		**6.43**	**5.25**	**5.92**	**6.37**	**6.94**	**7.56**	**8.22**
Cash flows for Project IRR (PAT + Dep + Int)		**42.54**	**39.25**	**37.81**	**36.15**	**34.60**	**33.10**	**31.65**
Cash flows for Project IRR	**(156.62)**	**42.54**	**39.25**	**37.81**	**36.15**	**34.60**	**33.10**	**31.65**
Project IRR	**14.78%**							

Cost Benefit Analysis for municipal corporation																	
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Annuity to ESCO for 7 years and O&M cost thereafter INR in lakhs			57.0	57.0	57.0	57.0	57.0	57.0	57.0	11.0	11.6	12.1	12.8	13.4	14.1	14.8	15.5
NPV of Cost		-242.6															
Annual kWh Savings kWh/yr		0	1107548	1107548	1107548	1107548	1107548	1107548	1107548	1107548	1107548	1107548	1107548	1107548	1107548	1107548	1107548
Tariff INR/kWh	5.00	5.0	5.3	5.5	5.8	6.1	6.4	6.7	7.0	7.4	7.8	8.1	8.6	9.0	9.4	9.9	10.4
Annual Cost Savings INR/yr in lakhs		0.0	58.1	61.1	64.1	67.3	70.7	74.2	77.9	81.8	85.9	90.2	94.7	99.4	104.4	109.6	115.1
Net benefits to municipal corporation INR in lakhs		-242.6	1.1	4.1	7.1	10.3	13.7	17.2	20.9	70.8	74.3	78.1	82.0	86.1	90.4	94.9	99.6
Cumulative Cash Flow INR in lakhs		-242.6	-241.4	-237.4	-230.3	-220.0	-206.3	-189.1	-168.2	-97.4	-23.0	55.0	137.0	223.1	313.4	408.3	507.9
NPV of benefits		451.4															
Discount rate (based on WACC)	14.3%																
Project IRR	**11.23%**																
Project Life	15																

5. Project financing

The project requiresa total investment of INR 157 lakhs which would be financed partly by equity and partly by debt. For the purpose of financial analysis we have bundled all the ECMs into one project on the underlying assumption that banks/FIs would not be willing be finance a project if the total fund required is not substantial. Following are the other benefits of bundling the various ECMs for implementation of project:

(i) Individual ECMs do not provide enough business volumes to attract ESCOs, and
(ii) Bundling of projects has benefits such as improved economic viability, ease of implementation; reputed vendors will participate and assist in proper project management.

The major parameters of the project are as under:

Table 14 ESCO Project Detail

Sr. No.	Particulars	Unit	Value
1	Estimated Investment	INR In lakhs	157
2	Tenure for the ESCO project	Years	7
3	Energy cost saved in the every year	INR in lakhs	150
4	NPV of ESCO project for seven years considering annuity of Rs.57 lakhs paid to ESCO	INR in lakhs	242
5	IRR of project for ESCO		14.78%

Once the ESCO determines, the project costs, and the level of savings based on its arrangement for the funds, the ESCO needs to determine the applicable terms and establish whether project financing can be structured to meet the needs of both parties (ESCO & Client).

5.1. Financing the Project

During the site visit and discussions, consultants learnt that Municipal Corporation official are interested in implement the ECM on ESCO mode. Therefore, the finance would be arranged by the ESCO.

ESCO would finance the project partly through equity and partly through debt. For this project, debt-equity ratio of 70:30 is considered. The rationale behind this assumption is that most of the FIs/Banks require upfront equity investment in the project. Hence, ESCO would have to arrange funds for equity proportion from its reserves.

For debt proportion, banks/FIs can be approached. The same is discussed in the following section.

5.2. Financing through FIs/Bank

FIs/Banks can act as strategic partners with ESCOs to provide funds for the project. In some cases, funds offered by FIs may carry higher interest rates but they may provide favourable terms and conditions such providing sufficiently long period for repayment according to the savings generated. However, every project proposal irrespective of Industry is assessed by FIs on the basis of the financial viability of the project. Funding through FIs/Banks would be beneficial to both the parties if following concerns are resolved.

ESCO's concerns: Financing must be project cash-flow based and not based on balance sheet, mortgage, guarantees or collaterals. It is understood that if these aspects decide sanctioning of loan then it is not considered to be part of EPC financing.

FI's concerns: Difficult to understand how energy savings (which are measured through parameters, such as meter readings and electricity bills), can be captured as money savings, and how payment security can be ensured.

FI's are also concerned as to how they can stake a claim on the security of the equipment installed by ESCOs in the client's premises, and how these can be liquidated in the event of a default.

5.3. Conclusion

On the basis of financial analysis, this project is financially viable. Therefore, it is recommended that ESCO may approach FIs/Banks to provide loan for the project. At present various banks have specific loan products to fund energy efficiency projects based on a bankable DPR.

However, if the ESCO is a micro, small and medium enterprise (MSME[9]), it can take benefit of concessional interest rates offered by SIDBI for energy efficiency projects.

Second option for implementing this project is taking support of a super ESCO established by Central Government. Energy Efficiency Services Limited (EESL) isSuper ESCO Company and aggressively taking up the implementation of ESCO projects in many states.Primarily the annuity model is proposed for ESCO projects by EESL. The key features of such ESCO projects are as follows:

1. The ESCO identify all CAPEX, OPEX, interest rates, project administration and monitoring fees and load them into the project costs over the span of seven years;
2. The State Government/Urban local body commits to the ESCO for regular payments after implementation of the project. A contract/MoU to this effect is signed between ESCO and ULB/State Government;
3. The risk of non-payment by urban local bodies to ESCO is minimized by delinking the payments from energy savings. The energy savings are proven on sample basis at the start of the project. Deemed saving approach is used for calculations of energy savings
4. Savings is established on sample basis only once at the start of ESCO project and verified and approved for the entire term of the ESCO project.
5. The cost associated to establishment of baseline energy consumption and post implementation monitoring of savings is minimized to a sample basis.

[9]As defined under Micro, Small and Medium Enterprise Act, 2006

Annexures

Table 15 List of Private ESCO

Sr. No.	Name of ESCO	Address	Contact Number	e-mail
1	Kirloskar Brothers Limited	Yamuna Survey No. 98/3 to 7, Banner, Pune-411045, Maharashtra	09921844433/ 020-27214342	Gajanan.Sahasrabudhe@kbl.co.in
2	Shakti Pumps (India) Ltd	Plot No. 401, 402 & 413, Industrial Area, Sector-III, Pithampur, Dist.- Dhar, Madhya Pradesh	07024110419	piyush.patidar@shaktipumps.com
3	Avya Energy Ventures Private Limited.	Flat No 502,NCL Kaveri -1 Apartments, Shanti Nagar, Hyderabad – 5000 028	07032700512	ram@avyagroup.com
5	Elpro Energy Dimensions Pvt Ltd.	#6,7,8 , Rajaji Nagar , IV th N Block, Dr.Rajkumar Road , Bangalore 560010, Karnataka	09845046780	elprochp@gmail.com
6	U V Krishna Mohan Rao Associates	-	-	uvkrao@uvka.net&uvkrao@vsnl.net