IIIEE Master's Theses 2005:11

Barriers and opportunities to implement energy efficiency in urban water systems through CDM

Case of State of Karnataka, India

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Thesis for the fulfilment of the
Master of Science in Environmental Management and Policy
Lund, Sweden

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ISSN 1401-9191

Acknowledgements

Saying "thank you" is lot easier than writing it, for; in former case one can use facial expressions and emotions to tell how much one is indebted to somebody. All people whomever I approached for any help during my thesis helped me. At the nick of the moment every help, big or small, gave me same level of comfort; be it KUIDFC's permission to share information with me or help from Ms. Suneetha, Librarian at KUIDFC who was more enthusiastic than me to collect information for me.

If there is only one person to whom I have to thank, it is Mr. C.M. Ram Kumar, Deputy Advisor, KUIDFC, for taking all administrative pains getting permission to share information and who helped me with an efficient and speedy access to the information and spend time in discussions. I am very happy to know him and hope to continue this professional relationship.

Less is more! Exactly that is what Mr. Luis Mundaca, Research Associate and my mentor at IIIEE, would say to a mortal like me, and who challenged me to do "more of less" by helping to fine tune the research objective. Same is the case with Dr. Prem Pangotra, Professor at Indian Institute of Management, Ahmedabad, India whose words of wisdom and practical suggestions helped me immensely to formulate my research tasks.

I am thankful Dr. Thomas B. Johannson, Director, IIIEE, for agreeing to be my supervisor for this work and I am thankful to the candid suggestion during initial phase of my thesis. At the same breadth I must be thankful to Dr. Amit Garg of UNEP, RISOE (Denmark) and Ms. Sudha Setty of Alliance to Save Energy, Bangalore (India) who gave me few leads to information & persons during initial phases.

My special thanks to Dr. Rambabu at Price Waterhouse Coopers, India who agreed to be my external supervisor and for giving me opportunity to work on real projects in Climate Change. This helped me to get a practical flavor of CDM in an organizational context.

There several friends who came to my help, both personally and professionally, during my "dark and cold" days in Sweden. "Thank you all batch10" and especially Peppe, Harsha, Berni, Rie, Iryna , Lars Strupiet, Jordan, Miako, Panate, Girum, Alaxander…… and Ram Prasad and Gireesh (in India) for keeping me in the groove.

Well after listening to Dr.Lars Hansson, one can not neglect the "third parts"- my family, who in a way sacrificed more than me for my studies. Especially my wife (Sridevi) and son (Sravan)- whose support and inspiration worked as anti-dote to crushing work and depressing winter; I would have dropped out of the programme without their support !

Lastly I must say "tack sa mycket" to all staff members of IIIEE for giving me an excellent opportunity to work with them.

Srinivasa Rao Gandepalli

11th September, 2005

Mumbai, India

Abstract

In this report, an urban water sector CDM project in Karnataka, India, is profiled as a case-study to analyse causes, effects and impacts of various barriers and to identify opportunities to overcome these barriers. The study attempts to identify key elements of a strategy for application to municipal sector CDM/EE projects both in Karnataka and in other parts of India. Like their counterparts in the rest of the world, Indian municipalities face similar organisational and financial barriers to implementing energy efficiency (EE). While energy efficiency has its own barriers to market penetration, sector specific barriers such as the diffuse nature of these organisations (large number of municipalities) and diffuse EE projects (many smaller projects) pose additional difficulties for EE implementation. For municipal water supply this not only results in wasteful use of resources like water, energy and chemicals, but also contributes to local and global sustainability problems. Municipal managers' lack of awareness about EE in urban water systems and incapacity to exploit EE opportunities results in large scale technical and commercial losses and broader sustainability concerns linked to urban water supply. As a platform to address these concerns at a higher level, the Clean Development Mechanism (CDM) is anticipated to bring new sustainability thinking to bear, engage new actors & channels of EE investment and increase accountability and credibility of municipal bodies through collaboration with multilateral agencies. However, municipal bodies must strengthen EE at both the municipal and sector level through enabling actions including improving capacity of municipal personnel, institutionalising energy efficiency and management and utilising available financial mechanisms and instruments.

Key words: energy efficiency, water efficiency, energy management, Clean Development Mechanism, urban water systems, municipal sector, barriers.

Executive Summary

Municipal services and sector which influence millions of people in India are known for their inefficiency both for their service levels and financial conditions. Especially in urban water sector, inefficient pumping system is major cause of technical and commercial losses resulting in higher cost of delivery for water as well as poor realisation of water charges contributing to bad financial performances of water utilities.

The main technical reasons for poor energy and water efficiency are vintage pumping systems with worn-out pumps, improper controls, unsuitable selection and design of pumping system *vis-à-vis* requirements, physical loss due to leakages in transmission network, poor maintenance and house keeping practices, improper loading of power transformers and pumps, etc.

Although the operational interventions required to tackle the efficiency problems are rather simple from technical sense, lack of awareness, technical capacity and organisational structure and bad finances are impeding their implementation. Keeping the above facts in view and requirements of the municipal sector, Alliance to Save Energy (ASE), India and Asian Development Bank (ADB), separately constituted municipal energy efficiency programme for 13 cities/ towns of Karnataka State in India, with the help of The Energy & Resource Institute (TERI).

The TERI's technical studies projected total EE potential (water efficiency included) from individual ULBs ranging from 14% to 46% of present total energy cost. The projected water savings due to loss reduction opportunities in main transmission line are also very significant ranging from 22% to 37% of flow at main pumping station. The total GHG savings projected range from 68 to 4 300 tons of CO_2 for various ULBs (See Table 5-1). Simple pro rata projections for State of Karnataka, based on results from 13 cities, indicate a total energy savings potential to the tune of 57.4 GWh of electricity or CER[1]s of 60 000 t CO_2 (calculated @ 1.052 kg CO2 /kWh for State of Karnataka grid in 2004)reductions from the Karnataka as given in the table below:

S.No	ULB Type	Total/ Average	Energy savings projected (kWh/year)	GHG reductions (t CO_2/ year)
1	City Corporations (CC) (Hubli-Dharwad, Mysore, Mangalore, Belgaum, Gulbarga)	Total	14 175 600	14 913
		Average	2 835 120	2 983
2	City Municipal Council (CMC)(Bellary, Karwar, Sirsi, Udipi)	Total	2 281 400	2 400
		Average	570 350	600
3	Town Municipal Council (TMC) (Arisikere-Tiptur, Bhatkal, Dandeli, Puttur)	Total	691 394	727
		Average	172 849	182
	Karnataka[2]	**Total**	**57.4 GWh**	**60 000**

The financial analysis indicate that these projects are highly attractive with project level internal rate of return (IRR) ranging from 57.3% to 2 266.7% (!!) and having an average simple pay back period of 5 months. Out of 13 cities where EE improvement studies have been done, projects from 5 cities (Hubli-Dharwad, Bellary, Tiptur-Arisikere, Mysore, Mangalore)

[1] CER stands for Certified Emission Reduction expressed in tones of CO_2 is measure of GHG reductions from CDM projects. 1 CER = 1 t CO_2 or equivalent GHG gas

[2] The averaged values for each ULB type are extrapolated on pro-rata basis to get projections for entire Karnataka (Author)

have been selected for implementation through CDM. For these 5 cities, financial analysis (City-wise) of projects is presented below:

ULB	Annual savings	Investment	Investment analysis			
	Million Rs.	Million Rs	Simple payback period (SPB) in years	Internal rate of return (IRR) without CER revenue	Internal rate of return (IRR) with CER revenue[3]	Change in IRR due to CER revenue
Hubli Dharwad	14.281	4.050	0.3	352.6%	376.6%	24.0%
Bellary	5.239	3.900	0.7	134.3%	142.2%	7.9%
Arasikere- Tiptur	1.701	0.980	0.6	173.6%	182.3%	8.8%
Mysore	10.140	5.400	0.5	187.8%	198.5%	10.7%
Mangalore	14.447	7 400 000	0.5	195.2%	203.8%	8.6%

In addition to these direct benefits, there are other indirect benefits to the society, State and environment which are intimately linked to sustainable development of the region. This includes:

- Improved coverage and /or service levels of water supply (water savings identified in few cities (Arisikere-Tipture, Belgaum, Gulbarga, Sirsi, Udipi) indicate that it is possible to improve per capita availability of water by 20-60 LPCD (Litres Per Capita per Day) or can be used to supply to around 164 000 people at present LPCD levels)

- Reduction in health risks for Karnataka, where 30% State's decease burden is attributed to water born deceases.

- Energy savings of 57.4 GWh, projected for entire State of Karnataka would mean a Rs.230 million ($5.1 million) savings every year for municipalities, which is around 25% of yearly energy cost or 11% of total O&M cost.

- It saves on fossil fuels as most of the electricity in India is generated through fossil fuels like coal, Lignite, oil and gas. For example, the projected 57.4 GWh/year energy efficiency potential would save around 40 000 tons of coal (equivalent) every year.

- The demand (power) saved will avoid in investment requirement in new power plants. For example the projected 57.4 GWh is equivalent to 8 MW power plant and would have cost the Government of Karnataka (GoK) / Government of India (GoI) around Rs. 400 million (@ Rs. 50 Million / MW, for coal based power plant). The demand saved will improve the power situation both in Karnataka and India where domestic and agricultural sectors compete for power due to power-shortage.

Despite of this technical and financial feasibility, and other benefits, why have these projects not been implemented? There are several organisational and financial barriers, most of them very specific as well as typical to municipal sector in India.

[3] CER value is considered $5/CER where $1 is equal to around Rs.45. IRR is based assumption of uniform energy and GHG savings over 10 year crediting period[Author]

The municipal sector in Karnataka / India is known for its technical and financial inefficiency. Municipal managers are more concerned about immediate requirements like delivery of water and energy or water efficiency was never on their operational or corporate agenda. Lack of metering and monitoring of energy consumption also lead poor maintenance practices, unaccountability and on overall municipalities are not that aware about EE opportunities as their counter-parts in industrial sector. This also led to poor internal capacities to implement any EE projects in urban water systems.

On financial front, poor finances on account of huge Unaccounted-For-Water (UFW) as high as 70% in some cities, which will not recover any costs, and poor energy efficiency are forcing municipal water utilities from taking up any programme. Also given the poor financial credibility and bad reputation of being bureaucratic, the access to debt market is difficult to municipal water utilities and same are the reasons for lack of private investors like ESCOs. Even if few ESCOs are interested in investing, present financial system at ULBs do not allow for retention of saved money with ULBs, as money for electricity bills is transacted directly between the power utility and Urban Development Department (UDD).

Given this scenario, implementation of these EE projects through CDM can positively influence the barriers mentioned above. For example,

- First it brings new players into the sectors interested in buying CERs from EE project facilitating new channel of investment, skill development. This especially benefits few "marginal" projects with higher financial risk. For example, the Community Development Carbon Fund (CDCF)[4] of the World Bank had funded PDD development for these projects [Ram Kumar, 2005] and had shown interest in buying CERs from Karnataka municipal EE improvement [Quality Tonnes, 2004], thus giving visibility and gravity to energy efficiency and helped to move the EE up in the priority ladder of urban policy makers in Karnataka. This also stimulated interest of policy makers to implement EE in public lighting system through ESCO/CDM.

  In the past many EE studies in ULBs have stopped with a report due lack of interest and finances from ULBs and but for support and interest from CDCF to implement the projects through CDM, these projects would also have met with same fate.

- It binds the ULB managers legally to implement and sustain the EE and making them accountable for delivery of CERs. This is true when project are implemented through any international cooperation and when influential agencies such as the World Bank or the Asian Development Bank, etc are involved.

- It facilitates metering, monitoring and accounting of energy & water as required for CDM monitoring & verification, there by systemising the energy efficiency and management function in ULBs.

- It facilitates training and capacity building of ULB personnel and improves managerial capacity in operations, maintenance of pumping systems. This facilitates systemising EE in future expansion of urban water systems. For example, during studies sponsored by ASE, an Energy Cell has been created at KUIDFC to disseminate information and results of studies among ULBs. This cell has been rechristened as Energy & Environment Cell to include other services like solid waster management also. This cell is discharging its multiple roles as a coordination centre, resource centre in energy and environmental issues related to ULBs including their implementation through CDM

[4] visit: http://carbonfinance.org/cdcf/router.cfm?Page=html/IndiaKarnatakaMunicipalWaterPumping.htm

[ASE, 2005]. Earlier ULBs do not have any common platform to disseminate issues of energy and environment in urban services.

- CDM could make the municipal sector as an attractive CDM portfolio, given the sustainable developmental impacts of EE and direct & local benefits social-economic benefits. It could influence Annex-B investors to buy CERs generated from these EE projects with significant local benefits compared to CERs from industrial sectors. This would put municipal sector in a better position regarding investment from public and private agencies.

- The carbon revenues coupled with energy savings would benefit the ULBs financially and also facilitates further improvements in the water systems. For projects in 5 CDM-ULBs with around 12 850 CERs/year (@ 5 USD/CER), this would mean additional revenue(i.e. over and above energy cost savings) of Rs. 2.9 Million per year (or Rs. 17.8 Million on present value[5] basis over 10 year crediting period which is about 82% (i.e. (17.8 X100)/21.73) of investment requirement). This indicate that although impact of CER revenue on project IRR is marginal, in absolute terms it strongly influences project finances, especially this revenue will help to reduce project risks and attract private investors like ESCOs.

- Capacities and systems developed in one urban service (say in water system) will also influence other services (street lighting etc) being offered by the same organisation (as discussed earlier), further contribute to GHG reductions. For example, after water system PDD is made and submitted, few EE technology suppliers in street lighting approached KUIDFC for implementing EE in street lighting through CDM through ESCO route.

While CDM plays a facilitation or catalytic role, ULBs have to organise themselves with proper management or organisational structure to institutionalise EE in municipal sector. Towards this they are required to develop a comprehensive strategy based on present barriers and opportunities. Based on study of Karnataka, the following key elements of strategy are suggested to implement EE through CDM:

- Awareness and capacity building for municipal sector
- Municipal energy management system
- Performance based operation and maintenance system
- Financial empowerment of urban water utilities
- Financial accountability of urban water utilities
- Securing financial resources

The strategy built on these key elements, not only facilitates present projects but also institutionalise energy efficiency and helps to reduce costs of monitoring, baseline and other documentation required under CDM. The capacity developed in the process also reduces the transaction costs related to EE implementation in other municipal services also.

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[5] present value of Rs. 2.9 Million per year for 10 years with a discount rate of 10% is Rs. 17.8 Million

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1 Introduction

1.1 Background

Clean Development Mechanism (CDM) is introduced as project based mechanism under Kyoto Protocol to implement GHG reduction projects in Non Annex I (developing countries) countries and transfer CO_2 equivalent credits (called certified emission reductions-CER) to Annex B (Annex I countries of UNFCCC which ratified Kyoto Protocol also) countries. While the main benefits for Annex B countries are reduced costs of abatement, the Non Annex I or host country benefit from technology transfer, local environmental improvement and sustainable development.

Many CDM projects which are coming up in various non-Annex I countries are more focused on industrial sector and big projects. For example, a review by Climate Business Network [CBN, 2005], of CDM projects in offing at UNFCCC, indicate that renewable energy and landfill gas projects constitutes the lion's share followed by fuel switching and energy efficiency. Also energy efficiency projects are coming mostly from high energy-intensive industries such as cement, metal chemicals, etc [CBN, 2005]. This propensity towards large projects is mainly because of the ease of identifying large EE measures, ease of managing the project, low transaction costs and ease of monitoring and verifying emissions [CBN, 2005] While benefits accrue mainly to the participating industry, small social benefits such as employment generation during the project commissioning and operation are being magnified as sustainable development to pass through the *Sustainability Condition (i.e. Step 5 of additionality test referred in section 6.4),* which requires that registration of a project under CDM should contribute to sustainable development of the host country. Whereas, EE projects especially small projects face market, financial, administrative, technical barriers despite their total potential for GHG reductions and sustainable developmental benefits. CDM can help realise these benefits by [CBN, 2005] "helping to catalyse the market transformation for energy efficiency, disseminating best practice technologies and techniques, strengthening local delivery and institutional capacity and providing extension services and training". In this thesis, author has selected one such sector; urban water system in India (and the State of Karnataka as a case) requiring such interventions and to examine how CDM can be used as well as what need to be done to use CDM, to implement energy efficiency.

1.2 Problem

About 2-3 % of the World energy consumption is used to pump & treat water for urban areas [ASE, 2002]. In India public water systems (both urban and rural systems) consume 2.55 % (for Karnataka, it is 5.69% of total consumption in the State) total electricity consumption in the country. In absolute terms, this amounts to 3 595.5 GWh and 1 310.7 GWh for India and Karnataka respectively, during the year 2003-04[CEA, 2005]. For many municipalities in developing country like India, this manifests into high energy costs, often more than 50 % of total municipal budget forcing severe financial conditions not only on water service delivery, but also on other municipal functions such as sanitation, education, roads, public transport, etc [ASE, 2003][KUIDFC, 2004]. What is more disturbing is the fact that demand for safe drinking water is going up due to urbanisation, population growth. While only 50% (89% in India) of the World's urban population has access to safe drinking water currently, the total urban population of the World is going to double in next 40 years [ASE, 2002]. Also increasing prices of energy and reduced availability of water will further aggravate the water service delivery in terms of cost, coverage and per capita availability. In India, while various agencies involved in water harvesting and delivery are continuously increasing availability of water, per capita availability of fresh water (including irrigation, industrial, domestic etc) has continuously decreased from 14 180 LPCD in 1951 to around 5 000LPCD in 2001. This value is expected to come down to around 3 100 LPCD (or 1140 Cu.m per person per year) by 2050, which is just above the scarcity condition of 2 740 LPCD (or 1 000 Cu.m per person per year) [Sankaranarayan, 2005]. This situation calls for both energy and water efficiency which has short term and long term developmental implications for government and society.

Many energy and water efficiency studies in India and world-wide [ASE, 2002][TERI, 2003] indicate that energy consumption in water utilities could be reduced by at least 25% cost-effectively with many EE projects requiring little or no money. For example, installation metering and monitoring would help to detect simple improvements which can be realised through changes in operational, behavioural and maintenance practices. Even large projects such as installing new efficient pumps are very attractive financially, although they require higher investments.

Despite of this high EE potential and ease of replication, municipal EE has not taken up well in India. This can be mainly attributable to municipal managers' lack of awareness of these opportunities, lack of technical and managerial internal capacities and more importantly, precarious financial situation[6] of most municipalities in India. While some municipalities are trying private sector participation through outsourcing of operation and maintenance of these services, this is done mainly from improving service levels and cost reduction point of view. Other problems are related to operational lacuna such as lack of measurement of energy consumption, lack of direct monitoring of energy consumption by municipalities, which is typical of smaller organisations in India.

The State of Karnataka, India is *probably* the first, not only in India but also in the World, to take advantage of CDM to address the urban developmental needs and submitted CDM projects for energy efficiency improvement in water pumping system for few municipalities. Although these are simple energy efficiency improvements from a technical point of view, their replication in municipal services across India would result in significant *local benefits* such as improved and extended services, reduced costs for urban bodies (e.g. municipalities, water utilities etc), there by leading to real sustainable development. There are also other spin off benefits for society such as reduced water leakage, reduction in electricity demand, health benefits, etc.

Implementing EE in these services through CDM would bring two kinds of positive cash flows; one from reduced energy costs and second one from sale of CERs (Certified Emission Reductions). However implementing EE projects through CDM requires additional costs called transactions costs, which depend on amount of CERs generated through these projects. Depending on total CERs, these projects would bring additional revenue stream besides reducing energy costs which can make the EE project more attractive for municipalities, ESCOs and other investors. More than financial aspects, CDM can bring additional (international) players into this sector and may help to overcome barriers like poor private sector participation by enhancing credit-worthiness of municipalities. In that context, work being done in Karnataka can serve as model for other municipalities and States to develop their own projects and learn from Karnataka's experience.

[6] The poor financial situation in Karnataka or other States can be attributed mainly to technical (inefficient pumping system, water leakage or loss) and commercial losses (metering errors, lack of metering, illegal connections) in municipal service delivery system apart from pricing of municipal services and poor revenue recovery mechanism (Author).

1.3 Research Objective and methodology

The main objective of this report is identifying barriers and opportunities to implement energy efficiency in urban water systems in the context of Climate Change and Clean Development Mechanism and recommend key elements or necessary conditions to realise the energy efficiency and GHG reduction potential in water pumping.

The following research questions will be answered to meet the objective:

- *What potential urban water system hold for EE improvements ?*
- *What barriers and opportunities exists to implement EE in urban water systems?*
- *How CDM can help to overcome few of barriers?*
- *What are the necessary conditions / key elements of strategy for EE to avail existing opportunities?*

The overall methodology involves case study approach where in the State of Karnataka, India is taken as case. Towards meeting this objective, the research work would be divided into following task and sub tasks:

Task 1: *Literature survey about the Clean Development Mechanism and energy efficiency implementation in organisational context:*

This task mainly involves literature survey on CDM and energy efficiency implementation in an organisational context. This would consist of the following sub-tasks;

Sub-task 1: Review of existing literature on Clean Development Mechanism with a view to understand few key issues like base line, additionality and sustainable development and practical issues of CDM project cycle, transaction costs and CDM financing models. This also consists of a brief review of current CDM projects in India.

The purpose of this sub-task is to build a theoretical framework on CDM and to understand the requirements for project to be considered under CDM.

Methodology: This task will be mainly done through text analysis of literature on CDM (both published books and on-line sources from organisations directly involved in the CDM process such as UNEP, UNFCCC).

Sub-task 2: This sub-task involves literature review on energy efficiency implementation in an organisational context, to understand what it takes to institutionalise energy efficiency through a (energy) management system. The purpose of this chapter is to examine requirements of a successful energy management system.

Methodology:. The methodology involves text analysis of general books on energy efficiency implementation from statutory organisations such as Bureau of Energy Efficiency (BEE) of Ministry of Power, Govt. of India which is the nodal agency in India for energy efficiency and conservation. The text analysis is further augmented by experiences drawn from water utilities all over the World (including Karnataka), by agencies like Alliance to Save Energy (ASE) through their “watergy” studies.

Task 2: *To review present status of municipal infrastructure in Karnataka, India:*

This task would involve the following sub-tasks;

Sub-task 3: Review of existing municipal infrastructure of water pumping from its service levels, coverage and energy efficiency

Sub-task 4: to review institutional, financial, operational conditional under which ULBs (Urban Local Bodies as the municipalities are called in India) in Karnataka operate with respect to delivering this service.

The purpose of these sub-tasks is to understand what leads and influences to inefficiency urban water systems, and to understand their linkages to each other.

Methodology: The subtask 3 and 4 will be carried out using published reports (secondary data) of infrastructure status in Karnataka as well as primary data from ULBs/nodal agencies representing ULBs. To depict the present status of infrastructure, a quantitative approach based on figures and facts would be used mostly. However if impact or significance of any parameters can not be quantified, the effect of these parameters will be discussed in qualitative terms. For example, most urban water depends on river sources which need to pump for longer distances. Here we know distance wise distribution of ULBs and its impacts on energy consumption. However we can not estimate, how much inefficiency it would bring into the pumping system. This mixed methodology captures both figures and perceptions and thus giving us comprehensive picture of what is going on.

Task 3: *To identify barriers and issues involved in implementing municipal energy efficiency:*

Sub-task 5: To study proposed or implemented EE projects in water as case(s) to understand potential and replicability of the EE projects in these sectors along with the techno-financial analysis of project.

Methodology: Taking proposed or implemented EE projects in water pumping as cases, investment analysis of projects with and without CDM revenues will be carried out along with technical potential for GHG emission reductions. Since financial analysis (project IRR and simple payback period) and emission reduction potential depends on EE potential which is closely correlated size of project or size of the city (ULB type), project-wise results will be averaged for each ULB-type to arrive at overall projections (by multiplying averaged results for ULB-type with number each type of ULBs in Karnataka) for the State of Karnataka. The data sources for this essentially comes from technical studies reports of energy efficiency studies conducted in 13 ULBs of Karnataka by The Energy & Resource Institute (TERI), India.

Sub-task 6: To identify issues/ barriers in the implementation of these EE projects in municipal water pumping. These barriers could be institutional/organizational, financial barriers in municipal sector. This task also involves identification cause and effects of identified barriers

Methodology: This will be carried out by collecting primary and secondary data available with the implementing agency (KUIDFC) such as project documents and organisational theory for implementing EE (see sub task 2) for a preliminary identification of issues and to structure frame-work of interviews with key personnel involved in Karnataka energy efficiency and

CDM projects. This frame work of issues will be discussed through a semi-structured interview with personnel involved in the projects to register perceptions regarding existence, significance, cause and effect of each issue. These perceptions are further augmented through quantitative data from infrastructure reports (as mentioned sub-task1) and/or TERI's & ASE technical reports. This mixed method (as mentioned above) using both quantitative and qualitative analysis will be employed to explain cause and effects of identified barriers /issues.

Task 4: ***To identify options and opportunities to overcome barriers & to recommend key elements of strategy to implement municipal energy efficiency in water pumping through CDM:***

Sub-task 7: To review and analyze what institutional and organizational measures being undertaken by Karnataka to implement EE improvements in water pumping. Further options and opportunities available to overcome each barrier will be discussed. This task also involves probing if CDM itself would help to overcome the identified barriers.

Methodology: The options & opportunities would be derived from by gap analysis by comparing present organisational barriers to EE (identified in sub task 6) *vis-à-vis* requirements of successful energy management system (as per sub task 2). Further opportunities, especially in financing EE projects is done market intelligence, available through reports (published as well as of donor organisations like the World Bank, USAID etc. A qualitative approach will be used to carry out this sub- task and information / data will be collected both from primary and secondary sources.

Sub-task 8: To recommend key elements of strategy to implement EE in municipal water pumping under CDM.

1.4 Scope and Limitations

This research mainly focuses on State of Karnataka as a case. Few cases from individual cities from other parts of India may be used to further support the arguments.

This report covers only one municipal service of water pumping on supply side. Demand side issues of water & energy efficiency, issues related to water pricing are not dealt with. However, water tariff issue for Karnataka is addressed to stress that it is the technical and commercial losses which are main culprits of poor finances of ULBs rather than water pricing. However this may not be true for other parts of India. Though street lighting is also good candidate for EE under CDM and facing similar barriers, this report scope is restricted (to urban water system) due to paucity of time. However, it is the author's opinion that the outcomes of the report equally apply to street lighting as well.

It does not cover other CDM projects possible such as Landfill gas recovery, Energy from Municipal solid waste as these are well established in CDM process all over the World.

The administrative structure in municipal sector in India is highly centralized and information collected from nodal agency KUIDFC may be subjective and biased. More over, all barriers may not be equally applicable to all States / ULBs and the key elements of strategy for EE may not be complete or not equally applicable to all States of India.

1.5 Outline

The thesis report is divided into 8 chapters (including this introduction chapter) and overall out line is presented below:

Chapter 1: Introduction

Introduces the "problem" and research objective with methodology, scope and limitations of present report.

↓

Chapter 2: Introduction to Clean Development Mechanism (CDM)

This chapter describes the Clean Development Mechanism (CDM) under Koto Protocol (KP) of UNFCCC to review operational aspects of implementing a project activity through CDM process. Although much has been written about CDM and KP which are available in print and as well as on internet, the purpose of this chapter is to give a theoretical framework to author's work in subsequent chapters. Given the constraints of space, only key and relevant aspects of CDM implementation at project level would be discussed.

↓

Chapter 3: Energy efficiency implementation in organizational context

This chapter describes requirements for successful implementation of energy management system in an organizational context and most of the examples and perceptions are drawn from India to fit the context since the case study of municipal EE is from India. The purpose of this chapter is to give a theoretical framework for implementation of EE in organizations and to answer what it takes to institutionalize EE through an energy management system.

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Chapter 4: Municipal systems and services in Karnataka

This chapter introduces the municipal system in Karnataka in general and urban water system with the institutions involved and brief explanation of their roles. This chapter also gives the reader with an account of service levels, operational & financial issues of urban water system with a view to understand present status.

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Chapter 5: Energy efficiency opportunities in urban water systems & CDM

This chapter details, typical energy efficiency opportunities based studies from 13 ULBs in Karnataka. The purpose of this chapter is to analyse the potential of EE in urban water system for its financial feasibility and replicability.

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Chapter 6: Barriers &opportunities to implement energy efficiency in urban water systems

This chapter examines the barriers to implement EE in urban water systems in the State of Karnataka with a view to understand the significance of the barriers and cause & effect of these barriers. On solution side, options available to overcome identified barriers and interventions made in Karnataka and other interventions required to be done are examined. Identification of barriers is done using semi structured interviews and discussions of key personnel in KUIDFC and KUWSDB, reports of KUIDFC, other agencies which worked with urban sector like ASE, TERI, organizational theory of implementing EE (which was discussed Chapter 3), market intelligence reports from USAID, Nexant etc with funding & other opportunities for implementing EE and author's own experience in implementing Energy Efficiency and Management in India, especially in industrial sector. This chapter also explains one crucial question of how and why CDM would be used to implement these projects.

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Chapter 7: Discussion and conclusions

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Chapter 8: Recommendations

2 Introduction to the Clean Development Mechanism

"No matter if the science is all phony, there are collateral environmental benefits…. climate change [provides] the greatest chance to bring about justice and equality in the world."

Christine Stewart, Canadian Environment Minister, Calgary Herald, December 14, 1998

This chapter describes the Clean Development Mechanism (CDM) under Koto Protocol (KP) of United Nations Framework Convention for Climate Change (UNFCCC) to review operational aspects of implementing a project activity through CDM process. Although much has been written about CDM and KP which are available in print and as well as on internet, the purpose of this chapter is to give a theoretical framework to author's work in subsequent chapters. Given the constraints of space, only key and relevant aspects of CDM implementation at project level would be discussed.

The United Nations Framework Convention on Climate Change (UNFCCC) which was adopted to combat to global-warming caused by anthropogenic emissions of green houses gases-GHGs (such as carbondioxide-CO_2, nitrousoxide-N_2O, methane-CH_4, sulpherhexaflouride-SF_6, perflourocarbons- PFCs and hydroflourocarbons-HFCs). The convention adopted Kyoto protocol (KP) with legally binding emission reductions for industrialised countries called Annex-I parties (in KP this list is called Annex-B since not all Annex-1 countries who ratified the convention, have not ratified the KP). The Kyoto Protocol which came into effect from February, 2005 has three cooperative mechanisms; International Emission Trading, Joint Implementation (JI) and Clean Development Mechanism (CDM) designed to help Annex-1 parties to achieve their emission reduction commitments at lower costs by allowing them to purchase or invest in emission reductions in other countries. [UNEP, 2004a]. These mechanism are applied briefly in the following paragraphs:

- International Emission Trading permits (Annex B) countries to transfer part of their "allowed emissions" called assigned amount units[7] (AAU).

- Joint Implementation (JI) allows one Annex B country to claim credit for emission reduction in another Annex B country through transfer Emission Reduction Units (ERUs) between the countries.

- Clean Development Mechanism (CDM) allows emission reductions from projects in non Annex I (developing) countries which contribute to the sustainable development and transfer the "Certified Emission Reductions (CERs)" for use by Annex B countries and companies in Annex B countries.

[7] UNFCCC allocated these AAU to all Annex B countries. If an Annex B country could reduce its GHG inventories below this allowances, it can transfer these AAU to other Annex B countries.

2.1 Clean Development Mechanism (CDM)

Article 12 of KP defines the CDM and main purpose as *"The purpose of the clean development mechanism shall be to assist Parties not included in Annex I in achieving sustainable development and in contributing to the ultimate objective of the Convention, and to assist Parties included in Annex I in achieving compliance with their quantified emission limitation and reduction commitments under Article 3."[UNFCCC, 1997]*.

Among the Kyoto mechanisms mentioned above, CDM is the only mechanism where developing countries can participate in the mitigation of climate change and offers an opportunity to make progress on climate as well as local environmental issues.[UNEP, 2004a].

2.2 Eligibility criteria for projects under CDM

This section describes the legal and other eligibility requirements of KP and other related decisions of COP (e.g. Marrakech Accord)[8] for individual projects be eligible for registration under CDM. To be eligible under CDM a project activity need to satisfy the CDM Executive Board that :

"

1. *the project activity must be undertaken in a non-Annex I country (i.e. a developing country) that is a Party to the Kyoto Protocol;*

2. *the participation of all participants must be voluntary and approved by the party authorising their participation (the Host Country or any Annex I Party involved in the project);*

3. *the project activity must be of a type that results in emission reductions by producing real, measurable and long-term benefits related to the mitigation of climate change;*

4. *the emission reductions must be additional to any emission reductions that would occur in the absence of the certified project activity; and*

5. *the project activity must contribute to the goal of national sustainable development for the Host Country." [UNEP, 2004b]*

While item (1) and (2) are tacit requirements for any CDM project, other eligibility requirements of the project, namely, type of projects, additionality requirements of emission reductions and sustainability development requirements would be discussed in the following sections.

2.2.1 Type of Projects & Small scale CDM (SSC) projects

The CDM adopts a bottom –up approach for including type of projects eligible since neither Kyoto protocol nor Marrakech Accords provides a comprehensive list of eligible type of projects. However going by experience so far, potential projects may include modernisation of existing plants, expansion of existing plants or completely new plants for following types of projects. [UNEP, 2004b].

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[8] These are basically operational guidelines to implement UNFCCC and KP as agreed during Conference of Parties (COP)-7 in Marrakech, 2001.

Table 2-1 Potential CDM projects [UNEP, 2004b]

Project type	**Examples**
Renewable energy projects	Biomass, geothermal, hydro, solar, tidal, wind, wave
Power projects	Fuel switching in a coal powered plant to natural gas Capturing landfill methane gas to generate electricity
Energy efficiency projects	Supply side energy efficiency in generating stations, transmission and distribution Demand side energy efficiency in industrial processes, buildings
Transport projects	Implementation of cleaner engine technologies Fuel cell and battery vehicle, upgrading existing fleet Mass transit substitution for private transport.
Forestry	Afforstation and reforestation
Others	Geological sequestration, geological sequestration for enhanced oil recovery, landfill gas recovery

Source: Legal Issues Guide Book to CDM, UNEP, Riso National Laboratory, Roskilde, Denmark (2004) Online: Available http://www.uneptie.org/energy/publications/pdfs/CDMLegalIssuesguidebook.pdf [2005, June, 20]

For small scale CDM (SSC) projects, CDM EB has simplified fast track mechanism in terms of simplified documentation, baseline and monitoring so that these projects can be pursued without rigorous and expensive approval and assessment processes required for large scale projects [UNEP, 2004b].These projects are defined as [UNFCCC, 2005a]:

“

(i) Type I: renewable energy project activities with a maximum output capacity equivalent of up to 15 megawatts (or an appropriate equivalent);

(ii) Type II: energy efficiency improvement project activities that reduce energy consumption on the supply and/or demand side, by up to the equivalent of 15 gigawatt hours per use;

(iii) Type III: other project activities that both reduce anthropogenic emissions by sources and directly emit less than 15 kilo tonnes of carbon dioxide equivalent annually.”

Small scale CDM (SSC) projects can take advantage of a simplified project design document[9], simplified methodology for baseline and monitoring plan. It is also possible to bundle same type of projects within the limits of SSC for PDD preparation, validation and verification so that administrative costs (or transaction costs as will be explained in later sections) associated with these tasks can be reduced. Further SSC projects also enjoy simplified requirements for environmental impact analysis, reduced registration fee and able to use same DOE to verify

[9] PDD: Document to be prepared and submitted y project participants to an accredited DOE for validation

and certify emission reductions (which further reduce the transaction costs).[UNEP, 2004b] [UNFCCC, 2005a] [UNFCCC, 2005b].

2.2.2 Baseline & Additionality

Article 12 of KP states that CDM project activity must result in reductions in emissions that are additional to any that would occur in the absence of the project activity. Further it requires that the project activity must lead to real, measurable and long term benefits related to mitigation of climate change [UNEP, 2004a].

Baseline: A project baseline is the scenario representing GHG emissions in the absence of the proposed CDM project activity. Baseline should be established in a transparent and conservative manner on a project specific basis and should take into account relevant national, sectoral policies and circumstances such as sectoral reform initiatives, local fuel availability, power sector expansion plans, etc.[UNEP, 2004b].

Marrakech Accords proposed three approaches to selecting baseline methodology, although there was no specific guidance on selection of methodology in project level circumstances. These are given below:

"

(i) Adopting the use of "existing actual or historic emissions as data. That is, the Project Participants base their Baseline calculations and methodology upon Greenhouse Gas data that exists or can be calculated with reference to known operations;

(ii) Emissions from a "technology that represents an economically attractive course of action, taking into account barriers to investment". This approach requires an investment analysis approach regarding possible project alternatives utilising alternative technologies. Once the project alternative with the most attractive financial returns is identified, then the Greenhouse Gas emissions generated from that project alternative are subtracted from the anticipated Greenhouse Gas emissions of the proposed CDM Project; and

(iii) "The average emissions of similar project activities undertaken in the previous five years, in similar …circumstances, and whose performance is in the top 20% of their category". This method identifies actual plant or technology similar to the proposed CDM Project and calculates the average emissions of this control group over the most recent five year period (assuming top 20% of category status)" [UNEP, 2004b]

Since there are no generic rules for fixing baseline methodology, CDM EB established a "methodology panel" to study baseline methodologies proposed by project participants on project to project basis, although these methodologies move towards standardisation over time. If project participants are not using a methodology already approved (called Approved Methodology-AM), they have propose a new methodology together with their PDD and get the approval of meth- panel [UNEP, 2004a]. The concept of baseline emissions and project emissions are depicted in the following figure [UNEP, 2004b].

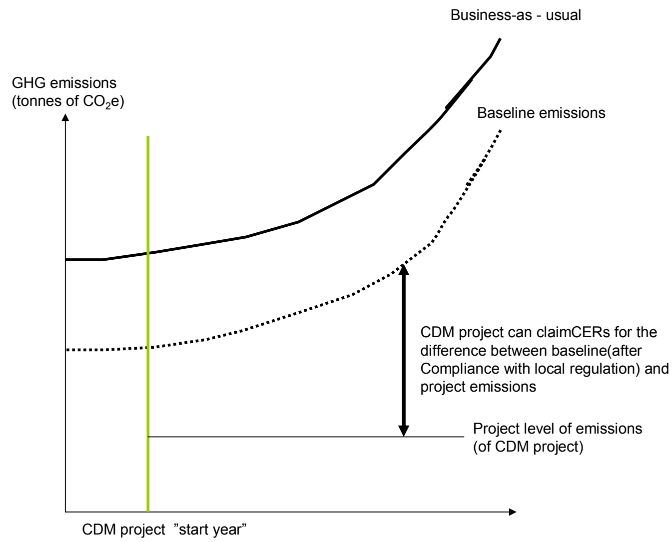

Figure 2-1 Concept of baseline and project emissions (source: UNEP, 2004b)

The approved base line methodology is crucial to CDM process as additional emission reductions (or CERs) of the project activity are calculated by subtracting project emissions from base line emissions as depicted in figure 2.1[UNEP, 2004b]

Additionality: Marrakech Accords defined Additionality requirements as "A CDM project activity is additional if anthropogenic emissions of GHGs by sources are reduced below those that would have occurred in the absence of the registered CDM project activity"[UNEP, 2004b].

Since there is wide difference between technologies, efficiencies of processes and industrial practices, a simple additionality criterion of GHG emissions reductions is not sufficient. The project developers, not only prove additional emission reductions of the project activity, but also affirmatively prove the project activity is not the most plausible scenario without CDM. Many project developers used different arguments to show this, such as [UNEP, 2004b]:

"

(i) Outlining the existence of various barriers to the project, e.g. economic, financial, institutional, technological, prevailing practice etc;

(ii) Indication that the project was a first-of-a-kind project or that the penetration of technology used in the proposed project activity is very low;

(iii) Trend analysis, e.g. of fuel mix in the electricity – generating sector;

(iv) Economic or financial arguments that the project is more costly than alternative options, and consequently would not proceed without the availability of revenues from CERs;

(v) Arguments that the project exceeded relevant requirements/standards (such as for gas capture from landfills);

(vi) Comparing the emissions of the project to that of a baseline (in turn determined by a specific scenario or investment analysis) ".

However, many of early CDM projects in electricity generation failed [UNEP, 2004b] to show project additionality because of lack of understanding and experience. Following on these failures, CDM EB issued further guidance regarding additionality during 10th meeting of EB, including a additionality tool which includes [UNEP, 2004a][UNEP, 2004b],

"

a) A flow-chart or series of questions that lead to a narrowing of potential baseline options.

b) A qualitative or quantitative assessment of different potential options and an indication of why the non-project option is more likely.

c) A qualitative or quantitative assessment of one or more barriers facing the proposed project activity (such as laid out for small-scale CDM projects).

d) An indication that the project type is not common practice (e.g. occurs in less than [< X%] of similar cases) in the proposed area of implementation, and not required by a Party's legislation/regulation. "

The additionality tool with flow chart is explained and used for projects in Karnataka in Chapter 6. For most energy efficiency projects which are very attractive financially at project level but fail to takes place due to presence of barriers such as lack of finance, technology or presence of technical risk, additionality is proved based on these barriers and by affirming that CDM registration will help to overcome these barriers.

2.2.3 Sustainable Development (SD)

While developing countries are concerned with immediate development, it is projected that these countries would surpass developed countries in terms of GHG emissions during 2010-2020 [UNEP, 2004c] which means their participation in climate change is required for any long term mitigation programme. CDM addresses these twin challenges of integrating development of developing countries with climate policies by mandating that any CDM project activity should contribute to sustainable development of host (developing) country which is a party to the Kyoto Protocol.

The key question is what constitutes sustainable development for developing countries? While there is no single operational definition, there is a consensus to view SD as encompassing three dimensions; the economic, the environmental & the social. The decision to include and ascertain what constitutes the SD criteria for CDM projects is left to host country as a sovereign right [UNEP, 2004c]. For example following table gives the SD criteria of India in the context of CDM.

Table 2-2 Sustainable Development criteria of India as host country of CDM

Project type	Examples
Social well being	The CDM project activity should lead to alleviation of poverty by generating additional employment, removal of social disparities and contribution to provision of basic amenities to people leading to improvement in quality of life of people.
Economic well being	The CDM project activity should bring in additional investment consistent with the needs of the people.
Environmental well being	This should include a discussion of impact of the project activity on resource sustainability and resource degradation, if any, due to proposed activity; bio-diversity friendliness; impact on human health; reduction of levels of pollution in general;
Technological well being	The CDM project activity should lead to transfer of environmentally safe and sound technologies that are comparable to best practices in order to assist in upgrading the technological base. The transfer of technology can be within the country as well from other developing countries also.

Source: CDM India (National CDM Authority of India), GoI. [Online] Available: http://envfor.nic.in/cdm/host_approval_criteria.htm# [2005, September, 2]

Given the uncertainty surrounding the SD criteria and indicators and having known the existing of linkages between national developmental goals and SD impacts of CDM, UNEP suggested a more pragmatic approach[UNEP, 2004c] to identify SD criteria and indicators based national policy priorities, goals, developmental plans, sectoral or local environmental plans or international developmental goals like Millennium Developmental Goals (MDGs), so that CDM projects designed (or having SD benefits on these lines) will support developing priorities of the host country. This aspect is also important as it is argued that SD impact assessment merely adds to transaction costs and is a complication for host countries [UNEP, 2004c].

Next question to ask is how project level interventions lead to SD at national level? The SD impacts and benefits at project level only have marginal effects on growth rates, distributional issues or environmental issues at national levels which mean these impacts may not give a direct indication of sustainability of development path. However, to operationalize SD indicators, it is assumed that [UNEP, 2004c], "if a project contributes to sustainable development at (local) project level, it will also have a marginal but positive effect on SD at national level".

Foe example in the context of energy and water efficiency projects in water utilities (in India), SD impacts can be:

Environmental

- Local environmental benefits in the form of resource (water) conservation
- Fossil fuel savings for energy efficiency improvement
- Reduction in local or regional pollution as less fossil fuel is used for same service

Economical

- Financial benefits to water utilities (municipalities)
- Reduction in capital and operational expenditure for present and future growth in water supply
- Reduction in capital requirement for additional power capacity (new power plants).

Social

- More population has access to safe drinking water improving their health, there by their capacity to work leading economic well being
- Creation of institutional capacity in water utilities
- Participation of new players (say private sector) in financing these projects[10]

While these impacts seem "ideological" given their marginal nature at a project level, taken in the spirit of CDM that a project activity should steer the development towards sustainability, diffusion of technology, techniques, capacity, and systems due to CDM projects will definitely contribute to a larger and real effect at national level.

2.3 Practical issues with CDM projects

2.3.1 CDM Project cycle

The following flow chart gives the steps involved in the CDM project implementation and these steps are reproduced from [UNEP, 2004b].

[10] This aspect will be discussed in detail and specific to Karnataka in subsequent chapters

PROJECT PARTICIPANTS COMPLETE A

PROJECT DESIGN DOCUMENT (PDD)

The PDD must be in accordance with the requirements of the CDM Executive Board. It functions to describe the project activity, the proposed baseline methodology and the Project Participants. It must also explain how the Additionality requirements will be met and how the emission reductions will be monitored. The PDD must also establish a "crediting period", for the project, which (for standard projects other than sinks projects) can be either seven years (with the possibility of 2 renewals) or ten years with no renewal option.

↓

DESIGNATED NATIONAL AUTHORITY ISSUES

LETTER OF APPROVAL

The Host Country must confirm (generally through its DNA) that it approves a CDM Project for the purposes of the Kyoto Protocol and that the project assists it to achieve its sustainable development goals.

↓

DESIGNATED OPERATIONAL ENTITY
VALIDATES PROJECT ACTIVITY

DOE reviews the PDD to confirm that the project activity meets the following requirements:

• participation is voluntary and Parties have established a DNA for the CDM;

• any non-Annex I countries participating in the project are parties to the Kyoto Protocol;

• stakeholder views have been considered;

• environmental impacts have been analysed;

• baseline methodology and monitoring plan are appropriate and comply with those approved by the CDM Executive Board;

• PDD contains provisions for monitoring, Verification and reporting in accordance with Article 12; and

• project activity conforms to all other requirements for CDM Projects.

After inviting and considering stakeholder comments on the PDD, the DOE determines whether to Validate the project.

↓

REGISTRATION BY THE EXECUTIVE BOARD

Registration will automatically occur within 8 weeks after the DOE has submitted the request to the CDM Executive Board, unless a Party involved in the project or three members of the CDM Executive Board request a review in relation to the Validation requirements.

↓

MONITORING BY PROJECT PARTICIPANTS

Project Participants are required to implement the monitoring plan in the PDD. This will require:

• collection and archiving of all data needed for the measurement and estimation of Greenhouse Gas emissions or sequestration;

• identification and attribution of the emissions to the project activity;

• assessment of environmental impacts; and

• quality assurance and control procedures for monitoring and calculating Greenhouse Gas emission reductions (simplified monitoring procedures can be used for small scale CDMs).

↓

VERIFICATION AND CERTIFICATION

BY DESIGNATED OPERATIONAL ENTITY

Periodic independent review and written assurances by a DOE of the monitored enhanced reductions in emissions during the verification period. This requires the DOE to:

• make the monitoring reports publicly available;

• calculate the enhanced Greenhouse Gas reductions;

• ensure the project complies with the PDD and CDM rules; and

• complete a Verification Report to confirm the amount of Greenhouse Gas emission reductions, and a Certification Report that certifies to the CDM Executive Board that the project activity actually achieved those reductions.

↓

↓

ISSUANCE OF CERs BY THE CDM EXECUTIVE BOARD
The CDM Executive Board will automatically issue CERs within 15 days after it receives the Certification Report (unless there is a request for review). CERs will be issued by electronic registry created and maintained by the CDM Executive Board. The CDM Executive Board registry administrator will: • issue the CERs and distribute them to the relevant national registries and/or accounts of the Project Participants as requested in the signed statement contained in the PDD; and • deduct a share of proceeds to cover administration costs and meet the costs of adaptation.

2.3.2 Transaction costs

While CDM helps to implement EE, the process is not automatic; it involves time and costs to put the project through CDM process mentioned in previous section. In a way the process is bureaucratic with documentation, approvals from host country, validation, registration, monitoring and verification and issuance of CERs all of which demand financial, administrative, technical, legal resources from project developers. In simple words, these efforts translate into costs which are called transaction costs.

Michaelowa et al classified CDM transaction costs into pre-operational, operational and trading phases as given below[Michaelowa et al, 2003]:

Table 2-3 CDM transaction costs

	Transaction cost component	Description
Pre-operational phase	Search costs	Costs incurred by investors and hosts as they seek out partners for mutually advantageous projects
	Negotiation costs	Includes those costs incurred in the preparation of Project Design Document that also documents assignment and scheduling of benefits over the project time period. It also includes expenses in organising public consultation with key stake holders
	Baseline determination	Development of baseline
	Approval costs	Costs of authorisation from host country
	Validation costs	Costs incurred in reviewing and revising PDD by operational entity
	Review costs	Costs of reviewing a validation document
	Registration costs	Registration by UNFCCC-CDM Executive Board
Operational phase	Monitoring costs	Costs to collect data
	Verification costs	Costs to hire an Operational entity and report to the CDM EB
	Review costs	Costs of reviewing a verification
	Certification costs	Includes costs in issuance of CERs by CDM EB
	Enforcement costs	Includes administrative and legal costs incurred in enforcing transaction agreement
Trading	Transfer costs	Brokerage costs
	Registration costs	Costs to hold an account in national registry

Source: Michaelowa et al, Transaction costs of the Kyoto mechanism, Climate Policy 3, 261-278, 2003

CDM, earlier was planned to be bilateral transaction between buyers in Annex B country and sellers in non-Annex I countries. However this has not happened and most widely used implementation model was unilateral where in project developers in non- Annex country will implement project and CERs are sold to buyers through a forward contract (after registration and before verification) or direct sale (after verification). This model has avoided the additional transaction costs for searching suitable partners and negotiating with them. The following table shows minimum estimates of transaction costs [UNEP, 2004a]:

Table 2-4 Registration fee [UNEP, 2004a]

Annual tCO_2 eq reduction	Registration fee (US $)=
<= 15 000	5 000
>15 000 and <=50 000	10 000
>50 000 and <=100 000	15 000
>100 000 and <=200 000	20 000
>200 000	30 000

Source: UNEP. (2004a). CDM: Information and Guidebook. United Nations Environmental Programme, Riso National Laboratory, Roskilde, Denmark. [Online]
Available: http://www.cd4cdm.org/Publications/cdm_guideline.pdf[2005, June, 20]

This registration fee would be paid up-front, but fee will be deducted from the share of proceeds at the issuance of CERs. Small scale projects if bundled so that size of the bundled project is within the limit specified for SSC projects, the fee is only $5 000 [UNEP, 2004a].

Table 2-5 Validation and verification costs [UNEP, 2004a]

	Estimated cost (US $)
Baseline study	18 000 - 23 000
Monitoring plan	7 000 - 15 000
Validation	15 000 - 30 000
Legal 6 contractual arrangements	23 000 - 38 000
Verification	7 000 per audit

Source: UNEP.(2004a). CDM: Information and Guidebook. United Nations Environmental Programme, Riso National Laboratory, Roskilde, Denmark. [Online]
Available: http://www.cd4cdm.org/Publications/cdm_guideline.pdf[2005, June, 20]

These estimates are from the year 2002 when neither the CDM market nor the rules were well developed and most consultants used to charge high dollar rates. However with increase in number of projects after KP came into force and expertise being developed among local project participants, consultants and DOEs, these costs are coming down rapidly. A robust costing is not possible, in present context due to the following reasons:

- These costs are result of commercial agreement between project participants and consultants/DOEs which is kept as secret unless there is involvement of public institution like the World Bank, etc.

- Larger organisations /corporates, generally take up variety of CDM projects varying in size (from few thousand CERs to few hundred thousand CERs) of CERs and as well as type of project (RE, EE or fuel switching) and consultant /DOE is given lump-sum contract. This makes project wise segregation of transaction costs impossible as well as even a smaller project gets the benefit of economy of scale.

- For few standardised projects like wind energy or projects with approved methodology, project participants themselves are preparing the documentation. Since this cost is internalised as salaries to the employees, this will (should) not come as cost for CDM.

Most recent estimate of transaction costs from India is dome by [Krey, 2004], who gave estimates according to size of the project. Since, except for registration charges and adaptation fee (2% of CER value which goes to funding adaptation programmes in Least Developing Countries) which depend on amount of CERs, other costs almost remain irrespective of project size. This makes economics of scale with transaction costs ranging from 0.12 $US/t CO_2 for very large projects (large hydro, landfill methane capture with CERs between 1 000 000 to 5 000 000 tCO_2 over 10 year crediting period), 0.3 $US/t CO_2 for large projects (wind farm, large industrial energy efficiency with CERs between 100 000 to 1 000 000 tCO_2 over 10 year crediting period), 2.2 $US/t CO_2 for small projects (small hydro, small industrial boiler conversion with CERs between 10 000 to 100 000 tCO_2 over 10 year crediting period), 21.28 $US/t CO_2 for mini projects (energy efficiency in residential sector, SMEs, mini hydro with CERs between 1 000 to 10 000 tCO_2 over 10 year crediting period)[Krey, 2004].

Given a current price (at minimum level) of around $ 7 / CER, only projects with around 100 000 CERs over 10years (i.e. 10 000 CER per year[11]) will be viable for implementation through CDM. Due to development of CDM market in India, these costs are getting reduced. Also, as mentioned, if PDD are developed by the project proponents (instead of consultants), transaction costs would come down further. The following table gives the transaction costs for the projects with less than 15 000 CERs per year.

Table 2-6 Present transaction costs (indicative) for SSC in India

Indicative transaction costs for CDM projects for less than 15 000 CER/annum (in the context of EE in urban water systems)	
Professional fee to consultant (for PDD, monitoring plan, baseline study till registration)	USD 15 000.00
Validation (onetime)	USD 10 000.00
Registration fee (0ne time)	USD 5 000.00
Adaptation levy (with every CER issue)	2% of CER value
Success fee to consultant (upon on successful registration)	10% of first year CER value
Verification fee (every year)	USD 3 000.00
Other assumptions (for EE projects in urban water systems:	
Cost for Stake holder's consultation is included in the PDD cost	
EIA cost is assumed to be zero for SSC procedures do not require EIA on rigourous basis and also present EE improvements do not warrrant	
Cost of attending for HCA meetings is included in the "others"	
Cost of monitoring is not considered as municipal personnel will be monitoring the project as done in regular monitoring of water pumped and electricity consumed (recording frequency may change due to CDM, but that would not result in additional cost)	
Legal charges are assumed be 15% of CERs in first year and 5% of CER value in first year assumed for "Other"/ miscellaneous expenses (Cost of attending for HCA meetings is included in the "others").	

Source: a. Dr. P. Rambabu, Price Waterhouse Coopers (PwC), India for costs (through personal communication) b. Author for assumptions

Based on above indicative costs, the author has worked out specific transaction costs and presented in **Appendix 1**. These costs are estimated for two scenarios, i.e., PDD developed by consultant and PDD developed by project proponent (in case of urban water system, project

[11] However, as discussed earlier, an organization may give a lump sum contract for "hand holding" through CDM process, in which even smaller projects with around 2000 -3000 CERs per year (can) will be considered. [Author]

proponent could be municipalities and / or nodal agency representing these municipalities) and three different values of CER selling price ($5/ CER, $7/ CER, $10/ CER). For projects with CERs between 10 000 to 15 000[12] per year, these vary between $ 0.82 /CER to $ 1.39 /CER (when PDD are to be developed by a consultant) and $ 0.60 /CER to $ 1.02 /CER (when PDD can be developed by a project proponent). However, for financial analysis, transaction costs of $2/ CER is taken to be on conservative side.

2.3.3 Project financing for CDM projects

CDM provides additional channels of securing project finance through CER generation and trading following three models [UNEP, 2004a] [Krey, 2004].

Unilateral Model: the host country (project developer in host country) develops and invests in the CDM project activity and sells (or banks) CERs. In this model all risks and benefits accrue to the project developer.

Bilateral Model: in this model, project developer and Annex-1 (or Annex B) enters into a partnership with an objective to transfer CERs to Annex-I country through an Emission Reduction Purchase Agreement (ERPA)

Multilateral Model: This is variation of bilateral model in which CERs are sold to a fund, which manages a portfolio of projects. This enables fund to spread of risk of investment and also investors can spread risk by investing in different funds.

The Prototype Carbon Fund (PCF) and Community Development Carbon Fund (CDCF) of the World Bank are examples of the multilateral funds where WB is the fund manager. The PCF was set up by the WB with 6 governments and 17 private entities with a total budget of $ 180 Million of which $ 105 Million are designated for CER purchases via ERPAs. Similarly CDCF, with targeted $ 100 Million capitalisation is set up for *small scale projects with measurable sustainable developmental* impacts. Towards this, CDCF is ready to pay an premium rate for CER purchase at 5-7 $/t CO_2 compared to PCF´s average targeted value of 3.15 $/t CO_2 [UNEP, 2004a][Krey, 2004].

Few Annex B governments such as Government of Netherlands (GoN), Government of Finland (GoF) are use bilateral, multilateral funds, Banks and tendering to purchase CERs. Presently there are no domestic multilateral funds in EE, although one fund (CDM India Initiative) is being started for clean and renewable energy projects in India for small scale projects under 15 MW [Mawandia, 2003].

As mentioned in previous section, CDM is originally thought to be implemented a bilateral model. However due to high transactions costs involved in search and negotiation and efforts required to deal with several sellers, this model is not taken up[13]. Even multilateral funds are structuring the CDM transaction through *weak unilateral* (CERs are bought through a forward contract called Emission Reduction Purchase Agreement- ERPA, before project is implemented by non- annex I party) or *pure unilateral* (CERs are bought through Direct

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[12] EE projects in Urban Water System generate fewer CERs from individual municipalities. This requires bundling of EE projects, preferably as small scale CDM (10000- 15000 CER per year) to take advantage of simplified methodologies for SSC projects.

[13] There is only one CDM project implemented (in Thailand) as bilateral project [Michaelowa, 2005]

Purchase Agreement after project is implemented by non- Annex I party and emission are verified) [Michaelowa, 2005]

2.4 CDM in India

India ratified the Kyoto protocol in 2002 and established National CDM Authority (NCA) under Ministry of environment & Forestry (MoEF).India topped the sale of CERs for the year 2003 -04 and enjoys high ranking in CDM market with wide range of projects (renewable, energy efficiency, fuel switching, industrial process, solid water management) to choose from and helping the CER buyers to extend their portfolio of projects.[IGEN, 2005][14]

As of may 2005, there are total 78 projects which received Host country Approval (HCA) of which 45 are renewable, 28 projects are energy efficiency (fuel switching and industrial process included) and 5 projects are in Fugitive emission (such as HFC-23 oxidation, landfill methane capture). However fugitive emission reduction projects contribute highest[15] to total CERs followed by energy efficiency (including fuel switching) and renewable energy production [IGEN, 2005].

A review of projects with MoEF[16] reveals that except for few landfill methane and solid waste management projects, most projects come from large and medium industrial or corporate entities such as iron& steel, sugar, paper, fertilisers, power plants, large chemical & energy industries. This indicate that small and medium enterprises (SME) or government utilities like water utilities, electricity distribution companies are yet to come into CDM.

[14] http://www.cdmindia.com/publications/INDIA-%20Worlds%20Leading%20CDM%20Destination.pdf

[15] There are two HFC-23 oxidation projects with host country approval which makes contribution of CER from fugitive sources the highest in total CERs [IGEN, 2005]

[16] visit: http://envfor.nic.in/cdm/cdm_india.htm

3 Energy Efficiency implementation in organizations

Given the multiple benefits of energy efficiency and conservation, many organizations in India are moving towards a management system to institutionalize EE, from a ceremonial and ad hoc management system. Many organizations in India, especially those with high energy intensity are even required by Energy Conservation Act (2001) of GoI, to designate an Energy Manager to implement EE in their respective organizations and report to the Bureau of Energy Efficiency (BEE), GoI about the energy savings measures. Even before this Act, many organizations have implemented Energy Management systems and gave equal importance to EE just as other organization functions like production, marketing, etc.

This chapter describes requirements for successful implementation of energy management system in an organizational context and most of the examples and perceptions are drawn from India to fit the context since the case study of municipal EE is from India. The purpose of this chapter is to give a theoretical framework for implementation of EE in organizations and to answer what it takes to institutionalize EE through an energy management system.

3.1 Implementing energy efficiency in organizations

Any organisation wanting to systemise energy management to implement EE is required assess its energy performance and continuously plan and implement strategies. Like any other organisational function, the success of energy management system depends on four factors; top management support, technical & managerial capacity, monitoring and strategy plan [BEE, 2003].

3.1.1 Top management support

The support of top management is starting point for any successful energy management and is essential for long term improvements. The support of top management can be measured or indicated in terms of how much of organisational resources, a firm would earmark for the function such as appointing an energy manager, building a dedicated EE team, financial allocation and its overall policy towards energy efficiency and conservation.

Appointment of Energy manager: The main tasks of an energy manager are [BEE, 2003] "setting up goals, tracking the progress and promoting energy management programme". In India depending on the size and activities of the organisation, an energy manager is appointed full time or clubbed with other connected functions like Environmental management. There are also cases where this function is outsourced[17] to consultants on a long term basis[ASE, 2002].

Energy conservation Act (2001)[18], of GoI gives comprehensive list of responsibilities of an energy manager, stipulated for 15 energy intensive sectors in India. Same list can be used even for other sectors (say municipal sector) wanting to initiate EE implementation. The responsibilities are reproduced here [BEE, 2005]:

[17] Ahmedabad municipality in India has outsourced its energy management function in water pumping system for two years [ASE, 2002]

[18] [Online] Available: http://www.bee-india.nic.in/EC%20Act/EC%20Act.html [2005, September, 3]

“

- Prepare an annual activity plan and present to management concerning financially attractive investments to reduce energy costs
- Establish an energy conservation cell within the firm with management's consent about the mandate and task of the cell.
- Initiate activities to improve monitoring and process control to reduce energy costs.
- Analyze equipment performance with respect to energy efficiency
- Ensure proper functioning and calibration of instrumentation required to assess level of energy consumption directly or indirectly.
- Prepare information material and conduct internal workshops about the topic for other staff.
- Improve disaggregating of energy consumption data down to shop level or profit center of a firm.
- Establish a methodology how to accurately calculate the specific energy consumption of various products/services or activity of the firm.
- Develop and manage training programme for energy efficiency at operating levels.
- Co-ordinate nomination of management personnel to external programs.
- Create knowledge bank on sectoral, national and inter-national development on energy efficiency technology and management system and information denomination
- Develop integrated system of energy efficiency and environmental up gradation.
- Co-ordinate implementation of energy audit/efficiency improvement projects through external agencies.
- Establish and/or participate in information exchange with other energy managers of the same sector through association “.

Form dedicated energy efficiency team: Many people and their decision affect and influence energy consumption and efficiency and to integrate EE and best practices into different parts organisation, there should be team from different departments/ sections, such as engineering, technical, finance, suppliers etc.[BEE, 2003]. For example a municipal water utility can have following energy efficiency team [ASE, 2002];

Table 3-1 Human resources required for water and energy efficiency team [ASE, 2002]

Potential Team Member	**Description of Role**
Top management	• Sell to mayor and other city officials • Break bottlenecks • Advocate for project funding • Ensure a team budget • Track progress
Energy manager	• Motivate team members • Provide team vision and create goals • Develop a work plan and implementation schedule • Assign tasks • Coordinate information flows • Evaluate system wide opportunities • Advocate for project financing • Facilitate interdepartmental cooperation
Unit level managers (water supply plant, treatment plant, delivery operations, and so on)	• Provide critical data • Identify and involve key technical staff • Implement and maintain projects • Discover critical design efficiency issues
Hydrology staff	• Contribute key technical know-how • Provide an important data source • Offer significant contribution to water supply/sanitation system wide planning • Liaison with a basin-level resource planning entity
Maintenance staff	• Identify and implement efficiency opportunities • Provide critical data
Energy staff	• Supply a major component of data • Contribute to project identification and implementation • Serve as resource for technology option
System planner	• Offer long-term investment awareness to watergy efficiency process
Finance staff	• Prioritize activities based on cost-effectiveness • Assess project-financing opportunities
Private sector	• Undertake consumption reductions as appropriate • Offer efficiency know-how and resources

Source: based on "Watergy: taking advantage of untapped energy and water efficiency opportunities in municipal water systems". Alliance to Save Energy, 2002.[Online]. Available: http://www.watergy.org/resources/publications/watergy.pdf [2005, May 6]

Energy team would encourage communication and sharing of ideas [BEE, 2003] and is considered to be best management model compared to an ad hoc energy efficiency programme or an EE programme with a single energy manage[ASE, 2002].

Institute an energy policy: Energy policy of the organisation provides foundation for successful energy management by [BEE, 2003] " setting performance goals and integrating energy management into organisational culture and operations". An energy policy works as public expression of organisations commitment and provides guidance and continuity to energy management function. The table below gives an example of energy policy of an Indian organisation [BEE, 2003]

Table 3-2 Example of energy policy of an organisation [BEE,2003]

KESORAM RAYON
(Division of Kesoram Industries Ltd.)
ENERGY POLICY

We shall strive for continuous energy economy through -

- Formulation of overall energy strategy and targets.
- All round participation of all employees through Small Group Activities
- Improved capacity utilization
- Upgradation of process, technology and equipment
- Better plant layout

As a part of our energy conservation and environment protection, we are committed to reduce specific energy consumption by 1% every year till 2010.

J.D. PALOD
President

Source: Bureau of Energy Efficiency- Bee (2003).General aspects of energy management and energy audit. Bureau of Energy Efficiency, Ministry of Power, GoI, New Delhi.

All industries falling under 15 sectors[19] designated by the Energy Conservation Act have to have their energy policy as a first step towards EE and many medium and large industrial plants from these sectors have some kind guiding energy policy. However small and medium enterprises or governmental utilities like municipal water utilities lack this kind of guiding document and articulation of energy performance goals at organisational level.

3.1.2 Building technical and managerial capacity

Many organisations realised that building capacities within the organisation help to lower the operating and capital cost, since an informed employee takes better decisions in operations of the equipment, selection of the equipment. The capacity of employees is enhances through variety of technical and management training programmes delivered by in-house or external experts. In Indian context, other ways of improving skill level includes encouraging the employees for professional competency programmes such as Energy managers' accreditation through Bureau of Energy Efficiency (BEE), Boiler Operating Engineer (BOE) of Central Boiler Directorate, etc.

[19] these are, Aluminum, Steel, Cement, Power generation Stations (thermal and hydro), Power transmission & Distribution companies, textiles, sugar, pulp & paper, chlor-alkali, fertilizers, chemicals, ports, Railways, Commercial establishment & Buildings, Petrochemical (Refineries, crackers),

Enhancing capacity building also includes up-gradation of measurement and monitoring instrumentation and data management, so that quality data/information and human skills are used in tandem [ASE, 2003].

3.1.3 Monitoring performance and goal setting

Monitoring of energy use forms the key element in many situations, since it helps to address few simple improvements through behavioural change or maintenance practices. In general, industry uses different performance metrics [ASE, 2002] such as pump efficiency, specific energy consumption, % of leakage, un-accounted water, etc to track its system performance by comparing and benchmarking with their own operations (intra-day, monthly or yearly), with an industry norm (national, international or best practice) or with equipment standard.

Monitoring of energy efficiency metrics indicate the performance gaps, there by help to set EE goals for the system or organisation.

In India few sectors like fertilisers, iron& steel, cement have sectoral norms (given by respective industry association) to foster competition among the industrial plants. BEE also gives annual awards for EE for different sectors based on overall performance of the plant as well as innovativeness of EE projects implemented

On this count also smaller industrial plants and utilities score less for not having any EE performance norms or standards.

3.1.4 EE Strategy

After knowing EE performance and opportunities for improvement, it is now time for a strategy to implement these EE improvement projects. Many EE projects suffer from several barriers, despite of their attractiveness financially and these barriers could be from within the organisation or from external sources.

BEE [BEE, 2003] suggests a tool called Force Field Analysis to arrive at a strategy to balance strengths and weaknesses (barriers) of EE projects. This involves the following steps;

“

Identify barriers that tend to work against the achievement of the goal: these may be internal to the organization (for example, a lack of expertise related to energy management) or external (for example, energy rate structures or government regulation).

Identify positive influences or forces that tend to work towards achievement of the goal; these may also be internal or external.

Estimate the relative strength of the negative and positive forces (for simplicity, we may want to identify them as low, medium and high strength).

Prioritize those forces that can be strengthened or weakened through your action plan with the greatest effect on achieving the goal (Tip: It is usually more effective to attempt to minimize negative forces than to try to strengthen forces that are already positive).”[BEE, 2003]

An example of Force Field Analysis presented below;

Table 3-3 Example of Force Field Analysis [BEE,2003]

Goal: To reduce energy consumption per unit of production	
Positive Forces (Acting towards the achievement of the Goal)	**Negative Forces (Acting against the achievement of the Goal)**
High price of energy	Absence of corporate energy policy
Energy efficient technology available	Lack of awareness throughout company
Incentive for high power factor	Insufficient skills and knowledge available
	Competing corporate priorities
Top Management commitment to energy conservation	Insufficient financial resources to fund measures
Energy is a relatively high component of product cost	

Source: Bureau of Energy Efficiency- BEE (2003).General aspects of energy management and energy audit. Bureau of Energy Efficiency, Ministry of Power, GoI, New Delhi.

Forced field analysis yields priority areas, for EE strategy on which detailed action plans for implementation will be developed.

3.2 Energy efficiency and CDM

Having seen that it takes lot of organisational efforts and resources to implement energy efficiency even without CDM, it is not surprising that in India (as well as other parts of the World) most EE projects under CDM are coming from large corporate houses. This is mainly because of organisational readiness and maturity of the large organisations to accept and implement EE, having internalised the costs (e.g. identification of projects, baseline study and monitoring costs are marginal or null, since good monitoring system already exists) because of internal capacities. However if a SME or water utility which has to start from scratch to implement EE, the upfront costs to metering, monitoring and capacity building may be significant. This will be the case whether EE projects are implemented via CDM or not. Now the key issue would be should we consider these costs as transaction costs for CDM? Author opines, it should not be, since it is anyway a cost to the organisation.

Many of the small organisations are caught in this situation, where EE potential exists but could not be realised due to higher upfront costs to start any EE initiative. Now the key question is whether CDM adds more worries, leave alone overcoming the existing barriers; Karnataka should explain this.

4 Municipal systems & Services in Karnataka

"Urbanization could lead to two widely differing scenarios. At one end of the spectrum is the Urban Ideal of well constructed homes, uninterrupted supply of electricity and water, and at the other end of spectrum is the Urban Horror of leaky roofs, erratic power supply, clogged drains and dry taps. The reality probably lies somewhere in between the two".

Source: Status of Urban Infrastructure in Karnataka, 2004

This chapter introduces the municipal system in Karnataka in general and urban water system with the institutions involved and brief explanation of their roles. This chapter also gives the reader with an account of service levels, operational & financial issues of urban water system with a view to understand present status.

4.1 Municipal system and Urban Local Bodies (ULBs) in Karnataka

The State of Karnataka (see Appendix 2 for map of Karnataka) is the fourth most urbanized State of India with 34 % of its total population (ca. 53 million) living in urban areas [KUIDFC, 2004]. Depending on the population urban centres are governed by various ULBs such as City Corporations (CC), City Municipal Council (CMC), Town Municipal Council (TMC), Town Panchayats () and Notified Area (NAC).

In bigger cities, some of the civic services such as water supply and drainage are handled by separate ULB such as water boards for ease of administration and all the ULB are either governed by Urban Development Department (UDD) or Directorate of Municipal Administration (DMA).The details of various ULB with population as per 2001 Census are as follows:

Table 4-1 Population details ULB type-wise

S. No	Type of ULB	No. of ULBs	Population in Million (2001 census)
1	City Corporations (CC)	6	7.349
2	City Municipal Council (CMC)	41	5.772
3	Town Municipal Council (TMC)	82	3.048
4	Town Panchayats ()	91	1.687
5	Notified Area (NAC)[20]	6	0.060
	Total	226	17.917

Source: KUIDFC (2004). Status of Urban Infrastructure in Karnataka [Online]. Available: http://www.karnataka.gov.in/urbandevelopment/docs/Infrastructure%20Report.pdf [2005, May 8]

[20] Notified areas are generally defense or high security establishments such as Army/ Air Force barracks, cantonments, etc. These are generally considered part of a in which they are located. (Author)

The ULB are entrusted with providing following municipal services to urban population:

- Water supply and sanitation
- Municipal solid waste management
- Roads
- Street lighting
- Other infrastructural services such as commercial properties, parks, public conveniences

4.2 Municipal water supply system: Institutions

Apart from ULBs, various organisations are involved in administration, design & installation, Operation & Maintenance and financing of urban water systems in Karnataka. The Urban Development Department (UDD) is the administrative department of GoK, which oversees the urban related activities and implements various activities through various agencies including ULBs as listed below:

Table 4-2 Roles & responsibilities of institutions involved in Karnataka urban water system

S. No	Institution / Entity	Roles & responsibility
1	Karnataka Urban Water Supply & Drainage Board (KUWSDB)	Provides facilities for potable water and under-ground drainage (UGD) in urban areas of Karnataka other than Bangalore region. Undertakes planning, design, implementation of water supply and UGD schemes. Primary role is not asset creation and not O&M. Undertakes scarcity relief works with financial assistance from GoK. Acts as conduit for financing water schemes.
2	Bangalore Water Supply & Sewerage Board (BWSSB)	Provides water supply and sewerage services to Bangalore Metropolitan Region.
3	Urban Local Bodies (ULBs)	Provides water supply and sanitation services. Levy water tariffs, install meters and collect water charges. Responsible for debt servicing.
4	Urban Development Department (UDD)	Nodal governmental department responsible for the formulation of policy & implementation and monitoring of the sector. Provides budgetary support through direct allocation and SFC (State Finance Corporation) devolutions.
5	Karnataka Urban Infrastructure Development Finance Corporation (KUIDFC)	Nodal agency for implementation of multi-laterally funded urban infrastructure projects

Source: KUIDFC (2004). Status of Urban Infrastructure in Karnataka [Online]. Available: http://www.karnataka.gov.in/urbandevelopment/docs/Infrastructure%20Report.pdf [2005, May 8]

The water services *were* traditionally provided, operated and managed by and ULBs. However centralised water and sanitation utilities such as KUWSDB and BWSSB have been created to unify and improve the service delivery and coordination among the ULBs. However, with the 74th amendment to the Constitution of India (in 1992), where the Local Governance is given importance, the management of operations and retail distribution is again transferred back to ULBs, and KUWSDB is responsible for creation of assets/facilities only. While this process is completed in most ULBs, few water supply schemes, both bulk and retail, are managed and operated by KUWSDB in places where ULBs do not have sufficient manpower and skills or where more than one ULB is benefiting from bulk supply and no ULB is ready to take responsibility of the bulk supply (including the pumping station) [KUIDFC, 2004].

4.3 Municipal water supply system: Operational aspects

Water Sources

Presently surface water from 7 rivers[21] forms the bulk of water supply in Karnataka. Bore wells and canals/reservoirs cover the rest. It is estimated that about 61% of urban population is supplied with river water [KUIDFC, 2004]. The following table summarizes source-wise coverage of drinking water for all urban population.

Table 4-3 Sources of drinking water in ULBs of Karnataka

S. No	Source	No. of ULBs
1	Bore wells(BW)	40
2	Tanks	5
3	Open Wells	1
4	Open well + BW	6
5	Tank + BW	5
6	River	112
7	River + BW	34
8	River + Tank	4
9	River + Tank +BW	1
	Total	**208**

Source: Government of Karnataka-GoK(2004). State of the Environment Report and Action Plan-2003. Department of Forest, Ecology and Environment, Government of Karnataka.

As evident from above table, major source of water is rivers and bulk water pumps are employed to transfer huge quantities of river water to urban areas. Following table shows average distance of source of water for 164 ULBs of Karnataka:

[21] Godavari, Krishna, Cauvery, North Pennar, South Pennar and West flowing rivers.

Table 4-4 Distance of water sources from ULBs

Distance in km	ULBs		Population[22]	
	Number	%	Number (Million)	%
< 5 km	59	36	2.19	21
5-15 km	55	34	2.83	27
15-25 km	30	18	3.04	29
> 25 km	20	12	2.28	22
Total	164	100	10.34 million[23]	100[24]

Source: KUIDFC (2004). Status of Urban Infrastructure in Karnataka [Online]. Available: http://www.karnataka.gov.in/urbandevelopment/docs/Infrastructure%20Report.pdf [2005, May 8]

From Above table, it is evident that 50% of urban population is supplied with water from sources located more than 15 km[25] away from urban centres resulting in financial (energy & manpower cost) and operational (physical loss through leakages, illegal connections, reliability of supply, maintenance of pipe lines, etc) implications.

Service levels of water supply

While 61 % of total urban population has access to safe (piped) drinking water, this values differs among ULBs, ranging from 37% (Gadag-Betegere) to 95% (Koppal). Even daily per capita values (expressed as LPCD- Litres per capita per day) estimated using pump capacity is 99 Liters and losses in distribution, theft/ illegal connection coupled with low availability of just 1-2 hours per day in most municipalities would represent a low service level [KUIDFC, 2004].

The following table presents the details of average LPCD against the norms set out by Karnataka Urban Water Supply & Drainage Board (KUWSDB)[26].

[22] This refers to percentage of total population who have access to safe drinking water

[23] 11 million people have access to drinking water out of ca. 18 million urban population in Karnataka

[24] MLD- Million Liters per day

[25] Distance from source is sometimes as high as 120 km [KUIDFC, 2004]

[26] KUWSDB is entrusted with creating water supply and drainage assets in Karnataka except the capital city Bangalore. It also carries out Operation & maintenance in 13 towns. However maintenance of these assets and service in rest of the Karnataka is the responsibility of ULBs.

Table 4-5 Comparison of average LPCD with Norms

Category	No. of ULBs	LPCD Norm as per KUWSDB[27]	No. of ULBs conforming to design norms	LPCD range	Average LPCD
Population < 20 000	58	≥70	21	19 (Hirekerur)-129 (Hosanagara)	90
Population 20 000 – 100 000	126	≥90	25	17 (Byadgi)-135 (Shikaripura)	75
Population > 100 000	21	≥100	8	33 (Bidar)-159 (Mangalore)	102
Total	205[28]		54		

Source: KUIDFC (2004). Status of Urban Infrastructure in Karnataka [Online]. Available: http://www.karnataka.gov.in/urbandevelopment/docs/Infrastructure%20Report.pdf [2005, May 8]

There are also regional differences in water availability and supply with coastal and southern regions (Cauvery region) better off compared to northern region. Northern districts like Bidar, Raichur, Dharwad and Gulbarga are forced to rely entirely on containerized water even for day-to-day needs, during the summer as water availability is low being a dry region with weak monsoon activity. This also explains the wide differences in LPCD. The State of Environment Report and Action Plan-2003 of GoK ascertained that inequity in distribution and inefficiency in water use has medium to high influence on public health, impact on vulnerable (poor) groups of society, productivity of economy, impact on ecosystem and gave highest priority to tackle the problem [GoK, 2004]. Since degree and severity of environmental pressure differs from region to region within Karnataka, Karnataka is contemplating policies and plans region-wise [GoK, 2004]

Operational problems in water supply & distribution

Apart from poor availability of drinking water, other operational problems in distribution are making the urban water supply unsustainable both financially and environmentally. The following are the typical problems in retails distribution [KUIDFC, 2004][GOK, 2004]:

- There is high amount of Unaccounted- For-Water (UFW) ranging from 30-70 %[29] due to physical loss (leakages) and illegal connections. The estimates from ULBs show about 100 000 un-authorised connections in domestic, commercial and industrial sectors together.

- No functioning of meters (about 30% meters do not work)

- No mapping of distribution network (no status of leakage, cracks) and maintenance undertaken only for visible and noticeable leakages

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[27] WHO attaches high health risk if LPCD is less than 50. However it prescribed a bare minimum of 7..5LPCD (for drinking only) as minimum acceptable level. (http://www.who.int/water_sanitation_health/diseases/WSH0302exsum.pdf)

[28] Information of other ULBs not available [KUIDFC, 2004]

[29] In Bangalore, it is estimated that UFW is around 35% in 2001-2002 [GOK, 2004]

- Poor engineering and design practices such as multiple and variable sizes of pipes, insufficient gradient leading to stagnation and reverse flow (thus resulting in higher energy consumption).

- Low pressure and excess water drawl due to proliferation of unauthorized connections (to make up for the pressure drop due to illegal water drawl and leakage, pump will be in high discharge pressure condition and this results in lower flow than the designed but consuming more energy due to lower efficiency at this off-design conditions.

- Public stand- posts (or "community taps") being used for commercial purposes by water vendors.

The problems mentioned above clearly indicate that there is rampant inefficiency in water and energy use. However, ULB personnel mostly undertakes repairs for visible and noticeable leakages, ignoring (or not aware of) the systemic and latent problems. This gives us enough scope for improving water efficiency, energy efficiency and commercial efficiency (i.e. metering etc.).

4.4 Municipal water supply system: Financial aspects

ULBs in Karnataka as well as other States of India are known for their bad and poor finances. All most all ULBs depend on grants and loans from Government, Banks and multilateral agencies such as the World Bank (WB), Asian Development Bank (ADB) for their capital and O&M expenditure.

The following sections detail the financial aspects for urban water supply.

Water supply costs

The energy and R&M (Repair and maintenance) cost constitutes the major portion of O & M (Operation and Maintenance) costs. The estimates for 2003-04 financial year (FY 03) is presented as below:

Table 4-6 Estimated O & M expenses of water supply

S.No	O &M Expense	Amount (Million Rupees)	% of Total O & M expenses
1	Establishment (salary, office accommodation etc)	500	24.4%
2	Energy (electricity)[30]	940	45.9%
3	Repairs & maintenance	560	27.3%
4	Chemicals	20	1.0%
5	Depreciation & Miscellaneous expenses	30	1.5%
	Total	2 050	100%

Source: KUIDFC (2004). Status of Urban Infrastructure in Karnataka [Online]. Available: http://www.karnataka.gov.in/urbandevelopment/docs/Infrastructure%20Report.pdf [2005, May 8]

[30] At individual ULB level, energy cost can range between In bigger cities, energy cost alone can be as high as 70%

As seen from above table, the energy charges and R&M costs run up to 70%. In capital city of Bangalore, where the water supply is from, Bangalore Water Supply and Sewerage Board (BWSSB), the energy cost is estimated to be Rs. 3.25 / kL[31] of total delivery cost of Rs. 6.58 / kL [KUIDFC, 2004].

Water Tariff: The water tariff is based on estimated O&M expenses and debt servicing [KUIDFC, 2004]. The total cost is spread over domestic, non-domestic and industrial users on weighted average basis, which means all expenses, (would) should have been recovered if all water supplied is metered, billed and revenue is recovered. However, given the large amount of Unaccounted- For-Water (UFW), i.e., difference between supplied water and billed water (UFW includes physical loss, theft, illegal connections, un-metered connections and connections with faulty meters), KWSDB could recover only 22% of O&M expenses[32] in FY 03. This explains the poor finances of ULBs and their dependence on loans, grants from various organisations. Owing to this poor revenue realization of water supply, many ULBs could not pay energy bills on time. Generally these energy bills are settled through Government of Karnataka (GoK) budgetary allocations through State Financial Corporation (SFC) [Ram Kumar, 2005].

Capital investments in urban water system

KUWSDB is the nodal agency for undertaking capital investments in urban water systems with loans from domestic financial institutions like HUDCO (Housing and Urban Development Corporation Limited), LIC (Life Insurance Corporation of India) and domestic banks. KUIDFC is responsible for projects financed by external sources such as WB, ADB, etc.

The capital investment is funded through a combination of the following [KUIDFC, 2004]:

- Grants and Loans from GoK / GoI
- Payments from ULBs
- Commercial Loans from domestic sources (LIC, HUDCO, Debentures)
- Commercial Loans from external sources (WB, ADB, etc)

The prevailing funding pattern for capital investments, in urban water systems, depends on population of the ULB and is presented below:

[31] 1kL=1000 Liters= 1 cubic meter

[32] Out of Rs. 2050 Million O&M expenses in FY 03, ULBs could recover only Rs. 450 millions from consumers [KUIDFC, 2004]

Table 4-7 Funding pattern for water supply schemes

S.No	Population range of ULBs	FI Loan %	Govt. grant %	ULB contribution %
1	Less than 20 000	0	100	0
2	20 000- 75 000	50	50	0
3	More than 75 000	66.67	23.33	10

Source: KUIDFC (2004). Status of Urban Infrastructure in Karnataka [Online]. Available: http://www.karnataka.gov.in/urbandevelopment/docs/Infrastructure%20Report.pdf [2005, May 8]

Not withstanding availability of loans / grants, many projects/investments envisaged suffer during the execution as ULBs fail to make their contribution[33]. Even many ULBs routinely fail to meet their debt- servicing obligations. This is the primary reason, why private investors are not ready to participate in this sector. And as result of these factors 150 ULBs (out of 208 ULBs) are languishing for some kind of augmentation and up-gradation in water supply system [KUIDFC, 2004].

[33] In any year only 50-70% of budgeted work is executed due to non payment of contributions (own share of capital) from ULBs [KUIDFC, 2004]

5 Energy Efficiency opportunities in urban water system & CDM

"Just as energy planners have discovered that it is often cheaper to save energy–for instance, by investing in home insulation and compact fluorescent lights–than to build more power plants, so water planners are realizing that an assortment of water efficiency measures can yield permanent savings and thereby delay or avert the need for expensive new dams and reservoirs, groundwater wells, and treatment plants".

–Worldwatch Institute's State of the World

Given the vintage[34] of water supply systems, technology and operational problems (refer Section 4.3), water supply systems in Karnataka (or else where in India) are known to operate at sub-optimal performance resulting in both technical and commercial losses. The following section details typical energy efficiency opportunities based studies from 13 ULBs in Karnataka. The purpose of this chapter is to analyse the potential of EE in urban water system for financial feasibility and replicability.

5.1 Energy efficiency opportunities in urban water systems

5.1.1 Energy efficiency opportunities & replicability

In 2002, Alliance to Save Energy (ASE), with support from USAID, sponsored energy audit studies in six (6) municipalities of varying size[35] (Hubli-Dharwad, Mysore, Bellary city, Belgaum, Gulbarga and Tipture-Arasikere) to explore the energy and water saving opportunities under it "Watergy"[36] programme in Karnataka. [ASE, 2005]. With the success of these studies in terms of actual and potential EE improvements, the Asian Development Bank supported similar EE studies in 7 more cities (Mangalore, Bhatkal, Dandeli, Karwar, Puttur, Sirsi and Udipi) under its Karnataka Urban Development & Coastal Environmental Management (KUDCEM) project. In all studies The Energy & Resource Institute (TERI) has done technical studies to identify the EE projects.

The urban system improvement projects identified in 13 ULBs can be broadly classified[37] into energy efficiency, water efficiency and energy management projects. All these projects are supply-side interventions in water system (from ULB point of view) and typical projects identified are [TERI, 2004a-m][38]:

- ✓ *Energy Efficiency projects* which include replacement retrofitting of old pumps, optimum sizing of pump (pressure and flow) to suit the system requirement, replacement and

[34] Many of the pumping systems in operation are of very old, dating back to 1960s and 1970s in many ULBs. [TERI, 2004a-m]

[35] These cities fall under City Corporations (CC), City Municipal Council (CMC) or Town Municipal Council (TMC). Town Panchayats are not taken up as they too small in size and often use water tapped from bulk supply lines going to bigger towns/cities.(Author)

[36] "Watergy" is the term coined by ASE to indicate the nexus between water pumping and energy consumption.

[37] This classification has been used by the author to differentiate projects which can be included in project categories as defined in CDM process. For example, electric power demand reduction project would not qualify for CDM since they would not result in energy/GHG savings.(Author).

[38] These projects are collated from reports of feasibility studies done by TERI, India for the 13 ULBs (Author)

retrofitting valves, increasing the size of suction and discharge pipes, cleaning and maintaining suction side of the pumps, switching off transformers powering the water pumps(when pumps are not in operation), avoiding parallel operation of power transformers, using more pipe lines to deliver water thus reducing frictional power loss, efficient controls etc.

- ✓ *Water efficiency* projects include mainly loss reduction opportunities in bulk supply lines and over flows from Over head tanks (OHTs) and reservoirs, reducing leakages from air vent valves and under ground leakages, etc .

- ✓ *Energy Management*[39] projects include power demand smoothening, installation of capacitors to improve power factor (thus avoiding penalty on low power factor and/or reducing power demand charges), surrendering excess contracted power demand (to reduce demand charges), rescheduling pump operation to reduce peak demand and demand charges, etc.

Most of the potential projects identified are of simple measures of retrofit& replacement with efficient equipments, systems and controls. Also there are few projects with operational improvements such as rescheduling of pumping operation, avoiding unnecessary valves, etc. From a technical point of view, all ULBs have similar problems and identified projects are applicable to all ULBs. This offers scope for standardising pumping system performance requirements (which can be demanded from ULB personnel operating or from ESCOs through a performance contract).

Out of above types of projects, demand reduction projects or techniques would not qualify for CDM as there would not be any GHG savings. Hence only potential and financial feasibility of energy efficiency and water efficiency projects would be discussed in the following sections.

5.1.2 Energy efficiency potential & financial feasibility

The TERI's technical studies projected total EE potential (water efficiency included) from individual ULBs ranging from 14% to 46% of present total energy cost. The projected water savings due to loss reduction opportunities in main transmission line are also very significant ranging from 22% to 37% of flow at main pumping station.

The total GHG savings projected range from 68 to 4 300 tons of CO_2 for various ULBs and as such these have to be bundled to make sufficient CERs, so that efforts and costs involved in project development under CDM would be justified. Further, bundling can be done in such a way so as to limit yearly energy savings to 15 GWh[40] to take advantages of simplified modalities of Small Scale CDM (SSC) projects.

The ULB-wise projected energy and water savings with GHG emission reductions are tabulated below:

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[39] These are all cost reduction projects without any reduction in energy consumption. (Author)

[40] For EE , projects with 15 GWh/year energy savings are allowed as SCC[UNFCCC, 2005a], [UNFCCC, 2005b]

Table 5-1 EE potential in urban water system ULBs and GHG emission reductions

S.No	ULB[41]	Energy Efficiency Potential (per Year)			Water savings	
		Total projected energy savings (GWh)	**Energy saved expressed as % of present energy cost**	**GHG reductions (t CO_2)**	**Estimated water savings (loss) in main transmission lines (Million. Litre/ year)**	**As % of main pumping station flow**
ULBs supported by ASE	***Hubli-Dharwad***	***4.101***	***14.4%***	***4 315***	-	-
	Bellary	***1.294***	***21.3%***	***1 362***	-	-
	Arisikere-Tiptur	***0.363***	***36.5%***	***382***	***292***	***31.1%***
	Mysore	***2.449***	***13.9%***	***2 576***	-	-
	Belgaum	2.307	12.0%	2 427	3285	23.7%
	Gulbarga	1.304	21.9%	1 372	1949	37.0%
ULBs supported by ADB	***Mangalore***	***4.013***	***26.5%***	***4 222***	-	-
	Bhatkal	0.086	46.0%	90	-	-
	Dandeli	0.177	17.6%	186	-	-
	Karwar	0.536	35.0%	564	-	-
	Puttur	0.065	17.5%	68	-	-
	Sirsi	0.199	17.0%	209	416	22.0%
	Udipi	0.252	17.2%	265	726	22.4%
	Total (for all ULBs)	17.146	Avg: 22.83%	18 038	6669	Avg:26.2%
	Total for CDM-ULBs	12.220	22.52%	12 857	-	-

Source: a. Information from TERI Energy Audit reports (project wise energy savings and water savings expressed as pumping station capacity). b. Authors calculations (total energy savings per ULB which excludes EE projects not eligible for CDM, GHG reductions, and total water savings per year).

The above GHG emissions are calculated at an emission factor of 1.052 kg CO_2/ kWh which is combined margin of Karnataka grid from which all ULBs draw power. Combined margin is the weighted average of Operating Margin (OM) and Built Margin (BM) of the Karnataka grid, calculated as per methodology (ACM 0002[42]) given by UNFCCC.[Quality Tonnes, 2004].

The following table summarises the energy savings and GHG reductions according type of ULB and projections for the State of Karnataka.

[41] ULBs in ***Bold-Italic-Shaded*** are bundled for implementation through CDM

[42] http://cdm.unfccc.int/UserManagement/FileStorage/ACM0002_Consolidated_elct_version_2.pdf

Table 5-2 Energy savings and GHG reductions as per type of ULB and EE projections for Karnataka

S.No	**ULB Type**	**Total[43]/ Average**	**Energy savings projected (GWh/year)**	**GHG reductions (t CO_2/ year)**
1	City Corporations (CC)	Total	14.176	14 913
	(Hubli-Dharwad, Mysore, Mangalore, Belgaum, Gulbarga)	Average	2.835	2 983
2	City Municipal Council (CMC)	Total	2.281	2 400
	(Bellary, Karwar, Sirsi, Udipi)	Average	0.570	600
3	Town Municipal Council (TMC)	Total	0.691	727
	(Arisikere-Tiptur, Bhatkal, Dandeli, Puttur)	Average	0.173	182
	Karnataka[44]	Total	57.4 GWh	60 000

Source: Total energy and GHG savings are calculated from Table 5-1 by combining results ULB type-wise. Average savings are calculated by dividing total savings with number ULBs considered. Projections for Karnataka are made by multiplying average savings (ULB type-wise) with total number of each type of ULB (from Table 4-1).

It is evident from the above table, that EE improvements results in significant energy and cost savings besides GHG emission reductions. In fact, the cost of energy saved and revenue from sale of CERs individual projects forms good savings and for many ULBs, the savings could ease the tight financial situation.

Financial Analysis: The financial analysis of individual EE projects for all 5 CDM-ULB[45] cities (Hubli- Dharwad, Bellary, Arisikere-Tiptur, Mysore, Mangalore) is done and presented in Appeadix-1. The financial analysis[46] of various EE projects proposed indicate that most projects can be completed with no or marginal investment and most project have simple pay back period of less than a year. There are very few projects are having 1-2 year (simple) payback period. Consequently, the project IRR calculated is in the range of 53% to 2 267 % (!!), which is very attractive for ULBs, ESCOs or other private investors. The following table 5-3 gives the key results for these CDM-ULBS.

[43] Here, "Total" refers to total energy and GHG reductions of ULBs studied for each ULB-type.

[44] The averaged values for each ULB type are extrapolated on pro-rata basis to get projections for entire Karnataka (Author)

[45] The financial analysis is restricted to 5 CDM-ULBs to avoid the too much of data with same end result. (Author)

[46] The technical reports of [TERI,2003] includes calculation of simple payback period and author included IRR calculation also since IRR is considered to be appropriate financial indicator in most CDM projects (refer to Appendix-1).

Table 5-3 Financial analysis of EE projects with and without CER revenue

ULB	Annual savings	Investment	Investment analysis			
	Million. Rs.	Million. Rs	Simple payback period (SPB) in years	Internal rate of return (IRR) without CER revenue	Internal rate of return (IRR) with CER revenue	Change in IRR due to CER revenue
Hubli- Dharwad	14.281	4.050	0.3	352.6%	376.6%	24.0%
Bellary	5.239	3.900	0.7	134.3%	142.2%	7.9%
Arasikere- Tiptur	1.701	0.980	0.6	173.6%	182.3%	8.8%
Mysore	10.140	5.400	0.5	187.8%	198.5%	10.7%
Mangalore	14.447	7.400	0.5	195.2%	203.8%	8.6%
Total	45.808	21.730	0.5	210.8%	224.1%	13.3%

Source: a. TERI energy audit reports [TERI, 2003a-m] for annual savings, investment and simple payback period. b. Author (for IRR calculation with and without CER revenue using built-in IRR formulae in MS Excel software) c. CER price is taken as $ 5/ CER on net basis, i.e. after deducting transaction costs $2/CER from market price of $7 /CER (present price is $7-13/CER and transaction costs for projects with this amount of CERs are estimated to be $0.60-1.39/CER. Transactions costs are estimated from typical costs used by Price Waterhouse Coopers, India for this type of projects with assumptions given in Table 2-6 & Appendix 1)

Despite of financial attractiveness of these projects, they have not been implemented due to presence several barriers typical for EE projects, small organisations and municipalities. These barriers and issues are discussed in Chapter 6.

6 Barriers & opportunities to implement EE in urban water systems

"Climate policy has been held hostage to a tacit presumption that if saving a lot more energy were possible at an affordable price, it would already have been implemented. That's like not picking up a $100 bill from the sidewalk because if it were real, someone would previously have picked it up; or like an entrepreneur who abandons a good business idea because if it were sound, it would have been done earlier".

–Amory B. and L. Hunter Lovins, ``CLIMATE: Making Sense and Making Money"

This chapter examines the barriers to implement EE in urban water systems in the State of Karnataka with a view to understand the significance of the barriers and cause & effect of these barriers. On solution side, options available to overcome identified barriers and interventions made in Karnataka and other interventions required to be done are examined. Identification of barriers is done using semi structured interviews and discussions of key personnel in KUIDFC and KUWSDB, reports of KUIDFC, other agencies which worked with urban sector like ASE, TERI, organizational theory of implementing EE (which was discussed Chapter 3), market intelligence reports from USAID, Nexant etc with funding & other opportunities for implementing EE and author's own experience in implementing Energy Efficiency and Management in India, especially in industrial sector.

The barriers identified are classified into organizational, financial, CDM related and other barriers and are discussed in the following chapters.

6.1 Organisational issues

6.1.1 Lack of awareness, information and capacity regarding EE opportunities

Energy efficiency, though not new to India, it has not taken well even in industrial sector, where there is relatively higher awareness & information availability about the opportunities and information is available for saving opportunities. This is despite of the fact that, industries are manned by best technocrats and corporates could invest resources for implementing EE. Industrial sector is also better off in information sharing through networks, conferences, workshops, training programmes. Where as, ULBs (municipalities), in Karnataka or other parts of India, have not been exposed to this kind of activities[47]. Hence it is very natural that the municipal managers, in general, are not aware of the EE opportunities in municipal services.

Another key influencing factor for lack of awareness and information is the lack of organisational culture in municipal system due to internal competition for scarce resources, making each municipal manager to look inward. This is further aggravated by getting sand-

[47] In my 7 years tenure at National Productivity Council of India known for Industrial EE in India & Asia Pacific, no municipal manager participated in any workshop/training programme/ conference organized by National Productivity Council, even when there is no fee to be paid for few programmes that have been sponsored by State/ Central Government [Author].

witched by interference from bureaucracy and political quarters[48] in the provision of water service (and other municipal services). The requirement to act as public interface with larger population (or customers) also takes efforts and time of municipal managers and most of the time, municipal managers are preoccupied with just delivering and meeting service and quality requirements. There is any hardly effort and capacity to do any EE improvements in urban water services.

The outcome technical studies conducted in urban water system could be used to disseminate the EE opportunities in urban water system among ULB personnel.

While all ULB managers need to be trained in EE, it may be prudent to form core team in energy efficiency from among ULB managers. The core team can develop expertise in EE implementation and undertake technical studies in all ULBs. This shall be augmented by regular conduct of awareness and refresher programmes for ULB personnel. The urban administration can also encourage municipal manager to become Accredited Energy Manager[49], so that all energy related matters can be handled by him/her.

Asian Development Bank has started a capacity programme in environmental management which could be utilised to deliver energy efficiency concepts also. Similar capacity building project sponsored by the Alliance to Save Energy (ASE), the World Bank are good examples of capacity buildings opportunities to deliver EE concepts[ASE, 2005].

6.1.2 Real and perceived insignificance of energy efficiency

The EE potential though seems large for ULB / Karnataka, can be achieved only by implementing large number of smaller projects [Quality tonnes, 2004]. The total energy and cost savings potential would be visible after implementing these small projects. Since this requires effort, time and other resources (administrative, technical, engineering and financial), municipal managers are not too interested in implementing EE. Even the cost savings projections of 25% of present energy cost, when seen in comparison with total O&M cost and capital budget of ULBs, is miniscule.

The main reason for this perception (or reality) is the lack of institutionalisation of EE in municipal system. Each EE project activity requires identification and implementation, requiring multi-disciplinary skills. Lack of institutionalisation of EE put greater demand for these skills and ULBs are not geared for this. Also most of the discussion and arguments for EE in industries or ULBs are centred on technical and financial aspects of the projects. The environmental, social benefits along with larger economic benefits to the society or country are never taken into account either by individual ULBs or State level municipal administration and urban development agencies.

Creation of institutional capacity & experience in EE would (have made) make the EE implementation as a routine activity as a separate organisational function[50] or as part of

[48] The opinions expressed are authors personal ones and have no connection with organizations, the author is affiliated to (Author).

[49] Bureau of Energy Efficiency (BEE) of Ministry of Power (MOP) of Government of India conducts the accreditation of Energy Manager (EM) and Energy Auditor (EA). The Energy Conservation Act, 2001 of India, mandates appointment of Energy Managers in 15 industrial and service sectors and energy audit of any industrial facility would be conducted through an Accredited Energy Auditor. Both EM and EA accreditation is administered through National Productivity Council of India. (Author)

[50] National Thermal Power Corporation (NC) is the best example of EE institutionalization. Each power plant has EE Cell whose capacity is built over period of 5 years with technical & training inputs from National Productivity Council of India

existing organisational function (say Operation & Maintenance, Repairs & Maintenance, Renovation & Modernisation, etc).

In Karnataka (and in other parts of India), the institutionalisation of EE in urban bodies is still in infancy. Presently, external agencies like National Productivity Council, The Energy & Resource Institute are engaged to conduct Energy audits to identify and develop EE projects. The cooperation of ASE with ULBs also led to establishment Energy & Environment cell at KUIDFC [ASE, 2004]. However at ULB level, there was no organisational function, as discussed in the following section.

6.1.3 Lack of Energy Management function in ULBs

There is no energy management function at ULBs. The existing and significance of this barrier is studied from two aspects- technical (metering, monitoring of energy consumption) and management (structure, accountability, reporting) aspects:

> ***Technical aspects:*** The existing metering and measurement of energy and other operational performance parameters not comprehensive in all ULBs. The level of instrumentation and monitoring required for any diagnosis is minimal. The energy audit studies of TERI also recommended up-gradation of instrumentation and monitoring in all ULBs where studies have done. The up-gradation of monitoring includes [TERI, 2003a-m] portable and on-line energy meters, pressure gauges, hour meters to log operating hours of each pump, water meters, etc. This is because of lack of performance norms /goals in terms of EE as explained below.
>
> ULB personnel are mostly concerned about delivery of water but not about the efficiency of the service. They are not concerned about energy consumption and efficiency due to lack of awareness and also due to the fact that ULBs do not pay their electricity bill themselves (this aspect is discussed in section 6.1.4 below). Some ULBs do not even see their energy bills which are directly sent Urban Development Department for payment to electric utility KCL (Karnataka Power Transmission Corporation Limited). This arrangement has been made by UDD and KCL as ULBs fail to pay electricity bills due to poor finances (see section 6.2 for further explanation on financial issues) [Ramakumar, 2005][KUIDFC, 2004][Quality tonnes, 2004].
>
> The effect of good metering and monitoring is well established in many studies. Many (about 17 cities from all over the World including 4 cities from India) case studies by Alliance to Save Energy [ASE, 2002] indicate that a good metering and monitoring of energy & other parameters would improve EE up to 10% by enabling detection of simple EE measures. Even the studies in 13 ULB of Karnataka indicate most EE projects were detected because of simple measurement and monitoring during energy auditing. Metering and monitoring is important for implementing and sustaining the EE. It is prerequisite for EE implementation through CDM and / or ESCO for monitoring and verification of energy savings and / or GHG reduction projections.
>
> ***Management Aspects:*** Management approach to EE can be classifies into three types; ad hoc or informal, Efficiency Manager (Single Manager), Efficiency

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to identify and implement EE. Today, each plant does about 10 energy/technical audits (through internal or external resources) on different systems of the plant and EE is implemented as a separate function or as part of O&E (Operations & Efficiency) or O&M (Operations & Maintenance).(Author)

Team[ASE, 2002]. The key characteristics of these management models are tabulated below:

Table 6-1 Management structures to approach water and energy efficiency in ULBs [A

	Management structure	Key characteristics	Resources and tools
(Low)←←Efficiency gains →→(High)	Ad hoc	• This is often the default approach. • Upper-level management focus is limited. • Efficiency activities are done without considering system wide impacts. • System maintenance is done on a reactive basis. •Little or no communication takes place among operating units.	• Water and energy metering or monitoring infrastructure is limited or nonexistent. • Water and energy data available are neither widely shared nor prepared in usable form. • Project funds are often unavailable.
	Single manager	• Response is often focused on one particular efficiency opportunity (location or technology). • Upper-level management recognizes the need to focus on efficiency. • Limited communication, but insignificant level of collaboration takes place among operating units. • Efficiency manager has little direct control over key personnel.	• Financing is available on the merits of the actual project. • Data gathering occurs, but is limited in scope and distribution. • Some personnel and equipment are designated for specific projects. • Projects are funded on a case-by-case basis.
	Efficiency team	• Response approaches efficiency as a system-wide issue; all operating units promote efficiency. • Upper-level management makes efficiency a priority and regularly checks progress. • System maintenance is an integral part of day-to-day activities. • Managers and staff recognize interconnection of various parts of the system in designing efficiency projects. • Watergy utility efficiency team leadership has some control over key personnel.	• Access to personnel with broad range of skills • Major data collection program with well designed and distributed reports • Efficiency is a key component of all financial decisions. • Cost savings from projects are often put back into a fund for additional upgrades. • Other innovative funding mechanisms are often available to implement projects

Source: Watergy: taking advantage of untapped energy and water efficiency opportunities in municipal water systems. Alliance to Save Energy, 2002. Available: http://www.watergy.org/resources/publications/watergy.pdf [2005, May 6]

From the above table, it is clear that Efficiency Team is the superior model, the ULB can employ to maximise the gains. The present management approach in ULBs of Karnataka can be at the most ad hoc approach as there is no separate efficiency manager or team at ULB level or State level. Case studies from Watergy studies [ASE, 2002] show that a corporate or organisation wide energy management plan in water utilities with efficiency team could save 5-15 % more energy than ad hoc approaches.

ULBs in Karnataka should develop an efficiency team (refer to section 6.1.1 also), members of which can be taken from different departments to use their skills, to integrate EE thinking into respective areas of working and there by institutionalise EE in ULBs. The Energy &

Environment cell established at KUIDFC should be expanded with personnel from ULB level (local level), KUWSDB (which designs and creates urban water assets), irrigation department (which harvests the river/surface water for urban areas), EE consultants, ESCOs, equipment / service providers to increase its capabilities.

6.1.4 Poor incentive for ULBs to exploit EE opportunities

Owing to poor finances of ULBs, many of them routinely fail to pay for contract and electricity bills and debt servicing. To avoid the disconnection of electric supply to the pumping stations, Urban Development Department (UDD) and KCL (electric utility in Karnataka) have made arrangement to pay electricity bills of ULBs directly from the UDD to KCL. In this arrangement, electricity bills of all ULBs are aggregated at State level by KCL and sent to UDD and the UDD pays the bills through State Financial Corporation (SFC), which is the financial conduit to transfer money from Government to individual ULBs. The same amount of money is deducted from total allocated budgetary grants (of Karnataka government) to ULBs. [Ram Kumar, 2005]

While the above arrangement ensures that KCL do not cut-off power supply to ULBs, same is the main reason for lack of accountability on part of ULBs for energy consumption and efficiency. This has led to wide-spread inefficiency, poor awareness and internal capacities of ULBs with respect to energy efficiency.

Now KUIDFC is working towards another arrangement where ULBs pay their bills at least for 5 ULBs where CDM is proposed. In this arrangement UDD/ SFC will pay amount of electricity bill into an escrow account and the ULB authorises the transfer of this amount (after receiving the electricity bill and after cross checking) to KCL However, many ULBs fear that this payment arrangement would victimise ULBs which are implementing EE. This is because, when EE is implemented and energy bill is reduced, UDD/SFC will transfer only reduced amount. This way the benefits of EE would not be transferred to ULBs. This will also become major problem if EE is implemented through ESCOs, where cost savings would have to be shared between ESCO and ULB. That is why KUIDFC is working a fixed payment as per benchmarked historical energy consumption and energy cost, so that benefits of EE will remain with ULBs [Ram Kumar, 2005]

6.1.5 Lack of performance based O&M practices

The existing practices of O&M do not factor energy efficiency. Maintenance is always a case of " fire fighting" in ULBs, i.e. maintenance is done when pump fails to operate. Hence all maintenance efforts are to make the system to work somehow, but not how efficiently. Few ULBs in Karnataka have awarded O&M contracts to private parties. This is only service based contract in which private party employs manpower to operate and attend any maintenance. There are no performance related parameters such as energy efficiency or specific energy consumption (kWh/m^3) as deliverables.

The main reasons for lack of performance based maintenance (and contracts) are lack of awareness, lack of monitoring instruments and lack of capacity to benchmark the performance on part of ULBs. Many project activities proposed in 13 ULBs of Karnataka [TERI, 2003a-m] are related to pump maintenance and retrofitting the pump internals to regain the efficiency. Hence proper monitoring instrumentation and incorporating energy efficiency into O&M would yield significant energy and cost savings. Since ESCOs generally provide performance based services, their participation should be encouraged and increased (see section 6.2 also).

6.2 Financial Issues

Although at project level, financial analysis of EE is very attractive, the overall poor performance of ULBs (as described in Chapter 4) is main influencing factor which is coming in the way of many aspects such as awareness, capacity building, private sector participation. This section examines the financial issues being faced in implementing EE and CDM can act as catalyst in overcoming these barriers.

6.2.1 Poor finances of ULBs

As mentioned and discussed earlier, financial conditions of ULBs, are very poor. The main reasons for this are lack of proper pricing, revenue/tax recovery systems[51] in municipalities, which have political implications. But there are many technical and administrative aspects which can be improved to improve ULB finances. These are issues of Unaccounted-For-Water (UFW) which would not bring any revenue; gaps in metering (lack of metering, non-working meters, faulty meters and illegal connection) which result in commercial loss for ULBs can be taken up easily, to improve the financial condition of ULBs.

Few banks like IDFC (Industrial Development Finance Corporation) and ICICI (largest private sector bank in India) have separate funds for EE, which mainly given to ESCOs. There are few loan guarantee schemes from developmental agencies like USAID (Refer section 6.2.2 for details), which can be used to secure loans from these banks. Karnataka should explore these opportunities and make its administrative and legal framework (e.g. legal title of CER to ESCOs, other private funds, etc) of ULBs to take advantage.

As it is, all the EE projects proposed under CDM in Karnataka municipal water system, are financially attractive (Refer section 5.1.2), even without CER revenue. It is the capital requirement which should be met. Apart from usual sources of project funding like loans/ debt, equity, grants (refer section 4.4 for capital structure of projects for ULBs in Karnataka as per their population), upfront payment from buyer of CERs can be used towards investment in EE. For example PCF provides up to 25% of CER value as upfront payment [UNEP, 2004a].

In EE projects proposed in 13 ULBs of Karnataka, about 10% to 72%[52] of investment requirement (on individual project basis) can be met if 25% of CER revenue paid as upfront. On average, this percentage works out 20.5% of total investment in 5 CDM-ULBs[53] (Refer to Appendix 4 for project-wise calculation). Given the possibility of about 23% to 50% grant from GoK, it is possible to secure 43% to 70% of total investment required, without any loan or debt. Since these projects also get energy cost savings, most projects will achieve financial closure within 3 months[54] from date of implementation. For ULBs or ESCOs, it can not get any better!

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[51] Pricing of water and revenue recovery issues are beyond the scope of present thesis; hence they have not been addressed here (Author).

[52] Except one project in Hubli-Dharwad, where CER upfront receipts are more than investment required [Author]

[53] Appendix 1 also gives project IRR with CER revenue. Since these EE projects are already attractive without CER revenue, its effect on project IRR is superficial/redundant. Hence, this aspect is not discussed further. However CER revenue in the form of up front payment from the CER buyers or ERPA (as collateral) would immensely help to meet investment requirements for EE. [Author]

[54] The average payback period for all projects (total 36 in total) in 5 CDM-ULBs, is around 5 months. When 75% of investment is secured through CER up front revenue and grants from GoK, the payback period will be 2.5 months (less than 3 months) [Author]

6.2.2 Lack of access to debt market & lack of participation from private sector

Given the precarious financial conditions of ULBs and ULBs frequent failure to service debts, accessing financial market for debt, through bonds/ debentures or loans from banks, is very difficult. Same reasons are cited for lack of private sector participation. Especially, the municipal bonds are very difficult to issue as this requires sovereign guarantee from the State and Central governments. As such bigger ULBs and only for bigger projects, it is possible to issue municipal bonds.[KUIDFC, 2004] [Quality Tonnes, 2004]

The capital requirements can be arranged through either project financing or corporate financing as described below [UNEP, 2004a];

- In ***project financing,*** a project company is formed and all the investments are viewed as assets of this company. Investment comes through either equity or debt with assets and cash flows (energy savings+ CER revenue) acting as security. In Karnataka, KUIDFC or KUWSDB can act as project-company to implement EE, with ULBs servicing debt through them[55].

- In ***corporate financing***, new projects are undertaken as extension of existing assets. Loans will become debts of the company and creditors have full recourse to all assets and revenues, over and above those created by the project. Here each ULB will have to secure debt, which may increase the administrative efforts and transaction costs. The advantage is each ULB is responsible for debt servicing on individual basis.

Other ways of using CER revenue for securing debt are; ERPA can be used as collateral[56] or CER revenue could be paid directly into the bank account for credit against debt-servicing [UNEP, 2004a]. Further, many developmental agencies like USAID, WB, GEF (Global Environmental Facility) have several financial instruments such as loan guarantee mechanism, conditional loan, interest rate buy-down grant, Direct Loan Structure, Development Credit Authority (USAID), Sustainable Guarantee Facility (SGF), etc [Nexant, 2003]. They are discussed in the following paragraphs:

Loan Guarantee Mechanism:

The World Bank through GEF[57], supported loan guarantee mechanism for EE projects in few countries (e.g. Hungary, China). This provides loan guarantees to financial institutions disbursing loans for EE projects. Both individual loans (transaction guarantee) as well as portfolio of small projects (Portfolio guarantee) can be covered as given below:

- *Transaction guarantee* is provided to local financial institutions(FIs) for repayment of EE loans given to end-users (ULBs in our case), leasing companies which use the loan to lease finance end-users and ESCOs which use the loans to finance energy service agreements.

- *Portfolio guarantee* is provided to local FIs for small EE loans and leasings.

[55] This is the present operating framework for infrastructure finance in most ULBs of India, including Karnataka [Author]

[56] CER purchase agreement with PCF is used as collateral in Plantar project (Brazil) [UNEP, 2004a]

[57] http://www.gefweb.org/PRIVATE/priv.htm

Conditional Loan

Conditional loan[58] is given based on performance condition and hence it is applicable not only to end-users, but also to ESCOs. In case of ESCOs, the energy saving payments[59](as per performance contract) made by end users (say ULBs) to ESCO is paid into a collateral control account or escrow account to service principal and interest. By capturing the end user payments directly, the loan/fund only takes technical risk of ESCOs performance. Further ICICI, India has a conditional loan/ grant scheme under Energy Conservation & Commercialisation (ECO)[60] project.

USAID Development Credit Authority (DCA)

Development Credit Authority of USAID is market based credit enhancement mechanism to mobilise private investment when USAID's local missions decide a credit enhancement will better serve local developmental interest than more traditional grant programme.

The DCA provides guarantee to 50% of lenders (commercial banks) commercial risk and barrowers could be private sector firms (like ESCOs or technology/equipment suppliers), municipalities and sub-sovereign (autonomous organisations) entities with less than 25% government stake and does not insist on collateral from the borrower. In all cases, USAID extends this assistance only if the project activity would otherwise not receive funding market. In case of ULBs in Karnataka (and in India), the EE implementation will definitely yield these local benefits (as discussed in section6.4.2.) and given the financial aspects under which ULBs operate, this facility could be a good match[61].

While lack of access to debt is definitely a problem the urban sector facing, many opportunities exist as discussed above. It is up to the ULBs and other agencies like KUIDFC or KUWSDB to explore and exploit these options. Many of these funds and loans require a good financial system in place with barrowers, i.e. ULBs, which need to be ensured before applying for any funding. As ULBs have only single entry system[KUIDFC, 2004] for accounting[62], this need to be changed to double entry accounting system or fund based accounting system, so that each fund/project could be tracked for its financial closure.

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[58] This concept is used in selling photo-.voltaic systems for rural homes in Southern India by SELCO-India (SI), a joint venture between India and US in which USAID gave conditional grant to SI.[Nexant, 2003]

[59] In India typically 70-80% of monthly/ yearly energy cost savings are transferred to ESCOs, so that ESCOs could recover the investment as early as possible [Author]

[60] ECO project is joint venture between USAID, ICICI band Ministry of Power (MoP) of India set up to commercialize EE through various market & financial approaches such as ESCOs [USAID, 2002].

[61] The municipalities in Bulgaria are in similar financial condition as ULB in Karnataka (or India). USAID used DCA in Bulgaria, by providing the United Bulgarian Bank (UBB), a private sector bank, with a portfolio guarantee on loans given to municipalities and some private sector firms to finance revenue generating energy efficiency projects [Nexant, 2003].

[62] The single entry accounting system does not differentiate source of money flowing in. It treats, for example, loan and water charges as positive (receipts). Hence if ULB gets a large loan and do not spend, it shows net as surplus (since it does not have assets and liability concept) and does not show as debt, so the financial results would not present true picture [Author].

6.3 CDM issues

6.3.1 Transaction costs of CDM project development

In case of urban water system EE, CERs may range from few hundred (300-400 t CO_2 per year) to few thousand (4000-5000 t CO_2 per year). To take the take the advantages of lower transaction costs, it is advisable to bundle few ULBs, so that total CER will be within 10000-15000 t CO_2 per year or more precisely, total energy savings potential is within 15 GWh, the limit set to be eligible as small scale CDM (SSC). Since SSC use simplified procedures and modalities for CDM, it is estimated that transaction costs would be lower by about 67% [UNEP, 2004a].

More over, with development of CDM market in India and development of more methodologies for base line and monitoring, the transaction costs for PDD development and validation are coming down rapidly. For EE projects under SSC, the monitoring requirements can be met through improving existing metering and monitoring. Also the Environmental Impact Assessment (EIA) requirements are also minimum since there are no negative impacts due to water and energy efficiency projects. These aspects of urban water system will make transaction costs lower than those estimated by [Krey, 2004].

Even a 2.2 $US/t CO_2 transaction cost[Krey, 2004] and 10000 CERs (per year after bundling) would result in around Rs.1.0 million which is about 5% of total investment required (see Appendix 3) and which ULBs should be able to pay up-front. While this may be small in percentage, given the competing requirements for capital in ULBs, they need some kind of external funds/ grants to complete at least pre-operational tasks of CDM such as developing PDD, validation, registration, etc. Another possibility exists with multilateral funds like CDCF of WB which finances PDD costs, there by reducing transaction costs.

For 5 ULBs where EE is being implemented through CDM, financial resources for technical studies and PDD development have been supported by ASE and WB respectively. For future projects, KUIDFC or another project proponent should take transactions costs into account, while applying for loans and grants.

Another aspect with transaction cost is that they do not occur at the same point in time. For example verification cost comes only after project is implemented and in operation for a year. In case of EE projects in ULBs with average 5 month pay back period, this means, ULB will not have any problems for meeting these costs.

6.3.2 Bureaucracy of CDM process

The total process of CDM involves extensive documentation, approvals, validation, and verification. It takes time (about 6 months) to get CERS issued. Hence for ULBs (8 No.s) which are not considered for CDM, KUIDFC is in the process of implementing EE through ESCO route without CDM to make the implementation faster [Ram Kumar, 2005].

This of draw-back of CDM process, it will be overcome only with time when sufficient methodologies would be developed to take advantage of "second mover", i.e. once we have approved methodologies for type of projects, baseline and monitoring efforts, time and costs involved in proposing a new methodology, new baseline and monitoring plans and data/information costs will reduce. For example, Karnataka being the first project have proposed a new methodology for EE improvements in municipal water system and had to put sufficient efforts in developing base line and monitoring methodology. Next time if some other State or other ULBs in Karnataka wants to implement same kind of projects, they can ULB personnel themselves can start the documentation required for project including baseline and monitoring. This also means transaction costs involved in PDD preparation would be very marginal.

6.4 Making a case for implement of EE in urban water systems through CDM

6.4.1 Additionality Requirements of CDM

The suitability of a project under CDM is based on fulfilling criteria of additionality and sustainability. In following sections, these criteria will be analysed for EE improvements in urban water services. The Additionality Tool [UNFCCC, 2004] developed by UNFCCC is used to analyse EE projects in urban water system.

The additionality tool a 5-step[63] screening process to demonstrate suitability of any project under CDM. The steps involved are shown in the Figure 6.1 and explained below [UNFCCC, 2004]:

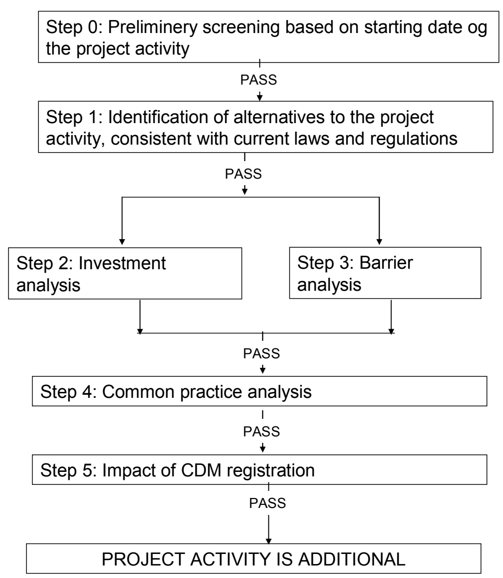

Figure 6-1 Flow chart showing steps to demonstrate additionality of projects under CDM (source:UNFCCC)

> ***Step 1:*** Identification of alternatives to proposed EE and proving proposed project activity generates additional GHG reductions compared to the alternatives. The alternatives can be another technology/ technique, current situation (i.e. present

[63] The additionality tool also has Step0, which screens projects as per starting date , for projects already implemented and wanting pre-crediting. The pre-crediting is allowed for projects implemented after 1st January 2000 and which would be registered before 31st December 2005. [UNFCCC, 2004]

situation /inefficiency to continue and there is no project activity). If this is proved, we can go Step 2(Investment barrier) ***OR/AND*** Step 3 (Barrier analysis) to prove the project additionality.

Step 2: Investment analysis involves financial analysis and comparison of proposed project and alternatives identified. The purpose is to prove that proposed activity is financially unattractive compared to the alternatives. If this is proved, Step 3 is optional and project will go for next screening through Step 4. If investment analysis shows, the project activity as an attractive one compared to at least one of the alternatives identified, then Step 3 (Barriers Analysis) has to be proved before going to Step 4.

Step 3: Barrier Analysis: This step involves barriers analysis to prove that in-spite of financial attractiveness of project activity, it would not be possible to implement duo presence of barriers such availability and reliability of technology, prevailing practices not encouraging the proposed project activity.

If either or both of Step2 & Step 3 can be proved, the project will pass through and go to Step 4.

Step 4: Common Practice analysis: This is a credibility check complimenting Step 2 and Step 3 to see to what extent the proposed technology or activity is diffused or penetrated in the particular region/ sector. If similar project exists in the region/ sector, project developers need to demonstrate how the proposed project activity is different from other projects of similar kind. If this is proved, project will proceed to Step 5.

Step 5: Impact of CDM registration: In this step, project developer has to demonstrate how CDM registration would help to overcome the barriers mentioned in previous steps.

If the proposed project passes all the steps, then project is considered as additional and is eligible for consideration under CDM. In the following sections, Steps will be applied to demonstrate additionality of EE projects in urban water system of Karnataka.

6.4.2 Demonstration of additionality for EE in urban water system

Identification of alternatives (Step 1)

The urban water systems in Karnataka or India do not have any EE performance norms or policies governing to this effect. In this context municipalities do not have specific plans for improving energy efficiency (although it might have happened incidentally, when replacing badly worn-out pump or when switching off additional power transformer that are not required). Hence in the context of urban water system, the alternatives to the EE project would be continuation of current situation without any project activity or same activity (EE implementation) without CDM.

Few operational improvements without requirements for any investment such as switching of transformers can be implemented even without CDM, once technical feasibility is established. But for majority of the EE projects, given the bad financial position of the ULBs and competing requirements from other urban services like sanitation, it is very likely that current situation will be continued, despite of having financially attractive project. Hence for these projects energy base line is energy consumed in the current situation and baseline emissions are estimated by multiplying energy baseline with emission factor of the grid from which ULBs draw power for pumping.

The EE improvements in pumping systems results in both power savings and water savings. However in practice, the water saved would used to supply to more people, or used to increase LPCD. Also due to growing water demand, the actual energy consumption would actually increase. Hence to capture energy savings due the project activities, energy consumption after EE will be normalised for current (baseline) water pumped, to arrive at project energy consumption [Quality Tonnes, 2004].

The difference between baseline energy and project energy consumption gives the net energy savings. This will be multiplied with emission factor of Karnataka grid to arrive at GHG reduction projections.

Investment analysis or Barrier analysis (Step 2 or Step 3)

As seen previously, many of the EE options in pumping system are low cost measures with good pay back period, which makes business sense. But given financial and other barriers present, these have not been implemented and the situation is most likely to continue.

Even though, there are few ESCOs which operate in industrial sector, there are very few projects in municipal sector[64] and mainly confined to "device" oriented solutions like efficient lighting and controls. They rarely venture into operational improvements such as those in pumping system EE where there is high project risk in energy savings projections. It is also true that bad finances of ULBs combined with bureaucracy deter ESCOs not to enter in municipal EE.

The presence of organisational and financial barriers, as discussed in previous sections, also prevents the project activity from happening. More pronounced barriers are lack of capacity and energy management system, smaller nature of projects which makes it difficult to get the attention of ULB officials and policy makers, perception that EE is technical specialty not aware of its larger environmental, economic and social benefits (see Step 5 below).

Common practice analysis (Step 4)

The similarity of projects identified in all 13 ULBs [TERI, 2003a-m] (Refer to Appendix-3 for projects in 5 CDM ULBs) where EE feasibilities studies have been conducted indicate, that all ULB suffer from similar kind of problems, which means that EE projects proposed are not common and have not diffused in municipal sector. This also indicates that situation in ULBs bundled for CDM represents the baseline and the GHG reductions they generate are additional.

ASE case studies [ASE,2002] which include 4 cities from India also reveal similar kind of projects identified, which shows that urban water system all over the India are in similar situation is not common a practice to implement EE in ULBs.

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[64] Few cities like Surat in Gujarat State have implemented lighting EE improvements through ESCOs (Author). Otherwise there are no known large scale projects in municipal services[Quality Tonnes, 2004]

Impact of CDM registration (Step 5)

The purpose of CDM is not only to provide low cost GHG abatement to Annex-B countries but also use the project activity as a vehicle to steer the economic development in Non-Annex-I country, to a sustainable one and help non-annex-I country to overcome financial, institutional, information and other barriers, so that similar project activities would be implemented and diffused in that country or in a particular sector. In the following paragraphs, the author would discuss these sustainable developmental benefits, followed by how CDM would help to implement and diffuse the EE in urban water system.

The EE in water pumping system results significant social and economic benefits apart from energy / GHG savings as presented below:

- It saves water (for water pumping system) in urban centres where there is severe water stress and perennial demand for safe drinking water. It improves the LPCD and/ or population covered with piped water. The following table shows the impact of potential water savings in four ULBs, in terms of increased per capita availability and additional population coverage achievable.

Table 6-2 Benefits of water savings in terms of increased per capita availability and additional population coverage

ULB where water savings potential in main supply line is established	Present LPCD	Increased LPCD due to water savings	Change in LPCD	Additional population coverage if present LPCD is maintained
Belgaum	152	199	47	59211
Sirsi	80	103	23	14250
Udipi	71	91	20	28028
Gulabarga	95	151	56	56211
Arisikere	134	195	61	5970
	Total	**-**	**-**	**163 669**

Source: a. Information from TERI Energy Audit reports for water savings potential and present LPCD & . b. Authors calculations for increased LPCD and additional population coverage

- The State of Environment Report-2003 of Karnataka Government [GoK, 2003] indicates that 30% of State's decease burden is related to water. The resultant health benefits, due to increased availability of safe drinking water, such as reduced cholera, gastroenteritis, trachoma and other water borne decease vectors would be significant.

- It saves on fossil fuels as most of the electricity in India is generated through coal. For example, the projected 57.4 GWh/year energy efficiency potential would save around 40 000 tons of coal (equivalent[65]) every year[66].

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[65] Total electricity savings are converted to equivalent coal to show fossil fuel savings. It does not mean that all savings in fossil fuel would be coal savings.

[66] Calculated at an average coal factor of 0.7 ton coal/ MWh [CEA, 2005] generation in typical power plant with Indian coal . This is still conservative since many smaller power plants have higher coal factor and transmission and distribution losses (T&D) are not taken into calculation(Author)

- The demand (power) saved will avoid in investment requirement in new power plants. For example the projected 57.4 GWh is equivalent to 8 MW[67] power plant and would have cost the GoK around Rs. 400 million (@ Rs. 50 Million / MW for coal based power plant). The demand saved will improve the power situation both in Karnataka and India where domestic and agricultural sectors compete for power due to power-shortage.

- The energy and power demand reduction results in reduced electricity bills. The cost of projected 57.4 GWh savings for Karnataka is around Rs. 230 Million[68] which is around 25% of energy cost and 11% of total O&M cost (Referring to table 4-6). This not only relieves ULBs from severe cash flow problem, but the amount saved can be diverted to other municipal services such as roads, sanitation etc.

- It stimulates the market, especially for energy efficient pumps, pipes and controls. Also it affects positively the design & operation of water infrastructure in future for expansion or capacity addition [Quality Tonnes, 2004].

- It helps to create institutional capacity to implement EE and gives visibility to environmental concern in urban services. This also helps to implement other environmental or climate change related programmes in other urban services like street lighting, solid waste management, public transport systems and demand-side water savings programmes for domestic and commercial customers in urban areas.

Having seen the financial attractiveness of EE projects in urban water systems and attendant environmental, economic and social benefits and having known that there are barriers to implementation, one key question to be addressed is why & how CDM can help to overcome any barriers?

- ❖ First it brings new players into the sectors interested in buying CERs from EE project facilitating new channel of investment, skill development. This especially benefits few "marginal" projects with higher financial risk. For example, the Community Development Carbon Fund (CDCF)[69] of the World Bank had funded PDD development for these projects [Ram Kumar, 2005] and had shown interest in buying CERs from Karnataka municipal EE improvement [Quality Tonnes, 2004], thus giving visibility and gravity to energy efficiency and helped to move the EE up in the priority ladder of urban policy makers in Karnataka. This also stimulated interest of policy makers to implement EE in public lighting system through ESCO/CDM.

In the past many EE studies in ULBs have stopped with a report due lack of interest and finances from ULBs and but for support and interest from CDCF to implement the projects through CDM, these projects would also have met with same fate.

- ❖ It binds the ULB managers legally to implement and sustain the EE and making them accountable for delivery of CERs. This is true when project are implemented through

[67] It is assumed that the energy savings are uniform through out the year and T&D losses around 20%. This is conservative since the power demand would be much more (i.e. more than 8 MW) since pumps are operated only during particular hours of the day.(Author)

[68] Calculated at the rate Rs. 4.00/kWh (this price ranges from Rs. 3.5/kWh to Rs. 5.5/kWh [TERI, 2003a-m] for individual ULBs depending on type of connection, demand charges, etc)

[69] visit: http://carbonfinance.org/cdcf/router.cfm?Page=html/IndiaKarnatakaMunicipalWaterPumping.htm

any international cooperation and when influential agencies such as the World Bank or the Asian Development Bank, etc are involved.

- It facilitates metering, monitoring and accounting of energy & water as required for CDM monitoring & verification, there by systemising the energy efficiency and management function in ULBs.

- It facilitates training and capacity building of ULB personnel and improves managerial capacity in operations, maintenance of pumping systems. This facilitates systemising EE in future expansion of urban water systems. For example, during studies sponsored by ASE, an Energy Cell has been created at KUIDFC to disseminate information and results of studies among ULBs. This cell has been rechristened as Energy & Environment Cell to include other services like solid waster management also. This cell is discharging its multiple roles as a coordination centre, resource centre in energy and environmental issues related to ULBs including their implementation through CDM [ASE, 2005]. Earlier ULBs do not have any common platform to disseminate issues of energy and environment in urban services.

- CDM could make the municipal sector as an attractive CDM portfolio, given the sustainable developmental impacts of EE and direct & local benefits social-economic benefits. It could influence Annex-B investors to buy CERs generated from these EE projects with significant local benefits compared to CERs from industrial sectors. This would put municipal sector in a better position regarding investment from public and private agencies.

- The carbon revenues coupled with energy savings would benefit the ULBs financially and also facilitates further improvements in the water systems. For projects in 5 CDM-ULBs with around 12850 CERs/year (@ 5 USD/CER), this would mean additional revenue(i.e. over and above energy cost savings) of Rs. 2.9 Million per year (or Rs. 17.8 Million on present value [70] basis over 10 year crediting period which is about 82% (i.e. (17.8 X100)/21.73) of investment requirement). This indicate that although impact of CER revenue on project IRR is marginal, in absolute terms it strongly influences project finances, especially this revenue will help to reduce project risks and attract private investors like ESCOs.

Capacities and systems developed in one urban service (say in water system) will also influence other services (street lighting etc) being offered by the same organisation (as discussed earlier), further contribute to GHG reductions. For example, after water system PDD is made and submitted, few EE technology suppliers in street lighting approached KUIDFC for implementing EE in street lighting through CDM through ESCO route.

[70] present value of Rs. 2.9 Million per year for 10 years with a discount rate of 10% is Rs. 17.8 Million

7 Discussion and conclusions

The urban water system, as discussed holds good potential for energy and water efficiency. Technical losses (energy and water) in water system affect the commercial performance of the service as well as overall financial performance of the individual ULB, which are already facing financial crises. Unlike other sectors where pricing and subsidies are shown as the main culprits of inefficiency, in water systems it is the technical aspects such as inefficient pumping system (worn-out pumps, over sized pumps, wrong selection of pumps and controls, leaky pipes, faulty meters) are main contributors to the inefficiency. This is further augmented by illegal and un-metered water connections. And all contributing to technical (energy and other operational) and financial losses. This creates the vicious loop of blame-game; that energy and water efficiency can not be implemented due to bad finances on one side and inefficiency in energy use and water systems is the main cause of bad finances. The end result is not only continuation of status quo but also complete ignorance of underlying environmental and social concerns.

So to do any improvement in urban water sector, we have two tasks to do; bring the environmental and social concerns to the front and use them as main force to the break the loop of blame game. Even if it sounds little ideological, in present business or organizational context in India, where people are more concerned about most immediate requirements, it is only CDM which can bring the sustainability concerns to the attention of policy/ decision makers since the CDM also carries some monitory benefit.

As seen from the previous chapters, the solutions to the energy and water efficiency problems are rather simple from a technical point of view. What is lacking is enabling organizational structure in ULBs such as lack of capacity, lack of metering, monitoring of performance, lack of accountability on both energy consumption and energy bills. Coupled with bad finances, and bad reputation of being bureaucratic, these barriers are also impeding other ways of financing the projects such as debt finance or participation of private sector (like ESCOs) in urban water sector. One way of improving the accountability and reducing bureaucracy is empowering individual ULBs to manage the finances including retaining of any savings due to energy and water efficiency improvements. This enables ULBs to enter into performance contracts with ESCOs on shared or guaranteed savings basis.

Now where will the CDM will add value or positively influence this process? The CDM process looks like a paradox at the first instance that it favours projects with barriers and same barriers are impeding the implementation of project. This paradox will be solved if we view the CDM as steering mechanism wanting change development to a sustainable one, rather than treating it as a money compensation mechanism. As discussed, it brings new players who are interested in GHG reductions, it will add additional financial value (over and above energy savings) which can make way for participation of private sector, it can bring influential international partners like WB, ADB, GEF which will improve the credibility of ULBs at the same time binds them with accountability so that ESCOs and other investors can enter the sector, it would bring additional channels of investment support through part-payment for CER sale when project is registered and using ERPA as collateral for loan. CDM is expected to make this market penetration of energy efficiency as well as its delivery mechanisms, happen in urban water system.

However, while CDM would help to initiate these first-steps, there should be a parallel effort, especially in improving organizational structure and management for energy efficiency in ULBs. Without this institutionalization of EE in ULBs (in terms of metering, monitoring, capacity, performance based contracts), EE is not possible whether it is through CDM and/or ESCO.

Now the question comes about costs of going through CDM process. Since the CER projections from individual ULBs are small, they have to bundled (as a SSC or large project) so that, some of transaction costs are minimized. While, this action (bundling) is implied anyway, present price signals from CDM market in India indicate that these costs are drastically coming down. Since CERs from individual ULBs are small, a bundled project with 10000-15000 CER per year would a manageable (from point of number of ULBs involved) and viable (with transaction cost not more than $2 / CER for this range of CER generation per year).

There are many EE and other cost reduction projects which can not be implemented through CDM, due to additionality considerations, but face same kind of barriers. In an theoretical sense and long term time frame, we can expect that CDM will facilitates their implementation also by removing general organizational and financial barriers. But in short term, ULBs have to find other ways of implementing such as pure ESCOs or through developmental bank loans (e.g. IDBI).

Keeping in above issues in mind, ULBs should have a long term strategy to tackle EE implementation, rather than operating in a project-like environment. Also, since CDM can only help to over few barriers, ULBs should explore other opportunities as well as improve internal organization structure suitable for EE implementation to create necessary conditions to take advantage of CDM and other opportunities. Towards that, key elements of the strategy have been suggested as recommendations in Chapter 8, below.

8 Recommended key elements of strategy to implement municipal EE through CDM

Based on the discussions, existing framework of municipal system and urban water system, the EE potential, analysis of barriers and opportunities, ULBs require a strategic frame work to implement EE through the Clean Development Mechanism. In this chapter, key elements of the strategy are recommended which is expected to result in faster implementation of EE, replicability of the implementation in all ULB in Karnataka (and India too). The strategic elements would be applicable to all EE projects, like energy efficiency in street lighting.

Awareness and capacity building:

ULBs should initiate a State level awareness and capacity building programme for all municipal personnel involved in urban water supply service. This should also involve specialised technical training in energy efficiency, at least for few members from each ULB, who can become part of Energy Efficiency Team. The capacity and team building is prerequisite to go with further implementation tasks either through CDM and/ or ESCOs. This would also institutionalise energy efficiency and management and help to reduce transaction costs involved in developing and implementing EE.

Municipal Energy Management System:

All ULBs should have their own energy management system in place. This involves installation and up-gradation of measurement and monitoring and reporting system for energy efficiency and other performance indicators. All ULBs should bench-mark their operations (with themselves) and track the performance accordingly. There should be energy coordinator for each ULB (as part of EE team), who is designated to deal energy consumption and efficiency issues and report the performance and gaps there of, to State-level centre (may be Energy & Environment cell at KUIDFC can act as resource and advisory centre).

Operation & Maintenance of pumping stations/ systems:

The ULBs involved in provision of water should resolve the issue of ownership/ governance of pumping stations among them. The pumping stations operated and maintained by other central utilities like KUWSDB should be transferred to respective municipalities to make the ULBs responsible and accountable for their performance.

O&M and R&M practices should be linked to energy efficiency and performance. As soon as performance gap is detected through measurement & monitoring, repairs and maintenance should be initiated. Since pumping performance is closely related to O&M and R&M, this linking is critical to sustain energy efficiency and deliver CERs committed in ERPA.

Financial empowerment of ULBS:

Each ULB should be empowered to pay for their costs, instead of UDD/SFS paying their bills together with retaining cost savings, due to EE implementation, with ULBs. This makes an incentive for individual ULBs to pursue EE, facilitate participation of ESCOs and share cost savings and to pay for debt-servicing for loans obtained for EE projects and to pay for project development activities.

Financial accountability of ULBS:

ULBs should be made accountable for debt/grant paid to them. The present single entry accounting system should changed to double entry and/ or project (fund based) accounting to present the true picture of finances of ULBs and track project performance.

Securing financial resources for EE:

ULBs and other State level agencies like KUIDFC or KUWSDB, should explore and exploit different opportunities for securing finances from domestic and external sources. They should choose suitable funding model (unilateral, bilateral and multilateral) of CDM using CER revenue. Since ERPA and upfront payments from CER buyers would contribute to investment, guarantees on loans/debt, the municipal administration should make necessary structural arrangements (administrative, financial, legal, etc) to enable ULBs to use them. This also applicable to enabling private sector or ESCOs participation in this sector, since some of the funds (DCA of USAID) are designed for private sector.

These key elements are all inter-linked with implementation of one element influencing the other. These key elements would help ULBs in formulating an implementation plan with detailed tasks to be done for each element, the structure of organizational resources required to complete these tasks. These elements may not be comprehensive since, only supply-side of water system is considered for study. There would be further additions to these key elements/factors from demand–side efficiency, is also considered.

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Abbreviations

@	At the rate of
ADB	Asian Development Bank, the
ADB	Asian Development Bank, the
ASE	Alliance to Save Energy
BDA	Bangalore Development Authority
BEE	Bureau of Energy Efficiency, India
BEE	Bureau of Energy Efficiency
CDM	Clean Development Mechanism
CER	Certified emission reduction
DMA	Directorate of Municipal Administration
DOE	Designated operational Entity
EE	Energy Efficiency
ERPA	Emissions Reduction Purchase Agreement
ESCO	Energy Service Company
GHG	Green House Gases
GoI	Government of India
GoK	Government of Karnataka
HUDCO	Housing and Urban Development Corporation Limited
IRR	Internal Rate of Return
KUIDFC	Karnataka Urban Infrastructure Development Finance Corporation
KUWSDB	Karnataka Urban Water Supply & Drainage Board
$kW_{el.}$	Kilowatt electrical
kWh	Kilowatthour
kWh	Kilo Watt hour
LIC	Life Insurance Corporation of India
MoP	Ministry of Power, India
MW	Megawatt
MWh	Megawatthour
NPC	National Productivity Council (of India)
NPV	Net Present Value
O &M	Operation & Maintenance
R &M	Repairs & Maintenance
Rs	Rupees (Indian)
SFC	State Finance Corporation (of Karnataka)
TERI	The Energy and Resource Institute
UDD	Urban Development Department (Govt. of Karnataka)
USAID	United States Agency for Industrial Development
WB	World Bank, the

Appendix

Appendix 1 – Transaction costs for EE projects in Urban Water Systems (under SSC)

Professional fee to consultant (for PDD, monitoring plan, baseline study till registration)	USD 15 000.00
Validation (onetime)	USD 10 000.00
Registration fee (0ne time)	USD 5 000.00
Adaptation levy (with every CER issue)	2% of CER value
Success fee to consultant (upon on successful registration)	10% of first year CER value
Verification fee (every year)	USD 3 000.00
Other assumptions :	
Cost for Stake holder's consultation is included in the PDD cost	
EIA cost is assumed to be zero for SSC procedures do not require EIA on rigorous basis and also present EE improvements do not warrant	
Cost of attending for HCA meetings is included in the "others"	
Cost of monitoring is not considered as municipal personnel will be monitoring the project as done in regular monitoring of water pumped and electricity consumed (recording frequency may change due to CDM, but that would not result in additional cost)	
Legal charges are assumed be 15% of CERs in first year and 5% of CER value in first year assumed for "Other"/ miscellaneous expenses (Cost of attending for HCA meetings is included in the "others").	

Source: a. Dr. P. Rambabu, Price Waterhouse Coopers (PwC), India for costs (through personal communication) b. Author for assumptions

Appendix 1 – Transaction costs for EE projects in Urban Water Systems (under SSC)- continued

		Transaction costs (US$/CER)								"Minimum Threshold" of CERs/ annum (CER quantity when NPV price of CER is equal to NPV of specific-transaction cost)
	CER / Annum→	**500**	**1000**	**1500**	**2000**	**3000**	**5000**	**10000**	**15000**	
	Contracted CER price (US$/CER)									
PDD by consultant	**5**	$15.20	$7.76	$5.28	$4.04	$2.80	$1.81	$1.07	$0.82	1590
	7	$15.33	$7.89	$5.41	$4.17	$2.93	$1.94	$1.19	$0.95	1140
	10	$15.52	$8.08	$5.60	$4.36	$3.12	$2.13	$1.39	$1.14	795
PDD by ULBs	**5**	$10.69	$5.47	$3.73	$2.86	$1.99	$1.29	$0.77	$0.60	1100
	7	$10.79	$5.57	$3.83	$2.96	$2.09	$1.39	$0.87	$0.70	785
	10	$10.93	$5.72	$3.98	$3.11	$2.24	$1.54	$1.02	$0.84	550

Source: Author

Appendix 2 – Map of Karnataka with districts

Appendix 3 – Financial Analysis of projects in CDM-ULBs

Appendix-3: Details of GHG savings and financial feasibility of EE projects in 5 CDM-ULBs									
ULB	Proposal	Annual savings			Investment	Investment analysis			
		GWh	GHG (t CO_2)	Million Rs.	Million Rs	Simple payback period (SPB) in years	Internal rate of return (IRR) without CER revenue	Internal rate of return (IRR) with CER revenue	Change in IRR due to CER revenue
Hubli Dharwad	Effy Improvement of Pump # 2 of jack well P/S	0.184	193	0.642	0.150	0.2	428.0%	457.0%	29.0%
Hubli Dharwad	Enhancing water flow from JPS	0.590	621	2.010	0.500	0.2	402.0%	429.9%	27.9%
Hubli Dharwad	Improving Output & effy of PS# II pumps	0.409	430	1.430	0.700	0.5	204.3%	218.1%	13.8%
Hubli Dharwad	Rescheduling of pump operation	1.948	2049	6.800	0.300	0.0	2266.7%	2420.4%	153.7%
Hubli Dharwad	Improving EE of 800HP 1(New) pump	0.438	461	1.533	0.000	0.0	Infinite	Infinite	NA
Hubli Dharwad	Improvement in common suction& discharge header	0.509	535	1.780	2.400	1.3	73.9%	82.1%	8.2%
Hubli Dharwad	Switch off primary of 1000kVA Trf, 50 kVA trf. And 250 kVA trf	0.025	26	0.086	0.000	0.0	Infinite	Infinite	NA

Appendix-3: Details of GHG savings and financial feasibility of EE projects in 5 CDM-ULBs									
ULB	Proposal	Annual savings			Investment	Investment analysis			
		GWh	GHG (t CO_2)	Million Rs.	Million Rs	Simple payback period (SPB) in years	Internal rate of return (IRR) without CER revenue	Internal rate of return (IRR) with CER revenue	Change in IRR due to CER revenue
Hubli Dharwad Total		**4.102**	**4 315**	**14.281**	**4.050**	**0.3**	**353%**	**377%**	**24.0%**
Bellary	Retrofitting Pump#2 to improve operating effy	0.060	63	0.231	0.000	0.0	Infinite	Infinite	NA
Bellary	Switching Trf of raw water pump house	0.010	10	0.037	0.000	0.0	Infinite	Infinite	NA
Bellary	Operating both supply lines (old+new) in low lift P/S	0.095	100	0.363	0.000	0.0	Infinite	Infinite	NA
Bellary	Replacing present pump with efficient pump	0.767	807	3.068	2.400	0.8	127.8%	135.4%	7.6%
Bellary	Optimum sizing of booster pump	0.363	382	1.540	1.500	1.0	102.6%	108.3%	5.7%
Bellary Total		**1.294**	**1 362**	**5.239**	**3.900**	**0.7**	**134.3%**	**142.2%**	**7.9%**
Arasikere-Tiptur	Removal of NRVs from discharge pipes	0.014	15	0.055	0.000	0.0	Infinite	Infinite	NA

Appendix-3: Details of GHG savings and financial feasibility of EE projects in 5 CDM-ULBs										
ULB	Proposal	Annual savings			Investment	Investment analysis				
		GWh	GHG (t CO_2)	Million Rs.	Million Rs	Simple payback period (SPB) in years	Internal rate of return (IRR) without CER revenue	Internal rate of return (IRR) with CER revenue	Change in IRR due to CER revenue
Arasikere-Tiptur	Increasing delivery pipe sizes	0.012	13	0.048	0.000	0.0	Infinite	Infinite	NA
Arasikere-Tiptur	To operate turbine pump rather than submergible pump	0.031	32	0.122	0.000	0.0	Infinite	Infinite	NA
Arasikere-Tiptur	Change of filling practice of OHT at Tipture	0.020	21	0.106	0.000	0.0	Infinite	Infinite	NA
Arasikere-Tiptur	Installation of one suitable size pump for Tiptur	0.079	83	0.424	0.350	0.8	121.1%	126.4%	5.3%
Arasikere-Tiptur	Installation of one suitable size pump for Arasikere	0.058	61	0.313	0.170	0.5	184.1%	192.2%	8.1%
Arasikere-Tiptur	Improving main water flow distribution system for Arasikere	0.038	40	0.200	0.050	0.3	400.0%	418.1%	18.1%
Arasikere-Tiptur	Shifting W pump with higher effy to replace lower effy supplementary pump	0.019	20	0.102	0.000	0.0	Infinite	Infinite	NA
Arasikere-Tiptur	Rectification of supplement pumps	0.022	23	0.064	0.000	0.0	Infinite	Infinite	NA
Arasikere-Tiptur	New for with suitable size for reservoir filling	0.052	55	0.208	300000	1.4	69.0%	73.1%	4.2%

Appendix-3: Details of GHG savings and financial feasibility of EE projects in 5 CDM-ULBs										
ULB	Proposal	Annual savings			Investment	Investment analysis				
		GWh	GHG (t CO_2)	Million Rs.	Million Rs	Simple payback period (SPB) in years	Internal rate of return (IRR) without CER revenue	Internal rate of return (IRR) with CER revenue	Change in IRR due to CER revenue
Arasikere-Tiptur	Installation of energy efficient motors for Arisikere supplementary pumps	0.020	21	0.059	0.110	1.9	52.9%	57.3%	4.4%
Arasikere- Tiptur Total		**0.363**	**382**	**1.701**	**0.980**	**0.6**	**173.6%**	**182.3%**	**8.8%**
Mysore	Increasing freq. Of suction sump cleaning (new Belagola scheme)	0.368	387	1.380	0.000	0.0	Infinite	Infinite	NA
Mysore	Optimum pump sizing as per user reqt in New Belagola scheme	0.315	331	1.181	0.000	0.0	Infinite	Infinite	NA
Mysore	To install low head, optimum pump for emergency pumping in Hongalli P/S	0.322	339	1.127	0.000	0.0	Infinite	Infinite	NA
Mysore	Replacing present booster pump with efficient pump	0.730	768	2.560	1.000	0.4	256.0%	273.3%	17.3%
Mysore	Replacing existing pumps with efficient vertical turbine pumps in Belagola	700 000	736	3 840 000	4.400	1.1	87.1%	90.9%	3.8%

Appendix-3: Details of GHG savings and financial feasibility of EE projects in 5 CDM-ULBs									
ULB	Proposal	Annual savings			Investment	Investment analysis			
		GWh	GHG (t CO_2)	Million Rs.	Million Rs	Simple payback period (SPB) in years	Internal rate of return (IRR) without CER revenue	Internal rate of return (IRR) with CER revenue	Change in IRR due to CER revenue
	Old scheme								
Mysore	Switching off one trf in Booster P/S	0.014	15	0.052	0.000	0.0	Infinite	Infinite	NA
Mysore Total		**2.449**	**2576**	**10.140**	**5.400**	**0.5**	**187.8%**	**198.5%**	**10.7%**
Mangalore	Optimum sizing of low lift pumps	1.348	1418	4.852	3.000	0.6	161.7%	172.4%	10.6%
Mangalore	Optimum sizing of High lift pumps	2.244	2361	8.078	3.500	0.4	230.8%	246.0%	15.2%
Mangalore	Avoiding parallel operation of trf	0.022	23	0.077	0.000	0.0	Infinite	Infinite	NA
Mangalore	Switching of transformer when pump is not in operation	0.006	6	0.021	0.000	0.0	Infinite	Infinite	NA
Mangalore	Suitable sizing of pumps for OHT (0.9ML tank)	0.120	126	0.432	200 000	0.5	216.0%	230.2%	14.2%

Appendix-3: Details of GHG savings and financial feasibility of EE projects in 5 CDM-ULBs										
ULB	Proposal	Annual savings			Investment	Investment analysis				
		GWh	GHG (t CO_2)	Million Rs.	Million Rs	Simple payback period (SPB) in years	Internal rate of return (IRR) without CER revenue	Internal rate of return (IRR) with CER revenue	Change in IRR due to CER revenue
Mangalore	Suitable sizing of 90 HPpumps for OHT	0.086	90	0.310	0.200	0.6	155.0%	165.2%	10.2%
Mangalore	Suitable sizing of 180 HPpumps for OHT	0.188	198	0.677	0.500	0.7	135.4%	144.3%	8.9%
Mangalore Total		**4.013**	**4222**	**14.447**	**7.400**	**0.5**	**195.2%**	**208.1%**	**12.8%**
Grand Total		**12.22**	**12858**	**45.808**	**21.730**	**0.5**	**210.8%**	**224.1%**	**13.3%**

Source: a. TERI energy audit reports [TERI, 2003a-m] for annual savings, investment and simple payback period. b. Author (for IRR calculation with and without CER revenue using built-in IRR formulae in MS Excel software) c. CER price is taken as $ 5/ CER on net basis, i.e. after deducting transaction costs $2/CER from market price of $7 /CER (present price is $7-13/CER and transaction costs for projects with this amount of CERs are estimated to be $0.6-1.39/CER. Transactions costs are estimated from typical costs used by Price Waterhouse Coopers, India for this type of projects with assumptions given in Appendix 1 d. Emission factor for Karnataka grid is taken as 1.052 kg CO2/ kWh[Quality Tonnes]

Appendix 4 – Contribution of CER revenue (paid as upfront 25% of CER value for 10 year crediting period) to investment

Appendix-4: Contribution CER upfront payments to investment requirements

ULB	Proposal	Annual savings			Investment	CER revenue per year (@ $US5/ CER and Rs. 45/ $US) Million Rs.	Upfront receipts from CER sale for 10 year crediting (25% of CER revenue) Million Rs.	up-front receipts as % of total investment
		GWh	GHG (t CO2)	Million Rs.	Million Rs.			
Hubli Dharwad	Effy Improvement of Pump # 2 of jack well P/S	0.184	193	0.642	0.150	0.043	0.067	44.5%
Hubli Dharwad	Enhancing water flow from JPS	0.590	621	2.010	0.500	0.140	0.215	42.9%
Hubli Dharwad	Improving Output & effy of PS# II pumps	0.409	430	1.430	0.700	0.097	0.149	21.2%
Hubli Dharwad	Rescheduling of pump operation	1.948	2049	6.800	0.300	0.461	0.708	236.1%
Hubli Dharwad	Improving EE of 800HP 1(New) pump	0.438	461	1.533	0.000	0.104	0.159	NA
Hubli Dharwad	Improvement in common suction& discharge header	0.509	535	1.780	2.400	0.120	0.185	7.7%

Appendix-4: Contribution CER upfront payments to investment requirements

ULB	**Proposal**	**Annual savings**			**Investment**	**CER revenue per year (@ $US5/ CER and Rs. 45/ $US) Million Rs.**	**Upfront receipts from CER sale for 10 year crediting (25% of CER revenue) Million Rs.**	**up-front receipts as % of total investment**
		GWh	GHG (t CO2)	Million Rs.	Million Rs.			
Hubli Dharwad	Switch off primary of 1000kVA Trf, 50 kVA trf. And 250 kVA trf	0.025	26	0.086	0.000	0.006	0.009	NA
Hubli Dharwad Total		**4.102**	**4315**	**14.281**	**4.050**	**0.971**	**1.491**	**36.8%**
Bellary	Retrofitting pump#2 to improve operating efficiency	0.060	63	0.231	0.000	0.014	0.022	NA
Bellary	Switching Trf. Of Raw water pump house	0.010	10	0.037	0.000	0.002	0.003	NA
Bellary	Operating both supply lines (old+new) in low lift pump house	0.095	100	0.363	0.000	0.022	0.035	NA
Bellary	Replacing present pump with efficient pump	0.767	807	3.068	2.400	0.182	0.279	11.6%
Bellary	Optimum sizing of booster pump	0.363	382	1.540	1.500	0.086	0.132	8.8%

Appendix-4: Contribution CER upfront payments to investment requirements

ULB	**Proposal**	**Annual savings**			**Investment**	**CER revenue per year (@ $US5/ CER and Rs. 45/ $US) Million Rs.**	**Upfront receipts from CER sale for 10 year crediting (25% of CER revenue) Million Rs.**	**up-front receipts as % of total investment**
		GWh	GHG (t CO2)	Million Rs.	Million Rs.			
Bellary Total		1.294	1362	5.239	3.900	0.306	0.471	12.1%
Arasikere-Tiptur	Removal of NRVs from discharge pipes	0.014	15	0.055	0.000	0.003	0.005	NA
Arasikere-Tiptur	Increasing delivery pipe sizes	0.012	13	0.048	0.000	0.003	0.004	NA
Arasikere-Tiptur	To operate turbine pump rather than submersible pump	0.031	32	0.122	0.000	0.007	0.011	NA
Arasikere-Tiptur	Change of filling practice of OHT at Tipture	0.020	21	0.106	0.000	0.005	0.007	NA
Arasikere-Tiptur	Installation of one suitable size pump for Tiptur	0.078	83	0.424	0.350	0.019	0.029	8.2%
Arasikere-Tiptur	Installation of one suitable size pump for Arasikere	0.058	61	0.313	0.170	0.014	0.021	12.4%

Appendix-4: Contribution CER upfront payments to investment requirements

ULB	Proposal	Annual savings			Investment	CER revenue per year (@ $US5/ CER and Rs. 45/ $US) Million Rs.	Upfront receipts from CER sale for 10 year crediting (25% of CER revenue) Million Rs.	up-front receipts as % of total investment
		GWh	GHG (t CO2)	Million Rs.	Million Rs.			
Arasikere-Tiptur	Improving main water flow distribution system for Arasikere	0.038	40	0.200	0.050	0.009	0.014	27.9%
Arasikere-Tiptur	Shifting W pump with higher effy to replace lower effy supplementary pump	0.019	20	0.102	0.000	0.004	0.007	NA
Arasikere-Tiptur	Rectification of supplement pumps	0.022	23	0.064	0.000	0.005	0.008	NA
Arasikere-Tiptur	New for with suitable size for reservoir filling	0.052	55	0.208	0.300	0.012	0.019	6.3%
Arasikere-Tiptur	Installation of energy efficient motors for Arisikere supplementary pumps	0.020	21	0.059	0.110	0.005	0.007	6.5%
Arasikere-Tiptur Total		0.363	382	1.701	0.980	0.086	0.132	13.5%

Appendix-4: Contribution CER upfront payments to investment requirements								
ULB	**Proposal**	**Annual savings**			**Investment**	**CER revenue per year (@ $US5/ CER and Rs. 45/ $US) Million Rs.**	**Upfront receipts from CER sale for 10 year crediting (25% of CER revenue) Million Rs.**	**up-front receipts as % of total investment**
		GWh	GHG (t CO2)	Million Rs.	Million Rs.			
Mysore	Increasing freq. Of suction sump cleaning (new Belagola scheme)	0.368	387	1.380	0.000	0.087	0.134	NA
Mysore	Optimum pump sizing as per user reqt in New Belagola scheme	0.315	331	1.181	0.000	0.075	0.115	NA
Mysore	To install low head, optimum pump for emergency pumping in Hongalli P/S	0.322	339	1.127	0.000	0.076	0.117	NA
Mysore	Replacing present booster pump with efficient pump	0.730	768	2.560	1.000	0.173	0.265	26.5%
Mysore	Replacing existing pumps with efficient vertical turbine pumps in Belagola Old scheme	0.700	736	3.840	4.400	0.166	0.255	5.8%
Mysore	Switching off one trf in Booster P/S	0.014	15	0.052	0.000	0.003	0.005	NA

Appendix-4: Contribution CER upfront payments to investment requirements

ULB	**Proposal**	**Annual savings**			**Investment**	**CER revenue per year (@ $US5/ CER and Rs. 45/ $US) Million Rs.**	**Upfront receipts from CER sale for 10 year crediting (25% of CER revenue) Million Rs.**	**up-front receipts as % of total investment**
		GWh	GHG (t CO2)	Million Rs.	Million Rs.			
Mysore Total		2.449	2 576	10.140	5.400	0.580	0.890	16.5%
Mangalore	Optimum sizing of low lift pumps	1.348	1 418	4.852	3.000	0.319	0.490	16.3%
Mangalore	Optimum sizing of High lift pumps	2.244	2 361	8.078	3.500	0.531	0.816	23.3%
Mangalore	Avoiding parallel operation of trf	0.022	23	0.077	0.000	0.005	0.008	NA
Mangalore	Switching of transformer when pump is not in operation	0.006	6	0.021	0.000	0.001	0.002	NA
Mangalore	Suitable sizing of pumps for OHT (0.9ML tank)	0.120	126	0.432	0.200	0.028	0.044	21.8%
Mangalore	Suitable sizing of 90 HPpumps for OHT	0.086	90	0.310	0.200	0.020	0.031	15.6%

Appendix-4: Contribution CER upfront payments to investment requirements

ULB	**Proposal**	**Annual savings**			**Investment**	**CER revenue per year (@ $US5/ CER and Rs. 45/ $US) Million Rs.**	**Upfront receipts from CER sale for 10 year crediting (25% of CER revenue) Million Rs.**	**up-front receipts as % of total investment**
		GWh	GHG (t CO2)	Million Rs.	Million Rs.			
Mangalore	Suitable sizing of 180 HPpumps for OHT	0.188	198	0.677	0.500	0.044	0.068	13.7%
Mangalore Total		4.014	4 222	14.447	7.400	0.950	1.459	19.7%
Grand Total		12.222	12 858	45.808	21.730	2.893	4.444	32.8%

Source: a. TERI energy audit reports [TERI, 2003a-m] for annual savings and investment . b. Author CER related calculations c. CER price is taken as $ 5/ CER on net basis (Please see Appendix 3 for rationale).