# Cities Matter:

## Energy Efficiency in the Water Sector

November 3–7, 2003
Mexico City, Mexico

November 17–21, 2003
Bangalore, India

sponsored by the
United States Agency
for International Development


in collaboration with the
International City/County
Management Association

# Overview

The "Cities Matter: Energy Efficiency in the Water Sector" Trainer's Guide is based on a course that was held in Mexico City, Mexico, on November 3–7, 2003, and in Bangalore, India, November 17–21, 2003. The course was developed and delivered by the International City/County Management Association (ICMA) under contract with the Energy Office of the U.S. Agency for International Development (USAID) in Washington, D.C.

The materials provided in this guide are meant to serve as the foundation for future offerings of the course. Future offerings may be held by USAID, by municipalities, or by municipal associations within or beyond the regions in which the initial course was held. The audience is assumed to be local government elected or appointed leaders, as well as those involved in managing water facilities for the locality. Presentations and activities will need to be adjusted to accommodate differences in goals, objectives, and parameters of specific training courses.

The course held in Mexico had 24 participants from six different countries (Brazil, Honduras, Nicaragua, Paraguay, the Dominican Republic, and Mexico) and was conducted in Spanish and Portuguese. Materials from that course are in Spanish and included in the Appendix of this manual. The India course had 34 participants from three countries in that region (India, Sri Lanka, and the Philippines); materials for that course were developed in English and are included in the main body of this Trainer's Guide. Participants were nominated by USAID Missions throughout Latin America and the Caribbean and Asia. Other attendees included representatives from USAID and the Alliance to Save Energy.

The offerings in India and Mexico were based on the same agenda, goals, and session objectives. The case studies and site visits differed in order to better relate to the specific region in which the training was held. In addition, differences in the trainers' styles and in participant needs also led to some variations in how the training was delivered.

The course is designed for a mix of participants. Some participants had an engineering background and worked in the water or energy sector; others were elected officials or other local government leaders, representatives of water associations, or consumer advocates. The course is thus designed to be flexible enough to meet the needs of both audiences and to help participants from both backgrounds to understand more about the synergies among the technical, managerial, and political aspects of energy efficiency in the water sector.

This Trainer's Guide focuses on the common basic format of the course. The generic course materials provided here should be adapted and made specific to the

country of participants. Where appropriate, trainers[1] should present relevant information about energy efficiency in the context of the region or country in which the training is given. Case studies or examples from the country in which the course is conducted may be most illustrative, although participant evaluations revealed that they benefited also from learning about the experiences of their counterparts in other countries.

## The Course Approach

The original Energy Efficiency in the Water Sector course was designed as a five-day course, with an optional pre-course session designed to familiarize participants with the terminology that would be used during the course.[2] This is particularly important when participants are from different countries and may not share the same native language or experience. This session was followed by a Welcome Reception to provide an informal setting for participants to mingle and to meet one another, the trainers, and other course leaders.

As with any training course, there is a need to balance the desire to invite all interested parties with the need to limit the group size for optimal learning. Because adults learn best when they are actively engaged, the structure and approach of this course is highly participatory, making extensive use of small-group discussions and interaction. Thus, it is recommended that the group be limited to a maximum of 35 participants.

In addition, participants in the India and Mexico course offerings were asked to complete a pre-course homework assignment. Participants were asked to collect and bring to the course basic information and documentation regarding energy efficiency in the water sector and decision making in their communities or countries regarding water use (including a typical household water bill, a water bill sent to a company or factory, the water rate structure, the city's electrical power invoice, the city's revenue and expenditure budget, and the city's current capital plan). The pre-course assignment also asked participants to familiarize themselves with various aspects of the relationship between the central government, the local government, and water service delivery. (The pre-course assignment can be found in the Handouts at the end of this Overview.) Requiring such pre-course work ensures that participants arrive at the first session with the background information they need to apply the content learned to the situation in their own countries.

[1] "Trainer" is used in this guide as a generic term for many types of training-related roles, including presenter, facilitator, and course planner. This guide uses the term "trainer" except when referring to a specialized role.

[2] Some participants indicated in the course evaluation that the course does not need to be this long; future course planners may want to consider adapting the materials for a three-day course or even a one-day workshop.

## Goals and Objectives

Planning always begins with where you want to end up. Course goals and objectives should be based on the general need that prompted the training session in the first place. But they should go beyond this, providing specific insight into desired outcomes. Consider the following questions:

< Why are we having the course or session? What do we hope to accomplish?

< What do we want participants to know when they leave the session?

< What do we want participants to do with the information they have learned?

**Course Goals.** The purpose of the Energy Efficiency in the Water Sector course is to augment the work already completed by the Alliance to Save Energy on the technical aspects of energy efficiency by incorporating the technical advice into a broader local government and policy framework based on ICMA's experience. The course offers information about energy efficiency techniques and results in the context of management, operations, and decision making at the local and state level. The focus of the course, as determined by USAID during the development phase, is energy efficiency in the water sector. The course format and approach may be adapted for other areas.

**Course Objectives.** The objectives of the course are to:

< Develop an understanding of the role of energy and energy efficiency within the context of local government and municipal management.

< Raise awareness of and competence in the application of energy-efficient techniques among municipal managers and practitioners at the local level.

< Establish a forum for dissemination and discussion of appropriate tools and best practices and encourage ongoing networks for information sharing.

In addition to these overall goals and objectives, each session has specific objectives. These are presented at the beginning of each session's materials. Trainers should review these session objectives carefully, revise them according to the needs of the audience and course, and ensure that the session adequately addresses the new objectives.

## Sessions

For the purposes of this trainer's guide, the course is divided into five days (the last day is a half-day only). The first day gives an overview of the topic of energy efficiency in the water sector; the following days focus on specific topics and introduce case studies.

DAY 1: Establishing the Framework

DAY 2: Energy Efficiency in the Water Sector: Current Practices and Options

DAY 3: Current Energy-Saving Practices in the Water Sector (Site Visit)

DAY 4: Putting It All Together

DAY 5: Action Planning.

The course culminates with presentations from small groups on strategies they will use in their communities and workplaces to improve energy efficiency. In their presentations, each group is asked to consider the following questions:

< How will energy consumption be reduced?

< What factors should be considered to calculate payback?

< How will you ensure that the payback is accounted for?

< How will you account for long-term sustainability of project implementation? Consider staff training, monitoring, financial management, etc.

< Who are the decision makers? What do they need to know to approve the project?

Throughout the course, small-group activities are used to facilitate the application of concepts to participants' own situations and build toward the final presentations. Groups of five or six participants work as teams to discuss area of energy efficiency in their respective countries or municipalities and explore how improvements might be made. To focus the discussion, each group is asked to identify a policy objective that it would achieve through better energy efficiency in the water sector and then to articulate an action plan for a specific municipality or state to meet that objective.

## Sample Agenda

The following agenda is from the 2003 course conducted in India. When designing further offerings, this agenda should be adapted to meet new goals or time frames. The agenda assumes that breaks are incorporated into the morning and afternoon sessions.

**DAY 1: Establishing the Framework**

9:00 Welcome and Opening Remarks
Course Objectives and Overview

10:30 Participant Exercise: Learning Goals

11:00 Presentation: The Urban Services Environment: Foundation for Complex Decision Making

**1:00 LUNCH**

2:00 Presentation: How Energy Efficiency Saves Money

4:00 Small-Group Exercise: Policy Objectives in Energy Efficiency in the Water Sector

5:00 Day 1 Wrap-Up and Adjourn

**DAY 2: Energy Efficiency in the Water Sector: Current Practices and Options**

9:00 Opening Session and Group Reports

10:00 Case Presentation: The Energy Audit

11:00 Presentation: Managing Energy-Efficient Water Services

**1:00 LUNCH**

2:00 Review of Morning Presentations

2:30 Small-Group Exercise: Current Energy-Efficient Practices, Policies, and Management in My City or Country

5:00 Day 2 Wrap-Up and Adjourn

**DAY 3: Current Energy-Saving Practices in the Water Sector**

9:00 Group Discussion: Preparing for the Site Visit

10:00 Site Visit: Observing the Realities
Group Discussion: Sharing Observations and Lessons Learned

**DAY 4: Putting It All Together**

9:00 Opening Remarks and Overview of the Day
Case Presentation: Putting into Action Energy-Efficient Policies and Programs

10:00 Presentation: Opportunities for Improving Energy Efficiency (Supply Side and Demand Side)

**1:00 LUNCH**

2:00 Presentation: Opportunities for Improving Energy Efficiency in Private Sector Participation

3:30 Small-Group Exercise: Strategy Preparation

**DAY 5: Action Planning**

9:00 Small Group Presentations: Strategies for Improving Energy Efficiency

12:15 Evaluation and Conclusion

1:00 COURSE ADJOURNS

In addition to the sessions listed here, the course began with a Sunday evening optional session to introduce participants to terminology and concepts. This was followed by a reception to welcome course participants and allow them to meet one another and the course instructors and leaders.

## Planning and Conducting a Course

The materials in this training manual are designed to be a guide for people planning future courses. It is recommended that anyone using the trainer's guide to plan or conduct a course read all course materials completely. The guide follows the course over four-and-a-half days. It can be used in its entirety to mimic and repeat the course that was conducted in 2003 in India and Mexico. Course planners can also use the information to select one day as an orientation to the topic or combine sessions from several days into a shorter, more focused course. The important thing is to organize the materials presented here to meet specific goals and objectives determined by the audience needs.

In this manual, an overview and objectives are provided for each day. Before conducting the session, read these carefully and adapt them to the needs of your audience and the goals of your course. In some cases, you may need to adjust the materials to accommodate a specialty within the group or to incorporate information that is not covered.

Each day is then broken into sessions, which focus on the presentation, case study, or learning exercise used to present new information, review what has been learned, and provide opportunities for participants (usually working as teams) to apply the concepts to their own situations. For each session, the manual provides:

< An overview, describing the purpose of the session

< Session objectives, which outline the three or four concepts participants are to glean from the session

< Trainer's notes, giving step-by-step instructions about how the session might be presented

< Handouts (where applicable) to be photocopied and distributed

< Overheads, which the trainer or presenter can adapt to meet the learning needs of participants.

As mentioned earlier, all of these materials are meant as guidelines only, not as a prescription of how the session should be presented. In fact, the presentations for the course in India and in Mexico varied greatly, due primarily to differences in the mix of participants and the knowledge, experience, and learning needs they brought to the course.

In particular, the timing may vary considerably from one group to another—depending not only on the expertise of the group, but also on the nature of the group discussion, the number and quality of the examples that are incorporated into the discussion, and preferences of the group and the presenter. Presenters

should consider any content information provided here (e.g., the overheads) as the skeleton of the presentation, adding examples that are relevant to the region or country in which the training is held and the audience that is present. It is strongly recommended that presenters practice their presentations ahead of time and make adjustments to the recommended timing according to their specific presentations rather than attempting to fit their presentation into the timing provided in this manual.

## Selecting Presenters and Facilitators

There are a number of things to consider when selecting presenters for this type of training course. In addition to content knowledge, presenters should have good presentation skills, including the ability to connect with the audience, to "read" the audience's reactions, and to alter the presentation accordingly. For diverse international audiences, experience working in a multicultural environment, with non-native English speakers, and with interpreters is helpful.

When considering presenters, look for balance among experts in theory (e.g., professors) and practitioners who are able to share real-life experiences. Contact all presenters well in advance of the course and give them guidelines for session objectives, topics to be covered in the presentation, preparation of overheads or handouts, and key questions for discussion. If presenters plan to stay for the duration of the training course, encourage them to serve as resources for the group without distracting from presentations as they are taking place.

In addition to presenters, there should be at least one facilitator who is responsible for overseeing the progress of the training course. It is the facilitator's role to ensure that sessions run according to the course schedule. The facilitator may also step in to clarify key concepts, ask key questions, summarize sessions and connect one presentation to another, handle question-and-answer sessions, and encourage the group to move forward if it gets stuck. Good facilitators have excellent communication skills and knowledge of group dynamics.

## Learning Approaches

Because adults learn best when there are opportunities to participate in discussions and apply what they are learning to their own experiences, the "Cities Matter: Energy Efficiency in the Water Sector" course is designed to be highly interactive. The presentations designed for this course focus on a specific aspect of energy efficiency (often with a case study) and provide plenty of time for discussion. Presentations are followed by opportunities for participants to apply the session content to their own countries or situations. The small-group exercises build on one another, so that by the end of the week, each group has a specific set of actions and priorities that the group members can apply to their community or work situation after the course.

The training includes a variety of learning approaches, including the following:

**Presentations.** Presentations provide the content of the topics studied. They should go beyond a lecture, however, by engaging the audience and connecting the subject matter to the situations or experiences of the participants. (The trainer's notes offer suggested brainstorming activities or discussion questions to help accomplish this.) When planning presentations, trainers should look for other opportunities to help participants tie what they are learning into their real-world responsibilities. Presentations should also include overheads and examples to keep the participants engaged in the discussion.

**Small-group exercises.** The exercises are designed to facilitate the involvement of all participants as they apply the concepts learned to their own country or situation. The small-group exercises ask participants to complete a specific task and then to share their findings with the larger group.

Small groups typically work best when there are no more than six participants in each group. In the 2003 offerings, participants were divided into groups with others from their country or region. When adapting the course, trainers should consider carefully what mix of individuals will work best for achieving their objectives. In some cases, it may be best to assign groups according to a common characteristic; for example, assigning all participants from the nonprofit sector to one group and those from the local government to another; breaking into groups so that people from the same community work together; or encouraging people with similar interests to join together. In other situations, it may be best to have diverse points of view in any given group. You may also want to consider allowing different participants to work together in different exercises; this encourages new relationships to be forged and ideas to be shared among participants.

It is important to provide clear instructions at the outset of the exercise about what the group is to accomplish. This is best achieved by showing an overhead or slide (prepared using Microsoft® PowerPoint software) with instructions, reviewing the instructions verbally, and asking if there are any questions before the groups begin their work. (Although a handout can be used instead of an overhead, having the instructions in an electronic format allows the trainer to change or update the exercise to accommodate what has taken place during the course.) Provide specific time limits and remind groups when they have only five (or ten) minutes left to complete their task. In addition, ask groups to select a spokesperson to be responsible for reporting on the group's discussion.

After small-group exercises, give each group time to report. Encourage groups to be brief. Respond following each group's presentation, asking questions for clarification or tying their discussion into past presentations. You may also ask others in the group to ask questions or add to what is mentioned.

After all groups have had a chance to report on their discussion, it is critical to summarize key ideas, focusing on what participants should take away from the

presentation and/or exercise. Usually you can best do this by asking the groups what they learned from the discussion and how they will apply what they have learned. Where appropriate, post their answers on a flip chart. The trainer's notes are designed to help presenters make sure that key points are reinforced at the close of each presentation.

**Field trips or site visits.** The third day of the training course featured a site visit. For the India course, participants visited the pumping station and the water treatment plant in Bangalore. In Mexico, participants visited the water operations in Tlalnepantla and Cuautitlan. The site visits provided an opportunity to see how management practices were implemented and to observe some of the technical aspects of energy efficiency discussed during the previous two days. The visits focused on the effect that energy-saving measures have had on daily operations.

For many of India's participants, this was their first visit to a pumping station. For others—engineers, for example—the site visit provided an opportunity to view a state-of-the-art facility. In the Mexico course offering, participants took with them to the site visit a list of questions and issues developed jointly as a summary of the previous day's sessions. The issues addressed improvements from supply, demand, and operational perspectives. The participants used the list to help them ask detailed questions and take notes about important issues.

The site visit is essentially a different way to present a case study of water efficiency. It is important to select the site carefully, so that participants at all levels will learn something from the visit. In Bangalore, the environmental expert trainer and engineers who work at the plant led the tour and answered questions.

To make sure that the site visit is a learning experience, it is important to prepare ahead of time. Make sure you present to everyone involved in planning and conducting the site visit the objectives of the course and those of the site visit as it relates to the course. It is advisable to visit the site well ahead of the site visit to get questions answered and take care of logistical arrangements. The site visit should be conducted by a water facility employee who is familiar with the operations under consideration. Other technical employees and non-technical experts (e.g., an elected official) should be available to answer participant questions.

Do *not* try to convince an organization or community to participate. It is better to have a less advanced program described by people who want to tell the story than a good program described by people who feel you are intruding. Leaders and staff who are knowledgeable about the process by which a new program was actually implemented, rather than people who can only describe the outcome, should share information about the site with the course participants.

The one-page handout at the end of this Overview (Site Visit Guidelines) can help trainers plan and conduct the site visit. Make sure those planning and conducting the site visit know how long the visit is expected to take and are familiar with the course goals as well as the specific session objectives for the site visit.

**Case studies.** The Energy Efficiency in the Water Sector course used several different approaches to case studies. Most of the presentations were made by guest speakers—practitioners responsible for implementing the changes discussed in their own country or community. One case was also presented through a site visit, as discussed previously. Site visits have the advantages of offering an opportunity for participants to see what is being discussed and of breaking up the long hours sitting in a classroom. In some cases, a short, written case study can also be used as part of a presentation or as background materials to supplement case studies presented by trainers or other practitioners.

The purpose of case studies is to connect theory to practice. Good case studies are relevant to the content of the presentation and to the specific parameters in which the participants work. Case studies should be changed each time the course is delivered to ensure that they are both relevant and up-to-date. Choose case studies very carefully and do not include them if they are not relevant to a specific point being made in the course.

Finally, when using the case studies, make sure that the linkage between the session objectives and the case study is clear. Don't assume that participants can make the linkage by simply hearing the presentation.

The handout on Case Presentation Guidelines (pages xvi-xvii) can help presenters prepare their case studies. Make sure that presenters know the length of time they will be expected to speak and are prepared to answer questions from the group. All presenters should have a copy of the course agenda, goals and objectives, and (if possible) the list of participants with any background information about participants that is available, such as their current position.

## Training Tips

It is important to tailor course materials to the knowledge and experience of participants. Data, examples, and anecdotes should be relevant to the audience.

In addition, the course should take into account the needs of adult learners. Take the following steps:

< Provide a comfortable learning environment.

< Discuss expectations at the outset of the training course and each session.

< Focus on practical skills and real-life examples.

< Provide ample opportunities for adults to integrate new ideas and concepts into their existing knowledge.

- Use interactive learning strategies. Long lectures can detract from learning.

- Accommodate different learning styles by using overheads, engaging participants in the discussion, recording their comments on flip charts, etc.

For learning to take place, trainers must effectively introduce the goals and objectives for each session, ask effective questions and guide group discussion, and provide closure at the end of each session. Trainers should take the following steps:

**Prepare carefully.** Prior to each session, review the reading assignment and the lesson outline, content, and activities. Try to anticipate questions and difficulties that participants are likely to have and review any areas that you are uncertain about. Plan carefully, but be flexible so that you can alter your plan to accommodate the needs of the group. Gather the materials and equipment you will need to conduct the lesson. A preparation checklist can help you make sure that you are ready.

**Review objectives.** In most cases, the session should begin with an overview of the session objectives and activities. Explain what you expect participants to learn from each activity and how the objectives fit into course goals (discussed later in this section).

**Give clear directions.** It is important to explain what is expected of participants for each activity. They need to know what they are to do, how they are to do it, and how much time they will have. When breaking into small groups, allow time for participants to rearrange themselves and the furniture so that you have their full attention before giving directions. If you are working with printed materials, be careful to allow participants sufficient time to read them on their own. Remain available to clarify directions throughout the sessions.

**Facilitate learning.** The facilitator's responsibilities include guiding the group process by keeping things moving, including all group members in the learning process, providing feedback, keeping participants directed toward the designated goal, and helping the group sum up each session. When conducting small-group activities, don't be tempted to join as a participant. Maintaining your role as facilitator allows you to roam around the room to observe how participants are doing, refocus them on the task at hand, or offer suggestions.

**Process information.** No matter how good the quality of the presentation or activity, it will be useless without processing the activity and the information learned in conducting it. Make sure you allow ample time for discussion after each presentation or activity. Use the flip chart to help record ideas and feedback. Remember, it is your responsibility to make sure participants relate the activity to the session objectives and to their own experiences and situations.

**Provide closure.** As you review key points, relate the learning back to the objectives you set. It is often helpful to ask for questions at the end of the session to

make sure that there are no loose ends. Be prepared to suggest additional resources for those who would like to explore a topic in more depth.

Look for ways to encourage participants to convert what they have learned into action. Use discussion questions and learning activities to inspire participants to reflect on their own situation, assess their strengths and weaknesses, and apply what they have learned.

You can also encourage participants to use new skills by ending the class with questions such as:

< What is the first thing you'll do when you get back home to apply what you have learned here?

< Who might be an ally in the strategies you might apply?

< What problems, if any, do you anticipate in applying the concepts you have learned?

**Be enthusiastic!** The trainer is a salesperson of ideas and a role model for the rest of the class members. Enthusiasm fosters a positive learning environment. Your positive (or negative) attitude may quickly become the prevailing mood of the group.

# Handout: **Pre-Course Assignment**

This course is designed to integrate the varying knowledge, experience, and situations of all participants. Accordingly, we require a modest investment of your time before you depart for the course. Information from this assignment will assist you with the course's analytical tasks.

Prior to the course, please collect basic information and documentation regarding energy efficiency in the water sector and decision making in your country and community (municipality or other local unit of government). These documents will be used to discuss the current situation with regard to energy efficiency in the water sector and what improvements may be appropriate. Bring a copy of:

< A typical household water bill

< A typical water bill that would be sent to a company or factory

< Your water rate structure*

< Your municipality's electrical power invoice (the rates that your city pays for electric power)*

< Your municipality's operating budget (revenues and expenditures)*

< Your municipality's current capital plan.*

(***Note:** If you do not work for or directly represent a municipality or other local unit of government, select a municipality from which to gather this information.)

Also, please be prepared to answer during discussions the following questions about your country or community:

< What is the relationship between the central government and local governments in your country?

< What is the relationship between the water sector and different levels of government (local, regional, and national)? What kind of authority and/or autonomy does the water sector have? Who makes decisions on water utilities?

< Does the central government subsidize water services in your country? If yes, how?

< What are the most compelling and pressing problems facing your water utilities/water distribution system today (e.g., leaking, inefficient billing or collection of revenues, stolen water, inefficient pumping, scarcity of water, poor access to water, water contamination)?

- What is the established network in your country or region for information dissemination and sharing of best practices in the water sector?

- What systems are used for billing and collecting revenue from water services delivery?

- Which (if any) environmental services have been privatized in your country? What have been the resulting costs and benefits?

# Handout: **Case Presentation Guidelines**

You have been selected to make a presentation because of the impact your work has had on basic conditions of human settlements and the lives of people in your community.

Case study presentations are the foundation of this course. It is through the experience of changing the way local government operates that new strategies will be developed and other local governments will make improvements.

Your case study should include two written documents: a written narrative that covers all points of the case study and a slide presentation that touches on key points in outline form for use during the oral presentation. Please remember that slides should only include key points, not the entire text.

In reporting the results of your project, please address the following points:

1. The conditions prior to the introduction of your project and the *expected* result or impact of the project. It is important to define both of these factors in the introduction so that the audience understands the obstacles addressed during the project implementation.

2. The actions that were taken to:

   < Plan and design. Who participated in planning or designing the project? How were citizen groups involved in the design?

   < Present the ideas/design to the appropriate decision-making group. What was the reaction of decision makers? Was the project submitted as a result of a government request, or was it initiated by a citizen or other outside group?

   < Develop new practices. What management, financial, or other practices were introduced or required? How were these incorporated and what was the reaction of the people who needed to change? To the degree possible focus the answer to these questions on four areas:

      – Revenue generation and financial management

      – Organization structure (bureaucracy)

      – Staff responsibilities and behavior

      – Citizen involvement

3. What human, institutional, and fiscal resources contributed to the success of the project? How were the resources secured?

4. What were the results? Describe the results in the context of the institutionalization of new practices as a result of your project. Will other projects be completed according to the new practices developed?

5. What would you do differently? What is the next step?

# Handout: **Site Visit Guidelines**

Your facility has been selected for a site visit for the "Cities Matter, Energy Efficiency in the Water Sector" course. The purpose of the site visit is to provide an opportunity for participants to see at work some of the principles and practices that they have learned in the classroom and to ask questions of practitioners. It is important to plan carefully to allow ample time for participants to tour the site and to ask questions during and after the tour.

One recommended approach to conducting the site visit follows:

< Good morning and welcome.

< Brief overview providing general information about the city and community (e.g., population, services provided, economic base, future outlook).

< Key information about the facility and services that the delegation is visiting (e.g., number of employees, number and types of customers served, percentage of the city's budget that is allocated to this service, revenue sources).

< Discussion of recent improvements or upgrades (including new technology), as well as a general description of the capital improvement plan for this service.

< Discussion of ongoing challenges and strategies for meeting these challenges.

< Overview of facility management and oversight. Is there a citizen commission or advisory committee assigned to this service? If yes, describe how they are involved.

< Discussion of other mechanisms that enable customers to give input on the service (e.g., complaints, hearings, planning meetings) and ways that customer input is addressed.

< Other key elements that will help course participants better understand the facility and services provided.

# Day 1: Establishing the Framework

## Overview

An energy-efficient urban service system takes advantage of cost-effective technologies and management practices to ensure that the customer's per-unit cost of a high-quality product, such as water, is as low as possible and includes conservation efforts on both the supply and the demand sides. This training course is designed to focus on the advantages of obtaining and maintaining technologies and management practices to gain energy efficiency in the water sector. The course reviews the issue from various perspectives to help participants better understand the synergies between the technical, managerial, and political aspects of energy efficiency in this sector. To do so, the course begins with a discussion of the local and national framework within which decisions are made that impact energy efficiency.

A welcoming session is used to acquaint participants with the course goals and objectives and with the course materials. Participants have an opportunity to introduce themselves and to discuss their expectations for the course. The day's sessions also focus attention on the purpose of energy efficiency—i.e., saving money. At the end of the day, participants break into country or community teams to begin to analyze the conditions in their own countries or communities. This analysis will serve as the framework for the action plan to be completed by the end of the course.

## Day 1 Goals

- To present course goals and objectives
- To introduce the concept of energy efficiency within the context of local government and municipal management
- To establish the framework in which decisions about energy efficiency in the water sector are made
- To discuss the many complex and interrelated factors that influence water policy and practices
- To consider the impact that energy efficiency can have on a local government's bottom line and the citizens that the local government serves.

# Trainer's Notes

## 1¼ hours Welcome and Introductions

*This part of the session consists of basic welcome and course introduction presentations. The session should be conducted by the course facilitator(s) and include a welcome by all program sponsors. This helps familiarize participants with these course leaders and remind them of what organizations have participated in the success of the program.*

*The session introduces the topic of energy efficiency in the water sector, particularly as it relates to the origin of the course. Experts predict that water will become more and more valuable in the decades to come. Some say that water will be to the 21st century what gold and oil have been in the past. Water is a natural phenomenon that is heavily influenced by human interaction. While most people assume that the abundance or scarcity of this valuable resource is fixed, it can be influenced by technology and management practices. Determining how to assess and address the reality of the water situation in one's own country or community is the first step toward self-sufficiency and efficiency in this sector.*

*15 min*

1. Begin by welcoming the group. Introduce yourself and all other trainers who are present. Review course goals and objectives. Explain what you expect participants to learn. Briefly explain that you hope to provide an overview of the topic for policy makers; provide tools that will help them make informed decisions; offer examples of energy efficiency in the water sector; and help teams of participants set strategic objectives. (You may choose to revise the course objectives listed in the Overview and the overheads for this session.) Review the course agenda, course materials, and procedures. Discuss also any issues related to accommodations, meals, and breaks.

*55 min*

2. Introduce course leaders, sponsors, and other content providers. Each should welcome the group and give an introduction to the topic by explaining how the course relates to the goals and objectives of USAID and discussing the origins of the "Cities Matter" program, focusing particular attention on its urban strategy, and on this course. Discussion should then turn to the growing importance of energy efficiency, citing statistics, trends, and issues from the country or region to reinforce this point. Leave time at the end of each presentation for questions from participants.[3]

[3] Another, perhaps better, option would be to have participant introductions immediately after the course introduction and then to begin the next session with an overview using the content here.

*5 min* 3. Conclude by summarizing key points from the presentations and tying these to the course goals and upcoming sessions. Remind participants of how the course is organized and provide a brief overview of today's sessions.

## ¾ hour Participant Exercise: Learning Goals

*The purpose of this session is to give participants an opportunity to introduce themselves and to share their expectations for the course. Participants are expected to play an active role throughout the course; this sets the stage for active involvement on the part of all.*

*5 min* 1. Explain that participants tend to get out of a course what they put into it. This course—like all Cities Matter courses—is designed to be highly interactive. Participants should ask questions when they have them and actively participate in small-group work. Point out that sometimes the best learning takes place informally during breaks and meals. Encourage participants to have lunch or dinner with others they don't know and to interact during the breaks.

*10 min* 2. The first step in creating a learning environment is to have participants get to know one another. Ask participants to spend a little time thinking about what they hope to gain from the course, i.e., their learning objectives or expectations for the course. Each participant should jot these down on a piece of paper. They should then discuss what they have written with the other people at their round table. Allow about 10 minutes for participants to share their expectations. (Having people first talk in small groups has the benefit of allowing participants to share ideas on a more informal basis rather than having to talk to a large group of strangers at the outset. Other options include having participants share their learning objectives or expectations with the course planners in advance, and then use these as a springboard for discussion of course objectives.)

*20 min* 3. Next, ask participants to stand and *briefly* introduce themselves, giving their name and title or position, organization, and home town and country. Each table should then share its expectations and learning objectives with the rest of the group. As participants share their learning objectives, list them on the flip chart. Stress that introductions should be brief; there will be plenty of time throughout the course to share other examples and information.

*5 min* 4. When all participants have had an opportunity to speak, briefly review the list of learning objectives and expectations on the flip chart. Briefly mention how they relate to the course goals and objectives and what aspects of the course may help participants reach these expectations. In addition to showing how most expectations are in alignment with the goals of the course, point out any that may be unrealistic. Leave the expectations posted throughout the course

so that facilitators and presenters can refer to them and adapt or adjust their presentations according to the needs and desires of the group.

*5 min*

5. Reiterate that you expect participants to be active learners—that they are likely to gain as much from the expertise in the room as from the more formal presentations. Explain that there are a few ground rules that help make learning possible in a participatory environment: respect, participate, and listen. Ground rules you may want to share include.

   < All participants are expected to attend all sessions and participate in small group activities at the level they feel most comfortable.

   < Feel free to speak up. This training program is designed to be participatory. You will likely learn as much from one another as from instructors. Ask questions, share ideas, support one another.

   < Put aside work relationships; everyone's input carries equal weight.

   < Turn off cell phones. This is an opportunity to get away from day-to-day responsibilities to focus on the topic at hand. (Explain how emergency calls will be handled; for example, if there is a number where a message could be sent to a participant.)

   < Unless a presenter asks otherwise, ask questions as they occur to you. (It is often a good idea to have a "parking lot" at the back of the room where participants can leave index cards with written questions that occur to them at a time when it might not be appropriate to ask or for questions that are slightly off topic.)

   Ask participants if they have any ground rules they would like to add. Close by asking participants how they prefer to be addressed: Should we use Mr. or Ms. __, or first names? Explaining that different cultures have different rules about these issues; first names are used for training in the U.S., but you would like to do whatever is most comfortable for participants.

## 2 hours Presentation: The Urban Services Environment: Foundation for Complex Decision Making

*Policies, laws, land-use plans, and capital investment plans are tools that can be used to impact water quality and water service delivery. Thus, understanding the geographic, political, and financial aspects that dictate the boundaries of water service and how water service delivery relates to other services is an important step in identifying how energy efficiency can be achieved.*

*This presentation looks at water delivery from various perspectives and illustrates the complexity of the issue. The purpose of this presentation is to allow participants to start building an analytical framework from which to craft their own*

*water policies. Rather than having one person present the entire session, this session is broken up by a case study, presented by a practitioner.*[4]

*5 min*

1. Explain the purpose of this session—to focus attention on the complexity of water service delivery and the impact that the framework in which water service delivery takes place has on quality and efficiency.

*15 min*

2. To get participants thinking about the topic, ask them who oversees water service delivery in their own countries and communities. What influence does the national government have on water services? What is the local government's role? Who else is involved?

*15 min*

3. Continue the discussion with a broad-based look at the many factors that influence water policy, including:

   < Shrinking financial resources

   < Local control

   < Protecting natural resources

   < Migration patterns (urbanization, suburbanization, or movement into rural areas. (In the U.S. and some other parts of the world, there is a tendency for sprawl and the creation of "exurbs," as people migrate from the cities to outlying areas. This creates problems for service delivery. In Asia and other parts of the world, there tends to be increased urbanization, which also puts pressure on services.)

*25 min*

4. Narrow the focus of the session by considering one or more case studies. This first case study should emphasize all of the underlying factors that contribute to excellence in municipal service delivery. While the case study can focus on water as an example, other municipal services should be included to demonstrate how improved management practices affect service delivery. The case study used in India began with a review of ICLEI and the assistance that it provides for cities in the region. A model for implementing energy efficiency practices was also shared. Case presentations could also be made by experienced local government practitioners.

   Regardless of who is presenting them, case studies should be rich in detail, offering information on changes in management that contributed to the results, initial investments and the cost savings that were realized, how services were improved, etc. Presenters should pay particular attention to the management tools and techniques used to improve water service delivery.

[4] In the India offering, the presentation was made by Deborah Kimble, a local government management specialist, and the case study was presented by Emani Kumar of the International Council for Local Environmental Initiatives. See the Day 1 overheads labeled "Energy Efficiency in Municipal Services."

*20 min* 5. Ask for questions from participants. Use these questions to further clarify benefits of energy efficiency and other information from the case, as well as to encourage discussion among participants about their experiences.

*30 min* 6. Address the critical issues from the presentation and begin to apply what has been learned from the case study to the situations participants face in their workplace or community. Lead a guided discussion to have participants analyze the case study and identify the critical issues that contributed to successful results. Then ask participants to add any areas that were not addressed in the case study that they believe to be important for increased energy efficiency in the water sector.

*5 min* 7. Conclude with a summary of the key learning points from this session.

## 1¾ hours Presentation: How Energy Efficiency Saves Money

This session draws linkages between policy objectives and two tools—planning and management—as ways to sustain the availability of water and to increase regional competitiveness. How does water management relate to energy efficiency? How much energy is needed to produce potable water or process wastewater in various countries and regions around the world? What factors contribute to cost differences?

*A presentation is used to identify the key elements that lead to inefficient water treatment and distribution and the related costs of such inefficiency. The focus is on the positive side of the equation, however, i.e., the financial advantages of using energy more efficiently and the benefits these cost savings have for the community.* [5]

*5 min* 1. Begin by introducing the topic and explaining how the small-group exercise that follows the presentation will relate to the presentation.

*40 min* 2. Follow the overheads ("Energy Characteristics in Water Utilities") to provide an overview of the various ways that energy efficiency can be addressed in the water sector, focusing on the aspects of planning that can contribute to efficiency in treatment and distribution. Briefly review the elements of a typical utility bill, and what the related charges actually cover. (If possible, obtain actual bills from the participants' countries before the course begins so that the presentation is as realistic and familiar as possible.) Then, cover the costs associated with water utility operations, characteristics, and costs. Conclude by emphasizing the following four points:

[5] In the India course offering, this presentation was made jointly by Terry Driscoll, a senior environmental policy analyst, who focused on planning for better efficiency, and Sudha Setty of the Alliance to Save Energy, who focused on water operations and management.

- < Electrical energy represents a major cost to water utilities.
- < Electrical energy cost is based on multiple factors.
- < Savings are achievable by focusing on operations.
- < Key to savings is to focus on particular tariff structure and operating characteristics.

*5 min*

3. Allow time for questions and answers about the relationship between planning and energy efficiency before continuing with the next part of the presentation.

*40 min*

4. Continue the discussion, now focusing on the management aspects of water efficiency. Discuss common problems in energy efficiency in the water sector, such as leaks, low *c*-value for pipes (high level of friction inside pipes, improper or inefficient system layout, system over-design, incorrect equipment selection, old or outdated equipment, poor maintenance, waste) and steps that cities can take to remedy these problems. The overheads entitled "Watergy: Taking Advantage of Untapped Energy and Water Efficiency Opportunities in Municipal Water Systems" can be used as a guide for this presentation. (Content will need to be adapted for the country or region in which training takes place.)

*5 min*

5. Encourage questions from participants about management and how it relates to efficiency in the water sector. Encourage participants also to offer additional tips, techniques, or strategies from their own experiences.

*5 min*

6. Conclude with a summary of the discussion, looking ahead to tie this and previous presentations into the small-group exercise that follows.

## 1 hour Small-Group Exercise: Policy Objectives in Energy Efficiency in the Water Sector

*In this small-group exercise, participants work in teams from their country or region to begin to analyze the conditions related to water service delivery in their own countries. The task allows participants to share information and experiences about the framework for service delivery in their country and how it impacts water service delivery. Participants then use this information to articulate one or more policy objectives for increased energy efficiency in the water sector.*

*5 min*

1. Introduce the exercise by explaining that you would like participants to review their country's and community's approach to water service delivery. Break into groups with participants from the same country or region in one group. If all participants are from the same country, it may be useful to divide the group so that there are different perspectives (e.g., local/central government, public/private/nonprofit, large/small communities) at each table. Explain that

participants will work in teams throughout the course; exercises will culminate in a team presentation on the morning of the last day.

*35 min*

2. To begin to focus on what it means to have energy efficiency in the water sector, ask teams of participants to think about the issue. Teams are to use what they have learned thus far and their own experience to discuss the following questions:[6]

   < What are the most influential or powerful factors that contribute to energy efficiency in the delivery of local government services? Once you have developed a list, put them in order of priority.

   < What are the most important or powerful factors that contribute to energy efficiency in water service delivery? Again, list these in order of priority.

   < If the answers or priorities on the lists differ, what accounts for the differences?

   < What are the biggest problems for water service delivery? What problems result in the greatest inefficiencies? Include managerial, policy, and administrative aspects. Prioritize your list of problems.

   Allow 35 minutes to discuss these questions.

*10 min*

3. Next, explain that groups should use their responses to begin to think about how actions relate to energy efficiency and what actions need to be taken. Teams should prepare flip charts listing what they believe to be the top two or three problems in water service delivery and the actions they would propose to address these problems. The flip charts will be used to share these with the rest of the class tomorrow morning.

*10 min*

4. Conclude with a summary of the day's work, emphasizing the key points that have been brought up. Look ahead to tomorrow's sessions, reminding participants of the time you will begin.

[6] Instructions for small groups should always be recorded on a flip chart, overhead, or handout so that participants can refer to them as needed during the exercise.

# Handout: Cities Matter: Energy Efficiency in the Water Sector

*"Cities, and not nations, are the true engines of economic growth"*
—JANE JACOB, URBANOLOGIST

In the second half of the 20th century, cities have emerged as important places in the political and economic structure of a nation. They are where commerce, people, ideas, and culture converge, and it is the role of the local government to mediate this convergence. As such, local governments are active players in the overall governing process of a country, and furthermore, they make a major contribution to economic conditions. In short, *cities matter*.

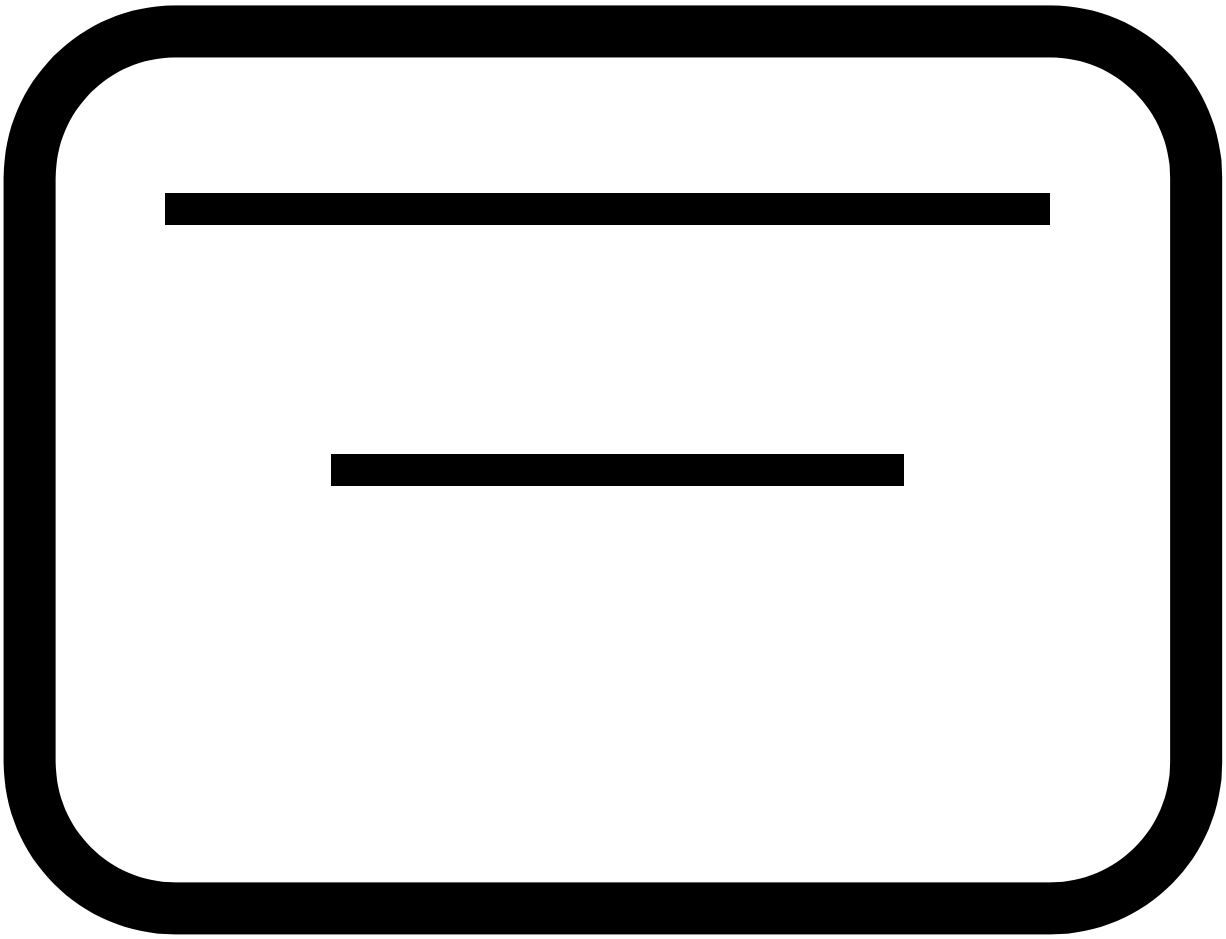
The importance of local administration is being recognized in the context of the dismal conditions in many of the world's cities. The capacity of local government to address the challenges of providing basic services—especially water—is fundamental. The failures of local administration are ever starker in many parts of the world, and the effects on everything from public health to capital formation are becoming clearer.

Once empowered, cities, through their governing structures, can more effectively and efficiently deliver services that advance investment opportunities. The challenge is to encourage the development of political and administrative structures at this level, which meet the demands of today's market economy while at the same time balancing the diverse needs of citizens and preserving the environment.

To that end, using the U.S. local government model and information from other countries as the base from which to begin our investigation, we have constructed a course that will allow the participants to consider how cities in other parts of the world can deliver water in an energy efficient manner as one of many important environmental services that meet the goals and objectives of the nation, the business community, and, most importantly, the citizens.

This course looks at the delivery and management of water and energy-efficient practices that can be put into place for more effective and efficient service. General financial and management issues will be explored and applied to the water sector, and can also be applied to other service areas. Themes inherent in this training program are the principles of citizen participation, comprehension of an effective local government structure, and attaining fiscal sustainability. This provides an invaluable opportunity for participants to examine the best practices of other local governments or water utilities and determine what lessons learned can be applied in their communities and countries.

# Overheads



# Cities Matter

# Energy Efficiency in the Water Sector

# Course Framework

- Provide the context: What are the principles and practices of effective environmental service management?
- Apply the principles to the water sector.
- Narrow the focus: How to achieve urban service objectives through energy efficiency programs.
- Walk through the course.

# The Context

- Shrinking financial resources
- Local control
- Exurbia: the answer to urbanization
- Protecting natural resources

# Principles and Practices

**Principles**

- Use resources efficiently
- Provide effective services
- Create opportunities
- Achieve market rate pricing

**Practices**

- Informed decision making
- Comprehensive management systems
- Performance measurement
- Financial practices

# Narrow the Focus:
# Why Energy Efficiency?

- Cost reduction
- Municipal budget relief
- More competitive industries
- Savings to residences
- Puts more money back into the local economy

# Course Overview

| Objectives | | Results |
|---|---|---|
| Overview for Policy Makers | → | Zero in on Participant Objectives |
| Tools for Informed Decisions | → | Define Decisions That Must Be Made |
| Examples | → | Select a Course of Action |
| Setting Strategic Objectives | → | Define Strategic Objectives |

# Energy Efficiency in Municipal Services

*A new initiative by Indian cities thru Cities for Climate Protection (CCP)*

Presentation by:
Emani B V Kumar
Director, CCP South Asia, ICLEI

# Presentation Overview

- About ICLEI
- India CCP Campaign
- CCP Objective & Methodology
- Energy Efficiency Initiatives by CCP Cities
- What next….

# About ICLEI

- The International Local Government Agency for Sustainable Development
- Organized in 1990 under the sponsorship of the UN Environment Program and the International Union of Local Authorities

# ICLEI's Mission

To build and support a global movement of local governments accelerating sustainable development through cumulative local actions

**Common goods:**

< Air

< Climate

< Water

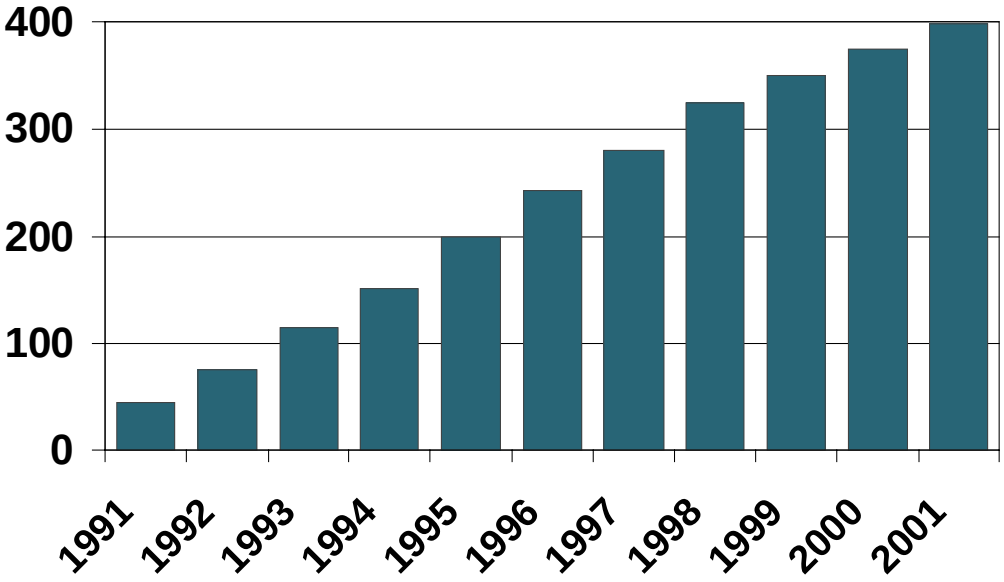
< Soil

< Biodiversity

< Food

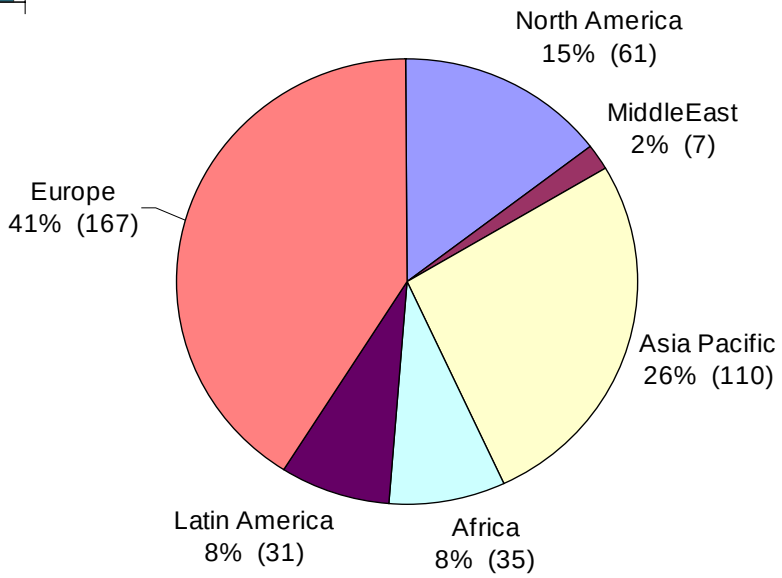
< Health

# ICLEI Membership




400+ local government members from 6 continents and 60 countries (October 2002)

**ICLEI Membership by Region**



# ICLEI's Global Campaigns

Local Agenda Action 21

*Cities for Climate Protection*

**The Water Campaign**

# CCP Profile

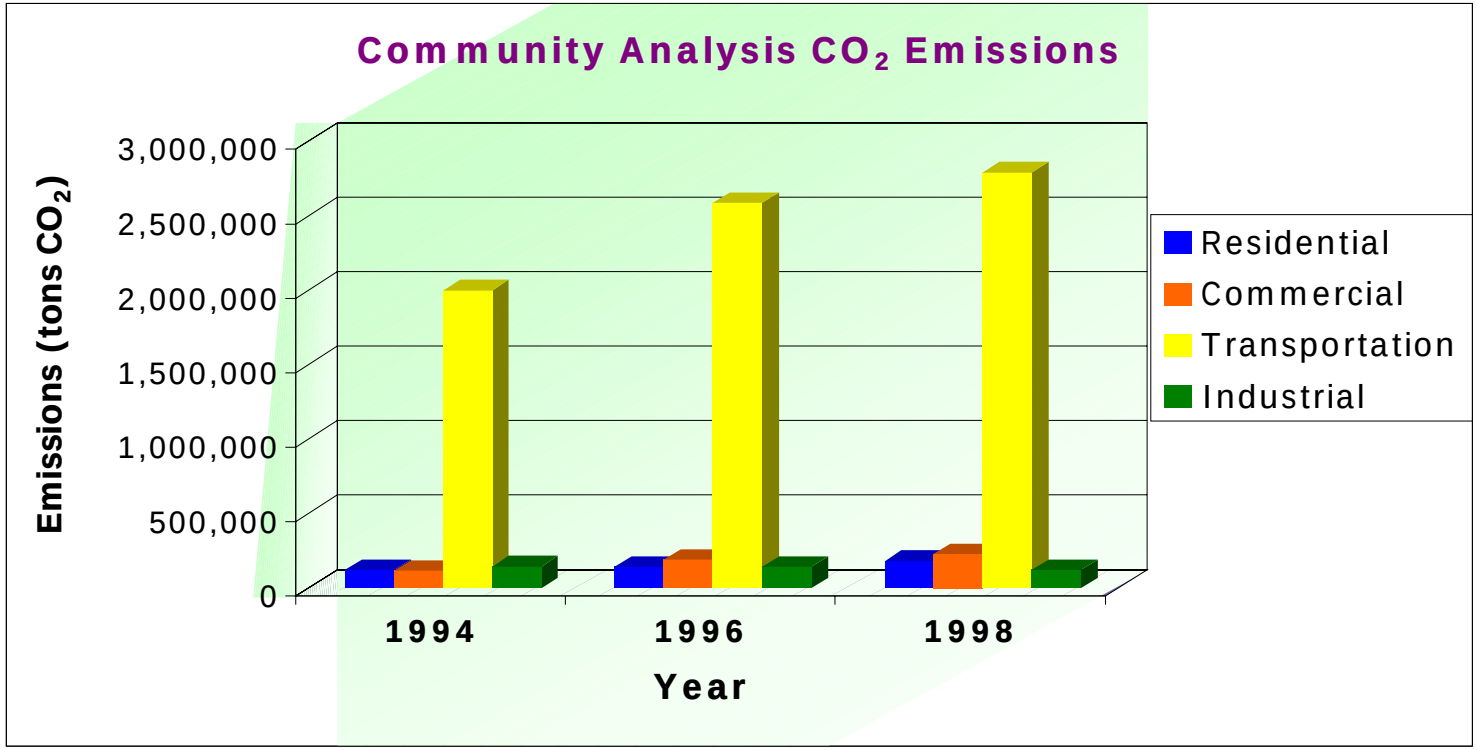
To build a worldwide movement of local governments to achieve measurable reductions in local greenhouse gas (GHG) emissions, improve air quality, and enhance urban livability.

# CCP Profile, continued

- Initiated in 1993 mostly in developed/industrialized countries
- More than 550 local government participants from six continents
- These municipalities represent 10%+ of global manmade greenhouse gas emissions

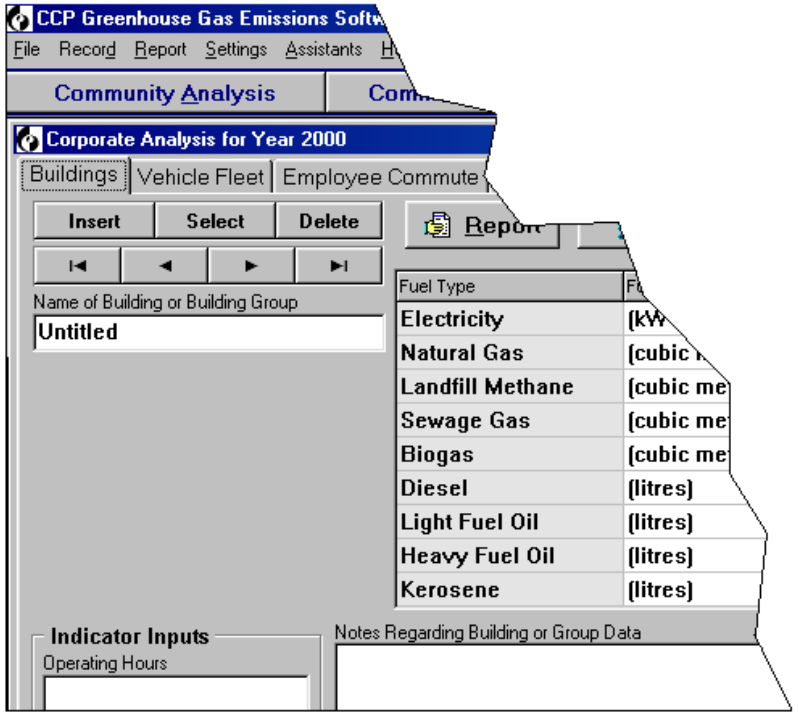
# Five-Milestone Framework

#1: Conduct Baseline Emissions Inventory and Forecast



# CCP Software

- User-friendly
- Contains detailed protocol for quantifying greenhouse gas and air pollution emissions
- Covers emissions from local government operations and from community transport and energy use



# Milestones….

#2: Establish Emissions Reduction/Avoidance

#3: Develop a Local Action Plan

#4: Implement Action Plan/Measures

#5: Monitor and Verify Progress

# India CCP Campaign

- India CCP campaign supported by USAID
- Launched in seven cities in October 2001
- Two-year first phase
- Inventory completed in all seven cities
- Action plans initiated in five cities
- Visible benefits

# Objective

To find innovative and cost-effective solutions to urban environmental and management problems that also mitigate city-level GHG emissions

# Participating Cities

Ludhiana in Punjab

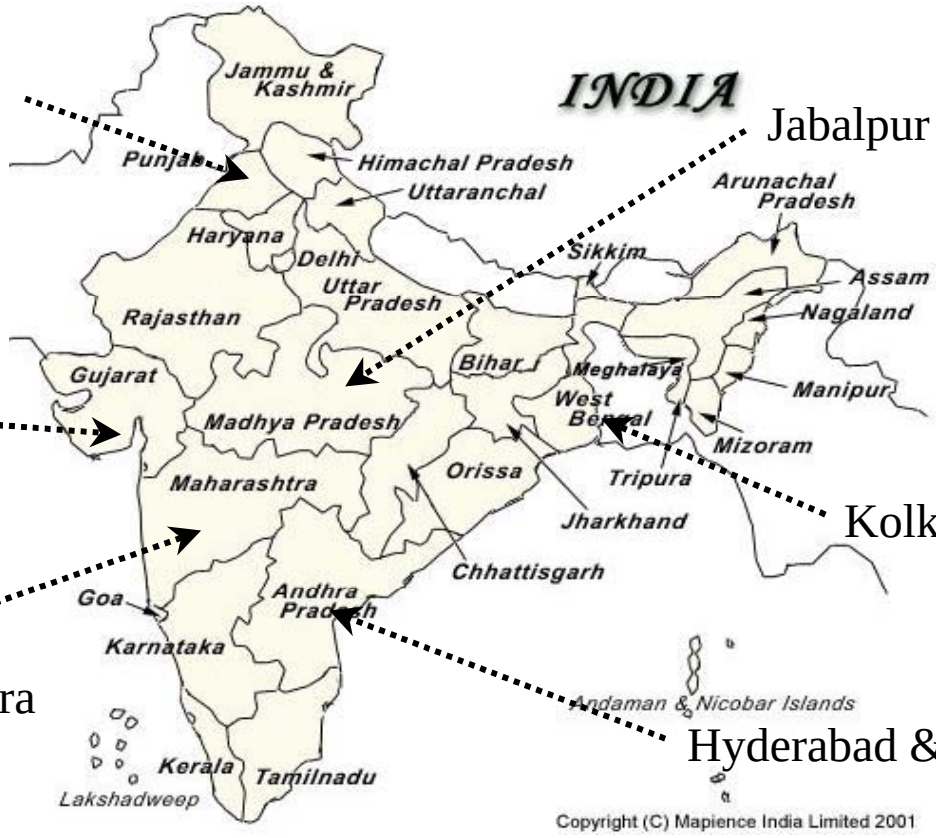
Jabalpur in Madhya Pradesh

Vadodara in Gujarat

Kolkata in West Bengal

Sangli in Maharashtra

Hyderabad & Guntur in Andhra Pradesh



# Statistics of CCP Cities

| City | Population | Area (Sq. Km) |
|---|---|---|
| **Guntur** | **566,820** | **46** |
| **Hyderabad** | **3,449,878** | **168** |
| **Jabalpur** | **951,468** | **135** |
| **Kolkata** | **4,580,544** | **186** |
| **Ludhiana** | **1,400,000** | **136** |
| **Sangli** | **436,639** | **110** |
| **Vadodara** | **1,306,035** | **108** |

# City-Level GHG Emissions

| City | CO2 Emissions (Tonnes/Year) |
|---|---|
| Ludhiana | 3,564,964 |
| Jabalpur | 680,492 |
| Kolkata | 4,922,098 |
| Hyderabad | 3,730,895 |
| Vadodara | 2,256,797 |
| Guntur | 466,142 |
| Sangli | 281,522 |

# An Approach for Implementation

SECTOR UNDER REVIEW

# Energy Efficiency Initiatives

# by Indian CCP Cities

# Energy Efficient Street Light Project, Jabalpur

- 60 retrofit tube lights in Nehru Park & Janaki Nagar
- A joint project by ICLEI, JMC & Asian Electronic Ltd.
- **Replacement of 40W *(53 W)* by 26W**
- **Savings/year for usage of 10 hours/day:** 5475 KWH/Yr
- **$eCO_2$ Reduction** = 7 tons per yr, 28 tons in 4 yrs
- **Cost of Project** = Rs. 55,000
- **Payback Period:** 1.7 yrs
- Total number of tube lights in city: 33295

# Solar Water Heating System, Jabalpur

- 1,000 Lit SWH installed at Engineering College Girls hostel
- A joint project by ICLEI, JEC, JMC & Sheryans Energy Pvt. Ltd.
- **Savings/year for usage of hot water for 7 months:**
  **14637** KWH/Yr
- **Cost of Project** = Rs. 175,000
- Annual Savings from Electricity + LPG = Rs. 98,656
- **e$CO_2$ Reduction** = 18.5 tons per yr

# Design-Based Street Lighting at Shastribridge, Jabalpur

- Use of IS 1944
- No. of poles & fittings 36
- Replacement of 250W HPSV with 150W HPSV
- **Savings/year : 13,140** KWH/Yr
- **Financial Savings = Rs40,600**
- **e$CO_2$ Reduction** = 13.5 tons per yr

# Energy Conservation –
# A Public Awareness Campaign

< One-day awareness campaign

< More than 400 residents visited

< Six companies displayed energy conservation products

< Mayor asked for installation of solar systems at his office

< ICLEI Team with retired engineers to form a energy cell, as part of JMC campaign

# Energy Efficiency in Water Pumping Systems, Kolkata

- Energy audit at RSM Square BPS
- Two Alternative solutions:
  - Zero Investment solution: 33% energy savings
  - Revamp and Replacement option: 1 Million KWH Savings
- Investment: 8,000,000
- Payback period: 2 years
- Power Factor: Present 0.81 Improvement 0.95
- Savings: Rs. 500,000/year
- Total pumping stations: 14 nos.

# Energy Efficiency in Water Pumping Systems, Guntur

- Energy audit at Sangamjagarlamudi Water Works
- Lower capacity RW system operation, seepage & evaporation losses, etc.
- Recommendations of new intake & pumping system, desilting, other repairs
- Investment: Around 7 million
- Payback period: > four years
- Low & no investment solutions
  - Stop water over flow by raw & clear water pumps coordination
  - Arresting seepage losses by repairs

# Energy Efficient Street Lighting by Power Savers, Guntur

- A joint project by ICLEI and GMC
- 35 KVA capacity Power Savers at 4 locations
- Average savings in KWH: 25.51%
- Monetary savings: Rs. 82431/Yr
- Total city load: 1100 KVA *(345 Nos. with a range of 1 to 10 KVA)*
- Cost of project: > Rs. 2 Million
- Payback Period: 1.3 yrs
- $eCO_2$ Reduction = 1147 tons per yr

# Energy Management in Street Lighting, Hyderabad

< Energy management thru Power Savers, timers & dimmer technology

< Pilot Project:

- E Consumption at 5 Switch points: 44352 KWH
- Savings in KWH: 19,958 = 45%
- Project Cost: Rs 135,000, Savings: Rs. 55,700
- Payback period – 2 years

< MCH Area:

- Actual Consumption: 30 Million KWH
- Estimated Project Cost: Rs. 100 Million
- Savings: Rs. 69 Million
- Payback period < 2 years

# What Next?

- The importance of Energy Efficiency
- Overwhelming response: > 30 cities
- USAID's response: Extension of 3 more years
- 10 more cities selected
- Project starts in Jan 2004
- Looking for more interactive ways with other LGs

# Energy Characteristics in Water Utilities

# Elements of Typical Utility Electric Bill

- Connection Charge—Fixed
  - Billing and metering
- Demand Charge
  - Max Kw demand (15-minute) for billing period
- Energy Charge
  - Kw-hrs used in billing period
- Power Factor
  - Based on plant average power factor & max demand
- Transformer Charge
  - Reducing primary to secondary (plant) voltage

# Demand Charge

- Utility must provide for peak power consumption in electrical grid
- Charge for the inefficiency of excess capacity online to meet whatever peak occurs
- A major area of potential cost savings

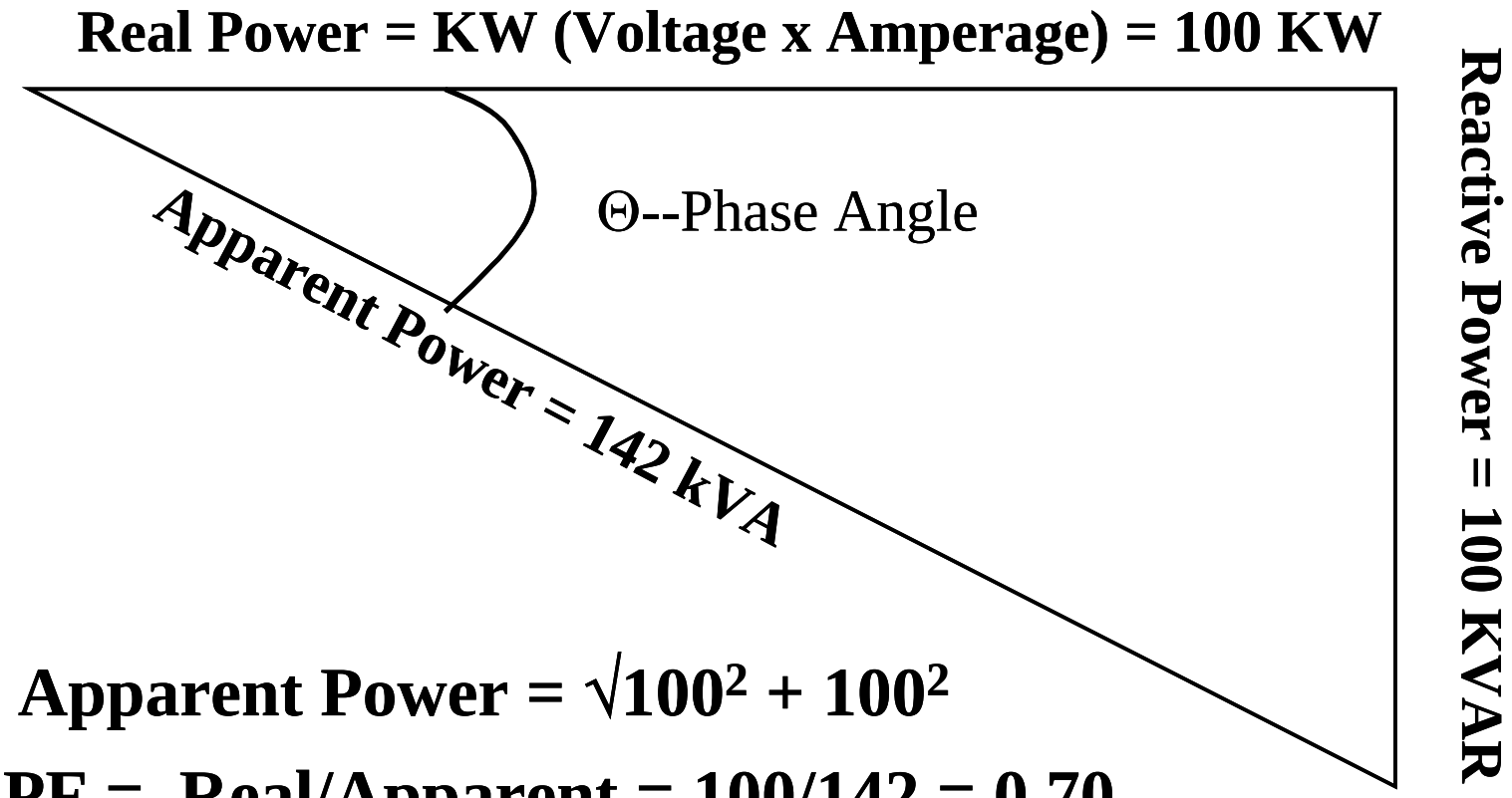
# Energy Charge

- Based on metered usage
  - Total Kw-hrs used/billing period
- Majority of utility's electrical cost contained in this category
- A major source of cost savings

# Power Factor

- Electrical energy has:
  - Real Power—power converted from energy to mechanical energy and lost heat—wattmeter
  - Reactive Power—power stored in inductive and capacitive elements & not used—volts x amps
- Utility must transmit additional energy through its lines and transformers to generate enough real power
- Power Factor = Real Power/Apparent Power

# Power Factor Calculation




**Apparent Power = $\sqrt{100^2 + 100^2}$**

**PF = Real/Apparent = 100/142 = 0.70**

# Power Factor Charge

- Power factor expressed as a decimal less than unity, say 0.92
- Essentially a penalty for low power factor operation
- Characteristic of induction motors usually installed in utilities
- charge can be reduced, but cost:benefit analysis necessary

# Transformer Charge

- Charge to reduce line voltage (115 KV) to plant voltage (5 KV)
- Impact based on demand
- Largely a design issue, probably not a retrofit

# Behavior-Based Tariffs

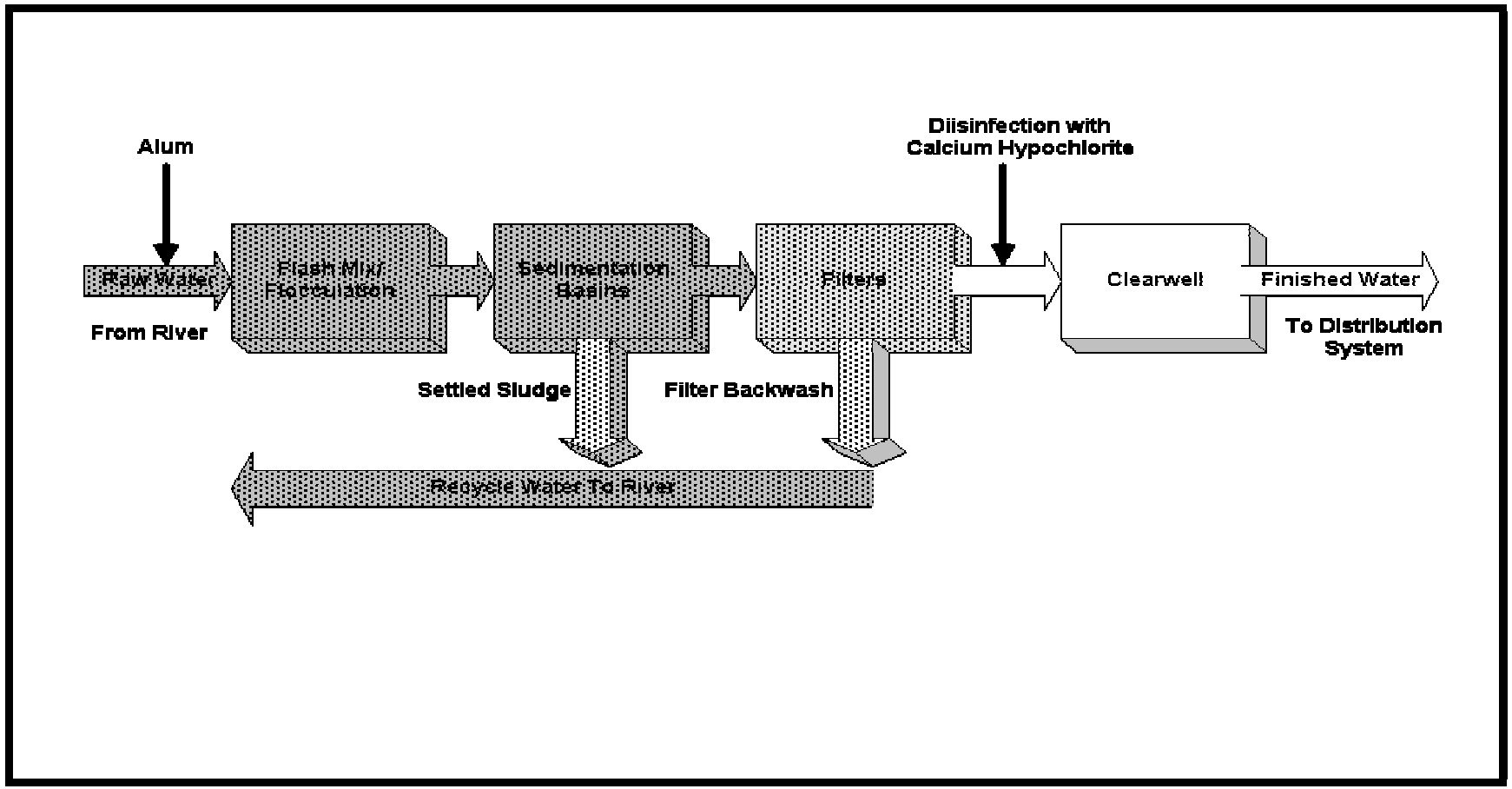
- Time-of-day
  - Lower unit costs for nighttime or weekend usage
- Interruptible
  - Lower unit costs for users able to reduce usage during peak usage periods
  - Usually involves running engine-generator set

# Water Utility Operations

# Typical Water Utility Cost Benchmarks

| Item | Benchmark |
|---|---|
| Labor & Fringes | 25–30% |
| Utilities | 20–30% |
| Chemicals | 10–20% |
| Maintenance & Repair | 10–15% |
| Operating Supplies | 10–12% |

# Typical Water Treatment Plant



# Major Operations and Characteristics

| Usage | Operating Hours Per Day |
|---|---|
| Raw Water Pumping | 8–20 |
| Backwash Pumps | 0.5–3.0 |
| Backwash Blowers | 0.5–3.0 |
| Finished Water Pumping | 8–20 |
| Mixers/Flocculators | 24 |

# Major Energy Cost Contributors and Characteristics

| Usage | Nature of Op'n[1] | Op'n Hours per Day | Impact on Energy Bill |
|---|---|---|---|
| Raw Water Pumping | I→C | 8–20 | Demand, Energy, P.F. |
| Backwash Pumps | I | 0.5–3.0 | Demand, P.F. |
| Backwash Blowers | I | 0.5–3.0 | Demand, P.F. |
| Finished Water Pumping | C | 8–20 | Demand, Energy, P.F. |
| Mixers/Flocculators | I→C | 24 | Energy, P.F. |

# Summary

1. Electrical energy represents a major cost to water utilities

2. Electrical energy cost is based on multiple factors

3. Savings are achievable by focusing on operations

4. Key to savings is to focus on particular tariff structure and operating characteristics

# Watergy

# Taking Advantage of Untapped Energy and Water Efficiency Opportunities in Municipal Water Systems

An USAEP/USAID Initiative
implemented by Alliance to Save Energy in India

Leena Pishe Thomas

# Who is the Alliance to Save Energy ?

- NGO coalition of prominent business, government, environmental, and consumer leaders who promote the efficient and clean use of energy worldwide to benefit the environment, economy, and national security

- Expertise in building, industrial, international, utility, policy, market development, and education

- 52 staff members with programs in U.S., over 30 countries including Russia, Ukraine, Hungary, Romania, Bulgaria, Poland, Ghana, Mexico, Central America, Brazil, Malaysia, Thailand, China, Philippines, Indonesia, Sri Lanka, and India

- Over 70 Alliance Associates

# India Facts

- Energy accounts for 60 percent of the water pumping costs
- Street lighting represents between 10 and 15 percent of a typical Indian municipal budget
- The Confederation of Indian Industry (CII) estimates water utilities have potential to improve water pumping system efficiency by 25 percent
- A study by Sustainable Cities Program indicates energy savings in certain cases of up to 40 percent

# Issue at Hand

Municipalities lack the organizational and technical capacity to effectively manage their energy and water resources.

# Watergy Efficiency

- Take advantage of the synergies that result from co-managing water and energy resources
- Reduce costs (consumer and municipality)
- Cut air pollution
- Improve public health
- Upgrade water and energy service
- Minimize strain on natural resources
- Reduce or eliminate major capital investment

# What is Watergy Efficiency?

**Watergy Efficiency** seeks to cost effectively deliver water services while minimizing water and energy use.

=

**Supply Side Efficiency Measures**

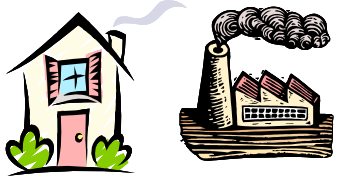
Water supply systems offer multiple opportunities to directly reduce water and energy waste while better serving the customers' needs

- *Leak and Loss Reduction*
- *Operations & Maintenance*
- *Pumping systems*
- *Primary/secondary wastewater treatment*
- *Pump systems*

+

**Demand Side Efficiency Measures**

*Consumers*
*Residential/Industrial*



Reducing demand by helping the consumer use water more efficiently decreases the required water supply saving both energy and water

- *Water efficient household appliances*
- *Low-flow toilets*
- *Low-flow showerheads*
- *Industrial water reuse*
- *Leak and water waste reduction*

+

**Comprehensive Demand Side/Supply Approach Synergies**

Looking at a water system comprehensively and making sure efficiency projects are designed in tandem creates even greater efficiency opportunities

- *Right sizing pump systems after reducing consumer demand*
- *Avoided wastewater treatment by promoting reuse and reducing demand*

# Common Problems Include:

- Leaks
- Low c-value for pipes (high level of friction inside pipes)
- Improper system layout
- System over-design
- Incorrect equipment selection
- Old, outdated equipment
- Poor maintenance
- Waste of usable water

# What Can Municipalities Do To Promote Watergy Efficiency?

- Create management infrastructure (EMC)
- Carry out facility assessments
- Expand water metering and monitoring systems
- Develop baselines and metrics
- Establish goals and benchmark success
- Develop an action plan for addressing waste
- Seek outside assistance
- Mobilize community action
- ***Management and leadership are key***

# Remedies May Involve

- System redesign and retrofitting of equipment
- Pump impeller reduction
- Leak and loss reductions
- Equipment upgrades
- Low-friction pipe
- Efficient pumps
- Adjustable speed drive motors
- Capacitors
- Transformers
- Maintenance and operation practices improvements
- Water reclamation and reuse

# No Cost/Low Cost Measures

- Surrendering of excess contract demand (KVA)
- Improvement of power factor (PF) (0.95)
- Improvement in O&M practices
- Separation of LT & HT load
- Minor rectification in pump
- Leak detection and repair

# Medium-Cost Investment Measures

- Installation of capacitors – Power factor improvement
- Replacement of low efficiency pump set
- Improvement in piping – suction & header
- Installation of energy efficient motors
- Enhancement of contract demand (in case of shortfall)

# What Municipalities Will Get

- More water delivered to consumers
- Saves money/better value for money spent
- Saves energy/extra energy for other usages
- Opportunity for savings: **15–40%** of annual energy cost
- Quick paybacks
- Can help reduce the need for new infrastructure

# Savings Overview

| Location | Annual Saving | | Saving with No Cost Implementation (Rs. Million/Year) | Implementation Cost (Rs. Million) | Average Payback (Year) |
|---|---|---|---|---|---|
| | Energy (Million KWH) | Value (Rs. Million) | | | |
| Bellary | 473 KVA + 1.29 KWH | 6.54 | 1.47 | 4.0 | 0.6 |
| Hubli-Dharwad | 604 KVA + 4.1 KWH | 15.59 | 2.81 | 4.13 | 0.3 |
| Mysore | 879 KVA + 2.45 KWH | 10.6 | 1.43 | 7.64 | 0.7 |
| Tiptur-Arasikere | 148 KVA + 0.37 KWH | 2.08 | 0.61 | 1.04 | 0.5 |
| *Total* | *2,104 KVA 8.21 KWH* | *34.81* | *5.89* | *16.82* | |

# Savings – Mysore

| Mysore | Annual Saving | | Implementation Cost (Rs. Million) | Average Payback (Year) |
|---|---|---|---|---|
| | Energy (KVA/Million KWH) | Value (Rs. Million) | | |
| Installation of single vertical turbine pump | 644 KVA<br>0.7 KWH | 3.84 | 4.4 | 1.15 |
| PF Improvement | 235 KVA<br>0.007 | 0.46 | 0.54 | 1.1 |
| Switching off transformer | 0.0014 | 0.05 | Nil | 0 |
| Replacement of pump | 1.367 | 4.87 | 2.7 | 0.6 |
| Change in operating practice | 0.368 | 1.38 | Marginal | 0 |
| *Total* | *879 KVA*<br>*2.56 KWH* | *10.6* | *16.82* | |

# Financing Options – For Implementing EE Measure

- State funds
- Shared savings agreements
- Performance contracts

# For More Information

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# DAY 2: Energy Efficiency in the Water Sector: Current Practices and Options

## Overview

Day 2 focuses on current options for improved energy efficiency in the water sector and suggests steps that local governments or other levels of government that manage water services can take to ensure that management practices are as efficient and effective as possible. Energy efficiency is about getting the most from operational and capital expenditures.

The day begins with a case study that explores the purpose and benefits of conducting an energy audit. This is followed by other planning and management tools that can be used to improve energy efficiency. After lunch, participants again break into their teams to address inefficiencies in the water service delivery in their workplace or community.

## Day 2 Objectives

- To present tools that can be used for making more informed decisions about and improving the efficiency of water service delivery
- To discuss the purpose and benefits of an energy audit and share examples of how local governments have used it
- To provide an opportunity for participants to identify inefficiencies in their own water system and to discuss how they might begin to address these inefficiencies.

# Trainer's Notes

## 1 hour Opening Session and Group Reports

*Following brief opening remarks, this session provides an opportunity for participants to share the critical issues they identified during yesterday's small group work.*

*The day begins with an opening session, providing an opportunity to review what has already taken place and touch on what will be covered during today's sessions.*

*15 min*

1. Begin by welcoming the group and reviewing what took place at yesterday's session. Ask participants if they have any questions about what they learned yesterday. Next, briefly describe the agenda for the day, introducing the topic and describing the sessions that will follow.

*30 min*

2. Ask a spokesperson from each team to give a brief (5-minute) report highlighting the previous day's small-group activity. Ask teams to share the two or three problems in water service delivery that they have listed on the flip chart and the actions they would propose to address these problems.

*15 min*

3. After all teams have made presentations, discuss similarities and differences. Lead a discussion about the different *types* of actions (managerial, policy, and administrative) that can be taken to improve energy efficiency in local government service delivery in general and in the water sector in particular. Also, encourage participants to share ideas with one another and to ask instructors more specific or focused questions. Leave the flip charts posted for reference as you continue to discuss solutions.

## 45 min Case Presentation: The Energy Audit[7]

*Often, the first step taken to improve energy efficiency is conducting an energy audit. In this session, the purpose and benefits of an energy audit are discussed. A case study of a city that has conducted an energy audit is used to introduce the process and the results that can be expected from an audit. This is followed by a summary of the key components of an effective energy audit.*

[7] In the India course offering, a brief introduction to the topic was made by Terry Driscoll, followed by a case study presentation of Vadodara by Subodh Shah, Executive Engineer for the Municipal Corporation of Vadodara. The case presentation is made in two parts; the second part takes place on Day 4.

*The case presentation is best made by someone familiar with the reason for the audit, the steps that were taken in conducting the audit, how results were used, and lessons learned. The presenter should be asked to prepare a presentation 15-20 minutes long and should be given guidelines that include course and session goals.*

*5 min*

1. Begin with a brief review of the session and its objectives. Explain that you are going to first present basic elements of an energy audit and energy management plan and then hear from how it has been applied in a specific community. Today's case presentation will focus on the audit, and it will be followed on Thursday with a presentation on the management and implementation.

*15 min*

2. Use the overheads entitled "Developing an Energy Management Plan" to lead a discussion of an energy management audit and an energy management plan.[8] (This is a short presentation, meant to lead into the case study. The instructor should work with the case presenter to try to tie the presentations together.) Begin by explaining that the energy management plan should be the key outcome of the energy audit. Then, discuss the key elements of the audit and the steps for conducting such an audit, using water services as an example. Discuss also the economic justification—the costs and benefits—which can be used to emphasize the need for an audit to decision makers. Show how to calculate and demonstrate payback as part of persuading decision makers to conduct an energy audit and implement the recommended strategies for improving energy efficiency.

*20 min*

3. Turn attention to the case presentation. Introduce the presenter, giving his or her name and title, and briefly explain why the city was selected as a case study. Turn the stage over to the presenter for the case presentation.[9] After a brief overview of the city demographics or other pertinent information (e.g., population, people served), the presenter should walk through the process of conducting an energy audit for the city or the water services sector, from the rationale behind and reasons for the energy audit, to the process of deciding how to conduct the audit, to the actual audit itself, to what was done with the information (i.e., how the results were applied to improve efficiency). The presenter should give as much detail as possible.

*5 min*

4. After the presentation, ask for questions from the group. Encourage participants to focus attention on the practical results of the energy audit and on lessons learned from the city's experience.

[8] In the India course offering, Terry Driscoll made this presentation.

[9] For the presentation used in the India offering, see the overheads entitled, "Vadodara's Energy Audit in the Water Sector." This presentation focused on general information; case presentations that focus more on the specific details of an energy audit conducted for a city may be more appropriate for this session.

## 2 hours Presentation: Managing Energy-Efficient Water Services

*The link between efficiently managing existing operating systems and the overall capital improvement plan for that and other services is too often neglected during decision-making sessions on budgets and future investments. This session addresses the day-to-day management issues (operational) and long-term investment planning (capital). The emphasis is on the link between the two.*

*5 min*

1. Begin with a brief overview of the session and the topics that will be addressed. Briefly explain that you will be looking at the capital budget and plan and at the operating budget and day-to-day management to see how the two are interrelated (i.e., the effect that each has on the other). Ask participants to think about their experience with these two types of tools and to think about whether they are clearly linked when making decisions about priority expenditures.

*45 min*

2. Turn attention next to the capital plan. Review the need for and benefits of capital improvement planning, using the overheads entitled "Elements of Typical Facilities Planning Study" as a guide.[10] Emphasize how strategic plans for water services impact other issues, such as health, economic development, and environmental sustainability. Discuss the elements of a feasibility study and how it is used in the facilities planning process. Discuss also the elements that should be included in a capital plan. (You may want to provide an example from a real water facility as a handout.) Conclude with a discussion of implementation. What is involved in the implementation phase of a capital improvements or facilities plan? What are the obstacles? How might these obstacles be overcome? Conclude by reviewing why capital plans are—or should be—linked with other capital plans to ensure compatibility.

*10 min*

3. Allow 10 minutes to respond to questions from participants before turning attention to the operating budget, employee issues, and service regulations, and how these influence decision making about water service. The focus should be on showing how operational factors impact overall efficiency. Give examples to demonstrate how the operating budget, employees, service regulations, and other operational issues can improve—or interfere with—efficiency. For example, having the local government manager or other leader meet with the water management staff to review monthly budget reports can help identify budget irregularities that may reveal any number of problems, from leaks, to problems with billing or collection, to staffing needs.

*45 min*

4. Introduce the topic and define the three elements to be discussed during this part of the session: the budget, employee issues (labor relations, training, cross-training, certification), and service regulations (construction, discharge, tap-in, capacity of system).[11] Follow the overheads entitled "Decision-Making

[10] In the India course offering, Terry Driscoll made this presentation.

[11] In the India course offering, Deborah Kimble made this presentation.

Tools" to further discuss each of these factors. Share examples from the U.S. and the region. In the area of budgeting, for example, a U.S. example can be used to demonstrate how funds for a specific service or utility (water) are segregated from the overall budget (fund accounting) and how accounting and financial reports allow decision makers to see when there is any irregularity, which helps them manage the service.

*10 min*

5. Allow a few minutes to respond to questions and comments from participants. Encourage them to think about how they have used each of the tools you have discussed. Which tools are they most comfortable with? Where might they be able to achieve the greatest improvement?

*5 min*

6. Conclude with a summary of the discussion. Among the points that should be emphasized are the following:

   < Strategic, by definition, means long term. However, most local governments don't have the luxury of time. Build benchmarks into the capital plan.

   < Capital plans that are developed in isolation from one another may stretch a community's resources beyond its capabilities. Capital plans should be coordinated. Linking capital plans for energy efficiency with other capital plans—particularly plans for new facilities or upgrades to existing facilities—can help the city achieve economies of scale.

   < Capital plans should also be tied to operating budgets. It is not enough to build a facility or complete another capital investment project (e.g., building or upgrading the water treatment plant); success depends on being able to manage and maintain it at a high quality level over time. The capital budget should therefore inform the operating budget about ongoing needs and anticipated expenditures.

   < Capital planning, the operating budget, management of employees, and service regulations are among the most powerful tools that can be employed to address any service delivery area.

   < Planning on the local level achieves buy-in and legitimacy among factions of the community.

   < Planning in reality is never as neat as in theory. Be ready to change to accommodate changing circumstances.

   < Be creative. Look for new opportunities to achieve energy efficiency.

## 2½ hours Small-Group Exercise: Current Energy-Efficient Practices, Policies, and Management Activities in My City or Country

*This exercise is designed to give participants, working in teams, an opportunity to apply what they have learned to their own city or country. Participants will work together to identify efficiencies and inefficiencies of the water sector of a particular city, as well as the policy and management practices that support or inhibit better practices.*

*10 min* 1. Break participants into the small groups they were in yesterday. (They will remain together as a team to complete the exercises throughout this course.) Share with them the learning objectives of this session, as listed above. If participants in the group are not all from the same city or other unit of government, tell groups that they will first have to identify the city that they want to focus on for the duration of the course.

*10 min* 2. To begin to focus on their own situation, ask participants to review the questions they were given as homework. They are to use their responses to these questions and the ensuing discussion to first identify a policy objective on which to focus attention for the rest of the course. (Examples might include augmenting the water supply, improving efficiency of the water facilities plant, or minimizing municipal energy costs without compromising quality.) Groups may first want to suggest several objectives, but they should determine the top priority, as this is what they will work on for the rest of the course.

*40 min* 3. When groups have determined their policy objectives, they should turn attention to efficiencies and inefficiencies of the water sector as it relates to this objective. They are to discuss the following questions:[12]

   < What areas are working well? List efficiencies in the water sector in your community today. Include managerial, policy, and administrative aspects that impact water delivery.

   < What areas are in need of improvement? List inefficiencies in the water sector in your community today. Again, include managerial, policy, and administrative aspects.

   < What institutional changes are needed to further benefit from efficiencies or to address inefficiencies you have listed?

   Allow 40 minutes to discuss these three questions.

[12] Write these on a flip chart or handout.

*30 min*

4. Ask groups to prepare a presentation for the entire class. Groups should be prepared to discuss the following:

   < The city on which it is focusing

   < The primary policy objective it has identified

   < The efficiencies and inefficiencies of the water sector

   < The institutional changes the group would recommend.

   Teams should use a flip chart and markers to share key points they plan to present.

*50 min*

5. Ask each group to give a report on its findings. A spokesperson from each group should share with the rest of the class its primary policy objective, the efficiencies and inefficiencies it has identified, and institutional changes it believes are needed to address inconsistencies. After each group's report, instructors should give feedback on the group's work, focusing particular attention on the strategies for improvement that the group has presented and other strategies that might be effective.

*10 min*

6. Wrap up with a summary of the discussion. Ask for questions or comments from the group regarding the exercise and the work of the groups. Conclude by looking ahead to how these activities will build toward a more extensive group report on the last day of the course.

# Handout: **Audit Forms**

| Utility | AUDIT FORM 1: ENERGY INPUT DATA | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| | **Production** | **Electricity Used** | | | **Fuel Oil Used** | | | **Natural Gas Used** | | | **Total Energy Cost** | |
| **Month** | **Cu M/Mo (000)** | **KWH (000)** | **Cost (000)** | **Cost/ KWH** | **L (000)** | **Cost (000)** | **Cost/L (000)** | **Cu M (000)** | **Cost (000)** | **Cost/ Cu M (000)** | **Total Cost (000)** | **Total Cost/ Cu M Water Produced** |
| Jan | | | | | | | | | | | | |
| Feb | | | | | | | | | | | | |
| Mar | | | | | | | | | | | | |
| Apr | | | | | | | | | | | | |
| May | | | | | | | | | | | | |
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| Sept | | | | | | | | | | | | |
| Oct | | | | | | | | | | | | |
| Nov | | | | | | | | | | | | |
| Dec | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Total Or Avg** | | | | | | | | | | | | |

| Utility | AUDIT FORM 2: ELECTRIC POWER DATA | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| **Month** | **KWH Used (000)** | **Measured Demand, KW (000)** | **Billing Demand, KW (000)** | **Apparent Power, KVA** | **Power Factor** | **Connection Charge (000)** | **Energy Charge (000)** | **Demand Charge (000)** | **Other (000)** | **Total Charge (000)** | **Total Cost (000)** | **Avg Cost / KWH** |
| Jan | | | | | | | | | | | | |
| Feb | | | | | | | | | | | | |
| Mar | | | | | | | | | | | | |
| Apr | | | | | | | | | | | | |
| May | | | | | | | | | | | | |
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| Nov | | | | | | | | | | | | |
| Dec | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Total Yearly** | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| **Monthly Avg** | | | | | | | | | | | | |

| Utility | AUDIT FORM 3: ELECTRIC EQUIPMENT LOAD SURVEY | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| | | | Estimated Load | | | | | | |
| Load | No of Units | Units In Service | Rated KW | % Load | Est KW | Estimated Run Time Per Day, Hrs | Est KW-HR Per Day (000) | Est KW-HR Per Month (000) | Avg Cost / Month (000) |
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AUDIT FORM 4 : WALK THROUGH AUDIT

Operating Unit _____ Date _____

Area _____ Preparer _____

1a. Functions in this plant area:

1b. Are these functions necessary:

---

2. Energy users in this area:

a. Process:

b. Lighting:

c. HVAC:

---

3. Unnecessary Equipment:

a: Process:

b. Worker comfort and safety:

---

4a. Area SOPs:

b. Are they being followed:

---

5. Equipment Use (periods)/ Exercise Schedule:

---

6. Standby Equipment/ Exercise Schedule:

---

7. Energy Conservation Ideas:

AUDIT FORM 5 : AUDIT ANALYSIS

Operating Unit _____ Date _____

Area _____ Preparer _____

Energy Conservation Idea:

---

Advantages:

---

Disadvantages:

---

Effects on Operation:

---

Capital Cost Calculation:

---

Operating Cost Calculation:

---

Energy Savings Calculation:

---

Summary

**Capital Costs (1)** _____

**Annual Energy Savings (2)** _____

**Add'l Operating Cost Savings (3)** _____

**Annual Savings (4) (2 –3)** _____

**Payback Period (1) / (4)** _____

AUDIT FORM 5 : AUDIT ANALYSIS—SAMPLE PAYBACK

Operating Unit _____ Date _____

Area _____ Preparer _____

Energy Conservation Idea: *Install Capacitors on Finished Water Pumps*

---

Advantages:

---

Disadvantages:

---

Effects on Operation:

---

Capital Cost Calculation: Capacitors (5) @ $15,000 = $75,000

---

Operating Cost Calculation: Power Factor Cost = $50,000 / Year

---

Energy Savings Calculation: Power Factor Cost Savings = $15,000 / Year

---

Summary

| | |
|---|---|
| **Capital Costs (1)** | **$75,000** |
| **Annual Energy Savings (2)** | **$15,000** |
| **Add'l Operating Cost Savings (3)** | **0** |
| **Annual Savings (4) (2 –3)** | **$15,000** |
| **Payback Period (1) / (4)** | **5.0** |

| Utility | AUDIT FORM 6: RECOMMENDATIONS | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| **No** | **Idea** | **Capital Cost (000)** | **Additional Operating Cost (000)/Year** | **Energy Savings (000)/Year** | **Payback, Years** | **Recommend?** |
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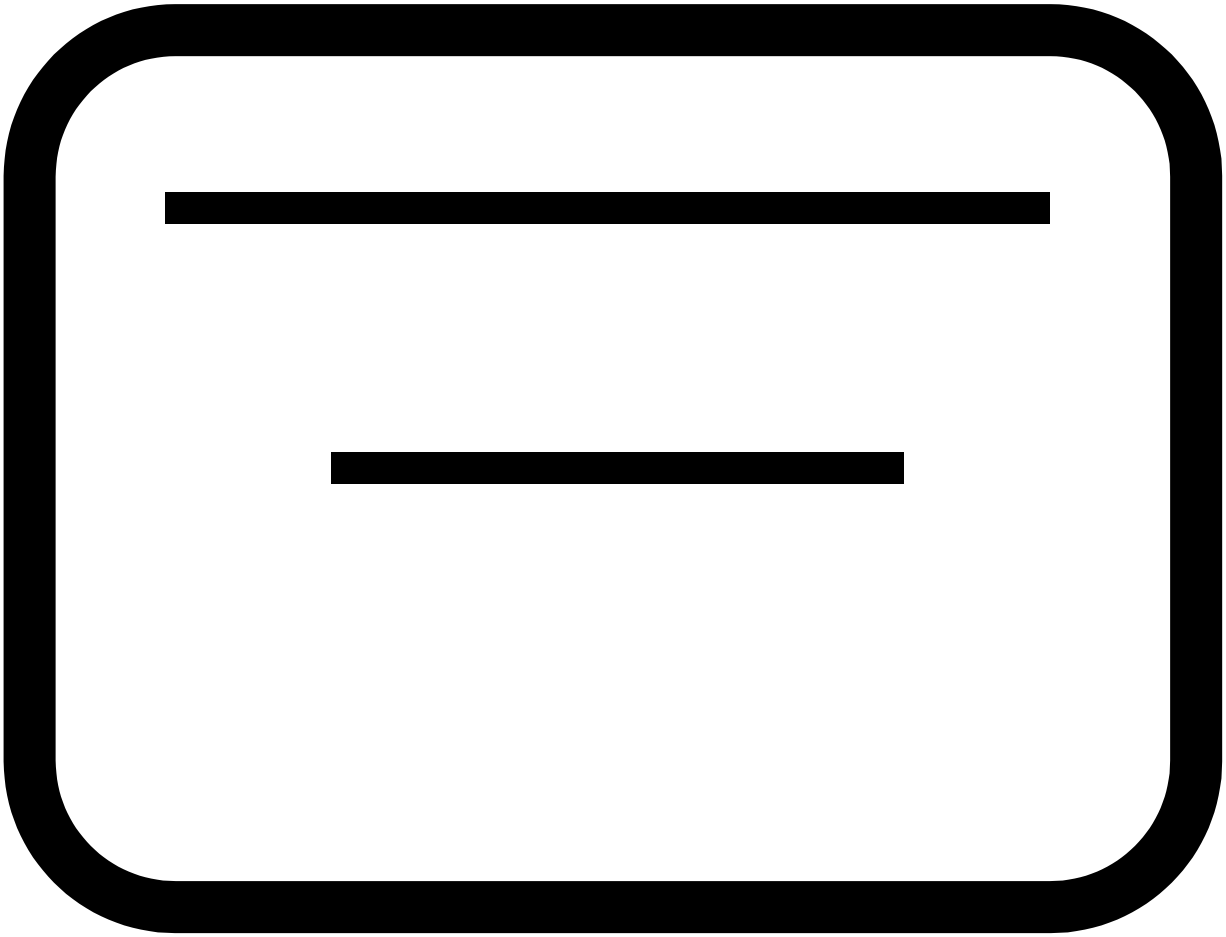
# Overheads



# Developing an Energy Management Plan

# Energy Management Plan

- Formalized Plan Designed To Optimize Energy Usage *While Maintaining Quality Standards*
- Focuses on Changes To Current Operations
  - Operations
  - Process
  - Equipment Replacement

# Steps to Energy Management

< Energy Audit

< Energy Management Plan

# Energy Audit

Systematic Effort To:

< Determine Overall Types, Sources, Amounts and Costs of Energy Used

< Determine Energy Use of Various Processes and Support Systems

< Identify Measures to Reduce Energy Expenses

< Analyze Economic Payback of Proposed Measures

< Recommend Promising Measures for Implementation

# Energy Audit Steps

1. Energy Inventory

2. Walk-through Audit

3. Detailed Audit

4. Technical Assistance

5. Recommendations

# Step 1: Energy Inventory

- Determine Types, Amounts, and Costs of Energy Delivered To Utility
- Compile Historical Energy Usage For 1–3 Years
- Compile List of Energy-Consuming Equipment
- See Audit Forms 1–3

# Step 2: Walk Through Audit

- Area-By-Area Tour of Facilities
- Starts at Control Room and Moves As Flow Through the Plant
- Team of 2–4 Auditors
- Single Walkthrough: ≅ 2–4 Hours
- Perform for Each Shift?
- See Audit Form 4

# Step 3: Detailed Audit

- More Detailed Evaluation of Energy Consuming Processes
- Identify and Analyze Energy Conservation Measures With Regard To:
  - Operational Changes
  - Process Modifications
  - Equipment Replacement

# Operational Changes

< Reduce Outside Lighting Levels

< Relamp Lights With Fluorescent Bulbs

# Economic Justification: Calculating Payback

- See Audit Form 5
- Identify Most Promising Ideas
- Prepare Capital and Operating Costs
- Quantify Benefits of Proposed Measure
- Determine or Identify Payback Hurdle
  - Payback Period (Months or Years)
  - Return on Investment

# Economic Justification: Calculating Payback (cont'd)

- Select Those Measures With Most Impact on Energy Cost and Quickest Payback
- Use Net Present Value to Calculate Costs of Those Measures With Multi-Year Paybacks
- Use Discount Rate = Weighted Average Cost of Capital

# Weighted Average Cost of Capital (WACC)—Calculation

< WACC = Blend of Average Debt Costs and Return on Equity

< Example:

  – Average Interest Rate of Debt = 10%

  – Debt = USD 12 Million

  – Average Return on Equity = 18%

  – Equity = USD 6 Million

# Weighted Average Cost of Capital (WACC)—Calculation

$$WACC = \underset{\text{Debt}}{[12/18]*10\%} + \underset{\text{Equity}}{[6/18]*18\%}$$

$$WACC = 6.7\% + 6\% = \underline{12.7\%}$$

# Vadodara's Energy Audit in the Water Sector

## *Methodology for Energy Audit & Conservation of Energy*

Subodh Shah,
Executive Engineer (Electrical)
Vadodara Municipal Corporation

# Energy Audit in the Water Sector

- Electricity is a scarce and costly commodity.
- All possible steps need to be identified and adopted to conserve energy and reduce energy costs.
- On average, water & wastewater services consume 12% to 15% of budgetary provisions to pay electricity bills in ULB.
- If ULBs in developing countries are made energy efficient, it will help to reduce the financial burden of ULB and the impact on the environment globally.

# Electricity Generation

- Thermal 75%
- Hydroelectricity 20%
- Nuclear & Other 05%

# Why Energy Conversion?

- Efficiency of thermal generation: 30-35%.
- One unit of electricity is produced by consuming three units of primary fuels.
- Transmission & distribution losses: 20–25%.
- One unit of electricity at user point requires three units of primary fuels.

# Why Energy Conversion? (cont'd)

- Setting up power stations costs Rs. 30 to 40 million per MW
- Transmission and distribution adds 50 to 60% of these costs.
- Conservation projects to save electricity is less expensive.
- Construction time for a power station is 5 to 10 years.
- Conservation projects can be set up in 1/2 to 3 years.

# Approach to Energy Audit

The strategy to be adopted in management of energy is:

< Conduct a thorough and in-depth energy audit.

< Implement measures for conservation of energy.

# Scope of Energy Audit

< Actual energy consumption.

< Calculated energy consumption

< Conducting performance test.

  – The higher the difference between actual & calculated energy consumptions, the more follow up action is required.

< Identifying inefficient operation & wastage.

< Identifying solutions and actions.

< Carrying out economical analysis of costs involved.

< Checking whether operating point is near best-efficiency point.

< Possibility of immediate improvement.

# Broad Review

- *C*-value of transmission main.
- Diameter of transmission main.
- Specified duty point for pump and operating range.
- Suitability of pump for the duty conditions.
- Suitability of ratings and sizes of motor, cable, transformer, and other electrical appliances.

# Study and Verification of Energy Consumption

< Examine a few electric bills.

< Examine log books of pumping operation to obtain data:

  – Total pump hours of individual pump sets.

  – Average daily pump hours.

< Calculate output of transformer for different load combinations.

< Cumulative input to motors divided by number of pump-sets operating in the combination shall give average input to motor.

< Calculate average input to pump.

# Study and Verification of Energy Consumption (cont'd)

- Hydraulic conditions for various combinations of pumps operating simultaneously.
- Operate each pump at the total head for each operating condition by throttling delivery valve and generating required head.
- Calculate average input to the pump for each operating condition by taking appropriate pump efficiency as per characteristic curves.
- If difference between average inputs to pumps for different working combinations are within 5% -7%, the performance can be concluded as satisfactory and energy efficient.
- If the difference is beyond limit, detailed investigation for reduction in efficiency of the pump is necessary.

# Example:
# Pump Running at Different Duty Conditions Than Design

# Specific Points

- Only one pump-motor set shall be tested at a time.
- All gauges and test instruments shall be calibrated.
- Rated head shall be generated by throttling valve on pump delivery.
- Efficiency of motor shall be as per the manufacturer's curve or type test certificate.
- Water level in the sump/make shall be maintained practically constant and should be measured frequently (once every 3-5 minutes).
- Test should be conducted for sufficient duration (about 30-60 minutes) for better accuracy.

# Test Gauges and Instruments

The following test gauges and instruments are required for a performance test:

< Determination of head (H):

  – Digital pressure & vacuum gauge (calibrated & highly accurate)

< Determination of discharge (Q):

  – Ultrasonic flow meter

< Power input to motor in Kw:

  – Digital instrument(s) capable of measuring all electrical parameters

# Measures for Conservation of Energy

- Routine measures
- Periodical measures
- Selection aspects
- Measures for system improvement
- It is most important to check operating parameters immediately after pump installation of pump/equipment to take immediate corrective measures, if required

# Study and Verification of Energy Consumption

- Examine a few electric bills to calculate average daily consumption in KWH.
- Examine log books to calculate average daily pumping hours.
- Calculate mean system kW drawn per pump set.
- Calculate output of transformer for loads of different combinations of pumps.
- Cumulative input to motors divided by number of pump-sets operating in the combination shall give average power input to motor.
- Depending on efficiency of motor, calculate average input to pump.

# Study and Verification of Energy Consumption (cont'd)

- Simulate hydraulic conditions for various combinations of pump sets operating simultaneously.
- Take separate readings of:
  - –suction and delivery head by vacuum and pressure gauges
  - –water level in sump/well by operating normal number of pumps.
- Calculate total head for each operating condition.
- Operate each pump at the total head for each operating condition by throttling delivery valve and generating required head.
- Calculate average input to the pump for each operating condition.
- Take appropriate pump efficiency from characteristic curves.

# Improving Power Factor to 0.98

- As per rule of power supply authority, average power factor (p.f.) of 0.9 is to be maintained.

- If average p.f. is less than 0.9, penalty at rate of 0.5% of bill per 1% shortfall in p.f. is charged. (Penalty will be as per tariff of power supply company.)

# Other Measures of Energy Savings

- Operation of working and standby transformer.
- Reduction of static head (suction side) by maintaining at or marginally below full sump level (FSL).
- Keep strainer or foot valve clean and silt free.
- Prevent throttling operation of pump.
- Replacement of existing mercury vapour lamps by sodium vapour lamps.

# Comparison of Design and Operating Parameters of Pumps

| | P-1 | P-2 | P-3 |
|---|---|---|---|
| Design Parameters of Pump set | | | |
| Power in KW | | | |
| Head in Meter | | | |
| Discharge in KL/mi | | | |
| Efficiency | | | |
| Operating Parameters | | | |
| Power in KW | | | |
| Head in Meter | | | |
| Discharge in KL/mi | | | |
| Efficiency | | | |
| Daily average Operating Hours | | | |

Operating parameters shall be measured immediately after replacement or refurbishment.

# Saving Potential by Studying Electric Bill

| | |
|---|---|
| **Average Daily Consumption in KWH** | |
| **Average Monthly Consumption in KWH** | |
| **System P. F.** | |
| **Maximum Demand (80% of Contract Demand)** | |
| **Billing Demand (KVA)** | |
| **Contract Demand (KVA)** | |
| **Saving Potential** | |

# Data Collection: Delivery Main

| | |
|---|---|
| **Diameter of delivery header & 'C' value.** | |
| **Type &size of valves delivery header.** | |
| **Layout of Delivery Main (in brief Age, Condition, Valves 'C' value etc.** | |
| | |

# Evaluation of Demand, Cost Involved, and Payback Period

| | | |
|---|---|---|
| **A** | **Evaluate Existing Demand** | |
| **B** | **If Demand increased select suitable discharge & Head for new Pump** | |
| **C** | **If Discharge increases beyond the capacity of existing Header main than suggest replacement of header main with suitable diameter** | |
| **D** | **EVALUATE DETAILED COST** | |
| | **Necessary switchgear, Pump-motor set & starter cabling, Deliver Header (if required)** | |
| **E** | **EVALUATE ANNUAL SAVING POTENTIAL IN KWH** | |
| **F** | **PAYBACK PERIOD** | |
| **G** | **ENERGY COST KWH / Kl** | |

# Elements of Typical Facilities Planning Study

# Need For Facilities Planning Study

- Determine Level of Unmet Needs (Demand)
- Establish Outlines of Needed Project
- Consider Alternatives—Find Most Cost Effective Project
- Consider Environmental Effects of Project
- Project Final Costs and Tariff to Customers
- Determine Affordability (Feasibility) of Project
- How Can Project Be Financed
  - From Tariffs
  - Government Guarantee

# Feasibility Study

- Provides Public Sector Officials With Preliminary Answers
- Provides for Planning of Capital Needs
- Provides Designer/Contractor With Idea of Project Scope

# Introduction

- Project Background
- General Services Required
- Previous Studies

# Existing Conditions

- Definition of Service Area
- Existing Water Infrastructure
- Existing Infrastructure—Other
- Site Data
  - Tie-In to Existing System
  - Location of Utilities
  - Soils and Foundations
  - Topography
  - Roads

# Demand Projections

- Population Growth and Usage
- Commercial Demand
- Industrial Demand
- Demand Outside Service Area

# Quality Standards

- Level of Service Provided
- Applicable Regulations and Codes

# Water Treatment and Distribution Alternatives

- Methods of Treatment
- Routes of Transmission Lines
- Environmental Impact of Alternatives
- Life Cycle Cost Analysis of Alternatives
  - Capital Costs
  - Annual Operating Costs
  - Present Value of Costs
- Phasing of Project

# Present Value Analysis

Alternative 1

- Initial Capital Cost = $75 Million
- Annual Operating Cost = $5 Million

Alternative 2

- Initial Capital Cost = $50 Million
- Additional Capital Cost (10 Years) = $20 Million
- Annual Operating Cost = $8 Million

# Present Value Analysis

| Alternative 1 | |
|---|---|
| PV of Capital = | 75.0 M |
| PV of O&M = | 45.4 M |
| Total PV = | 120.4 M |

| Alternative 2 | |
|---|---|
| PV of Capital = | 50.0 M |
| PV of Later Cap = | 7.7 M |
| PV of O&M = | 72.6 M |
| Total PV = | 130.3 M |

SELECT ALTERNATIVE 1: LOWEST PRESENT VALUE

# Recommended Plan

- Detailed Description of Project
- Capital Cost Estimate
- Annual Operations & Maintenance Costs
- Projected Cash Needs
- Proposed Tariff Structure
- Affordability Determination

# Project Permitting/Agreements

- Identify Necessary Permits For Project
- Ministry Approvals
- Determine Existing Agreements That Apply
- Determine Additional Agreements To Be Executed

# Project Implementation

- Listing of Necessary Documents
  - Contract
  - Bid Documents
- Suggested Procurement Method
  - Prequalify?
  - Restrict Number of Bidders?
  - How Many Envelopes?
- Schedule of Events

# Implementation Schedule

- Invitation To Prequalify
- Prequalification Period
- Invitation To Bid
- Pre-Bid Conference
- Bid Preparation Period
- Bid Evaluation
- Bid Award
- Final Negotiation and Award

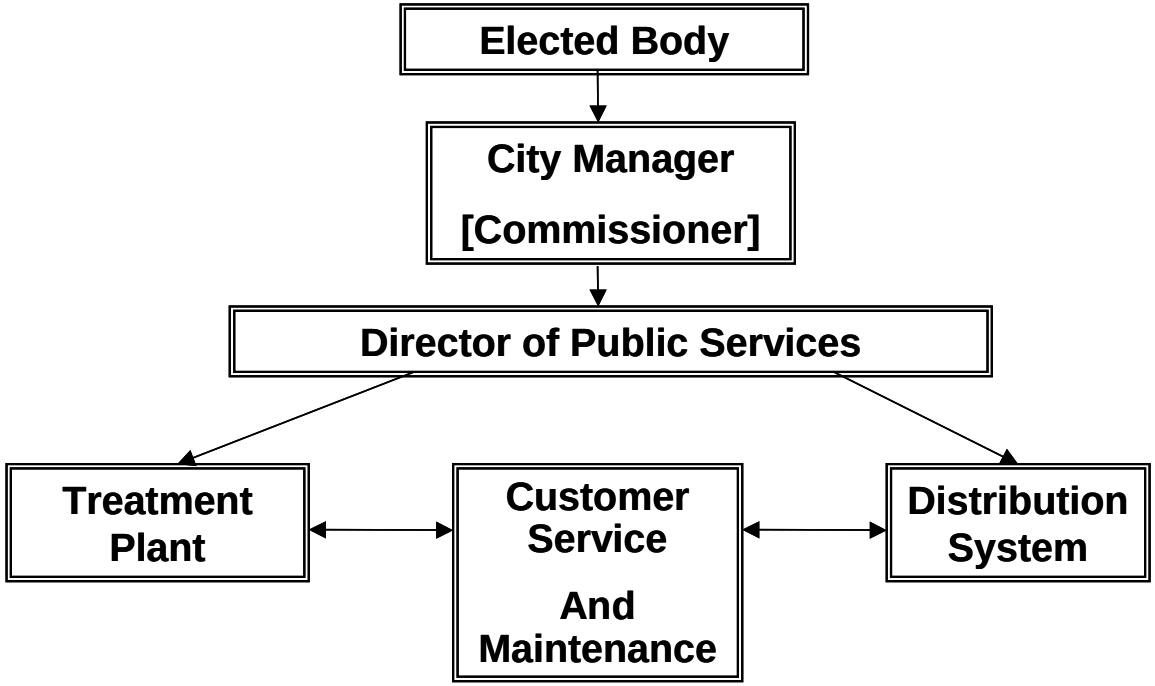
# Typical Annexes

- Site Photos
- Applicable Standards
- Financial Analysis Model
- Sample Agreements
- Existing Tariff Schedule

# Decision-Making Tools

Budget
Employee Incentives
Service Regulations

# Organizational Structure



# Sample Local Budget[13]

## Key Factors

< Revenue & Expenditures

< Accountability

< Transparency

< Performance

[13] The presenter should use a current budget from a full-service city or a city that has water services to demonstrate the key point about using the budget as a management tool to improve overall operations as well as energy efficiency and quality of water service.

# Employee Incentives:
# Changing Work Habits

- Working conditions
- Training
- Performance
- Certifications
- Compensation

# Service Regulations

- Ordinances
- Ready-To-Serve Fees
- Excavation and Connection Permits
- Shut-Off Policies

# DAY 3: Current Energy-Saving Practices in the Water Sector

## Overview

Day 3 is devoted to applying the principles and concepts covered thus far to a real-life situation through a visit to a water facility where significant improvements in energy efficiency have been made. The site visit may focus on policies, management practices, technology, and other improvements that have influenced energy efficiency. Through the visit to a water facility, this session provides participants with concrete and detailed information about the problems that were addressed, the action steps taken, and the results achieved.

The site visit not only serves as an alternative way to present a case study, it also provides an opportunity for participants to see service delivery in action. In the India course offering, the site visit was made to the pumping station and water treatment plant in Bangalore. In Mexico, participants visited water operations in Tlalnepantla and Cuautitlan.

Following the site visit, there will be a debriefing session to review the lessons learned and to relate the visit back to the course content.

## Day 3 Objectives

- To present a real case showing how tools have been applied to improve energy efficiency in the water sector
- To provide an opportunity for participants to see water operations in action and to ask questions of practitioners—those who have implemented improvements in water services
- To help participants link theory with practice.

# Trainer's Notes

## ¾ hour — Group Discussion: Preparing for the Site Visit

*The day begins with a session designed to help participants prepare for the site visit. It is often helpful for the course facilitator and/or instructors to work with the person who will be planning and leading the site visit in developing a check-list of things participants should look for or questions they may want to ask.*

*10 min*

1. Begin with an overview of the day's activities. Explain where you are going on the site visit and what you hope to accomplish. Ask for a show of hands of those who have been to the facility you are visiting today. Then ask for a show of hands of those who have visited water operations in another place. To get the discussion started, ask those who have been to water operations what most impressed them (good or bad). What will they be most interested in seeing during this trip? (If this generates a good discussion, you may want to list responses on the flip chart.)

*20 min*

2. Ask participants to pair up with a neighbor. Working in pairs, participants are to come up with two or three questions that will help them learn more about energy efficient practices and results. What do they most want to learn about the energy efficiency of this facility?

*15 min*

3. Convene the group, and ask for a few volunteers to share their questions. Distribute a checklist or other questions prepared for this purpose.

## 5 hours — Site Visit: Observing the Realities

*After a short overview and exercise designed to prepare participants for the site visit, participants take a tour of the selected facility, listen to the story of the energy efficiency measures that have been implemented, and hear about the results (i.e., the benefits that improvements have had for the facility, the local government, and customers).*

*4½ hours*

1. Participants visit the selected site, where they learn about energy-efficiency practices and other improvements that have been implemented and their results. Participants should also use the checklists and questions prepared for this session to ask questions of local government employees.

*25 min*

2. Upon returning to the classroom, debrief participants regarding their experiences. Ask participants to share with you one of the questions they prepared before the visit and the answer to this question. Raise the following questions:

- What did you learn about water operations and services?
- What most impressed you about the facility you visited? What (if anything) was unique?
- How did the city's (facility's) approach to improving energy efficiency relate to the approaches learned over the last couple of days? Did the city undertake an energy audit? How did the city justify the investment of resources into an energy audit or implementing the improvements?
- How did the energy efficiency measures accommodate the priorities and needs of the city, the facility, and customers?
- What needs were met? What results were achieved?
- Based on this example, what are the keys to the implementation of energy efficiency measures?
- What strategies, tools, or techniques you witnessed today could you apply to improve energy efficiency in your community or country? What other types of lessons learned might you be able to apply to your own situation?

*5 min* 3. Conclude with a summary of the discussion.

# Day 4: **Putting It All Together**

## Overview

On Day 4, sessions review the various options for energy efficiency in the water sector that have been discussed and begin to focus on the costs (e.g., capital investment, staff time) and benefits (e.g., cost savings, quality improvements, increased service area) of various approaches. Following a case study that is used to share how energy-efficient policies and programs can be implemented, sessions review and summarize the various energy efficiency opportunities that exist in the water sector (and elsewhere), with particular emphasis on the role the local government plays in identifying and implementing energy-efficient strategies.[14]

Attention then turns to applying the information learned during the course. The first session of the afternoon is designed to provide guidance to teams as they formulate a strategy for their own community and country, focusing particular attention on how to measure performance and who should be involved in implementing energy efficiency practices. The day concludes with a team exercise in which teams outline the various actions to be taken to improve energy efficiency in their own communities or countries and the resources that are needed. Teams prepare for reports to be made the following day.

## Day 4 Objectives

- To review implementation steps and learn how one community implemented the recommendations following an energy audit
- To review energy efficiency opportunities that may exist in the water sector
- To introduce benchmarking for performance measurement and connect performance measurement to improvement in the water sector
- To discuss financing options
- To encourage participants to identify ways in which they will use the tools introduced in this course to begin to address the problems of their water systems.

[14] It is often important to modify plans to accommodate the needs of participants. In the initial course offering in India, for example, sessions on "Financing Options" and "Forms of PSP Transactions" were not offered. In their place were presentations on "Calculating Payback on Energy-Saving Measures" and "Prequalification and Tendering Process." Although there are no talking points or guidelines for presenting these changes, the overheads are included to help course planners incorporate these topics into future offerings.

# Trainer's Notes

**1 hour** **Case Presentation: Putting into Action Energy-Efficient Policies and Programs**

*Following opening remarks and an overview of the day, a guest presenter shares how strategies were implemented following an energy audit. For continuity, this session may focus on the same city as the case study on Day 2, so that the implementation directly follows the audit. (This was the approach taken in the Fall 2003 offerings.) The presenter should be asked to prepare a presentation 20-25 minutes long and given guidelines that include course goals and learning objectives for this session.*

*10 min*

1. Begin with a review of the previous day's site visit. Ask participants if they have any questions about what was learned during the site visit or on the previous two days. (If you have a question "parking lot" where participants have posted written questions, answer these at this time.) Give a brief overview of today's sessions, focusing on how they follow from what has already taken place during the course.

*25 min*

2. Turn attention to the case presentation. If the case presentation focuses on a different city than the Day 2 case study, introduce the presenter and briefly explain why this site was selected as a case study. If it focuses on the same city, briefly review the topic of the Day 2 presentation and the topic of today's presentation. Turn the floor over to the guest presenter. The case study presenter should spend 20–25 minutes discussing the implementation phase of energy efficiency improvement. The presentation should focus on how the local government applied the results of the energy audit, what steps were taken to make improvements, and what outcomes resulted from implementing energy efficiency measures.[15] As always, the presentation should be as specific as possible, linking specific problems found during the energy audit to specific actions taken and specific results.

*15 min*

3. After the presentation, ask for questions from the group. Encourage participants to focus attention on the practical results of the energy efficiency measures and on lessons learned from the city's experience.

[15] The overheads used during the course offering in India are entitled "Improving Energy Efficiency in Water Service, Vadodara." During this course, the presenter also introduced energy efficiency measures taken in the city's street lighting, as participants had expressed interest in learning more about this topic. This is an example of how to modify a course to address the needs and interests of participants and to make the most of the expertise of instructors and presenters.

*10 min*

4. Conclude with a summary of the discussion. Raise the following questions:

   < What factors contributed to the city's success in implementing energy efficiency measures?

   < What steps did the city take to measure its success?

   < What, if anything, would you do differently in implementing energy efficiency strategies in your community?

## 3 hours Presentation: Opportunities for Improving Energy Efficiency (Supply Side and Demand Side)

*Having introduced energy efficiency policies and practices in general, this session provides more specific and concrete information about what is needed. The session is broken into four major parts: benchmarking for performance measurement, consumption modeling, public information and communication, and financing options. Ample opportunities for questions and group discussion should be factored in to break up the time participants spend listening and taking in new information. A 15-minute break should also be scheduled between two of the four parts. In the India course offering, different instructors were responsible for presenting the different parts, which also helps break up the session.*[16]

*45 min*

1. Begin with a general overview of the topics of this session, explaining how they fit together. Then turn attention to the first topic: benchmarking for performance measurement. Explain that those wishing to implement energy efficiencies must understand operating conditions, be able to develop baseline measures, and have the ability and willingness to continually measure and improve practices. Begin by emphasizing the value and benefits of performance measurement. Use the overheads entitled "Performance Measurement" to review the steps taken to identify appropriate performance measures and establish benchmarks. Be sure to point out that it is essential for performance measures and benchmarks to focus on the outcomes and results you hope to achieve.

*15 min*

2. The second topic covered during this session is consumption modeling. Briefly, this seeks to answer the question, "How do you determine rates of use and plan for the future in order to meet community needs?" Begin by asking participants how rates are (or have been) determined in their own localities. Raise the following questions: What information is needed? How often are rates reviewed? How does the locality account for projected changes in population or needs?

[16] In the India course offering, Deborah Kimble presented the sections on benchmarking for performance measurement and public information and communication; Terry Driscoll presented the sections on consumption modeling and financing options.

*30 min*

3. Continue the presentation by explaining that this is one of the most difficult—and important—aspects of realizing gains in efficiency in service delivery. Modeling is key to success. Defining modeling and explain how it is used for energy consumption in the water sector. Use the overheads entitled, "Modeling for Energy Consumption in Water Utilities" to show what is needed to estimate energy requirements for various aspects of the water treatment and delivery system.

*15 min*

4. The next part of this presentation focuses on the importance of public communication. Begin by asking participants to think about their own public information and communication methods. How are customers informed of changes in service delivery or rates? Do citizens understand how decisions about rates and other issues are made? Are they concerned about efficiencies or inefficiencies? Why or why not?

*30 min*

5. Discussion of public information continues by focusing on the importance of effective public information activities. Involving citizens in efforts to save energy and conserving water is essential to energy efficiency. Give examples of how educating citizens about the need for water conservation has affected the utility's expenditures and/or bottom line. Turn next to the issue of citizen education. What strategies can be used to educate citizens about the city's goals for energy efficiency improvements? (See the overheads entitled "Public Information.")

*45 min*

6. The final topic covered in this session is financing. Use the overheads entitled "Financing Options for Water Utilities" to lead a discussion of the problems faced by municipalities in developing countries, the solutions that are needed, and how these solutions can be paid for. Review "traditional" funding sources, and the problems or limitations of these sources. Emphasize the need to be innovative in exploring ways to finance improvements. Link the discussion to any of the case presentations that have been made during the course—how did the cities mentioned in these case studies pay for an energy audit and/or the implementation of energy efficiency improvements? Emphasize that over time such improvements will pay for themselves; it is critical to demonstrate that an initial investment will save money over time. Point out also that it is essential to link capital financing with operations and management. Ongoing maintenance and management needs and expenditures should be identified at the outset of the program to ensure that there is sufficient funding. Establishing the link between capital financing and operations makes it possible to both manage the funds and repay the loans.

## 1½ hours Presentation: Opportunities for Improving Energy Efficiency in Private Sector Participation

*This session is designed to provide guidance to participants in formulating a strategy for their community or country. Discussion focuses on activities that can*

*influence the supply and demand of energy in the water sector over both the short and longer terms. The presentation focuses on the importance of setting clear goals and objectives and on identifying measurement tools for assessing progress. Finally, the session focuses on the people who might be involved on an energy efficiency management team.*

*5 min* 1. Begin by introducing the session and explaining how it is linked to the team action planning and reports that will follow.

*15 min* 2. Begin the discussion by asking participants to list energy efficiency practices, policies, and activities on the *supply* side. As participants give responses, list them on the flip chart under the heading "Supply." Then, ask participants to list energy efficiency practices, policies, and activities that affect *demand.* List these under the heading "Demand."

*45 min* 3. Turn attention to issues related to private sector participation (PSP). Use the overheads entitled "Forms of PSP Transactions" to discuss various energy efficiency options, adding to what has already been discussed thus far. Discuss facility design and improvements and on the contracting process, focusing attention on the advantages and disadvantages of various alternatives.

*10 min* 4. Ask for questions from the group. Use participants' questions to lead a discussion of any experiences participants have had with building or improving capital buildings.

*10 min* 5. Turn attention to the people who are involved in energy efficiency improvement in the water sector. Begin by asking participants who should be involved in leading an energy efficiency initiative. Raise the following questions:

- Who will be involved in making decisions about conducting an energy audit?
- Who will be involved in implementing recommendations that come from the energy audit?

List responses on the flip chart. Responses should include municipal elected officials, local government managers, the utility manager, financial institutions, etc. What role does each of these people play in ensuring success?

*5 min* 6. Conclude with a summary of the discussion. Emphasize that because each community is different—has different problems, needs, and resources—the solution to its problems will differ. For example, who should be on an efficiency team and who should take the lead in forming and maintaining this efficiency team will vary in each community.

## 1½ hours Small-Group Exercise: Strategy Preparation

*This exercise is designed to give participants, working in teams, an opportunity to apply what they have learned to their own city or country. Working from handouts, participants will work together to develop an action plan that identifies steps to be taken to move an energy efficiency initiative forward in their communities; the changes that will have to be made, the tools that will be used to effect these changes, and the resources that are needed. Discussions may include strategies for "quick-fix" options versus long term challenges.*

*10 min*

1. Break participants into the small groups they were in yesterday. Share the learning objectives of this session and explain how this session follows from the small-group work they've already done. Define also the end product (i.e., action plan for improving or implementing energy efficiency in the water operations of their community or country). Explain how you would like reports to be made tomorrow morning and what types of information you expect to be included.

*75 min*

2. Ask participants to work through the "Action Planning" handout. (This handout has three pages, and asks for teams to identify one inefficiency on each page.) This handout is designed to help teams develop an action plan for addressing inefficiencies. This plan will help their community or country meet the policy objective they identified earlier in the course. Remind participants to focus both on the supply and the demand side of the equation in identifying inefficiencies. Teams should then develop the result or outcome they hope to achieve in addressing the inefficiency. The action plan should be as specific as possible, including specific actions to be taken, the deadline for completing them, and who (which person, title, workgroup, organization, etc.) should be responsible. In developing the plan, teams should consider both short- and longer-term actions to be taken. They should also take resources into consideration. In what areas would municipalities take the lead on implementing changes? In what areas will they need outside assistance? Allow teams an hour and 15 minutes to work on their plans and reports. Be available to answer questions or give guidance as teams undertake this work.

*5 min*

3. Conclude with a summary of the work to be completed and a look ahead to the next day's activities, reminding participants to post notes for their reports before leaving this evening.

# Handout: **Action Planning**

**Policy Objective:**

**Sub-Objective I:**_____

| Critical Issue or Inefficiency | Tool/Approach to Address | Expected Outcome & How to Measure |
|---|---|---|
| | | |

**Action Plan**

| Timeline (When) | Responsibility (Who) | Action Steps (Activities) |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

**Sub-Objective II:**_____

| Inefficiency | Tool/Approach to Address | Expected Outcome & How to Measure |
|---|---|---|
| | | |

**Action Plan**

| Timeline (When) | Responsibility (Who) | Action Steps (Activities) |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

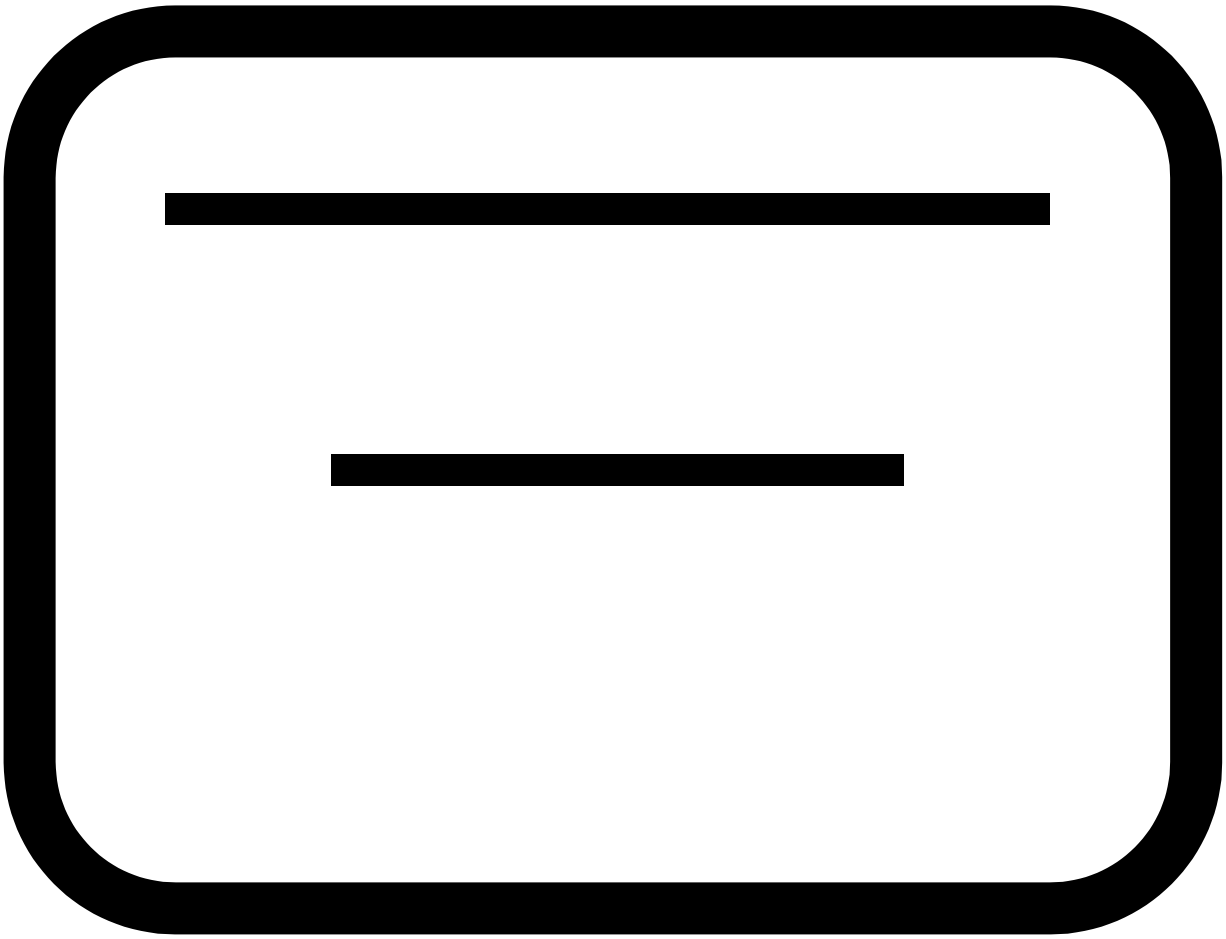
**Sub-Objective III:**_____

| Inefficiency | Tool/Approach to Address | Expected Outcome & How to Measure |
|---|---|---|
| | | |

**Action Plan**

| Timeline (When) | Responsibility (Who) | Action Steps (Activities) |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

# Overheads



# Forms of PSP Transactions

# Forms of Transactions

- Design/Build (Turnkey)
- Design/Build/Operate
- BOT/BOOT
- Concessions
- Service Contract
  - Contract Operations
  - Contract Management

# Design/Build/Operate

- Contractor (Consortium) Designs & Constructs Facility
- Lump-Sum Price
- All Public Financing of Capital Cost
- Public Sector Ownership at Acceptance
- Operation (Optional) for Lump-Sum

# Design/Build/Operate (cont'd)

Public Financing Available

Specific Scope of Work

Best for New Facilities

< Advantages

  – Public Freed of Commercial Risk

  – Debt Financing May Be Cheaper than Equity

< Disadvantages

  – More Difficult for Upgrades

# Build-Operate-Transfer (BOT)

- Consortium Designs, Constructs, Finances & Operates Facility: 10–25 Year Contract
- Lump-Sum Price ("Take or Pay")
  - Fixed Payments Begin at Construction Completion
  - Operation Payment Adjusted According to Demand, Inflation, & Currency
- Public Sector Ownership at Acceptance (vs BOOT)
- Transfer at Contract End:
  - Retain Private Operator
  - Tender Operation to Other Bidders
  - Public Operation of Facility

# Build-Operate-Transfer (cont'd)

Public Financing Unavailable

Specific Scope of Work

Best For New Facilities

- Advantages
  - Public Freed of Commercial Risk
- Disadvantages
  - More Difficult for Upgrades/Additions
  - Larger Companies/Consortiums
  - Take or Pay Clause

# BOT Take Or Pay Clause

< Government Agrees To Pay Private Sector For Minimum Demand At Guaranteed Price

- Demand Forecast Is Most Critical Element of Feasibility Study
- Major Risk in BOT Projects
- Often Required By Lenders

# Concessions

- Used in Large Projects with Comprehensive Scope Including Billing and Collection
- Consortium Designs, Constructs, Finances & Operates All Facilities: 20–30 Year Contract
- Lump-Sum Price or Adjusted Through Negotiations
  - Price Often Quoted as a Tariff
- Public Sector Ownership of Facilities

# Concessions (cont'd)

Imprecise Scope of Work

Comprehensive Scope of Services

Addressing Long-Term Needs

- Advantages
  - Responsibility for All Services
  - No "Take or Pay" Clause
- Disadvantages
  - Tender Difficult/Complex Contract
  - Existing Employees?

# Service or Management Contracts

- Also Termed “Contract Operations”
- Contractor Performs Operations Function Only—No Capital Provided
- Lump-Sum But Adjusted for Demand, Inflation, & Currency Fluctuations
- “Maintenance Bank” Used
  - Maintenance Set Aside as Allowance
  - Contractor Receives What is Spent

# Service Contracts

- Little or No Capital Required
- Utility Optimization Desired:
  - Lower Operating Costs
  - Improved Quality
  - Higher Technology
- Shorter-Term: 5–7 Years

# Service Contracts (cont'd)

- Advantages
  - Utility Optimization
  - Transfer Risk to Private Sector
  - Fixed Cost
  - Savings Can Be Provided Up Front (Discounted)
- Disadvantages
  - Staff Layoffs Possible
  - Loss of Control?

# Service Contracts (cont'd)

< Upfront Payment Example:

- City Operates Water Facility for $2 M/Year
- Service Contractor Offers $1.5 M for 5 Years
- $0.5 M per Year Savings or $2.5 M Overall
- City Receives, For Example, $1.5 M on Contract Signing and City Retains Same Tariff

# Calculating Payback on Energy-Saving Measures

# Calculating Payback—Example

- Cost of Installing High Efficiency Motors in Finished Water Pump Station—US$1.3 M
- Current Annual Energy Cost—US$1.6 M
- Estimated New Energy Cost—US$1.3 M
- WACC = 12.7%
- Estimated Equipment Life = 15 Years

# Calculating Simple Payback—Example

Annual Energy Savings = 1.6–1.3 = 0.3 M

Simple Payback = 2.5 M / 0.3 M = 8.3 Years

# Calculating Payback—PV

- PV Capital Investment = 1.3 M
- PV O & M Savings (i = 12.7%, n = 15 Years) = 0.27 M
- Payback PV Basis = 1.3 M / 0.27 M = 9.25 Years

# Prequalification and Tendering Processes

# Prequalification Process

< Timing in the Project Life-Cycle

  – Following Project Identification/Pre-Feasibility Study

  – During or Following Project Feasibility Study

< Identify Screening Criteria:

  – Domestic Vs. International

  – Prior Experience on Similar Projects

  – Financial Stability

  – Current Backlog

  – Ability to Execute Project

  – Litigation/Change Order History?

# Prequalification Process (cont'd)

- Request for Qualifications
  - Domestic Advertisements
  - International Advertisements
  - Utility Website
  - Commercial Attache At Embassy
- Stipulate Format and Content
  - Executive Summary
  - Minimum Content
  - Maximum Pages

# Evaluation of Qualifications

- Screen According to Established Evaluation Criteria
- Evaluation Matrix
- Weighted Vs. Unweighted Criteria
- Publish Prequalification Results & Notify Firms of Results

# Tendering Process

- Complete Feasibility Study
- Develop Tender Documents
- Develop Bid Forms
  - Technical Proposal Content
  - Financial Proposal Content
- Develop Bid Evaluation Criteria
- Prepare and Send Invitation to Bid to Prequalified Firms Only

# Pre-Bid Meeting

- Mandatory or Optional Attendance
- Project Description & Special Requirements
- Tour Existing Facilities If Any
- Information Exchange
  - Addenda If Any
  - Questions & Answers (Follow Up in Writing)
- Publish Minutes By Addendum

# Forms of Procurement

- Sole Source Negotiation
- Two-Envelope Process
- One-Envelope Process
- Quality Based Selection (QBS)

# Sole Source Negotiation

- Often Not Allowed
- Not “Transparent”
- Generally Not Competitive
- Higher Cost To Public

# Two-Envelope Process

- Minimum Proposal Qualification
- Technical Envelope Evaluated First
  - Technical Clarifications Requested
  - Notification of Qualification
  - Qualified Technical Proposals to Next Round (Financial Envelope)
  - Formal Presentation/Interview?
- Financial Envelope Opened in Public

# Two-Envelope Process (cont'd)

- Technical Envelope
  - Preliminary Design
  - Construction Details and Methods
  - Alternate Bid Information
  - Exceptions to Contract
  - Bid Bond
- Financial Envelope
  - Price
  - Performance Bond

# Two-Envelope Process (cont'd)

< Lowest Responsive Bidder Wins

< No Carryover of Prequalification or Proposal Evaluation Scores

(You and Your Proposal Are Either Qualified or You Are Not)

# One-Envelope Process

- Prequalification Step
- Technical and Financial Proposals Together in Single Envelope
- Presentation/Interview?
- Technical and Financial Evaluations Combined to Provide a Single Score
- Highest Score Wins
- How Much to Weigh Each?
  - 70% Technical/30% Price
  - 50% Technical/50% Price
- Is Technical Evaluation Too Subjective?

# Comparison of Processes

| **Two Envelopes** | **One Envelope** |
| --- | --- |
| < Slower Selection | < Faster Selection |
| < Lower Risk of Bid Protest | < Higher Risk of Bid Protest |
| – Lowest Bidder Is Clear | – Subjective Scoring of Technical Proposal |
| | – Subjective Weighting of Technical and Financial Factors |

# Quality-Based Selection—1

- Prequalification of Proposers
- Separate Technical and Financial Proposals (“Two Envelopes”)
- Evaluation and Ranking of Technical Proposals
- Top Technical Firm Selected

# Quality-Based Selection—2

< Open Financial Proposal of Only the Top Ranked Technical Proposal and Negotiate Price

< Open Financial Proposal of Second Ranked Technical Firm Only If Negotiations With Top Ranked Firm Fail

→ Most Appropriate for Consultant Selection

# One Envelope or Two?

# Methods of Procurement

- One-Step Submittal
  - Prequalification/Technical Proposal/Financial Proposal
- Two-Step Submittal
  - Prequalification
  - Technical/Financial Proposal
- Three-Step Submittal
  - Prequalification
  - Technical Proposal
  - Financial Proposal

# Methods of Procurement (cont'd)

Which Should You Use ?

Why ?

The Envelope Please!

# The Project

- Identified Serious Need for Wastewater Treatment Project in New Delhi:
  - 30,000 M3/Day Capacity
- Needs To Be Constructed As Soon As Possible
- Have Selected Private Sector Financing Option

# Single Envelope

Questions:

< List in Order Your Top 5 Evaluation Criteria

< Assign a Weight to Each That You Feel Is Proper

# Two Envelope

Questions:

< List in Order Your Top 5 Evaluation Criteria

< Assign a Weight to Each That You Feel Is Proper

# Follow-up Events

You Receive Proposals From 3 Firms:

< Local Indian

  – Magdi and Jary (MAGARY)

  – Moustafa, Yusif and Ali (MYA)

< International

  – Fumble Stumble & Trip (FS & T)

# MAGARY

- Performed One Project Like the Proposed Project
- Reference From the Previous Project Did Not Seem Satisfied
- MAGARY Will Commit to Your Schedule
- Price Was 50% of Next Lowest Firm (MYA) at $10 M

# MYA

- Performed Several Projects Like Proposed But All Smaller
- Project References All Very Good
- MYA Proposal Says “We’re Not Sure Who We Will Assign To Manage Project; We Will Do That When You Award The Project”
- Also, They Have So Much Work, They Are Not Willing to Commit to Schedule
- MYA’s Price Is $20 M

# Fumble, Stumble & Trip

- Large International Firm With Hundreds of Similar Projects
- Great Project References
- No Office in India; Says “The Project Will Be Done in Our New Jersey Office With Two Trips to New Delhi”; No Local Partner
- FS & T Will Commit to Schedule
- Price Is $30 M

# Selection—Single Envelope

- Evaluate and Rank Firms Using Your Criteria
- Select Your Firm

# Selection—Two Envelope

- Evaluate Firms Using Your Technical Criteria
- Evaluate Firms Using Your Financial Criteria
- Select Your Firm

# Results

| GROUP | MYA | MAGARY | FST |
|---|---|---|---|
| 1 | 2 | 1 | 3 |
| 2 | 2 | 1 | 3 |
| 3 | 3 | 1 | 2 |
| 4 | 3 | 2 | 1 |

# Case Study
# Improving Energy Efficiency in Water Service

## Vadodara Municipal Corporation (VMC)

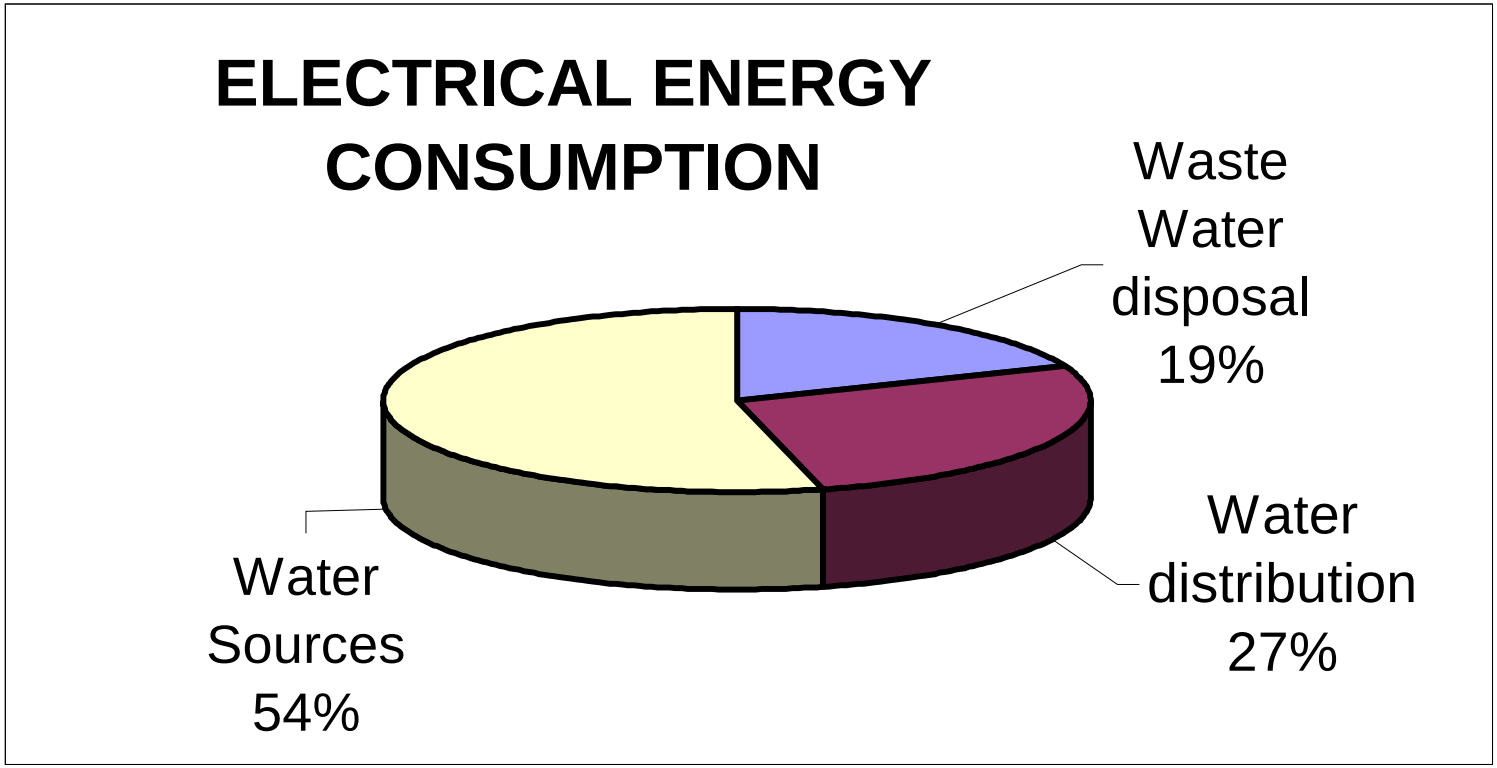
## Through
## Energy Audit

Subodh Shah,
Executive Engineer (Electrical)
Vadodara Municipal Corporation

# Water Services and Electrical Load of Vadodara City

| | Load in MW | Consumption in million KWH | Amount in Million Rs. |
|---|---|---|---|
| Water supply source | 4.7 | 28.656 | 131.28 |
| Water distribution | 6.51 | 14.4 | 67.95 |
| Wastewater | 4.2 | 10.386 | 43.58 |

# Electrical Energy Consumption



# Conditions Prior to the Introduction of the Energy Audit

- Electricity bills were never checked
- Payment of penalty for poor power factor (p.f.)
- Charges for contract demand were paid and never took corrective measures to avoid penalty charges
- Attempt was never made to check the operating parameters of pump sets
- Energy waste due to lack of awareness of operating parameters
- Diameter and layout of pumping mains never checked

# Corrective Measures by Studying Electric Bills

| Corrective Measure | Saving in Million Rs. |
|---|---|
| p.f. improvement | 3.2 |
| Reduction in contract demand (750 to 475 KVA) | 0.72 |

# Measuring Efficiency of Pump Set

- For the purpose of measuring pump efficiency, simultaneous measurements of flow (Q), power (kw) and head (H) are to be taken
- Flow meter, pressure gauge, and digital electrical measuring instruments are required
- Energy Auditor needs to be appointed to check:
  - Gap between design and operating parameters
  - Recommendation for replacement or refurbishment of pump(s)
  - Electrical energy saving potential, required investment, and simple payback period
  - Energy loss in parallel operation of pump sets
  - Layout of pumping mains
  - Diameter with respect to flow

# 1999 Energy Audit

The agency appointed for the energy audit study carried out a detailed study and found reasons for inefficient operation of pump sets:

< Pump running with throttled valve

< Excess margins in head

< Higher head resulting in change in operating parameters, drawing more power than required

< Some pumps had outlived their useful lives and were operating at 12% to 35% efficiency

# 1999 Energy Audit (cont'd)

Other reasons for inefficient operation of motor-pump sets are:

< Poor suction lift

< Undersized suction & delivery pipe

< High friction loss due to improper layout of delivery pipeline

< Parallel operation of pumps with different duty conditions

< Low power factor (p.f)

< Ignorance of preventive maintenance

# Elements That Contributed to Success

- The then chairman of Standing Committee has taken an interest in the project and sanctioned the budget
- The project was approved by municipal commissioner in consultation with Mayor and Chairman of Standing committee
- Upon retirement of old staff, young people were recruited, and they were made aware and trained in the field of energy efficiency

# Results Achieved: Saving Achieved by VMC Efforts Prior to Appointment of Energy Auditor

| **Savings obtained by increasing power factor (P.F.)** | | | | |
|---|---|---|---|---|
| Sr. No. | Location | P.F. Before improvement | P.F. After improvement | Approx. saving per annum in million Rs. Lacs since 1997. |
| 1. | Nalanda Overhead (O/H) Tank | 0.75 to 0.80 | 0.9 to 0.98 | 0.6 |
| 2. | Sewasi – Gotri O/H Tank | 0.70 to 0.80 | 0.9 to 0.98 | 0.4 |
| 3. | Tandalja O/H Tank | 0.50 to 0.60 | 0.9 to 0.98 | 0.8 |
| 4. | Gajrawadi sewage pumping station | 0.40 to 0.50 | 0.9 to 0.98 | 1.2 |
| 5. | Atladra sewage pumping station. | 0.80 to 0.85 | 0.9 to 0.98 | 0.2 |
| | | | Total Annual Savings Rs. 3.2 Lacs | |

# Results Achieved (cont'd)

**RESULTS ACHIEVED:**

**Savings obtained by Reducing Contract Demand (C.D.)**

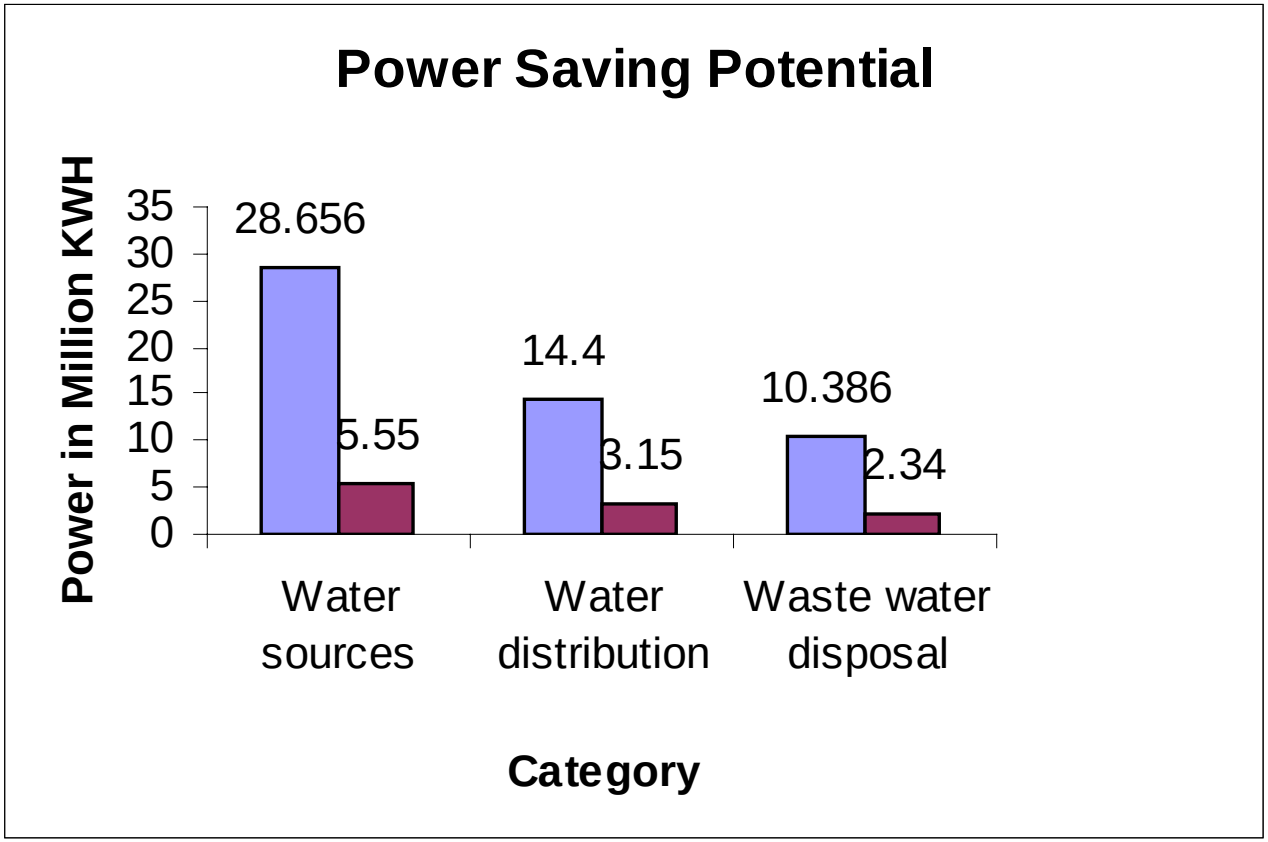
| Sr. No. | Location | Previous Contract Demand | Current Contract Demand after reduction | Savings per annum in Rs. lacs. |
|---|---|---|---|---|
| 1. | Nalanda Overhead (O/H) Tank | 750 | 475 | 2.4 |
| 2. | Sewasi – gotri O/H Tank | 750 | 475 | 2.4 |
| 3. | Tandalja O/H Tank | 750 | 475 | 2.4 |

# Results Achieved (cont'd)

**OVERALL SAVINGS IDENTIFIED BY ENERGY AUDITOR.**

| WATER SERVICE AREA | Recommendations of Energy Audit study | | Annual Electric bill | | Annual Saving Potential | | Investment in Millions Rs. | Simple Pay-back Period In months |
|---|---|---|---|---|---|---|---|---|
| | Pump Replacement | Pump Refurbishment | MILLION | | MILLIONS | | | |
| | | | Kwh | Rs | Kwh | Rs | | |
| Water Source (French Wells) | 15 | 9 | 28.66 | 131.4 | 5.55 | 24.96 | 11 | 6-8 |
| Water Distribution Pum.St. | 18 | 47 | 16.34 | 73.94 | 3.15 | 14.18 | 12 | 14-15 |
| Waste water collection T&D | 34 | 2 | 9.12 | 21.60 | 2.34 | 10.35 | 7 | 10-12 |
| TOTAL | 67 | 58 | 54.12 | 226.94 | 11.0 4 | 49.67 | 30 | 8 |

# Power Saving Potential



# Case Study: Sewage Lift Station, Gajarawadi

**CASE STUDY OF GAJRAWADI LIFT STATION:**
**COMPARISION OF DESIGN & OPERATING PARAMETERS:**

| Parameter | Pump-4 | | Pump-5 | | Pump-6 | |
|---|---|---|---|---|---|---|
| | Operating | Design | Operating | Design | Operating | Design |
| Head (M) | 11.14 | 19 | 6.6 | 18 | 6.6 | 18 |
| Discharge (KL / Min) | 37.5 | 36.66 | 25.8 | 42.96 | 21.13 | 42.96 |
| Power (KW) | 127 | 145 | 152 | 165 | 200 | 165 |
| Efficiency (%) | 63.26 | 78 | 21.54 | 78 | 12.91 | 78 |

# Case Study: Sewage Lift Station, Gajarawadi (cont'd)

| Parameter | Pump-1 | | Pump-2 | |
|---|---|---|---|---|
| | Old Pump | Replaced with | Old Pump | Replaced with |
| Head (M) | 18 | 16 | 18 | 16 |
| Discharge (KL / Min) | 19.1 | 36.66 | 19.1 | 36.66 |
| Power (KW) | 85 | 150 | 85 | 150 |
| Efficiency (%) | - | 82 | 13 | 82 |

Note: 1) Pump replaced with corrosion resistance coating in all internals to increase the efficiency and to extend service life.
2) After replacement pump no 1 to 4 become identical and hence can reduce inventory, with increased operating reliability.
3) Pump no 3 & 6 has very low operating efficiency- kept standby.

# Case Study: Sewage Lift Station, Gajarawadi (cont'd)

| | |
|---|---|
| 43612 KL/ day | 0.086 KWH / KL |
| 86444 KL/ day (2002) | 0.045 KWH / KL (Annual saving 1.862 million kwh) |
| Present flow is 128029 KL / day Electric consumption 4825 KWH / day | 0.037 KWH / KL |

# Case Study: Sewage Lift Station, Shastribridge

| **COMPARISION OF DESIGN & OPERATING PARAMETERS: For Shastribridge sewage lift station.** | | | | |
|---|---|---|---|---|
| **Parameter** | **Pump-2** | | **Pump-3** | |
| | **Operating** | **Design** | **Operating** | **Design** |
| **Head (M)** | **10.35** | **18** | **10.7** | **18** |
| **Discharge (KL / Min)** | **9.6** | **8** | **10** | **8** |
| **Power (KW)** | **45** | **45** | **45.5** | **45** |
| **Efficiency (%)** | **42.47** | **78** | **45.24** | **78** |
| **Average Electric consumption 1100 KWH / day** | | | | |

# Case Study: Sewage Lift Station, Shastribridge (cont'd)

- Both the pumps were replaced with high discharge capacity.
- Energy auditor recommended for the present flow:
  - Head = 10 Mtrs., Discharge = 11 KL / Min.
- The corporation replaced the pump:
  - Head = 12 Mtrs., Discharge = 15 KL / Min.
- Total discharge of the pumping station increased from 11400 KL / day to 19051 KL / day.
- Energy consumption reduced from 0.083 KWH / KL to 0.043 KWH / KL by replacing pump with higher efficiency & proper duty condition.

# Case Study: Gajarawadi & Shastribridge Lift Station

| Sewage Pumping Stations | Investment in Million Rs. | Power Saving | | Simple Payback period |
|---|---|---|---|---|
| | | in Million KWH | in Million Rs. | |
| Gajarawadi | 2 | 1.862 | 8.379 | 2 months |
| Shastribridge | 1.2 | 0.236 | 1.062 | 14 months |

# Case Study: Overhead Water Tank, Lalbaug

| COMPARISION OF DESIGN & OPERATING PARAMETERS:<br>Lalbaug Overhead water tank | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Parameter | Pump-1 | | Pump-2 | | Pump-3 | | Pump-5 | |
| | Opera-ting | Design | Operating | Design | Operating | Design | Opera-ting | Design |
| Head (M) | 30 | 40 | 33 | 40 | 31 | 40 | 31 | 40 |
| Discharge (KL / Min) | 7.45 | 11 | 17.4 | 22.2 | 7.5 | 11 | 22 | 22.2 |
| Power (KW) | 81 | 110 | 188 | 220 | 86 | 110 | 184 | 220 |
| Efficiency (%) | 56.35 | 80 | 57.05 | 80 | 50.86 | 80 | 70.51 | 80 |
| Average daily Energy Consumption 4652 KWH (from Electric bill.) | | | | | | | | |

# Case Study: Overhead Water Tank, Lalbaug (cont'd)

- Water demand increased due to development in the command area
- Water level in the elevated tank was not maintained
- Complaints of water supply with low pressure
- The VMC has increased pumping capacity by replacing two pumps (3 & 6):
  Q= 21 KL/Min  Head- 34 M

# Case Study: Overhead Water Tank, Lalbaug (cont'd)

CASE STUDY:
**SAVINGS ACHIEVED AFTER REPLACEMENT OF PUMP AT LALBAUG**

| Parameter | Pump-1 | | Pump-3 | |
|---|---|---|---|---|
| | Old Pump | Replaced with | Old Pump | Replaced with |
| Head (M) | 40 (30.5) | 35 | 40 (31) | 35 |
| Discharge (KL / Min) | 7.45 | 22 | 7.5 | 22 |
| Power (KW) | 81 | 160 | 86 | 160 |
| Efficiency (%) | 56.35 | 82 | 50.86 | 82 |

NOTE: -

(1) After replacement total discharge was increased from 22491 to 26100,
Which helped to maintain water level in elevated tank.
(2) Average Daily consumption of has reduced
(3) KWH consumption per kiloliter has reduced from 0.198 to 0 .141 KWH

# Case Study: Overhead Water Tank, Lalbaug (cont'd)

**DETAILS OF SAVING ACHIEVED:**

| Sr No | Location of the pumping station | Pump Efficiency | | KWH / KI | | Annual Energy saving (million KWH) | Energy in GJ | Reduction in GHG emission ($CO_2$ in tones) |
|---|---|---|---|---|---|---|---|---|
| | | Before replacement | After replacement | Before replacement | After replacement | | | |
| 1 | Lalbaug overhead tank | 50.86-70.51 | 86 | 0.198 | 0.141 | 0.543 | 1955 | 638 |
| 2 | Gajarawadi sewage pumping station* | 12.91-63.26 | 83 | 0.086 | 0.045 | 1.862 | 6703 | 2189 |
| 3 | Atladra sewage treatment plant | 33.43-35.23 | 83 | 0.079 | 0.033 | 0.730 | 2628 | 858 |
| 4 | Shastri-bridge pumping station | 42.45 | 82 | 0.083 | 0.043 | 0.236 | 850 | 270 |
| 5 | Fajalpur & Poicha French wells | 48-72 | 82 | - | - | 4.3 | | |

# Case Study: Overhead Water Tank, Lalbaug (cont'd)

Before PUMP replacement

| Sr. No. | Location | No of pumps | Power of pump | Operating Hours | Design Head | Opera-ing Head | Flow | Efficiency | Power consu-med | Amount | Water pumped | Energy consumed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | *HP* | *Hrs/day* | *mt* | *mt* | *Kl/min* | *%* | *Million KWH* | *Million Rs.* | *Kl/day* | *KWH/Kl* |
| 1 | **Lalbaug overhead tank** | **6** | **4x150 2x300** | **11** | **40** | **33.00** | **7.45-22.00** | **50.86-70.51** | **1.631** | **7.524** | **22491** | **0.198** |
| 2 | **Gajrawadi sewage pumping station*** | **6** | **2x110 2x200 2x250** | **34** | **18** | **12.00** | **21.13** | **12.91-63.26** | **1.38** | **6.356** | **43612** | **0.086** |
| 3 | **Atladra sewage treatment plant** | **4** | **4x50** | **48** | **9.15** | **6.63** | **6.1** | **33.43-35.23** | **0.51** | **2.029** | **17568** | **0.079** |
| 4 | **Shastribridge pumping station** | **3** | **2x60 1x30** | **19** | **18** | **11** | **10** | **42.45** | **0.346** | **1.504** | **11400** | **0.083** |

# Case Study: Overhead Water Tank, Lalbaug (cont'd)

After PUMP replacement

| Sr. No. | Location | No of pumps | Power of pump | Operating Hours | Design Head | Operating Head | Flow | Efficiency | Power consumed | Amount | Water pumped | Energy consumed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | *HP* | *Hrs/day* | *mt* | *mt* | *Kl/min* | *%* | *Million KWH* | *Million Rs.* | *Kl/min* | *KWH/Kl* |
| **1** | **Lalbaug overhead tank** | **6** | **4x300 2x150** | **23** | **35** | | **22.2** | **86** | **1.491** | **7.155** | **26100** | **0.141** |
| **2** | **Gajrawadi sewage pumping station*** | **6** | **4x200 2x250** | **39.3** | 14 | | **36.66** | **83** | **1.439** | **6.751** | **86444** | **0.045** |
| **3** | **Atladra sewage treatment plant** | **3** | **3x50** | **43** | **8** | | **30** | **83** | **0.516** | **2.244** | **43193** | **0.0327** |
| **4** | **Shastribridge pumping station** | **3** | **2x100 1x55** | **13** | **11** | | **13.23** | **82** | **0.299** | **1.30** | **19051** | **0.043** |

# Development of New Projects With Energy-Efficient Practices

< The corporation has institutionalized energy efficiency practices as a result of energy audit study in the development of new projects

# Strategy Adopted for Development of New Tube Well Project

- Scanty rainfall in the year 1999-2000.
- Possibility of zero flow in the river Mahi by December 2000.
- River Mahi contributes 75% of water for the city.
- Tube well project was planned for 32 MGD.
- Selection of Head, based on Report of Energy Audit.

# Recommendations of the Department for the Tube Well Project

| | VERTICAL TURBINE PUMP | SUBMERSIBLE PUMP |
|---|---|---|
| CAPITAL COST | RS. 3.94 LACS | RS. 2.51 LACS |
| HEAD & DISCHARGE | 75 M &150 $M^3$ / HOUR | 75 M &150 $M^3$ / HOUR |
| OVER ALL EFF. | 72.8% | 65.2% |
| MOTOR INPUT | 42.4 KW | 47.4 KW |
| DAILY ELECTRIC CONSUMPTION IN KWH (24 HOURS) | 1017.6 KWH | 1137.6 KWH |
| ANNUAL CONSUMPTION @ RS 4.5/KWH | RS.16.71 LACS | RS. 18.69 LACS |
| OPERATING LIFE | 10 YEARS AND MORE | 5 YEARS |
| SIMPLE PAYBACK PERIOD | 10 MONTHS | |

# Tube Well Project (cont'd)

It was computed that:

< Excess investment in VT pump can be recovered within 8–10 months.

< Operating parameters are very close to the recommendations.

< Operating parameters of both types of pumps are mentioned in the next slide.

# Operating Parameters of the Tube Well Project After Pump Installation

| | VERTICAL TURBINE PUMP | SUBMERSIBLE PUMP |
|---|---|---|
| CAPITAL COST | RS. 4.92 LACS | RS. 2.21 LACS |
| HEAD & DISCHARGE | 75 M &150 $M^3$ /HOUR | 75 M &150 $M^3$ /HOUR |
| OVER ALL EFF. | 72.27% TO 73.63% | 64.47% TO 66.24% |
| MOTOR INPUT | 41.9 KW | 48.20 KW |
| DAILY ELECTRIC CONSUMPTION IN KWH (22 HOURS) | 921.8 KWH (Savings: 138.6 kwh/day) | 1060.4 KWH |
| ANNUAL CONSUM. @ RS 4.5/KWH RS. IN LACS | RS.14.51 (16.71) (Saving:Rs. 2.19 lacs) | RS. 16.70 (18.69) |
| ANNUAL SAVINGS | 0.49 LACS KWH & RS. 2.19 LACS. | |
| SIMPLE PAY BACK PERIOD | 15 MONTHS (Excess Capital cost Rs. 2.71 lacs) | |

# STP Process Selection and Energy Saving

Process selection on the basis of energy consumption and treatment efficiency:

< ASP & UASB process compared.

< Capital cost of UASB is higher than ASP process.

< Operational cost of UASB is much lower than ASP.

< Power generation from bio-gas.

< Treated effluent – very high standard.

# Comparison of ASP & UASB Processes

| Sr. No. | Cost Head | Present Cost, in Mill. Rs. | |
|---|---|---|---|
| | | **ASP Process** | **UASB Process** |
| 1 | Capital Cost | 90.00 | 122.2 |
| 2 | Net Operating Cost / Annum | 22.771 | 15.92 |
| 3 | Capitalized Net Operating Cost over 15 years @ 10 % per annum interest | 173.2 | 121.1 |
| | **Capitalized Total Cost (1 + 3)** | **263.2** | **243.3** |

# Conclusions From the Operation of ASP and UASB Processes

- The Capital Cost for UASB process is 35% higher.
- However the Operating Costs of ASP are 43% higher.
- UASB process generates 2400 kwh/day power from bio-gas.
- The plant treats the sewage to BOD 15 to 24 mg/l, COD 40 to 80 mg/l, and Total Suspended Solids up to 20 to 24 mg/l.
- After treating the sewage to such a high level, Vadodara Municipal Corporation is now thinking along the lines of “reuse of sewage.”

# Measures Yet To Be Implemented

< Water source

– Replacement of 15 pump sets at four French wells

– Refurbishment of 9 pumps

VMC will be able to achieve power saving of 4.3 million kwh amounting to Rs. 18 million after pump replacement at French wells (24).

< Water Distribution

– Replacement of 18 pump sets

– Refurbishment of 47 pumps

After replacing these pumps VMC will be able to achieve further saving potential of 3.15 million kwh amounting to Rs. 14.18 million with a simple payback period of 10 to 12 months.

# New Practices To Be Adopted

- Power loading condition shall be incorporated in tender to procure pump with best possible operating efficiency.
- Pump shall be tested immediately after installation to determine the gap between design & operating parameters.
- It will help to take immediate corrective actions, if required.
- Training will be provided to the operator and engineers.
- A revolving fund for energy efficiency project shall be created in the budget. Financial savings achieved by the project shall be credited to the revolving fund.
- Established an energy cell, which shall have functions as shown in next slide.

# Functions of Energy Cell

- Monitor and guide the program.
- Facilitate a single window approval for future energy saving programs.
- Ensure sustainability of the energy saving program after the life of the project.
- Introduce and implement newer technologies for energy efficiency.
- Create energy efficiency awareness among staff, elected representatives, and decision makers.

# Performance Measurement

# Performance Measurement: What Is Its Value?

< Identify unit cost

< Communicate with the public

< Make management decisions

< Determine cost of policy impacts

< Link budget with public priorities

< Improve decision making

# Measures Fit Results

Identify the:

- Program
- Vision, mission, or objective
- Program activities

# Measures Fit Results (cont'd)

Determine:

- Targets
- Inputs
- Outputs
- Efficiency
- Outcomes
- Context

# Modeling for Energy Consumption in Water Utilities

# Estimating Energy Requirements for a WTP

| PROJECTED ELECTRICAL ENERGY USAGE—450,000 M3/Day TREATED WATER | | | | | | | |
|---|---|---|---|---|---|---|---|
| | OUTPUT | INPUT | NO UNITS | % Full | HRS/DAY | KW-HRS/ | KW-HRS/ |
| MOTOR | KW | KW | OPN | Load Amps | OPN | DAY | YEAR |
| | | | | | | | |
| Flash mixer | 6 | 6.5 | 10 | 0.7 | 24 | 1,097 | 400,413 |
| Pulsators | 15 | 16.3 | 20 | 0.9 | 24 | 7,043 | 2,570,870 |
| Filter air scour blowers | 37 | 40.2 | 10 | 0.9 | 1 | 347 | 126,830 |
| Filter backwash pump | 42 | 45.5 | 10 | 0.9 | 4 | 1,620 | 591,376 |
| Pulsator sludge pump | 9 | 9.6 | 20 | 0.9 | 12 | 2,058 | 751,105 |
| Alum mixer | 2 | 1.6 | 20 | 0.7 | 24 | 548 | 199,957 |
| Alum dosing pump | 1 | 0.8 | 20 | 0.7 | 24 | 274 | 99,978 |
| Polymer feed system | 3 | 2.7 | 20 | 0.7 | 24 | 913 | 333,261 |
| Chlorination water pump | 8 | 8.2 | 6 | 0.9 | 24 | 1,057 | 385,630 |
| Miscellaneous @ 5 % | 6 | 6.6 | 1 | 0.9 | 24 | 142 | 51,795 |
| **TOTAL** | **127** | **138** | | | | **15,099** | **5,511,214** |

# Estimating Energy Requirements for a WTP (cont'd)

| PROJECTED ELECTRICAL ENERGY USAGE—450,000 M3/Day TREATED WATER | | | | | | | |
|---|---|---|---|---|---|---|---|
| | OUTPUT | INPUT | NO UNITS | % Full | HRS/DAY | KW-HRS/ | KW-HRS/ |
| MOTOR | KW | KW | OPN | Load Amps | OPN | DAY | YEAR |
| | | | | | | | |
| Flash mixer | 6 | 6.5 | 10 | 0.7 | 24 | 1,097 | 400,413 |
| Pulsators | 15 | 16.3 | 20 | 0.9 | 24 | 7,043 | 2,570,870 |
| Filter air scour blowers | 37 | 40.2 | 10 | 0.9 | 1 | 347 | 126,830 |
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| Chlorination water pump | 8 | 8.2 | 6 | 0.9 | 24 | 1,057 | 385,630 |
| Miscellaneous @ 5 % | 6 | 6.6 | 1 | 0.9 | 24 | 142 | 51,795 |
| **TOTAL** | **127** | **138** | | | | **15,099** | **5,511,214** |

**Kw-Hrs/Year = Input Kw x No of Units x %FLC x Hrs of Opn/Day x 365**

# Estimating Energy Requirements for Pumping

| **AVERAGE DAY** | Cu M/Day | 250,000 | 260,000 | 285,000 | 310,000 | 325,000 |
|---|---|---|---|---|---|---|
| | L/S | 2,894 | 3,009 | 3,299 | 3,588 | 3,762 |
| **Electrical Cost Estimate (Estimate at Demand, Not Actual Pumps)** | | | | | | |
| **Raw Water Pumping** | | | | | | |
| NUMBER OF PUMPS INSTALLED | | 10 | 10 | 10 | 10 | 10 |
| UNIT CAPACITY | L/S | 880 | 880 | 880 | 880 | 880 |
| NUMBER OF UNITS IN OPERATION | | 3.3 | 3.4 | 3.7 | 4.1 | 4.3 |
| DESIGN HEAD | M | 108 | 108 | 108 | 108 | 108 |
| | kPa | 1024 | 1024 | 1024 | 1024 | 1024 |
| POWER PER UNIT | KW | 1,060 | 1,060 | 1,060 | 1,060 | 1,060 |
| ESTIMATED ON-LINE POWER | KW | 3,485 | 3,625 | 3,973 | 4,322 | 4,531 |

**Kw = No of Units in Opn x**

# Public Information

# Public Information

- Understand the participants' views of public information
- Select an issue and work with participants to articulate why citizen understanding is important
- Identify multiple public information processes and when to use which one

# Public Information Processes: How to Choose the Right Approach

- High public engagement
- Low public engagement
- Critical nature of change required
- Degree of change

# Public Information Processes: How to Choose the Right Approach (cont'd)

- Citizen interaction required
- Citizen input required
- Information gathering

# Saginaw Water Rate Increases

Challenges to the urban poor

# DAY 5: Action Plan Presentations

## Overview

In this final session, participants present their action plans. The session concludes with a wrap-up of the course, focusing once again on the lessons learned, before participants complete course evaluations and receive certificates of completion.

## Day 5 Objectives

- To provide an opportunity for participants to share and receive feedback on their action plans
- To review key concepts from the course and bring closure
- To obtain feedback from participants that can be used in planning and implementing the course in the future.

# Trainer's Notes

## 2½ hours Small-Group Presentations: Strategies for Improving Energy Efficiency

*This session focuses on the work that teams have done during the course, as each team has an opportunity to share and get feedback on the steps they will (or would) take to improve energy efficiency in the water sector.*

*20 min*

1. Welcome back the group and review the day's agenda. If anyone has to leave early, emphasize the importance of completing a course evaluation before leaving. Tie up any loose ends from the previous day's work.

*1 hr, 45 min*

2. Ask each team to take about 15 minutes to present its plan. Teams should first remind the class of the policy issue they identified in the exercise in Day 2. They then should share each specific problem or inefficiency they identified, the tool or approach they will (or would) use to address the inefficiency, and their expected outcome. Teams should also be specific in terms of their action plans—giving specific deadlines and specifying who (the person, title, organization, or other group) should take the lead.

   After each group has presented its plan, ask for questions or comments from the rest of the class. Instructors should also give feedback, pointing out specific things they like about the plan, as well as what improvements or changes they might suggest. Instructors should also ask groups what types of problems the team faced in developing the plan, answering questions that teams may have about the actions they are suggesting.

*25 min*

3. After all groups have made presentations, discuss common themes and approaches. Emphasize the following key points:

   < Different approaches are needed for different localities. Approaches should be tailored to capitalize on the needs, opportunities, and resources of a specific locality.

   < It is critical to "crunch the numbers" to be able to demonstrate that a short-term investment will pay off over time. Such information may be essential to convince decision makers and citizens of the need for an energy audit and plan, as well as to take specific actions to improve energy efficiency.

   < A number of trends may influence what can be accomplished in the future. Technology, for instance, is ever-changing. Localities should find ways to keep up with the latest tools.

- Local governments can learn a great deal from one another, as evidenced in this course. Strong associations and informal gatherings can help strengthen local governments.

- An active citizenry is an important instrument for change. Without having customers engaged, it is difficult to address many inefficiencies, particularly on the demand side of the equation.

- Change takes time. Look for opportunities to find quick solutions as you work on larger problems. Celebrate small successes and gains.

## ½ hour Evaluation and Conclusion

*The course ends with written evaluations and a brief ceremony to bring closure to the course. (The course may end with lunch to allow participants an opportunity to say goodbye.)*

*15 min* 1. Distribute the course evaluation forms to participants. (A sample evaluation form can be found at the end of these materials.) Emphasize any areas of the evaluation where you would like particular guidance. Allow participants 15 minutes to complete the evaluations.

*5 min* 2. Thank participants for their time. Encourage them to keep in touch with one another as they return to their communities, particularly as they begin to implement the action plans they have developed. Ask them to think about the one step they will take to further the plan in the next week and to write a reminder in their calendar or notebooks. Specific actions could include looking up a site on the Internet, setting up a meeting with a colleague in their community, or following up with one of the presenters to learn more about a specific case.

*10 min* 3. Hand out certificates of completion.

# Handout: **Course Evaluation**

## Cities Matter:
## Energy Efficiency in the Water Sector

**Name (optional): _____**

Overall, how would you rate this course on a scale of 1-10 (10 being the highest rating)?

Briefly, why did you give this rating?

How helpful do you think this course will be to you in your work?

How has this course changed your thinking about energy efficiency or the impact it can have on the efficiency and effectiveness of water services?

What were the most useful parts of the course (case studies, presentations, discussions, analysis, readings, informal information exchange)? Why?

Please comment briefly on each of the sessions.

What suggestions do you have to improve the course?

What follow-up activities or other course topics would you recommend?

Other comments: