Energy Efficiency Opportunities and Challenges in Water Supply System

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Energy and Resource Efficiency in Urban Water Management

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ALLIANCE TO SAVE ENERGY

Using less. Doing more.

WATERGY WATER & ENERGY EFFICIENCY

What is the Alliance to Save Energy?

Mission:

- To promote energy efficiency worldwide to achieve a healthier economy, a cleaner environment, and greater energy security.

- ***Organization:***
- Non-profit organization with HQ in U.S.; operations world-wide
- Staffed by 80+ professionals

Who is the Alliance to Save Energy?

- Established in 1977
- Non-Profit
- A **leader** in energy efficiency in all sectors:
  - **municipal**
  - **industry**
  - **buildings**
  - utilities
  - appliances
  - transportation
  - research
  - policy
  - education
  - federal government (e.g., FEMP)
- Experience in more than 35 countries
- Office in India (Bangalore) for more than a decade

The Alliance's Municipal EE Experience - India

- Tamil Nadu
- Karnataka
- Andhra Pradesh
- Madhya Pradesh
- Maharashtra
- Gujarat

- Delhi Jal Board (DJB)
- Municipal Corporation of Greater Mumbai (MCGM)
- Vishakhapatnam MC
- Pune MC

Watergy

Watergy Facts

- Every liter of water that passes through a system has a significant energy cost, compounded by the money invested to produce it.
- In developing countries, the cost of energy for supply of water may easily consume up to half of a municipality's budget.
- Energy expenditure is the second largest cost after labour.
- 1/3 of India's urban population lacks direct access to clean, affordable and reliable water services

Overview- Indian Municipal Sector

- Second Largest Municipal System in the World
- India's Municipal sector consumes 4% of total electricity

- Energy Consumption by Public Water Works
    - ✓2.57% relative to total Energy Consumption by all Sectors
    - ✓**19,200 Million Units in absolute terms (2011-12)**
    - ✓19,200 Million Units (projected for 2011-12)

Data source: BEE/CEA




Why Municipal Water Energy Efficiency ?

Water Supply is Energy-Intensive

Water Utility Systems that Use Energy

Stage	Operation	Energy-Using Systems
Extraction	Deep well or surface	Pumping systems
Treatment	Chemical & physical	Piston-type dosing pumps, pumping systems, fans, agitators, centrifugal blowers
Between Source and Distribution Network	Sending drinking water to the distribution grid	Pumping systems
	Booster pumping	Pumping systems
Distribution	Distribution to end users	Pumping systems
Storm and Sanitary Sewer Systems	Piping of sewage, rainwater	Pumping systems
	Wastewater treatment and disposal	Pumps, fans, agitators, centrifugal blowers
Support Systems	Support functions of utility building(s)	Lighting systems, HVAC, etc.

What is happening?

Energy Efficiency Challenges for Indian Cities

- Cities lack technical, managerial and financial capacity to implement projects
- Lack of metering & monitoring systems - difficult to establish baseline
- Connected load energy consumption doesn't match with the actual energy bills
- High rates of unaccounted for water; unreliable water services
- No existing Government policy on reducing energy consumption in water delivery;
- Low confidence in PPP- Fair deals take time to set-up
- Procurement is based on 'first cost' (L1) NOT on **Life Cycle Cost**

What's happening …..reasons for Poor Efficiency

- Over design in view of catering future need or unrealistic use of factor of safety margin
- Changes in operating practices/schedules
- Efficient component NOT installed and/or operated properly
- Inadequate metering and monitoring facilities

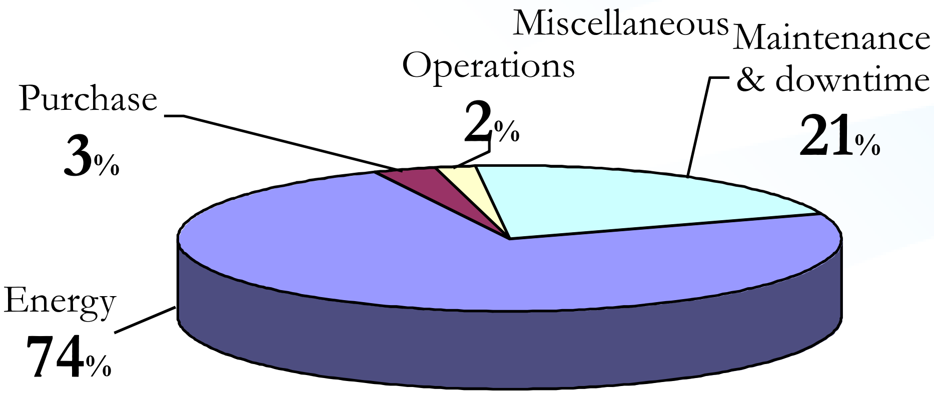
Why Oversized Pump ?

- Safety margins were added to the original calculations. Several people are involved in the pump buying decision and each of them is afraid of recommending a pump that proves to be to small for the job.
- It was anticipated that a larger pump would be needed in the future, so it was purchased now to save buying the larger pump later on.
- It was the only pump the dealer had in stock and you needed one badly. He might have offered you a "special deal" to take the larger size.
- You took the pump out of your spare parts inventory. Capital equipment money is scarce so the larger pump appeared to be your only choice.
- You purchased the same size pump as the one that came out of the application and that one was over sized also.

How Oversized Pump ?

- Required flow- 150 LPS – after final calculation
- Design Engineer – 10-15 % extra – 12% (approx.)
- New Flow- 168 LPS
- Approval Committee – keeping future demand into consideration – Suggest – 10 % more
- Revised Flow – 185 LPS
- Purchasing Department – In View of better commercial deal Supplier suggest higher capacity pump in Same price range- again flow increases by 10 - 12 % approx.
- Final Flow- 207 LPS
- Net Increase in Flow – 38 % - at the time of Installation
- Final effect at operation end- Throttling to get reduced flow

Life Cycle Cost of an Efficient vs. Inefficient Pump

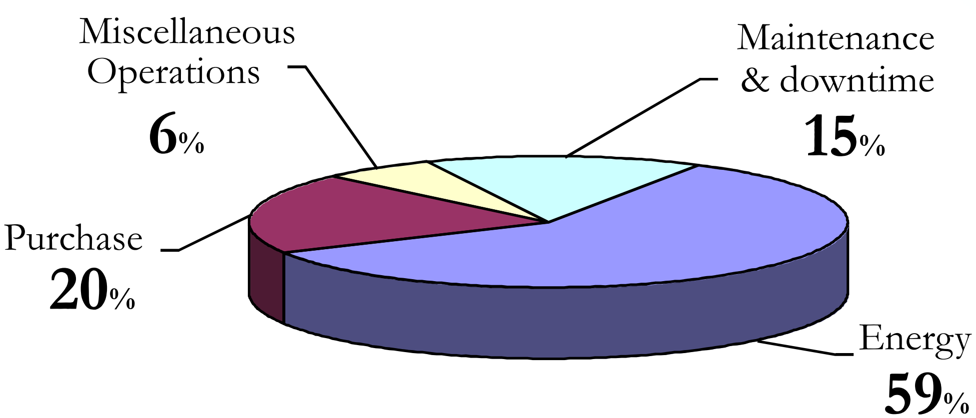


Life Cycle Costing: Inefficient Pump

- Purchase Price: $28,000

1st Yr Energy Cost: $69,000

- Total in Year One: $ **97,000**



Life Cycle Costing: Energy Efficient Pump

- Purchase Price: $56,000

1st Yr Energy Cost: $19,600

- Total In Year One : $75,600

Benefits - Municipal Energy Efficiency

- **Extremely Cost Effective (20 to 40% saving potential)**
  - This translates to at least 4000 MUs of energy savings
  - Simple Payback 2 to 3 years
  - Reduces the need for new infrastructure
  - Avoid the need for an additional capacity **In National /State Interest**
  - Reduced energy intensity will help climate change mitigation efforts
  - Reduce demand and supply gap at the national/state level
- **Improved Municipal Services**
  - Time to incorporate best practices
  - Better and more reliable services to community
  - Enhanced service level

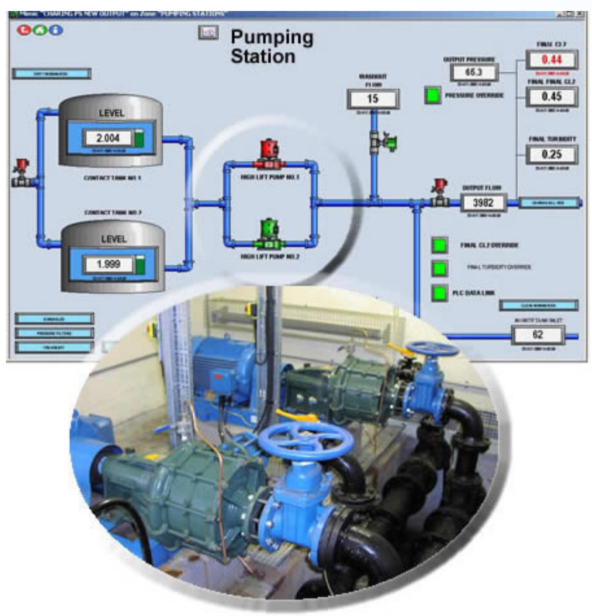
Energy Efficiency Measures

Cost-Effective Interventions

- Pumps
- Leak Management
- Automated Controls

Pressure Management

Metering & Monitoring



Typical Energy Audit Findings in a Pumping Station

- Inefficient Pumps & Motors
- Mismatch in Head and Flow
- Inadequate Pipe Sizing
- Excess Contract Demand
- System Over design

No/Low Cost Measures

- Surrendering of Excess Contract Demand (KVA)
- Improvement of Power factor (PF) (0.98)
- Improvement in O & M Practices
- Separation of LT & HT Load
- Minor Rectification in Pump
- Leak Detection and Repair
- Rescheduling of pumping operation
- Star Mode operation: Under-loaded motors

Medium Cost Investment Measures

- Installation of Capacitors – Power factor improvement
- Impeller Trimming
- Replacement of inefficient Pumps
- Installation of Energy Efficient Motors
- Improvement in Piping – Suction & Header
- Application of Soft Starters
- Application of VFDs – for variable demands(Sewage systems)

Other Measures…

- In multiple pump operations, judiciously mix the operation of pumps and avoid throttling
- Have booster pump for few areas of higher head
- Reduction in pressure, if pressure is higher than required, reducing unnecessary load
- Pipeline rehabilitation

Energy Saving Options – Water Pumping

Category # 1 *Electrical systems and motors*	*Category # 2* *Pumping systems*	*Category # 3* *Operational and other aspects*
Fine tuning of contract demand	Suitable sizing of pumps	Leakage reduction
Penalties paid in lieu of maintaining low power factor	Replacing of pumps due to poor efficiency	Operating schedules / Practices of pumps
Segregation of Lighting and Fan loads	Replacing of the impellers	Parallel operation Vs individual operation of pumps
Switching "OFF" of transformers	Rectification of pumps	Changes in filling practices
Power factor improvement	Header and piping systems	
Clubbing of facilities		

Measures to Improve Efficiency and Typical Payback Periods

<table>
<tr><th>Measure</th><th colspan="2">Function</th><th>PB (yrs)</th></tr>
<tr><td>Reduce peak use</td><td colspan="2">Control demand during peak rate hours</td><td>0 – 2</td></tr>
<tr><td rowspan="2">Optimizing electric installations</td><td colspan="2">Power factor optimization</td><td>0.8 - 1.5</td></tr>
<tr><td colspan="2">Reduction in voltage imbalance</td><td>1 – 1.5</td></tr>
<tr><td rowspan="2">Improved O&M</td><td colspan="2">Routine pump maintenance</td><td>2</td></tr>
<tr><td colspan="2">Deep well maintenance and rehabilitation</td><td>1 - 2</td></tr>
<tr><td rowspan="4">Production and pumping</td><td colspan="2">Automated controls</td><td>0 – 5</td></tr>
<tr><td colspan="2">Replace oversized pumps with more appropriate and efficient pumps</td><td>2-3</td></tr>
<tr><td colspan="2">Optimize pumping systems efficiencies</td><td>0.5 – 1.5</td></tr>
<tr><td colspan="2">Trim the impeller</td><td>0.1 - 1</td></tr>
<tr><td rowspan="3">Distribution system</td><td colspan="2">Use of highly efficient motors</td><td>2 -3</td></tr>
<tr><td colspan="2">Redesign of the grid</td><td>2-3</td></tr>
<tr><td>Control pressure and output in the networks</td><td rowspan="2">Sectoring; variable speed drives; regulating valves</td><td>1.5-3</td></tr>
<tr><td rowspan="4">Technological improvement on the demand side</td><td>Flow recovery program</td><td>0.5 - 3</td></tr>
<tr><td colspan="2">End-use efficiency</td><td>1 - 3</td></tr>
<tr><td colspan="2">Metering systems</td><td>1 - 2</td></tr>
<tr><td colspan="2">Efficient wastewater technologies</td><td>1 - 2</td></tr>
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Municipal EE Project Approach

Municipal EE Project Cycle

Stage 1

Program conceptualization

*Top level by in and commitments

*Discussions with stakeholders

*Assessment of project size

*Initial basic data and inventory details

*Implementation strategy

Procurement

*Expression of interest
- *Evaluation*
- *Short listing*

* Development of RFP and model performance contract

*Issue RFP
- *Technical and financial evaluation*

**Select Implementer*
- *Award contract*

Stage 2

Investment Grade Audit

*Start IGA study
- *Draft IGA report submission*
- *IGA report review by project committee*
- *Draft report discussions with Implementer -Fine tuning*

*Final report submission
- *Freezing and acceptance of EE proposals*
- *Baseline and M&V methodology*

Financing and Implementation

*Signing Energy Performance Contract

*Arrange for 3rd party financing

*Establish TRA/ESCROW account

*Procure equipment and services

*Post installation

*M&V report- (Hiring of 3rd party verifier)

*Repayment

*Training

Case Studies

Energy Saving Potential & Implementation

Energy Saving Potential in Four Towns in Karnataka

Type of Proposal	Nos.	Saving Potential, Rs. Lakh	Investment Required, Rs. lakh
No Cost (immediate)	20	67	Nil
Short Term (1 -12 months)	18	178	78 (Payback: 5 months)
Medium Term (1 – 2 years)	6	63	77 (Payback: 15 months)
Total	**44**	**308**	**155** **(Payback: 6 months)**

Mysore, Bellary, Hubli –Dharwad, Tipture-Arsikere

Energy Saving Potential in Two Towns in Andhra Pradesh

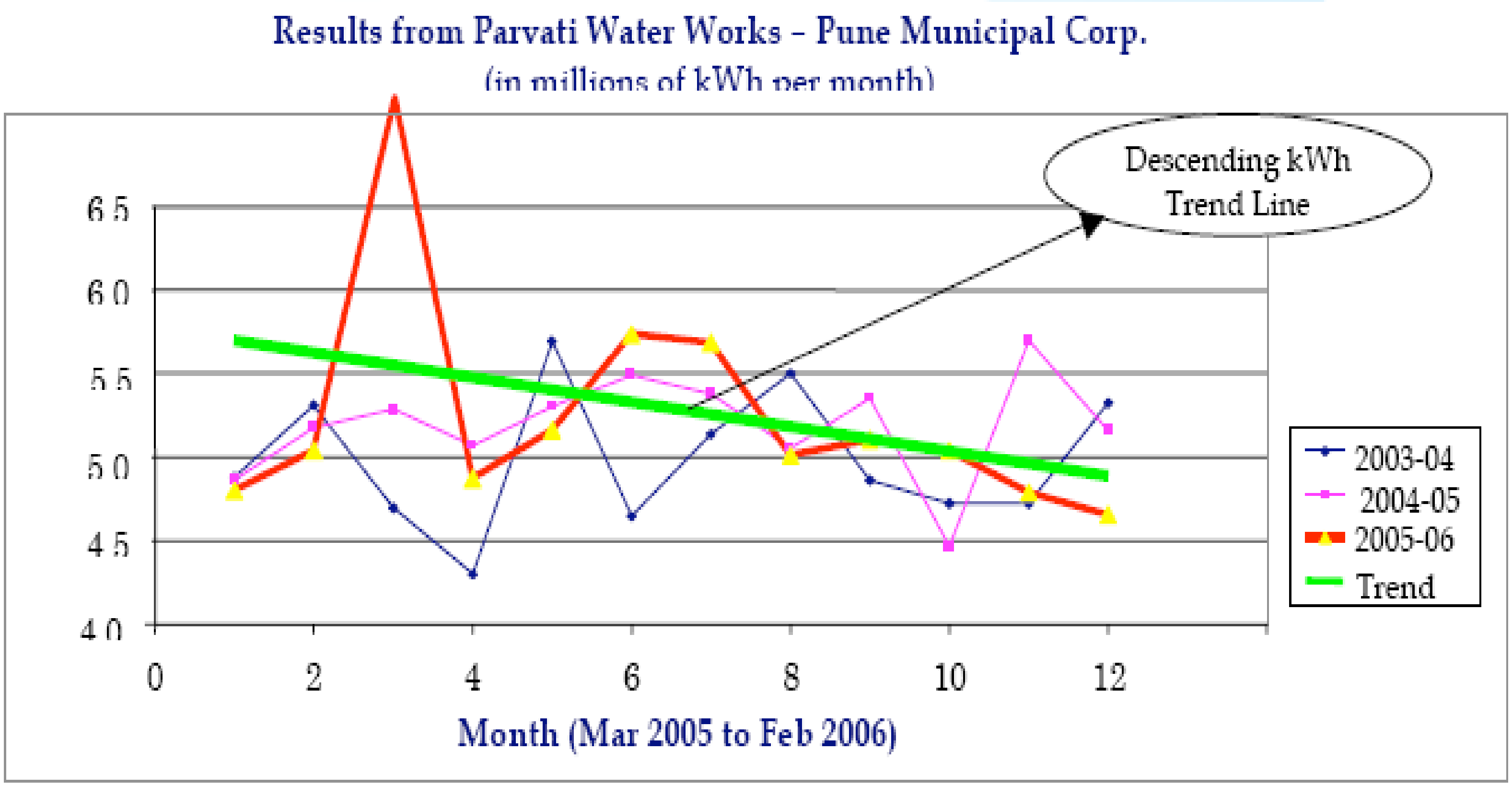
Type of Proposal	Nos. of EE Measures	Saving Potential, Rs. Lakh	Investment Required, Rs. lakh
No Cost (immediate)	10	31.1	0
Short Term (1 -12 months)	6	31.0	20 (Payback: 8 months)
Medium Term (1 – 2 years)	2	1.8	2.5 (Payback: 17 months)
Total	**18**	**63.9**	**22.5** **(Payback: 5 months)**

Vijaynagarm, Karimnagar

Energy Saving Potential Pune Municipal Corporation

Type of Proposal	No. of EE Measures	Annual Saving Potential Rs. Lakh	Cost of Implementation Rs. Lakh	Payback Period, months
Short term,	11	103.7	32	4
Medium term	4	42.1	55	16
Total	**15**	**145.8**	**87**	8

Pune Municipal Corporation



- Additional 10% Water Delivered

Tamil Nadu - Highlights

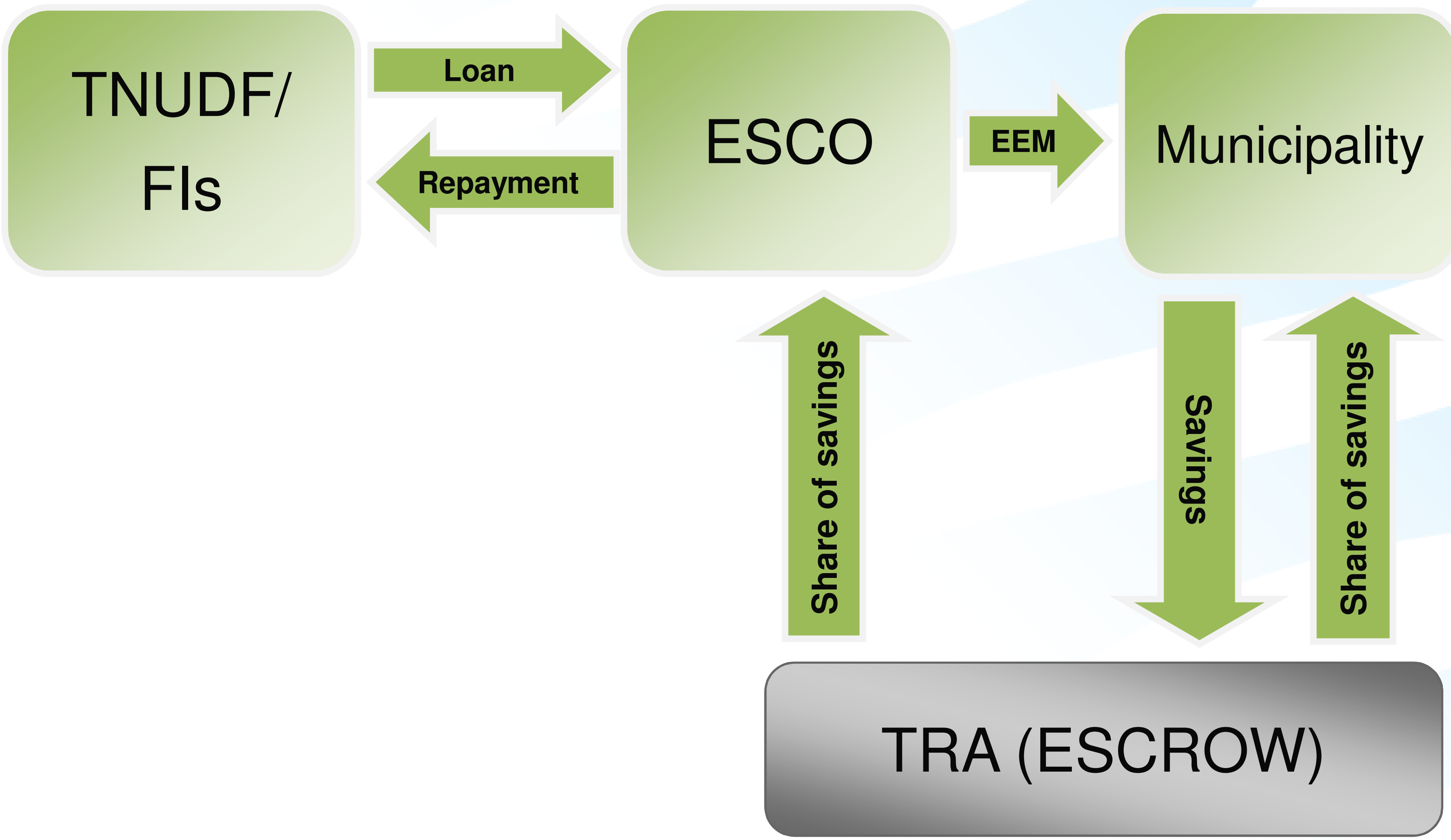
- Partnership with Tamil Nadu Urban Infrastructure Financial Services Limited (TNUIFSL), CMA, ULBs
- Implementing energy efficiency projects in 29 municipalities in water pumping and street lighting
- 2 Energy Service Companies implementing the project

- Bid Evaluation Process:
  - EOI – 13 Responses
  - RFP issued to 8
  - Responses to RFP - 6
  - LOI issued to 2 ESCOs
- IGA reports in discussion
- EPC between ULBs and ESCOs will be signed soon

Estimated Cost savings

US $ 800,000/year

Tamil Nadu Project – Implementation Model



Other Projects

- Delhi Jal Board
  - Low and medium cost measures implemented
  - Accruing Annual Savings of Rs. 7 Crore
  - Established Energy Management Cell
- Municipal Corporation of Greater Mumbai (MCGM)
  - Largest urban water supply system in India
  - Population - 11.9 million
  - 39 pumping station (152 + pumps) and 36 booster pumping stations
  - 2005-06 Energy consumptions- 250 Million kWh units (approx.)
  - Annual Energy bill - Rs. 815 million +
  - Projected Annual Energy savings-197 million kWh
  - CO_2 emission reduction- 175,238 Metric tones per year

Puducherry UT Water Supply System

Puducheery UT Water Supply System

- 4 key circles (Puducherry , Karaikal , Mahe , Yanam)
- Water supply managed by Public Water Works
- Reliance on Ground Water Resources (Bore wells)

As per Central Electricity Authority(CEA) – 18^{th} EPS Data

- Water Works Energy Consumption
  - 2010-11- 37.68 Million Unit (MU)
  - 2013-14 - 55.18 MU
  - 2021-22 - 107. 55 MU (approx. 300% growth)

- Estimated Energy Saving Potential @ 20-25% = 13.7 MU (for year 2013-14)

Present Per Capita Supply and Sewage Generated

Sl. No	*Particulars*	*Details*
1	Urban areas	135 LPCD
2	Rural areas	70 LPCD
3	Sewage generation	60 MLD
4	Sewage treated by PWD*	13 MLD
	Mode of disposal	Sea

*Modernization and expansion of existing Sewage Treatment Plants of Public Works Department with underground sewage transport facilities are in progress.

Policy Framework at the UT level

Puducherry Water Policy 2012 - State Water Policy with an operational action plan in order to achieve the desired objectives

<u>A few key highlights</u>

- Water Resource Planning, Institutional Mechanism
- Project Planning , Monitoring of Projects
- Ground Water Development
- Rain Water Harvesting
- Drinking Water
- Financial and Physical Sustainability
- Private Sector Participation
- Conservation
- Climate Change
- Performance Improvement, Training , Maintenance and Modernization

Lesson Learnt & Way Forward

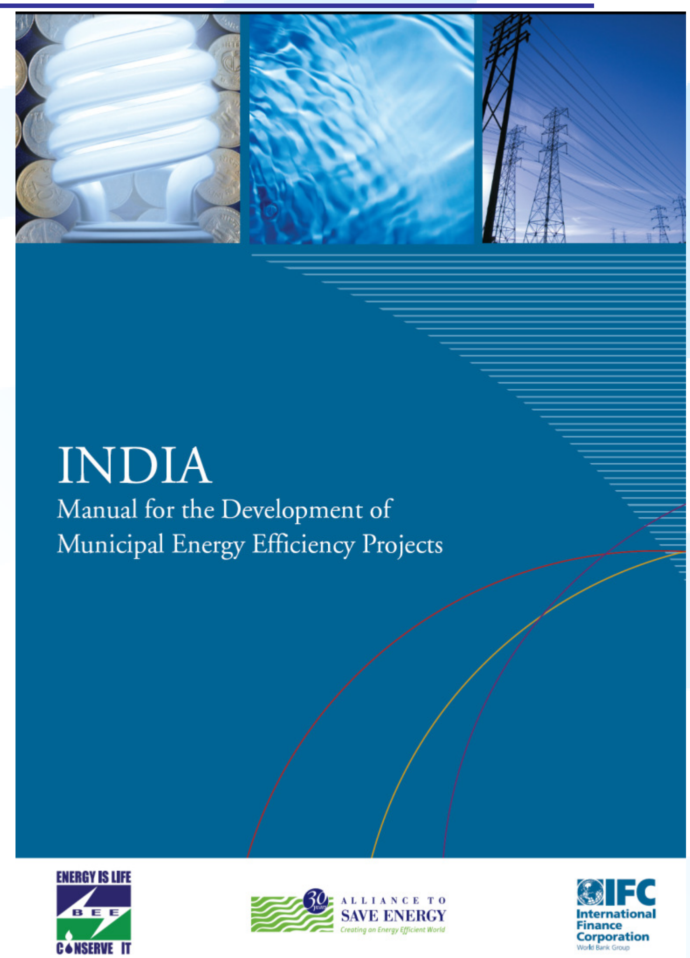
- Quality of data plays a crucial role in delivering performance
- Post project M&V is key to success
- EE projects should be a part of infrastructure development projects
- Performance related Uncertainties can’t be completely eliminated but reduced
- Most of the Cities doesn’t have capacity and capabilities to handle larger EE projects – needs to create dedicated energy management cell
- Project development time needs to be cut down

Lesson Learnt & Way Forward

- High turnover among government decision makers and staff can stall projects – needs institutlization of efforts
- Capacity of the project management committee members should be developed to enable them to carry out assessments and reviews
- Need to develop cost-effective M&V strategies to mitigate the risk associated with projects
- Capacity need to be build for M&V agency

Guidelines to Develop and Implement Municipal EE Projects

- Jointly released with Bureau of Energy Efficiency
- Targets:
  - Municipalities/ULB
  - EE services providers
  - Financial institutions
- Contains:
  - Step by step guidelines
  - Templates (RFPs, PCs, etc)



www. ase.org/resources/manual-development-municipal-energy-efficiency-projects

Define energy efficiency as a "Requirement" Not as an "Option" or "Choice"

For More Information:

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