Energy Efficiency Opportunities and Challenges in Water Supply System

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Energy and Resource Efficiency in Urban Water Management

Organised by CSE, New Delhi

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**
  - utilities
  - research
  - federal government (e.g., FEMP)
  - **industry**
  - appliances
  - policy
  - **buildings**
  - transportation
  - education
- 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

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
  - ✓**18,927 Million Units (2012-13)**
  - ✓**36,3297** Million Units (Estimated for 2021-22)
  - ✓Growth approx. 92% in 9 year

Data source: BEE/CEA 18EPS

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 manpower.
- 1/3 of India's urban population lacks direct access to clean, affordable and reliable water services

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's happening?

Energy Efficiency Challenges for Indian Cities

- Cities lack technical, managerial and financial capacity to design & 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
- 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 (*factor of safety margin*)
- Changes in operating practices/schedules – to cater the current needs (*pumping head changes*)
- Efficient component NOT installed and/or operated properly
- No existing Government policy on reducing energy consumption in water delivery;

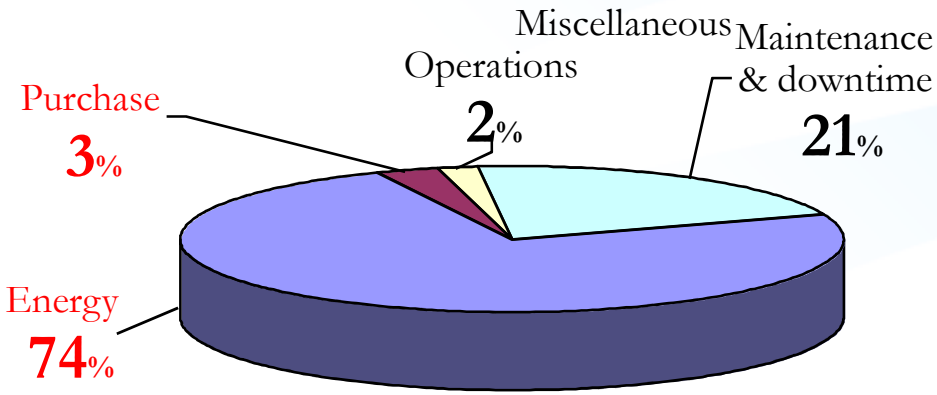
Why Oversized Pump ?

- 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 ?

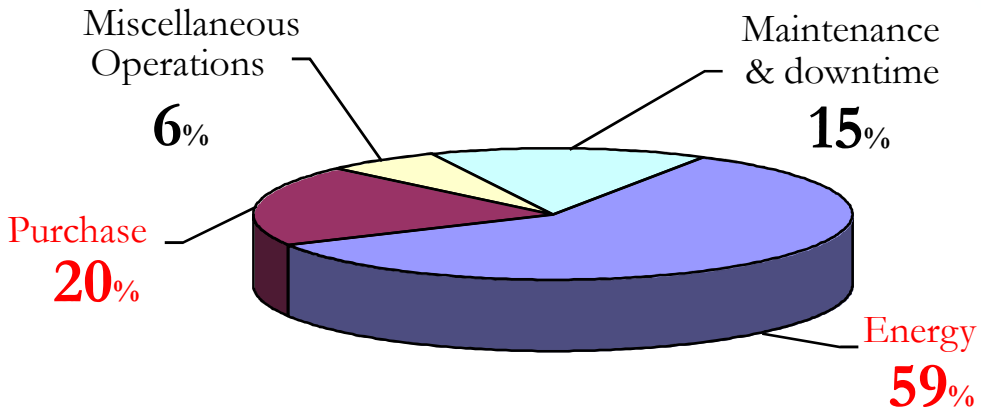
- Required flow- 150 LPS – after final calculation
- Design Engineer – 10-15 % extra – 12% (approx.)
- New Flow- 168 LPS
- Approval Committee – keeping future demand into consideration – Suggest – 10 % more
- Revised Flow – 185 LPS
- Purchasing Department – In View of better commercial deal Supplier 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 procurement
- **Final effect at operation end- Throttling to get reduced flow**

Life Cycle Cost of an Efficient vs. Inefficient Pump



- Purchase Price: $28,000
- 1st Yr Energy Cost: $69,000
- Total in Year One: $ **97,000**

Life Cycle Costing: Inefficient Pump



- Purchase Price: $56,000
- 1st Yr Energy Cost: $19,600
- Total In Year One : $75,600

Life Cycle Costing: Energy Efficient Pump

Benefits - Municipal Energy Efficiency

- **Extremely Cost Effective (20 to 40% saving potential)**
  - at least 4000 Million Units of energy savings
  - Simple Payback 2 to 3 years
  - Reduces the need for new infrastructure
- **Improved Municipal Services**
  - Time to incorporate best practices
  - Reduces the cost recovery margin
  - Enhanced service level

In National /State Interest

- Reduced energy intensity will help climate change mitigation efforts
- Reduce demand and supply gap at the national/state level

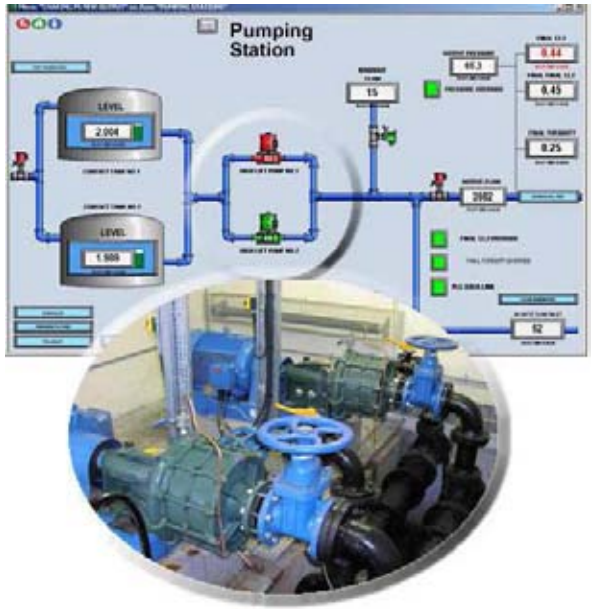
Energy Efficiency Measures – Water Supply Systems

Cost-Effective Interventions

- Pumps & Motors
- Leak Management(NRW)
- Automated Controls

Pipelines(Pressure Management)

Metering & Monitoring



Energy Assessment Findings in Typical Pumping Station

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

No/Low Cost Measures – Easy to implement

- Surrendering of Excess Contract Demand (KVA)
- Power factor Improvement (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 (*TOD tariff*)
- Star Mode operation: *Under-loaded motors*

Medium Cost Measures

- 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)

Measures to Improve Efficiency and Typical Payback Periods

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

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

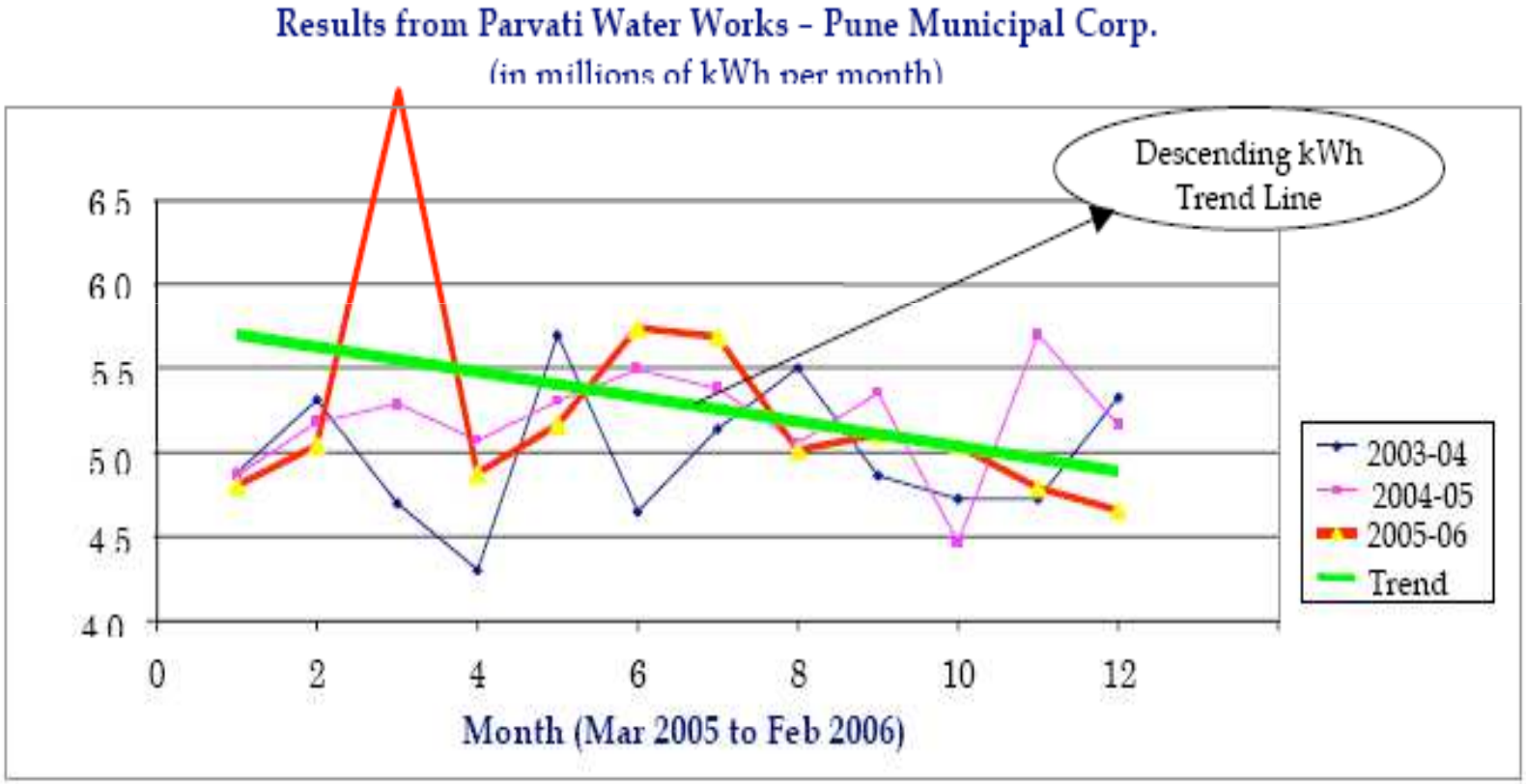
Type of Proposal	Nos. of EE Measures	Saving Potential, Rs. Lakh	Investment Required, Rs. lakh
No Cost (immediate)	10	31.1	0
Short Term (1 -12 months)	6	31.0	20 (Payback: 8 months)
Medium Term (1 – 2 years)	2	1.8	2.5 (Payback: 17 months)
Total	**18**	**63.9**	**22.5 (Payback: 5 months)**

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

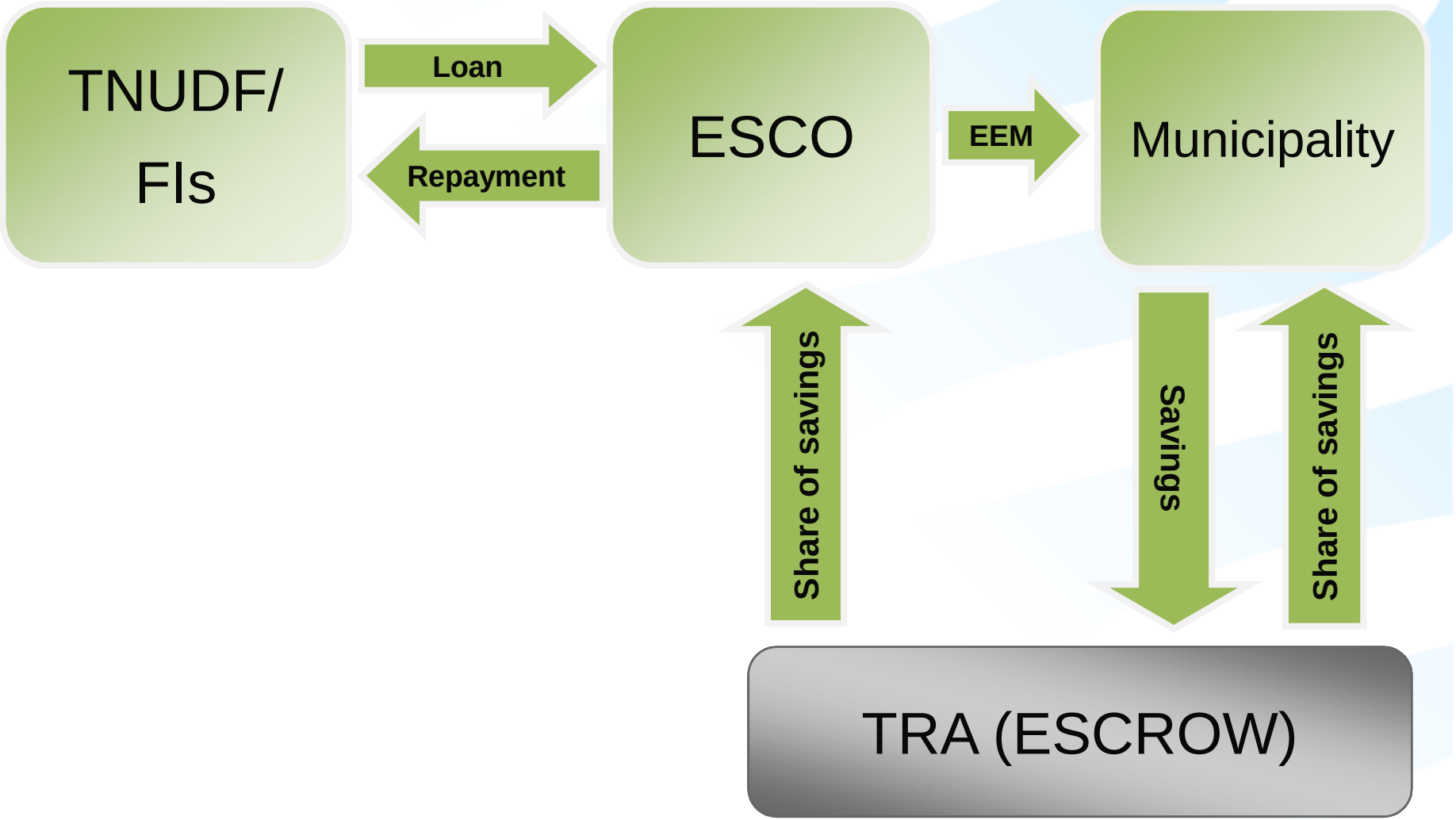
Tamil Nadu - Highlights

- 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
- Project Supported by REEEP

- 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
  - CO2 emission reduction- 175,238 Metric tones per year

Goa Water Supply System

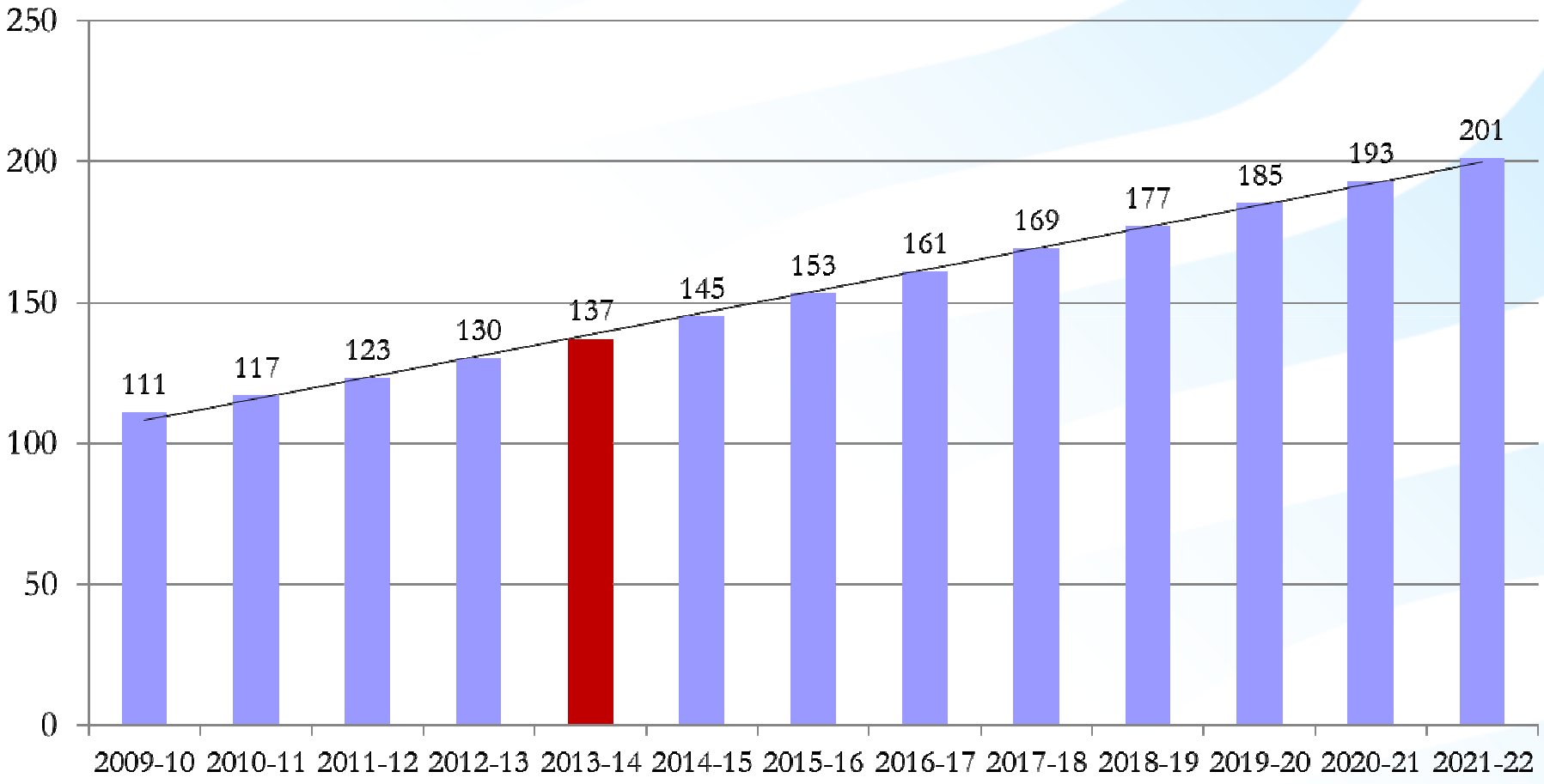
GOA Water Supply System

- Reliance on Surface Water
- Major sources *(Opa, Assonora, Sanquelim, Salaulim, Canacona, Dabose and Chandel)*
- Managed by Public Water Works

As per Central Electricity Authority(CEA) – 18th EPS report

- Water Works Energy Consumption
  - 2010-11- 117 Million Unit (MU)
  - 2013-14 – 137 MU
  - 2021-22 – 202 MU (approx. 85-90% growth over ten year)

Water Works Energy Consumption Growth Pattern-GOA



Estimated Energy Saving Potential @ 25% = 34 Million Unit (for year 2013-14)

Some facts…..

- Total water supplied = 464 MLD
- Water supply cost approx.– Rs 13-14 per cubic meter
- Till last five year it was around Rs 7-8 per cubic meter (80% increase)
- Consumer pay only Rs 2.5-3.5 per cubic meter

- Non Revenue Water(NRW) : 45%*
- Means, 209 MLD loss of treated water
- Revenue loss in the tune of 27 lacs/day…
- Approx.. energy expenditure in lost revenue lost (@20%**)= 5 lacs/day

- *JICA workshop*
- ** *ASE assessment*

Opportunities …..

- Total water supplied = 464 MLD
- Energy consumption as per CEA data= 137 MU (2013-14)
- Efficiency gain @ 25% = 29 MU (lighting and other load excluded for estimation purpose)
- Cost savings in the tune of 9 Crore per annum (energy cost @3/kwh)

η improvement will play a significant role in making cost recovery

- **JICA workshop*
- *** ASE assessment*




Costly potable water dow ×

articles.timesofindia.indiatimes.com/2013-03-22/goa/37935502_1_raw-water-water-requirement-verna-industrial-estate

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Costly potable water down the drain

Paul Fernandes, TNN Mar 22, 2013, 04.34AM IST

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Tags: PWD | potable water | GOACAN

PANAJI: Goa's citizens often suffer nightmares over their water requirement, but a sizeable quantum of the costly, treated tap water along with the tax-payers' money are washed away in several non-potable ways.

The PWD spends about Rs 70 lakh every day to treat 457 million litres of water to cater to Goa's 14-lakh population. Officials in the department explain that each cubic metre unit (1,000 litres) costs about 12 or more, but the domestic consumer receives it at a "very cheap rate of just 2.50 per cubic metre".

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Goa Government Initiative …..

- Incentive for better PF management
- Water & energy audit: Reimbursement of 25% of the cost of water and energy audit by a recognized institution/consultant
- Water & energy conservation equipment: Reimbursement of 25% of the cost of water and energy conservation equipment, subject to a cap of Rs. 100,000 per unit
- Fairly good % of metered connection
- NRW reduction program in place – from a present 45% to 20% within a period of six years. *

* News article, TOI

Other Key Drivers

- Gov. plan to increase water supply to 100 LPCD in rural areas and 150 LPCD in urban areas

That means,

  - implementation of new water supply projects
  - New pumping system, expanded pipeline,
  - Integrated sewage handing and treatments facilities
- Energy price is expected to keep increasing
- Water tariff – continued to be lowest ??

►►All these will lead to added expenditure on energy , required more budgetary allocation

What needs to be done …

A. Optimization of the existing pumping system and machineries (*energy audit, baseline establishment-kwh/mld, efficiency improvement, better O&M practices*, etc..)

B. Augmentation/Rehabilitation of the old pumping systems (*correct sizing of pumps and motors, remove capacity mismatch in parallel operation of pumps, pipeline replacement, re-routing of the transmission mains, application of booster pumps for farthest point)*

What needs to be done …cont..

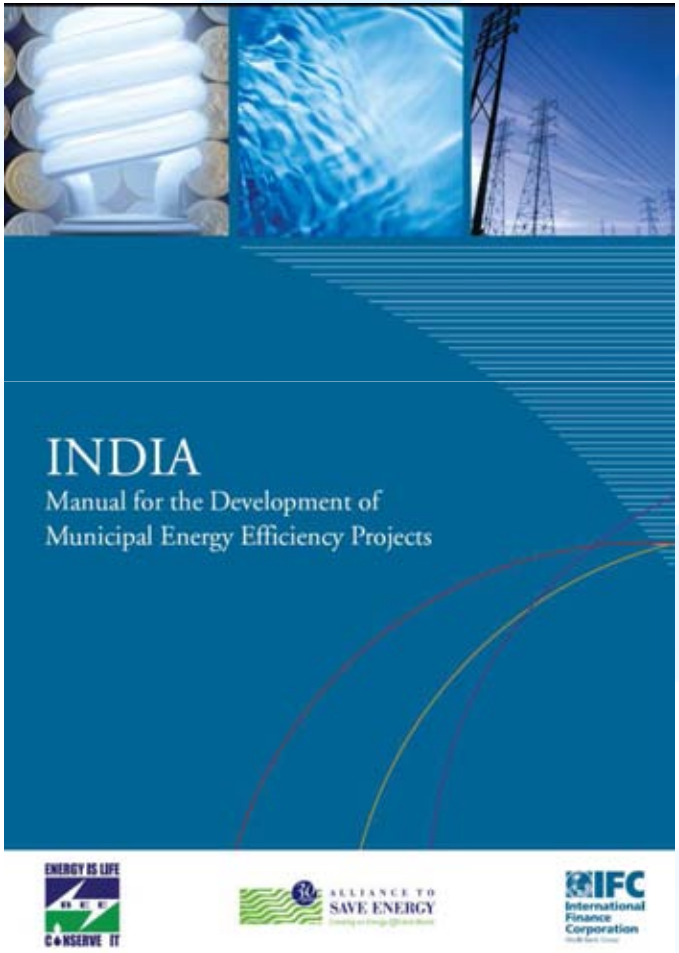
A. Integrated energy efficiency design approach – for implementing new water pumping and sewage project

- ✓ Efficient design and procurement of pumps and motors
- ✓ Adopt modular approach while considering forecasting (*pumps to be added periodically over a period of time, bigger pumps selection with small size impellers*, *adequate pressure mgmt. to avoid leakages, etc*..)
- ✓ Application of VFDs in variable load condition(*very effective for sewage pumping*)

►► JnNURM Phase II will gives importance to all these while selecting and approving projects..

Guidelines to Develop and Implement Municipal EE Projects

- Released with Bureau of Energy Efficiency and the Alliance
- 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"

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