5. Utilities 1: Water Management

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Pretoria, 15 October 2019
Training Overview

Utilities: Water Management

Scenario: Local residents are complaining about unreliable and costly drinking water supply

Question: What can you do to reduce energy use in the water sector and improve service delivery?
Training Overview

1. Energy use in water
   • Context: Water-energy nexus, increasing demand
   • Drivers of energy use

2. Tools: Strategies for energy efficiency
   • Reducing energy use; recover energy; time energy use

3. Activity: Barriers to water energy efficiency
Training Overview

• This session starts the municipal services section. Like other sessions we first call attention to the water sector and the importance of sustainable water service through energy efficiency.

• We examine the drivers of energy use in the water sector as this will be the basis of energy efficiency programmes in the water sector.

• We then go to a structured discussion of case studies of how energy efficiency is implemented, from energy use reduction, energy recovery, and demand side response.

• The activity is designed to organise the thoughts of participants towards consequences of barriers and the solutions possible. This allows them to map out possible barriers that might be silently affecting their revenues, hence their ability to take out a loan for EE investments.
1. Energy use in water
1. **Energy use in water: Context**

Share of population without access to electricity or water in rural areas

Access to safe drinking water and energy costs associated with it remains a challenge in developing and emerging economies.
Energy is needed to obtain, process, and distribute water and water is also needed to keep energy services running. Energy efficiency is hence, important to provide both services.

Source: https://www.iea.org/weo/water/
1. Energy use in water: Context in South Africa

The water supply and wastewater treatment sectors have the highest electricity efficiency savings potential among the electricity consuming sectors in South African municipalities.

1. Energy use in water: Drivers
1. Energy use in water: Drivers - Extraction

Source and location of water for extraction dictate the complexity of treatment and add extra energy use.
1. Energy use in water: Drivers - Treatment

Treatment technologies affect energy consumption and is highly influenced by the source of the raw water.

Source: https://www.researchgate.net/publication/257935517_The_unintended_energy_impacts_of_increased_nitrate_contamination_from_biofuels_production/figures?lo=1
1. Energy use in water: Drivers - Pumping

Pump motors run almost non-stop. Improperly sized pumps or inefficient motors result in higher energy cost. Technologies like VFD ensure high efficiency even with varying demand.

Source: EPRI Solutions (2005). Bringing Energy Efficiency to the Water & Wastewater Industry: How Do We Get There? WEFTEC

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Energy Costs in Water Supply

- Finished Water Pumping: 67%
- Water Treatment: 14%
- Raw Water Pumping: 11%
- In-Plant Water Pumping: 8%

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Extract, Extraction, Treatment, Use, End Use
1. Energy use in water: Drivers - Distribution and end-use

Leakage in distribution is estimated to contribute to additional 11% losses

Leakages, blockages, and scales in piping all contribute to higher pumping energy use for the same water service delivered

1. Energy use in water: Drivers - Sewage treatment

Sewage treatment depend on the conditions of the wastewater, but the major contributor to cost is the efficiency of the aerators and their motors.

1. Energy use in water: South Africa’s municipal context

Potential electricity savings per Sector (MWh/a) in 9 cities of the South African Cities Network (SACN)

![Pie chart showing percentage of energy use across different sectors]

Example of Energy Savings Performance Contract for Water Loss Reduction and EE Improvement in Emfuleni

- Competitive bidding process

- Municipal water utility Metsi-a-Lekoa of Emfuleni signed a water and energy performance contract with WRP Engineering Consulting Company under BOT- 5 year contract

- “Shared savings agreement” in the contract: WRP received remuneration based on verified energy and water savings
2. Tools: Strategies for energy efficiency
2. Tools: Strategies for energy efficiency

Reduce Energy use
- Energy management systems
- Improve motor efficiencies
- Improve controls

Recover Energy
- Anaerobic biodigestion of sewage to recover energy

Time Energy use
- Stagger activities towards off-peak hours
2. Tools: Strategies for energy efficiency

Reduce Energy use

- **Energy management systems** allow an organised approach of measurement and operational action towards saving energy.

- **Example: Brasilia Federal District Water EnMs**
  - Growing population, informal urban settlements, old pipes
  - Growing difficulty to provide service as demand increases
  - The provision of management systems allowed systematic identification of *water loss as major problem* due to adoption of management system.

http://www.acquacon.com.br/waterloss2010/presentations/day7/17h00eltongoncalvesdia07sala2.pdf
2. Tools: Strategies for energy efficiency.

Reduce Energy use

- Energy management systems
- Improve motor efficiencies
- Improve controls

Example: Brasilia Federal District EnMs (major steps)
- Conducted auditing and data collection
- Summarize sources of energy consumption

Images are representation only of the process undertaken and not the actual data of CAESB.

2. Tools: Strategies for energy efficiency. Reduce

- Energy management systems
- Improve motor efficiencies
- Improve controls

**Example: Brasilia Federal District EnMs**
- EnMs allowed them to measure **costs of water losses**, identify **billing problems**, and find optimum solutions based on cost and benefit. Resulted to immediate **25% reduction in water loss and energy savings** in the first 3 years

http://www.acquacon.com.br/waterloss2010/presentations/day7/17h00eltongoncalvesdia07sala2.pdf
2. Tools: Strategies for energy efficiency.

Reduce Energy Use

- Energy management systems
- Improve motor efficiencies
- Improve controls

- EnMS can be executed by third party through energy service performance contracts

**Case study:** Water Loss Reduction and EE Improvement in Emfuleni

- Competitive bidding process, “Shared savings agreement” where contractor received remuneration based on verified energy and water savings
  - 14, 250MWHr annual electricity savings
  - USD 3.8 M per year in savings
  - 7-8 million m3 annual water savings

2. Tools: Strategies for energy efficiency. Reduce

Reduce Energy use

- Energy management systems
- Improve motor efficiencies
- Improve controls

- Replacing motors: Savings could **go up to 1500 GWhr/yr** depending on motor size and hours of operation

Source: https://betterbuildingssolutioncenter.energy.gov
2. Tools: Strategies for energy efficiency. Reduce

Reduce Energy use

- Energy management systems
- Improve motor efficiencies
- Improve controls

**Example:** Motor replacement in wastewater aerators in Green Bay Wisconsin

50% reduction in electricity


2.14 GWh/year savings = 126 homes
2. Tools: Strategies for energy efficiency. Reduce

Reduce Energy use

- Energy management systems
- Improve motor efficiencies
- Improve controls

**Example:** Motor replacement in pumping in Columbus, Georgia

- 25% reduction in electricity
- $250,000 in energy cost
- 1-year payback period

2. Tools: Strategies for energy efficiency. Reduce

Reduce Energy use

- Energy management systems
- Improve motor efficiencies
- Improve controls

- Fluctuations in biological load can change over a 24-hr period, hence aeration could be adjusted if it were automatic. **Manual or poor control** can cause excess energy use by as **much as 50-65%**

Source: [https://betterbuildingssolutioncenter.energy.gov](https://betterbuildingssolutioncenter.energy.gov)
2. Tools: Strategies for energy efficiency. Recover

- Anaerobic biodigestion of sewage to recover energy

- Ramping up energy recovery helps achieve SDG 6.2 (sanitation for all) and SDG 6.3 (halving the percentage of untreated water) by 2030

https://www.iea.org/weo/water/
2. Tools: Strategies for energy efficiency. 

- **Example:** South Africa study with **2.21MW** of load shift achieved, with around **69k USD annual savings**

https://repository.nwu.ac.za/bitstream/handle/10394/15212/Els_LA_2015.pdf?sequence=1

- **Stagger activities towards off-peak hours**
2. Tools: Strategies for energy efficiency. Time

- **Example:** Electricity cost savings and opportunities in Ann Arbor > shifting filter backwash cycles to off-peak reduced energy costs from demand

- **Stagger activities towards off-peak hours**

  - **9000 USD investment**
  - **1500-2000 USD per month in cost savings**

Note: share of energy consumption was established after investing in monitoring equipment (EnMS feature)

[https://www.seventhwave.org/sites/default/files/222-1.pdf](https://www.seventhwave.org/sites/default/files/222-1.pdf)
2. Tools: Strategies for energy efficiency. Other Strategies

• **Subsidies:** Are the subsidies targeting the right people? Are they consumed by the rich or the industrial consumers?

• **Financing:** Is billing and collection easy? Is budget secured?

• **Training:** Are the operators capable of spotting energy efficiency problems and conducting the repairs and improvements needed?
3. Activity
### 3. Activity

On three tables, discuss consequences and possible solutions on the following barriers: regulatory/institutional; economic; information/capacity

#### Regulatory/Institutional

<table>
<thead>
<tr>
<th>Barrier</th>
<th>Consequence</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>...</td>
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#### Economic

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#### Information/Capacity

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<th>Regulatory/Institutional</th>
<th>Economic</th>
<th>Information/Capacity</th>
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</thead>
<tbody>
<tr>
<td>Politicised water/sewage tariffs</td>
<td>Low credit rating of water utilities</td>
<td>Inadequate management information about EE</td>
</tr>
<tr>
<td>Subsidised water/electricity</td>
<td>Small size of EE investments (individual EE measures)</td>
<td>Lack of knowledgeable operators doing EE</td>
</tr>
<tr>
<td>Budgeting structure constraints</td>
<td>Underdeveloped EE financing market</td>
<td></td>
</tr>
<tr>
<td>Roles and responsibilities of operational staff and procurement within the utility is fixed</td>
<td>Expensive EE technologies</td>
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3. Activity

ACTIVITY

(feel free to add additional barriers based on your experience)
### 3. Activity

#### Potential answers

<table>
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<tr>
<td></td>
<td>Politicised water/sewage tariffs</td>
<td>Lack of revenue, affecting revenue and subsequent capability to invest in EE improvements</td>
<td>Sectoral reform: increase financial sustainability as a priority along with social concerns on water</td>
</tr>
<tr>
<td></td>
<td>Subsidised electricity</td>
<td>Lack of revenue, affecting revenue and subsequent capability to invest in EE improvements</td>
<td>Subsidy reforms / sectoral reform</td>
</tr>
<tr>
<td></td>
<td>Budgeting structure constraints</td>
<td>Reliance on operating cost from municipality reduces incentive to invest in EE improvements</td>
<td>Sectoral reform: increase independence of utility to reduce reliance on municipality</td>
</tr>
<tr>
<td></td>
<td>Roles and responsibilities of operational staff and procurement within the utility is fixed</td>
<td>Lack of system-wide understanding and hence decisions regarding energy</td>
<td>Establish energy management team which has a mandate to control energy cost</td>
</tr>
</tbody>
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### 3. Activity

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<td>Low credit rating of water utilities</td>
<td>Difficult to access EE for investment</td>
<td>Part of national effort to increase EE policy framework, energy services and financing opportunities - Reduce risks through guarantee facilities - Bundling through 3rd party arrangements like ESCOs - Dedicated fund/credit lines - Tax credits for EE equipment (check colleagues at AE)</td>
<td></td>
</tr>
<tr>
<td>Small size of EE investments (individual EE measures)</td>
<td>Difficult to gain commercial bank attention for smaller loans</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underdeveloped EE financing market</td>
<td>Many financially attractive EE investments cannot be implemented</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expensive EE technologies</td>
<td>Difficult to justify practicality of purchase</td>
<td>Bulk purchasing could reduce price of supply</td>
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### 3. Activity

#### Potential answers

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|                      | Inadequate management/government information about EE | Lack of interest to support EE interventions | • Develop and disseminate case studies and good practices  
• Develop centralized platforms for knowledge sharing  
• Develop benchmarking and assessment tools to guide decision making  
• Awards and recognition |
|                      | Lack of knowledgeable operators doing EE | Inability to identify energy saving opportunities | • Conduct training and peer-to-peer learning  
• Learning energy efficiency networks ([Check Industry stream colleagues](https://www.esmap.org/sites/default/files/esmap-files/FINAL_EECI-WWU_TR001-12_Resized.pdf)) |
Resources
Resources


Resources

OECD Principles on Water Governance

Urban Water Supply and Sanitation in Southeast Asia
A Guide to Good Practice


Additional slides
In Southeast Asia, cost is high but often, the quality does not match the price.
Energy use in water: Drivers - Pumping

Pump motors run almost non-stop. Improperly sized pumps or inefficient motors result in higher energy costs. Technologies like VFD ensure high efficiency even with varying demand.

Source: http://www.gozuk.com/applications/vfd-for-pumps.html
Strategies for energy efficiency. Reduce

Reduce Energy use

- Energy management systems
- Improve motor efficiencies
- Improve controls

• Example: Leak management system allowing preventive maintenance and timing of replacement
