5. Utilities: Water Management

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IEA #energyefficientworld

5. Utilities: Water Management

Trainer(s): Mel Slade

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?

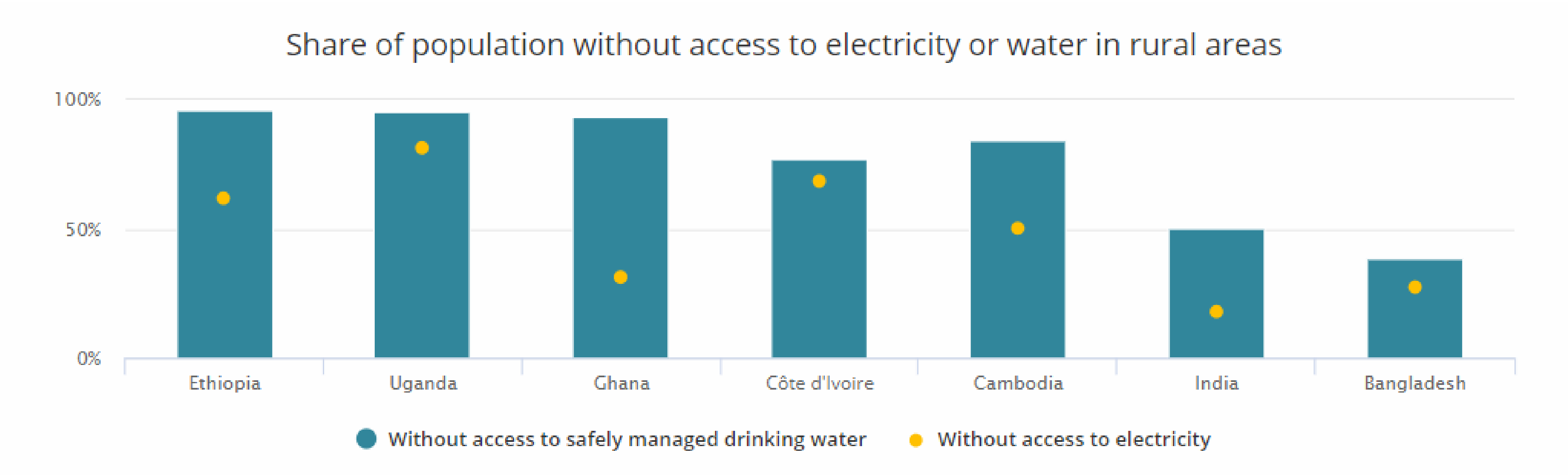
5. Utilities: Water and Sewage

1. **Energy use in water** — 10 mins
   - Context: Water-energy nexus, increasing demand
   - Drivers of energy use
2. **Tools: Strategies for energy efficiency** — 10 mins
   - Reducing energy use; recover energy; time energy use
3. **Activity : Barriers to water energy efficiency** — 30 mins
4. **What are the steps?** — 15 mins

1. Energy use in water

1. Energy use in water: Context

Where to start? | Tools | What are the steps?

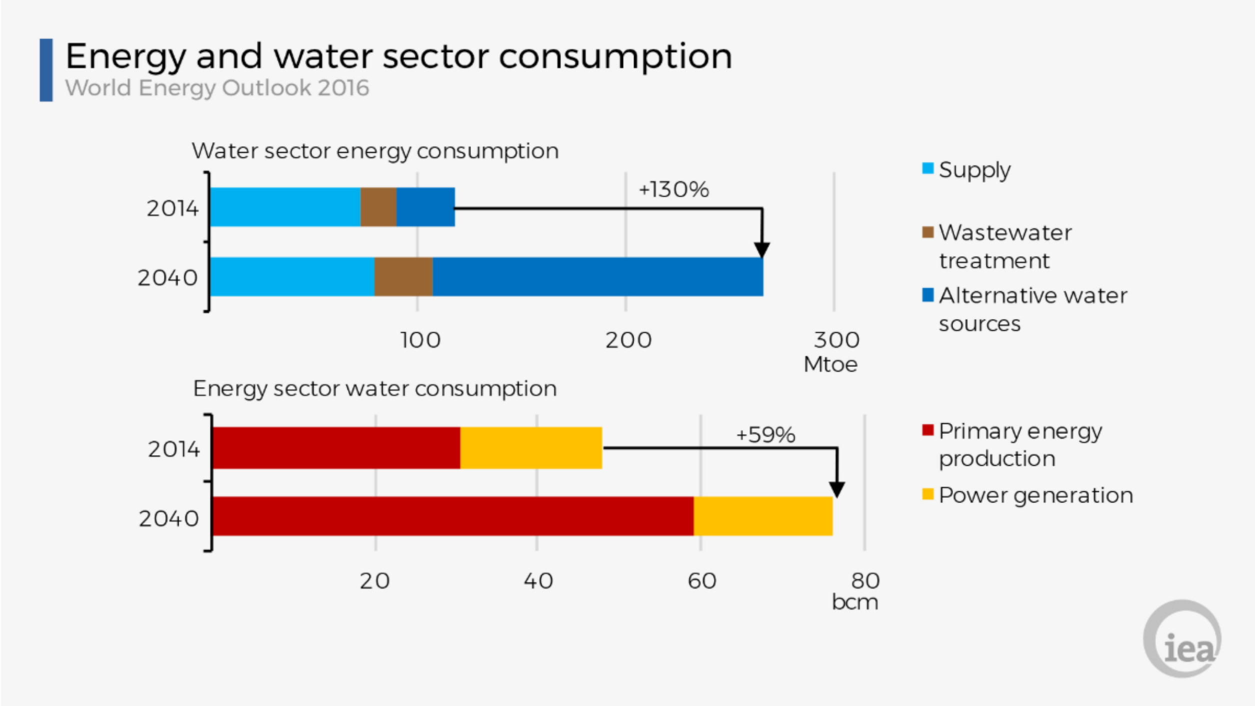


Access to safe drinking water and energy costs associated with it remains a challenge in developing and emerging economies

https://www.iea.org/weo/water/ Sources: IEA analysis, WHO/UNICEF JMP

1. Energy use in water: Context

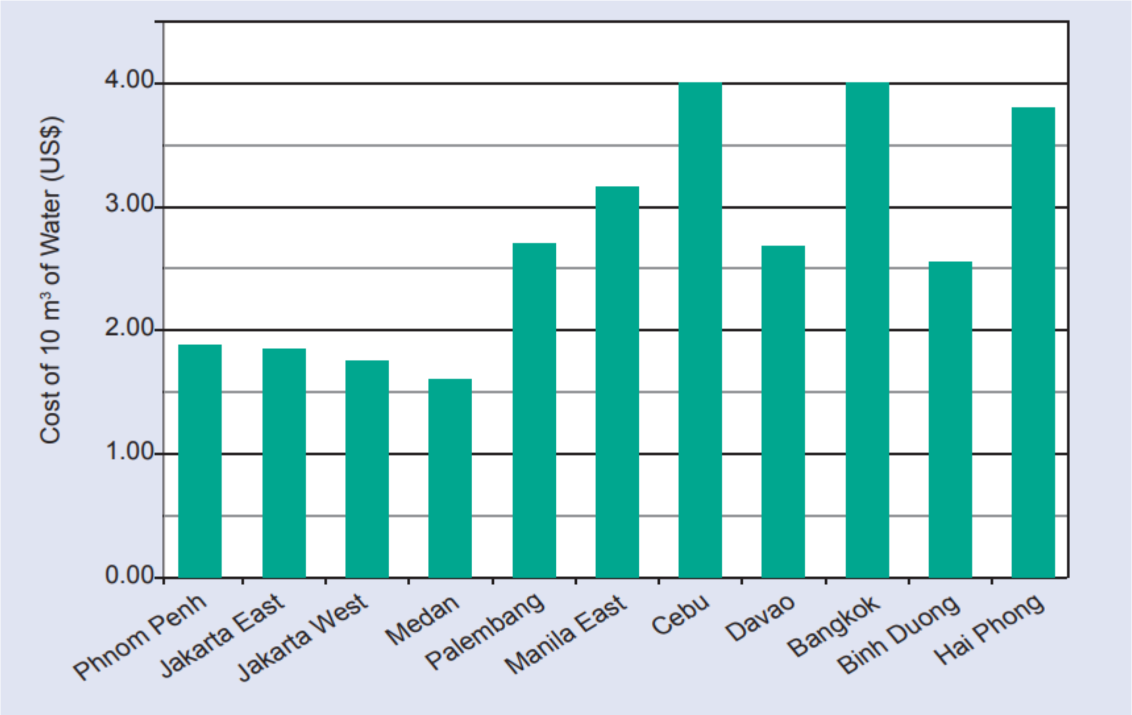
Where to start? | Tools | What are the steps?



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

1. Energy use in water: Context in Southeast Asia

Where to start? | Tools | What are the steps?

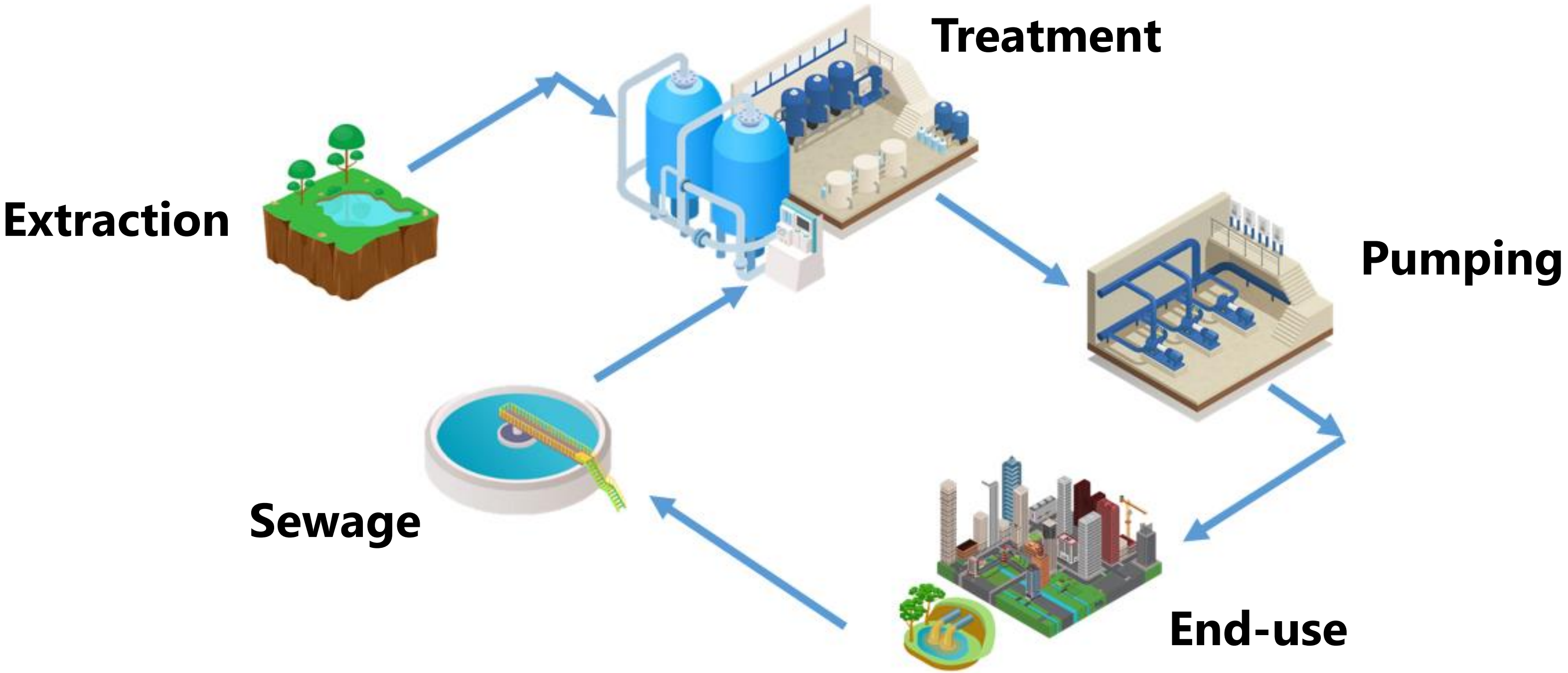


In Southeast Asia, cost is high but often, the quality does not match the price

https://www.pseau.org/outils/ouvrages/adb_urban_water_supply_and_sanitation_in_southeast_asia_a_guide_to_good_practice_2014.pdf

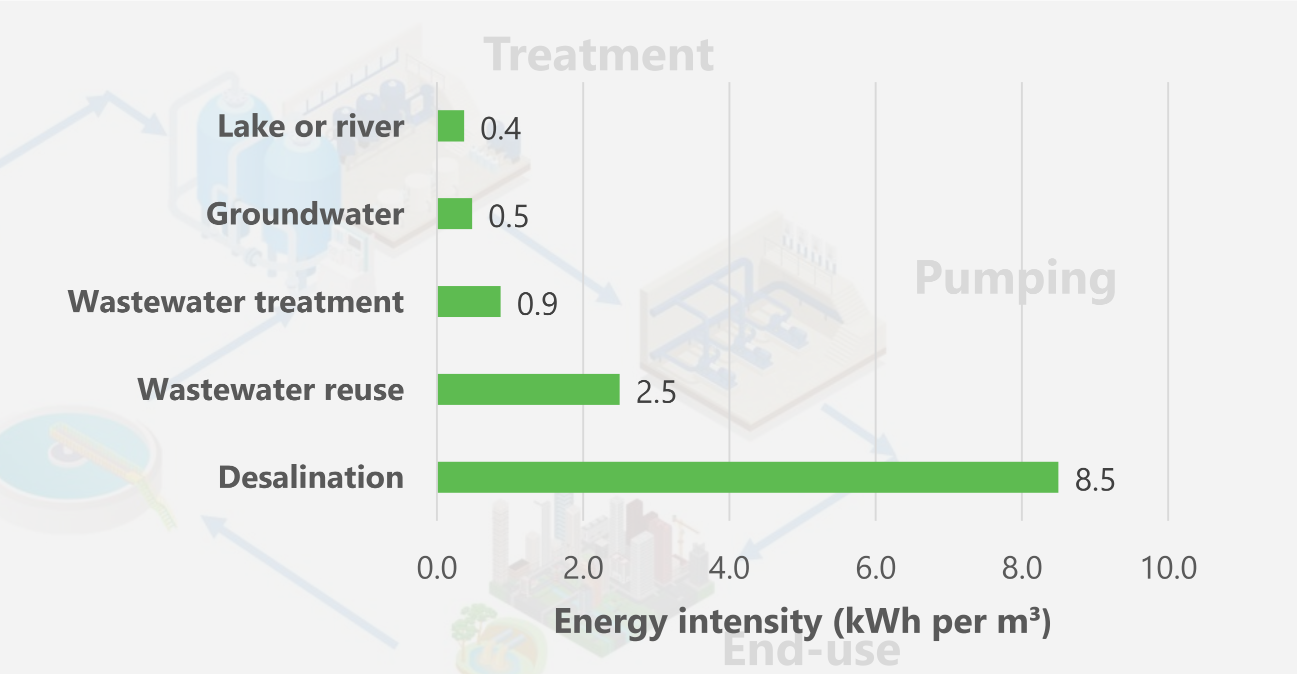
1. Energy use in water: Drivers

Where to start? | Tools | What are the steps?



1. Energy use in water: Drivers - Extraction

Extraction

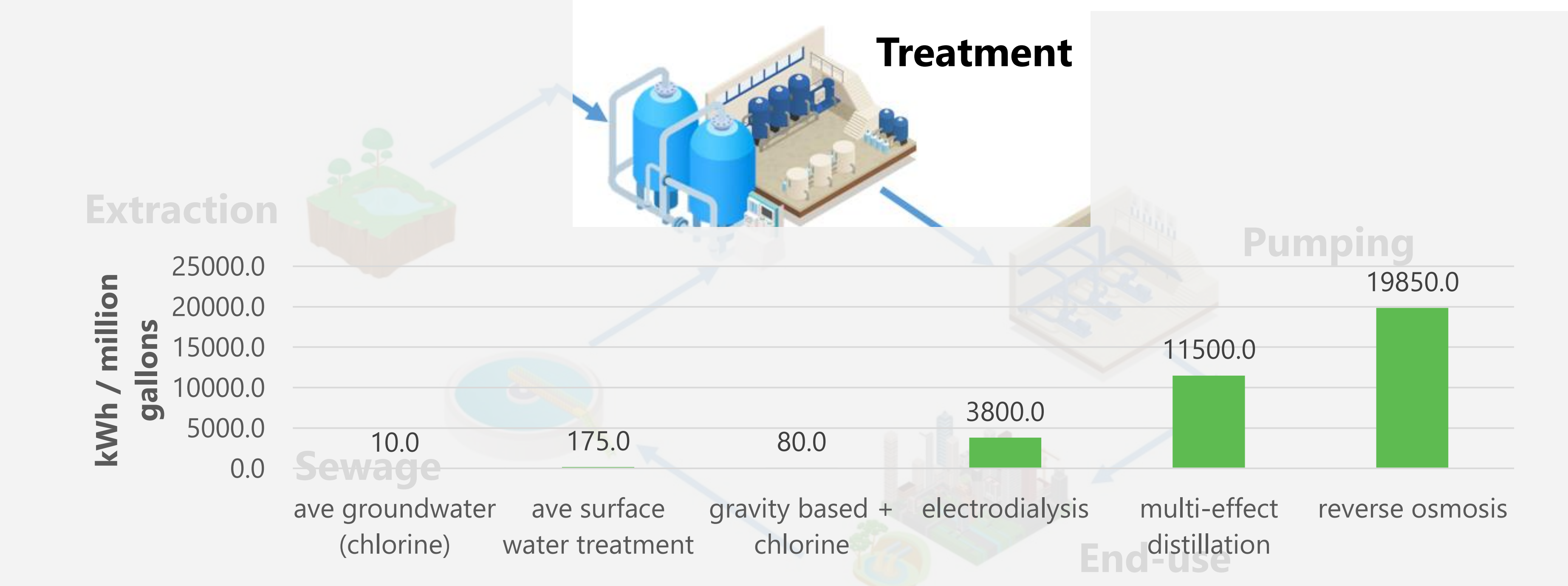


Source EPRI Water and Sustainability Volume 4 https://www.epri.com/#/pages/product/1006787/

Source and location of water for extraction dictate the complexity of treatment and add extra energy use

1. **Energy use in water:** Drivers - Treatment

Where to start? | Tools | What are the steps?

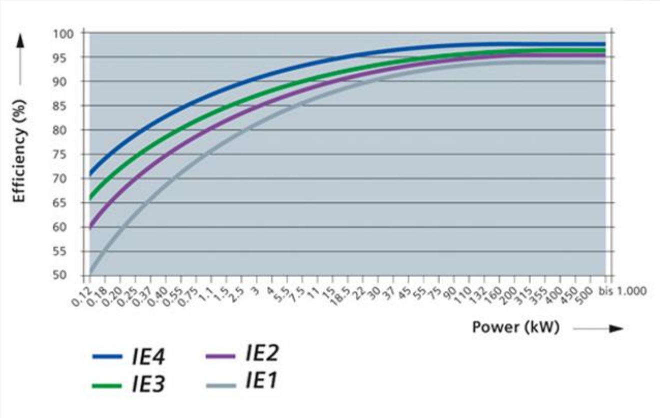


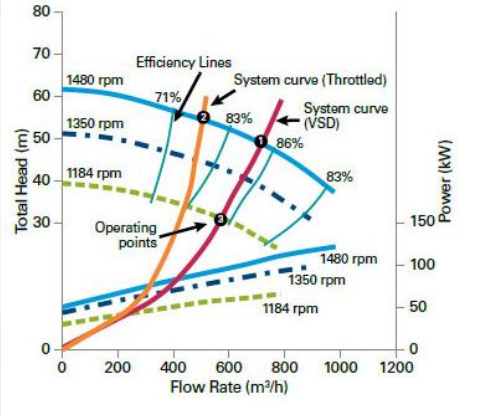
https://www.researchgate.net/publication/257935517_The_unintended_energy_impacts_of_increased_nitrate_contamination_from_biofuels_production/figures?lo=1

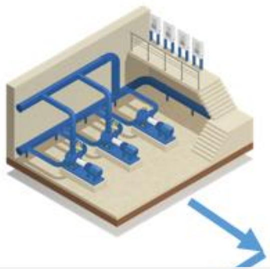
Treatment technologies affect energy consumption and is highly influenced by the source of the raw water

1. **Energy use in water:** Drivers - Pumping

Where to start? | Tools | What are the steps?







Pumping

Source http://www.gozuk.com/applications/vfd-for-pumps.html

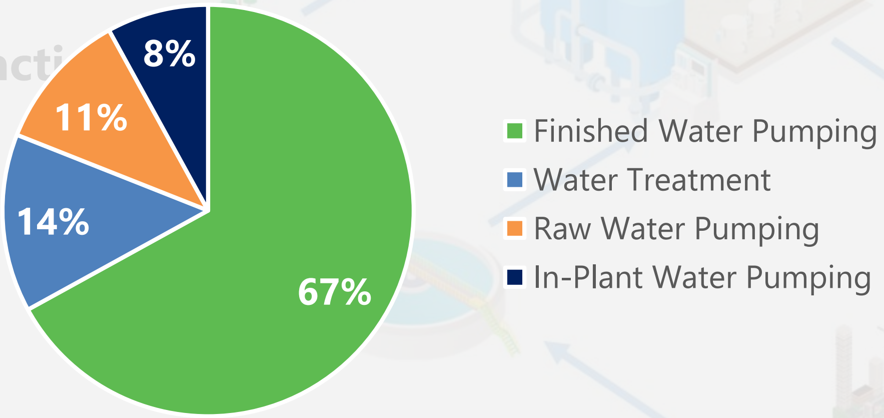
Source https://w3.siemens.com/drives/global/en/motor/low-voltage-motor/efficiency-standards

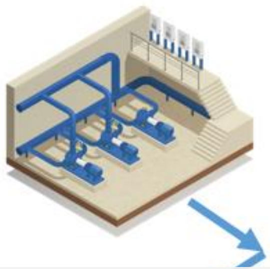
Pump motors run almost non-stop. Improperly sized pumps or inefficient motors result to higher energy cost. Technologies like VFD ensure high efficiency even with varying demand

1. **Energy use in water:** Drivers - Pumping

Where to start? | Tools | What are the steps?

Energy Costs in Water Supply





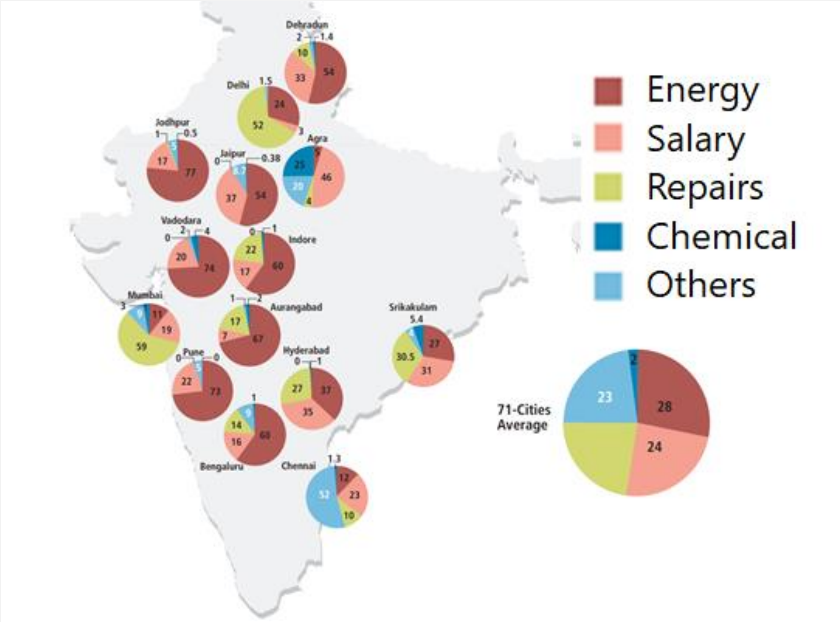
Pumping

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

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

1. **Energy use in water:** Drivers - Distribution and end-use

Where to start? | Tools | What are the steps?



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

Source [Mainstreaming Energy Efficiency in Urban Water and Waste Water, Centre for Science and Environment India 2017], [Excreta Matters 2012 CSEI]

Treatment

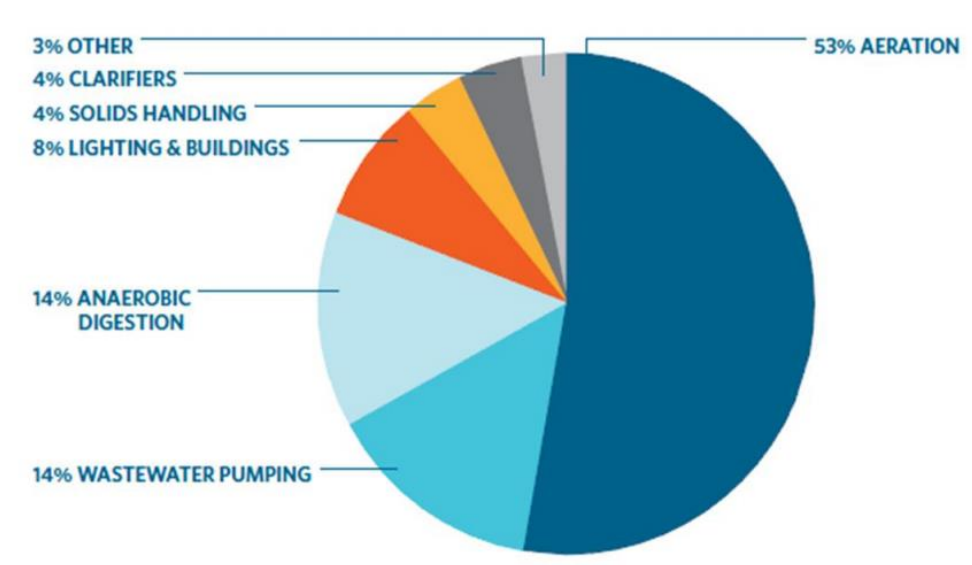
Pumping

End-use

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

Where to start? | Tools | What are the steps?



End-use

Source: Wastewater Treatment Energy Savings Guide: Energy Trust of Oregon

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

2. Tools: Strategies for energy efficiency

2. Tools: Strategies for energy efficiency

Where to start? → **Tools** → What are the steps?

Reduce Energy use

- Energy management systems
- Improve motor efficiencies
- Improve controls

Recover Energy

- Anaerobic biodigestion of sewage to recover energy

Time Energy use

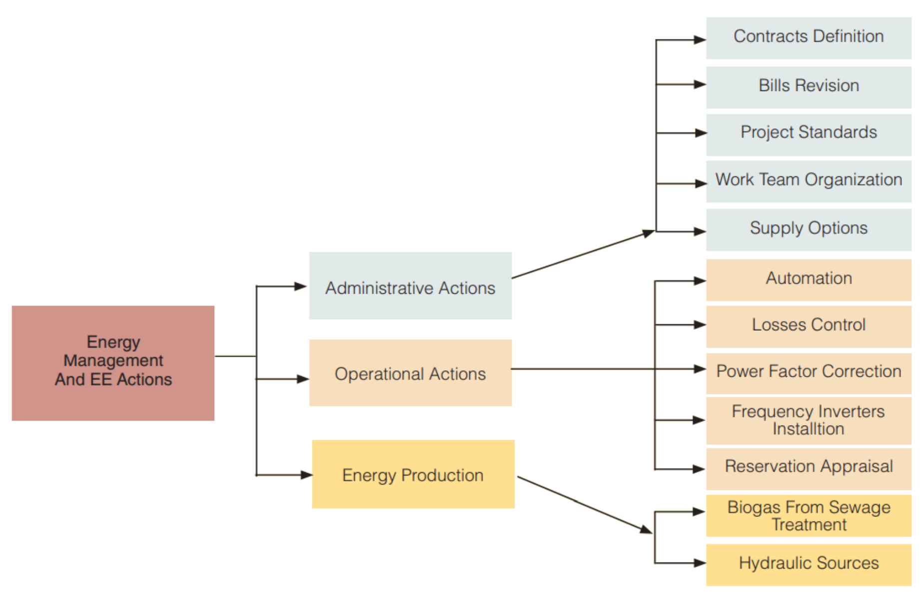
- Increase water reservoir capacity to free up time to conduct treatment and other activities during off-peak hours

2. Tools: Strategies for energy efficiency. Reduce

Reduce Energy use

- **Energy management systems**
- Improve motor efficiencies
- Improve controls

- Example: Brasilia Federal District Water energy management structure



https://www.esmap.org/sites/default/files/esmap-files/FINAL_EECI-WWU_TR001-12_Resized.pdf

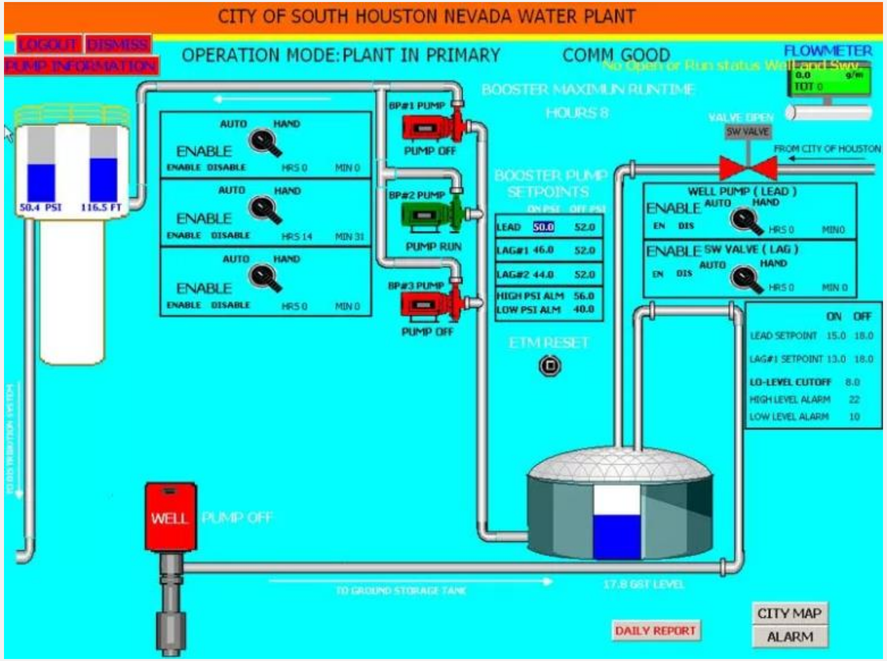
2. Tools: Strategies for energy efficiency. Reduce

Where to start? | **Tools** | What are the steps?

Reduce Energy use

- **Energy management systems**
- Improve motor efficiencies
- Improve controls

- Example: Use of SCADA in South Houston

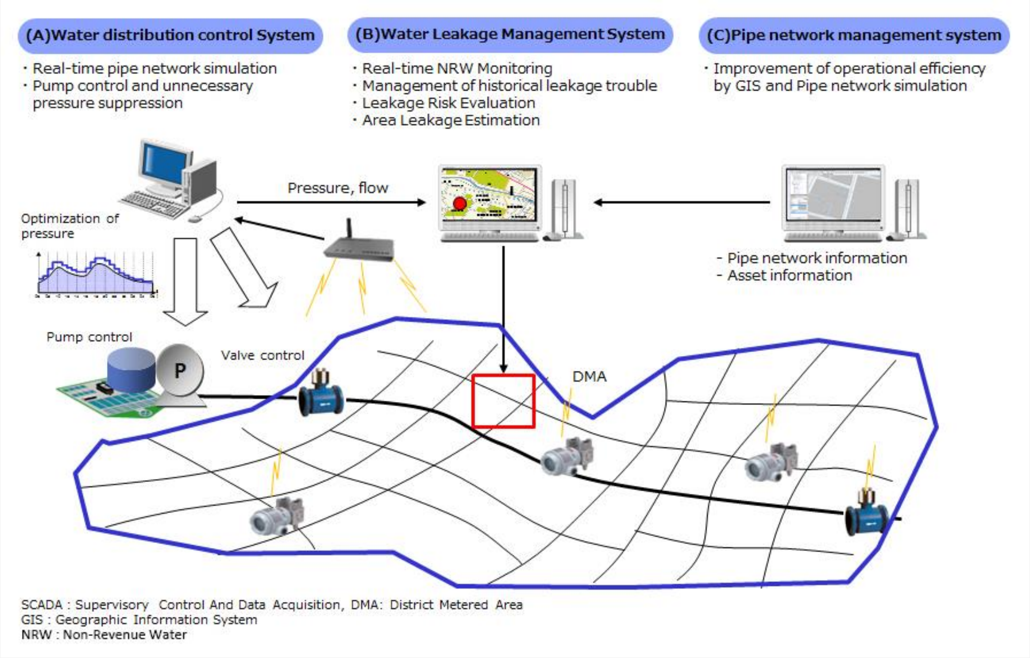


Source https://www.defensemedianetwork.com/stories/water-utilities-scada-systems-proven-vulnerable-cyber-attack/

Reduce Energy use

- **Energy management systems**
- Improve motor efficiencies
- Improve controls

- Example: Leak management system



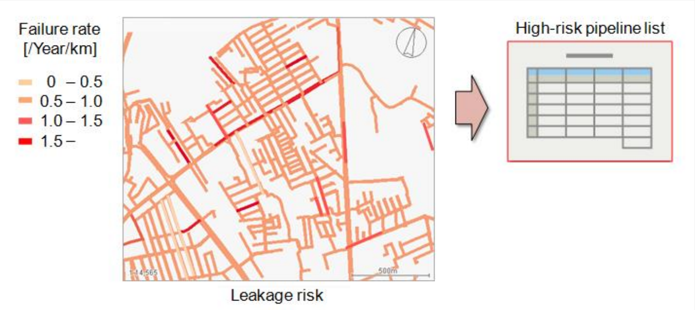
Source http://www.hitachi.com/businesses/infrastructure/product_site/water_environment/water_leakage/index.html

Reduce Energy use

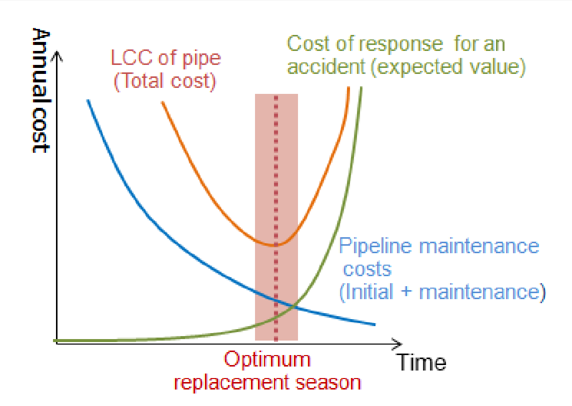
- **Energy management systems**
- Improve motor efficiencies
- Improve controls

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

Preventive maintenance



Timing of replacement



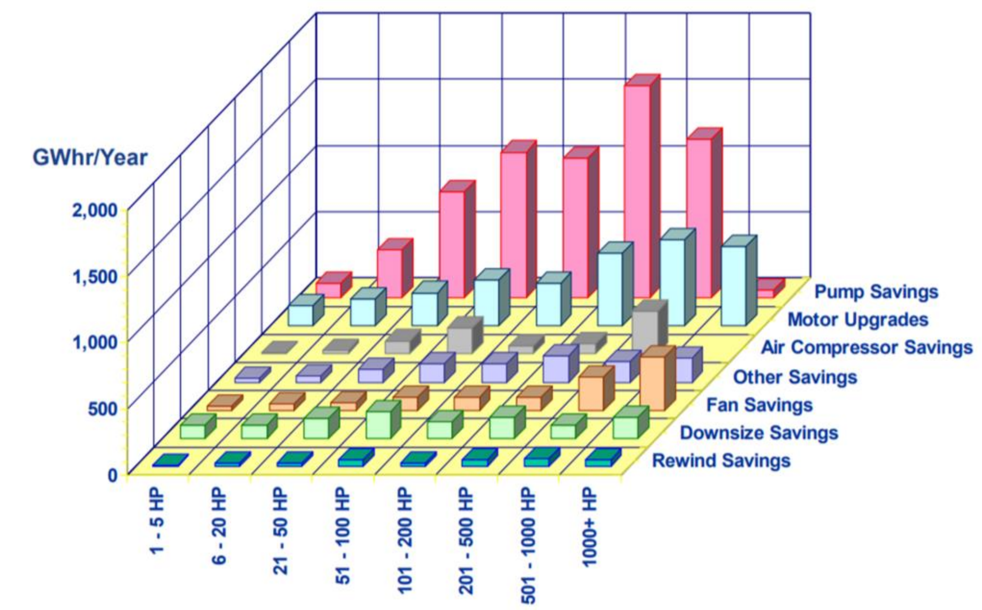
Source https://www.viavisolutions.com/en-us/products/seeker-d-mca-iii

2. Tools: Strategies for energy efficiency. Reduce

Reduce Energy use

- Energy management systems
- **Improve motor efficiencies**
- Improve controls

- Savings based on the sizes of the motors and hours of operation could **go up to 1500 GWhr/yr**



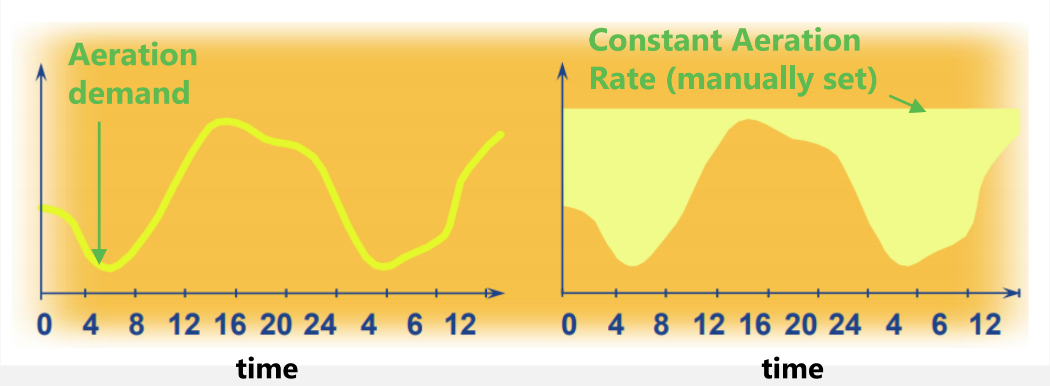
Source https://betterbuildingssolutioncenter.energy.gov

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

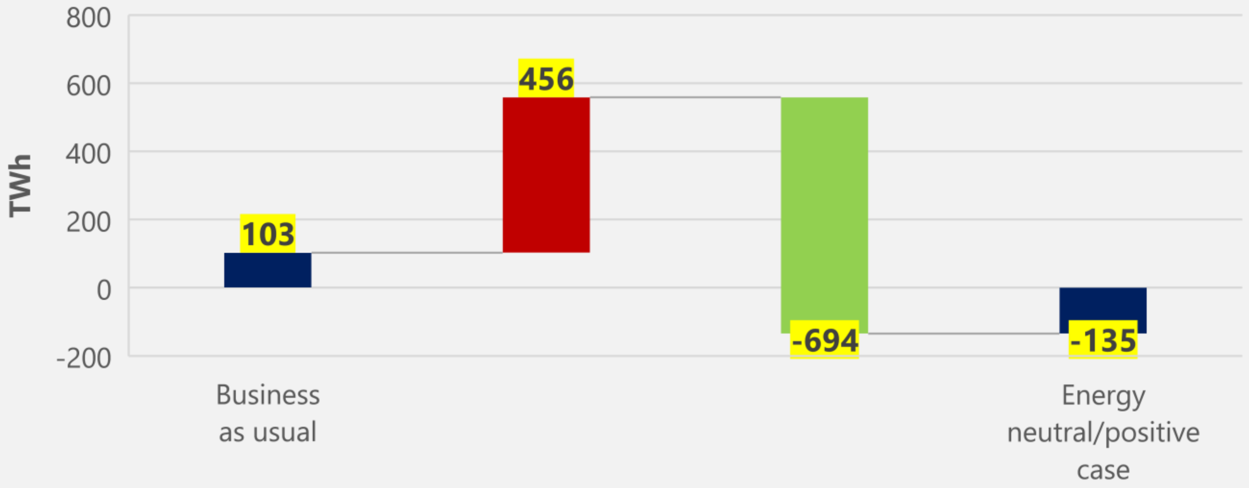
2. Tools: Strategies for energy efficiency. Recover

Where to start? | Tools | What are the steps?

Recover Energy

- **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



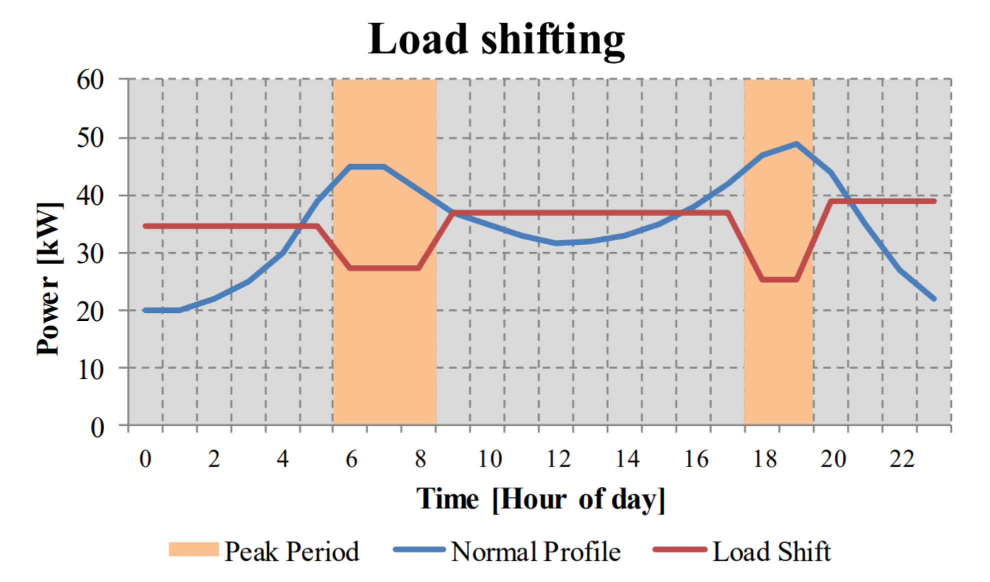
https://www.iea.org/weo/water/

2. Tools: Strategies for energy efficiency. Time

Time Energy use

- **Increase water reservoir capacity to free up time to conduct treatment and other activities during off-peak hours**

- 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

2. Tools: Strategies for energy efficiency. Other Strategies

Where to start? | Tools | What are the steps?

- **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

Where to start? › Tools › **What are the steps?**

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

Regulatory/Institutional

Barrier	Consequence	Solution
…	…	…

Economic

Barrier	Consequence	Solution
…	…	…

Information/Capacity

Barrier	Consequence	Solution
…	…	…

3. Activity

Where to start? | Tools | What are the steps?

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

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

https://www.esmap.org/sites/default/files/esmap-files/FINAL_EECI-WWU_TR001-12_Resized.pdf

ACTIVITY

(feel free to add additional barriers based on your experience)

3. Activity

Where to start? | Tools | What are the steps?

Potential answers

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

https://www.esmap.org/sites/default/files/esmap-files/FINAL_EECI-WWU_TR001-12_Resized.pdf

3. Activity

Where to start? | Tools | What are the steps?

Potential answers

Economic		
Barrier	**Consequence**	**Solution**
Low credit rating of water utilities	Difficult to access EE for investment	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)**
Small size of EE investments (individual EE measures)	Difficult to gain commercial bank attention for smaller loans	
Underdeveloped EE financing market	Many financially attractive EE investments cannot be implemented	
Expensive EE technologies	Difficult to justify practicality of purchase	Bulk purchasing could reduce price of supply

https://www.esmap.org/sites/default/files/esmap-files/FINAL_EECI-WWU_TR001-12_Resized.pdf

3. Activity

Where to start? › Tools › What are the steps?

Potential answers

Information/Capacity		
Barrier	**Consequence**	**Solution**
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

4. What are the steps?

https://www.epa.gov/sites/production/files/2015-08/documents/wastewater-guide.pdf

4. What are the steps?

Plan	***Step 1. Get Ready*** ▪ Establish the facility's energy policy and overall energy improvement goals ▪ Secure and maintain management commitment, involvement and visibility ▪ Choose an energy "fenceline" ▪ Establish energy improvement program leadership ▪ Secure and maintain employee and management buy-in ***Step 2. Assess Current Energy Baseline Status*** ▪ Establish a baseline and benchmark facilities ▪ Perform an energy audit ▪ Identify activities and operations that consume the most energy or are inefficient ***Step 3. Establish an Energy Vision and Priorities for Improvement*** ▪ Identify, evaluate, and prioritize potential energy improvement projects and activities ***Step 4. Identify Energy Objectives and Targets*** ▪ Establish energy objectives and targets for priority improvement areas ▪ Define performance indicators

https://www.epa.gov/sites/production/files/2015-08/documents/wastewater-guide.pdf

4. What are the steps?

Do	***Step 5. Implement Energy Improvement Programs and Build a Management System to Support Them*** ▪ Develop action plans to implement energy improvements ▪ Get top management's commitment and approval ▪ Develop management system "operating controls" to support energy improvements ▪ Begin implementation once approvals and systems are in place
Check	***Step 6. Monitor and Measure Results of the Energy Improvement Management Program*** ▪ Review what the facility currently monitors and measures to track energy use ▪ Determine what else the facility needs to monitor and measure its priority energy improvement operations ▪ Develop a plan for maintaining the efficiency of energy equipment ▪ Review the facility's progress toward energy targets ▪ Take corrective action or make adjustment when the facility is not progressing toward its energy goals ▪ Monitor/reassess compliance status

https://www.epa.gov/sites/production/files/2015-08/documents/wastewater-guide.pdf

4. What are the steps?

Act	***Step 7. Maintain the Energy Improvement Program*** ▪ Continually align energy goals with business/operation goals ▪ Apply lessons learned ▪ Expand involvement of management and staff ▪ Communicate success

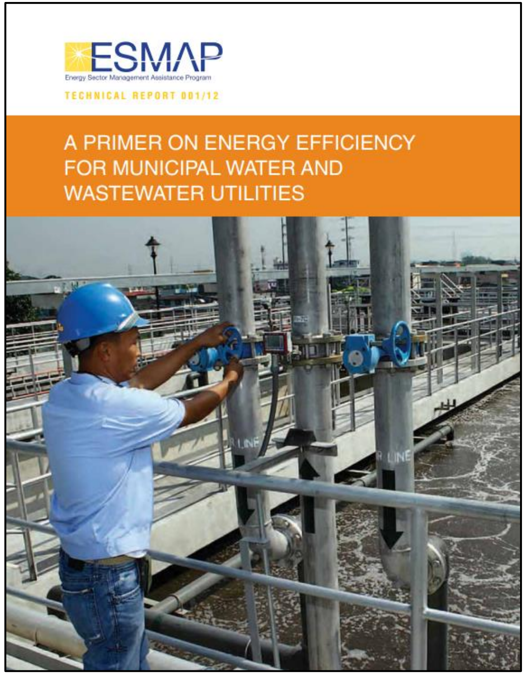
https://www.epa.gov/sites/production/files/2015-08/documents/wastewater-guide.pdf

Key Resources

WORLD BANK GROUP

ESMAP

Energy Sector Management Assistance Program



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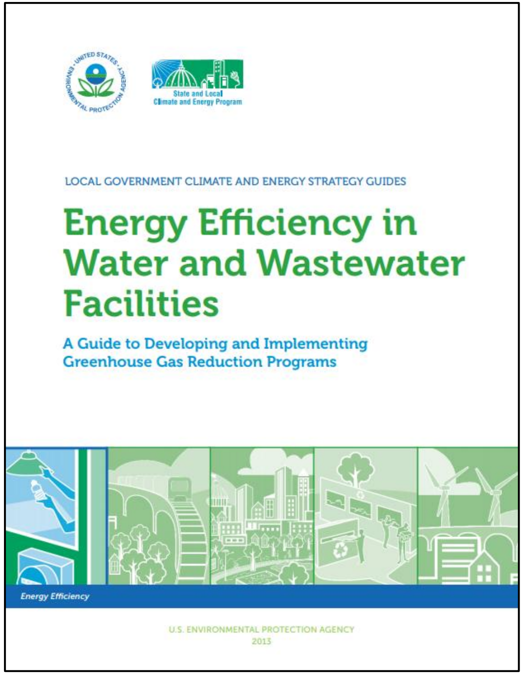

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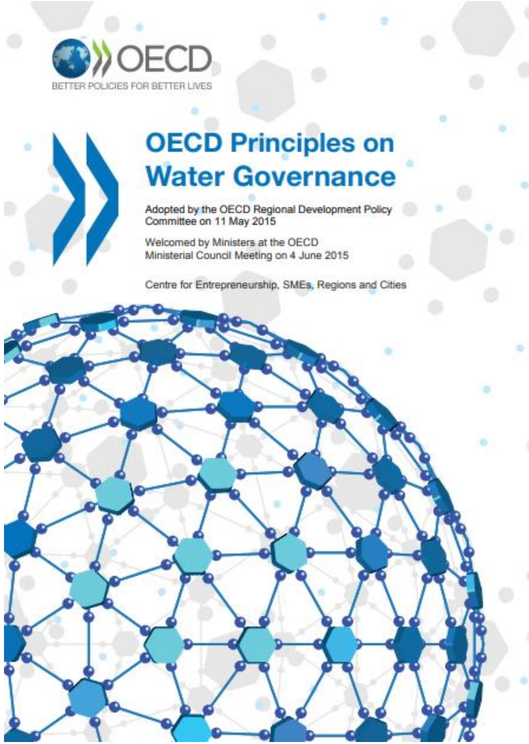
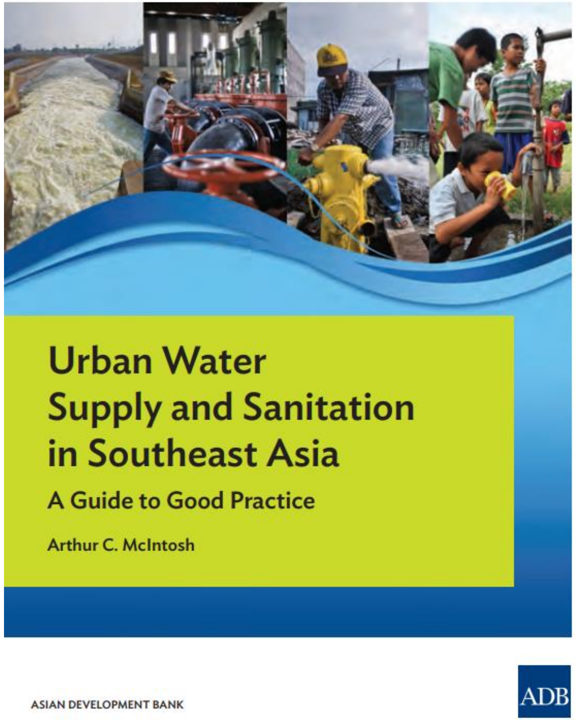
Key Resources



http://www.oecd.org/cfe/regional-policy/OECD-Principles-on-Water-Governance.pdf



https://www.pseau.org/outils/ouvrages/adb_urban_water_supply_and_sanitation_in_southeast_asia_a_guide_to_good_practice_2014.pdf

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