NYSERDA Focus on Municipal Water and Wastewater Facility Energy Efficiency

Basic Operator Training

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Under contract with NYSERDA

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Understanding Energy Use

You will understand your electricity bill and what affects energy costs.

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Energy and the Environment

- Sustainability
- Global Warming
- Limited Natural Resources
- Physical and Economic Impact of Energy Use

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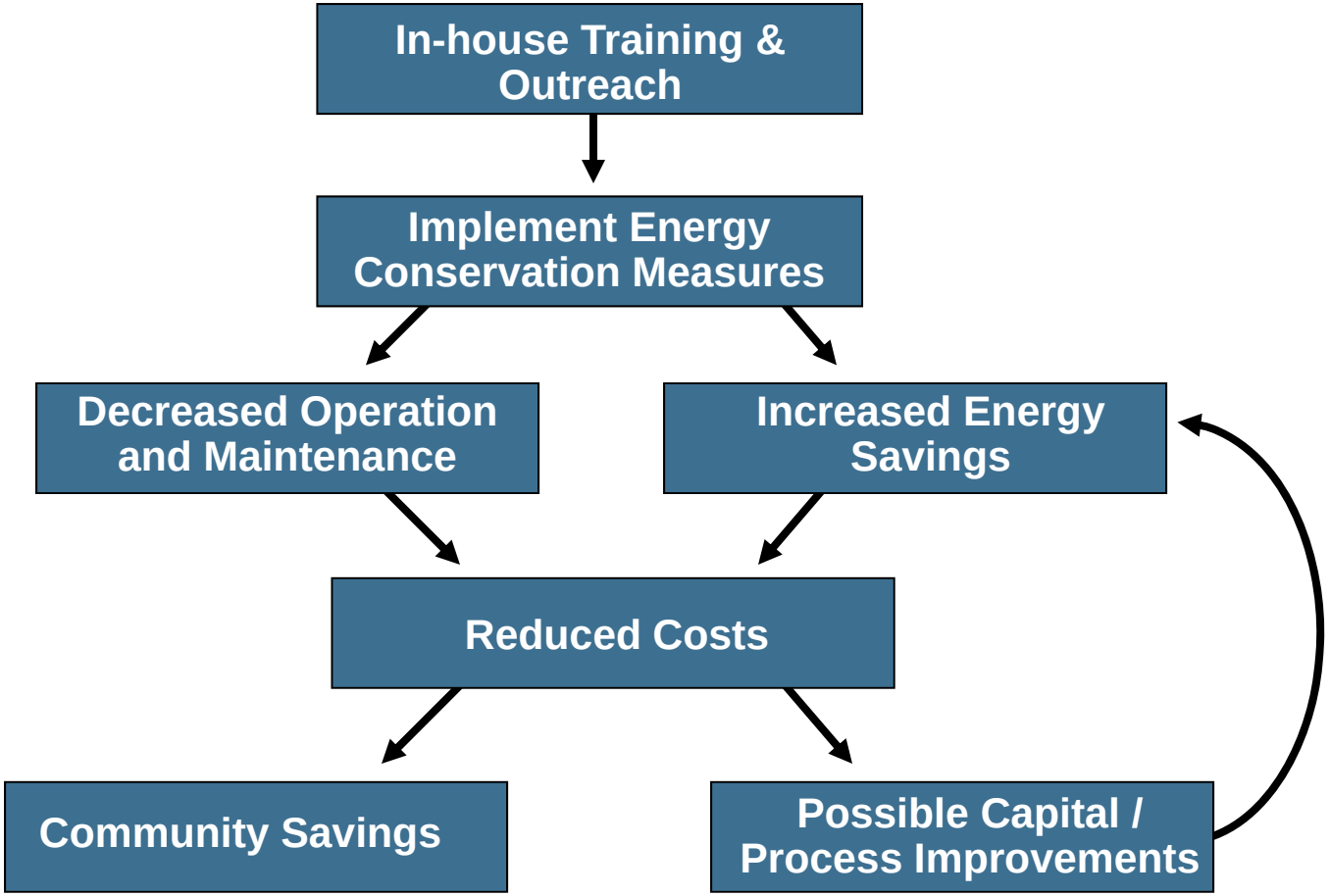
Potential Gains from Energy Efficiency



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Understanding Energy Use

- Electricity is generally billed according to
  - (1) demand (i.e., instantaneous energy use) and
  - (2) energy consumption (i.e., the amount of energy used during a specific period).
- Demand is instantaneous energy use
  - Watt, kilowatt (kW), megawatt (MW)
- Energy is the ability to do work.
  - kilowatt-hour (kWh)
- Energy Consumption (kWh) = Demand (kW) X time (hr)

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Electric Billing

Non-Residential electricity is generally billed as:

- **Consumption Charge** based on electricity use ($/kWh)
- **Demand Charge** typically based on peak 15-minute demand during each month ($/KW)

Both may be estimated or actual measurements

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Peak Load

Peak load hours occur during the times of maximum demand at a facility. Electric providers often offer incentives to shift peak energy loads to off-peak hours by charging increased rates during peak hours and reduced rates during off-peak hours.

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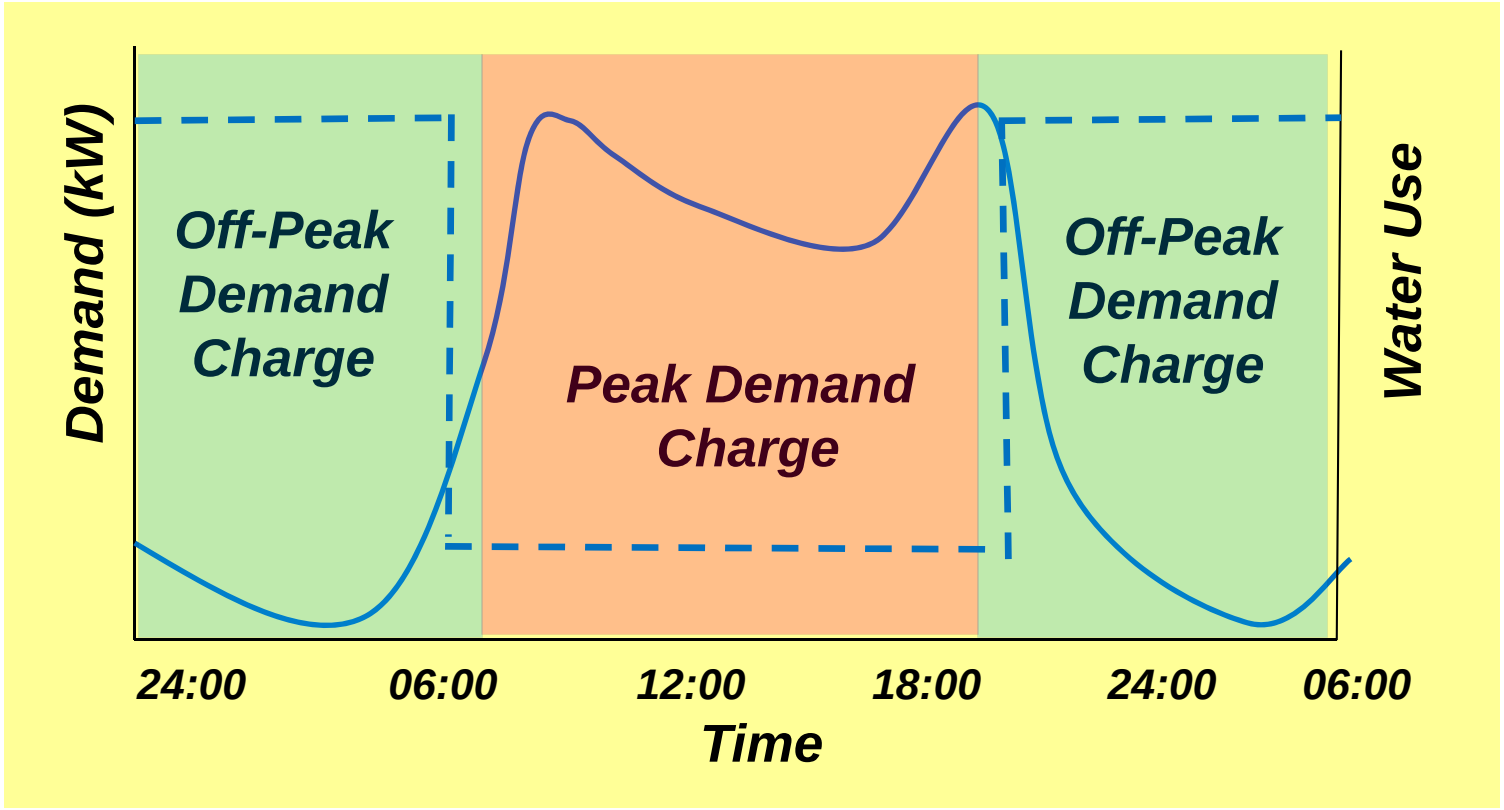
Peak Demand Charges



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ABC Energy Provider

Account 000934561
March 20 – April 19. 2008

Meter Reading	Energy	Demand
Apr 19 (Actual)	20500	56.2
		42.9
		56.2
		56.2

Demand charges represent over 40% of the total

Delivery 10400 kWh @ $0.0175	$182.00
Supply 10400 kWh @ $0.105	$1092.00
Demand 56.2 kW @ $16.65	$935.73
SBC/RPS Charge 10400 kWh @$0.0025	$26.00
Total ABC Electricity Charges	**$2,235.73**

Notes: *SBC is Systems Benefit Charge*
RPS is Renewable Portfolio Standard

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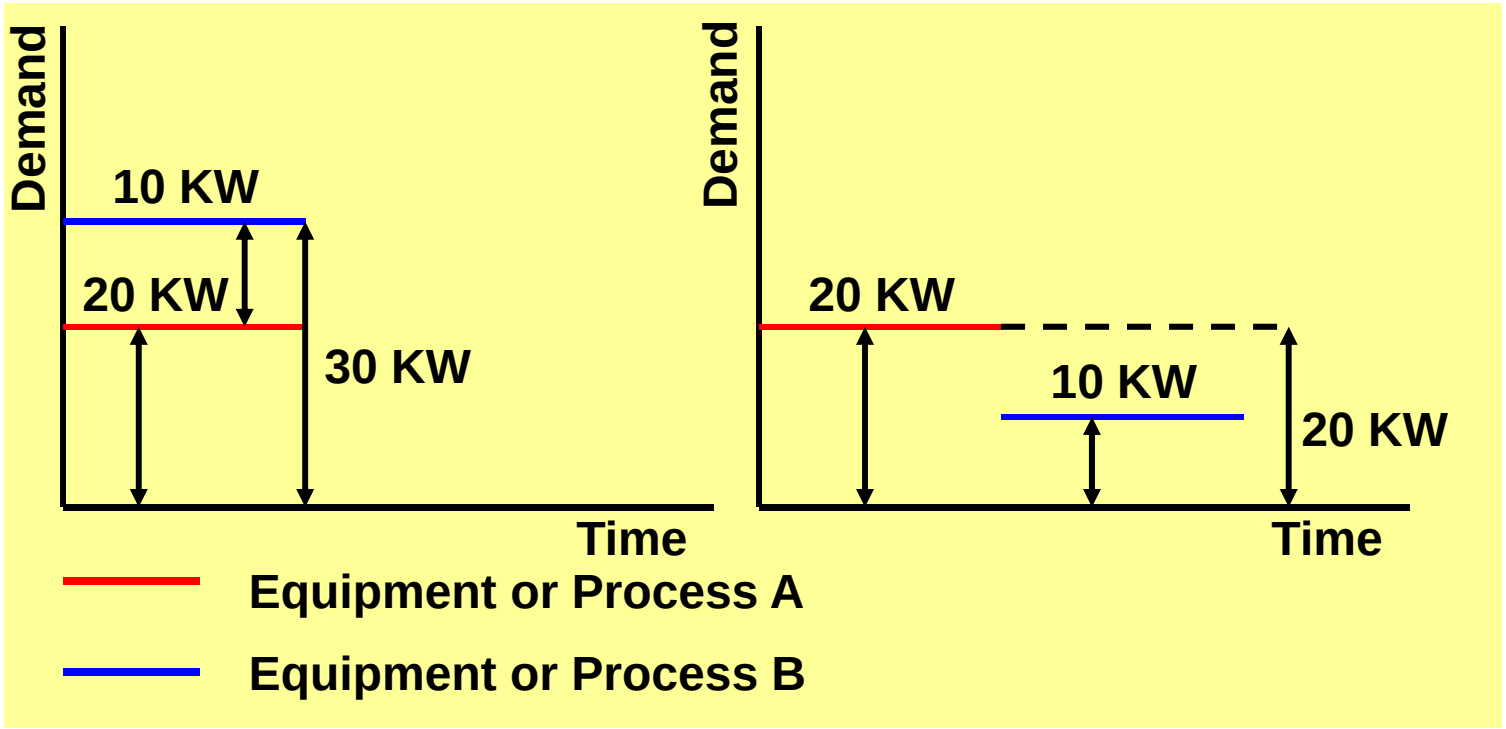
Reducing Demand Charges

- Supplement energy use with co-gen or biogas
- Automated demand flattening
- Demand flattening throughout day (or shift) through operational modification



Cost Impact of Demand Reduction

(Simplified Example)

- **Scenario 1:**

  100 HP motor runs for 1 hour per day

Consumption Cost:

100 HP x 0.75 KW/HP x 1 H/D x 365 D/Y = 27,375 kWh/Y

27,375 kWh/Y x $0.10/kWh = $2,738/Y

Demand Cost:

100 HP x 0.75 kW/HP x $16.65/KW/M x 12 M/Y = $14,985/Y

Total Annual Cost $17,723

Cost Impact of Demand Reduction

(Simplified Example)

- **Scenario 2:**

  10 HP motor runs for 10 hours per day

Consumption Cost:

10 HP x 0.75 KW/HP x 10 H/D x 365 D/Y = 27,375 kWh/Y

27,375 kWh/Y x $0.10/kWh = $2,738/Y

Demand Cost:

10 HP x 0.75 KW/HP x $16.65/KW/M x 12 M/Y = $1,499/Y

Total Annual Cost $4,237

Understanding Energy Use - Summary

The **energy use charge** is based on the actual amount of energy consumed. Energy use is measured in kilowatts-hours (kWh).

The **demand charge** is based on the greatest amount of electricity used by the customer in any 15 minute period during the billing period. Demand is measured in kilowatts (kW).

The demand charge has a significant effect on overall electricity costs.

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Wastewater Systems: Component & Energy Use Breakdown

You will become familiar with the various elements of water and wastewater systems and the factors that affect energy use.

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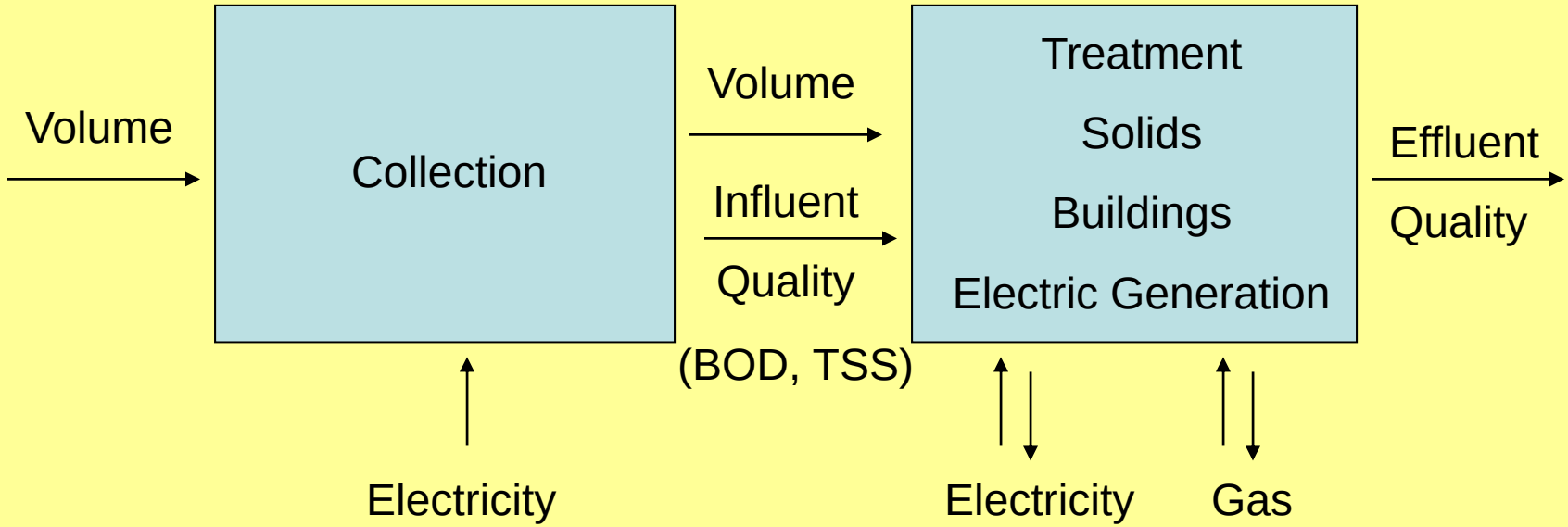
Wastewater Industry
Parameters Affecting Energy Consumption



Source: Carlson, Steven. "Water and Wastewater Utility Energy Index Project Overview." CDH Energy.

Wastewater Treatment Processes

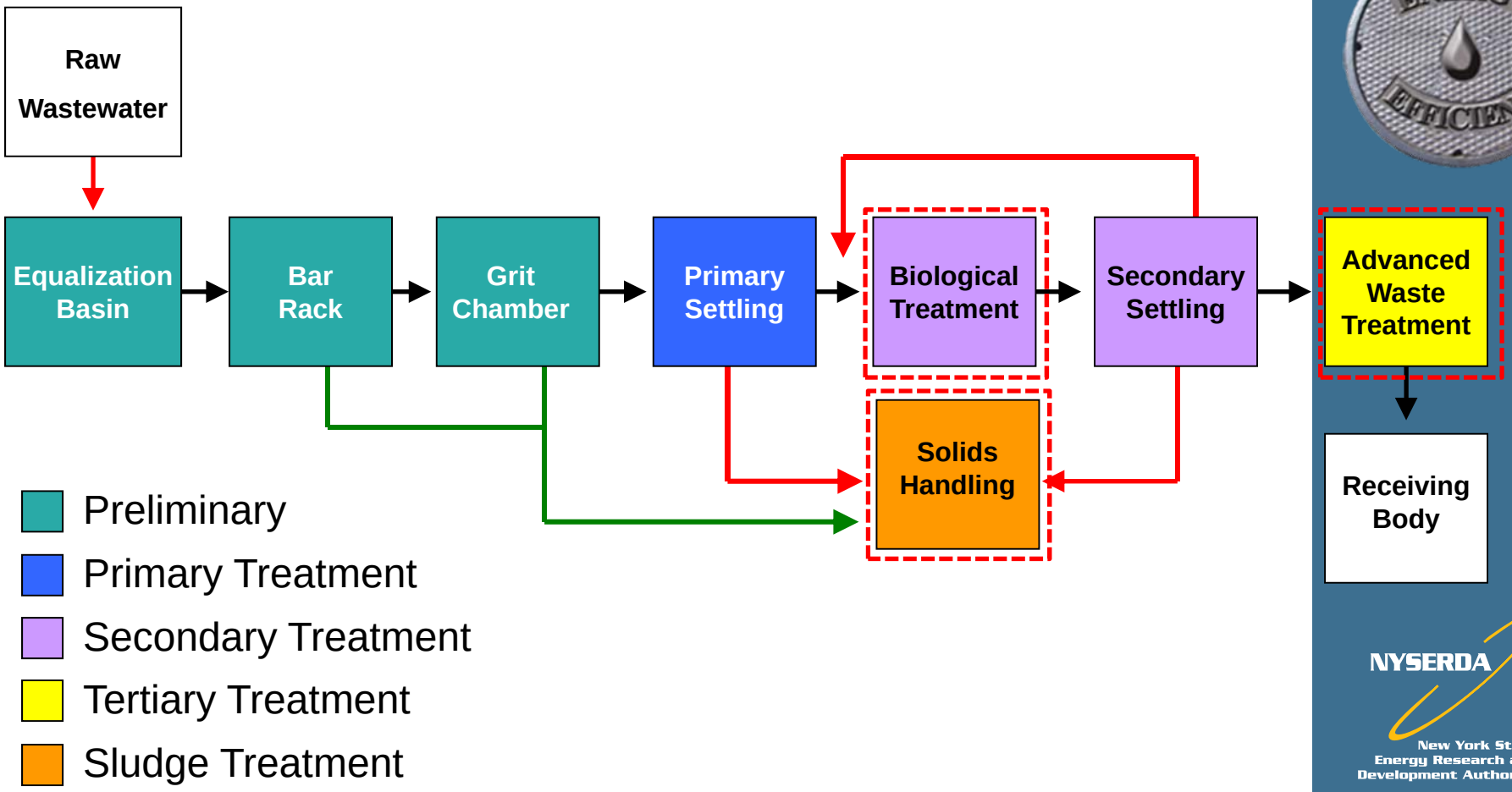


Diagram adapted from Davis and Cornwell, *Introduction to Environmental Engineering.* 1998

Levels & Types of Wastewater Treatment

Preliminary	Removes solids that might clog or damage equipment.	1. Bar Rack 2. Grit Chamber 3. Equalization Basin	
Primary	Suspended matter settles out or floats to the surface for removal.	Sedimentation Basin (Primary Tank)	
Secondary	Biological process that removes remaining dissolved or particle organics.	Fixed Film	1.) Trickling filters 2.) Rotating Biological Contactors
		Suspended Growth	Activated Sludge A. Aeration Tank B. Clarifier
Tertiary	Removes nutrients and suspended solids and kills microorganisms.	Nutrient Removal	1.) Phosphorus 2.) Nitrogen
		Filtration	1.) Sand Filter 2.) Multimedia Filters
		Disinfection	1) Chlorine 2) UV 3) Ozone
Sludge Treatment	Process that treats the solids collected from all other treatment phases.	Thickening	
		Stabilization/Digestion	
		Conditioning	
		Dewatering	
		Reduction	

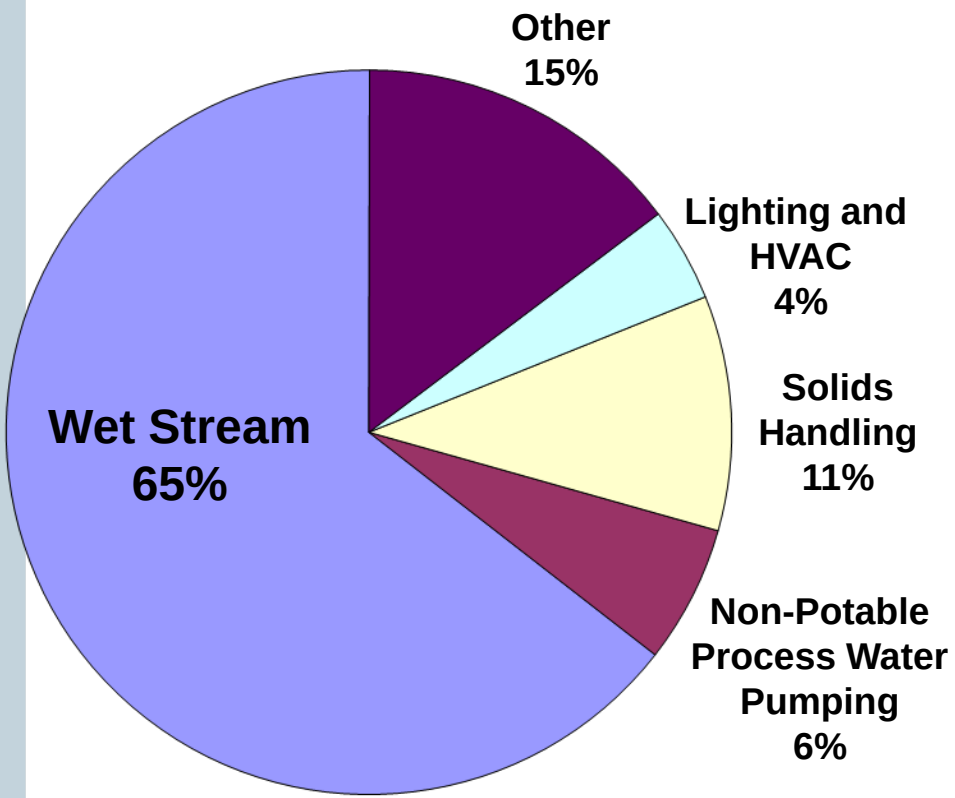
Wastewater Overall Electricity Use

Wet Stream Processes:

Wastewater Pumping
Preliminary Treatment
Primary Treatment
Secondary Treatment
Advanced Treatment
Disinfection

Wet Stream Processes typically represent two-thirds or more of the electricity use at a WWTP.

For activated sludge plants, the majority of wet stream electricity use is related to the aeration tanks



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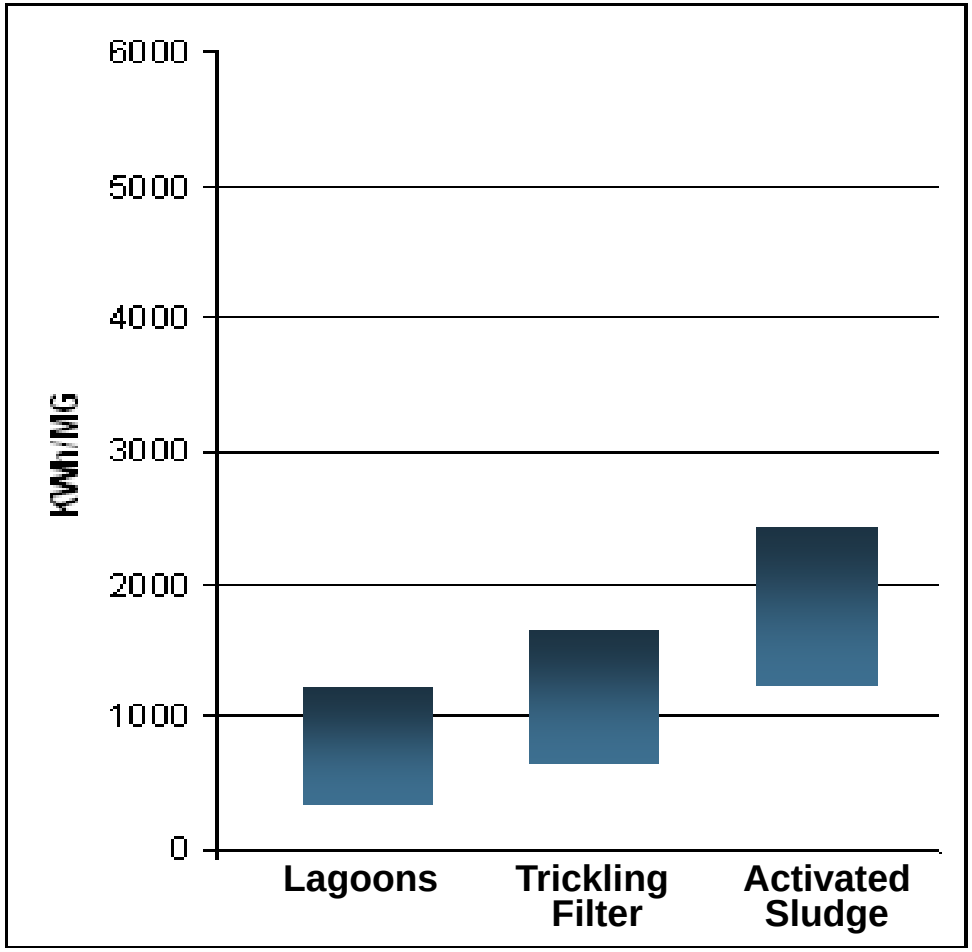
Ranges of Unit Energy Consumption for Wastewater Treatment

National Numbers

Source: Adapted from Energy Audit Manual for Water/Wastewater Facilities. EPRI. 1994.



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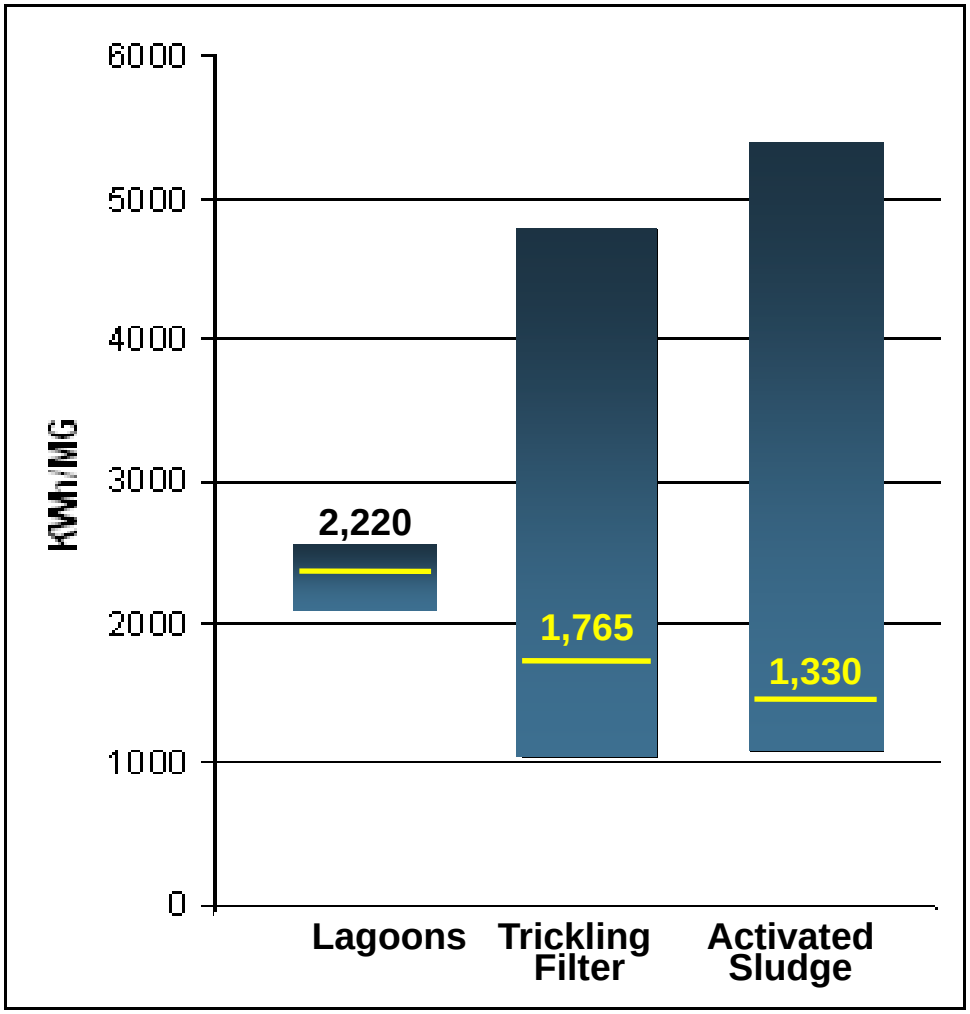
Ranges of Unit Energy Consumption for Wastewater Treatment

NYS Numbers

Source: Adapted from Assessment of Energy Use in NY's Water and Wastewater Sector. MPI. 2007.



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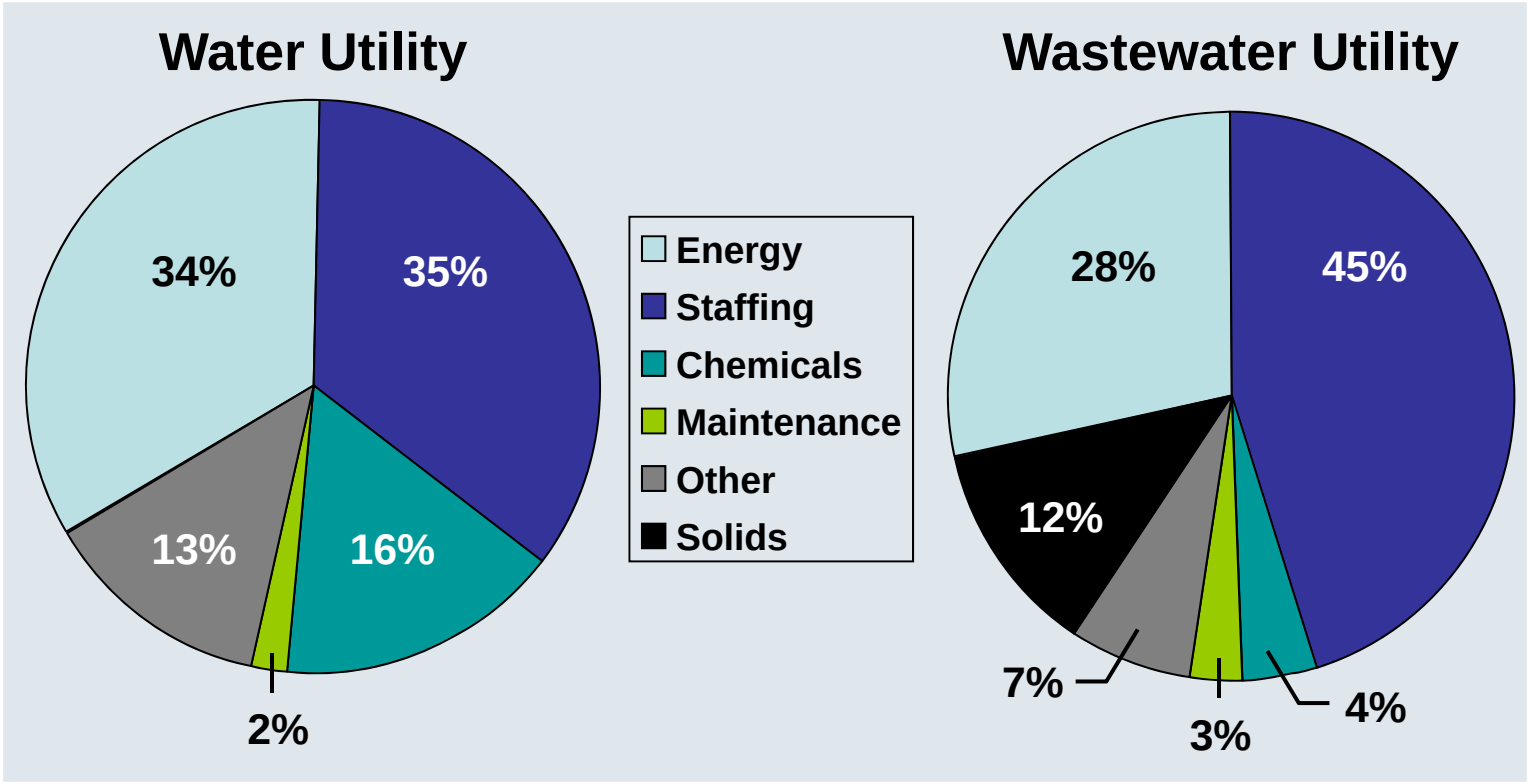
Operation and Maintenance Costs

Energy accounts for a significant portion of utility O&M budgets.



Source: Jones, Ted. "Municipal Water/Wastewater Breakout Session." CEE. 18 January 2007.

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Wastewater Treatment Summary

Pumping is one of the most energy intensive components of a wastewater system.

Both wet stream and solid handling processes of wastewater treatment present opportunity for energy improvements.

Energy accounts for a significant portion of utility O&M budgets.

The Energy Efficiency Process

You will use a step by step procedure to develop and implement energy improvement measures.

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Development of Energy Efficiency Plan

1. Understand Your Energy Use
2. Evaluate the System
3. Identify Energy Efficiency Opportunities
4. Prioritize Opportunities for Implementation
5. Implement Measures
6. Monitor Results

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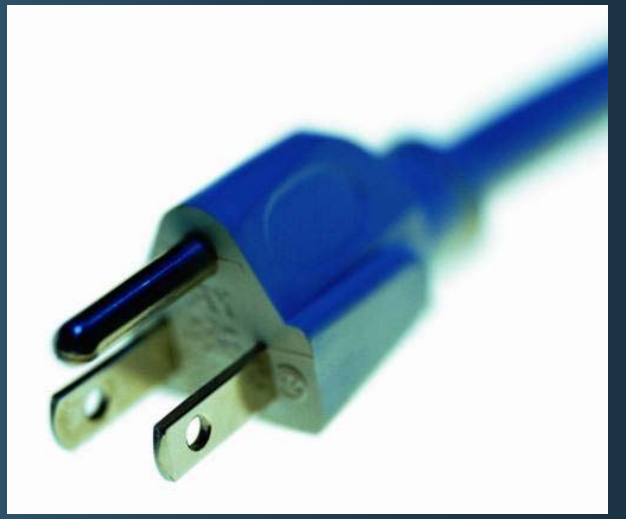
1. Understand Your Energy Use

The Electric Bill

How and where is energy used?



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1. Understand Your Energy Use (continued)

- Develop an equipment inventory
- An equipment inventory should be organized by process and include:
  - nameplate horsepower
  - hours of operation per year
  - field measured power
  - kilowatt hours per year

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2. Evaluate the System

- Collect Data and Understand Why You're Collecting Data
- The evaluation should answer three questions:
  - How much energy is being used?
  - Where is the energy being used?
  - When is the energy being used?

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2. Evaluate the System (continued)

Establish Benchmarks to assess your performance:

- Internal Benchmarking
  - Energy use trends at a facility
  - Submetering, kWh/MG, kWh/lb BOD, etc.

- External Benchmarking
  - Comparison of system and component demands to baseline energy use and energy use of similar facilities

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2. Evaluate the System (continued):

Tracking Performance with Operation and Process Trends

Useful Metrics:

- Energy use based upon plant flow
  - Energy used per million gallons treated (kWh/MG)
- Peak energy use based upon pumping requirements
  - Energy used per million gallons pumped (kW/MG)
- Energy use based upon contaminant removal
  - Energy used per pound of biological oxygen demand removed (kWh/lb BOD)
  - Energy used per pound of total suspended solids removed (kWh/lb TSS)
  - Energy used per pound of biosolids handled (kWh/lb biosolids)
- Oxygen Transfer Efficiency (OTE)
  - Ratio of the amount of oxygen dissolved into the water to the total amount of oxygen pumped into the water

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3. Identify Energy Efficiency Opportunities

Reducing Energy Consumption/ Improving Energy Efficiency

- Building operations
  - lighting upgrades
  - HVAC upgrades
- System Operations
  - equipment upgrades
  - process upgrades
  - equipment prioritization & optimization
  - automate process monitoring & operational control
- Equipment maintenance and upkeep – Integrate into Asset Management Planning

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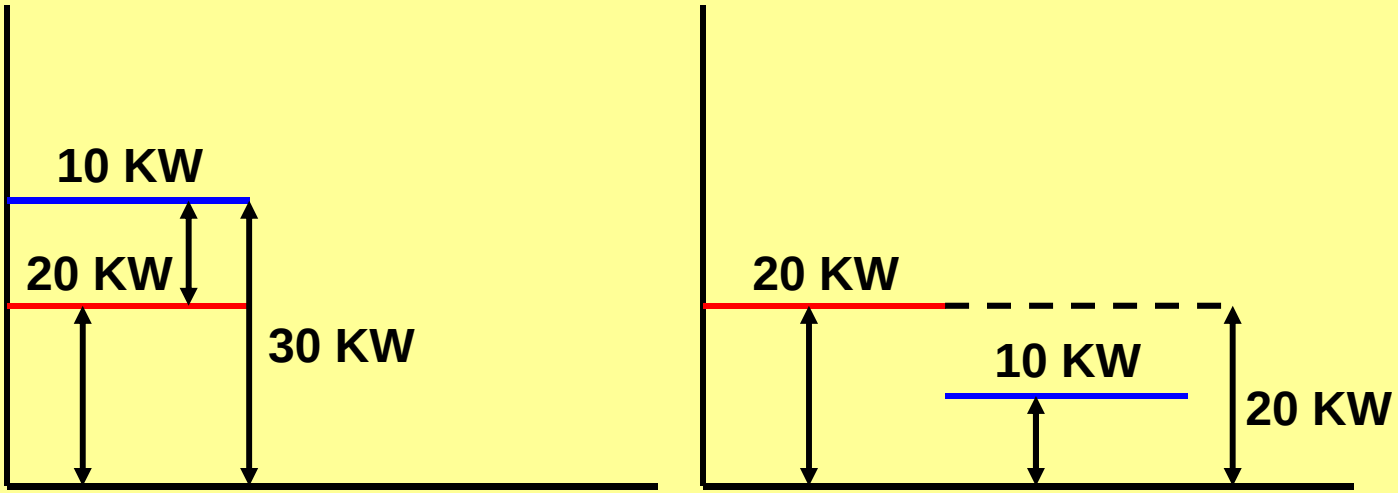
3. Identify Energy Efficiency Opportunities (continued)

Reducing Demand Charges

- Supplement energy use with co-gen or biogas
- Demand flattening throughout day (or shift)



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3. Identify Energy Efficiency Opportunities (continued)

Cost Impact of Demand Charge (Simplified Illustration)

- **Scenario 1:**
  - 100 HP motor runs for 1 hour per day

Consumption Cost:

100 HP x 0.75 KW/HP x 1 H/D x 365 D/Y = 27,375 kWh/Y

27,385 kWh/Y x $0.10/kWh = $2,739/Y

Demand Cost:

100 HP x 0.75 kW/HP x $16.65/KW x 12 M/Y = $14,985/Y

Total Annual Cost $17,724

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3. Identify Energy Efficiency Opportunities (continued)

Cost Impact of Demand Charge (Simplified Illustration)

- **Scenario 2:**
  - 10 HP motor runs for 10 hours per day

Consumption Cost:

10 HP x 0.75 KW/HP x 10 H/D x 365 D/Y = 27,385 kWh/Y

27,385 kWh/Y x $0.10/kWh = $2,739/Y

Demand Cost:

10 HP x 0.75 KW/HP x $16.65/KW x 12 M/Y = $1,499/Y

Total Annual Cost $4,238

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Typical Energy Improvements

- Proper Maintenance and Upkeep
- Lighting and HVAC
- VSDs on Pumps, Blowers, Compressors, etc.
- Asset Management Planning
  - Pump Optimization & Prioritization
  - Reduction in Pipe Leakage
- DO Oxygen Sensors
- Fine Bubble Aeration
- Correctly Sized High Efficiency Motors

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4. Prioritize Opportunities for Implementation

- Capital cost
- Equipment condition
- Operational cost/savings
- Energy savings
- Payback period
- Effects on plant processes and labor, chemical costs
- Risk
- Financing, funding and rebates
- Sustainability/Environmental Stewardship Initiatives

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Energy Efficiency Process Summary

- Understand your energy use by becoming familiar with the structure of your electric bill and by recognizing where and how energy is used.
- Evaluate your system using internal and external benchmarking.
- Identify energy efficiency opportunities in building and system operations and through maintenance and equipment upkeep. Reduce costs through demand flattening.
- Prioritize energy efficiency measures focusing on low hanging fruit first.

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