Energy Management for the Utility of the Future: How Good is Good Enough?

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Outline

- Utility of the Future: Resource Recovery Paradigm
- Brief Look at the Energy Profile
- Can we compare energy consumption?
- Is Energy Neutrality a Real Deal?
- Is Excellent Performance Necessary?
- Should there be a Different Way of Thinking?
Utility of the Future

Waste Streams → Value Streams

Preliminary Treatment
Raw Wastewater

Primary Treatment

Secondary Treatment

Advanced Treatment

Disinfection

Outfall
Receiving Water Body

Energy Factory
Nutrient Factory
Product Factory

WATER FACTORY
New Paradigm for Municipal and Industrial Wastewater Treatment

- **Wastewater Treatment/Pollution Abatement Plant**
  - Treated Water

- **Resource Recovery Production Plant**
  - Commercial Products

- **Goal:**
  - Regulatory Compliance at Lowest Cost

- **Goals:**
  - Environmental Enhancement
  - Revenue Generation
  - Social Benefits

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Roadmap to a Resource Recovery Facility

- **Review**: Trends & State-of-the-Science
- **Develop**: Your Utility’s Perspective on RR
- **Identify**: Considerations of RR for Your Facility
- **Draft**: Your Master RR Plan

Level of Effort

[Stantec logo]
Be Familiar with Current State-of-the-Science for Resource Recovery
How is Energy Demand Distributed?

Power demand of W & WW Utilities:
- 0.3% of global
- 3-4% of US
- 25-40% of municipal O&M

Source: Kroiss and Svardal, 2011; NYSERDA, 2008
How Much Energy Do We Consume?

Total Energy Consumption per Capita per Year (2014)

Distribution depends on:
- population density
- energy source profile
- dominant land use
- industrial profile

Source: IEA, 2016
Regional Energy Consumption Projections for Wastewater Treatment

Source: Electricity Use and Management in the Municipal Water Supply and Wastewater Industries; WRF/EPRI, 2013

Is this enough to matter?
Energy’s Footprint in W & WW Sector

Source: Wilson, 2009; Meda and Comel, 2010; Voutchkov, 2010; Lazarova et al., 2012
How Does the Wastewater Industry Benchmark in Energy Consumption?

Energy Consumption at Treatment Facilities - Process

Energy Consumption at Treatment Facilities – Process Equipment

Source: Umble, A. and Lee, K. (2013), Adapted from AWWARF data (2007);
How is Energy Consumption Distributed Across Plant Processes?

Energy Distribution in Wastewater Treatment by Unit Process

Source: Moore, L., University of Memphis, 2012
How Does the Wastewater Industry Benchmark in Energy Consumption?

Stricter Standards → More Energy!

Source: Kang, et al./USEPA, 2009
Stricter Standards → More Energy!

Source: Kang, et al./USEPA, 2009
The Case for Nutrient Recovery: Economics of Removal

Source: Bratby and Jimenez, WERF 2011
How Does the Wastewater Industry Benchmark in Energy Consumption?

Loading Removal is a more appropriate metric

Should Energy Neutrality be Pursued?

Theoretical chemical energy potential of organic matter:
= 4 kWh / kg COD

Annual average energy requirements:
- Larger plants = 33-35 kWh/pe
- Smaller plants = > 40 kWh/pe (<10,000 pe)
Energy Neutrality: A Reality?

- 70-80% COD
- Enhanced biogas production
- Reduced energy consumption
- Reduced capital cost

[Diagram of wastewater treatment process]
Is Energy Neutrality a Reality?
Reduce Demand

Is Energy Neutrality a Reality? Reduce Demand

Impact of Biosolids Process Configurations on Energy Balance

Source: Barber, W., "The Influence of Biosolids on Attaining Energy Neutrality at a WW Treatment Works", WEF 2014
Impact of Biosolids Pretreatment Process Technology on Energy Balance

Source: Barber, W., "The Influence of Attaining Energy Neutrality at a WW Treatment Works", WEF 2014
What About Co-Digestion?

- CHP generally covers site demand for heat but not electricity without external carbon sources

- Food wastes:
  - 55-78% carbohydrates
  - 15-21% protein
  - 5-22% fats/lipids

- Food wastes can contain inhibitory substances

Source: Examination of Food Waste Co-Digestion to Manage the Peak in Energy Demand at WWTPs; Lensch, D., et al.; Water Science & Technology, 73(3), 2016
Should Full Energy Recovery be the Focus in Today’s Economic Pressure-cooker?

How good is good enough?
Can we operate to “good enough” reliably and predictably?
Is “good enough” an appropriate ethic for the industry?

Is there a Different Paradigm? Consideration of Capacity Utilization

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Is there a Different Paradigm? Consideration of Performance

Is there a Different Paradigm? 
Consideration of Performance

Broader Perspective Enhances Energy and Financial Savings Potential

- Identify options for improved energy management at utility and at the end-users
- Define scenarios for implementing options into the urban water system
- Quantify the energy-saving potential of options at both utility and City level

Broader Perspective Enhances Energy and Financial Savings Potential

Measures for Energy Savings Potential and Cost-effectiveness

- 1 Active leak detection and pressure management
- 2 Scrubber ventilation efficiency
- 3 Sewage pumping efficiency
- 4 Minimizing the use of DAF
- 5 Most open valve aeration strategy
- 6 Inverter speed control pump
- 7 Aeration optimization
- 8 Plant upgrade for biogas recovery
- 9 Existing STP reuse and minor recycling
- 10 Stormwater harvesting
- 11 Water-efficient clothes washer rebate
- 12 Water-efficient shower head rebate
- 13 Dual flush toilet rebate
- 14 Solar hot water system rebate
- 15 Alarming visual display monitors for shower
- 16 Plumber visit
- 17 Cooling towers upgrade
- 18 Irrigation and landscape efficiency

Broader Perspective Enhances Energy and Financial Savings Potential

- Water Use Distribution
  - 65% residential
  - 24% commercial/industrial
  - 11% non-revenue

- 1300 GWh saved for Utility
- 5800 GWh saved for City

- Residential Conservation
- Unaccounted-for water

Utilities need incentives to look beyond boundaries

Summary

- Energy demand in Water & Wastewater treatment is costly at utility scales
- Benchmarking most useful when based on load, but sensitive to process and scale
- Energy demand is sensitive to regulation: O&M is critical
- Energy neutrality is real, but requires outside carbon sources to supplement current technology
- Pushing to operation capacity reaps energy savings
- Acceptable, as opposed to excellent performance, saves money, but is it an appropriate compromise?
- Utilities must go “outside the fence line” to realize benefits that accumulate from conservation across the community