NJWEA Conference May 2017

Energy Management for WRRFs: Does It Matter? Should it Matter?

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Outline

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?

How is Energy Demand Distributed?



How Much Energy Do We Consume?

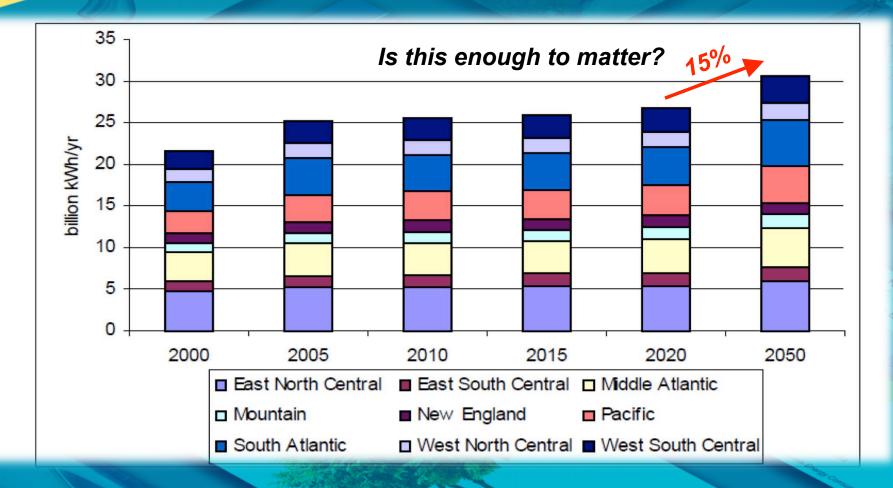
Total Energy Consumption per Capita per Year (2014) < 73,270 kWhr 73,270 to 117,230 kWhr 117,230 to 175,850 kWhr > 175,850 kWhr Source: IEA, 2016

Distribution depends on:

- population density
- energy source profile
- dominant land use
- industrial profile
 - agricultural
 - resource extraction
 - resource processing

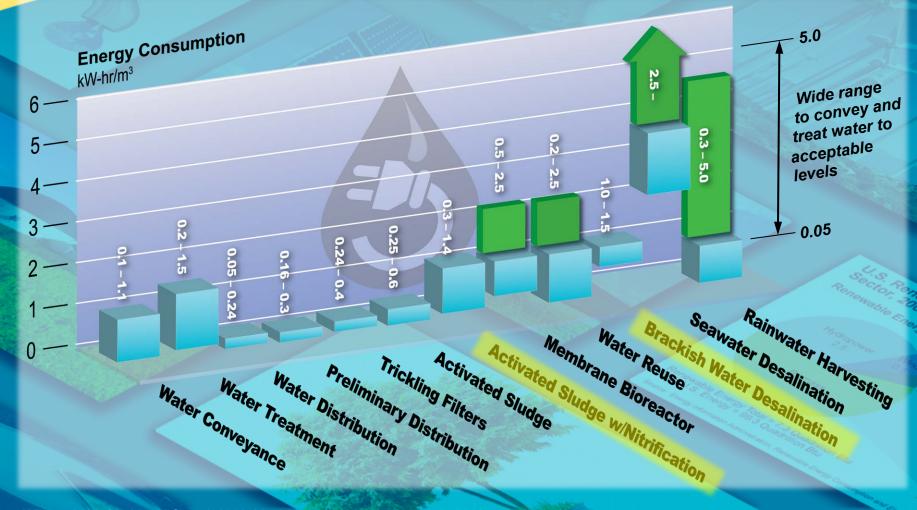
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Regional Energy Consumption Projections for Wastewater Treatment



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

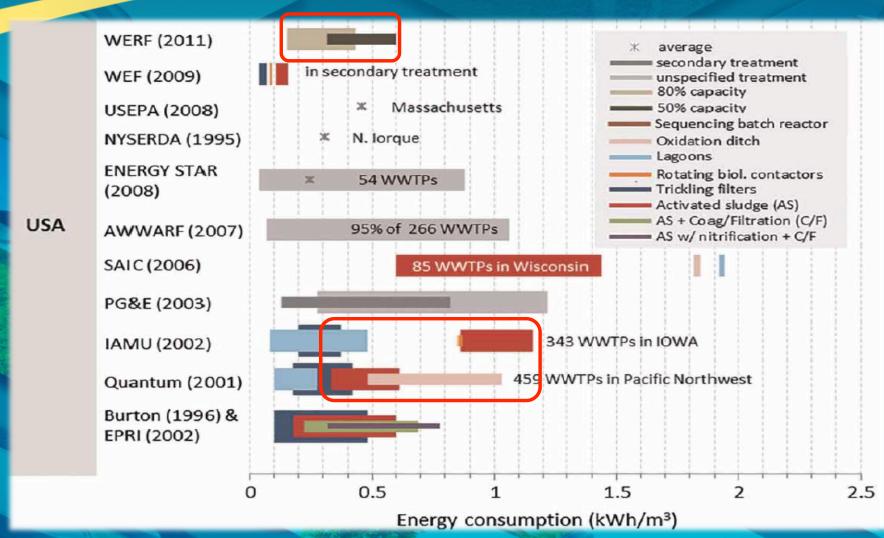
Energy's Footprint in W & WW Sector



6

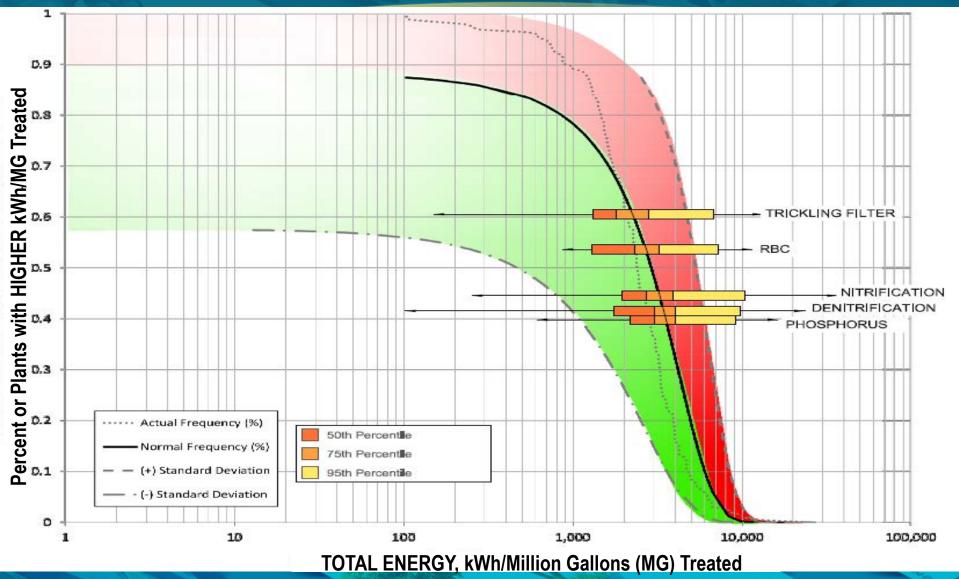
Source: Wilson, 2009; Meda and Cornel, 2010; Voutchkov, 2010; Lazarova et al., 2012

How Does the Wastewater Industry Benchmark in Energy Consumption?

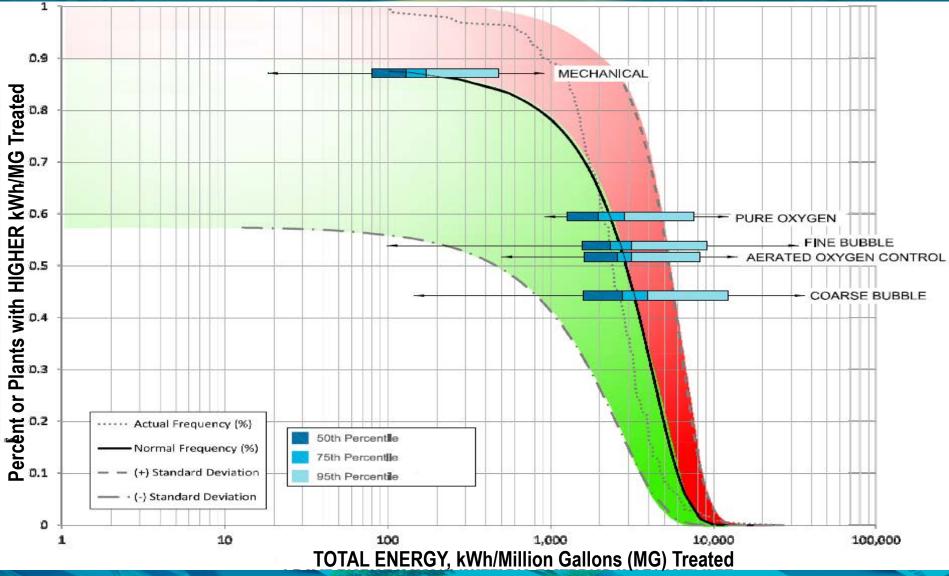


Source: "Energy Performance Indicators of Wastewater Treatment: A Field Study with 17 Portuguese Plants", Silva, C., Rosa, M.; Water Science & Technology, 72(4), 2015

Energy Consumption at Treatment Facilities



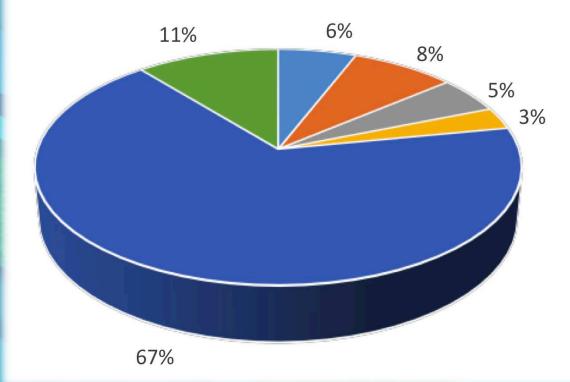
Energy Consumption at Treatment Facilities



Source: Umble, A. and Lee, K. (2013), Adapted from AWWARF data (2007);

How is Energy Consumption Distributed Across Plant Processes?

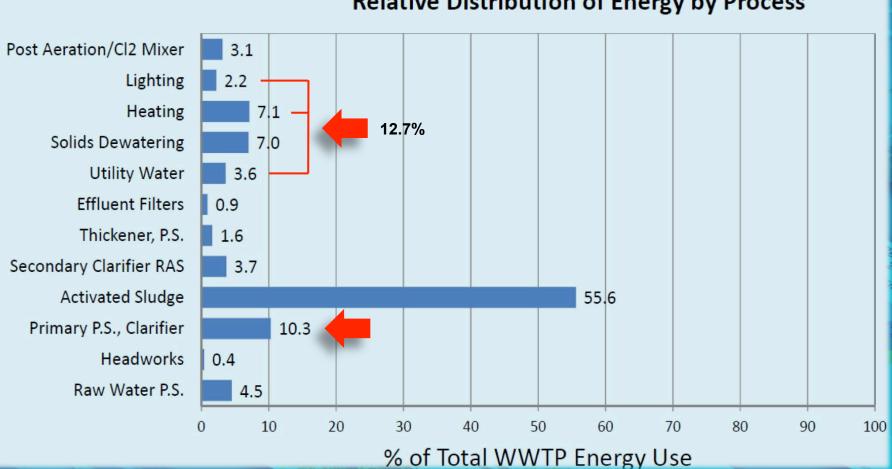
Energy Consumption in WRRFs



- Infrastructure
- Filtration
- Pumping
- Mechanical Treatment
- Biological Treatment
- Sludge Treatment

Source: "Toward Energy Neutrality by Optimizing the Activated Sludge Process of the WWTP", Manner, S., et al.; Water Science & Technology, 73(12), 2016

Energy Distribution in Wastewater Treatment by Unit Process



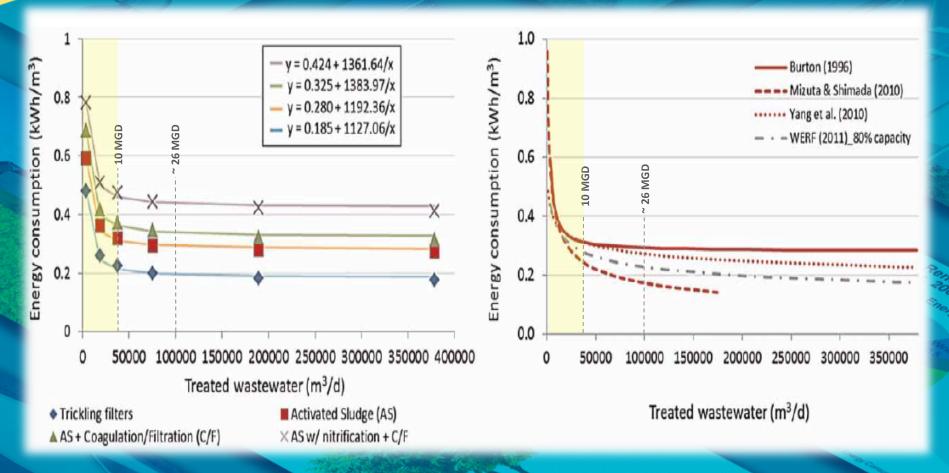
Relative Distribution of Energy by Process

Source: Moore, L., University of Memphis, 2012

Process

How Does the Wastewater Industry Benchmark in Energy Consumption?

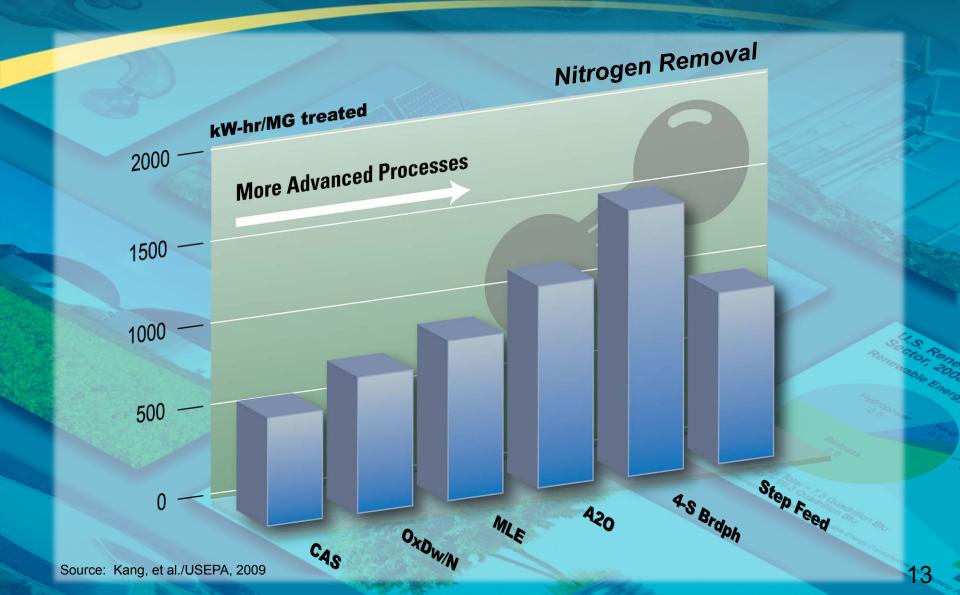
Smallest plants require greatest unit energy consumption



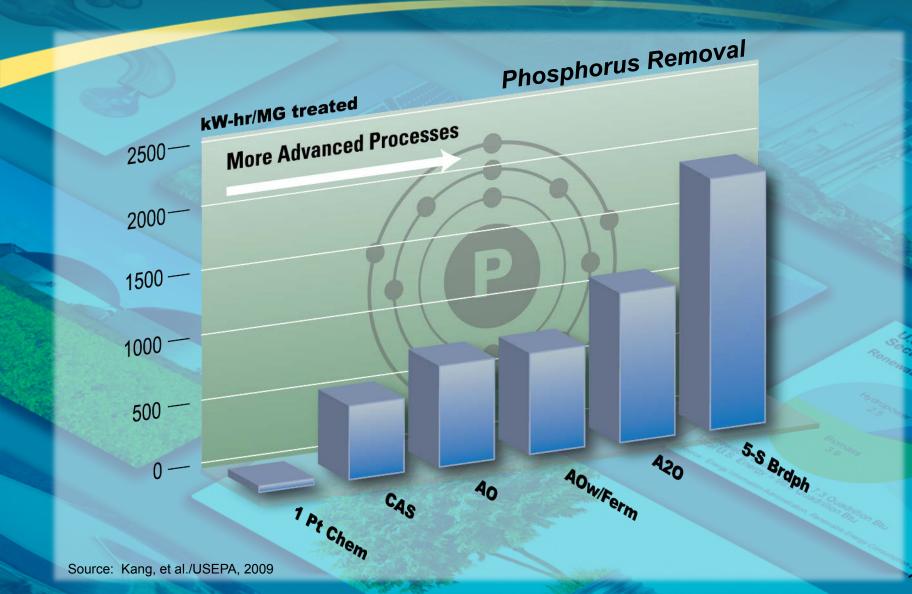
Source: "Energy Performance Indicators of Wastewater Treatment: A Field Study with 17 Portuguese Plants", Silva, C., Rosa, M.; Water Science & Technology, 72(4), 2015

12

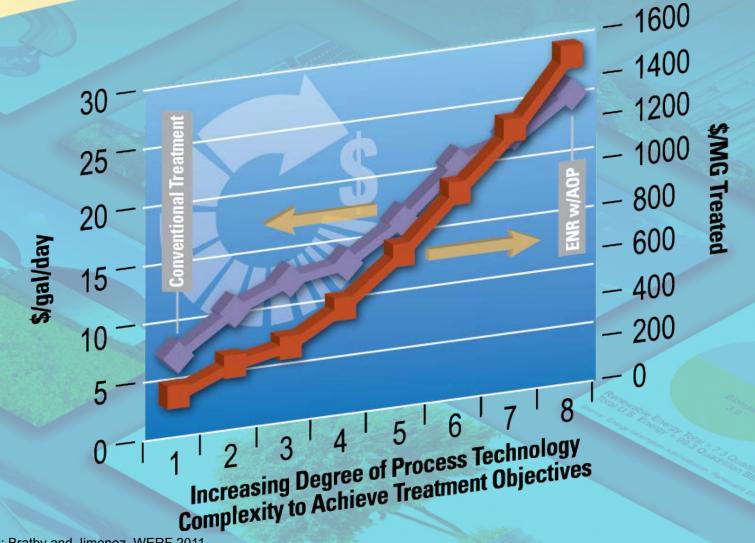
Stricter Standards \rightarrow More Energy!



Stricter Standards → More Energy!

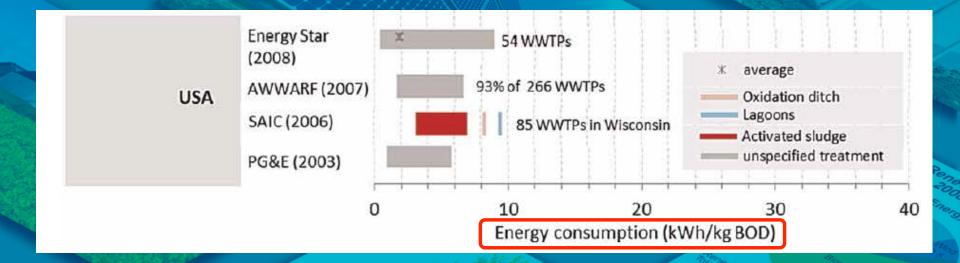


The Case for Nutrient Recovery: Economics of Removal



How Does the Wastewater Industry Benchmark in Energy Consumption?

Loading Removal is amore appropriate metric



Source: "Energy Performance Indicators of Wastewater Treatment: A Field Study with 17 Portuguese Plants", Silva, C., Rosa, M.; Water Science & Technology, 72(4), 2015

16

Should Energy Neutrality be Pursued?

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

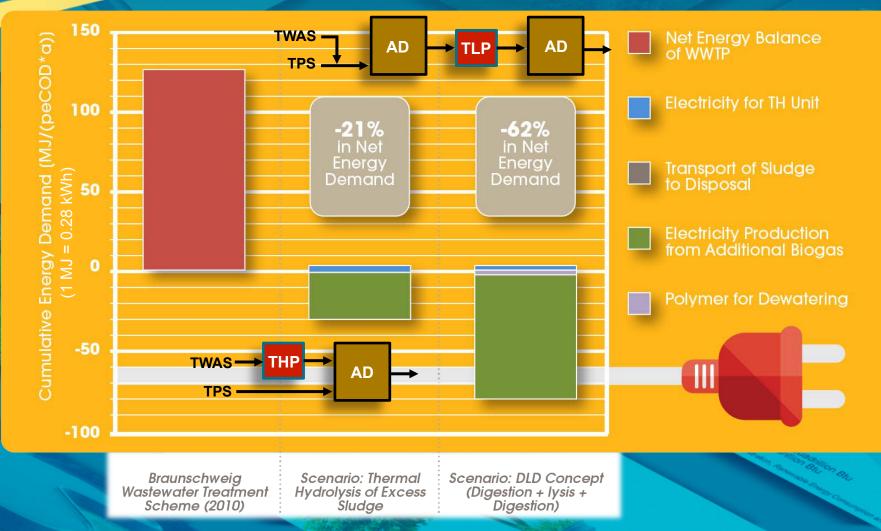
MW-hr/yr

Advanced Energy Technology

> Reduce Demand

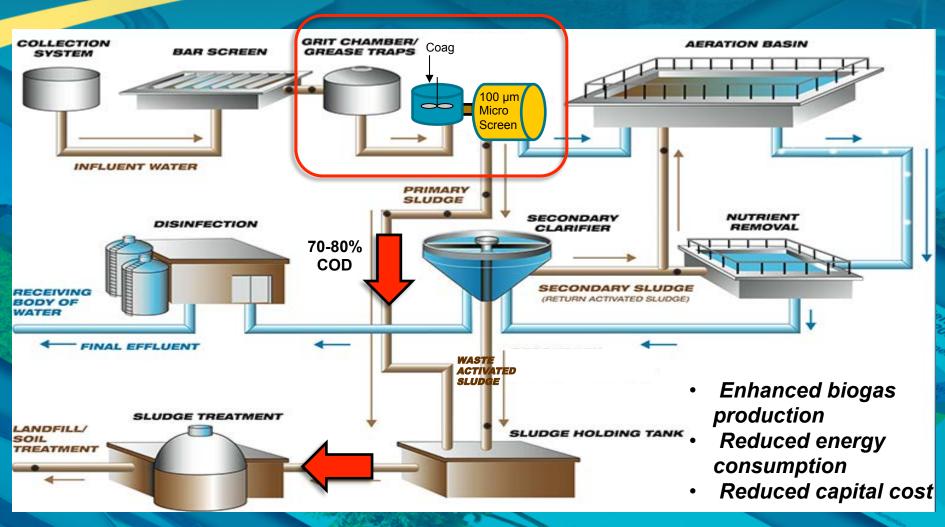
Net-Zero Pre-digestion Treatment Efficient CHP Advanced Anaerobic 800-1000 Digestion Enhanced Pretreatment Process Efficiencies On-line Automated Controls Sidestream Treatment 1800 Annual average energy requirements: Larger plants = 33-35 kWh/pe Based on ~10 MGD CAS WWTP Smaller plants = > 40 kWh/pe (<10,000 pe) 17

Is Energy Neutrality a Reality? Reduce Demand

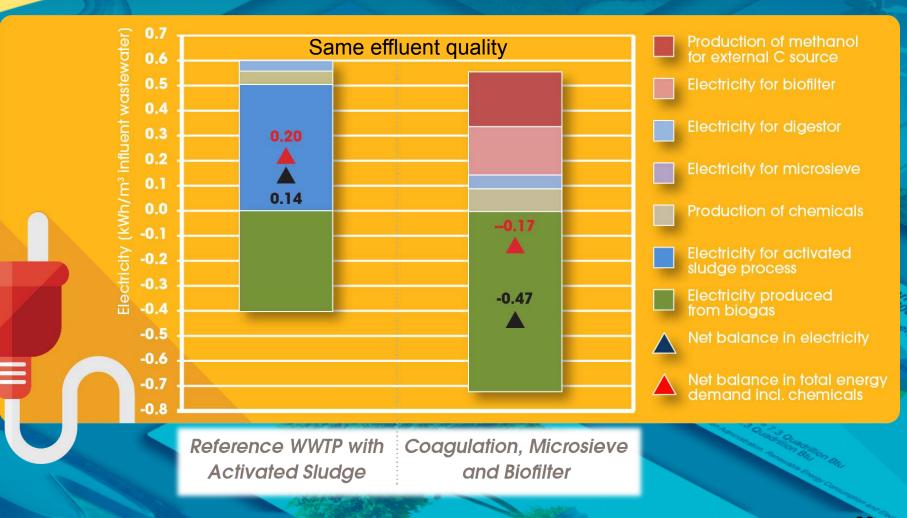


Source: Evaluating New Processes and Concepts for Energy and Resource Recovery from WWTPS with LCA"; Remy, C., et al.; Water Science & Technology, 73(5), 2016 18

Is Energy Neutrality a Reality?

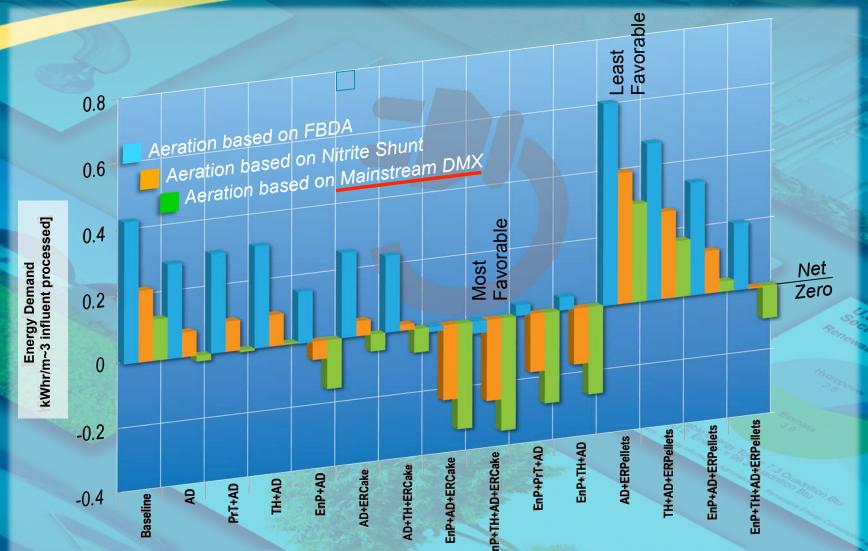


Is Energy Neutrality a Reality? Reduce Demand



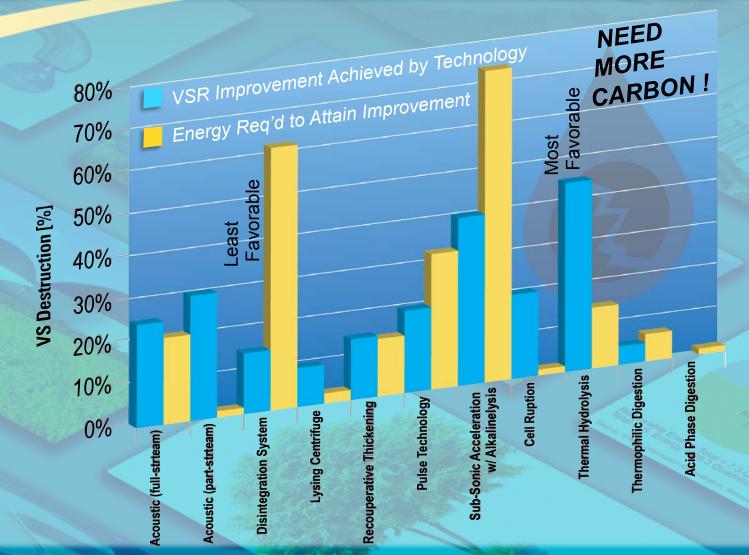
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Impact of Biosolids Process Configurations on Energy Balance



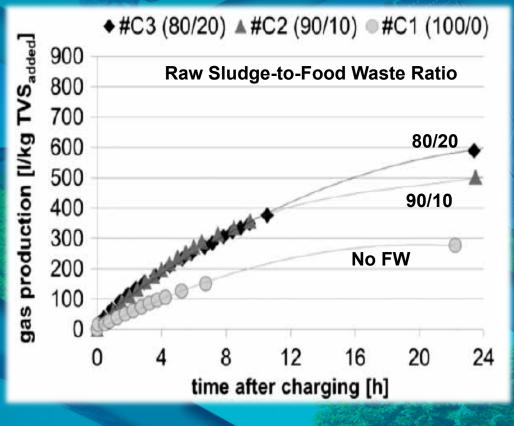
Source: Barber, W., "The Invfluence of Biosolids on Attaining Energy Neutrality at a WW Treatment Works", WEF 2014

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

Should Full Energy Recovery be the Focus in Today's Economic Pressurecooker?

Establish assessment & objectives criteria Action planning

Dn

WWTP Management PI & PX calculation

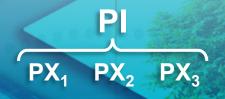
Identify opportunities for continuous improvement

> Compare with references Assess PI & PX results

Plan

Chec

Act



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

24

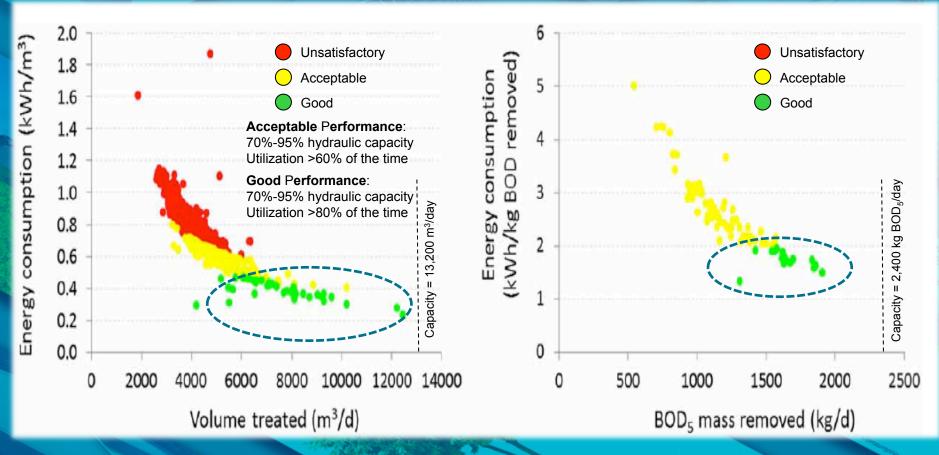
Source: "A Comprehensive Approach for Diagnosing Opportunities for Improving the Performance of a WWTP", Silva, C., et al.; Water Science & Technology, 74(12), 2016

Is there a Different Paradigm? Consideration of Capacity Utilization

Energy Consumption as a Function of Plant Hydraulic Capacity

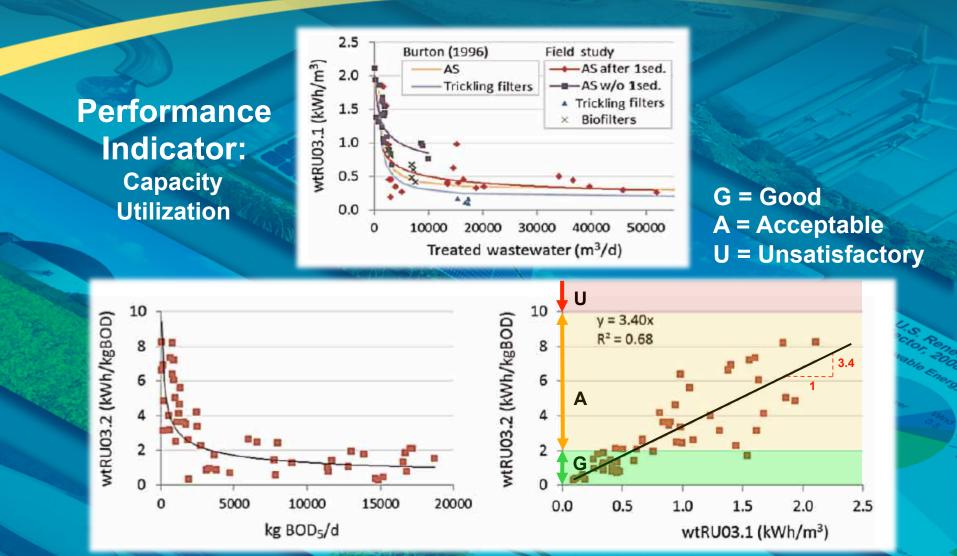
Energy Consumption as a Function of Plant Process Capacity

25



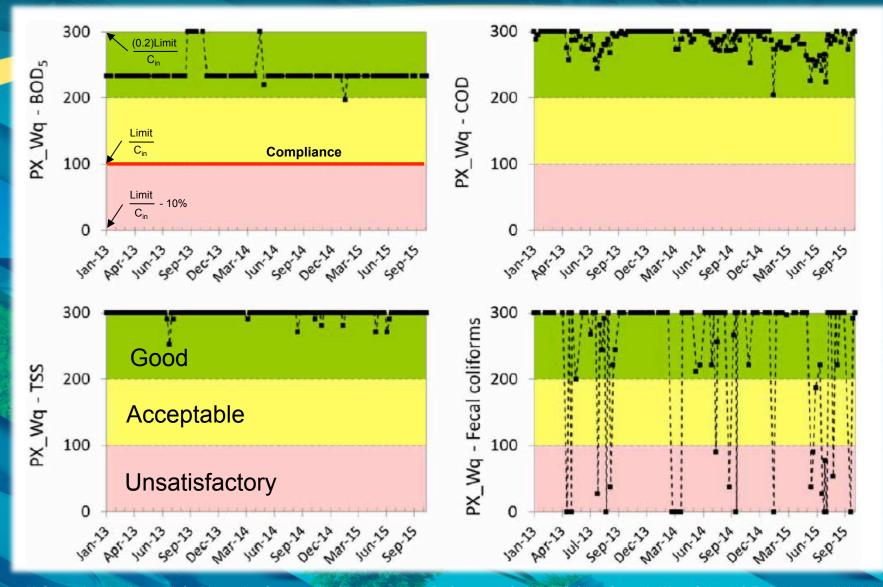
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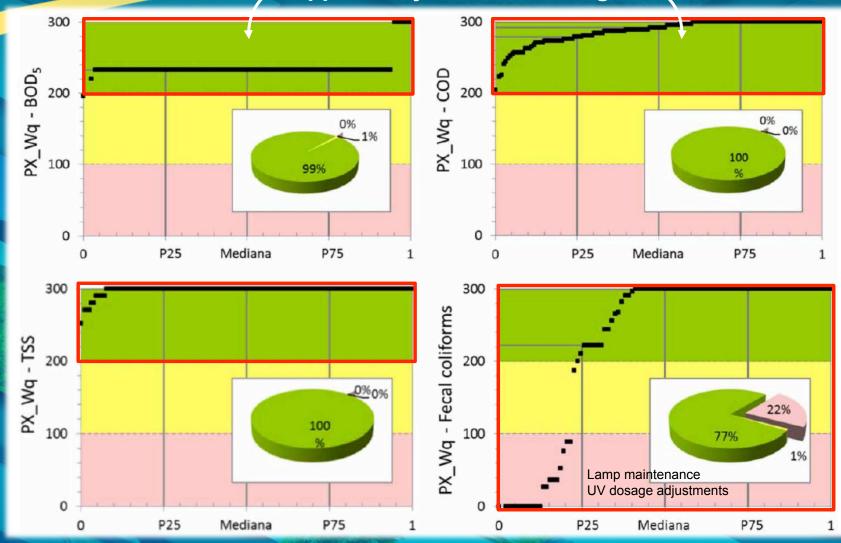
Is there a Different Paradigm? Consideration of Performance



Source: "A Comprehensive Approach for Diagnosing Opportunities for Improving the Performance of a WWTP", Silva, C., et al.; Water Science & Technology, 74(12), 2016

Is there a Different Paradigm? Consideration of Performance

Opportunity for Cost Savings? ~



Source: "A Comprehensive Approach for Diagnosing Opportunities for Improving the Performance of a WWTP", Silva, C., et al.; Water Science & Technology, 74(12), 2016

28

Broader Perspective Enhances Energy and Financial Savings Potential

Water

Supply System

Wastewater

Teatment

System

Water Utility
Perspective
City
Perspective

Water - Related Energy

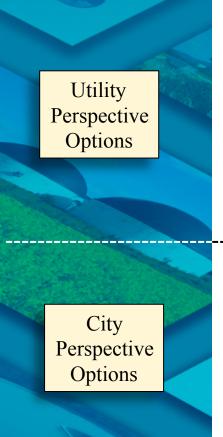
- Identify options for improved energy management at utility and at the end-users
- Define scenarios for implementing options into the urban water system
- Quantify the energy-saving potential of options at both utility and City level

Water - Related Energy Management Investment

Source: "City-scale Analysis of Water-Related Energy Identifies More Cost-effective Solutions", Lam, K., et al., Water Research, 109, 2017

Broader Perspective Enhances Energy and Financial Savings Potential

Measures for Energy Savings Potential <u>and</u> Cost-effectiveness

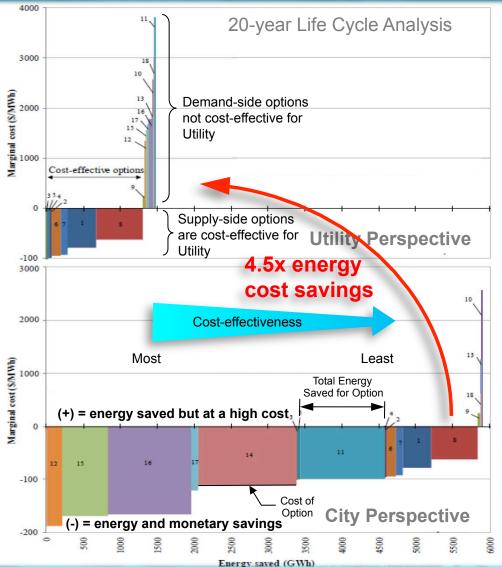


- 1 Active leak detection and pressure management
- 2 Scrubber ventilation efficiency
- 3 Sewage pumping efficiency
- 4 Minimizing the use of DAF
- 5 Most open valve aeration strategy
- 6 Inverter speed control pump
- 7 Aeration optimization
- 8 Plant upgrade for biogas recovery
- 9 Existing STP reuse 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

Supply-Side Options

Demand-Side Options

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 Solar hot water rebates Unaccounted-for water Utilities need incentives to look beyond boundaries

31

Source: "City-scale Analysis of Water-Related Energy Identifies More Cost-effective Solutions", Lam, K., et al., Water Research, 109, 2017

Summary

- Energy demand in Water & Wastewater treatment is costly
- Benchmarking most useful when based on load, but highly 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 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

Energy Consumption Economy Depends on Plant Size

