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

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Global Wastewater Practice Leader

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Napa, CA

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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?

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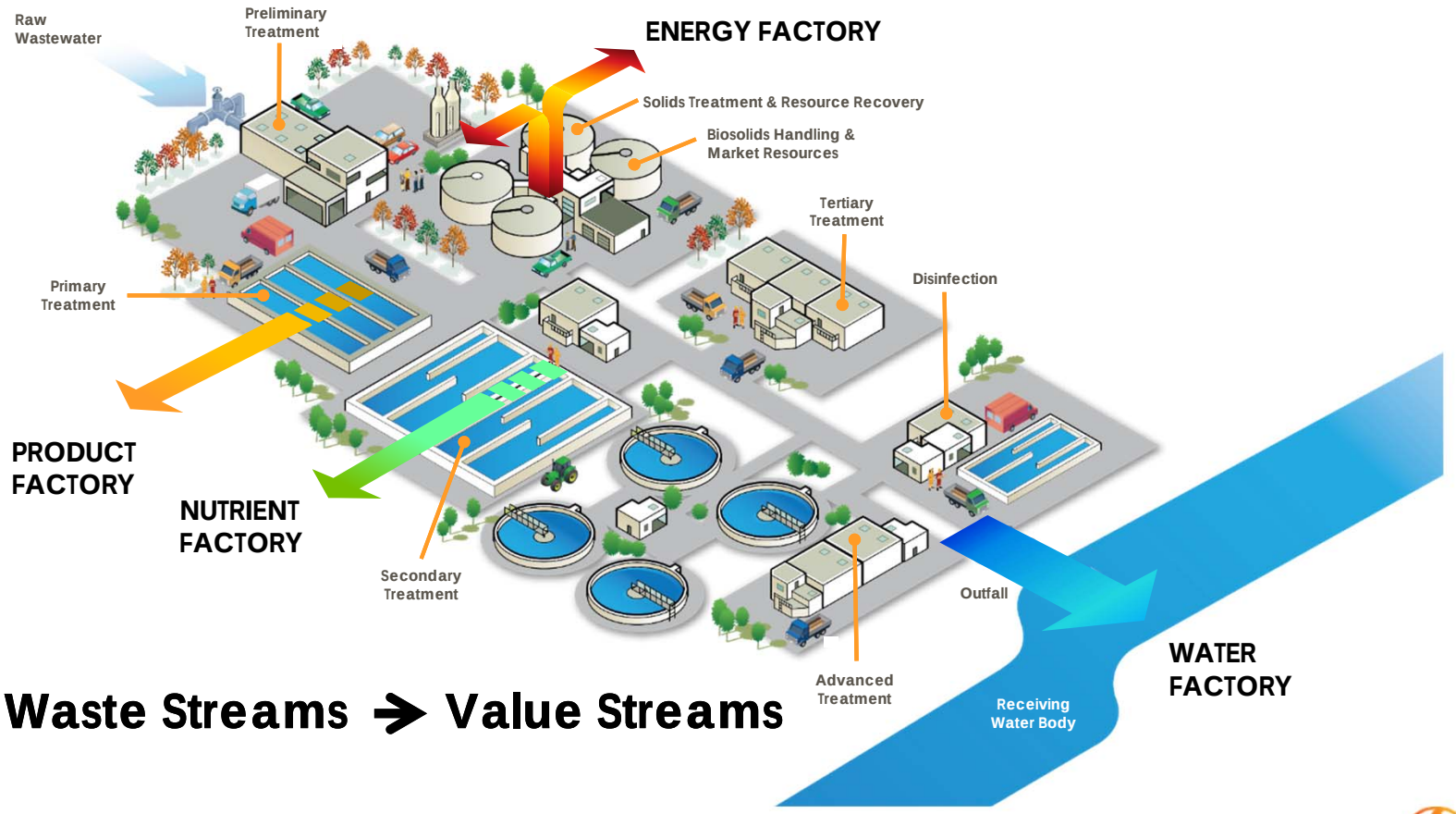
Utility of the Future



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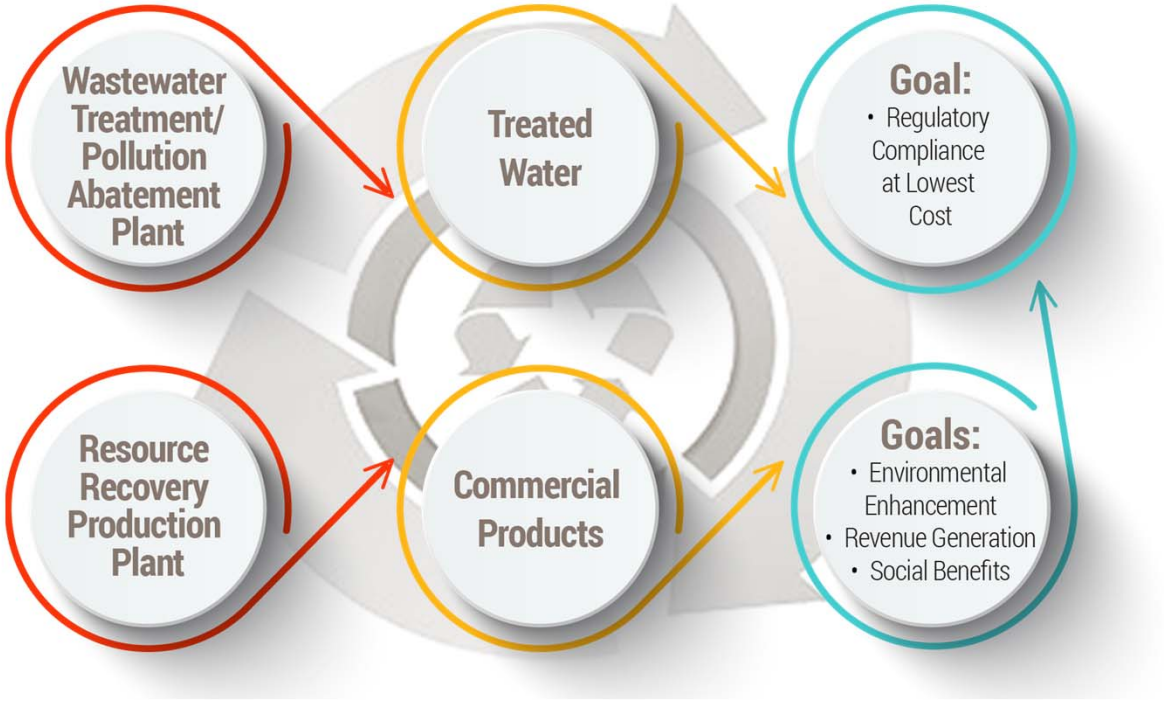
New Paradigm for Municipal and Industrial Wastewater Treatment



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Roadmap to a Resource Recovery Facility

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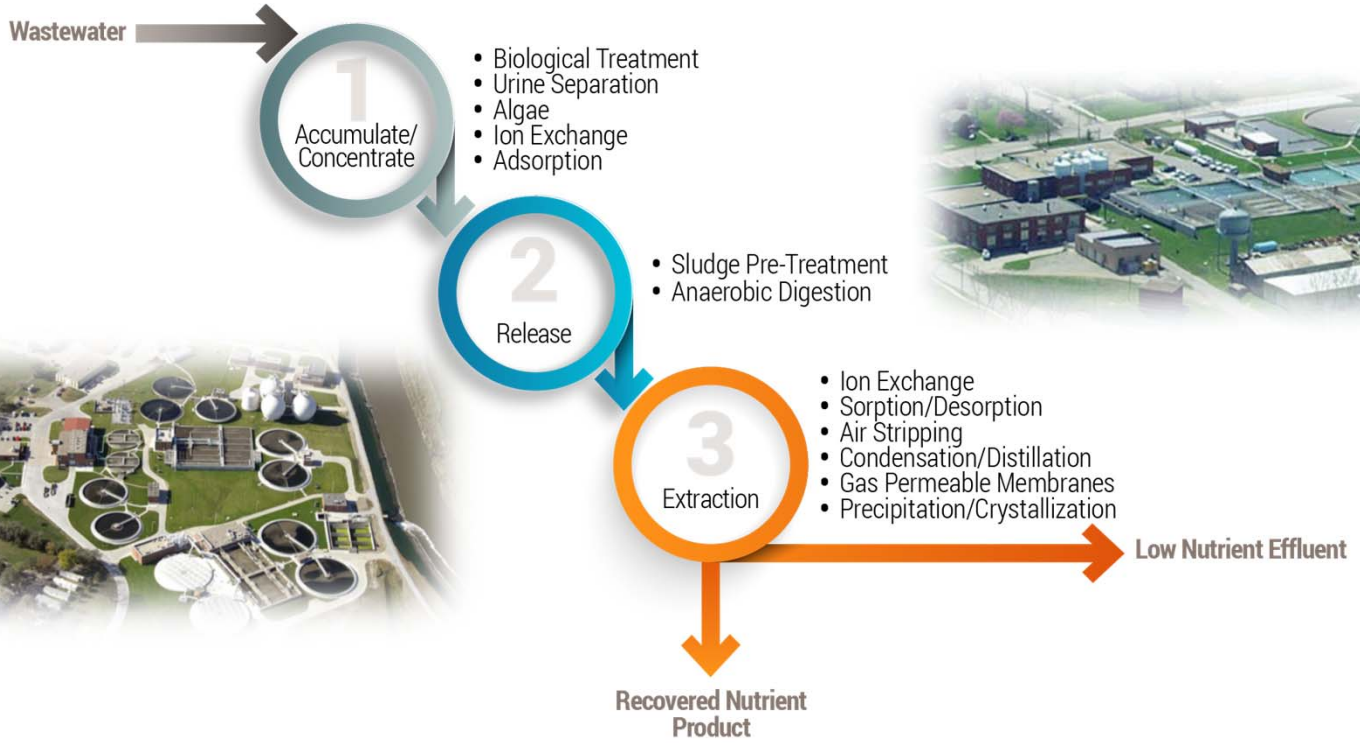
Be Familiar with Current State-of-the-Science for Resource Recovery



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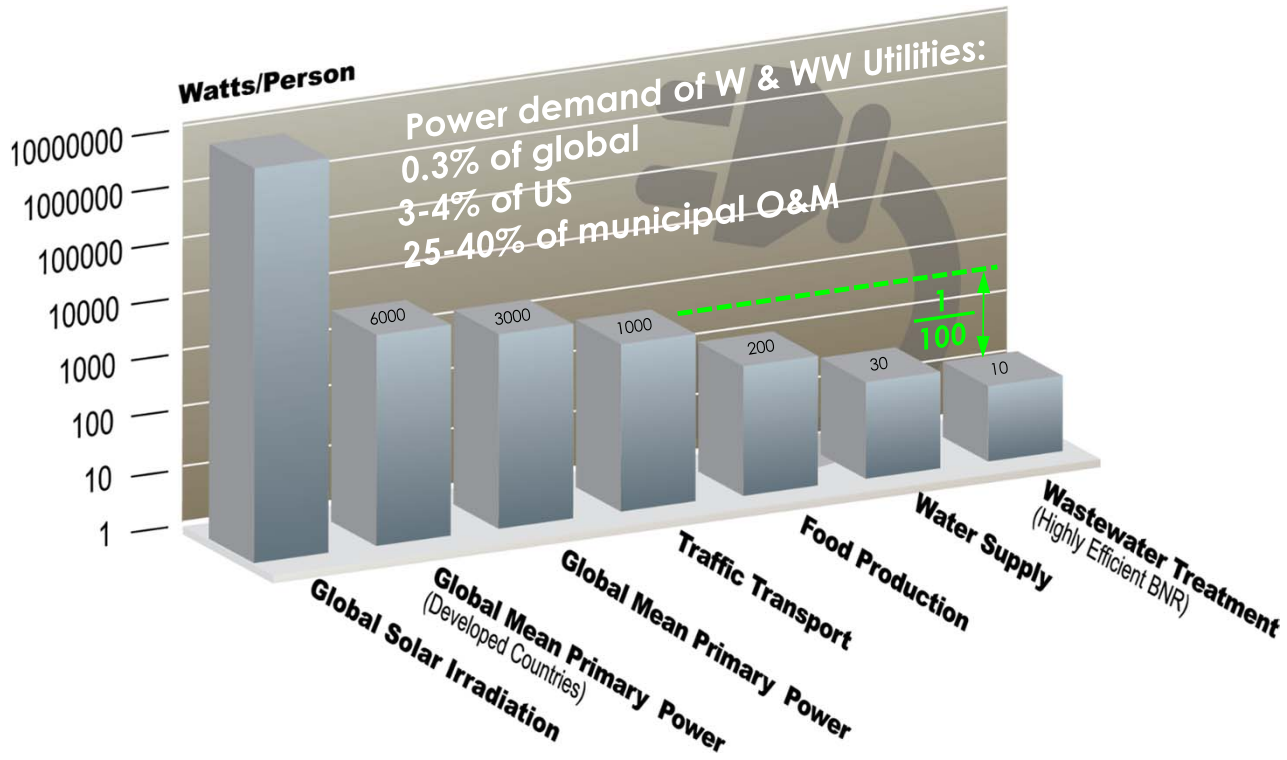
How is Energy Demand Distributed?



Source: Kroiss and Svardal, 2011; NYSERDA, 2008

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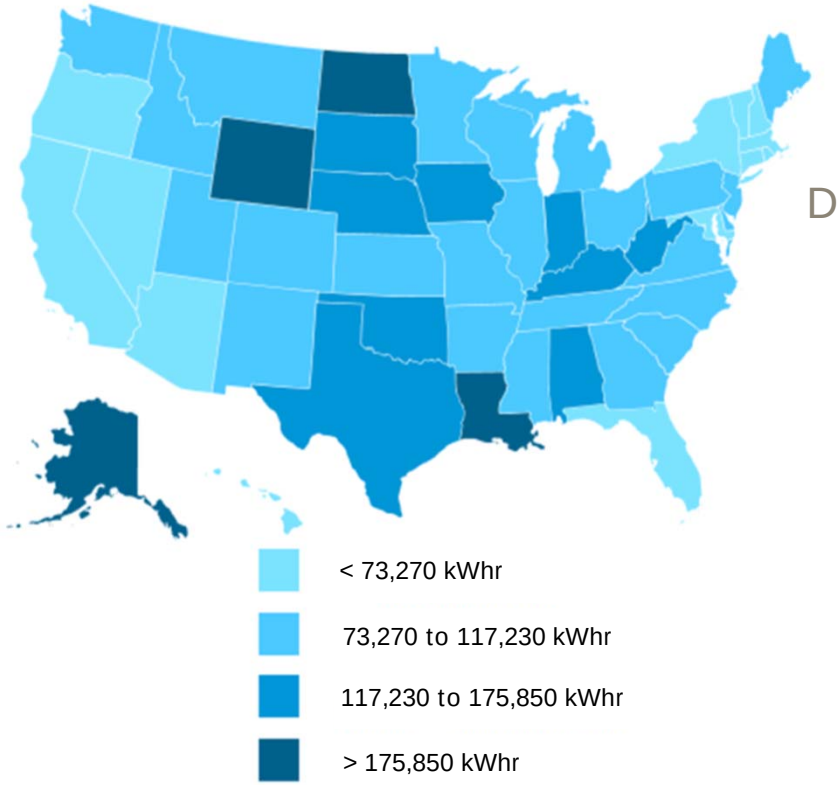
How Much Energy Do We Consume?

Total Energy Consumption per Capita per Year (2014)



Source: IEA, 2016

Distribution depends on:

- population density
- energy source profile
- dominant land use
- industrial profile

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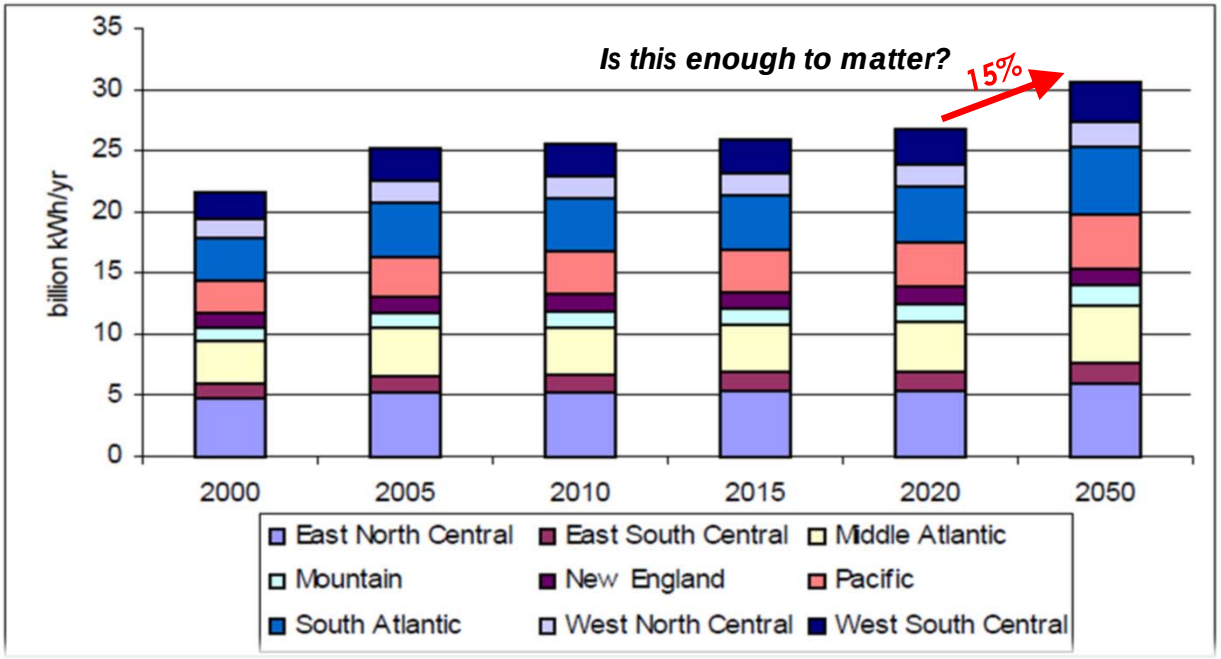
Regional Energy Consumption Projections for Wastewater Treatment



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

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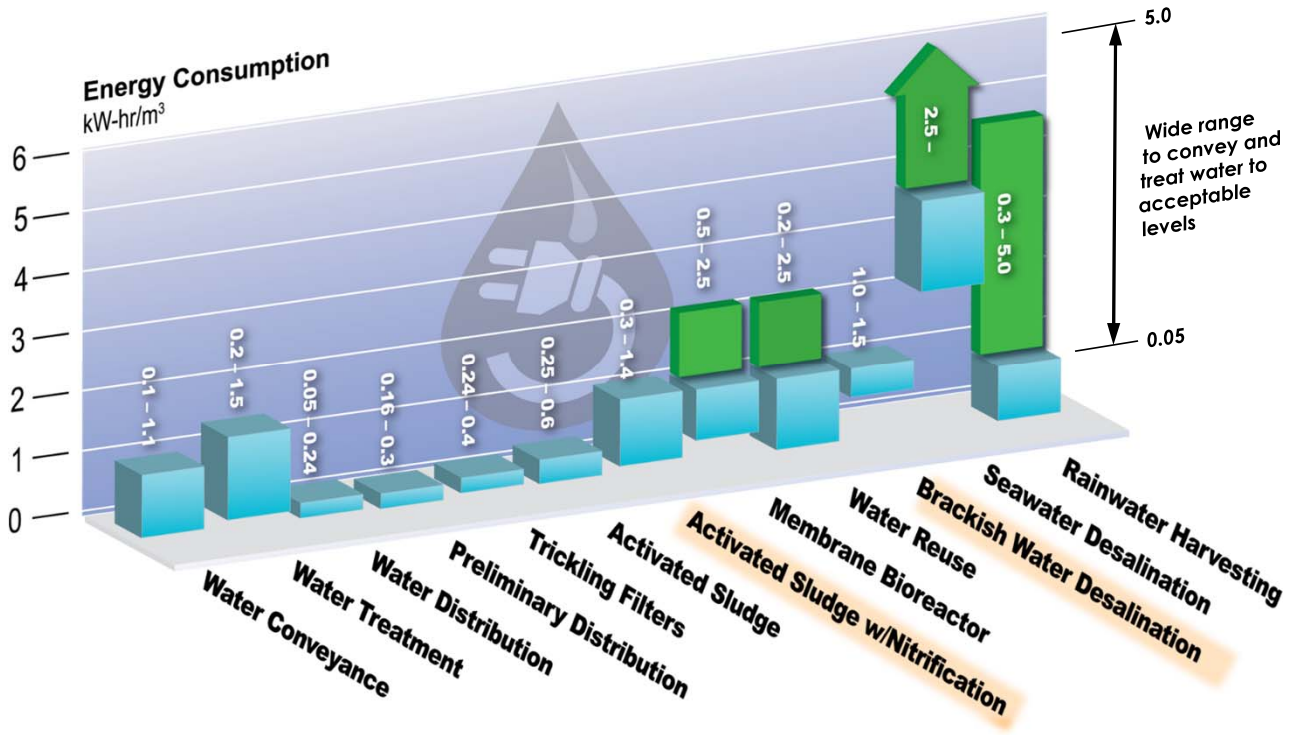
Energy's Footprint in W & WW Sector



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

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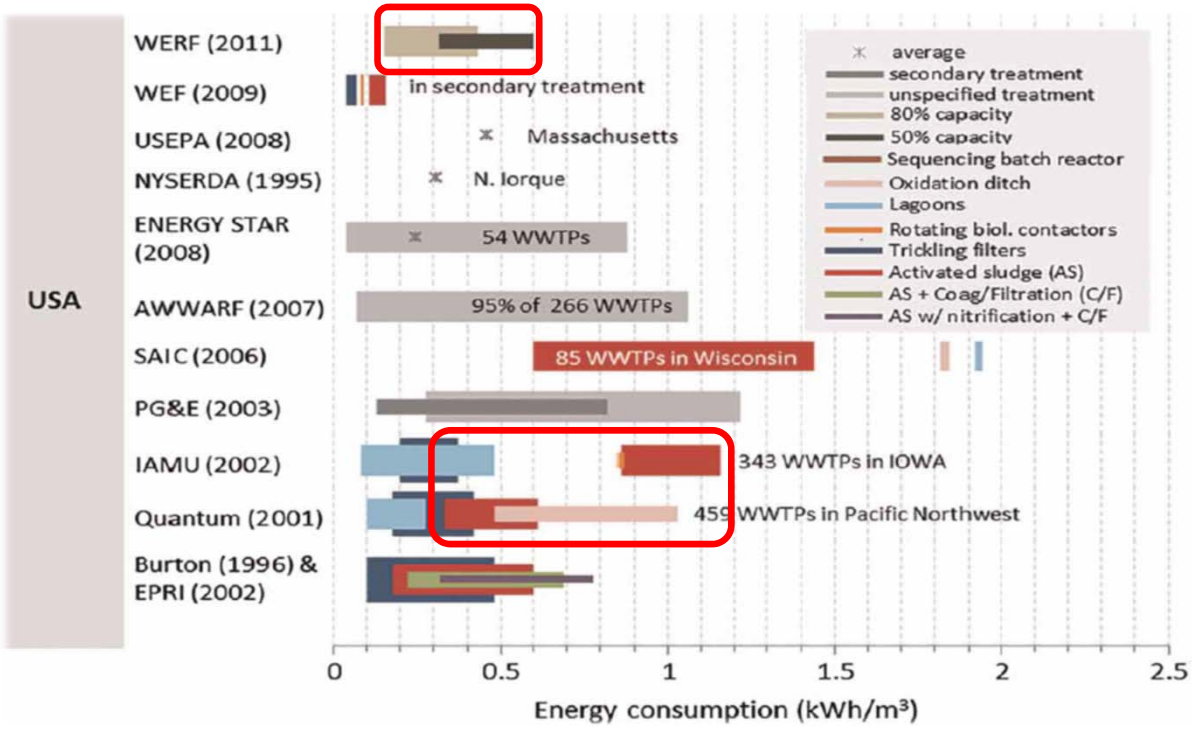
How Does the Wastewater Industry Benchmark in Energy Consumption?



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

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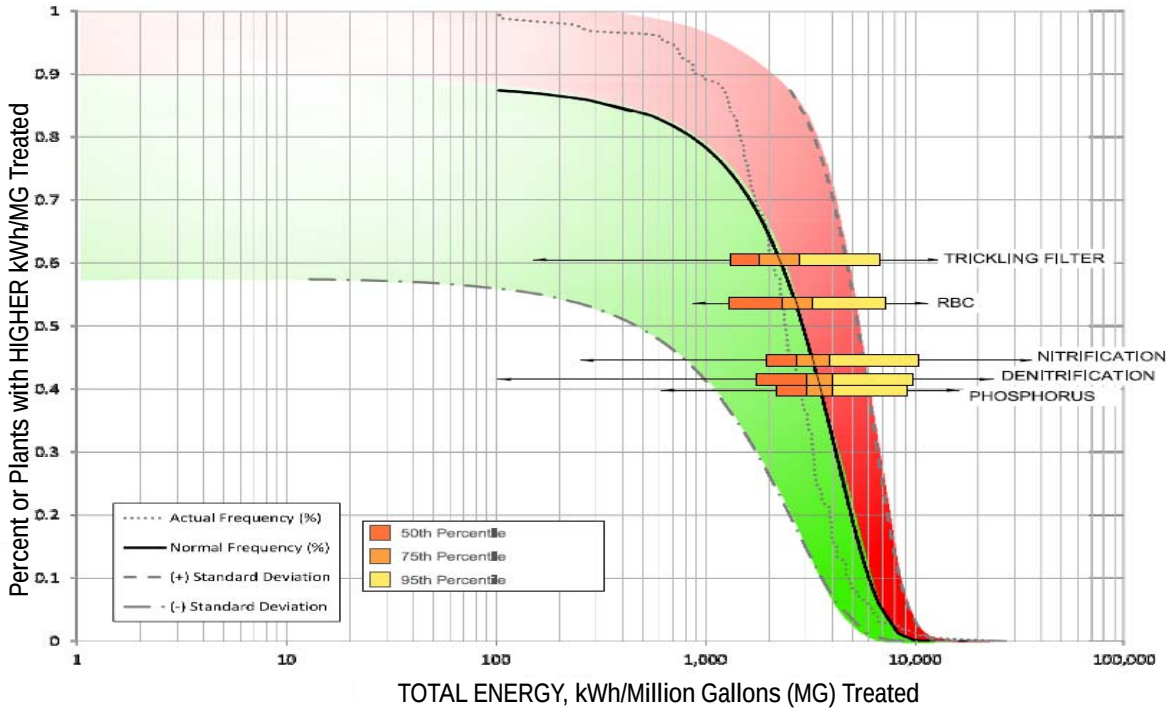
Energy Consumption at Treatment Facilities - Process



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

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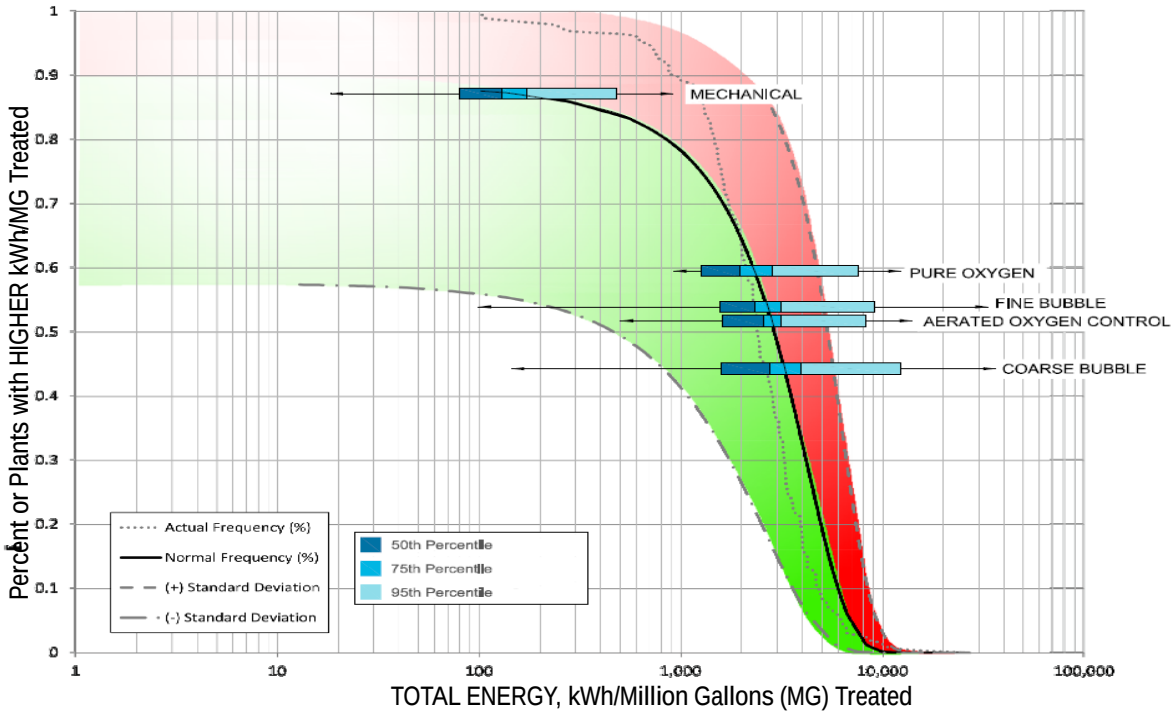
Energy Consumption at Treatment Facilities – Process Equipment



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

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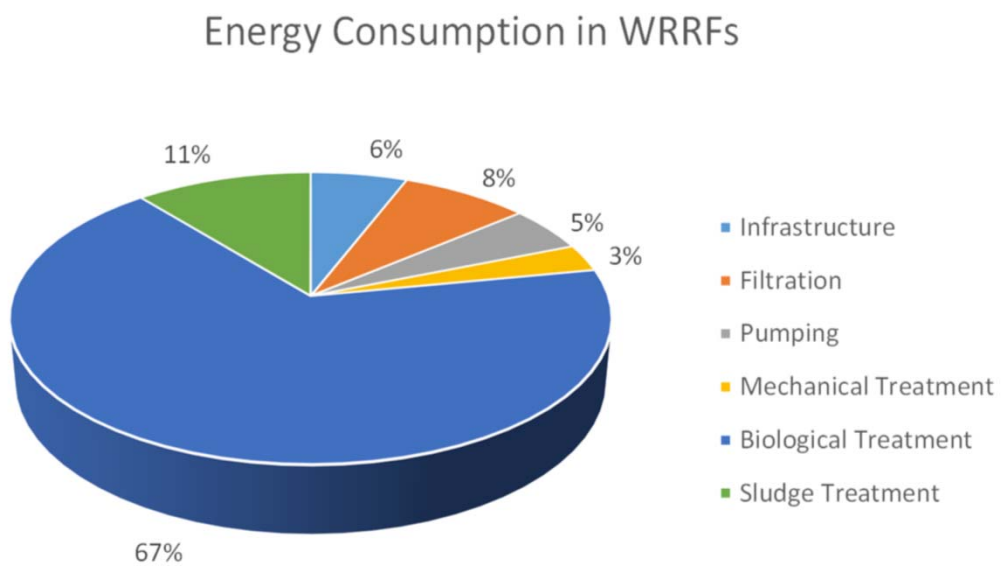
How is Energy Consumption Distributed Across Plant Processes?



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

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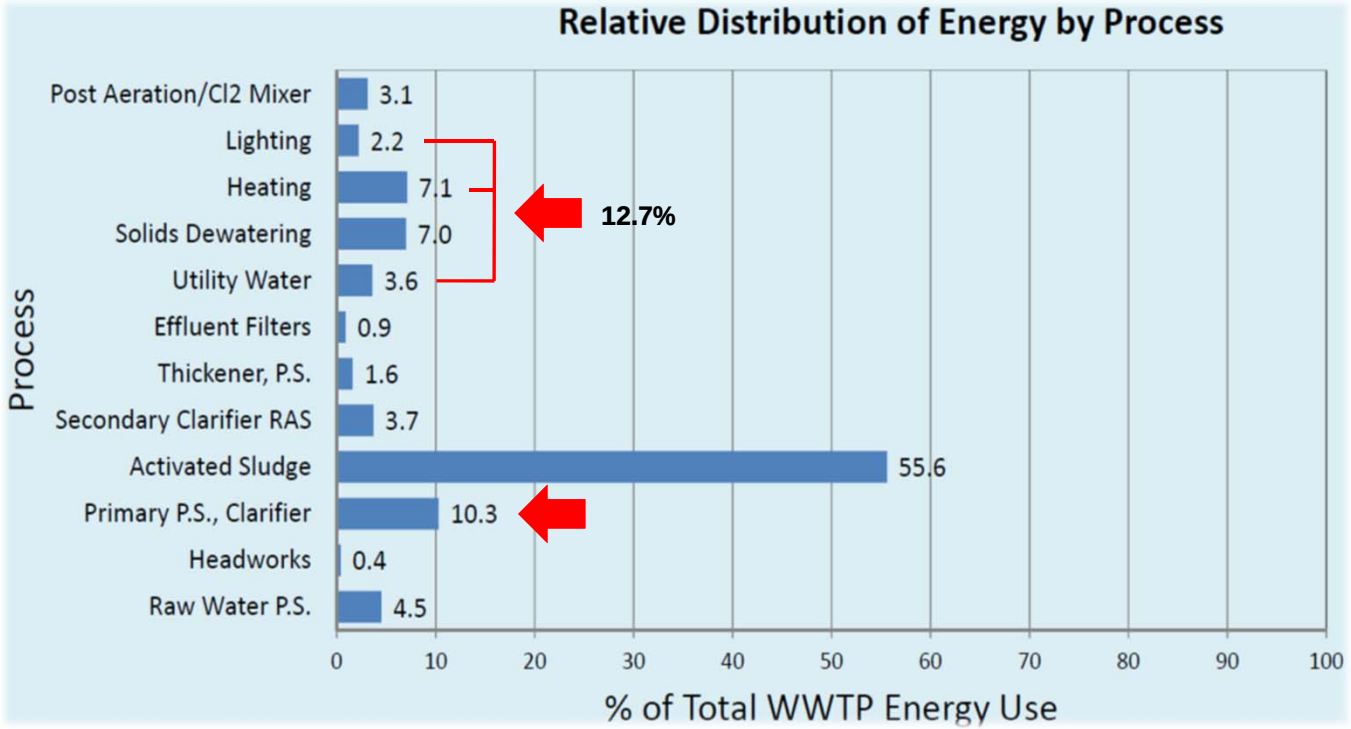
Energy Distribution in Wastewater Treatment by Unit Process



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

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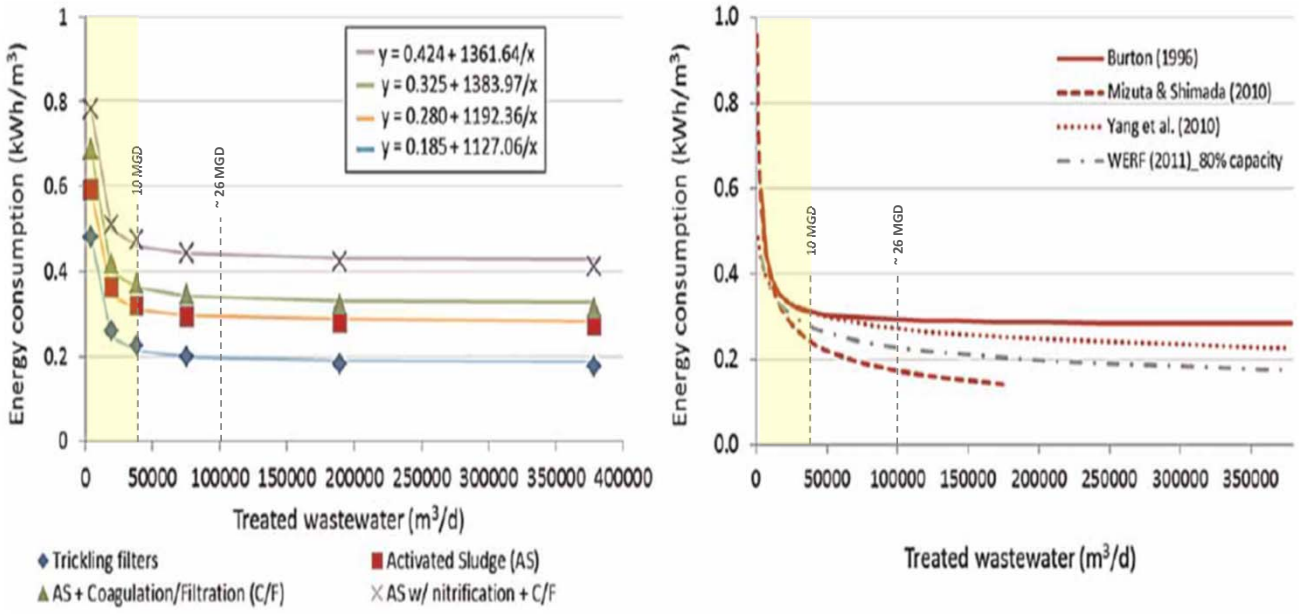

Source: "Energy Performance Indicators of Wastewater Treatment: A Field Study with 17 Portuguese Plants", Silva, C., Rosa, M.; Water Science & Technology, 72(4), 2015

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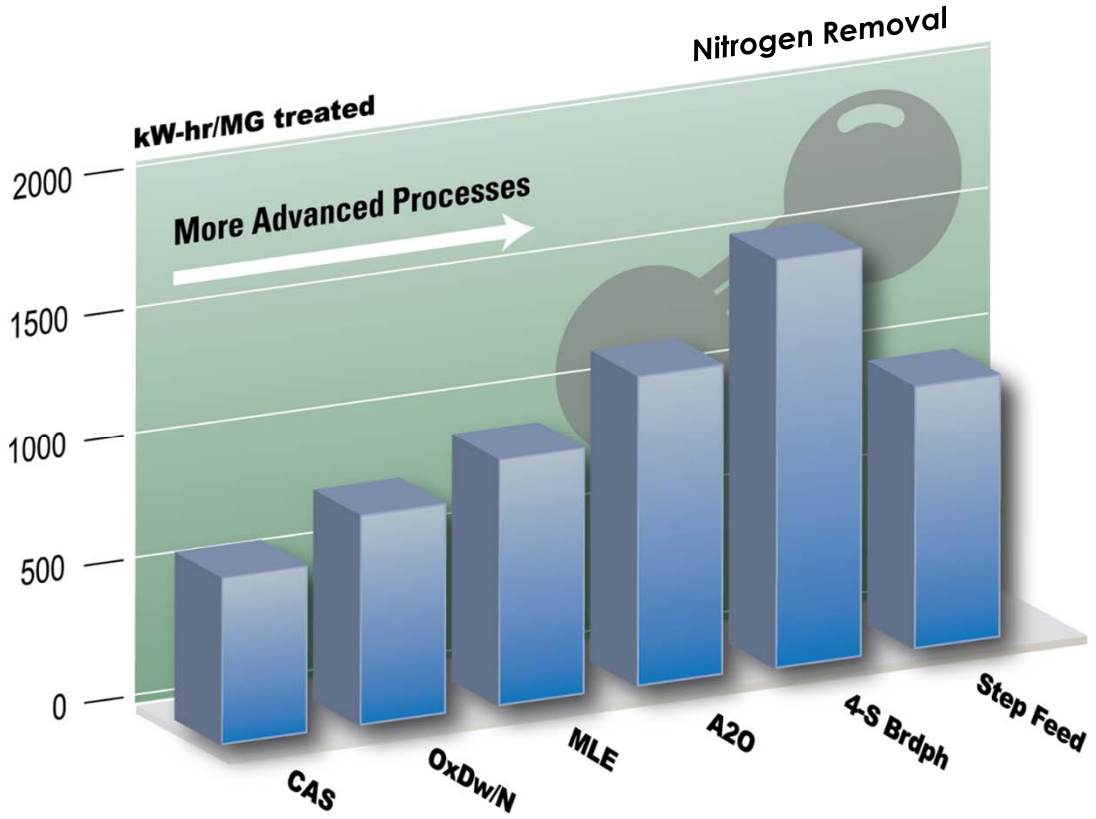
Stricter Standards → More Energy!



Source: Kang, et al./USEPA, 2009

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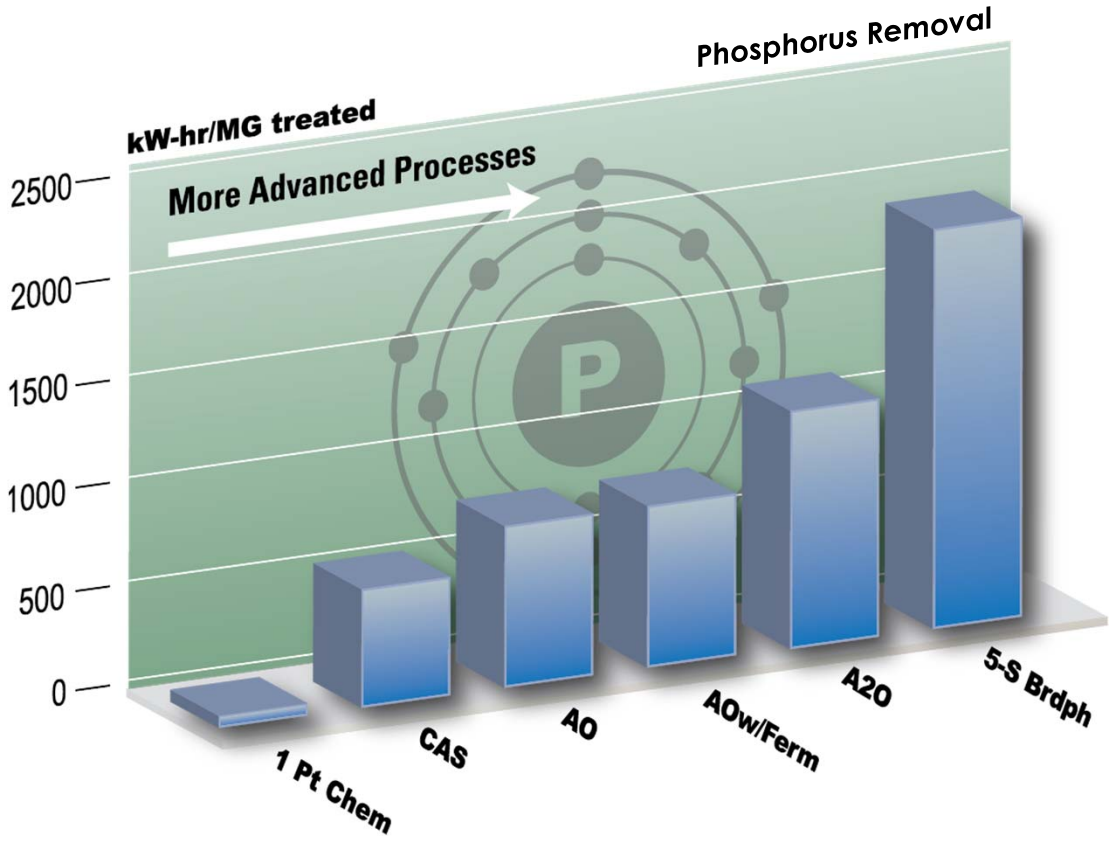

Source: Kang, et al./USEPA, 2009

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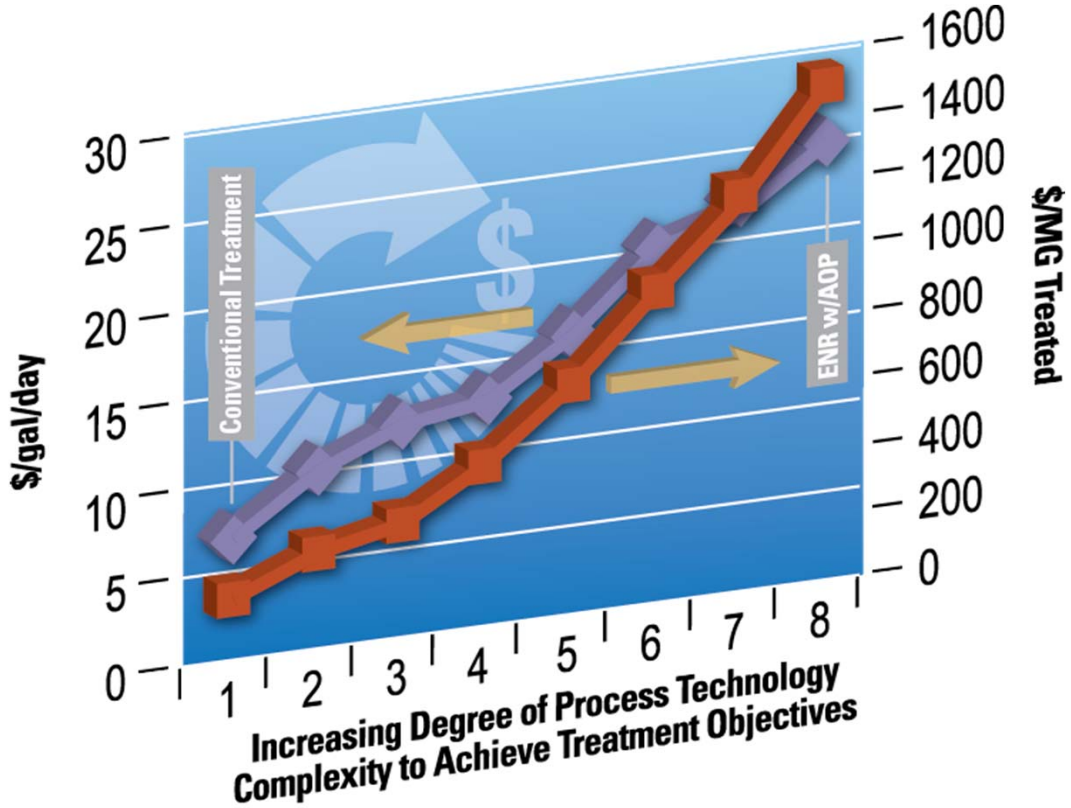
The Case for Nutrient Recovery: Economics of Removal



Source: Bratby and Jimenez, WERF 2011

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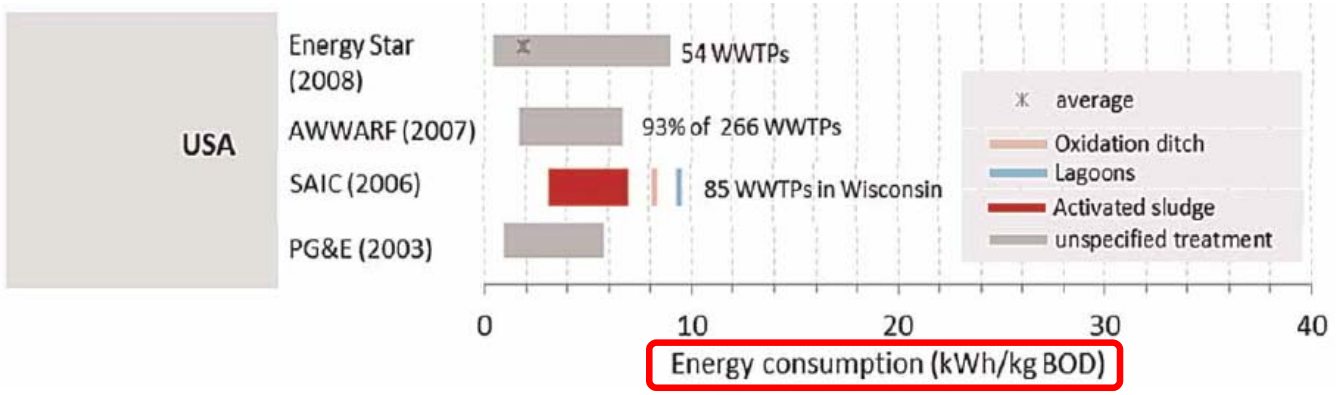
How Does the Wastewater Industry Benchmark in Energy Consumption?

Loading Removal is a more 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

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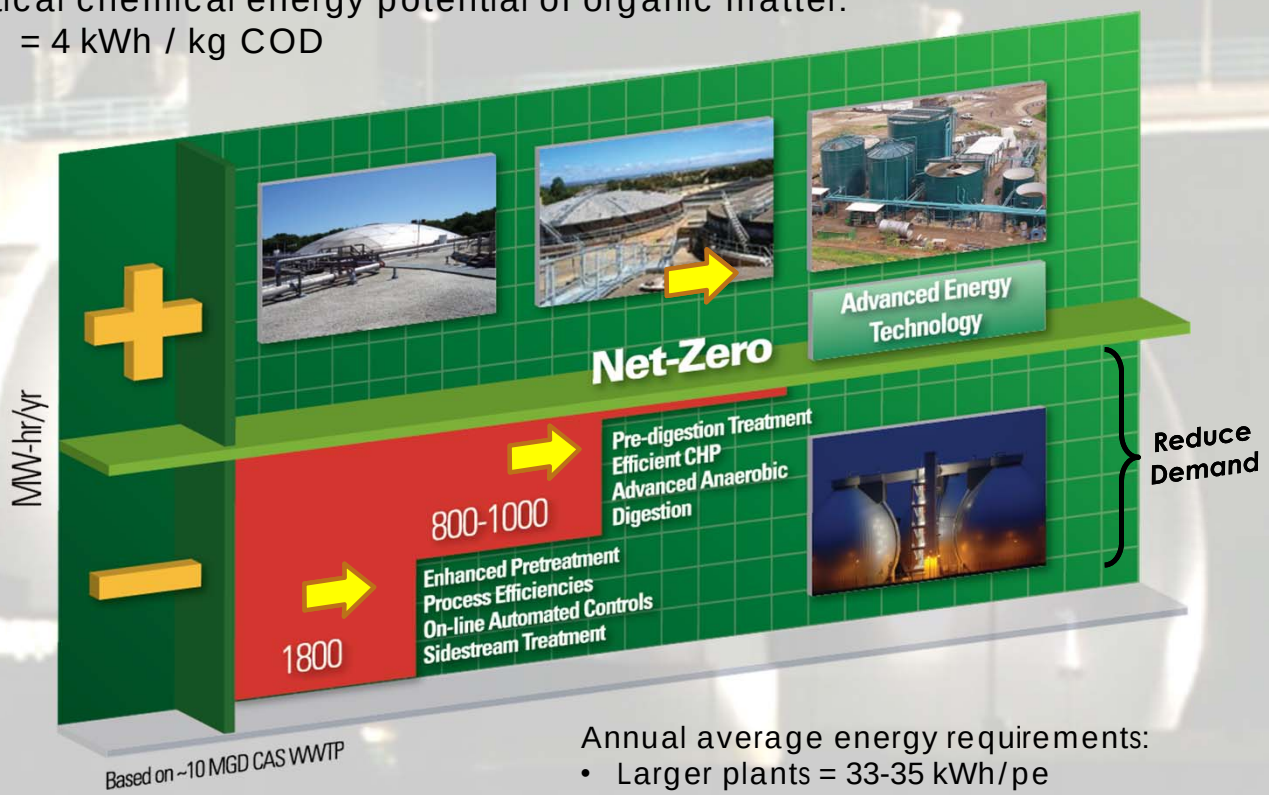
Should Energy Neutrality be Pursued?

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)

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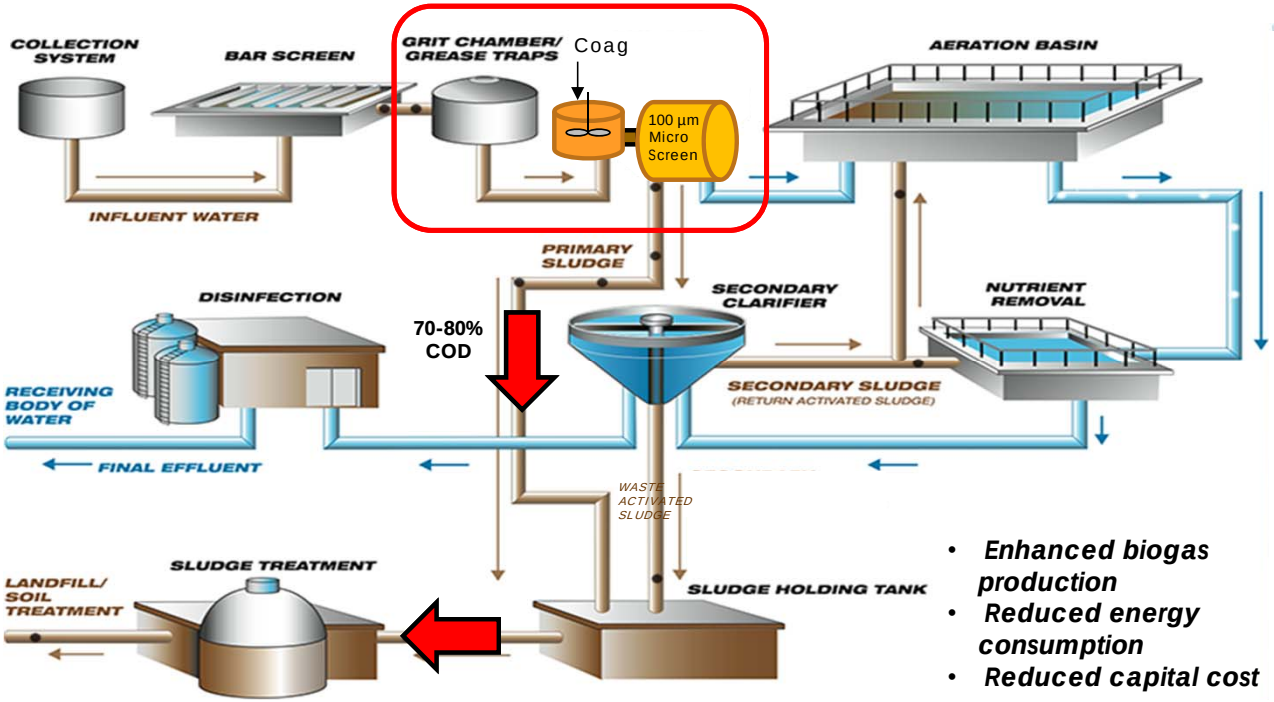
Is Energy Neutrality a Reality?



- ***Enhanced biogas production***
- ***Reduced energy consumption***
- ***Reduced capital cost***

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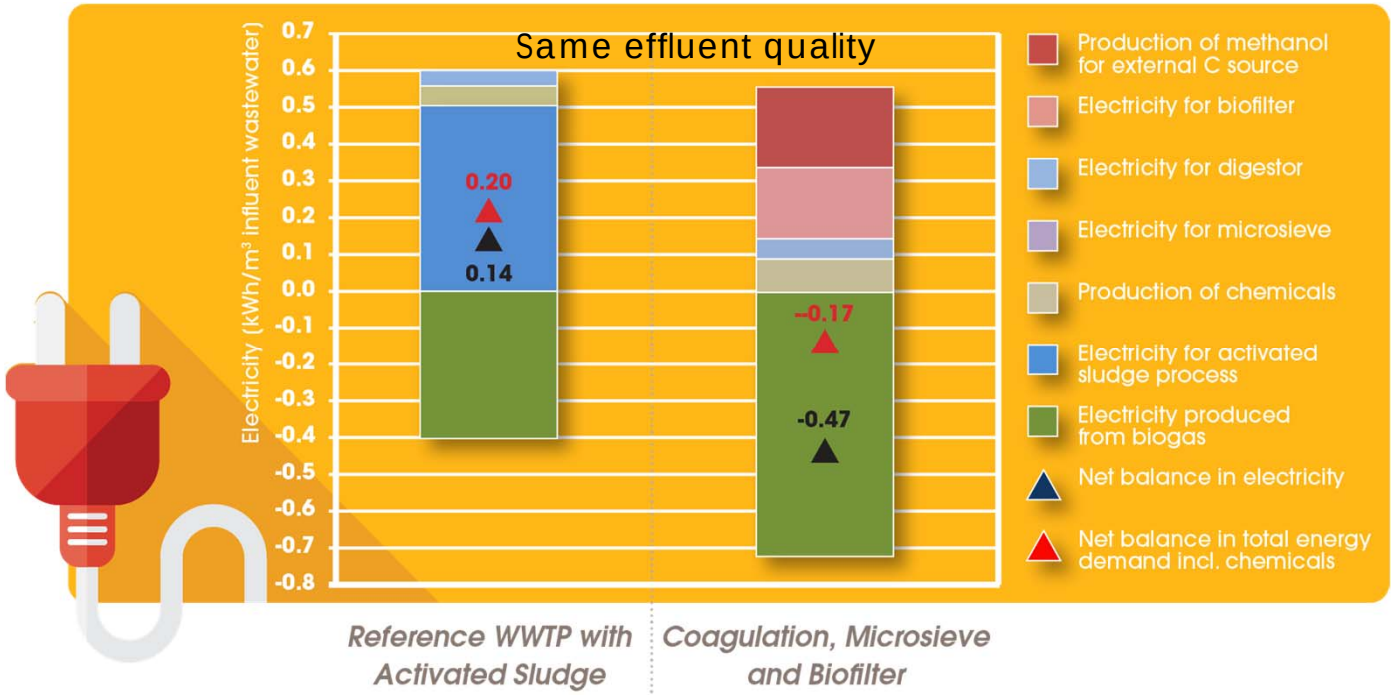
Is Energy Neutrality a Reality? Reduce Demand



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

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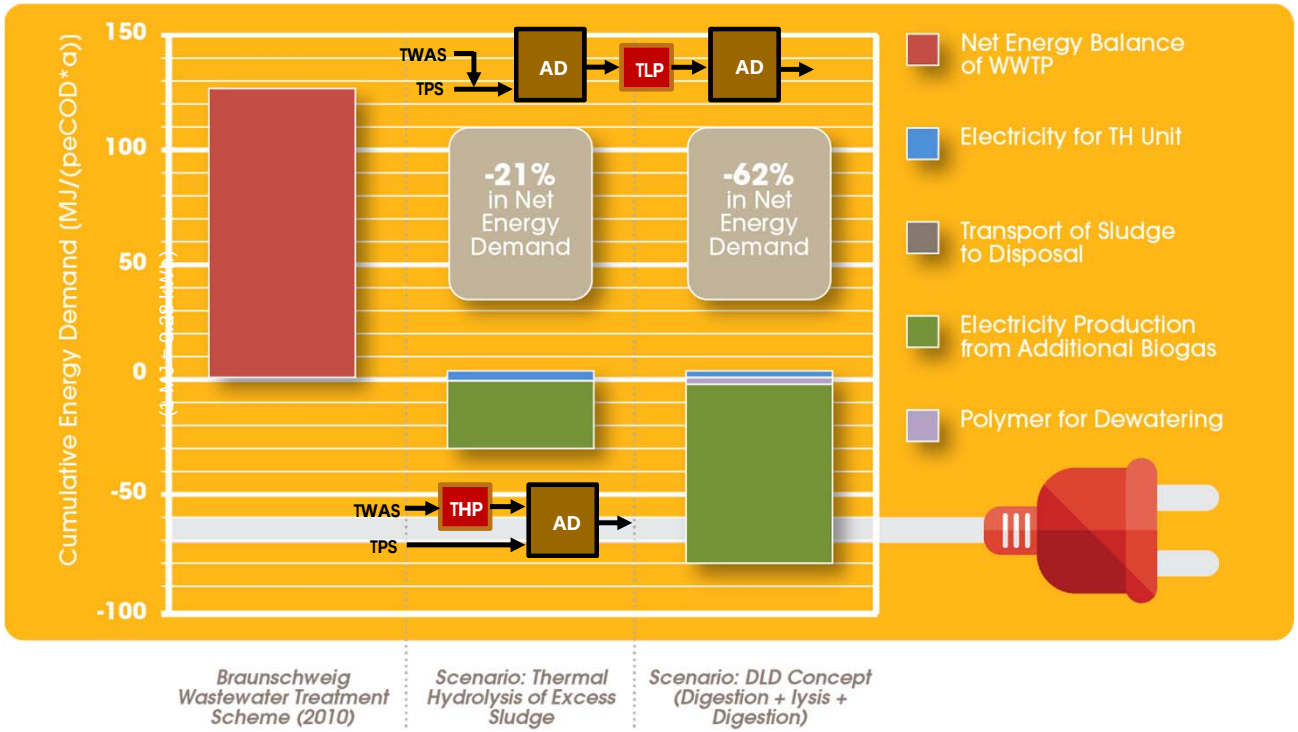

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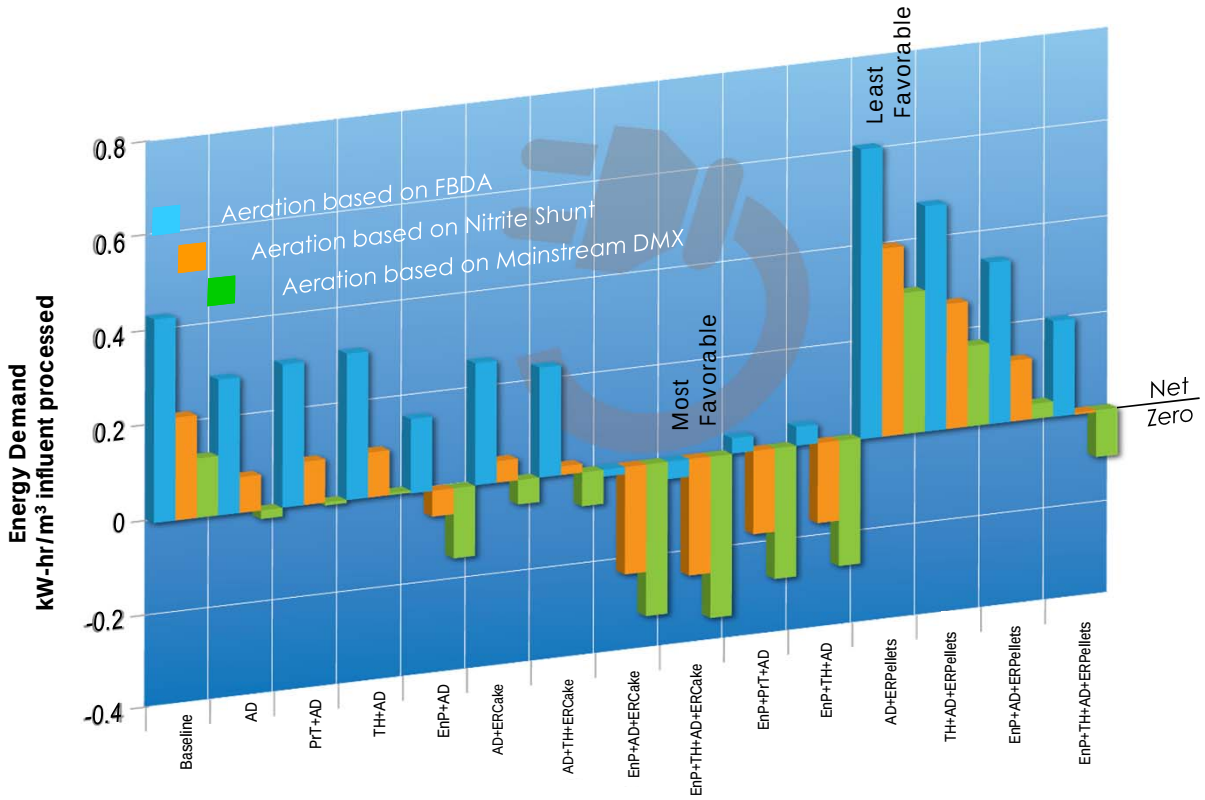
Impact of Biosolids Process Configurations on Energy Balance



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

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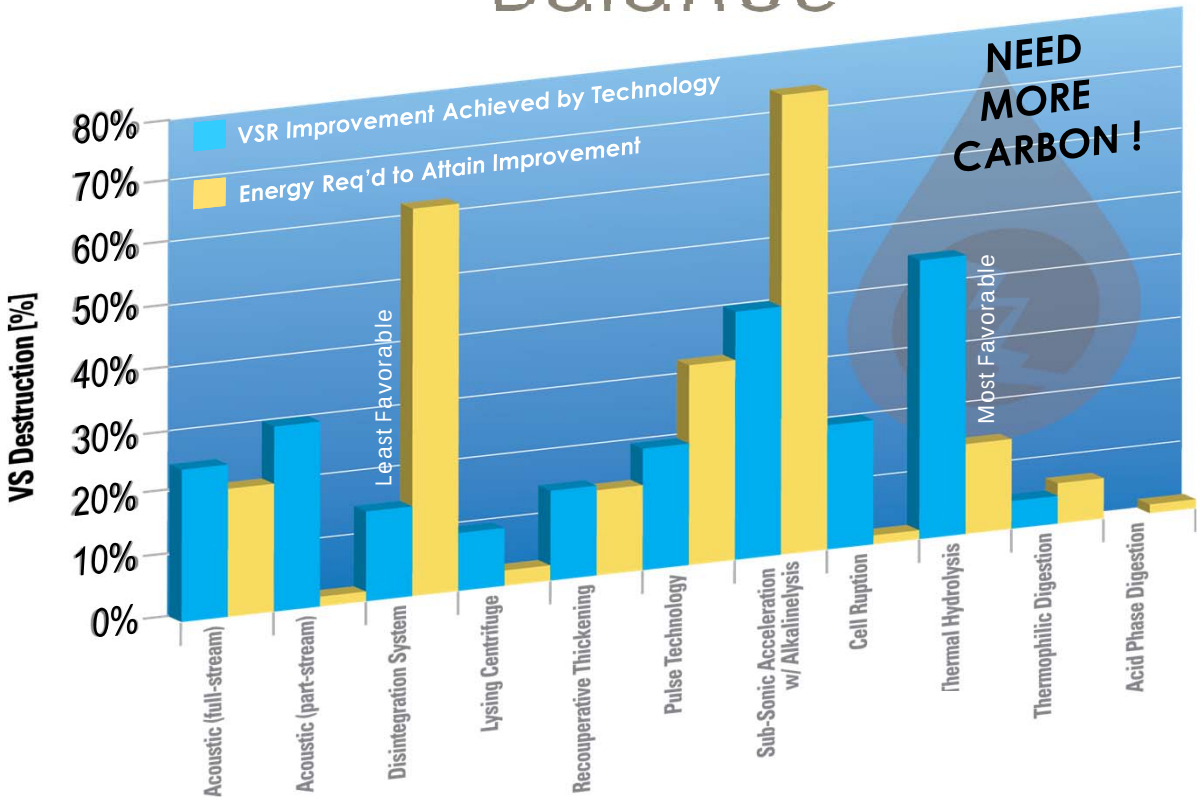
Impact of Biosolids Pretreatment Process Technology on Energy Balance



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

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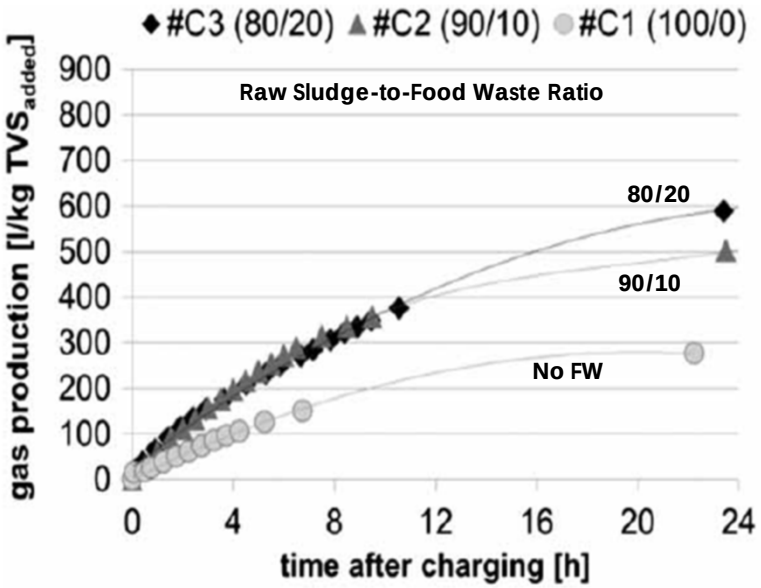
What About Co-Digestion?



- 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

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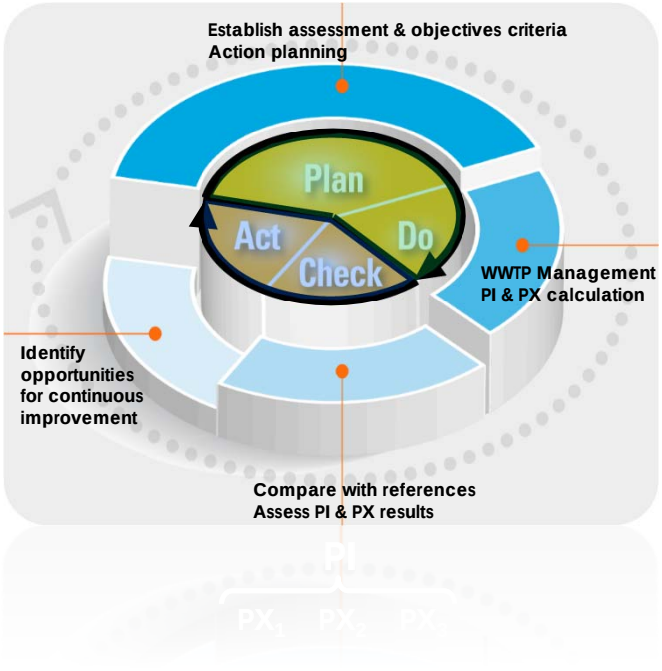
Should Full Energy Recovery be the Focus in Today's Economic Pressure-cooker?



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

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

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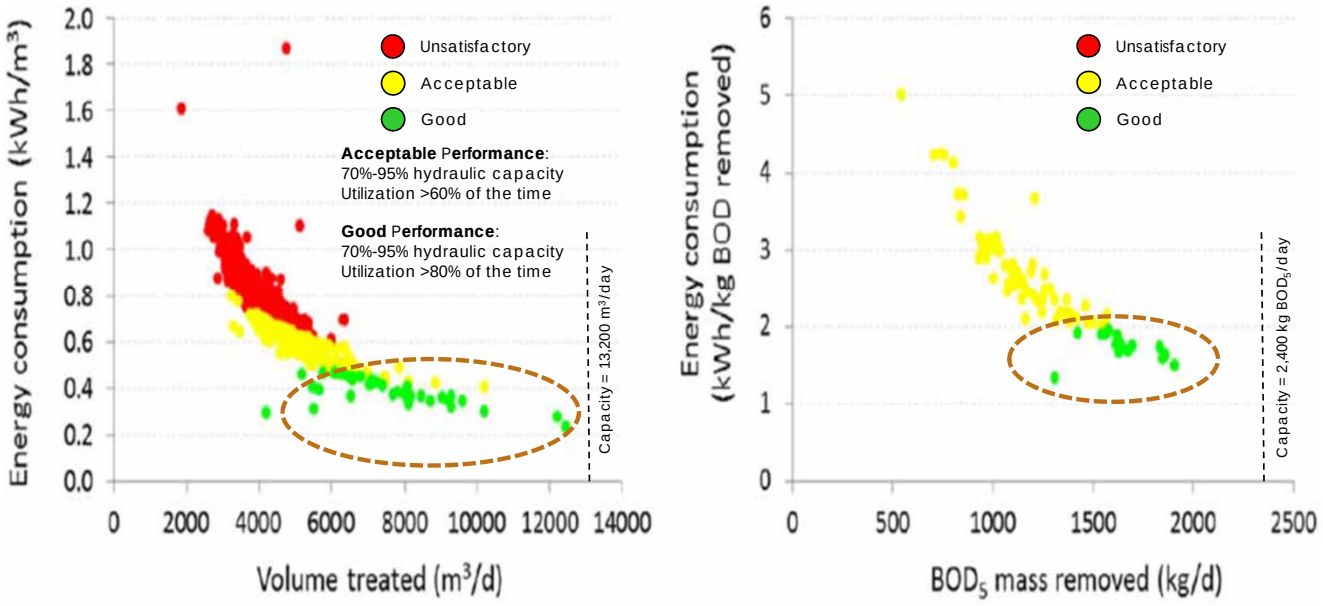
Is there a Different Paradigm? Consideration of Capacity Utilization



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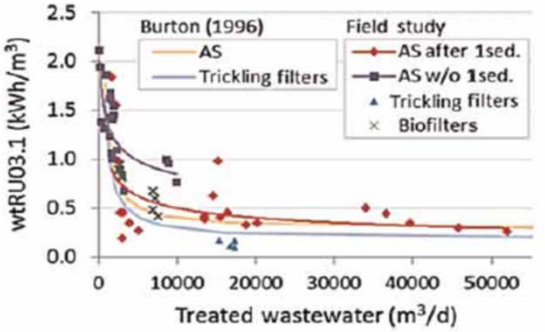

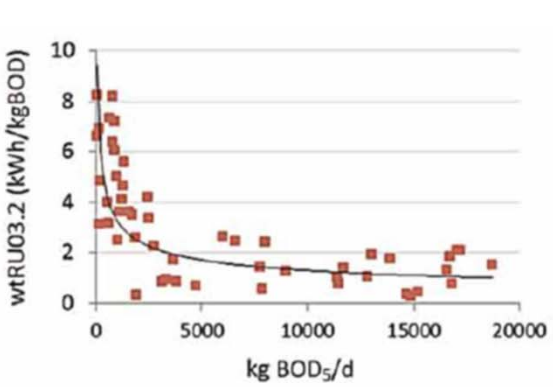

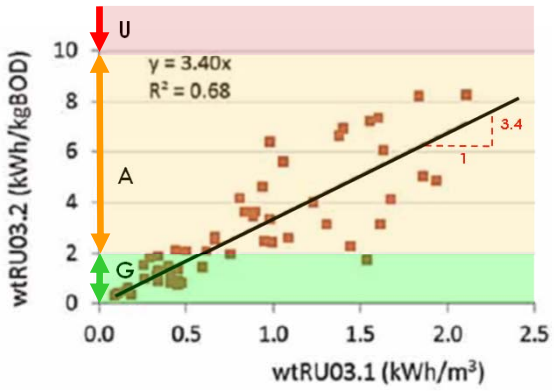

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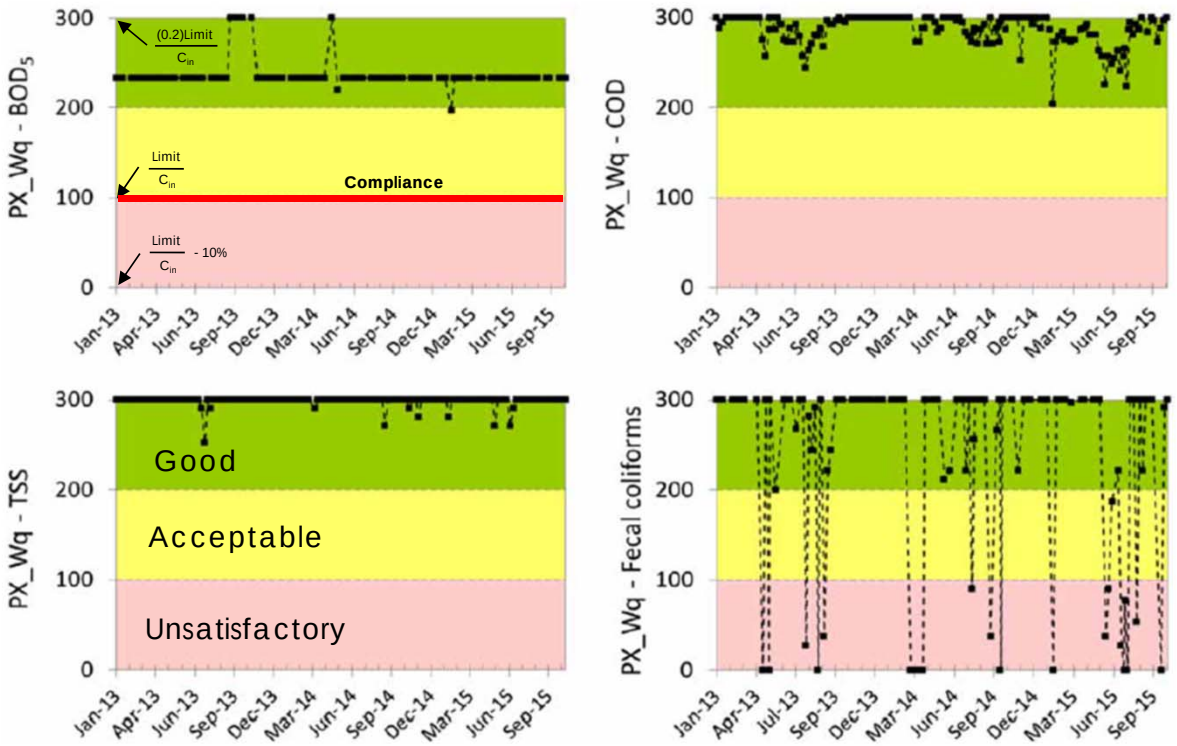
Is there a Different Paradigm? Consideration of Performance



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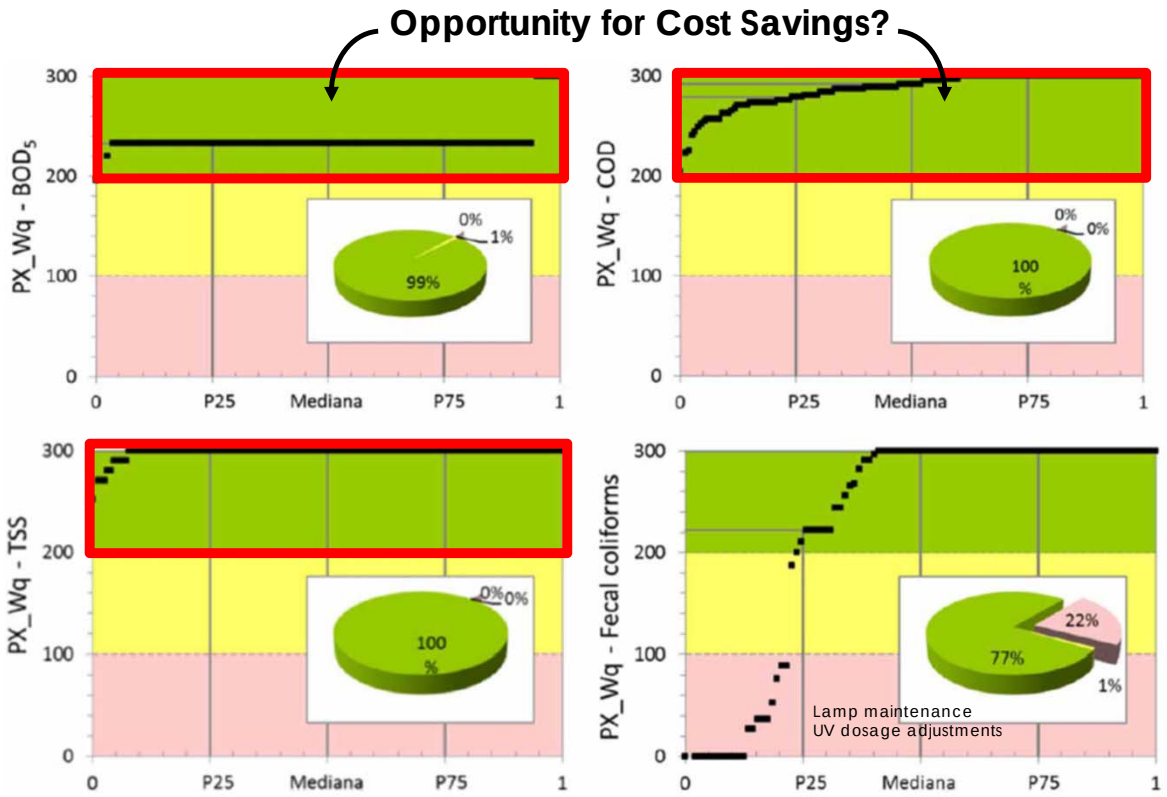

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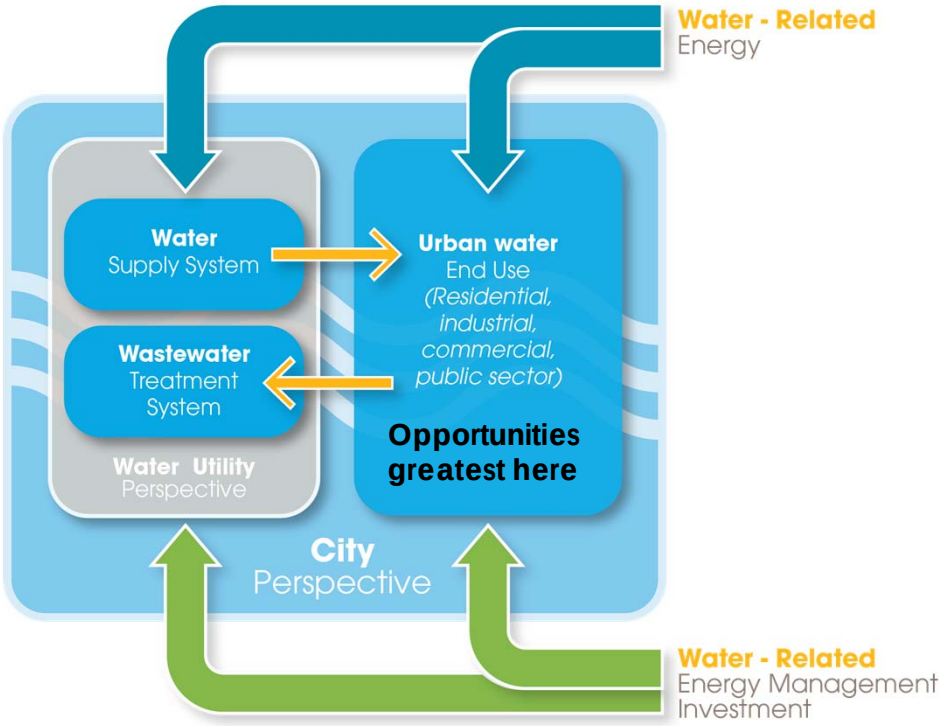
Broader Perspective Enhances Energy and Financial Savings Potential



- 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

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

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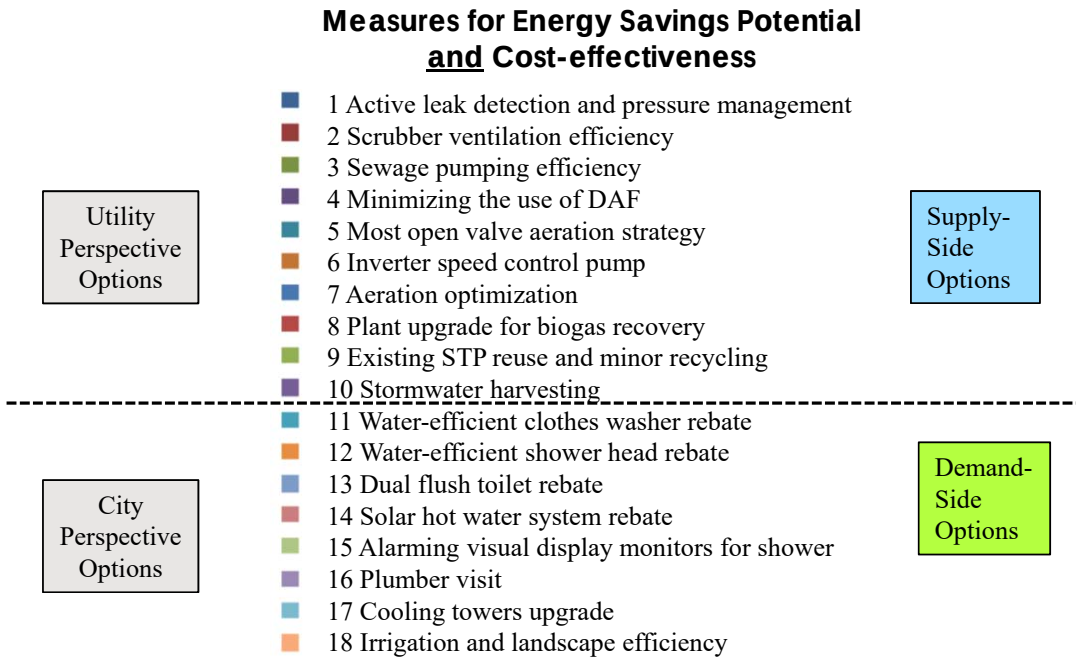

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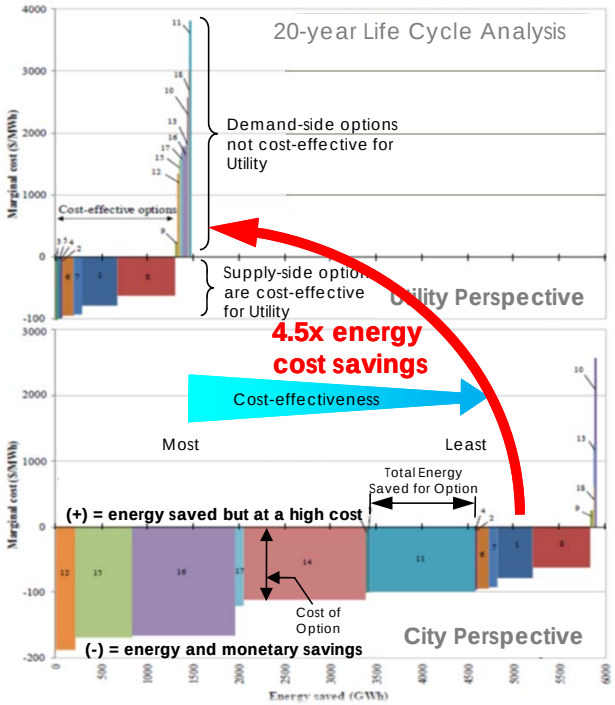

- Water Use Distribution
  - 65% residential
  - 24% commercial/industrial
  - 11% non-revenue
- 1300 GWh saved for Utility
- 5800 GWh saved for City
  - Residential Conservation
  - Unaccounted-for water
- Utilities need incentives to look beyond boundaries

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

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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

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