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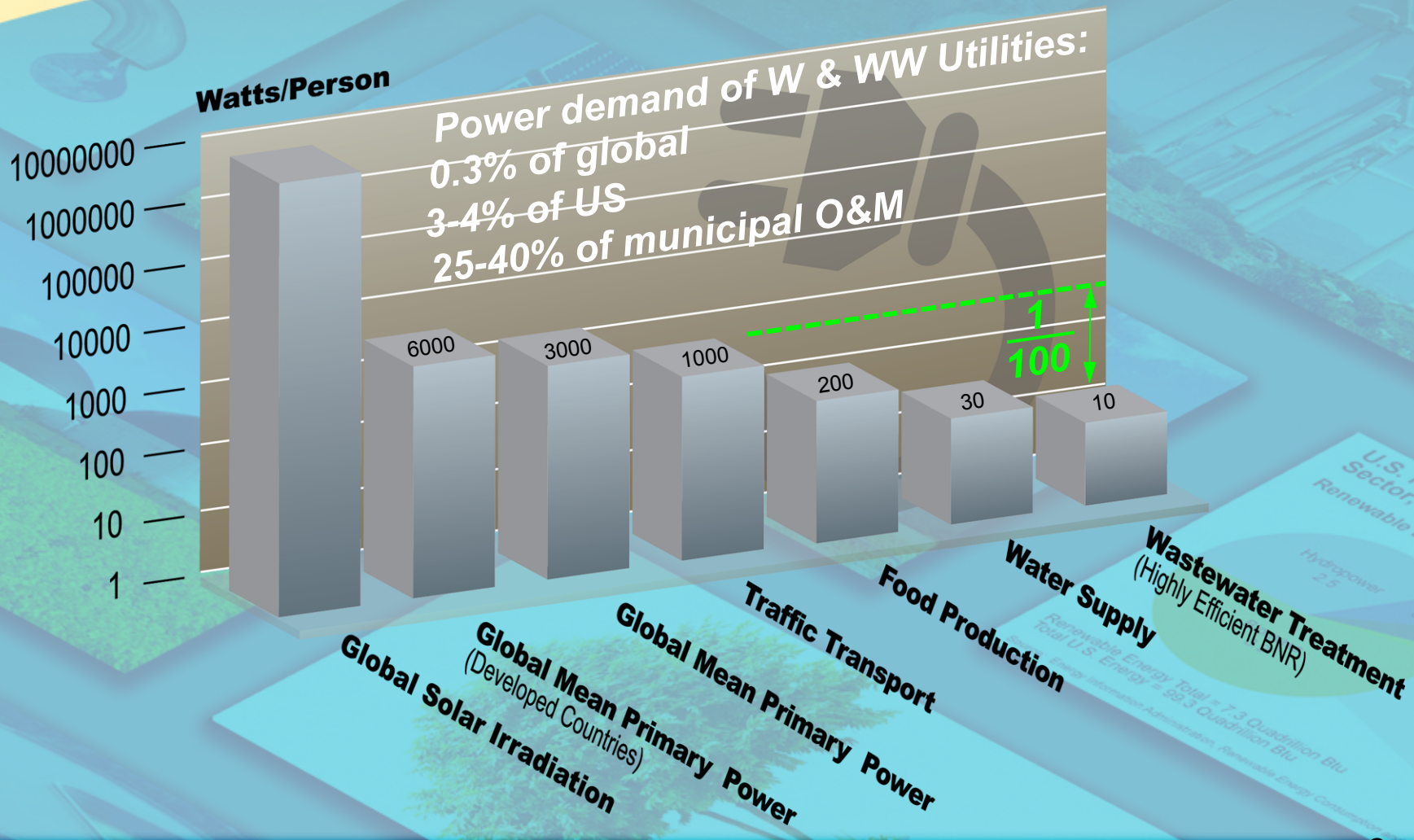
Energy Management for WRRFs: Does It Matter? Should it Matter?

Art Umble, PhD, PE, BCEE
Global Wastewater Practice Leader
MWH now part of Stantec

Outline

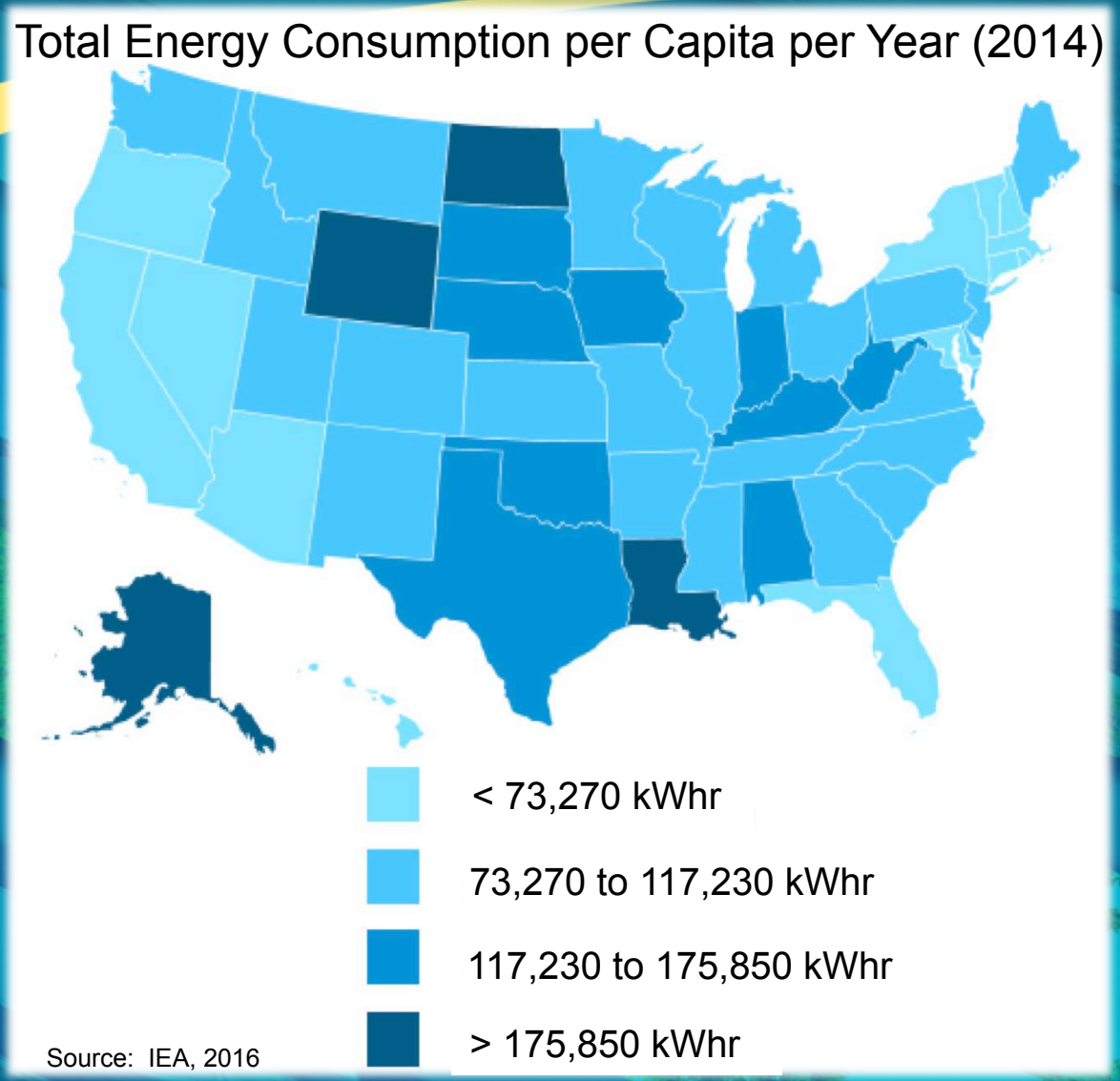
- Brief Look at the Energy Profile
- Can we compare energy consumption?
- Is Energy Neutrality a Real Deal?
- Is Excellent Performance Necessary?
- Should there be a Different Way of Thinking?

How is Energy Demand Distributed?



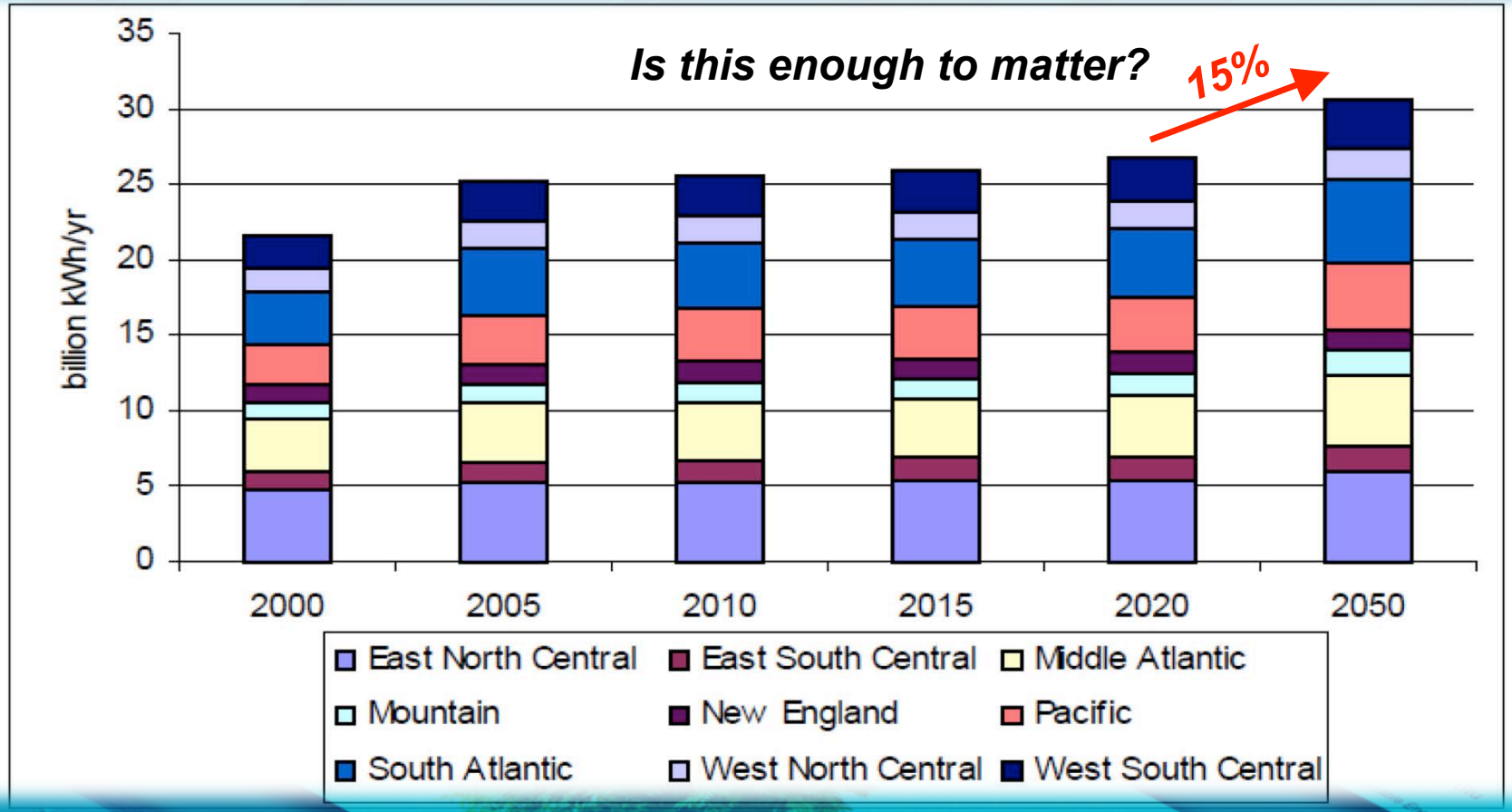
Source: Kroiss and Svardal, 2011; NYSERDA, 2008

How Much Energy Do We Consume?



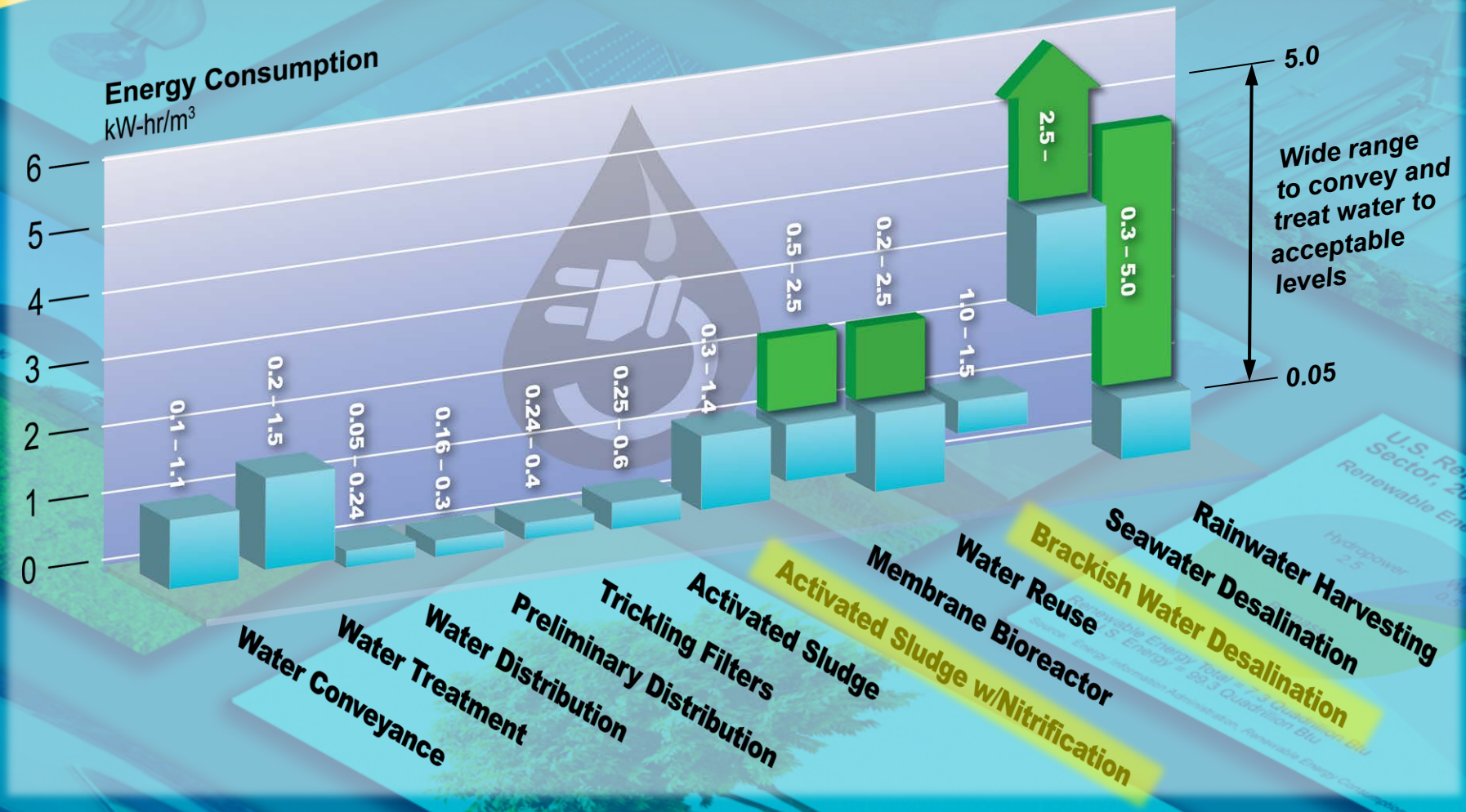
- **Distribution depends on:**
  - *population density*
  - *energy source profile*
  - *dominant land use*
  - *industrial profile*
    - agricultural
    - resource extraction
    - resource processing

Regional Energy Consumption Projections for Wastewater Treatment



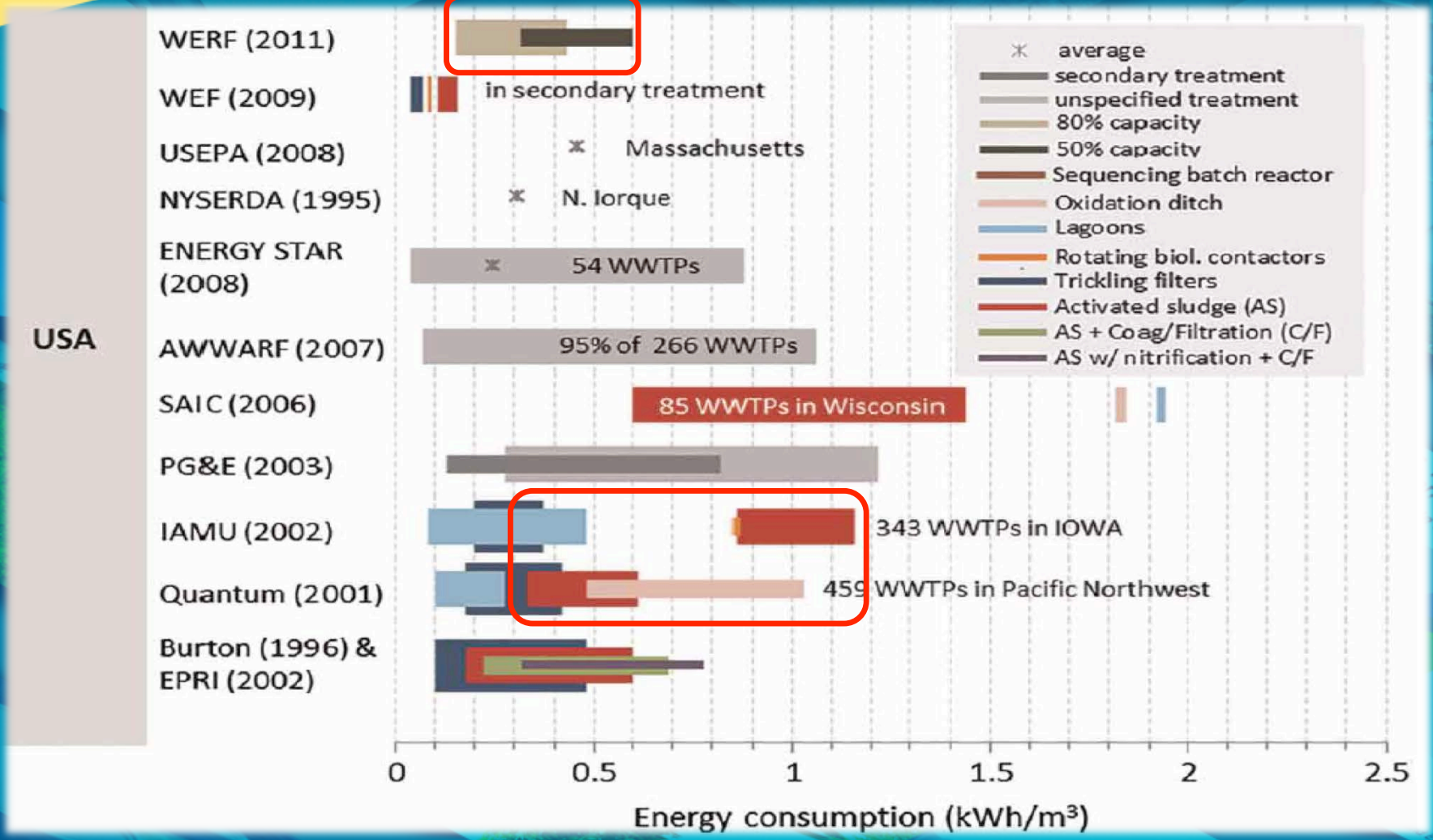
Source: Electricity Use and Management in the Municipal Water Supply and Wastewater Industries; WRF/EPRI, 2013

Energy's Footprint in W & WW Sector



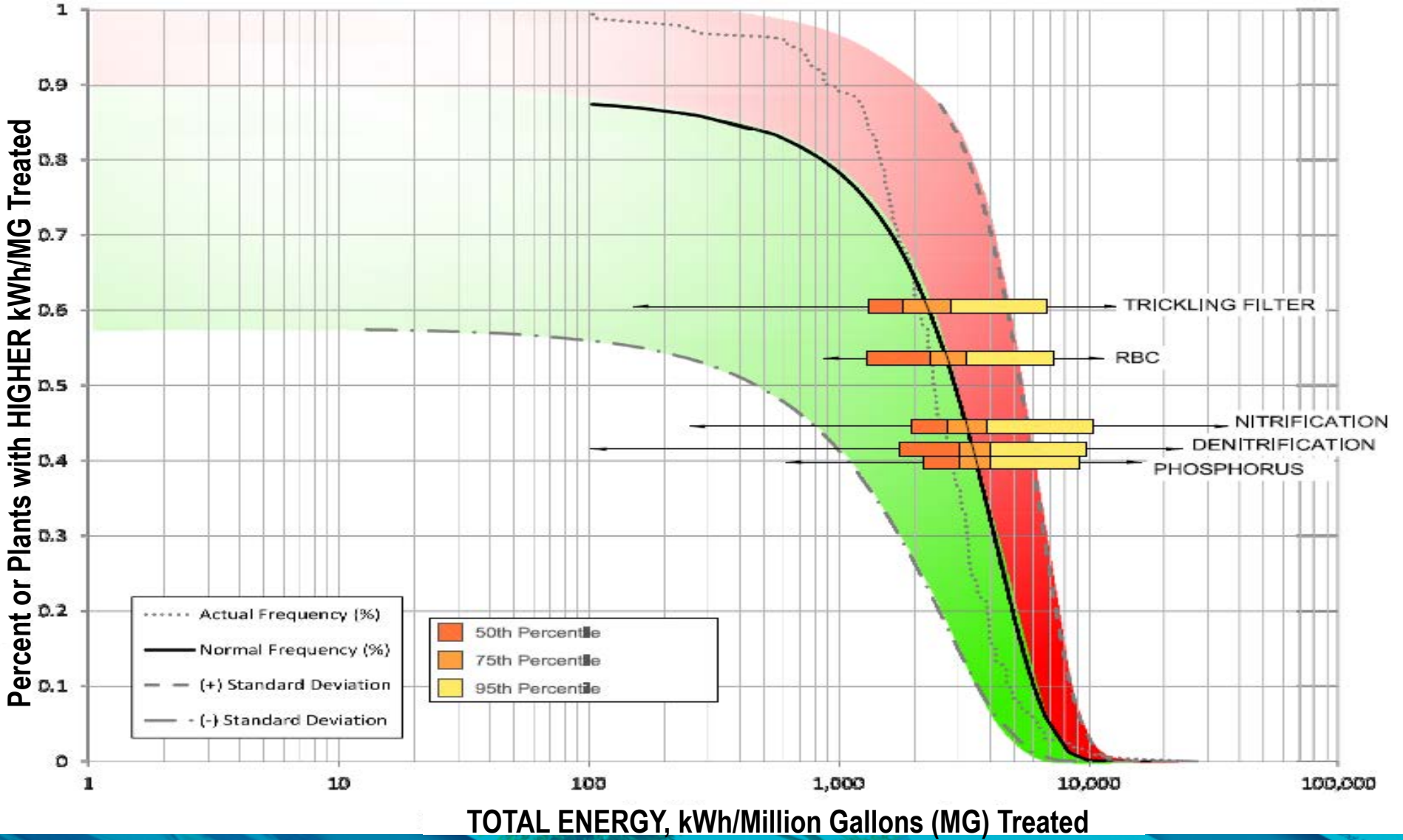
Source: Wilson, 2009; Meda and Cornel, 2010; Voutchkov, 2010; Lazarova et al., 2012

How Does the Wastewater Industry Benchmark in Energy Consumption?



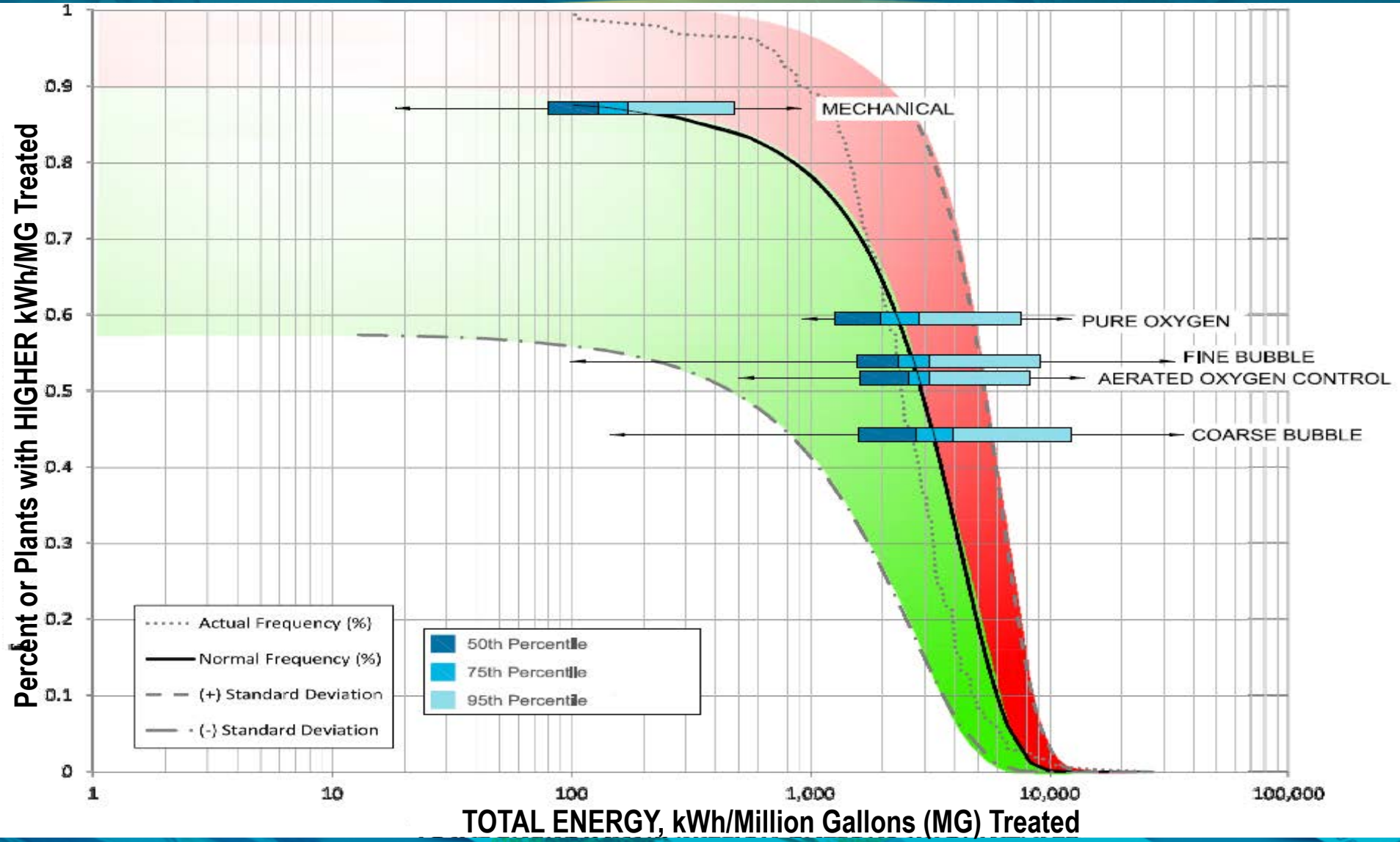
Source: "Energy Performance Indicators of Wastewater Treatment: A Field Study with 17 Portuguese Plants", Silva, C., Rosa, M.; Water Science & Technology, 72(4), 2015

Energy Consumption at Treatment Facilities



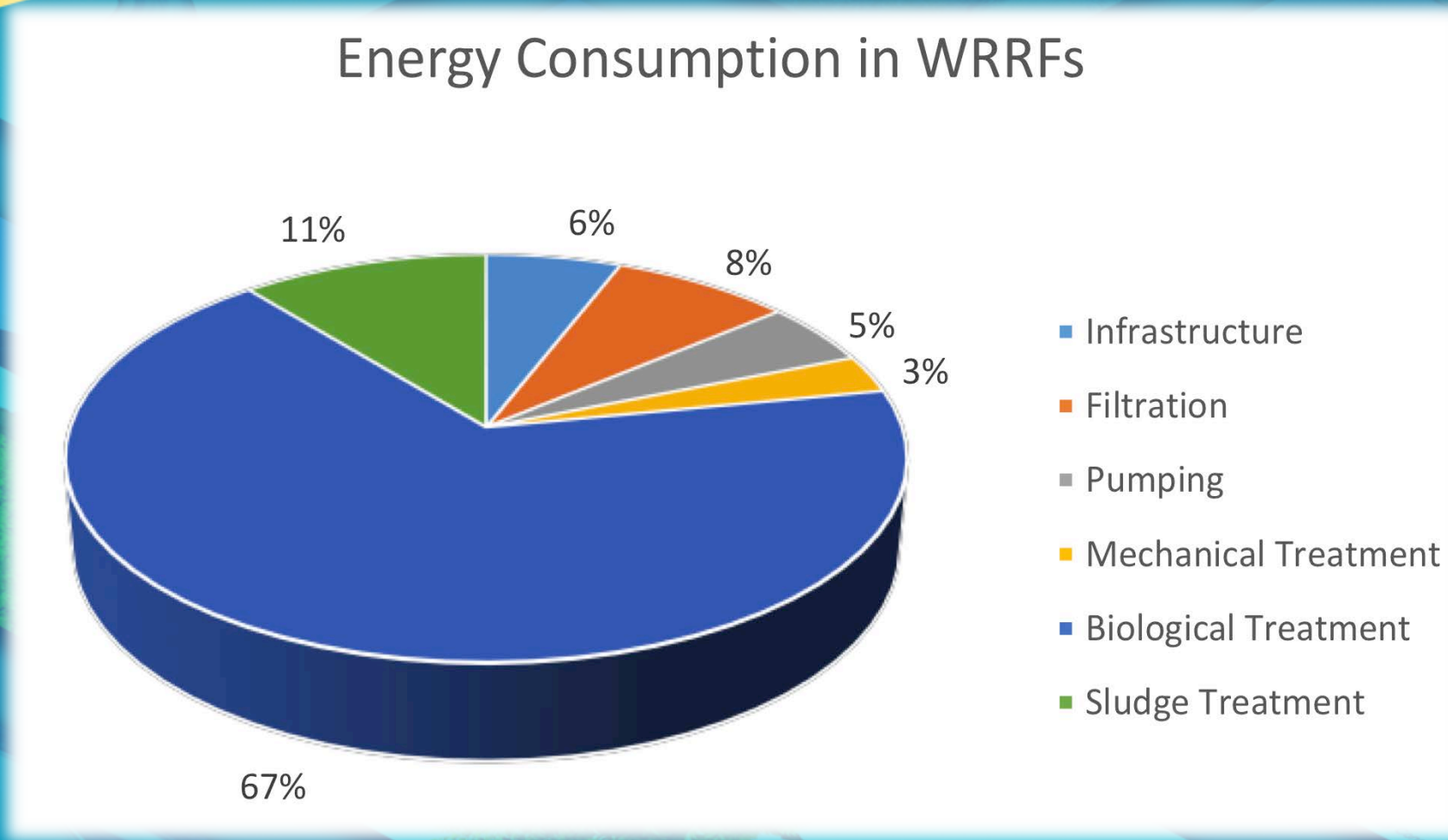
Source: Umble, A. and Lee, K. (2013), Adapted from AWWARF data (2007)

Energy Consumption at Treatment Facilities



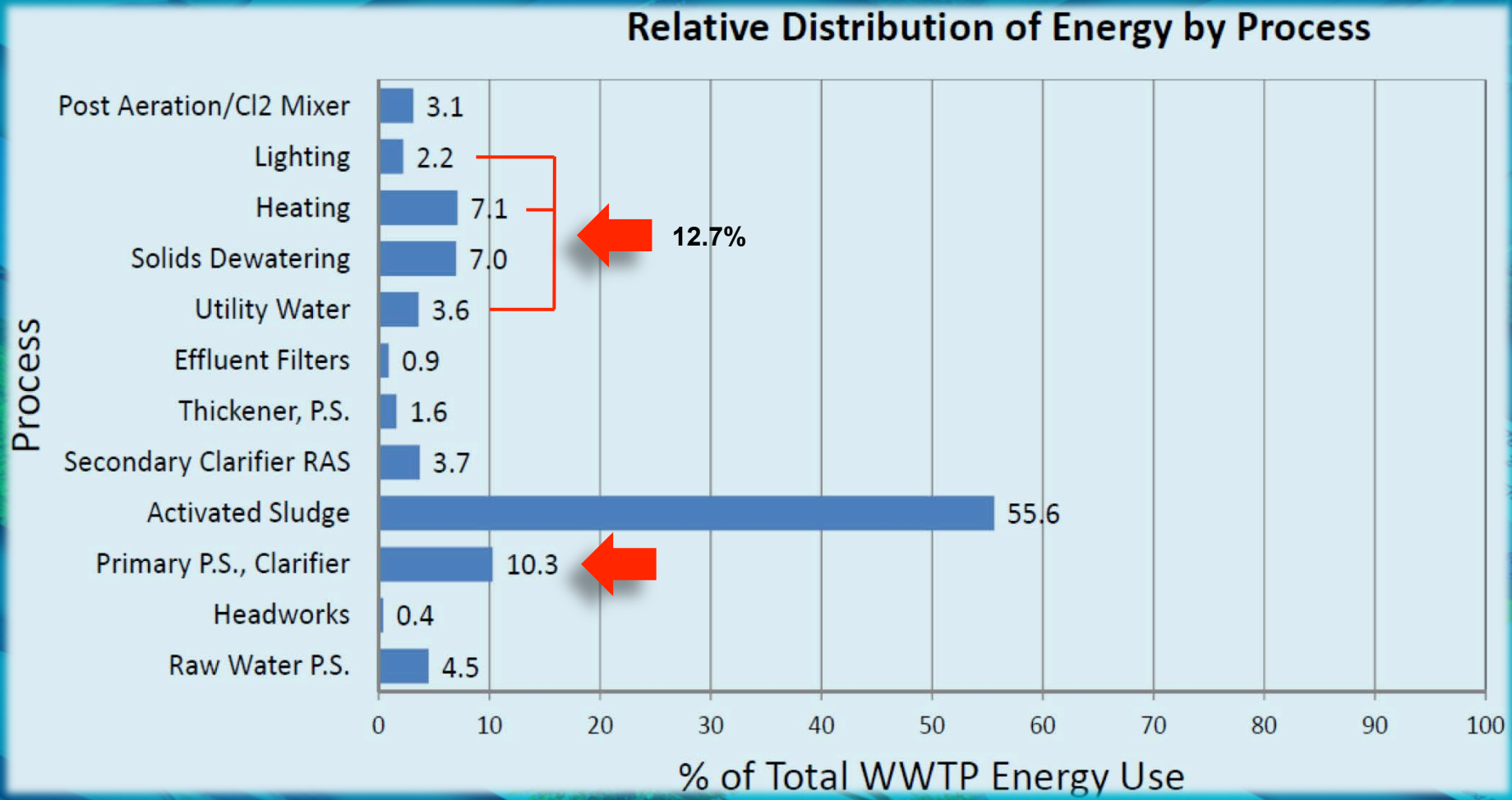
Source: Umble, A. and Lee, K. (2013), Adapted from AWWARF data (2007);

How is Energy Consumption Distributed Across Plant Processes?



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

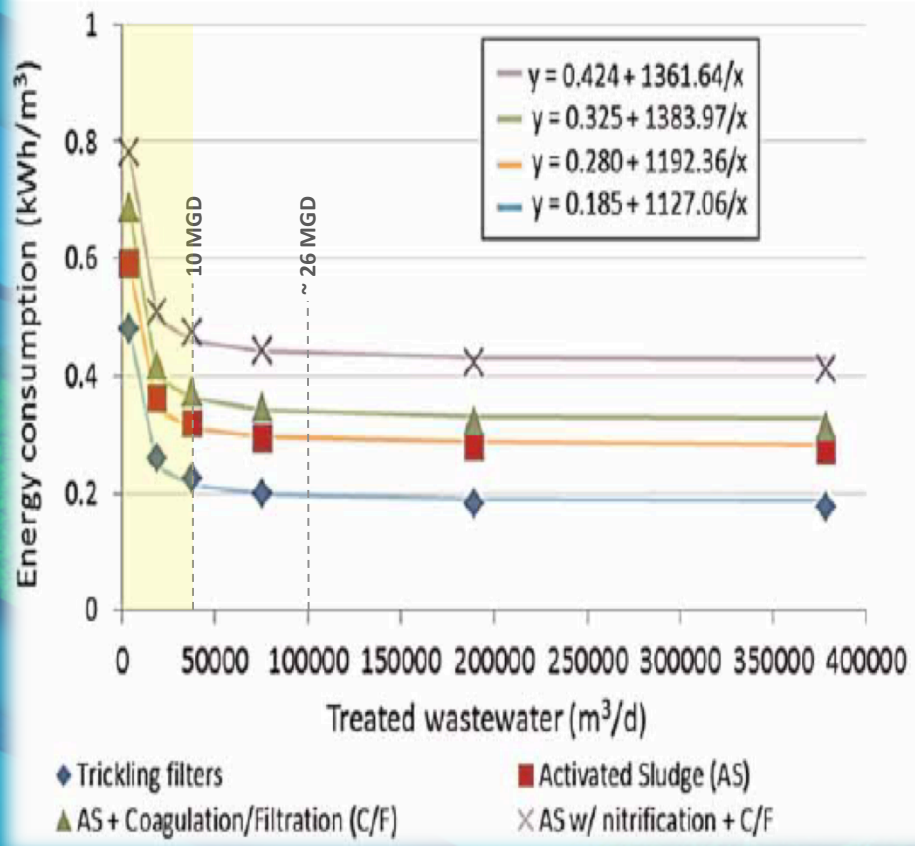
Energy Distribution in Wastewater Treatment by Unit Process

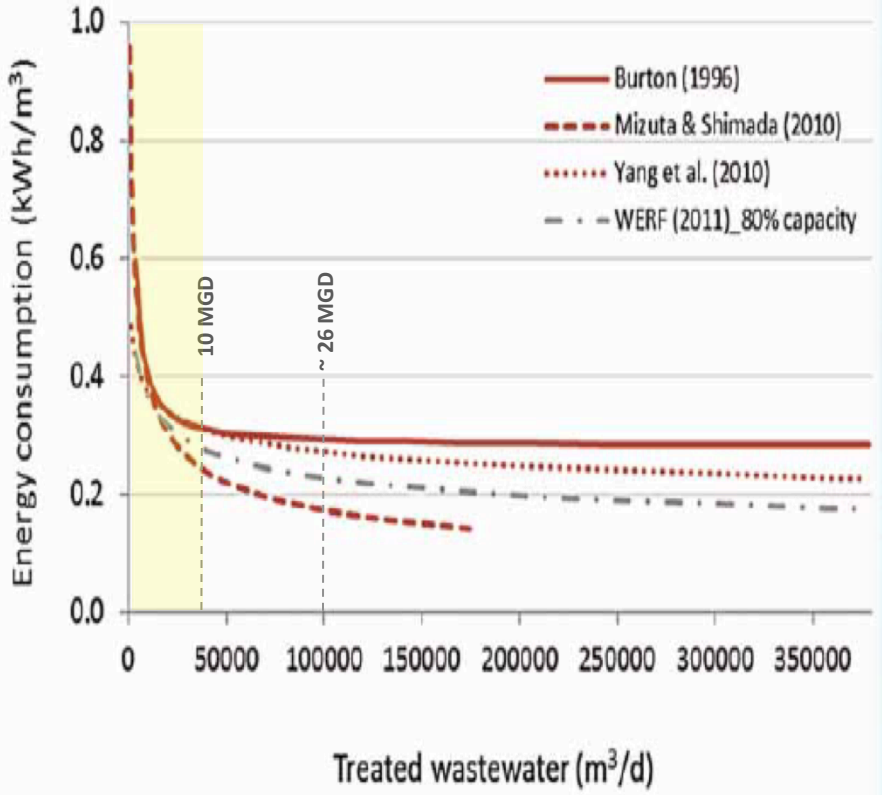


Source: Moore, L., University of Memphis, 2012

How Does the Wastewater Industry Benchmark in Energy Consumption?

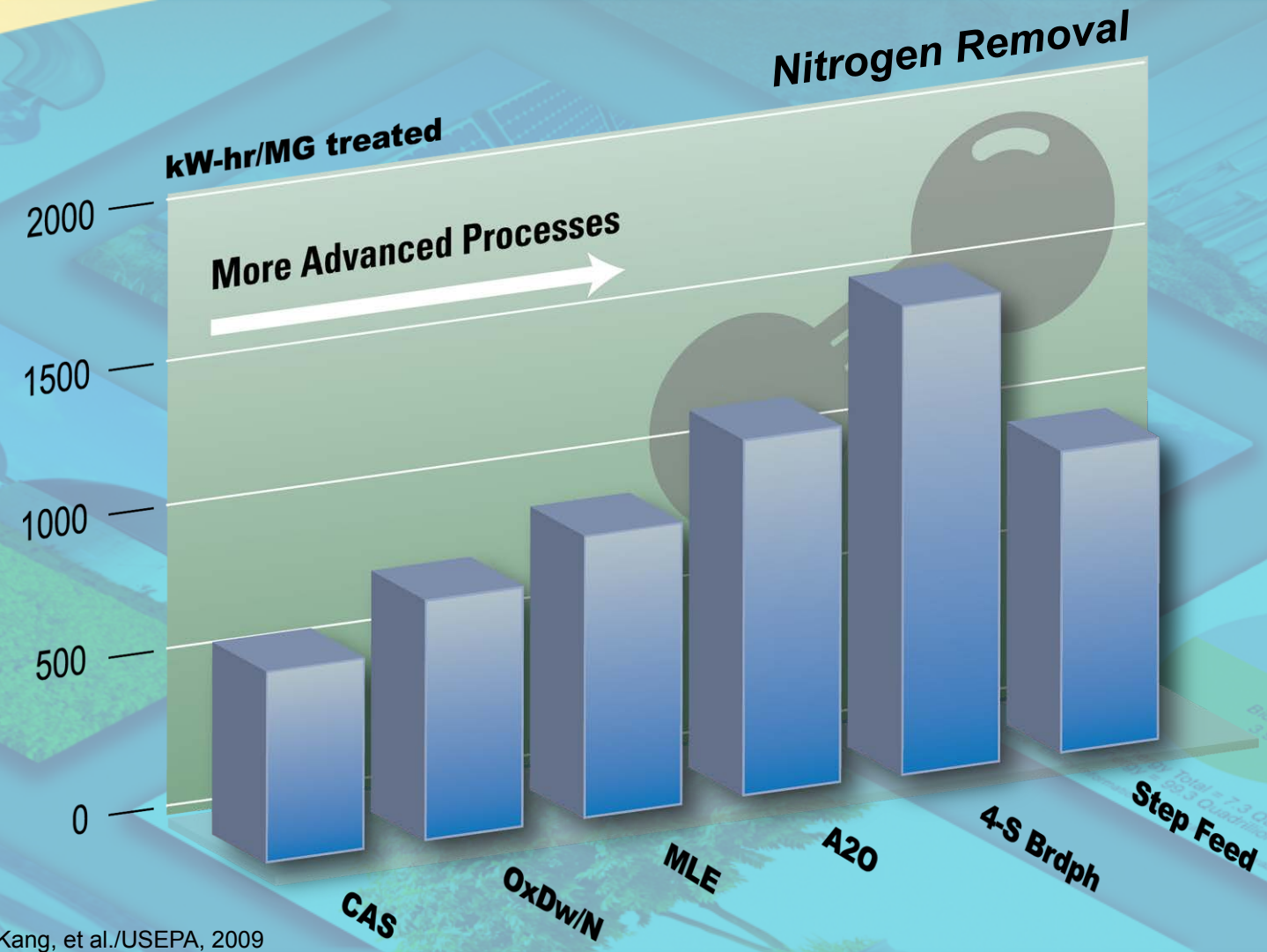
Smallest plants require greatest unit energy consumption





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

Stricter Standards → More Energy!



Source: Kang, et al./USEPA, 2009

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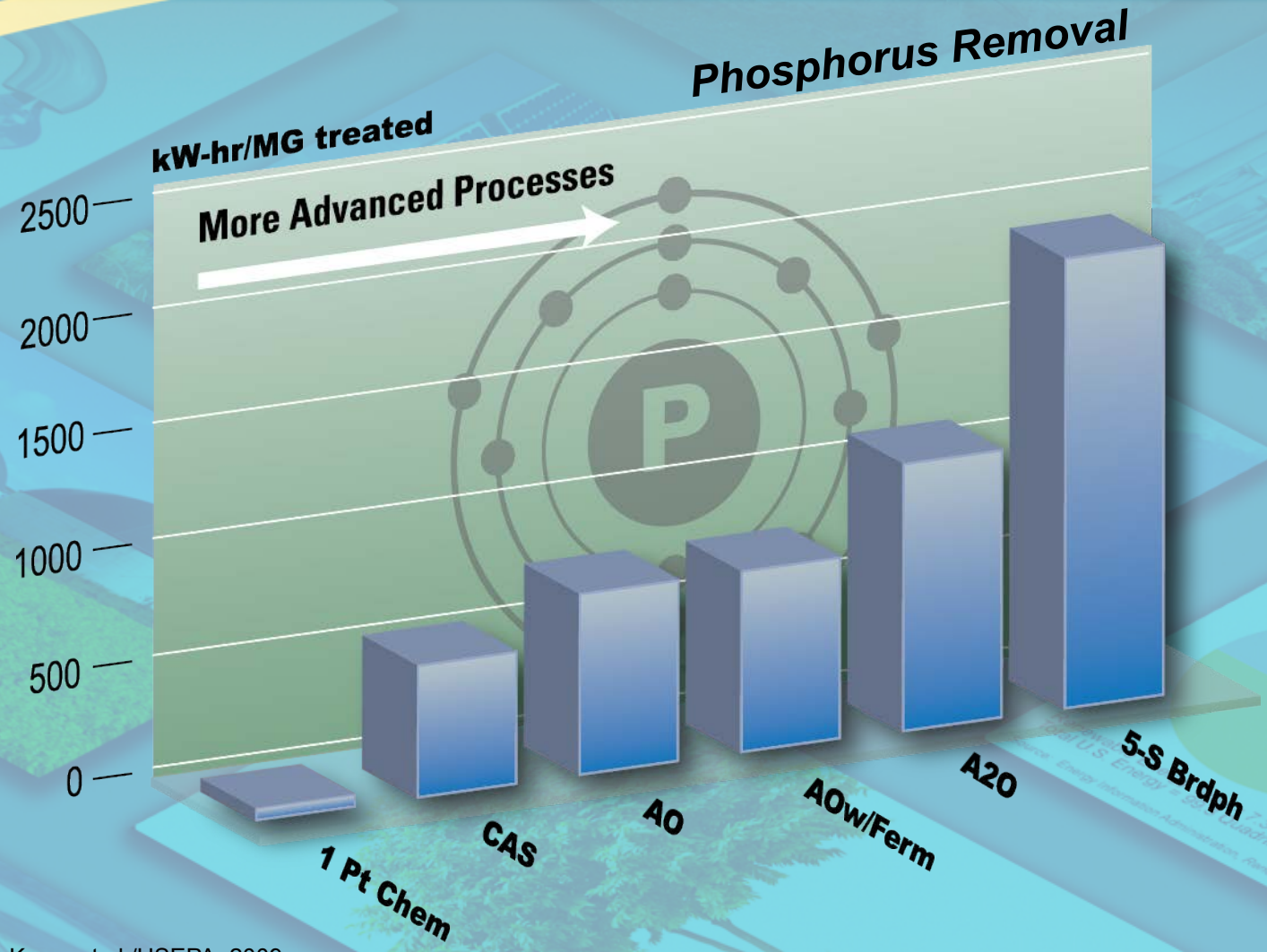
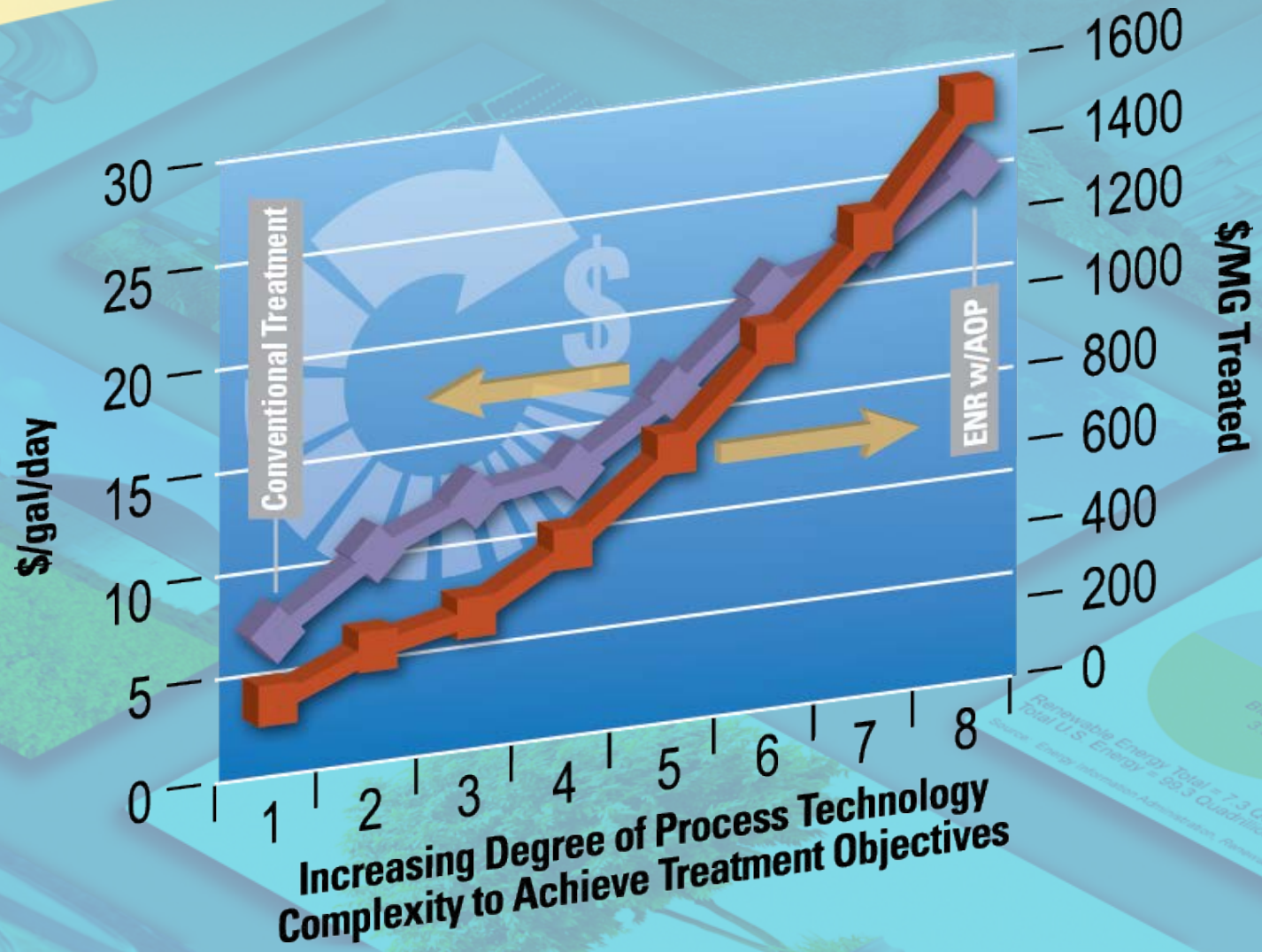


Source: Kang, et al./USEPA, 2009

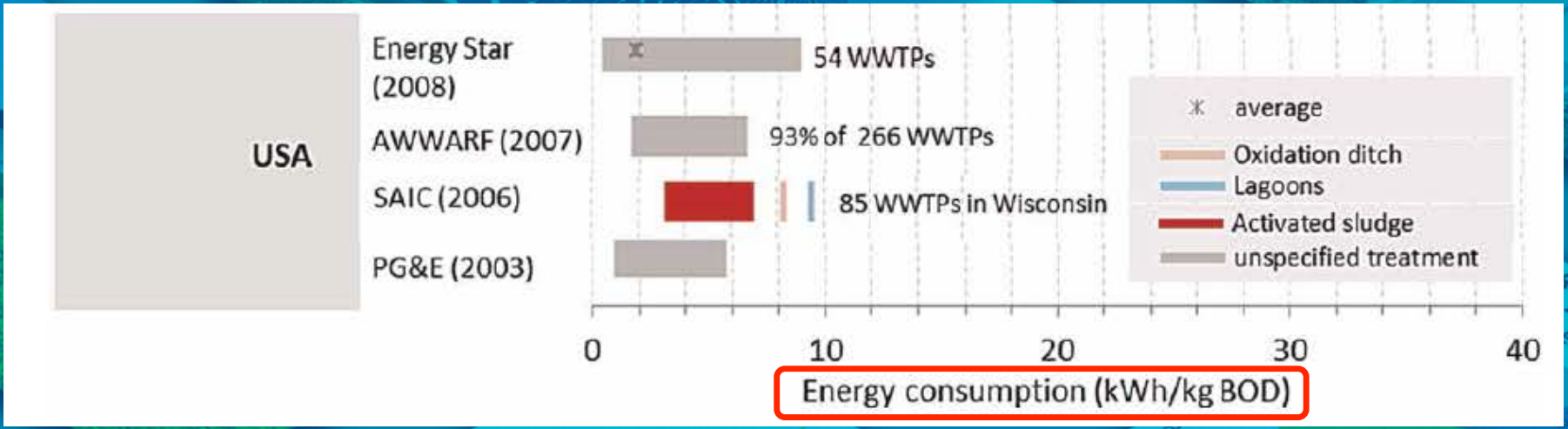
The Case for Nutrient Recovery: Economics of Removal



Source: Bratby and Jimenez, WERF 2011

How Does the Wastewater Industry Benchmark in Energy Consumption?

- Loading Removal is amore appropriate metric



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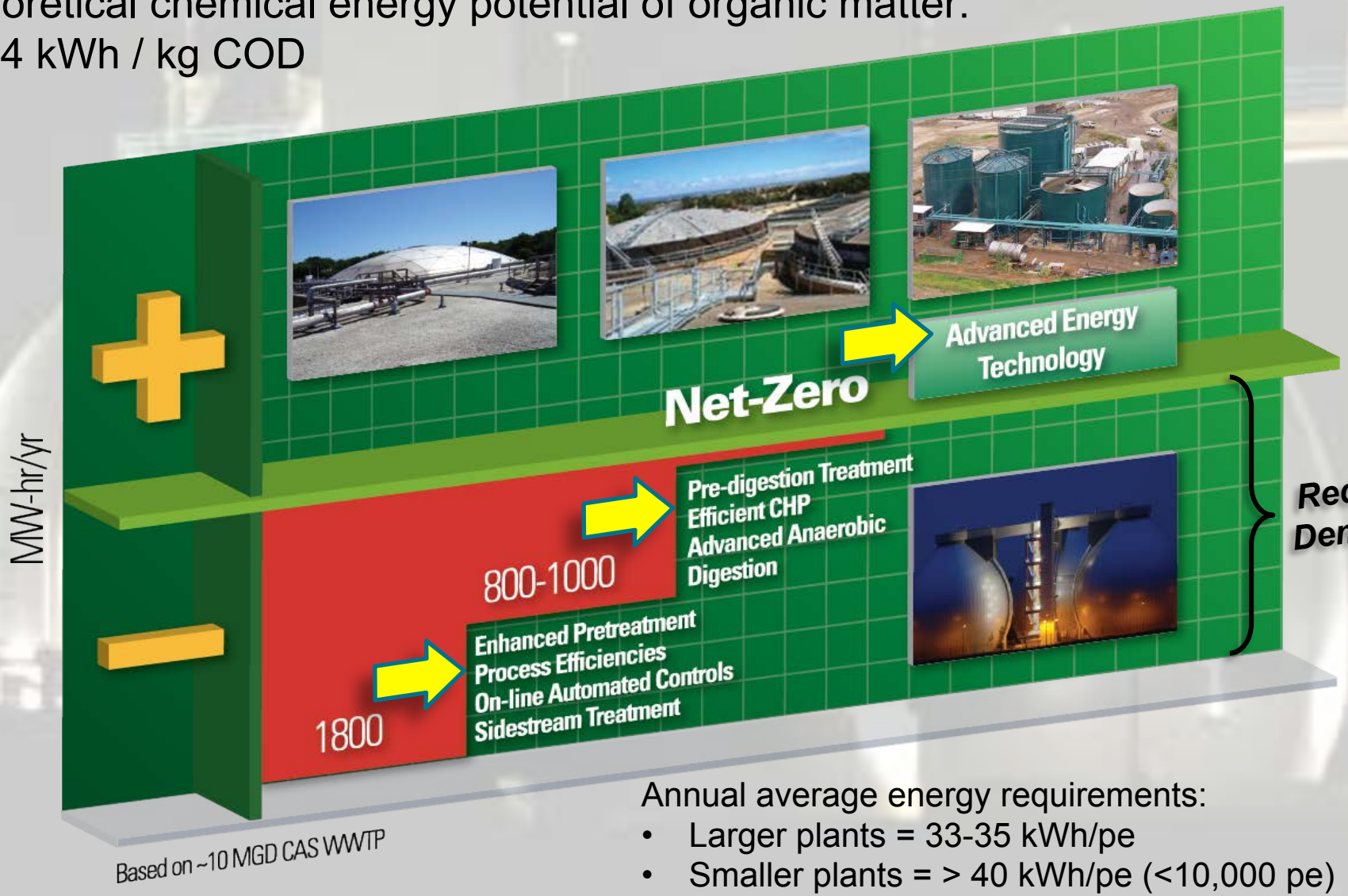
Should Energy Neutrality be Pursued?

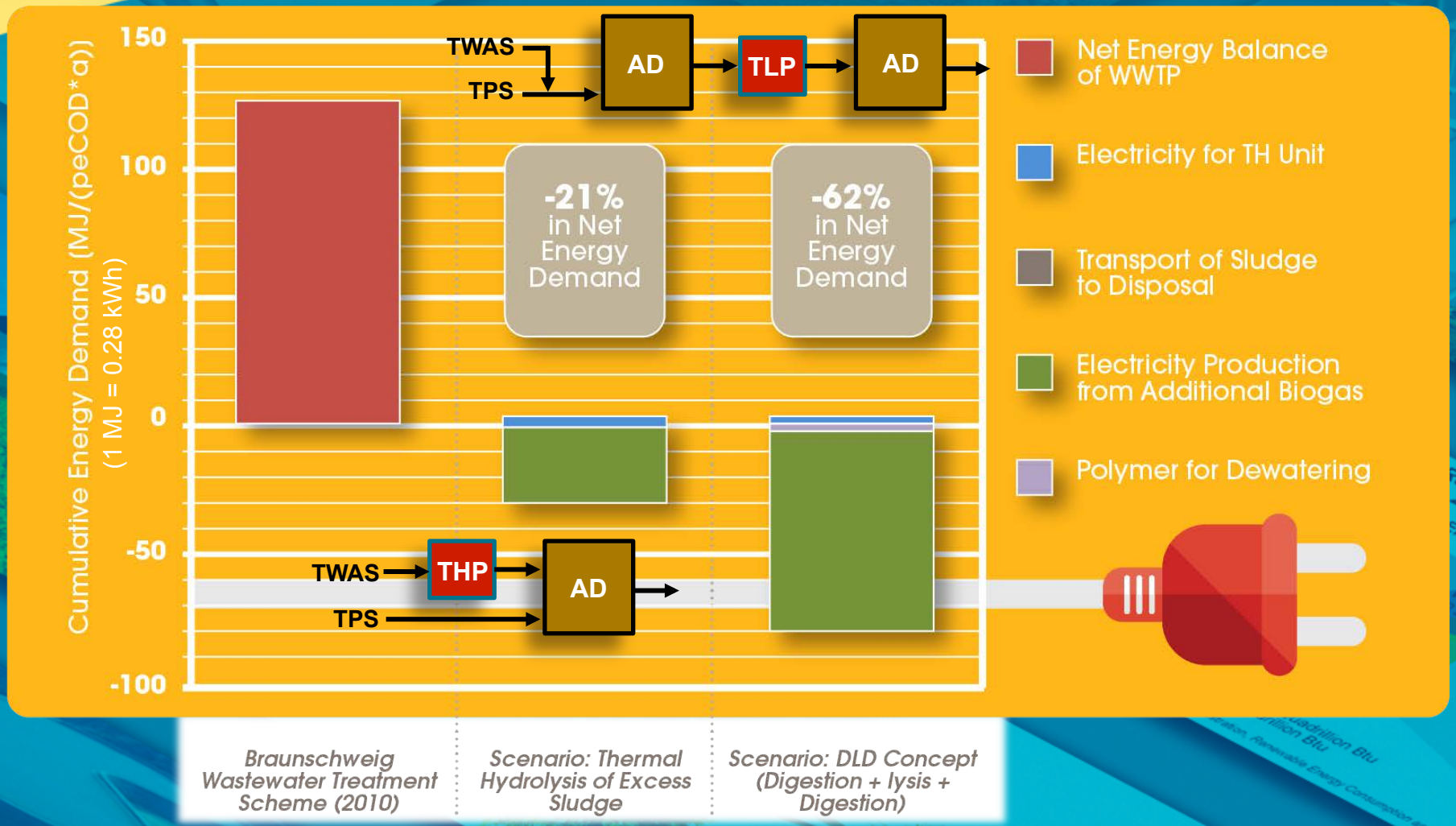
Theoretical chemical energy potential of organic matter:
= 4 kWh / kg COD



Annual average energy requirements:

- Larger plants = 33-35 kWh/pe
- Smaller plants = > 40 kWh/pe (<10,000 pe)

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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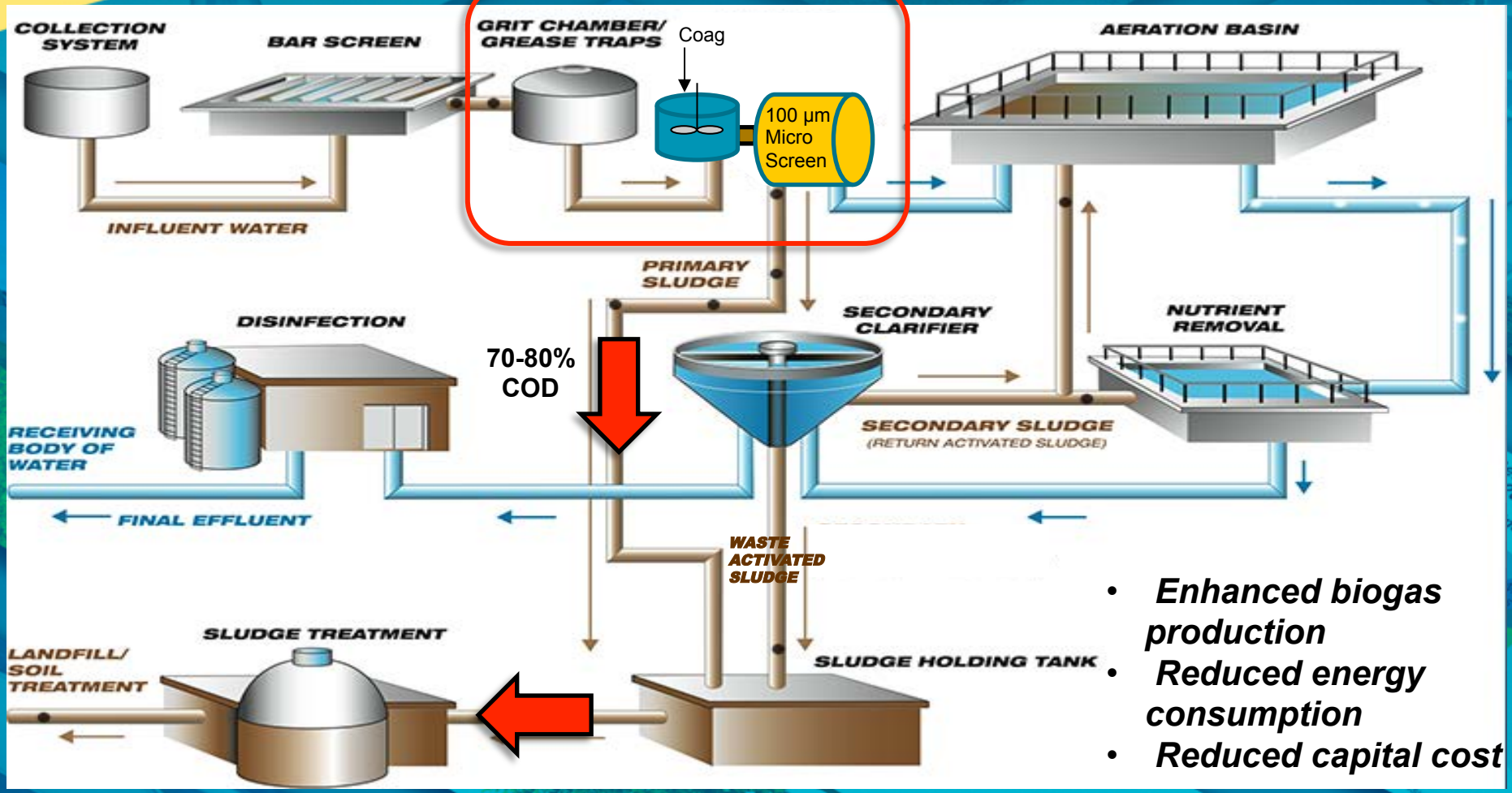
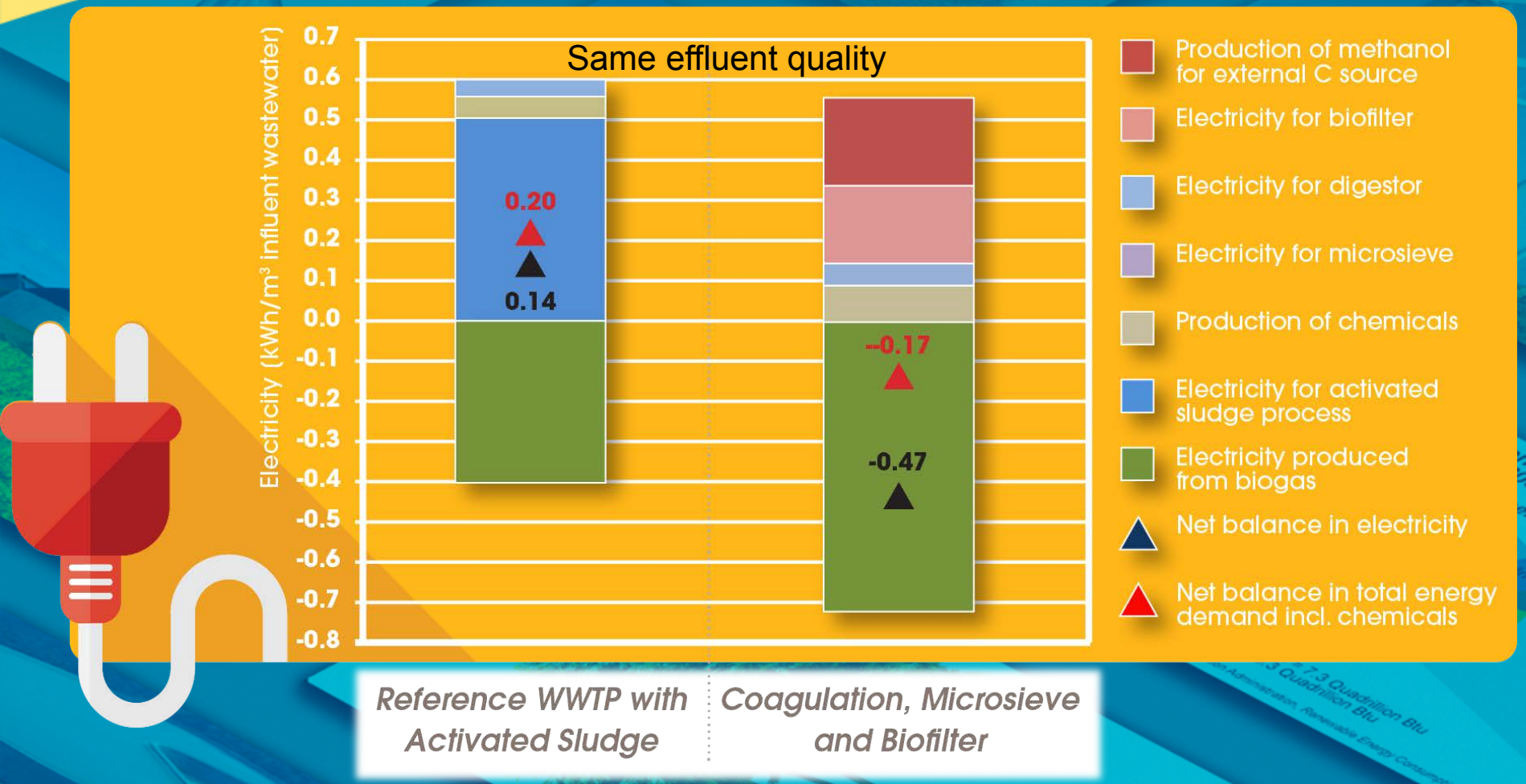


- *Enhanced biogas production*
- *Reduced energy consumption*
- *Reduced capital cost*

Is Energy Neutrality a Reality? Reduce Demand



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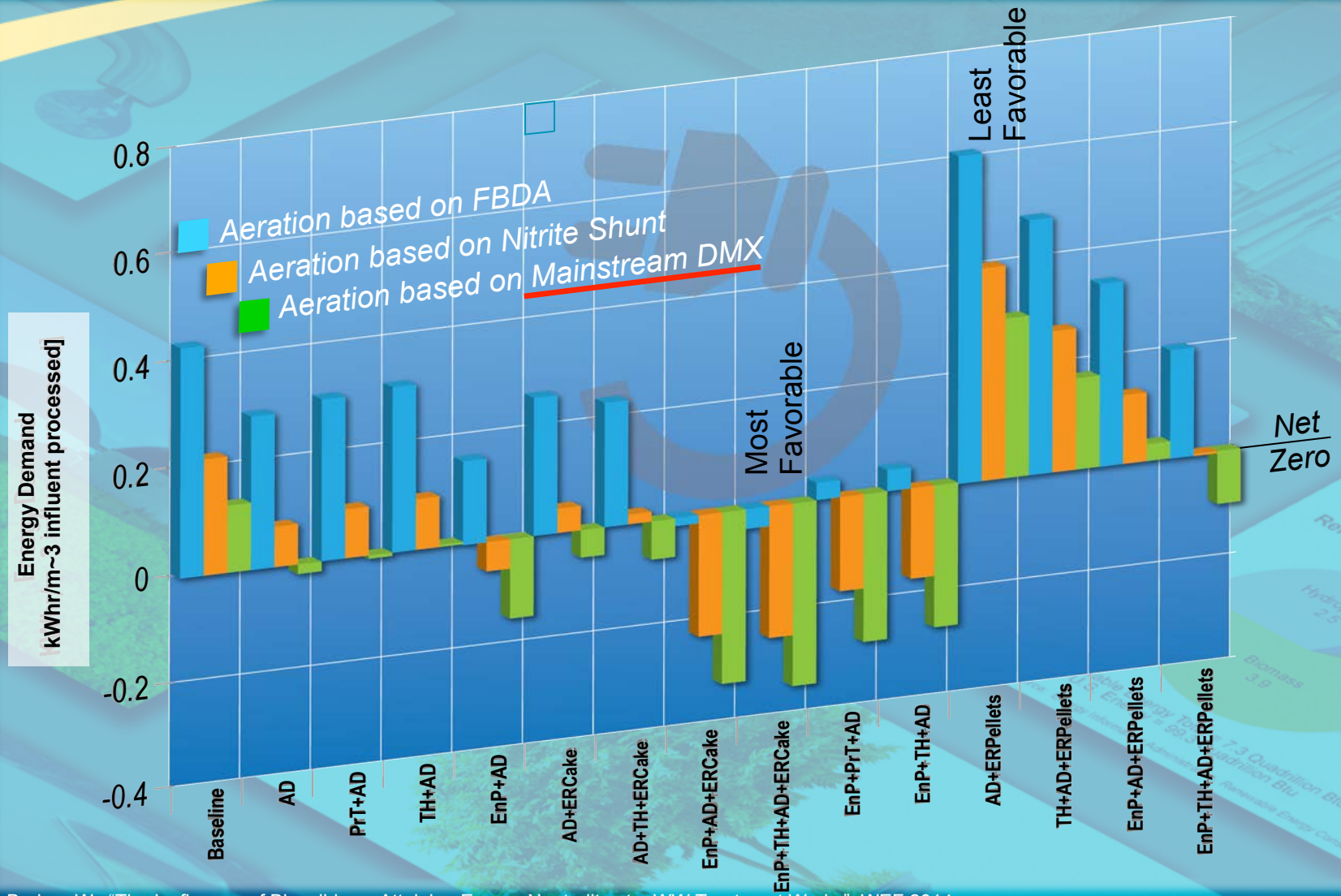
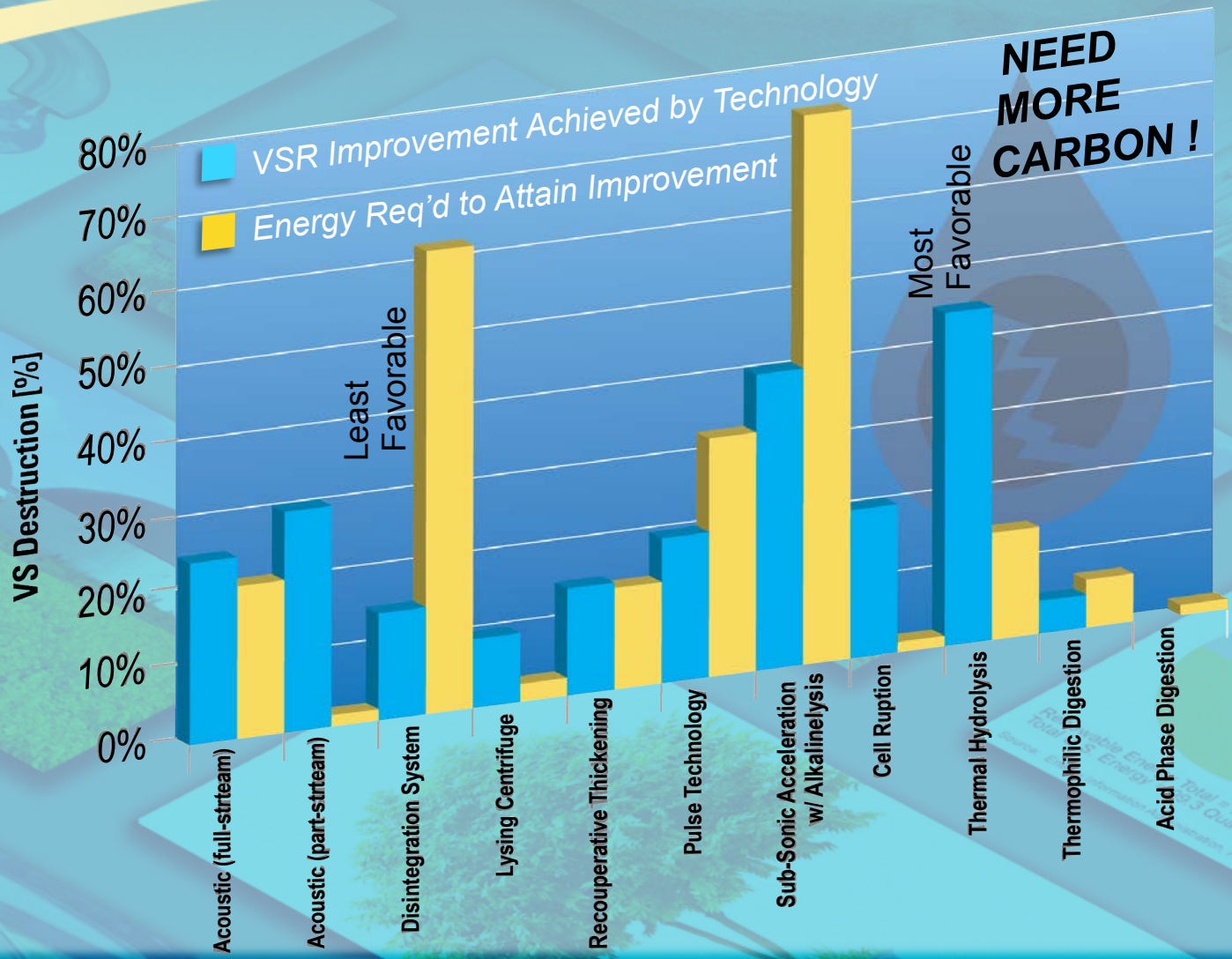
Impact of Biosolids Process Configurations on Energy Balance



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



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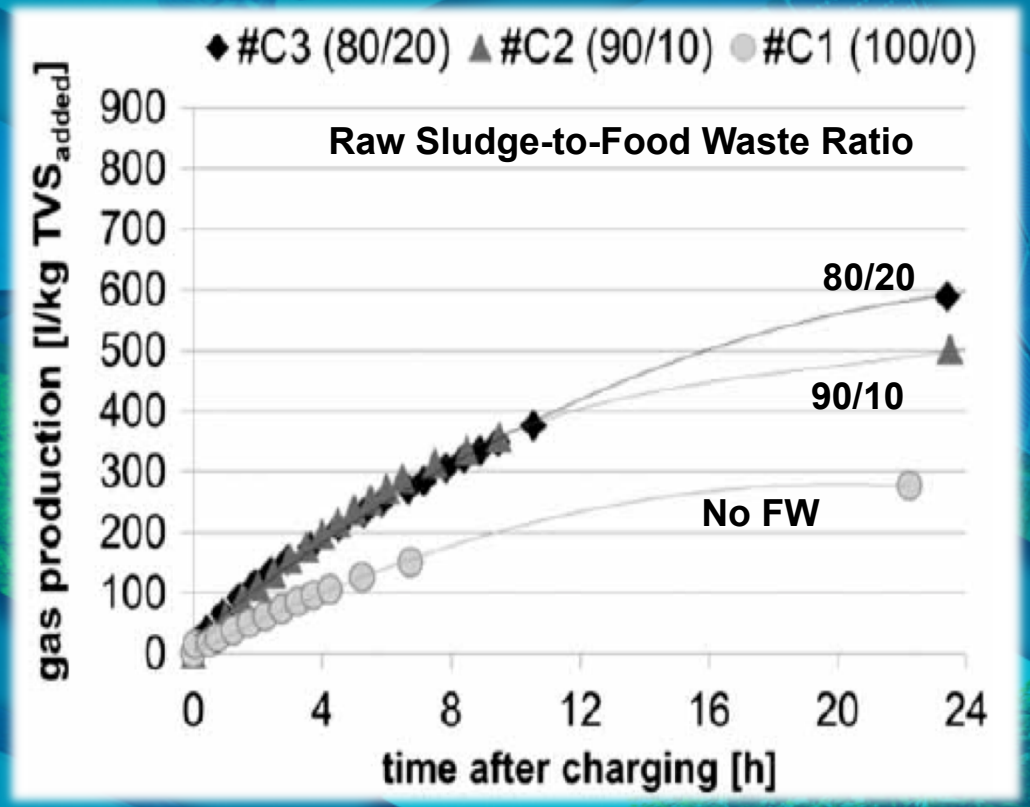
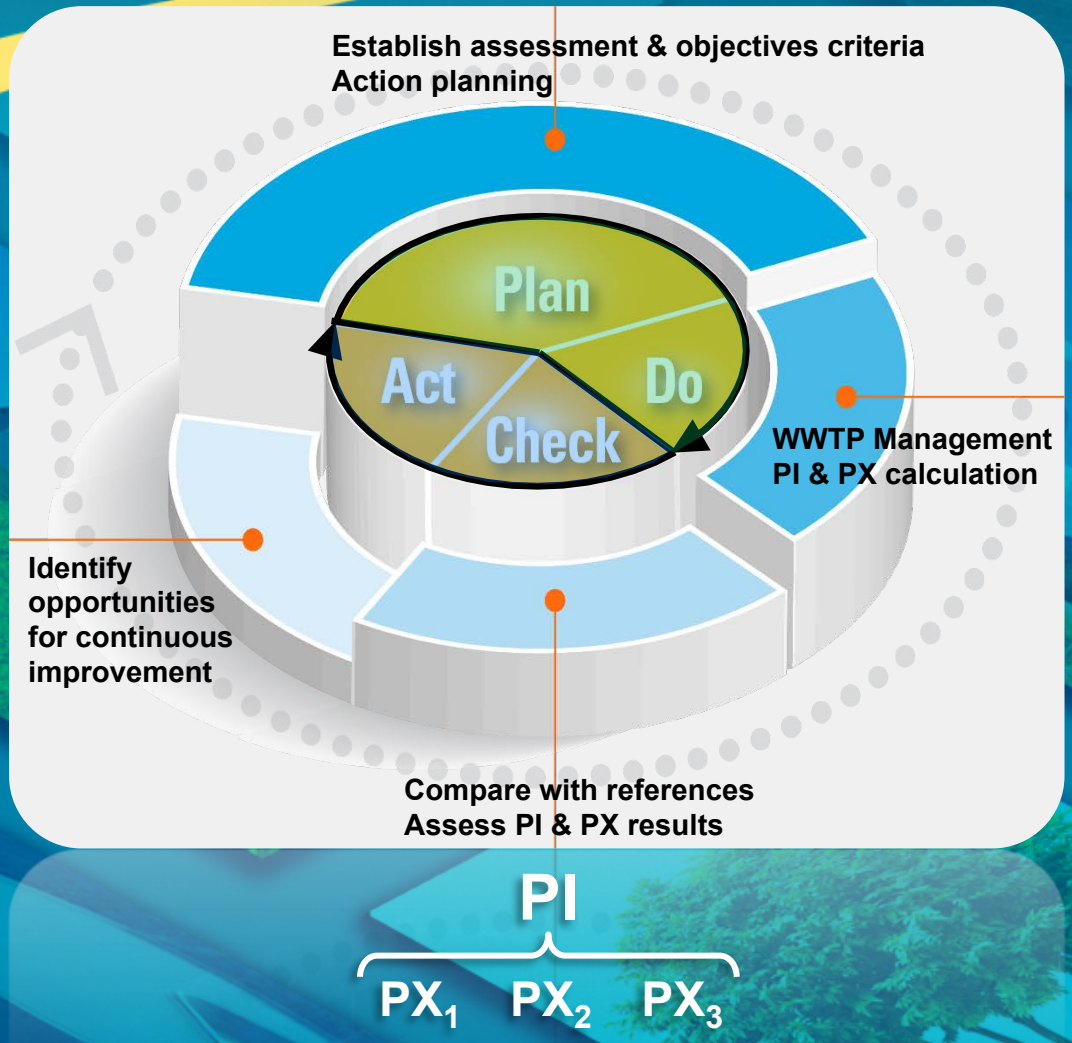
What About Co-Digestion?



- 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

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

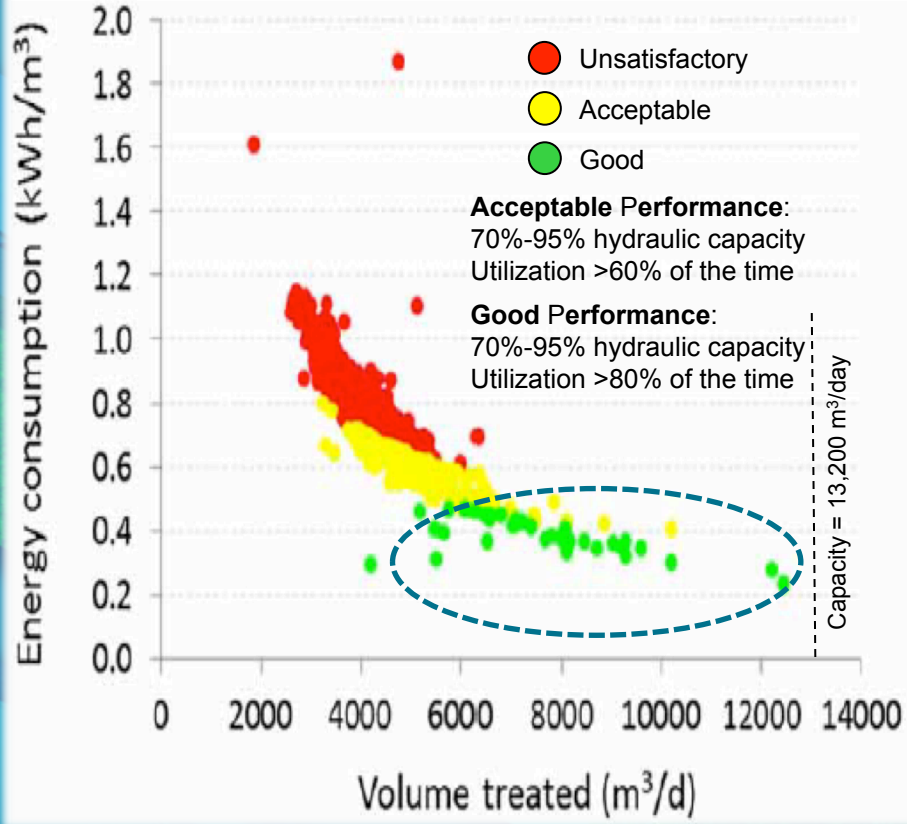


- How good is good enough?
- Can we operate to "good enough" reliably and predictably?
- Is "good enough" an appropriate ethic for the industry?

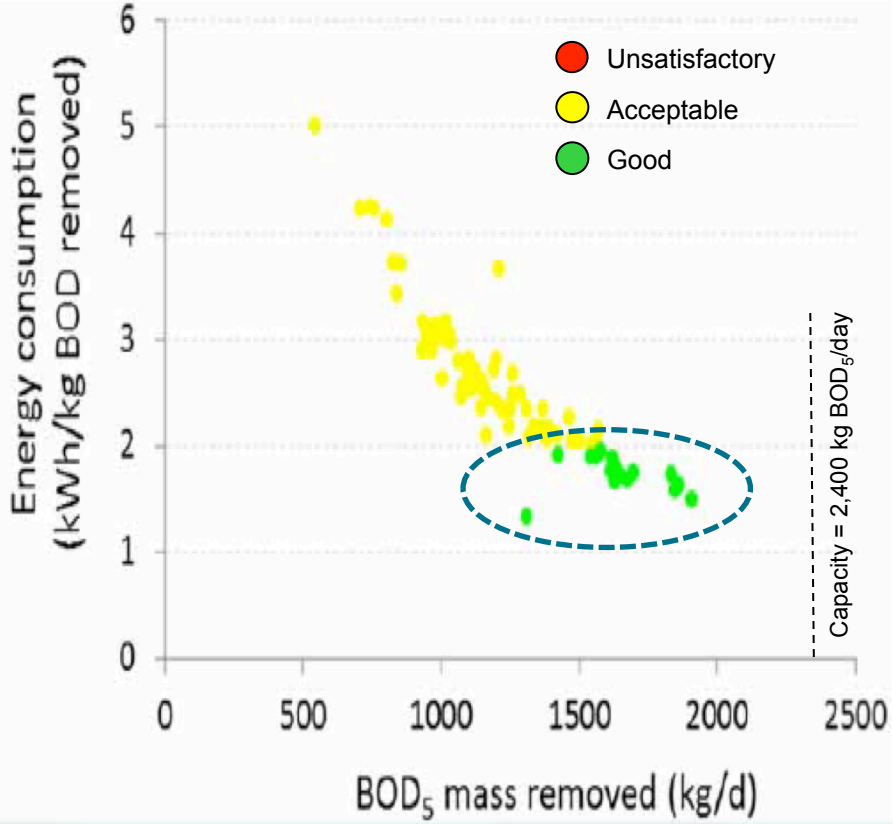
Source: "A Comprehensive Approach for Diagnosing Opportunities for Improving the Performance of a WWTP", Silva, C., et al.; Water Science & Technology, 74(12), 2016

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



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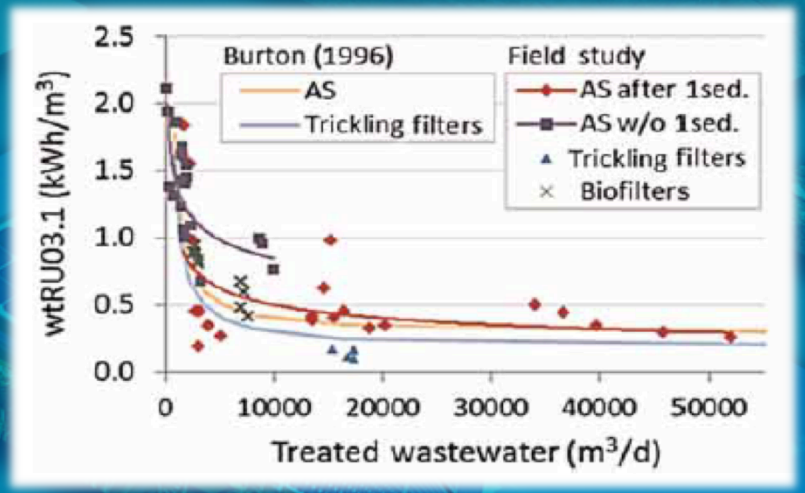
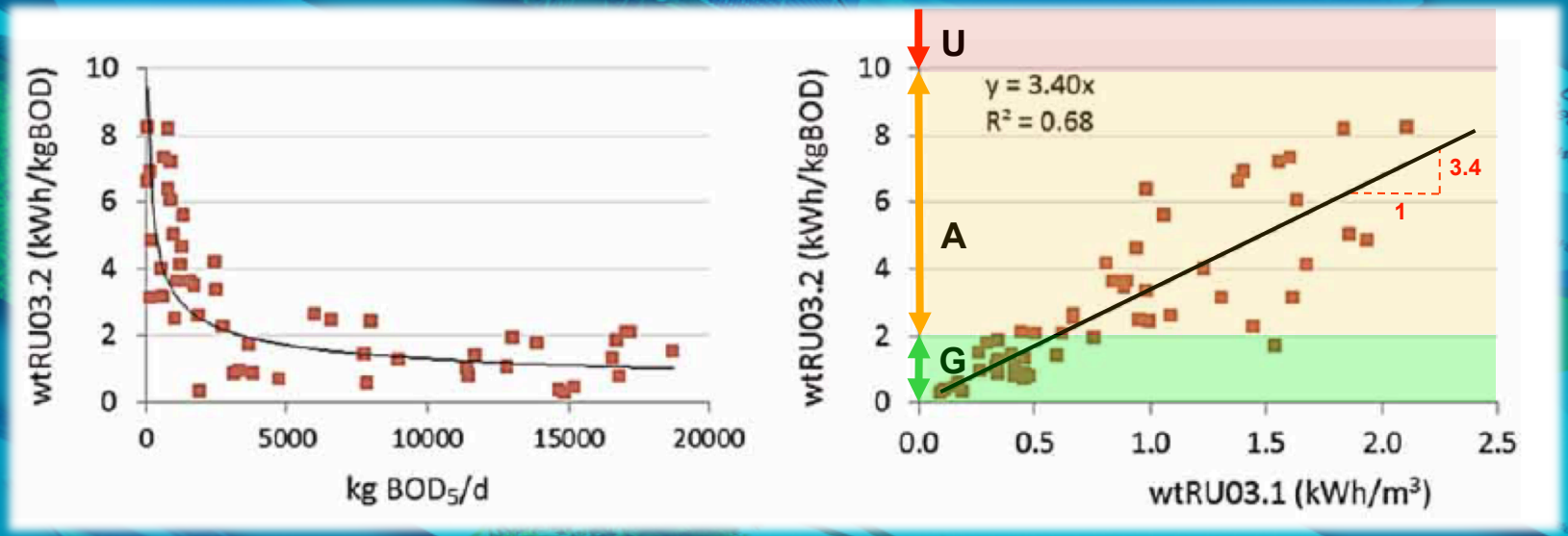
Performance Indicator:
Capacity Utilization



G = Good
A = Acceptable
U = Unsatisfactory



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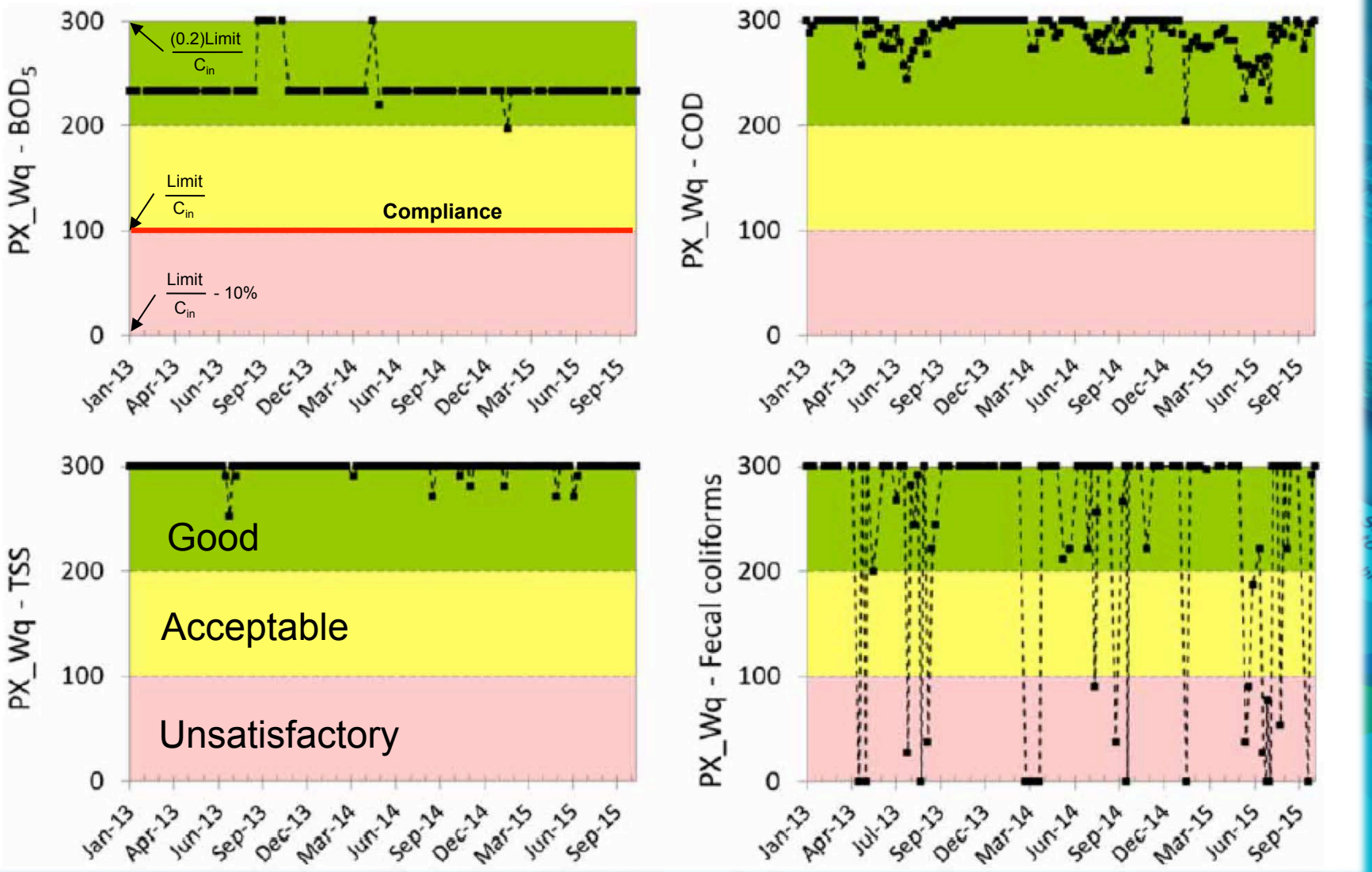
Is there a Different Paradigm? Consideration of Performance



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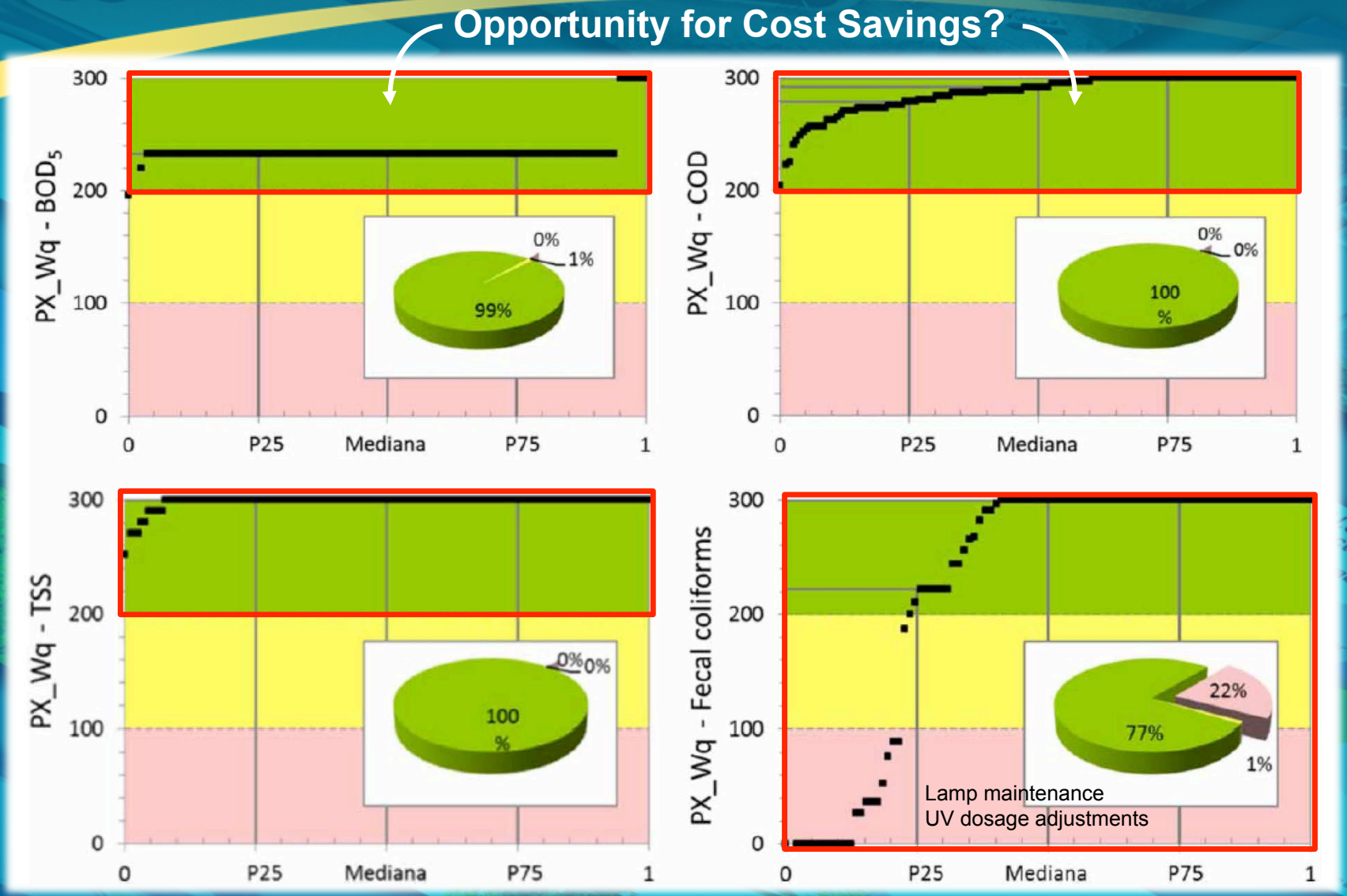

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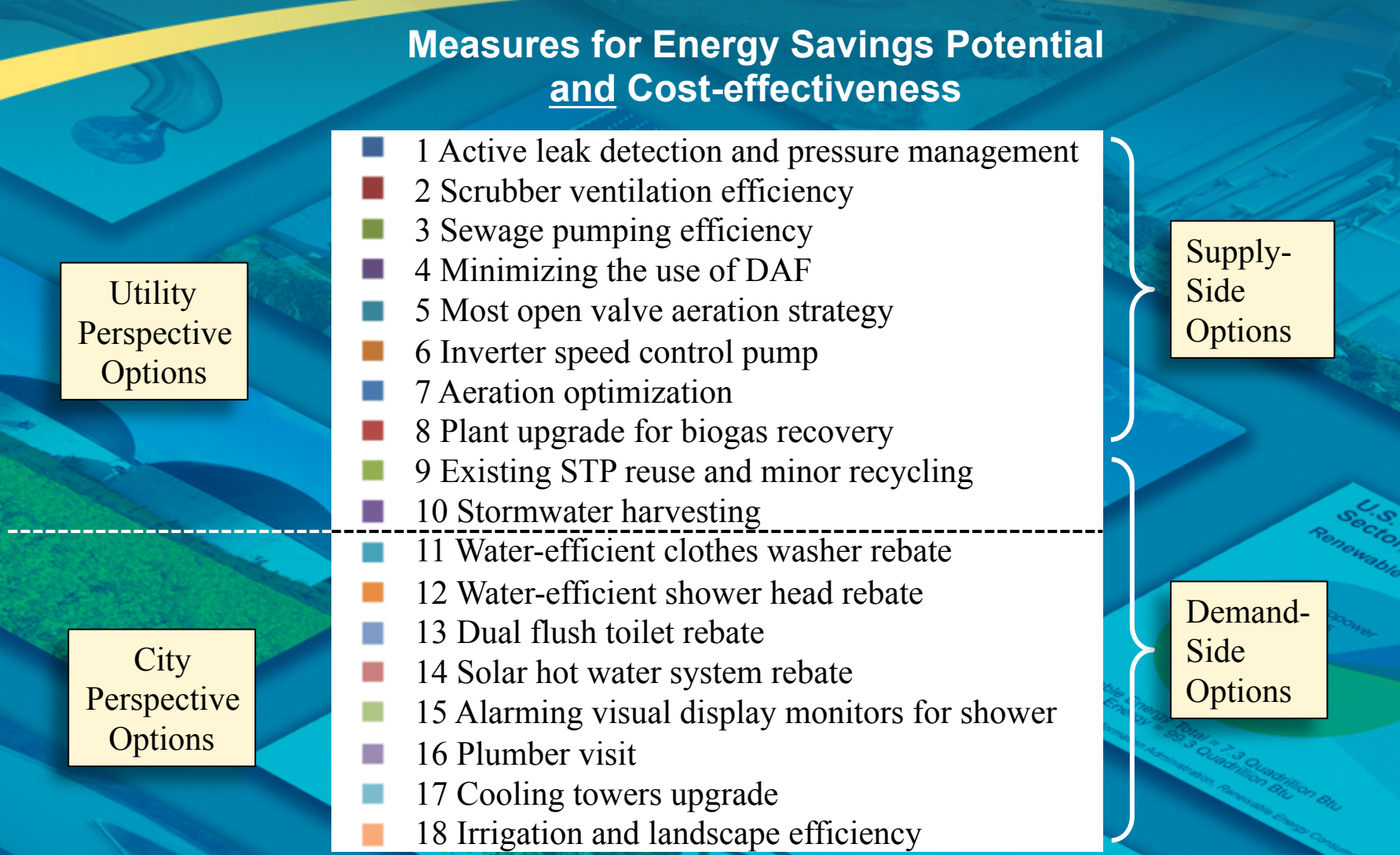
Broader Perspective Enhances Energy and Financial Savings Potential

- 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

Broader Perspective Enhances Energy and Financial Savings Potential



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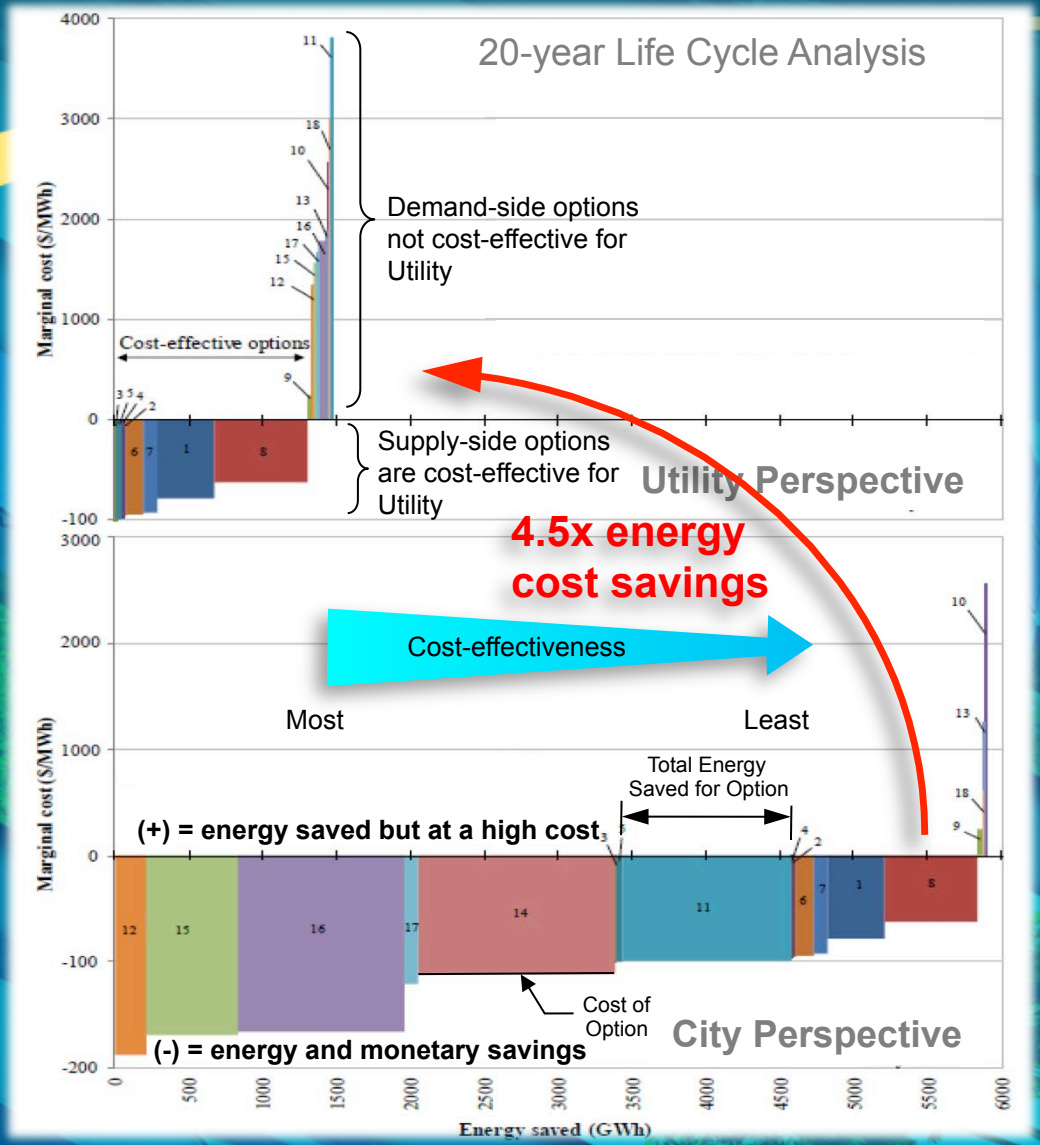


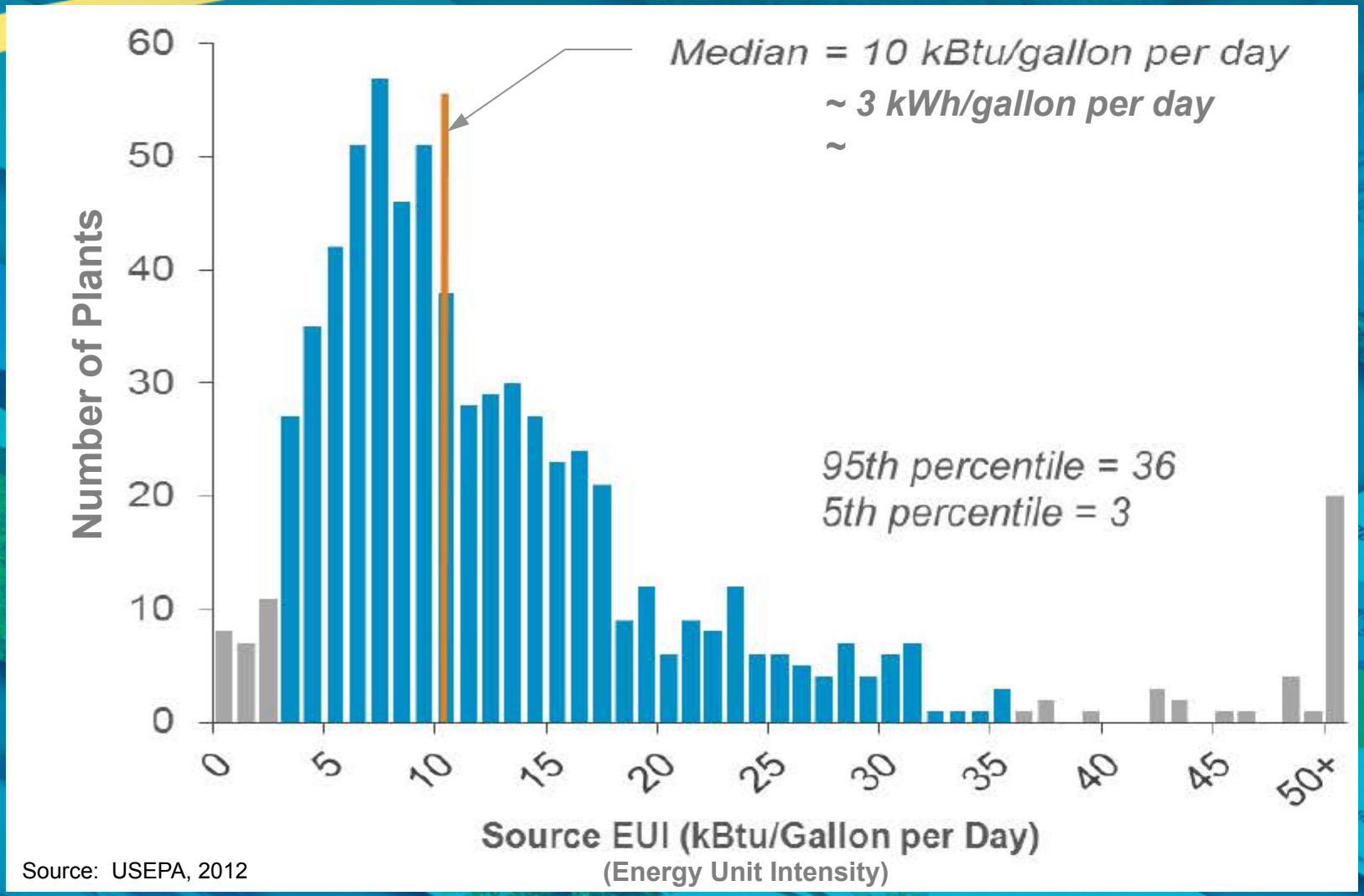
- **Water Use Distribution**
  - *65% residential*
  - *24% commercial/industrial*
  - *11% non-revenue*
- **1300 GWh saved for Utility**
- **5800 GWh saved for City**
  - *Residential Conservation*
    - *Solar hot water rebates*
  - *Unaccounted-for water*
- **Utilities need incentives to look beyond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

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

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



Source: USEPA, 2012