Getting to Zero:
Best Practices to Reduce Energy at Your Facility

Energy Reduction Outline

1. Getting to Zero: Challenges and Overview
2. Best Practices to Reduce Energy Consumption / Cost at WWTPs
3. Finding Savings by Looking in the Corners
4. Overdesign: An Energy Nightmare

Energy Reduction Outline

1. Getting to Zero: Challenges and Overview

To Be Truly Sustainable, You Want to Optimize Plant Inputs/Outputs

Energy

(Electricity, Gas, Fuels)

Chemicals

Various Supplies

Raw Sewage, FOG, Septage, Food Waste

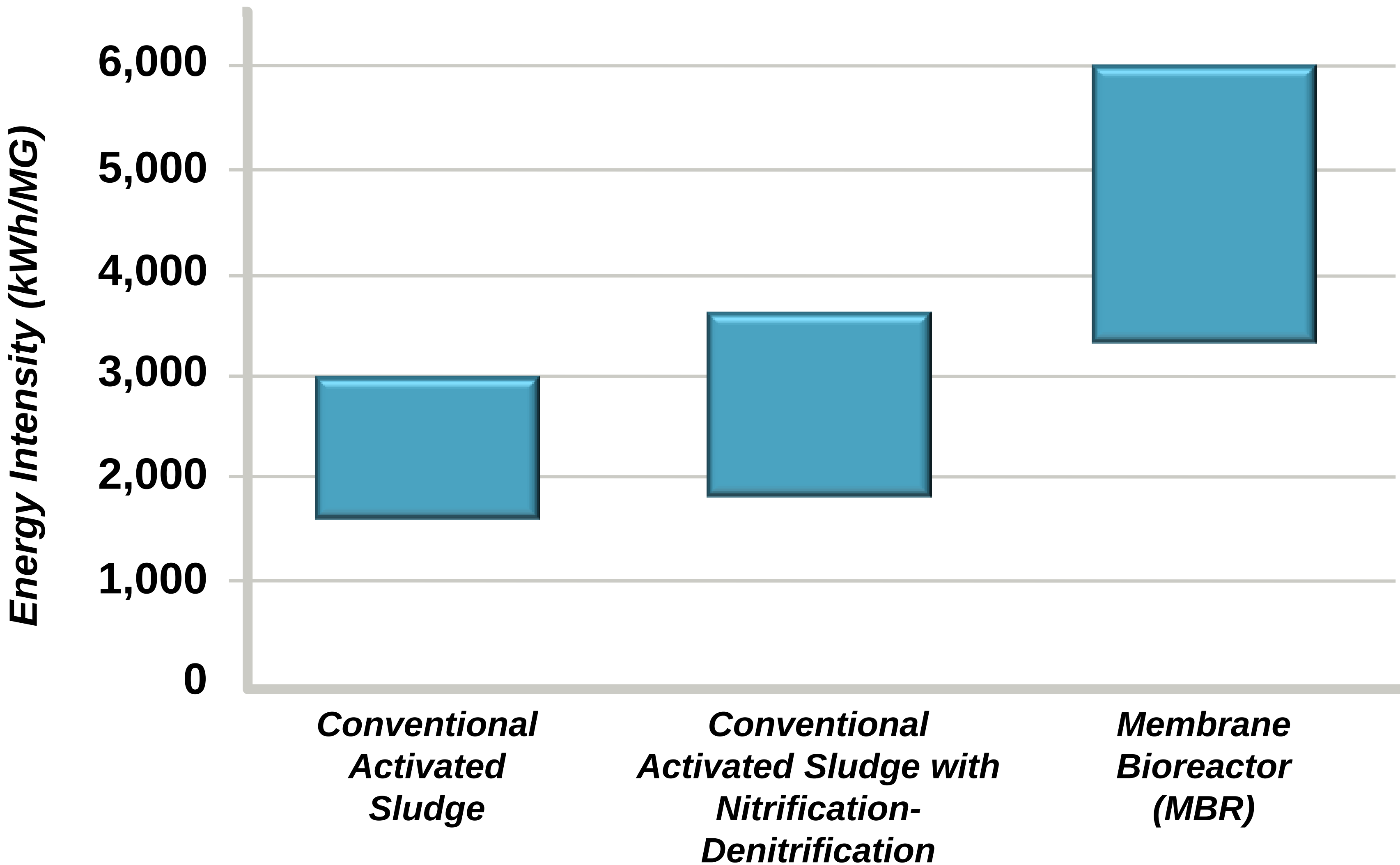
Air Emissions

Solid Waste

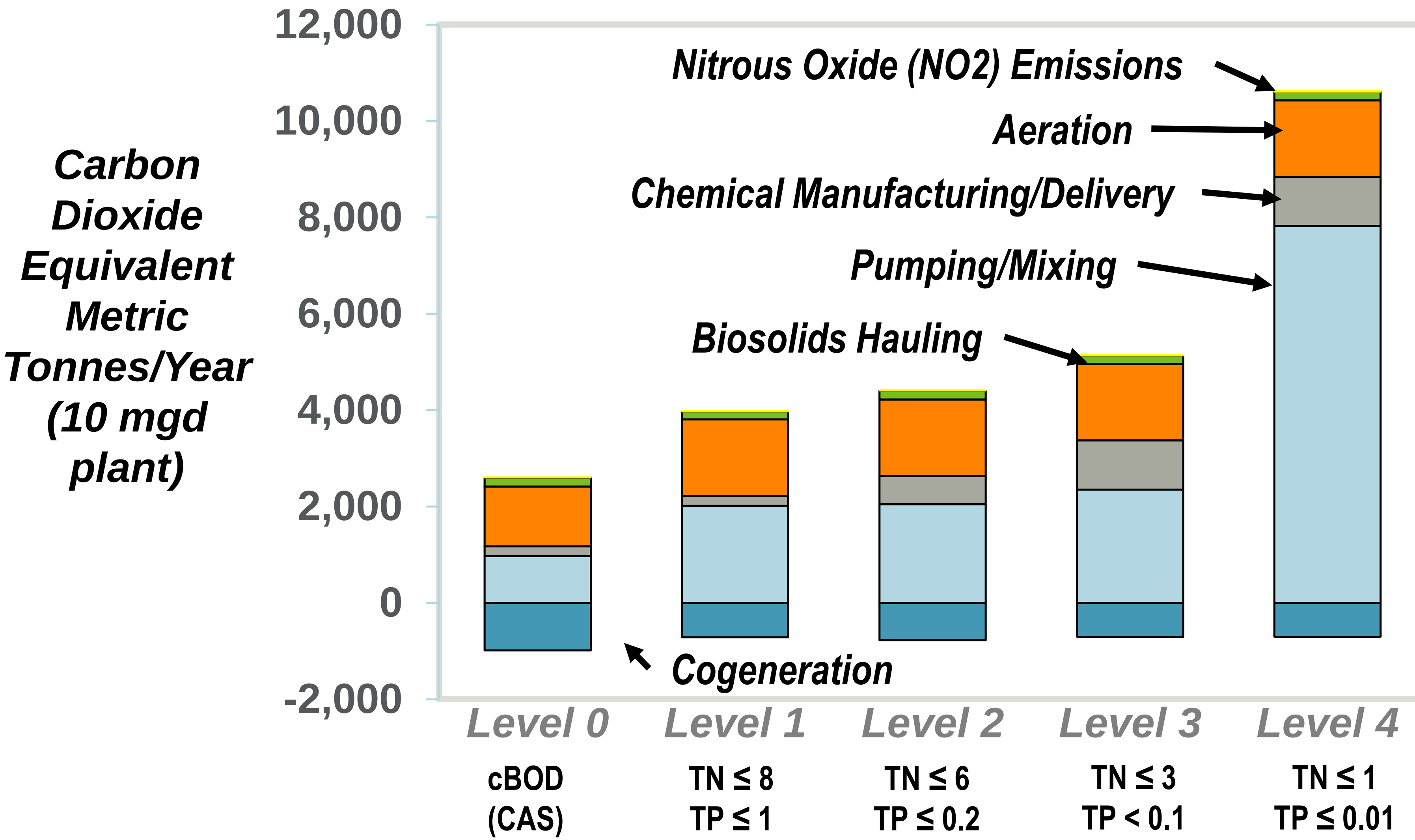
Resource Recovery

Biogas, Nutrient Recovery, Biosolids

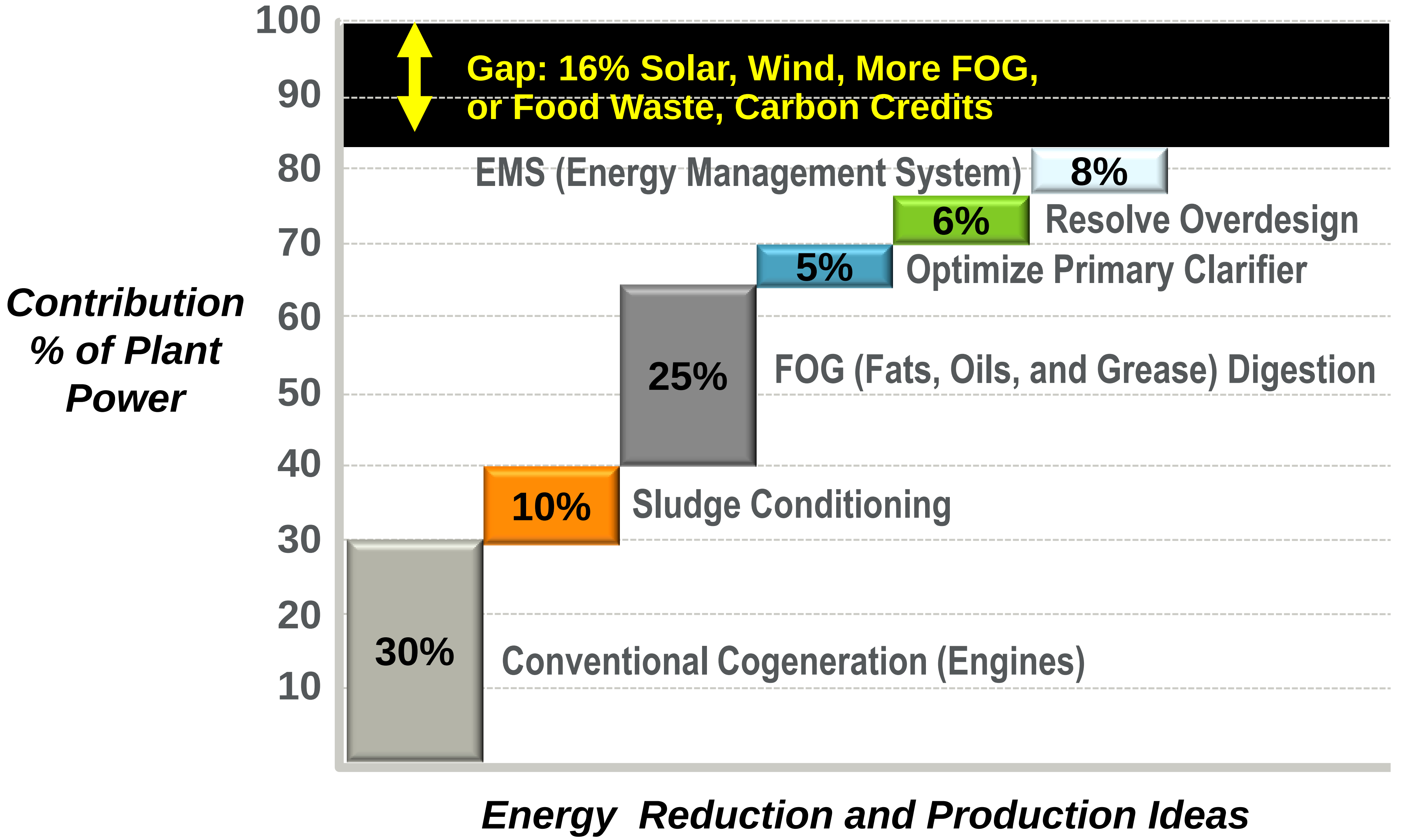
Treatment Process Impacts Energy/Sustainability



…And Things Are Worse for Nutrient Removal



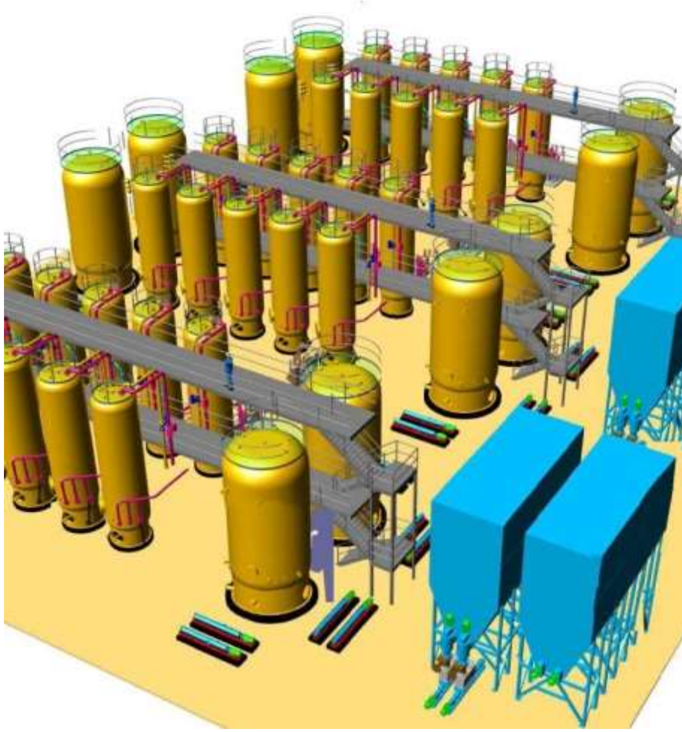
Here’s How We Get to Net Zero Energy



First and Foremost,
You Will Need Anaerobic Digestion of Biosolids

Enhanced Digesters

Conventional Digesters



Cambi

FOG Digestion & Food Waste Can Increase Digester Gas by 50-200%

- Virtually 100% volatile solids destruction
- Highly degradable
- Relatively easy to accept, process, and find
- Very small increase in biosolids production
- May improve volatile destruction of primary/WAS

Alternative Digestion or Biosolids Conditioning

1

Acid Phase Digester

2

Thermophilic

3

Temperature-Phased Anaerobic Digestion (TPAD)

4

Pretreatment with Electricity, Pressure, Heat, Chemicals, Mechanical Abrasion

Cogeneration Using Only Digester Gas Can Produce up to 30% of Plant Power

Microturbines
25% Efficient

Reciprocating Engines
32 to 39% Efficient

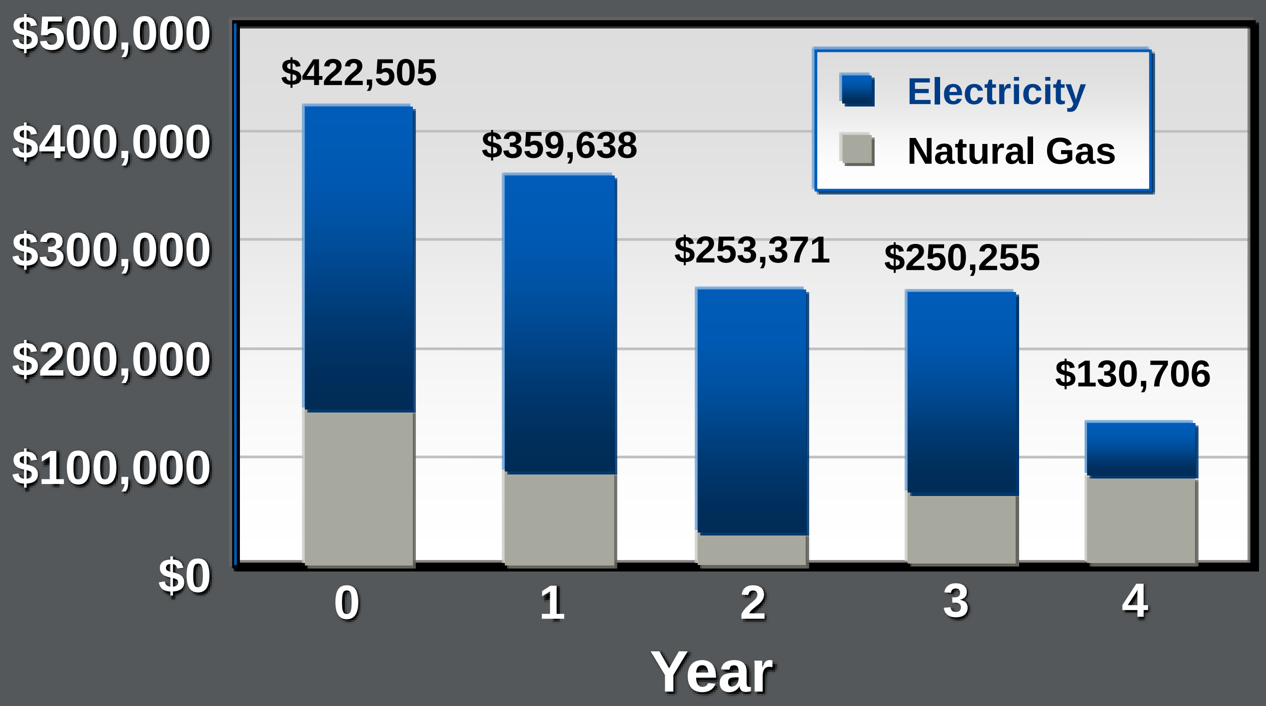
Fuel Cells
45% Efficient

Agenda

1. Getting to Zero: Challenges and Overview

2. Best Practices to Reduce Energy Consumption / Cost at WWTPs

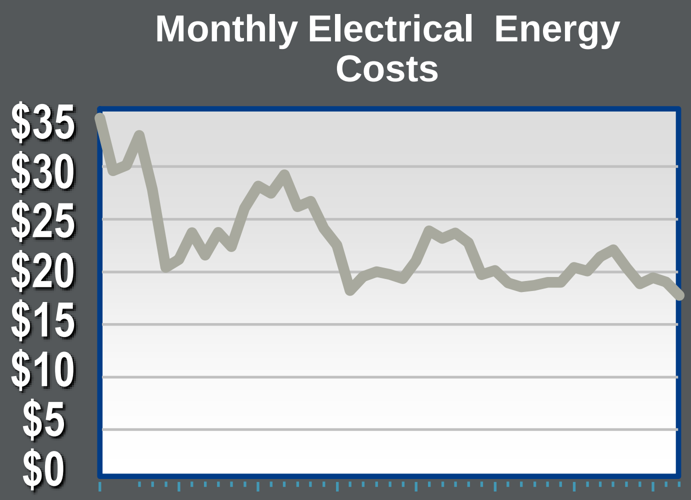
Top ~~10~~ 11 "Best Practices" for Wastewater Energy Optimization

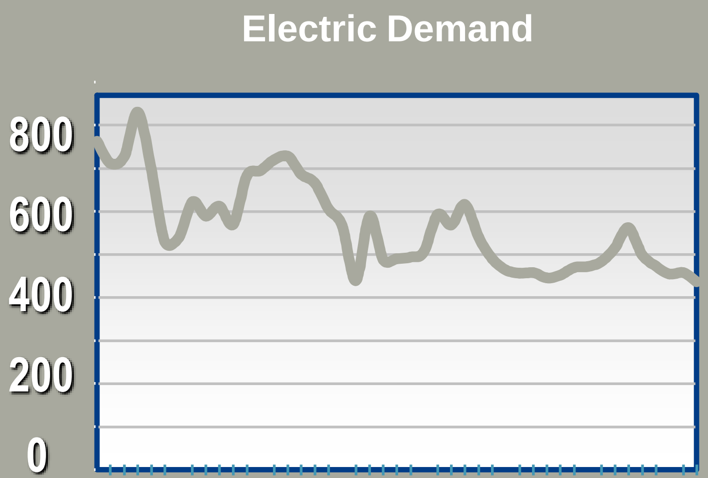


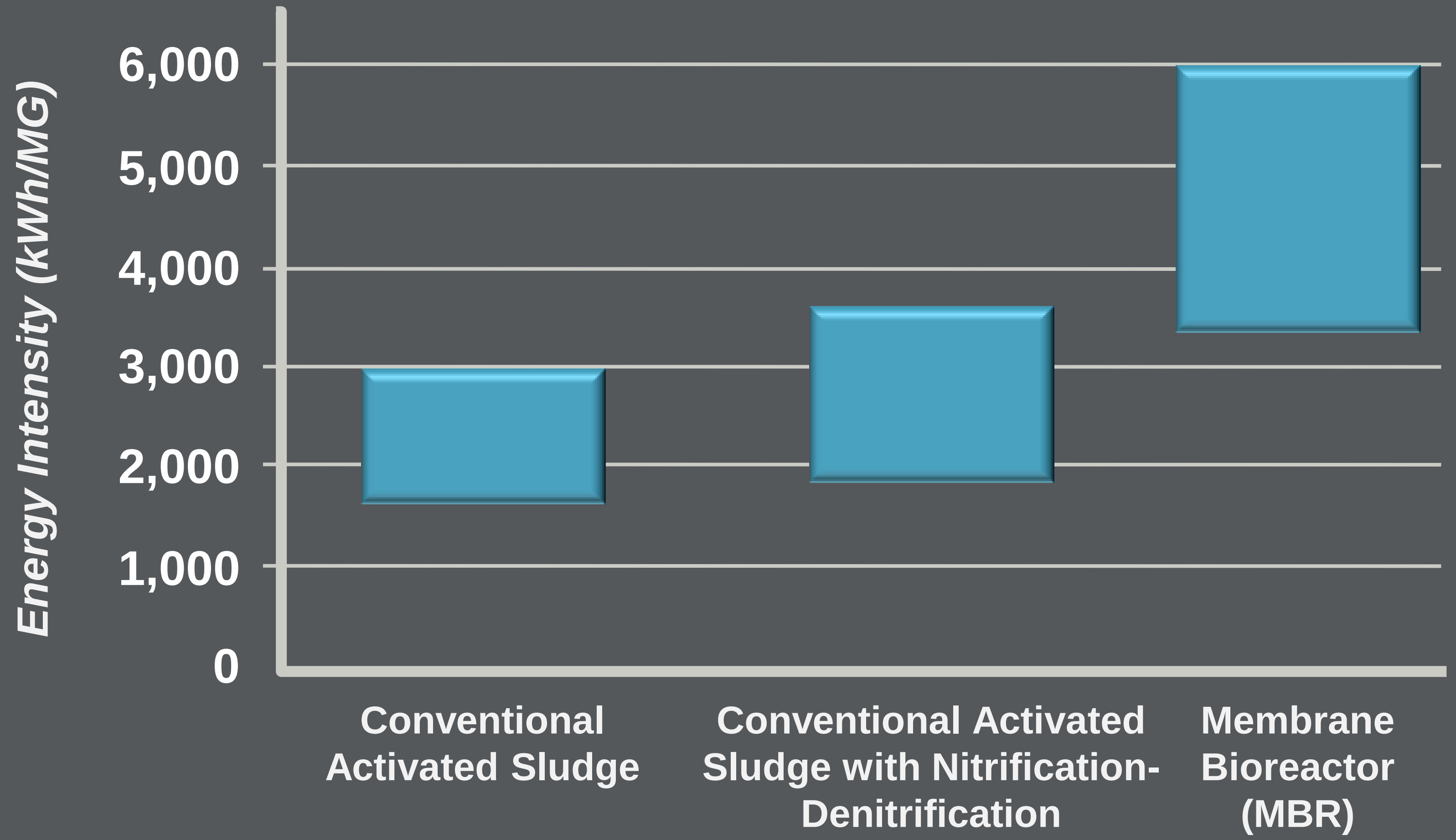
11. Create Your Energy/Sustainability Team

10. Engineering/Operating Staff Must Have Access to Energy (Electricity & Gas) Billing Information

- Get your hands on those bills!
- Plot monthly energy consumption demand cost and consumption



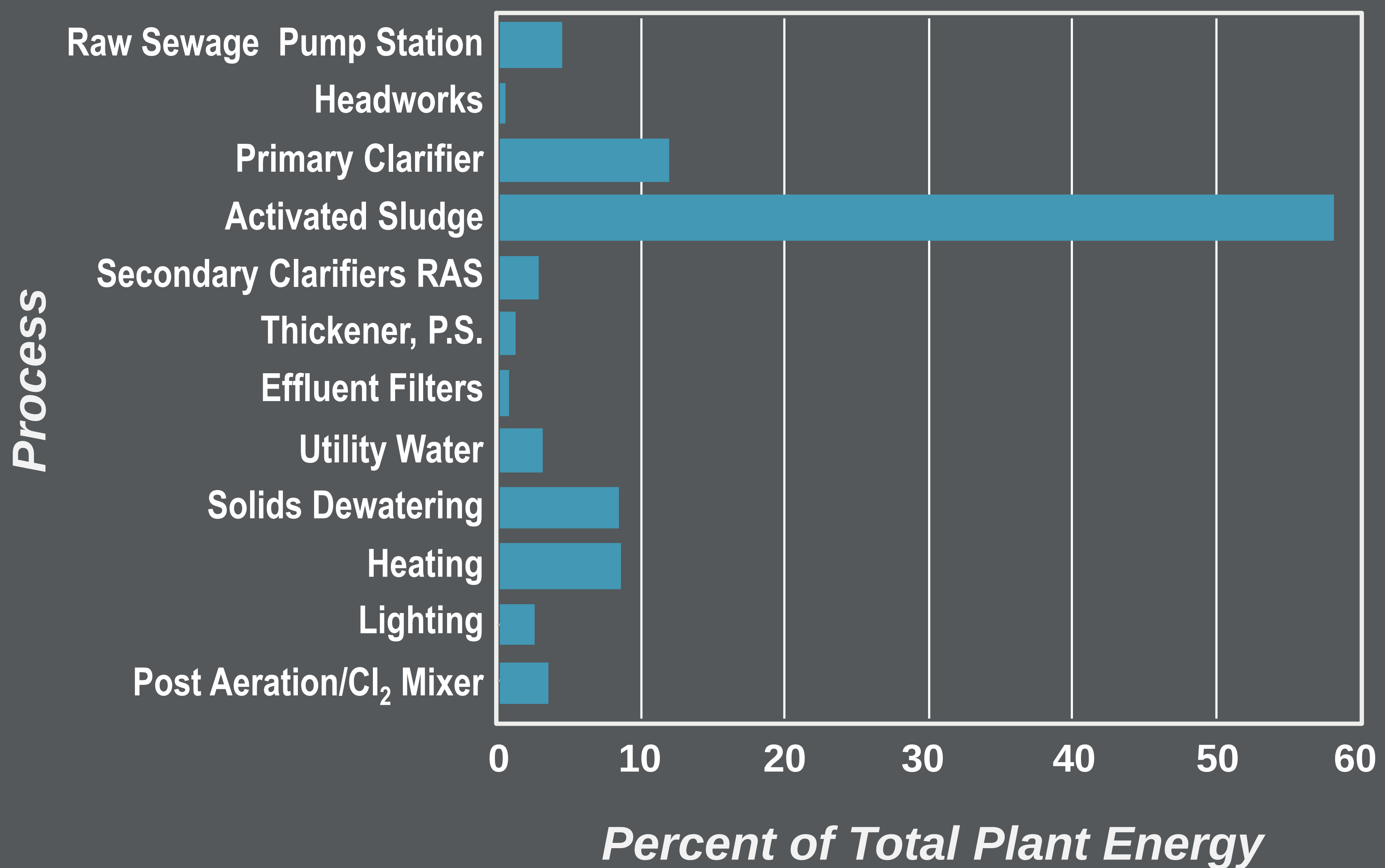




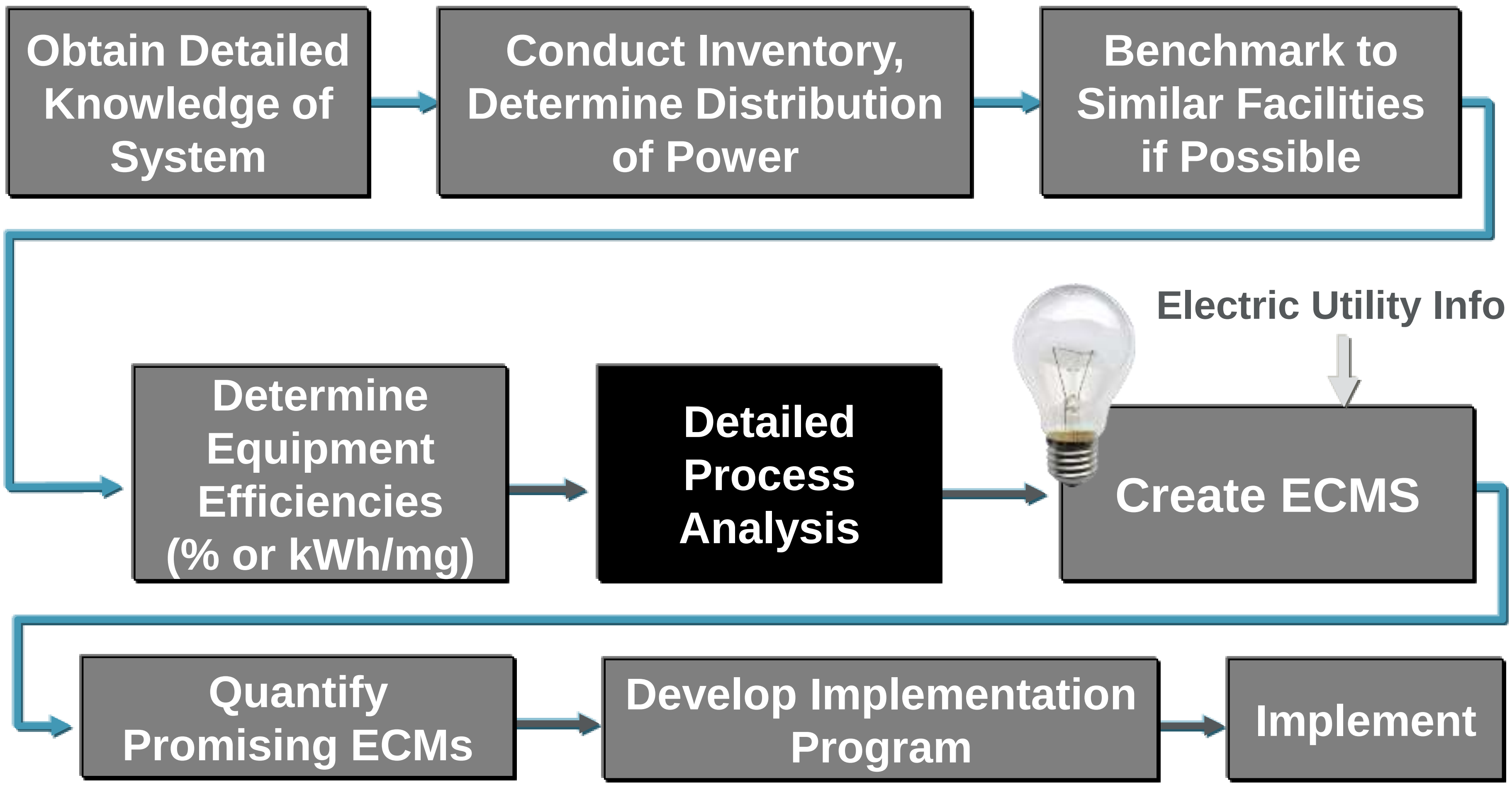
9. Benchmark Pumping and Treatment Facilities

Benchmarking allows you to “begin with the end in mind”

8. Find Out Where the Energy is Being Used



7. Develop an Orderly Process for Conducting Optimization at Facilities



6. Ask "What If" for Every Piece of Equipment

What if … turned it off?

What if … ran it at lower capacity?

What if … found more efficient equipment?

5. Drill into the Details!

The little stuff in the corners add up

4. Recognize and Then Resolve Over Design Problems

A design energy checklist will help!

3. Look Carefully at Renewables

One Megawatt Photovoltaic System at WWTPs are Very Popular!

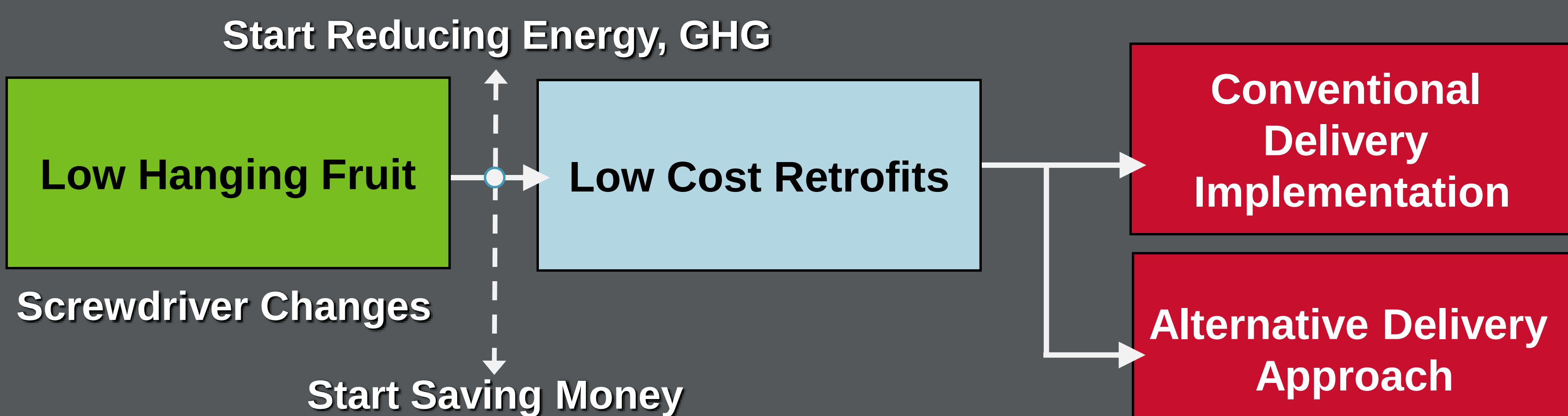
Renewable energy can often be implemented with no capital cost to your organization

2. Fully Engage Your M&O Staff

- Training
- Motivation Programs
- Access to Energy Billing Data
- Do Some Myth Busting

1. Just Do It

Devise the Implementation Program that Works Best for You



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Raw Sewage Pumping Station

- Maximize wet well level
- Some pumps are more efficient than others… Why?
- Wire to water efficiency?
- Pump sequencing

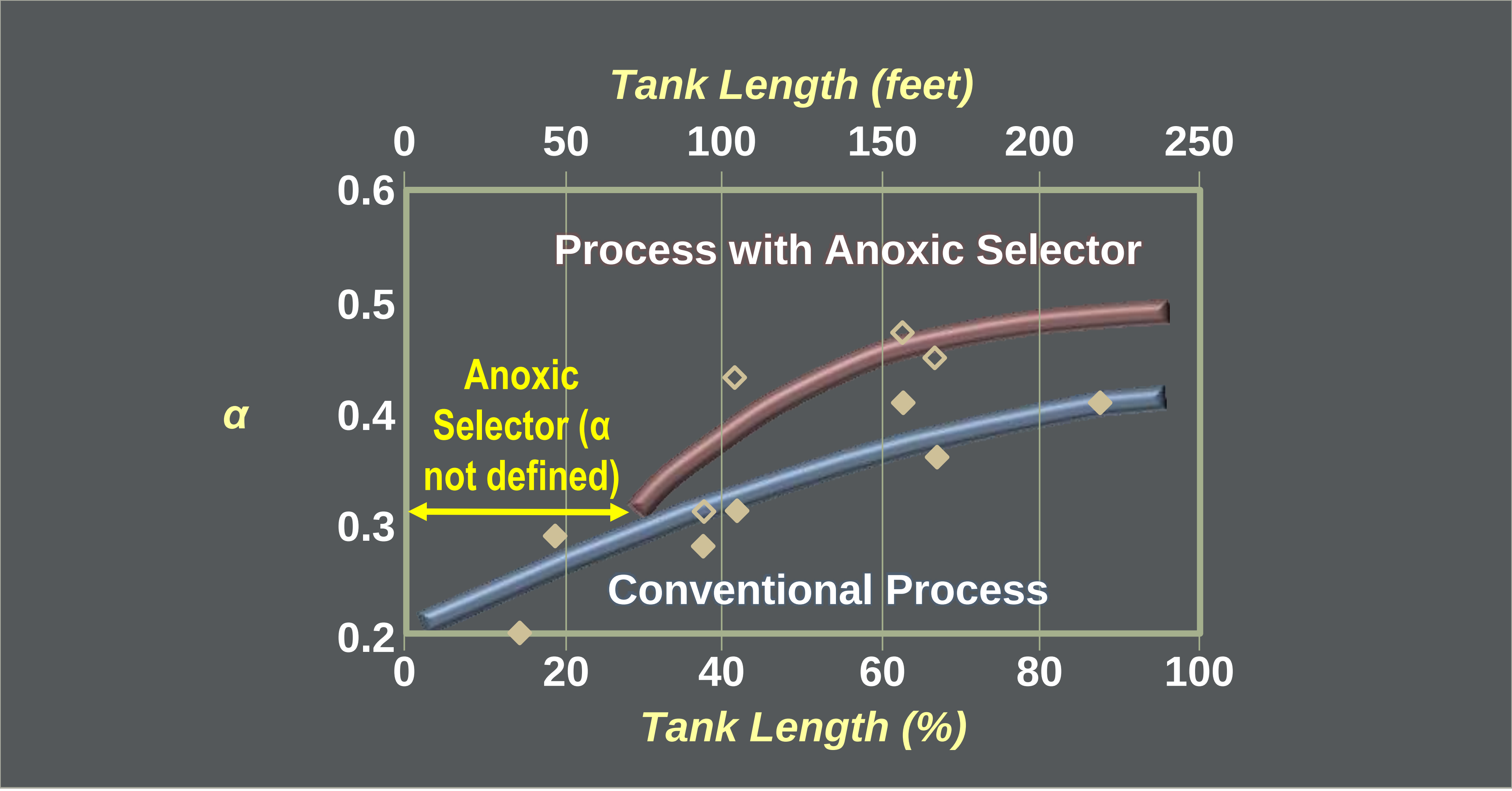
Headworks/Grit

- Need to run grit pumps full time?
- Headworks building heating optimization

Improving Primary Clarifier Performance Can Make A Difference

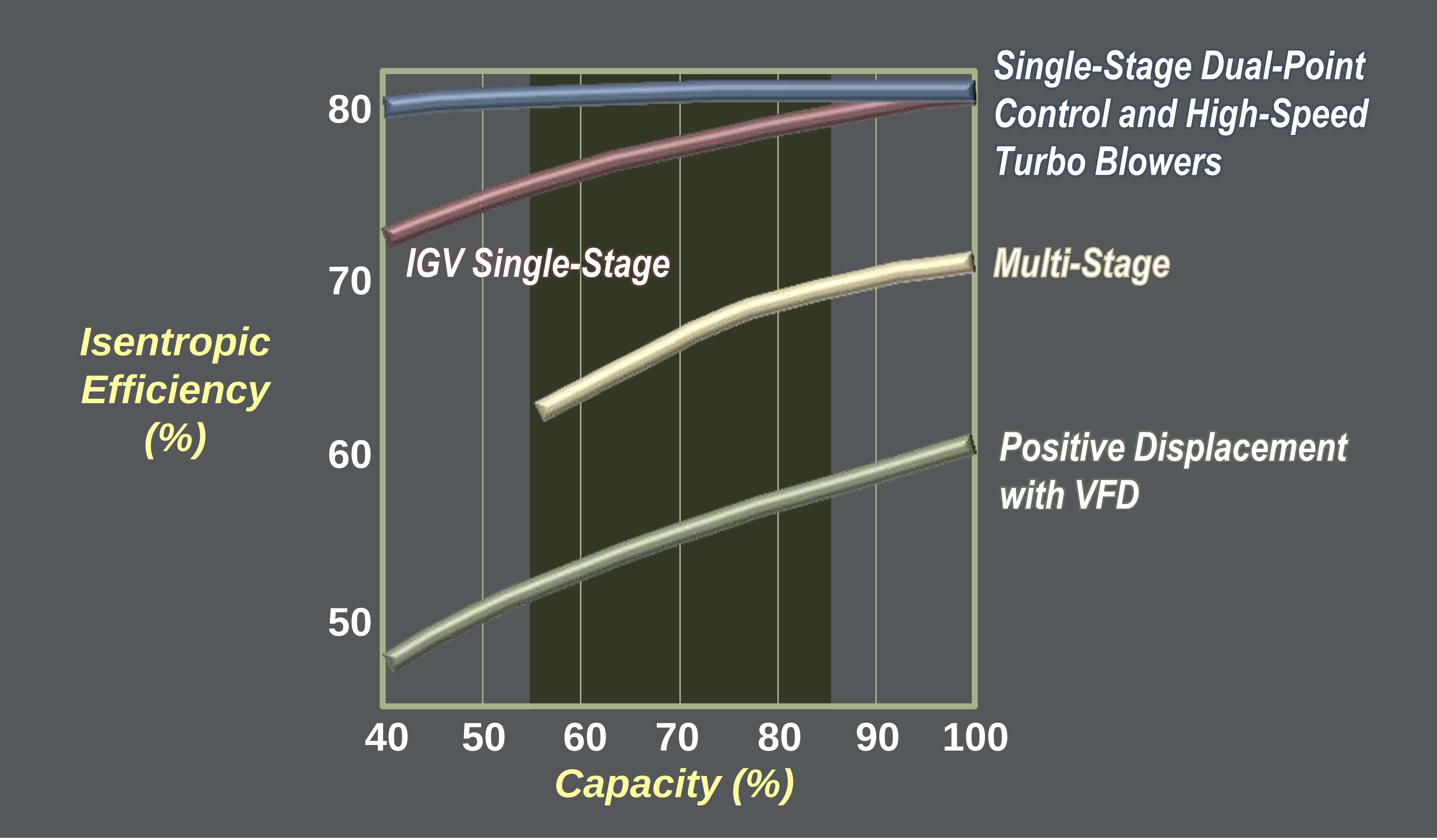
- Improved hydraulics and baffling can increase suspended solids (SS) removal by 10%

- SS = BOD = Energy in activated sludge process



Make Alpha Work for You, Not Against You in Heavily Loaded Section of Aeration Basin

Energy Saving Benefits of Denitrification - Rosso and Stenstrom (2007)



Blower Selection and Sizing is Critical

Blower/Aeration Systems

- Blower type
- Discharge header pressure
- DO, ammonia control
- Most open valve position control
- Overdesign!

Mixing for Sludge or Mixed Liquor Basins

- Use VFDs to optimize energy
- Affinity Laws:

Small reduction in pumping
=
Large reduction in energy

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We Don’t Need to Optimize Energy

… We Have a Brand New Plant!

Activated Sludge Aeration System Design Approach

Where is the Energy??

Blowers!!

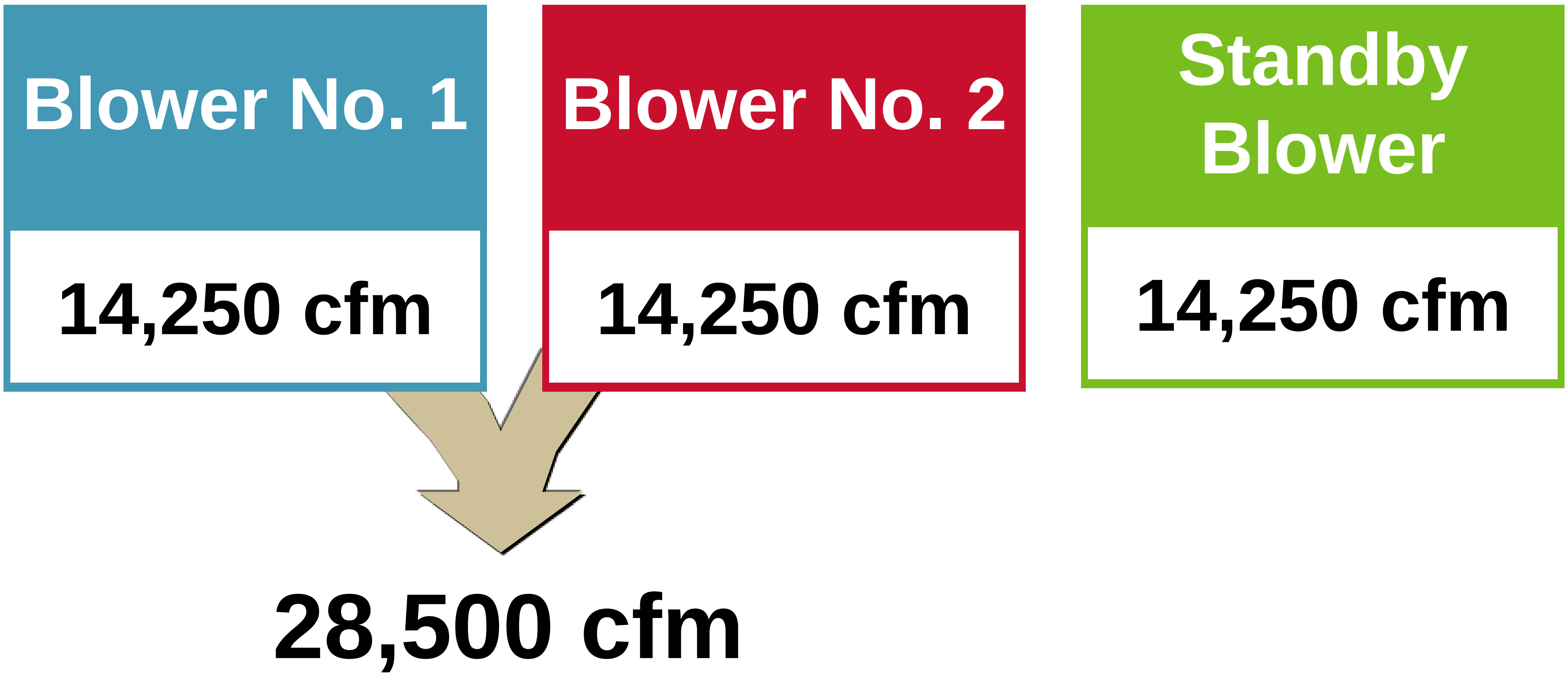
Peaking Factors for Overdesigned Blower Systems

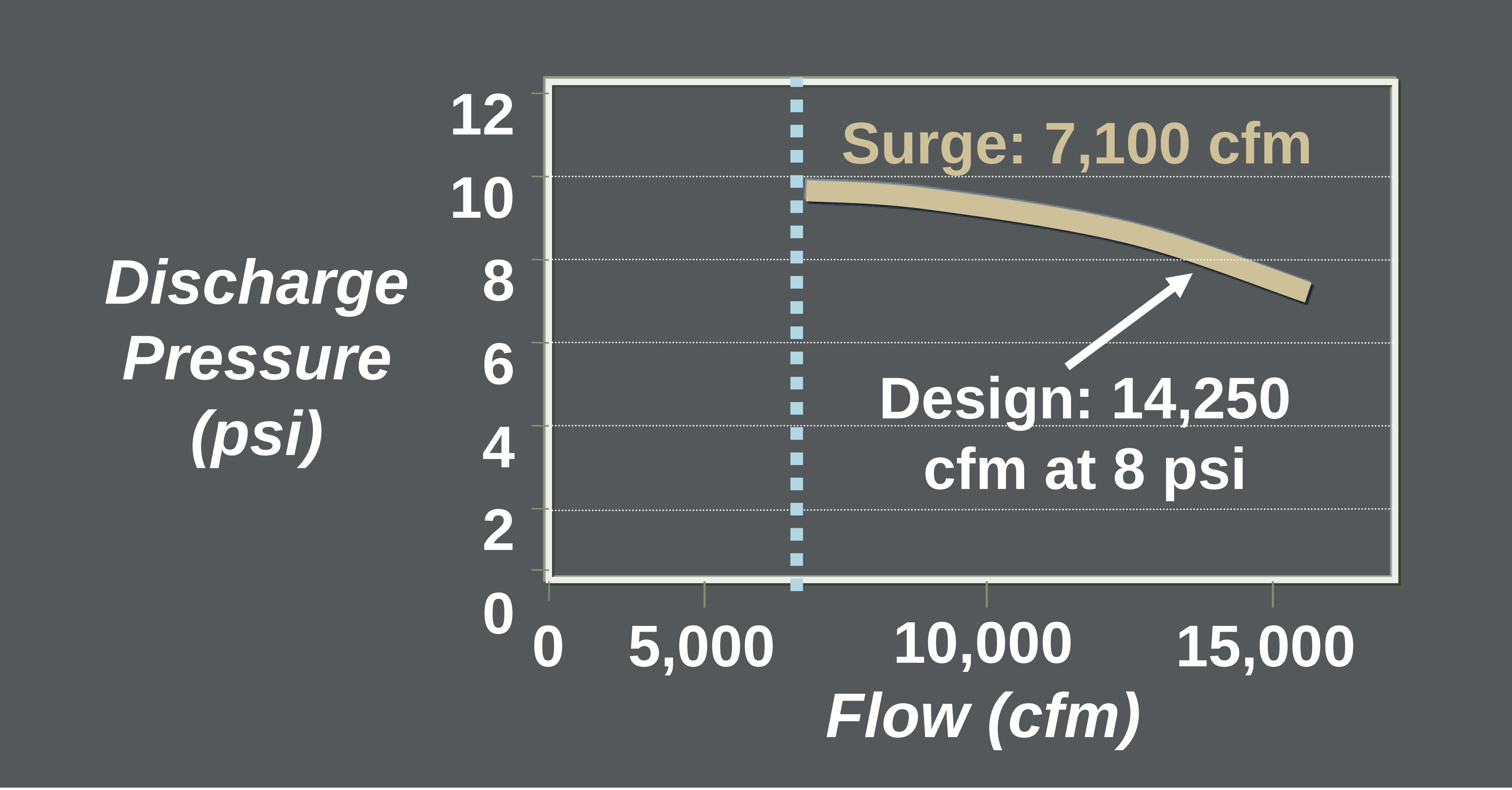
	Avg Condition	Worst Case	Peak Factor
Yearly: Peak Day versus Average Day BOD	1.00	1.20	1.20
Diffuser Alpha (a)	0.55	0.39	1.40
Peak Day versus Average Day Ammonia	1.00	1.30	1.15
Diurnal: Maximum Hour versus Average BOD	1.00	2.00	2.00
Design Year 2035 versus current Loads	1.00	1.34	1.34
Ten States Standards vs. Actual BOD Data	1.00	1.10	1.10
			x 5.7!

Blower Design Conditions

Average Flow Conditions Now	5,000 cfm Air Flow
Worst Case Future	28,500 cfm

Three-Blower Installation
Will Require 14,250 cfm Blowers





Multi-Stage Blower Has Surge Point at Approximately 50-60 Percent of Design Capacity

Blower No. 1	Blower No. 2	Blower No. 3	Blower No. 4
8,000 cfm	8,000 cfm	14,250 cfm	14,250 cfm

OR

Blower No. 1	Blower No. 2	Blower No. 3	Blower No. 4
8,000 cfm	14,250 cfm	14,250 cfm	14,250 cfm

What Should You Do?

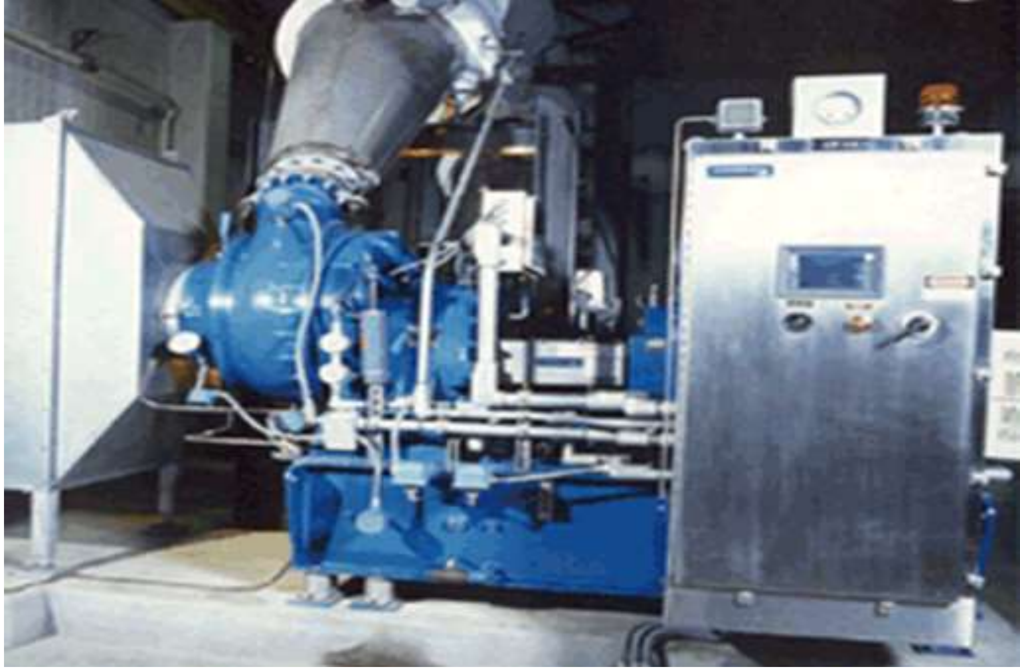
It's Becoming Quite Fashionable to Combine Blower Types

Blower No. 1	Blower No. 2
8,000 cfm	8,000 cfm

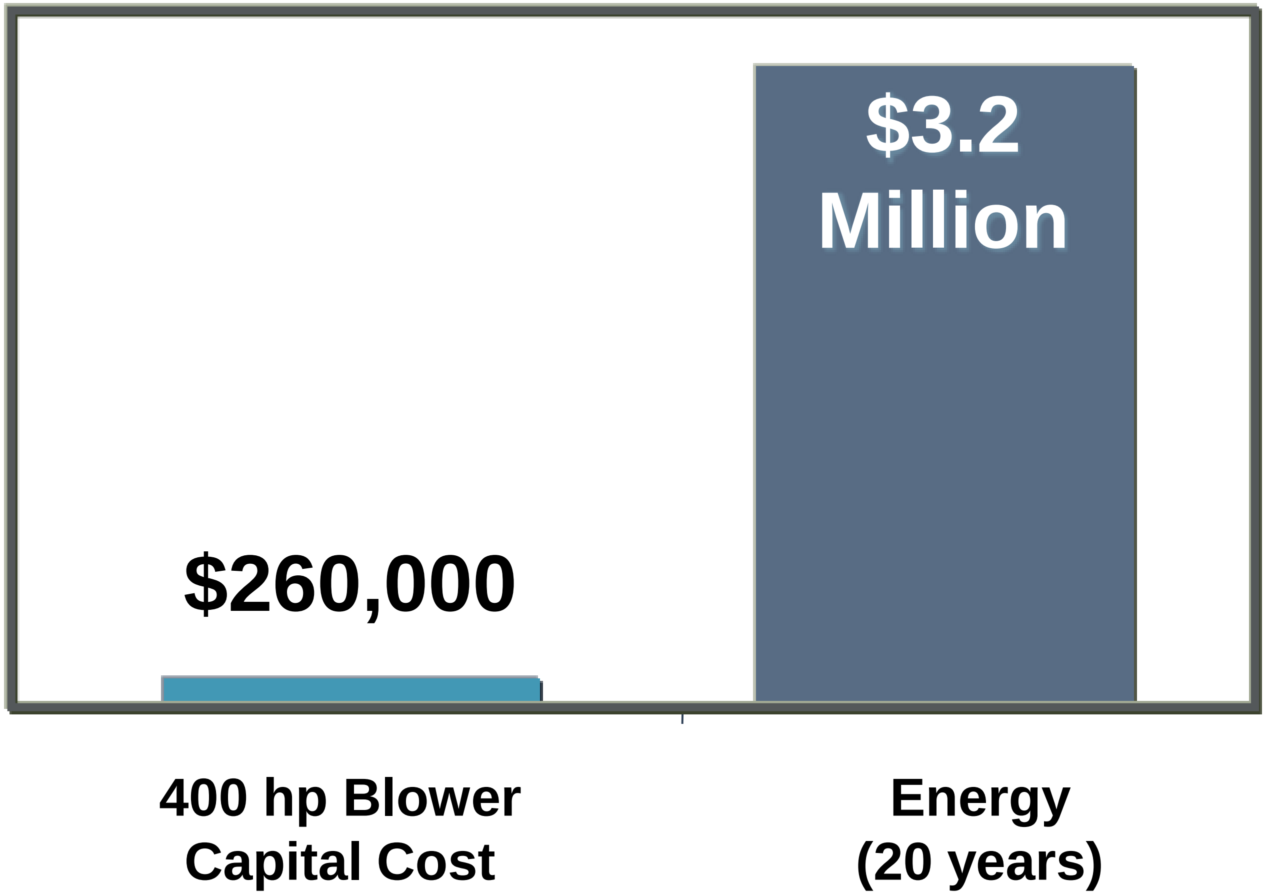
Two Single-Stage

Blower No. 3	Blower No. 4
14,250 cfm	14,250 cfm

Two Multi-Stage



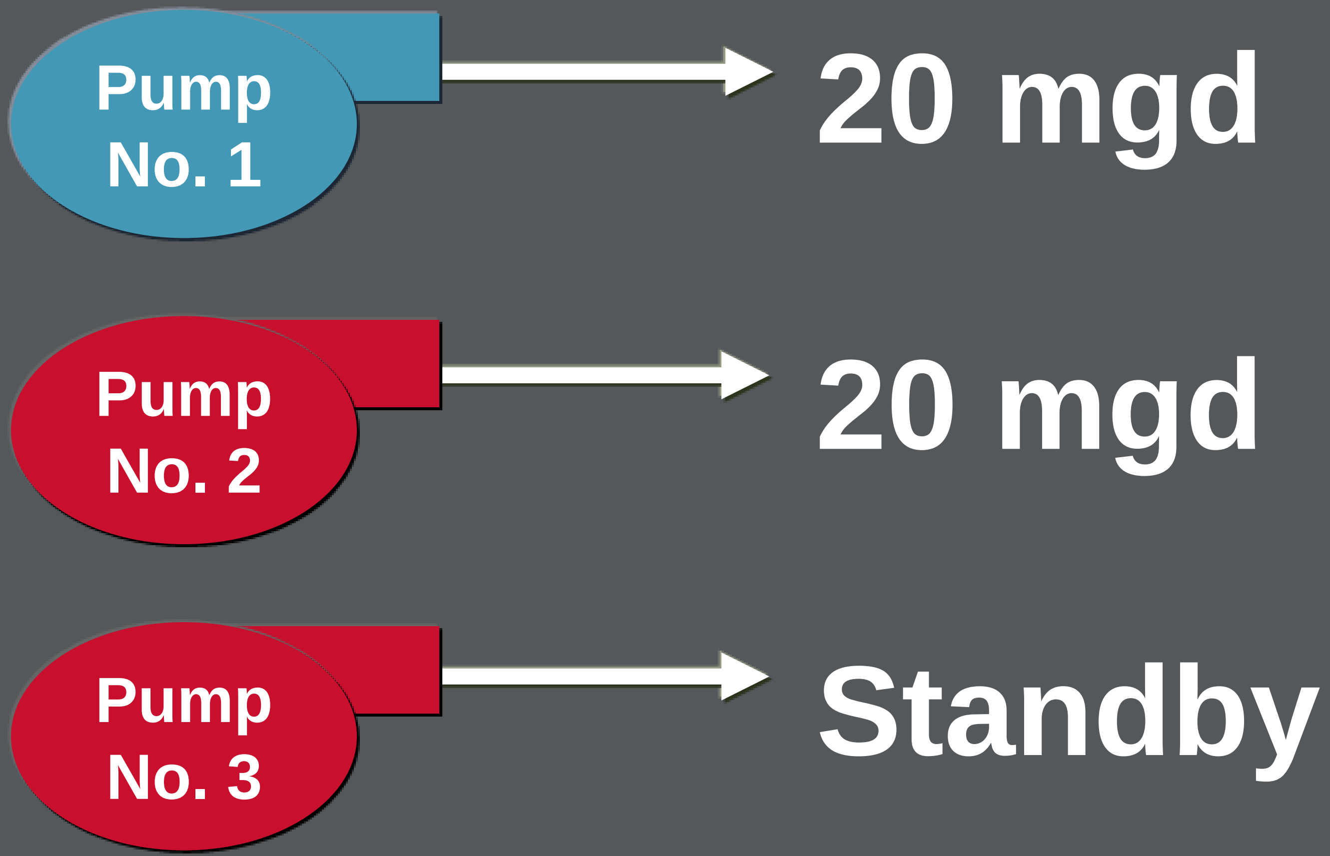
Don’t Scrimp on Adding Equipment that Will Optimize Energy at Average Conditions



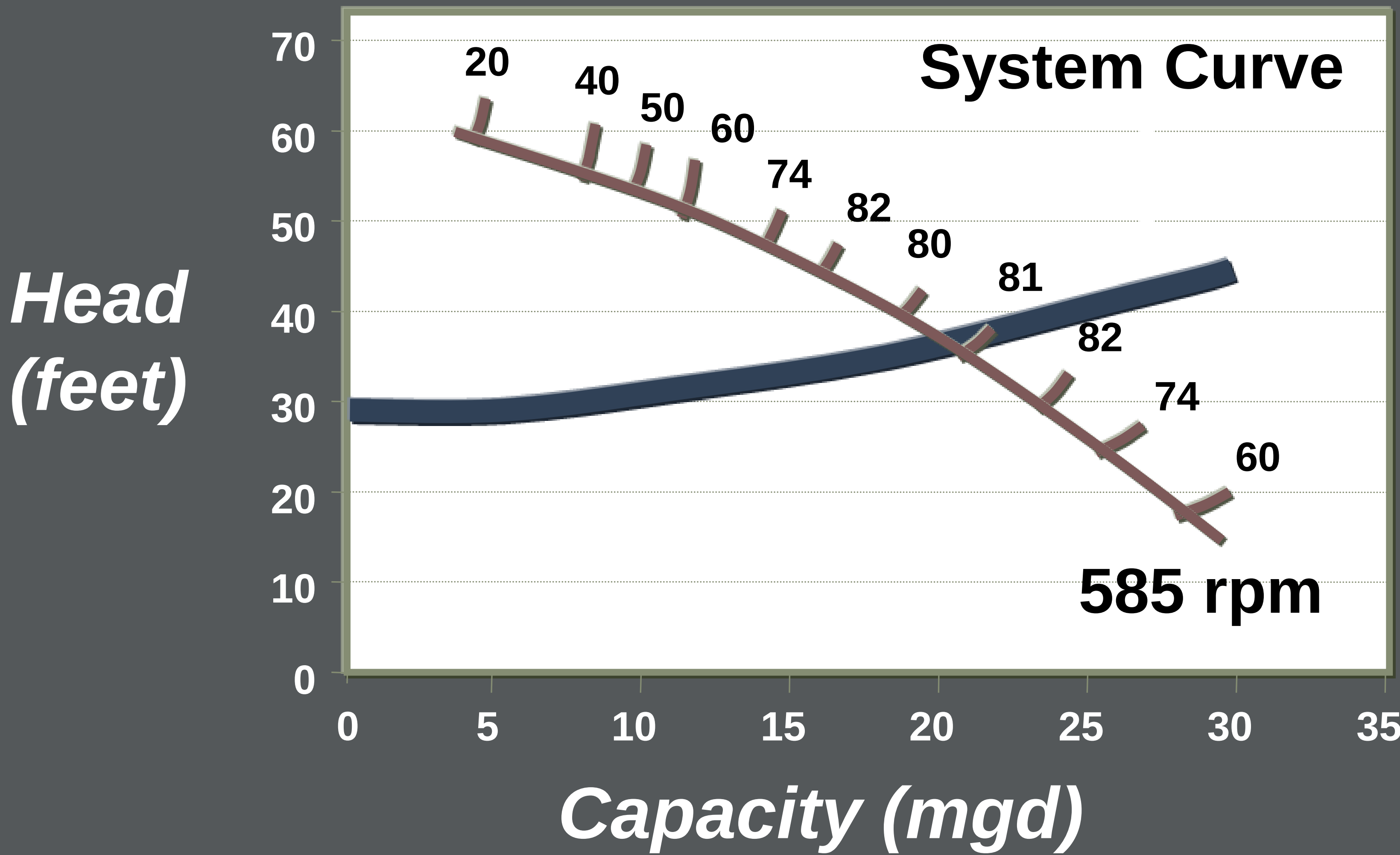
What About Pumps?

- Raw Sewage Pumping Station

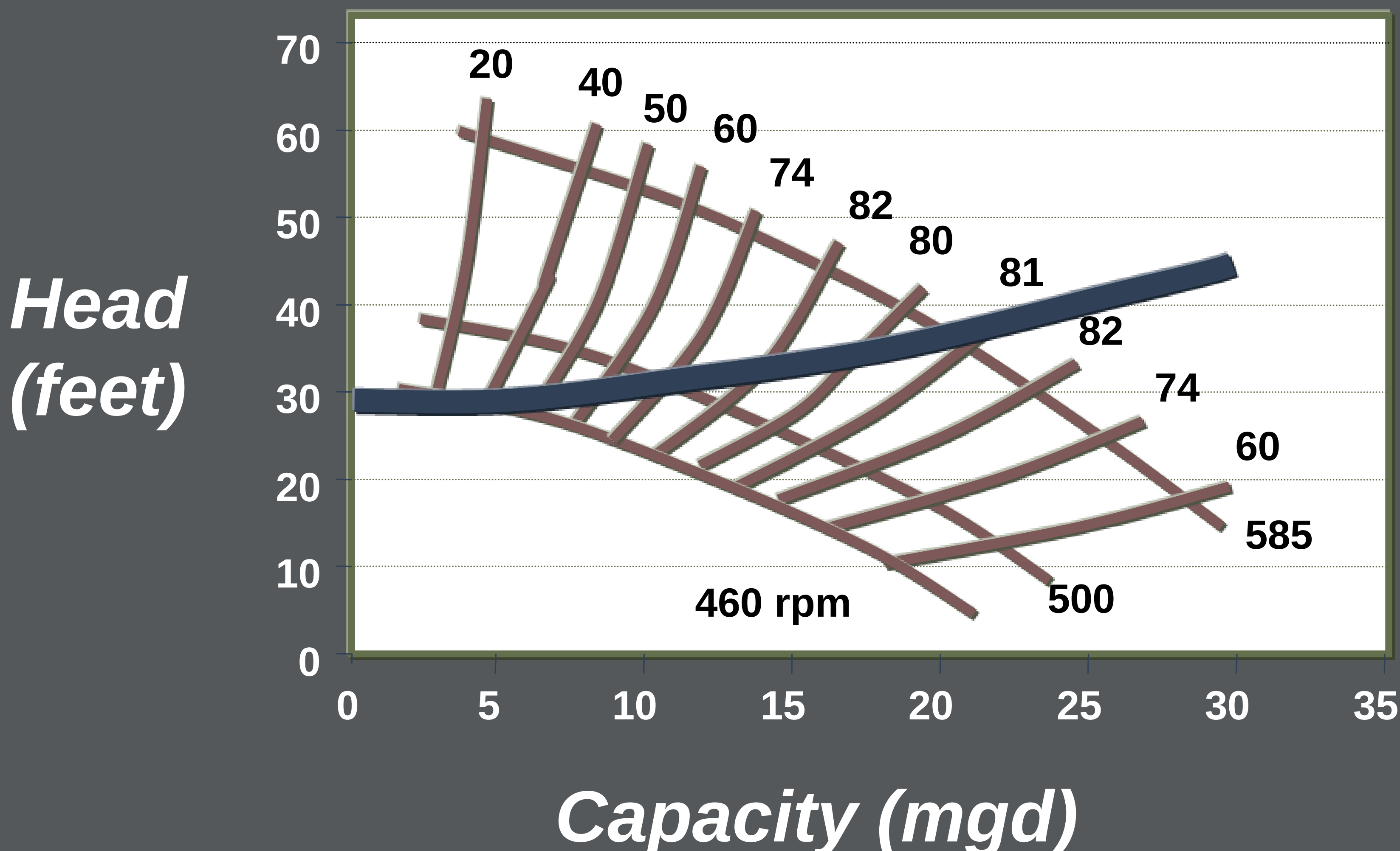
Average Flow	**10 MGD**
Peak Conditions	**40 MGD**



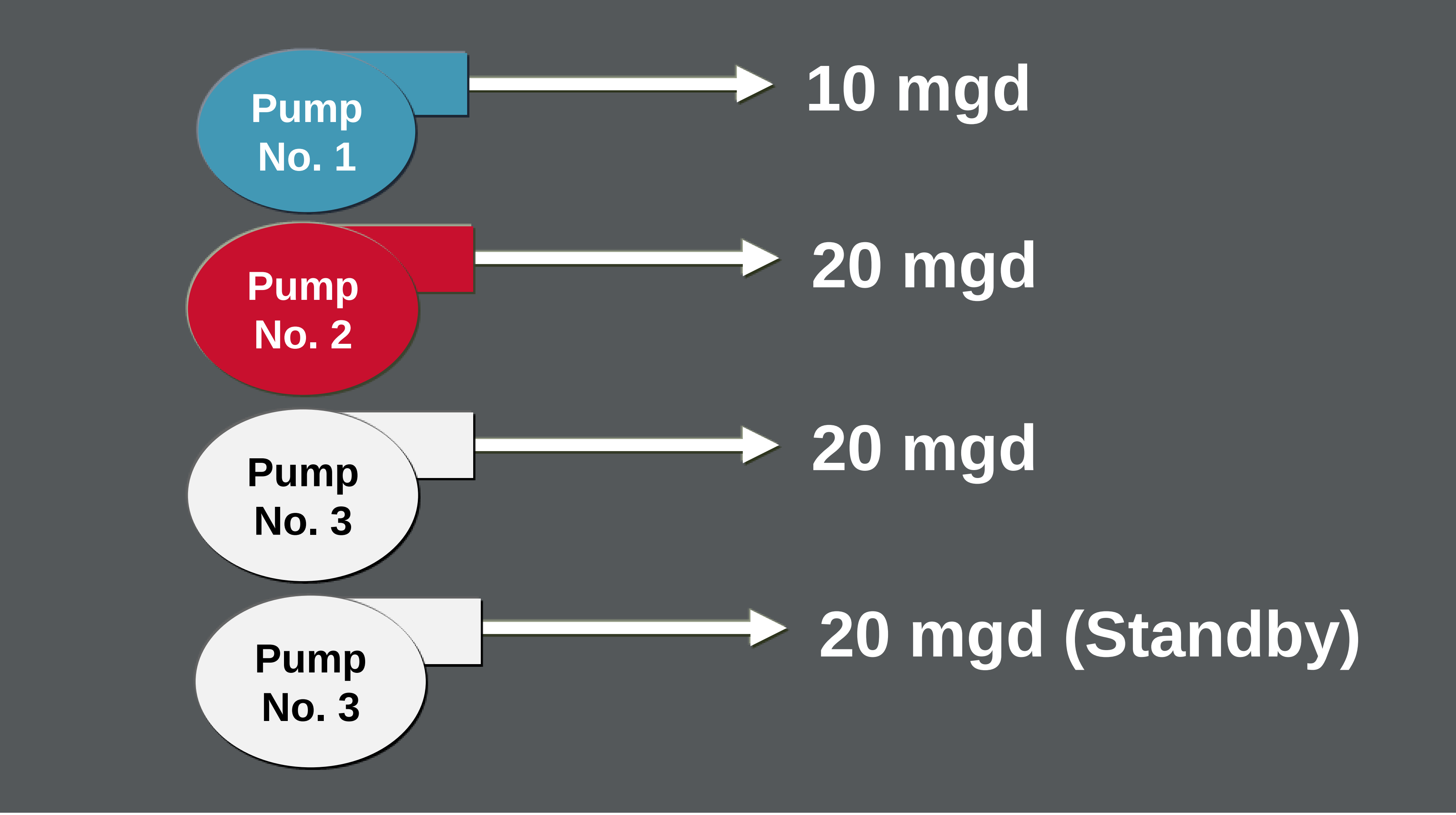
Raw Sewage Pump Station Configuration



We Have The Perfect Pump!

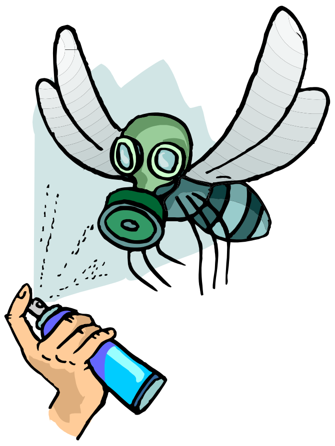


Ouch! 5 mgd is Starting to Get Ugly!


Pump
No. 1
10 mgd
Pump
No. 2
20 mgd
Pump
No. 3
20 mgd
Pump
No. 3
20 mgd (Standby)

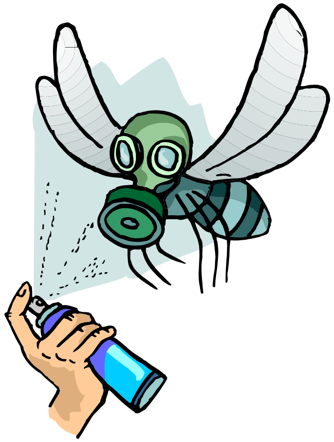
A Solution.

Your Overdesign Repellant



- Equipment operates at “worst case” conditions < 5 percent of the time
- Most designs are specified to be efficient at worst case conditions
- Equipment is often unstable, inefficient at average/minimum conditions

Your Overdesign Repellant



- Use “jockey” pumps, blowers for minimum, average conditions
- Kick those designers in the behind!
  Ask about operation without all the safety factors

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