



Significant Aeration Energy Savings

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Presentation Outline

- Aeration & Energy
- Beloit WPCF Background
- Aeration System Review
- Design for Energy Reduction
- Design Considerations
- Electrical Usage Impact
- Financial Impact
- Lessons Learned

AERATION & ENERGY

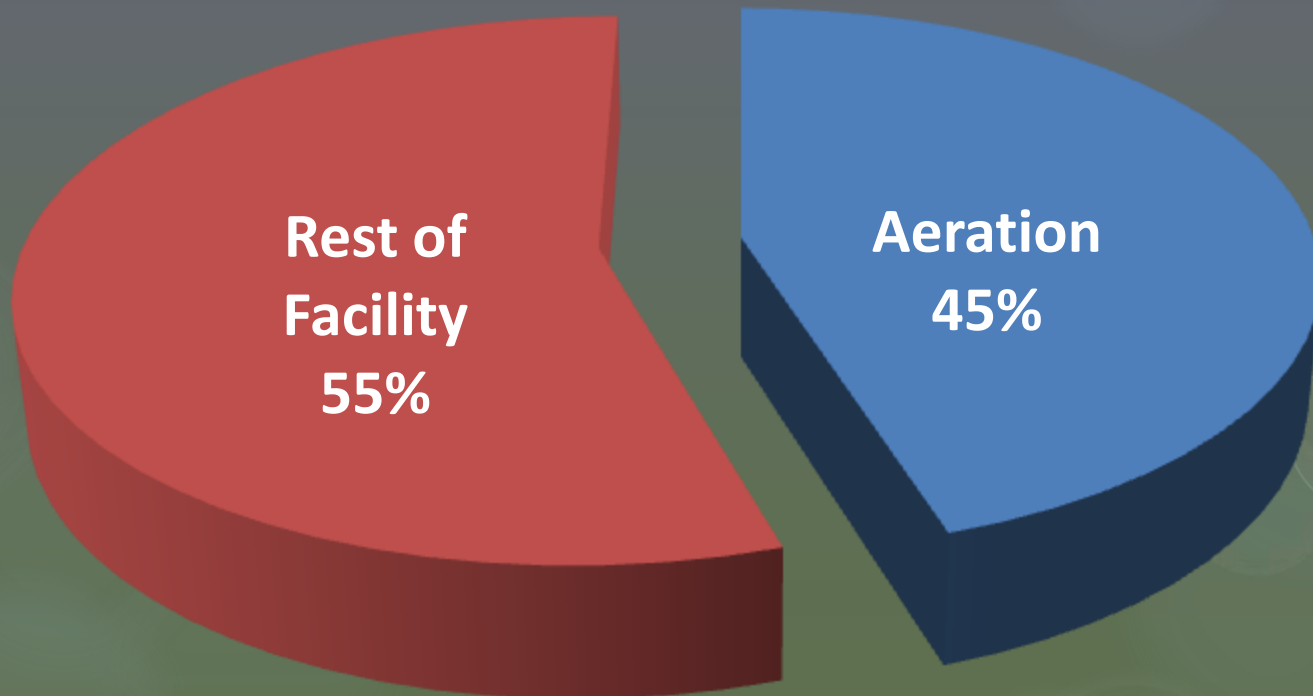
- Utility costs are expected to increase in the future
- U.S. WTPs & WWTPs account for roughly 100 billion kWh annually (Electric Power Research Institute)
- Aeration system power requirements are often 40% to 60% of an activated sludge plant's total energy demand
- Electricity is produced from mostly non-renewable resources



City of Beloit (WI) Water Pollution Control Facility

BELOIT WPCF BACKGROUND

- Average raw influent flow of 5.5 MGD
- Aeration energy use accounts for 45% of facility energy use:

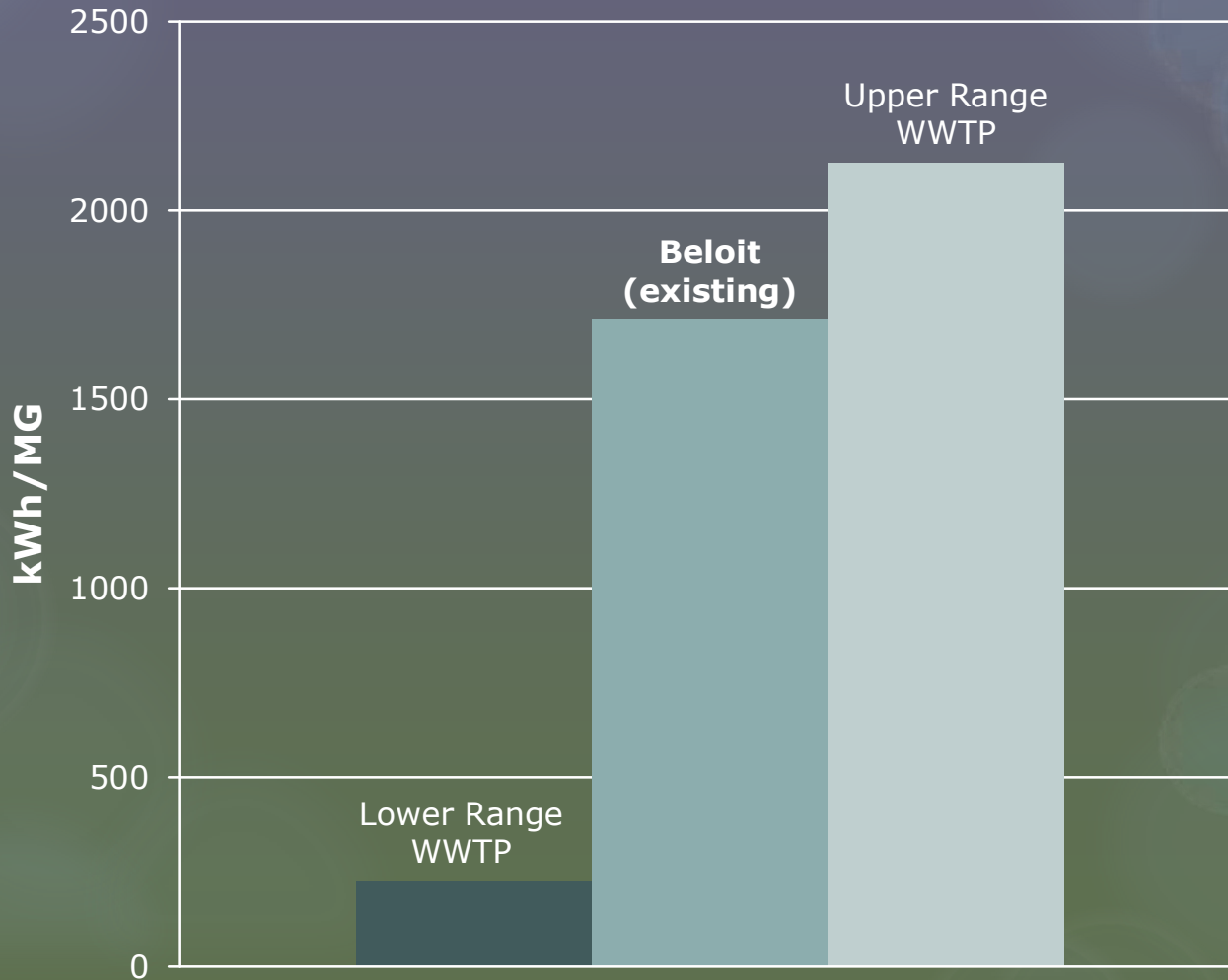


BELOIT WPCF BACKGROUND

- Aeration energy cost is approximately \$260,000/yr at \$0.05/kWh
- Normalized aeration energy use:
 - 1,710 kWh/MG
 - 538 kWh/1,000 lb BOD (raw influent)

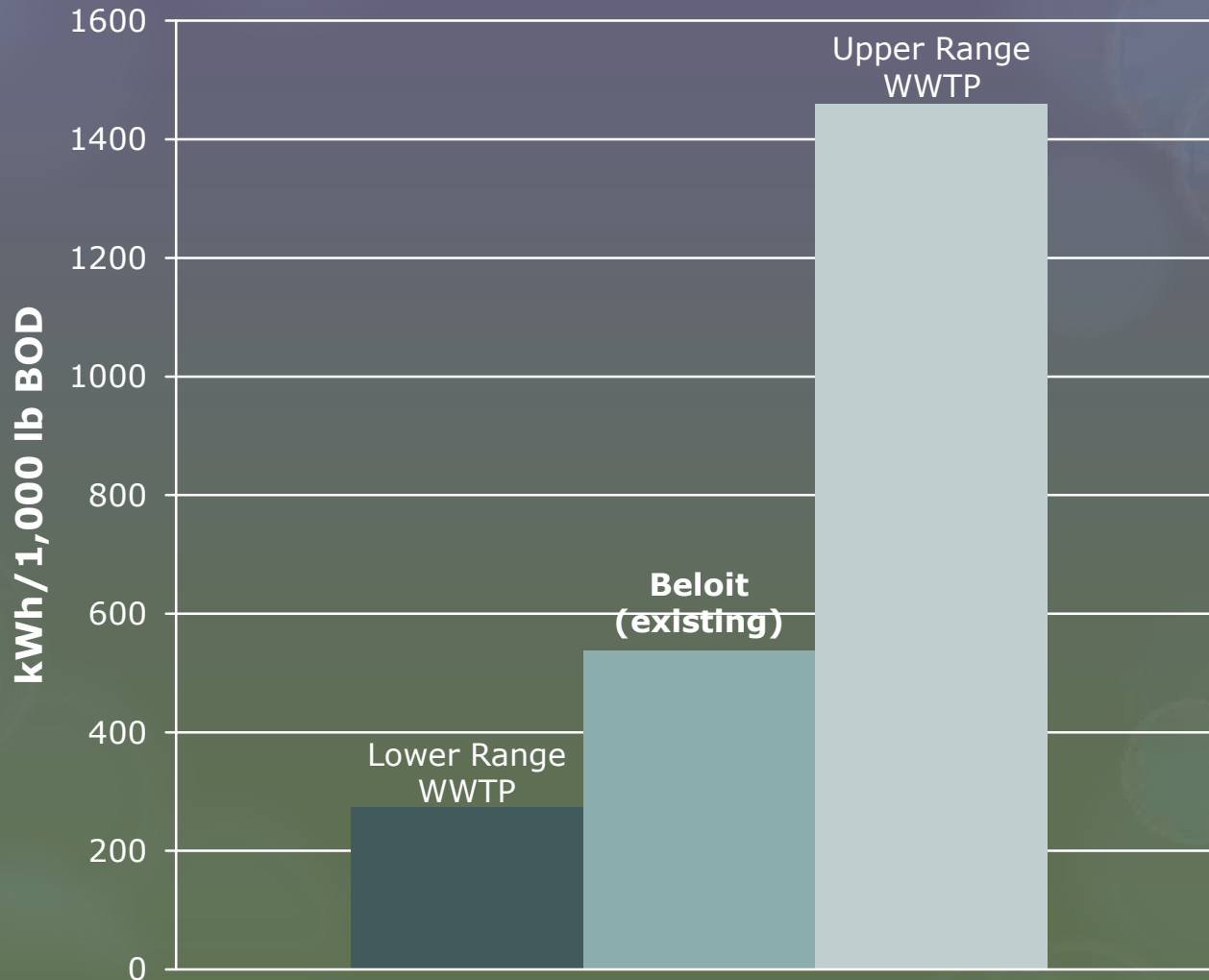
BELOIT WPCF BACKGROUND

Aeration Energy Use per Unit of Influent Flow



BELOIT WPCF BACKGROUND

Aeration Energy Use per Unit of BOD



Aeration System Review



Basins	(4) Buried Concrete Tanks, Each with Anoxic and Oxidic Zones
Diffuser Type	Fine Bubble Ceramic Diffusers
Blowers	(3) 600 HP and (2) 400 HP Multistage Centrifugal Blowers Installed in 1989
Controls	Soft Starts, DO Control of Air Flow, Surge Protection, Time Delays Installed in 1989

Aeration System Review



Three
600 HP
Blowers

Two
400 HP
Blowers

DESIGN FOR ENERGY REDUCTION

- Air flow rate should be varied according to wastewater oxygen demand
- Dissolved oxygen measurements used to vary air flow in real time
- Blower surge control considerations



DESIGN FOR ENERGY REDUCTION

- Potential aeration flow control methods:
 - Flow blow-off
 - Inlet throttling
 - Adjustable discharge diffuser
 - Variable speed drive **Best choice for Beloit**
 - Parallel operation of multiple units

DESIGN FOR ENERGY REDUCTION – Alternatives Review

Option	Blower(s)	Motors	New VFDs	XMFR Rqmts	Capital Cost Estimate
1	600 HP	Replace 4160V w/new	6 pulse 480V 600HP	Step down, then up	\$170,100
2	600 HP	Replace 4160V w/new	18 pulse 4160V 600HP	None	\$216,000
3	600 HP	Replace 4160V with new 460V	18 pulse 4160 to 460V 600HP	Integral to VFD	\$174,060
4	(2) 400 HP	Reuse existing 460V	(2) 18 pulse 460V 400HP	None	\$166,000

DESIGN FOR ENERGY REDUCTION

- The two 400 HP blowers provide sufficient air flow (max. 11,260 cfm) for normal operations
- Control Modifications
 - ❖ Set 400 HP blowers to Lead and Lag 1
 - ❖ Set 600 HP blowers to Lag 2, Lag 3 & Backup

DESIGN FOR ENERGY REDUCTION

- Two 18 pulse, IEEE 519, 460V, 400HP VFD units



DESIGN FOR ENERGY REDUCTION

○ New HMI Control and Monitoring Screen

GENERAL TUNING

USE INDIVIDUAL BLOWER OIs FOR BLOWER SETPOINTS

Auto-Start

	Current Value	Value to Send
LEAD BLOWER	4	4
LAG 1 BLOWER	6	6
LAG 2 BLOWER	5	5
LAG 3 BLOWER	3	3
STANDBY BLOWER	2	

Change Blower Lead/Lag/Standby Status

MAX Quantity of Blowers to Run: 1

LAG BLOWER DELAY min: 120.0

Air Diff Response Delay sec: 90

Air Diff Tolerance CFM: 75

SELECT CONTROL MODE

1= DO Control
2= Schedule: 1

Discharge Header Values

	Air Flow	Pressure
F.S.	70000	15.00
Low Alarm	2000	0.00
High Alarm		10.00

MAIN SCHEDULE SET BASIN SET

01/01 Tank 4 High DO

DESIGN CONSIDERATIONS

- VFD addition effects motor grounding
- Vibration sensors added in conjunction with VFDs
- Surge protection controls



RELATED VFD UPGRADE

- 1.5 MW capacity Cummins diesel standby power generator
- Power WRF if utility feeds are unavailable
- VFD impact on inrush and generator design



AERATION SYSTEM ELECTRICAL USAGE IMPACT

Before VFD Upgrade	After VFD Upgrade	Energy Reduction
45.2% of facility	39.7% of facility	12.2% (percent change)
8,570 kWh/d	7,300 kWh/d	14.8%
1,710 kWh/MG	1,569 kWh/MG	8.2%
538 kWh/1000lb BOD	473 kWh/1000lb BOD	12.1%

FINANCIAL IMPACT REVIEW

- Construction cost of approximately \$115,000
- Annual utility savings of \$14,800 at \$.05/kWh
- Received a Wisconsin Focus on Energy grant of \$46,500
- Payback Period:
 - 4.6 years with grant
 - 7.8 years without grant
- Grant required application and justification submittals



focus on energysm

The power is within you.

LESSONS LEARNED

- VFD addition to aeration blowers can significantly reduce energy consumption
- Aeration control systems require comprehensive evaluation before modification
- VFD applications - New or retrofit systems
- Energy grants really are within reach!

QUESTIONS?

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