Energy Management at Municipal WWTPs

Session 2

April 22, 2021

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Waste Reduction Partners

Energy Management Target

Reduce Energy use per Million gallons wastewater and potentially provide better treatment

Discover and use lower cost energy options

Introduction

Purpose – Increase awareness of energy use and potential for reducing plant operating expenses for wastewater operators

Remember our Drivers from Session 1:

- Budget considerations
- Water-Energy Nexus
- Importance of Energy Efficiency
- Continuous Improvement
- Municipal Sustainability Initiatives, ISO 14001

WWTP Energy Management Sequence

1. Organize an Energy Management Program
2. Discover your Plant Baseline Energy Use
3. Plant(s) Evaluation
4. Energy Savings Possibilities
5. Start with No-cost and Low-cost Items
6. Get involved in setting Priorities for Higher Cost Potentials
7. Be aware of Planning for capital improvement
8. Assist in Tracking and Reporting Results

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Agenda – Two Sessions
Energy Management Training

Session 1: Organize an Energy Management Program

Energy Vocabulary Literacy

Utility Billing – Understanding your billing

Baseline Data & Tracking (at utility billing level)

Benchmarking

Plant Survey & Evaluations:

Session 2: Common BMPs for Energy Management

Renewables

OWASA: Energy Management Case Example – Mary Tiger

Resources for Taking the Next Step

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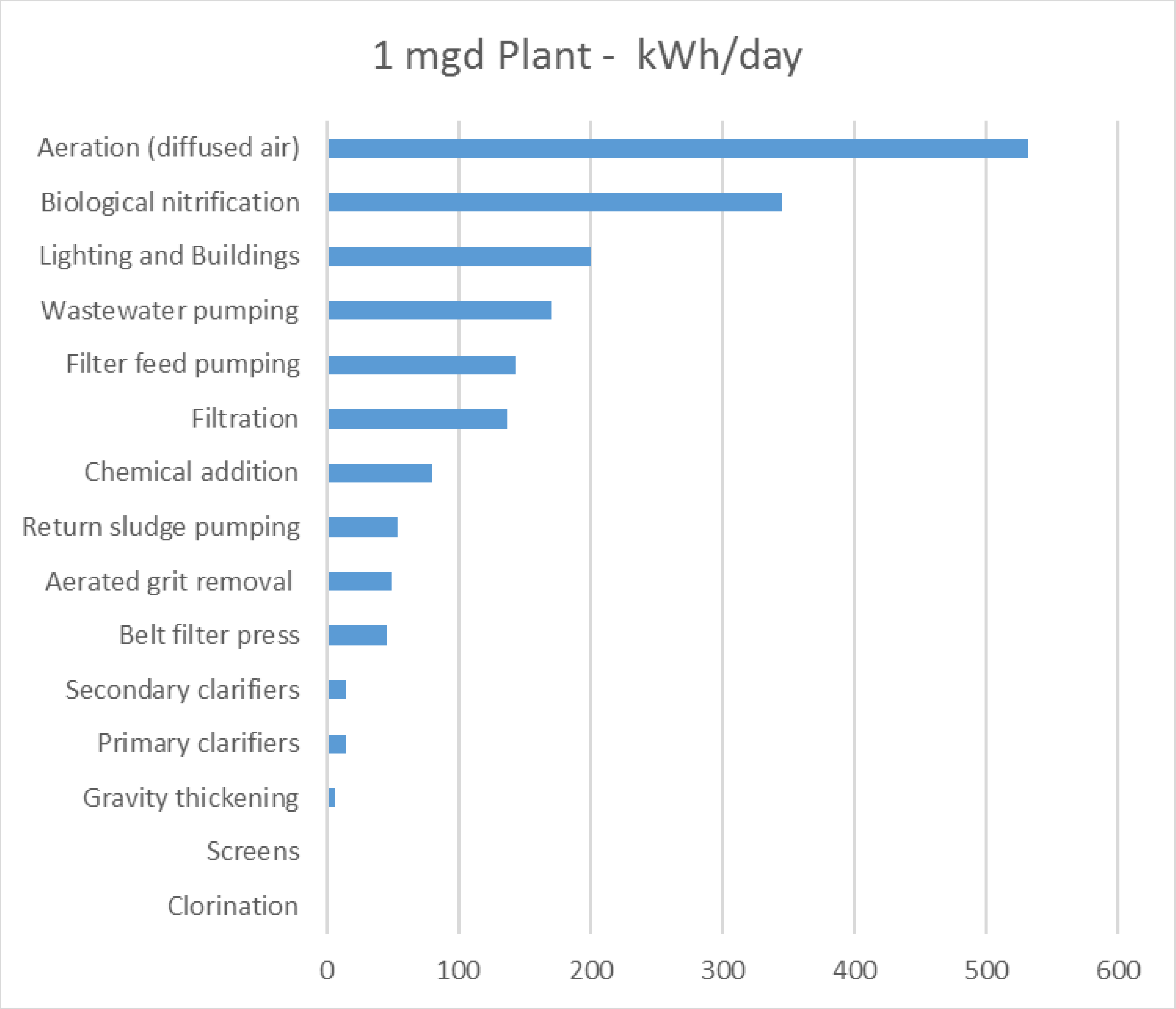
Energy Savings Possibilities

- Identifying ways to use less energy or reduce costs using lower cost energy
- Stay informed about energy management by reading, study, participating in continuing education relative to energy

Typical Energy Balance – 1 mgd plant



Source: WEF MoP 32, 2009

Energy Savings Possibilities

- Capital program or equipment replacement - example replace electric motors with high Eff
- Process change - change regular aeration to sequence batch reactor
- Operational change – Use fewer units if hydraulic conditions allow
- Automation or controls - Rely on ORP instead of DO for oxidation, Add process control
- Maintenance improvements – Consider a rewinding program for motors
- Business measures – train operators, make energy management a priority

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Best Management Practices are available for reducing energy use and costs of operation

Energy Savings Categories

- Organizational Energy Management
- Treatment Process Energy Management
- Building Systems Energy Management
- Renewable Distributed Generation

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Questions?
Comments?

Organizational

Divert Flexible Use to Off-Peak Times

Plant Example: 40% of the electric bill could be monthly peak Demand charge (kW)

60% is for energy consumption in kilowatt hours (kWh) for the month.

The off-peak energy charge ($/kWh) is 20% less during off-peak hours verse on-peak times.

Return clarifier or basin contents to head of plant during off-peak time so that increase pumping is at lower cost :

Saving potential: 20% of the pumping energy charges.

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Organizational:
Motor Management & Rewind Standards

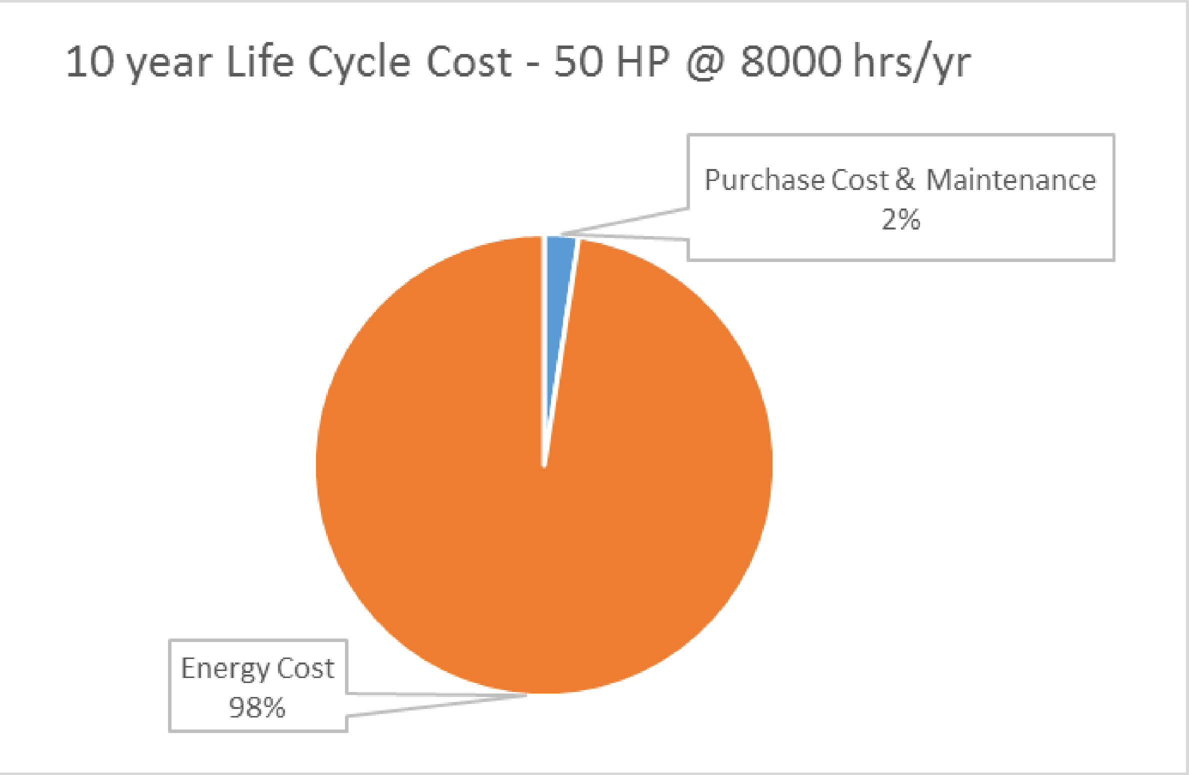
- Establish rewind quality standards with vendors
- Vendors should follow ANSI/EASA standard AR100-2015 Recommended Practices
- strive to have zero to less than 0.5 percent efficiency losses for rewinds of large motor (=>5o HP),
- Vendor certified to Proven Efficiency Verification (PEV) program by Advanced Energy.org (National experts right in Raleigh!).

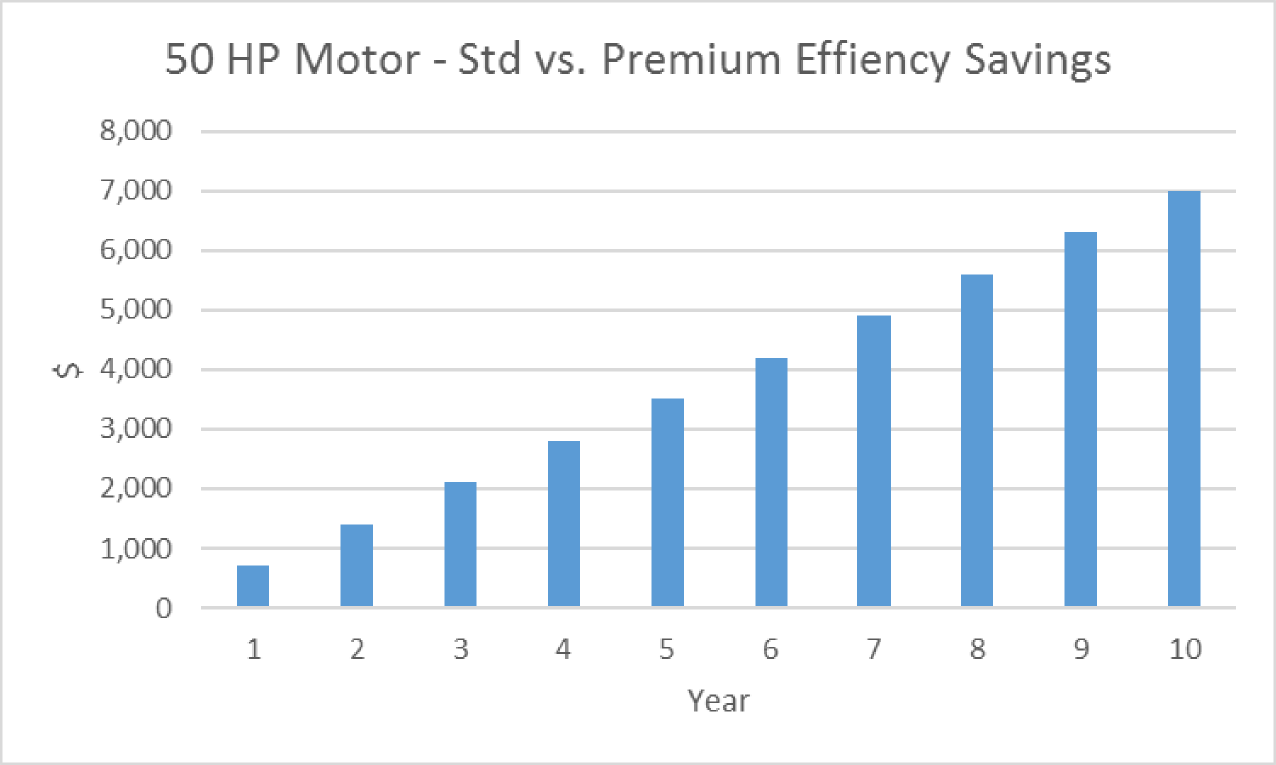
-Don’t rewind less than ~ 50 HP

-Procure only NEMA Premium Efficiency and

-Consider Super Premium Efficiency (IE4) Induction Motors (1 -2 % efficiency gain over Premium Efficiency)

Organizational:
Motor Operating Costs Examples





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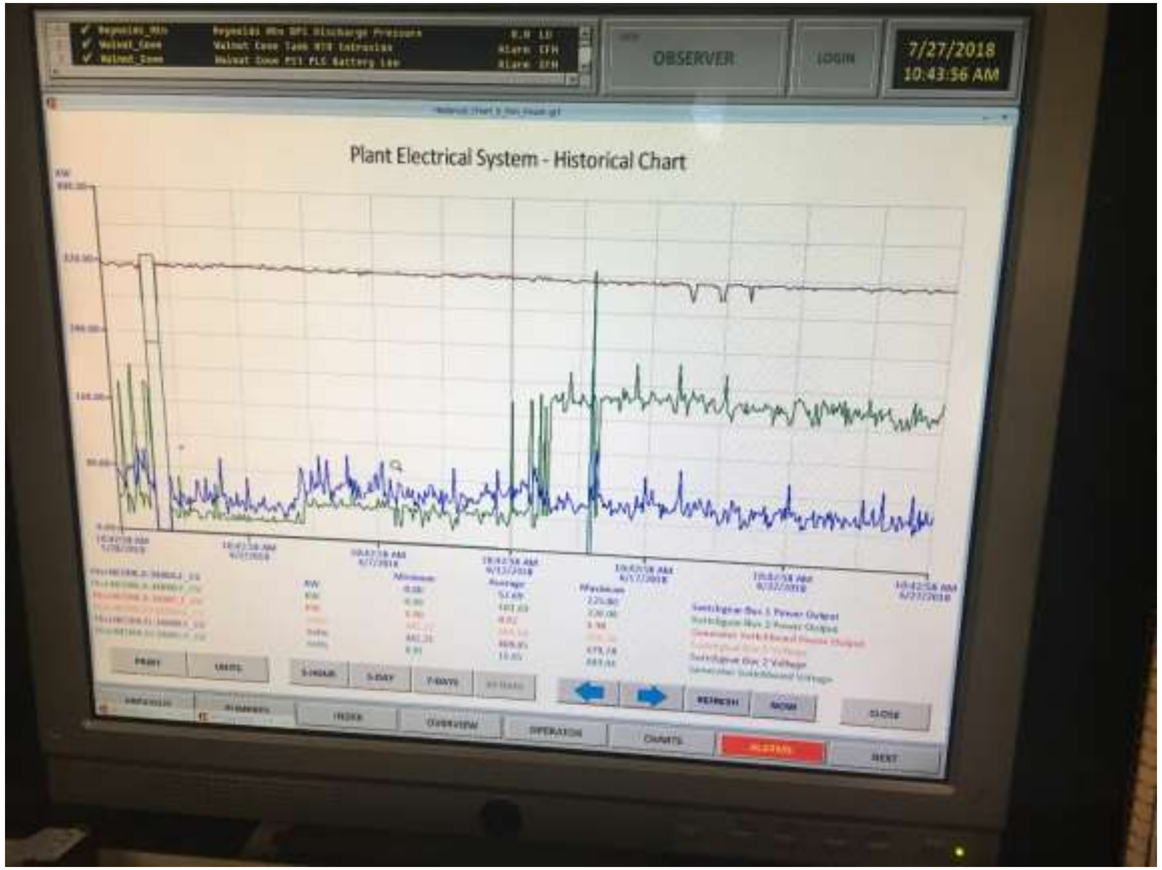
Organizational:

Energy-Use Monitoring & Control on SCADA



- How are your monitoring current energy use on SCADA?
- Look for opportunities to manage energy use on SCADA monitored and controlled equipment.
- Energy kW Demand Management and kWh monitoring should be goal for SCADA

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Treatment Process Energy Management

Evaluate some of the changes suggested in earlier sessions covering nitrification and phosphorus removal

Treatment:
Aeration Upgrade with Duke Rebates

Project: Coarse to Fine Bubble Diffusers on Aeration Basin

Automate DO control with throttle control on primary blower

Project Cost: $1.4 Million

Duke Energy Smart Saver "Custom" Incentive: $340,000

Savings: 4 million kWh and 450 kW

Annual Electric Cost Savings: $280,000

Treatment Process Energy Management

Consider installing or using existing VFD to match process demand

Treatment Process Energy Management

Energy use with decreased speed for centrifugal pumps

Flow is proportional to the pump's speed but energy use is proportional to the cube root of the speed.
This results in a reduction of approximately 15% energy use for a 5% reduction in flow

$V_2 = V_1 \times (R_2/R_1)$	volume	gallons or gallons per time
$H_2 = H_1 \times (R_2/R_1)^2$	head	ft of water typical
$P_2 = P_1 \times (R_2/R_1)^3$	power	Horsepower (convert to kW, 1 hp = 0.746 kW)

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Treatment Process Energy Management

Assume H - ft	50
solve for G	
WHP = HQ / 3960	
Water Horsepower	
Eff WHP	80
(G) - gal/min	6336

Jackson Crk Effluent Pumps 2 units

Permit - 7.5 MGD

Pumps - 100 HP   From Design data ---->   6,000,000 gal per day   24 hr   Design was approx -->   5208 gpm

15.8 hr/day at assumed WH calc pumping volume

Electric Rate $/kw $0.061

NOTE: For VFD change, horsepower is proportional to cube of speed
volume is directly proportional to speed   * Gorman-Rupp Pumps Engineering Data

Assumed hr/yr 2 pumps   5,761   KW/HP   0.746

Motor Load   90%

Motor Efficiency   91%   Motor HP   100

	gpm	hours	extra hours/yr
No VFD 100%	6336	5760.7	N/A
at 95% of max	6019	6064	303
at 90% of max	5702	6401	640
at 85% of max	5386	6777	1017

KW hr Annual	KW	VFD factor	$/hr	Motor HP Load	Motor efficiency	VFD Speed Reduction	Annual costs
425028	73.78		$4.50	90	91%	0%	$25,926.71
396665	65.41	0.857375	$3.99	77.2	88%	5%	$24,196.55
356009	55.62	0.729	$3.39	65.6	88%	10%	$21,716.57
317552	46.85	0.614125	$2.86	55.3	88%	15%	$19,370.64

Note: Actual annual cost for 2019 is in the SRU total billing

avg hr/day at 15% reduction   18.57

$2,479.98 <------ Savings per year for average rate   At 5% red with VFD is a 10% annual savings

40655 KW saved annually for 5% avg speed reduction

Pump affinity laws used for operation with VFD

Treatment Process Energy Management

Energy use with decreased speed for centrifugal pumps

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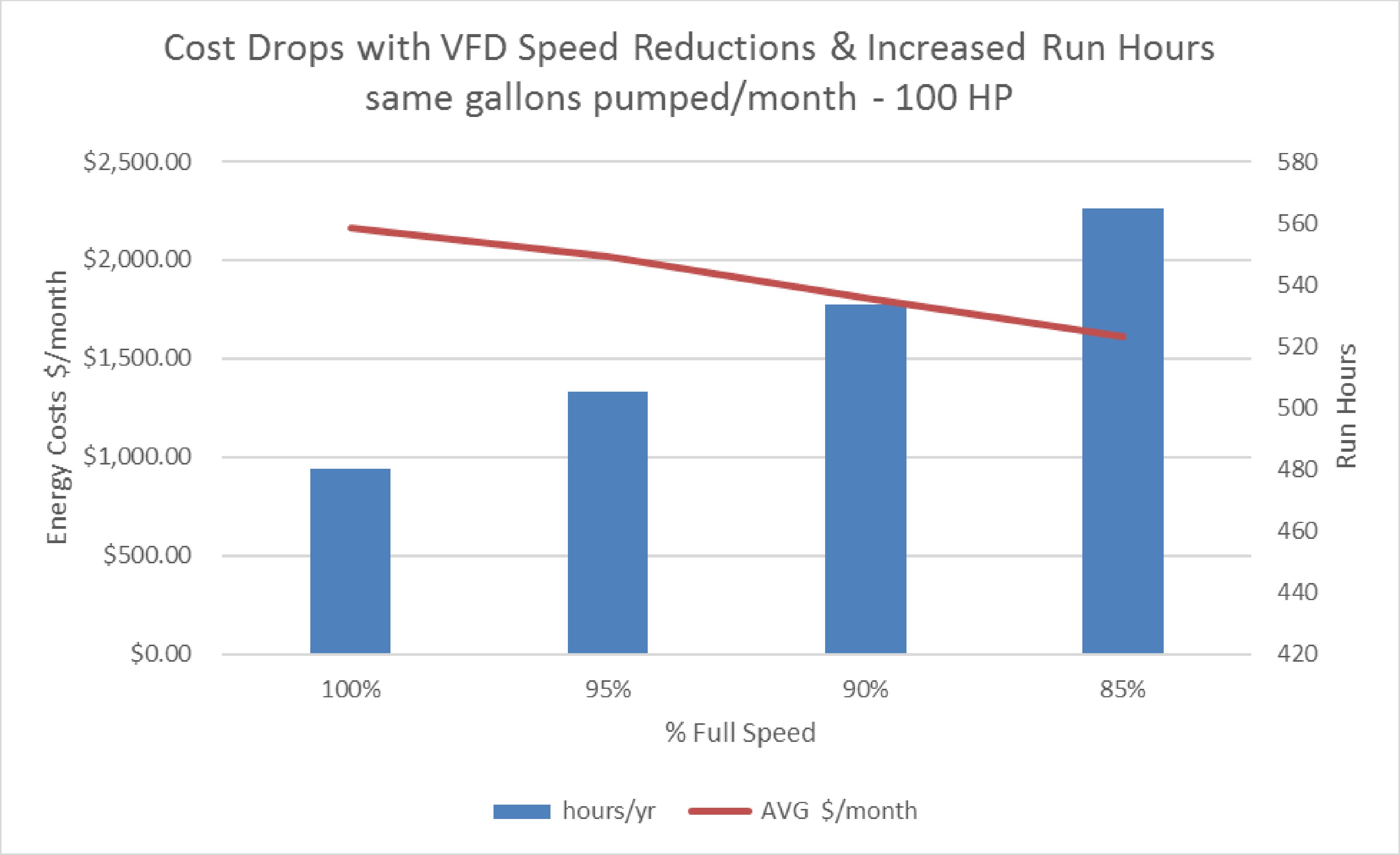
Treatment Process Energy Management

Hours operation and costs with decreased speed for centrifugal pumps



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Treatment Process
Energy Management

Slow and Steady
wins the race

Questions?
Comments?

Building Systems:
LED Lighting Upgrades

<u>75% wattage reduction possible</u>

Lab/Office: 106 Watt 2’x4’ fluorescent troffer to 26 Watt LED retrofit kit

0.08 kW saved x 3000 hours x $0.089 per kWh = $21 savings per fixture per year ($40 Panel Duke rebate)

High Bay Lighting: 440 Watt Metal Halide to a 150 Watt LED

0.2 kW saved x 5000 hours/year x $0.089 per kWh = $89 savings per fixture per year ($150 Duke rebate)

<u>50% wattage reduction typical</u>

Strip Fixtures Work Space: 32 W 4 ft. fluorescent lamp to 15 W LED

0.017 kW saved x 3000 hours x $0.089 per kWh = $5 per lamp per year ($3 Duke rebate)

LED pricing can make simple payback in 2 to 5 years, less with rebates or higher use

Building Systems:
Unit Electric Heaters

Commonly 5 KW or even 10 KW

Manual controlled

How many unit heaters do you have?

<u>Cost to run one heater 24 hours</u>:

5 kW x 24 hours x \$0.089 /kWh = \$10.68 (\$320/month)

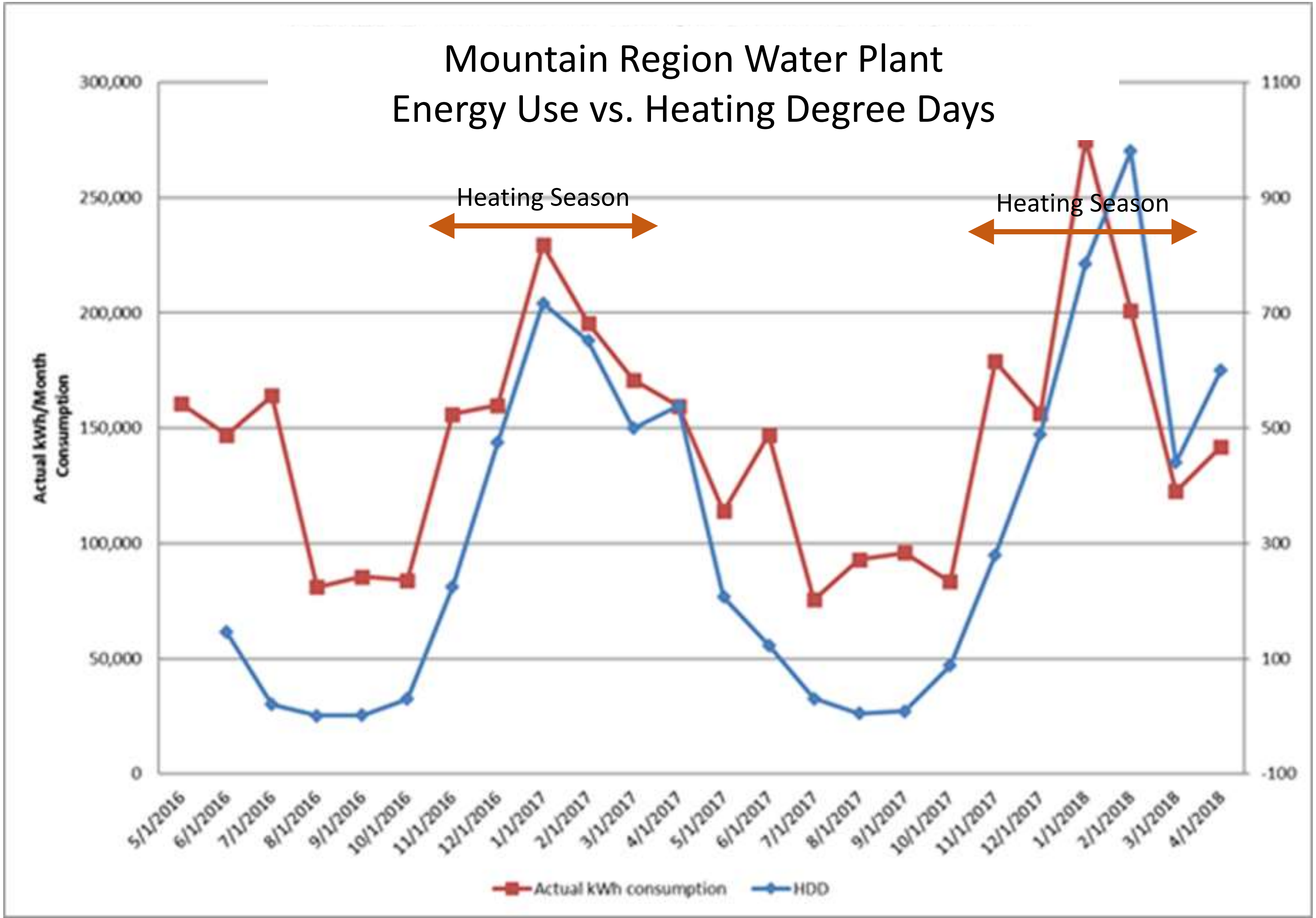
10 kW x 24 hours x \$0.089/kWh= \$21.36 (\$640/month)

- Consider electric radiant (better w/ bay doors and high bay areas)
- Consider natural gas radiant heaters
- Consider the need for use - to avoid freeze impacts
- Consider setting at 50 - 55 degrees

Unit Heater Impacts

Gravity Supplied water plant seasonal e nergy use

25 unitary electric fan heaters



Questions?

Comments?

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Renewable Distributed Generation

Town of Taylorsville: Solar Peak Shaving

Renewables:
Anaerobic Digestion: “Renewable Natural Gas” Opportunities

Anaerobic Digesters

Floating Roof

Heater – Natural gas fired

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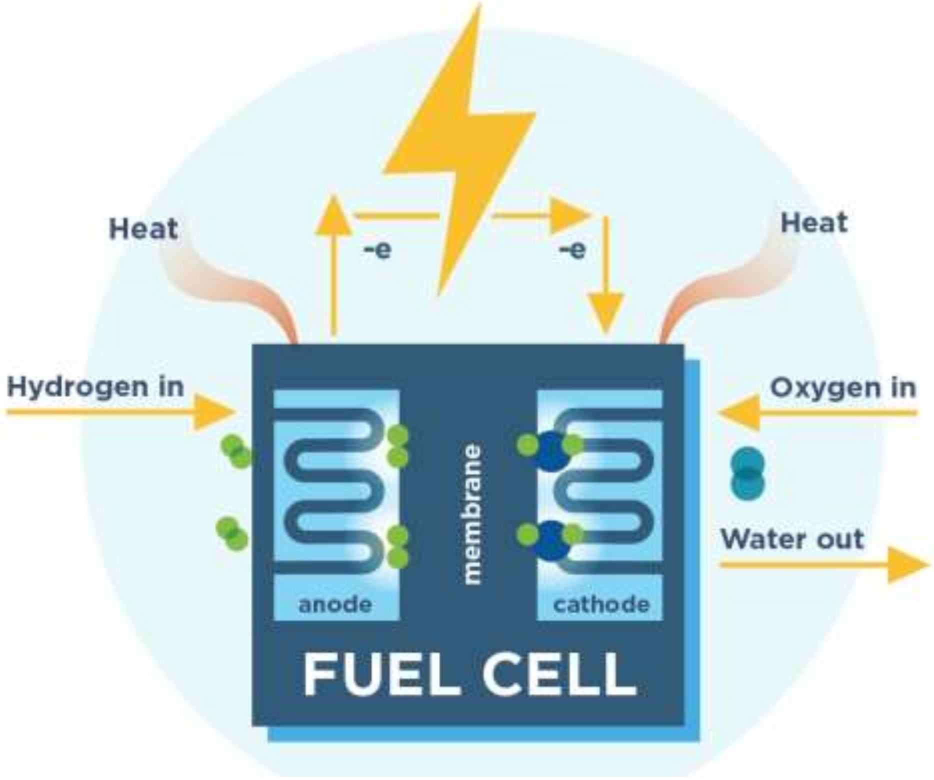
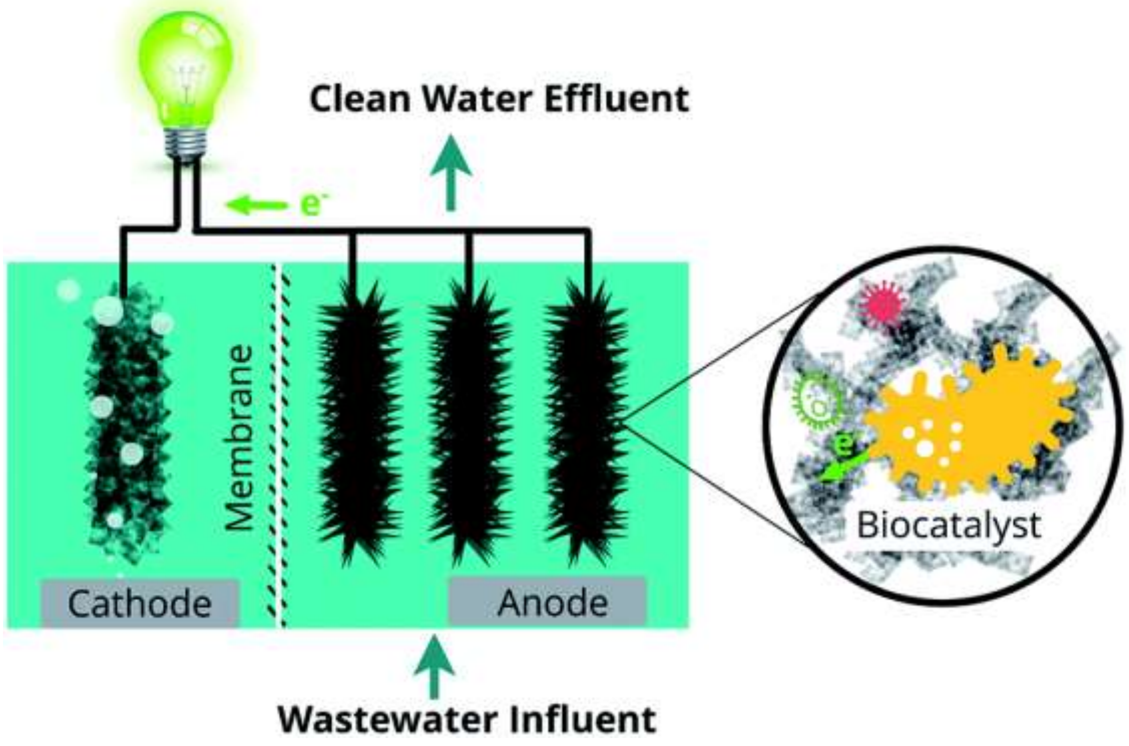
Microbial Fuel Cell





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Questions?
Comments?

Energy Management at OWASA

April 22, 2021

OWASA

Carrboro-Chapel Hill's not-for-profit public service agency delivering high quality water, reclaimed water, and wastewater services.

WATER SUPPLY

University Lake

Cane Creek

Quarry Reservoir

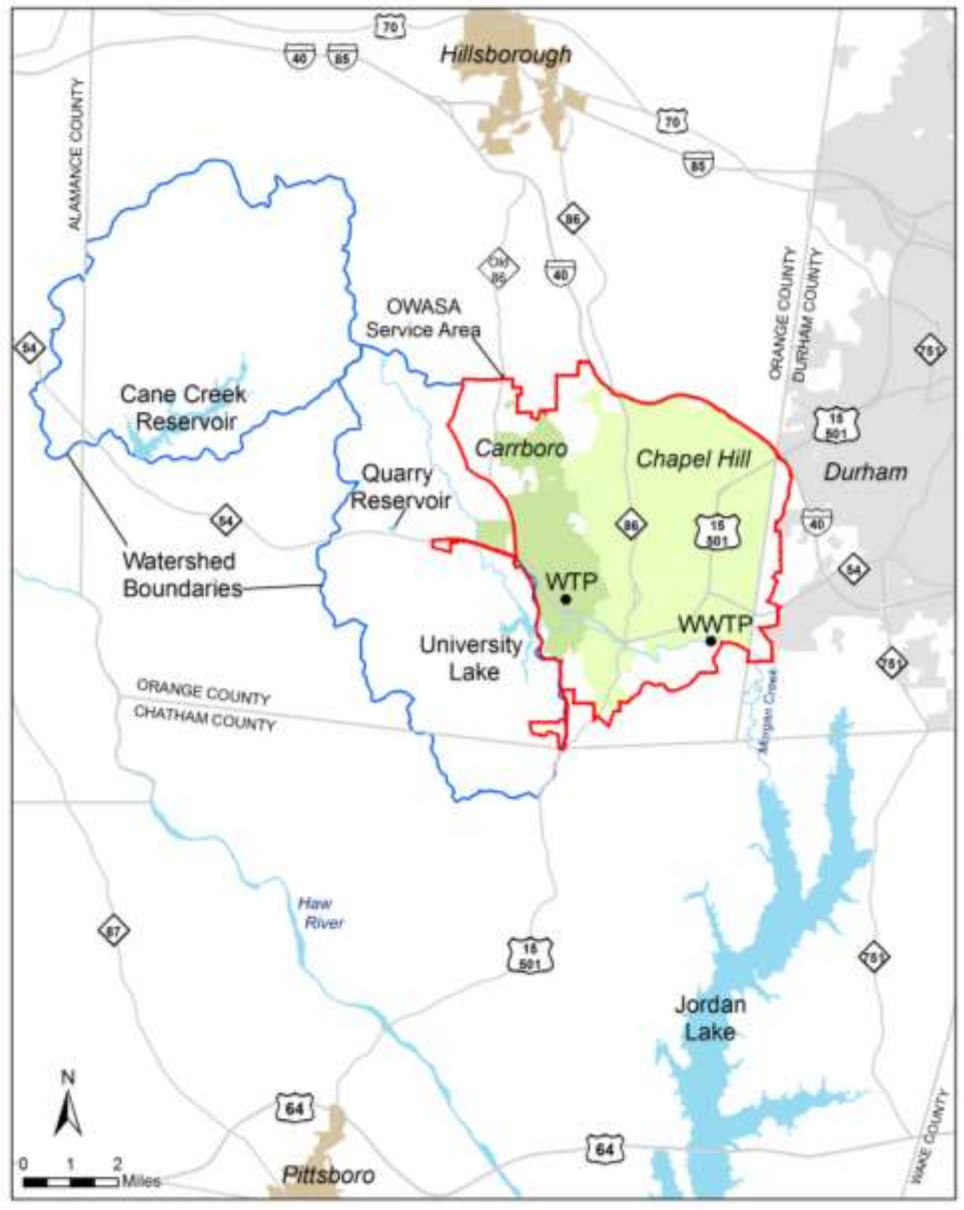
Jordan Lake

Jones Ferry Road Water Treatment Plant

WASTEWATER MANAGEMENT

Mason Farm Wastewater Treatment Plant

Reclaimed Water



Energy Management Plan Achievements

52%
reduction in greenhouse gas emissions*

32% reduction in electricity use*
20% reduction in natural gas use*

Investment in Cost-Effective Energy Projects

Over
$550,000
annual savings purchase of electricity and natural gas purchases*

Energy-Minded Decision Making

Capital Projects

Operations and Maintenance

Biogas-to-Boiler Restoration

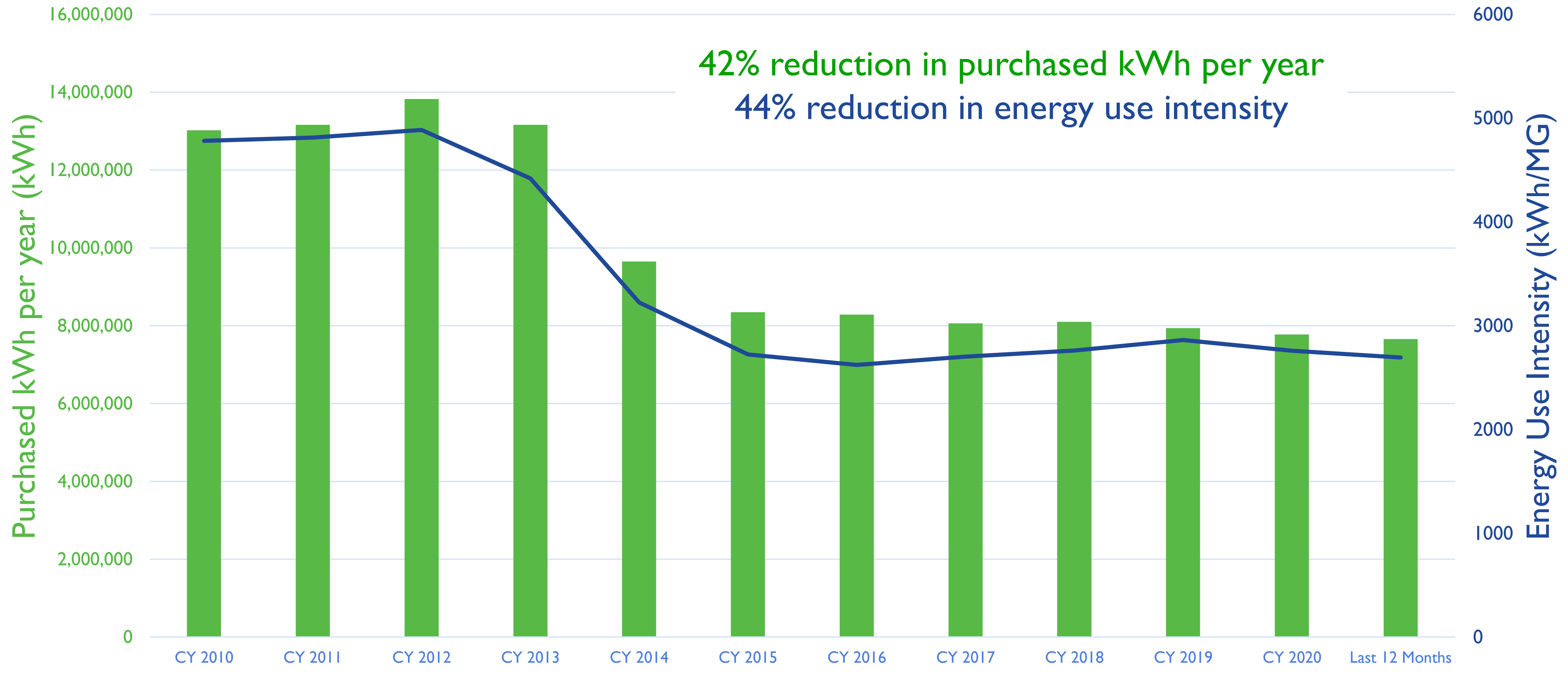
Since 2010 Baseline

Mason Farm WWTP

Capacity: 14.5 MGD

Annual Average: 8 MGD

Energy Use at Mason Farm WWTP



Energy Efficiency Upgrade: Aeration and Aeration Basin Mixing Process Equipment

Old System

- **Four NSL and Six East Aeration Cells**
  - Jet Mixing / Aeration Pod(s)
  - Up to 1000 scfm / pod
  - 14 HP pump(s) – continuous operation
- **Six West Aeration Cells**
  - Jet Mixing / Aeration Header
  - Up to 3000 scfm / header
  - Two 50 HP pumps – continuous operation
- **Two Aeration Cells – 5A / 5B**
  - Jet Mixing / Aeration Header
  - Up to 1500 scfm / header
  - 50 HP pump – continuous operation
- **Multistage Centrifugal Blowers**
  - Three 3600 scfm – 150 HP blowers
  - Three 5600 scfm – 250 HP blowers
  - Use between 500-650 HP – depending on time of the year

Energy Efficiency Upgrade: Aeration and Aeration Basin Mixing Process Equipment

New System

- **Four NSL Cells**
  - High Efficiency Mixer - < 5 HP
  - Aluminum Covers and Odor Control
- **Twelve Aeration Basin Cells**
  - Fine Bubble Diffusers – 2000 or 3000 scfm
  - High Efficiency Mixer - < 5HP (standby)
  - Aluminum Covers and Odor Control (6 cells)
- **Two Aeration Cells – 5A / 5B**
  - Fine Bubble Diffusers – 1500 scfm
  - Four High Efficiency Mixers - < 3HP (standby)
- **High Efficiency Blowers**
  - Four 5000 scfm – 250 HP blowers
  - One 5600 scfm – 250 HP Multistage (backup)
- **New SS Air Header, 3 Carbon Scrubbers**

New Aeration System: Financial Impact

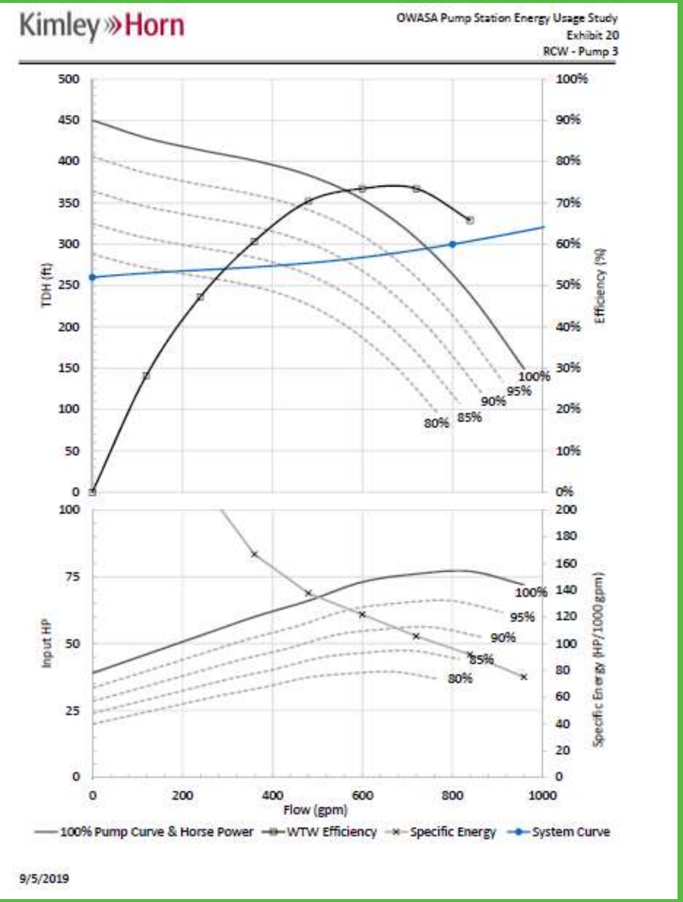
- Capital Costs: $8 million
  - $6.56 million, 20-Year, No-Interest Loan: NC Clean Water State Revolving Fund (Saved an estimated $1.7 million over lifetime of loan)
  - Duke Energy Customer SmartSaver Incentive: $168,000

- Estimated Energy Savings: $220,000/year
- Realized Energy Savings: $275,000/year

Pump Station Evaluations

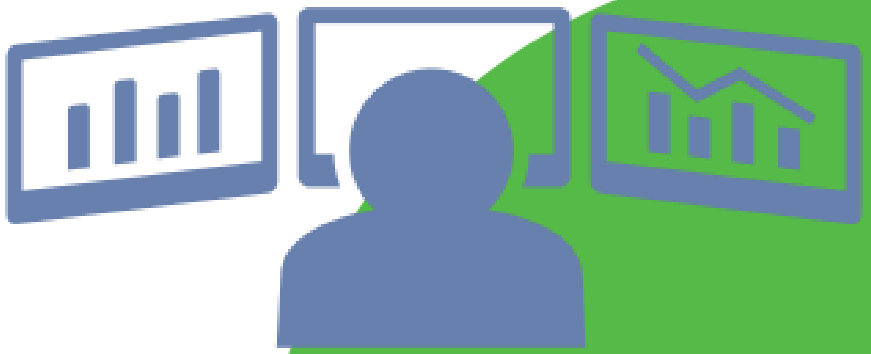
Recommendations included:

- Speed adjustments
- Operating set points: (E.g. wet well levels)
- Simultaneous operation
- Pump replacement
- System modifications (e.g. hydropneumatic tanks, piping)

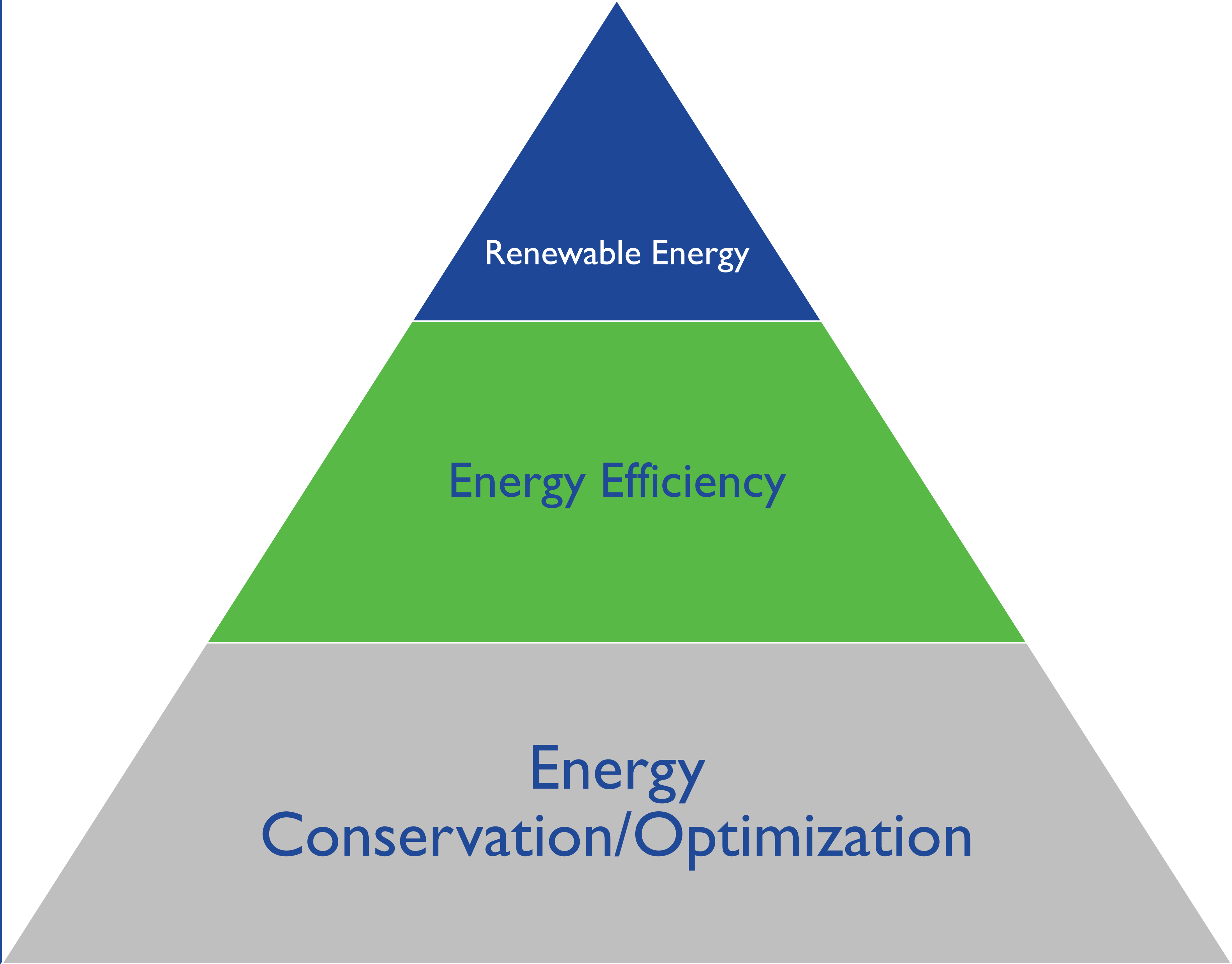


Energy-Minded Decision Making

- Extend backwash filter cycles and reduce air scouring frequency
- Optimize odor control system
- Online ORP/nitrate monitoring
- Phased HVAC upgrades
- Reduce I&I
- Pump station monitoring
- WWTP Master Plan



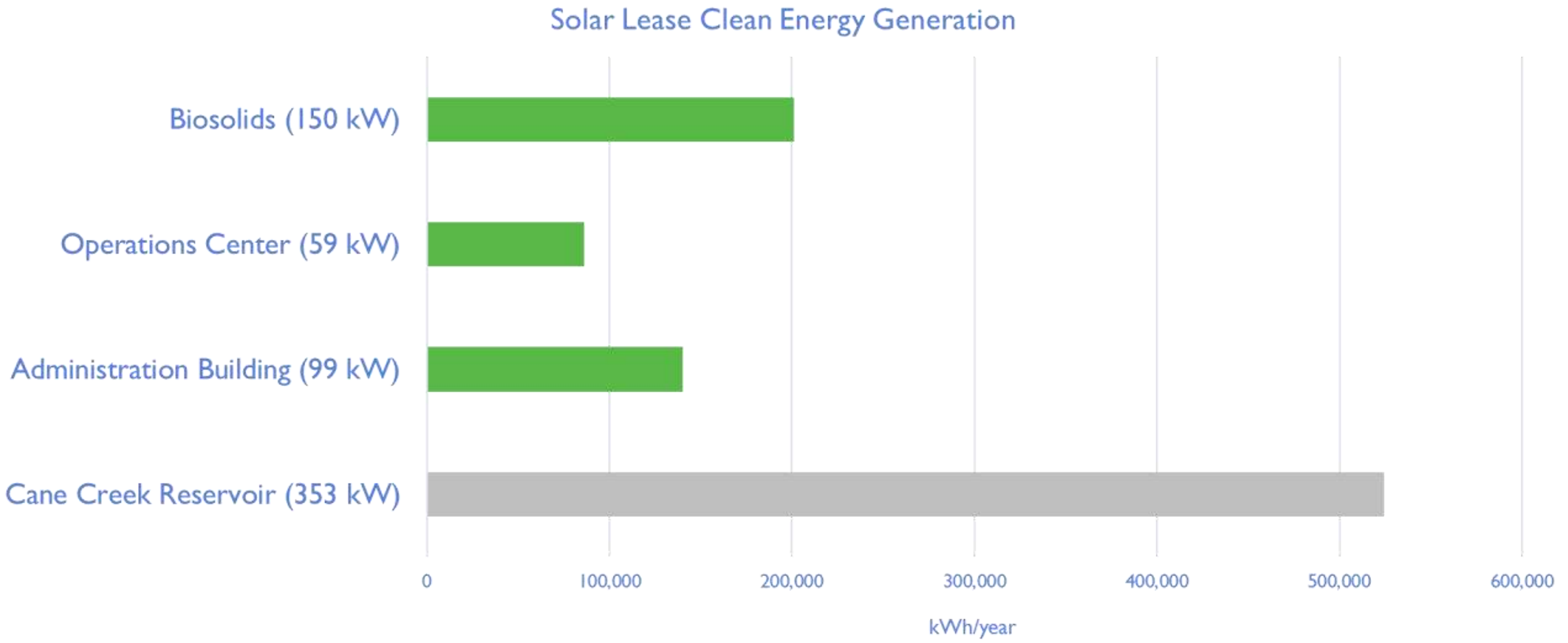
Energy Management Pyramid



Solar Leasing

- Public-private partnership
- 25-year term
- OWASA's lease payment is less than energy savings
- Down-payment covered by Duke Energy rebate
- System owned and operated with private partner

Progress Towards Goal: Solar Photovoltaics



Thank you

Mary Tiger

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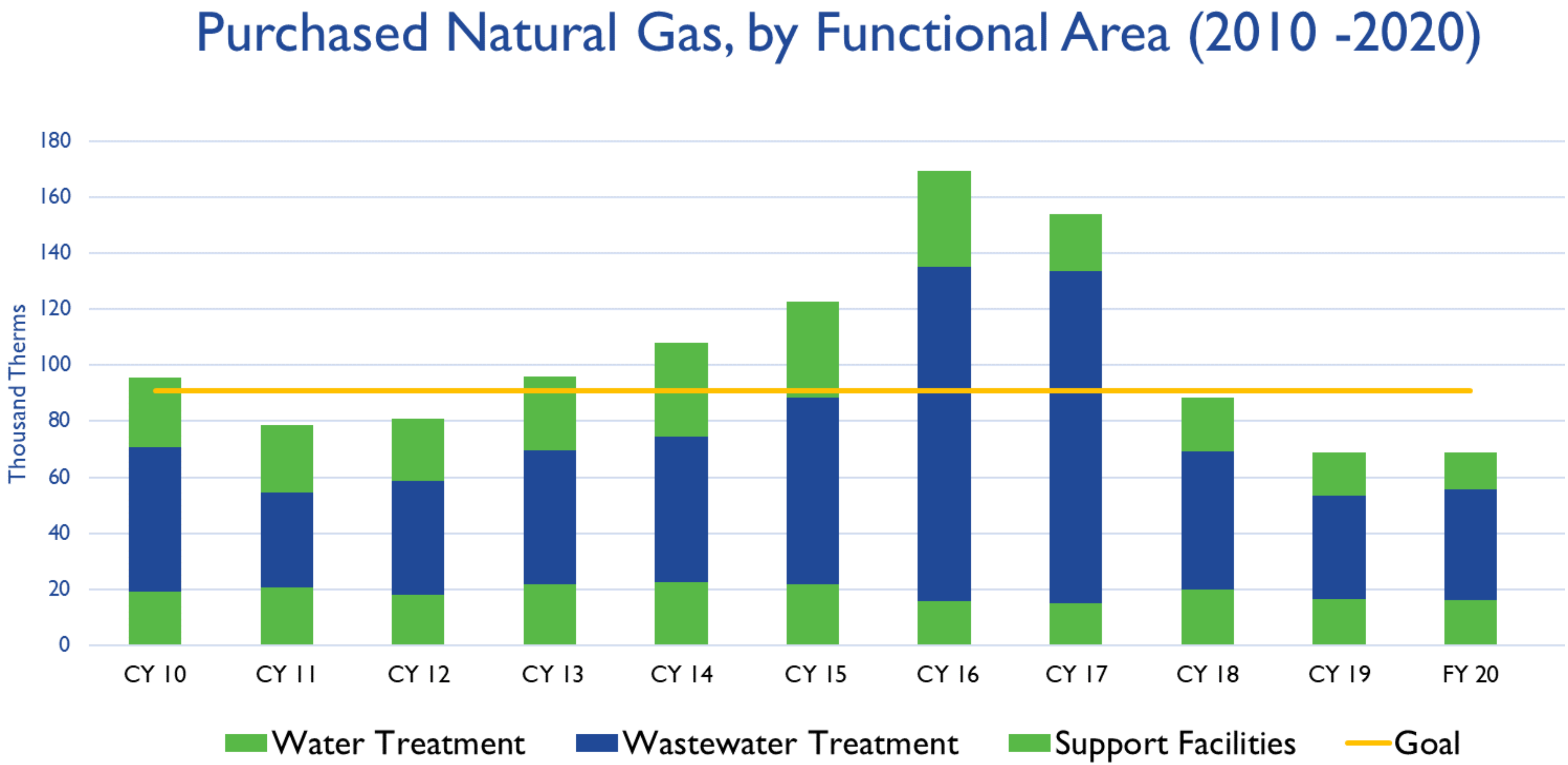
OWASA's Energy Management Program

Systematic identification, evaluation and pursuit of energy management opportunities

- Energy and water conservation & process optimization
- Energy-minded decision making
- Investment in cost-effective energy management projects

Objective 2: Reduce use of purchased natural gas by 5% by the end of CY2020 compared to the CY2010 baseline.



28% decrease

since 2010


Questions?
Comments?

Resources to take the next step

- Duke Energy: Business Advisor Advisors and Large Account Rep (
- Dominion Energy: RNG Projects (Lee McElrath, Dominion Energy NC 828-230-7118)
- Your Local COOP/Municipal Utility Rep
- Your Peer Networks: PWOC-WEF
- Your Consulting Engineer
- State Grant Sources: Green Project Reserve
- Advanced Energy: Kitt Butler, kbutler@advancedenergy.org
- Energy Efficiency Assessment Providers
  - Waste Reduction Partners (serving all of NC)
    - Russ Jordan, Energy Manager, rjordan@wrpnc.org, (828) 251-7477
  - NC Rural Water Association (serving populations <10,000)
    - Natalie Narron, Energy Efficiency Circuit Rider, natalienarron@ncrwa.org, (336) 887-0741
- EPA: Brendan Held & Team

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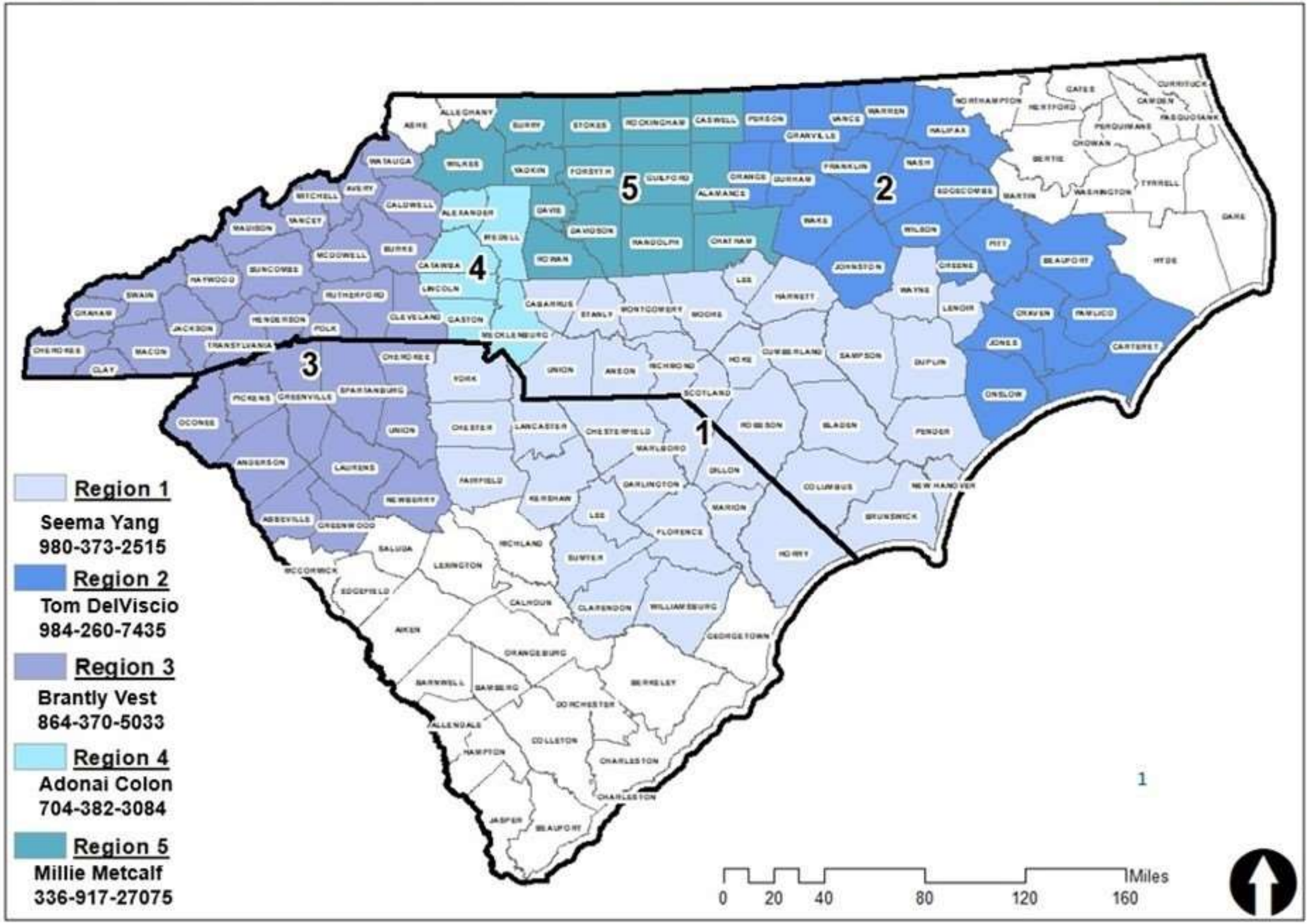
Business Energy Advisors Carolinas



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Waste Reduction Partners – Energy Assessments

- *Land of Sky's WRP program provides no-cost energy efficiency and waste assessments.*
- *Clients: Any water/wastewater plant, business or institution in NC.*
- *The Team: 40 staff and volunteer engineers (statewide)*
- *Past energy work with: Asheville Water Resources Department, Town of Salisbury, Town of Boone, Cape Fear Public Utility Authority, Kerr Lake, and others*
- *Results: –past 5 years: 275 clients served, $16.4 million in utility cost savings, 130,000 MWh saved*
- *Initiate a Project: WasteReductionPartners.org or Russ Jordan rjordan@wrpnc.org*

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Questions?
Comments?

Thanks to following utilities for sharing demonstration information and photos.

Acknowledgements

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