Advancing Energy Efficiency in Wastewater Treatment: What We've Learned

Ben Bolton, Energy Programs Administrator
October 26, 2018

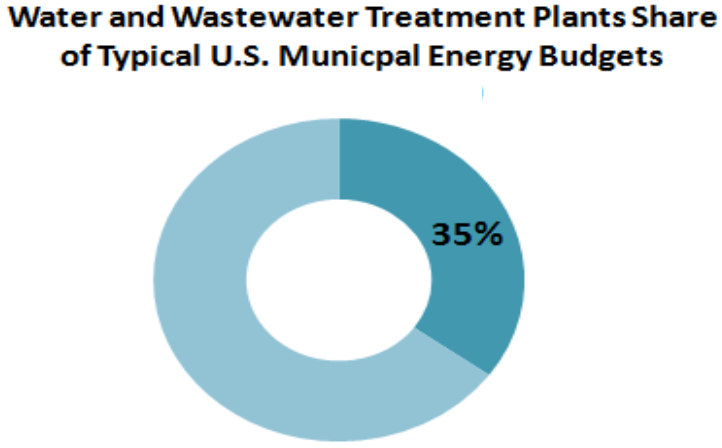
Energy Efficiency at Wastewater Treatment Facilities Workshop
Hosted by Illinois EPA Office of Energy
Southern Illinois University School of Law, Carbondale, Illinois

Why we should care

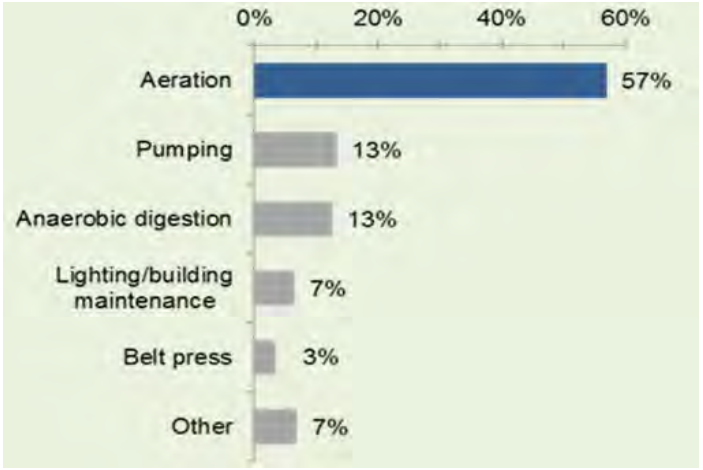
- We spend people's money.
  - Tax dollars, public bonds, utility rates
- Elected officials tell us to show savings.
- Defend capital expenses.
- Environmental Stewardship

Energy-Water Nexus

- Water & wastewater plants use ~4% total energy in U.S.
- Largest energy consumer for municipal governments
  - 30-40% of total utility bills
- Energy use expected to grow 20% in next 15 years

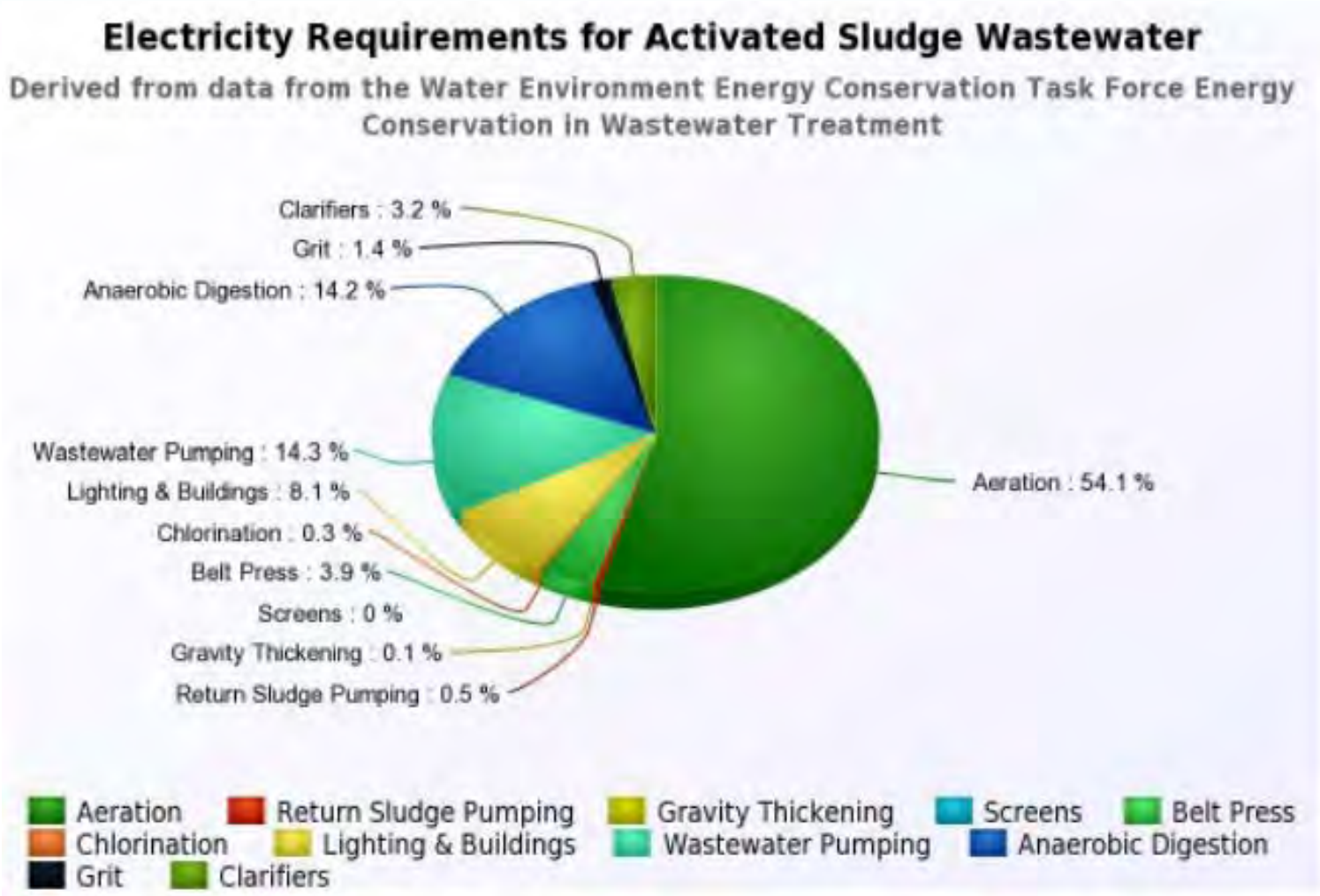


Source: Energy Efficiency in Water & Wastewater Facilities, U.S. EPA, 2013

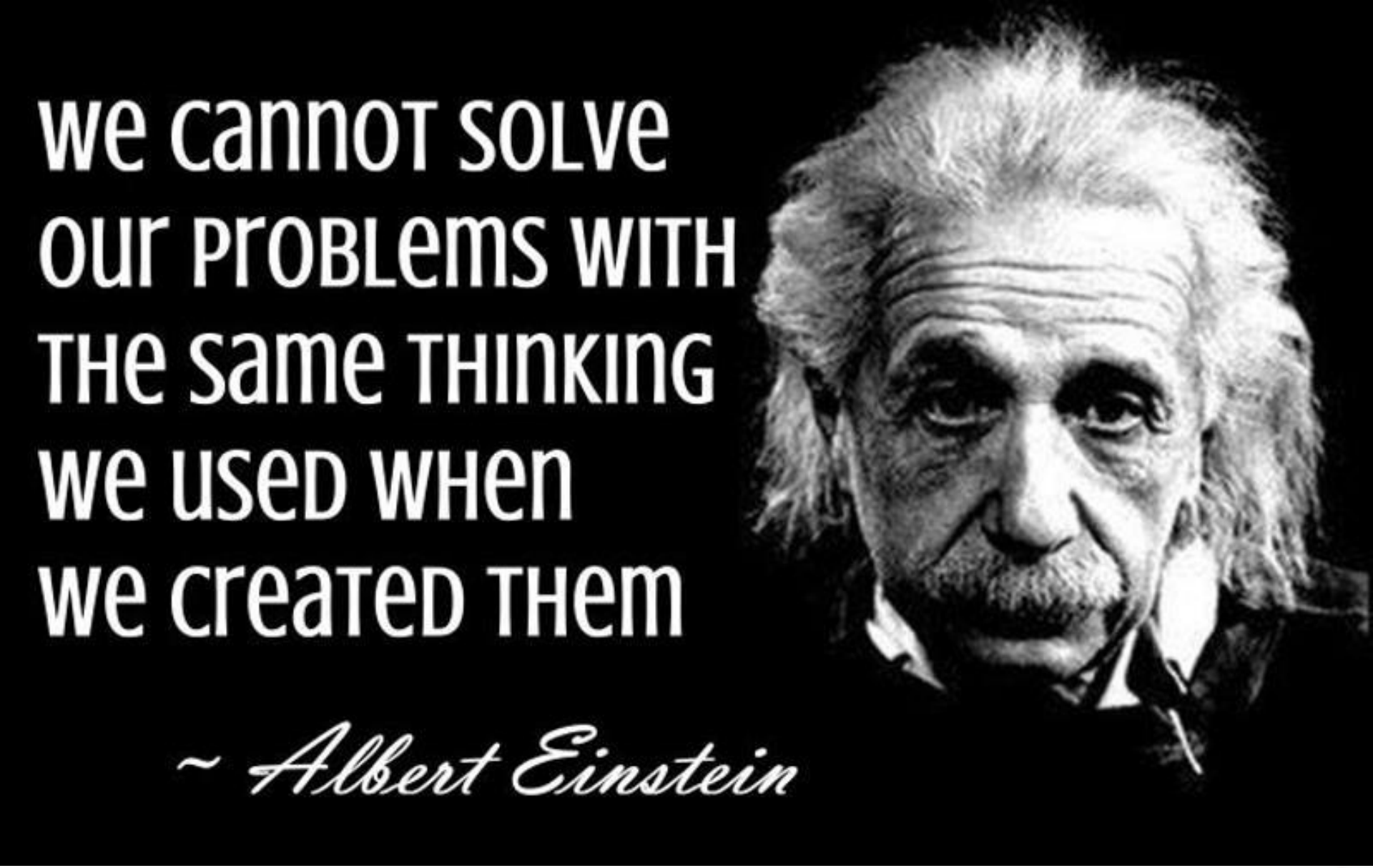


Source: Energy-Positive Water Resource Recovery Workshop Report, National Science Foundation, U.S. DOE, U.S. EPA, April 2015

Energy-Water Nexus



Source: Energy Best Practices Guide: Water & Wastewater Industry
https://focusonenergy.com/sites/default/files/WW-Best-Practices_web.pdf


We cannot solve
our problems with
the same thinking
we used when
we created them
~ Albert Einstein

Energy Efficiency Partnership

Region 4

Process

- EPA Region 4 prioritizes wastewater systems based on submitted water quality data.
- Project team meets in person and creates list of candidates to invite to participate.
- Team checks with environmental field inspectors and Comptroller's Office for issues and referrals.
- Deputy Commissioner sends letter to inviting the Mayor and copies operators to participate.
- Team performs energy assessment site visits.
- 2 to 3 Technical Workshops with free CEUs
- Provide implementation and tracking support

Advancing Energy Efficiency in WWTP

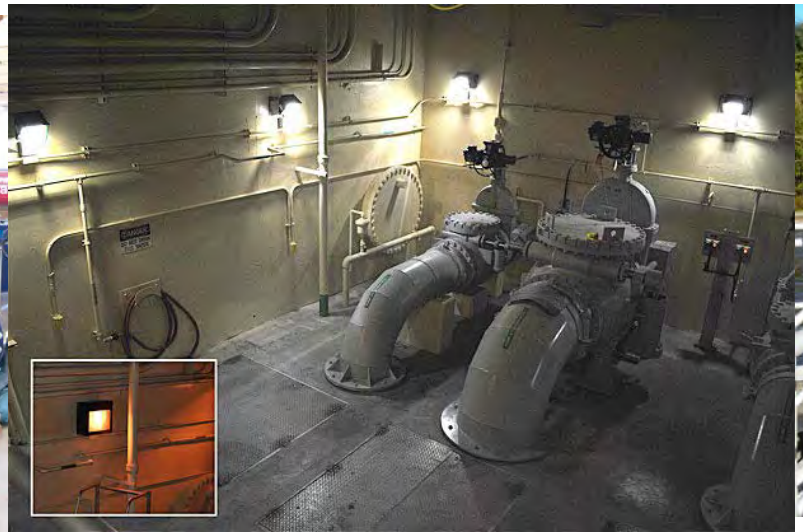
- 24 Water and Wastewater Facilities assessed in TN and AL in 2 years.

- For wastewater facilities implementing TDECs low-to-no-cost recommendations:
  - Average 19% reduction in annual energy costs
  - Average 40% reduction in average nutrient discharge

- *Identified* savings since 2016 (verification underway):
  - $390,468 annual cost savings
  - 4,358,200 kWh/year savings
  - 95 tons per year nutrient reduction

Things we recommend

- Manage electric load. Operate smart.
- LEDs bring instant energy savings.
- Upgrade HVAC with better controls.
- Upgrade pumps & motors.
- Install Variable-Frequency Drives (VFDs).
- Denitrification by monitoring Dissolved Oxygen (DO) levels



Things We Don’t Recommend

Carthage TN Wastewater Treatment Plant

Design Capacity 0.625 MGD
Average Capacity 0.330 MGD

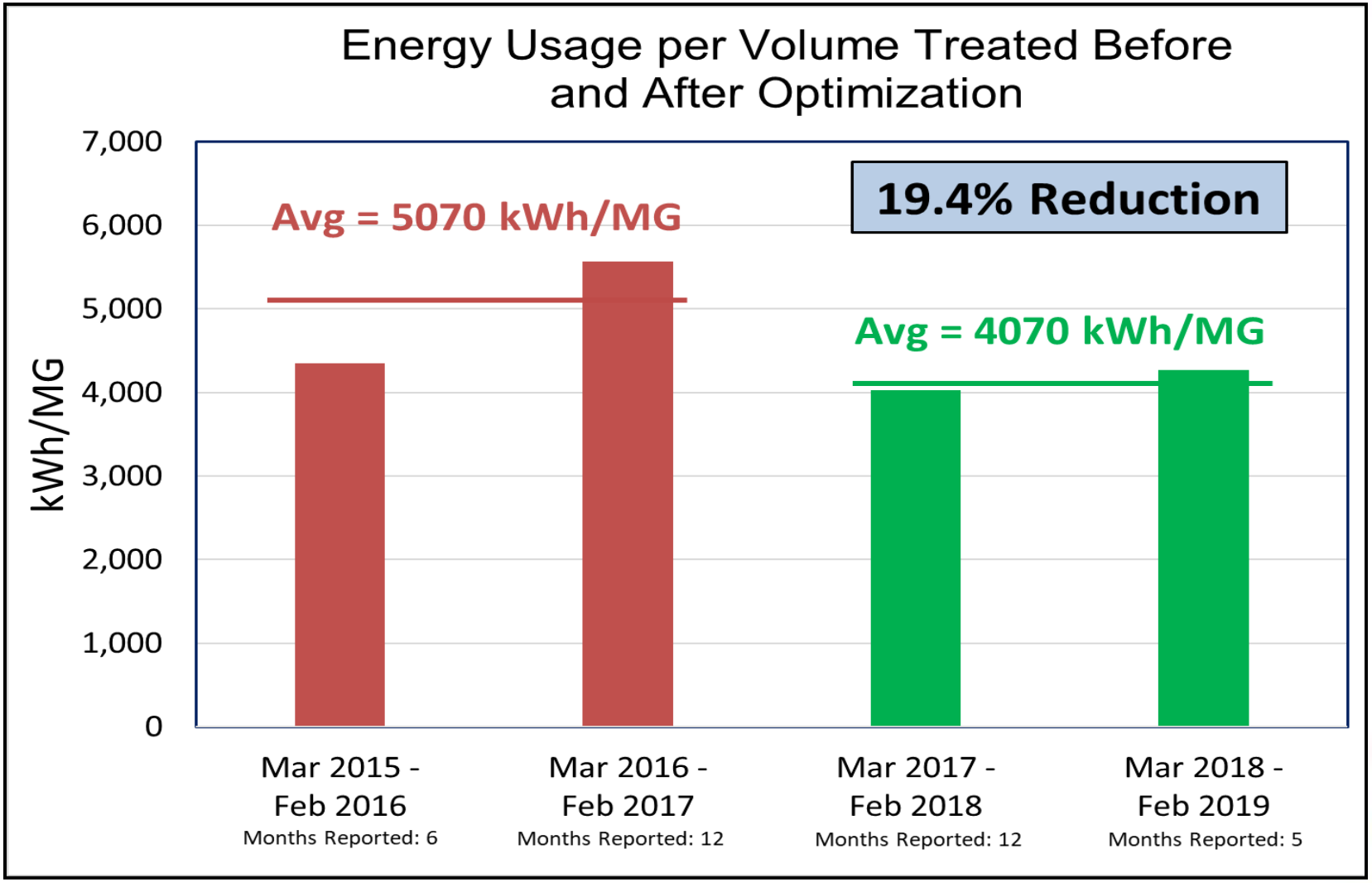
Carthage Wastewater Treatment Plant

Carthage Wastewater Treatment Plant

- Difference in Design & Average Capacity meant WWTP was underloaded = OPPORTUNITY!
- Annular aeration basin with final clarifier
- Biosolids treated in 2 aerobic digesters in series
- Team observed:
  - Solids retention time in aeration basin & 1st digester sufficient to treat solids. 2nd basin was redundant.
- Recommendation:
  - Reduce 2nd basin to 6 hours/day
- Results:
  - Reduce electricity use 14% with 15% loading increase
  - Peak electric demand down 11%
  - **Annual Cost Savings $7,000/year, 19% per MG**

TN

Carthage: Measured Energy Savings



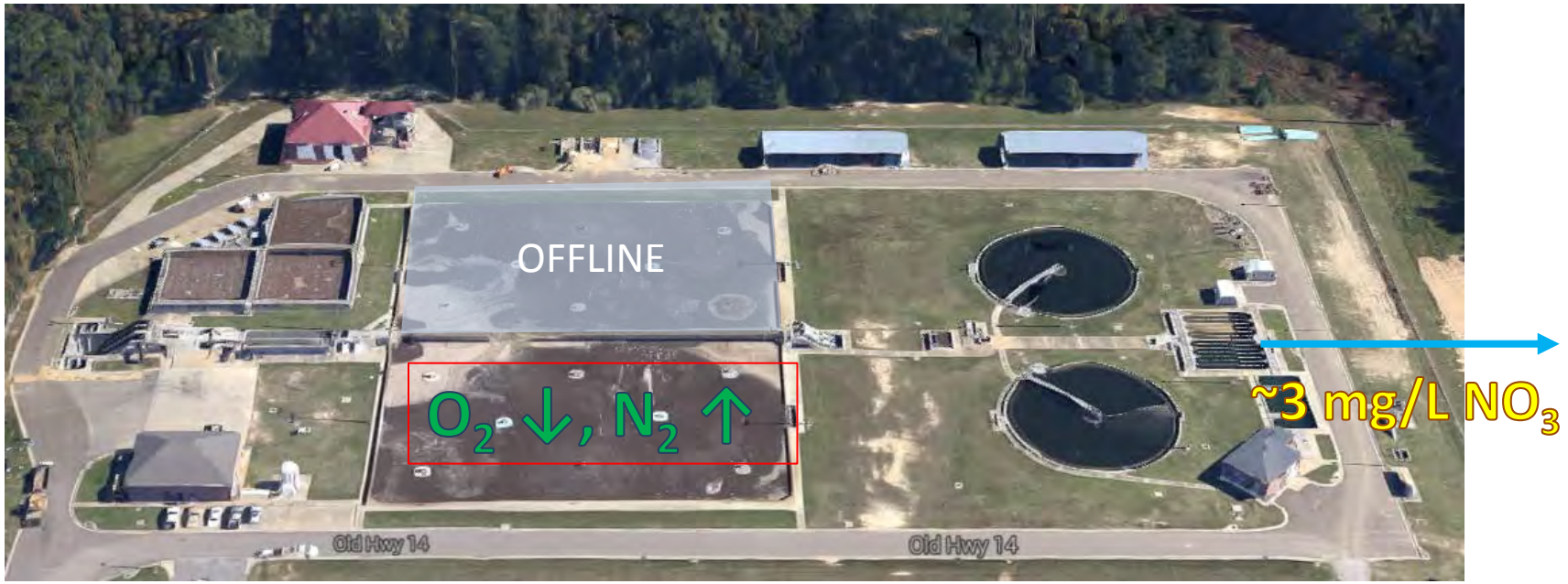
kWh/MG = kilowatt-hours per million gallons of water treated

Wetumpka AL Wastewater Treatment Plant

Optimization Opportunities:

- Low hydraulic and organic loading
- High effluent nitrate
- Flexible aeration system
  - 12 75-HP Surface Aerators
  - Variable Frequency Drives
  - 2 40-HP Mixers

Wetumpka AL Wastewater Treatment Plant

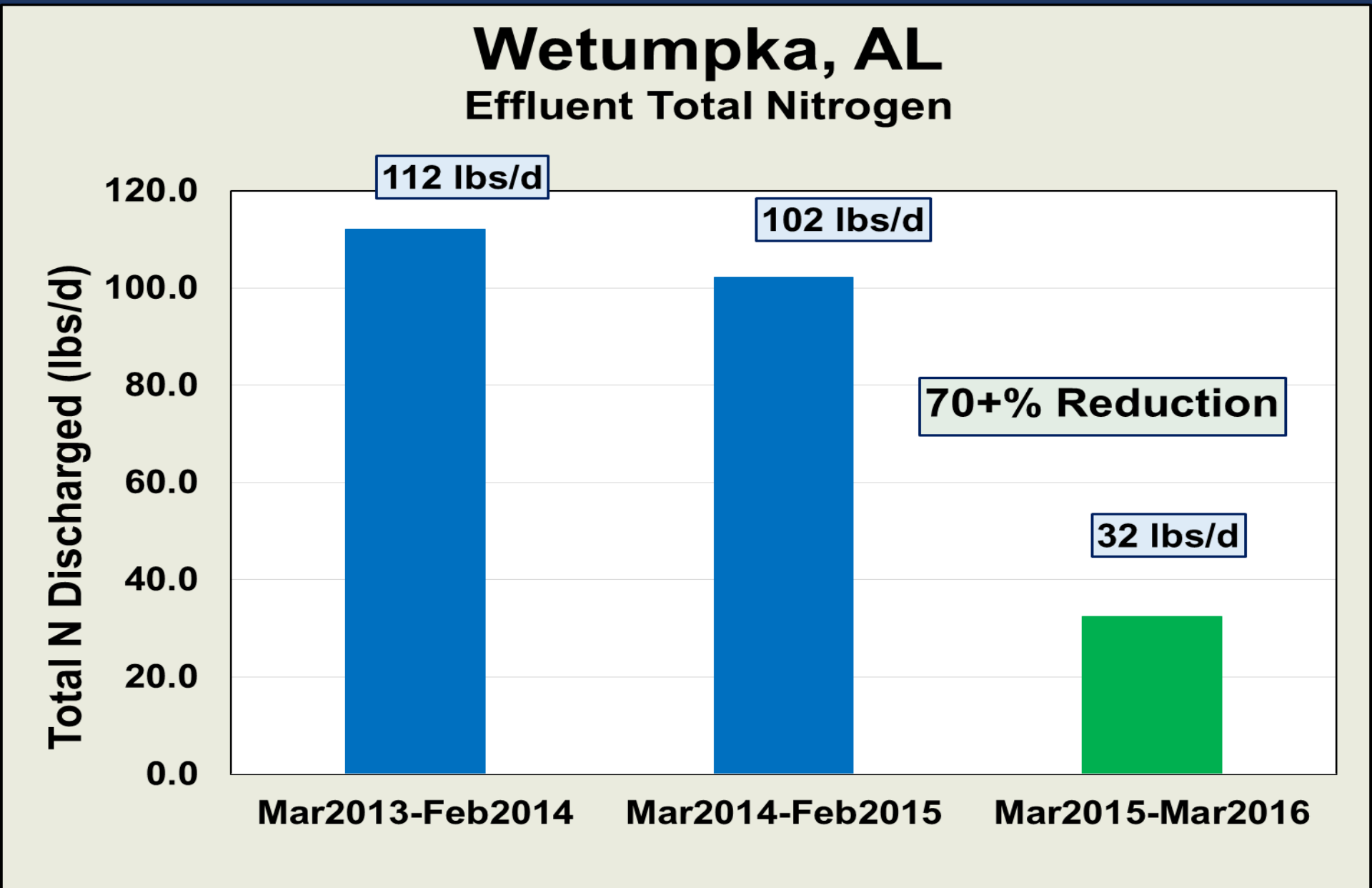


Recommendations:

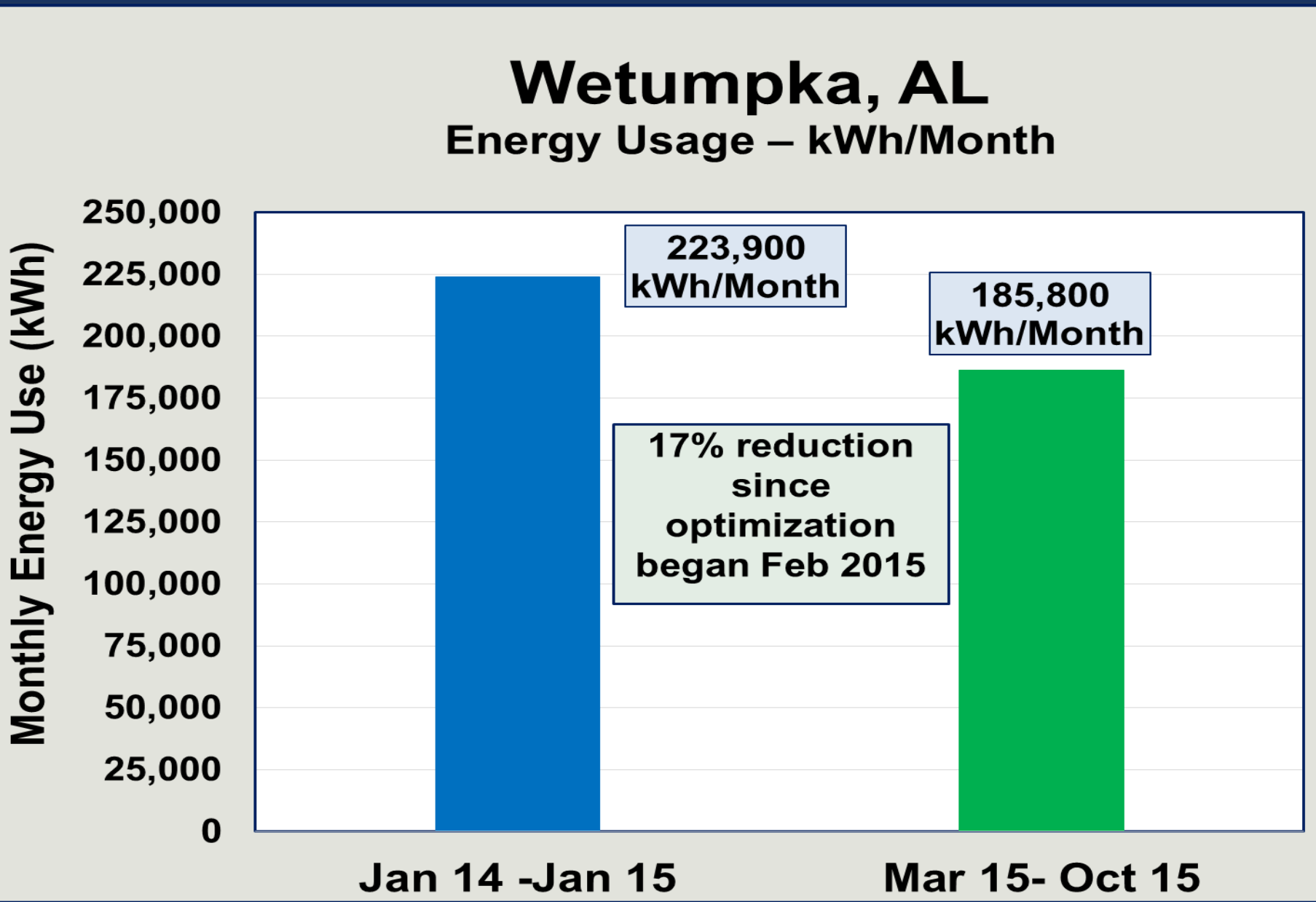
- Reduce number of aeration basins in service
- Reduce nitrate through intermittent aeration
- Reduce supplied oxygen
  - Lower DO set points
  - Reduce speed of aerators

TN

Wetumpka AL Wastewater Treatment Plant



Wetumpka AL Wastewater Treatment Plant



Bio-Tiger Model

- Developed by Larry Moore, Ph.D., P.E., Professor of Civil Engineering, University of Memphis
- Excel spreadsheet simulates activated sludge process & pre-populated with a 1 MGD case study.
- BioTiger model & User Manual are FREE.
- Video: Introduction to Bio-Tiger: the biokinetic wastewater treatment facility evaluation tool

Energy Lesson: Aeration Design

	Transfer Rate (# O_2/HP·hr)
Coarse Air Bubble	1.5
Fine Air Bubble	3.3
Mechanical Aeration	3.9
Fine Air Bubble w/Full Floor Coverage & High Efficiency Blowers	6.6

Energy Lesson

Dissolved Oxygen (DO) level >1.0 mg/L is wasting energy.

Source: Sate Energy Conservation Office, Texas, 2018

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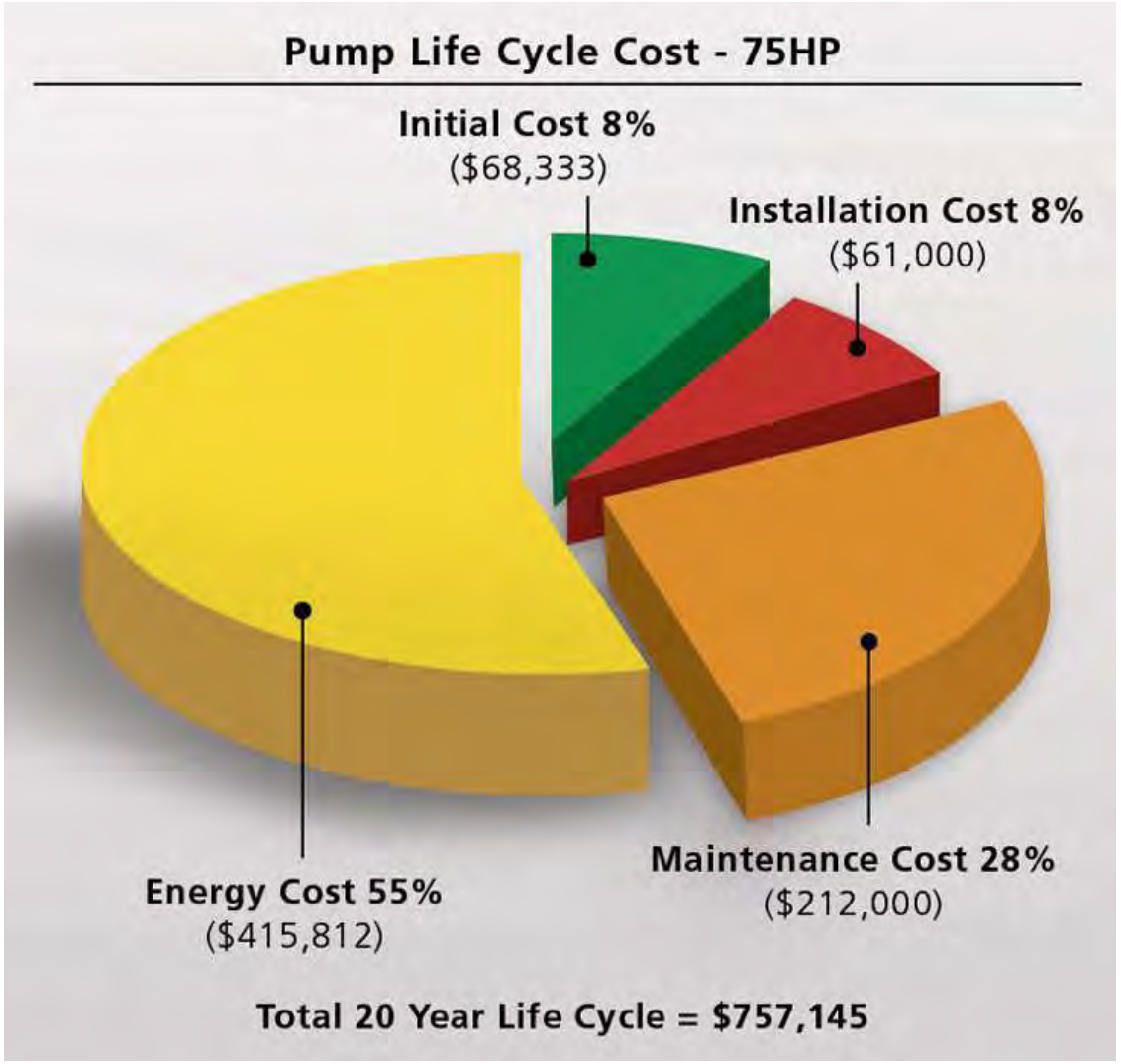
Energy Lesson: Life Cycle Cost for a Pump



Energy Lesson

Buy the most energy efficient pump possible.

Energy Lesson: Get to Know Your Bill

1. Get a copy of your monthly bill and review it to understand the information it provides.
2. Contact and get to know the energy provider account representative for your facility.
3. Determine what rate schedule your energy provider has applied to your facility.
4. Meet with your account representative to assess if this rate schedule is the most appropriate for your facility.

Read More

- Appendix B: Understanding Your Electric Bill, p. 155
- https://dnr.wi.gov/aid/documents/eif/focusonenergy_waterandwastewater_guidebook.pdf

Energy Lesson: Chemicals

- **UV Disinfection**
  - Guideline: Cost-effective within 7 years compared to chlorination/dechlorination.
  - Safer than storing chlorine.
  - Bulb type is important. High efficiency is best.
- **Alkalinity**
  - Adding lye is expensive.
  - Better denitrification may eliminate need.

Energy Lesson: LED Lighting

- Saves ~80% power use for lighting
- Less maintenance, last years
- Replacement LED tubes do not require a ballast
- Bundle with other energy projects

Why a Drop of 4^0F Made a Big Difference for a Garment Maker's Bottom Line: https://www.npr.org/sections/goatsandsoda/2018/07/23/629871725/why-a-drop-of-4-degrees-made-a-big-difference-for-a-garment-makers-bottom-line

Energy Lesson
Switch to LEDs

TN

Franklin TN Water Reclamation Plant

Participated the first year & installed a 1 MW solar array.

(Photos: Nashville Ledger (L) Google Earth image (R))

[EPA Region 4 Case Study on Franklin]

Tennessee Water & Wastewater Energy Efficiency Partnership 2012

City of Franklin

Serving it's Residents

HISTORIC FRANKLIN TENNESSEE

TN

TDEC OEP Additional Resources Webpage

https://www.tn.gov/environment/program-areas/energy/state-energy-office--seo-/programs-projects/programs-and-projects/energy-doe-state-energy-program-competitive-awards/energy-doe-area-2-award-energy-efficiency-wastewater/energy-doe-area-2-additional-resources.html

- Additional Case Studies

https://www.tn.gov/environment/program-areas/energy/state-energy-office--seo-/programs-projects/programs-and-projects/energy-doe-state-energy-program-competitive-awards/energy-doe-area-2-award-energy-efficiency-wastewater/energy-doe-area-2-case-studies.html

Additional Resources: Focus on Energy

- Focus on Energy: Energy Best Practices Guide: Water & Wastewater, p.91
- https://dnr.wi.gov/aid/documents/eif/focusonenergy_waterandwastewater_guidebook.pdf

- Appendix B: Understanding your Electric Bill, p.155

Lessons Learned

- Any size plant can find savings.
- Small investments produce big results.
- Using savings for upgrades motivates staff to find more opportunities
- City hall and treatment plants share responsibility for effective energy management.

"Next time you drive over a bridge and see clean water, thank a wastewater operator."

Dr. Larry Moore, P.E.
Professor Emeritus, Civil Engineering
University of Memphis

TN Governor's Environmental Stewardship Award, Lifetime Achievement, 2018

Questions?

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U.S. Department of Energy Disclaimer

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Energy Efficiency at Wastewater Treatment Facilities

A workshop hosted by Illinois EPA Office of Energy

Join us on October 26th in Carbondale, IL for interactive presentations about the many ways to save energy at wastewater treatment plants! Exchange ideas with other WWTP operators who are reducing energy at their facilities, and discover available incentives.

Schedule

8:00-8:30	Breakfast catered by Panera
8:30-8:45	Welcome and opening remarks Illinois EPA
8:45-9:15	Combined Heat & Power opportunities Graeme Miller, Energy Resources Center
9:15-10:00	Success stories: Reducing energy at local plants Cambria and Carbondale WWTPs
10:15-10:45	Low-cost/no-cost strategies with big savings Ben Bolton, Tennessee Department of Environment and Conservation
10:45-11:15	WWTP Energy Assessment Program Illinois EPA, ISTC, SEDAC
11:15-11:45	Ameren Illinois incentives
11:45-12:00	Q&A and Wrap-up

Register Now!
https://go.illinois.edu/WWTPEnergyWorkshop

When: October 26, 2018, 8am-noon
Where: SIU School of Law, Lesar Law Building
1150 Douglas Dr., Carbondale, IL 62901

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