# Energy Management at Municipal WWTPs

Session 1

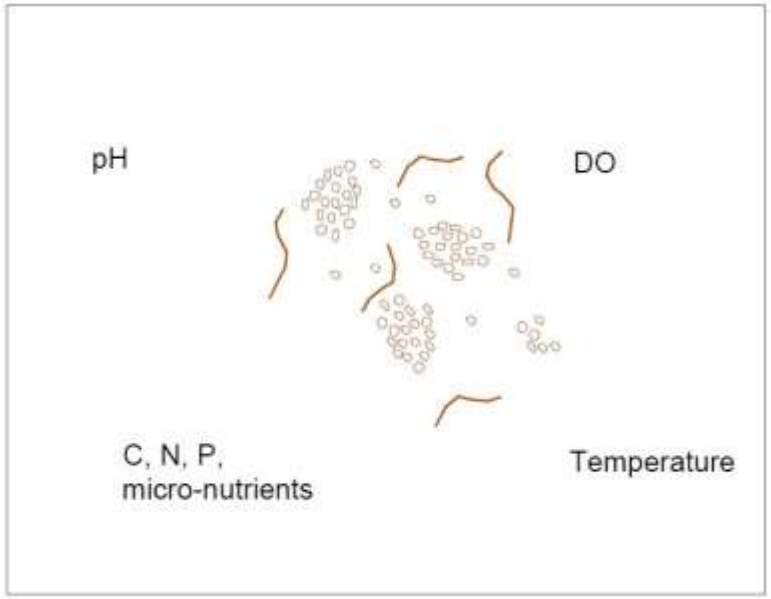
April 15, 2021

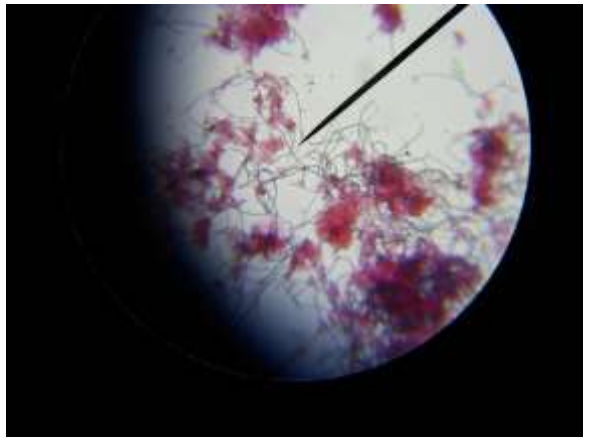
Ron Haynes, PE & WWTP Operator
Terry Albrecht, PE, CEM
Waste Reduction Partners

# Give back to your WWTP

## Decrease energy use per Million gallons treated

And provide a better environment for the activated sludge (BUGS)



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# OBJECTIVES

1. Provide operators the basics of energy management
2. Share energy vocabulary, billing, and benchmarking concepts
3. Learn how to identify and evaluate potential energy saving projects
4. Hear case study examples
5. Know about resources for your next steps on the energy management journey

These two sessions will complement and reinforce what your learned in this training series on biological nutrient removal and aeration modeling.

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# Drivers for Improving Energy Management

- Energy use at POTW are typically 30-40% of the total energy use for municipal governments
- Operating costs 2nd to town staffing
- Tightening Operational Budgets
  - Industry loss, COVID-19, Capital Improvement Demands
- Continual Improvements Efforts
- Municipal Sustainability Goals
  - Local energy and carbon reduction goals, ISO 14001, Environmental Stewardship Initiative, other programs.

*Nationwide municipal WWTP consume 30 terawatts-hours of energy annual at a cost of approximately $2 billion*

*WWTP energy recovery could be 4th after Wind, Solar, and biofuel as a renewable energy source*

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# Renewable Energy Opportunities

Can some of this energy be recovered managed as renewable?

Possible future developments:

- Conversion to greater use of Anaerobic Digesters and capture methane with combined heat and power – by using other biosolids sources like food waste
- Microbial fuel cells (MFC)
- Complex operations could lead to Higher Pay $$ for Operators? 

https://www.energy.gov/sites/prod/files/2018/01/f46/WastewaterTreatmentDataGuide_Final_0118.pdf

https://www.researchgate.net/publication/337340063_Energy_use_and_challenges_in_current_wastewater_treatment_plants

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# Energy Efficiency: The Opportunity

- Municipalities can save 15 to 30% on energy costs using efficient practices
- Achieve cost savings annually
- Plan for the future – “Do not outrun your headlights”

- https://www.epa.gov/sustainable-water-infrastructure/energy-efficiency-water-utilities

## Agenda – Two Sessions
Energy Management Training

Session One

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 Two:

Common BMPs for Energy Management

Renewables

OWASA: Energy Management Case Example – Mary Tiger

Organizational Support

Resources for Taking the Next Step

# POLL

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# 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

Adapted from: Wastewater Energy Management, NYSERDA, 2019

# What’s your Energy IQ?

Energy Management Literacy

# Energy Vocabulary

- **kWh** – "energy use" - consumption of 1,000 watts electrical energy over a period of one hour . NOTE: Watts = volts x amps

- **kW** "energy demand" – maximum power used in a period of time measured in kilowatts (billed as KW in any 15 or 30-minute period during the billing month) kW as active power or sometimes as KVA (apparent power)

- **Rate Structures** – Sometime Complicated pricing protocol set by your utility which dictates cost of units of electricity (kWh), KW demand, service fees, base charges, on-Peak charges, riders, taxes and other fees. Types: General Service, Time of Use, Pilot, Real-Time Pricing, Renewables & others.

- **On-peak, Off-peak Periods** – Daily hours which set the price of both energy use KWH and demand, KW. Summer and Water month have unit peak periods. Off peak period charges are lower and the best time to schedule higher use at the WWTP.

- **Load Factor** – Average Load (kW) divided by Peak Load in a period of time given as a percentage,

- **Motor load** – The percentage of maximum load that an electric motor operates in an actual situation. A value of between 50 and 100% is typical. Below around 50% motor load, electrical motors are much less efficient

- **Energy Unit – Btu** It is necessary at times to convert kWh to Btu for comparison with other form of energy like Natural gas, LP gas, gasoline, etc. 1 kWh = 3,412 Btu

- **Therms** – Unit of Energy used for natural gas: 1 therm = 100,000 Btu, 1 Decatherm = 10 Therms = 1,000,000 Btu

- **GHG – Greenhouse Gases**, $CO_{2e,}$ commonly expresses Lbs, tons or metric tons $CO_{2e}$ 1 KWH = 0.747 lbs $CO_{2e}$ (for NC electricity providers statewide, 2020)

# Energy Vocabulary

**Energy Use Intensity (EUI) –** This is a benchmark type parameter with energy units per unit of production. EPA relies on this parameter for comparison of WWTP relative to energy use nationwide and regularly publishes the results of studies

**Power Factor (PF)** is the ratio of working power, measured in kilowatts (kW), to apparent power, measured in kilovolt amperes (kVA)

**Horsepower (HP) vs. Killowatts (kW)** – One horsepower is equal to 0.746 kW or 1 kW = 1.341 HP

Janes Watt created this term to compare output of steam engines with the power of draft horses hp = F x d / t where F = Force, d = distance and t = time

**Water Horsepower** – in units that operators use most frequently, the following equation:

**WHP = HQ / 3960 – H** = change in pressure as in feet of water, Q = flow rate in gallons per minute, and the 3960 is a constant that enables use of the English units

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# Demonstration of water horsepower equation

Plant conditions:  4 MGD, 4,000 gpm instantaneous Flow, Head 150 ft WC

WHP = HQ / 3960  Where H = head in ft WC and Q = flow in gpm

WHP = 150 x 4000/3960 = 151 hp;

With a 200 hp motor on the pump, the motor load is about (151/200) x 100 = approx. 76%

Operating at this motor load is an efficient operating condition

We need to consider the motor efficiency.  Assuming the motor is 91% efficient, the input horsepower in electrical is  151 hp x  1/0.91 = 166 hp  **ENERGY IN**

# Demonstration of water horsepower equation

WHP = 150 x 4000/3960 = 151 hp **ENERGY OUT**

The 166 hp is equivalent to 166 hp x 746 watt/hp x 1 kw/ 1,000 watt = 124 kW **ENERGY IN**

For 3 phase we must consider the power factor and current characteristics :

Typical power factor for induction motors is 0.85 and N (amps) = kW x 1000/( V x1.732 x PF)

For 124 kW and a system voltage of 460V, the Amp draw can be calculated as

N = 124 x 1000/(460 x 1.732 x PF) = 184 amps Notice that the conversion from kW to W was necessary

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# Demonstration of water horsepower equation

Plant conditions:  4 MGD, 4,000 gpm inst. Flow, Head 150 ft WC

HP input = (HQ / 3960) motor efficiency

HP input = (150 x 4000/3960)/0.91 = 166 hp  Equivalent to 124 kW

The amp draw was  N = 184 amps with PF = 0.85;  That is the average value you should find for the  three legs of the 3 phase

If an operator or maintenance technician measures the Amperage draw on the 3 phase and knowing the voltage, then the kW input can be calculated to check it s contribution to your facility bill

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# Demonstration of water horsepower equation

Plant conditions:  4 MGD, 4,000 gpm Instantaneous Flow

HP input = (150 x 4000/3960)/0.91 = 166 hp

The 166 hp is equivalent to 166 hp x 746 watt/hp x 1 kw/ 1,000 watt = 124 kW

How many hours will the pump operate to meet the flow demand during an average monthly billing?

4,000,000 gal/day x 1 min/4,000 gal x 1 hour/60 min x 30 day/month = 500 hour/month

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# Demonstration of water horsepower equation

HP input = (150 x 4000/3960)/0.91 = 166 hp

The 166 hp is equivalent to 166 hp x 746 watt/hp x 1 kw/ 1,000 watt = 124 kW

If you operate this pump and motor 500 hour in a monthly billing period, that results in 62,000 kWh so if your average rate is $0.07 per kWh, the it could cost $4,340 for electricity to operate the Main Lift pump

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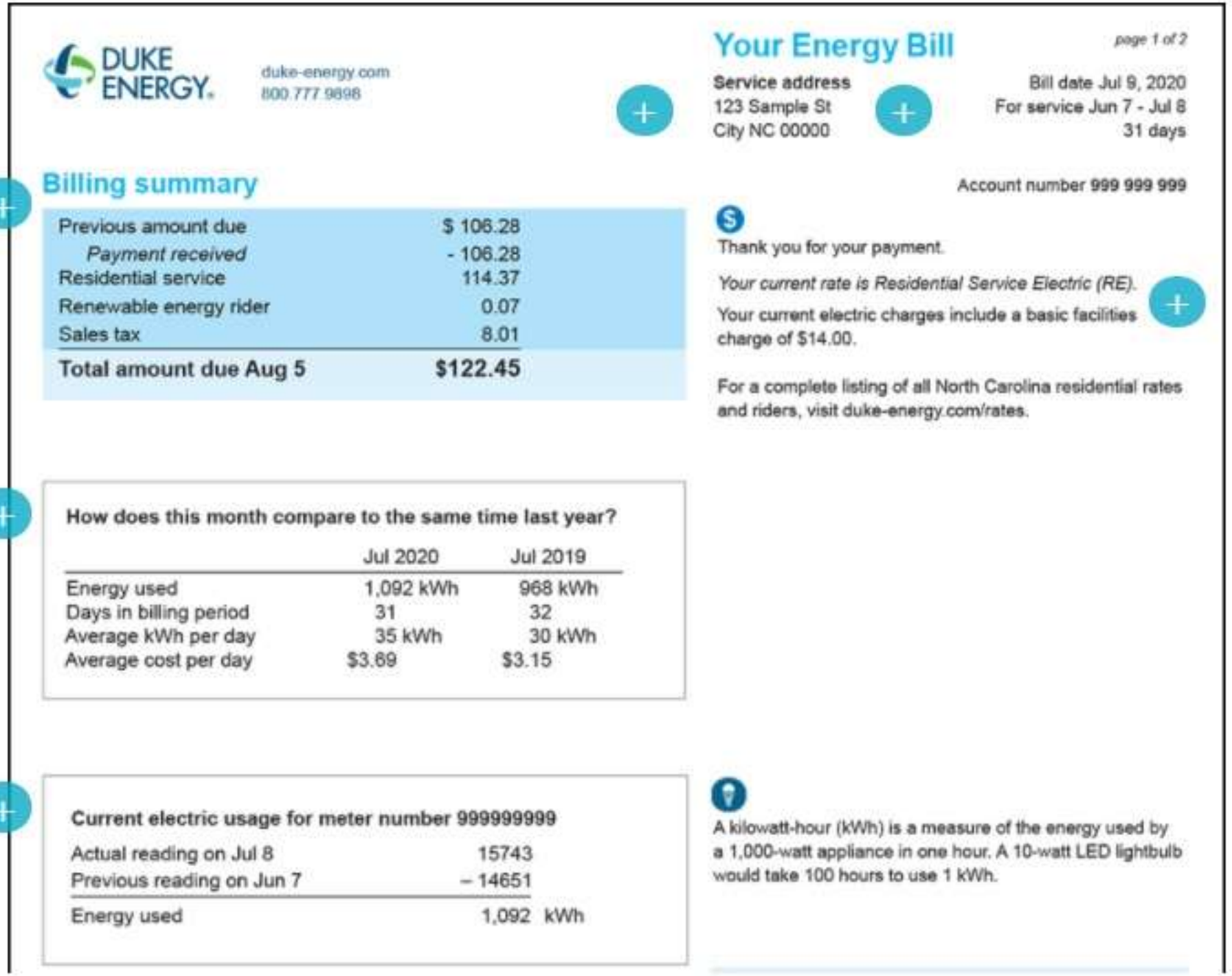
# Demystifying Your Utility Bill maybe…

Electrical Utility Billing and Rates Examples

# Example Duke Energy Residential Bill



DUKE ENERGY.

duke-energy.com
800.777.9898

## Your Energy Bill



**Service address**
123 Sample St
City NC 00000

Bill date Jul 9, 2020
For service Jun 7 - Jul 8
31 days

Account number 999 999 999

## Billing summary

| | |
|---|---|
| Previous amount due | $ 106.28 |
| *Payment received* | - 106.28 |
| Residential service | 114.37 |
| Renewable energy rider | 0.07 |
| Sales tax | 8.01 |
| **Total amount due Aug 5** | **$122.45** |

Thank you for your payment.

*Your current rate is Residential Service Electric (RE).*

Your current electric charges include a basic facilities charge of $14.00.

For a complete listing of all North Carolina residential rates and riders, visit duke-energy.com/rates.

**How does this month compare to the same time last year?**

| | Jul 2020 | Jul 2019 |
|---|---|---|
| Energy used | 1,092 kWh | 968 kWh |
| Days in billing period | 31 | 32 |
| Average kWh per day | 35 kWh | 30 kWh |
| Average cost per day | $3.69 | $3.15 |

**Current electric usage for meter number 999999999**

| | |
|---|---|
| Actual reading on Jul 8 | 15743 |
| Previous reading on Jun 7 | – 14651 |
| Energy used | 1,092 kWh |

A kilowatt-hour (kWh) is a measure of the energy used by a 1,000-watt appliance in one hour. A 10-watt LED lightbulb would take 100 hours to use 1 kWh.

# Sample Bill: Grant Creek WWTP, Salisbury

DUKE ENERGY.

CITY OF SALISBURY
1915 GRUBB FERRY RD

**Account Number**
Verification Code
Bill Date 03/19/2021
**Current Charges Past Due After 04/05/2021**

Service From: FEB 16 to MAR 18 ( 30 Days) Your next scheduled meter reading will occur between APR 20 and APR 23

| *PREVIOUS BILL AMOUNT* | *PAYMENTS (-)* | *NEW CHARGES (+)* | *ADJUSTMENTS (+ OR -)* | *AMOUNT DUE (=)* |
|---|---|---|---|---|
| *$11,149.24* | *$11,149.24* | *$11,623.02* | *$0.00* | *$11,623.02* |

| METER NUMBER | METER READINGS: PREVIOUS | PRESENT | MULTI-PLIER | TOTAL USAGE | RATE SCHEDULE DESCRIPTION | AMOUNT |
|---|---|---|---|---|---|---|
| 910567 | | | | | OPT-V TOU Secondary Small Gen | |
| | | | | | Customer Charge | 32.17 |
| | 0.00 | 1.32 | 300 | 396 KW | On-Peak Actual Demand(Winter) | |
| | | | | 396 KW | On-Peak Billing Demand | 3,815.97 |
| | 0.00 | 1.32 | 300 | 396 KW | Off-Peak Actual Demand | |
| | 5621.975 | 5786.727 | 300 | 49,426 KWH | On-Peak Energy(Winter) | 2,786.34 |
| | 43114.385 | 43859.925 | 300 | 174,236 KWH | Off-Peak Energy | 4,224.35 |
| | | | | | Renewable Energy Rider | 3.81 |
| | | | | | Sales Tax | 760.38 |
| | | | | | **Amount Due** | 11,623.02 |

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# SCHEDULE OPT-V (NC)
# OPTIONAL POWER SERVICE, TIME OF USE
# WITH VOLTAGE DIFFERENTIAL

Duke Energy Carolinas Example

TYPE OF SERVICE:
RATE:

III Secondary Service

Delivery voltage less than or equal to 600 volts where the maximum on-peak actual demand during the months of June September is as follows: Small -- less than or equal to 1000 kW; Medium -- greater than 1000 kW but less than or equal 3000 kW; Large – greater than 3000 kW

| | | Small | Medium | Large |
|---|---|---|---|---|
| A. | Basic Facilities Charge | $32.17 | $32.17 | $32.17 |
| B. | Demand Charge | | | |
| | On-Peak Demand Charge per kW of Billing Demand per month June 1 – September 30 (Summer) | $17.0366 | $15.8699 | $13.6565 |
| | On-Peak Demand Charge per kW of Billing Demand per month October 1 – May 31 (Winter) | $9.6363 | $8.8081 | $7.5835 |
| C. | Energy Charge | | | |
| | All On-Peak Energy per month, per kWh | 6.2351 ¢ | 6.3444 ¢ | 6.3359 ¢ |
| | All Off-Peak Energy per month, per kWh | 3.0222 ¢ | 3.0883 ¢ | 3.0750 ¢ |

DETERMINATION OF ON-PEAK AND OFF-PEAK HOURS
RIDERS: (9 LISTED)
DETERMINATION OF BILLING DEMAND:
POWER FACTOR CORRECTION:
OTHER….

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| | 0.00 | 1.32 | 300 | [illegible] KW | Off-Peak Actual Demand | |
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| Electricity Usage | This Month | Last Year |
|---|---|---|
| Total KWH | 101,100 | 106,200 |
| Days | 28 | 30 |
| AVG KWH per Day | 3,611 | 3,540 |
| AVG Cost per Day | $285.78 | $264.48 |

# Understanding On/Off Peak Electric Rates: Nano Plant

Running Plant during "off-peak" hours (Green zone) is **28% cheaper**

Every "off-peak" hour (Blue zone) *Avoided* **saves $7.34/hour**

**Water Production Power Costs**

Typical Electricity Demand: 612 KW
On-Peak Demand: $8—$10.60/KW/Mo.
Average Cost: **$643 per Day**
Typical Power Bill: $234,000 per year

Operator's Example

## Summer Season

April 1 - September 30

RUN PLANT between 10 p.m. to 9 a.m. weekdays for lower rates


## Winter Season

October 1 - March 31

RUN PLANT between 9 p.m. to 6 a.m. and 1 p.m. to 4 p.m. weekdays for lower rates


Weekends and (Duke) Holidays are Off-Peak– lower cost

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# NC Coop bill example

## Your energy summary

Account

Billed for 201 CASEY LN (SEWER PLANT FRONT) on October 1, 2018

### Charges

From your last summary

| | |
|---|---|
| Amount | $9,957.75 |
| Payment Received | -9,957.75 |
| Balance before new Charges | $0.00 |

**New charges this summary**

| | |
|---|---|
| NC REPS | 2.44 |
| Distribution Demand 25 kW @ $2.15 | 53.75 |
| Distribution Demand 256.088 kW @ $1.18 | 302.18 |
| Supply Demand 281.088 kW @ $4 | 1,124.35 |
| Electric Service | 7,173.57 |
| NC Sales Tax 7.0% | 605.94 |
| Current Charges | $9,262.23 |
| **Total Amount Due** | $9,262.23 |

### Usage

Readings and usage

Meter **8388715** (LP-4)
08/31/2018 to 10/01/2018

| | |
|---|---|
| Previous reading | 44799 |
| Current reading | 45273 |
| Meter multiplier | 192 |
| kWh | 91008 |
| kW - Demand | 281.088 |

**Your Special Messages**

- You will now find more detailed line items on your bill. Please note these are not new charges and your rate has not increased. The additional detail is to provide you with more information. If you have questions, please contact us.

# Calculating Your Baseline Energy Use Data & Tracking


## Considerations

### What
Decide what data you should track.

- Scope: plant, collection, system
- Multiple electric meters, gas meters, multiple utilities

### How
What's the process & who's doing it?

- Accessing your utility(ies) use data
- Monthly tracking, annual summary
- Data collection systems – spreadsheets, Energy Star, ICLEA -Clearpath,  and s

### Why
What's the purpose of the tracking?

- Operational feedback
- Municipal energy, carbon, GHG reduction goals

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Example COOP Use & Cost Data



# Dollar/Usage Summary

## Blue Ridge Energy



Name/Address: Town of Boone,
PO Box 192
Boone, NC 28607-0192

| | | Billed | | | Adjustments | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Accountno | Bill Date | Billed Amt | KWH Amt | KWH | Billed Amt | KWH Amt | KWH | Billed Amt | KWH Amt | KWH |
| 24202100 | 04-SEP-2019 | $19,470.75 | $15,496.58 | 209,664 | $0.00 | $0.00 | 0 | $19,470.75 | $15,496.58 | 209,664 |
| 24202100 | 01-AUG-2019 | $16,387.20 | $13,232.38 | 190,080 | $0.00 | $0.00 | 0 | $16,387.20 | $13,232.38 | 190,080 |
| 24202100 | 01-JUL-2019 | $20,314.49 | $16,043.45 | 212,544 | $0.00 | $0.00 | 0 | $20,314.49 | $16,043.45 | 212,544 |
| 24202100 | 03-JUN-2019 | $18,396.38 | $14,740.14 | 205,056 | $0.00 | $0.00 | 0 | $18,396.38 | $14,740.14 | 205,056 |
| 24202100 | 01-MAY-2019 | $19,634.45 | $15,795.77 | 222,912 | $0.00 | $0.00 | 0 | $19,634.45 | $15,795.77 | 222,912 |
| 24202100 | 01-APR-2019 | $21,183.87 | $17,169.24 | 248,832 | $0.00 | $0.00 | 0 | $21,183.87 | $17,169.24 | 248,832 |
| 24202100 | 01-MAR-2019 | $19,673.34 | $15,829.13 | 223,488 | $0.00 | $0.00 | 0 | $19,673.34 | $15,829.13 | 223,488 |
| 24202100 | 01-FEB-2019 | $20,736.34 | $16,882.27 | 248,832 | $0.00 | $0.00 | 0 | $20,736.34 | $16,882.27 | 248,832 |
| 24202100 | 02-JAN-2019 | $22,038.11 | $17,716.96 | 248,832 | $0.00 | $0.00 | 0 | $22,038.11 | $17,716.96 | 248,832 |
| 24202100 | 03-DEC-2018 | $19,175.30 | $15,459.15 | 220,032 | $0.00 | $0.00 | 0 | $19,175.30 | $15,459.15 | 220,032 |
| 24202100 | 02-NOV-2018 | $21,284.42 | $17,090.15 | 239,040 | $0.00 | $0.00 | 0 | $21,284.42 | $17,090.15 | 239,040 |
| 24202100 | 01-OCT-2018 | $20,374.54 | $16,430.76 | 233,856 | $0.00 | $0.00 | 0 | $20,374.54 | $16,430.76 | 233,856 |
| 24202100 | 04-SEP-2018 | $19,065.70 | $15,531.73 | 229,824 | $0.00 | $0.00 | 0 | $19,065.70 | $15,531.73 | 229,824 |
| 24202100 | 01-AUG-2018 | $16,867.28 | $13,683.01 | 199,872 | $0.00 | $0.00 | 0 | $16,867.28 | $13,683.01 | 199,872 |
| 24202100 | 02-JUL-2018 | $17,294.90 | $13,855.90 | 192,960 | $0.00 | $0.00 | 0 | $17,294.90 | $13,855.90 | 192,960 |
| 24202100 | 01-JUN-2018 | $19,248.21 | $15,353.21 | 209,664 | $0.00 | $0.00 | 0 | $19,248.21 | $15,353.21 | 209,664 |
| 24202100 | 01-MAY-2018 | $18,944.11 | $15,352.46 | 222,912 | $0.00 | $0.00 | 0 | $18,944.11 | $15,352.46 | 222,912 |
| 24202100 | 02-APR-2018 | $18,317.85 | $14,680.64 | 204,480 | $0.00 | $0.00 | 0 | $18,317.85 | $14,680.64 | 204,480 |
| 24202100 | 01-MAR-2018 | $18,258.37 | $14,684.73 | 207,360 | $0.00 | $0.00 | 0 | $18,258.37 | $14,684.73 | 207,360 |
| 24202100 | 01-FEB-2018 | $19,862.36 | $16,025.64 | 228,672 | $0.00 | $0.00 | 0 | $19,862.36 | $16,025.64 | 228,672 |
| 24202100 | 02-JAN-2018 | $17,825.00 | $14,288.66 | 199,296 | $0.00 | $0.00 | 0 | $17,825.00 | $14,288.66 | 199,296 |
| 24202100 | 01-DEC-2017 | $16,610.42 | $13,332.56 | 187,200 | $0.00 | $0.00 | 0 | $16,610.42 | $13,332.56 | 187,200 |
| 24202100 | 01-NOV-2017 | $19,063.56 | $15,192.58 | 206,784 | $0.00 | $0.00 | 0 | $19,063.56 | $15,192.58 | 206,784 |
| 24202100 | 02-OCT-2017 | $16,602.23 | $13,268.21 | 183,168 | $0.00 | $0.00 | 0 | $16,602.23 | $13,268.21 | 183,168 |

# How does my plant compare on energy use?

# Benchmarking

External and Internal


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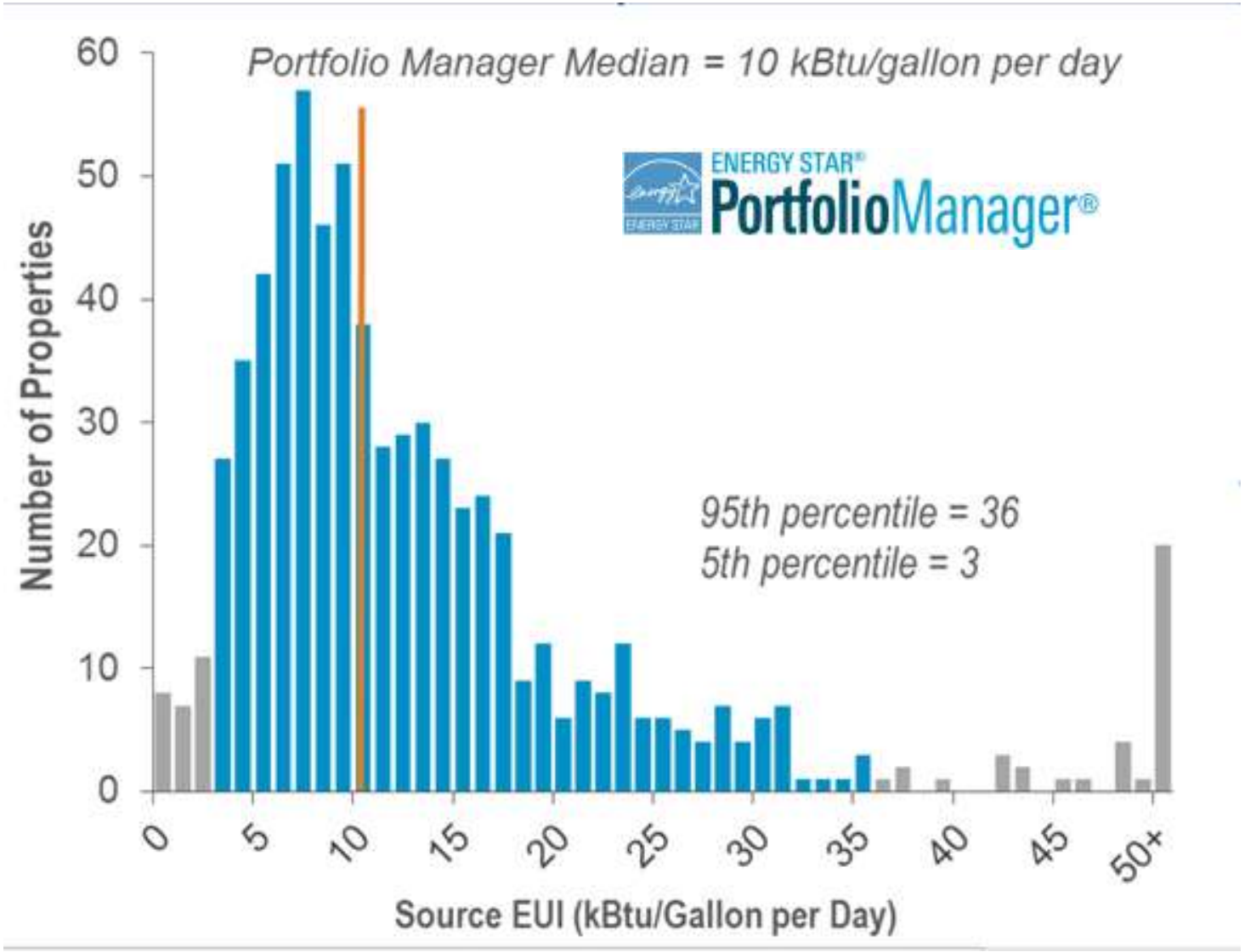
# Benchmarking

EPA Energy Star, Portfolio Manager

- Energy Use Intensity (EUI) Usually given in energy unit per production or process unit per time
- EPA uses kBtu/gpd  or thousand Btu per gallon per day
- Median value 10 kBtu/gallon per day (1377 plant reporting, 2015)
- “Source” vs. “Site” Energy Use
- NC Plants:  11 -  25 kBtu/gpd

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# Benchmarking

## New York State Data (2012/2013)

| Plant Size Category | No. of plants | Energy Use kWh/mg |
|---|---|---|
| NY State Average | | 1,800 |
| < 1 mgd | 520 | 4,620* |
| 1 – 5 mgd | 106 | 2,300 |
| 5 – 20 mgd | 43 | 1,970 |
| 20 – 75 mgd | 19 | 1,370 |
| > 75 mgd | 14 | 1,280 |

## WEF MOP 32 (2010)

| Plant Size | Energy Use kWh/mg |
|---|---|
| | |
| 1 – mgd | 2,951 |
| 5 – mgd | 1,926 |
| 10 – mgd | 1,791 |
| 20 - mgd | 1,676 |
| 50 – mgd | 1,588 |
| 100 - mgd | 1,558 |

Source:
Wastewater Energy Management: Best Practices Handbook, March 2019, NYSERDA
Water Environment Federation, MOT No. 32 for WWTP (2010)

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# Benchmarking - Internally

## Evaluate

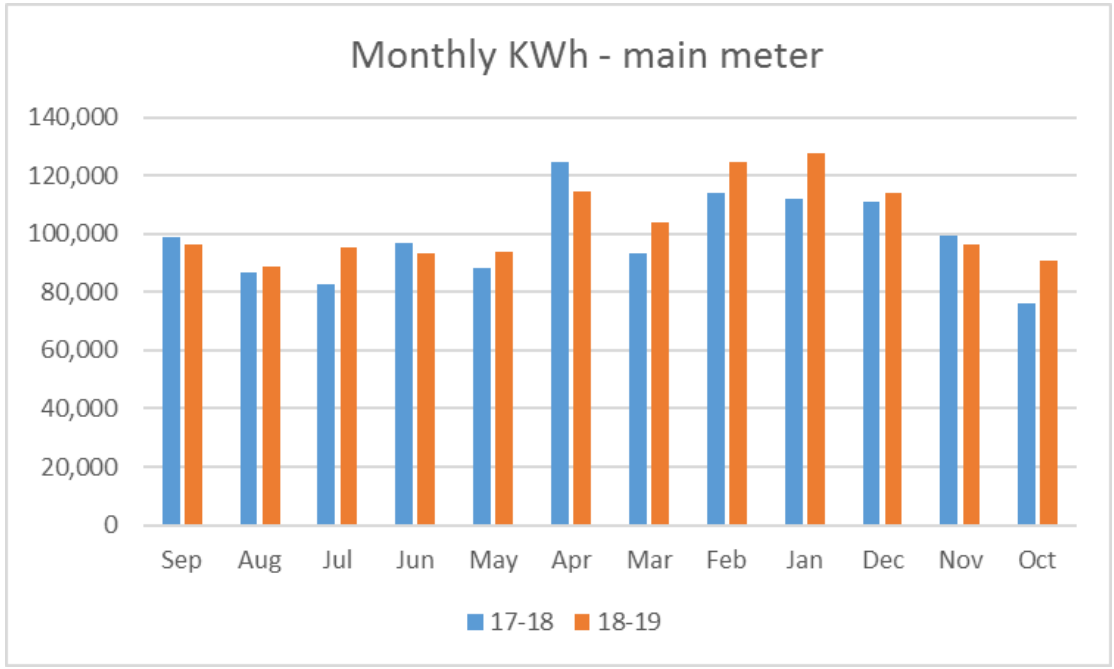
- Whole Plant
- Individual Processes (if metered separately)

## Compare

- Month to month
- Year to year
- Season to season

## Parameters

- kWh/million gallons treated
- kWh/Pound of BOD removed
- Million Btu/Million gallons Treated




With your internal data collected, It may be useful to compare your plant with other facilities using the benchmark

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# WWTP Energy Management Sequence

Plant Evaluation

## Blowers

Aeration and Aerobic Digestion

## Pumps

Main Lift/ RAS / WAS

## Compressors

DAF / Sludge Transfer/ Misc Process

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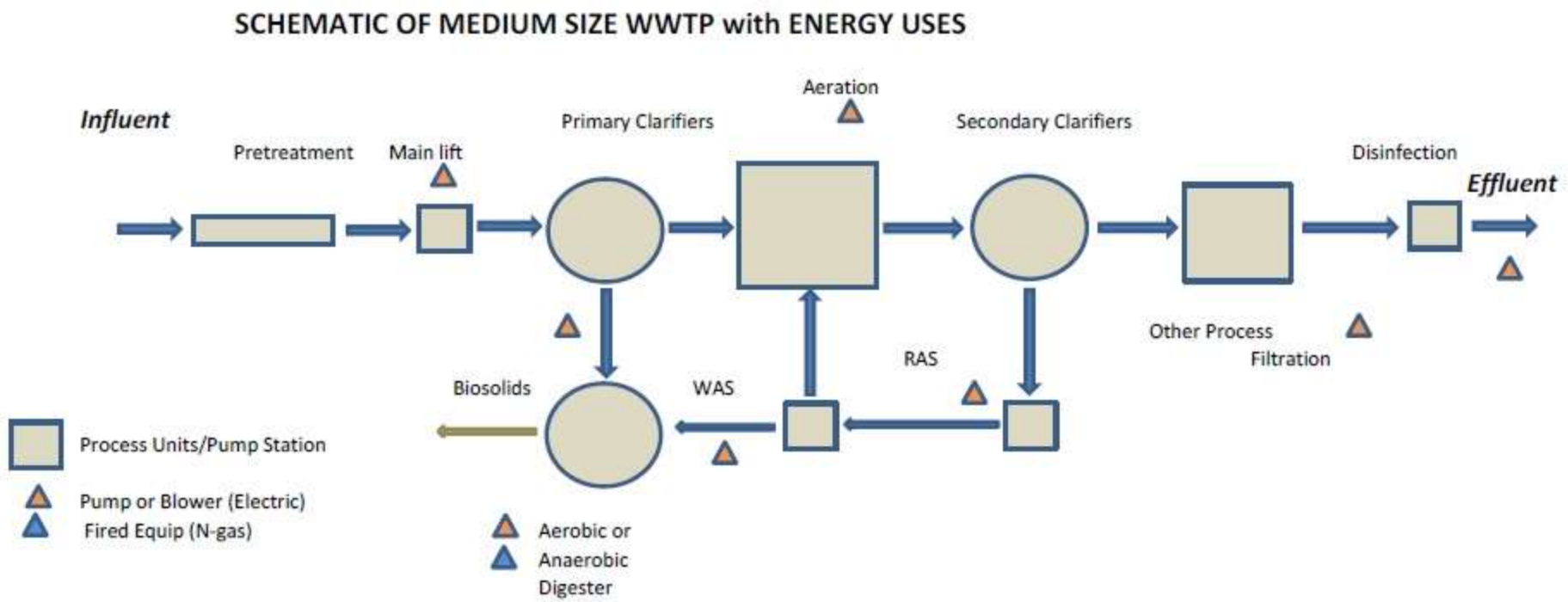
# WWTP Energy Management Sequence

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# WWTP Energy Management Sequence

Plant Evaluation

Energy Balance : input = output plus accumulation

Electrical Energy input is recorded, some is wasted due to inefficiency of motors, drives

Energy Output can be estimated for pumps - flow against head (WHP)

Energy used by blowers, mixers can be estimated using time of operation and amp draw

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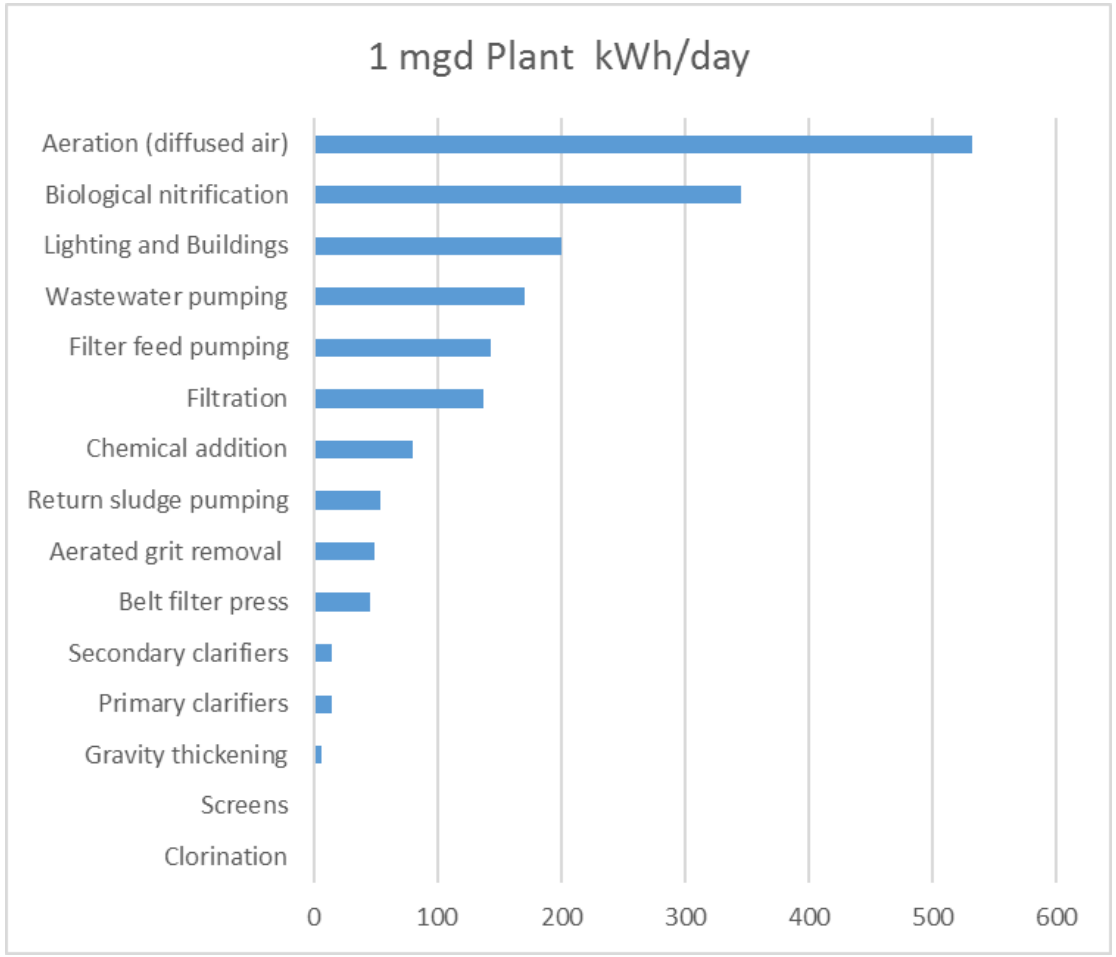
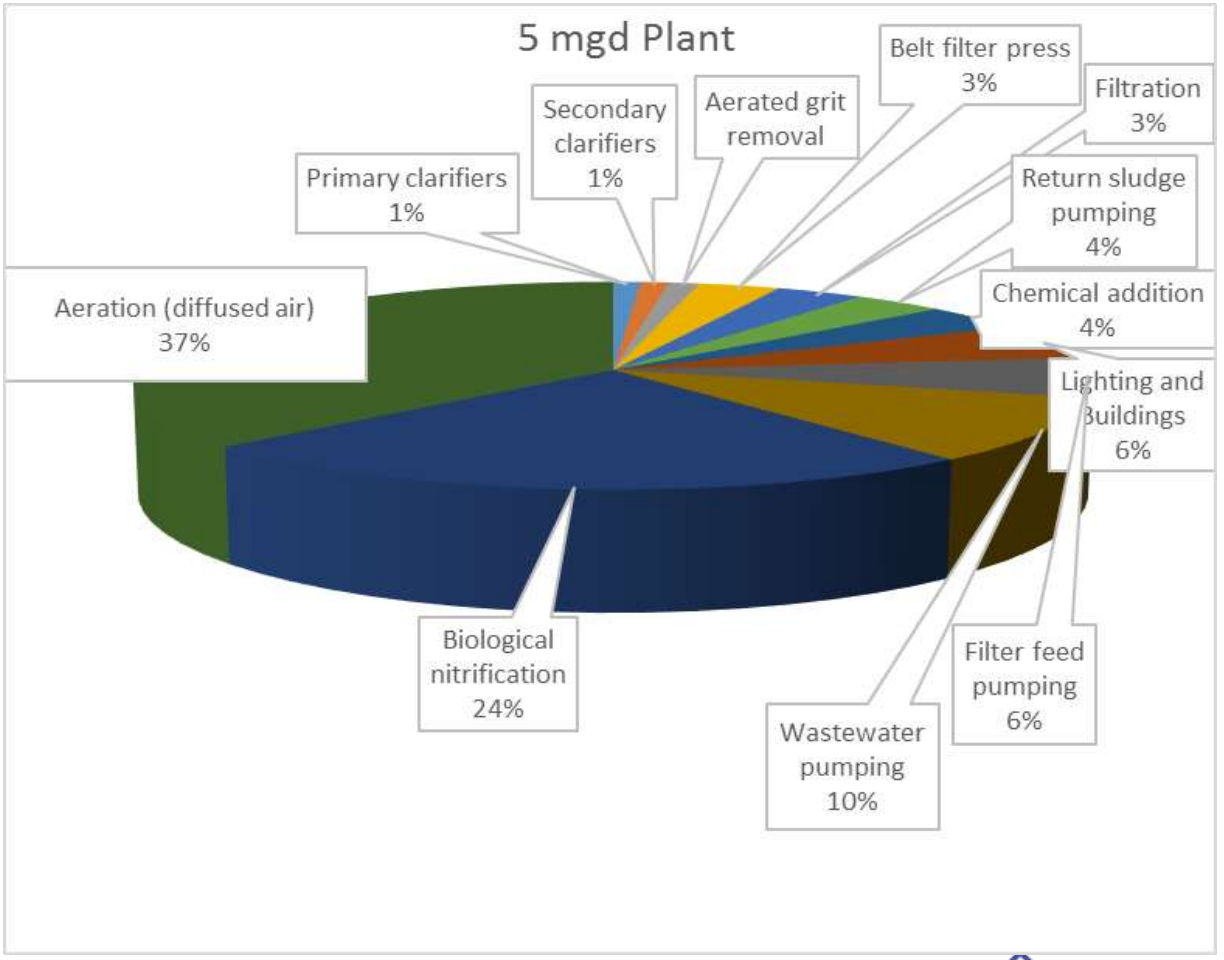
# Typical Energy Use Balance - WWTP




Source: WEF MOP No. 35 2010

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# WWTP Energy Management Sequence

## Plant Evaluation

- What are the sizes of your equipment, how many hours per day does the equipment operate, and what are the parameters that influence energy use?
- What are the efficiency ratings for different pieces of equipment?

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Plant Evaluation

Facility Equipment List

What is needed?  Take photos of nameplates


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# Equipment list with energy use

| Location (facility) | Jackson Creek WWTP | | | | | | KW/HP 0.746 | | Assumed power factor 0.87 | | Assumed avg elec rate $0.070 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Equipment List | Equipment | Motor Size (HP) | Motor Eff (%) | Phase | Motor Load (%) | Voltage (volts) | Oper Amps (amps) | ESTIMATED Annual oper (hr) | Power Factor | Apparent Horsepower | Average Electric Load (KW) | Approx Annual Elec Use (KW-H/YR) | Approximate Electric Cost ($/Yr) | Calculated Total $ | VFD y/n |
| Pretreatment | Misc equip Inf | 20 | 90% | 3 | 85% | 460 | | 5000 | | | 14.1 | 70,456 | $4,931.89 | | |
| Influent | Pump 1 | 75 | 90% | 3 | 90% | 460 | | 2865 | | | 56.0 | 160,297 | $11,220.77 | | Y |
| | Pump 2 | 75 | 90% | 3 | 90% | 460 | | 2865 | | | 56.0 | 160,297 | $11,220.77 | | Y |
| | Misc equip | 30 | 90% | 3 | 85% | 460 | | 5000 | | | 21.1 | 105,683 | $7,397.83 | | N |
| Mechanical Aerators | A1 | 75 | 90% | 3 | 90% | 460 | | 6570 | | | 56.0 | 367,592 | $25,731.41 | | N |
| | A2 | 75 | 90% | 3 | 90% | 460 | | 6570 | | | 56.0 | 367,592 | $25,731.41 | | N |
| | A3 | 75 | 90% | 3 | 90% | 460 | | 6570 | | | 56.0 | 367,592 | $25,731.41 | | N |
| | A4 | 75 | 90% | 3 | 90% | 460 | | 6570 | | | 56.0 | 367,592 | $25,731.41 | | N |
| Mixers for aeration | M1 | 25 | 90% | 3 | 90% | 460 | | 6570 | | | 18.7 | 122,531 | $8,577.14 | | N |
| | M2 | 25 | 90% | 3 | 90% | 460 | | 6570 | | | 18.7 | 122,531 | $8,577.14 | $127,477.72 | N |
| Effluent Pumps | Eff Pump 1 | 100 | 90% | 3 | 85% | 460 | | 1920 | | | 70.5 | 135,275 | $9,469.23 | | Y |
| | Eff Pump 2 | 100 | 90% | 3 | 85% | 460 | | 1920 | | | 70.5 | 135,275 | $9,469.23 | | Y |
| Return Activated Sludge | RAS 1 | 30 | 90% | 3 | 90% | 460 | | 7000 | | | 22.4 | 156,660 | $10,966.20 | | N |
| Screw Pumps | RAS 2 | 30 | 90% | 3 | 90% | 460 | | 7000 | | | 22.4 | 156,660 | $10,966.20 | | N |
| | RAS 3 | 30 | 90% | 3 | 90% | 460 | | 7000 | | | 22.4 | 156,660 | $10,966.20 | $32,898.60 | N |
| Digester Blowers | Blower 1 | 75 | 90% | 3 | 90% | 460 | | 5000 | | | 56.0 | 279,750 | $19,582.50 | | unk |
| Aerobic digesters | Blower 2 | 75 | 90% | 3 | 90% | 460 | | 4500 | | | 56.0 | 251,775 | $17,624.25 | | unk |
| | Blower 3 | 100 | 90% | 3 | 90% | 460 | | 5000 | | | 74.6 | 373,000 | $26,110.00 | | unk |
| Ventilation | Exhuast Fan | 5 | 88% | 3 | 90% | 460 | | 0 | | | 3.8 | 0 | $0.00 | | |
| | | | | | | | | | | | | 3,466,165 | | | |
| | | | | | | | | | Total Annual KWH | | | 3,786,758 | $279,508.73 | | |

Thanks to following utilities for sharing demonstration information and photos.














# Acknowledgements

WRP
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