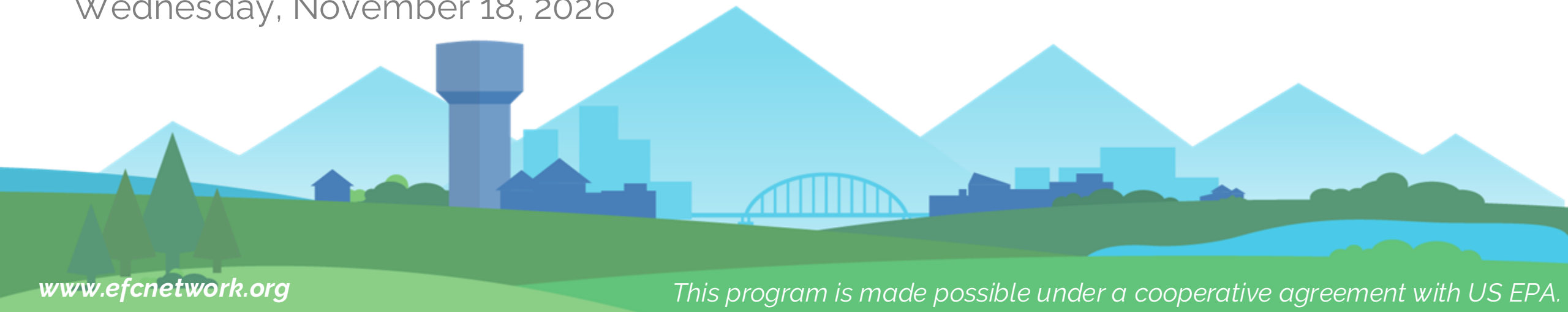
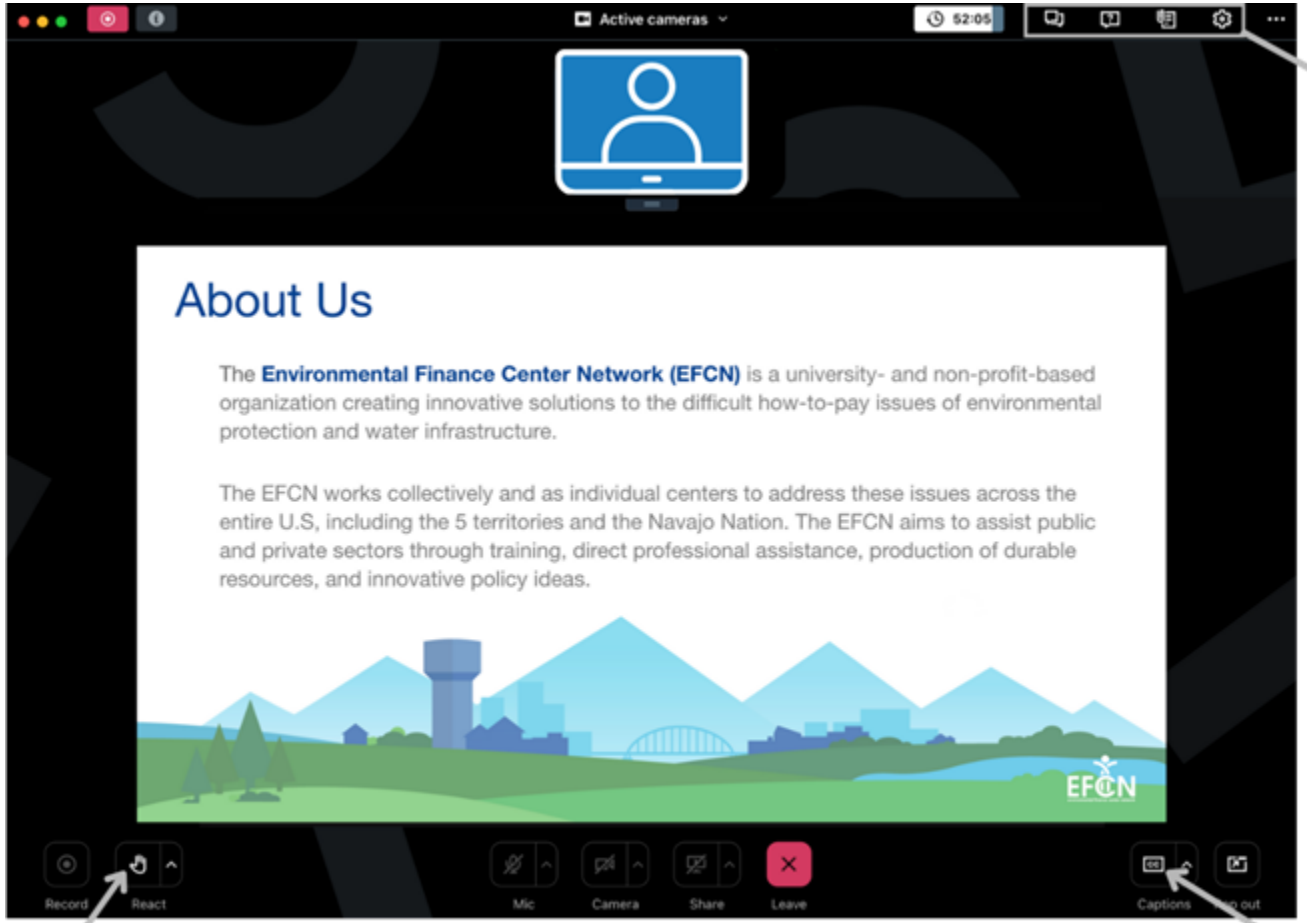
Save Money by Applying Energy Management Practices

Dawn Nall
Wednesday, November 18, 2026



This program is made possible under a cooperative agreement with US EPA.

GoToWebinar Logistics



Chat **Materials**

Submit Questions
in the questions box at anytime and send

Settings/Audio
Ensure your audio is connected. Choose between computer audio or phone call.

Raise Your Hand or React 👍 👎 👏 ❤️ 😆

Closed Captions
Enable live captions during the session.

EFCN
environmental finance center network

Certificate of Completion

This session has **NOT** been submitted for pre-approval of Continuing Education Credits, but eligible attendees will receive a certificate of attendance for their personal record.

To receive a certificate:

- You must attend the entire session
- You must register and attend using your real name and unique email address - group viewing credit will not be acceptable
- You must participate in all polling questions
- Certificates will be sent via email within 30 days

If you have questions or need assistance, please contact smallsystems@syr.edu.

About Us

The **Environmental Finance Center Network (EFCN)** is a university- and non-profit-based organization creating innovative solutions to the difficult how-to-pay issues of environmental protection and water infrastructure.

The EFCN works collectively and as individual centers to address these issues across the entire U.S, including the 5 territories and the Navajo Nation. The EFCN aims to assist public and private sectors through training, direct professional assistance, production of durable resources, and innovative policy ideas.



Meet Our Partners:



EFCN
environmental finance center network

YOU DON'T HAVE TO NAVIGATE WATER CHALLENGES ALONE.

EFCN
environmental finance center network

Request Free Technical Assistance Today

Our team of partners can help you tackle your Technical, Managerial, and Financial (TMF) challenges head-on.

Areas of assistance include, but are not limited to:

- Funding & Financial Strategy
- Workforce Development
- Security & Cybersecurity
- Regulatory Compliance
- Rate Setting & Affordability
- Asset Management
- System Performance
- Public Engagement
- Utility Management
- Succession Planning

*efcnetwork.org/**get-help***

Free Funding Application Support!

Join the hundreds of communities who have received free assistance from the **Environmental Finance Center Network**!



Receive Expert Guidance On:

- Finding the right funding programs for your project
- Understanding eligibility & application timelines
- Support the development of strong, competitive applications
- Looking for funding to match or supplement funding you've already received

Reach out today: *efcnetwork.org/**get-help** or use the link shared in the chat!*

EFCN
environmental finance center network

Keep Learning. Stay Connected.

EFCN
environmental finance center network

Register for our

Webinars & Workshops:

Subscribe to

EFCN's Email List:

Subscribe to

EFCN's YouTube:

Why Energy Management?

EFCN
environmental finance center network

Energy Consumption of WW Treatment

Treatment plants are the largest energy consumers for municipalities

- 30-40% of total energy usage by municipalities

WW and DW systems account for ~2% of total energy usage in the U.S.

- Results in the production of ~45 million tons of greenhouse gases annually

Energy usage accounts for ~40% of operation costs of water utilities

- Energy efficiency practices can reduce this cost by 15-30%

Source: EPA

Where is Energy Used in Wastewater Treatment

Aeration, pumping, solids handling, and lighting and HVAC account for the highest consumers of energy for wastewater treatment processes









Trends Affecting Energy Use

Ener

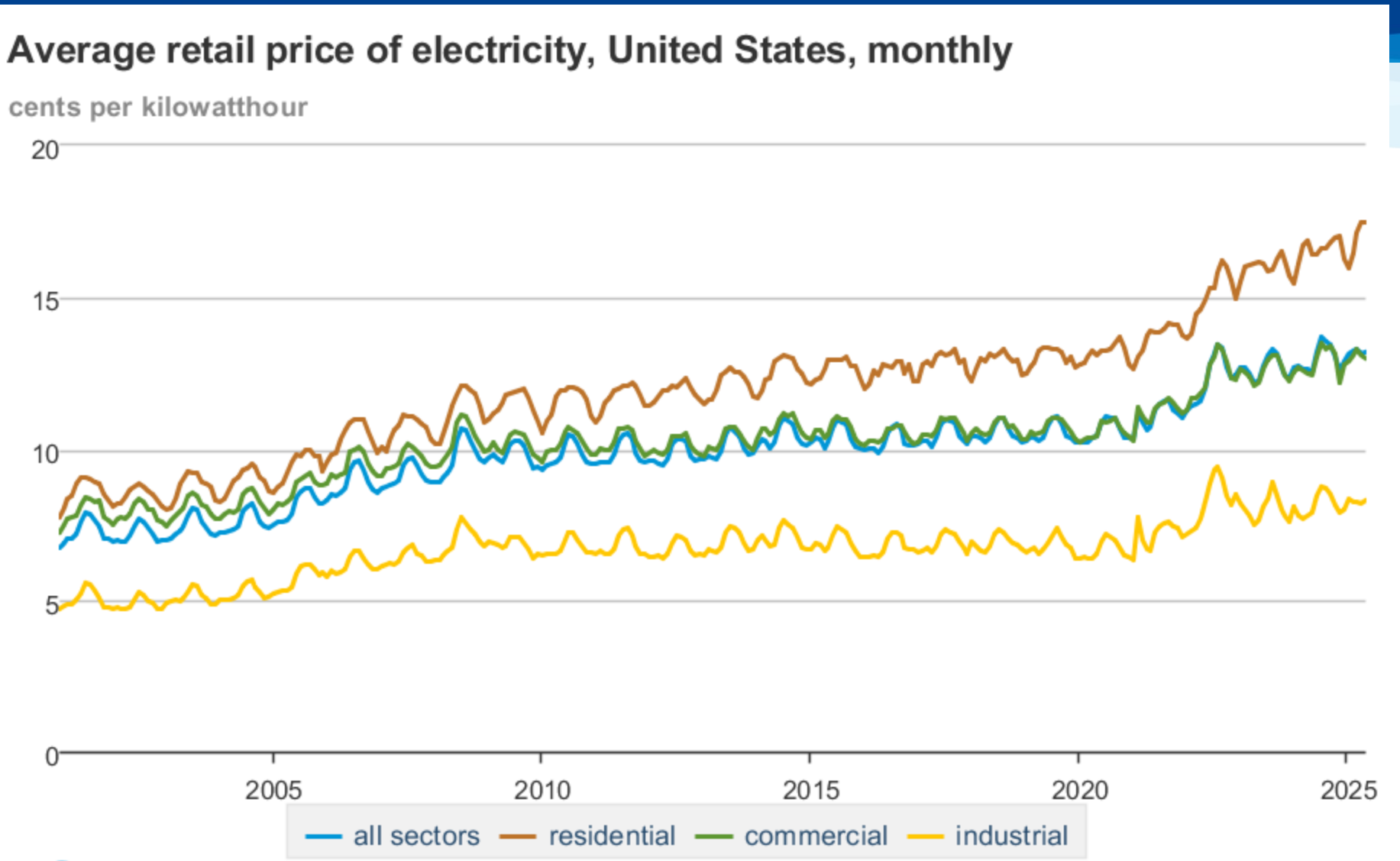
- Acc

Ener
disch

- Inc
cor
incr

New

- UV



eia Data source: U.S. Energy Information Administration

EFCN environmental finance center network

Energy Use Concepts

Utilities traditionally treat energy as a cost of doing business

- Rationale is that this cost cannot be controlled
- Efforts are not made to mitigate costs associated with energy use
- Results in the depletion of capital costs to offset rising operating costs and keep user fees low
- This leaves utilities vulnerable to unforeseen financial constraints



Energy Management Concepts



Energy Management Opportunities

- Improve Energy Efficiency & Manage Total Energy Consumption
- Control Peak Energy Demands
- Manage Energy Cost Volatility
- Improve Energy Reliability
- Opportunities for Renewable Energy

**These goals often overlap with other management practices (i.e. preventive maintenance program improves motor efficiency and improves reliability)

Benefits of Energy Efficiency

Cost Savings & Financial Resilience

- Ability to withstand volatility of energy costs

Improved Operational Efficiency

- Contributes to overall asset management efforts

Environmental & Climate Benefits

Stakeholder engagement and recognition

Energy Management Program Basic Steps

Step 1. Establish Organizational Commitment

Step 2. Develop a Baseline of Energy Use

Step 3. Evaluate the System and Collect Data

Step 4. Identify Energy Efficiency Opportunities

Step 5. Implement No- and Low-Cost Opportunities

Step 6. Prioritize Opportunities for Implementation

Step 7. Develop an Integrated Capital/Energy Plan

Step 8. Provide for Progress Tracking and Reporting

Source: NYSERDA

EFCN
environmental finance center network

Step 1 – Establish Organizational Commitment

Team responsibilities include:

Develop the Energy Management plan

Establish goals

Define the resources needed

Provide information to others (i.e. CIP team)



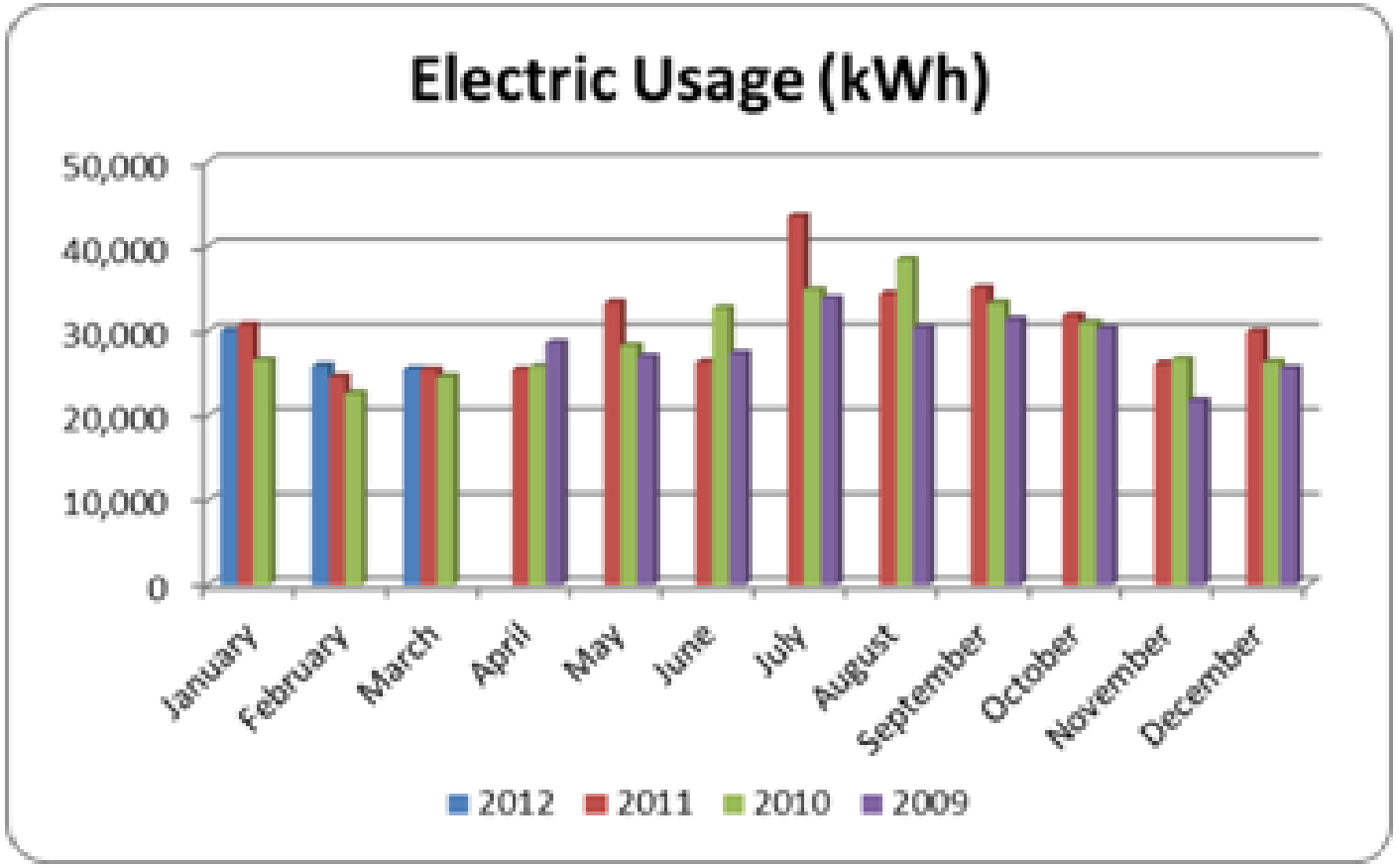
Why Bother?

- Without the commitment of several individuals at varying levels within your utility, successful implementation of an energy management plan will be difficult

- Think of The Avengers – no one individual could have saved the city or universe; it took all of them working towards a common goal to be successful!



Step 2: Develop a Baseline of Energy Use



Why Bother?



- Energy efficiency gains = $$ saved
  - The process of investigating energy use, and improving awareness among staff, can provide measurable energy efficiency gains on the order of 3-5%.
- Value shown before resources committed
  - Successfully developing a basic understanding of energy use can be a good 'early victory,' allowing the team to demonstrate some value even before any significant resources are committed to the program.

Step 3: Evaluate the System and Collect Data





Step 4: Identify Energy Efficiency Opportunities

- The energy management team should identify a broad array of energy efficiency opportunities



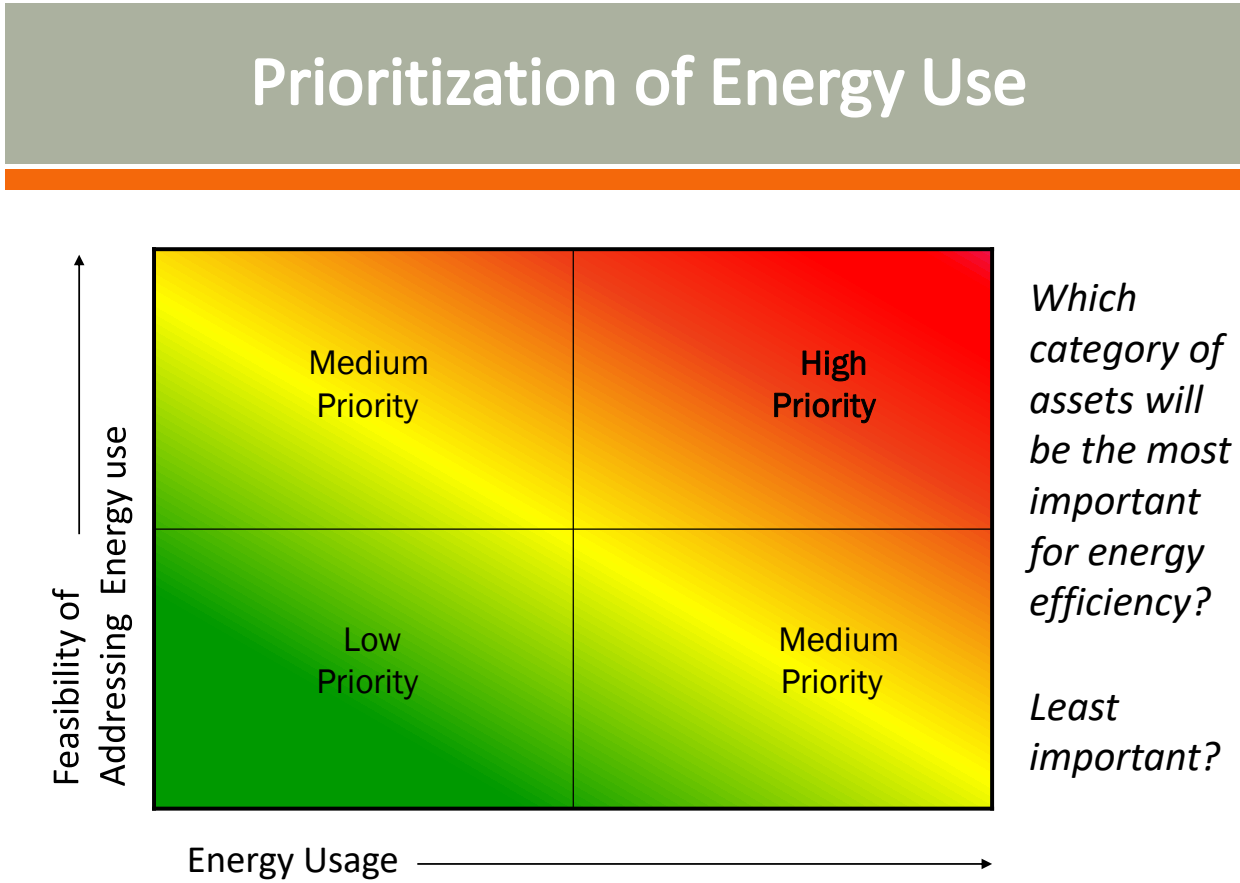
Categories for Energy Efficiency Opportunities

- Capital program or equipment replacement
- Process change
- Operational change
- Automation or controls
- Maintenance improvements
- Business measures

Step 5. Implement No- and Low-Cost Opportunities

- Look at the list developed in Step 4
- Identify the opportunities that require no-cost or low-cost
  - May require only operational changes or cultural changes
- Implement these opportunities first

Step 6: Prioritize Opportunities for Implementation



Step 7: Develop an Integrated Capital/Energy Plan

Step 1
- Who
- What
- When

Step 2
- Who
- What
- When

Step 3
- Who
- What
- When



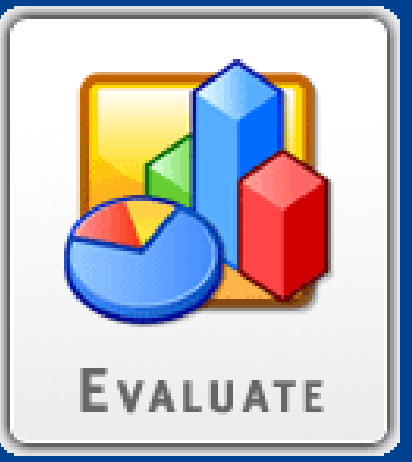
Step 8: Provide for Progress Tracking and Reporting



System Evaluation and Energy Audit

EFCN
environmental finance center network

Step 3: Evaluate the System and Collect Data



Have you ever had an energy audit or assessment completed at our utility?

- Yes
- No
- Not a Utility

Who can help?

Power companies

State energy or environmental agencies

Engineering firms

Energy Service Companies- ESCOs

EFCN

Energy Audit

- Comprehensive and detailed review of all energy consumption components of a facility
- Includes HVAC, insulation, and review of all motors, compressors, and electrical equipment.
- May not include operations optimization
- Typically preformed by outside entities

Energy Assessment

- Less rigorous than an audit.
- Looks at primary energy users of the facility
- Looks for “low hanging fruit” of energy savings.
- Should include a review of operations to detect operations adjustments that could save energy.
- Can be done internally or by outside entities

EFCN
environmental finance center network

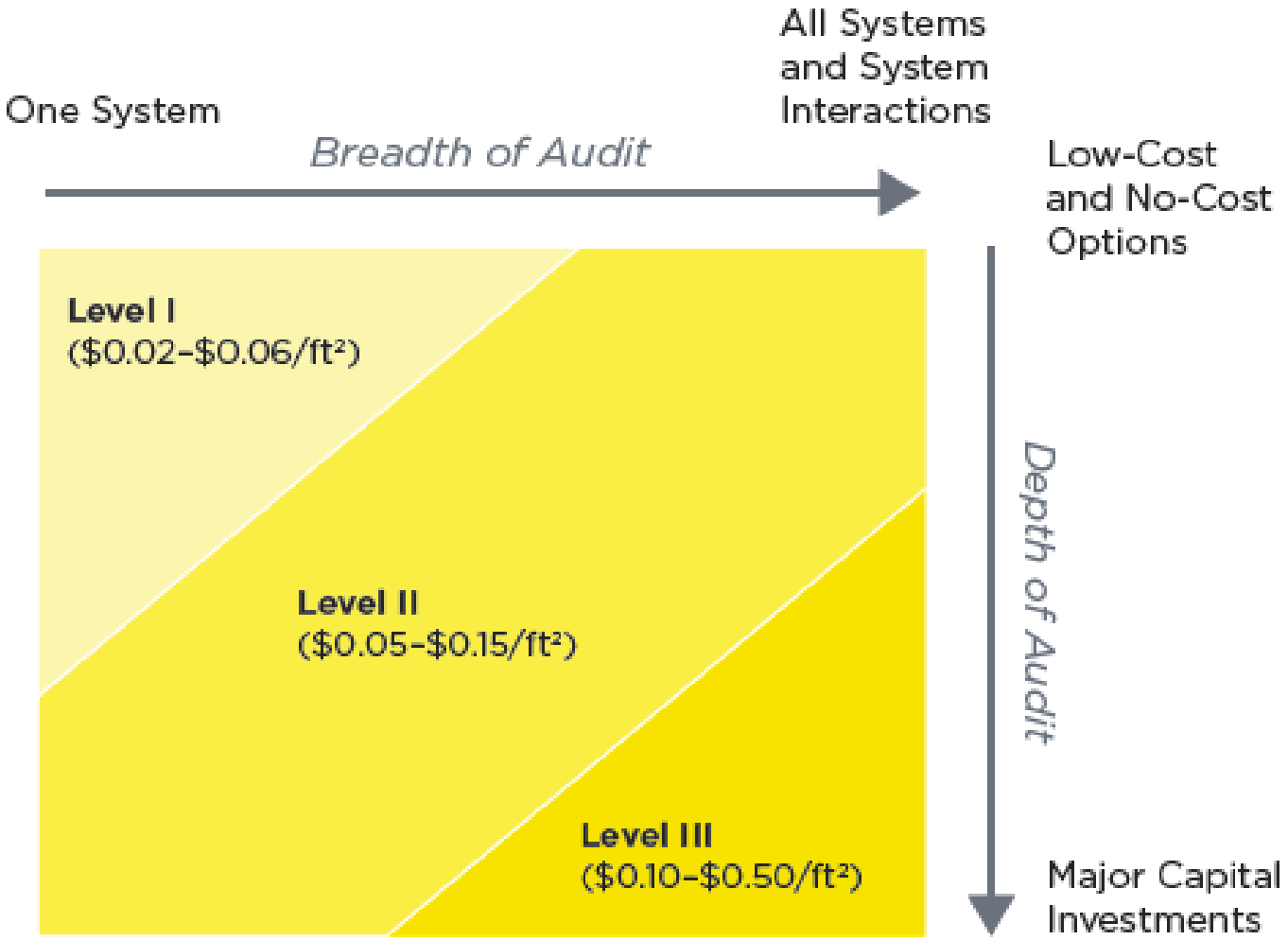


Figure 2-3 Cost and quality of the three levels of energy audits beyond preliminary analysis

Source: NRAL Advanced Energy Retrofit Guide – K-12 Schools

Level 1 Energy Audit

Steps

1. Visit each wastewater process to complete a “walk through” inventory of facilities.
2. Interview personnel to understand how each facility is used.
3. Gather data on energy use, facility capacity, and energy cost.
4. Prepare energy use inventory report to serve as documentation of baseline energy use of facilities and to identify potential opportunities to reduce energy use.

Before the Walk Through

Define the energy team

Discuss goals and deliverables

- Reduce energy use/costs
- Reduce during peak hours
- Minimize disruption of service

Determine areas to assess

Develop a schedule



Before the Walk Through

Available data/plant information – gather and review

- Plant flows
- Utility bills (energy and water sold, 2 years)
- Pumping records
- Well logs
- Operational hours/day (run times)
- Equipment operating times
- Drawings/plans
- Previous audit data
- SCADA reports – runtime reports, backwash reports, etc.
- Anything else you think might be helpful

Before the Walk Through

Identify Rate Schedules

- Energy Utilities
  - Electric
  - Gas
  - Other?

Other preparations

- Energy using equipment accessibility – ladder, broom
- Flashlight
- Camera
- Pencil, paper for rubbing



The Process Walk Through

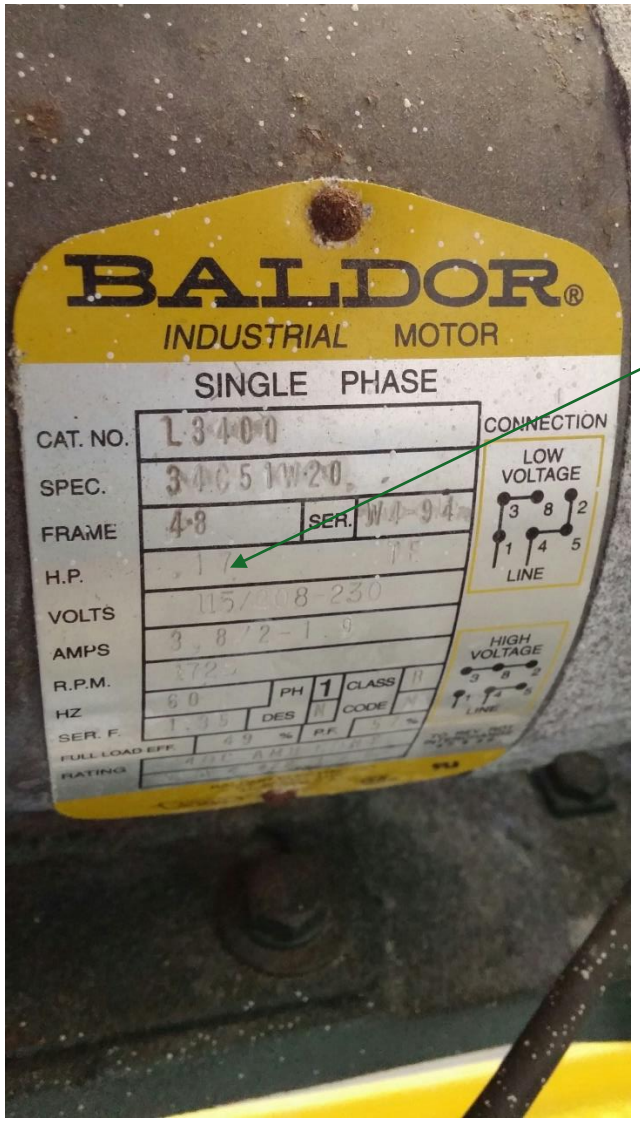
Gather Important Field Data

- Nameplate Horsepower
  - Take a picture of the equipment and then zoom in on the nameplate
- Operational Information
  - Seasonal
  - Variable Speed
  - Pumping against throttled valve
- Runtime Information
  - Hours per day, month or year

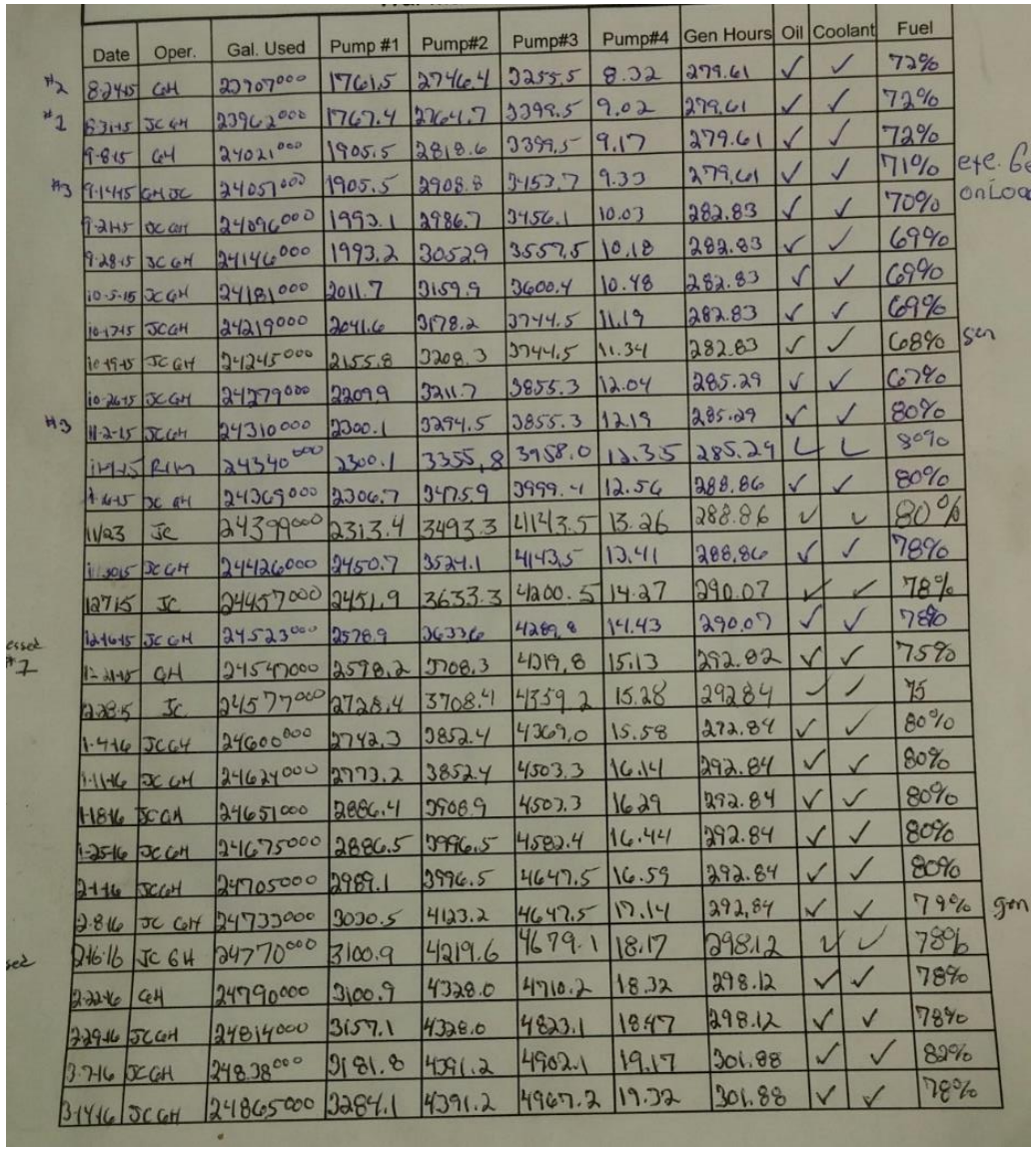
Note this pump has a VFD

Find the Nameplate





Find the HP rating



	Date	Oper.	Gal. Used	Pump #1	Pump#2	Pump#3	Pump#4	Gen Hours	Oil	Coolant	Fuel	
#2	8245	GH	23707000	1761.5	2746.4	3255.5	8.32	279.61	✓	✓	72%	
#1	8-31-15	JC GH	23962000	1767.4	2764.7	3299.5	9.02	279.61	✓	✓	72%	
	9-8-15	GH	24021000	1905.5	2818.6	3399.5	9.17	279.61	✓	✓	72%	
#3	9-14-15	GH JC	24057000	1905.5	2908.8	3453.7	9.33	279.61	✓	✓	71%	etc. Ge
	9-21-15	JC GH	24096000	1993.1	2986.7	3456.1	10.03	282.83	✓	✓	70%	onLoa
	9-28-15	JC GH	24146000	1993.2	3052.9	3557.5	10.18	282.83	✓	✓	69%	
	10-5-15	JC GH	24181000	2011.7	3159.9	3600.4	10.48	282.83	✓	✓	69%	
	10-12-15	JC GH	24219000	2041.6	3178.2	3744.5	11.19	282.83	✓	✓	69%	
	10-19-15	JC GH	24245000	2155.8	3208.3	3744.5	11.34	282.83	✓	✓	68%	gen
	10-26-15	JC GH	24279000	2209.9	3211.7	3855.3	12.04	285.29	✓	✓	68%	
#3	11-2-15	JC GH	24310000	2300.1	3294.5	3855.3	12.19	285.29	✓	✓	80%	
	11-9-15	RHM	24340000	2300.1	3355.8	3958.0	12.35	285.29	L	L	80%	
	11-16-15	JC GH	24369000	2306.7	3415.9	3999.4	12.56	288.86	✓	✓	80%	
	11/23	JC	24399000	2313.4	3493.3	4143.5	13.26	288.86	✓	✓	80%	
	11-30-15	JC GH	24426000	2450.7	3524.1	4143.5	13.41	288.86	✓	✓	78%	
	12/7/15	JC	24457000	2451.9	3633.3	4200.5	14.27	290.07	✓	✓	78%	
	12-14-15	JC GH	24523000	2578.9	3633.6	4289.8	14.43	290.07	✓	✓	78%	
essel #7	12-21-15	GH	24547000	2578.2	3708.3	4319.8	15.13	292.82	✓	✓	75%	
	12-28-15	JC	24577000	2728.4	3708.4	4359.2	15.28	292.84	✓	✓	75	
	1-4-16	JC GH	24600000	2742.3	3852.4	4369.0	15.58	292.84	✓	✓	80%	
	1-11-16	JC GH	24624000	2773.2	3852.4	4503.3	16.14	292.84	✓	✓	80%	
	1-18-16	JC GH	24651000	2886.4	3908.9	4503.3	16.29	292.84	✓	✓	80%	
	1-25-16	JC GH	24675000	2886.5	3996.5	4582.4	16.44	292.84	✓	✓	80%	
	2-1-16	JC GH	24705000	2981.1	3996.5	4647.5	16.59	292.84	✓	✓	80%	
	2-8-16	JC GH	24733000	3030.5	4123.2	4647.5	17.14	292.84	✓	✓	79%	gen
see	2-16-16	JC GH	24770000	3100.9	4219.6	4679.1	18.17	298.12	✓	✓	78%	
	2-22-16	GH	24790000	3100.9	4328.0	4710.2	18.32	298.12	✓	✓	78%	
	2-29-16	JC GH	24814000	3157.1	4328.0	4823.1	18.47	298.12	✓	✓	78%	
	3-7-16	JC GH	24838000	3181.8	4391.2	4902.1	19.17	301.88	✓	✓	82%	
	3-14-16	JC GH	24865000	3284.1	4391.2	4967.2	19.32	301.88	✓	✓	78%	

Copy or Photograph Operational Information found in the field

EFCN
environmental finance center network

After the Assessment Interpreting the data – going from HP to $

What to do with your data?

Collect it in one place – at least one year's worth

- Handwritten
- Electronic
  - Table
  - Spreadsheet

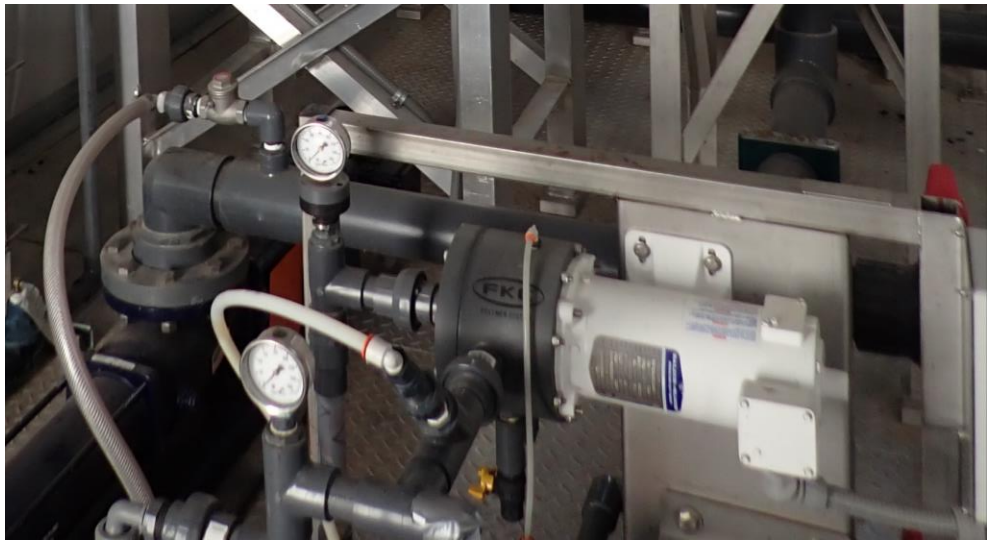
The benefit of a spreadsheet – it helps you do the math

Data Collected in Walkthrough

Asset Name – Each piece of equipment you looked at should be written down separately

Nameplate Horsepower (HP) – Review your pictures if you need to

Variable Frequency Drive – Note if the equipment uses a VFD. If so, this requires more information to accurately calculate the energy consumed (HP reduction % = frequency reduction)



Data Collected in Walkthrough

Average Run Time - Based on field observation, staff reports, SCADA data, runtime reports, etc.

Design Specs – If flow rates aren't known, look for what the design was intended for (pump tests, well logs, other documents)

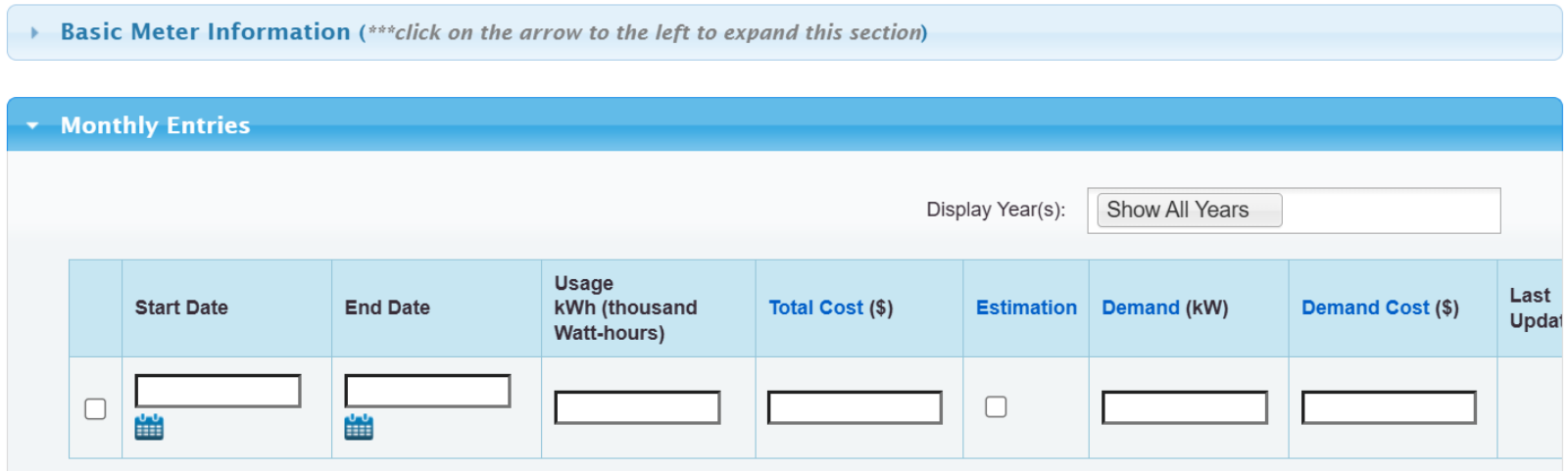
Operating Status – Based on observation or staff report, alternate, lead lag, seasonal, off-line for 3 months, etc.

Calculations

Calculated Power Consumption (kW) - Horsepower x 0.746 (conversion factor)

Hours of Operation per Year –Calculated from the avg. run time (convert hrs/day to hrs/year, etc.)

Total kWh per Year – Calculated power consumption (kW) x Hours of operation per year



Calculations

Average Energy Costs (cents/kWh) – Based on energy bills, energy rate schedule

Total Cost - Total kWh per year x Average Energy Cost

Cost per MG - Total cost/Total flow – this is often the only way to compare “apples to apples”

System - Energy Use Assessment

Asset Name	Type of Energy Used	Nameplate HP	Variable Speed Y/N	Calculated Power Consumption (kW)	Hours of Operation per Year	Total kWh per Year	Average Run Time	Design Specs	Operating Status	Avg. Cost cents/kWh	Total Cost	Cost per MG
Lift Pump 1	Electric	40	Y	29.84	3,889	116,054	324			$ 0.09	$10,495	$ 186.65
Lift Pump 2	Electric	20	Y	14.92	2,383	35,557	199	235gpm		$ 0.12	$4,313	$ 116.20
Bar Screen	Electric			0		0				$ 0.09	$0	
Aeration Blower 1	Electric	30	Y	22.38	2,740	61,324	228		alternate	$ 0.09	$5,546	$ 124.94
Aeration Blower 2	Electric	30	Y	22.38	2,702	60,465	225			$ 0.09	$5,468	
Sludge Pumps 1 and 2	Electric	10	N	7.46	192	1,432				$ 0.09	$130	
Digester Heaters 1 and 2	Electric			24	80	1,920				$ 0.09	$174	
Chlorine Pump 1	Electric	20	Y	14.92	2,740	40,883		33 gpm		$ 0.09	$3,697	$ 89.44
Chlorine Pump 2	Electric	20	Y	14.92	2,702	40,310		33 gpm		$ 0.09	$3,645	
Recirculation Pump 1	Electric	10	Y	7.46	2,740	20,441				$ 0.09	$1,849	$ 54.07
Recirculation Pump 2	Electric	10	Y	7.46	2702	20,155				$ 0.09	$1,823	
TOTAL ENERGY COST PER YEAR											$ 37,138	77%

EFCN
environmental finance center network

Converting HP to $

Asset	HP	kW	Hours per Year	Energy Costs	Total Cost per Year
Lift Pump 1	20	14.92	3644	$0.29/kWh	$15,766
Aeration Blower 1	30	22.38	2253	$0.29/kWh	$14,622
Sludge Pump 1	40	29.84	45	$0.33/kWh	$443

Runtime Records - 1 year average

Date	Lift Pump 1	Lift Pump 2	Aeration Blower 1	Aeration Blower 2
Jan-14	328.3	326.9	218.4	288.1
Feb-14	256	176.6	204.5	149
Mar-14	222.2	220.2	206.6	137.4
Apr-14	223.9	232.3	182.1	172.1
May-14				
Jun-14	283.4	251.3	227.5	183
Jul-14	365.7	51.7	311.5	187.2
Aug-14				
Sep-14	380.9	235.1	241.1	219.1
Oct-14	418.9	9.3	227	254
Nov-14	370.9	138.8	217.4	291.3
Dec-14	322.7	321.8	223.5	294.1
AVERAGE (hrs/month)	324.1	198.6	228.3444	225.1444

Flow Data

Date	Influent Pump 1	Influent Pump 2	Total Influent	Reuse Water	Sludge Transfer	Chlorine Dosing
Jan-14	2,424,000	5,241,300	7,665,300	5504.7	7186.5	761.3
Feb-14	3,643,500	3,429,500	7,073,000	4,526	5,913	608.1
Mar-14	2,066,700	4,442,200.00	6,508,900	4,732	6,127	711.3
Apr-14	2,212,400	5098500	7,310,900	4,917	6,456	455.5
May-14	2,309,500	5,294,900.00	7,604,400	5196.2	6923.7	426.6
Jun-14	2,829,000	4,840,000.00	7,669,000	5,261	6,948	374.6
Jul-14	7,207,600	564,200.00	7,771,800	5,839	7,545	510.6
Aug-14	8,222,700	300.00	8,223,000	6,284	8,024	613.8
Sep-14	8,189,500	1,800.00	8,191,300	6,069	7,710	538.4
Oct-14	8,514,400	-	8,514,400	6,159	7,948	256.9
Nov-14	5,871,100	2,477,800.00	8,348,900	6,606	8,459	286.9
Dec-14	2,737,300	5,723,900.00	8,461,200	6,803	8,907	515.3
				67,898	88,149	6,059
TOTAL	56,227,700	37,114,400	93,342,100	67,898,190	88,148,980	6,059,300

Energy Data – 2 year average

Wastewater Plant			
Date	Usage	$	$/kWh
Jul-13	42,800	$3,751.03	$0.09
13-Aug	39,200	4027.2	$0.10
13-Sep	38,200	$4,997.54	$0.13
13-Oct	51,300	$5,243.56	$0.10
13-Nov	35,700	$3,392.59	$0.10
13-Dec	34,600	$2,921.69	$0.08
Jan-14	50,300	$3,663.11	$0.07
Feb-14	49,300	$3,883.38	$0.08
Mar-14	44,400	$3,594.15	$0.08
Apr-14	36,400	$3,562.10	$0.10
May-14	33,700	$3,500.51	$0.10
Jun-14	39,400	$3,545.77	$0.09
Jul-14	34,700	$3,611.89	$0.10
Aug-14	47,400	$5,372.83	$0.11
Sep-14	53,200	$5,896.31	$0.11
Oct-14	48,000	$4,795.34	$0.10
Nov-14	44,200	$3,428.60	$0.08
Dec-14	50,100	$3,231.45	$0.06
Jan-15	56,300	$3,245.96	$0.06
Feb-15	53,200	$3,780.00	$0.07
Mar-15	45,900	$3,723.50	$0.08
Apr-15	40,400	$3,491.86	$0.09
May-15	38,400	$3,311.71	$0.09
TOTAL	1,007,100	$89,972.08	
AVERAGE	43,787	$ 3,911.83	$ 0.09

Using the Data to Make Decisions about Energy Use and Operations

EFCN
environmental finance center network

What's all that data tell you?

What's all that data tell you

- Energy Costs per Year
  - For each individual piece of equipment
- Better understanding of the operations of each piece of equipment
  - Constant on
  - Runs monthly
  - Averages 4 hours/day

So now what?

- Begin identifying Energy Efficiency Opportunities
  - System changes that allow you to reach your energy goals
- Then you will prioritize those projects and implement them

EFCN
environmental finance center network

Categories for Energy Efficiency Opportunities

- Capital program or equipment replacement
- Process change
- Operational change
- Automation or controls
- Maintenance improvements
- Business measures



NYSERDA's Best Practices

Operational Flexibility

Staging of Treatment Capacity

Managing for Seasonal/Tourist Peaks

Flexible Sequencing of Basin Use

Idle or Turn off Equipment

Electric Motors: Install High Efficiency Motors

Electric Motors: Automate to Monitor and Control Supervisory Control and Data Acquisition (SCADA)

Electric Motors: Variable Frequency Drives Applications

Electric Motors: Correctly Size Motors

Electric Motors: Properly Maintain Motors

Electric Motors: Improve Power Factor

Pumps: Optimize Pump System Efficiency

Pumps: Reduce Pumping Flow

Pumps: Reduce Pumping Head

Pumps: Avoid Pump Discharge Throttling

Optimize Grit Removal System

Chemically Enhanced Primary Settling

Optimize Aeration System

Fine Bubble Aeration

Variable Blower Ariflow Rate

Dissolved Oxygen Control

Filtration: Sequence Backwash Cycles

Ultraviolet (UV) Désinfection Options

UV Désinfection: Install Dose Pacing

Sludge: Improve Solids Capture in DAF System

Sludge: Replace Centrifuge with Screw Press

Sludge: Replace Centrifuge with Gravity Belt Thickener

Biosolids Digestion Options

Aerobic Digestion Options

Biosolids Mixing Options in Aerobic Digesters

Biosolids Mixing Options in Anaerobic Digesters

Optimize Anaerobic Digester Performance

Cover Basins for Heat Reduction

Recover Excess Heat from Wastewater

Reduce Fresh Water Consumption/Final Effluent Recycling

EFCN
environmental finance center network

Case Study

EFCN
environmental finance center network

Town of Crested Butte

Project Overview

Town of Crested Butte operates a 0.6 MGD oxidation ditch wastewater treatment plant that serves a small mountain community

Department of Energy's National Renewable Energy Laboratory (NREL) partnered with the town to conduct an energy audit through their program to identify low-and no-cost energy efficiency opportunities

Source: https://www.osti.gov/servlets/purl/1036045

Listed Key Energy Efficiency Opportunities

Replace underutilized Lift Pump No. 1 with a more efficient unit

Address excessive inflow and infiltration (I&I) during snowmelt season

Replace non-functional DO sensor and integrate with VFD for better control

Cycle off mixers during aerator operation to reduce redundant energy use

Replace aging surface aerator with more efficient model

Deactivate one UV bank and optimize bulb replacement practices

Retrofit piping to bypass an idle, energy-wasting aerobic digestion tank

Improve sludge transfer system to minimize blower operation time

Prioritized Opportunities

Implement Priority Short-Term Actions

- Mixer cycling
- DO sensor replacement
- UV optimization

Pursue Long-Term Upgrades

- Use external funding (e.g.,CWSRF,USDARD)

Develop an Energy Management Plan (EMP)

Benchmark Portfolio

Conduct I&I study and engage community in water conservation initiatives

Process	Recommendations	Savings (kWh - % energy - $/year)
Influent Pumping/Headworks	Use Pump No.1 during low flow (ST) Conduct I&I study (LT) Replace Pump No.1 (LT)	4,300 - 10% - $150 14,000 - 35% - $550 8,700 - 20% - $350
Aeration/Oxidation Ditch	Turn mixers off when aerator operates (ST) Replace DO meter (ST) Connect new DO meter to SCADA/ Replace aerator (LT)	45,900 - 90% - $1,750 19,800 - 10% - $750 123,000 - 40% - $4,700
UV Disinfection	Remove one UV bank from service/ Determine if bulbs can be removed (ST)	32,000 - 50% - $1,200
Solids Handling	Retrofit piping to feed sludge directly from thickened sludge tank to centrifuge (LT)	23,500 100% - $1,000
ST = short-term, LT- long-term		

EFCN
environmental finance center network

Energy Management System Resources

New York State Energy Research and Development Authority (NYSERDA)

United States Department of Energy (DOE) Sustainable Wastewater of the Future (SWIFt) Accelerator

Energy Star Portfolio Manager

Environmental Protection Agency (EPA) Energy Efficiency for Water Utilities


Questions?

Thank You For Attending!

Take a moment to check out our resources:

Tools & Publications:
efcnetwork.org/resources/tools-and-publications

Multimedia Library | Podcasts, Blogs, and Videos:
efcnetwork.org/multimedia

State Funding Tables:
efcnetwork.org/resources/funding-tables

Educators Resource Hub | Water Lesson Plans & Career Resources:
efcnetwork.org/resources/educators-resource-hub



Subscribe to EFCNews:

Monthly round up of news, resources, and events from EFCN.

Subscribe to Septic-Savvy:

Quarterly news, resources, and insights to keep you septic-savvy.

CONTACT INFORMATION



SOUTHWEST
ENVIRONMENTAL
FINANCE CENTER

Dawn Nall
dnall@unm.edu

Department of Civil Engineering MSC01 1070
1 University of New Mexico
Albuquerque, NM 87131
505-277-0644
swefc@unm.edu
http://swefc.unm.edu