Using Energy Savings to Help Support Equipment Upgrades

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Greta Thunberg Recent Quote:

"Blah, Blah, Blah. Green Economy. Blah, Blah, Blah. Net Zero by 2050. This is all we hear from our so called leaders. Words that sound great but so far have not lead to action"

"Hypocrites and greenwashing"

Do you just claim to be "efficient" or do you have the data to back it up?

Poll Question

What electric energy and system data do you track monthly? (check all that apply)

Survey Choice	Last Year Polled %
Electric bill kWh and total cost	80%
Electric bill individual charges (demand/supply/delivery)	40%
Electric use benchmarked with flow or BOD	18%
Pump station energy bill data compared with pump run time	36%
None of the above	--

Some progress, but the numbers need to be higher

Grading your Energy Initiatives

"A" Grade

- **Detailed monthly energy bill data is entered into a spreadsheet.**
- **Energy use is benchmarked with process data, graphed and compared with last year and last month.**
- **Each month, energy use/demand is compared with equipment operation (run time, electric heat thermostat settings, wet weather, etc…). Additional flow/runtime/power meters are installed to optimize & track energy for individual systems.**
- **Engineers that are designing facility upgrades are held accountable for including energy efficient features and using the NHDES Energy Design Guidance Document.**
- **Multiple energy projects are actively being pursued *and savings are tracked* on both sides of the meter.**

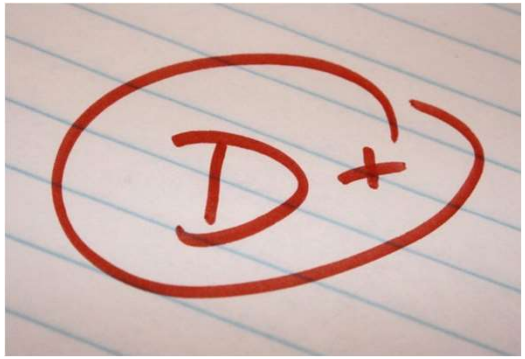
The municipalities that embrace these actions deserve an "A"

Grading your Efficiency Initiatives

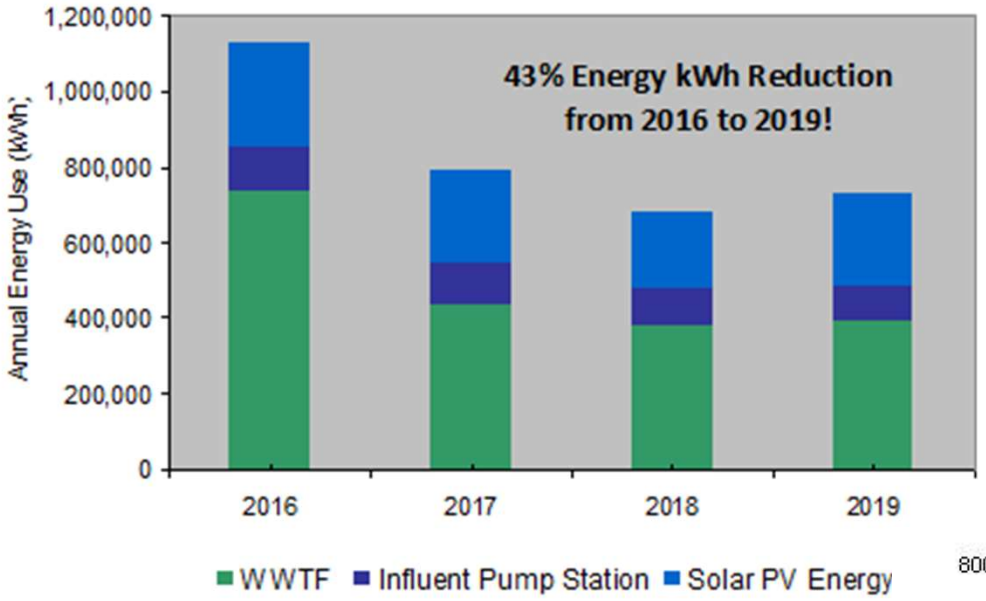
"D" Grade

- Monthly energy bill data (only kWh and cost) is tracked by the town office but not reviewed by plant staff monthly.
- No benchmarking with process data or comparing energy use with equipment operation.
- Minimal equipment meters, run time data is collected but not used.
- When engineers say "the new design is efficient" that's good enough.
- Staff believes that there is no need to pursue energy projects since the facility installed some LED lighting, have VFDs and energy efficient motors.

These municipalities get a "D" grade

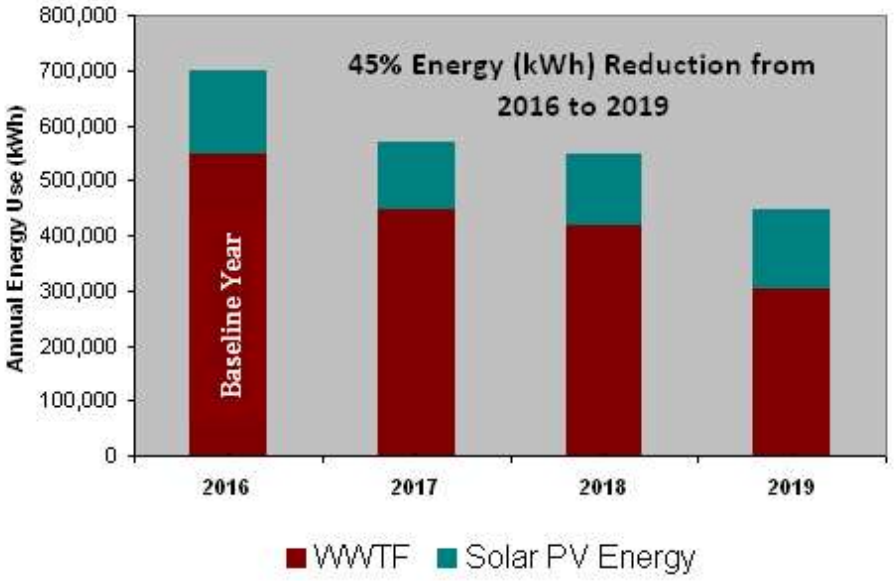


How do you compare with other New Hampshire Water/Wastewater Systems?



Peterborough WWTF data shows a 43% reduction in energy

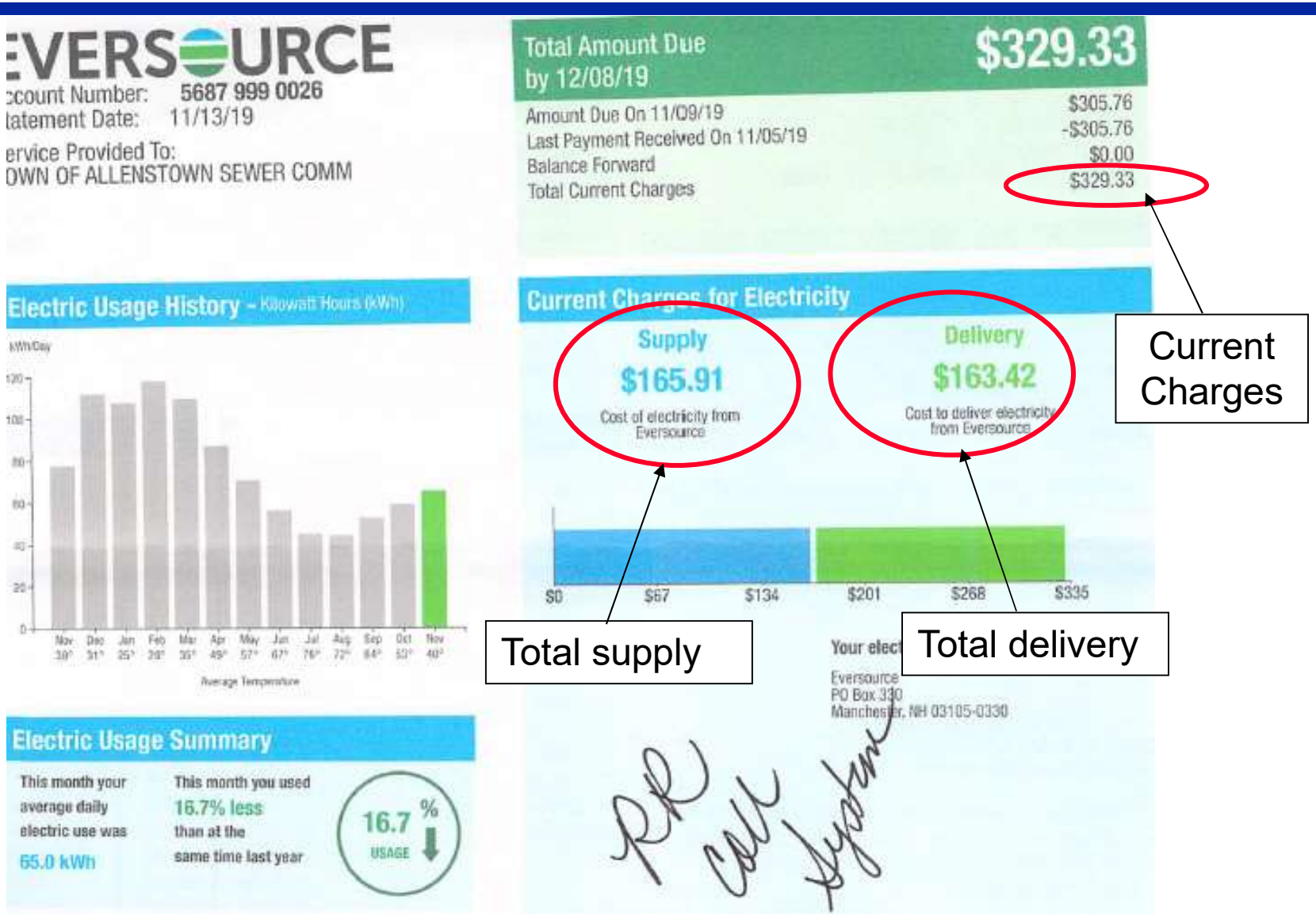
Plymouth WWTF data shows a 45% reduction in energy



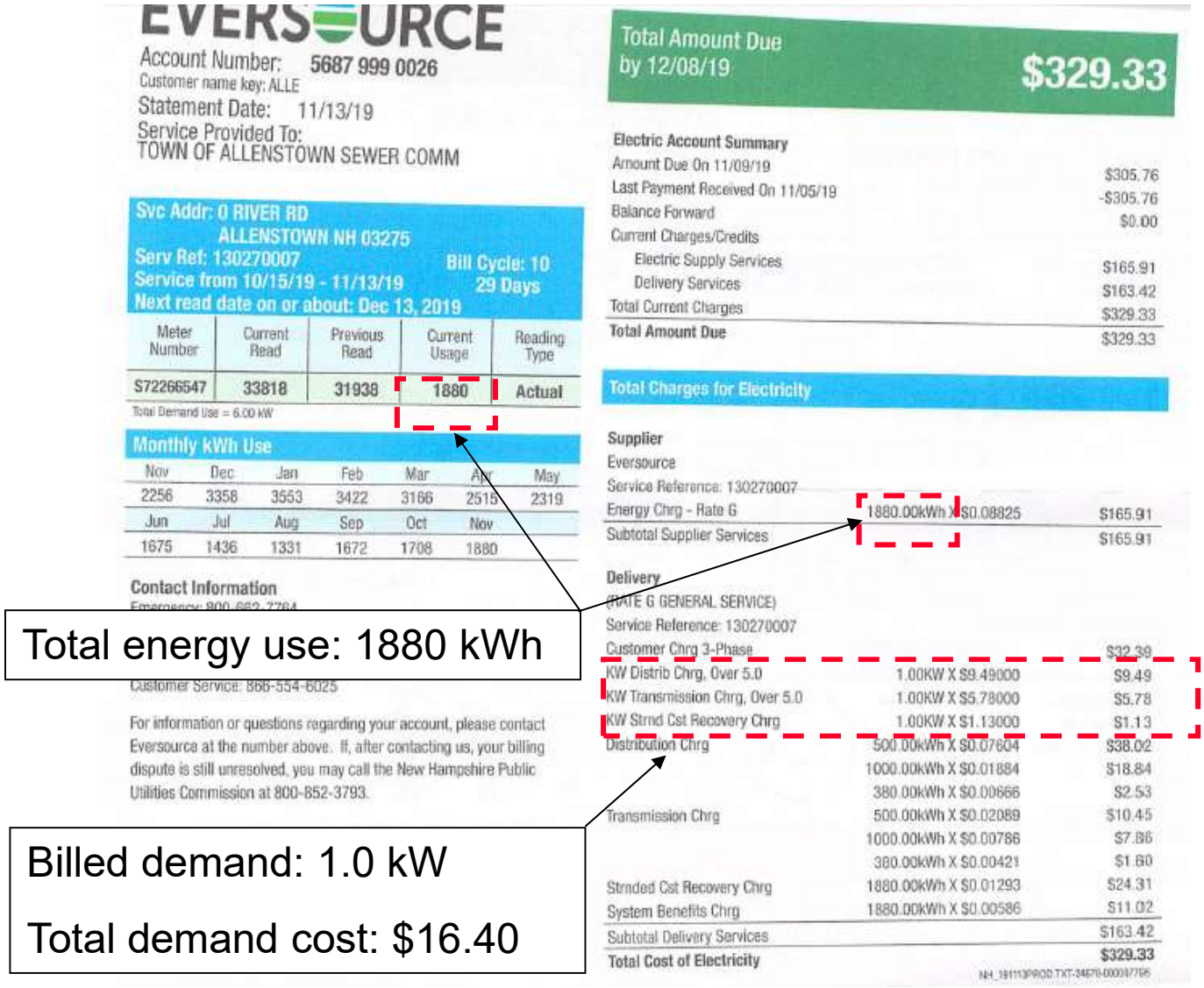
First Piece of the Puzzle:

Start with the Utility Bills

Eversource Bill (Page 1)



Eversource Bill (Page 2)



EVERSOURCE

Account Number: 5687 999 0026
Customer name key: ALLE
Statement Date: 11/13/19
Service Provided To:
TOWN OF ALLENSTOWN SEWER COMM

Svc Addr: 0 RIVER RD
ALLENSTOWN NH 03275
Serv Ref: 130270007 Bill Cycle: 10
Service from 10/15/19 - 11/13/19 29 Days
Next read date on or about: Dec 13, 2019

Meter Number	Current Read	Previous Read	Current Usage	Reading Type
S72266547	33818	31938	1880	Actual

Total Demand Use = 6.00 kW

Monthly kWh Use

Nov	Dec	Jan	Feb	Mar	Apr	May
2256	3358	3553	3422	3166	2515	2319
Jun	Jul	Aug	Sep	Oct	Nov	
1675	1436	1331	1672	1708	1880	

Contact Information
Emergency: 800-662-7764
Customer Service: 866-554-6025

For information or questions regarding your account, please contact Eversource at the number above. If, after contacting us, your billing dispute is still unresolved, you may call the New Hampshire Public Utilities Commission at 800-852-3793.

Total Amount Due by 12/08/19 $329.33

Electric Account Summary

Amount Due On 11/09/19	$305.76
Last Payment Received On 11/05/19	-$305.76
Balance Forward	$0.00
Current Charges/Credits	
Electric Supply Services	$165.91
Delivery Services	$163.42
Total Current Charges	$329.33
Total Amount Due	$329.33

Total Charges for Electricity

Supplier
Eversource
Service Reference: 130270007

Energy Chrg - Rate G	1880.00kWh X $0.08825	$165.91
Subtotal Supplier Services		$165.91

Delivery
(RATE G GENERAL SERVICE)
Service Reference: 130270007

Customer Chrg 3-Phase		$32.39
KW Distrib Chrg, Over 5.0	1.00KW X $9.49000	$9.49
KW Transmission Chrg, Over 5.0	1.00KW X $5.78000	$5.78
KW Strnd Cst Recovery Chrg	1.00KW X $1.13000	$1.13
Distribution Chrg	500.00kWh X $0.07604	$38.02
	1000.00kWh X $0.01884	$18.84
	380.00kWh X $0.00666	$2.53
Transmission Chrg	500.00kWh X $0.02089	$10.45
	1000.00kWh X $0.00786	$7.86
	380.00kWh X $0.00421	$1.60
Strnded Cst Recovery Chrg	1880.00kWh X $0.01293	$24.31
System Benefits Chrg	1880.00kWh X $0.00586	$11.02
Subtotal Delivery Services		$163.42
Total Cost of Electricity		**$329.33**

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Total energy use: 1880 kWh

Billed demand: 1.0 kW

Total demand cost: $16.40

Tracking Pump Station Energy Bill Data with a Simple Excel Spreadsheet

Energy Use (kWh) & Demand (kW)

Supply, Delivery & Demand Costs

Month	Energy Use (kWh)	Actual Demand (kW)	Demand Cost	Delivery (kWh) Cost	Monthly Fee	Energy Supply Cost	Total Delivery Cost	Total Cost
Jan	3,553	7.6	$43	$213	$30	$320	$286	$606
Feb	3,422	10.5	$90	$205	$30	$308	$326	$634
Mar	3,166	7.6	$43	$190	$30	$285	$263	$548
Apr	2,515	7.8	$46	$151	$30	$226	$227	$453
May	2,319	6.8	$30	$139	$30	$209	$199	$407
Jun	1,675	4.7	$0	$101	$30	$167	$128	$295
Jul	1,436	4.3	$0	$86	$30	$143	$121	$264
Aug	1,331	4.7	$0	$80	$30	$125	$122	$247
Sep	1,672	5.5	$8	$100	$30	$148	$149	$297
Oct	1,708	5.8	$13	$102	$30	$151	$155	$306
Nov	1,880	6	$16	$113	$30	$166	$163	$329
Dec	2,722	6.1	$18	$163	$30	$240	$190	$430
Totals	**27,399**	**77.4**	**$307**	**$1,644**	**$360**	**$2,488**	**$2,327**	**$4,815**

This is Why You Track Even the Small Bills..

2020	Energy Use (kW/h)	Billed Demand (kW)	Demand Cost	Energy (kW/h) Cost	Monthly Cost	Total Supply	Total Delivery	Total Cost
Jan	41	0.1	$0	$2	$17	$4	$19	$23
Feb	50	0.1	$0	$3	$17	$4	$20	$24
Mar	46	0.1	$0	$3	$17	$4	$20	$24
Apr	46						20	$24
May	50						20	$24
Jun	44						20	$23
Jul	50						20	$24
Aug	43						$20	$23
Sep	46	0.1					$20	$24
Oct	49	0.1					$20	$24
Nov	44	0.1					$20	$23
Dec	462	1.5					$44	$83
Totals	960	2.6					$262	$344

2020 Energy Data for Water Storage Tank

2021	Energy Use (kW/h)	Billed Deman (kW)					Total Delivery	Total Cost
Jan	1035	1.5					$79	$168
Feb	1031	1.5	$0	$62	$17	$88	$79	$167
Mar	1,038							$168
Apr	1,193							$191
May	981							$160
Jun	1,110							$179
Jul	1,129							$181
Aug	1,006	1.5	$0	$60	$17	$86	$77	$163
						2021 Prorated		$2,064

2021 Energy Data for Water Storage Tank

Annual 2020 cost only $344

Annual 2021 prorated cost **$2,064**

PT

Next Piece:

Summarize Equipment Run Time & Process Data

Internal System Data Collection

- Collect monthly equipment run time. If you don't have hour meters – just start with your best guess.
- If equipment is on a VFD, estimate typical speeds (in the future this should be recorded on log sheets).
- Last step: Estimate equipment power draw (to be discussed).

Group equipment by each process and use the data to estimate energy use for each system.

Developing the baseline is the first step to identify energy savings and help justify equipment upgrades.

Tracking Pump Station Energy Bill Data with a Simple Excel Spreadsheet

Pump Hours & Energy Use

Pump Energy & Misc. Energy (most of it for electric heat)

Month	Pump #1	Pump #2	Total Pump Hours	Monthly Flow (MG)	Pump Energy Use (kWh)	Estimated Energy Use (kWh) for Misc. Equipment	Station Billed Energy Use (kWh)
Jan	26	26	52	0.7	417	3,136	3,553
Feb	24	24	47	0.6	376	3,046	3,422
Mar	26	26	52	0.7	417	2,749	3,166
Apr	25	25	50	0.7	403	2,112	2,515
May	26	26	52		417	1,902	2,319
					403	1,272	1,675
					417	1,019	1,436
					417	914	1,331
					403	1,269	1,672
Oct	26	26	52	0.7	417	1,291	1,708
Nov	25	25	50	0.7	403	1,477	1,880
Dec	26	26	52	0.7	417	2,305	2,722
Total	**307**	**307**	**613**	**8.1**	**4,906**	**22,493**	**27,399**

How you use hours to get to energy use is coming up

Estimating/Measuring 3-Phase Power

Preliminary

For those of you with amp meters

kW = motor hp * .746 * estimated load

kW = motor hp * .746 * amp measurement / motor FLA

kW = amps * voltage * 1.732 * power factor / 1000
(amperage measured)

kW = instantaneous value from single CT power meter

kW = instantaneous value with 3-CT power meter

kW = may be shown on VFD display!

HOURS * kW = kWh

Accurate

Figuring out the Plant Energy Use Breakdown

Using run time and estimated kW for pump stations is simple - but what about all the equipment at the Water/WW Plant?

Estimating energy use can be done the same way – just do one system at a time

One System in the Energy Balance

Aeration System

Equipment	Motor Hp	Power (kW)	Annual Hours	Annual Energy Use (kWh)
Anoxic Mixer #1	2.50	2.20	4,380	9,636
Anoxic Mixer #2	2.50	2.20	4,380	9,636
Blower #1	20.00	7.00	2,920	20,440
Blower #2	20.00	7.00	2,920	20,440
Blower #3	20.00	7.00	2,920	20,440
Total				**80,592**

Motor HP

Power (kW) at typical Blower VFD speed (on VFD display, estimate or measured)

Evenly divided for equipment based on 8760 hours/year

The Energy Balance Results

Plant System	Baseline Annual Use (kWh)	Percent of Total
Septage	955	0%
Preliminary Treatment	2,850	1%
Influent Pumping	15,655	5%
Aeration	80,592	24%
Final Clarifiers/RAS Pumps	11,763	3%
UV Disinfection	52,560	16%
Effluent Pumping	0	0%
Sludge Storage	60,444	18%
Sludge Dewatering	5,555	2%
Miscellaneous Process Equipment	2,238	1%
WWTF & PS Building Systems	105,280	31%
Annual Total	**337,892**	**100%**
Annual Electric Use from 2020 Bills	**337,500**	**--**

Once the energy balance is completed, it becomes obvious where all your energy is going. *For this WWTF these four systems account for 89% of this plant's energy use.*

Now that you have energy data, you need to see how it is matched to system operation

Additional Metering/Data May be Needed

Pump System

-Flow & pressure instrumentation to evaluate efficiency

-Is the pump matched to what is required by the system?

Aeration

-Flow, pressure and dissolved oxygen

-Are the blowers/aerators matched to what the system needs?

Heating Systems

-Are you operating the heating unit at the lowest thermostat level?

-Are you using the lowest cost method of heating?

Installing Hour Meters for Additional Equipment

- Run-time meters are standard for pump systems
- They can also be used for generator block heaters, electric space heaters and dehumidifiers.

Wastewater & Water Plant Benefits for Investing in Meters

- Having reliable meters for high energy use equipment will help identify energy savings.

System	Metering Equipment	Benefit
Fuel Oil & Propane Tanks	Electronic Fuel Gauge	Track fuel use monthly Avoid running out of fuel
Blowers	Airflow Meter Energy kWh submeter	Help poor diffuser efficiency Identify air leaks Evaluate blower efficiency
Pumps	Flow Meter Run time meter Energy kWh meter	Provide pump energy use reality check. Evaluate pump efficiency Determine operational issues
Electric Heaters, Block Heaters, Dehumidifiers	Plug in run time meters Energy kWh meters	Identify hidden energy use and impact of thermostat/control settings

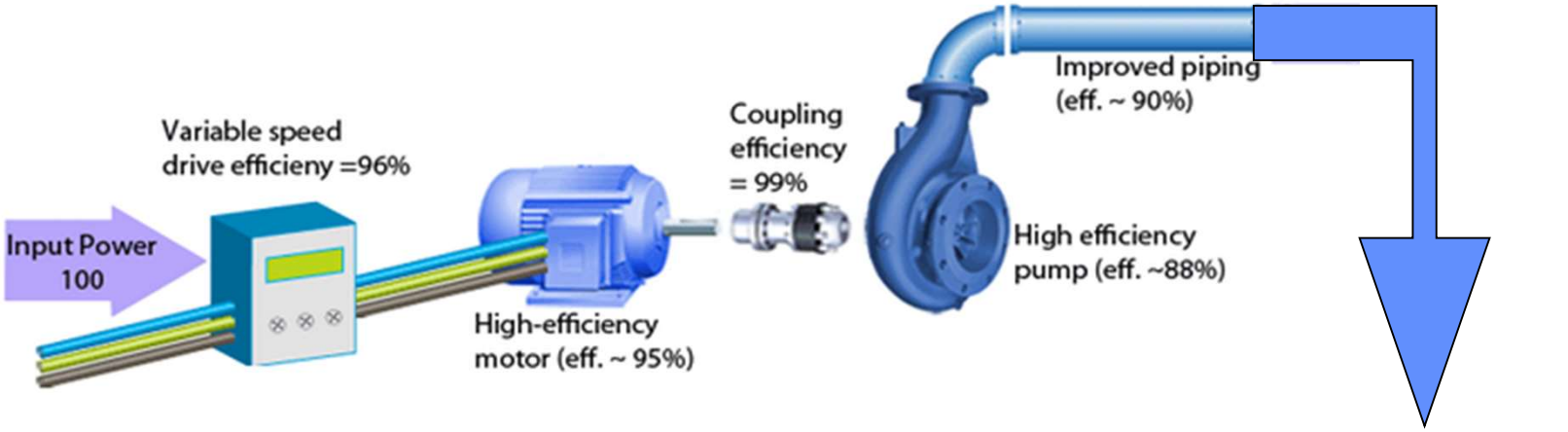
Benefits of Metering/Data Tracking

- **Increases energy use awareness.**
- **Improves system reliability.**
- **Helps identify equipment performance issues.**
- **Provides the data needed to calculate equipment efficiency.**
- **Most important… Helps you determine if the equipment is matched to SYSTEM REQUIREMENTS.**

Metering/Data Tracking will help you Make Better Decisions when Upgrading Equipment/Systems

System or Component "Efficiency"?

Real savings come from "System Efficiency" not "Component Efficiency" Improvements.



END USE

Minimizing losses on the *end use side* of the equipment has a *much greater savings impact* to help support equipment/system upgrades.

System "Leakage" Poll Question

What "leaks" do you suspect are a problem at your plant (check all that apply)?

Survey Choice	% Polled Last Year
Blower airflow	40%
Plant water piping leakage	38%
Building air leakage from door seals or ventilation dampers that don't seal tightly.	100%
No "leaks" that I know of	--

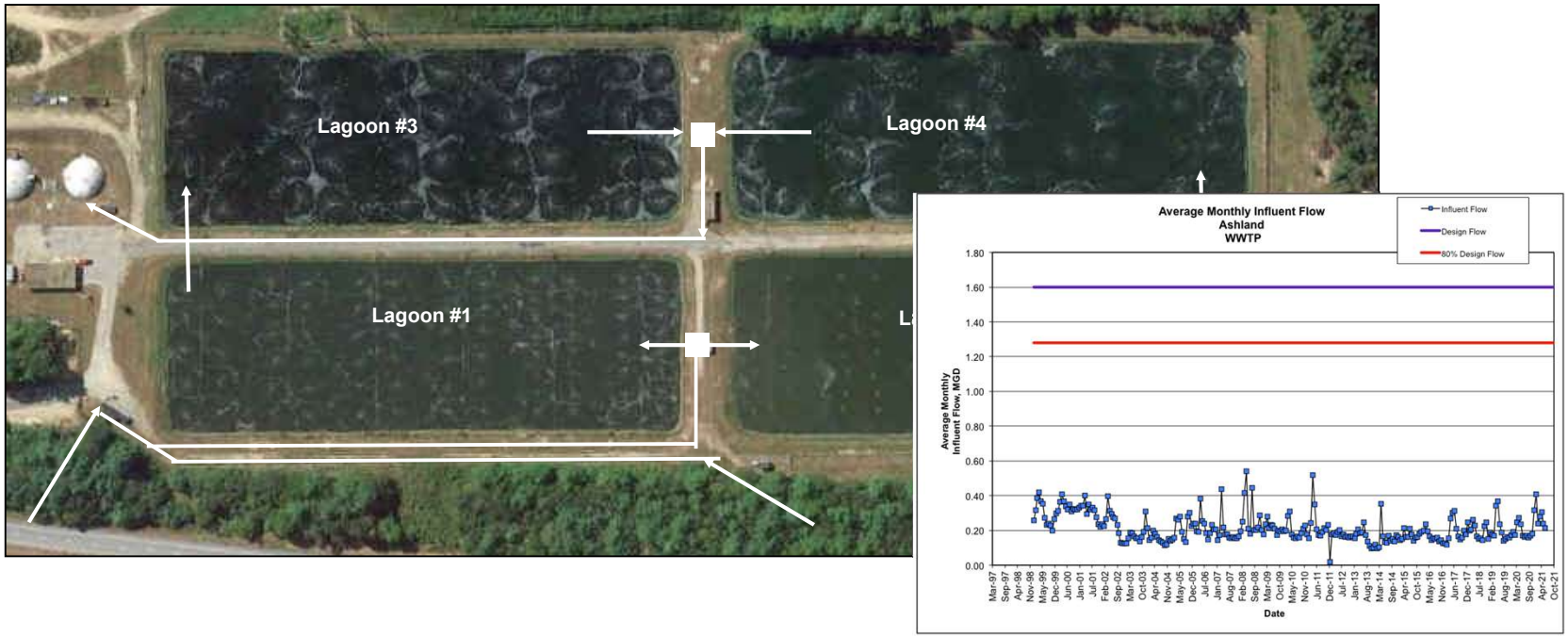
If you can quantify the leakage you can justify the work to fix it!

How can energy savings be used to support equipment upgrade projects?

Example #1 Lagoon Blower/VFD Energy Saving Measure

Take the Short Term Savings or
Invest in Assets for Long Term Resiliency?

Blower Energy Saving Project



Existing Operation/Potential Changes

-Two parallel lagoon systems operated, but with low flows only one primary/secondary needed.

-With fewer diffusers to supply, the 75 hp blower VFD speed can be dropped from 60 Hz to 30 Hz while maintaining a DO >2.0 mg/l

Option #1: Realize Immediate Savings

Existing blower energy use at 60 Hz (1700 scfm curve value):

41.5 kW * 8760 hours =363,512 kWh

New reduced VFD speed 33 Hz (800 scfm curve value):

18.6 kW * 8760 hours =162,511 kW

Annual cost savings:

363,512 kWh – 162,511 kWh * $0.115/kWh = $23,115

Simple Payback: Immediate

Is this the best approach?

OR…

Option #2: Invest in Assets

Is a better approach to use the energy savings to justify upgrading the system assets?

ECM #1: Upgrade 20 year old fine bubble diffusers: ~$100,000

OM #1: Purchase more stable boat for DO readings ~$ 2,000

Original Annual Savings: $23,115

Asset Investment: $102,000

Simple Payback: 4.4 years

If a higher simple payback was acceptable, maybe new blowers/VFDs could also have been justified

Getting Started

A few action items that you can start with to optimize your equipment operation.

-Can you put your VFD in manual and adjust the speed to determine the ***optimal kW/MG***?

-Have you adjusted your DO setpoint ***as low as possible*** to optimize blower operation (1 mg/l reduction can mean a ~8% blower system energy use reduction).

-What are your electric heater thermostat settings? If you have a high low knob, are you using a thermometer to ***verify the setting is 50 degrees of less?***

-***Start developing a plan*** (installing metering, collecting data, etc…) to identify aeration/water system leaks and tighten up your buildings to reduce air infiltration.