Energy Basics

Bills, Benchmarks, and Baselines

Wastewater/Water Energy Training Program

Session 1 June 13, 2012

Energy Smart Industrial
BPA ENERGY EFFICIENCY


Chad Reed →
thor
PARTS UNLIMITED
9


Don’t be that guy…
thor

- Where have I been?
  - Historic power consumption
  - Past audits and efforts
- Where am I now?
  - Reading an Electric Bill: kW, KVars and Demand – OH MY!
  - Rate schedules, meter multipliers
  - Benchmarking
- Where am I headed?
  - Energy Audits
  - Typical Savings Opportunities

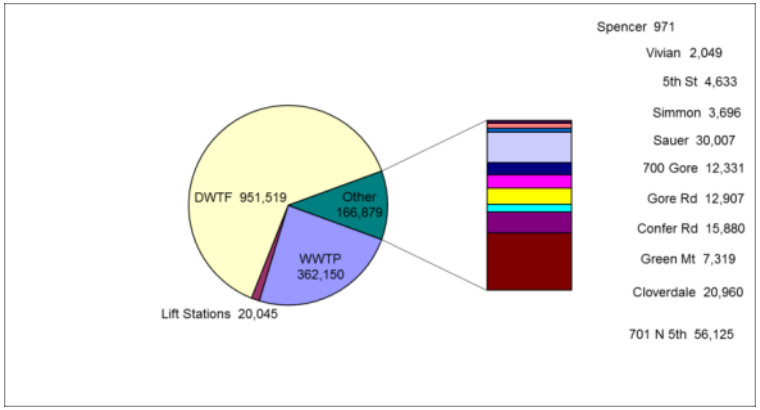
Where have I been?

- Do you know your local power and gas account rep?

- Your rep can provide a printout of historical usage and associated charges.
  - Is there a trend?
  - Any “step” changes – e.g. switching from chlorine disinfection to UV . . .?

Where have I been?

- Other issues associated with billing:
  - Who reviews and pays your monthly power bill?
  - What percentage of your operating costs goes towards energy?
  - How much am I paying for demand vs. consumption?
  - Where am I using energy?



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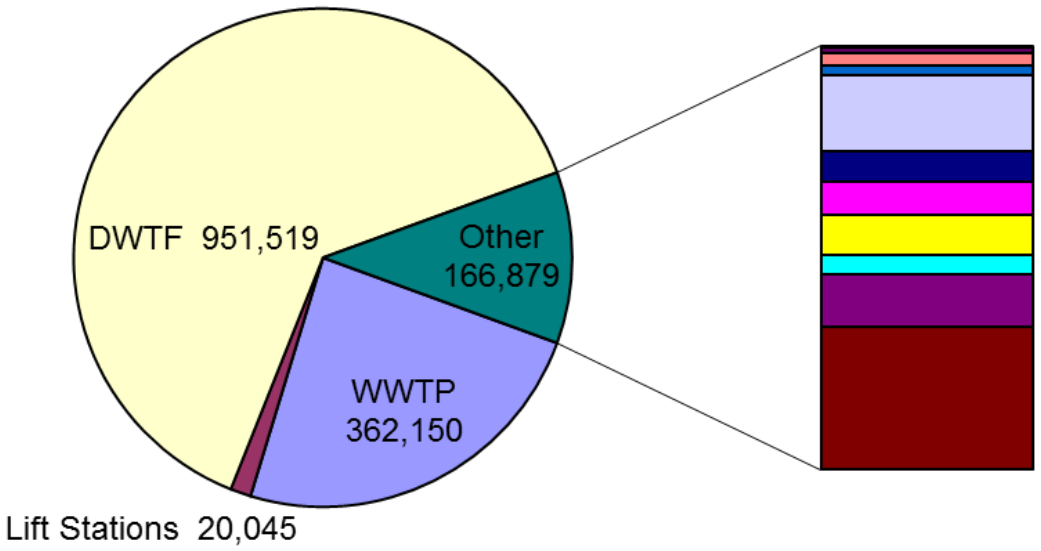


Spencer 971

Vivian 2,049

5th St 4,633

Simmon 3,696

Sauer 30,007

700 Gore 12,331

Gore Rd 12,907

Confer Rd 15,880

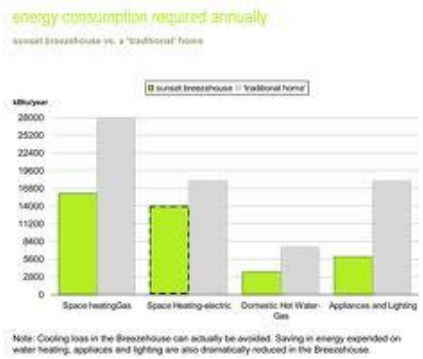
Green Mt 7,319

Cloverdale 20,960

701 N 5th 56,125

Where have I been?

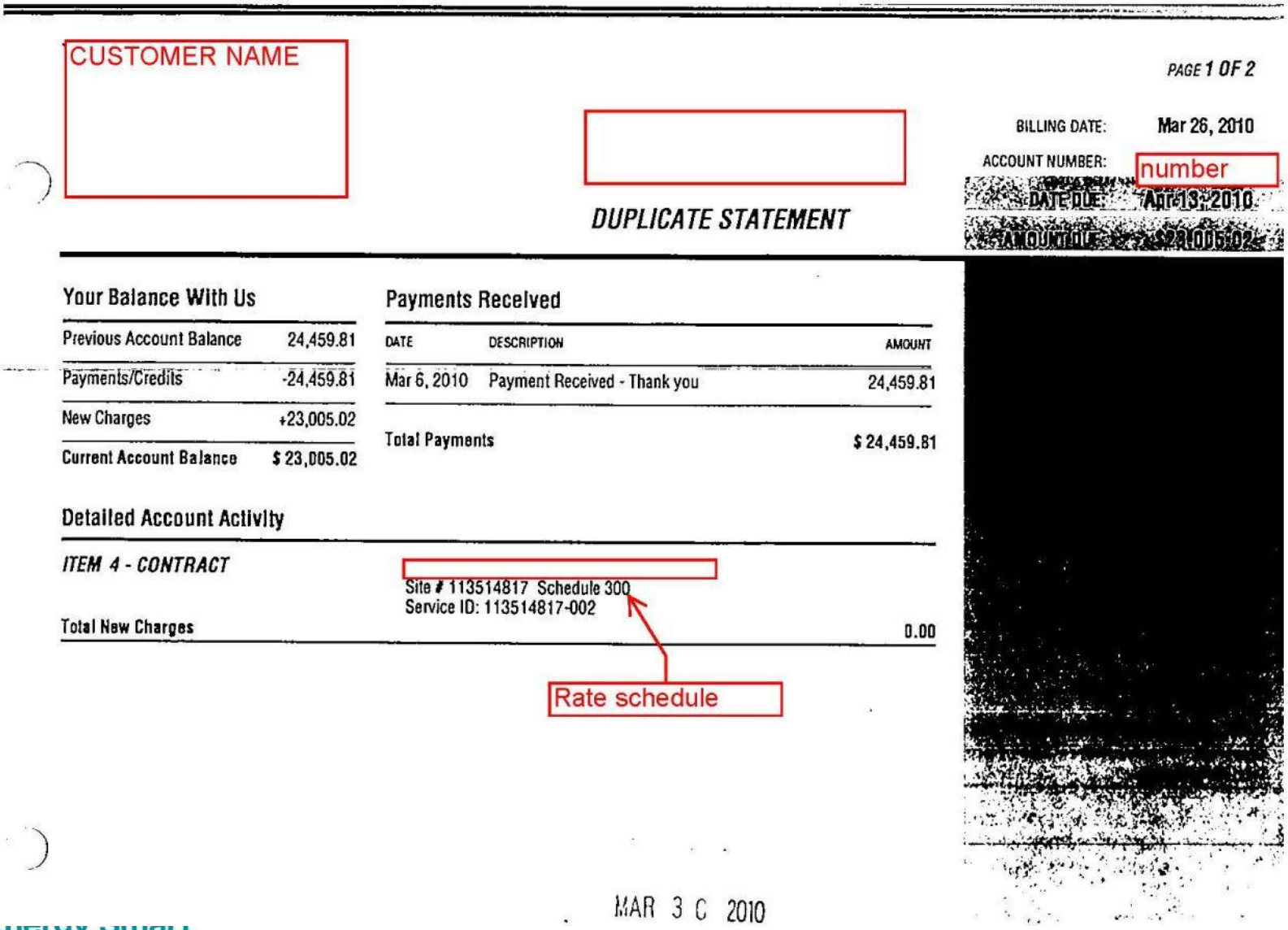
- Has your facility ever performed or received an energy study or audit?



- Dust off those old energy studies.
  - Similar or same equipment still in use? – Probably!
  - Ideas that were good then are usually still good now.

Where am I now?

- *The Basics – Your Power Bill*
  - What rate are you paying?
  - How is power measured?
  - What is a “demand charge” and how can I control it?
  - What is “power factor” and does it matter?



CUSTOMER NAME

PAGE 1 OF 2

BILLING DATE: Mar 26, 2010

ACCOUNT NUMBER: number

DATE DUE: Apr 13, 2010

AMOUNT DUE: $23,005.02

DUPLICATE STATEMENT

Your Balance With Us

Previous Account Balance	24,459.81
Payments/Credits	-24,459.81
New Charges	+23,005.02
Current Account Balance	$ 23,005.02

Payments Received

DATE	DESCRIPTION	AMOUNT
Mar 6, 2010	Payment Received - Thank you	24,459.81
Total Payments		$ 24,459.81

Detailed Account Activity

ITEM 4 - CONTRACT

Site # 113514817 Schedule 300
Service ID: 113514817-002

Rate schedule

Total New Charges 0.00

MAR 3 0 2010

[redacted]

Questions about your bill: Call toll free [redacted]

BILLING DATE: **Mar 26, 2010** ACCOUNT NUMBER: [redacted] DATE DUE: **Apr 13, 2010** AMOUNT DUE: **$23,005.02**

ITEM 5 - ELECTRIC SERVICE

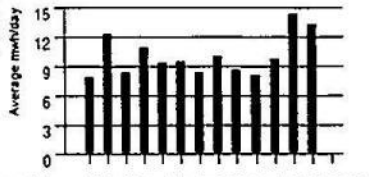
[redacted]
Sewer Treatment Schedule 30
Service ID: 113514817-003

METER NUMBER	SERVICE PERIOD From	To	ELAPSED DAYS	METER READINGS Previous	Current	METER MULTIPLIER	AMOUNT USED THIS MONTH
28819932	Feb 24, 2010	Mar 25, 2010	29	10344	10669	1,200.0	390,000 kwh
28819932	Demand	Mar 25, 2010			0.615	1,200.0	738 kw
28819932	Reactive	Mar 25, 2010			0.413	1,200.0	496 kvar

Next scheduled read date: 04-23. Date may vary due to scheduling or weather.

NEW CHARGES - 03/10	UNITS	COST PER UNIT	CHARGE
Basic Charge - 3P Pri Delivery	842 kw	0.6000000	782.20
Demand Charge Pri - Min 100 Kw	738 kw	3.8900000	2,870.82
Base Supply Demand Charge	738 kw	1.0000000	738.00
Delivery Charge Primary	390,000 kwh	0.0012200	475.80
Oregon Tax Charge	390,000 kwh	0.0014200	553.80
Reactive Power Charge Pri	201 kvar	0.6000000	120.60
Supply Engy Pri 1st 20000 Kwh	20,000 kwh	0.0455400	910.80
Supply Engy Pri > 20000 Kwh	370,000 kwh	0.0404500	14,966.50
Public Purpose		0.0300000	642.56
Energy Conservation Charge	390,000 kwh	0.0015700	612.30
Low Income Assistance	390,000 kwh	0.0005000	195.00
Jc Boyle Dam Removal Surcharge for 8 day(s)	107,586 kwh	0.0003200	34.43
Copco/Iron Gate Dams Remv Schg for 8 day(s)	107,586 kwh	0.0009500	102.21
Total New Charges			23,005.02

Historical Data - *ITEM 5*



Your Average Daily kwh Usage by Month

PERIOD ENDING	MAR 2010	MAR 2009
Avg Daily Temp.	47	45
Total kwh	390000	231600
Avg kwh per Day	13448	7986
Cost per Day	$793.28	$517.00

Total rate: $0.04516/kWh

Demand Charge

Reactive Charge

Billing Terminology

Basic unit of electrical power is the watt, which is a pretty small unit. So we use kW, which is one-thousand of them.

or kiloWatt, as in

Watt . . . James Watt

but not that Watt →

From City of Thief River Falls, MN website:
http://www.citytrf.net/billing_process.htm

APPLIANCE	WATTS	HOURS USED	KWH USED PER MONTH	MONTHLY COST AT 8.7 CENTS PER KWH
Coffee Maker	894	10/mo.	9	78 cents
Toaster	1246	3/mo.	4	35 cents
Microwave	1450	11/mo.	16	$1.39
Range – large element	2100	16/mo.	34	$2.96
Range – small element	1600	16/mo.	26	$2.26
Oven – conventional	3500	30/mo.	105	$9.14
Dishwasher	1200	25/mo.	30	$2.61
Refrigerator – 18 cu. ft. frostfree	720	250/mo.	180	$15.66
Freezer – 15 cu. ft.	340	292/mo.	99	$8.61
Freezer – 15 cu. ft. frostfree	440	333/mo.	147	$12.79
Clothes Washer	500	30/mo.	15	$1.31
Clothes Dryer	4800	30 loads	91	$7.92
Iron	1010	12/mo.	12	$1.04
Water Heater	4500	Continuous	476	$41.41
Space Heater	1500	8/day	372	$32.36
Window Air Conditioner	1100	5/day	171	$14.88
Portable Fan	115	40/mo.	5	44 cents
Furnace Fan Motor – intermittent	350	200/mo.	70	$6.09
Furnace Fan Motor – continuous	350	720/mo.	252	$21.92
Lighting – 100 watt incandescent	100	6/day	18	$1.57
Lighting – 60 watt incandescent	60	6/day	11	96 cents
Compact Fluorescent – 60-watt equiv.	18	6/day	3	26 cents
Fluorescent – 2 four ft. tubes	100	6/day	18	$1.57
Stereo/CD Player	50	4/day	6	52 cents
Radio	10	8/day	2	17 cents
TV – 19 inch - Note all TV's vary greatly by brand and type	105	6/day	20	$1.74
TV – 27 inch	125	6/day	23	$2.00
TV – 42 inch LCD	225	6/day	41	$3.57
TV - 50 inch Plasma	350	6/day	63	$5.48
VCR/DVD	30	1/day	1	9 cents
Dehumidifier	250	6/day	47	$4.09
Fish Tank – pump, heater, light	130	Continuous	96	$8.35
Computer & Monitor	40	Continuous	29	$2.52
Ink Jet Printer	25	8/mo.	.2	2 cents
Laser Printer	1000	8/mo.	8	70 cents

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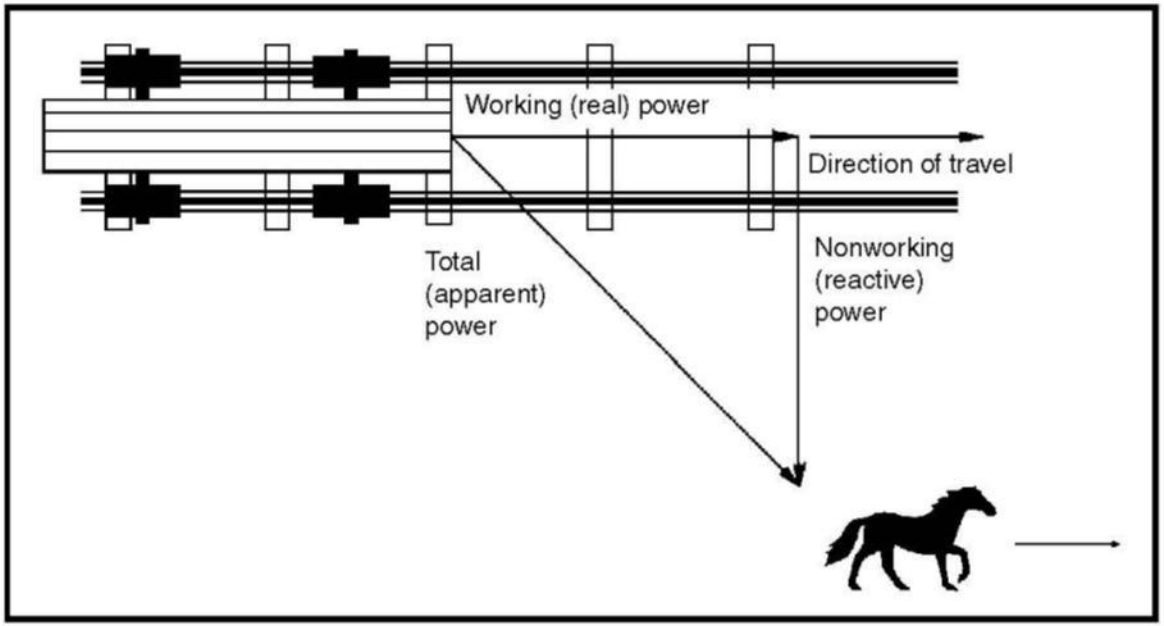
Billing Terminology

- kWh = kilowatt hour = 1000 Watts for 1 hour
  - 1 hp = 0.746 kW, so figure a 10 hp motor burns about 7.5 kW if running at full load.
  - That means a 15 kW unit heater is like a 20 hp motor
- Demand Charge - kW
  - The highest 15 - 30 minute average operating load during the billing month
  - Utilities must have the capacity to provide that amount of power, so it helps pay for the infrastructure.
  - “In-rush current” at motor start does not typically impact demand charge.
- Power Factor – Or “reactive” power
  - Measured in kVAR’s = Volt-Amps (Reactive)
  - Think of pulling a rail car.

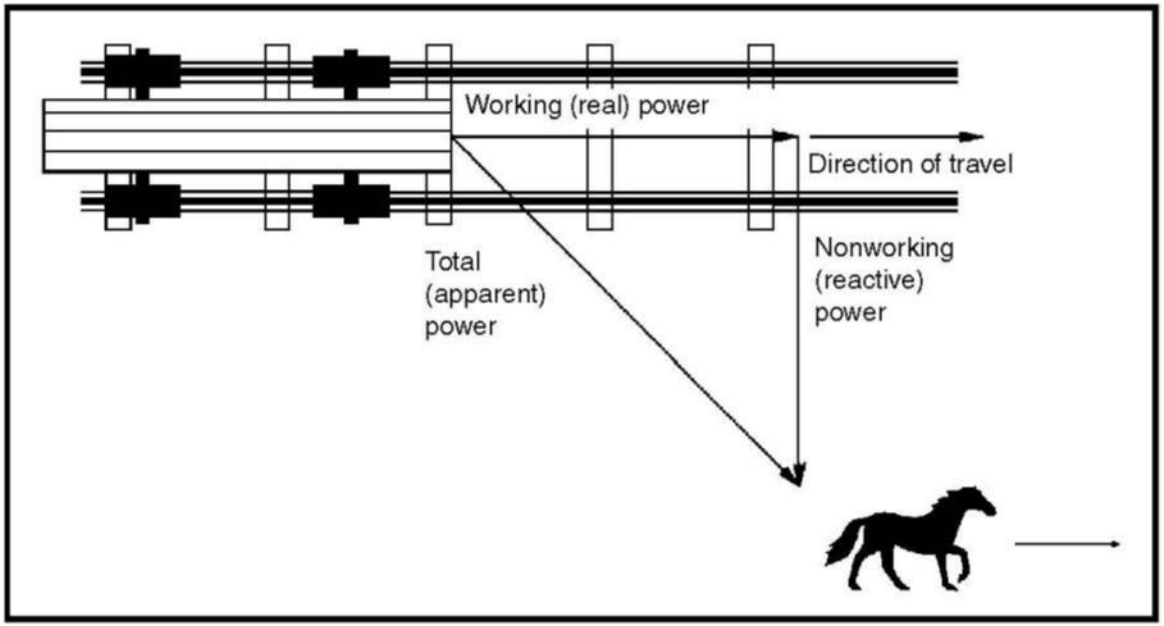
What is Power Factor?



Power Factor = Real (Useful) Power / Apparent (Supplied) Power

- the closer this is to 1.0, the happier your utility will be . . .

What is Power Factor?



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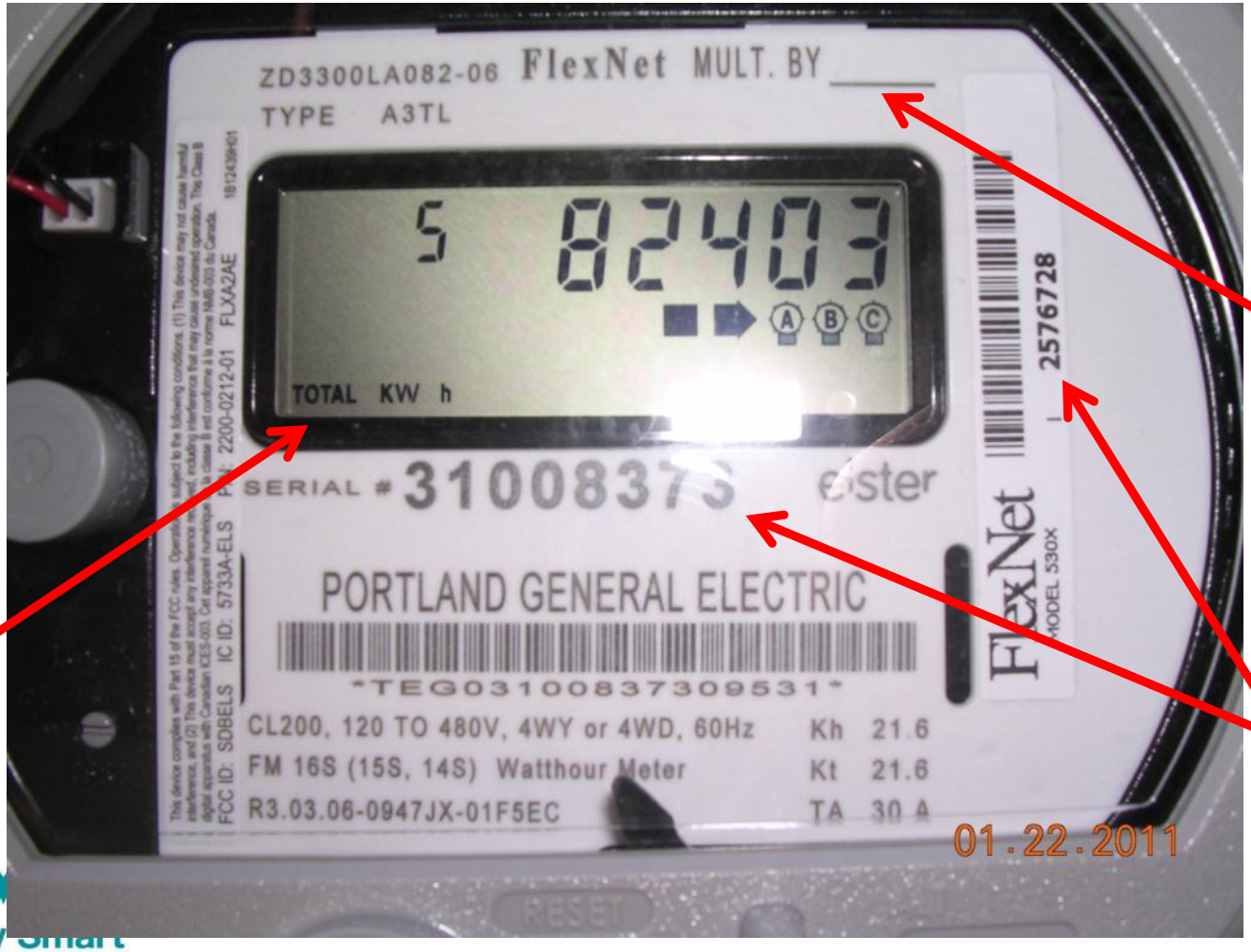
By the way,

1 HP

= 745.7 Watts

= 0.7457 kW

Meter Reading



PAGE 2 OF 2

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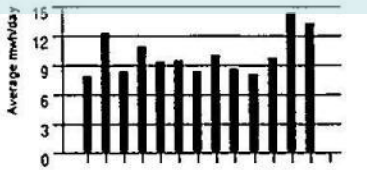

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Demand Charge

Reactive Charge

Customer LOTT ALLIANCE

PUGET SOUND ENERGY

Account No. 175-377-777-8

Electric Detail: 500 ADAMS ST NE # LOTT PLANT, OLYMPIA

Rate/ Dates	Meter Number	Pres Read	Prev Read	Pres Date	Prev Date	Mult	KWH (Usage)	Bill Demand	KVAR Hours	Code	Amount
31E-C-KV	Z003556845			04/19		2400		1888.8		ACTL	
31E-C-KV	Z003556845	13505	13245	04/19	03/21	2400			624000	ACTL	
31E-C-KV	Z003556845	22368	22026	04/19	03/21	2400	820800			ACTL	
31E-C-KV	Z003995063	14747	14747	04/19	03/21	2400				ACTL	
31E-C-KV	Z003995063	22754	22754	04/19	03/21	2400				ACTL	

03/22/12 03/31/12	Basic Charge		$113.31
03/22/12 03/31/12	Energy Charge	283,036.46 KWHS @ $.060001 Per KWH	$16,982.47
03/22/12 03/31/12	Demand Charge	1,888.8 KW @ $8.36 Per KW	$5,444.99
03/22/12 03/31/12	Reactive Power Charge	215,173.92 KVRH @ $.00103 Per KVRH	$221.63
03/22/12 03/31/12	Electric Conservation Program Charge	283,036.46 KWHS @ $.003321 Per KWH	$939.96
03/22/12 03/31/12	Power Cost Adjustment	283,036.46 KWHS @ $.00 Per KWH	$.00
03/22/12 03/31/12	Green Power Purchase	283,036.46 KWHS @ $.006 Per KWH	$1,698.22
03/22/12 03/31/12	Federal Wind Power Credit	283,036.46 KWHS @ $.000185CR Per KWH	$52.36CR
03/22/12 03/31/12	Renewable Energy Credit	283,036.46 KWHS @ $.00 Per KWH	$.00
03/22/12 03/31/12	Merger Credit	283,036.46 KWHS @ $.000209CR Per KWH	$59.15CR
03/22/12 03/31/12	Regulatory Asset Tracker	283,036.46 KWHS @ $.000075 Per KWH	$21.23
03/22/12 03/31/12	Effect Of Olympia City Tax	$25,310.30 @ $.09 Per Dollar	$2,277.93
		Charge Total	**$27,588.23**

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Customer LOTT ALLIANCE

PSE PUGET SOUND ENERGY

Account No. 175-377-777-8

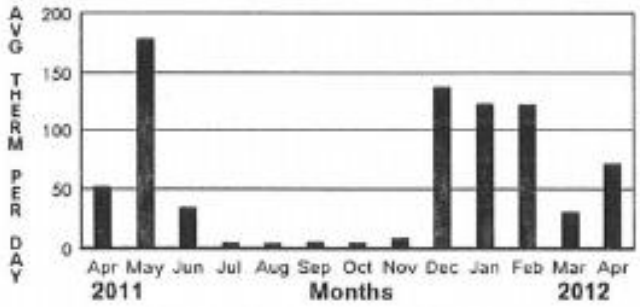
Gas Detail: A ST & FRANKLIN, OLYMPIA
Special Account ID: 1408
Utility Cost Manager

Rate	Meter Number	Pres Read	Prev Read	Pres Date	Prev Date	Turnup	Pressure / Temp	FPV / BTU Factor	CCF / Therms	Code
31G-C	000604810	08377	07387	03/30	03/01	990	15.10	1.002246	2008.61	ACTL
							60	1.031	2070.88	

Dates	Charge Description	Quantity	Price per Unit	Amount
03/02/12 03/30/12	Basic Charge			$32.32
03/02/12 03/30/12	Delivery Charge	2,070.88 Therms	@ $.31893 Per Therm	$660.47
03/02/12 03/30/12	Cost of Gas	2,070.88 Therms	@ $.64552 Per Therm	$1,336.80
03/02/12 03/30/12	Gas Conservation Program Charge	2,070.88 Therms	@ $.02627 Per Therm	$54.40
03/02/12 03/30/12	Merger Rate Credit	2,070.88 Therms	@ $.00276CR Per Therm	$5.72CR
03/02/12 03/30/12	Effect Of Olympia City Tax	$2,078.27	@ $.0904 Per Dollar	$187.88
	Current Gas Charges			**$2,266.15**

A late fee of 1% will apply to overdue charges, if any. Please see the reverse side for details on late payment charges.

A 3.852% state utility tax is included in gas rates charged.



ENERGY USAGE COMPARISON

For Bill Period	This Year	Last Year	Change
Mar-Apr			
No. of days	29	29	0
THRM use	2070.9	1496	574.9
Avg. THRM use per day	71.4	51.6	19.8
Avg. temp. per day	42F	43F	-1F

Where am I now?

- Benchmarks can be used for your “Energy Dashboard”

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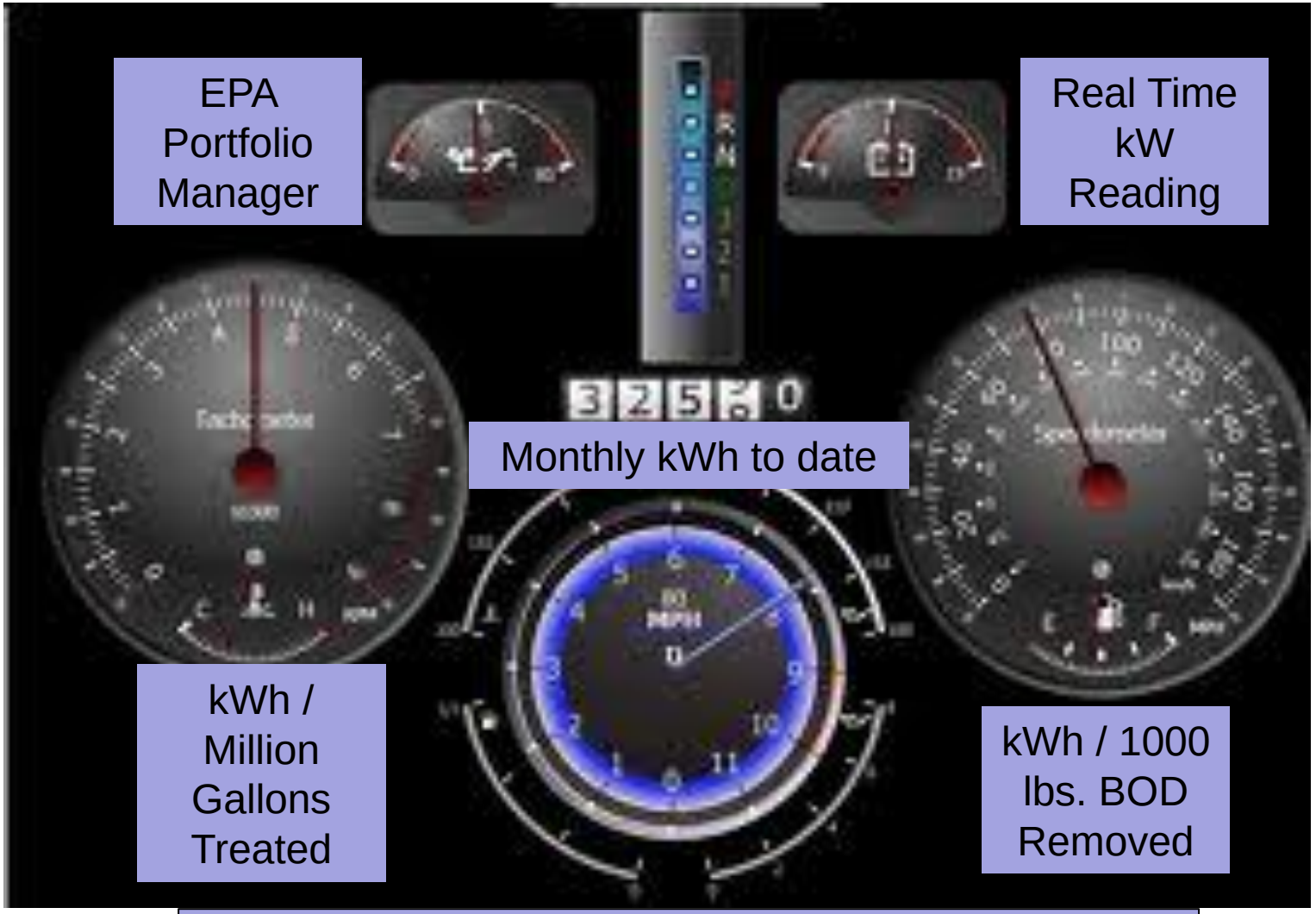

$$\text{Load Factor} = \frac{\text{kWh}}{\text{Peak kW x 24 x days in billing period}} \text{ X } 100$$

Load Factor:

Plant with 1 motor on 24/7 and 9 others only running day shift.

	Operating kW	# of hrs / mo.	Monthly kWh		
Motor 1	37.285	720	26,845		This is the 24/7 load.
Motor 2	37.285	240	8,948		These are all running 8 hours per day.
Motor 3	37.285	240	8,948		
Motor 4	37.285	240	8,948		
Motor 5	37.285	240	8,948		
Motor 6	37.285	240	8,948		
Motor 7	37.285	240	8,948		
Motor 8	37.285	240	8,948		
Motor 9	37.285	240	8,948		
Motor 10	37.285	240	8,948		
Total Monthly Usage (kWh)			107,381		
Peak Demand	372.85	(Because all 10 motors are running together during day shift.)			
	107,381	Total kWh consumed in Billing Cycle			
	268,452	Maximum kWh potential (as if PEAK demand ran all the time) = Peak D			
	0.4	Divide the two above			
Load Factor =	40	Multiply by 100 to convert to a percentage			

Get total kWh from power bill

Demand kW (from bill) x 24 hrs x # days in bill cycle

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Load Factor:

Plant with 1 motor 24/7; others moved to evening and graveyard shifts

	Operating kW	# of hours	Monthly kWh				
Motor 1	37.285	720	26845.2		Continuous		
Motor 2	37.285	240	8948.4		Day		
Motor 3	37.285	240	8948.4		Day		
Motor 4	37.285	240	8948.4		Day		
Motor 5	37.285	240	8948.4		Day		
Motor 6	37.285	240	8948.4		Evening		
Motor 7	37.285	240	8948.4		Evening		
Motor 8	37.285	240	8948.4		Evening		
Motor 9	37.285	240	8948.4		Grave		
Motor 10	37.285	240	8948.4		Grave		
Total Monthly Usage (kWh)			107,381	Same kWh as example 2A and 2B			
Peak Demand	186.425	(Because 5 motors are running together during day shift, 4 d					
	107,381	Number of kWh in Billing Cycle					
	134,226	Maximum kWh potential (as if PEAK demand ran all the time					
	0.8	Divide the two above					
Load Factor =	80	Multiply by 100 to convert to a percentage					

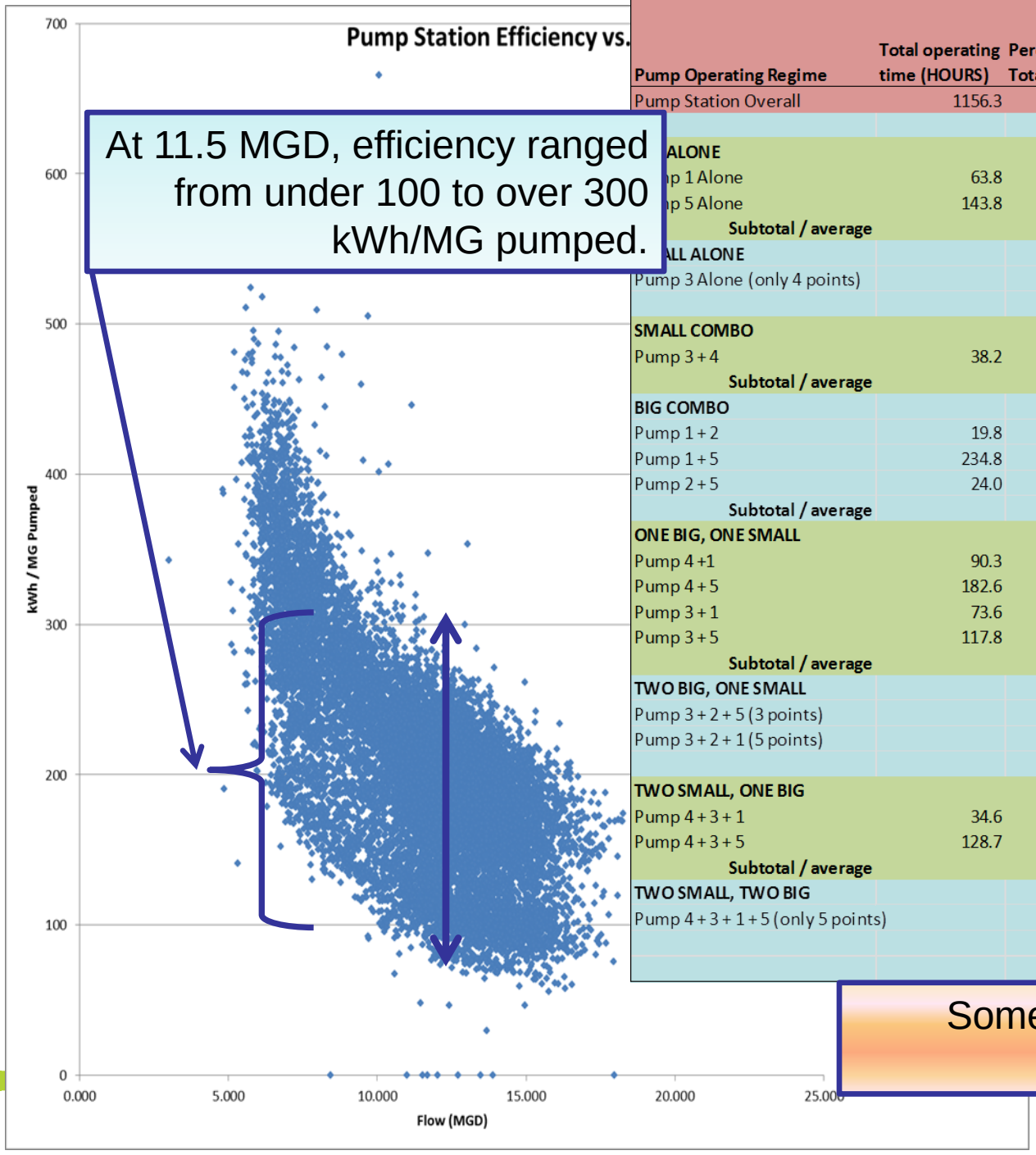
Still using same total energy

Demand dropped (why?)

Load factor now 80%, because the load has been shifted to equalize demand.

Where am I now? - Benchmarking

- Other possible benchmarks or metrics:
  - Process specific; e.g. average pump discharge pressure, number of hours spent above target D.O. levels, average transmembrane pressure, # of DE recoats per month, etc.
  - Total Power Cost / Total kWh
  - Total Energy Used Annually and Monthly
  - kWh per million gallons pumped is common unit for pumping



At 11.5 MGD, efficiency ranged from under 100 to over 300 kWh/MG pumped.

Pump Operating Regime	Total operating time (HOURS)	Percent of Total Runtime	Average flow (MGD)	Average kWh/MG Pumped	Flow % Offset from Ave	Eff % Offset from Ave
Pump Station Overall	1156.3		11.5	204.3	0.0%	0.0%
ALONE						
p 1 Alone	63.8	5.5%	10.9	140.2	-5.9%	31.4%
p 5 Alone	143.8	12.4%	12.2	126.8	6.0%	37.9%
Subtotal / average		**17.9%**	**11.5**	**133.5**	**0.1%**	**34.7%**
LL ALONE						
Pump 3 Alone (only 4 points)						
SMALL COMBO						
Pump 3 + 4	38.2	3.3%	12.9	100.3	12.2%	50.9%
Subtotal / average		**3.3%**	**12.9**	**100.3**	**12.2%**	**50.9%**
BIG COMBO						
Pump 1 + 2	19.8	1.7%	11.6	222.3	0.8%	-8.8%
Pump 1 + 5	234.8	20.3%	11.5	246.1	-0.7%	-20.4%
Pump 2 + 5	24.0	2.1%	11.4	243.3	-1.6%	-19.1%
Subtotal / average		**24.1%**	**11.5**	**237.2**	**-0.5%**	**-16.1%**
ONE BIG, ONE SMALL						
Pump 4 +1	90.3	7.8%	11.7	202.4	1.4%	0.9%
Pump 4 + 5	182.6	15.8%	11.3	209.3	-1.9%	-2.5%
Pump 3 + 1	73.6	6.4%	11.6	200.6	0.3%	1.8%
Pump 3 + 5	117.8	10.2%	11.1	208.7	-3.6%	-2.1%
Subtotal / average		**40.1%**	**11.4**	**205.3**	**-0.9%**	**-0.5%**
TWO BIG, ONE SMALL						
Pump 3 + 2 + 5 (3 points)						
Pump 3 + 2 + 1 (5 points)						
TWO SMALL, ONE BIG						
Pump 4 + 3 + 1	34.6	3.0%	13.3	206.1	15.3%	-0.9%
Pump 4 + 3 + 5	128.7	11.1%	10.9	260.0	-5.8%	-27.3%
Subtotal / average		**14.1%**	**12.1**	**233.1**	**4.7%**	**-14.1%**
TWO SMALL, TWO BIG						
Pump 4 + 3 + 1 + 5 (only 5 points)						

Some pump combinations should be avoided.

Where am I now? - Benchmarking

- Which one is “right”?
  - Probably none, but taken together over time, they can help you determine whether you are heading in the right direction.
- Things to consider
  - Where is your fenceline?
  - What data gathering / monitoring capability do you already have? What tests and record-keeping processes are already in place?
  - What things can you control?
  - What time commitment is required to maintain or perform the benchmarking?

Where am I now? - Benchmarking

"Don't step on it . . . it makes you cry."

Where am I now? - Benchmarking

- Some lessons learned:
  - Benchmarks are great for tracking your facility's performance over time. They are of limited value in comparing your facility to another.
  - You will need to include the energy you produce on-site as well as the energy you buy to obtain a true picture of your facility's efficiency.
  - Complicated benchmarks can be useful simply as a tool that forces you to gather data in a regimented manner.
  - Benchmarks are powerful marketing and communication tools.
  - Be Consistent! They are only useful if they are developed using the same methods during each reading.

Small Group Work

- *Which benchmarks seem most appropriate for your facility?*
- *How often will you track them?*
- *Are there any specific issues that need to be addressed?*

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Conservation Programs

Wastewater/Water Energy Training Program

Session 1 June 13, 2012

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ESI Utilities Within Washington

WASHINGTON (WEST)
Blaine, City of
Centralia City Light
Clallam County PUD
Clark Public Utilities
Cowlitz County PUD
Eatonville, Town of
Grays Harbor PUD
Klickitat PUD
Lakeview Light & Power
Lewis County PUD
Mason County PUD #1
Mason County PUD #3
McCleary, City of
Orcas Power & Light Cooperative
Pacific County PUD #2
Peninsula Light
Port Angeles, City of
Seattle City Light
Skamania County PUD #1
Snohomish County PUD
Sumas, City of
Tacoma Power
Tanner Electric Coop
Wahkiakum PUD
Whatcom County PUD #1

WASHINGTON (EAST)
Asotin County PUD
Benton PUD
Benton REA
Big Bend Electric Coop
City of Cheney Light & Public Works
City of Chewelah Electric Dept.
Columbia REA
Consolidated Irrigation District
Coulee Dam, Town of
Ellensburg, City of
Ferry County PUD #1
Franklin PUD
Grant County PUD
Inland Power & Light
Kittitas County PUD
Modern Electric Water Co.
Nespelem Valley Electric Cooperative
Okanogan Co PUD #1
Pend Oreille County PUD
Richland, City of
Vera Water & Power District

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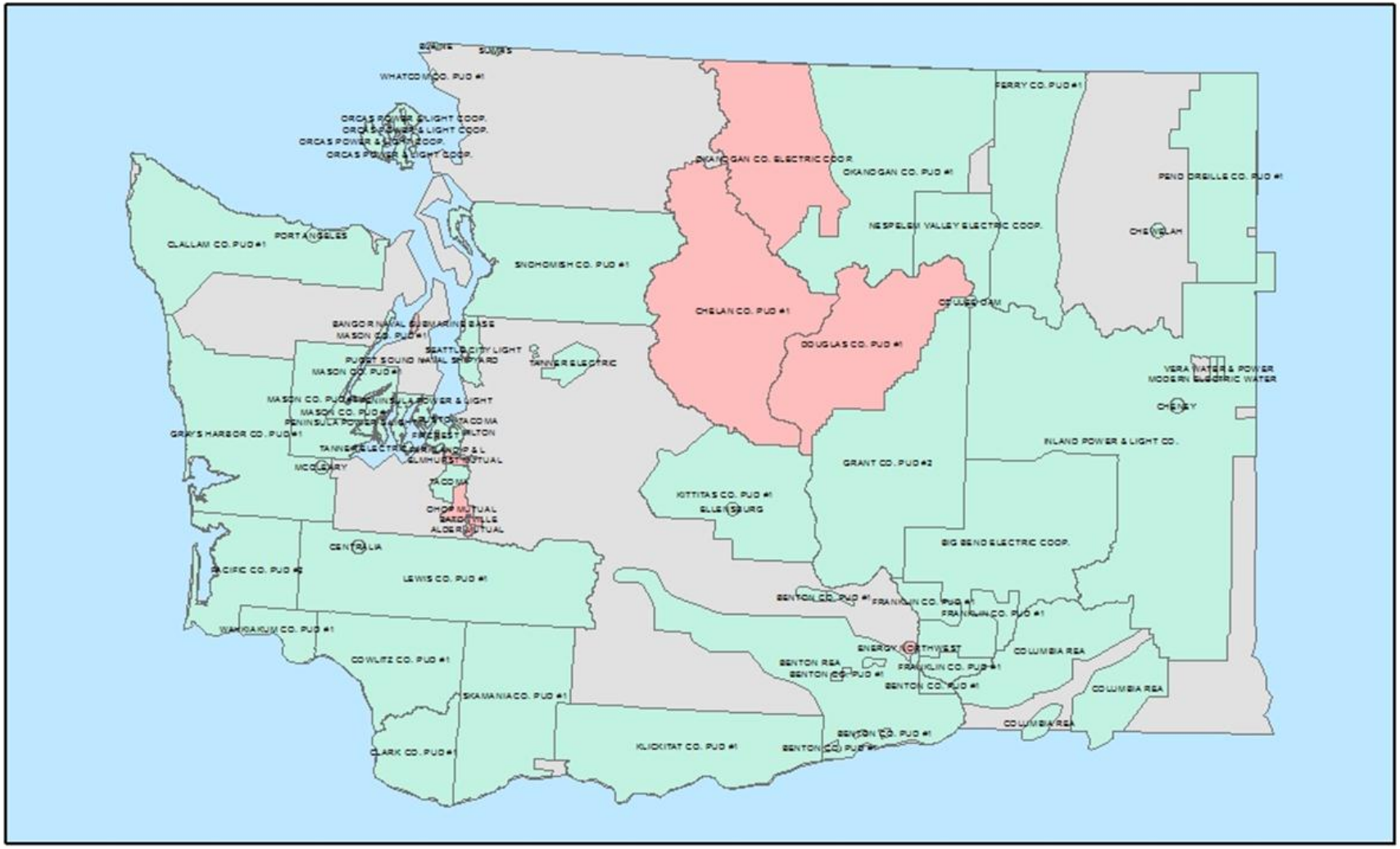
BPA Public Utilities - Washington State - ESI Opt-In Status



Legend

- Opted In Utilities
- Non-Opted In Utilities

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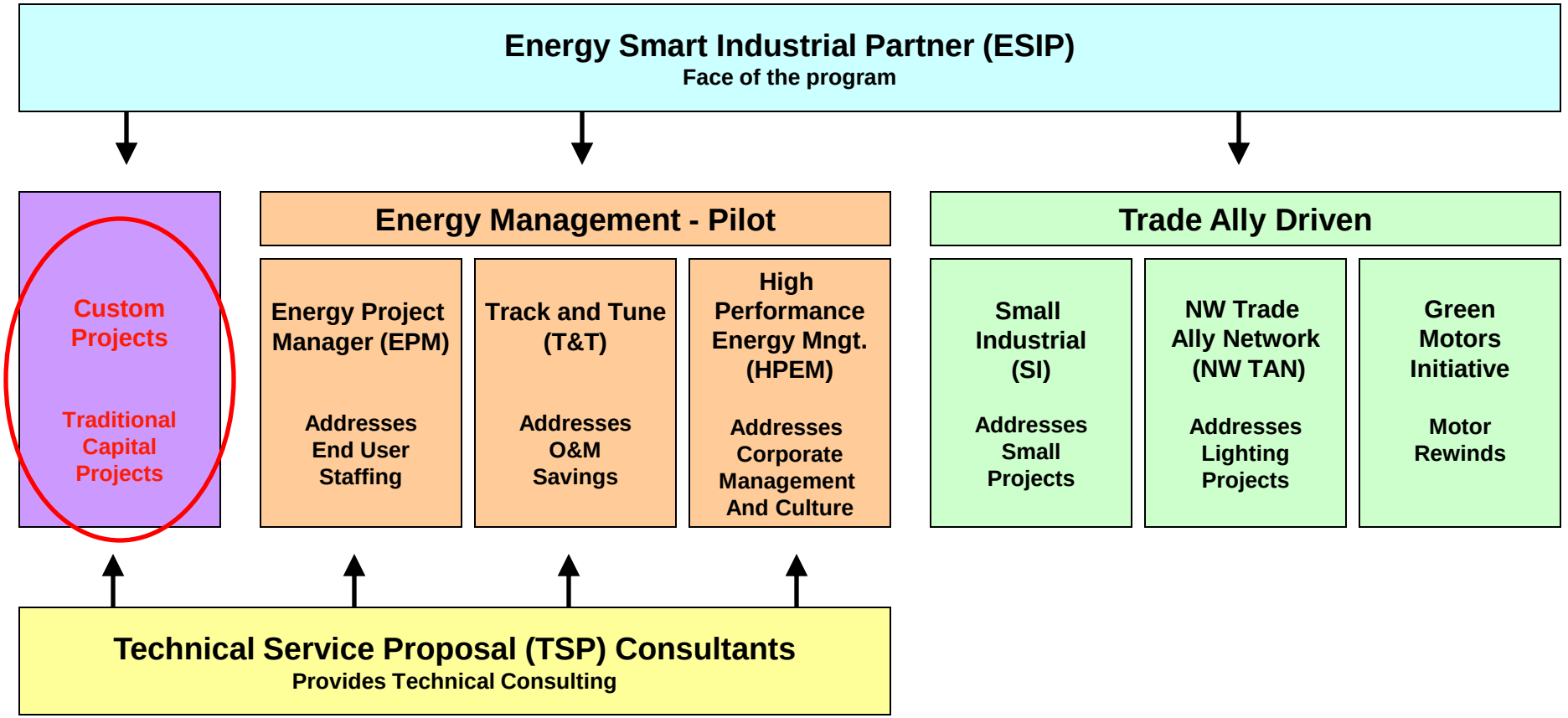
Energy Smart Industrial Program Components



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Custom Projects

- Incentives for traditional capital projects.

- Pumps
- Fans
- Compressed Air
- Refrigeration
- Lighting
- Motors
- Variable Frequency Drives
- Control Upgrades
- Process Upgrades

-Depending upon utility, but up to $0.25 per kWh saved in first year.

-Capped at 70% of project cost

-You get the lesser of 25 cents / kWh OR 70% of project cost.

-Project cost can include design fees, and can be incremental cost between “baseline” and “efficient” equipment for new construction

-Paid based on Measured and Verified (M&V) savings.

-The payment comes after the project is complete, so capital funds still needed upfront to cover the project.

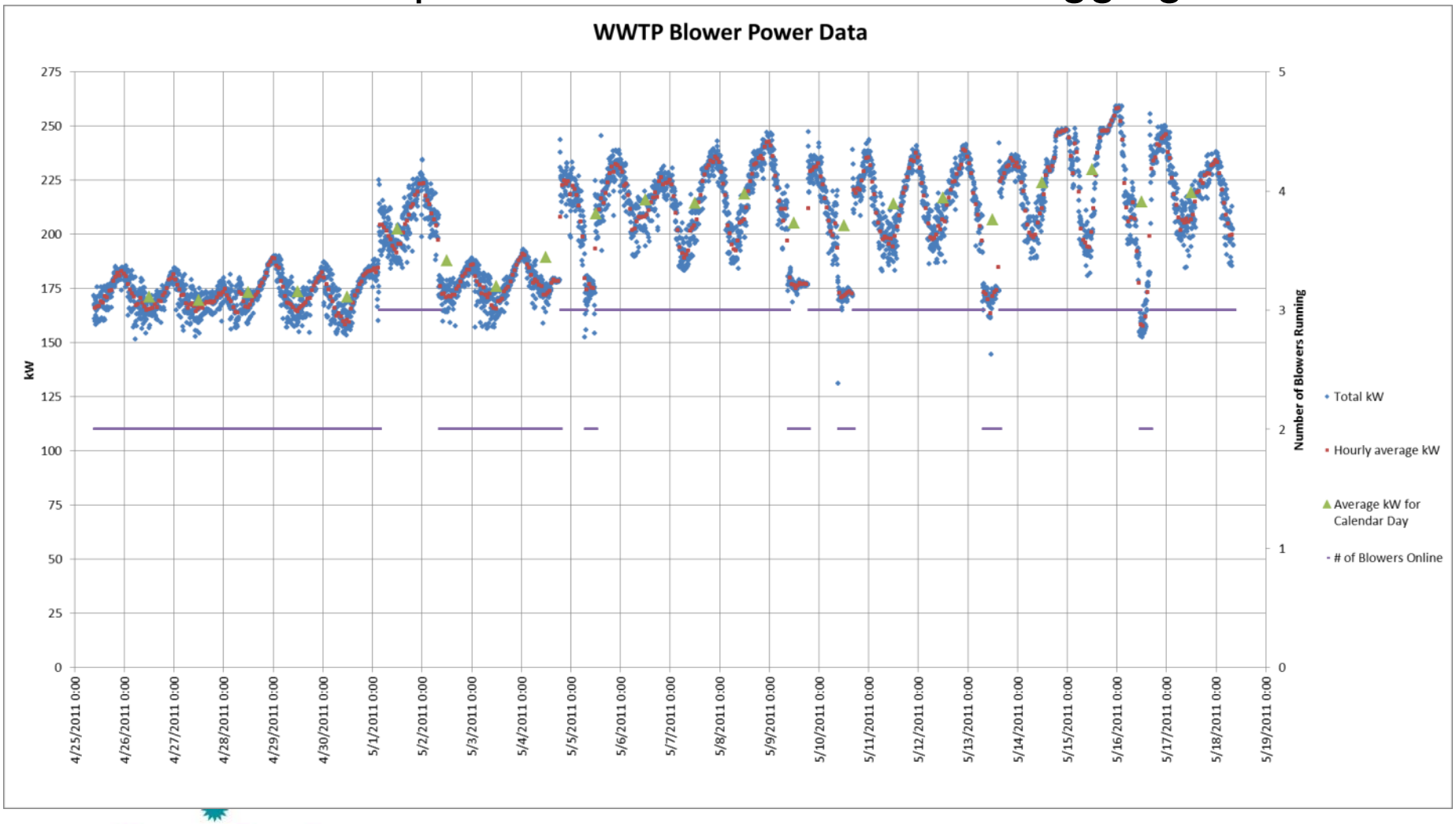
Project Documentation

- Requirements depend on scale and complexity of project.
  - The overall program costs are impacted by the “overhead” costs of scoping, data analysis, and M&V.
  - Many plants have really good SCADA systems with relatively poor reporting / data mining experience.
- New construction is generally M&V’d by comparing the actual plant performance (once constructed) to a model of the plant that wasn’t built.
  - The energy calcs are often easier than gathering the cost data.

Project Documentation

- ESI program will complete energy estimates and draft the CPP
  - Engineer / Contractor help is welcome and usually required
- Once CPP is approved and project is complete, ESI program will complete the M&V
  - “M&V Light” = Spot checks + sound engineering
  - Full M&V can range from a couple weeks to several months of energy monitoring.
  - If monitoring equipment is part of plant, we can use that system in lieu of separate loggers.

Example of Robust, Short Term Logging



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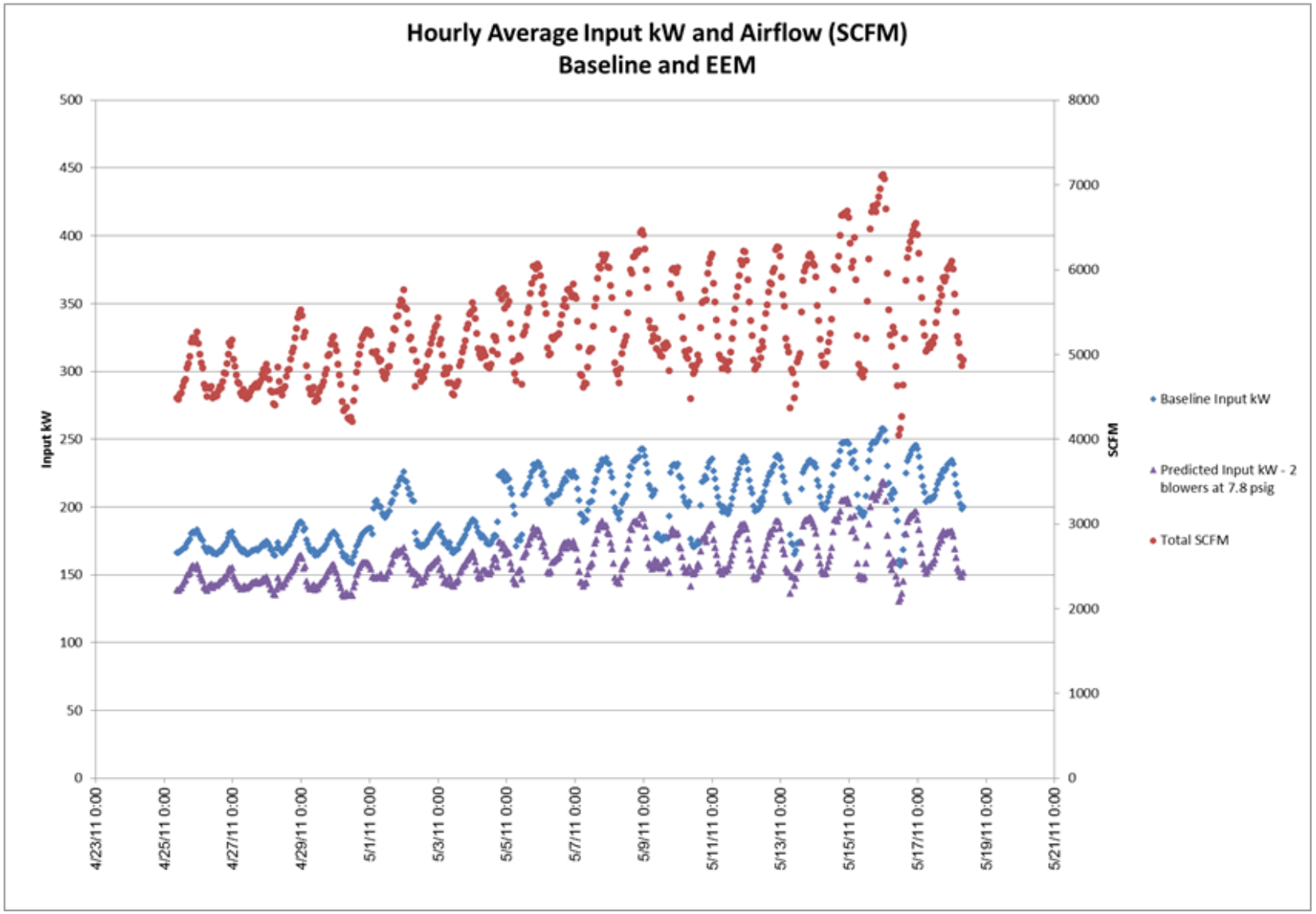
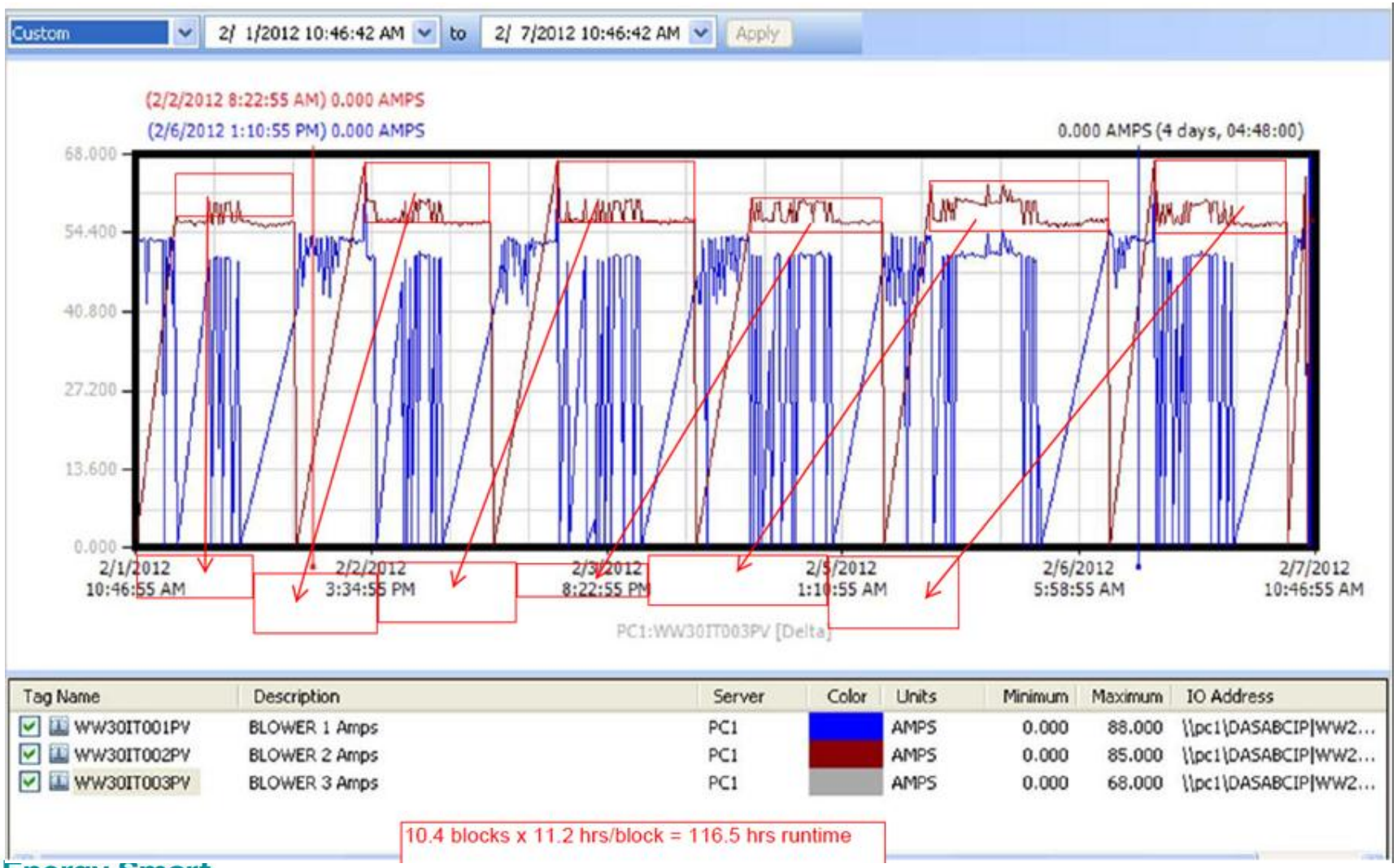
Resulting EEM Analysis

Figure 8: Model Results for Airflow, Baseline, and Predicted Blower kW



Being flexible helps . . .



Things to Remember

- DON'T BUY EQUIPMENT UNTIL THE CPP IS APPROVED!
- We'll need to collect the project cost data, so if it can be gathered and organized during the project, it saves everyone time.
- We are here to help, so please just call or email.

O&M Opportunities

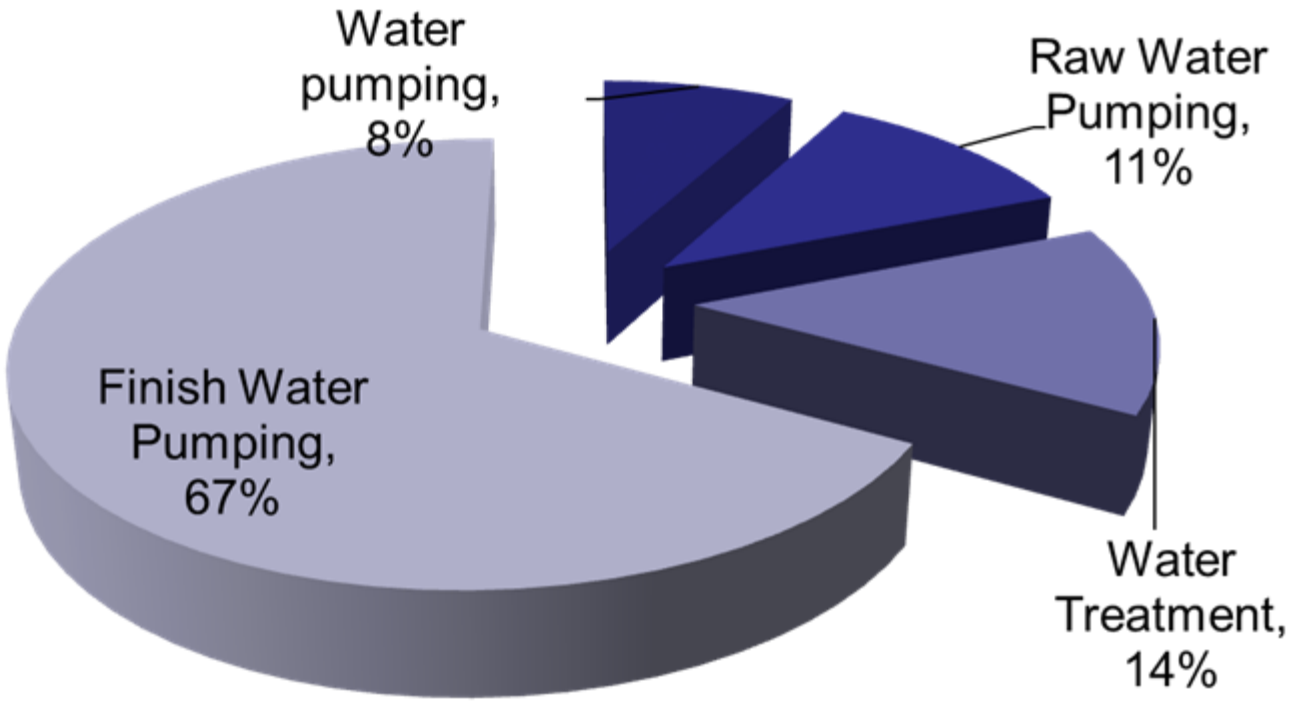
- Started with the OrACWA Cohort
- Quick payback
- Baby Steps
- Real opportunities

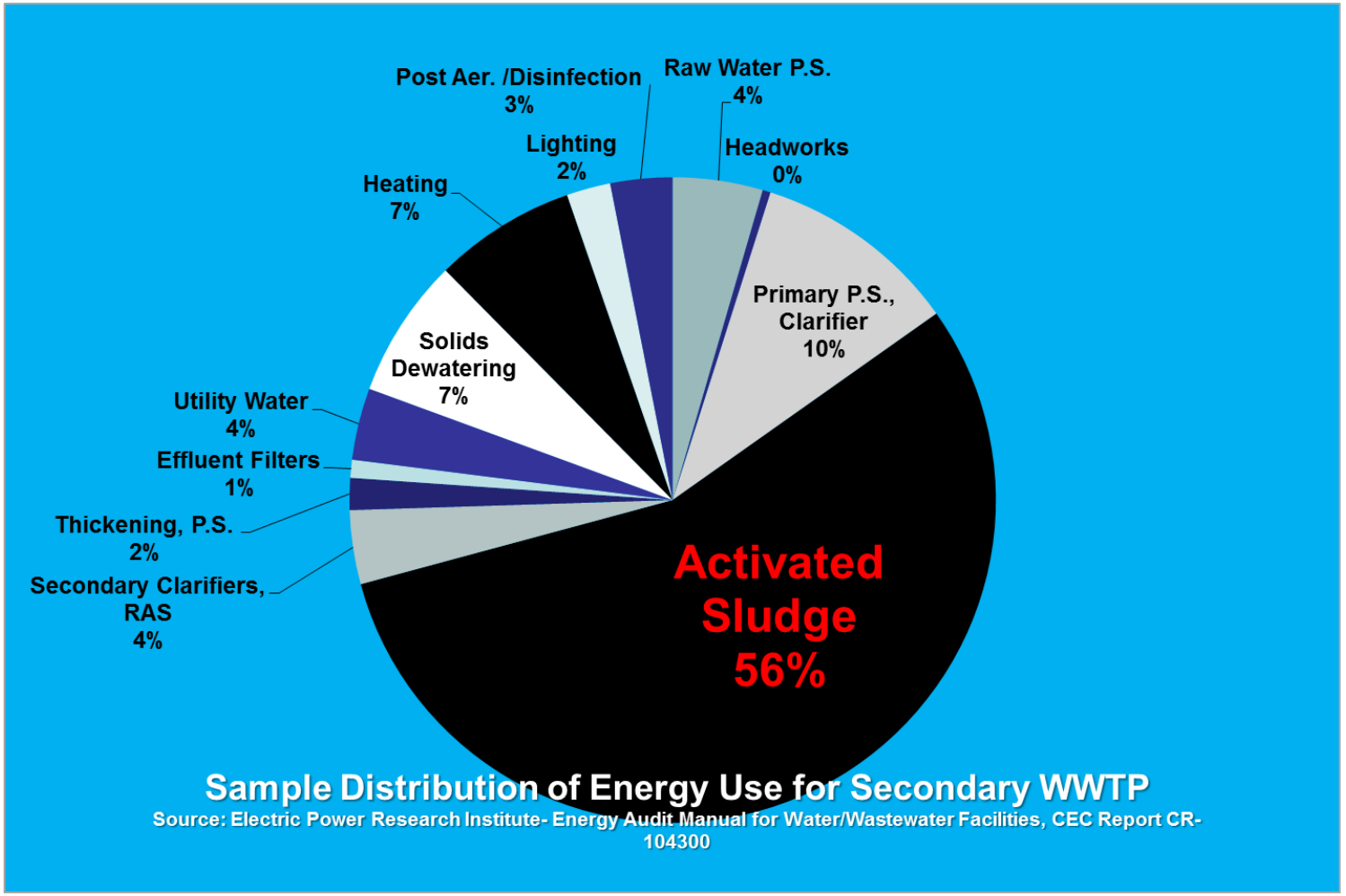
A tough nut to crack

- Designed for 20 years of growth
- Design – Bid – Build separates capital costs from O&M cost risks & rewards
- Regulatory backstop – and little or no tolerance for errors due to experimentation
- Energy costs are considered “fixed” with a slight adjustment each year for inflation
- PNW enjoys relatively low power costs – some PUD’s are lowest in the U.S.
- Clean water regardless of cost . . .

Typical Water Facility Energy Use

Thank you Steve James, J-U-B Engineers





Typical Wastewater Facility Energy Use

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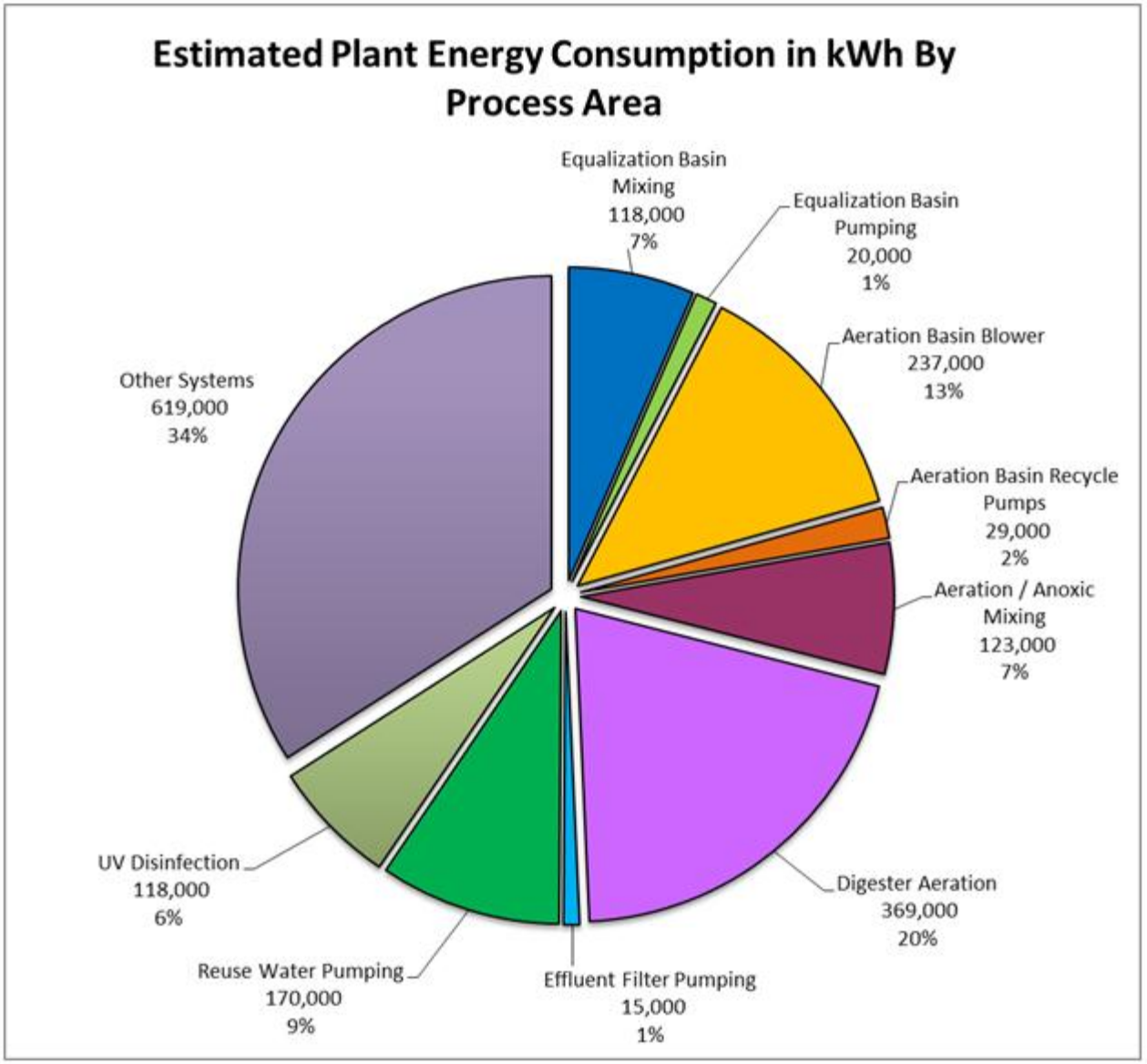

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