THE REAL POWER OF WATER

IMPROVING THE ENERGY EFFICIENCY OF OUR WATER DELIVERY SYSTEMS

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TO GET PRESENTATION AND EXCEL WORKSHEET

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THE NEXUS

EVERY SINGLE DROP OF WATER YOU EXPLORE, DEVELOP, PUMP, MOVE, STORE, TREAT, BOOST, OR RECLAIM -

THE NEXUS

REQUIRES A PROPORTIONAL AMOUNT OF ENERGY AND POWER TO MAKE THE DELIVERY.

THE NEXUS

THE GREATER THE VOLUME AND/OR THE GREATER THE PRESSURE (OR ELEVATION) OF THE WATER DELIVERY – THE GREATER THE COST - ITS THAT SIMPLE

AND THIS IS WHY ENERGY IS ONE OF THE SINGLE LARGEST DIRECT COSTS TO A WATER UTILITY, AND WHY WATER SUPPLIERS ARE ONE OF THE LARGEST CONSUMERS OF ENERGY ON THE PLANET !

MANAGING THE WATER RESOURCE

- HOW WE MANAGE OUR WATER PUMPING AS WELL AS ALL DELIVERY RELATED PROCESSES DETERMINES (AMONG OTHERS):
  - HOW MUCH WE (THE UTILITY) PAY FOR WATER.
  - THE END COST TO OUR CUSTOMERS.
  - THE MAINTENANCE LOADS AND IMPACTS ON OUR WATER DELIVERY SYSTEMS.
  - THE IMPACTS ON THE POWER UTILITY GENERATION SYSTEMS AND GRID.
  - AND ULTIMATELY - THE RELIABILITY AND QUALITY OF OUR WATER SERVICE.

OUR OBJECTIVE

IS TO EXPLORE THE MANY WAYS WE CAN BETTER

MANAGE THIS WATER RESOURCE –

WHILE FINDING WAYS TO MORE EFFICIENTLY AND

ECONOMICALLY DELIVER THE SAME TO THE PUBLIC.

OBJECTIVES

- LEARN ABOUT THE ENERGY AND POWER RELATIONSHIP
- LEARN MORE ABOUT YOUR PUMP APPLICATIONS AND CURVES
- UNDERSTAND BETTER THE ENERGY DYNAMICS OF YOUR SYSTEM
- LEARN TO TAKE OWNERSHIP AND BECOME THE CHAMPION OF YOUR ENERGY MANAGEMENT PROGRAMS.
- UNDERSTAND MORE ABOUT YOUR OBSTACLES TO CHANGE, I.E. WATER RIGHTS, PERSONNEL AND OPERATIONAL ISSUES, ETC.

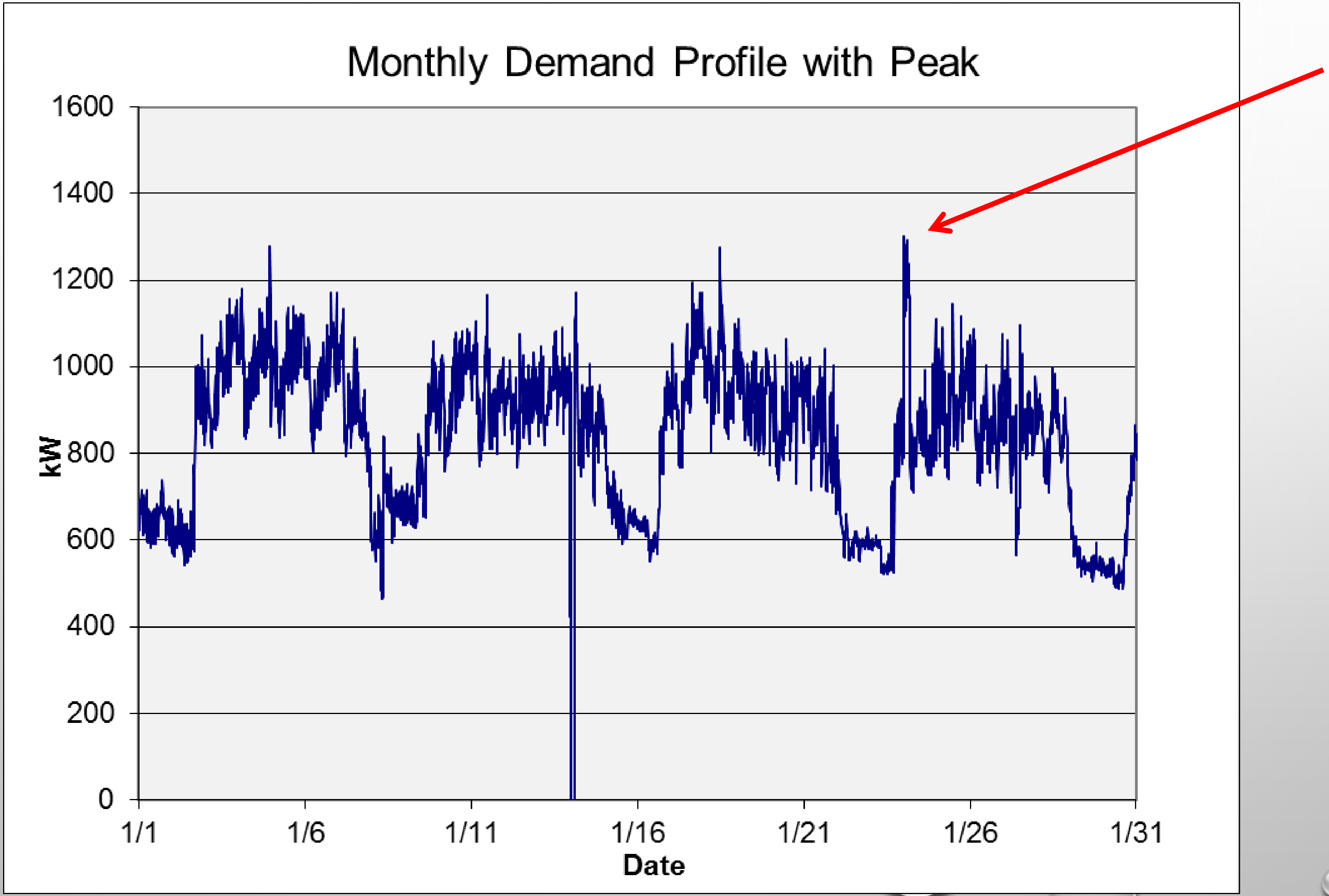
POWER AND ENERGY

HOW ARE THEY DIFFERENT ?

WHAT IS POWER?

- POWER IS WHAT IS NEEDED TO SUPPLY A MECHANICAL OR ELECTRICAL DEVICE WITH ENERGY.
- POWER CAN ALSO BE THOUGHT OF AS THE PEAK OR SET OUTPUT CAPACITY OF A MECHANICAL DEVICE – SUCH AS AN ELECTRICAL MOTOR, OR GASOLINE ENGINE.
- WE THINK OF THIS OFTEN IN HORSEPOWER UNITS (HP).
- ONE HORSEPOWER EQUALS 746 WATTS.
- POWER IS SIMILAR TO FLOW IN A WATER SYSTEM.
- YOU MEASURE WATER FLOW WITH A METER **AT ONE INSTANCE**, IN UNITS SUCH AS – GALLONS PER MINUTE OR PER SECOND, (GPM OR GPS).
- YOU MEASURE POWER IN A SIMILAR WAY – WITH A METER **AT ONE INSTANCE**, IN UNITS SUCH AS – WATTS OR HORSEPOWER.

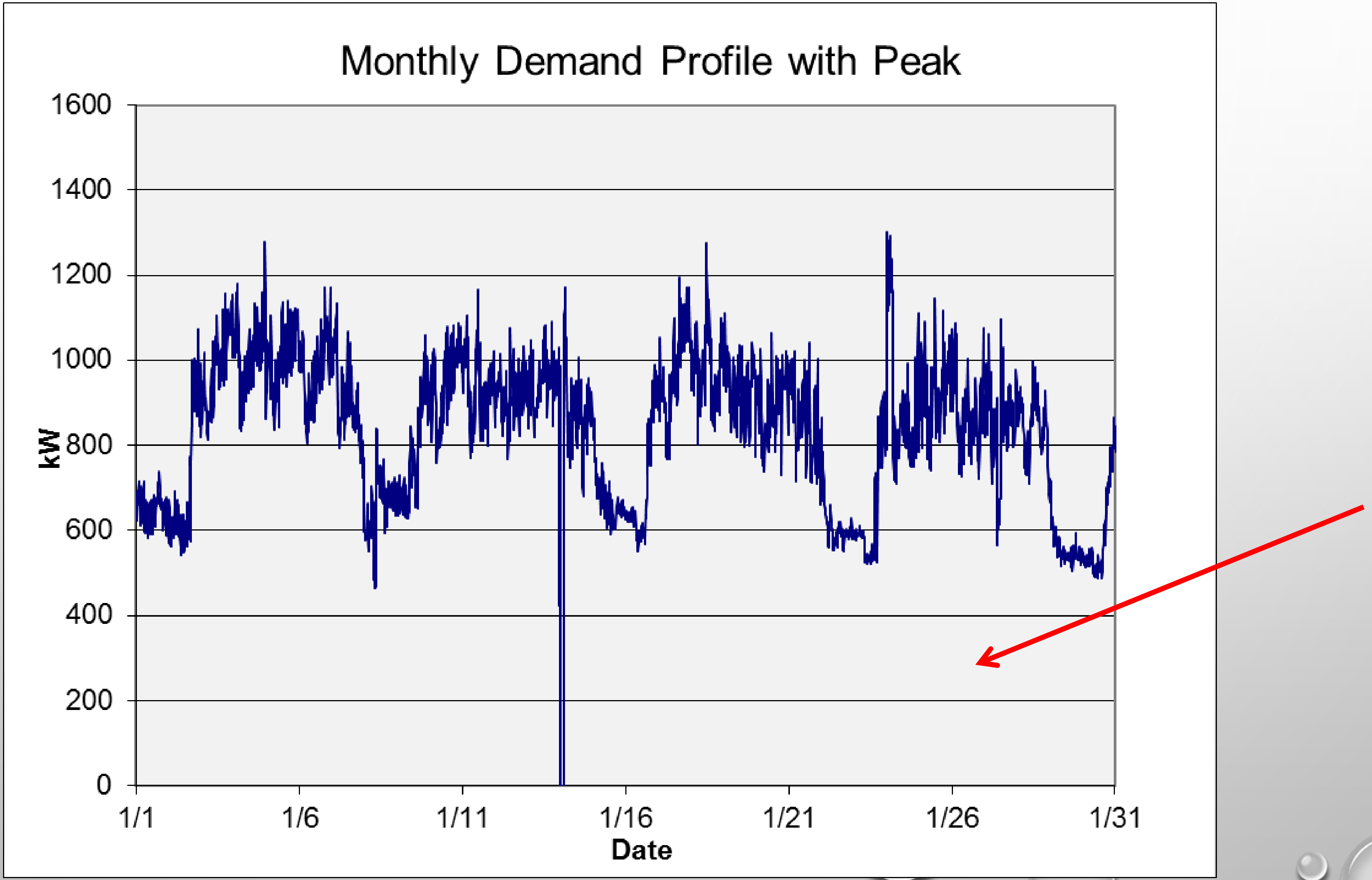
What is Peak Power ?



WHAT IS ENERGY?

- ENERGY IS THE USEFUL POWER DERIVED FROM THE UTILIZATION OF PHYSICAL OR CHEMICAL RESOURCES, TO PROVIDE LIGHT AND HEAT OR TO WORK MACHINES.
- ENERGY CAN BE THOUGHT OF AS POWER x TIME, OR A MEASUREMENT OF THE AMOUNT OF POWER CONSUMED OVER A GIVEN TIME PERIOD (SUCH AS HOURS OR YEARS). LIKEWISE, THIS CAN BE A MEASUREMENT OF THE ENERGY CONSUMED BY A MECHANICAL DEVICE.
- WE THINK OF THIS OFTEN IN KILOWATT HOURS (KWH).
- ENERGY IS A PRIMARY BILLING COMPONENT USED BY ELECTRICAL UTILITIES.
- ENERGY IS SIMILAR TO VOLUME IN A WATER SYSTEM.
- YOU MEASURE WATER VOLUME OVER TIME WITH A METER IN UNITS SUCH AS – GALLONS PER MONTH.
- YOU MEASURE ENERGY THE SAME WAY – WITH A METER OVER A TIME PERIOD, IN UNITS SUCH AS – KILOWATT HOURS PER MONTH.

What is Energy ?



THE SIMPLE EXPLANATION

- **POWER** IS RELATED TO HOW FAST A CAR CAN GO (ASSUMING AN EQUIVALENT MASS OF ALL CARS COMPARED).

- **ENERGY** IS RELATED TO HOW USEFUL YOUR CAR IS AND HOW MUCH FUEL YOUR CAR CONSUMES (ASSUMING AN EQUIVALENT DISTANCE OR TIME OF ALL CARS COMPARED).

IN THE WATER INDUSTRY - WE ARE BILLED FOR BOTH

POWER AND **ENERGY**

HOW ARE WE BILLED ?

- ENERGY IS BILLED SIMILAR TO WATER. WE PAY SO MUCH PER MONTH FOR THE TOTAL KILOWATT HOURS CONSUMED DURING THAT PERIOD. THE METER KEEPS A RUNNING TOTAL – LIKE A WATER METER.
- POWER ON THE OTHER HAND, IS A ONE TIME INSTANTANEOUS CHARGE FOR THE PEAK POWER KILOWATT DEMAND HIT EACH MONTH. IT IS RESET TO ZERO AT THE BEGINNING OF EACH BILLING PERIOD.
- IN THE WATER INDUSTRY - POWER CAN MAKE UPS AS MUCH AS HALF OF THE TOTAL BILL !

THE WATER POWER CALCULATION

- $hp = \frac{h \cdot q}{3{,}960}$

- **WHERE:**
  - *HP* = WATER HORSEPOWER
  - *H* = TOTAL DYNAMIC PUMPING HEAD IN FEET
  - Q = FLOW IN GALLONS PER MINUTE (GPM)

- TO ARRIVE AT THE ACTUAL POWER NEEDED – WE DIVIDE THE ANSWER BY THE % EFFICIENCY OF THE <u>PUMP,</u> AND THEN THE <u>MOTOR</u> (INCLUDING DRIVES, ETC.) TO ARRIVE AT THE TOTAL <u>WIRE TO WATER HORSEPOWER</u>.

COMMON WATER & ENERGY TERMS

- THE FLOW OF WATER IS EXPRESSED IN TERMS SUCH AS GPM, OR MGD, OR AC-FT/YEAR.
- FLOW IN AN ELECTRICAL SYSTEM IS EXPRESSED AS CURRENT AND IS MEASURED IN AMPS (ABBR. = I).
- THE PRESSURE OF WATER IS A FUNCTION OF ITS ELEVATION HEAD AND IS EXPRESSED IN TERMS SUCH AS PSI, OR FEET OF HEAD.
- THE PRESSURE IN AN ELECTRICAL SYSTEM IS EXPRESSED AS VOLTAGE, WHICH IS ITS ELECTROMOTIVE FORCE (ABBR. = E).
- POWER IN WATER IS A FUNCTION OF THE PRESSURE TIMES THE FLOW, AND IS EXPRESSED IN UNITS SUCH AS HORSEPOWER (HP).
- POWER (P) IN AN ELECTRICAL SYSTEM IS A FUNCTION OF THE VOLTAGE TIMES THE CURRENT AND IS EXPRESSED AS WATTS OR KILOWATTS (KW).

POWER EQUATIONS

- KILOWATTS FOR 3 PHASE SYSTEMS

$$\text{KiloWatts,kW} = \frac{(\text{Current,I}) \times (\text{Voltage,E}) \times (\text{Power Factor,PF}) \times 1.732}{1{,}000\ \text{W/kW}}$$

- 1 HORSEPOWER (HP) EQUALS 746 WATTS, OR 0.746 KILOWATTS

ENERGY EQUATIONS

- KILOWATT HOURS:

$$\text{Kilowatt Hours,kWh} = \left(\text{Kilowatts,kW}\right) \times \left(\text{Run Hours,RTh}\right)$$

- CONVERTING KILOWATT HOURS TO KILOWATTS:

$$\text{Kilowatts,kW} = \frac{\left(\text{Kilowatt Hours,kWh}\right)}{\left(\text{Run Hours,RTh}\right)}$$

COMMON WATER AND ENERGY TERMS CONT.-

- THE VOLUME OF WATER BILLED BY UTILITIES IS EXPRESSED IN TERMS SUCH AS GALLONS, CUBIC FEET, OR AC-FT.
- THE VOLUME OF ENERGY BILLED BY ELECTRICAL UTILITIES IS EXPRESSED IN TERMS OF KILOWATT HOURS OR KWH.
- THE PEAK CAPACITY DEMAND OF AN ERC (EQUIVALENT RESIDENTIAL CONNECTION) ON WATER UTILITIES INFRASTRUCTURE IS BILLED AS A ONE TIME IMPACT FEE.
- THE PEAK CAPACITY DEMAND OF A CUSTOMER ON ELECTRICAL UTILITIES INFRASTRUCTURE IS BILLED MONTHLY WITH THE ENERGY CHARGE – AND IS CALLED THE PEAK POWER OR DEMAND LOAD.
- HEAD LOSS IN FEET OR PSI IS A MEASUREMENT OF FRICTION OR PRESSURE LOSS IN A PIPE OR OTHER SYSTEM AND INCREASES WITH FLOW. HEAD LOSS IS ALSO REFERRED TO AS PRESSURE LOSS.
- RESISTANCE IN OHMS IS A MEASUREMENT OF FRICTION OR VOLTAGE DROP IN A WIRE OR OTHER ELECTRICAL SYSTEM AND INCREASES WITH CURRENT. RESISTANCE RESULTS IN VOLTAGE DROP OR LOSS (ABBR. R OR Ω).

COMMON WATER AND ENERGY TERMS CONT.-

- WATER IS STORED IN A TANK OR A RESERVOIR.
- ELECTRICITY IS STORED IN A BATTERY OR CAPACITOR (VERY SHORT TERM).
- WATER PRESSURE AND/OR FLOW IS BOOSTED WITH A PUMP.
- ELECTRICAL VOLTAGE AND/OR CURRENT IS BOOSTED WITH A STEP-UP TRANSFORMER OR MORE PROPERLY A GENERATOR.
- WATER PRESSURE IS REDUCED WITH A PRESSURE REDUCING VALVE.
- ELECTRICAL VOLTAGE IS REDUCED WITH A STEP-DOWN TRANSFORMER OR MORE PROPERLY A TRANSISTOR.
- LARGE WATER FLOWS/PRESSURES ARE CONTROLLED (LARGE RAM) WITH A VERY SMALL FLOW/PRESSURE BY A PILOT OPERATED (SMALL RAM) HYDRAULIC CONTROL VALVE, I.E. RELIEF VALVE, PRV, ON-OFF VALVE.
- LARGE ELECTRICAL CURRENTS/VOLTAGES ARE CONTROLLED WITH A VERY SMALL CURRENT/VOLTAGE WITH A TRANSISTOR (I.E. VFD'S). TRANSISTORS HAVE A DIODE (CHECK VALVE) BUILT INTO THE LARGE VALVE. THE PILOT IS CONTROLLED BY A LOW-CURRENT SIGNAL (EITHER CONSTANT CURRENT FOR A BJT OR CONSTANT PRESSURE FOR A FET) WHICH DIRECTLY AFFECTS THE CURRENT THROUGH THE CONNECTED LARGER VALVE.

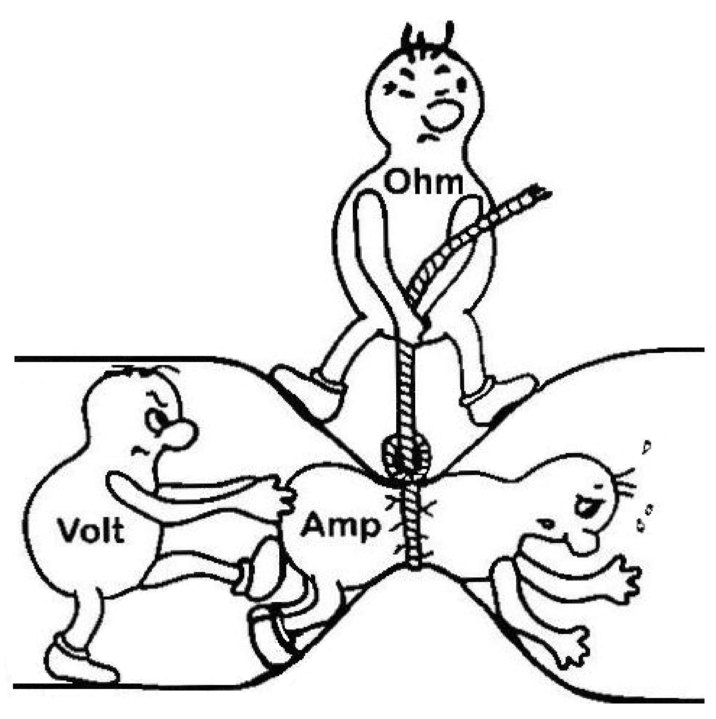
COMMON WATER AND ENERGY TERMS CONT.-

- WATER FLOW DIRECTION IS REGULATED BY A CHECK-VALVE.
- ELECTRICAL CURRENT DIRECTION IS REGULATED BY A DIODE (LEAKS A LITTLE).
- A CONSTRICTION IN THE BORE OF A PIPE, REQUIRES MORE PRESSURE TO PASS THE SAME AMOUNT OF WATER FLOW. ALL PIPES HAVE SOME RESISTANCE TO FLOW.
- A RESISTER IN AN ELECTRICAL SYSTEM, REQUIRES MORE VOLTAGE TO PASS THE SAME AMOUNT OF CURRENT, AND USUALLY GIVES OFF HEAT. ALL WIRES HAVE SOME RESISTANCE TO CURRENT.
- A VALVE TURNS THE FLOW OF WATER ON OR OFF. IT CAN ALSO BE A VARIABLE CONSTRICTION IF PARTIALLY OPEN.
- A SWITCH TURNS THE CURRENT ON OR OFF IN A CIRCUIT. A VARIABLE RESISTOR IS SIMILAR TO A VARIABLE VALVE AND CONTROLS CURRENT OR VOLTAGE, I.E. VOLUME CONTROL ON AN AMPLIFIER.
- A MOTOR-DRIVEN PUMP CONVERTS ELECTRICAL ENERGY INTO WATER ENERGY
- A HYDRO-ELECTRIC TURBINE CONVERTS WATER ENERGY INTO ELECTRICAL ENERGY.
- A WELL AND PUMP BOOST A SOURCE OF WATER IN THE GROUND IN A HYDROLOGIC CIRCUIT, AND STORE IT IN A RESERVOIR FOR USE FUTURE . IT IS RETURNED TO THE GROUND OR ENVIRONMENT AFTER USE WHEN IT IS RELEASED FROM A WASTEWATER TREATMENT PLANT OR IS USED IN IRRIGATION, ETC.
- A GENERATOR OR BATTERY BOOST ELECTRICAL ENERGY IN THE GROUND FOR USE IN AN ELECTRICAL CIRCUIT, AND CAN FURTHER STORE IT IN A BATTERY FOR FUTURE USE. IT IS RETURNED TO THE GROUND AFTER DOING ITS WORK.

OTHER WATER AND ENERGY TERMS CONT.-

- CAPACITOR - A TANK WITH ONE CONNECTION AT EACH END AND A RUBBER MEMBRANE DIVIDING THE TANK IN TWO. WHEN WATER IS FORCED INTO ONE PIPE, EQUAL WATER IS SIMULTANEOUSLY FORCED OUT THE OTHER PIPE, YET NO WATER CAN PENETRATE THE RUBBER DIAPHRAGM. ENERGY IS STORED BY THE STRETCHING OF THE RUBBER. AS MORE CURRENT FLOWS "THROUGH" THE CAPACITOR, THE BACK-PRESSURE (VOLTAGE) BECOMES GREATER, THUS CURRENT "LEADS" VOLTAGE IN A CAPACITOR. AS THE BACK-PRESSURE FROM THE STRETCHED RUBBER APPROACHES THE APPLIED PRESSURE, THE CURRENT BECOMES LESS AND LESS. THUS CAPACITORS "FILTER OUT" CONSTANT PRESSURE DIFFERENCES AND SLOWLY-VARYING, LOW-FREQUENCY PRESSURE DIFFERENCES, WHILE ALLOWING RAPID CHANGES IN PRESSURE TO PASS THROUGH.
- INDUCTOR - A HEAVY PADDLE WHEEL (OR ATTACHED TO A FLY WHEEL) PLACED IN THE CURRENT. THE MASS OF THE WHEEL AND THE SIZE OF THE BLADES RESTRICT THE WATER'S ABILITY TO RAPIDLY CHANGE ITS RATE OF FLOW (CURRENT) THROUGH THE WHEEL DUE TO THE EFFECTS OF INERTIA, BUT, GIVEN TIME, A CONSTANT FLOWING STREAM WILL PASS MOSTLY UNIMPEDED THROUGH THE WHEEL, AS IT TURNS AT THE SAME SPEED AS THE WATER FLOW. THE MASS AND SURFACE AREA OF THE WHEEL AND ITS BLADES IS ANALOGOUS TO INDUCTANCE, AND FRICTION BETWEEN ITS AXLE AND THE AXLE BEARINGS CORRESPOND TO THE RESISTANCE THAT ACCOMPANIES THE INDUCTOR. THE PRESSURE DIFFERENCE (VOLTAGE) ACROSS THE DEVICE MUST BE PRESENT BEFORE THE CURRENT WILL START MOVING, THUS IN INDUCTORS VOLTAGE "LEADS" CURRENT. AS THE CURRENT INCREASES, APPROACHING THE LIMITS IMPOSED BY ITS OWN INTERNAL FRICTION AND OF THE CURRENT THAT THE REST OF THE CIRCUIT CAN PROVIDE, THE PRESSURE DROP ACROSS THE DEVICE BECOMES LOWER AND LOWER.
- DC - CONSTANT FLOW (CURRENT) OF ELECTRICITY OR WATER IN ONE DIRECTION IN A CIRCUIT OF WIRES OR PIPES.
- AC (LOW FREQUENCY) - WATER OR ELECTRICAL FLOWS OSCILLATING BACK AND FORTH IN WIRES OR PIPES, I.E. ALTERNATOR IN ELECTRICAL SYSTEMS OR PISTON PUMP ON A WATER SYSTEM WITH NO CHECK VALVES.
- AC (HIGH FREQUENCY) – SIMILAR TO SOUND BEING TRANSMITTED THROUGH THE WATER PIPES.
- INDUCTIVE SPARK - USED IN INDUCTION COILS, SIMILAR TO SURGE OR WATER HAMMER, CAUSED BY THE INERTIA OF WATER WHEN FLOW IS STOPPED SUDDENLY.

VOLTAGE, CURRENT, AND RESISTANCE



A PLAN

ENVIRONMENTAL GOAL:

Mountain Regional Water will strive to make water and energy resource conservation and environmental management a cornerstone in all of its operations and service.

#	ENVIRONMENTAL STRATEGIES	IMPLEMENTATION PROCESSES	ENVIRONMENTAL RESULTS	DATE of Implemen-tation	Funding Source(s)	Current Annual Savings Estimate
	OBJECTIVE A – External Service Provider Strategies:					
1	Implement optimum Rocky Mountain Power (RMP) rates on pumping facilities that may assist in reducing pump energy and/or power charges (i.e. switching from rate 6 to rate 6A or 6B where possible).	Monthly and Annual Analysis of all accounts using Mountain Regional rate models.	Reduces costs as well as impact on RMP generation and transmission systems.	2006	Internal Operational Funds	40,000
2	Ensure key facilities are accessible to outside utilities in all seasons to guarantee that meters are read in an accurate and timely fashion.	In our O&M process. Continuing effort on some facilities, i.e. well 5, 3-mile well, etc. Lost Canyon Pump Station put on continuous energy profiler meter reading system through Verizon connection.	Reduces estimated RMP reads which make it difficult to estimate off-peak management practices in future re-adjusted bills.	2011	Internal Operational Funds	1,000
3	Record and log power and gas consumption data as needed to ensure accuracy in billings as well as facilitating reliable budgetary projections.	Each months bills currently checked and approved.	Better energy management.	2009	Energy and Resource Budget	Unknown
4	Graph energy and gas use to demonstrate success of conservation and management strategies.	Each months bills currently checked and approved. Many heating thermostat setting and malfunction problems are found annually.	Better energy management. Cost savings and carbon footprint reductions.	2009	Energy and Resource Budget	1,500
5	Eliminate small unnecessary electrical accounts – replace with solar systems if and where feasible.	Future Study	Better energy management. Cost savings and carbon footprint reductions.	2012-14	-?-	Unknown
6	Investigate net metering opportunities on smaller accounts using solar, wind, or energy recovery generation devices or other similar and authorized equipment	Future Study	Better energy management. Cost savings and carbon footprint reductions.	2012-14	-?-	Unknown

LOSSES AND LEAKS

- A SIGNIFICANT CAUSE OF ENERGY INEFFICIENCY IN A WATER SYSTEM IS SIMPLY THE LOSS OR LEAKING OF WATER, EITHER ACCOUNTABLE LOSSES OR UNACCOUNTABLE LOSSES.

TYPES OF LOSSES

1. UNBILLED METERED CONSUMPTION
2. UNBILLED UNMETERED CONSUMPTION
3. UNAUTHORIZED CONSUMPTION
4. CUSTOMER METERING INACCURACIES
5. SYSTEMATIC DATA HANDLING ERRORS
6. LEAKAGE ON DISTRIBUTION SYSTEM MAINS
7. LEAKAGE ON SERVICE LINES (LATERALS)
8. LEAKAGE ON TANKS AND OVERFLOWS
9. LEAKAGE WITHIN PLANTS AND EQUIPMENT

THE EXTENDED PERIOD MODEL FINDS ISSUES WITH:

1. LOOPING
2. LEAPING
3. LOSING
4. LOADING

LOOPING

- THE PROCESS OF UNWARRANTED OR REPEATED BOOSTING OF THE SAME WATER.
- ASK THIS QUESTION: COULD A PUMP OR SYSTEM OF PUMPS POSSIBLY BE BOOSTING WATER, OR ANY PORTION THEREOF IN ONE OR MORE CONTINUOUS LOOPS?

WHERE CAN LOOPS OCCUR ?

- BETWEEN ZONES IN PRV STATIONS
- THROUGH NORMALLY CLOSED VALVES
- IN PUMP STATIONS AND WELLS THROUGH:
  - LEAKING RETURN PRV OR FIRE RETURN VALVES
  - PUMP PRESSURE RELIEF VALVES (CIRCULATION OR BY-PASS TYPES)
  - LEAKY CHECK VALVES
  - DEEP WELL LEAKING FOOT VALVES
  - HOLES IN WELL PUMP COLUMN PIPING

LEAPING

- THE PROCESS OF UNNECESSARILY PUMPING A SOURCE, SUCH AS A WELL, OR LOWER ZONE AROUND (OR "LEAP-FROGGING" OVER) A HIGHER PRV SEPARATED PRESSURE ZONE (OFTEN THROUGH A SEPARATE PUMPING LINE) TO A TANK, WHEN A PUMP WOULD BE USING SIGNIFICANTLY LESS ENERGY BY SIMPLY PUMPING THE NECESSARY DEMAND PRESSURES (OR A PORTION THEREOF) DIRECTLY INTO THE PRESSURE ZONE IN WHICH IT IS LOCATED. THIS PROBLEM CAN BEST BE REMEDIED IF THERE ARE OTHER SOURCES OR TANKS THAT CAN SUPPLY THE HIGHER TANK ZONE MORE EFFECTIVELY.

HOW CAN LEAPS BE MITIGATED ?

- BY NOT DESIGNING THE HIGHEST ZONE TO HAVE THE ONLY RESERVOIR, OR
- TO POSSESS ALL OF THE FIRE AND EMERGENCY STORAGE.
- USING SMALLER PUMPS TO PRESSURIZE THE ZONE THE PUMP OR WELL IS LOCATED IN.
- ENSURING THAT NORMALLY CLOSED ZONE PRV STATIONS DO NOT LEAK.
- MODEL AND RE-DESIGN THE DISTRIBUTION SYSTEM TO POSSIBLY CONNECT MORE EFFICIENTLY TO ADJOINING ZONES OF SIMILAR PSI.

LOSING (PRESSURE)

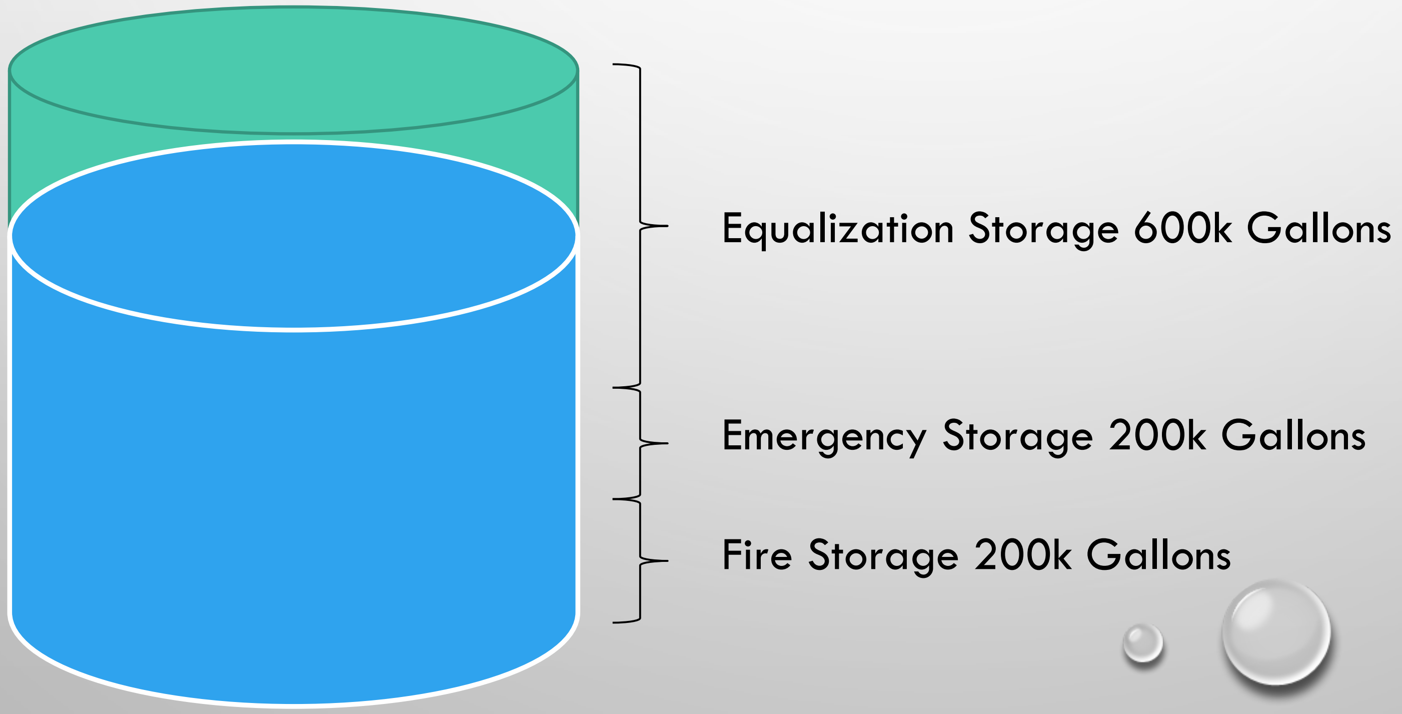
- THE PROCESS OF PREMATURELY REDUCING OR BREAKING A USABLE WATER SUPPLY HEAD PRESSURE, WHICH COULD HAVE BEEN BETTER UTILIZED IN A LOCAL OR ADJOINING ZONE WITHOUT THE DROP.
- EXAMPLE: BREAKING A SPRING OR FLOWING WELL PRESSURE, OR A WHOLESALE SUPPLY DELIVERY POINT PRE-MATURELY, JUST TO RE-PUMP SOMEWHERE THE VERY SAME WATER. A PRV MEANS AN ENERGY LOSS.

LARGER STORAGE IS KEY

- **WHAT ENERGY MANAGEMENT STRATEGIES ARE ONLY AVAILABLE TO A WATER SUPPLIERS?**
  - WE POSSESS THE ABILITY TO STORE WATER!
  - STORING WATER IS SIMILAR TO STORING ENERGY.
  - WHICH IN TURN ALLOWS US:
    - THE ABILITY TO RUN HIGH ENERGY AND POWER MOTORS AND OTHER EQUIPMENT AT CONTROLLED RATES, AND
    - DURING CONTROLLED PERIODS OF TIME.
  - WE NEED TO ENLARGE THIS VALUABLE RESOURCE AND USE IT!
  - THIS IS TRULY UNIQUE IN THE WORLD OF COMMERCIAL AND INDUSTRIAL POWER CONSUMERS!
  - **OUR STORAGE RESERVOIRS – ARE OUR BATTERIES !**

STORAGE EFFICIENCIES

- USE STORAGE MORE EFFECTIVELY.
- UTILIZE MORE EQUALIZATION STORAGE (KNOW FIRST WHAT IS THE EQUALIZATION, FIRE, AND EMERGENCY CAPACITY OF EACH RESERVOIR).
- KNOW YOUR DIURNAL CURVES BY MODELING YOUR SYSTEM.
- DON'T CHASE DEMAND WITH SOURCES THROUGHOUT THE DAY – USE THE TANK.



LOADING

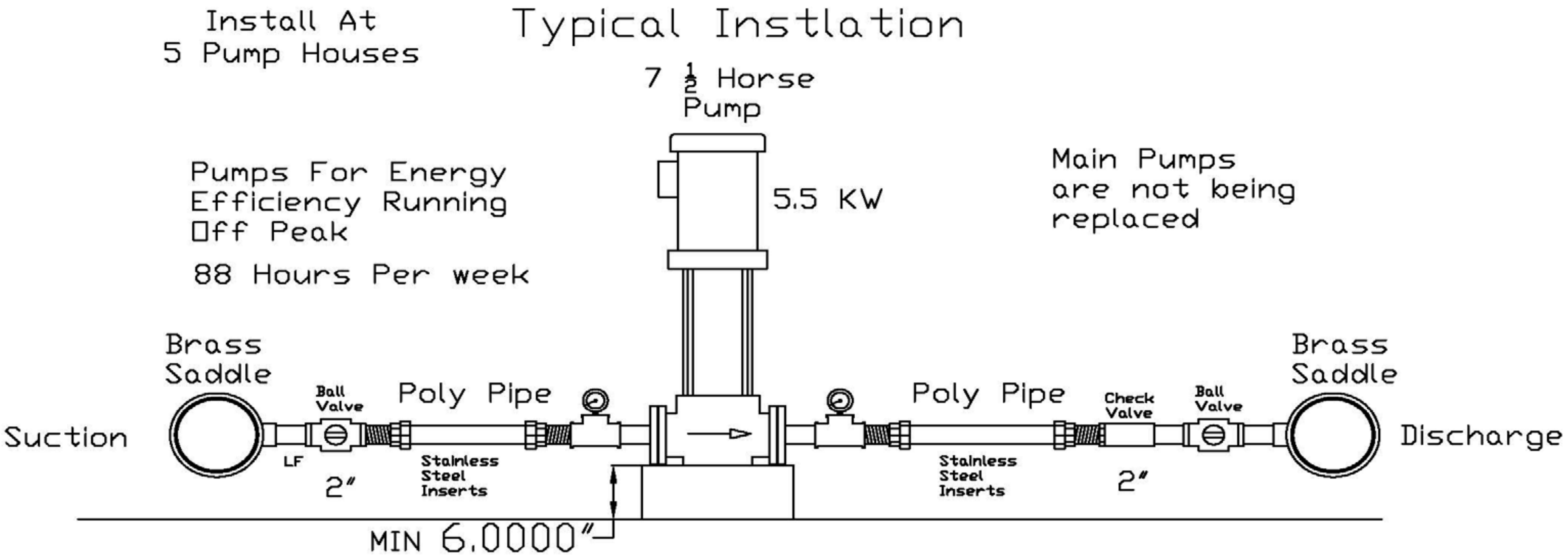
- THE PROCESS OF RUNNING PUMPS AND ELECTRICAL EQUIPMENT IN AN INEFFICIENT TIMING OR POOR CAPACITY AND LOADING MANNER. IF LOADING IS CONTROLLED DELIBERATELY AND PROPERLY – SIGNIFICANT SAVINGS CAN BE REALIZED, BUT IF PUMPS ARE RUN IN A RANDOM OR NON OPTIMIZED SITUATION, THE COSTS CAN BE EXCESSIVE. (BEWARE OF THE PROGRAMED LAG PUMPS !!!)

ELECTRICAL LOAD FACTORS (LF)

- THE LOAD FACTOR (LF) ON A PUMPING SYSTEM HAS A BIG IMPACT ON MONTHLY RATES, OFTEN AS BIG AS GOING "OFF-PEAK".
- LOAD FACTOR IS A MEASUREMENT OF THE AMOUNT OF TIME A FACILITY RUNS DURING THE BILLING CYCLE. A LARGE PART OF AN ELECTRICAL BILL IS THE DEMAND OR PEAK POWER CHARGE, AND IF A PUMPING SYSTEM RUNS AT A HIGH CAPACITY FOR A SHORT TIME – THE PEAK POWER (KW) CHARGE IS ASSESSED – ON AS LITTLE AS A 15 MINUTE PUMPING PERIOD.
- IF THE PUMPING SYSTEM CAN RUN LONGER – SAY 80% OF THE TIME, AT A LOWER CAPACITY – THE SAME AMOUNT OF WATER IS PUMPED DURING A DAY OR MONTH, BUT THE PEAK POWER CHARGE IS MUCH LESS.
- LF IS EXPRESSED AS A %, WHERE 100% MEANS THE PUMPS RAN 24/7.   50% MEANS THEY RAN HALF OF THE TIME DURING THE BILLING PERIOD, ETC.
- MOST PUMPING FACILITIES ARE DESIGNED TO RUN FOR SHORT PERIODS NORMALLY, AROUND 25% LF, AND COST CONSIDERABLY MORE TO RUN. THE LONGER RUN PERIODS ARE SAVED FOR EMERGENCIES OR BUILD-OUT.
- A VFD CAN HAVE A BIG IMPACT ON LOAD FACTORS IF SIZED AND APPLIED CORRECTLY, AND CAN SAVE ON MOTOR MAINTENANCE AND EFFICIENCY AS WELL.

THE JOCKEY & LOAD FACTOR

CENTERVILLE CITY STANDARD JOCKEY PUMP PLAN



OPERATIONAL LOAD CHANGES & THE SAW

THE LOAD FACTOR

- CALCULATING THE LOAD FACTOR OF A FACILITY
  - (ASSUMING PRIMARILY THE LOADS ARE PUMPS):

$$\frac{E}{PT}$$

- WHERE:
  - E = ENERGY IN KWH
  - P = POWER IN KW
  - T = HOURS IN BILLING CYCLE (USE 732 HOURS/MONTH IF UNKNOWN)

LOAD FACTOR OF A PUMP STATION

Facility Pump Count:	**HP**		**KW**	
Pump 1 HP	125	or	93	
Pump 2 HP	125	or	93	
Pump 3 HP	125	or	93	
Total	375	or	280	

Typical Summer Bill:				
KW	197	or	264	**HP**
KWH	35,760			
Average Summer Plant Continuous Power - KW	49	or	65	**HP**
Load Factor in %	**25%**			

Typical Winter Bill:				
KW	197	or	264	**HP**
KWH	16,873			
Average Winter Plant Continuous Power - KW	23	or	31	**HP**
Load Factor in %	**12%**			

Recommendations:

Use one 65 HP Pump with a VFD if Feasable

OR Use two 30 HP Pumps

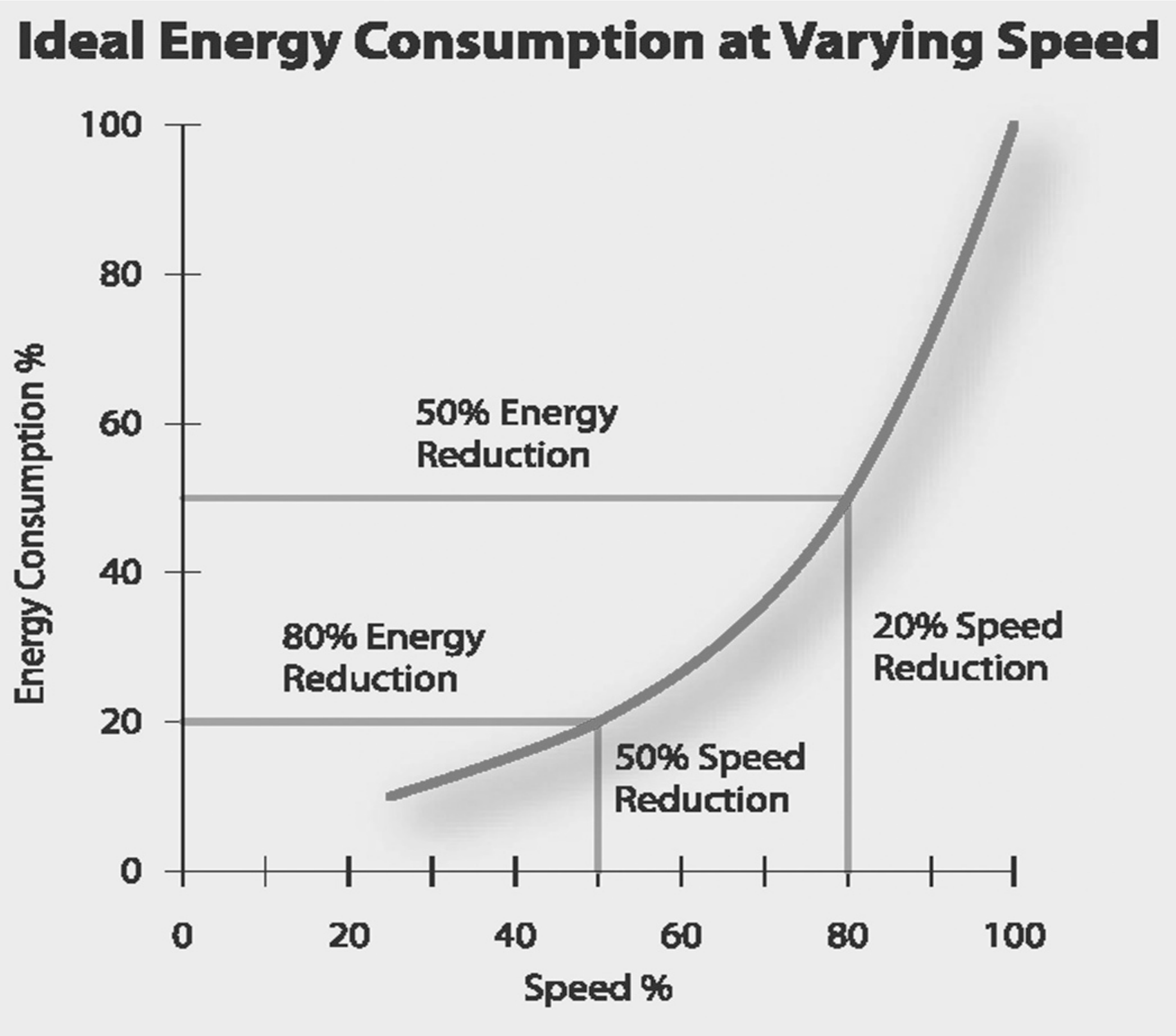
THE VARIABLE FREQUENCY DRIVE (VFD) LOAD CONTROL


DANGER

ENERGY SAVINGS WITH A VFD

- BESIDES SAVING POWER IN A PUMPING SYSTEM, VFD'S CAN ALSO BE UTILIZED TO SAVE ENERGY (KWH).
- MANY PUMPING SYSTEMS ARE PUMPING TOO GREAT OF FLOW IN A RESTRICTED PIPING SYSTEM AND THE HEAD LOSSES CAN BE SIGNIFICANT, I.E. IMPROPERLY SIZED PUMP TO PIPE SYSTEM.
- A VFD CAN SAVE ENERGY BY REMOVING THE SYSTEM RESTRICTIONS. IT CAN ALLOW PUMPS TO RUN FOR A LONGER PERIOD AT A LOWER FLOW (SIMILAR TO THE POWER SAVINGS ABOVE).
- A VFD CAN ACT AS A TRIM FOR PUMP IMPELLERS. PUMP COMBINATIONS CAN WORK MORE EFFICIENTLY.
- VFD'S DO NOT ALWAYS SAVE ENERGY AND ARE NOT ALWAYS IDEAL FOR SOME PUMPING SYSTEMS, NAMELY HIGH HEAD SYSTEMS WHICH HAVE A LARGE STATIC HEAD TO OVERCOME.

EFFECT OF A VFD ON ENERGY CONSUMPTION



SOME OF THE WORST PUMPING OFFENSES

- PUMPING DURING PEAK ELECTRICAL UTILITY LOADS INCREASES COSTS MORE AND REDUCES THE RELIABILITY OF THE ELECTRICAL SERVICE. THESE ARE PASSED ON TO YOU AS ADDITIONAL <u>POWER</u> DEMAND COSTS.
- PUMPING AT A HIGH CAPACITY FOR A SHORT PERIOD OF TIME INCREASES THE POWER LOAD AND ACCOMPANYING <u>POWER</u> DEMAND CHARGE.
- PUMPING AT UNNECESSARILY HIGH FLOW RATES FOR SHORT PERIODS OF TIME ALSO INCREASES HEAD LOSSES AND CONSUMES MORE ENERGY. THESE COSTS ARE PASSED ON TO YOU AS AN ADDITIONAL <u>ENERGY</u> CHARGE.

PUMP LOADING SUMMARY

- USE YOUR LARGE BATTERIES (RESERVOIRS) BETTER.
- SMALLER PUMPS AND MORE PUMPS ARE BETTER.
- LONGER PUMP RUN TIMES ARE BETTER.
- LEAD WITH SMALL PUMPS FIRST –
- THEN USE THE LARGER PUMPS FOR THE LAG.
- BUT LOWER THE SET POINTS OF LAG PUMPS SIGNIFICANTLY.

LESSEN ON-PEAK PUMPING

- THE OFF PEAK PERIOD IS 11:00 PM TO 7:00 AM ON WEEK DAYS (40 HR) AND ALL DAY ON WEEKENDS (48 HR) – MEANING YOU CAN PUMP AS MUCH ON A WEEKEND AS ALL 5 WEEKDAYS! THIS IS WHERE STORAGE IS IMPORTANT!
- FILLING THIS PERIOD AS MUCH AS POSSIBLE CAN SIGNIFICANTLY REDUCE:
  - YOUR ENERGY AND POWER COSTS.
  - THE BURDEN ON THE POWER GRID.
- THE KEY IS TO LOAD THIS OFF-PEAK PERIOD TO A 100 % FACTOR.
- A HYBRID OF OFF-PEAK PUMPING AND A LOWER PUMP LOAD DURING THE ON-PEAK PERIOD CAN ALSO BE VERY EFFECTIVE. (I.E. 1 PUMP ON, 3 OFF)
- OFF-PEAK NEEDS TO BE WEIGHED AGAINST POSSIBLE ENERGY LOSSES FROM HIGH FLOWS DURING THIS SHORT PERIOD. A HYDRAULIC MODEL WILL TELL.

Total Flows **1000 Gals**

How much water is needed for a week:

Update Database Values

Month-Year:	Jan-15

Date:	Lyons Well	Church Well	New City Hall Well	Carrington Well	Ricks Creek Well	Holbrook Well	Chase Lane Well North	Chase Lane Well South	Weber Flow 1	Weber Flow 2	Wells Total	Weber Total	Combined Total
1	0.00	338.41	0.00	0.00	373.20	0.00	0.00	0.00	0.00	0.00	711.61		711.61
2	0.00	1101.60	0.00	0.00	1132.01	0.00	0.00	0.00	0.00	0.00	2233.62		2233.62
3	0.00	339.95	0.00	0.00	365.92	0.00	0.00	0.00	0.00	0.00	705.87		705.87
4	0.00	1119.19	0.00	0.00	1106.95	0.00	0.00	0.00	0.00	0.00	2226.14		2226.14
5	0.00	718.59	0.00	0.00	419.59	0.00	0.00	0.00	0.00	0.00	1138.18		1138.18
6	0.00	340.75	0.00	0.00	295.64	0.00	0.00	0.00	0.00	0.00	636.39		636.39
7	0.00	338.72	0.00	0.00	337.38	0.00	0.00	0.00	0.00	0.00	676.10		676.10
8	0.00	352.19	0.00	0.00	381.41	0.00	0.00	0.00	13.11	0.00	733.60	13.11	746.71
9	0.00	354.25	0.00	0.00	386.43	0.00	0.00	0.00	0.00	0.00	740.67		740.67
10	0.00	357.91	0.00	0.00	380.37	0.00	0.00	0.00	0.00	0.00	738.28		738.28
11	0.00	1163.08	0.00	0.00	1167.37	0.00	0.00	0.00	0.00	0.00	2330.45		2330.45
12	0.00	810.66	0.00	0.00	816.48	0.00	0.00	0.00	0.00	0.00	1627.14		1627.14
13	0.00	344.53	0.00	0.00	327.54	0.00	0.00	0.00	0.00	0.00	672.07		672.07
14	0.00	359.71	0.00	0.00	373.00	0.00	0.00	0.00	0.00	0.00	732.71		732.71
Average:	0.00	574.25	0.00	0.00	561.66	0.00	0.00	0.00	0.94	0.00	1135.92	13.11	1136.85
Total:	0.00	8039.54	0.00	0.00	7863.29	0.00	0.00	0.00	13.11	0.00	15902.83	13.11	15915.93

Comments:

High This Month	2330.45
Low This Month	636.39

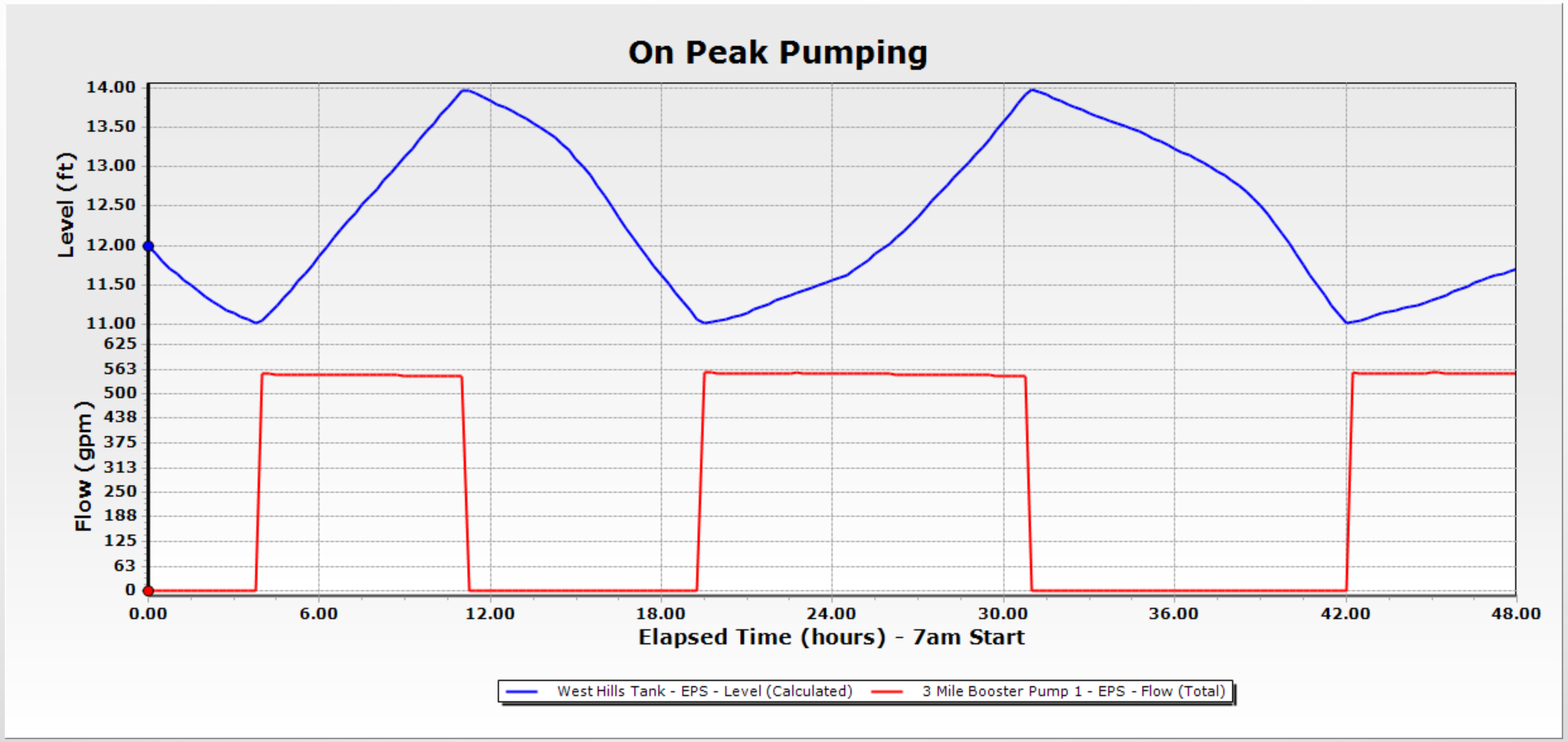
One week of pumping:

5 days OFF PEAK pumping 3,538,150

2 days OFF PEAK(48 hours) 3,957,590

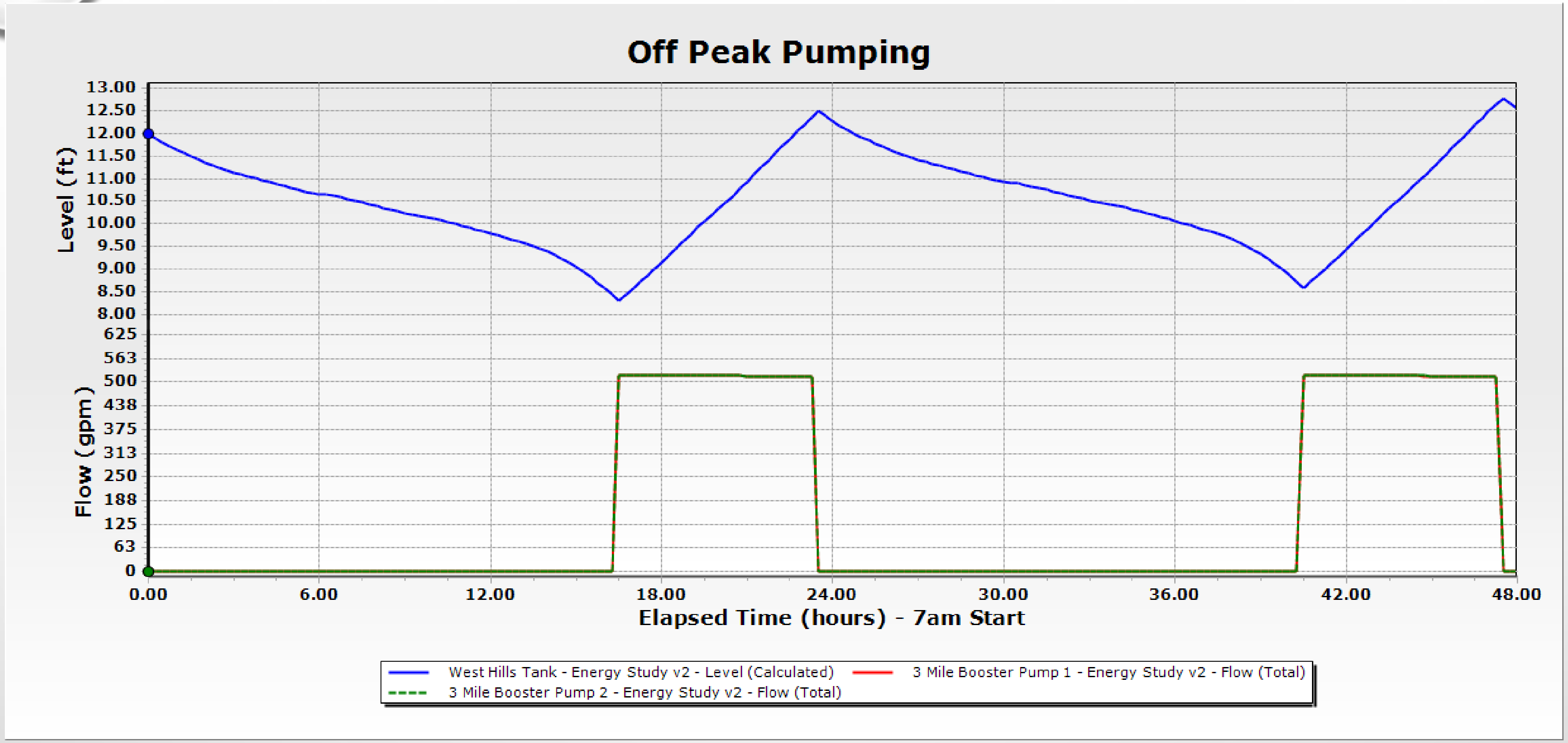
Total: 7,495,740

MODEL THE SAVINGS



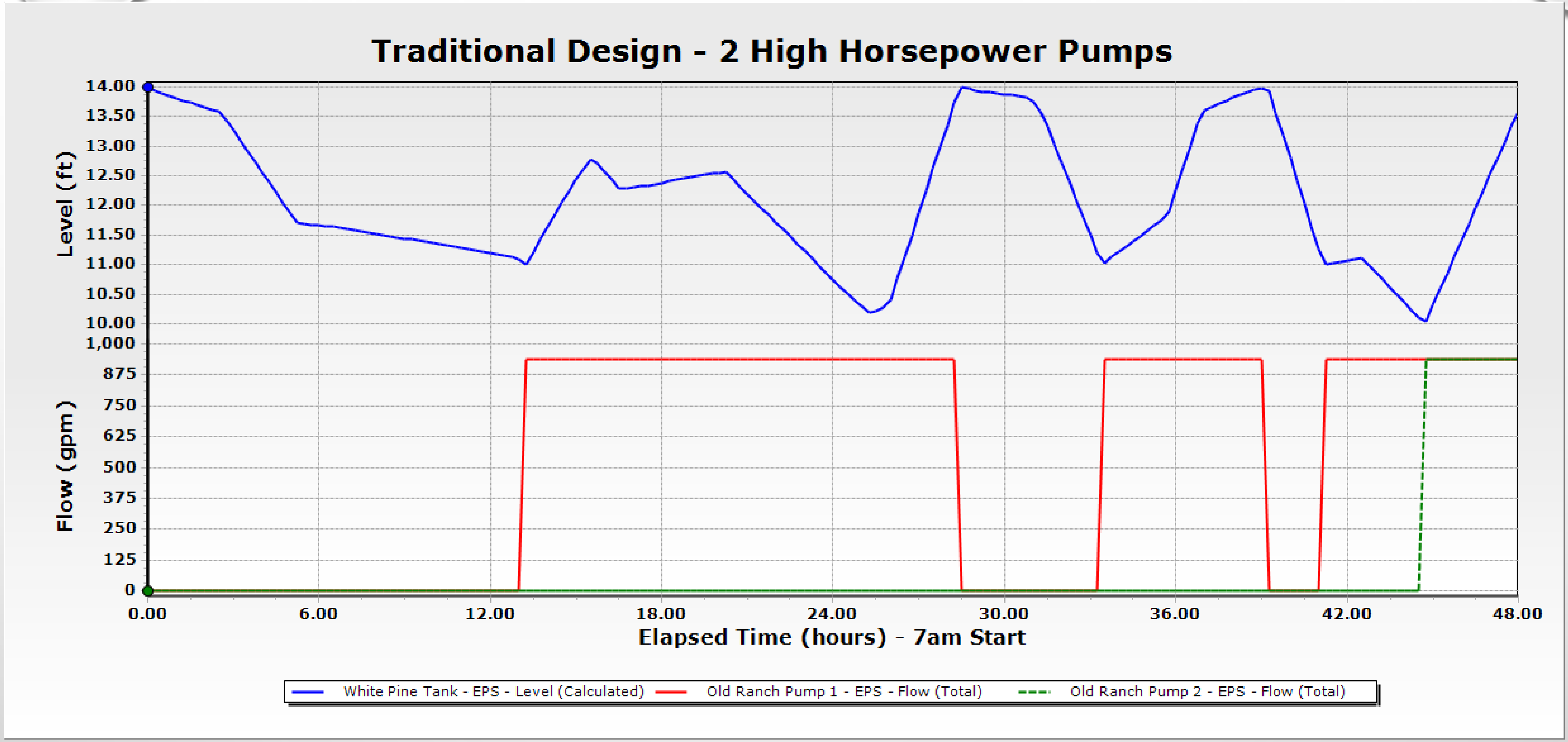
Pumping solely based on level; 1st cycle begins at 11am, ends at 6pm; 1 pump running

On Peak Pumping - Monthly						
Demand (Power) Charge: $6.41 per kW						
On Peak Energy Charge: 11.73¢ per kWh						
Off Peak Energy Charge: 3.53¢ per kWh						
Volume Pumped (MG)	Peak Power (kW)	Demand Charge	Total Energy (kWh)	Energy Charge	Total Bill	Cost per MG
13.02	49.3	$316	19,392	$1,531	$1,847	$142



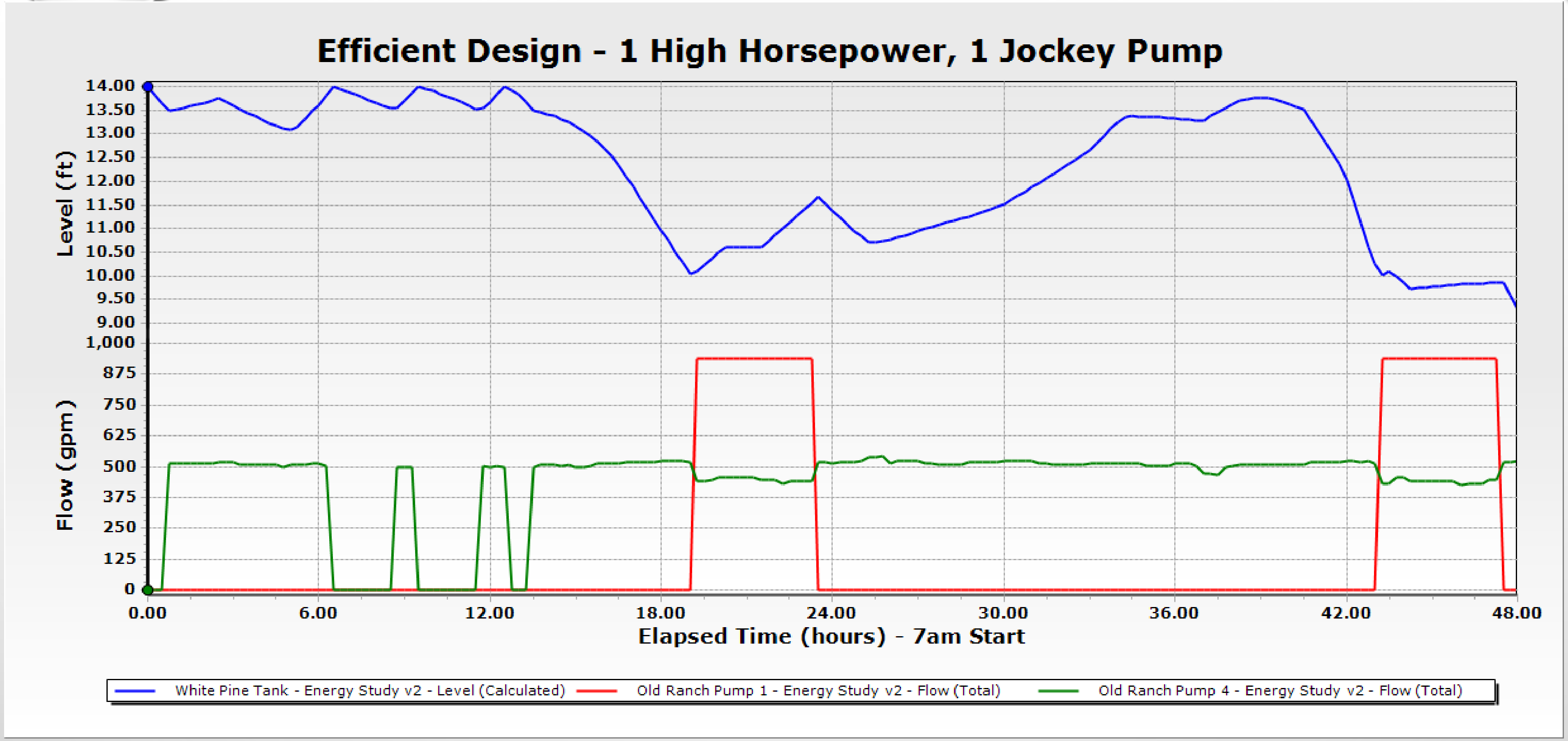
Pumping based on off peak time window; 2 pumps running to maximize volume pumped during off-peak window

Off Peak Pumping - Monthly						
Demand (Power) Charge: $6.41 per kW						
On Peak Energy Charge: 11.73¢ per kWh						
Off Peak Energy Charge: 3.53¢ per kWh						
Volume Pumped (MG)	Peak Power (kW)	Demand Charge	Total Energy (kWh)	Energy Charge	Total Bill	Cost per MG
13.21	95.8	$615	20,393	$720	$1,335	$101



2 high horsepower pumps maintaining level with low load factor

Traditional Design - 2 High Horsepower Pumps - Monthly						
Demand (Power) Charge: $6.41 per kW						
On Peak Energy Charge: 11.73¢ per kWh						
Off Peak Energy Charge: 3.53¢ per kWh						
Volume Pumped (MG)	Peak Power (kW)	Demand Charge	Total Energy (kWh)	Energy Charge	Total Bill	Cost per MG
30.12	189.9	$1,217	42,840	$3,294	$4,511	$150



Jockey pump increases load factor yet leads to decreased costs

Efficient Design - 1 High Horsepower, 1 Jockey Pump - Monthly						
Demand (Power) Charge: $6.41 per kW						
On Peak Energy Charge: 11.73¢ per kWh						
Off Peak Energy Charge: 3.53¢ per kWh						
Volume Pumped (MG)	Peak Power (kW)	Demand Charge	Total Energy (kWh)	Energy Charge	Total Bill	Cost per MG
30.79	125	$801	42,024	$3,079	$3,881	$126

LINE AND DISTRIBUTION MODELING

- LINES – MODEL THE DISTRIBUTION SYSTEM AND ENSURE THAT LINE SIZING ISSUES ARE IDENTIFIED AND RESOLVED.
- LONE AND FORGOTTEN PRV'S. FIND THESE AND DETERMINE WHICH ARE LOSING THEIR SETTINGS, OR NEED ADJUSTING.
- LOWER PRV PRESSURES IF YOU CAN, OR EVEN AT NIGHT IN CERTAIN ZONES USING SET BACK PRV VALVES.
- LOWER PRESSURES SAVES ENERGY BY REDUCING WATER LOSS.

KEY RMP PUMPING ENERGY RATES

- **RATE 23** – SMALL COMMERCIAL – LOW DEMAND < 30KW, THIS IS TYPICALLY THE HIGHEST UNIT COST RATE FOR WATER PRODUCTION.
- **RATE 6** – COMMERCIAL – MEDIUM DEMAND < 1 MW (MOST COMMON PUMPING RATE).
- **RATE 6A** – A COMMERCIAL <u>TIME OF DAY ENERGY RATE</u>. IF YOU HAVE A LOW LOAD FACTOR – YOU CAN SAVE ON THIS RATE. IT ALSO HAS AN OFF PEAK RATE BUILT IN. (5 KW MINIMUM CHARGED REGARDLESS OF USE)
- **RATE 6B** – IS THE RATE 6 <u>POWER TIME OF DAY OFF-PEAK RATE</u>. * (SEE NOTE)
- **RATE 8** – LARGE COMMERCIAL / INDUSTRIAL RATE > 1 MW. SLIGHTLY LOWER RATES BUT THE OFF-PEAK PERIOD DOUBLES IN THE SUMMER MONTHS FROM 8 HOURS TO 16 HOURS PER DAY!
- **RATE 9** – LARGE INDUSTRIAL TRANSMISSION RATE. SHOULD BE CONSIDERED IF LOADS ARE CONSISTENTLY ABOVE 1-2 MW. CONSIDERABLY LOWER RATES AND OFF PEAK PERIODS ARE THE SAME AS RATE 8, BUT YOU NEED TO TAKE THE SERVICE FROM A TRANSMISSION LINE AT THE HIGH VOLTAGE SIDE, 46KV AND ABOVE, AND CONSTRUCT, OWN, AND OPERATE A SUB-STATION.
- **NOTE** - RATES CAN BE CHANGED, BUT NOT MORE THAN ONCE A YEAR.

RATE 9 TRANSMISSION CUSTOMERS HAVE THESE

OFF PEAK PERIODS

- THE NORMAL OFF PEAK PERIODS FOR RMP ARE:
  - 11:00 PM TO 7:00 AM ALL YEAR
  - ALL DAY ON WEEKENDS AND HOLIDAYS.
- FOR RATE 8 AND 9 CUSTOMERS THEY ARE:
  - 9:00 PM TO 1:00 PM IN THE SUMMER MONTHS, AND
  - 11:00 PM TO 7:00 AM IN THE WINTER MONTHS.
  - ALL DAY ON WEEKENDS AND HOLIDAYS
- SUMMER MONTHS ARE <u>MAY</u> THROUGH <u>SEPTEMBER</u>
- YOU LOOSE THE POWER DEMAND SAVINGS IF YOU GO ON PEAK FOR EVEN A MINUTE (EXCEPT 6A).
- <u>NOTE *</u>: RATE 6B HAS A 12 MONTH AVERAGED MINIMUM KW – PRIOR TO THE 6B ELECTION. BE CAREFUL AND PRACTICE FOR A YEAR BEFORE ELECTING THIS RATE (TRY TO GET ON-PEAK LOADS AS LOW AS POSSIBLE)! OR – START A NEW FACILITY WITH THIS RATE IF YOU ARE GOING TO GO OFF-PEAK FROM THE VERY BEGINNING.

IMPORTANT OFF-PEAK WARNINGS

- AGAIN, BEWARE OF RATE 6B – WITH GREAT SAVINGS COMES GREAT RESPONSIBILITY.
- BEWARE OF SOURCE TESTS OR PUMP EXERCISE SCHEDULES.
- CHECK METER CLOCKS AT LEAST ANNUALLY – PROVIDE A SMALL TIME BUFFER IN YOUR RUN SCHEDULES.
- STUDY THE RATE TARIFFS REGULARLY !
- REMEMBER THE "DAYLIGHT SAVINGS TIME" CHALLENGE !
  - *DUE TO THE EXPANSIONS OF DAYLIGHT SAVING TIME (DST) AS ADOPTED UNDER SECTION 110 OF THE U.S. ENERGY POLICY ACT OF 2005 THE TIME PERIODS SHOWN HEREIN (OFF-PEAK) WILL BEGIN AND END ONE HOUR LATER FOR THE PERIOD BETWEEN THE SECOND SUNDAY IN MARCH AND THE FIRST SUNDAY IN APRIL, AND FOR THE PERIOD BETWEEN THE LAST SUNDAY IN OCTOBER AND THE FIRST SUNDAY IN NOVEMBER.*

Rocky Mountain Power Rate Comparisons

Rates as of: 1/1/2016

		Rate 6	Rate 6A	Rate 6B	Rate 8	Rate 9
Load Implications:		< 1,000 KW			> 1,000 KW Load	
Power Time of Day Rate:				X	X	X
Energy Time of Day Rate:			X		X	X
POWER Rate / KW	Summer On Peak	14.62	6.52	14.62	15.56	13.96
	Summer Off Peak	14.62	6.52	-	-	-
	Winter On Peak	10.91	5.47	10.91	11.19	9.47
	Winter Off Peak	10.91	5.47	-	-	-
	Facilities	4.04	-	4.04	4.76	2.22
ENERGY Rate / KWH	Summer On Peak	0.038404	0.119652	0.038404	0.050722	0.046706
	Summer Off Peak	0.038404	0.036294	0.038404	0.034250	0.029400
	Winter On Peak	0.035420	0.100079	0.035420	0.039759	0.035164
	Winter Off Peak	0.035420	0.030446	0.035420	0.034250	0.029400
Summer ON Facilities Charge %		27.63%		27.63%	30.59%	15.90%
Winter ON Facilities Charge %		37.03%		37.03%	42.54%	23.44%

< 30 KW	
No Time of Day Options Available	
Rate 23	
If > 15 KW	8.65
If > 15 KW	8.65
If > 15 KW	8.70
If > 15 KW	8.70
Facilities	-
If <= 1.5 KWH	0.117665
If > 1.5 KWH	0.066112
If <= 1.5 KWH	0.108329
If > 1.5 KWH	0.060896

A CLOSER LOOK AT THE RATES…

Average Annual Power and Energy Costs per ERC by Rate, Irrigation Zone, and Pumping Elevation

RATE 6 and 6B (On Rate 6B Off Peak Power is Lower)

	Power Rate	Energy Rate	
Sum. ON	14.27	0.038127	
Sum. OFF	14.27	0.038127	0.0 on 6B
Win. ON	10.65	0.035143	
Win. OFF	10.65	0.035143	0.0 on 6B
Facilities	4.04	Only Power on 6B	

RATE 6A (Off Peak Energy is Low

	Facilities (Power) Rate	Energy Rate
Sum. ON	6.45	0.117997
Sum. OFF	6.45	0.035526
Win. ON	5.41	0.098633
Win. OFF	5.41	0.029770
Facilities	0.00	

RATE 23 (< 30 kw) If >15kw

	Power Rate	Energy Rate	
Summer	8.65	0.117300	<=1.5 kwh
Summer	8.65	0.065763	>1.5 kwh
Winter	8.70	0.107967	<=1.5 kwh
Winter	8.70	0.060524	>1.5 kwh
Facilities	0.00		

Rate 6A saves on low load factor

Ft. Head	Irr. Zone	Ave. Ann. Gal	Annual kw/h	Rate 6	Rate 6	Rate 6	Rate 6B	Rate 6A	Rate 6A	Rate 6A	Rate 6A	Rate 23	Rate 23	Rate 23	Rate 23
		LOAD FACTORS >>>		20%	50%	80%	Off Peak	20%	50%	80%	Off Peak	20%	50%	80%	<15kw
500	1	242,897	635.52	119.83	62.08	47.64	37.40	88.10	67.48	62.33	42.15	89.56	60.21	52.88	72.51
500	2	247,816	648.40	122.26	63.34	48.61	38.15	89.89	68.85	63.59	43.00	91.37	61.43	53.95	73.98
500	3	283,074	740.65	139.65	72.35	55.52	43.58	102.68	78.65	72.64	49.12	104.37	70.17	61.62	84.50
500	4	300,293	785.70	148.14	76.75	58.90	46.23	108.92	83.43	77.06	52.11	110.72	74.44	65.37	89.64
500	5	367,528	961.62	181.31	93.93	72.09	56.58	133.31	102.11	94.31	63.77	135.51	91.11	80.01	109.71
500	6	414,265	1,083.90	204.37	105.88	81.25	63.78	150.26	115.09	106.30	71.88	152.75	102.70	90.18	123.66

But is higher on high load factor

Rate 8 and 9 double the Off-Peak period to nearly 20 hours per day (over a week) - thus reducing capital costs on pumping equipment. (More time = smaller pumps)

RATE 8

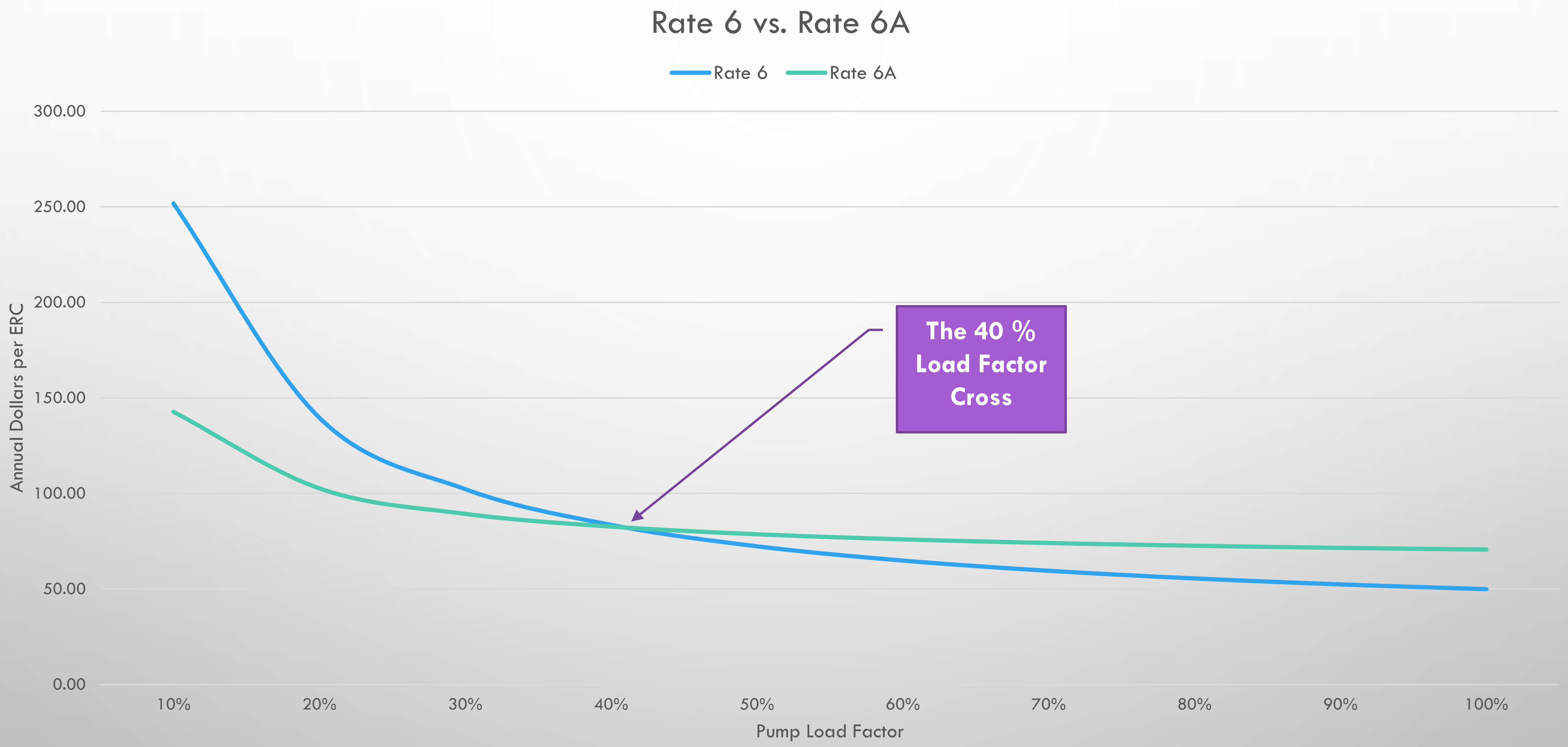
	Power Rate	Energy Rate
Sum. ON	15.40	0.049961
Sum. OFF	0.00	0.033641
Win. ON	11.08	0.039109
Win. OFF	0.00	0.033641
Facilities	4.71	

RATE 9

	Power Rate	Energy Rate
Sum. ON	13.75	0.045818
Sum. OFF	0.00	0.028777
Win. ON	9.32	0.034453
Win. OFF	0.00	0.028777
Facilities	2.19	

Ft. Head	Irr. Zone	Ave. Ann. Gal	Annual kw/h	Rate 8	Rate 8	Rate 8	Rate 8	Rate 9	Rate 9	Rate 9	Rate 9
		LOAD FACTORS >>>		20%	50%	80%	Off Peak	20%	50%	80%	Off Peak
500	1	242,897	635.52	129.24	66.22	50.46	32.22	102.56	53.79	41.59	23.33
500	2	247,816	648.40	131.86	67.56	51.48	32.88	104.64	54.88	42.44	23.80
500	3	283,074	740.65	150.62	77.17	58.81	37.55	119.53	62.68	48.47	27.19
500	4	300,293	785.70	159.78	81.86	62.38	39.84	126.80	66.50	51.42	28.84
500	5	367,528	961.62	195.55	100.19	76.35	48.76	155.19	81.39	62.93	35.30
500	6	414,265	1,083.90	220.42	112.93	86.06	54.96	174.92	91.73	70.94	39.79

THE 40 % RATE CROSSING



POTENTIAL ANNUAL SAVINGS EXAMPLES:

- CURRENT ENERGY COSTS (TYPICAL RATE 6 @ 20% LF):
  - ANNUAL COST PER ERC = $ 140.00 TIMES 1,000 ERC'S = $ 140,000.00
- MOVED TO RATE 6A WITH NO LF CHANGE:
  - ANNUAL COST PER ERC = $ 103.00 TIMES 1,000 ERC'S = $ 103,000.00 — $ 37,000 DOLLAR SAVINGS
- RATE 6 MANAGED TO 80% LF:
  - ANNUAL COST PER ERC = $ 56.00 TIMES 1,000 ERC'S = $ 56,000.00 — $ 84,000 DOLLAR SAVINGS
- MOVED TO RATE 6A AND MANAGED TO TOTAL OFF-PEAK:
  - ANNUAL COST PER ERC = $ 49.00 TIMES 1,000 ERC'S = $ 49,000.00 — $ 91,000 DOLLAR SAVINGS
- FOR LARGER USERS THAT CAN MOVE TO RATE 8, OR 9:
  - RATE 8 TOTALLY OFF PEAK — $ 102,000 DOLLAR SAVINGS
  - RATE 9 TOTALLY OFF PEAK — $ 113,000 DOLLAR SAVINGS
- RATE 6B IF * "TOTALLY WEANED FROM POWER" — $ 96,000 DOLLAR SAVINGS

A BRIEF NOTE FOR LARGER USERS

- THE OFF-PEAK RATE FOR RATE 6 AND THE RATES 8 AND 9 LOOK SIMILAR, BUT THE FOLLOWING NEEDS TO BE REMEMBERED:
  - THE OFF-PEAK PERIODS FOR THE NUMBER 6 RATES (6A AND 6B) CAN NEVER GO MORE THAN 8 HOURS PER DAY.
  - THE OFF-PEAK PERIODS FOR THE 8 AND 9 RATES GO TO 16 HOURS PER DAY IN THE SUMMER.
  - MOST PUMPING SYSTEMS WILL NEED TO GO PARTIALLY ON-PEAK IN THE PEAK MONTHS TO MEET THE DAILY AND MONTHLY DEMANDS OF THE SYSTEM WHEN THE LIMITATION IS ONLY 8 HOURS PER DAY.
  - IF YOU HAVE THE ABILITY TO USE 1 MW – YOU MAY WANT TO CONSIDER A FORCED CHANGE TO RATE 8 (PAY A LARGE POWER PENALTY AT FIRST) TO ENJOY THE BENEFITS OF A LONGER OFF PEAK SUMMER PERIOD (STUDY CAREFULLY).
  - THIS MAKES THE SAVINGS FOR RATE 8 AND 9 LARGER THAN MAY APPEAR IN THIS SIMPLIFIED MODEL, SINCE THE OFF-PEAK PERIODS WILL LIKELY BE MAINTAINED.

A RATE - SAVINGS STRATEGY (THE GREATER THE EFFORT – THE GREATER BENEFIT)

- **EASY** – IF YOU HAVE LOW LF, (<40%) MOVE TO RATE 6A.
- **MODERATE** – STAY ON RATE 6 AND INCREASE YOUR LF OR PUMPING EFFICIENCY BY:
  - MANAGING YOUR CONTROL SCHEME BETTER (SCADA)
  - INSTALLING VFD'S ON PUMPING SYSTEMS (RMP MAY HELP PAY !!!)
- **HARDER** – MOVE YOUR RATE TO 6A AND SHED YOUR ENERGY LOADS TO OFF-PEAK PERIODS.
- **HARDEST** – IF YOUR ARE A LARGE USER – MOVE TO RATE 8 OR 9 AND GO OFF-PEAK AS MUCH AS IS POSSIBLE. USE HIGH PUMP LOADS OFF-PEAK AND REDUCE LOADS ON-PEAK – WITH LARGE LOAD FACTORS.

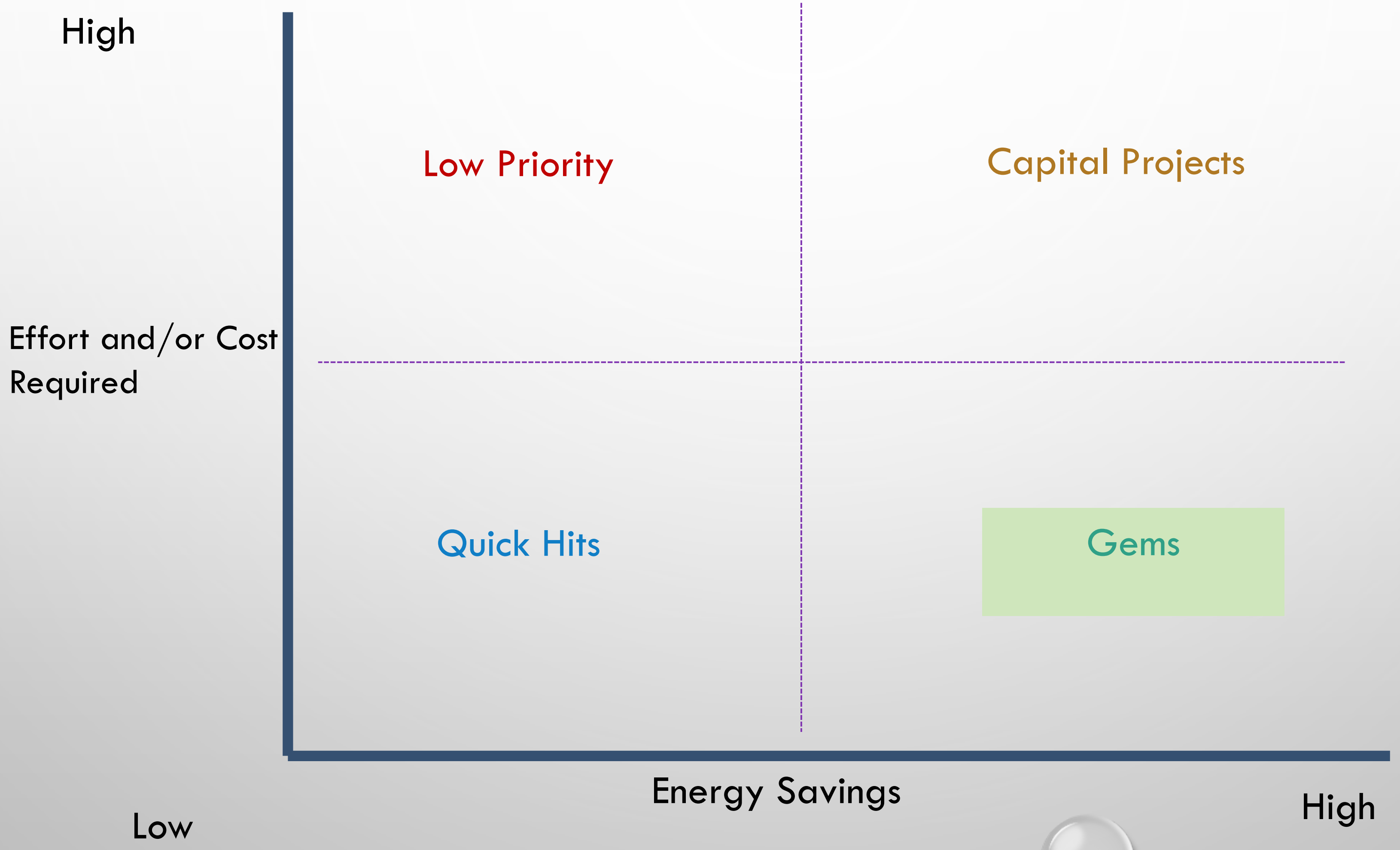
THE CUSTOMER EFFICIENCY CHARGE

- 3.2 % OF ALL OF OUR ENERGY BILLS PAY INTO THIS FUND !
- FOR EXAMPLE - I PAY NEARLY 20,000 DOLLARS A YEAR INTO THIS FUND.
- WE ALL NEED TO TRY TO GET THIS BACK THROUGH THE WATT-SMART PROGRAM.
- IF YOU DON'T – SOMEONE ELSE WILL USE YOUR GENEROUS DONATION FOR THEIR ENERGY EFFICIENCY PROJECTS !

OTHER INCENTIVES

- SEEK OTHER ASSISTANCE AND OTHER EFFICIENCY TRAINING PROGRAMS, I.E. RMP, RWAU, STATE, ETC.
- APPLY FOR INCENTIVES – LEARN ABOUT GOVERNMENT AND UTILITY INCENTIVES AVAILABLE, I.E. STATE, RMP WATTSMART, ETC.
- INVESTIGATE ENERGY SERVICE COMPANY (ESCO'S) CONSTRUCTED PROJECTS.
- IF YOU DON'T SOMEONE ELSE WILL !

THE LOW HANGING FRUIT

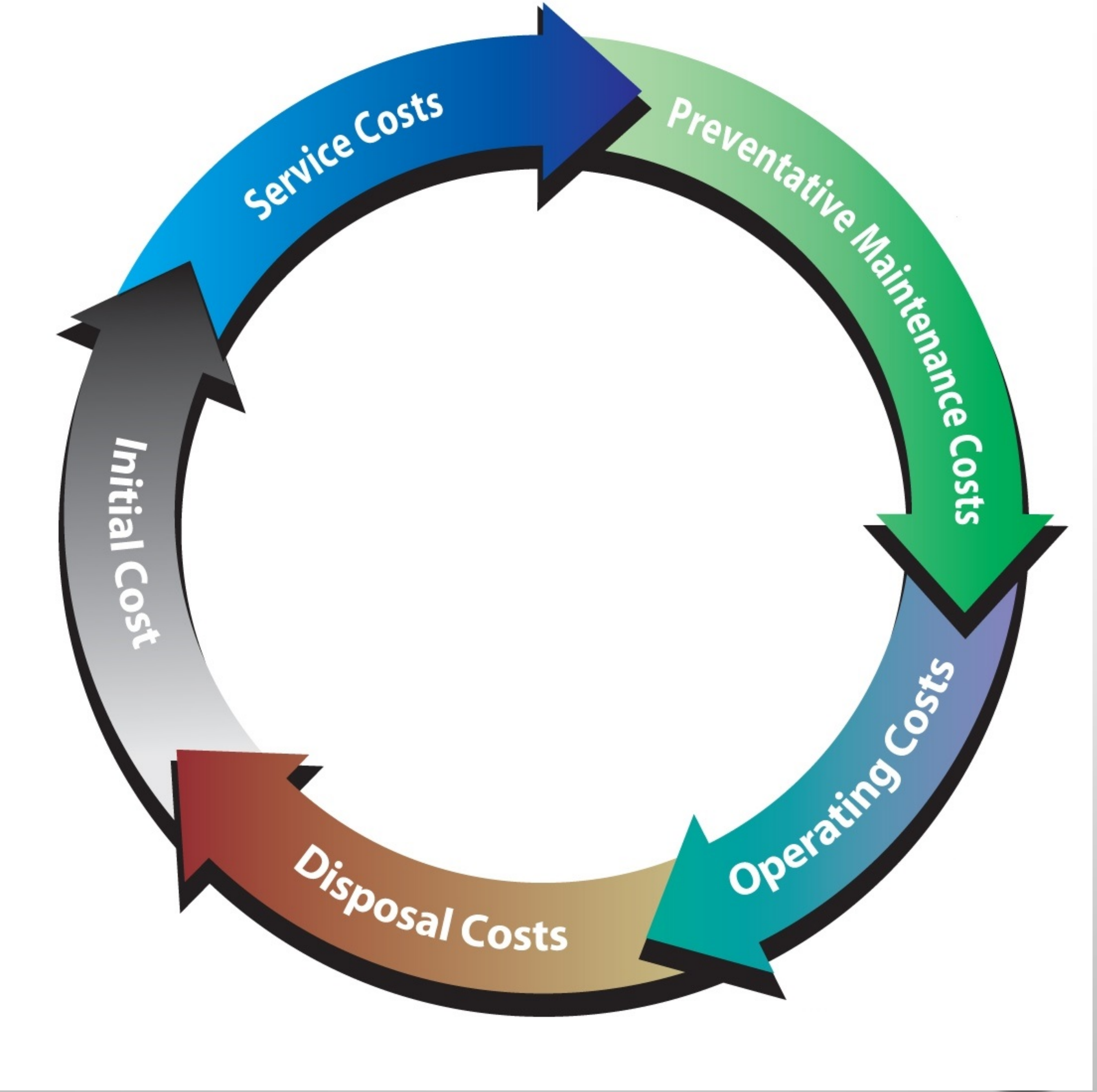


SOME TYPICAL LOW HANGING FRUIT

- SIMPLY CHANGE RATES TO 6A ON A LOW LOAD FACTOR.
- CURTAIL OR USE INEFFICIENT SOURCES OR PUMPING SYSTEMS LESS.
- DON'T EVER REGULATE PUMP FLOWS WITH A VALVE OR A BYPASS !!!
- INCREASE THE LOAD FACTORS OF PUMPS.
- ACCOUNT FOR LOST WATER AND DISTRIBUTION SYSTEM INEFFICIENCIES.
- PUMP OFF-PEAK WHERE FEASIBLE.
- EVALUATE FOR SERVICE OR REPLACEMENT, ALL OLD AND WORN PUMPING EQUIPMENT.
- MODEL YOUR SYSTEM , THERE ARE MANY PROJECTS TO BE HAD HERE !

LIFE CYCLE COSTS

- REGARDING ENERGY PROJECT FEASIBILITY – WE NEED TO COMPARE THE SUM OF ALL RECURRING AND ONE-TIME (NON-RECURRING) COSTS OVER THE FULL LIFE SPAN OR A SPECIFIED PERIOD OF THE FACILITY OR SYSTEM. INCLUDING PURCHASE PRICE, AMORTIZATION COSTS, INSTALLATION COSTS, OPERATING COSTS, MAINTENANCE AND UPGRADE COSTS, AND REMAINING (RESIDUAL OR SALVAGE) VALUE AT THE END OF OWNERSHIP OR ITS USEFUL LIFE.



Service Costs
Preventative Maintenance Costs
Operating Costs
Disposal Costs
Initial Cost

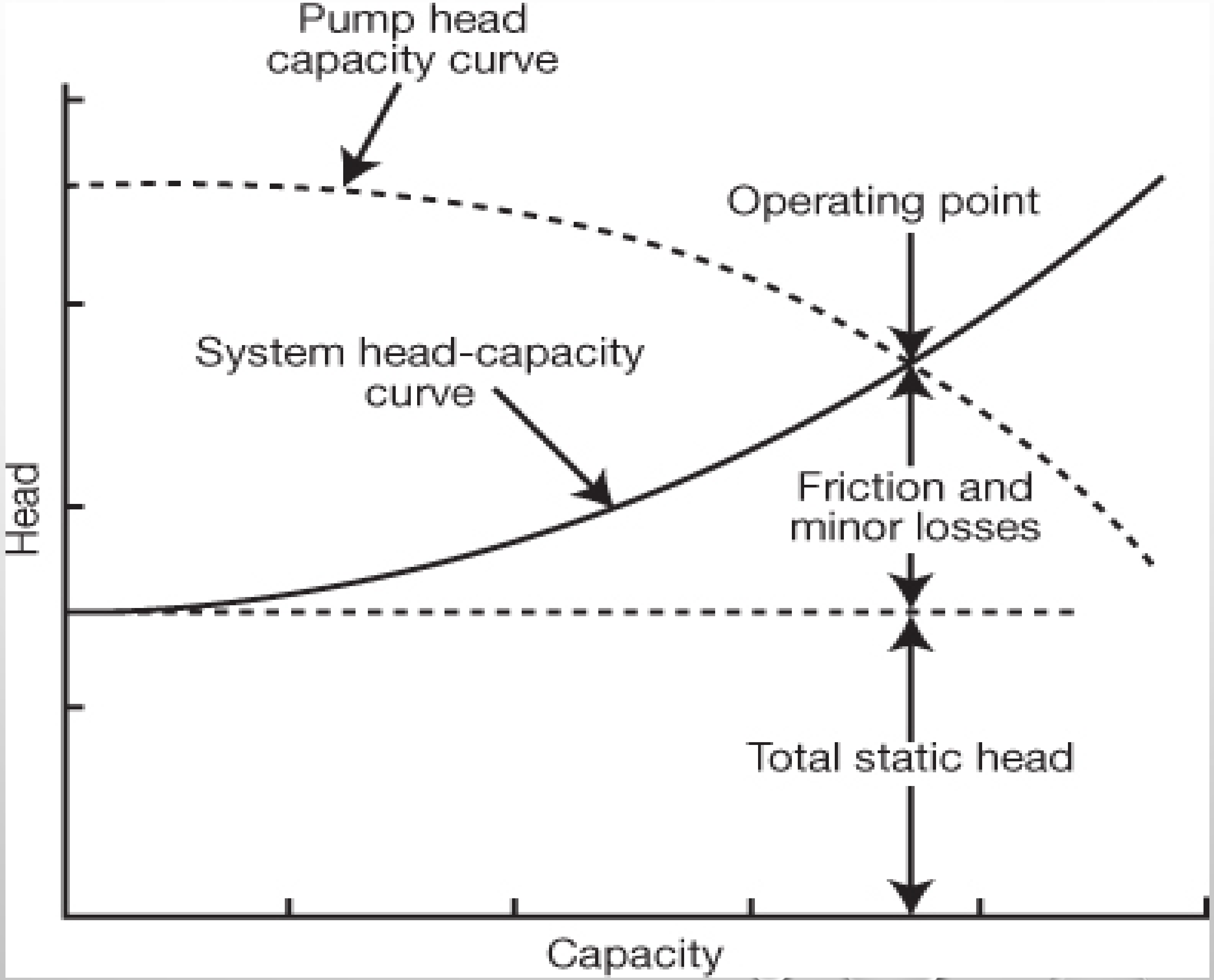
MOST ENERGY PROJECTS SHOULD PAY FOR THEMSELVES IN 7 YEARS OR LESS.

DON'T GO INTO THE RED,
WHILE TRYING TO BE GREEN !

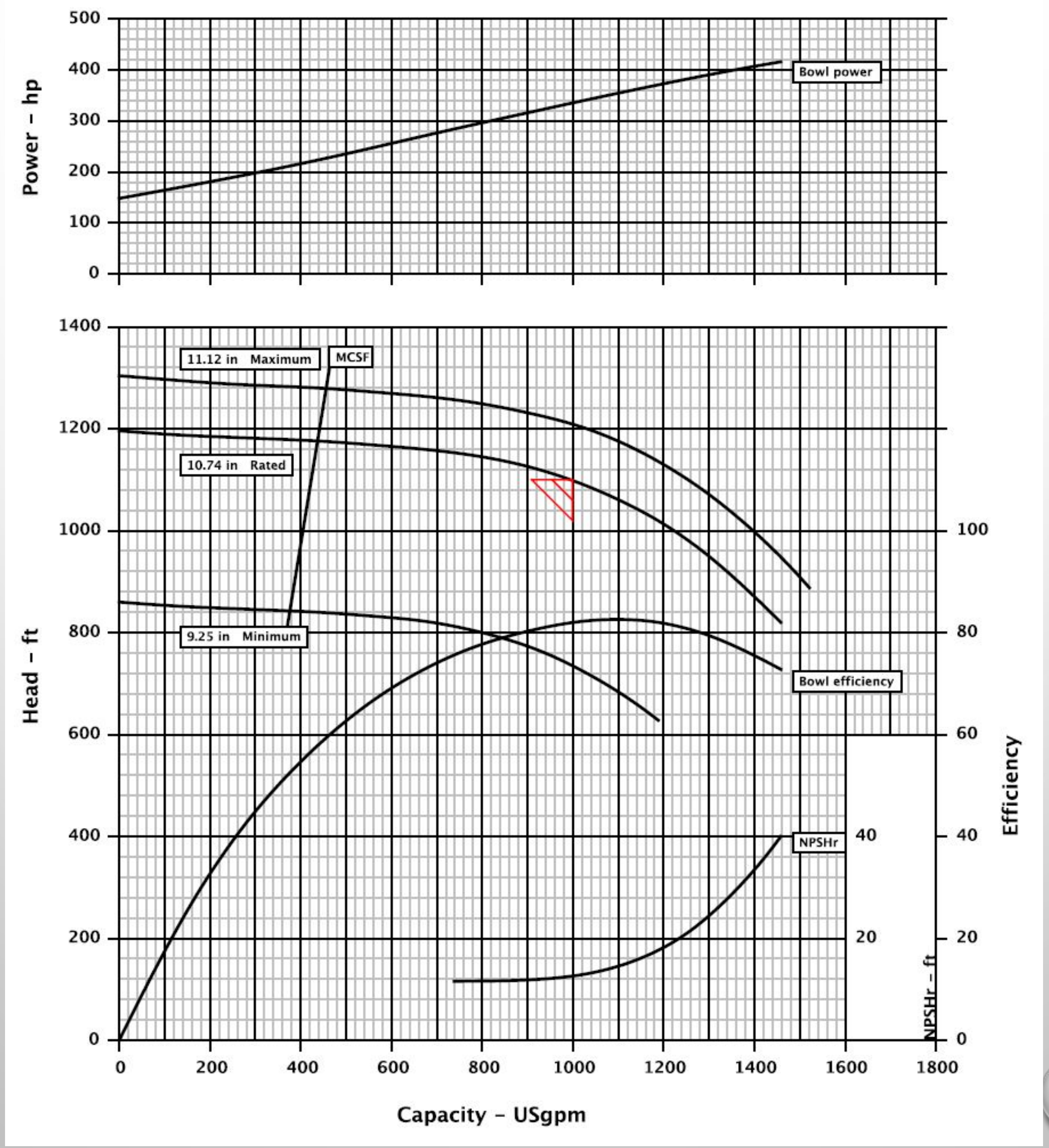
LEANER AND MEANER PUMP SYSTEMS

- TEST ALL PUMP PERFORMANCE OFTEN.
- POST PUMP CURVES AND TEST RESULTS AT PUMP SITES.
- UNDERSTAND THE PROPER OPERATION AND SETTINGS AND APPLICATION OF A VFD, OR A SOFT START. KNOW HOW TO PROGRAM AND CHECK THESE.
- UPGRADE OLD MOTORS TO HIGH EFFICIENCY MOTORS.
- LUBRICATE MOTORS WITH HIGH EFFICIENCY SYNTHETIC OILS (I.E. ROYAL PURPLE).
- LISTEN TO PUMP OPERATION – BE AWARE OF BEARING WEAR, ETC.
- DESIGN LEANER PUMPING SYSTEMS. DO NOT OVERSIZE PUMPS OR MOTORS.
- KNOW YOUR SYSTEM CURVES AT EACH FACILITY.

PUMP CURVE FUNDAMENTALS

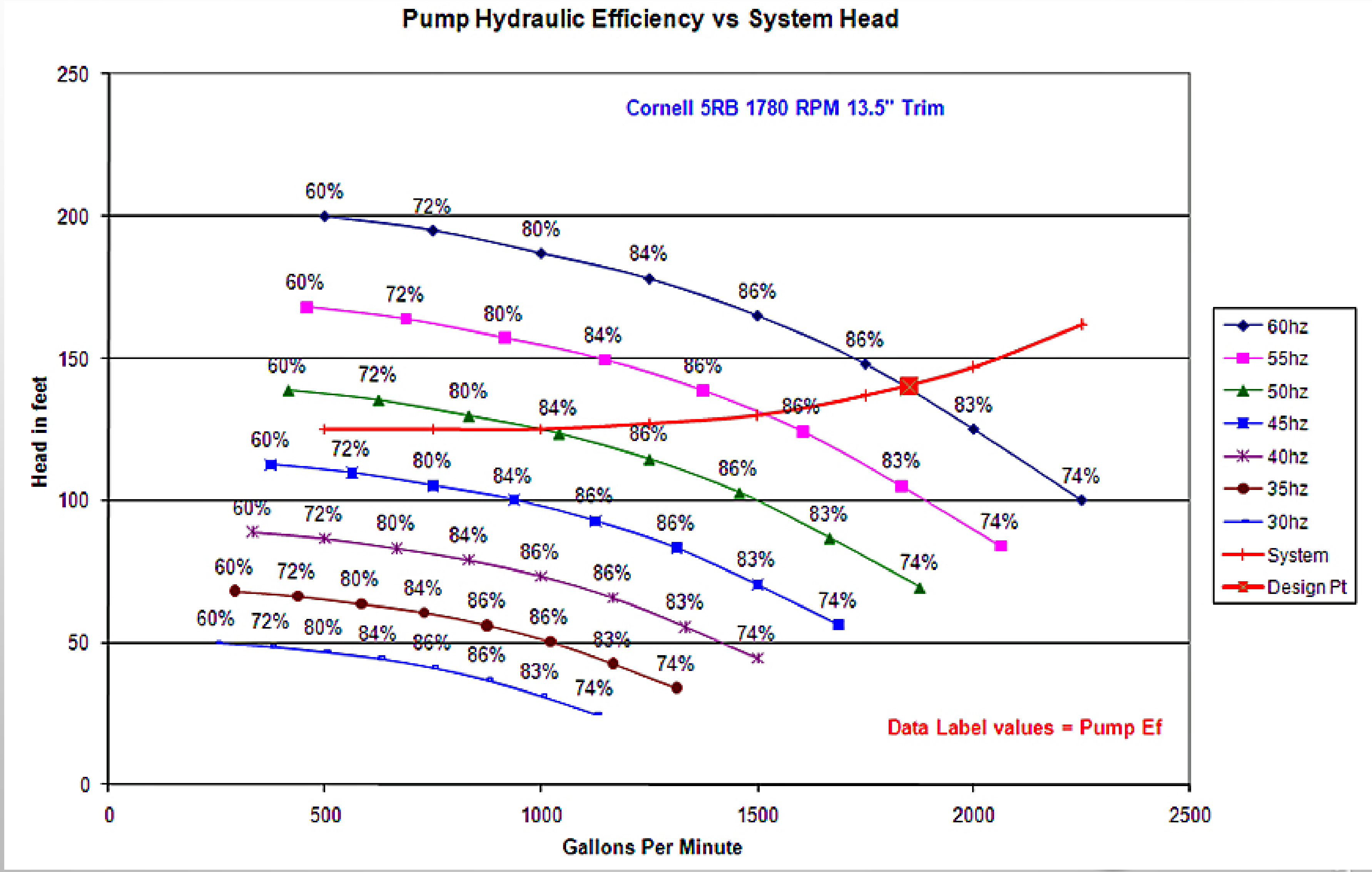


A TYPICAL PUMP CURVE



A VFD PUMP CURVE

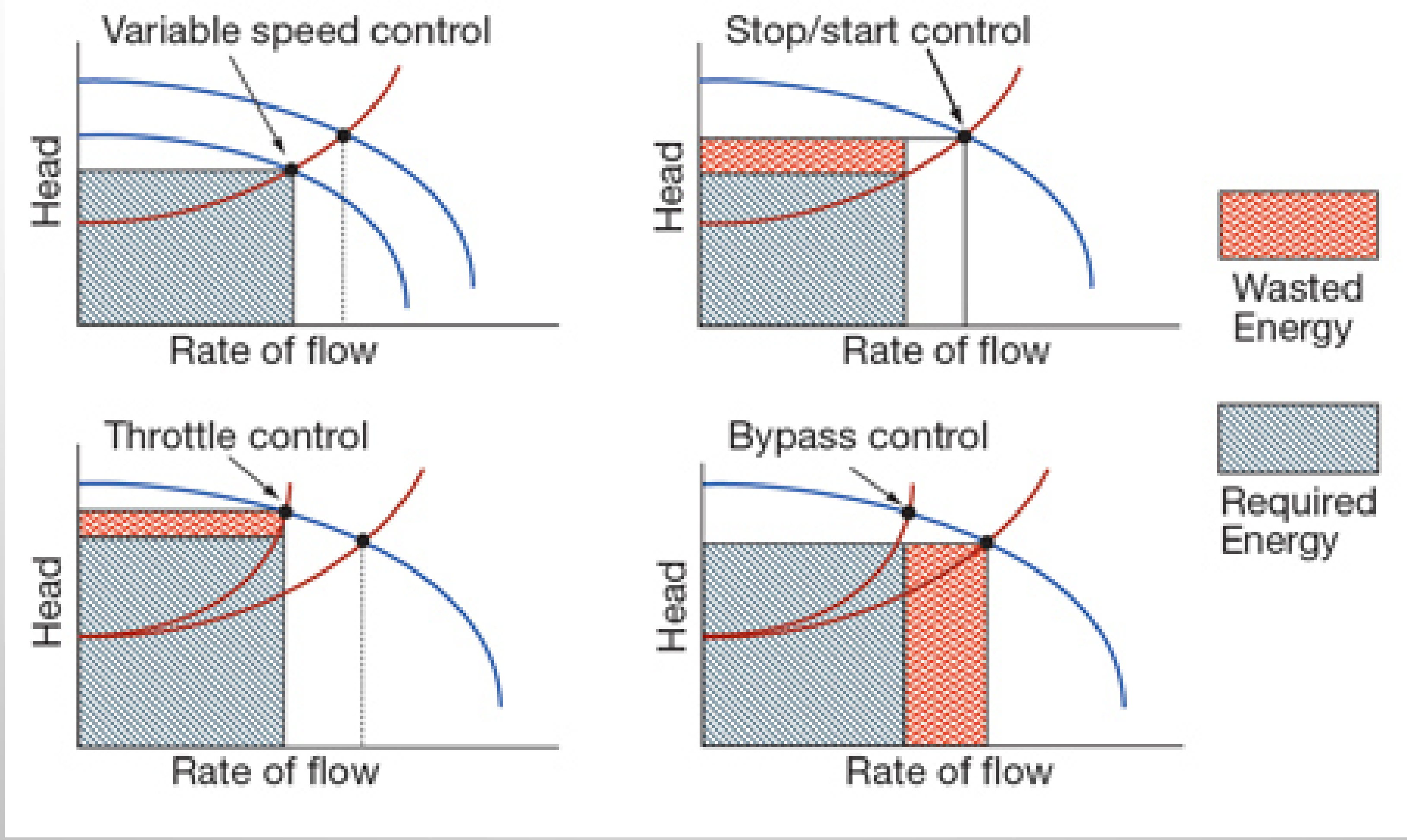
QUESTION - HOW SLOW CAN THIS PUMP BE RUN ?



PUMP RESTRICTION ISSUES

- DO NOT REGULATE ANY FLOWS WITH A VALVE.
- IMAGINE DRIVING DOWN THE ROAD AT 100 MPH, AND WHILE KEEPING YOUR FOOT AT THE SAME POSITION ON THE ACCELERATOR, STOPPING OR SLOWING DOWN YOUR SPEED WITH YOUR BRAKE. YOU CONSUME THE SAME AMOUNT OF ENERGY BUT INSTEAD OF USING IT, YOU ARE BURNING IT UP IN YOUR BRAKING SYSTEM. SIMILAR TO USING A RESTRICTING VALVE OR EXCESSIVE PUMPING FLOWS.
- DO NOT REGULATE FLOWS WITH A BY-PASS SYSTEM.
- REPLACE A PUMP THAT IS NOT DESIGNED FOR THE APPLICATION.
- KNOW WHEN A VFD IS <u>NOT</u> AN EFFICIENT RESTRICTION.

EFFECTS OF PUMP THROTTLING AND BY-PASSING

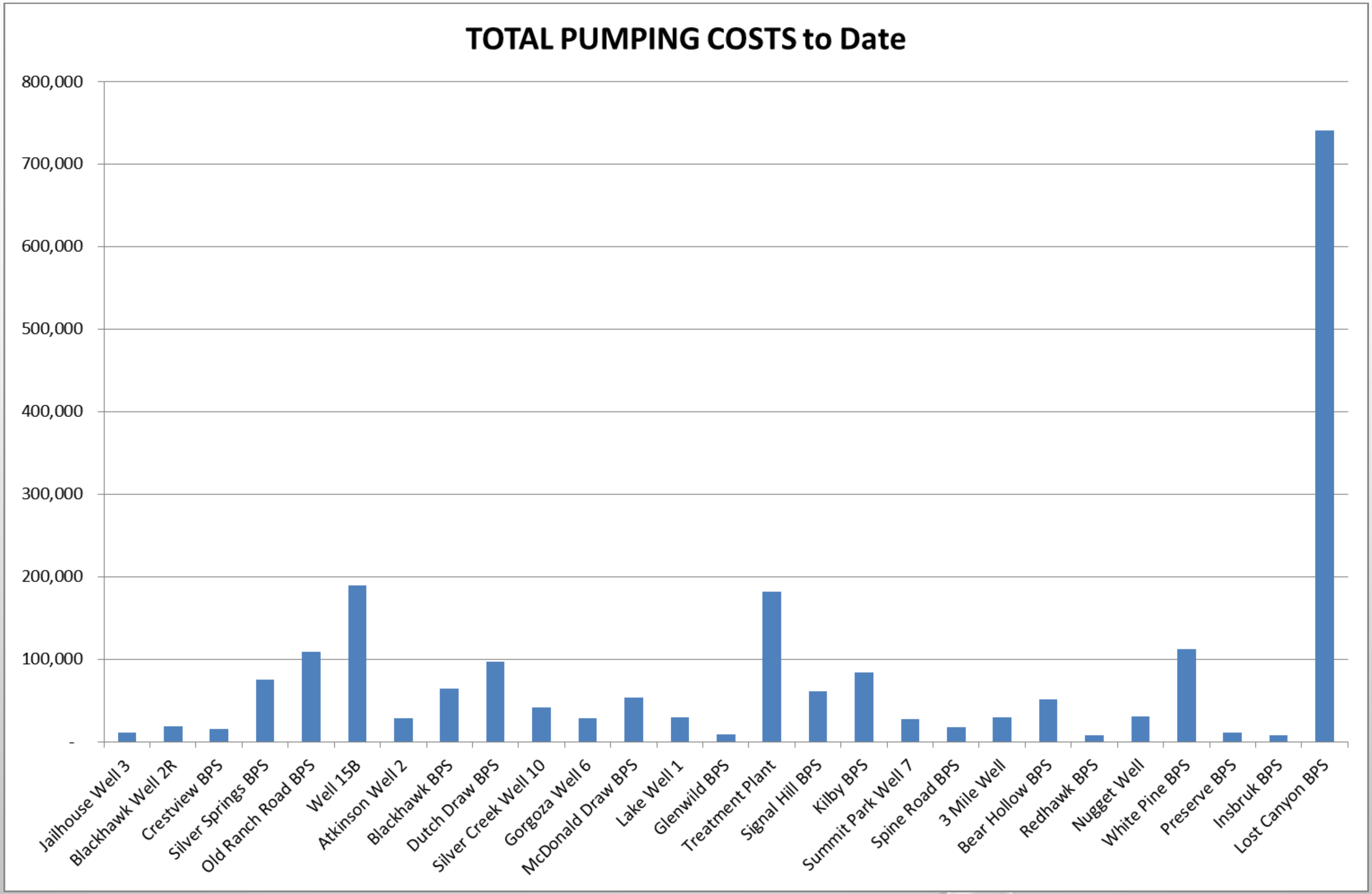


ANALYZE WATER & POWER DATA

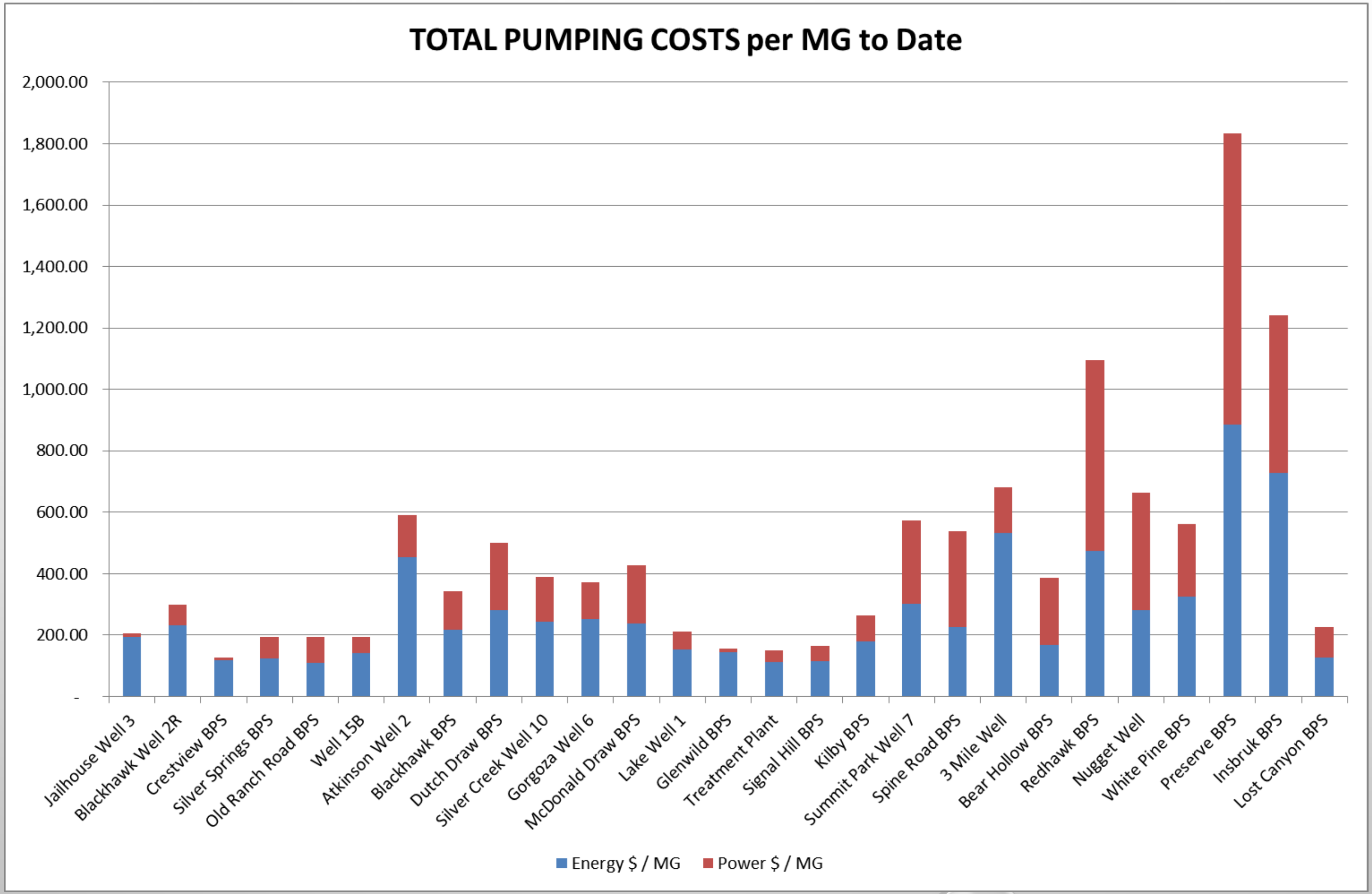
- COMPARE MONTHLY WATER PUMPING VOLUMES TO ENERGY DATA.

TOTAL COSTS			LOAD STATISTICS					PEAKING	WATER PUMPING SYSTEM EFFICIENCY and UNIT COSTS													
ENERGY and POWER	Other Misc Fixed Costs	TOTAL BILL	Average Plant Cont. Power KW	Energy Capacity Utiliz-ation Factor	Power Capacity Utiliz-ation Factor	Actual Period Load Factor	Potential $ Savings if Run @ 100% LF	Potential $ Savings if Pumps Run @ 100% Off-Peak	Total Gallons of Water Production or Delivery	Ave Monthly Head in Ft	Ave Monthly GPM	Feet of Head per KW	Ave GPM per KW	Ave Gallons per KWH	Theo-retical Cont. Water KW	Ave Wire to Water Effic-iency %	KWH per 1000 gallons	Energy Cost per 1000 Gallon	Power Cost per 1000 Gallon	% of Bill as Power Load	Total Cost per 1000 Gallon	Total Cost per MG
885.99	89.59	975.58	14.21	4.65%	26.08%	17.82%	309.08	212.33	1,182,581	827	27	10	2	114	4.19	29.51%	8.79	0.4312	0.3180	42.45%	0.7492	749.20
2,049.09	179.78	2,228.87	23.83	7.79%	64.43%	12.09%	928.22	431.15	3,273,484	827	75	4	3	188	11.61	48.71%	5.33	0.3034	0.3226	51.53%	0.6260	625.97
2,715.42	181.53	2,896.95	36.89	12.06%	63.78%	18.92%	849.08	783.14	5,868,063	827	134	4	4	217	20.80	56.40%	4.60	0.2843	0.1784	38.56%	0.4627	462.75
3,555.99	221.37	3,777.36	60.38	19.75%	63.78%	30.97%	722.90	1,082.06	9,549,485	827	217	4	4	216	33.86	56.07%	4.63	0.2627	0.1097	29.45%	0.3724	372.38
3,013.22	195.65	3,208.87	49.13	16.07%	63.78%	25.19%	783.34	812.78	7,953,581	827	181	4	4	221	28.20	57.40%	4.52	0.2472	0.1317	34.75%	0.3789	378.85
2,484.85	170.60	2,655.45	31.26	10.22%	64.10%	15.95%	855.02	747.98	4,769,634	827	109	4	3	208	16.91	54.10%	4.80	0.3077	0.2133	40.94%	0.5210	520.97
1,558.76	126.71	1,685.47	14.70	4.81%	64.43%	7.46%	820.35	365.04	2,870,946	827	65	4	4	267	10.18	69.24%	3.75	0.2342	0.3088	56.87%	0.5429	542.94
1,831.76	139.65	1,971.41	23.83	7.79%	65.41%	11.91%	792.79	449.60	2,525,654	827	58	4	2	145	8.95	37.58%	6.91	0.3689	0.3563	49.13%	0.7253	725.26
2,089.07	169.51	2,258.58	33.61	10.99%	66.72%	16.47%	766.77	505.29	3,400,798	827	77	4	2	138	12.06	35.88%	7.23	0.3444	0.2699	43.94%	0.6143	614.29
2,071.06	207.53	2,278.59	30.22	9.88%	67.05%	14.74%	786.52	540.35	2,932,806	827	67	4	2	133	10.40	34.41%	7.54	0.3916	0.3145	44.54%	0.7062	706.17
1,874.02	188.00	2,062.02	25.03	8.19%	66.07%	12.39%	796.38	459.91	2,257,700	827	51	4	2	123	8.00	31.98%	8.11	0.4274	0.4026	48.51%	0.8301	830.06
3,564.54	(1,604.07)	1,960.47	46.01	15.05%	65.41%	23.01%	1,406.69	812.59	2,307,074	827	53	4	1	68	8.18	17.78%	14.60	0.7531	0.7919	51.25%	1.5450	1,545.05
1,381.89	-	1,381.89	21.80	7.13%	35.32%	20.19%	403.40	408.80	1,936,755	827	44	8	2	121	6.87	31.49%	8.24	0.4525	0.2610	36.58%	0.7135	713.51
1,456.89	-	1,456.89	18.96	6.20%	35.32%	17.56%	478.14	419.98	2,427,245	827	55	8	3	175	8.61	45.38%	5.72	0.3613	0.2389	39.81%	0.6002	600.22
2,333.81	-	2,333.81	30.16	9.87%	64.10%	15.39%	890.54	565.74	5,118,387	827	117	4	4	232	18.15	60.16%	4.31	0.2503	0.2056	45.10%	0.4560	455.97
2,877.75	-	2,877.75	47.43	15.51%	63.78%	24.32%	792.44	723.85	7,323,218	827	167	4	4	211	25.96	54.74%	4.74	0.2500	0.1430	36.39%	0.3930	392.96
3,109.67	-	3,109.67	47.87	15.66%	63.45%	24.67%	784.72	928.90	11,458,044	827	261	4	5	327	40.62	84.86%	3.06	0.1805	0.0909	33.50%	0.2714	271.40
2,775.99	-	2,775.99	38.63	12.64%	63.78%	19.81%	859.52	766.54	5,273,277	827	120	4	3	186	18.70	48.39%	5.36	0.3232	0.2033	38.61%	0.5264	526.43
1,899.32	-	1,899.32	24.15	7.90%	64.10%	12.32%	859.24	389.41	1,383,235	827	31	4	1	78	4.90	20.30%	12.78	0.6646	0.7085	51.60%	1.3731	1,373.10
1,951.46	-	1,951.46	25.36	8.29%	64.43%	12.87%	858.22	410.03	2,409,622	827	55	4	2	130	8.54	33.69%	7.70	0.4011	0.4088	50.48%	0.8099	809.86
5,894.10	(2,947.05)	2,947.05	94.21	30.81%	65.41%	47.10%	1,042.06	1,823.38	5,583,321	827	127	4	1	81	19.79	21.01%	12.35	0.7028	0.3528	33.42%	1.0557	1,055.66
2,222.11	-	2,222.11	27.05	8.85%	65.09%	13.59%	859.75	613.90	4,188,750	827	95	4	4	212	14.85	54.90%	4.73	0.2930	0.2375	44.78%	0.5305	530.49
1,463.80	-	1,463.80	21.86	7.15%	35.98%	19.87%	440.71	426.06	2,571,259	827	59	8	3	161	9.12	41.71%	6.22	0.3554	0.2139	37.57%	0.5693	569.29
1,375.11	-	1,375.11	18.58	6.08%	35.00%	17.36%	442.10	419.19	2,537,878	827	58	8	3	187	9.00	48.43%	5.36	0.3310	0.2108	38.91%	0.5418	541.83
1,914.66	-	1,914.66	20.93	6.85%	63.78%	10.73%	908.09	402.60	2,838,536	827	65	4	3	185	10.06	48.08%	5.40	0.3161	0.3584	53.13%	0.6745	674.52
2,535.81	-	2,535.81	27.98	9.15%	63.78%	14.35%	995.45	631.09	5,894,342	827	134	4	5	288	20.90	74.69%	3.47	0.2330	0.1972	45.83%	0.4302	430.21
3,766.51	-	3,766.51	59.02	19.30%	63.78%	30.26%	810.46	1,067.37	8,562,152	827	195	4	3	198	30.36	51.44%	5.05	0.3042	0.1357	30.86%	0.4399	439.90
4,131.47	-	4,131.47	61.26	20.03%	63.45%	31.58%	791.15	1,352.74	9,582,745	827	218	4	4	214	33.97	55.46%	4.68	0.3105	0.1207	27.99%	0.4311	431.14
3,878.57	-	3,878.57	56.45	18.46%	63.78%	28.95%	825.77	1,223.77	8,750,388	827	199	4	4	212	31.02	54.96%	4.72	0.3104	0.1328	29.96%	0.4432	443.25
2,998.90	-	2,998.90	41.20	13.48%	63.78%	21.13%	891.17	834.88	5,888,021	827	134	4	3	195	20.87	50.66%	5.12	0.3174	0.1919	37.68%	0.5093	509.32
1,935.98	-	1,935.98	20.98	6.86%	63.12%	10.87%	894.76	442.12	2,939,845	827	67	4	3	191	10.42	49.67%	5.22	0.3170	0.3415	51.86%	0.6585	658.53
1,843.59	-	1,843.59	17.54	5.74%	64.10%	8.95%	936.91	394.47	2,174,476	827	50	4	3	169	7.71	43.95%	5.90	0.3746	0.4732	55.82%	0.8478	847.83

COMPARE YOUR DIFFERENT PUMP BILLS



THEN COMPARE ELEC. COSTS PER MG (SPECIFIC ENERGY)



CONSOLIDATE WATER RIGHTS

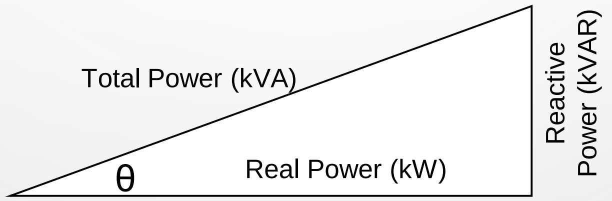
- IT IS OFTEN DIFFICULT TO OPERATE AND PRIORITIZE WATER PUMPING SYSTEM OPERATIONS IF YOU HAVE WATER RIGHT CONSTRAINTS IN EACH SOURCE.
- INVESTIGATE THE CONSOLIDATION OF WATER RIGHTS SO THAT THEY ARE USABLE IN MULTIPLE SOURCES, ALLOWING FULL ENERGY EFFICIENCY FLEXIBILITY.

POWER FACTOR

- POWER FACTOR CORRECTION – THE OTHER ENERGY EFFICIENCY STRATEGY.
- POWER FACTOR IS A MEASUREMENT OF THE REACTIVE POWER IN A SYSTEM (VARS) AND IS AN INDICATOR OF HOW INEFFICIENT A PUMPING DRIVE SYSTEM IS.
- IT IS A FUNCTION OF THE MAGNETIZING ENERGY AND SLIPPAGE OF A MOTOR, AND IF IT IS LESS THAN 0.90, THE UTILITY WILL ASSESS A PENALTY ON YOUR POWER BILLS.
- THE PENALTY IS USUALLY AN INCREASE IN ON-PEAK KW POWER DEMAND LOAD.
- THIS PROBLEM CAN BE REMEDIED BY A VFD, OR BY ADDING PROPERLY SIZED CAPACITORS TO A CIRCUIT.

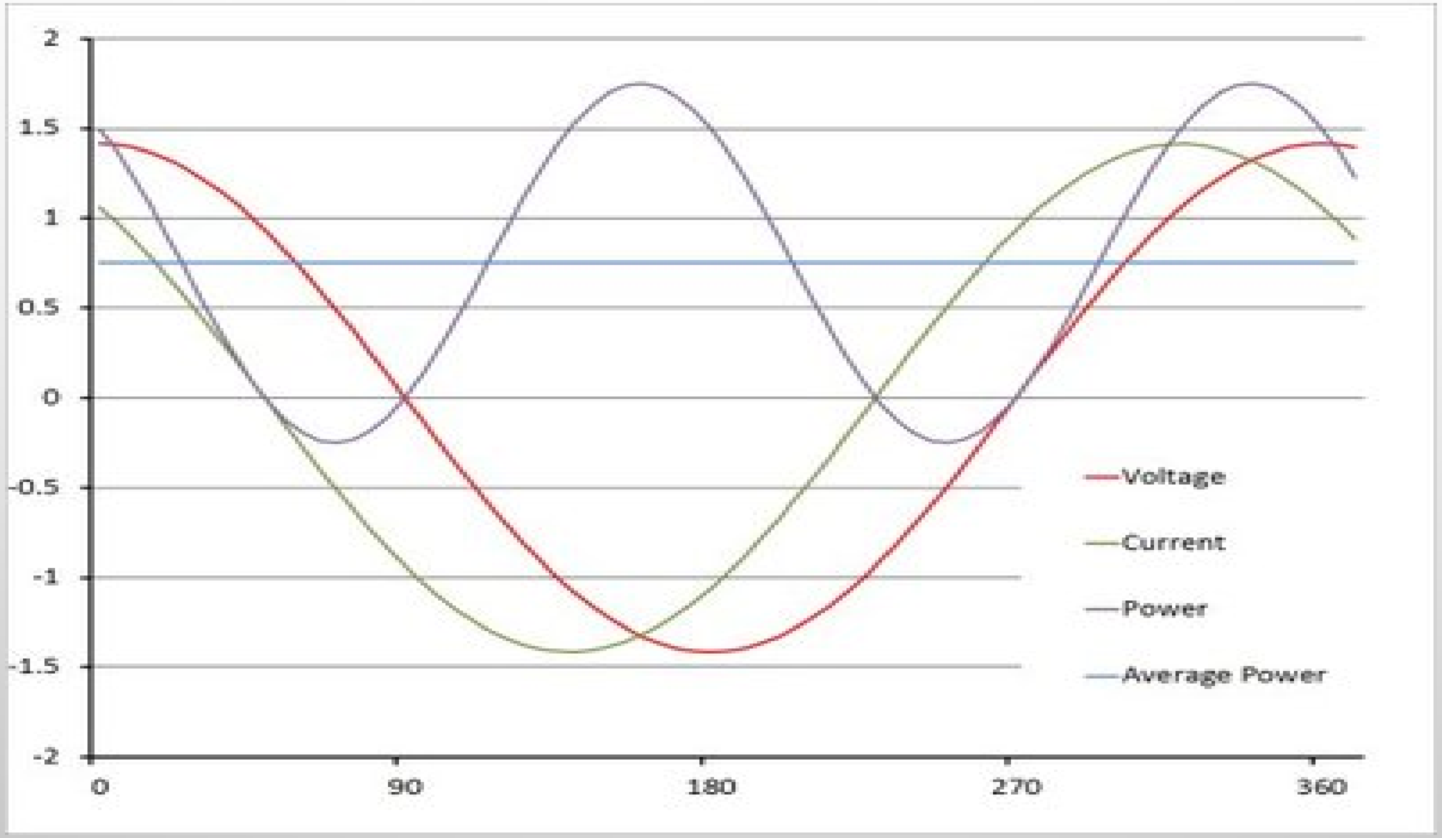
POWER FACTOR CONT-

- THE POWER FACTOR - (PF) IS THE SAME AS THE COSINE OF THE PHASE ANGLE (Θ) IN DEGREES BY WHICH CURRENT LAGS VOLTAGE IN AN INDUCTIVE CIRCUIT, OR BY WHICH CURRENT LEADS VOLTAGE IN A CAPACITIVE CIRCUIT. IN A TYPICAL SINGLE PHASE RESONANT HOUSEHOLD TYPE CIRCUIT (120 VAC) POWER FACTOR (PF) IS USUALLY 1.0, OR SO CLOSE TO 1.0 THAT THE POWER FACTOR SHOULD BE IGNORED OR ASSUMED TO BE 1.0.

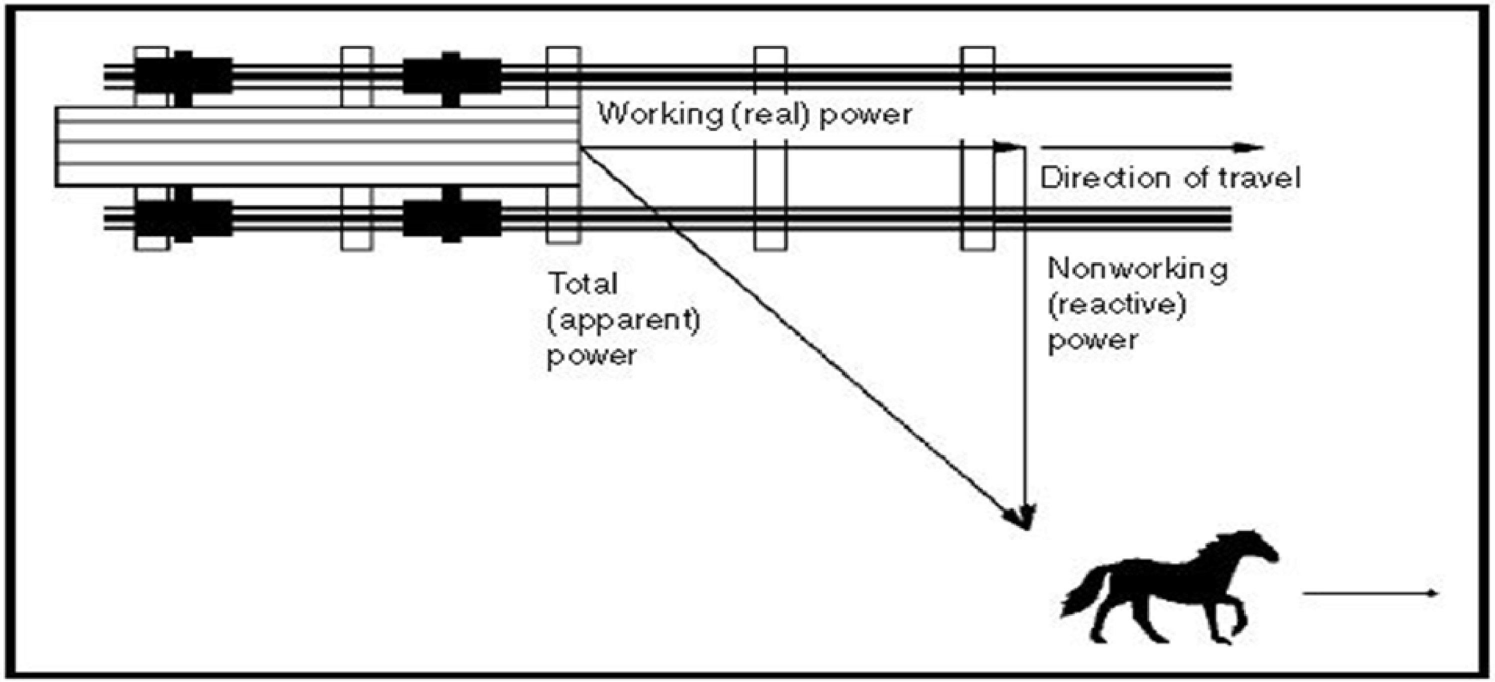


- THE POWER TRIANGLE SHOWS THE RELATIONSHIPS OF THE DIFFERENT POWER COMPONENTS. EACH OF THESE MAY BE SOLVED USING THE PYTHAGOREAN THEOREM. REACTIVE POWER GENERATES THE MAGNETIC FIELD FOR INDUCTIVE LOADS SUCH AS MOTORS, TRANSFORMERS, LIGHTING BALLASTS, ETC. REACTIVE POWER IS MEASURED IN KILOVARS (KVAR). TOTAL POWER (MEASURED IN KVA) IS A COMBINATION OF REAL POWER AND REACTIVE POWER. THE BASIC FORMULA FOR POWER FACTOR IS THE MATHEMATICAL RATIO OF REAL POWER TO TOTAL POWER. Θ = PHASE ANGLE. THESE EQUATIONS WORK FOR BOTH SINGLE AND 3 PHASE POWER.

POWER FACTOR



What is Power Factor?



To understand power factor, visualize a horse pulling a railroad car down a railroad track. Because the railroad ties are uneven, the horse must pull the car from the side of the track. The horse is pulling the railroad car at an angle to the direction of the car's travel. The power required to move the car down the track is the working **(real)** power. The effort of the horse is the total **(apparent)** power. Because of the angle of the horse's pull, not all of the horse's effort is used to move the car down the track. The car will not move sideways; therefore, the sideways pull of the horse is wasted effort or nonworking **(reactive)** power.

The angle of the horse's pull is related to power factor, which is defined as the ratio of real (working) power to apparent (total) power. If the horse is led closer to the center of the track, the angle of side pull decreases and the real power approaches the value of the apparent power. Therefore, the ratio of real power to apparent power (the power factor) approaches 1. As the power factor approaches 1, the reactive (nonworking) power approaches 0.

$$\textit{Power Factor} = \frac{\textit{Real Power}}{\textit{Apparent Power}}$$

THE EFFICIENCY PROCESS SHOULD NOT:

- RISK THE SAFETY OF ANY PERSONNEL. FOR EXAMPLE, SELECTING MEDIUM AND HIGH VOLTAGE MOTORS FOR LARGER PUMP SYSTEMS ARE GENERALLY MORE ENERGY EFFICIENT, BUT IF YOUR ORGANIZATION IS NOT EQUIPPED TO MAINTAIN SUCH HIGHER RISK EQUIPMENT, SAFETY MAY BE SEVERELY COMPROMISED.
- JEOPARDIZE ANY FEDERAL, STATE, AND LOCAL WATER QUALITY STANDARDS AND REGULATIONS.
- DIMINISH ESTABLISHED LEVELS OF SERVICE STANDARDS OF YOUR SYSTEM, I.E. LOW DISTRIBUTION SYSTEM PRESSURE LEVELS, OR RESERVOIR EMERGENCY STORAGE LEVELS, ETC.
- CREATE FINANCIAL BURDENS, INCLUDING STAFFING LEVELS, WHICH CAN EASILY EXCEED ANY SAVINGS.
- RESULT IN WHAT I CALL THE EFFICIENCY PARADOX. I.E. SOME PROJECTS MAY CONTRADICT EACH OTHER WITHOUT A CAREFUL AND THOROUGH ANALYSIS. FOR EXAMPLE, THE POWER COST SAVINGS ACHIEVED BY CONFIGURING A PUMP STATION TO RUN AT HIGHER FLOW RATES DURING OFF-PEAK (NIGHT) PERIODS, MAY BE EASILY OFFSET BY AN ADDITIONAL COST OF ENERGY IF THE DISTRIBUTION SYSTEM IT PUMPS INTO WAS NOT DESIGNED FOR THE ADDITIONAL FLOWS.

LEVEL OF SERVICE PROTECTION

- IN ALL OF THE ENERGY AND POWER EFFICIENCY EFFORTS WE TAKE, ON WE MUST REMEMBER THAT OUR EFFORTS SHOULD NOT CROSS ANY OF THE FOLLOWING BOUNDARIES:
  - WATER QUALITY IS NOT JEOPARDIZED.
  - CUSTOMER PRESSURE IS NOT REDUCED BEYOND LEGAL MINIMUMS.
  - FIRE FLOWS AND VOLUMES ARE NOT JEOPARDIZED.
  - BACKFLOW PROTECTION IS MAINTAINED.
  - EMERGENCY STORAGE IS NOT JEOPARDIZED.
  - REDUNDANCY AND NECESSARY BACK-UPS ARE NOT CURTAILED.

SCADA 2.0

- 1. TYPICAL OPERATION BASED ON RESERVOIR SET POINTS
- 2. OFF PEAK MODE – RUN EVERYTHING OFF-PEAK IF RESERVOIRS ALLOW (CAN ELIMINATE POWER DEMAND CHARGE - 6B, 8, 9, OR REDUCE ENERGY CHARGE – 6A).
- 3. OFF PEAK - LOAD FACTOR MODE – RUN EVERYTHING OFF-PEAK IF RESERVOIRS ALLOW, BUT PUMP THE ENTIRE OFF-PEAK PERIOD AT LOWER FLOWS (CAN ELIMINATE POWER CHARGE – 6B, 8, 9, AND REDUCE ENERGY CHARGE FOR ALL RATES.
- 4. LOAD FACTOR MODE – FILL THE ENTIRE DAY WITH AS FEW OF PUMPS AS POSSIBLE (OR RUN SMALLER JOKEY PUMPS), OR REDUCE HZ ON VFD'S (CAN SIGNIFICANTLY REDUCE ENERGY CHARGE AND POWER CHARGE). OFF-PEAK CAN STILL OPERATE ON SOME PUMPS TO FORM A HYBRID OF THE TWO MODES.
- 5. EFFICIENCY FAILOVER MODE OPTION - IF #2 OR #3 FAILS – THEN SWITCH TO #4, ADDITIONAL OPTION - IF #4 FAILS – THEN SWITCH TO #1.

LOGIC AND SCADA CONTINUED

- REPORTING AND ALARMING - SCADA SYSTEM REVIEWS CONTINUOUS SUPPLY, DEMAND, AND PUMP EFFICIENCY, WITH GPM PER KW, (SPECIFIC POWER) AND GALLONS PER KWH, (SPECIFIC ENERGY) WITH HISTORICAL TRENDS AND ALERTS.
- LINK SCADA SYSTEMS TO THE HYDRAULIC MODEL SYSTEM IF POSSIBLE.
- AND LINK SCADA TO WORK ORDER SYSTEMS FOR MORE EFFICIENT PREVENTATIVE MAINTENANCE PROGRAMS.

THE LEAD AND/OR LAG

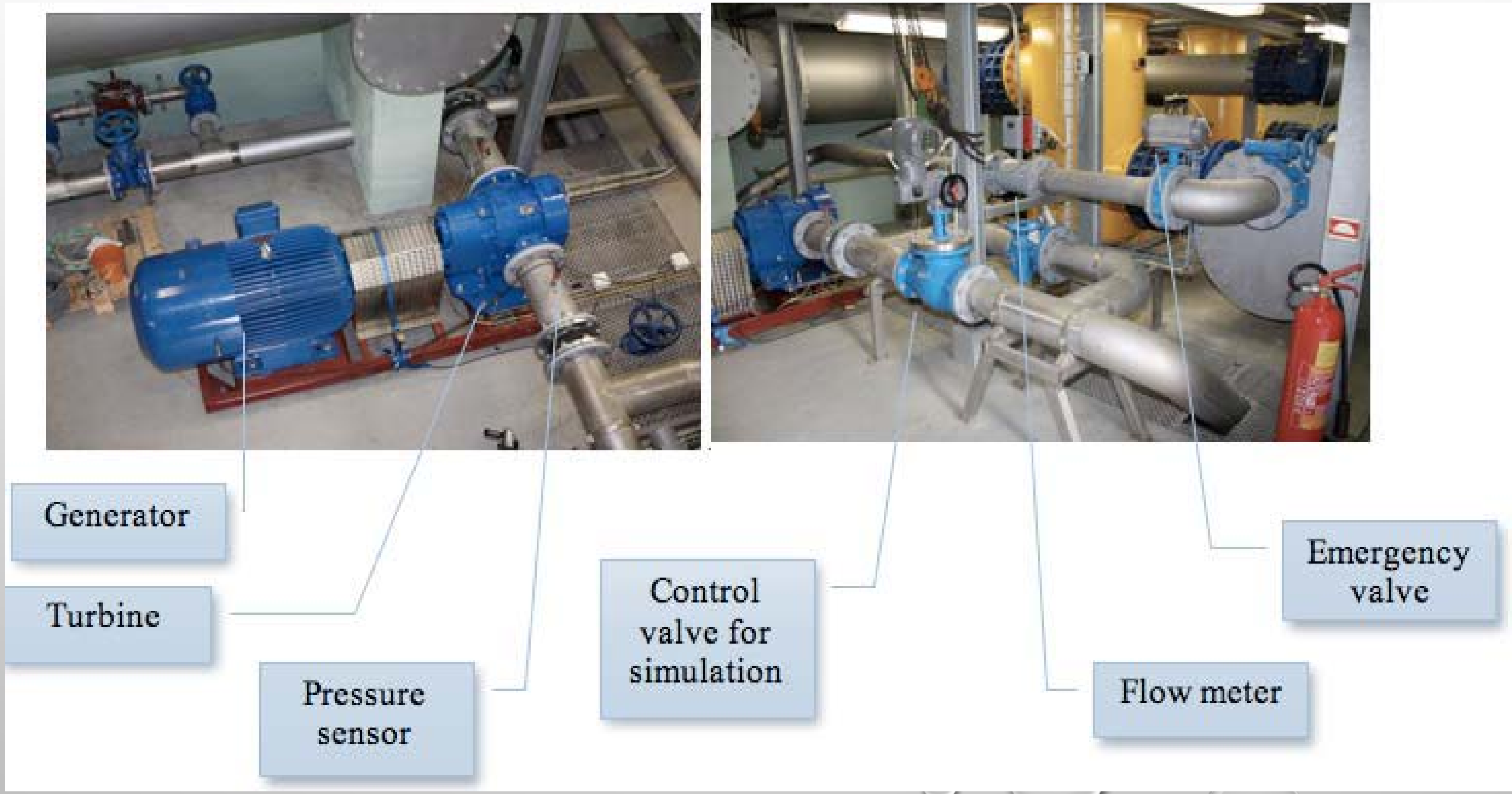
- ALARM AND PREDICT IMPENDING PUMP LAG CYCLES IF POSSIBLE, AND MITIGATE OR IMPROVE THE EFFICIENCY OF THEIR USAGE.
- DEPENDING ON THE SIZE OF THE JOCKEY PUMP(S), YOU MAY NEED TO MODIFY YOUR LEAD/LAG LOGIC FROM THE TYPICAL **AND** LOGIC, WHERE A LEAD PUMP STARTS (I.E. THE JOCKEY PUMP), **AND** THEN A LARGER LAG PUMP IS ADDED IF NECESSARY, TO AN **OR** LOGIC SCENARIO. IN AN **OR** LOGIC, THE LEAD PUMP RUNS FIRST, THEN IF A LARGER LAG PUMP IS NEEDED, THE LEAD PUMP SHUTS OFF FIRST, THEN THE LARGER LAG PUMP(S) RUN.
- IN THIS SYSTEM YOU LEAD **OR** LAG, INSTEAD OF THE COMMON LEAD **AND** LAG. THIS PREVENTS THE JOCKEY PUMP(S) FROM WASTING ENERGY AND POWER WHEN THE LARGER LAG PUMP(S) OPERATES.
- A SYSTEM MAY ALSO HAVE 2 JOCKEY PUMPS, WHERE THE LEAD LOGIC PERFORMS AN **AND** OPERATION ON THOSE FIRST, THEN THE **OR** LOGIC ON THE LARGER PUMPS AFTER. THIS LOGIC DESIGN CAN SAVE A SIGNIFICANT AMOUNT OF ENERGY AND POWER.

LIGHTING AND HVAC EFFICIENCY

- **INSULATION**. CONCRETE IS NOT TYPICALLY A GOOD INSULATOR. INSULATE THE OUTSIDE BURIED PORTIONS WITH PROTECTED INSULATION. WHERE ABOVE GROUND, INSULATE THE INSIDE.
- **LIGHTING**. REVIEW HO T5 AND LED LIGHTING OPTIONS. STANDARDIZE ON ONE SYSTEM. SKYLIGHTS CAN BE VALUABLE IN CERTAIN SITUATIONS. SECURITY MAY BE A CONCERN WITH THESE HOWEVER.
- **HVAC** – THIS CAN BE VERY SIGNIFICANT. ELECTRICAL RESISTIVE HEATING SYSTEMS CAN OFTEN HAVE KILOWATT LOADS HIGHER THAN EVEN SOME OF THE PUMPING SYSTEMS (3-15 KW). IF THIS IS THE CASE – SERIOUSLY LOOK AT OTHER ALTERNATIVES FOR HEATING AND/OR COOLING. A SMALL LOOP OF WATER AROUND A PUMP SYSTEM CAN SUPPLY SIGNIFICANT COOLING POTENTIAL, AND EVEN POSSIBLY SOME HEATING SOLUTIONS. REVIEW SHALLOW GEOTHERMAL (SOMETIMES REFERRED TO AS GEO-EXCHANGE) OPTIONS WHERE YOU USE THE WATER ITSELF FOR THE HEAT EXCHANGE MEDIUM. REVIEW SOLAR THERMAL SYSTEMS FOR DAY-TIME HEATING. THESE CAN BE COUPLED WITH GEOTHERMAL SYSTEMS AS WELL.
- **HUMIDITY** - MOISTURE FROM CONDENSATION CAN BE A PROBLEM, ESPECIALLY IF A PUMP OR PLANT IS OVER HEATED. REVIEW ECONOMICAL HUMIDITY CONTROL SYSTEMS. PROPER VENTILATION CAN BE IMPORTANT AS WELL. AIR HEAT EXCHANGERS CAN BE USED IN SOME SITUATIONS.

GEO-EXCHANGE (USING SYSTEM WATER FOR HEAT AND COOLING)

ENERGY RECOVERY OPTIONS



PORTLAND, OR - ENERGY RECOVERY PROJECT

CHANGE YOUR ENGINEERING MINDSET

- ENSURE THAT ALL NEW WATER STORAGE AND PUMPING FACILITIES ARE DESIGNED AND SIZED WITH OFF-PEAK PUMPING DEMANDS IN MIND.
- REMEMBER A HIGH OR GRADUALLY CLIMBING SYSTEM PEAKING FACTOR (USUALLY OVER 2.0) CAN BE AN INDICATION OF ONE OR MORE INHERENT INEFFICIENCIES OF THE SYSTEM.
- STUDY POTENTIAL ASR PROGRAMS (AQUIFER STORAGE AND RECOVERY), INCLUDING POSSIBLY OTHER SIMILAR GROUNDWATER PROGRAMS TO REDUCE THE PEAK PUMPING AND TREATMENT LOAD ON THE COMPANY FACILITIES IN THE SUMMER MONTHS.
- STUDY OTHER POSSIBLE MAJOR SURFACE WATER STORAGE PROJECTS TO REDUCE THE PEAK CAPACITY IMPACTS OF SECONDARY SYSTEMS IF APPLICABLE.

ENGINEERING MINDSET CHANGES …

- STUDY WHERE HYDRO-ELECTRIC ENERGY RECOVERY MAY BE IMPLEMENTED AT LARGE PRESSURE REDUCTION LOCATIONS OR OTHER STORAGE LOCATIONS. SITUATE KEY PRV'S NEAR POWER INFRASTRUCTURE IF POSSIBLE. ALSO – LOCATE PRV'S IN PLANTS OR PUMPING STATIONS IF THEY ARE ADJACENT TO THE SAME. PRV ENERGY RECOVERY IS STILL IN ITS INFANCY, AND AS OF LATE, IS STILL NOT AS FEASIBLE ON SMALL PRV SYSTEMS.
- INVESTIGATE THE POSSIBILITY OF INCORPORATING WIND AND/OR SOLAR ENERGY SYSTEMS TO FACILITATE NET METERING OR ENERGY SALES OPPORTUNITIES NEAR PLANTS OR OTHER FACILITIES.
- WITH MATURE GIS DATA – COMPUTER MODEL THE DISTRIBUTION SYSTEMS TO FIND AREAS OR FACILITIES THAT MAY BE INEFFICIENT OF UNDERSIZED, DECREASING POSSIBLE WATER LOSSES AND PUMPING DEMANDS.

ENGINEERING MINDSET CHANGES …

- PROVIDE WORKABLE AND DYNAMIC WATER MODELS TO STAFF AND TRAIN IN THE PROPER USE THEREOF, I.E. SIMPLE EPANET SYSTEMS.
- STUDY WATER SOURCES AND PUMPING FACILITIES TO FIND THE ACTUAL ENERGY AND POWER COSTS PER ACRE FOOT OR MG OR KG. THE COMPANY CAN THEN DEVELOP A STRATEGY TO PUMP WATER FROM MORE EFFICIENT PUMPING SYSTEMS AND ALSO SHUT DOWN OR MOTHBALL FACILITIES THAT ARE INEFFICIENT OR REDUNDANT.
- ASSIST IN THE POSSIBLE WATER RIGHT MODIFICATIONS TO BEST FACILITATE THE PUMPING PRIORITIZATION STRATEGIES DERIVED FROM ABOVE.
- MAKE THE SCADA SYSTEM SMARTER. MONITOR AREAS FOR REAL-TIME WATER LOSSES AND PRESSURE CHANGES. LOOK AT SUPPLY AND DEMAND NUMBERS.

ENGINEERING MINDSET CHANGES …

- MODEL THE SYSTEM TO TEST FOR EFFICIENCIES IN PUMPING, DISTRIBUTION, AND STORAGE SYSTEMS.
- AUTOMATE METER READING AND BILLING SYSTEMS, UPGRADE METERS IF NEEDED.
- CHOOSE THE CORRECT POWER RATES FOR EACH SERVICE AND DESIGN THE FACILITY FOR SUCH.
- ENLARGE WATER STORAGE SYSTEMS IF POSSIBLE (REQUIRE MORE OF NEW DEVELOPERS).
- PUMP OFF-PEAK AS MUCH AS PRACTICABLE.
- IMPROVE THE WATER DISTRIBUTION SYSTEM WHERE NEEDED.
- DESIGN PUMPING PLANTS WITH MORE AND SMALLER SELECTABLE PUMPS AND MOTORS, OR WITH LARGER MOTORS ON VFD'S.

ENGINEERING MINDSET CHANGES …

- NEVER UNDERESTIMATE THE POWER OF "JOCKEY PUMP(S)". CONSIDER ALSO A SEASONAL 2 STAGE PUMPING SYSTEM WITH SMALLER PUMPS IN THE WINTER AND LARGER PUMPS IN THE SUMMER.
- DESIGN THE HIGHEST EFFICIENCY POINT OF A PUMP CURVE AROUND IMMEDIATE PUMPING NEEDS AND HAVE A STRATEGY TO MODIFY THAT WITH FUTURE PUMP CHANGES OR VFD PROGRAM MODIFICATIONS AS FUTURE BUILD-OUT PUMPING NEEDS WARRANT. DON'T DESIGN THE BEST EFFICIENCY FOR A POINT WAY OUT IN THE FUTURE – WHICH IN MANY INSTANCES MAY NOT EVEN COME.
- USE A VFD RATHER THAN A RESTRICTING VALVE OR A BY-PASSING STRATEGY – OR SIMPLY CHANGE OUT THE PUMPS.
- INCREASE SIZES OF TRANSMISSION LINES OR LOOP DISTRIBUTION LINES IF PUMPING HEAD IS TOO HIGH ON A PUMPING PLANT.

ENGINEERING MINDSET CHANGES …

- AVOID VFD'S ON HIGH PRESSURE PUMPING SYSTEMS. USE MORE AND SMALLER PUMPS IF NEEDED TO SIMULATE A VFD SYSTEM IF NEEDED.
- COOL PUMPING SYSTEMS PROPERLY AND EFFICIENTLY.
- CORRECT POWER FACTOR ISSUES ON ACCOUNTS THAT ARE PENALIZED WITH CAPACITOR BANKS.
- INVESTIGATE THE INDUSTRIAL RATE 9 FEASIBILITY ON LARGE PROJECTS (GREATER THAN 1 MEGAWATT AND WITHIN 1 MILE OF TRANSMISSION).
- TRAIN AND ASSIST IN THE IMPLEMENTATION OF A REGULAR WATER AND ENERGY AUDIT PROGRAM.
- PRIORITIZE PUMPING SYSTEMS BASED ON EFFICIENCIES.

ENGINEERING MINDSET CHANGES …

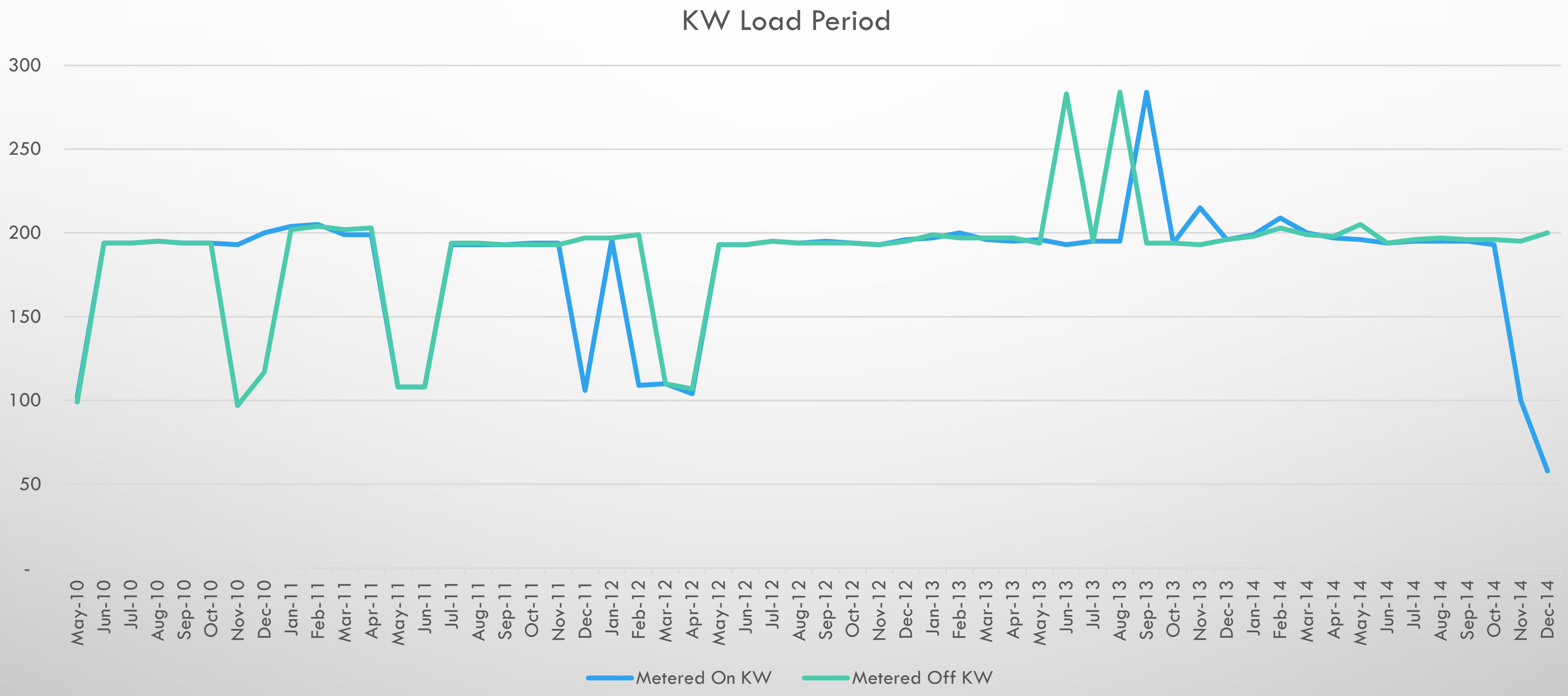
- PUMP OR DELIVER LOWER PRICED WATER IN CRITICAL HIGH USE AREAS IF POSSIBLE.
- KEEP EXPENSIVE WATER IN THE HIGHEST ZONE(S) AS MUCH AS POSSIBLE. PREVENT IT FROM UNNECESSARILY FLOWING DOWN INTO LOWER ZONES.
- IMPROVE PRESSURE ZONE CONTROL.
- INCORPORATE A MASS BALANCE SYSTEM IN KEY AREAS IF POSSIBLE (SUPPLY LESS DEMAND) TO PROMPTLY DETECT LEAKS, ETC. THIS COULD BE AUTOMATED BY SCADA IN CERTAIN AREAS, ESPECIALLY WITH NEWER FIXED READ CUSTOMER WATER METERS.

MULTIPLE SMALL PUMPS VS. A COUPLE LARGE PUMPS

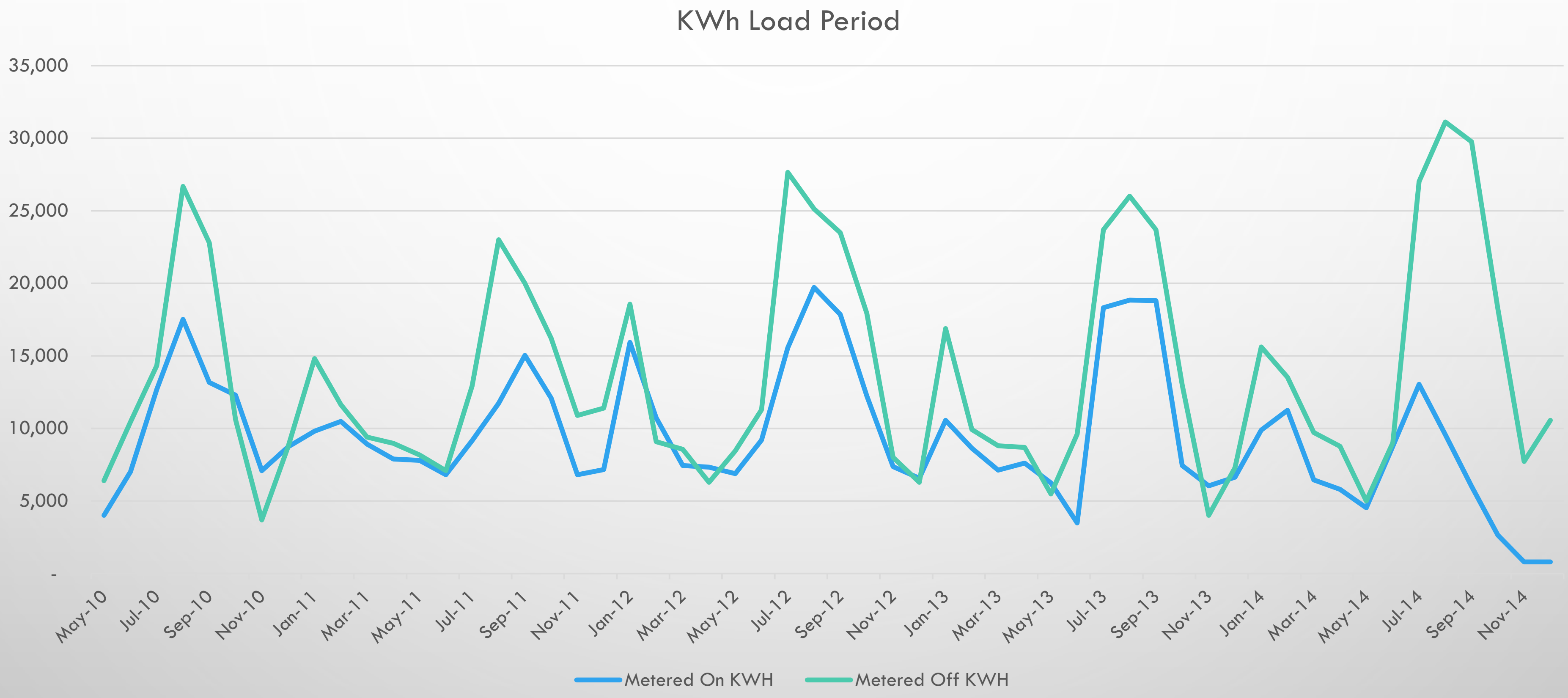
REMEMBER – "SLOW AND STEADY"

THE RESULTS !

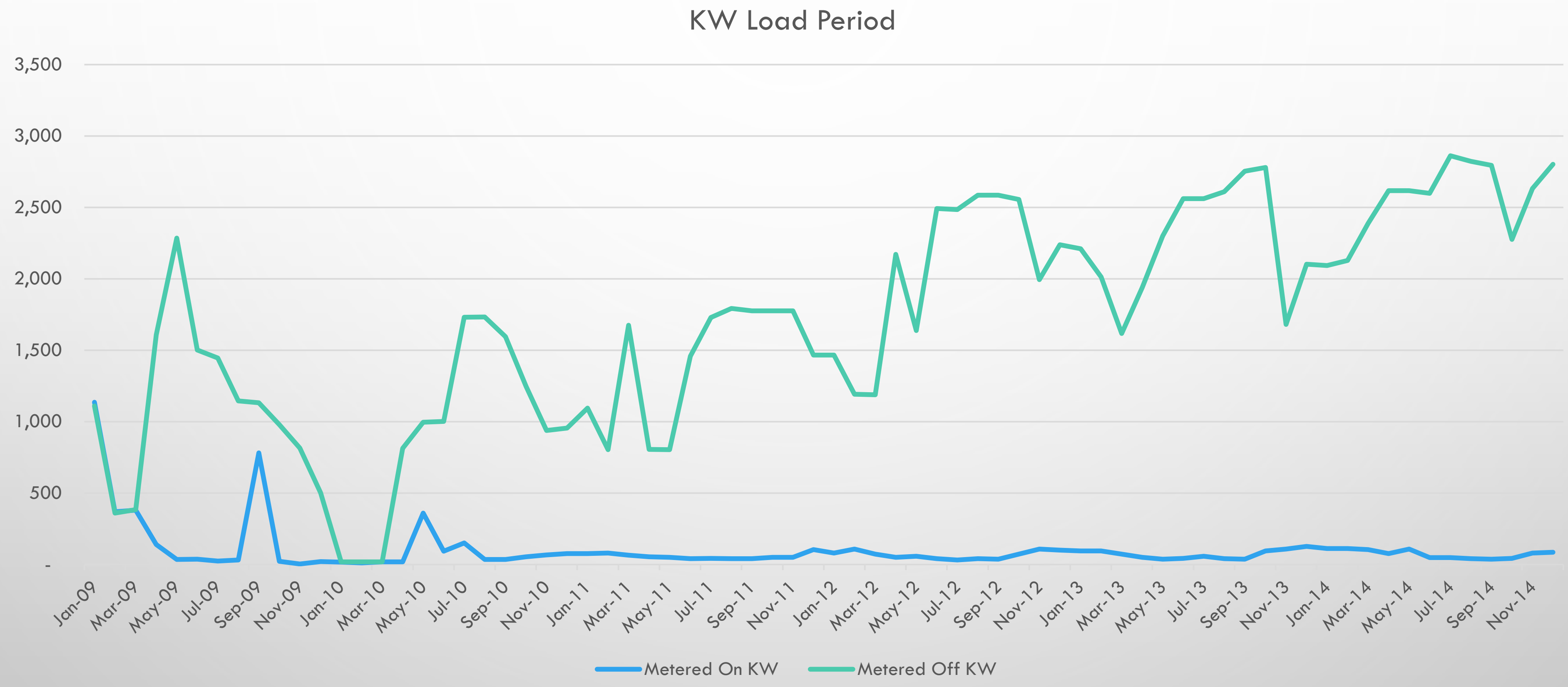
POWER ON-OFF PEAK LOAD



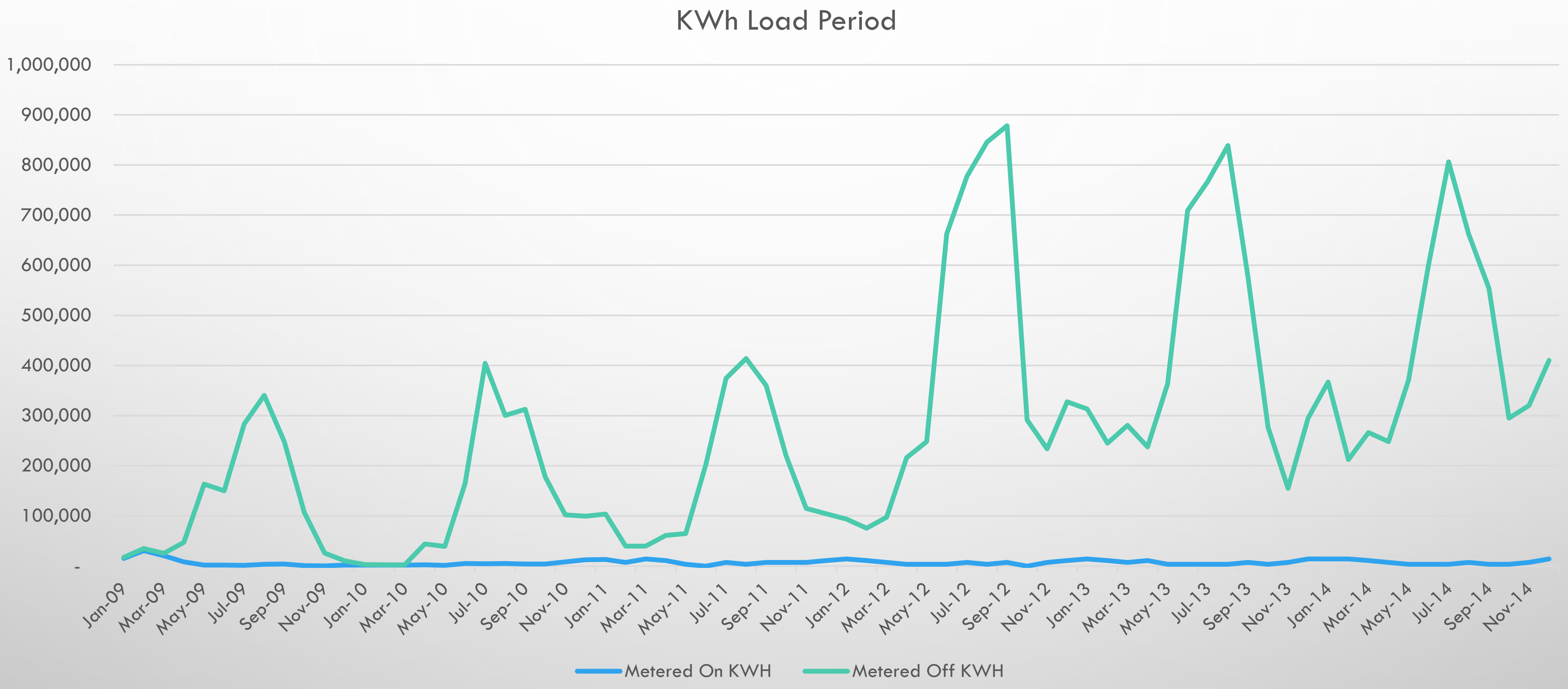
ENERGY ON-OFF LOADS

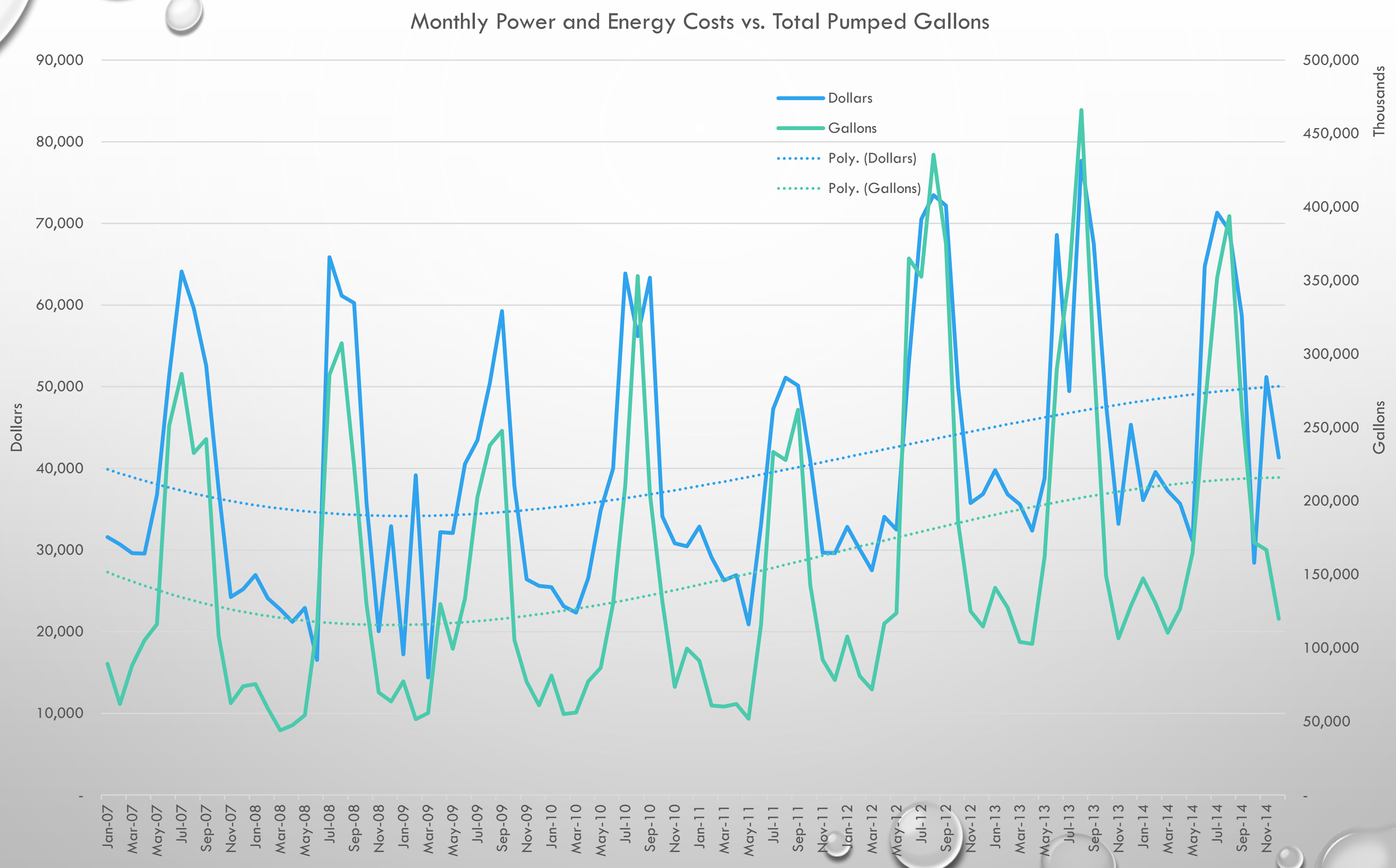


POWER ON-OFF PEAK LOAD



ENERGY ON-OFF LOADS





Monthly Power and Energy Costs vs. Total Pumped Gallons
Dollars
Gallons
Poly. (Dollars)
Poly. (Gallons)
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
-
Dollars
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
-
Thousands
Gallons
Jan-07
Mar-07
May-07
Jul-07
Sep-07
Nov-07
Jan-08
Mar-08
May-08
Jul-08
Sep-08
Nov-08
Jan-09
Mar-09
May-09
Jul-09
Sep-09
Nov-09
Jan-10
Mar-10
May-10
Jul-10
Sep-10
Nov-10
Jan-11
Mar-11
May-11
Jul-11
Sep-11
Nov-11
Jan-12
Mar-12
May-12
Jul-12
Sep-12
Nov-12
Jan-13
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Jul-13
Sep-13
Nov-13
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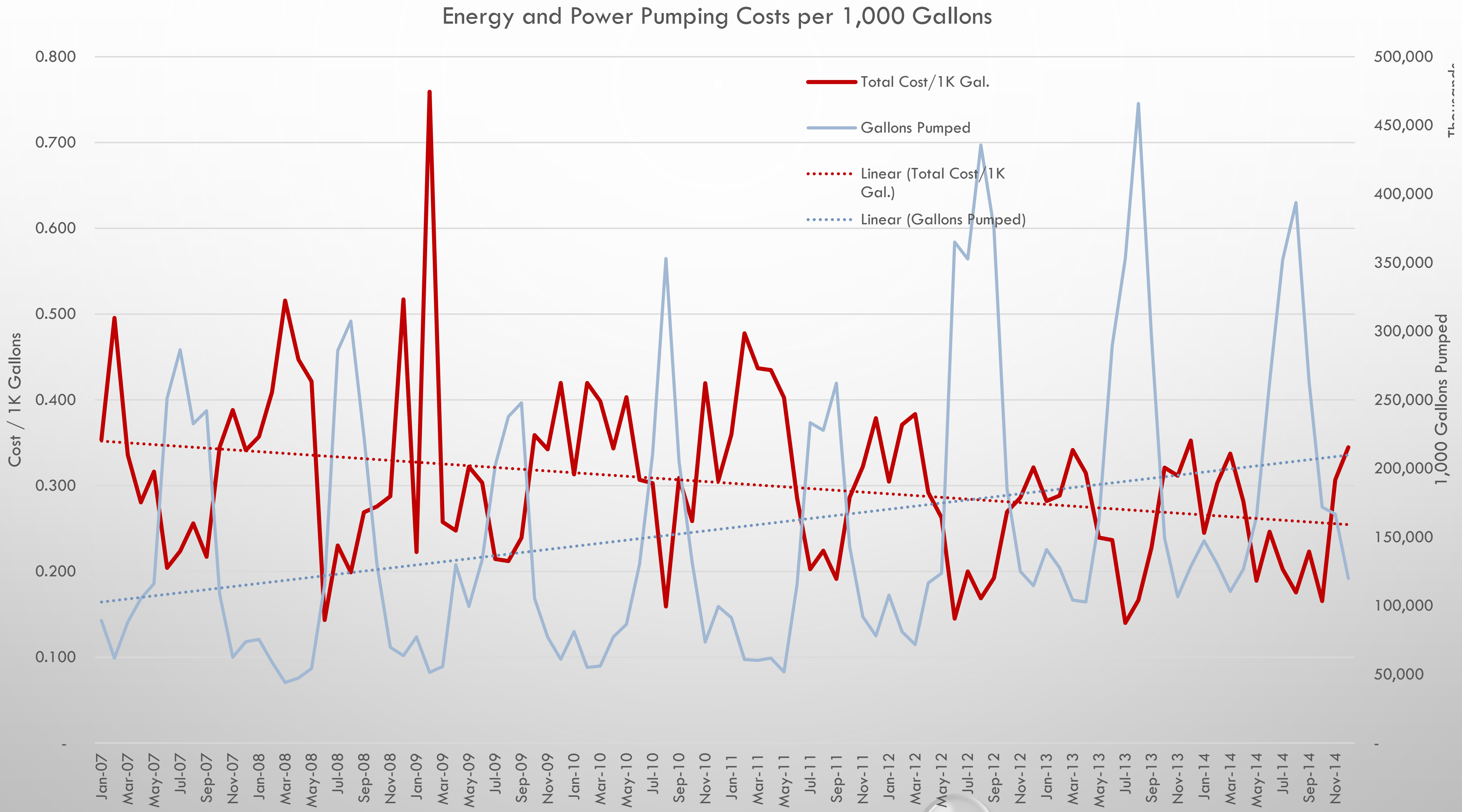
Mar-14
May-14
Jul-14
Sep-14
Nov-14



Energy and Power Pumping Costs per 1,000 Gallons
Total Cost/1K Gal.
Gallons Pumped
Linear (Total Cost/1K Gal.)
Linear (Gallons Pumped)
Cost / 1K Gallons
1,000 Gallons Pumped
Thousands
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
-
500,000
450,000
400,000
350,000
300,000
250,000
200,000
150,000
100,000
50,000
-
Jan-07
Mar-07
May-07
Jul-07
Sep-07
Nov-07
Jan-08
Mar-08
May-08
Jul-08
Sep-08
Nov-08
Jan-09
Mar-09
May-09
Jul-09
Sep-09
Nov-09
Jan-10
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Nov-12
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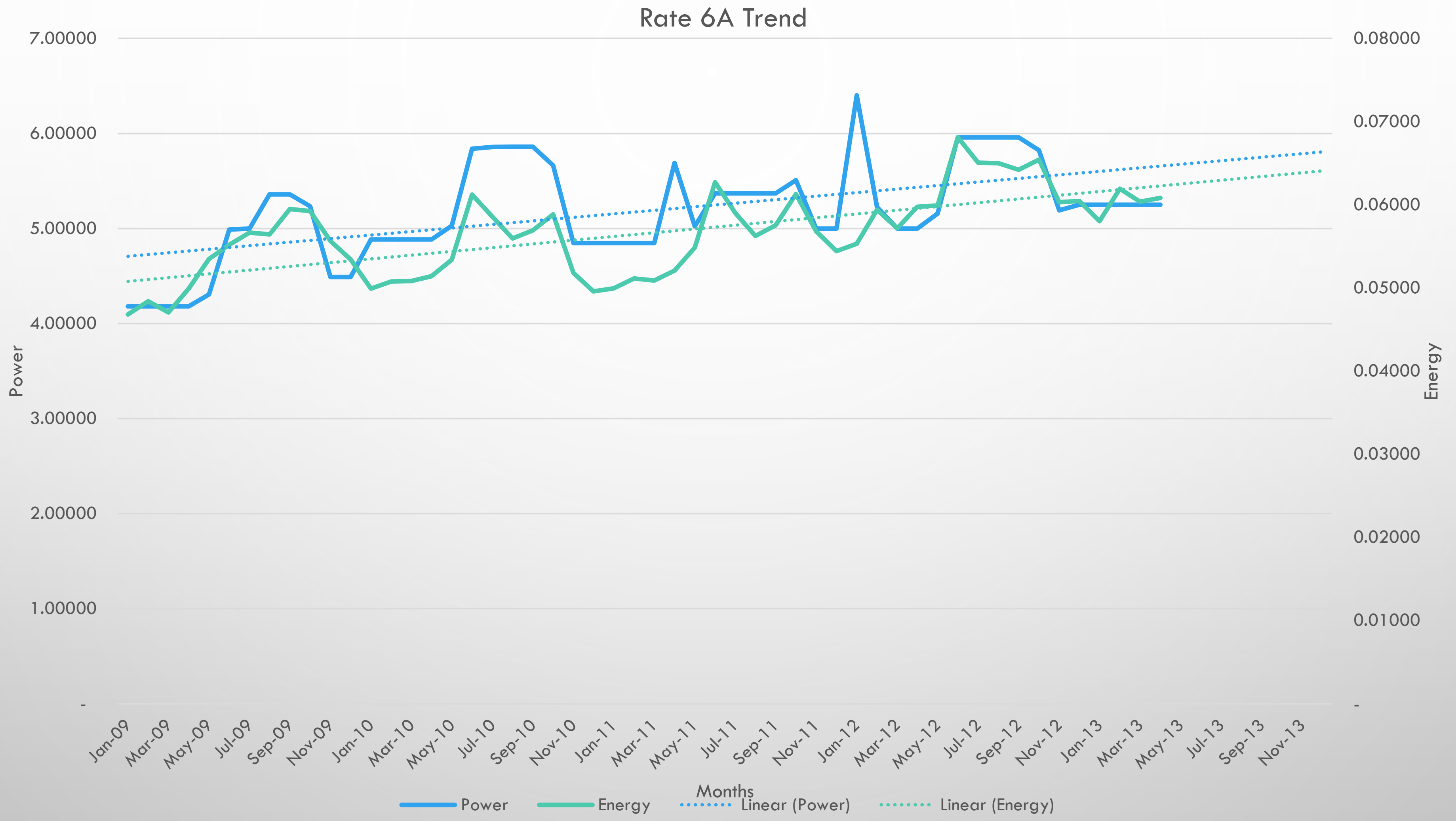
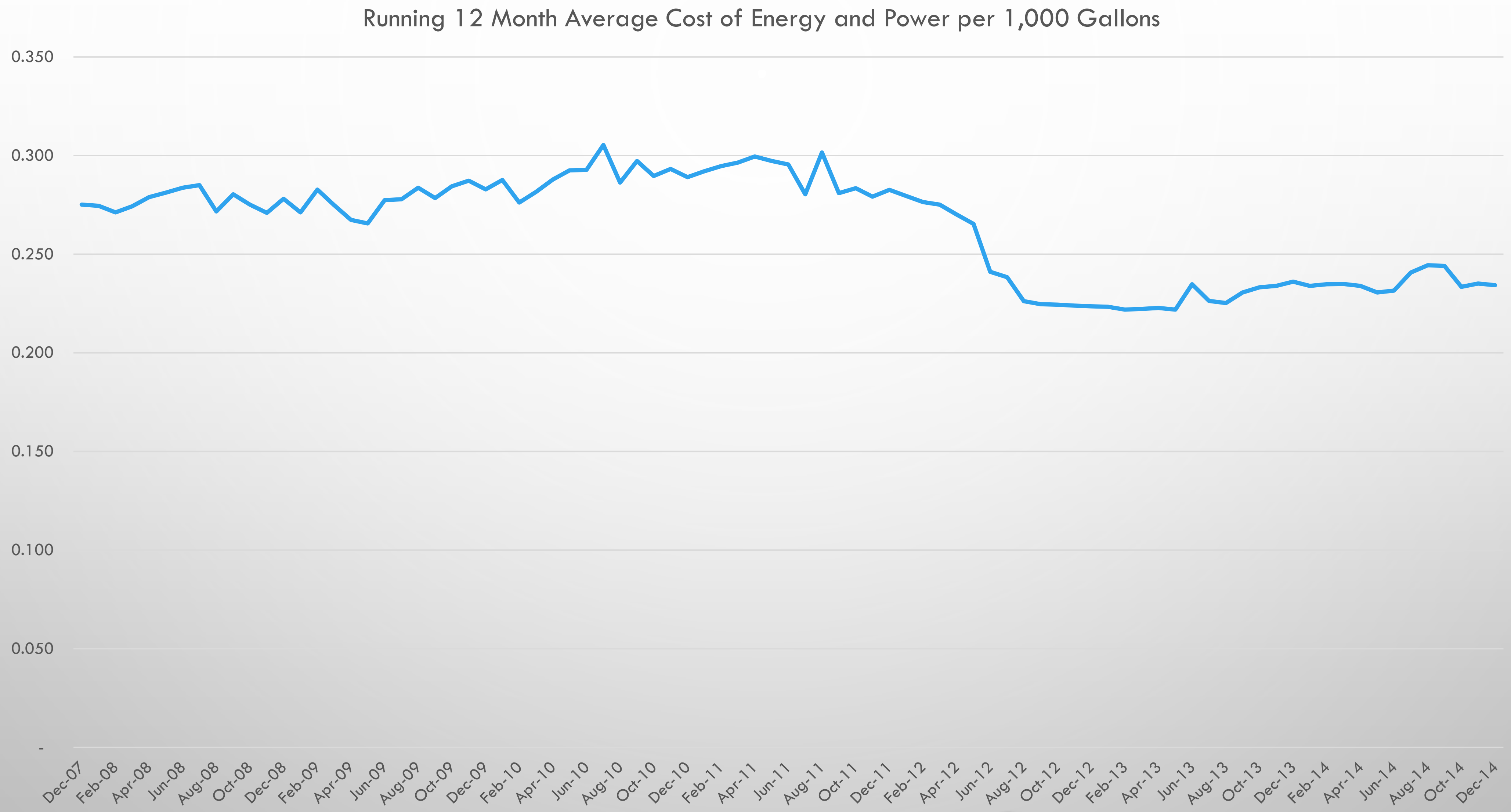
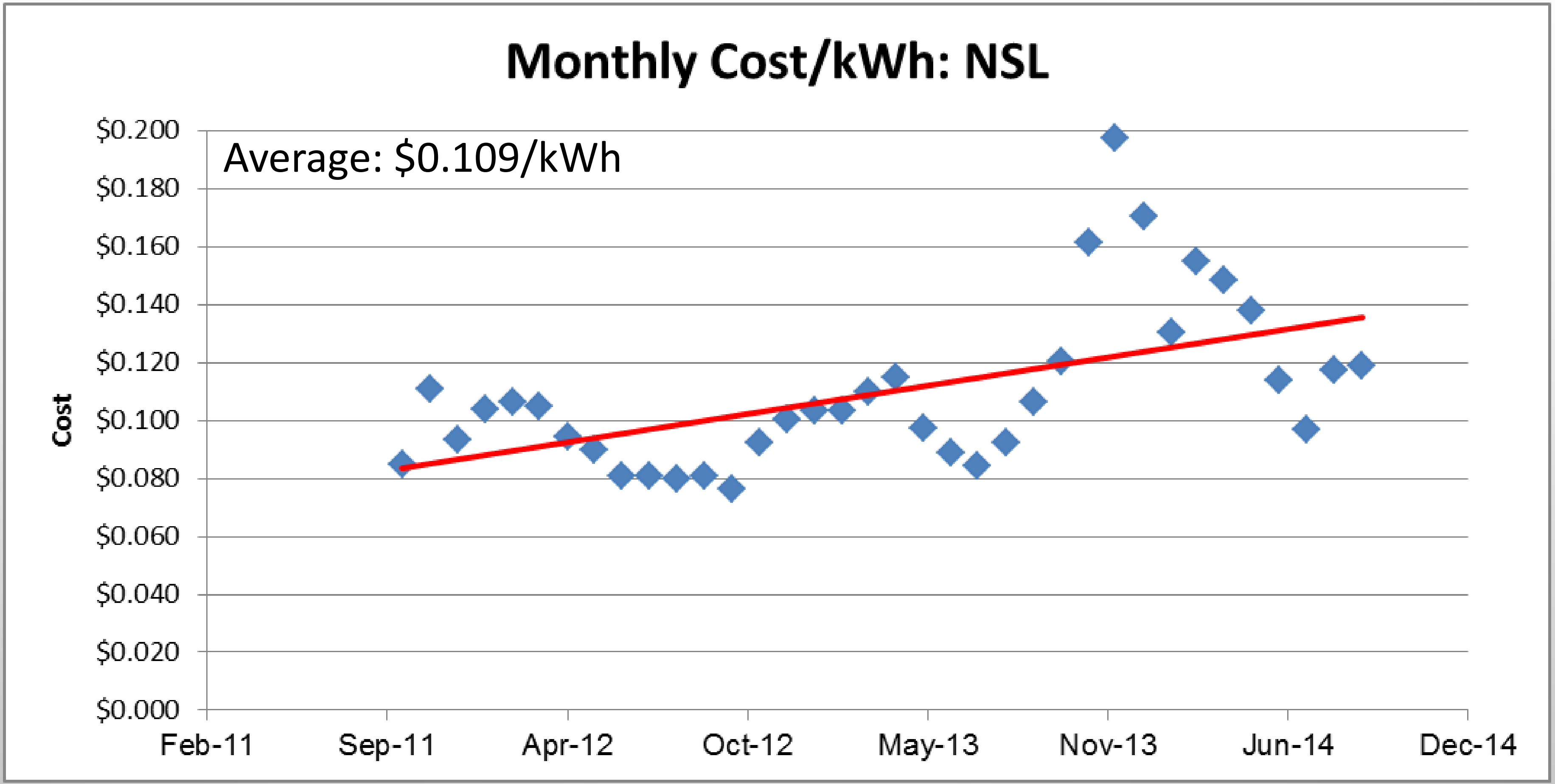
May-14
Jul-14
Sep-14
Nov-14

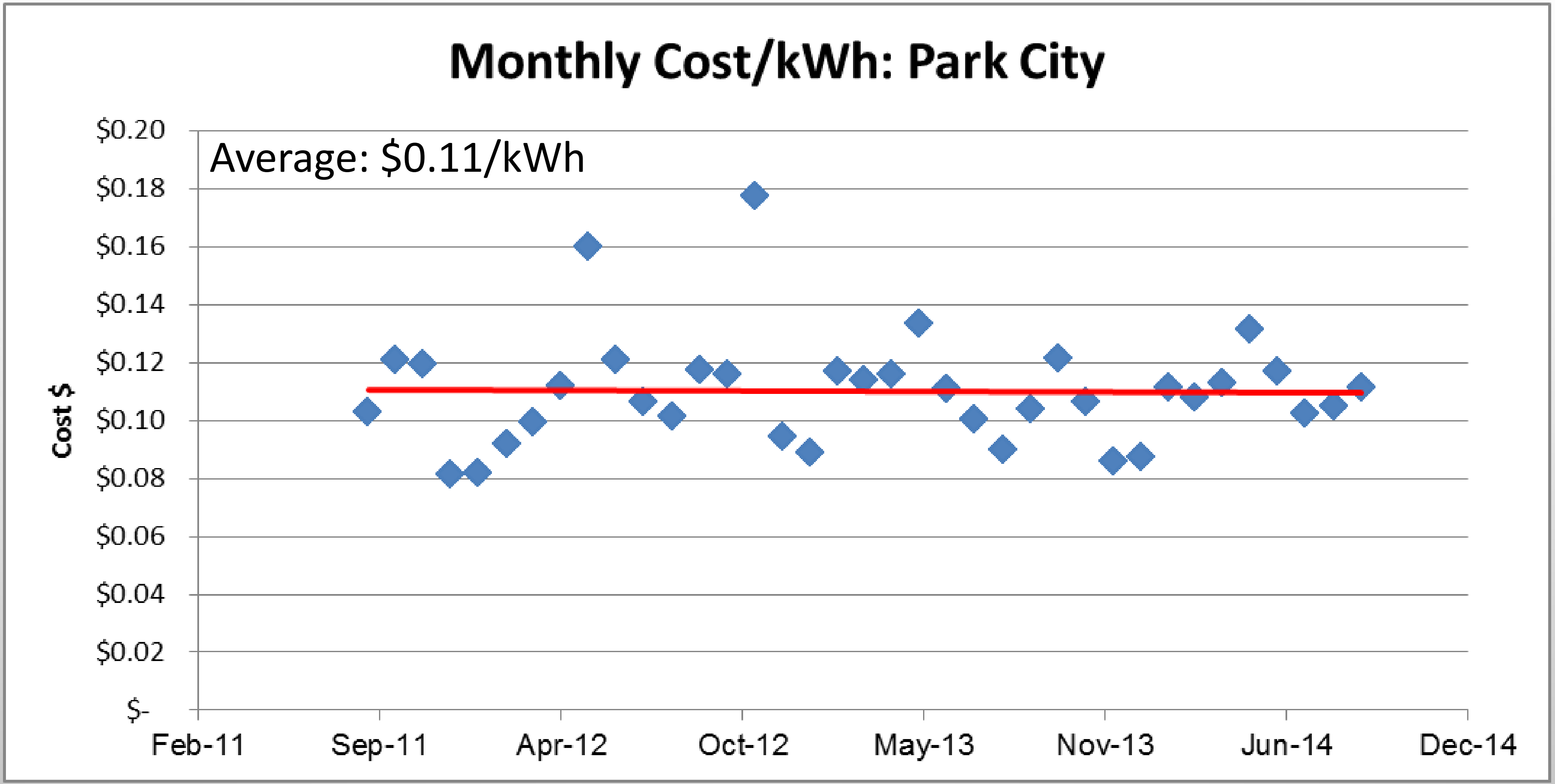


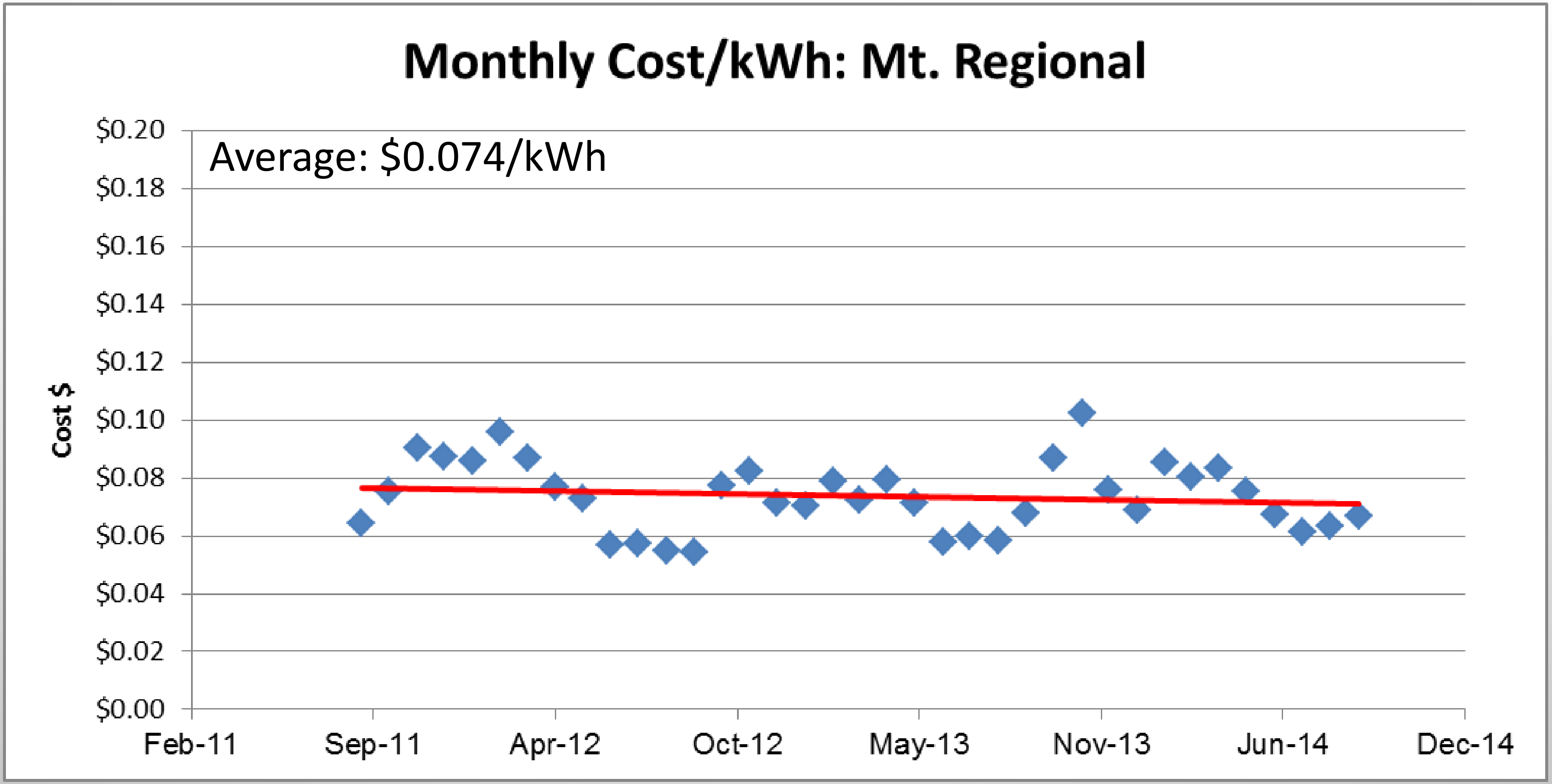
Rate 6A Trend
7.00000
6.00000
5.00000
4.00000
3.00000
2.00000
1.00000
-
Power
0.08000
0.07000
0.06000
0.05000
0.04000
0.03000
0.02000
0.01000
-
Energy
Jan-09 Mar-09 May-09 Jul-09 Sep-09 Nov-09 Jan-10 Mar-10 May-10 Jul-10 Sep-10 Nov-10 Jan-11 Mar-11 May-11 Jul-11 Sep-11 Nov-11 Jan-12 Mar-12 May-12 Jul-12 Sep-12 Nov-12 Jan-13 Mar-13 May-13 Jul-13 Sep-13 Nov-13
Months
Power
Energy
Linear (Power)
Linear (Energy)


Running 12 Month Average Cost of Energy and Power per 1,000 Gallons
0.350
0.300
0.250
0.200
0.150
0.100
0.050
-
Dec-07
Feb-08
Apr-08
Jun-08
Aug-08
Oct-08
Dec-08
Feb-09
Apr-09
Jun-09
Aug-09
Oct-09
Dec-09
Feb-10
Apr-10
Jun-10
Aug-10
Oct-10
Dec-10
Feb-11
Apr-11
Jun-11
Aug-11
Oct-11
Dec-11
Feb-12
Apr-12
Jun-12
Aug-12
Oct-12
Dec-12
Feb-13
Apr-13
Jun-13
Aug-13
Oct-13
Dec-13
Feb-14
Apr-14
Jun-14
Aug-14
Oct-14
Dec-14



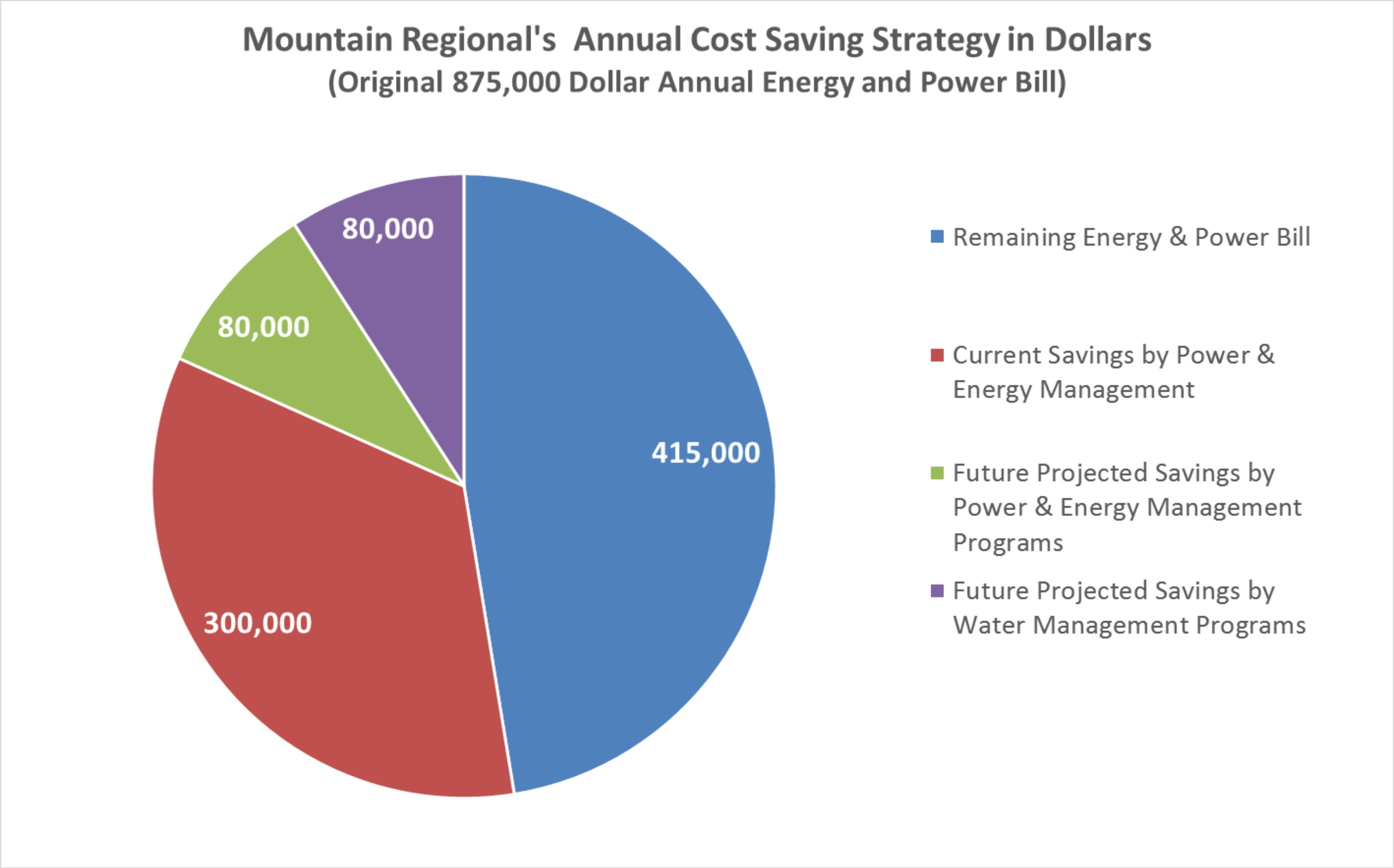
Monthly Cost/kWh: NSL
Average: $0.109/kWh
Cost
$0.200
$0.180
$0.160
$0.140
$0.120
$0.100
$0.080
$0.060
$0.040
$0.020
$0.000
Feb-11
Sep-11
Apr-12
Oct-12
May-13
Nov-13
Jun-14
Dec-14


Monthly Cost/kWh: Park City
Average: $0.11/kWh
Cost $
$0.20
$0.18
$0.16
$0.14
$0.12
$0.10
$0.08
$0.06
$0.04
$0.02
$-
Feb-11
Sep-11
Apr-12
Oct-12
May-13
Nov-13
Jun-14
Dec-14



Monthly Cost/kWh: Mt. Regional
Average: $0.074/kWh
Cost $
$0.20
$0.18
$0.16
$0.14
$0.12
$0.10
$0.08
$0.06
$0.04
$0.02
$0.00
Feb-11
Sep-11
Apr-12
Oct-12
May-13
Nov-13
Jun-14
Dec-14

SO – HOW MUCH DID WE SAVE ?



MORE DETAILED RESOURCES

- RURAL WATER CONFERENCE TRAINING – ANNUAL CONFERENCE: RWAU.NET
- UTAH DIVISION OF DRINKING WATER – DRINKING WATER ENERGY (COST) SAVINGS PROGRAM: DEQ.UTAH.GOV/PROGRAMSSERVICES/PROGRAMS/WATER/DWESHANDBOOK
- ROCKY MOUNTAIN POWER – WATTSMART PROGRAM: WATTSMART.COM

SO

WHAT IS THE REAL POWER OF WATER?

YOU ARE THE POWER

NOW PUT THIS ENERGY TO USE !

THANK YOU

DOUG@MTREGIONAL.ORG