What Every Operator should know about Energy Management:

38th Annual MWOA Conference

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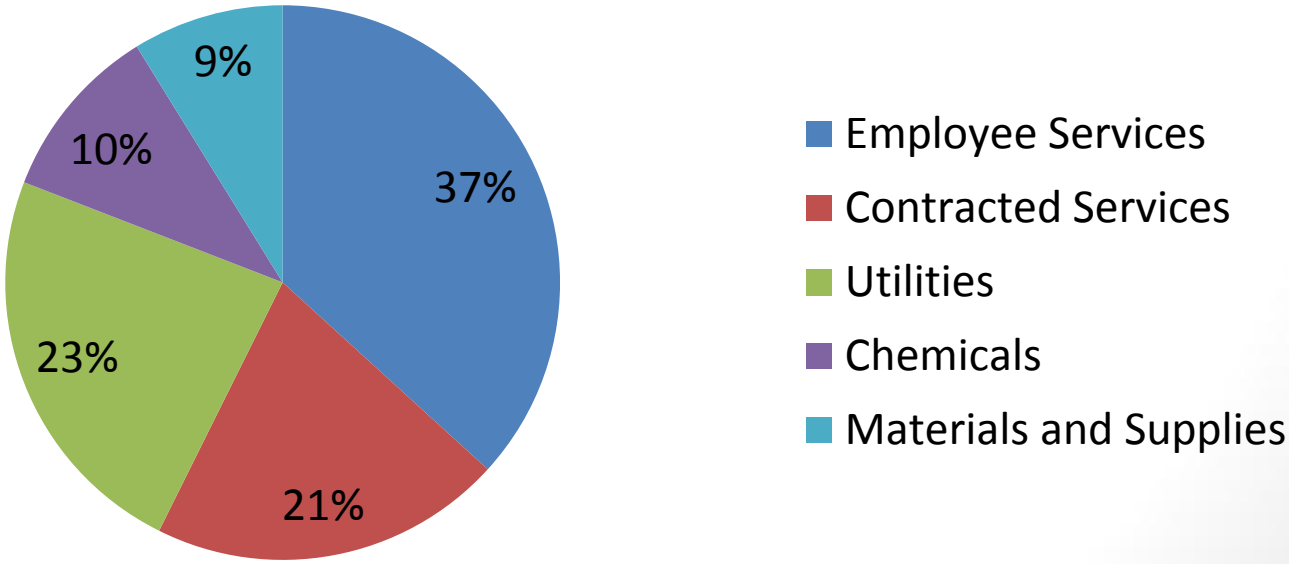
Presentation Outline

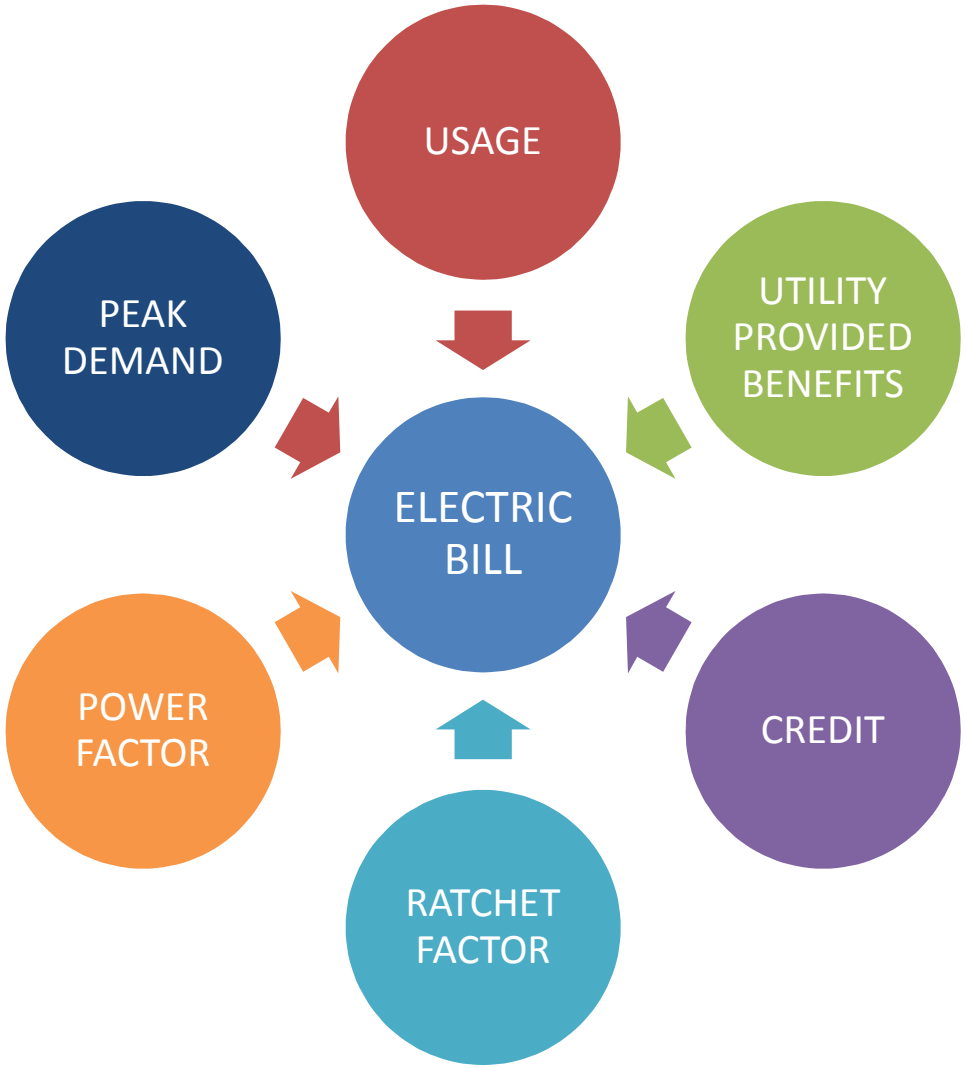
- Why should we care about Energy Use?
- Electric Utility Billing
- Motors
- Lighting
- Air Usage
- Other Savings
- Summary

Why Should we Care about Energy Management?

- Wastewater utilities are high energy users
- Economics (save on your operating budget)
- Enhance existing equipment
- Replace aged equipment at no cost through energy savings



Understanding Your Electric Bill



Electric Bill – Demand Charge

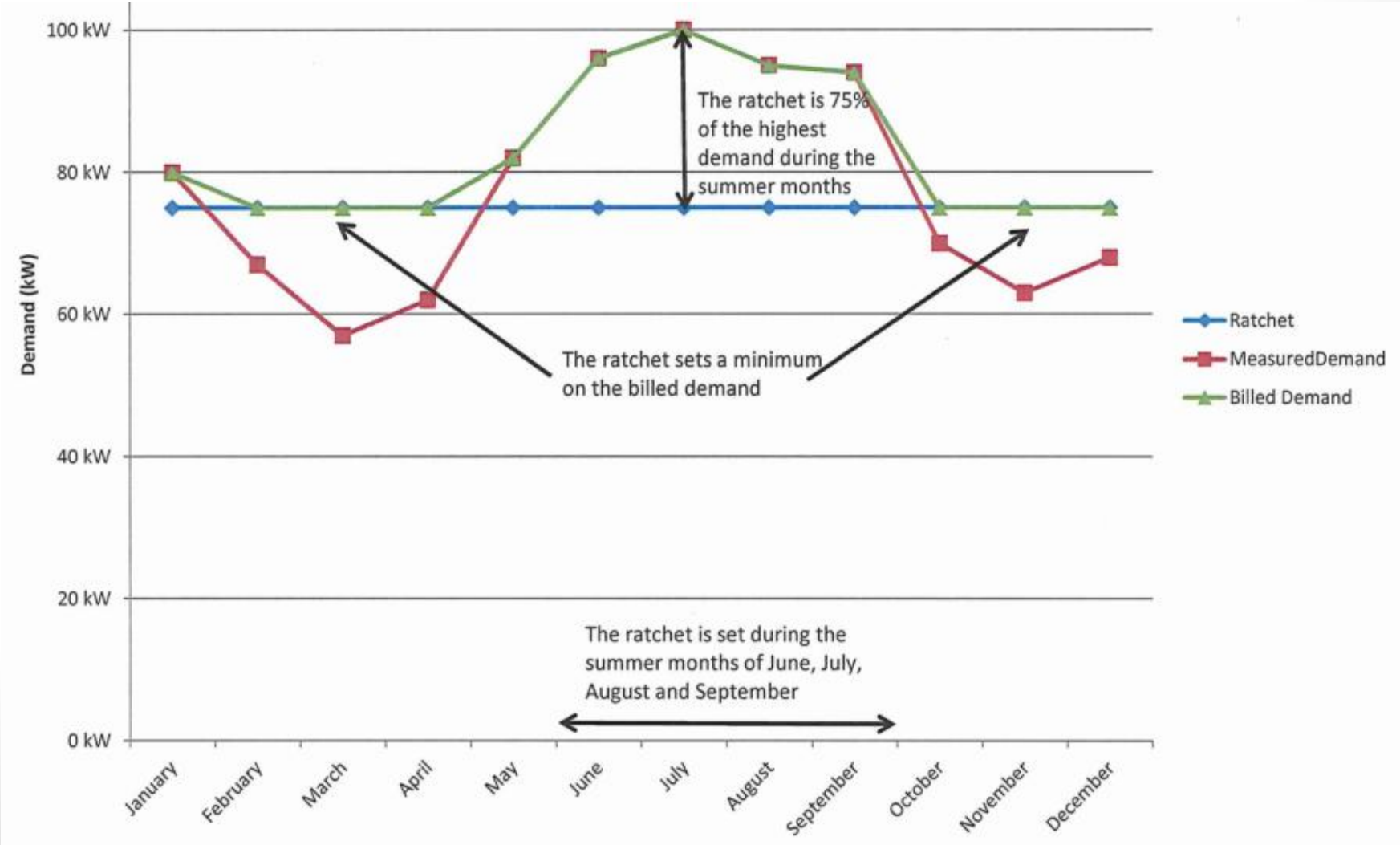
- Amount of energy consumed during the billing period
- 864,000 KWH x $0.054 per KWH = $46,820.16
- Most Utility Bills have On Peak and Off Peak Charges
  - Most WWTP's cannot do much about this
  - Have to treat wastewater when it comes

Meter #82802 Readings		
JUN 30 7851	Actual reading	
MAY 30 7731	Actual reading =	120 X 7200 Mult. = 864000 KWH
Energy Charge		$46,820.16

Energy Bill – Peak Demand

- Average peak energy usage for a pre-determined timeframe (common is 15 minute average)
- Peak demand charge is there because the electric utility must build infrastructure to support the peak demand
- Wastewater utilities are lucky in that:
  - Demand is fairly constant throughout the day or year
  - Ability to turn off equipment for short intervals
  - Properly stage preventative maintenance items to prevent large peak demands

Energy Bill – Ratcheting Factor



Energy Bill – Power Factor

- Power Factor applies to the amount of real and unreal power.
  - Real Power is the amount of power applied to the mechanical device (motor) and can be measured in amps
  - Unreal power is the amount of power not used due to a misalignment in electrical sine waves (MAGIC)
- Power Factor of 1.0 means all power supplied is converted to horsepower.
- Power Factor of .75 means only 75% of power is used.
- Utilities typically have a minimum power factor required
  - For Rochester the minimum power factor required is 0.95
  - Power factor less than specified incurs a penalty.

Energy Bill – Power Factor

Example:

- Power factor = 0.75
- Required power factor = 0.95
- Peak demand billed = $\frac{\textit{peak power demand x power factor required}}{\textit{power factor achieved}}$
- 100 kwh x .95/.75 = 127 kwh

- 100 kwh used but 127 kwh billed

Energy Bill – Power Factor

- Power Factor Correction
  - Purchase equipment with higher power factor
  - Add capacitors
  - Don’t add capacitors to VFD’s
  - WRP rule of thumb is to add capacitors to motors 10 hp and up

Energy Bill - Credits

- Talk to your electric utility!
- Meter ownership
- Transformer ownership
- If two power supplies, may get credit for one not in use
- Curtailment or interruptible demand
  - Reduces electric utilities peak demand
  - Typically involve turning equipment off or running a generator
  - Commonly during summer months
  - Maximum number of days specified by electric utility

Energy Bill Comparison

1,000,000 kwh usage (1,380 kw/hr)

$0.05 per kwh usage and $16.50 per kwh peak demand

Power Factor minimum = 0.95

WWTP A

- Peak Demand = 1500 kwh
- Power Factor = 0.95
- Curtailment Credit of $4k
- 1,000,000 kwh x $0.05 = $50k
- 1500 kwh x $16.50 = $25k
- $50k + $24.75k - $4k =

$71,000

WWTP B

- Peak Demand = 2300 kwh
- Power Factor = 0.72
- No Curtailment
- 1,000,000 kwh x $0.05 = $50k
- 2,300 kwh x .95/.72 x $16.50 = $50k
- $50k + $50k =

$100,000

Electric Bill Summary

- Many factors effect the amount you pay in power
  - Usage
  - Peak Demand
  - Power Factor
  - Ratchet Factor
  - Credits
- Call your electric utility
- Take advantage of electric utility programs and their personnel
- Proper management of your energy can save MEGA BUCKS
- When calculating future returns based on energy savings include all factors which effect usage rate

Equipment to Start Saving

- Motors
  - Pumps
  - Mixers
  - HVAC
  - Air Compressors
- Lights
- Air Audits
- Heating and Cooling Loops
- Generator
- Many More
- Start with large horsepower equipment and work your way down

Return On Investment (ROI)

- Compares new equipment electrical costs and maintenance costs to existing equipment and figures a payback.

- $$\mathrm{ROI} = \frac{Capital\ Cost - Rebates}{Annual\ electrical\ savings + Annual\ maintenance\ savings}$$

- Rules of thumb for “GO” or “NO GO” decision
  - ROI < 2 yrs, GO
  - 2 yrs < ROI < 6 yrs, Fully Assess Situation but likely GO
  - 6 yrs < ROI, NO GO

Motors

- Gather information on existing installations
  - Manufacturer
  - Voltage/phase/hertz
  - RPM
  - Constant speed or VFD
  - Horsepower
  - Year Installed
  - Efficiency
  - Amp draw
  - Power Factor
- Compare existing motor efficiency to premium efficient motors
- When is end of useful life?

Key Motor Details

- Nameplate motor efficiency is important BUT not the only factor
- Manufacturer reliability
- Projected motor loading
  - New motors may turn slightly faster and therefore draw more power. $LoadFactor_{new} = LoadFactor_{old} \times (RPM_{new}/RPM_{old})^3$
  - Typical is 80% to 90%
- Power Factor at projected motor loading
  - Higher power factor the better.
- VFD Rated?
- Cost

Motor Efficiency

- Theoretical Power (electric) =
  0.746 x hp x Load Factor / Efficiency
  - Higher the efficiency, less power used
  - Lower the load factor, less power used

Description	Old	New
Spec data		
Horsepower	30	30
Efficiency	87.5%	93.5%
Load factor	85.0%	85.0%
Power (kw)	21.7	20.3

- Measurable Power (electric) =
  1.73 x V x Amp x Power Factor/1000

Description	Old	New
Measured data		
Current (amps)	32.77	34.15
Power Factor	0.815	0.765
Voltage	477.8	477.4
Speed (rpm)	1770	1782
Power (kw)	22.1	21.6

- Measure existing & new installation!
- ROI from 0.6 yrs to 2.5 yrs

Motor Selection Criteria

- High Efficiency
- Low Cost
- High Power Factor (and therefore lower amps)
- Load Factor
- Return on Investment
- Frame size
- RPM
- Power Supply

Lighting

- Lighting has come a long way in recent years
- 100 – 150 lumens per watt
- Runtime in 60,000 hours plus
- Common options to reduce energy
  - LED
  - CFL
  - Induction lighting
  - Motion sensors
  - Turn off lights when not in room
  - Use less lights for security and maneuverability when not in use
- Large rebates compared to capital cost of fixture

Lighting Replacement Example

- 175 watt metal halide lights replaced with 50 watt LED lights
  - LED lights have higher lumen output
  - Metal halide bulb is 175 watts but fixtures were closer to 210 watts
  - 106 fixtures
- ROI
  - $285 per fixture installed
  - Rebates were high at $89 per fixture
  - Energy Savings of $119/yr
  - ($285-$89) / $119 = 1.6 yrs ROI "GO"
- $12,000 per year in energy savings plus reduced maintenance

Lighting

- Common fixtures that can be replaced
  - Metal Halide with T8 or LED lights
  - T12 with T8 lights
  - Street lighting
  - Wallpacks
  - Simple bulb replacement
- Go to an industrial light supplier
- Class 1 Div 1 lighting
  - Where are you?

Air Leaks

- Plant Air – not process air which is high volume, low pressure
- A 1/8” opening in air piping can account for $1,500 per year in energy loss
- Air audits can save big
- Electric utility may have air leak detector and/or air reduction program
- Pneumatic controls on HVAC are also a big source of air consumption

Air Leak Correction Example

- WRP performed air audit
- Equipment provided by electric utility
- Findings:
  - 104 leaks
  - Corrected 60 leaks
  - $30,000 annually in energy savings
  - All equipment purchased for leak correction and labor was less than one year energy savings
  - Reduced size of new compressors required to replace aged equipment
- Additional electric utility rebate
- That hissing sound <u>is not</u> normal.

Where else can we save?

- Heating and cooling Loops
- Engine generator use of methane gas
- Boiler use of methane gas
- Setup plant to minimize pumping
  - Liquid process
  - Solids process

Summary of Energy Bill

- Talk to your electric utility provider
  - Rebates
  - Credits
  - Audit Programs
- Know your power bill
  - Energy Usage
  - Peak Demand
  - Power Factor
  - Ratcheting Factor
- Control preventative maintenance tasks
- Return on Investment

Summary of Key Savings

- Motors
  - Large energy consumers
  - Smaller motors are typically more efficient than older motors
  - Account for higher speed motors
  - Power Factor
- Lighting
  - High efficient lighting is now available
  - Get with a professional distributor
- Air
  - Leaks are high energy consumers

Thank you for Attending

QUESTIONS?