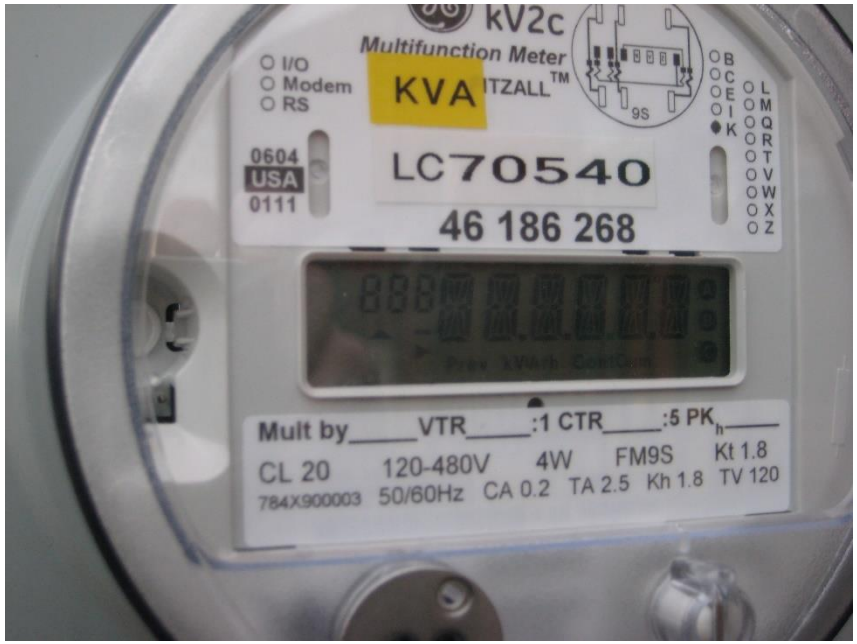
Reading & Understanding Electric Bills

Water & Wastewater Energy Conservation & Savings

Brett Ward
Municipal Technical Advisory Service
Institute for Public Service
The University of Tennessee

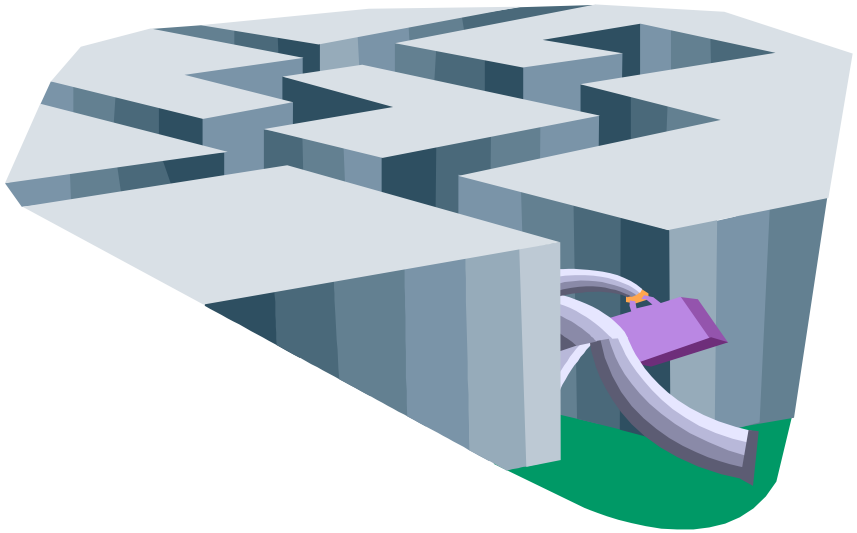
Economy & Energy/Electricity

- Use Less!
- Use it more efficiently
  - Equipment
  - Use of the equipment
  - Processes
- Continuous Effort!
- Who is interested?
- Who will help you?
- Who will get you the tools?



Every trip has a beginning

- With Electrical Energy Management it begins with your current electric bill.



Electric Bill Information

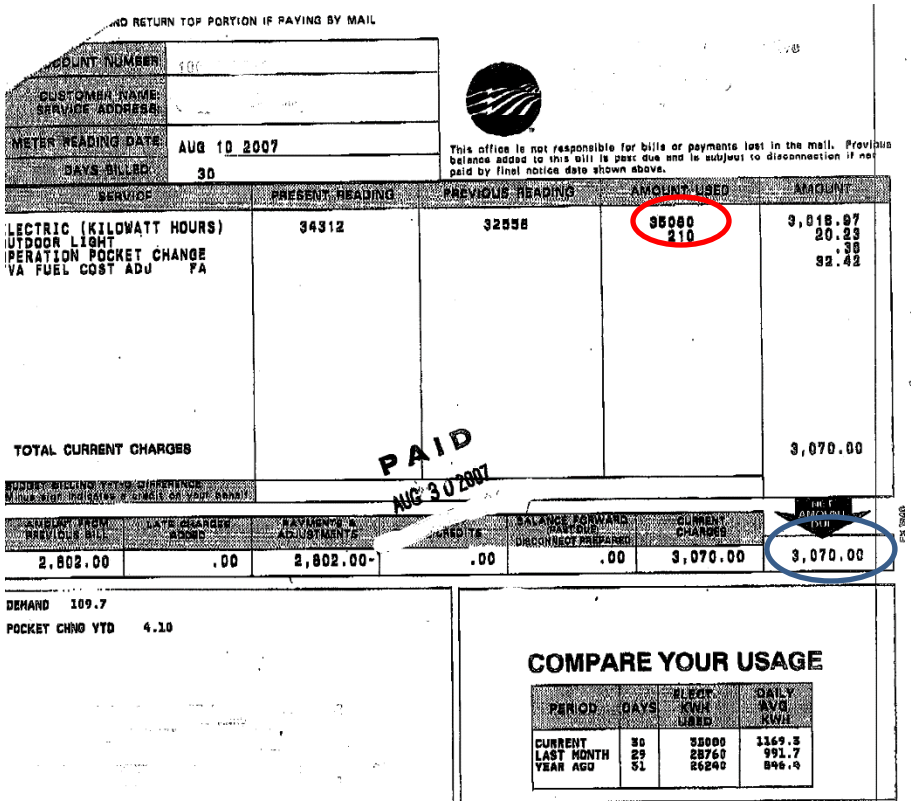
- Simple Bill
  - Minimal Information
  - Perhaps only Dollar Amounts
- Complex Billing Statement
  - Details of Money
    - Current charges or minimum charges
  - Details of Electrical Usage
    - How much Energy Used- kWh(Energy) ~Total Gallons
    - How fast it was used- kW (Demand) ~ GPM
    - Way it was used- kW/kVA (Power Factor)

Electrical Billing

- kWh-kilo watt hours, total Energy Usage- rate offset the base cost of generation and transmission
- kW-kilo watts, demand charge- rates paid to offset the cost of larger infrastructure needed to provide the peak demand
- Power Factor Penalties- buried within the Demand charges, offset the reactive power loss

Sample Statements

Simple Bill



...ND RETURN TOP PORTION IF PAYING BY MAIL

ACCOUNT NUMBER 100

CUSTOMER NAME
SERVICE ADDRESS

METER READING DATE AUG 10 2007

DAYS BILLED 30

This office is not responsible for bills or payments lost in the mail. Previous balance added to this bill is past due and is subject to disconnection if not paid by final notice date shown above.

SERVICE	PRESENT READING	PREVIOUS READING	AMOUNT USED	AMOUNT
LECTRIC (KILOWATT HOURS)	34312	32558	35080	3,018.97
UTDOOR LIGHT			210	20.23
PERATION POCKET CHANGE				.36
VA FUEL COST ADJ FA				32.42
TOTAL CURRENT CHARGES				3,070.00

PAID
AUG 30 2007

AMOUNT FROM PREVIOUS BILL	LATE CHARGES APPLIED	PAYMENTS & ADJUSTMENTS	CREDITS	BALANCE FORWARD (AMOUNT DISCONNECT PREPARED)	CURRENT CHARGES	NET AMOUNT DUE
2,802.00	.00	2,802.00-	.00	.00	3,070.00	3,070.00

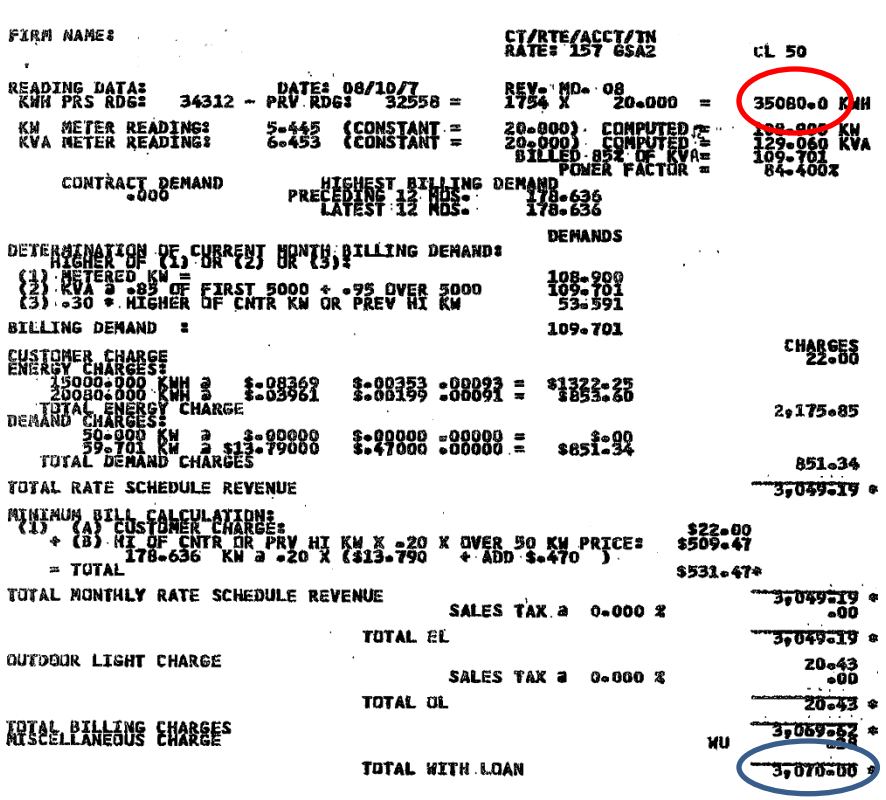
DEMAND 109.7

POCKET CHNG YTD 4.10

COMPARE YOUR USAGE

PERIOD	DAYS	ELECT. KWH USED	DAILY AVG KWH
CURRENT	30	35080	1169.3
LAST MONTH	29	28760	991.7
YEAR AGO	31	26240	846.4

Detailed Statement



FIRM NAME:

CT/RTE/ACCT/IN
RATE: 157 GSA2 CL 50

READING DATA:
KWH PRS RDG: 34312 - PRV RDG: 32558 = REV. MO. 08
1754 X 20.000 = 35080.0 KWH

KW METER READING: 5.445 (CONSTANT = 20.000) COMPUTED = [illegible] KW
KVA METER READING: 6.453 (CONSTANT = 20.000) COMPUTED = 129.060 KVA
BILLED 85% OF KVA= 109.701
POWER FACTOR = 84.400%

CONTRACT DEMAND .000
HIGHEST BILLING DEMAND
PRECEDING 12 MOS.: 178.636
LATEST 12 MOS.: 178.636

DETERMINATION OF CURRENT MONTH BILLING DEMAND:
HIGHER OF (1) OR (2) OR (3):

	DEMANDS
(1) METERED KW =	108.900
(2) KVA @ .85 OF FIRST 5000 + .95 OVER 5000	109.701
(3) .30 * HIGHER OF CNTR KW OR PREV HI KW	53.591
BILLING DEMAND :	109.701

					CHARGES
CUSTOMER CHARGE					22.00
ENERGY CHARGES:					
15000.000 KWH @	$.08369	$.00353	.00093 =	$1322.25	
20080.000 KWH @	$.03961	$.00199	.00091 =	$853.60	
TOTAL ENERGY CHARGE					2,175.85
DEMAND CHARGES:					
50.000 KW @	$.00000	$.00000	.00000 =	$.00	
59.701 KW @	$13.79000	$.47000	.00000 =	$851.34	
TOTAL DEMAND CHARGES					851.34
TOTAL RATE SCHEDULE REVENUE					3,049.19 *

MINIMUM BILL CALCULATION:
(1) (A) CUSTOMER CHARGE: $22.00
+ (B) HI OF CNTR OR PRV HI KW X .20 X OVER 50 KW PRICE: $509.47
178.636 KW @ .20 X ($13.790 + ADD $.470) $531.47*
= TOTAL

TOTAL MONTHLY RATE SCHEDULE REVENUE 3,049.19 *
SALES TAX @ 0.000 % .00
TOTAL EL 3,049.19 *

OUTDOOR LIGHT CHARGE 20.43
SALES TAX @ 0.000 % .00
TOTAL OL 20.43 *

TOTAL BILLING CHARGES 3,069.62 *
MISCELLANEOUS CHARGE WU .38

TOTAL WITH LOAN 3,070.00 *

First Challenge

- Find the Local Power Company representative who can thoroughly explain the detailed statement
  - Front line Customer Service have a “script”
  - Highly Technical Culture
  - Many terms, abbreviations, and acronyms
  - Person who knows the details may not be customer service oriented

Detailed Statement

Meter Readings in kWh

Note Constant

Demand Reading in kW

#1 Demand Reading in kW

#2 Demand billed @ 85% of kVA

Power Factor is 84.4%

~Contract Demand

Highest Billing Demand (12 months)

#3 Demand 30% , highest 12 mo. Dmd

Demand Billed on 109.7 kW

Customer Charge

Energy Costs

1st 15,000 kWH + FCA

Remaining 20080 kWH

Demand Charges

1st 50 kW no charge

Remaining 59.7 kW +

Minimum Demand

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FIRM NAME:                                          CT/RTE/ACCT/TN
                                                    RATE: 157 GSA2          CL 50

READING DATA:              DATE: 08/10/7            REV. MO. 08
 KWH PRS RDG:   34312 - PRV RDG:   32558 =          1754 X    20.000  =     35080.0 KWH

 KW  METER READING:     5.445  (CONSTANT =          20.000)  COMPUTED =     108.900 KW
 KVA METER READING:     6.453  (CONSTANT =          20.000)  COMPUTED =     129.060 KVA
                                                    BILLED 85% OF KVA=     109.701
                                                          POWER FACTOR =      84.400%

     CONTRACT DEMAND          HIGHEST BILLING DEMAND
           .000          PRECEDING 12 MOS.    178.636
                           LATEST 12 MOS.     178.636

                                                    DEMANDS
DETERMINATION OF CURRENT MONTH BILLING DEMAND:
    HIGHER OF (1) OR (2) OR (3):
 (1) METERED KW =                                   108.900
 (2) KVA @ .85 OF FIRST 5000 + .95 OVER 5000        109.701
 (3) .30 * HIGHER OF CNTR KW OR PREV HI KW           53.591

BILLING DEMAND  :                                   109.701

                                                                        CHARGES
CUSTOMER CHARGE                                                          22.00
ENERGY CHARGES:
    15000.000 KWH @   $.08369   $.00353 .00093 =  $1322.25
    20080.000 KWH @   $.03961   $.00199 .00091 =   $853.60
   TOTAL ENERGY CHARGE                                                2,175.85
DEMAND CHARGES:
       50.000 KW  @   $.00000   $.00000 .00000 =      $.00
       59.701 KW  @ $13.79000   $.47000 .00000 =   $851.34
   TOTAL DEMAND CHARGES                                                851.34

TOTAL RATE SCHEDULE REVENUE                                          3,049.19 *

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          178.636  KW @ .20 X ($13.790   + ADD $.470  )
    = TOTAL                                                 $531.47*

TOTAL MONTHLY RATE SCHEDULE REVENUE                                  3,049.19 *
                                    SALES TAX @  0.000 %                .00
                                TOTAL EL                             3,049.19 *
OUTDOOR LIGHT CHARGE                                                    20.43
                                    SALES TAX @  0.000 %                .00
                                TOTAL OL                                20.43 *

TOTAL BILLING CHARGES                                                3,069.62 *
MISCELLANEOUS CHARGE                                          WU         .38

                                TOTAL WITH LOAN                      3,070.00 *
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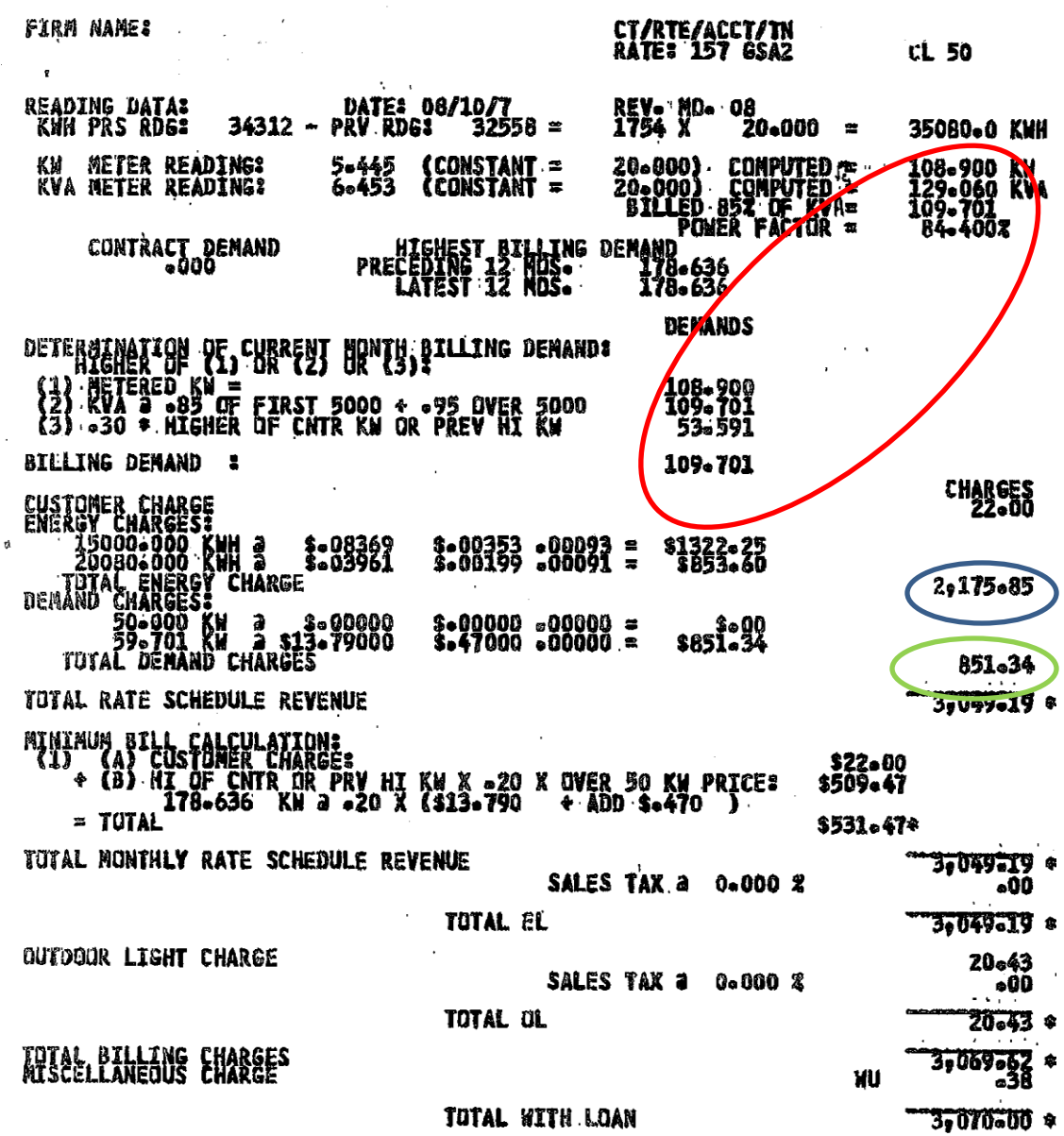
Saving Money

1. Use less kWH
2. Keep Power Factor >85%
3. Minimize Demand Charges



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                           LATEST 12 MOS.     178.636

                                                   DEMANDS

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                                                                        CHARGES
CUSTOMER CHARGE                                                           22.00
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   TOTAL ENERGY CHARGE                                                 2,175.85
DEMAND CHARGES:
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   TOTAL DEMAND CHARGES                                                  851.34

TOTAL RATE SCHEDULE REVENUE                                            3,049.19 *

MINIMUM BILL CALCULATION:
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            178.636  KW @ .20 X ($13.790   + ADD $.470  )
      = TOTAL                                                $531.47*

TOTAL MONTHLY RATE SCHEDULE REVENUE                                    3,049.19 *
                                    SALES TAX @  0.000 %                 .00
                                TOTAL EL                               3,049.19 *

OUTDOOR LIGHT CHARGE                                                      20.43
                                    SALES TAX @  0.000 %                 .00
                                TOTAL OL                                  20.43 *

TOTAL BILLING CHARGES                                                  3,069.62 *
MISCELLANEOUS CHARGE                                            WU        .38

                                TOTAL WITH LOAN                        3,070.00 *
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Use Less Energy or kWh

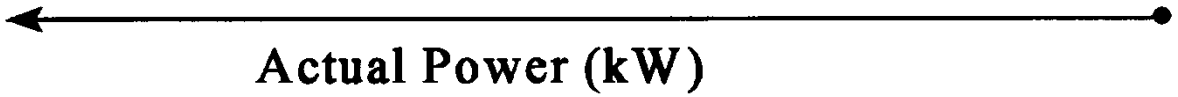
- Turn stuff OFF!
  - Don’t over aerate
  - Do not discharge Nitrate (NO_3)
    - If you Nitrify, Denitrify Effluent and Sludge or Biosolids
  - Lots of other actions
    - Improve efficiency and reduce waste
- Generate your own kWh

Power Factor Penalties

Reactive Energy Management

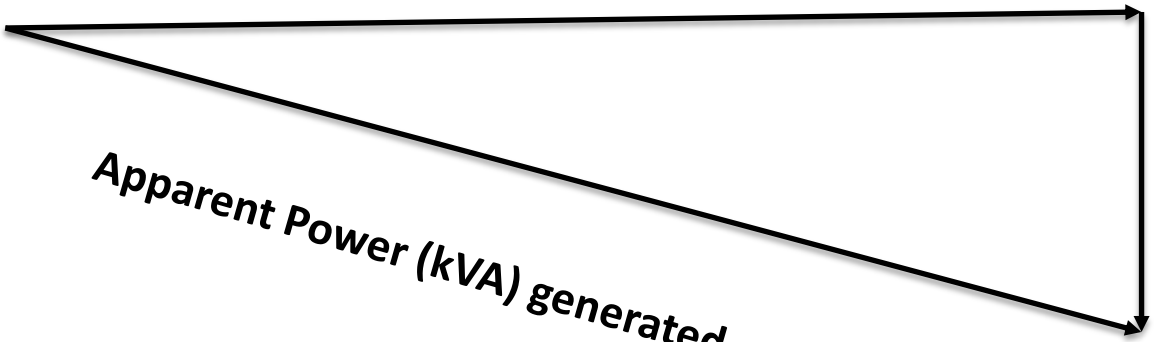
- Keep Power Factor above 85%
- Distributors generally will help you
- Reduce inductive load
  - Inductive motors, ballasts, arc welders, transformers, loads with wound coils, idling or lightly loaded motors
  - Add capacitors- whole plant or single motor
- Improves electrical efficiency of the system

Power Factor Triangle



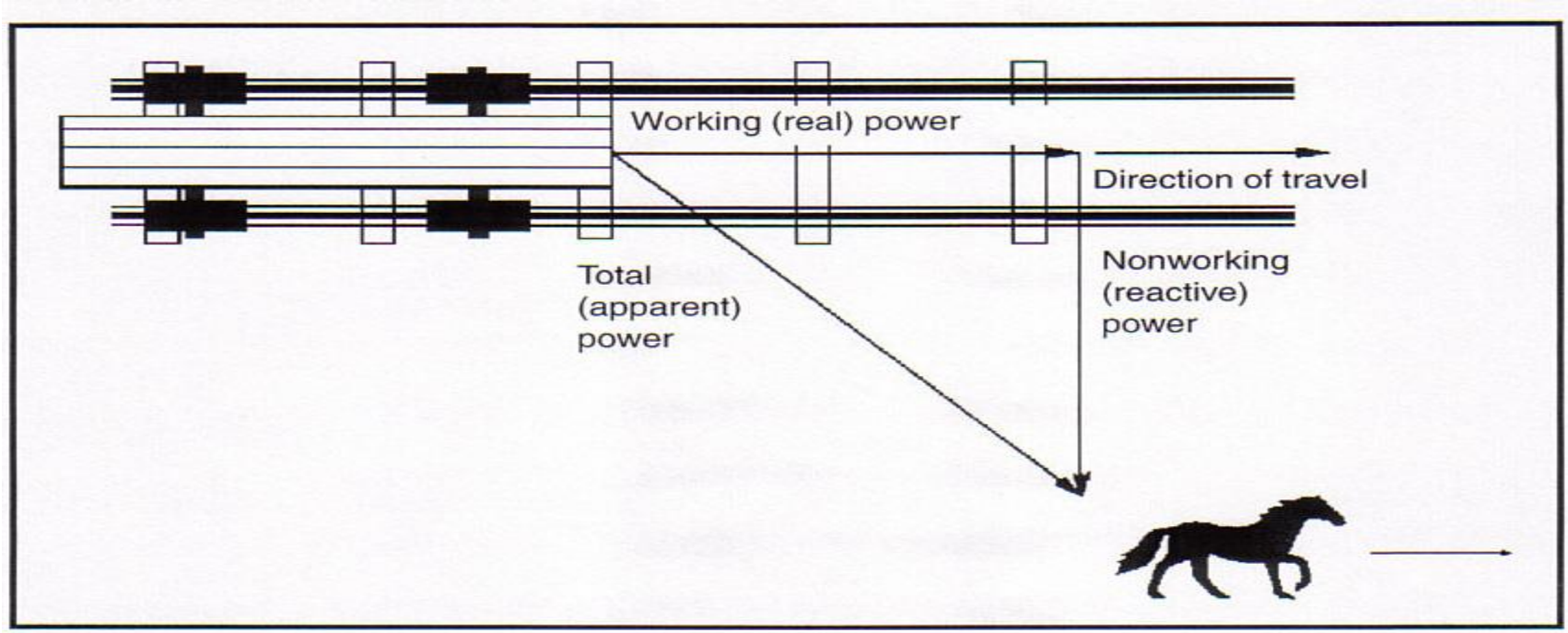
Resistive Load (light bulb, electric heat)

Actual Power (kW or Hp) does real work



Reactive Power (kVAR) power loss Because of the type of equipment

Inductive Load (motor)



Power required to move the railcar down the track is the working (real) power

The effort of the horse is the total (apparent) power

The car will not move sideways; not all of the horses effort is used to move the car down the track

The sideways pull of the horse is wasted effort, nonworking (reactive) power.

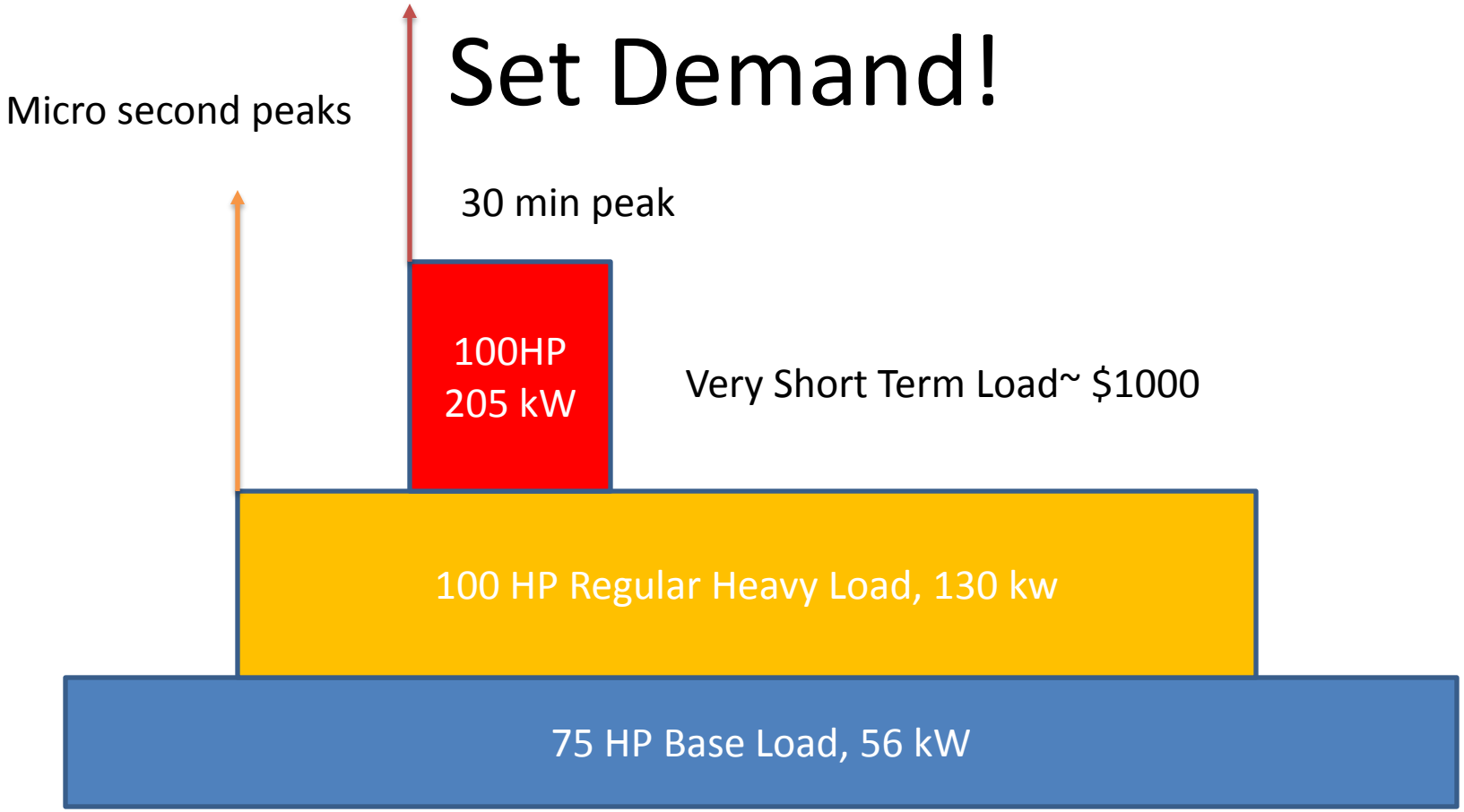
Power Factor

- Idling or lightly loaded motors
  - Screw Lift Pumps
  - Some Blowers, near empty digester
- Adjustable Speed Drives- at low speeds some types have very low Power Factor, (70%)
  - Three types: variable voltage inverter, current source inverter, & pulse width modulation
  - VVI & CSI drives have lower Power Factor at low speed but are marginally more efficient at low speed and less costly to purchase than the PWM drive

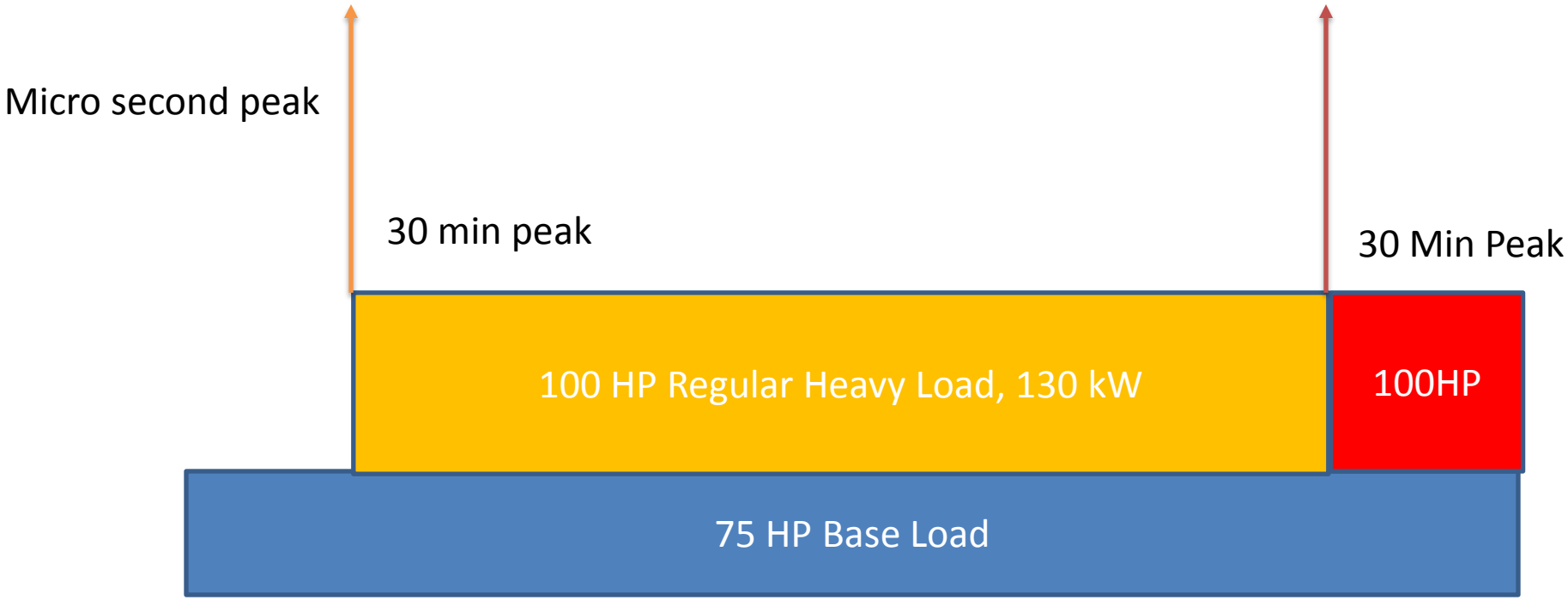
Reduce Demand Charges

- Know Thy Demand
- Demand Curve, Graph, Chart
- EnerNOC, real time demand graphs
- Peak 30 minutes each Month set the Demand
- Keep it FLAT, keep it Short

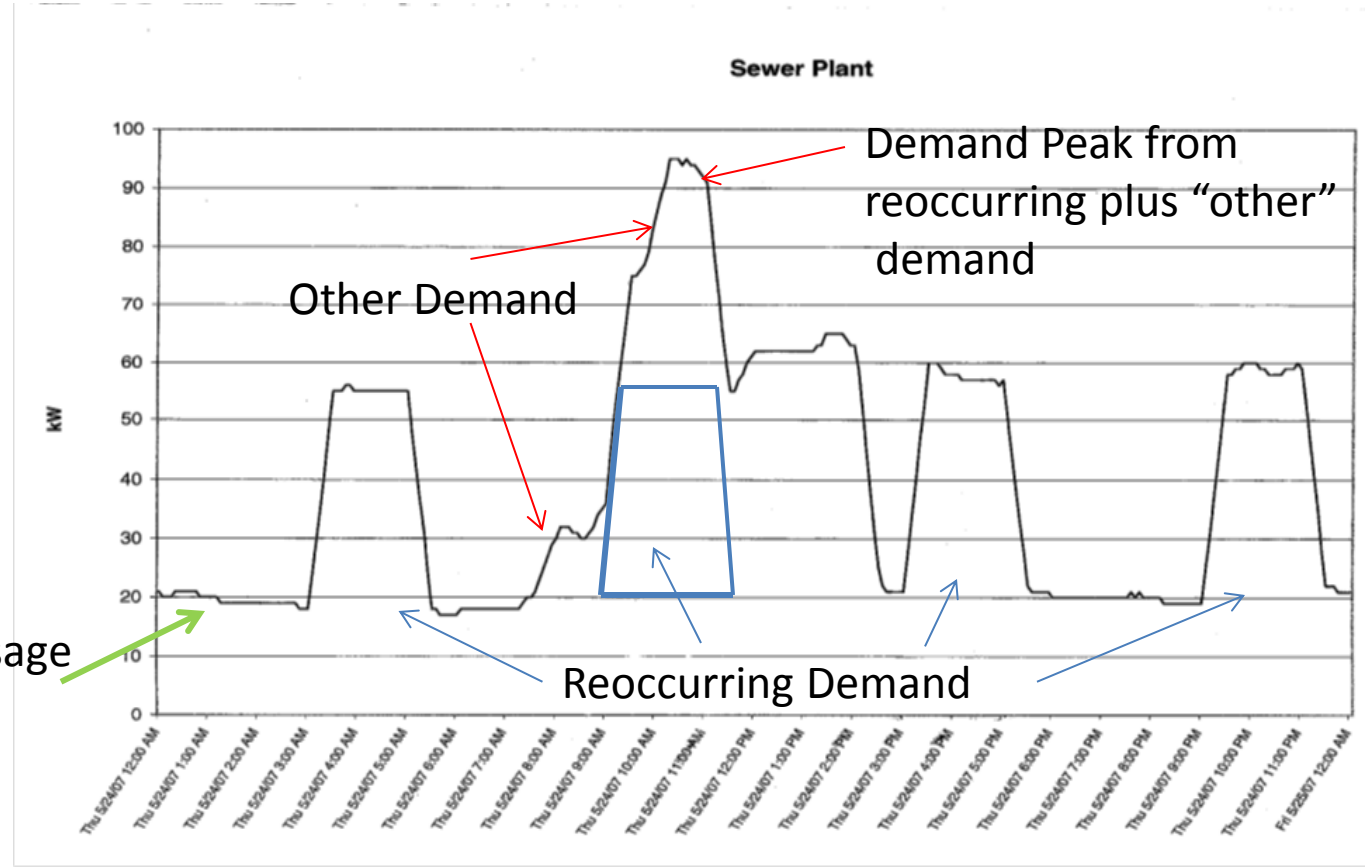
Demand Myth
Motor Starting Current Does NOT Set Demand!



Can Short Term Demand be Moved to Reduce Peak 30 Minute Demand



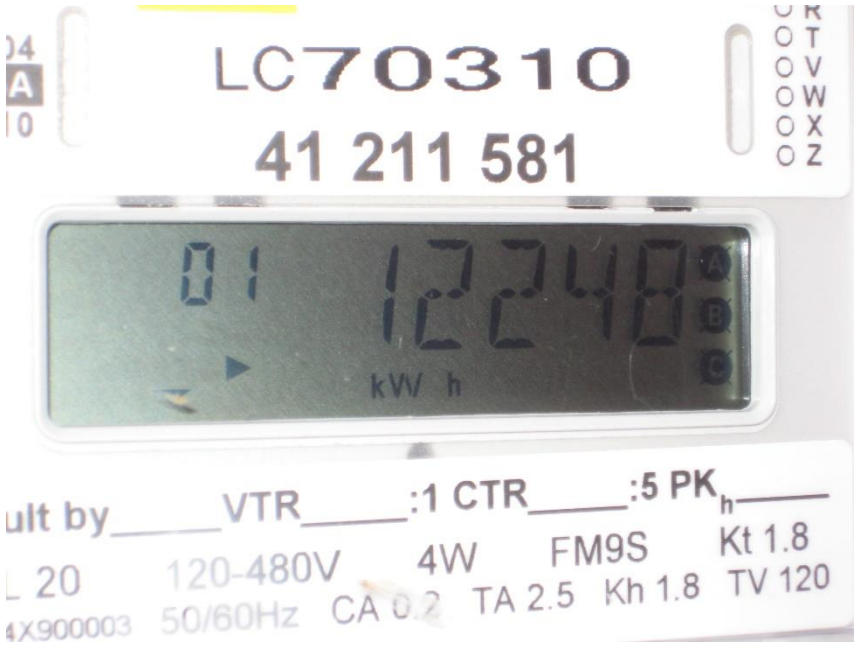
Example Demand Graph



Water Plant Demand Example

- $15,000 per year savings in Demand Charges
- 4 year payback on Utility portion of Energy Grant
- Updated 2-40 hp High Service pump
  - High Efficiency motors and pumps & VFD's
- Change operations from 9hr/day to 18 hr/day
  - Same volume, fewer motors pumping, longer hours, better customer pressure

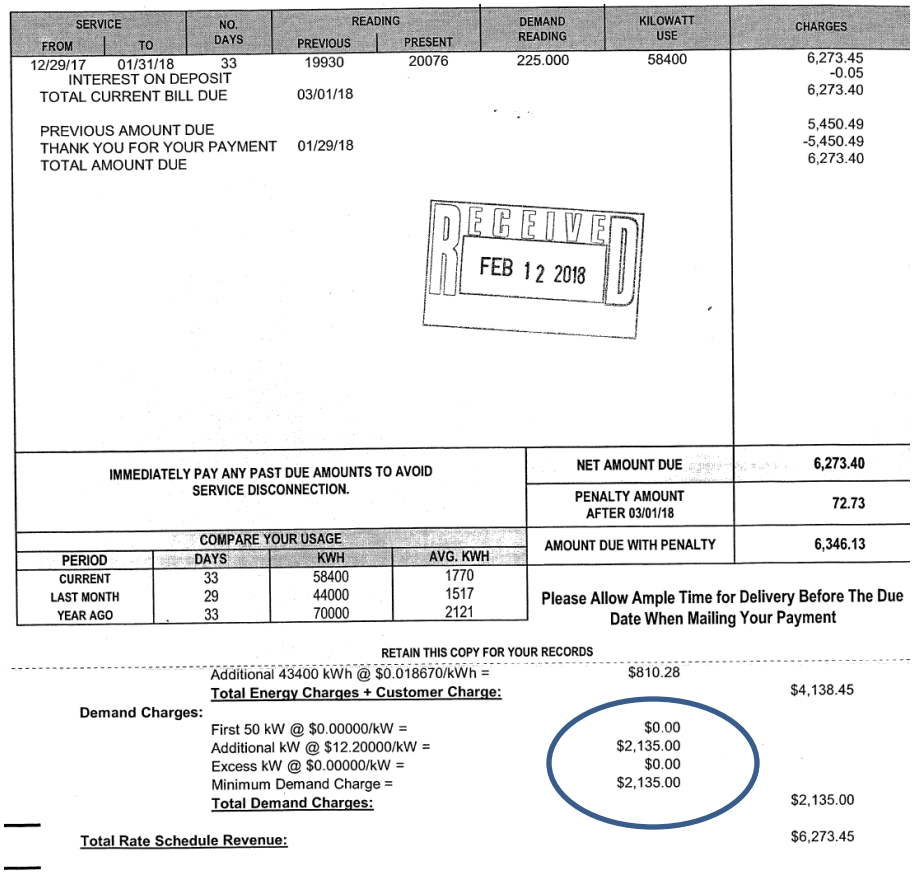
Demand Charges



- NA at < 50 kW
- Often 30-50% of the Cost.
- Includes Power Factor penalties
- Peak 30 minute reading each Month
- Motor starting has little impact, motor running does!

Contract Charges

- Contract Charges
  - Know and understand any contract minimum charges, probable from construction charges
- Minimum Demand
  - Annual Peak Demand



SERVICE FROM	SERVICE TO	NO. DAYS	READING PREVIOUS	READING PRESENT	DEMAND READING	KILOWATT USE	CHARGES
12/29/17	01/31/18	33	19930	20076	225.000	58400	6,273.45
INTEREST ON DEPOSIT							-0.05
TOTAL CURRENT BILL DUE			03/01/18				6,273.40
PREVIOUS AMOUNT DUE							5,450.49
THANK YOU FOR YOUR PAYMENT			01/29/18				-5,450.49
TOTAL AMOUNT DUE							6,273.40

RECEIVED FEB 12 2018

IMMEDIATELY PAY ANY PAST DUE AMOUNTS TO AVOID SERVICE DISCONNECTION.

NET AMOUNT DUE	6,273.40
PENALTY AMOUNT AFTER 03/01/18	72.73
AMOUNT DUE WITH PENALTY	6,346.13

COMPARE YOUR USAGE

PERIOD	DAYS	KWH	AVG. KWH
CURRENT	33	58400	1770
LAST MONTH	29	44000	1517
YEAR AGO	33	70000	2121

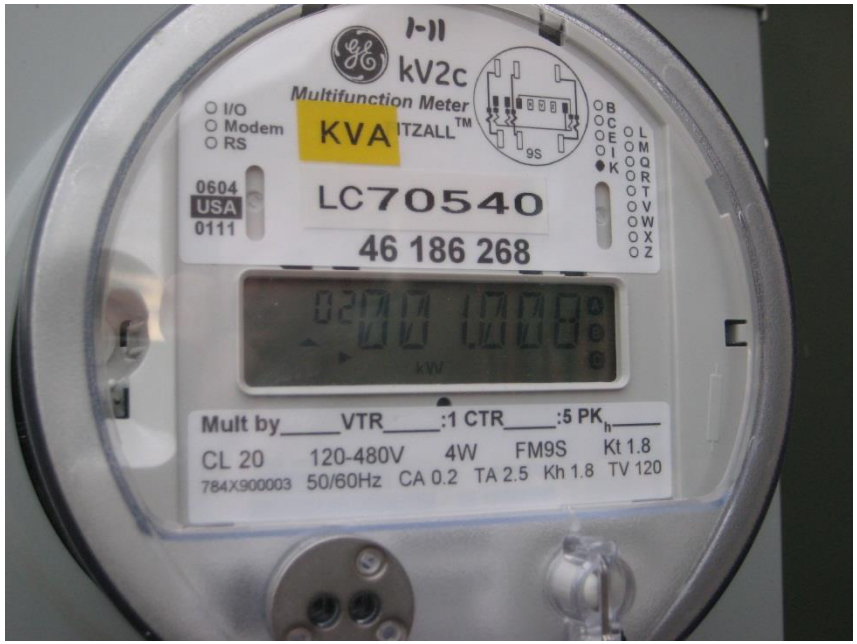
Please Allow Ample Time for Delivery Before The Due Date When Mailing Your Payment

RETAIN THIS COPY FOR YOUR RECORDS

	Additional 43400 kWh @ $0.018670/kWh =	$810.28	
	Total Energy Charges + Customer Charge:		$4,138.45
Demand Charges:			
	First 50 kW @ $0.00000/kW =	$0.00	
	Additional kW @ $12.20000/kW =	$2,135.00	
	Excess kW @ $0.00000/kW =	$0.00	
	Minimum Demand Charge =	$2,135.00	
	Total Demand Charges:		$2,135.00
	Total Rate Schedule Revenue:		$6,273.45

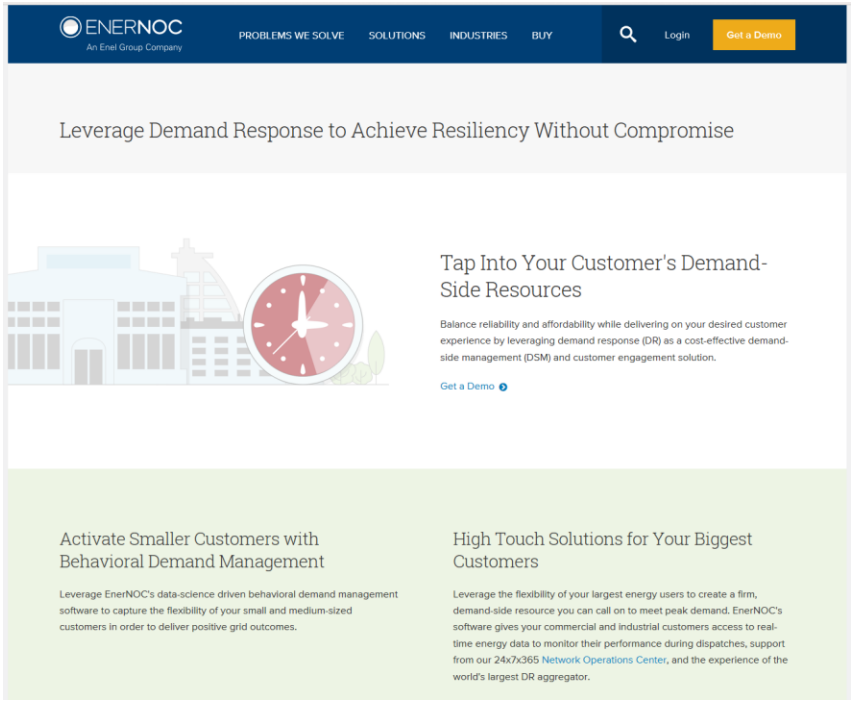
Electric Bill Information

- Energy usage kWh
- Rate of usage
  - Demand
  - kW
- How its used
  - Power Factor shows inductive or capacitive load
- Contract Minimums



Other Charges, Rates, or Revenue

- On/Off Peak Rates
  - Energy- kWh
  - Demand- kW
- Seasonal Rates
- Generation sellback rates
- EnerNOC- demand response
  - Revenue
  - Real time demand graph

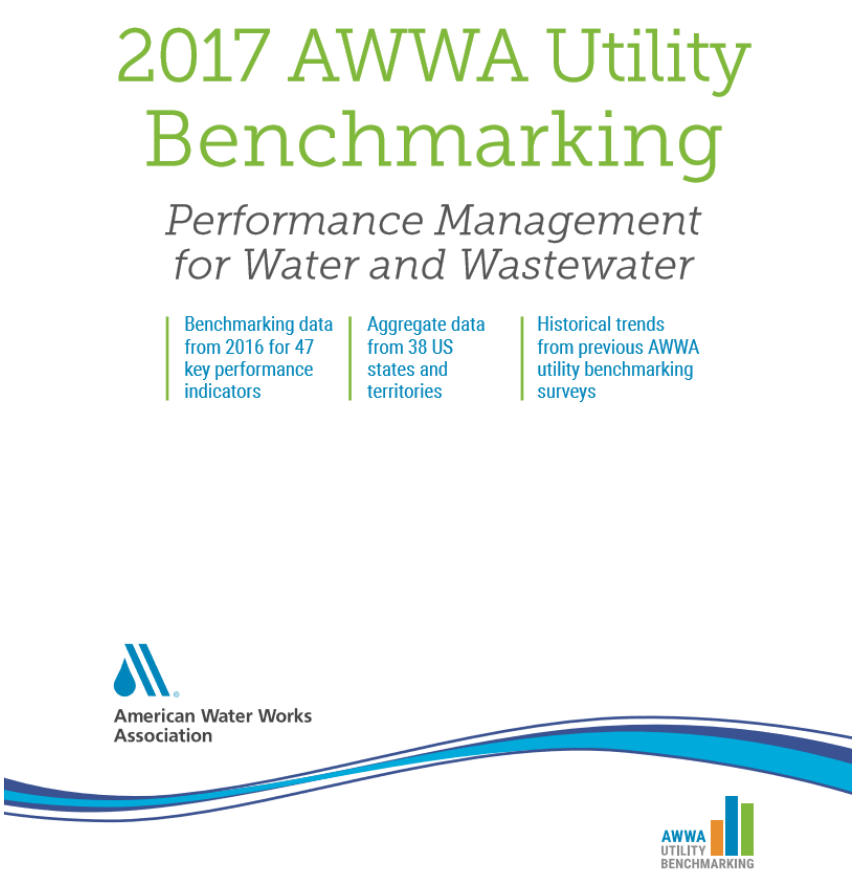


Questions or Comments

Electrical Savings for Operators

- Know your billing and usage details
- Benchmark
- Know your equipment usage
  - Water treatment ~ pumping
  - Sewer treatment ~ aeration, pumping
- Know plant/system operations
- Care for your equipment
- Design and purchase wisely

Benchmarking



- Use your own data
  - Current Usage
  - After improvement actions
- Tennessee Utilities
- AWWA
- Others

Know Your Equipment

- Where is the big usage
- Where is Demand set
- Water- pumping
  - Age, efficiency, valving, piping
  - PSAT- Pumping System Assessment Tool
  - https://www.energy.gov/eere/amo/articles/pumping-system-assessment-tool

Know Your Equipment

- Where is the big usage
- Where is Demand set
- Sewer
  - Aeration ~ pumping
  - Nitrate discharge
  - Solids processing

Know Your Plant/System Operations

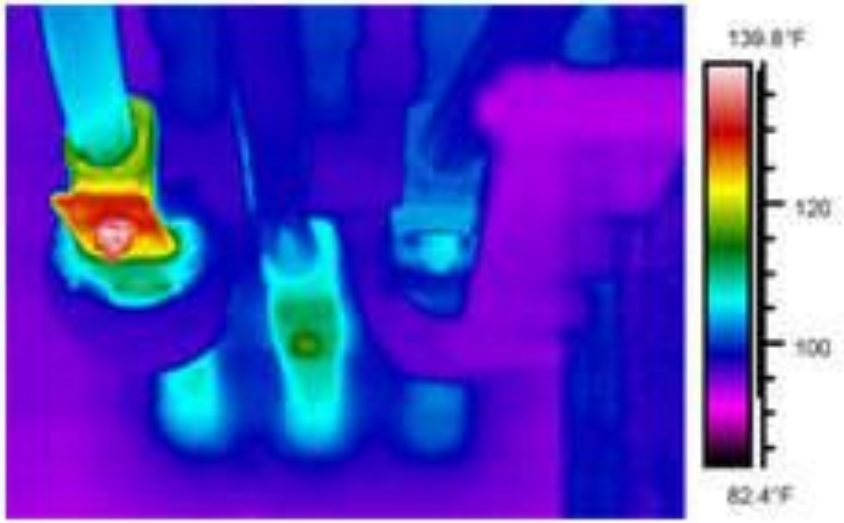
- Water: Regulatory Minimums
  - Volume & pressure
  - Tanks, elevations, pressure zones
  - Customer usage, dry weather usage, fire fighting

- Sewer: Permit requirement
  - Lowing hanging fruit is Nitrate
  - If you nitrify, can you denitrify ~ 30% savings
  - What about sludge and biosolids
    - Aeration/ nitrate, dewatering

Care of Equipment

- Properly Lubricated
- Properly Aligned
- Tight Connections
- Balanced voltage and current

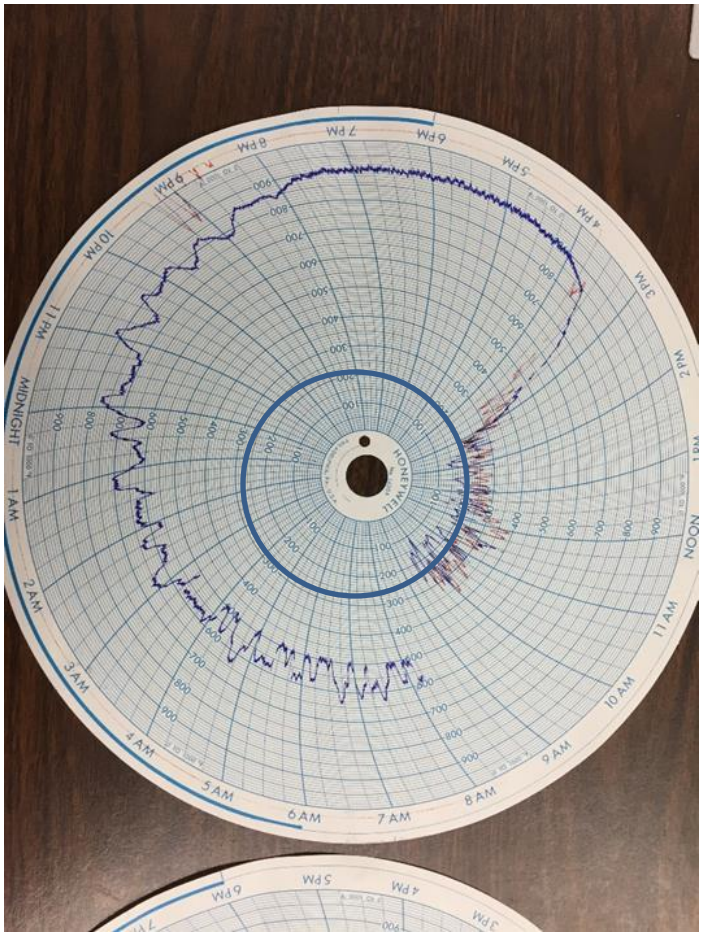
- Facility Lighting-LED



Design and Purchases

- Design for energy efficiency
- Single speed motors operating in the efficient part of the pump curve, but……
- Multiple smaller units vs One large unit

Another Energy Waste: I/I & Leaks



Resources

- https://www.tn.gov/environment/program-areas/energy/state-energy-office--seo-/programs-projects/programs-and-projects/energy-doe-state-energy-program-competitive-awards/energy-doe-area-2-award-energy-efficiency-wastewater.html
- http://www.mtas.tennessee.edu/sewer
- https://www.tva.gov/Energy/EnergyRightSolutions
  - Comprehensive Services through local Power Company
- https://www.energystar.gov/
- https://www.tntech.edu/engineering/research/cmr/tennessee-3-star-industrial-assessment-center/energy-efficiency-assessments