

# GEAPS/GRAIN JOURNAL EDUCATIONAL WEBINAR SERIES



**GEAPS**  
*Grain Elevator and Processing Society*



This webinar reviews an education  
session presented at GEAPS  
Exchange 2017

# GEAPS EXCHANGE 2018

March 24-27, Denver, CO



# Introduction

- Education on Utility Bills & Power Concepts



# Objectives

- Gain an understanding of industrial power
- Questions to ask your utility provider
- Identify ways to save money
- Real world examples

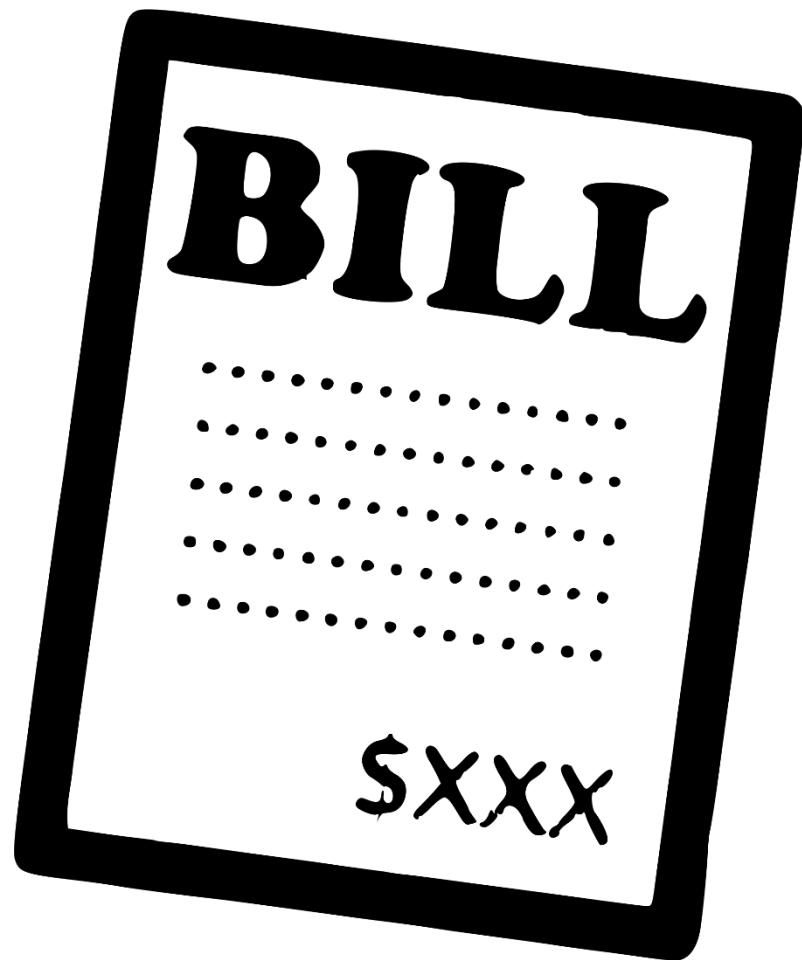
# It's Time to Pay the Bills...

HIGH RATE ELECTRIC COMPANY  
1234 AMPERAGE DR.  
SOMEWHEREVILLE, KS 55555

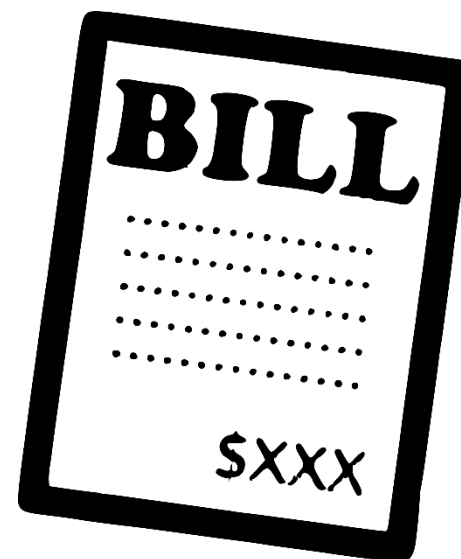


THE GRAIN ELEVATOR COMPANY  
987 MAIN ST.  
SOMEWHEREVILLE, KS 55555

# It's Time to Pay the Bills...



# Let's Investigate



# Power, Energy, & Demand

## Power

- Instantaneous reading of electricity
- Measured in kilo-watts (kW)



## Energy

- Accumulation of power over time
- Consumption
- Measured in kilo-watt hours (kWh)



## Demand

- Average power your facility requires over 15 minutes
- (Average Speed Driven over 15 minute time period)



# Contact your Utility Provider

Is there a business size classification, how am I classified, and what is the criteria?

Is there a penalty or adjustment for low power factor?

How is demand calculated?

# 1 . Business Size

Is there a business size classification, how am I classified, and what is the criteria?

Is there a penalty or adjustment for low power factor?

How is demand calculated?

# Power Bill – Business Size

## Business Size Classification

- Small General ( < 200 kW )
  - 220 kW Monthly Average or 300 kW
- Medium General ( 200 – 1,000 kW)
  - 1,100 kW Monthly Average or 1,500 kW
- Large General (1,000 kW – 25,000 kW)
  - 25,000 kW moved to Industrial & Large Power

## Tariff Information:

<https://www.westarenergy.com/rates-and-regulations>

# Power Bill – Business Size

## Small General Service

Basic Service Fee .....\$22.50

### Demand

**For the months of June through September:**

*\$8.47 per kW for all kW more than 5 kW*

**For the months of October through May:**

*\$4.38 per kW for more than 5 kW*

### Energy Use

*\$0.069699 per kWh for the first 1,200 kWh*

*\$0.050723 per kWh for all additional kWh*

**Plus all applicable adjustments and surcharges.**



# Power Bill – Business Size

## Medium General Service

*The Medium General Service – commercial and industrial customers with electrical demand greater than 200 kW are eligible to be served under this tariff.*

**Basic Service Fee ..... \$100.00**

### Demand

*\$15.615204 per kW*

### Energy Use

**For the months of June through September:**

*\$0.019261 per kWh*

**For the months of October through May:**

*\$0.014627 per kWh*

**Plus all applicable adjustments and surcharges.**



# Medium Demand Charge

## MEDIUM GENERAL SERVICE

### MINIMUM MONTHLY BILL

The greater of the Basic Service Fee plus the Demand Charge for 200 kW of Billing Demand, or the minimum specified in the electric Service Agreement, plus all applicable adjustments and surcharges.

### BILLING DEMAND

Billing Demand shall be the greatest of:

- Tariff Minimum → 1. 200 kW, or
- Actual Demand → 2. The average kW load supplied during the 15 minute period of maximum use during the month, adjusted for excessive lagging power factor, as described below, or
- Ratchet Clause → 3. 50 percent of the highest Billing Demand, as adjusted for power factor, established during the previous billing months of June, July, August or September, within the most recent 11 months, or
- 4. The minimum demand specified in the Electric Service Agreement.

# Power Bill – Business Size

## Large General Service

*This rate applies to customers with electrical demand of 1,000 kW to 25,000 kw.*

**Basic Service Fee.....\$250.00**

### **Demand**

*\$14.103727 per kW for service taken at primary voltage*

### **Energy Use**

*\$0.015390 per kWh for all kWh*

**Plus all applicable adjustments and surcharges.**



# Large Demand Charge

<u>LARGE GENERAL SERVICE</u> Formerly High Load Factor (HLF)	
<u>BILLING DEMAND</u>	
Billing Demand shall be the greatest of:	
Tariff Minimum →	1. 1,000 kW, or
Actual Demand →	2. the average kW load supplied during the 15 minute period of maximum use during the month, adjusted for excessive lagging power factor, as described below, or
Ratchet Clause →	3. 85 percent of the highest Billing Demand, as adjusted for power factor, established during the previous billing months of June, July, August or September, within the most recent 11 months, or
	4. the minimum demand specified in the Electric Service Agreement.



# Tariff Example

	2016 May	2016 June	2016 July	2016 Aug	2016 Sept	2016 Oct	2016 Nov	2016 Dec	2017 Jan	2017 Feb	2017 Mar
<b>1) Tariff Minimum</b>	200	200	200	200	200	1000	1000	1000	1000	1000	1000
<b>Actual Demand</b>	720	1390	1300	1300	1585	1390	1630	1390	1200	1150	1300
<b>2) Adjusted Demand</b>	800	1575	1400	1325	1635	1435	1640	1390	1200	1150	1310
<b>Summer Peak Demand</b>	944	1574	1574	1574	1635	1635	1635	1635	1635	1635	1635
<b>3) 50%/85% of Summer Peak</b>	472	787	787	787	818	1390	1390	1390	1390	1390	1390
<b>Peak Demand month</b>	Jun-15	Jun-16	Jun-16	Jun-16	Sep-16	Sep-16	Sep-16	Sep-16	Sep-16	Sep-16	Sep-16
<b>Billing Demand</b>	800	1575	1400	1325	1635	1435	1640	1390	1390	1390	1390

Reclassified

# Business Size Comparison

	<b>SMALL</b>	<b>MEDIUM</b>	<b>LARGE</b>
<b>Criteria</b>	<b>&lt; 200 kW</b>	<b>&lt; 1,000 kW</b>	<b>&lt; 25,000 kW</b>
<b>Basic Fee</b>	<b>\$ 22.50</b>	<b>\$ 100.00</b>	<b>\$ 250.00</b>
<b>Demand</b>	<b>Summer: \$ 8.47 Other: \$ 4.38</b>	<b>\$ 15.61</b>	<b>\$14.10</b>
<b>Usage</b>	<b>First 1200: \$ 0.069 After: \$ 0.0507</b>	<b>Summer: \$0.0192 Other : \$ 0.0146</b>	<b>Anytime: \$ 0.0153</b>
<b>Tariff Min</b>	<b>None</b>	<b>200 kW</b>	<b>1,000 kW</b>
<b>Ratchet</b>	<b>None</b>	<b>50% Highest Summer Demand</b>	<b>85% Highest Summer Demand</b>

# Business Size Example

Demand: 299 kW; Usage 33,000 kWh; February

	SMALL	MEDIUM
<b>Service Fee</b>	\$ 22.50	\$ 100.00
<b>Demand</b>	Oct – May: \$ 4.38 = \$4.38 X 299 kW = \$1,309.62	\$ 15.61 = \$15.61 X 299 kW = \$4,667.39
<b>Usage</b>	1200 kWh * \$0.06969 31,800 kWh * \$0.0507 = \$2,448.54	33,000 kWh * \$ 0.0146 = \$481.80
<b>Total</b>	\$3,780.66	\$5,249.19

# Power Bill – Business Size

Rate Schedules for Kansas and Missouri.

Missouri Detailed Tariffs

Kansas Detailed Tariffs

Rate Schedule Title	Schedule No.	Rate Schedule Title	Schedule No.
<a href="#">Table of Contents</a>	TOC-1	<b>Table of Contents</b>	
<a href="#">Tax Adjustment</a>	1	<a href="#">Table of Contents</a>	TOC-1
<a href="#">Additional Equipment Rental Charge</a>	2	<b>Residential</b>	
<a href="#">Reserved for Future Use</a>	3	<a href="#">Residential Service</a>	11
<a href="#">Reserved for Future Use</a>	4	<a href="#">Residential Other Use</a>	12
<a href="#">Residential Service</a>	5	<a href="#">Residential Time of Day Service</a>	16
<a href="#">Residential Other Use</a>	6	<b>Commercial and Industrial</b>	
<a href="#">Reserved for Future Use</a>	7	<a href="#">Small General Service</a>	31
<a href="#">Residential Time of Day Service (Frozen)</a>	8	<a href="#">Small General Service - Space Heating</a>	44
<a href="#">Small General Service</a>	9	<a href="#">Medium General Service</a>	32
<a href="#">Medium General Service</a>	10	<a href="#">Medium General Service - Space Heating</a>	45
<a href="#">Large General Service</a>	11	<a href="#">Large General Service</a>	33
<a href="#">Reserved for Future Use</a>	12		

<http://www.kcpl.com/my-bill/for-business/rate-information-for-business-customers/detailed-tariffs>



EDUCATIONAL WEBINAR SERIES

## 2 . Power Factor

Is there a business size classification, how am I classified, and what is the criteria?

**Is there a penalty or adjustment for low power factor?**

How is demand calculated?

# Power Bill – Power Factor



What is power factor?

Warning...Math Ahead!!!

# Power Equation

For 3 Phase AC Motors

- $\text{Watts} = \text{Volts} \times \text{Amps} \times 1.73 \times \text{PF}$

Example:

- 480VAC
- 60 Amps
- Power Factor: 75%



# Power Equation

Watts = Volts X Amps X 1.73 X PF

Watts = 480 V X 60 Amps X 1.73 X 75%

Watts = 37.4 kW

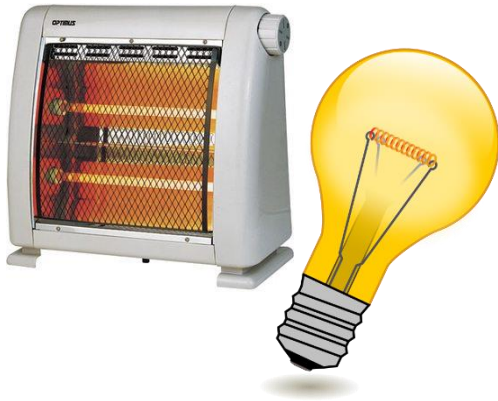




# So What is Power Factor?

## 3 Components of Electrical Loads

RESISTIVE



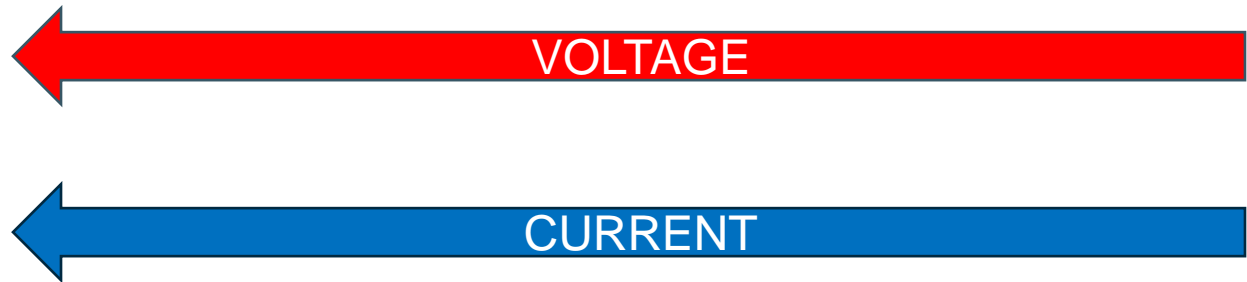
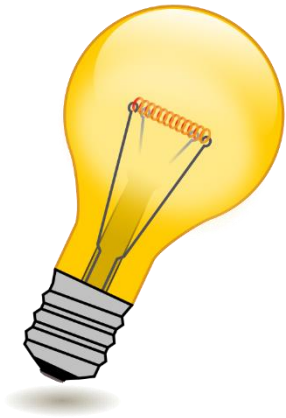
INDUCTIVE



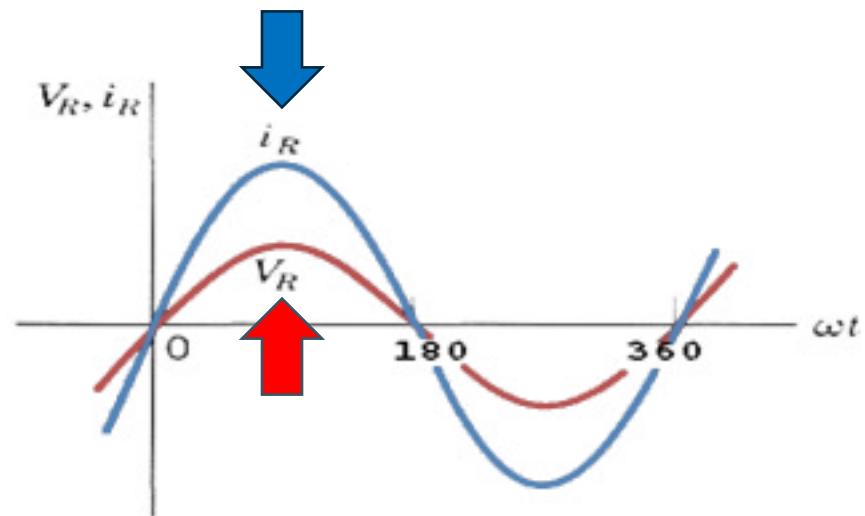
CAPACITIVE



# Purely Resistive Loads



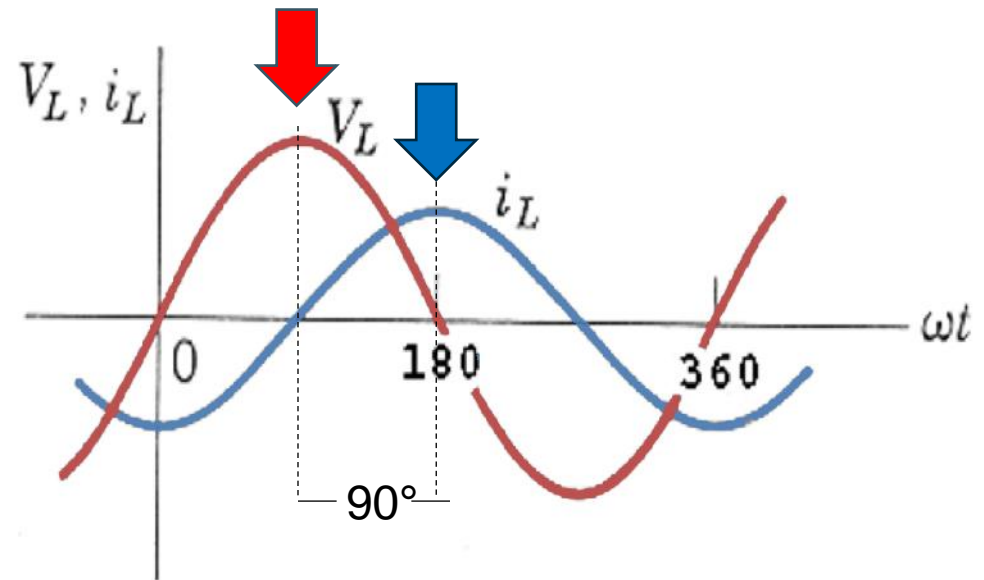
100% Power  
Factor  
“In Phase”



# Purely Inductive Loads



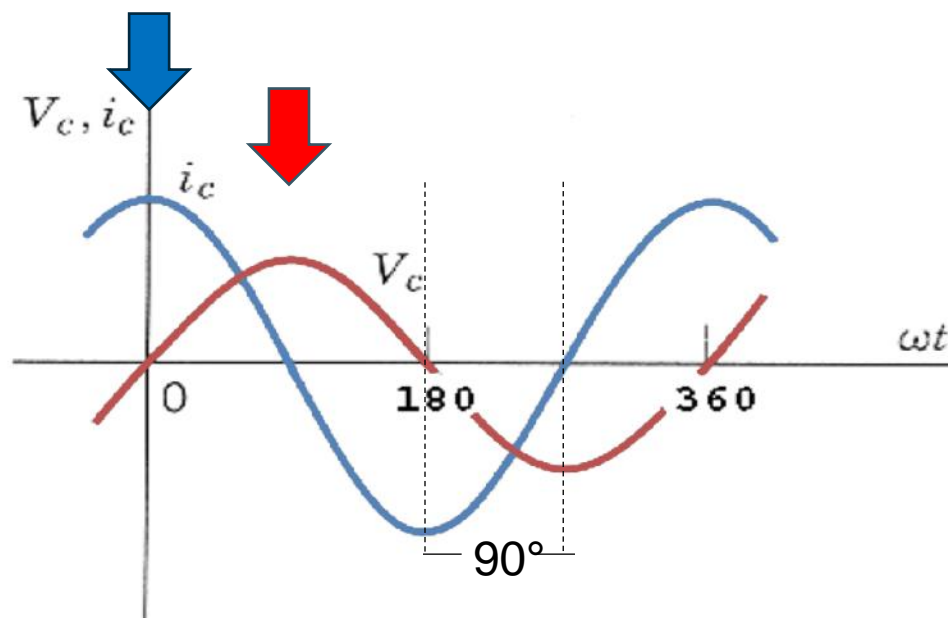
0% Power  
Factor  
LAGGING



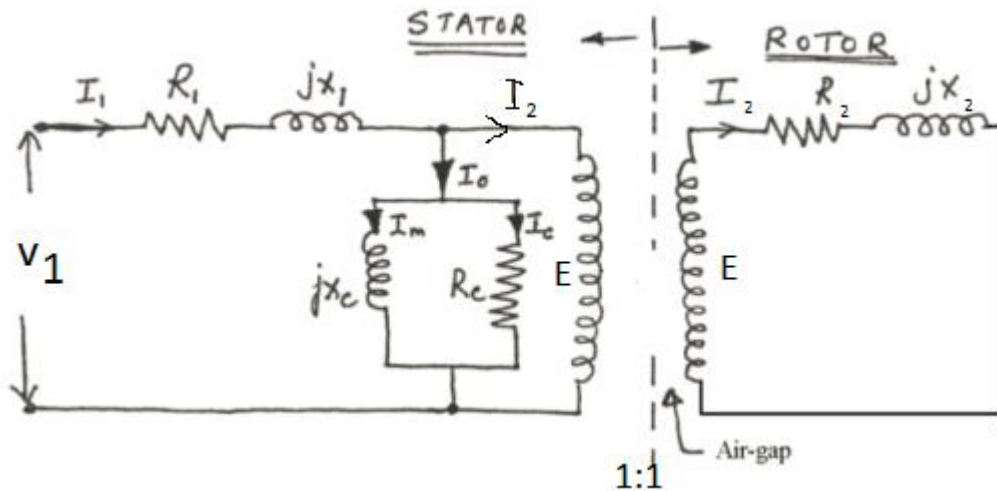
# Purely Capacitive Loads



0% Power  
Factor  
LEADING



# Motor Loads



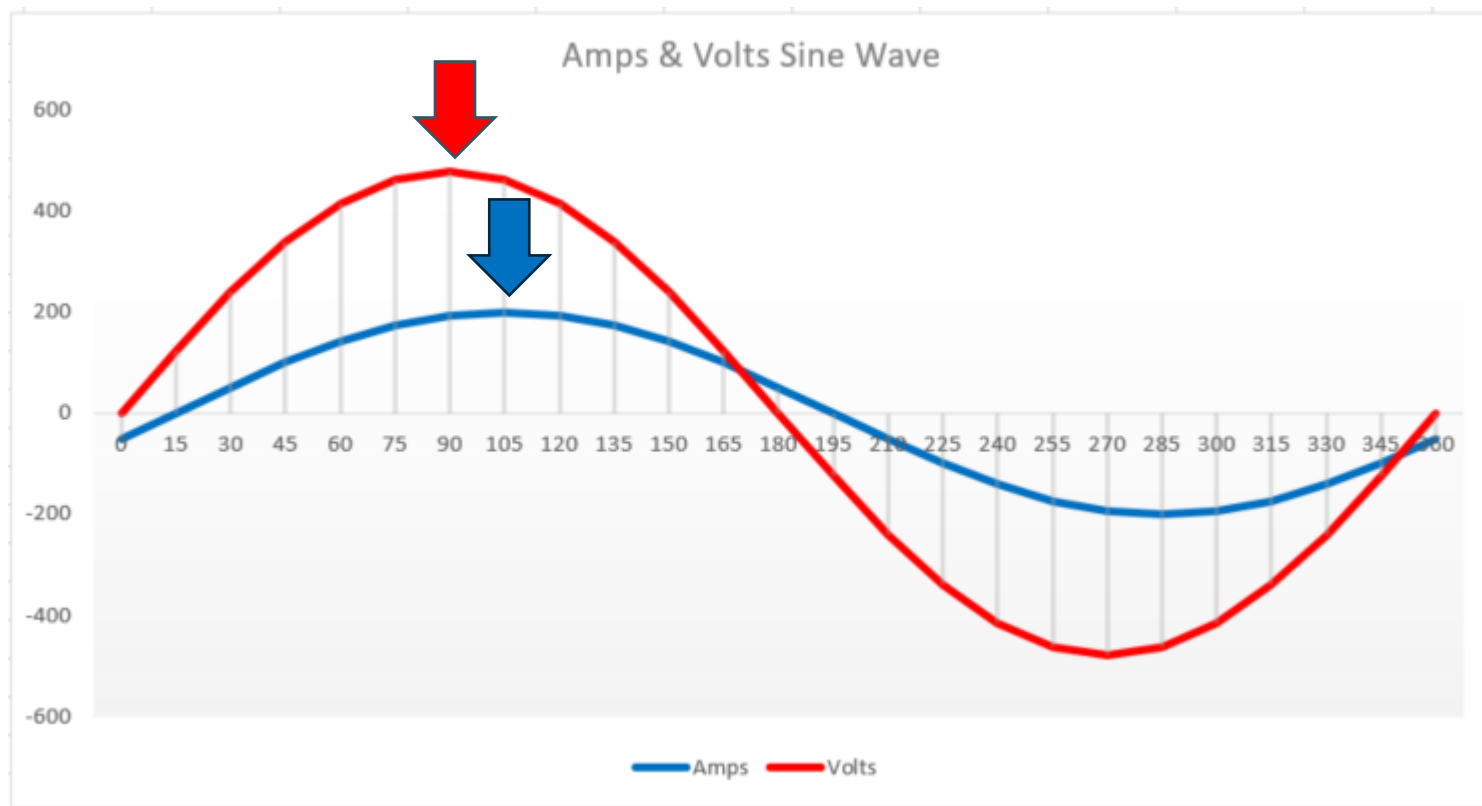
Induction motor is a combination of resistive and inductive elements.

# Power Factor Calculations

1. Cosine of the phase shift difference between the voltage and current
2. Watts / Volt-Amps  
(ratio of Real Power to Apparent Power)

# Power Factor Calculation

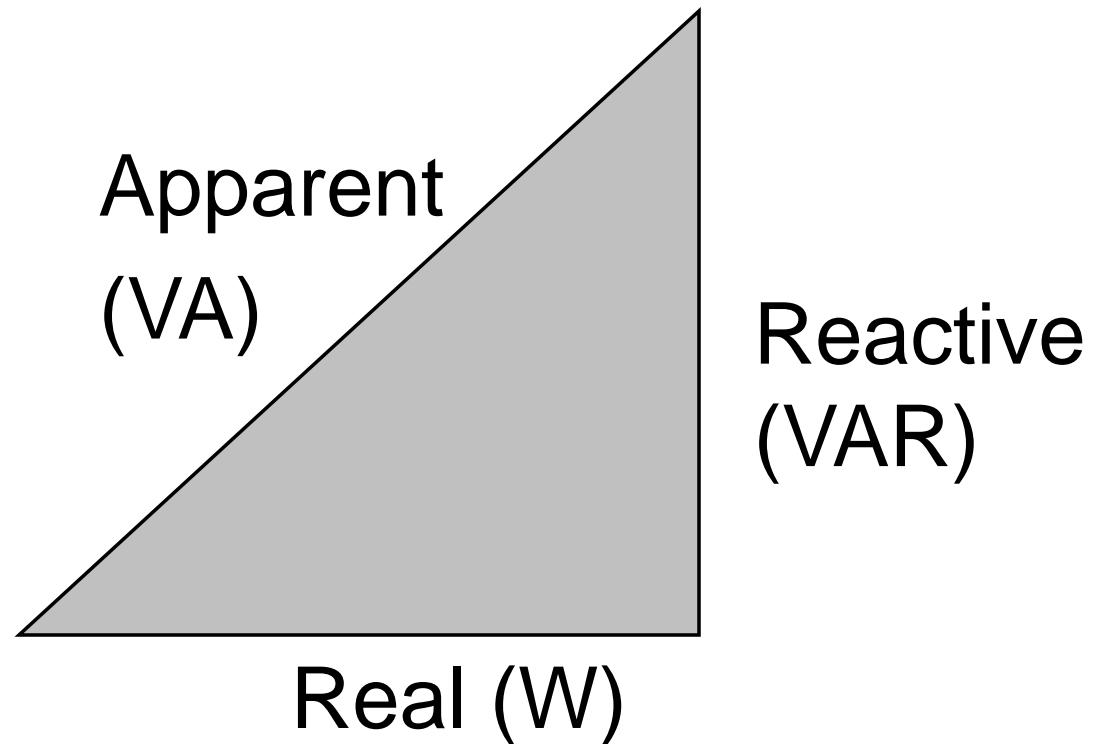
$$PF = \cos(105^\circ - 90^\circ) = \cos(15^\circ) = 96.5\%$$



# The Power Triangle

## 3 Elements

- Real Power
- Reactive Power
- Apparent Power

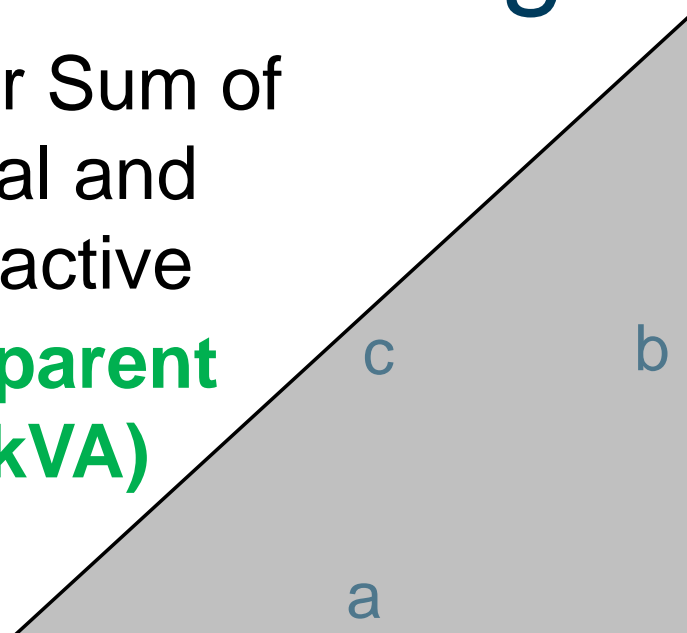




# The Power Triangle

Vector Sum of  
Real and  
Reactive

**Apparent  
(kVA)**



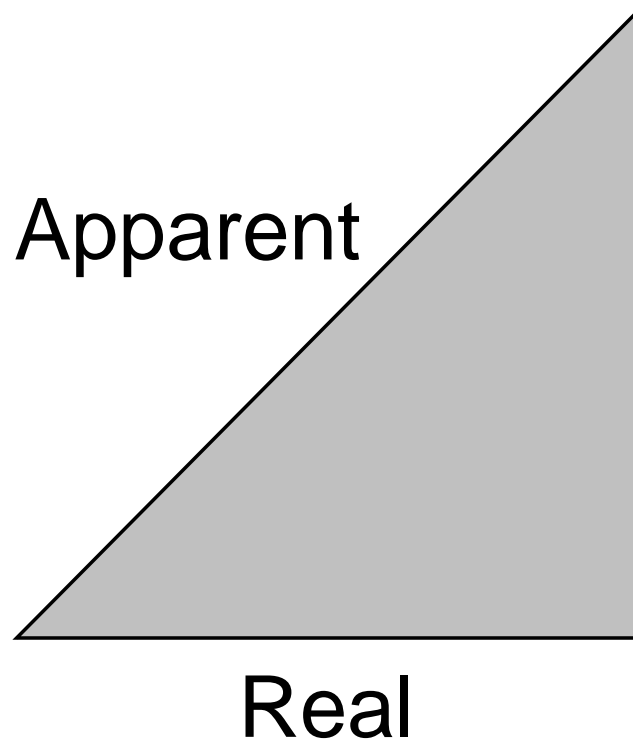
Inductive &  
Capacitive  
Elements

**Reactive  
(kVAR)**

Resistive Element  
**Real (kW)**

$$a^2 + b^2 = c^2$$

# The Power Triangle

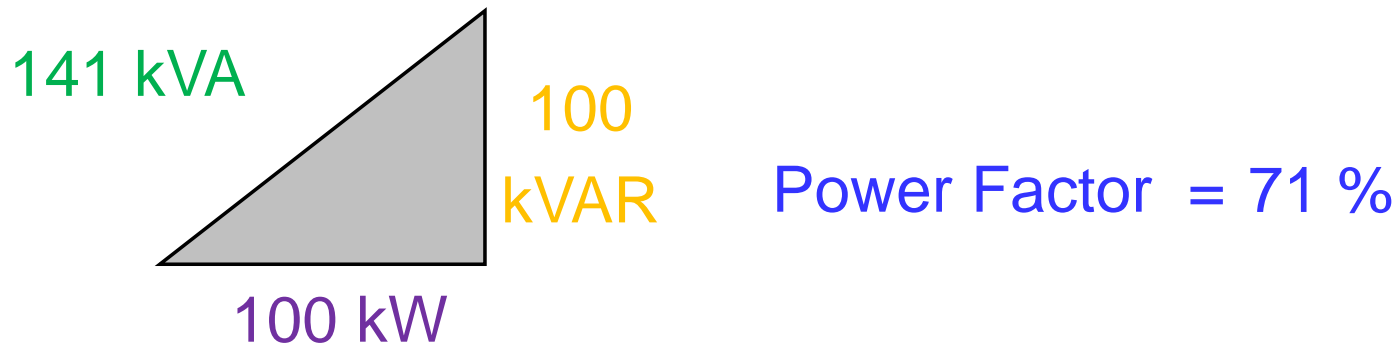


Reactive

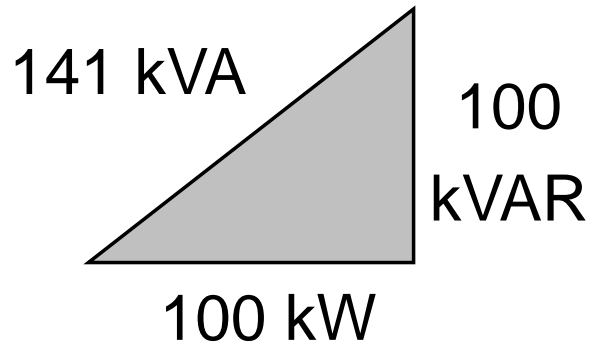
$$\text{Power Factor} = \frac{\text{Real}}{\text{Apparent}}$$

# Power Triangle Calculations

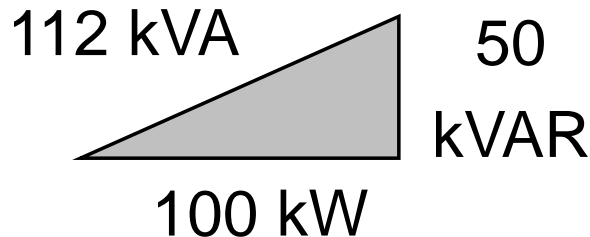
- Power = Volts X Amps X  $\sqrt{3}$  X PF
- Power = 480 X 170 X  $\sqrt{3}$  X 71%
- Power = 100 kW



# The Power Triangle Example



$$\text{Power Factor} = \frac{100 \text{ kW}}{141 \text{ kVA}} = 71 \%$$



$$\text{Power Factor} = \frac{100 \text{ kW}}{112 \text{ kVA}} = 89 \%$$

# Analogy



# Why is this Important?

## High Power Factor Saves You Money

- Avoid penalty / adjustments on bill
- Utility provider doesn't have to upgrade infrastructure



# Power Bill – Power Factor

## Utility Companies Usually Have a Target Threshold

- May be a direct penalty if PF is below threshold
- Demand charge may be recalculated

Example:

- Target PF is 90%, Demand = 521, PF=85%
- Demand  $\times$  90% / PF
- 521 kW  $\times$  90% / 85%
- 521 kW  $\times$  1.06 = 552 kW
- Additional Cost = (552 kW  $\times$  \$16) – (521 kW  $\times$  \$16)
- Additional Cost = \$8,832 - \$8,336 = \$496
- = \$6,000 / yr

# Power Factor Correction

Real World Example:

Improve Average Power Factor from 80% to 90%

Average Monthly Demand is 1,822 kW

PF Penalty: \$4,058/month

Cost: \$85,000 to install

Auto-Capacitor Bank

ROI Payback: 1.75 Years





# How Can I Improve Power Factor?

Minimize Equipment Running Idle

Idle Leg

Parameter Name	Value
Output Frequency	60.04
Commanded SpdRef	60.00
Mtr Vel Fdbk	60.00
Commanded Trq	0.00
Torque Cur Fdbk	10.31
Flux Cur Fdbk	42.10
Output Current	43.22
Output Voltage	451.83
Output Power	8.24
Output Powr Fctr	0.23

Utilized Leg

Parameter Name	Value
Output Frequency	60.22
Commanded SpdRef	59.88
Mtr Vel Fdbk	59.88
Commanded Trq	0.00
Torque Cur Fdbk	70.68
Flux Cur Fdbk	59.04
Output Current	92.08
Output Voltage	458.67
Output Power	56.69
Output Powr Fctr	0.77

# Non-Utilized Equipment Cost

$$\text{Watts} = 480 \text{ V} \times 60 \text{ Amps} \times 1.73 \times 23\%$$

$$\text{Watts} = 11.5 \text{ kW}$$

$$11.5 \text{ kW} \times \$0.10 / \text{kWh}$$

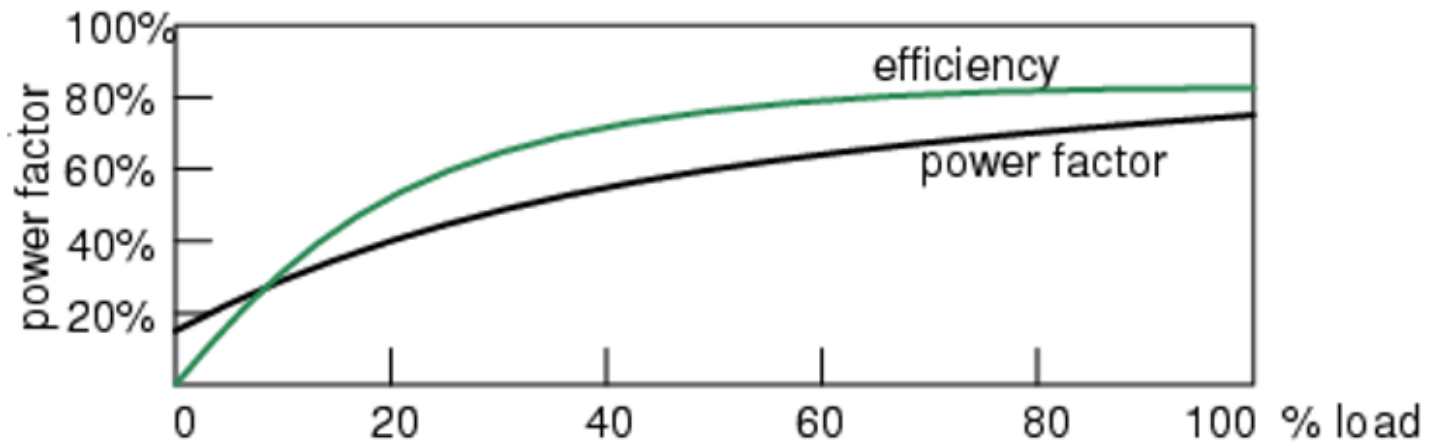
$$=\$1.15 / \text{hr}$$



# How Can I Improve Power Factor?

Be Careful about Over-Sized Motors

- Optimal Power Factor Occurs at 100% FLA

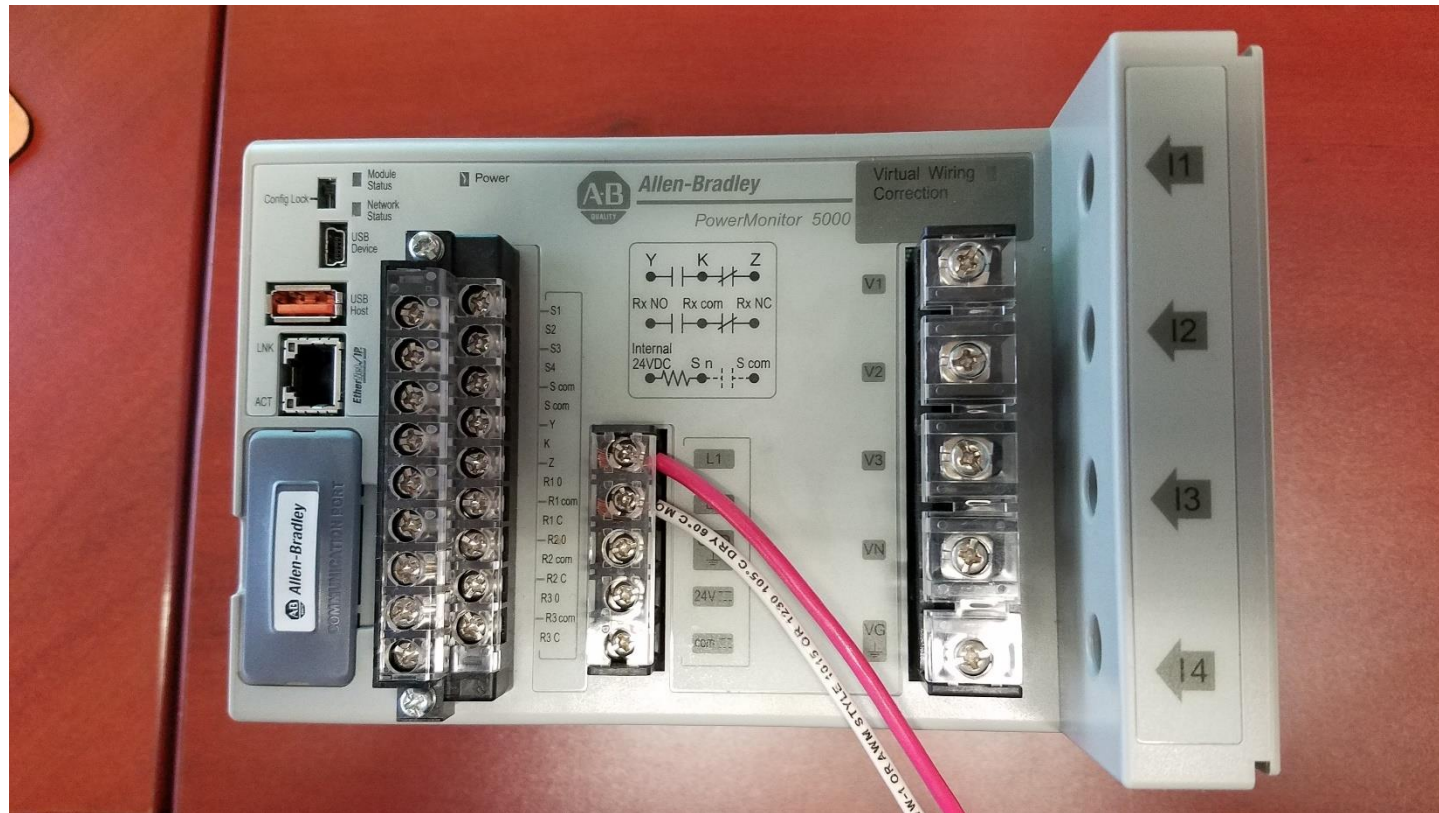


# Variable Frequency Drives

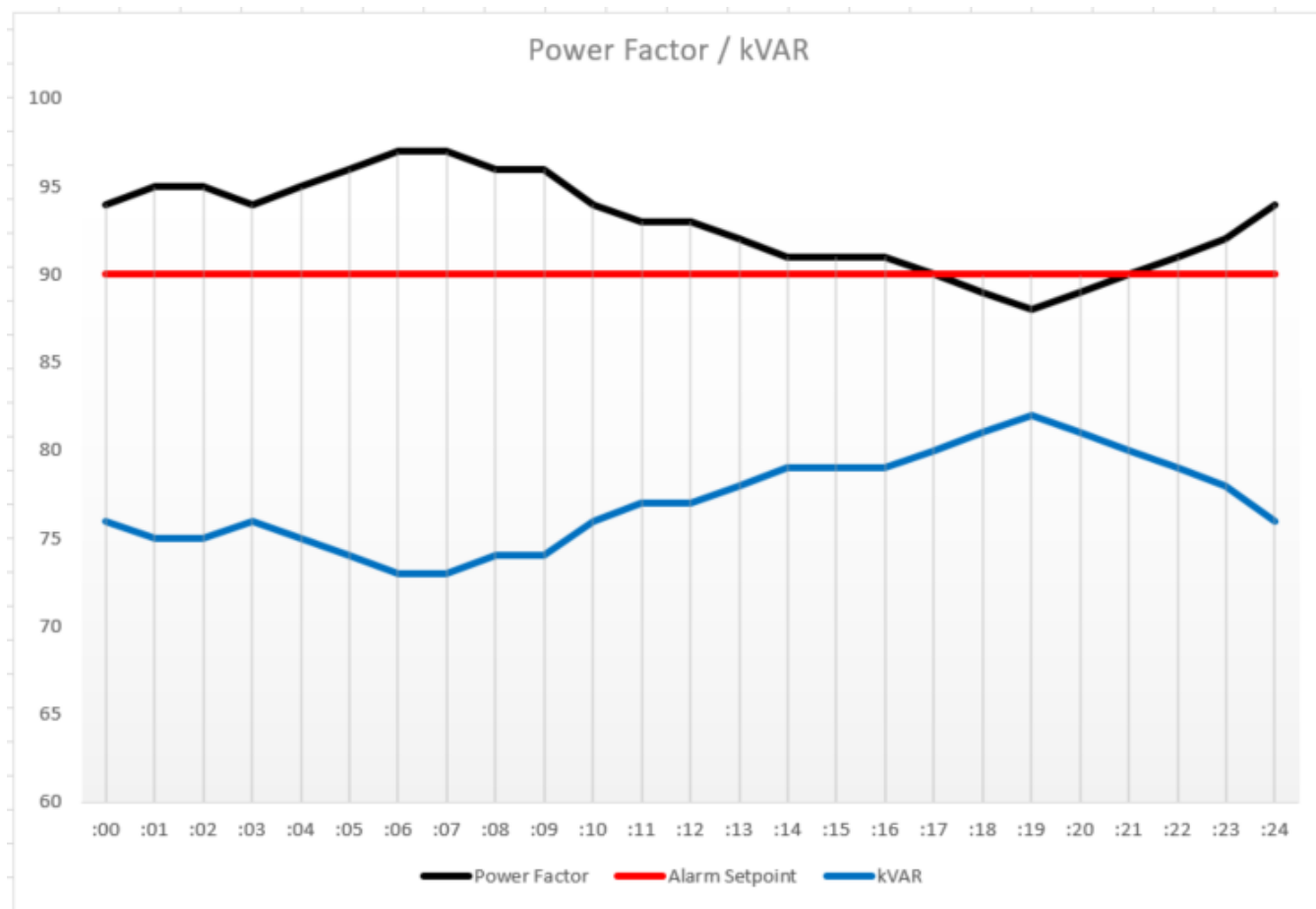


- Improve Power Factor
  - Isolates motor from utility
- Added Benefit of Less Power at Reduced Speeds
- Easier on Equipment
  - Start/Stop More Often

# Measuring Power Factor



# Software to Monitor Power Factor



# 3 . Demand

Is there a business size classification, how am I classified, and what is the criteria?

Is there a penalty or adjustment for low power factor?

**How is demand calculated?**

# Power Bill – Demand

## Demand

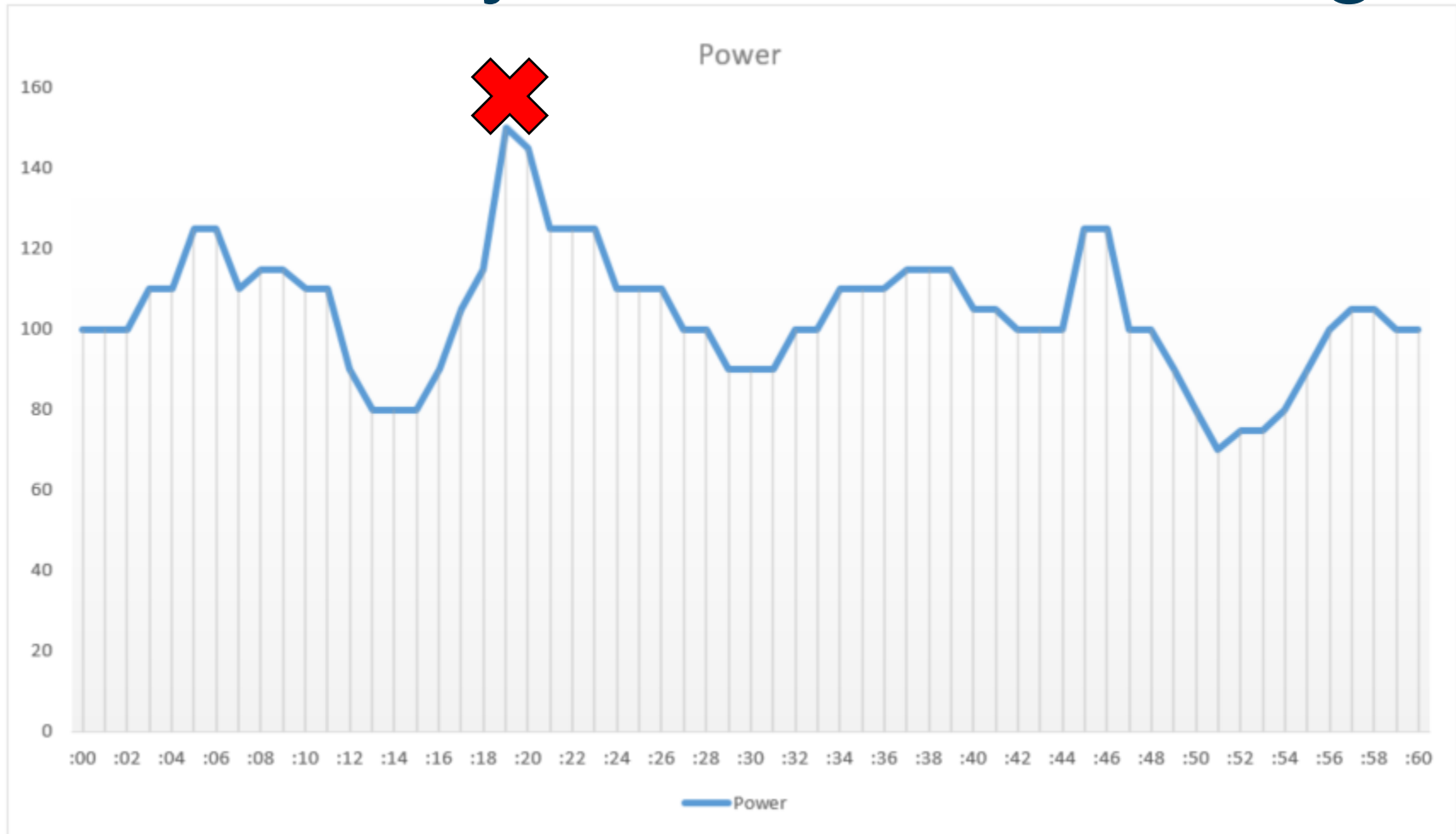
- Average rate of energy use over time
- Generally, power is sampled every 1 second and averaged over a 15-minute interval

## Myth:

- Demand is the instantaneous power peak
- Don't confuse Peak Power & Peak Demand



# This is not your Demand Charge...



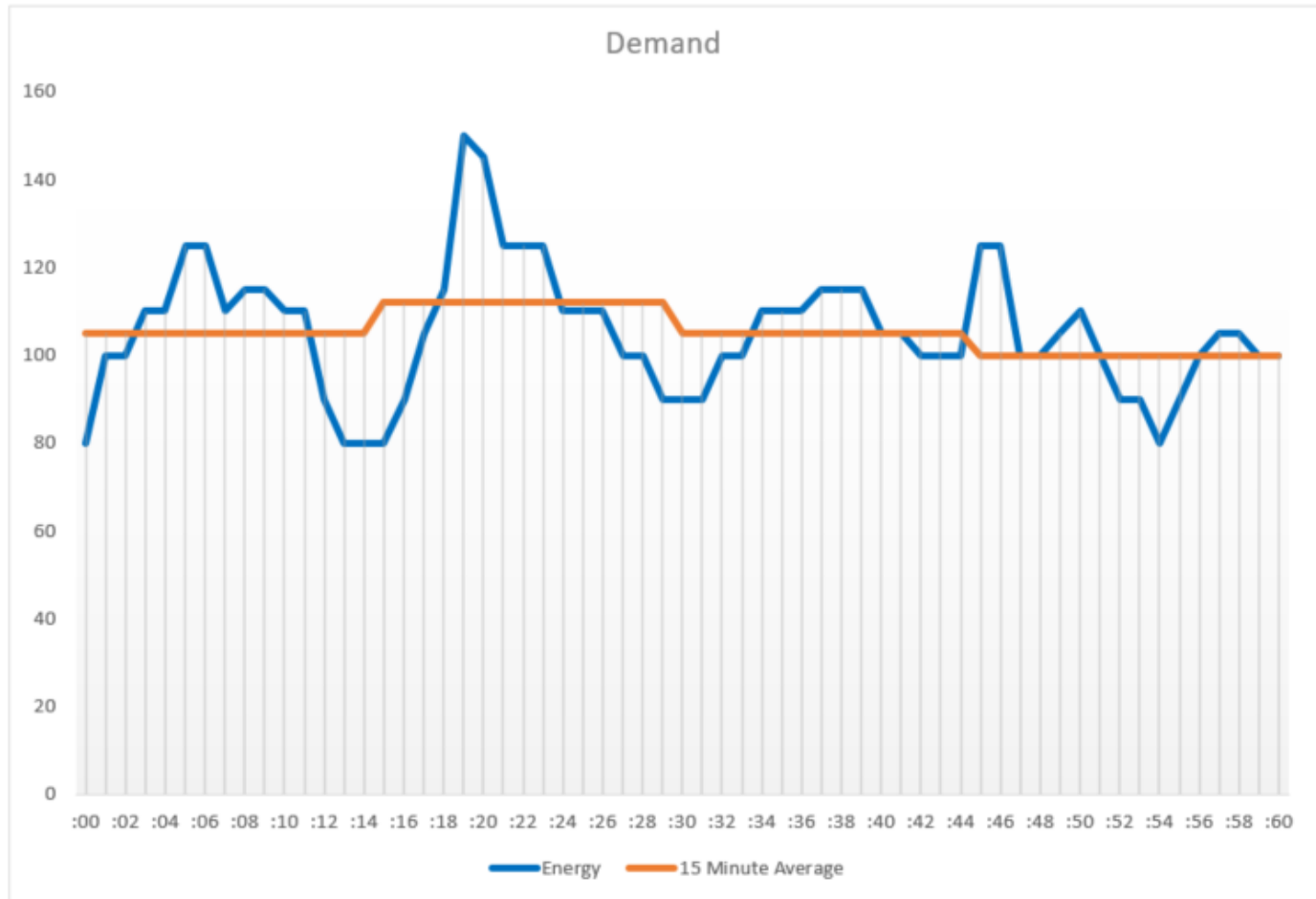
# Demand Types

## Fixed Interval

- Typically 15 minutes (30 minutes)
  - :00 - :15, :15 - :30, :30 - :45, :45 - :00
  - 2,880 intervals in 30 day month
- Demand averaged across 15-minutes
- Billed for largest 15-minute interval for month



# 15 Minute Average



# Demand Example

## Sampled every 10 seconds

- The first minute average was higher even though the peak occurred in minute two.

First Minute	:00	:10	:20	:30	:40	:50	Average
	275	285	300	290	300	275	<b>287.5</b>
Second Minute	:00	:10	:20	:30	:40	:50	Average
	200	205	<b>500</b>	<b>500</b>	0	0	234.2

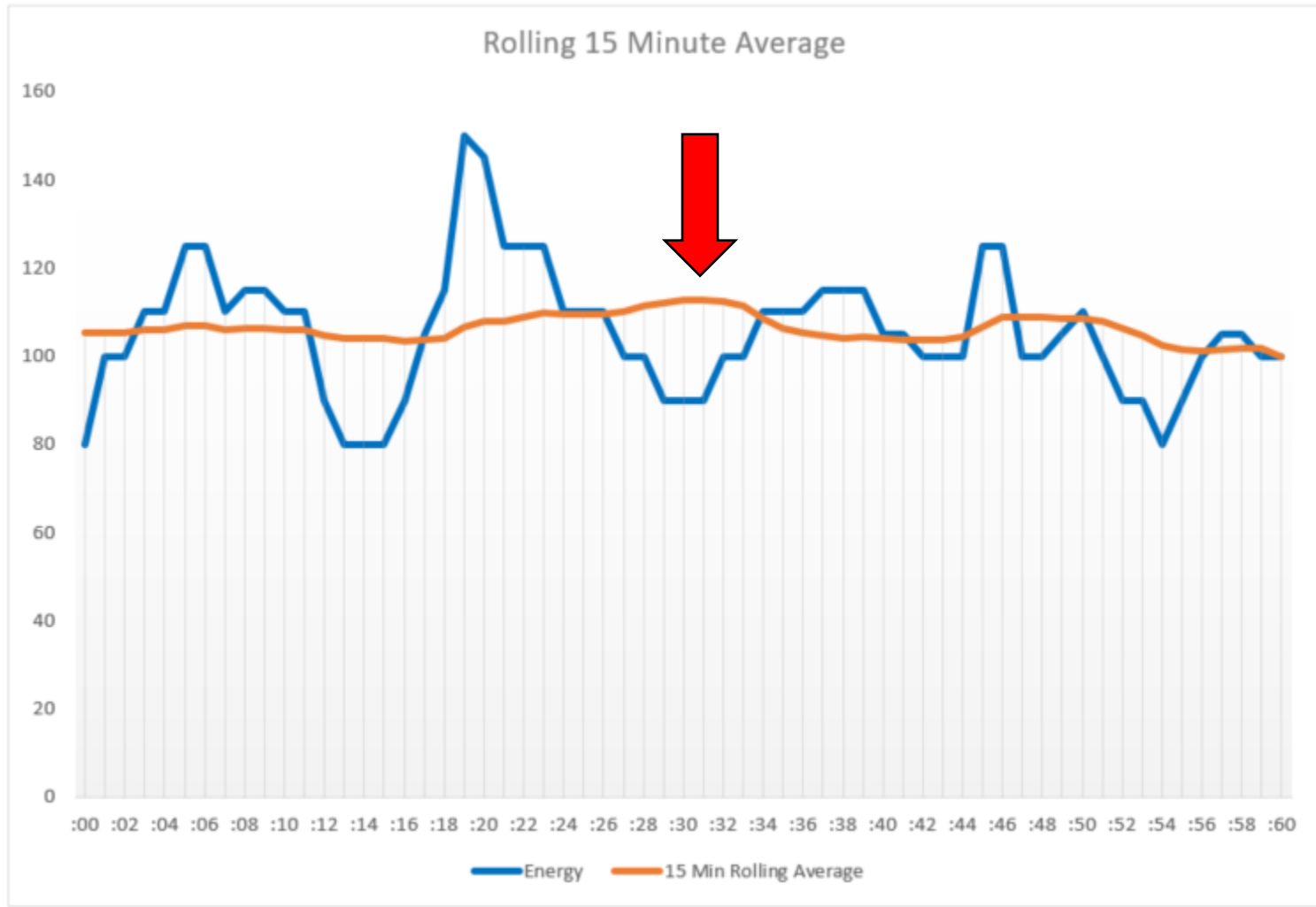
# Demand Types

## Rolling Interval

- Typically 15-minute windows
  - :00 - :15, :01 - :16, :02 - :17 ... :59 - :14
  - **43,200 intervals in 30 day month**
- Demand averaged across 15-minutes
- Billed for largest 15-minute interval in month



# Demand Graph Rolling



# It only takes one...

One 15-minute window can have a significant impact on your monthly bill



# Real World Example

## Demand Example

JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JULY
469	406	306	482	600	643.4	795	639.7	567.5	459	473.6	576	551.7

Monthly Average: 536 kW

- Cut \$6,500 by limiting demand Nov-Feb to average



# What can we do about this?

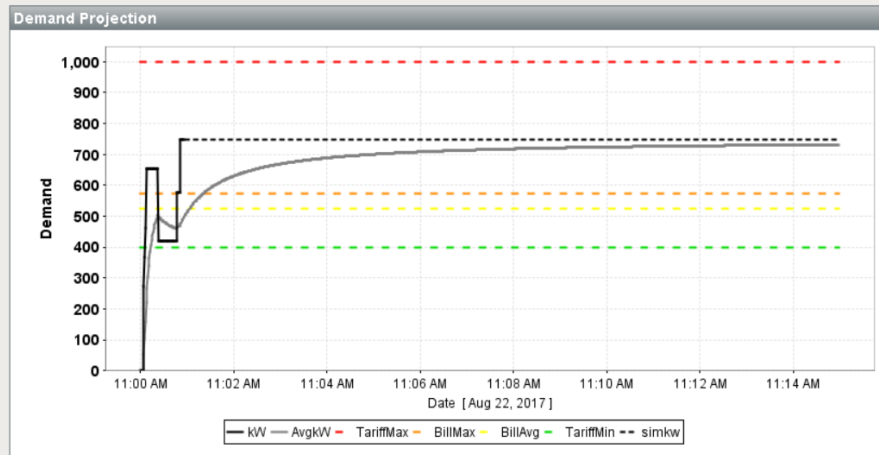
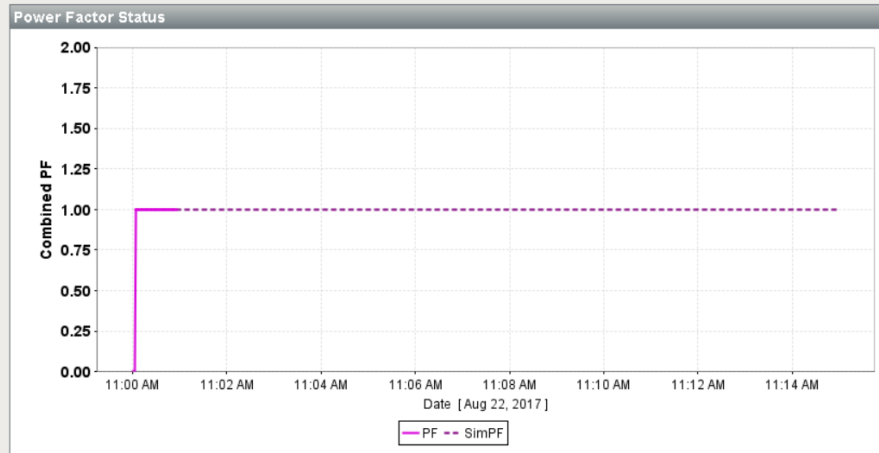
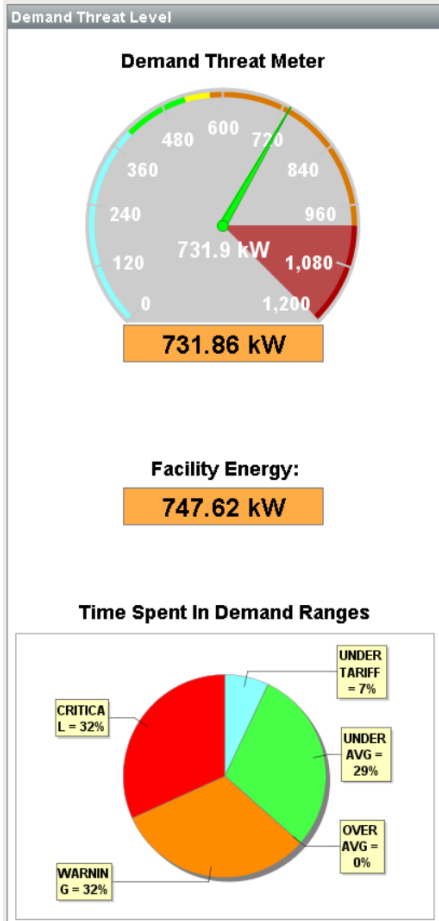
## ENERGY MANAGEMENT



# Historical Analysis



# Facility Dashboard



**Running Equipment Summary**

RAIL LEG 1	kW: 19
RAIL LEG 2	kW: 19
REC LEG 1	kW: 95
REC LEG 2	kW: 95
REC LEG 3	kW: 95
REC LEG 4	kW: 95
BIN 1 FANS (10x60HP)	kW: 327
RECLAIM BELT	kW: 0
REC DRAG 1	kW: 0
REC DRAG 2	kW: 0
REC DRAG 3	kW: 0
REC DRAG 4	kW: 0
TOP DRAG 1	kW: 0
TOP DRAG 2	kW: 0
TOP DRAG 3	kW: 0
TOP DRAG 4	kW: 0
BIN 1 AUGER	kW: 0
HYD PUMP	kW: 0

■ Equipment Runni...

# Real Time Estimation

**Energy Usage Fee Settings (Total KWH Charge)**

Current Period Usage: **117,360 KWH** X

Use Different Charge For First KWH Block

First KWH Block Size:  X

Summer Months: Start:  End:

Enter usage cost per KWH (After first 1200 KWH)

Non-Summer:  Summer:  .....

Enter usage cost per KWH applied to first 1200 KWH

Non-Summer:  Summer:  .....

**\$5,975.62**

**Energy Demand Fee Settings (Max Period KW Charge)**

Current Period Demand: **460 KW** - Free KWs:  X

Adjust For Power Factor (PFD)

Current PF:  Target PF:

Summer Months: Start:  End:

Enter Demand Cost Per KW

Non-Summer:  Summer:  ..... **\$1,992.90**

**Additional Fees Setup**

	Name	Amount	Multiply By	Last Edit	Fee Total
<input checked="" type="checkbox"/>	Fuel Charge	\$0.017161	Period Usage	May 3, 2016 10:13 AM	\$2,014.01
<input type="checkbox"/>	Transmission	\$0.014982	Period Usage	Apr 27, 2016 3:06 PM	\$1,758.29
<input type="checkbox"/>	Property Tax	\$0.002233	Period Usage	Apr 27, 2016 3:11 PM	\$262.06
<input type="checkbox"/>	EE	\$0.000235	Period Usage	Apr 27, 2016 3:06 PM	\$27.58
<input type="checkbox"/>	Basic Service Fee	\$22.50	Fixed (x1)	May 4, 2016 10:05 AM	\$22.50
					<b>\$4,084.45</b>

**SUBTOTAL:** **\$12,052.97**

Include Franchise Fee

\$12052.97 x

Include Sales Tax

\$12655.62 x

**TOTAL ESTIMATED BILL:** **\$13,559.59**

# Energy Management Expense

- Single Power Monitor Hardware & CTs
- Electrical Installation
- Software
- \$16,000 - \$40,000

# Incentives

[http://literature.rockwellautomation.com/idc/groups/multi\\_media/documents/multimedia/files/virtualbrochure/pems/index.html](http://literature.rockwellautomation.com/idc/groups/multi_media/documents/multimedia/files/virtualbrochure/pems/index.html)

Kansas Energy Office  
Kansas Corporation Commission  
1500 SW Arrowhead Road  
Topeka, KS 66604  
785.271.3170 fax: 785.271.3268  
[www.kcc.ks.gov/energy/](http://www.kcc.ks.gov/energy/)

Links:

[Kansas Corporation Commission - Energy Division](#)

[Federal Energy Management Program](#)

[Database of State Incentives/Policies for Renewables & Efficiency](#)

# Conclusion

Understand your energy bill structure

Do an audit of your energy bills

- Look for low power factor
- Look for high demand months
- Look at your Business size classification

Actively monitor your power with power monitors and software

# Thank You

## Kasa Controls & Automation



EDUCATIONAL WEBINAR SERIES



# Questions



# References

- [http://www04.abb.com/GLOBAL/seitp/seitp202.nsf/viewunid/57D1C4FC9FB087F885256D420065AF11/\\$file/Power+Factor+Improved+Via+AC+Drives+--+Release.pdf](http://www04.abb.com/GLOBAL/seitp/seitp202.nsf/viewunid/57D1C4FC9FB087F885256D420065AF11/$file/Power+Factor+Improved+Via+AC+Drives+--+Release.pdf)
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- [https://en.wikipedia.org/wiki/Volt-ampere\\_reactive](https://en.wikipedia.org/wiki/Volt-ampere_reactive)
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