

PSE Power System Engineering, Inc.

Midwest Rural Energy Council

Rate Design

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Power System Engineering, Inc.
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FULL-SERVICE CONSULTANTS
www.powersystem.org

About PSE

- Power System Engineering, Inc. (PSE) is a **full-service consulting firm** for electric utilities.
- Our team has extensive experience in all facets of the utility industry, including communications, IT, and smart grid automation; economics, rates, and business planning; electrical engineering; planning and design; and procurement, contracts, and deployment.
- Established in 1974 to serve the engineering and technology needs of electric utilities.
- Have served more than 250 clients including distribution cooperatives, G&Ts, municipal utilities, and IOUs.
- 100 % employee owned and managed.
- About 84 employees with offices in Wisconsin, Ohio, Minnesota, South Dakota, Indiana, and Kansas.
- PSE is independent:
  - PSE is a 100 % independent consulting firm with no sales ties or marketing affiliations with any vendors.
  - PSE is NOT a value-added reseller (VAR) of any software, hardware or services from any supplier.
  - Our entire business model is based on being an agent, advocate, resource, and technical advisor to our clients.

PSE Services

Utility Automation

- Technology Work Plans
- Integration, Testing, Training and Support
- Cyber Security & IT Assessments
- Substation and Distribution Automation
- Strategic Planning
- Consulting and Procurement services on SCADA, AMI/AMR, OMS, GIS, CIS, and others

Economics & Research

- Load Forecasting
- Statistical Performance Measurement (Benchmarking)
- Market & Load Research
- Energy Efficiency
- Demand Side Management (DSM)
- Value of Service
- Other Economic Studies

Rates & Financial Planning

- Revenue Requirement Studies
- Class Cost of Service Studies
- Rate Design
- Key Account Services
- Rate Comparisons & Competitive Assess.
- Strategic & Financial Planning

Communications

- Strategic Comm. Planning
- Technology Assessments: Private vs. Commercial
- Land Mobile Radio Design
- Radio Path & Propagation Studies
- Fiber WAN Design & Procurement
- GIS Mapping & Integration of Communication Assets
- Microwave & Fixed Data Design & Procurement

Engineering & Design

- System Planning Studies
- Distributed Generation Strategies
- Transmission Studies
- Power Factor Correction Studies
- System Loss Evaluation
- Substation Design
- Line Design

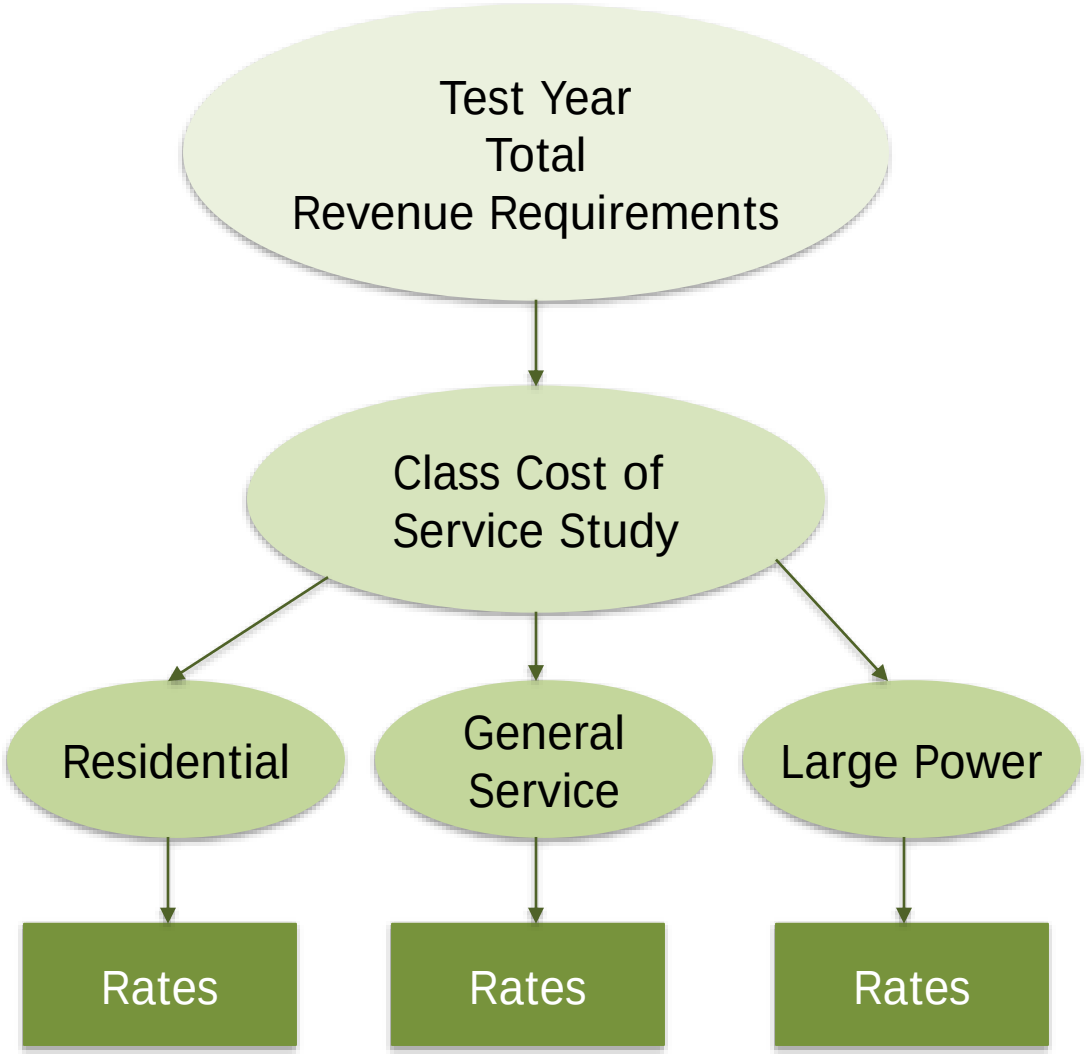
Agenda

1. Overview of Electric Rate Making
2. Rate Design
3. Understanding Your Electric Bill
4. What the Future Holds

When or Why does a utility change rates?

- A change in revenue requirements – increase or decrease in costs to provide service
- Realign revenue to balance responsibility for costs between rate classes
- Implement new rate structures – to promote fairness within a rate class
- In the end…very carefully and with the input of outside experts, internal experts and with the approval of the elected Boards or regulatory commissions

Rate Study Process



Task 1: Revenue Requirement

- Identify total cost of service for the utility.

Task 2: Cost of Service

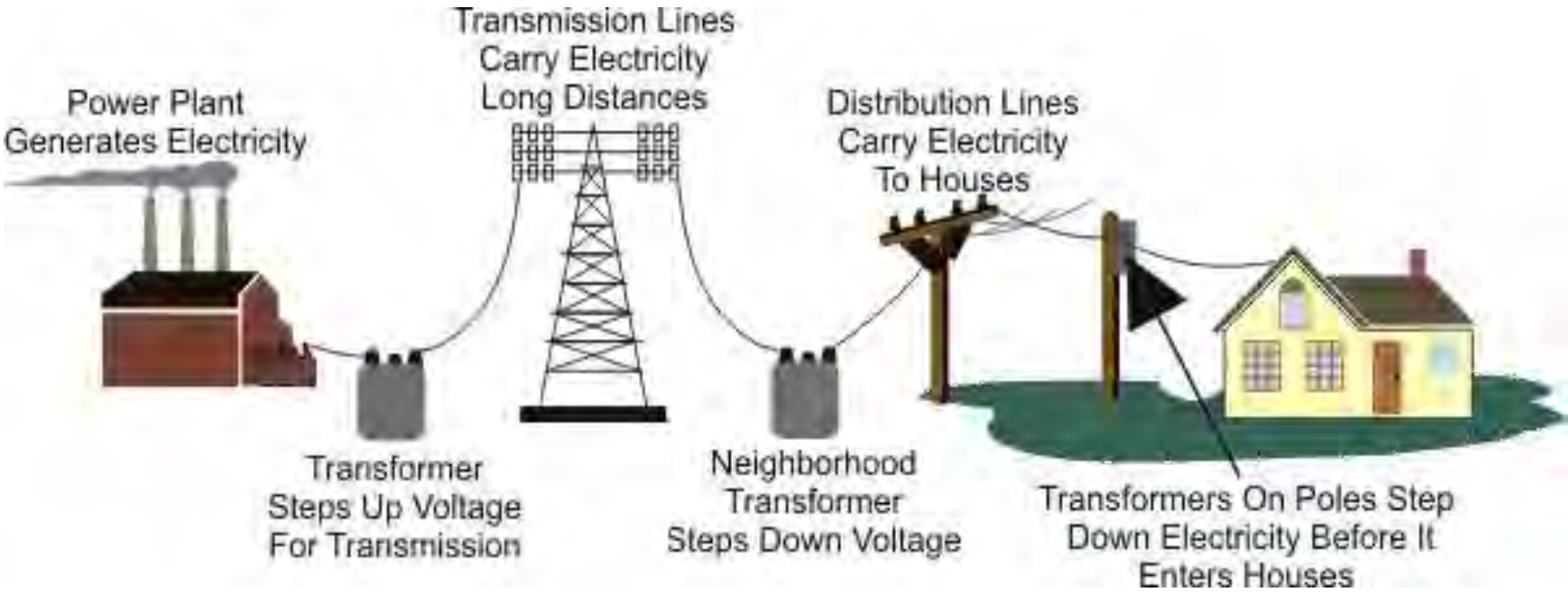
- Identify class responsibility for revenue requirement.
- Provide unit cost info for use in rate design.

Task 3: Rate Design

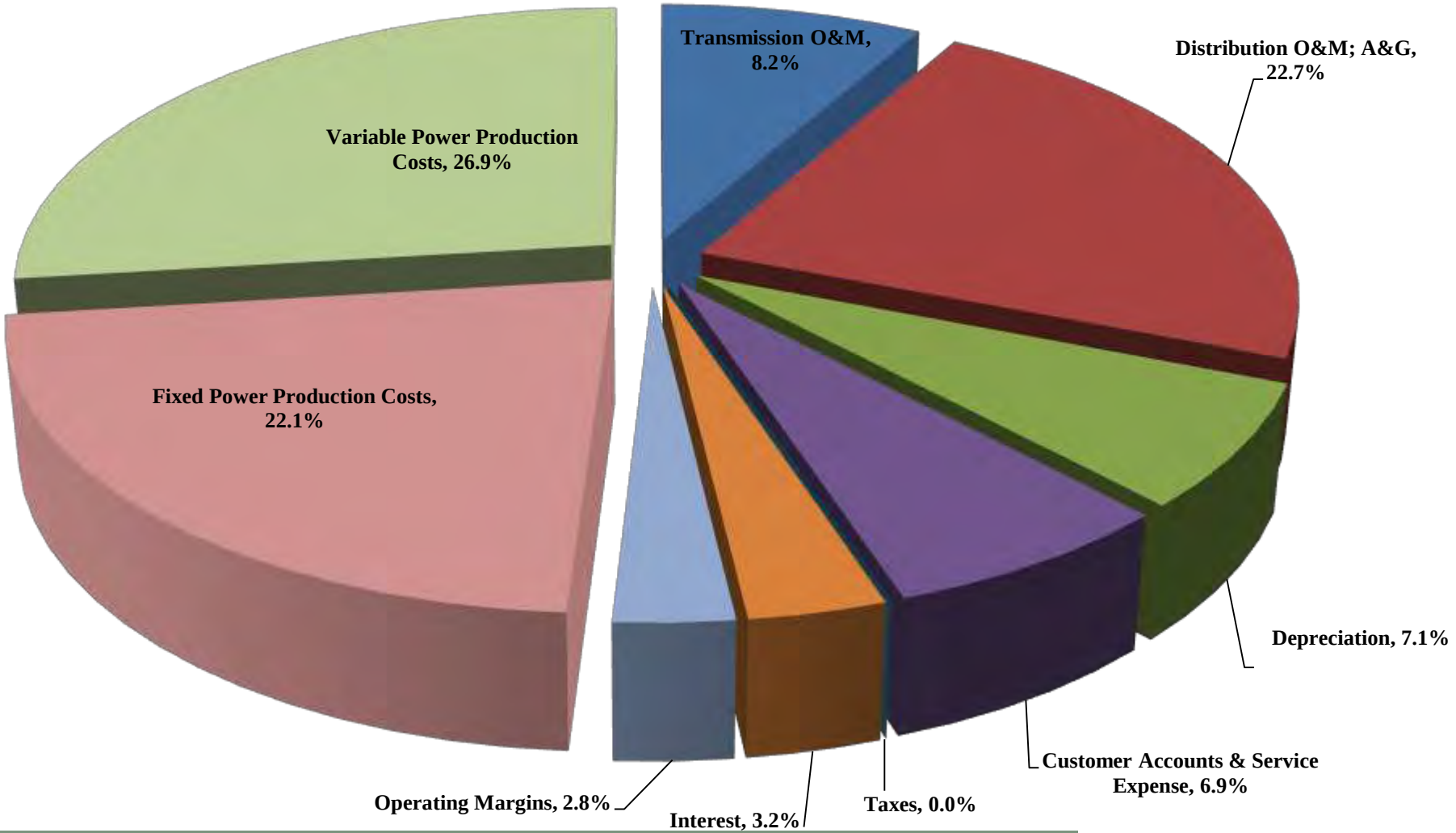
- Recover adequate revenue.
- Balance other ratemaking objectives.
- Pursue specific ratemaking objectives of the utility.

Cost of Providing Service

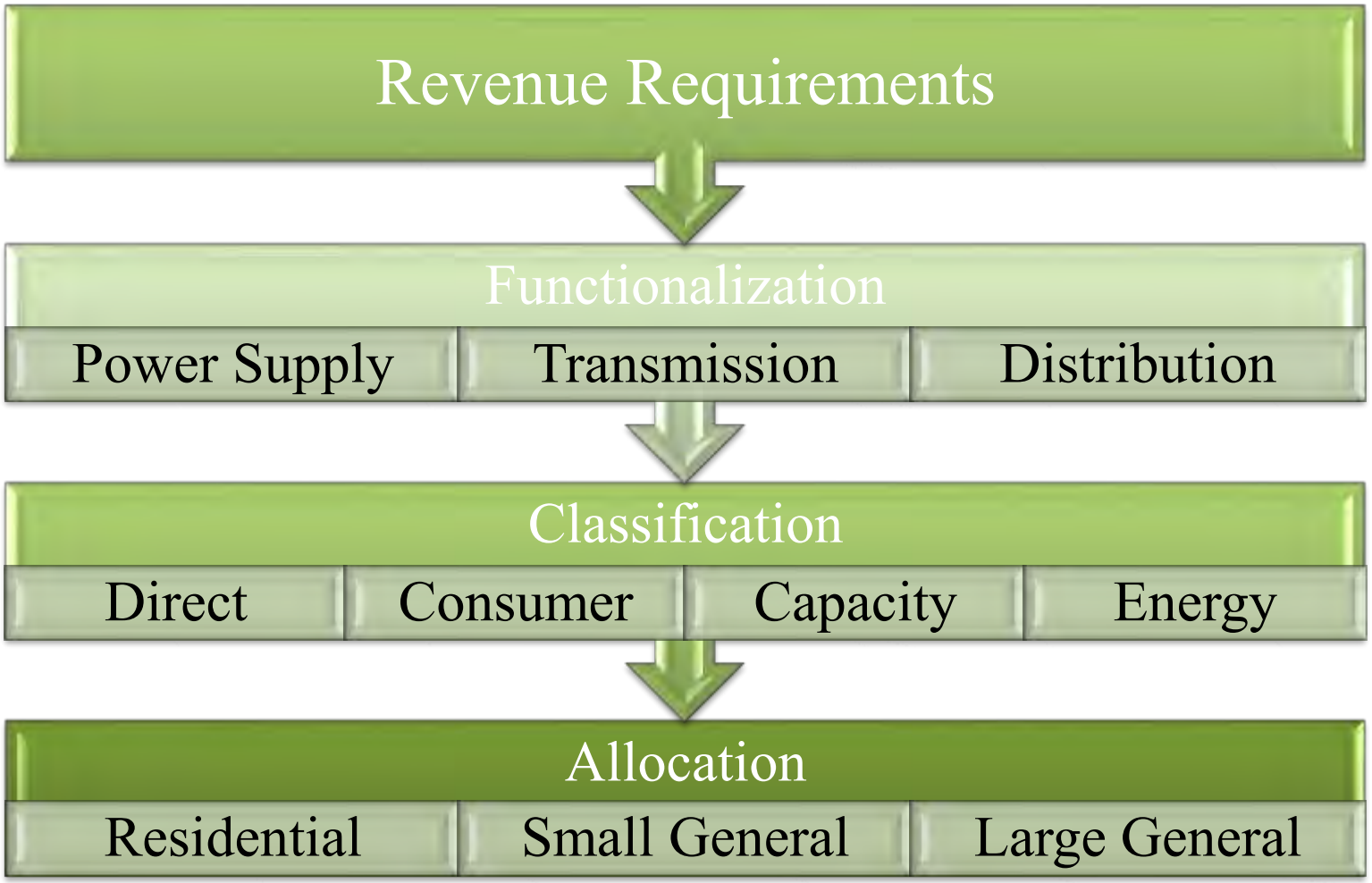
- Electric rates are designed to cover the cost of providing service for the major functions
  - Generation
  - Transmission
  - Distribution



What's in a Retail Rate?



Class Cost of Service Flow



- Cost causers should be cost payers

Typical Rate Design Objectives

Rate Design Process

Step 1: Determine rate class increases

- Allocation of increase between rate classes
- Cost of service vs. other objectives
- Narrow or eliminate cross-class subsidization
- Rate Design Objectives
  - Customer Acceptance
  - Avoid Abrupt Changes
  - Comparison with Neighbors
  - Continuity between Rates

Rate Design Process

Step 2: Design rates to collect the determined increase by class

- Focus on equity or recovery within the rate classes
- Facility Charge, Demand Charge, Energy Charges
- Rate Structure Objectives
  - Update to TOU Rates
  - Demand Charge Increases
  - Increase to Fixed Charges

Costs ➔ Rates

- Different types of costs, therefore different types of rates
  - Consumer Costs ➔ Facility Charge
    - Billing, metering, meter reading, portion of distribution system
  - Capacity Costs ➔ Demand Charge
    - Power production demand costs, transmission system costs, non-consumer portion of distribution system
  - Energy Costs ➔ Energy Charge
    - Power production energy costs

Commercial & Industrial Rates

- Types of service:
  - Firm
  - Interruptible
    - Rate
    - Peak Alert Credit
  - Standby

Rate Design Options

- Time-Of-Use Rates
- Demand Rates
- Contract Rates
  - Aid to Construction
  - Fixed Charge Rates
- Standby Rates
- Rate Riders
  - Economic Development Credits
  - High Load Factor Credits
  - Conservation Improvement Credits
  - Energy Cost Adjustments

Time-of-Use Rates

- Sends better price signals, reflects the cost of energy at the time it is being used
- Reflects wholesale power costs – distribution costs are typically not time dependent
- Seasonal – Summer, Winter, Other (Shoulder)
- Hourly – On Peak, Off Peak
- Assume an On Peak window that matches wholesale power providers
- Or, reduce the On Peak window to fewer hours more closely matching utilities typical peak times – allowing customers more flexibility to adjust their usage.

Rate Comparisons

- Commercial Customer
- Average Maximum Peak – 150 kW
  - Summer - 210 kW
  - Winter – 210 kW
  - Other – 90 kW
- On Peak kWh 30%
- Off Peak kWh 70%
- Load Factor 60% - 65,700 Ave kWh
- Coincidence Factor 80% - 120 kW average
- Results in average monthly bill of $ 6,600 or 10.05¢/kWh

Time-Of-Use Energy Rates

- Facility Charge $ 75.00 per month
- Energy Charge
  - On Peak $ 0.2000 per kWh
  - Off Peak $ 0.0560 per kWh

Time-Of-Use Energy Rates

- Facility Charge $ 75.00 per month
- Energy Charge
  - Summer
    - On Peak $ 0.2828 per kWh
    - Off Peak $ 0.0560 per kWh
  - Winter
    - On Peak $ 0.1560 per kWh
    - Off Peak $ 0.0560 per kWh

Demand Charge Rates

- Maximum kW – Non-Coincident demand
  - Harder for customer to manage
  - More closely reflects allocation of distribution capacity costs
- On Peak kW
  - Highest kW during the On Peak window each month
  - Depending on the On Peak Window may be easier to manage
  - A more narrow window is generally preferable
- Coincident kW
  - The customers kW at the time of utilities wholesale demand peak
  - Paired with notifications of likely peaks??
  - Paired with programs to control peak??

Time-Of-Use Rates

- Facility Charge $ 75.00 per month
- Demand Charge $ 4.00 per kW
- Energy Charge
  - Summer
    - On Peak $ 0.2811 per kWh
    - Off Peak $ 0.0460 per kWh
  - Winter
    - On Peak $ 0.1460 per kWh
    - Off Peak $ 0.0460 per kWh

Demand Rates

- Large Power Rate
  - Facility Charge $ 75.00 per month
  - Demand Charge $ 18.97 per NCP kW
  - Energy Charge $ 0.056 per kWh

Utilization

Driver A (10,000 miles per year)

	$2,400	Monthly Car Payment
+	$600	Insurance
+	$200	License
+	$1,000	Gasoline
=	$4,200	Annual Cost
=	**42¢ per mile**	

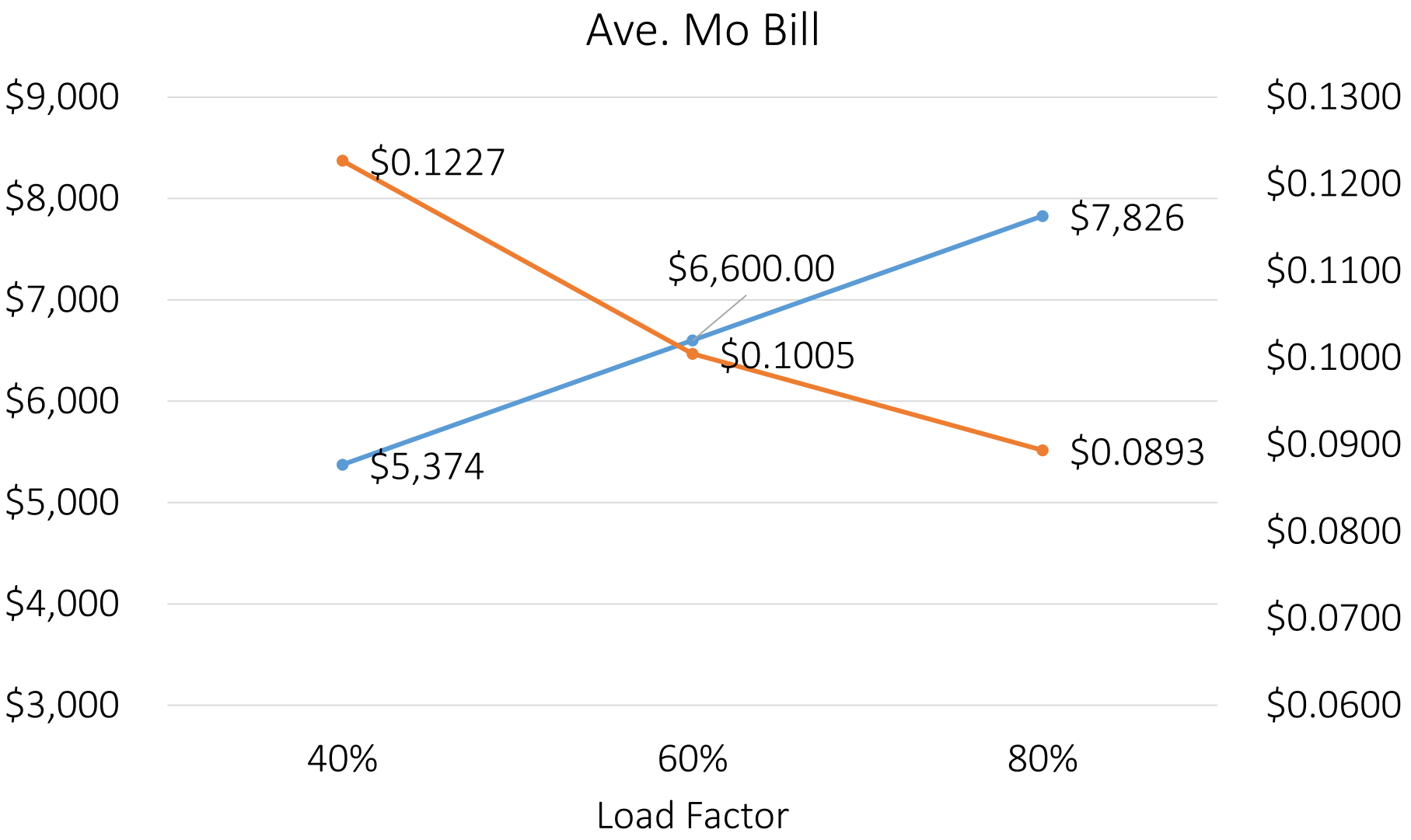
Driver B (20,000 miles per year)

	$2,400	Monthly Car Payment
+	$600	Insurance
+	$200	License
+	$2,000	Gasoline
=	$5,200	Annual Cost
=	**26¢ per mile**	

Load Factor

- Large Power Rate
  - Facility Charge $ 75.00 per month
  - Demand Charge $ 18.97 per NCP kW
  - Energy Charge $ 0.056 per kWh
- At 60% Load Factor: 150 kW and 65,700 kWh per mo
  - $6,600/month or 10.1¢/kWh
- At 40% Load Factor: 150 kW and 43,800 kWh per mo
  - $5,374/month or 12.3¢/kWh
- At 80% Load Factor: 150 kW and 87,600 kWh per mo
  - $7,826/month or 8.9¢/kWh

Load Factor



Coincidence Factor

- Maximum Peak – 150 kW Average
  - Summer/Winter – 210 kW
  - Other – 90 kW
- Coincident Peak – 80% Coincidence Factor
  - Summer/Winter – 168 CP kW
  - Other – 72 CP kW
- Coincident Peak – 60% Coincidence Factor
  - Summer Winter – 126 CP kW
  - Other – 54 CP kW

Demand Rates (Unbundled)

- Large Power Coincident Rate
  - Facility Charge $ 75.00 per month
  - Distribution Demand $ 4.00 per NCP kW
  - Purchase Power Demand
    - Summer $ 27.50 per CP kW
    - Other $ 15.00 per CP kW
    - Winter $ 21.00 per CP kW
  - Energy Charge
    - On Peak $ 0.0625 per kWh
    - Off Peak $ 0.0460 per kWh

Coincidence Factor

- Average Monthly Bill – 80% Coincident
  - $6,600 per month 10¢/kWh
- Average Monthly Bill – 60% Coincident
  - $5,900 per month 9¢/kWh
- Average Monthly Bill – 40% Coincident
  - $5,310 per month 8.8¢/kWh

Contract Rate

- Fixed Charge calculated based on specific plant investment
  - The utilities distribution costs, including capital recovery, O&M, property taxes, customer costs and overhead
  - Collected through a monthly facility charge or a combination of monthly facility charge and distribution demand
  - Evaluate potential risk of stranded assets
  - Typically require up-front contributions
- Power costs are a pass-thru rate

Standby Rates: Utility Cost Recovery

- Utility
  - Recover cost of grid dedicated in whole or in part to delivering power to Standby customers
  - Recover cost of generation reserved to serve backup
- Can be structured as separate rate or as rider to prevailing rate
- One schedule may include provisions for Supplemental, Backup, Maintenance and Economic Replacement Service or may be separated
- In our experience Standby Rates are often implemented as riders.

Standby Rider – Reservation Fee

- Reservation Fee
  - Bundled or unbundled
  - Billing Demand
  - Customer must contract for a sufficient level of Contract Standby Demand (CSD) to meet customer requirements
  - If CSD is exceeded by actual usage, then a new CSD level will be established for the next 12 months
  - Utility only required to provide capacity up to CSD

Standby Rider – Usage Fees

- Usage Fee – Firm Demand
  - If usage results in wholesale capacity charges then prevailing tariff demand rate applies – minus reservation fees paid during the same billing month
  - Usage in some months will not result in wholesale capacity charges
  - If usage exceeds CSD level, then CSD will be adjusted
- Usage Fee – Firm Energy
  - Firm Energy is billed at the same energy charge contained in the base tariff

Standby Rider – Usage Fees

- Usage Fee – Non-Firm Demand
  - Power may not be available when needed by a non-firm standby customer
  - If non-firm usage results in wholesale power capacity charges, then customer will be billed no less than:
    - Demand rate in the prevailing tariff (minus reservation fees paid during the same month), or
    - Cost of higher wholesale demand charges
  - If usage exceeds Contracted Standby Demand level, then CSD will be adjusted

Standby Rider

- Usage Fee – Non-Firm Energy
  - Energy may not be available when needed by a non-firm standby customer
  - Non-Firm Energy is billed at no less than:
    - Energy charge contained in the base tariff, or
    - Cost of higher wholesale energy charges

Rate Riders

- Economic Development Riders
- Large Load High Load Factor Credits
- Conservation Improvement Program
- Energy Cost Adjustments
- Power Factor Penalties

Large C&I Rates Pros and Cons

- Pros
  - More cost of service based rate design than energy only
  - Provides a price signal related to capacity driven costs
  - Stabilizes revenues versus volatility of energy use
- Cons
  - More complicated to understand and explain
  - Can cause more high bill questions
  - Requires demand metering

Understanding Your Electric Bill

- Facility Charge
- Energy Cost ($/kWh)
- Demand Cost ($/kW)
- Power Factor Penalty

Understanding Your Electric Bill

1. Understanding Electric Rates
   a. It important to understand what makes up your electric bill
   b. It is important to review your bill and identify all the various charges – energy, demand, power factor penalty ….

Current Charges

Electric Charges Usage Period: 12/19/11 to 01/21/12	
Power Factor 64.26%	
Actual Demand-kW	152
Adjusted Demand-kW	213
Billable Demand	95
Invoice # 407230322	
General Service 33 Days	
Basic Service Chg	$25.15
Energy Charge 10400 kWh @ $0.022950	$238.68
Demand Charge Winter 95 kW @ $7.080000	$672.60
Environmt Imprvmt Rider 10400 kWh @ $0.001693	$17.61
Environmt Imprvmt Rider 95 kW @ $0.664526	$63.13
Fuel Cost Charge 10400 kWh @ $0.029926	$311.23
Resource Adj	$75.14
Interim Rate Adj	$70.98
Subtotal	**$1,474.52**
State Tax @6.875% (93 % Exempt)	$7.09
Total Amount	**$1,481.61**

Meter Reading Information

Meter #000002811990

Reactive Energy-KVArh

Company Reading on 01/21		3123
Company Reading on 12/19		3092
Difference	**kVArh**	**31**
Multiplier		x 400
Total Usage in 33 Days	**kVArh**	**12400**

Total Energy-kWh

Company Reading on 01/21		2893
Company Reading on 12/19		2867
Difference	**kWh**	**26**
Multiplier		x 400
Total Usage in 33 Days	**kWh**	**10400**

Understanding Your Electric Bill

2. Facility Cost, Energy Cost & Demand Cost
    a. Facility charge is related to cost of utility owned equipment at your site – transformer, CT cabinet, meter, etc.
    b. Energy cost is related to the average cost of production at the generation facility such as fuel, maintenance, operational costs, etc. and is measured in $/kWh.
    c. Demand Cost is related to infrastructure cost such as transmission and distribution power lines, substations, peaking plants, etc. and is measured in $/kW or $/kVA.
        i. It is typically recorded as the average kW demand over a 15, 30 or 60 minute interval. (Typically see distribution demands set at 15 minute interval and power supply set at 30 or 60 minute interval.
        ii. Demand for the entire month is set in a single 15 minute interval.

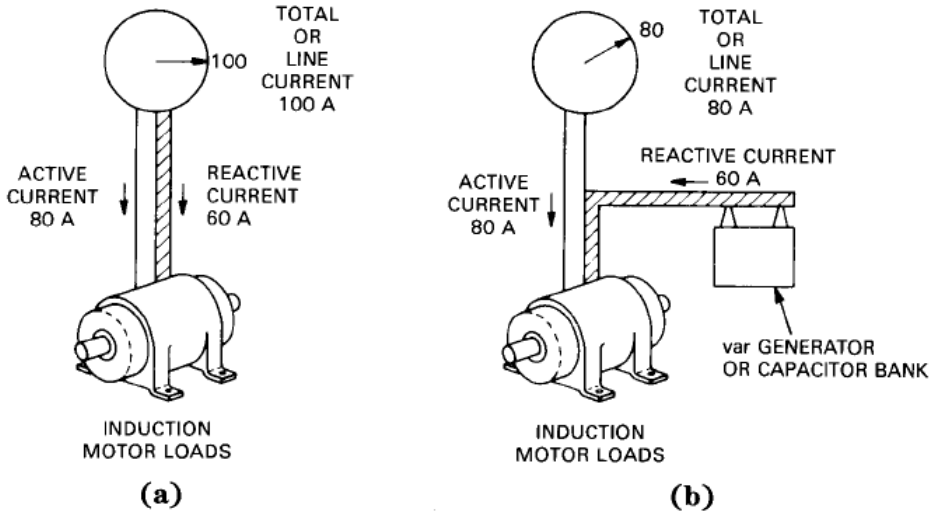
Understanding Your Electric Bill

3. Understanding Power Factor Penalty

   a. Power factor is the ratio of kW/kVA (beer/foam). The utility wants to sell beer and have the facility provide their own foam.

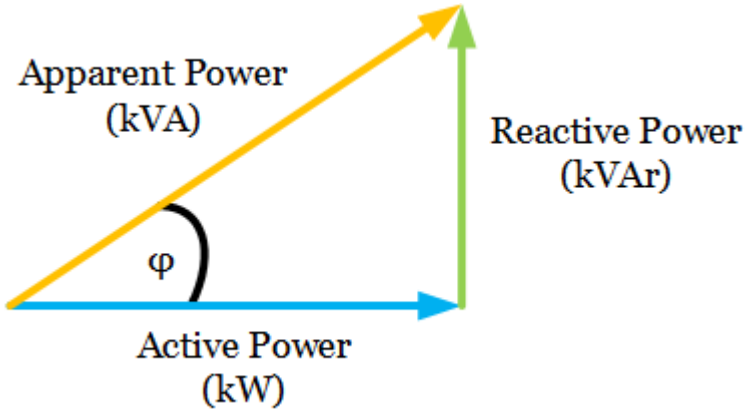
   b. Power factor penalties are imposed in different ways. The (2) most common are - adjusted kW or billed kVA

   c. Every motor on your site needs kVAR so you have the option of getting that from the utility (possible penalty) or provide it locally with capacitors.



Understanding Your Electric Bill

- Power Factor Correction
  a. What is power factor?



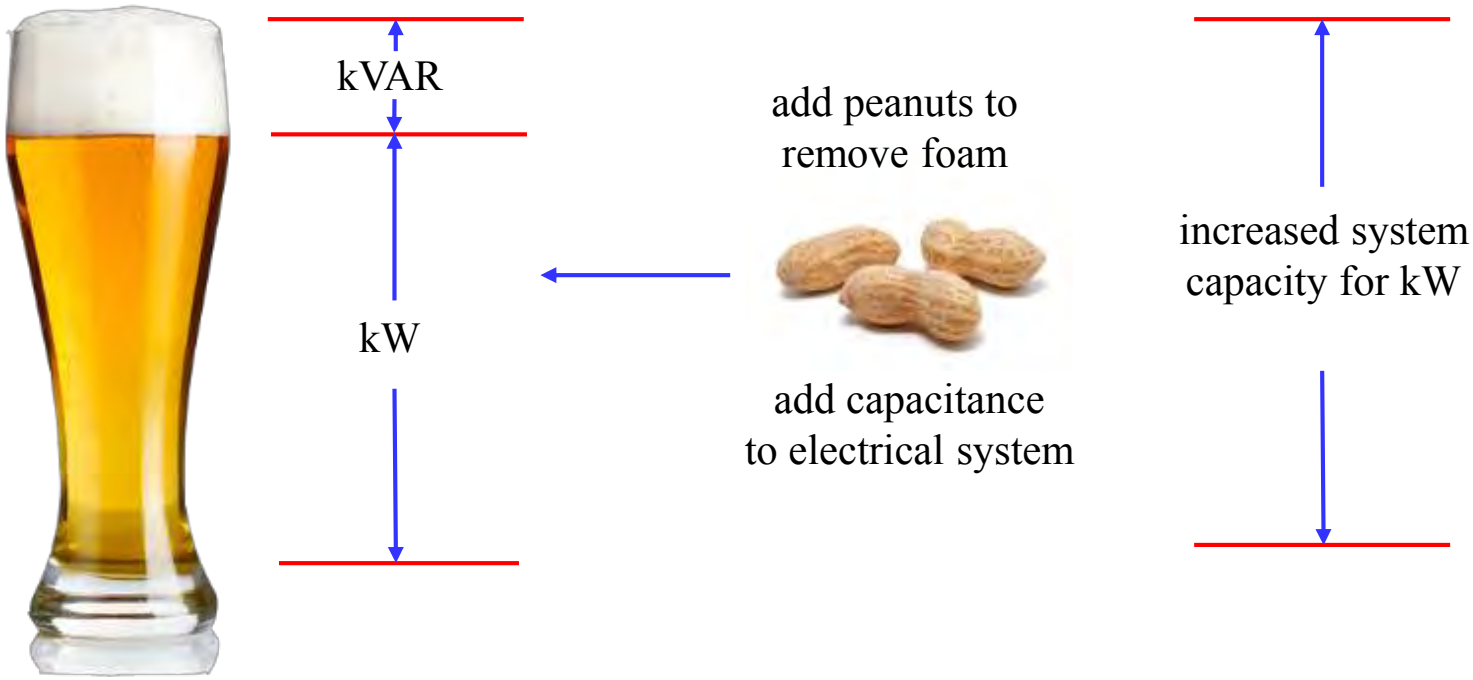
Power Factor = kW / kVAR

  b. Does my utility bill include a power factor penalty?

  c. What can be done at my site to improve power factor?

Understanding Your Electric Bill

- Improving power factor at your site



Power Factor Penalty

4. Sample Calculation with adjusted kW

recorded demand = 500 kW

utility demand charge = $12/kW

recorded power factor = 75%

utility required PF = 90%

<u>Utility Billing for Demand</u>

recorded demand is adjusted by % below required PF

90% - 75% = 15%

500 kW (1.15) = 575 kW

demand charge = 500 kW * ($12) = $6,000

adjusted demand charge = 575 kW * ($12) = $6,900

power factor penalty = $6,900 - $6,000 = $900

Power Factor Penalty

4. Sample Calculation with billed kVA

recorded demand = 500 kW
recorded power factor = 75%

utility demand charge = $12/kVA
utility required PF = None

<u>Utility Billing for Demand</u>

kVA = kW/PF kVA = 500/.75 kVA = 667

demand charge = 667 kVA * ($12) = $8,004

correcting power factor to 90% and recalculating bill

kVA = kW/PF kVA = 500/.90 kVA = 556

demand charge = 556 kVA * ($12) = $6,672

HIDDEN power factor penalty = $8,004 - $6,672 = $1,332

Understanding Your Electric Bill

5. Options to Lower Electric Bills
   a. Reduce energy usage to lower kWh – energy savings
   b. Reduce overall demand to lower kW – demand savings
   c. Work with serving utility company to verify what programs are available for savings
   d. Implement energy and demand saving devices that maximize utility savings

Understanding Your Electric Bill

Standard Efficiency vs. Premium Efficiency Example …

Detailed Cost Comparison Calculator:

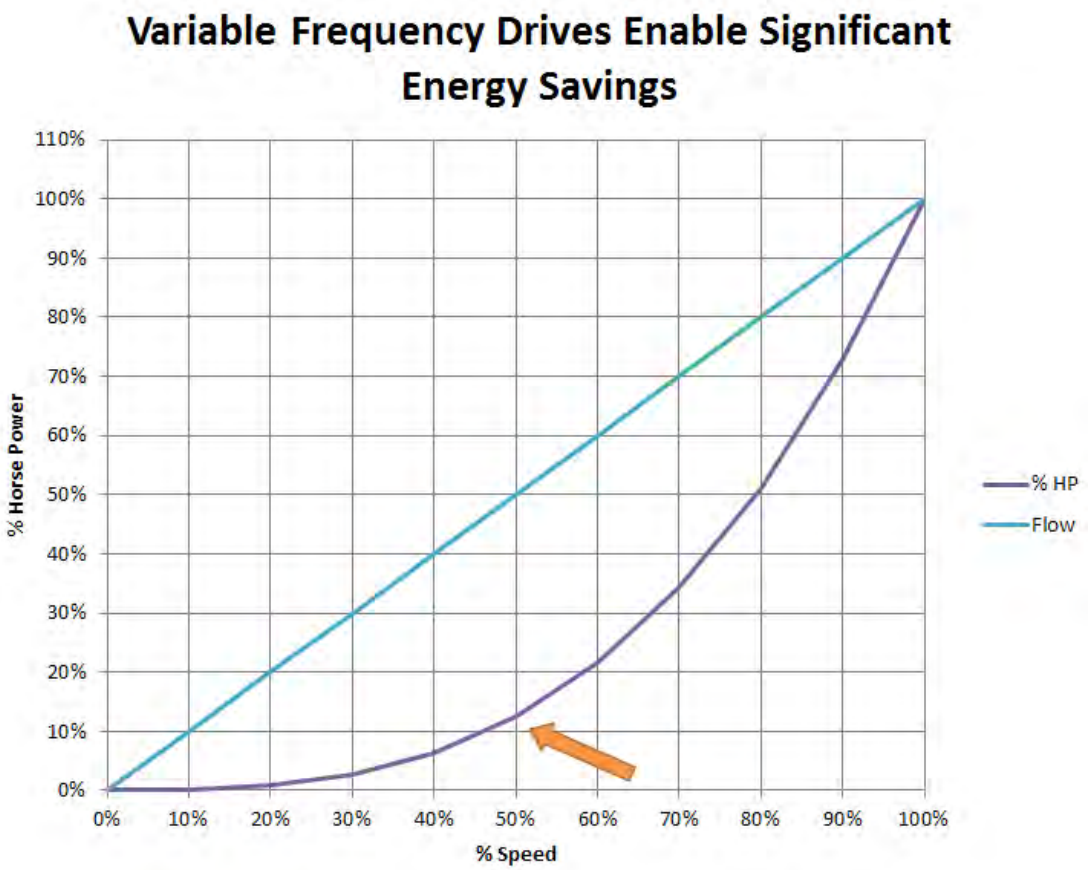
Motor 1		Motor 2 (optional)	
HP	50	HP	50
Efficiency (%)	82.5	Efficiency (%)	93.6
Operating Hours	2000	Operating Hours	2000
Elec. Cost ($/kWh)	0.10	Elec. Cost ($/kWh)	0.10
Estimated Operating Cost @ 100% Load Factor			
	$9,042 (Baseline) 90,424 kWh		$7,970 (88% of Baseline) 79,701 kWh

Calculate

Annual Cost Savings (based on daily usage)

	Motor Details	days/wk	2 hrs/day	4 hrs/day	8 hrs/day	12 hrs/day	24 hrs/day
1	50hp 82.5% eff vs 50hp 93.6% eff	5	$279	$558	$1,115	$1,673	$3,346
1	50hp 82.5% eff vs 50hp 93.6% eff	7	$391	$783	$1,566	$2,348	$4,697

Understanding Your Electric Bill



Motor Affinity Laws:

$Q_2/Q_1 = N_2/N_1$

$HP_2/HP_1 = (N_2/N_1)^3$

50% speed = 15% Energy

What the Future Holds

1. Energy and Demand Dashboard
   a. Need to have information available to your operators showing them how much money can be saved.

   b. Real-time dashboard with live summary of energy and demand cost and total electric bill.

   c. A pre-staging screen to turn motors on and off prior to actually doing it to show how it effects electric bill.

Energy and Demand Dashboard Continued

3-Phase Voltage
460VAC

ENERGY DASHBOARD

Equipment	HP	VAC	EFF	P.F.	HRS / Day	KWH / Day	ON/OFF	HP	FLA	KW	KVA	KVAR
Bin #1 Fan "A"	40	460	90%	0.89	12	397.707	ON	40	46.74	33.142	37.238	16.979
Bin #1 Fan "B"	40	460	90%	0.89	8	265.138	ON	40	46.74	33.142	37.238	16.979
Bin #2 Fan "A"	40	460	90%	0.89	12	397.707	ON	40	46.74	33.142	37.238	16.979
Bin #2 Fan "B"	40	460	90%	0.89	8	265.138	ON	40	46.74	33.142	37.238	16.979
Reclaim Conveyor #1	50	460	90%	0.89	8	331.422	ON	50	58.42	41.428	46.548	21.224
Fill Conveyor #2	50	460	90%	0.89	8	331.422	ON	50	58.42	41.428	46.548	21.224
Bucket Elevator	150	460	95%	0.91	8	941.937	ON	150	162.39	117.742	129.387	53.645
Grinder #1	200	460	95%	0.91	8	1,255.916	ON	200	216.53	156.989	172.516	71.527

KWH / Day
4,186.386

HP	FLA	KW	KVA	KVAR
610.0	682.72	490.156	543.953	235.537

Power Shed Period OFF KW

Energy Cost
$ 6,279.58

Demand Cost
$ 5,881.87

Total Charge $ 12,161.45

Energy and Demand Dashboard Continued

3-Phase Voltage
460VAC

ENERGY DASHBOARD

Equipment	HP	VAC	EFF	P.F.	HRS / Day	KWH / Day	ON/OFF	HP	FLA	KW	KVA	KVAR
Bin #1 Fan "A"	40	460	90%	0.89	12	397.707	OFF	0	0.00	0.000	0.000	0.000
Bin #1 Fan "B"	40	460	90%	0.89	8	265.138	OFF	0	0.00	0.000	0.000	0.000
Bin #2 Fan "A"	40	460	90%	0.89	12	397.707	OFF	0	0.00	0.000	0.000	0.000
Bin #2 Fan "B"	40	460	90%	0.89	8	265.138	OFF	0	0.00	0.000	0.000	0.000
Reclaim Conveyor #1	50	460	90%	0.89	8	331.422	OFF	0	0.00	0.000	0.000	0.000
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Grinder #1	200	460	95%	0.91	8	1,255.916	ON	200	216.53	156.989	172.516	71.527

KWH / Day
4,186.386

HP	FLA	KW	KVA	KVAR
400.0	437.34	316.159	348.451	146.395

Power Shed Period OFF KW

Energy Cost
$ 6,279.58

Demand Cost
$ 3,793.91

Total Charge $ 10,073.49

What the Future Holds

2. Distributed Generation – Wind, Solar, Steam
   a. With energy prices increasing, the economics of distributed generation is starting to make sense
   b. Utilizing "waste" steam at existing facility to operate a steam turbine
   c. Opportunities for solar
      i. Behind the meter installations
      ii. Joint venture opportunities with serving utilities

Copy Right Information Here

What the Future Holds

3. Our understanding of the electric grid needs to be updated.
   a. Generation – what is changing?
      i. Coal fired plants are being decommissioned and taken out of the equation.
      ii. Natural gas fire power plants are being brought online to replace capacity of coal fired power plants.
      iii. Generation is being distributed on the grid near the actual load to avoid dealing with transmission interconnection rules and regulations.
   b. Transmission
      i. Transmission system is aging and needs to be updated. This will continue to drive up demand charges.
      ii. Federal Energy Regulatory Commission (FERC), North American Electric Reliability Corporation (NERC) regulations
   c. Distribution
      i. Microgrids – localized grids that can disconnect from the traditional grid to operate autonomously. Microgrids can strengthen grid resilience.
      ii. Smart Grids – electric grid which includes a variety of operational and energy measures including smart meters, renewables, energy efficiency resources, etc.

What the Future Holds

3. Increased Automation and Controls
   a. Evaluate your existing controls and automation system to determine if your system has more capabilities than you are currently using
   b. Maximize throughput of system by monitoring gate position, conveyor amps, bucket elevator amps, grain temperature, grain moisture, etc.
   c. Would more automation increase your efficiency
      i. Minimize downtime
      ii. Maximize equipment life cycle
      iii. Minimize personnel requirements

Q & A

Thank You

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