



Energy Accounting & Education

Steve Craker, FOCUS ON ENERGY®



focus on energy®

Partnering with Wisconsin utilities



Agenda

- Energy Management
- Understanding Your Energy Bill
- Facility Best Practices
- Renewable Energy





Energy Management





Key Thoughts

- Energy is a business issue
- Energy improvements are an investment, not a cost
- Energy saving low-cost/no-cost initiatives
- Building tune-ups via Retro-Commissioning



Importance of Energy Management

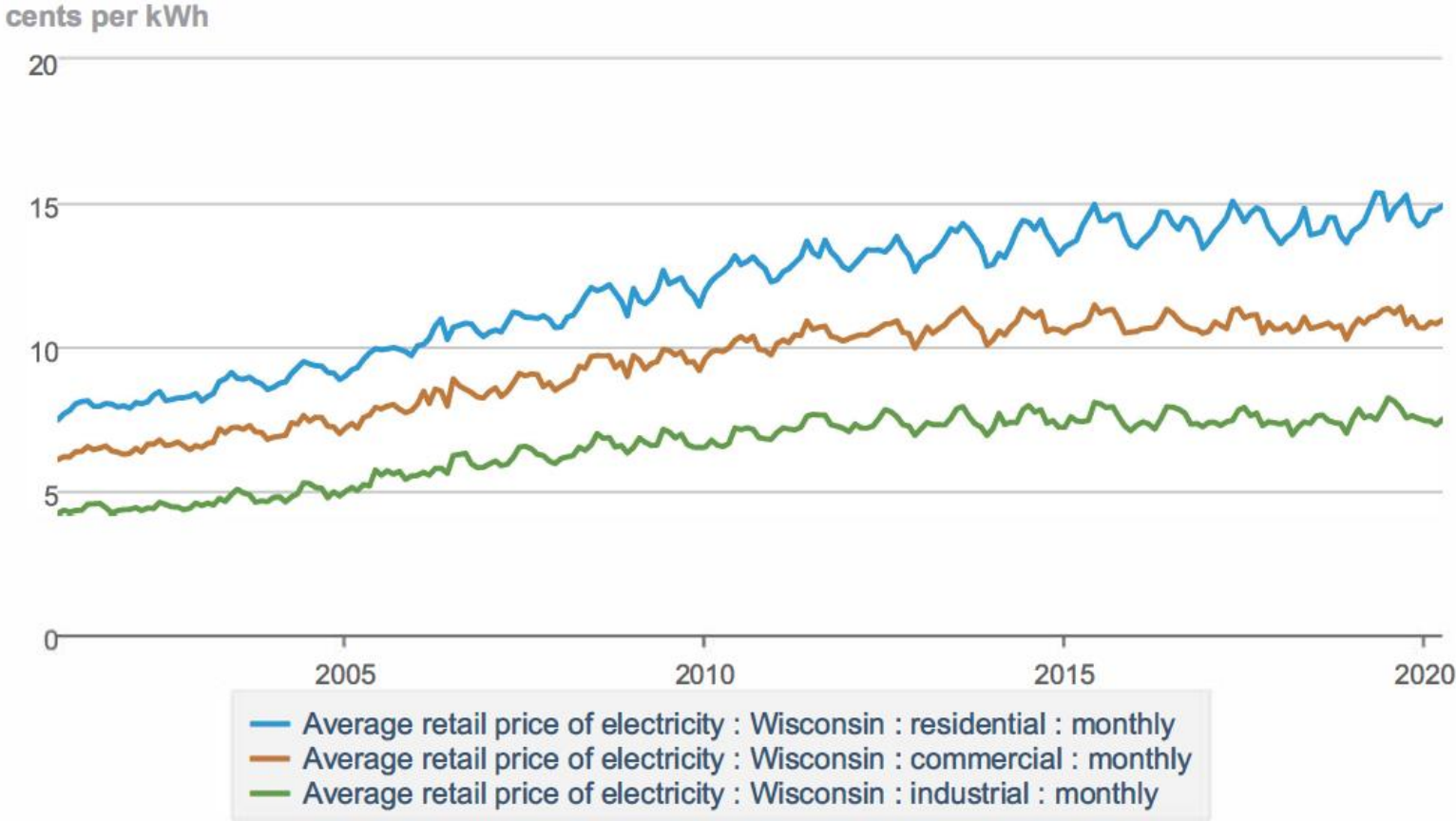
- Can result in 6% reduction in building energy use intensity¹
- Demand may account for up to 25% of your monthly electric bill
- Operational changes alone can save significant energy
- Increases occupant comfort (indoor air quality)
- Increases safety and reliability (light levels, etc.)
- Positive impact on productivity
- Electrical utility rates have consistently risen and the natural gas market can be volatile

¹Meng, T., Hsu, D. and Han, A., 2020. Measuring Energy Savings From Benchmarking Policies In New York City. [online] Aceee.org. Available at: https://www.aceee.org/files/proceedings/2016/data/papers/9_988.pdf.



Importance of Energy Management

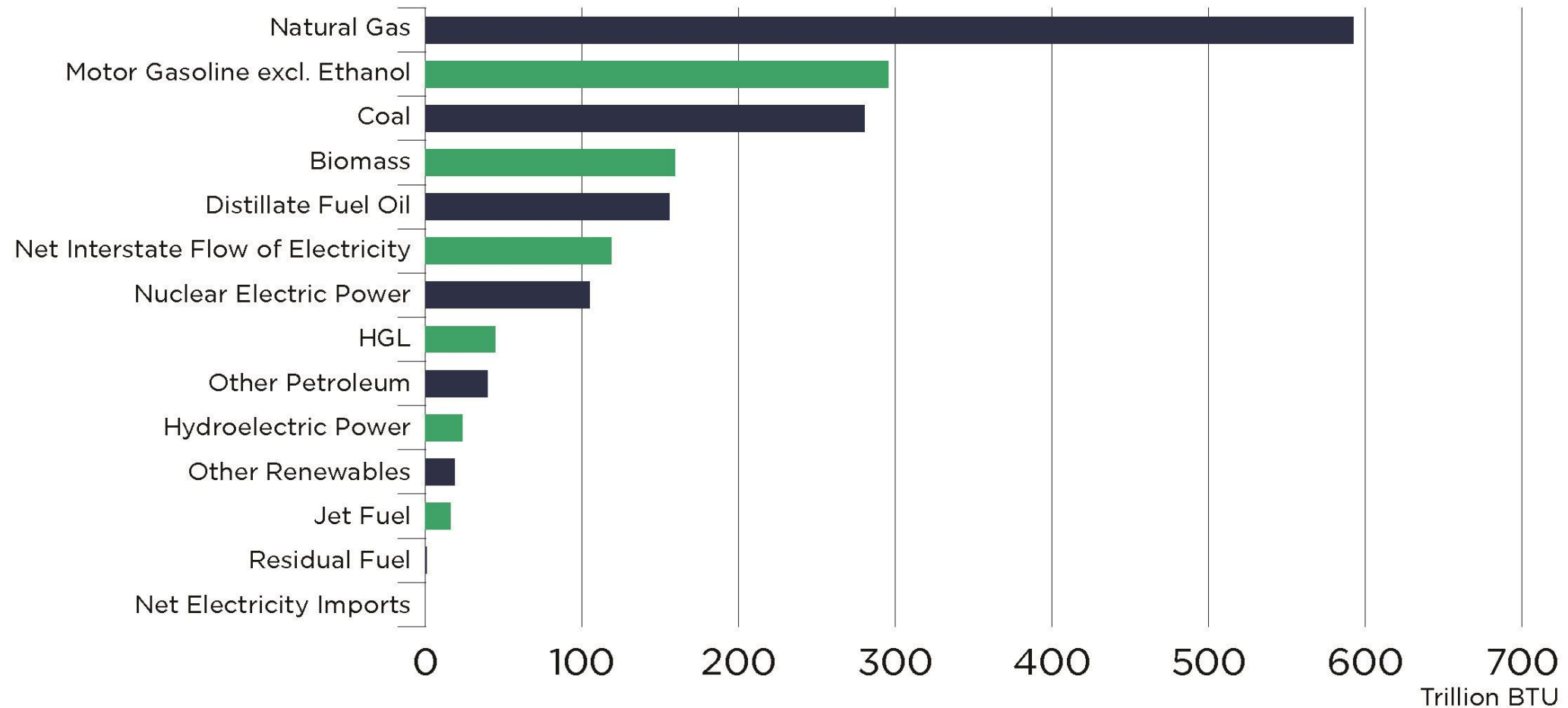
Wisconsin Average Retail Price of Electricity, by Sector



Data source: U.S. Energy Information Administration



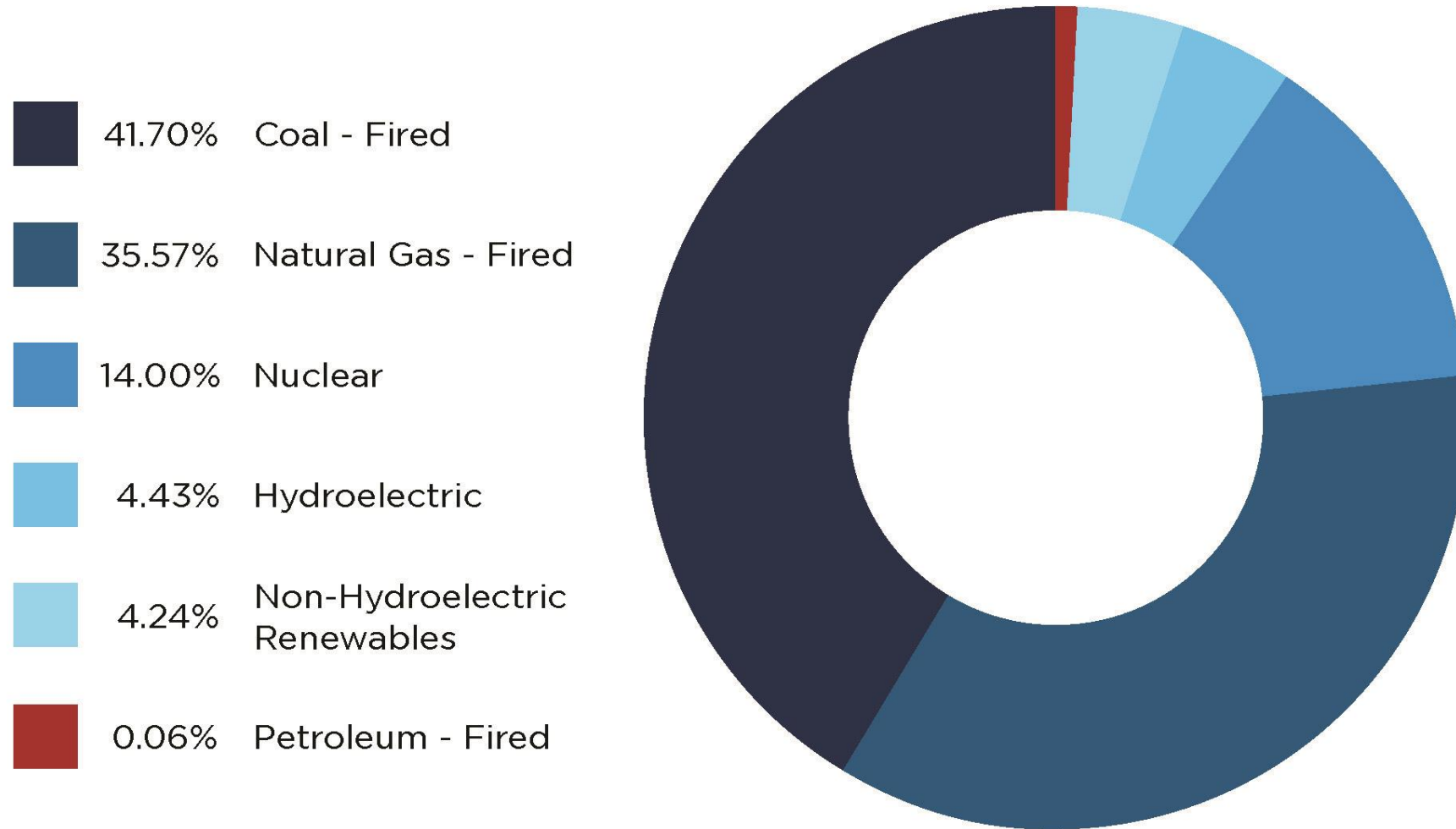
Wisconsin Energy Consumption Estimates



Source: State of Wisconsin – Clean Energy Plan



Wisconsin Net Electricity by Source (June 2021)

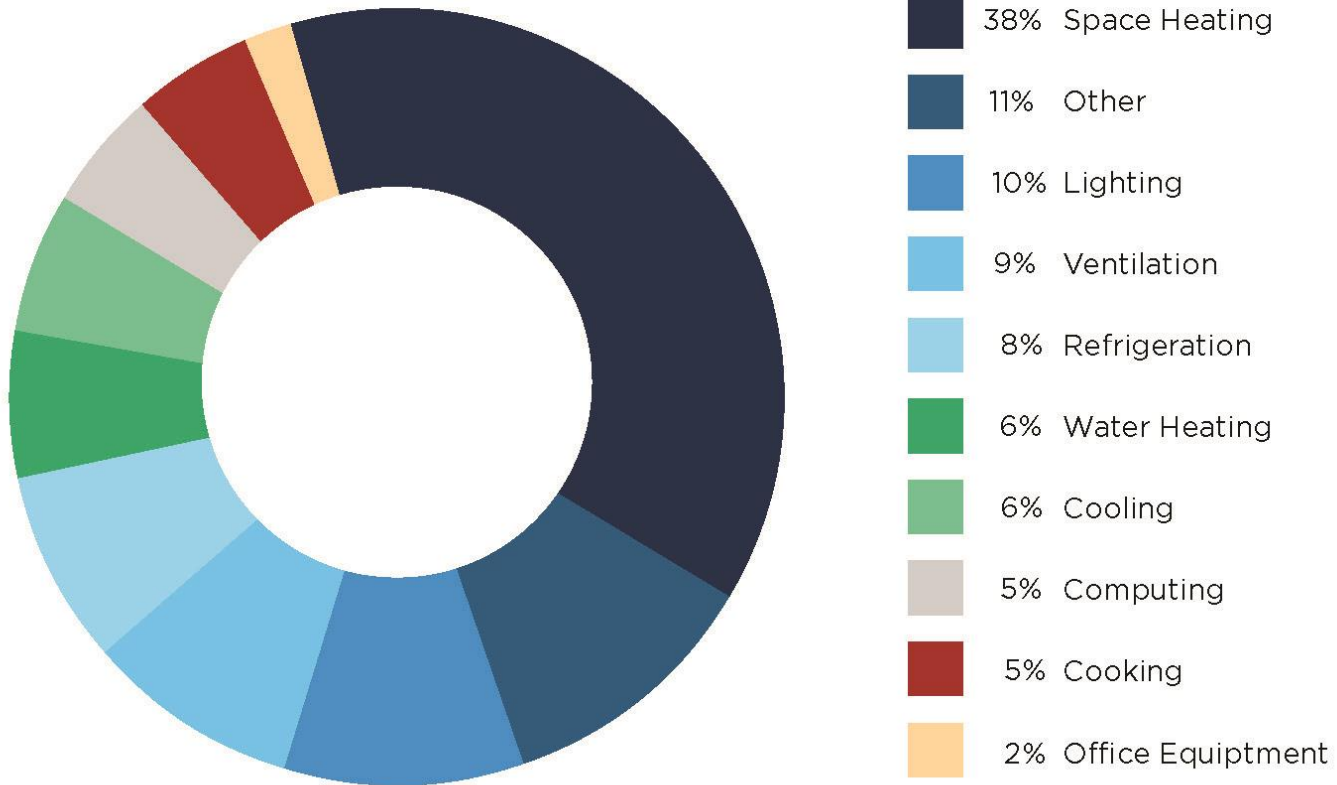


Source: State of Wisconsin – Clean Energy Plan



Wisconsin Commercial Energy Use and Heating

AVERAGE ENERGY CONSUMPTION BY END USE
COMMERCIAL



Source: State of Wisconsin – Clean Energy Plan





Goal of Practical Energy Management

- Create an energy management program and cross-functional team that is:
 - Strategic
 - Measurably effective
 - Attainable
 - Sustainable for years





Benchmarking

- Measuring a building's energy use and then comparing it to the average for similar buildings – weather normalized
- Allows owners and occupants to understand their building's relative energy performance
- Helps identify opportunities to cut energy waste
- Cannot manage what you do not measure





2018 Public Schools Benchmarking

- 1,223 buildings
- 212 school districts
- Representing 60% of Wisconsin's K-12 public schools
- Representing 94% of Wisconsin counties





2018 Public Schools Benchmarking

- Participating schools represent:
 - Total energy costs exceeding \$95 million annually
 - Building area over 129 million ft²





Benchmarking with ENERGY STAR Portfolio Manager®

- FREE online tool provided by ENERGY STAR to measure and track energy
- Benchmark the performance of one building or a portfolio of buildings in a secure online environment
- Starting point for Practical Energy Management



Portfolio Manager

- To get started benchmarking in Portfolio Manager, the following items will be needed...
 1. Property information:
 - Primary function
 - Name, address, zip/postal code
 - Year built
 - Gross floor area
 2. Property use details, e.g.:
 - Operating hours
 - Number of computers
 - Number of workers, etc.
 3. Consumption data for all resources that you need to report for the duration of the compliance period

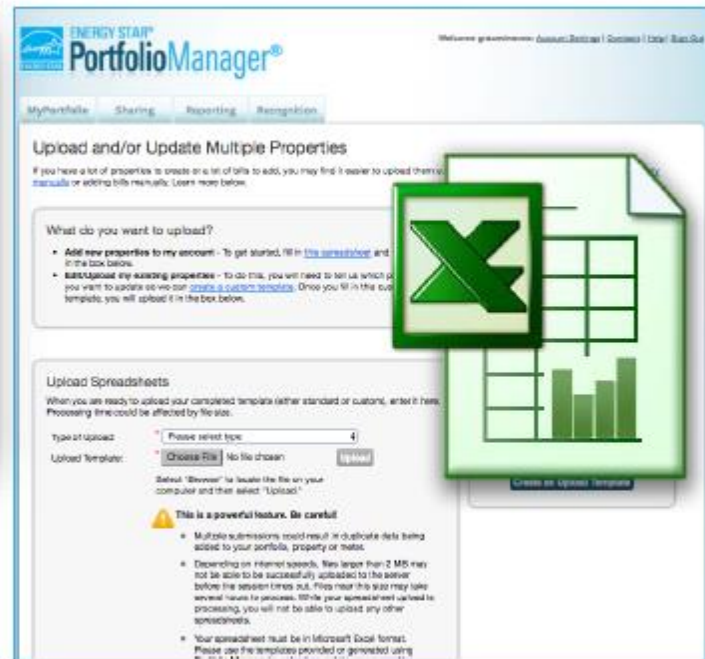


Entering Data into Portfolio Manager

Manual entry



Spreadsheet upload



Automated data uploads



Choose the best data management method.

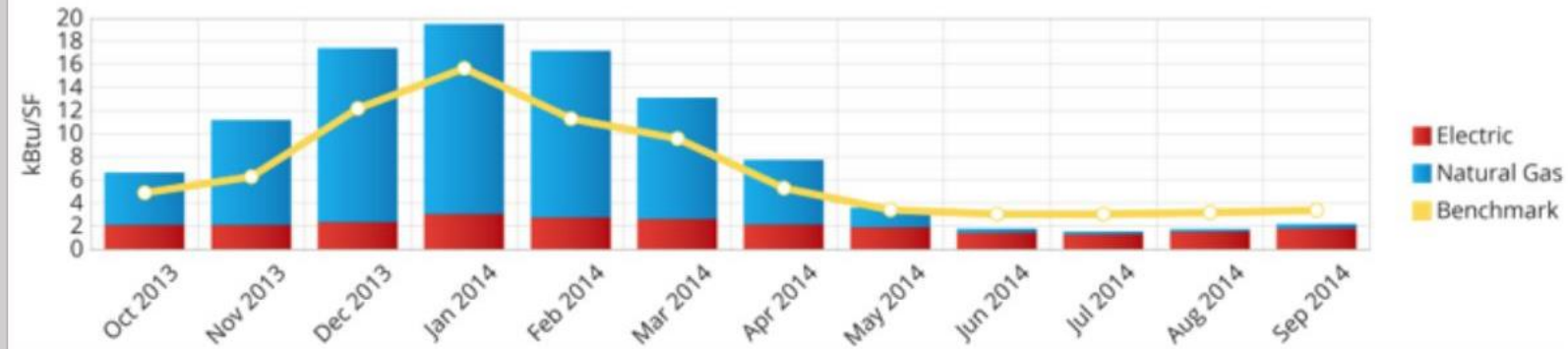
Source: ENERGY STAR®



Identify Problems and Priorities with Data

Monthly Consumption Compared to Benchmark

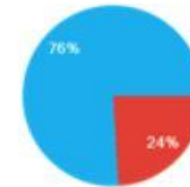
Actual consumption compared to the modeled benchmark by month.



Consumption by Energy Source Type

Actual consumption and cost broken out by the various energy source types.

	Total Usage	Usage/SF	kBtu	kBtu/SF	Energy Cost	\$/SF
Electric	567,729 kWh	7.31 kWh	1,937,090	24.95	\$53,511	\$0.69
Natural Gas	60,995 Therms	0.79 Therms	6,099,527	78.55	\$51,663	\$0.67
Total			8,036,617	103.50	\$105,174	\$1.35

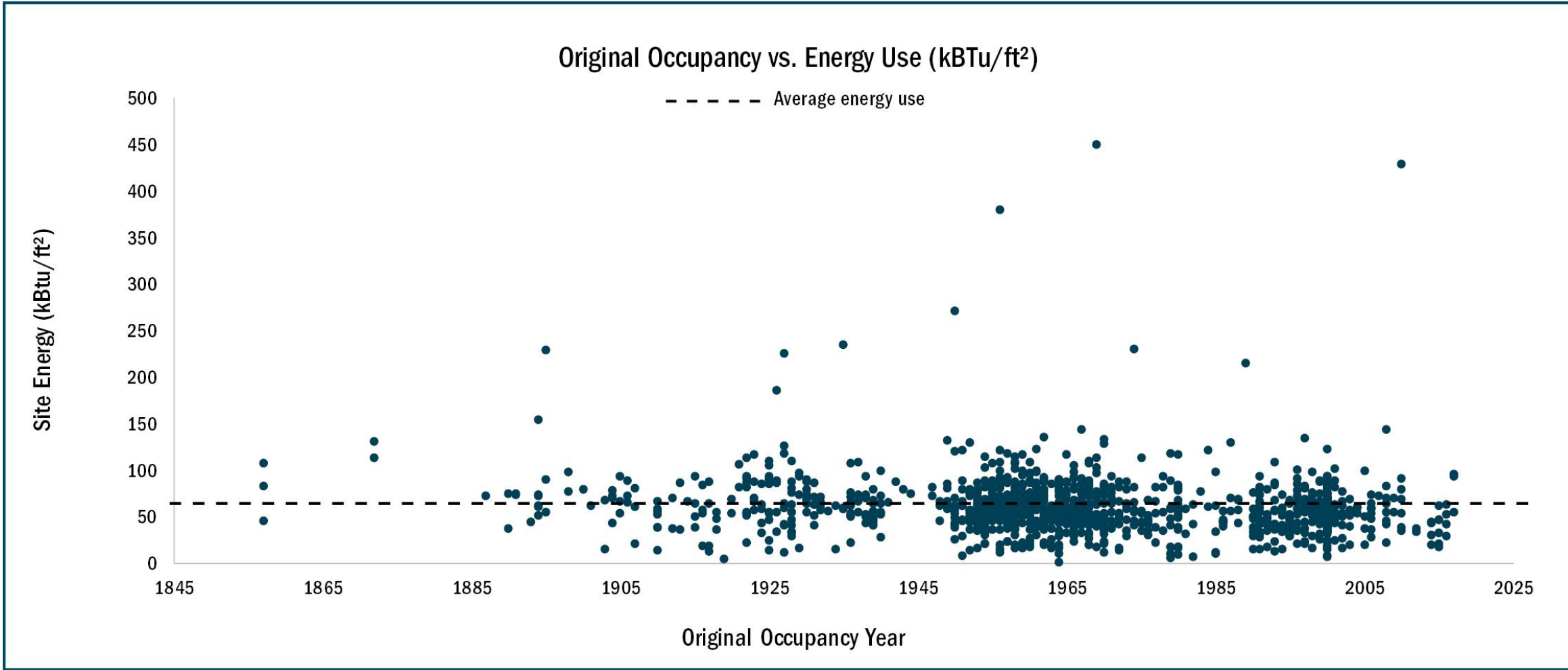


Using period October 2013 to September 2014

Source:



Occupancy vs. Energy Use



Energy Use Break Down

	Overall Energy Use (kBTU/ft ²)	Natural Gas Use	Electricity Use
Elementary School	60.3	72%	28%
Middle School	57.3	68%	32%
High School	59.7	66%	34%
Schools with Pools	67.1	68%	32%

About 12% higher energy intensity with pools



Comparing Benchmarking Results

	2006	2018
Districts	226	212
School Buildings	1,293	1,213
Million Square Feet	109	129
Total Energy Use (kBTU/ft ²)	70.70	54.31
Heating Fuel Use (kBTU/ft ²)	49.60	34.76
Normalized Heating Fuel Use (kBTU/ft ² /Heating Degree Day (HDD))	7.20	5.04
Electricity Use (kWh/ft ²)	6.00	5.73
Decrease in energy usage between studies	23%	

Air-conditioned buildings:

- 2006 – 46%
- 2018 – 52%





Natural Gas Transportation

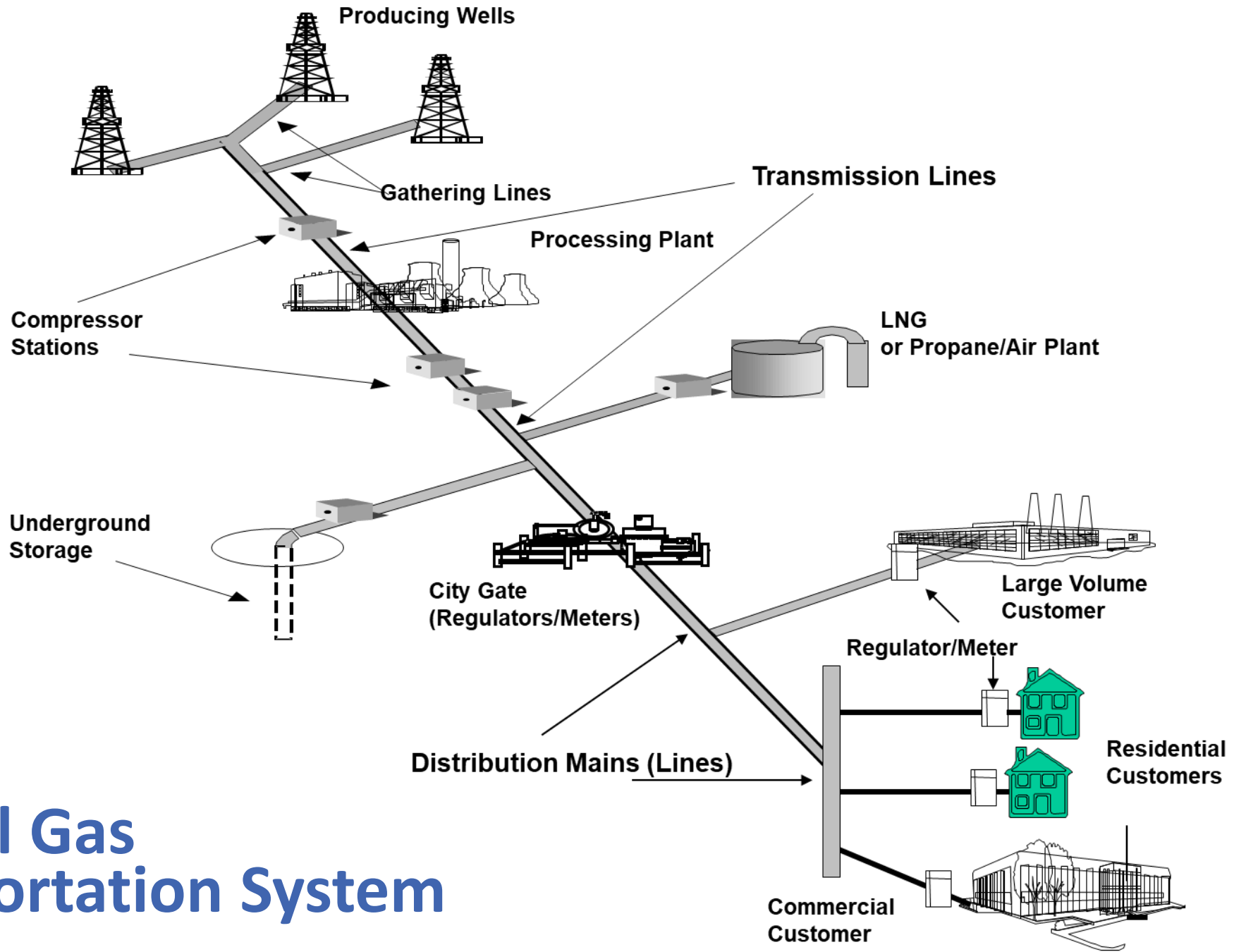
System Supply Customer

- Purchased by utility
- Transported by utility
- Distributed by utility
- Maintained by utility
- Billed by utility

Transportation Customer

- Purchased by marketer
- Transported by marketer
- Distributed by utility
- Maintained by utility
- Billed by both





Natural Gas Transportation System

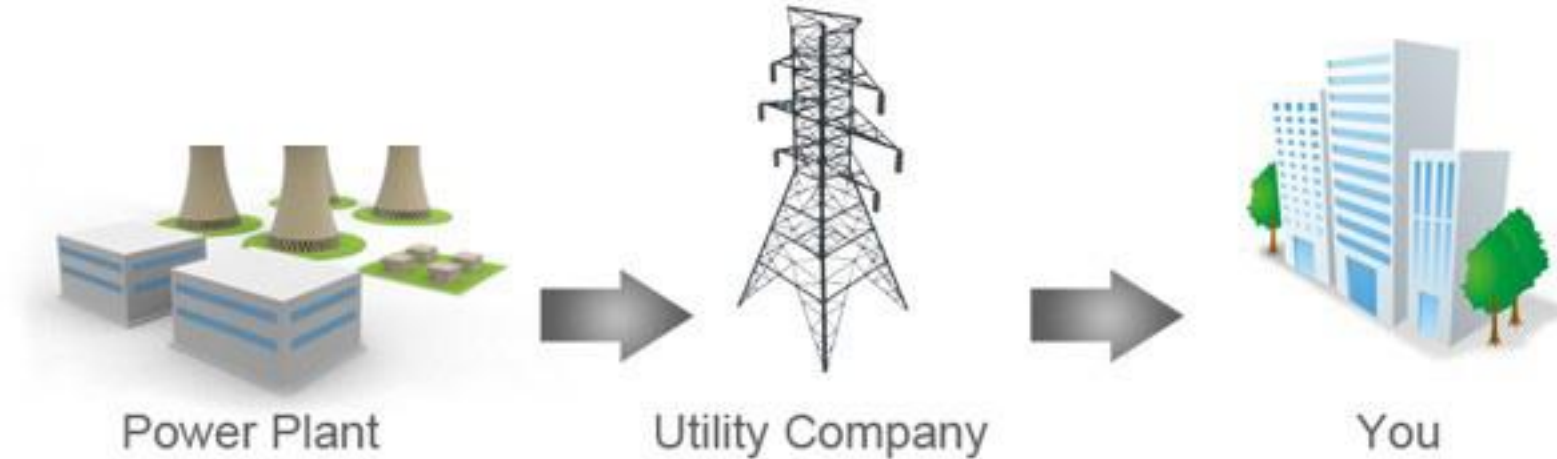


Natural Gas Cost Factors

- Actual purchase price of gas
- Gas transportation costs
- Public Service Commission (PSC) regulates utilities, not marketer
- Market fluctuations
- Price-locking
- Combination of weather and market determine the savings/costs in any given year
- Commodity price/
transportation price



Energy Regulation



Energy Deregulation



**Before and
After Regulation**



Understanding Your Energy Bill





Benefits

- Contain separate charges for energy consumption and demand
- Represent a large manageable portion of your yearly budget
- Use the savings on other projects
- Help to manage rising energy costs



Degree Days



Degree Day

Indicates how far a day's average temp departs from 65°F

Heating Degree Day

Measures heating energy demand and indicates how far the average temp falls below 65°F



Cooling Degree Day

Measures cooling energy demand and indicates how far the temperature averages above 65°F

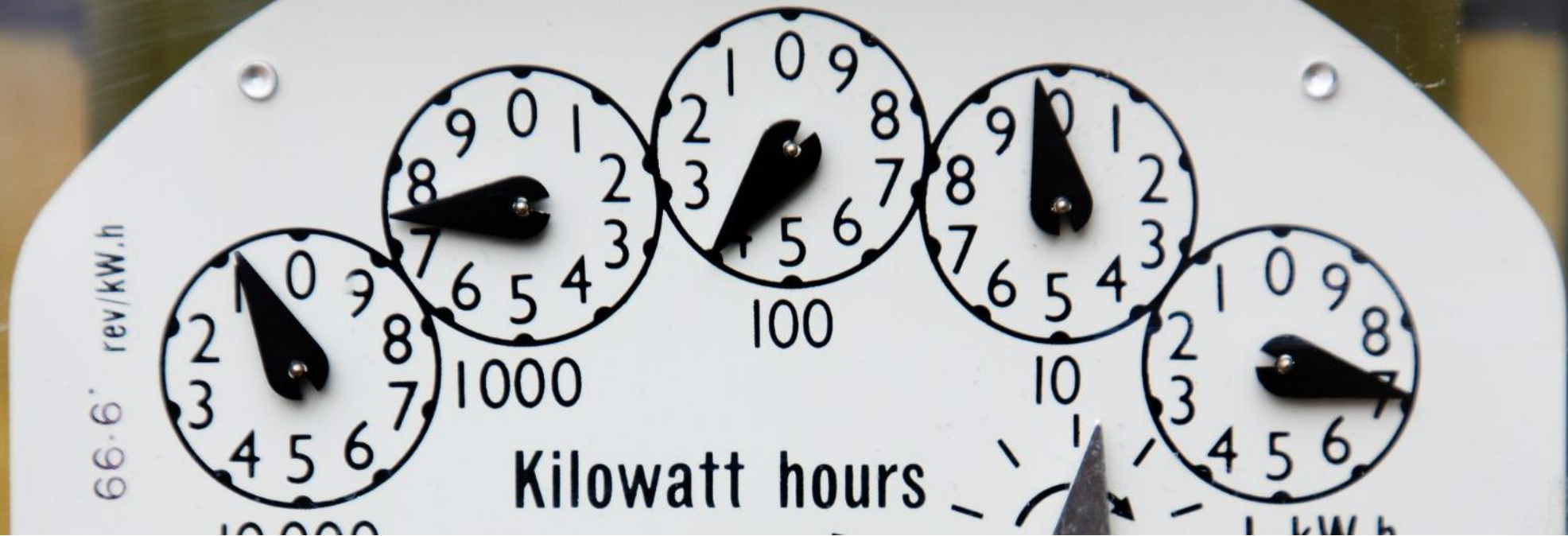




Customer Charges

- Recurring charges for administrative activities for maintaining a customer account (also referred to as service charges)
- Includes billing, metering, and meter reading





What is a Kilowatt?

Kilowatt (kW)

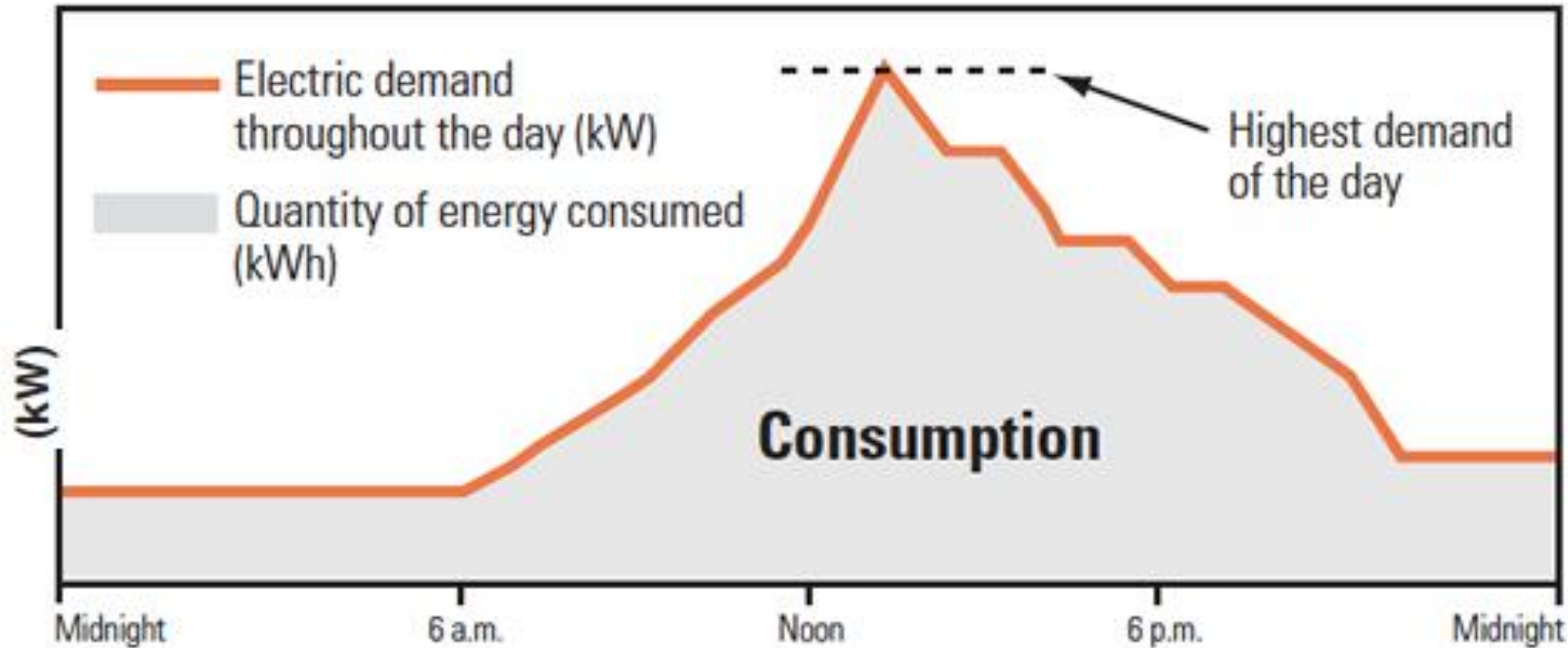
- One kilowatt equals 1,000 watts
- 10 bulbs @ 100 watts each

Kilowatt-hour (kWh)

- Basic unit of electric energy
- One kilowatt of power supplied to or taken from an electric circuit steadily for one hour
- One kilowatt-hour equals 1,000 watt-hours



Electrical Demand (kW) and Energy (kWh)



kWh off/on peak

- $500 \text{ kW} \times \$13.80 = \$6,900$
- $500 \text{ kW} \times \$1.85 = \925



Therm vs. kWh

	Btu	Multiplier	Btu	Unit Cost	Multiplier	Total Cost
1 Therm	100,000	1.0	100,000	\$0.70	1.0	\$0.70
1 kWh	3,412	29.3	100,000	\$0.10	29.3	\$2.93





Time of Use Rate

- Varies by the time of day electricity is used
- Higher rates are charged during hours of peak system usage
- Lower energy costs by shifting use to “off-peak” hours when electricity costs less
- Consult with your local utility representative
 - May require a special meter





On-Peak vs. Off-Peak Rates

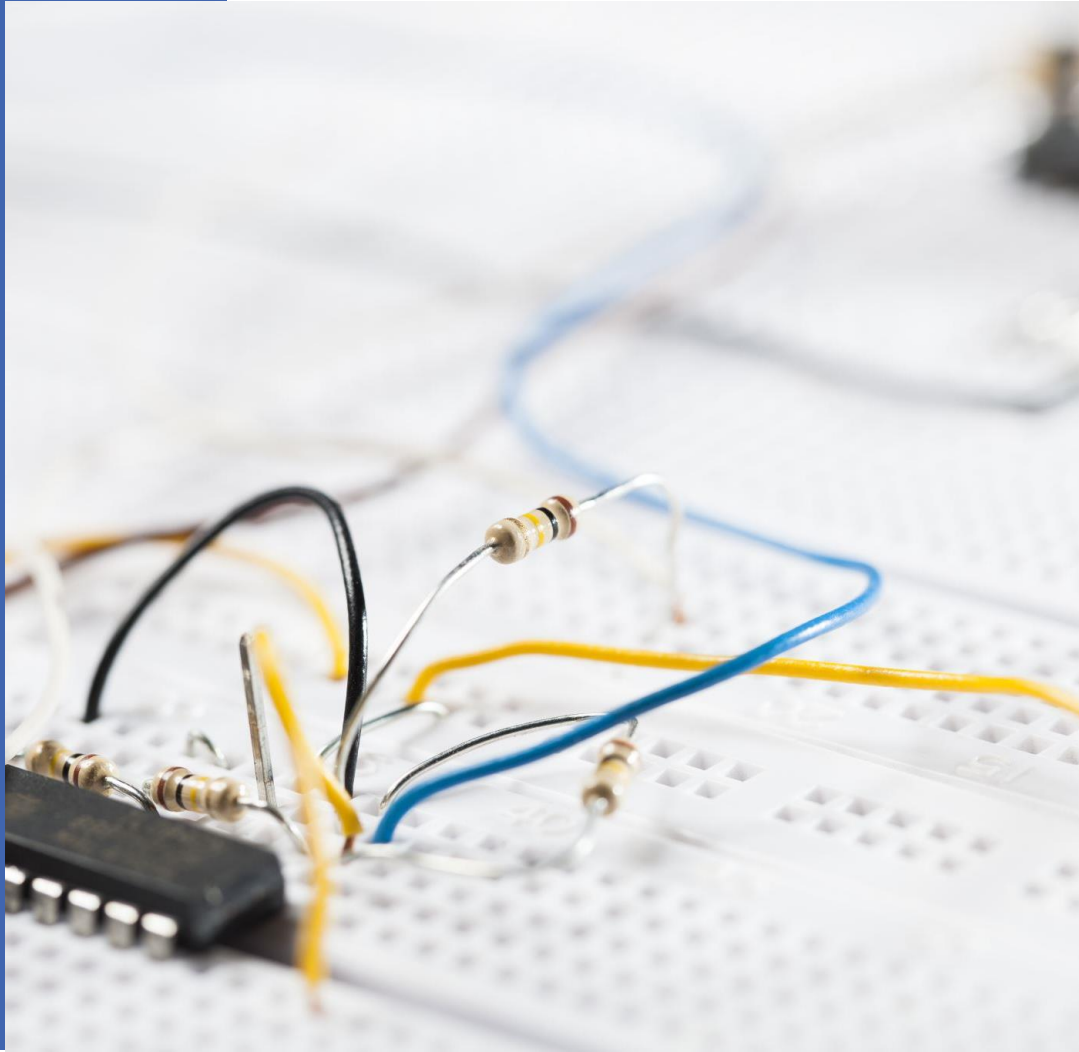
On-Peak Rate

- Period between 9:00 am and 9:00 pm, Monday through Friday, when most energy is used
- Excludes weekends and holidays

Off-Peak Rate

- Includes all hours not included in the on-peak period





Power Factor

- Ratio of real power (kW) to apparent power (kVA) at any given time in an electrical circuit
- Power factor of one (unity power factor) goal of electric utilities
- Facilities are charged a penalty if their power factor is much different from one



Electric Bill

1. Billing dates
2. Number of calendar days
3. All energy (kWh) used during peak hours
4. Maximum demand during on-peak hours
5. All energy (kWh) used outside peak hours
6. Demand during billing period (on and off peak)
7. On-peak period

Customer Detail		Bill Due: 06/20/2018	
ABC ELEMENTARY SCHOOL EDUCATION LANE XYZ, WI 00000		Account Number	2205
		Service From	1 03/28/2018
		Service To	04/28/2018
		Bill Days	2 31
Electric Power Usage			
<u>Energy Usage</u>			
On-Peak	3 29,024 kWh	On-Peak Maximum Demand	4 176.20 kW
Off-Peak	5 14,918 kWh	Date/Time	04/18/2018 1:00 PM
Total Energy	43,942 kWh	Maximum Measured Demand	6 176.20 kW
Total Reactive Energy	13,190 kvarh	Date/Time	04/18/2018 1:00 PM
On-Peak = 7am-9pm, M thru F	7	Distribution Demand	319.50 kW
		Date/Time	09/18/2017 10:30 AM
Billed Demand = On-Peak Maximum Measured Demand			176.20 kW
Average Power Factor = (Total Energy / SQRT (Total Energy ^2 + Total Reactive Energy ^2)) x 100			95.8%
Average Load Factor = (Total Energy / (Maximum Demand x Hours in Billing Period)) x 100			33.5%
Bill Computation Under Rate Schedule			Cp2
Customer Charge			\$200.00
Demand Charges			
Distribution Demand	319.50 kW	x	\$1.75
Demand	176.20 kW	x	\$8.00
Total Demand Charges			\$1,409.60
			\$1,968.73
Energy Charges			
On-Peak	29,024 kWh	x	\$0.05950
Off-Peak	14,918 kWh	x	\$0.04900
Total Energy Charges	43,942 kWh		\$1,726.93
			\$730.98
			\$2,457.91
Subtotal Demand and Energy Charges			\$4,426.64
Power Cost Adjustment Clause	43,942 kWh	x	(\$0.0019)
			(\$83.49)
TOTAL POWER COST			\$4,543.15
Sales Tax (100.00% Tax Exempt)	\$4,543.15	x 5.60% x	0.00%
			\$0.00
TOTAL POWER BILL			\$4,543.15
Commitment to Community Charge			\$35.00
Late Charge			\$0.00
Balance Forward			\$0.00
TOTAL ELECTRIC BILL			\$4,578.15



Electric Bill

8. Maximum demand during the last 12 months (on and off peak)
9. Indicator of extra power supplied by the utility
10. Indicator or average demand compared to maximum demand
11. Monthly flat fee
12. Charge for maximum demand during the last 12 months

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Average Load Factor = (Total Energy / (Maximum Demand x Hours in Billing Period)) x 100				10 33.5%	
Bill Computation Under Rate Schedule					Cp2
Customer Charge					11 \$200.00
Demand Charges					
Distribution Demand	319.50	kW	x	12 \$1.75	\$559.13
Demand	176.20	kW	x	\$8.00	\$1,409.60
Total Demand Charges					\$1,968.73
Energy Charges					
On-Peak	29,024	kWh	x	\$0.05950	\$1,726.93
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Late Charge					\$0.00
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TOTAL ELECTRIC BILL					\$4,578.15



Electric Bill

13. Charge for on-peak maximum demand during the billing period
14. Charge for energy used during peak hours
15. Charge for energy used during off-peak hours
16. Monthly allowable adjustments made by the utility
17. Wisconsin state-mandated fixed fee

Customer Detail				Bill Due: 06/20/2018		
ABC ELEMENTARY SCHOOL EDUCATION LANE XYZ, WI 00000			Account Number		2205	
			Service From		03/28/2018	
			Service To		04/28/2018	
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<u>Energy Usage</u>						
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Energy Charges						
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TOTAL POWER BILL					\$4,543.15	
Commitment to Community Charge					17 \$35.00	
Late Charge					\$0.00	
Balance Forward					\$0.00	
TOTAL ELECTRIC BILL					\$4,578.15	



Natural Gas Bill

1. Tariff detailing service charges
2. Fixed and variable costs of providing service
3. Cost of natural gas
4. Carrying cost of gas and storage
5. Actual cost of natural gas
6. Cost of operations to supply and maintain utility service
7. State and county tax if applicable

Non-Residential Gas Service

1 - **Rate:** GC3F - Gas Firm Service, Medium Commercial & Industrial 20000-200000 Therms **Billed for: 30 Days**

Billing Period	Meter Number	Current Reading	Previous Reading	Metered Units	Multiplier	Usage
Jan 02 - Feb 01	987698765	23,777	19,484	3,893 CCF	1.125	4,603 therms

2 - Distribution Charge	4603.00 therms X \$0.0874	\$402.30
3 - Gas Supply Base Rate	4603.00 therms X \$0.3973	\$1,828.77
4 - Gas Supply Acquisition Charge	4603.00 therms X \$0.0103	\$47.41
5 - Gas Supply Market Adj	4603.00 therms X \$0.059534	\$273.21
6 - Customer Charge	30.000 Days X \$3.00	\$90.00
7 - County Tax	\$2641.69 X 0.5%	\$13.21
7 - Wisconsin Sales Tax	\$2641.69 X 5%	\$132.08
Total Current Charges		\$2,786.98



Take Action

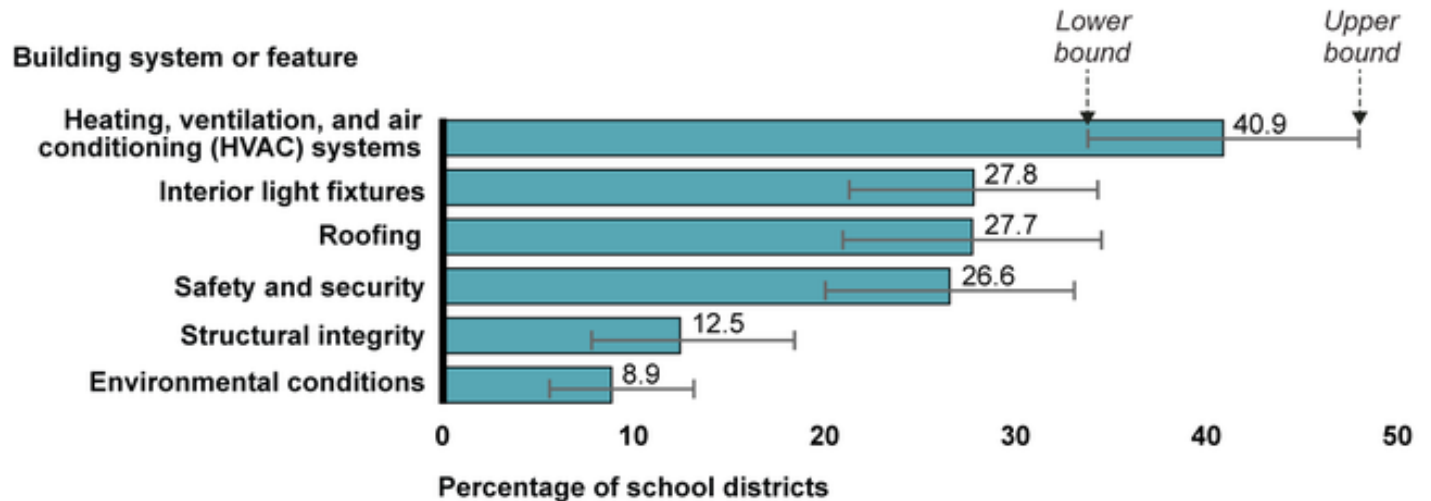
- Identify the time of on-peak demand
- Determine the causes of peak energy use and identify ways to reduce it
- Consider possible strategies to shift equipment operations into electric utility off-peak period
- Set controls so operations are staggered
- Develop a comprehensive energy and cost reduction plan and share it with operators
- Benchmark your energy use and evaluate trends over time



District Upgrade Needs

- According to the State of Our Schools 2021 report, WI Schools have a \$1.5 billion annual capital budget gap
- Upgrade needs include:
 - 40% - HVAC
 - 27% - Lighting

Chart 1: Annual Operating and Capital Facilities Standard, Expenditures, and Gap



Source: GAO analysis of school district survey data. | GAO-20-494





Facility Best Practices



Lighting

- Upgrade your fixtures to light-emitting diodes (LEDs)
- Scale back over lit areas
- Utilize control strategies
- Perform preventative maintenance



Lighting Comparison

60 watt Incandescent



Yearly Operating Cost - **\$12.92**

Energy Usage - **60w**

Brightness(Lumens) - **800**

Bulb Lifetime- **750 Hours**

14 watt CFL



\$58 Lifetime Savings

over an incandescent with the same brightness

Yearly Operating Cost - **\$3.01**

Energy Usage - **14w**

Brightness(Lumens) - **800**

Bulb Lifetime - **10,000 Hours**

12 watt LED



\$200 Lifetime Savings

over an incandescent with the same brightness

Yearly Operating Cost - **\$2.58**

Energy Usage - **12w**

Brightness(Lumens) - **800**

Bulb Lifetime- **50,000 Hours+**

4everled



Lighting Upgrade



Before

After



HVAC

- Perform routine maintenance
- Practice commissioning and retrocommissioning
- Install direct digital controls
- Invest in premium efficiency, ultra efficiency or electronically commutated motors (ECMs)
- Install Variable Frequency Drives (VFDs)



Heating Systems

- Size boilers appropriately
- Install high-efficiency boilers
- Upgrade burners
- Install controls
- Utilize VFDs or ECMs
- Consider stack economizers for boiler systems
- Survey steam traps and condensate return



Heating Systems

- Install high-efficiency furnaces, unit heaters, and rooftop units
- Install infrared heaters
- Eliminate electric resistance heat when possible
- Install high-efficiency heat pumps
- Control refrigerant flow



Cooling Systems

- Size chillers and select type appropriately
- Install high-efficiency chillers
- Utilize chiller heat recovery
- Install direct digital controls
- Incorporate VFDs
- Utilize ice storage
- Insulate pipes, fittings, and valves
- Install high-efficiency direct expansion cooling
- Install high-efficiency heat pumps



Ventilation Systems

- Perform routine maintenance
- Optimize your ventilation strategy
- Utilize demand-controlled ventilation (DCV)
- Exhaust fan control
- Exhaust air energy recovery
- Economize temperature set points
- Utilize ventilation controls
- Convert to variable air volume (VAV) systems
- Consider VFDs
- Explore displacement ventilation



Water Heating

- Study fuel options
- Install a high-efficiency hot water heater
- Determine hot water system sizing
- Perform routine maintenance
- Consider natural gas or chemical wash to reduce electrical demand



Demand Limiting Controls

- Control peak demand with lock out stages of cooling equipment
- Use a peak demand strategy to monitor and control facility (smart building)



Energy Efficient Kitchen

- Purchase ENERGY STAR® equipment
- Review booster heater use for dishwashing
- Update kitchen ventilation equipment





Renewable Energy





Offset Energy Bills

- Over 7,300 schools in the U.S. have solar installations
- Wisconsin ranks #12 in the nation with 148 schools with solar (The Solar Foundation)
- Dramatic decline in costs make solar options widely accessible
- Average cost of solar panels per watt in Wisconsin is \$2.83/watt (Solar-Estimate)





Ideal Candidate

- Schools include underutilized spaces:
 - Facility structures offer a large, flat area ideal for solar rooftop systems
 - Parking lots have space for photovoltaic canopies to capture the sun
 - Vacant land provides an opportunity for a solar farm to maximize energy output



Types of Solar Options



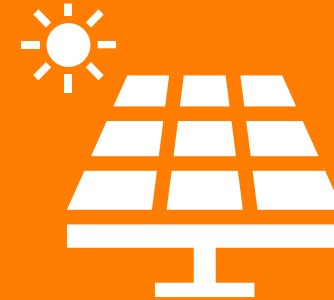
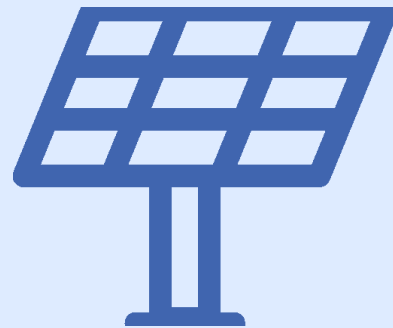
Roof-mount

Common option
requiring minimal
maintenance

Pole-mount

Option when roof
space is limited

Requires adequate
land space



Ground-mount

Large areas of land
with ample sun
exposure

Generate more power
than roof system





Educational Opportunities

- Provides an on-site learning experience
- Allows students to learn about real-world energy issues
- Gives students the ability to track data through monitoring systems
- Motivate students to explore careers in energy conservation and sustainability





Financial Incentives

- Contact your local utility for renewable energy programs and incentives they offer
- Research available incentive funding from Focus on Energy and State Energy Office Funds
- Explore fundraising opportunities and private donations





Resources for Help

- Your energy team
- Focus on Energy
- Utility representative
- Vendors
- Peers
- Other resources:
 - www.epa.gov
 - www.energystar.gov





Takeaways

- Unlimited energy supplies do not exist
- Pricing can fluctuate beyond control
- Energy is an everyday issue
- Act now to make a difference – avoid higher future costs
- Saved operation and maintenance funds from reduced energy billing can be used in other areas of operation





Questions?