Energy Accounting & Training

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

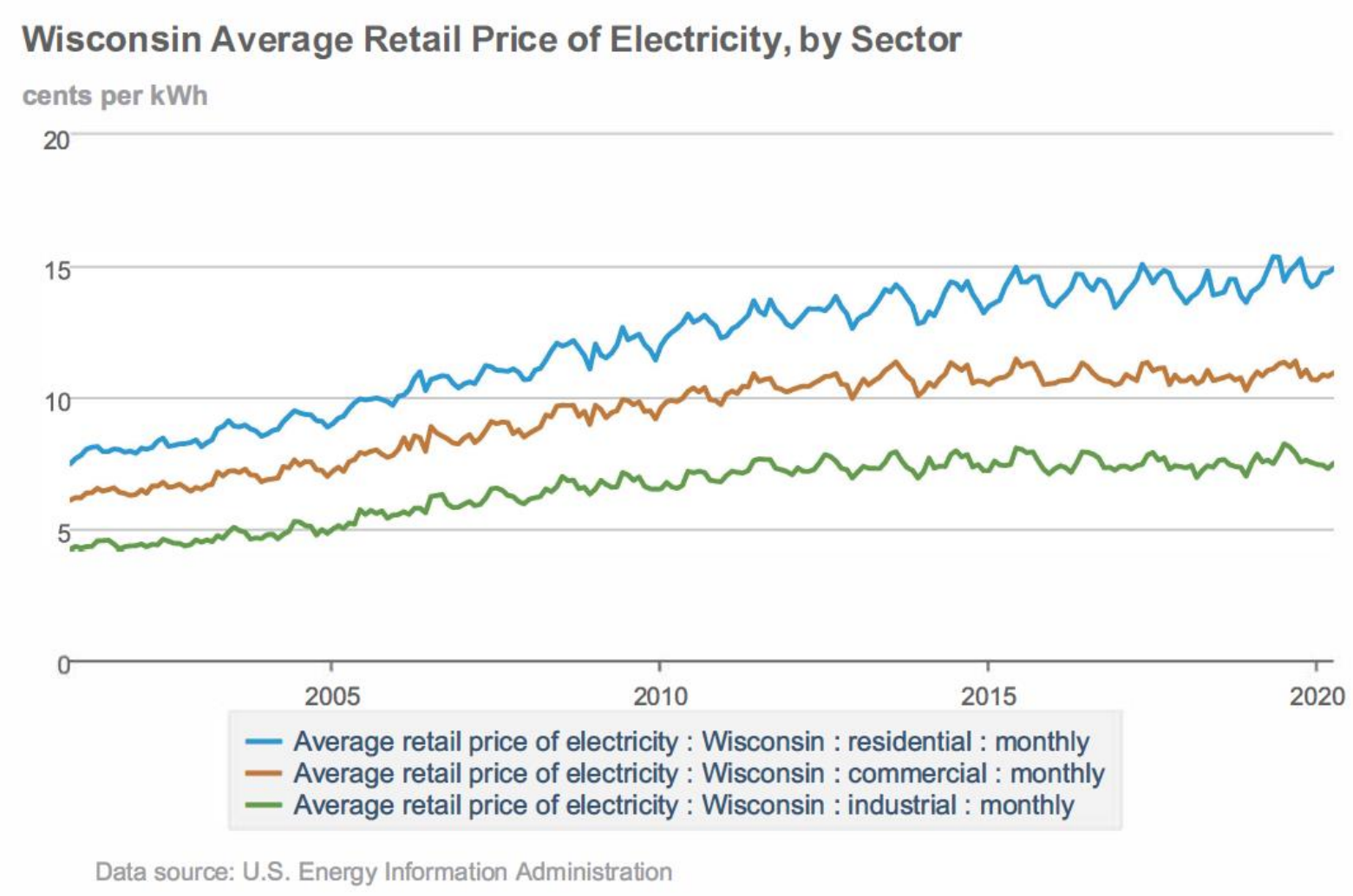
- Energy is a business issue
- Energy improvements are an investment, not a cost
- Energy saving low-cost/ no-cost initiatives
- Building tune-ups via Retro-Commissioning

Importance of Energy Management

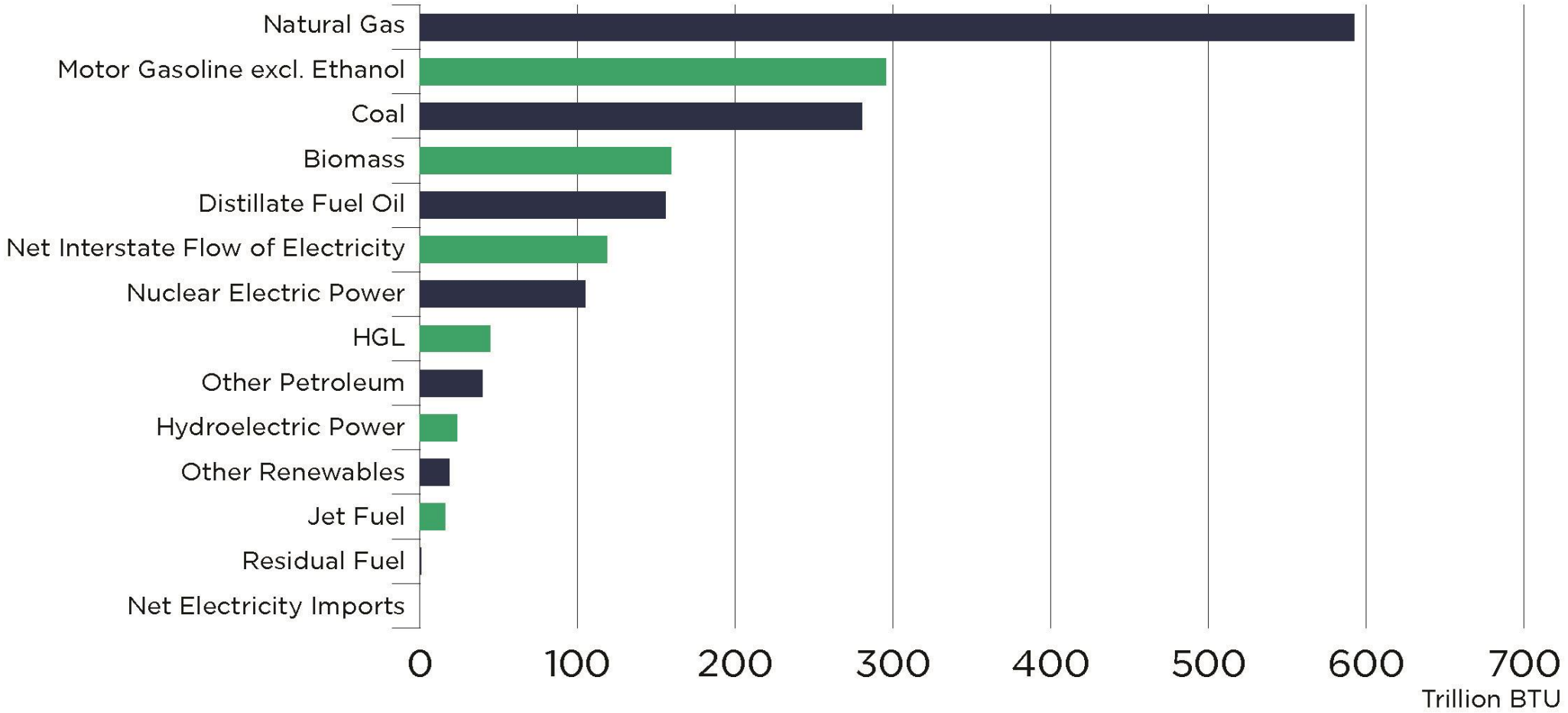
- Can result in 6% reduction in building energy use intensity[1]
- Demand may account for up to 25% of your monthly electric bill
- Operational changes alone can save significant energy
- Increases occupant comfort (indoor air quality)
- Increases safety and reliability (light levels, etc.)
- Positive impact on productivity
- Electrical utility rates have consistently risen and the natural gas market can be volatile

[1]Meng, 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

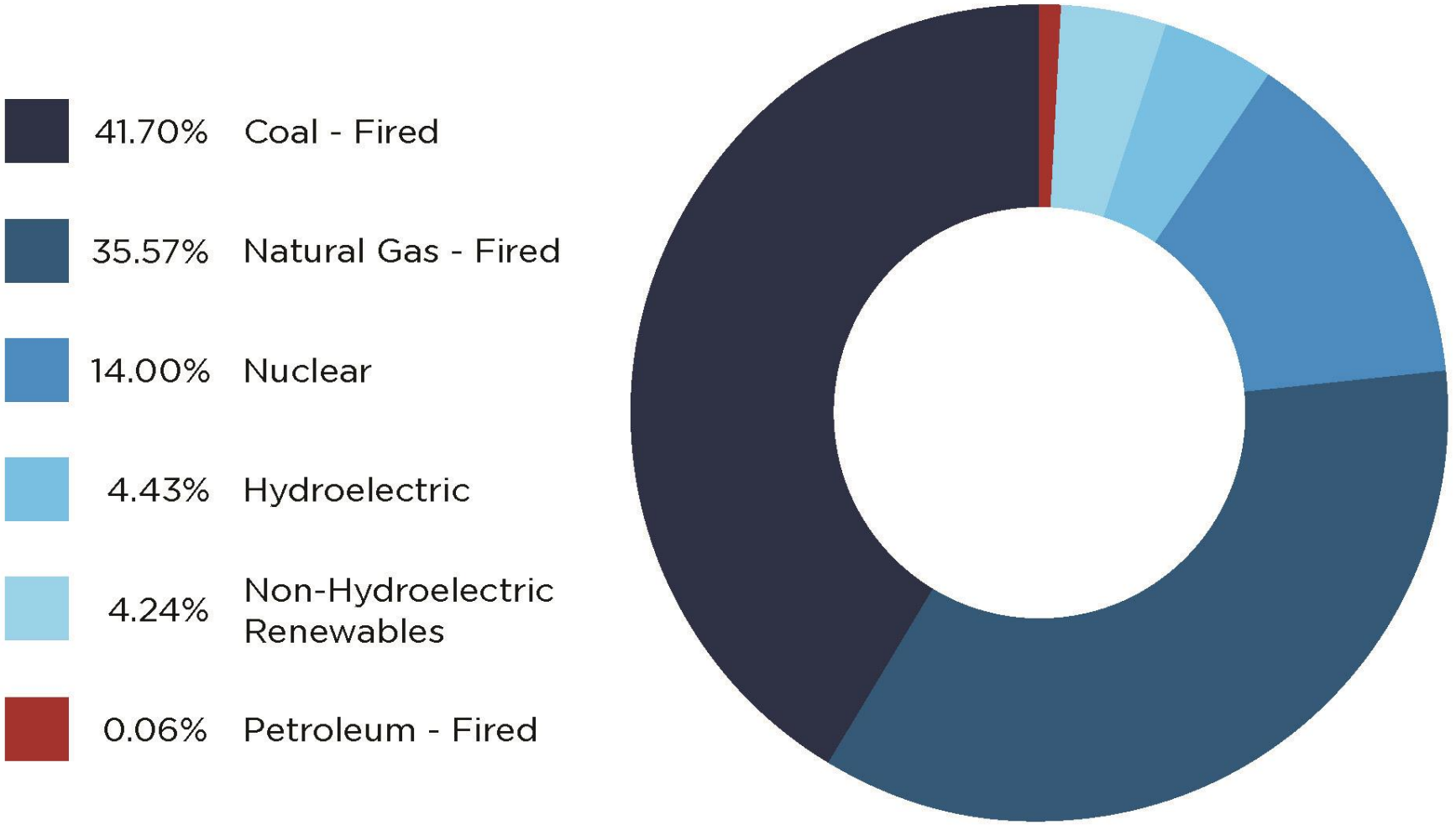


Wisconsin Energy Consumption Estimates



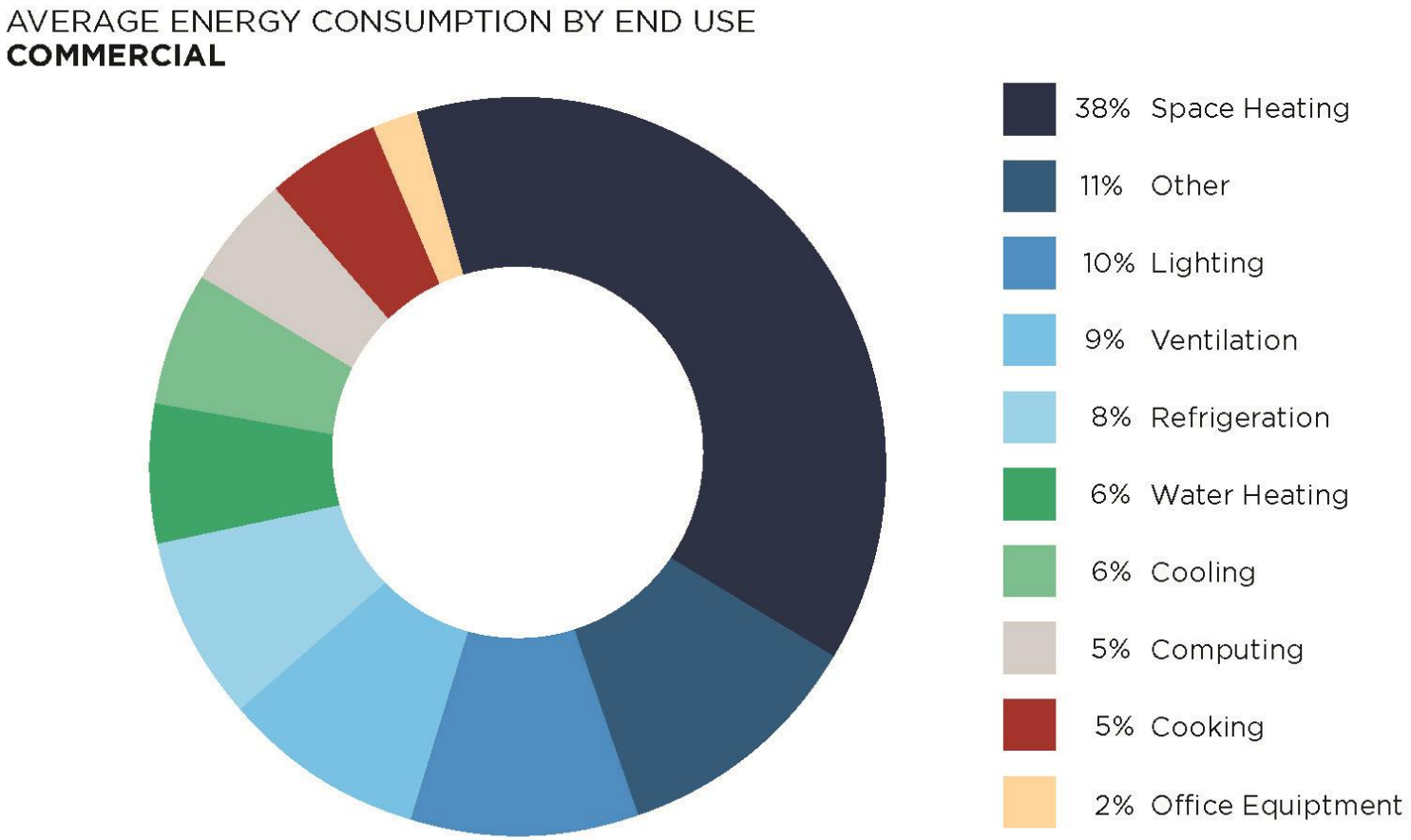
Source: State of Wisconsin – Clean Energy Plan

Wisconsin Net Electricity by Source (June 2021)



Source: State of Wisconsin – Clean Energy Plan

Wisconsin Commercial Energy Use and Heating



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

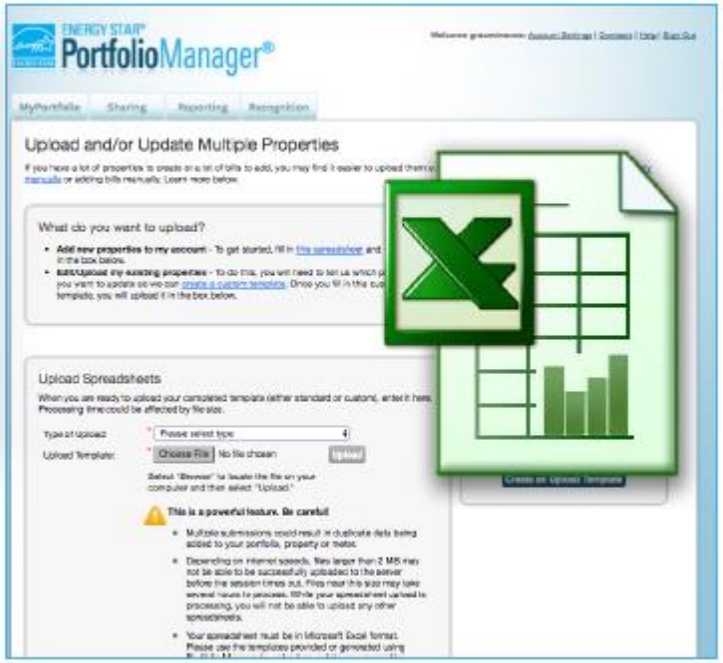
Portfolio Manager

- 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

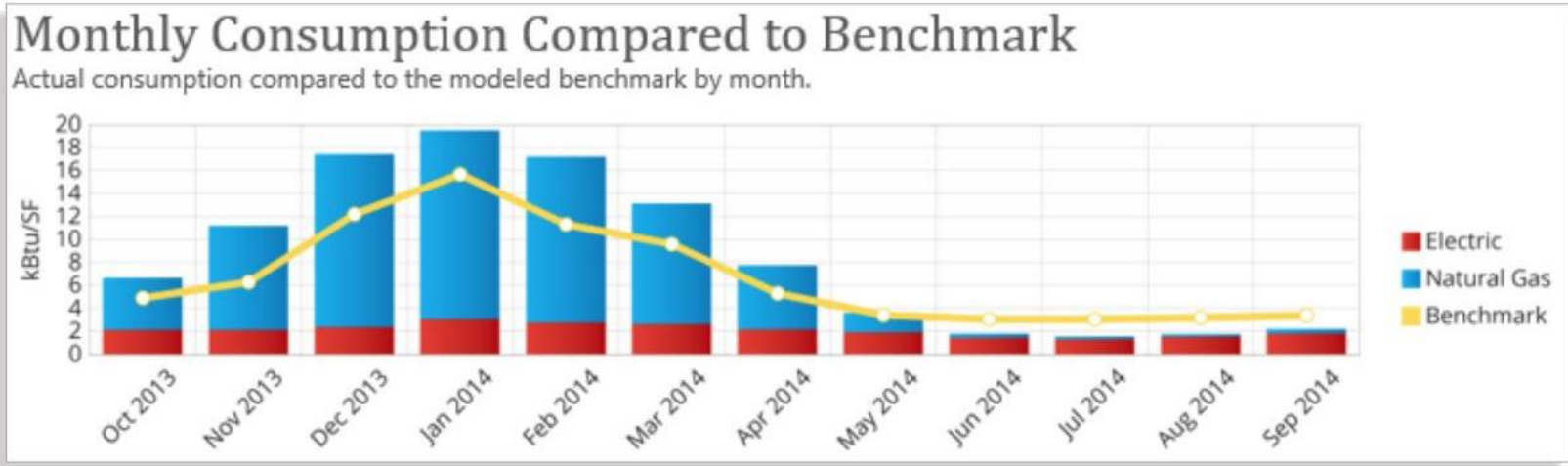


Automated data uploads

Choose the best data management method.

Source: ENERGY STAR®

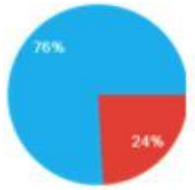
Identify Problems and Priorities with Data



Consumption by Energy Source Type

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

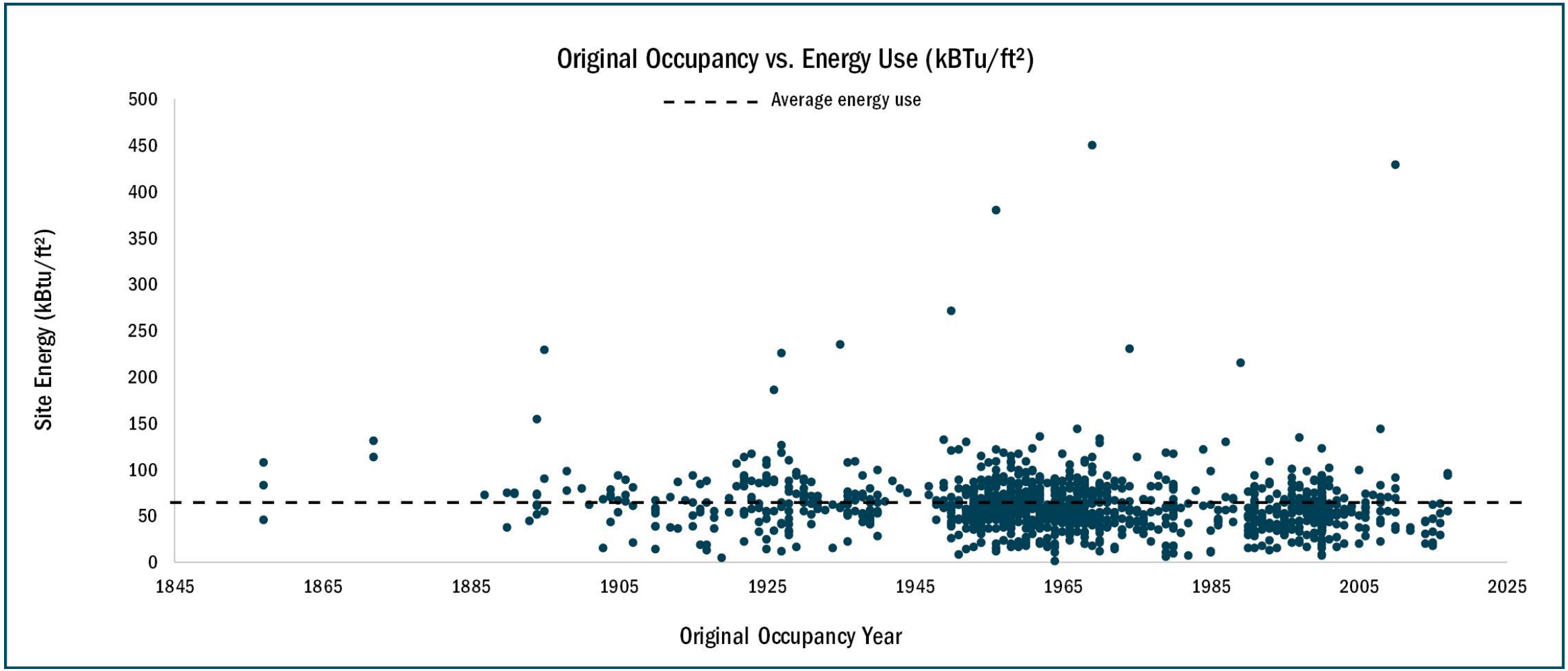
	Total Usage	Usage/SF	kBtu	kBtu/SF	Energy Cost	$/SF
Electric	567,729 kWh	7.31 kWh	1,937,090	24.95	$53,511	$0.69
Natural Gas	60,995 Therms	0.79 Therms	6,099,527	78.55	$51,663	$0.67
Total			**8,036,617**	**103.50**	**$105,174**	**$1.35**



Using period October 2013 to September 2014

Source: 3 BENCHMARKING

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

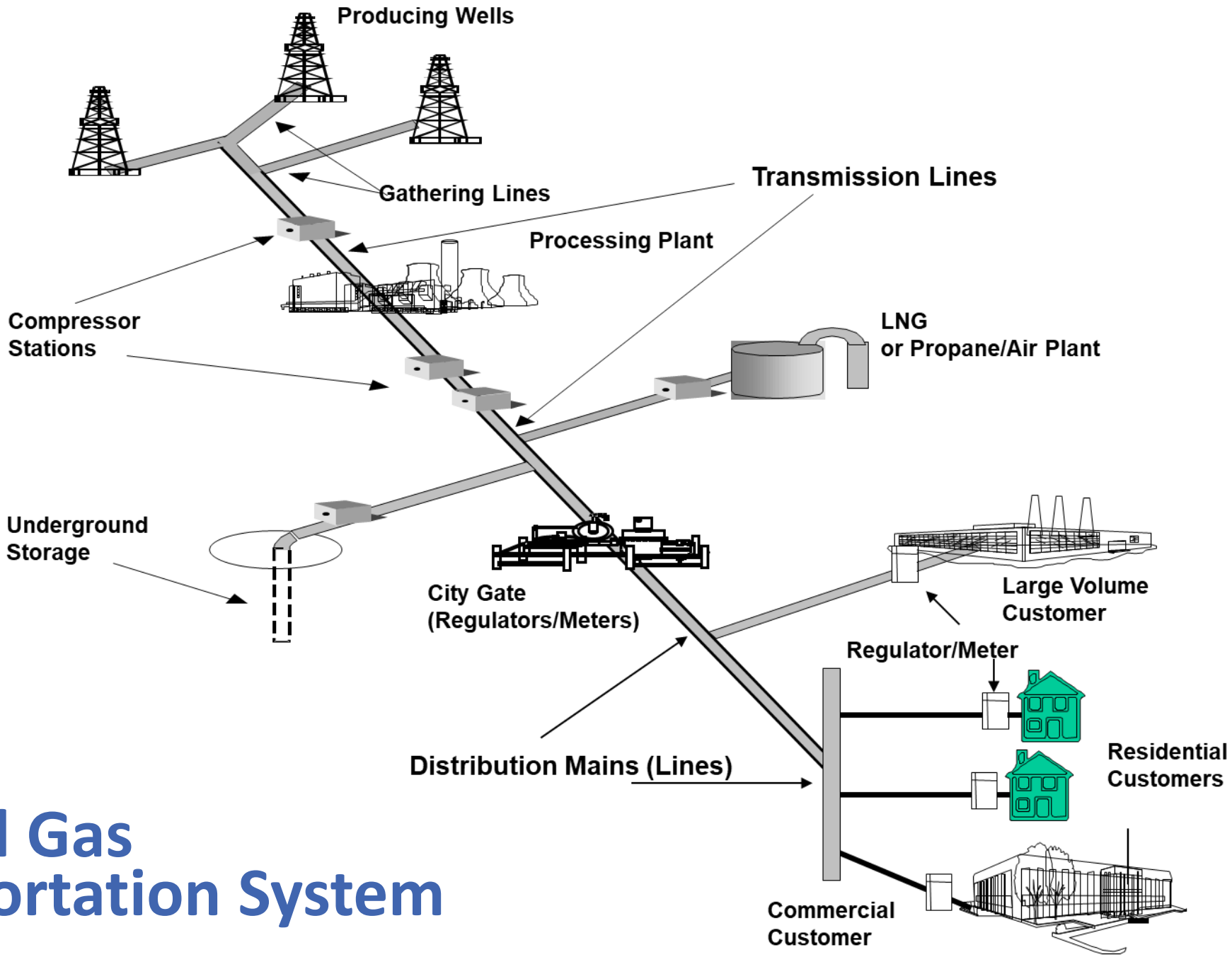
System Supply Customer

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

Transportation Customer

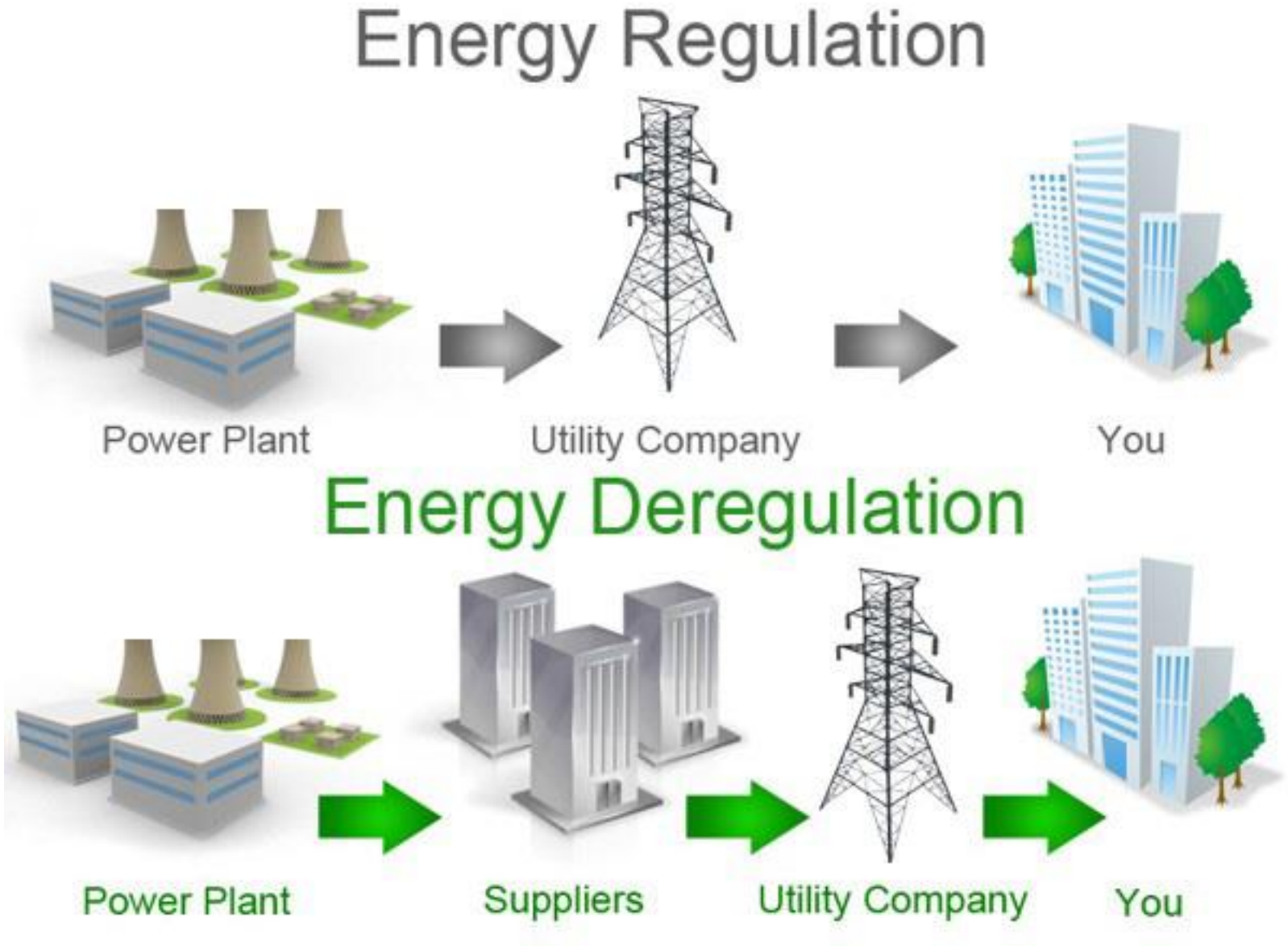
- Purchased by marketer
- Transported by marketer
- Distributed by utility
- Maintained by utility
- Billed by both

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



Before and After Regulation

Source: US Gas & Energy

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

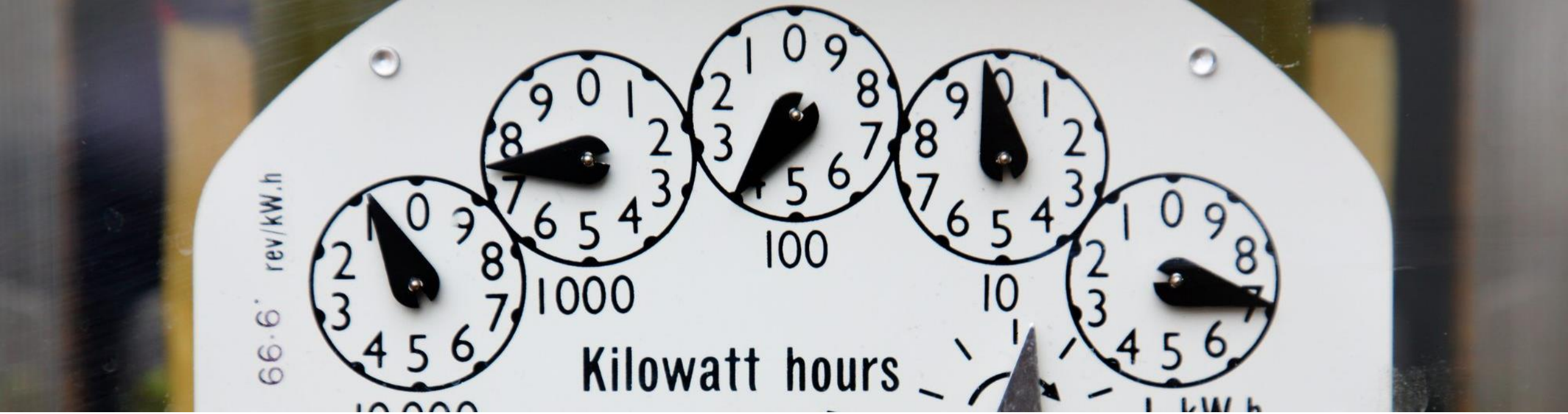
Measures heating energy demand and indicates how far the average temp falls below 65°F

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?

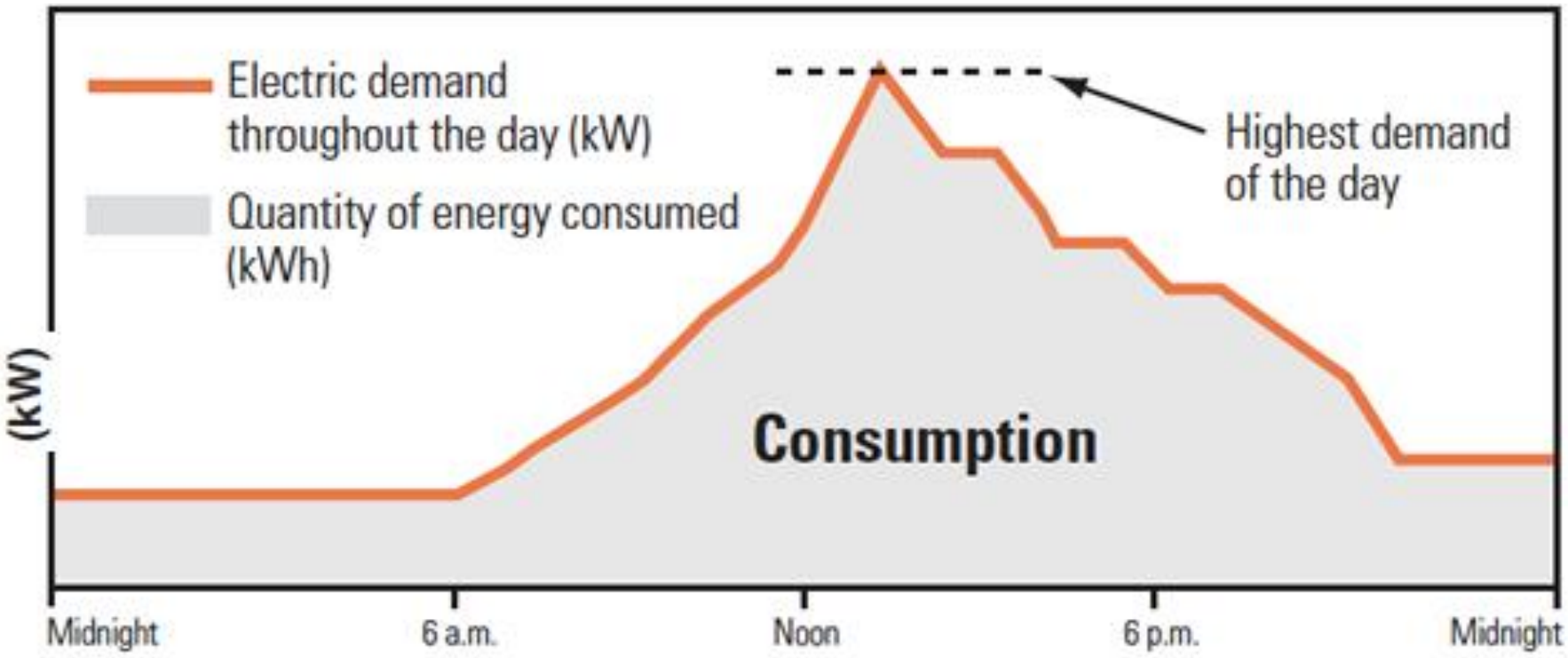
Kilowatt (kW)

- 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 kW x $13.80 = $6,900
- 500 kW x $1.85 = $925

Therm vs. kWh

	Btu	Multiplier	Btu	Unit Cost	Multiplier	Total Cost
1 Them	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

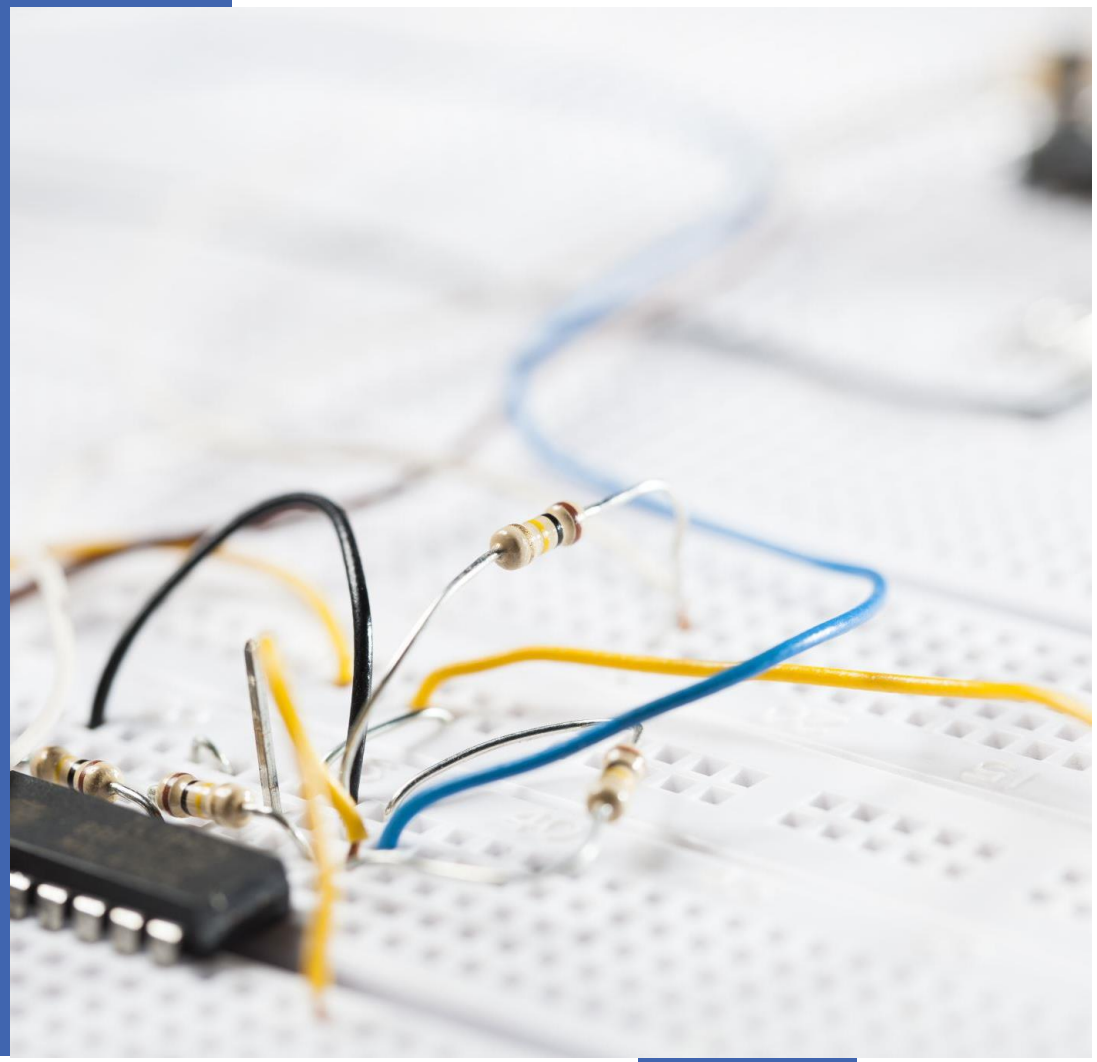
On-Peak vs. Off-Peak Rates

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

Energy Usage			
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	$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	
Off-Peak	14,918 kWh	x	$0.04900	$730.98	
Total Energy Charges	43,942 kWh			$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

Customer Detail					**Bill Due: 06/20/2018**
ABC ELEMENTARY SCHOOL EDUCATION LANE XYZ, WI 00000				Account Number Service From Service To Bill Days	2205 03/28/2018 04/28/2018 31
Electric Power Usage					
Energy Usage On-Peak Off-Peak Total Energy	29,024 kWh 14,918 kWh 43,942 kWh			On-Peak Maximum Demand Date/Time	176.20 kW 04/18/2018 1:00 PM
Total Reactive Energy	13,190 kvarh			Maximum Measured Demand Date/Time	176.20 kW 04/18/2018 1:00 PM
On-Peak = 7am-9pm, M thru F				(8) Distribution Demand Date/Time	319.50 kW 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					(9) 95.8%
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					
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Demand	176.20 kW	x	$8.00	$1,409.60	
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Commitment to Community Charge Late Charge Balance Forward					$35.00 $0.00 $0.00
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 Service From Service To Bill Days	2205 03/28/2018 04/28/2018 31
Electric Power Usage					
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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					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

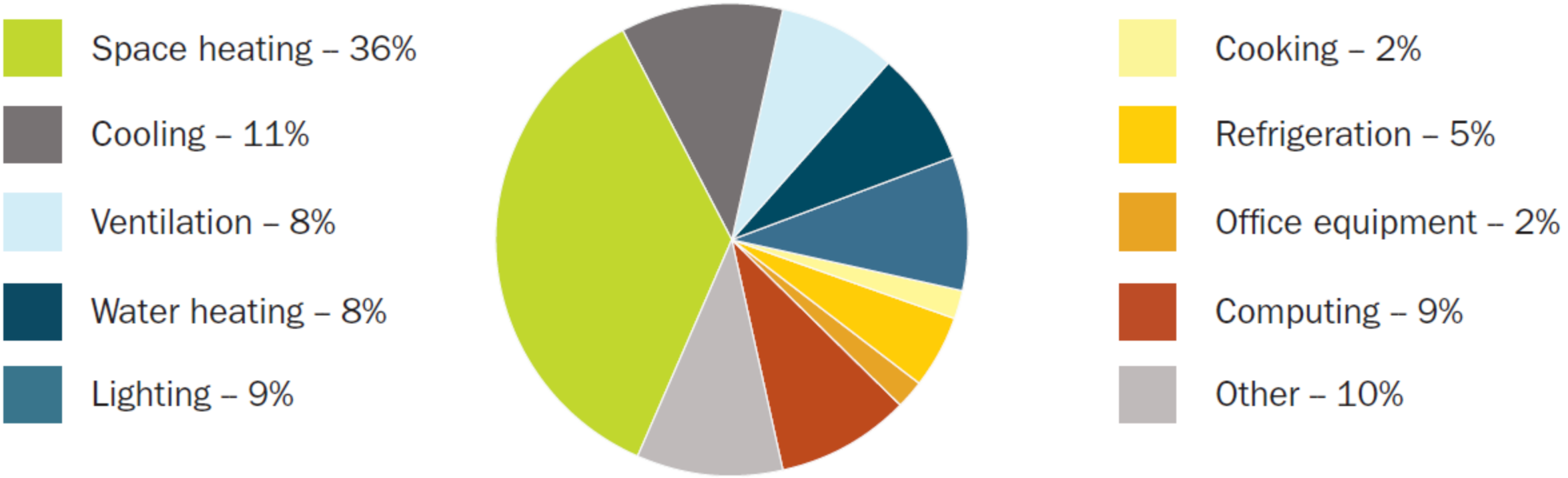
Non-Residential Gas Service

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**

Energy Sources



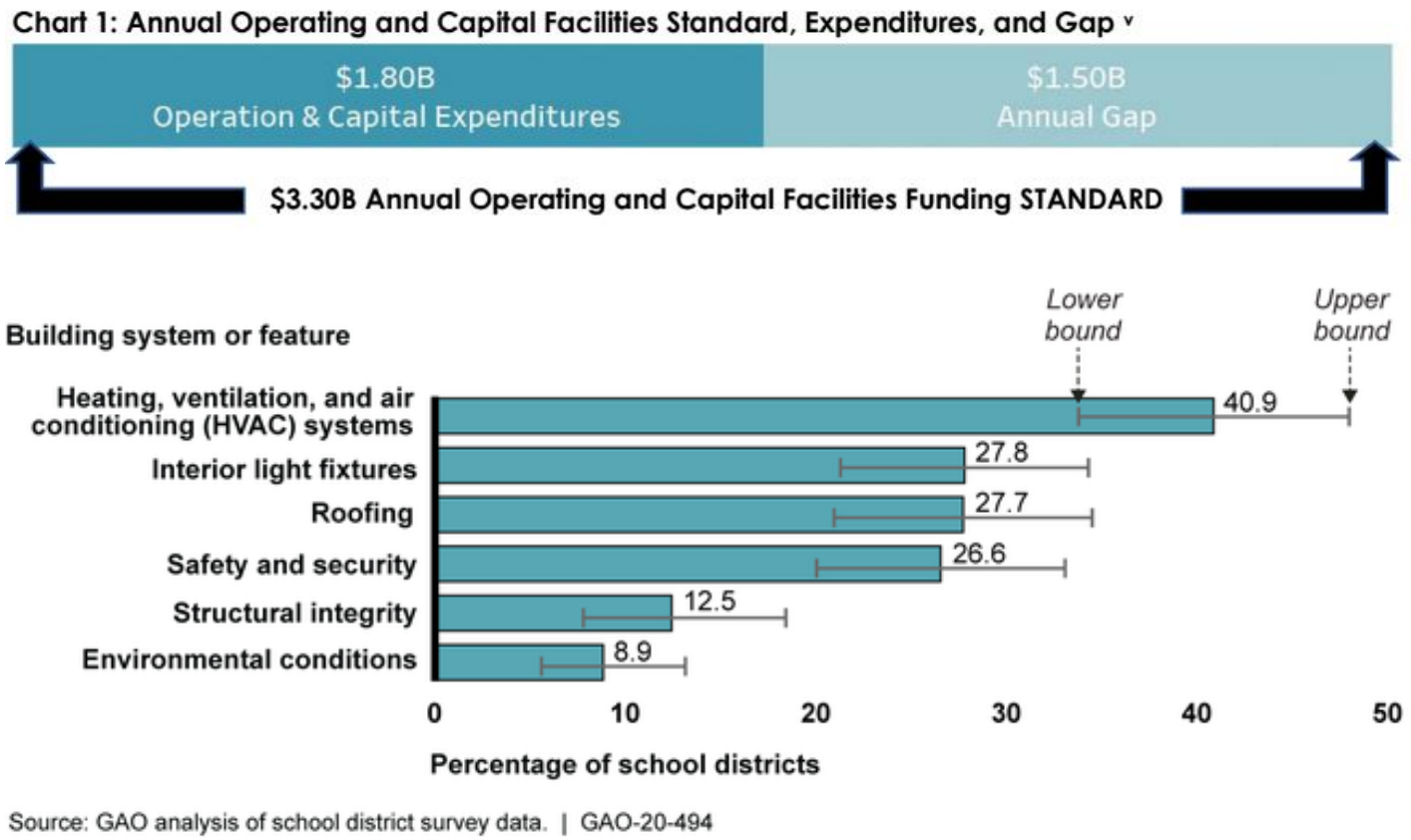
Data from 2016 Commercial Buildings Energy Consumption Survey

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



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**

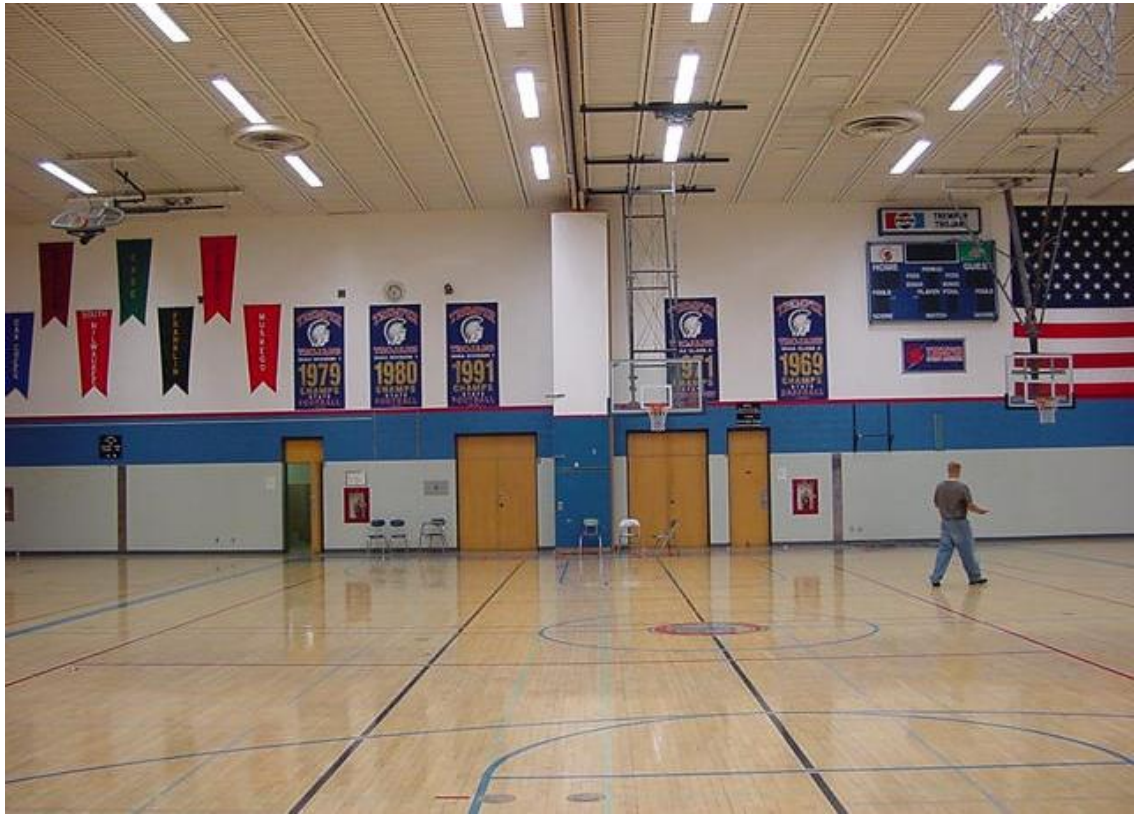
- Yearly Operating Cost - **$2.58**
- Energy Usage - **12w**
- Brightness(Lumens) - **800**
- Bulb Lifetime- **50,000 Hours+**

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

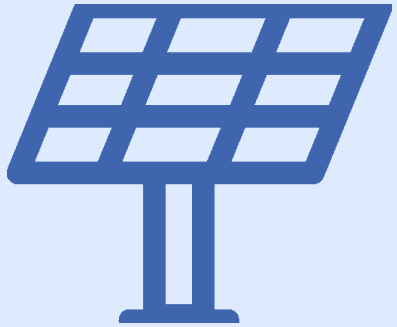
Roof-mount

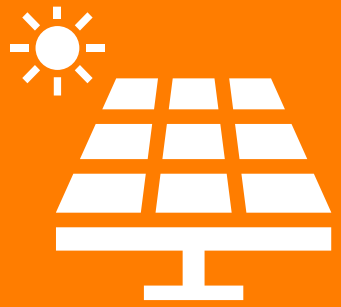
Common option requiring minimal maintenance

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?