Lake County 2018 Energy Audit Report

Prepared by:

CCJM Engineers, Ltd.
303 East Wacker Drive, Suite 303
Chicago, IL 60601
Telephone: 312 669-0609
Issued: September 12, 2018
Ref: CCJM#1717-075

TABLE OF CONTENTS

INTRODUCTION

Lake County has a strong record of sustainably managing its many facilities. Renovations and equipment replacements to reduce energy consumption have been conducted consistently since 2008, including HVAC upgrades, lighting retrofits, and implementation of a building automation system. In 2018, the County began a new series of energy audits through its sustainability consultant, Quercus Consulting, and the engineering firm CCJM. This report summarizes the findings for the following Lake County facilities:

- Administrative Tower/Courts Complex
- Coroner's Office
- Public Defender's Office
- Adult Probation Office
- Central Permit Facility and Administrative Offices

The following facilities will receive energy audits in the next phase of this project, in 2019:

- Health Center in Waukegan
- Northeast Central Pump Station
- Bridlewood Reservoir
- Hawthorne Center Lift Station

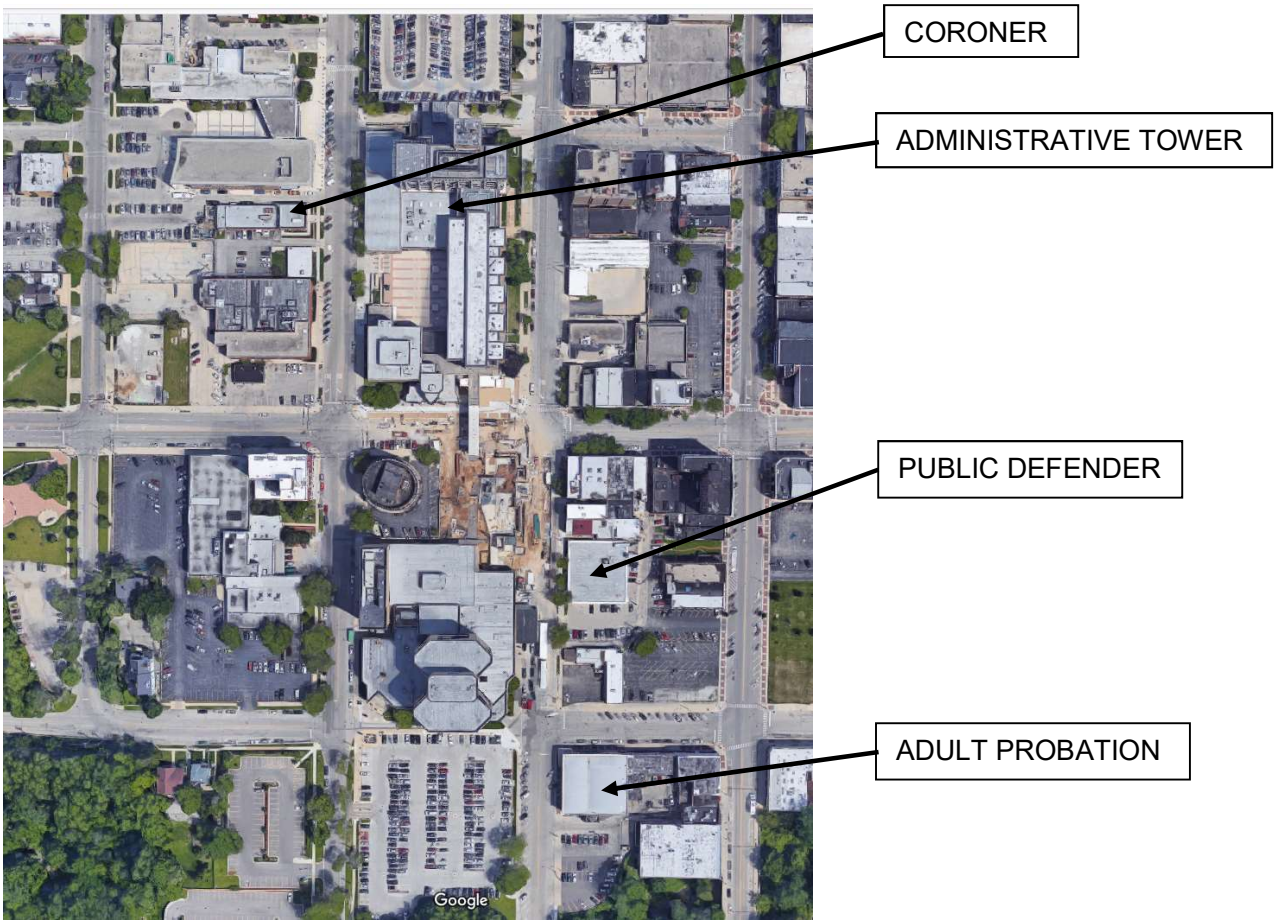
The County's water treatment plants also will receive energy assessments facilitated by the Illinois Environmental Protection Agency. Mill Creek and Vernon Hills should be complete by the end of 2018, and Des Plaines will be assessed in 2019.

The goal of this energy audit process is to collect and document actual energy consumption against industry benchmarks per facility type to (1) validate that energy conservation measures (ECMs) implemented since the last energy audit in 2008 have resulted in energy savings, and (2) identify any additional ECMs and energy best practices that can be applied to these properties and serve as a template for other facilities in the Lake County portfolio.

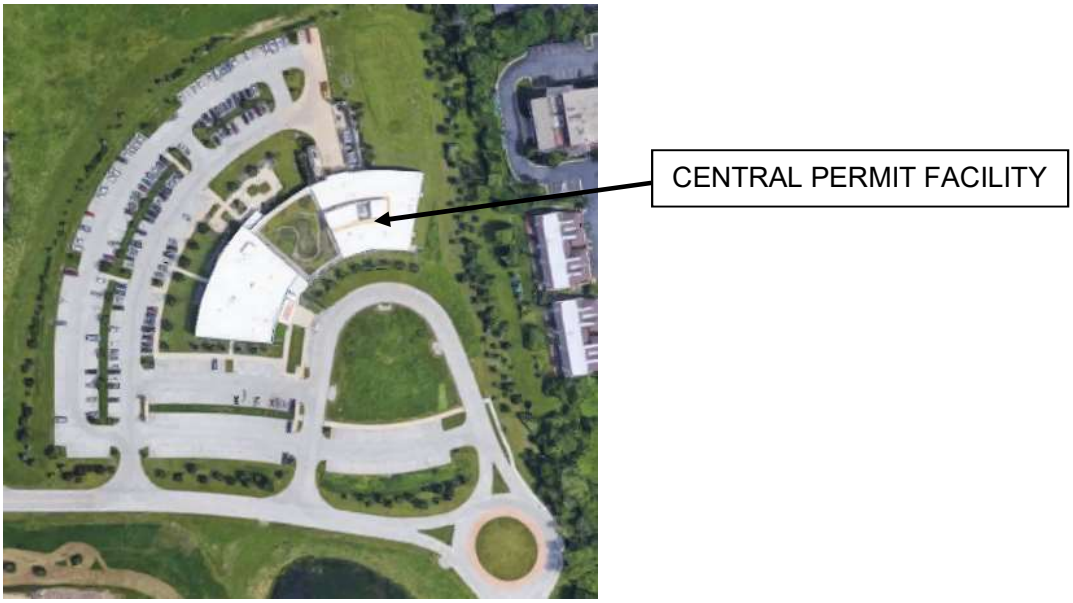
The audits to date revealed that equipment replacements implemented in these facilities over the past 10 years have ensured that they are operating at an optimal level of energy consumption for their size and function. In fact, the actual cost savings average is at least 50% higher[1] than the cost savings projected at the time of the first energy audits in 2008. There are no new recommendations for the Central Permit facility, whereas each of the others would benefit from lighting retrofits. Window replacements in Court Building C would realize additional savings.

[1] Electrical rates have increased by at least 15% since the 2008 audit, and natural gas rates have decreased by around 7%; the 50% figure accounts for this, but the rate changes are not accounted for in the facility-specific comparisons in Figures 5 and 10.

Lake County Downtown Waukegan Buildings



Central Permit Facility, Libertyville



ADMINISTRATIVE TOWER / COURTS COMPLEX

Overview

This property is a complex composed of four buildings totaling 300,000 square feet served by a central plant of boilers and water-cooled chillers. The interconnected buildings include Administrative Tower 'A', County Administrative Building 'B', and Court Buildings 'C' and 'D'.

Central Plant Serving A, B, C, and D

1. Hot Water System
    a. Five Fulton "Vantage" 4,000 mbh condensing hydronic boilers, 90% thermal efficiency, installed in 2011
    b. Variable volume hot water pumps

2. Chilled Water
    a. Trane 450-ton centrifugal chiller, installed in 1999
    b. Two McQuay 290-ton centrifugal chillers with oil-free magnetic bearings and dual compressors, installed in 2011
    c. Variable volume chilled water pumps
    d. The two McQuay chillers are used for partial load efficiency during lower load conditions. The Trane chiller is staged on as the building load increases.
    e. Cooling tower on top of Administrative Tower 'A' with three fans retrofitted with VFD controls

3. Domestic Hot Water
    a. Bell & Gossett variable speed triplex domestic booster pump
    b. Lochinvar electric storage water heaters
    c. Navien condensing, tankless water heaters, 96% thermal efficiency, installed 2014

Figure 1: Summary of Annual Utility Usage 2016-2017

Utility	Unit	Yearly	
Electric	kWh	Energy:	5,102,491
		Cost:	$430,628
		kWH/ft^2	16.99
		$/ft^2	$1.43
Natural Gas	Therms	Energy:	140,567
		Cost:	$82,345
		kBtu/ft^2	46.81
		$/ft^2	$0.27
Carbon Dioxide*	Pounds	Electricity	4,139,651
		Natural Gas	1,698,235
		Total	5,837,886
Total	Million BTU	Energy:	31,466
		Cost:	$512,972
		kBtu/ft^2	104.78
		$/ft^2	$1.71
Water	1000 Gallons	Water:	3,937
		Cost:	$18,568

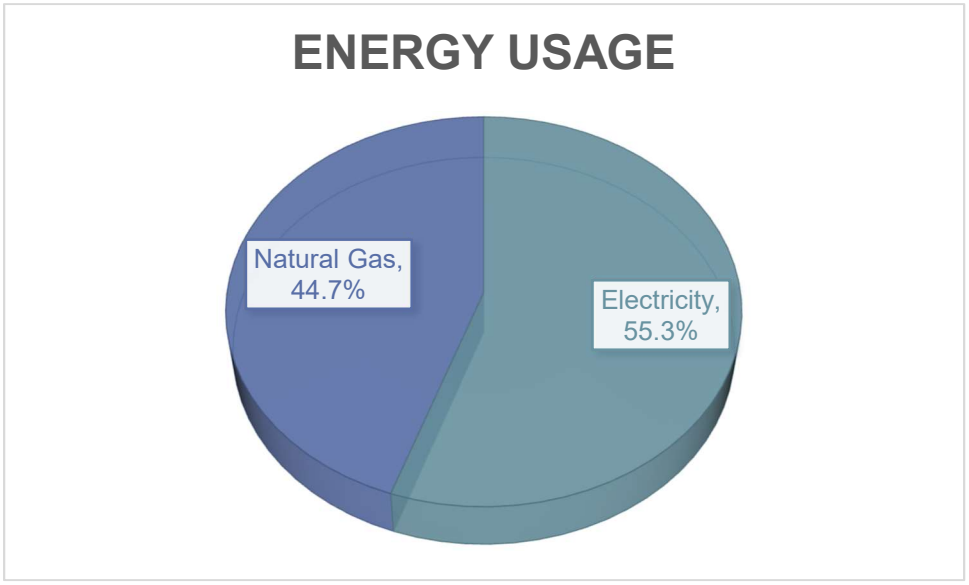
*Source: Energy Information Administration

Figure 2: Median Property Comparison

Metric	Unit	18 N County	Median Property*
Source Energy Intensity	kBtu/ft^2/yr	231	263
Site Energy Intensity	kBtu/ft^2/yr	104	119
Source Energy Use	kBtu/yr	69,425,996	79,261,430
Site Energy Use	kBtu/yr	31,466,400	35,924,181
Energy Cost	Dollars ($)	$512,972	$589,036
GHG Emissions	Metric Tons CO2e	3,965	4,527

*Source: EPA Portfolio Manager

Figure 3: Annual Energy Usage & Cost by Percent



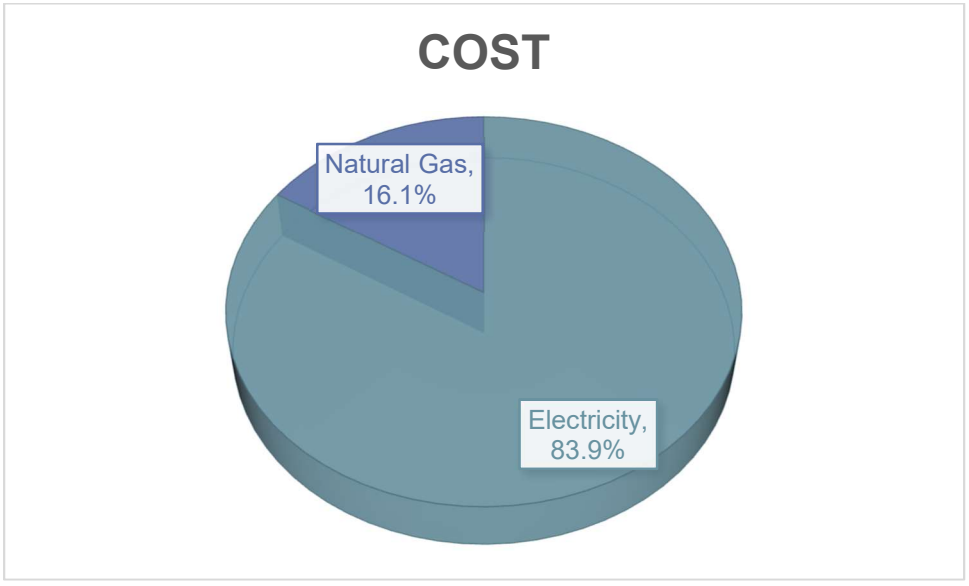


Figure 4: Year Over Year Comparison

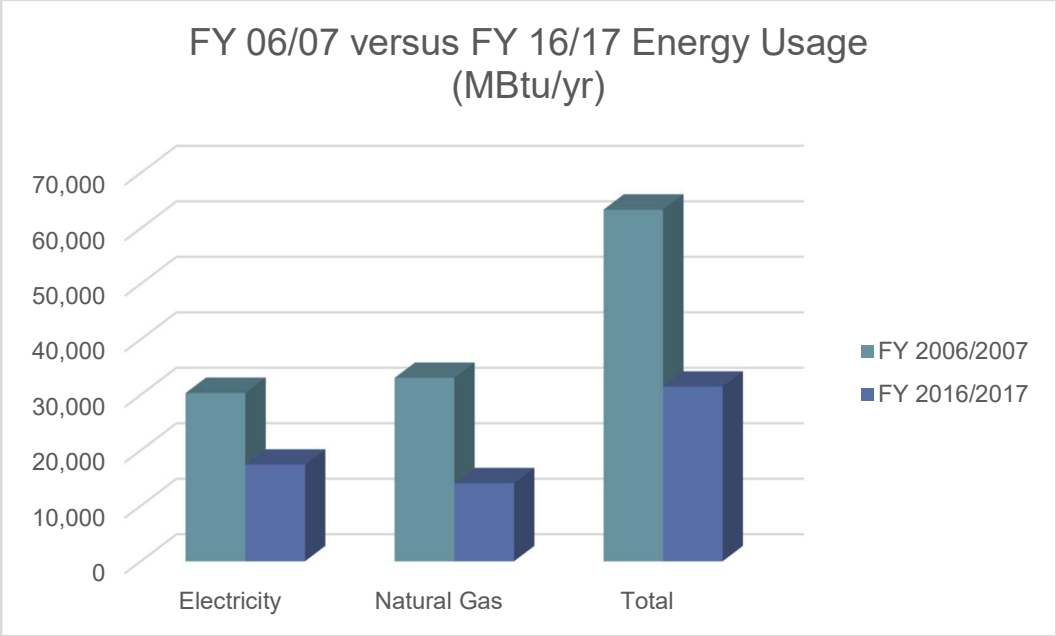


Figure 5: ECMs Implemented

ECM*	Description	Energy Cost Savings ($/yr)
1	Modify chilled water piping and improve chiller efficiency.	$38,000
2	Oxygen trim control of boiler burners.	$17,000
3	Convert chilled water pumping to primary/variable secondary.	$10,000
5	Replace booster pumps.	$4,000
6	Install VFDs on cooling tower fans.	$3,000
7	Building A - improved windows and insulation.	$32,000
8	Building A&B - modify controls to save energy when unoccupied	$62,000
9	Building A - Lighting Retrofits	$32,000
12	Building B – Lighting Retrofits	$19,000
15	Building C - Lighting Retrofits	$72,000
16	Underground parking garage lighting retrofits	$16,000
17	Building D - Modify controls to save energy when unoccupied	$40,000
18	Building D - Lighting Retrofits	$17,000
	Total Projected Savings	$362,000
	Actual Savings (2006/07 vs. 2016/17)	$853,607

*Source: Grumman/Butkus Associates 2009 Energy Audit

Over the last decade, Lake County has implemented many of the recommended high impact Energy Cost Savings Measures to reduce the utility footprint of the Administrative Tower and Courts Complex. The data indicates that the implementation of a modern building management system in combination with other equipment efficiency upgrades resulted in utility savings exceeding the original estimates. The ECMs implemented in this building complex can be applied to other buildings in the Lake County portfolio, both large and small, to maximize energy savings potential.

CORONER'S OFFICE

Overview

The Coroner's Office is 10,135 square feet and served by its own heating, cooling, and ventilation systems. It has received recent upgrades within last two years to all of its main mechanical systems.

Building Systems

1. Envelope
    a. Insulated masonry with U-value of approximately U-0.131. The windows have been upgraded to double-pane. Insulation has been added to the roof for approximate U-value of U-0.093.

2. Hot Water System
    a. Two Fulton "Endura" 750 mbh condensing hydronic boilers, 97.1% thermal efficiency
    b. Variable volume inline hot water pumps

3. Chilled Water
    a. Daikin 60-ton air-cooled condenserless scroll compressor chiller w/ remote air-cooled condenser
    b. Variable volume inline chilled water pumps

4. Ventilation
    a. Two rooftop air handling units with hot water and chilled water coils
    b. Rooftop exhaust fans

5. Domestic Hot Water
    a. PVi "Conquest" 199 mbh condensing water heater, 97% thermal efficiency
    b. Variable volume recirculation pump

6. Lighting
    a. T-8 lamps with electronic ballasts, compact fluorescents, manual switches

Figure 6: Summary of Annual Utility Usage 2016-2017

Utility	Unit	Yearly	
Electric	kWh	Energy:	197,060
		Cost:	$16,718
		kWH/ft^2	19.44
		$/ft^2	$1.65
Natural Gas	Therms	Energy:	10,863
		Cost:	$9,461
		kBtu/ft^2	107.18
		$/ft^2	$0.93
Carbon Dioxide*	Pounds	Electricity	159,875
		Natural Gas	131,239
		Total	291,114
Total	Million BTU	Energy:	1,759
		Cost:	$26,179
		kBtu/ft^2	173.52
		$/ft^2	$2.58
Water	1000 Gallons	Water:	134
		Cost:	$731

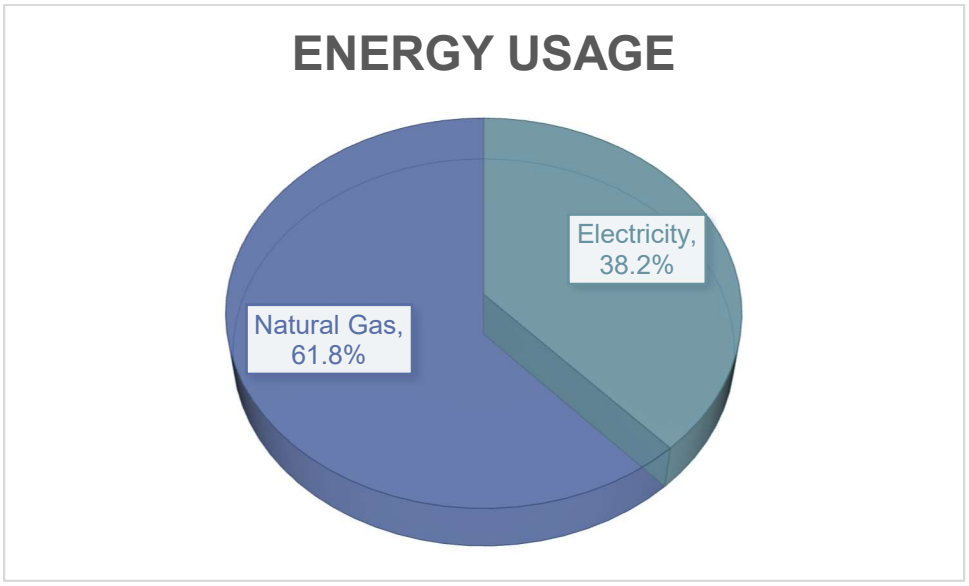
*Source: Energy Information Administration

Figure 7: Median Property Comparison

Metric	Unit	26 N MLK	Median Property*
Source Energy Intensity	kBtu/ft^2/yr	320	174
Site Energy Intensity	kBtu/ft^2/yr	173	94
Source Energy Use	kBtu/yr	3,251,852	1,763,744
Site Energy Use	kBtu/yr	1,758,669	953,989
Energy Cost	Dollars ($)	$26,179	$14,210
GHG Emissions	Metric Tons CO2e	182	98

*Source: EPA Portfolio Manager. Note that data is limited with regards to comparison to other coroner's office facilities. A standard medical office was used for comparison. There are other coroner process loads, such as refrigeration, that cannot be accounted for in the median property comparison.

Figure 8: Annual Energy Usage & Cost by Percent



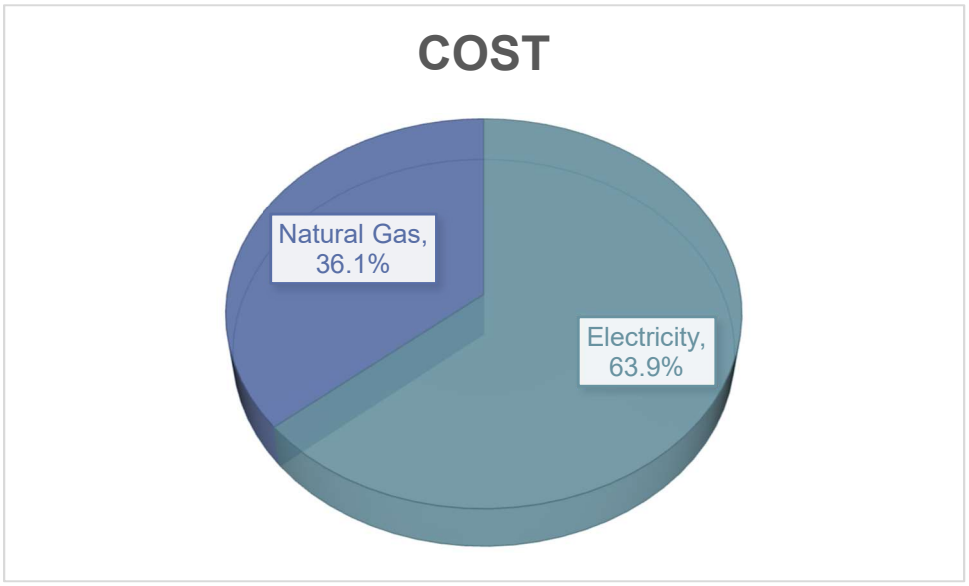


Figure 9: Year Over Year Comparison

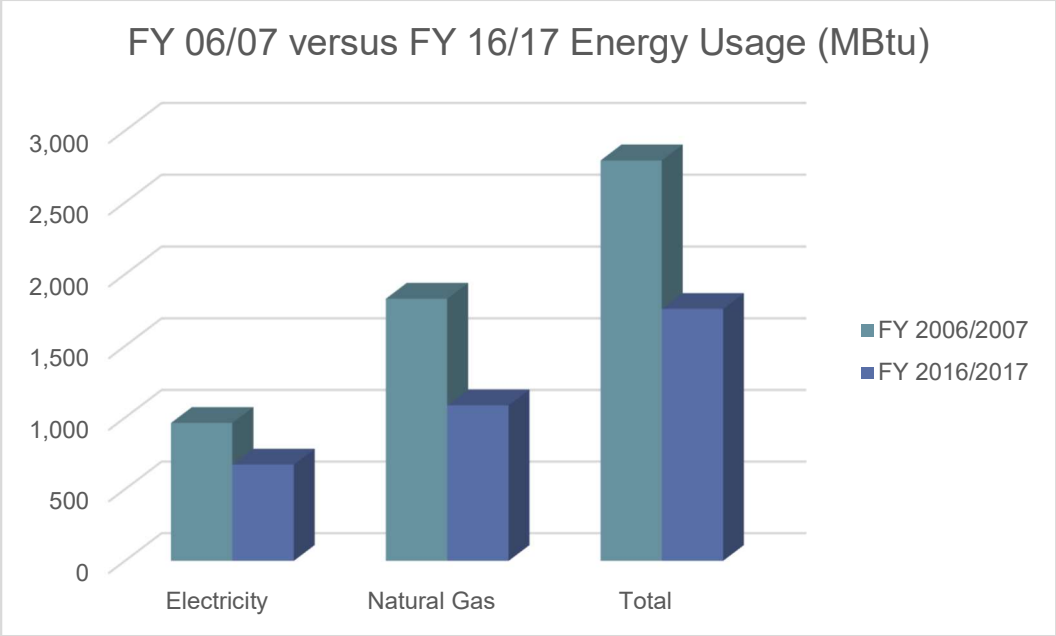


Figure 10: ECMs Implemented

ECM*	Description	Energy Cost Savings ($/yr)
35	Turn off AHU during unoccupied hours	$4,000
36	Lighting retrofits	$1,000
	Total Projected Savings	$5,000
	Actual Savings (2006/07 vs. 2016/17)	$25,483

*Source: Grumman/Butkus Associates 2009 Energy Audit

In addition to the ECMs implemented, the Coroner's Office received other upgrades after the 2009 audit similar to the Administrative Tower/Courts Complex, including high efficiency water heaters, high efficiency boilers, variable speed pumps, updated chillers, and updated rooftop units. The combination of all of these features has led to significant energy usage savings in a relatively small building.

ADULT PROBATION

Overview

The Adult Probation building is 32,500 square feet and served by its own heating, cooling, and ventilation systems.

Building Systems

1. Envelope
    a. Insulated masonry with U-value of approximately U-0.131. The windows have been upgraded to double-pane. Insulation has been added to the roof for approximate U-value of U-0.093.

2. Hot Water System
    a. Two A.O. Smith “Legend 2000” 750 mbh condensing hydronic boilers, 90% thermal efficiency, installed in 2006
    b. Constant volume primary and secondary pumps.

3. Chilled Water
    a. Carrier 96-ton liquid screw chiller with remote condenser, installed in 2007
    b. Constant volume chilled water pumps.

4. Ventilation
    a. Indoor Carrier air handling unit with hot water and chilled water coils, and variable speed fans
    b. VAV reheat boxes
    c. Building exhaust fans on occupancy schedule control

5. Domestic Hot Water
    a. 60 gallon storage water heater, 82% thermal efficiency
    b. Constant volume recirculation pump

6. Lighting
    a. T-8 lamps with electronic ballasts and compact fluorescents
    b. Manual wall switches and occupancy sensors

Figure 11: Summary of Annual Utility Usage 2016-2017

Utility	Unit	Yearly	
Electric	kWh	Energy:	390,372
		Cost:	$35,899
		kWH/ft^2	12.01
		$/ft^2	$1.10
Natural Gas	Therms	Energy:	8,670
		Cost:	$5,526
		kBtu/ft^2	26.68
		$/ft^2	$0.17
Carbon Dioxide*	Pounds	Electricity	316,709
		Natural Gas	104,740
		Total	421,449
Total	Million BTU	Energy:	2,199
		Cost:	$41,425
		kBtu/ft^2	67.66
		$/ft^2	$1.27
Water	1000 Gallons	Water:	163
		Cost:	$756

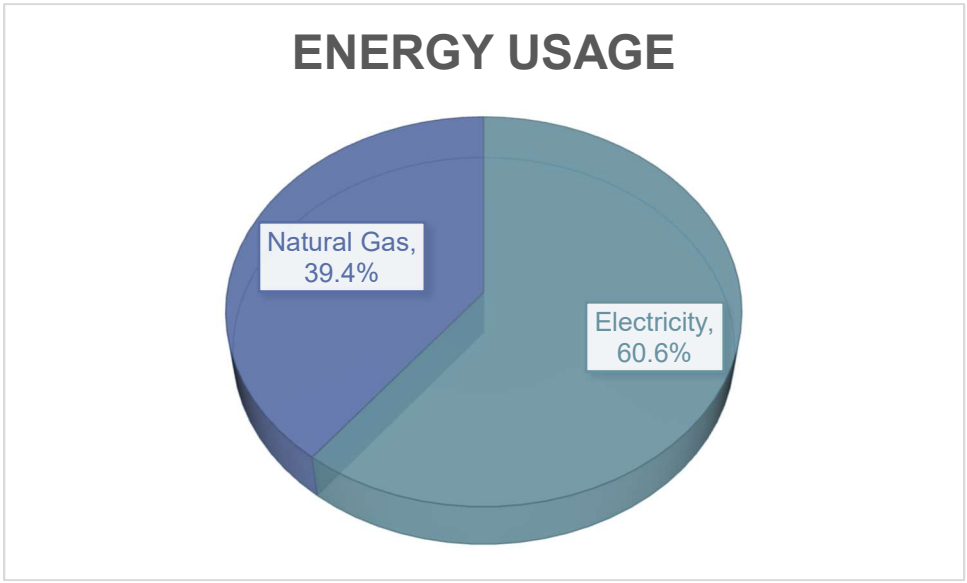
*Source: Energy Information Administration

Figure 12: Median Property Comparison

Metric	Unit	215 W Water	Median Property*
Source Energy Intensity	kBtu/ft^2/yr	156	209
Site Energy Intensity	kBtu/ft^2/yr	67	90
Source Energy Use	kBtu/yr	5,092,670	6,797,588
Site Energy Use	kBtu/yr	2,198,906	2,935,110
Energy Cost	Dollars ($)	$41,425	$55,343
GHG Emissions	Metric Tons CO2e	292	390

*Source: EPA Portfolio Manager

Figure 13: Annual Energy Usage & Cost by Percent



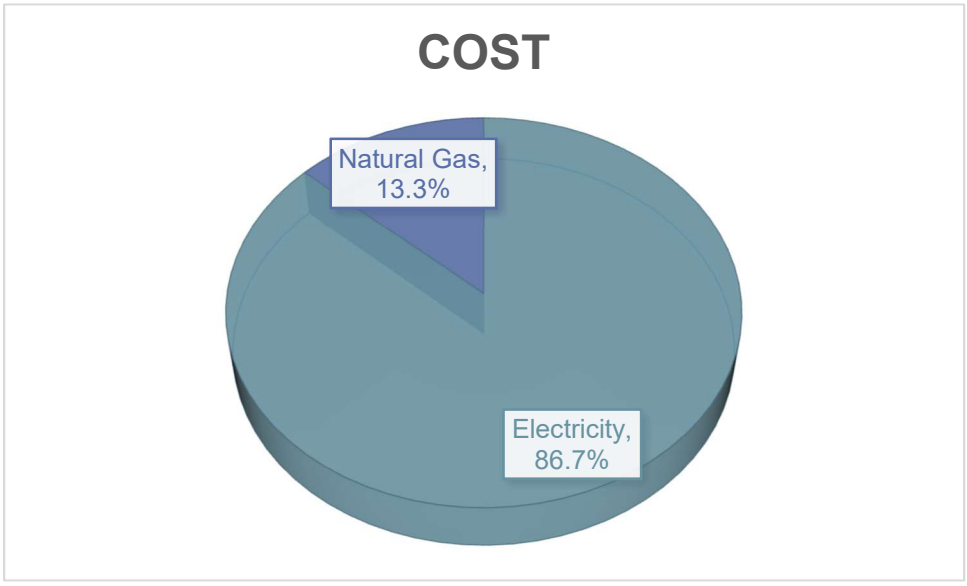
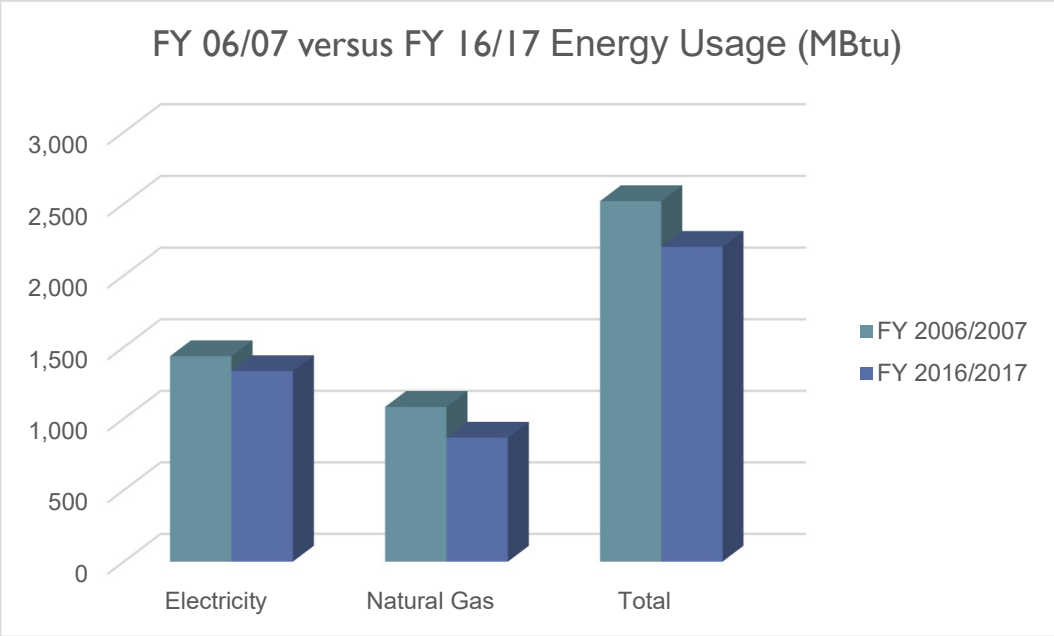


Figure 14: Year Over Year Comparison



ECMs Implemented

No Energy Cost Savings Measures were identified during the previous energy audit. Upgrades implemented since the 2009 audit, including new high efficiency boilers, new variable volume air handling unit, and occupancy controls have realized annual energy cost savings of $14,751 in 2016/17 compared to same time period in 2006/07. Even though this facility did not have ECMs recommended by an audit, the data collected and analyzed clearly indicates that the equipment upgrades have resulted in a significant reduction in energy consumption.

PUBLIC DEFENDER OFFICE

Overview

The Public Defender Office is 20,674 square feet and served by its own heating, cooling, and ventilation systems.

Building Systems

1. Envelope
    a. Insulated masonry with U-value of approximately U-0.131. The windows have been upgraded to double-pane. Concrete roof with layer of insulation for approximate U-value of U-0.093.

2. Hot Water System
    a. Two Patterson-Kelly “Mach” 750 mbh condensing hydronic boilers, 95% thermal efficiency, installed in 2008
    b. Constant volume primary pumps and variable volume secondary pumps

3. Chilled Water
    a. McQuay 60-ton air-cooled chiller on roof
    b. Constant volume chilled water pumps

4. Ventilation
    a. Indoor McQuay air handling unit with hot water and chilled water coils, and variable speed fans
    b. VAV reheat boxes
    c. Building exhaust fans on occupancy schedule control

5. Domestic Hot Water
    a. A.O. Smith “Master-Fit” 81-gallon storage water heater, 80% thermal efficiency, installed in 2008
    b. Constant volume recirculation pump

6. Lighting
    a. T-5 lamps with electronic ballasts and compact fluorescents
    b. Manual wall switches and occupancy sensors
    c. LED exit signs

Figure 15: Summary of Annual Utility Usage 2016-2017

Utility	Unit	Yearly	
Electric	kWh	Energy:	167,844
		Cost:	$16,827
		kWH/ft^2	8.12
		$/ft^2	$0.81
Natural Gas	Therms	Energy:	3,952
		Cost:	$4,909
		kBtu/ft^2	19.12
		$/ft^2	$0.24
Carbon Dioxide*	Pounds	Electricity	136,172
		Natural Gas	47,748
		Total	183,920
Total	Million BTU	Energy:	968
		Cost:	$21,737
		kBtu/ft^2	46.82
		$/ft^2	$1.05
Water	1000 Gallons	Water:	76
		Cost:	$427

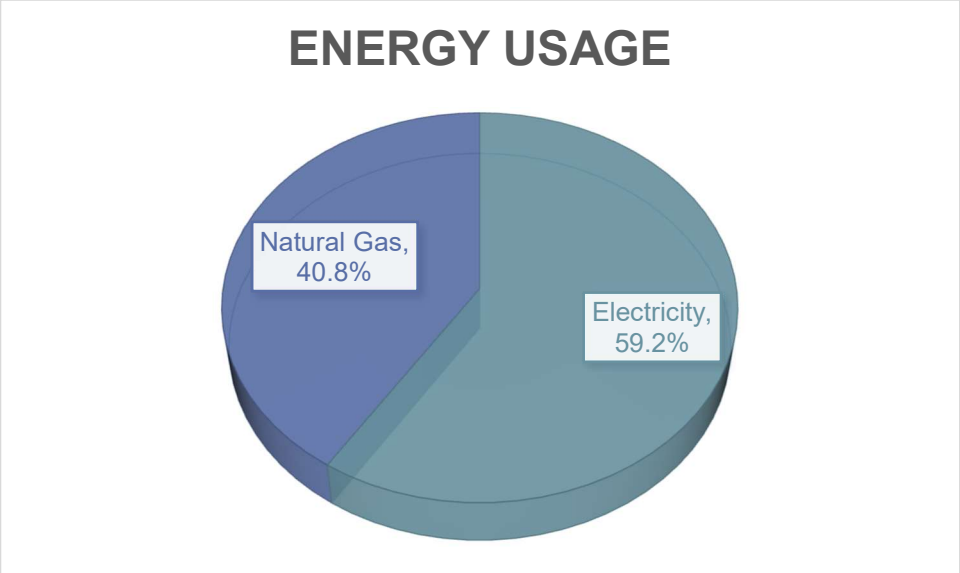
*Source: Energy Information Administration

Figure 16: Median Property Comparison

Metric	Unit	15 S County	Median Property*
Source Energy Intensity	kBtu/ft^2/yr	107	195
Site Energy Intensity	kBtu/ft^2/yr	46	85
Source Energy Use	kBtu/yr	2,213,187	4,042,172
Site Energy Use	kBtu/yr	967,906	1,767,746
Energy Cost	Dollars ($)	$21,737	$39,605
GHG Emissions	Metric Tons CO2e	126	231

*Source: EPA Portfolio Manager

Figure 17: Annual Energy Usage & Cost by Percent



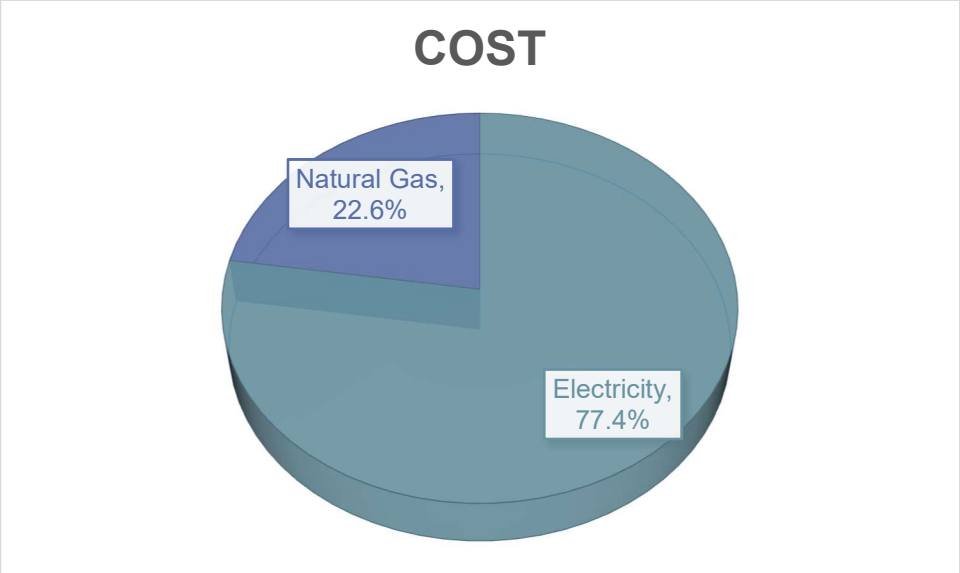
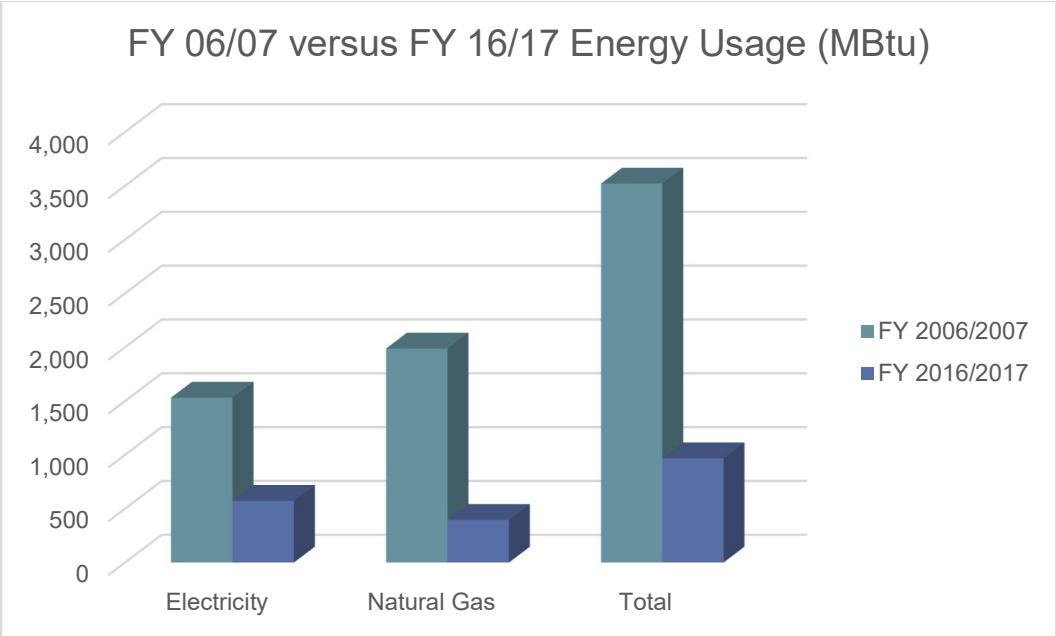


Figure 18: Year Over Year Comparison



ECMs Implemented

No Energy Cost Savings Measures were identified during the previous energy audit. Upgrades implemented since the 2009 audit, including new high efficiency boilers, variable volume pumps, new high efficiency variable volume air handling units, upgraded lighting, and occupancy controls have realized annual energy cost savings of $44,911 in 2016/17 compared to same time period in 2006/07. Even though this facility did not have ECMs recommended by an audit, the data collected and analyzed clearly indicates that the equipment upgrades have resulted in a significant reduction in energy consumption.

CENTRAL PERMIT FACILITY

Overview

The Central Permit Facility is 64,152 square feet and served by its own heating, cooling, and ventilation systems. The building was constructed in 2010.

Building Systems

1. Envelope
    a. Insulated masonry with U-value of approximately U-0.088. The windows are tinted double pane. Steel roof with layer of insulation for approximate U-value of U-0.050.

2. Hot Water System
    a. Two Buderus 4,000 mbh condensing hydronic boilers, 97.6% thermal efficiency
    b. Constant volume primary pumps

3. Chilled Water
    a. Two York 270-ton water cooled screw chillers
    b. Baltimore 270-ton cooling towers with variable speed fans
    c. Constant volume cooling tower pumps, constant volume primary pumps, variable volume secondary pumps

4. Ventilation
    a. Indoor air handling unit with hot water and chilled water coils, and variable speed fans
    b. Indoor laboratory makeup air unit with hot water and chilled water coils, variable speed fans, and energy recovery coil runaround loop.
    c. VAV reheat boxes
    d. Building exhaust fans on occupancy schedule control

5. Domestic Hot Water
    a. Storage water heater, 80% thermal efficiency
    b. Constant volume recirculation pump

6. Lighting
    a. T-5 & T-8 lamps with electronic ballasts and compact fluorescents
    b. Manual wall switches and occupancy sensors, lighting control system dimming and time of day scheduling
    c. LED exit signs

Figure 19: Summary of Annual Utility Usage 2016-2017

Utility	Unit	Yearly	
Electric	kWh	Energy:	1,696,744
		Cost:	$146,034
		kWH/ft^2	26.45
		$/ft^2	$2.28
Natural Gas	Therms	Energy:	37,185
		Cost:	$21,359
		kBtu/ft^2	57.96
		$/ft^2	$0.33
Carbon Dioxide*	Pounds	Electricity	1,376,568
		Natural Gas	449,244
		Total	1,825,812
Total	Million BTU	Energy:	9,508
		Cost:	$167,393
		kBtu/ft^2	148.21
		$/ft^2	$2.61
Water	1000 Gallons	Water:	632
		Cost:	$7,337

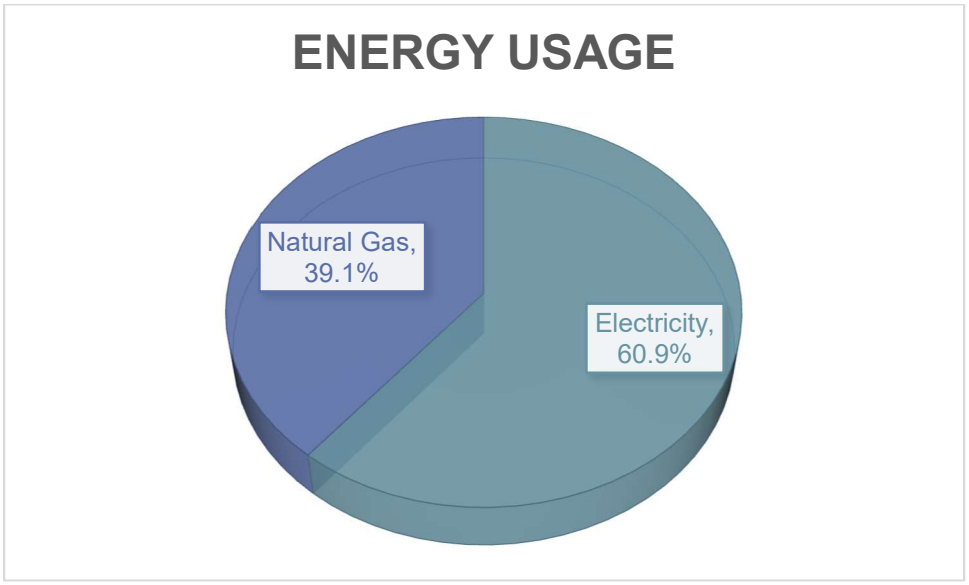
*Source: Energy Information Administration

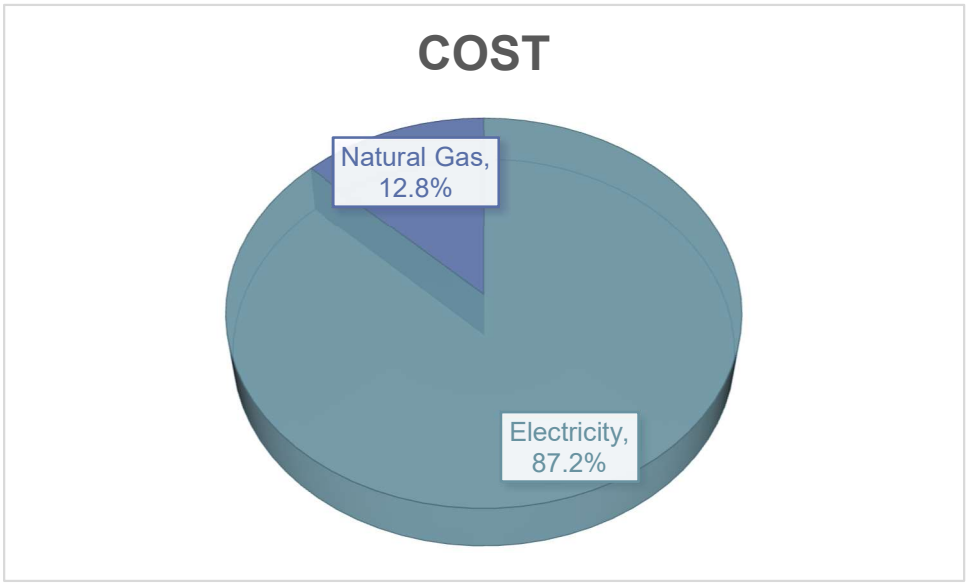
Figure 20: Median Property Comparison

Metric	Unit	500 W Winchester	Median Property*
Source Energy Intensity	kBtu/ft^2/yr	344	229
Site Energy Intensity	kBtu/ft^2/yr	148	98
Source Energy Use	kBtu/yr	22,082,796	14,732,992
Site Energy Use	kBtu/yr	9,507,791	6,343,317
Energy Cost	Dollars ($)	$167,393	$111,494
GHG Emissions	Metric Tons CO2e	1,267	845

*Source: EPA Portfolio Manager

Figure 21: Annual Energy Usage & Cost by Percent





ECMs Implemented

This building was constructed after the 2009 energy audit, so no Energy Cost Savings Measures have been identified and there has been no need for equipment upgrades. The systems that are installed are comparable to all of the high efficiency systems installed in other buildings in this report. When comparing to the median property, it should be noted that there is limited comparison data for office buildings with extensive testing laboratories. There are process loads associated with various testing equipment and procedures that increase the buildings energy use intensity over a median baseline building. Considering that the age of the main building equipment is relatively new, and there has been little improvement in energy code requirements and equipment efficiencies between 2010 and 2018, there are likely no ECMs that would create a significant reduction in energy usage. Maintaining and operating equipment per the standards used in other buildings will result in stable energy usage into the future.

NEW ECM RECOMMENDATIONS

The energy audit process revealed several new Energy Cost Savings Measures that could result in cost savings.

- Building C that houses the courts still had many original single pane windows that were not replaced with the remainder of the windows in the Administrative Tower/Courts Complex. Although a complex project to implement within court schedules, and a lengthy payback period, replacing the windows with new double-pane will result in both energy savings and improved occupant comfort.
- At each facility (except Central Permit) replacing all of the exterior incandescent and High-Intensity Discharge lamps (HID) with LED fixtures is recommended to reduce energy costs, reduce maintenance time and costs, and to improve the quality of nighttime lighting for comfort and security.

The recommended ECMs are summarized below. The "simple payback" does not account for utility rebates or grants which the County could obtain to support the projects. Those subsidies, estimated to be at least seven percent of the capital cost[2], would reduce the County's capital outlay for the project and reduce the return on investment.

Figure 22: ECM Recommendations

ECM	Description	Energy Cost Savings ($/yr)*	Electricity Savings (kWh/yr)*	Gas Savings (therms/yr)*	Estimated Capital Cost ($)**	Simple Payback (years)
101	Replace remainder of windows in Building C courts complex with insulated, double pane windows with thermal break.	$38,000	103,143	20,136	$313,600	8.3
102	Administrative Tower/Courts Complex - Retrofit/replace exterior lighting fixtures with LED.	$2,441	16,939	N/A	$20,400	8.4
103	Coroner's Office - Retrofit/replace exterior lighting fixtures with LED.	$1,220	8,470	N/A	$10,200	8.4
104	Public Defender - Retrofit/replace exterior lighting fixtures with LED.	$1,005	6,975	N/A	$8,400	8.4
105	Adult Probation - Retrofit/replace exterior lighting fixtures with LED.	$862	5,979	N/A	$7,200	8.4
	Total	$43,528	141,506	20,136	$359,800	8.3

*Source: Trace 700 Energy Model

**Source: RS Means 2018

[2] Estimated value of the 2018 ComEd prescriptive program for lighting incentives.