Energy Assessment Report

Prepared for

[redacted]

4[redacted]

Prepared by

InversEnergy - Energy Consulting Engineers

Assessment Date: 07/13/2024

Reviewer Cerification

As a professional auditor, I hereby certify that I have reviewed this study for accuracy and completeness and that it is correct to the best of my knowledge. I hereby certify that our firm has followed our firm's internal quality control process, and that this study has been adequately reviewed by our firm's staff. I hereby certify that this study meets all requirements outlined in the contract between our firm and the Contracting Agency, and all other Program requirements.

Thomas Kim	_____	07/16/2024
Printed Name	Signature	Date

Executive Summary

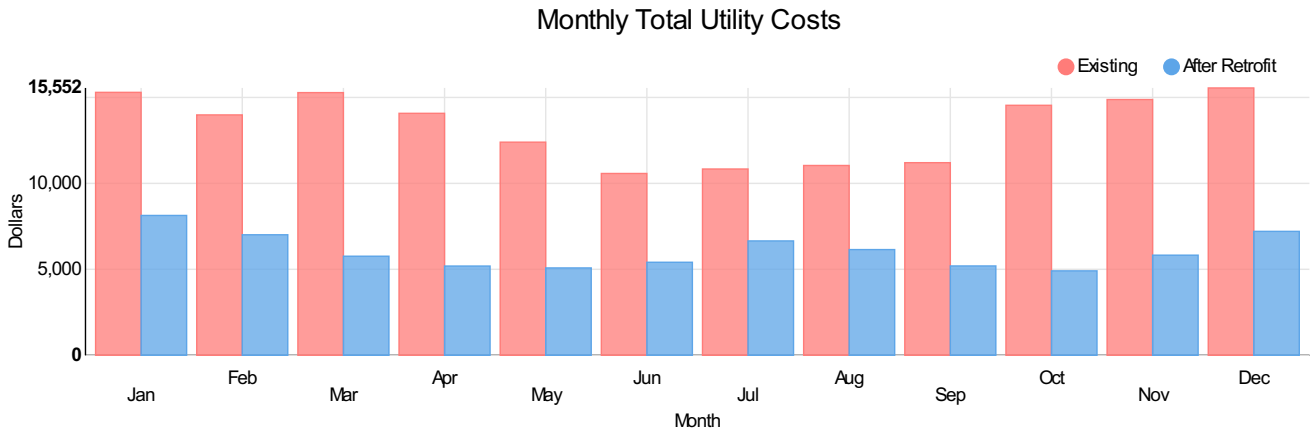
Building retrofits for [redacted] can result in significant energy savings with Energy Conservation Measures (ECMs) recommended in this report. The building is a 72,376 square-foot 3-story structure intended for use as a general office. It is located at [redacted] in climate zone 4A by ASHRAE Standard 90.1.

Whole building energy modeling was performed to understand the end-use breakdown of energy consumption and determine the impact of potential energy efficiency measures. The energy model was calibrated using local hourly weather data to align with metered energy consumption to ensure that the model is representative of actual building energy consumption (an NMBE of -1.9% and a CVRMSE of 21.1%). The weather data was replaced with normalized hourly weather data (TMY3), PA_Philadelphia_Internati.bin. It is used as a baseline (pre-retrofit) model in this analysis.

The table below illustrates the financial summary for the package of measures. It is recommended that upon the building owner's request, building stakeholders apply for incentive money and engage in sensible energy supply contracts that will protect against market fluctuations. In addition, stakeholders may elect to use on-bill financing to reduce or even eliminate up-front costs to implement efficiency measures. In many cases, the combination of reduced energy consumption, incentive money, and on-bill financing through one of our supply partners results in a positive cash flow from day one.

Annual Energy Costs A	Annual Costs* Savings B	Cost of Measures C	Potential Incentives D	Net Project Costs C-D	Payback Period C/B	Net Payback Period (C-D)/B
$159,665	$87,141	$716,275	$66,259	$650,016	8.2 yrs	7.5 yrs

* Savings calculations in this table reflect total savings from all measures implemented at the same time.



Dollar ($)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	15,296	13,984	15,281	14,076	12,398	10,576	10,836	11,041	11,204	14,543	14,878	15,552
After Retrofit	8,134	7,010	5,762	5,190	5,081	5,410	6,652	6,148	5,196	4,910	5,823	7,208

The above table and bar graph illustrate the monthly total utility costs for the building. The data is presented both before (Existing) and after the implementation of some retrofit or energy-saving measures (After Retrofit). The costs are displayed for each month from January to December and are based on normalized weather data.

Predicted Potential Savings

Metric	Existing		After Retrofit		Savings	
	Energy	Cost	Energy	Cost	Energy	Cost
Electricity kWh	958,790	$90,131	513,940	$52,940	46.4%	41.3%
Natural Gas therm	66,223	$69,534	18,653	$19,584	71.8%	71.8%
Total		***$159,665***		***$72,524***		***54.6%***

The above table shows predicted potential savings for energy consumption and costs, comparing a baseline scenario with an "after retrofit" scenario. The recommendations identified in this report have the potential to reduce energy costs by 54.6%, which is estimated to be $87,141.

Key Audit Findings

Below is a summary table of key findings regarding energy efficiency measures and the energy performance of existing buildings. The main body of the report provides further details on these observations.

1.	In the audit year 2012, the baseline building spent $159,665 on all utilities.
2.	12 Energy Conservation Recommendations (ECRs) are identified.
3.	Annualized savings for of all ECMs totals $87,141 (54.6%) in energy costs.
4.	Potential to reduce total GHG emissions by 567 metric tons CO_2 .
5.	Potential to reduce Energy Use Index by 63.4%.
6.	Estimated payback period from building budget energy savings for recommended ECMs is 8.2 years without utility incentives. After receiving utility incentives, net payback period is 7.5 years.

Performance Scores

ENERGY STAR Score (1-100)		Site EUI (kBtu/ft2) ENERGY STAR Medium (115)		In Operation Score (1-100)		Asset Score (1-100)	
Existing	**After Retrofit**	**Existing**	**After Retrofit**	**Existing**	**After Retrofit**	**Existing**	**After Retrofit**
27	87	153	50	21	71	25	73

The table shows performance scores related to energy efficiency measures, both the current scores and projected scores after a retrofit or upgrade. The rows represent three different metrics:

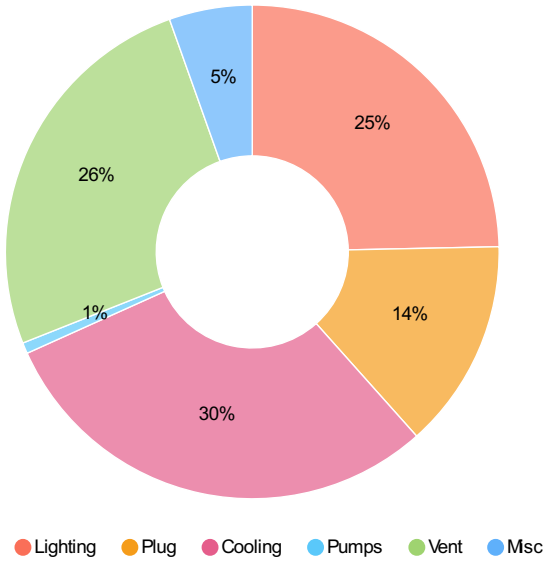
- ENERGY STAR Score (1-100): This rating scales a building's energy efficiency on a scale of 1 to 100, with a higher score indicating better energy performance. The building initially had a score of 27, but after the retrofit, the score increased to 87.
- ENERGY STAR Median Score (50): This appears to be a reference value or median score for comparison purposes.
- Site EUI (kBtu/ft2): This represents the building's energy use intensity, measured in kBtu per square foot. Initially, the site EUI was 153.3 kBtu/ft2, but it dropped to 50 kBtu/ft2 after the retrofit, indicating a significant reduction in energy consumption.
- ENERGY STAR Median EUI (114.7 kBtu/ft2): This appears to be a reference value or median EUI for comparison purposes.
- In Operation Score (1-100): This score rates how well the building's systems are operating, with 100 being optimal. The initial score was 21, which increased to 71 after the retrofit, suggesting a significant improvement but still relatively low performance.
- Asset Score (1-100): This likely evaluates the inherent physical characteristics and design of the building itself. The initial asset score was 25, which increased to 73 after the retrofit, indicating that the physical attributes may have been positively impacted.

The retrofits are expected to provide considerable improvement across all three metrics after the upgrades are implemented.

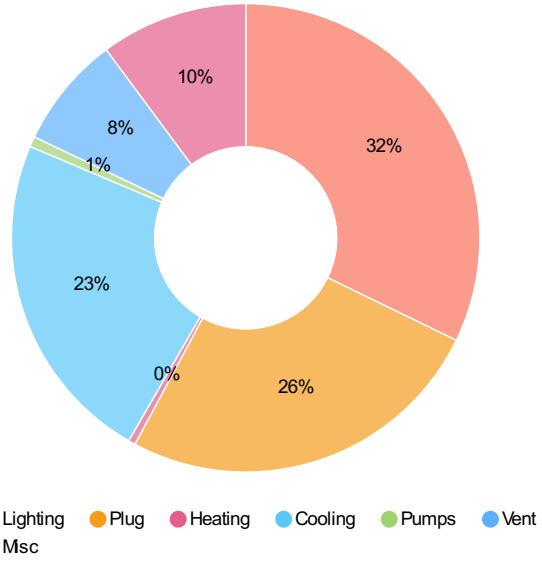
End-use Analysis

The chart and table below show the electricity end-use breakdown at the existing and predicted savings after retrofit.

Baseline in kWh



Post-retrofit in kWh



Electric Consumption by End-use

End-use	Electric Energy kWh			Electric Demand‡ kW		
	Existing	After Retrofit	Savings	Existing	After Retrofit	Savings
Interior Lighting	236,491	165,542	30.0%	49	34	30.0%
Plug Load	131,729	131,729	0.0%	25	25	0.0%
Space Heating	0	2,480	0.0%	0	1	0.0%
Space Cooling	286,343	118,499	58.6%	117	105	10.2%
Pumps	6,865	3,671	46.5%	1	1	9.2%
Ventilation	245,198	39,852	83.7%	41	41	0.1%
Misc Load	52,166	52,166	0.0%	6	6	0.0%
Total	958,793	513,939	46.4%	239	213	10.9%

‡ denotes peak demands of each end-use. End-use demand and its savings of aggregated peak demands could be different.

This above table provides a detailed breakdown of the electric energy consumption and demand for various end-uses in the building, both for the existing scenario and after a retrofit.

Other Consumption by Energy Type

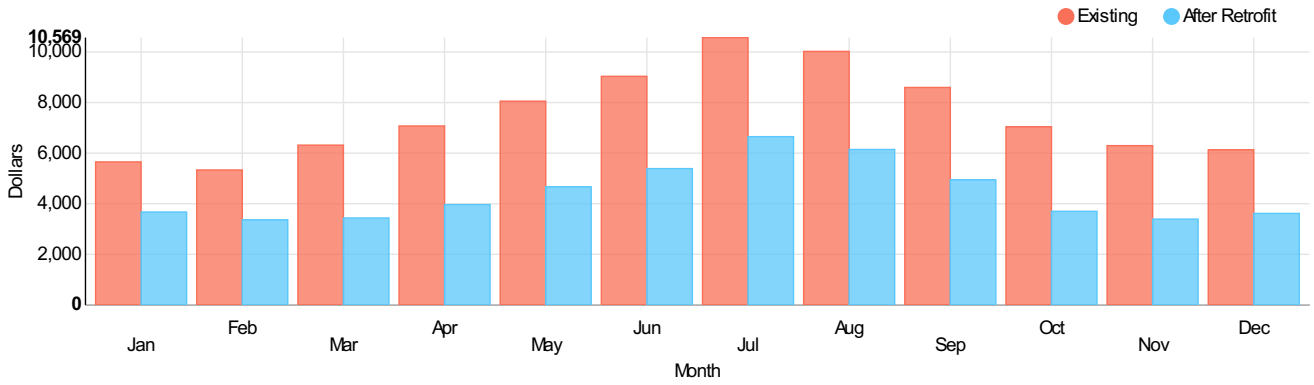
Energy Type	Unit	End-use	Existing	After Retrofit	Savings
Natural Gas	therm	Space Heating	66,222	18,652	71.8%

The above table compares energy usage except electricity, before and after some retrofit or energy efficiency measures will be implemented.

Monthly Costs and Usage

Monthly Electricity Costs

The chart below shows monthly electricity costs, including both electric consumption and demand charges.



Monthly Usage Costs

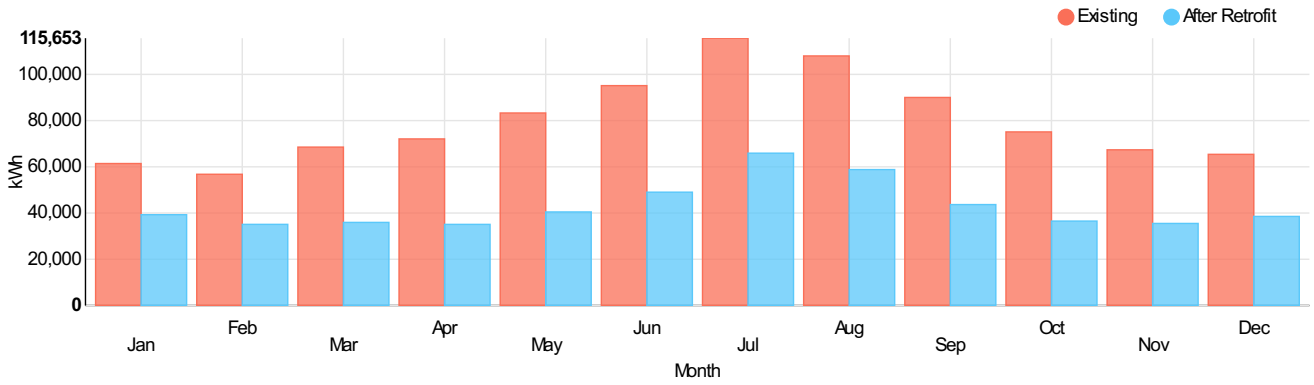
Dollar ($)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	4,582	4,236	5,113	5,377	6,214	7,097	8,628	8,056	6,715	5,603	5,026	4,879
After Retrofit	2,931	2,619	2,682	2,618	3,020	3,658	4,917	4,387	3,258	2,725	2,649	2,875

Monthly Demand Costs

Dollar ($)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	1,072	1,099	1,204	1,698	1,841	1,941	1,941	1,968	1,883	1,436	1,271	1,251
After Retrofit	742	742	755	1,347	1,647	1,730	1,735	1,758	1,686	975	742	742

The above table suggests that the after retrofit case results in lower electricity usage and (demand) costs compared to the existing, potentially indicating energy efficiency improvements or other modifications made to the facility.

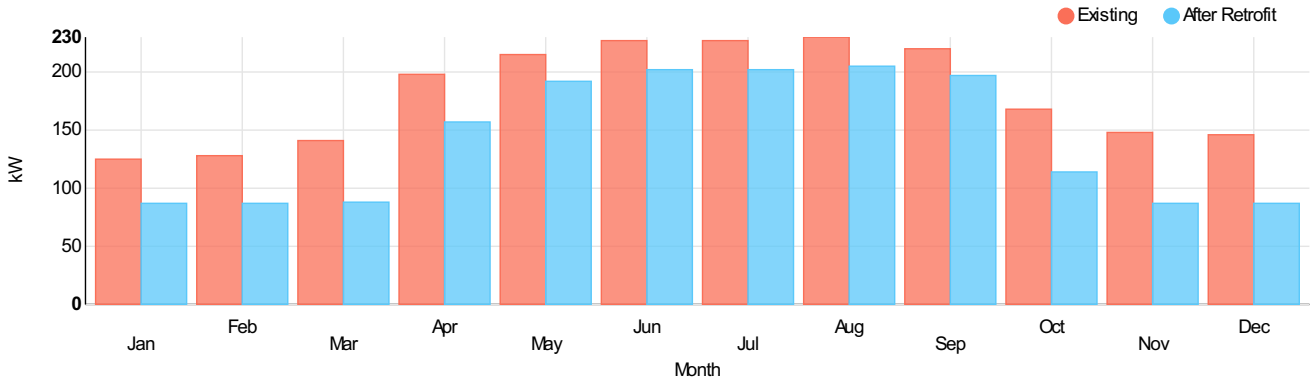
Monthly Electricity Consumption



kWh	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	61,427	56,782	68,536	72,080	83,296	95,131	115,653	107,985	90,015	75,111	67,367	65,407
After Retrofit	39,286	35,108	35,955	35,101	40,483	49,035	65,911	58,809	43,670	36,529	35,508	38,545

The above table compares the monthly electricity consumption in existing and after retrofit cases. The graph displays data for a full year, from January to December.

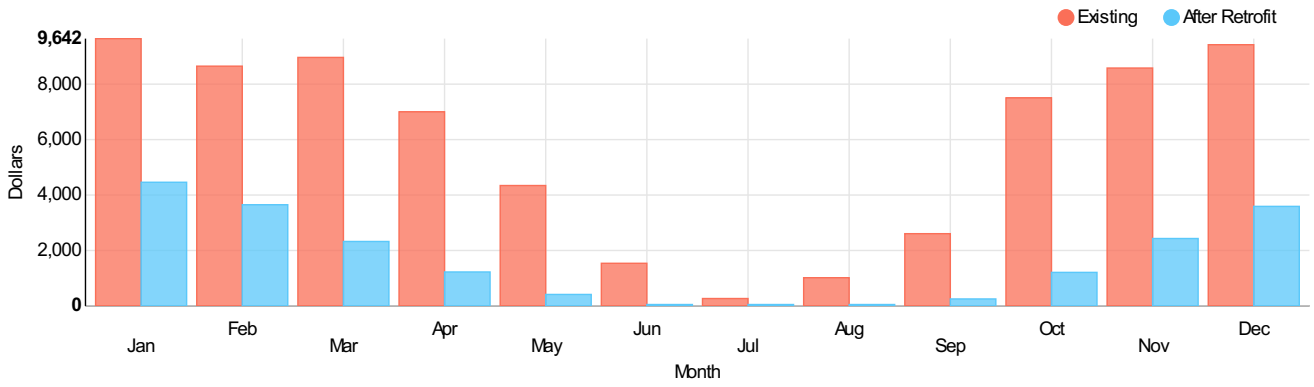
Monthly Electricity Demand



kW	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	125	128	140	198	215	226	226	230	220	168	148	146
After Retrofit	87	87	88	157	192	202	202	205	197	114	87	87

The above data depicts the monthly electricity demand for existing and after retrofit cases. The x-axis represents the months of the year, while the y-axis displays the electricity demand in kW. The data suggests that the retrofit measures implemented are effective in reducing electricity demand, particularly during the high-demand summer months, likely through improved energy efficiency measures targeting cooling loads.

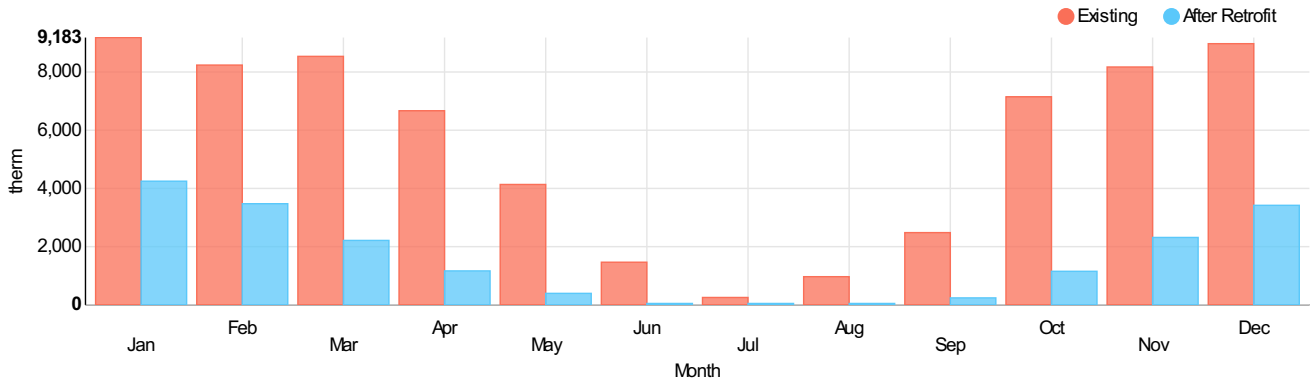
Monthly Natural Gas Costs



Dollar ($)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	9,642	8,649	8,964	7,001	4,343	1,538	267	1,017	2,606	7,504	8,581	9,422
After Retrofit	4,461	3,649	2,325	1,225	414	22	0	3	252	1,210	2,432	3,591

The data suggests that the after retrofit case results in lower usage costs compared to the existing, potentially indicating energy efficiency improvements or other modifications made to the facility.

Monthly Natural Gas Consumption



therm	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Existing	9,183	8,238	8,537	6,668	4,136	1,465	254	968	2,482	7,147	8,172	8,973
After Retrofit	4,249	3,475	2,214	1,167	395	21	0	3	240	1,153	2,316	3,420

The above table compares the monthly consumption in existing and after retrofit cases. The graph displays data for a full year, from January to December. The graph clearly illustrates the potential energy savings achievable through the implementation of retrofit measures.

Retrofit Measures

The table below displays the current conditions and suggested Energy Conservation Measures.

#	Energy Conservation Measure	Description	Existing	After Retrofit
1	Interior Lighting	Lighting Power Density in W/ft^2	1.0	0.7
2	DX Cooling	Efficiency in EER	10.3	11.2
3	Min Fan Operation	System Level	0.7	0.3
4	Min Airflow Ratio	Zone Level	0.5	0.3
5	Interior Fan Speed		captured	Optimized Variable
6	Supply Air Temperature Reset	VAV system	not in use	use
7	Boiler Type		gas-fired	condensing
8	Boiler Performance	Efficiency in %	81.7	96.7
9	Hot Water Pump Head	in ft	64.1	48.0
10	Hot Water Temperature	in deg F	186.6	140.0

niu denotes not in use

Low-cost Measures

The following table shows current building operations and recommended operation changes.

#	Low-cost Measure	Description	Existing	After Retrofit
1	HVAC Startup	Weekdays	24/7	6 am
2	HVAC Shutdown	Weekdays	24/7	6 pm
3	Days of Operation	HVAC Monday thru	24/7	Friday
4	# of Floor(s) Conditioned in 24/7	Above Ground	3	0
5	# of Floor(s) Unlit	Above Ground, Conditioned	0	not changed
6	# of Floor(s) Unconditioned	Above Ground	0	not changed
7	# of Basement(s) Unconditioned	Below Ground	1	not changed
8	Cooling Setpoint Temperature	in deg F	74.6	76.0
9	Heating Setpoint Temperature	in deg F	70.2	not changed
10	Cooling Setback Temperature	in deg F	74.6	82.0
11	Heating Setback Temperature	in deg F	70.2	56.0

Utility Rates

The electric company supplying electricity to the building is **PECO**. Electric costs were modeled per **GS-General Service** based on published tariff information online. Electric costs in the table below are a blended rate which includes the average annual base rate, demand charges, and surcharges. Natural gas costs used for the analysis are a blended rate including surcharges. Fuel oil costs used for the analysis are a blended rate including surcharges. Purchased chilled water costs used for the analysis are a blended rate including surcharges. Purchased steam costs used for the analysis are a blended rate including surcharges.

	Electricity	Natural Gas
Existing	$0.09 per kWh	$1.05 per therm
After Retrofit	$0.10 per kWh	$1.05 per therm

Recommendations

No	Measure Type	Recommendation	Electricity kWh	Electricity kW	Natural Gas therm	Cost Savings A	Retrofit Costs B	Utility Incentives C	Net Costs B-C	Payback (B-C)/A	SIR **
1	Interior Lighting	Replace with high-efficiency lighting	73,209	14	-553	$6,380	$70,950	$18,316	$52,633	8.2	1.8
2	HVAC Scheduling	Change HVAC operating schedule	0	0	0	$0	$7,237	$0	$7,237	∞	0.0
3	Building Operation	Change building operation	74,021	2	10,622	$16,710	$7,237	$3,701	$3,536	0.2	23.6
4	Space Temperature	Change setpoint/setback temperature	8,958	0	93	$945	$724	$1,344	-$620	-0.7	-7.6
5	Cooling Efficiency	Replace with high-efficiency DX systems	23,688	10	0	$2,385	$325,676	$7,154	$318,522	133.6	0.1
6	Fan Control	Install/optimize two- or variable fan speed contol	45,049	0	-32	$3,679	$54,279	$9,010	$45,269	12.3	1.2
7	HVAC Control	Program/maintain supply air temperature reset control	48,601	0	6,337	$10,443	$20,264	$5,832	$14,432	1.4	10.9
8	HVAC Control	Optimize fan static pressure controls	80,224	0	-13	$6,437	$54,279	$16,045	$38,234	5.9	2.5
9	HVAC Control	Optimize terminal fan operation	28,829	0	22,642	$26,323	$7,961	$4,324	$3,637	0.1	108.6
10	HVAC Efficiency	Replace with high effciency boiler	-5,104	0	10,301	$10,421	$162,757	$0	$162,757	15.6	1.6
11	HVAC Control	Optimize hot water pump head	1,773	0	-60	$75	$3,178	$532	$2,646	35.3	0.3
12	HVAC Control	Optimize hot water temperature	-6,695	0	228	-$279	$1,733	$0	$1,733	-6.2	-1.6
	Total		*372,553*	*26*	*49,565*	*$83,519*	*$716,275*	*$66,258*	*$650,016*		

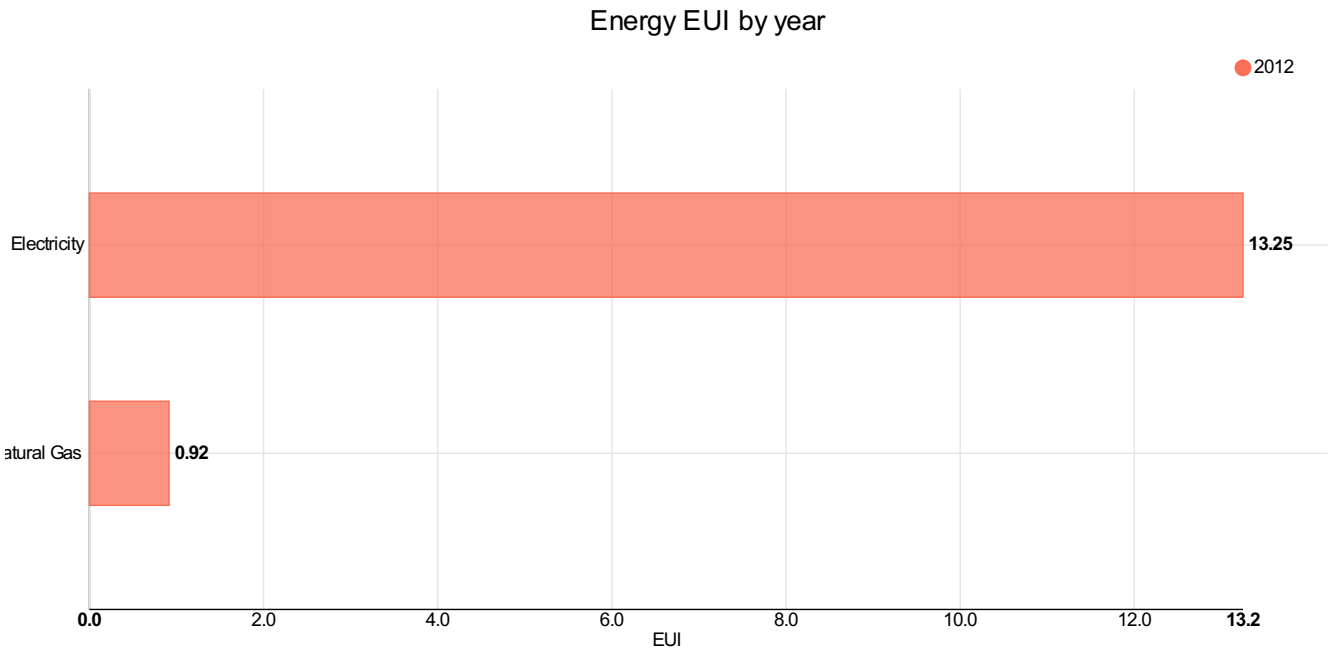
Note: Savings calculations in this table reflect savings from individual measures only and do not assume that other recommendations have been implemented. Calculations and assumptions used are solely based on the existing equipment and usage schedules.

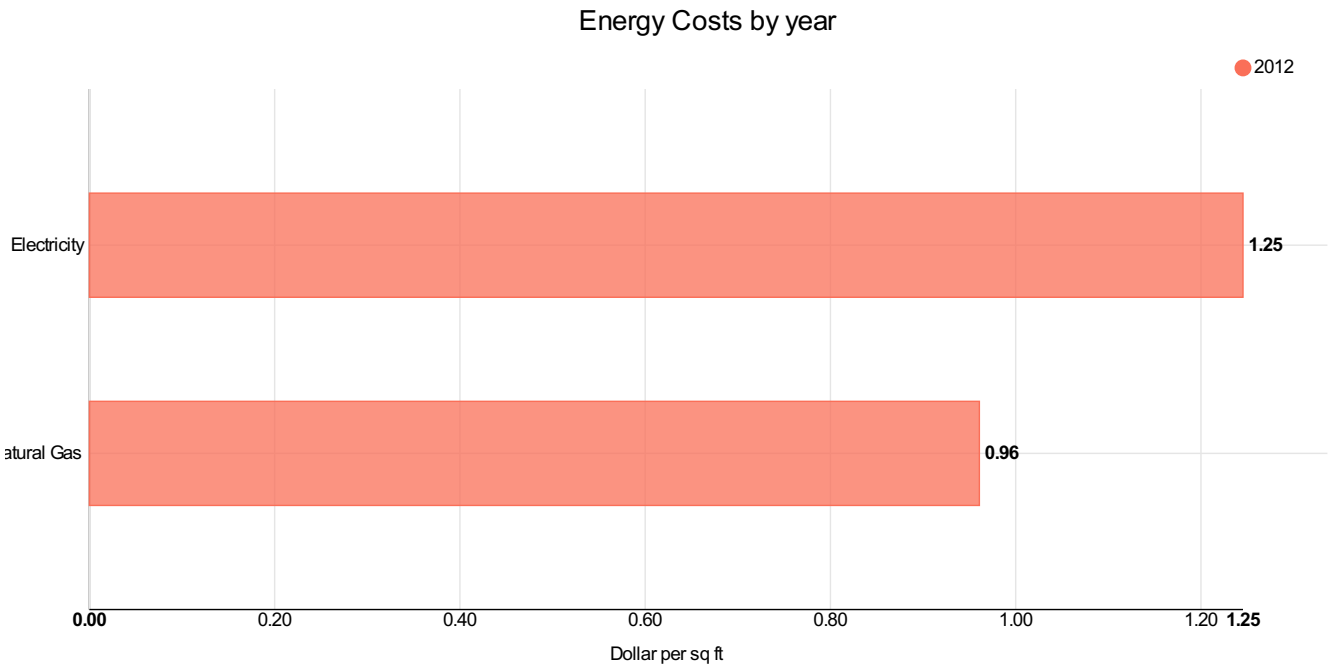
** SIR (Savings to Investment Ratio) is calculated using `A/(B-C) * life expectancy`. `C` is zero in the case of no incentive.

Utility Consumption

The use of an Energy Use Intensity (EUI) indicator provides the means to equalize the way that energy use is compared between various types of buildings and evaluate the means of reducing overall energy consumption. The EUIs in the table below are weather-normalized using TMY3 weather data based on the climate zone in the building is located.

Year	Electricity kWh/ft2	Natural Gas therm/ft2	Electricity $/ft2	Natural Gas $/ft2
2012	13.2	0.9	1.2	1.0

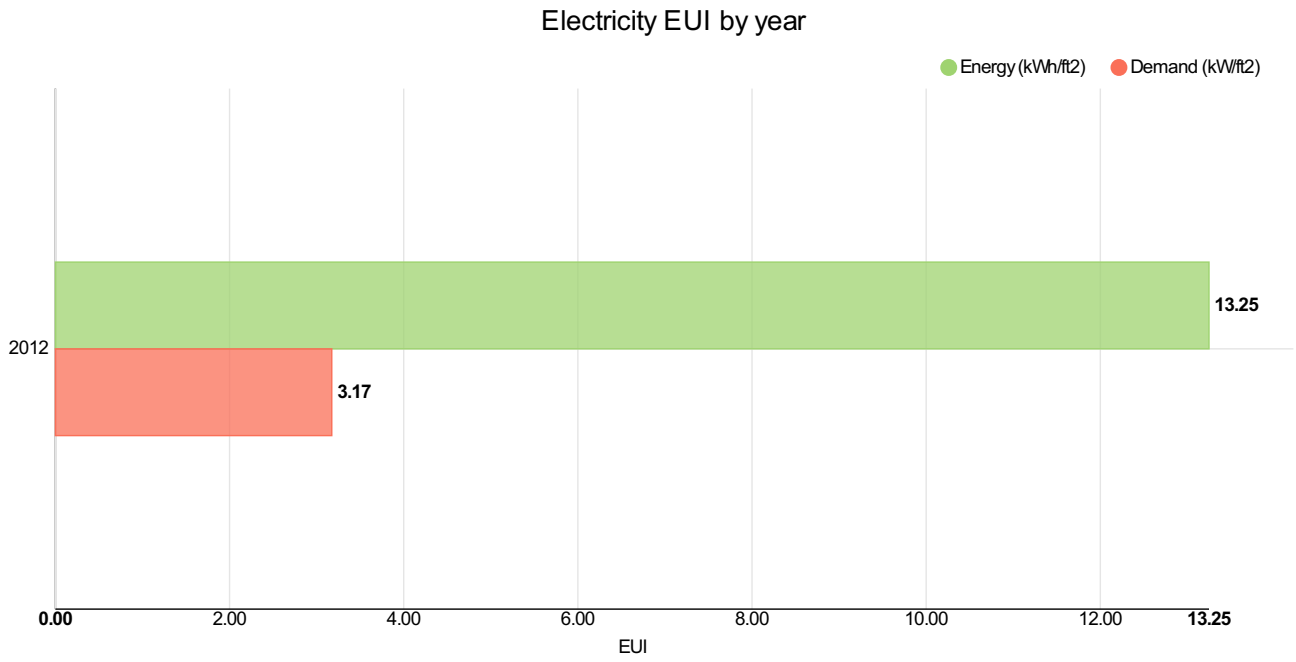


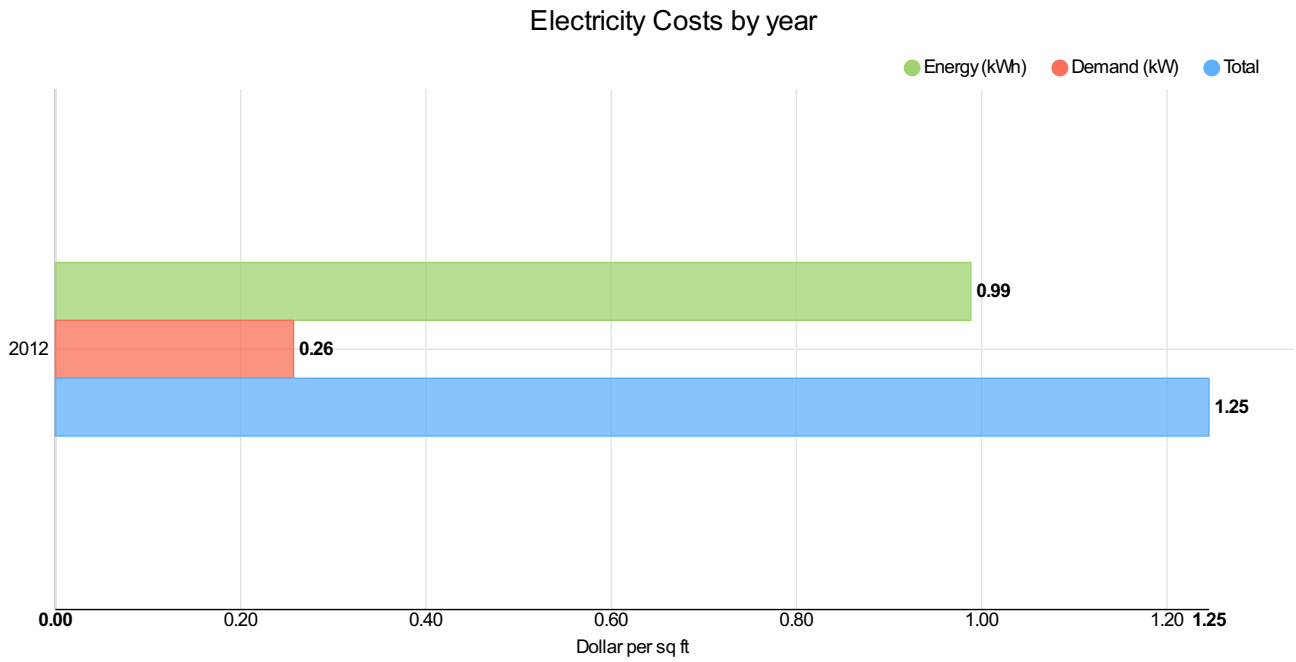

Energy Costs by year
2012
Electricity
1.25
atural Gas
0.96
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.25
Dollar per sq ft

Electricity Consumption

The below table presents data on electricity energy supply, demand, and costs by year. By comparing energy supply, demand, and costs across different years, changes can be analyzed over time.

Year	Electricity		Costs		
	Energy kWh/ft2	**Demand** W/ft2	**Energy** $/ft2	**Demand** $/ft2	**Total** $/ft2
2012	13.2	3.2	1.0	0.0	1.2




Electricity Costs by year
Energy (kWh)
Demand (kW)
Total
2012
0.99
0.26
1.25
0.00
0.20
0.40
0.60
0.80
1.00
1.20
1.25
Dollar per sq ft

Electricity End-use

The table breaks down annual electricity consumption per square foot by end-use category.

Year	Electricity End-uses kWh per ft2					
	Lighting	Plug	Cooling	Pumps	Vent	Misc
2012	3.3	1.8	4.0	0.1	3.4	0.7