Harlan Township
Strategic Energy Plan

JUNE 2020

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1. Purpose of Energy Planning

Energy planning investigates issues centered on energy use and delivery in the community; identifies how these issues intersect with land use patterns and transportation choices; and formulates strategies to improve the efficiency of energy use in the community. Energy planning at the local level becomes the convergence of planning for many other issues. Energy planning and energy related initiatives have a large role in quality building standards; emergency management planning (since most community –wide emergency events involve the disruption of power delivery); facility cost and fiscal projections; air quality; and land use.

This Energy Plan was produced through the efforts of the Ohio Kentucky Indiana (OKI) Regional Council of Governments and the Greater Cincinnati Energy Alliance working with a steering committee named by Harlan Township. This planning effort was funded through the Duke Class Benefit Fund with the aim of bringing about improved energy efficiency in southwest Ohio.

The goals and objectives included in this plan were drafted by the plan steering committee after reviewing the information included in the associated chapters. A draft of this document was posted on the Community Energy Plan website at energy.oki.org.

This plan will serve to organize action by Harlan Township, its residents, and businesses to meet the stated goals. This plan should be evaluated periodically to ensure the proposed actions are bringing the desired outcomes, and the stated goals remain relevant to the overall needs and desires of the community.

2. Overview of Harlan Township's Energy Strategy

The process of determining this energy strategy and goals is the work of a three-member committee. The committee reviewed information to develop an energy strategy for Harlan Township. The committee adopted the following mission statement to guide the development of the plan:

Mission Statement

Harlan Township will pursue opportunities to save residents and businesses money by becoming a more energy efficient community. The township will accomplish this through cost effective improvements to township facilities and by providing residents and businesses with information about the benefits of investing in energy efficiency.

With the mission in mind, the following goals were developed for the Harlan Township Energy Plan.

Energy Plan Goals

Goal 1	Harlan Township will reduce energy consumption in township owned buildings by 10 to 25 percent by identifying and implementing energy and cost saving opportunities.
Goal 2	Harlan Township will take simple steps to educate its residents and businesses about the benefits of energy efficiency.
Goal 3	Harlan Township will encourage predictable development patterns in order to save energy and reduce pressure on township resources.

Strategies

The Harlan Township Energy Plan recommends implementing the following strategies to achieve the goals of the plan and to ensure that it becomes an energy efficient, sustainable, affordable, and attractive community for residents and businesses.

Residential Strategies

1	Educate residents about the benefits of installing energy efficiency improvements.
2	Connect low-income residents with information about programs that can assist them with addressing high energy bills or installing energy saving improvements.
3	Work with the Warren County Rural Zoning Commission to develop explicit language that promotes the placement or use of roof mounted solar systems.

Commercial, Industrial, and Government Strategies

1	Monitor energy usage at township owned facilities.
2	Install energy efficiency improvements at township facilities that provide operational benefits and a return on investment.
3	Work with adjacent communities to form an ESID which will allow commercial properties to take advantage of PACE financing.

3. Energy Consumption

A major component of a community energy plan is understanding how much energy the community uses, who is using it, how it is being used, and how much it costs. This information can inform priorities when deciding between efficiency initiatives that target different users while also serving as a baseline to measure the impact of future energy efficiency initiatives in the community.

Harlan Township is served by two different utilities, Duke Energy Ohio and Dayton Power & Light (DP&L).[1] This analysis is based strictly on data from Duke Energy. As a result, it fails to take into consideration approximately two-thirds of the households located in block group 1 of census tract 324.

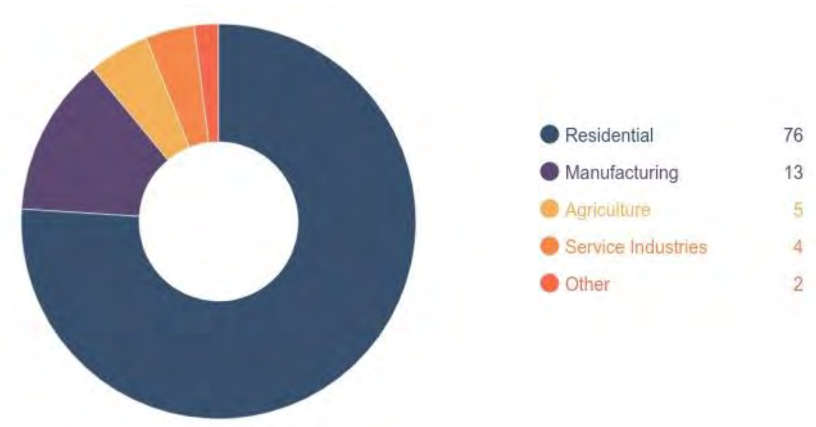
Residential and commercial structures in Harlan Township consumed over 115.8 million kBtus of energy from Duke Energy in 2016 at a total cost of over $3.76 million.[2]

Figure 1: Total Energy Consumption and Cost 2016

	Amount Consumed	Cost
Electricity	32,926,371 kWh	$3.73 million
Natural Gas	34,751 CCF	$33,780

The residential sector accounted for 76 percent of electricity consumption from Duke Energy in 2016 while the commercial and agricultural sectors accounted for 24 percent. Residential usage is likely to remain the largest consumer of electricity in the future due to the increased residential development that is occurring throughout the township.

Figure 2: Harlan Township Electricity Consumption by Sector, 2016



[1] A map of the Duke Energy and DP&L territories is available in Appendix A.
[2] This figure does not include the costs associated with fuel sources such as propane and fuel oil.

Natural gas is used for space heating, water heating, and some manufacturing processes. In 2016, the residential sector accounted for 78 percent of natural gas consumption while the commercial sectors accounted for 22 percent. Natural gas service is limited to areas along the State Route 28 corridor. As a result, residential usage will continue to be the dominate consumer of natural gas in Harlan Township for the foreseeable future.

Figure 3: **Harlan Township Natural Gas Consumption by Sector, 2016**

Residential Energy Use

Residential energy use depends on the energy consuming devices used in the home and the efficiency of those devices. Electricity and propane are the most-consumed energy sources in residential buildings throughout Harlan Township. Figure 4 shows the amount of energy consumed by Harlan Township residents and the estimated total cost by energy source. The estimated total annual energy cost of Duke Energy residential customers is $4.1 million and equates to an average cost of $819 per capita or $2,428 per household. Improving the energy efficiency of residential buildings by an average of five percent could save residents over $205,172 annually based on 2016 utility rates.

Figure 4: **Residential Energy Consumption and Cost**[3]

	Amount Consumed	Cost
Electricity	25,081,328 kWh	$2,838,088
Natural Gas	27,164 CCF	$36,531
Propane	330,000 gal	$884,400
Heating Oil	144,900 gal	$344,427

[3] Duke Energy and the 2016 American Communities Survey.

Space heating accounts for the largest share of energy use in residential buildings. Electricity is the most common source of fuel for heating residential buildings in Harlan Township followed by propane and fuel oil.

Figure 5: **Residential building fuel consumption by end use.**[4]

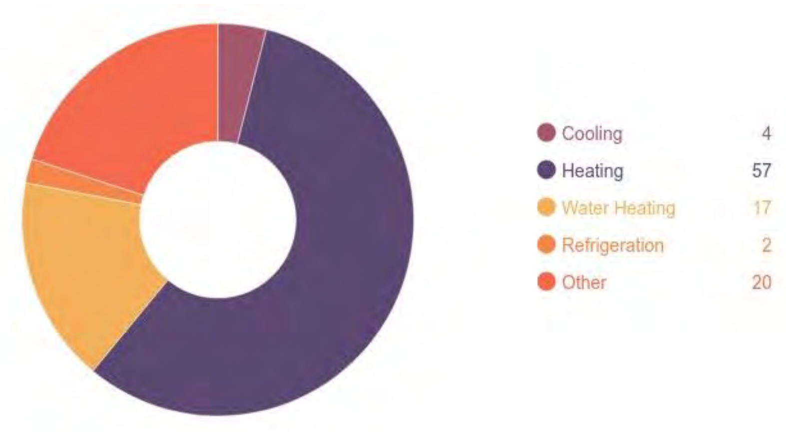


Figure 6 provides a snapshot of residential energy consumption in the community relative to several nearby peer communities (Fayetteville, Morrow, Blanchester, and Amelia). Harlan Township residents appear to consume more electricity per household than neighboring communities based on the available data.

The large difference between Harlan Township and the peer communities with respect to natural gas usage and annual cost is likely due to a data quality issue. The values for Harlan Township were calculated directly from data provided by Duke Energy and only considered the number of households that use natural gas. The data for the peer communities was obtained from the U.S. Department of Energy's City Energy Profile whose calculations may not take into consideration the fact that not all homes have access to natural gas. This may artificially lower the usage and cost figures in the peer communities.

Figure 6: **Annual Residential Energy Consumption and Costs, 2016.**[5]

	Harlan	Peer Communities
Average kWh per household	15,228	14,480
Average annual electricity cost per household	$1,723	$1,710
Average CCF per household	566	207
Average annual natural gas cost per household	$761	$278

[4] U.S. Energy Information Administration, 2015
[5] U.S. Department of Energy, 2016

Commercial and Industrial Energy Use

Commercial and industrial buildings range in size from small storefronts to large industrial and retail facilities. In general, commercial and industrial buildings have an energy profile like that shown in Figure 7. However, the actual profile will vary depending on the type of facility.

Figure 7: **Commercial building fuel consumption by end use.**[6]

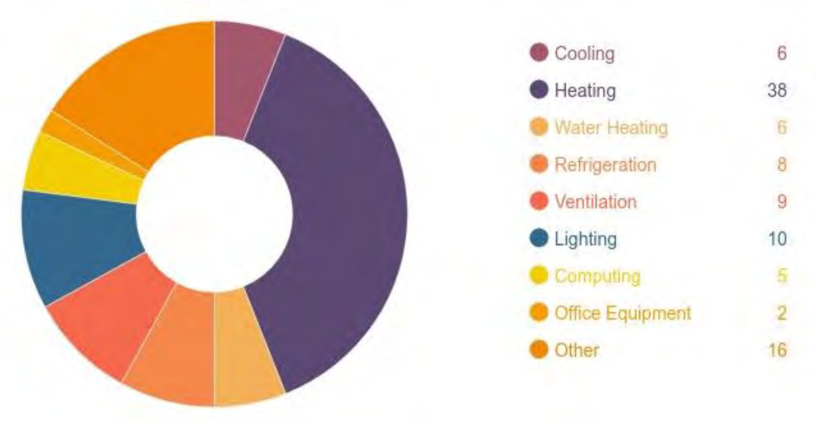


Figure 8 provides a snapshot of commercial and industrial energy consumption in the community relative to four nearby peer communities (Fayetteville, Morrow, Blanchester, and Amelia). Harlan Township consumes less kWh of electricity and CCF of natural gas per square foot than its local peers. The significant difference in both categories may be due to the nature of the commercial and industrial facilities located in each community. Harlan Township does not have many energy intensive industrial facilities.

Figure 8: **Commercial and Industrial Energy Consumption and Costs, 2016.**[7]

	Harlan	Peer Communities
Total C&I building area (square feet)	395,754	1,743,720
Average kWh per square foot	19.82	32.8
Average CCF per square foot	0.09	1.35

[6] U.S. Energy Information Administration, 2012
[7] U.S. Department of Energy, 2016

4. Transportation and Land Use

Transportation

Measuring the use of energy for transportation for a local community is a very difficult task. This plan looks to data regarding means of transportation to work gathered by the U.S. Census Bureau as part of the American Community Survey. This data is available for any local political jurisdiction, can be tracked for changes over time, and can be compared with other communities. The peer communities chosen for this comparison are Turtlecreek, Hamilton, Goshen, Union, and Salem Townships.

The percentage of workers living in a community who opt to commute in a way which saves energy – by carpooling, riding the bus, biking, walking, or working from home is used as an indicator of the efficient use of energy for transportation. It should be recognized that some workers may commute to work via the above means for reasons other than conserving energy. However, these means of travel are more energy efficient than commuting to work alone in a car.

Figure 9: **Means of Commuting to Work**

	Harlan Township	Peer Communities	Warren County	Regional Average
By Car	90.4%	92.6%	93.0%	90.8%
Carpooling	5.8%	7.7%	6.3%	8.0%
Public Transportation	0.0%	0.1%	0.4%	2.0%
Walking	1.3%	0.8%	0.6%	2.1%
Bicycle	0.7%	0.0%	0.1%	0.2%
Work from Home	7.3%	6.1%	5.6%	4.2%

Almost all Harlan Township residents commute alone in their personal vehicles. It is notable that Harlan Township trends slightly lower than peer communities, Warren County, and the region average in commuting by car. However, the township lags in the number of commuters who carpool. The rate of carpooling widely varies by community. In Goshen Township, 12 percent of workers carpool to work while in neighboring Hamilton Township only 3.4 percent carpool. Census data reports that nearly half of workers in Harlan Township work within Warren County, but also that two-thirds of workers travel more than 30 minutes to get to work. This seems to indicate that there is room to boost carpooling rates among residents.

Harlan Township is not served by public transportation, and the ridership number in the table above makes that clear. Without meaningful service, there is not an opportunity to address this.

On a positive note, the township shows significantly higher rates of workers walking and riding their bikes to work. Admittedly, the numbers are small compared with those who commute by car but are significantly above levels seen in peer communities and in the county overall. Harlan Township does not have any dedicated pedestrian or bike infrastructure, but overall traffic in the community is light enough that people feel safe walking or biking on most roadways. In the event of proposed development that would increase traffic, the township should ensure the ability to navigate the community by foot or bicycle.

Harlan Township, located in the southeast corner of the county, has not seen the development pressures prevalent in the southwest corner of the county. However, it would be wise to ready development regulations prior to that pressure arriving. Development pattern has a significant effect on future energy use in a community.

Land Use

Harlan Township is experiencing an increasing demand for new residential construction on large lots. As these development pressures occur, they place new demands on the services offered by the township such as road maintenance and public safety. One way to both reduce and concentrate the demands placed on these services is to promote cluster developments.

Cluster developments are residential developments that utilize only a portion of the developable site for housing and leave a significant portion of the site in an undeveloped state. Cluster developments are also known as conservation developments. There are several benefits of this style of development in a rural community. By leaving a significant portion of the site undeveloped, cluster developments impose less visual impact on the surrounding countryside, allowing the community to preserve its rural character. By clustering the homes, it minimizes the amount of infrastructure and impervious surface, which minimizes stormwater runoff and future maintenance costs to the township. The Aberlin Springs development in central Warren County is an example of a development that uses these principles.

Figure 10: Cluster Development

Cluster developments also reduce energy consumption. By clustering the home sites closely together, lot sizes are significantly smaller than typical rural lots. Smaller lots mean that there is less lawn to maintain. This reduces the need to water which requires energy to treat and distribute as well as less which fertilizer which is a very energy intensive product to produce. The more space that can be conserved as natural, or remain in agricultural production, the less energy a residential development will use. Cluster developments also minimize infrastructure. This reduces the amount of energy required for construction and maintenance.

5. Utility Aggregation and Energy Resiliency

Duke Energy Ohio is the utility responsible for the delivery of electricity and natural gas services for residents and businesses in Harlan Township. It is responsible for maintaining the electric and natural gas infrastructure that delivers energy throughout the township. However, residents and businesses can choose their own energy provider. This section reviews how Harlan Township can educate its residents and businesses about their utility bill and how it can use utility aggregation to secure a competitive electricity and natural gas rate for its residents. It also provides an overview of different considerations related to the resiliency of the energy grid.

Understanding Utility Usage

One key component to helping residents understand the benefits of energy efficiency is equipping them with the skills necessary to read their monthly utility bill. The ability of residential and commercial utility users in Ohio to select their own energy suppliers has resulted in an influx of companies trying to obtain new customers. In some cases, companies offer very low energy rates that either are accompanied by a hefty monthly fee or escalate rapidly over time. Customers that do not read the agreement closely and do not know how to read their utility bill may find that they are ultimately paying more per kWh of electricity or CCF of natural gas than they were with their previous provider.

As the local utility provider responsible for the delivery or transmission of electricity and natural gas to most residents in Harlan Township, Duke Energy is also responsible for billing customers. It has several resources on its website to help customers understand how to read their utility bill.[8] A sample Duke Energy bill highlighting the key places to review is also provided in Appendix B. By knowing the correct place to find the rate that they are paying for natural gas or electricity, customers can determine if they are paying more than the local "Price to Compare" rate. In addition, the Public Utilities Commission of Ohio's "Energy Choice Ohio" website at www.energychoiceohio.gov allows customers to compare the rates and programs offered by different electricity and natural gas suppliers operating in their area.

Utility Aggregation

Ohio's deregulated energy market enables property owners to select their own electricity and natural gas providers. Communities are permitted to aggregate their residents together to buy electricity and/or natural gas as a group to gain buying power in the marketplace. According to the Public Utilities Commission of Ohio, Harlan Township does not offer an aggregation program to its residents.

Ohio law allows local governments to create a utility aggregation program using either an opt-in or opt-out methodology. The opt-in program allows each resident to sign up individually for the aggregation program created by the local government. The local government must hold a minimum of two hearings on the program and pass a resolution supporting its creation. This type of aggregation program often results in minimal savings to residents because the program does not have an established pool of participants to increase its buying power.

An opt-out program requires voter approval to implement and often results in lower utility rates because all residents in the community are automatically enrolled in the program. This type of aggregation program must be approved by a majority of voters in the community during a primary or general election. Once approved by voters, the local government must hold two public hearings to review the aggregation

[8] Information on reading your utility bill can be found at https://www.duke-energy.com/home/billing/reading-your-bill

program. Once the local government has adopted the plan, residents must be notified that they will be automatically enrolled in the aggregation program unless they elect not to participate. This notification must also state the rates, charges and other terms and conditions of enrollment in the program.[9]

Regardless of the type of aggregation program that Harlan Township may decide to implement, it is important to educate residents about the program and its benefits. Information about the program should appear on the township's website and in other government communication channels such as newsletters or social media. Residents that want to determine if they can save money by opting out of any future aggregation program offered by Harlan Township should visit the Public Utilities Commission of Ohio's "Energy Choice Ohio" website at www.energychoiceohio.gov. The website allows users to compare the rates and programs offered by different electricity and natural gas suppliers operating in their area.

Energy Resiliency

Resiliency is how susceptible a community is to threats, and how capable they are in overcoming threats when they do occur. One of the factors that goes into determining a community's resiliency is the condition of its energy infrastructure. Harlan Township has an above ground electrical infrastructure, although some below ground may exist in newer housing developments.

There are several types of events that may test the resiliency of the energy infrastructure. The most common type are weather related events, such as wind and ice, that can impact above-ground power and communications networks.

There are three primary components to a resilient energy system: prevention, recovery, and survivability.[10]

Prevention
This focuses on preventing damage to the distribution system. Damage can occur in numerous ways, including from weather incidents or traffic accidents. The utility works to minimize the risk of damage through design standards, inspection procedures, and maintenance routines. The utility will periodically trim trees and vegetation in the vicinity of transmission or distribution lines to reduce the risk of damage in a weather event. The distribution network is designed to provide multiple pathways to deliver electricity in the event of damage to a portion of the network.

Recovery
This component centers on how the community and the utility can work together to quickly assess and repair damage to the energy utility network. In the aftermath of a major weather event that causes significant damage to the energy utility network, communication between local emergency responders and utility companies is essential to identifying and assessing locations where disruption of the network occurred and dispatching utility crews to those locations. Coordination is often required between local responders and utility crews on dealing with downed trees or accident scenes.

The Warren County Emergency Management Agency (EMA) maintains an emergency response plan and provides information to local governments to prepare their own emergency response plans. The county emergency response plan designates the local community as the party responsible for addressing energy related issues. It must assess local conditions, identify areas affected by shortages or outages, communicate and coordinate with utilities regarding outages and facilities of high priority, and communicate with residents and businesses. Harlan Township coordinates with the Warren County EMA and is equipped to perform the necessary functions in the event of a significant energy outage.

[9] Public Utilities Commission of Ohio (https://www.puco.ohio.gov/be-informed/consumer-topics/governmental-energy-aggregation-local-community-buying-power/)
[10] Electric Power Research Institute (www.epri.com)

Survivability

The survivability component refers to a community's ability to continue to provide essential functions and service through an energy shortage or outage. Essential functions typically include communications, public order and safety, potable water, and essential power to certain health care facilities. The role of ensuring these core functions typically fall to local governments and institutions.

A new aspect to the survivability function involves distributed generation (privately owned solar panels and wind turbines). Most distributed generation systems are designed to shut down in the event of a power outage. This is to prevent power lines from being energized while utility crews are attempting to repair them. If certain safeguards are installed, then distributed generation systems can be temporarily isolated from the grid and used to provide power in the event of an outage to the property where they are installed.

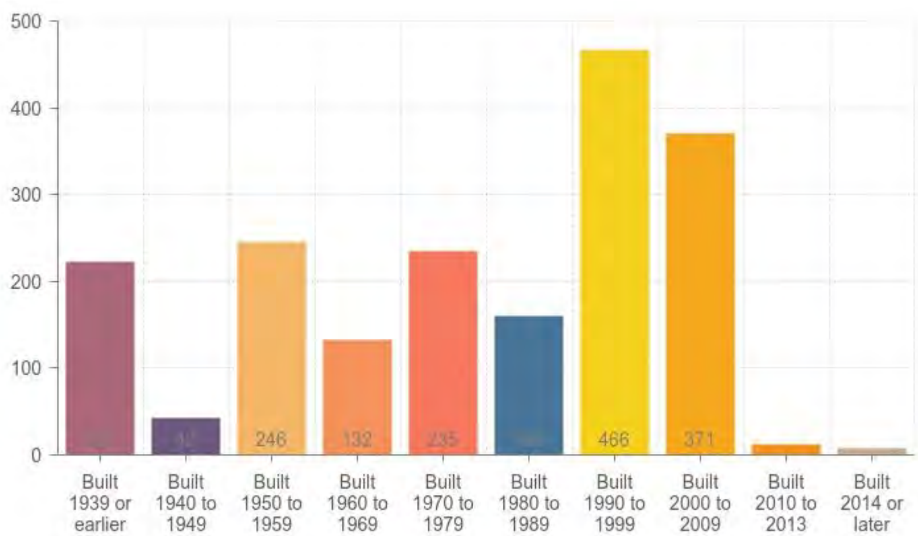
6. Residential Energy Efficiency

Harlan Township contains over 1,600 residential housing units according to the American Communities Survey. These buildings offer significant opportunities to reduce energy waste and save money on annual utility costs. This section identifies priorities for improving existing residential buildings and provides options for programs that can encourage property owners to install efficiency measures.

Residential Building Stock

Harlan Township contains a diverse housing stock that has developed over time. Approximately 80 percent of residential buildings in Harlan Township were built before 2000 when energy efficiency became an integral component of new home construction methods. Energy code requirements for insulated windows, higher R-rated insulation in the walls and ceilings, and a tighter building envelope began during this period

Figure 11: Harlan Township Residential Building Age by Decade Built[11]



Residential Energy Improvements

Buildings built within the same decade share characteristics that impact their overall energy efficiency. Older homes were not designed with energy efficiency in mind, so they present significant opportunities to reduce energy usage and improve comfort. A study conducted by the Joint Center for Housing Studies of Harvard University found that homes in the Midwest built prior to 1970 use 20 percent more energy per square foot than homes built since 1990.[12]

[11] U.S. Census Bureau, 2017
[12] Joint Center for Housing Studies of Harvard University, 2007

The amount of energy consumed by a household is determined by a variety of factors including those outlined in the table below. Energy consumption is dictated not only by the age and construction of the home, but also by the behaviors and purchasing decisions of its residents.

Figure 12: **Factors impacting household energy consumption**

Electricity	Natural gas
Square footage	Square footage
Presence and efficiency of air conditioning	Building age
Efficiency of lighting	Building envelope efficiency
Efficiency of appliances and systems	Efficiency of heating system
Occupant behavior	Occupant behavior
	Systems operation and maintenance

While elements of construction, such as insulation, are not constant among homes of the same era, they can help define the general energy efficiency of a home and dictate the type of improvements required to improve efficiency. The improvements listed below represent five of the most common energy efficiency improvements for homes in Harlan Township.

Attic insulation
Older homes were not constructed with attic insulation, but small levels may be present in homes built from the 1960s onward. If old insulation is present, then it has likely lost most if not all its insulating value and should be evaluated by a professional. In homes with a Cape Cod style attic, it is important to properly insulate the attic floor, knee walls, slopes, and ceiling. ENERGY STAR recommends that attics in this region have insulation levels between R49 and R60.

Air sealing
Most older homes have significant issues with air infiltration. Special attention should be paid to sealing penetrations into the home to reduce drafts and improve comfort. Penetrations and gaps in the attic plane such as electrical boxes, plumbing stacks, ductwork, chimneys, and chases should be sealed prior to adding additional insulation. All penetrations in the foundation, including the rim joists if present, should be properly air sealed.

Heating systems
Older furnaces should be replaced with an ENERGY STAR high efficiency unit. If natural gas is not available, then a ground source or air source heat pump should be installed. Duct work should be sealed with mastic and insulated if located in unconditioned space.

Cooling systems
Many older homes did not originally have cooling systems. A forced air system may have been installed at some point in time. Older air conditioning units should be replaced with an ENERGY STAR high efficiency unit or an air source heat pump. Ductless mini-split heat pumps provide an energy efficient alternative to a window air conditioning unit if forced air is not present.

Windows
Home built during the early 1900s originally had single pane windows with wood frames. By the 1950s, steel or aluminum single pane windows became commonplace. Neither of these types of windows were designed to prevent air infiltration or to provide any insulation value. Simple repairs to older windows can be made to make them more energy efficient. Windows should be properly sealed

and caulked to reduce infiltration. Older wood windows should be examined to ensure that their weights and ropes work properly so that the windows close correctly. Storm windows should also be installed to provide additional insulating properties and to protect the wood windows. If steel or aluminum windows are present, the best option is to replace them with ENERGY STAR rated replacement windows.

Appendix C provides an overview of the different types of energy efficiency improvements needed by residential properties in Harlan Township based on age.

Energy Burden

Energy burden is defined as the percentage of a household's annual gross income that goes toward payment of annual utility costs (electric, natural gas, or other heating fuel). This measure illustrates how the impact of high energy prices and inefficient housing are disproportionately felt by different population groups or households in different parts of the community. Energy costs that may be affordable to a middle-class household, may not be affordable to a low-income household. In fact, low-income households spend three times more of their income on energy bills than higher income households.[13]

$$\text{Energy Burden} = \frac{\text{Total Annual Energy Utility Spend}}{\text{Total Gross Household Income}}$$

Households that face high energy burdens experience many negative long-term economic and health related burdens. Research has found that there are three separate but interrelated consequences of energy burden: (a) illness and stress, (b) financial challenges, and (c) housing instability.[14]

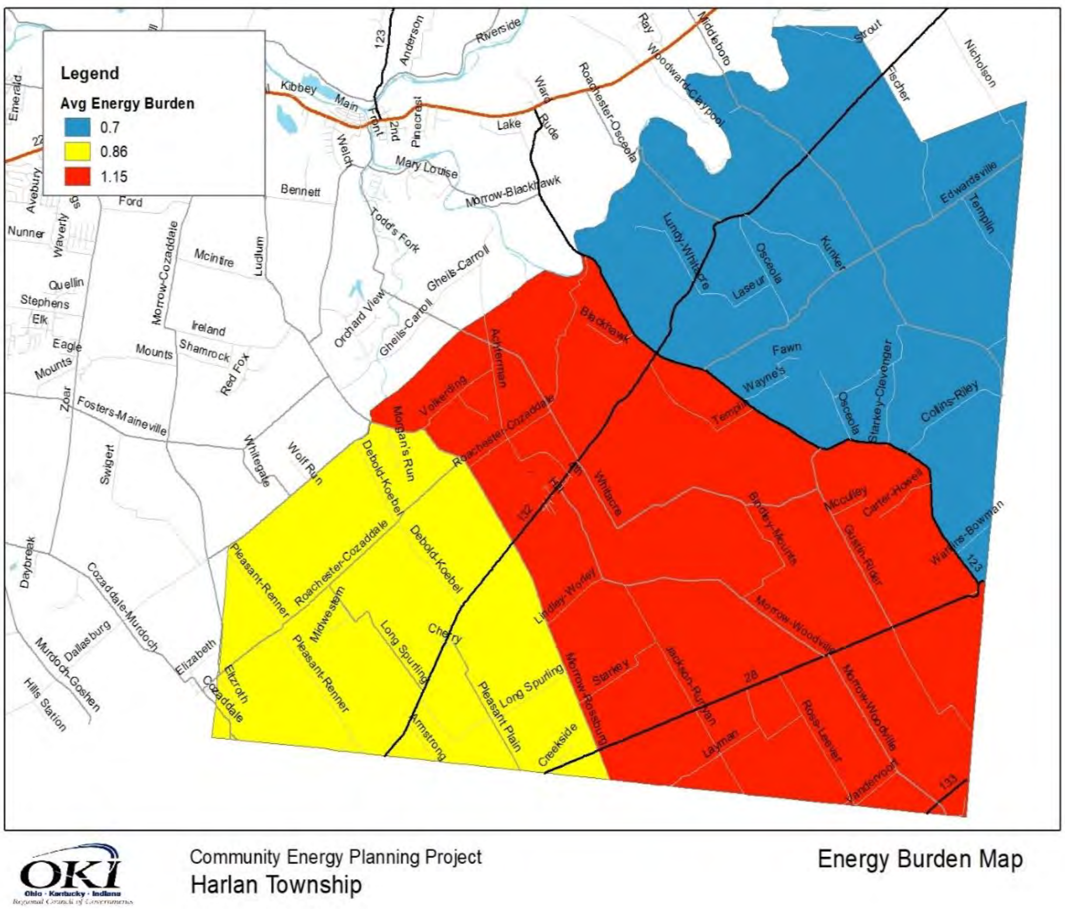
Figure 13: **Drivers of household energy burden**[15]

Type of Driver	Examples
Physical	Inefficient and poorly maintained HVAC systems Poor insulation, leaky roofs, and inadequate air sealing Weather extremes that raise the need for heating and cooling
Economic	Chronic economic hardship due to persistent low income Sudden economic hardship Inability to afford the up-front costs of energy efficiency improvements
Policy	Insufficient or inaccessible policies and program
Behavioral	Lack of access to information about bill assistance or energy efficiency programs Increased energy use due to age or disability

[13] Drehobl and Ross, 2016
[14] Hernandez and Bird, 2010
[15] Drehobl and Ross, 2016

The median household energy burden in Harlan Township is 2.59 percent, which is far below the energy poverty threshold of 6 percent. The census block group with the highest energy burden runs diagonally through the center of the township. It has an energy burden of 3.30 percent which is still below the energy poverty threshold.

Figure 14: **Relative Energy Burden by Census Block Group**



With only three census block groups in Harlan Township, the analysis of energy burden is not particularly nuanced. While there do not appear to be any census block groups in Harlan Township with extremely high levels of energy burden, it is important to keep a few issues in mind. The first is that the data used to calculate energy burden does not take into consideration the costs associated with heating a home using fuels other than natural gas. If that data was available for analysis, then the energy burden values will likely increase considerably. Second is that even if the energy burden values are below the energy poverty threshold, there are likely residents experiencing issues related to high energy burden. As a result, it is important to make residents aware of the resources that are available to assist them. The three strategies outlined below can be implemented at the local level to educate and inform residents.

Leverage community-based organizations to implement energy related programs
Low-income households nationwide may not trust government agencies, utilities, or energy efficiency contractors. It is important to work with community-based organizations that are viewed as trusted

sources of information and who advocate for residents. These organizations can be utilized to host or sponsor programs designed to educate community members about energy efficiency related topics.

Conduct outreach and education programs to increase energy literacy
Low-income homeowners and tenants can be better positioned to act if they understand how to save energy in their dwelling. Programs that promote greater energy literacy and teach energy saving strategies that households can implement on their own, can help to decrease energy burden.[16]

Connect residents with existing energy programs
In many cases low-income households lack access to communication channels that can inform them about the variety of programs designed to address energy related issues. It is important to provide residents with information about programs available in the community that could assist them with addressing high energy bills or installing energy saving improvements.

Programs to Boost Residential Energy Efficiency

Harlan Township should educate residents about existing programs designed to assist them with improving the energy efficiency of their home. These programs range from utility incentives and loan programs to low income weatherization programs. A listing of these programs is available in Appendix D.

In addition to leveraging existing programs, Harlan Township should consider developing new programs to assist its residents with reducing energy consumption. It is important to ensure that new programs are designed to meet the specific needs of the community for them to produce their desired outcomes.

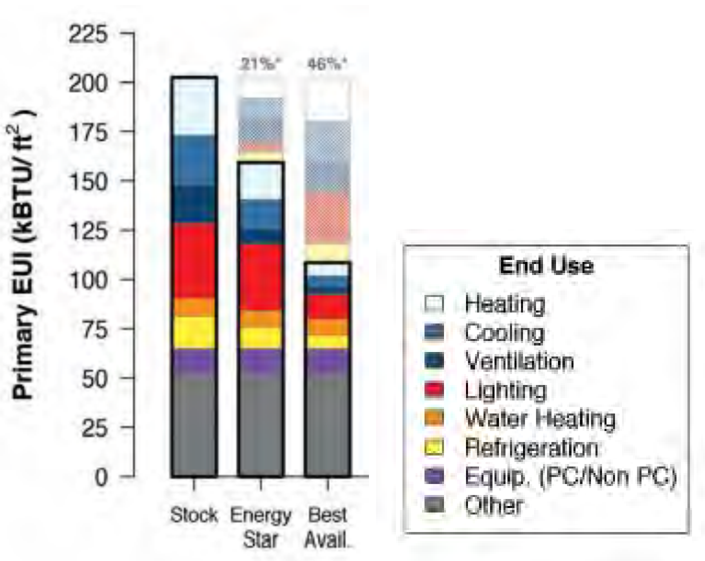
Education and Outreach
Harlan should work to improve the energy literacy of its residents. The township can leverage its communication channels such as newsletters and social media to provide residents with energy saving tips and information designed to educate them about the benefits of improving the efficiency of their homes. In addition, the township could partner with local groups to host energy efficiency workshops in the community. The workshops would focus on steps that both property owners and renters could take to reduce their energy usage and improve comfort.

[16] Hernandez and Bird, 2010

7. Commercial, Industrial, and Governmental Energy Efficiency

According to the U.S. Department of Energy, improving heating and cooling related building components in commercial buildings such as windows, walls, roofs, controls, and HVAC equipment to ENERGY STAR recommended levels can decrease energy consumption by 21 percent. Upgrading to the best available technologies could reduce energy consumption even further, saving property owners up to 46 percent.

Figure 15: **Potential Commercial Energy Savings.**[17]



While the commercial and industrial buildings in Harlan Township vary in age and usage, there are several improvements that property owners can make to reduce energy usage.

Lighting
Many commercial and industrial buildings continue to rely on incandescent or florescent bulbs for lighting. Switching to high efficiency LED bulbs can reduce energy usage by up to 70 percent. In some cases, it may be necessary to switch out the fixture or remove the ballast prior to installing a LED bulb.

Building Controls
While most commercial and industrial buildings have set hours of operation, they often do not have systems in place to effectively manage their lighting or heating and cooling systems. Installing proper building controls can ensure that the building operates in an efficient manner. Controls can range from a simple programmable thermostat in a small commercial storefront to a more advanced computer-based system in larger facilities. On the lighting front, property owners can utilize occupancy sensors, timers, and other controls to ensure they are not lighting areas that are not in use.

[17] U.S. Department of Energy, 2015

Heating and Cooling Systems
Commercial and industrial property owners should develop a plan to replace heating and cooling equipment rather than waiting until failure. This will reduce costs associated with emergency repairs and/or rental chillers that would be required to keep the system operational until a new unit could be obtained. Property owners should install high efficiency equipment to maximize energy savings.

Local Government Energy Usage

Harlan Township relies on electricity and propane to power governmental functions ranging from heating and cooling to lighting. Currently, most of the energy consumed to provide governmental services is utilized for heating. The large difference between electricity and heating usage is an indicator that there are significant opportunities for energy efficiency improvements in township owned buildings.

Figure 16: **Harlan Township governmental energy consumption by end use**

	Percentage of energy usage
Facilities - Electricity	33.84%
Facilities - Heating	66.16%

Graphet Data Mining conducted an energy audit of the Harlan Township Administration Building to identify potential energy conservation opportunities. The study completed a review of the building's energy usage patterns as well as its heating and cooling equipment, lighting, and control systems.

The administration building, including the fire bays, used just under $28,000 in propane and electricity during the twelve-month period examined. Propane represents the largest utility cost. An analysis of the data showed that Harlan Township is paying $0.100 per kWh for electricity which is slightly high for a commercial user. This could be because the township does not use enough electricity to qualify for lower rates. On the propane side, the township paid an average of $2.34 per gallon in 2018 which was a competitive rate.

Figure 17: **Harlan Township Administration Building Energy Usage**

	Amount Consumed	kBtu Equivalent	Cost
Electricity	84,296 kWh	287,630	$8,850
Propane	8,003 gal	732,272	$18,726

The administration building's occupancy varies throughout the day due to its mixed uses. The portion of the building that houses the fire department has a unique schedule while the administrative offices are used primarily during traditional business hours. In addition, the community room is used in the evenings and on weekends for meetings and events. This results in a building dynamic that must be properly managed to maximize energy efficiency.

A complete version of energy audit report prepared by Graphet can be found in Appendix F. The report identified the following energy conservation opportunities (ECO) as high priorities:

Adjust temperature settings on the HVAC units during unoccupied hours
The HVAC units in the building are adjusted by users daily which can result in the units operating at inefficient temperatures during unoccupied hours. Adjusting temperature settings based on occupancy can result in significant energy savings. The township should determine what hours it feels are acceptable to adjust thermostats to an unoccupied set point and program the existing thermostats. This ECO is estimated to save between $1,460 to $1,825 annually.

Interior and exterior lighting
Harlan Township currently uses fluorescent bulbs throughout the facility. The township should begin the process of upgrading to LED bulbs for interior and exterior fixtures. Due to the age of the existing ballasts, the township should use Type B LED bulbs in the interior spaces. Type B LED bulbs bypass the ballast and are connected directly to the existing electrical wiring. By converting to Type B LED bulbs, the township could save an estimated $1,928 to $2,143 in electricity costs annually.

The exterior metal halide and halogen bulbs should also be replaced with LED bulbs. By converting to Type C LED bulbs, the township could save an estimated $1,242 to $1,380 annually.

HVAC replacement strategy – Building
There are two different types of split systems providing heating and cooling to the administration building. There are two air-source heat pumps that were installed in 2018 and two propane-fired systems installed in 2000. The propane-fired systems are at a point where the township should have a replacement strategy in place for when they are no longer operational. The township should replace the older systems with ENERGY STAR rated air-source heat pumps. This ECO is estimated to save between $2,500 to $3,000 annually.

HVAC replacement strategy – Apparatus Bay
The apparatus bay is currently heated by six propane-fired heaters. These heaters accounted for 68 percent of propane used at the facility and cost $12,719 to operate. The township should consider more efficient methods for heating the apparatus bays. Air-source heat pumps could be spread throughout the bay to minimize the amount of ductwork needed. Another option would be to investigate propane-fired infrared heaters. Vendors for each option should be able to provide the township with estimated operation costs based on usage scenarios. This ECO is estimated to save between $6,858 to $7,619 annually.

The table below provides a basic overview of the major ECOs identified by Graphet.

Figure 18: **Energy Conservation Opportunities for Harlan Township**

ECO	Priority	Investment Required	Estimated Annual Cost Savings
Implement temperature setbacks	High (Operational)	Minimal	$1,460 - $1,825
HVAC replacement	Mid (Investment)	Medium	$2,500 - $3,000
Retrofit lighting	Mid (Investment)	Medium	$3,441 - $3,824

Heater replacement apparatus bay	Mid (Investment)	High	$6,858 - $7,619
Insulate apparatus bay doors	Low (Investment)	Medium	$695 - $868

Programs to Boost Commercial and Industrial Energy Efficiency

The following programs are available to encourage investment in energy saving improvements by commercial and industrial property owners.

Duke Energy Smart $aver
Rebates are available to help offset the costs associated with installing certain approved energy efficiency measures. As of 2020, Duke Energy offers rebates for lighting, HVAC, and commercial and industrial equipment.

DP&L Rebates
Rebates are available to help offset the costs associated with installing certain approved energy efficiency measures. As of 2020, DP&L offers rebates for lighting, HVAC, and commercial and industrial equipment.

PACE Financing
Property Assessed Clean Energy (PACE) is a financing mechanism available to commercial and industrial properties for energy efficiency and renewable energy improvements. PACE provides financing for 100% of an energy project's cost and is repaid for up to 25 years with a voluntary special assessment added to the property's tax bill. It enables property owners to increase the value of their building and reduce energy costs with no down payment or personal guarantee. PACE is a simple and effective way to finance new construction and upgrades to buildings.

8. Renewable Energy

Approximately 80 percent of the energy used in Ohio is currently derived from power plants fueled by coal or natural gas. While these forms of energy production are relatively cheap, they generate air pollution and greenhouse gases which negatively impact public health in our region. In the American Lung Association's 2019 State of the Air report, Warren County received an F for its number of high ozone days while the Cincinnati metropolitan area was ranked the 13th worst for annual particulate pollution out of over 200 metropolitan areas.[18]

These impacts, coupled with rising energy costs, are leading more and more homeowners and businesses to look for alternative energy options. Renewable energy offers clean, sustainable, and increasingly cost-competitive sources of energy. The three renewable sources prevalent locally are solar, geothermal, and to a lesser extent, wind.

Distributed Generation

Distributed generation refers to electricity that is generated, and in many cases fed to the electric grid, from sources that are dispersed throughout the community. The most common example of this are privately owned solar panels that provide energy for individual homes or businesses, but also feed excess power back to the grid through net metering. Distributed generation is also becoming a larger portion of the nation's energy generating capacity. In 2017, the US Energy Information Agency projected a 400% increase in solar distributed generation capacity by 2040, making it the fastest growing sector of new electric generation capacity.

Distributed generation offers several key benefits to a community. First, most sources of distributed generation are renewable. Also, these energy sources provide power with little to no emissions. Distributed generation improves the resiliency of the utility network because they lessen the chance of an event knocking out a critical portion of generating capacity on the grid. Finally, distributed generation, because it is located closer to the point of use, reduces line losses from the transmission of electricity over longer distances.

Each new home and business adds to the need for new generating capacity, causing the existing power plants to work harder and, as a result, increasing air pollution. Once enough new homes and businesses are added, a new power plant would be required to keep up with the demand. Solar panels can greatly offset the demand increase from new development, reducing air pollution and the need for additional power plants in the future.

Solar Photovoltaics

Solar photovoltaics have been available for decades, but only recently gained widespread popularity due to lower costs. Ten years ago, the cost of a solar panel installation was $8.82 per Watt. Today, a similar installation would cost less than $3.00 per Watt. These price declines have shortened the payback on a solar PV system and made them more affordable to homeowners in the region.

Most solar installations remain connected to the electrical grid even though they have solar panels. Any excess electricity produced by the solar panels that cannot be used by the property at the time it is

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[18] American Lung Association, 2019

produced is sent to the grid. Under the current regulatory structure in Ohio, property owners are compensated for any excess electricity produced through a process known as net metering.

According to the Public Utilities Commission of Ohio (PUCO), there are currently four residences in Harlan Township registered as certified solar facilities. However, because property owners are not required to register their solar installations with PUCO, there could be additional commercial or residential properties in the township that have installed solar panels.

There are several steps that Harlan Township can take to make it easier for property owners to invest in solar in the future.

Launch a Solar Campaign
Solar campaigns create a group purchasing and community outreach program in order to accelerate demand and reduce individual costs for solar installations in a community. They also seek to increase awareness of solar energy and financing options, thereby helping to build sustained growth of the local solar market. Solar United Neighbors partners with communities to conduct solar campaigns.

Develop a Permit Checklist
A permit checklist can help guide a solar installer or other interested party through the permitting process by clearly stating the necessary types of plan reviews and required permits for a solar installation. A basic permit checklist outlines the sequential steps of the permitting process while a more comprehensive checklist also includes applicable standards for each step in the review process.

The Warren County Building & Zoning Department currently has a FAQ page dedicated to solar and wind power which offers some basic information on the process. Harlan Township could work with the department to enhance the page with the addition of the permit checklist that includes all the information that residents are required to provide in order to receive a permit for a solar installation.

Update Zoning Regulations
The current Warren County Rural Zoning Code used by Harlan Township addresses ground mounted solar equipment (Sec. 3.102.10) but is silent on roof mounted solar installations. Harlan Township should work with Warren County Rural Zoning Commission to develop explicit language that promotes the placement or use of roof mounted systems. One of the biggest potential barriers to solar energy use is a lack of clarity in the local zoning code about what types of solar energy systems are permitted in what locations. This will prevent any future interpretations of the code that might prohibit roof mounted solar installations. Appendix E provides sample language that could be put forward to address this issue.

Geothermal

Geothermal heat pumps, or ground source heat pumps, use the constant temperature of the earth for heating and cooling. Most geothermal systems circulate a refrigerant through a closed loop that is placed in horizontal or vertical wells dug in the ground. The refrigerant is used to extract heat from the ground in the winter and to transfer heat back into the ground in the summer. The refrigerant then passes through a heat exchanger where it is distributed through a forced air system.

Because geothermal systems rely on the temperature of the earth, there is no onsite combustion and therefore no emissions of carbon dioxide, carbon monoxide or other greenhouse gases like there is with a gas furnace or boiler. However, the heat pump unit does use a small amount of electricity, which may be generated using fossil fuels.

Geothermal systems are expensive to install due to the costs associated with digging the wells, but they can reduce annual operating costs by up to 50 percent. Their performance is impacted by extremely cold temperatures, so it is important to have a back-up source of heat such as a gas or propane furnace that can be used when needed. Property owners should work with a contractor that is certified by the International Ground Source Heat Pump Association (IGSHPA) to ensure that the system is designed and installed correctly.

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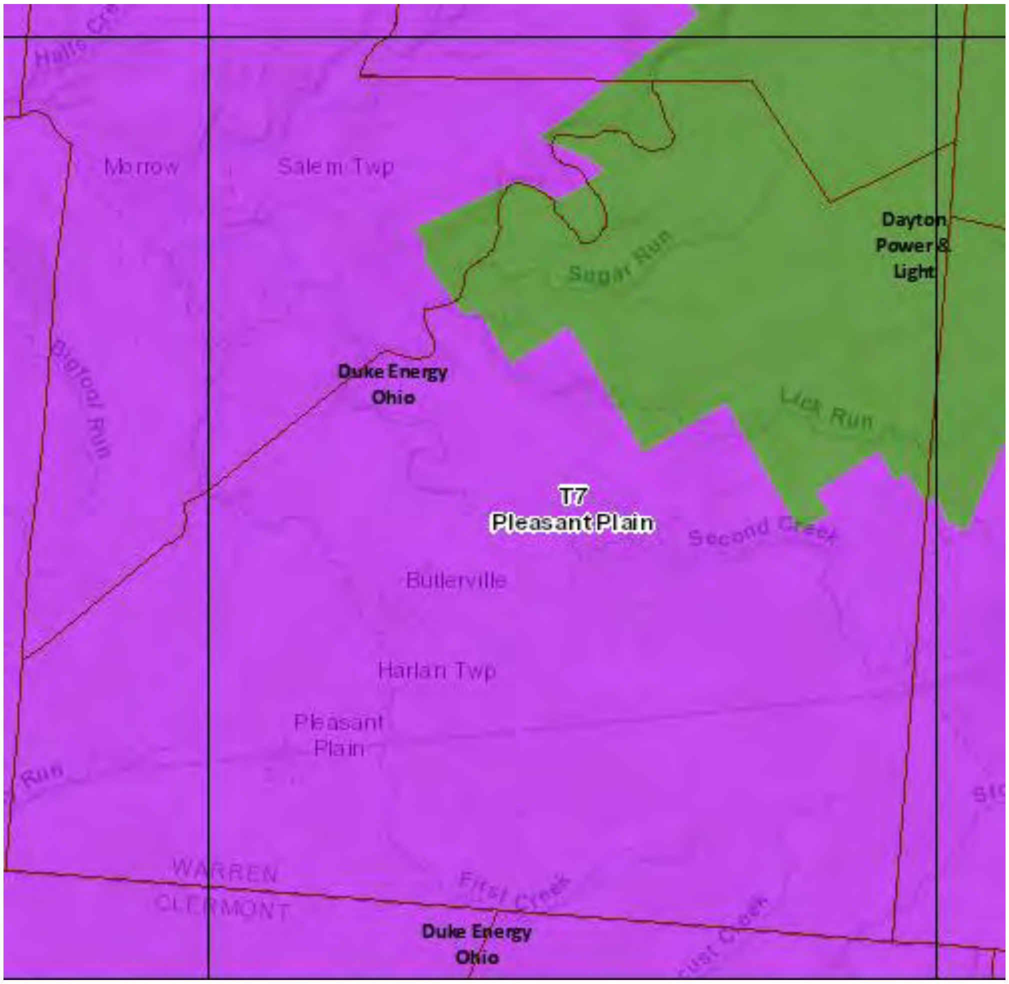
10. Appendix

Appendix A: Duke Energy and DP&L Territories



Appendix B: Sample Duke Energy Bill

This section provides an overview of some of the important sections that appear on your Duke Energy bill. The letter next to each description corresponds to the red circled letter on the attached sample Duke Energy bill.

A. Billing Summary

Perhaps the most important section on the first page is the billing section. It shows the previous amount due as well as any payments that were received. If there is a remaining balance, then it will be noted as well. The bottom portion of the section shows the current charges for the billing period as well as the total amount due.

B. Your Usage Snapshot

The usage snapshot located on the first page is a useful tool that shows a 13-month summary of electricity and natural gas usage. The line graph provides a visual interpretation of monthly usage. Homes with natural gas should have higher usage in the winter months and lower in the summer months.

For electricity, usage should be lower in the winter months with a peak in the summer as more electricity is used for air conditioning. However, if electricity is used for heating, then the usage chart should be higher in the winter months than the summer.

The table under each graph shows the amount of energy used in the current month verses that same month a year ago. Those values may be similar, but they may differ significantly depending on what the weather was like during that month each year.

C. Billing details

The Billing details section on the third page provides a detailed overview of your natural gas and electric charges. The first charge listed will be the fixed charges. These are charges that are paid to Duke Energy regardless of how much energy is used each month.

Below the fixed charges will be the distribution charges which are based on the amount of natural gas or electricity that Duke Energy delivered. The next item listed are any riders set by the Public Utility Commission of Ohio.

The generation charges for electric and gas cost recovery charges for natural gas appear below the riders line item. This is where the name of the electric and natural gas supplier appears if it is not Duke Energy. This section also shows the price per unit of energy that the user is paying.

D. Notes section

On the right-hand side of the third page is the Price to Compare section. This shows the price that Duke Energy is charging per kilowatt hour (kWh) of electricity. That price can be compared to the price the user is paying per kWh which appears in the Billing details - Electric section under Generation charges.

DUKE ENERGY.

duke-energy.com
800.544.6900

Your Energy Bill

Service address
123 Sample St
City OH 00000

Bill date Oct 23, 2020
For service Sep 21 – Oct 22
31 days

Account number **999 999 999**

Thank you for your payment.

A

Billing summary

Previous amount due	$ 198.29
Payment received Oct 15	- 198.29
Current electric charges	100.35
Current gas charges	50.02
Total amount due Nov 14	**$ 150.37**

B

Your usage snapshot

	Current Month	Oct 2019	12-Month Usage	Average Monthly Usage
Electric (kWh)	849	928	11,373	[illegible]

12-Month usage based on most recent history

	Current Month	Oct 2019	12-Month Usage	Average Monthly Usage
Gas (CCF)	19	10	568	47

12 Month usage based on most recent history

Mail your payment at least 7 days before the due date or pay instantly at *duke-energy.com/billing*. Late payments are subject to a 1.5% late charge.

DUKE ENERGY.
P.O. Box 1326
Charlotte NC 28201-1326

Account number **999 999 999**

Amount due

$ 150.37 by Nov 14	*After Nov 14, the amount due will increase to $152.63.*

$ ______ *Add here, to help others with a contribution to HeatShare*

$ ______ **Amount enclosed**

000549 0000024295

Sally Sample
123 Sample St
City OH 00000-1234

P.O. Box 1326
Charlotte NC 28201-1326

09880389 0 9752709 1 0000011588 6 0000011588 6 0000011588 6

Your usage snapshot - continued

Current electric usage for meter number 999999999		
Actual reading on Oct 22	80793	
Previous reading on Sep 21	– 79944	
Energy used	849	kWh

A kilowatt-hour (kWh) is a measure of the energy used by a 1,000-watt appliance in one hour. A 10-watt LED lightbulb would take 100 hours to use 1 kWh.

Current gas usage for meter number 999999999		
Actual reading on Oct 22	3962	
Previous reading on Sep 21	– 3943	
Energy used	19	CCF

One centum cubic foot (CCF) is the amount of gas in a 100-cubic-foot space. If you have a standard oven, it would take about 20 hours to use 1 CCF of gas.

C

Billing details – Electric

Customer charge	$6.00	
Delivery charges		
Energy charges		
849 kWh @ $0.02534200	21.52	
Delivery riders	22.01	
Generation riders	0.73	
Generation charges		
Rider RC	17.63	
Rider RE	33.76	
Rider AERR	0.25	
Rider SCR	-1.55	
Current electric charges		**$100.35**

Billing details – Gas

Fixed delivery service charge	$33.03	
Usage-based charge		
19 CCF @ $0.03272800	0.62	
Gas delivery riders	8.17	
Gas cost recovery		
19 CCF @ $0.43183210	8.20	
Current gas charges		**$50.02**

D

Your current rate is Residential Service, Winter (RS).

The charges for the current billing period include the following amounts to meet each of these Ohio requirements: Energy Efficiency = $2.34, Peak Demand Reduction = $0.58, Renewable Energy = $0.61

Price to compare: In order for you to save money, an electric supplier must offer you a price lower than 5.90 cents per kWh for the same usage that appears on this bill. To review competitive offers from electric suppliers, visit the Public Utilities Commission of Ohio's "Energy Choice Ohio" website at www.energychoice.ohio.gov. To learn more about Price to Compare, visit duke-energy.com or contact Duke Energy for a written explanation.

Riders are costs the Public Utilities Commission of Ohio has approved to cover investments in improving the energy infrastructure or other additional expenses.

Your current delivery rate is Residential Service (RS).

This month's Gas Cost Recovery (GCR) charge for customers purchasing their natural gas from Duke Energy is **$0.4318321** per CCF, which includes a base GCR of $0.4117 and Ohio excise tax of $0.0201321.

For a complete listing of all Ohio rates and riders, visit duke-energy.com/rates.

Appendix C: Residential Energy Efficiency Improvements

The table below provides an overview of the different types of energy efficiency improvements needed by residential properties in Turtlecreek based on their age.

	Cost	Savings Impact	Pre-1900	1900-1940s	1950s	1960s	1970s	1980s - 1990s	2000 and beyond
Air Sealing	Low	High	✓	✓	✓	✓	✓	✓	
Rim Joists	Low	High	✓	✓	✓	✓	✓		
Attic Insulation	Low	High	✓	✓	✓	✓	✓	✓	
Basement Insulation	Medium	Medium	✓	✓	✓	✓	✓		
Crawlspace Insulation	Low	High	✓	✓	✓	✓	✓		
Wall Insulation	High	High	✓	✓	✓	✓			
Heating Systems	High	Medium/ Low	✓	✓	✓	✓	✓	✓	✓
Cooling Systems	High	Medium/ Low	✓	✓	✓	✓	✓	✓	✓
Windows	High	Low	✓	✓	✓	✓	✓	✓	
Areas above unconditioned spaces	Low	High		✓	✓	✓	✓	✓	
Knob and tube wiring	Medium	NA	✓	✓					
Asbestos	High	NA		✓	✓	✓			
Vermiculite	High	NA			✓	✓			

Appendix D: Residential Energy Efficiency Programs

Duke Energy Residential Programs

Smart $aver
Rebates are available to help offset the costs associated with installing certain approved energy efficiency measures. As of 2020, Duke Energy offers rebates for heat pump water heaters, insulation and air sealing, variable-speed pool pumps, and high efficiency air conditioners and heat pumps.

Home Energy House Call
Homeowners may request a free in-home energy assessment that will identify ways to improve energy efficiency. The program is only available to homeowners.

LED Program
Duke customers can receive up to 15 LED bulbs every 5 years. In addition, Duke offers an online lighting stores where customers can purchase various types of LED bulbs at discounted prices.

Dayton Power & Light Residential Programs

Residential Rebates
Rebates are available to help offset the costs associated with installing certain approved energy efficiency measures. As of 2020, DP&L offers rebates for insulation and air sealing, heat pump water heaters, and high efficiency air conditioners and heat pumps.

LED Program
DP&L customers can receive instant, in-store rebates on LED bulbs at participating retailers. In addition, DP&L offers an online lighting stores where customers can purchase various types of LED bulbs at discounted prices.

Income Qualified Programs

A wide variety of programs are available to low-income households to help reduce high energy burden. Unfortunately, many low-income households are either not aware of the programs or do not know how to access them. Harlan Township should work with local partners to educate residents about these programs and help sponsor events to facilitate the registration process.

Home Energy Assistance Program (HEAP)
Provides eligible households assistance with their home energy bills. This one-time benefit is applied directly to the customer's utility bill or bulk fuel bill. The Winter Crisis Program (HEAP Winter Crisis Program) helps income eligible households maintain their utility service if they are threatened with disconnection, have been disconnected, or have less than a 25 percent supply of bulk fuel in their tank. The program runs from November 1 until March 31. The Summer Crisis Program (HEAP Summer Crisis Program) provides bill payment assistance for persons 60 years of age and older or those with a certified medical condition. The program runs from July 1 until August 31.

- **Eligibility:** Households must have a household income at or below 175 percent of the federal poverty guidelines to participate in the program and must report total gross household income for the past 30 days (12 months preferred) for all household members. Both homeowners and renters are eligible for assistance.
- **Local program implementer:** Warren County Community Services (WCCS)

Home Weatherization Assistance Program (HWAP)
Provides eligible individuals with assistance to improve the energy efficiency of their homes and reduce their energy costs. HWAP provides a home inspection to identify energy saving improvements and the installation of cost-effective improvements.

- **Eligibility:** Households must have an income at or below 200 percent of the federal poverty guidelines. Priority is given to households with residents older than age of 60, those with disabilities, those with children in the home, and households with a high energy usage and/or burden. All families who have received assistance any time during the last 12 months under Supplemental Security Income (SSI), Temporary Assistance for Needy Families (TANF), or Home Energy Assistance (HEAP) (does not include Emergency HEAP) are automatically income eligible for weatherization services.
- **Local program implementer:** Warren County Community Services (WCCS)

Duke Energy Weatherization Program
Helps eligible households save energy and reduce expenses through the installation of energy saving improvements and by providing education on energy saving behaviors the household can adopt. The program is available to single-family and multi-family units.

- **Eligibility:** Households must have a household income of less than 175 percent of the federal poverty guidelines. Both homeowners and renters are eligible for assistance.
- **Local program implementer:** People Working Cooperatively

Duke Energy Furnace Replacement
Provides eligible households with a replacement for inefficient or inoperable heating systems.

- **Eligibility:** Households must have a household income of less than 175 percent of the federal poverty guidelines and use more than 1 therm of natural gas per square foot of living space.
- **Local program implementer:** People Working Cooperatively

Duke Energy Refrigerator Replacement
Provides eligible households with a replacement for inefficient refrigerators as determined by a two-hour metering test.

- **Eligibility:** Households must have a household income of less than 200 percent of the federal poverty guidelines. The program is available to single-family and multi-family residences. Participants must show verification of refrigeration ownership.
- **Local program implementer:** People Working Cooperatively

Electric Partnership Program (EPP)
Assists eligible households in reducing their electricity usage. EPP provides in-home audits and installs appropriate electric energy efficiency measures to reduce electric usage. Customers also receive information on how they can reduce their electric use and improve their home's efficiency.

- **Eligibility:** Households are eligible for EPP if they are on or eligible for the Percentage of Income Payment Plan Plus (PIPP), have 12 months of electric usage at their current address, and have an annual electric baseload usage of at least 5,000 kWh.
- **Local program implementer:** People Working Cooperatively

Percentage of Income Payment Program Plus (PIPP Plus)
Helps households manage their energy bills by establishing consistent monthly payments based on a percentage of household income. Homes heated with gas have a monthly payment of 6% of their household income for their natural gas bill and 6% of their household income for their electric bill. Homes heated with electric have a monthly payment of 10% of their household income. The balance of a household's utility bill is subsidized by the state of Ohio. There is a minimum monthly payment of $10.00. Paying 24 on-time and in-full payments eliminates any outstanding balance with the utility company that a household may have.

- **Eligibility:** Households must have a household income at or below 150 percent of the federal poverty guidelines and have utility service from an electric or natural gas company regulated by the Public Utility Commission of Ohio. Households applying for PIPP must report total gross household income for the past 30 days (12 months preferred) for all members. Both homeowners and renters are eligible for assistance.
- **Local program provider:** Warren County Community Services (WCCS)

Figure D1: **Summary of income qualified programs**

Program	Weatherization Assistance	Utility Bill Assistance	Income Qualification	Renters Eligible	Program Provider
Home Energy Assistance Program		✓	Less than 175%	✓	Warren County Community Services (WCCS)
Home Weatherization Assistance Program	✓		Less than 200%		Warren County Community Services (WCCS)
Duke Energy Weatherization Program	✓		Less than 175%	✓	People Working Cooperatively
Duke Energy Furnace Replacement	✓		Less than 175%		People Working Cooperatively
Duke Energy Refrigerator Replacement	✓		Less than 200%	✓	People Working Cooperatively
Electric Partnership Program	✓		Less than 150%		People Working Cooperatively
Percentage of Income Payment Program Plus		✓	Less than 150%	✓	Warren County Community Services (WCCS)

Other Energy Efficiency Programs

Federal Income Tax Credit
Residential property owners are eligible to receive a federal tax credit for renewable energy products installed prior to December 31, 2021. The tax credit is limited to solar water heat, solar photovoltaics, geothermal heat pumps, and small wind turbines. The tax credit is equal to 26 percent of the project cost for projects installed by the end of 2020 and 22 percent for projects installed by the end of 2021. The tax credit is scheduled to expire at the end of 2021.

Rural Energy for America Program (REAP) Renewable Energy Systems and Energy Efficiency Improvements
The U.S. Department of Agriculture (USDA) provides loan financing and grant funding to agricultural produces and rural small business to purchase or install renewable energy systems or make energy efficiency improvements. Loan guarantees are available on loans up to 75% of eligible project costs and grants are available for up to 25% of eligible project costs. In 2019, USAD provided grants ranging from $3,215 to $20,000 to 19 projects in Ohio. Projects ranged from solar arrays upgrading grain dryers, and poultry house improvements. To apply for the program, contact your local USDA office.

- **Eligibility:** Agricultural produces with at least 50% of gross income coming from agricultural operations and small businesses in eligible rural areas.

State of Ohio ECO-Link Loan Program
The Office of the Ohio Treasurer of State works local lending partners to provide up to a 3% interest rate reduction for loans that are used to fund energy efficiency improvements. Additional information is available at www.ECOLink.ohio.gov.

Zonolite Attic Insulation Trust
Homeowners that have asbestos-containing vermiculite insulation in their attic may qualify to receive financial compensation to offset the costs associated with removing the hazardous substance. Homeowners who think they may have asbestos-containing vermiculite insulation should visit www.zonoliteatticinsulation.com for additional information.

Appendix E: Sample Zoning Language

Roof-Mounted Solar Energy Systems

i. Roof-mounted solar panels that are integrated with the surface layer of the roof structure or are mounted flush with the roof structure may be permitted on any roof surface of a principal building or accessory building.

ii. Roof-mounted solar panels that are mounted at an angle to the roof structure shall only be permitted on roof surfaces that face the side or rear lot.

iii. Solar panels may be mounted on flat roofs provided there is a parapet wall or other architectural feature that screens the view of the panels. Such panels may be mounted on an angle provided they do not extend more than five feet above the roof surface.

iv. A certificate of zoning compliance shall not be required for roof-mounted solar energy systems.

Appendix F: Energy Audit Report

Ohio | Development Services Agency

Sustainable Energy Efficiency Program

Energy Plan

Rev 2

for

HARLAN TOWNSHIP

Pleasant Plain, Ohio

Attn: Rick Howry

November 2019

Graphet DATA MINING
<Empowering Energy Efficiency>

Telephone (513) 474-4870 www.graphet.com

Contents

1.0- EXECUTIVE SUMMARY

The Harlan Township management team is interested in reducing the energy consumption of the Harlan Township Fire Department facility. This planning and technical study presents energy conservation opportunities (ECOs) to be considered for the Harlan Township Fire Department facility. It is possible for the Harlan Township Fire Department facility to reduce energy costs by 76%, approximately $20,907 of the electric and propane bills, with a comprehensive strategic energy management plan. Note that the cost savings potential is so high due to the ECOs which switch heating from propane to air-source heat pump (electric). Table 1-1 below describes the annual energy savings that could be realized by implementing each ECO and the cost associated with it. The savings and cost totals are based on best estimates. Each ECO has its own simple payback estimate that is independent of the other ECOs.

1.1- Energy Goals and Objectives

Past studies, brainstorming of ideas for energy conservation, and available utility and operating data were used to develop an understanding of potential energy conservation opportunities (ECOs). These opportunities were identified and evaluated with a focus on setting priorities for implementation. Suggested energy goals for Harlan Township Fire Department facility were developed relative to baseline energy consumption and rates. These energy goals are categorized below as short-term, mid-term, and long-term goals. Rebates include Duke Energy rebates as well as material cost compensation from state-funded grants.

1.1.1- Short-Term Goals

Energy conservation projects that are categorized as short-term priorities have a simple payback of less than two years, would provide a substantial upgrade in ease of building control, or are deemed as critical equipment replacements. The proposed short-term energy conservation measure is:

- **HVAC:** ECO 1: Implement Temperature Setbacks during Unoccupied Hours

By investing $30, the Harlan Township Fire Department facility can improve efficiency and reduce energy costs by $1,825, or 7% of total energy cost. Simple payback for this group is instantaneous.

There are no material costs associated with this ECO. Labor costs consist of the time it would take for the staff to implement the setbacks. There are no Duke Energy rebates associated with this project.

1.1.2- Mid-Term Goals

Energy conservation projects that are categorized as mid-term priorities have a simple payback of less than five years. The proposed mid-term energy conservation measures are:

- **Lighting:** ECO 4b-ii: Retrofit Interior Lighting to Type B LED with Daylighting and Occupancy Sensors
- **Lighting:** ECO 5b: Retrofit Exterior Lighting to Type C LED

By investing $16,421 (before rebates), the Harlan Township Fire Department facility can improve efficiency and reduce energy costs by $3,785, or 14% of total energy cost. Simple payback, including Duke Energy rebates, for this group is approximately 4 years.

Duke Energy rebates include $1,449 for interior lighting. There are no Duke Energy rebates for exterior lighting in Ohio.

1.1.3- Long-Term Goals

Energy conservation projects that are categorized as long-term priorities have a simple payback of greater than five years. The proposed long-term energy conservation measure is:

- **HVAC:** ECO 2: Interior HVAC System Replacement Strategy (Air-Source Heat Pumps)
- **HVAC:** ECO 3: Apparatus Bay HVAC System Replacement Strategy
- **Lighting:** ECO 4d: Retrofit Interior Compact Fluorescent and Incandescent Lighting to LED
- **Envelope:** ECO 6: Insulate Glass Apparatus Bay Doors
- **Solar:** ECO 7: Install a Solar Photovoltaic System

By investing $209,743 (before rebates), the Harlan Township Fire Department facility can improve efficiency and reduce energy costs by $15,297, or 55% of total energy cost. Simple payback for this group is approximately 13.6 years. Duke Energy rebates include $1,700 for the high efficiency air-source heat pumps.

Table 1-1: Energy Conservation Opportunities – Cost Benefit Analysis

TABLE E-1 SUSTAINABLE ENERGY CONSERVATION - PLANNING PHASE
POTENTIAL FOR ENERGY COST REDUCTION

ECO	System	Opportunity	Selected (Y/N)	Priority	Project Cost Min	Project Cost Max	Energy Cost Savings Min	Energy Cost Savings Max	Rebates Min	Rebates Max	Payback, yrs With Rebates Min	Payback, yrs With Rebates Max	Payback, yrs Without Rebates Min	Payback, yrs Without Rebates Max
1	HVAC	Implement Temperature Setbacks during Unoccupied Hours	Y	Operational	$15	$30	$1,460	$1,825	$0	$0	0.01	0.02	0.01	0.02
2	HVAC	Interior HVAC System Replacement Strategy (Air-Source Heat Pumps)	Y	Long	$20,740	$24,400	$2,500	$3,000	$1,445	$1,700	7.72	7.57	8.30	8.13
3	HVAC	Apparatus Bay HVAC System Replacement Strategy	Y	Long	$86,400	$96,000	$6,858	$7,619	$0	$0	12.60	12.60	12.60	12.60
4b	Lighting	Combined Opportunities: 4b-i, 4b-ii	Y	Mid	$10,403	$12,482	$2,164	$2,405	$1,304	$1,449	4.20	4.59	4.81	5.19
4b-i	↑	*Retrofit Interior Lighting to Type B LED*	*A*	*Mid*	*$9,188*	*$11,024*	*$1,928*	*$2,143*	*$1,304*	*$1,449*	*4.09*	*4.47*	*4.77*	*5.14*
4b-ii	↑	*Retrofit Interior Lighting to Type B LED with Daylighting and Occupancy Sensors*	*A*	*Mid*	*$1,215*	*$1,458*	*$236*	*$262*	*$0*	*$0*	*5.15*	*5.56*	*5.15*	*5.56*
4d	Lighting	Retrofit Interior Compact Fluorescent and Incandescent Lighting to LED	Y	Long	$311	$373	$35	$39	$0	$0	8.89	9.56	8.89	9.56
5b	Lighting	Retrofit Exterior Lighting to Type C LED	Y	Mid	$3,282	$3,939	$1,242	$1,380	$0	$0	2.64	2.85	2.64	2.85
6	Envelope	Insulate Glass Apparatus Bay Doors	Y	Long	$1,768	$8,240	$695	$868	$0	$0	2.54	9.49	2.54	9.49
7	Solar	Install a Solar Photovoltaic System	Y	Long	$80,730	$80,730	$3,771	$3,771	$0	$0	21.41	21.41	21.41	21.41
		All Projects			$203,649	$226,194	$18,725	$20,907	$2,749	$3,149	10.73	10.67	10.88	10.82
		Percent of Present Energy Costs					68%	76%						
		Operational Priority Projects			$15	$30	$1,460	$1,825	$0	$0	0.01	0.02	0.01	0.02
		Percent of Present Energy Costs					5%	7%						
		High Priority Projects			$0	$0	$0	$0	$0	$0				
		Percent of Present Energy Costs					0%	0%						
		Mid Priority Projects			$13,685	$16,421	$3,406	$3,785	$1,304	$1,449	3.64	3.96	4.02	4.34
		Percent of Present Energy Costs					12%	14%						
		Long Priority Projects			$189,949	$209,743	$13,859	$15,297	$1,445	$1,700	13.60	13.60	13.71	13.71
Percent of Present Energy Costs							50%	55%						

All the numbers in red are estimates at this time

Cells in red signify ECOs which need more development

*** CO2 emissions are calculated using the updated eia.gov state carbon factors**

Table 1-2: Energy Conservation Opportunities – Energy Savings

TABLE E-1 SUSTAINABLE ENERGY CONSERVATION - PLANNING PHASE
POTENTIAL FOR ENERGY COST REDUCTION

					Electric Savings Breakdown				Propane Savings Breakdown	
			Selected		Demand, kW		Energy, kWh		Energy	
ECO	System	Opportunity	(Y/N)	Priority	Min	Max	Min	Max	Min	Max
1	HVAC	Implement Temperature Setbacks during Unoccupied Hours	Y	Operational	1	1	5,199	6,499	391	488
2	HVAC	Interior HVAC System Replacement Strategy (Air-Source Heat Pumps)	Y	Long	-2	-2	-13,860	-16,300	1,700	2,000
3	HVAC	Apparatus Bay HVAC System Replacement Strategy	Y	Long	-5	-6	-43,713	-48,570	4,892	5,436
4b	Lighting	Combined Opportunities: 4b-i, 4b-ii	Y	Mid	7	7	20,611	22,901	0	0
4b-i	↑	*Retrofit Interior Lighting to Type B LED*	*A*	*Mid*	*7*	*7*	*18,366*	*20,407*	*0*	*0*
4b-ii	↑	*Retrofit Interior Lighting to Type B LED with Daylighting and Occupancy Sensors*	*A*	*Mid*	*0*	*0*	*2,245*	*2,494*	*0*	*0*
4d	Lighting	Retrofit Interior Compact Fluorescent and Incandescent Lighting to LED	Y	Long	1	1	334	372	0	0
5b	Lighting	Retrofit Exterior Lighting to Type C LED	Y	Mid	3	3	11,827	13,141	0	0
6	Envelope	Insulate Glass Apparatus Bay Doors	Y	Long	0	0	510	637	274	342
7	Solar	Install a Solar Photovoltaic System	Y	Long	4	4	35,900	35,900	0	0
		All Projects			9	9	16,808	14,580	7,257	8,266
		Percent of Present Energy Costs								
		Operational Priority Projects			1	1	5,199	6,499	391	488
		Percent of Present Energy Costs								
		High Priority Projects			0	0	0	0	0	0
		Percent of Present Energy Costs								
		Mid Priority Projects			10	10	32,438	36,042	0	0
		Percent of Present Energy Costs								
		Long Priority Projects			-1	-2	-20,829	-27,961	6,866	7,778

2.0- UTILITY DATA ANALYSIS

Procurement strategies employed for energy sources determine the unit costs for energy, the rate structures, and contract terms. Utility data analysis begins with an understanding of:

- How much energy is used and what it costs (bills and usage information – typically monthly billed data) and
- A preliminary understanding of the impact weather has on energy usage

This section provides an analysis of the Duke Energy supplied electricity as well as Suburban Propane supplied propane.

2.1- Billed Data

The available monthly billed data with respective account and procurement information is summarized in Table 2-1 below.

Table 2-1: Available Billing Data Account Information

Utility	Distributor / Supplier	Premise/Account	Meter	Service Address	Date Range
Electric	Duke Energy	1670-2213-01-4	108261256	9120 Morrow Rossburg Rd.	11/18/2016 - 11/19/2018
Propane	Suburban Propane	1402-024810	-	9120 Morrow Rossburg Rd.	12/7/2016 - 11/28/2018

The most recent full year of valid data available for all utilities is selected as the baseline for billed data analysis. The baseline for the utility billed data that is considered in the following sections is December 2017 through November 2018.

2.1.1- Total Utilities Breakdown

A pie chart of the total utility costs from December 2017 through November 2018 is shown in Figure 2-1. Electric costs account for 32% of total utility cost and propane costs account for 68% of total utility cost. Total utility costs were shown to be $27,576.

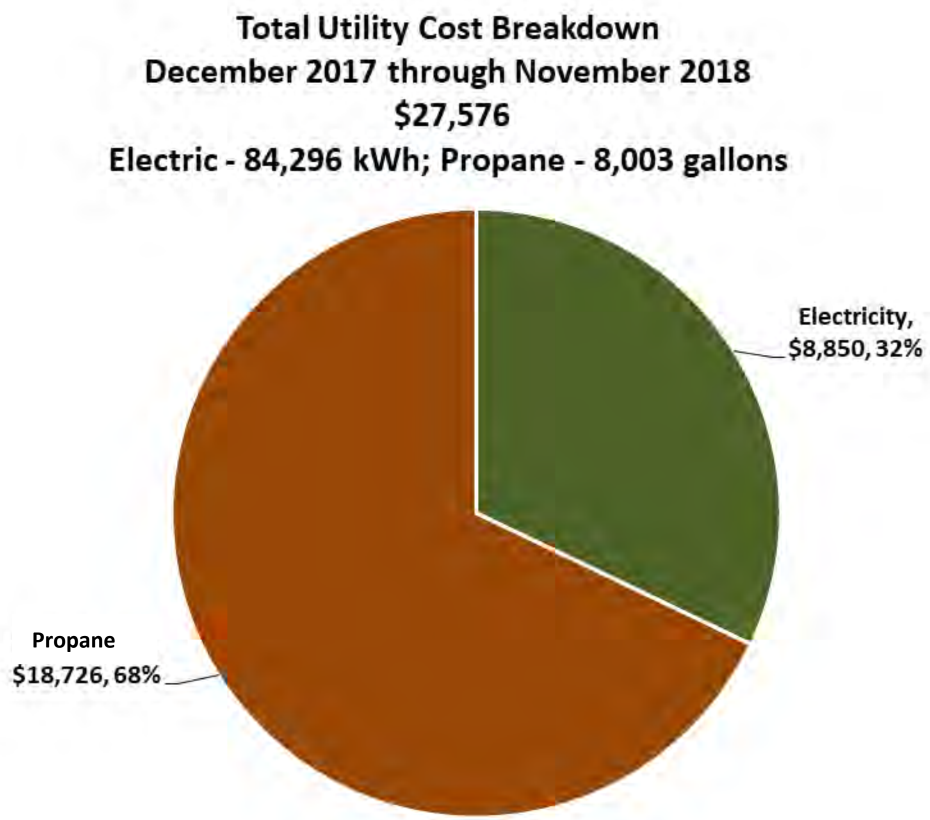


Figure 2-1: Total Utility Cost Breakdown

A detailed summary of the monthly billing data from December 2017 through November 2018 is shown in Table 2-2.

Table 2-2: Annual Utility Cost Summary

Electric

Billing Period	Annual Cost, $	Annual Consumption, kWh	Unit Cost, $/kWh	Peak Demand, kW			Consumption Per Day, kWh/day		
				Min	Max	Avg	Min	Max	Avg
Dec'17 - Nov'18	$8,850	84,296	$0.10	24	43	32	149	277	231

Propane

Billing Period	Annual Cost, $	Annual Consumption, gal	Unit Cost, $/gal	Usage Per Day, gal/day		
				Min	Max	Avg
Dec'17 - Nov'18	$18,726	8,003	$2.34	8	58	22

Total Annual Cost
$27,576

2.1.2- Utility Cost Breakdown

Duke Energy is both the supplier and distributor for the Harlan Township Fire Department facility electricity; therefore, the total electricity cost is not broken down into separate supplier and distributor costs.

Figure 2-2 provides a breakdown of the propane charges. Transportation and Safety P&T charges consist of a very small percentage compared to the propane charge.

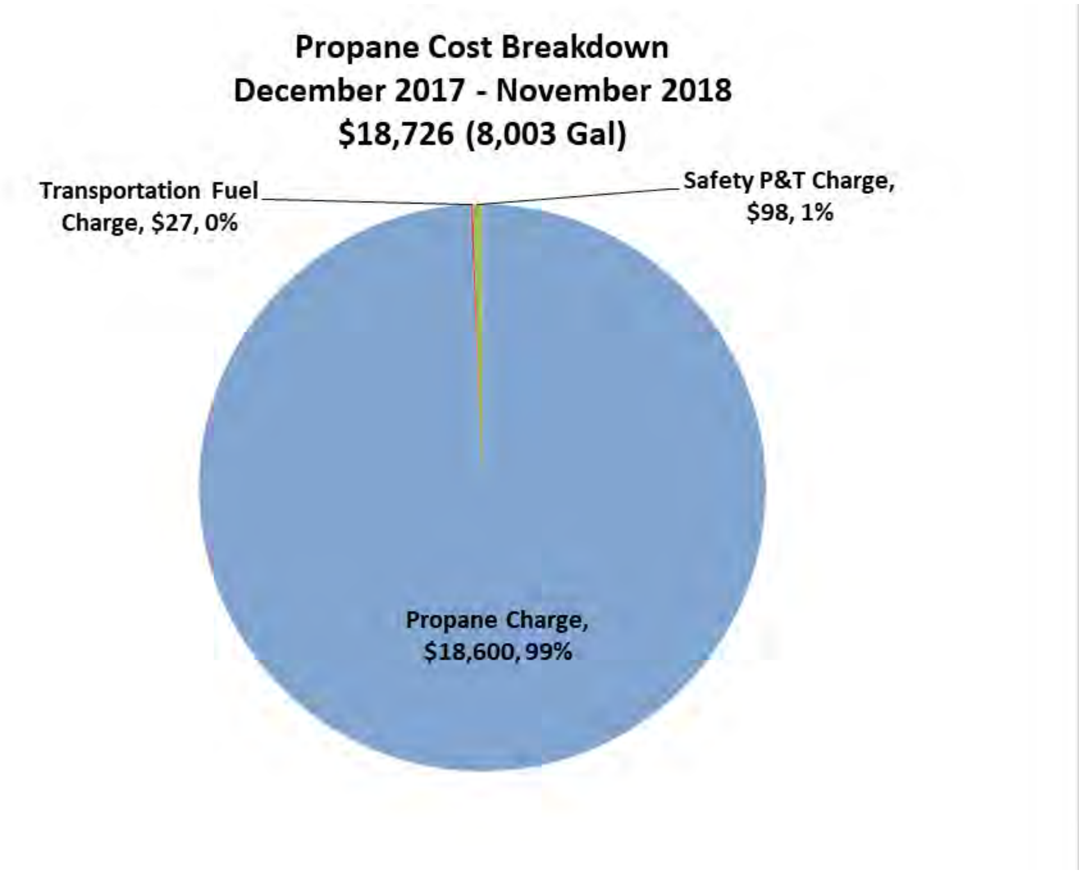


Figure 2-2: Propane Cost Breakdown by Components

2.2- Interval Data

There is no interval data associated with this facility.

3.0- UNDERSTANDING OF PERFORMANCE AND OPPORTUNITIES

Understanding of performance and opportunities begins with the development of an energy flow map which provides a framework to classify utility energy consumptions by systems, equipment, and functions. An attempt has been made to categorize ECOs into short-, mid- and long-term priorities. Further discussion with Harlan Township personnel may result in these ECOs being re-categorized based on team input.

3.1- Energy Flow Map

The purpose for developing the energy flow map is to determine the annual energy consumptions for the different operations and building needs. The energy flow map is an organization tool which:

- Identifies purchased and generated utilities
- Assists in understanding current energy performance by systems and equipment
- Establishes a reasonable baseline of existing conditions
- Helps identify potential areas for energy conservation opportunities
- Promotes systems optimization to maximize facility energy efficiency

The purchased utilities for the Harlan Township Fire Department facility are:

- Electricity
- Propane

The generated utilities for this site are:

- Compressed Air
- Domestic Hot Water

The allocation of energy consumption to various operations and utilities requires an understanding of the building systems and equipment, operating schedules, and monitored data. This information was gathered from building drawings, building walkthroughs, monitored and trended data, and other data gathering on site. See Appendix A: Figure 4-1 for the Energy Flow Map.

3.2- Electrical Energy Consumption

Available equipment data and operating parameters were used to determine major electric users and their expected annual electric use.

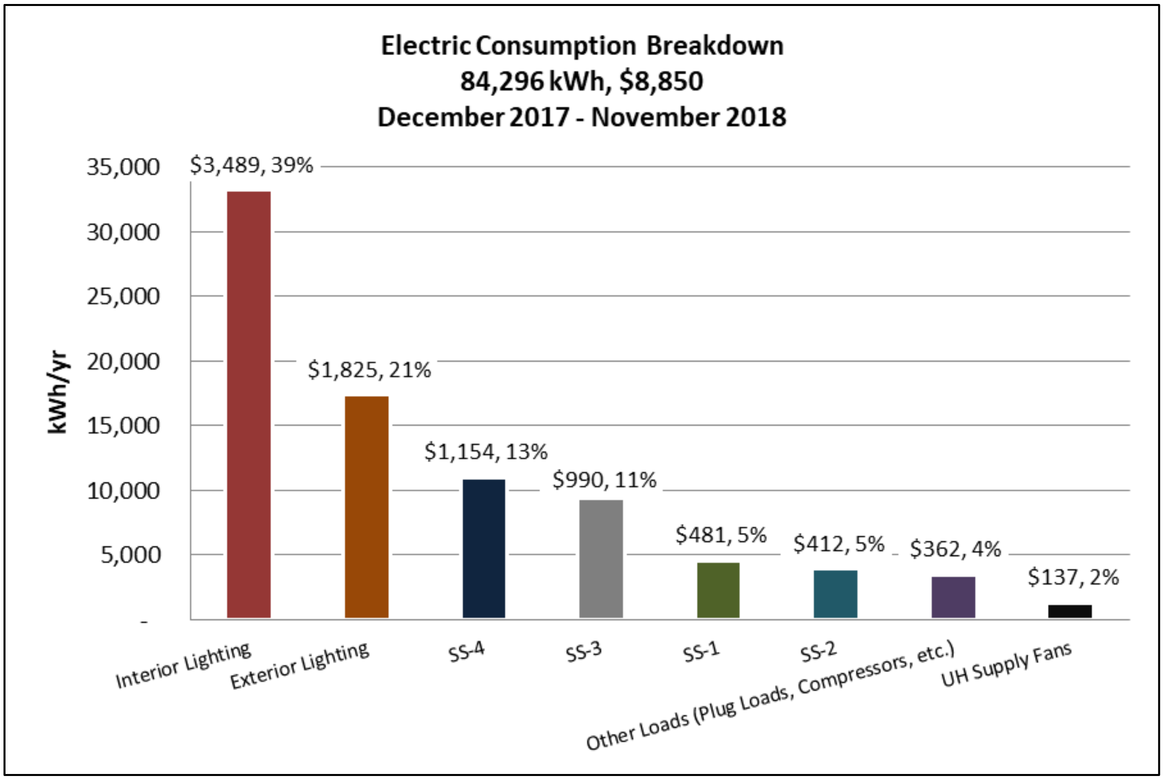


Figure 3-1: Electric Energy Consumption by Equipment

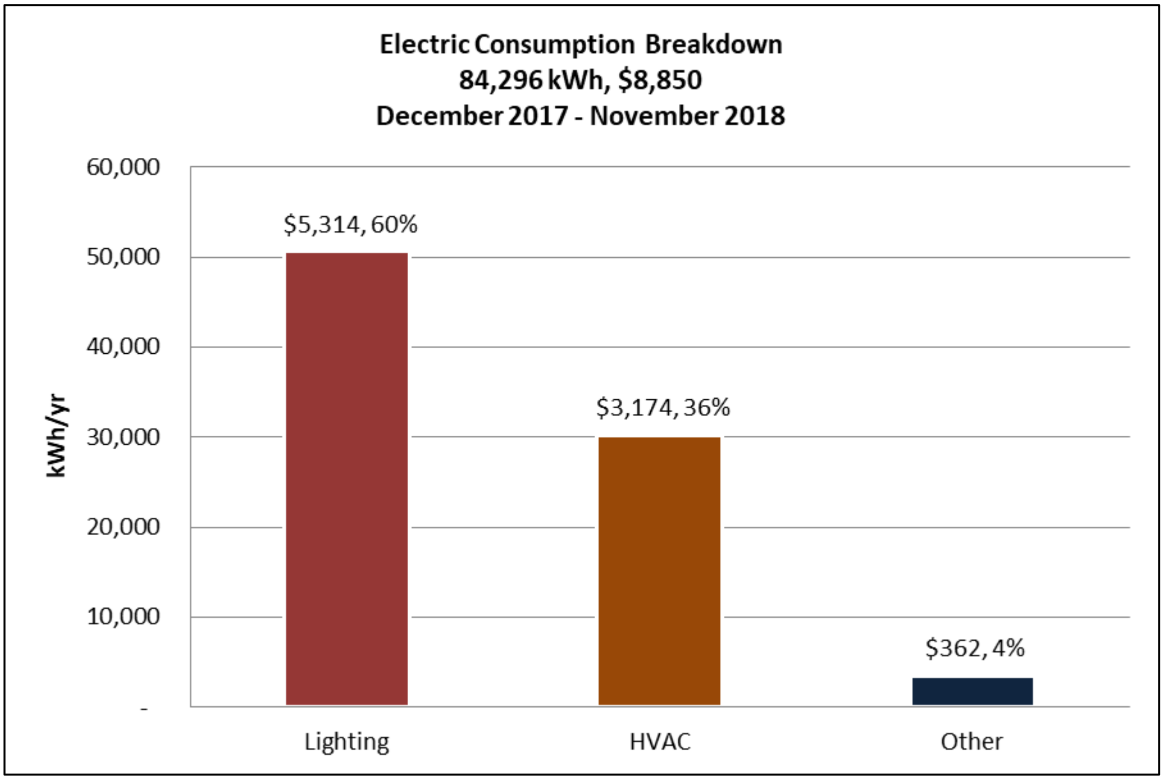


Figure 3-2: Electric Energy Consumption by System

Figure 3-1 shows the breakdown of electric energy consumption by equipment type, and Figure 3-2 shows the breakdown of electric energy consumption by system type. The top energy intensive systems for this building are shown in Figure 3-2 above and listed below.

1. **Lighting** contributing 60%
2. **HVAC** contributing 36%
3. **Other** contributing 4%

Appliance electric, which can also be categorized as plug loads, contains computers, monitors, servers, kitchen appliances, compressors, etc. This is noted as "Other" in Figure 3-2: Electric Energy Consumption by System.

3.3- Propane Energy Consumption

Available equipment data and operating parameters were used to determine major propane users and their expected annual propane use.

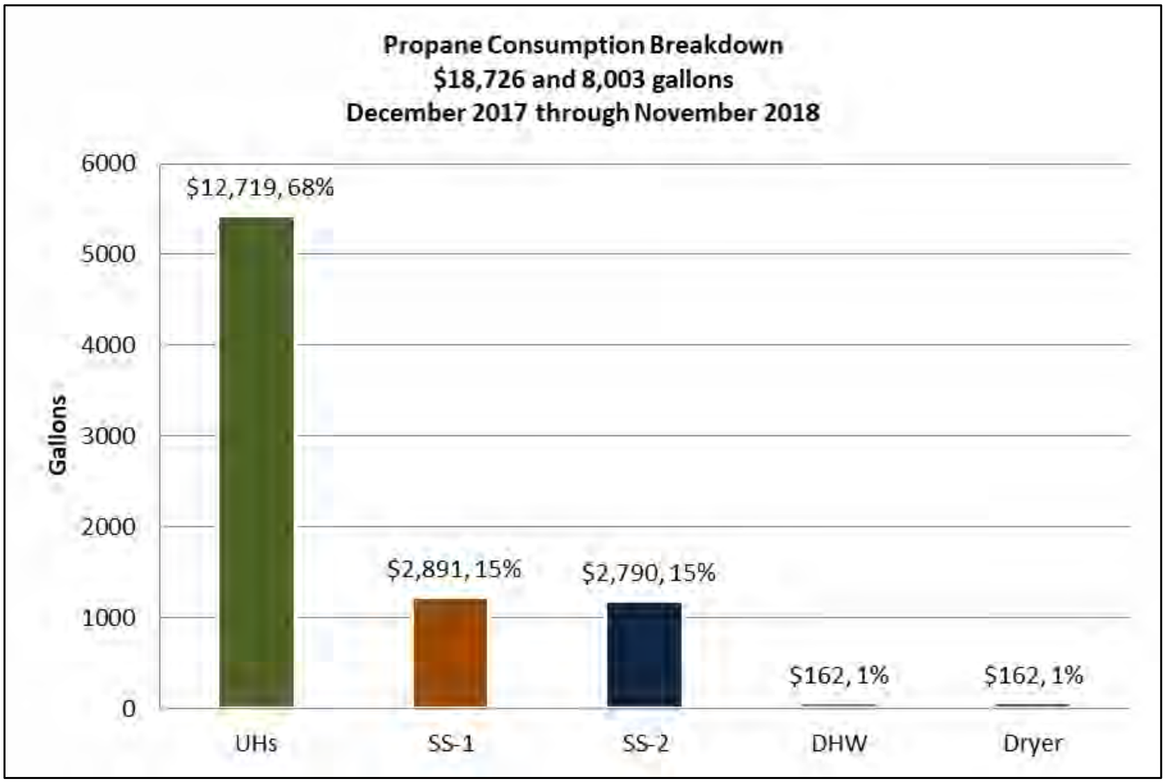


Figure 3-3: Propane Energy Consumption by Equipment

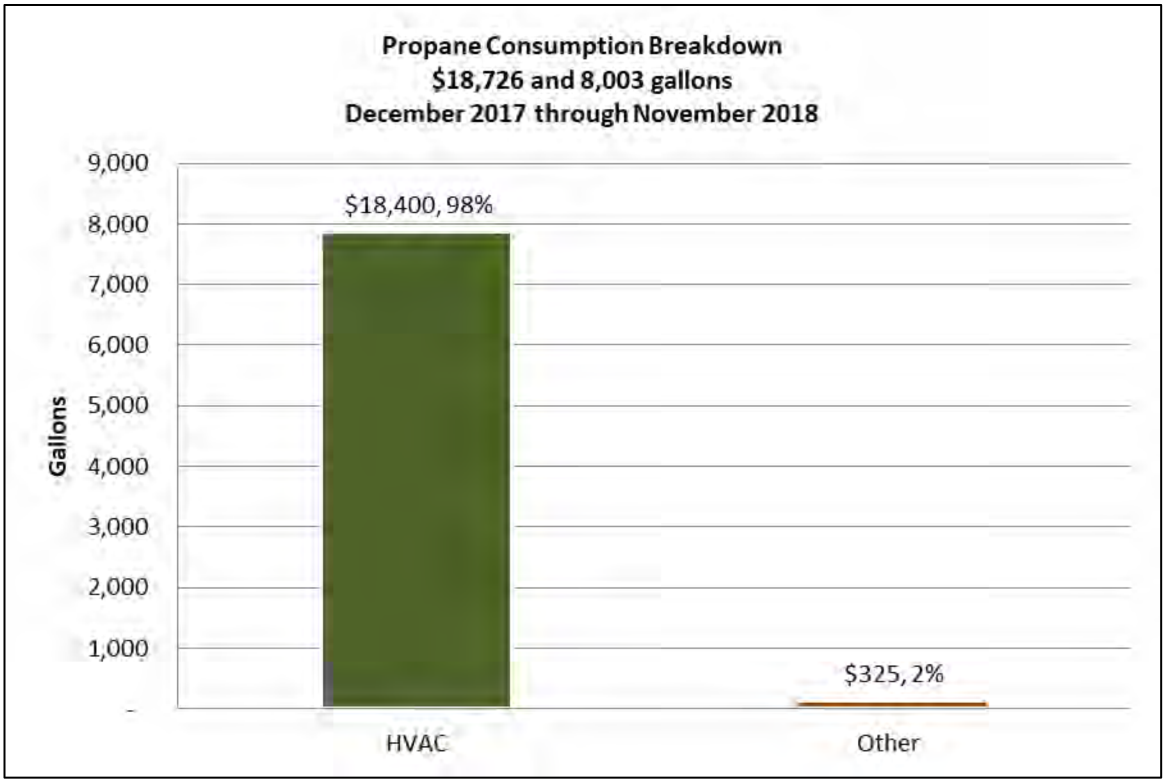


Figure 3-4: Propane Energy Consumption by System

Figure 3-3 shows the breakdown of propane energy consumption by equipment type, and Figure 3-4 shows the breakdown of propane energy consumption by system type. The top energy intensive system for this building is HVAC, contributing 98%, as shown in Figure 3-4 above. The "Other" category contains domestic hot water and the dryer.

3.4- Potential Opportunities

The following energy conservation opportunities (ECOs) were considered for developing the energy conservation plan. These are based on the key areas indicated by the energy flow map.

- **ECO 1-3 – HVAC Upgrades**
    - Implement Temperature Setbacks during Unoccupied Hours
    - Interior HVAC System Replacement Strategy
    - Apparatus Bay HVAC System Replacement Strategy
- **ECO 4-5 – Lighting Upgrades**
    - Retrofit Interior Lighting to LED (with Daylighting and Occupancy Sensors)
    - Retrofit Exterior Lighting to LED
- **ECO 6 – Envelope Upgrades**
    - Insulate Glass Apparatus Bay Doors

- **ECO 7 – Solar Photovoltaic System**
    - Install a Solar Photovoltaic System

3.4.1- HVAC System Baseline and Opportunities

The Harlan Township Fire Department facility is conditioned using (4) split systems. (2) Split systems are Goodman heat pump units, and the other (2) split systems are Bryant propane-fired heating units. Both types of split systems contain direct expansion (DX) cooling.

The (2) Goodman heat pump split systems contain a compressor, a reversing valve that allows the unit to act as both a cooling and heating unit, and a supply fan. The gross total cooling capacity of the (2) Goodman split systems, based on nameplate data, is 6 tons (3 tons each). The (2) Bryant propane-fired split systems contain a compressor, furnace, and a supply fan. The gross total cooling capacity of the (2) Bryant systems is 10 tons (5 tons each).

The (2) Bryant split systems serve the Conference Room and Kitchen. One of the Goodman split systems serves the Offices while the second Goodman unit serves the Dayroom area. Based on the serial numbers, the (2) Bryant units were installed in 2000, and the (2) Goodman units were installed in 2018. Thermostat set points are likely 68°F in the winter and 76°F in the summer; however, Rick Howry stated that building occupants do adjust the set points. Currently, there are no unoccupied thermostat setbacks in place.

Propane-fired unit heaters serve the Apparatus Bay. (4) Reznor unit heaters serve the original portion of the Apparatus Bay. (2) Reznor unit heaters serve the expansion portion of the Apparatus Bay. Typically, in the winter, all (4) original unit heaters run, while only one of the expansion unit heaters runs.

Total baseline electric consumption for HVAC amounts to 30,234 kWh/yr ($3,174) and accounts for 36% of total electric usage. Total baseline propane consumption for HVAC amounts to 7,864 gallons ($18,400) and accounts for 98% of total propane usage. Refer to Appendix B: Table 5-1 for the HVAC equipment list, Table 5-2 for the HVAC Room System Assignment, and Figure 5-1 for a visual representation of the HVAC layout.

The current for one of the Bryant split systems as well as one of the Goodman split systems was monitored for about two weeks, 08/29/2019 to 09/12/2019. This data, along with the monitored compressor data, can be seen in Appendix B: 5.1- Monitored Equipment.

ECO 1 – Implement Temperature Setbacks during Unoccupied Hours

Significant HVAC cooling and heating energy savings can be achieved by actively setting back zone temperatures during periods of unoccupied times. This can be done by programming the thermostats at the thermostat interface.

It is recommended that the facility maintains its summer set point of 76°F for occupied times and implements a set point of 80°F for unoccupied times and also maintains its winter set point of 68°F for occupied times and implements a set point of 62°F for unoccupied times.

The energy savings through temperature setbacks are estimated as 6,499 kWh/yr ($682) and 488 gallons/yr ($1,143) for both the cooling and heating seasons. The savings are estimated by assuming that the Multipurpose Room is occupied Monday through Thursday evenings from 5:00pm to 9:00pm as well as Saturday and Sunday 12:00pm to 5:00pm for 10 months of the year. It is assumed that the Office area is occupied Monday through Friday 8:00am to 5:00pm. Also, it is assumed that the Dayroom and surrounding area is occupied 24 hours/day Monday, Wednesday, and Friday to account for the on-call person as well as 8:00am to 5:00pm Tuesday and Thursday. All other times were assumed to be unoccupied. The cost to implement this ECO would be minimal.

See Appendix C: Table 6-1 for calculation details.

ECO 2 – Interior HVAC System Replacement Strategy

Based on the serial numbers, the (2) Goodman air-source heat pump units were installed in 2018, and the (2) Bryant split system units were installed in 2000. It is recommended to replace these units when they are about 20 years old. The following sections detail options that Harlan Township has when replacing these units. The first section details replacement options for the air-source heat pump units (Goodman units), and the second section details replacement options for the propane-fired split system units (Bryant units).

Note that by the time the replacement unit(s) is/are specified and installed, the high efficiency ratings as well as Duke Energy rebate requirements stated here may have changed. It is recommended that at that time an additional review of what the current high efficiency ratings are, as well as Duke Energy rebates, is performed.

Replacement Options for the Goodman Units

Based on the serial numbers, the (2) Goodman air-source heat pump (ASHP) units were installed in 2018 and will likely not need to be replaced until they are about 20 years old. However, when it is time to replace these two units, the following sections detail some of the available options.

Note that because ASHPs are currently installed, it is important that when specifying a replacement unit, a less efficient technology is not specified. A replacement option for these two units should not include a unit that uses propane as its heating source. Propane-heating is an expensive option and is also less efficient than heating with an ASHP.

Option 1: Ground-Source (Geothermal) Heat Pump

A ground-source, or geothermal, heat pump system would be a replacement strategy for all (4) of the units (Goodman and Bryant). A ground-source heat pump transfers heat between the ground and the building. Due to the ground being approximately 55°F year-round, it can act as both a heat source and sink depending on the time of year.

The system works by circulating water from the building to the ground and back again. During the winter, the ground acts as a heat source, warming the circulating water. The heat pump then concentrates this thermal energy and transfers the heat to the air which is ducted out to the facility. During the summer, the reverse process occurs. The ground acts as a heat sink and absorbs heat from the circulating water.

Advantages include a system that is very efficient and therefore has a low carbon footprint, has a low operating cost, and likely eliminates the need for propane usage. Ground-source heat pumps have an efficiency that is greater than 100% on both the heating and cooling sides. Higher efficiencies result in decreased energy usage and costs. Ground-source heat pumps are also more efficient than ASHPs.

Disadvantages include high upfront costs, longer installation, and site dependency. It may also require supplemental heating such as electric or propane. A consultant would need to perform a site visit to confirm that the property is suitable for this type of system.

ENERGY STAR recommends a minimum 17.1 EER cooling efficiency and a minimum 3.6 COP heating efficiency. Savings are estimated as 12,100 kWh/year due to the increased cooling efficiency for all (4) units as well as increased heating efficiency for the (2) Goodman units. There would also be an increased electricity usage of approximately 13,500 kWh/year due to switching from propane heating to heat pump heating for the (2) Bryant units. This results in a net increase of 1,400 kWh/year. Propane savings are estimated as 2,000 gallons/year. Note that these savings reflect replacing all (4) units with a ground-source heat pump system. Savings are based on installing a system with the minimum efficiencies listed.

Option 2a: More Efficient Air-Source Heat Pumps

Another option is to replace the (2) Goodman units with more efficient ASHPs. This would be a one-to-one replacement of the current units with similar sized units which have an increased cooling and heating efficiency.

Advantages include a system that is efficient, and therefore has a lower carbon footprint, as well as moderate upfront costs (compared to Option 1). ASHPs have an efficiency that is greater than 100% on both the heating and cooling sides. Higher efficiencies result in decreased energy usage and costs. Another advantage is that ASHPs offer a high efficiency option without the complicated and expensive installation that a ground-source heat pump would require.

Disadvantages include that it is not as efficient as a ground-source heat pump, and it may require supplemental heating such as electric or propane.

ENERGY STAR recommends a minimum 15 SEER/12.5 EER cooling efficiency and a minimum 8.5 heating seasonal performance factor (HSPF). Savings are estimated as 800 kWh/year due to the increased cooling efficiency. Savings are based on installing a system with the minimum efficiencies listed.

Replacement Options for the Bryant Units

Based on the serial numbers, the (2) Bryant split system units were installed in 2000 and will likely need to be replaced in the next few years. The following sections detail some of the available options.

Options 1, 2b, and 3 are opportunities that would eliminate propane usage. Options 4 and 5 are opportunities that would still require propane usage.

Option 1: Ground-Source (Geothermal) Heat Pump

Please see the *Ground-Source (Geothermal) Heat Pump* write-up under the *Replacement Options for the Goodman Units* section. Note that the savings listed under the write-up is reflective of replacing all (4) units with a ground-source heat pump system.

Option 2b: Air-Source Heat Pumps

A second option is to replace the (2) Bryant units with ASHPs. This would be a one-to-one replacement of the current units with similar sized units.

Advantages include a system that is efficient and therefore has a lower carbon footprint, moderate upfront costs (compared to Option 1), and likely eliminates the need for propane usage. ASHPs have an efficiency that is greater than 100% on both the heating and cooling sides. Higher efficiencies result in decreased energy usage and costs. Another advantage is that ASHPs offer a high efficiency option without the complicated and expensive installation that a ground-source heat pump would require.

Disadvantages include that it is not as efficient as a ground-source heat pump, and it may require supplemental heating such as electric or propane.

ENERGY STAR recommends a minimum 15 SEER/12.5 EER cooling efficiency and a minimum 8.5 heating seasonal performance factor (HSPF). Savings are estimated as 2,400 kWh/year due to the increased cooling efficiency. There would also be an increased electricity usage of approximately 19,500 kWh/year due to switching from propane heating to heat pump heating. This results in a net increase of 17,100 kWh/year. Propane savings are estimated as 2,000 gallons/year. Savings are based on installing a system with the minimum efficiencies listed.

Option 3: Electric Heating Split Systems

A third option is to replace the (2) Bryant units with split systems that include DX cooling and an electric furnace. This would be a one-to-one replacement of the current units with similar sized units.

Advantages include a system that is more efficient on the heating side than a propane-fired furnace, eliminates propane usage, and has moderate upfront costs. An electric heating coil will be 100% efficient as all of the electricity input will be output as heat.

A disadvantage is that it is not as efficient as a heat pump on the heating side.

ENERGY STAR and Duke Energy rebates recommend a minimum 15-16 SEER/12.5 EER cooling efficiency. Because it is an electric heating unit, the heating efficiency is 100%. Savings are estimated as 2,400 kWh/year due to the increased cooling efficiency. There would also be an increased electricity usage of approximately 48,600 kWh/year due to switching from propane heating to electric heating. This results in a net increase of 46,200 kWh/year. Propane savings are estimated as 2,000 gallons/year. This option would likely not payback because the estimated savings would not be great enough to offset the increase in electricity. Savings are based on installing a system with the minimum efficiencies listed.

Option 4: More Efficient Split Systems

A fourth option would be to replace the (2) Bryant units with split systems that are identical to the current ones in type and size but have greater cooling and heating efficiencies.

Advantages include a moderate upfront cost, the possibility to save some propane by pre-heating the combustion air, and ability to work well heating-wise in very cold weather.

Disadvantages include lower cooling and heating efficiencies than a heat pump system, lower heating efficiency than electric heating, and continued propane usage. These lower efficiencies result in increased energy usage and operating costs.

ENERGY STAR and Duke Energy rebates recommend a minimum 15-16 SEER/12.5 EER cooling efficiency. Because the current Bryant units have an estimated heating efficiency of 93%, it is recommended to install a unit with a minimum heating efficiency of 93%. Savings are estimated as 2,400 kWh/year due to the increased cooling efficiency. Propane savings are estimated as 80 gallons/year (with a 97% heating efficiency). Cooling savings are based on installing a system with the minimum efficiencies listed.

Option 5: Rooftop-Unit

A fifth option is to replace the (2) Bryant units with a rooftop unit (RTU). The RTU would contain DX cooling, a propane-fired furnace, an economizer, and a variable frequency drive (VFD) on the supply fan. The RTU would be sized the same as the total of both Bryant units.

Variable air volume (VAV) supply boxes would need to be installed within each zone. The economizer would allow the unit to decrease the need for mechanical cooling in mild or cold weather. During mild or cold weather, economizers use outdoor air to cool the supply air ("free cooling") rather than by mechanical cooling. VAV boxes and the VFD would allow the system to turn down the supply fan speed and therefore vary the airflow supplied to each zone.

Advantages include electricity savings from the economizer and VFD as well as the ability to provide ventilation air (outdoor air) to the zones.

Disadvantages include a high upfront cost, longer installation, the need to install VAV boxes, decreased heating efficiency compared to a heat pump or electric heating, and continued propane usage.

Duke Energy rebates recommend a minimum 12.2 EER cooling efficiency for the size range that the proposed RTU would fall under. Because the current Bryant units have an estimated heating efficiency of 93%, it is recommended to install a unit with a minimum heating efficiency of 93%. Savings are estimated as 3,000 kWh/year due to the increased cooling efficiency, economizer usage, and supply fan turndown. Propane savings are estimated as 80 gallons/year (with a 97% heating efficiency). Savings are based on installing a system with the minimum cooling efficiencies listed.

Replacement Options Summary

Based on the Harlan Township Fire Department site and options listed above, it is recommended to go with Options 2a and b: Air-Source Heat Pumps. Because the (2) Bryant units will likely need to be replaced within the next few years, it is recommended to replace them with air-source heat pumps. When the (2) Goodman units need to be replaced, they can also be replaced with more efficient air-source heat pumps.

Updating to a ground-source heat pump system would be the most efficient option; however, not the most practical one. The (2) Goodman units were recently installed and will likely not need replaced for another 20 years. Therefore, replacing the (2) Goodman units when the (2) Bryant units need replaced would not make sense. If all (4) units were in need of being replaced around the same time period, then a ground-source heat pump system could be a more logical option.

Based on RS Means, replacing all (4) units with air-source heat pumps would cost approximately $24,400. Duke Energy rebates would amount to approximately $1,700. With energy cost savings of around $3,000/year, this would result in a simple payback of about 8 years.

Please see Appendix C: Table 6-2 for a summary of all available replacement options.

ECO 3 – Apparatus Bay HVAC System Replacement Strategy

Currently, (6) Reznor propane-fired unit heaters serve the Apparatus Bay area. Typically, only (5) of the unit heaters run. The Apparatus Bay is heated; however, it is not cooled.

One option to improve efficiency and costs for heating the Apparatus Bay area is to install an air-source heat pump (ASHP). An ASHP would provide heating through electricity instead of propane. ASHPs are greater than 100% efficient on both the heating and cooling sides.

It is noted that when using an ASHP, supply air temperatures will not be as high as when using the propane-fired unit heaters. Therefore, the Apparatus Bay may feel colder to its occupants with this type of system. It is recommended to leave the propane-fired unit heaters installed as a backup source of heating. The propane-fired unit heaters can act as supplemental heating if occupants are not satisfied with the output of the ASHP as well as during extreme cold periods. The ASHP will provide the primary source of heating with the propane-fired unit heaters only coming on when necessary.

When installing the ASHP, there are two options. The first option is an ASHP could be installed so that it is dedicated only to the Apparatus Bay. The second option is that an ASHP could be installed for the Apparatus Bay at the same time as the replacement units for the (2) Bryant units. With this option, a central condensing unit, rather than individual ones for each area, could be installed. This would likely result in some cost and efficiency savings.

Installing an ASHP would require the installation of ductwork in the Apparatus Bay area. Based on RS Means, installing an ASHP as well as ductwork is estimated as costing around $100,000. This is based on an ASHP sized to meet the peak heating load for the Apparatus Bay. With energy cost savings of around $7,600/year, this would result in a simple payback of about 12.6 years. Please consult design engineers for more accurate sizing and cost information if interested in going forth with this project.

Please see Appendix C: Table 6-3 for calculation details.

3.4.2- Lighting Baseline and Opportunities

A total of 234 interior lighting fixtures and 24 exterior lighting fixtures were counted during the site walkthrough. The interior lighting fixtures are primarily 4-foot 32-watt T8 fluorescent lamps. The exterior lighting fixtures are primarily halogens and metal halides with several wallpacks that have been updated to LEDs.

Total baseline energy consumption for lighting amounts to 50,613 kWh/yr ($5,314) and accounts for 60% of total electric usage. This total lighting baseline includes 33,230 kWh/yr ($3,489) for interior lighting and 17,384 kWh/yr ($1,825) for exterior lighting. Refer to Appendix B: Table 5-3 and Table 5-4 for the lighting fixtures list.

ECO 4 – Retrofit Interior Lighting to LED

During the site walkthrough, it was observed that Harlan Township Fire Department facility contains interior fluorescent lighting. It is recommended to replace the fluorescent lighting with LEDs. The next sections will detail different replacement strategies available. If the site plans to replace the ballasts soon, Type B or C is recommended. Type C would require a high upfront cost and long payback; therefore, Type B is recommended over Type C. Type A is not recommended as it would not provide a solution for the aging ballasts.

ECO 4a-i – Retrofit Interior Lighting to Type A LED

Type A tubes are referred to as 'plug-n-play' because the lamps are designed to simply plug into the current fixture and utilize the current fluorescent ballast installed. This allows for the lowest upfront project costs due to not having to replace the current fixture or ballast, or purchase a lamp with an internal driver.

The cost to implement Type A lamp replacement for the interior lighting, including Duke Energy rebates, is estimated as $7,177 based on the 1,000Bulbs online database. The material and labor costing does not account for future fluorescent ballast replacement. Total energy savings are estimated as 18,264 kWh/yr ($1,918).

Refer to Appendix C: Table 6-4 for details on the savings calculations.

ECO 4a-ii – Retrofit Interior Lighting to Type A LED with Daylighting and Occupancy Sensors

The purpose of occupancy sensors is to help regulate and reduce energy usage when there are no occupants within an area or zone. Occupancy sensors are designed to turn lighting fixtures on and off automatically as needed. If multiple occupancy sensors are placed in a large office area or individual offices that are not occupied constantly, they are able to turn off the lights for the areas that are not currently needed. These sensors are also of great use in areas such as bathrooms that are occupied only infrequently and only for short periods of time. Rather than leaving the lights on all day, the lights only turn on for the short period of time they are needed.

Additionally, daylighting sensors would be beneficial for areas that receive a lot of ambient (natural) light. Daylighting sensors can dim or turn off lights when enough ambient light enters the area.

In general, for large open office areas, hallways, and bathrooms, an ultrasonic ceiling mounted occupancy sensor is recommended. Ultrasonic sensors operate based on vibration and are able to detect vibration in a relatively wide area.

In general, for the small individual offices and conferences rooms, a passive infrared wall sensor was selected. Infrared sensors operate based on line of sight and, as such, work best in small, enclosed areas. They are significantly less expensive than ultrasonic sensors.

During the Energy Plan Review meeting, it was discussed that occupancy sensors would only be installed in the Storage, Restrooms, and Bay areas. It is recommended to install passive infrared occupancy sensors in the Multipurpose Storage, Kitchen Storage, Janitor's Storage, Laundry/Haz-Mat, and Electrical Closet. It is recommended to install ultrasonic occupancy sensors in the Women's and Men's Restrooms. It is recommended to install daylighting sensors in the Apparatus Bay. The additional cost to implement the occupancy and daylighting sensors, based on estimates from 1000Bulbs database, is $1,458 with total energy savings estimated as 2,573 kWh/yr ($270).

Refer to Appendix C: Table 6-5 for details on the savings calculations.

ECO 4b-i – Retrofit Interior Lighting to Type B LED

Significant energy savings can be realized by replacing the fluorescent lamps with LEDs. It is recommended that the existing fluorescent lamps be replaced by Type B LED lamps. Type B is recommended over Type A because during the Energy Review Meeting, it was discussed that the current ballasts need to be replaced soon. This would result in higher future maintenance costs if Type A replacement were chosen. Additionally, Type B is recommended over Type C due to the significantly higher payback than Type C replacement.

Type B tubes are a ballast bypass model where the internal driver is powered directly from the main voltage supplied to the existing fixture, thereby requiring several structural and wiring modifications. This often leads to higher initial cost when compared to Type A replacement, but lower maintenance costs due to the absence of ballasts. Type B tubes are characteristically more efficient than Type A, with no power loss from the removal of the existing LFL ballast, but Type B tubes are similarly limited in dimming and control capabilities. Since direct wiring can cause sparking and lamp failure, strict adherence to installation instructions is mandatory.

The cost to implement Type B lamp replacement for the interior lighting, including Duke Energy rebates, is estimated as $9,575 based on the 1,000Bulbs online database. Total energy savings are estimated as 20,407 kWh/yr ($2,143).

Refer to Appendix C: Table 6-6 for details on the savings calculations.

ECO 4b-ii – Retrofit Interior Lighting to Type B LED with Daylighting and Occupancy Sensors

See the write-up under ECO 4a-ii Retrofit Interior Lighting to Type A LED with Daylighting and Occupancy Sensors for more details on this ECO.

During the Energy Plan Review meeting, it was discussed that occupancy sensors would only be installed in the Storage, Restrooms, and Bay areas. It is recommended to install passive infrared occupancy sensors in the Multipurpose Storage, Kitchen Storage, Janitor's Storage, Laundry/Haz-Mat, and Electrical Closet. It is recommended to install ultrasonic occupancy sensors in the Women's and Men's Restrooms. It is recommended to install daylighting sensors in the Apparatus Bay. The additional cost to implement the occupancy and daylighting sensors, based on estimates from 1000Bulbs database, is $1,458 with total energy savings estimated as 2,494 kWh/yr ($262).

Refer to Appendix C: Table 6-7 for details on the savings calculations.

ECO 4c-i – Retrofit Interior Lighting to Type C LED

Type C offers the highest system efficiency, best system compatibility, and greatest overall performance. Type C can be integrated with robust dimming and control functionality which helps to offset moderate labor and installation costs with heightened efficiency well into the future. Note the significant electrical or structural modification is required resulting in higher labor and installation costs.

The cost to implement Type C lamp replacement for the interior lighting, including Duke Energy rebates, is estimated as $40,991 based on the 1,000Bulbs online database. Total energy savings are estimated as 22,223 kWh/yr ($2,333).

Refer to Appendix C: Table 6-8 for details on the savings calculations.

ECO 4c-ii – Retrofit Interior Lighting to Type C LED with Daylighting and Occupancy Sensors

See the write-up under ECO 4a-ii Retrofit Interior Lighting to Type A LED with Daylighting and Occupancy Sensors for more details on this ECO.

During the Energy Plan Review meeting, it was discussed that occupancy sensors would only be installed in the Storage, Restrooms, and Bay areas. It is recommended to install passive infrared occupancy sensors in the Multipurpose Storage, Kitchen Storage, Janitor's Storage, Laundry/Haz-Mat, and Electrical Closet. It is recommended to install ultrasonic occupancy sensors in the Women's and Men's Restrooms. It is recommended to install daylighting sensors in the Apparatus Bay. The additional cost to implement the occupancy and daylighting sensors, based on estimates from 1000Bulbs database, is $1,458 with total energy savings estimated as 2,185 kWh/yr ($229).

Refer to Appendix C: Table 6-9 for details on the savings calculations.

ECO 4d – Retrofit Interior Compact Fluorescents and Incandescents to LED

Additionally, the compact fluorescent and incandescent lamps can be replaced with LEDs. The cost for this replacement is estimated as $373 based on the 1,000Bulbs online database. Total energy savings are estimated as 372 kWh/yr ($39).

Refer to Appendix C: Table 6-10 for details on the savings calculations.

ECO 5 – Retrofit Exterior Lighting to LED

During the site visit, it was observed that the majority of exterior lighting is metal halide or halogen. It is recommended to update the exterior lighting to LED. It is recommended to install Type C LEDs because they offer the greatest energy savings and highest efficiency and overall performance.

ECO 5a – Retrofit Exterior Lighting to Type B LED

Type B tubes are a ballast bypass model where the internal driver is powered directly from the main voltage supplied to the existing fixture, thereby requiring several structural and wiring modifications. This often leads to higher initial cost when compared to Type A replacement, but lower maintenance costs due to the absence of ballasts. Type B tubes are characteristically more efficient than Type A, with no power loss from the removal of the existing LFL ballast, but Type B tubes are similarly limited in dimming and control capabilities. Since direct wiring can cause sparking and lamp failure, strict adherence to installation instructions is mandatory.

The cost to implement Type B lamp replacement for the exterior lighting is estimated as $2,800 based on the 1,000Bulbs online database. Total energy savings are estimated as 12,901 kWh/yr ($1,354).

Refer to Appendix B: Table 6-11 for details on the savings calculations.

ECO 5b – Retrofit Exterior Lighting to Type C LED

Significant energy savings can be realized by replacing the exterior fixtures with LEDs. It is recommended that the existing lamps be replaced with Type C LED lamps.

Type C offers the highest system efficiency, best system compatibility, and greatest overall performance. Type C can be integrated with robust dimming and control functionality which helps to offset moderate labor and installation costs with heightened efficiency well into the future. Note the significant electrical or structural modification is required resulting in higher labor and installation costs.

The cost to implement Type C lamp replacement for the exterior lighting is estimated as $3,938 based on 1,000Bulbs online database. Total energy savings are estimated as 13,141 kWh/yr ($1,380).

Refer to Appendix B: Table 6-12 for details on the savings calculations.

3.4.3- Envelope Baseline and Opportunities

ECO 6 – Insulate Glass Apparatus Bay Doors

The Harlan Township Fire Department facility contains an Apparatus Bay with (8) vehicle doors. (4) Of the vehicle doors are facing north and are all glass. The remaining (4) vehicle doors are solid and face south. The glass vehicle doors are estimated as single pane and there is a large amount of heat loss through them during the winter.

It is recommended to apply a thin, window film to the glass vehicle doors. The film can be easily applied by an authorized dealer and can increase the R-value of the glass such that a single pane would have the equivalent R-value of a double pane and a double pane would have the equivalent R-value of a triple pane.

Implementing the window film would result in unit heater electricity savings (the supply fan would run less) and propane savings. The total energy savings are estimated as 637 kWh/yr ($67) and 342 gallons of propane ($801).

Refer Appendix C: Table 6-13 for details on the savings calculations.

3.4.4- Solar Photovoltaic System

ECO 7 – Install a Solar Photovoltaic System

The Harlan Township Fire Department facility can decrease their grid electricity consumption significantly by installing a solar photovoltaic (PV) system onsite. It is recommended that the facility first work toward becoming as energy efficient as possible on the demand and supply sides and, after that, to install a solar PV system. This entails implementing all of the recommended ECOs prior to sizing and installing the solar PV system.

After implementing all of the recommended ECOs, Harlan Township Fire Department facility will have a yearly electricity consumption of approximately 105,620 kWh/year with a maximum demand of approximately 39 kW. These numbers assume that ECO 2 Option 2 (Interior HVAC Replacement Strategy: Air-Source Heat Pumps), ECO 3 (Apparatus Bay HVAC Replacement Strategy), ECO 4b-ii (Retrofit Interior Lighting to Type B LED with Daylighting and

Occupancy Sensors), and ECO 5b (Retrofit Exterior Lighting to Type C) are chosen along with ECO 1 (Implement Temperature Setbacks during Unoccupied Hours) and ECO 6 (Insulate Glass Apparatus Bay Doors). Note that several of the ECOs will actually increase the facility's electricity usage, ECOs 2 and 3, due to switching from propane heating to electric source heating.

The array is sized at 27 kW resulting in an electricity output of approximately 35,920 kWh/year; this, along with the ECO implementations, will result in the facility decreasing their electricity consumption by 17%. The array size was determined based on available roof space. Sizing was estimated using PV Watts with the location of Pleasant Plain, Ohio specified.

A 27 kW array is estimated as costing $80,730. Solar is estimated as costing $2.99/watt based on estimates from Energy Sage. Please review cost estimates once designing the solar PV system becomes a priority as prices will likely have changed.

Refer to Appendix C: Table 6-14 for calculation details.

4.0- APPENDIX A: SYSTEM FLOW DIAGRAMS

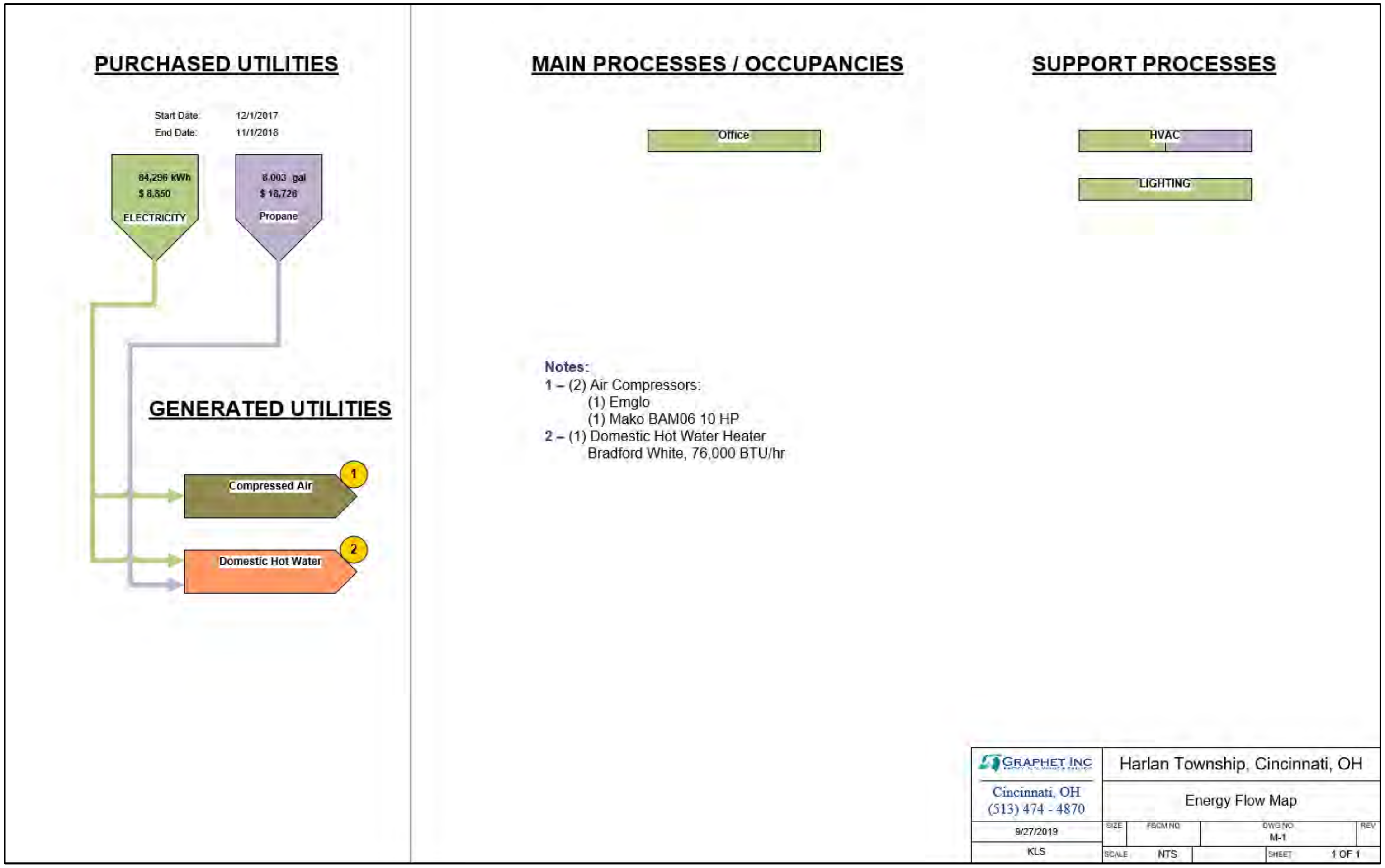


Figure 4-1: Energy Flow Map

5.0- APPENDIX B: BASELINE CONSUMPTION AND EQUIPMENT

Table 5-1: HVAC Equipment List

Manuf	Model #	Serves	Cooling			Heating	Fan			Notes
			Cooling (tons)	Cooling (Btuh)	SEER	Heating (Btuh)	Fan (HP)	Fan (kW)	Airflow (CFM)	
Bryant	CK5AXA060024AAAA, 593C1060-C	Multipurpose & Kitchen	5	60,000	10	60,000	0.25	0.2	2,250	Split system - DX clg, NG htg
Bryant	CK5AXA060024AAAA, 593C1060-C	Multipurpose & Kitchen	5	60,000	10	60,000	0.25	0.2	2,250	Split system - DX clg, NG htg
Goodman	GSZ140361KE	Offices	3	36,000	14	36,000	0.17	0.1	1,200	Split system - Heat Pump
Goodman	GSZ140361KG	Dayroom	3	36,000	14	36,000	0.17	0.1	1,200	Split system - Heat Pump

Table 5-2: HVAC Room System Assignments

Room #	Room Name	System	Manufacturer
100	Vestibule	SS-3	Goodman
101N	Multipurpose Room	SS-2	Bryant
101S	Multipurpose Room	SS-1	Bryant
101A	Storage	SS-4	Goodman
102	Corridor	Assign to SS-3	Goodman
103	Chief's Office	SS-3	Goodman
104	Office	SS-3	Goodman
105	Kitchen	SS-1	Bryant
105A	Kitchen Storage	SS-2	Bryant
106	Janitor's Closet	Assign to SS-3	Goodman
107	Communications	SS-3	Goodman
108	Corridor	Assign to SS-3	Goodman
109	Corridor	Assign to SS-3	Goodman
109A	Closet	Assign to SS-3	Goodman
110	Laundry/Haz-mat	SS-4	Goodman
111	Electrical Closet	Assign to SS-3	Goodman
112	Corridor	SS-4	Goodman
113	Women's Restroom	SS-4	Goodman
114	Men's Restroom	SS-4	Goodman
115	Dayroom	SS-4	Goodman
116	Apparatus Bays	UHs	Reznor

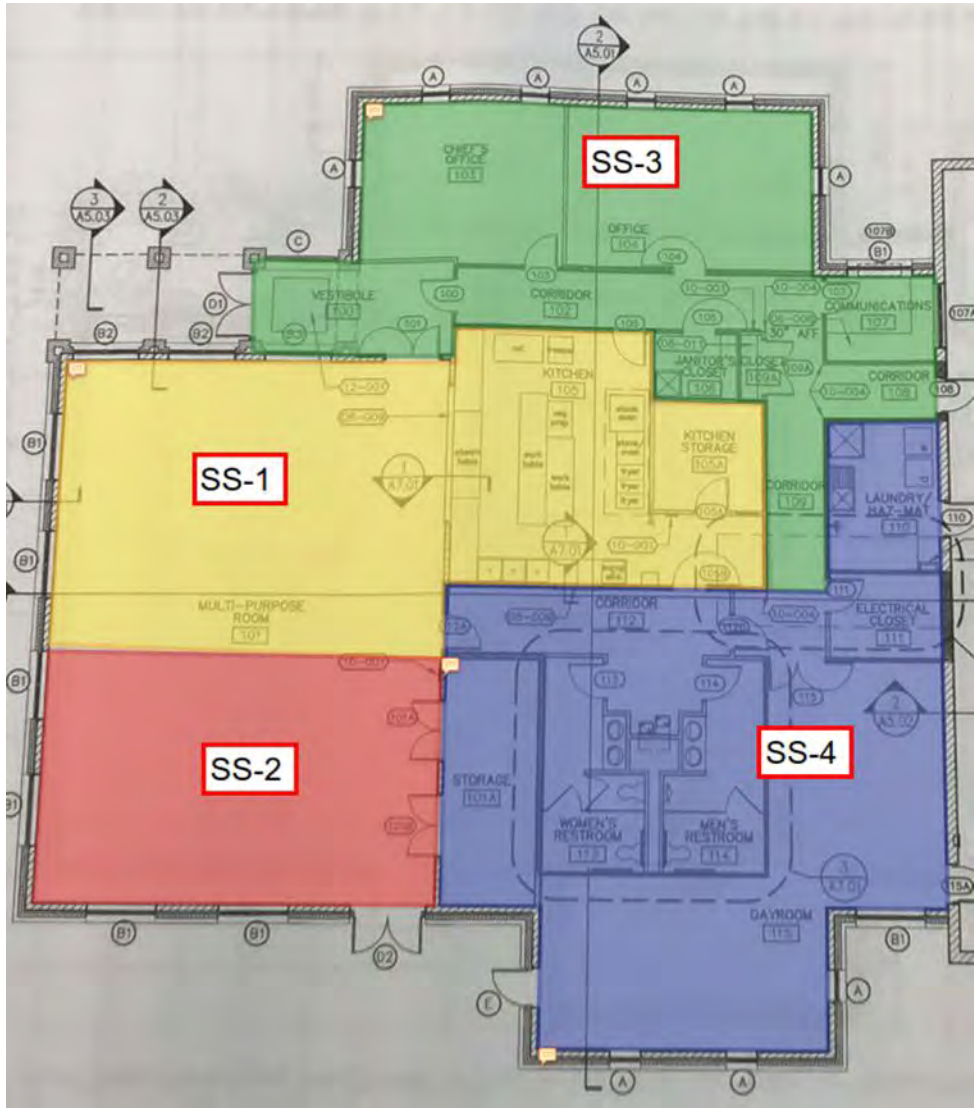


Figure 5-1: HVAC Layout

Table 5-3: Lighting Baseline Fixtures

Interior Fixtures

Room #	Room Name	Wattage/Lamp	Lamps/Fixture	Wattage/Fixture	# Fixtures	Total Wattage	Hours/Yr	kWh	Type	Schedule
100	Vestibule	13	1	13	5	65	0	0	CFL screw-in	Never On
100	Vestibule	32	4	128	1	128	8760	1121	Fluorescent 4-ft tubes	Always On
101N	Multipurpose Room	32	4	128	12	1536	1172	1800	Fluorescent 4-ft tubes	Multipurpose
101N	Multipurpose Room	150	1	150	9	1350	0	0	Incandescent can screw-in	Never On
101S	Multipurpose Room	32	4	128	12	1536	1172	1800	Fluorescent 4-ft tubes	Multipurpose
101S	Multipurpose Room	150	1	150	9	1350	0	0	Incandescent can screw-in	Never On
101A	Storage	32	4	128	1	128	46	6	Fluorescent 4-ft tubes	Storage
102	Corridor	32	4	128	3	384	8760	3364	Fluorescent 4-ft tubes	Always On
103	Chief's Office	32	4	128	4	512	2292	1174	Fluorescent 4-ft tubes	Office
104	Office	32	4	128	6	768	2292	1761	Fluorescent 4-ft tubes	Office
105	Kitchen	32	4	128	9	1152	292	336	Fluorescent 4-ft tubes	Kitchen
105A	Kitchen Storage	32	4	128	1	128	46	6	Fluorescent 4-ft tubes	Storage
106	Janitor's Closet	32	4	128	1	128	46	6	Fluorescent 4-ft tubes	Storage
107	Communications	32	4	128	2	256	2292	587	Fluorescent 4-ft tubes	Office
108	Corridor	32	4	128	1	128	8760	1121	Fluorescent 4-ft tubes	Always On
109	Corridor	32	4	128	1	128	8760	1121	Fluorescent 4-ft tubes	Always On
109A	Closet	13	1	13	1	13	46	1	CFL screw-in	Storage
110	Laundry/Haz-mat	32	2	64	2	128	2292	293	Fluorescent 4-ft tubes	Office
111	Electrical Closet	32	4	128	1	128	46	6	Fluorescent 4-ft tubes	Storage
112	Corridor	32	4	128	2	256	8760	2243	Fluorescent 4-ft tubes	Always On
112	Corridor	60	1	60	1	60	8760	526	Incandescent screw-in	Always On
113	Women's Restroom	17	2	34	1	34	8760	298	Fluorescent 2-ft tubes	Always On
113	Women's Restroom	32	4	128	1	128	8760	1121	Fluorescent 4-ft tubes	Always On
113	Women's Restroom	32	1	32	1	32	8760	280	Fluorescent 4-ft tubes	Always On
114	Men's Restroom	17	2	34	1	34	8760	298	Fluorescent 2-ft tubes	Always On
114	Men's Restroom	32	4	128	1	128	8760	1121	Fluorescent 4-ft tubes	Always On
114	Men's Restroom	32	1	32	1	32	8760	280	Fluorescent 4-ft tubes	Always On
115	Dayroom	32	4	128	10	1280	4579	5861	Fluorescent 4-ft tubes	Dayroom
116	Dayroom - Sleeping Room	32	4	128	2	256	4579	1172	Fluorescent 4-ft tubes	Dayroom
117	Dayroom - Sleeping Room	13	1	13	2	26	4579	119	CFL screw-in	Dayroom
116	Apparatus Bays	32	2	64	130	8320	2292	19073	Fluorescent 4-ft tubes	Office

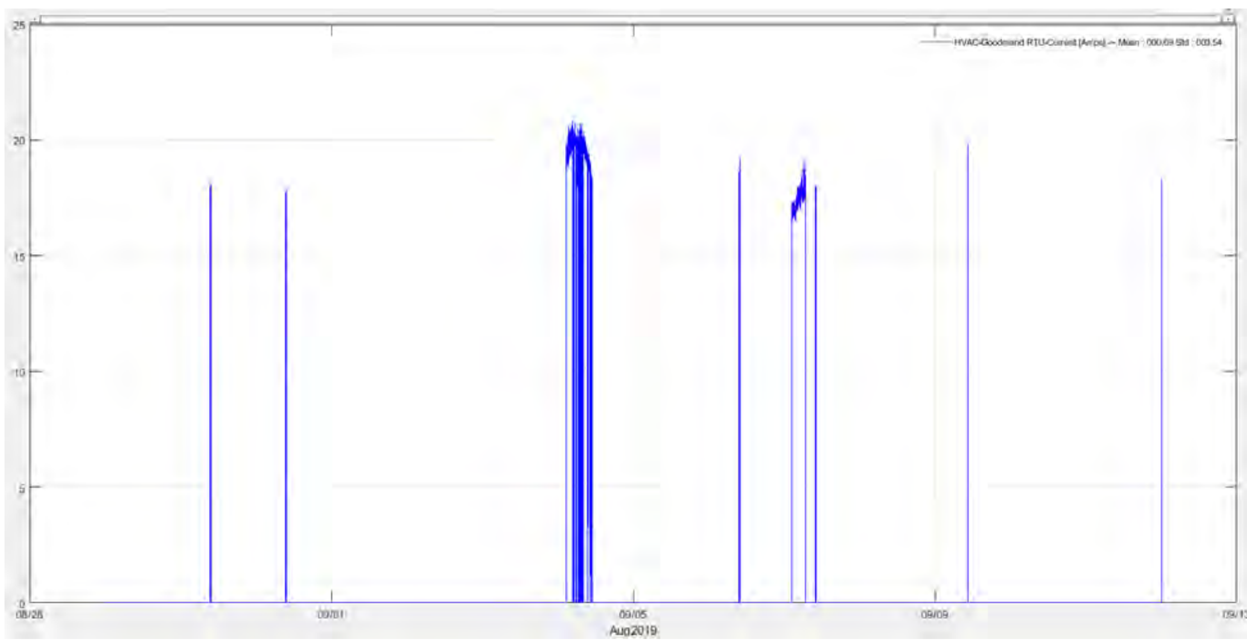
Table 5-4: Lighting Baseline Fixtures, continued

Exterior Fixtures

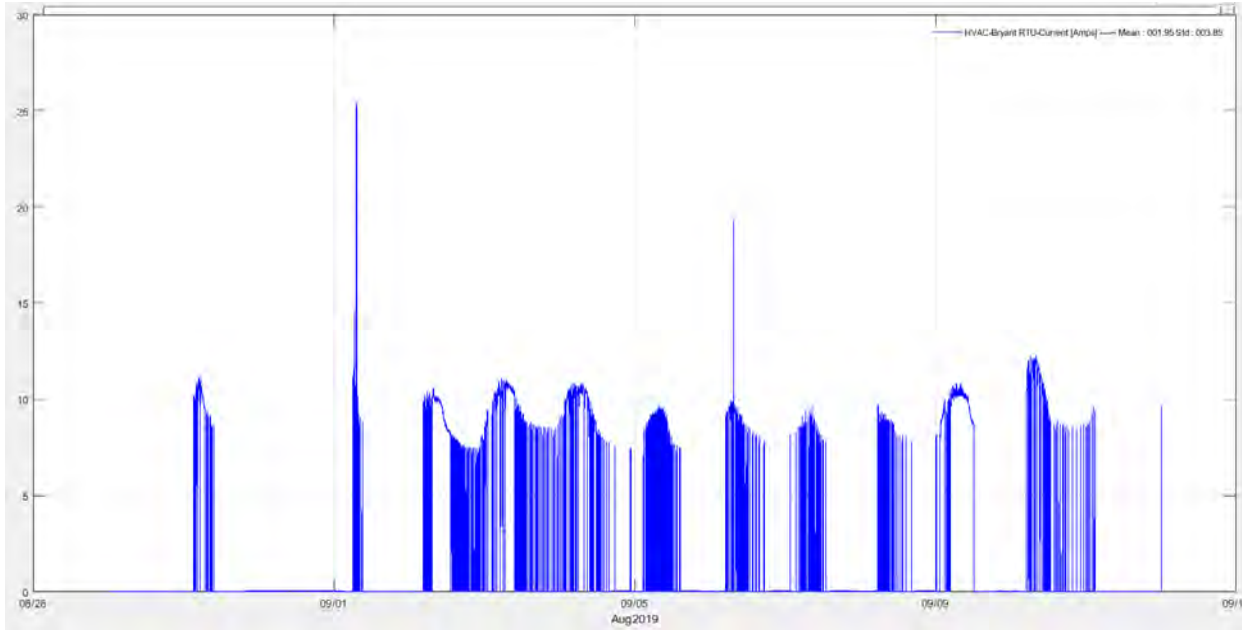
Area	Wattage/Lamp	Lamps/Fixture	Wattage/Fixture	# Fixtures	Total Wattage	Hours	kWh	Type
Parking Lot Pole	400	1	400	13	5200	4000	20,800	Halogen
Wallpacks	50	1	50	4	200	4000	800	LED
Wallpacks	100	1	100	4	400	4000	1,600	MH
Canopy	13	1	13	2	26	4000	104	CFL?
Flag Flood Light	20	1	20	1	20	4000	80	LED

5.1- Monitored Equipment

Goodman Unit



Bryant Unit


HVAC-Bryant RTU-Current [Amps]
Mean : 001.95 Std : 003.85
30
25
20
15
10
5
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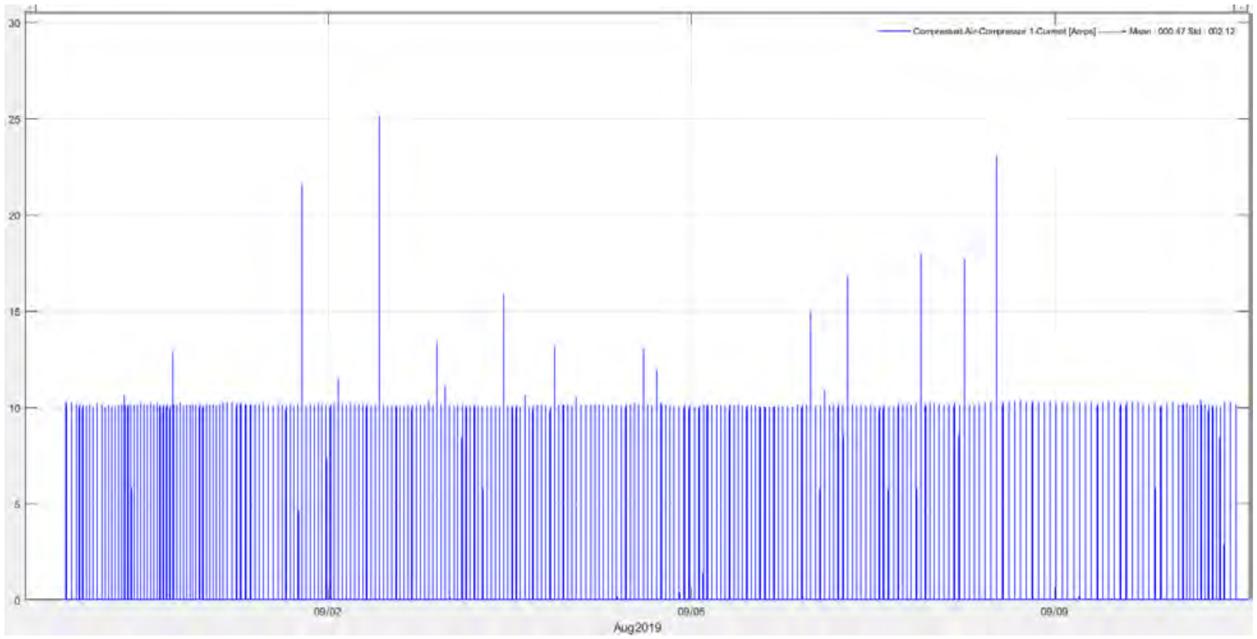
08/28
09/01
09/05
09/09
09/13
Aug2019

Compressor



6.0- APPENDIX C: ENERGY SAVING CALCULATIONS

Table 6-1: ECO 1 (Temperature Setbacks) Calculation

The savings for this ECO were calculated using a HAP model. Below are the results and assumptions regarding the occupied hours.

Occupied Schedule - Office (SS-3)	M-F	7a-6p	52 wks	
Occupied Schedule - Multi Rm (SS-1,2)	M-Th	5p-9p	52 wks	
	SS	12p-5p	44 wks	~85% of year
Occupied Schedule - Day Room (SS-4)	MWF	24 hrs	52 wks	
	TTh	7a-6p	52 wks	

BASELINE	SF (kWh)	Clg (kWh)	Htg (kWh)	Htg (kBtu)
SS1	1752	4413	-	124692
SS2	1752	3525	-	120351
SS3	876	3468	8345	-
SS4	876	4298	9612	-
	5256	15704	17957	245043

PROPOSED	SF (kWh)	Clg (kWh)	Htg (kWh)	Htg (kBtu)
SS1	528	3555	-	98678
SS2	505	2833	-	97083
SS3	389	3056	6609	-
SS4	563	3935	8202	-
	1985	13379	14811	195761

SAVINGS	SF (kWh)	Clg (kWh)	Htg (kWh)	Htg (kBtu)
SS1	1224	858	-	26014
SS2	1247	692	-	23268
SS3	487	412	1736	-
SS4	313	363	1410	-
	3271	2325	3146	49282
Adjusted to Bill	2432	1728	2339	44687

Total kWh Savings	**6,499**	**8%**	**$682**
Total kBtu Savings	**44,687**		
Total Gal Savings	**488**	**6%**	**$1,143**
			$1,825

Table 6-2: ECO 2 (Interior HVAC Replacement) Details

#	Type	Recommended Efficiency		Potential Energy Savings/Increase				Potential Cost Savings			Estimated Project Cost ($)	Duke Energy Rebate ($)	Simple Payback (years)
		Cooling	Heating	Electricity Savings (kWh/yr)	Electricity Increase (kWh/yr)	Propane Savings (gal/yr)	Propane Increase (gal/yr)	Electricity ($/yr)	Propane ($/yr)	Net ($/yr)			
1	Geothermal Heat Pumps	17.1 EER[1]	3.6 COP[1]	12,100	13,500	2,000	0	-$100	$4,700	$4,600	~$80,000	~$1,700	~17
2	All Units to ASHPs	≥ 15 SEER / ≥ 12.5 EER[1]	≥ 8.5 HSPF[1]	3,200	19,500	2,000	0	-$1,700	$4,700	$3,000	~$24,400	~$1,700	~8
2a	Current ASHPs to More Efficient ASHPs			800	0	0	0	$100	$0	$100	~$10,000	~$640	>20
2b	Current Furnace SS Units to ASHPs			2,400	19,500	2,000	0	-$1,800	$4,700	$2,900	~$14,400	~$1,060	~5
3	Current Furnace SS Units to DX Cooling, Electric Heating SS	≥ 15-16 SEER / ≥ 12.5 EER[1,4]	100%[2]	2,400	48,600	2,000	0	-$4,900	$4,700	-$200	~$20,800	~$1,130	NA
4	Current Furnace SS Units to More Efficient SS Units		≥ 93%[3]	2,400	0	80	0	$300	$200	$500	~$13,600	~$1,130	>20
5	Current Furnace SS Units to Rooftop Unit (DX Cooling, Propane Furnace, Economizer, VFD)	≥ 12.2 EER/ ≥ 14 IEER[4]	≥ 93%[3]	3,000	0	80	0	$300	$200	$500	~$50,000	~$730	>20

Table 6-3: ECO 3 (Apparatus Bay HVAC Replacement) Details

BASELINE				
Model		**In**	**Out**	
	Supply Fan (kWh)	**Heating (kBtu)**	**Heating (kBtu)**	
UHs	1,752	548,549	455,296	***Model***
UHs	1,302	497,401	412,843	***Adjusted to Bill***
Baseline Eff	83%			
Propane Use (gal/yr)	5,436			
Propane Cost ($/yr)	$ 12,719			
UH1 Size (BTU)	165,000	*input rating*		
UH1 Qty	4			
UH2 Size (BTU)	105,000	*input rating*		
UH2 Qty	1			
UH Total Capacity (BTU)	765,000	*input rating*		
UH Total Capacity (kBTU)	765	*input rating*		

PROPOSED			
Proposed HSPF	8.5	$HSPF = \frac{kBTU}{kWh}$	
Equiv COP	2.5		
Yearly kWh_in	48,570		
Elec Cost ($/yr)	$ 5,099		
Sizing Estimate			
COP is 2.5			
UH Capacity (kBtu)	307		
Max Htg Load (kBtu)	278.8	*from model*	
Design Load (kBtu)	300		
RSMeans Est ($)	84000		
Ductwork	12000		
Total	96000		

Table 6-4: ECO 4a-i (Type A Lighting) Calculation

		Current								Type A Replacement								Savings
Room #	Room Name	Current Fixture	Wattage/Lamp	Lamps/Fixture	Wattage/Fixture	# Fixtures	Total Wattage	Hours/Yr	kWh	Replacement Fixture	Wattage/Lamp	Lamps/Fixture	Wattage/Fixture	# Fixtures	Total Wattage	Hours/Yr	kWh	kWh
100	Vestibule	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 11.5W LED Tubes	15	4	60	1	60	8760	526	596
101N	Multipurpose Room	Fluorescent 4-ft tubes	32	4	128	12	1536	1172	1800	4ft 11.5W LED Tubes	15	4	60	12	720	1172	844	956
101S	Multipurpose Room	Fluorescent 4-ft tubes	32	4	128	12	1536	1172	1800	4ft 11.5W LED Tubes	15	4	60	12	720	1172	844	956
101A	Storage	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 11.5W LED Tubes	15	4	60	1	60	46	3	3
102	Corridor	Fluorescent 4-ft tubes	32	4	128	3	384	8760	3364	4ft 11.5W LED Tubes	15	4	60	3	180	8760	1577	1787
103	Chief's Office	Fluorescent 4-ft tubes	32	4	128	4	512	2292	1174	4ft 11.5W LED Tubes	15	4	60	4	240	2292	550	624
104	Office	Fluorescent 4-ft tubes	32	4	128	6	768	2292	1761	4ft 11.5W LED Tubes	15	4	60	6	360	2292	825	935
105	Kitchen	Fluorescent 4-ft tubes	32	4	128	9	1152	292	336	4ft 11.5W LED Tubes	15	4	60	9	540	292	157	178
105A	Kitchen Storage	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 11.5W LED Tubes	15	4	60	1	60	46	3	3
106	Janitor's Closet	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 11.5W LED Tubes	15	4	60	1	60	46	3	3
107	Communications	Fluorescent 4-ft tubes	32	4	128	2	256	2292	587	4ft 11.5W LED Tubes	15	4	60	2	120	2292	275	312
108	Corridor	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 11.5W LED Tubes	15	4	60	1	60	8760	526	596
109	Corridor	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 11.5W LED Tubes	15	4	60	1	60	8760	526	596
110	Laundry/Haz-mat	Fluorescent 4-ft tubes	32	2	64	2	128	2292	293	4ft 11.5W LED Tubes	15	2	30	2	60	2292	138	156
111	Electrical Closet	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 11.5W LED Tubes	15	4	60	1	60	46	3	3
112	Corridor	Fluorescent 4-ft tubes	32	4	128	2	256	8760	2243	4ft 11.5W LED Tubes	15	4	60	2	120	8760	1051	1191
113	Women's Restroom	Fluorescent 2-ft tubes	17	2	34	1	34	8760	298	2 ft 11W LED Tube	11	1	11	1	11	8760	96	201
113	Women's Restroom	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 11.5W LED Tubes	15	4	60	1	60	8760	526	596
113	Women's Restroom	Fluorescent 4-ft tubes	32	1	32	1	32	8760	280	4ft 11.5W LED Tubes	15	1	15	1	15	8760	131	149
114	Men's Restroom	Fluorescent 2-ft tubes	17	2	34	1	34	8760	298	2 ft 11W LED Tube	11	1	11	1	11	8760	96	201
114	Men's Restroom	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 11.5W LED Tubes	15	4	60	1	60	8760	526	596
114	Men's Restroom	Fluorescent 4-ft tubes	32	1	32	1	32	8760	280	4ft 11.5W LED Tubes	15	1	15	1	15	8760	131	149
115	Dayroom	Fluorescent 4-ft tubes	32	4	128	10	1280	4579	5861	4ft 11.5W LED Tubes	15	4	60	10	600	4579	2747	3114
116	Dayroom - Sleeping Room	Fluorescent 4-ft tubes	32	4	128	2	256	4579	1172	4ft 11.5W LED Tubes	15	4	60	2	120	4579	549	623
116	Apparatus Bays	Fluorescent 4-ft tubes	32	2	64	130	8320	2292	19073	4ft 11.5W LED Tubes	15	2	30	130	3900	2292	8940	10133
							17,668		**46,250**						**8,272**		**21,593**	**24,657**
						Adjusted to Bills	**13,087**		**34,259**						**6,127**		**15,995**	**18,264**

Table 6-5: ECO 4a-ii (Type A Lighting Daylighting and Occupancy Sensors) Calculation

		Current								Type A Replacement								Total Savings	Sensor Savings
Room #	Room Name	Current Fixture	Wattage/Lamp	Lamps/Fixture	Wattage/Fixture	# Fixtures	Total Wattage	Hours/Yr	kWh	Replacement Fixture	Wattage/Lamp	Lamps/Fixture	Wattage/Fixture	# Fixtures	Total Wattage	Hours/Yr w/ Occ Sensors	kWh	kWh	kWh
100	Vestibule	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 11.5W LED Tubes	15	4	60	1	60	8760	526	596	0
101N	Multipurpose Room	Fluorescent 4-ft tubes	32	4	128	12	1536	1172	1800	4ft 11.5W LED Tubes	15	4	60	12	720	1172	844	956	0
101S	Multipurpose Room	Fluorescent 4-ft tubes	32	4	128	12	1536	1172	1800	4ft 11.5W LED Tubes	15	4	60	12	720	1172	844	956	0
101A	Storage	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 11.5W LED Tubes	15	4	60	1	60	23	1	4	1
102	Corridor	Fluorescent 4-ft tubes	32	4	128	3	384	8760	3364	4ft 11.5W LED Tubes	15	4	60	3	180	8760	1577	1787	0
103	Chief's Office	Fluorescent 4-ft tubes	32	4	128	4	512	2292	1174	4ft 11.5W LED Tubes	15	4	60	4	240	2292	550	624	0
104	Office	Fluorescent 4-ft tubes	32	4	128	6	768	2292	1761	4ft 11.5W LED Tubes	15	4	60	6	360	2292	825	935	0
105	Kitchen	Fluorescent 4-ft tubes	32	4	128	9	1152	292	336	4ft 11.5W LED Tubes	15	4	60	9	540	292	157	178	0
105A	Kitchen Storage	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 11.5W LED Tubes	15	4	60	1	60	23	1	4	1
106	Janitor's Closet	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 11.5W LED Tubes	15	4	60	1	60	23	1	4	1
107	Communications	Fluorescent 4-ft tubes	32	4	128	2	256	2292	587	4ft 11.5W LED Tubes	15	4	60	2	120	2292	275	312	0
108	Corridor	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 11.5W LED Tubes	15	4	60	1	60	8760	526	596	0
109	Corridor	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 11.5W LED Tubes	15	4	60	1	60	8760	526	596	0
110	Laundry/Haz-mat	Fluorescent 4-ft tubes	32	2	64	2	128	2292	293	4ft 11.5W LED Tubes	15	2	30	2	60	573	34	259	103
111	Electrical Closet	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 11.5W LED Tubes	15	4	60	1	60	23	1	4	1
112	Corridor	Fluorescent 4-ft tubes	32	4	128	2	256	8760	2243	4ft 11.5W LED Tubes	15	4	60	2	120	8760	1051	1191	0
113	Women's Restroom	Fluorescent 2-ft tubes	17	2	34	1	34	8760	298	2 ft 11W LED Tube	11	1	11	1	11	2190	24	274	72
113	Women's Restroom	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 11.5W LED Tubes	15	4	60	1	60	2190	131	990	394
113	Women's Restroom	Fluorescent 4-ft tubes	32	1	32	1	32	8760	280	4ft 11.5W LED Tubes	15	1	15	1	15	2190	33	247	99
114	Men's Restroom	Fluorescent 2-ft tubes	17	2	34	1	34	8760	298	2 ft 11W LED Tube	11	1	11	1	11	2190	24	274	72
114	Men's Restroom	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 11.5W LED Tubes	15	4	60	1	60	2190	131	990	394
114	Men's Restroom	Fluorescent 4-ft tubes	32	1	32	1	32	8760	280	4ft 11.5W LED Tubes	15	1	15	1	15	2190	33	247	99
115	Dayroom	Fluorescent 4-ft tubes	32	4	128	10	1280	4579	5861	4ft 11.5W LED Tubes	15	4	60	10	600	4579	2747	3114	0
116	Dayroom - Sleeping Room	Fluorescent 4-ft tubes	32	4	128	2	256	4579	1172	4ft 11.5W LED Tubes	15	4	60	2	120	4579	549	623	0
116	Apparatus Bays	Fluorescent 4-ft tubes	32	2	64	130	8320	2292	19073	4ft 11.5W LED Tubes	15	2	30	130	3900	1719	6705	12368	2235
							17,668		**46,250**								**18,119**	**28,131**	**3,474**
						Adjusted to Bills	**13,087**		**34,259**								**13,422**	**20,838**	**2,573**

Table 6-6: ECO b-i (Type B Lighting) Calculation

		Current								Type B Replacement								Savings
Room	Room Name	Current Fixture	Wattage/Lan	Lamps/Fixtu	Wattage/Fixtu	# Fixtur	Total Watta	Hours/	kWh	Replacement Fixture	Wattage/Lan	Lamps/Fixtu	Wattage/Fixtu	# Fixtur	Total Watta	Hours/	kWh	kWh
100	Vestibule	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 15W LED Tubes	15	3	45	1	45	8760	394	727
101N	Multipurpose Room	Fluorescent 4-ft tubes	32	4	128	12	1536	1172	1800	4ft 15W LED Tubes	15	3	45	12	540	1172	633	1167
101S	Multipurpose Room	Fluorescent 4-ft tubes	32	4	128	12	1536	1172	1800	4ft 15W LED Tubes	15	3	45	12	540	1172	633	1167
101A	Storage	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 15W LED Tubes	15	3	45	1	45	46	2	4
102	Corridor	Fluorescent 4-ft tubes	32	4	128	3	384	8760	3364	4ft 15W LED Tubes	15	3	45	3	135	8760	1183	2181
103	Chief's Office	Fluorescent 4-ft tubes	32	4	128	4	512	2292	1174	4ft 15W LED Tubes	15	3	45	4	180	2292	413	761
104	Office	Fluorescent 4-ft tubes	32	4	128	6	768	2292	1761	4ft 15W LED Tubes	15	3	45	6	270	2292	619	1142
105	Kitchen	Fluorescent 4-ft tubes	32	4	128	9	1152	292	336	4ft 15W LED Tubes	15	3	45	9	405	292	118	218
105A	Kitchen Storage	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 15W LED Tubes	15	3	45	1	45	46	2	4
106	Janitor's Closet	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 15W LED Tubes	15	3	45	1	45	46	2	4
107	Communications	Fluorescent 4-ft tubes	32	4	128	2	256	2292	587	4ft 15W LED Tubes	15	3	45	2	90	2292	206	381
108	Corridor	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 15W LED Tubes	15	3	45	1	45	8760	394	727
109	Corridor	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 15W LED Tubes	15	3	45	1	45	8760	394	727
110	Laundry/Haz-mat	Fluorescent 4-ft tubes	32	2	64	2	128	2292	293	4ft 15W LED Tubes	15	2	30	2	60	2292	138	156
111	Electrical Closet	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 15W LED Tubes	15	3	45	1	45	46	2	4
112	Corridor	Fluorescent 4-ft tubes	32	4	128	2	256	8760	2243	4ft 15W LED Tubes	15	3	45	2	90	8760	788	1454
113	Women's Restroom	Fluorescent 2-ft tubes	17	2	34	1	34	8760	298	2ft 9W LED Tubes	9	2	18	1	18	8760	158	140
113	Women's Restroom	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 15W LED Tubes	15	3	45	1	45	8760	394	727
113	Women's Restroom	Fluorescent 4-ft tubes	32	1	32	1	32	8760	280	4ft 15W LED Tubes	15	1	15	1	15	8760	131	149
114	Men's Restroom	Fluorescent 2-ft tubes	17	2	34	1	34	8760	298	2ft 9W LED Tubes	9	2	18	1	18	8760	158	140
114	Men's Restroom	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 15W LED Tubes	15	3	45	1	45	8760	394	727
114	Men's Restroom	Fluorescent 4-ft tubes	32	1	32	1	32	8760	280	4ft 15W LED Tubes	15	1	15	1	15	8760	131	149
115	Dayroom	Fluorescent 4-ft tubes	32	4	128	10	1280	4579	5861	4ft 15W LED Tubes	15	3	45	10	450	4579	2060	3800
116	Dayroom - Sleeping Room	Fluorescent 4-ft tubes	32	4	128	2	256	4579	1172	4ft 15W LED Tubes	15	3	45	2	90	4579	412	760
116	Apparatus Bays	Fluorescent 4-ft tubes	32	2	64	130	8320	2292	19073	4ft 15W LED Tubes	15	2	30	130	3900	2292	8940	10133
							17,668		**46,250**						**7,221**		**18,701**	**27,549**
						Adjusted to Bills	**13,087**		**34,259**						**5,349**		**13,853**	**20,407**

Table 6-7: ECO 4b-ii (Type B Lighting Daylighting and Occupancy Sensors) Calculation

		Current								Type B Replacement								Total Savings	Sensor Savings
Room	Room Name	Current Fixture	Wattage/Lan	Lamps/Fixtu	Wattage/Fixtu	# Fixtur	Total Watta	Hours/	kWh	Replacement Fixture	Wattage/Lan	Lamps/Fixtu	Wattage/Fixtu	# Fixtur	Total Watta	Hours/Yr w/ Occ Sensors	kWh	kWh	kWh
100	Vestibule	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 15W LED Tubes	15	3	45	1	45	8760	394	727	0
101N	Multipurpose Room	Fluorescent 4-ft tubes	32	4	128	12	1536	1172	1800	4ft 15W LED Tubes	15	3	45	12	540	1172	633	1167	0
101S	Multipurpose Room	Fluorescent 4-ft tubes	32	4	128	12	1536	1172	1800	4ft 15W LED Tubes	15	3	45	12	540	1172	633	1167	0
101A	Storage	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 15W LED Tubes	15	3	45	1	45	23	1	5	1
102	Corridor	Fluorescent 4-ft tubes	32	4	128	3	384	8760	3364	4ft 15W LED Tubes	15	3	45	3	135	8760	1183	2181	0
103	Chief's Office	Fluorescent 4-ft tubes	32	4	128	4	512	2292	1174	4ft 15W LED Tubes	15	3	45	4	180	2292	413	761	0
104	Office	Fluorescent 4-ft tubes	32	4	128	6	768	2292	1761	4ft 15W LED Tubes	15	3	45	6	270	2292	619	1142	0
105	Kitchen	Fluorescent 4-ft tubes	32	4	128	9	1152	292	336	4ft 15W LED Tubes	15	3	45	9	405	292	118	218	0
105A	Kitchen Storage	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 15W LED Tubes	15	3	45	1	45	23	1	5	1
106	Janitor's Closet	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 15W LED Tubes	15	3	45	1	45	23	1	5	1
107	Communications	Fluorescent 4-ft tubes	32	4	128	2	256	2292	587	4ft 15W LED Tubes	15	3	45	2	90	2292	206	381	0
108	Corridor	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 15W LED Tubes	15	3	45	1	45	8760	394	727	0
109	Corridor	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 15W LED Tubes	15	3	45	1	45	8760	394	727	0
110	Laundry/Haz-mat	Fluorescent 4-ft tubes	32	2	64	2	128	2292	293	4ft 15W LED Tubes	15	2	30	2	60	573	34	259	103
111	Electrical Closet	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 15W LED Tubes	15	3	45	1	45	23	1	5	1
112	Corridor	Fluorescent 4-ft tubes	32	4	128	2	256	8760	2243	4ft 15W LED Tubes	15	3	45	2	90	8760	788	1454	0
113	Women's Restroom	Fluorescent 2-ft tubes	17	2	34	1	34	8760	298	2ft 9W LED Tubes	9	2	18	1	18	2190	39	258	118
113	Women's Restroom	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 15W LED Tubes	15	3	45	1	45	2190	99	1023	296
113	Women's Restroom	Fluorescent 4-ft tubes	32	1	32	1	32	8760	280	4ft 15W LED Tubes	15	1	15	1	15	2190	33	247	99
114	Men's Restroom	Fluorescent 2-ft tubes	17	2	34	1	34	8760	298	2ft 9W LED Tubes	9	2	18	1	18	2190	39	258	118
114	Men's Restroom	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 15W LED Tubes	15	3	45	1	45	2190	99	1023	296
114	Men's Restroom	Fluorescent 4-ft tubes	32	1	32	1	32	8760	280	4ft 15W LED Tubes	15	1	15	1	15	2190	33	247	99
115	Dayroom	Fluorescent 4-ft tubes	32	4	128	10	1280	4579	5861	4ft 15W LED Tubes	15	3	45	10	450	4579	2060	3800	0
116	Dayroom - Sleeping Room	Fluorescent 4-ft tubes	32	4	128	2	256	4579	1172	4ft 15W LED Tubes	15	3	45	2	90	4579	412	760	0
116	Apparatus Bays	Fluorescent 4-ft tubes	32	2	64	130	8320	2292	19073	4ft 15W LED Tubes	15	2	30	130	3900	1719	6705	12368	2235
							17,668		**46,250**						**7,221**		**15,334**	**30,916**	**3,367**
						Adjusted to Bills	**13,087**		**34,259**						**5,349**		**11,358**	**22,901**	**2,494**

Table 6-8: ECO 4c-i (Type C Lighting) Calculation

		Current								Type C Replacement								Savings
Room	Room Name	Current Fixture	Wattage/Lan	Lamps/Fixtu	Wattage/Fixtu	# Fixtur	Total Watta	Hours/	kW	Replacement Fixture	Wattage/Lan	Lamps/Fixtu	Wattage/Fixtu	# Fixtur	Total Watta	Hours/	kWh	kWh
100	Vestibule	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 13W LED	13	3	39	1	39	8760	342	780
101N	Multipurpose Room	Fluorescent 4-ft tubes	32	4	128	12	1536	1172	1800	4ft 13W LED	13	3	39	12	468	1172	549	1252
101S	Multipurpose Room	Fluorescent 4-ft tubes	32	4	128	12	1536	1172	1800	4ft 13W LED	13	3	39	12	468	1172	549	1252
101A	Storage	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 13W LED	13	3	39	1	39	46	2	4
102	Corridor	Fluorescent 4-ft tubes	32	4	128	3	384	8760	3364	4ft 13W LED	13	3	39	3	117	8760	1025	2339
103	Chief's Office	Fluorescent 4-ft tubes	32	4	128	4	512	2292	1174	4ft 13W LED	13	3	39	4	156	2292	358	816
104	Office	Fluorescent 4-ft tubes	32	4	128	6	768	2292	1761	4ft 13W LED	13	3	39	6	234	2292	536	1224
105	Kitchen	Fluorescent 4-ft tubes	32	4	128	9	1152	292	336	4ft 13W LED	13	3	39	9	351	292	102	234
105A	Kitchen Storage	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 13W LED	13	3	39	1	39	46	2	4
106	Janitor's Closet	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 13W LED	13	3	39	1	39	46	2	4
107	Communications	Fluorescent 4-ft tubes	32	4	128	2	256	2292	587	4ft 13W LED	13	3	39	2	78	2292	179	408
108	Corridor	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 13W LED	13	3	39	1	39	8760	342	780
109	Corridor	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 13W LED	13	3	39	1	39	8760	342	780
110	Laundry/Haz-mat	Fluorescent 4-ft tubes	32	2	64	2	128	2292	293	4ft 13W LED	13	2	26	2	52	2292	119	174
111	Electrical Closet	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 13W LED	13	3	39	1	39	46	2	4
112	Corridor	Fluorescent 4-ft tubes	32	4	128	2	256	8760	2243	4ft 13W LED	13	3	39	2	78	8760	683	1559
113	Women's Restroom	Fluorescent 2-ft tubes	17	2	34	1	34	8760	298	2ft 9W LED	9	2	18	1	18	8760	158	140
113	Women's Restroom	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 13W LED	13	3	39	1	39	8760	342	780
113	Women's Restroom	Fluorescent 4-ft tubes	32	1	32	1	32	8760	280	4ft 13W LED	13	1	13	1	13	8760	114	166
114	Men's Restroom	Fluorescent 2-ft tubes	17	2	34	1	34	8760	298	2ft 9W LED	9	2	18	1	18	8760	158	140
114	Men's Restroom	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 13W LED	13	3	39	1	39	8760	342	780
114	Men's Restroom	Fluorescent 4-ft tubes	32	1	32	1	32	8760	280	4ft 13W LED	13	1	13	1	13	8760	114	166
115	Dayroom	Fluorescent 4-ft tubes	32	4	128	10	1280	4579	5861	4ft 13W LED	13	3	39	10	390	4579	1786	4075
116	Dayroom - Sleeping Room	Fluorescent 4-ft tubes	32	4	128	2	256	4579	1172	4ft 13W LED	13	3	39	2	78	4579	357	815
116	Apparatus Bays	Fluorescent 4-ft tubes	32	2	64	130	8320	2292	19073	4ft 13W LED	13	2	26	130	3380	2292	7748	11325
							17,668		**46,250**						**6,263**		**16,250**	**30,001**
						Adjusted to Bills	**13,087**		**34,259**						**4,639**		**12,037**	**22,223**

Table 6-9: ECO 4c-ii (Type C Lighting Daylighting and Occupancy Sensors) Calculation

		Current								Type C Replacement								Total Savings	Sensor Savings
Room	Room Name	Current Fixture	Wattage/Lan	Lamps/Fixtu	Wattage/Fixtu	# Fixtur	Total Watta	Hours/	kW	Replacement Fixture	Wattage/Lan	Lamps/Fixtu	Wattage/Fixtu	# Fixtur	Total Watta	Hours/Yr w/ Occ Sensors	kWh	kWh	kWh
100	Vestibule	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 13W LED	13	3	39	1	39	8760	342	780	0
101N	Multipurpose Room	Fluorescent 4-ft tubes	32	4	128	12	1536	1172	1800	4ft 13W LED	13	3	39	12	468	1172	549	1252	0
101S	Multipurpose Room	Fluorescent 4-ft tubes	32	4	128	12	1536	1172	1800	4ft 13W LED	13	3	39	12	468	1172	549	1252	0
101A	Storage	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 13W LED	13	3	39	1	39	23	1	5	1
102	Corridor	Fluorescent 4-ft tubes	32	4	128	3	384	8760	3364	4ft 13W LED	13	3	39	3	117	8760	1025	2339	0
103	Chief's Office	Fluorescent 4-ft tubes	32	4	128	4	512	2292	1174	4ft 13W LED	13	3	39	4	156	2292	358	816	0
104	Office	Fluorescent 4-ft tubes	32	4	128	6	768	2292	1761	4ft 13W LED	13	3	39	6	234	2292	536	1224	0
105	Kitchen	Fluorescent 4-ft tubes	32	4	128	9	1152	292	336	4ft 13W LED	13	3	39	9	351	292	102	234	0
105A	Kitchen Storage	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 13W LED	13	3	39	1	39	23	1	5	1
106	Janitor's Closet	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 13W LED	13	3	39	1	39	23	1	5	1
107	Communications	Fluorescent 4-ft tubes	32	4	128	2	256	2292	587	4ft 13W LED	13	3	39	2	78	2292	179	408	0
108	Corridor	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 13W LED	13	3	39	1	39	8760	342	780	0
109	Corridor	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 13W LED	13	3	39	1	39	8760	342	780	0
110	Laundry/Haz-mat	Fluorescent 4-ft tubes	32	2	64	2	128	2292	293	4ft 13W LED	13	2	26	2	52	573	30	264	89
111	Electrical Closet	Fluorescent 4-ft tubes	32	4	128	1	128	46	6	4ft 13W LED	13	3	39	1	39	23	1	5	1
112	Corridor	Fluorescent 4-ft tubes	32	4	128	2	256	8760	2243	4ft 13W LED	13	3	39	2	78	8760	683	1559	0
113	Women's Restroom	Fluorescent 2-ft tubes	17	2	34	1	34	8760	298	2ft 9W LED	9	2	18	1	18	2190	39	258	118
113	Women's Restroom	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 13W LED	13	3	39	1	39	2190	85	1036	256
113	Women's Restroom	Fluorescent 4-ft tubes	32	1	32	1	32	8760	280	4ft 13W LED	13	1	13	1	13	2190	28	252	85
114	Men's Restroom	Fluorescent 2-ft tubes	17	2	34	1	34	8760	298	2ft 9W LED	9	2	18	1	18	2190	39	258	118
114	Men's Restroom	Fluorescent 4-ft tubes	32	4	128	1	128	8760	1121	4ft 13W LED	13	3	39	1	39	2190	85	1036	256
114	Men's Restroom	Fluorescent 4-ft tubes	32	1	32	1	32	8760	280	4ft 13W LED	13	1	13	1	13	2190	28	252	85
115	Dayroom	Fluorescent 4-ft tubes	32	4	128	10	1280	4579	5861	4ft 13W LED	13	3	39	10	390	4579	1786	4075	0
116	Dayroom - Sleeping Room	Fluorescent 4-ft tubes	32	4	128	2	256	4579	1172	4ft 13W LED	13	3	39	2	78	4579	357	815	0
116	Apparatus Bays	Fluorescent 4-ft tubes	32	2	64	130	8320	2292	19073	4ft 13W LED	13	2	26	130	3380	1719	5811	13262	1937
							17,668		**46,250**						**6,263**		**13,300**	**32,950**	**2,950**
							13,087		**34,259**						**4,639**		**9,852**	**24,408**	**2,185**

Table 6-10: ECO 4d (Compact Fluorescent and Incandescent Lighting) Calculation

		Current								Replacement								Savings
Room #	Room Name	Current Fixture	Wattage/Lamp	Lamps/Fixture	Wattage/Fixture	# Fixtures	Total Wattage	Hours/Yr	kWh	Replacement Fixture	Wattage/Lamp	Lamps/Fixture	Wattage/Fixture	# Fixtures	Total Wattage	Hours/Yr	kWh	kWh
100	Vestibule	CFL screw-in	13	1	13	5	65	0	0	CFL screw-in	8	1	8	5	40	0	0	0
101N	Multipurpose Room	Incandescent can screw-in	150	1	150	9	1350	0	0	Incandescent can screw-in	23	1	23	9	207	0	0	0
101S	Multipurpose Room	Incandescent can screw-in	150	1	150	9	1350	0	0	Incandescent can screw-in	23	1	23	9	207	0	0	0
109A	Closet	CFL screw-in	13	1	13	1	13	46	1	CFL screw-in	8	1	8	1	8	46	0	0
112	Corridor	Incandescent screw-in	60	1	60	1	60	8760	526	Incandescent screw-in	8	1	8	1	8	8760	70	456
117	Dayroom - Sleeping Room	CFL screw-in	13	1	13	2	26	4579	119	CFL screw-in	8	1	8	2	16	4579	73	46
							2864		**645**						**486**		**144**	**502**
						Adjusted to Bills	**2121**		**478**						**360**		**106**	**372**

Table 6-11: ECO 5a (Exterior Type B Lighting) Calculation

	Current								Type C Replacement								Savings
	Current Fixture	Wattage/Lamp	Lamps/Fixture	Wattage/Fixture	# Fixtures	Total Wattage	Hours/Yr	kWh	Replacement Fixture	Wattage/Lamp	Lamps/Fixture	Wattage/Fixture	# Fixtures	Total Wattage	Hours/Yr	kWh	kWh
Halogen	Parking Lot Pole	400	1	400	13	5200	4000	20,800	80 W Cornbulb	80	1	80	13	1040	4000	4,160	16,640
LED	Wallpacks	50	1	50	4	200	4000	800	-	-	-	-	-	-	-	-	0
MH	Wallpacks	100	1	100	4	400	4000	1,600	54 W Cornbulb	54	1	54	4	216	4000	864	736
CFL	Canopy	13	1	13	2	26	4000	104	8 W LED Lamp	8	1	8	2	16	4000	64	40
LED	Flag Flood Light	20	1	20	1	20	4000	80	-	-	-	-	-	-	-	-	0
						5,846		**23,384**						**1,272**		**5,088**	**17,416**
					Adjusted to Bills	**4,330**		**17,321**						**942**		**3,769**	**12,901**

Table 6-12: ECO 5b (Exterior Type C Lighting) Calculation

	Current								Type C Replacement								Savings
	Current Fixture	Wattage/Lamp	Lamps/Fixture	Wattage/Fixture	# Fixtures	Total Wattage	Hours/Yr	kWh	Replacement Fixture	Wattage/Lamp	Lamps/Fixture	Wattage/Fixture	# Fixtures	Total Wattage	Hours/Yr	kWh	kWh
Halogen	Parking Lot Pole	400	1	400	13	5200	4000	20,800	75 W LED Fixture	75	1	75	13	975	4000	3,900	16,900
LED	Wallpacks	50	1	50	4	200	4000	800	-	-	-	-	-	-	-	-	0
MH	Wallpacks	100	1	100	4	400	4000	1,600	50 W LED WP	50	1	50	4	200	4000	800	800
CFL	Canopy	13	1	13	2	26	4000	104	8 W LED Lamp	8	1	8	2	16	4000	64	40
LED	Flag Flood Light	20	1	20	1	20	4000	80	-	-	-	-	-	-	-	-	0
						5,846		**23,384**						**1,191**		**4,764**	**17,740**
					Adjusted to Bills	**4,330**		**17,321**						**882**		**3,529**	**13,141**

Table 6-13: ECO 6 (Insulate Apparatus Bay Vehicle Doors) Calculation

The savings for this ECO were calculated in HAP. Below are the results and assumptions regarding the window R-values.

https://www.energydepot.com/RPUcom/library/BUILD001.asp

	R-value	U-value
Single Pane	0.9	1.111
Double Pane	1.7	0.588
Triple Pane	2.56	0.391

R-VALUES FOR DIFFERENT WINDOW SYSTEMS*		
Description	Winter	Summer
Single Pane	0.9	0.96
Double Pane		
.25" air space	1.72	1.64
.5" air space	2.04	1.78
Triple Pane		
.25" air space	2.56	2.27
.5" air space	3.22	2.56

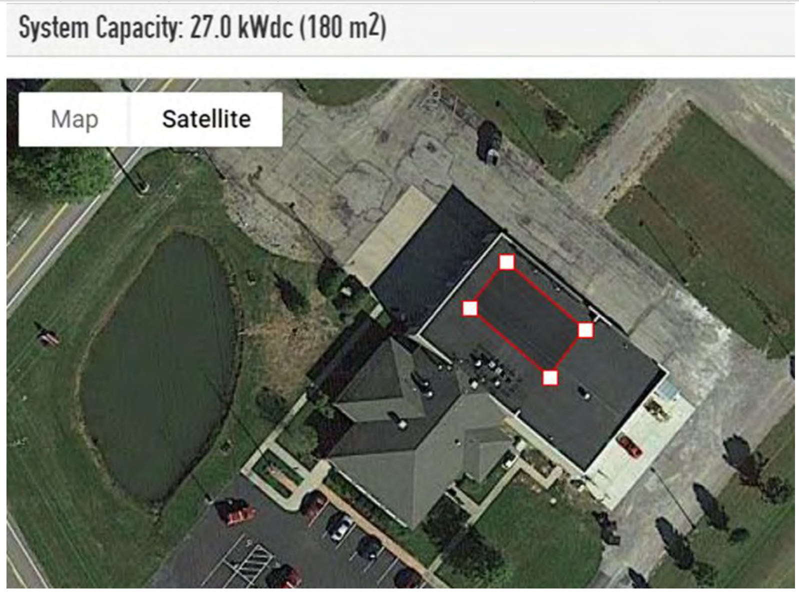
*These are representative R-values. The size of the window and type of frame will affect the average R-values for a specific window.

	SF (kWh)	UHs (kBtu)
Baseline	1,302	497,401
Proposed	665	466,062
Savings	637	31,339
% Savings	49%	6.3%

	Min	Max
Elec Savings (kWh/yr)	510	637
Propane Savings (kBtu)	25,071	31,339
Propane Savings (gals)	274	342
Elec Cost Savings ($)	$ 54	$ 67
Propane Cost Savings ($)	$ 641	$ 801
Total Cost Savings ($)	$ 695	$ 868

Table 6-14: ECO 7 (Solar Photovoltaic) Calculation

Harlan	December 2017 - November 2018									
Max Demand (kW)	43.2			$ 0.1050	$/kWh	Old Base	84,296			
Elec Usage (kWh/yr)	84,296					ECOs	(21,320)	-25%		
Potential Elec Savings (kWh/yr)	(21,320)					Solar	35,923	43%		
Potential Demand Savings (kW/yr)	4.7					New Base	**69,693**	83%		
Elec Usage after ECOs (kWh/yr)	105,616									
Elec Demand after ECOs (kW)	39									
Array										
Demand Sized at (kW)	27			Max Cost ($)	$ 68,621					
Elec Output (kWh/yr)	35,923			Min Cost ($)	$ 56,511					
Cost ($)	$ 80,730						SP (w/o Incentives)		21.4	yrs
Tax Incentives ($)	$ 24,219	30%		Elec Savings (kWh)	35,923		SP (w/ min Incentives)		18.2	yrs
	$ 12,110	15%		Elec Cost Savings ($/yr)	$ 3,771		SP (w/ max Incentives)		15.0	yrs



7.0- APPENDIX D: COSTING INFORMATION

7.1- Lighting Option

The following costs are estimated from the 1,000 Bulbs online database.

Table 7-1: Interior Type A Lighting Project Costs Calculations ECO 4a-i

Type A Replacement												
Replacement Fixture	**Lamps/Fixture**	**# Fixtures**	**Cost/Lamp**	**Cost/Fixture**	**Total Material**	**Labor/Lamp**	**Labor/Fixture**	**Total Labor**	**Rebate/Lamp**	**Rebate/Fixture**	**Total Rebate**
4ft 11.5W LED Tubes	4	1	5	20	**20**	8.33	33.32	**33.32**	3	12	**12**
4ft 11.5W LED Tubes	4	12	5	20	**240**	8.33	33.32	**399.84**	3	12	**144**
4ft 11.5W LED Tubes	4	12	5	20	**240**	8.33	33.32	**399.84**	3	12	**144**
4ft 11.5W LED Tubes	4	1	5	20	**20**	8.33	33.32	**33.32**	3	12	**12**
4ft 11.5W LED Tubes	4	3	5	20	**60**	8.33	33.32	**99.96**	3	12	**36**
4ft 11.5W LED Tubes	4	4	5	20	**80**	8.33	33.32	**133.28**	3	12	**48**
4ft 11.5W LED Tubes	4	6	5	20	**120**	8.33	33.32	**199.92**	3	12	**72**
4ft 11.5W LED Tubes	4	9	5	20	**180**	8.33	33.32	**299.88**	3	12	**108**
4ft 11.5W LED Tubes	4	1	5	20	**20**	8.33	33.32	**33.32**	3	12	**12**
4ft 11.5W LED Tubes	4	1	5	20	**20**	8.33	33.32	**33.32**	3	12	**12**
4ft 11.5W LED Tubes	4	2	5	20	**40**	8.33	33.32	**66.64**	3	12	**24**
4ft 11.5W LED Tubes	4	1	5	20	**20**	8.33	33.32	**33.32**	3	12	**12**
4ft 11.5W LED Tubes	4	1	5	20	**20**	8.33	33.32	**33.32**	3	12	**12**
4ft 11.5W LED Tubes	2	2	5	10	**20**	8.33	16.66	**33.32**	3	6	**12**
4ft 11.5W LED Tubes	4	1	5	20	**20**	8.33	33.32	**33.32**	3	12	**12**
4ft 11.5W LED Tubes	4	2	5	20	**40**	8.33	33.32	**66.64**	3	12	**24**
2 ft 11W LED Tube	1	1	6.5	6.5	**6.5**	8.33	8.33	**8.33**	3	3	**3**
4ft 11.5W LED Tubes	4	1	5	20	**20**	8.33	33.32	**33.32**	3	12	**12**
4ft 11.5W LED Tubes	1	1	5	5	**5**	8.33	8.33	**8.33**	3	3	**3**
2 ft 11W LED Tube	1	1	6.5	6.5	**6.5**	8.33	8.33	**8.33**	3	3	**3**
4ft 11.5W LED Tubes	4	1	5	20	**20**	8.33	33.32	**33.32**	3	12	**12**
4ft 11.5W LED Tubes	1	1	5	5	**5**	8.33	8.33	**8.33**	3	3	**3**
4ft 11.5W LED Tubes	4	10	5	20	**200**	8.33	33.32	**333.2**	3	12	**120**
4ft 11.5W LED Tubes	4	2	5	20	**40**	8.33	33.32	**66.64**	3	12	**24**
4ft 11.5W LED Tubes	2	130	5.0	10	**1300**	8.33	17	**2166**	3	6	**780**
					2,763			**4,598**			**1,656**

Table 7-2: Interior Type A Lighting Daylighting and Occupancy Sensors Project Costs Calculations ECO 4a-ii

Type A Replacement								
Replacement Fixture	# Occ Sensors	Cost/Sensor	Total Material	Labor/Sensor	Total Labor	Rebate/Sensor	Total Rebate	Type
4ft 11.5W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 11.5W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 11.5W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 11.5W LED Tubes	1	13	**13**	60	**60**	0	**0**	PIR
4ft 11.5W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 11.5W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 11.5W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 11.5W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 11.5W LED Tubes	1	13	**13**	60	**60**	0	**0**	PIR
4ft 11.5W LED Tubes	1	13	**13**	60	**60**	0	**0**	PIR
4ft 11.5W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 11.5W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 11.5W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 11.5W LED Tubes	1	13	**13**	60	**60**	0	**0**	PIR
4ft 11.5W LED Tubes	1	13	**13**	60	**60**	0	**0**	PIR
4ft 11.5W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
2 ft 11W LED Tube	1	75	**75**	60	**60**	0	**0**	Ultrasonic
4ft 11.5W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 11.5W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
2 ft 11W LED Tube	1	75	**75**	60	**60**	0	**0**	Ultrasonic
4ft 11.5W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 11.5W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 11.5W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 11.5W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 11.5W LED Tubes	4	85	**340**	60	**240**	0	**0**	Daylighting
			555		**660**		**0**	

Table 7-3: Interior Type B Lighting Project Costs Calculations ECO 4b-i

Type B Replacement											
Replacement Fixture	Lamps/Fixture	# Fixtures	Cost/Lamp	Cost/Fixture	Total Material	Labor/Lamp	Labor/Fixture	Total Labor	Rebate/Lamp	Rebate/Fixture	Total Rebate
4ft 15W LED Tubes	3	1	6.5	19.5	**19.5**	12.5	37.5	**37.5**	3	9	**9**
4ft 15W LED Tubes	3	12	6.5	19.5	**234**	12.5	37.5	**450**	3	9	**108**
4ft 15W LED Tubes	3	12	6.5	19.5	**234**	12.5	37.5	**450**	3	9	**108**
4ft 15W LED Tubes	3	1	6.5	19.5	**19.5**	12.5	37.5	**37.5**	3	9	**9**
4ft 15W LED Tubes	3	3	6.5	19.5	**58.5**	12.5	37.5	**112.5**	3	9	**27**
4ft 15W LED Tubes	3	4	6.5	19.5	**78**	12.5	37.5	**150**	3	9	**36**
4ft 15W LED Tubes	3	6	6.5	19.5	**117**	12.5	37.5	**225**	3	9	**54**
4ft 15W LED Tubes	3	9	6.5	19.5	**175.5**	12.5	37.5	**337.5**	3	9	**81**
4ft 15W LED Tubes	3	1	6.5	19.5	**19.5**	12.5	37.5	**37.5**	3	9	**9**
4ft 15W LED Tubes	3	1	6.5	19.5	**19.5**	12.5	37.5	**37.5**	3	9	**9**
4ft 15W LED Tubes	3	2	6.5	19.5	**39**	12.5	37.5	**75**	3	9	**18**
4ft 15W LED Tubes	3	1	6.5	19.5	**19.5**	12.5	37.5	**37.5**	3	9	**9**
4ft 15W LED Tubes	3	1	6.5	19.5	**19.5**	12.5	37.5	**37.5**	3	9	**9**
4ft 15W LED Tubes	2	2	6.5	13	**26**	12.5	25	**50**	3	6	**12**
4ft 15W LED Tubes	3	1	6.5	19.5	**19.5**	12.5	37.5	**37.5**	3	9	**9**
4ft 15W LED Tubes	3	2	6.5	19.5	**39**	12.5	37.5	**75**	3	9	**18**
2ft 9W LED Tubes	2	1	9.0	18	**18**	12.5	25	**25**	3	6	**6**
4ft 15W LED Tubes	3	1	6.5	19.5	**19.5**	12.5	37.5	**37.5**	3	9	**9**
4ft 15W LED Tubes	1	1	6.5	6.5	**6.5**	12.5	12.5	**12.5**	3	3	**3**
2ft 9W LED Tubes	2	1	9.0	18	**18**	12.5	25	**25**	3	6	**6**
4ft 15W LED Tubes	3	1	6.5	19.5	**19.5**	12.5	37.5	**37.5**	3	9	**9**
4ft 15W LED Tubes	1	1	6.5	6.5	**6.5**	12.5	12.5	**12.5**	3	3	**3**
4ft 15W LED Tubes	3	10	6.5	19.5	**195**	12.5	37.5	**375**	3	9	**90**
4ft 15W LED Tubes	3	2	6.5	19.5	**39**	12.5	37.5	**75**	3	9	**18**
4ft 15W LED Tubes	2	130	6.5	13	**1690**	12.5	25	**3250**	3	6	**780**
					3,150			**6,038**			**1,449**

Table 7-4: Interior Type B Lighting Daylighting and Occupancy Sensors Project Costs Calculations ECO 4b-ii

Type B Replacement								
Replacement Fixture	# Occ Sensors	Cost/Sensor	Total Material	Labor/Sensor	Total Labor	Rebate/Sensor	Total Rebate	Type
4ft 15W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 15W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 15W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 15W LED Tubes	1	13	**13**	60	**60**	0	**0**	PIR
4ft 15W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 15W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 15W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 15W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 15W LED Tubes	1	13	**13**	60	**60**	0	**0**	PIR
4ft 15W LED Tubes	1	13	**13**	60	**60**	0	**0**	PIR
4ft 15W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 15W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 15W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 15W LED Tubes	1	13	**13**	60	**60**	0	**0**	PIR
4ft 15W LED Tubes	1	13	**13**	60	**60**	0	**0**	PIR
4ft 15W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
2ft 9W LED Tubes	1	75	**75**	60	**60**	0	**0**	Ultrasonic
4ft 15W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 15W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
2ft 9W LED Tubes	1	75	**75**	60	**60**	0	**0**	Ultrasonic
4ft 15W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 15W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 15W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 15W LED Tubes	0	0	**0**	60	**0**	0	**0**	-
4ft 15W LED Tubes	4	85	**340**	60	**240**	0	**0**	Daylighting
			555		**660**		**0**	

Table 7-5: Interior Type C Lighting Project Costs Calculations ECO 4c-i

Type C Replacement													
Replacement Fixture	Lamps/Fixture	# Fixtures	Cost/Lamp	Cost/Fixture	Cost/Driver	Total Material	Labor/Lamp	Labor/Fixture	Labor/Driver	Total Labor	Rebate/Lamp	Rebate/Fixture	Total Rebate
4ft 13W LED	3	1	11.5	34.5	35	**69.5**	12.5	37.5	80	**117.5**	3	9	**9**
4ft 13W LED	3	12	11.5	34.5	35	**834**	12.5	37.5	80	**1410**	3	9	**108**
4ft 13W LED	3	12	11.5	34.5	35	**834**	12.5	37.5	80	**1410**	3	9	**108**
4ft 13W LED	3	1	11.5	34.5	35	**69.5**	12.5	37.5	80	**117.5**	3	9	**9**
4ft 13W LED	3	3	11.5	34.5	35	**208.5**	12.5	37.5	80	**352.5**	3	9	**27**
4ft 13W LED	3	4	11.5	34.5	35	**278**	12.5	37.5	80	**470**	3	9	**36**
4ft 13W LED	3	6	11.5	34.5	35	**417**	12.5	37.5	80	**705**	3	9	**54**
4ft 13W LED	3	9	11.5	34.5	35	**625.5**	12.5	37.5	80	**1057.5**	3	9	**81**
4ft 13W LED	3	1	11.5	34.5	35	**69.5**	12.5	37.5	80	**117.5**	3	9	**9**
4ft 13W LED	3	1	11.5	34.5	35	**69.5**	12.5	37.5	80	**117.5**	3	9	**9**
4ft 13W LED	3	2	11.5	34.5	35	**139**	12.5	37.5	80	**235**	3	9	**18**
4ft 13W LED	3	1	11.5	34.5	35	**69.5**	12.5	37.5	80	**117.5**	3	9	**9**
4ft 13W LED	3	1	11.5	34.5	35	**69.5**	12.5	37.5	80	**117.5**	3	9	**9**
4ft 13W LED	2	2	11.5	23	35	**116**	12.5	25	80	**210**	3	6	**12**
4ft 13W LED	3	1	11.5	34.5	35	**69.5**	12.5	37.5	80	**117.5**	3	9	**9**
4ft 13W LED	3	2	11.5	34.5	35	**139**	12.5	37.5	80	**235**	3	9	**18**
2ft 9W LED	2	1	9.5	19	24	**43**	12.5	25	80	**105**	3	6	**6**
4ft 13W LED	3	1	11.5	34.5	35	**69.5**	12.5	37.5	80	**117.5**	3	9	**9**
4ft 13W LED	1	1	11.5	11.5	35	**46.5**	12.5	12.5	80	**92.5**	3	3	**3**
2ft 9W LED	2	1	9.5	19	24	**43**	12.5	25	80	**105**	3	6	**6**
4ft 13W LED	3	1	11.5	34.5	35	**69.5**	12.5	37.5	80	**117.5**	3	9	**9**
4ft 13W LED	1	1	11.5	11.5	35	**46.5**	12.5	12.5	80	**92.5**	3	3	**3**
4ft 13W LED	3	10	11.5	34.5	35	**695**	12.5	37.5	80	**1175**	3	9	**90**
4ft 13W LED	3	2	11.5	34.5	35	**139**	12.5	37.5	80	**235**	3	9	**18**
4ft 13W LED	2	130	11.5	23	35	**7540**	12.5	25	80	**13650**	3	6	**780**
						12,770				**22,598**			**1,449**

Table 7-6: Interior Type C Lighting Daylighting and Occupancy Sensors Project Costs Calculations ECO 4c-ii

Type C Replacement Replacement Fixture	# Occ Sensors	Cost/Sensor	Total Material	Labor/Sensor	Total Labor	Rebate/Sensor	Total Rebate	Type
4ft 13W LED	0	0	**0**	60	**0**	0	**0**	-
4ft 13W LED	0	0	**0**	60	**0**	0	**0**	-
4ft 13W LED	0	0	**0**	60	**0**	0	**0**	-
4ft 13W LED	1	13	**13**	60	**60**	0	**0**	PIR
4ft 13W LED	0	0	**0**	60	**0**	0	**0**	-
4ft 13W LED	0	0	**0**	60	**0**	0	**0**	-
4ft 13W LED	0	0	**0**	60	**0**	0	**0**	-
4ft 13W LED	0	0	**0**	60	**0**	0	**0**	-
4ft 13W LED	1	13	**13**	60	**60**	0	**0**	PIR
4ft 13W LED	1	13	**13**	60	**60**	0	**0**	PIR
4ft 13W LED	0	0	**0**	60	**0**	0	**0**	-
4ft 13W LED	0	0	**0**	60	**0**	0	**0**	-
4ft 13W LED	0	0	**0**	60	**0**	0	**0**	-
4ft 13W LED	1	13	**13**	60	**60**	0	**0**	PIR
4ft 13W LED	1	13	**13**	60	**60**	0	**0**	PIR
4ft 13W LED	0	0	**0**	60	**0**	0	**0**	-
2ft 9W LED	1	75	**75**	60	**60**	0	**0**	Ultrasonic
4ft 13W LED	0	0	**0**	60	**0**	0	**0**	-
4ft 13W LED	0	0	**0**	60	**0**	0	**0**	-
2ft 9W LED	1	75	**75**	60	**60**	0	**0**	Ultrasonic
4ft 13W LED	0	0	**0**	60	**0**	0	**0**	-
4ft 13W LED	0	0	**0**	60	**0**	0	**0**	-
4ft 13W LED	0	0	**0**	60	**0**	0	**0**	-
4ft 13W LED	0	0	**0**	60	**0**	0	**0**	-
4ft 13W LED	4	85	**340**	60	**240**	0	**0**	Daylighting
			555		**660**		**0**	

Table 7-7: Compact Fluorescent and Incandescent Lighting Project Costs Calculation ECO 4d

Replacement Replacement Fixture	Lamps/Fixture	# Fixtures	Cost/Lamp	Cost/Fixture	Total Material	Labor/Lamp	Labor/Fixture	Total Labor	Rebate/Lamp	Rebate/Fixture	Total Rebate
CFL screw-in	1	5	1	1	**5**	1.5	1.5	**7.5**	0	0	**0**
Incandescent can screw-in	1	9	14.5	14.5	**130.5**	1.5	1.5	**13.5**	0	0	**0**
Incandescent can screw-in	1	9	14.5	14.5	**130.5**	1.5	1.5	**13.5**	0	0	**0**
CFL screw-in	1	1	1	1	**1**	1.5	1.5	**1.5**	0	0	**0**
Incandescent screw-in	1	1	1	1	**1**	1.5	1.5	**1.5**	0	0	**0**
CFL screw-in	1	2	1	1	**2**	1.5	1.5	**3**	0	0	**0**
					270			**41**			**0**

Table 7-8: Exterior Type B Lighting Project Costs Calculations ECO 5a

Type C Replacement Replacement Fixture	Lamps/Fixture	# Fixtures	Cost/Lamp	Cost/Fixture	Total Material	Labor/Lamp	Labor/Fixture	Total Labor	Rebate/Lamp	Rebate/Fixture	Total Rebate
80 W Cornbulb	1	13	112	112	**1456**	40	40	**520**	0	0	**0**
-	-	-	-	-	**0**	-	-	**0**	-	-	**0**
54 W Cornbulb	1	4	48	48	**192**	40	40	**160**	0	0	**0**
8 W LED Lamp	1	2	1	1	**2**	1.5	1.5	**3**	0	0	**0**
-	-	-	-	-	**0**	-	-	**0**	-	-	**0**
					1,650			**683**			**0**

Table 7-9: Exterior Type C Lighting Project Costs Calculations ECO 5b

Type C Replacement Replacement Fixture	Lamps/Fixture	# Fixtures	Cost/Lamp	Cost/Fixture	Total Material	Labor/Lamp	Labor/Fixture	Total Labor	Rebate/Lamp	Rebate/Fixture	Total Rebate
75 W LED Fixture	1	13	-	125	**1625**	-	80	**1040**	0	0	**0**
-	-	-	-	-	**0**	-	-	**0**	-	-	**0**
50 W LED WP	1	4	-	73	**292**	-	80	**320**	0	0	**0**
8 W LED Lamp	1	2	1	1	**2**	1.5	1.5	**3**	0	0	**0**
-	-	-	-	-	**0**	-	-	**0**	-	-	**0**
					1,919			**1,363**			**0**