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The 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 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 the City of Middletown. 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 version of these goals were presented for public review from November 5th until December 31, 2019 at Middletown City Hall, as well as posted on the Community Energy Plan website at energy.oki.org.

Feedback was also solicited via two web surveys, which received 31 responses. The detailed results of the survey is shown in the Appendix of this document.

This plan will serve to organize action by the City, 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.

Overview of Middletown's Energy Strategy

The process of determining this energy strategy and goals is the work of an appointed eight member committee. The committee reviewed information and public input. They deliberated to collectively arrive at the enclosed strategy. Early in the process, the committee provided input, and adopted the following mission statement to guide the development of the plan:

MISSION STATEMENT

Middletown will prioritize the reduction of energy use to reduce costs on residents and businesses, improve the condition of homes and businesses, contribute to the revitalization of the community, and to signal the ambition that Middletown is ready to meet the challenges of the future. The City will lead by example in reducing municipal energy use, engage residents and businesses in efforts to reduce energy use in the community, and seek to prioritize energy efficiency in ways that address the community's most pressing needs.

Feedback from Public Involvement

Public feedback was solicited on a number of topics during the planning process. This feedback was primarily gathered through two online surveys. The following are the primary takeaways from the public feedback received:

- There seems to be strong support for a utility aggregation program to lower utility costs, but respondents were split with 53% supporting prioritizing the lowest cost and 40% would like to prioritize renewable energy sources, even if that costs a bit more.
- Respondents strongly support efforts to extend energy-efficiency programs to low and moderate income households, with over 56% of respondents ranking this goal as "most important" or "very important".

Complete Details of the survey responses are located in Appendix A at the end of this document.

Energy Plan Goals

Goal 1	Middletown will prioritize energy efficiency programs and improvements that provide a strong economic return on investment for the city, and its residents and businesses.
Goal 2	Improve the energy efficiency of Middletown's housing stock to save residents money and revitalize neighborhoods.
Goal 3	Utilize energy efficiency as a path to business retention and development.

Strategies

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

Residential Strategies

1	Encourage residents to modify behaviors in order to conserve energy.
2	Middletown should partner with reputable home energy efficiency providers to increase residents' awareness and access to incentives and programs that will help increase the installation of energy efficient improvements.
3	Encourage on-site renewable energy for residential buildings.
4	Middletown should address the rental property split incentive through the following actions: ○ Identify rental housing for low-income residents in the city and partner with SELF to make tenants and landlords aware of the Home Weatherization Assistance Program (HWAP) ○ Engage property owners of the handful of large apartment complexes in the community about the availability of PACE financing for improvements. ○ Increase awareness of energy efficiency as a housing market consideration among local landlords. ○ Engage renters with ways they can improve the energy efficiency, and reduce their energy bills, through simple, low-cost, and easy improvements such as LED lightbulbs, weather stripping windows and doors, managing their thermostat, and low-flow showerheads.

Commercial and Industrial Strategies

1	Encourage energy efficient upgrades to existing commercial and industrial buildings through PACE financing.
2	Improve the energy efficiency of the city buildings and operations as part of ongoing capital improvements and publicize the results to encourage similar private investments in energy efficiency.
3	Encourage on-site renewable energy for commercial buildings.

Actions

The Middletown Energy Plan encourages the City Government to commit to the following action items that will assist the city in implementation of the recommended strategies.

Action 1	Continue working to convert the City's streetlights to LED fixtures.
Action 2	Choose energy efficient vehicles when replacing vehicles in the city's fleet
Action 3	Perform recommended improvements to City Hall with high return on investment, as listed in facility energy assessment.
Action 4	Develop a checklist detailing the permits required and necessary requirements applicable to solar, wind, and geothermal installs on homes and businesses.
Action 5	Partner with the Chamber of Commerce to hold an annual PACE workshop.
Action 6	Identify rental housing for low-income residents in the city and partner with SELF to make tenants and landlords aware of the Home Weatherization Assistance Program (HWAP)
Action 7	Host a Solarize campaign in partnership with the Greater Cincinnati Energy Alliance
Action 8	Engage residents with an educational campaign to encourage energy efficiency through low-cost improvements and behavior changes.
Action 9	Work with a non-profit (Habitat for Humanity?) to develop a "model remodel" project to promote energy-efficient retrofits for existing housing.

Energy Use and Delivery

The City of Middletown is located in northeast Butler County, with a portion of the city in northwest Warren County. The city sits between the Great Miami River and Interstate 75 and maintains ties to both the Greater Cincinnati Region to the south and the Greater Dayton Region to the north. Middletown grew in the first half of the 20th century as an industrial town, with the main products being steel and paper. Today, Middletown is emerging with a more diversified economy, a burgeoning healthcare sector, and more of its residents commuting to work outside of the city. Middletown has never felt more connected to the region as the urbanized areas of Cincinnati and Dayton expand towards each other along I-75.

Electric & Natural Gas Use

A major component of a community energy plan is understanding how much energy the community uses, what land uses are 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.

Residential and commercial structures in Middletown consumed over 5.97 billion kBtus of energy in 2016 at a total cost of over $101.9 million. Figure 1 provides a breakdown of energy consumption and cost by energy source.

Fig 1: Total Energy Use and Cost, Middletown 2016 (GCEA)

	Amount Consumed	Cost
Electricity	893,250,389 kWh	$77.17 million
Natural Gas	28,627,927 CCF	$24.77 million

The residential sector accounted for 22 percent of electricity consumption in 2016 while the commercial and industrial (C&I) sectors accounted for 78 percent (Figure 2). Commercial and

industrial use is likely to remain the largest consumer of electricity in the future even if its share of overall usage declines.

Natural gas is used for space heating, water heating, and some manufacturing processes. In 2016, the residential sector accounted for 33 percent of natural gas consumption while the commercial and industrial (C&I) sectors accounted for 67 percent (Figure 3). The portion of natural gas usage attributable to the C&I sector will continue to dominate natural gas usage in Middletown given the energy intensive nature of that sector.

Because the commercial and industrial sectors dominate energy use in the community, it is essential to address actions targeted towards energy efficiency in these sectors among the goals contained in this plan.

Fig 2: Electricity Use by Land Use, Middletown 2016 (Duke Energy)

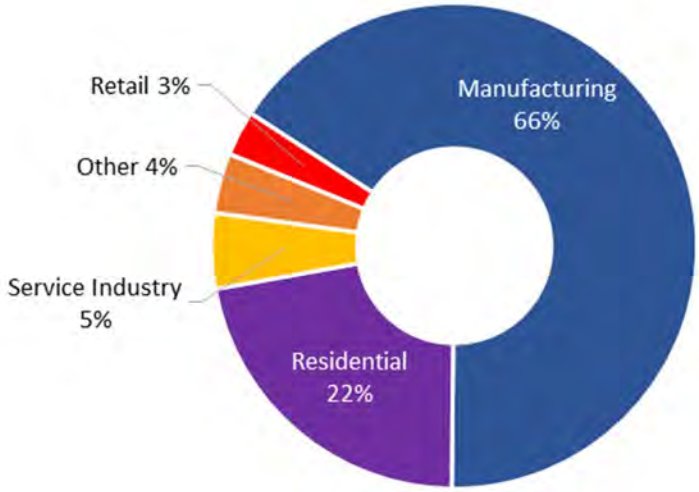
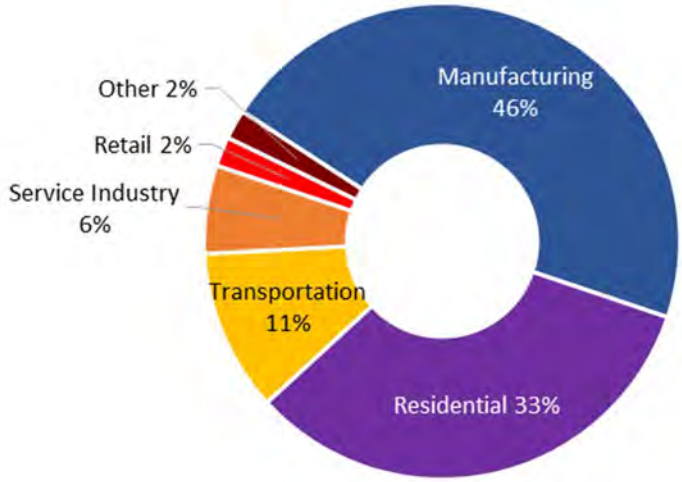


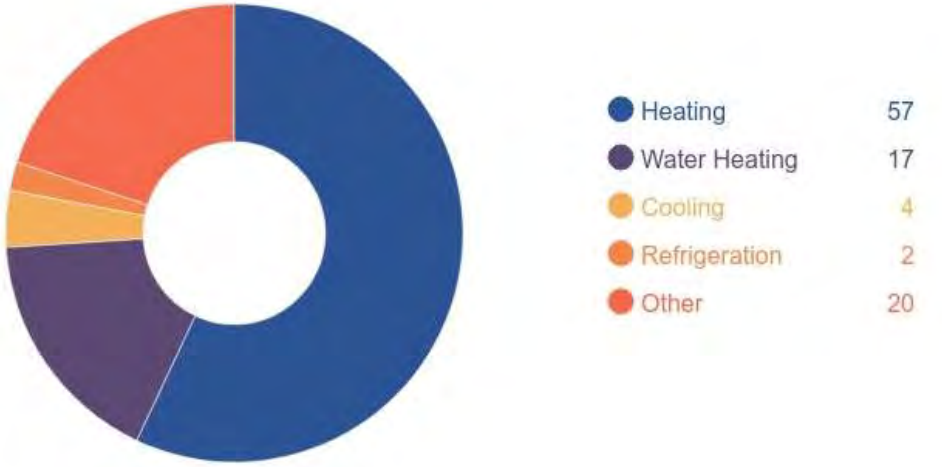
Fig 3: Natural Gas Use by Land Use, Middletown 2016 (Duke Energy)



Residential Energy Use

Residential energy use depends on the energy consuming devices used in the home and the efficiency of those devices. Natural gas and electricity are the most-consumed energy sources in residential buildings throughout Middletown. The total annual energy cost of $37.37 million equates to an average cost of $770 per capita or $1,984 per household. Improving the energy efficiency of residential buildings by an average of five percent could save residents over $1.87 million annually based on 2016 utility rates.

Fig 4: Residential Building Energy Consumption by End Use
Source: U.S. Energy Information Administration, Residential Energy Consumption Survey (RECS) 2015. Table CE3.3



Space heating accounts for the largest share of energy use in residential buildings (Figure 4). Natural gas is the most common source of fuel for heating although some buildings may use electricity. Weatherizing the home by improving insulation levels and sealing air leaks can decrease energy usage attributable to space heating. Strategies for improving the energy efficiency of homes are discussed beginning on page 21.

Fig 5: Residential Energy Consumption and Costs, 2016
(U.S. DOE City Energy Profile https://apps1.eere.energy.gov/sled/#/)

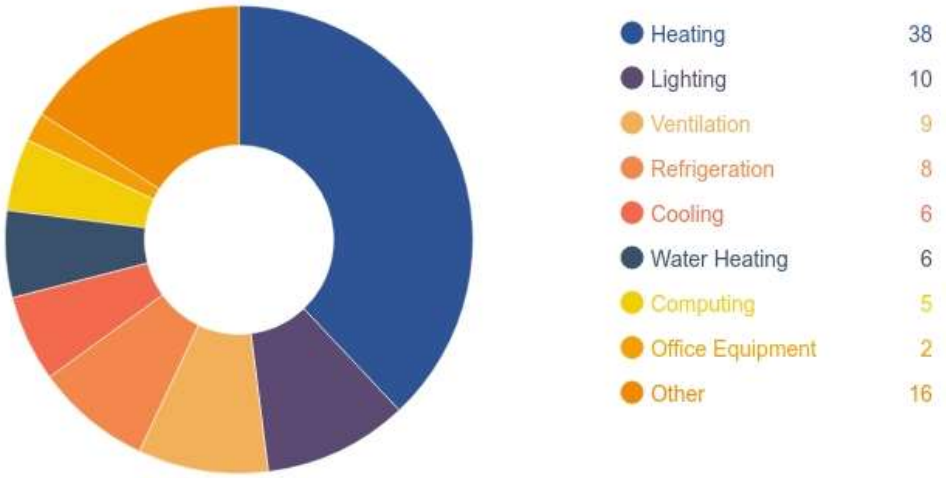
	Middletown	Peer Cities
Number of households	18,641	57,275
Average kWh per household	11,912	10,027
Average annual cost per household	$1,399	$1,306
Average CCF per household	482	555
Average annual cost per household	$585	$538

The table in Figure 5 shows that the typical Middletown home consumes 19% more electricity than the typical house found in peer cities (Findlay, Lima, and Springfield), but consumes 13% less natural gas. Even by consuming less gas, Middletown residents pay more for gas than residents of the peer cities, according to data reported by utilities to the Department of Energy.

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 6. However, the actual profile will vary depending on the type of facility.

Fig 6: Commercial building fuel consumption by end use
Source: U.S. Energy Information Administration, 2012 Commercial Buildings Energy Consumption Survey, Table E1



According to a 2015 report from 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 usage for heating by 33% and cooling by 40% (Figure 6). While only accounting for 10% of energy use, upgrading to energy efficient lighting offers a low-cost way for commercial properties to reduce their energy costs. With being low-cost, lighting and controls upgrades in commercial buildings typically supply the best return on investment of all possible efficiency upgrades.

Fig 7: Commercial and Industrial Energy Consumption and Costs, 2016
(U.S. DOE City Energy Profile https://apps1.eere.energy.gov/sled/#/)

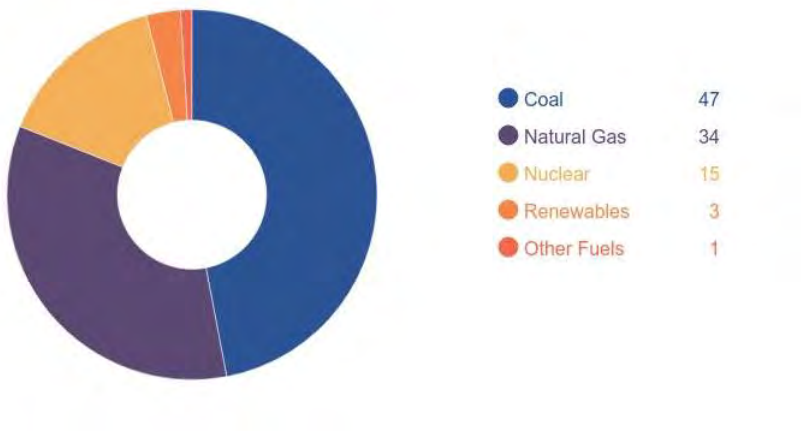
	Middletown	Peer Cities
Total C&I building area (square feet)	10,925,848	47,227,123
Average kWh per square foot	38.78	28.26
Average CCF per square foot	1.763	1.302

Green House Gas Emissions

Greenhouse gases are gases that emit radiant energy in the Earth's atmosphere and contribute to changes in global temperatures. There are a number of different greenhouse gases released into the atmosphere including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O).

The amount of greenhouse gases produced by a community can be traced in part to how its electricity is generated. In Ohio, the majority of electricity is generated by coal-fired power plants. Coal plants in Ohio are gradually being replaced by power plants fueled by natural gas which have lower greenhouse gas emissions. A 2014 study by the National Oceanic and Atmospheric Administration found that power plants fueled by natural gas release approximately 40 percent less carbon dioxide than coal-fired plants.[1]

Fig 8: Ohio Electricity Sources, 2018



The residential and C&I sectors in the City of Middletown emitted 653,791 metric tons of greenhouse gases in 2016. This figure includes emissions from electricity production as well as from the burning of natural gas for heating or industrial processes. Table 11 shows greenhouse gas emissions by source in 2016 for Middletown as compared to the average emissions of its peer communities (Findley, Lima, and Springfield).

[1] de Gouw, J. A., Parrish, D. D., Frost, G. J. and Trainer, M. (2014), Reduced emissions of CO_2, NOx, and SO_2 from U.S. power plants owing to switch from coal to natural gas with combined cycle technology. Earth's Future, 2: 75-82.

Fig 9: Annual Greenhouse Gas Emissions by Source (metric tons), 2016
(U.S. DOE City Energy Profile https://apps1.eere.energy.gov/sled/#/)

Source	Middletown	Peer Cities (Avg)
Residential	220,833	209,807
Commercial and Industrial	432,958	455,963
TOTAL	653,791	665,770

Based on total annual greenhouse gas emissions, Middletown performed better than the average of its peer cities. Its emission levels were higher for residential structures, but lower with regards to commercial and industrial usage. In order to control for potential differences in the building stock, Table 12 compares greenhouse gas emissions based on building area.

Fig 10: Greenhouse Gas Emissions (metric ton) per square foot
(U.S. DOE City Energy Profile https://apps1.eere.energy.gov/sled/#/)

Source	Middletown	Peer Cities
Residential	0.0075	0.0077
Commercial and Industrial	0.0396	0.0290
TOTAL	0.0471	0.0367

While Middletown's residential emissions per square foot are slightly below those of its peers, the commercial and industrial sector emits significantly more than its peer cities.

Energy Delivery

Duke Energy Ohio is the utility responsible for the delivery of, and billing for, electricity and natural gas for residents and businesses in the City of Middletown. Duke maintains the electric and natural gas infrastructure delivering energy to homes and businesses.

Middletown is home to the NTE Middletown Energy Center, the first turbine generator with heat recovery in Southwest Ohio. Opened in 2018, the power plant provides 475 megawatt peak generation. The plant produces electricity efficiently and on-demand. It's designed to rapidly increase or decrease production based on demand; something larger power plants are unable to do. This feature allows the plant to efficiently produce power when needed, but conserve energy

when not needed. Power plants like the Middletown Energy Center are key to expanding the use of renewable energy sources like solar or wind. When the sun doesn't shine or the wind doesn't blow, turbine power plants can quickly spool up to meet the electricity demand.

Aggregation

Ohio's deregulated energy market enables property owners to select their own electricity and natural gas providers. Communities are permitted to join their residents together to buy electricity and/or natural gas as a group to gain buying power in the marketplace. As the local utility provider, Duke Energy adds distribution charges to the rate offered through the aggregation program. Customers still receive one utility bill where the generation and delivery charges are itemized separately.

Middletown does not currently have an aggregation program for electric and natural gas utilities. There are two types of aggregation programs – opt-in or opt-out. Opt-in programs require residents to sign up for the aggregation deal to get the negotiated price; the default is that residents stay with their current energy provider. Conversely, opt-out programs automatically enroll all eligible households and businesses in the aggregation program. Customers are permitted to opt-out of the aggregation program, but must take definitive action to do so. Opt-out programs must be approved by voters. If an opt-out program is approved, the local government must formulate a plan to manage the program and hold two public hearings to take comments on the program. Opt-in programs can be enacted through the action of the city council of the local government, and do not require a direct vote at an election.

Aggregation programs are beginning to offer renewable and carbon free options in their portfolio. If the city wishes to set a goal of achieving a high percentage of energy from renewable or carbon-free sources, executing an aggregation program that targets those sources is the best way to meet that goal.

Energy Resiliency

Resiliency is how susceptible a community is to threats, and how capable they are in overcoming threats when they do occur. In regards to energy infrastructure, there are a number of common, and not so common events that may test the resiliency of the system. First and foremost on this

list are weather events that can impact above-ground power and communications networks. Wind and ice events are the most common phenomenon that have the ability to impact utility networks. Underground utilities are also susceptible to disruption by shifting ground or by accidental damage from construction activity.

There are three components to a resilient energy system: prevention, recovery, and survivability[2].

Prevention **-** This is about preventing damage to the distribution system. Damage can occur in numerous ways. The most common are as the result of 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 **-** Recovery is about how the community and the utility works 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 the utility companies is essential to identifying and assessing locations where disruption of the network occurred and how to get utility crews to those locations. Coordination is often required between local responders and utility crews on dealing with downed trees or accident scenes.

The Butler County Emergency Management Agency (EMA) maintains an emergency response plan, and provides information to local governments to prepare their own emergency response plans. Regarding energy, the county emergency response plan designates the local community responsible for assessing local conditions, areas affected by shortages or outages, communication and coordination with utilities regarding outages and facilities of high priority, communication with residents and businesses providing energy information and recommending actions to conserve energy. Middletown coordinates with the Butler County EMA and is equipped to perform the necessary functions in the event of a significant energy outage.

[2] 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 is allowing for distributed generation (privately owned solar panels and wind turbines). Given the proper setup, these facilities can be of use in a power outage situation, but also can pose a risk to utility crews working to repair the electric grid. In an outage situation, distributed solar panels or wind turbines could push power out onto the electric grid, which would endanger workers working to repair the grid. Typical solar and wind power systems are not equipped to provide backup power in the event of an outage. It takes a sizeable battery to be able to use solar or wind generation as an emergency power source.

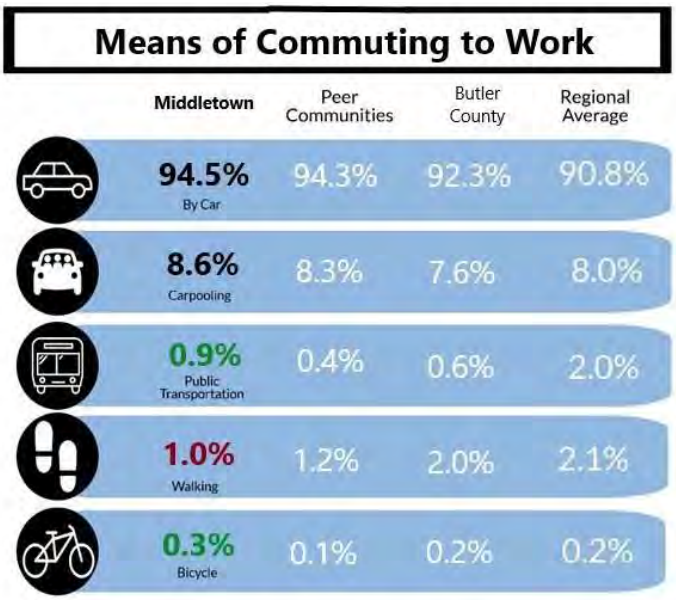
Transportation and Land Use

Transportation Energy Use

Measuring energy use 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 US 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 the cities of Hamilton, Lebanon, and Springboro.

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.

Fig 11: Means of Commuting, Middletown 2017 (American Community Survey 2012-17)



Peer Communities: Cities of Hamilton, Lebanon, and Springboro

Middletown residents predominantly commute to work by car, which mirrors peer communities, the county, and region as a whole. Where Middletown excels is in the use of public transportation and bicycling to work, which both exceed peer communities. Walking is not as popular with Middletown workers, but only slightly below peer communities. Middletown currently requires in its subdivision regulations that pedestrian connections be provided in the middle of long blocks. These connections allow pedestrians to take more direct routes to their destination, increasing the feasibility of walking as a transportation choice.

Urban Heat Island

The urban heat island effect is created by impervious surfaces, such as roads, parking lots, and buildings, which retain heat from the sun's radiation. At night, these surfaces release the retained heat, creating a localized area of higher temperatures. Localized "hot-spots' combine to create a dome of hot air over a metropolitan area.

Impervious surfaces causing increased heat values:

- Dark roofing material
- Parking lots
- High concentration of buildings
- Lack of tree canopy

The phenomenon impacts energy use, particularly in the summer months, when air conditioners forced to run more often, and for longer periods of time due to the increased air temperatures.

In Middletown, there are several areas of concentrated high temperatures, as seen in the map in Figure 13. These areas correspond with areas dominated by large buildings and parking lots combined with a lack of trees. Conversely, residential areas in Middletown display cooler tones due to less concentrated impervious surfaces and more trees.

In fact, the prevalence of tree cover in a community is found to be the leading indicator of heat island effect. The chart below shows the clear relationship between the two.

Fig 12: Relationship between Urban Heat Islands and Tree Cover (OKI)

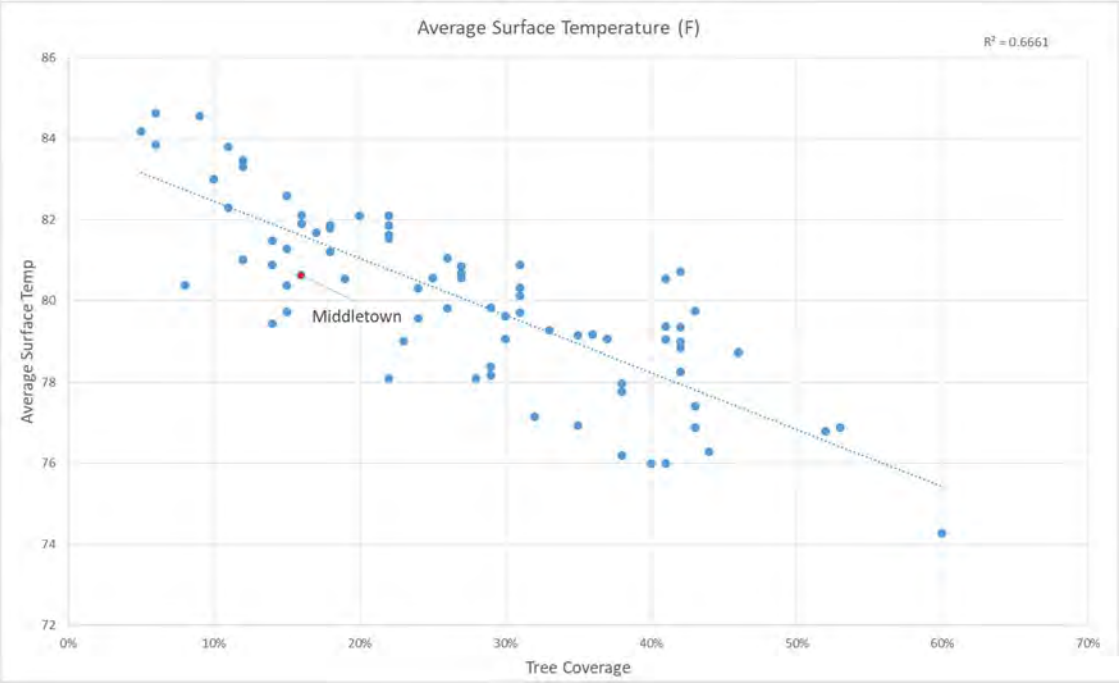
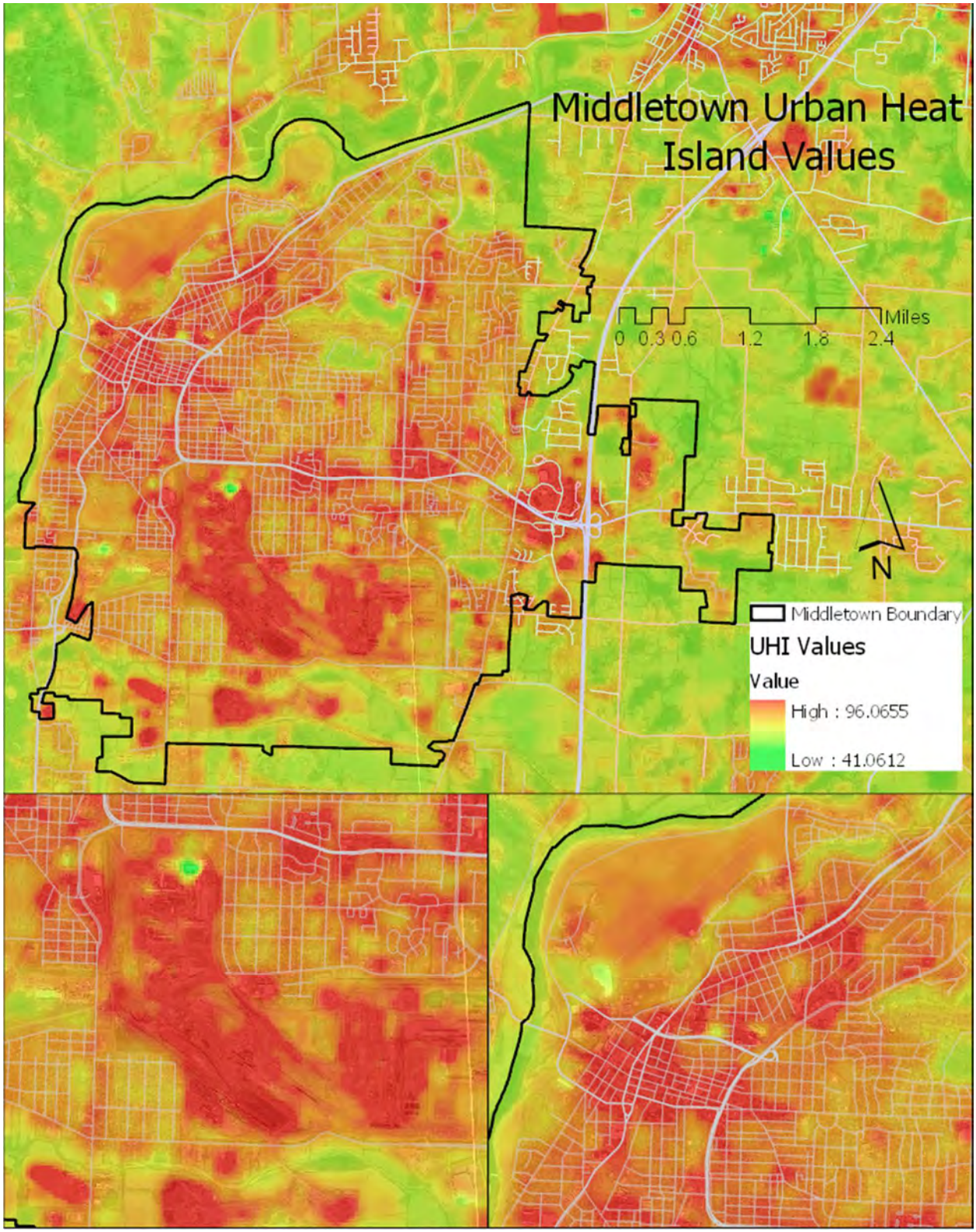


Fig 13: Middletown Urban Heat Island (OKI)



The best ways to combat the urban heat island effect is by limiting the amount of large The

The best way for a community to reduce the size and impact of urban heat islands is to preserve and promote the urban tree canopy. As a Tree City USA city for twelve years running, Middletown is dedicated to doing this. Middletown currently has a tree preservation ordinance. Also, developers are required to provide trees along new street and in and around new parking lots. These trees provide shade that prevents asphalt surfaces from absorbing excessive amounts of radiant heat from the sun, while also directly cooling the air through evapotranspiration.

Middletown also encourages the use of green infrastructure techniques as part of its stormwater management strategy. Green infrastructure utilizes natural features and components to absorb, filter, and direct stormwater runoff. This takes the form of raingardens, bioswales, or specially designed landscaping elements that reduce the amount of runoff from a site or from adjacent roadways.

Recycling

Recycling is another community activity that can significantly reduce energy use. Many of the products and packaging we use and throw away everyday can be recycled. Recycling an item is often a less energy intensive process than making new items from virgin materials[3].

Here are the typical energy savings for recycling certain materials:

- Glass: 10 – 15% energy savings
- Aluminum: 94% energy savings
- Iron and Steel: 72% energy savings
- Plastics: 55 – 65% energy savings
- Paper: 64% energy savings

Middletown provides trash removal service to residents via a contract with Rumpke. This contract includes curbside recycling service. Rumpke offers the ability to track recycling volume in the city. Over time, this data can be used to track trends and to set goals related to rates of recycling. Also, Middletown is home to one of the largest metal and electronics recycling companies in the region – Cohen USA.

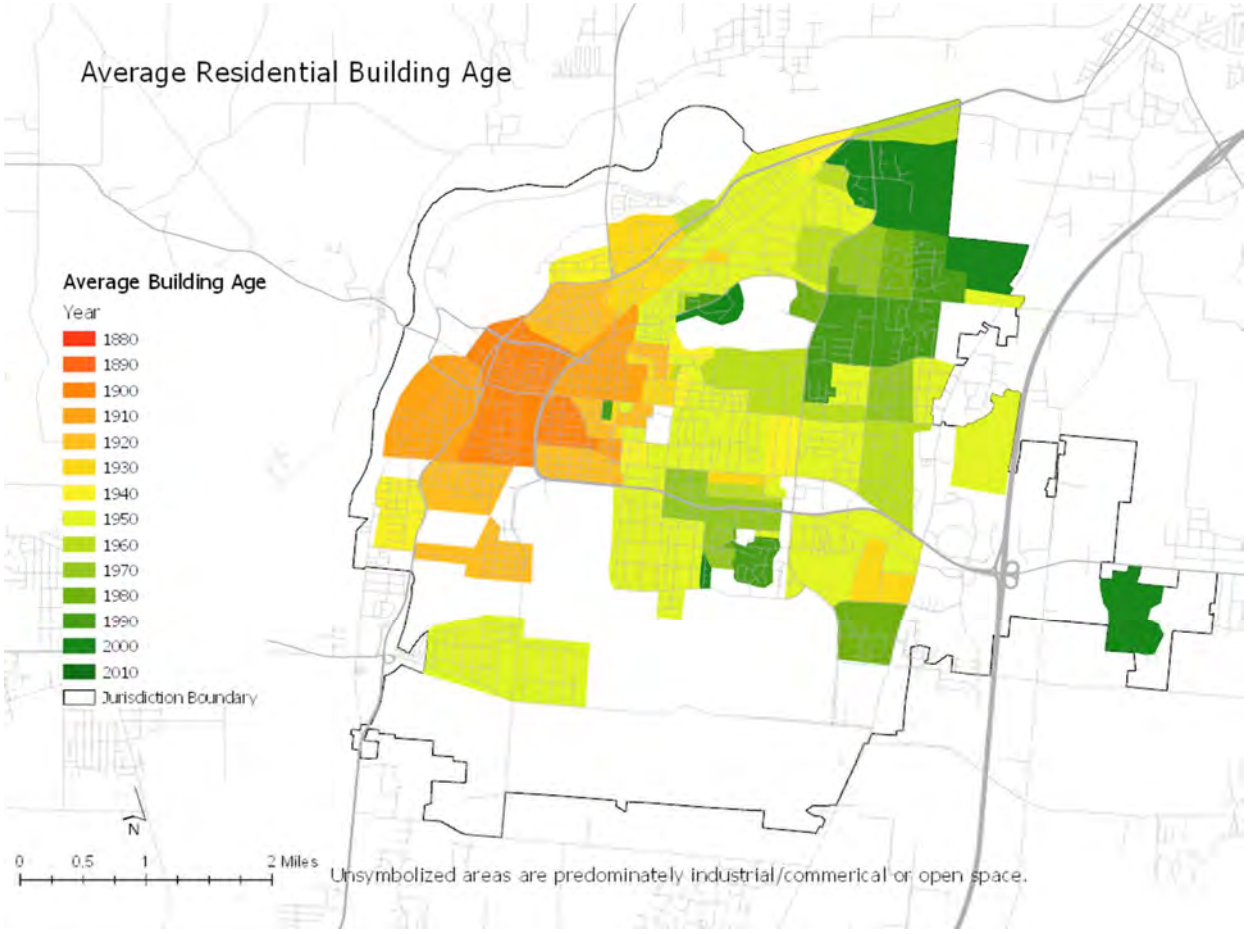
[3] The American Geosciences Institute. How does recycling save energy?. https://www.americangeosciences.org/critical-issues/faq/how-does-recycling-save-energy, accessed 5/17/19

Residential Energy Efficiency

The City of Middletown contains over 21,000 residential housing units according to the American Communities Survey. These buildings offer significant opportunities to reduce wasted energy 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.

The City of Middletown contains a diverse housing stock that has developed over time. The City has concentrations of older homes from the 1890s to 1920s along its western border near the historic urban core. As one moves east from this area, the homes become progressively younger as they transition from 1950s post-war construction to newer homes built in the 2000s.

Fig 14: Average Residential Building Ages City of Middletown (OKI)



Approximately 88 percent of residential housing units were built prior to 1990 when building codes began to require energy efficient construction practices.

Residential Energy Improvements

Buildings built within the same decade share characteristics that impact their overall energy efficiency. Older homes present significant opportunities to reduce energy usage and improve comfort since they were not designed with energy efficiency in mind. 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.[4]

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.

Fig 15: 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 Middletown.

	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	●	●	●	●	●		

[4] Joint Center for Housing Studies of Harvard University, 2007.

Crawlspace Insulation	Low	High	●	●	●	●	●		
Wall Insulation	High	High	●	●	●	●			
Heating Systems	High	Medium	●	●	●	●	●	●	●
Cooling Systems	High	Medium	●	●	●	●	●	●	●
Windows	High	Low	●	●	●	●	●	●	
Areas above unconditioned spaces	Low	High		●	●	●	●	●	
Knob and tube wiring	Medium	NA	●	●					
Asbestos	High	NA		●	●	●			
Vermiculite	High	NA			●	●			

Appendix B, provides an overview of the different types of energy efficiency improvements needed by residential properties in Middletown based on when they were constructed.

Middletown residents who responded to the survey show that making energy efficient improvements to their homes is a priority. Topping the list of improvements is changing out old lightbulbs for new LED bulbs – 97% of survey-takers reported that they have made this improvement. Nearly 40% said they have installed extra attic insulation and almost 50% have upgraded to a high efficiency furnace or air-conditioner. 40% of respondents indicated they have installed energy efficient doors or windows. It is important to note that most residents who responded to the survey are homeowners. Only 10% of respondents are renters which is significantly less than the 48% rental rate in Middletown.

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.[5]

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

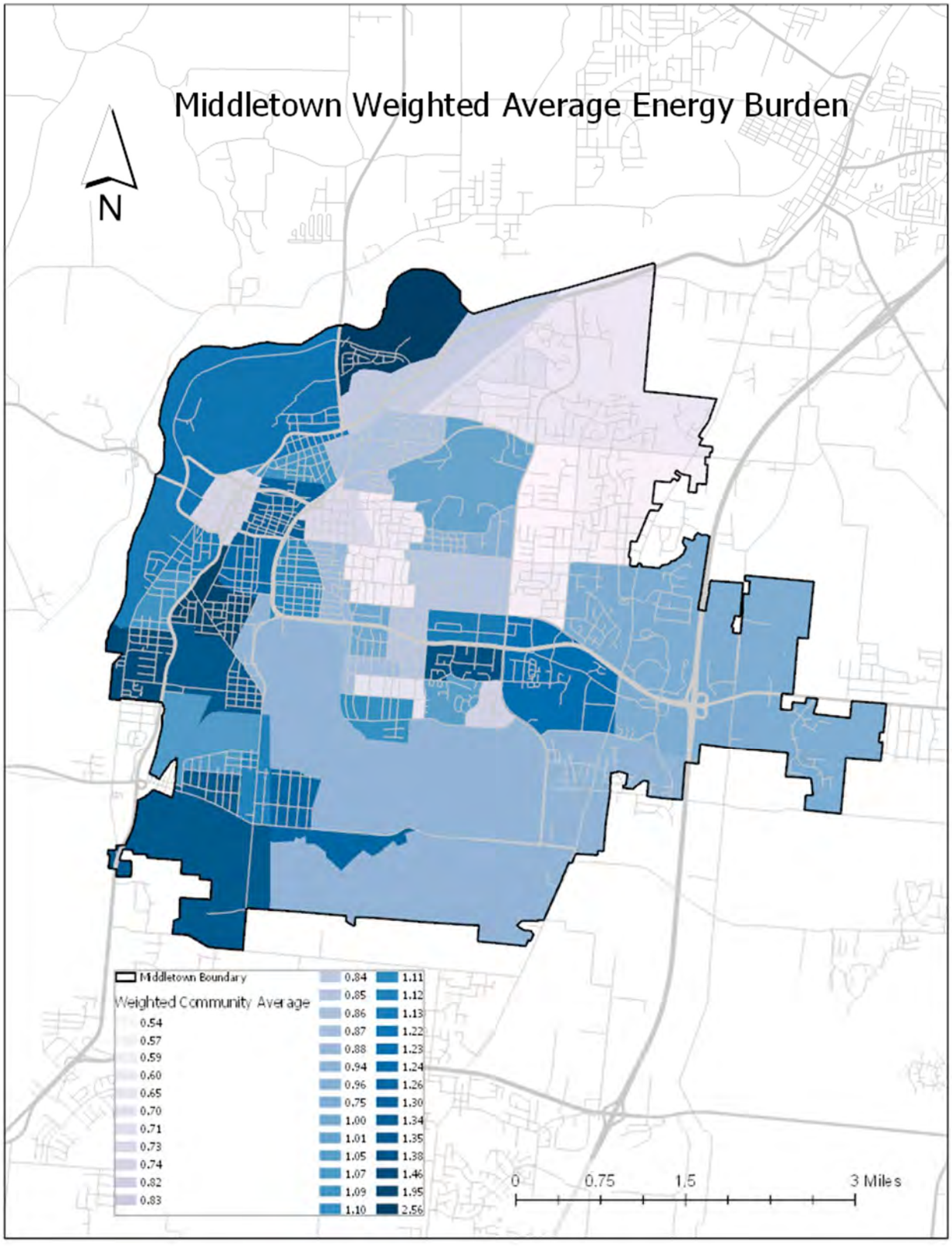
Households that face high energy burdens experience many negative long-term economic and health related burdens. Research has found that there are three separate but interrelated consequences of energy burden: (a) illness and stress, (b) financial challenges, and (c) housing instability.[6]

Fig 19: Drivers of household energy burden
Source: ACEEE, Lifting the High Energy Burden in America's Largest Cities, April 2016

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 programs
Behavioral	Lack of access to information about bill assistance or energy efficiency programs Increased energy use due to age or disability

[5] Drehobl and Ross, 2016
[6] Hernandez and Bird, 2010

Fig 20: Relative Energy Burden by Census Block Group (OKI)



Residential utility data from 2016 was obtained from Duke Energy and used to determine average annual utility cost per household at the census block group level. The utility data provided included the total number of residential accounts in each census block group as well as the total amount spent on residential utilities. In order to determine the average annual household utility cost, the total amount spent on utilities was divided by the number of accounts. The average annual household utility cost per census block group includes all applicable fees and riders as well as generation and distribution costs.

The U.S. Census Bureau's American Communities Survey was used to obtain median household income data at the census block group level. Energy burden was calculated at the census block group level by dividing the average annual utility cost per household by the median household income. A neighborhood energy burden figure was then calculated by finding the weighted average energy burden across the census block groups in each neighborhood. This was done to remove the impact of different size census block groups on calculations at the neighborhood level.

Areas with high energy burden in Middletown, represented by darker colors on Figure 4, appear to be concentrated in the census block groups along the western edge of the city as well as along Roosevelt Boulevard. These areas contain some of the oldest housing in the city. The information shown in the map can be used to guide efforts to identify areas with a high energy burden and provide them with programs that can improve energy efficiency and reduce costs.

The median energy burden across all census block groups in the City of Middletown is 4.6%. Low-income census block groups are those that have a median household income equal to or less than 80% of the median household income for all census block groups in the city. There are 7 census block groups that fall into the low-income category based on this definition. The median energy burden in these census block groups is 6.34%.

Neighborhood Energy Burden Analysis

There are 5 neighborhoods in the City of Middletown with weighted energy burden levels greater than six percent, which is considered the threshold for energy poverty. The neighborhood with the highest energy burden is Riverside Village with a rate of 11.78%. This value may be high due to the large number of mobile homes that form the housing stock in the neighborhood. Mobile homes tend to be extremely inefficient and often have a high utility usage per square foot. Appendix D provides an overview of the energy burden values for all neighborhoods in the city.

Fig 22: City of Middletown neighborhoods with weighted energy burden above 6%

Neighborhood	Weighted Energy Burden
Riverside Village	11.78%
Douglas	6.71%
Prospect	6.35%
Meadowlawn	6.24%
Church	6.11%

Strategies to address Energy Burden

A 2018 report from the Environmental Defense Fund found that there are ways to help overcome many of the causes of energy burden in low-income households. Increasing investment in energy efficiency services for low-income households would help create healthier and more resilient communities, saving energy, and lowering bills for customers who need it most.[7] While there are a number of solutions that should be pursued at the state level, this three strategies listed below can be implemented at the local level.

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.[8]

Deploy resources to address health and structural issues
Up to 15% of low-income households nationwide may be unable to participate in weatherization programs due to health and safety issues in the home, such as mold or leaky roofs, which prevent programs from installing energy saving improvements.[9] The city and its partners should work to identify funds to address health and structural issues so that more homes can qualify for weatherization programs.

[7] Environmental Defense Fund, 2018
[8] Hernandez and Bird, 2010
[9] Environmental Defense Fund, 2018

Rental Housing and Energy Efficiency

Rental housing poses a unique challenge to improving the energy efficiency of residential buildings. This stems from the fact that owners of rental housing do not have an economic incentive to improve the energy efficiency of their buildings since they will not reap the financial benefits of the improvements. This results in what is known as a split incentive. It occurs when one party owns the property and can make significant investments in its energy efficiency; but the benefits of those improvements go to another party (the renter). This situation results in neither party having a significant interest in investing in the energy efficiency of rental properties.

While there are a number of solutions that can be pursued to address the split incentive issue, the majority of research has focused on the three strategies listed below.

Incentives

Designed to encourage investment by offering grants, loans, or rebates to offset the costs of energy efficiency improvements. The value of the incentive needed to overcome the split incentive problem is extremely high. While incentives are a popular mechanism to encourage investment in energy efficient improvements among homeowners, they have not shown to be effective when applied to rental housing.

Transfer of Benefits Agreements

Allows a share of the utility savings experienced by the renter to flow back to the landlord, thus providing an economic incentive to invest in energy efficiency. This provides the renter with a more comfortable and efficient space and the landlord with a return on their investment. However, it is difficult to predict the value of the resulting energy savings so a high level of trust is required between the two parties.

Residential Energy Conservation Ordinance

An ordinance passed by a local or state government that requires the owner of an applicable residential property to document a minimum standard of energy efficiency when a property is sold. The benefits of a RECO ordinance is that it sets and enforces a minimum standard of energy efficiency.

More information about each strategy to overcome split incentives is available in Appendix C.

Addressing the split incentive problem is an important way for Middletown to make significant strides in boosting residential energy efficiency. According to a 2016 study by the American Council for an Energy-Efficient Economy (ACEEE), the median renter experiences an energy burden greater than that of the median low-income homeowner.[10] Figure 17 shows the five neighborhoods with the highest percentage of renters in Middletown.

[10] Drehobl and Ross, 2016.

Fig 17: City of Middletown neighborhoods with highest percentage of rental units[11]

Neighborhood	Percentage of Rental Units
Downtown	99.0%
Church	79.2%
Oakland	67.4%
Douglas	66.4%
University	64.0%

Programs to Boost Residential Energy Efficiency

The City of Middletown 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 B.

In addition to leveraging existing programs, Middletown 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 in order for them to produce their desired outcomes.

Incentive Programs

Middletown could offer incentives or rebates to residents who install certain energy efficiency measures. This approach helps to reduce the costs associated with installing energy efficiency improvements. It is important to develop program guidelines to ensure that incentive programs produce the desired outcome. The guidelines could limit the types of measures for which the incentive could be used (e.g., insulation and air sealing only) or limit who is eligible to access the incentives (e.g., income-based criteria). Failure to create proper guidelines will likely result in the incentives being utilized by homeowners who would have made the improvements even if the incentives were not available. Middletown will need to identify funds on an annual basis to support the program in order to ensure that it has a lasting impact.

Education and outreach

Middletown 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. Middletown could work

[11] Freeman, Heard, and Crawford, 2016.

with Duke Energy or local home improvement and hardware stores to donate basic weatherization items such as weather stripping and spray foam to be included in a weatherization kit provided to workshop attendees. Building on the success of free smoke alarm programs run by fire departments across the country, Middletown could provide inexpensive programmable thermostats to attendees. Volunteers or city officials would need to follow-up with workshop attendees to ensure that any materials provided are installed.

Community Reinvestment Areas

Middletown could leverage the Ohio Community Reinvestment Area (CRA) program to provide purchasers of properties with an incentive to make energy efficiency improvements. A CRA currently exists for downtown Middletown. Depending on its boundaries, it could be expanded to include other areas within the city. Property owners that improve the energy efficiency of a residential structure to a certain level could receive a property tax exemption for a set period. A CRA would not require the identification of funding, but it would result in a decrease in property tax revenue.

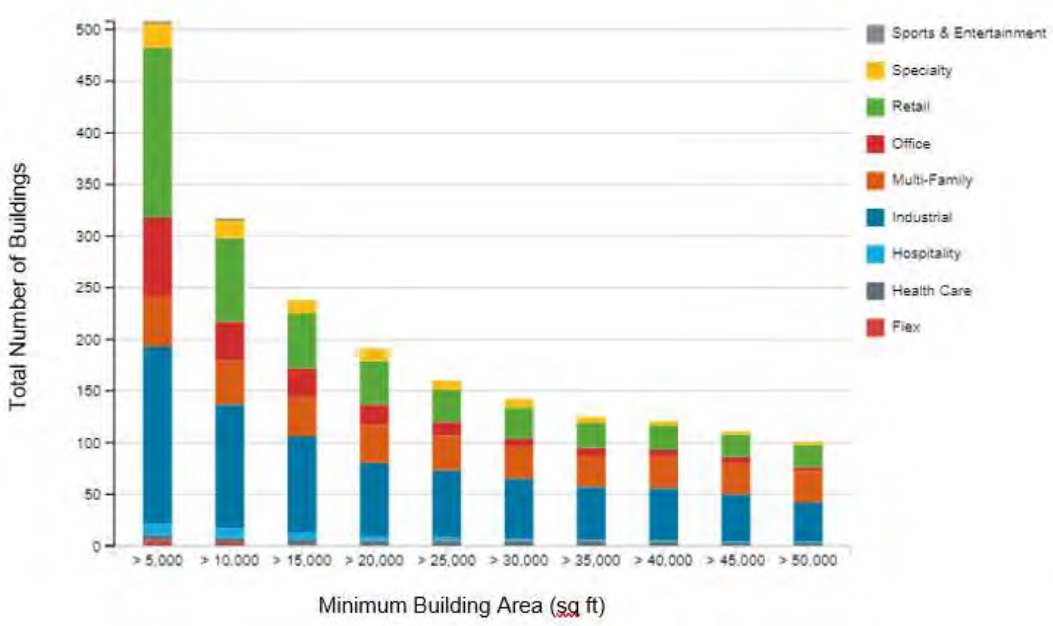
Commercial, Industrial, and Government

The City of Middletown has approximately 2,000 commercial and industrial buildings with a building area of over 10.9 million square feet.[12] These buildings offer significant opportunities to reduce energy waste and save money on annual utility costs.

Commercial and Industrial Building Stock

Middletown contains a wide variety of commercial and industrial buildings. Understanding the composition of the building stock can help Middletown assess the impacts of different policies and programs that it may implement. Retail and industrial manufacturing are the two most prevalent building uses across all square footage categories in the commercial and industrial sector. Approximately half of the buildings in the commercial and industrial sector are less than 15,000 square feet in area.

Fig 23: Commercial and Industrial buildings by floor area[13]



[12] U.S Department of Energy, 2016. *State & Local Energy Data.*
[13] U.S Department of Energy, 2016. *State & Local Energy Data.*

Steel manufacturing is the largest consumer of electricity and natural gas in the industrial sector. It uses ten times more electricity and three-and-a-half times more natural gas than the next closest industrial activity. Distribution and supply chain facilities are the largest consumers of electricity in the commercial sector while hospitals are the largest consumer of natural gas.

Fig 24: Largest commercial and industrial sector consumers of electricity and natural gas[14]

Electricity Use	Category	Number of Establishments	Total Electricity Use (MWh)
Primary Metal Manufacturing	Industrial	3	144,669
Merchant Wholesalers, Durable Goods	Commercial	32	16,463
Paper Manufacturing	Industrial	6	15,028
Non-store Retailers	Commercial	5	13,153

Natural Gas Use	Category	Number of Establishments	Total Natural Gas Use (Mcf)
Primary Metal Manufacturing	Industrial	3	1,092,173
Petroleum and Coal Products Manufacturing	Industrial	2	296,701
Paper Manufacturing	Industrial	6	76,512
Hospitals	Commercial	1	45,790

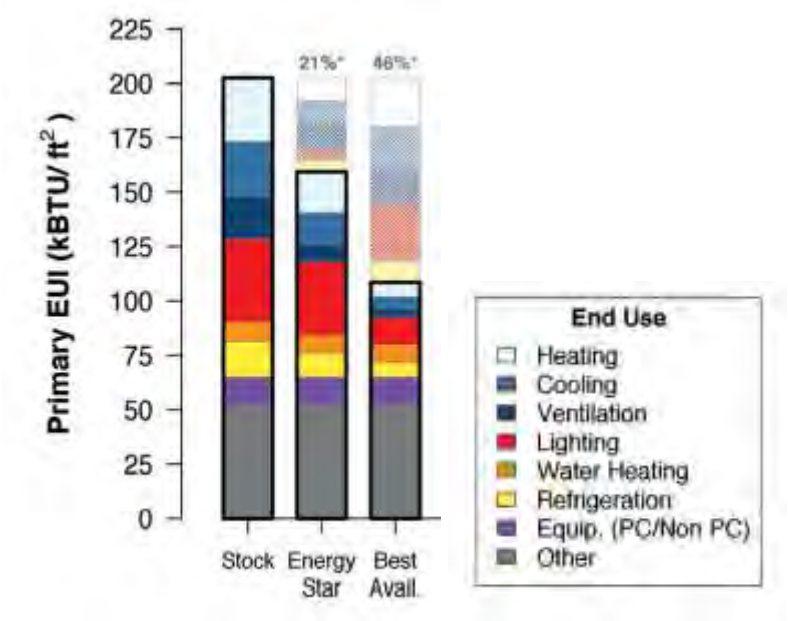
Commercial and Industrial Energy Improvements

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

[14] U.S Department of Energy, 2016. *State & Local Energy Data.*

percent. Upgrading to the best available technologies could reduce energy consumption even further and reduce consumption by up to 46 percent.

Fig 25: Potential Commercial Energy Savings by Improvement Type[15]



While the commercial and industrial buildings in Middletown vary in age and usage, there are several improvements that any building can do 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 attributable to lighting 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

[15] U.S. Department of Energy, 2015. page 146.

storefront to a more advanced computer-based system in larger facilities. With respect to lighting, property owners can utilize occupancy sensors, timers, and other controls to ensure they are not lighting areas that are not in use.

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 in order to maximize energy savings.

Municipal Energy Use

The City of Middletown relies on electricity and natural gas to power governmental functions ranging from facilities and street lighting to parks and water treatment. The largest consumer of energy used to provide governmental services is water and sewage treatment. It uses three times the energy of all other city services combined.

Fig 26: City of Middletown municipal energy consumption by end use 2018

	Percentage of electricity usage
Water and sewage treatment	76.78%
Facilities	17.91%
Streetlights	3.66%
Parks	1.21%
Uncategorized	0.44%

Street Lighting

Street lighting plays an important role in economic growth and community safety. On average, street lighting accounts for as much as 40 percent of a municipality's electric bill. In the case of Middletown, street lighting accounts for 4.32 percent of total governmental electricity

consumption. When water and sewage treatment is removed from the calculation, street lighting accounts for 28 percent of electricity consumption.

Fig 27: City of Middletown governmental electricity consumption by end use

	Percentage of electricity usage	Percentage of electricity usage without water and sewage
Water and sewage treatment	84.19%	-
Facilities	9.68%	62.36%
Streetlights	4.32%	27.82%
Parks	1.30%	8.37%
Uncategorized	0.52%	3.33%

Switching to energy efficient street lighting that utilizes LED technology could help Middletown reduce its electricity demand for lighting by 50 percent or more. LED bulbs last longer and offer significant maintenance and operational benefits when compared to existing high-intensity discharge (HID) sources.

Decision-makers often cite the upfront costs of LED technology as the most significant roadblock toward prospective street lighting conversions. Conversions to LED technology should be evaluated using a full life cycle cost/benefit analysis. The U.S. Department of Energy offers a lighting retrofit analysis tool though its Better Buildings Outdoor Lighting Accelerator to assist local governments with this process.[16]

The Outdoor Lighting Accelerator created the decision tree shown in Appendix E to help local governments determine the best way to pursue lighting projects. One of the first steps is to determine who owns the street lights. Currently, street lights in Middletown are owned by Duke Energy. This means that the city would need to work directly with Duke Energy to purchase and install the fixtures.

Middletown should evaluate the cost effectiveness of any proposal for street lighting improvements it receives from Duke Energy. Switching to LED fixtures should have a relatively short payback. If Duke Energy's proposal has what Middletown deems an excessive payback period, then there may be other replacement options it could pursue. Some local governments

[16] U.S. Department of Energy, 2016. *Outdoor Lighting Accelerator Toolkit*.

are purchasing the street lights back from their local utilities and financing the improvements through arrangements with an energy service company (ESCO). Funds are repaid through guaranteed savings achieved by the contractor. Another tool offered by ESCOs are tax-exempt lease purchases (TELP). Lease payments are made through the energy savings resulting from the lighting upgrades. TELP agreements are lease-to-own, so the local government will take control of the lighting at the end of the agreement.

Facility Assessment

Graphet Data Mining conducted an energy audit of the Middletown City 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 city building used just under $200,000 in natural gas and electricity during the twelve-month period examined. Electricity represents the largest utility cost as well as the largest energy source consumed. An analysis of the data showed that Middletown is paying $0.072 per kWh for electricity which is a competitive rate. On the natural gas side, Middletown is paying $13.90 per MMBtu which is on the high side. The city should ensure that it obtains competitive rates in its future utility contracts.

Fig 28: Middletown City Building Energy Usage

	Amount Consumed	kBtu Equivalent	Cost
Electricity	1,751,356 kWh	5,975,876	$125,455
Natural Gas	47,833 ccf	4,879,000	$67,840

The city building's occupancy varies throughout the day due to its mixed uses. The portion of the building that houses the Police Department is occupied 24 hours a day while the administrative offices are used primarily during traditional business hours. In addition, the council chambers are used in the evenings for meetings. This results in a building dynamic that must be properly managed in order 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:

Interior lighting

The city building contains approximately 1,540 lighting fixtures, of which an estimated 75 percent utilize fluorescent tubes. Building staff are in the process of switching the fluorescent

tubes to energy saving LED bulbs, but are doing so only when the existing fluorescent bulb is in need of replacement. Graphet recommends that the city convert all of the remaining fluorescent bulbs to LED as soon as possible. By converting to LED bulbs, the city could save an estimated $10,800 to $12,000 in electricity costs annually.

HVAC controls

The city recently replaced the hot water boilers in the city building which should result in significant energy savings. However, additional programming on the control systems is needed to maximize the operational efficiencies of the new system. Boiler unit one is a modulating boiler which can adjust the amount of heat it provides based on need. Boiler unit two does not modulate so it is only able to run at full capacity. The city should work with Trane to update the system controls to allow the lead boiler to be determined based on the amount of heat required. In the fall when minimal heat is required, unit one would be the only boiler used. In the winter when temperatures get colder, boiler two would become the lead unit and boiler one would modulate its heat production based on the amount required. This ECO is estimated to save $2,000 to $2,500 annually.

Install variable frequency drives on boiler pumps

The existing boiler pumps run at full speed once the supply temperature reaches 160°F. Installing variable frequency drives (VFD) on the boiler pumps will allow the controls to be more tightly tuned since the amount of power required is dictated by flow and pressure. This can result in significant savings due to the fact that VFDs can use less than half the power of full speed drives. This ECO is estimated to save $1,500 to $2,000 annually.

Implement load sharing strategy for chillers

The current chilled water pumps and fans are set to run until they reach maximum output, at which time a second pair is turned on to help meet the additional load. Load sharing would allow multiple pumps and fans to operate at lower speeds at the same time and then ramp up as needed. By operating at lower speeds, less power is required. The city should work with Trane to update the chiller control system to incorporate load sharing. This ECO is estimated to save $2,500 to $3,500 annually.

Adjust operation of the air handler units during unoccupied hours

The air handler units in the city building are currently set to operate 24 hours a day, 365 days a year. Shutting off the air handler units that serve areas with significant hours of unoccupied time could result in significant savings. The city should determine what hours it feels are acceptable to shut off the air handlers and then work with Trane to program the controls system. This ECO is estimated to save $4,100 to $5,200 annually if the units are shut off from 5:00 PM to 5:00 AM. Actual savings may be less based on the number of hours the city decides to shut off the air handlers.

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

Fig 29: Energy Conservation Opportunities for the Middletown City Building

ECO	Priority	Investment Required	Estimated Annual Cost Savings
Modulate hot water boilers	High (Operational)	Minimal	$2,007 - $2,509
Install VFD on boiler pump	High (Investment)	Low	$1,552 - $1,940
Replace chiller 2	High (Investment)	High	$4,301 - $5,377
Load sharing for chillers	High (Operational)	Minimal	$2,445 - $3,413
Interior LED lighting retrofit	High (Investment)	Medium	$10,786 - $11,984
Replace ground mounted plaza lights with LED fixtures	High (Investment)	Medium	$2,129 - $2,365
Align air handler unit operations with building occupancy patterns	High (Operational)	Minimal	$4,164 - $5,205
Install energy efficient windows	Low (Investment)	High	$3,980 - $4,972
Install VFD on hot water pumps	Low (Investment)	Low	$310 - $387
Boiler stack heat recovery	Low (Investment)	Medium	$1,423 - $2,847

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 2019, Duke Energy 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.

Renewable Energy

The majority of energy used by Middletown residents and businesses is produced by coal or natural gas power plants. While these forms of energy are relatively cheap, they generate air pollution and releases large amounts of greenhouse gas. The American Lung Association's annual *State of the Air* report ranked Cincinnati 27th for the number of high ozone days and 18th for annual particle pollution out of over 200 metropolitan areas.

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 – solar, wind turbine, or geothermal. Also, these energy sources provide power with no emissions. To be fair, there are also some distributed generation sources that are based on combustion and do involve emissions; such as municipal solid waste incinerators and gas turbine generators, like the recently opened Middletown Energy Center. 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, because it is located closer to the point of use, distributed generation reduces line losses from the transmission of electricity over longer distances.

The public benefits of distributed generation are strong enough that the California Energy Commission now requires all new homes in the state be equipped with solar panels. 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.

Renewable energy offers clean, sustainable, and increasingly cost-competitive sources of energy. The two renewable sources that can be installed at the local level are solar and geothermal.

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 $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.

Fig 30: Solar panels are adaptable to most roofing types

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 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. Homeowners and commercial property owners can ensure that their system is designed and installed correctly by working with solar companies that have NABCEP certified employees on staff.

Currently, there are four properties in Middletown – two residential and two commercial – that have solar arrays registered with PUCO. Also, two out of the 11 takers of the Middletown Energy Plan Survey who responded indicated they plan to install solar or wind generation in the next two years.

As part of a previous project, OKI built tool that estimates the solar potential of rooftops in the region. The tool is open for anyone to use at https://solar.oki.org . Many of the rooftops of commercial buildings show very good potential for solar.

One of the biggest potential barriers to solar energy use is the failure of local zoning codes to clearly state what types of solar energy systems are permitted in different locations. Middletown has already set clear procedures for permitting solar energy in Section 1206.01(e)(21) of its

development code. The code provides guidelines for installing ground-mounted or roof-mounted solar energy systems and is not overly restrictive in its language.

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

- **Launch a Solarize Campaign –** The Village of Silverton currently partners with the Greater Cincinnati Energy Alliance to bring solar to its residents and businesses. Solarize 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.

- **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.

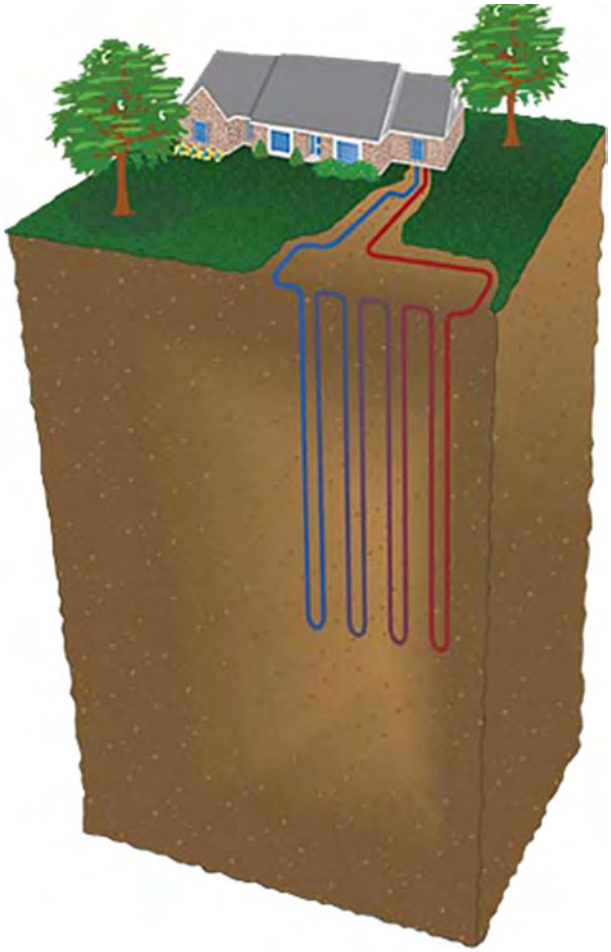
  The checklist should include all the information that Middletown residents and businesses are required to provide in order to receive a permit for a solar installation. The Warren County Building & Zoning Department currently has a FAQ page dedicated to solar and wind power which Middletown could use a resource when developing its own page. The page should provide basic information on the solar permitting process and include the checklist for reference.

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's 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.

Fig 31: Geothermal systems use the consistent temperature of the earth to more efficiently heat and cool buildings



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 electric resistance heat or a gas furnace that can turn-on 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.

Appendix A: Middletown Energy Survey Results

There were two surveys conducted as part of the Middletown Energy Plan. This first survey, conducted in August 2019 was targeted to South Middletown residents and was distributed through the Middletown Community Building Institute. This survey received 15 responses. The Middletown Energy Survey was launched in November 2019 and promoted in the following ways:

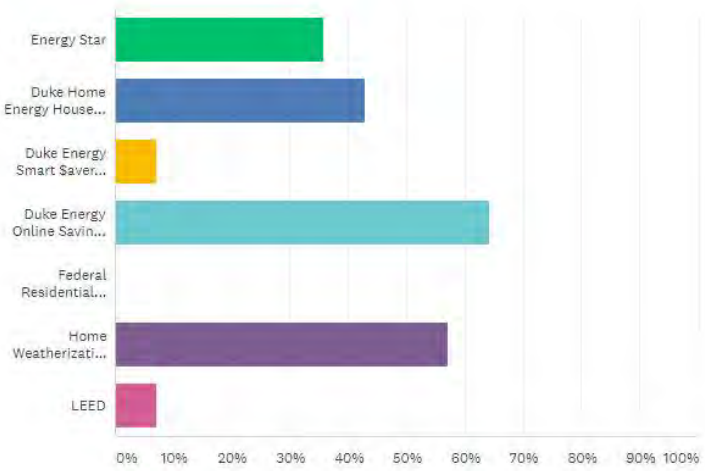
- Targeted Facebook posts to residents living in the Middletown area
- Via the Energy Plan Website, https://energy.oki.org
- Via the City's social media channels.

By December 18, 2019, the surveys received a total of 31 responses. The results of these responses are analyzed in the following pages.

South Middletown Survey Results

Please indicate which of the energy efficiency programs you are familiar with:

Answered: 14 Skipped: 1



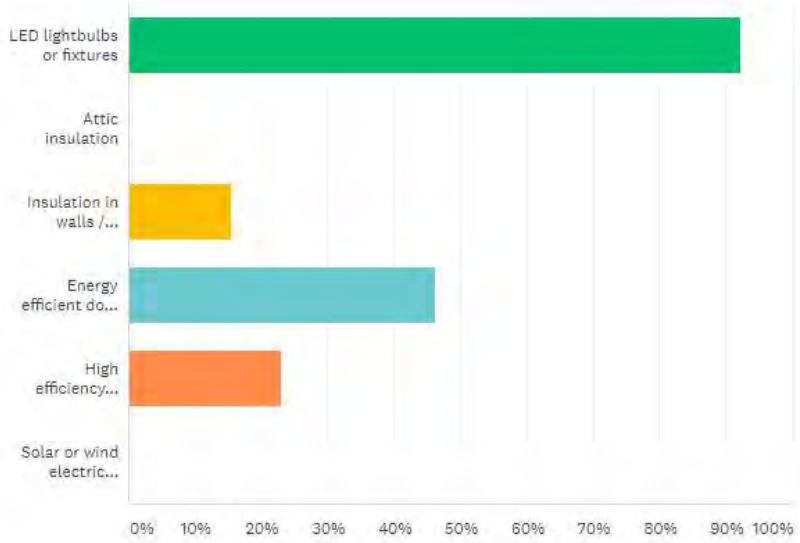
ANSWER CHOICES	RESPONSES	
Energy Star	35.71%	5
Duke Home Energy House Call	42.86%	6
Duke Energy Smart $aver rebate program	7.14%	1
Duke Energy Online Savings Store for LED lightbulbs	64.29%	9
Federal Residential Renewable Energy Tax Credit	0.00%	0
Home Weatherization Assistance Program (HWAP)	57.14%	8
LEED	7.14%	1
Total Respondents: 14		

Q2

Customize Save as

Have you installed any of the following energy efficient upgrades in your home?

Answered: 13 Skipped: 2



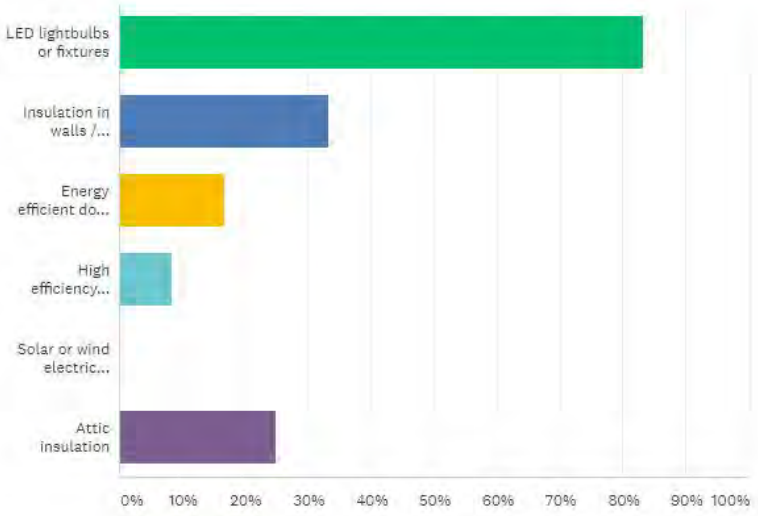
ANSWER CHOICES	RESPONSES	
LED lightbulbs or fixtures	92.31%	12
Attic insulation	0.00%	0
Insulation in walls / crawlspace	15.38%	2
Energy efficient doors and windows	46.15%	6
High efficiency furnace / air conditioner	23.08%	3
Solar or wind electric generation	0.00%	0
Total Respondents: 13		

Q3

Customize Save as

Do you plan to install any of these energy efficiency improvements in your home in the next 2 years?

Answered: 12 Skipped: 3



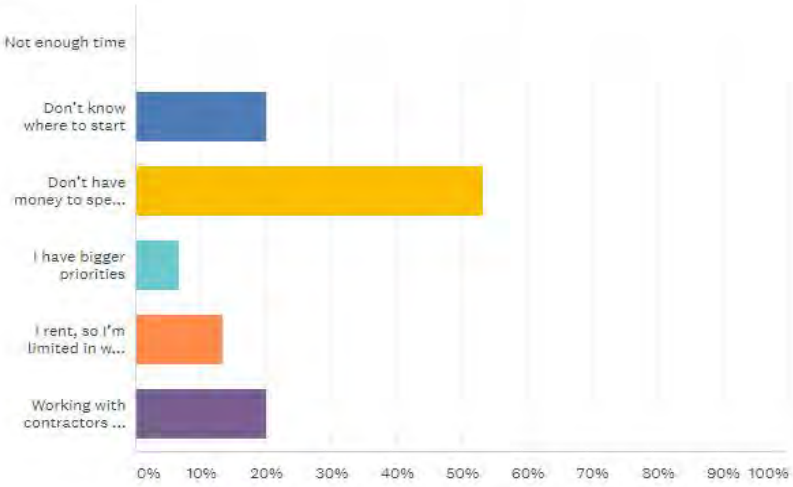
ANSWER CHOICES	RESPONSES	
LED lightbulbs or fixtures	83.33%	10
Insulation in walls / crawlspace	33.33%	4
Energy efficient doors and windows	16.67%	2
High efficiency furnace / air conditioner	8.33%	1
Solar or wind electric generation	0.00%	0
Attic insulation	25.00%	3
Total Respondents: 12		

Q4

Customize Save as

What do you see as your top 3 challenges that might prevent you from making energy efficient improvements?

Answered: 15 Skipped: 0



ANSWER CHOICES	RESPONSES	
Not enough time	0.00%	0
Don't know where to start	20.00%	3
Don't have money to spend on improvements	53.33%	8
I have bigger priorities	6.67%	1
I rent, so I'm limited in what improvements I can make on my own	13.33%	2
Working with contractors is a hassle and I don't know who to trust	20.00%	3
Total Respondents: 15		

Comments (4)

Showing 4 responses

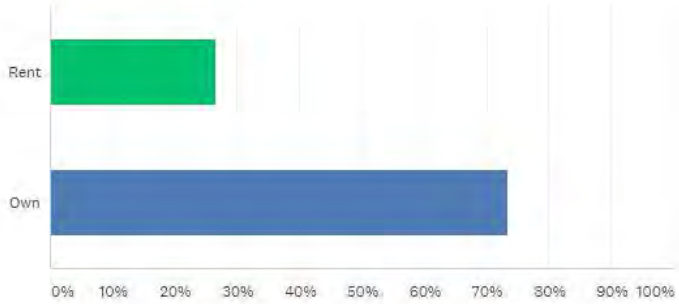
My house is energy efficient aleeady	8/24/2019 2:50 PM	View respondent's answers Add tags
Home is fairly energy efficient.	8/22/2019 4:08 PM	View respondent's answers Add tags
do not have the funds at this time.	8/22/2019 3:06 PM	View respondent's answers Add tags
Live in apartment	8/22/2019 2:28 PM	View respondent's answers Add tags

Q5

Customize Save as

Do you rent or own your home?

Answered: 15 Skipped: 0



ANSWER CHOICES	RESPONSES	
Rent	26.67%	4
Own	73.33%	11
TOTAL		15

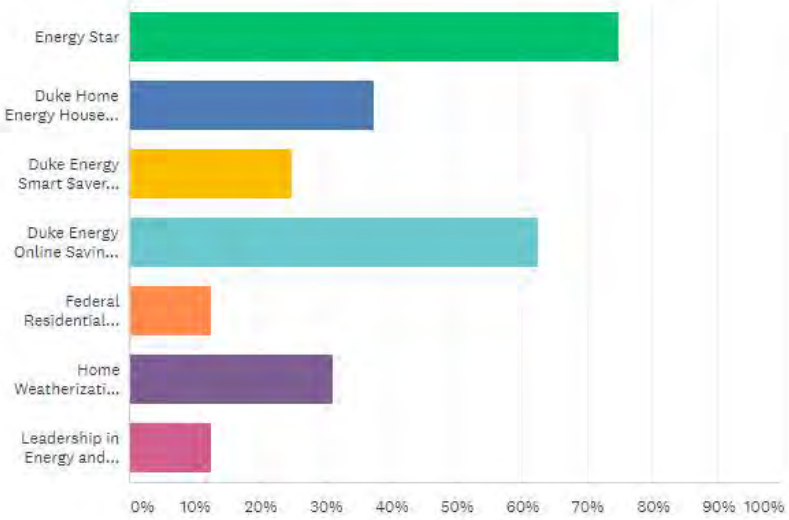
General Middletown Energy Plan Survey

Q1

Customize Save as

Please indicate which of the energy efficiency programs you are familiar with:

Answered: 16 Skipped: 0



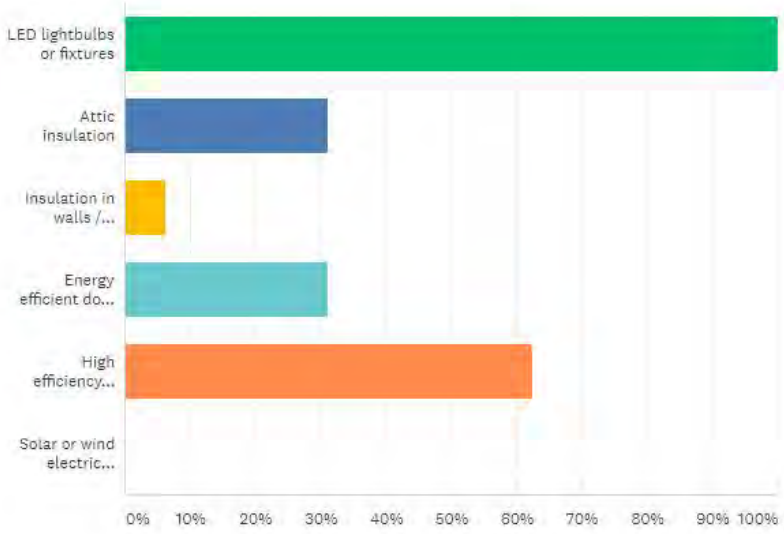
ANSWER CHOICES	RESPONSES	
Energy Star	75.00%	12
Duke Home Energy House Call	37.50%	6
Duke Energy Smart $aver rebate program	25.00%	4
Duke Energy Online Savings Store for LED lightbulbs	62.50%	10
Federal Residential Renewable Energy Tax Credit	12.50%	2
Home Weatherization Assistance Program (HWAP)	31.25%	5
Leadership in Energy and Environmental Design (LEED)	12.50%	2
Total Respondents: 16		

Q2

Customize Save as

Have you installed any of the following energy efficient upgrades in your home or business?

Answered: 16 Skipped: 0



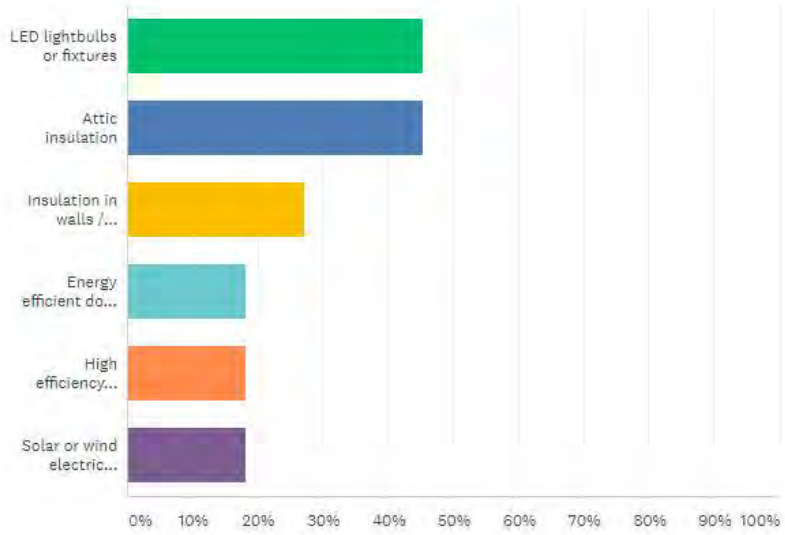
ANSWER CHOICES	RESPONSES	
LED lightbulbs or fixtures	100.00%	16
Attic insulation	31.25%	5
Insulation in walls / crawlspace	6.25%	1
Energy efficient doors and windows	31.25%	5
High efficiency furnace / air conditioner	62.50%	10
Solar or wind electric generation	0.00%	0
Total Respondents: 16		

Q3

Customize Save as

Do you plan to install any of these energy efficiency improvements in your home or business in the next two years?

Answered: 11 Skipped: 5



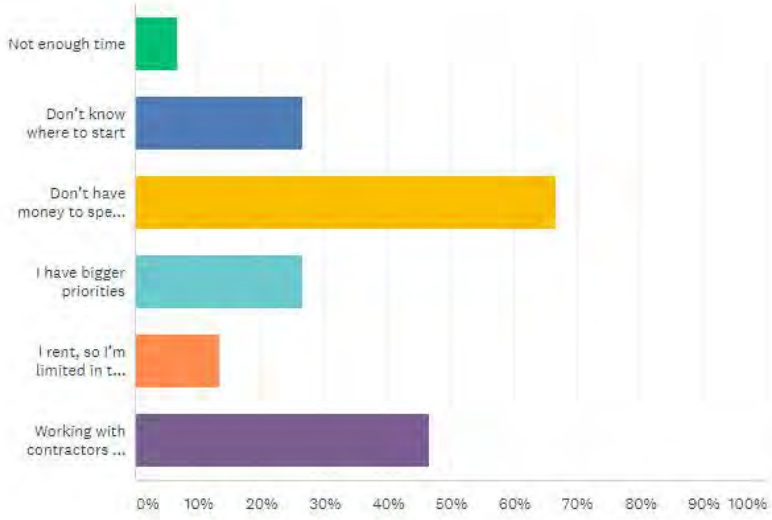
ANSWER CHOICES	RESPONSES	
LED lightbulbs or fixtures	45.45%	5
Attic insulation	45.45%	5
Insulation in walls / crawlspace	27.27%	3
Energy efficient doors and windows	18.18%	2
High efficiency furnace / air conditioner	18.18%	2
Solar or wind electric generation	18.18%	2
Total Respondents: 11		

Q4

Customize Save as

What do you see as your top three challenges that might prevent you from making energy efficient improvements?

Answered: 15 Skipped: 1



ANSWER CHOICES	RESPONSES	
Not enough time	6.67%	1
Don't know where to start	26.67%	4
Don't have money to spend on improvements	66.67%	10
I have bigger priorities	26.67%	4
I rent, so I'm limited in the types of improvements I can make on my own	13.33%	2
Working with contractors is a hassle and I don't know who to trust	46.67%	7
Total Respondents: 15		

Showing **2** responses

Only 2 I can think of

12/3/2019 11:27 PM View respondent's answers Add tags

Knowing which products to use where

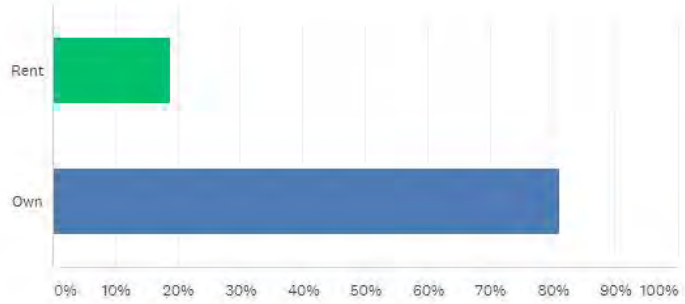
11/19/2019 7:04 PM View respondent's answers Add tags

Q5

Customize Save as

Do you rent or own your home?

Answered: 16 Skipped: 0



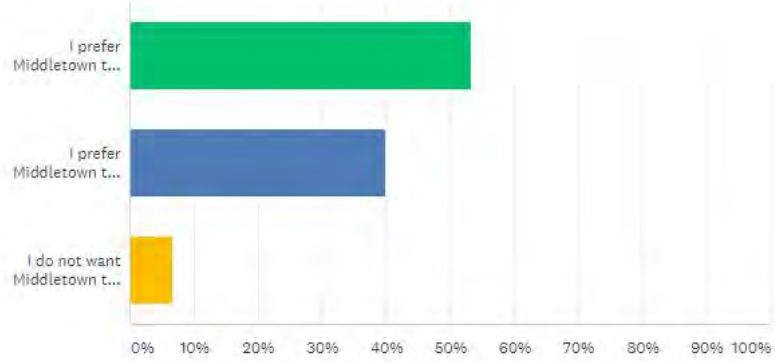
ANSWER CHOICES	RESPONSES	
Rent	18.75%	3
Own	81.25%	13
TOTAL		16

Q6

Customize Save as

Utility aggregation programs allow local governments in Ohio negotiate lower prices with energy suppliers for their residents. The program is based on the number of potential customers that are eligible under the aggregation program. Communities can also offer, or select a preferred energy source, including renewables like solar or wind. By choosing renewables as a preferred option, the community can promote the development of these energy sources, signaling local demand for renewable energy. Residents are not obligated to participate in the utility aggregation program, and can choose their own energy provider if they wish.What stance toward utility aggregation do you prefer the City of Middletown take?

Answered: 15 Skipped: 1



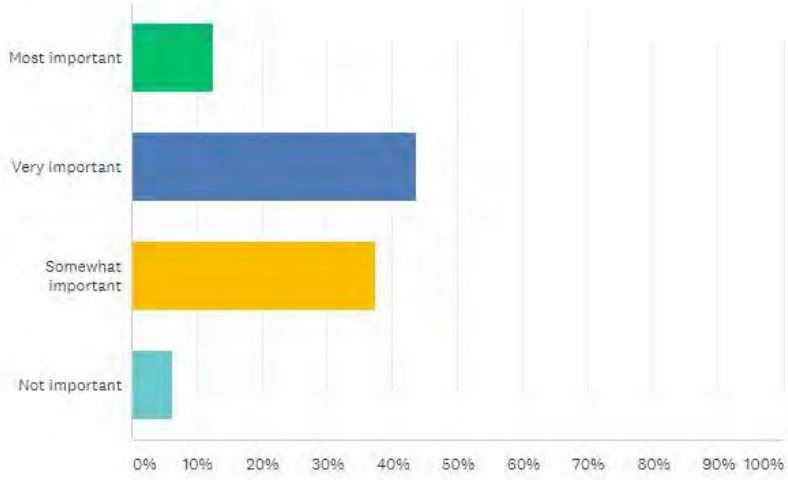
ANSWER CHOICES	RESPONSES	
I prefer Middletown to offer a utility aggregation program that prioritizes the lowest cost.	53.33%	8
I prefer Middletown to offer a utility aggregation program that supplies 100% renewable energy, even if the cost is a little higher.	40.00%	6
I do not want Middletown to offer a utility aggregation program.	6.67%	1
Total Respondents: 15		

Q7

Customize Save as

Traditional programs used to incentivize energy-efficient improvements to residential dwellings usually come in the form of rebates, and are typically restricted to homeowners. These programs produce the most energy savings per cost of the incentive. However, these programs are not eligible to renters, and are not successful in reaching low to moderate income households because the owner must pay for the improvements upfront to receive the rebate. The result is households that are the most cost-burdened by energy, and typically live in the oldest, least energy-efficient housing in the community, are not being helped by the majority of current incentives to boost energy efficiency.How important is it to you that Middletown addresses the issue of energy burden and promotes energy efficiency to low and moderate income households and renters?

Answered: 16 Skipped: 0



ANSWER CHOICES	RESPONSES	
Most important	12.50%	2
Very important	43.75%	7
Somewhat important	37.50%	6
Not important	6.25%	1
TOTAL		16

Appendix B: Improvements to Building Energy Efficiency

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 of 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 in order 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 homes were often heated using hot water or steam boilers. If an older boiler is still in use, it should be replaced with a new 95% efficient ENERGY STAR unit. In addition, all accessible distribution piping should be insulated. Other homes may have a forced air system installed. 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: Ways of Addressing Rental Housing Split Incentive

Incentives

Incentives are a very standard practice to encourage energy efficient investments for both homeowners and businesses. Incentives can be offered through utilities, non-profits or government to encourage investments in energy efficiency. However, the amount of incentive needed to overcome the rental housing split incentive problem is reportedly very high. A study[17] found that an incentive covering 80% of the cost of an improvement was necessary to spark interest from 50% of landlords eligible for the program. That is a lot of money needed to gain just moderate interest in the program.

Other factors affect the market penetration of incentive programs beyond the dollar amount offered. The type of incentive can be a significant factor. Incentives can be offered as grants, where money is provided up front. Another type of incentive is a rebate, where the customer must pay the total cost of the improvement before being reimbursed. Finally, incentives can take the form of loans, which don't reduce the principal cost, but can help those who don't have cash on hand for the improvement.

Another factor in the success of any incentive program is how effectively the program is marketed to its intended target population. To achieve success, an incentive program must effectively reach and drive the targeted population to make desired energy efficient improvements. If the population isn't aware of the incentive, or the incentive isn't enough to drive action, the incentive will not be successful.

While incentives are a popular mechanism to encourage investment in energy efficient improvements among homeowners, they have not shown to be effective when applied to rental housing.

Transfer of Benefits Agreements

Another strategy to combat the split incentive problem is using agreements to create a bridge between landlords and renters over which the benefits of energy efficient improvements can flow. When a landlord invests in energy efficient improvements, the renter realizes an economic benefit in the form of lower utility bills. A Transfer of Benefits Agreement (TBA) allows a share

[17] Nexus Market Research, Inc. 2005. "Results of Focus Groups Among Landlords Eligible for the MassSAVE Program: Draft." Cambridge, MA.

of that economic benefit to flow back to the landlord, thus providing an economic incentive to making the investment in energy efficiency.

Literature review[18] uncovered two ways a TBA program can be structured. One way, dubbed Pay-As-You-Save, or PAYS, is organized through the utility. The other, called a Green Lease, is an agreement between tenant and landlord that adjusts the rent to share the economic benefits of the improvements.

Pay-As-You-Save (PAYS) offers loans to landlords to make energy efficient improvements. This loan is then repaid through a surcharge the tenant agrees to have placed on their utility bill. The amount of the surcharge is set so that the tenant still sees a net reduction in their utility bill. The surcharge remains on the utility bill until the loan is paid off, even if the tenants change. This type of program requires the close cooperation of the utility company, locally Duke Energy, to handle billing. It is also unclear what mechanism ensures that the tenant's utility bill achieves a net decrease. Without this assurance, a tenant likely wouldn't be comfortable with the program.

A Green Lease is where the landlord and tenant(s) enter into a more direct agreement with one another, through the help of an energy consultant. The energy consultant certifies the expected savings the tenant will see on their utility bill due to the improvements. A portion of that expected savings is paid each month to the landlord. Again, the tenant sees a net reduction in total costs of rent plus utilities while most of the savings from reduced utility bills flow to the landlord who paid for the improvements. However, since this is an agreement between the landlord and a particular tenant or set of tenants, if the tenant(s) move out, the payments to the landlord cease. There is a significant risk that the landlord might not recoup his or her investment.

Transfer of Benefit Agreements directly address the root of the split incentive problem by creating a mechanism of transferring most, but not all of the immediate economic benefit of lower utility bills to the landlord, who pays for the improvements. Some of the benefit is retained for the tenants to provide both parties with an interest in energy efficient improvements. Where the TBAs tend to fall short is the relative transience of tenants and the reliance on a high level of trust and transparency between landlords and tenants.

Residential Energy Conservation Ordinance

A Residential Energy Conservation Ordinance (RECO) is an ordinance passed by a local or state government that requires the owner of an applicable residential property to document a minimum standard of energy efficiency at such time when the property is extensively renovated or right before the property is sold. The documentation is provided by a certified inspector or

[18] Williams, Beth E. 2008.."Overcoming Barriers to Energy Efficiency for Rental Housing" Master's Thesis for the degree of Master in City Planning, Massachusetts Institute of Technology, pg. 31-39

licensed engineer and typically documents the amount and condition of insulation, efficiency of heating systems, and sometimes includes a measurement of air-tightness using a blower door test.

Of the communities reviewed that have passed a RECO ordinance, most are located in northern climates where energy use for heating is more significant than average. There were no examples of a RECO found in Ohio, and therefore cannot be sure that such an ordinance would be deemed a valid use of a community's police powers.

One example – Burlington, VT – specifically targeted rental properties in its RECO ordinance. The Burlington ordinance contains a few key compromises: first, if a property is not found to be in compliance with the ordinance at the time of transfer, the new owner has one year to make the improvements (extensions may be granted due to cost or financing issues), and second, the ordinance sets a cap to the cost of the required improvements. However, once the transfer of the property is done, there are no other enforcement mechanisms to ensure the promised improvements are made by the new owner.

The benefits of a RECO ordinance is that it sets, and somewhat firmly enforces a minimum standard of energy efficiency. Through this, all renters can be assured of dwellings that are reasonably comfortable and efficient with low utility bills. Also, it also alerts buyers of a property if it didn't pass inspection, which contributes to an informed marketplace.

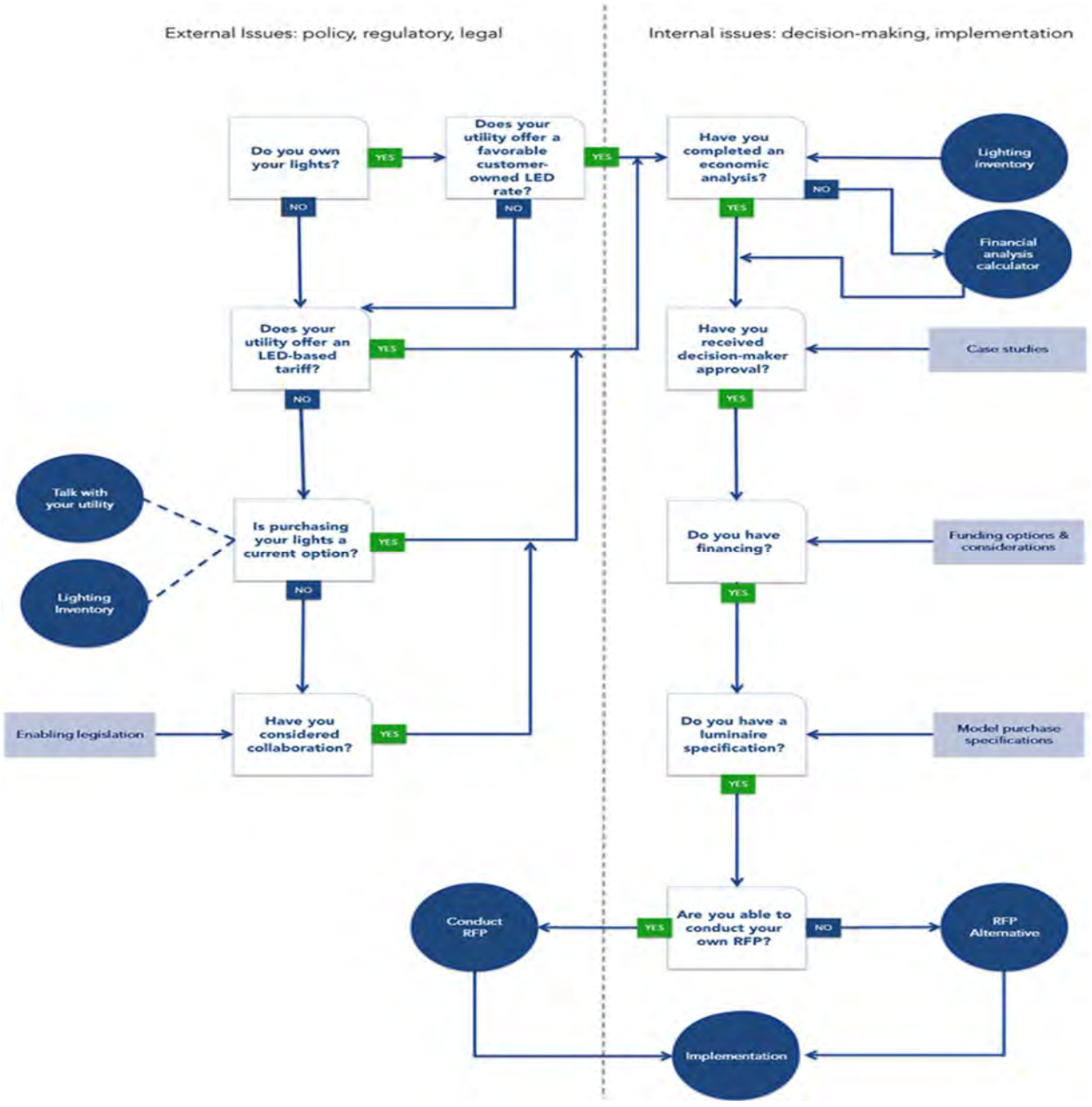
Because the main triggering mechanism to a RECO is the sale of a property, Silverton would require the Hamilton County Auditor's Office to enforce the ordinance by not allowing sales to be executed without documentation of compliance. It would be logical that landlords and real estate professionals would be opposed to legislation that added additional barriers to the transfer of properties.

Appendix D: Energy Burden by Neighborhood

Neighborhood	Weighted Median Household Income	Weighted Average Annual Energy Cost	Weighted Neighborhood Energy Burden
Riverside Village	$15,398	$1,814	11.78%
Douglas	$17,289	$1,161	6.71%
Prospect	$26,225	$1,408	6.35%
Meadowlawn	$24,028	$1,500	6.24%
Church	$19,354	$1,181	6.11%
Oakland	$26,111	$1,488	5.7%
Far Hills	$31,583	$1,783	5.65%
Harlan Park	$25,804	$1,456	5.64%
Amanda/Oneida	$28,805	$1,513	5.27%
Lewis/Clifton Farms	$28,664	$1,494	5.21%
South	$28,142	$1,444	5.13%
Sherman	$25,815	$1,318	5.11%
Lakeside	$27,250	$1,367	5.02%
University	$42,321	$1,978	4.67%
Greenfields	$28,432	$1,465	4.33%
New England Heights	$44,643	$1,932	4.33%
Mayfield	$35,181	$1,453	4.25%
Barbara Park	$30,229	$1,263	4.12%
Wildwood	$39,500	$1,571	3.98%
Euclid/Runnymede	$47,628	$1,861	3.91%
Avalon	$35,625	$1,379	3.87%
Dixie Heights	$37,917	$1,448	3.82%
Highlands	$51,976	$1,749	3.55%
Downtown	$25,556	$870	3.4%
Sunset Park Place	$45,962	$1,536	3.34%
Springhill	$53,115	$1,738	3.27%
Creekview	$52,272	$1,672	3.26%
Manchester Meadows	$76,563	$2,282	2.98%
Eldorado/Williamsdale	$68,622	$1,909	2.78%
Rosedale	$86,572	$2,228	2.57%

Appendix E: Municipal Decision Tree for Upgrading Street Lighting

The U.S. Department of Energy through its Better Buildings Outdoor Lighting Accelerator designed the decision tree below to assist local governments with implementing energy efficient streetlighting improvements.



Source: https://betterbuildingsinitiative.energy.gov/solutions-at-a-glance/