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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.

Figure 1. Insulation being installed in the attic of a home.
Source: Attic Air website, 2016

This Energy Plan was produced through the efforts of the Ohio Kentucky Indiana (OKI) Regional Council of Governments and the Greater Cincinnati Energy Alliance (GCEA), working with a steering committee named by Turtlecreek 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 version of these goals were presented for public review on the Community Energy Plan website at energy.oki.org.

This plan will serve to organize action by the 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.

Overview of Turtlecreek Township's Energy Strategy

The process of determining this energy strategy and its goals is the work of an appointed five-member committee. The committee reviewed information. 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

Turtlecreek Township is committed to being conscientious and efficient in its use of energy. This energy plan will provide specific guidance to community leaders to comprehensively, effectively, and equitably address the energy needs and goals of the township. The implementation of this plan will provide for a more energy efficient, sustainable, inexpensive, and attractive community for residents and businesses.

Energy Plan Goals

Goal 1	Turtlecreek Township will encourage development that incorporates features and design elements that contribute to building, infrastructure, and transportation energy savings.
Goal 2	Turtlecreek Township will be a leader in assisting residents, businesses and stakeholders in achieving their overall energy efficiency goals.
Goal 3	Turtlecreek Township will engage with residents and community partners to ensure that all residents have the opportunity to benefit from efforts to reduce energy use and the cost of energy in the community, especially those not typically served by traditional energy efficiency incentives.

Actions

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

Action 1	Continue to plan for pedestrian and bicycle facilities that connect residents to parks, schools, and businesses.
Action 2	Seek out and include renewable sources of energy in the township's utility aggregation program when it comes up for renewal in 2022.
Action 3	Engage with Duke Energy and the Greater Cincinnati Energy Alliance to bring information about energy efficiency to residents and businesses.
Action 4	Provide qualifying residents with information about the Home Weatherization Assistance Program available through the Miami Valley Community Action Partnership.
Action 5	Invest in energy efficient improvements for township buildings and parks, including LED lighting and efficient mechanical systems.
Action 6	Work with Duke Energy to evaluate converting the Township's streetlights to LED fixtures.
Action 7	Prioritize energy efficiency when replacing township vehicles and equipment.
Action 8	Evaluate and make operational changes to save energy.
Action 9	Encourage proposed low-density developments to adopt a cluster development design.
Action 10	Require developers to provide shade trees in and around parking lots and along streets to mitigate the impact on the urban heat island.
Action 11	Encourage residents to plant trees in their yards to restore the township's tree canopy. The township can partner with Taking Root's Energy Saving Trees program.
Action 13	Reduce barriers for residents to install solar on their homes, including: Launch a solarize campaign and develop a permit checklist for homeowners and contractors.

Action 14	Designate township fire stations as locations where residents can drop-off non-perishable food donations. Partner with a local food pantry to periodically collect the donations.
Action 15	Host a Warren County Soil and Water District workshop on backyard composting.
Action 16	Partner with the Warren County Extension Office to provide residents with information about food safety and how to interpret expiration dates on food packaging.
Action 17	Use information provided by the township's trash contract to track overall recycling rates over time.
Action 18	Partner with a local recycling business to host a recycling drive, where residents can bring old electronics and other items to be recycled.

Energy Use and Delivery

Turtlecreek Township is in the central and western portion of Warren County, covering an area of 70.4 square miles. The main business district is located along Ohio State Route 63, near the western border of the Township. There were 3,724 occupied housing units in Turtlecreek in 2017, approximately 13 percent of which are rental.

Poised for future residential growth, Turtlecreek Township is primarily a bedroom community of nearly 15,600 residents. The township has shown population growth of 5% since 2010 (14,800). The Township is geographically positioned near local employment and employment in nearby cities. Transportation access to nodes of higher-density, economic centers in Warren and Butler County, such as Mason, Lebanon and Monroe, are facilitated by interstate highways and state routes. The Township is the home of Warren County's largest employer, Otterbein SeniorLife, and one of the most recent developments at Union Village town center, Warren County Sports Park. An increase in residential infill is slated for Turtlecreek Township, as a part of the plan for the commercial town center, including a long-term goal of 4,500 new units (single-family, condominiums, multi-family).[1] Other nearby employers include Warren County, Lebanon Correctional Institution, Warren Correctional Institution, Miami Valley Gaming, Lebanon City Schools, and Advics Manufacturing of Ohio, Inc.

Electric & Natural Gas Use

A major component of a community energy plan is understanding how much energy the community uses, 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 Turtlecreek Township consumed over 1.9 billion kBtu of energy in 2016, at a total cost of over $38.7 million.[2]

[1] Schroeder, Kaitlin. "Warren County Developers Plan $1.5 Billion Mixed-Use Village Center." bizjournals.com. Dayton Business Courier, May 1, 2017. https://www.bizjournals.com/dayton/news/2017/05/01/warren-county-developers-plan-1-5-billion-mixed.html.

[2] Data only includes Duke Energy customers for electric and/or natural gas. Other heating fuels are not included.

The estimated amount of CO^2 for the Township's electricity use is based on the typical mix of sources for electricity available in the region, which is currently supplied by coal and natural gas power plants.[3] Line losses are also a significant factor because much more electricity is produced than is delivered to the customer.[4] In this region, electricity produces more CO^2 per unit of energy (kBtu) than natural gas produces, as shown, below, in Figure 2. As is the case for the entire region, the key to significantly reducing the Township's production of CO^2 lies in adopting a clean source of electricity.

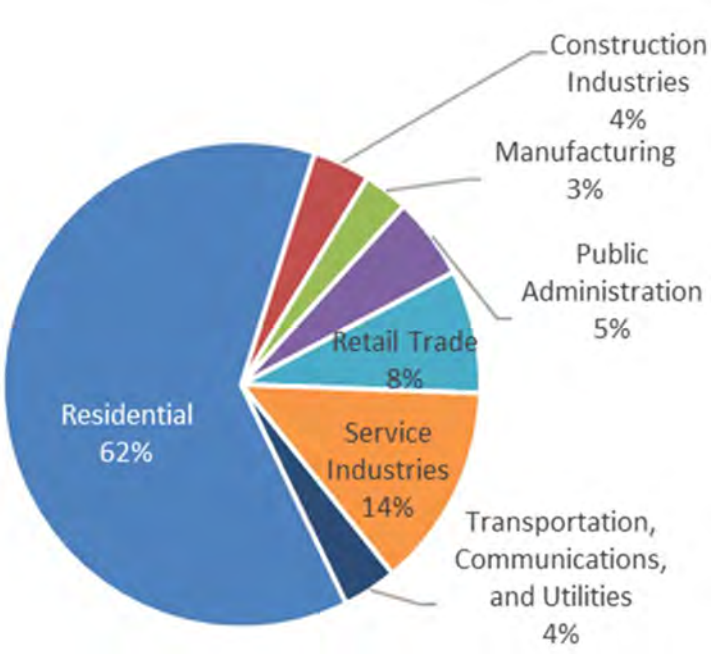


Figure 1. Natural Gas Use in Turtlecreek – 2016 (Duke Energy)

Figure 2. Total Energy Consumption, Emissions, and Cost in Turtlecreek Township 2016. (GCEA)

	Amount Consumed	kBtu	Tons CO_2	Lb CO_2/ kBtu	Total Cost
Electricity	329,052,748 kWh	1,122,774,583.7	256,497	0.457	$30.67 million
Natural Gas	7,884,334 CCF	804,202,196.7	43,433	0.108	$8.04 million
TOTAL	-	1,926,976,780.4	299,930		$38.71 million

[3] "Independent Statistics and Analysis." n.d. Ohio - State Energy Profile Overview. U.S. Energy Information Administration (EIA). Accessed December 20, 2019. https://www.eia.gov/state/?sid=OH.

[4] "Independent Statistics and Analysis." n.d. How Much Electricity Is Lost in Electricity Transmission and Distribution in the United States? - FAQ. U.S. Energy Information Administration (EIA). Accessed December 19, 2019. https://www.eia.gov/tools/faqs/faq.php?id=105&t=3.

Natural gas is used for space heating, water heating, and some manufacturing processes. In 2016, the residential sector accounted for 62 percent of natural gas consumption, while the commercial and industrial (C&I) sectors accounted for 38 percent[5] (see Figure 1). The portion of natural gas use attributable to the residential sector is much larger than its proportion of electric use.

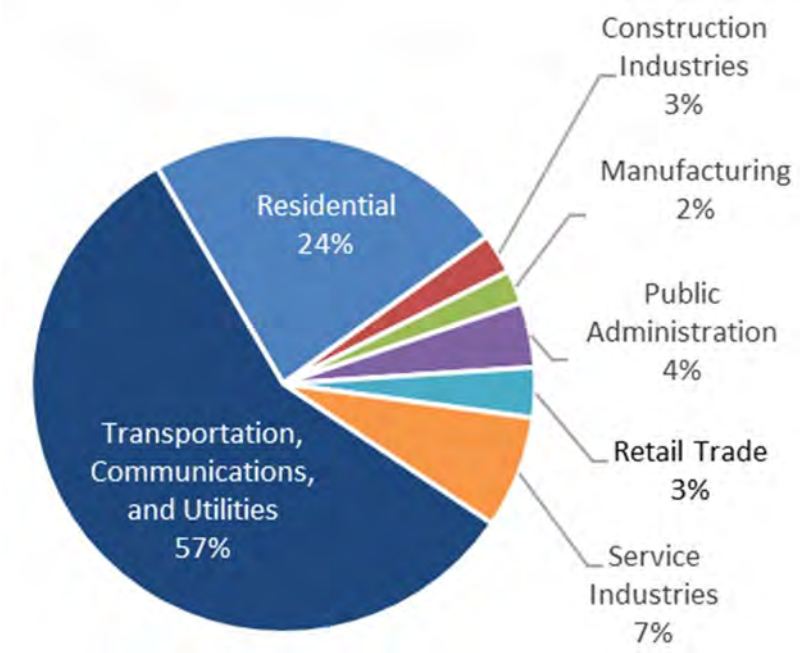


Figure 3. Electricity Use in Turtlecreek – 2016 (Duke Energy)

The residential sector accounted for 24 percent of electricity consumption in 2016, while the commercial and industrial (C&I) sectors accounted for 76 percent[6] (see Figure 3). In the case of the outsized electricity use by the transportation, communications, and utilities sector, there is a single user in this sector which is responsible for this use. Because this is a single, specialized operation, the township does not have the ability to affect the electricity use or efficiency. Disregarding the outsized utility sector, residential is the largest user of electricity.

Because the residential sector dominates energy use in the community, it is essential to address actions targeted towards energy efficiency in the residential sector.

Residential Energy Use

The number of ways we use energy in our homes is rapidly changing. Residential energy use depends on the energy consuming devices used in the home and the efficiency of those devices.

[5] "2016 Community Energy Uses for Turtlecreek Township." Letter. n.d. *2016 Community Energy Uses for Turtlecreek Township: Duke Energy*.

[6] *2016 Community Energy Uses for Turtlecreek Township: Duke Energy*.

Natural gas and electricity are the most-consumed energy sources in residential buildings throughout Turtlecreek Township.

Space heating accounts for the largest share of energy use in residential buildings[7] (see Figure 4). Natural gas is the most common source of fuel for heating, but there are residential property owners throughout the Township that rely on other fuel sources including electricity, fuel oil, wood stoves, or pellet stoves as their primary heating fuel. Weatherizing the home by improving insulation levels and sealing leaks can decrease energy usage attributable to space heating and reduce energy costs.

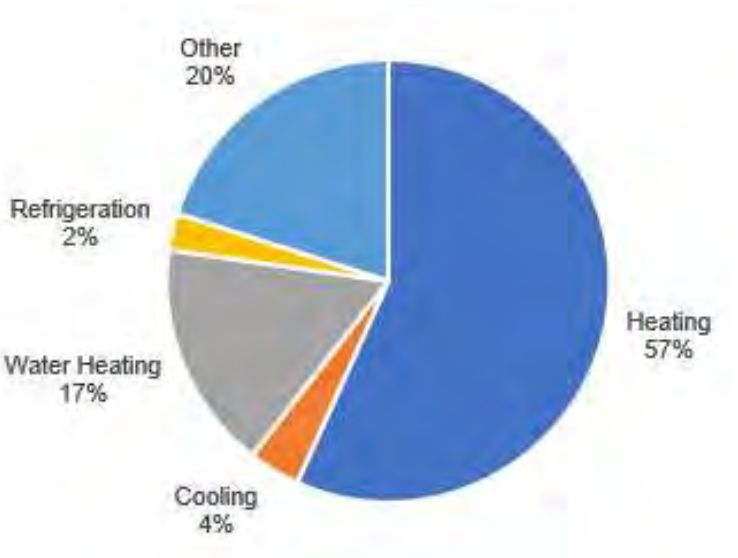


Figure 4. Residential building fuel consumption by end use.
Source: U.S. Energy Information Administration, Residential Energy Consumption Survey (RECS) 2015. Table CE3.3

In 2016 Ohio residents consumed 51,000 kBtu per capita, according to the U.S. Energy Information Administration[8]. Based on data from Duke Energy for the same period, Turtlecreek Township residents consumed 48,878 kBtu per capita or about four percent less than the state average.

Commercial and Industrial Energy Use

Commercial buildings range in size from small storefronts to large industrial and retail facilities. Regardless of size, commercial buildings in this region of the country demonstrate a similar energy use pattern[9] (see Figure 5). Space heating and cooling represent 44 percent of energy use in commercial buildings. According to a 2015 report from the U.S. Department of Energy, improving heating and cooling-related building components in commercial buildings such as

[7] "Independent Statistics and Analysis." n.d. Residential Energy Consumption Survey (RECS) - Energy Information Administration. U.S. Energy Information Administration (EIA). Accessed December 20, 2019. https://www.eia.gov/consumption/residential/index.php.

[8] "Ohio State Energy Profile." n.d. Ohio Profile. U.S. Energy Information Administration (EIA). Accessed December 20, 2019. https://www.eia.gov/state/print.php?sid=OH.

[9] "Independent Statistics and Analysis." n.d. Commercial Buildings Energy Consumption Survey (CBECS) - Analysis & Projections. U.S. Energy Information Administration (EIA). Accessed December 20, 2019. https://www.eia.gov/consumption/commercial/reports.php.

windows, walls, roofs, controls, and heating, ventilation, and air conditioning (HVAC) equipment to ENERGY STAR recommended levels can decrease energy usage for heating by 33 percent and cooling by 40 percent. While only accounting for 10 percent of energy usage, upgrading to energy efficient lighting offers a low-cost way for commercial properties to reduce their energy costs.

In 2012, commercial buildings in the Midwest Census region used 88,761 Btu per square foot, according to the U.S. Energy Information Administration.[10]

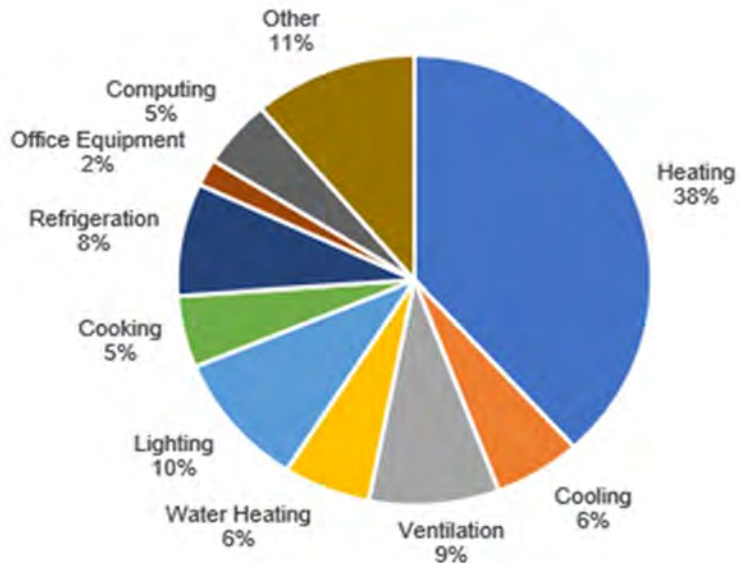


Figure 5. Commercial building fuel consumption by end use, Source: U.S. Energy Information Administration, 2012 Commercial Buildings Energy Consumption Survey, Table E1

Transportation Energy Use

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.

As you can see by the table (see Figure 6), most commute in personal vehicles alone. It is notable that Turtlecreek Township trends slightly lower than peer communities, Warren County, and the region average in commuting by

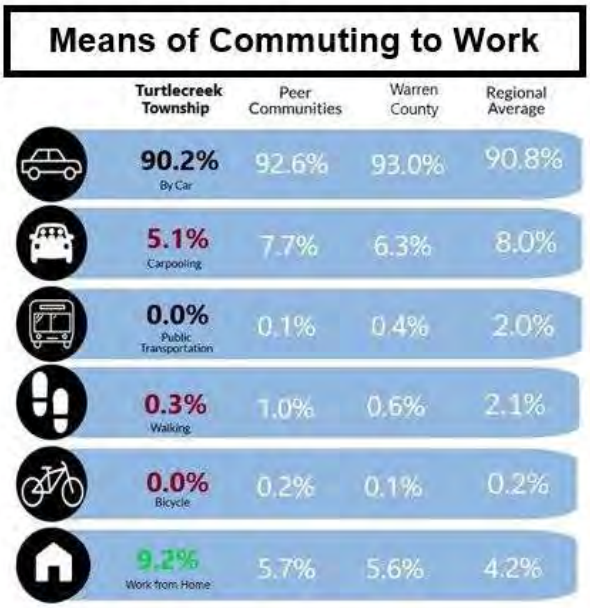


Figure 6. Means of Commuting to Work – 2016. Data sourced from 2013-2017 U.S. Census estimates

[10] U.S. Energy Information Administration (EIA)

car. However, the township lags behind in the number of commuters who carpool. The rate of carpooling varies widely by community. Goshen Township boasts 12 percent of their workers carpool to work, while in neighboring Hamilton Township, only three percent carpool.[11] Increasing the rate of carpooling would prove difficult, as commuters' comfort with carpooling in a post Coronavirus world is expected to be significantly less.

Turtlecreek Township is not served by affordable fixed-route public transportation, and the ridership number in the table above makes that clear. Without meaningful service, there really isn't an opportunity to address this. Walking and biking, obviously don't make up a large portion of commuting made shares. However, making a community more walkable and bike friendly is important as it develops into a more urbanized community. On the positive side, Turtlecreek Township leads in the most energy efficient commute – which is no commute at all. Over nine percent of township residents work from home.

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 Turtlecreek Township. Duke maintains the electric and natural gas infrastructure, delivering energy to homes and businesses.

Energy Resiliency

Resiliency is how susceptible a community is to threats, and how capable they are in overcoming threats when they do occur. The three components of energy resiliency are prevention, recovery, and survivability[12]. In regards to energy infrastructure, there are a number of uncommon events that may test the resiliency of the system, such as wind, ice and tornadoes.

- Prevention – Duke Energy puts a lot effort into preventing damage to the energy grid through trimming branches away from power lines and regular system maintenance.
- Recovery – Warren County Emergency Management Agency (EMA) works with first responders, utilities, and local governments to game plan responses to possible emergencies.

[11] Data Access and Dissemination Systems (DADS). 2010. "Table S0802: Means of Transportation to Work by Selected Characteristics." American FactFinder - Results. U.S. Census. October 5, 2010. https://factfinder.census.gov/bkmk/table/1.0/en/ACS/17_5YR/S0802/0600000US3916577868.

[12] "Grid Resiliency." n.d. EPRI Public Site. Electric Power Research Institute. Accessed December 20, 2019. https://www.epri.com/#/pages/sa/grid-resiliency?lang=en-US.

- Survivability – describes the ability for key pieces of infrastructure to be able to weather and overcome a disruption. This includes duplicative communication channels and backup power to ensure key facilities and infrastructure are available in an emergency.

Energy Aggregation

Ohio's deregulated energy market enables property owners to select their own electricity and natural gas providers. Communities are permitted to buy electricity and/or natural gas as a group to gain buying power in the marketplace. Other possible benefits from negotiation can include consolidated billing, energy management services and energy use analysis.

In November 2018, the majority of voters in Turtlecreek Township elected to authorize opt-out aggregation - a bulk purchasing method that allows potential members the ability to choose not to participate in the group program. Since September 2019, Turtlecreek Township has offered an opt-out electric and natural gas aggregation program for eligible Township residents and small businesses. At this report's writing AEP Energy is the program's electric supplier and Constellation NewEnergy is the program's natural gas supplier.

The electric generation rate Turtlecreek secured through the aggregation program is currently $0.04698 per kWh. This rate is lower than Duke Energy's "price to compare" rate, which is currently $0.0568 per kWh. As the local utility provider, Duke Energy adds distribution charges to the rate offered through the aggregation program. Similarly, the township offered eligible residential and small commercial customers the ability to participate in the natural gas aggregation program. The price is $0.0363 per ccf for natural gas supply charges, for a period of 32 months. As with the electric, Duke Energy provides distribution of the natural gas, and adds separate charges for this service to customers' bills.

Aggregation programs offer local governments a significant tool in reducing their community's impact on air quality and greenhouse gas emissions. A community has the ability to select an energy provider that delivers clean renewable energy. The gap in price between the least expensive electricity option and the least expensive 100% renewable sourced electricity has closed significantly in the past few years. As of February 2020, clean electricity was priced about 2% higher cost than the lowest comparable general sourced electricity on Ohio's electric generation marketplace found at energychoice.ohio.gov.

If in 2022, when the township's current aggregation deal expires, Turtlecreek Township desires to reduce the community's impact on air quality and greenhouse gas emissions, selecting a supplier of 100% renewable energy for the aggregation program is the best way to have the largest impact.

Energy Efficiency in Homes

Turtlecreek Township contains over 3,700 residential units. The building stock in Turtlecreek tends to be more recent construction, particularly in the western half of the township. These structures should be most up-to-date with insulation and modern energy efficient appliances and systems. Some subdivisions in the northeast quadrant of the township appear to have been developed in the 1970s or 1980s. Houses of this vintage contain less insulation and could rely on older, less energy efficient systems and appliances. Finally, the Township features a small number of original homes built in the late 19th or early 20th centuries. Originally, these homes would not have contained insulation.

Most homes in Turtlecreek Township rely on electricity or natural gas for heating – 38 percent and 34 percent, respectively. However, 24 percent of homes rely on more expensive liquid propane gas or fuel oil for heat.

Improvements in Existing Homes

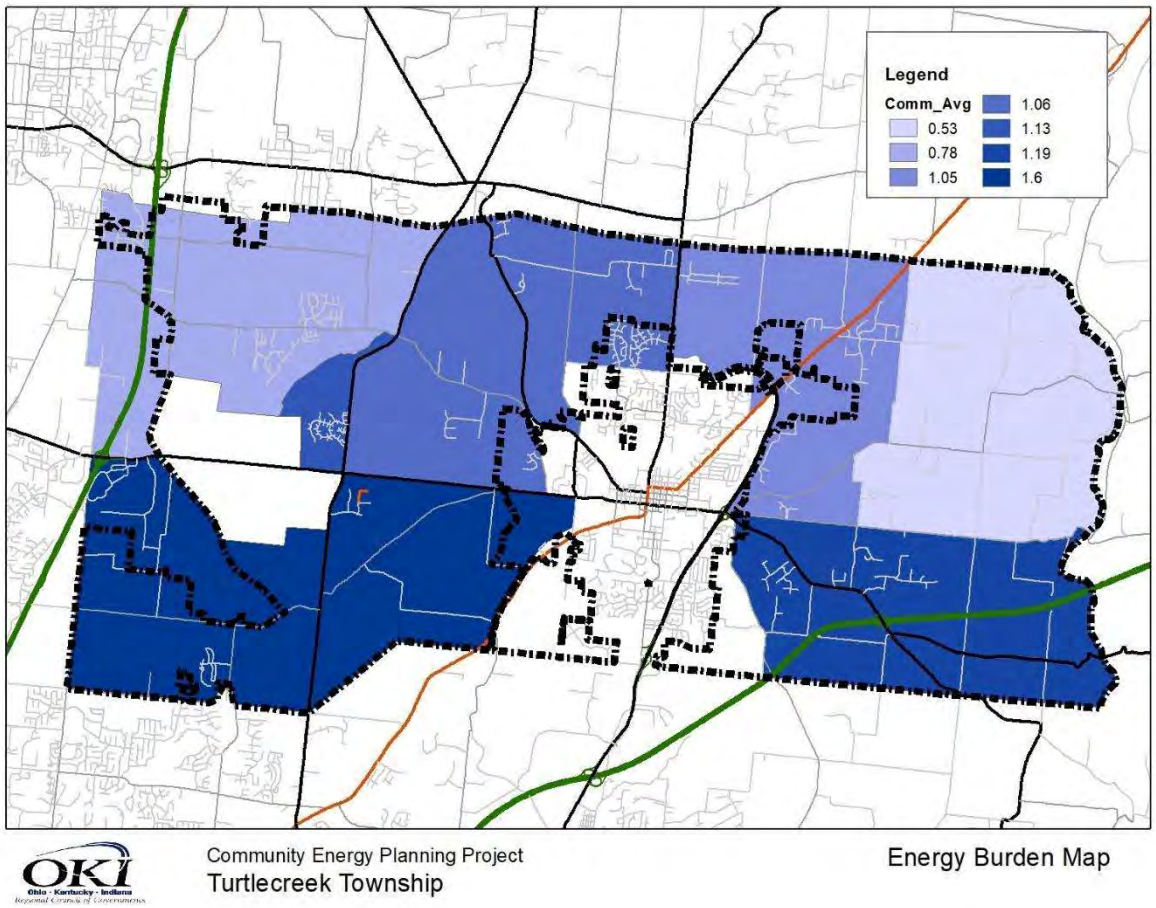
Improving the energy efficiency is of interest to most homeowners. Many of these improvements are low-cost, and can be performed by a do-it-yourselfer. Homes built before 1970 were not generally designed with energy efficiency in mind, and significant improvements in efficiency are possible. A chart located in Appendix A of this document provides an overview of the different types of energy efficiency improvements applicable to residential properties in Turtlecreek Township, based on when the home was built.

Energy Burden

Energy Burden is the measure of the percentage of household income spent on energy compared to the average household. The higher the percentage, the higher the energy burden. 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. This information can be used to guide efforts to specifically reach out to groups experiencing high energy burden with programs that can improve energy efficiency and cost.

Energy burden is measured by combining the average electricity and natural gas sales in a census block and dividing by household income. The result is then divided by the community average. Values over one indicate an average household energy burden greater than the community average. Values less than one indicate energy burden that is less than average.

Figure 7. Relative Energy Burden by Census Block Group (OKI, 2018)

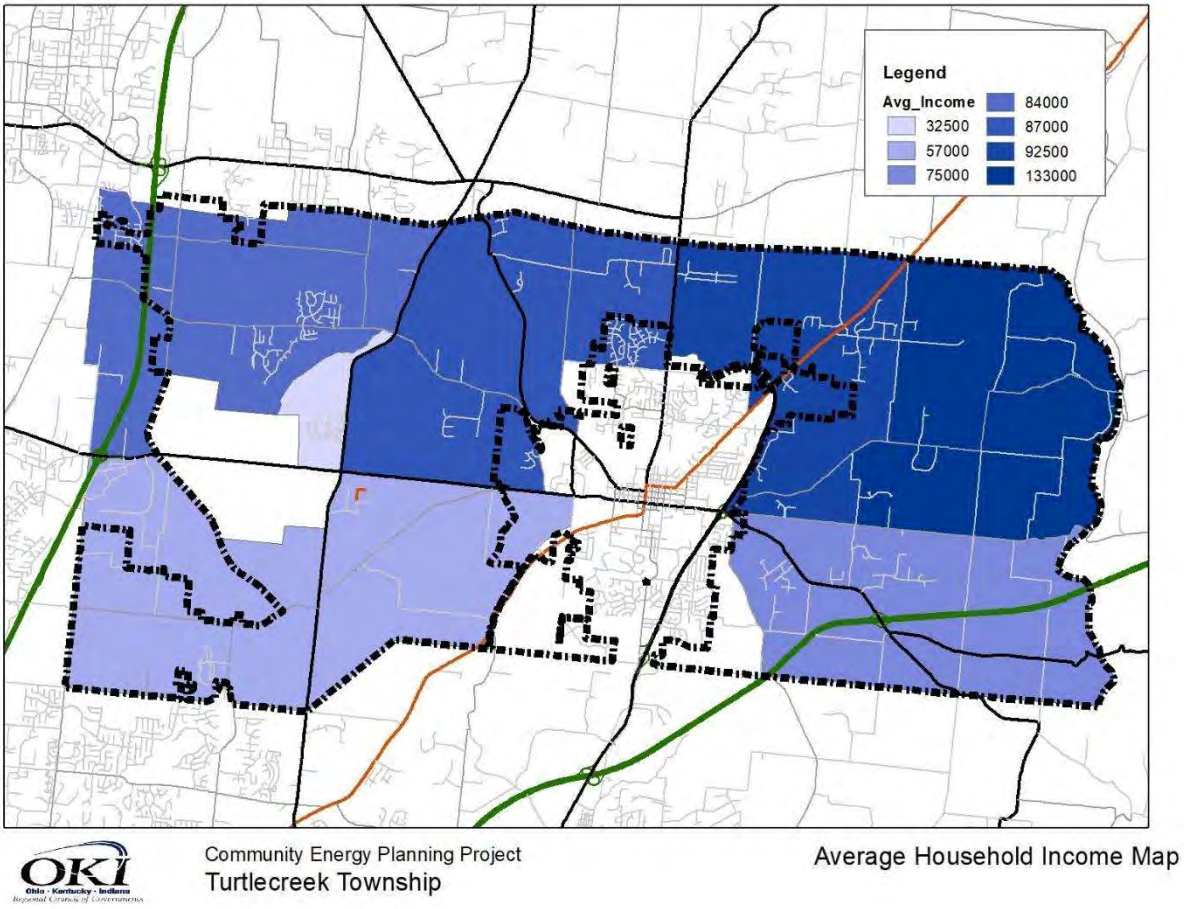


As seen in the map in Figure 7, the census block groups in the southern half of the township experience the most energy burden. The most cost burdened block group in the southwest quadrant experiences energy bills 60 percent higher as a percentage of income than the average household in the township.

Energy burden analysis is meant to identify disparity in the use, cost, and affordability of energy. Disparity in Energy Burden is often felt by residents of particular groups. We look at how Energy Burden coincides with low income, elderly, and minority residents, and residents who rent. In Turtlecreek Township, energy burden mostly coincides with lower household incomes (Figure 8).

It should be noted that the two block groups that experience the highest energy burden also have the highest percentage of homes that use propane or fuel oil for heating. While the homes that use gas or electric to heat are measured experiencing higher energy burden, a significant number of homes in these areas likely experience much higher heating bills due to their reliance on alternative fuels for heat.

Figure 8. Turtlecreek Township Average Household Income (OKI, 2017)



Residential Energy Efficient Incentives / Programs

There are a number of existing incentives and programs available that encourage investment in energy efficient products and improvements by building owners. It is important to understand how these existing programs intersect with the specific needs of the community and where specific needs are not being met.

Below are existing energy efficiency programs and incentives currently available to Turtlecreek Township residents and businesses.

Duke Energy Ohio

Duke Energy Ohio offers a wide range of programs to help homeowners reduce their energy usage.

- **Smart $aver**: Rebates are available to help offset the costs associated with installing certain approved energy efficiency measures. As of 2018, 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.

- **Business Programs:** Duke offers a range of programs designed to assist businesses with reducing their energy use. Programs include free energy assessments, free energy consultations, and rebates.

State of Ohio ECO-Link Loan Program

The Office of the Ohio Treasurer of State works with local lending partners to provide up to a three percent interest rate reduction for loans that are used to fund energy efficiency improvements. Additional information is available at www.ECOLink.ohio.gov.

Miami Valley Community Action Partnership

Miami Valley Community Action Partnership offers programs that provide weatherization assistance to homeowners and renters in Warren County that meet certain income guidelines. Assistance includes free energy audits, installation of insulation and air sealing improvements, lighting upgrades, as well as other efficiency related measures. The Home Weatherization Assistance Program is funded through the State of Ohio.

Energy Efficiency in Commercial Buildings

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 (see Figure 9). Upgrading to the best available technologies could reduce energy consumption even further, saving property owners up to 46 percent.[13]

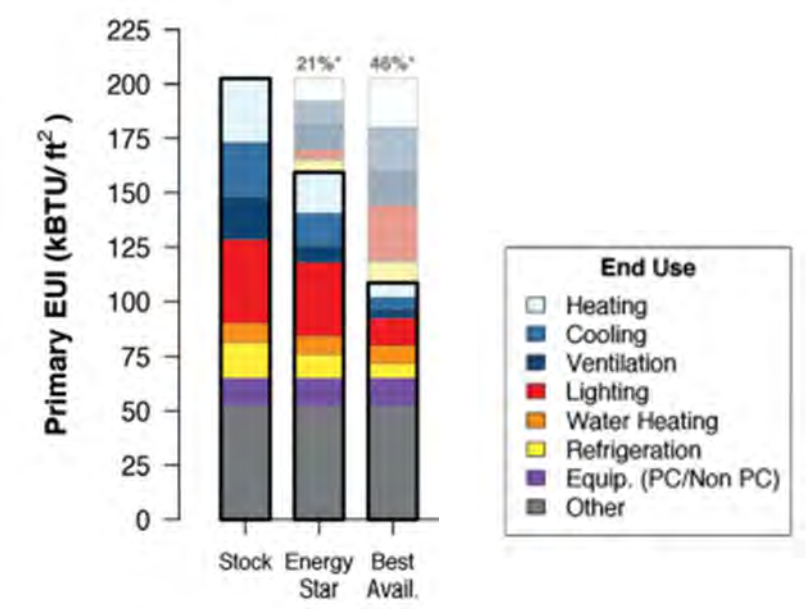


Figure 9. Potential Commercial Energy Savings. Source: US DOE, Quadrennial Technology Review, Chapter 5, September 2015, page 146

While the commercial and industrial buildings in Turtlecreek vary in age and use, there are several improvements that any building can do to reduce energy use.

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 use, 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, often, they do not have systems in place to effectively manage their lighting or heating and

[13] U.S. Department of Energy (DOE). 2017. "Quadrennial Technology Review: An Assessment of Energy Technologies and Research Opportunities." DOE. March 15, 2017. https://www.energy.gov/sites/prod/files/2017/03/f34/quadrennial-technology-review-2015_1.pdf.

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.

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.

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 (including apartment buildings with 5 or more units) for energy efficiency and renewable energy improvements. These improvements can range from insulation, heating and cooling equipment, to solar or wind power generation. PACE provides financing for 100 percent 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.

Local Government Energy Use

Turtlecreek relies on electricity, natural gas, and fuel oil 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.

Figure 10: Turtlecreek governmental energy consumption by end use

	Percentage of energy usage
Facilities - Electricity	31.30%
Facilities - Heating	68.70%

Graphet Data Mining conducted an energy audit of the Turtlecreek Township Administration Building and Station 31 on Oregonia Road 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 and maintenance bays, used just under $28,000 in natural gas and electricity during the twelve-month period examined. Electricity represents the largest utility cost. An analysis of the data showed that Turtlecreek is paying $0.099 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 natural gas side, Turtlecreek is paying $10.07 per MMBtu which is a competitive rate.

Figure 11: Turtlecreek Administration Building Energy Usage

	Amount Consumed	kBtu Equivalent	Cost
Electricity	166,409 kWh	567,811	$16,407
Natural Gas	10,988 ccf	1,120,800	$11,290

Station 31 used just under $5,200 in fuel oil and electricity during the twelve-month period examined. Fuel oil represents the largest utility cost. An analysis of the data showed that

Turtlecreek is paying $0.134 per kWh for electricity, which is not a competitive rate. On the fuel oil side, Turtlecreek is paying $2.70 per gallon which is a competitive rate.

Figure 12: Station 31 Energy Usage

	Amount Consumed	kBtu Equivalent	Cost
Electricity	7,579 kWh	25,861	$1,013
Fuel Oil	1,543 gal	214,477	$4,159

The administration building's occupancy varies throughout the day due to its mixed uses. The portion of the building that houses the fire department is occupied 24 hours a day while the administrative offices are used primarily during traditional business hours. In addition, the trustee 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 I. The report identified the following energy conservation opportunities (ECO) as high priorities:

Interior and exterior lighting

Turtlecreek has already converted all the interior lighting at the administration building to LED bulbs, which has served to significantly reduce its electricity usage. The township should now begin the process of upgrading its exterior fixtures to LED bulbs as well. By converting to LED bulbs, the township could save an estimated $944 to $1,049 in electricity costs annually.

Station 31 has not had any of its interior or exterior lighting upgraded to LED bulbs. Based on growth patterns in the township, the future of the facility is under discussion. If the township decides to continue to operate the facility as a community meeting space with limited usage hours, then switching to LED bulbs is less of a priority. However, if the township decides to operate the facility as a staffed fire station, then it should upgrade the lighting to LED. By converting to LED type B bulbs under this scenario, the township could save an estimated $1,234 to $1,481 annually.

HVAC replacement strategy – Administration Building

The split systems currently providing heating and cooling to the administration building are 13 years old. The systems are at a point where the township should have a replacement strategy in place for when they are no longer operational. One option for replacement would be to replace the split systems with a roof-top unit. This option has a higher upfront cost and would result in considerable annual savings. The second option is to replace the existing split

systems with newer high efficiency units. This option will have a lower upfront cost and could allow the units to be replaced on an as needed basis.

HVAC replacement strategy – Station 31
Station 31 currently has one split system that provides heating and cooling and one furnace for heating only. Given the high cost of fuel oil for heating, the township should consider switching to an air source heat pump. A new high efficiency heat pump can operate at lower external temperatures than older models. This limits the reliance on electric resistant heating to periods when temperatures are extremely low. By installing new high efficiency air source heat pumps, the township could save an estimated $1,906 to $2,118 annually.

Adjust temperature settings on the HVAC units during unoccupied hours
The HVAC units in the administration building are set at a constant temperature 24 hours a day, 365 days a year. 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. This ECO is estimated to save between $1,030 to $1,471 annually if the thermostats are set to reflect occupancy hours.

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

Figure 13: Energy Conservation Opportunities for Turtlecreek Township

ECO	Priority	Investment Required	Estimated Annual Cost Savings
Implement temperature setbacks	High (Operational)	Minimal	$1,030 - $1,471
Split system replacement at administration building	Low (Investment)	Medium	$143 - $245
Split system replacement at Station 31	Mid (Investment)	Medium	$1,906 - $2,118
Exterior lights at administration building	High (Investment)	Minimal	$944 - $1,049
Interior LED lighting retrofit at Station 31	High (Investment)	Minimal	$1,467 - $1,630
Insulate apparatus bay doors at administration building	Low (Investment)	High	$600 - $706

Street Lighting

Switching to energy efficient streetlighting that utilizes LED technology could help Turtlecreek Township reduce its electricity demand for lighting. 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 streetlighting 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.[14]

The Outdoor Lighting Accelerator created the decision tree shown in Appendix F to help local governments determine the best way to pursue lighting projects. One of the first steps is to determine who owns the streetlights. Currently all streetlights in Turtlecreek Township are owned and maintained by Duke Energy. This means that the township would need to work directly with Duke Energy to purchase and install the fixtures.

Turtlecreek Township should evaluate the cost effectiveness of any proposal for streetlighting improvements it receives from Duke Energy. LED bulbs produce a better light than traditional streetlights which would improve the physical environment of the community and enhance public safety.

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

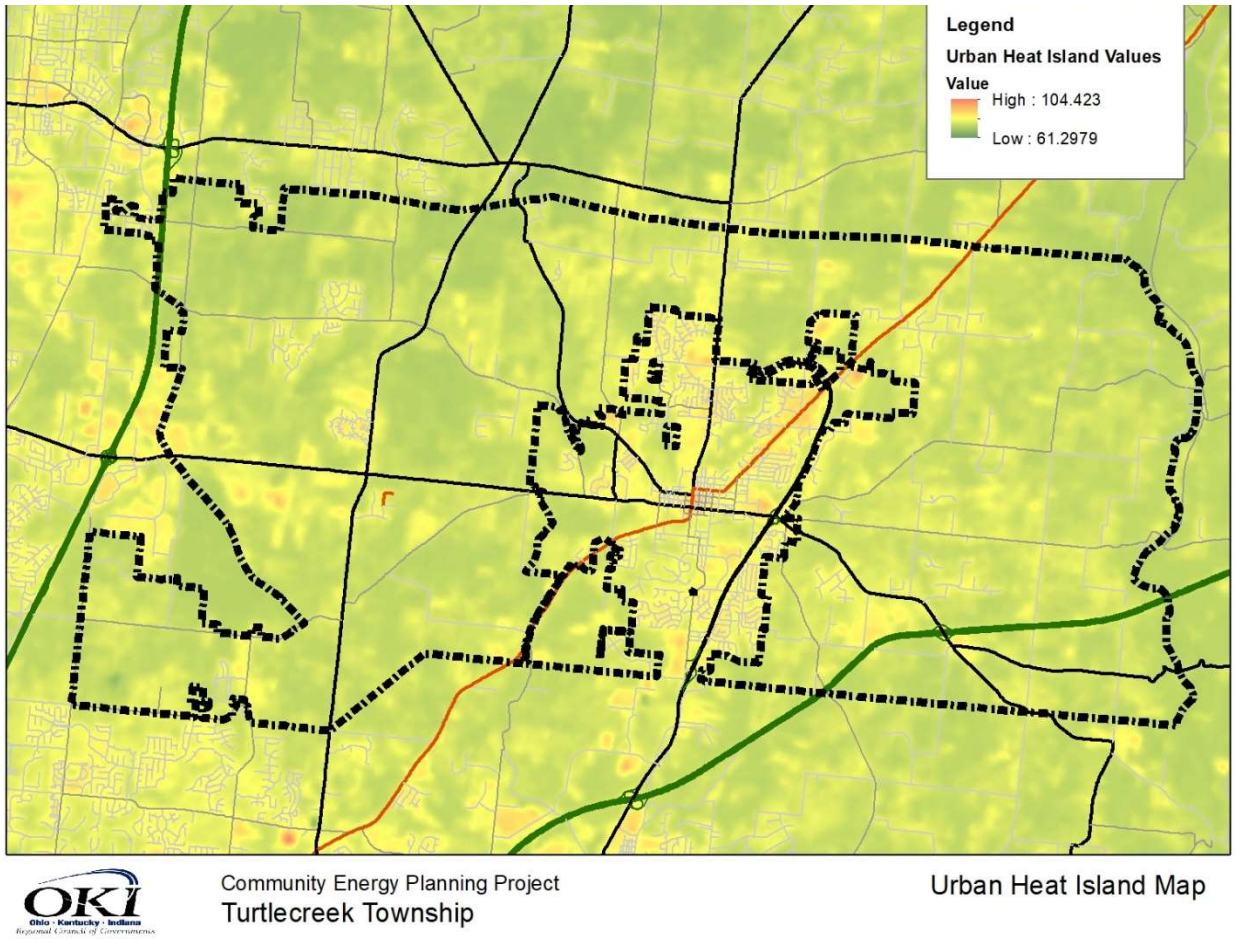
Development Patterns

Turtlecreek Township, which surrounds the city of Lebanon, and has convenient access to both I-75 and I-71, is currently seeing significant development pressure. The township is home to the largest single residential development in the region, Union Village, currently in its first phase of development. This one development will bring over 4,500 new homes, along with a mixed use town center. With this expected growth on the horizon, Turtlecreek Township has the opportunity to encourage a pattern of development that promotes energy efficiency.

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

Figure 14. Urban Heat Island Map. Source: OKI, 2019



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 include:

- Dark roofing material
- Parking lots
- High concentration of buildings
- Areas with a lack of tree canopy

The phenomenon impacts energy usage, particularly in the summer months, when air conditioners are forced to run more often, and for longer periods of time due to the increased air temperatures in localized areas, and more generally in the urbanized region.

Walkability

With transportation comprising a significant percentage of a community's energy usage, designing roads that accommodate pedestrians and bicycles provides an energy saving alternative to cars. Walking or biking for shorter trips reduces air pollution and is a good form of exercise. Certain development patterns and infrastructure can promote walking as an alternative to car travel. A summary of the ample benefits of a capable sidewalk and trail network are listed below.

- Increases the opportunity for physical activity, thus, positively impacting public health by combating inactivity.
- The walkability of a neighborhood can increase property values.
- Forges a better sense of community.
- Improves air quality and decreases energy use by reducing vehicle trips.

The ***Lebanon Turtlecreek Trails Initiative*** provides a detailed vision for a network of trails to connect the core community, new developments, and community destinations, facilitating walking and bike trips throughout the township. Also, The ***Turtlecreek Crossroads Plan*** incorporates some of these ideas of connection, pedestrian activity, and placemaking, with a focus on creating a node of density, rather than commercial "strip" development along major roadways.

Cluster Developments

Cluster developments are residential developments that utilize only a portion of the developable site for development, and leaves a significant portion of the site in an undeveloped state. Cluster developments have also gone by the name Conservation Developments. The benefits of this style of development in a rural community are many. 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.

Figure 15: Typical Cluster Development Plan

Cluster developments also reduce energy consumption in a number of ways. By clustering the home sites closely together, lot sizes are significantly smaller than typical rural lots. Lawn is a particularly energy-hungry land cover. It takes energy to mow. It also requires watering through dry times – water that requires a lot of energy to treat and pump to the house. Additionally, fertilizer is an 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.

Additionally, cluster developments minimize infrastructure. This saves energy in the construction and maintenance of these items. The asphalt streets also contribute to the Urban Heat Island Effect. Minimizing the area covered by streets, and providing areas of tree canopy reduces this impact. In downtown areas, street trees can serve to noticeably reduce summer temperatures.

Lastly, another benefit of this conservation design is minimizing storm water runoff. Storm water management is related to energy efficiency because properly designed infrastructure around cluster settlements allow municipalities to spend less energy treating and moving drinking and waste water. For example, reduced demand at power plants can be achieved by reducing rainwater flows unto sewer systems.

Tree Canopy

Tree canopy is shown to be the strongest determinant of the heat island effect's impact on a community. The higher the percentage of tree canopy, the lower the surface temperatures found within the community. It is also important that the tree canopy be located strategically near buildings, parking lots and roadways, as these development features have the largest impact on the heat island effect. With their shade, trees can significantly reduce the amount of heat these features absorb during the day, and lessen their heat island impact.

In the most recent data available from 2007, Turtlecreek Township is shown to have 23% tree canopy coverage overall. This coverage is relatively low, given that the township is not densely developed. This is likely due to the township's agricultural past. Given this current dearth of tree canopy, it is very important that significant tree coverage be included as development progresses in the township.

The Warren County Rural Zoning Code, which applies to development in Turtlecreek Township, requires trees for parking lots containing 50 or more spaces. The amount of trees required in and surrounding parking areas is sufficiently generous to provide significant shading. In fact, providing trees at a rate much more than the code requires could in some cases be detrimental to the health of the trees, and result in a higher rate of failure among the trees provided.

While landscaping requirements around parking lots are ample enough to provide the needed shade benefit, there is nothing in the code requiring the trees provided to be shade trees. Developers are free to provide any type of tree, and could meet the requirement by providing less expensive ornamental tree varieties that provide little to no shade benefit.

We encourage the following changes to the landscaping requirements found in Article 3, Chapter 4 of the Warren County Rural Zoning Code:

- Section 3.401 A - specifically note shading of buildings, parking lots, roadways, and other large areas of impervious surface to reduce the impact on the urban heat island effect among the stated purposes of the Chapter.
- Require a certain percentage (perhaps 85-90%) of the trees counted in the parking lot landscape requirement be shade trees.
- Define the term "shade tree" as "An evergreen or deciduous tree of a species with an expected mature height of over forty (40) feet and an expected crown spread of over (30) feet." or similar definition.

It will also be important to replenish the tree canopy in new residential subdivisions. This can be done through zoning by requiring street trees and/or a minimum number of trees planted per lot by the builder. The township could also partner with advocacy groups, like Taking Root, or local nurseries to encourage residents to plant a tree in observance of Arbor Day. These efforts will gradually boost the tree canopy coverage in the township and mitigate new development's impact on the urban heat island effect.

Emerging Energy Trends

The majority of energy used by Turtlecreek 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 release large amounts of greenhouse gas. The American Lung Association's annual *State of the Air* report ranked the Cincinnati Metro Area 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 becoming a larger portion of the nation's energy generating capacity. In 2017, the U.S. Energy Information Agency projected a 400 percent 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. Distributed generation improves the resiliency of the utility network because it lessens the chance of an event knocking out a critical portion of generating capacity on the grid. Finally, distributed generation is located closer to the point of us and 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 (PV)

While it is commonly accepted that the best region in the U.S. to harvest solar resources is in the Southwest (New Mexico, Arizona, etc.), data shows that solar penetration levels to surface, in the Southwest Ohio region, are among the highest in the state (see Figure 16).[15] Therein lies an opportunity for Turtlecreek Township to assist residents and businesses which have indicated an interest in harvesting solar energy by providing applicable information about solar energy options.

The Office of the Ohio Consumers' Council provides user-friendly, consumer protection guides about their utilities and alternative energy sources. These resources, such as the Solar Power Factsheet, can be found at www.occ.ohio.gov.

The Solarize initiative, facilitated by the Greater Cincinnati Energy Alliance, is a partnership with local governments to assist homeowners and interested residents with the solar installation process, free of charge to the community. It provides solar energy advice for homes and businesses, access to the certified, solar installation network, and offers discounted pricing on solar equipment.

An important aspect to consider when planning for solar installations, on existing or future buildings, is the solar potential and roof orientation to the sun. In partnership with GCEA, OKI provides an online, interactive Solar Map that allows users to determine if the building is good for solar or too shaded solar, using a specific address. Additionally, this resource can indicate the percentage of useable roof area, the size of the potential system, the potential number of kilowatts per year that the system would produce, an annual utility savings estimate and optimal areas of the roof for the panels. Many of the rooftops of commercial buildings show very good potential for solar. More information can be found at www.solar.oki.org/map/.

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.

[15] National Renewable Energy Laboratory (NREL). "Solar Maps." NREL.gov. Accessed January 17, 2020. https://www.nrel.gov/gis/solar.html.

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 North American Board of Certified Energy Practitioners® (NABCEP®) certified employees on staff.

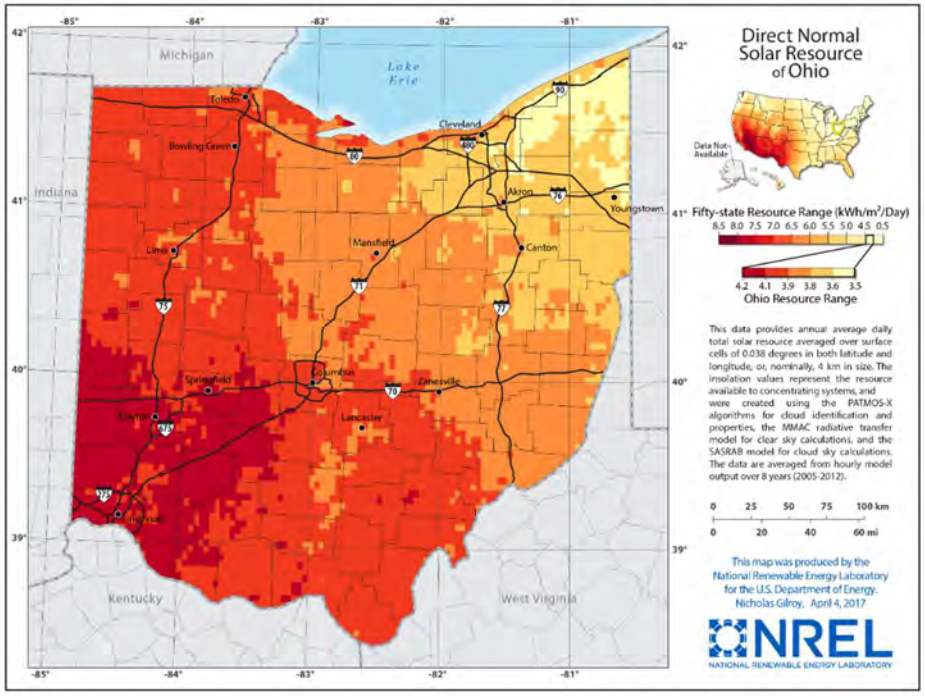


Figure 16. Average daily total solar resource, measured using grid cells in Ohio.
Source: NREL, 2017

Currently, there are four properties in Turtlecreek registered with the Public Utilities Commission of Ohio (PUCO) as certified solar facilities.[16] However, because property owners are not required to register with the PUCO, there could be some additional commercial or residential properties in Turtlecreek that have installed solar panels.

There are several steps that the Turtlecreek Township can take to make it easier for property owners to invest in solar. Here are a few best practices a community can take:

- **Launch a Solarize Campaign –** Turtlecreek Township 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.

[16] "Ohio-Certified Renewable Facilities." 2017. PUCO. January 17, 2017. https://www.puco.ohio.gov/utility-maps/electric-maps/ohio-certified-renewable-facilities/.

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 Turtlecreek requires in order to permit a solar installation.

- **Discount or Waive Permit Fees-** For existing homes and new development, discounting waving fees can act as an incentive mechanism to spur further residential solar because it increases affordability of installation.

- **Indicate an interest in renewable technologies in future, non-energy related plans –** Developing a vision for renewable energy use and capacity involves using and evolving the tools and resources that the Township, and its region, utilizes to make sound decisions about what the community aspires to become. Tools and resources that guide in this way focus on work towards plans, such as updates to the comprehensive plan, economic development plans, corridor plans, transportation plans, redevelopment plans and public facilities plans'. A positive outcome of plan revision and implementation, as related to energy, is communication toward consensus, integration, continuity and sustainability in the future growth of Turtlecreek.

Electric Vehicles

Electric vehicles (EVs) are vehicles that use electric motors, to be propelled, and are fueled by electric energy. There are three types of EVs: hybrid electric, plug-in hybrid electric, hydrogen fuel cell and all-electric. Benefits of driving EVs include regenerative braking systems, higher fuel efficiency than internal combustion (gasoline) systems and reduced noise, as they run more quietly. Energy sources for electricity utilization vary, but the most fuel efficient EV, with the lowest emissions, are non-hybrid, electric and hydrogen-fuel cell vehicles. Over the past eight years, U.S. plug-in electric vehicle sales have continued to increase, with sales nearly doubling from 2017 to 2018 (see Figure 17).

There are two main ways of fueling electric vehicles. The most popular is with batteries that must be recharged through a plug. There are a couple of disadvantages with cars of this type. First, the batteries add considerable weight to the vehicles, which, in turn, consumes more energy. Second, battery electric vehicles require considerable time to recharge. The other, less common type of electric vehicles is hydrogen fuel cell vehicles (HFC). HFC vehicles use a fuel cell that mixes air with pure hydrogen to create electric current. There are no batteries and HFC vehicles can be refueled in five minutes with similar range as a gasoline car. The main downside to HFC vehicles is the need to build infrastructure and refueling stations to support the vehicle fleet. There is more information about the distinct features of each EV type discussed in Appendix H.

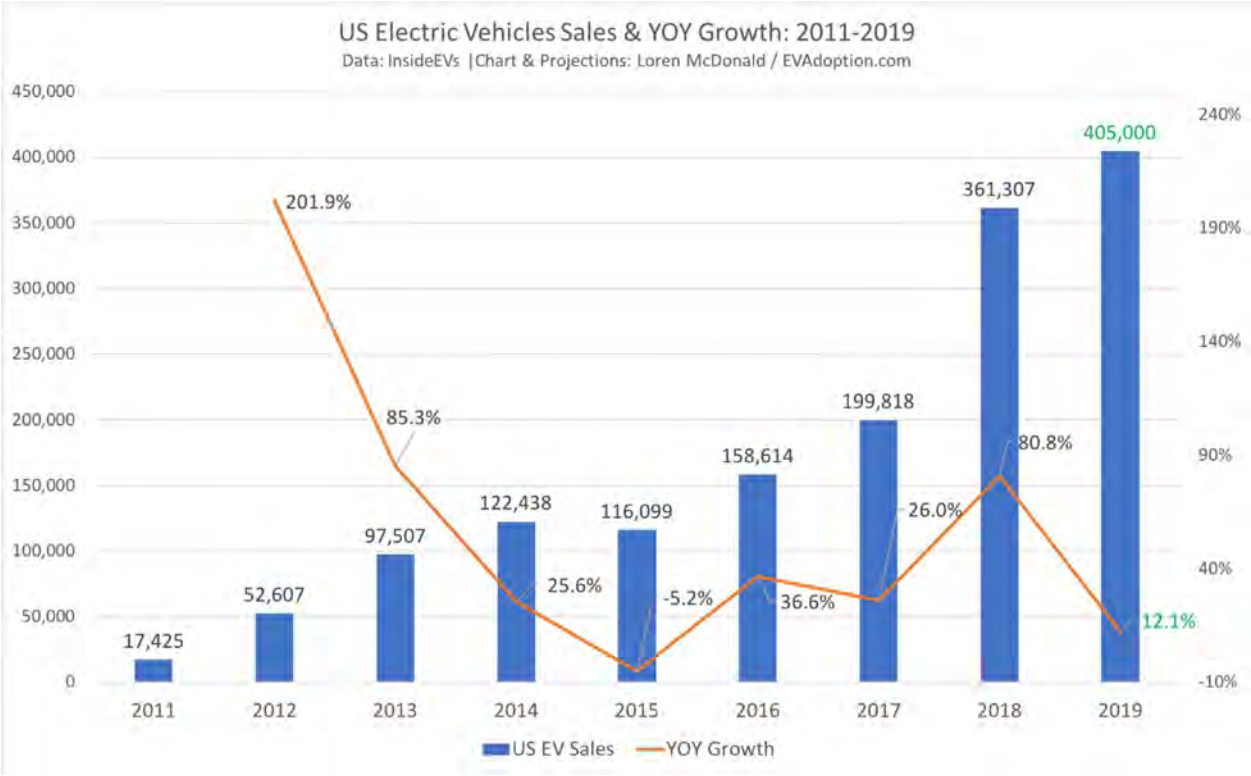


Figure 17. Growth of US Electric Vehicle Sales 2011- 2019

Within the existing fueling infrastructure, there are zero public hydrogen fuel stations in Ohio. However, there are over 1,000 electric charging stations. Depending on type of battery and charger, the battery can charge in full in one day (Level 1 chargers), several hours (Level 2 chargers), or in 30 minutes (DC Fast Chargers). Chargers can be located at residential properties, workplaces and public destinations. There two public Level 2 chargers near Turtlecreek Township, at the Premium Outlets in Monroe and Clearcreek Park in Springboro. There are no DC Fast Chargers near Turtlecreek Township.

Concerns about access to alternative fuel stations in communities are forming around equity considerations- a topic relevant to land use and potential zoning regulatory action. As the use of

electric vehicles, and their charging stations, may increase, the local community will need convenient access to charging infrastructure, especially among residents who rent, because they cannot install private chargers at their homes. While not at that point yet, there may be a time when the township will need to concern itself with equitable access to charging infrastructure for its residents.

Behavior and Energy Use

Behavior and how we use resources can have significant influence over energy use, even when the connection to energy isn't apparent. Two examples of this are how our use of food and the act of recycling waste can impact energy use.

Food and Energy

While it might be difficult to see the connection between food and energy, food is, in fact, the physical manifestation of many layers of added energy. Food must be grown or raised, taking energy from the sun, water, and nutrients in the soil to grow plants. Those plants are food themselves, or fed to raise animals. Food must be processed and/or packaged, transported and distributed, adding more layers of energy. According to the USDA, food related energy use accounts for nearly 16 percent of total US energy use and growing. On the whole, food is very energy intensive to make and deliver to the customer. In the US, it takes over 8 calories of energy to deliver one calorie of food to the customer. Some products, like beef, require ten times as much energy.

There are ways that local government can help reduce the amount of food waste, and in turn, save wasted energy:

- Offer the community's fire stations as locations where residents can donate non-perishable food. Fire stations are staffed 24/7 and therefore are convenient for residents to drop off donations. A partnership can be formed with a local food bank to regularly gather the donated items. There are several dozen food banks serving southwest Ohio. Here is a website listing them https://www.help4seniors.org/Find-Resources/Resource-Directory-Results.aspx?CategoryID=Food+Pantries+and+Soup+Kitchens

- Encourage the school district to start a food rescue program at schools. Amity Elementary School in Deer Park has a Food Share Table in the cafeteria. Students can place unwanted food items on the table where other students can select them. Any unwanted items at the end of lunch are taken to a local food pantry.

- Residential Composting – The Warren County Soil and Water Conservation District holds yearly workshops to teach residents how to compost in their own backyards. The township can host one of these workshops and help publicize it to residents.

- There is often confusion about expiration dates printed on the packaging of the food we buy. This confusion can lead to food being discarded when it might be perfectly fine to eat. The County Health Department and/or the County Extension Office offers food safety education and brochures. The township can partner with these agencies to bring this information to residents and businesses.

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.[17]

Here are the typical energy savings for recycling certain materials:

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

Turtlecreek Township provides trash removal service to residents via a contract with Rumpke. This contract includes curbside recycling service.

[17] 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

Appendix A: Improvements to Building Energy Efficiency

Below are several common ways to improve the energy efficiency of structures built in the late 19th and 20th centuries.

Figure 18. Applicable Energy efficiency improvements by building age. Source: GCEA, 2018

	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	●	●	●	●	●	●	●
Cooling Systems	High	Medium	●	●	●	●	●	●	●
Windows	High	Low	●	●	●	●	●	●	
Areas above unconditioned spaces	Low	High		●	●	●	●	●	
Knob and tube wiring	Medium	NA	●	●					
Asbestos	High	NA		●	●	●			

Attic insulation: Energy continued to be cheap during the 1950s, so attic insulation was not commonplace. The second floor of Cape Cod style homes built during this period are often hot in the summer and cold in the winter, due to the lack of insulation. The attics, slopes, and knee walls of Cape Cod style homes should be properly insulated to save energy and improve comfort. Ranch style homes are easier to insulate, due to the open attic spaces and may have already had insulation added. Homes with wood siding used balloon-frame construction that can be insulated by dense packing insulation into stud cavities, once all knob and tube wiring has been removed. Insulating solid brick homes is difficult due to lack of wall cavities. This can be solved by framing new walls on the interior, installing insulation, and finishing with drywall. In some instances, homeowners may have the space finished for extra storage and living space. ENERGY STAR recommends that attics in this region have insulation levels between R38 and R60.

Vermiculite is a lightweight brownish-gold mineral that became a popular insulation material in the 1950s. Unfortunately, most of the vermiculite used in insulation was contaminated with asbestos. If you suspect that your insulation is vermiculite, do not disturb it. Contact a qualified professional to test the insulation for asbestos. Vermiculite insulation must be removed before additional insulation is installed. Homeowners may qualify for financial assistance with removing vermiculite.

Windows: Homes built during this period originally had steel or aluminum single pane windows which were viewed as an upgrade over wood windows. The windows were not designed to prevent air infiltration or to provide any insulation value. While replacement with modern energy efficient windows is the best solution, windows that are not replaced should be sealed and caulked, to reduce infiltration. Storm windows are a more cost-effective option to replacement, but do not provide the benefits associated with new windows.

Air Sealing and windows: Air infiltration issues are common in homes of this era. Special attention should be paid to sealing penetrations to reduce drafts, which negatively impact energy usage.

Air penetration is common due to the wood frame, single pane construction of 1900s-1940s era homes. Simple changes can improve the efficiency of historic windows. Ensure windows are properly sealed and caulked, to reduce air penetration. Check to make sure all weights and ropes work properly so the window can close properly. 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 should be properly air sealed.

In the 1950s the common framing materials changed to steel or aluminum, while keeping the single paned design. The metal framing material was viewed as an upgrade, during this era, yet does not adequately reduce air infiltration. The best solution is replacement, with modern, energy efficient windows. If not replaced, windows should be sealed and caulked.

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 percent efficient ENERGY STAR unit. In addition, all accessible distribution piping should be insulated. Other homes may have a forced air system that was installed at some point in time, as was commonplace in the 1950s. 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. Older air conditioner units should be replaced with ENERGY STAR units, as well. Duct work should be sealed with mastic and insulated, if located in an unconditioned space. Homes with electric resistance heaters should consider upgrading to a forced air system with a heat pump.

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.

Water: Residential energy efficiency for water use is tied to hot water usage. There are numerous sources throughout the home that may potentially use hot water, such as a clothes washer, shower, dishwasher, and kitchen and bathroom faucet. Manufacturers have been federally mandated to produce low-flow fixtures, to achieve a greater water savings than older models.[18] This includes low-flow faucets and showerheads. Home appliances should be replaced with ENERGY STAR high efficiency units.

[18] United States Department of Energy (DOE). n.d. “Reduce Hot Water Use for Energy Savings.” Energy.gov. Accessed March 2, 2020. https://www.energy.gov/energysaver/water-heating/reduce-hot-water-use-energy-savings.

Appendix B: Urban Heat Island

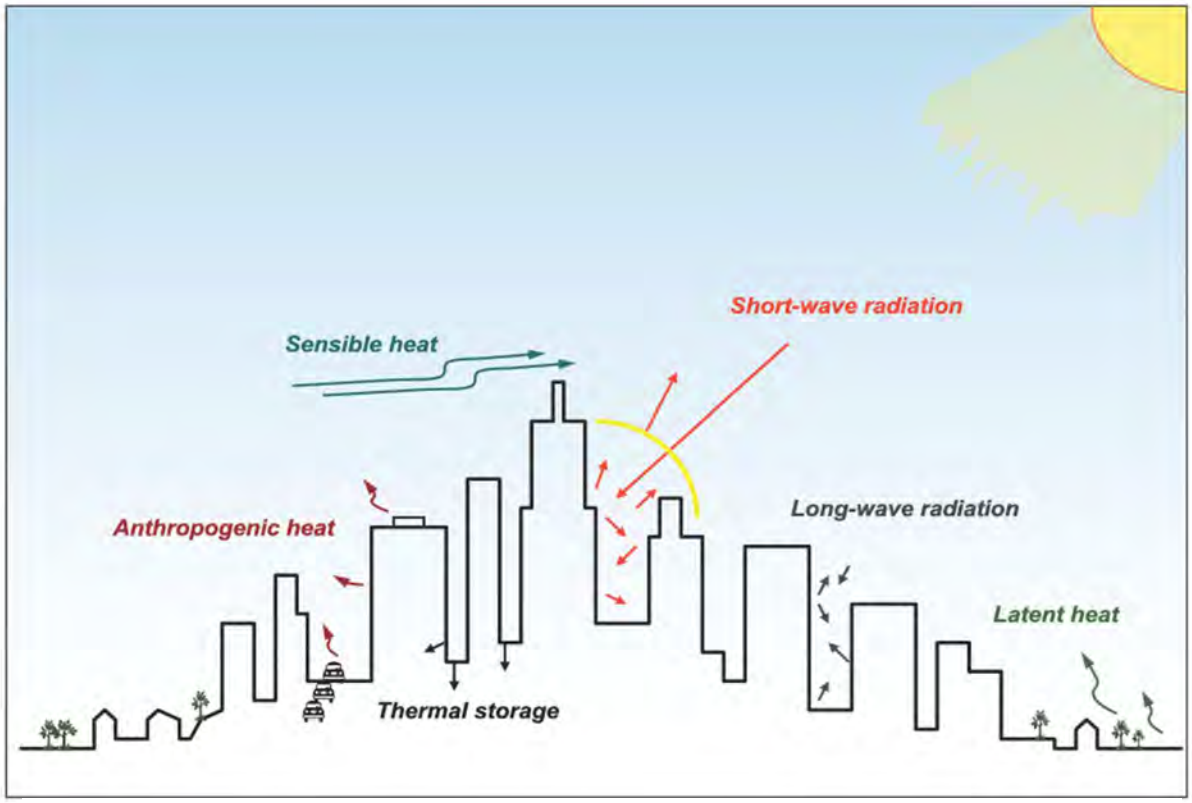


Figure 19 . Urban Surface Energy budget. Source**:** U.S. EPA, Reducing Urban Heat Islands, 2014, Chapter 2, page 11

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[19]

[19] U.S. Environmental Protection Agency. 2014. "Reducing Urban Heat Islands: Compendium of Strategies-Urban Heat Island Basics." US EPA. June 23, 2014. https://www.epa.gov/sites/production/files/2014-06/documents/basicscompendium.pdf.

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[20] found that an incentive covering 80 percent of the cost of an improvement was necessary to spark interest from 50 percent of landlords that are 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 do not reduce the principal cost, but can help those who do not 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 is not aware of the incentive, or the incentive is not 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

[20] 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.

A literature review[21] uncovered two ways a TBA program can be structured. One way, called Pay-As-You-Save, or PAYS, is organized through the utility. The other, called a Green Lease, is an agreement between the tenant and landlord that adjusts the rent in order 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 would not be comfortable with the program.

A Green Lease is where the landlord and tenant 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 moves 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, 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 when the property is extensively renovated, or right

[21] 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

before the property is sold. The documentation is provided by a certified inspector or 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, it is unlikely that the 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 text of this ordinance is included in the Appendix of this plan. 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 Resiliency

Weather events 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 susceptible to disruption by shifting ground or by accidental damage from construction activity, also. Less commonly, but more prevalently due to climate change, extreme weather events, such as tornadoes, can cause damage and outages that require extensive repair to infrastructure.

Resiliency is how susceptible a community is to threats, and how capable they are in overcoming threats when they do occur. There are three components to energy resiliency:

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.

Figure 20. Utility line workers in action. Source: Radio WOSU, 2017

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.

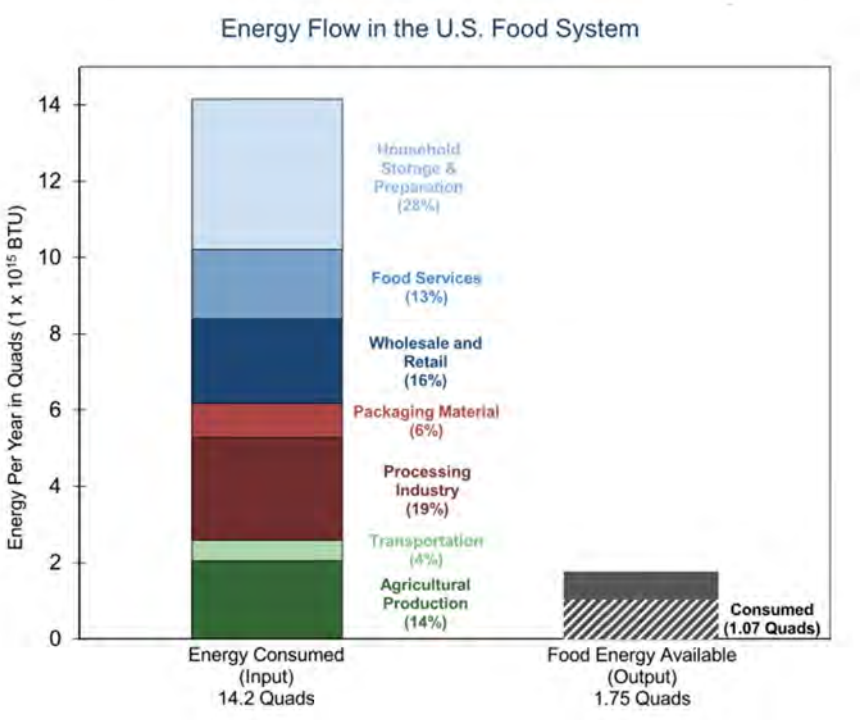
A new aspect to the survivability function is allowing for distributed generation (privately owned solar panels and wind turbines). Given the proper setup, these facilities can be of use in a power outage situation, but also can pose a risk to utility crews working to repair the electric grid. In an 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.

Appendix E: Food Waste and Energy

Food Waste

With so much energy used to produce food in the US, it should be seen as a precious commodity. However, estimates show that about 40 percent of the food produced is never actually eaten.[22] Some of this happens as a byproduct of food processing, bulk storage, or transportation before it reaches store shelves. But, it's estimated that 31 percent of food bought by consumers is thrown away.[23] Accounting for waste, we spend 14 times more energy producing food than we derive from it.

That wasted food then becomes a whole different problem – a trash problem. Food waste is the single largest component going into municipal landfills, at 22 percent of total municipal solid waste generated.[24] There, food waste contributes to another environmental problem – the creation of methane gas. Methane is a potent greenhouse gas and food waste is responsible for 8 percent of global greenhouse gas emissions. If food waste was a country, it would rank third in the world for GHG emissions



[22] Balkan, Elizabeth, JoAnne Berkenkamp, Darby Hoover, Yerina Mugica, Dana Gunders, JoAnne Berkenkamp, Dana Gunders, et al. 2019. "Food Waste." NRDC. Natural Resources Defense Council. December 4, 2019. https://www.nrdc.org/issues/food-waste.

[23] Buzby, Jean C., Hodan F. Wells, and Jeffrey Hyman. 2014. The Estimated Amount, Value, and Calories of Postharvest Food Losses at the Retail and Consumer Levels in the United States. US Environmental Protection Agency Economic Research Service (ERS).

[24] US Environmental Protection Agency. 2015. https://www.epa.gov/sites/production/files/2018-07/documents/2015_smm_msw_factsheet_07242018_fnl_508_002.pdf

behind China and the United States.[25]

Reducing Food Waste

Given the above, the problem of food waste seem like a herculean task to overcome. While that may be true, there are simple actions we all can take to reduce the energy impact of food and reduce the amount of wasted food.

Figure 22. Ways to Reduce Food Waste. Source: US EPA, 2019

Eat Local – food products in the US travel increasingly long distances before they land on the shelf in the local supermarket. Buying locally grown produce can save a significant amount of energy through cutting transportation.

Eat Less Meat – a meat-based diet (28 percent calories from animal products) uses twice as much energy to produce as a vegetarian diet.[26] Also, meat and dairy products are among the highest contributors to food waste in production and spoilage.

Eat Organic – Organic produce don't use chemicals that require lots of energy to produce.

Use Less Refrigeration – Home refrigeration accounts for 13 percent of the total energy cost of the US food system.[27] Processed and convenience foods typically require refrigeration, whereas whole foods, like beans, rice, produce, and cereals don't. Refrigerators today are more energy efficient, but increases in size have largely offset the gains.

[25] Food and Agriculture Organization of the United Nations. http://www.fao.org/fileadmin/templates/nr/sustainability_pathways/docs/FWF_and_climate_change.pdf
[26] "U.S. Food System Factsheet." University of Michigan. U.S. Food System Factsheet | Center for Sustainable Systems. Accessed December 23, 2019. http://css.umich.edu/factsheets/us-food-system-factsheet.
[27] Center for Sustainable Food Systems, University of Michigan. 2018. "US Food System Fact Sheet." Pub. No. CSS01-06

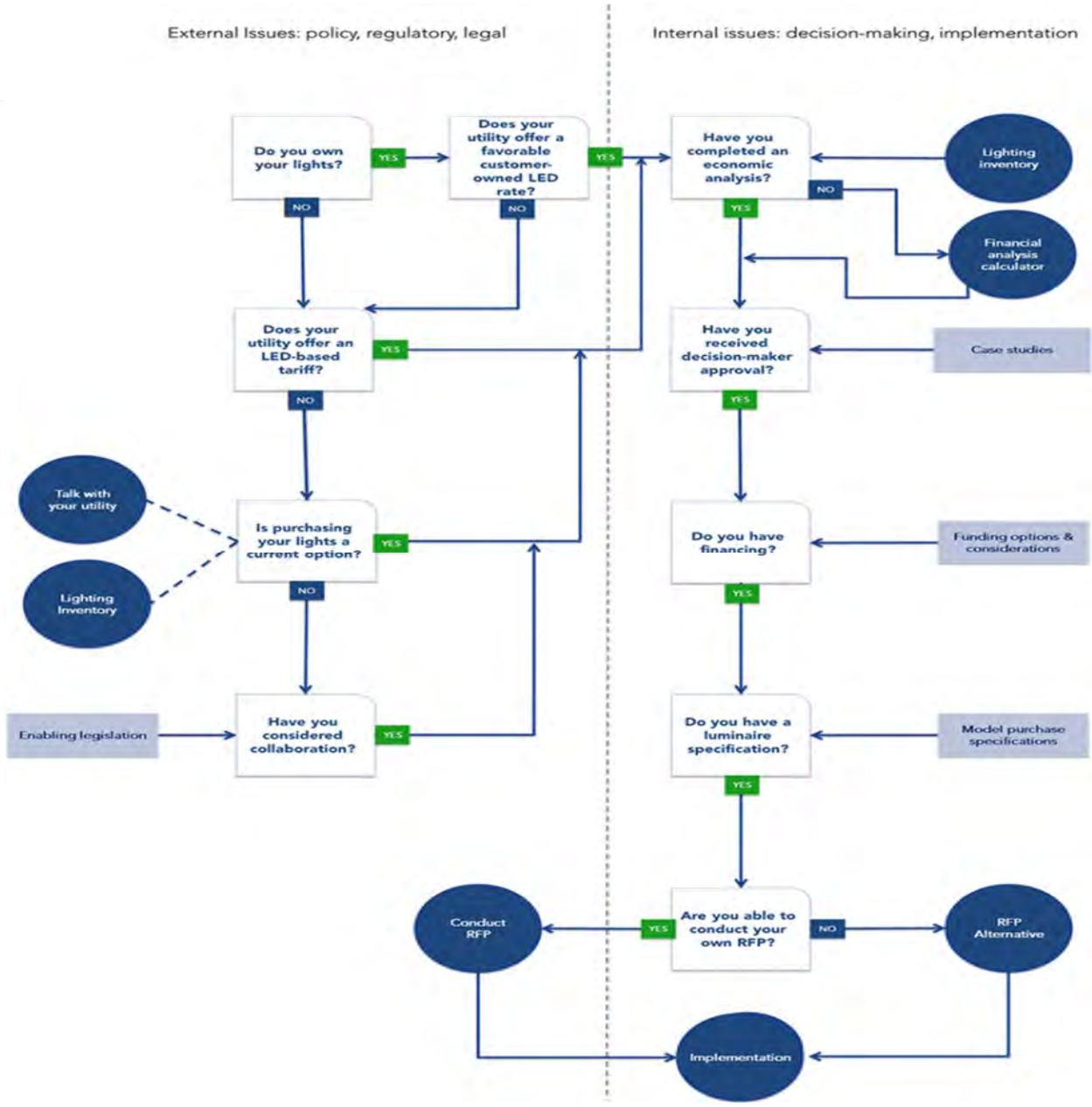
Reduce Waste – Most household food waste is due to spoilage. Avoid this by buying smaller amounts, planning meals, and freezing or canning extra produce. Also, much of discarded foods are still safe to eat, but are tossed due to confusion over "sell by" or "use by" dates.[28]

Even with careful planning, excess food still occurs. The diagram above illustrates the hierarchy of preferred ways to dispose of excess or spoiled food. Here are local resources to aid with sustainably dealing with unwanted food.

[28] USDA, ERS (2016) "Food Product Dating" https://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/food-labeling/food-product-dating/food-product-dating

Appendix F: Municipal Decision Tree for Upgrading Street Lighting

The U.S. Department of Energy Better Buildings Outdoor Lighting Accelerator[29]



[29] https://betterbuildingsinitiative.energy.gov/solutions-at-a-glance/outdoor-lighting-decision-tree-tool-successful-approaches-cities-states-and

Appendix G: Types of Electric Vehicles

There are two types of internal fueling systems for non-hybrid, electric vehicles: electric battery and hydrogen fuel cell. Hydrogen fuel cells use pure hydrogen gas to produce electricity internally. Electric is generated through a chemical reaction - air and hydrogen mix, creating an electric current that expels water and heat. Compared to gasoline, this type of EV reduces greenhouse emissions by 50 percent when hydrogen is produced and processed from natural gas, and by 90 percent when processed using wind energy. Hydrogen can be produced from domestic fuel sources, such as natural gas, biomass, water and waste products.

Hydrogen fueled cars can re-fuel in less than five minutes and have a drive range of over 300 miles. This EV is considered emission free, because the internal chemical reaction only produces water vapor and warm air. Current consumer access is limited to specific geographic regions, like areas in California, but is growing based on developing infrastructure. In Ohio, these EVs qualify for alternative fuel tax credits.

Electric battery EVs draw electricity directly from the local electric grid and store it in the vehicle's battery. The system includes an all-electric auxiliary battery, a charge port, a DC/DC converter, and electric traction motor, onboard charger, power electronics controller, thermal system, traction battery pack and electric transmission. This type of EV produces zero tailpipe emissions. The fuel for this kind of EV can be produced from domestic fuel sources, such as natural gas, coal, nuclear energy, and renewable resources.

EV Charging Stations, Near and Within Turtlecreek Township, Ohio

Station Name	Zip Code	Access Days and Times	No. of Stations, Level 2	Open Date	EV Connector Types	Access	EV Pricing
AAA - Maineville	45039	24 hours daily	1	4/3/2018	J1772	public	Free
Walmart	45040	24 hours daily	3		CHADEMO, J1772, J1772 COMBO	public	Information unavailable
North Park	45066	Dawn to dusk daily	1	6/1/2012	J1772	public	Free
Clearcreek Park	45066	Dawn to dusk daily	1	4/18/2014	J1772	public	Free
Total Cable Solutions	45066	24 hours daily	2	1/1/2014	J1772	public	Free
Dorothy Lane Market Springboro	45066	24 hours daily	2	5/1/2016	J1772, TESLA	public	Free
Liberty Center	45069	24 hours daily	2		J1772	public	$0.15 per kWh
Contech Engineered Solutions LLC	45069	For building tenant use only	2	8/1/2014	J1772	private	Information unavailable
Walmart	45069	24 hours daily	3		CHADEMO, J1772, J1772 COMBO	public	Information unavailable
Woodhouse Day Spa	45069	24 hours daily	2	9/30/2019	TESLA	public	Free
Kings Nissan	45249	Dealership business hours	1	1/31/2012	J1772	public	Free
Kings Nissan	45249	Information unavailable	1	1/31/2012	J1772	private	Information unavailable
Bob Sumerel Tire and Service	45249	24 hours daily	1		J1772	public	Free
McCluskey Chevrolet	45249	24 hours daily	6	12/1/2016	J1772	public	Free
Kings Chrysler Jeep Dodge Ram	45249	Dealership business hours	2	5/1/2017	J1772	public	Information unavailable
Harpers Station	45249	24 hours daily	10		CHADEMO, J1772 COMBO	public	Information unavailable
AAA Club Alliance, Inc.	45249	24 hours daily	1		J1772	public	$0.49 per kWh

Source: www.afdc.energy.gov, www. plugshare.com. Accessed 4/1/2020.

Appendix H: Walkability in Suburban Residential Development Patterns

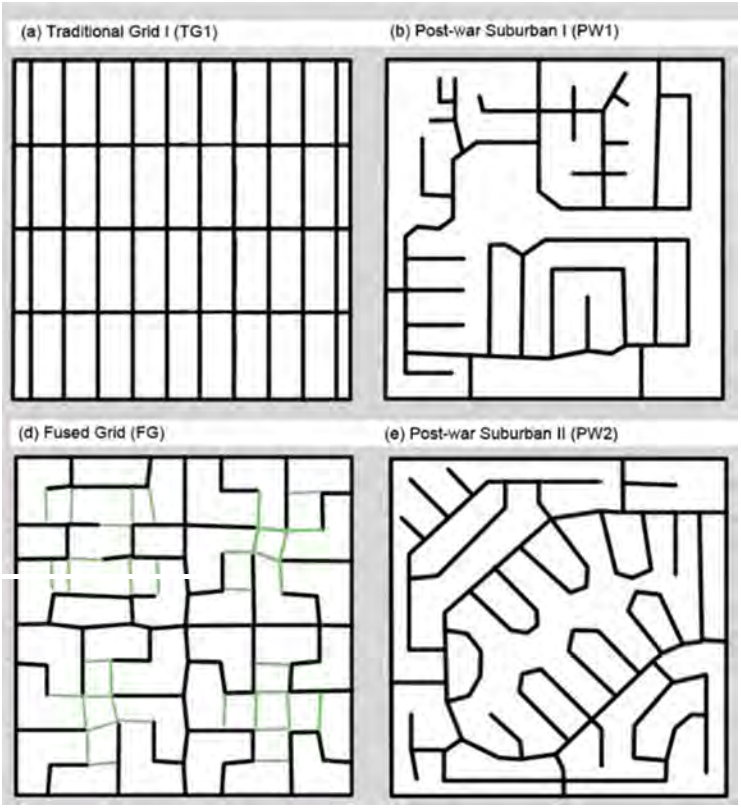
The advent of the automobile and post-war development changed the complexion of American streets. The traditional grid pattern is now typically reserved for high density areas while suburban developments adopted patterns akin to (b) and (e) below.

All four patterns have a direct impact on the daily decisions of commuters. The decision of walking versus driving is dependent on multiple variables, such as distance and traffic volume.

Both of the post-war development models prioritize car travel over walking. There are limited incentives for pedestrians in these patterns and, consequently, special accommodations have to be made.

The fused grid pattern (d) incentivizes walking by providing more direct routes for pedestrians. The fused grid maintains the suburban hierarchy of cul-de-sacs and collectors for cars.[30]

Even without implementing a full-scale fused grid pattern, tenants of its design can be implemented to incentivize walking over driving.



[30] Jin, Xiongbing and Roger White. "An Agent-Based Model of the Influence of Neighbourhood Design on Daily Trip Patterns." Computers, Environment and Urban Systems 36, no. 5 (2012): 398-411.

Appendix I: Turtlecreek Township Facility Energy Assessment Report