Elected Officials

Dan Unger, *Trustee President*

Raj Rajagopal, *Trustee Vice President*

Greg Insco, *Trustee*

Heather Harlow, *Fiscal Officer*

Township Administration

Geoff Milz, *Township Administrator*

Jeffrey Weckbach, *Assistant Township Administrator*

Jenna LeCount, *Director of Planning, & Zoning*

Frank Cook, *Fire Chief*

Kevin Schwartzhoff, *Director of Public Services*

Emily Randolph, *Finance Director*

Mark Denney, *Police Chief*

Energy Plan Steering Committee

Jenna LeCount

Rachel McKinney

Dionne Owens

Garett Pace

Ronald Roberto

Matt Tietsort

COLERAIN
EST. 1794

Table of Contents

The Energy Plan Element

The Colerain Township Comprehensive Plan Update is comprised of several "elements" that thoroughly address the topics of land use, transportation, housing, energy, natural systems, public facilities and services, economic development, intergovernmental coordination, and capital improvements.

The Purpose of this element is to investigate issues centered around energy use and delivery in the community; identify how these issues intersect with land use patterns and transportation choices; and formulate strategies to reduce wasted energy, improve the resiliency of energy systems, meet future demands for energy, and improve access to and the use of renewable and/or cleaner sources of energy. Energy planning at the local level becomes the convergence of planning for many other issues. Energy planning and initiative 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 Element 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 Township Board of Trustees and Colerain Township staff. This planning effort was funded through a Duke Energy / Greater Cincinnati Foundation grant.

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 at an open-house style meeting on March 17, 2018 at Northgate Mall, displayed in the rotunda of the Township Administration Building from March 23rd through April 27th, as well as posted on the Community Energy Plan website at energy.oki.org.

Feedback was also solicited via a web survey, which received 70 responses. The results of the survey is shown in the Appendix of this document. The open-house meeting was promoted via the energy.oki.org website, and via the township Facebook page. Also, the meeting was promoted via boosted social media posts, reaching over 2,200 Facebook users in the Colerain area.

This document will address the issues associated with the following six items:

- Energy Use and Delivery
- Energy's Impact on Land Use and Transportation
- Reduce Wasted Energy
- Improve Resiliency
- Meet Future Demands
- Improve access to renewable energy

1. Energy Use and Delivery

Colerain Township, Ohio is located to the northwest of Cincinnati in Hamilton County. The Great Miami River forms the township's western border and US 27, known as Colerain Avenue along most of its length in Hamilton County, runs north/south through the center of the township. The township covers an area of 43 square miles.

The Township features a regional retail business district along Colerain Avenue. The district is anchored by several large retail developments such as Northgate Mall and Stone Creek Center. Colerain Township to provide additional text.

Colerain is a suburban community which saw its most rapid development beginning in the late 1940's through the 1970's in the southeast half of the township. While the pace of housing development has slowed, new housing continues to be added. There were 22,319 occupied housing units in Colerain Township according to the 2016 American Community Survey conducted by the United States Census Bureau. The majority of residential housing units are located to the east of the Colerain Avenue corridor and in the area between Interstate 275 and Colerain Avenue. Most of the township's housing is single family (80.3%), and the amount of housing that is multi-family (2 or more unit structures) has held steady at roughly 20% of structures between 2009 and 2016. However, the percentage of renter occupied housing in the township has shown marked increase from 18.6% in 2009 to 26.1% in 2016.

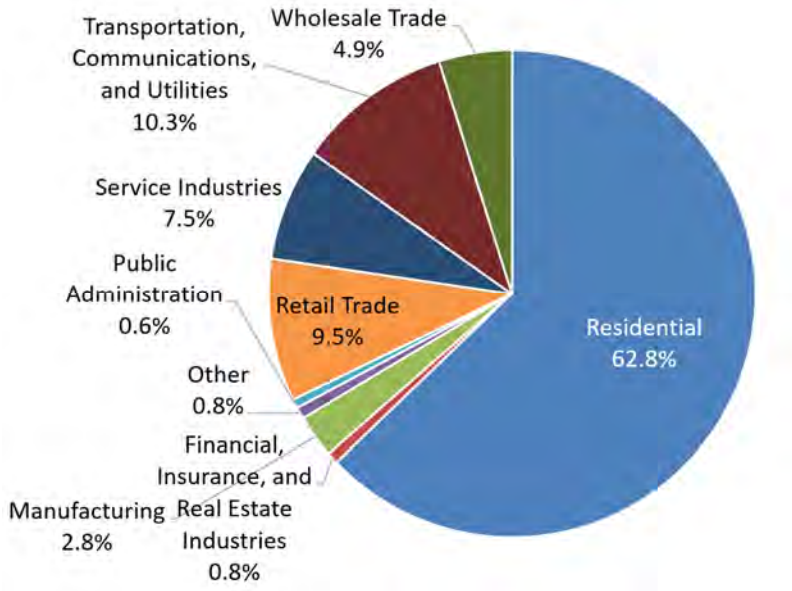

Fig 1: Natural Gas Use in Colerain – 2016 (Duke Energy)

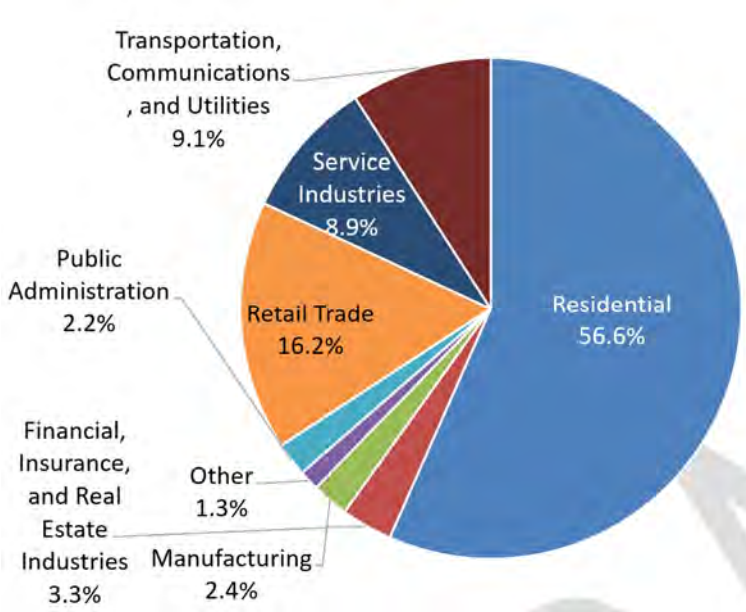

Fig 2: Electricity Use in Colerain – 2016 (Duke Energy)

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

Township Energy Use

Natural gas is used for space heating, water heating, and some manufacturing processes. In 2016, Colerain used 15,204,688 CCF of natural gas (Figure 1). Usage is dominated by the residential land use category followed by the combined retail and service industries. This is inline with current land use patterns. Future natural gas usage patterns are likely to remain the same based on projected growth patterns for the community.

Total electric use in the township during 2016 was 468,860,490 kWh (Figure 2). The largest electric user is the residential land use category followed by the combined retail and services industry categories. This is also in line with current land use patterns. Residential usage will likely remain the largest user in the future even if its share of overall usage declines.

Residential Energy Use

The number of ways that humans use energy in their homes is rapidly changing. 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 Colerain Township.

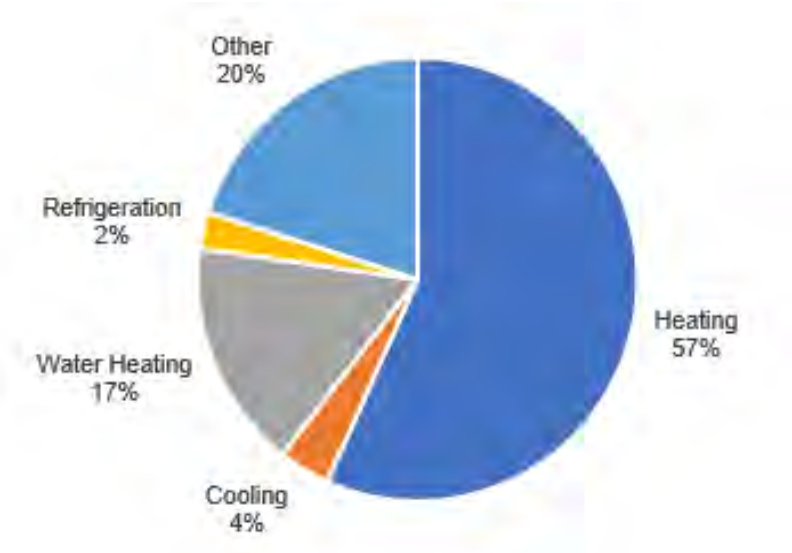

Fig 3: Residential building energy consumption by end use (U.S. Energy Information Administration, Residential Energy Consumption Survey (RECS) 2015)

In 2016 Ohio residents consumed 51,000 kBtu per capita according to the U.S. Energy Information Administration[1]. Based on data from Duke Energy for the same period, Colerain Township residents consumed 30,598 kBtu per capita or about 60 percent of the state average.

Space heating accounts for the largest share of energy use in residential buildings (Figure 3). 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.

Commercial 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 (Figure 4).

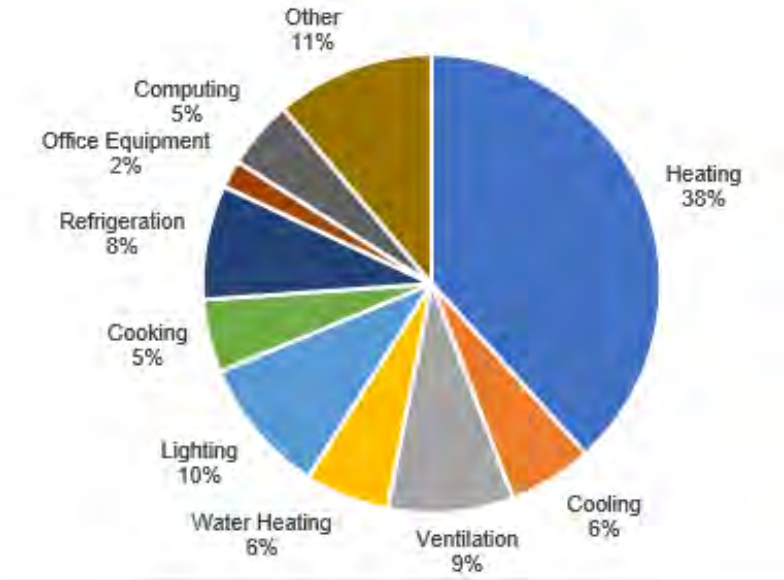

Fig 4: Commercial building fuel consumption by end use (U.S. Energy Information Administration, 2012 Commercial Buildings Energy Consumption Survey)

[1] https://www.eia.gov/state/print.php?sid=OH

Space heating and cooling represent 44% 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 windows, walls, roofs, controls, and HVAC equipment to ENERGY STAR recommended levels can decrease energy usage for heating by 33% and cooling by 40%. While only accounting for 10% 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's Commercial Buildings Energy Consumption Survey (CBECS).

Transportation Energy Use

Measuring the use of energy for transportation for a local community is a very difficult task. The variety and number of vehicles, trips both in and outside the community, and fuel sources make gathering meaningful direct data nearly impossible. Instead, 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.

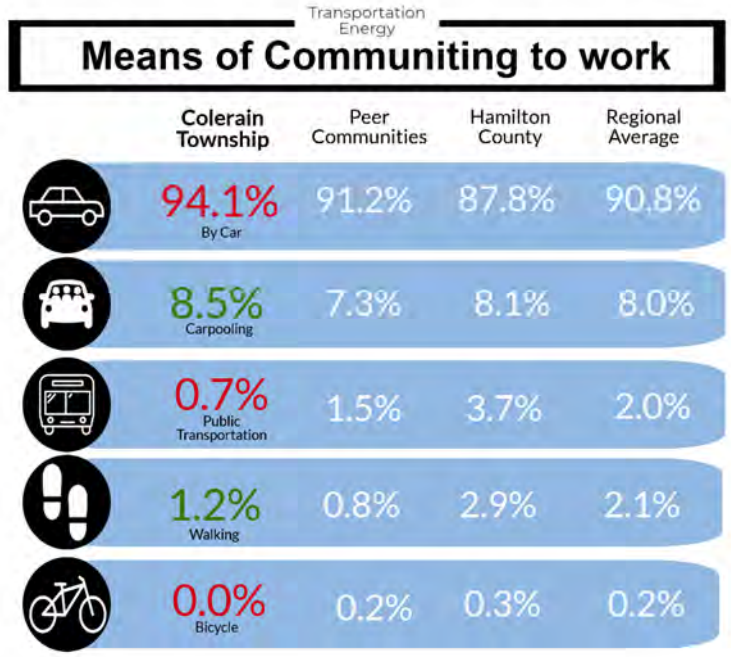

Fig 5: Means of Commuting to Work – 2016 (US Census)

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.

The table above (fig. 5) illustrates how the residents of Colerain Township commute to work compared with

Fig 6: Bike lanes dedicate space within the roadway for bicyclists and improve safety.

residents of selected peer communities and residents of Hamilton County and the region as a whole. The peer communities selected were Green, Anderson, and Sycamore Townships, plus Blue Ash and Forrest Park.

Colerain residents commute more often by car, but somewhat make up for that by carpooling more often. Also more residents walk to work than in the selected peer communities. However, Colerain still falls significantly behind the county and region averages for walking.

Colerain residents do not use public transportation at anywhere near the rate of their peer communities or the county as a whole. The township even falls below the served by bus. Colerain is served by two standard routes and one express route along Colerain Avenue. One of the routes, the 17, cuts across Compton Road to Hamilton Avenue to provide connections to three other routes, two of which offer crosstown access without going downtown. The other two routes serving along Colerain Avenue, the 19 and 74X, head straight downtown. With relatively good access to the region's bus network, the lower level of use is noteworthy.

The entire Cincinnati region falls short when it comes to commuting by bicycle. Much of the area's hilly terrain has a big role in this. Even at that, Colerain has so few bicycle commuters, that they fail to register in the statistics. Most of the businesses and offices in the township are located along Colerain Avenue. With this thoroughfare forming the spine of the road network, few residents could commute without travelling Colerain Avenue. With its heavy, impatient traffic, and sometimes narrow lanes and rutted pavement, Colerain Avenue is not a hospitable place for cyclists.

The common thread between the meager use of busses and bicycles for commuting is the car-dominated environs of Colerain Avenue. While sidewalk is provided along most of Colerain Avenue within the township, many of the residential subdivisions nearby lack pedestrian connections out to the main arterial. Improving pedestrian and bicycle access around Colerain Avenue is key to improving use of transit and biking for residents' commutes.

Energy Burden

Energy burden is the percentage of a household's total income that is spent on energy. 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 households with high energy burdens with programs that can improve energy efficiency and costs.

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

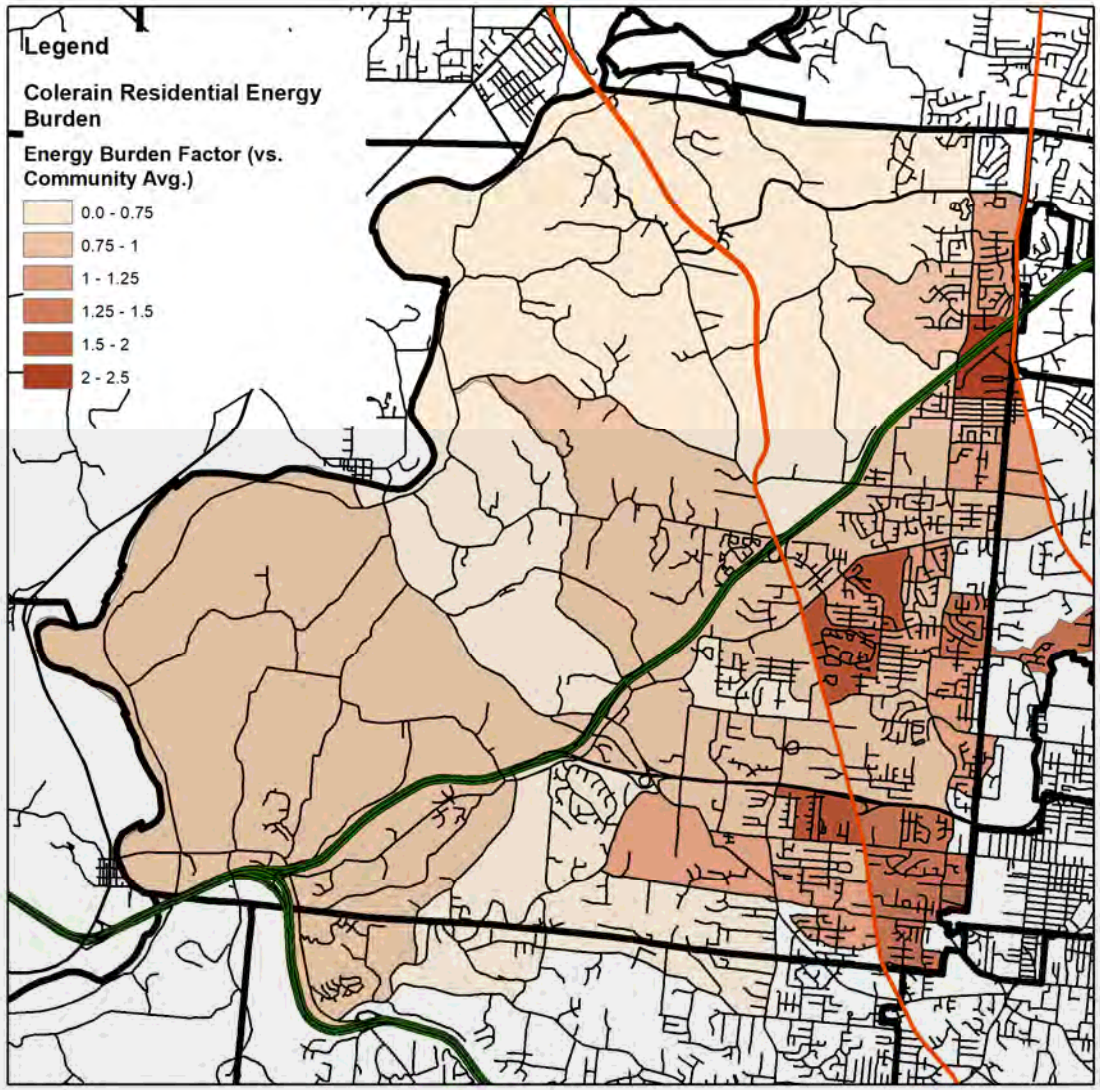

Fig 7: Relative Energy Burden by Census Block Group (OKI)

The prevalence of energy burden in Colerain is worst along the eastern edge of the community, as seen in the map in Fig. 7.

Areas of high energy burden often coincide with certain population groups – low-income, minority, and elderly households. It can be important to note where these populations overlap with areas experiencing high energy burden because outreach efforts should be tailored to the impacted populations.

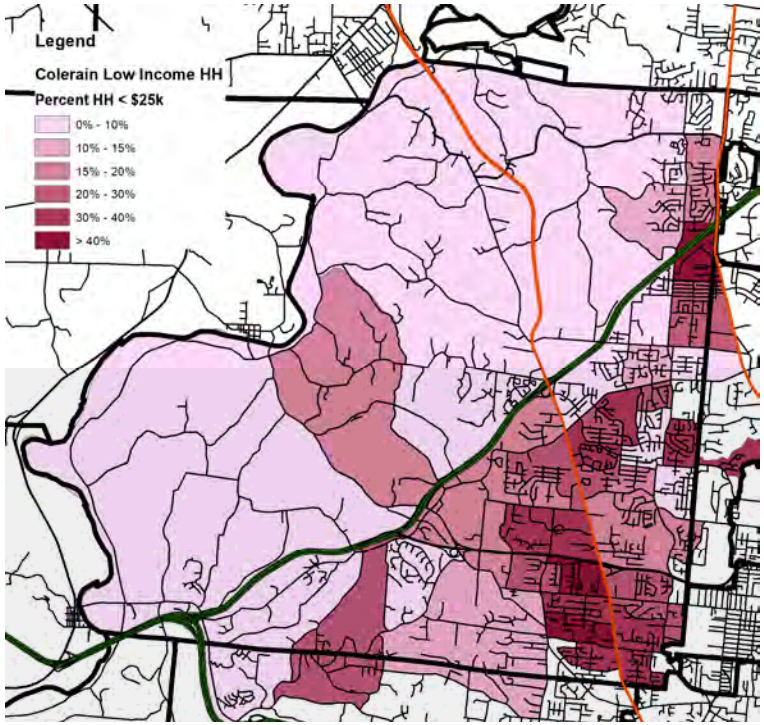

Fig 8: Concentration of Low-income Households (US Census)

In Colerain, the areas of highest energy burden correspond to the areas of highest concentrations of low-income households. It was also found that areas with higher concentrations of minority and senior populations also experience higher energy burden.

Reducing energy burden in the community is a two-pronged strategy of reducing the amount of energy used by affected households, and also reducing the cost of energy. Households that experience high energy burden do so

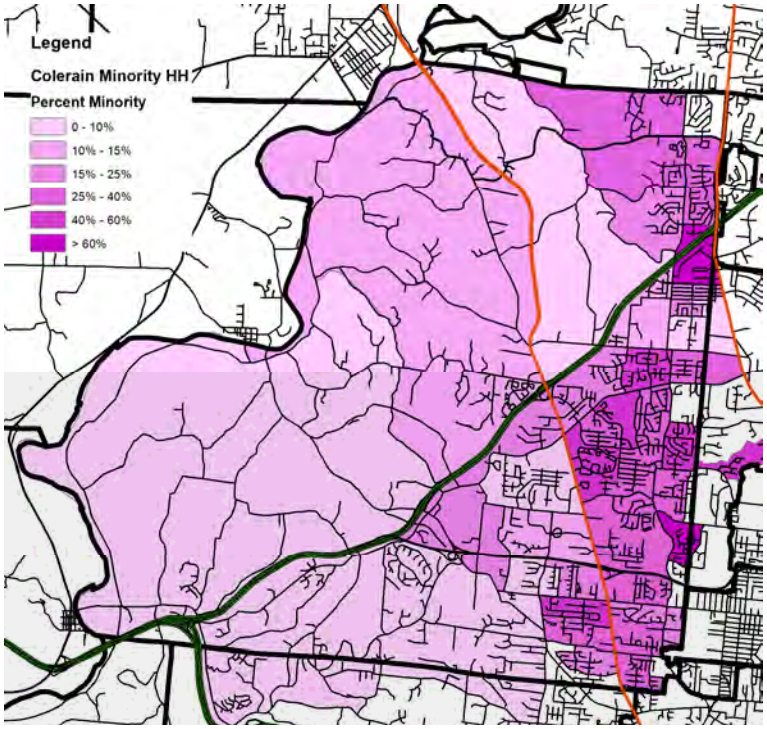

Fig 9: Concentration of Minority Population (US Census)

because of two factors: low-income causes the proportion of household income dedicated to energy cost to be disproportionately high, and the energy efficiency of To reduce the amount of energy used by households with high energy burden, investments must be made in improving the energy efficiency of the dwelling and equipment used in the home. Reducing the cost of energy can be done through aggregation deals and with income-based energy cost assistance programs. Colerain Township currently has an aggregation agreement

Residential Energy Efficiency

(Should this section be under CH3, Reduce Wasted Energy?)

Colerain Township contains a diverse housing stock that has developed over its history. While the Township does contain a significant number of older homes, the majority of homes were constructed beginning in the 1950s. Each housing development or neighborhood contains homes that were built during the same era that share similar characteristics. These characteristics help to define the energy efficiency of the home and dictate the type of improvements required to improve efficiency.

This section provides an analysis of the most important efficiency improvements recommended for certain eras of residential structures in Colerain Township.

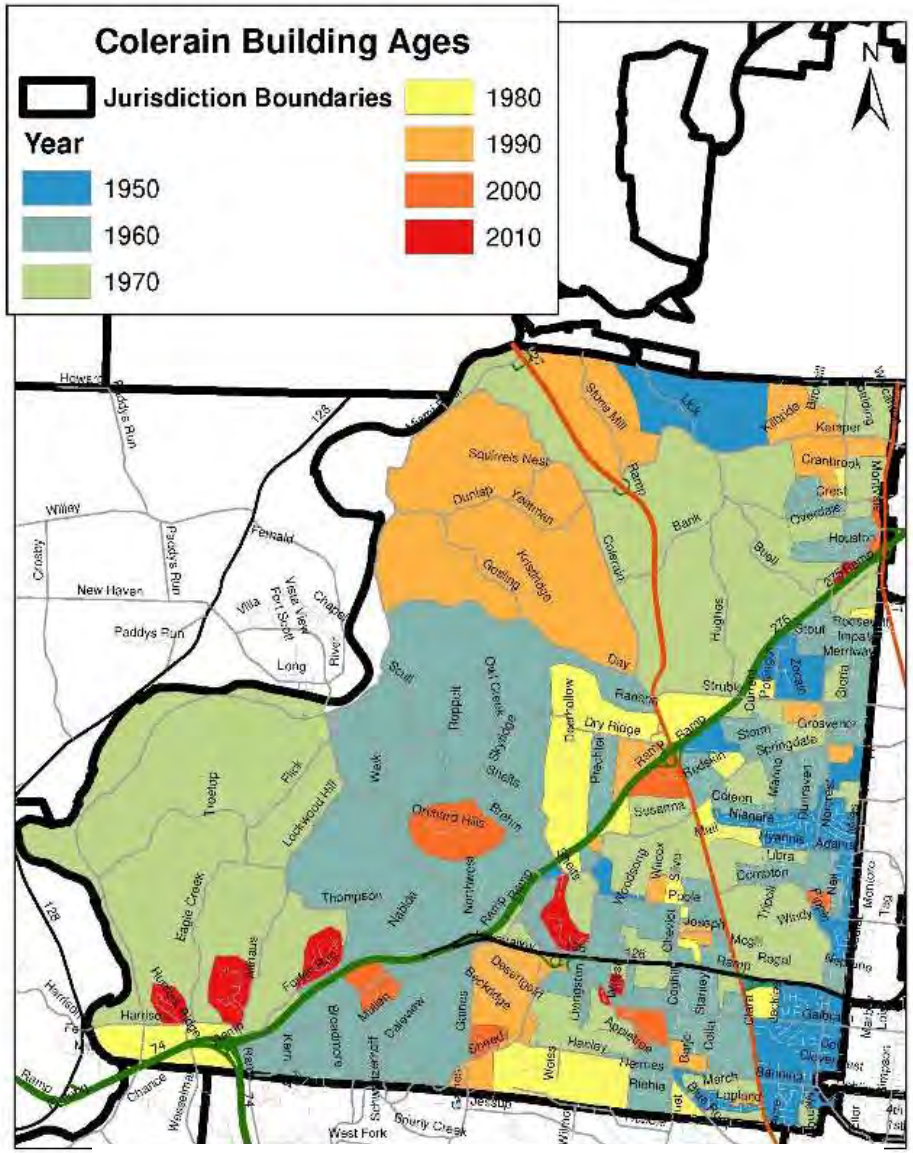

Fig 10: Predominant Building Age (OKI)

1950s and 1960s Era Homes

The end of World War II brought with it a housing boom that extended well into the 1950s. Large numbers of Cape Cod and ranch style homes were built during this period. The items listed below represent some of the major energy efficiency needs for homes built during the 1950s and 1960's:

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. 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: Home 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: Homes from this period often 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 should be properly air sealed.

1970s Era Homes

Energy efficient construction methods became more common during the 1970s due to the energy crisis. However, energy codes were in their infancy so there are plenty of improvements that can be made to homes from this period. The items listed below represent some of the major energy efficiency needs for homes built during the 1970s:

Basements and crawlspaces: Uninsulated rim joists allow cold air to enter the home. All exposed rim joists in

basements and crawlspaces should be insulated and air sealed to prevent air infiltration. Wall insulation is recommended in basements that are used as conditioned space. However, any moisture issues must be addressed prior to insulating. When a crawlspace is present, either the ceiling or walls should be insulated. Fiberglass insulation installed in the floor joists should be covered with an air barrier. A vapor barrier should also be installed on the floor of the crawlspace to prevent future moisture issues.

Attic insulation: Attic insulation became standard in the 1970s with most homes having R-19 insulation when constructed. Additional insulation may have been added over time. Ductwork in the attic should be properly insulated. Attics connected to living spaces should have the connecting wall insulated as well. ENERGY STAR recommends that attics in this region have insulation levels between R38 and R60.

Air sealing: Homes from this period often 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 should be properly air sealed.

1990s and Newer Era Homes

Energy efficiency became an integral component part of new homes construction methods in the early 2000s. Energy code requirements for insulated windows, higher R-rated insulation in the walls and ceilings, and a tighter building envelope began during this period.

Living spaces above garages: Many homes built during this period have living spaces located above the garage. If the living space is consistently cold in the winter, then the ceiling of the garage may not be insulated and sealed properly. Verify if insulation is present and install if needed.

Heating and cooling systems: Homes built during this period utilize a forced air system for heating and cooling. While the equipment has probably been replaced once, furnaces, air conditioners, or heat pumps that are older than 10 years should be replaced with an ENERGY STAR high efficiency unit. Duct work should be sealed with mastic or an aerosol sealant to reduce air leakage and improve performance. Duct work located in an attic or crawlspace should be inspected to ensure that they are still properly insulated

Rental Housing and Energy Efficiency

Rental housing poses a unique challenge to encouraging energy efficiency. Owners of rental housing often do not have an economic incentive to improve the energy efficiency of their buildings. This lack of incentive stems from the usual

arrangement of the renter paying the utility bill. Any extra investment in energy efficiency would not benefit the owner, but only benefit the renter through lower utility bills. Given this, the renter would be the one incentivized to invest in energy efficient improvements. Renters are not financially tied to the property and would not be comfortable investing significant money into the energy efficiency of a property given that such investments have lengthy payback periods. Also, renters would not be able to make some improvements without the permission of the owner.

This situation is called a split incentive. It is where one party (the landlord) is the owner of the building, has a presumably long-term interest in the property, and has the ability to make significant investments in the energy efficiency of the building; but, the benefits of those improvements go to another party (the renter) who is not inclined to make significant investments in a property they don't own and have only a temporary attachment to. This situation results in neither party having a sufficient interest in investing in the energy efficiency of these properties. As a consequence, encouraging the improvement of these properties pose a significant challenge.

Research into the topic of split incentives relating to energy efficiency in rental properties reveals three ideas to overcoming the problem:

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[2] 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

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

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

Literature review[3] 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.

[3] 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

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 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 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, Colerain 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.

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 Colerain Township. Duke maintains all of the electric and natural gas infrastructure delivering energy to homes and businesses.

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. Since 2012, Colerain Township has offered an electric aggregation program for residential and small commercial customers that reduces utility costs for property owners. As the local utility provider, Duke Energy adds distribution charges to the rate offered through the aggregation program. Electricity costs in Colerain are currently around $0.102 per kWh, which is below the 2017 average retail price for electricity in the Cincinnati region of $0.1143 per kWh.

Colerain Township also offers residential and small commercial customers the ability to participate in its natural gas aggregation program. Excluding fixed delivery charges, the 2017 average retail price for natural gas in the Cincinnati region was $0.655 per ccf. It is difficult to compare the rate Colerain Township customers pay through the aggregation program to the regional average due to the complex nature of natural gas distribution charges. The rate of participation in the Township's aggregation agreement is XX% for electric and XX% for natural gas. To date, the aggregation agreement has saved Township residents and businesses $XXX dollars. I'm not sure if these or similar stats are available for the township's aggregation agreement?

Alternative Heating Fuels

A small portion of homes in Colerain Township utilize energy sources other than electricity or natural gas for primary or supplementary heating. These alternative fuels include wood or wood pellets, propane, or heating oil.

The use of wood or wood pellets as a heating source has some advantages and disadvantages. Wood is considered a renewable resource that can be replenished after harvesting. It is also locally available for little or no cost – and can be a useful way to dispose of certain types of yard debris. Disadvantages of heating with wood include the bulky nature of wood and the need for lots of wood storage on-site. Also, keeping a wood furnace going involves some labor. Burning wood releases hazardous gasses (nitrogen oxide and carbon monoxide) and soot into the air, and can be a nuisance to neighbors in close proximity. Finally, after the wood is burned, ash is left which must be disposed of properly.

Homes that use propane or heating oil typically do so because a natural gas connection is unavailable. Propane and heating oil are more expensive fuels to heat with than natural gas.

These fuels are stored on-site in tanks which must be refilled periodically.

Recommendations

- Track the use of energy in Colerain Township over time to measure progress on other goals of this plan.
- Maintain electric and natural gas aggregation agreements to ensure residents and businesses have access to the lowest available energy prices.
- Improve pedestrian and bicycle infrastructure along and in the vicinity of Colerain Avenue to allow residents a safe option to use a more energy efficient mode of transportation like walking, biking, or public transportation in lieu of driving.

2. Energy's Impact on Land Use and Transportation

Urban Heat Island

The urban heat island effect is created by impervious surfaces, like roads, parking lots, and buildings, which retain heat from the sun's radiation. Then during the night, these surfaces release the retained heat, creating a localized area of higher temperature. Together, all of these localized "hot-spots" in the urbanized area create a dome of hot air over a metropolitan region. This phenomenon is important to energy because, in the summer, it causes air conditioners to run more often, and for longer periods of time due to the increased air temperatures.

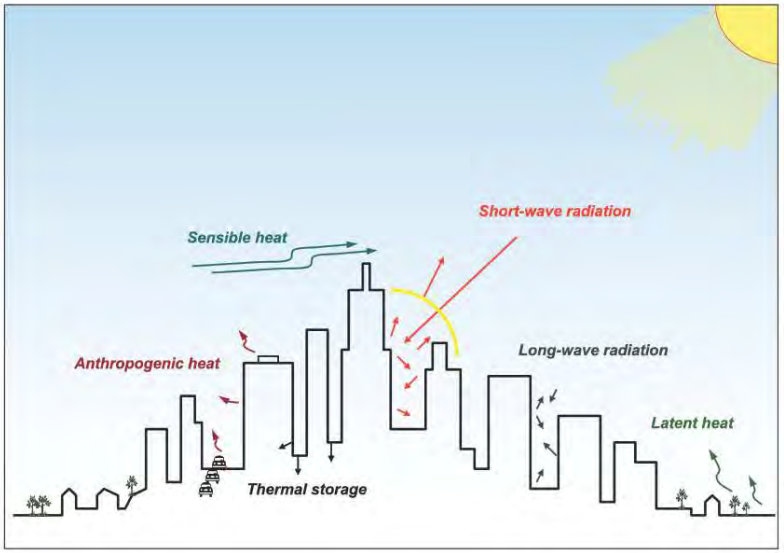

Fig 11: Sources of Urban Heat Island Effect (US EPA)

The map on the next page shows average land surface temperature which corresponds to intensity of the urban heat island effect. You can see the streets and parking lots show up in yellow to red tones indicating elevated surface temperatures. The hottest spots in the township are along Colerain Avenue where there are large parking lots and roofs at the mall, Stone Creek Center and at Dry Ridge Road.

Areas that have tree cover show cooler tones. In fact, the prevalence of tree cover in a community is found to be the

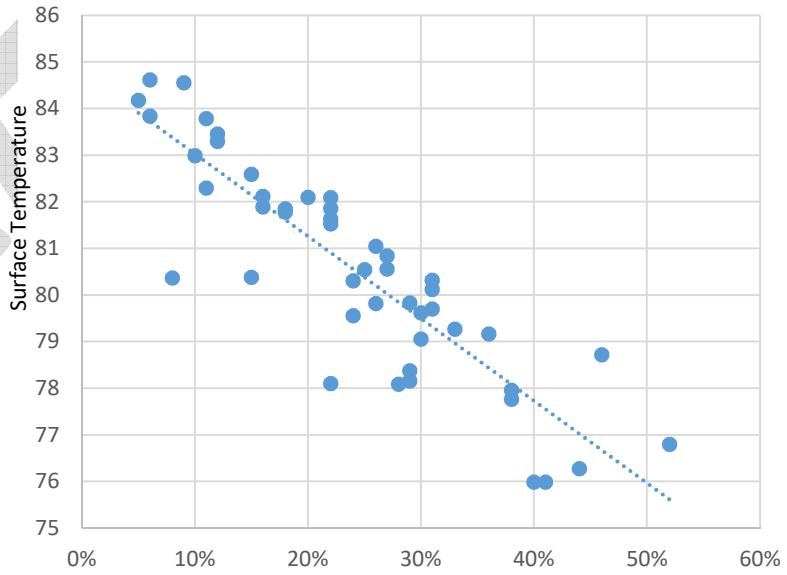

Fig 12: Relationship between Urban Heat Islands and Tree Cover (OKI)

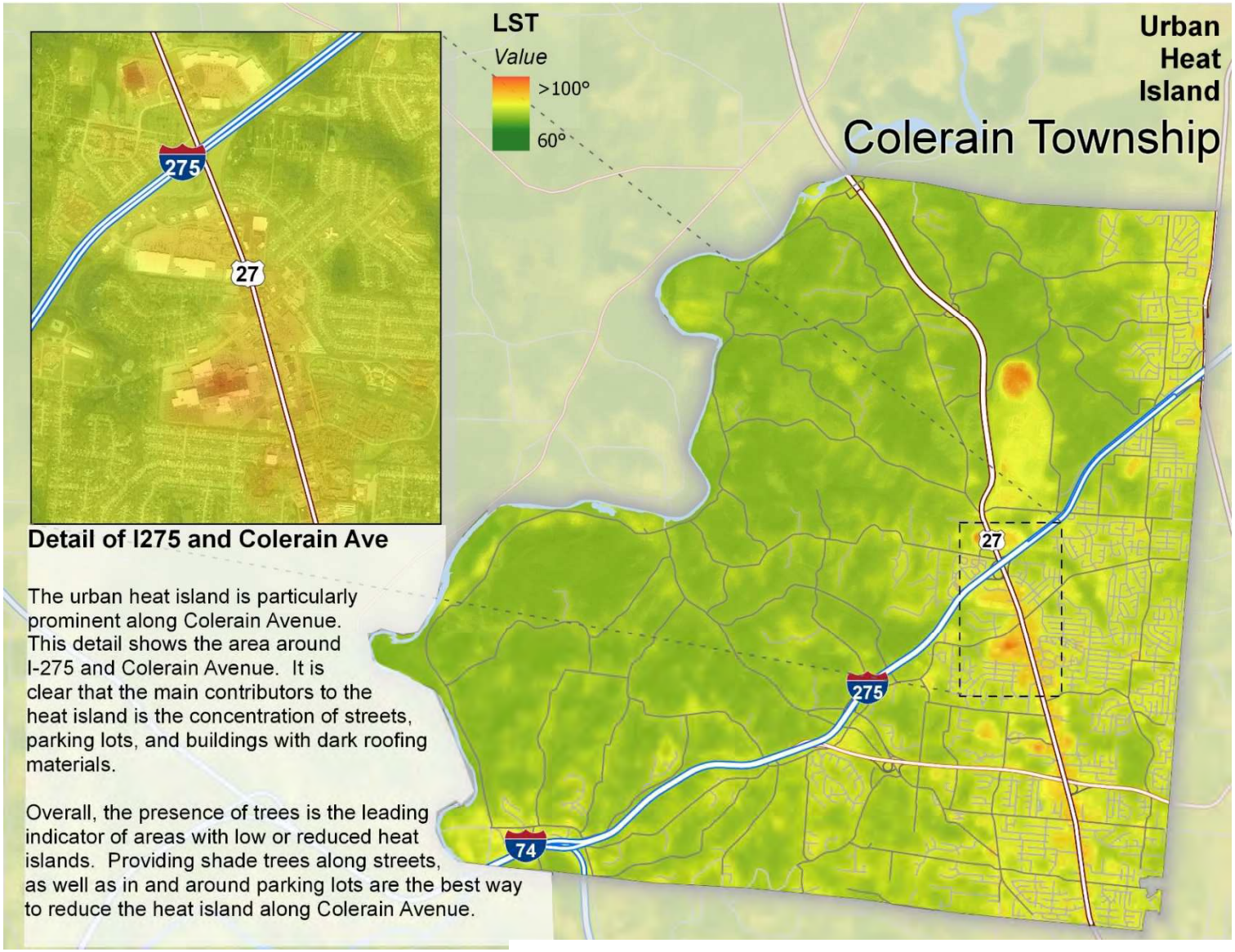

Fig 13: Heat Island Map of Colerain Township (OKI)

leading indicator of heat island effect. The chart below shows the clear relationship between the two.

The best ways to combat the urban heat island effect is by limiting the amount of large impervious surfaces like roofs, streets, and parking lots within the urban landscape; and by reducing the amount of heat absorbed by these features by using light colored coatings and providing as many deciduous shade trees as possible in their vicinity.

The township's Zoning Resolution requires "shade trees" in and around parking lots. However, the term shade tree is not defined in the code. Township staff reports that developers typically provide tree varieties that do not provide significant shading. The Zoning Resolution section regulating landscaping in parking lots should be revised to provide more emphasis on shading. Also, the term "shade tree" should be defined in the code to ensure that developments provide the intended result.

Energy Efficient Development Patterns

Development patterns can have a big impact on how much energy a community consumes. Structuring new development around some key principles, or by injecting these principles into existing development, can change travel patterns and relationships between land uses and activities. Travelling shorter distances or by different methods can reduce energy use.

The following factors are ways development patterns in a community can help reduce energy use:

Land Use Mix

Mixed use developments create areas where retail, office, entertainment, and residential uses mix—often sharing the same building. These developments are designed to be walkable and active, encouraging multiple activities and less driving. Mixed use districts often provide higher density residential, which supports businesses and transit. This reduces the need for driving and parking, and improves the diversity of housing types available in the community.

Pedestrian-friendly mixed use developments reduce energy use by encouraging walking, biking, or transit use over automobile trips.

Fig 14: Mixed use development

Connectivity

Transportation has a big impact on how much energy a community uses. Designing roads that not only accommodate cars, but also pedestrians, bikes, and busses provides options to use more efficient ways of getting around. One city bus can take as many as 38 cars off the road. A bike lane takes up 1/3 to ½ the space as a typical road lane. Walking and biking for short trips reduces energy use, reduces air pollution, and is a good form of exercise. Community development patterns, infrastructure (sidewalks, paths, and bike lanes), and access to transit support and promote these modes as viable alternatives to cars.

Fig 15: Pedestrian-friendly sidewalks and access to transit

Density and Pattern

Residential density near a major route like Colerain Avenue, paired with pedestrian connections, support the transportation options listed above. Also, street pattern can make walking in a community easier. The diagram in Figure 16 shows four types of residential street patterns. A study[4] modelled the impacts of pattern on mode choice and ease of travel by both walking and by car. Both post-war suburban

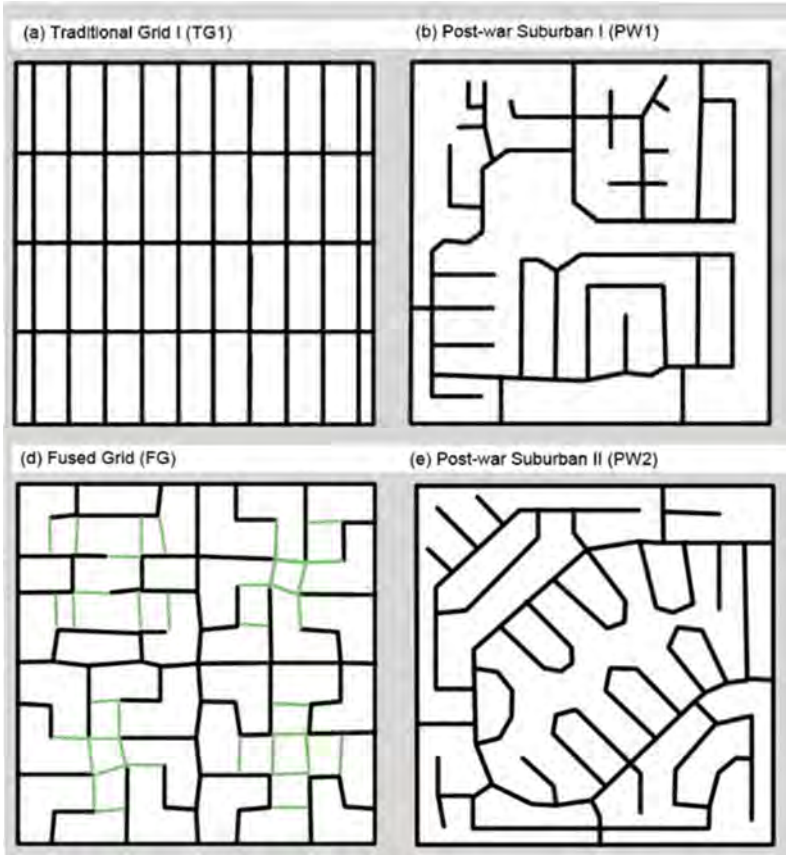

Fig 16: Residential street patterns (Jin, Xiongbing and Roger White)

[4] 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, Issue 5 (September 2012)

patterns prioritize car travel over pedestrians. The fused grid pattern was best at encouraging walking by providing more direct routes for pedestrians, while maintaining the suburban hierarchy of cul-de-sacs and collectors for cars.

Lawns are a large consumer of energy in our communities. Energy is used in mowing, treating and transporting the water that irrigates it, and to make the fertilizers that keep it green and healthy. Lawns are our nation's largest irrigated crop – three times larger than corn. Reducing the amount of space devoted to lawns can save a significant amount of energy.

Cluster developments reserve a significant portion of a development site as natural. These natural areas can encompass land features not conducive to development like hillsides and stream corridors. Home sites are concentrated on smaller lots than the permitted density would allow, but overall density remains at or below zoning requirements. With the smaller lots, there is less clearing of natural areas, less lawn to maintain, less roadway and utility infrastructure to maintain. Instead, the community gains areas of preserved woodlands, wetlands and riparian corridors.

Fig 17: Cluster developments save energy by reducing infrastructure and lawn

Diversity of Housing

There are a wide variety of jobs available in most communities—professional jobs, office jobs, retail, and service sector jobs that attract workers of all ages and income levels. A diverse range of housing is needed to house these workers and their families. Without diversity in housing, many workers will need to live outside of the community and commute from longer distances. Not only does this require more energy for commuting, it also can hurt businesses in the community by making it more difficult to attract and retain employees. Communities should offer a range of housing products that fit with the population and business composition of the community.

Community Schools

Schools spend a significant amount of their budgets and energy bussing students to and from school. Some communities use a Community Schools model, where schools form the hub of a neighborhood, and are located among residential development. Sidewalks or paths within the neighborhoods offer safe routes for children to walk or ride their bikes to school rather than being bussed. Also, playgrounds, athletic fields, and other school amenities can

more easily serve double duty as neighborhood amenities because of their proximity.

Fig 19: Walking school busses saves energy, prevents emissions, and is a healthy activity

Local Food Production

Much of the food we eat travels thousands of miles before it reaches the shelves at our local grocery store. All of this transportation takes energy. Locally grown or raised foods don't require as much energy because they don't travel as far. Communities can provide an outlet for local food through organizing a farmers' market. While it won't replace the need for groceries, a farmers' market will provide a small energy savings, at the same time supporting local agricultural businesses.

Recommendations

- Take steps to reduce the urban heat island effect prevalent along Colerain Ave.
    a. Include trees as part of any designed streetscape improvements along Colerain Ave.
    b. Update the requirement for trees in and around parking lots to require shade trees.
- Provide facilities and opportunities for travel in the Township by walking, bicycle or other non-motorized vehicle, or using bus/ transit to reduce the reliance on car trips.
    a. Work to provide safe and attractive sidewalks that connect residences, businesses, schools, parks, transit stops, and other destinations within the community.

b. Encourage residents to utilize transit options for commuting when possible.

- Promote new development that is energy efficient.
  a. Encourage multi-family and higher residential densities within walking distance from the Colerain Ave corridor, as appropriate, to promote walking and transit use and create a more lively and welcoming commercial district.
  b. Promote cluster development that makes efficient use of infrastructure while minimizing impacts to natural features and hydrology.
  c. Promote commercial developments that are pedestrian and bike friendly by reducing building setbacks, providing sidewalks along the street frontage, and providing clearly designated pedestrian walkways from the street.

3. Reduce Wasted Energy

Existing Programs to Boost Energy Efficiency

A number of programs exist to help homeowners improve the energy efficiency of their homes.

Duke Energy

Duke Energy 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.

State of Ohio ECO-Link Loan Program

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

People Working Cooperatively

People Working Cooperatively offers programs that provide weatherization assistance to homeowners and renters in Hamilton 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.

Zonolite Attic Insulation Trust

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

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. 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 generating 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. There are also some distributed generation sources that are based on combustion and produce emissions; such as municipal solid waste incinerators and gas turbine generators. Distributed generation improves the resiliency of the utility network because they lessen the chance of an event knocking out a critical portion of generating capacity on the grid. Finally, distributed generation, because it is located closer to the point of use, reduces line losses from the transmission of electricity over longer distances.

Each new home and business adds to the need for new generating capacity and distribution infrastructure, 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. 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.

Currently, nine properties are registered with the Public Utilities Commission of Ohio (PUCO) as certified solar facilities. Because property owners are not required to register with the PUCO, there are likely other homeowners throughout the Township that rely on solar energy as an additional source of electricity.

Colerain Township Efficiency Program Options

Colerain Township should consider developing an energy efficiency program for its residents that could be implemented at a low cost. Research has shown that residents view their local government as a trusted source for information. As a result, residents are more likely to take action when they receive energy efficiency guidance from the Township than from other sources.

Local governments across the country that have successfully created energy efficiency programs that can be used as models for the township. The following program ideas provide a way for the Township to connect residents with the resources and programs that can address their needs.

- Social media – Leverage the Township's social media presence and other communication channels to educate residents about simple steps they can take to improve their energy efficiency.
- Block grant funds – Community development block grant funds can be used to provide financial assistance or

incentives to low-income homeowners to complete energy efficiency improvements.

- Gamification App – There are several gaming applications available that allow homeowners to track their energy conservation activities. The Township can create competitions amongst residents or neighborhoods to encourage energy efficiency.
- Community partners – Work with churches, faith-based communities, and other community organizations to educate their members about the benefits of energy efficiency through workshop and guest speaker opportunities.
- Local school districts – Partner with Duke Energy to educate children in the local primary schools about energy efficiency. Northwest Schools have partnered with Duke Energy in the past to offer home energy savings kits.
- Energy Ambassadors – Identify residents that would like to serve as ambassadors in the community to spread the word about energy efficiency.
- House parties – Organize house parties in different neighborhoods where residents can learn about improving their home's energy efficiency.
- Workshops – Conduct workshops in low-income neighborhoods to educate residents about no-cost or low-cost improvements they can make that will reduce energy consumption. The improvements discussed would be geared towards renters as well as homeowners. It may also be possible to get home improvement stores located in the Township to donate materials to assist with the improvements.

One resource that could help the Township with the creation and implementation of many items listed above is the Get Efficient program offered by the Greater Cincinnati Energy Alliance (GCEA). The program works to remove many of the barriers that prevent homeowners from implementing energy efficiency projects. The program helps residents identify what improvements they need to make to their home, connects them with qualified contractors, and provides advice on financing options. Combining the services offered by the Get Efficient program with some of the other items listed above, would enable the Township to offer residents an energy efficiency program with minimal fiscal impact to the Township

Colerain Facility Assessment

In January 2017, Colerain Township had Four Seasons Environmental, Inc. conduct a Retro-Commissioning Study of three township owned facilities – the Administration Building, the Public Works Facility, and the Senior and Community Center. The study included a comprehensive review of the heating and cooling equipment and their related controls in the three buildings. The Township also completed a separate

lighting assessment in 2017 to identify the costs and benefits associated with LED lighting upgrades to the three buildings listed above. The Township moved forward with the recommendations contained in the lighting assessment and completed the project in 2017 resulting in a projected annual savings of $13,325.

Administration Building

The Colerain Township Administration Building, located at 4200 Springdale Road, is a 19,656 square foot office building constructed in 1997. The building's occupancy varies throughout the day due to its mixed uses. The portion of the building that houses the Police Department is in use 24 hours a day, 365 days a year while the administration offices are used during traditional business hours and the trustee chambers are used only for public meetings. This creates an interesting building dynamic that must be properly managed to maximize energy efficiency.

The study identified the following needs for the facility:

Automation system and controls: The existing automation systems and controls are over 20 years old and are no longer in production. In addition, the study determined that the existing equipment is not performing as expected. This may be due to programming errors that would need to be corrected by a trained expert or due to the condition of the equipment. If the issues are determined to be with system and controls, it would be extremely costly to obtain replacement parts. The study determined that it would be more cost effective to replace the aging systems than to try and keep them in operation.

Mechanical equipment: The existing mechanical equipment is reaching the end of its life cycle. The chiller as well as the hot and chilled water pumps will need to be replaced within the next 3-5 years. The study recommends developing a plan for the replacement of this 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. In addition, motors and dampers in the distribution system are also failing and will need to be replaced in the future.

Senior and Community Center

The Colerain Township Senior and Community Building, located at 4300 Springdale Road, is a 9,740 square foot building originally constructed in 1982. An addition was completed in 1994. The building occupancy varies throughout the day based on scheduled events and activities. Several residential furnaces and air conditioners are used to heat and cool the original portion of the building. The addition is heated using a hot water coil and cooled using traditional condensing units. There is not currently a central control system to efficiently manage the different systems throughout the building.

The study identified the following needs for the facility:

Controls: A thermostat is used to control each of the heating and cooling systems in the building. While the thermostats are programmable, they are either not programmed properly or are malfunctioning. This results in the building being kept at the same temperature at all times. The study recommends installing a centralized control system for the building and if possible, connecting it the control system for the administration building. At a minimum, the existing thermostats should be properly programmed to ensure that the building is not being heated or cooled when it is not occupied.

Mechanical equipment: The furnaces and air conditioners in the original portion of the building are reaching the end of their useful life. The air conditioners currently use R-22 coolant which is no longer produced and costly to replace if leaks are discovered. The study recommends replacing the units with high efficiency models that are properly sized for the building. The equipment servicing the new portion of the building was installed in 2012 and does not need to be replaced. It should be serviced on an annual basis to ensure that it is operating efficiently.

Public Works Facility

The Colerain Township Public Works Facility, located at 4160 Springdale Road, is a 37,564 square foot building constructed in 2003. The building consists of approximately 30,000 square feet of open garage bays and approximately 7,000 square feet of offices.

The study identified the following needs for the facility:

Mechanical systems: The office portion of the facility relies on residential natural gas furnaces and air conditioners for heating and cooling. These systems are original to the building and are reaching the end of their useful life. The air conditioners currently use R-22 coolant which is no longer produced and costly to replace if leaks are discovered. The study recommends replacing the units with high efficiency models that are properly sized for the building. If possible, commercial grade air handlers should be used to ensure proper distribution throughout the system.

Controls: Individual thermostats are used to control each of the heating and cooling systems in the building. The thermostats are not programmable and cannot be tied to a central control system. This results in the building being kept at the same temperature at all times. The study recommends installing a centralized control system for the building.

Radiant heaters: Large natural gas radiant heaters are used to heat the garage bays. The heaters can be controlled by a centralized system. While the existing heaters are in good condition, they should be replaced with more efficient models when they are no longer operational.

Improving Energy Efficiency

The retro-commissioning study revealed that there are several ways to improve the energy efficiency of buildings owned by Colerain Township. One improvement that each of the buildings have in common is the need for an improved control system to operate the various heating and cooling systems. This improvement can range from replacing the advanced centralized system in the administration building to installing and programming thermostats in the public works facility and the senior and community center. Properly controlling and monitoring the heating and cooling systems can result in significant energy savings and reduce operational costs. The study identified the following savings associated with updating and properly programming the building controls and automation systems.

Building	Savings Potential from Improved Controls
Administration Building	$29,818
Senior and Community Center	$12,873
Public Works Facility	$12,123
TOTAL	**$54,814**

Each of the facilities also have mechanical equipment that is reaching the end of their useful life. The Township should plan for their replacement over the next few years. Given the age of the equipment in the administration building, it is in the Township's interest to plan for a scheduled replacement rather than waiting until the unit fails. This will reduce costs and losses in productivity due to the replacement process. The smaller residential units in the other facilities will pose fewer challenges when it comes to replacement, but they should still be replaced before failure to minimize disruptions and costs. The improvements to the mechanical systems identified during the assessment would result in a significant investment into the facilities at a relatively low ROI. However, these systems are essential to the operation of the facility and will need to be replaced at some point in the future.

Recommendations

- Establish an Energy Efficiency Program tailored to the needs of Colerain Township's residents and businesses
  a) Work / partner with the Greater Cincinnati Energy Alliance to identify existing and new initiatives targeted to encourage Colerain residents and businesses to save energy.
  b) Devise a plan for messaging and engagement around driving awareness and participation in the township energy efficiency program.
- Continue to evaluate energy efficient improvements to Township Facilities for operational benefits and return on investment
  a) Include replacement of Administration Building HVAC equipment in capital improvement plans

4. Energy Resiliency

Resiliency is how susceptible a community is to threats, and how capable that community is 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[5].

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

Fig 19: Maintenance is key to a resilient energy grid

[5] Electric Power Research Institute (www.epri.com)

required between local responders and utility crews on dealing with downed trees or accident scenes.

The Hamilton 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. Colerain coordinates with the Hamilton County EMA and is equipped to perform the necessary functions in the event of a significant energy outage.

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). 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.

Resiliency in Colerain Township

Much of the electric infrastructure in Colerain is located above ground on utility poles that run along roadways. These powerlines are susceptible to weather and damage from ice, falling trees, or car accidents. Temporary outages are not an uncommon occurrence, yet the sudden inconvenience of losing power can be impactful on residents and businesses. In some cases, the loss of power can pose an immediate health risk to those who rely on certain medical equipment.

Duke Energy is responsible for maintaining the energy utility infrastructure in Colerain Township. The township should work with Duke Energy to address any locations that show repeated disruption to identify remedies to improve the resilience of the utility network.

Locating utilities underground shields the network from most causes of damage, and results in a significant improvement in resiliency. This also removes unsightly utility poles from the roadside. The cost of moving overhead utilities underground is quite significant and is not feasible to implement township wide. However, underground utilities should be considered as part of a significant infrastructure project along Colerain Avenue.

Recommendations

- Ensure that township facilities are prepared to serve necessary functions in the face of a disruption in electricity or widespread emergency
    a) Ensure backup power is available for communications and other necessary equipment
- Work with Duke Energy to address any areas prone to outages that the township is aware of

5. Meet Future Demands

It is important that the Township's energy infrastructure be able to accommodate its future needs. Future development and technologies can require service that the existing system is not equipped to provide.

Capacity and Infrastructure

Can existing energy infrastructure accommodate expected or planned future growth? Certainly, different uses have different energy needs, but all new developments require access to adequate energy infrastructure and capacity.

Residential growth in Colerain Township has remained steady over the past five years, averaging XX new single family homes and XX new multi-family units per year. Much of the remaining land for residential development is hilly with less desirable road access. With low potential for the development of larger-scale subdivisions, it seems unlikely the township will see a strong uptick in homebuilding in the next several years. Rather, it should be expected most residential growth will occur as infill and small-scale subdivisions. This type of development will not stress the capabilities of the existing energy grid.

Commercial development in Colerain has shown an uptick over the past five years, increasing from XXX SF in 2012, to XXX SF in 2017. There are some notable developments happening, such as the new Kroger at Springdale, the Rumpke Headquarters, and the Duke Energy facility in Groesbeck. Commercial development continues to be focused on the Colerain Avenue corridor.

The scale and nature of future development in the township will be outlined in the Land Use Element. Once that element is complete, it is important that township staff meet with their representative from Duke Energy to analyze how specific components of the plan intersect with the current energy grid. Duke representatives can identify needed improvements, if any are necessary based on planned future development.

The general expectation is that future development in Colerain Township can be accommodated by the existing electric and natural gas infrastructure.

New Energy Technologies

There are a handful of new energy related technologies on the horizon that communities should be aware of. At present, none of these technologies are at a point where they warrant any immediate action from local governments, but communities should continue to watch development for potential opportunities and impacts.

Plug-in Electric Vehicles

Plug-in electric vehicles (PEVs) are perhaps the most imminent emerging energy technology today. These types of vehicles have been available on the market for five years, and in that time, sales have grown exponentially. As robust as this growth sounds, electric vehicles still only account for 1.5% of new car sales.

PEVs run on batteries, and are recharged by plugging them in at charging stations at home, or available stations in the community. As the number of PEVs on the road grows, the need for charging stations will also grow. The US Department of Energy currently lists 22,143 publicly available charging stations in the United States and Canada. There are three charging locations in Colerain Township with a total of six charging stations.

- Walmart, 10240 Colerain Ave. – 3 stations
- Jeff Wyler Nissan, 8680 Colerain Ave. – 2 stations
- McCluskey Automotive, 9024 Colerain Ave. – 1 station

One of the key decisions a community will face regarding PEVs is regarding the availability of charging stations in the community. A community can choose to let the market dictate the prevalence of publicly available charging stations. Currently, due to the relative lack of public charging stations, most owners install a charging station at home. However, this option is not available to those who live in most apartments of condominium developments. To address equity issues related to access to PEV technology, a community might choose to require a certain number of charging stations in the same way many regulate the number of parking spaces provided.

Smart Grid

The electric grid in the United States was built in the 1890's and improved upon as technology progressed. Throughout all this time, the electric grid still functions much the same way as it did in the 19th Century. The Smart Grid is about using real-time data to actively manage power along the grid to improve reliability, efficiency, and control. Some specific benefits of Smart Grid technology are:

- More efficient transmission of electricity
- Quicker restoration of electricity after power disturbances
- Reduced operations and management costs for utilities, and ultimately lower power costs for consumers
- Reduced peak demand, which will also help lower electricity rates
- Increased integration of large-scale renewable energy systems
- Better integration of customer-owner power generation systems, including renewable energy systems
- Improved security

Hydrogen Power

Hydrogen as an energy source is much further away from practical reality than PEVs or the Smart Grid, but it could be unparalleled in its ability to transform the energy landscape. Hydrogen is the most abundant element in the universe and here on earth, but it doesn't naturally occur by itself – it's always attached to other elements. Hydrogen is also one of the most energy dense substances known. The key to using hydrogen in a sustainable way is via the hydrogen fuel cell. A hydrogen fuel cell combines pure hydrogen with oxygen in the air. This process creates electricity. The byproduct of this reaction is pure water.

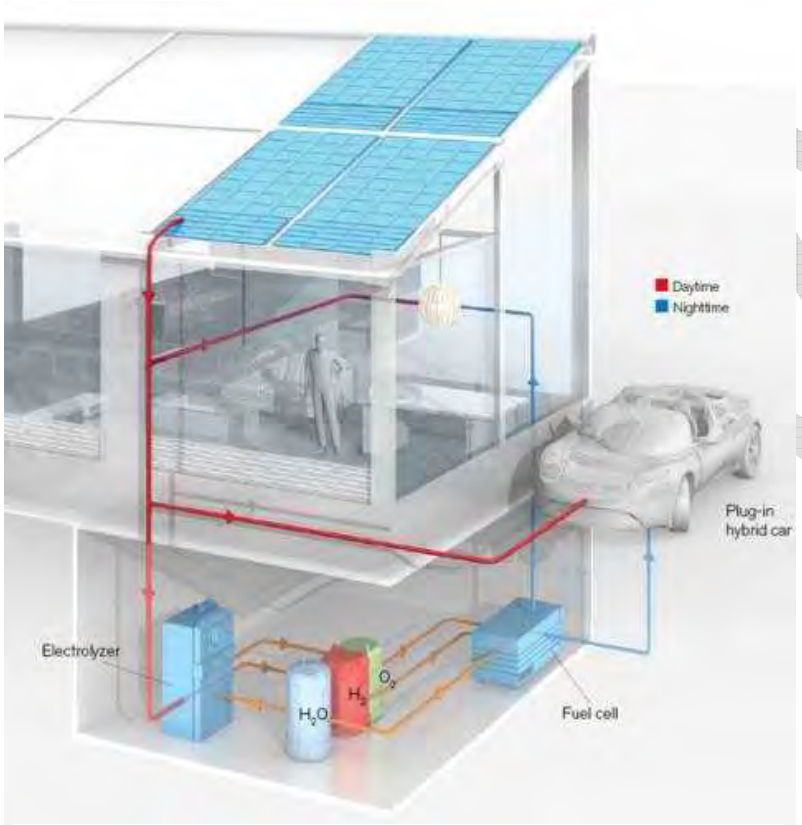

Fig 20: Home hydrogen power station (making-hydrogen.com)

Today, use of hydrogen as an energy source for our homes and transportation remains expensive and impractical. Hydrogen production is inefficient, mostly reliant on fossil fuels, and is polluting. Also, we currently lack infrastructure to enable safe transportation of hydrogen to homes, businesses, and future hydrogen fueling stations.

However, the vision for the future of hydrogen is about using local renewable energy, like solar, hydro, or wind, to generate hydrogen that can be stored and used in fuel cells that power individual buildings and vehicles. In this scenario, each home, business, and vehicle would contain its own compact power station that operates efficiently, reliably, and completely pollution free. There will be no energy grid and no centralized electric generation.

It's easy to envision how transformative this potential future would be to communities. Not only would the miles of utility poles and wires be obsolete, but a use, building, or home could be located anywhere. No regard to connections to "the grid" would be necessary. Access to utilities play a very influential role in how communities develop. If those connections and centralized systems were no longer necessary, what changes would be possible? Hydrogen power offers the potential of finding out.

Recommendations

- Availability of energy is a significant factor in the viability of proposed development.
    a) Meet with Duke Energy representatives to discuss areas of planned future development as the township develops a Future Land Use Plan.
- Continue to be aware of emerging technologies that promise to affect energy use, delivery, or community development patterns.
    a) As electric car ownership grows, be aware of equity issues which might be created by lack of access to charging stations.
    b) In the future, consider using zoning requirements to address any equity issues that emerge.

6. Improve Access to Renewable Energy

A topic that is attracting more awareness is not how much energy is used or how it is delivered to homes and businesses, but how that energy is created. The majority of energy used in the Midwestern United States is derived from fossil fuels. Electricity is generated in coal or natural gas power plants. These fuels have been used because they are plentiful and relatively cheap. However, producing energy this way also generates air pollution and releases large amounts of greenhouse gas. This not only contributes to the broad issue of climate change, but more importantly, has specific impacts on public health right here in our region. In the American Lung Association's annual *State of the Air* report, Cincinnati ranked 27th for number of high ozone days, and 18th for annual particle pollution out of over 200 metropolitan areas.

The local air pollution has a very real impact on public health in the region. A University of Cincinnati and Cincinnati Children's Hospital study links the region's poor air quality with the increased prevalence of birth defects in the region.[6] Also, a separate Children's Hospital survey finds that area children are more likely to be diagnosed with asthma.[7]

Renewable energy offers clean, sustainable, and increasingly cost-competitive sources of energy. The two renewable sources prevalent locally are solar and, to a lesser extent, wind.

Solar Energy

While most think of photovoltaic (PV) arrays – turning sunlight into electricity – when using the term solar energy, there is a number of different technologies that fall under that term. There is passive solar, where a building is designed to utilize sun exposure to maximum benefit through use of carefully placed windows, overhangs, masonry materials, active shutters, and landscaping. These elements allow sunlight to passively warm the building interior in winter, but adjust to block out the sun's heat in summer. Solar water heating can be used to provide hot water for bathing and washing. The hot water sometimes is also circulated through radiators to heat the building. Solar energy has even been used by some to cook food using a solar oven.

[6] Cincinnati Children's Hospital Medical Center. "Exposure to air pollution just before or after conception raises risk of birth defects." ScienceDaily. ScienceDaily, 11 December 2017. www.sciencedaily.com/releases/2017/12/171211090755.htm

[7] Cincinnati Children's Hospital Medical Center. "Child Well-being Survey". Cincinnati Enquirer, 25 June 2018. www.cincinnati.com/story/news/2018/06/25/child-health-asthma-adhd-more-common-greater-cincinnati-kids/725592002/

Solar energy is generated by infrared radiation from the sun. It is renewable and emission-free energy at the point of use or generation. Solar electricity is generated by photovoltaic panels, either stand-alone, or mounted to the rooftops of buildings, and then either used on-site or sent out on the electric grid. Excess electricity sent out on the grid can lower the building owner's utility bill through net metering. Solar energy has been on the market for decades, but only recently gained widespread popularity with lower costs. Ten years ago, the cost of a solar panel installation was $8.82 per watt. Today, a similar installation would cost $3.14 per watt. These price declines have shortened the payback on a solar PV system.

Fig 21: Roof-mounted solar panels.

Solar energy can improve resiliency because the generation of electricity is located on-site. Disruptions to the electric grid or brownouts caused by excessive peak demands can leave whole communities without power. Solar energy can be used by individual homeowners and businesses as a means of backup power or heating. There are some precautions necessary because excess electricity sent out on the damaged grid poses a serious risk to utility workers repairing damage to the electric grid.

Solar energy can reduce the extra generating capacity required to serve new development in fast growing regions. Each new house or business adds to the amount of energy required to power a community. If centralized power plants in the region are operating at capacity, the added power requirement would require adding more generating capacity in the form of a new power plant. That's expensive! Solar energy is a way to incrementally add capacity in a relatively cost effective way as development happens, without burdening existing rate-payers.

What can a community do to help their residents and businesses take advantage of solar energy's potential? Here are several steps and best practices a community can take:

Launch a Solarize Campaign

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.

A solarize campaign typically provides a limited time offer with tiered pricing structures that customers can take advantage of, lowering customer acquisition costs. It can help installers reduce their lead times which lowers the cost for local residents. Finally, solarize campaigns Increase awareness of solar energy and financing options, helping to build sustained growth of the local solar market.

Locally, the Greater Cincinnati Energy Alliance, a non-profit, runs a solarize campaign.

Engage Homeowners Associations

Homeowners associations often include stricter aesthetic and architectural restrictions and requirements that, sometimes, prohibit residents from installing solar systems on their properties. Several homeowners associations across the United States have developed architectural guidelines to allow for solar installations while preserving the aesthetic character and causing minimal inconvenience for neighbors. Homeowners associations should be engaged and encouraged to develop solar friendly policies.

Addressing Solar in the Zoning Code and other Local Ordinances

Zoning codes, solar ordinances, and comprehensive plans can establish the vision and goals for solar development within a community. They can establish solar as "by-right" or "as-of-right" and set forth clear guidance for the development of rooftop, ground-mounted, and large-scale solar systems, removing major procedural barriers by creating a precise, regulatory pathway for solar-energy development. Policies can include integrating solar into comprehensive planning documents and subdivision regulations, modifying aesthetic requirements, and encouraging solar-ready construction.

The Colerain Township Zoning Resolution permits solar panels "as of right" in any zoning district as an accessory use. This use is subject to specific regulations and requires the issuance of a Zoning Certificate. This benefits residents and businesses looking to add solar power by establishing straight forward regulations and making the process of gaining approval simple and relatively quick.

Creating a Permit Checklist

A permit checklist can help guide an installer or other interested party through the permitting process by clearly stating all of the necessary types of plan reviews and required permits for a solar installation. A basic permit checklist would outline the sequential steps of the permitting process while a more comprehensive checklist would also include applicable standards for each step in the review process. The checklist should include all of the information that a jurisdiction would require in order to permit a solar installation. The checklist content will likely vary according to local context, such as density of development or weather conditions (such as snow or ice that can add weight to roof loads). Jurisdictions should review their own local regulations and guidelines should distinguish procedural differences between residential and commercial installations.

Additional details about how a community can help ease the process for residents and businesses who want to install solar can be found at solar.oki.org.

Wind Energy

Wind is another renewable, no-emission source of energy. Wind energy is harnessed by wind turbines that generate electricity. While wind turbines come in many sizes, even some small enough for use on residential properties, most wind power is generated at the utility scale using a distributed array of turbines referred to as a "wind farm". Wind farms are a common sight in rural areas of the Midwest and Great Plains.

Like solar, wind energy is scalable at relatively low costs compared to traditional power plants. Also, as dispersed generation, a system of wind farms are more resilient than a single power plant even though it still relies on the grid to bring the power to homes and businesses.

A particular issue with wind power is that it's only really viable in certain areas. The obvious fact is it takes wind (lots of wind) to make wind power. Due to the hilly terrain and relatively generous tree cover, wind power doesn't have much viability in the Greater Cincinnati area. Within Colerain Township, there is only one location that might hold any promise for wind power. That spot would be the top of the Rumpke landfill. It is the highest point in southwest Ohio and is free

Fig 22: Utility-scale wind farm

of trees. The amount and consistency of available wind increases with elevation. Also, the presence of buildings and trees creates turbulence in straight line winds that reduces the efficiency of a wind turbine.

For these reasons, residential scale wind turbines are not popular in urban or suburban areas. To be efficient at harnessing prevailing winds, a wind turbine must be positioned at least double the height of surrounding buildings and trees. This height is usually 100 – 150 feet. Zoning requirements usually don't allow structures of this height. Additionally, wind turbines generate soft, but discernable

noise. This noise could create issues with neighbors in built-up areas.

While conditions in Colerain Township do not favor wind energy, the township is prepared with specific regulations addressing both large and smaller, residential scale wind turbines. Like solar, wind powered systems are listed as an accessory use "as of right" subject to specific limits and regulations in the Zoning Resolution. Again, having the zoning requirements specifically listed and approvals granted without necessarily going to a zoning board makes wind power more accessible to residents and businesses that want to take advantage of it.

Property Assessed Clean Energy (PACE)

Property Assessed Clean Energy (PACE) is a financing mechanism for energy efficiency upgrades or renewable energy installations for commercial properties (including apartment buildings with 5 or more units). These improvements can range from insulation, heating and cooling equipment, to solar or wind power generation.

The financing for the improvements are paid back through a special assessment on the property tax bill. Payback periods typically range from 5 to 25 years. The financing is tied to the property, and not the owner or occupant. This offers a measure of certainty to investors that the loan will eventually be repaid. As a consequence, interest on the loan is relatively low and typically, no collateral is required. These features expand the reach of PACE funding to those who might not be able to use traditional financing mechanisms.

(INSERT TEXT ABOUT SPECIFIC OHIO RULES ESTABLISHING A PACE DISTRICT AND COLERAIN'S EFFORTS IN DOING SO)

Recommendations

- Remove barriers preventing residents and businesses from utilizing solar energy.
    a) Ensure the township zoning code continues to allow solar energy equipment "as of right" with defined regulations. This makes the system design and permitting process straightforward and quick.
    b) Engage with homeowners associations in the township about improving approval procedures for solar installations to help make the process quicker and more predictable for homeowners seeking solar improvements.
- Establish a PACE district in Colerain Township to allow businesses to take advantage of the financing tool.
    a) If necessary, partner with adjacent communities to achieve the minimum three projects to establish a PACE district.

Recommended Goal	Objective	Timeframe	Partner(s)
Track the use of energy in Colerain Township over time to measure progress on other goals of this plan.		Continuous	Duke Energy
Maintain electric and natural gas aggregation agreements to ensure residents and businesses have access to the lowest available energy prices.		Continuous	
Improve pedestrian and bicycle infrastructure along and in the vicinity of Colerain Avenue to allow residents a safe option to walk, bike, or use public transportation in lieu of driving.		Mid - Long	OKI, ODOT
Take steps to reduce the urban heat island effect prevalent along Colerain Ave.	Include trees as part of any designed streetscape improvements along Colerain Ave.	Mid - Long	
	Update the requirement for trees in and around parking lots to require shade trees	Short	
Provide facilities and opportunities for travel in the Township by walking, bicycle or other non-motorized vehicle, or using bus/ transit to reduce the reliance on car trips.	Work to provide safe and attractive sidewalks that connect residences, businesses, schools, parks, transit stops, and other destinations within the community	Mid - Long	Schools, Churches, Businesses, Neighborhoods, OKI
	Encourage residents to utilize transit options for commuting when possible	Short - Mid	Metro

Recommended Goal	Objective	Timeframe	Partner(s)
Promote new development that is energy efficient	Encourage multi-family and higher residential densities within walking distance from the Colerain Ave corridor, as appropriate, to promote walking and transit use and create a more lively and welcoming commercial district	Short	
	Promote cluster development that makes efficient use of infrastructure while minimizing impacts to natural features and hydrology	Short	
	Promote commercial developments that are pedestrian and bike friendly by reducing building setbacks, providing sidewalks along the street frontage, and providing clearly designated pedestrian walkways from the street	Short	
Establish an Energy Efficiency Program tailored to the needs of Colerain Township's residents and businesses	Work / partner with the Greater Cincinnati Energy Alliance to identify existing and new initiatives targeted to encourage Colerain residents and businesses to save energy	Short - Mid	Greater Cincinnati Energy Alliance
	Devise a plan for messaging and engagement around driving awareness and participation in the township energy efficiency program	Short - Mid	Greater Cincinnati Energy Alliance
Continue to evaluate energy efficient improvements to Township Facilities for operational benefits and return on investment	Include replacement of Administration Building HVAC equipment in capital improvement plans	Short	

Recommended Goal	Objective	Timeframe	Partner(s)
Ensure that township facilities are prepared to serve necessary functions in the face of a disruption in electricity or widespread emergency	Ensure backup power is available for communications and other necessary equipment	Short - Mid	
Work with Duke Energy to address any areas prone to outages that the township is aware of		Continuous	Duke Energy
Availability of energy is a significant factor in the viability of proposed development	Meet with Duke Energy representatives to discuss areas of planned future development as the township develops a Future Land Use Plan	Short	Duke Energy
Continue to be aware of emerging technologies that promise to affect energy use, delivery, or community development patterns	As electric car ownership grows, be aware of equity issues which might be created by lack of access to charging stations	Mid	
	In the future, consider using zoning requirements to address any equity issues that emerge	Mid	
Remove barriers preventing residents and businesses from utilizing solar energy	Ensure the township zoning code continues to allow solar energy equipment “as of right” with defined regulations. This makes the system design and permitting process straightforward and quick	Short	
	Engage with homeowners associations in the township about improving approval procedures for solar installations to help make the process quicker and more predictable for homeowners seeking solar improvements	Short - Mid	HOAs

Recommended Goal	Objective	Timeframe	Partner(s)
Establish a PACE district in Colerain Township to allow businesses to take advantage of the financing tool	If necessary, partner with adjacent communities to achieve the minimum three projects to establish a PACE district	Short - Mid	Adjacent communities